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CCJ COMBINED CYCLE Journal

Number 73 2023

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WTUI 

The Western Turbine Users group welcomes GE aero owner/operators to the international organization's 32nd Annual Conference & Expo in San Diego. 7

User Group Reports

Best Practices Awards

Recognition

Upcoming Meetings

Alstom Owners Group
Annual Conference & Vendor Fair
March 20-24
EPRI Campus
Charlotte, NC
https://aogusers.com

Film Forming Substances
Sixth Annual Conference
March 21-23
Monash University
Prato, Italy
https://FilmFormingSubstances.com

7F Users Group
Annual Conference & Vendor Fair
May 15-19
Renaissance Atlanta Waverly Hotel
Atlanta, Ga
https://www.powerusers.org

European HRSG Forum
Ninth Annual Conference
May 16-18
Monash University
Prato, Italy
https://europeanHRSGforum.com

Siemens Energy Gas Turbine Conference
June 5-8
Renaissance Orlando at Sea World
Orlando, Fla
dawn.mccarter@siemens-energy.com

D5-D5A Users
Annual Conference & Vendor Fair
June 5-7
Chattanooga, Tenn
https://www.501D5-D5AUsers.org

HRSG Forum
Annual Conference and Vendor Fair
Renaissance Atlanta Waverly Hotel
Atlanta, Ga

LM2500 INSULATION SOLUTIONS AT ITS FINEST

ARNOLD GROUP

CCUG honors Dave Such with its Individual Achievement Award

Xcel Energy's Dave Such was selected the lone recipient of the Combined Cycle Users Group's Individual Achievement Award (IAA) in 2022, the 26th person to be so honored (list below) since the award's inception in 2013. Voting is by members of the CCUG's steering committee, chaired by Phyllis Gassert of Talen Energy. Aaron Kitzmiller of Vistra Corp heads the subcommittee responsible for nominating award candidates.

Recall that the IAA recognizes individuals who have demonstrated excellence in the development, design, construction, management, operation, and/or maintenance of combined-cycle facilities throughout their careers.

The search for award candidates is ongoing. Readers are encouraged to nominate one or more individuals for the 2023 award before the June 2 deadline. The process: Complete and submit the nomination form posted on the CCUG website at www.powerusers.org. Refer questions to aaron.kitzmiller@vistracorp.com.

Dave Such has, throughout a 40-year industry career, unselfishly shared his deep technical expertise with the combined-cycle user community—especially that related to the operation and maintenance of GE 7F gas turbines. He has been involved with some early 7FA turbines from commissioning through full unit life extension—including one with more than 25 years of service and 180,000 fired hours.

Dave has gained a reputation for encouraging the industry to advance and pursue unique solutions to difficult problems. Example: He pioneered the use of third-party refurbishment and manufacturing of 7F turbine components at a time when the OEM was the only option. He also taught himself how to tune combustion systems and apply unique techniques to improve both engine operation and performance.

Most recently, Dave has been the technical lead for gas-turbine flexibility upgrades within Xcel Energy and has successfully installed some of the latest GE combustion and turbine hardware on several units—including DLN 2.6+ with axial fuel staging. The industry continues to benefit from Dave's passion for sharing this experience with others.

Additionally, he has been a great mentor to colleagues within Xcel Energy and has supported fellow owner/operators industry-wide by sharing turbine parts when they find themselves in a challenging situation.

Dave is currently a leader in the user community as a member of the 7F Users Group's steering committee, which he has been a part of for 15 years. He continues to share his experiences with others via insightful technical presentations at industry conferences.

In accepting his award, Such said, "Although this is an Individual Achievement Award, most of us realize that significant achievements in the power industry are group projects. The many user groups and conferences we have today promote collaboration and the sharing of knowledge that drives important accomplishments. I am very grateful for this particular recognition award, but also want to clarify that I am merely a product of being an active member of the community of power user groups for over 20 years. Regardless, I feel incredibly honored. Thank you very much."

Past recipients of the CCUG award

Robert Anderson, Competitive Power Resources
Rodger Anderson, DRS-Power Technology Inc
J Edward Barndt, Rockland Capital
Pierre D Boehler, NRG Technical Services
Harry Carbone, Duke Energy
Chuck Casey, Riverside Public Utilities
Andrew M Donaldson, PE, WorleyParsons
Kevin C Geraghty, NV Energy
William J Gillis, ExxonMobil
Michael David Hoy, TVA
Wayne T Kawamoto, Corona Cogen
Robert Krowech, PE, HRST
Raymond Martens, Klamath Cogen and Peakers
Clyde Maughan, Maughan Engineering Consultants
Dr Robert Mayfield, Tenaska Westmoreland
Andrew McNeil, NV Energy
Patrick Myers, Ceredo Generating Station
William F O'Brien, IHI Power Services
John F D Peterson, BASF
Steve Royall, PG&E
Daniel C Sampson, WorleyParsons
Rick Shackelford, NAES Corp
Peter So, Calpine Corp
Paul M White, PE, Dominion Resources Services
William Wimperis, Constellation Energy (Exelon)

Note that the company affiliations of past recipients may have changed over the years. Plus, some individuals have retired.

COMBINED CYCLE Journal

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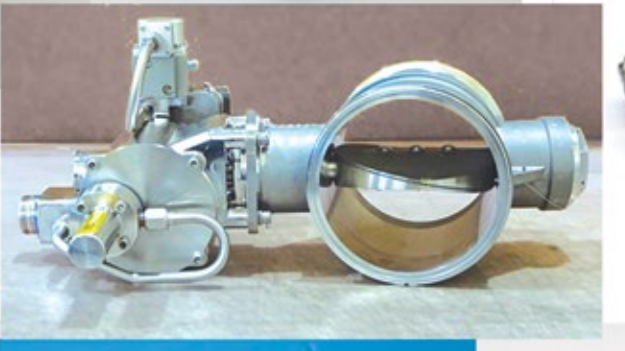

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WESTERN TURBINE Users

SAN DIEGO
March 2023

32nd Annual Conference and Expo

President's welcome

On behalf of the board of directors, officers, breakout-session chairs, and support staff, welcome to the 32nd annual conference of the Western Turbine Users.

In the late 1980s, a handful of brave investors purchased some early model LM2500 and LM5000 gas turbines for service in California. Their O&M personnel quickly realized the common issues and advantages of the LM engine, gathering in small groups to compare experiences and provide solutions to present to the OEM.

Western Turbine Users was born. Incorporating in 1990, the small group of plant representatives grew to 50, doubled to 100, then 500, and now is over 1000 members strong. Be proud to associate with our organization's legacy, rich history, and worldwide influence as you collaborate with other industry professionals. Little did our predecessors imagine their forethought would result in something as meaningful, relevant, and influential as WTUI.

Join me in celebrating 33 years of the evolving General Electric aeroderivative gas turbine industry. Users like you have challenged equipment suppliers to improve their products, as we demand new uses and extend the lives of our gas turbines and all support equipment. As a WTUI member, your conference contribution is the root to our success. You are a vital element of the volunteer organization as we move forward.

Ed Jackson
President, WTUI

Highlights

Sunday, March 12

7:30 Golf tournament at the Riverwalk Golf Course

2:00 Conference registration opens

3:30 Welcome to WTUI/Conference familiarization session

5:30 Welcome reception, exhibit hall opens

Monday, March 13

8:00 President Ed Jackson's welcome, program updates, introductions, treasurer's report, WTUI 1990 to present

9:30 Presentations by the Authorized Service Providers: MTU, IHI, TCT

10:45 Mark Axford's worldwide gas-turbine business update with Tony Brough

11:45 GE Services presentation

12:00 Lunch/exhibits

1:30 Women in Power

2:30 Technical meetings for LM2500, LM5000, LM6000, LMS100 users

6:30 Monday night reception

Tuesday, March 14

8:00 Technical meetings for LM2500, LM5000, LM6000, LMS100 users

12:00 Lunch/exhibits

2:30 Special Technical Presentations on best practices, fogging, CEMS, emissions control, firm dispatchable clean power, root cause analysis, HRSG/SCR maintenance, generator monitoring, bearing health

Wednesday, March 15

8:00 Technical meetings for LM2500, LM5000, LM6000, LMS100 users

10:45 GE new products update

12:00 Adjourn

What's inside this special section:

Published by the COMBINED CYCLE Journal

32nd Annual Conference & Expo

March 12 – 15, 2023
San Diego Convention Center

Western Turbine Users Inc, the world's largest independent organization of aeroderivative gas-turbine owner/operators celebrates 33 years of service to the industry at its 32nd annual conference and expo, March 12-15, 2023, in the San Diego Convention Center.

The last three years have been especially challenging for the user-managed group. This is the first in-person meeting since the state of California stopped WTUI from conducting its annual event at the Long Beach Convention Center in March 2020 because of Covid-19 concerns. That would have been WTUI's 30th Annual Conference and Expo.

In its place, a brief update on the organization's activities was presented online a few months later to keep the membership informed on what the OEM and its four licensed Authorized Service Providers (ASPs)—MTU Power, TransCanada Turbines (TCT), IHI Corp, and Air New Zealand Gas Turbines—were doing. Note that ANZGT exited its LM power and marine businesses as 2022 came to a close.

Robust virtual conferences, simulating the group's traditional in-person meetings, were conducted in 2021 (the 30th annual, officially) and 2022 (the 31st) given the ongoing pandemic. These online events were produced in collaboration with CCJ, each over a period of three weeks, in 10 highly-focused half-day sessions (11 in 2022).

Summaries of the 2022 presentations follow the 2023 conference overview, immediately below. The 2022 presentations, as well as those from the 2021 conference, 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 32 (2023)

Perhaps the most important reason for attending the San Diego conference is the opportunity to reconnect with colleagues whom you haven't seen—and, in some cases, haven't spoken to—in three years. WTUI's organizers provide plenty of time to fulfill this objective. Prime examples include a golf tournament Sunday morning at the Riverwalk Golf Club (7:30 start), the vendor-sponsored Sunday evening welcome reception from 5:30 to 8:30 in the exhibit hall, and the Monday night reception with live entertainment, from 6:30 to 9:30, in Room 6AB of the Convention Center.

For WTUI first-timers, it's not necessarily about reconnecting 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 New Conference Attendee session (called WTUI Conference Familiarization in the technical program, p 10).

It is chaired by Andrew Gundershaug, plant general manager, Calpine Corp, 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 LM5000 and LM6000 breakout sessions.

Gundershaug is a patient instructor who will help newcomers maximize the benefits of participating proactively in the engine-specific technical sessions on Monday, Tuesday, and Wednesday. Plus, he will provide valuable guidance on how to assure units under their purview operate safely and at high reliability.

In his opening remarks on Sunday, Gundershaug will explain the conference arrangement, how to organize your participation, and how to navigate the 2023 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—that is, gear or direct drive. The LM2500 will be examined in detail.

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

- Presentations by the OEM and the ASPs focusing on shop findings and solutions. Important to have CCJ's acronyms sidebar handy (p 14) 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.
- Technical presentations by consultants and third-party solutions providers invited by the organiza-

Continues on p 14

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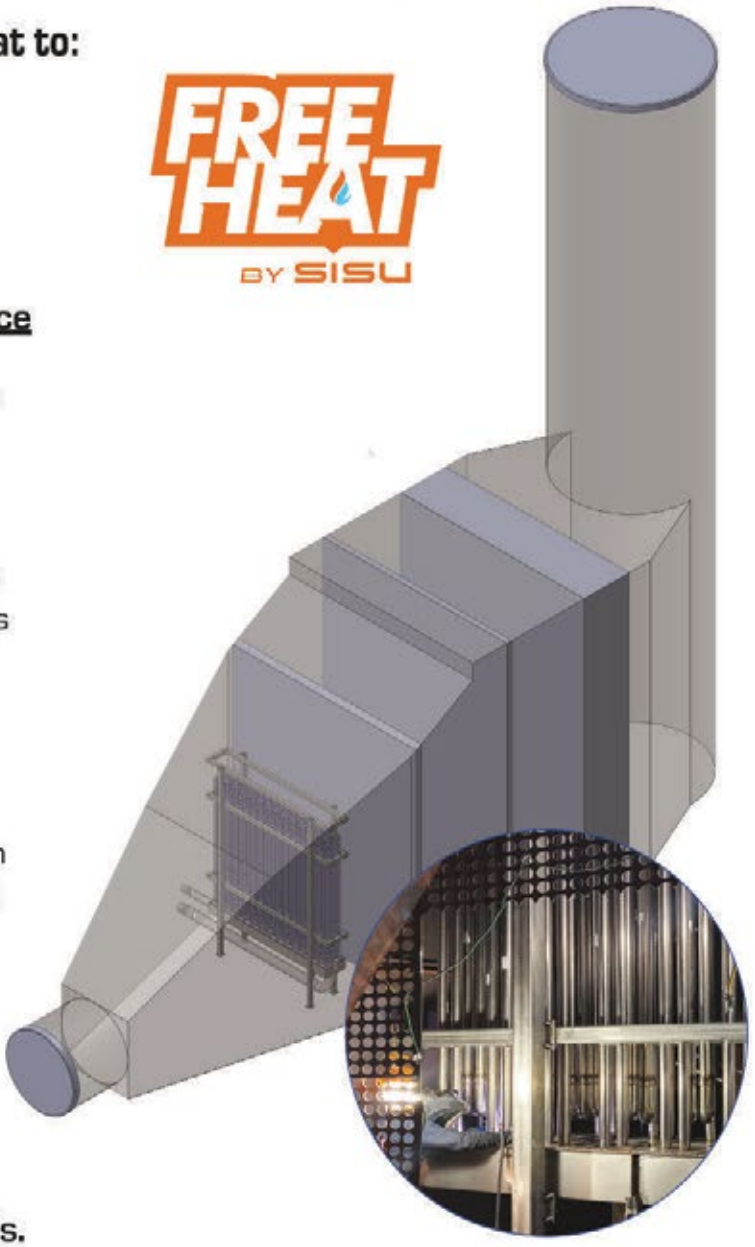

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Technical Program

As of January 9, 2023

Where to go (see floorplan, p 4)

Registration: *Sails Pavilion Lobby*
Exhibit Hall: *Sails Pavilion*
Breakfasts: *Sails Pavilion*
Luncheons: *Sails Pavilion*

LM2500 Breakout Meetings, *Room 6DE*
Chair: Garry Grimwade, Riverside Public Utilities

LM5000 Breakout Meetings, *Room 10*
Chair: Perry Leslie, Wellhead Services Inc

LM6000 Breakout Meetings, *Room 6CF*
Chair: Dave Fink, Southwest Generation

LMS100 Breakout Meetings, *Room 11AB*
Chair: Steve Worthington, Arizona Public Service Co

Sunday, March 12

AFTERNOON

2:00 to 7:30 Registration

3:30 to 5:00 WTUI Conference Familiarization, *Room 9*
Chair: Andrew Gundershaug, Calpine Corp
All new registered conference attendees

EVENING

5:30 to 8:30 Exhibitor-Sponsored Welcome Reception, *Sails Pavilion*
All registered attendees, spouses/guests

Monday, March 13

MORNING

7:00 to 4:00 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 9:30 General Session/WTUI 1990-2023, *Room 6AB*
All registered conference attendees

9:30 to 10:30 ASP Presentations (IHI, MTU, TCT), *Room 6AB*
All registered conference attendees

10:30 to 10:45 Break, *Sails Pavilion*

10:45 to 11:45 Gas-Turbine Business Update, *Room 6AB*
Mark Axford, Axford Turbine Consultants LLC
All registered conference attendees

11:45 to noon GE Services Presentation, *Room 6AB*
All registered conference attendees

AFTERNOON

Noon to 2:30 Lunch/Exhibits
Must have name badge to enter

2:30 to 5:30 Breakout Meetings: LM2500, LM5000, LM6000, LMS100
Users, ASPs, and GE only

EVENING

6:30 to 9:30 Monday Night Reception, *Room 6AB*
All conference attendees and registered spouses, guests must have name badge, wristband and be 21 to enter

Tuesday, March 14

MORNING

7:00 to 4:00 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

9:30 to 10:00 Break, *Sales Pavilion*

10:00 to noon Breakout Meetings: LM2500, LM5000, LM6000, LMS100
Users, ASPs, and GE only

AFTERNOON

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 "CCJ Best Practices," *Room 6DE*

"Monitoring Bearing Health with Confidence," *Room 11AB*
GasTOPS Ltd

"Firm Dispatchable Clean Power," *Room 6CF*
Industrom Power LLC

3:30 to 4:30 "Increasing Plant Performance by 10% with Fogging," *Room 6DE*
ProEnergy

"Best Practices for RCA in Context of a Potential Dispute," *Room 11AB*
Exponent

"Utilizing Integrated-Path Optical CEMS to Meet EPA Regs," *Room 6CF*
CEMTEK Environmental

4:30 to 5:30 "Benefits of Maintaining Emissions Systems and HRSGs," *Room 11AB*
Groome Industrial Service Group

Shaft Voltage and Current on Generators," *Room 6DE*
Iris Power—Qualitrol

"Gas Turbine SCR," *Room 6CF*
Cormetech Inc

Wednesday, March 15

MORNING

7:00 to 8:00 Breakfast, *Hawaiian Corridor, adjacent to Rooms 7-11*
All registered conference attendees

8:00 to 10:30 Breakout Meetings: LM2500, LM5000, LM6000, LMS100
Users, ASPs, and GE only

10:30 to 10:45 Break, *Hawaiian Corridor*

10:45 to 11:45 GE New Products Update, *Room 6AB*
All registered conference attendees

11:45 to noon Wrap-up/Adjourn, *Room 6AB*
All registered conference attendees

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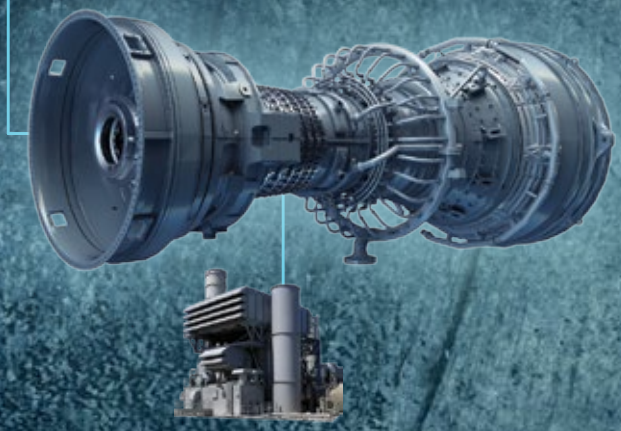

LMS100*

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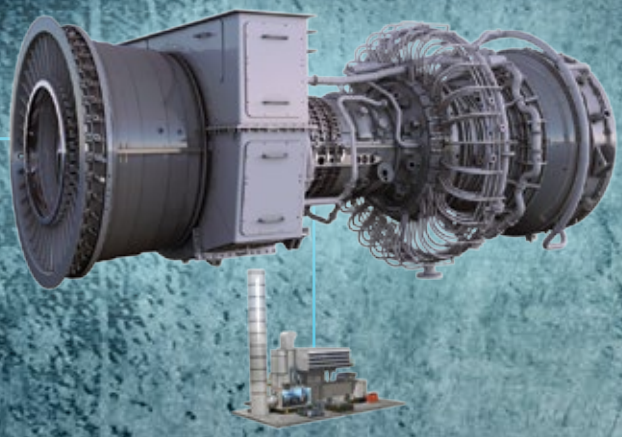

LM6000*

50 million operating hours (OH)

LM2500*

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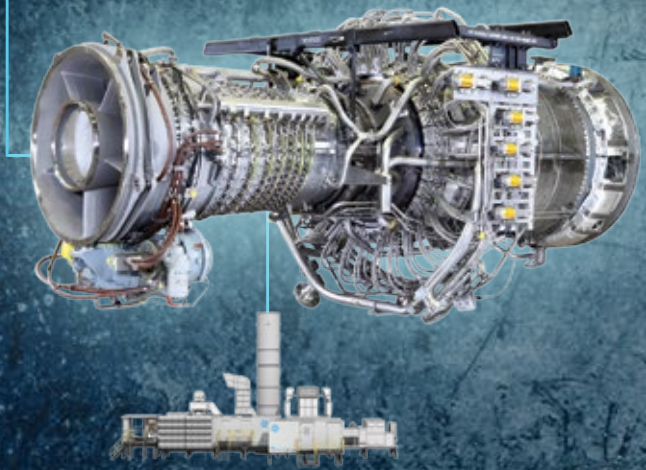

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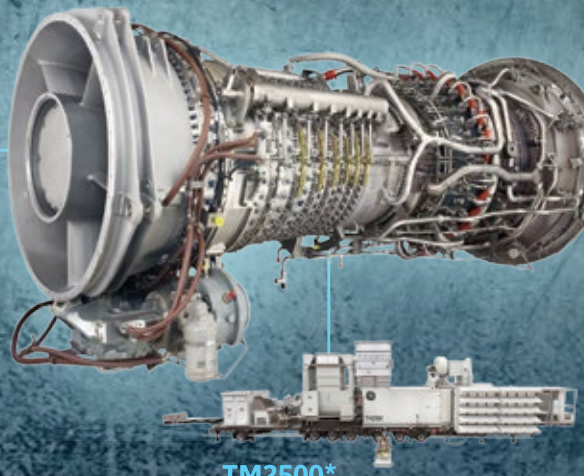

TM2500*

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Continued from p 8

tion's leadership team (p 22).

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The first morning

The pace of the meeting quickens after breakfast Monday as all attendees gather in Convention Center Room 6AB for opening remarks by President Ed Jackson, plant manager of Missouri River Energy Services' Exira Generating Station in Brayton, Iowa.

Recall that Jackson succeeded John Hudson, who resigned as plant manager of Orange Grove Energy Center in San Diego and left the aero world for greener pastures early in 2022. Hudson had taken the helm from Chuck Casey, utility generation manager for Riverside (Calif) Public Utilities, in April 2020. Casey served as president for seven years.

Following the introduction of officers, directors, breakout session chairs, and support staff, plus the treasurer's financial report, badge rules, and other business matters, Mike Raaker of Raaker Services LLC, the group's historian/ambassador will present on the organization's rich history of service to the industry (p 32).

Presentations by the three remaining service providers authorized by GE to work on LM engines run until the morning break.

Highlights of the first morning are presentations by Tony Brough, president, Dora Partners & Company, and Mark Axford, president, Axford Turbine Consultants. Brough will update the group on the state of the global gas-turbine market using engine-specific and geographic stats considered by many the industry's most reliable. Axford, who has presented to this group on the state of the energy industry for nearly two decades and a crowd favorite, will have his crystal ball to help attendees prepare for the future.

A short presentation by GE Services closes out the morning session.

Engine-specific sessions

Breakout meetings for the LM2500, LM5000, LM6000, and LMS100 gas turbines, the core of WTUI's technical program, begin Monday afternoon at 2:30 and run until 5:30. Attendance is limited to users, ASPs, and GE. These sessions continue Tuesday morning from 8 to noon with a break at 9:30. However the first 90 minutes is for users only; ASPs and GE are invited to join in from 10 until lunch. Wednesday, the breakout sessions go from 8 to 10:30 for users, ASPs, and GE. Adding, that's a total of 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 WTUI VP Garry Grimwade, who is responsible for operating and maintaining four LM6000s, four GE10s, and an LM2500-powered combined cycle at Riverside (Calif) Public Utilities. Before his involvement with land-based aero engines, he spent a decade working with "big iron," including a 700-MW merchant facility and two GE "H" frames. Grimwade, who hails from the UK, served in the US Navy as an aviation machinist's mate before investing five years at the Pacific Gas Turbine Center.

Others taking turns at the front of the room to share their knowledge include Oliver Eckert of MTU Power, Robert Smans of TCT, and Nam Tran of GE, the OEM's LM2500/TM2500 product leader. Tran will be supported by GE Gas Power's Tyler Dowty, Pedro Montiel, and Theo Sanchez, and Field-Core Service Manager Wayne Romeo. Mike Carlson, LM2500 and LMS100 program manager for the Aero Alliance joint venture between GE and Baker Hughes, also will be participating. That JV was formed to provide spare parts, repairs, and maintenance services for aero engines.

MTU's presentation is expected to address the following issues, common to all engine models in the fleet, based on plans received by the editors in January:

Continues on p 20

Acronyms

Keep this list of acronyms nearby during the conference. You'll find that most speakers talk in "shorthand," using acronyms freely. If you're not up to snuff on your aero lingo you can get lost in a hurry and possibly miss key points. The "cheat sheet" below can help you remain focused.

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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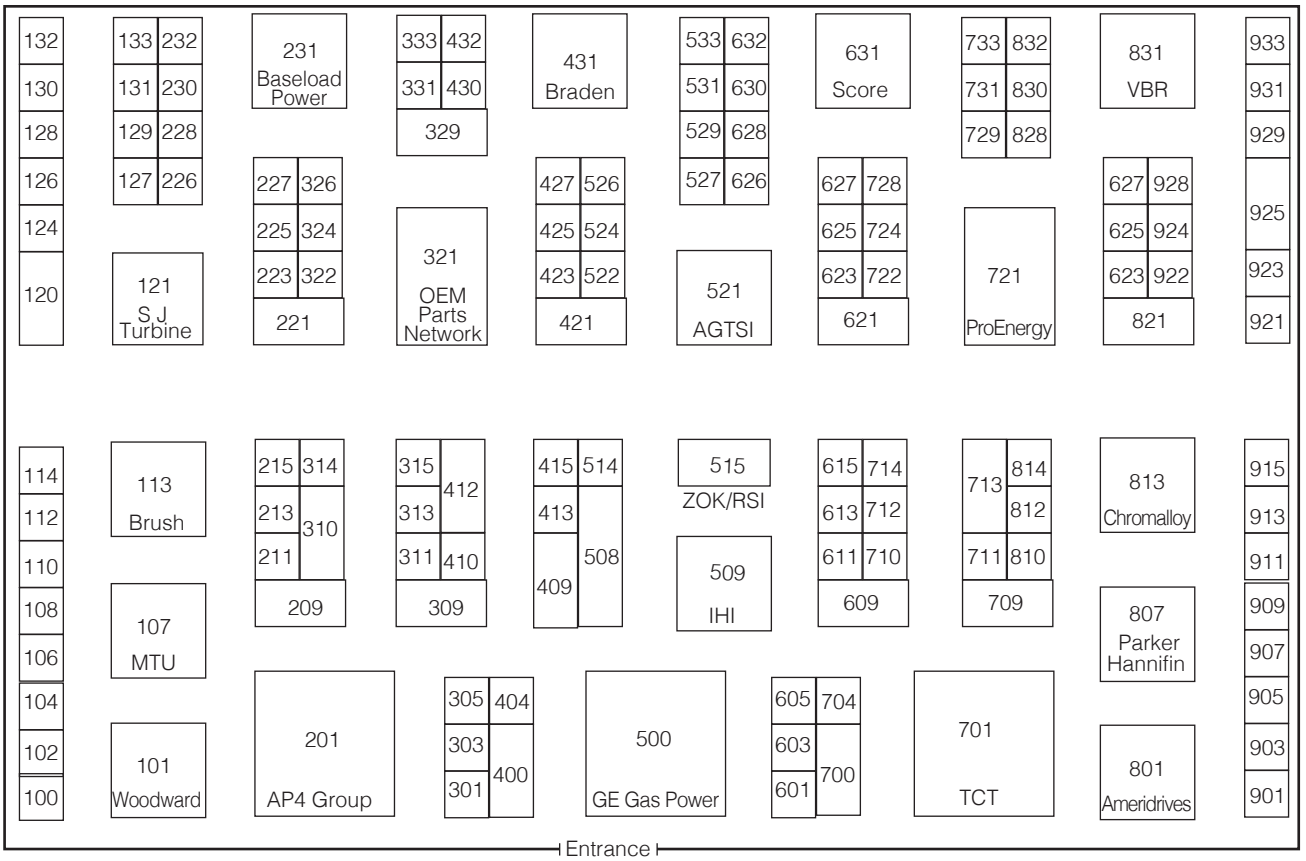

Alphabetical order by company as of Feb 13

Company	Booth
AAF International	415
Advanced Filtration Concepts	223
Advanced Turbine Support	823
Aeroderivative Gas Turbine Support	521
Air Hygiene International	722
Airgas Specialty Products	400
Alta Solutions	228
Ameridrives International	801
AMETEK Power Instruments	907
AP4 Group	201
APR Energy	915
Arkwin Industries	100
ARNOLD Group	700
Baseload Power Generation Parts & Services	231
BASF	313
Bearing Inspection	613
Braden Filtration	812
Braden Group	431
Bradley Griffin	709
Brownell Aeroderivative Consulting	711
Brush Services	113
Caldwell Energy	605
California Analytical Instruments	531
Camfil Power Systems	209
Catalytic Combustion	322
CECO Environmental	425
CEMTEK KVB-Enertec	303
ChangeOVR Filtration	524
Chromalloy	813
CleanAir Engineering	310
Conax Technologies	324
Continental Controls	625
Core Tech Industrial	225
Cormetech	621
Dekomte de Temple	825
Detector Electronics	104
Doble Engineering	423
Donaldson	404
Dynamis Power Solutions	526
EagleBurgmann Industries	724
ECT	712
Electric Machinery	129
Electrical Maintenance Consultants	922
eLogger	410
Emerson	514
EnergyLink International	704
Enerpac/Sweeney Aerospace Tools	315
Environex	623
EthosEnergy	713
Evident Scientific	909
Exponent	710
Fossil Energy Research (FERCO)	924
GasTOPS	609
GE Gas Power	500
Groome Industrial Service Group	329
Ground Power Parts	630
Gusto Gen	421
HILCO Filtration	221
HPI Energy Services	527
HRST	529
Hy-Pro Filtration	821
IHI	509
Industrial Air Flow Dynamics	106
Industrom Power	108
Integrated Power Services	921
Iris Power-Qualitrol	522
KAAM Group	413
Liburdi Turbine Services	114
M & C Tech Group North America	628
Marioff, NA	729
Maximum Turbine Support	508
Mee Industries	326
Met Weld International/ CRDX	913
MFS (Mechanical Field Support)	925
Minimax Fire Solutions International	714
Montrose Environmental Group	615
MPW Industrial Services	215
MTU Maintenance Hannover	107
Munters	430
National Electric Coil	810
National Mechanical Services	828
Nederman Pneumafil	227
Nord-Lock Group	305
OEM Parts Network	321
ORR Protection Systems	726
Pacific Standard Environmental	213

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Petrotech	611
Precision Iceblast (PIC)	226
ProEnergy	721
Relevant/Switch Filtration	412
Rochem Technical Services (USA)	814
Rotation Solutions	120
Rust Automation & Controls	112
S J Turbine	121
Score Energy	631
SISO Engineering	603
Sisu Energy and Environmental	110
SSS Clutch	409
Strategic Power Systems	301
Sulzer Turbo Services Houston	102
SVI/Bremco	905
Synergy Catalyst	331
T2E3	311
Teledyne API	427
Temisa	923
Thermo Fisher Scientific	626
TOPS Field Services	127
Toshiba America Energy Systems	903
TransCanada Turbines	701
Turbine Technics	309
Turbomachinery Intl	827
Umicore Catalyst USA	601
Universal Analyzers	211
US Cleanblast	926
Uspei	830
VBR Turbine Partners	831
Vector Systems	911
Veolia Water Technologies & Solutions	314
ViewTech Borescopes	124
Waygate Technologies	901
Woodward	101
World of Controls	627
ZOK/RSI	515

Numerical order by booth number as of Feb 13

Booth	Company
100	Arkwin Industries
101	Woodward
102	Sulzer Turbo Services Houston
104	Detector Electronics
106	Industrial Air Flow Dynamics
107	MTU Maintenance Hannover
108	Industrom Power
110	Sisu Energy and Environmental
112	Rust Automation & Controls
113	Brush Services
114	Liburdi Turbine Services
120	Rotation Solutions
121	S J Turbine
124	ViewTech Borescopes
127	TOPS Field Services
129	Electric Machinery
201	AP4 Group
209	Camfil Power Systems
211	Universal Analyzers
213	Pacific Standard Environmental
215	MPW Industrial Services
221	HILCO Filtration
223	Advanced Filtration Concepts
225	Core Tech Industrial
226	Precision Iceblast (PIC)
227	Nederman Pneumafil
228	Alta Solutions
231	Baseload Power Generation Parts & Services
301	Strategic Power Systems
303	CEMTEK KVB-Enertec
305	Nord-Lock Group
309	Turbine Technics
310	CleanAir Engineering
311	T2E3
313	BASF

Booth	Company
314	Veolia Water Technologies & Solutions
315	Enerpac/Sweeney Aerospace Tools
321	OEM Parts Network
322	Catalytic Combustion
324	Conax Technologies
326	Mee Industries
329	Groome Industrial Service Group
331	Synergy Catalyst
400	Airgas Specialty Products
404	Donaldson
409	SSS Clutch
410	eLogger
412	Relevant/Switch Filtration
413	KAAM Group
415	AAF International
421	Gusto Gen
423	Doble Engineering
425	CECO Environmental
427	Teledyne API
430	Munters
431	Braden Group
500	GE Gas Power
508	Maximum Turbine Support
509	IHI
514	Emerson
515	ZOK/RSI
521	Aeroderivative Gas Turbine Support
522	Iris Power - Qualitrol
524	ChangeOVR Filtration
526	Dynamis Power Solutions
527	HPI Energy Services
529	HRST
531	California Analytical Instruments
601	Umicore Catalyst USA
603	SISO Engineering
605	Caldwell Energy
609	GasTOPS
611	Petrotech
613	Bearing Inspection
615	Montrose Environmental Group
621	Cormetech
623	Environex
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628	M & C Tech Group North America
630	Ground Power Parts
631	Score Energy
700	ARNOLD Group
701	TransCanada Turbines
704	EnergyLink International
709	Bradley Griffin
710	Exponent
711	Brownell Aeroderivative Consulting
712	ECT
713	EthosEnergy
714	Minimax Fire Solutions International
721	ProEnergy
722	Air Hygiene International
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801	Ameridrives International
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915	APR Energy
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922	Electrical Maintenance Consultants
923	Temisa
924	Fossil Energy Research (FERCO)
925	MFS (Mechanical Field Support)
926	US Cleanblast

Continued from p 14

- Oil supply tube repair for the compressor rear frame (CRF), turbine mid frame (TMF), and/or turbine rear frame (TRF)—including general instructions on how repairs are made both onsite and in the shop.
- TRF oil leakage.
- Excessive oil mist from the package vapor separator vent.
- Main gas strainer problem reported by a user experiencing a sudden increase in T48 spread.
- Hot-gas-induced vibration reading traced to a crushed HP recoup gasket with material missing.
- Water-wash automatic drain valves installed upside down causing piping to be connected to the wrong valve ports.

TCT's program, planned at the same time as MTU's, focuses on these issues, among others:

- CRF engine mount damage attributed to a user's poor maintenance procedure.
- Wear and tear of the lever arm for the high-pressure-compressor's (HPC) variable stator vane (VSV).
- Update on the hinge-bracket wear associated with the dual-fuel manifold.
- Clogging of cooling holes in high-pressure-turbine (HPT) first- and second-stage blades. Suspected gremlin: contaminated NO_x water.
- Update on a LM2500+G No. 7 ball-bearing event discussed at a previous meeting. Particles observed by the D-sump chip detector increased in both size and quantity over time.

Additionally, TCT will offer suggestions on (1) what constitutes a proper oil analysis, (2) best practices for preventive maintenance activities, and (3) the use of tarpaulins to protect engine shipping containers from environmental conditions.

GE is expected to begin its podium time with a review of fleet performance in terms of reliability and availability, and then review the reliability/maintainability improvements it has implemented since 2014. Next comes coverage of engine programs completed, active engine programs, best practices, package programs completed and active, and a review of product bulletins and alerts.

The OEM has extensive experience to share given the LM2500 fleet of GE power units now numbers more than 1100 engines with over 35-million service hours.

Of interest to many users will be the OEM's "How to" messages. Examples: How to avoid the four-hour lockout; reduce startup time to full load; and improve reliability and operability with a Flex 500 control system upgrade.

Attendees also will want to hear about GE's new HPT first-stage blade and about ongoing developments in HPT second-stage-blade life extension, stiffer TMF liner axial support, reducing manifold distress in the single annular combustor, and other work.

The LM5000 session is chaired by Perry Leslie, who watches over the Yuba City Cogeneration Plant for Wellhead Services. 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).

Leslie's planned program encompasses the following:

- Fleet status and exit update by Air New Zealand Gas Turbines, plus the status of spare parts. Paul Humby will give a brief overview of shop repairs over the last year.
- Technical presentation by Steve Johnson of S J Turbine (Booth 121 in the Exhibit Hall).
- Sulzer is primed to present on the power turbine (Booth 102).
- Alta Solutions (Booth 228) will present on vibration analysis.
- Discussion topics include the fol-

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LM2500, Garry Grimwade, *Riverside Public Utilities*
LM5000, Perry Leslie, *Wellhead Services Inc*
LM6000, Dave Fink, *Onward Energy*
LMS100, Steve Worthington, *Arizona Public Service Co*
New users, Andrew Gundershaug, *Calpine Corp*

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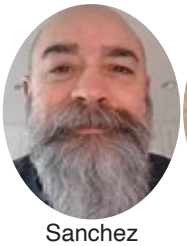
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Toburen

Western Turbine's leadership team consists of the officers, directors, breakout-session chairs, and support personnel who plan and execute the world's largest and most comprehensive technical meeting on GE aeroderivative engines for electric power production, gas compression, and ship propulsion. Day-to-day operations are managed by an experienced support staff.

The individuals in this army of volunteers dedicate hundreds of hours of personal time annually to keep you informed on engine technology, operation, and maintenance.

The material presented by owner/operators, the OEM and its authorized service providers, and independent third-party providers of products and services is important and conducive to your success. Participation in WTUI meetings will help you manage your plant in a manner that maximizes revenue, efficiency, and availability/reliability, and minimizes pollutant emissions—all while maintaining the highest degree of safety.

lowing: Continuation of the megawatt-swing discussion started last year, variable geometry inspection, steam-flow-control upgrade, package component maintenance.

The LM6000 program was developed by Breakout Session Chair Dave Fink of Onward Energy with four of the industry's most knowledgeable on that engine: Ralph Reichert of MTU Power, Robert Smans of TCT, Hiroshi Aoki of IHI, and Nasser Chraibi of GE.

Fink, an I&C technician and operator at Southwest Generation's Fountain Valley (Colo) facility, is responsible for maintenance at the six-unit LM6000 peaking plant. His power-generation career includes six years as an electrician's mate in the US Navy and a decade as I&C technician at Calpine's Gilroy facility (1 × 1 7EA-powered combined cycle and three LM6000 peakers). Fink also spent eight years with F W Marsh LLC, supporting GE in the commissioning and field service of LM engines.

MTU's lineup of presentation topics

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includes these:

- Domestic object damage (DOD) caused by T48 thermocouple probes.
- Effect of fifth-stage HPC blade event on work scope.
- Standard service bulletins for overhaul work scope.
- Consequences of contaminated Sprint water.
- Service bulletin update of experiences:
  - SB349, improved HPC first- and second-stage inner shrouds.
  - SB340, improved HPT Stage 2 nozzle segments.
  - SB342/348, introduction of the 4B/5R bearing with nitride hardening.
  - SB323, improved O-rings of Aflas material in the TRF sump.
- Failure to light off because of fuel-system fine-particle contamination.
- Low-performance troubleshooting (eighth-stage valve issue).
- Causes and consequences of thermal-barrier-coating (TBC) loss on B-ring heat shields.

TCT plans to present on these topics:

- LPC corrosion. Severe corrosion was identified in 2022 on four Stage-0 discs, two Stage-1 discs, and on the forward shafts of four machines.
- LPC Stage-0 disk inspection (SB356/357).
- VSV actuation-ring fretting.
- VSV lever-arm cracking.
- Bolt-hole corrosion at the 4R bearing found on two LM6000PC engines.
- HPT second-stage outer- and inner-band erosion and cracking.
- Introduction to new second-stage nozzle assemblies for the HPT.
- Variable-geometry pump gear-teeth wear.
- Lube-oil-system chip detectors and interpretation of results, with recommended corrective action.

IHI's lineup of presentation topics includes the following:

- Failure of the No. 5 bearing and oil shield in the CRF.
- Failure of the No. 4 bearing in the CRF.
- Inspection of VSV housing bolts for HPC Stages 3-5, including checking of the bolt locking feature.
- Fretting of LPT fifth-stage disc dovetail serrations.
- VIGV forward inner-case corrosion.

GE is prepared to update attendees on HPC first-stage-blade mid-span shroud concerns, dovetail coating refurbishment of HPC blades in Stages 3 to 5, VSV bushing durability, 11th-stage check valves, T48 thermocouples, LPT PCC flex joint, HPC 14th-stage blade distress, HPC VSV inner-shroud bushing wear, lifting-equipment load-test certification, VBV transition-

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duct cracking, exhaust diffuser and clamshell cracks, jacking-oil hoses for Brush DAX generator.

In addition, Strategic Power Systems will present on the value of its Operational Reliability Analysis Program (ORAP®) and the impact of forced-outage incidents (number of incidents, number of plants affected, hours of outage time) during 2022. This is a session highlight.

The LMS100 session is guided by Steve Worthington with OEM input from Tim Schneck. Worthington is the facility manager of Arizona Public Service Co's Ocotillo Power Plant, with responsibility for an eclectic fleet of peaking gas turbines: five LMS100s, 10 LM6000s, four W501AAs, one GE 7EA, and one GE Frame 5. Prior to joining APS a decade ago, he held responsible positions at several eastern utilities. Worthington is a 12-year US Navy veteran.

The only attendees invited to LMS100 sessions are GE employees and users. No ASPs are licensed by GE at this time to work on the LMS100. The editors did not receive an outline of planned presentation content prior to the WTUI meeting.

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 beginning at 2:30, 3:30, and 4:30. Highlights:

2:30

Best practices, *Scott Schwieger, CCJ.* Best practices submitted to CCJ as part of its annual awards program, sponsored by the periodical and WTUI, will be reviewed, with open discussion to follow. Attendees are invited to share their best practices at their seats.

Monitor bearing health with confidence, *Simon Wilson, GasTOPS.* Bearing damage events and unreliable detection technologies are leading causes of unplanned outages and unexpected costs. Damage develops gradually and may be predicted accurately with the proper detection technology—such as GasTOPS's Oil Debris Monitoring technology, available since the mid-1990s.

It combines the company's online MetalSCAN product with its offline advanced troubleshooting capabilities (oil, filter, and chip analysis) to provide an accurate picture of bearing health.

Firm, dispatchable clean power, *Paul Angel, Industrom Power.* Presenter has deep knowledge of LM products having spent more than 30 years with GE Aviation and GE Power before joining Industrom Power. He was an LMS100 product line leader for the OEM and earlier had design and product-line responsibilities on the LM2500 and LM6000.

Angel will speak to a new clean-energy technology/system that recovers waste heat to produce electric power. The carrot is 20% more power and a heat-rate improvement for an LM6000 powerplant.

His presentation begins with an overview of the technology, how it works, and a demonstration timeline. Next, the components of a 10-MW product for use with LM6000 engines will be discussed—including performance improvements. An energy balance, startup times, and other operational benefits also are covered.

3:30

Increasing LM6000 turbine plant performance by 10% through wet fogging, *Paul DiMascio and Chris Evans, ProEnergy.* Presentation focus is on "R&D in action." Wet fogging is compared to other power-augmentation strategies—such a low-pressure water spray, evaporative cooling, and air injection. The R&D process is discussed, along with current performance gains, and the path toward increased power and profitability in any climate.

Best practices for root-cause analysis in the context of a potential dispute, *Dr Ty Porter, PE, and others, Exponent.* Industrial failures often have the potential for a dispute between two or more parties related to liability for causation and, ultimately, responsibility to recover unexpected costs from the outage.

Unintentional improper handling of physical evidence and information can have a negative impact on the outcome of a potential dispute regardless of the technical reasons for the failure.

Focus of the presentation is best practices for plant personnel and other involved parties following an unexpected failure in the context of a potential dispute—including evidence handling and storage, provenance of email and other written communications, and information/data management. Case-study examples are included.

Utilizing integrated-path optical CEMS (IP-CEMS) to meet EPA regulations, *Mariza Mendoza, Cemtek KVB-Enertec.* Focus of the presentation is the technology, costs, maintenance, and calibration requirements associated with the use of IP-CEMS technology. It uses cross-stack Tunable Diode Laser Spectroscopy (TDLS) and Differential Optical Absorption Spectrometer (DOAS) to monitor gas emissions for CO_2, CO, NO, NO_2, NO_x, SO_2, HCl, and NH_3, in lieu of traditional extractive CEMS to meet EPA 40CFR60 regulations.

Mendoza will share the information needed to evaluate use of this technology at your plant—including a cost comparison to extractive CEMS, spare parts, maintenance, calibration, etc. Case studies of recent installations are included, plus a review of a demonstration test performed to meet EPA 40CFR75 for a gas turbine operating on natural gas.

4:30

Shaft voltage and current monitoring, *Sunny Gaidhu, PE, Iris Power (Canada).* Shaft monitoring can provide early warning of rotor, stator, and bearing insulation problems, as well as grounding-brush condition, to support safe operation of large generators.

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- Evaluate grounding-brush performance.
- Provide early warning of problems.
- Improve the quality of diagnostics if used in conjunction with other monitors—such as shorted rotor turns, vibration, etc.

A case study completes the presentation.

Benefits of servicing and maintaining gas-turbine emissions systems and HRSGs, *Jeff Bause, Groome Industrial Services Group*. Company's KinetiClean, EPRI-certified, is proven technology for cleaning HRSG heat-transfer surfaces to increase energy output, strengthen the bottom line, and reduce the risk of fines and regulatory action that can result from air-permit noncompliance. Presentation describes the system, discusses its installation and removal, and shares proven results.

Gas turbine SCR, *Dan Johnson, PE, Cormetech Inc.* Focus is on advancements in catalyst technology to serve gas-turbine assets in a changing world.

WTUI 31 (2022)

WTUI's 31st annual meeting was a virtual production given lingering concerns about Covid-19 and its many variants. More than 600 owner/operators participated worldwide, with the all-participants number around 975. The increase in total attendance of about 125 registrants over the virtual 30th conference a year earlier indicated an increasing level of comfort with the online format for sharing technical information.

The program was divided into 11 half-day segments over a four-week period. The highlights:

Day 1, President Ed Jackson's welcome; gas-turbine market update by Tony Brough, president, Dora Partners; industry forecast and commentary by Mark Axford, Axford Turbine Consultants.

Day 2, LM-engine refresher workshop led by Andrew Gundershaug of Calpine; overviews of field and shop capabilities by GE and its Authorized Service Providers (MTU, TCT, ANZGT, and IHI).

Day 3, LM6000 with an LM5000 breakout session. ORAP® (Strategic Power Systems' Operational Reliability Analysis Program) analysis of fleet performance and Top 10 causes of forced outages by SPS's SVP Tom Christiansen; details of shop/field findings in the last year from MTU, TCT, and IHI.

Day 4, LMS100. ORAP analysis of fleet performance and Top 10 causes of forced outages; GE updates of field and shop solutions.

Day 5, LM2500. ORAP analysis of fleet performance and Top 10 causes of forced outages; details of shop/field findings in the last year from MTU, TCT, and ANZGT.

Day 6, LM6000. GE updates of field and shop solutions.

Day 7, LM6000. User presentations and roundtable discussion.

Day 8, LM2500. User presentations and roundtable discussion.

Days 9-11, Special Technical Presentations from ProEnergy, ARNOLD Group, EMW filtertechnik, Cemtek KVB-Enertec, HRST, SISU Energy and Environmental, Woodward, Siemens Energy, GasTOPS, EnergyLink International, Nord-Lock Group, and AGT Services.

Aero library

WTUI and GE have collaborated to make available to owner/operators recordings or PowerPoints of key presentations made at the 31st (2022) annual conference. Abstracts below highlight the topics covered to facilitate selection of the presentations of greatest value to you and others at your plant.

The Western Turbine videos are available on its Basecamp Forums by searching "2022 WTUI Virtual Conference Links." To gain access to the forums, users must request same, by email, from Webmaster Wayne Feragen at wferagen@wtui.com. GE's presentations on the LMS100, LM6000, and LM2500 are available through the OEM's myDashboard website. The link for GE users to register or sign on to myDashboard is https://registration.gepower.com/registration.

Find abstracts of the Special Technical Presentations made during the final three days of the conference in the last section of this report. If you need more detail, please contact the company directly.

Axford's industry forecast and commentary and Brough's gas-turbine market update (2021 data). Talking points: US war on fossil fuels accelerates, only one large combined-cycle order in 2021, big sales rebound for LM2500s and LM6000s, federal obstruction explains much of the decline in GT orders, wakeup call in Texas after the big freeze, LNG projects (new and delayed), batteries and lithium, hydrogen, carbon capture, and much more.

Engine refresher workshop. Covers engine basics; reviews acronyms; drawings abound on lube-oil system and bearings, accessory gearbox, and engine layout from variable inlet guide vanes through the turbine rear frame with valuable drawings of each section/module/component; generator and its principal components. Highly recommended by the editors to guide in-plant training.

LM6000 ORAP analysis. Major contributors to downtime in 2021; Top 10 contributors to forced-outage incidents. Regarding the latter, combustion was at the top of the list with more than 100 incidents at 20 plants; controllers and software were next with issues identified at 33 plants; gas fuel metering and staging valves were in the third position; vibration, fourth, led all contributors in outage hours.

LM6000 session with IHI. Principal topics: Fretting of LPT fifth-stage-disc dovetail serrations, SAC combustor failure, No. 3 bearing stationary oil seal, leading-edge damage on HTP second-stage nozzles.

LM6000 session with TCT. Topics: Rosan fittings in the accessory and transfer gearboxes, fan mid-shaft corrosion, missing/loose heat shields on DLE combustors, leaking CRF oil manifold, update on LPT first-stage nozzle distress, shipping container maintenance and upgrades, handling and maintenance considerations for package hoisting.

Videos also are available of MTU's LM6000 presentation and of the LM2500 ORAP, TCT, ANZGT, and MTU presentations.

Special Technical Presentations

GasTOPS

Monitor bearing health with confidence

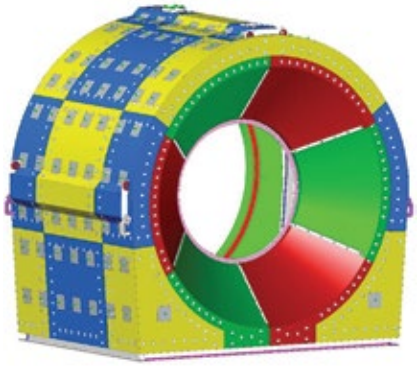
Debris monitoring of scavenge oil

GasTOPS's MetalSCAN sensor detected ferrous debris in an LM6000's A-sump after the engine had been operating continuously for 12,500 hours. A lease engine was ordered while operation continued, allowing O&M personnel the time necessary to plan the overhaul and avoid what was estimated to be a 96-hr forced outage

alerts on the onset and progression of bearing/gear damage by detecting both ferrous and non-ferrous particles. This helps owners and operators decide how much longer than can operate an engine with incurring a forced outage. Oil debris monitoring is said to provide the earliest warning of damage. Thus, it is proactive, not reactive like chip detectors, vibration monitors, and spectrometric oil analysis.

Sensors, which fit inline on the scavenge discharge, are said to be reliable and not produce false positives. Installation typically can be done in a day; the ROI usually is a year or less.

Advanced O&M troubleshooting is said to include the company's MetalSCAN (online, real-time indication of damage), FilterCHECK (offline, extraction of filter debris), and ChipCHECK (offline, alloy identification of debris) components.

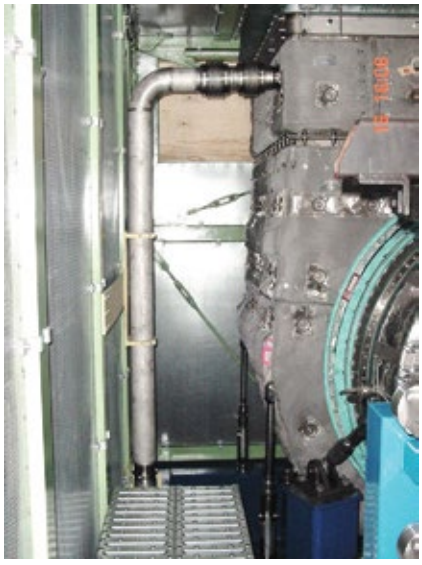


Arnold Group insulation systems for LM2500 and LM6000 engines are designed for a perfect fit to the gas turbine, thereby maximizing the lifetime of the thermal shield

Arnold Group

Optimized insulation for gas turbines

Pierre Ansmann opened his presentation to point to problems with insulation systems avoided by use of his company's 3D-shaped blankets that fit perfectly to the shape of exhaust-system components—including the following:



- Interlocking steps between blankets, and use of stainless-steel foil and super-tight wire mesh, virtually eliminate vibration damage.
- Blanket damage requiring repair/replacement every outage.
- Surface hot spots conducive to insulation damage.
- Overheated noise enclosure.
- Loose fibers and dust that cause health and safety issues.

A series of photos provides details.

EMW filtertechnik

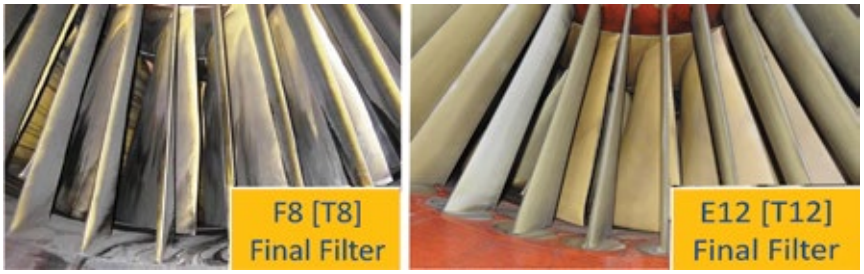
Better filtration pays for itself

This is Part 2 of Florian Winkler's presentation; the first part was delivered at WTUI 30. A summary of that presentation appeared in CCJ No. 69, p 20.

Winkler brought attendees up to date on ISO 29461, the new test standard for air intake filter systems protecting rotary machinery. He compared lab test results versus results under real operation for initial pressure drop, efficiency values, classification and dust holding capacity.

Conclusions drawn:

- E10 should not be considered as a final filter for gas turbines.
- Classes of filters with efficiencies higher than E10 show larger pressure drops initially but the rate of their DP increases slows over the service lifetime.
- In both the short- and long-term, E12 filters support top performance



EMW filtertechnik tests showed the dramatic difference in the condition of compressor blades after 5000 hours for units with F8 final filters (left) relying on online and offline washing versus those with E12 filters without washing (right)

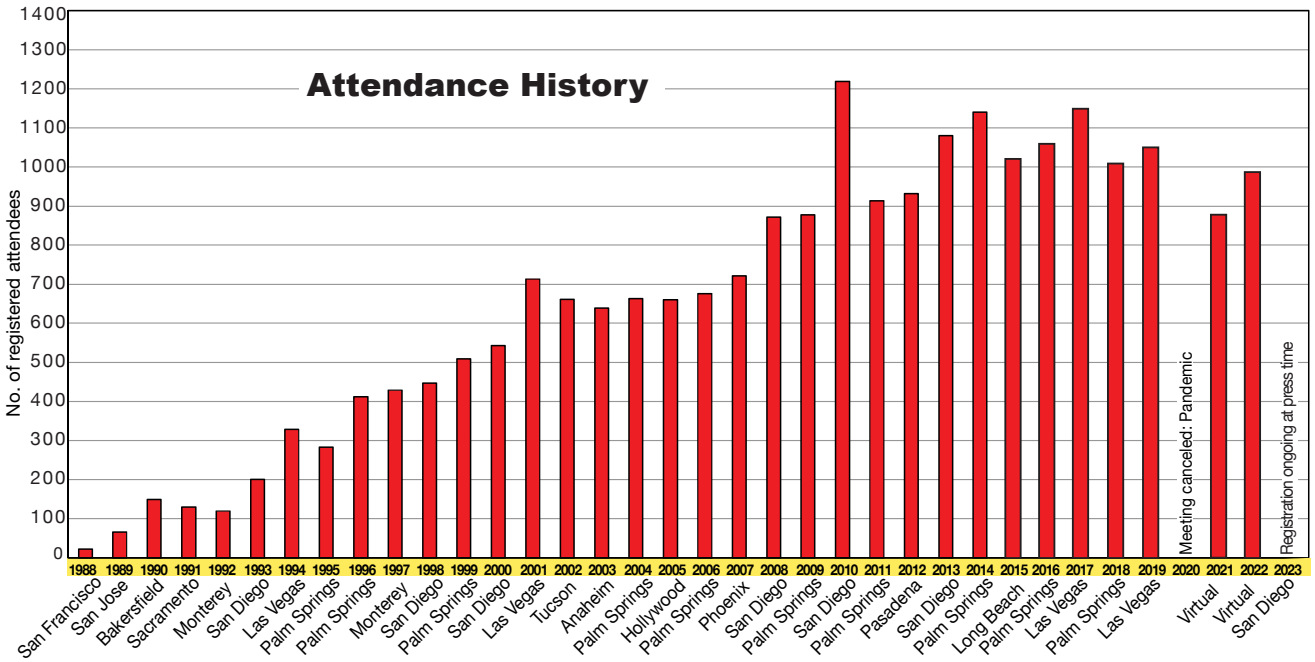
and high availability for gas turbines.

- Key performance indicators such as dust holding capacity are of relatively low significance, especially for high-efficiency HEPA filters.

AGT Services Inc

Outage planning: Don't forget your moneymaker—the generator

Jamie Clark began by urging attendees to get a baseline condition assessment of their generators as soon as possible and to fix what's required



Western Turbine Users—a historical perspective

Editors note: The timeline below was compiled from many contributors and is not complete by any means, but it offers a perspective on how the Western Turbine Users Inc (WTUI) came to be and the positive impact it has had on electricity supply worldwide. The organization was founded, built, and is operated by cadre of highly motivated volunteers dedicated to providing a robust forum for the exchange of technical, operations, and maintenance information and experience to improve the reliability and economic viability of GE LM-series power-generation facilities.

1939 The first utility gas turbine to generate electricity, rated 4 MW and developed by Brown Boveri & Cie of Switzerland, is commissioned in the town of Neuchatel.

1967 IHI, one of the three ASPs supporting WTUI technical sessions, begins working in the areas of gas-turbine power generation equipment and cogeneration operations.

1969 GE launches the LM2500 engine; marine propulsion is the first application.

1971 First industrial use of an LM2500 is in the oil and gas industry.

1979 LM2500 is first used in power generation service.

1982 A handful of users responsible for O&M at several West Coast LM2500 generating facilities and the first LM5000 cogen plant at Simpson Paper Co (Shasta mill) in Anderson, Calif, begin meeting every couple of months in break rooms to discuss problems/solutions, best practices, lessons learned. This is the beginning of what would become WTUI. The host plant was responsible for coffee and lunch.

IHI's first LM5000 begins operating in the US.

Stewart & Stevenson receives its first US LM2500 genset order for the Hawaiian Independent Refinery Inc. It begins operating the following year under the watchful eye of HIRI's 20-something lead engineer, Wayne Kawamoto, later elected WTUI's first treasurer.

The first West Coast LM2500PC installed by GE's Turbine Business Operations Div (TBO) is commissioned at Procter & Gamble's Oxnard (Calif) manufacturing plant as a Purpa-qualified cogeneration package. Mike Raaker, WTUI's historian/ambassador, was the technical engineer assigned to that project by P&G.

1983 Simpson Paper Co (Shasta mill) commissions the first LM5000 installed in the US. Steve Johnson, one of WTUI's early proactive users, has responsibility for the engine and quickly becomes expert in operating and maintaining the problematic GT model. Visit Johnson, now owner of SJ Turbine, in the Exhibit Hall, Booth 121.

1985 The LM5000 at Simpson

AGT Services suggests consideration be given to robotic inspection, when possible, to avoid removal of the field

to assure reliable service—even if it takes a major to do it. Clark suggested consideration of robotic inspections in lieu of field removal where possible and offered the pros and cons of using robots.

He also recommended a re-evaluation of the timeline for future inspections where there have been significant changes in operating duty.

Clark touted the value of electrical tests for the stator, focusing on the following:

- Winding copper resistance, each phase.
- 5-kVdc insulation resistance and PI, each phase.

Paper Co (Shasta mill), which went commercial in May 1983, serves as the beta test site for the development of steam injection. Tests were successful and brisk sales of LM5000 STIG80 and STIG120 gas turbines followed.

1988 TransCanada Turbines Ltd (TCT), one of the three ASPs, is established as a joint venture between the Wood Group and TransCanada Corp.

1989 Power Systems Engineering Inc is purchased by Dow Chemical Co and the business is renamed Destec Energy Inc.

1990 WTUI incorporates in the fall. Bylaws are developed.

1991 Strategic Power Systems Inc (SPS) begins collecting O&M data for GE, sharing this information with WTUI. SPS has worked collaboratively with the WTUI leadership since incorporation.

The first LM6000PA designed for NO_x control by use of water or steam injection goes into service.

1992 John Tunks resigns as president of WTUI and Jim Hinrichs is elected to succeed him.

1994 The first LM6000PB, equipped with a dry low emissions combustion system (DLE), begins operation. It produces less than 25 ppm NO_x.

1995 Simpson Paper Co's LM5000 STIG80 in Anderson, Calif, reaches 100,000 operating hours.

1996 California begins its first experiment in retail electricity competition. John Fintland, owner and founder, Advanced Filtration Concepts Inc, participates in his first WTUI meeting and hasn't missed exhibiting since.

Larry Flood is appointed WTUI's first webmaster. He remains in that position until Wayne Feragen relieves him in 2006. Feragen continues in that position today, among others. The first LM2500+ rolls off the production line.

1997 The first Model PC and PD engines leave the GE factory.

Jack Dow and Mike Raaker retire from the WTUI Board of Directors. Dow was elected secretary in 1998, a position he held until 2008. Raaker was elected VP in 2002 and remained in that position until retiring in 2010. He currently serves as the organization's ambassador and historian.

The first LM6000PC (SAC) and PD (DLE) models, more powerful than the earlier PAs and PBs, achieve commercial operation.

1998 LM6000 highlights include a variable-speed mechanical-drive option, commercial operation of the first dual-fuel DLE combustor, and first commercial operation of the Model PC Sprint™ (Spray Intercooled Turbine) system.

Stewart & Stevenson sells its gas-turbine business to GE as Mark Axford leaves S&S to launch the consulting firm that bears his name.

2000 More than 200 LM6000s have entered commercial operation since the model was introduced in 1991.

More than 23,000 MW of GT capacity begins operating in this first year of what came to be known as the "gas-turbine bubble." From 2000 through 2004, a nominal 200,000 MW of GT capability is installed in the US. During the same period, WTUI attendance grows by nearly 30%.

Dynegy generating plants are sold to El Paso Merchant Energy, which four years later sells its powerplants to Northern Star Generation LLC, illustrating the volatile nature of the independent power business.

2001 Base-load cogeneration contracts begin transitioning to cycling/peaking agreements.

TCT begins supporting technical sessions for the annual WTUI meetings. This effort continues today.

2002 GE pulls its support for WTUI.

2004 Aeroderivative Gas Turbine Support Inc exhibits only months after the company is founded by Alan Mibab, who had been attending the show for years in another vendor's booth. AGTSI has not missed a meeting since.

GE-authorized ASPs begin providing technical support to WTUI and its membership.

2005 Editors of the Combined Cycle Journal attend their first Western Turbine meeting. It was the beginning of a close collaboration with the WTUI Leadership Team, benefiting CCJ's coverage of LM engines as well as users and vendors in this industry sector.

2006 First LMS100 engine, rated a nominal 100 MW and having an efficiency of 46% (LHV) in open-cycle operation, enters commercial service for owner/operator Basin Electric Power Co-op at the utility's Groton (SD) Generating Station.

2007 A new management team at GE reinstates the company's support of WTUI.

Riverside Energy Resource Center, a four-unit LM6000-powered peaking facility managed by WTUI Director Chuck Casey, earns CCJ's Pacesetter Plant Award for the design of a zero-liquid-discharge system that has demonstrated its ability to satisfy the often-conflicting goals of regulatory compliance and affordable capital and operating costs.

Steve Johnson, a former WTUI director, makes a career change and launches SJ Turbine Inc (Exhibit Hall Booth 121).

2008 Advanced Turbine Support LLC's President Rod Shidler and Field Service Director Mike Hoogsteden display the firm's capabilities at WTUI for the first time. They haven't missed a meeting since. Visit them in the Exhibit Hall (Booth 823).

Chuck Casey is elected secretary of WTUI, a position he retains until his election as president in 2013.

Jim Hinrichs and Jack Dow become the first WTUI officer/director retirees to earn lifetime membership in

- Dc leakage, each phase.
- 1-min dc hipot at 38.25 kV, each phase.
- Resistance check and 1-min 500-Vdc megger of all RTDs.

As for what to inspect on the stator, he listed the winding, endwinding support system, wedge system, gas-gap baffle studs, rubber baffles, bushing box, and stator core (for tightness, iron migration, damaged/overheated laminations, and vent duct blockage).

Photographs included in the presentation help users understand what to look for and how to evaluate what their level of concern should be.

Moving to the field (rotor), Clark recommended these electrical tests:

- Winding copper resistance.
- Insulation resistance and PI.
- Ac impedance test.

As for what to inspect on the field, he recommended checking the following under the retaining rings: field winding/brazes, turn insulation, migration of slot insulation, movement of blocking, main lead, coil-to-coil jumper, and pole-to-pole jumper. He also suggested examining the field body for wedge/retaining ring contact, wedge movement, heating, vent blockage, and balance weights.

Cemtek KVB-Enertec

Tunable Laser Spectroscopy (TDLS) for NH_3 compliance, inlet monitoring, and stack EPA compliance monitoring

The motivation for Gary Cacciatore's presentation is on his sec-

the organization.

Jon Kimble succeeds Jim Hinrichs as president of WTUI and serves in that capacity until his retirement in 2012.

WoodGroup Pratt & Whitney opens a shop in Florida to overhaul LM2500s and FT4s. The business is not sustainable long-term.

2009 Bob Nelson's battle with cancer ends at age 46. The former WTUI director was SMUD's superintendent of thermal projects, highly regarded by industry peers and well liked. Nelson's recipe for professional success: "No serial number ones."

Groome Industrial Service Group presents its capabilities in SCR and CO catalyst cleaning at WTUI for the first time. Jeff Bause, CEO, has been a regular participant since.

Terry Bundy Generating Station, powered by LM6000s and managed by WTUI Director Brad Hans, receives CCJ's Best of the Best Award for its water conservation program that includes recovery of nearly 1000 gal/hr of condensate from inlet-air cooling systems during a hot, humid summer day.

IHI partners with Reed Services Inc in the Cheyenne Service Center equipped especially for supporting LM6000 owner/operators.

2010 WTUI's 20th anniversary celebration is held aboard the USS Midway.

2011 Lincoln Electric System's LM6000-equipped Terry Bundy Generating Station, managed by WTUI Director Brad Hans, receives a CCJ Best Practices Award for its state-of-the-art ammonia-tank leak-suppression system. Successful demonstration of the spray system significantly reduced both risk to plant personnel and the potential for offsite exposure.

TCT opens its state-of-the-art 220,000-ft² repair and overhaul facility in Airdrie (near Calgary).

2012 Chuck Casey replaces Jon Kimble as president of WTUI.

WoodGroup Pratt & Whitney withdraws from its LM2500 overhaul offering.

2013 Riverside Public Utilities' Clearwater Cogeneration Plant, managed by the then LM2500 Breakout Session Chair John Baker, contributes to an advancement in the state of the art developed by Fossil Energy Research Corp (Exhibit Hall Booth 924) for determining the remaining life of SCR catalyst in-situ.

TCT expands its testing facility to better support the LM6000 PA, PB, PC, PD, and PF engines.

Wood Group and Siemens' TurboCare form the joint-venture company EthosEnergy Group, specializing in the maintenance, repair, and overhaul of gas and steam turbines.

2014 Alliance Pipeline shares with LM users its experience in using HEPA filters on gas-turbine air inlet systems. Details are provided in CCJ's special publication for WTUI's 24th annual meeting. The company gave HEPA two thumbs up based on four years of normal pipeline use and rigorous analysis of results.

Jim Hinrichs, past president and the face of WTUI for two decades, passes unexpectedly during a back operation.

2015 MTU, one of the three ASPs, closes in on 20 years of participation at WTUI.

WTUI celebrates its 25th anniversary.

GE launches its LM6000PF+, said to be the most-efficient aero for combined-cycle service.

2016 ProEnergy gains success as an independent aero depot—performing scheduled maintenance, emergency outages, and everything in between for owner/operators of LM6000 and LM2500 gas turbines. Its Level IV service facility is centrally located in Sedalia, Mo. Visit ProEnergy in the Exhibit Hall at Booth 721.

2017 Wayne Kawamoto, Western Turbine's treasurer since incorporation in 1990, retires as plant manager of the LM5000-powered Corona Cogen facility and resigns as an officer of the user group on the last day of the year.

2018 Wayne Kawamoto is appointed WTUI conference executive director on the first business day of the year.

The California-based user group opens its first office at 25201 Paseo de Alicia, Ste 215, Laguna Hills 92653.

2019 Baker Hughes emerges as an important provider of services to the LM community. Baker Hughes Co, which merged with GE Oil and Gas in 2017 to become Baker Hughes, a GE company, divests from GE and re-establishes itself as Baker Hughes Co. GE owns 38% of the new company.

2020 The organization's 30th anniversary meeting is canceled because of the Covid-19 pandemic, just a couple of weeks before its scheduled start in the Long Beach Convention Center.

Chuck Casey resigns as president of WTUI, having served the group in that capacity for seven years. John Hutson is elected his replacement.

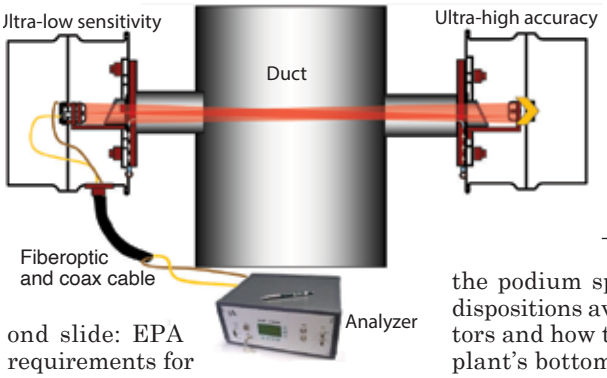
2021 The organization's first virtual conference is conducted over 10 half-days during a three-week span. Nearly 600 owner/operators and 850 total attendees participate.

2022 WTUI's second virtual conference draws more than 600 users worldwide and nearly 1000 total participants.

Ed Jackson is elected the organization's sixth president, replacing John Hutson, who left the aero community.

2023 The first in-person annual meeting in three years is held in San Diego.

WTUI's online forum celebrates its 10th anniversary. The interactive LM6000 forum, launched by Webmaster Wayne Feragen and supported by the entire leadership team, is one of the most valuable prerogatives of membership. When you don't know whom to call about a current problem, posting your question online likely will provide the guidance to get you moving in the direction of a solution.



Cemtek KVB-Enertec's Tunable Diode Laser double-pass stack configuration for measuring emissions meets, and may exceed, EPA's Performance Specification 18 modified for NH_3

ond slide: EPA requirements for NH_3 measurement are changing. Those familiar with ammonia measurement will benefit most from the level of detail presented; others are sure to welcome the heads up on recent changes in air emissions regulations.

What might be news to those who have not kept up on the government's rules on NH_3 measurement is that PPS-001, "Preliminary Performance Specifications for Ammonia Continuous Emission Monitors (CEMs)," has been declared "outdated from a technical standpoint" and has been removed from EPA's Air Emission Measurement Center website. This resource provides information on test methods for measuring pollutants from smokestacks and other industrial sources.

The recommendation of experts is that facilities or testers preparing to install/operate a NH_3 CEMS should consider use of the principles/procedures of Performance Specification (PS) 18 and Appendix F Procedure 6, or PS 15. Reference methods to consider are Method 320 and CTM-027.

The lion's share of Cacciatore's slide deck covers the company's Tunable Diode Laser (TDL) solution (see schematic) for determining emissions compliance and for process control. It is said to meet, possibly exceed, PS 18 modified for NH_3, which is recommended by EPA. Ultra-high accuracy and sensitivity, and "immediate" response time are among TDL's attributes—as are ease of installation and maintenance, low operating costs, and an expected lifetime of more than a decade.

ProEnergy

Condition-based maintenance drives efficiency for LM gas turbines

VP Aero Products Bob Bosse's theme was the economic responsibility of owner/operators in maintaining the high availability/reliability of their land-based generation assets—focusing on the LM6000—and how they might benefit from lessons learned in the aero world.

Bosse spent about half his time at the podium speaking about the five dispositions available to owner/operators and how to use them to benefit a plant's bottom line. The five dispositions are:

- *Accept* (use as is). Prior to measurement and/or in-depth inspection, the part or component is cleaned and inspected visually—and cleared for operation.
- *Rework* eliminates any nonconformance with drawings, specifications, or contract requirements, thereby allowing continued use.
- *Repair* reduces, but does not eliminate a nonconformance which is subject to review and agreement by the engine owner or its agent. Examples illustrated have to do with coatings—their method of deposition, surface preparation, etc.
- *Reject* is a temporary disposition to allow acceptance of a part's condition provided it is corrected at a later date or by alternative repair. Simply put, the condition is beyond the current allowances for recommended repair.
- *Scrap* indicates a part is beyond repair and must be destroyed. However, the decision to scrap is the owner's or its authorized representative.

Some of the material Bosse covered—such as LM-engine component repair and replacement processes—is discussed in detail in the report on PROENERGY CONFERENCE 22 which follows the WTUI section.

EnergyLink International

Turnkey retrofit services—from need to low-cost finish: Building an effective project

Presentation at the Western Turbine 2022 virtual conference was similar to that given at the ProEnergy meeting which follows this report and includes a summary of EnergyLink's work.

Nord-Lock Group

Wedge-locking technology that secures fasteners, prevents bolt loosening

If you're not familiar with the company's wedge-locking technology, review this slide deck—particularly if your bolted connections keep coming loose because of vibration, temperature changes, etc. Joint tightness is achieved by a system comprised of a pair of washers that have cam faces on one side and radial teeth on the opposite side. The bolted joint is secured with tension, not friction, and will not rotate loose.

Results of vibration test, torque/load diagrams, and other engineering data assist decision-making.

SISU Energy & Environmental

Increase power production and reduce maintenance with SISU's free-heat ammonia vaporization retrofit system

The company's vaporization system eliminates electric heaters, reducing operating costs and maintenance. Installation is said to be fast and easy, payback rapid, and reliability higher.

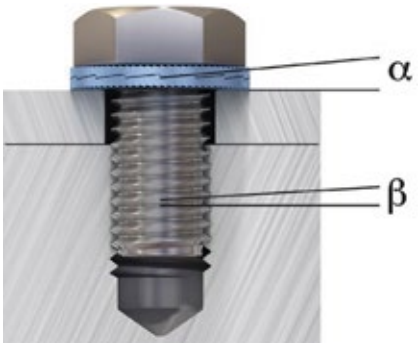
Also of possible interest is SISU's enhanced gasket retention system for CO catalyst modules which effectively confines the rope seal gasket, all but eliminating its migration. For those challenged by the shifting of SCR catalyst modules, the company has developed an integrated sealing and positioning modification to control that shifting.

HRST Inc

Aging HRSGs: Problems to anticipate in the second half of life

Ned Congdon, PE, is a frequent and respected presenter at WTUI meetings, known for his practical approach to problem-solving. He discussed the following age-related HRSG problems:

- Creep/overheat damage in superheaters and reheaters.
- Duct-burner problems.
- Economizer failures from age and cycling.
- Waterside deposits in HP evapora-



Nord-Lock. Come up to speed on a technology that promises to keep your fasteners tight despite the presence of vibration and other loosening mechanisms. In the diagram, note that since the cam angle, α, is larger than the thread pitch, β, a wedge effect is created by the cams and the bolt is prevented from coming loose

tors.

- Drain-pipe corrosion under insulation.

Congdon shares best practices that he's learned over the years. A few examples: a good flame length for duct burners is from 6 to 10 ft, duct-burner flames should only reach one-half to two-thirds the way down the firing duct, inspect regularly for indications of overheat damage to boiler tubes with assistance from view ports or furnace cameras, etc.

There's much to be gained from a review of the slide deck, perhaps all not new, but a valuable reminder at least.

Siemens Energy

LM-series gas-turbine package solutions

A big benefit of attending Western Turbine meetings is the opportunity they afford for identifying new products/services suppliers to add to your list of potential bidders for future projects.

Siemens Energy described its capabilities as a full-train solutions provider for the LM fleet, focusing on the LM2500, LM2500+, and LM2500+G4. Company experience encompasses more than 300 LM projects over the years. Its state-of-the-art overhaul and repair facility in Norway has testing capabilities for the LM2500 gas generator and corresponding power turbines (PGT-25, Vectra, DR-61, GT-61, and 6-Pack).

Presentation describes service capabilities, exhaust system life-extension program, fuel system upgrades to combat contamination and "sticky valves," air-inlet filtration upgrade, and control system upgrade. Last is offered in five levels to accommodate specific replacement needs to deal with obsolescence—such as HMI, fuel controller, fuel valves, and complete control system.

Beyond its service capabilities, Siemens Energy has a range of assets available for lease—short-term for planned and unplanned outages; flex or long-term lease to delay capital spending; and Siemens Energy ownership with the customer responsible for operation.

Woodward

Plant performance optimization using advanced control techniques and modeling

Presentation speaks to the opportunity for plant performance optimization during a controls upgrade. Benefits can accrue from the integration of dedicated balance-of-plant controls into the gas-turbine control system.

Case study described is the integration of SCR controls into the engine controller. Prior to the upgrade, the SCR was controlled manually by operators because the PLC logic provided with the emissions control system did not work in automatic mode. Emissions control required operator attention/focus for adjustments during startup, and changes in load, tempering air, Sprint, etc.

The simulation and modeling strategy used is described and easy to understand, with graphics enhancing the learning experience. Onsite simulation testing and commissioning complete the information package.

Post upgrade, SCR control operates in automatic mode, maintaining NO_x emissions at less than 4 ppm at the catalyst exit for all steady-state load operating points. Emissions deviations experienced with manual operation have been eliminated and ammonia slip reduced. CCJ

HRST Inc. With the duct burner at maximum firing, use view ports to visually observe the flames for length and shape. Important to avoid flame impingement

Siemens Energy. The company's life extension program for the LM2500 includes field repair solutions such as the flange upgrade shown here

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- CO Catalyst Cleaning & Repacking
- Ammonia Injection Grid Cleaning
- Ammonia Vaporizer Cleaning
- SCR & CO Catalyst Replacement
- HRSG Tube Cleaning
- Inlet Filter House & Duct Refurbishment

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Transitioning operator rounds from paper to electronic records

Challenge. Regular visual inspection of plant equipment is critical to managing a safe and efficient generating station. When plant operators use clipboards and paper checklists on rounds, safety-critical and process information may not always be recorded properly. Station personnel require a reliable and accurate method of log-keeping when performing their routine duties—including operator rounds, running logs, safety inspections, and shift turnovers.

Solution. The Lawrence County O&M staff researched several electronic record-keeping options and selected PlantLog. The software is designed to be extensible, allowing it to serve a variety of purposes. PlantLog features universal components, allowing staff to design a data-logging workflow to meet Lawrence County's exact operational needs.

Barcodes are used to identify assets that are tracked using the Logs feature in the software. They ensure accuracy and also provide an electronic record within that asset for use in trending, thereby increasing reliability. At Lawrence County, the PlantLog app is installed on an iPad, providing operators the tools to complete each procedure/inspection.

Most data collection is completed using the iPad mobile app, which facilitates barcode scanning and offline data collection. However, log records also can be added from the web application.

Results. Plant supervisors developed a data-collection plan for plant operations. Personnel keep detailed electronic records of asset conditions during facility rounds or when performing maintenance/safety procedures. The PlantLog scheduling feature notifies operators when activities are due or when readings fall outside the normal range. The following workflow was implemented:

- Groups. Geographical or functional areas within the plant are defined.
  - Asset barcodes require operators to scan a physical tag to perform an activity.
- Logs were defined and organized to represent each asset.
  - Assigned unique barcode values to logs to associate with physical tags.
  - Added optional details for a log, such as serial numbers and vendors.
- Activity. Specific events and procedures to be performed on an asset were defined.
  - Assigned recurring schedules for each activity to specify when the procedure must be performed based on specific dates or from when it was last performed.
  - Specified the *absolute* range permitted for any given numeric item to reduce human error.
  - Specified the *optimal* range permitted for any given numeric item. Values outside the optimal range are regarded as an exception and presented in red type.

A complete history of asset conditions can be viewed through the logs page of the web application.

Lawrence County Generating Station

Owned by Hoosier Energy Rural Electric Co-op Inc (four units) and Wabash Valley Power Assn (two units)

Operated by NAES Corp

258 MW, six simple-cycle LM6000 natural-gas-fired peaking units, located in Lawrence County, Ind, and connected to Hoosier's 161-kV transmission line

Plant manager: Robert VanDenburgh

Project participants:

Matthew O'Hara, lead O&M tech
Jared Thomas, O&M/IC&E tech
Kevin Wildner, O&M tech

Energía del Valle de México I (EVM-I)

Owned by Energía del Valle de México

Operated by NAES Corp

100 MW (net), gas-fired facility equipped with three LM6000PF simple-cycle engines, located near Mexico City

Plant manager: Javier Badillo

Reduce cost of consumables, maintenance for gas chromatographs

Challenge. Each of the site's three gas turbines was equipped with a gas chromatograph (GC), hardwired to its control system, to adjust combustion continuously 24/7 and maintain air emissions within regulatory limits. The GC sends two 4-20-mA signals to the control system: the fuel's lower heating value (LHV) and specific gravity (SG).

Annual O&M cost for keeping three GCs in service amounts to nearly $40,000—three-quarters of that for helium and calibration gas, the remainder for preventive maintenance (consumable parts, such as filters and valve internals). Staff's challenge was to reduce this expense.

Solution. The economic impact of the pandemic forced a change in the dispatch profile for the plant's gas turbines, creating an opportunity to optimize operation of the GCs. Specifically: Use one GC to transmit LHV and SG data to all three engines simultaneously and hold the remaining GCs in reserve.

Results. An engineering and cost analysis confirmed that the plan put forth by staff to operate one GC and route the data from it to all three engines was indeed viable. Modifications required to allow each GC to provide data to all gas turbines cost $26,000—including training. Note that the equipment was installed and commissioned by plant personnel. The net present value benefit over 20 years was calculated at nearly $500,000.

Project participant:
Carlos Moreno, plant engineer

Worthington Generation LLC

Owned by Hoosier Energy Rural Electric Co-op Inc

Operated by NAES Corp

174 MW, four simple-cycle LM6000 natural-gas-fired peaking units, located in Greene County, Ind, and connected to Hoosier's 138-kV transmission line

Plant manager: Robert VanDenburgh

Belt guards benefit maintenance

Challenge. Fan belts for the LM6000 package can be dangerous, difficult, and time-consuming to access. The heavy, bulky motor housing (a/k/a doghouse) maintenance panels must be removed to access the motor, belts, and grease fittings (Fig 1). In addition to the maintenance challenges, personnel also strive to remove animal/bird access points to the belt area.

Solution. The NAES safety committee researched and discovered pulley/belt guards are available specifically for the LM6000 Aerovent fans. Removing the bulky doghouses and installing the smaller, more streamlined pulley/belt guards would achieve the plant's goals.

1. Bulky doghouse panels must be removed to do maintenance

2. Pulley/belt guards benefit safety, improve reliability

Results. Pulley/belt guards were ordered and installed on the package fans (Fig 2). This safety improvement eliminated the pinch points introduced when lifting the heavy access panels. It also eliminated access points for animals/birds, significantly improving reliability. Also, maintenance inspections are safer and fan reliability has improved.

Project participants:
Matthew O'Hara, lead O&M tech
Jason Robertson, O&M/IC&E tech
William Hooker, O&M technician
Garett Ray, O&M technician

Sentinel Energy Center

Owned and operated by DGC Operations LLC

800 MW, gas-fired peaking facility equipped with eight LMS100 simple-cycle engines, located in North Palm Springs, Calif

Plant manager: Dennis Johnson

Energy control and lockout/tagout

Challenge. Sentinel Energy Center was tasked with keeping safety a top priority when developing energy control procedures (ECP) to protect plant personnel when they are near the hazards identified. Creating and using procedures that are easy to understand is essential to maintaining a safe working environment.

Solution. Staff created specific procedures for each high-risk evolution—including everything from the start of the energy control process in the control room to the return to normal state after work is completed. Key elements of the procedures include the following:

- Evaluate the system using P&IDs, walkdowns, and plant experience by an experienced operator.
  - Examples are given of things that should be considered, such as when power supplies are analyzed—including transformers, buses, and highlines—make sure downstream devices, motors, buses, etc, are included in the scope and effectively disabled, disconnected, or controlled to prevent back-feed.
  - Ensure evaluations are reviewed and approved by plant management.
- Determine a means for testing the effectiveness of isolation. Experience indicates equipment can be switched "off" and locked, and yet still start because of malfunction, mislabeling, or multiple electrical feeds. Doing a thorough hazard energy analysis provides an excellent opportunity to determine the means to verify the effectiveness of the isolation and LOTO.
- Create a specific procedural tool to identify hazards and how they are controlled using a step-by-step process.
- Verify that the steps specified in the procedure have been completed. One way to do this is by way of photos of the isolation means.

After an energy control procedure has been developed for a given project, assemble staff in the control room to review the work permit and job safety analysis. Review the goal of the procedure along with any specifics, plus the potential hazards, PPE required, and any stopping points.

During this meeting, create the teams responsible for different aspects of the ECP. Once the teams go into the plant to start work, provide a copy of the procedure to be followed step-by-step, and initialed when completed. Normally, each team includes a member of management as a safety observer, the operator responsible for the system, and a verifier.

Safety signage was identified as a good best practice by a third-party auditor

Communicate each step that involves the control room to the CRO before the evolution occurs. This includes venting, operation of E-stops, and pressure verifications. Work on the day of isolation is completed relatively stress-free because of the effort put into procedure development.

The training conducted for each evolution also is important. When it can be planned, a trainee and trainer are identified for each phase of the process—including authorizer, verifier, safety observer, and the person responsible for managing the day.

Procedure reviewed and understood, the LOTO is implemented to lock equipment in the de-energized state before work begins.

Results. The O&M team has used the methodology described to create multiple tools (attachments to the ECP procedure) for addressing high-risk operations. Some of the specific tools that have been created or improved upon include these:

- Isolation of the 700-psig natural-gas supply systems to each of the eight gas turbines.
- Facility power-outage response.
- Generator breaker isolation from the 245-kV transmission line.

The most important aspect of the procedure is the inclusion of every participating operator and maintenance technician in the work and their ability to complete the process stress-free on a plant-only workday during the first day of the outage.

Many of the procedures include multiple revisions because recommendations are encouraged and after each evolution the process is reviewed and improved. The process has been recognized during independent third-party audits. Here's a comment from a recent audit report: "We found exceptional practices in the programs for control of hazardous energy (lockout/tagout)—including the site work-permit process, confined-space entry procedures (including the ongoing effectiveness review), safety signage, and colors for facility and pipeline markings, and hazard communication for the employee safety committee operation."

Project participants:
Dennis Johnson, plant manager
Larry Wilson, maintenance manager
Jesse Ballou, operations manager
David Wells, EH&S coordinator
Entire plant team

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Repair of FT8 dual-fuel nozzles extends parts life

Anson and Hamlet Generation Facilities

Both facilities owned and operated by North Carolina Electric Membership Corp

Each 360 MW, gas-fired peaking facility equipped with six FT8® Swift-pac® simple-cycle engines, Anson located in Lilesville, NC, Hamlet in Hamlet, NC

Plant manager: Shawn Fowler

Background. North Carolina Electric Membership Corp's (NCEMC) Anson and Hamlet Generation Facilities have 24 P&W FT8-3 gas turbines. The sites operate primarily on natural gas, with distillate-oil backup. Both oil and gas operation use water injection for NO_x control.

Challenge. Liquid fuel was backflowing into the gas supply system causing coking in fuel nozzles, gas supply hoses, and headers (Fig 1), thereby preventing an unimpeded return to gas operation after liquid-fuel operation.

The root cause of the issue was thermal shock experienced during the fuel-gas startup cycle when water injection is initiated. The internal stress cracking created allows crossflow between the liquid and gas sections within the nozzle. A review of nozzle history demonstrates nozzles tend to fail at roughly 1100 startup cycles (Fig 2).

Note that the dual-fuel nozzle design is used in both single- and dual-fuel units. Water and fuel oil are premixed prior to the nozzle and share the same piping.

Issues identified after liquid-fuel operation include the following:

- Coking of fuel nozzles (gas orifices and supply port), gas supply hoses, and the gas-supply manifold.
- Inability to transfer back to gas fuel, which is conducive to forced outages.

Liquid-fuel operation and supply piping are not affected.

Although not experienced frequently at the NCEMC plants because of predictive emissions monitoring (PEMs) based on five-year testing, high CO_2 readings during scheduled testing were corrected by replacing affected nozzles. It would be a reasonable assessment that prematurely mixing water and gas within the nozzle prior to combustion could result in more frequent emissions issues when measured via CEMs.

Solution. NCEMC asked Liburdi Turbine Services (LTS), Mooresville, NC, to evaluate and potentially develop a repair for the failing fuel nozzles. After an engineering assessment of a failed fuel nozzle, LTS felt confident it was repairable (Fig 3).

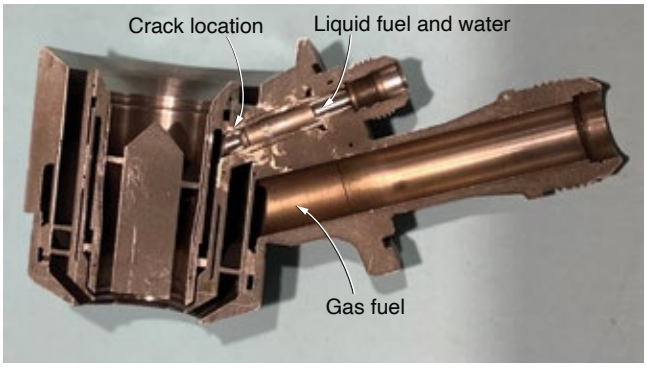
Liburdi developed and executed the repair of one fuel nozzle. To ensure the repair's viability, LTS, working with its sister company Liburdi Dimetrics, designed, engineered, and built a simulator replicating the startup conditions of an operating fuel nozzle (Fig 4). For the test, LTS used three fuel nozzles: one new, one service-run, and one repaired by Liburdi.

Results. The three fuel nozzles were tested simultaneously (Fig 4), replicating the startup cycle by heating

1. Coking in fuel nozzles, gas supply header, and hoses impeded transferring back to gas fuel after operating on distillate oil

POS. #	A1A	A1B	A2A	A2B	A3A	A3B
1	HGGUAH9688	HGGUAH9675	HGGUAH9519	HGGUAH9603	HGGUAH9282	HGGUAH9518
2	HGGUAH9602	HGGUAH9647	HGGUAH9534	HGGUAH9468	HGGUAH9573	HGGUAH9361
3	HGGUAH9539	HGGUAH9689	HGGUAH9548	HGGUAH9553	HGGUAH9646	HGGUAH9536
4	HGGUAH9514	HGGUAH9638	HGGUAH9550	HGGUAH9572	HGGUAH9598	HGGUAH9599
5	HGGUAH9676	HGGUAH9654	HGGUAH9593	HGGUAH9511	HGGUAH9582	HGGUAH9253
6	HGGUAH9685	HGGUAH9683	HGGUAH9504	HGGUAH9464	HGGUAH9395	HGGUAH9318
7	HGGUAH9682	HGGUAH9656	HGGUAH9605	HGGUAH9651	HGGUAH9586	HGGUAH9597
8	HGGUAH9684	HGGUAH9673	HGGUAH9607	HGGUAH9500	HGGUAH9614	HGGUAH9256
9	HGGUAH9611	HGGUAH9657	HGGUAH9548	HGGUAH9537	HGGUAH9594	HGGUAH9304
*CI Date(s)	Dec 2017 No Nozzles Replaced	Aug 2013 and Oct 2017	Nov 2015 and Sep 2017	Sep-17	Feb-18	Feb-18
*LF Hours		104	218	152	280	214
*Cycles		625	1041	1027	1105	1096
*Fired Hours		4091	6426	6133	6135	6016

2. A review of fuel-nozzle history shows nozzles tend to fail at roughly 1100 startup cycles. Numbers of hours and starts presented in the table refer to when nozzles were replaced. Black type indicates nozzle was repairable; yellow indicates nozzles that were scrapped



3. Fuel nozzle cutaway shows where cracking occurred, forcing replacement

4. Tests of one new, one service-run, and one repaired fuel nozzle were conducted simultaneously to verify the viability of Liburdi's repair process

and thermally shocking with induced water injection. After 250 cycles, the fuel nozzles were examined using both fluorescent penetrant inspection (FPI) and a pressure test. Upon completion, NCEMC was confident in the integrity of the repair and has installed LTS-repaired fuel nozzles in its units.

The repaired fuel nozzles are operating normally. They would have been scrapped by the OEM using its current test criteria. FT8-3 fuel nozzles now can be repaired at a fraction of the cost of new.

Project participants:

Shawn Fowler, plant manager
Jeff Chapin, Liburdi Turbine Services
Nathaniel Derby, Liburdi Turbine Services
Alan Bumgardner, Liburdi Dimetrics Corp

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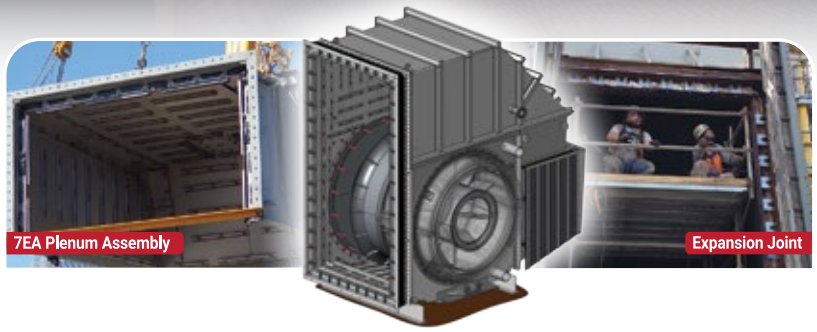

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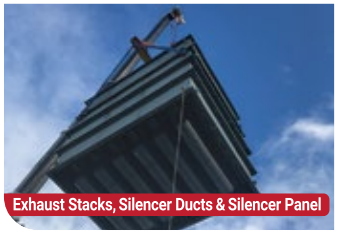
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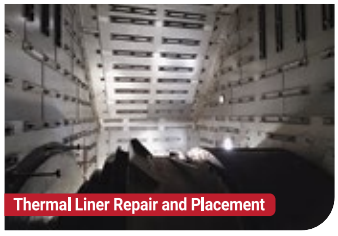
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PROENERGY CONFERENCE 22

Single-source services firm emerges for the LM6000 user community

Decades ago, a slide popular to include in electricity conference presentations went something like this: Technology tells us what we can do; government tells us what we will do. Today, that would be called a "meme." As applied to the peaking and load-following power market where GE aeroderivative gas turbines play, that meme also captures the essence of the ProEnergy Services (PES) inaugural user conference held Nov 1-4, 2022 in Kansas City, Mo, at least for the information delivered in the general sessions and roundtables (Fig 1).

Billed as the "premier LM-focused event," the subtext of the content was that PES and its partner ecosystem can assist LM (Land and Marine) owner/operators, especially those with LM6000 machines, with just about anything that's ailing their unit or the balance of plant (BOP), and even upgrade components, systems, and performance.

After all, PES operates 4900 MW of LM machines, conducts wide-ranging product R&D and applications engineering, functions as a depot with spare LM units and in-kind and upgraded parts available, and repairs units from all over the world.

The conference, and its subtext, come at an auspicious time. The industry, like the world around it, is reeling from inflationary pricing pressures, global supply-chain delays and shortages, and lack of critical materials, even as all of us recover from, or are exhausted by, the multi-year malaise of a global pandemic.

At the next level down, owner/operators are frustrated with the OEM as their machines endure ever higher numbers of starts and shrinking operating windows trying to satisfy the insatiable demand for more renewables.

In short, timing may not be everything but it does tend to drive success. As if to reinforce the point, the resumes of many of the speakers were laden with decades of experience employed by the OEM.

Conference topics were wide-ranging, from general market and machine trends, the nitty gritty of single-crystal directionally solidified turbine blade and nozzle materials, load reversals with LM units, and much in-between.

Readers are urged to review the conference program (https://www.proenergyservices.com/PEC2022/) and contact Chris Evans (cevans@proenergyservices.com), VP, marketing, for access to the video library or individual presentation slides.

What follows here is a high-level summary and highlights of the conference material stitched together from audio recordings and slide decks, with information of likely keenest interest to the plant-level personnel coming first.

1. Carlos Picon, chief commercial officer, Waldemar Brinster of Power Service Consulting, and Chris Evans, VP marketing (l to r) peruse the badges for the more than 100 participants in ProEnergy Services' inaugural user conference

LMs and LRs—as in "load reversals"

With respect to new information valuable to the user community, the presentation by Matt Kuffler, PE, plant engineer, Austin Energy's Sand Hill Energy Center (Fig 2), on "Load Following: Creating a Roadmap from Failures to Successful Operations" stands out (Fig 3).

Sand Hill experienced five separate domestic object damage (DOD)/foreign

2. Austin Energy's Sand Hill Energy Center was erected in stages: four simple-cycle LM6000s in 2001, a 300-MW 1 × 1 combined cycle in 2004, and two simple-cycle LM6000s in 2010. Total generating capability is 595 MW

3. Plant Engineer Matt Kuffler discusses operational dispatch changes for Sand Hill and proactive approaches to ensure unit reliability

4. Edge-of-contact crack in the aft pressure face of Blade 2 in the fourth stage of the HP compressor was the root cause of this 2017 failure. The airfoil liberated while the dovetail remained in the spool. Coating was missing at the origination point of the crack with coating depletion leading to increased stress. The OEM said this was the industry's first reported failure of a dual-intensity peened blade (introduced in 2014 and installed that December)

object damage (FOD) events through 2017, each stemming from a compressor blade edge-of-contact (EOC) failure (Fig 4). Kuffler covers what the plant/Austin Energy had to do to mitigate the impacts from these failures, then prevent them.

He referred to Service Bulletin 310 which refers to the O&M manual that calls for replacing stages 3-5 high-pressure compressor blades after 1500 starts because "load-following units are susceptible to more rapid, significant changes in HP shaft speed as the MW setpoint fluctuates"—what the OEM calls "load reversals." Units with high number of LRs will experience accelerated wear on the contact surface coating.

Sand Hill took necessary reactive and preventive maintenance steps to manage the situation, but what is really illuminating, and worth a look for anyone else experiencing this phenomenon, is how the plant began tracking load LRs unit by unit from a data-analysis point of view.

The plant found that when comparing the OEM definitions of a load reversal to its own data, Sand Hill's load-following activities resulted in more reversals than were readily apparent. In short, the plant quickly created an LR-based maintenance strategy rather than a starts-based one to better plan the life of their HPC stage 3-5 hardware.

Read your O&M manual!

What causes the most failures of LM machines in the field? Not following OEM guidelines, noted the Technical Roundtable panelists (Fig 5). For one, sites should conduct an external inspection every time the engine shuts down. It's in the manual.

Considering how often these machines start and stop these days, that's a lot of inspections. But if you don't follow the guidelines for peaker engines, you risk losing the lawsuit when you face a serious O&M event and "better call Saul." Another panelist suggested more frequent borescope inspections as well.

Other content gems from the tech roundtable:

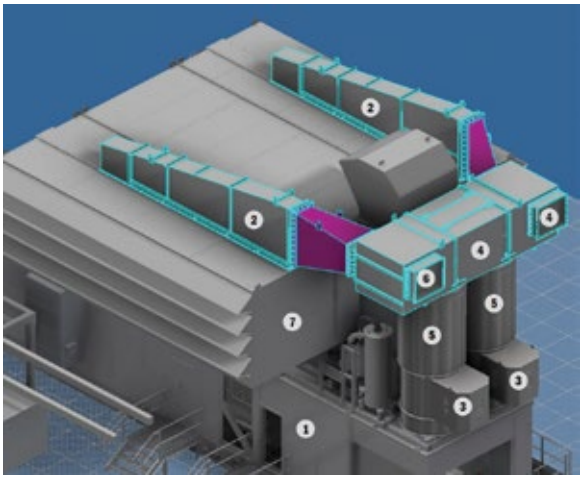
- Changes in turbine usage are posing technical challenges. At one time, one panelist reminisced, the OEM said that aero machines had no cycling limit (which kind of makes sense from their history in the aircraft market). Another panelist noted that the "stage 3-5 blade problems are not yet under control, even if many iterations of design mods have improved the situation."
- Machines with power augmentation in the 10-minute market are facing "lots of issues" pushing more water through the machine, including water getting into the lube-oil system. Also, moist ventilation air allows water to get into the oil sump when fogging and augmenting, a problem when you are shutdown, not when you are running. It was suggested that users may need to extend downtime to dry out sump areas. Another recommended practice is to add water/oil separators.
- Perhaps a longer-term, but more pernicious issue, with high-cycling, water-injected, power-augmented machines are damage-mode changes. There is more fretting, more wear, and more cracks in hot-section components. Users need to think harder about starts-based maintenance.

5. A panel of technical leaders addressed a wide range of topics—including cyclic limits of aeroderivative engines and the effects of higher run time, such as increased wear and oxidation. From right to left: Mike Tulk, Rockland Capital; Bill Schoultheis, REPS Resource; Paul DiMascio, ProEnergy; Brion Patt, Chromalloy; and Rob Andrews, ProEnergy

6. Rockland Capital's Mike Tulk and Bill Paff (back to camera) confer before the latter's presentation on cold-weather prep. Tulk participated in the technical leaders' panel (Fig 5)

Winter is coming

Cold-weather prep has been a sizzling topic for several years now, in particular because of the February 2019



7. ProEnergy's anti-icing system used to protect Rockland Capital's Shelby County Energy Center was a focal point of Bill Paff's presentation. He began with descriptions of the following components recently added to the company's system: anti-icing ducting (2), plenum (4), and atmospheric exhaust vents (6). How the system works came next: Turbine inlet-air heating is accomplished by extracting air, warmed by the operating turbine, from the enclosure package (1). The heated air is recirculated via ducting (2) and injected upstream of the filter house (7), thereby promoting thermal mixing and inhibiting ice formation in downstream components. Package ventilation fans (3) discharge into the plenum above the silencers. When temperatures rise and heated air is not required it is exhausted to atmosphere.

ERCOT-wide freeze debacle. Bill Paff, VP, asset management, Rockland Capital (Fig 6), in a session on winterization, essentially laid out three options his company evaluated for a long-term strategy at a plant in Illinois.

They are (1) a water-glycol coil-based heating system for about $1.0- to $1.4-million per engine, (2) taking heat from the hotter compressor stages and redirecting it to the inlet for $450k to $1.3-million (but the necessary valves were not available), and (3) taking heat from the turbine enclosure, which penciled out to between $450k to $950k per engine. However, option 2 could open up a site permit review, a risk few owners likely would take.

It turns out option 3 is a package offered by PES and available as a 100% turnkey EPC installation (Fig 7). When ambient temperature drops below 40F, warm air from the turbine enclosure is redirected through ducts, added atop the enclosure roof, to the combustor air-inlet filter house before the filter cartridges.

Kevin Chaffin (Fig 8), recently named ProEnergy's O&M director, delivered the second presentation on short-term strategies, and focused on the steps his crew took to protect six peakers at the HO Clarke Power Station in Texas one to two weeks before the ERCOT 2019 storm "Uri" event:

- Scaffolding erected around the NO_x water spray system.
- 36 electric heaters ordered with two per structure.
- Plywood wind breaks built for air compressors.
- Plant staffed for 24/7 periodic rounds.
- Blankets wrapped around instrument panels.

Suffice to say, all Clarke units were 100% available during the entire event, although the site lost water supply for three days.

One audience member described a once-in-a lifetime snow event during which cooling-tower drift laden with frozen particles entered the turbine inlet air filter. The unit got so cold, the control system went into run-back.

Other lively audience comments described how level transmitters froze up, how one site instituted a change to the control system so they could click a button and force a transmitter out of service "if it was going wacko," how another site discovered that their heat tracing stopped one inch before cabinets containing critical transmitters, and the rather glib observation that "ERCOT rules [on winterization] change every other day."

Perhaps the most useful comment: "Is anyone using simple thermal cameras?" Apparently, this user found them to be a very inexpensive solution for checking heat tracing and identifying other potential problems during winter prep.

8. Kevin Chaffin, recently named ProEnergy's O&M director, shared the successful winterization strategies used to protect six peakers at the HO Clarke Power Station in Texas against ERCOT's 2019 "Uri" freeze event

9. Paul Dimascio, ProEnergy's VP engineering, discusses the stage 2 nozzle wear

Upgraded hot sections

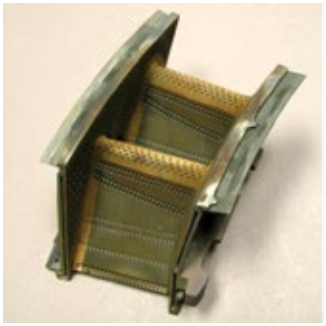
Brion Patt, global director of sales, Chromalloy, and Paul Dimascio (Fig 9), VP engineering, PES, spoke on the benefits of single-crystal hardware and improving stage 2 nozzle life. Chromalloy is the "partner of choice" for parts, said Dimascio. Patt's presentation is an extended review of Chromalloy's hot-section component fabrication, repair, and upgraded parts capabilities.

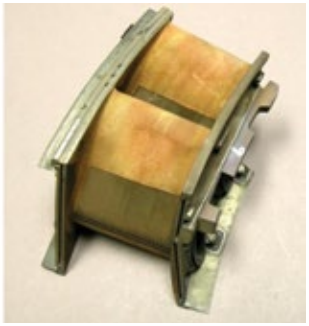
Without diving too deep into the weeds of metallurgical formulations, hot-section piece identifiers, and trade names, the broader messages are that Chromalloy is a repair source authorized by the OEM that also has developed its own repair techniques and upgraded parts (Figs 10-12).

Patt took pains to explain that Chromalloy's legacy business in aircraft means that, as a non-OEM, they "can't make a mistake" in order to retain Parts Manufactured Approvals (PMA) from the Federal Aviation Administration (FAA). They inspect their parts four and five times before release.

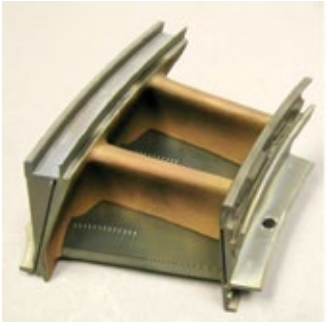
Patt went on to claim that Chromalloy parts have never been attributed to an aircraft engine failure. The company has developed thermal-barrier-coating (TBC) top coats beyond OEM-type TBC offerings and has redesigned cooling holes for extended life because "stage 1 blades and stage 2 vanes [nozzles] are showing more damage than they would like. . . ."

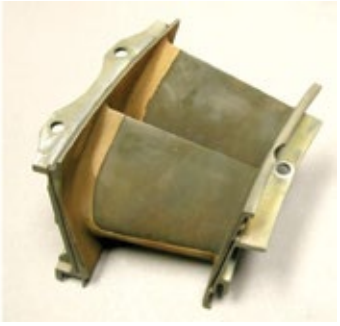
Dimascio addressed stage 2 nozzle



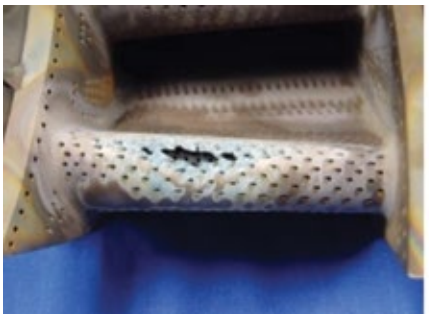


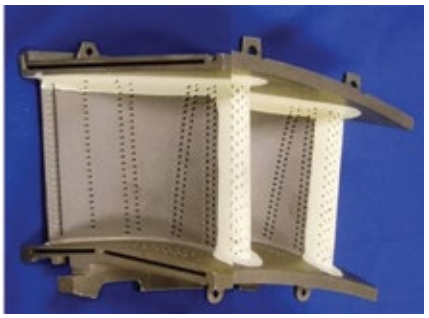
10. Chromalloy's Brion Patt, who tag-teamed with ProEnergy's Paul Dimascio, shared some of his company's successes in the manufacture and repair of critical HP turbine components. Above is what its LM6000 first-stage turbine nozzles with a platinum aluminide coating looked like after operating for 8000 hours on liquid fuel





11. Second-stage HPT vanes with platinum aluminide coating and air-plasma-sprayed ceramic TBC after 8000 hours on liquid fuel





12. Excessive burning and erosion of the first-stage HPT nozzle at left was corrected with air-plasma-sprayed TBC (right)

13. Jeff Wirt, EnergyLink International, presents on ammonia-injection-grid optimization to maintain environmental compliance

life and a competitive analysis of three solutions—improve materials, improve cooling techniques, and/or add TBC.

One audience member asked the pair to explain the recent shortage of blades for catastrophic rebuilds. Among the responses was that the war in Ukraine has caused a worldwide nickel shortage. Currently, the company has a two- to three-month timeframe for delivery of hot-section parts.

NO_x removal: Turbulence is key

The session on ammonia and flow distribution, in the Asset Management Track, was led by Jeff Wirt, director, catalyst systems, EnergyLink International (Fig 13). It proved to be a primer of sorts on SCR, with the underlying message about the importance of flows, reagent and exhaust mixing, NH_3-to-NO_x ratio, and uniform distribution of NH_3 to NO_x across the catalyst grid (Fig 14).

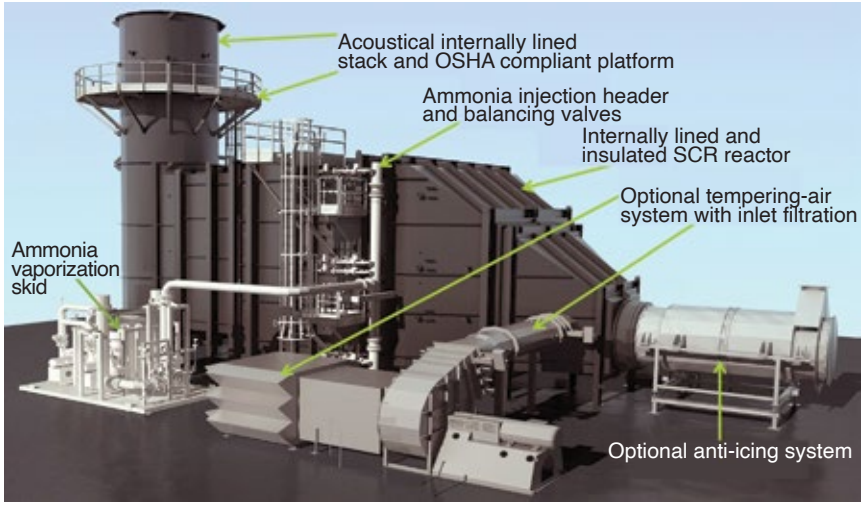
EnergyLink has a proprietary blending technique that can achieve a 5% RMS (root mean square) level blend rate. Traditional mixing design apparatus is more like 25% and higher. The way to achieve that 5% figure is better mixing at the point of NH_3 injection by blending ambient air with turbine exhaust to control temperature and increase turbulence. Blending plates create an area of low pressure which promotes mixing of ammonia and turbine exhaust.

According to EnergyLink, this technique, for which they guarantee performance, will lower the total NH_3 tonnage consumption, achieve a slip level of under 5 ppm (and as low as 1.2), and allow more operating hours because of the higher removal efficiency. Indeed, one slide showed four PES turbines all measuring at average slip levels of well under 2 ppm.

One audience member pleaded with the speaker not to widely report the 1.2 slip figure, lest permit limits get ratcheted down everywhere. Another audience member asked why the process diagram called for two fans and the answer was redundancy. A third asked whether a high-temperature catalyst formulation was available for the LM2500 product and the answer was not yet, but experts are working on it.

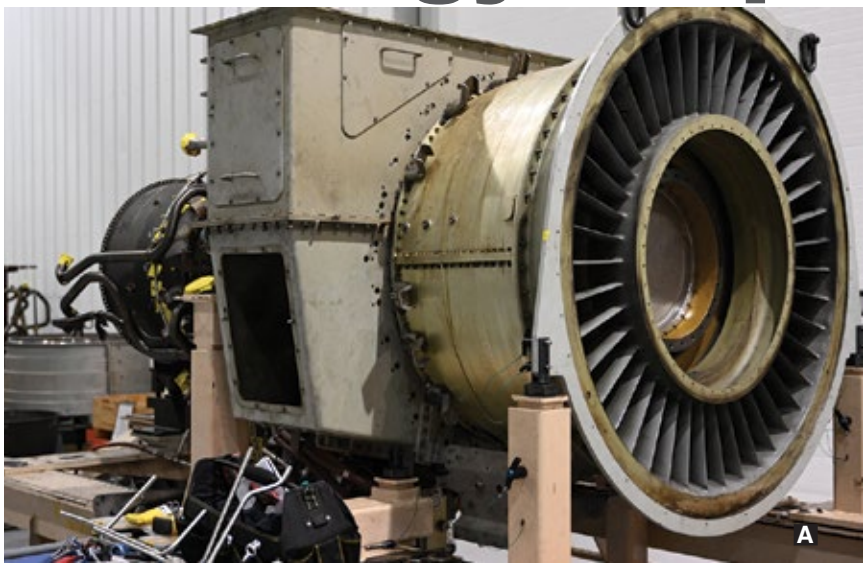
Quiet parts out loud

Mercifully, some presenters were willing to "say the quiet parts out loud,"



14. Elements of an SCR catalyst system was one of Wirt's "refresher" slides

ProEnergy shop tour


A


B


F


G

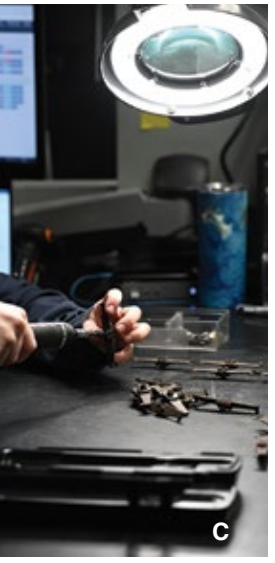

K

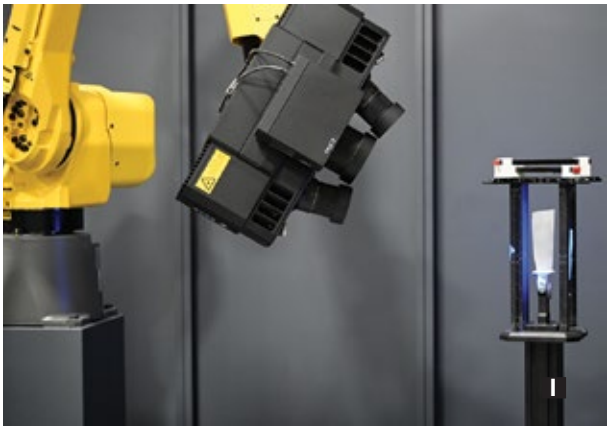
ProEnergy focuses exclusively on the operation and maintenance of LM6000 and LM2500 gas turbines. The company says it operates the only *independent* Level-IV aeroderivative depot in the world at its 1-million-ft² campus in Sedalia, Mo. The LM6000 shown in Fig **A** is in Gate 1, "Induction and Disassembly."

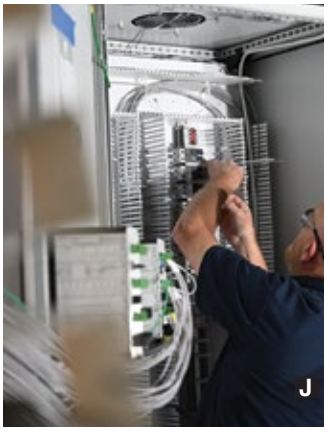
Eric Thornton, parts prep operator, is among the dozens of skilled technicians for Gates 2 and 3 in the Aeroderivative Repair and Manufacturing (ARM) Center, where assessment of piece-parts condition begins in **B** with cleaning, followed by an in-depth series of inspections by fluorescent penetrant, CMM, Faro arms, and more.

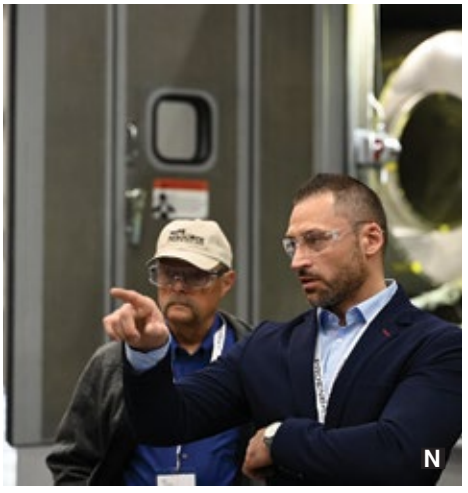
Daisy Gay, parts inspector, conducts detailed inspections of various components, ranging from individual piece parts—including the VSV linkage arms shown in **C**—to major items, including combustors. Each component, part, and piece is subject to in-depth inspection in Gate 2, which includes the turbine vanes in **D**. Gate 3 is where in-house repairs **E** to turbine parts are made—including welding, braising, shot peen, and heat treat.

Brenton Johns, turbine technician, installs repaired components **F** to complete an LM6000 major overhaul in Gate 4, "Assembly." He leverages processes that include blade grinding to eight one-thousandths of an inch to maximize power and engine longevity. Fuel nozzles **G** are calibrated to ±2% using an exclusive 20-step repair process.









Aero Manufacturing Manager Brandon Harrison, at right in **H**, listens to an explanation of how ProEnergy mitigates shortages of critical spares, by making new parts in-house. Blue-light scanner **I** is an important component in the company's advanced manufacturing initiative, which includes a climate-controlled machining center.

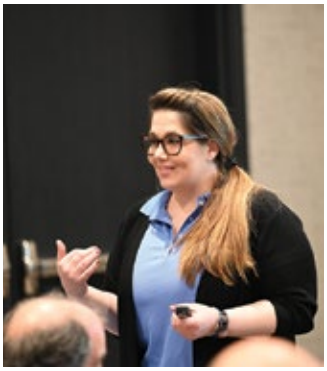
Terry Fielder, panel wireman, constructs modern control systems **J** for the LM6000 gas turbine, as well as its generator and associated auxiliary systems. A sizable portion of the ProEnergy campus is devoted to manufacture of LM6000 packages **K** under the PowerFLX name. New packages are fabricated in-house **L** from raw steel—including welding, paint, and final assembly. Dozens of skilled fabricators manufacture one LM6000 package **M**—including mechanical and electrical BOP—every two weeks, and have the capability to produce many more.

Waldemar Brinster, senior project and service engineer for Power Service Consulting in Germany, tours the package assembly area **N** where major components and skids are finalized for transport.

The test cell **O** serves as a proving ground for overhauled turbines, as well as for the future of the LM6000 platform. The site represents a $12-million investment toward the development of a fully hydrogen-powered turbine.

15. Executive panel offered a panoramic view of the electric-power industry's generation sector by experts representing a 40-GW fleet, small peaking operator, cooperative, and consultancy. From right to left: Randy Bird, Sky Global; Jens-Peter Schmidt, RWE; Chris Jimenez, Arizona G&T Co-op; Mark Axford, Axford Consulting; and Landon Tessmer, ProEnergy

when it came to general trends in the industry. For example, Mark Axford, president, Axford Turbine Consultants, noted during the Executive Roundtable (Fig 15) on the opening morning that "using hydrogen to make electricity is absurd, economic nonsense." Later in the conference, Jens-Peter Schmidt, project manager, RWE (a German energy company), said during a user panel that gas-fired plants in his country "must have H_2 [cofiring] or the project will not fly."



16. Colleen Deist of Brush shared tips on how to extend the life of generators through best practices for generator maintenance and inspections

17. David Evinrude, ProEnergy's customer service manager, was co-leader with Chad Hall for the strategy session focusing on condition-based repairs. He presented detailed data to illustrate that expanded parts-service limits and cyclic-life management can meet the evolving LM mission profile while broadening end-user maintenance and management choices

18. Chad Hall, ROC manager, partnered with Evinrude (Fig 17) on the condition-based-repairs strategy session, sharing how inspection, repair, and replacement options maintain or enhance LM platform reliability and efficiency standards at reduced operating cost

What you should do technologically isn't always congruent with what you will do politically.

What you can do with H_2 was discussed in an earlier technical roundtable. The LM6000 can do 35% H_2 blends and ProEnergy is leveraging a $12-million-plus investment in the technology to "push this" beyond published limits. However, it may require modifications to the combustor as the faster H_2 flame speeds, and its low mass and high volume, can challenge the combustor throat area and potentially melt combustor-section parts.

In response to an audience question, one panelist noted that the impact on machine heat rate from H_2 firing is neutral and engine control won't change, but flow into the machine will be a challenge and higher NO_x production may necessitate higher water injection rates. Both can impact machine reliability.

Absurd or not, the recently passed US federal Inflation Reduction Act (IRA) includes the first subsidies for H_2, said a panelist. The idea of delivering H_2 as ammonia (NH_3) was also broached. Compressed H_2 could take advantage of existing storage and transport infrastructure. On the other hand, ammonia is easier to store onsite than H_2. An additional safety factor with H_2 is that it rises and dissipates, while ammonia settles in low-lying areas.

In response to an audience question, a panelist noted that H_2 won't affect the SCR catalyst but will drive up the turbine exhaust temperature and increase NO_x output, both of which will affect SCR system design and operation.

One panelist in separate session noted that some developers are looking at producing H_2 as NH_3 with no-carbon wind energy and shipping it to Europe to meet their H_2 co-firing needs.

Grid-scale batteries were also subjected to some honest discussion. Executive roundtable panelists noted that even the subsides in the IRA won't make solar + batteries "cheaper." New natural gas projects are still more economical, in part because "you need four to six times more solar and batteries to make an apples-to-apples comparison to gas-fired peakers." And solar with batteries impose their own environmental quandaries. For one, birds mistake large solar paneled areas for lakes and dive into them; scrapped older solar panels are being dumped into rural areas, according to one panelist.

Battery permits often require water tanks for fire protection even though water doesn't snuff out a lithium fire. Panelists urged their listeners to work with local authorities and citizens towards a better understanding of the tradeoffs and hazards associated with large batteries.

More starts, less time

The evidence for what these machines are now enduring is incontrovertible, at least in the aggregate. David Heatherington, president, McCoy Power Reports, reported data from the EPA Clean Air Markets program covering 2015 to 2022 on start/stops for combustion units over 20 MW, which confirm that simple-cycle peakers are gaining share of the peaking market relative to boiler units. And 88% of starts involve a run cycle less than 24 hours.

Drilling down, 74% of combined-cycle stops involve run times of less than 24 hours. Plus, 30% of simple-cycle stops deliver fewer than 100 MWh to their respective grids. To convert data science into something digestible, Heatherington's slides break out two groups of units—the resiliency group and the Big Four (PJM, MISO, ERCOT, and CAISO)—and analyzes each one's starts behavior for duration and load delivery.

Tom Christiansen, SVP, Strategic Power Systems, reported aggregate data from its ORAP database, representing 9400 LM unit-years. Utilization factors for aeros in power and cogen are up 19% in the past year. In the 1990s, an aero unit may have operated for an average of a week when started; today it is more like 10 hours. In the US, peaking units average three starts per week. There has been a 200% rise in starts frequency with an attendant reduction in hours per start.

The good news: Starting reliability for simple-cycle units is relatively high and consistent over the last 10 years, at 98-99%, even though the number of starts per unit has risen dramatically over that period. However, overall reliability and availability have declined somewhat since the early 1990s, with availability taking more of a dive than reliability over the last decade.

What price components?

Texas, apparently, is in a class all by itself when it comes to starts. A panelist in the technical roundtable noted that some machines in that state are starting and stopping six to eight times a day! Which brings up the question of how to adjust maintenance programs for the high-starts regime. Lower-cost materials can be used but component life is shortened. Do you spend less on parts but overhaul more often?

The same question came up from the audience in a session on SCR and catalyst. Switch to a lower-cost catalyst and replace it every five years instead of 10? A PES expert responded that they could do some R&D and look into this.

The Yellow Brick Road?

David Rhodes, SVP, Onward Energy (owner/operator of 56 generation sites comprising solar, wind, and thermal), addressed the path to net zero carbon in the conference keynote address. In short, he stated it is possible to get to 100% carbon-free grid, but many stars must align. One that isn't mentioned often in forums like this one is transmission, which is expanding at only 1.5% average per year over the last few decades, and more like 1% annually over the past decade.

The federal IRA intends to supercharge renewables, he stressed, but without the corresponding transmission, the carbon-free megawatts can't get to the load. Already, there are huge curtailments taking pace in Texas and the Northeast, he added.

A natural-gas plant is still more economically competitive than batteries plus renewables when the regulatory preferences and public sentiment are stripped away. However, some jurisdictions are "pricing in" carbon which penalizes gas projects even more. An example quoted $70/ton of carbon.

Rhodes also made this key point, another example of the "quiet part out loud": One way to make natural gas more sustainable is to identify and mitigate methane leaks. Just 2% gas leakage, given methane's order of magnitude higher warming capability in the atmosphere, means that gas-fired capacity is no better than coal in overall carbon footprint.

A member of the user panel, later in the conference, noted a separate challenge developing gas peakers in Texas: ERCOT is agnostic to generation type and applications are taken in the order they are received. There could be 40 solar facilities in the queue which may not ever get built holding up a gas peaker project.

Finally, to emphasize what solution won't be coming to the rescue anytime soon, Rhodes noted that the ratio of published material on carbon capture and storage to actual CCS capacity is about 10,000 to one, lots of talk but no action, in other words. That got a few chuckles from the audience.

The balance of content

Other presentations covered the following:

- Representatives from Brush Electric (Fig 16) reviewed all the things Brush can do for generator owner/operators, which the company claims is just about everything.
- PES' Bob Bosse, VP, aero products, David Evinrude (Fig 17), customer service manager, and Chad Hall (Fig 18), manager, Remote Operating Center (ROC) reviewed condition-based maintenance, highlighting the capabilities of the strategy, especially when combined with a capable ROC.
- PES experts advocated for fogging over evaporative cooling, concluding that wet fogging could increase performance by 10%.
- PES experts delivered a half-day "refresher course" on LM6000 technology.

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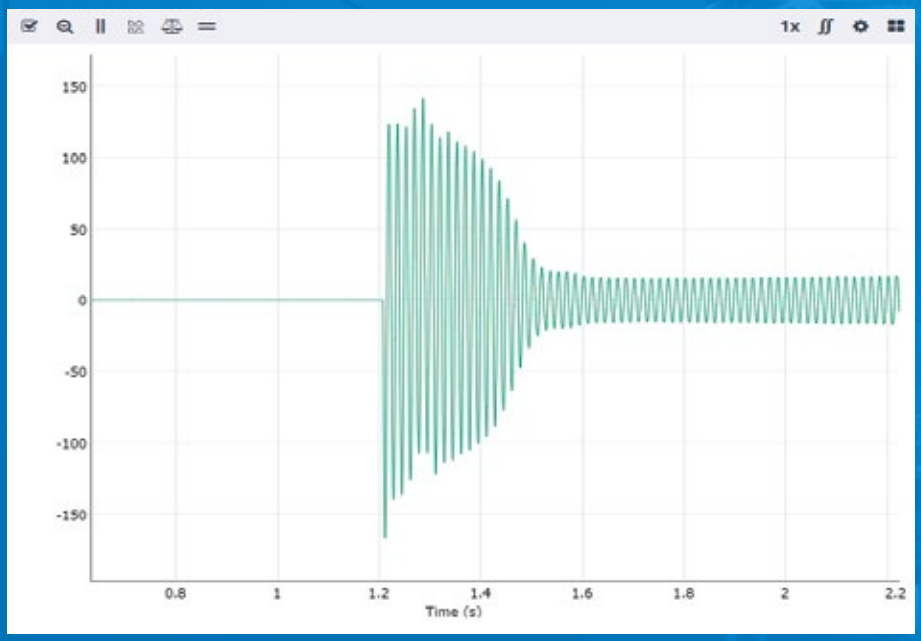

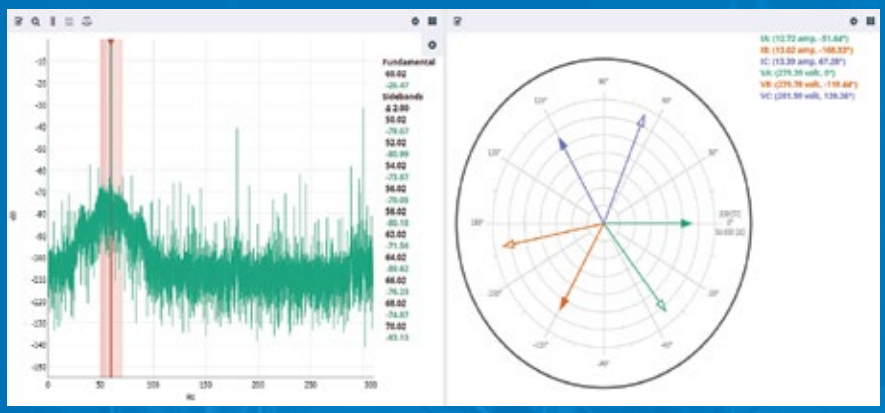

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Register at:	https://www.aogusers.com **Helpline:** ashley@aogusers.com

Program highlights

Monday, March 20

10:00 End-user closed session
12:00 LUNCH
1:00 Introduction to the GE all-afternoon session for end-users
Tom Freeman
1:05 Agenda and overviews of the GT11N/N2/24 fleets
Stefano Tartoni and Tom Stroud
1:20 Technical GT update and rotor lifecycle management
Martin von Planta and Stefano Tartoni
3:10 BREAK
3:30 Parts lifecycle management
Stefano Tartoni
3:45 Excitation and SFC systems
Dimitrios Kokidis
4:00 Repairs
Josh Pryor
4:20 Steam/Gen
Ricardo Santillan
4:35 Controls: Mark VIe success stories
Robert Turner/Sebastien Bertrand
4:55 Open discussion

Tuesday, March 21

9:00 How gas-turbine maintenance has changed: Innovation, quality, retirement
Bobby Noble, EPRI
9:30 GT starts and stops: Measuring grid intermittency
David Hetherington, McCoy Power Reports
10:00 GT26 rebuild project
Rocksavage Power Station
10:30 Alstom slot-liner cracking and failure
MD&A
11:00 Alstom field machining and outage support
K Machine Industrial Services
11:30 Plant improvements, spare parts, and mechanical services
Hughes Technical Services
12:00 LUNCH
1:00 Advanced steam turbine and HRSG warming for increased startup flexibility
Arnold Group
1:30 GT supply-chain challenges: Component repair to reduce waste and improve turn time
Liburdi Turbine Services
2:00 Manufacturing blades and vanes for GT11D5, N, and NM
SUNG IL (SIM)
2:30 BREAK
3:00 TBA
Allied Power Group
3:30 Recap and feedback
6:00 AOG meet and greet (Marriott)
Courtesy of AOG gold sponsors

Wednesday, March 22

9:00 How Nord-Lock Group products benefit AOG users
Nord-Lock Group
9:30 Attemperators for modulating combined-cycle/peaker plants
Advanced Valve Solutions
10:00 Rotor life extension
Doosan Turbomachinery Services
10:30 Case study: Repairs of GT11 and GT13 components
TRS Global Services
11:00 Case study: Firing temperature validation
AIM Power Consulting
11:30 Generator cycling
AGT Services Inc
12:00 LUNCH
1:00 KinetiClean HRSG tube cleaning technology
Groome Industrial Service Group
1:30 Upgrade solutions for Advant-based control systems
Emerson
2:00 BREAK
2:30 TBA
Camfil
3:00 Lifecycle maintenance and extension of WX/WY-model generators
National Electric Coil
3:30 Recap and feedback

Thursday, March 23

9:00 End-user closed session
10:00 EPRI laboratory tour
12:00 LUNCH
1:00 The following four training sessions, conducted in parallel, run until 5:00:
Session 1, Gas-turbine failure analysis
Kevin Weins and Doug Nagy, Liburdi Turbine Services
Session 2, Generational diversity
Wade Younger, The Value Wave
Session 3, P13/Blueline training
Tom Douglas, Hughes Technical Services
Session 4, Alstom generators
Jamie Clark, AGT Services Inc

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Owner/operators of Siemens Energy/Westinghouse Electric Corp 501F and 501G gas turbines were arriving at the Peppermill Resort and Spa in Reno, Nev, as the electronic files for this issue (CCJ No. 73) were being transmitted to the printer. While there is no report on the 2023 conferences of the 501F and 501G Users Groups here, the programs for these events are summarized below.

The two user groups were co-locating for the first time in three years. These organizations last shared the same in-person venue in February 2020 at the Hilton West Palm Beach, about a month before the pandemic changed things.

Arrangement of the 2023 conference (February 19-23) is much the same as it was before Covid-19 struck. Sunday's program features social events for all attendees. The agenda for Monday—including a safety roundtable focusing on human performance, vendor presentations (so-called Vendorama), and vendor fair—also is for both the 501F and 501G Users Groups. The organizations meet independently on Tuesday, Wednesday, and Thursday for technical presentations by users, services providers, and OEMs.

Participants in the respected Vendorama program, which runs from the morning break until the meeting concludes about an hour before the vendor fair, are listed in sidebar on p 60 along with the titles of their presentations. User attendees registered on the 501F website can get access to the slide decks when they are posted there, about a month from now.

Another sidebar on p 60 lists participants in the vendor fair.

501F program for 2023

The 501F Users Group is a private community of owners and operators of 501F gas turbine/generators established to discuss the operation, maintenance, inspection, troubleshooting, repair, and optimization of their plants and equipment.

Membership in the organization is limited to individuals who are directly involved in the construction or O&M of Siemens Energy, Westinghouse, and Mitsubishi Power 501F, 701F, and SGT6-5000F gas turbines and who are employed by companies with a direct ownership and/or operational interest in those engines.

Annual conferences are developed and moderated by the group's officers and directors (sidebar adjacent). Agenda highlights for the F frame's portion of the 2023 joint meeting are presented immediately below for Tuesday, Wednesday, and Thursday (half day), February 21-23.

Tuesday, February 21: First half the morning session encompasses a closed user section and generator roundtable with associated presentations by owner/operators. Siemens Energy's program follows the morning break and runs until lunch. PSM is at the podium for the entire afternoon.

Wednesday, February 22: Inlet and exhaust and compressor roundtables and their associated user presentations run from the opening bell to the break. Rotor and hot-gas-section roundtables complete the morning program. Mitsubishi Power is at the podium for the entire afternoon.

Thursday, February 23: Morning-only program features combustor and auxiliaries roundtables before refreshments and the outage roundtable following.

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Jaime Oliveira, *O&M senior manager, Norte Fluminense, EdF*

501F 2022 conference recap

A Covid outbreak a week or so before the 2022 meeting was to start at the Hyatt Regency in New Orleans, February 20, dramatically reduced the number of attendees expected, both user and vendor. Recall that this conference was the group's return to an in-person program following a virtual meeting in 2021.

Since many owner/operators participating in the 2023 conference were not able to attend last year, the editors compiled some of that meeting's technical highlights below to help you "connect the dots" since the 2020 in-person conference.

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Vendorama presentations

Advanced Turbine Support, *Contingency planning for steam-turbine outages*
AGT Services, *Are you abusing your generators?*
Arnold Group, *Advanced steam-turbine and HRSG warming for significant startup improvement*
Braden Filtration, *Pulse versus non-pulse filters—when and how to choose*
Camfil Power Systems, *An IoT approach to predictive maintenance*
Camfil Power Systems, *New ISO test standard for gas-turbine inlet filtration*
C C Jensen, *Oil maintenance in powerplants—What about transformer oil?*
CECO Environmental/Peerless Mfg, T*op Five most common issues affecting your SCR System*
Doosan Turbomachinery Services, *Status of 501F manufacturing programs*
EagleBurgmann, Extended-lifecycle soft parts for Frame 501 expansion joints
Environex, *Enhanced SCR and CO system management to meet today's operational challenges*
Environment One Corp, *Best practices for automated gas-manifold and generator purging*
Frenzelit, *501F upgrades for legacy units*
HRST, *Bigger HRSGs and the new problems they create*
Hy-Pro Filtration, *Lube-oil maintenance*
Industrial Air Flow Dynamics, *ASME B31.1 (Section VII) as it relates to high-energy and covered piping systems*
Industrial Air Flow Dynamics, *Gas-turbine expansion joints*
Marioff NA, *Protection of gas turbines using high-pressure water mist*
Mee Fog, *Wet compression of 501Fs*
Mitsubishi Power, *Product and services update*
National Electric Coil, *Aging generator lifecycle planning and issue update*
Nord-Lock, *501F four-way-joint solution*
NRG Faist Corp, *New ISO 29461-2 and gas-turbine air inlet filters*
ORR Protection Systems, *Product and services update*
Powerflow Engineering, *Long-term wear and failure modes of torque converters in starting packages*
PSM, *Product and services update*
Shell Oil Products, *PAG-based EHC fluid—A sustainable alternative to phosphate ester for EHC application*
Sulzer Turbo Services Houston, *Product and services update*
SVI Dynamics/Bremco, *Case studies on turbine-exhaust-system gas-path upgrades to improve safety, reliability, and performance*
Tetra Engineering Group, *Potential for hydrogen use in GT-CC duct burners under new USA H_2 production tax*
Veracity Technology Solutions, *Advanced NDT testing methods for decreasing operational risk*

User presentations

Just shy of a dozen presentations by owner/operators were incorporated into the seven 501F roundtables conducted in 2022: Inlet and exhaust, compressor, rotor, hot-gas section, combustors, auxiliaries, and outage planning.

Summaries of the presentations follow, each introduced by boldface type.

Get the details by accessing the PowerPoints on the group's website at https://forum.501Fusers.org. Find them in the "2022 Conference Materials" folder (click on the magnifying-glass symbol at the top right-hand side of the page). Only registered users are admitted to this portion of the website.

2021 outage highlights for this unique 2 × 1 combined cycle, described in two presentations, include a steam-turbine major, ST valve inspections, second majors and FD3 upgrades for the gas turbines, and generator inspections on the steamer and one of the gas turbines.

Planning for the outage, the largest in the plant's history, started in 2019. Given the large amount of work slated for 2021, some was moved forward to 2020 to free up crane time, reduce interferences, and level-out the workload of facility personnel.

History: First unit installed on the greenfield site nearly 30 years ago was a 501D5. A 501FC+ was added two years later. Year 2000 saw installation of a 501FD2 and a steam turbine. Upgrade of the FC+ to FD2 and conversion to the combined cycle followed immediately.

Key topics in the first presentation were implementation of (1) purge credit, to eliminate purging during startup and (2) inlet heating, to improve availability and expand the unit's operating range. P&IDs are provided for both enhancements. Lessons learned provide valuable guidance.

501F/G exhibitors in 2023

AAF International
Accumetrics
Advance Turbine
AGT Services Inc
Allied Power Group
Alta Solutions Inc
American Thermal Solutions
Arnold Group
Badger Industries
BBM-CPG Technology
Bearings Plus
Braden
Bruel & Kjaer Vibro
C C Jensen
Camfil Power Systems
Catalytic Combustion Corp
CECO Environmental/Peerless Mfg
Conax Technologies
Conval Inc
Cutsforth Inc
Doble Engineering Co
Donaldson Company
Doosan Turbomachinery Services Inc
Durr Universal Inc
EagleBurgmann
Environex Inc
Environment One Corp
Faist Filters
Falcon Crest Aviation Supply Inc
Fisher Improvement Technologies
Frenzelit Inc
Freudenberg Filtration
Groome Industrial Service Group
Hilco Filtration Systems
HRST Inc
Hy-Pro Filtration
Industrial Air Flow Dynamics Inc
Iris Power-Qualitrol
Kingsbury Inc
Koenig Engineering Inc
Liburdi Turbine Services Inc
LPG Industries Inc
Macemore Inc
Marioff NA
Mee Industries Inc
Millennium Power Services
Mitsubishi Power
Moog
Munters Corp
National Electric Coil
Nederman Pneumafil
Nord-Lock Inc
ORR Protection
Parker Hannifin Corp
Powerflow Engineering Inc
PSM
Rochem Technical Services
ROMCO Manufacturing Inc
Schock Manufacturing
Shell Oil Products
Siemens Energy
Sulzer Turbo Services Houston Inc
SVI Industrial (SVI Dynamics/Bremco)
Tetra Engineering Group Inc
TOPS
Trinity Turbine Technology LP
TRS Services LLC
Vector Systems Inc
Veracity Technology Solutions
Viking Turbine Services Inc
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Note that the current purge procedure uses normal spin-down time at the end of a run to count as the purge credit for the next run. (Consult NFPA 85 for details.) It eliminated the air entrainment into the oil system experienced with the method replaced which was said to have damaged the torque converter wheel. Benefits of purge credit include a 10-min decrease in startup time, longer oil life, reduced stresses on the HRSG, etc.

The second presentation discusses changes to the outage plan made necessary by Covid-19 restrictions, reviews schedule and contractor laydown considerations, and profiles, by way of photos, rotor swaps and upgrades to single-piece exhaust cylinders on both gas turbines.

GT major inspections and exhaust replacements presentation is recommended reading by the editors, who are both familiar with the facility profiled and similar work done at other plants. Original scope of work for this 501FD2-powered 2 × 1 combined cycle, planned as a 30-day effort, was the following:

- Major inspection of one gas turbine with rotor exchange and turbine upgrade, plus exhaust refurbishment. Second GT: upgrade only.
- Steam-turbine medium inspection with bearing and valve replacement.
- Pressure-wave cleaning of both HRSGs, plus floor-liner replacement on one.
- Controls upgrade for the entire plant.
- Generator robotic inspections.
- Rebuilds of one cooling-water pump and one boiler-feed pump.

The work described in greatest detail is that for the exhaust section. Inspections conducted as soon as the units had cooled found that Row 4 tip measurements in one engine were significantly different than those recorded only five months earlier. Plus, two of the unit's six exhaust struts severed during that time.

For those not familiar with exhaust sections, the presentation provides excellent drawings, complete with detailed callouts, explaining the issues and parts involved. In addition, there are summaries of both fleet and plant experiences involving the exhaust section.

Repair options to correct the major deficiencies identified included weld repair and exhaust cylinder and manifold replacement. A new plan was developed: Extend the outage from 30 to 45 days to conduct majors on both gas turbines and replace the exhaust cylinders and manifolds on both machines.

The presentation concludes with a list of additional findings and corrective actions.

DLN to ULN conversion. Upgrades of SCR systems incorporated in this 2 × 1 combined cycle's HRSGs were not viewed as adequate to meet new rules governing NO_x emissions and expected future limits on ammonia slip. Ultra-low NO_x was selected as the preferred solution. It was believed capable of reducing NO_x from 25 ppm to 9 to 12 ppm. Pictures describe the work in progress.

Here are the results described by the speaker:

- Plant output decreased by about 5 MW.
- Plant heat rate increased by about 290 Btu/kWh.
- Combustor dynamics were virtually zero.
- Plant is meeting its NO_x requirements, but struggling with CO.
- Ammonia consumption has been reduced by about half.

One year of experience with FlameTOP. Presentation discusses recent modifications to one of two gas turbines at this 501FD2-powered 2 × 1 combined cycle that are providing the additional power expected (and sometimes more). Here's a list of the changes:

- Retrofit of FlameSheet™ combustors to boost engine output and increase efficiency.
- Installation of PSM's GTOP system, with its hardware upgrades to increase output and extend maintenance intervals.
- Addition of inlet bleed heat to the compressor to increase turndown.
- Installation of AutoTune 3.0/PLP for tighter unit control.
- Retrofit of PSM's exhaust cylinder and manifold.
- Installation of Arnold insulation for the walls, floor, and ceiling of the exhaust transition duct to reduce performance-robbing heat losses.

FlameTOP7 from PSM is said to increase the simple-cycle output of a standard 501FD2 by 20 MW while reducing heat rate by 3.8%. Unit turndown can extend below 40% of the full-load rating with both FlameSheet and inlet bleed heat installed. NO_x emissions are less than 9 ppm across the load range.

After flipping through the slide deck, read "Desert Basin reports experience, success with first 501F FlameTOP7" in CCJ No. 66 (2021) for details.

A second plant also reported a GTOP success, this one involving GTOP6 mods to both engines of the 501FD2-powered 2 × 1 combined cycle—including new combustion hardware, 16th-stage compressor blades, first- and second-stage turbine vanes and blades, and other improvements. The benefits: More than 22 MW of additional combined-cycle capacity and a heat-rate reduction of 80 Btu/kWh.

This presentation is valuable for the balance-of-plant (BOP) assessment described, which was part of the process for evaluating the benefits of upgrading the gas turbines. The report for this effort highlighted safety valves and steam silencers as having insufficient capacity. Plus, the steam turbine's pressure and temperature limits were identified as a potential limitation, along with both the condensate pumps and the boiler-feed pumps. Changes to safety-valve settings were required, too. Other modifications needed post implementation also are discussed.

Multiple gas-turbine events experienced at a 501F4-powered 3 × 1 combined cycle that occurred during a three-month period are described in this presentation. Here's a description of the events and what was done to correct them:

- Operators noted that one gas-turbine in the eight-year-old combined cycle experienced a step change in vibration (relative and seismic) and an output loss of about 1 MW. About a week later, personnel reported hearing a fast-rattle/buzz type of noise inside the exhaust end of the machine. It was accompanied by a nominal loss in unit output of about 3 MW. The engine was shut down and inspected. Initial findings: damage to Row 3 and 4 turbine blades, vanes, and ring segments. Repairs were made and the unit returned to service.
- A second gas turbine tripped along with a loud bang and high relative and seismic vibrations. Vibration levels across the unit reached trip levels and were at or above 16 mils. Inspection findings included damage to Row 3 and 4 turbine blades, vanes, and ring segments, plus the rotor, exhaust cylinder, lube-oil piping, and inlet manifold. Repairs were made and the unit returned to service.
- A major inspection was initiated on the combined cycle's third gas turbine about six weeks after a borescope inspection of Row 3 blades and ring segments did not reveal any significant findings. However, first inspection conducted during the major revealed some distorted Row 3 blade shroud platforms and exhaust-cylinder heat erosion. Unit returned to service after a two-month outage.

Details on how cooling flows and exhaust temperatures were measured at load loads to verify model calculations. Input from Siemens Energy based on RCA results also is summarized.

IGV history/maintenance. The presenter walks you through inlet-guide-vane modifications made over the years to prevent sticking by improving bush-

ing lubrication—the first, for the top half of the bushing, ProdMod 98-1410 in 1998. Westinghouse modified the lower half the following year using the procedure described in ProdMod 99-0240. Siemens Service Bulletin 51004 Rev 2 is recommended reading.

IGV seize-up/icing. The same W501FC+ engine with the sticking problem (summary immediately above) experienced freeze-up when moisture accumulated in some of the IGV bushings (lower half in particular) and the ambient temperature dropped to minus 2F. All blades in Row 1 had ice deposits, those in Row 2 had some ice or frost. Operational information related to mitigation efforts is included in the slide deck.

Problem was resolved by installation of a torpedo heater to defrost ice followed by exercising all the bottom-half IGVs. Borescope inspection revealed no damage. A chart provided by the speaker shows first-stage icing potential at several IGV angles. Attendees were referred to Siemens Energy's TA 2005-015 Rev 1 to learn more about icing and how to avoid it.

Generator main-lead failure experienced by a South American owner/operator covered problem identification, steps to repair, and lessons learned. Background: Four failures occurred: Broken B phase for the KN steam turbine/generator at this 3 × 1 combined cycle was found in December 2008 and occurred again three months later. Since that time, all main leads have been x-rayed during every turbine outage.

The NDE effort paid off: Phase A in one of the W501FD2 gas turbine/generators was found broken in November 2011 (at more than 900 equivalent starts and 38,000 equivalent baseload hours). T1 failed at the brazed joint below the main lead flange connection to the bushing; x-rays showed cracks in T2, T3, T5, and T6 in locations similar to T1. A second failure occurred in this gas turbine in April 2021 at 1327 ES and 113,453 EBH.

Photos of the first and second GT failures are provided in the presentation together with an overview of repairs, inspections, and tests conducted. Best-effort cleaning also is described.

RCA of a 16-kV flashover. This case history pertains to a unit in reserve shutdown. Incident overview: The GSU and isophase bus (IPB) to the generator circuit breaker (GCB) were energized at 16 kV. A flashover event occurred in the C phase of the breaker on a high-side potential transformer. Inspection revealed water/condensation only in C phase.

Heaters in the IPB were working, but the breaker that feeds heaters inside of the GCB had tripped. Subsequent removal of isophase links at the auxiliary transformer for hi-pot testing revealed water inside of the adapter between the isophase and transformer. Cracks were found in the weld that secures the adapter to the top of the transformer. Photos are provided.

Corrective actions:

- Cleaned and sealed the weld with silicone and spray sealant and began investigating a long-term solution—including possible weld repair.
- Added GCB heater breaker status to plant rounds.
- Planned the addition of humidity sensors and thermometer in the GCB and the transmission of data back to the control system for alarming purposes.

Vendor presentations

OEMs for the 501F gas turbine are Siemens Energy, Mitsubishi Power, and GE, with highly capable PSM and Doosan Turbomachinery Services half a step back—between the manufacturers having their nameplates on the engines and the long list of specialty products/services providers serving this fleet.

Presentations made by Siemens Energy and Mitsubishi Power personnel at the 2022 meeting in New Orleans are not posted to the 501F Users Group website. The former had the podium for only two hours. Its presentations are posted to the OEM's customer extranet portal at https://cep.siemens-energy.com.

GE did not participate in the meeting.

PSM held the floor for an entire afternoon. The company's execs and top engineers participated, presenting on recent 501F projects completed and those in the pipeline, 501F FlameTOP (FlameSheet™ and GTOP7), operational flexibility, hydrogen initiatives and roadmap, supply-chain issues and mitigation, 501F repairs (focus on R1 blades and vanes), product-line update (rotors, exhaust, diaphragms), troubleshooting, and service engineering.

While these presentations also are not posted to the 501F website, you can request them from your plant's PSM representative.

Virtual presos. The following eight vendor presentations were made during the special 501F virtual Vendorama program conducted at the end of September 2022. Most are updates of what the vendors had to say during the in-person Vendorama program in New Orleans earlier in the year. Access both the slides and recordings of these presos using the QR code nearby.

PSM, *Fuel and operational flexibility: Hydrogen capabilities and the latest on 501F upgrades and developments,* highlights some of PSM's 501F fleet activities and R&D projects.

Environment One Corp, *Generator condition monitor for air-cooled machines,* discusses the technology's application and contribution to higher reliability—covering principle of operation, system description, sample applications, and design considerations.

Arnold Group, *Advanced single-layer turbine warming system*. Detailed system description, operating experience, and value proposition are presented.

Braden Filtration, *Air inlet pulse filters: Are you keeping pace with the industry?* A thorough assessment of pulse-type filtration systems for maximizing gas-turbine performance. Includes details on fibers, chemical coatings, and membranes.

Catalytic Combustion, *Effects of sulfur on CO catalyst when operating at lower temperatures,* offers solutions for protecting against catalyst degradation by sulfur contamination.

National Electric Coil, *Aeropac I generator challenges, failures, and recovery,* provides two case studies with guidance on developing a repair plan and identifying major milestone progressions.

C C Jensen Inc, *De-mistifying varnish: Why the CJC VRU varnish removal unit is the safest and most efficient technology.* A tutorial that includes varnish characterization, impacts of turbine operation on varnish formation, importance of oil analysis and tests of greatest value, methods of varnish removal, online condition monitoring, etc.

EagleBurgmann Static Sealing Solutions, *PulseBreaker™ technology for high-efficiency units and 501F/G maintenance tips.* Shares why this new type of gas-turbine exhaust joint is more capable than the company's traditional quilted design: The latter keeps insulation in place, the former offers better protection for insulation media. Focus is on design details.

In-person presentations. Companies making the following presentations during the February in-person Vendorama program chose not to participate in the virtual Vendorama session in September. The slide decks for these presos can be accessed on the 501F website along with the user presentations.

Cutsforth Inc, *Case study on electro-*

magnetic interference (EMI) monitoring illustrates the company's ability to validate an event and prevent a failure. Presentation shows how information from high-speed waveforms, spectrum scans, and data analyses captured from shaft ground monitoring and EMSA were used by SMEs to identify the source of high voltages and arcing and allow repair before the generator experienced significant damage.

EMW filtertechnik, *Better filtration pays for itself—Part 2.* This is a follow-on to the company's 2021 presentation, offering a deeper look into the main KPIs of the filter industry and updated results from several gas-turbine projects.

APG-Allied Power Group, *501FD2/3 Row 3 turbine-blade repair and life extension,* is vintage Aaron Frost, an industry leader in the subject matter presented. Reviews historical R3 blade designs, inspections, findings during those inspections, characterizations of defects and where they are located and materials affected, and much more.

Doosan Turbomachinery Services Inc, *501F Row 1 blades: Operational and historical repair experience.* Focuses on the many design differences among Row 1 blades made over the last 25 years with emphasis on OEMs, materials, and coatings.

Advantages and disadvantages from a repair-management point of view are provided, in addition to standard repair recommendations and other considerations for maximum lifecycle management.

B K Vibro America, *A method for calculating complex asymmetric distributed weight splits.* If a turbine rotor has a significant number of existing balance weights where an additional balance weight is needed, a complex asymmetric weight distribution can be used instead to help minimize the total number and mass of weights needed versus a single simple weight split.

Environex Inc, *Is your SCR/CO system ready for turndown?—Part 2* is a follow-on to the company's presentation in February 2020. Back then the focus was how higher NO_2/NO_x ratios in exhaust gas were increasing SCR system performance requirements. However, recent field data show another phenomenon is causing even higher NO_2/NO_x at the SCR catalyst inlet: Lower VOC emissions requirements. Goal of the preso is to help operations personnel better understand what to look out for when specifying SCR and CO catalysts.

Frenzelit Inc's *Expansion joint upgrades for legacy 501FD and 5000F units* brings you up to date on product improvements to eliminate the root cause of cracking and premature expansion-joint failures.

HRST Inc's *Considerations for fast ramping and peak capacity* walks you through these topics: optimal startup procedures, gas-turbine purge time calculation, purge credit feasibility, steam-turbine considerations, HP-drum ramp rate, tube metal temperature, and nameplate capacity. Goals include helping users (1) avoid startup damage from water pooling in the reheater and superheater when offline and (2) mitigate pressure-part stress from rapid temperature changes.

JASC's *Zero-emissions equipment* provides operational readiness for liquid-fuel operation and allows the testing of the liquid-fuel system without burning oil in the turbine. Company's technology enables fuel-transfer rates approaching 100% and fuel-system flow-control functionality which only requires service at intervals of four to five years.

Nord-Lock Group, *The four-way-joint leak solution* described is said to be a robust fix which incorporates hydraulic and mechanical tensioning techniques, and internal seal with adjustable retainers, and improved bolt-hole and flange sealing system. Result: Zero leaks.

Sensatek Propulsion Technology Inc's *Turbotrack*™ monitors the actual condition of rotating parts. The company's on-blade temperature/strain sensor system can be deployed without continuously dismantling the engine, rapidly accelerating testing while reducing costs.

Shell Oil Products, *Healthy machines through real-time lubricant condition monitoring.* Describes the company's program for monitoring oil and equipment condition 24/7 to give advance notice of impending mechanical failures while providing continuous remote data-gathering.

Sulzer Turbo Services Houston Inc, *Maintaining 501F rotors,* shares company's robust, repeatable repairs and solutions to the following issues, among others: broken alignment fits of forward stub shaft, compressor through-bolt failures, fretted air baffles, and significantly worn disc seal arms. Plus, how Sulzer conducts shop rotor inspections, evaluates findings, and plans steps forward.

SVI Industrial, *Repair procedures: The good, the bad, and the ugly,* shows through a series of photos how to evaluate HRSG weld repairs. Topics include how to find the leak, Code repair concerns, identifying repair methods, raising/lowering panels for tube repair, plugging tubes, jacking panels, Code requirements for stress relief, key Alloy 91 weld features, post-weld heat treatment, welding method 6, and supplement 8.

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The 501G Users Group is a small organization of well-connected engineers and technicians who have "grown up" together—so to speak—and very familiar with their colleagues' plants and equipment. The first Siemens/Westinghouse 501G, installed by Lakeland Electric, began commissioning operations in April 1999, but COD wasn't until March 2001—only one month before the second machine began commercial operation at Millennium.

Fleet size is small by industry standards—24 engines at 13 sites in the US and one in Mexico (sidebar). Four plants are equipped with one engine each; seven have two gas turbines; two are equipped with three machines each, arranged in 1 × 1 combined cycles.

User meetings typically host one-third to one-half first-timers, so many discussions are similar from year to year because newcomers have to be brought up to speed. But there's not much turnover in the top positions at G facilities which means each meeting pretty much picks up where the last one left off. This contributes to presentation efficiency because there's a minimum amount of repetition.

Most user groups serving GT owner/operators organize their technical programs by sections of the engine—for example, compressor combustion section, turbine, etc. By contrast, the G users generally begin with an "annual report" from each plant and follow that nominal half-day program with user presentations on emerging and significant plantwide issues of importance to the fleet.

Excerpts from plant reports and abstracts of selected presentations made during the pandemic and not previously presented in CCJ follow this year's agenda, summarized below, based on information made available to the editors on January 17.

2023 program

Highlights of the 501G User Group's 2023 conference, co-located at the Peppermill Resort and Spa in Reno, Nev, with the 501F User Group's annual meeting, are presented here for Tuesday, Wednesday, and Thursday (half day), February 21-23. The Monday program for both groups is described in the 501F article on p 58.

Tuesday, February 21: First half of the morning session hosted a highly interactive workshop on Human Performance, complete with (1) an explanatory presentation by an experienced user, (2) learning teams, and (3) tips on how to avoid the Blame Game.

Presentations and discussion on retubing of rotor air coolers (RAC) and the fuel-gas heater completed the morning program. User experiences and challenges were shared by attendees.

Siemens Energy was at the podium after lunch. A technology review of the inlet and compressor sections, plus a general discussion on debris contributors and management, got the afternoon program rolling. A technology review of the combustor, turbine, and exhaust sections followed, with updates on NextGen and Row 1 vanes completing the day.

Wednesday, February 22: Morning session reviewed fleet statistics and key issues, which are incorporated into the plant reports presented by representatives of all facilities participating. Presentations on HP bypass replacement and OST valve replacement closed out the morning program.

Afternoon session featured two interactive roundtables:

1. Generators, focusing on:
   - Major maintenance.
   - Risk/reward and how it may change based on a variety of factors.
   - Major spares, rewind kits, and contingency planning.

Steering committee

Chair (acting): Mark Winne, plant manager, *Millennium Power Partners*
Scott Wiley, outage manager, *Vistra Corp*
Guy Taylor, plant engineer, *Lakeland Electric*
John Wolff, technical support/compliance manager, *Ironwood LS Power*

W501G fleet: 13 plants, two-dozen units

Ackerman Combined Cycle Plant, TVA, Ackerman, Miss
Athens Generating Plant, operated by NAES Corp, Athens, NY
Ennis Power Plant, Vistra Corp, Ennis, Tex
Fuerza y Energia Naco Nogales SA de CV (FENN), Gas Natural Fenosa México, Agua Prieta, Sonora, México
Granite Ridge Energy Center, Calpine Corp, Londonderry, NH
Harquahala Generating Facility, operated by NAES Corp, Tonopah, Ariz
Hillabee Generating Station, Constellation Energy Corp, Alexander City, Ala
Ironwood, operated by EthosEnergy Group, Lebanon, Pa
Magic Valley Generating Station, Calpine Corp, Edinburg, Tex
Magnet Cove Generating Station, Arkansas Electric Cooperative Corp, Malvern, Ark
C D McIntosh Jr Power Plant, Lakeland Electric, Lakeland, Fla
Millennium Power Partners, operated by NAES Corp, Charlton, Mass
Wise County Power Plant, Vistra Corp, Poolville, Tex

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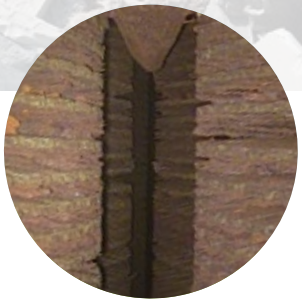
Millennium Power Partners, operated by NAES Corp, Charlton, Mass
Wise County Power Plant, Vistra Corp, Poolville, Tex

WHEN IS 10 TONS OF DEBRIS A GOOD THING?

Recently Precision Iceblast Corporation was contracted to clean a standard HRSG located in the United States after explosion cleaning methods were utilized. The client initially experienced somewhat positive results from the explosion cleaning efforts. However, within a short time frame the client's back pressure increased near gas turbine tripping points.

Precision Iceblast Corporation removed an additional 10 tons of debris after explosion cleaning efforts. Client experienced an additional 3.5" reduction in back pressure. Client has been able to maintain the reduced back pressure after the PIC HRSG Deep CleaningTM process.

It was determined that explosion cleaning efforts were only able to clean to the fourth/fifth row of tubes leaving a large amount of the heating surface untouched.



AFTER EXPLOSION CLEANING
(4TH & 5TH ROWS OF TUBES)

AFTER PIC HRSG DEEP CLEANING
(4TH & 5TH ROWS OF TUBES)

PIC HRSG Deep Cleaning

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- ✓ Dramatic increase in Gas Turbine output
- ✓ Closest return to design back pressure possible
- ✓ No requirement to remove other contractors from the HRSG unit
- ✓ Scaffold required ensuring complete cleanliness allowing for borescope inspection of each level of the HRSG

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2. O&M considerations for fuel-gas heaters:
   • Identifying fuel-gas leaks and operating with them.
   • Alarms versus trips—prudent engineering guidance.
   • Bundle replacement options.

Thursday, February 23: User presentations addressed Row 3 turbine-blade ring deflection, AVR upgrades, and other topics of interest.

Excerpts from recent 501G plant reports

- Challenges getting into the market because of high gas prices.
- Two big outage events: Row 1 blade failure and generator lead failure, the latter attributed to misalignment of the lead from the generator to the isophase bus.
- L-1 steam-turbine blade failure (generator drive end) damaged the L-0 row and tubes in the condenser impingement zone. Analysis revealed stress corrosion cracking as the cause. Opened the HP/IP turbine while the LP blades were being replaced and found some problems there as well. The distribution grid, located just ahead of the reheater in one of the HRSGs, also failed, damaging some tubes. Temporary repairs made; permanent repairs deferred a couple of months to accommodate the addition of necessary structural support.
- At a 2 × 1 plant with about 50k hours of operation on the GTs and steamer, and 1000 starts on each gas turbine and about 650 on the steamer, addressed an exhaust-casing split-line leak on one GT. Recommended fix was casing-bolt replacement at 110% of the recommended torque.
- Trunnion vibration issues on a 501G were solved by regreasing. Plant's greasing process then was updated to reflect lessons learned. Similar problem on another unit in the fleet was corrected by replacing the grease fittings. The originals were worn out and grease was not getting to where it was needed. Yet another user, similarly affected, reported that his plant's solution was to jack up the unit and remove old hard grease.
- Combined cycle with just over 100k hours on both GTs and the steamer reported that the NextGen upgrade done a couple of years ago to permit operation at lower loads continues to perform well. However, CO is still elevated (two- or three-fold higher) during starts compared to DLN hardware. On the plus side, output increased and NO_x emissions were about 20% lower than DLN.
- Flashback thermocouple failures were problematic at this plant and all t/cs were replaced on both gas turbines. Issue wasn't resolved until Siemens redesigned the thermocouples.
- Key issues reported by a user involved turbine through bolts, Row 1 blade/vane events, L-0 blades. LP economizer was replaced because of degradation caused by ammonia salts, which were attributed to early operating problems caused by tube leaks.
- Catastrophic failure of a steam turbine was described by an attendee who said the unit was rebuilt over a 250-day outage and back in operation at the time of the meeting. No one was hurt. Damage included shaft failure, generator and many condenser tubes destroyed, and HRSG casing hammered by liberated bearing parts.
- Another plant reported positive

results from a gas-turbine NextGen upgrade. Hardware is cleared to run 12,000 hours to HGP, but borescope inspections will continue—to track degradation. T3000 was upgraded, too, and the control system is performing well. Participants were reminded that if they upgrade their controls, set points must be reinstalled. A small hydrogen leak also was mentioned but it is actively monitored and not considered a problem.

- OST valves are believed associated with the rotor air cooler (RAC) not operating properly. Seats can stick and valve not open as intended during startup. Plant has identified a vendor that may be able to provide an alternative with a replaceable seat.
- Plant reported an issue with its Nash vacuum pumps. Steam jet ejectors believed too small for the duty so Nash pumps must run all the time and can overheat. Last time a condenser leak check was performed, the steam jets and one Nash pump were required to hold vacuum. A couple of other participants recommended doing a helium leak check and paying special attention to the integrity of the crossover pipe.
- A 2 × 1 combined cycle was operating in true peaking mode because of low gas prices. A rotor swap on one of the gas turbines forced operation in the 1 × 1 mode.
- Major on a KN steam turbine involved machining out and replacing stellite seats on valves. During the overhaul, investigation of actuator oil leaks revealed the wrong plugs had been inserted previously. Bearing oil leakage was high because a worn seal ring had not been replaced during the last overhaul. Plant struggled with vacuum leaks in the last year which were attributed to rupture discs being near end-of-life.
- Plant reported high ammonia slip, corrected temporarily by cleanout of the ammonia injection grid (AIG). Replacement and upgrade alternatives are being considered. An attendee offered that the Peerless Edge® AIG retrofit it implemented operates with ammonia slip and NO_x within specifications. Prior to the retrofit, plant reduced load to control slip.
- A vibration step change on one of plant's two gas turbines was investigated with borescope inspection finding Row 4 hardware missing and several Row 1 vanes breached. Operator training was being considered.
- Leaking tubes in the fleet leader's kettle boiler were simply plugged to enable continuing operations.
- Wear and tear on this 1 × 1 plant's HRSG prompted use of thermography to identify hot spots, resulting in a partial rebuild of the boiler's walls. The floor also was rebuilt to eliminate release of insulation. Finally, ports were added on top of the HRSG for NO_x traverse testing.
- Another plant reported rebabbiting and repair of its exhaust bearing, plus replacement of Row 1 ring segments, one combustion basket, and one transition piece.
- One gas turbine at a 2 × 1 plant with more than 100k hours of service completed a rotor exchange and replaced four Row 1 blades and three Row 1 vanes during that major. Its sister unit also conducted vane and blade work during the overhaul, including a few airfoil replacements.
- The representative of a 3 × 1 combined cycle discussed a DCS upgrade to T3000 Version 8.2 on the trio of gas turbines, which averaged about 70k operating hours and 2000 starts. The steam turbine, with about 100,000 hours under its belt, and one GT benefitted from AVR (automatic voltage regulation) upgrades.

- One gas turbine at a 2 × 1 facility experienced an expansion-joint failure, resulting in a unit trip. Other happenings: A significant forced outage was caused by the failure of a startup frequency controller. One unit suffered flashbacks on Can 3 following a low-gas-pressure event.

  Plus, pieces of lockwire wire were found in combustion cans during a borescope inspection and removed; there were multiple igniter failures (some sticking after insertion); Row 1 STM (short-term mitigation) vanes were installed on both units to address the vane-distress phenomenon reported in the fleet. Regarding the last point, the modified vanes increase backflow margin, improve impingement cooling, and supply additional film cooling to the leading-edge of concern.
- Major inspections were conducted on both the steam and gas turbines at a 1 × 1 facility with about 100k service hours.

  However, within one month of outage completion, five of six RTDs monitoring the generator had failed; ST vibrations were high during post-outage starts, increasing regularly from 8 to 14 mils; throttle and governor valves on the steamer began sticking during starts; and the reheat stop valve was sticking—sometimes.
- Borescope inspections on two gas turbines, each with nearly 100k hours of service and 1800 starts, revealed no issues with Row 1 mitigation vanes. Center igniters were installed on one unit; however, cables were not connected properly, causing a fired abort on startup.

  Second GT experienced a full-load trip attributed to a flameout caused by initiation of steam power augmentation. Logic mod fixed that problem.
- A 1 × 1 plant with more than 100k service hours and 2700 starts identified flow-accelerated corrosion (FAC) in the HP economizer upper headers and LP economizer. Planning for replacements during the next outage is underway.

  Other issues of concern included turbine through bolts, Row 1 blades and vanes, increased intervals for blade inspections (8k to 12k hours). Plant experienced its first through-bolt failure at 20k hours, second at 30k; current set of bolts has been in service about 40k hours.

Abstracts of recent 501G user presentations

Takeaways from safety roundtables:

- Populate your plant safety committee with motivated personnel and use corporate guidelines to ensure job safety.
- Excavations frequently are required at relatively new sites for fixing underground infrastructure. Proper barriers for personnel protection are particularly important. Know where to dig, how to dig, and how to refill to prevent collapse.
- Conduct a 10- to 15-min safety meeting before start of work and at end of day. In the morning, review what could happen given the planned activities; in the afternoon, what did happen. Make discussion topics germane to the work scheduled for the next couple of days.
- Attendees expressed concern about different procedures at different plants, particularly when changes in ownership occur. Procedures

are not one-size-fits-all and unless carefully thought through can take control out of the hands of those who know the most.

- Maintain a no-blame culture. If something doesn't seem right, ask questions. After an incident, all plant supervisors and personnel should ask themselves, "What could I have done to prevent the problem from occurring?"
- Virtually every plant acknowledges that it has a "good" safety program, according to a poll of attendees. But the challenge is to make it better. Remember that complete paperwork doesn't mean the work is being done safely.
- Contract safety personnel on patrol is money well spent. These folks typically are good at "coaching," not criticizing.
- Consider implementing a "good catch" program to keep concerns in front of the group until they are corrected.
- Annual air-quality-management and respirator training are recommended for all plant personnel.

Bearing problem? Nah, it was a lube-oil temperature problem.

The details: Collector bearing vibrations on one gas turbine suddenly increased to more than 6 mils. Bearing area was inspected; there were no obvious findings. Vibrations reappeared daily soon after GT restart. Corporate engineering was consulted. Vibrations reached a high of 7.7 mils, but with a trip setting of 8.5 there were concerns.

Was collector compartment temperature a cause? A portable a/c unit was installed, but the problem remained. Was something in the generator causing the problem? Nothing obvious based on a thorough inspection.

One day vibration was not a problem: Weather was cool and wet—an "ah-ha" moment. Put two lube-oil coolers in parallel to reduce oil temperature and the problem disappeared.

Staff found cooling-water temperature was higher than normal because of several failed spray nozzles in the tower; also, the collector bearing was lightly loaded. Nozzles replaced and bearing loading corrected, the unit returned to normal operation with one lube-oil cooler in service.

A two-decade operating history of high HRSG backpressure (BP) and derates for a 1 × 1 combined cycle provided valuable lessons learned. The plant, designed for baseload operation, was commissioned and soon pressed into cycling service for several years. Almost from the get-go, the HRSG experienced fouling by ammonia salts from the SCR and rust accumulation, most evident in the last tube sections. Result: A gas-turbine derate of 15 MW.

After years of monitoring pressures, trying online cleaning methods (sonic horns, vibrators on lower headers) and offline cleaning (dry ice, air jets, pressure wave), and dehumidifiers on the GT inlet and LP inlet to the HRSG, plant, beginning in 2008, resorted to adding stiffeners in the HRSG. Lower baffle plates were removed in the LP and IP sections and several different baffle configurations were tried to identify the most effective alternative. Also, SCR controls, and economizer recirculation temperature controls, were adjusted to increase the allowable BP from 28 to 30 in. H_2O.

In the face of continued elevated BP in 2016, the facility pursued permanent modifications beginning in 2017 (through 2020) to increase allowable backpressure to 45 in. H_2O and address other issues—such as tube leaks.

These included doubling the number of stiffening plates in the roof, floor, and walls; replacing the LP economizer, LP superheater No. 1,

and LP evaporator tube bundles; and upgrading the expansion joints. Eleven tube rows in the LP economizer were replaced with 15 smaller-diameter tubes, creating a 20 in. cleaning lane between the LP economizer and the LP evaporator/superheater No. 1.

Pressure wave was by far the most effective cleaning method, being able to remove about five times as much debris as dry ice. The story may not be over, though. The unit has not been cleaned since 2020 and BP is beginning to rise again—even though the unit is now operating baseload.

Transition-piece steam pipe failure. During a local crawl-through inspection, plant personnel found a tube liberated from one transition piece. A full unit check found cracks in two more transition pipes in roughly the same place. Dye-pen inspections of the remaining TPs found no additional problems. Other users in attendance reported similar cracking.

RCA conclusion was that the dynamic frequency of the engine was close to the natural frequency of the transition piping. The OEM recommended increasing the exhaust temperature to create greater separation from the natural frequency of the transition piping. A logic change was made and no problems have been reported since.

Case study of a condenser event may well be one of the most valuable safety briefs you'll receive if you have a combined-cycle plant with a fuel gas heater (FGH). An abridged account follows.

As a result of the failure of a main lead in the steam turbine/generator, the facility was in a steam-turbine outage in January 2022 during which the GTs remained "available" to the grid (with fuel at pressure up to the FGH stop valves). With the plant experiencing numerous issues with the FGH (for example, leaking gas isolation valves) and its leak-detection system (prone to false alarms), and other factors, natural gas found its way to the condenser via the IP water-side supply line (the source of heat for the FGH).

The plant was down for 10 days, but with cold weather in the forecast, the gas turbines were started to build up pressure to about 50 psig in the HRSG to prevent freezing. The steam pressure in the HRSG provided the motive force to move the gas that had been accumulating in the IP drum to flow down the steam piping to the condenser.

When a welder arrived to repair a 1-in. pipe connection on the outside of the condenser, the arc ignited the gas and the subsequent explosion blew out six rupture discs on top of the unit, caused bolting threads on the LP steam-turbine cover to fail, and damaged internal structural supports. Rupture-disc parts were found all over the plant site. The explosion was heard and felt throughout the plant.

No one was injured (not even the welder), no condenser tube leaks occurred, and the LP section of the turbine suffered no internal damage.

Recommendations to avoid a similar incident elsewhere, included the following:

- Eddy current test FGH tube bundles and perform leak testing at least every six years.
- Utilize more robust inserts when plugging tubes.
- Ease plant staff access to vent valving and instrumentation.
- Establish fleet standard critical preventive maintenance guidelines for FGH systems.
- Install permanent redundant methane detectors on air ejectors with feedback to control system.

Plant has no vacuum pumps so steam pressure is required on a unit start to raise vacuum. Staff found the time required for a unit start creeping

up and budgeted time for checking piping, drains, valves, etc, to find out where the leak was. One day it was not possible to get the vacuum low enough to roll the steamer. More leak checking required.

The gremlin was in the crossover pipe from the IP section to the LP. OEM's plan was to remove the 60-in.-diam pipe and re-gasket both ends. Outage time required: Six days.

Alternative plan proposed by Furmanite America: Install scaffolding, remove insulation, remove crossover-pipe bolts and clean threads, lubricate threads, and reinstall. Plus, the steam-turbine/generator enclosure was modified to allow steam/hot air to escape and cool down that area, which got hotter as the unit ran. Bolts were so loose all the way around the pipe flanges, nuts could be removed by hand. Staff believes the bolts worked loose because of unit cycling.

The bottom line: Tough working environment, but the job was completed in two days at less than 20% of the OEM's quote—including drilling required for Furmanite injection (and the Furmanite) and reinstallation of insulation.

Recommended PM: Check all bolts periodically, especially following a change in operating regimen. If you find two bolts loose on one flange, change the gasket as well as all the bolts. Same goes for flanges on GT bleed piping and air extraction lines.

Generator lead failure caused unit to trip from 42% load. All auxiliary power was lost; unit coasted down on dc lube and seal oil; generator hydrogen loss was significant; electrical testing revealed winding was grounded in all three phases. Significant damage—including melted copper and other debris—was found in the lead box.

Main lead T2 cleat was blown out during the event with carbon dust and debris (molten metal) falling into the generator. Carbon dust was distributed all over the generator by the hydrogen blower. Rotor was pulled for cleaning and full rewind.

The presenter said upgraded main leads, reflecting the realities of today's operating paradigms, were installed. He recommended others consider doing the same on the advice of experts. It was his opinion that the original brazed joint failed because of years of cycling service.

This forced outage ran six months and cost $15 million. Ownership change and other upset conditions stopped work four times during the outage, which should have taken but 45 days. Speaker said it should take 14 24-hr days.

NextGen CO emissions. Speaker's experience was reflected in his "warning" to attendees that they should expect higher CO emissions on a cold start after implementing NextGen. He showed different rates of CO emissions during cold, warm, and hot starts and load changes. A slide showing old DLN emissions versus NextGen showed CO with NextGen was higher from 10 to 30 minutes after startup. By the 30-min hold point during a cold start the plant had consumed 40% of its CO allowance.

Remembering Steve Bates

If you didn't know Steve Bates, who died suddenly November 30 (2022), at age 57, while on vacation with family, be assured it was a privilege. The plant manager of Vistra Corp's Wise County 2 × 1 G-class combined cycle in Poolville, Tex, and chairman of the 501G Users Group, Steve was a technically competent, respectful, and unflappable leader who never passed on an opportunity to help a colleague.

A citizen of England, Canada, and the US, Steve was generous, kind, compassionate, and highly respected for his ability to make those around him feel seen and appreciated

He was a big supporter of CCJ's mission and an industry luminary who viewed personnel safety as a top priority long before many others. Example: Most recently, and with his company's support, Steve alerted powerplant owner/operators to the potential for leakage by fuel-gas-heater stop valves and the possibility of an explosive mixture of fuel and air forming in the condenser.

He presented on this possibility at every opportunity—including meetings of the Combined Cycle Users Group, HRSG Forum (dig deeper in CCJ No. 72, p 42), and other industry organizations.

In a world that's prone to short-circuit discussions of findings in accident investigations, Steve was committed to sharing such knowledge to protect powerplant personnel and the public at large; no corners were cut on his watch. Interestingly, he did everything by the book and it didn't take longer than not.

Some of the people who knew Steve best share their thoughts below.

Steve was such a nice guy. When I heard the coroner revealed that Steve had a large heart, I laughed—as it wasn't surprising. Everyone knew Steve had a large heart. You knew it from every interaction you had with him. Steve cared! He cared a lot!

Steve cared about me and my family, he cared about my plant and my team, and he cared about my turbine. He cared about all of our turbines! For more than 10 years Steve selflessly led the 501G Users Group, painstakingly tracking and working diligently to manage a multitude of issues to resolution. Steve was a great listener and worked hard to ensure our voices were heard and our issues were brought forward.

Steve and Lynn Bates sit alongside Arnold Group's Pierre Ansmann at a Dallas Stars ice-hockey game. The couple was married 38 years and raised two daughters—Cynthia and Amanda

It was a joy to watch Steve wrestle with Siemens. His intimate knowledge and understanding of the 501G, his tenacious grasp of current issues, along with his calm demeanor and good humor made him a formidable foe in any debate or discussion. Steve would hang on to an issue like a pit bull, unwilling to let go until Siemens understood and acknowledged his viewpoint. The drama of watching/waiting for his opponent to capitulate was always entertaining. Steve fought for all of us, because he cared, he cared a lot.

After a tumultuous start to 2022 [the Texas deep freeze], Steve turned his focus to Human Performance and the influence it can have both in our success and in the adversity we face. By allowing the 501G users access and insight into a significant event at his plant, and specifically how human interaction influenced several contributing causes, he gave us an understanding of why it is important that we improve our understanding of Human Performance and strive to integrate human-performance tools and processes into our daily lives.

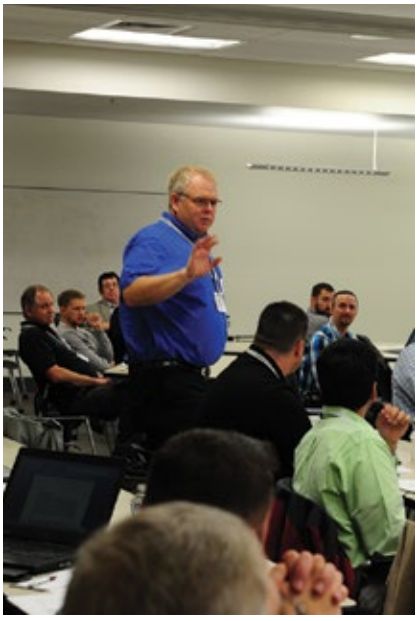
Again, Steve did this because he cared. He cared a lot. His caring and support will be profoundly missed.

Mark Winne

I am privileged to have worked for Steve for over 14 years. He was a great mentor and friend. Steve showed me the ropes and gave me the tools to be a successful manager. He had a wonderful personality and was deeply engaged with every team member at the plant. Steve's dedication, knowledge, kindness, and loyalty to the team was key in developing a great culture and family atmosphere at Wise County.

I loved being able to walk in Steve's office, sit down, and brainstorm ideas

Steve was a fun-loving guy who lit up the room



Steve's thirst for knowledge was never-ending. Here he participates in the first meeting of the Generator Users Group, founded by Consultant Clyde V Maughan at age 89

to improve plant performance, or even to just share thoughts on recent events. Everyone at the plant has a deep void with the loss of Steve and we will never forget all that he brought to each of our lives.

He will be forever in our hearts.

Michael Coffman

I met Steve many years ago through the 501G Users Group. As Chairman for more than 10 years, Steve was very approachable and inviting for anyone to participate. He provided strong leadership for our group with his industry knowledge, and his ability to establish great relationships

A group of ORGs (old retired guys) and hopeful candidates gathered to salute Steve and celebrate his life the evening before his funeral. Seated are Corky Ranallo, Jon Rice, Ramiro Cerecer, Bill Tyus, Robert Stevens, Mike Knisely, Scott Wiley, John Stuart, David Blackshear, Neal Coffey, Rodney Kapavik, and John Shue

No better pastime than fishing

Food—the best way to bring people together. Third-place team at a recent plant cook-off, an annual event at Wise County: Maintenance Manager Oscar Rich, Steve, Production Manager Mike Coffman, and Outage Manager Scott Wiley (l to r)

with all 501G frame owners, vendors, and Siemens. Steve was an open book, always willing to share for anyone who wanted to learn more. He was professional and had a great moral compass. I did not work with Steve as closely as those who interfaced with him on a daily basis; however, he has left quite an impression on me. Steve will be greatly missed.

Kevin B Robinson

Whether on a fishing boat or in the corporate boardroom, you knew that friendly smile and outgoing personality were always going to be there to greet you. I met Steven Bates while working as a contractor in Arkansas. He was managing the Tractabel facility just outside of Malvern and had a small job for us to do that turned into a very big job and eventually me going to work for him full time—an invitation I always will be grateful for.

Steven was a study of many things and always on top of recent activities, not only in the power business, but anything that piqued his interest. Steven's leadership with the 501G Users Group is one of the reasons why the G frame has been so successful. He always brought the skills of team-building and inclusion to the table, and doing so with the Siemens team, made our user group's effort a great environment as well as very productive. We were able to work together to solve many problems in this frame as it was being developed.

Steven was a tri-citizen of the world. Born in England, he moved to Canada and then to the United States; he had citizenship in all three countries. I was working with Steven as he studied for his US citizenship test, learning a few things myself in that process. He and wife Lynn worked hard, passed the test, and were awarded citizenship. Flags of the three countries draped the table displaying the urn with Steven's ashes.

But above all, Steven's relationship with his god, wife, children, and grandchildren were always something to aspire to, and as in many other things, Steven led by example in all of these areas. Our industry will miss Steven Bates; I will miss him for his friendship and camaraderie.

Neal Coffey

Having known Steve for the past dozen or so years and working directly with him on the 501G Users Group steering committee for the last decade, words cannot describe the personal and professional loss that we are all feeling. Steve was always willing to help and share his knowledge and experience with anyone needing it. As the committee chair, he worked tirelessly to promote a culture of respect, openness, and integrity among users, vendors, and OEMs.

Although Steve will be missed by all, his legacy will live on through the memories, accomplishments, and friendships made throughout the years. I will personally miss his friendship and camaraderie, in addition to all of the other outstanding character traits that made him the person he was.

John R Wolff

Steve Bates was an exceptional person who will be dearly missed by the Vistra family and the 501G Users Group. He became chairman of the 501G steering committee in 2011 and has provided years of dedicated service. Steve's leadership on the committee was what drove the 501G users to become a very close-knit family that was well informed of all the issues we were dealing with on the G frame. When I think of Steve, I see a family man, a leader, a communicator, a friend, and a mentor that I will miss.

Scott Wiley

Many years ago, while attending my first 501F and 501G Users

Group conferences, I noticed a few guys sitting off to the side of the podium and, based on their looks and my read on their demeanor, I was quickly wondering what I had gotten myself into. One of them was someone I worked with, Pete Sobieski, but the vibes the other two gave off was scary. Turns out they were Mark Winne and Steve Bates, and oh how wrong my read was.

Fast forward almost two decades and I dare say I was barely tapping into the deep well that was Steve Bates. While the last few years have been filled with uncertainty, loss, and changes to the status quo, I consider myself privileged to have grown closer to Steve and wife Lynn during that time.

I feel very fortunate to have vivid memories of what turned out to be our last in-person evening together at Dezerland. Steve, Lynn, myself, and a few others were enjoying some beverages and desert and Steve was laughing harder than I had ever seen. Turns out he found the idea of me on a little Vespa hilarious. That was a wonderful evening and I will always have that memory of him happy and jovial.

Over the last year, the 501G Users Group, which Steve was chairing, got very involved in working with us on the upcoming conference and in that light Steve had just finished working with a Human Performance organization and you could tell it had really kindled a flame for him. He was so excited he brought it to the Boards of both user groups and we decided to include it in the upcoming conference.

Steve was a man of commitment, honor, and grace. His passion for what we do, and how we do it, was awesome to see after such a distinguished career, when some folks are just riding the wave. Steve was full-steam-ahead and just as passionate before his vacation as he was when I met him all those many years ago.

I will miss his unassuming nature, the roles that he filled so well, and the counsel he offered. More importantly, I will miss the person that he was. The author, A A Milne (Winnie the Pooh) summed up so much in the following sentence: "How lucky am I to have something that makes saying goodbye so hard." I offer, in closing, that all of us who knew and worked with Steve were indeed lucky.

Ivan Kush

I still don't know what to say. When I heard the news, the first thing I thought was that we still owed Steve a lube-oil pump that we had borrowed.

When we were at the 501G Users Group meeting in Orlando this past May, I ended up in the hospital. Steve called and wanted to come spend time with me so I wouldn't be alone. He then reached out to ensure I made it home, and reached out again a few days later to see how I was doing.

Steve was one of the most genuine people I have ever met. He had a very calming way about him and no matter what subject I called to discuss, I always came away with a completely different perspective. Knowing and working with Steve has made me a much better person, and I will forever miss him.

Steve Cole

Steve Bates was my friend and a role model for more than 10 years. Steve's passing it hit me really hard because only a few hours earlier I was commenting on his Facebook post about spending holiday time in Hawaii.

As plant manager, Steve was at all times very knowledgeable, calm, and relaxed. He always had a smile on his face—even during the toughest negotiations. I visited him at Wise County annually and spent quality time with Steve at the many turbine confer-

ences we both attended. He was highly respected in the industry, inspiring, and a caring person who always put family and friends first.

Pierre Ansmann

Leading a user group is no small task: There are many aspects of that role most don't see. Being a good leader takes a lot of knowledge, professionalism, interpersonal skills, and tact. Steve Bates was a great leader and helped build a solid framework for cooperation and engagement that helped solve many concerns for the W501G fleet that has benefited both the users and Siemens Energy.

I had the privilege of working with Steve and truly believe we would not have been as successful without his involvement. When we first met, the fleet really needed attention and a different approach to tackle some of the tough challenges present in the fleet. He helped pioneer a new way of working with Siemens Energy, and while holding us accountable, was fair in his approach and used his collaboration skills to bring both sides together for the benefit of the fleet.

His engagement allowed us to amplify our interface with better ways to communicate and resolve some of the toughest issues facing the frame. For a period of time, we executed four face-to-face customer meetings annually—including "deep dive" technical meetings as well as monthly net meetings to help everyone stay on top of the rapid pace of development of solutions.

Steve helped bring the customers together and was instrumental in creating an atmosphere of cooperation and inclusion that was key to solving some of the most difficult tasks. He was firm and truthful, but also open-minded and accepting of others' inputs and ideas. This leadership made him stand out in the crowd and brought us all together. We are all better today because of the way Steve facilitated positive engagement while building solid working partnerships and friendships. God bless Steve Bates.

Mark Carter, SGT6-6000G product manager

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Best Practices Awards

Owner/operators of 501 and V engines share best practices

This compendium of award-winning best practices recognized by industry peers in 2022 focuses on the 501G, 501F, 501D5A, 501D5, V84, and V94 fleets. Six plants powered by 501F gas turbines received Best Practices Awards (photos), plus three equipped with 501Gs, two with V84s, and one each with 501D5, 501D5A, and V94 engines. The best practices:

501G:

- Athens Generating Plant (A potpourri of plant safety improvements; Change in chemical treatment reduces environmental impact, cuts cost).
- Kings Mountain Energy Center (Remote-user cybersecurity; Conditioning system extends useful life of steam-turbine EHC fluid).
- McIntosh Power Plant (HRSG mod allows an increase in backpressure to boost power output). This best practice received a Best of the Best Award and was profiled in the last issue (CCJ No. 72), p 79.

501F:

- CPV Valley Energy Center (Steam-turbine fast-cooldown logic and procedures reduce outage time;

CPV Valley Energy Center

MPC Generating

Rolling Hills Generating

Mitigating effects of severe winter weather events; Mobile electronic logging benefits operations, maintenance, and compliance; Lighting enhancements).

- MPC Generating (Automate back-up source of hydrogen to maximize generator availability).
- Rolling Hills Generating (Monitor humidity in your excitation-transformer termination cabinet).
- State Line Power Station. (Forget the sewer, reuse RO reject water).
- Whitewater Cogeneration Facility (Operational Tag Program advises on why equipment is in its current state).
- Kleen Energy Systems. (Eliminate generator-breaker weather intrusion).

501D5A:

- Mid-Georgia Cogen (New logic prevents GT trip caused by DP transmitter failure).

501D5:

- Milford Power (Repurpose "old" parts/products to support a new functional need).

V84:

- Pleasant Valley Station (Modify fuel-oil piping to unload faster, increase resiliency in cold weather).
- Walton County Power (Better ventilation improves availability of fuel-gas valves; Water-wash system upgrade improves operations and safety).

V94:

- Genelba Thermal Power Plant (Identify, correct combustion-chamber issue using methodology created by plant personnel). This best practice received a Best of the Best Award and was profiled in CCJ No. 72, p 63.

CCJ's annual Best Practices Awards program, supported by user groups, has as its primary objective recognition of the valuable contributions made by owner/operator personnel to improve the safety and performance of generating facilities powered by gas turbines. Looking ahead, you might want to begin considering what success stories to share with colleagues in 2023. Entries are due March 31 (details at https://www.ccj-online.com/best-practices).

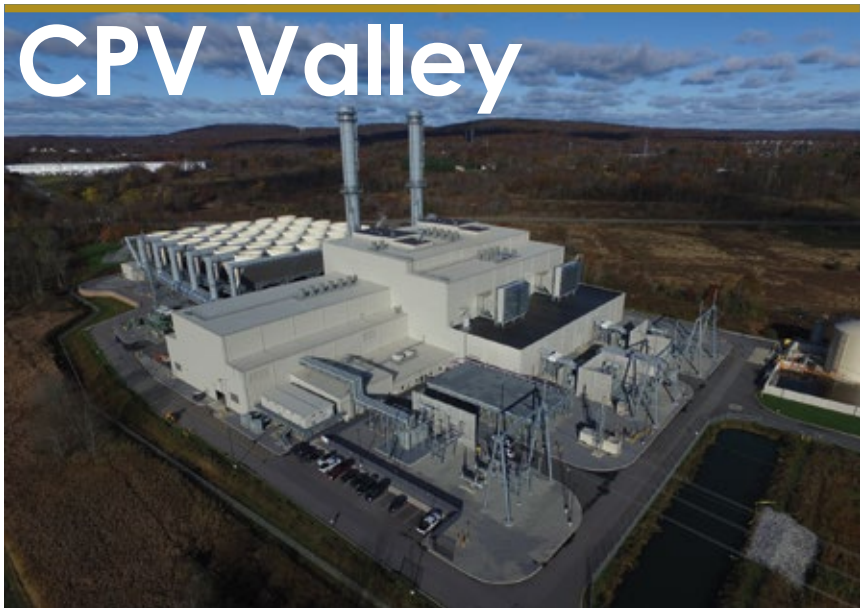
To prime your thought processes, know that subjects of greatest interest generally are fast starts, new skills/workforce development, water management, performance improvements, plant safety, outage management, O&M, and predictive analytics.

State Line Power Station

Whitewater Cogeneration Facility

Kleen Energy Systems

CPV Valley



Reduce outage time by implementing steam-turbine fast-cooldown logic, procedures

Challenge. The steam turbine (ST) at Valley Energy Center typically was taking up to eight full days for proper cooldown prior to removal from turning gear. This delayed any inspections, tests, or other items requiring access to the unit, extending outage durations. It also delayed any balance-of-plant (BOP) work requiring the shutdown of station power for periods that would interfere with proper lube-oil cooling, etc.

Solution. Plant personnel worked with the turbine OEM to implement fast-cooling logic and procedures to reduce the required ST cooldown time. This made necessary a combination of controls changes, testing, temporary mechanical changes to the system during cooldown, and training of O&M staff.

Operators can start the ST cooldown process several hours before shutdown while producing power at reduced levels of output. When operating at minimum load, attemperators slowly ramp down the HP- and reheat-steam temperatures from about 1050F to 750F. Once the ST is offline, an adequate amount of natural cooling is allowed (usually about eight hours).

LOTOs then are put in place to remove several inspection flanges on the ST control valves to allow air to flow into the system (Fig 1). Also of note, the maintenance department set up specific toolboxes (Fig 2) so all tools and necessary parts are staged and ready to use for this purpose—thereby saving time assembling all of these items for each cooling event.

When the fast-cooling system is started following a shutdown, it auto-

CPV Valley Energy Center

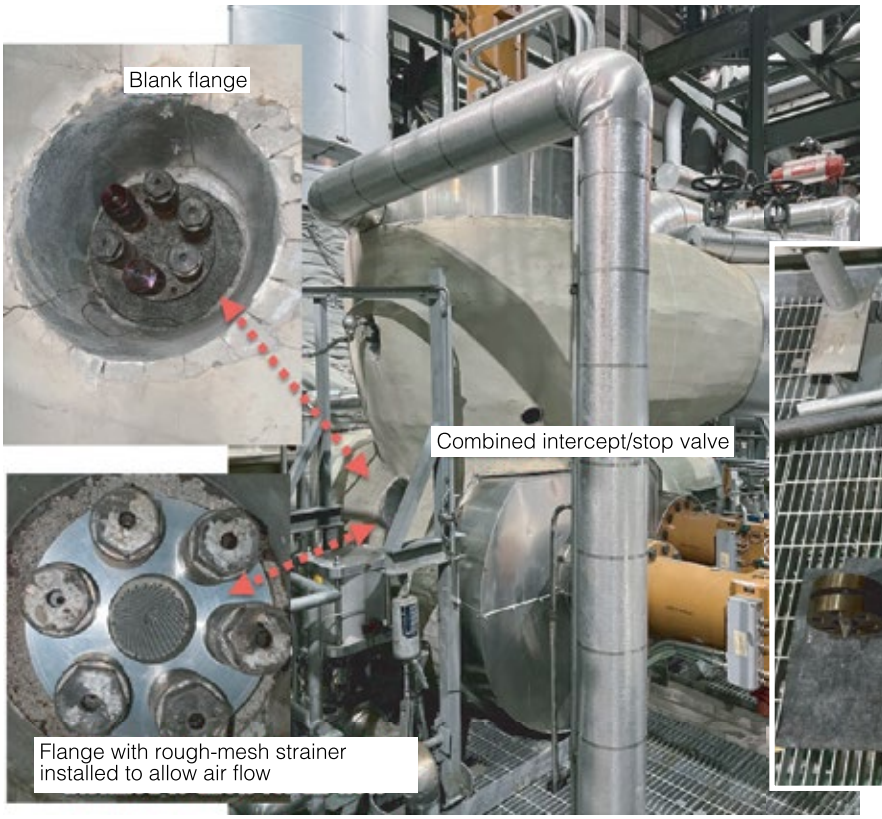
Owned by CPV/Diamond Generating Corp (DGC)

Asset managed by Competitive Power Ventures Inc (CPV)

Operated by DGC Operations LLC

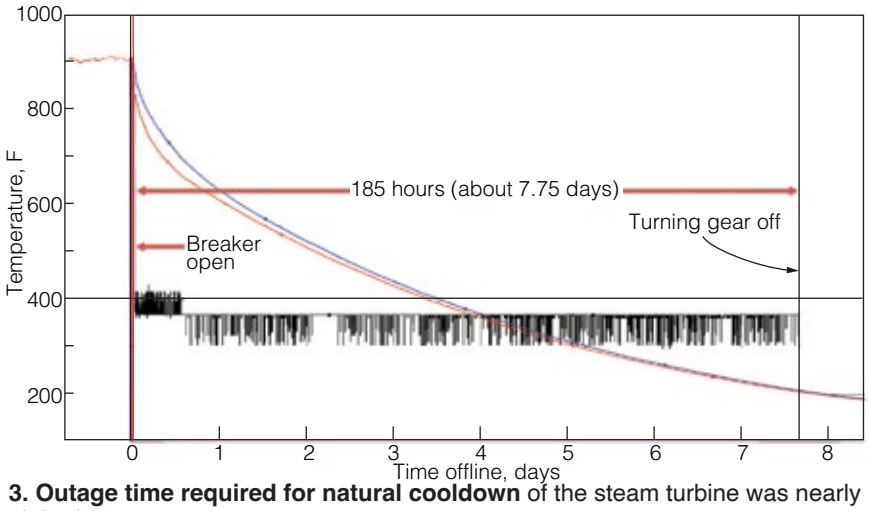
680 MW, gas-fired facility equipped with a SGT6-5000-powered 2 × 1 combined cycle, located in Middletown, NY

Plant manager: Ben Stanley (former), Michael Baier (current)

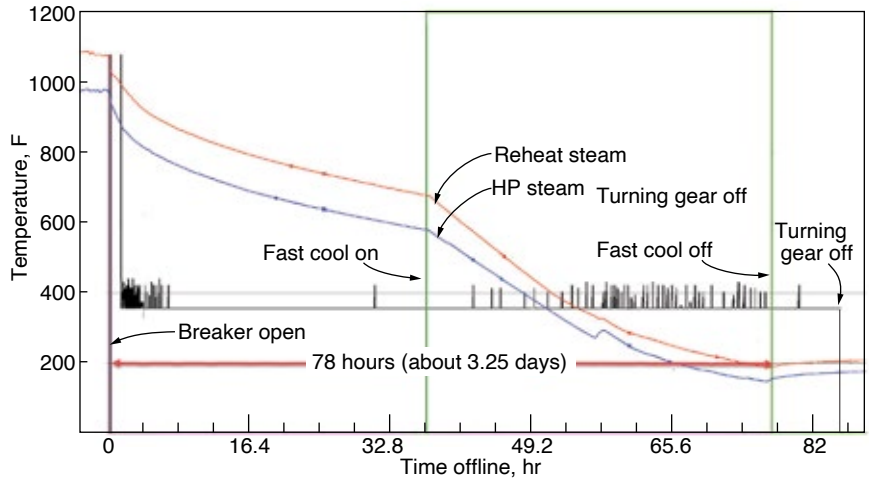


1. Blank inspection flanges on the steam-turbine control valves were replaced with flanges having rough mesh strainers to allow air to flow into the system

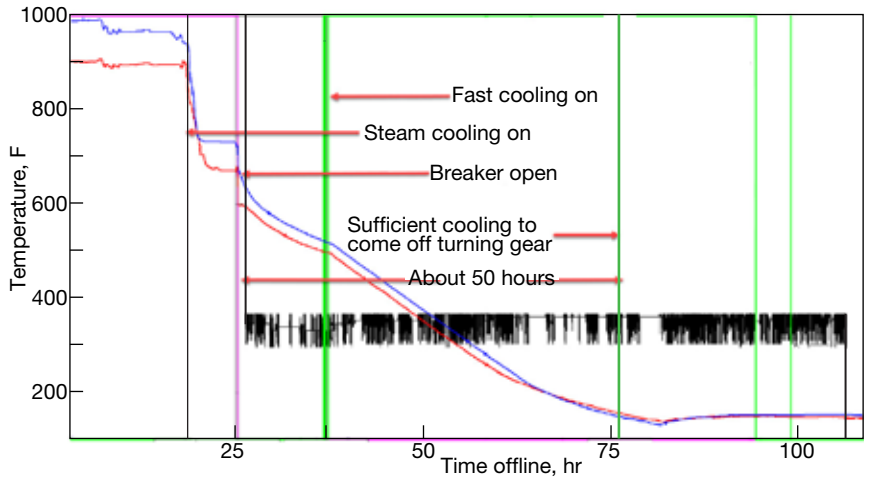
2. Toolbox is equipped to allow rapid replacement of blank flanges with the so-called fast-cool flanges shown



3. Outage time required for natural cooldown of the steam turbine was nearly eight days



4. Fast cooldown using the offline cooling method exclusively



5. Fast cooling using both online steam cooling and offline cooling

matically controls the BOP vacuum pumps to draw air into the system through the inspection ports while the control valves adjust air flow to maintain the appropriate cooldown rate.

During this process, the control system (along with the operator) monitors the turning-gear speed, casing temperatures, and other critical parameters. The process is terminated if the turbine starts to slow down; this would indicate that the internal clearances are going out of tolerance.

The entire process is captured in the plant's Engineering Change Management (ECM) system.

Results. Use of the fast-cooling system saves as much as 135 hours of outage time, all while maintaining the appropriate cooldown rates issued by the OEM. Here are the results for the different cooldown scenarios at CPV Valley:

- No cooling (natural cooldown rate), about 185 hours (Fig 3).
- Fast cooldown using only the offline cooling method, about 78 hours (Fig 4).
- Fast cooldown using both online steam cooling and offline cooling, about 50 hours (Fig 5).

Project participants:
Don Atwood, asset manager
Dave Engelman, operations manager
Ed Peters, maintenance manager
Efrain Morales, lead shift operator
Ernie Hill, lead shift operator
Chris Mahoney, lead shift operator
Vic Polesel, lead shift operator
Tom Viertel, lead mechanic

Meeting the operational challenges caused by severe winter weather

Challenge. Valley Energy Center's gas-turbine inlet filtration system employs static filters with no automated means of cleaning, debris removal, or heating. During certain severe winter weather and wind-driven snow events, the filters clog-up (Fig 6), forcing an auto unload and/or complete shutdown. This typically happens during periods of high load and market demand, which creates system vulnerability and lost revenue for the project.

Solution. After some trial and error, the following actions were implemented to mitigate issues during severe winter weather events:

- Upgraded the prefilters to a "reverse pocket" design that allows the snow to fall off without significant manual action.
- Worked with the filter manufacturer to mitigate installation and fit-up issues to minimize filter clogging. Several design changes were made—including filter clips, sealing-material thickness, and hardware.
- Plant personnel developed a tiered severe-weather protocol that outlines actions needed prior to and during the event, plus recovery methods to minimize the potential impacts and downtime. This

6. Design of the gas-turbine inlet filtration system (left) was conducive to filter plugging (right) during wind-driven snow events (center)

includes weather-forecast alerts, revised market bidding strategies, resource planning, and plant-operations planning and recovery.

- The O&M team developed strategies to ensure onsite support was available to monitor the weather impacts and to remove snow from the filter inlet houses safely and as quickly as possible.
- Staff is working with a third-party engineering firm to evaluate inlet heating solutions for future application.

Results. While severe weather still can be a challenge for the facility, it has operated successfully at minimum load or in a 1 × 1 configuration during several recent snow events. Outages that typically took a day or two to recover from have been reduced to just a few hours while the storm passes—thereby minimizing weather impacts on system reliability and revenue generation.

Additionally, and probably most importantly, personnel safety has been improved with less manual action needed for snow removal.

Project participants:
Ed Peters, maintenance manager
Don Atwood, asset manager
Tom Viertel, lead mechanic
Preston Patterson, CPV's director of reliability and asset management

7. Equipment visibility improved dramatically following lighting enhancements

Mobile electronic logging benefits operations, maintenance, compliance

Challenge. It has taken years to move from paper log sheets and forms to electronic methods in the field. Filing and storing or scanning thousands of pages annually takes time. It also requires that the paper be touched several times as it passes from field to supervisory personnel, and then to administration staff and others, before being physically filed away. Plus, it can be difficult to locate a physical document when required by an audit or other review process (especially as the documents age).

Solution. Staff implemented an integrated electronic software system with the following purposes:

- Operator rounds. Operators enter data in the field and it is available for immediate review.
- Compliance inspection checklists. Prefilled checklists are in the system and O&M personnel are prompted to ensure they are fully completed.
- Critical notifications. Certain events trigger email notifications to key staff.
- Work-order submittals from the

field. O&M technicians can generate a work order from the field directly into the computerized maintenance management system (CMMS).

- Safety observations are entered directly into the system. Results are uploaded in seconds and emailed automatically to plant personnel for review.
- Vendor chemical delivery requests are entered into the log and email notifications are sent automatically to the suppliers' customer service departments.
- All data are available from any mobile device with an internet connection and the appropriate security credentials.

Results:

- Reduction of paperwork and onsite storage.
- Instant access to all data in a searchable and filterable database.
- Increased employee knowledge of digital processes.
- Increased awareness of safety inspections and issues from instant electronic notifications.

Valley Energy Center personnel submitted with their entry samples of the plant's inspection log, truck unloading checklist, and safety inspections, together with in-service photos of the ruggedized tablet selected, but they were not conducive to meaningful display in the printed magazine.

Project participants:
Dave Engelman, operations manager
Jamie Longhenry, EHS coordinator

Lighting enhancements improve personnel safety, boost morale

Challenge. Valley Energy Center is in the Northeast, where winters are long and very cold, so designers located the entire plant inside a building. The indoor location demanded more lighting than usual. Third-party lighting assessments, performed after construction was completed, indicated there was (and still is) room for improvement. Many places in the plant are shaded by equipment, or the lighting isn't focused into the areas needed (Fig 7).

Solution. Through employee and management observations, key areas were identified for additional lighting, as the photos illustrate. Work orders were generated in the CMMS for installation. Lighting additions also were evaluated by engineering to ensure that all circuit components met the required conditions for hazardous atmospheres—if necessary.

Results:

- Improved safety conditions in dark areas.
- Better view of areas for inspections and work activities.
- Reduced the need for temporary lighting, flashlights.
- The brighter workplace increased employee morale.

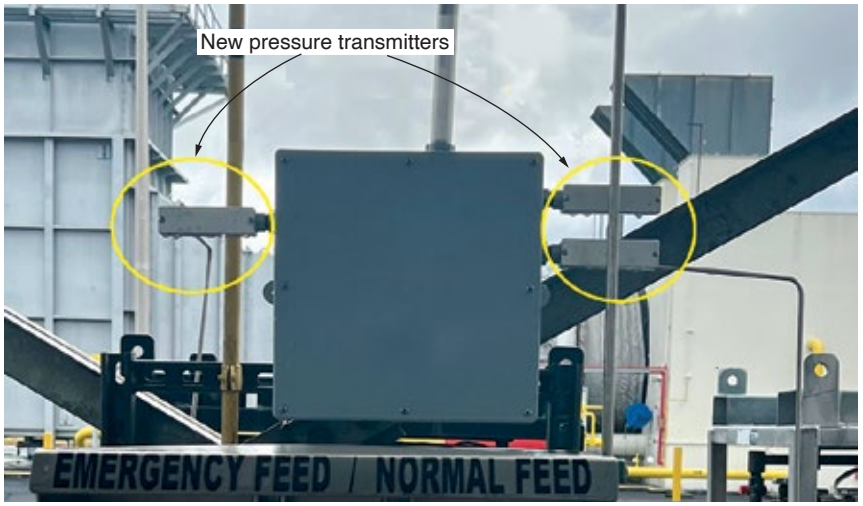
Project participants:
Ed Peters, maintenance manager
Bob Arraiz, lead IC&E technician
McKenzie Slauenwhite, plant engineer

MPC Generating

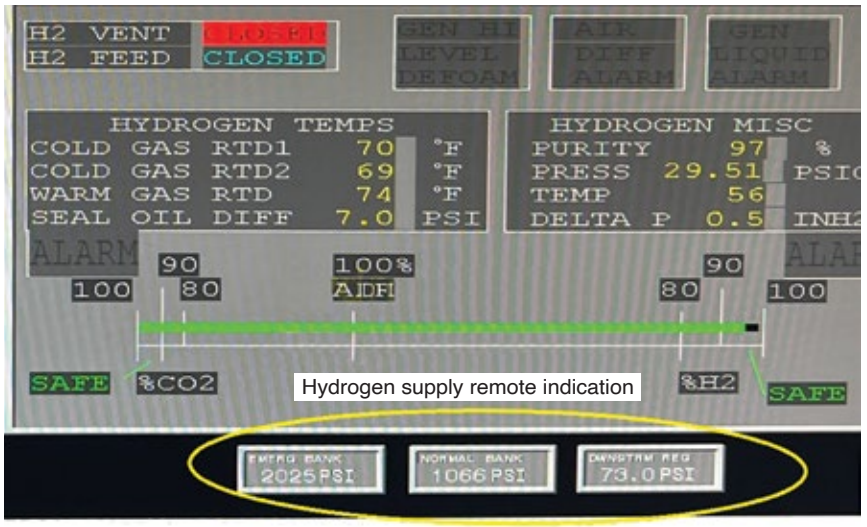
MPC Generating
Owned by Mackinaw Power LLC
Operated by Cogentrix Energy Power Management
386 MW, gas/oil-fired simple-cycle facility equipped with two 7FA gas turbines, located in Monroe, Ga
Plant manager: Mike Spranger

Automate backup source of hydrogen to maximize generator availability

Challenge. MPC Generating's hydrogen-cooled generator historically had experienced unavailability events because of empty hydrogen supply cylinders. The low-hydrogen supply issues resulted from high consumption attributed to large ambient-temperature swings and piping leaks. With the plant typically staffed during normal business hours Monday through Friday, events that occurred after hours or on a weekend would not necessarily be identified in a timely manner.



1. Three pressure transmitters were installed in the hydrogen supply system



2. Hydrogen supply pressure, ambient temperature, and other plant parameters are displayed to assist in troubleshooting efforts

Solution. Goals were to improve generator availability and provide more efficient troubleshooting capability. Three Dwyer pressure transmitters were installed in the hydrogen system, one for each supply bank (normal and emergency) and one for system pressure (Fig 1). Pressure readings are sent to the DCS and recorded in both the DCS and OSI PI historians. Two hydrogen supply alarms were added to the DCS: Normal hydrogen supply low-pressure alarm at 400 psig and emergency hydrogen supply low-pressure alarm at 1000 psig.

Note that if an alarm condition occurs when technicians are offsite, they are notified by text message.

Additionally, a graphic displaying the hydrogen supply pressures was added to the generator screen in the DCS (Fig 2). Hydrogen supply pressure, ambient temperature, and other plant parameters now can be compared in trend analysis to better improve operational availability, training, and troubleshooting efforts. The idea for the modification, and installation work, were by plant operators with oversight provided by the O&M manager.

Result: Unavailability events attributed to low hydrogen supply have not been experienced since this best practice was implemented.

Project participants:
Chris Harris, O&M lead technician
Chaz Gibson, O&M lead technician
Nick Sanz, O&M lead technician
Rich Ramocan, O&M technician

Rolling Hills

Monitor humidity in your excitation-transformer termination cabinet

Challenge. Rolling Hills Generating has five excitation transformers, each tied to the 18-kV isophase bus at ground level through a dry bay shroud (Fig 1). In April 2021, a flashover event occurred in one of these shrouds, caused by tracking on the A-phase seal-off bushing which was attributed to moisture buildup.

The shrouds are equipped with strip-style heaters to keep those spaces dry. There is no remote or local monitoring of the space heaters, just an annual PM verifying operation. But a space heater failed to operate, allowing moisture buildup, and ultimately, the flashover event.

Solution. With the evidence of what happens when a shroud has no mitigation strategy against moisture, the decision to monitor the atmosphere inside the shroud made the most sense. The plant researched several options before deciding to purchase a sensor that would monitor both the humidity and the temperature of the space. The sensor chosen was an EE210 from Instrumart. It displays temperature and the humidity on the screen at the same time so the operator knows whether the space is cooler than expected or has unusually high humidity.

Result. Sensor readings have been added to daily walkdowns, performed by a technician. The sensor (Fig 2) provides "eyes" to see what's going on inside a shroud without having to go through the clearances to open up the space. The monitor has done a good job proving space integrity. The plant plans to develop a similar method for the isophase duct itself to help aid the forced air in preventing any possible flashover events.

Project participant was Tyler Legg.

Rolling Hills Generating LLC

Owned by Eastern Generation LLC

Operated by Consolidated Asset Management Services

850 MW, gas-fired simple-cycle facility equipped with five 501F gas turbines, located in Wilkesville, Ohio

Plant manager: Corey Lyons

1. Excitation transformer is tied to the isophase bus through a dry bay shroud, where the flashover occurred

2. Sensor monitors both space temperature and humidity

State Line Power Station

Owned by Liberty Utilities and Evergy

Operated by Liberty Utilities

613 MW, gas-fired, consists of a 501FD3-powered 2 × 1 combined cycle and a simple-cycle 501D5 engine, located in Joplin, Mo

Plant manager: Brian Berkstresser

Forget the sewer, reuse RO reject water

Challenge. Liberty Utilities' charge is to be a responsible steward of the environment. As a result, plant personnel underwent a complete review of the water systems at their site to identify potential environmental benefits. One possible source of water saving: Reuse reject water from the reverse-osmosis (RO) system instead of dumping it to the city sewer.

Solution. Staff tested, and a third party confirmed, that RO reject water, while not suitable for some uses, was an acceptable source of makeup for the cooling tower. To facilitate this change, the state water agency had to give its approval (which it did) and then the process changes could begin.

Results. The site is now reusing over 9-million gal of water yearly. Annual cost savings are over $50,000 between reduced sewer bills and less water purchased for the cooling-tower cycle.

Project participant:
Curt Kennedy, maintenance manager

Reject water from the RO system is reused in the cooling tower, saving on sewer and raw-water costs

Whitewater Cogeneration Facility

Owned by LSP Whitewater Cogen
Operated by NAES Corp

250 MW, gas/oil-fired facility equipped with a W501FC-powered 1 × 1 combined cycle, located in Whitewater, Wisc

Plant manager: Mark Scholl

Operational tag program advises on why equipment is in its current state

Challenge. There are times in the life of a powerplant when a piece of equipment is retired in place, infrequently used, or just needs some field information.

Whitewater Cogen developed an indentification program to notify O&M teams on why a device or system is in its current state.

Solution. The plant uses Instamation Systems Inc's RedTag Pro software for its LOTO program. With a majority of the facility's devices (valves, breakers, etc) already in its RedTag LOTO database, Whitewater also uses this database for its Operational Tag Program, at no additional software expense.

An operational tag was developed so it can be produced using the same printer that makes the plant's LOTO tags. This tag is of the same size, shape, and material as the LOTO tag, eliminating the need for an additional printer.

Operational tags are orange and have the word "Operational" printed at the top (Fig 1). They are considered a consumable and can be disposed of when no longer needed. Information on the operational tag is the following: log number, sequential tag number, identification number associated with the equipment, equipment description, the state the equipment is in, plus any direction an operator may need in the field as to why the equipment is in that state.

An Operations Log also was developed using the RedTag Pro software (Fig 2). The log relies on sequential entry to track the number of operational-tag entries there are at the plant.

OPERATIONAL TAGS

Operational Tag Log # : 3

Page 1 of 1

Date Issued : 3/8/2022

Issued By : Harmeson, Scott

Equipment : DCS

Equipment ID : DCS-691

Reason For Operational Tags :

Un-Plug Cord in a Cyber-Security Event

Comments :

Tag #	Device Discription	Device Location	Device ID	Tagged Position
1	Maintenance Shop Router Power Cord	Maintenance Shop	1-721-CORD-001	Plugged In
2	Maintenance Shop Router Ethernet Cord	Maintenance Shop	1-721-CORD-002	Plugged In
3	Plant DMZ Router Power Cord	MCC-023 CT Electrical Package	1-691-CORD-001	Plugged In
4	Plant DMZ Router Ethernet Cord	MCC-023 CT Electrical Package	1-691-CORD-002	Plugged In

1, 2. Operational tag is at left, tag log at right. Highlights confirm information on the tag has been recorded in the log

The operational-tag form is similar to a LOTO form, identifying dates the individual who issued the tags, the equipment, equipment IDs, reason for the tags, comments section, and sequential tag list with the information that has been printed on the tag. This form also was developed using the RedTag Pro software.

Results:

- When Whitewater's fuel-oil forwarding system is idle, the operations department isolates system components. The Operations Tag Program identifies these components and why they are in their current state. Tags support the lineup when the equipment is placed back in service.
- Operational tags are used to support critical actions in the field to reduce the chance of human error. For example, they give all technicians onsite the ability to accurately and confidently pull the correct plug during a chaotic or stressful event. An illustration: Whitewater Cogen has placed operational tags on ethernet and power cords that should be pulled in the event of a cybersecurity event.
- The Operational Tag Program also is used when a system is retired in place. Tagging equipment thusly can track changes over a facility's lifetime and help staff remember when and why the equipment was removed from service. It also is used to identify equipment removed from service but still in place.

Project participants:
Larry Moorman, O&M manager
Scott Harmeson, O&M lead

Kleen Energy Systems LLC

Owned by EIF Kleen LLC

Operated by NAES/Kleen Energy Systems LLC

620 MW, gas-fired facility equipped with a SGT6-5000FD3-powered 2 × 1 combined cycle, located in Middletown, Conn

Plant manager:
John O'Rourke

Eliminate generator-breaker weather intrusion

Challenge. Kleen Energy was experiencing moisture infiltration into the generator breaker controls circuitry resulting in ground conditions. This infiltration was attributed to aging of the BX connectors and the breakdown of sealing components. Multiple actions were implemented in efforts to re-establish adequate sealing. The long lead-time for BX connectors was an additional challenge and emphasized the need for a solution. The goal was to mitigate water infiltration to reduce the occurrence of ground conditions.

Solution. To block New England weather effects, such as driving rain and snow melt, from impinging on the breaker coffin covers, a plexiglass panel was installed (Fig 1). While this eliminated some of the weather effects, there was also moisture running from the top of the breaker covers. As this moisture flowed down, the surface adhesion acted as a conduit for it to enter the circuitry. The action taken to interrupt this occurrence was the installation of another panel with a gutter (Fig 2) to interrupt that surface adhesion while capturing the moisture and physically directing it away from the breaker.

Results. While the long-term repair is replacement of the BX connectors, this interim repair has been successful in mitigating moisture infiltration of the breaker circuitry. Since completion of the combined panel and gutter system, there have been no ground-fault-related occurrences.

1. A plexiglass panel was installed on the breaker to protect against inclement weather

2. Gutter collects water and directs it away from the breaker

Project participants:
Kevin Caldwell
plant engineer
Jeff Erksa
maintenance supervisor
Gary Thibodeau
maintenance technician
Kenny Duffy
IC&E technician

Kings Mountain Energy Center

Owned by Carolina Power Partners

Asset management by CAMS

O&M by NAES Corp

475 MW, gas-fired facility equipped with one M501GAC-powered 1 × 1 combined cycle, located in Kings Mountain, NC

Plant manager: Sean Spain

Cybersecurity for remote users

Challenge. In an effort to maintain business continuity and generation reliability (especially during the Covid-19 pandemic) it was necessary to allow employees/users remote access to Kings Mountain's (KMEC) local business network for budget information, plant historical trends, CMMS, etc. Several instances occurred that required extended periods of remote work.

Importantly, separation of the plant control system from outside access had to be maintained to comply with cybersecurity policies and industry best practices.

Solution. Allow users access via a preassigned VPN connection using multifactor authentication (MFA). KMEC employed a Watchguard SSL application for VPN access in conjunction with Duo Mobile for MFA verification. The users sign into the VPN client using their network log-in credentials. Following a successful log-in, the users are prompted on their mobile devices by Duo Mobile to confirm the log-in attempt. Once approved, the users are granted remote access.

Results. Given previous design considerations for network architecture and layout, no segregation of the business and control networks was needed to execute the VPN policy. Verification of firewall rules and air-gapped equipment confirmed previously engineered business and control network segregation prior to VPN implementation.

KMEC was able to successfully maintain generation reliability and business continuity while also maintaining a secure network through the cybersecurity policy described above.

Project participants:
KMEC O&M and IT support teams

Retrofit conditioning system restores health of steam-turbine EHC fluid

Challenge. While electrohydraulic control (EHC) fluids deliver excellent performance, they are viable only when properly maintained. In the presence of unscavenged moisture and particulates, sludging and etching can occur. Slit-lock (a result of micron-size particles lodging between valve spool and bore) in typical spool-bore tolerances can cause valve sticking and unsatisfactory system performance—the former conducive to catastrophic failure of the steam system.

The EHC system commissioned at KMEC was unable to handle acid scavenging filters. Through the plant's oil analysis program, staff observed a linear trajectory of Acid Number, such that after three years of operation the halfway point of the EHC fluid's recommended useful life was reached.

Conditioning skid keeps EHC fluid in good health

Solution. A side-stream oil-conditioning skid, with one particulate filter and one acid scavenging filter, was purchased and installed (photo). The system was designed to return the Acid Number to that near the properties of new oil, thereby extending its useful life.

Results. Improved EHC fluid health, oil-replacement scope pushed outside of current forecasts, and steam-turbine valve control system reliability all were impacted positively by this improvement project. Engineering and installation work was done internally, making this an extremely low-cost solution with an ongoing benefit.

Project participants:
KMEC O&M team

Plant safety improvements increase level of personnel protection

Athens Generating Plant

Owned by Kelson Energy

Operated by NAES Corp

1080 MW, gas-fired facility equipped with three 501G-powered 1 × 1 combined cycles, located in Athens, NY

Plant manager: Steve Cole

Challenge. Athens Generating Plant continuously strives to create and promote a safe working environment. In 2021, many procedures and plant structures were re-evaluated and staff identified several areas that could be made safer.

Safety Compliance Services was engaged to perform a working and walking-surface audit to identify trip hazards. Areas where improvements were recommended included the following: (1) Curbs were insufficient when located in areas where workers walk; (2) Low protruding objects with no indication can be difficult to see; (3) High-vis paint is insufficient for drop-offs; (4) Steps with unequal rises do not conform to OSHA 1910.25.

Other concerns identified by staff included the following:

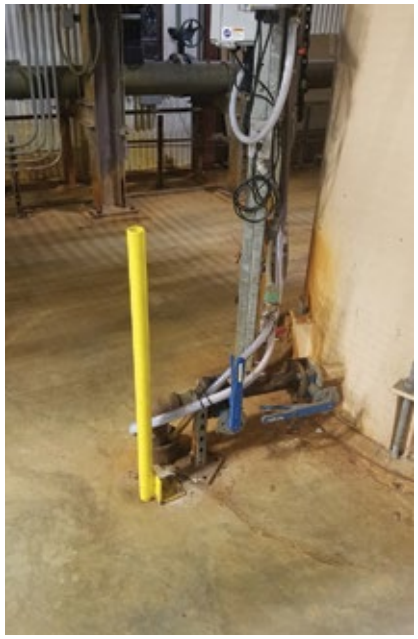
- The condensate building has an upper platform, accessible only by ladder, that operators check at least twice daily, placing an unnecessary strain on personnel.
- During shutdowns, operators were required to open rotor-air-cooler (RAC) drain valves. This involved crawling under several pipes and presented a hazard.
- Many plant doors had no windows. Thus, swinging open a door quickly could possibly hit something or someone on the other side.
- An exterior HRSG platform was accessible only by using a ladder for access via a small confined-space hatch.
- The fire protection system had valves which protruded outward and could easily be walked into.
- The hydrogen purge procedure for gas turbine/generators had some language changes that made it unclear, and it did not have minimum time limits.
- The starting package for the gas turbine was up high and had no railings to prevent a fall.

Solution. Athens worked with multiple vendors to tackle the safety concerns identified. Staff followed the advice of Safety Compliance Services to correct trip hazards. Examples: Curbs around containment dikes in areas were workers walk were fitted with guardrails to prevent a person from walking into the curb (Fig 1); Drop-offs had guardrails installed or extended for the entire length of the drop (Fig 2); Posts were installed adjacent to low protruding objects that could not be removed, to prevent people from walking into them (Fig 3); Steps were redesigned such that they had rises and runs in conformance with OSHA 1910.25.

In addition to the vendor-recommended changes, Plant personnel made other safety improvements to address concerns previously noted. Examples:

1. Guardrail protects against curb trip hazard

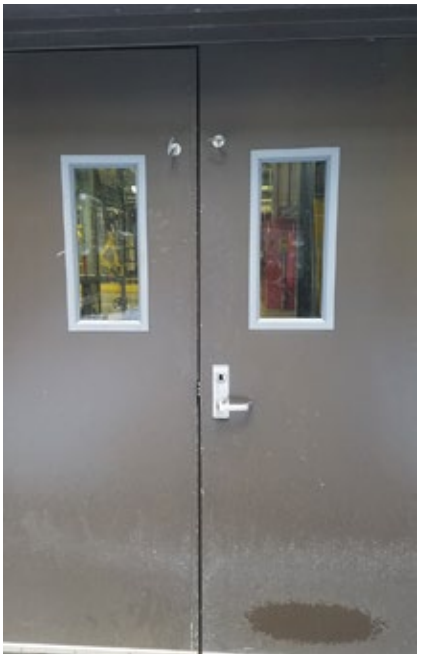
2. Guardrail protection should extend the length of the drop



3. Posts helps prevent people from walking into protruding objects

4. Stairs replaced ladder

5. Valve operator extension eliminates crawling under piping



6. Windows installed in doors without them

- The ladder to the upper platform in the condensate building was replaced with stairs to mitigate the strain on operators (Fig 4).
- The RAC drain valves were modified so operators didn't have to crawl under pipes to access them (Fig 5).
- Windows were installed on all high-traffic doors and turbine-hall doors (Fig 6).
- A small staircase and platform were installed to ease access to the HRSG exhaust; the confined-space hatch was made larger.
- A guardrail was installed around the fire protection system so someone couldn't walk into a protruding valve.
- The generator hydrogen purge procedure was revised to include more specific details involving the hydrogen supply-line purge. Minimum purge time was established at 24 hours.
- Guardrails were installed around the starting package to eliminate a fall hazard.

Results. The improvements have been well-received by operators and other plant personnel and have greatly reduced the chance of a workplace accident. The stairs and RAC valve mod greatly reduce the strain on operators. The stairs and platforms added have facilitated access and reduce the potential for injury. Trip-hazard improvements have proven extremely useful in preventing trips and falls.

Project participants:
Chris Mitchell, O&M manager
Kyle Kubler, O&M manager

Water-treatment improvement reduces environmental impact, cuts cost

Challenge. Athens Generating used ferric chloride, a corrosive chemical with safety concerns, as a coagulant for solids removal in the clarification process for water supplied from the Hudson River (Fig 7). Its use as a flocculant has been phased out in most water-treatment processes because of its hazardous nature. Use of ferric chloride also introduced iron into the outfall to the FFWT, burdening downstream water-treatment equipment.

Solution. Athens switched to Klaraid-IC1172—a polymer aluminum chloride (PAC)—which is considered non-hazardous under OSHA 29CFR 1910.1200. It eliminates the use of ferric chloride, and based on tests conducted by the plant, also eliminates the need for sodium hydroxide, another corrosive and hazardous chemical.

Results. Use of Klaraid-IC1172 has been very successful. By reducing the iron residual from using Klaraid in place of ferric chloride, conductivity of the effluent to the FFWT also was reduced. Plus, PAC helped reduce the amount of product needed for water treatment.

7. Ferric chloride has been eliminated as a coagulant in treating river water

PACs have little effect on pH, allowing Athens to maintain proper water specs, and helping the water-treatment vendor eliminate sodium hydroxide. In turn, conductivity was reduced by 200 to 300 ohms.

A cost analysis determined that the price per month to use ferric chloride was just north of $10,000, while Klaraid cost less than half that. By switching to Klaraid, Athens also has eliminated the hazards associated with transporting, handling, and disposing of ferric chloride.

Project participants:
Chris Mitchell, O&M manager
Kyle Kubler, O&M manager
Jon True, compliance manager
Bernard Freeza, operations coordinator

Milford

Repurposing old parts, materials

Challenge. People tend to retain in storage unused or unwanted items that have either been replaced with a better product or a newer model. Why don't they just throw them away?

Many powerplant employees believe these items may have value as emergency spares—assuming they are in relatively good condition. This thought process works well for parts, but unfortunately it is carried over to most anything that is no longer used. Thus, the creation of the proverbial "bone yard."

Solution. Years after placing an item in storage you may have need for something that may not exist in a catalog or is not readily available. Using the power of employee collaboration and a little Yankee ingenuity, a team member remembers an old something stored away that with a little modification may fit a current need. This best practice is about how Milford Power repurposed some old, unwanted items to support a new functional need.

Results. The three examples below illustrate the viability of repurposing old parts and materials and the cost-savings and the professional pride that result from problem-solving.

Milford Power LLC

Owned by Starwood Energy Group Global

Operated by NAES Corp

210 MW, gas-fired facility equipped with a 501D5-powered 1 × 1 combined cycle, located in Milford, Mass

Plant manager: William Vogel

Project participants:

James Blackwell, maintenance technician

William Vogel, plant manager

1. Milford staff found a potential hazard in moving high-pressure gas bottles in and out of a storage shed. The overhead door provided ample space for bottle access, but the step up/down from this area presented a potential bottle handling hazard (Fig,1).

The idea of forming up a concrete ramp in the font of the door would provide a safer method of moving the bottles for sure, so plans began to identify the materials and time needed to complete this project.

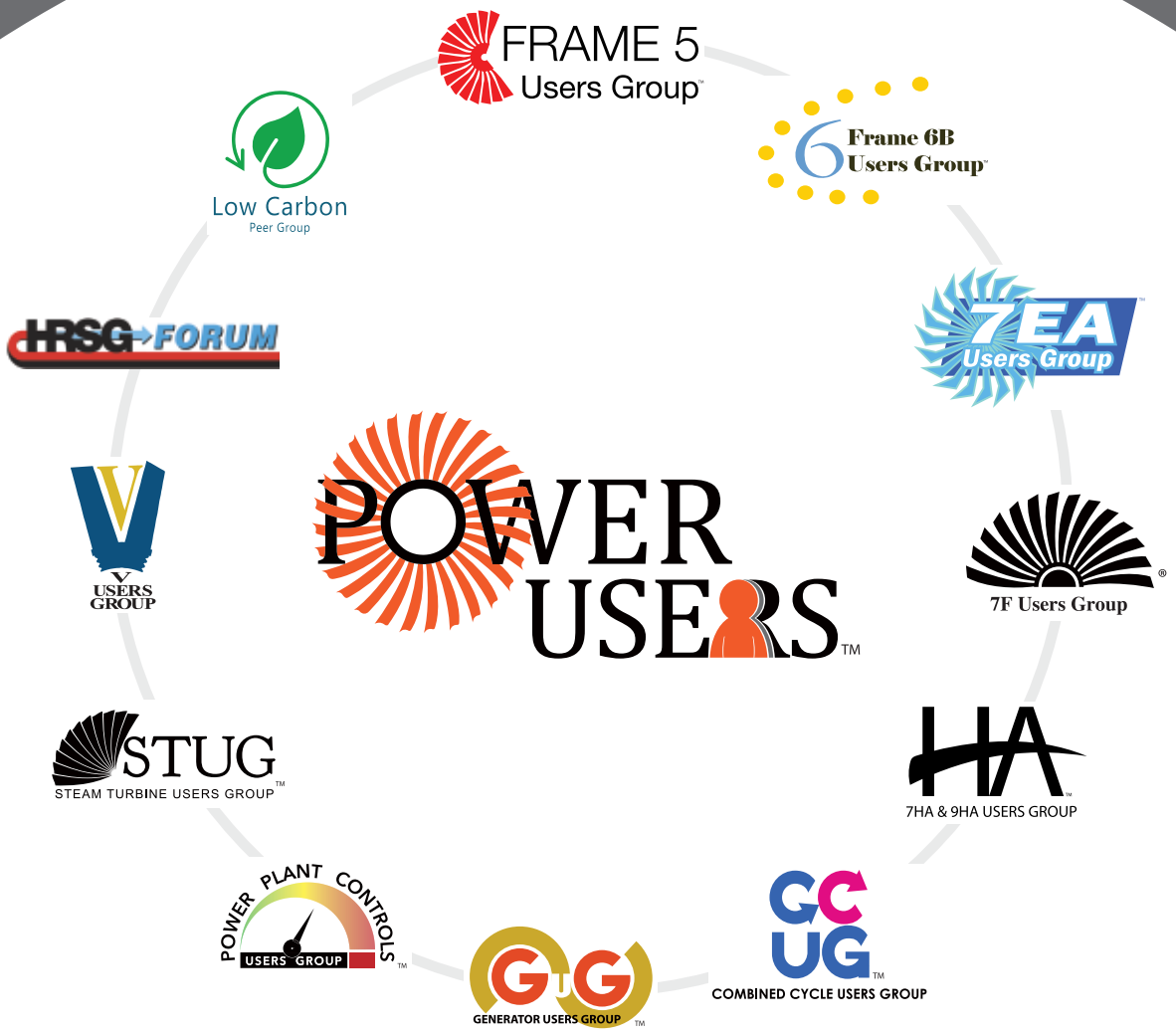
But during the planning process, a maintenance mechanic remembered a ramp at the old truck unloading area serving the warehouse. The ramp was cleaned up and test-fitted in front of the overhead door serving the bottle storage area. With a coat of paint and some concrete fasteners, the ramp was ready for service as shown in the photo.

2. Another item that required attention was the location of the plant's utility-cart battery chargers. For years the chargers were left on the floor in the area where the carts were parked for charging. Given the amount of traffic in the turbine building during outages, the chargers would be moved to provide contractors room for their tooling and materials.

The simple solution would be to purchase a charging station and have it installed, but staff found an old metal table in one of our out-buildings previously used for an analyzer. It was repurposed as the plant's new charger table (center photo). A coat of paint and a few concrete lag bolts were all that was needed. The new arrangement met all expectations during a recent outage.

3. Plant personnel using the back door of the warehouse to facilitate access to/from the power block noticed the original concrete stairs and platform had deteriorated over time. Reason: Heavy use of sand and salt in winter to prevent slips and falls.

As a result, the platform would no longer support the railing anchor bolting. Staff's plan was to chip out the platform area and repour with new concrete. However, a maintenance mechanic observed that the plant was no longer using a support skid for the gas-turbine's wet compression system. So, he removed the unused equipment and resized the skid to match platform dimensions. Once installed, the base of the handrails were welded to the steel plate and the entire unit painted yellow (photo, right). Problem solved.



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Mid-Georgia Cogen

Owned by Rockland Capital

Operated by IHI Power Services Corp

300 MW, gas-fired facility equipped with a 501D5A-powered 2 × 1 combined cycle, located in Kathleen, Ga

Plant manager: Keith Charles

GT trip attributed to failed transmitter

Challenge. A gas turbine tripped during startup on A-stage over fuel. After troubleshooting, staff determined a failed fuel-gas differential-pressure (DP) transmitter was the cause. Investigation revealed the transmitter had failed a few days prior to the restart, when the unit was offline. The fuel-gas valve DP did not generate an alarm with the unit offline; logic was such that an alarm would be generated only if the unit were in service.

Solution. Staff developed and implemented logic to detect DP across all GT fuel-gas valves with the valves closed, even with the unit offline, to provide a DCS alarm.

Results. The new logic will detect a failed transmitter when the unit is offline, thereby allowing time for repairs before causing a failed start or forced-outage event.

Project participant:
Josh Jones

Modify evaporative-cooler water supply system to reduce waste

Challenge. The OEM-installed evaporative-cooler water supply system incorporated a float valve which routinely failed in the open position, causing the cooler basin to overflow. At Mid-Georgia Cogen, the overflow drain is routed to ground and there is no instrumentation on the basin for high-level notification. Thus, someone had to visually identify an overflow condition.

Solution. Staff purchased and installed solenoid valves to replace the float valves. They are NEMA 4X and the power supply is protected with GFCI. Solenoids provide better control of make-up water and prevent basin overflow.

Results. The solenoids provide better control of water supplied to the evap cooler and prevent basin overflow. Their reliability has reduced evap-cooler downtime and reduced water consumption.

Project participant:
Josh Jones

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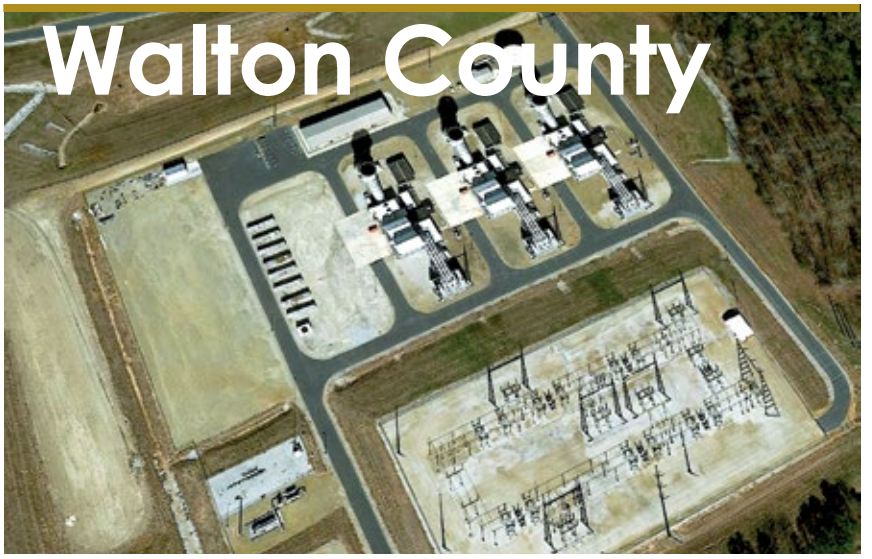

Improving ventilation in the fuel-gas valve room

Walton County Power

Owned by Mackinaw Power

Operated by Cogentrix Energy Power Management

450 MW, gas-fired simple-cycle facility equipped with three V84.3 gas turbines, located in Monroe, Ga

Plant manager: Mike Spranger

Challenge. Prevent ambient temperature swings from affecting the operation of gas-valve actuators.

Solution. At Walton County Power, fuel-gas isolation valves are located

1. Natural ventilation to atmosphere is provided via stationary louvers

2. Open area to atmosphere is regulated by adjusting the position of the aluminum plate

in a room separate from the gas system. This room is naturally ventilated to atmosphere through a set of stationary louvers (Fig 1). When not operating, the gas turbines were receiving "not ready to start" alarms because of a mismatch in the gas valves' set point and indication. Technicians determined that dramatic changes in ambient temperature were causing the mismatches.

A 0.125-in. aluminum plate mounted in an adjustable track was installed inside the louver opening to stabilize room temperature (Fig 2). The opening to atmosphere is determined by ambient temperature, with the plate is positioned accordingly and held in place by set screws along the track.

Results. Since the plates were installed, the plant has not had any alarms triggered by mismatches in gas-valve position and indication. Stabilizing the gas-room temperature has contributed positively to unit availability. Success was achieved at minimal cost by using materials left over from other projects.

Project participants:
James Goins Jr, O&M manager
Chris Harris, Chaz Gibson, Nick Sanz, and Scott Hobbs, O&M technicians
Rich Ramocan, lead technician

Upgrade of GT water wash system improves operations, safety

Challenge. Gas-turbine compressors are water washed as needed and during maintenance outages. The water wash system consisted of a 100-gal tank and pump/motor assembly mounted on a portable cart. Technicians faced several problems when performing washes, including these:

- Cart was difficult to move because of its size, weight, and deteriorated plastic wheels.
- Limited space around the cart made it difficult to operate.
- The reservoir had to be filled with a water hose from a spigot over 100 ft away, making it difficult to turn the water on/off as needed during the procedure.

These discrepancies resulted in slip hazards from spilled water and a much longer period of time to conduct the operation than expected.

Solution. Upgrades made to the water wash system to improve operator safety and reduce the time to conduct the operation included these:

- Permanently mounted the water tank on a sloped frame.
- Plumbed a water fill line with isolation valve on the tank.
- Added a water hose and squeegee for cleaning.

Results. The amount of time needed to conduct the water-wash procedure was reduced by 40%, and minimal cleanup was required after the operation was completed. Plus, the number of technicians required for water washing was reduced. Safer working conditions was a result.

Project participants:
James Goins Jr, O&M manager
Chris Harris, Chaz Gibson, and Scott Hobbs, O&M technicians
Rich Ramocan, lead technician

Fuel-oil pipe mod speeds unloading, increases resiliency

Challenge. Pleasant Valley's fuel-oil unloading skid was designed with two pumps—one main, one backup. Each, rated 210 gpm, is severely undersized to keep up with consumption by the plant's generating units.

Solution. A project was developed to reduce unloading time when fuel oil is burned. This need typically occurs when natural gas is curtailed and ambient temperature is well into the negative range—such as during polar vortices.

But instead of procuring new pumps and motors, piping was modified to run both pumps at the same time, thereby doubling flow and halving the unloading time . With all three gas turbines operating baseload, this modification allows the engines to run an additional 56 hours compared to having one pump in service. During extreme weather events this provides added load support for at least 2.3 days.

Results. Baseload fuel flow to each V84.3A engine is 192 gpm, 165 gpm to the D5A—a total of 548 gpm for the site. Given the capacity of each unloading pump is 216 gpm, the maximum offload rate is 432 gpm, leaving a shortfall of 116 gpm.

Capacity of the fuel-oil tank is 600,000 gal, meaning a full tank will empty in a little more than 18 hours with all three gas turbines running baseload. Continuing, tank capacity will support 30 additional hours of operation with one pump running while the three engines are in service and 86 more hours when using both pumps to unload. The increased run time of 56 hours with two pumps translates to more than $426,000 in additional revenue at $25/MWh, given the ability to generate 436 MWh for each of those hours.

Project participants: Mike Herman, Chuck Condon, Tyler Felix, Kevin Beske, Craig Birkett, Michelle Anderson, Mike McVietty, and Mike Altmann.

Pleasant Valley Generating Station

Great River Energy

423 MW (summer), gas/oil-fired simple-cycle facility equipped with two V84.3A2 gas turbines and one 501D5A unit, located in Dexter, Minn

Plant manager: Tye Stuart

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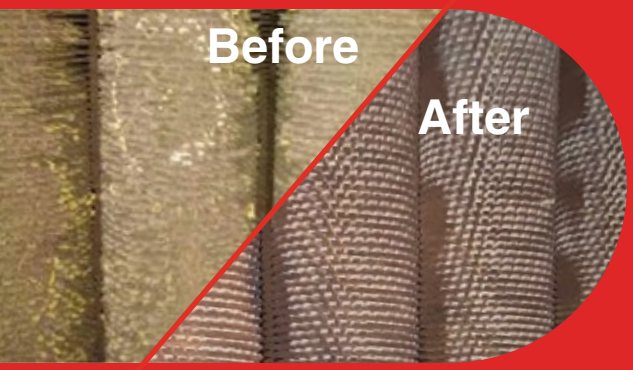

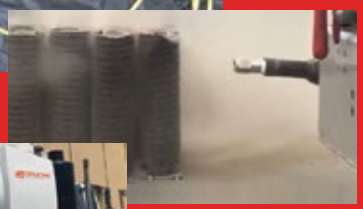

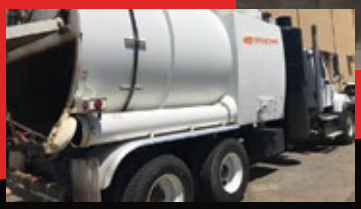

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