Welcome to the “End of Summer” edition of What’s Watt, the Power Industry Division’s tri-annual newsletter. It has been a tradition for the Director’s message in this issue of the POWID newsletter to summarize our annual Symposium, generally held in early June each year. I am quite unintentionally breaking with that tradition this year, and will summarize the 2013 Orlando Symposium in the “Fall” newsletter in addition to reviewing Automation Week that will be held in Nashville the week of November 4th, 2013.

What I can say about the 2013 Symposium today is that a number of people worked an exorbitant amount of volunteer hours to make the Symposium a success. Bill Sotos, Brandon Parker, Jason Makansi, Tim Hurst, Terri Graham and a host of other POWID volunteers pulled off the Symposium in other than ideal circumstances, of which a last minute hotel change was thrown in the mix. ISA staff provided their usual diligent support and pin-point focus in support of the event. Working closely together is the only way these groups can ever conduct a successful POWID Symposium.

I say “End of Summer” and “unintentionally” above because I am so far behind, causing the summer newsletter to be more of an early fall edition. Thank you to all that have been patient with me while I adjust to several life changing events; one of which is a self-declared and wife certified case of “Old-Timers Syndrome.”

I was unable to attend the Orlando Symposium; only the second Symposium I have missed since 1998. During that 15 year span, attendees had the opportunity to interface with nearly 3,000 colleagues at 12 different Symposium locations. The only repeat locations during that 15 year span have been Orlando and Scottsdale, which is also the site of the 2014 Symposium. Each year held in this location we have had at or near record attendance, and are planning for great participation again in 2014. Look for upcoming details from the 2014 Symposium General Chairman Aaron Hussey in the very near future. Like in 2008, the host Hotel will be the Scottsdale Hilton.

In these days of cost reduction, right-sizing, and doing more with less, ISA is no different. ISA as a whole and POWID in particular are only as good as the “volunteers” that make up the membership. Everyone who is a POWID member ‘volunteers’ by virtue of ‘volunteering’ their dollars toward annual dues. Every ISA Division and Section is run by volunteers, making it “Our ISA.” Countless times we have all heard someone say “what’s in it for me?” Well, if paying the annual dues and reading one newsletter a year is all you put into ISA that may well be all you get out of ISA. But if you participate in a Symposium, write and present a paper, attend an ISA training session, become active in a local Section or Division, you may find the additional benefits outweigh the effort invested in your new level of participation. I urge you to get involved at a higher level and make an investment—After all, it is “Our ISA”!

If you have any comments or suggestions on ways the Division can improve, please feel free to contact me at dyounie@casemi.com.

Best Regards,
Denny Younie
POWID Director 2013–14
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2013 ISA POWID Symposium a Great Success

By Bill Sotos, Hurst Technologies
56th POWID Symposium General Chairman

The ISA’s 56th POWID (Power Industry Division) Symposium that concluded in early June was a truly outstanding program, showcasing the latest developments in instrumentation, controls, software, renewable energy technology, communications, government regulations, and cyber security. During this very full week, we offered three tracks (Generation, Fossil, and Nuclear) that included 14 well attended sessions. We also offered three formal training classes, as well as EPRI industry meetings and standards committee meetings. The exhibit hall was full of vendors who were showing off their products and services. Attendees were able to come away with valuable knowledge that they can apply to improve their technical expertise, organizational efficiency and competitiveness. All of this was contained in a wonderful meeting facility, the Rosen Shingle Creek Hotel. It is not an exaggeration to say that this hotel, including its staff, was simply a fabulous place to hold our event.

Next year, the ISA POWID Symposium moves on to Scottsdale, Arizona at the Hilton Scottsdale Resort and Villas. Aaron Hussey of Expert Microsystems will be the General Chairman. Please support Aaron and his team as they plan for ISA POWID 2014.

It was an honor and a privilege to be the General Chairman for ISA POWID 2013. On behalf of the entire Symposium planning team and the ISA POWID Executive Committee, we thank all of the many attendees, exhibitors, speakers, volunteers, and ISA staff for their efforts in making our event a success. I hope everyone had a great experience at ISA’s 2013 Power Industry Division Symposium and that they will continue to support the ISA POWID Symposium in the future.

You can view the final program from this year’s Symposium at: http://www.isa.org/~powid/powid_2013/2013_final_program.pdf

2013 ISA POWID Symposium Supporters:
POWID 2013 Symposium leaders assembled an incredible technical program, clockwise from top left: Bill Sotos, General chair, Jason Makansi and Brandon Parker, Program Chairs. Center: Rodney Jones of ISA served as the overall event coordinator. Bottom panorama: The POWID Executive Committee was busy planning for the upcoming year: Bob Queenan, Alan Zadiraka, Dale Evely, Brandon Parker, Jim Batug, Aaron Hussey, Seth Olson, Roger Hull, Cyrus Taft, Don Labbe, Mike Skoncey, Jason Makansi, Xinsheng Lou, Joe Vavrek (photographer) and guests.

Photographs in this edition of the newsletter were provided by Joe Vavrek, collages and captions were assembled by Don Labbe. The editor would like to thank Joe and Don for their hard work in this regard.
The site of POWID 2013 was the spectacular Rosen Shingle Creek with spacious accommodations and fine food supporting the traditional friendly environment of the POWID Symposium.
Kenneth B. Medlock III, Ph.D. provided one of the keynote addresses. He is the James A. Baker, III, and Susan G. Baker Fellow in Energy and Resource Economics at the Rice University’s Baker Institute and the senior director of the Center for Energy Studies, as well as an adjunct professor and lecturer in the Department of Economics at Rice University. He is a principal in the development of the Rice World Natural Gas Trade Model, aimed at assessing the future of international natural gas trade.

He has published numerous scholarly articles in his primary areas of interest: natural gas markets, energy commodity price relationships, gasoline markets, transportation, national oil company behavior, economic development and energy demand, and energy use and the environment. He also teaches courses in energy economics and supervises Ph.D. students in the energy economics field.

Dr. Medlock is currently the vice president for academic affairs for the United States Association for Energy Economics (USAEE). In 2001, he won (joint with Ron Soligo) the International Association for Energy Economics Award for Best Paper of the Year in the Energy Journal. In 2011, he was given the USAEE’s Senior Fellow Award. He is also an active member of the American Economic Association and the Association of Environmental and Resource Economists, and is an academic member of the National Petroleum Council (NPC).

Medlock has served as an adviser to the U.S. Department of Energy and the California Energy Commission in their respective energy modeling efforts. He was the lead modeler of the Modeling Subgroup of the 2003 NPC study of long-term natural gas markets in North America, and was a contributing author to the recent NPC study “North American Resource Development.” Medlock received his Ph.D. in economics from Rice in 2000, and held the MD Anderson Fellowship at the Baker Institute from 2000 to 2001.
Dr. Peggie Koon provided one of the keynote addresses. She is the 2013 International Society of Automation (ISA) President-Elect Secretary and will be ISA President in 2014. Dr. Peggie Koon, director of strategy, partnership development and management at Morris Communications Company, LLC has been named vice president of audience for TAC Media and The Augusta Chronicle, a new, senior-level position created by each of Morris Publishing Group's metro markets. This new role will focus on building a powerful community voice by growing the news, audience and digital efforts. Dr. Koon has a BA in mathematics from Smith College in Northampton, Massachusetts. She completed graduate studies in Industrial and Systems Engineering at the Georgia Institute of Technology in Atlanta, Georgia, and received her doctorate degree in Management Information Systems from Kennedy Western University in Cheyenne, Wyoming.
Scott Fowler is the Electrical & Controls Engineer at Lakeland Electric, a mid-sized, municipal-owned entity in Lakeland, Florida. His responsibilities include oversight of Distributed Control Systems throughout the Power Production division and electrical generation equipment throughout the plants. Prior to his employment at Lakeland Electric, Scott worked in the Chemical Manufacturing industry for 20 years in a variety of roles including: Instrumentation Technician, Software Developer, Database Manager, and Instrumentation & Electrical Supervisor. Early in his career, Scott was employed as an Instrumentation & Control Specialist at two large nuclear plants, and prior to this served six years in the US Navy as a nuclear Reactor Operator aboard a fast attack submarine. Scott holds a BS degree in Computer Engineering and an MBA from the University of South Florida.
The Power Industry Roundtable session chaired by Jason Makansi, President, Pearl Street Inc. provided an exciting view of the future of U.S. power production. Panel members included: James Flowers, Southern Nuclear, Jim Colgary, Director, Government Affairs, Nuclear, Energy Institute, Scott Fowler of Lakeland Electric, Dr. Peggie Koon, ISA President Elect, Dr. Kenneth Medlock, Senior Director, James A. Baker, Institute for Public Policy’s Center for Energy Studies, Dr. Robert Peltier, Editor-in-Chief, Power Magazine.
The sessions are the heart and soul of the POWID Symposium. With 16 sessions and over 65 presentations, the POWID Symposium is the Showcase of Innovation for the Power Automation Industry.
ISA POWID Award Winners Announced

By Don A. Andrasik
ISA POWID Honors & Awards Coordinator

Celebrating Excellence Award for Standards Excellence
Congratulations to Cyrus Taft, who was selected by the ISA Executive Board to receive the Celebrating Excellence Award for Standards Excellence. The award presentation will be made at the 51st Annual ISA Honors & Awards Gala which will be held on Monday evening, November 4th, 2013 at the Renaissance Nashville Hotel in downtown Nashville, Tennessee, USA.

POWID Service Award:
Again, congratulations to Cyrus W. Taft, recipient of the POWID Service award at the 2013 Symposium.

As a committed and tireless leader, Cyrus Taft provides support in the operation of POWID, ISA77 committee and ISA as a whole. Cyrus has shown excellent service in fulfilling positions of: Secretary, Director, Past Director, ISA Governance Structure Task Force member, Program Chairperson, Session Chairperson, Paper reviewer, Author, and ISA 77.43, 77.82, & 77.39 Chairperson. Cyrus is now performing as the POWID Webmaster. ISA, and especially POWID, have benefited from his dedicated service.

POWID Achievement Award
Congratulations to Dr. Robert Peltier, recipient of the POWID Achievement award at the 2013 Symposium.

As Editor-In-Chief of POWER magazine, Dr. Peltier consistently promotes the advancement of the power industry in automation, and other technologies, utilized in generation and distribution. Dr. Peltier organizes the written word of innovation in instrumentation, controls, automation and other fields. His efforts provide an influential periodical that promotes instrument and control as one of the full range of technologies utilized in power. The industry has benefited from his editorials, article selection, and guidance.

2013 Symposium recognition of the Best Three Papers of 2012

Best Paper
Coordinated Feedwater Heater Energy Control to Achieve Higher Peak Load Generation & Reduced NOx Emissions
By: Don Labbe, Invensys Operations Management

2nd Best Paper
Smart Firing Control System
By: Corey Houn, Wisconsin Public Service
Bernie Begley, Wisconsin Public Service
Alan Morrow, Invensys Operations Management
Don Labbe, Invensys Operations Management
Tom Kinney, Invensys Operations Management
Andy Speziale, Invensys Operations Management

3rd Best Paper
Robustness Enhancement of PID Cluster for a Nonlinear Power Plant Model with Time Delay
By: Shu Zhang, Dept. of Mech. Sci. and Engr., Univ. of Illinois at Urbana-Champaign
Joseph Bentsman, Dept. of Mech. Sci. and Engr., Univ. of Illinois at Urbana-Champaign
Cyrus W. Taft, Taft Engineering

POWID Awards Nomination Request to All POWID Members

By Don A. Andrasik, ISA POWID Honors & Awards Coordinator

In meeting more and more of the members, I cannot help but be impressed by the talent displayed in our POWID group. There are many individuals that display their talents in “beyond the norm” fashion. During your busy days, when such an individual is identified, recognize them by nominating that person for a POWID award as listed below:

- POWID Achievement Award
- POWID Facilities Award
- POWID Services Award
- Robert N. Hubby Scholarship

Nomination forms for these POWID awards can be found at: http://www.isa.org/~powid/awards/powidawardforms.zip

Do not forget there are also ISA “Celebrating Excellence” awards of which POWID members are well deserving. Information on those awards and how to submit nominations for them can be found at: http://www.isa.org/Content/NavigationMenu/General_Information/Honors_and_Awards1/Honors_and_Awards.htm
Clockwise from left: Dr. Robert Peltier, recipient of the POWID Achievement award; Dr. Joseph Bentsman, Cyrus Taft and Don Labbe, 2012 best paper award recipients; Mike Skoncsey with Cyrus Taft, recipient of the POWID Service award.

Luncheon keynote speaker was Lieutenant Lee Cuthbertson, MSD Port Canaveral of the U.S Coast Guard. Lt. Cuthbertson provided a fascinating discussion of the many duties of the U.S. Coast Guard covering a coastline stretching nearly 10,000 miles. Just one of the more notable remarks was that there are more NY city policeman than the entire U.S. Coast Guard.
The Symposium leaders were honored for their contributions to POWID 2013, clockwise from top left: Bill Sotos of Hurst Technology, General Chair; Brandon Parker of Black & Veatch, Program Co-chair; Terri Graham and Tim Hurst of Hurst Technology, Symposium coordinator and paper review chair; Mike Skoncey, past Honors & Awards Chair and Jason Makansi of Pearl Street Inc., Program Co-chair. The technical success of the symposium is based on the hard work of the session developers: Chad Kilger of AMS, Tim Hurst of Hurst Technology, Bob Queenen of Scientech, Xinsheng Lou of Alstom, Michael Fox of ABB, Jim Batug of PP&L, Danny Crow of Invensys, Shizhong Yang of Alstom, James Flowers of Southern Nuclear, Bruce Geddes of Southern Engineering Services, Ray Torok of EPRI and Brandon Parker of Black & Veatch.
Top panel: audience for awards luncheon

Bottom panel clockwise from left: Gold Champions: Case M&I, POWER Magazine, Emerson, Siemens, Invensys and Curtiss Wright; booth activity during conference; Silver Champions: Hurst Technology, Consolidated Controls, Honeywell, Maverick Technologies, Doosan HF Controls and PAS.
 ISA 2014 POWID Symposium Is Looking for You

Aaron Hussey, Expert Microsystems, and Conference General Chairman, cordially invites you to...

Mark your calendar and submit an abstract:  
57th Annual Power Industry  
Symposium & Exhibits  
June 1–6, 2014  
Scottsdale, Arizona, Hilton Scottsdale Resort

If you and/or your company are involved in Instrumentation & Control, automation, digital technology, wired and wireless communication, plant and performance software, asset and knowledge management, cybersecurity, and/or simulators and training for power generation, plan to attend the industry's leading forum for sharing technology, application experiences, and best practices. ISA’s 2014 Power Industry Symposium (POWID 2014) covers all types of power stations—coal, nuclear, gas-fired gas turbine/combined cycle, and renewable energy (hydroelectric, solar, and wind, and biomass), and smart grid, distributed generation, combined heat and power, and micro-grids—all over the world.

POWID is large enough to provide a comprehensive program of presentations and panel discussions necessary for professional development yet small enough to induce intimate conversations around special topics critical to your company's competitive growth and vitality. The exhibit hall typically attracts 30-40 companies giving you a chance to really get to know solution providers without feeling overwhelmed by a hall requiring a GPS to navigate. POWID has a long-standing relationship with Power Magazine, which potentially can leverage your exposure from several hundred attending a conference to an audience of tens of thousands in print and on-line.

This year, the symposium's theme is “Instrumentation & Control Solutions for Today's Industry Challenges.” Organizers seek papers (peer-reviewed) and presentations (subject to review) on the following topics:
- cybersecurity
- environmental control systems
- combustion turbine and combined cycle plants
- advanced technologies and applications
- fleet management and performance/M&D centers
- sensors and wireless data communication

A full track with up to eight sessions on nuclear plant topics will feature modernization strategies, post-Fukushima impacts, state of cybersecurity requirements and solutions, regulatory challenges and lessons learned, I&C strategies for small modular reactors (SMR), digital equipment obsolescence, EMI testing requirements, set points and uncertainties, operability determination experiences, SRP Chapter 7 changes, and commercial grade dedication.

For more information, please visit www.isa.org/powid. The site will include a link to an automatic paper abstract submission form. However, if you have questions or wish to discuss your involvement in POWID (or you have problems with the automated on-line forms), please contact one of the individuals below:

**General Chair**  
Aaron Hussey, Expert Microsystems  
ahussey@expmicrosys.com.

**Nuclear Program**  
Bob Queenan, Curtiss Wright  
rqueenan@curtisswright.com.

**Hydro and Renewables Program**  
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xinsheng.lou@power.alstom.com.

**Generation Program**  
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nfox@epri.com.

**Fossil Program**  
TBD—volunteer being identified

**Exhibit Coordinator**  
Brandon Parker, Black & Veatch  
parkerbs@bv.com.

**Exhibit Registrar**  
Carol Schafer, ISA  
cshafer@isa.org.

**Power magazine content**  
Robert Peltier, Editor in Chief, Power Magazine  
robertp@powermag.com.
The Symposium Program Committee is soliciting abstracts for full papers and for presentations. All paper submissions will be peer reviewed to ensure high quality and originality. Symposium Proceedings will be published on CD for distribution to attendees and also made available on the ISA web site. Suggested topics for submissions include:

### 2014 ISA POWID Symposium Paper and Presentation Suggested Topics

#### Hydroelectric/Renewables
- **Innovations**
  - Steam Cycle Augmentation
  - Energy Storage
- **Challenges**
  - Predictive Control
  - Long-term reliability

#### Fossil
- **Environmental Control Systems**
  - Scrubbers
  - SCR Controls
  - Regulatory Challenges
- **Combustion Turbine and Combined Cycle Plants**
  - Operational Flexibility
  - Start-up and Ramp Rates
  - Load Range Extension

#### Nuclear
- **Plant Modernization**
  - SRP Chapter 7 and ISGs
  - Digital Obsolescence
  - Plant Modernization Experiences
  - EMI Testing and Immunity
- **New Nuclear Plants**
  - Conventional Commercial Reactors
  - Small Modular Reactors
  - Regulatory Challenges

#### Programmatic
- **Setpoints, Uncertainties and TSTF-493 Implementation**
- **Commercial Grade Dedication**
- **Operability Determinations**

#### Fukushima Accident Impact
- **SFP Instrumentation**
- **FLEX Approach to Beyond-Design-Basis External Events**

#### Generation
- **Cybersecurity**
  - NERC CIP Requirements
  - Implementation & Audits
  - Testing & Intrusion Detection
- **Equipment Development**
  - New Sensors
  - Wireless Sensor Applications & Standards
  - Fieldbus
- **Smart Grid Outlook**
  - Impact on Generating Plants
  - Communication Standards
- **New Generating Plants (non-nuclear)**
  - IGCC
  - Renewables
  - Regulatory Challenges
- **Advanced Control Technology and Applications**
  - Simulation and Training
  - Advanced Control
  - Automation
- **Human Factors Engineering**
  - Alarm Management
  - High Performance HMI
  - Control Center Design
- **Fleet Management**
  - Remote Monitoring
  - Inspection and Maintenance
  - Condition Monitoring Systems
  - Alarm management
  - Training the Next Generation

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For more information on the 2014 ISA POWID Symposium and to submit an abstract, please go to [www.isa.org/powersymp](http://www.isa.org/powersymp) or contact:

- **General Chair** ........................................... Aaron Hussey, Expert Microsystems, ahussey@expmicrosys.com
- **Program Co-Chair, Generation** ............................ Neva Fox, nfox@epri.com
- **Program Co-Chair, Hydro & Renewables** ............ Xinsheng Lou, xinsheng.lou@power.alstom.com
- **Program Co-Chair, Nuclear** ................................ Bob Queenan, rqueenana curtisswright.com
- **Program Co-Chair, Fossil** .................................... TBD—volunteer being identified
- **Exhibit Coordinator** ........................................... Brandon Parker, parkerbss@bv.com
- **Exhibit Registrar** ........................................... Carol Schafer, cshafer@isa.org
- **Power Magazine Content** ................................. Robert Peltier, robertp@powermag.com
ISA 2013 POWID—
A Spouse’s Point of View

By Tricia Logan

Orlando! Mickey Mouse, Disney, SeaWorld and so much more! Once again ISA hosted its meeting in the beautiful Orlando area. This year we had a tiny blip to contend with called “a weather system” bringing lots of clouds and rain, but it could not put a damper on our fun since most of the attractions were water related.

We missed Paula, Sherry, Jane, Teresa, and so many more this year that have long been an instrumental part of the ISA “spouses group.” We have always enjoyed each year’s meeting and this one was no exception.

The Rosen Shingle Creek Resort was magnificent, as usual. Good service and food sources all around. The pool areas and grounds were beautifully designed with all the region’s amazing trees, plants and flowers.

Thanks to Mike and Rodney a tiny glitch with the room access keys to the spouses lounge was resolved expediently; and once again we had a great meeting room to start our day. It’s always fun to sit and visit with each other and catch up on the past year’s developments. Each day was packed with shopping, dining, relaxing by the pool, site seeing, and much more!

Once again ISA made this an unforgettable week for all the spouses, which was filled with laughter, fun, fellowship and great memories.

I’m already looking forward to visiting with everyone in Scottsdale next June so, until then, ya’ll have a great year.

POWID Task Force for the Future Initiative

From Information provided By: Jason Makansi
President, Pearl Street, Inc.
ISA POWID Executive Committee (Excom) member

At the June 2012 Excom meeting in Austin, Texas, Jason Makansi agreed to create a “Task Force for The Future” comprised of professionals significantly younger than the typical POWID Excom member. The objective was to solicit their feedback about the next POWID conference, the co-located Excom meeting, and their ideas and suggestions for how we might begin to adapt for more appeal to the generation of engineers behind us. As a result, Jason was able to interest three automation professionals in participating in those events this past June in Orlando, and Jason gratefully received their feedback on behalf of POWID following the event. All three of these individuals were enthusiastic about permanent involvement with ISA POWID and proposed specific activities that they’d be willing to undertake to help POWID grow and thrive, not just survive the way we are now. However, they also illuminated gaps that need to be addressed.

Initial recommendations to the Excom, based on their input, are as follows:

- Formally adopt an adjunct to the Executive Committee, the Young Professionals Advisory Board (YPAB, or something like that)
- Appoint the three individuals as founding members of the YPAB
- Give the YPAB as much latitude as possible to shape and direct POWID towards their vision
- Appoint a mentor from the Excom to the YPAB who also can act as a liaison to the Excom
- Consider putting into play the specific suggestions from the group

Here are some of the things these three individuals identified as potential benefits for them in POWID:

- Conversations with experienced professionals
- Tutorials on subjects that are essential to advancing their careers and issues they face in real time in their jobs
- Networking opportunity in recruiting others for POWID involvement, especially at the power stations
- Identifying and cultivating resources outside of their company
- Getting educated for an I&C position quickly and achieving a competitive edge over others
- Getting educated about the latest vendor product/services
- Making connections by directing outreach to vendors and POWID prospects

The Excom will be discussing all of this further at its next meeting in November and hopefully will begin taking action on this shortly after that.
Plant I&C/Wireless Technology Guidebook Released by Power Magazine

This guidebook exclusively features plant I&C and wireless articles, including full charts, photographs, graphs and step-by-step instructions, previously featured in POWER magazine. The book is available in a PDF format. 96 pages.

The Table of Contents for the guidebook is as follows:
- Innovative boiler master design improves system response
- Drum pressure the key to managing boiler stored energy
- Accurately measure the dynamic response of pressure instruments
- Upgraded control system adds to merchant plant’s bottom line
- Digital networks prove reliable, reduce costs
- Pressure-sensing line problems and solutions
- Fully automating HRSG feedwater pumps
- Digital plant controls provide an essential edge
- How to avoid alarm overload with centralized alarm management
- New tools for diagnosing and troubleshooting power plant equipment faults
- Automated exhaust temperature control for simple cycle power plant
- Increasing generation ramp rate at Morgantown Generating station’s coal-fired units
- Concerns about temperature equalizing columns used for steam drum level measurement
- Thermocouple response time study for steam temperature control
- FBC control strategies for burning biomass
- Plantwide data networks leverage digital technology to the max
- Wireless technologies connect two LCRA plants
- Enhancing plant asset management with wireless retrofits
- Low-cost wireless sensors can improve monitoring in fossil-fueled power plants
- Artificial intelligence boosts plant IQ
- Distributed control technology: from progress to possibilities

For more information or to download your own copy visit the POWID online store at: http://www.powermag.com/powerpress/511.html.

Resources Available to ISA POWID Members

This information provided by Bob Hubby
POWID Section/Division Liaison

The International Society of Automation (ISA) regularly provides resource materials from the Divisions to District and Section leaders. As a POWID member, you have access to the Power Industry Division (POWID) specific information, and if you are also a District or Section leader, you have access to that type of information for all Divisions. The following is the resource list that was recently provided to those leaders by POWID’s Bob Hubby:

1. Automation Technical Papers—ISA’s comprehensive collection of technical articles according to technical topic—a subscription service www.isa.org/techpapers
2. Division newsletters – all contain best technical papers—use this as a section programming resource. All division newsletters can be found on the web at each division’s homepage—but access is restricted to division members. Main division web page: www.isa.org/divisions
3. ISA Standards Catalog – a listing of current available standards. Presentation of a critical standard could be used as a section programming resource. http://www.isa.org/Template.cfm?Section=Standards2&Template=/customsource/isa/Standards/AutomationStandards.cfm
5. ISA continuing education and training is available for download at: www.isa.org/training
6. ISA Training Institute Regional Course Catalog—Regional course catalogs are not available online, but available courses can be seen by region at http://www.isa.org/Template.cfm?Section=Find_Training&template=/TaggedPage/LocationAlphaOrder.cfm&ICID=1
7. The Power Industry Division Website – This web site contains power industry division papers for many years back to 1959 under the left click hot spot “Conference Proceedings”; these are available only to division members. www.isa.org/~powid
8. All Division Websites – These websites can be reached through the divisions list but many provide access to division resources only to their division members. http://www.isa.org/Template.cfm?Section=Division_List
9. ISA Web Seminars – Available when you are through the link at www.isa.org/websem
10. Systems Integration Community page: www.isa.org/systemsintegration
11. ISA Standards link for the member “view only” free standards access benefit: www.isa.org/memberbenefits
Well, here we are again, ready to stride out into the fertile field of measurement uncertainty analysis. Good to see you again! Last time we discussed the five types of systematic error (bias) and commented on how important it was to estimate their potential magnitudes, or, systematic uncertainties (bias).

Note the ambiguity of the term “bias”. It has been used by many to refer to the systematic error for a single measurement. They say “bias” meaning the actual difference between their measurement and the true value of the test. Others at times will estimate the potential magnitude of this type of error and call that the “bias.” Here they mean the +/- interval about the measurement that estimates the possible extent of the true systematic error. Confused? So am I. Dr. Gooddata, therefore recommends we largely abandon the term “bias,” as it is used ambiguously, and instead use the terms “systematic error” and “systematic uncertainty.” “Systematic error” is the actual error that exists between a measurement and the measurand’s true value with zero random errors. “Systematic uncertainty” is taken to mean the estimate of the limits to which we could expect the systematic error to range with some confidence. Whoops, here come the statisticians again!

In the International Standards Organization’s (ISO) “Guide to the Expression of Uncertainty in Measurement,” it is recommended that uncertainty analysts (that’s you) assign both a distribution and a confidence interval to each systematic uncertainty estimated. The U.S. National Standard on test uncertainty, “ASME PTC19.1 - Test Uncertainty,” has been rewritten and recommends that estimates of systematic uncertainties be assumed to represent a Gaussian-Normal distribution and be estimated at 68% confidence. (That would make systematic uncertainties estimates of one $s_{\xi}$ as the degrees of freedom are assumed to be infinite for each of these systematic uncertainties.)

Remember also that the combined effect of several sources of systematic uncertainty is still determined by the root-sum-square method and the result. This interval would contain the true value 68% of the time in the absence of random errors (whose limits we now estimate with “random uncertainties.”)

The systematic uncertainty of the result would then be:

$$b_R = \left[ \sum_i (b_i)^2 \right]^{1/2}$$

where each $b_i$ is a 68% confidence estimate of the systematic uncertainty for source $i$. This allows us to work with equivalent $s_{\xi}$ values throughout this analysis. We will need that capability when we also deal with the random uncertainties.

How about those random uncertainties! The latest U. S. National Standard recommends (as does the ISO Guide) estimating their magnitude limits as one standard deviation for the average at a particular level in the measurement hierarchy. That is, the random uncertainty for an uncertainty source is the standard deviation of the average for that uncertainty source. It is noted as one $s_{\xi}$. Here too, the random uncertainty for the test result is the root-sum-square of the random uncertainties for each level in the measurement hierarchy.

The random uncertainty of the result is then:

$$s_R = \left[ \sum_i \left( s_{\xi,i} \right)^2 \right]^{1/2}$$
where each \( s_{X,i} \) is the standard deviation of the average for that level in the measurement hierarchy.

Note that with this approach, we are working with equivalent \( s_X \) values for both systematic and random uncertainties. Why is this important? How does this help us? Let’s see.

Now that we are all experts in the determination of the systematic and random uncertainties of a measurement, the question we must approach with exceptional anticipation is this: “what good is it to calculate only systematic and random uncertainties? Shouldn’t we find a way to combine them in to a measurement uncertainty for the measurement result?” (I know; that’s two questions.)

For a long time there were two primary approaches to this problem of calculating a single number to represent the measurement result uncertainty. Those two uncertainty models (kind of like Ford and Chevy for your car buffs) were the \( U_{ADD} \) and the \( U_{RSS} \) models. These were also known (that’s a.k.a. for your murder mystery buffs) as \( U_{99} \) and \( U_{95} \) respectively. That is the former provided approximately 99% coverage and the latter approximately 95%.

Well, what were these models and isn’t there something better after all these years?

The \( U_{ADD} \) model was:

\[
U_{ADD} = [B_R + t_{95}S_X]
\]

The \( U_{RSS} \) model was:

\[
U_{RSS} = \left( (B_R)^2 + (t_{95}S_X)^2 \right)^{1/2}
\]

Note that when it is said that \( U_{ADD} \) provides approximately 99% coverage (not confidence) and that \( U_{RSS} \) provides approximately 95%, the key words are approximately and coverage.

We use approximately because these coverages were determined by simulation, not statistics. They are right, in the long run, but not exact. How come we use the term coverage and not confidence? Also, what happened to that new, better uncertainty model? Do any of you know the answers? Why coverage and what new model?

What is this coverage thing? Why not express these uncertainty intervals (hint, new word there) as confidence intervals? The reasoning is this: The systematic uncertainty, \( B_R \), was an estimate of the limits of systematic error to about 95% coverage. \( B_R \) was not a statistic but an estimate. \( S_X \) was however, a true statistic. It was appropriate to speak of confidence only with a true statistic.

Both of the above uncertainty equations combine a statistic, \( S_X \), with a non-statistic, \( B_R \). The result cannot be an interval (that new word) with a true confidence but rather provides coverage as documented by simulation.

We first will handle one additional approach to estimating uncertainty. Until now our emphasis has been on grouping uncertainty sources as either systematic or random. The ISO has published their “Guide to the Expression of Uncertainty in Measurement”. This “Guide” does not recommend grouping uncertainty sources or errors by systematic or random categories. It recommends grouping them as either “Type A” where there is data to calculate a standard deviation, or, “Type B” where there is not. This approach seems in conflict with the commonly applied terminology of “systematic” and “random” uncertainty sources.
However, there now is coming into vogue (popularity, not the magazine) a new uncertainty model that combines the best features of both methods. It handles the ISO recommendations of using “Type A” and “Type B” classifications and still allows the engineer to quote uncertainties in the more physically understandable venue of “systematic” and “random.” How can this be? What compromises were reached?

Let’s address that super-secret, now revealed, new uncertainty model that combines the best features of the US/ASME model and that of the ISO model. Let’s first review the basic principles of each model.

We’ll start with the ISO model. With this uncertainty model, sources of error and their uncertainties, the estimates of the limits of those errors, are grouped by Type. Type A uncertainties have data associated with them for the calculation of standard deviation. Type B uncertainties do not have such data and must be estimated by other means (that’s methods not averages here). The total uncertainty, ISO calls it the “expanded uncertainty,” is then calculated by root-sum-square of the two Types of uncertainties. But first, all the elemental Type A and Type B uncertainties are combined by root-sum-square. That is, we first calculate:

$$U_A = \left[ \sum (U_{A,i})^2 \right]^{1/2}$$

and then we calculate:

$$U_B = \left[ \sum (U_{B,i})^2 \right]^{1/2}.$$

Note here that the $U_{B,i}$ need an assumed distribution and degrees of freedom. The new U. S. National Standard published by the ASME recommends that the $U_{B,i}$ be assumed to be representative of error sources that are normally distributed and that the degrees of freedom are assumed to be infinite.

It is also important to recognize that all the $U_{A,i}$ and $U_{B,i}$ uncertainties are standard deviations of the average for that uncertainty source. That is, they all represent one $x_s$.

We then need to combine the $U_A$ and $U_B$ uncertainties into the total uncertainty (called the “expanded” uncertainty by the ISO). That expanded uncertainty is:

$$U_{ISO} = \pm K \left[ (U_A)^2 + (U_B)^2 \right]^{1/2}.$$

The constant out front, “$K$,” is used to provide the confidence desired. The most common choice for that constant is Student’s $t$ at 95% confidence. This would provide an uncertainty with 95% confidence. This ISO expanded uncertainty would then be written:

$$U_{ISO} = \pm t_{95} \left[ (U_A)^2 + (U_B)^2 \right]^{1/2}.$$

Before the Student’s $t_{95}$ can be determined, there is one more important step. Do you know what it is? Have you any idea? The degrees of freedom for $U_{ISO}$ are needed. How do we get that? Well, each standard deviation of the average we’ve used in the two $U_A$ and $U_B$ equations above has its associated degrees of freedom. For the $U_A$ the
degrees of freedom come directly from the data that is used to calculate the standard deviations of the average, that is,

\[ v_i = N_i - 1 \]

where \( v_i \) is the symbol for degrees of freedom, sometimes abbreviated as d.f.

These degrees of freedom are for all the \( U_{A,i} \) where \( N_i \) is the number of data points used to calculate the standard deviations of the average.

For the \( U_{B,i} \), the degrees of freedom are assumed to be infinite.

The degrees of freedom, d.f. or the Greek letter \( \nu \), for the \( U_{ISO} \) is computed for the total uncertainty with the Welch-Satterthwaite approximation. This formula is:

\[
d.f. = \nu = \frac{\left[ \sum_i (U_{A,i})^2 + \sum_i (U_{B,i})^2 \right]^2}{\sum_i \frac{(U_{A,i})^4}{v_i} + \sum_i \frac{(U_{B,i})^4}{v_i}}
\]

This formula is a real pain so put it in your computer program and use it as needed. Hand calculations are very frustrating here. One simplifying aspect is that item in the last term in the denominator, \( \frac{(U_{B,i})^4}{v_i} \), is zero as the \( v_i \) is infinity.

Now, with the degrees of freedom, d.f. or \( \nu \), the Student’s \( t_{95} \) can be found in a table in any statistics text. Not a problem.

Further, if 95% confidence is not desired but 99% or some other confidence is, just use the proper Student’s \( t \).

Well, there you have it. Now, we need to consider the U. S. Uncertainty Standard and how to calculate that uncertainty. What are its major components? Hint, they are not Type A and Type B which are associated with the origin of the information used to estimate the values for the elemental uncertainties; they are associated with the impact of uncertainties on the test result. Second hint, these groupings are familiar to engineers and they use them the world over. Do you know what they are? Next time....

Until then, remember, “use numbers not adjectives.”

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Far too often, equal percentage control valves are found in applications where linear control valves should have been used. This article explains equal percentage control valves and sets guidelines for their use.

What is an Equal Percentage Control Valve?
The relationship between valve stem position and the flow rate through a control valve is described by a curve called the valve’s flow characteristic curve, or simply the valve characteristic. An equal percentage flow characteristic is a nonlinear curve of which the slope increases as the valve opens, while a linear flow characteristic is a straight line (Figure 1).

Figure 1. Equal percentage and linear flow characteristics.

Control valves manipulate the rate of liquid/gas flow through them by altering the open area through which the liquid/gas passes. Linear valves increase the open area linearly with valve travel, while equal percentage valves open progressively more area with valve travel (Figure 2).

Why do we need Equal Percentage Valves?
PID controllers are linear devices and, for optimal performance, the process should behave linearly too. That is, if the controller output changes from 10% to 20%, the process should respond just as much as it would if the controller output changes from 80% to 90%. From this requirement, it seems that linear control valves should be sufficient.

However, up to now we have been talking about the inherent/design flow characteristic of control valves. This is the flow characteristic that a valve exhibits if the pressure difference across it remains constant throughout its operating range. But in practice this is often not the case. The pressure difference across a valve is often a function of flow, and it changes with valve position. Consequently, the inherent flow characteristic is often distorted by the process and we refer to the resulting curve as the installed valve characteristic.

So we have to refine our linearity requirement to reflect the installed valve characteristic. Sometimes we need to use a control valve with an equal percentage inherent characteristic to obtain a linear installed characteristic. Two distinctly different scenarios follow.

Scenario 1a
Consider a centrifugal pump for providing pressure, and a control valve for controlling the flow (Figure 3). As the pump delivers more flow, its capability for generating pressure decreases. Therefore the pressure differential across the control valve is high at low flow rates; and it is low at high flow rates. An equal percentage valve can offset this change in differential pressure to exhibit a more linear installed characteristic.

Figure 3. Simple flow control loop with centrifugal pump.

Scenario 1b
However, we can’t just assume that because we have a centrifugal pump, we need an equal percentage valve. If the system pressure (backpressure) downstream of the valve remains high, for example when pumping into a pressurized system, the pump will likely stay high on its curve, and the pressure across the control valve will not change appreciably. In this case a linear valve might be a better choice.

If we consider the pressure differential across the valve versus flow, we can make the right choice in Scenarios 1a and 1b. If the pressure differential remains reasonably constant, a linear valve is required (but please read Scenario 2 below). If the pressure differential drops by more than 50%, equal percentage can provide better linearity. To remove the guesswork, use valve-sizing software. The software should allow you to specify a few pressure-differential...
versus flow points and based on that, it will recommend the best valve for the application.

**Scenario 2**

Let’s consider a steam-condensing heat exchanger (Figure 4). The pressure upstream of the valve is kept constant by the boiler and steam pressure controller. The pressure downstream of the valve is determined by the condensate temperature, which is roughly equal to the outlet temperature, which is controlled to a constant setpoint.

**Figure 4. Steam-condensing heat exchanger.**

In other words, the pressure differential across the steam control valve remains relatively constant, regardless of the flow. Should we then use a linear valve. Well, we should actually use ratio control in which we control the steam flow rate as a ratio of the process flow rate and use a linear valve, but that is another story. Most heat exchanger control designs are as simple as shown in Figure 4.

Even though the constant differential pressure across the valve calls for a linear control valve, this process calls for an equal percentage valve. At low process flow rates, the outlet temperature is very sensitive to changes in steam flow. At high process flow rates, the steam flow must be changed much more to affect the heater outlet temperature to the same degree. This can be accomplished by using an equal percentage control valve. At small valve openings, the valve sensitivity is very low, which cancels the high sensitivity of the process. The valve sensitivity increases as the valve opens more – which is exactly what is required because the sensitivity of our heat exchanger decreases with increased process flow rates.

**Conclusion**

An equal percentage control valve should be used when the pressure differential across the valve decreases with increases in flow rate. Valve sizing software should be able to find the right valve characteristic for the job. Also, equal percentage control valves should be used in control loops of which the process gain decreases with increases in flow rate. If none of these conditions apply, the loop is likely better off with a linear control valve.

Stay tuned!

Jacques Smuts
Principal consultant of OptiControls, and author of Process Control for Practitioners.

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**A Request from the Newsletter Editor**

By Dale Evely, P.E.
POWID Newsletter Editor

The goal that POWID works toward is to publish three newsletters each calendar year; with the basic schedule being publication in March (Spring), August (Summer) and December (Fall). All three of the newsletters are published electronically and the Spring newsletter is also published in paper format and mailed to those of you who live in the USA. Since the newsletter is only as good as its content, I would like to encourage each of you to submit technical articles as well as other articles of broad interest for publication in future newsletters. Technical content that is specific to the automation side of the power industry is what provides the best benefit to our membership so please share with your colleagues any tidbits that have been beneficial to you in your job or in expanding your knowledge base. You can send your articles to dpevely@southernco.com (please limit any attachments to 5MB or my mail server may not let them through and I will never know that you tried to send them). If the article was not authored by you, please provide us with a statement that you have cleared publication of the material with the author. I look forward to hearing from you.

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ABSTRACT

Proportional-integral-derivative (PID) controllers have been widely utilized in power plant system as dominant control strategy for the past decades. In the previous work, several procedures for simultaneous tuning of PID gains have been applied to an industry-standard nonlinear six PID-type controllers cluster in the closed loop. The cluster was controlling 4-input-7-output nonlinear power plant model with time-delay representing sufficiently well a typical coal-fired boiler/turbine system. Although satisfactory time domain performance was achieved, it was discovered that through closed-loop linearization the closed-loop robustness performance of the original model under the standard PID cluster around operating points is rather poor. This can be only marginally affected through tuning, implying that a well-tuned cluster would require retuning under not very significant changes in plant parameters to maintain adequate performance. In this paper, A consistent robustness enhancement procedure is proposed to correct the main structural deficiencies of the existing cluster by introducing into it additional control elements, for example - off-diagonal proportional links, based on full-rank linear H\(_\infty\) controller design, to approximate the robustness performance of the latter. The simplest nonlinear PID cluster robustification is presented. This type of PID cluster redesign could be easily implemented using the existing software/hardware control equipment. The closed-loop system consisting of the original and the robustified PID clusters with the original plant model is simulated respectively. The simulation results have shown that the closed-loop performance of the original model with standard PID cluster significantly degrades under a typical plant model perturbation, while the latter has much smaller effect on the performance of the closed loop with the original model and the robustified PID cluster.

1. Introduction and Background

Proportional-integral-derivative (PID) controllers have been widely utilized in power plant control system for the past fifty years. In the previous study [1] and [2], a closed-loop system consisting of a 4-input-7-output nonlinear power plant model with time-delay representing sufficiently well a typical coal-fired boiler/turbine system and a nonlinear cluster of six PID-type controllers was specified, with cross-coupling of the variables similar to that in a real power plant. In order to capitalize on the
interactions among process variables and loops to attain better overall time-domain performance, several procedures of simultaneous tuning of PID gains in multi-loop control system using local and global optimizers have been utilized. The particular local technique selected - the IFT (iterative feedback tuning) - used the linearized version of the PID cluster for signal conditioning, but the data collection and tuning were carried out on the full nonlinear closed-loop system. The particular global techniques (used in the local tuning) were particle swarm optimization (PSO), simulated annealing (SA), and genetic algorithm (GA). They all provided the pre-specified time domain responses through the appropriately chosen static and/or dynamic weighting of the individual terms in the performance index. However, an additional outcome of simultaneous tuning has been the discovery that the robustness performance of the standard PID cluster structure is rather poor and that this property can be only marginally affected through tuning, implying that a well-tuned cluster would require retuning under not very significant changes in plant parameters to maintain adequate performance. One possible solution to improving the closed-loop robustness performance is to taking advantage of modern multivariable control techniques such as robust optimization to maintain stability as well as desired performance under the existence of system disturbances.

Advanced multivariable control designs such as LQG [12] [13], $H_{\infty}$ approach [14] [16] [17], and predictive control [15] have been successfully applied to the control of modern power plant system in recent years. In the previous study [3], we designed a multivariable $H_{\infty}$ controller for a 4-input-7-output nonlinear boiler/turbine model with time-delay. The resulting robust control system was demonstrated to display performance robustness superior to that of the fine-tuned nonlinear PID controllers. In [14], the author has proposed a multivariable $H_{\infty}$ controller for utility plant and then reduced the $H_{\infty}$ controller to a multivariable PI controller to approximate its robustness. The approximated PI controllers are finally implemented to control the utility plant. Inspired by the reduction methodology in [14], we propose a robustness enhancement solution to correct the main structural deficiencies of the existing cluster by introducing into it additional control elements, such as off-diagonal proportional links, based on full-rank linear $H_{\infty}$ controller design, to approximate the robustness performance of the latter. This type of PID cluster redesign could be easily implemented using the existing control software/hardware equipment without introducing the complexity and difficulty associated with the high order robust controller.

The paper is organized as follows. The nonlinear process model used in this paper and its linearization around the operating condition are discussed in section 2. Section 3 presents the $H_{\infty}$ controller design for this boiler/turbine system in [3]. In section 4 the resulting $H_{\infty}$ controller is reduced to a lower-order PI controller which is then projected onto the existing PID cluster by introducing some off-diagonal links. We compare the closed loop robust performance attained by the original PID cluster with that of the proposed robustified PID cluster in section 5. Section 6 provides closed-loop simulation under setpoint changes and model perturbation. Conclusions are given in section 7.

2. Plant Modeling and Linearization

The plant model used in this work is shown in Figure 1. The model is an incremental model which describes dynamics of all deviation variables with respect to nominal operating condition and is designed to represent a 250 MW plant dynamics around 80% operating point. The model dynamics
were selected based on the power plant model proposed in [4] and the authors’ experience with similar plants. Additional details about the process can be found in [4]. The nominal operating point values are specified as follows:

Megawatt Output = 200 MW
Throttle Pressure = 12.5 × 10^6 Pa
Steam Flow Rate = 80 %
Excess oxygen = 3 %
Air Flow Rate = 80 %
Drum Level = 0 m
Feedwater Flow Rate = 80 %
and all inputs are 80 %.

The process outputs in this model are: \( \Delta y_1 \) - MW, Unit Load, (megawatts), \( \Delta y_2 \) - TP, Throttle Pressure, (Pa), \( \Delta y_3 \) - SF, Steam Flow Rate, (%), \( \Delta y_4 \) - O2, Excess oxygen, (%), \( \Delta y_5 \) - AF, Air Flow Rate, (%), \( \Delta y_6 \) - DL, Drum Level, (m), \( \Delta y_7 \) - FW, Feedwater Flow Rate, (%).

The control inputs to the process are: \( \Delta u_1 \) - TV, Turbine Valve Position, \( \Delta u_2 \) - FR, Firing Rate Demand, \( \Delta u_3 \) - FD, FD Fan Damper Demand, \( \Delta u_4 \) - FWV, Feedwater Valve Position Demand, and \( k \) - Controller parameter vector.

The model is nonlinear as shown in Figure 1. Deadtimes are included in the model, i.e. blocks “TV to MW3”, “FR to PT2” and “FR to FF2” to represent the time delays inherent in the processes, such as coal pulverizer dynamics. There are cross couplings in the model between several inputs and outputs. The turbine valve position affects both the power output and the throttle pressure as does the firing rate demand. The latter also affects the excess oxygen. The power output (steam flow rate) also affects the drum level. The control system model structure used in the closed-loop simulation is that given in Figure 2. Then nonlinearities of the control arise from the lookup table, bias and multiplication components as shown in Figure 2. Thus, the controller is given by the six-PID cluster that includes one lookup table and one multiplication operator and two biases, making the cluster nonlinear. This control system model structure provides a simple but non-trivial testbed for the multi-loop tuning and \( H_\infty \) design.
Figure 1 Simplified process model schematic diagram in Simulink

Figure 2 SIMULINK representation of the nonlinear PID cluster
Although the model in the paper is nonlinear, the real process is almost always working in the vicinity of its operating point around which the linearized model is a good approximation of the nonlinear system. On the other hand, controllability and observability tests are easily applied to the linearized model, providing indication for the controllability and observability of the nonlinear system around operating condition. Therefore, linearization of the nonlinear model around its operating condition is carried out in [3]. The linearized system is obtained in the form of a 7x4 transfer function matrix given by:

\[
\begin{bmatrix}
MW & TP & SF & O2 & AF & DL & FW \\
11 & 12 & 0 & 0 & 0 & 0 & 0 \\
21 & 22 & 0 & 0 & 0 & 0 & 0 \\
31 & 32 & 0 & 0 & 0 & 0 & 0 \\
42 & 43 & 0 & 0 & H_{44} & 0 & 0 \\
53 & 0 & 0 & 0 & H_{54} & 0 & 0 \\
61 & 62 & 64 & 0 & 0 & 0 & 0 \\
74 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

where

\[
H_{11}(s) = \frac{900s^5 - 9000s^4 + 4.05 \times 10^4 s^3 - 9.45 \times 10^4 s^2 + 9.45 \times 10^4 s}{2760s^6 + 2.784 \times 10^4 s^5 + 1.266 \times 10^5 s^4 + 3.007 \times 10^5 s^3 + 3.153 \times 10^5 s^2},
\]
\[
+ 2.55 \times 10^4 s + 105
\]

\[
H_{12}(s) = \frac{0.0001454s^4 - 9.691 \times 10^{-7} s^3 + 2.907 \times 10^{-5} s^2 - 4.523 \times 10^{-6} s + 3.015 \times 10^{-7}}{s^6 + 0.6747s^5 + 0.2054s^4 + 0.03273s^3 + 0.00233s^2 + 1.762 \times 10^{-5} s + 6.844 \times 10^{-8}},
\]
\[
- 3.677s^2 - 0.0352s - 0.001043
\]

\[
H_{21}(s) = \frac{9.45 \times 10^4 s^2 + 0.008645s + 4.9 \times 10^{-5}}{5s^3 + 1.042s^2 + 0.008645s + 4.9 \times 10^{-5}},
\]
\[
H_{22}(s) = \frac{0.000603s^4 - 0.000402s^3 + 0.0001206s^2 - 1.876 \times 10^{-5} s + 1.251 \times 10^{-6}}{s^6 + 0.6747s^5 + 0.2054s^4 + 0.03273s^3 + 0.00233s^2 + 1.762 \times 10^{-5} s + 6.844 \times 10^{-8}},
\]
\[
180s^5 - 1800s^4 + 8100s^3 - 1.89 \times 10^4 s^2 + 1.89 \times 10^4 s
\]
\[
2760s^6 + 2.784 \times 10^4 s^5 + 1.266 \times 10^5 s^4 + 3.007 \times 10^5 s^3 + 3.153 \times 10^5 s^2
\]
\[
+ 2.55 \times 10^4 s + 105
\]

\[
H_{31}(s) = \frac{2.907 \times 10^{-5} s^4 - 1.938 \times 10^{-5} s^3 + 5.815 \times 10^{-6} s^2 - 9.045 \times 10^{-7} s + 6.03 \times 10^{-8}}{s^6 + 0.6747s^5 + 0.2054s^4 + 0.03273s^3 + 0.00233s^2 + 1.762 \times 10^{-5} s + 6.844 \times 10^{-8}},
\]
\[
- 0.008151s^4 + 0.005434s^3 - 0.00163s^2 + 0.0002536s - 1.691 \times 10^{-5}
\]
\[
25s^8 + 226.5s^7 + 226.7s^6 + 105.6s^5 + 28.51s^4 + 4.664s^3 + 0.4349s^2
\]
\[
+ 0.01827s + 6.762 \times 10^{-5}
\]

\[
H_{32}(s) = \frac{0.25}{3600s^4 + 2040s^3 + 409s^2 + 34s + 1}
\]

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The staircase algorithm [5] is then used to determine the controllability and observability of the linearized system after transforming the transfer function into a state-space representation characterized by 52 state variables. From staircase algorithm, it has been shown that there are also 52 controllable states and 52 observable states. Therefore, by the definitions of the controllability and observability [6], the linearized system is both controllable and observable although it essentially a 4×4 system since only four out of seven outputs need to track the setpoint changes.

### 3. Robust Controller Design

Following the notation and discussion in study [3], the standard representation of a closed loop plant with uncertainties can be given by the feedback structure in Figure 3, where \(P(s)\) is the generalized plant, \(K(s)\) is the controller, and \(\Delta(s)\) is a representation of the uncertainties in the model. The diagram in Figure 3 contains the following signals: \(u\) and \(y\) are the vectors of control inputs to the plant and measured outputs fed to the controller, respectively. The vectors \(w_p\) and \(z_p\) are specially constructed quantities which may contain signals that have no direct representation at any point in actual plant but explicitly relate to the design objectives. The vector \(w_p\) is usually referred to as the vector of ‘external’ or ‘performance’ inputs that cannot be controlled, such as actuator or measurement noise. The vector \(z_p\) is usually referred to as the vector of ‘performance’ outputs, which are signals to be kept small, such as functions of errors or control signals (e.g. the ‘output’ of control signal activity). The vectors \(w_u\) and \(z_u\) are referred to as the ‘uncertainty’ inputs and outputs respectively.
By lumping $w_p$ with $w_u$ and $z_p$ with $z_u$ into vectors $w$ and $z$, respectively, we can partition $P(s)$ as

$$P(s) = \begin{bmatrix} P_{11}(s) & P_{12}(s) \\ P_{21}(s) & P_{22}(s) \end{bmatrix}$$

where

$$z = P_{11}w + P_{12}u$$

$$y = P_{21}w + P_{22}u$$

or employing state-space representation and standard notation, as

$$P(s) = \begin{bmatrix} D_{11} & D_{12} \\ D_{21} & D_{22} \end{bmatrix} + \begin{bmatrix} C_1 \\ C_2 \end{bmatrix} (sI - A)^{-1} \begin{bmatrix} B_1 & B_2 \end{bmatrix} = \begin{bmatrix} A & B_1 & B_2 \\ C_1 & D_{11} & D_{12} \\ C_2 & D_{21} & D_{22} \end{bmatrix}$$

Using an output feedback controller $K(s)$ in the control law $u = K(s)y$, the following transfer function is obtained:

$$z = T_{w,z}(s)w \quad \text{where} \quad T_{w,z}(s) = P_{11} + P_{12}K(I - P_{22}K)^{-1}P_{21}$$

The $H_\infty$ control problem ([10] and [11]) consists of finding a controller, $K$, that stabilizes $P$ and ensures that the infinity norm of the closed-loop transfer function is below some prespecified bound, $\gamma$, i.e. finding

$$K_\infty \equiv \{K : K \text{ stabilizes } P(s), \|T_{w,z}(s)\|_\infty \leq \gamma \}$$

where
\[ \| T_{w,z}(s) \|_\infty = \sup_w \| z \|_2 \leq \gamma \] (1)

under the following assumptions
(1) \((A, B_2)\) is stabilizable and \((A, C_2)\) is detectable;
(2) \(D_{12}\) has full column rank, and \(D_{21}\) has full row rank;
(3) \[
\begin{bmatrix}
A - j\omega I & B_2 \\
C_1 & D_{12}
\end{bmatrix}
\]
has full column rank for all \(\omega\);
(3) \[
\begin{bmatrix}
A - j\omega I & B_1 \\
C_2 & D_{21}
\end{bmatrix}
\]
has full column rank for all \(\omega\)

Such controller, if found, stabilizes \(P(s)\) for all uncertainties \(\Delta(s)\) satisfying
\[ \| \Delta(s) \|_\infty \leq \frac{1}{\gamma}, \Delta(s) \in \text{BIBO stable} \]
while also satisfying (1), i.e. attenuating the effect of the performance inputs (noise and disturbances) on the performance outputs (errors).

The development of the generalized plant model follows the procedures described in [8] and [9]. Measurement noise and plant disturbances are not considered and will be addressed elsewhere. The uncertainty comes from the time delay and other approximations during the linearization. A diagram of the complete generalized plant model used for the controller design is shown in Figure 4. In Figure 4,

\( w = [r] \) — reference signals
\( u = [u] \) — control inputs
\( z = \begin{bmatrix} z_c \\ z_e \end{bmatrix} \) — control activity
\( y = \begin{bmatrix} y_p \\ y_e \end{bmatrix} \) — performance error
\( \gamma \) — measured outputs
\( \gamma \) — integrated output error

An additional state \( \gamma \), where \( \gamma = y - r \), is added to this linear system. This state is introduced to ensure tracking and is treated as an additional output, resulting in the following system

\[
X = \begin{bmatrix} x \\ \gamma \end{bmatrix} = \begin{bmatrix} A & 0 \\ C & 0 \end{bmatrix} \begin{bmatrix} x \\ \gamma \end{bmatrix} + \begin{bmatrix} 0 & B \\ D & -I \end{bmatrix} \begin{bmatrix} r \\ u \end{bmatrix}
\]

\[
Y = \begin{bmatrix} y \\ \gamma \end{bmatrix} = \begin{bmatrix} C & 0 \\ 0 & I \end{bmatrix} \begin{bmatrix} x \\ \gamma \end{bmatrix} + \begin{bmatrix} 0 & D \\ 0 & 0 \end{bmatrix} \begin{bmatrix} r \\ u \end{bmatrix}
\]
For the boiler/turbine unit considered in this paper, the controller designed on the basis of the nominal model given in Figure 1 should guarantee tracking of dispatched load demand and maintain the desired throttle pressure, excess oxygen, and drum level under modeling uncertainty by manipulating the four inputs.

To ensure the ability of the controller to force the plant output, \( y \), to track a step reference signal, \( r \), it is necessary to introduce integrators as elements of the error weighting matrix \( W_e \). In order to generate stable control law under integral action and include this action into the optimization procedure, the signal to be minimized is the ideal integrated error \( z_e \). This signal is calculated by subtracting the reference input \( r \) from the plant output \( y_p \), and filtering the result through the integrator \( W_e \) and, further, through the diagonal scaling matrix \( G_e \). The signal \( y_e \) is obtained by passing error signal \( y_p - r \) through the integrator \( W_e \). While \( z_e \) is the signal used in the design stage for optimization purpose, signal \( y_e \) is the actual quantity used in the feedback loop for control purpose.

The diagonal constant scaling matrices \( G_e \) and \( G_c \) in Figure 4 are used to tune the controller to yield an acceptable close-loop transient response. \( G_e \) tunes the weighting of the integration error in the cost function. If the weighting is increased, the controller will be more aggressive, and the system will have faster transient response but bigger overshoot and higher peak values of the control signal. \( G_c \) is designed to directly tune the control effort. If \( G_c \) increases, the resulting controller will generate more conservative control signal with smaller peak values, with the overshoot of the closed-loop system tracking response decreasing and the transient response time increasing.

For the specific chosen values of weighting and scaling matrices and the resulting \( H_\infty \) controller, the reader can refer to the previous study [3] for more details.

### 4. Robustness Enhancement of PID Cluster
From section 4 in the previous study [3], we notice that the robustness of the standard PID cluster structure in Figure 2 SIMULINK representation of the nonlinear PID cluster is rather poor. The $H_\infty$ norm of the closed-loop system with linearized PID cluster is about 2700.5. It’s also been demonstrated in study [3] that the $H_\infty$ controller derived in section 3 did improve the closed-loop system robustness, reducing the $H_\infty$ norm to about 5.3047. Although the multivariable robust control design successfully addressed the robustness deficiency existing within the PID cluster, a minimal state-space realization of the designed $H_\infty$ controller has order of 31. This high order controller will cause practical implementation issues in real application and spur the need to investigate the performance of simplified reduced-order controllers. Moreover, the PID control law is still the dominant algorithm in the industry and the most familiar method to operational practitioners due to its easy implementation and tuning properties. Therefore, in this section, we investigate the strategy and performance of reduced order PID type approximated multivariable robust controller and project it onto the original PID cluster to enhance the overall closed-loop robustness.

The robust controller can be represented by a state space realization of the form

$$x = A_k x + B_k u$$
$$y = C_k x + D_k u$$

where $A_k \in \mathbb{R}^{n \times n}$, $B_k \in \mathbb{R}^{n \times p}$, $C_k \in \mathbb{R}^{q \times n}$, $D_k \in \mathbb{R}^{q \times p}$, $n$ is the number of states, $p$ is the input dimension and $q$ is the output dimension. If the rank of the matrix $A_k$ is equal to $n$, assume $s \ll \sigma_{\text{min}}(A_k)$, i.e. minimum singular value of $A_k$, since we are most interested in the low-frequency band. So by truncating the Taylor expansion of the controller with respect to the variable $s$, we can derive the following proportional type (P) controller:

$$K(s) = C_k (sI - A_k)^{-1} B_k + D_k$$

$$\approx D_k - C_k A_k^{-1} B_k$$

It is clear that based on the above procedure the resulting P controller achieves good approximation of the robust controller at low frequencies.

In the present case, our goal is to approximate the 31$^{\text{st}}$ order $H_\infty$ controller at low frequencies with a P type controller. The P gains are given as:

$$P = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & -0.0505 & 0.0024 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -0.0451 & 0.0012 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -0.0451 & 0.0012 & -0.2492 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -0.0795 & 0.0021 & 0 & -0.0003
\end{bmatrix}$$

Then the above P-controller is projected onto the PID cluster in Figure 2 by paralleling the P-controller with the PID cluster, i.e. summing these two controllers together, to enhance the robustness performance of the latter. This procedure is equivalent to introducing additional control elements, in this case some proportional links based on full-rank linear $H_\infty$ controller design, into the existing PID control system to improve its robustness. For illustrative purposes, a simplified structure of the above robustness enhanced PID control system is shown in Figure 5. The schematic of the robustified PID cluster is shown in Figure 6. The four additional integrator blocks in Figure 6 are introduced because the last four inputs of the full rank $H_\infty$ controller as shown in Figure 4 are $\gamma$ where $\dot{\gamma} = y - r$. 

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Consequently the approximation $P$ of the $H_{\infty}$ controller also requires the inputs as $\gamma$ instead of $y - r$. That’s the reason why the integrators were used in Figure 6 to generate the desired inputs $\gamma$.

Figure 5 Structure of the robustified PID control system
5. Robust Performance Comparison between PID Cluster and Robustness Enhanced PID Cluster

To provide a meaningful comparison of the resulting robustified PID controller and the conventional PID cluster presented in Figure 2, the $H_{\infty}$ norm of the closed-loop system for the latter compatible with that for the former should be defined. For this purpose, the block diagram in Figure 4 is reorganized to duplicate the PID controlled closed-loop system in Figure 2. The new diagram is as shown in Figure 7.
Here the scaling matrices $G_c$ and $G_e$ are omitted to make the closed-loop system dependent only on the chosen set of PID parameters.

Linearizing the nonlinear PID cluster in Figure 2 yields

$$K_s(s) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & -PID_1 & 0 & 0 & 0 & 0 & -PID_2 & 0 & 0 & 0 & -PID_3 & 0 & 0 & 0 & -PID_3 \times PID_2 & -0.4 \times PID_3 \times PID_4 & 0 \\ 0 & 0 & PID_3 & 0 & -PID_3 & 0 & 0 & 0 & -PID_3 \times PID_2 & -PID_3 \times PID_3 & 0 & 0 & 0 & 0 & -PID_3 \times PID_3 & 0 & 0 & 0 & -PID_3 \times PID_3 \times PID_4 & 0 \end{bmatrix}$$

where

$$PID_i = k_i + \frac{k_{ii}}{s} + k_{ij} s, \quad i = 1, \ldots, 6, \quad j = 1, 2, 3$$

Here $PID_{1,3,4,5,6}$ are PI controllers while $PID_2$ is PID controller. Two sets of PID controller parameters are defined below. The first one is the set of the initial controller parameters in [1]:

$$k_{11} = 1, k_{12} = 0.1, k_{21} = 0.05, k_{22} = 0.00001, k_{23} = 2, k_{31} = 4, k_{32} = 0.1,$n
$$k_{41} = 4, k_{42} = 0.4, k_{51} = 1, k_{52} = 0.0001, k_{61} = 20, k_{62} = 0.6$$

The second set is that for the IFT tuned controller parameters in [1]:

$$k_{11} = 0.7853, k_{12} = 0.0987, k_{21} = 0.3642, k_{22} = 0.00001, k_{23} = 10.6147, k_{31} = 1.5766, k_{32} = 0.0739,$n
$$k_{41} = 1.4767, k_{42} = 0.2126, k_{51} = 0.6889, k_{52} = 0.00009917, k_{61} = 17.4811, k_{62} = 0.3845$$

The PID cluster closed-loop system is still defined as $z = T_{w,z}(s)w$, where

$$w = [r] \quad \text{reference signals},$$

$$z = \begin{bmatrix} z_c \\ z_{ce} \end{bmatrix} \quad \text{control activity, performance error},$$

$$w = [r] \quad \text{reference signals},$$

$$z = \begin{bmatrix} z_c \\ z_{ce} \end{bmatrix} \quad \text{control activity, performance error},$$

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and
\[ \|T_{wz}(s)\|_\infty = \sup_w \|z\|_2 \leq \gamma. \] (4)

Figure 8 compares the Bode plots of the singular values of the closed-loop systems for the robustified IFT-tuned PID cluster, the original IFT-tuned PID cluster control systems with PID gains of (3) and full-order \( H_\infty \) controller. It can been seen from Figure 8 that the full-order \( H_\infty \) controller has the best robustness performance among three controllers. The robustified PID controller rolls off to reject high-frequency noise signals sharply and responds to lower-frequency load disturbances and setpoints. The closed-loop system with the robustified PID controller shows considerable improvements in overall robustness when compared to that with the IFT tuned PID cluster, especially in the low-frequency range. The \( H_\infty \) norms of the closed-loop systems controlled respectively by conventional PID cluster using (2), IFT-tuned PID cluster using (3), robustified IFT tuned controller and full-order \( H_\infty \) controller are given in Table 1. Looking at the definition of norms in (4) and Figure 3, it is seen that the robustness enhancement PID cluster provides better closed-loop performance (significantly lower values of the performance error vector) under the same uncertainties than the PID clusters. Table 1 also shows that PID cluster tuning only marginally affects its performance robustness.

<table>
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<tr>
<th></th>
<th>Initial</th>
<th>IFT</th>
<th>Robustified IFT</th>
<th>( H_\infty )</th>
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<tr>
<td>( |T_{wz}|_\infty )</td>
<td>2700.5</td>
<td>4380.9</td>
<td>1000</td>
<td>71.6216</td>
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</table>

Table 1 Closed-loop uncertainty/performance \( H_\infty \) norm comparisons between the original PID controller, the IFT-tuned PID controller, robustified IFT-tuned PID controller and full-order \( H_\infty \) controller.
6. Simulation Results

In this section, the performance of the robustified IFT PID controller was evaluated. It has been demonstrated that the difference between the robust performance measure of the linearized closed loop under PID cluster and that under the robustified PID cluster seen in Table 1 manifests itself in the significant time domain difference in the closed-loop behavior with the original model under the same plant dynamics change.

6.1. Simulation with the Original Model
First, the resulting robustified IFT-tuned PID controller is applied to the original nonlinear boiler/turbine model to see the time domain performance of the closed-loop system under 2%/min ramp changes in load demand setpoint. The control objective is to track the dispatched load demand while maintaining throttle pressure, excess oxygen, and drum level under modeling uncertainty. Figure 9 compares the tracking performances of the original IFT-tuned PID cluster, the robustified IFT-tuned PID cluster in Figure 2 SIMULINK representation of the nonlinear PID cluster and the full-order $H_{\infty}$ control system under the same reference signals, showing good performance of all closed loops with the nonlinear model, while the robustified PID cluster is performing comparably to that of the original PID cluster. Figure 10 shows the corresponding control signals for the robustified PID cluster.

Figure 9 Comparison of the output responses generated by the closed loop with the original IFT-tuned PID cluster, the robustified IFT-tuned PID cluster and the full-order $H_{\infty}$ robust controller under 2%/min load ramping increase. The units are: megawatts for $y_1$, psi for $y_2$, % for $y_4$, and inches for $y_6$. 

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6.2. Simulation with the Perturbed Model

To assess the time domain performance robustness of both controllers, the plant model perturbation is introduced in the form of two additional blocks as shown in Figure 11. One is increasing the signals in the Turbine Valve Position to Throttle Pressure loop (block “Gain 2”). The other is decreasing the signals in the Turbine Valve Position to Megawatt Output loop (block Gain 3”). In Figure 12, the comparison was performed between the time responses of the closed-loop systems controlled by the original IFT-tuned PID cluster, the robustified IFT-tuned PID cluster and the full-order H_{\infty} controller. It is seen that the output responses of the PID controlled system are seriously affected by the change of plant parameters – oscillations are present in all the system outputs and the settling time has been significantly increased, whereas the robustified PID controller taking advantage of the best robustness performance of the full-order H_{\infty} controller significantly reduces the outputs to their corresponding setpoints with improved transient and steady state performance.

Figure 10 Robustified PID cluster control signals behavior during ramp change in megawatt output setpoint. The units are all %.
Figure 11 Process model with perturbation in the form of two gains: block Gain 2 in the Turbine Valve Position to Throttle Pressure loop and block Gain 3 in the Turbine Valve Position to Megawatt Output loop
Figure 12 Comparison of the output responses generated by the original IFT-tuned PID cluster, the robustified IFT-tuned PID cluster and the full-order $H_\infty$ robust controller under model uncertainty with 2%/min load ramping increase. The units are: megawatts for $y_1$, psi for $y_2$, % for $y_4$, and inches for $y_6$.

The above results demonstrate that the robustified PID cluster with additional static elements achieves better tracking performance under perturbation in model dynamics than the original PID cluster. The results show that although the robustified PID cluster does not attain the full performance robustness of the full-rank $H_\infty$ controller, it still provides substantially better performance robustness than the IFT-tuned PID cluster of Figure 2.

6. Conclusion

In this paper, an effective methodology was proposed to enhance the overall robustness of the existing well-tuned PID cluster with structural deficiencies on a nonlinear 4-input-7-output boiler/turbine.
system. The method is introducing additional control elements based on full-rank linear $H_{\infty}$ controller design, to approximate the robustness performance of the latter. The detailed steps of the $H_{\infty}$ controller design procedure have been presented. The robust performance measures have been computed for closed-loop systems under the original PID cluster and the robustified PID cluster, and the former was shown to be characterized by robustness significantly lower than that of the latter. The simulation results have shown that under the presence of complicating factors such as coupling between variables, time delay, and nonlinearities, the proposed robustification strategy provides time domain performance comparable to that attained by well-tuned PID cluster. However, when the plant dynamics undergoes changes, the PID cluster controlled closed loop exhibits a severe loss of performance, whereas the closed loop under robustified controller exhibits substantially improved performance with reduced oscillation and faster settling time. The performance robustness of the full-rank linear $H_{\infty}$ controller, however, is still higher and, hence, shows potential for further PID cluster robustification. The future work will attempt to develop more comprehensive projections procedures to bring robust performance of the PID cluster closer to that of the full-rank linear $H_{\infty}$ controller.

References:


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By: Dan Lee
POWID Membership Chair
February 2013 through June 2013

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<tr>
<td>Mr. Manjunath Subrahmanyam</td>
<td>Managing Director</td>
<td>RTP Controls India Pvt Ltd</td>
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<tr>
<td>Mr. B Sajan</td>
<td>Design Engineer</td>
<td>Mecon Limited</td>
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<td>Mr. Patrick Suzano</td>
<td>Tecnico Manutencao</td>
<td>Samarco Mineracao SA</td>
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<td>Mr. Yuto Suzuki</td>
<td>Engineer</td>
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<tr>
<td>Ms. Melanie Swanson</td>
<td>Instrumentation &amp; Controls Technologist</td>
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<td>Mr. Charles Swanson</td>
<td>Controls Engineer</td>
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<td>Jamie Sweeney</td>
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<tr>
<td>Mr. Andrew Sweet</td>
<td>Instrumentation Technician</td>
<td>Michelin North America</td>
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<td>Mr. Arnold Szelezcz</td>
<td>Manager</td>
<td>Mag-One Controls</td>
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<td>Mr. Jeffrey Talbot</td>
<td>General Manager</td>
<td>Summit Instrument Specialties</td>
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<td>Vasco Tangkulung</td>
<td>Operation Engineer</td>
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<tr>
<td>Mr. Thomas Taylor</td>
<td>Controls System Infrastructure Specialist</td>
<td>BP Products North America</td>
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<tr>
<td>Mr. Roger Teague</td>
<td>VP of Business Development</td>
<td>Epic Integrated Services LLC</td>
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<td>Mr. Kevin Thompson</td>
<td>Senior Application Engineer</td>
<td>Perpetua Power</td>
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<td>Mr. Joel Thompson</td>
<td>Regional Sales / Service Manager</td>
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<td>Jose Tialpan</td>
<td>Automation Engineer</td>
<td>Operation Technology Inc</td>
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<td>Roberto Tonicello</td>
<td>Marketing and Sales Manager</td>
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<td>Sr Technical Training Specialist</td>
<td>Siemens Energy Inc</td>
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<td>Ignacio Torres</td>
<td>Measurement Engineer</td>
<td>CenterPoint Energy</td>
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<tr>
<td>Nathalie Torres Pirona</td>
<td>Ingeniero De I and C</td>
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<td>Mr. John Torvick</td>
<td>I&amp;E General Foreman</td>
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<td>Paul Tovar</td>
<td>Controls System Engineer</td>
<td>HPI LLC</td>
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<td>Ing. Alan Tovar Jacquez</td>
<td>Sales Engineer</td>
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<td>Sr Field Engr/Project Manager</td>
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<td>Mr. David Trautlein</td>
<td>Manufacturing Engineer</td>
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<td>Mr. William Tritschler</td>
<td>Lead Consultant C&amp;I Engineer</td>
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<td>Mr. John Turner</td>
<td>Senior I&amp;C Engineer</td>
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<td>Mr. Sam Uwaifo</td>
<td>Project Engineer</td>
<td>National Grid</td>
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<td>Mr. Agustin Valencia Gil-Ortega</td>
<td>Ingeniero Proyectos I And C</td>
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<td>Mr. Andres Valles Carboneras</td>
<td>Ingeniero I and C</td>
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<td>Mr. Clint Vanderford</td>
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<td>Mr. Alejandro Vargas Barrera</td>
<td>Instrument Technician</td>
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<td>Mr. Pedro Vasquez</td>
<td>E&amp;I Superintendent</td>
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<td>Mr. Miguel Velasco Valganon</td>
<td>Tecnico Seguridad Informatica</td>
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<td>Mr. Muthu Kumar Venketasubramanian</td>
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<tr>
<td>Mr. Suresh Venugopal</td>
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<td>Fichtner Consulting Engineers</td>
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<td>Mr. Wouter Veugelen</td>
<td>Senior Manager, Cyber Security Consulting</td>
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<td>Ing. Raul Villalon</td>
<td>Senior Instrumentation Engineer</td>
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<td>Regional Sales Manager</td>
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<td>Mr. Ravindra Virpara</td>
<td>Instrument Technician</td>
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<td>J C Waal Engineering Co</td>
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<tr>
<td>Bonny Wadikonyana</td>
<td>Training and Development Officer</td>
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<tr>
<td>Mr. Dariusz Walczak</td>
<td>Staff Engineer</td>
<td>Babcock Power</td>
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<td>Mr. Martin Walker</td>
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<td>Park Webster</td>
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<td>James Weit</td>
<td>Senior Applications Engineer</td>
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<td>Mac Instruments</td>
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<td>Ms. Janice Wilson</td>
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<td>Morrow Engineering Inc</td>
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<td>LW System Automation</td>
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<td>Hoy Wong</td>
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<td>Mr. David Wright</td>
<td>Control Specialist</td>
<td>Southern Company</td>
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<tr>
<td>Mr. Michael Yenne</td>
<td>Control &amp; Electrical Technician</td>
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<tr>
<td>Mr. Venkata Yerramillli</td>
<td>Senior Instructor Instrumentation</td>
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</tbody>
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Welcome New POWID Students

Donie Abraham
Mr. Richard Adolphs
Imteyaz Ahamed
Mr. Ali Alaqouq
Mr. Saad Alqahtani
Mr. Lucas Amando De Barros
Taylor Anderson
Jheferson Araujo
Mr. Omoarebun Aruya
Ms. Maria Aviles Conde
Mr. Abhinav Ayri
Victor Banda
Matthew Bell
Ms. Olga Benavides
Kyle Benson
Mr. Sushrut Bhalerao
Ms. Anusha Bhandary
Ms. Akanksha Bhangale
Ms. Anusha Bhandary
Ms. Akanksha Bhangale
Abhishek Bhardwaj
Ms. Tanvi Bhatia
Mr. Prabir Biswas
Mrs. Jontay Blatcher-Benion
Frank Bonilla
Mr. Kshitiz Byahatti
Keith Cannon
Javier Cano
Mr. Feligi Cappi Da Costa
Jamey Carbaugh
Joshua Carey
Refugio Carrillo
Augusto Carvalho
Rodrigo Castro
Henrique Cavagnoli
Alok Chauhan
Ms. Shraddha Chogle
Mr. Siddhant Chougule
Mr. Pravin Chougule
Daniel Coltogrone
Mr. Garry Conklin
Fred Copeland
Diego Costa
Marcelo Costa
Eduardo Costa
Mr. Brian Crawford
Brian Criado
Anitha Dana Rajan
Arnavijit Das
Donald Day
Ms. Vaishali Dhakate
Mr. Ganesh Dhonmar
Prashant Dhumal
Adrian Diaz
Mr. Karl Diekevers
Mr. Mohammed Eltayb
Mariltza Espinoza Herrera
Monica Emilia Espinoza Oscco
Mr. Paul Ezenwa
Rafael Fugundes Rosa Campos
Miguel Ferrer Monze
Gerald A. Fongwe
Marcos Rogerio Freitas
Raul Galnedo Sabater
Mr. Jorge Garcia Lozano
Giovanni Gentile
Zachary Greenleaf
Ms. Yonne Greer
Jeff Griffith
Seunghee Han
Ms. Kristen Harris
Mr. Syed Hatim
Mr. Chad Hawkins
Ian Hernandez
Eduardo Herrera
Mr. Eduardo Hoffmann
Jeremy Hogue
Mr. Owen Hurley
Mr. Mihir Inamdar
Mr. Shyam Iyer
Anthony Jackson
Carla Jensen
Ms. Hongzhi Jiang
Ms. Rosa Jimenez
Mr. Mandar Joshi
Ms. Nikhita Joshi
David Joyce
Ms. Supriya Juikar
Ms. Swati Kadam
Rohan Kadam
Mr. Girish Kamath
Gauri Katkadi
Mr. Michael Kenney
Nikhil Khadakban
Mr. Mansoor Khalili
Abhishek Khichi
Mr. Jongsup Kim
Andrew King
Sanket Kulkarni
Ketaki Kunte
Mr. Nitin Lad
Sarah Lal G S
Frank Lam
Mr. Viktor Lambov
Barry Langer
Kent Larsen
Mr. Larry Lawhorn
Tyler Leadbetter
John Leasure
Johnathan Lewis
Alejandro Llamas Minarro
Mr. Cai Loss
Mr. Kelley Lowry
Shander Lyrio
Mr. Charles Maclin
Mr. Ganesh Malshikhar
Onkar Mandre
Nikhil Manudhan
Javier Marco Carrillo
Ignacio Martinez Salvador
Joby Mathews
Vipul Maurya
Mr. Somkene Mbakwe
Chad McDermott
Nicholas Mesko
Mr. Rafael Meyer
Yaminah Meza
Sanket Mhatre
Ms. Shweta Mhatre
Deepak Mishra
Mr. Gaurav Kumar Mistry
Alejandro Modrijal
Marcos Monfardini Filho
Ms. Iolanda Monteiro
Mr. Bharat Moorthy
Ms. Tanvi Mudhale
Ms. Anu Muvadgah
Shurti Nair
Sharika Nambudiri
Gabriel Naves
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Mr. Zenison Novelli
Mandeep Singh Obbi
Ms. Rebecca欧阳
Mr. Lucas Oliveira
Orenan Oliveira
Winston Oliveira
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Cain Ortiz
Mr. Adam Ortiz
Christopher Osuala
Ms. Veenamol P V
Jahi Pandey
Tiago Pandolfo
Mr. Jimit Patel
Prashe Patel
Mr. Vaibhav Patil
Avadnath Patil
Mayue Patil
Vaibhav Patil
Pedro Henrique Pisz
Mr. Jorge Penha
Aquinaldo Pereira
Mr. Felix Perez Zamora
Mccai Phelps
Mr. Kunal Phondekar
Milena Pinto
Ms. Leidy Poveda
Rahul Raj
Rojan Rajan
Shawn Ramsey
Prasanth Ravi
Chaitra Ravikumar
Mr. Gabriel Reisz
Mr. Jairo Rincon Ramos
Nolan Robertson
Gutierry Rocha
Maycon Rodrigues de Souza
Luis Rodriguez
Christopher Rowan
Mr. James Russell
Bhuvaneshwari Sabapathy
Ms. Saumya Sajib
Kunal Sakhardande
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Ms. Devashree Thakare
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Tushar Thakur
Seth Thomason
Ms. Smita Tiwari
Mayank Tiwari
Ing. Melissa Torres Salazar
Mr. Ronald Torres Vieira
Daniel Trout
Sangeeth TV
Maheshkumav Upadhyay
Ms. Riddhi Vaidya
Mr. Jamison Van’t Hul
Akvaro Varela
Mr. Puchparaj Varma
Vinicius Vasconcelos
Ryan Weber
Eric Welhmeiler
Jacob Weninger
Cherill White
Mr. Adam White
Mr. Cameron Wingo
Hassanain Witwit
Semere Wondmagesen
Mr. Martin Wrobel
Bhagawantappa Yergal
Gederson Zillo
Indrajit Zope
Mr. Mohit Chhabra
Mr. Jose Mojica
Mr. Jose Mojica
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ISA POWID Executive Committee Update

The ISA Power Industry Division (also known as POWID) is organized within the Industry and Sciences (I&S) Department of ISA to provide a means for information exchange among engineers, scientists, technicians, and management involved in the use of instrumentation and control in the production of electrical power by any means including but not limited to fossil and nuclear fuels. The POWID Executive Committee (EXCOM) administers the activities of the division. The Executive Committee normally meets three times per year, traditionally in late winter or early spring, at the POWID Annual Symposium in June, and at the annual Fall ISA Event in the Fall. POWID Executive Committee meeting minutes and attachments can be found at: http://www.isa.org/MSTemplate.cfm?Section=POWID_Meeting_Minutes1&Site=Power_Industry_Division&Template=/ContentManagement/MSContentDisplay.cfm&ContentID=89063.

ISA67 Nuclear Power Plant Standards Committee Update

By ISA67 Committee Chair Bob Queenan

ISA67 is responsible for all ISA nuclear plant instrumentation and control standards and last met on June 5th at the annual POWID Symposium. There were not enough voting members present to constitute a quorum, so no official business was conducted. No changes in membership were proposed. SP67.01 on Transmitter and Transducer Installation met at the symposium. Bill Barasa, the chair, reported that the standard will need minor revisions to address comments and will be submitted for ballot this year. SP67.02 on Sensing Lines and Tubing also met at the symposium. Klemme Herman, the chair, reported that the committee is working on a new draft and intends a first ballot this year. SP67.03 on RCS Leak Detection did not meet. Tim Hurst reported that the committee was staffing up, but that there was no clear technical success path for reliably detecting a one gpm leak in all circumstances. More work is needed before a draft can be prepared. SP67.04 on Setpoints met as well; Pete Vandevisse sat in for Jerry Voss, the chair. The recommended practice was issued and no other significant items were raised. SP67.06 on Performance Monitoring does have an active subcommittee that is addressing comments to the current standard and intends to ballot a revision this year. The meeting was adjourned with no new business being brought forward. More information about the ISA67 Committee and its activities can be found at the committee website at: http://www.isa.org/MSTemplate.cfm?MicrositeID=212&CommitteeID=4674. Please consider getting involved today!

ISA77 Fossil Power Plant Standards Committee Update

By ISA77 Committee Co-Chairs Bob Hubby and Daniel Lee

Hello, Power Industry members! We are pleased to report that the ISA77 committee has started the process of reaffirming four documents: ISA77.13.01 Turbine Steam Bypass Systems, ISA77.42.02 Feedwater Control—Drum level Measurement, ISA 77.43.01 Unit Plant Demand Development and ISA 77.60.04 HMI—Electronic Screen Displays. All four documents have been balloted, comments have been returned, and the respective sub-committees have reviewed the resolution to the comments. Since the resolution will result in requirement changes within these document, all four documents will enter a revision cycle that requires both a future committee and public ballot. The committees are working on preparing a final revision document for balloting. The ISA77.20.01 Simulation subcommittee is also starting a revision cycle for its document. The Simulation sub-committee held a meeting in conjunction with the CS PowerPlantSim conference in Tampa on January 28, 2013. In addition, there are two subcommittees working on drafting new documents. The ISA77.22.01 Power Plant Automation and ISA77.30.01 Power Plant Controls System—Dynamic Performance Test Methods and Procedures subcommittees are holding regular meeting (live and physical meeting). The respective chairs are looking for new committee members for these documents. If you are interest in any of these topics and would like to contribute in the development of these standards, please contact the respective committee chair. Most committee meetings are held via web meeting so no travel is required. Your technical input is greatly appreciated. The ISA77 committee last met on Thursday June 5 at the Rosen Shingle Creek Hotel, Orlando Florida. The ISA77 committee meeting minutes, along with other information about the committee, can be found on the ISA77 committee web site at http://www.isa.org/MSTemplate.cfm?MicrositeID=248&CommitteeID=4710.