

November 1-2, 2017

**2017 UNIVERSITY TURBINE
SYSTEMS RESEARCH
PROJECT REVIEW MEETING**



U.S. DEPARTMENT OF
ENERGY



**NATIONAL
ENERGY
TECHNOLOGY
LABORATORY**





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About the UTSR Meeting

The National Energy Technology Laboratory University Turbine Systems Research (NETL-UTSR) program manages a portfolio of university-based turbine research projects. The UTSR program offers a Gas Turbine Industrial Fellowship funded by sponsoring gas turbine manufacturers. This fellowship has helped to facilitate the transition of the best students from academia to the gas turbine industry, thereby helping to maintain U.S. leadership in this important area of technology.

The success of the UTSR program has been made possible by a network of universities, the collaborating gas turbine industry, and the DOE turbine program – all of which are facilitated by an annual UTSR project review meeting, which is open to the public and brings together experts from academia, industry, and government to present and discuss ongoing turbine research sponsored by the DOE Office of Fossil Energy UTSR program under existing cooperative agreements.

The UTSR program chooses the meeting venues that are in close proximity to leading universities directly involved in turbine research. The 2017 UTSR project review meeting will be held at the DoubleTree by Hilton Hotel & Suites in downtown Pittsburgh, near the University of Pittsburgh campus in Pittsburgh, Pennsylvania. Pittsburgh is becoming a hub for additive manufacturing and the city is uniquely positioned to make a major impact in this field with the growing presence of manufacturers in the region combined with academic resources and customers for the products. Therefore, this year’s meeting theme is “Impact of Additive Manufacturing on Gas Turbines”. There will be two keynote speakers, Dr. Rob Gorham, and Dr. Dave Conover. Dr. Gorham is Executive Director of America Makes, an expert in advanced manufacturing and defense research. Dr. Conover is Chief Technologist for Mechanical Products of ANSYS, who has extensive experience in simulation software developments for turbomachinery, material processing, and manufacturing. The meeting will feature a panel discussion, which will focus on the impact of additive manufacturing on gas turbines. The meeting will include three technology tracks: Combustion/Pressure Gain Combustion, Aero/Heat Transfer/Supercritical CO₂, and Materials. The meeting will also include a majority of NETL’s extramural projects for the Advanced Turbines Program, as well as internal NETL R&D projects. The meeting will feature approximately 60 DOE sponsored projects in the form of oral and poster presentations.



UTSR Technology Summary

Since the inception of the DOE turbine program, the NETL-UTSR program has sought to support the underlying scientific research necessary to develop advanced turbines and turbine-based systems in support of the DOE's turbine program's strategic goals and program mission needs. This is accomplished by funding university-based research projects that address scientific R&D and technical challenges in turbine-based systems and technology. This research focuses on the fundamental and applied issues associated with advancing the performance and efficiency of turbines in fossil fuel power generation beyond current state-of-the-art. Technical areas of interest include combustion, aerodynamics, heat transfer, materials, technology development for supercritical carbon dioxide based power cycles, pressure gain combustion, and oxy-fuel turbine based systems and technology.

The projects are typically three years in duration and focus on applied laboratory/bench scale R&D. Currently 13 universities and 25 projects are involved in the NETL-UTSR program. The innovations and scientific understanding generated under this program will then be transferred to industry manufacturers for incorporation into their next generation turbine technology products with the goal of producing reliable, affordable, clean, efficient, and cost-effective energy supplies.

One of the main purposes of this UTSR project review meeting is to facilitate peer-to-peer knowledge sharing and collaboration across boundaries to create a network of expertise and facilitate the acceleration of advancements in those fields.



Organizing Committee

Klaus Brun
Patcharin (Rin) Burke
Minking Chyu
Bill Day
Richard Dennis
Karen Lockhart
Heather Quedenfeld

Southwest Research Institute
US DOE – NETL
University of Pittsburgh
KeyLogic
US DOE – NETL
SSC Deltha
US DOE – NETL



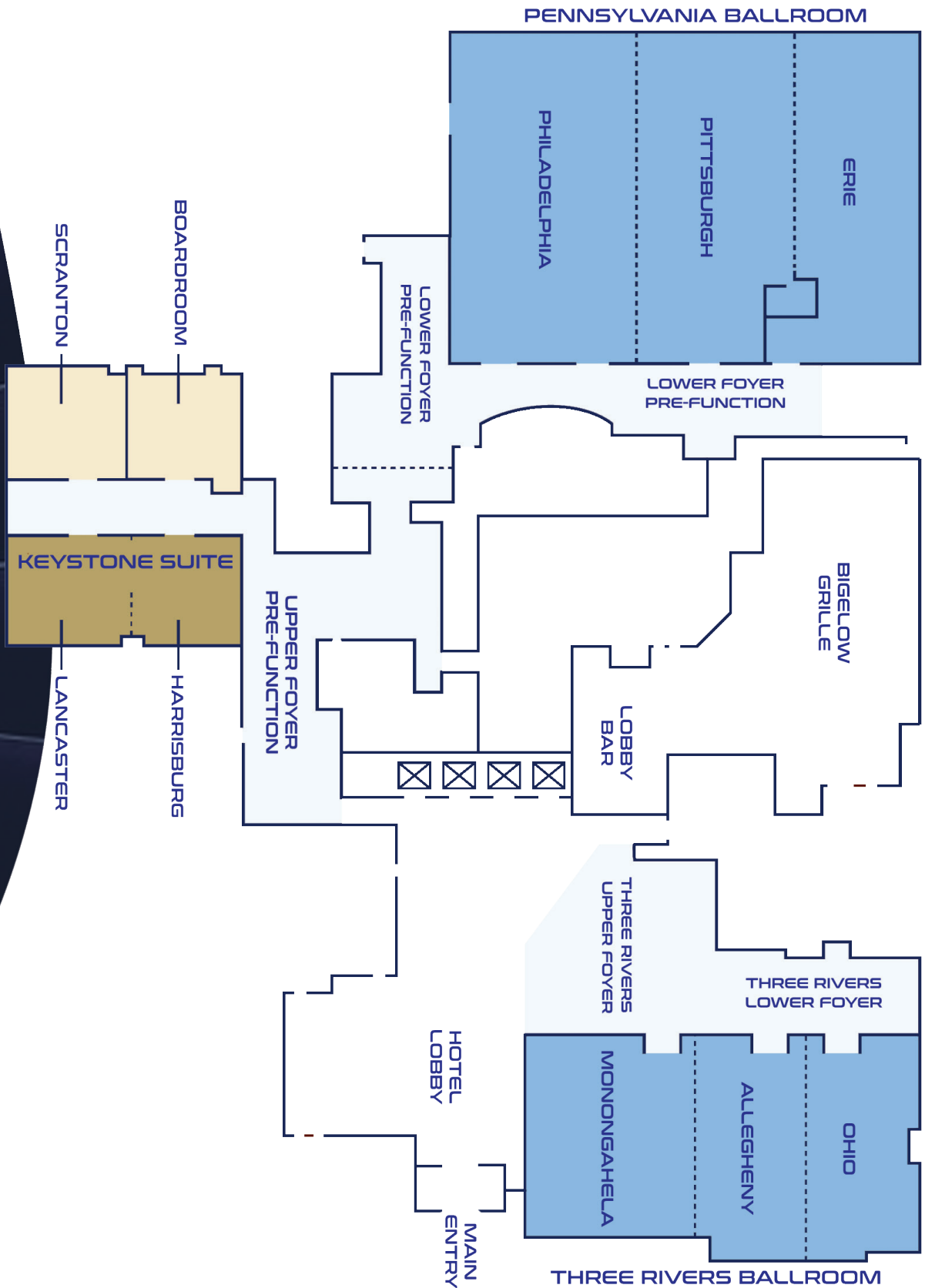
UTSR Industry Committee

John Alday
Klaus Brun
Daniel Burnes
Jim Downs
Tony Eastland
Jonathan Li
Kathryn Rominger

FlexEnergy
Southwest Research Institute
Solar Turbines, Inc.
Florida Turbine Technologies
Gas Technology Institute
Siemens Energy, Inc.
General Electric



Doubletree Floor Plan



LOBBY LEVEL



Agenda-At-A-Glance

Day/Time	Track 1-Combustion & Pressure Gain Comb	Track 2-Aero/Heat Transfer/sCO2	Track 3- Materials
Wednesday, November 1, 2017			
Wed, 7:00am	Registration - Pennsylvania Upper Foyer		
Wed, 7:00am	Continental Breakfast - Pennsylvania Lower Foyer		
Wed, 8:00am	General Session - Philadelphia/Pittsburgh Room		
Wed, 8:00am	Welcome and Introduction - Greg Reed, Director, Center for Energy, University of Pittsburgh		
Wed, 8:15am	Overview of DOE Advanced Turbines Program - Richard Dennis, Turbine Technology Manager, NETL		
Wed, 8:45am	Panel Discussion: Impact of Additive Manufacturing on Gas Turbines (John Barnes-Royal Melbourne Institute of Technology; Jack Beuth-Carnegie Mellon University; Richard Grylls-SLM Solutions; Kirk Rogers-GE; Ramesh Subramanian-Siemens; Albert To-University of Pittsburgh)		
Wed, 10:15am	Poster Session - Erie Room		
Wed, 11:00am	Supercritical Carbon Dioxide Pilot Plant Test Facility Project - Scott Macadam, GTI		
Wed, 11:30am	Lunch - Three Rivers Ballroom		
	Philadelphia Room	Pittsburgh Room	Harrisburg/Lancaster Room
	Moderator: Mark Freeman and Don Ferguson	Moderator: Robin Ames and Seth Lawson	Moderator: Patcharin Burke and Richard Dalton
	Combustion	Aero/Heat Transfer	Materials
Wed, 1:00pm	GE Power - Michael J. Hughes	The Pennsylvania State University - Karen Thole	Siemens Energy, Inc. - Jay Morrison
Wed, 1:45pm	Georgia Institute of Technology - Jerry Sietzman	Purdue University - Tom Shih	GE Power - John Delvaux
Wed, 2:30pm	Virginia Tech. - Suhyeon Park and Siddhartha Gadiraju and NC State University - Srinath Ekkad	University of North Dakota - Forrest Ames and Illinois Institute of Technology - Sumanta Acharya	Purdue University - Thomas Siegmund
Wed, 3:15pm	Poster Session - Erie Room		
Wed, 4:00pm	University of South Carolina - Tanvir Farouk	NETL - Selcuk Can Uysal and Sridharan Ramesh	Georgia Institute of Technology - Richard (Rick) Neu
Wed, 4:45pm	University of Michigan - Venkat Raman	University of Pittsburgh - Minking Chyu and West Virginia University - Bruce Kang	The Ohio State University - Pengyang Zhao
Wed, 5:30pm	Texas A&M University - Eric Petersen	The Ohio State University - Jeffrey Bons	Oak Ridge National Laboratory - Bruce Pint
Wed, 6:15pm	Meet, then Walk to the Energy Innovation Center for the Keynote Presentation and Reception		
Wed, 7:00 pm	Keynote Speech: A New Paradigm in US Innovation, Rob Gorham, Executive Director, America Makes		
Thursday, November 2, 2017			
Thur, 7:00am	Registration - Pennsylvania Upper Lobby		
Thur, 7:00am	Continental Breakfast - Pennsylvania Lower Lobby		
	Combustion	Supercritical CO2	Materials
	General Session - Philadelphia/Pittsburgh Room		
Thur, 8:30am	Keynote Presentation: New Simulation Frontiers in Gas Turbine Development, Dave Conover, Chief Technologist, ANSYS		
	Philadelphia Room	Pittsburgh Room	Harrisburg/Lancaster Room
	Moderator: Mark Freeman and Don Ferguson	Moderator: Robin Ames and Seth Lawson	Moderator: Patcharin Burke and Richard Dalton
Thur, 9:15am	Purdue University - Jay Gore	General Electric Global Research - Rahul Bidkar	Oak Ridge National Laboratory - Philip J. Maziasz
Thur, 10:00am	The Pennsylvania State University - Jacqueline O'Connor	Thar Energy, LLC - Marc Portnoff	NETL - Omer Dogan
Thur, 10:45am	Coffee Break - Erie Room		
	Pressure Gain Combustion	Supercritical CO2	Materials
Thur, 11:15am	Oregon State University - David L. Blunck	Electric Power Research Institute - Steven C. Kung	University of California, Irvine - Daniel Mumm
Thur, 12:00am	Lunch - Three Rivers Ballroom		
Thur, 1:00pm	University of Michigan - Mirko Gamba	University of Central Florida - Subith Vasu	Argonne National Laboratory - Jiangang Sun
Thur, 1:45pm	The Pennsylvania State University - Stephen Peluso	Georgia Institute of Technology - Wenting Sun	Electric Power Research Institute - Horst Hack
Thur, 2:30pm	Purdue University - Steve Heister	Southwest Research Institute - Jacob Delimont	Oak Ridge National Laboratory - Sebastien Dryepondt
Thur, 3:15pm	Coffee Break - Erie Room		
Thur, 3:45pm	NETL - Don Ferguson	NETL - Peter Strakey	Questek Innovations LLC - Ricardo Komai
Thur, 4:30pm	Aerojet Rocketdyne - Ken Sprouse	NETL - Seth Lawson and Robin Ames	Direct Vapor Technologies - Derek Hass
Thur, 5:15pm	Open Discussion, Workshop Summary, Closing Comments and Wrap-up - Richard Dennis, Turbine Technology Manager, NETL - Philadelphia/Pittsburgh Room		
Thur, 5:30pm	Adjourn		



WEDNESDAY, NOV. 1

7:00 a.m. – Registration - Pennsylvania Upper Foyer
Continental Breakfast - Pennsylvania Lower Foyer

General Session – Philadelphia/Pittsburgh Room

8:00 a.m. – Welcome and Introduction
Gregg Reed, Director, Center for Energy, University of Pittsburgh

8:15 a.m. – Overview of the U.S. Department of Energy's Advanced Turbines Program
Richard Dennis, Turbine Technology Manager, U.S. Department of Energy, National Energy Technology Laboratory

8:45 a.m. – Panel Discussion: Impact of Additive Manufacturing on Gas Turbines
Moderators: Richard Dennis, U.S. Department of Energy, National Energy Technology Laboratory, and Minking Chyu, University of Pittsburgh
John Barnes – Royal Melbourne Institute of Technology
Jack Beuth – Carnegie Mellon University
Richard Grylls – SLM Solutions
Kirk Rogers – GE Additive
Ramesh Subramanian – Siemens Energy, Inc.
Albert To – University of Pittsburgh

10:15 a.m. – Poster Session – Erie Room

11:00 a.m. – Supercritical Carbon Dioxide Pilot Plant Test Facility Project
Scott Macadam, Gas Technology Institute

11:30 a.m. – Lunch – Three Rivers Ballroom

Combustion (Track 1) – Philadelphia Room

Moderator: Mark Freeman and Don Ferguson, U.S. Department of Energy, National Energy Technology Laboratory

1:00 p.m. – Advanced Multi-Tube Mixer Combustion for 65% Efficiency
Michael Hughes, GE Power

1:45 p.m. – High Temperature, Low NO_x Combustor Concept Development
Jerry Seitzman, Georgia Institute of Technology



WEDNESDAY, NOV. 1

2:30 p.m. – Evaluation of Flow and Heat Transfer Inside Lean Pre-Mixed Combustor Systems Under Reacting Flow Conditions

Suhyeon Park and Siddhartha Gadiraju, Virginia Tech, and Srinath Ekkad, North Carolina State University

3:15 p.m. – Poster Session – Erie Room

4:00 p.m. – Final Report: An Experimental and Modeling Study of NO_x-CO Formation in High Hydrogen Content Fuels Combustion in Gas Turbines Applications

Tanvir Farouk, University of South Carolina

4:45 p.m. – Boundary Layer Flashback in Hydrogen-Rich Gas Turbines

Venkat Raman, University of Michigan

5:30 p.m. – High Pressure Turbulent Flame Speeds and Chemical Kinetics of Syngas Blends with and without Impurities

Eric Petersen, Texas A&M University

Aero/Heat Transfer (Track 2) – Pittsburgh Room

Moderator: Robin Ames and Seth Lawson, U.S. Department of Energy, National Energy Technology Laboratory

1:00 p.m. – START: Turbine Sealing of Underplatform Flows

Karen Thole, The Pennsylvania State University

1:45 p.m. – RANS and LES of Internal and Film Cooling

Tom Shih, Purdue University

2:30 p.m. – Thermally Effective and Efficient Technologies for Advanced Gas Turbines

Forrest Ames, University of North Dakota and Sumanta Acharya, Illinois Institute of Technology

3:15 p.m. – Poster Session – Erie Room

4:00 p.m. – Cooled Turbine Model with Advanced Cooling Calculations

Selcuk Can Uysal, U.S. Department of Energy, National Energy Technology Laboratory and Sridharan Ramesh, WVURC

4:45 p.m. – Design, Fabrication and Performance Characterization of Near-Surface Embedded Cooling Channels (NSECC) with an Oxide Dispersion Strengthened (ODS) Coating Layer

Minking Chyu, University of Pittsburgh and Bruce Kang, West Virginia University

5:30 p.m. – Revolutionizing Turbine Cooling with Micro-Architectures Enabled by Direct Metal Laser Sintering

Jeffrey Bons, The Ohio State University



WEDNESDAY, NOV. 1

Materials (Track 3) – Harrisburg/Lancaster Room

Moderator: Patcharin Burke, U.S. Department of Energy, National Energy Technology Laboratory
and Richard Dalton, KeyLogic

1:00 p.m. – CMC Advanced Transition for 65% Combined Cycle
Jay Morrison, Siemens Energy, Inc.

1:45 p.m. – High Temperature Ceramic Matrix Composite Nozzles for 65% Efficiency
John Delvaux, GE Power

2:30 p.m. – Creep-Fatigue Interaction in IN 718
Thomas Siegmund, Purdue University

3:15 p.m. – Poster Session – Erie Room

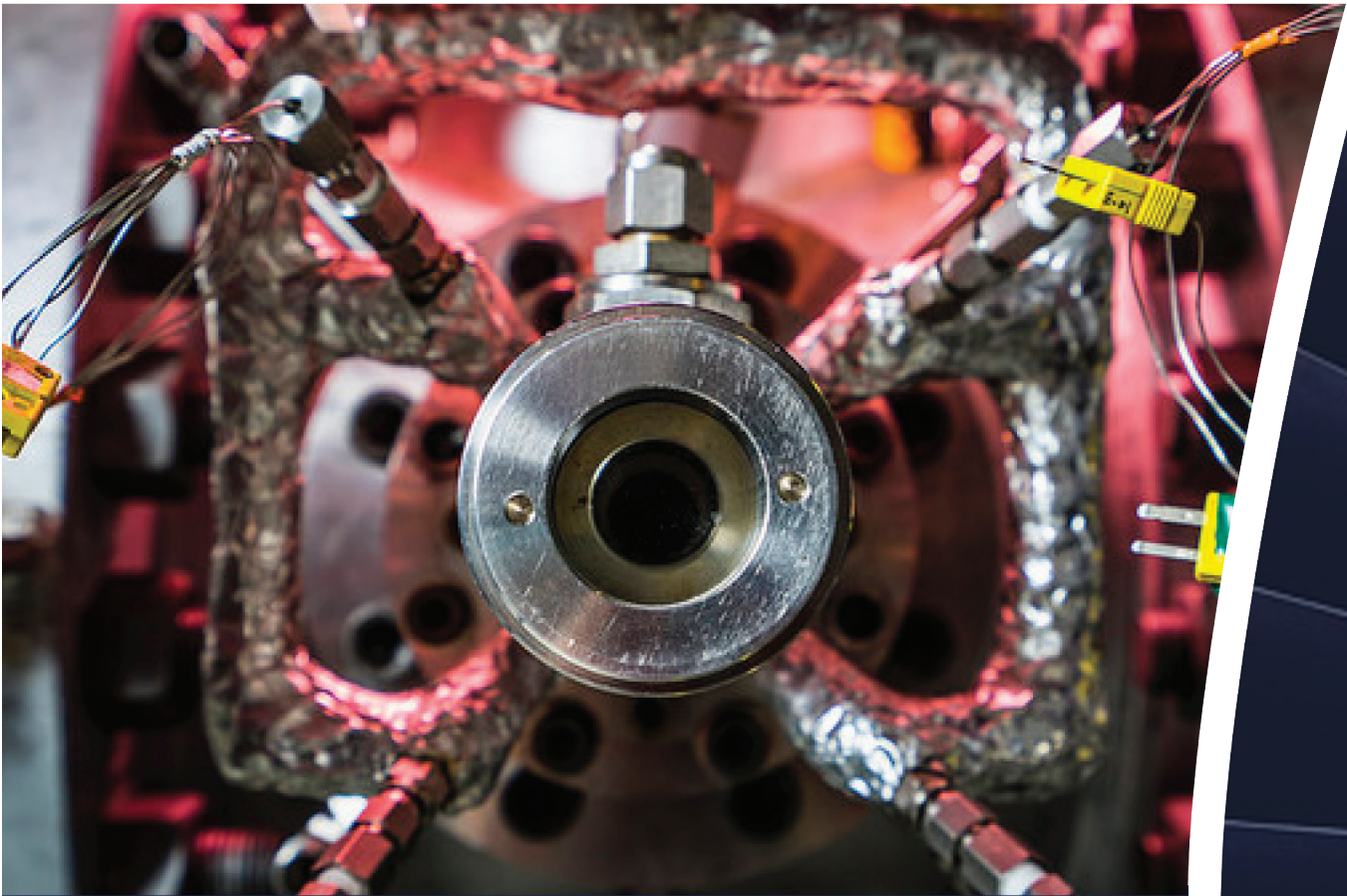
4:00 p.m. – Microstructure Sensitive Crystal Viscoplasticity for Ni-Base Superalloys
Richard (Rick) W. Neu, Georgia Institute of Technology

4:45 p.m. – ICME for Creep of Ni-Base Superalloys in Advanced Ultra-Supercritical
Steam Turbines
Pengyang Zhao, The Ohio State University

5:30 p.m. – Materials Issues for Advanced Supercritical CO₂ and High Efficiency
Gas Turbines
Bruce Pint, Oak Ridge National Laboratory

6:15 p.m. – Energy Innovation Center, Keynote Presentation

7:00 p.m. – Keynote Speech
A New Paradigm in U.S. Innovation
Rob Gorham, America Makes



THURSDAY





THURSDAY, NOV. 2

7:00 a.m. – Registration - Pennsylvania Upper Foyer
Continental Breakfast - Pennsylvania Lower Foyer

General Session – Philadelphia/Pittsburgh Room

8:30 a.m. – Keynote Presentation
New Simulation Frontiers in Gas Turbine Development
Dave Conover, ANSYS

Combustion (Track 1) – Philadelphia Room

Moderator: Mark Freeman and Don Ferguson, U.S. Department of Energy, National Energy Technology Laboratory

9:15 a.m. – Effects of Exhaust Gas Recirculation (EGR) on Turbulent Combustion
Jay Gore, Purdue University

10:00 a.m. – Understanding Transient Combustion Phenomena in Low-NO_x Gas Turbines
Jacqueline O'Connor, The Pennsylvania State University

10:45 a.m. – Break – Erie Room

Pressure Gain Combustion (Track 1) – Philadelphia Room

11:15 a.m. – Development of Coal Fired PDE
David L. Blunck, Oregon State University

12:00 p.m. – Lunch – Three Rivers Room

1:00 p.m. – An Experimental/Computational Study of Non-Idealities in Practical Rotating Detonation Engines
Mirko Gamba, University of Michigan

1:45 p.m. – Effect of Mixture Concentration Inhomogeneity on Detonation Properties in Pressure Gain Combustors
Stephen Peluso, The Pennsylvania State University

2:30 p.m. – Update on Rotating Detonation Combustion Studies
Steve Heister, Purdue University

3:15 p.m. – Break – Erie Room



THURSDAY, NOV. 2

3:45 p.m. – Overview of Research on Rotating Detonation Engines at NETL
Don Ferguson, U.S. Department of Energy, National Energy Technology Laboratory

4:30 p.m. – Rotating Detonation Combustion for Gas Turbines
Ken Sprouse, Aerojet Rocketdyne

Supercritical CO₂ (Track 2) – Pittsburgh Room

Moderator: Robin Ames and Seth Lawson, U.S. Department of Energy, National Energy Technology Laboratory

9:15 a.m. – Low-Leakage Seals for Utility-Scale sCO₂ Turbines
Rahul Bidkar, General Electric Global Research

10:00 a.m. – Development of Modular, Low-Cost, High-Temperature Recuperators for the sCO₂ Power Cycle - Project Update
Marc Portnoff, Thar Energy, LLC

10:45 a.m. – Break – Erie Room

11:15 a.m. – Predicting the Oxidation/Corrosion Performance of Structural Alloys in Supercritical CO₂
Steven C. Kung, Electric Power Research Institute (EPRI)

12:00 p.m. – Lunch – Three Rivers Room

1:00 a.m. – Chemical Kinetic Modeling Development and Validation Experiments for Direct Fired Supercritical Carbon Dioxide Combustor
Subith Vasu, University of Central Florida

1:45 p.m. – Investigation of Autoignition and Combustion Stability of High Pressure Supercritical Carbon Dioxide Oxy-Combustion
Wenting Sun, Georgia Institute of Technology

2:30 p.m. – Combustor Design for Direct Fired Supercritical CO₂ Oxy-Combustion
Jacob Delimont, Southwest Research Institute

3:15 p.m. – Break – Erie Room

3:45 p.m. – Oxy-Combustion Fundamentals for Direct-Fired Cycles
Peter Strakey, U.S. Department of Energy, National Energy Technology Laboratory

4:30 p.m. – sCO₂ R&D Status Facilitated Discussion
Seth Lawson and Robin Ames, U.S. Department of Energy, National Energy Technology Laboratory



THURSDAY, NOV. 2

Materials (Track 3) – Harrisburg/Lancaster Room

Moderator: Patcharin Burke, U.S. Department of Energy, National Energy Technology Laboratory and Richard Dalton, KeyLogic

9:15 a.m. – Properties of Advanced Ni-Based Alloys for A-USC Steam Turbines
Philip J. Maziasz, Oak Ridge National Laboratory

10:00 a.m. – Materials and Manufacturing for Supercritical CO₂ Power Cycles
Omer Dogan, U.S. Department of Energy, National Energy Technology Laboratory

10:45 a.m. – Break – Pennsylvania Lower Foyer

11:15 a.m. – Abradable Sealing Materials for Emerging IGCC-Based Turbine Systems
Daniel Mumm, University of California, Irvine

12:00 p.m. – Lunch – Monongahela/Allegheny Room

1:00 p.m. – Gas Turbines Materials Life Assessment and Non-Destructive Evaluation
Jiangang Sun, Argonne National Laboratory

1:45 p.m. – Advanced Ultra-Supercritical Component Testing
Horst Hack, Electric Power Research Institute

2:30 p.m. – Microstructure and Properties of Hastelloy X Fabricated by Additive Manufacturing
Sebastien Dryepondt, Oak Ridge National Laboratory

3:15 p.m. – Break – Erie Room

3:45 p.m. – Exploration of High Entropy Alloys for Turbine Applications
Ricardo Komai, QuesTek Innovations, LLC.

4:30 p.m. – Advanced Bond Coats for Thermal Barrier Coating Systems Based on High Entropy Alloys
Derek Hass, Direct Vapor Technologies International

Open Discussion – Philadelphia/Pittsburgh Room

5:15 p.m. – Workshop Summary, Closing Comments and Wrap-Up
Richard Dennis, U.S. Department of Energy, National Energy Technology Laboratory

5:30 p.m. – Adjourn





KEYNOTE SPEAKERS

DAVID CONOVER

David Conover has over 35 years of experience in mechanical CAE software development with ANSYS, Inc. During his career as a software developer at ANSYS, he has been involved in the development of elements, nonlinear material models, solution strategies, and solvers. Conover also architected the FEA solver code in use today and led the efforts to embrace distributed memory parallelism within it. He played a leading role in modernizing the mechanical turbomachinery capabilities, including mistuning and forced response. Lately, he has been spearheading a team to support additive manufacturing (3D printing) including topology optimization and process simulation. Conover has also managed the development group and in his current position as Chief Technologist, he leads the R&D initiatives concerning mechanical applications at ANSYS, Inc. Conover has a BS and MS in Civil Engineering from Carnegie Mellon University.

RICHARD DENNIS

Richard Dennis is currently the Technology Manager for Advanced Turbines and Supercritical Carbon Dioxide Power Cycle Programs at the U.S. Department of Energy's National Energy Technology Laboratory (NETL). These programs support university, industry and U.S. national laboratory research, development and demonstration projects. Dennis has a BS and MS in Mechanical Engineering from West Virginia University. From 1983 to 1992, Dennis worked in the on-site research group of NETL where he conducted research related to pressurized fluidized bed combustion, gasification and gas stream particulate cleanup for advanced coal based power generation. From 1993 to 2000, Dennis managed contracted research for the DOE Office of Fossil Energy in advanced fossil fuel power generation including coal combustion, gasification, fuel cells, and gas turbines. In 2002, Dennis was selected as the Turbine Technology Manager. In 2014 – 15, Dennis served as the technology manager for the DOE FE Advanced Combustion Systems technology area. Currently, Dennis is serving as the Technology Manager for Advanced Turbines and Supercritical Carbon Dioxide Power Cycles programs at NETL.

ROB GORHAM

Rob Gorham joined the America Makes team in 2013 as the Deputy Director of Technology Development and in May 2014 was promoted to Director of Operations. In May 2017, Gorham was promoted to Executive Director of America Makes. He has more than a decade of solid defense research and advanced manufacturing experience. Prior to joining America Makes, Gorham was the Senior Manager of the Manufacturing Exploration and Development (MXD) group within the Advanced Manufacturing Systems and Prototyping (AMS&P) directorate of Lockheed Martin (LM) Aeronautics – Advanced Development Programs (ADP). In this position, Gorham was responsible for leading the transition-focused development and the application of affordable manufacturing technologies for LM Aeronautics and other LM Business Areas across the corporation.



KEYNOTE SPEAKERS

GREGG REED

Dr. Gregory Reed is the Director of the University of Pittsburgh's Center for Energy and the Energy GRID Institute; Director of the Electric Power Systems Laboratory in the Swanson School of Engineering at Pitt; and Professor of Electric Power Engineering in the Swanson School's Electrical & Computer Engineering Department. He is also the Director of the Grid Technologies Collaborative for the U.S. Department of Energy; and an inaugural member of the National Academies of Science and Engineering's Energy Ambassador Program. In addition to these roles, Dr. Reed is the owner and principal consultant of Power Grid Technology Consulting, LLC, and serves as Chief Science Advisor on the Board of Directors for the E-Merge DC Alliance.



PANELISTS

JOHN BARNES

John Barnes is the Founder and Managing Director of The Barnes Group Advisors. John founded TBGA after 25 years of service in leadership roles at Arconic, the Commonwealth Scientific Industrial Research Organization of Australia, Lockheed Martin Skunk Works™ and Honeywell Aerospace to address the growing industrialization needs of additive manufacturing. Barnes brings 20+ years of metal additive manufacturing, plus 25 years of complex product development to solve the toughest problems together with his team of Advisors, who all told have 55 years of AM experience.

Prior to The Barnes Group Advisors he was

- Vice President of Advanced Manufacturing & Strategy at Arconic, where he developed the proposal and qualification of the first series production titanium AM parts for Airbus
- Director of the High Performance Metal Industries Program for CSIRO, the national science agency for Australia, where he stood up the first national additive manufacturing innovation center
- Senior Manager for Manufacturing Exploration and Development at Lockheed Martin Skunk Works, where he implemented technology on F-22, X-47B and classified programs
- Program Manager of Marine Engines programs at Honeywell Engines

He has supported advanced materials, processing, manufacturing and product development projects in titanium, advanced polymers, composites, carbon nanotubes, novel metal extraction/ production, additive manufacturing of both polymer and metallic systems and low observable manufacturing methods.



PANELISTS

JACK L. BEUTH

Dr. Jack L. Beuth is Professor of Mechanical Engineering at Carnegie Mellon University. Dr. Beuth received his Ph.D. in Engineering Sciences from Harvard in 1992. He has been a researcher in the field of additive manufacturing for over 20 years. Dr. Beuth's modeling research in additive manufacturing has led to the development of "process map" approaches for mapping out the role of principal process variables on process characteristics such as melt pool geometry, microstructure, porosity and build rate. His research is allowing unique insights into process control, expansion of process operating ranges, identification of tests needed to characterize a process, and unique comparisons of AM processes operating in very different regions of processing space.

RICHARD GRYLLS

Dr. Grylls received a bachelor's degree in Materials Science from The University of Oxford, and a Ph.D. in Metallurgy from The University of Birmingham. In 1998, he joined GE Aviation in the turbine airfoil materials development group, and became responsible for single-crystal nickel-base superalloy development, as well as materials development for airfoil repair. He also led a multidisciplinary team developing next-generation turbine engine alloys and coating systems. In 2001 Dr. Grylls joined Optomec to lead materials and process development and application for the LENS metal 3D Printing technology. In 2015, he joined SLM Solutions North America as their technical director. In this role, he is responsible for technical leadership for the SLM Solutions metal 3D printers in the USA. Dr. Grylls is co-inventor on 22 U.S. patents and three European patents, and has co-authored 23 technical papers.

KIRK ROGERS

Dr. Kirk Rogers is Technology Leader, Additive Manufacturing at the GE Additive N. American Customer Experience Center (CeC), in Pittsburgh, PA. He has used additive technology to solve manufacturing & supply chain problems for the last 10 years. His priorities at the CeC have been startup and university partner identification and relationship building, matching the technology portfolio to business projects, and team leadership in engineering design for Additive Manufacturing. Prior to CATA, Dr. Rogers spent 15+ years at GE Healthcare where he designed manufacturing processes for and launched new products; Identified and applied new process methodologies and inspection techniques; and developed patent and technology strategy. Between GE assignments, he also did a short stint at Carlisle Brake and Friction, developing methodologies to transform carbon composite materials.

Dr. Rogers has 25 years of experience in materials processing, primarily powder metallurgy, 15 of which were focused on P/M of refractory metals. He has also done research on novel joining methods, novel molybdenum and tungsten alloys, recycling and sustainable manufacturing. A technical innovator, and adept thinker, Rogers has obtained 3 US patents, more than 20 ideas filed as trade secrets or patent disclosures, and has produced more than 30 publications. Recently, he has become a known public speaker and regional thought leader in AM, having given several Keynotes in the past calendar year.

Rogers obtained his B.S. Materials Engineering from Case Western Reserve University, and masters and Ph.D in Materials Science and Engineering from Purdue University. He completed postdoctoral work at Ohio State University, and is a certified Six Sigma Blackbelt.



PANELISTS

RAMESH SUBRAMANIAN

Ramesh Subramanian is a Principal Expert in the Gas Turbine Engineering Organization and a senior member of the Additive Manufacturing Implementation Team for large gas turbines. He is a key technical advisor to Siemens Management on advanced materials and manufacturing technologies. At Siemens, he has led the research and development of Advanced Thermal Barrier coatings for gas turbines for 15 years. During this time, he was responsible for the strategic direction, intellectual property generation, development and implementation of advanced coatings in industrial gas turbine components for both the service fleet and new engines. Following this, he was responsible for innovation management for gas turbine technologies for advanced high efficiency engines. As part of the additive manufacturing team, Subramanian is responsible for establishing a strong foundation in materials uncertainty quantification and impact on component risk. He is also pursuing the application of advanced materials data analytics and machine learning for faster deployment of gas turbine products. Subramanian received his Ph.D. in Materials Science and Engineering from Cornell University and Bachelor's degree in metallurgical engineering from the Indian Institute of Technology, Bombay. He has 70 issued patents to date and 36 reviewed journal papers. He was awarded the Siemens Inventor of the year in 2001 and Siemens Top Innovator in 2007. He is a member of the ASM-Thermal Spray Society, American Ceramic Society and ASME.

ALBERT TO

Dr. Albert To is currently Associate Professor & CNG Faculty Fellow in the Department of Mechanical Engineering and Materials Science at University of Pittsburgh, where he also serves as the Director of the ANSYS Additive Manufacturing Research Laboratory. He received his BS degree from UC Berkeley and MS degree from MIT. He obtained his Ph.D. from UC Berkeley in 2005 under the supervision of Shaofan Li and Steve Glaser and conducted postdoctoral research with Wing Kam Liu at Northwestern University from 2005-2008. Dr. To joined the University of Pittsburgh as an Assistant Professor in 2008. His research interests lie in design optimization and process modeling for additive manufacturing, multiscale methods, and computational mechanics. Currently, his research group is actively working on developing the "Lattice Structure Design Optimization" software for generating optimal lightweight designs for additive manufacturing. He has over 70 peer-reviewed journal publications in journals such as *Additive Manufacturing*, *Computer Methods in Applied Mechanics and Engineering*, *Journal of Mechanics and Physics of Materials*, and *Scripta Materialia*. He is an editorial board member of *Additive Manufacturing*, *International Journal of Rapid Manufacturing*, and *Journal of Micromechanics and Molecular Physics*. He was a recipient of the NSF BRIGE award in 2009 and the 2016-2017 Board of Visitors Faculty Award for the single faculty who had the most productive previous academic year in the engineering school at Pitt.



POSTER PRESENTATIONS

The Effect of Transient Fuel Staging on Self-Excited Instabilities in a Multi-Nozzle Gas Turbine Combustor
Wyatt Culler, The Pennsylvania State University

Improving NO_x Entitlement with Axial Staging
Scott Martin, Embry-Riddle Aeronautical University

Topology Optimization of Variable-Density Lattice Structure for Highly Efficient Convective Heat Transfer
Lin Cheng, University of Pittsburgh

Modified Method of Inherent Strain for Prediction of Residual Distortion in Metal Additive Manufacturing
Xuan Liang, University of Pittsburgh

Discrete Element Roughness Modeling for Design Optimization of Additively and Conventionally Manufactured Internal Turbine Cooling Passages
Robert Kunz, The Pennsylvania State University

Turbulence Effects on Chemical Pathways for N-Dodecane
Debolina Dasgupta, (presenter Tim Lieuwen), Georgia Institute of Technology

ICME Design of High-Temperature Turbine Materials
James Saal, QuesTek Innovations

In-Situ Optical Monitoring of Operating Gas Turbine Blade Coatings Under Extreme Environments
Ranajay Ghosh, University of Central Florida

Enhancing Heat Transfer Performance and Oxidation Resistance of Near Surface Cooling Channels Using Additive Manufacturing Technologies
Sarwesh Narayan Parbat, University of Pittsburgh

Thermal-Fluid and Mechanical Investigation of Additive Manufactured Geometries for Enhanced Transpiration Cooling
Zheng Min, University of Pittsburgh

Injector Design for an sCO₂ Cycle, Oxy-Fuel Combustor
Timothy Cook, UTSR Gas Turbine Fellowship Program

Durable High Temperature Thermal Barrier Coatings
Amarendra K. Rai, UES Inc.



POSTER PRESENTATIONS

Predictive Analytics Using Large-Scale Degradation Data

Nagi Gebraeel, Georgia Institute of Technology

Fuel Injection Dynamics and Composition Effects on RDE Performance

Mirko Gamba, University of Michigan

ANSYS 17.2 Thermal Verification

Selvin Reyes, University of Central Florida

High Frequency Transverse Combustion Instabilities in Low-NO_x Gas Turbines

Vishal Acharya, Georgia Institute of Technology

High-Fidelity Simulation of Turbulent Mixing and Combustion for Supercritical CO₂ Power Systems

Reza Sheikhi, Dena Scientific

High Temperature, Low NO_x Combustor Concepts

Matthew Sirignano, Georgia Institute of Technology

Feasibility of Micro Heat Flux Gauges on Polyimide

Shawn Siroka, The Pennsylvania State University

Effectiveness & Additively Manufactured 777 & Tripod Film Cooling Holes

Jacob Snyder, The Pennsylvania State University

Large Eddy Simulations for Direct-Fired Supercritical CO₂ Combustor

D.T. Banuti, D. Kim, S. Bose and L. Shunn, Cascade Technologies, Inc.

Surface Patterning and the Effects on Dynamic Characteristics of Annular Hole-Pattern Seals

Alexandrina Untaroiu, Virginia Tech

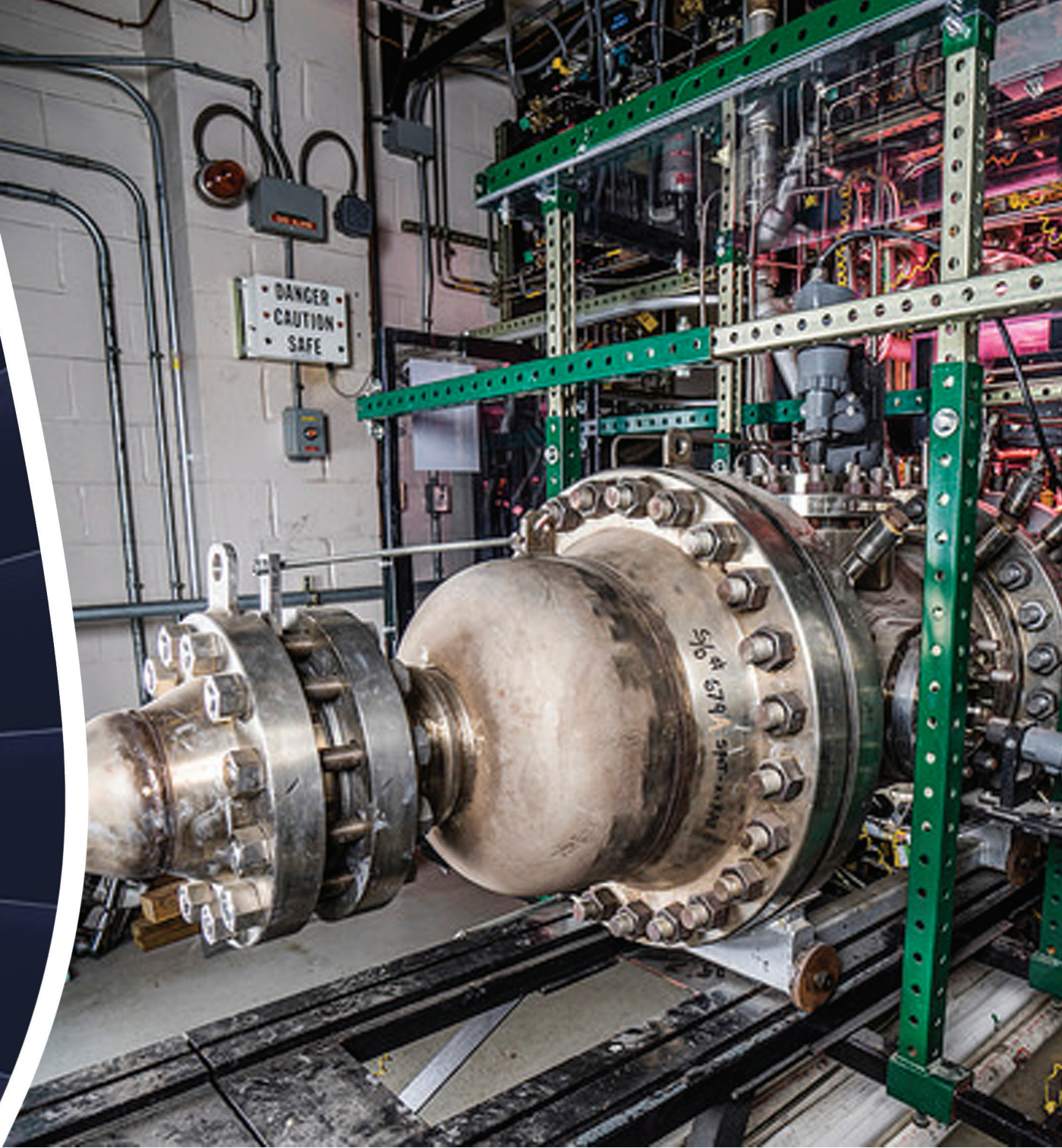
Superalloy MMC Components for Advanced Turbine Systems

D. Baker and A. Biswas, Advanced Powder Solutions, Inc. and

G. Dinda, Wayne State University and S. Kottlingham, General Electric

Integrated TBC/EBC for SiC Fiber Reinforced SiC Matrix Composites for Next Generation Gas Turbines

Rajendra K. Bordia, Clemson University



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