global Gas Turbine News

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ATLANTA, GEORGIA USA /// ASME INTERNATIONAL GAS TURBINE INSTITUTE

Get Ready for ASME Turbo Expo 2012 in Copenhagen!

In this issue

Turbo Expo attendees celebrated the launch of ASME Turbo Expo 2012 during the closing ceremony of the 2011 exposition in Vancouver. Join us at the Bella Center, June 11-15, 2012, in Copenhagen, Denmark, for ASME Turbo Expo 2012!

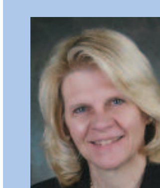
Conference Chair Karen Thole spotlighted other members of the 2012 leadership team, including Executive Conference Chair Lennart Nilsson and Technical Program Chair Jaroslaw Szwedowicz.

Lennart Nilsson has been responsible for gas turbines worldwide at Siemens AG since 2009. In the 1980s he worked for Westinghouse as a development engineer for large steam turbine generators and for Mitsubishi Electric as an exchange engineer. Nilsson entered engineering management in the 1990s and became involved in worldwide generator activities; in 1998, he took over responsibility of the Westinghouse facility in Poland. Three years later he became head of generators in Muelheim, Germany, and by 2005 his responsibilities expanded to include generators worldwide.

Jaroslaw Szwedowicz is Program Manager "Technology and Methods" for Alstom Power in Switzerland. He is responsible for product technology for the service of gas turbines, offering further enhanced performance, extended lifetime and environmental solutions across the plant life cycle through continuous product improvements. He has over 20 years of industry and academic experience in lifetime methodologies of mechanical systems. Jaroslaw has authored over 30 technical publications, and holds 3 patents with over 10 patent applications pending. He chairs the IGTI Structures and Dynamics Committee, and previously served as committee vice chair, vanguard, and session organizer. Szwedowicz is an associate editor of the ASME *Journal of Engineering for Gas Turbines and Power* and also serves as a board member of the Swiss Section of the ASME.

Visit www.turboexpo.org today for the latest details.

Lennart Nilsson



Karen Thole

Jaroslaw Szwedowicz

Call for Papers ASME Turbo Expo 2012

Abstracts are due by **September 12, 2011**, and must be submitted online (plain text, 400 word limit) via the IGTI Conference Web site at www.turboexpo.org.

The 2012 Publication Schedule:

- Abstract Submission - **September 12, 2011**
- Draft Paper Due Date - **November 14, 2011**
- Paper Reviews Complete - **December 19, 2011**
- Author Notification of Paper Acceptance - **January 16, 2012**
- Submission of Final Paper - **February 27, 2012**
- Final Paper Approval by Review Chair - **March 26, 2012**

Exposition

When you exhibit at Turbo Expo, you will be among other key industry players. Turbo Expo brings together the top players in the turbomachinery industry and academia – attracting a key audience from aerospace, power generation and other prime mover-related industries. Exhibiting at Turbo Expo will maximize your ROI by placing your company in front of a focused target market, enabling you to generate high-quality leads to achieve your marketing objectives.

Exciting brand-enhancing sponsorship packages are also available! Packages are designed around your particular corporate goals and are an extremely effective way for your company to really stand out from the crowd – before, during and after the Show.

To insure your company's participation in the 2012 exposition, contact IGTI at +1-404-847-0072 x1646 or via e-mail at igtiexpo@asme.org. *

View From The Chair

By Klaus Brun, Ph.D., Chair, IGTI Board

Klaus Brun, Ph.D., is the Manager of the Machinery Section of Southwest Research Institute in San Antonio, Texas.

Welcome to the *Global Gas Turbine News* (GGTN), the quarterly newsletter of the International Gas Turbine Institute (IGTI). I have the great honor of being the Chair of the IGTI Board for the next 12 months, and I am looking forward to working with all of you during this period. During my term as Chair, I will try to frequently communicate with you through GGTN, the IGTI web-page, and e-mails, and I would like to solicit your candid feedback about the direction and operation of the institute.

We have just completed another record-breaking Turbo Expo 2011 in Vancouver which - because of our strong volunteer support - was another great success for the gas turbine and turbomachinery community. Thank you very much for all the hard work you have put in organizing this event.

I also want to take this opportunity to thank Ron Bunker, the outgoing board chair, for the outstanding service he has provided to IGTI during the previous 12 months. He has certainly made strong positive mark on our organization, and I look forward to continue working with him in the future.

It is customary for the new IGTI board chair to set the tone for the direction of IGTI and indicate to membership where we will aim to take our organization this year. It is my intention to change things a bit: After the IGTI board has spent the last few years improving our synergy with ASME, IGTI will now focus internally on improving upon our existing products, as well as expanding into new services in our continuing effort to support the needs of our broad turbomachinery community.

Progress in these areas has already been made over the past years on items such as the refurbished IGTI web-page which features a "Job Board" and an "IGTI Who's Who" and much other useful information about IGTI training, conferences, networking opportunities, scholarships, and publications. I encourage all of you to visit the website at http://igti.asme.org/ to see what is already there and to let me know how we can make it better.

Another area that has seen improvements has been the Turbo Expo review process web-tool, although judging from membership feedback, there are still vast opportunities to make this better. We will work on this, and I hope that all of you will continue to provide the IGTI board and staff with open and frank feedback on this most critical tool in our Turbo Expo conference process. We always, always want to know how we can improve the quality of the paper review process while maintaining fairness and expediency for the authors.

The IGTI Plus initiative has led to new and exciting additions to Turbo Expo such as wind turbines, steam turbines, fans & blowers, and concentrated solar power. Clearly, the IGTI technical community has huge experience that can be utilized in these fields, and we need your help to grow these and other areas where IGTI can positively contribute to the overall turbomachinery community. Our focus will remain gas turbines, but all aspects of energy exploration, conversion, and delivery that involve rotating turbomachines can benefit from our expertise and accumulated knowledge.

Over the last 40 years, the volunteer community of IGTI has created a tremendous number of technical papers which were published at Turbo Expo. An effort to digitize all these papers is nearing completion, and the IGTI board is currently evaluating how to best disseminate this valuable information back to our members. Clearly, this is a product that was created by IGTI volunteers, and it should be made available to our membership as soon as possible. Options for this process range from downloadable papers from our website to complete CDs of all of IGTI technical papers. It is very important that we hear from you about how you would like these papers to be made available to IGTI members.

IGTI has ramped up training opportunities over the last few years in the form of webinars, multi-day classes, self-study courses, and workshops. A good example of this initiative was the gas turbine training week held in February at SwRI. We had 36 attendees participate in the five days of classes covering such areas as gas turbines and compressors, root cause failure analysis, rotordynamics, and field testing. Because of the success of this event, we are now evaluating whether we should hold a similar event in Europe or in Asia. Please let me know if you have any ideas on possible locations and topics.

Again, your feedback is valuable, and I will attempt to respond to all emails or letters from you. Please help us in finding new ways on how we can improve IGTI for all of you.

You can drop me a note at klaus.brun@swri.org or call me at 210-522-5449.

Thanks. ✲

Turbo Expo 2011 attendees at the annual Women Working in Turbomachinery Dinner.

The 2011 Women's Dinner attendees enjoy the skyride up to a chalet on Grouse Mountain.

Welcome New IGTI Board Members!

Dr. Howard Hodson, Professor of Aerothermal Technology and Director of the Whittle Laboratory at the University of Cambridge, is our new Incoming Member. Dr. Allan Volponi, Discipline Chief and Senior Fellow for Diagnostics, Prognostics and Health Management at Pratt & Whitney is serving as our new Member-at-Large. Please refer to the April issue of the *Global Gas Turbine News*, page 50, for more detailed information.

CALENDAR OF EVENTS

SEPTEMBER 12-15, 2011
40th Turbomachinery Symposium
George R. Brown Convention Center | Houston, TX USA
The Symposium, which features technical sessions and an exposition, focuses on users concerned with maintenance, performance, troubleshooting, operation, and purchase of rotating equipment. Visit IGTI in booth #308!

SEPTEMBER 28, 2011
Wind Turbine Tutorial Webinar
11:00 AM - 12:00 PM EDT | Register today: http://igti.asme.org
This tutorial provides an overview of wind turbine technology as we know it today. Starting from a historical perspective, the concept of wind power is developed up through today's standards. In addition, a discussion of the technology development needs will provide attendees with insight into potential areas of research and development.

OCTOBER 10-14, 2011
Combined Heat & Power Course

OCTOBER 31 – NOVEMBER 4, 2011
Design and Performance of the Axial Turbine Component of Gas Turbine Engines
Cranfield University | Bedfordshire, UK
http://www.cranfield.ac.uk/soe/shortcourses/gte/

NOVEMBER 3, 2011
Engineering Ethics in Action Webinar
11:00 AM - 12:00 PM EST | Register today: http://igti.asme.org

NOVEMBER 7-11, 2011
IGTI Gas Turbine Training Week (Europe)
Helmut-Schmidt University | Hamburg, Germany
Co-sponsored by Southwest Research Institute & Solar Turbines Inc.

Nov. 7–8: Introduction to Gas Turbines and Centrifugal Compressors
Nov. 9: Machinery Performance Testing and Troubleshooting
Nov. 10: Root Cause Failure Analysis of Gas Turbines
Nov. 11: Rotor and Blade Dynamics

For more details and to register, visit http://igti.asme.org.

NOVEMBER 13-18, 2011
International Gas Turbine Congress 2011
Osaka, Japan
The IGTC'11 promises to continue the tradition of nine previous congresses held in Japan, bringing together people from academia, industry, and government to share in the latest information on developments in the field of gas turbines, turbochargers, steam turbines, and their applications.
For more info, visit: http://www.gtsj.org/english/igtc/IGTC11/index.html

NOVEMBER 21-25, 2011
Gas Turbine Technology for Operations and Maintenance Engineers Course
Cranfield University | Bedfordshire, UK
http://www.cranfield.ac.uk/soe/shortcourses/gte/

FEBRUARY 27- MARCH 2, 2012
IGTI Gas Turbine Training Week (USA)
Southwest Research Institute | San Antonio, TX USA

Feb. 27–28: Gas Turbines & Compressors
Feb. 29: Root Cause Failure Analysis
Mar. 1: Rotor and Blade Dynamics
Mar. 2: Field, Factory Testing and Dynamics

For more details and to register, visit http://igti.asme.org.

APRIL 18-20, 2012
International Conference on Fan Noise, Technology and Numerical Methods
Congress Centre of CETIM | Senlis, France
This event will be a forum for fan and system designers, manufacturers and operators, with the aim of improving our understanding of fans and their system interaction. The conference combines the next in the series of IMechE international conferences on Fan Technology and the CETIAT/CETIM International Symposium on Fan Noise. For more information and to download the call for papers, visit http://www.fan2012.org/
Abstracts of 300 – 400 words in English need to be submitted by September 1, 2011.

JUNE 11-15, 2012
ASME Turbo Expo 2012
Bella Center | Copenhagen, Denmark
IGTI's flagship event comprises a major gas turbine conference and exhibition.

JULY 30 - AUGUST 1, 2012
48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit and 10th International Energy Conversion Engineering Conference
Hyatt Regency | Atlanta, Georgia

JUNE 3-7, 2013
ASME Turbo Expo 2013
San Antonio Convention Center | San Antonio, Texas
IGTI's flagship event comprises a major gas turbine conference and exhibition.

IGTI Call for Technical Symposium Topics and Volunteers

The ASME International Gas Turbine Institute is asking for each of our "key" IGTI technical committees, or two or more in concert, to take the lead in organizing a specialty symposium in their field, or some subset of their area.

There is no minimum requirement to be a "key" committee or topical area, simply an identified set of volunteers willing to make an event successful, and a topic (general or specific) that addresses a need (i.e. the 2004 Aero Engine Life Management symposium was an effort of several committees).

The criteria for these specialty symposia include:

- Participant size of 100 to 300 persons
- One or two parallel sessions at most
- No exhibits, making locations for such events very flexible.
- Key subject areas attracting broad international participation. (Examples: Experimental-Computational Validation Collaborations; Combustion Dynamics & Mitigation; Engine Thermal Management; Prognostics & Health Monitoring)
- Symposiums will be held on a rotating basis, though a strict schedule is not required. Each key area would hold a symposium to update progress roughly once every six years, though some may be more frequent and others less so. Because of this rotating schedule, these events should not draw away too much from Turbo Expo, yet they can serve to provide more intimate focus meetings for our members.

The IGTI staff and the IGTI Board will aid in identifying and communicating with potential symposia sponsors and supporting organizations, including industry and government. The IGTI staff will also support event organization, marketing, and execution.

To suggest a technical symposium topic and/or volunteers for the symposium, please contact: IGTI Managing Director Michael Ireland at irelandm@asme.org or IGTI Board Chair Klaus Brun at klaus.brun@swri.org.

TURBO EXPO
Turbine Technical Conference & Exposition
Presented by ASME International Gas Turbine Institute

Turbo Expo 2011 Sails Successfully into Vancouver

ASME Turbo Expo 2011 in Vancouver maintained its reputation as the world's premier gathering of turbomachinery professionals. Throughout the week, delegates shared practical experiences, knowledge and ideas on the latest gas turbine technology trends and challenges, as well as on related topics in wind and steam turbine technology, fans and blowers, and concentrated solar power.

Led by Executive Conference Chair Ibrahim Yimer of National Research Council Canada, the opening session featured an exceptional keynote focused on "Clean and Efficient Turbomachinery Technologies for Future Low Carbon Economies", followed by the annual awards program of prestigious ASME and IGTI gas turbine awards. The Technical Conference offered five days of nearly 1,000 technical presentations, including special honorary lectures by the Industrial Gas Turbine and IGTI Scholar award winners, Donald Brandt, GE, and Om Sharma, United Technologies/Pratt & Whitney.

During the three-day Exposition, delegates met with representatives of premier companies supplying quality turbomachinery products and services. Special recognition went to Pratt & Whitney and Numeca as exhibition visitors voted their displays the best. A welcome reception and a mixer for early career engineers and students added to the variety of abundant networking opportunities throughout the week. The reception and dinner for women working in the turbomachinery area featured talks from Lisa Burgarella of Pratt & Whitney and Susan Scofield of Siemens, sponsors of the event. ASME Incoming President Victoria Rockwell also provided advice and encouragement to all of the women gathered for the dinner.

If turbomachinery is part of your professional life, you cannot afford to miss the annual ASME Turbo Expo! To plan for 2012, see page 49 of this issue and keep informed throughout the year by visiting Turbo Expo online at www.turboexpo.org. *

Thank You Turbo Expo 2011 Sponsors

GE
Rolls-Royce
Pratt & Whitney
ANSYS
CD-adapco
Solar Turbines
NUMECA
Parker Hannifin
Siemens
Flowmaster
Southwest Research Institute
ALSTOM
Karalit
Olympus
Elsevier
NRC-CNRC
Concepts NREC

People's Choice Award
Pratt & Whitney – Best Large Display

People's Choice Award
Numeca – Best Small Display

Turbo Expo provides many opportunities for networking.

Lisa Burgarella (top) and Susan Scofield (left) shared their experiences at the Women's Dinner.

IGTI Honors Individuals for Achievements in the Gas Turbine Industry during Turbo Expo 2011

TURBO EXPO
Turbine Technical Conference & Exposition
Presented by ASME International Gas Turbine Institute

Each year during Turbo Expo, IGTI hosts an awards program to honor individuals who have made significant contributions to the gas turbine industry. This year the awards program was held in conjunction with the grand opening keynote on Monday, June 6.

left to right: ASME Incoming President Victoria Rockwell, Dr. Dilip Ballal, Dr. Ronald Bunker

Dr. Dilip Ballal received the **2011 R. Tom Sawyer Award**, which is given to an individual who has made important contributions to advance the purpose of the gas turbine industry and the International Gas Turbine Institute over a substantial period of time. Ballal is Head of the Energy and Environment Engineering Division and the Hans von Ohain Distinguished Professor at the University of Dayton. He is a former Chairman of the Board of the International Gas Turbine Institute and is currently the ASME Senior Vice-President of Institutes. Ballal is also Editor-in-Chief of the ASME *Journal of Engineering for Gas Turbines and Power.*

left to right: Dr. Ronald Bunker, Dr. Donald Brandt, Dr. Richard Tuthill

Dr. Donald Brandt received the **IGTI Industrial Gas Turbine Technology 2011 Award** for outstanding contributions and industry leadership in global engineering management, new product introduction and university partnership.

left to right: Dr. Anthony Strazisar and Dr. Om Sharma

The **2011 IGTI Scholar Award** was presented to Dr. Om Sharma, United Technologies Research Center. Sharma gave a lecture on *"The Role of Physical and Numerical Experiments in the Development of High Performance Axial Flow Turbines."*

The **IGTI John P. Davis Award** was shared by four individuals, Ernst Schneider, Saba Demircioglu Bussjaeger, Susana Franco, and Dirk Therkorn for their 2009 ASME Turbo Expo technical paper, *"Analysis Of Compressor On-Line Washing To Optimize Gas Turbine Power Plant Performance."* Schneider, Bussjaeger and Therkorn all work for ALSTOM (Switzerland) Ltd. Franco works for MAN Diesel & Turbo Schweiz AG.

left to right: Dr. Ronald Bunker and Dr. Dirk Therkorn. Additional authors not pictured.

left to right: Dr. Ronald Bunker, Victoria Rockwell, Dr. John Denton, Dr. John Longley and Dr. Budimir Rosic. Eric Curtis not pictured.

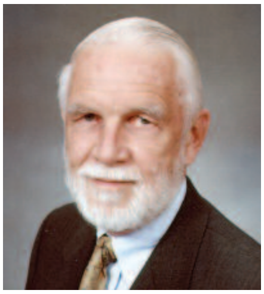
The **ASME Gas Turbine Award** was awarded to Eric M. Curtis, John D. Denton, John P. Longley, and Budimir Rosic for their paper presented at Turbo Expo 2009, *Controlling Tip Leakage Flow over a Shrouded Turbine Rotor using an Air-Curtain.* Curtis, Denton and Longley are all affiliated with Cambridge University. Rosic is a university lecturer at Oxford University.

Throughout the conference IGTI also honored more than 100 authors with "Best Paper Awards" for papers presented during Turbo Expo 2010 in Glasgow, UK. Plaques were given to these individuals at their respective technical committee meetings. *

Featured Column: ***As the Turbine Turns...***

PBMR–A Future Failsafe Gas Turbine Nuclear Power Plant?

By Dr. Lee S. Langston, Professor Emeritus of Engineering, University of Connecticut



Langston is a former editor of the ASME Journal of Engineering for Gas Turbines and Power and has served on the IGTI Board of Directors as both Chair and Treasurer.

Earlier this year on Friday, March 11, a severe earthquake of magnitude 9.0 commenced at 2:46 pm (Japan time) in the Pacific Ocean sea-bed, 80 miles east of the coastal city of Sendai on the central island of Honshu. Operating nuclear power plants in this northeast part of Japan underwent automatic shutdown, with control rods inserted into reactor cores, triggered by earthquake ground acceleration sensors.

The large 4700 MWe Fukushima Daiichi nuclear power plant complex, on the coast some 150 miles north of Tokyo, was one of these. The complex, one of the 25 largest nuclear power stations in the world, is made up of six separate boiling water reactor (BWR) units. These BWR units, powering steam turbine driven generators, were designed to withstand a 8.2 Richter scale earthquake (comparable to the 1906 San Francisco event). On the logarithmic Richter scale the March 11 9.0 earthquake was 7 to 8 times more powerful than that for which the reactors were designed.

Of the Fukushima Daiichi six reactors, Units 5 and 6 were offline for planned inspection and Unit 4 had been completely defueled. Units 1, 2 and 3, with nominal outputs of 498 MWe, 796 MWe and 796 MWe respectively, were in operation before their earthquake induced automatic shutdown. Even with control rods fully inserted, these three units still needed electric powered circulating water pump cooling, due to the residual heat (as much as 3% of the normal operating heat load) generated by intermediate radioactive elements, created by the uranium fission process.

At 3:44 pm, a 14 meter high tsunami reached the Fukushima Daiichi complex, overtopping facilities designed to withstand a 5.7 meter tsunami. All alternating current sources - both off-site and on-site emergency diesel generators - were knocked out by the high tsunami, depriving the reactor cores (and associated spent fuel pools) of internal cooling water and their ultimate heat sink, pumped-in sea water.

In addition, plant workers reported seeing the diesel generator fuel tanks being washed out to sea in the receding tsunami. There were backup batteries to supply emergency power for a matter of hours, but eventually, reactor coolant water overheated, increasing pressures and temperatures in the reactor pressure vessel. Pressure was automatically relieved to the containment suppression pool, but this reduced the water inventory in the reactor. As the water level lowered in the reactor, the fuel rods continued to heat up and an exothermic reaction between the zirconium fuel rod cladding and the remaining coolant generated hydrogen. When the hydrogen was subsequently released from the reactor pressure vessel and mixed with air, the resulting explosions caused further damage to the units.[1]

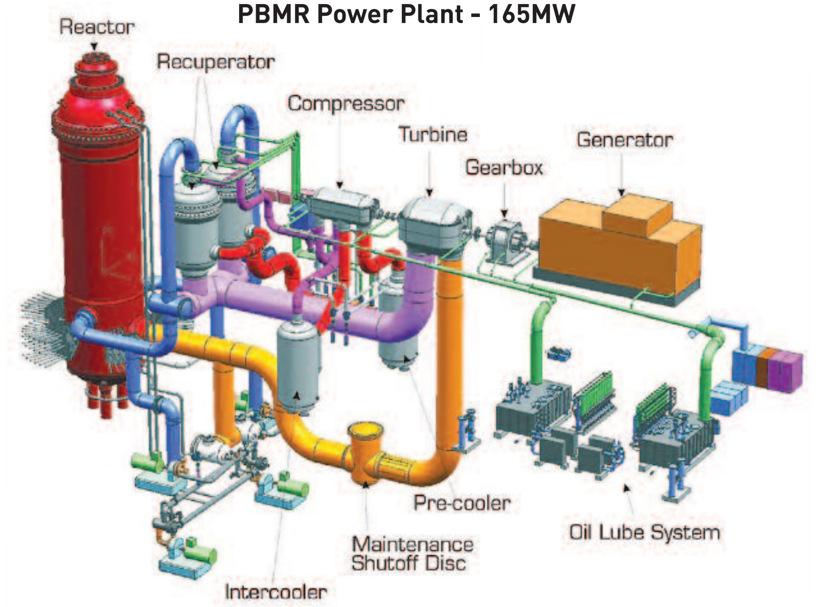
The inability to provide reactor coolant, despite multiple-layered backup systems that all depended on AC power, led to extensive damage to at least three separate nuclear reactors. In Pennsylvania in 1978 similar damage occurred at Three Mile Island (TMI) due to operator error when the emergency cooling system was turned off. In the New York Times,[2] Lake Barrett, the senior US Nuclear Regulatory Commission engineer for TMI, noted that TMI – which took 14 years and the removal of about 150 tons of radioactive rubble to clean up – "...was a walk in the park compared to what they've got..." in Japan. With Fukushima Daiichi, at least three water cooled reactors of the six are damaged and stabilizing each one is complicated by the presence of its leaking neighbors. It is almost certain that four reactors grouped together are lost investments, never to operate again.

Under development, there is a gas turbine nuclear power plant that completely eliminates the possibility of a devastating loss-of-coolant accident. Called the Pebble Bed Modular Reactor (PBMR) it was to be built in South Africa, until funding problems recently ended this promising program. Both Past Chair of the IGTI Electric Power Committee, Sep van der Linden,[3] and I[4] have written about the PBMR power plant.

Uranium dioxide nuclear fuel, coated with mass diffusion and radioactive fission product containment layers of pyrolytic carbon and silicon carbide, is formed into nuclear poppy seed-sized fuel particles. Some 15,000 of these are embedded in a tennis ball-size graphite sphere, which is encased in a thin carbon shell, sintered, annealed and machined to a uniformed diameter of 6 cm. These are the "pebbles" – the name given by Farrington Daniels in the early days of nuclear power in 1944-1945.

...CONTINUED ON PAGE 59

PBMR Power Plant - 165MW



ASME IGTI Professional & Member Development

By Shirley Barton, IGTI Professional & Member Development Manager

Member Services:

Young Engineer Travel Award

IGTI offers several travel awards to students and young engineers employed in industry or government to attend ASME Turbo Expo **to present papers of which they are authors.** Please visit the IGTI web site at http://igti.asme.org/ for more detailed information.

Outgoing IGTI Board Members

- Knox Millsaps, Jr.
- Sigmar Wittig

Outgoing IGTI Technical Committee Chairs

Aircraft Engine
- Bill Cousins

Combustion, Fuels & Emissions
- Timothy C. Lieuwen

Cycle Innovations
- Changduk Kong

Industrial & Cogeneration
- Qun Zheng

Marine
- Tony Wilcoxson

Microturbines & Small Turbomachinery
- James Kesseli

Oil & Gas Applications
- Jeff Moore

Turbomachinery
- Zolti S. Spakovszky

Please contact Shirley Barton (bartons@asme.org) regarding information on:
- Navigating IGTI "Who's Who" Directory
- Committee Member Updates
- Volunteer Opportunities
- IGTI Awards and Scholarships
- Training & Development

Professional Development:

- *New!* IGTI has partnered with the Helmut-Schmidt University in Hamburg, Germany to conduct a European Training Week November 7-11, 2011. The week is being sponsored by Helmut-Schmidt University, Southwest Research Institute and Solar Turbines Incorporated.
- IGTI will partner once again for the fourth year with Southwest Research Institute to offer four hands-on training workshops the week of February 27th to March 2nd, 2012 at the SwRI facility in San Antonio.

Sign up Now! Live, Interactive Webinars!

- **Wind Turbine Tutorial**
  Wednesday, Sept. 28, 2011
- **Engineering Ethics in Action Webinar**
  Thursday, Nov. 3, 2011

2011 Turbo Expo Workshops

IGTI would like to thank all of the following Instructors for their time and for sharing their knowledge with all the participants who attended these workshops!

"Introduction to Optimization Methods & Tools for Multi-disciplinary Design in Turbomachinery"
Instructors: Dr. Tom Verstraete, von Karman Institute for Fluid Dynamics and Professor Li He, Rolls-Royce/RAEng Oxford University; Dr Shahrokh Shahpar, Rolls-Royce

"Gas Turbine Operation & Maintenance"
Instructor: Ron Natole, Natole Turbine Enterprises Inc. (NTE)

"Technology & Applications of Turbine Coatings"
Instructors: Doug Nagy, Liburdi Turbine Services and Purush Sahoo, ASM-LLC

"Advances in Turbines Aero-thermo-mechanical Design & Analysis"
Instructors: Frank Hasselbach, Rolls-Royce; Dr. Guillermo Paniagua, von Karman Institute for Fluid Dynamics; Dr. Ron Bunker, GE Global Research Center; Dr. John Clark, the Propulsion Directorate, Air Force Research Laboratory; Dr. Howard Hodson and Dr. John Coull, Univ. of Cambridge; Dr. Eric Seinturier, Turbomeca; Dr. Miguel Visbal, Air Vehicles Directorate, Air Force Research Laboratory

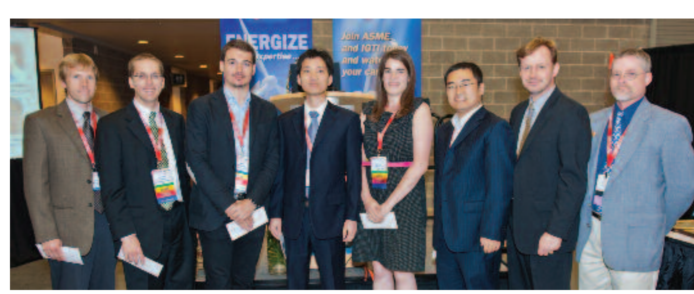
"Gas Turbine Aerothermodynamics & Performance Calculations"
Instructor: Syed Khalid, Rolls-Royce North America

"Basic Gas Turbine Metallurgy and Repair Technology"
Instructors: Lloyd Cooke, Doug Nagy, and John Bottoms with Liburdi Turbine Services; Warren Miglietti, Power Systems Mfg., LLC

If you have a topic you think will be of value to the turbine industry and would like to present it in a webinar format or a "face-to-face" format, please contact Shirley at bartons@asme.org. ✻

Young Engineer Travel Awards Presented at Turbo Expo

IGTI offered several travel awards to students and young engineers employed in industry or government to attend ASME Turbo Expo to present papers on which they were authors. Six individuals were selected for the Vancouver conference. We congratulate them all for their efforts! ✻



Winners included: **Jason E. Albert,** *University of Texas at Austin;* **Tim Allison,** *Southwest Research Institute;* **Fabio De Bellis,** *Polytechnic University of Bari;* **Hejie Li,** *GE Aviation;* **Melissa Wilcox,** *Southwest Research Institute;* **Lei Zhao,** *University of New Orleans*

Improving Survivability of Aircraft from Uncontained Gas Turbine Engine Failures

By Prof. Chris Adams, Director for the Center of Survivability and Lethality, Naval Postgraduate School (www.nps.edu/csl) Monterey, CA, and
Mr. John Manion, Senior Engineer, Naval Air Warfare Center, Weapons Division, China Lake, CA

Modern, high-bypass ratio aircraft gas turbines used in commercial aviation and on military transports have an exceptionally high level of reliability; however, events do occur that lead to catastrophic engine failures. While typically the engine is destroyed in such events, it is desired to fully contain any debris and not have a fire that spreads. Occasionally an engine will suffer an uncontained engine debris event. Most engines are required to meet a specific level of debris containment, but more severe events can and do occur such as the November 4, 2010 incident of Qantas flight 32 (an Airbus A380 aircraft with Rolls-Royce Trent 900 series engines). The number 2 engine sustained an uncontained failure of the Intermediate Pressure (IP) turbine disc soon after takeoff from Changi Airport, Singapore, for Sydney, Australia.

Commercial airplane manufacturers are required by both the US Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) to certify that their designs are able to meet stringent requirements of flight safety in case of a catastrophic event. Recent military aircraft programs, using specific military designs and commercial derivatives, have also required certification similar to FAA and EASA requirements.

Although the design safety requirements are now essentially the same for commercial and military aircraft, there currently is no standard methodology for certifying the safety of the aircraft in the event of a hazardous uncontained engine event for both military and commercial aircraft. The FAA document Design Considerations for Minimizing Hazards caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor Failure (AC 20-128A) provides additional guidance for completion of the numerical analysis although no specific methodology is identified.

Each aircraft manufacturer and engine company has its own methodology, and only recently has the US military adopted a common tool, UEDDAM (Uncontained Engine Debris Damage Assessment Model), for its methodology to consider uncontained events in a more realistic manner. UEDDAM can handle the analysis for the release of the primary rotor-disk segment plus smaller engine debris fragments in directions out of the plane of rotation.

In the case of military use of commercial derivative aircraft, there are usually two separate safety assessments required. The original aircraft must be certified by the FAA and EASA for the first. The second is following the modifications for the military, where the same aircraft must again be safety certified by essentially the same rules.

A common methodology for analyzing the hazard from uncontained engine debris would benefit engine manufacturers, air framers, and customers, with increased reliability and reduced costs. It would result in confidence that the results for all the different agencies are in agreement. Further, it would reduce efforts in the case of multiple assessments both in the civil cases of aircraft or engine repair and in the case of military modification to a commercial aircraft.

The debris from an uncontained engine event consists of high energy penetrators that range in mass from 10s of grams (a few ounces) to a high of 135 kg (300 pounds) and should be viewed as aircraft combat survivability damage mechanisms since they can perforate, slice, severe, crush, or dislodge flight critical components or other aircraft critical components. Their velocity when exiting the engine cowling can be up to 305 m/s (1,000 ft/s). Any assessment methodology must model the effects of all debris potentially penetrating into the aircraft, its passing into and through structural components, and its impacting aircraft flight critical components. Thus, these assessments must evaluate both effects of damaged flight critical components on their aircraft system function and the cascading effects that multiply degraded systems have on overall aircraft flight capability. The larger, more massive, debris fragments can also create structural and decompression failures. Therefore, an analysis methodology would require both physical (e.g., finite element) and functional modeling of all the aircraft components within the zone of debris expansion from an engine.

In the case of the Qantas Airbus A380 incident, the uncontained engine debris cut electrical and hydraulic lines in the leading edge of the wing causing the loss of multiple systems. Additionally, two fuel tanks were penetrated causing significant fuel loss and creating a fire hazard. Although damage began with a single engine event, the cascading damage effects quickly lead to over 50 automated system warnings to the crew regarding systems failures or impending failures. Civilian commercial aircraft are designed with redundancy for reliability and safety, such that if a single system fails another system can provide the same or similar function. However, as Dr. Robert E Ball described in his book *The Fundamentals of Aircraft Combat Survivability Analysis and Design,* second edition, redundancy without effective separation is only reliability and not survivability (avoiding or withstanding the damage effects of a damage mechanism).

The failed Rolls-Royce Trent 900 engine is removed from a Qantas Airbus A380 (Australian Transport Safety Bureau)

In the late 1990's, the FAA initiated an effort to develop an assessment methodology that would model of all the aircraft components within the zone of debris expansion from an engine. The Naval Air Warfare Center Weapons Division (NAWC-WD), China Lake, was funded to develop a tool to assess the hazard from an uncontained engine debris event. This effort resulted in a computerized methodology for hazard assessment based on existing, well-established, and well understood Tri-Service vulnerability assessment methodology. The code, Uncontained Engine Debris Damage Assessment Model (UEDDAM), is based on two principal vulnerability assessment codes: FASTGEN and COVART. Each of these codes has been used for over 25 years for the assessment of damage effects on an aircraft from incident kinetic energy penetrating objects – i.e., missile fragments. The UEDDAM code models both the physical and functional characteristics of all aircraft components within the debris zone; the functional relationships of all flight critical components and systems; the penetration of the debris through the aircraft; the damage characteristics of debris against component; and, it then sums up the results into a probabilistic "hazard level" of an event as a function of aircraft flight phase.

The UEDDAM code requires an input of a three-dimensional (3D) geometric description of aircraft components positions within the aircraft and, thus, in relationship to each other. The description ("aircraft model") uses a specific input format; one that can be processed by FASTGEN to develop debris travel vectors ("rays") through the aircraft, to identify which components are intercepted by each ray and the geometry of this intersection. These debris rays are then used in COVART to assess the penetration depth the debris would be expected to achieve along each ray. COVART identifies which critical components are hit, and gathers the probability of component damage of each component hit. Naturally, this sub-process also requires input data on damage characteristics associated with every possible critical component. COVART will also predict the effects on overall system function as a result of critical component damage; this is done by using an input file that defines component/system functional flow characteristics. UEDDAM then post-processes the output data from COVART, which utilized FASTGEN rays, to yield the hazard levels as a function of a particular debris event.

Adopting an assessment methodology, like UEDDAM, results in a universal standard and uniformity of debris hazard evaluation across the involved agencies. Maintaining the 3D aircraft geometry model and its component/system functional flow data generated by aircraft manufacturers during their initial hazard assessment would simplify later debris hazard reassessments required by maintenance, repair, or military-modification to a commercial aircraft. Given UEDDAM already exists; we see this as the low-cost solution to creating this assessment standard for both commercial and military. ✲

A380 Engine Damage Aft

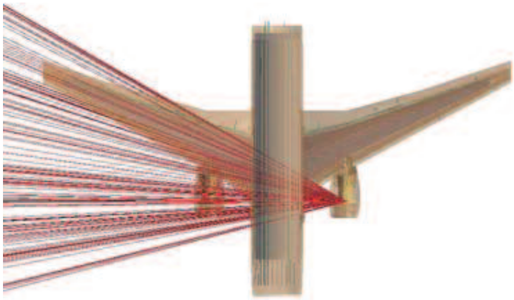
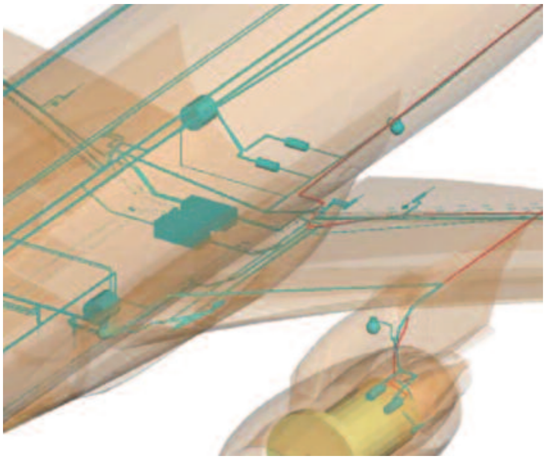
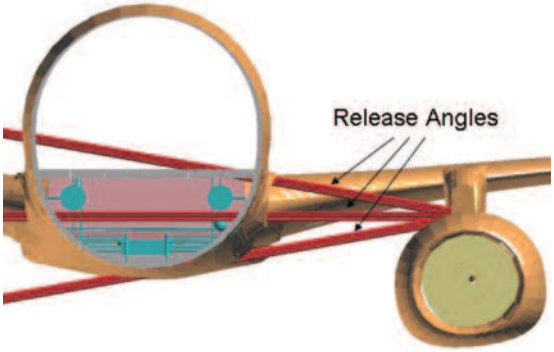


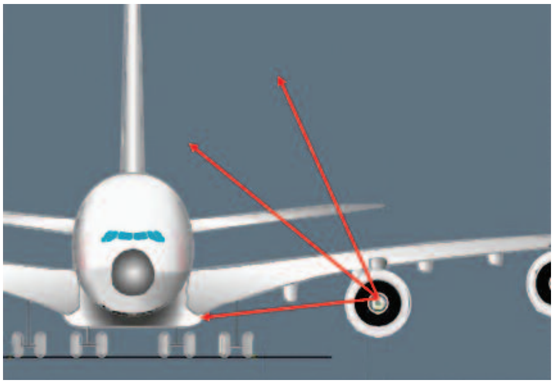
Figure from the UEDDAM user manual



Hydraulic Pressure Line in a Generic Twin-Engine Aircraft. (from UEDDAM user manual).



Release Angles. (from UEDDAM user manual).



Damage Trajectory. (from UEDDAM user manual).

Call for Nominations

2012 IGTI Industrial Gas Turbine Technology & IGTI Aircraft Engine Technology Awards

Nominations are being solicited for the **Industrial Gas Turbine Technology Award** and the **Aircraft Engine Technology Award** for presentation at ASME Turbo Expo, to be held June 11-15, 2012, in Copenhagen, Denmark.

Industrial Gas Turbine Technology Award...

The Industrial Gas Turbine Award recognizes sustained personal creative scientific or technological contributions unique to electric power or mechanical drive industrial gas turbine technology. Eligible areas of accomplishment are gas turbine design, application, operations/maintenance, and research/development/deployment, performed in an industrial, academic or research laboratory environment in one or more of the following fields:

- Combustion, Fuels, & Emissions Abatement
- Controls
- Diagnostics
- Electric Power Plant Integration
- Fluid Dynamics & Thermal Sciences
- Operation, Maintenance, & Life Cycle Cost
- Manufacturing, Materials, & Metallurgy
- Structures & Dynamics
- Thermodynamic Cycles
- Turbomachinery

The Industrial Gas Turbine Technology Award will include an opportunity to deliver a lecture or present an invited technical paper on the work for which the award is being bestowed, at ASME Turbo Expo in Copenhagen in June 2012. The recipient of the award will very desirably, but not necessarily, be a member of The American Society of Mechanical Engineers. The award will be made to a single individual.

Nominating and supporting letters for the Industrial Gas Turbine Technology Award should be sent by October 14, 2011 to:

Philip Andrew
General Electric Co.
300 Garlington Road
Greenville, SC 29602 USA
philip.andrew@ge.com

Nominating letters should contain all information on the nominee's relevant qualifications. The Award Committee will not solicit, nor consider, materials other than those described below. The selection committee will hold nominations active for a period of three years.

A minimum of two supporting letters from individuals, other than the nominator, must accompany the nominating letter. Supporting letters should reflect peer recognition of the nominee's breadth of experience with various aspects of industrial gas turbine technology.

Aircraft Engine Technology Award...

The Aircraft Engine Award recognizes sustained personal creative contributions to aircraft gas turbine engine technology. Eligible areas of accomplishment are aircraft engine design, and/or research and development performed in an industrial, academic or research laboratory environment in one or more of the following fields:

- Aircraft Engine Propulsion
- Airframe-Propulsion Integration
- Combustion & Fuels
- Controls
- Diagnostics
- Heat Transfer
- Manufacturing Materials & Metallurgy
- Structures & Dynamics
- Turbomachinery

The Aircraft Engine Technology Award will include an opportunity to deliver a lecture or present an invited technical paper on the work for which the award is being bestowed, at ASME Turbo Expo in Copenhagen in June 2012. The recipient of the award will very desirably, but not necessarily, be a member of The American Society of Mechanical Engineers. The award will be made to a single individual.

Nominating and supporting letters for the Aircraft Engine Technology Award should be sent by October 14, 2011 to:

Dr. William T. Cousins
Chair, Aircraft Engine Technology Award Committee
United Technologies Research Center
411 Silver Lane, MS 129-89
East Hartford, CT 06108 USA
cousinwt@utrc.utc.com

Nominating letters should contain all information on the nominee's relevant qualifications. The Award Committee will not solicit, nor consider, materials other than those described below. The selection committee will hold nominations active for a period of three years.

A minimum of two supporting letters from individuals, other than the nominator, must accompany the nominating letter. Supporting letters should reflect peer recognition of the nominee's breadth of experience with various aspects of aircraft engine technology.

Welcome New Technical Committee Officers

We are pleased to announce the new technical committee officers for July 2011 through June 2013.

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As the Turbine Turns . . . PBMR . . . CONTINUED FROM PAGE 54

The PBMR reactor vessel, 90 ft high and 20 ft wide, is packed with about 450,000 heat-producing nuclear pebbles. Helium gas coolant then flows around and between the pebbles stacked in the reactor vessel, emerging at about 900 deg F. The reactor, acting in place of a combustor, provides heated gas (helium) to drive a gas turbine, connected to a 165 MWe electric generator. The non reacting helium flow continues through the rest of the regenerative, intercooled Brayton cycle, and re-enters the pebble bed reactor to be heated again, completing a closed cycle, of 41% thermal efficiency.

In the event of a complete shutdown of helium flow in a pebble bed reactor, the temperature would rise at most to 2,900 deg F, a level well below the thermal limit of graphite pebbles. At the higher temperature, the more plentiful uranium-238 nuclei absorb more neutrons (due to an effect called Doppler broadening) and the reactor output decreases, lowering the reactor temperature until an equilibrium is reached. The reactor heat is transferred passively by radiation, conduction, and natural convection to the steel reactor vessel, which is designed to reject the heat without human intervention.

The first pebble bed reactor began operation near Aachen, Germany in 1966 and ran successfully for 21 years, providing heat for a small steam power plant. Tests run during it's life demonstrated safe operation in the event of a total shutdown of the helium coolant.

Although the South African PBMR project has ended, the Chinese are currently building two pebble reactors, but these are used to generate steam for a conventional Rankine cycle. The Rankine (steam turbine) cycle is being used because it is less challenging from both design and material standpoints. This makes no sense to me, since it adds another working fluid (water) which lowers the thermal efficiency and retains the danger of water ingress into the reactor, with it's attendant reactions with high temperature graphite. Also, gas turbine power plants have long since been shown to have lower operating and capital costs than those of steam.

What we need is a government-private industry sponsored effort to develop a gas turbine nuclear power plant using a pebble bed reactor, which holds so much promise as a failsafe, high reliability carbon-free source of electricity. ✲

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