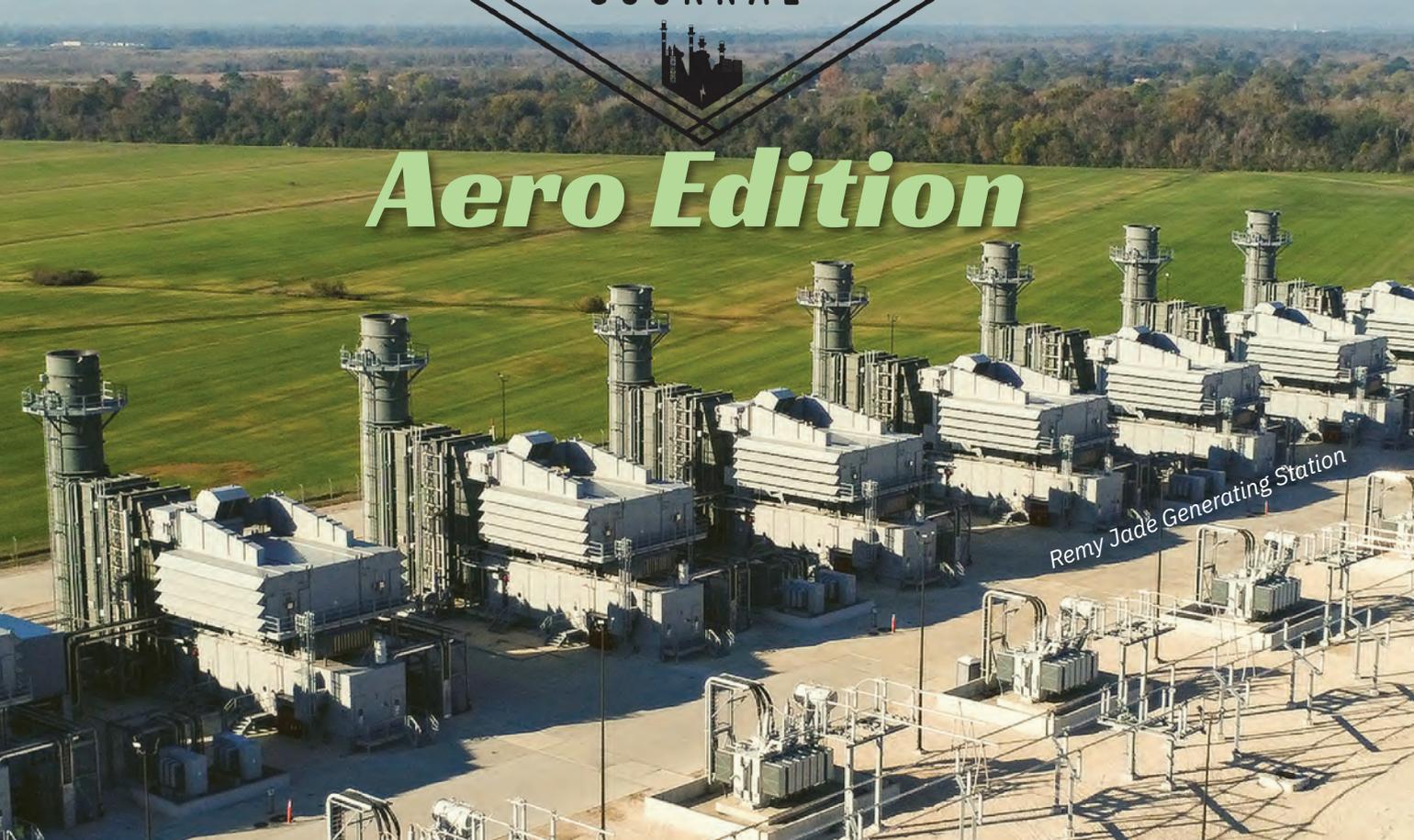


- GAS TURBINES
- STEAM TURBINES
- HRSGS
- GENERATORS
- CONTROLS
- AUXILIARIES

Issue 85 (2026)
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Aero Edition



Remy Jade Generating Station

USER GROUP RECAPS

- 06...Western Turbine Users
- 70...FT8 and FT4 Users Groups
- 79...HRSG Forum América Latina
- 106...PROENERGY Conference 2026

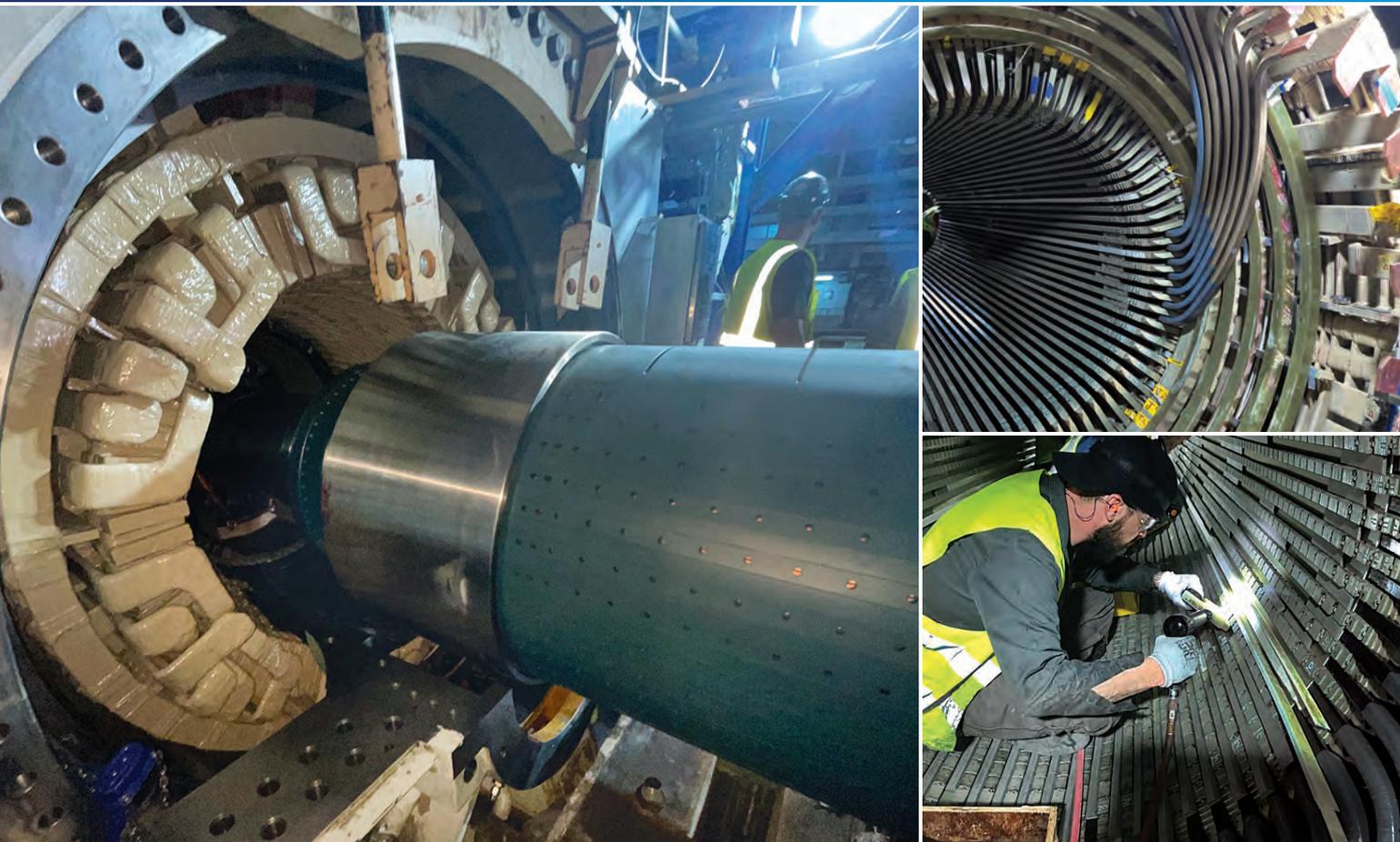
FEATURES

- 50...Analytics backed by experience
- 59...Growing integrity risk in HEP tees
- 62...Field HVTs for advanced GTs
- 64...Open-market peaker conversion
- 104...BB4 pump reliability upgrades
- 109...Smarter inlet filter selection

BEST PRACTICES

- 87. WattBridge LM6000 Fleet
- 90. MID Woodland, Unit 2
- 91...Mariposa Energy Project
- 92...Sentinel Energy Center
- 94...Wildflower: Indigo & Larkspur
- 96...Exira Station
- 97...HKW Freimann
- 98...REO Cogen
- 99...M B Lee Peakers
- 100...University Park North
- 101...Nevada Cogen No. 2
- 102...Edgewood Energy

330H Generator Stator Rewind Onsite



Read this case study at www.MDAturbin.com/330H

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PLAN FOR 2026: CCGT INDUSTRY EVENTS



FT8 Users Group March 17-19

EPRI Main Campus and Marriott University Place, Charlotte, NC. Details/registration at www.ft8users.com. Contact: Ashley Potts, ft8@ft8users.com.

FT4 Users Group March 17-19

EPRI Main Campus and Marriott University Place, Charlotte, NC. Details/registration at www.ft4users.com. Contact: Ashley Potts, ft4@ft4users.com.



WTUI (LM2500, LM6000, LMS100) April 7-10

Long Beach, Ca. Details/registration at www.wtui.com. Contact: Charlene Raaker, craaker@wtui.com.



7F Users Group May 18-22

Woodlands Waterway Marriott, Houston, Tex. Details/registration at www.powerusers.org. Contact: SV Events, planning.team@sv-events.net.



European HRSG Forum May 19-21

Monash University, Prato, Italy. Details/registration at www.europeanhrsgforum.com. Contact: Rachel Washington,

rachel@meccaconcepts.com.au.



Legacy Turbine Users Group (Frames 7E, 6B, 5) June 22-25

The OMNI Hotel, Oklahoma City, Okla. Details/registration at www.powerusers.org. Contact: SV Events, planning.team@sv-events.net.



Alstom Owners Group Mid-July

TBD, Houston, Tex. Details/registration at www.aogusers.com. Contact: Ashley Potts, ashley@aogusers.com.



HRSG Forum July 20-23

Woodlands Waterway Marriott, Houston, Tex. Details/registration at www.powerusers.org. Contact: SV Events, planning.team@sv-events.net.



HA Users Group August 3-6

Fort Lauderdale Marriott Harbor Beach Resort, Fl. Details/registration at www.powerusers.org. Contact: SV Events, planning.team@sv-events.net.



Power Users Combined Annual Conferences (CCUG, GUG, PPCUG, STUG, and LCPG) August 24-27

Marriott Rivercenter on the River Walk, San Antonio, Tex. Details/registration at www.powerusers.org. Contact: SV Events, planning.team@sv-events.net.



Combustion Turbine Operations Technical Forum (CTOTF) August 30-September 3

Grand Hyatt River Walk. San Antonio, Tex. Details/registration at www.ctotf.org. Contact: Christine Doyle, chrisdoyle@ctotf.org.



CCGT/HRSG Forum: América Latina September 22-24

Blue Tree Premium Morumbi, São Paulo, Brasil. Details/registration at www.hrsgamericalatina.com. Contact: Bianca Carreira, bianca@hrsgamericalatina.com.



Wärtsilä Users Group October 12-15

Crowne Plaza French Quarter, New Orleans, La. Details/registration at www.powerusers.org. Contact: Jacki Bennis, jacki@somp.co.



Australasian Boiler and HRSG Forum Late November

Brisbane, Australia. Details/registration at www.abhug.com. Contact: Rachel Washington, rachel@meccaconcepts.com.au.



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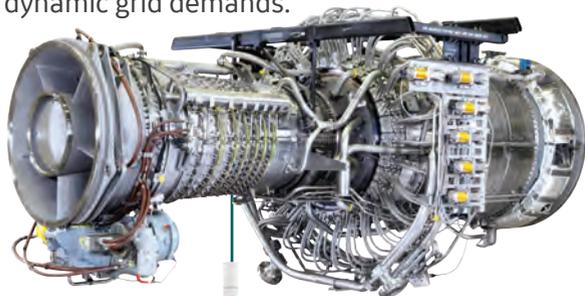
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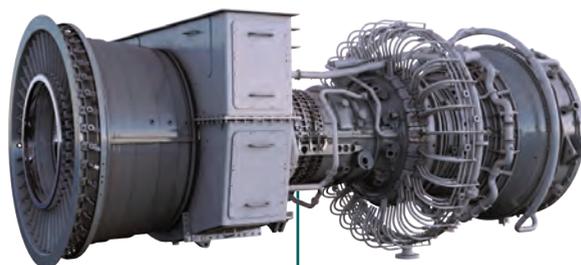
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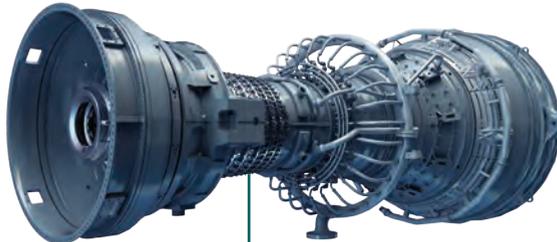
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35TH ANNUAL CONFERENCE AND EXPO

April 7-April 10, 2026

Long Beach Convention Center

Western Turbine Users Inc, the world's largest independent organization of aeroderivative gas-turbine owner/operators, celebrates another year of service to the industry at its annual conference and expo, April 7-April 10, 2026, in the Long Beach Convention Center. One of the biggest changes this year is a switch to a Tuesday-Friday schedule rather than its traditional Sunday-Wednesday program.

What follows is an overview of the upcoming 35th WTUI meeting, plus technical highlights from last year's conference. Presentations from the 2025 meeting, as well as those from earlier conferences, are available at <https://wtui.com/forums> for WTUI members wanting to dig into the details. For access, email Wayne Feragen, treasurer and webmaster, at wferagen@wtui.com.

WTUI 35 (2026)

The Long Beach conference offers the opportunity to reconnect with colleagues, some of whom you may not have seen recently because of all the industry changes. WTUI organizers provide plenty of time to fulfill this objective.

Prime examples include a golf tournament Tuesday morning at the Skylinks at Long Beach golf course (7:30 a.m. to 1 p.m.) and the new addition of an axe throwing tournament (10 a.m. to 1:30 p.m.). Plus, the vendor-sponsored Tuesday evening welcome reception, from 5:30 to 8:30 in the exhibit hall, which is your first opportunity to thank the more than 130 exhibitors (p 10) and sponsors (p 22) for their participation. The Wednesday night reception is in the Pacific Ballroom (adjacent to the convention center), from 6:30 to 9:30, and will feature local foods, live music, and interactive exhibits with a special theme.

For WTUI first-timers, it's not necessarily about connecting with colleagues, but rather meeting new people with professional needs and concerns that align with theirs. The best place to begin this process is at the Tuesday afternoon session (3:30-5:00), "Welcome to WTUI/Conference Familiar-

ization," in Promenade 102A.

The Tuesday session is chaired by Gary Grimwade, senior utilities generation technician, City of Riverside, who has years of experience in the design, operation, and maintenance of GE aeros, gained both on his day job and as the organizer and discussion leader of Western Turbine's LM2500 and special technical breakout sessions.

Grimwade is a hands-on, practical instructor who will help newcomers maximize the benefits of participating proactively in the engine-specific technical sessions on Wednesday, Thursday, and Friday. Plus, he will provide valuable guidance on how to assure units under their purview operate safely and at high reliability. He'll be joined by other members of the WTUI leadership, so bring your question and tap hundreds of years of aeroderivative expertise.

In his opening remarks on Tuesday, Grimwade will explain the conference arrangement, how to organize your participa-

tion, and how to navigate the 2026 sessions for maximum effectiveness. Then he will review the progression of the LM product line from the 2500 to the 5000, to the 6000, and finally to the LMS100. The philosophy of each turbine variant will be discussed and how the turbine/generators are arranged—for example, gear or direct drive.

The slide deck for the 2025 presentation, which will be updated for 2026, contains many very instructive drawings and photographs useful in plant-breakroom training sessions. Review it on the WTUI website to better prepare for this session.

A quick read through the technical program (p 8) will remind you of WTUI's value to your professional growth and development. Highlights include the following:

- Access to the industry's top technical talent Tuesday evening through Friday afternoon in the vendor fair to help you solve plant problems. Think of this as free consulting.

President's welcome

On behalf of the board of directors, officers, breakout-session chairs, and support staff, welcome to the 35th annual conference of the Western Turbine Users.

In the late 1980s, a handful of investors brought early LM2500 and LM5000 gas turbines to California. Their O&M teams quickly recognized shared challenges and advantages, and began meeting to compare experiences and develop solutions to take back to the OEM. From that practical, peer-to-peer problem solving, WTUI was born.

Incorporating in 1990, the organization grew from a small group of plant representatives to 50 members, then 100, then 500, and today more than 1000 strong. You are part of a legacy with a rich history and worldwide influence, built by users committed to improving equipment performance, reliability, and long-term value.

That legacy matters more than ever. Our industry is seeing explosive growth in demand for reliable, firm dispatchable power to secure the grid and support the "always on" requirements of the data-center revolution. Aeroderivatives are increasingly relied on for flexibility, responsiveness, and availability as power systems evolve.



Users like you have challenged equipment suppliers to improve their products, as we demand new uses and extend the lives of our gas turbines. Your participation is the root of our success. Thank you for contributing to this volunteer organization as we move forward together.

Ed Jackson
President, WTUI



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TECHNICAL PROGRAM



Conference Mobile App

As of Feb 19, 2026

Conference registration: Convention Center Promenade Lobby
Exhibits: Convention Center Exhibit Hall C
Breakfasts Monday and Tuesday: Convention Center Exhibit Hall B
Breakfast Wednesday: Convention Center Promenade Ballroom 104 (foyer)
Luncheons: Convention Center Exhibit Hall B
LM2500 Breakout Meetings: Promenade 103
 Chair: Joshua Svejcar, Veolia
LM5000 Breakout Meetings: Promenade 102A
 Chair: Perry Leslie, Yuba City Cogeneration
LM6000 Breakout Meetings: Promenade 104
 Chair: Luis Sanchez, TransAlta
LMS100 Breakout Meetings: Promenade 102B/C
 Chair: Larry Wilson, Onward Energy

TUESDAY, APRIL 7

MORNING

7:30 to 1:00 Golf tournament, Skylinks Golf Course
Bus departs Hyatt lobby @ 6:00 and Renaissance @ 6:15
 10:00 to 1:30 Axe Throwing Tournament
Bus departs Hyatt lobby @ 9:00

AFTERNOON

2:00 to 7:30 Conference registration
 3:30 to 5:00 Welcome to WTUI/Conference Familiarization, Promenade 102A
 Chair: Garry Grimwade, City of Riverside
All new registered conference attendees

EVENING

5:30 to 8:30 Exhibitor-Sponsored Welcome Reception, Convention Center Exhibit Hall
All registered attendees and spouses/guests

WEDNESDAY, APRIL 8

MORNING

7:00 to 4:00 Conference registration
 7:00 to 8:00 Breakfast
All registered conference attendees
 7:00 to 5:30 Exhibit Hall open
Must have name badge to enter
 8:00 to 9:00 General Session, Promenade Ballroom 104
All registered conference attendees
 9:00 to 9:30 ASP Updates: IHI and MTU, Promenade Ballroom 104
All registered conference attendees
 9:30 to 9:45 Break, Exhibit Hall B
 9:45 to 11:00 GE Services/New Products Update, Promenade Ballroom 104
All registered conference attendees
 11:00 to noon Worldwide GT Business Update, Promenade Ballroom 104
 Mark Axford, Axford Turbine Consultants LLC
All registered conference attendees

AFTERNOON

Noon to 1:00 Lunch and activity awards
Must have name badge to enter
 Noon to 2:30 Lunch/Exhibits
Must have name badge to enter
 1:30 to 2:30 Women in Energy, Promenade 102A
 JoAnn Haynes, CleanAir Engineering
 2:30 to 5:30 Breakout Meetings: LM2500, LM5000, LM6000,

LMS100
Users, GE, and ASPs only (blue and yellow badges)

EVENING

6:30 to 9:30 Wednesday Night Reception, Convention Center Pacific Ballroom (adjacent to the Convention Center)
All conference attendees and registered spouses/guests. Must have name badge or wristband and be 21 years old for entry.

THURSDAY, APRIL 9

MORNING

7:00 to 4:00 Conference registration
 7:00 to 8:00 Breakfast
All registered conference attendees
 7:00 to 2:30 Exhibit Hall open
Must have name badge to enter
 8:00 to 9:30 Breakout Meetings: LM2500, LM5000, LM6000, LMS100 **Users only (blue badges)**
 Break, Exhibit Hall
 9:30 to 9:45 Breakout Meetings: LM2500, LM5000, LM6000, LMS100 **Users only (blue badges)**
 9:30 to 11:00 Breakout Meetings: LM2500, LM5000, LM6000, LMS100 **Users, GE, and ASPs only (blue and yellow badges)**

AFTERNOON

Noon to 1:00 Lunch and recognition awards
Must have name badge to enter
 Noon to 2:30 Lunch/Exhibits
Must have name badge to enter
 2:30 to 5:30 Special Technical Presentations
All registered conference attendees
 2:30 to 3:30 NO2 to NO converter efficiency testing (PSE), Promenade 102B/C
 Aero best practices (CCJ), Promenade 103
 Advanced air intake filtration retrofits (Camfil), Promenade 104
 3:30 to 4:30 Enhancing GT plant efficiency and reliability through intelligent data analysis tools (SISO), Promenade 102B/C
 Generator offline diagnostic testing and visual inspections (Kinectrics), Promenade 103
 Non-destructive tools and methods for inspecting engine components (APS & Exponent), Promenade 104
 4:30 to 5:30 Unlocking hidden efficiencies in LM turbine operations: The power of electronic logs (Onward Energy), Promenade 102B/C
 Why pitot tube pumps outperform traditional pump designs for fuel and NOx water injection (Thomas Pump), Promenade 103
 Generator failure issues (Baseload Power) (SPS), Promenade 104

FRIDAY, APRIL 10

MORNING

7:00 to 8:00 Breakfast
 8:00 to 11:45 Open Forums: LM2500, LM5000, LM6000, LMS100
All registered conference attendees
 11:45 to noon Wrap-up/Adjourn, Promenade Ballroom 104
All registered conference attendees



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EXHIBITORS

As of Feb 19, 2026



Conference
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Advanced Filtration Concepts	Flender Graffenstaden Gears	
Advanced Turbine Support	Freudenberg Filtration Technologies	
Aeroderivative Gas Turbine Support (AGTSI)	Freudenberg Flow Technology	PROENERGY
Aerotest Limited	Gas Turbine World	PTD Companies Group
AeroTurbine Services	GasTops	PureTec
AGT Services	GE Vernova	PWF Industrial
Air Hygiene International	Global Energy Services Alliance	Reed Services (RSI)
Airgas Specialty Products	Gradient Lens Corp	Regal Rexnord
Alta Solutions	Groome Industrial Service Group	Relevant Power Solutions
AP4 Group	GTSMRO	Rochem Fyrewash
Baker Hughes	Gulf Turbine Services	Roxtec USA
Baseload Power	GustoRPW	Score Energy Ltd
Beamex	Halifax Fans	SCR Solutions
Braden Group	Hawk Eye	Secretariat
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Caldwell Energy Company	Industrial Air Flow Dynamics (IAFD)	SISO Engineering
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Catalytic Combustion Corporation	InsulTech	SJ Turbine
CECO Environmental	Interlock Energy	SSS Clutch
CEM Service Group	Iris Power LP	Strategic Power Systems
CEMTEK KVB-Enertec	JDS Services	SVI Bremco
changeOVR	KAAM Group	Swift Filters
Chentronics	Kinectrics	Switch Filtration/Relevant Solutions
Chromalloy	King Nutronics/Raptor Scientific	Synergy Catalyst
Clean Air Engineering	Liburdi Turbine Services	T2E3
Conax Technologies	Lone Star Controls	Tarco Consulting
Continental Controls Corp	M&C TechGroup	TE Wire & Cable
Cutsforth	Marioff	Teledyne
DENOX Environmental Group	Maximum Turbine Support	The BG Service Company
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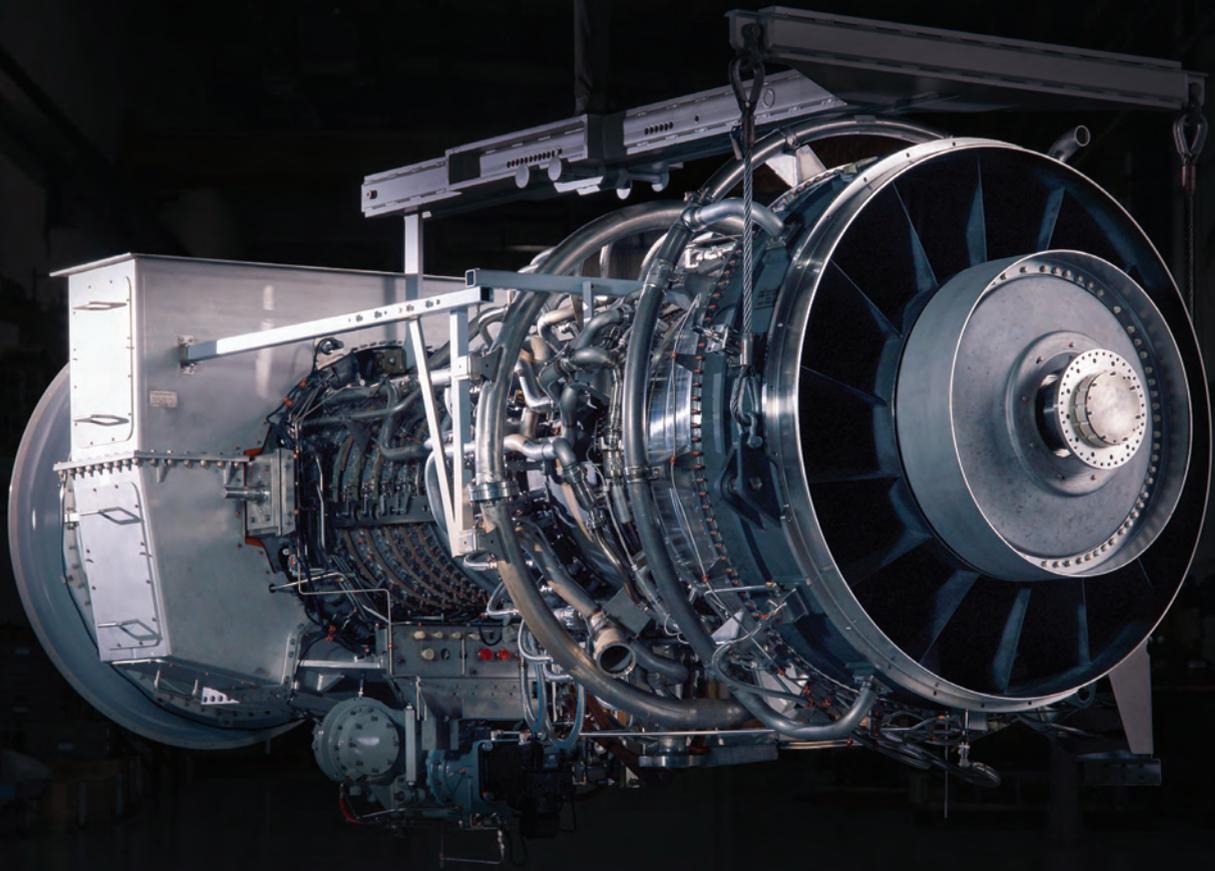
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PROENERGY



- Special technical presentations by consultants and third-party solutions providers invited by the organization’s leadership team (p 16).
- Presentations by the OEM, select ASPs, and PROENERGY focusing on shop findings and solutions. Important to have CCJ’s acronyms sidebar handy (p 24) while listening to these experts because they tend to speak in shorthand—HPCR for high-pressure compressor rotor, FPI for fluorescent penetrant inspection), RPL for replaced part, etc. You don’t want to disengage from the speaker to figure out what an acronym means.
- Experience with upgrades to boost output, availability, and/or reliability, and to reduce emissions.
- Open discussions in user-only sessions that provide insights you’ll find valuable for improving the performance of your engines.

WEDNESDAY MORNING

The pace of the meeting quickens after breakfast Wednesday in Exhibit Hall B of the Convention Center as all registered attendees gather at 8:00 for the General Session in Promenade Ballroom 104 for opening remarks by WTUI President Ed Jackson, plant manager of Missouri River Energy Services’ Exira Generating Station in Brayton, Iowa.

Jackson, who was elected WTUI’s leader in 2022, is only the sixth president in the organization’s more than three decades of service to the industry. His predecessors: John Hudson, 2020-2022; Chuck Casey, 2013-2020; Jon Kimble, 2008-2013; Jim Hinrichs, 1992-2008; and John Tunks, 1990-1992.

Following the introduction of officers, directors, breakout session chairs, and support staff, plus the treasurer’s financial report, badge rules, and other business matters, the conference agenda will be reviewed and appropriate acknowledgments made.

Highlights of the first morning’s presentations are the following:

- From 9:30 to 10:00, attendees welcome back to the stage two of the three service providers (a/k/a ASPs) authorized by GE to work on LM2500 and LM6000 engines, MTU and IHI, but TCT will not be participating.
- GE Services’ offerings and the OEM’s new products update in Promenade Ballroom 104 from 9:45 to 11:00.
- Worldwide gas-turbine business update by Tony Brough and Mark Axford, from 11:00 to lunch at noon, also in Promenade Ballroom 104. Brough, president, Dora Partners & Company, will update the group on the state of the global gas-turbine market using engine-specific and geographic stats considered by many among the industry’s most reliable. Mark Axford, president, Axford Turbine Consultants, who has presented to this group on the state of the energy industry for two

decades and a crowd favorite will use his crystal ball to help attendees prepare for the future.



Brough



Axford

ENGINE-SPECIFIC SESSIONS

Breakout meetings for the LM2500, LM5000, LM6000, and LMS100 gas turbines, the core of WTUI’s technical program, begin Wednesday afternoon at 2:30 and run until 5:30 (user, GEV, and ASP attendees only). Sessions continue Thursday morning for users and GE at 8:00 until a 15-minute break in the Exhibit Hall starting at 9:15. The meetings continue for users only from 9:30 until lunch at noon.

The Friday program features open-forum breakouts for all registered conference attendees from 8:00 to 11:45. Here’s where you can learn more from the experience of independent service providers like PROENERGY, Score Energy and others. In sum, that’s more than nine hours of intense information transfer from engine experts to the user community. You can’t get “training” of such high caliber anywhere else in the world.

The LM2500 program is guided by Joshua Svejcar, district manager for Ever-Green Energy in the Minneapolis area. Previously, he served in management positions at Veolia North America and Foster Wheeler. Ever-Green operates the energy systems for the University of Minnesota’s Twin Cities Campus.

The LM5000 session is chaired by Perry Leslie, who watches over the Yuba City Cogeneration Plant. His responsibilities there include I&C, mechanical maintenance, and operations. Leslie has served that facility since 2004 while also managing the now-shuttered Binghamton Cogeneration Plant for a brief period. Before Yuba City, he spent six years as a field service technician for GE in the Bakersfield area working on LM1600, LM2500, LM5000, and LM6000 engines. He began his career with a six-year stint in the US Navy as a GT systems technician (electrical).

The LM6000 program is led by newly appointed Breakout Session Chair Luis Sanchez, a gas turbine specialist at TransAlta Energy. Celebrating over two decades with the company, Sanchez provides fleet-level engineering support across generating assets with accountability spanning asset plan-

ning, maintenance and overhaul planning, capital improvements, new-build development and commissioning, performance diagnostics, and evaluation of emerging technologies. He supports both aeroderivative and large-frame units, with experience across major OEM platforms, and is responsible for developing operating processes and maintenance work scopes, monitoring fleet condition to optimize maintenance intervals, and maintaining the historical documentation used to manage the GT fleet.

The LMS100 session is guided by another newly appointed session chair, Larry Wilson, O&M manager for Diamond Generating Corp’s Sentinel Energy Center, responsible for the site’s eight LMS100 units. Prior to this, he spent over seven years at Larkspur Energy maintaining their LM6000s. Wilson was first exposed to the power and propulsion industry in the US Navy, where he served nearly 10 years as a Gas Turbine Systems Technician. The only attendees invited to LMS100 sessions are GE employees, users, and some hand-selected specialty consultants.

SPECIAL TECHNICAL PRESENTATIONS

This Thursday afternoon at Western Turbine meetings is reserved for nine Special Technical Presentations, approved by WTUI leadership, to extend the meeting’s content beyond the four GEV aero engines on the program. The hour-long presentations (with Q&A) are arranged in three parallel sessions beginning at 2:30, 3:30, and 4:30. Slide decks are posted on the WTUI website, but access requires an email request to Webmaster Wayne Feragen at wferagen@wtui.com.

2:30-3:30

NO2 to NO converter efficiency testing, Ryan James, CEO, and Matt Swanson, account manager, Pacific Standard Environmental.

Inconsistent NOx converter efficiency test results continue to challenge facilities that rely on continuous emissions monitoring systems (CEMS) for regulatory compliance. This presentation previews a collaborative test program designed to pinpoint where variability is introduced during NO2-to-NO conversion efficiency checks, then translate the findings into practical improvements sites can apply to better meet EPA and local air district requirements.

The work focuses on systematic, side-by-side evaluation of the key elements that influence NO2-to-NO conversion efficiency outcomes. Testing will examine multiple NO2 sources, including certified cylinders, NO2 generators, and Tedlar bag methods, along with a range of NO2-to-NO converters.



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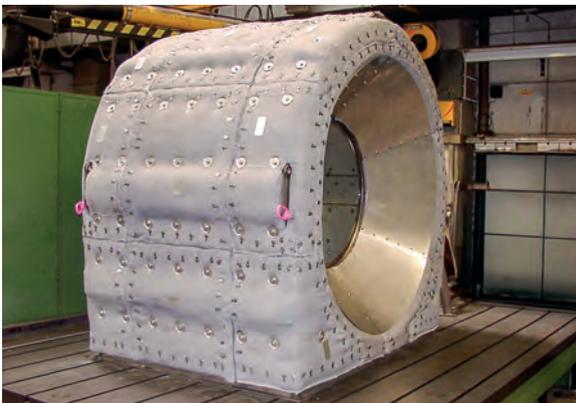
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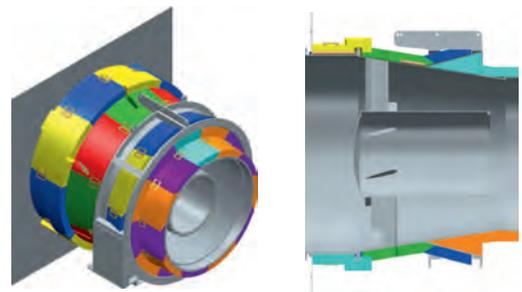
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It also will assess NOx measurement transducers and analyzers to understand instrument response and stability, and it will evaluate the gas transport and delivery devices used to move calibration gas from source to analyzer, where losses, adsorption, leaks, or residence-time effects can bias results.

After testing is completed, the data will be analyzed to identify which conditions and configurations most strongly correlate with unstable or non-repeatable efficiency results. The intent is to provide the industry with actionable guidance that improves repeatability, reduces avoidable failed or questionable tests, and supports more consistent compliance with EPA and local district expectations.

Attendees should come away with a clearer view of which parts of the test chain are most likely to drive variability, a comparative understanding of NO2 source and transport options and their practical risks, and recommendations that can be incorporated into site procedures for converter efficiency testing and troubleshooting. *Promenade 102 B/C*

Best practices, Scott Schwieger, general manager, CCJ.

Best practices submitted by aeroderivative owner operators to CCJ's annual awards program, sponsored by CCJ and WTUI, will be reviewed in an interactive session designed to surface practical ideas that can be applied at operating sites. The discussion spans plant and fleet challenges, with examples drawn from the LM2500, LM6000, and LMS100 communities, plus open microphone sharing from attendees.

The review highlights recurring categories in the Best Practices program, such as fast starts, outage management, performance improvements, water management, plant safety procedures, predictive analytics and monitoring and diagnostic centers, and O&M improvements for generators, transformers, high voltage electrical systems, and major mechanical balance of plant equipment.

Rather than a slide heavy lecture, the format emphasizes what was done, why it was needed, how it was implemented, and what changed afterward. Participants will hear success stories that improve starting reliability, reduce forced outages, cut parasitic losses, strengthen compliance readiness, and shorten troubleshooting cycles. The open discussion invites users to share their own best practices, compare approaches across sites, and discuss what works, what does not, and what to watch for when replicating a solution. Attendees should leave with a list of ideas and contacts for follow up in their fleets. *Promenade 103*

Advanced air intake filtration retrofits Alexandre Gilbert, key account lead for retrofit and plant optimization, Camfil Power

Systems.

The presentation will examine how air inlet filtration design can limit the output and efficiency of LM6000 aeroderivative gas turbines, especially in wet or humid service. Many installations rely on cylindrical composite filters that impose higher pressure drop, handle water poorly, and restrict filtration choices. Those constraints can accelerate compressor fouling, increase heat rate, reduce available megawatts, and drive frequent filter changeouts and online or offline compressor washes.

Reviews of retrofit alternatives that correct key shortcomings without requiring major modifications to existing intake housings will be discussed. It shares before-and-after performance data from two LM6000 sites where upgraded filtration systems were installed in as little as two weeks. Results include more than 40% lower differential pressure across the filters, improved water management, and slower fouling rates.

Operationally, the sites report fewer wash outages, reduced filter replacement activity, and improved unit availability during adverse weather. The improvements are linked to higher net power, better heat rate, and lower emissions intensity by reducing parasitic losses and stabilizing compressor condition.

Attendees will gain practical guidance on evaluating inlet losses, selecting retrofit configurations, and estimating economic value, payback, and lifecycle benefits for LM6000 fleets. With clear steps for implementation. *Promenade 104*

3:30-4:30

Enhancing GT plant efficiency and reliability through intelligent data analysis tools, Kellan McCarthy, CTO, and Maxwell Erwin, CEO, SISO Engineering.

Power in the Numbers explores how higher-resolution data capture and targeted analytics can improve gas-turbine plant reliability, efficiency, and troubleshooting speed beyond what standard DCS platforms typically provide. The session shows how combining open-source tools with proprietary monitoring and engineering expertise turns raw signals and network traffic into actionable findings for operators and technicians.

Three field examples anchor the discussion. In the first, a unit experienced severe fuel-flow and megawatt oscillations during liquid-fuel operation after a major outage, leading to trips and additional downtime. By capturing high-speed running data and reviewing the full fuel-control loop, the root cause was traced to a mis-tuned speed-regulator gain, and multi-load tuning restored stable operation across the load range.

The second example applies packet capture to an OT communications problem with a battery system, using a mirrored switch

port and Modbus traffic review to confirm the controller side stopped requesting data; a targeted reset restored communications.

The third example provides a practical snapshot of machine learning, using exhaust temperature profile datasets to train and validate a neural-network anomaly detector for future monitoring.

Attendees will leave with concrete methods to accelerate root-cause analysis, reduce trips, support heat-rate improvement, and maintain emissions compliance with greater confidence. *Promenade 102 B/C*

Generator offline diagnostic testing and visual inspection, Sunny Gaidhu, P.E., senior technical advisor, Kinectrics Inc.

Promenade 103

Gaidhu will deftly explain how planned, outage-based offline diagnostics can identify insulation degradation and core defects before they escalate into forced outages, and how to pair those results with online monitoring to improve trending and decision-making. Attendees will get a clear view of what each offline method can and cannot reveal, including IR/PI, capacitance and dissipation factor, partial discharge, TVA probe surveys, UV corona imaging, DC ramp testing, and ELCID core testing.

Two case studies, a 13.8-kV air-cooled generator and a 24-kV hydrogen-cooled generator, show how integrating partial-discharge findings with detailed visual inspections and core evaluations supports targeted corrective actions and more defensible follow-up plans. The session's value is a practical, test-by-test framework for outage scoping and data interpretation, helping owner-operators estimate remaining insulation life, prioritize repairs, and reduce the likelihood of premature winding failures.

Non-destructive tools and methods for inspecting engine components, Kyle Spaulding, senior engineer, Arizona Public Service, and Blake Whitely, managing engineer, Exponent, Inc.

Non-destructive inspection methods can reveal developing damage in turbine engine components long before it forces an outage, and they can also accelerate credible root-cause findings after an event. This presentation surveys a practical toolbox of inspection and characterization techniques that turbine users can apply across the full lifecycle, from routine condition monitoring to failure analysis.

It explains what each method can and cannot detect, typical access and surface-prep requirements, and how to select the right technique for suspected mechanisms such as filtration-related contamination, foreign object damage, fatigue cracking, corrosion, clashing, and blade tip rubs.

The session walks through commonly used field methods, including detailed visual and borescope inspections, dye penetrant,

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eddy current, ultrasonic, magnetic particle, radiography, and acoustical and vibrational monitoring, then connects them to higher-resolution laboratory approaches such as CT X-ray, light microscopy, scanning electron microscopy, and energy-dispersive X-ray spectroscopy.

Real-world case examples from turbine operators and investigators illustrate how evidence from multiple techniques is combined to confirm damage morphology, identify initiating features, and separate symptoms from causes.

Attendees will leave with a clearer decision framework for inspection planning, improved communication with NDE and lab providers, and actionable ideas to strengthen maintenance strategies and risk mitigation across diverse fleets. *Promenade 104*

4:30-5:30

Unlocking hidden efficiencies in LM turbine operations: The power of electronic logs, Jon Caccamise, O&M manager, Onward Energy.

Many LM gas turbine sites still rely on paper logs, manual data transcription, and disconnected permitting tools, creating errors and consuming operator time that could be spent on reliability and performance improvement. This presentation shows how one LM6000PC combined-cycle facility modernized those workflows by adopting a unified electronic logbook that becomes the operating “hub” rather than just a digital notebook.

The session explains how automated log entries, shift-turnover summaries, and

compliance reminders reduce repetitive tasks and standardize documentation. It also describes consolidating Hot Work and Confined Space permits, cold-weather readiness checklists, and other routine controls into the same platform, eliminating multiple standalone applications.

Integration with the PI historian is highlighted as a practical step-change, PI Events can automatically create entries, populate templates, and prompt follow-up actions so investigations and corrective actions are captured consistently.

Configurable, threshold-based alerts provide real-time notification when logged values drift outside limits, improving situational awareness and enabling earlier intervention. Dashboards and widgets then translate the log data into at-a-glance status views for operators and supervisors.

Attendees will take away implementation lessons, audit-friendly approaches to requirements such as NERC EOP-012, and a roadmap for extending digital logs into CMMS integration, LOTO streamlining, ROC use, and automated reporting. *Promenade 102 B/C*

Why pitot tube pumps outperform traditional pump designs for fuel and NOx water injection, Austin Egan, senior applications engineer, Thomas Pump.

Fuel delivery and NOx water injection systems play an outsized role in the reliability, availability, and emissions compliance of GE LM-series turbines, yet many sites still depend on pump designs that can be sensitive to changing operating conditions.

Egan will explain why commonly used

high-pressure positive displacement, horizontal multistage, and end-suction centrifugal pumps may struggle with hydraulic instability, thrust events, and accelerated wear as load and flow demands vary. Typical failure modes, including cavitation damage, seal distress, and rapid bearing degradation, can drive forced maintenance and lost megawatt production.

The session makes the technical case for pitot tube pump technology as a more robust alternative for LM fuel and water injection service. It walks through how pitot tube pumps convert velocity into static pressure in a single stage and why that approach can provide a more stable hydraulic operating curve.

The discussion connects hydraulic stability to practical outcomes operators care about, including extended seal life, improved reliability, and longer maintenance intervals. Field application examples are used to illustrate measurable improvements relative to traditional pump types and to highlight where pitot tube pumps are most likely to deliver value.

Attendees will leave with selection considerations, expectations for lifecycle performance, and guidance on standardizing pump strategies to reduce unplanned outages and simplify support. *Promenade 103*

Generator failure issues, Robert Vandenabeele, director of business development, Baseload Power (GESA).

Generator failure modes often develop quietly, then surface as forced outages during peak demand. This presentation focuses on inspection findings and failure

ACRONYMS TO REMEMBER

AGB—Accessory gearbox (also called the transfer gearbox)
 AVR—Automatic voltage regulator
 CCM—Condition maintenance manual
 CCR—Customized customer repair
 CDP—Compressor discharge port
 CFF—Compressor front frame
 COD—Commercial operating date
 CPLM—Critical-parts life management
 CRF—Compressor rear frame
 CWC—Customer web center (GE)
 DEL—Deleted part
 DLE—Dry, low emissions combustor
 DOD—Domestic object damage
 EM—Engine manual
 FFA—Front frame assembly
 FOD—Foreign object damage
 FPI—Fluorescent penetrant inspection
 FSNL—Full speed, no load
 GG—Gas generator (consists of the compressor and hot sections only)
 GT—Gas turbine (consists of the gas generator pieces with the power turbine attached)
 GTA—Gas-turbine assembly
 HCF—High-cycle fatigue

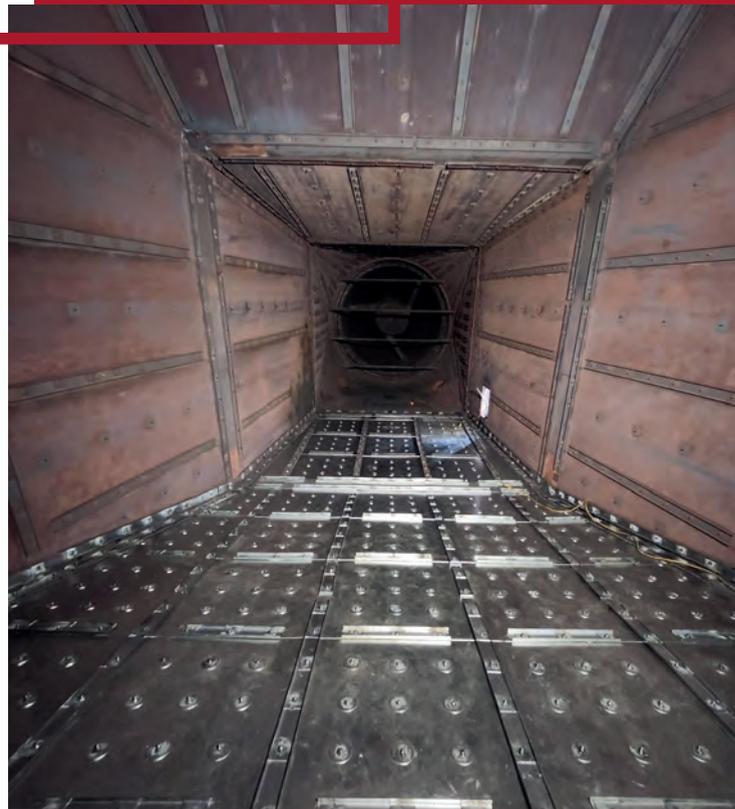
HGP—Hot gas path
 HPC—High-pressure compressor
 HPCR—High-pressure compressor rotor
 HPCS—High-pressure compressor stator
 HPT—High-pressure turbine
 HPTN—High-pressure turbine nozzle
 HPTR—High-pressure turbine rotor
 IGB—Inlet gearbox
 IGV—Inlet guide vane
 IPT—Intermediate-pressure turbine (LMS100)
 IRM—Industrial repair manual
 LM—Land and marine
 LCF—Low-cycle fatigue
 LO—Lube oil
 LPC—Low-pressure compressor (not on LM2500; just LM5000 and LM6000)
 LPCR—Low-pressure compressor rotor
 LPCS—Low-pressure compressor stator
 LPT—Low-pressure turbine
 LPTR—Low-pressure turbine rotor
 LPTS—Low-pressure turbine stator
 MCD—Magnetic chip detector
 MOH—Major overhaul
 NGV—Nozzle guide vane
 OEM—Original equipment manufacturer

PN—Part number
 PT—Power turbine (turns a generator, pump, compressor, propeller, etc)
 PtAl—Platinum aluminide
 RCA—Root cause analysis
 RDS—Radial drive shaft
 RFQ—Request for quote
 RPL—Replaced part
 SAC—Single annular combustor
 SB—Service bulletin
 SL—Service letter
 SUP—Superseded part
 STIG—Steam-injected gas turbine
 TA—Technical advisor
 TAT—Turnaround time
 TAN—Total acid number (lube oil)
 TBC—Thermal barrier coating
 TGB—Transfer gearbox (also called the accessory gearbox)
 TMF—Turbine mid frame and thermal mechanical fatigue
 TRF—Turbine rear frame
 VBV—Variable bleed valve (not on LM2500; just LM5000 and LM6000)
 VBVD—Variable bypass valve doors
 VIGV—Variable inlet guide vanes
 VSV—Variable stator vane
 VSVA—Variable stator-vane actuator

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mechanisms that most commonly threaten long-term reliability of turbine-driven generators, with emphasis on what users can look for during planned outages and condition assessments.

The discussion reviews stator concerns such as core heating, core lamination degradation, winding faults, slot wedge migration, and localized partial discharge or vibration-related sparking, plus the role foreign object intrusion can play in initiating damage. On the rotor field side, attention is given to retaining-ring condition, turn insulation integrity, and ground insulation health, tying observable indicators to probable electrical or mechanical drivers. Additional failure themes include turn breaks, coil distortion, thermal sensitivity, and problems associated with radial lead connections, all of which can progress from minor abnormalities to major repairs if not detected early.

Attendees will hear how to interpret what inspections reveal, which observations warrant immediate action versus continued monitoring, and how documentation of findings supports trending over time. The goal is to help plant teams improve outage scope decisions, prioritize corrective work, and reduce the risk of repeat events by addressing root contributors before they escalate. Practical examples will anchor each topic. *Promenade 104*

ACKNOWLEDGEMENT

The heart and soul of WTUI, Jim Hinrichs, the organization's second and longest-serving president, told the editors years ago, is the dedicated user who understands that helping a colleague is an investment in his or her own company and expertise. "What's Joe's problem today, could be mine tomorrow," he said.

In the opinion of the editors and others, it is unlikely the aero engines served by WTUI would have achieved commercial success as quickly as they did without dedicated owner/operators contributing to the solutions implemented by the OEM and others to improve their operability and maintainability.

The Honor Roll salutes the WTUI officers and members of the board of directors, who have contributed mightily to the success of this organization since its founding in 1990, and to the industry at large. If you see the nametag of anyone on the list in your travels, please thank them for their productive and unselfish contributions to the successes enjoyed by the greater LM community.

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WTUI 2025 RECAP

Across WTUI 2025's LM2500, LM6000, and LMS100 breakouts in Long Beach (March 30 to April 2, 2025), the technical conversation had converged on the same operating reality: outages and reliability outcomes had been driven as much by data quality, execution discipline, and supply chain constraints as by the underlying hardware.

Three common threads had surfaced repeatedly. First, contamination control and configuration control had remained the foundation for preventing repeat events, especially where bearings, variable geometry, and hot-section durability dominated the risk profile. Second, condition-based planning had continued to override "catalog intervals," with borescope evidence and trending treated as the deciding inputs. Third, depot duration, parts lead times, and counter-history fidelity had increasingly shaped what owners could plan and defend, from spares strategy to life decisions and "as returned" accounting.

LM2500, GE VERNOVA

The LM2500 breakout sessions combined GE Vernova (GEV) fleet updates, an SPS ORAP® RAM review, user-only lessons learned, and third-party briefings on controls, depot services, fuel-system repairs, and insulation.

Discussions focused on unplanned engine removals, bearing contamination risk, compressor and hot-section life expectations, preservation for peaking or intermittent duty, and growing concern over repair turn times and parts support for package and controls hardware.

Session chair Josh Svejcar opened the first users-and-OEM block on Monday afternoon. GEV's Nam Tran led the OEM segment with a safety moment, an agenda review, and introductions to product, field-service, fleet, and package engineering staff supporting the LM2500 and TM2500 fleets.

The session notes emphasized that the recap captured questions and discussion stimulated by presentations, and encouraged attendees to review posted slide decks for full technical detail.

Early questions focused on clarifying fleet definitions and product terminology.

GEV distinguished its electrical power generation fleet from Baker Hughes units supporting oil and gas applications, including power generation in that sector. Users asked about the "UPT," which GEV described as a newer power turbine intended for power generation with G4 and G5 engines, with a larger diameter and higher output.

Package evolution came up quickly as well. Differences were discussed across generations, including older trailer-based

layouts versus later configurations with top-mounted filtration and engine options.

Package experience and operating practices. GEV's package team review covered common O&M themes and practical habits users said had improved condition awareness.

One site reported continuing operator rounds and manual gauge-reading documentation to build familiarity with the package, not just screen-based monitoring. Users discussed simple troubleshooting tools too, including handheld black lights used to trace oil leaks by fluorescence differences between fresh and aged oil.

For DLE fuel-gas characterization, GEV recommended using a chromatograph rather than a calorimeter when measuring gas composition for mapping.

For peaking-unit preservation, GEV suggested that a unit shut down for a month or more should have been started to full-speed, no-load, while shutdowns of less than 30 days did not require such a start. Users asked about preservation guidance for TM2500 packages, and GEV pointed to TP2200 as a practical guide for earlier generations, noting that later, generation-specific versions might follow. Heaters were described as a means to maintain temperatures above the dew point.

Unplanned engine removals. An extended discussion covered unplanned engine removals (UERs). Users described a range of recent UER experiences, including events attributed to bearings, power-turbine bearing failures, warped flanges, IGV bearing issues, a TMF collapse, and compressor blade or dovetail cracking findings.

GEV's follow-on review of UER drivers stressed contamination control as the dominant bearing risk. In response to a question on event-type breakdowns, GEV said most bearing events had been tied to hard particle contamination, without offering a specific percentage. On early warning indicators, GEV said there had not been a reliable "tell-tale" sign ahead of failure.

Users asked about detection tools. GEV said it had not been aware of many MetalSCAN systems in power generation service and did not cite familiar examples of MetalSCAN-detected bearing failures in that segment, although a user noted experience with the system in oil and gas.

On monitoring strategy, GEV said it had no plans to add high-frequency vibration monitoring for bearing failures. The discussion highlighted practical limitations as well: sensor location and transfer functions reduced sensitivity to bearing distress, and earlier attempts to identify events via vibration had created false positives. Participants favored chip monitoring and analysis as a more reliable indicator.

Compressor and washing discussion. In compressor findings and preventive actions, GEV said hot-restart tip rub had been observed at the 4 o'clock and 8 o'clock posi-

tions, and noted that rub location depended on package cooling flow.

Users asked about "high time" engines after incorporation of VSV-related service bulletins. GEV said it did not know the high-time record but was not aware of issues after those bulletins were incorporated. A user recommended assigning a single competent person to approve FOD-zone cleanliness after maintenance.

Online water washing generated practical debate. GEV said a load limit had been used to prevent combustor blowout and recommended developing site-specific intervals based on borescope checks and experience, including trending ratios for baseload operation.

GEV said it had not seen an erosion risk from "too much" washing. Users countered that improved inlet filtration could reduce the need for washing, and some reported seeing limited efficiency benefit from online washes, preferring to trend efficiency in spreadsheets to guide cleaning decisions.

ORAP review and hot-section life expectations. SPS's Bob Steele presented findings from the ORAP system, with the presentation available to participants on the WTUI user site.

GEV then continued the UER-driver review into combustion and hot-section events. Users raised controls-display needs, including the importance of showing fuel-to-water ratio for operators on certain package configurations.

Life and interval expectations triggered broader discussion. GEV described standard intervals of 25,000 hours for a hot section and 48,000 hours for an overhaul, with half intervals when operating on diesel oil, and cycle limits defined for critical parts only. GEV also explained that inspection intervals had been intended to indicate continued operability for the next interval after a successful borescope inspection, and that parts life depended on configuration and duty.

Users pushed back with mixed experience, ranging from hot-section parts falling well short of 25,000 hours at some sites to nearly 50,000 hours at others, with components such as VSV bushings driving decisions. Participants argued intervals should have been condition-based and said procurement and budgeting assumptions often treated 25,000 hours as a planning expectation, creating problems when life fell short. Users also raised concerns about cycle-limit notifications and depot "as returned" cycle accounting, and noted that k-factors for the cycle calculation had recently been included in the G4 O&M manual.

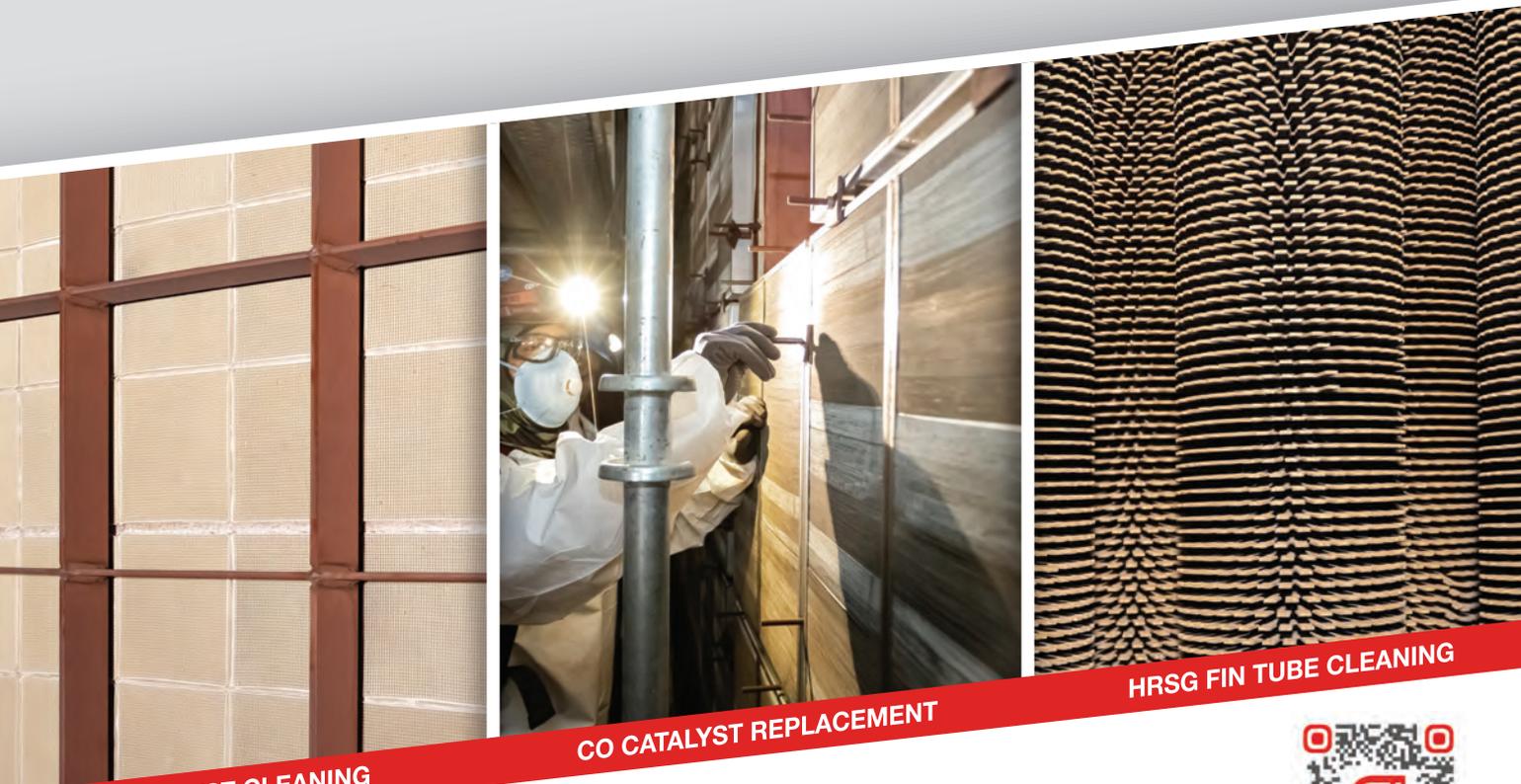
LM2500 USERS-ONLY SESSION

The users-only block focused on outage execution and verification practices. A user presentation on VSV bushing replacement and borescope inspection summarized practical

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lessons, including crane and rigging practices, taking advantage of engine-out access to replace the bellmouth seal, pre-ordering main engine mount bearings, and using alternative methods to suspend the engine and verify VSV settings when LVDTs were not available.

Discussion addressed HP recoup orifice practice as well. Users suggested keeping multiple orifice sizes on hand, increasing size cautiously one step at a time, and re-marking any orifice drilled to a new size. A third-party kit was mentioned as a work-around for measuring VSVs when LVDTs were not present.

Vendor qualification emerged as a theme after users described receiving an “OK to run” conclusion from a borescope performed with a nonconforming scope, followed by a later inspection that identified multiple holes in a combustor liner requiring changeout. Users discussed liner repair versus rotatable replacement decisions and recommended inspecting rotatables for cracks beyond the locations cited in the BSI manual.

Users also exchanged concerns about TM2500 Gen 8 package quality control and controls capability, citing overspeed events on startup and recommending verification of external overspeed settings. Several users described replacing certain control platforms with alternative systems. Additional package issues discussed included generator PMG weight liberation into the excitation system, ground-fault monitor reliability after heater-off conditions, and recurring transmitter failures that led some sites to switch transmitter brands.

Depot turn times, parts gaps. Depot turn times and communication quality drew sustained attention. Users cited cases where hot-section or engine work extended well beyond initial quotations, including assets remaining in depot for more than a year. One user said weekly status calls had improved progress visibility and sometimes helped move the process. Participants questioned whether service agreements had improved turn time and expressed concern over depot reporting cadence and content.

Hardware support gaps surfaced in separate user comments as well, including recurring air-oil separator hose failures on multiple G4 engines, reported oil loss rates, and limited OEM replacement parts availability, which prompted discussion of alternate sourcing options.

LM2500, THIRD-PARTY BRIEFINGS

Wednesday’s open sessions included third-party updates tied to near-term maintenance logistics:

- Baker Hughes reviewed digital services and said iCenter had already been available to customers.
- Score Energy discussed fuel system and accessories repair, including nozzle repair

locations, typical 3–4 week turn times, limited spare-nozzle availability during repairs, and a recommendation to align nozzle repair with broader engine repair events.

- PROENERGY discussed LM2500 work scope from a Level IV depot perspective and said it had offered field services and rotatables beyond hot sections.
- Woodward reviewed controls products, obsolescence, and upgrade paths, including limits on testing older valves and stated support expectations for specific platforms beyond 2027.
- GE Aerospace reviewed life-limited parts methodology and the impact of partial-power operation and partial cycles. Users emphasized that incomplete cycle tracking increased conservatism and could force premature replacement of parts with remaining life, and they argued depots, OEMs, and operators needed aligned processes because “history cannot be recreated.”
- Arnold Group discussed insulation solutions, citing a typical six-month path from scanning to installation and noting limited LM2500-specific data on efficiency gain at the time of the session.

Food for thought. Three themes cut across OEM, SPS, user-only, and third-party segments:

1. Contamination control remained central to reducing bearing-driven UER risk, and participants viewed chip monitoring as more dependable than vibration signatures for early detection.
2. Interval planning remained contentious. Users pushed for condition-based expectations and clearer communication of cycle limits and return-from-depot cycle accounting.
3. Execution discipline, including vendor qualification, FOD-zone verification, and careful preservation practices, offered practical ways to reduce avoidable downtime in peaking and intermittent duty.

LM6000 BREAKOUTS

The LM6000 break-out sessions covered GEV fleet updates, SPS ORAP® RAM benchmarking, a user-only discussion on recurring problem areas, and an independent forum featuring third-party service and monitoring perspectives.

Across the three days, recurring themes included combustor configuration tradeoffs, HPC stage 3–5 blade and bushing wear drivers, the need for disciplined borescope documentation and counter tracking, and practical steps that reduced forced-outage exposure through spares, inspections, and preservation.

How the break-out was structured. Session chair Dave Fink opened the Monday OEM session, reviewed the anti-trust statement, and noted he would step down as LM6000 chair after six years, with Luis

Sanchez named as the incoming chair. Tom Christiansen of SPS served as session secretary.

The session notes were organized chronologically and did not reproduce the engineering depth contained in the posted slide decks. Approved end users can contact Wayne Feragen, wferagen@wtui.com, for access.

LM6000, GEV

GEV’s Nasser Chraibi opened with a safety moment and fleet overview. John Heaton then reviewed completed and active engine programs, using “legacy” to describe PA to PF models and “growth” for PF+, PF1, PF2, PG, and PH models. The discussion distinguished PF1 from PF2 primarily by combustor type and emissions capability.

RQM SAC combustor experience and tuning sensitivities. The OEM review included Rich Quench Mix (RQM) experience for SAC units, with discussion of reduced water demand for NOx compliance and questions around turndown capability, CO performance, and the role of fuel-nozzle gasket and shim selection. One user reported higher CO than expected with RQM compared to Jet-RAD and RAD-RAD at that site, while GEV said its broader experience had shown lower CO.

HPC stage 3–5 blades and the SB 310 discussion. For legacy engines, GEV attributed stage 3–5 blade failures primarily to VSV off-schedule operation and edge-of-contact conditions linked to starts, cycles, and load reversals. SB 310 was discussed as a response to the edge-of-contact issue, and GEV emphasized VSV system checks aligned with borescope intervals.

For PF+ engines, the discussion reviewed multiple dovetail-related field events and an ongoing fleet root-cause effort that included GE Aerospace participation as an independent reviewer. GEV said it had been stocking blades and reiterated that blade design mixing within a stage had not been acceptable. Users discussed the practical reality that there had been no OEM-authorized field service and that support and quality responsibilities differed across providers.

Other hardware items. The OEM segment also highlighted items users were encouraged to stock or monitor, including 11th-stage check valves, T48 thermocouples, and variable-geometry (VG) pumps, with discussion of failure consequences and replacement expectations.

Package programs and safety. Package program topics were presented by Jurgen De Ceuster and covered several safety and reliability issues:

- GEV described an interlock design on certain Universal Gen 1 and Gen 2 packages that could have forced unsafe access during engine handling, and emphasized that no one should have climbed on an engine while it was suspended.

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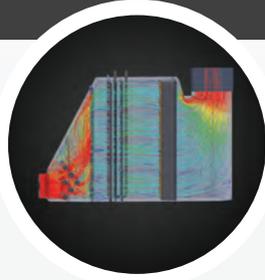
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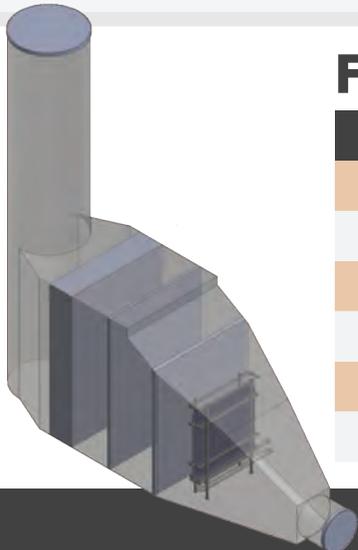
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- The session addressed the need to respect fire suppression saturation time before opening enclosure doors, and GEV indicated manuals and letters would be aligned to avoid conflicting guidance. Cameras were being evaluated as part of a potential kit.
- Cycling duty was associated with cracking in certain exhauster diffuser and clamshell designs. A redesigned diffuser approach was discussed with a target increase in cycle capability, along with changes in repair welding practices.
- A flashover event was tied to condensation risk, prompting a change in recommended cubicle thermostat settings from 70°F to 90°F, with planned documentation updates.
- WHRU heat exchanger distress and glycol leak issues were discussed, with the notes indicating an OEM update addressed an undersized glycol tank concern raised by a user.

Field services and more. Wayne Romeo continued the GEV segment with a One Field Services update that included best practices and lessons learned, and he made a recruiting request for mechanically inclined candidates.

Chraibi reviewed GEV bulletins and letters and provided a hydrogen roadmap update. In response to user questions, the notes indicated demonstration units operated on hydrogen only for a few hours based on fuel availability, and the discussion included expected NOx and CO ranges.

Heaton discussed positive clearance control migration to legacy units, including a revised boot design and a recommended heat-shield approach intended to improve durability near the LPT.

LM6000, ORAP

Tom Christiansen presented ORAP results for the LM6000 fleet and described SPS as an independent third party that collected and analyzed owner-operator data across prime movers and industries. For LM engines, participation was sponsored by GEV for its customers, with the primary user burden described as data reporting.

Key ORAP points included:

- Participation for LM6000 was cited at 310 units, representing about 29% of the installed base.
- The reported duty-cycle split among reporting units was 30% baseload, 14% cycling, and 56% peaking.
- SPS reviewed standard availability and reliability metrics, plus forced outage incidents and hours by major system, including top contributors.
- SPS indicated ORAP can import NERC GADS .txt files and could generate those files from ORAP inputs as part of participation.
- On gas fuel valve events, a user asked for detail on control valves versus shut-

off valves, and the notes recorded a split heavily weighted toward control valves.

- SPS noted it had collected control system type but did not consistently capture control system age, and it referenced prior studies indicating control upgrades reduced trips.

LM6000, USERS-ONLY SESSION

The user-only session covered recurring issues and peer practices:

- Users compared combustor distress patterns, including cracking, ignitor ferrule issues, and TBC spallation experiences across configurations and duty profiles. Several comments linked cracking to post-overhaul outcomes, and users compared gasket and shim selections as part of tuning.
- Users discussed an updated PF1 and PF2 thrust orifice spreadsheet and noted that PF1 and PF2 thrust balance logic differed materially from legacy engines.
- One user described a best practice of collecting all borescope videos and photos before the inspector left the site, rather than relying solely on the final written report.
- Users discussed premature HPT stage 1 wear at low-load operation, the introduction of new Carboloy pads via service bulletin, and the value of carrying spare blade sets.
- Users described connector and wiring practices, including connector cleaning and wiring replacement tied to engine-change events, to reduce intermittent VSV and VBV feedback issues.
- Users compared hour-to-start ratios and replacement expectations for S2 nozzle assemblies, with multiple viewpoints on what constituted a realistic planning interval.
- Multiple users described operating without the PCC manifold, with one noting a performance impact and differentiating the value of PCC between legacy and growth engines for casing life.
- Users discussed SPRINT nozzle test methods, replacement criteria, and the economics of replacing large quantities annually, including reference to a site-built test rig described in prior years.
- Users discussed lubrication system biological growth and noted it could be difficult to eliminate once established, reinforcing proactive oil management practices.
- One user recommended third-party borescope inspection before accepting engines, even when represented as new, based on damage found post-test cell.
- The chair recommended post-run walk-downs to spot changes, while another peer described foil-wrapping suspected leak areas to localize the source after operation.
- Users compared camera approaches

ranging from rated systems to low-cost “expendable” strategies and retrofits into existing rated housings.

LM6000, THIRD-PARTY BRIEFINGS

The Wednesday open forum included outside organizations and case-study style discussions:

- SISO Engineering discussed analytics capability, data handling, and the feasibility of adding “first out” capability to older control systems depending on platform constraints.
- GE Aerospace reviewed life-limited parts methodology and the impact of partial-power operation and partial cycles. Users emphasized that incomplete cycle tracking increased conservatism and could have forced premature replacement of parts with remaining life, and they argued depots, OEMs, and operators needed aligned processes because “history could not be recreated.”
- Wattbridge discussed monitoring insights and alarm strategy considerations using examples from field issues.
- Premium Plant Services described cleaning approaches and tooling intended to protect coatings and seals during cleaning processes, with discussion of exposure time and impacts.
- SCORE Energy discussed fuel nozzles and accessories, including typical rebuild turn times for VG pumps and HCUs and practical variability driven by part variants.
- Entrust discussed root cause analysis approaches and case studies relevant to LM equipment.

Points to Consider going forward.

- Combustor performance and durability outcomes varied by configuration and site conditions, and the discussion reinforced that tuning details, including gasket and shim selections, influenced emissions and operability outcomes.
- HPC stage 3–5 distress remained a fleet priority, with VSV health and edge-of-contact exposure repeatedly tied to blade outcomes and inspection practices.
- ORAP participation continued to provide a benchmarking path for availability, reliability, and forced-outage drivers, but the value of the dataset depended on consistent reporting inputs, especially around controls-related event categorization and cycle history.
- Users emphasized verification practices, including comprehensive borescope media capture, practical leak-finding methods, and disciplined spares strategies for recurring failure items.

LMS100 BREAKOUTS

The LMS100 break-out session an ORAP reliability review, GEV updates, and open user

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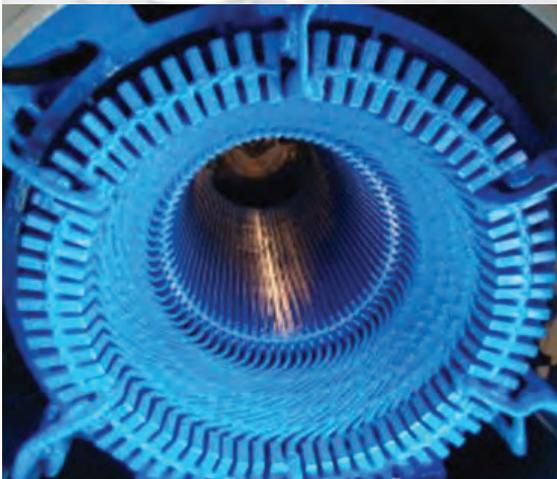
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discussion aimed at turning fleet experience into practical maintenance and outage-planning decisions.

Session chair Jason King framed the break-out around user questions and peer exchange, with the goal of surfacing issues that affected real-world operation and maintenance planning.

LMS100, ORAP

SPS's Sal DellaVilla used the ORAP dataset to review current and historical RAM experience for LMS100 units whose owners reported to ORAP. SPS and GEV reviewed findings ahead of WTUI to align key parameters.

Several clarifications affected how attendees interpreted the KPI plots:

Scope of RAM metrics. The RAM parameters discussed applied to the simple-cycle plant, including the GEV package and associated station equipment or balance of plant.

Aggregation across duty cycles. The metrics pooled all reported duty cycles, which reduced the influence of high duty-cycle units with longer mission time. SPS indicated it was considering KPI views by duty cycle for a future WTUI meeting.

Trend line discussion. The ORAP pages shown during the session indicated RAM performance had trended downward since 2021.

Downtime contributors. Major contributors to downtime were summarized on an incidents basis and a downtime-hours basis. SPS said it planned to revise these views to make component sources of downtime more actionable.

Data process improvement. SPS noted interest in a future ORAP-focused session on data reporting and collection, including the value of the Equipment Breakdown Structure (EBS) and how ORAP differed from other reporting systems.

LMS100, GEV

Supply chain and parts strategy. GEV's Tim Schneck described organizational changes among GEV, Baker Hughes, the Aero JV, and GE Aerospace that were intended to broaden access to parts inventory while keeping GEV Aero Services as the primary supply channel.

In the parts update, Greg Dickey outlined a strategy aimed at keeping assets running, including a push toward a more "unconstrained" global supply chain approach. GEV also described steps to expand inventory availability and said it planned to add overhauled parts in 2025 as an additional path to increase coverage.

Users raised specific pain points that shaped the discussion:

- Turbine parts lead times varied widely, with some items extending into multi-year horizons.

- Users cited gaps for specific components, including NOx water pumps, and characterized certain items as single-source with long lead times.

- Users also questioned Service Bulletin execution material availability and consistency.

Controls and counting cycles. Counter tracking emerged as both a technical and commercial concern because it affected rotatable life decisions, shop planning, and risk. GEV said a controls change intended to help with counter tracking was expected to be available in 2025.

Users also pressed for better counter history fidelity for rotatables and clearer alignment between actual rotatable condition, applied duty, and tracked counters.

Repairs and life-extension work. With limited availability of some new replacement parts, GEV described assessing industrialization of selected repairs and evaluating the potential to open operational and life limits where technically justified.

Examples discussed included frame and tube hardware, compressor blade sets planned for 2025 availability, and an IPT cooling manifold. The expected results were described on a 2026 to 2027 timeline for some items.

GEV also described service-support needs under consideration, including outage forecasting customization, repair capability expansion, and efforts to reduce turnaround time.

Pricing concerns and planning signals. Users raised concerns about escalations in new-part pricing, including examples of large increases. GEV said scarcity was not driving pricing and committed to reviewing cases where users saw significant escalation. Users also emphasized planning practices such as risk-buy analyses and using ORAP data to support spares and outage planning decisions.

Reliability and enhancements. GEV's Karen Kornuta presented RAM KPI results as median values, meaning half the fleet was at or above the reported value and half was at or below it.

The reliability enhancement discussion included hot-section durability topics, with an emphasis on following recommended maintenance and replacement intervals for affected components. On the IPT, the discussion referenced field-change hardware, a planned improved fix to increase cooling air to S2N, and interest in user evaluation sets, with new hardware availability discussed on a longer-term timeline.

LMS100, END-USER SESSION

In the user-only session, consultant Dave Brownell summarized themes from long experience with the LMS100 platform and emphasized a "trust, but verify" approach to maintenance execution.

User-facing practices that were reinforced

included:

- **Reference control.** Users described verifying that manuals and GEKs were current through the OEM portal.

- **Borescope (BS) plug inspections and spares.** Users discussed increasing instances of stuck or difficult-to-remove BS plugs and the risk of losing future borescope access. The discussion emphasized correct plug selection and installation details, plus documenting plug condition with photos in borescope reports.

- **FOD and DOD awareness.** Users discussed installation details and housekeeping steps intended to reduce the risk of loose hardware becoming foreign object debris.

- **Flow-path health and cleanliness.** Users emphasized recurring borescope inspection discipline and water washing ahead of BSI to support effective maintenance.

- **External inspections and small-parts readiness.** Users highlighted field inspection focus areas and the value of keeping certain spares available on site.

- **Counter discipline.** Users reinforced tracking cycles for life-limited parts and reporting counter values at the unit, module, and rotatable level to improve planning and data fidelity across the fleet.

Operational considerations for LMS100 users. Several near-term actions appeared to have broad support across users and the OEM:

1. *Counter tracking should be treated as a reliability input, not an administrative task.* When counter data was incomplete, rotatable risk increased and life decisions became harder to defend.
2. *Outage scope and spares planning need to account for long lead times and obsolescence risk.* Users described parts that fell into long lead-time categories and raised concerns about obsolescence for some controls and electrical items.
3. *Fleet RAM trends should be translated into component-level work lists.* Users signaled that KPI views were most valuable when they directly informed outage scope and spares strategy.
4. *Inspection discipline protected future maintenance options.* The BS plug discussion reinforced how small installation details could remove diagnostic capability and increase forced-outage risk.

Reflection points to consider for WTUI 2026.

1. *Contamination and configuration control remained the simplest high-leverage reliability actions.* Bearing outcomes, variable geometry health, and combustor and compressor durability had repeatedly traced back to what entered the machine and how it was set up and operated.
2. *Condition evidence carried more weight than interval language.* Borescope findings, trending, and documented history



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had driven planning scope, especially where “standard intervals” did not match site results.

3. *Counters and event categorization has become planning infrastructure.* Incomplete history and inconsistent categorization had increased conservatism, created disagreement, and could have forced premature replacement decisions.

4. *Depot and supply chain constraints shape outage strategy.* Lead times, depot duration variability, and communication quality had influenced risk buys, spares coverage, and how early owners had to commit to scope.

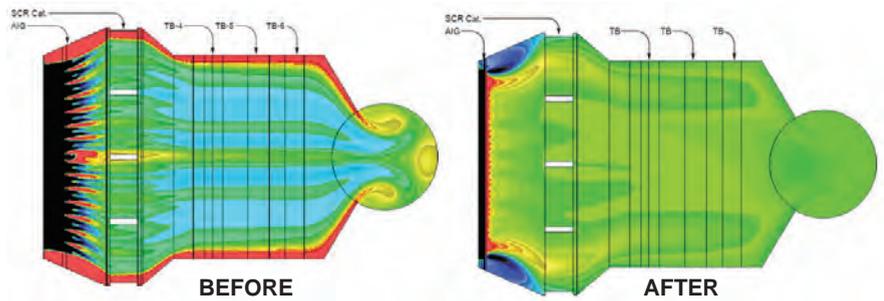
SPECIAL TECHNICAL PRESENTATIONS

Tuesday afternoons at Western Turbine meetings are reserved for nine Special Technical Presentations, approved by WTUI leadership, to extend the meeting’s content beyond the four GE aero engines on the program. The hour-long presentations (with Q&A) are arranged in three parallel sessions. Slide decks are posted on the WTUI website, but access requires an email request to Webmaster Wayne Feragen at wferagen@wtui.com.

CCJ aeroderivative best practices, *Scott Schwieger, Combined Cycle Journal.*

Projects recognized in 2024 from aeroderivative and combined-cycle facilities were reviewed and discussed. The awards program collected practical, field-proven ideas across categories including O&M, performance improvement, safety, predictive analytics, environmental stewardship, management, and water conservation.

Solutions included moving a NOx water-injection pressure transmitter to a heated space to prevent winter freeze trips, adding wireless relief-valve position monitoring on a gas-compressor skid to trigger automatic shutdown and prevent oil spills, installing a fixed access platform to reduce fall risk during anti-icing work, cleaning contaminated fuel-gas piping to lower CO and NOx while extending combustor life, and modifying FOD-screen access doors with hinges and handles to eliminate pinch points and allow one-person operation. He also noted a water-conservation project that reused



Airflow Sciences. CFD-guided AIG and flow-control changes improved SCR-inlet ammonia uniformity from severe wall bias (left) to near-target RMS (right), reducing ammonia consumption and limiting salt-related pressure-drop growth

blowdown and instrument drains through reverse osmosis, saving millions of gallons annually.

The recap closed with a reminder on WTUI BaseCamp access and related WTUI resources to share best practices. All these solutions are easily accessible using the search bar on the CCJ website.

LM6000 plants recognized:

- Edgewood Energy
- Equus Power
- Mariposa Energy Project
- Mashav Energy
- REO Cogeneration Plant
- Shoreham Energy
- Worthington Generation Station

Flow modeling for aero powerplant performance optimization, *Matt Gentry, engineering manager, Airflow Sciences Corp.*

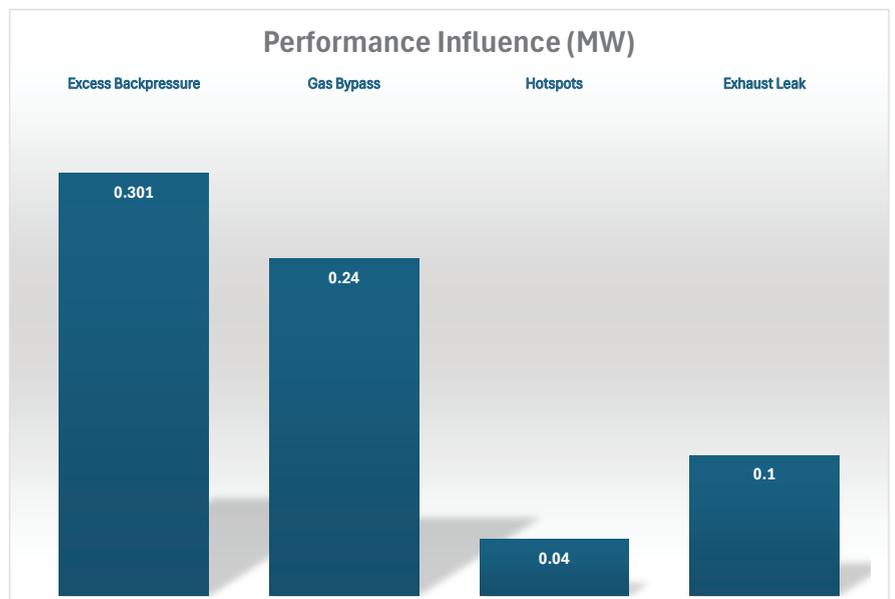
Gentry explored how flow modeling and field measurements were used to verify designs and troubleshoot aeroderivative power plants, with emphasis on velocity, temperature, ammonia distribution, and pressure drop as competing objectives. The speaker compared CFD, physical scale modeling

(typical 1:8 to 1:16 “cold flow”), and field testing, and argued that modeling reduced trial-and-error fixes that could be costly or create new problems.

Key design considerations included managing turbulent, swirling turbine discharge profiles, improving velocity uniformity through catalysts, tube banks, and stacks, and accounting for site layout effects on turbine inlet conditions. Ammonia injection performance was framed around achieving a uniform ammonia-to-NOx ratio at the SCR catalyst, with a modern target near 5% RMS, and the talk noted that older AIG systems often had improvement potential.

Case studies showed how perforated plates, straighteners, and mixing baffles were evaluated in CFD to improve flow and species uniformity without unacceptable backpressure penalties.

In an HRSG example tied to ammonium-salt fouling and high gas-side pressure drop, AIG redesign and perimeter flow control improved distribution at the catalyst face, stabilized pressure drop over time, and reduced ammonia consumption, while also reducing the need for frequent tube clean-



HRST. Relative output impact for common HRSR performance and integrity issues in a 1x1 LM6000 combined-cycle configuration, used to prioritize O&M and retrofit actions



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ing. The conclusions stressed that seals, baffles, and simple flow devices had outsized performance impacts.

Improving HRSG efficiency with operational and design modifications, *Jack Odium, northwest regional manager, HRST Inc.*

Odium reviewed operational and design changes that improved heat-rate and megawatt output in HRSG-based combined-cycle plants. In a low-load duct-burner study on an LM6000 with a Foster Wheeler HRSG, controlled burner firing increased steam-turbine output and supported participation in the spinning-reserve market, while constraints such as attemperation demand, duct temperature, and tube-metal limits were managed.

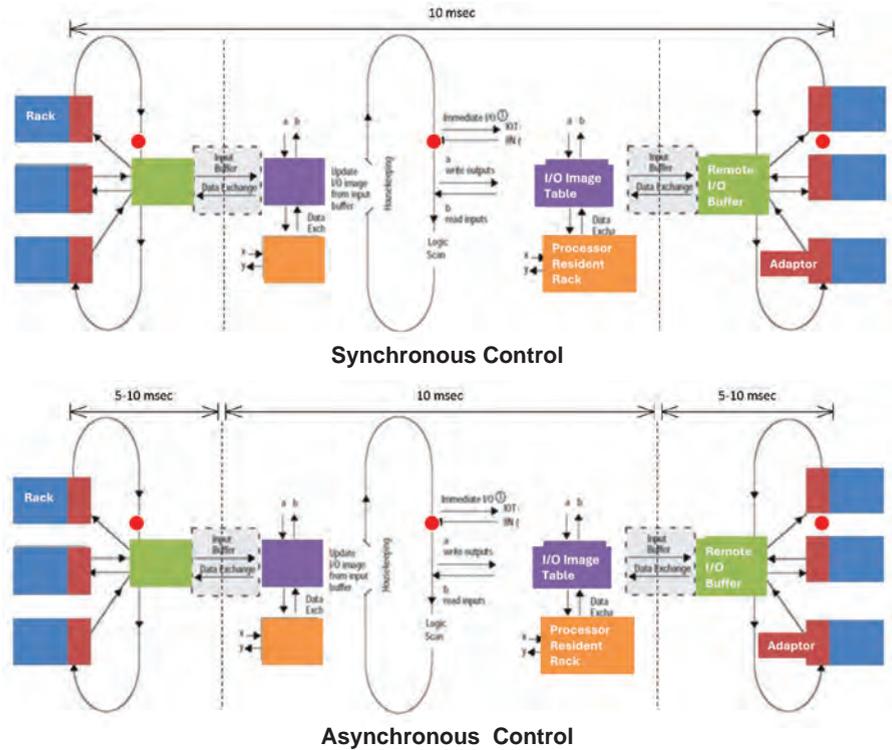
A second case addressed fast hot starts on an LM2500 with an Aalborg HRSG. By maintaining the HP drum within a defined temperature and pressure window, the team increased ramp rate during heavy cycling without adding damage to the drum or nozzles. The talk then described gas-side fouling and exhaust backpressure as contributors to lost steam production, a shift in duty downstream toward less valuable IP/LP steam, and higher gas-turbine backpressure, increasing trip or runback risk and worsening heat rate.

Recommended mitigations included dehumidified layup, periodic module and catalyst cleaning, repairing tube leaks, preventing inlet-duct liner failures, and keeping rainwater out during outages.

Finally, the presenter emphasized exhaust-gas bypass through casing and baffle gaps, explained why small openings could elevate stack temperature and reduce steam generation, and presented simplified performance modeling to prioritize baffle repairs under limited budgets. Casing hotspots were framed as safety hazards.

Troubleshooting 101: What do I do next? *John Stulp, senior staff application engineer, and Brooks Hoffman, sales manager, Woodward.*

The practical session explained how LM-series aeroderivative turbine controls translated hundreds of signals into fuel, vari-



Woodward. Control-system I/O timing comparison showed how synchronous buffering (top) reduced total throughput time versus asynchronous transfers (bottom), improving response for speed-sensitive turbomachinery signals

able-geometry, and sequencing actions that protected the engine while meeting load demands. The speakers described control I/O as the foundation, noting that typical applications processed 400-plus input signals (speed, temperatures, pressures, positions, and flows) and drove 100-plus outputs (metering valves, staging valves, variable geometry, and MCC commands).

They compared local, centralized, and distributed I/O architectures and emphasized that cabling, shielding, grounding, isolation, and I/O quality often determined reliability more than hardware cost. The presentation then walked through closed-loop regulation, using PID concepts to show how multiple governors managed speed, temperature, pressure, load, and acceleration, with a “voted” regulator taking control depending on operating conditions. Fuel-control examples

showed how a single fuel-demand value was conditioned into flow commands for SAC and DLE engines, including multi-path splits for DLE variants.

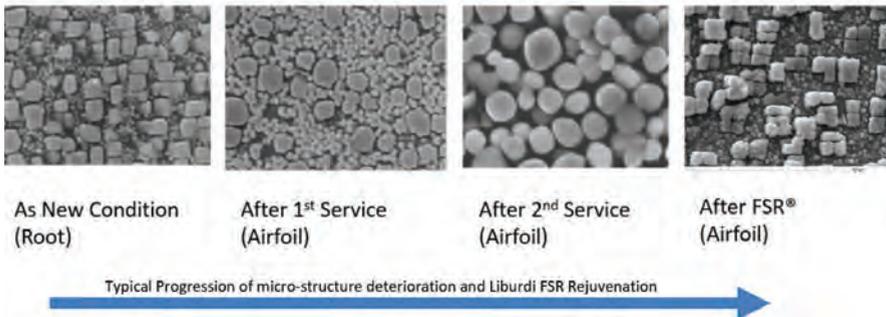
Variable-geometry control was presented as dedicated closed loops that tracked scheduled positions to protect stall margin, with fault logic for sensor disagreement, actuator issues, and rate limits. The session closed with sequencing examples for starter and lube systems, NOx controls, wash systems, and DCS communications integration.

Aeroderivative airfoil repair options and best practices, *Scott Hastie, engineering manager, Liburdi Turbine Services Inc.*

Repair expert Hastie outlined how aeroderivative component repairs were planned and executed to extend LM2500 and LM2500+ hot-section life while controlling overhaul cost and schedule risk. He positioned repairs as a primary lever for reducing lifecycle maintenance expense, noting that hot-section parts dominated spend and that repair typically represented a fraction of new-part replacement cost.

Hastie advised a “who, what, where, when, why, and how” for repairs, emphasizing repair-vendor turnaround time as a driver of total overhaul cycle time and recommending condition-based triggers such as borescope findings, vibration indicators, and reaching performance limits.

Liburdi’s approach combines conventional restoration with advanced processes. A stepwise flow was presented from incoming

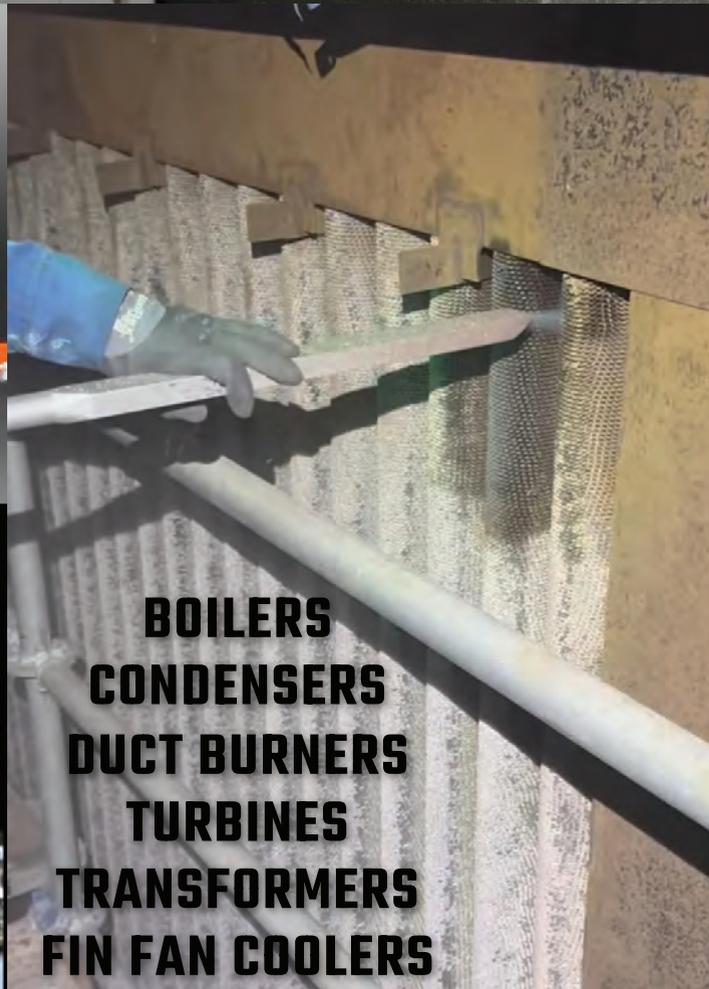
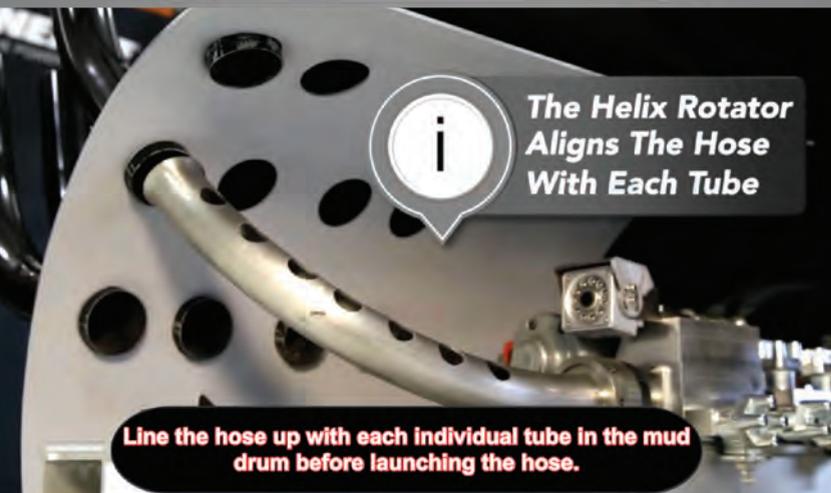


Liburdi Turbine Services. FSR® Full Solution Rejuvenation restored blade micro-structure and geometry indicators, supporting creep-strength recovery relative to the pre-rejuvenation condition

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Donaldson. Post-wildfire photos show inlet filters heavily soot-loaded while compressor blading remains comparatively clean. Higher-efficiency, environment-matched systems reduce smoke/PM carryover and can turn an extreme event into a filter change instead of a compressor wash or damage risk

inspection through strip, geometry repair, heat treatment, coating, and final inspection. For blades, the speaker described FSR® Full Solution Rejuvenation using proprietary vacuum heat treatment and HIP to restore microstructure and creep capability, supported by before-and-after imagery and stress-rupture comparisons against new-part standards.

Also highlighted was automated CT and X-ray wall-thickness evaluation to improve accept-reject decisions and protect remaining life margin. For nozzles, an HP1 repair sequence was presented from damage removal through material build-up, machining, inspection, and cooling-hole restoration

with design upgrades before coating and return to service.

How to prevent catastrophic failure during extreme conditions—wildfires, for example, Bob Reihardt, power-gen manager, Donaldson.

The presentation described how inlet-air filtration reduced LM6000 risk during extreme weather and contamination events. Reihardt framed filtration as a lever for protection, efficiency, maintenance, and availability, and he grouped threats as foreign objects, large particulates, fine particles, and salts or chemicals. He explained Donaldson’s Er-W-P classification, tying

filter selection to particle-removal efficiency (Er0–Er5), water tightness (W0–W5), and pulse-cleaning recovery (S–P5).

As it goes with most filter talks compared conventional F8/F9 filtration with higher-efficiency (H) EPA media rated E10–E12, noting that improved efficiency helped preserve compressor condition and output over time. For humid or coastal sites, he emphasized water-tight designs and described spray-test verification and performance curves illustrating reduced water passage and stable pressure drop. For dusty, arctic, or storm-driven loading, he highlighted pulse-recovery ratings developed from extended dust exposure intended to simulate sandstorm conditions.

Environmental examples estimated particulate mass entering an LM6000 over seven days at AQI 50, 100, and 150 and showed how higher-efficiency filtration reduced ingested loading. He also outlined selection factors including water-washing practices, run hours, pulse capability, and change-out intervals.

Aeroderivative generator challenges, W Howard Moudy, managing director, National Electric Coil.

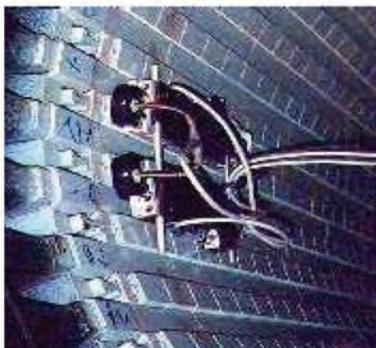
It’s tough getting old and the generator is certainly not immune to aches, pains, or wrinkles. But, luckily there’s vastly experienced outfits like NEC who understand the issues encountered when extending generator life. Moudy stressed that projects begin with understanding why components degraded and then planning work around known deficiencies, outage duration, and constraints.

He stressed specifications worked best when they stated performance requirements and acceptance criteria rather than prescribing how vendors must execute the job, and that the best time to develop specifications was before an outage was imminent.

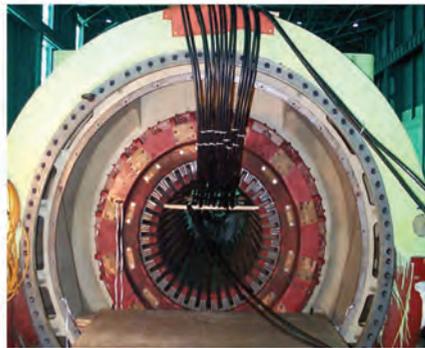
The rotor discussion covered transit loading, conductor cracking, distortion, joint quality, and hardness checks and geometry verification. Cycling received attention because many units designed for baseload service had been redeployed for frequent starts, increasing cyclic stress. One case described crack propagation in a corner conductor design and a corrective rewind using new copper and revised corner geometry to better withstand cyclic duty.

For continued-service decisions, Moudy outlined nondestructive examination options: ultrasonic, magnetic particle, eddy current, dye penetrant, plus hardness and profile checks.

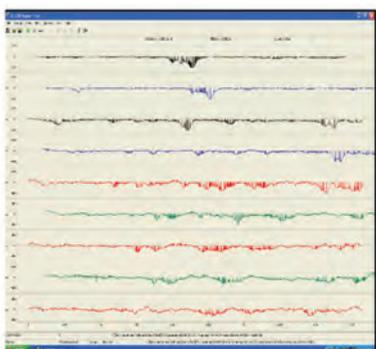
Stator topics included core construction and diagnostic tools such as EICid and loop testing, with guidance on investigating high milliamp indications and correcting hot spots above average core temperature. The talk closed with replacement-winding data needs, loss drivers, and insulation qualification testing.



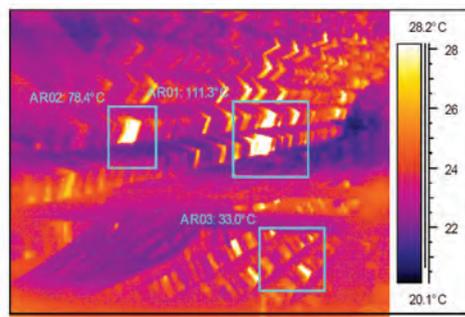
EICid Test



Loop Test



EICid Results



Loop Results

National Electric Coil. EICid (left side) and loop testing (right side) criteria helped target stator-core faults, prompting corrective action on high current indications and localized hot spots



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Torsion strength.....	.2900in-lbs
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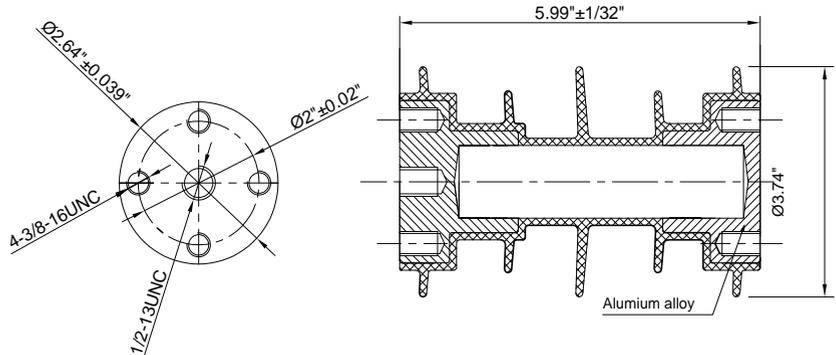
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Maintain, monitor, and modernize to make aging switchgear safer,

Umer Khan, PE, global product manager, ABB Electrification Service.

The presentation outlined a practical approach to keeping medium- and low-voltage switchgear reliable by combining preventive maintenance, condition monitoring, and targeted modernization. It emphasized that maintenance programs had to align with NFPA 70B for equipment maintenance and NFPA 70E for workplace electrical safety, including a documented Equipment Maintenance Plan, periodic audits, thermographic inspections, and current power-system and arc-flash studies supported by up-to-date single-line diagrams.

Preventive maintenance activities included visual inspections, cleaning, lubrication, functional checks, and electrical testing, along with relay calibration, dielectric withstand testing, partial-discharge testing, and breaker testing to identify insulation, contact, and protection issues before they became outages. Khan compared run-to-failure, time-based preventive maintenance, and condition-based strategies, presenting predictive approaches as a way to reduce unplanned failures while avoiding both over-maintenance and deferred work.

For modernization, he described retrofit pathways intended to minimize downtime and preserve existing switchgear footprints, including protective-relay upgrades, LV and MV retrofill or direct-replacement breaker options, generator breaker retrofits, and arc-flash risk-reduction features. It also introduced monitoring and reporting tools designed to integrate with SCADA or pow-



ABB. Maintenance strategy tradeoffs for switchgear, showing how condition-based monitoring supported predictive actions that reduced failure risk and improved productivity

er-management systems to provide dashboards, alarms, and automated reports for electrical balance-of-plant decision support. The central message was to extend asset life while improving safety and availability.

Predictive analytics: Applying SI processes in ORAP® with the national labs, *Salvatore A DellaVilla Jr, founder, chairman, and CEO, Strategic Power Systems Inc.*

The chief data guru described how SPS applied AI and machine-learning methods inside ORAP® in collaboration with US Department of Energy national laboratories to help plant operators anticipate failures and respond to changing duty cycles. Work that began in 2018 by NETL and ORNL was extended beyond proof-of-concept with verification and validation support from an operating-plant advisory board.

DellaVilla explained that ORAP's fleet

database, roughly 3,000 units with detailed pedigree, event history, age, and operating data, was fused with first-principles models and neural-network approaches to predict both what would happen next and when.

The modeling stack included multiple event-trend models (Random Forest and XGBoost variants), sequence models (Long Short-Term Memory) for cause prediction, and additional XGBoost-based approaches, while survival models were evaluated but not used.

Results were presented through an ORAP Analytics Portal, which showed predictions for event timing and event cause on LMS100 and LM6000 fleets and improving accuracy as more data accumulated. The program then moved toward production, with automated prediction generation, integrated dashboards, and an NLP data-entry aid, followed by beta validation, interface refinement, and pilots with up to six plants. [ccj](#)



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Operations experts get the most from your plant analytics

Thirty years before artificial intelligence (AI) became part of common public lexicon, the powerplant industry was getting steeped in it. There was always the question, however, how far you could “push” the technology and reduce staff expertise. Now, a relatively new entrant to the M&D-as-a-service space emphasizes how its operations experts remain in the loop.

A little history: Predictive analytics technology began to be applied in powerplants in the mid-to-late 1990s when the earliest software packages came on the market. Typically, these packages pulled data from the plant historian, then applied pattern recognition algorithms to detect parameters ‘out of range.’

As the technology improved, coincident with the move by large owner/operators (O/O) to remote and centralized monitoring and diagnostics (M&D) centers in the late 2000s, software with advanced pattern recognition (APR) algorithms became a standard feature in these centers, along with thermal performance monitoring, vibration monitoring, and other functions. Experts at the M&D centers usually assisted the folks at the plant in responding to anomalies.

Consolidated Asset Management Services (CAMS), a large powerplant operator, offers its asset performance management (APM) APR as a service with a different idea. The company emphasizes the operations expertise, along with the technology. While they license their APR technology from Prometheus, CAMS APM is happy to work with whatever APR technology is available at their clients’ plants.

According to David Saad, a veteran in the APR space, with years under his belt at one

of the pioneer APR software providers, most of the available software packages work in similar ways today. What distinguishes a service provider is how effective they are in helping the plant respond to the alerts and anomalies.

These days, less and less actual engineering expertise resides at CCGT plants as staffing levels shrink. More expertise is outsourced, whether to third parties or engineering departments within the O/O organization. Relatively young, inexperienced engineers are replacing veterans who retire.

Saad says: “Other firms providing these services deploy less experienced engineers to monitor the APR screens, and when they find deviations, they contact a subject matter expert (SME) to confirm what the issue is, even if it is as simple as a bad signal. Then other departments are alerted, such as maintenance and monitoring, to verify whether bad data was used to train the model. In fact, the information is bouncing between too many folks in the loop, gumming up the works.”

CAMS philosophy is that *one* SME is assigned to respond to and resolve issues, indicated by the software, for the client. “We call it “engineer-in-a-box,” notes Saad, a counterpoint to those who sell “software in a box.” “We are APR software agnostic,” adds Ken Earl, VP in charge of the APM team, “the experience we bring to the table as a reliable partner, as operators of 65,000 MW of power facilities, is key.”

“In other words,” Saad explains, “we don’t just dispatch a daily or weekly report to the plant.”

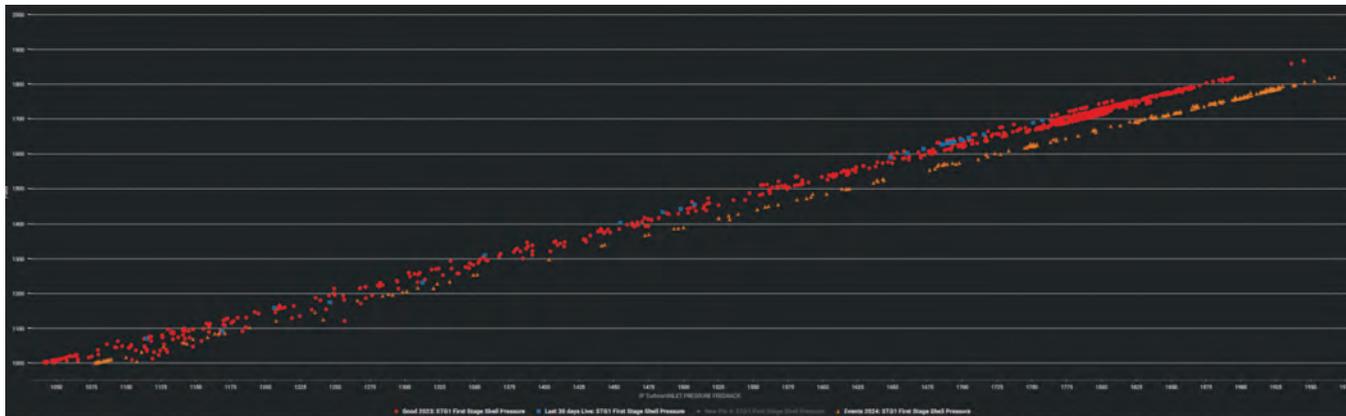
An example of when expertise comes in handy is knowing which subsystems need monitoring. APR typically monitors the

CUSTOMER FEEDBACK UNDERSCORES VALUE

CAMS APM has delivered significant value to our facility by enabling early detection of parameters operating outside historical trends, says Anner Reyes, Plant Manager, Parkway Sewaren 7 Generation Center. This has helped us prevent forced outages. The proactive approach gives plant staff ample time to source materials, allocate resources, and plan repairs during scheduled shutdowns, rather than reacting to emergencies.

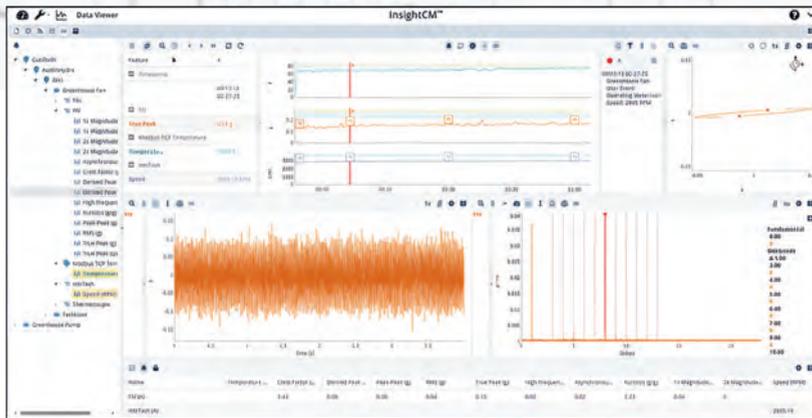
Unlike traditional OEM monitoring, CAMS APM customizes its service to our station by incorporating input from plant personnel and building models around real-time concerns. Their real-time support, combined with historical data analysis and SME expertise, has been instrumental in troubleshooting complex issues, even challenging OEMs to investigate combustion problems that could have caused major damage. CAMS APM goes above and beyond by offering a tailored, collaborative approach that transforms monitoring into a powerful tool for reliability and operational excellence.

steady state data from operations, but it is also vital to keep an eye on systems, like liquid fuel, which are “still live” even if the plant



1. Noting steam turbine inlet pressure changing gradually versus steam turbine first stage pressure was key to site recovering 10 MW (with associated revenue) and avoiding FOD to the high-pressure steam turbine

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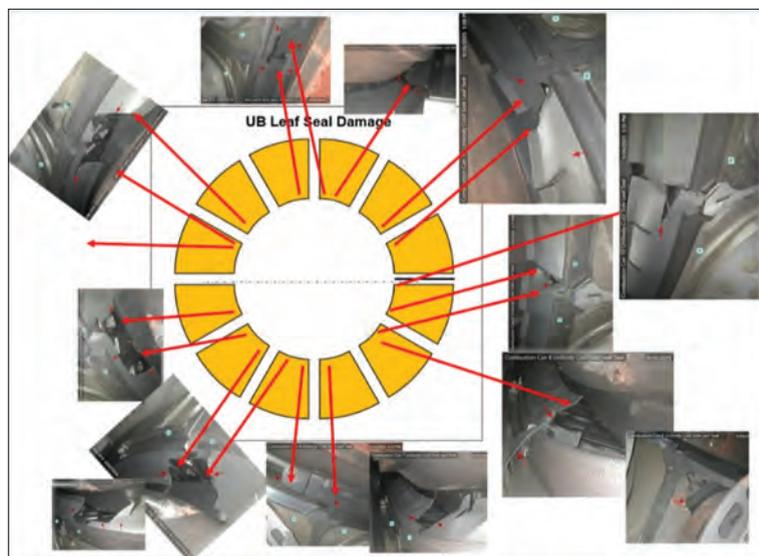
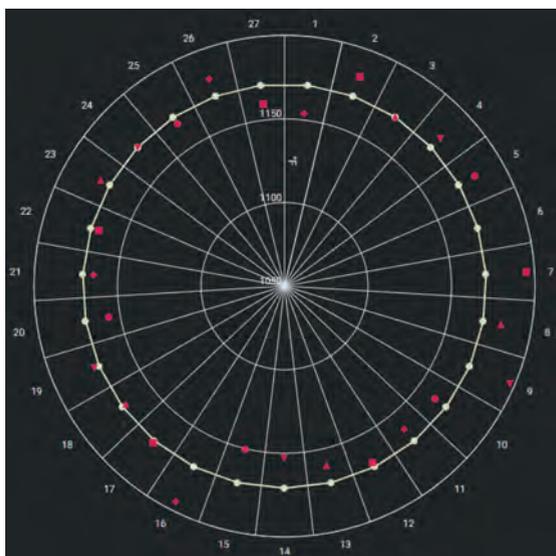
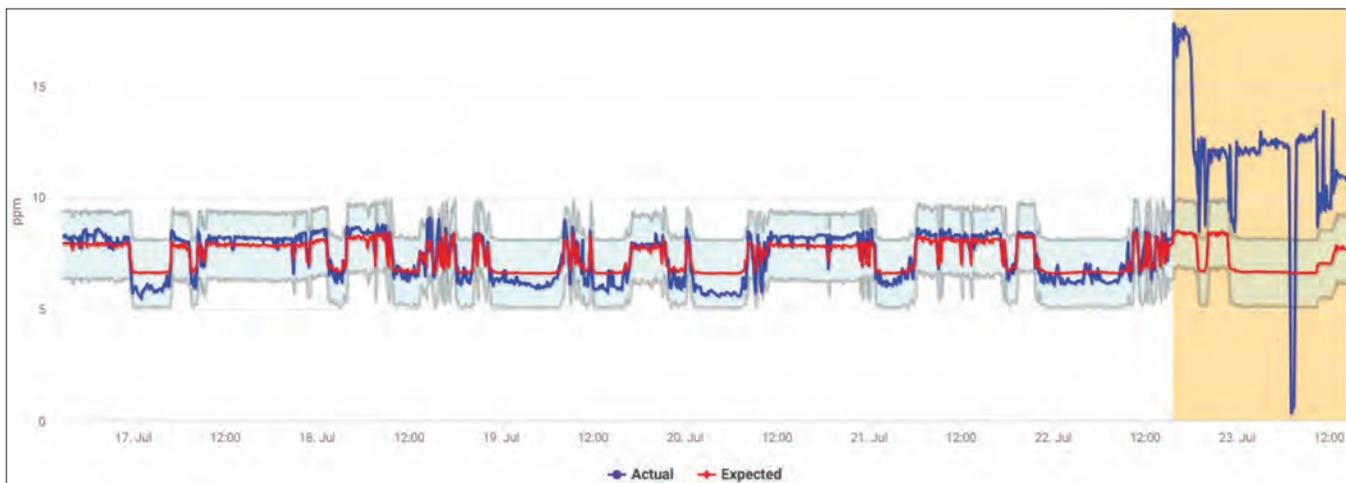
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2. After flagging elevated pre-SCR NOx levels (top), CAMS APR examined radar plots (bottom, left) to identify hot and cold regions of the GT exhaust, and which combustor cans were responsible for the temperature (and combustion dynamics) variations. Photographs of actual unibody hardware issues were mapped based on the data (bottom, right)

isn't burning it. CAMS APM experts aren't limited to the main gas turbine, HRSG, and steam turbine islands either. For example, they monitor data from dissolved gas analyzers (DGA) in the GSU transformers ranging from simple (one or two gases) to more complex DGAs looking for up to 10 gases.

CAMS experts also help their clients set up the APR monitoring system, clean up the tag list in the data historian, enhance the APR system already installed, and even suggest adding instrumentation which will make the APM more effective. Many plants have APR software, but staff do not have the time to get the most out of it. "Today, most CCGT plant O&M staff are not plant-engineering focused, because they are relegated to project management and reacting to day-to-day issues," Earl stresses. CAMS has also enhanced the basic software they've licensed from Prometheus to improve modeling and visualization.

Examples of how CAM APR works with their clients follow.

Gain MW, prevent FOD. Summer of 2024, CAMS APM was investigating pos-

sible performance loss on a CCGT block triggered by the APR software. Utilizing pin charts (which quickly separate groups of data by color), a gradual shift was noted, from the previous year, of steam turbine inlet pressure vs steam turbine first stage pressure (Fig 1).

The site was able to schedule an outage, before capacity testing, during which heavy debris was found in the steam turbine main strainer, along with a sheared pin from one of the main-steam stop valves. The planned outage repairs allowed the site to recover 10 MW, which allowed for \$700,000 additional revenue. Also, the timely outage prevented the valve pin from releasing downstream and causing foreign object damage (FOD) to the high-pressure turbine. A previous similar FOD incident resulted in damages costing \$5-million.

Fix NOx, combustor issues. Last summer, CAMS APM noted an increase in engine exhaust NOx upstream of the catalyst at a site. Utilizing live radar plotting (Fig 2), experts identified hot and cold regions in the exhaust profile to help the site iden-

tify which combustion cans were possible culprits. These temperature variations, together with combustion dynamics changes, supported an in-depth analysis by the OEM to improve operability until the planned major inspection the following spring.

Meanwhile, the site took advantage of its fall planned shutdown to borescope the unit, subsequently discovering multiple issues with the unibody seal and one combustion nozzle. This compelled the site to extend the outage prior to the winter run season and address these issues. The work performed has returned GT exhaust NOx to appropriate levels, alleviating concerns with permit exceedances until the spring 2026 planned shutdown.

Forecast bearing trip limit. In May 2025 CAMS APM noted an increasing rate of change on the GT exhaust bearing vibration at a site. OEM reps were contacted, who suggested the behavior and values were normal. To ensure this situation was being adequately monitored, and to inform the customer well in advance of an impact on operations, CAMS APM added a forecast



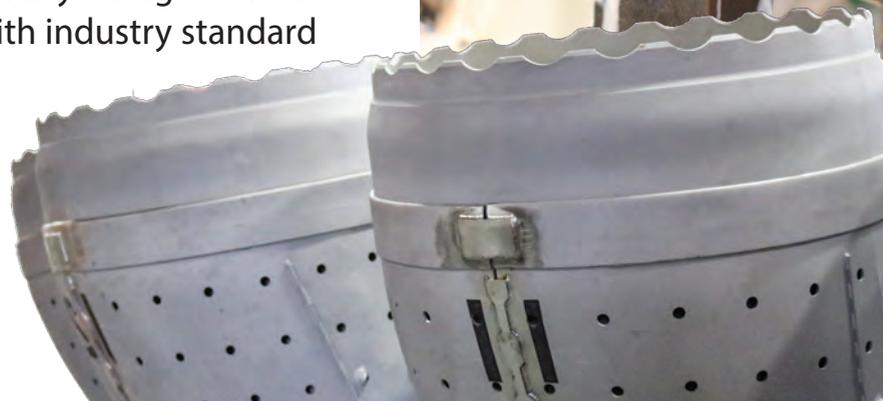
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3. Forecasting model for GT exhaust bearing vibration was built for a site, which allowed CAMS to anticipate when the site would reach trip levels (less than two weeks)

model (Fig 3). Five months later, the model indicated the situation was worsening. The site was notified that it had 13 days before reaching the trip limit on the exhaust bearing vibration.

The site again contacted the OEM reps. The OEM reiterated that the behavior and values were normal. However, as a precaution, the trip limit parameter was raised by the OEM. This prevented the unit from going into a runback or trip so the site could make it to the spring 2026 major inspection.

Caution on VAR. While many APM-as-a-service providers are quick to point out the huge dollar savings from one or two ma-

ajor “catches,” CAMS takes a different tact. “While these numbers can appear dramatic,” Earl stresses, “they are extremely site- and O/O-organization specific.” If a client wishes to use such value at risk (VAR) numbers internally or report them, we will work with them to do so, but they have to agree on the methodology used.”

Avoiding reactive response to mal-performance. The following example illustrates how the CAMS APM team goes beyond just monitoring. An alert was issued to a site on irregular vibration in an auxiliary cooling tower fan. Readings had been erratic for almost a year, spiking to 0.62 mils, almost

double the historical trend. The anomaly had not affected the non-drive end of the assembly, indicating a potential gearbox issue. In response, and with CAMS recommendations, the plant initiated a work order to inspect the fan.

To mitigate further risk, the fan was designated for emergency use only to avoid further damage and potential failure until the gearbox could be replaced at the next outage. CAMS then refined the models around cooling tower fans with new data. By identifying which gearbox components should be scrapped and which could be repaired and retained, CAMS team helped the client reduce repair costs by up to 50%. [ccj](#)

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A close-up photograph showing several stacks of cylindrical metal sleeves. The sleeves are made of a polished, reflective metal, likely stainless steel, and are arranged in a row, slightly overlapping. The lighting creates bright highlights and deep shadows, emphasizing the metallic texture and the circular openings of the sleeves.

sleeveit

ELIMINATES BUTT WELDS
ELIMINATES PURGING
ELIMINATES RT

A photograph showing several vertical metal pipes or tubes. The pipes are made of a dark metal, possibly steel, and have a slightly textured surface. They are arranged in a row, with some in the foreground and others in the background. The lighting is dramatic, with strong highlights and deep shadows, creating a sense of depth and texture.

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High-temperature tees present growing risk in HEP systems

High-temperature tees in main steam and hot-reheat service are emerging as a serious integrity risk across combined-cycle and advanced coal-fired plants. Speaking at the NBBI 93rd General Meeting, Dr. John Siefert (EPRI) reported hundreds of field leaks attributed to creep-related cracking in wrought tees, with damage appearing in as little as 37,000 operating hours (Fig 1). This is well below the 300,000 to 400,000 hours traditionally assumed for high-energy piping (HEP) in the creep range. With as many as ~10 tees per 2x1 combined-cycle block, the cumulative fleet exposure is significant.

Field experience shows cracking across multiple manufacturers and alloy grades (notably Grades 22, 91, and 92). Failures have occurred in both crotch regions and girth welds, and in both shop and field welds. Although no catastrophic ruptures have been reported to date, Siefert cautioned that the trend demands immediate industry attention due to the safety implications of through-wall leaks in high-temperature service. This is especially true for tees in high traffic or consequence locations.

DESIGN GAPS, FABRICATION FLAWS

The governing fitting standard, ASME B16.9, defines only an envelope geometry and does not require a minimum crotch

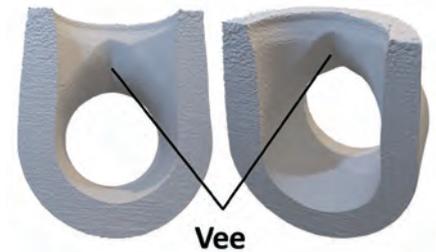
thickness calculation. As a result, tees often enter service with under-designed crotch regions. Additional issues include:

- Crotch “vee” excavations from forming or defect removal connected to the inside diameter (ID) that act as stress risers. In some instances this material has been replaced with repairs given a subcritical post weld heat treatment (PWHT) and thus exposing the heat affected zone (HAZ) from the repair to the hoop stress (Fig 2).
- Mis-stamped or undocumented materials, including rogue components
- Low hardness values in the tee fitting which may reduce the long-term creep performance
- Girth welds located too close to the crotch, increasing the local stress acting across the vulnerable HAZ regions

Documentation alone has proven unreliable, and when provided, is extremely limited. Several failures have been identified on tees carrying complete certification records with some exhibiting composition limits within the improved Grade 91 Type 2 limits. This highlights the compounding effects of elevated temperature operation in the creep range and the inadequacy of the design for such service.

FLEET-WIDE EXPOSURE

Replacement costs for a single tee can

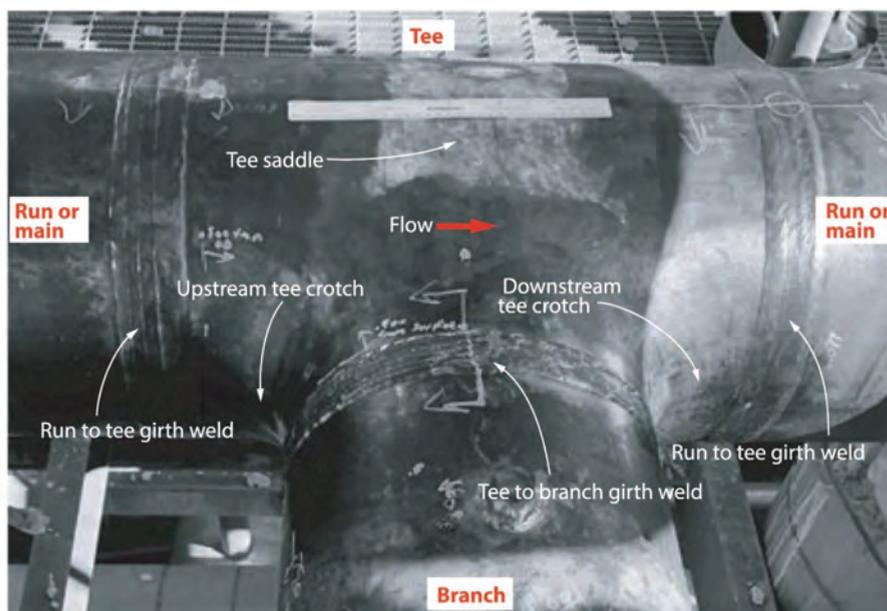


2. Crotch “vee” as crack initiator. Local material removal after forming to remove

exceed \$500,000 when scaffolding, insulation, labor, and outage time are included. Worldwide financial exposure for tees alone is estimated in the tens of billions, with risk extending to seam-welded elbows and other fittings fabricated to A-/SA-234.

To address the issue, EPRI is developing a document with industry stakeholders that will provide the necessary technical requirements to bolster end-user/owner specifications. This guidance is expected to include improved design approaches and fabrication control beyond the limits of B16.9 and A-/SA-234. For components already in service, Siefert outlined a post-construction response strategy emphasizing screening to prioritize where focused inspection may be required, enhanced QA/QC for new or replacement fittings, and options for run/repair/replacement with an emphasis on fitness-for-service given the lead times for the preferred machined forging replacement option.

The slide deck and transcript from Siefert’s presentation, Emerging Issues in the Power Generation Industry, are available at no cost from NBBI by scanning the QR codes provided with the session materials.



1. Terminology for a tee intersection in a high-temperature, HEP system



Presentation



Remarks

What's happening in the GT industry

PEOPLE

Trinity names Stivender to lead field services

The Trinity Turbine Technology team recently announced that Errol Stivender has joined the company as VP of Trinity Turbine Services, overseeing all field service operations going forward.



Stivender

Stivender brings more than 35 years of experience in gas and steam generation as well as the refining and petrochemical market sectors. This includes turbine and generator installation, rehabilitation, and rotating-equipment reliability. His background includes field leadership and project management across complex rotating machinery, including compressors, gas/steam turbines, and gas expanders, as well as customer-facing roles supporting major OEM frames, including GE and Westinghouse equipment.

Trinity president Phillip Scott emphasized continuity for customers, moving forward with the existing team of mechanical specialists while adding talent as demand grows. The company also plans near-term meetings with customers that include Stivender, site leadership, and business development to align on current and future needs.

Additional investments in process to meet customer and market demands with Trinity include:

- New additional vacuum furnace
- Two additional more coating booths
- 60,000 square feet of shop capacity expansion
- Opening of Trinity North annex increasing capacity of component repair processing
- Expanded fuel nozzle repair, flow testing services

Family owned and established in 2002, Trinity Turbine Technology serves as a one-stop shop for turbine-related needs, including component repair, engineered coatings, field services, and capital parts supply. The company supports the heavy industrial frame gas and steam turbine fleets at their Rosharon, Texas facilities strategically located just south of Houston, Texas. More details at their website: www.trinityturbine.com.

In-game adjustments

After more than four decades in the industry, Tom Freeman transitioned from player to coach, applying a career's worth of experience to strategic advisory work. He retired from GE Vernova in 2025 and now serves as head coach at Gas Turbine Coach LLC, working with utilities, independent power producers, data centers, service providers, and OEMs to help them plan, position, and execute future strategies.



Freeman

At GE Vernova, Freeman most recently served as Chief Customer Consultant for the Americas, where he helped align OEM capabilities with owner/operator needs and champion practical, customer-focused solutions.

Freeman said his work today extends way beyond gas turbines. He advises organizations across the power sector on technical positioning, market strategy, and long-term decision-making in a rapidly evolving energy landscape. Contact: thomas.freeman@gasturbinecoach.com.

Inlet cooling is hot again

The Turbine Inlet Cooling Association (TICA) announced its new officers and directors. The non-profit organization promotes the development and exchange of knowledge related to GT inlet cooling for enhancing power output.



Rose

Officers

- Chairman: Justin Rose, Munters Corp
- President: Keith Flitner, Continental Controls Corp
- VP: Mike Manoucheri, Thermal Energy Corp
- Secretary: Eric Busbey, MVF Process Controls
- Treasurer: Patricia Graef, Patricia Graef Consulting

Directors

- John Andrepont, The Cool Solutions Co
- Nick Rogers, Stellar Energy Global Infrastructure

TICA also encourages gas-turbine users to take advantage of its complimentary membership option. The association said benefits include the full TIC Performance Calculator, full TIC Installation Database, access to experts across turbine inlet cooling technologies, and opportunities to help shape TICA activities around user needs.

M&A

Three major deals reshaped the market in early 2026, as buyers targeted gas-fired capacity in PJM, ERCOT, and ISO New England. For owner/operators, the key metrics were straightforward: MW, valuation, and market exposure. The throughline was clear, with acquirers placing a premium on dispatchable gas assets in competitive regions, especially PJM and ERCOT, to serve accelerating demand from data centers and broader electrification.

Constellation closes Calpine. Constellation completed its Calpine acquisition on January 7, 2026, and said the combination created the nation's largest power producer. The company emphasized the pairing of Constellation's nuclear fleet with Calpine's gas and geothermal assets to serve rising load from data centers and other large users.

A key condition before closing was DOJ's antitrust settlement, which required divestiture of six plants in Delaware, Pennsylvania, and Texas tied to Constellation's proposed \$26.6-billion Calpine acquisition.

Vistra plucks Cogentrix. Vistra signed definitive agreements to acquire Cogentrix, adding about 5,500 MW of natural-gas generation across PJM, ISO New England, and ERCOT. The portfolio included 10 modern gas facilities.

Vistra pegged the net purchase price at about \$4.0 billion after expected tax benefits and highlighted an implied valuation of roughly \$730/kW.

NRG closes on LS Power portfolio. NRG closed its LS Power portfolio transaction in late January, adding about 13 GW from 18 natural-gas-fired plants plus CPower's commercial and industrial virtual power plant platform.

NRG said the acquisition doubled its generation fleet and expanded its footprint in key markets, especially the Northeast and Texas, while adding demand-side capability. The transaction was first announced in 2025 at a reported \$12-billion valuation, and LS Power later described the completed sale as roughly \$13 billion in cash and NRG stock.

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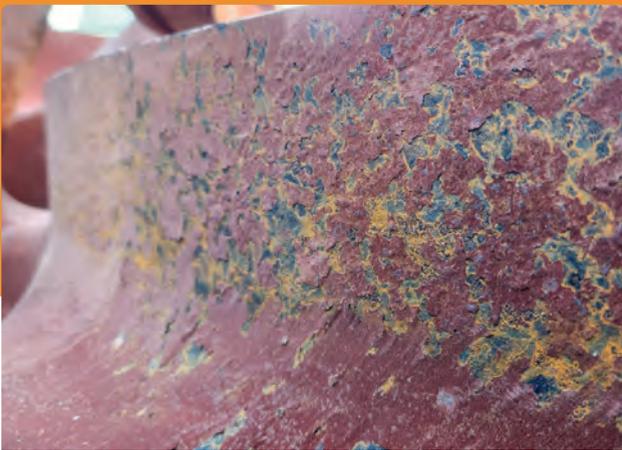
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Field-Applied Protection for Advanced Gas Turbines



Gas turbine oxidation

At elevated temperatures, oxidation forms on internal casing surfaces that are out of direct line of sight. Oxide scale forms, loses adhesion, and exfoliates during normal thermal cycling, in some cases even without unit operation. These flakes migrate downstream, where they can plug cooling passages, erode thermal-barrier coatings, and contribute to premature distress of blades (buckets), vanes, and other hot-gas-path components.

In practice, the issue is often first identified indirectly through premature distress or early replacement of Stage 1 turbine blades, rather than through direct observation of the casing surfaces where oxidation originates.

This degradation mechanism has been observed repeatedly on F-, G-, H-, and J-class machines operating at higher firing temperatures and is often only recognized after downstream damage has occurred. For many operators, the economic impact is driven by shortened maintenance intervals and unplanned intervention on first-stage hot-gas-path hardware. Extending Stage 1 bucket maintenance by even a single cycle is often sufficient to offset the cost of preventative mitigation.

Integrated Global Services (IGS) addresses this issue through field-applied High Velocity Thermal Spray (HVTS®), which prevents oxidation debris generation at the source by applying a protective cladding to susceptible casing surfaces. The approach has been technically evaluated and validated by all three major gas turbine OEMs.

Rising compressor pressure ratios in advanced-frame gas turbines have pushed late-stage compressor temperatures beyond 930°F (500°C). While this improves efficiency, it also accelerates oxidation of low-chrome steel components in compressor discharge and combustion-adjacent sections, creating a fleet-wide reliability concern.

HVTS is executed entirely within planned outages, without impact to the outage critical path, and can be applied during minor, HGP, or major outages, with the rotor installed or removed. Typical on-site scope duration is 6–10 days per unit, depending on access and scope.

IGS provides end-to-end, turn-key execution, including:

- Engineering guidance and surface preparation requirements
- On-site application and quality verification
- Protection of critical interfaces
- Full environmental, safety, and bio-waste management compliance

Field experience spans F-, G-, H-, and J-class units across North America, Latin America, APAC, and the Middle East, with a cumulative operating hours total exceeding 200,000. Post-outage borescope inspections and open-unit examinations have consistently confirmed cladding integrity.

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Open-market DLN-1 system anchors quick CC-to-GT peaker conversion

Ingenuity is never in short supply in the gas turbine (GT) industry, but some projects do amplify the wow factor more than others. Case in point: A Texas plant where a 1987-vintage, 2x1 7EA combined cycle (CC) cogeneration plant was converted into a peaking facility serving the lucrative ERCOT market.

Collaboration among several non-OEM services firms drove success of the project from the commercial side. With TOPS Field Services as the consortium leader and project architect, more than a dozen subcontractors played integral roles in the project's success. What follows is a testament to industry resourcefulness and a new paradigm of executing major maintenance and upgrades where competitors become partners providing valuable solutions for the aging gas turbine fleet.

The major upgrade on the technology side was the replacement of the existing 7EA water-injected diffusion combustor system with a DLN-1 system including the associated controls and fuel delivery hardware, so that the project could comply with a 9-ppm NO_x standard while maximizing output. Prior to project inception, the plant was running in a sub-optimal condition with only one HRSG functioning and the GTs in need of other major overhaul work.

Faced with the loss of its steam host, and thus the source of injection steam for NO_x control in 2023, the owners nevertheless wanted to continue capitalizing on ERCOT peak power prices. Adding an SCR to the units wasn't feasible as this major configuration change would force a Best Available Control Technology (BACT) requirement under the Texas Environmental Quality Commission (TEQC) rules. OEM-based solutions were cost- and schedule-prohibi-

tive as well. So, the challenge of continuing operation without its primary water source drove the need for a creative engineering solution.

Owners turned to a project team consisting of TOPS Field Services (primary contractor), Doosan (rotor overhauls), TTS (DLN-1 system, control and combustion system integration, gas heater and AutoTune system), National Electric Coil (generator inspections and rewedging work), and Gulf Coast Bearings (bearing refurbishing). Others included GTBars, Strickland Welding, Southwest Tool Co, and Phillips Fabrication.

Consultant Erik Boleman, Barr Engineering, was brought in by the owners to assist with the TEQC permit. TTS in turn engaged Allied Power Group (open-market DLN components procurement and refurbishment) and Sulzer Turbo Services (combustor flow testing and combustion liners). With all the pieces in place, it was time to get down to business.

According to TTS President Frank Hoegler, the owners had already decided on the peaker conversion once TTS was brought into the project. While the project was primarily compliance-driven, the owners were "watching everyone around them make money running peakers." TTS' past experience on DLN-1 conversions helped assure the owners that they could meet the new NO_x levels without an SCR while minimizing capital and on-going O&M costs.

TOPS' Jeremy Four notes that many 7EAs are equipped with DLN-1 systems (Fig 1) today but the Big Spring units had a legacy dual fuel combustion system. What distinguishes Big Spring's is that the combustion system was assembled from both new and used components sourced from multiple locations. For example, end covers, secondary

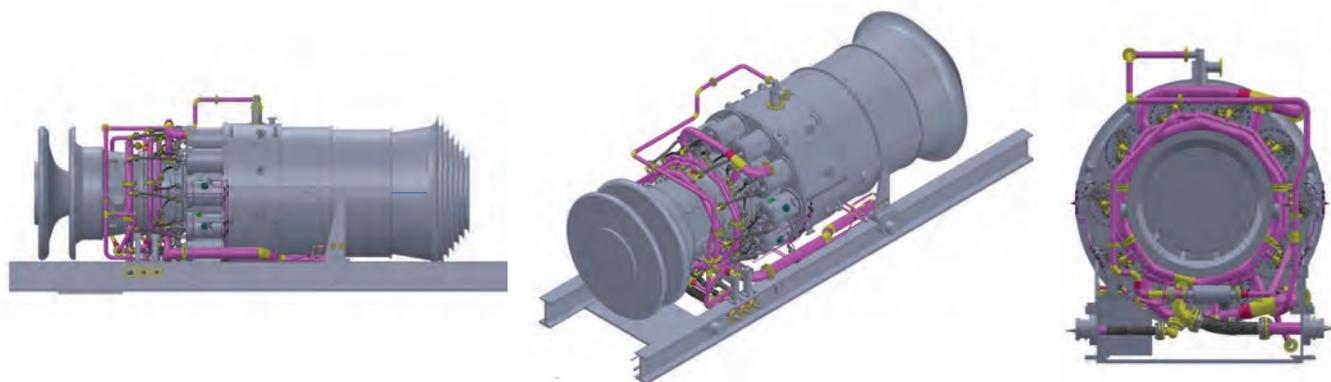
fuel nozzles, flow sleeves, transition pieces, and liners are refurbished/repared after-market parts; primary gas tips, casings, inner and outer crossfire tubes, and bullhorn brackets were new (at installation time).

Sulzer's Michael Andrepont describes the assembly of the combustor system "almost like an R&D project" because of the intensive testing, data analysis, and flow modeling which took place between Sulzer and TTS to ensure that the components were properly modified, assembled, installed and integrated with the new controls.

Sulzer is one of few shops with the capability to conduct combustor liner air flow testing required for this project in addition to fuel nozzle flow testing. To meet the NO_x and CO emissions targets, this type of liner flow testing capability is critical for meeting the design fuel-to-air ratio within the premixing zone of the combustor.

TTS' Mitch Cohen went deep on this point. "Fuel nozzles get flow-tested all the time, and all the repair shops have this capability. But the flow testing of liners we needed for this project required a test stand that can provide much larger flow volumes than required for fuel nozzles or standard liner flow testing." Cohen, a combustion engineer, began his career in the GE development lab. His intimate knowledge of GT combustion is captured in Combined Cycle Journal articles going back to the early 2000s.

He explained that, at the Sulzer shop, the liner sits in a test stand on a hole in the floor (Fig 2), beneath which is a fan sucking air through the cylinder. The outside surface of the liner is at atmospheric pressure; the inside of the liner is at negative pressure; a venturi-type flow meter measures the flow through the liner. Combustor liners have holes creating many flow paths. By opening



1. Combustion system hardware for the DLN-1 was procured from the open market, tested, analyzed, modified, and assembled to convert a 1987-vintage cogen CC plant into simple cycle peakers

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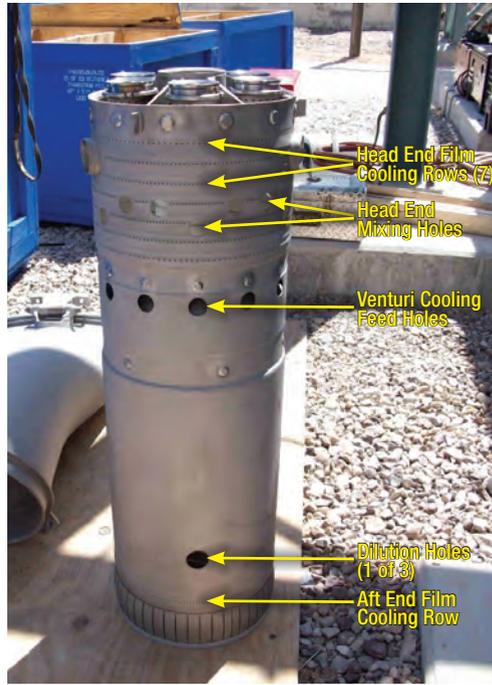
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2. Multiple air flow paths for the combustion liner (resting on the liner flow test stand in the Sulzer shop) were accurately measured to verify dimensions and/or make necessary modifications, especially the dilution holes, critical to minimizing NOx emissions

and closing different sets of holes, you can obtain the effective areas of each flow path, which then go into a combustion flow model. When fuel flows are added, the model predicts flow, pressure, and temperature distributions through the combustor, which, in turn, are used to predict NOx emissions.

Andrepoint added that the liner flow test stand is calibrated annually to an EPRI standard; thus measurements are accurate and repeatable. Unique “fake” end-cover assemblies allow measurement of leak-by as well, necessary for accurate total flow testing.

When you procure parts from multiple sources, you have to validate the dimensions of the holes and the flows through each, says Cohen, then put them together to verify that you have accurate primary and sec-

ondary air flows and therefore proper fuel/air ratios. But the dilution holes, three holes drilled at the aft end of the liner spaced 120 deg around the perimeter, are where you can adjust the NOx levels.

Much of the hardware came from APG, who supplied two sets of primary and secondary fuel nozzles, flow sleeves, transition pieces, outer combustion chambers, and installation hardware, plus one set of combustion liners. “We purchased two sets of combustors and liners from two sources. It turned out that the dilution holes in one set were way too big for this application. The fix was to reduce the hole size. Not only does the NOx level have to comply with the TEQC standard, but the combustor also has to handle seasonal variations and changes

arising from equipment degradation over time. So, really, you’re looking to achieve a NOx level less than 9 ppm.”

Flows through the venturi cooling holes also didn’t match up between the two liners so these had to be corrected as well. It turned out that the fuel nozzles’ effective areas from both sets were also too large, so TTS manufactured new primary nozzles because discharge holes are integral to the nozzle body and can’t be made smaller. APG was able to modify the secondary nozzles by cutting off the radial fuel injection pegs and welding on new pegs with smaller discharge holes.

Post flow test, APG pre-assembled combustion “stacks” in its combustion service center to verify fit-up, alignment, and clocking, reducing the risk of field rework during installation by TOPS.

Other hardware procured to complete the combustor system included igniters and flame detectors; primary, secondary, and transfer gas manifolds and pigtailed; fuel metering skirts to direct the fuel into the three lines (Fig 3) feeding the combustor (with TTS electric control valves); and a “purge credit” compliant valve configuration to eliminate the unit purge requirement for faster dispatch (Fig 4).

The obsolete Mark IV controls were replaced with a TTS redundant TMS-1000R turbine control system (Fig 5) built on the Allen-Bradley ControlLogix, PLC-based architecture, along with monitoring and protection I&C. Control of the remaining legacy balance-of-plant (BOP) systems and I/O needed to operate the plant in simple cycle were migrated from the obsolete Infi90 DCS and integrated into the ControlLogix system.

Other features of the control system work included:

- The obsolete generator control and protection panels (GCP) were upgraded.
- The existing DECS-400 digital excitation control system was retained and reinstalled in the new GCP. A new Schweitzer



3. Fuel feed to the GTs includes a hydraulic stop valve and three electric control valves



4. Valving arrangement to obtain the purge credit helps peaking GT facilities get dispatched quicker after shutdowns



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Nine months to reinvent 40-year-old turbines

The 7EA GTs with Speedtronic Mark IV controls were originally configured for dual-fuel base-load operation to facilitate the production of cogenerating steam from the HRSG/steam turbine bottoming cycle for an adjacent refinery (and for GT NOx control). Over the years, several GT hardware upgrades were made to increase the firing temperature from the 2020oF original design point to 2035oF.

After the steam host contract expired, the plant continued selling power. More recently, the liquid fuel system was decommissioned. Finally in 2023, owners faced an obsolete plant configuration, antiquated GT and plant controls (Bailey Infi 90), deteriorating equipment and HRSGs beyond their useful lives and leaking following the big Texas freeze. Yet the plant was still being regularly dispatched into the spot market. Owners assessed the continued viability of the facility, which presented two options: retire and sell equipment for scrap, or invest to convert to simple cycle and serve the spot market.

The owners chose the second option but had to work fast to ensure that they could take advantage of the 2024 peak season. Abiding by OEM shop schedules and costs for new equipment would not meet this requirement. A team of aftermarket services firms was assembled to tackle this challenge

and a fast-track solution was identified. Project engineering and procurement commenced mid-October 2023, with July 2024 the target for commercial operations. That meant less than nine months to obtain the new air permit (due to significant change in plant configuration); remove old equipment; conduct design and engineering; overhaul rotors; find, test, and assemble DLN-1 components handling 2035F firing temperature; and procure and install control system components! This target was met and unit commissioning was completed in July 2024 meeting its deadlines.

During commissioning of the modified GTs in July 2024, no re-tuning of the combustion hardware was required, confirming the accuracy of the modeling and component modifications. GTs met compliance NOx and CO levels.

Well into 2024, the site was reportedly operating up to the owner's expectations. One of the project team reported in mid November 2025 that the plant had run for four days straight (impressive for a set of peakers).

Open market sourcing of the combustor hardware is expected to have long-term economic advantages. Unrestricted by an LTSA, replacement parts can be competitively bid, reducing costs and adding flexibility to outage scheduling.

SEL-700G multifunction digital protection relay was provided to replace the original grouping of analog protection relays.

- An electrical protection study was undertaken to determine the correct digital protection relay settings for the new application.
- New performance instrumentation packages were installed on each GT.
- Unit performance analyses were undertaken to determine the new temperature control settings for a 2035F firing temperature.
- New reverse-osmosis (RO) water treatment control components, installed during the project by the owners, were integrated into the new BOP control system.

BEYOND THE COMBUSTOR

Doosan Turbomachinery Services' (DTS) contribution centered on rotor and hot-gas-path hardware work that had to be executed in parallel with the DLN-1 and controls scope. DTS was brought in by TOPS specifically for "rotor overhauls" on the two 7EAs, providing the heavy mechanical work needed to return aging machines to dependable service while the plant transitioned away

from its former combined-cycle configuration.

DTS's David Lawrence explained that the firm performed "full unstack" work on both turbine rotors and supplied new disks and spacers for the units. He added that one set of buckets had already been repaired previously, and Doosan removed, repaired, and reinstalled that set before the unit returned to service. Lawrence also attributed the decision to replace all disks to known "rock and lift" history on these machines, reflecting legacy peaker duty and wear consistent with fast-start operation over time.

Schedule support appears to be a differentiator in the DTS scope. Lawrence notes that Doosan had turbine wheels in stock or already in process anticipating upcoming 7EA fleet needs, and that shifting outage timing at another client allowed Doosan to reallocate disks among multiple rotors and remain the "lone supplier" of those components for the TOPS-led effort. Beyond the major rotor work, he cited additional repairs including second- and third-stage nozzle medium repairs with coating, load-coupling inspection and repair, and supplying rotor stands used for shipping the rotors back and forth.



5. New control hardware includes the generator/turbine control and protection panel, fuel gas skid control panel, and combustion system pressure ratio controls

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Building on recent fruitful conferences and increased fleet utilization, the FT8 Users Group and FT4 Users Group will convene at the EPRI Charlotte campus for a single, co-located three-day meeting designed to strengthen peer-to-peer problem solving for owner/operators and create structured touchpoints with OEMs and solution providers. Expect practical lessons learned, candid fleet discussions, and training focused on improving day-to-day operations and maintenance.

The group is supported by EPRI's Gas Turbine R&D organization, led by Bobby Noble, and its two complementary research programs, P216 and P217, aimed at improving fleet reliability and maintenance decisions for today's widely deployed machines while also reducing risk for advanced-class units and new technologies.

Day 1. End-user sessions center on peer exchange—what's working, what's not, and the highest-priority technical and O&M challenges across both fleets. Strategic Power Systems will share the latest fleet statistics, and Liburdi Turbine Services will provide an update on third-party repair solutions in development.

In the afternoon, FT8 users requested an extended OEM session with Mitsubishi Power Aero (MPA), building on a very constructive session in 2025 (details below), to align on recurring issues and practical paths forward. On the FT4 side, Sulzer Turbo Services will present the latest on MRO and service offerings for the fleet.

Day 2. Steering committee remarks and introductions set the stage for eight solution-provider presentations, highlighting practical case studies, repair/upgrade approaches, and field lessons learned intended to be directly applicable for O&M teams—spanning the turbine, generator, controls, and emissions systems.

In the evening, twenty-four aero-focused vendors will be available from 4:00–7:00 pm for deeper one-on-one discussions following a full day of technical content (see sponsor and exhibitor logos for the full roster).

Day 3. End-user closing sessions consolidate key takeaways, align on next steps,

and capture open items for follow-up—then transition into operator-focused training designed to strengthen execution for both new and experienced personnel. This year, Karel de Nave (KDN Global Gas Turbine Support) and Camfil Power Systems will lead the training program.

KDN will cover FT8/FT4 collector box (CB) alignment, emphasizing correct positioning and measurement checks to accommodate thermal distortion and clearances. The session will address how improper alignment can contribute to casing distortion, rubs, abnormal bearing/rotor loading, and—at the extreme—structural bending or engine damage.

Camfil Power Systems will cover how air-inlet filtration and inlet-system design affect turbomachinery performance, with practical guidance to optimize output while reducing operational risk and improving asset availability, reliability, and profitability.

A shop tour at Liburdi Turbine Services will round out the meeting with a hands-on look at repair processes and practices, tying technical sessions to real-world execution.

Register now. End users can register at no cost. If you operate FT8 and/or FT4 assets, this is the best three-day window of the year to compare notes with peers, pressure-test maintenance and upgrade plans, and leave with ideas you can implement immediately. Register at ft8users.com and ft4users.com.

FT8 2025

User Session

In the closed-door end-user session to kick off the conference, operators compared recurring equipment issues and subsequent fixes. The discussion stayed practical, centering on start reliability, control and hydraulic system weaknesses, maintenance-driven HSE risks, and persistent frustration with limited post-event root-cause transparency. Several participants also pushed for better knowledge capture so future troubleshooting threads documented final fixes, not just theories.

Gas-start light-off reliability. Multiple users reported startup issues on gas, with “failure to light off” treated as a recurring pattern across more than one engine. Troubleshooting themes included:

- Verifying ignition health and gas control-valve response
- Reviewing start permissives and valve-position logic that could be too conservative or too aggressive at initial fuel admission

One operator reported improved outcomes after adjusting the initial valve opening setpoint upward and pairing it with ramp-rate and temperature-based logic refinements, implying that start tuning, not just hardware condition, influenced repeatability.

Start system “not coming up to speed.” A shared example described a unit that would not accelerate, where early suspicion centered on hydraulics, but the ultimate cause was electrical, linked to soft-starter behavior. The takeaway was to include electrical checks earlier in the diagnostic sequence to avoid wasted outage time.

“Yellow dust” and hexavalent chromium. Users discussed a bulletin addressing yellow dust and potential hexavalent chromium exposure, with questions on:

- Appropriate field test methods and sampling practices.
- Mitigation steps during maintenance.
- Documentation and disposal expectations.

Several referenced field test kits and abatement or neutralizing spray as practical measures, while noting uncertainty about how far the mitigation needed to go to satisfy environmental and safety requirements.

Hydraulic and control-system stability. Participants reported accumulator bladder degradation and downstream impacts, including contamination near servo pump intake areas and operational instability. Pressure control and “normal” operating targets were debated, including a field example describing wide pressure swings and improvement after adjusting system pressure toward a stated normal value.

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2026 Steering Committees

FT8

Ramiro Gonzalez, O&M support manager,
Middle River Power
Ahmed Ibrahim, director of operations,
Middle River Power
Reid Cashion, plant engineer,
North Carolina Electric Cooperatives
George Shambo, plant manager,
NVEnergy
Richard Carter, director,
Global Turbine Support

FT4

Jeff Drury, plant supervisor,
City of Higginsville
Preston Walsh, generation manager,
Great River Energy
Casey Johnson, operations manager,
Chillicothe Municipal Utilities
Matt Deely, sales manager,
Sulzer Turbo Services

Servo component refurbishment. Users discussed refurbishment pathways for IGV/DSV-related servo hardware, including the view that magnetic performance could degrade over time and that some third-party services could re-magnetize and re-validate components. Participants noted that repair

feasibility still depended on mechanical condition and parts availability.

Mechanical alignment and hot-section interface distress. A technical exchange highlighted how collector box to diffuser alignment and restraint conditions could contribute to binding during thermal growth, raising the risk of accelerated seal wear and localized distress.

A field approach was described that combined measurement during outage work with targeted modification of restraint or alignment features to reduce binding and improve repeatability.

Varnish risk. Users compared operating practices, including “sync and idle,” and related them to oil condition management. One participant described rapid varnish formation under certain ambient conditions with some approved oils, with better experience reported after switching products, reinforcing the need to match lubricant selection and conditioning practices to the unit’s operating environment.

Information flow, shop access, transparency. Operators expressed concern about the difficulty of obtaining detailed root-cause documentation raising this collectively through the user group.

Separate comments described tighter controls on facility access and suggested that cleared third parties could help provide oversight and better reporting back to own-

ers.

Problem solved? A very active discussion forum exists for problem solving and parts sharing a forum.ft8users.com, but this great resource is only as good as the information entered. A recurring theme was that troubleshooting discussions often accumulated ideas without documenting final outcomes. Users advocated:

- Better categorization by system
- Volunteers to help close out threads with verified fixes and contributing factors
- In short, close the loop

OEM Session

MPA’s session with the FT8 Users Group was structured less like a slide presentation and more like a working discussion on where support processes had helped and where users had wanted faster, more consistent outcomes. MPA representatives Adeel Raza, Lex Poth, Bob Yanko emphasized open dialogue, follow-through after the meeting, and clearer internal handoffs between customer support, aftermarket, and engineering so user requests did not stall.

Open dialogue. MPA framed its participation as a way to surface “blind spots” that had not always made it through normal channels and to keep OEM development aligned with real operating pain points. The message was that user-group feedback helped the OEM prioritize fixes, upgrades,



25 Litre
Can
6.6
US Gallons



210 Litre
Drum
55.5
US Gallons



1,000 Litre
IBC
264
US Gallons



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pH
7.2 - 7.5

Specific Gravity
1.01

Corrosion Inhibitor
Yes

Total Alkali Metals
After Dilution
< 0.5 ppm



pH
8.0 - 8.5

Specific Gravity
1.00

Corrosion Inhibitor
No

Total Alkali Metals
After Dilution
< 4 ppm

and future hardware and software changes, rather than learning years later that owner/operators had migrated to alternate solutions and vendors.

MPA also pushed for a two-way accountability model: users were encouraged to escalate when answers felt incomplete, and MPA committed to bringing engineering into discussions when needed, even if it meant taking action items offline and returning with a better response.

Escalation to engineering. A recurring theme was that some technical requests had been “lost in translation” or stuck in an internal handoff, particularly when the initial request entered through non-engineering routes. MPA suggested users ask for engineering participation when a response did not square with site conditions, and it said those calls also improved the aftermarket team’s ability to translate problems and solutions.

MPA also closed with a call for scheduled follow-ups in the weeks after the meeting, using customer support managers and engineering resources to review site-specific issues, budgets, and alternatives.

Lead times. Users pressed MPA on what they described as long lead times and slow RFP response cycles. MPA acknowledged that lead time inflation had extended beyond any single OEM but said it had been working to improve forecasting, increase material on shelves, and better align stocking decisions with what had failed most often in the field.

MPA also invited users to share intelli-

gence on reputable vendors with inventory that might have been leveraged to shorten downtime. The company described expanding repair pathways, qualifying multiple repair vendors, and prioritizing a “pain list” of parts that most impacted availability, while noting that prioritization was only effective if the OEM understood which parts were hurting the fleet.

Staffing and third-party support. One question focused on whether MPA planned to expand application engineering capacity or integrate third-party control expertise similar to other OEM approaches. MPA said it had added capability, including bringing in at least one person from Woodward, but noted that repeated rework cycles could occur when requests changed from one case to the next and the technical framing was inconsistent. The company asked users to help by providing clearer definitions of the work so requests could be executed faster.

RCAs. A major owner/operator concern was the lack of a predictable root-cause analysis (RCA) deliverable when components were sent in for repair. Users described a gap between receiving a shop report and receiving a true causal explanation with recommended preventive actions, especially when fleet-wide risk management and insurers had asked for answers.

MPA responded that it had been building a more consistent approach, including documenting analyses more systematically and engaging engineering resources focused on fleet issues. The session referenced a known

FT8 fleet issue, an inner sidewall burn concern, and a fix involving added cooling and chamfers, presented as an example of problem recognition and corrective action. MPA’s position was that an RCA process had existed but had not been consistently communicated or triggered through normal workflows, and that improving that trigger mechanism had been part of the needed change.

Engineering support. Users also raised the broader question of when technical sup-



HPI Energy. Controls retrofits are becoming more common as the FT8 fleet ages and legacy systems become obsolete. At Klamath Falls, two Twin Pak units replaced Netcon 5000 with an ABB platform, updating core sequencing and protection logic for long-term operability

SCHOCK Retrofit Systems

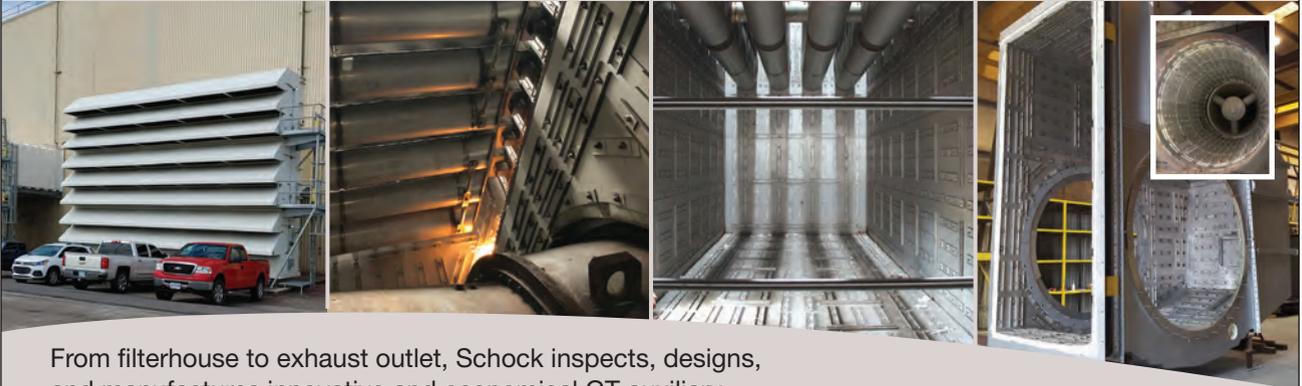
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port became billable work. MPA's response was that not every assist should have been charged, particularly when it was part of OEM responsibility to develop solutions, but that extended engineering effort tied to a defined proposal could have required billing transparency tied to tangible deliverables. The company emphasized working collaboratively on troubleshooting and maintenance issues and differentiating that from new development work.

Component reliability updates. Late in the session, MPA discussed ongoing work on component reliability, including reference to an EGT-probe topic that had gained traction internally. MPA reported field experience with a probe configuration operating without failures at at least one site, and it indicated an updated design had been expected within roughly six months, while cautioning against declaring victory prematurely.

MPA also offered to analyze failed probes at no cost and provide an RCA-style report of findings, while acknowledging limits in taking responsibility for third-party probe designs. The company described a replacement posture in which probes purchased from MPA that failed within a year could have been replaced free of charge, subject to the stated terms discussed in the meeting.

Steps forward. MPA's FT8 Users Group session highlighted a set of actionable themes many fleets recognized:

- Escalation was most effective when

users requested engineering participation early, especially when responses did not match site conditions

- Parts pain needed to be visible and specific, including high-impact items and lead-time failures, so OEM stocking and repair prioritization matched fleet reality
- A usable RCA deliverable, not only a shop summary, mattered for fleet prevention and insurer questions, and expectations had to be aligned on what was included versus billable engineering scope
- The user group plans to trigger ongoing follow-up actions, not just a once-a-year forum, with defined next steps routed through customer support management and engineering

Solutions Providers

FT8 market overview: ORAP data

Tom Christiansen, Strategic Power Systems

The fleet overview came with important caveats about representativeness. With 400+ FT8 units in operation, the ORAP dataset reflects only the units that chose (and were able) to report—so a single major forced outage, extended maintenance outage, or control-upgrade campaign at one site can materially skew year-to-year trends in a sample this size.

Using the SPS ORAP database—an inde-

pendent, IEEE 762-compliant RAM dataset built from monthly unit reporting—the presenter summarized a 2015–2024 simple-cycle FT8 sample totaling about 508 unit-years. The population was ~80% US-based, and 48 FT8 units were actively contributing at the time of the review. He emphasized that *broader participation* would improve confidence in the trends and encouraged attendees to enroll in ORAP at no cost.

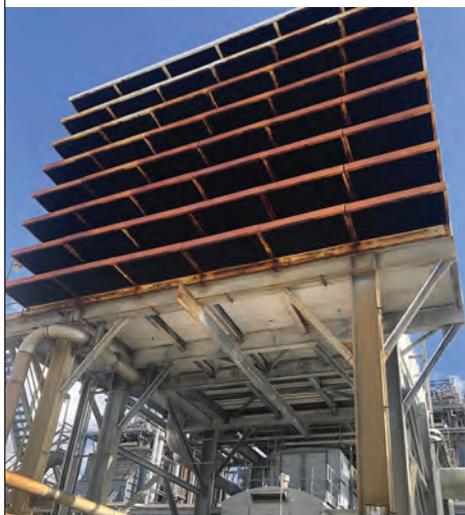
Within those limits, the reported operating profile looked predominantly peaking: average service factor declined from just under 10% (2015) to about 3% (2024), with starts also trending down to roughly 63/year, while mission time held near four hours per start.

Reliability averaged about 94% over the decade and ran near 97% over the last three years, with a notable 2021 dip attributed to multiple contributors rather than any single root cause. Availability averaged 86.5% over 2015–2024 and rose to about 94% in 2024, while 2023 results reflected downtime associated with control-system upgrades.

Forced-outage downtime hours were dominated by the engine (~64%) and balance-of-plant (~32%), and starting reliability remained above 99% (often ≥99.5%), comparing favorably with broader peaking aeroderivative fleets.

FT8 controls upgrade from Netcon 5000 to ABB

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Wayne Tomlinson, HPI Energy Services

This intriguing case study described a controls modernization project for two FT8 Twin Pak generator sets at Klamath Falls, where an obsolete Woodward Netcon 5000 control system was upgraded to an ABB control platform. The work was framed as a software and integration challenge as much as a hardware changeout, because much of the existing logic was not accessible and documentation was limited.

The HPI team developed and implemented new sequencer and governor functional-

ity on the ABB hardware while reverse-engineering operational behavior from the installed system, which required building more complex governor code with limited visibility into legacy configuration. The solution also integrated high-speed stall detection using a Rockwell ControlLogix PLC, plus bleed and variable geometry control using Woodward SPC (servo positioner controllers).

Additional balance-of-plant control elements included anti-surge bleed-air control and thrust-balance system control, intended to preserve stable compressor operation and protect rotating hardware during transients. The Klamath case was presented as an example of combining multiple control platforms and specialty functions into a cohesive FT8 package control architecture while managing obsolescence risk and maintaining operational reliability.

Aeroderivative airfoil repair options and best practices

Robert Tollett, Liburdi Turbine Services

Keeping with the spirit of finding alternatives and developing solutions for the FT8 users, Tollett focused the presentation and discussion on extending FT8/GG8 hot-section component life by combining inspection, dimensional restoration, and tailored coatings and heat-treatment, rather than defaulting to replacement.

The repair scope covered gas-path hardware such as turbine blades and vanes, seal

segments, combustor cans, and nozzles, with parts typically removed by an overhaul shop and shipped to a specialized repair vendor for processing.

For FT8/GG8 hardware, the workflow emphasized early intervention so internal and external coatings could be stripped, base material condition verified, and geometry restored before damage became non-repairable. Tollett framed the business around supply-chain constraints and cost: repairs commonly ran about 10%–30% of new-part cost resulting in significant cost savings.

Component-specific examples included GG8 stage 2 turbine blade repair development and GG8 stage 1 vane damage investigations. In the vane case, metallography indicated high-temperature oxidation in a cobalt-based vane alloy and recommended selection of more oxidation-resistant repair and coating systems. The FT8/GG8 services list also included dual-fuel fuel-nozzle work and combustion-chamber repairs. Needless to say, the end users in attendance were filled with intrigue on these developments.

Catalyst cleaning

Matt Cohen, Groome Industrial Service Group

Cohen reviewed how SCR and CO catalyst systems in FT8 applications lost performance when flow, temperature, or reagent distribution became non-uniform, and how targeted maintenance restored conversion



Liburdi. Dual-fuel nozzle repair is a leading, practical option to extend FT8/GG8 hot-section component life



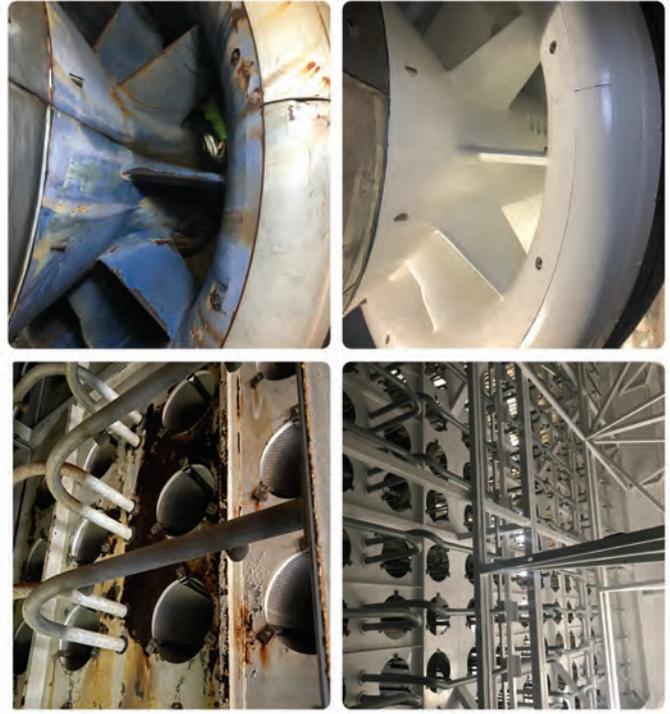
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while controlling backpressure. Key contributors to degraded catalyst effectiveness were described as poisoning (for example alkali and alkaline earth compounds), fouling by dust and fly ash, thermal phase change, moisture exposure on susceptible catalyst types, and mechanical issues such as damaged seals, insulation blockages, and ammonia control problems.

A structured catalyst maintenance program was outlined around inspection and testing, cleaning interventions, and follow-up verification using operating data and differential-pressure trending. For SCRs, the discussion emphasized vacuuming and regulated-air cleaning to remove masking and plugging, plus repacking and restacking to preserve a uniform face and limit bypass that could drive conversion loss and structural damage.

For CO catalyst, acid washing and regas-



Grome. A "full SCR system analysis" pairs catalyst test results with plant operating data and on-site inspection to separate true catalyst deterioration from upstream system issues

keting were presented as options to reduce backpressure, improve conversion uniformity, and extend catalyst life. Ammonia injection grid (AIG) reliability was tied to lance, header, and vaporizer cleaning, followed by tuning using permanent sampling grids to map maldistribution by zone and confirm improvements.

Monitor bearing health with confidence
Simon Wilson, GasTops

Wilson explained why traditional bearing damage indicators in aeroderivative packages often provided little usable pre-warning, and why missed or false events could drive forced-outage hours and costly secondary damage. He reviewed the progressive nature of bearing surface fatigue and noted that debris generation rate depended on load and speed, while particle counts correlated to damaged area and particle-size distribution remained largely independent of bearing size.

Condition-monitoring theory was framed around shifting from reactive detection (seconds to minutes) to proactive protection (days to months), enabling maintenance planning inside the P-F interval. The talk then described an in-line oil-debris monitoring approach that measured metallic particles in a flow-through sensor before filtration, distinguishing ferrous and non-ferrous signatures and trending cumulative debris, composition, and size profile to support "safe to operate" and remaining-life estimates.

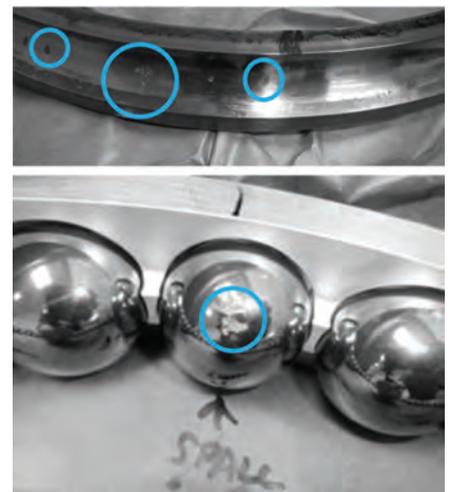
Configuration options were outlined for multi-sensor installations on scavenge returns (including inside an FT8 package) or a single-sensor approach on a common scavenge return, with electronics located outside the package. Case examples cited multi-day

planning windows ahead of a power-turbine bearing event, reduced production loss by scheduling around low-demand periods, and avoided secondary damage through controlled operation.

Controls obsolescence and new products

Matthew Ryan, Woodward

The session reviewed lifecycle support considerations for FT8 control-system and fuel-system components, with emphasis on planning maintenance to avoid forced outages. It described why overhauling control hardware in advance of repair reduced operational risk by converting high-cost, unplanned events into scheduled work with re-



GasTops. Online oil-debris monitoring flags bearing damage earlier than vibration, temperature, or chip detectors helping to avoid secondary damage and trips, stage replacement hardware, and reduce production losses

Cartridge filter solutions for turbomachinery



served capacity and parts, and by returning assemblies to “zero-hour” condition through replacement of wear items such as seals, bearings, and gaskets.

Recommended overhaul intervals were aligned to turbine OEM schedules, cited as 50,000 hours or six years, and contrasted with run-to-failure outcomes that typically carried higher outage cost.

Ryan also summarized recent control-system obsolescence history, noting the end

of regular production for LON LinkNet in April 2015 and its replacement by LINKnet-HT modules with higher I/O density and environmental robustness. LINKnet-HT capabilities highlighted included a wide ambient temperature range (-40 to 100C), high vibration tolerance (8.2 Grms), shock rating (40G), improved isolation, and options for redundant CAN communication.

Fuel-system lifecycle risk was addressed through the 3103 fuel-metering valve support timeline and the transition path to GS40/50 hardware and service tooling connectivity.

MeeFog means more power

Thomas Mee, Mee Industries

In today’s world, the thirst for megawatts is seemingly unquenchable, making a very appealing business case for high-pressure fogging and wet compression. The company namesake highlighted applications to increase FT8 output during hot-day conditions by reducing inlet air temperature and increasing inlet mass flow.

Mee described system architecture built around staged nozzle manifolds and distribution lines designed for even fog coverage across the inlet, with vibration analysis used to verify mechanical integrity of nozzle-line assemblies under operating conditions. Droplet-size control was positioned as a key technical variable, with examples comparing nozzle configurations and highlighting that

larger droplets (greater than about 60 microns) increased the risk of non-evaporated carryover, while appropriately sized droplets supported effective evaporative cooling and stable wet compression.

A performance example for an FT8 in Midwest summer conditions quantified incremental power gains from evaporative fogging and additional gains from wet compression at higher water flow, illustrating how the same package could be operated at different injection rates depending on ambient wet-bulb limits and desired output uplift.

He closed with fleet experience counts for FT8 and FT4 installations using evaporative fogging and wet compression, emphasizing the importance of nozzle staging and distribution verification to maintain repeatable performance across units.

Key elements of generator life extension

Howard Moudy, National Electric Coil

The esteemed generator professor outlined a practical framework for extending large generator life by combining early planning, specification discipline, and component qualification. Moudy emphasized that specifications worked best when they defined measurable performance requirements and acceptance criteria, and when they aligned with commercial RFQ documents without becoming “everything but the kitchen sink.”



Woodward. With the planned obsolescence of the 3103 fuel metering valve, Woodward recommends the GS40/50 family as the replacement, designed for flange-to-flange compatibility with the 3103 to simplify installation and incorporate modern enhancements.

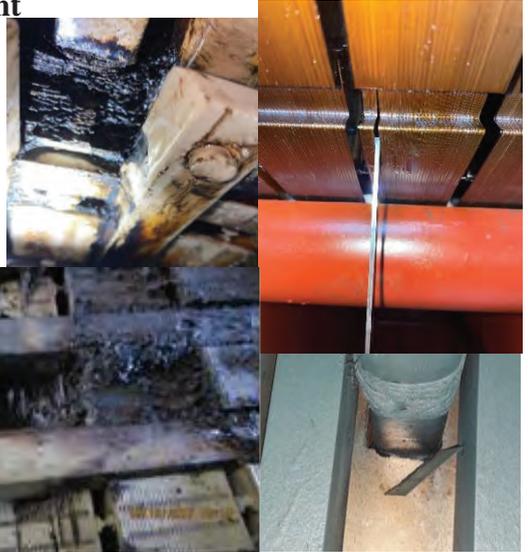
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He then rolled into rotor life-extension topics focusing on risk controls during handling and transport, using a transit loading example to show how improper timbering and restraint geometry could allow rotor movement and create avoidable damage. Technical drivers for rotor refurbishment were tied to conductor condition, including cracking, fatigue distortion, compression, dusting, and joint quality, with cycling identified as a primary stressor for machines originally designed for baseload duty but later operated cyclically.

Qualification methods for continued use were described through a suite of NDT techniques (UT, MPT, ECT, DPT) plus hardness and geometry checks. The rotor high-speed balance process was reviewed step-by-step, including TIR checks, balancing through critical speeds, a 10% overspeed hold, and repeat mechanical and electrical testing across the operating range.

Moudy closed with stator discussions highlighting core testing using EICid and loop tests, and winding-manufacturing choices, comparing insulation-process consistency, loss optimization (I²R, eddy, circulating currents), and 100% final test verification.

GT filter selection optimization Jerod Walters, Camfil Power Systems

The experienced applications engineer positioned inlet-air filtration as a practical lever to protect turbomachinery capacity,

efficiency, and availability, and emphasized a structured, measurement-based approach supported by warranties and field validation. Walters said that after COVID-era supply disruptions the company shifted manufacturing back to North America, stating that about 99% of products were made in North America, with most of that in the US.

The approach began with site alignment, considering seasonal and local environmental conditions, turbine duty cycle and application, maintenance intervals, and the economic value of performance. Tools intended to quantify real site conditions include an ambient mapping capability and an inlet measurement device to track particulate loading, differential pressure by stage, and projected impacts over operating hours. For side-by-side validation, the CamLab is available as an on-site, multi-filter comparison setup that could be run as a blinded test against competing products under the plant's actual conditions.

Camfil also highlighted life-cycle cost modeling that separates filter purchase cost from pressure-drop penalties, soiling-related losses, downtime risk, and fuel and CO₂ implications. Walters also referenced the ISO 29461 turbomachinery inlet filtration standard series covering performance, endurance in fog or mist, and mechanical integrity.

FT8 overhaul workflow

Robert Vandenaabee, Baseload Power

The presentation summarized an FT8 ma-



Baseload Power. Dirty stator end windings (top) before cleaning, Positron cleaning (center) to remove contamination from copper and insulation, and re-insulation (bottom) to restore dielectric integrity ahead of reassembly and rotor installation

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Product Experience Chart

Customer History

OEM	Fog Systems Installed	Wet Compression
Ansaldo	8	4
GE	802	220
Hitachi	4	1
Kawasaki	4	0
Mitsubishi	50	7
Mitsubishi Aero	106	64
Siemens	148	64
Solar	12	1
Total	1134	361



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for inspection and overhaul workflow, from package access through generator and excitation repairs, and tied it to facility capabilities needed to execute heavy maintenance safely and repeatably. The overhaul process was described as starting with roof removal and engine lift preparation, followed by power-turbine (PT) removal and staging for rotor extraction.

The rotor was then pulled and transferred for cleaning and refurbishment steps, including stator cleaning, removal of heavy contamination (“dirty stator” condition), and positron cleaning.

Electrical restoration work was described

as including reinsulation prior to reassembly, with the rotor shown “ready” before reinsertion and final alignment activities. The closeout scope highlighted PT shaft alignment as a critical step to protect bearings and avoid repeat vibration issues after reassembly.

Vandenabeele also covered support work on excitation and controls, including AVR A30 repair using a test rig and decision logic to repair or replace control cards, monitor cards, and auxiliary boards. Parts readiness was emphasized with examples of consumables and spares such as shaft seals, hoses, RTDs, heaters, gaskets, fuses, diodes, lube-

oil pumps, and spare bearing-exciter components.

Introduction to rotor dynamics

Robert Hopwood, HPI Energy Services

It was difficult not to learn a lot during this extended primer presentation, which explained rotor dynamics as the study of vibration behavior and stability in rotating machinery, with emphasis on high-speed gas-turbine applications where imbalance, misalignment, resonance, and instability mechanisms could rapidly escalate risk.

Hopwood reviewed how vibration analysis supported both diagnosis (what mechanism drove vibration) and prognosis (how severe it was and how long it might remain acceptable), extending time to failure and reducing cost through condition-based intervention. Core measurement concepts were summarized, including amplitude (peak, peak-to-peak, RMS), frequency in Hz or cpm, and the practical use of displacement, velocity, and acceleration as complementary indicators across different frequency ranges.

The rotating equipment engineer described how FFT-based spectrum analysis decomposed complex waveforms into discrete frequency components, enabling identification of 1X running-speed vibration, harmonics, and sub-synchronous or super-synchronous content. Multiple visualization tools were discussed, including trend plots, spectra and cascades, orbits, shaft centerline plots, Bode plots, and polar (Nyquist) plots, each used to validate critical speeds, damping, rub behavior, and structural resonance.

Sensor selection and mounting were presented as determinative for data quality, comparing prox probes, velocity transducers, and accelerometers, and highlighting keyphasor reference for speed and phase.

He closed with practical troubleshooting guidance focused on separating real machine behavior from bad data, recognizing signatures of unbalance, misalignment, oil whirl, rubs, bearing and gear distress, combustion-driven vibration, and resonance, and applying balancing best practices (trial weights, phase convention control, and linearity assumptions) to achieve stable corrections. [CCJ](#)



Brazil hosts first HRSG Forum América Latina as flexibility pressures rise



The first annual HRSG Forum América Latina was held September 22-24, 2025, at Blue Tree Premium Morumbi, São Paulo, Brazil under the guidance of the newly formed steering committee consisting of:

- Júlio Paulin, Petróleo Brasileiro S.A
- Luiz Cortez, Âmbar Energia
- Willians Nunes, Eneva
- Luiz Felipe, ENPERA Assessoria Empresarial Ltda

This inaugural event focused on issues and concerns related to heat recovery steam generators, gas and steam turbines and combined-cycle system operations. More than 100 registrants attended representing 10 countries and included owner/operators, international technical consultants, and premier OEM and equipment service providers.

Presenting sponsors included Alutal, Arnold Group, Dekomte, GE Vernova, HRST, NEM Energy, Precision Iceblast, Tuff Tube Transition, ValvTechnologies and Vogt Power.

Bob Anderson (Competitive Power) and Barry Dooley (Structural Integrity) moderated the event.

This Latin America event, conducted in English, is now part of the annual user group HRSG conferences and technical discussions that take place globally:

- HRSG Forum (US).
- European HRSG Forum.
- Australasian Boiler and HRSG Forum.
- HRSG Forum América Latina.

BRAZIL

The Federative Republic of Brazil is the largest country in South America with a population of more than 200 million. São Paulo is the most populous city. Brazil's monthly grid load has increased steadily and in February 2025, exceeded 106 GW.

Generation capacity, explained by Julio Paulin, Petrobras, is a mix of approximately 56 percent hydroelectric, 17 percent wind, 17 percent thermal, 9 percent solar, and 1 percent nuclear.

Paulin was on hand to address *Flexible operation impacts on HRSGs and boilers*.

"With this capacity mix, operating outside the thermal optimal point is becoming

routine," he said. "Our big question is, what is the cumulative impact on the lifespan of HRSGs and boilers" and "are we sacrificing reliability in the name of flexibility?" Operating many plants originally designed for base load, Brazil is sharing in these global industry concerns.

"Thermal cycling and fatigue are the hidden costs of this flexibility," he explained. "Frequent startups and shutdowns increase the impacts on equipment integrity and raise questions about current maintenance models," he stated.

Brazil's Ministry of Mines and Energy has programs in place to enhance overall grid stability and integrate renewables. Paulin said, "The new Regulatory Dispatch Capacity Reserve Auction [in Brazil] demands fast and flexible response" which might not align with the physical limits of these HRSGs. So the questions become: "Is there room for dialogue between engineering and regulation," and "can we bring technical evidence to influence energy policy decisions?"

His discussion again raised global industry concerns with existing equipment, adapting assets without compromising safety and performance and implementing retrofit solutions for the long term. Participant thoughts and comments amongst stakeholders, solutions providers, OEMs, and consultants followed as the importance of this collaboration became apparent.

COMMON GLOBAL ISSUES

Luiz Fernando Cortez, Âmbar Energia (Brazil), presented *Long- and short-term layup for flexible operations*. His case study was the 470 MW Araucária combined cycle power plant with two Siemens SGT6-5000F 160 MW gas turbines, two Aalborg HP-LP HRSGs and one Alstom DKZ2 steam turbine.

He covered corrosion rates and estimated tube wall loss under both dehumidified and non-dehumidified scenarios. He also explained preservation strategies and shutdown preparation for both dry and wet layup. In addition, he explained a currently-used gas-side dehumidification system, and a steam turbine and condenser dehumidification system in detail.

The current preservation strategies, he continued, have both advantages and dis-

advantages. While the strategies maintain equipment in ready-to-start condition and reduce corrosion risks, nitrogen and water leakages affect preservation quality. Disadvantages also include the high cost of bulk liquid nitrogen, electric power consumption for dehumidification, and the general safety risks of using nitrogen.

He ended with a look at alternative preservation methods including chemical treatment during long-term layup (oxygen scavenger), dry preservation with compressed air, use of vapor-phase corrosion inhibitors, and an ongoing evaluation of film-forming substances.

Oxides: In an earlier presentation, Cortez discussed *Oxide growth and exfoliation in HRSGs*. He repeated the global issues of base-load-designed units being forced into cycling and fast load changes.



1. Example of exfoliation damage



2. Solid particles accumulation on HP steam turbine stop valve strainer basket

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- Casing and Insulation Repairs

Cortez offered historical reviews and current understandings of oxide growth and exfoliation (OGE) for both HRSGs and steam turbines (Figs 1 and 2).

He offered a six-point overview:

1. Oxide formation: Long-term high temperature plus dissolved oxygen lead to growth of multiple layers of magnetite and hematite.
2. Thermal impact: Each oxide has a distinct thermal expansion coefficient, and repeated heating/cooling create thermal stresses.
3. Microcrack initiation: Stresses accumulate and break oxide/metal interfaces. The oxide layer gradually loses adhesion.
4. Detachment and transport: Fragments break off and are carried by steam flow. Particles travel through the main steam lines.
5. System consequences: Impacts include tube and drain blockages, deposition and wear on valves, and erosion of HP/IP turbine blades.



3. Evaporator tube removed for hydrogen damage and under-deposit corrosion

6. Progressive degradation: Fresh metal surfaces are exposed to new oxidation. Repetition accelerates failures and reduces system reliability.

He offered a detailed review of the three oxides association with OGE:

- Magnetite (Fe₃O₄).
- Hematite (Fe₂O₃).
- Iron-chromium spinel [(Fe, Cr, Ni)₃O₄].

Ivan Jimenez, Orygen (Peru), offered a *Case study of hydrogen damage and under-deposit corrosion* for the 480 MW Ventanilla Combined Cycle Power Plant in Lima, Peru. The plant features two Siemens SGT6 gas turbines, two Vogt/NEM HRSGs and one

Siemens steam turbine, operational since 2006.

In 2016, increases in makeup water were detected and inspections revealed widespread tube failures in an HRSG HP evaporator.

The area was in the first module of the evaporator, consisting of two rows of tubes, 92 tubes in each row. Two-thirds of the failures were in the lower section of the HRSG (elevations below 2.5 m/8 ft).

Tubes were removed and laboratory root cause analysis began (Fig 3).

As Jimenez explained, "Hydrogen damage represents one of the characteristic



4. Termorio vertical-path HRSGs, Rio de Janeiro, Brazil

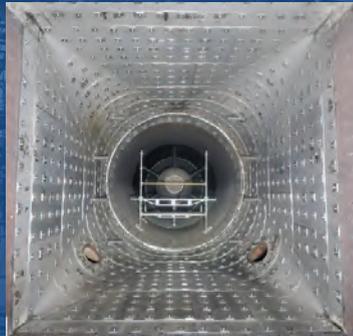
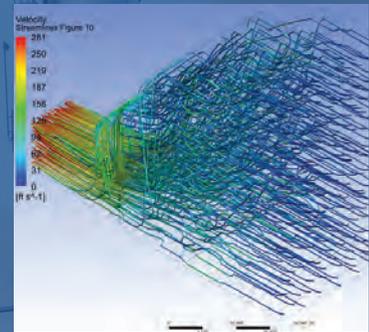
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mechanisms of under-deposit corrosion.” “The second factor,” he continued, “is the presence of chlorides within the internal deposits.”

He then discussed chemical cleaning and installation of a new evaporator module.

He ended with seven recommendations:

1. Duct burner use is a critical factor. It is essential to verify burner condition and performance.
2. Install and maintain reliable temperature monitoring systems; watch for thermal peaks and temperature differentials at critical locations.
3. Thermal load limits: Thermal overloading significantly increases the risk of failures. Strictly comply with OEM-defined limitations.
4. Apply cycle chemistry guidelines without exception, including monitoring.
5. Adopt proven methods for layup.



5. Casing failure at Termorio

6. Plan for cleaning. Action is required before a problem escalates.

7. Periodic and predictive monitoring should include wall thickness measurements in critical piping. Anticipate failures.

Julio Paulin returned to discuss *Issues with vertical HRSGs*. He first compared vertical and horizontal gas path designs.

For vertical, he discussed two power plants: Termobahia and Termorio, both commissioned in 2004 with John Cockerill/CMI HRSGs designed for base load (Fig 4).

Casing failures (Fig 5) became apparent in 2014.

The inlet duct insulation also suffered multiple failures. He also discussed possible duct burner influences.

His final thoughts included:

- There are fewer studies and publications available for vertical HRSGs.
- John Cockerill/CMI has an active support team and is currently conducting remaining life assessments on the HRSGs.
- Burner issues were considered to have a minor influence on casing failures.
- Night-shift thermography remains the most effective method for detecting flue gas leaks.

Daniel Kadylak, Vogt Power, presented a *HP drum replacement* project in Chile in late 2024, reviewing startup and shutdown thermal gradient and stress data. Drum nozzle crack depths were reviewed in detail, leading to a discussion of stronger materials and thinner drums. The drum had been in

service since 1997 (27 years).

In this replacement case, for example, drum wall thickness changed from 5 in. to 3.5 in. and drum weight changed from 265,000 lb to 170,000 lb. See Fig. 6. Nozzle connections were also improved.

ASME Section 1 Code requirements (2025 vs. 1995) were reviewed.

Leandro de Souza Schiara, Petrobras/Unesp (Brazil), discussed *Remaining life assessment of HRSGs operating in cycle conditions: thermal fatigue*.

He discussed a cooperative analysis by Petrobras and São Paulo State University that targets “quantitative remaining life assessment of some critical components of a three-pressure horizontal gas path HRSG in an attempt to withstand many start/stop cycles, reviewing the main damage mechanisms in cyclic operation. Numerous model-



6. Replacement drum with thinner walls and reduced weight

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Finding better ways to inspect them so they stay in running order is ours.



Through Fin Tube Scanning for Wall Thinning



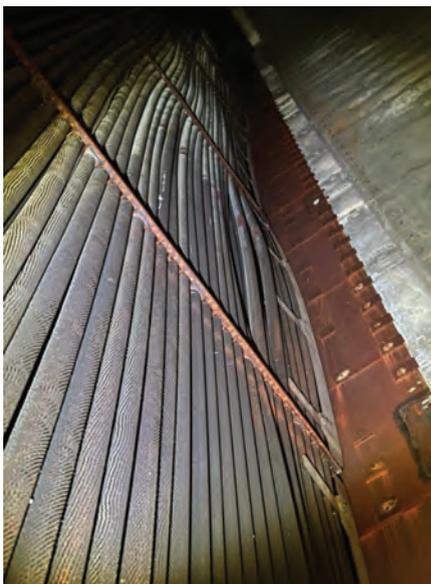
Tube to Header Weld Examination for Cracking



Internal Inspection, Collecting Tube Video & Measuring Wall Loss



Better Tools,
Better Inspections,
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7. Wave-like tube deformation likely resulting from severe thermal shock at commissioning

ing specifics were presented for all critical components. He ended with a note that “life management must consider a holistic approach including operation, maintenance, inspection, and specific calculations.”

Luiz Felipe, ENPERA Assessoria Empresarial (Brazil), offered *The practical application of FMEA (failure mode and effects*

analysis) for boilers.

As he explained, FMEA is “a key step in implementing Reliability Centered Maintenance.” It is a “simple tool to quantify what you know and assemble it in a logical manner.” By doing so, owner/operators can be proactive, and can develop “dramatic improvements in maintenance plans” and ensure proper plan execution.

He offered specific examples based on boiler tube failure histories leading to discussions of thermal fatigue, flow-accelerated corrosion, and overheating with a strong focus on safety.

Willians Nunes, Eneva (Brazil), highlighted *HRSG performance issues on commissioning* which showed how quickly HRSG thermal and flow imbalances can damage pressure parts (Fig 7).

Sharing experience, Nunes discussed commissioning issues of a 1 x 1 plant with GE 7FA.04 gas turbine, operational since 2013, converted to combined cycle with Nooter/Eriksen HRSG and Siemens SST-600, operational in early 2025. HRSG performance issues on commissioning were discussed in detail.

Barry Dooley reviewed *Optimum cycle chemistry control for HRSGs and fossil plants.*

A key feature was a specific review of Repeat Cycle Chemistry Situations (RCCS), addressed in detail by both Dooley and Anderson during the event.

Primary RCCS are:

- Corrosion products.
- HRSG HP evaporator and boiler water-wall deposition.
- Contaminant ingress.
- Drum carryover.
- Lack of shutdown protection.
- Inadequate on-line, alarmed instrumentation.
- Non-optimum chemical cleaning.
- High levels of air in-leakage.
- Not challenging the status quo.

Dooley ended with a complete list of Technical Guidance Documents available without charge from www.IAPWS.org.

Bob Anderson case studies highlighting the *Importance of reheater isolation and avoiding HP superheater loop seal formation during layup.*

Key takeaways:

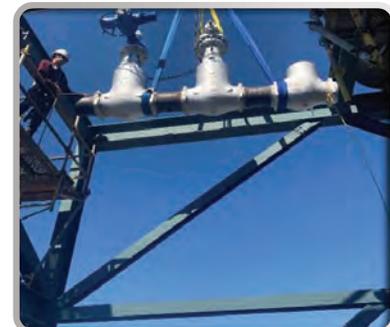
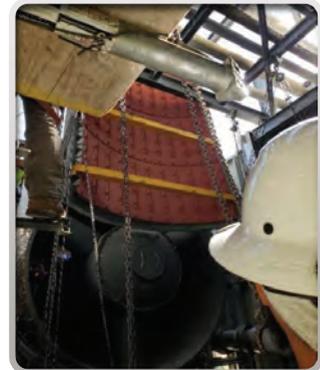
- A large quantity of condensate will form in the reheater if it is pressurized during layup. If not detected and drained prior to startup, water hammer, damaging thermal transients to pipe work and steam turbine water induction have occurred.
- Condensation normally occurs in the HP superheater during hot layup. If accumulated condensate floods lower superheater piping and/or headers a loop seal will form, isolating the HP drum from the superheater modules and steam pipework downstream of the loop seal. Further condensation in the isolated downstream superheater modules and pipework result in



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HP superheater outlet pressure decreasing below HP drum pressure, resulting in water carryover “over the top” into downstream superheater modules with resultant undesirable thermal transients. If not discovered and drained prior to startup, damaging thermal transients in

HP superheater pressure parts and steam pipework result.

- The easy solution is to monitor for pressurization of the reheater and differential pressure between the HP superheater outlet and HP steam drum during layups and drain the offending water prior to startup.

used to justify expected lifetime. Needless to say, the repairs were completed within the outage timeframe and no additional failures have been reported.

Jake Waterhouse, Dekomte de Temple, detailed *Expansion joint developments for plant reliability*. He focused on practical design and monitoring advances that improve combined-cycle reliability by addressing two chronic leak-and-heat sources: gas-turbine exhaust expansion joints (EJs) and HRSG penetration seals.

SOLUTIONS

Tube failures, especially at the tube-to-header connection, plague owner/operators the world over, and with increased utilization of CCGT and conventional fossil units in South America, Marcus Hutchinson of Tuff Tube Transition (TTT) generated significant interest with *Boiler and HRSG tube repairs revolutionized*.

Case studies highlight “hot-to-cold” transitions and fast outage installs where EJs delivered with internal insulation reduced outage duration. The presentation then shifted to penetration seals, outlining how metallic bellows and packed glands can be costly, maintenance-intensive, and not always gas tight. The Dekomte retrofit approach emphasizes fabric-based seals and bellow-to-fabric conversions (often split designs) that avoid post-weld NDT/heat treatment, install quickly, and better manage casing insulation integrity. A newer multi-nozzle “combination” concept staggers penetrations to control temperatures and prevent fabric-to-fabric contact; a thermal survey after one year of operation is cited as meeting expectations.



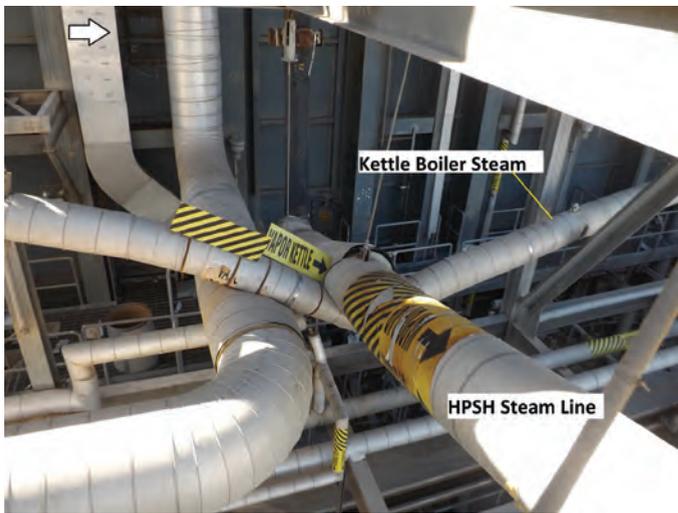
8. TTT purgeless sleeve and tube-to-header connection eliminates open-root butt welds and back-purging, reducing oxidation risk and cutting installation time

A testimony from EDF’s Guillaume Grognet was the driving force behind the value proposition. A short outage window at EDF’s advanced-class Bouchain CCGT prompted a shift away from conventional tube-to-header repair practices. The site opted for TTT’s Tuff Tube Header Connection (TTHC) hardware and installation support to address recurring HP economizer tube leaks while minimizing inspection burden and weld complexity (Fig 8).

Grognet, the site’s maintenance engineer, reported that 60 tube connections were completed in roughly two and a half shifts, with visual inspection replacing radiography, and with finite-element analysis (FEA)

Sergio Xavier, Alutal Industrial Controls (Brazil), offered *Excellence in online water/steam cycle analysis systems (SWAS) for power plants*.

Xavier walked through many topics in-



9. Resulting piping damage from dissimilar metal weld failure (left) and water hammer (right)

cluding the value of online monitoring, the variety of international guidelines (IAPWS, VGB, EPRI and ASTM) including Safe Operating Limits, specific sampling points, the critical parameter monitors, and a look at advanced measurement technologies.

His summary: “By controlling chemistry, you control plant reliability and profitability. A proper steam and water analysis system,” he noted, “is an insurance policy.”

Laura Mikovich, ValvTechnologies, “zeroed in” on zero-leakage isolation as essential in HRSG applications and how metal-seated ball valves mitigate chronic leakage seen with globe valves. With globe designs, line pressure raises unseating force and small leaks can escalate into steam cutting, wire drawing, erosion, flashing, and cavitation, hurting heat rate, reliability, and commissioning schedules while creating warranty and penalty exposure for OEMs/EPCs.

The company’s quarter-turn ball valve offers a straight-through flow path, higher seating force, protected sealing surfaces, and higher Cv. RiTech HVOF hardfacing plus extended lapping deliver durable, self-repairing, metal-to-metal sealing and long cycle life, lowering total cost of ownership for operators.

Daniel Acosta, HRST, discussed *Maximizing HRSG reliability in a cycling world through inspection of covered piping systems (CPS) and other neglected areas*. Editor’s Note: “Covered” here means included in ASME Code, not physically covered.

Acosta’s purpose was to discuss what is “covered” by Code, looking at lessons learned since the 1980s, beginning with coal-fired units. His relevance to the conference was to look at the many high-pressure, high-temperature HRSGs that are approaching 15 to 20 years in age.

These units, he discussed, are subjected to many cycles, contain questionable material properties, can have uncertain OEM designs, and are constantly undergoing changing operating profiles. Piping system repairs

are normally large, expensive projects with long lead-time components.

Common problem areas also include bypass valves, attemperator piping, and others.

This detailed presentation on piping systems reviewed a range of information encompassing:

- ASME B31.1 Piping Code requirements including maintenance and operation.
- Often overlooked code requirements including:
 - Written operation and maintenance procedures that cover topics mandated by the code.
 - Review of any dynamic events since the last condition assessment.
 - Water/steam hammer.
 - Thermal hydraulic events.

- Record keeping: procedures, drawings, material history and failure analysis.

He included case studies on dissimilar metal welds and water hammer (Fig 9).

Acosta recommended piping system walkdowns as part of condition assessment to look for the common problem areas: areas that undergo significant thermal stress, areas at risk of creep damage, attemperator spools, bypass valves, piping support/constraint issues, large valve bodies, branch welds, dissimilar metal welds, undrainable low points, and transition areas from HRSG OEM scope to piping OEM scope.

Pierre Ansmann and Norm Gagnon of Eugen Arnold GmbH dove deep into upgrading gas- and steam-turbine insulation to reduce heat losses, eliminate hot spots, improve safety, and recover heat-rate performance. Typical field problems are burned fabrics, gaps, sagging blankets, fiber/dust hazards, overheated auxiliaries, high enclosure temperatures, excessive ventilation demand, and outage rework.

The Arnold solution is a 3D, single-layer blanket system with 45° interlocking edges and stepped interfaces to prevent leakage paths during thermal expansion, plus a permanent stainless-steel substructure (no pins) that locks each blanket into a dedicated position for repeatable fit and faster access during outages.

The design targets an insulation surface temperature no more than ~15°C above ambient, with step-protection panels to extend life and enable safer walkways. Case studies show materially lower surface/enclosure temperatures and a reported heat-rate improvement on a 501F unit attributed largely to the insulation upgrade.

The duo also highlighted integrated steam-turbine and HRSG warming concepts, citing faster starts, reduced fatigue, lower startup fuel/emissions, and quantified parasitic loads and install timelines (Fig 10).

Neolia Acero Terrés, NEM Energy, of-



10. Steam turbine outfitted with insulation-integrated warming system provides the agility needed to respond to volatile dispatch and market signals

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Key Benefits

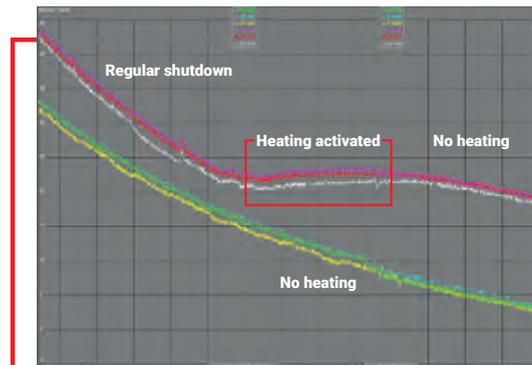
- Up to 75% reduction in startup time
- Lower fatigue on HP drum and piping
- Freeze protection and startup hold capability
- Significant fuel and demin water savings
- Lower CO emissions at startup
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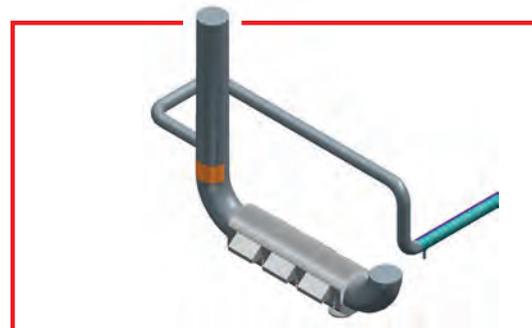
- ~100kW parasitic load to maintain temp
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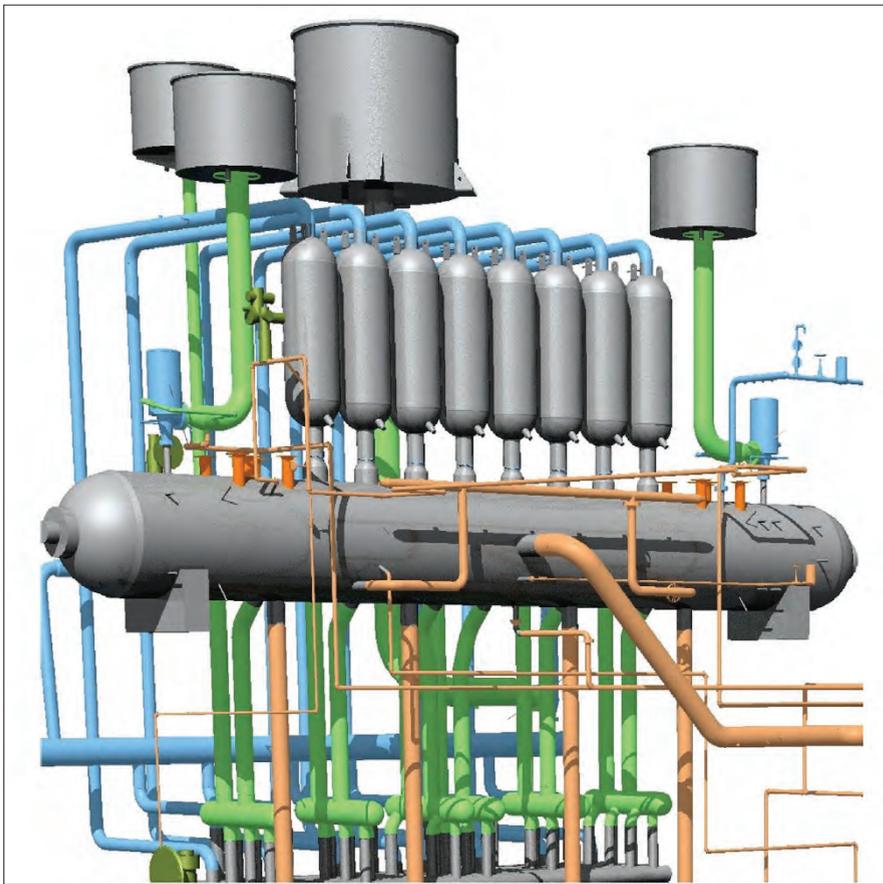
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11. DrumPlus™ NEM Energy patented technology

ferred *Enhancing CCGT flexibility with Drum-Plus™ and diverter damper technology.*

The drum design (Fig 11) features:

- Separator bottles (small vessels) as secondary water-steam separator.
- Minimized nozzle sizes.
- Enhanced flexibility with multiple down-comers.

Terrés presented a case study of an installation in Argentina, in operation since 2020. This plant at Genelba is two units, each featuring a 198 MW gas turbine and two-pressure DrumPlus HRSG, operational since 2020.

“Enhancing flexibility” means lower fatigue damage to the HP drum during start/stop so that the HP drum is no longer the limiting factor in how fast the unit can be started.

Kenneth Hutchison and Markus Heitzmann of GE Vernova connected water/steam chemistry discipline with HRSG reliability upgrades and lifetime extension. The speakers **stress** a simple premise: HRSG design (materials, pressure, temperature) dictates the chemistry program, and chemistry quality determines whether the unit meets its design potential or “actively dismantles” itself through corrosion and deposition.

Several field examples show that many failures are rooted in miscommunication among OEM, EPC, and operator: oversized chemical dosing lines create long transport delays that make stable control impossible;

removing key analyzers (such as sodium) to save CAPEX can leave the plant blind to condenser leaks and drive rapid corrosion; poorly maintained analyzers are worse than none because they create false confidence; and misunderstanding system architecture (for example, an LP drum functioning as a feedwater tank) can lead to wrong chemical dosing and carryover into HP circuits and the steam turbine.

The deck also calls out improper blow-down quench practices that can cause flashing, scaling, and thermal shock damage, and it recommends quenching in downstream piping instead of the atmospheric tank.

For mitigation, GEV highlights continuous online monitoring to validate instrument health, flag out-of-spec excursions, diagnose root causes (dosing errors, air ingress), and track cumulative time out of limits. For long-term management, it outlines HRSG upgrade pathways and planning windows tied to GT outages, including desuperheater and safety-valve resizing and major pressure-part replacements (often with material upgrades to address FAC) to restore reliability as cycling accelerates life consumption.

Ron Preston of Precision Iceblast presented *HRSG performance rejuvenation with deep cleaning technology.* The patented service for CCGT plants is built on 30+ years of experience and more than 1,800 HRSG units cleaned worldwide. The approach targets 80–95% of heating-surface area using spe-

cialized wands and alignment methods to clean both upstream and downstream tube faces, even in staggered bundles, with customized plans based on HRSG drawings and tube-stress calculations.

Case studies from Spain and Italy show major debris removal (Fig 12), improved cleanliness verified by borescope inspections, and operational benefits tied to back-pressure restoration, including lower stack temperature, higher GT/ST output, and improved heat rate.

THE FULL CONFERENCE

HRSG Forum América Latina was comprehensive and detail oriented and only selected highlights are presented above. Attendees enjoyed inclusive and wide-ranging topics and informative discussions that included the following, which can be further researched at the CCJ website:

- Bob Anderson, Competitive Power, *16 years of HRSG thermal transient assessment results.*
- Eugene Eagle, EPRI, *HRSG offline internal inspections.*
- Barry Dooley, *Flow-accelerated corrosion: science and approach.*
- Barry Dooley, *Latest film-forming substance (FFS) application results and direction.*
- Eugene Eagle, EPRI, *Integrated life management of tee intersections in high-temperature high-energy piping systems.*
- Eugene Eagle, EPRI, *Gas turbine upgrades and HRSG assessments.*

2026

The second annual HRSG América Latina conference will be held in Brazil in September 2026. Information will be available at <https://hrsgamericalatina.com/>



12. HRSG Deep Cleaning™ removed 4629 lb (2100 kg) of retained debris, restoring gas-path cleanliness and heat-transfer surface exposure beyond conventional methods



Advanced monitoring and predictive solutions

Challenge. Demand for dispatchable power generation continues to set records. Aeroderivative peaking plants, in particular, have logged record starts, stops, and run hours in nearly every quarter over the last three years. While that operating cadence can be profitable, it also accelerates equipment wear. Between inspections, operators often have limited visibility into actual machine condition and are forced to run until alarms or failures occur.

Tools for truly proactive peaking-asset operation have remained difficult to implement. Traditional remote monitoring and diagnostics (RM&D), though effective in many applications, often identifies issues only after they have developed. At the same time, supply-chain constraints have worsened the consequences of delayed detection. Critical parts and spares can require a year or more to procure, and depot turn times remain extended. Those delays conflict directly with the record utilization many plants are now seeing.

Solution. PROENERGY developed Advanced Monitoring & Predictive Solutions (AMPS), a dedicated in-house 24/7 monitoring center designed to deliver timely, actionable insights beyond conventional M&D (Fig 1). The platform combines automated alerts, predictive tools, and direct engineering support to identify developing problems and recommend mitigation steps before failures occur. This approach allows plant and fleet operators, including the PROENERGY WattBridge fleet, to plan outages and pro-

cure parts on their schedules.

AMPS includes two core functions:

- 1. Advanced Monitoring.** This function tracks real-time performance and issues automated operational and trip advisories when preset thresholds are reached. Advisories are generated with minimal manual processing to reduce delays, improve awareness of critical issues, and support a proactive operating culture. Each advisory includes triggering data, AMPS diagnostic context, and clear online and offline recommendations for site response. Trip advisories include root-event data, AMPS analysis, and immediate guidance to support rapid troubleshooting. All advisories also include a real-time feedback channel that supports direct collaboration between site personnel and AMPS engineers.
- 2. Predictive Solutions.** This function identifies potential failures months, weeks, or days in advance to improve long-term reliability. The system uses machine learning and Advanced Pattern Recognition (APR) to establish a benchmark for each unit's unique operating profile. It then compares incoming sensor data, including speed, vibration, temperature, load, and other parameters, against expected performance to detect subtle deviations. This enables AMPS to identify emerging issues before alarms are triggered, allowing operators to intervene early and avoid unplanned downtime.

AMPS helps operators move from reactive, manual processes to a streamlined, insight-driven model supported by a lean remote team. By applying standard operating procedures, business rules, advanced analytics, and artificial intelligence (AI), the system prioritizes the most urgent alerts and helps teams make faster, better-informed decisions. Over time, users gain stronger situational awareness, reduce risk, and improve resource allocation through data-backed

WattBridge Fleet

Owned and operated by
PROENERGY

2,400-MW simple-cycle aeroderivative fleet with 50 x LM6000PC located throughout Texas

Plant manager: Humberto Figueroa, Jaymes Martens, Eric Kuper



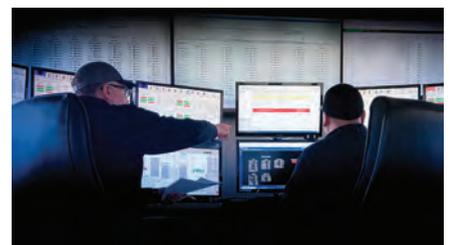
planning and continuous monitoring.

A key differentiator is the human expertise behind each advisory. Recommendations are developed by former plant managers, project leaders, and experienced operators with more than 120 years of combined aeroderivative experience. That depth of knowledge turns complex data into prescriptive guidance that accelerates issue resolution, minimizes downtime, and supports performance recovery.

AMPS represents more than an incremental improvement to traditional M&D. It is a step change in capability. By combining real-time automation, predictive intelligence, and hands-on engineering insight, it delivers the speed, accuracy, and foresight required to support a modern, fast-growing fleet. The result is a scalable toolset for proactive maintenance, streamlined operations, and more strategic outage management, with measurable gains in efficiency, uptime, and long-term asset performance.

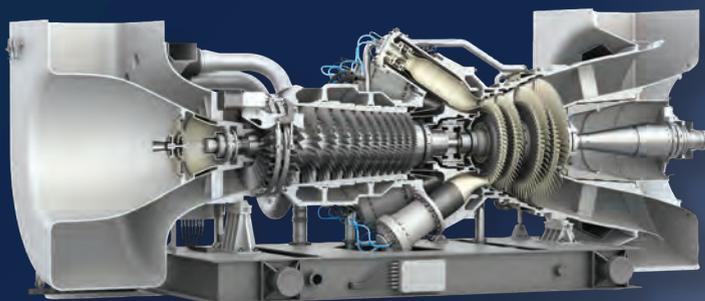
Results. PROENERGY developed, tested, and successfully applied AMPS across the six-facility WattBridge peaking portfolio. Representative case studies from WattBridge and a third-party user follow:

Case study 1: \$2.5M saved by averting catastrophic event. AMPS alerted WattBridge to escalating vibration across multiple sensors,



1. AMPS operators keep eyes on the prize 24/7

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- Longer oil lifespan
- Prevention of seal degradation

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a potential warning sign of high-pressure compressor (HPC) and midshaft damage, allowing the operator to avoid turbine HPC damage valued at \$2.5 million. After the unit tripped twice, AMPS observed rising vibration levels, performed a playback study, and issued an advisory identifying high turbine vibration. A borescope inspection later confirmed damage to multiple blades and the HPC, along with an oil leak.

Case study 2: \$600K in damages and delays avoided with early warnings and guidance. A PROENERGY customer's LM6000 site avoided a bearing failure that would have cost an estimated \$600,000 and delayed operations by at least three to four months. AMPS identified three performance deviations before alarms occurred and predicted an impending scavenge-pump failure. The issue was mitigated in less than a week, enabling the facility to provide reliable power during an ERCOT weather watch tied to two winter storms.

Case study 3: \$937K in downtime and damages avoided through expert analysis. AMPS helped a WattBridge facility avoid approximately \$937,000 in potential equipment damage and unplanned downtime by detecting early signs of HPC damage across stages 3 through 14. After AMPS observed a steady rise in vibration, the site was alerted and the unit tripped shortly afterward. Playback analysis indicated possible internal damage, which a borescope inspection confirmed. Findings included rotor blades with heavy

rub indications and blade wear beyond acceptable limits, conditions that could have led to major repairs and extended outages during a period of elevated energy-alert risk. Timely action returned the unit to service ahead of peak demand and demonstrated the value of early detection, expert diagnostics, and coordinated site support.

Fuel flowmeter certification

Challenge. Fuel flowmeters are a critical component of continuous emissions monitoring systems (CEMS), and their recertification can create significant labor, downtime, and cost. Certification is required for natural-gas-fired turbines subject to Title 40 of the Code of Federal Regulations (CFR) Part 75. Appendix D of 40 CFR Part 75 requires fuel flowmeters to be recertified at least every 20 calendar quarters from the initial installation date or the date of the most recent accuracy test.

A common approach is to purchase a replacement flowmeter, schedule an outage and labor, swap the meter, and send the original unit to a lab for recertification. That process can take one to two days and adds avoidable cost.

Solution. PROENERGY uses a non-invasive clamp-on ultrasonic flowmeter to measure

natural-gas flow while the unit remains on-line, providing a faster, lower-cost recertification option (Fig. 2). The method can be completed in hours rather than days, avoids unit downtime, and minimizes cost. When paired with a Relative Accuracy Test Audit (RATA), it also requires no additional testing days.

By leveraging the technical capabilities of the PROENERGY Environmental Services team, the company provides EPA-required compliance while maintaining full commercial availability.

Results. The recertification approach preserved EPA compliance while protecting operating performance. Efficiency gains for WattBridge and a third-party client are summarized below:

Case study 1: Zero-downtime EPA compliance. PROENERGY helped a WattBridge



2. Clamp-on ultrasonic flowmeter



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facility maintain EPA compliance with zero downtime by completing two required tasks during a single mobilization. The site faced the same deadline for its annual CEMS RATA and the 20-calendar-quarter fuel flowmeter certification requirement for each unit. PROENERGY combined the RATA and fuel flowmeter certification work using an ultrasonic flowmeter to measure fuel flow, saving up to four days of combined downtime.

Case study 2: Out-of-compliance avoidance. For a third-party client, the PROENERGY Environmental Services team arrived onsite and completed the required certification the same day, preserving EPA compliance with zero downtime. The client had initially planned to purchase new flowmeters and swap them out ahead of the compliance deadline for two natural-gas-turbine fuel flowmeters. That plan became impractical because of supply-chain constraints and limited lab availability for certifying existing meters. The PROENERGY approach saved up to two days of downtime while avoiding delays tied to parts and lab access.

Fogging water reclamation

Challenge. Water is critical to aeroderivative performance. WattBridge, described as the world's largest LM6000 commercial

fleet, uses water both to reduce emissions and to maximize power output in hot climates. The fleet includes 50 LM6000PC engines operating in Texas at about a 15% capacity factor and fogging eight months per year, resulting in significant water demand. Fogging can consume up to 12,000 liters per hour by cooling intake air to increase output and reduce NOx emissions.

PROENERGY O&M operated an existing fogging system that generated process-water runoff requiring capture and disposition. A reclamation system became necessary because about 25% of inlet fogging water was being lost, average water cost was approximately \$0.35/gal, and the system operated roughly 67% of the year. Because runoff quality remained relatively good, discharge offered little value. The water volume was large enough to make reuse a clear priority.

Solution. Vanessa Garcia, fleet engineer, led the development of a fogging-water reclamation system by leveraging plant personnel knowledge and using as much existing infrastructure as possible. With summer approaching and limited time for design, procurement, and installation, Garcia coordinated an effort that combined in-house engineering resources with a third-party vendor.

Within months, the team designed and installed a modified fogging system that reclaimed runoff and improved water use across the WattBridge peaking fleet. The

system captured runoff water, pumped it to a temporary tank, and returned it to the raw-water storage tank for reuse. The drain-collection arrangement included pump skids, piping, and a tank (Fig 3).

Results. The team's zero-tolerance approach to unauthorized process-water discharge, combined with a focus on reusing high water volumes, met environmental requirements and reduced water costs by approximately \$2.2 million. Those savings were achieved even while using well-water assets to produce demineralized water.



3. Fogging water drain configuration

AIG retrofit for enhanced NOx control and efficiency

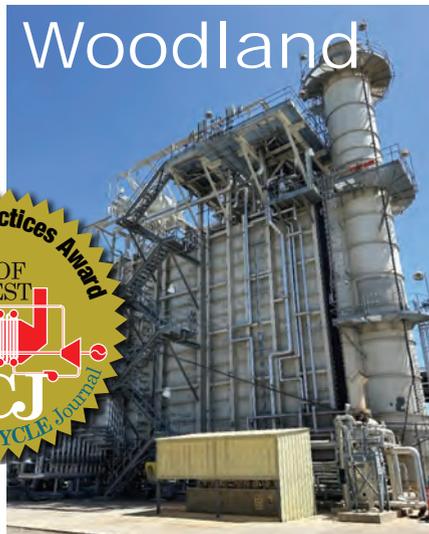
Challenge. The Modesto Irrigation District (MID) Woodland Generation Station Unit 2, an LM6000 combined cycle gas turbine commissioned in 2003, has long faced operational challenges in meeting its stack NOx and ammonia slip limits during transitions between fired and unfired operation. These challenges required operational modifications to always stay in emissions compliance.

Solution. SCR Solutions LLC conducted a detailed inspection and analysis using advanced computational fluid dynamics (CFD) modeling to evaluate the existing SCR and AIG performance. The CFD model revealed severe distribution imbalances, with ammonia concentration too high along the top and bottom of the duct and too low along the side walls, leading to ineffective NOx reduction and high local ammonia slip. The original AIG also featured large flow bypass zones due to poor mechanical design.

It was determined that a complete AIG re-design was required. The new best practice retrofit included:

- Increasing number of AIG lances from 24 to 50
- Increasing number of injection holes by 2x
- Adding top and bottom AIG lances to address dead flow zones
- Installing integral mixing plates on each lance
- Incorporating side wall fairings to eliminate bypass flow
- Extending upper and lower flow baffles to enhance flow uniformity

Engineering efforts included laser scanning of the system to compensate for incom-



plete OEM drawings and developing a precise 3D model for fabrication. All materials were fabricated in New Jersey and shipped to the Modesto site. Installation was completed on an aggressive schedule, with demolition of the old AIG and installation of the new system.

Results. The retrofit yielded substantial performance improvements. Fig 1 shows a before and after comparison of the ammonia distribution at the SCR catalyst face. The original design produced high ammonia concentrations at the top and bottom of the catalyst bed.

In addition, there were low ammonia concentrations along the side walls. These poor distributions created poor SCR performance. The modified design greatly improved the distributions of ammonia, both along the top and bottom and also along the side walls.

After the AIG was installed, MID ran a stack test to confirm the stack NOx, ammonia slip and ammonia flow (Fig 2). The table below shows a comparison of the before and after results where ammonia slip and consumption was reduced by 83% and 16% respectively.

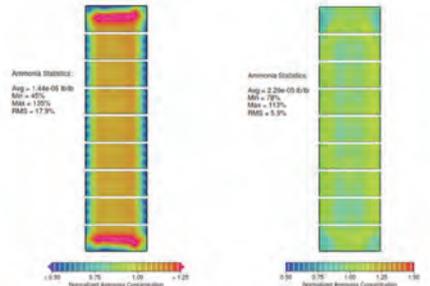
As a result of the retrofit, the following were the benefits realized:

Woodland Generation Station, Unit 2

Owned and operated by Modesto Irrigation District

83-MW, 1x1, LM6000 combined cycle located in Modesto, Calif

Plant manager: Paul Mercer



1. Ammonia distribution at SCR catalyst inlet

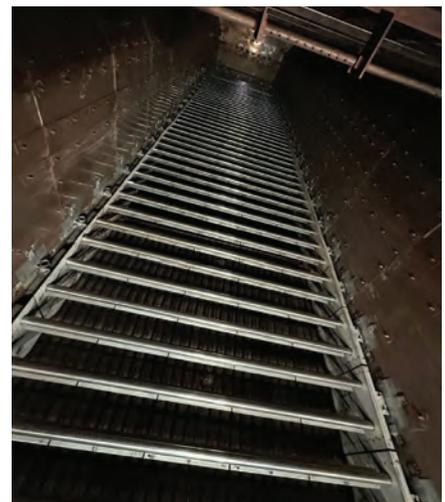
- **Environmental Compliance.** Consistent NOx and ammonia slip compliance across all operating modes.
- **Operating Cost Savings.** Reduction in ammonia consumption translates to tangible annual savings.
- **Catalyst Longevity.** Improved distribution reduces localized ammonia slip and extends catalyst life.
- **Improved Plant Flexibility.** Reliable NOx control across varying loads and during transitions between fired/unfired modes.
- **Fast-track Execution.** Project engineered, fabricated, and installed within ~12 weeks total, minimizing downtime.

Project Participants:

Paul Mercer, plant manager
Richard Behler, generation supervisor
Michael J Miller, environmental compliance specialist

Before and After Field Test Results

Parameter	Units	Pre-Retrofit	Post-Retrofit
		9-18-24	2-5-25
CT Load	MW	48.0	47.9
Stack NOx	ppmvd @ 15% O ₂	2.2	2.14
DeNOx	%	93	93
Ammonia Slip	ppmvd @ 15% O ₂	3.54	0.59
Ammonia Flow (29%)	lb/hr	80.3	67.6



2. Final AIG installation

Mariposa



Mariposa Energy Project

Owned by Diamond Generating Corp
Operated by DGC Operations

200 MW, gas-fired 4 × 0
LM6000PC-powered (Sprint
equipped) peaking plant, located in
Alameda County, Calif.

Plant manager: Justin Crook

Fuel-gas letdown controls provide multiple benefits

Background. Mariposa Energy Project is a 200-MW peaking facility in northern California with four LM6000 units. Plant fuel supply is delivered from the utility header, then reduced through a letdown station feeding the compressor building and CTG fuel headers.

Challenge. On average, PG&E fuel-gas supply to the plant fluctuates from about 620 to 860 psig. The letdown station uses two parallel regulators set to limit supply to roughly 680 psig. From there, gas flows to a lead compressor intended to start when inlet pressure drops below about 640 psig, with a lag compressor starting at high lead loading. Once running, compressors are programmed to cycle off when inlet pressure is above about 660 psig for 20 minutes.

The team reports this arrangement created three recurring problems:

- Slow pressure-control response during normal cycling. The online letdown PCV responded slowly to supply-pressure swings and CTG load changes, leading to premature starts of the lead and lag fuel-gas compressors, even when upstream pressure remained well above 700 psig.
- Header pressure spikes after a CTG trip. The letdown skid did not react quickly enough to abrupt demand loss, allowing the fuel header pressure to rise close to a reported 720-psia limit and trigger fuel-system shutdown events on remaining units.
- Mechanical positioner limitations. The legacy Fisher mechanical valve positioners required manual tuning, often with the valve out of service for extended periods. They also offered no remote access, no straightforward integration into modern monitoring, and less precise response than digital positioners.

Solution. The site implemented a set of co-

ordinated fixes spanning hardware, controls logic, and instrumentation.

The team replaced the Fisher mechanical valve controller/positioner with a Fisher FIELDVUE DVC6200 Series smart digital valve positioner (Fig 1). Three practical benefits result:

- Faster, repeatable tuning and auto-calibration, reducing time the valve must be removed from service
 - Built-in diagnostics to support troubleshooting and maintenance planning
 - Ability to capture valve and process behavior in a historian for condition monitoring, including response time and travel deviation
- The controls changes leverage Ovation DCS capabilities to tighten pressure control and improve response during rapid fuel-demand changes. Some highlights include:
- Closed-loop PID control with valve position feedback
 - Dual outlet pressure transmitter feedback (redundancy)
 - Auto/manual mode setpoint tracking to

reduce bumps during mode changes

- Additional safety logic intended to mitigate over-pressurization risk during abrupt CTG load reductions and trips

A second pressure transmitter was added at the fuel letdown skid outlet to support redundant control and alarming (Fig 2). Dual-transmitter function block logic and HMI faceplates were implemented in the plant BOP Ovation DCS for monitoring and alarms.

Results. After project completion, the team reports the letdown skid discharge pressure stays within about ± 5 psig of setpoint despite utility supply fluctuations. More notably, the plant's fuel-gas compressors reportedly have not started for five months following the upgrade, reducing auxiliary load and associated maintenance demand.

Participants:

Justin Crook, plant manager
Fred Yarcho, O&M manager
Oliver Caouli ICE tech



1. Mechanical positioner replaced by smart digital valve positioner to enable diagnostics, auto-calibration, and improved response



2. Fuel letdown skid transmitter addition



Sentinel Energy Center

Owned by Sentinel Energy Center LLC

Operated by DGC Operations LLC

850 MW, eight unit, LMS100 simple cycle peaking facility located in North Palm Springs, Calif.

Plant manager: Dennis Johnson

First responder awareness training

Background. Large power generating facilities present hazards and layout complexities that many local responders do not encounter routinely. Sentinel Energy Center formalizes recurring first-responder awareness training to improve safety, shorten decision time, and strengthen coordination between plant staff and outside agencies.

Challenge. Even well-trained emergency responders can be disadvantaged by an unfamiliar site. A gas-turbine-based facility includes high-voltage equipment and overhead lines, pressurized fuel gas systems with vents, combustible adjacent materials, and multiple chemical inventories distribut-

ed around the plant. Plant layouts also create navigation and access challenges, especially when equipment yards, switchyards, and fenced areas complicate staging and apparatus movement (Fig 1).

The underlying issue is not responder capability, it is the time penalty imposed by uncertainty. During an emergency, responders need rapid answers to practical questions: what hazards are present, where they are located, what can be isolated, what must not be operated, and how to move safely around the site.

Solution. The training program is structured as an awareness-level introduction

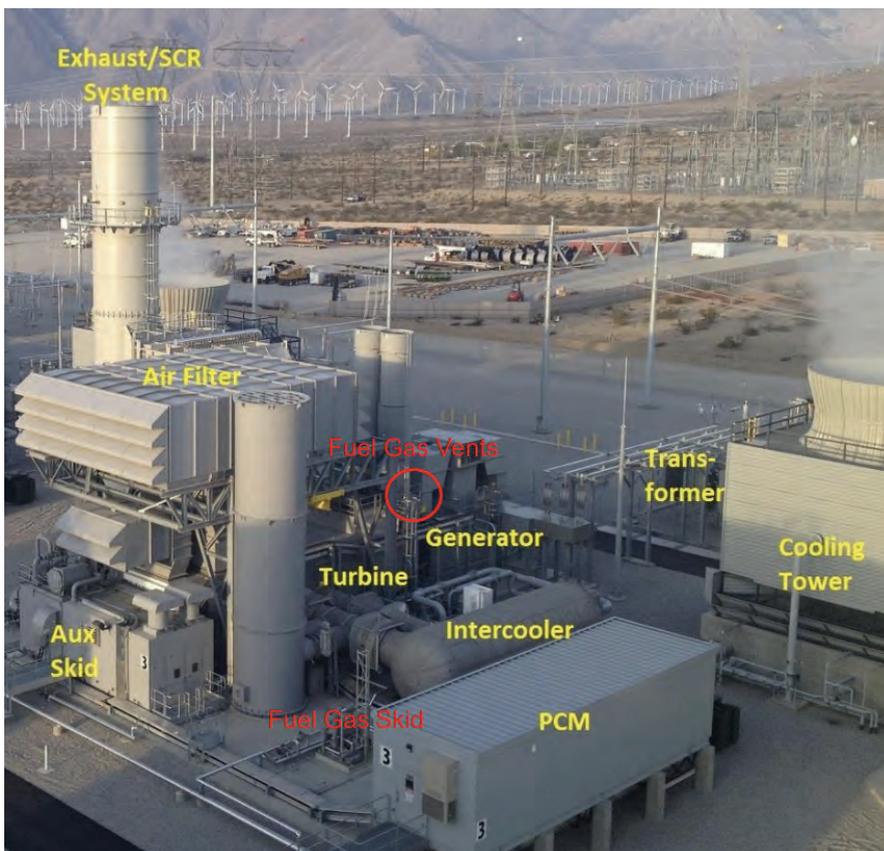
tailored to the specific facility. Content is built around equipment walkdowns, maps and aerial views, and scenario-driven discussions that prompt responders to ask the right questions early. Topics are organized by hazard category and by the plant systems most likely to influence incident escalation or isolation strategy.

The approach combines the following system orientation with hazard recognition:

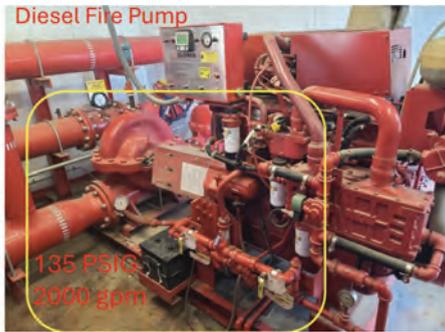
- Fuel gas systems and vents. Review typical package locations, isolation concepts, and how to avoid unintended venting during response.
- Firewater system orientation. Identify pump types and expected pressures and flows to support hydrant and sprinkler operations (Fig 2).
- Electrical hazards. Emphasize GSU and auxiliary transformers, switchyard exposure, and battery energy storage as additional sources of stored or backfed energy (Fig 3).
- Bulk chemicals. Provide a simple inventory and location awareness for common plant chemicals, including concentrations where applicable.
- Bulk oils. Reinforce spill and fire considerations for lubricating, transformer, fuel, and waste oils, and how adjacent tanks can change defensive priorities (Fig 4).
- Labeling and signage. Use consistent pipe labeling and signage maintenance to shorten time to isolate, identify contents, and communicate hazards.
- Combustible adjacent materials. Address how nearby combustible loading can influence fire spread and exposure protection decisions.
- Access and egress. Confirm which access gates need a backup means of opening if the site is de-energized and normal controls are unavailable (Fig 5).

A key element of the program is a short list of prompts responders can use to cross-check isolation and exposure risks with operations staff. Examples include:

- Electrical: What is de-energized, what remains energized nearby, and whether cooling systems and DC sources remain in service.



1. Typical gas-turbine package overview used to orient responders to major equipment groupings and approximate locations, including fuel gas skids and vents



2. Firewater system overview highlighting pump lineup and representative pressures and flows for electric, diesel, and jockey pumps

- Chemicals and oils: What chemicals are present, in what concentrations, and whether bulk oil tanks are adjacent to the incident area.
- Flammable gases: Whether fuel gas can be isolated without venting, whether automatic vents can be manually isolated, and where safe vent areas exist.
- General access: Whether gates can be locked or held open during de-energization, and whether load limits or unusual site features affect apparatus access.

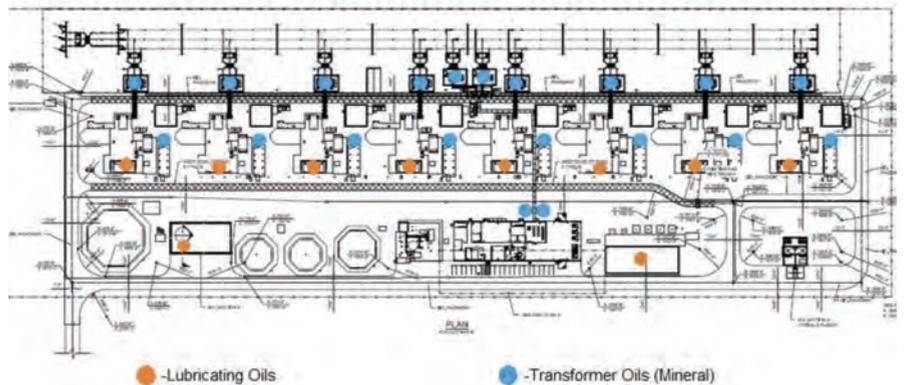


3. Electrical hazard overview showing GSU and auxiliary transformers, switchyard exposure, and battery energy storage as an additional energy source

Results. Routine awareness training as a risk-reduction measure has four expected outcomes: improved safety, more effective response, stronger collaboration, and sustained preparedness through regular refreshers. By aligning responders and plant staff on hazards, access, and isolation concepts before an incident, the plant expects fewer delays, fewer missteps, and clearer communications during an actual event.

Owner/operators looking to implement a similar program can use the following checklist:

- Maintain a responder-ready facility overview, including a one-line, site map, access points, and staging options, and refresh after major projects.
- Document and communicate chemical inventories and concentrations, including storage locations and response considerations.
- Review firewater capacity and pump configuration, and walk down hydrant and sprinkler zones with responders.
- Create a high-voltage and energy-storage awareness module that addresses transformers, switchyard, MCCs, and battery energy storage, including backfeed risks.
- Confirm fuel gas isolation philosophy and vent control options, and clarify what responders should and should not operate.
- Verify gate backup opening methods, and test them periodically.
- Establish an annual cadence and include makeup sessions to account for turnover on both sides.



4. Bulk oils map and storage diagram supports exposure evaluations, spill control, and firefighting strategy



5. Facility access gate requires backup means of opening if normal power or controls are unavailable

Participants:

Dennis Johnson, Larry Wilson, Jesse Balou, and David Wells.



Indigo



Larkspur

Wildflower Energy LP

Owned by Diamond Generating Corp

Operated by DGC Operations

Indigo Generation: 136-MW simple-cycle peaking plant in North Palm Springs, Calif, with three GE LM6000 PC Enhanced Sprint gas turbines.

Larkspur Energy: 98-MW simple-cycle peaking plant in Otay Mesa, Calif, with two GE LM6000 PC Sprint gas turbines.

Plant manager: Mike Carpenter

Bluetooth level sensors add hands-off tank-level access

Background. Site personnel routinely verify levels on several storage tanks supporting plant operations. The existing level indications were approaching end-of-life, and the previous instrument platform had limited support and parts availability. Rather than replacing like-for-like, the team used the instrument refresh to improve both maintainability and field safety.

Challenge. Traditional level-instrument checks and adjustments often require a technician to reach the transmitter or local display mounted on the vessel. That can mean:

- Ladder or manlift access
- Fall protection requirements
- More time per task, especially when verifying multiple tanks during rounds or work planning

The team wanted a replacement that maintained measurement accuracy while reducing the exposure associated with elevated access.

Solution. Indigo selected Endress+Hauser Micropilot FMR60B radar level transmitters to replace the aging instruments (Fig 1). The application conditions include minimal

turbulence and no internal obstructions, which supports reliable non-contact radar measurement performance for tank level.

The differentiator for the site was not only updated radar technology, but also the ability to connect to the device via Bluetooth using a mobile app. Once installed and powered, technicians can access key configuration and diagnostic functions from the ground,

including setup, reading values, and calibration checks, without physically attaching to the instrument at elevation.

An external display is also available. This enables level readings to be viewed from a more accessible location, improving visibility during rounds and reducing the need to position personnel near the top of the tank.

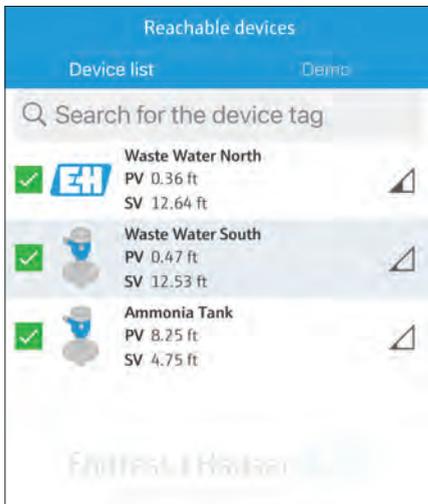
A mobile interface shows multiple tanks listed as reachable devices, with level values displayed in feet for each tag (Fig 2). A local Endress+Hauser RIA15 indicator displays level in feet. The transmitter installed on a tank-top connection, with a short cable run from the sensor head.

Results. The site describes the task of taking readings or checking levels as “literally hands-off,” because technicians can perform routine verification and many configuration steps without a ladder, manlift, or fall harness. The benefits reported are primarily in maintainability and safety:

- Fewer elevated-access tasks for routine checks and troubleshooting
- Simplified calibration and verification using mobile connectivity



1. Tank-top installation view of the radar level



2. Mobile app “Reachable devices” screen showing Bluetooth-connected level instruments and current PV/SV level values for multiple site tanks

■ Improved accessibility of level information when an external display is installed. While the submittal does not quantify labor-hours saved, the change targets a recurring activity, tank-level verification, where even small per-task reductions can compound over time, especially across multiple tanks and frequent rounds.

Participants:

Mike Carpenter, plant manager
 Mike Noll, O&M manager
 Mike Mathews, IC&E lead technician

Compact ladders improve safety, access

Challenge. Wildflower personnel continually look for safer ways to perform critical tasks, and this improvement demonstrated how a simple change could strengthen an onsite safety program.

Accessing the ladders to the turbine and generator platforms presented a recurring slip-and-fall risk, particularly when employees had oil residue on their boots or when rain made ladder rungs wet and slippery. The risk increased further during maintenance activities when personnel were carrying tools or equipment and could not maintain full contact while climbing.

In addition, lines routed near the base of the ladders created another hazard during ingress and egress. Personnel could inadvertently step on those lines, increasing the risk of line damage or slipping on wet piping.

Solution. The site installed small aluminum two-step ladders at the base of the ladders leading to the turbine and generator platforms. This modification improved access by providing a more stable transition point

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and helping personnel maintain three points of contact while climbing, even when one hand was occupied with tools or equipment. The solution was simple, low-cost, and easy to implement, while addressing a frequent onsite safety concern.

Results. Adding the small aluminum two-step ladders provided a safer approach for accessing the platform ladders.

The flat, serrated step surface offers better footing and grip than standard ladder

rungs, reducing slip risk during wet or oily conditions. The step ladders also reduce the likelihood of stepping on lines or piping near the ladder base during entry and exit. Overall, the modification improves personnel safety during routine access and maintenance activities.

Participants:

Mike Carpenter, plant manager
 Mike Noll, O&M manager
 All site personnel



3. Improved turbine and generator access



Exira Station

Owned by Western Minnesota Municipal Power Agency
 Operated by Missouri River Energy Services

140-MW, simple-cycle peaking facility with three LM6000PC gas turbines located in Brayton, Iowa.

Plant manager: Ed Jackson

Sprint purge drain-valve upgrade prevents water intrusion into instrument air

Background. Frequent cycling of the SPRINT system created a pathway for water to migrate into Exira Station’s instrument-air system, affecting multiple turbine and balance-of-plant functions. Because the instrument-air header supports critical purge and actuation needs across the plant, moisture carryover became a reliability issue, especially during cold Midwest winters. The station eliminated the problem by adding opposed solenoid drain valves to the SPRINT purge lines, a hardware-only change that required no control system modifications.

Instrument air often behaves like background infrastructure until contamination affects multiple end users. At Exira, the same instrument-air supply used for the SPRINT purge also supports:

- Bearing purge on shutdown
- CDP purge valve actuation air
- SPRINT valve actuator supply
- Other plant systems including CEMS and gas scrubbers

With a shared header serving multiple critical loads, any moisture that enters the instrument-air system can cascade into actuator issues, failed valve movements, and start reliability problems.

Challenge. The instrument-air purge solenoids were not completely watertight, allowing water to migrate past them as the SPRINT system cycled on and off. When SPRINT check valves degraded or failed, even more water migrated downstream and into the instrument-air system.

The operational impact extended beyond the SPRINT package. Exira experienced repeated problems across multiple systems that depend on instrument air, and the station attributes the condition to several

forced outages. Cold-weather exposure increased the consequence: moisture in air systems can contribute to sluggish valve response, failed actuation, and freeze-related restrictions that are difficult to diagnose during short-notice peaking starts.

Solution. Added solenoid drains to SPRINT purge lines. Exira installed solenoid drain valves that operate in opposition to the existing instrument-air purge solenoid valves. The design intent is to remove water at the point of entry, before it migrates into the instrument-air header.

Key elements of the retrofit:

- No control system changes. The new drain valves are wired using the existing solenoid valve wiring.
- Opposed operation. When the purge valve is open, the drain valve is closed. When the purge valve is closed, the drain valve opens.
- Drain to package. When SPRINT is on-line, the SPRINT check valve should see pressure that keeps it closed. If water passes the check valve, the drain arrangement provides a path for that water to discharge into the package instead of progressing into instrument air.

The modification provides a simple visual indicator for operators and technicians. If water is observed inside the package, it suggests the associated check valve may be passing and should be inspected. That visibility helps shift the response from reactive troubleshooting of plant-wide instrument-air symptoms to targeted evaluation of the likely leakage path.

Results. After installing the drain system for the HP and LP SPRINT circuits and the

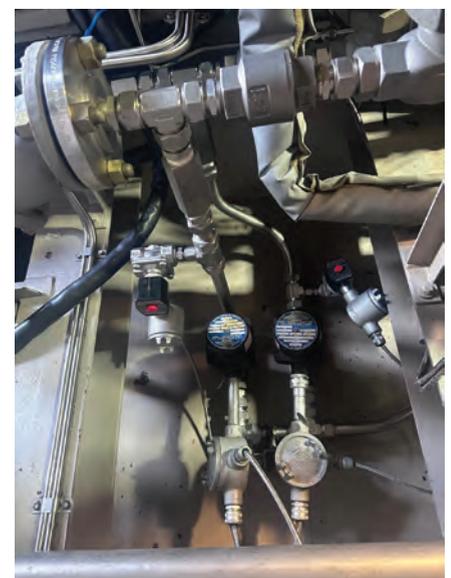
SPRINT skid, Exira reports elimination of water in the instrument-air system. The

- Far fewer CDP purge valves failing to cycle
- Fewer problems with SPRINT control valves
- Little to no issues with other devices that utilize instrument air

For a simple-cycle peaking site, the improvement supports higher start readiness and reduces forced-outage risk during winter operations.

Participants:

Plant O&M technicians Devon Meyer, Greg Hauswirth, Jon Edwards, and Corey Petrie.



1. Solenoid drain-valve arrangement installed on the SPRINT purge lines



HKW Freimann Power Plant

Stadtwerke München

125-MW cogeneration facility powered by LM6000PF+ gas turbines located in Munich, Germany.

Plant manager: Simon Weig

Automated reports provide rapid plant insight and understanding

Background. HKW Freimann is one of Munich's major powerplants, supplying power and heat and incorporating district-heating assets, heat storage, and battery storage. In 2020, Stadtwerke München (SWM) refurbished the gas-turbine installation and commissioned two LM6000 PF2 units. These were the first PF2 units commissioned worldwide, and SWM's prior operational experience primarily involved heavy-duty turbines rather than aeroderivatives.

From the start, SWM targeted operational improvement through a better understanding of unit behavior, faster detection of abnormal conditions, and more efficient planning of tuning and troubleshooting work.

Challenge. The site identified a common owner/operator barrier: having ample plant data but limited internal capability to consistently convert those data into actionable insight. The practical requirement was that insights had to arrive in a format that fit operating routines, not as an additional software burden or a one-off engineering exercise.

Key challenges included:

- Building a repeatable workflow from data collection through insight generation, rather than ad hoc analysis
- Delivering results in minutes to support daily decision-making and early anomaly detection
- Avoiding lengthy, costly trial-and-error testing by narrowing the problem space with data first

Solution. SWM implemented an automated reporting system based on centralized plant data that provided easily digestible visualizations that could be reviewed in about five minutes. Here's how it worked.

Standardize the data workflow. The program was organized around four steps: collect data, prepare data, analyze, and convert results into insights through visualization.

A foundational decision was to transfer and archive plant data into a central database alongside the control system, enabling consistent access and supporting automation.

Automate preparation and reporting. SWM used daily reporting as the primary adoption mechanism. Data were cleaned and filtered automatically, then compiled into reports that provided a comprehensive overview and could be reviewed in about five minutes. Reports were auto-generated and distributed by email, creating a predictable cadence for review.

Screen first, then deep dive. SWM paired lightweight daily screening with deeper analysis only when the screening indicated an abnormality. For deep dives, the plant implemented the analysis tool Visplore, particularly its pattern-search capability to find similar events across multiple signals and time periods.

This tiered approach delivered:

- fast, routine situational awareness through automated reports, and
- efficient troubleshooting and root-cause isolation through pattern search and signal overlays

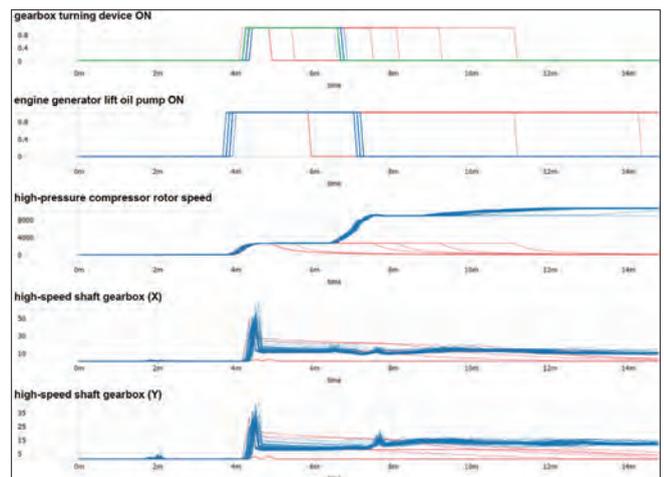
Results. The site reported operational value in three areas: emissions oversight and tuning efficiency, abnormal-event diagnosis and mitigation planning, and improved troubleshooting of transient issues such as start-ups.

Emissions monitoring and threshold-excedance

tracking were a key early use case, especially during commissioning. By correlating emissions behavior with operating conditions such as compressor inlet temperature, SWM identified operating regions associated with higher NO_x and used those findings to plan mapping activities more efficiently. The intended outcome was improved targeting of mapping and tuning work, reducing time and cost associated with unnecessary experimentation.

Using pattern search and signal correlation, SWM identified load rejections as events that significantly affected the generator thrust bearing and contributed to increased bearing temperature. The analysis supported follow-on monitoring actions, including more precise tracking of generator vibrations to assess long-term bearing impacts after load rejections. SWM also planned to add MetalSCAN from GasTOPS to strengthen ongoing condition monitoring.

SWM also applied the same data-centric approach to intermittent false starts, described as shutdowns initiated by the turning gear at low speed, followed by successful subsequent cranks. By overlaying multiple signals across start attempts and distinguishing failed versus successful patterns, SWM identified a no-lift condition during false starts. A subsequent inspection found the jacking-oil pump degraded, enabling targeted corrective action rather than extended troubleshooting by substitution (Fig 1).



1. Overlaid start-attempt trends (failed starts in red) show turning-gear and lift-oil pump status, compressor rotor speed, and gearbox vibration



REO Cogen

REO Cogeneration Plant

Owned and operated by Lansing Board of Water & Light

100 MW, 2 x 1 LM6000PF-powered combined cycle equipped with IST once-through steam generators, located in Lansing, Mich.

Plant manager: Tom Dickinson

LOTO wall improves outage awareness

Challenge. Because REO Cogen is certified to ISO 55001, certain documents must be controlled. Historically, the plant printed LOTO clearances and placed them on a table beneath the associated numbered group lock box.

The team found this arrangement as cumbersome during outages, making it harder for operations to manage multiple clearances and maintain situational awareness of affected equipment. The method also created a risk of paperwork being misplaced, and the plant reports several incidents of missing clearances.

Solution. In 2023, REO revised and re-

vamped its LOTO program through a joint effort involving Operations, Maintenance, and Safety. A central element of the update is the design and layout of a dedicated LOTO wall located within the control room.

Key features described include:

- Clear, numbered document boxes on the wall, where each clearance packet is hung and protected, rather than stacked on a table.
- Associated numbered lock boxes mounted to the wall so the clearance paperwork and the physical locking hardware stay paired.
- Role-based lock color coding (maintenance, operations, engineering, contrac-

tor, etc.), allowing quick visual identification of who is signed on to the LOTO.

Results. The plant reports the LOTO wall improves both administrative control and day-to-day usability:

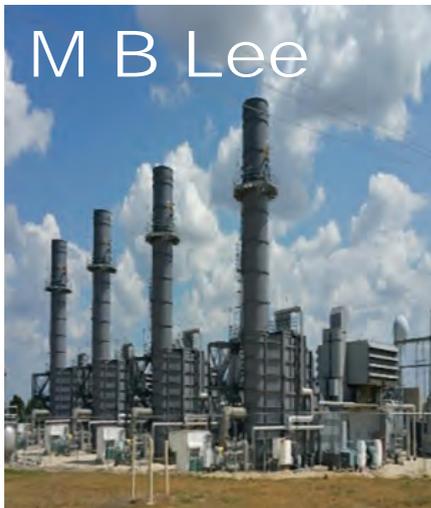
- *Improved visibility of work status.* The wall shows how many clearances are active and what equipment is out of service.
- *Reduced risk of lost paperwork.* Clearances are secured in designated, numbered locations rather than left on a table.
- *Faster access for personnel.* Individuals signing on and off can locate the correct packet quickly.
- *Better situational awareness for operations.* Operators can see who is working on equipment by observing lock colors without searching through documents.

Participants:

Josh Zussman, Al Cox, and the REO maintenance team.



1. Color coding helps operations quickly identify who is signed on to each clearance and where work is in progress



M B Lee

Milton B Lee Peakers

CPS Energy

376-MW simple cycle peaking facility powered by eight LM6000PC gas turbines located in San Antonio, Tex.

Plant manager: Ryan McDonnell

Starting reliability and forced outage rate improvements

Challenge. Following an extended period of subpar performance, the owner partnered in 2017 with the gas-turbine OEM and an engineering firm to evaluate reliability across the eight LM6000PC peaking units and identify improvement opportunities. The objective was to restore expected reliability and improve unit readiness for peak-season dispatch.

Solution. Rather than a single equipment fix, CPS Energy underwent a “best practices rebuild” across maintenance fundamentals, parts readiness, organizational capability, and execution discipline. The program focuses on eliminating repeat causes of start failures and reducing the duration and impact of forced outages.

The team identified gaps in the existing PM strategy, particularly for critical equipment that lacked adequate inspection or tasking. New PM plans are implemented to improve early detection and reduce the probability of functional failures that typically surface as start issues on peaking units.

Improve spare parts readiness. The plants create new storeroom stock items for critical parts. The intent is to shorten restoration time when failures occur and to reduce both the frequency and duration of outage events linked to parts availability.

Add dedicated technical support capability. CPS Energy adjusts the staffing structure by hiring dedicated technical support staff to drive reliability best practices for the LM6000 fleet. The submission credits this group with improving troubleshooting effectiveness, developing longer-term maintenance plans, and strengthening asset life-management practices.

Institutionalize root-cause analysis. The plants perform root-cause analyses (RCA) on failures affecting the LM6000 units. CPS Energy reports that RCA findings lead directly to new PM plans and to refurbishing or replacing aging equipment that contributed to repeat events.

Upgrade or refurbish aging equipment. Outdated equipment is upgraded or refurbished as part of the recovery plan. In parallel, OEM recommendations are reevaluated, and CPS Energy reports a decision to replace some critical equipment on a time basis instead of run hours to reduce the probability of age-related failures.

Improve outage planning and execution. Outage management practices are enhanced to maximize efficiency. CPS Energy notes that while outage frequency remains consistent, outage duration declines significantly by focusing on critical items and addressing multiple issues during the same

outage window.

Build targeted training. The program adds strategic staff training curricula to improve technical knowledge for problematic plant systems. The dedicated technical staff receives specialized LM6000 training, which CPS Energy says strengthens troubleshooting capability and overall site expertise.

Results. Plant staff significant improvement since the 2017 study, attributing the change to revamping best practices, shifting to a proactive stance, and adding dedicated personnel. Reported outcomes include:

- 100% starting reliability achieved
- Marked improvement in EFOR relative to the pre-study period
- Reduced outage duration, driven by improved planning, focus on critical items, and bundling corrective work
- Lower impact from parts-related delays, supported by stocking critical spares

Proactive replacement of certain critical items based on time, combined with RCA-driven PM improvements, reduces unexpected failures and supports higher availability during critical seasons.

Participants: Paolo Solorzano, Kyle Yeh, Gabriel Golden, Brian Stahl, Jody Nottingham, Gabriel Cisneros, and Mark Rodriguez.

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University Park

University Park North and South

Owned by LS Power
Operated by IHI Power Services

North: 540-MW, simple-cycle peaking facility with twelve GE LM6000s.
South: 300-MW, simple-cycle peaking facility with six FT8 TwinPacs.
The plant is located in University Park, Illinois.

Plant manager: Brandon Dupler

Prevent freeze-related start failures

Background. University Park North and South use demineralized NOx water injection to reduce NOx emissions on simple-cycle peaking units. Cold-weather events in the Chicago area periodically freeze stagnant water at pipe contact points, forcing the plant to hold units out of service to remain in compliance. The site implemented a low-cost modification and an operator-driven procedure, using instrument air to clear NOx water lines when temperatures drop below freezing.

NOx water injection uses demineralized water injected into the combustor with natural gas to reduce firing temperature and lower NOx emissions. At University Park, NOx is described as the plant's most restrictive permitting constraint because of its role as an ozone precursor at ground level.

Because the facility operates as a peaker, water can sit in small-bore runs and low points between dispatch events. That operating profile increases exposure to freezing, especially at support and hanger contact points where cold can migrate into the line during wind-driven events.

Challenge. Both University Park North and South insulated and heat traced the NOx water piping. Even after insulation and heat-trace updates, the site continues to experience freeze-ups during severe wind and low temperature conditions.

The team identified a repeatable failure mechanism: At approximately minus 14F, cold migrates from the steel support structure through the pipe hanger and freezes the water at contact points when there is no water flow. When operators attempt a start at those temperatures, the result is either no NOx water flow or reduced flow, which prevents compliance with emissions limits and can block unit operation.

Operationally, this creates two compounding risks:

- Forced outages and delayed starts during cold snaps when dispatch value is high.

- Compliance exposure because the units cannot legally operate without NOx water injection available.

Solution. University Park adopted a simple, economical approach: tie the plant air system into the NOx water system so operators can clear the line when temperatures warrant.

The site incorporated temperature triggers into operator rounds. When conditions are below freezing, operators momentarily open the air line to blow water out of the NOx water piping (Fig 1). After verifying the line is cleared, operators isolate the air supply so the unit remains ready for the next start. The same evolution is performed after shutdowns when ambient conditions indicate a freeze risk.

Key implementation details include:

- A clear, repeatable valve lineup so the

blowdown evolution is consistent across shifts.

- Isolation capability so the air tie-in is secured after the line is cleared.
- A verification step confirming water has been removed before returning the system to standby.

Results. The modification is now installed on the site's LM6000 engines and on the FT8-3 units.

During the 2023–2024 winter, the plant experienced multiple forced outages and start-up issues attributed to frozen NOx water lines. In the following winter season, after the air tie-in and procedure are implemented, the team reports zero start failures or NOx-water issues caused by frozen lines.

Fast-track Execution. Project engineered, fabricated, and installed within ~12 weeks total, minimizing downtime.



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Right-sizing plant air for non-dispatch periods

Background. Nevada Cogeneration Associates 2 (NCA2) shifted from a baseload operating model after a long-term power purchase agreement ended, and the O&M team targeted auxiliary loads that did not need “full-size” equipment when the plant was not generating.

Challenge. When the plant was offline or not dispatched, compressed-air demand typically dropped to essentials: instrument air, minimal service air, and system support. However, maintaining availability of dry, reliable air remained non-negotiable because it directly supported controls and device reliability.

The challenge for the NCA2 team was to meet these reduced needs without:

- Operating large compressors at low load and poor efficiency.
- Accepting higher cycling and wear on major assets.
- Compromising instrument-air quality, especially moisture control.

Solution. Plant staff developed a project to install a smaller air compressor to support the reduced compressed-air requirement

during non-generation periods, allowing the larger compressors to remain off when their capacity was not needed. The project became known onsite as “JT’s Compressor,” recognizing John Thompson’s role in planning and installation.

A key decision was to execute the work internally. After preliminary planning, the team determined site personnel could complete both design and installation in-house, reducing outside labor cost and schedule duration.

Ownership approval was obtained after the planning team presented the long-term savings case. The installation was completed in just under a month while the plant continued normal operations.

Elements that contributed to the short cycle time and smooth implementation included:

- Clear definition of the operating envelope: the compressor was intended primarily for plant-down or non-dispatch conditions.
- Internal design and installation, which compressed schedule and avoided contractor mobilization delays.
- Early alignment with ownership on economics and reliability benefits, which

Nevada Cogeneration Associates No. 2

*Owned by Panamint Capital
Operated by IHI Power Services*

85-MW, gas-fired, 3 × 1
LM2500-powered combined-cycle
cogeneration facility located in Las
Vegas, NV

Plant manager: Chris Benkman

supported prompt approval.

Results. The plant reported an energy-cost savings of \$11 per hour when the smaller compressor was used in place of the larger units. With typical operation of about four months per year, or approximately 2800 hours, the annual savings were about \$30,000. The team also noted a simple payback of roughly 135 days based on the \$11 per hour operating-cost delta and the runtime profile.

Since early 2024, JT’s Compressor operated regularly during plant-down periods, and the team reported an improved overall operating profile even with limited use to offline windows.

Participants: Holly Adair, Michael Smith, Cannon Anderson, Peter Phelps, and Chris Benkman.

Edgewood



Edgewood Energy LLC

Owned by Milepost Power Holdings
Operated by NAES Corp

92-MW, simple-cycle peaking facility with two GE LM6000 gas turbines located in Brentwood, NY.

Plant manager: John Lawton

Fuel-gas hose pressure testing isolates package leak

Challenge. One of the site’s gas turbines triggers recent package LEL alarms. During operation, personnel also report smelling natural gas around the package. The alarming is inconsistent, but the site treats it as a credible leak indication and pursues multiple paths to identify and eliminate likely sources.

Actions taken include:

- Testing and calibrating package combustible-gas detector sensors.
- Proactively replacing combustible-gas detector sensor modules.
- Inspecting internal package gas piping, flanges, and connection points, checking for leaks, and re-tightening as needed.
- Checking connections and flanges on the final coalescer external to the package.

After these measures, the issue persists.

The remaining gap is the set of fuel-gas hoses attached to the combustor (Fig 1), which cannot be thoroughly inspected in place.

Solution. To evaluate the hoses directly, site personnel develop a controlled removal-and-test method designed to minimize downtime and keep work manageable.

Key elements of the approach:

- Remove combustor fuel-gas hoses in groups of six at a time.
- Pressurize the removed hoses with nitrogen using a dedicated regulator and fittings suitable for nitrogen service.
- Submerge the pressurized hoses in a large tub filled with water.
- Observe for bubbles, which provide a clear visual indication of leak location.

The nitrogen pressure is set to 400 psig to closely resemble operational conditions. The method is intentionally straightforward so it can be repeated periodically without specialized equipment beyond standard fittings, a nitrogen bottle and regulator, and a

containment tub (Fig 2).

Results. The setup performs as intended. After testing several hoses, personnel identify one hose with a small hole (Fig 3). The site determines this defect is the source of the gas leak within the package. After the hose is replaced, the LEL alarms and gas odor do not recur.

With a successful root-cause identification and a proven test arrangement, the site commits to periodic fuel-gas hose testing going forward using the same materials and methodology.

Participants:

- Michael Citarelli
- Anthony Angieri
- Joseph Cruz
- James Casey



1. LM6000 combustor with gas hoses attached



2. Test setup used for the activity. Blue container at right is filled with water. Nitrogen bottle at left connects to hoses; pressure set at 400 psig to closely resemble operating conditions



3. Close-up of the small hole found in one of the tested hoses



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Overcoming vulnerability in segmental ring pump designs

By Dewayne Gilreath and Christen Mancini, Hydro, Inc.

Segmental-ring (BB4) boiler-feed pumps (BFP) can be sensitive to external forces, hydraulic instability, and alignment. This case study reviews modifications implemented to reduce leakage, minimize wear, and mitigate balance-device-driven vibration.

The boiler-feed system is the heart of the steam cycle, supplying feedwater to the HRSG for steam generation. Many combined-cycle facilities use high-energy segmental-ring (BB4) pumps for this critical service. Because the segmental-ring design relies on a large number of stacked components—without the stabilizing environment of a barrel—these pumps can be sensitive to external forces, hydraulic instability, and alignment issues. Given the pump's direct impact on power generation, reliability is paramount.

After experiencing high vibration, casing leakage, and other indicators of poor performance early in service, a combined-cycle owner/operator (O/O) identified design vulnerabilities and pursued modifications to improve robustness and restore best-in-class tolerances. Working with Hydro's Atlanta facility (Hydro South), the team implemented upgrades focused on three areas (Fig 1):

- Eliminating leakage paths
- Minimizing wear and restoring rotor stiffness
- Reducing axial shuttling and balance-device-driven vibration

ELIMINATING LEAKAGE PATHS

Casing leakage was attributed to a combination of insufficient O-ring compression, material limitations, and incomplete maintenance instructions. Maintaining an effective O-ring seal requires (1) an elastomer compatible with the pumped-fluid temperature and pressure and (2) groove geometry that delivers adequate compression to maintain contact at sealing surfaces and compensate for minor surface imperfections.

Inspection found the groove sealing the balance-line flange to the pump discharge head was too deep to achieve the required compression. The flange was machined to restore the appropriate groove depth. All O-rings were upgraded to AFLAS®, a high-performance fluoroelastomer suited for elevated temperature and corrosive environments.

A documentation and work-instruction gap also contributed to recurring leakage. The seal-housing liner—installed with an interference fit—must be removed to access and replace two wear rings and associated “hidden” O-rings in that location. Because the existing O&M manual did not include these steps, prior maintenance cycles had not addressed these components. As an additional safeguard, the seal-housing sealing area was overlaid with 309L stainless steel to mitigate corrosion that had developed as a result of leakage in this area.

RESTORING ROTOR STIFFNESS, REDUCING RISK OF WEAR

The next objective was to reduce drivers of premature wear throughout the pump. Close-clearance regions—such as wearing-to-impeller-hub clearances—act as water-lubricated bearings that provide rotor stiffness and damping. Maintaining these clearances helps preserve stability, particularly in segmental-ring designs with many stages and long, slender shafts.

A foundational step in any multistage pump refurbishment is restoring components to best-in-class standards. Segmental-ring pumps demand experience and attention to detail during restoration and assembly. Tight control of bore geometry, face runout, and shaft straightness reduces the drivers of misalignment. Avoiding excessive fit-ups is also essential: because these

pumps consist of stacked components, excessive register fits can accumulate and produce large offsets across the assembly (Fig 2).

To further reduce wear, wear surfaces were hardened using direct laser deposition (DLD). DLD provides a hard surface (typically around 55 HRC) while maintaining base-material ductility—unlike through-hardening, which can increase brittleness. In this upgrade, both the impeller hub and stationary wear rings were brought to similar hardness. With no hardness differential, there is no sacrificial component; if contact occurs, the components tend to “bounce” rather than wear, extending service life.

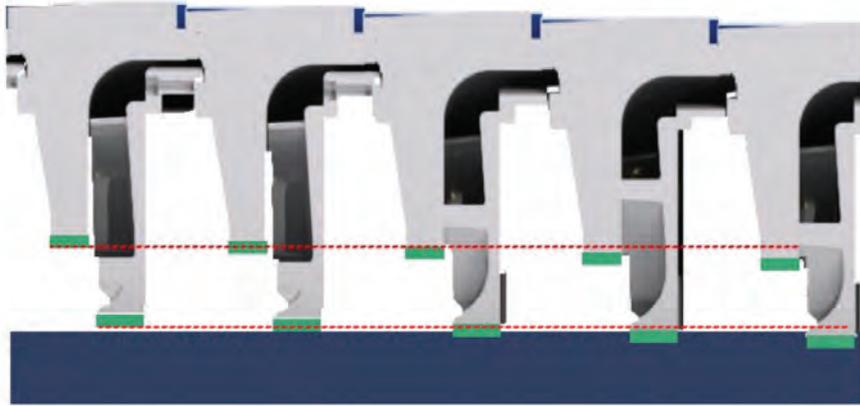
Another wear driver was identified at the interface between the last-stage impeller and the balance device. The original configuration left a gap between the last-stage impeller and the rotating balance sleeve. Without a positive stop to prevent outboard movement, the impeller could shuttle axially and contact the balance device and outboard diffuser face, accelerating wear. A set screw was added to the impeller hub to limit outboard movement and prevent contact.

Finally, several assembly practices were implemented to reduce risk and improve alignment:

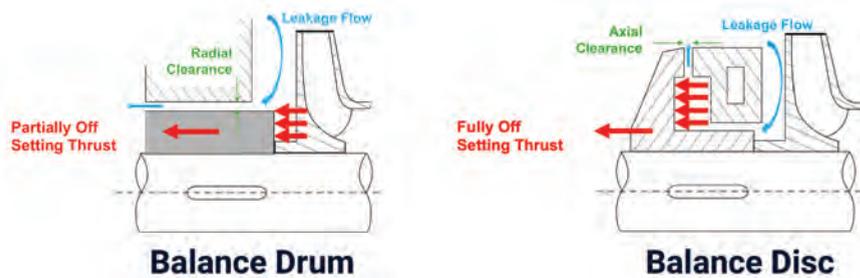
- Chroming was applied to the impeller and balance-sleeve shaft fits to reduce galling risk during assembly (long, inter-



1. Pump as received



2. Offset due to tolerance stack-up



3. Balance device comparison

ference-fit bores are particularly susceptible).

- The pump was assembled in the vertical orientation to reduce the register-fit stack-up that can occur with horizontal assembly.
- Cold alignment between motor and pump was re-evaluated versus original specifications to better account for thermal growth and achieve proper hot alignment.

REDUCING BALANCE-DEVICE-DRIVEN VIBRATION

With leakage and wear addressed, the final focus area was high vibration. Two drivers were identified within the balance device design and operation:

1. Propensity for axial thrust reversals
2. Fluid swirl in the balance-drum-to-sleeve clearance

Both contributed to elevated subsynchronous vibration.

One reason the pump was susceptible is that it uses a straight balance drum rather than a flanged balance disk. The balance device reduces axial thrust during operation, lowering thrust-bearing load. A flanged balance disk, with both axial and radial clearances, is generally a self-compensating design capable of balancing axial thrust across operating points. A straight balance drum, by contrast, typically balances thrust at only one operating point (Fig 3).

Balance-drum sizing is based on total axial thrust from pressure acting on impeller

hubs, which depends on wear-ring diameters. If wear-ring diameters change, residual axial thrust changes. During standard refurbishment, wear-ring clearances are often renewed by skim cutting the impeller hub and/or stationary wear-ring locating bore to remove damage, then installing a new wear ring sized to restore the intended clearance.

This approach can result in varying wearing diameters across stages, depending on how much machining was required.

In this case, wear-ring diameter changes were sufficient to disrupt the intended residual axial-thrust balance. Axial thrust could also be affected by hydraulic instability at the impeller discharge when operating away from best efficiency point (BEP). Off-BEP operation can introduce intermittent, unpredictable swirl that increases the likelihood of axial thrust reversals—detrimental to bearing and seal life. To reduce this risk, Hydro South re-established not only design clearances, but also preserved the original design diameters of wear components.

The last concern was evidence of fluid swirl in the balance-device clearance. It was suspected that the as-installed running position had been adjusted during shop testing to reduce vibration, but that running position was not documented. Two flow breaks were added to the stationary balance drum to disrupt swirl, reduce subsynchronous vibration, and stabilize operation.

FINAL THOUGHTS

Hydro South has upgraded three of the end user's BFPs using the modifications outlined above and expects to complete the remaining pumps over the next several years (Fig 4). The improved operating behavior and reduction in vibration demonstrate that chronic instability in segmental-ring designs is not inevitable.

By going beyond standard repair scopes and applying targeted design and process upgrades, users can reclaim reliability in these critical assets—reducing risk to both safety and unit availability. [ccj](#)



4. Refurbished pump preparing for shipment

‘Move fast, break things’ versus an electric infrastructure mindset

At the 4th Annual PROENERGY Conference, held in Phoenix, AZ in January, the mood was buoyant. Gas turbine (GT) orders (and shop reservations) are skyrocketing, electricity demand growth is higher than it's been in decades, hyperscale data centers and their insatiable need for electricity are being built and planned throughout the country, and restrictive regulatory regimes, at least at the federal level, are being relaxed.

Several speakers seemed to bask in the glow of that phrase characterizing the digital revolution: “Move fast and break things,” originally coined, or at least attributed to, Mark Zuckerberg, founder of Facebook, now part of the digital behemoth and hyper-scale investor, Meta.

However, percolating just below the giddiness over the prospects of phenomenal growth were the real constraints of infrastructure businesses like electricity production and delivery. After all, as one panelist said, IT systems depreciate in a few years. Electricity infrastructure is planned on a 20–50-year time horizon. Additionally, explosive growth poses its own inherent challenges, and the keynote speaker, and a host of panelists, were not shy in addressing them.

SURGE OR BUBBLE?

The venerable Mark Axford, Axford Turbine Consultants, headlined the conference by juxtaposing two words for the state of the market, surge or bubble, and then emphatically answered, Surge!

The numbers Axford put up are breathtaking (Fig 1). At least one GT vendor expects demand to exceed 100 GW/yr worldwide from 2026 to 2035. For context, that's a decade of orders at the same rate as the peak of the last period of manic GT orders, 1997-2001. Axford cautioned that sustaining peak-cycle ordering rates for a full decade is unlikely, given the many variables that can disrupt demand and project execution.

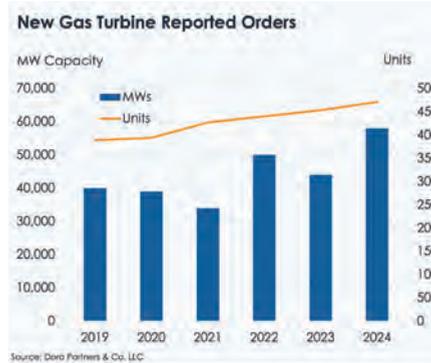
Adding to the upbeat outlook, consolidation is reshaping the owner/operator landscape as major fleets are getting bigger, with players like Constellation absorbing large GT operators such as Calpine. At the same time, new OEM entrants from Korea are moving into the market, while big dogs like GE Vernova and Siemens Energy are ramping manufacturing capacity at speed.

Meanwhile, Axford continued, huge hyperscale data centers are getting built. As an example of what hyperscale means to the electricity production side, the \$15-billion Stargate AI data center outside of Abilene,

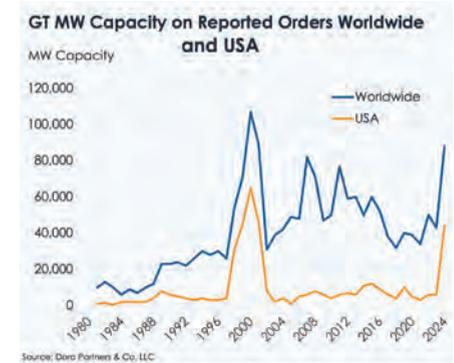
Texas, will have 39 LM5000 Xpress simple-cycle units and five Solar Turbine Inc units. \$500-billion worth of other Stargate sites are being planned and built in other

locations around the country.

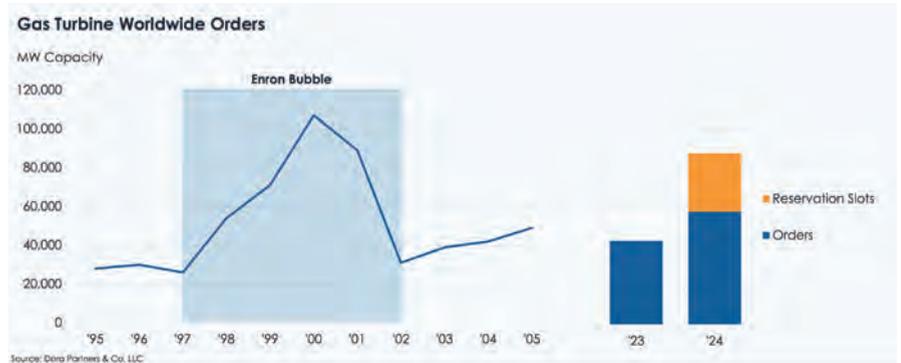
The second “big deal” project Axford highlighted is the \$10-billion, 4500 MW combined cycle facility on the grounds of



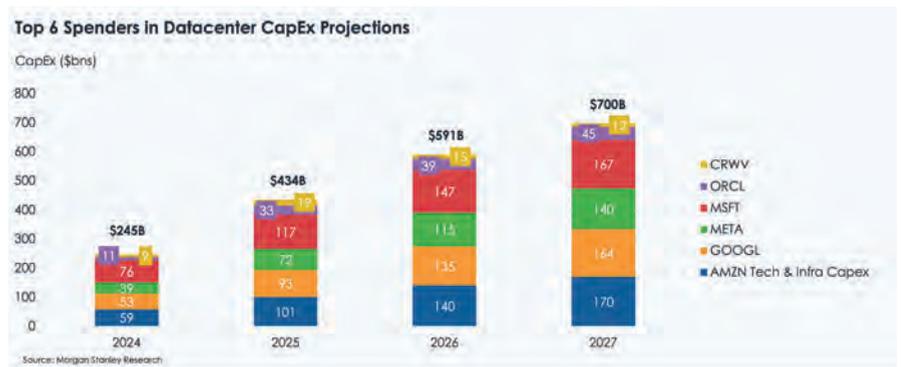
Reported GT orders and MW capacity up 21% and 45% respectively in 2024 compared to 2019



MW capacity on reported orders both worldwide and USA are approaching near peak levels



Current gas turbine worldwide orders are high, yet still below peak Enron levels



Morgan Stanley Research projects hyperscalers will hit \$700 billion in capex in 2027

1. Recent flurry of GT orders is predicted by some industry experts to usher in a sustained wave of capacity additions, says the keynoter at the PROENERGY 2026 conference, and not a bubble (like the Enron years), mostly because the companies building massive, electricity-hungry hyperscale data centers have strong earnings and balance sheets



2. PROENERGY treated attendees to an up-close look at Salt River Project's Coolidge Expansion Project, another example of "speed to power" in practice. The site is being built around a fleet of 12 x LM6000 units designed for fast starts, fast ramps, and flexible, modular dispatch

the former coal-fired Homer City powerplant in western Pennsylvania. All the output is expected to be consumed by data centers, not by the PJM grid. Homer City will comprise seven 7H2.02 GTGs and seven steam turbine/generators.

Third project highlighted is the \$20-billion "Colossus" project on the Tennessee-Mississippi border near Memphis. Phase 2, now underway, will include six PROENERGY PE6000 units along with eight Solar Titan 350 units and other smaller Solar units.

One thing that makes this a surge, not a bubble like the dotcoms of yore, is that the AI digital firms are well-capitalized and are funding the build-out from revenues, Axford noted. As if to redefine the word, uptick, Axford revised an earlier uptick of 7-10% in GT order growth for 2025 to 22%! It's good to be wrong in the right direction.

What might alter that direction? Axford lists Sparc architecture (scalable processors), low power chips coming onto the market, invasion of Taiwan (where much global chip-making capacity resides), new regulations on the AI industry or electricity, and political upheaval in the US. It's an AI arms race, he concluded.

TEMPER, TEMPER

What does all this mean for one of the largest public power companies (and the largest raw water supplier) in the US? Well, according to Bill McClellan, Salt River Project (SRP), it means SRP is planning to double its installed capacity within a decade. "It took us 100 years to build our first 13,000 MW," he noted. SRP is adding capacity "at an unprecedented rate," an example being the addition of 12 LM6000 units at its Coolidge site, which already has 12 LM6000s (Fig 2). The public utility already has approval to add 6000 MW.

He tempered the optimism a bit by reminding the audience of the development risks involved, among them: Building the associated transmission; supply chain issues (noting step-up transformers as an example); tariffs/tax credits, labor costs (and rising costs "across the board") gas supply constraints in certain areas (SRP's territory is one); regulatory uncertainty; and community opposition of which there is a "tremendous increase across the state [of Arizona]."

Panelists in the following business roundtable, "Evolving Power Demands," elaborated on many of these risks and opportunities (Fig 3). Speakers included: John Adams, Crusoe (powerplant developers for the Stargate facility mentioned above); Tyler Kopp, Energy Capital Partners (ECP, private equity investor and majority stakeholder in PROENERGY); Dylan Bearce, Tucson Electric Power (owned by Canadian firm UniSource); Kim Flowers, NavEnergy (coal operations on the Navajo territory); and moderator Landon Tessmer, PROENERGY.

OUT WITH OLD DEFINITIONS

Tessmer started them off with what was perhaps a rhetorical question, has the definition of "bridge technology" (which had referred to GTs as a bridge to a sustainable future) changed? The answer was unanimous: Cycling GTs were, just a few short years ago, considered the "backbone" to stabilize intermittently available capacity from renewables, but they are now the bridge to "grid catch up" and "speed to baseload capacity expansion."

Some of the rhetoric did echo earlier GT booms. A major GT supplier in the 1990s used to offer a Pro Gen scheme (progressive generation) – build simple cycle, expand to CC, and add a coal gasification plant if necessary (and as a hedge on gas prices). That

strategy, of course, might have looked good on paper to executives with little engineering and regulatory experience, but was impractical for many reasons. No one needed it besides because the natural gas "scarcity" and emphasis on "clean coal" technologies of that period was replaced by a natural gas glut.

Adams noted that simple cycles are being built now for speed to capacity, but "combined cycles will be added later." Hydrogen and/or carbon capture are now playing the role of gasified coal, options available should the regulatory regime demand ultra-low CO2 emissions. Flowers mentioned the responsibility to "future-proof asset decisions," and Adams the concept of "adding in the flexibility for H2 firing and CO2 capture." However, Kopp noted that CO2 capture rates ding the financial structure with a \$15/MW-hr premium and H2 in GTs in the US "does not pencil in."

From an operational perspective, H2 combustion is "different," Bearce observed, and requires different combustor tuning techniques. "It's a contingency piece," he noted."

OBSTACLES MOUNT

Adams described the current climate as "the hottest market he's seen in forty five years in the business," "we can't get GTs fast enough for 2029 and 2030," and "it's going to be crazy for the next five years," sentiments echoed by Kopp who said AI companies "are the best capitalized firms on the planet." Nevertheless, the obstacle course was evident from panelists' remarks.

Water. Adams said there's been a huge refocus on water, and commitment to net zero water consumption or even water production at hyperscale data centers. Bearce noted that there are "ways around water [constraints], but costs escalate."

Transmission. Flowers conceded that you can't have generation without transmission and that land issues and routing are "so complicated." Bearce added, transmission costs have to be spread across the customer base. He also mentioned load pockets, land availability, and public opposition: "Contingency analysis is not just N-1, there are lots of guesses involved." "We need much more engagement with customers," he continued, "there are lots of balls in the air with respect to public perception."

Overall implication: Expanding transmission is not necessarily compatible with "speed to power."

Labor. Adams listed two critical challenges. One is the lack of workers in the US currently. "We are 250,000 laborers short," he lamented, "we need 80,000 electricians alone!" That could bite even harder at a time of severe restrictions on immigration. "How do we make construction work 'sexy,'" he queried, "an electrician can make \$200K annually today!" Labor is related to the other challenge, cost inflation: "EPC costs have doubled over the last two years," Adams



3. Panelists discuss how gas turbines have shifted from “bridge technology” to a bridge for rapid baseload expansion, alongside mounting hurdles from water and transmission to labor, fuel security, and data-center reliability requirements

stated. However, data center revenue “can easily cover those costs.”

Lack of gen options. Supporting the “surge” conclusion is the lack of other generation options. No one is yet talking about a return to coal (although coal plants take much longer to build). Tessmer did ask the panel about small modular reactors (SMRs), but they were roundly dismissed, at least for the short term. Some of the commentary: Viable technology is at least five years away, the US has no repository for spent fuel, regulatory framework does not support the size, and the technology is not compatible with “speed to power.” Large scale batteries, even with costs coming down, have one big limitation: They supply no inertia to the grid.

Fuel supply. Access to natural gas resources is critical, which is why Texas and Pennsylvania are such hot regions for power plants and data centers. Tessmer noted that “50% of our quotes for LM6000s request dual-fuel capability.” Adams stressed having two sources of gas at the site. Dylan mentioned the premiums incurred for flexibility in long-term gas delivery. “But they are worth it,” he stressed. It is costly to have diesel-firing backup “just sitting there,” Adams bemoaned.

The “nines.” Reliability requirements for data centers were another eye-opener. Where once digital companies talked about “five or six nines” for power quality, their sights have lowered to 99.9%. Flowers noted that data centers must plan for curtailments. Adams stated that you need 1000 MW of batteries for 1000 MW of electric supply. Also,

lots of smaller GTs present better N+1 reliability than a few large units. Synchronous generators can also play a role.

Almost inconceivably, data centers can experience demand swings of up to 100 MW per nanosecond. As such, they pose a quantum leap in reliability challenges, offering opportunities for fast response batteries and flywheels behind the meter. Such dramatic load swings can cause failures in GTGs, too.

ANALYTICS, OUTAGES, PEOPLE

Three critical themes emerged from the Operational Challenges panel: more and better use of data analytics, new approaches for outage management, and finding, retaining, and training site workers. Panelists were Scott Smith, TC Energy; Brian Palmer, FM Global; Paolo Rocha, Silicon Valley Power; Cory Anderson, PROENERGY; and moderator Lance Herrington, PROENERGY.

“Is the intermittency factor following renewables over- or understated,” asked Herrington, to kick it off. Understated, answered Palmer immediately. Anderson noted that machine inspections get harder to manage, complicating risk-reward decisions. Smith mentioned that it’s harder to find parts for peaking plants. All agreed that new ways forward were needed for managing outages, such as relying more on condition-based assessments, less on calendar-based planned downtime, and shifting work from majors to minors to avoid the industry crunch of typical spring and fall outage periods.

Following a more general question on getting better at maintenance, Rocha noted

that even having a spare turbine for a 2-unit LM6000 combined cycle isn’t adequate for reliability. Units go into depots for 12-18 months these days, he continued.

Palmer and Smith proved to be big champions of predictive analytics to inform risk-based decisions. Smith went further, asking can we deploy AI for better modeling and predictions of machine health and potential component issues, and better use of analytics in business planning. Herrington emphasized an opportunity for the industry to standardize on how borescope inspections are conducted, and for O/Os to “bring all the prediction data together in one place. Yes, agreed Palmer, data is still reviewed “in silos.” More collaboration among owners, operators, service providers, and insurers would help.

Rocha called the “people aspect of operations” a “terrible” issue for them. “We are in an area with an exorbitant cost of living and have a huge problem attracting talent.” Palmer reiterated what most should know: Equipment losses are often driven by poor operator decisions.

COMING DOWN THE PIKE...

PROENERGY execs asked that most of the details divulged in the R&D session not leave the room, but one headline, in particular, is in order:

- The new PE6000 engine has been successfully validated and 20 units have shipped. Fleet leader has 750 starts and 4235 hours; fleet totals are 3741 starts and 27,384 hours. [ccj](#)

Easy as 1,2,3: Choose inlet filters based on GT-specific standards

ISO has published the first turbomachinery-specific standards for air intake filters. ISO 29461-1, ISO 29461-2 and ISO 29461-3 establish uniform test methods for efficiency and dust holding capacity, performance in fog and mist, and mechanical integrity at high pressure. While this is not breaking news, the combination of the three standards is a powerful decision-making tool. Camfil's turbomachinery filtration experts prompted this recap for CCJ readers directly involved in plant O&M, to clarify how the standards should be applied on the deck plates.

Gas turbines, especially in the advanced class, are highly sensitive to particulate and moisture ingress. Filters span a wide efficiency range, from coarse pre-filters to ultra-fine finals that keep compressors and hot-gas paths clean. Until now, plants relied on standards created for other industries, including EN779, ASHRAE 52.2, ISO 16890 and ISO 29463/EN1822, and then tried to map those results to turbine service. ISO 29461 closes that gap by aligning laboratory

methods with field realities and by providing a single classification approach that covers the full filter range.

EFFICIENCY AND DUST LOADING

ISO 29461-1 is the first international test standard dedicated to reporting mechanical filtration efficiency and dust holding capacity for turbomachinery air inlet filters, from pre-filters to HEPA grades.

Key points for plants:

- One classification system. It replaces the need to cross-reference EN779, ASHRAE 52.2, ISO 16890 and ISO 29463/EN1822 when specifying turbine filters, reducing ambiguity for buyers and engineers.
- Electrostatic effects excluded. Reported efficiency reflects mechanical capture, not transient electrostatic charge that dissipates early in service and can overstate field performance.
- Standardized dust loading. All filters are dust-loaded under a single procedure, enabling comparable dust holding capacity and life estimates. This is the first stan-

dard that dust loads HEPA-class elements for lifecycle comparison.

Implications: Specifications and bids now can be evaluated on equal footing. Plants can optimize pre-filter and final-filter pairings based on verified loading curves and pressure-drop development, not marketing equivalencies.

FOG, MIST AND HYDROPHOBICITY

ISO 29461-2 addresses wet operation by assessing endurance in fog and mist and resistance to water penetration across the entire filter element, not just media swatches.

Why it matters:

- Controls contaminant migration in wet conditions. Without hydrophobic features, water can dissolve salts or push fine particles through the media to the clean side, leading to fouling, erosion and corrosion downstream.
 - Replaces disparate in-house tests. Prior practice varied by supplier, from no hydrophobicity testing to media-only tests under EN20811/ISO811 or AATCC 127. ISO 29461-2 standardizes methods and parameters for the complete filter.
 - Objective pass/hydrophobic rating. The 3-hour test requires: pressure drop under 1000 Pa, no measurable downstream water, and, for a "hydrophobic" label, a water-dye confirmation of zero bypass.
- Specifying guidance: For sites with frequent fog, sea spray or high humidity, prioritize filters that meet desired efficiency per ISO 29461-1 and achieve a hydrophobic rating with low, stable pressure drop per ISO 29461-2.

MECHANICAL INTEGRITY AT HIGH PRESSURE

ISO 29461-3 introduces a rigorous wet burst protocol to verify the mechanical robustness of turbomachinery filters under high differential pressure, including moisture-laden loading.

Plant-relevant outcomes:

- FOD risk mitigation. The burst test confirms no parts break loose or release downstream at elevated pressure differentials, protecting compressor blading and seals.
- Durability under cyclic duty. Methods address continuous and cyclical pressure loads, aligning with fast-start and peaking profiles common in modern fleets.
- Post-burst efficiency check. After wet burst exposure up to about 25 in. w.g. (approximately 6250 Pa), the standard assesses damage and any drop in particulate efficiency. A filter rated T10 in new condition, for example, might degrade to



Filter after high-pressure burst. Upstream view of a Camfil CamGT filter following burst testing—no visible pleat rupture, media tears, frame deformation, or seal failure observed. Filters should demonstrate strong mechanical durability under high pressure per ISO 29461-3:2024 to support safe operation.

T8 if the media has torn or structurally yielded in service. ISO 29461-3 measures and reports that change.

Three-step method: Confirm initial efficiency per ISO 29461-1, perform the wet burst to the specified pressure, then verify no loose pieces, no sudden pressure-drop reductions indicative of tears, and measure any efficiency reduction.

APPLYING THE TRIO IN PROCUREMENT AND OPERATIONS

For robust filter strategies, consider the standards together:

- Efficiency and life, via ISO 29461-1, to balance compressor cleanliness against pressure-drop penalties over a full loading cycle.
- Wet-weather resilience, via ISO 29461-2, to prevent water bypass and contaminant

migration in fog or mist.

- Structural safety margin, via ISO 29461-3, to avoid catastrophic failures during high ΔP events and to understand post-event efficiency.

A practical selection path for wet sites is to specify final filters that are high efficiency, for example T10 or higher in ISO 29461-1 classifications, with documented hydrophobic performance under ISO 29461-2, and demonstrated burst resilience per ISO 29461-3.

TAKEAWAYS FOR OWNER-OPERATORS

- Expect clearer apples-to-apples comparisons across vendors. Require suppliers to provide ISO 29461-1 reports with loading curves and end-of-life criteria, ISO 29461-2 fog-and-mist results with pass or hydro-

phobic ratings, and ISO 29461-3 burst integrity evidence with post-test efficiency.

- Align maintenance triggers with standardized dust-loading behavior and pressure-drop evolution rather than calendar intervals alone.
- For coastal, industrial or high-humidity sites, move hydrophobicity from a “nice to have” to a minimum requirement to control salt and fine contaminant transport under wet conditions.

Bottom line. ISO 29461-1, -2 and -3 provide a coherent, turbomachinery-focused basis for specifying, evaluating and operating inlet filters. Plants can now ground decisions in standardized, turbine-relevant data on efficiency, wet performance and mechanical integrity, improving protection of high-value assets while optimizing pressure-drop and lifecycle cost. [ccj](#)

Index of advertisers COMBINED CYCLE Journal
No. 85 (2026)

Advanced Filtration Concepts.....	17	HRST	81	HA Users Group	48
Advanced Turbine Support.....	34-35	IHI AMERICAS	21	HRSG Forum.....	103
AGTServices	37, 77	Integrated Global Services (IGS)	62-63	Low Carbon Peer Group	54
AGTSl.....	7	JASC.....	29	Power Plant Controls User Group	54
Arnold Group USA.....	18-19, 85, 111	Liburdi Turbine Services	45	Steam Turbine Users Group	54
Caldwell Energy	89	Maximum Turbine Support.....	15	Precision Iceblast Corp.....	26-27
Camfil Power Systems.....	76	MD&A	2	ProEnergy.....	12-13
Clean-Co Systems	43	Mee Industries.....	78	Schock Manufacturing.....	73
Crown Electric	46-47	National Breaker Services.....	46-47	Sisu Energy & Environmental	33
Cust-O-Fab Specialty Services.....	67	National Electric Coil	95	Sulzer Turbo Services	71
Cutsforth	51	NYCO Group	88	SVI Industrial	25
Dekomte de Temple	80	Power Engineering Services and Solu- tions.....	99	Synergy Catalyst	49
Donaldson Company	9	Power Users Group		Taylor’s Industrial Coatings	75
Doosan Turbomachinery Services.....	65	7EA Users Group	69	TesTex.....	82
EnergyLink International	11	7F Users Group.....	61	Thermal Chemistry.....	101
Filter Doc.....	74	Combined Cycle Users Group.....	54	Trinity Turbine Technology	53
Fucich LLC	83	Frame 5 Users Group	69	Tuff Tube Transition	55-58
GE Vernova.....	4-5	Frame 6B Users Group	69	Umicore	41
Groome Industrial Service Group 31, 112		Generator Users Group	54	Van Hydraulics.....	101
Gulf Turbine Services.....	39			Zokman Products.....	72



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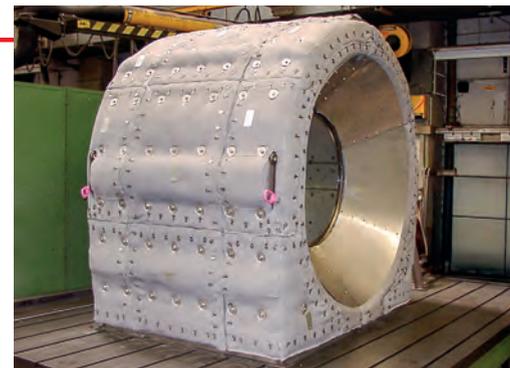
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