sCO2

5th International

SUPERCRITICAL CO_2 POWER CYCLES

SYMPOSIUM

San Antonio • Texas • March 28-31, 2016

U.S. DEPARTMENT OF ENERGY | NETL

SwRI®

SOUTHWEST RESEARCH INSTITUTE

SYNOPSIS

The 5th International Supercritical CO_2 Power Cycles Symposium is a technical meeting organized and designed by industry, academia, and government agencies to advance the development of technology for power cycles with supercritical carbon dioxide (CO_2) as the working fluid. Every two to three years, researchers, industry partners, and end users meet to learn about advancements in the field, discuss priorities, and establish a critical path for technology development. The perspective gained will allow researchers to better coordinate work and allow participants greater insight into the overall direction of this technology. The first symposium was held at the Massachusetts Institute of Technology in 2007, the second was held at Rensselaer Polytechnic Institute in 2009, and the third was held at the University of Colorado at Boulder in 2011. The 2014 symposium was held in Pittsburgh, PA. The technical papers and presentations for the 2016 symposium will be available online following the symposium, archived alongside those of the previous workshops. The goal of the symposium is to facilitate peer-to-peer knowledge sharing and collaboration across organizational and company boundaries that will create a network of expertise and accelerate advancements in the field.

TECHNOLOGY SUMMARY

Carbon dioxide is an extremely efficient working fluid in its supercritical state. Power cycles based on SCO_2 as the working fluid, instead of steam, have the potential for higher thermal efficiencies with lower capital cost when compared to state of the art steam-based power cycles. Taken together, the unique features of SCO_2, which include having a small environmental footprint, lower water use, fuel/heat source flexibility, and the potential for lower capital cost – along with multiple performance benefits that result from higher efficiency (e.g. lower fuel use, reduced emissions, less cooling water) are creating broad interest in the SCO_2 power cycle. Additionally, this power cycle is synergistic with a wide spectrum of heat sources—the SCO_2 cycle can be configured to operate with a variety of heat sources including nuclear, fossil fuel, and renewables such as concentrating solar and geothermal. The high power density characteristic of the cycle tends to amplify benefits in each application. Greater thermal efficiency means more power can be produced per unit of fuel which ultimately reduces power plant operating costs, payback periods, and emissions. Additionally, carbon dioxide is an attractive working fluid because its critical pressure and temperature are reasonable to work with, it is non-toxic, it can be easily obtained, and it is inexpensive. And finally, heat engines that use supercritical CO_2 as a working fluid are smaller and less complex than heat engines that use many traditional working fluids including superheated steam, helium, and organic fluids. A main purpose of this symposium is to help identify and resolve technical and cost issues in the development of this technology.

ORGANIZING COMMITTEE

Symposium Co-Chairs:

Klaus Brun, Southwest Research Institute, **Rich Dennis**, U.S. Department of Energy, National Energy Technology Laboratory

Ganesan (Subbu) Subbaraman / Gas Technology Institute
Robert Fuller / Barber-Nichols
Eric Clementoni / Bechtel Marine Propulsion
Steve Wright / Critical Energy
Rene Pecnik / Delft University of Technology
Thomas Soulas / Dresser-Rand
Tim Held / Echogen
David Thimsen / EPRI - Electric Power Research Institute
Max Peter / General Electric
Renaud Le Pierres / Heatric
Voramon Dheeradhada / General Electric
Jeong Ik Lee / KAIST
Craig Turchi / National Renewable Energy Laboratory
Dereje Shiferaw / Heatric
Jim Pasch / Sandia National Laboratories
Klaus Brun / Southwest Research Institute
Lalit Chordia / Thar Energy
David Sánchez / University of Seville
Walker Dimming / NET Power
Pete Friedman / Newport News
Richard Dalton / Leonardo Technologies Inc.
Rich Dennis / US DOE - Office of Fossil Energy NETL
Steve Reeves / US DOE - Office of Nuclear Energy
Gary Jesionowski / Leonardo Technologies Inc.
Paul Murray / Areva
Joe Stekli / DOE
Matt Usher / American Electric Power
Karl Wygant / Samsung Techwin

AGENDA AT-A-GLANCE

5th International Supercritical CO_2 Power Cycles Symposium

FINAL - March 28 - 31, 2016 -- AGENDA AT-A-GLANCE

Day/Time				
Monday, March 28th				
Mon, 12:00 - 6:00 pm	Pre-Conference Tutorial Sessions at Southwest Research Institute			
Mon, 5:00 pm	Registration (Terrace Room Foyer)			
Mon, 6:30 pm	Industry Sponsored Reception - Speaker #1 Jeremy Fetvedt, 8Rivers (Terrace Room)			
Tuesday, March 29th				
Tues, 7:00 am	Continental Breakfast / Registration (Salon Del Ray Foyer)			Posters Displayed
Tues, 8:00 am	Welcome - Klaus Brun, Southwest Research Institute / Richard Dennis, NETL (Salon Del Rey)			
Tues, 8:10 am	Mayor's Welcome - Ivy Taylor (Salon Del Rey)			
Tues, 8:25 am	Keynote Speaker #2: Adam Hamilton, Southwest Research Institute Keynote Speaker #3: Matt Usher, American Electric Power (Salon Del Rey)			
Tues, 9:25 am	Break / Poster Session (Salon Del Ray Foyer)			
Tues, 9:45 am	Panel Session I: High-Level DOE Panel Session (Salon Del Rey)			
Tues, 11:15 am	Lunch (El Mirador Room) / Poster Session (Salon Del Ray Foyer)			
Tues, 12:15 pm	HEAT EXCHANGERS II Papers: 110, 17, 134, 00 Chair: Renaud Le Pierres	OXY FUEL II Papers: 7, 40, 104, 202 Chair: Pete Strakey	MATERIALS II Papers: 43, 56, 66, 203 Chair: David Thimsen	
Tues, 2:15 pm	SYSTEM MODELING II Papers: 14, 64, 90 Chair: Nathan Weiland	THERMAL STORAGE I Papers: 94, 76, 125 Chair: David Sanchez	TURBOMACHINERY I Papers: 36, 54, 89 Chair: Karl Wygant	
Tues, 3:45 pm	Break / Poster Session (Salon Del Ray Foyer)			
Tues, 4:05 pm	Panel Session II: Industry Panel Session (Salon Del Rey)			
Tues, 6:00 pm	Dinner - Keynote Speaker #4: Nick Johnston, Heatric (El Mirador Room)			
Wednesday, March 30th				
Wed, 7:00 am	Continental Breakfast / Registration (Salon Del Ray Foyer)			Posters Displayed
Wed, 7:45 am	Welcome - Klaus Brun, Southwest Research Institute (Salon Del Rey)			
Wed, 8:00 am	Keynote Speaker #5: Adam Cohen, Deputy Under Secretary for Science and Energy (Salon Del Rey)			
Wed, 8:30 am	Break / Poster Session (Salon Del Ray Foyer)			
Wed, 8:50 am	HEAT EXCHANGERS III Papers: 75, 98, 105, 13 Chair: Jeong Lee	FLUID MECHANICS II Papers: 21, 95, 30, 204 Chair: Peter Friedman	SYSTEM CONCEPTS II Papers: 47, 92, 148, 201 Chair: Tim Allison	
Wed, 10:50 am	TESTING I Papers: 57, 20, 49 Chair: Seth Lawson	OXY FUEL I Papers: 1, 116, 103 Chair: Ganesan Subbaraman	HEAT REJECTION/COOLING I Papers: 113, 3, 82 Chair: Craig Turchi	
Wed, 12:20 pm	Lunch - Awards Ceremony / Keynote Speaker #6: Jeffrey Phillips, EPRI (El Mirador Room)			
Wed, 1:10 pm	SYSTEM MODELING I Papers: 32, 58, 102 Chair: Eric Clementoni	TURBOMACHINERY III Papers: 128, 91, 122 Chair: Rich Dennis	HEAT REJECTION/COOLING II Papers: 77, 22, 142 Chair: Tim Held	
Wed, 2:40 pm	TESTING III Papers: 10, 69, 129 Chair: Karl Wygant	SYSTEM MODELING III Papers: 51, 100, 59 Chair: Aaron McClung	FLUID MECHANICS I Papers: 65, 133, 52 Chair: Rene Pecnik	
Wed, 4:10 pm	Break / Poster Session (Salon Del Ray Foyer)			
Wed, 4:30 pm	Panel Session III: University R&D Panel Session (Salon Del Rey)			
Thursday, March 31st				
Thurs, 7:00 am	Continental Breakfast / Posters (Salon Del Ray Foyer)			Posters Displayed
Thurs, 8:00 am	HEAT EXCHANGERS I Papers: 108, 53, 18 Chair: Jim Pasch	TURBOMACHINERY II Papers: 71, 72, 55 Chair: Klaus Brun	MATERIALS I Papers: 9, 114, 27 Chair: Patcharin Burke	
Thurs, 9:30 am	TESTING II Papers: 85, 93, 60 Chair: Robin Ames	SYSTEM MODELING IV Papers: 67, 83, 119 Chair: Steve Wright	SYSTEM CONCEPTS I Papers: 23, 35, 00 Chair: Ty Neises	
Thurs, 11:00 am	Break / Poster Session (Salon Del Ray Foyer)			
Thurs, 11:20 am	Panel Session IV: National Laboratories R&D Panel Session (Salon Del Rey)			
Thurs, 12:30 pm	Closing / Adjourn (Salon Del Rey)			
Thurs, 1:00 pm - 4:00 pm	Southwest Research Institute Facility Tour			

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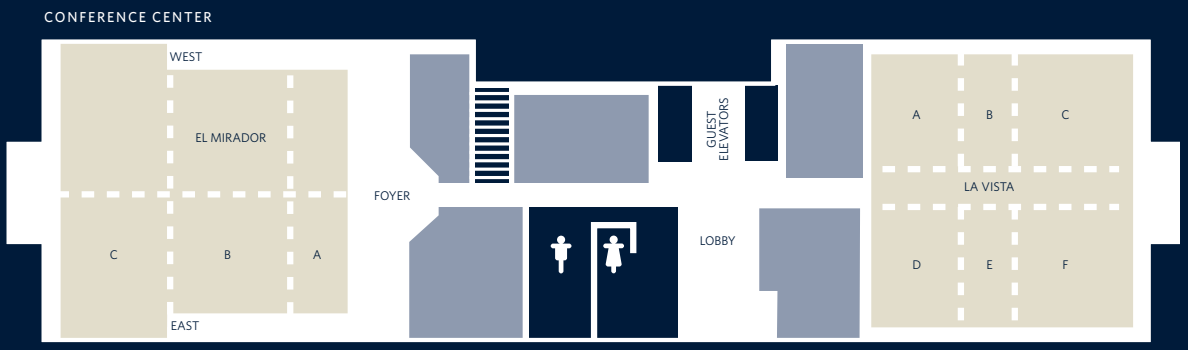
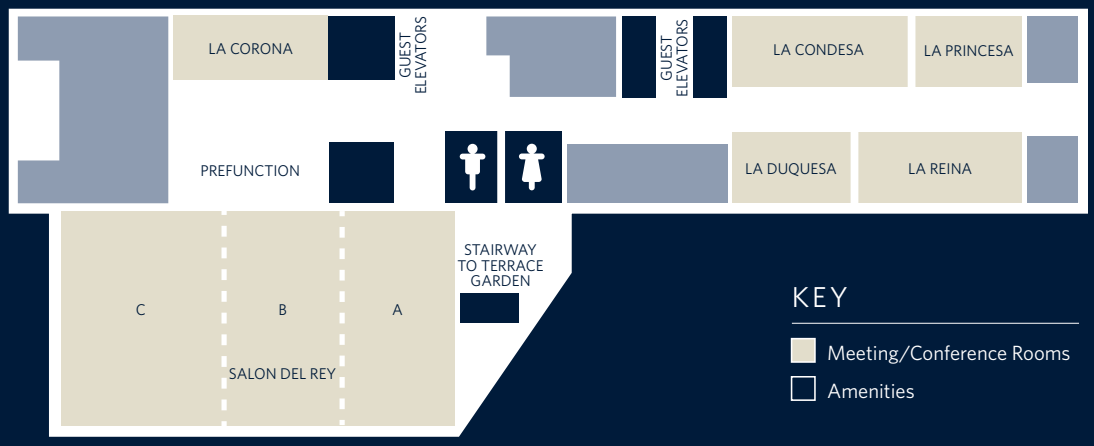
HILTON PALACIO DEL RIO FLOOR PLAN





KEY

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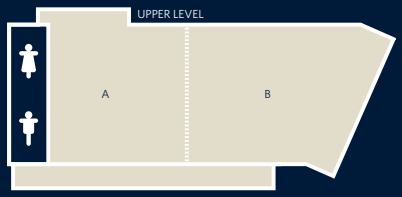
- Amenities



MEETINGS

Hilton Palacio del Rio offers over 27,000ft² of event space, most of which overlooks the scenic River Walk. Our professional audio/visual team can add the perfect touch to help make your event memorable.

THE PAVILION BY HILTON

This historic building, built in the late 1800's and just steps from the River Walk in HemisFair Park, has been renovated into an elegant meeting and event space.

LOCATION

Location, location, location! Hilton Palacio del Rio is one of the best places to stay in San Antonio. Situated along the River Walk and across the street from the San Antonio Convention Center.

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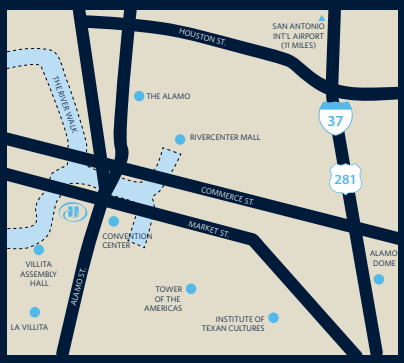


DETAILED PROGRAM

MONDAY, MARCH 28TH

PRE-CONFERENCE TUTORIAL SESSIONS
12:00 PM – 6:00 PM at Southwest Research Institute

1. **12:00 PM – 1:30 PM** **Industrial Tutorial: A Fundamental Review of sCO_2 Power Cycles**
   Grant Musgrove, Southwest Research Institute

2. **1:30 PM – 3:00 PM** **Turbo Machinery: Turbo Machinery Design for Supercritical CO_2 Applications**
   Jeff Moore, Southwest Research Institute

3. **3:00 PM – 4:30 PM** **Heat Exchanger Tutorial: Heat Exchangers for Supercritical CO_2 Power Cycle Applications**
   Grant Musgrove, Southwest Research Institute

4. **4:30 PM – 6:00 PM** **Materials Tutorial: Materials for Supercritical CO_2 Power Cycle Applications**
   Ganesan Subbaraman, Gas Technology Institute

REGISTRATION
5:00 PM – 7:00 PM in Terrace Room Foyer

TERRACE ROOM - INDUSTRY SPONSORED RECEPTION
6:30 PM – 9:00 PM

INTRODUCTION: *Klaus Brun, Southwest Research Institute*

KEYNOTE PRESENTATION: *Jeremy Fetvedt, Chief Engineer, 8Rivers*

TUESDAY, MARCH 29TH

SALON DEL REY FOYER REGISTRATION
7:00 AM – 8:00 AM

CONTINENTAL BREAKFAST/ POSTERS
7:00 AM – 8:00 AM in Salon Del Rey Foyer

WELCOME AND PRELIMINARIES
8:00 AM – 8:10 AM in Salon Del Rey
Klaus Brun, Southwest Research Institute
Rich Dennis, U.S. Department of Energy, National Energy Technology Laboratory, Conference Co-Chair

MAYOR'S WELCOME
8:10 AM – 8:25 AM in Salon Del Rey
Ivy Taylor, San Antonio Mayor

DETAILED PROGRAM

TUESDAY, MARCH 29TH

KEYNOTE PRESENTATIONS
8:25 AM – 9:25 AM
Adam Hamilton, President, Southwest Research Institute
Matt Usher, P.E., Director, Technology Development & Policy Support, American Electric Power

COFFEE BREAK AND POSTER SESSION
9:25 AM – 9:45 AM in Salon Del Rey Foyer

PANEL SESSION I: DEPARTMENT OF ENERGY PANEL SESSION
9:45 AM – 11:15 AM in Salon Del Rey
Introduction/Chair: Rich Dennis, U.S. Department of Energy, National Energy Technology Laboratory

- *Darren Mollot, Director, Office of Advanced Fossil Energy Technology, U.S. Department of Energy*
- *Sal Golub, Associate Deputy Assistant Secretary for Nuclear Reactor Technologies, Office of Nuclear Energy, U.S. Department of Energy*
- *Matt Bauer, Technology Manager, Concentrating Solar Power, U.S. Department of Energy*

LUNCH
11:15 AM – 12:15 PM in El Mirador Room

POSTER SESSION
11:15 AM – 12:15 PM in Salon Del Rey Foyer

SALON A – HEAT EXCHANGERS II
12:15 PM – 2:15 PM
Session Chairs: Renaud LePierres and Ty Neises

1. **High Effectiveness, Compact, High Pressure and Low-Cost Recuperator for Supercritical CO_2 Power Cyles**
   John Kelly, Altex Technologies Corporation
2. **Ceramic, Microchannel Heat Exchangers for Supercritical CO_2 Power Cycles**
   Charles Lewinsohn, Ceramatec, Inc.
3. **Use of 1-D Enthalpy Method for a High-Temperature Recuperator Made of Polymer Derived Ceramic Composite for a Supercritical CO_2 Power System**
   Mahmood Mohagheghi, University of Central Florida

DETAILED PROGRAM

TUESDAY, MARCH 29TH

SALON B – OXY-FUEL COMBUSTION SYSTEM CONCEPTS II

12:15 PM – 2:15 PM

Session Chairs: Pete Strakey and Rich Dennis

1. **Developing a Validated Chemical Kinetics Model for sCO_2 Combustion and Implementation in CFD**
   Subith Vasu, University of Central Florida
2. **Exergy Analysis of the Allam Cycle**
   Mathias Penkuhn, Technische Universität Berlin
3. **Oxy-Coal Fired Circulating Fluid Bed Combustion with a Commercial Utility Size Supercritical CO_2 Power Cycle –** *Walter Shelton, U.S. Department of Energy, National Energy Technology Laboratory*
4. **Oxy-Combustion Integration for Direct Fired sCO_2 Cycles**
   Aaron McClung, Southwest Research Institute

SALON C – MATERIALS II

12:15 PM – 2:15 PM

Session Chairs: David Thimsen and John Shingledecker

1. **Short Duration Corrosion Performance of Carbon Steels in sCO_2 at 260°C**
   Matt Walker, Sandia National Laboratories
2. **The Effect of Temperature and Pressure on Supercritical CO_2 Compatibility of Conventional Structural Alloys**
   Bruce Pint, Oak Ridge National Laboratory
3. **Exfoliation Propensity of Oxide Scale in Heat Exchangers Used for Supercritical CO_2 Power Cycles**
   Adrian Sabau, Oak Ridge National Laboratory
4. **Characterization of Turbomachinery Materials for sCO_2 Application**
   Ganesan Subbaraman, Gas Technology Institute

SALON A – MODELING AND CONTROL II

2:15 PM – 3:45 PM

Session Chairs: Nathan Weiland and Pete Friedman

1. **Advanced Gas Foil Bearing Design for sCO_2 Power Cycles –** *Peter Chapman, Mechanical Solutions, Inc.*
2. **Simulation of sCO_2 Integrated System Test with ANL Plant Dynamics –** *Anton Moisseytsev, Argonne National Laboratory*
3. **Preliminary Design Study on a Multi-Megawatts Fossil-Based Supercritical CO_2 Recompression and Reheat Integral Test Facility –** *Hongzhi Li, Xi'an Thermal Power Research Institute Co., Ltd.*

SALON B – THERMAL STORAGE

2:15 PM – 3:45 PM

Session Chairs: David Sánchez and Steve Wright

1. **Supercritical CO_2 Based Heat Pump Cycle for Electrical Energy Storage for Utility Scale Dispatchable Renewable Energy Power Plants –** *Vipluv Aga, General Electric*
2. **High-Temperature Corrosion of Diffusion Bonded Ni-Based Superalloys in Supercritical CO_2 Conditions**
   Omer Dogan, U.S. Department of Energy, National Energy Technology Laboratory
3. **Comparison of Conventional and CO_2 Power Generation Cycles for Waste Heat Recovery**
   Gregor Klemencic, Institute for Energy Systems and Thermodynamics

DETAILED PROGRAM

TUESDAY, MARCH 29TH

SALON C – TURBOMACHINERY I

2:15 PM – 3:45 PM

Session Chairs: Karl Wygant and Klaus Brun

1. **Small Scale sCO_2 Compressor Impeller Design Considering Real Fluid Conditions**
   Sesha Govindan, Universität Duisburg-Essen
2. **Meanline and CFD Analyses at Design and Off-Design Operation of a Supercritical CO_2 Radial Inflow Turbine**
   Zicheng Wei, Carleton University
3. **Mean Line Design of Radial Inflow Turbine for sCO_2 Power Systems**
   Thirumalai NC, Center for Study of Science, Technology and Policy (CSTEP)

COFFEE BREAK AND POSTER SESSIONS

3:45 PM – 4:05 PM in Salon Del Rey Foyer

PANEL SESSION II: INDUSTRY PANEL SESSION

4:05 PM – 5:35 PM in Salon Del Rey

INTRODUCTION/MODERATOR: *Lalit Chordia, Thar Energy*

- *Thomas Soulas, Dresser-Rand*
- *Vann Bush, GTI*
- *Mike Bowman, GE*
- *Renaud LePierres, Heatric*

DINNER

6:00 PM – 8:00 in El Mirador Room

KEYNOTE PRESENTATION:

Nick Johnston, Director of Business Development, Heatric

DETAILED PROGRAM

WEDNESDAY, MARCH 30TH

REGISTRATION
7:00 AM – 7:45 AM in Salon Del Rey Foyer

CONTINENTAL BREAKFAST /POSTERS
7:00 AM – 7:45 AM in Salon Del Rey Foyer

WELCOME
7:45 AM – 8:00 AM in Salon Del Rey
Klaus Brun, Southwest Research Institute

KEYNOTE PRESENTATION
8:00 AM – 8:30 AM in Salon Del Rey
Adam Cohen, Deputy Under Secretary for Science and Energy

COFFEE BREAK AND POSTER SESSION
8:30 AM – 8:50 AM in Salon Del Rey Foyer

SALON A – HEAT EXCHANGERS III
8:50 AM – 10:50 AM
Session Chairs: Jeong Lee and Robin Ames

1. **Diffusion Bonding of H230 Ni-Superalloy for Application in Microchannel Heat Exchangers**
   Omer Dogan, National Energy Technology Laboratory
2. **Commercialization of sCO_2 Brayton Power Cycles**
   Gary Rochau, Sandia National Laboratories
3. **Modelling Off-Design Performance of sCO_2 Heat Exchangers**
   Kevin Hoopes, Southwest Research Institute

SALON B – FLUID MECHANICS AND HEAT TRANSFER II
8:50 AM – 10:50 AM
Session Chairs: Peter Friedman and Pete Strakey

1. **The Influence of Radiative Transfer on the Turbulent Flow Inside Solar Absorbers Operating with Supercritical CO_2**
   Rene Pecnik, Delft University of Technology
2. **Flow Stratification in the Horizontal Pipe with Heated Supercritical CO_2**
   Xu Chu, Institute of Nuclear Technology and Energy Systems (IKE), University of Stuttgart
3. **Two-Layer Model for the Heat Transfer to Supercritical CO_2**
   Eckart Laurien, University of Stuttgart
4. **Detailed CFD Simulations on Heat Transfer to Supercritical Fluids**
   Rene Pecnik, Delft University of Technology

DETAILED PROGRAM

WEDNESDAY, MARCH 30TH

SALON C – SYSTEM CONCEPTS II

8:50 AM – 10:50 AM

Session Chairs: Tim Allison and Craig Turchi

1. **sCO_2 Cycle Design and Control Strategy for the SFR Application –** *Min Seok Kim, KAIST*
2. **Performance Comparison of Supercritical CO_2 Versus Steam Bottoming Cycles for Gas Turbine Combined Cycle Applications –** *Pierre Huck, GE Global Research*
3. **Process Modeling of a Closed-Loop sCO_2 Geothermal Power Cycle –** *Brian Higgins, GreenFire Energy*
4. **Sensitivity of an Operating Supercritical CO_2 Brayton Cycle to Compressor and Turbine Inlet Temperature –** *Eric Clementoni, Bechtel Marine Propulsion Corporation*

SALON A – TESTING I

10:50 AM – 12:20 PM

Session Chairs: Seth Lawson and Tim Held

1. **The Effect of O_2 and H_2O on Oxidation in CO_2 at 700°- 800°C –** Bruce Pint, Oak Ridge National Laboratory
2. **Preliminary Design and Considerations of a MWE Scale sCO_2 Integral Test Loop** *Junfeng Wang, Nuclear Power Institute of China*
3. **Research on the Development of a Small-Scale Supercritical CO_2 Power Cycle Experimental Test Loop –** *Young-Jin Baik, Korea Institute of Energy Research*

SALON B – OXY-FUEL COMBUSTION SYSTEM CONCEPTS I

10:50 AM – 12:20 PM

Session Chair: Ganesan (Subbu) Subbaraman and David Sánchez

1. **Challenges in Designing Fuel-Fired sCO_2 Heaters for Closed sCO_2 Brayton Cycle Power Plants** *Paul S. Weitzel, EPRI*
2. **Simulation of a Direct Fired Oxy-Fuel Combustor for sCO_2 Power Cycles –** *Jacob Delimont, Southwest Research Institute*
3. **Performance Baseline for Direct-Fired sCO_2 Cycles –** *Nathan Weiland, National Energy Technology Laboratory*

SALON C – HEAT REJECTION AND COOLING I

10:50 AM – 12:20 PM

Session Chair: Craig Turchi and Patcharin Burke

1. **A Comparative Study of Heat Rejection Systems for sCO_2 Power Cycles –** *Timothy Held, Echogen Power Systems, LLC*
2. **SCO_2 Heat Exchanger Analysis for a Waste-Heat-Recovery Rankine Cycle** *Kevin Anderson, Cal Poly Pamona*
3. **Integration of Pumped-Heat-Electricity-Storage into Water/Steam Cycles of Thermal Power Plants** *Damien Malpiece, GE Power*

DETAILED PROGRAM

WEDNESDAY, MARCH 30TH

LUNCH
12:20 PM – 1:10 PM in El Mirador Room

AWARDS CEREMONY
Lifetime Service Award, Special Service Award, Best Poster, and Best Paper

KEYNOTE PRESENTATION
Jeffrey Phillips, EPRI Senior Program Manager

SALON A – SYSTEM MODELING AND CONTROL I
1:10 PM – 2:40 PM
Session Chairs: Eric Clementoni and Azam Thatte

1. **Transient Analyses of sCO_2 cooled KAIST Micro Modular Reactor with GAMMA+ Code**
   Bongseong Oh, KAIST
2. **Synergy of sCO_2 Power Cycle and CCS systems –** *Ladislav Vesely, Czech Technical University in Prague*
3. **A Practical Look at Assumptions and Constraints for Steady State Modeling of sCO_2 Brayton Power Cycles**
   Nathan Weiland, National Energy Technology Laboratory

SALON B – TURBOMACHINERY III
1:10 PM – 2:40 PM
Session Chair: Rich Dennis and Walker Dimming

1. **Application of Hydrostatic Bearings in sCO_2 Turbomachinery –** *Jason Preuss, Barber Nichols*
2. **Multi-Scale Coupled Physics Models for Performance and Life Prediction of Supercritical CO_2 Turbomachinery Components –** *Azam Thatte, GE Global Research*
3. **Static and Dynamic Properties of Journal Bearings Lubricated with Supercritical CO_2, Part 1 & 2**
   Saeid Dousti, Rotor Bearing Solutions International

SALON C – HEAT REJECTION AND COOLING II
1:10 PM – 2:40 PM
Session Chairs : Tim Held and Doug Hofer

1. **Technical and Economic Feasibility of Dry Air Cooling for the Supercritical CO_2 Brayton Cycle Using Existing Technology –** *Sandeep Pidaparti, Georgia Institute of Technology*
2. **Methodology of Modeling and Comparing the Use of Direct Air-Cooling for a Supercritical CO_2 Brayton Cycle and a Steam Rankine Cycle –** *Patrick Hruska, University of Wisconsin-Madison*
3. **Next Generation Integrated Simulation Platform to Cover All Engineering Phases of CO_2 Power Cycle**
   Ian Boys, Schneider Electric Software,LLE.

DETAILED PROGRAM

WEDNESDAY, MARCH 30TH

SALON A – TESTING III

2:40 PM – 4:10 PM

Session Chairs: Karl Wygant and Klaus Brun

1. **Demonstration Testing and Facility Requirements for sCO_2 Brayton Commercialization**
   Lon Dawson, Sandia National Laboratories
2. **Phased Approach to Development of a High Temperature sCO_2 Power Cycle Pilot Test Facility**
   Douglas Hofer, GE Global Research
3. **Impact of sCO_2 Properties on Centrifugal Compressor Impeller: Comparison of Two Loss Models for Mean Line Analyses** – *Jay Kapat, University of Central Florida*

SALON B – SYSTEM MODELING AND CONTROL III

2:40 PM – 4:10 PM

Session Chairs: Aaron McClung and Jim Pasch

1. **Parametric Analysis of sCO_2 Power Cycles Operating at Moderate Temperatures**
   Peter Friedman, Newport News Shipbuilding
2. **Analysis and Optimization for Off-Design Performance of the Secompression sCO_2 Cycles for high Temperature CSP Applications** – *Ty Neises, University of California, Los Angeles*
3. **Thermo-Economic Analysis of Four sCO_2 Waste Heat Recovery Power Cycle Systems**
   Steven Wright, SuperCritical Technologies Inc.

SALON C – FLUID MECHANICS AND HEAT TRANSFER

2:40 PM – 4:10 PM

Session Chairs: Rene Pecnik and Seth Lawson

1. **Experimental Assessment of Thermodynamic Properties for Metastable CO_2**
   Derek Paxson, MIT Gas Turbine Lab
2. **Numerical Investigation of Potential Erosion Mechanism for Turbulent Flow of sCO_2 in a Pipe Bends** – *Sourabh Apte, Oregon State University*
3. **Understanding Wet Gas in a Supercritical CO_2 Cycle**
   Melissa Poerner, Southwest Research Institute

COFFEE BREAK AND POSTER SESSION

4:10 PM – 4:30 PM in Salon Del Rey Foyer

PANEL SESSION III: UNIVERSITY R&D PANEL SESSION

4:30 PM – 6:00 PM in Salon Del Rey

INTRODUCTION/MODERATOR: *Eric Clementoni, Bechtel Marine Propulsion*

- *Mark Anderson, University of Wisconsin*
- *Jay Kapat, University of Central Florida*
- *David Sánchez, University of Seville*
- *Jeong Ik Lee, KAIST*
- *Henry Saari, Carleton University*

DETAILED PROGRAM

THURSDAY, MARCH 31ST

CONTINENTAL BREAKFAST/POSTERS
7:00 AM – 8:00 AM in Salon Del Rey Foyer

SALON A - HEAT EXCHANGERS I
8:00 AM – 9:30 AM
Session Chairs: Jim Pasch and Tim Allison

1. **The Selection, Evaluation and Rating of Compact Heat Exchangers (SEARCH) Software Suite – Code Capabilities and Experimental Comparison –** *Matthew Carlson, Sandia National Labs*
2. **Economical Analysis of sCO_2 Brayton Cycles with PCHE Recuperator Design Optimization** *Dereje Shiferaw, Heatric, Division of Meggitt Ltd.*
3. **Optimization of S-Shaped Fin Channels in Printed Circuit Heat Exchangers for Supercritical CO_2 Test Loop** *Xiaoqin Zhang, The Ohio State University*

SALON B - TURBOMACHINERY II
8:00 AM – 9:30 AM
Session Chairs: Klaus Brun and Rene Pecnik

1. **Conceptual Designs of 50MW and 450MW Supercritical CO_2 Turbomachinery Trains for Power Generation from Coal - Part 1: Cycle and Turbine**– *Rahul Bidkar, GE Global Research*
2. **Conceptual Designs of 50MW and 450MW Supercritical CO_2 Turbomachinery Trains for Power Generation from Coal - Part 2: Compressors and Off-Design Operation** – *Rahul Bidkar, GE Global Research*
3. **Application of an Integrally Geared Compander to an sCO_2 Recompression Brayton Cycle** *Jason Wilkes, Southwest Research Institute*

SALON C - MATERIALS I
8:00 AM – 9:30 AM
Session Chairs: Patcharin Burke and Aaron McClung

1. **Oxidation/Corrosion in Materials for Supercritical CO_2 Power Cycles** – *John Shingledecker, EPRI*
2. **Effect of Oxygen Impurity on Corrosion in Supercritical CO_2 Environments** *Jacob Mahaffey, University of Wisconsin - Madison*
3. **Materials Performance in Supercritical CO_2 in Comparison with Atmospheric Pressure CO_2 and Supercritical Steam –** *Gordon Holcomb, National Energy Technology Laboratory*

SALON A - TESTING II
9:30 AM – 11:00 AM
Session Chairs: Robin Ames

1. **Operation Results of a Closed Supercritical CO_2 Simple Brayton Cycle** *JaeEun Cha, Korea Atomic Energy Research Institute*
2. **Thermodynamic Model Investigation for Supercritical CO_2 Brayton Cycle for Coal-Fired Power Plant Application** – *Qiao Zhao, EDF R&D*
3. **Initial Transient Power Operation of a Supercritical CO_2 Brayton Cycle with Thermal-Hydraulic Control** – *Martha King, Bechtel Marine Propulsion Corporation*

DETAILED PROGRAM

THURSDAY, MARCH 31ST

SALON B - SYSTEM MODELING AND CONTROL IV

9:30 AM – 11:00 AM

Session Chairs: Steven Wright and David Thimsen

1. **Performance Evaluation of a Supercritical CO_2 Power Cycle Coal Gasification Plant**
   Scott Hume, EPRI
2. **A Comparative Study of Solar Heliostat Assisted Supercritical CO_2 Recompression Brayton Cycles: Dynamic Modeling and Control Strategies** – *Dia Milani, The University of Sydney*
3. **Pathway to Cost Competitive Concentrated Solar Power via Supercritical CO_2 Power Cycles**
   Matthew Bauer, United States Department of Energy

SALON C - SYSTEM CONCEPTS I

9:30 AM – 11:00 AM

Session Chairs: Ty Neises and Nathan Weiland

1. **Dependence of Thermal Efficiency on Receiver Temperature of Solar Thermal Power Systems Combined with Supercritical CO_2 Gas Turbine Cycle and Brayton CO_2 Gas Turbine Cycle**
   Yasushi Muto, Tokyo Institute of Technology
2. **A Supercritical CO_2 Low Temperature Brayton-Cycle for Residual Heat Removal**
   D. Brillert, Universität Duisburg-Essen

BREAK AND POSTER SESSION

11:00 AM – 11:20 AM in Salon Del Rey Foyer

PANEL SESSION IV: NATIONAL LABORATORIES R&D PANEL SESSION

11:20 AM – 12:30 PM in Salon Del Rey

INTRODUCTION/MODERATOR: *Jim Pasch, Sandia National Laboratories*

- *Bruce Pint, Oak Ridge National Laboratory*
- *Alan Kruizenga, Sandia National Laboratories*
- *Craig Girardi, Argonne National Laboratory*
- *Anton Moisseytsev, Argonne National Laboratory*
- *Craig Turchi, NREL*
- *Peter Strakey, National Energy Technology Laboratory*
- *Eric Clementoni, Bechtel Marine Propulsion Corporation*

CLOSING AND ADJOURN

12:30 PM

SWRI FACILITY TOUR AT SOUTHWEST RESEARCH INSTITUTE

1:00 PM – 4:00 PM

PRESENTER BIOGRAPHIES

DR. DARREN MOLLOT

Dr. Darren Mollot is the Office Director for Advanced Fossil Technology Systems within the Office of Clean Coal and Carbon Management in the Department of Energy's (DOE) Office of Fossil Energy. His Office's responsibilities include the research development and demonstration of a broad array of fossil fueled energy technologies including carbon dioxide capture utilization and permanent storage, advance power generation systems including gasification, combustion, and fuel cells, and cross cutting research including material development, computer simulations, sensors and controls.

Dr. Mollot has been working for the Department since 1992 and has held positions throughout the organization including as a Research Scientist and Project Manager at the DOE's National Energy Technology Laboratory (NETL), and at the National Carbon Capture Center where he served as technical liaison and participated as part of the startup.

Prior to joining DOE, Dr. Mollot held various positions with the private sector including at IBM and Westinghouse Electric Corporation. In 1999, he was selected as a Congressional Science Fellow and served a year on Senator Rockefeller's staff advising on issues related to science and technology.

Dr. Mollot earned his Doctor of Philosophy from the State University of New York at Buffalo in Mechanical and Aerospace Engineering.

MIKE BOWMAN

Mike Bowman is currently the Advanced Technology Leader for Sustainable Energy at GE's Global Research Center. In this role Mike leads a large portfolio of multidisciplinary research aimed at delivering technology differentiation to GE businesses, with emphasis on Power & Water, Energy Management, and Oil & Gas. The research portfolio spans areas from renewables to traditional fossil energy systems as well as energy resources and water technologies. The underlying goal for all of the efforts is sustainability, maximizing efficiency, and minimizing environmental footprint.

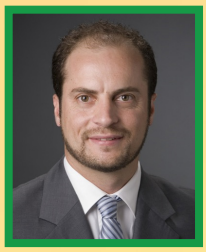
Mike holds bachelors and masters degrees in mechanical engineering from Union College with the focus in thermodynamics and combustion. In 1997 Mike joined GE Research where he worked on technologies for gas turbines, steam turbines, and diesel engines as well as lead the efforts in understanding climate change and CO2 science. He has held the position of Energy Systems Lab Manager where he led a team of engineers that were responsible for advanced research on a wide array of energy conversion technologies. Following this role Mike took the position of Executive Manager in GE Power & Water. In this role, Mike was responsible for leading the technology development efforts to advance the state of art for the GE Steam Turbines. He built an organization located across 4 global sites and had technical responsibility for conceptual design, performance, heat transfer, sealing, power train dynamics, clearances, and aerodynamics.

In addition to his GE roles, Mike was invited to join the United Nations IPCC (Intergovernmental Policy on Climate Change). In this role he represented GE at several global meetings and made contributions to their Technical Assessment Report #4. He has been an invited speaker at the Statoil Research Summit and the Greentech Innovation Network to talk on various energy technologies. In 2003 Mike was selected as a member of the MIT TR100, the top 100 young innovators in the world. Mike is also an Adjunct Professor at Union Graduate College where he teaches courses in Disruptive Technologies and Sustainable Energy. Mike holds over 20 patents and has had 5 peer-reviewed publications.

DR. MATT BAUER

Matthew Bauer serves as a technology manager in the Department of Energy's Solar Energy Technology Office on contract from ManTech International Corporation. Matthew's research background is in the field of microscale heat transfer. Specifically, he has worked to develop novel heat transfer measurement methods and to tune materials' intrinsic thermophysical properties. Matthew received his PhD from the University of Virginia in mechanical engineering

PRESENTER BIOGRAPHIES



THOMAS SOULAS

Thomas Soulas is Director Business Development, Advanced Energy Systems, at Dresser-Rand, A Siemens Business. He is responsible for the development and commercialization of innovative technologies within the Dresser-Rand portfolio, including the Echogen supercritical CO2 waste heat recovery solution and the Ener-Core Power Oxidizer system, through licensing agreements and strategic partnerships. In particular, he leads all the business development activities related to launching of the technologies in the marketplace. Mr. Soulas has been with the company since 2002. He has authored and coauthored several technical papers in the fields of annular seals, bulk-flow analysis, rotor stability testing, hydrostatic bearings, and vibration root cause analysis (including electric motors and generators).
Mr. Soulas has a Master of Science in Mechanical Engineering from Texas A&M University (2001) and a B.S. in Engineering from Ecole Centrale de Lyon, France (1998). He also has an MBA from Rice University (2009).

DR. BRUCE PINT

Bruce Pint is the group leader of the Corrosion Science and Technology group at ORNL where he has worked since 1994. He received his Ph.D. in Ceramic Science and Engineering from M.I.T. in 1992 and has been conducting high temperature oxidation research since 1986. He is a Fellow of both ASM International and NACE International. He leads the ORNL sCO2 compatibility team funded by the US Department of Energy, Office of Fossil Energy and the Solar Energy Technology Program.

SAL J. GOLUB

As Associate Deputy Assistant Secretary for Nuclear Reactor Technologies, Mr. Golub manages a portfolio of nucear reactor technologies, including light water and advanced reactor concepts, small modular reactor deployment and space and defense power systems.

Prior to his current assignment, Mr. Golub led the reactor development component of the Global Nuclear Energy Partnership as Director of Fast Reactor Development. Mr. Golub has also served as the Office of Nuclear Energy's Director of Corporate Communications and External Affairs.

While in the private sector, he completed a variety of challenging projects in the commercial nuclear industry, including supervisory and management positions at 4 nuclear power stations in the areas of design, construction engineering, plant startup, licensing, operations and maintenance.

Mr. Golub received his degree in Civil and Environmental Engineering from Clarkson University and is a graduate of the Federal Executive Institute.

DR. JEFFREY NORTHRIDGE PHILLIPS

Dr. Phillips is a Senior Program Manager at the Electric Power Research Institute (EPRI) where he is responsible for EPRI's research activities focused on developing advanced fossil fuel-based power plants that include the capture and storage of CO2. Dr. Phillips has a PhD in Mechanical Engineering from Stanford University, a BSME from Washington University and a BA from Austin College. He worked for Shell Oil Company, Molten Metal Technology and Fern Engineering before joining EPRI in 2004. In addition to his work at EPRI, he is in the middle of a four-year term on the Cabarrus County Board of Education, which supervises a school district serving 31,000 students in North Carolina.

PRESENTER BIOGRAPHIES

DR. KLAUS BRUN

Dr. Brun is the Program Director of the Machinery Program at Southwest Research Institute. His experience includes positions in engineering, project management, and management at Solar Turbines, General Electric, and Alstom. He holds six patents, authored over 150 papers, and published two textbooks on gas turbines. Dr. Brun won an R&D 100 award in 2007 for his Semi-Active Valve invention and ASME Oil & Gas Committee Best Paper/Tutorial awards in 1998, 2000, 2005, 2009, 2010, 2012, and 2014. He was chosen to the "40 under 40" by the San Antonio Business Journal. He is the past chair of the ASME-IGTI Board of Directors and the past Chairman of the ASME Oil & Gas Applications Committee. He is also a member of the API 616 and 692 Task Forces, the Middle East and Far East Turbomachinery Symposiums, the Fan Conference Advisory Committee, and the Supercritical CO2 Conference Advisory Committee. Dr. Brun is the Executive Correspondent of Turbomachinery International Magazine and an Associate Editor of the ASME Journal of Gas Turbines for Power.

NICK JOHNSTON

Nick studied chemical engineering at the University of Wales where he studied under Jack Richardson (of Coulson and Richardson fame) where he graduated in 1985. Since then Nick has worked in the heat transfer sector with a number of different technologies. He started working in the design department of Filtration and Transfer, a UK company building shell and tube heat exchangers and extended surface hairpin exchangers. Filtration and Transfer was part of the Meggitt group of companies.

In 1990 Nick joined Heatric – at the same time as the Meggitt/Heatric JV was created. Since then Heatric has progressed from a start-up to becoming a major supplier of high integrity compact exchanger technology. During that time Nick has had many roles in design, engineering, research and development, sales and general management; he is currently responsible for Business Development and Customer Service and Field Support for the extensive operating fleet of PCHEs.

MATTHEW USHER

Mr. Usher has more than seventeen years of experience at AEP in power plant equipment engineering and design. Specific areas of focus have included air quality control systems (AQCS), carbon capture & storage (CCS), and strategic business planning. In his current role as Director of New Technology Development & Policy Support, Matt leads a multi-disciplined team responsible for R&D and strategic planning around new technologies to enhance AEP's diverse generating portfolio.

Matt and his team provide technical guidance to both internal and external stakeholder groups to support and assist in shaping government and regulatory policies that impact AEP and the industry. Matt received his Bachelor of Science degree in Mechanical Engineering from the University of Kentucky in 1998, and holds a Masters in Business Administration from Otterbein University. Matt is a registered Professional Engineer in the state of Ohio.

CRAIG S. TURCHI

Craig is a senior engineer within NREL's Thermal Systems Group.
He has been with the Concentrating Solar Power program and Thermal Systems Group at NREL for 13 years, where he leads NREL's CSP Systems Analysis task and assists with the development and assessment of heat-transfer fluids, thermal-storage concepts, and advanced power systems. He was responsible for development of several of the CSP technology metrics associated with the DOE's SunShot Initiative and has championed the development of s-CO2 for CSP applications.

PRESENTER BIOGRAPHIES

DR. MARK ANDERSON

Dr. Mark Anderson is chief scientist in the department of engineering physics and director of the University of Wisconsin's Thermal Hydraulic Laboratory. He has research groups working on supercritical fluid heat transfer, turbomachinery and materials. Dr. Anderson has worked on supercritical fluids for about eight years starting with work on the GENIV supercritical water reactor designs. He is currently the US representative to the International Atomic Energy Agency (IAEA) for the coordinated research project on supercritical fluids. He is an active member of the American Nuclear Society (ANS), the American Physical Society (APS) and the American Institute of Aeronautics and Astronautics (AIAA). Dr. Anderson was recently awarded the young investigator engineering achievement award from the American Nuclear Society for his work in supercritical fluids and other areas. Dr. Anderson earned his bachelor's degree in physics from the University of Wisconsin -River Falls and his doctorate in Nuclear Engineering from the University of Wisconsin - Madison. He has been awarded 3 patents and has published over 150 papers. His work has included experimental research on supercritical fluids, LWRs passive safety systems, liquid salt heat transfer, liquid sodium heat transfer, heat storage systems, high energy density physics, reactor materials, and advanced optical diagnostics.

Heat transfer: Dr. Anderson began the initial work on the heat transfer and depressurization issues associated with the GENIV supercritical water reactor. He also initiated several studies to look at compact heat exchangers for the S-CO2 power cycle and has worked with industrial partners to develop optimal channel heat exchangers for S-CO2. He has developed several heat transfer correlations capable of predicting heat transfer near the supercritical point of different fluids and lead research to help understand the safety implications of a depressurization event from a S-CO2 and SCW reactor system. Dr Anderson was the investigator to develop techniques to optical study the thermal boundary layer in supercritical water.

SC-fluid materials: Dr Anderson constructed and operated several supercritical fluid test facilities for the DOE. In this work he exposed samples to supercritical fluids for several thousands of hours to understand what materials (alloys or seals) would work under several different conditions.

DR. ADAM COHEN

Dr. Adam Cohen has more than 30 years of experience in management of research and development, strategic planning and operations at Princeton (PPPL), Argonne National Laboratory (ANL), and the Department of Energy. As Deputy Director for Operations at PPPL, he was responsible for both the engineering and operations function at PPPL, including design efforts, project management, human resources, financial activities, outreach, ES&H and applied research activities. He also served on the NJ DEP Oyster Creek Oversight Panel and on the Department of Energy's Laboratory Operations Board.

Previously, he served as senior advisor to the DOE Under Secretary for Science for nuclear energy programs, and at Argonne as Chief Operations Officer, as the head of environment, safety and health, as a nuclear facility manager, and as a researcher/principal investigator on nuclear fuels and materials. Earlier in his career, he spent four years in the U.S. Navy as a submarine officer, and he worked at Babcock & Wilcox manufacturing nuclear fuel for research reactors.

He holds degrees in Materials Science and Engineering from Northwestern University and Columbia University, and a business degree from the University of Chicago.

DR. ALAN KRUIZENGA

Dr. Alan Kruizenga (MS Nuclear Engineering and Engineering Physics (NEEP) '07, MS Mechanical Engineering and PhD NEEP '10) is a Principal Member of the Technical Staff at Sandia National Laboratories California, where he currently leads work investigating materials compatibility, materials selection, and efficiency-generating technology for solar power systems and advanced reactor concepts. Alan is passionate about bringing practical knowledge, application-orientation, and problem-solving to theoretical science to make great ideas a reality. During his postgraduate studies at the University of Wisconsin - Madison, Dr. Kruizenga was a Nuclear Regulatory Fellow at the University of Wisconsin-Madison where his work focused on heat transfer in complex geometries for SCO2 Brayton cycle application.

PRESENTER BIOGRAPHIES

ADAM L. HAMILTON

Mr. Hamilton serves as chief executive officer of Southwest Research Institute, one of the nation's largest independent applied research and development organizations. SwRI® conducts approximately $550 million of contract research annually and employs more than 2,700 people. For more than 28 years, Mr. Hamilton has provided leadership and technical contributions to intelligence, defense, public safety, homeland security, environmental science, public health and law enforcement programs. He has multidisciplinary technical expertise including engineering, biological sciences, chemical sciences, space sciences, mathematics, modeling, quality assurance, software development, and risk assessment.

Before joining Southwest Research Institute in September 2014, Mr. Hamilton served 13 years as President and Chief Executive Officer of Signature Science, LLC, the Austin, Texas based subsidiary of SwRI that specializes in national security, biotechnology, chemistry, environmental science and engineering. Currently, he serves as the Chairman of Signature Science.

Mr. Hamilton is the chairman of Signature Science, L.L.C. and the 2015 United Way Volunteer of the Year chair. He also serves on the board of the Greater San Antonio Chamber of Commerce and the University of Texas at San Antonio Advancement Council. He is a Trustee of the San Antonio Medical Foundation and the Texas Biomedical Research Institute. Mr. Hamilton is a member of the American Society of Mechanical Engineering (ASME) Industry Advisory Board (IAB) and a member of the Industry and Community Affiliates (ICA) of The Academy of Medicine, Engineering & Science of Texas (TAMEST). He is also a board member of the Greater Austin Crime Commission and is on the Training Advisory Board for the Office of the Texas Attorney General. Mr. Hamilton has served as the Future Plans Officer (N5) for Texas State Guard Maritime Regiment (TMAR) and as the Deputy Director for Risk Assessment for the Texas Engineers Task Force on Homeland Security. He is a Graduate of the Federal Bureau of Investigation Citizens' Academy and a Graduate of Leadership Austin.

Degrees and Certifications: Mr. Hamilton holds an M.S. degree in Engineering (1987), from The University of Texas at Austin; a B.S. degree in Aerospace Engineering (1985), from The University of Texas at Austin; and is a Professional Engineer, Texas #76784. He is certified in Homeland Security Level-V, #102905; American College of Forensic Examiners Institute; certified Firearms Instructor, #411598; Texas Commission on Law Enforcement; and ICS, NIMS, and NRP certified, FEMA, #582031.

DR. ANTON MOISSEYTSEV

Anton Moisseytsev is a Principal Computational Nuclear Engineer at Nuclear Engineering Division of Argonne National Laboratory. He is a member of the Innovative Nuclear Systems Development section. He has ten years of experience in modeling and simulation of various reactor systems, including design and analysis of the advanced reactors and energy conversion systems, safety analysis of nuclear reactors, and code development for steady-state and transient simulations of nuclear power plants.

Anton has been involved in the development of the supercritical carbon dioxide Brayton cycle at Argonne since 2002. He is responsible for the development of the computational models and computer codes for the analysis of the S-CO2 cycle. Anton Moisseytsev has developed an automatic control strategy for a S-CO2 cycle and carried out safety and transient analysis of several fast reactor systems with S-CO2 energy converter.

Anton Moisseytsev received Ph.D. degree from Texas A&M University in 2003.

PRESENTER BIOGRAPHIES

CRAIG GERARDI

Craig Gerardi leads the Reactor Safety Testing and Analysis (RSTA) section of the Nuclear Engineering Division at Argonne National Lab. Craig's experimental work supports safety and severe accident studies of light water reactor and advanced reactor technologies including the SCO2 energy conversion system and the sodium-cooled fast reactor. Craig obtained his Ph.D. and M.S. in Nuclear Science and Engineering from the Massachusetts Institute of Technology and holds B.S. degrees in Mechanical Engineering and Nuclear Engineering from the University of Maryland, College Park.

JEREMY FETVEDT

Jeremy Fetvedt is the Chief Engineer at 8 Rivers, where he leads the development of 8 Rivers' portfolio of technologies. In this role, Mr. Fetvedt's primary focus has been the invention and development of all conceptual and practical aspects of the supercritical CO2 Allam Cycle, including new cycle development, overall system design, equipment design and specification, and process modelling. He has also led the engineering of the NET Power supercritical CO2 demonstration plant through the pre-FEED, FEED, and detailed design stages. His current focus is on the development of the operational and controls philosophy for the Allam Cycle, including dynamic model, controls and simulator development.

Mr. Fetvedt has an extensive background in physics and engineering. He previously worked at Varian, Inc., where he led the design of next generation scientific instruments for the pharmaceutical industry. Prior to Varian, he was at Nomaco, Inc., where he worked on projects ranging from plant expansions, to networked reaction injection molding press control systems, to developing co-extrusion tooling for applications such as the Nomacorc, an artificial wine cork.

Mr. Fetvedt earned both his Bachelor's and Master's degrees in Mechanical Engineering from North Carolina State University.

DR. HENRY SAARI

Dr. Saari received his PhD in Aerospace Engineering from Carleton University in 2003. His PhD research was part of a collaborative research program between Carleton University, Pratt and Whitney Canada, and the Institute for Aerospace Research, National Research Council Canada on the development and modelling of directionally solidified titanium aluminide alloys. He is currently Associate Professor in the Department of Mechanical and Aerospace Engineering at Carleton University. Dr. Saari's research includes processing, properties, and joining of gas turbine materials, corrosion of materials in supercritical carbon dioxide, and supercritical carbon dioxide Brayton cycle development.

DR. DAVID SÁNCHEZ

David Sánchez graduated in Mechanical Engineering from University of Seville in 2001, where he also earned his PhD in Energy Engineering in 2005. His research activities have followed parallel tracks: applied research in the field of fundamental thermodynamics and turbomachinery for large power generation systems based on consolidated technologies, and innovative power generation concepts. These two disciplines merged synergistically when Dr. Sánchez started researching the supercritical power cycle along with co-workers from University of Seville (Spain) and Cranfield University (United Kingdom). Within this field, the focus of this research group has been on the analysis of centrifugal compression systems with a recent interest in heat exchanger modelling.

Dr. Sánchez currently serves as Associate Professor in Energy Systems and Turbomachinery at the University of Seville (Spain) and is Vice-Chair of the Cycle Innovations Committee of the International Gas Turbine Institute (2015-2017).

PRESENTER BIOGRAPHIES

DR. JAY KAPAT

Dr. Jay Kapat is the Lockheed Martin Professor in the Department of Mechanical & Aerospace Engineering at the University of Central Florida (UCF). He is the Founding Director for the Center for Advanced Turbomachinery and Energy Research (CATER). He is also the Associate Director of the Florida Center for Advanced Aero-Propulsion (FCAAP). His own research is focused on (a) heat transfer, aerodynamics and advanced cooling techniques for gas turbine engines, electrical generators and rocket engines, (b) supercritical carbon dioxide based power generation cycles and associated components, and (c) chemistry and performance characterization of alternative fuels for aviation. He joined UCF in 1997. Prior to that, Prof Kapat received Sc.D. from the Massachusetts Institute of Technology, MS from Arizona State University, and B.Tech. (Hons) from Indian Institute of Technology Kharagpur – all in Mechanical Engineering.

DR. JEONG IK LEE

Jeong Ik Lee was educated at Seoul National University until 2003 from the Department of Nuclear Engineering. In 2007 he completed his PhD degree in Nuclear Science and Engineering from Massachusetts Institute of Technology with a support from the MIT Manson Benedict Fellowship. During his postdoctoral research at KAIST Institute of Eco-energy from 2008 to 2010, he was involved in various nuclear energy system design and analyses projects. In 2010 he took up an assistant professorship in KAIST and moved to UAE to join Khalifa University of Science and Technology as a joint-professor in Nuclear Engineering program. After staying in UAE for one year, he came back to KAIST and he was promoted to associate professor in 2015.

His major research interests are nuclear energy system engineering and analyses. Currently his research group is very active in the supercritical CO2 power cycle technology development. His research on the supercritical CO2 cooled small modular nuclear reactor was recognized as the top ten research achievements of KAIST in 2014. He is now the deputy secretary of supercritical CO2 power cycle initiative in Korea. He also organized a joint special committee between Korean Nuclear Society and Korean Maritime and Shipbuilding Society to investigate and promote the idea of civilian ocean nuclear system in 2014.

DR. JIM PASCH

Dr. Jim Pasch has professional experience in four distinct fields. In 1995, he supported the Air Force Air Combat Training Systems program as a systems engineer in Fort Walton Beach, Florida. In 1998, Pratt & Whitney hired Jim as a member of their rocket propulsion systems team in West Palm Beach, Florida. Jim spent eight years in this capacity analyzing test and flight data from the Space Shuttle Main Engine. Jacobs Engineering hired Jim in 2006 as NASA ramped up the Constellation program to replace the aging shuttle fleet. While working at Marshall Space Flight Center, Jim was tasked with analyzing and quantifying various thermal hydraulic and control risks to the successful launch of the Ares I-X mission. In 2010, Sandia National Labs hired Jim for his thermodynamic and thermal hydraulic expertise, first to support the nuclear waste disposal program in Carlsbad, New Mexico, then to take over as the principal investigator for Sandia closed Brayton cycle R&D efforts in Albuquerque.

ERIC CLEMENTONI

Eric Clementoni is a Principal Engineer in the Future Concept Development unit at Bechtel Marine Propulsion Corporation. Mr. Clementoni has been actively working on supercritical carbon dioxide power cycles since 2010 serving as the lead engineer for the 100 kWe Integrated System Test and now performing evaluations of plant concepts using supercritical carbon dioxide power cycles. He has published numerous conference and journal papers on operational results of the Integrated System Test.

Mr. Clementoni received his B.S. in Chemical Engineering from Rose-Hulman Institute of Technology in 2004. He is currently the vice-chair of the ASME International Gas Turbine Institute (IGTI) Supercritical CO2 Power Cycles Committee.

PRESENTER BIOGRAPHIES

VANN BUSH

Vann Bush is Managing Director at the Gas Technology Institute, an independent, not-for-profit, applied R&D business. He oversees all matters relating to the conversion of coal, biomass, and raw natural gas into power, chemicals, and liquid fuels production. The team under Mr. Bush includes staff in Des Plaines, IL and in Birmingham, AL who actively support commercial deployments of gasification, biofuels, and gas processing processes developed at GTI, and serve as a solutions development partner for industry.

Mr. Bush tracks industry and government trends, develops business opportunities, secures contracts, and directs research and development activities associated with thermochemical conversion and gas processing technologies or systems. Research and development work spans basic materials developments, bench-scale testing, large pilot-scale evaluations, and techno-economic assessments. Mr. Bush is responsible to sustain and develop core competencies and staff for these R&D programs, build and assess resources required to perform work effectively (including collaborations with academia, government, and corporations), and attract strategic new business.

Current R&D topics include biomass feedstock pretreatment technology, advanced coal gasification technology, integrated processes for drop-in biofuels production, a sulfur recovery process for natural gas and syngas applications, and a compact process for natural gas upgrading as well as CO2 capture.

Before joining GTI, Mr. Bush served in numerous positions up to Vice President of Environment and Energy at Southern Research Institute where he conducted, supervised and managed projects in coal combustion and gasification, biomass co-firing, emissions monitoring, pollution control systems, and technologies to mediate greenhouse gas emissions.

Mr. Bush is a graduate with high honors of the University of North Alabama, and completed his Masters degree in Physics at the University of Alabama in Birmingham.

DR. LALIT CHORDIA

For over 30 years Dr. Lalit Chordia has pioneered research and development, manufacturing and commercialization of supercritical fluid technology, an environmentally friendly, materials processing technology. Dr. Chordia's work extends across multiple industries to applications in food, pharmaceuticals, nutraceuticals, chemicals and energy. Some examples of his involvement in supercritical fluid process and equipment technologies over the years are natural pharmaceutical and spice extraction, drug purification and design, coatings, electronics cleaning, cooling, advanced biofuels and a host of other applications and equipment technologies.

Dr. Chordia received his bachelor's degree from IIT Madras and his doctorate from Carnegie Mellon University in 1985, both in Chemical Engineering. In 1982, Dr. Chordia co-founded Suprex Corp., and served as Vice President of Engineering and R&D. He then formed Thar Technologies in 1990. Thar has expanded its operations into multiple industries both domestically and internationally and has earned a reputation as a world leader in high pressure process and equipment technologies, particularly the use of supercritical carbon dioxide, which has zero ozone depletion and net zero global warming potential. Through Dr. Chordia's leadership of the company, Thar has grown into multiple companies: 1) Thar Instruments, a separations science and equipment company since sold to Waters Corp., 2) Thar Process, a global provider of all-natural food and chemical processing solutions, 3) Thar Pharmaceuticals, a clinical stage drug development company, and 4) Thar Energy, a developer of advanced alternative green energy technology.

Dr. Chordia has been the principal investigator on multiple research and development projects, including two prestigious Advanced Technology Program awards through the National Institute of Standards and Technology and multiple Department of Energy projects. Dr. Chordia received the Distinguished Alumnus Award of IIT Madras in 2010 and the Carnegie Science Entrepreneur Award in 2015. In 2002 Dr. Chordia was honored as the SBA's Small Business Exporter of the Year, and in 2016 he was elected a Fellow to The American Association for the Advancement of Science (AAAS).

Beyond his own business and to remain loyal to his community commitment, Dr. Chordia is a Board Member of Children's Hospital of Pittsburgh Foundation and World Affairs Council of Pittsburgh, serves on the Steering Committee for Sustainable Pittsburgh, is a Co-founder of the US-India Forum and is an Adjunct Research Scientist at the Software Engineering Institute of Carnegie Mellon University. He also serves on the Allegheny County Green Action Team and is an appointee of the U.S. Secretary of Commerce to the Western Pennsylvania District Export Council.

PRESENTER BIOGRAPHIES

DR. PETE STRAKEY

Dr. Strakey is a research scientist at the National Energy Technology Laboratory in Morgantown, WV. He received his PhD in mechanical engineering from the Pennsylvania State University and spent the next 10 years studying rocket injector sprays and high-pressure combustion at the Air Force Research Laboratory at Edwards Air Force Base in California. During this time he gained expertise in high-pressure experimentation and laser diagnostics as well as Computational Fluid Dynamics. In 2004 he moved back to the east coast to work in the fossil energy power generation field at NETL. Since then he has focused his research in gas turbine combustion, pressure gain combustion and model validation.

RENAUD LE PIERRES

Renaud Le Pierres is responsible for assisting in the development of Heatric business within new markets, mainly power generation, chemical processing, carbon capture, and waste heat recovery.

He works within the Business Development team that, with the help of the Design Development Team, adapts existing products or develops new ones, when required, to satisfy these new markets requirements.

Renaud Le Pierres has been involved in sCO2 Power Conversion Cycles projects since 2005, with successful supplies of equipment to Sandi National Laboratories, Argonne National Laboratories, GE, and ECHOGEN.

In this role, he participates actively in the sCO2 community, including regularly presenting heat exchanger tutorials and chairing discussion panels at ASME Turbo Expo.

IVY TAYLOR, MAYOR, CITY OF SAN ANTONIO

Ivy R. Taylor was elected Mayor of San Antonio on June 13, 2015. Prior to that, she was appointed to the office of Mayor in July, 2014, to fulfill Julian Castro's unexpired term. She had served as the District 2 City Council Representative for a total of five years beginning with her election in June, 2009.

Mayor Taylor began her career working for the City of San Antonio in the Housing and Community Development Department and the Neighborhood Action Department. While at the City, she worked with a variety of neighborhood associations, developers and nonprofit organizations in order to facilitate inner city redevelopment. After six years, she left employment with the City of San Antonio to become Vice President at Merced Housing Texas. At Merced, she worked to create and implement programs to improve family stability for apartment community residents. For six years, Mayor Taylor also lectured at UTSA in the Public Administration Department.

During her tenure on the City Council and as Mayor, she has remained focused on balanced growth throughout our city and targeted investment in areas where opportunities have been limited. She led the effort to bring over $50 million in federal funding for revitalization of San Antonio's Eastside. As Mayor, she and the City Council worked with San Antonio Water System to achieve unanimous approval for the Vista Ridge Water Supply project which will help ensure water supply for our growing city.

Mayor Taylor currently serves on the board for Healthy Futures of Texas and Big Brothers Big Sisters of South Texas. She has served on the City's Planning Commission and as a Commissioner for the City's Urban Renewal Agency (SADA). Mayor Taylor completed the Leadership San Antonio class sponsored by the Greater San Antonio Chamber of Commerce, and in 2004 was acknowledged by the San Antonio Business Journal as a "Rising Star" in their "40 under 40" class.

Mayor Taylor obtained a Master's Degree in City and Regional Planning from the University of North Carolina at Chapel Hill in 1998. In 1992, she received a Bachelor's Degree from Yale University. Mayor Taylor is a devoted wife and a mother.

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