WESTERN TURBINE Users

Palm Springs
March 2011

21ST ANNUAL CONFERENCE AND EXHIBITION

Published by the COMBINED CYCLE Journal

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WESTERN TURBINE Users

21st Annual Conference and Exhibition

Published by
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PSI Media Inc

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WELCOME ALL to the 2011 meeting of the WTUI! Join us as we continue our mission to share technical information to advance the operability and reliability of the General Electric line of aeroderivative gas turbines.

The Western Turbine Users Inc started as an informal gathering of a few engineers and managers aimed at overcoming the challenges faced by operators in improving the day-to-day reliability and operability of these machines. Over the years, the dedication and innovative efforts of the Users; the technical design, material improvement, and procedural modifications by GE in response to User experiences; and the collaboration of the Users with GE and the Repair Depots have combined to make these engines some of the most reliable gas turbines in service. Word has spread regarding the value of attending this conference and attendance has grown steadily. Your continuing participation is critical to the group's success.

This is WTUI's 21st annual meeting to discuss the issues facing our industry. The members of your all-volunteer Board of Directors, breakout-session chairs, conference coordinators, GE- authorized Repair Depots, and industry vendors and exhibitors have again prepared a great program. As always, our aim is to produce this technical conference in a pleasant venue at a low cost. A special thanks to all involved for their sincere efforts at achieving those goals. We hope you enjoy the conference activities and find your time spent with us valuable.

This is *your* conference. Your feedback and suggestions are welcome. Please let us know how we can better serve you by contacting one of the breakout-session chairs, any member of the Board of Directors, emailing us at info@wtui.com, or simply completing and submitting the conference questionnaire provided.

Again, welcome to Palm Springs. Thanks for coming and please enjoy yourselves!

My sincerest regards and best wishes for success,
Jon Kimble, Wellhead Services Inc
President, WTUI

Mark your calendar

WESTERN TURBINE USERS

W.T.U.I.
Pasadena City of Roses
2012

2012 Conference & Expo · March 18-21

Pasadena Conference Center

The leading forum for aero users provides owner/operators of LM2500, LM5000, LM6000, and LMS100 gas turbines an opportunity to network with peers, and service providers, to identify opportunities for improving engine performance, availability, and reliability while holding emissions to the lowest practicable levels.

Program is under development. Prospective **delegates** and **exhibitors** are urged to contact WTUI conference staff today, by e-mail (info@wtui.com), and ask to be placed on the mailing list for meeting announcements as they are made available.

Where to go

(see floor plan, p 10)

Registration: Renaissance Ballroom Foyer
Exhibition: Convention Center Exhibit Hall
Breakfasts: Renaissance Ballroom Foyer
Luncheons: Convention Center Oasis 4
LM2500 breakout meetings: Mojave Learning Center
Chair: John Baker, Calpine Corp
LM5000 breakout meetings: Sierra/Ventura
Chair: Chuck Toulou, Ripon Cogeneration LLC
LM6000 breakout meetings: Catalina/Madera
Co-Chairs: Brian Atkisson, Riverside Public Utilities; David Merritt, Kings River Conservation District
LMS100 breakout meetings: Pasadena
Chair: Don Haines, Wood Group Power Operations Inc

Sunday, March 20

AFTERNOON

2:00 to 8:00	Registration
4:00 to 5:30	New user orientation/LM engine basics, *Andreas* Bob Boozer, PPL University Park LLC **Users only**

EVENING

5:30 to 8:30	Welcome hospitality, *Convention Center Exhibit Hall* **All conference attendees**

Monday, March 21

MORNING

7:00 to 8:00	Breakfast
7:00 to 5 pm	Registration
8:00 to 8:15	General Session, *Catalina/Madera/Pasadena* **All conference attendees**
8:15 to 9:30	Depot presentations, *Catalina/Madera/Pasadena* **All registered attendees**
8:30 to noon	Exhibit Hall open
9:30 to 9:45	GE presentation
9:45 to 10:00	User presentation, *Catalina/Madera/Pasadena* LM2500+G4 installation, Jack Kelley, Jacobs Engineering Group Inc **All registered attendees**
10:30 to noon	Breakout meetings: LM2500, **Users + Depots + GE** LM5000, **Users + Depots** LM6000, **Users + Depots** LMS100, **Users + GE**

AFTERNOON

Noon to 1:00	Luncheon
1:00 to 5:30	Exhibit Hall open
1:00 to 5:00	Breakout meetings: LM2500, **Users + Depots + GE** LM5000, **Users + Depots** LM6000, **Users + Depots + GE** LMS100, **Users + GE**
5:45 to 10:00	Monday night reception (see p 8 for details)

Tuesday, March 22

MORNING

7:00 to 8:00	Breakfast
7:00 to 5 pm	Registration

PROGRAM

8:00 to 8:30 Worldwide gas-turbine update,
Catalina/Madera/Pasadena
Mark Axford, Axford Turbine Consultants LLC
All registered attendees

8:30 to 9:00 Fleet performance update,
Catalina/Madera/Pasadena
Strategic Power Systems Inc
All registered attendees

8:30 to noon Exhibit Hall open

9:00 to 9:15 Break

9:15 to 10:00 Breakout meetings: LM2500, LM5000, LM6000, LMS100
Users only

10:00 to 10:30 Break in Exhibit Hall

10:30 to noon Breakout meetings:
LM2500, **Users + Depots + GE by invitation**
LM5000, **Users + Depots + GE**
LM6000, **Users only**
LMS100, **Users + Depots + GE**

AFTERNOON

Noon to 1:00 Luncheon

1:00 to 5:30 Exhibit Hall open

3:00 to 4:00 Special technical presentations
All registered attendees
1. "GT Package Design," *Catalina/Madera*
   Toshiaki Sato, IHI Inc
2. "Failure Analysis," *Mohave Learning Center*
   Dave Christie, IMR Corp
3. "CWT Discharge/ZLD Technologies," *Sierra/Ventura*
   Jim Vickers, PE, Separation Processes Inc

4:00 to 5:00 Special technical presentations
All registered attendees
1. "Developing Cycles Tracking Programs in Plant Control Systems and Critical Parts Tracking Experience," *Sierra/Ventura*
   Ed Jackson, Missouri River Energy Services; Chris Heiberger, Wellhead Services Inc; Dan Dowler, Encana Corp
2. "Engine/Component Repair Services," *Mojave Learning Center*
   Brian Hulse, Wood Group Pratt & Whitney
3. "NERC Regulatory Update," *Catalina/Madera*
   Chris Siplin, Wood Group GTS

Wednesday, March 23

MORNING

7:00 to 8:00 Breakfast

8:00 to 10:00 Breakout meetings:
LM2500, **Users + Depots + GE by invitation**
LM5000, **Users + Depots + GE**
LM6000, **Users + Depots + GE**
LMS100, **Users + GE**

10:00 to 10:10 Break

10:10 to 10:30 Breakout meetings:
LM2500, **Users only**
LM5000, **Users + Depots**
LM6000, **Users + Depots + GE**
LMS100, **Users + GE**

10:30 to 11:30 GE new products update,
Catalina/Madera/Pasadena
All conference attendees

11:30 to noon Wrap-up and adjourn,
Catalina/Madera/Pasadena

SOCIAL FUNCTIONS

Social events are critical to the success of every user group because they enable people to meet in a relaxed environment and expand their networks for problem-solving. The Western Turbine Users is hosting several functions in 2011 that you won't want to miss; some would not have been possible without financial support from sponsors identified on signage in the Exhibit Hall. Please thank them when you have the opportunity.

The headline events are listed below. Note that buses will board passengers for the golf tournament, Monday night reception, and spouse tour right outside the lobby of the Renaissance Palm Springs Hotel. The tennis tournament will be at the Plaza Racquet Club, which is within walking distance. There are special fees for the golf and tennis tournaments and the spouse tour.

Sunday events

The golf tournament, the first official function of the 2011 WTUI Conference, will be conducted Sunday, March 20, at the Indian Canyons Golf Course (north course), which is less than four miles from the hotel. Tournament Chair and Board Member Jim Bloomquist says buses will pick up golfers outside the main entrance of the hotel at 6 a.m. He expects more than 100 participants.

Format will be a four-person, 18-hole shotgun scramble. Prizes will be awarded at the Monday luncheon for lowest team score, men's and women's longest drive, and closest to the pin. Bloomquist reports that the course is surrounded on three sides by breathtaking, colorful, natural mountain vistas, sheltered from the wind and nestled at the base of the San Jacinto Mountains.

The north course is 6943 yards (par 72). It was designed by the noted architect, William P Bell, and is steeped in tradition. The course meanders through Palm Springs' stylish "Canyon" region which boasts a wide array of authentic mid-20th-century homes and stunning mountain views. It is accentuated by thousands of palm, olive, and other native trees.

The course has six challenging water

Buses, for activities requiring them, board outside the Renaissance lobby

Indian Canyons Golf Course

Plaza Racquet Club

Relax at the Renaissance pool

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hazards. The largest, located between the ninth and 18th holes, hosts the course's visual centerpiece—the historic Walt Disney fountain which shoots water jets over 100 ft high.

The tennis tournament, chaired by WTUI Past President Jim Hinrichs, will be at the Plaza Racquet Club, a stone's throw from the hotel. Players are requested to gather in the Renaissance lobby at 11 a.m. and warm up for the tournament by walking to the nine-court facility. The outing is planned for three hours. About a dozen participants are expected.

Those unable to participate on Sunday, can schedule a game at another time by calling the racquet club at 760-323-8997. Rental racquets, ball machine, and backboard are available. The courts are well-lit for nighttime activity.

The group's Sunday evening welcome reception, which includes the opening of the exhibition, runs from 5:30 to 8:30 in the Convention Center (see map, p 10). More than 800 user and vendor participants are expected. WTUI Treasurer Wayne Kawamoto of Corona Energy Partners Ltd says, "Don't miss it!"

Monday events

Spouse tour is a cultural journey, steeped in history, along the San Andreas Fault in the comfort of a luxury motor coach. Boarding is at 8:45 a.m. just outside the Renaissance lobby; a 3 p.m. return is expected. Dress comfortably!

An entertaining naturalist guide will share interesting facts and stories along the way, bringing your eco-adventure and the desert to life. You'll learn about desert plants, animals, geology, pioneer history, and Indian culture as you explore the tortured landscape of the San Andreas Fault zone.

A visit to the historically accurate replica Cahuilla Indian Village, which sits on the documented archeological site of the tribe's ancient village of Palteewet, offers an opportunity to learn about customs, ceremonies, and the everyday lives of these people.

Lunch, of course, is included. Afterwards there's an opportunity to stroll El Paseo Drive—the so-called Rodeo Drive of the Desert—which features over 300 world-class shops, boutiques, galleries, etc, that line the floral and statue-filled shopping district.

The Monday night reception will be at The Living Desert, a zoo dedicated to the preservation of desert animals of North America and Africa, which face many challenges to their survival. Buses will pick up participants outside the Renaissance lobby at 5:45 p.m. Expect to return by 10 p.m. Dress is casual. Comfortable shoes and a light jacket are recommended—the latter because of an expected cool evening breeze.

IMPORTANT: You MUST have your conference badge with you to attend this event. NO EXCEPTIONS.

When you exit the bus at The Living Desert, you will have a short journey through the desert to your destination, the African village of Wa Tu Tu. During the safari, you will share rare experiences with desert animals up close.

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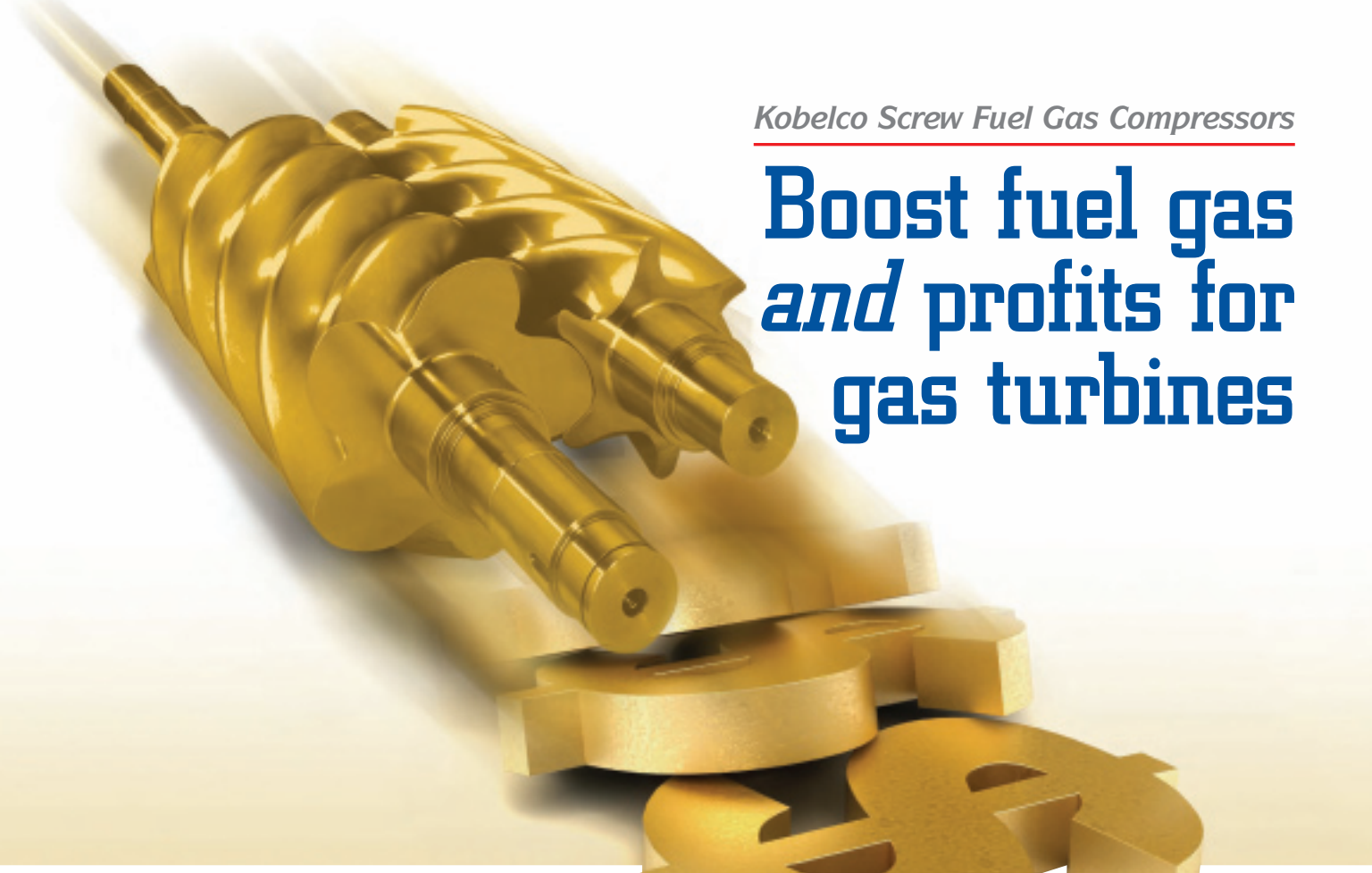

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For example, a KOBELCO screw compressor is reducing power costs by an average 1,250 kW/hr (compared to centrifugal or reciprocating compressors) in one fuel gas boosting application due to suction gas pressure fluctuation. That projects to a savings of approximately $10 million over a typical 20-year life cycle.

Screw fuel gas boosting compressor used with aeroderivative gas turbine (output: 50 MW)

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BADGE RULES

QUALIFICATIONS

Blue

User members registered for conference sessions.
Allowed to attend all sessions of the conference.

Persons and business entities that own, or are directly engaged pursuant written contracts, in the full-time operation and/or maintenance of GE aeroderivative gas turbine power plants. Memberships held by a designated representative have one (1) voting right.

Yellow

Vendor/Associate members registered for conference sessions.
Allowed to attend all sessions of the conference except those specified for "users only," "users + depots," or "users + GE."

OEMs and suppliers and vendors providing support services or materials for the ongoing operation and/or maintenance of power plants. No voting rights are held by these memberships.

Red

Vendor/Associate members not registered for the conference sessions.
These attendees usually are exhibitors only.

OEMs and suppliers and vendors providing support services or materials for the ongoing operation and/or maintenance of power plants. No voting rights are held by these memberships.

Orange

Registered spouses of User and Vendor/Associate members.
Allowed to partake in all meals of the conference, including the Monday night dinner.

Pre-registered spouses of registered conference attendees who have pre-purchased spouse meal plans.

Black

Special one-day pass.
These attendees include students, press, convention/hotel special guests, and city officials.

Requests submitted by special interest groups/individuals that have been approved in advance by the Board of Directors.

Gray

Officers, directors, and staff of WTUI
(including SPS note-takers).

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'And you thought the housing market was lousy'

Those were the first words Mark Axford spoke at his annual January sit-down with the editors to review the US and global markets for gas and steam turbines. The founder of Houston-based Axford Turbine Consultants, respected for his solid industry data, provided a market analysis for 2010 based on actual orders placed during the first nine months.

Axford's valued current-year projections and market insights are the focus of his annual report to the WTUI membership, which begins at 8 a.m. Tuesday in the Catalina/Madera/Pasadena rooms. Final 2010 numbers also will be available at that time.

"The recession that has been felt throughout the US has been especially hard on the power generation business," Axford said. US orders for both gas and steam turbines fell again during 2010 (Figs 1, 2).

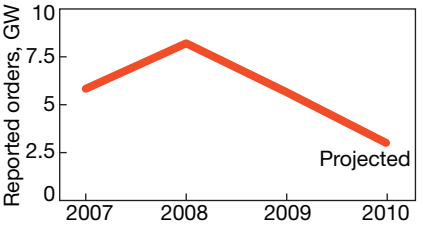
The fundamental problem, he added, was that industrial demand for electricity continued to stagnate in 2010 because the recession forced factories to operate at relatively low capacity factors.

While cumulative kilowatt-hour consumption in the US was up 4.2% in 2010 versus 2009, most of that gain was attributable to a very hot summer (Fig 3). Air conditioning load was significantly higher than average. Even with the significant bump in kilowatt-hour sales last year, consumption was still below the figure for 2007.

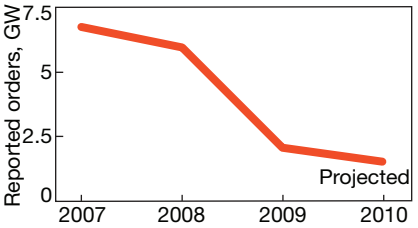
Assuming "normal" summer weather for 2011, DOE predicts electricity consumption will be lower in 2011 than it was in 2010. This would mean three down years in the last four for the first time in the nation's history.

Globally, Axford said, 2010 orders for gas turbines essentially were flat, while those for steam turbines were off by about 25%. Geographically, he continued, gas turbine orders were spread relatively uniformly around the world. But steam turbine orders were concentrated in Asia because both India and China are adding considerable coal-fired capacity.

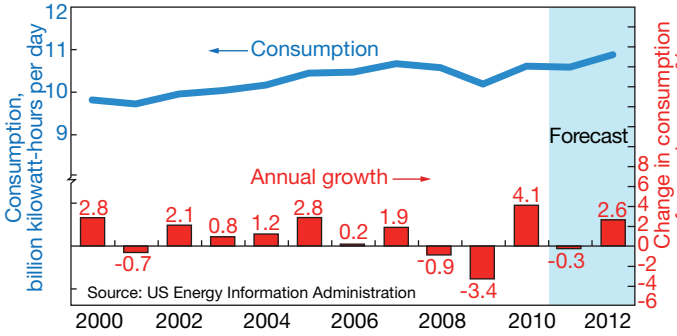
Axford believes that "until we see a steady increase in the demand for electricity of 1% to 2% annually, and a return to ordering of new generating capacity based on the lowest total cost of delivered electricity [no subsidies], construction of simple- and combined-cycle power stations will remain subdued."



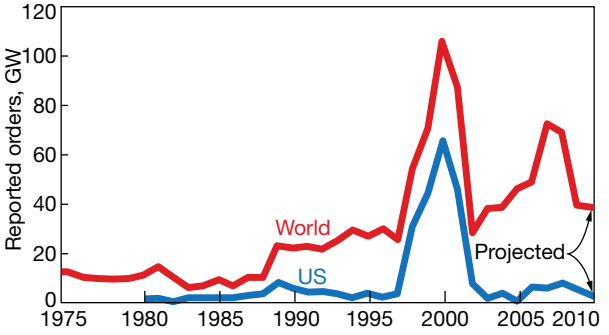
1. US gas turbine orders for units larger than 10 MW dipped again in 2010. Data are for engines larger than 10 MW



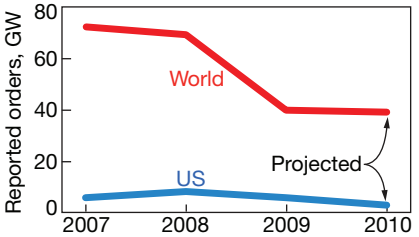
2. US steam turbine reported orders in 2010 were few and far between



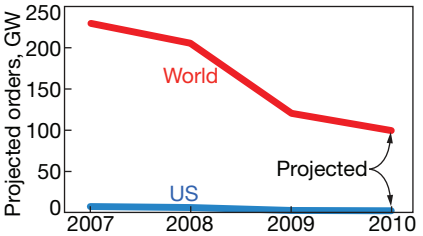
3. Total electricity consumption in the US in 2010 was less than that recorded in 2007



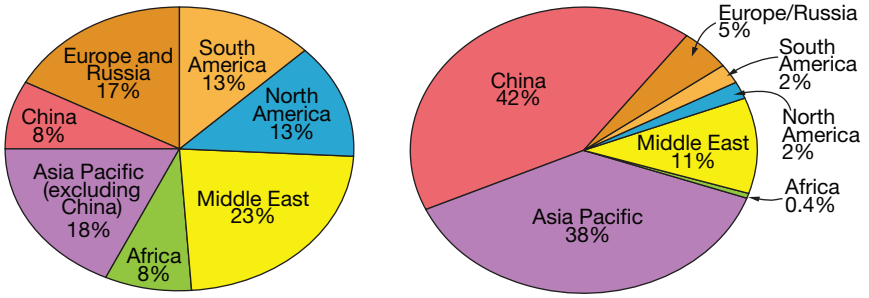
4. Gas turbine orders worldwide and US for the last 35 years. Data from 1990 to date are for units larger than 10 MW



5. Detailed look at gas turbine orders worldwide and US for the last four years



6. Steam turbine orders worldwide are off sharply because of the recession



7, 8. Geographical distribution of 2010 gas turbine orders (left; 28,997 MW through Sept 30) reveals a relatively even spread in sales worldwide. Steam turbine orders (right; 99,250 MW projected for the year based on 3Q/2010 data) are dominated by sales activity in China and Asia Pacific (primarily India)

FREE Calendar featuring our Turbinettes (Rene' above) for End-Users of the above turbines.

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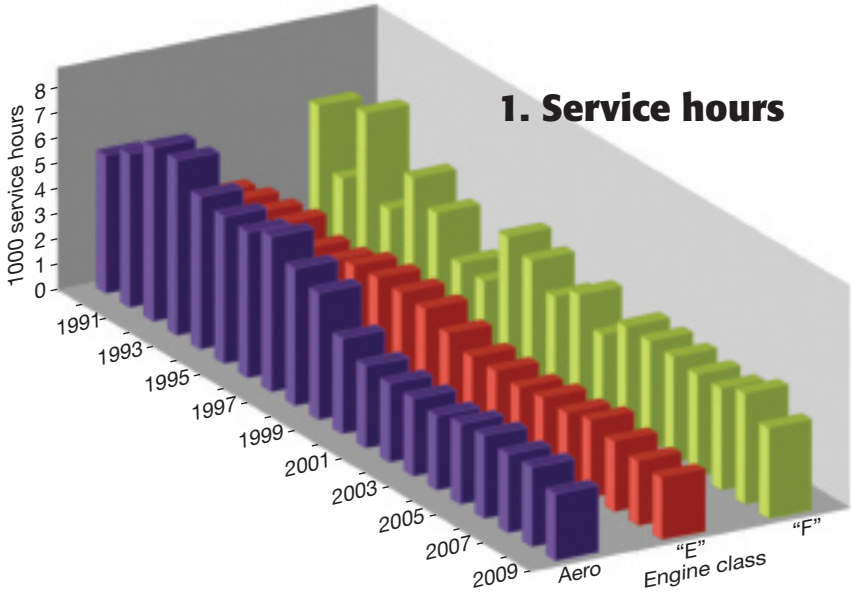
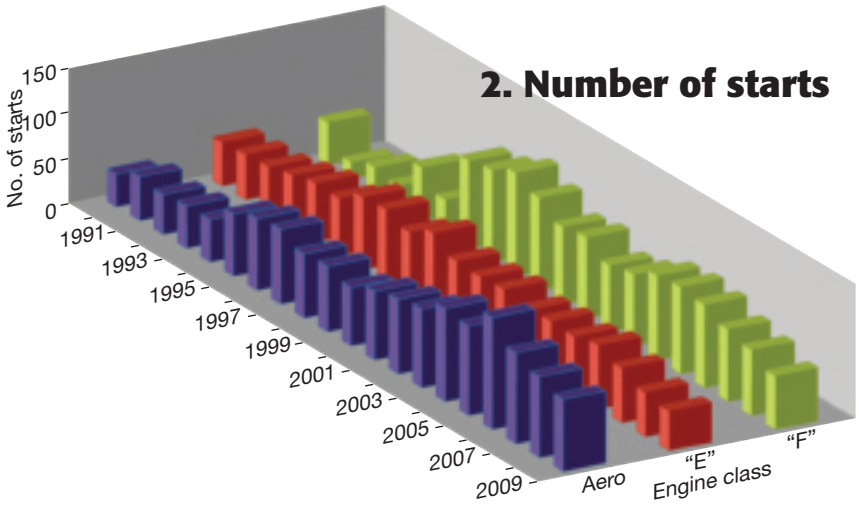
Changing duty cycles and gas turbine reliability—a look back

By Salvatore A DellaVilla Jr, CEO, Strategic Power Systems Inc

Characteristics of ORAP data sample for 1991-2010

	Aeros	"E" class	"F" class
Average number of units reported	270	230	105
Maximum number of units reported	552	290	336
Percent of units in combined cycle	72	59	87
Percent of units burning only natural gas	95	91	99





"In June of 1892, a jubilant Charles Scott, the young Westinghouse engineer who had assisted Tesla when he'd first come to Pittsburgh, announced this first commercial use of the whole Tesla system, including the long problematic induction motor, in the *Electrical Engineer.* 'The aggregate time lost. . .was, by actual count, less than 48 hours during three-fourths of a year. . . .'"

From Jill Jonnes' *Empires of Light: Edison, Tesla, Westinghouse, and the Race to Electrify the World*

Forty-eight outage hours over three-quarters of a year translates to a reliability factor of 99.3%. Thus, from the very start of the electric power industry, the reliability of each product developed—such as the first ac induction motor—was recognized as a key performance indicator required for commercial acceptance and economic viability.

The industry has grown and the technologies it relies on have advanced, but there continues to be a need to understand how powerplant equipment is performing relative to market expectations for high reliability. Changing patterns in demand have resulted in challenging duty cycles that require operating flexibility and this will impact the reliability and capability of plants powered by gas turbines.

For more than 20 years, data from the ORAP® program obtained from numerous operating powerplants worldwide have provided the opportunity to assess and understand trends in equipment duty and performance. The following analysis reviews ORAP data compiled for aero, "E," and "F" class engines in electric generation service to identify operational differences based on equipment size/

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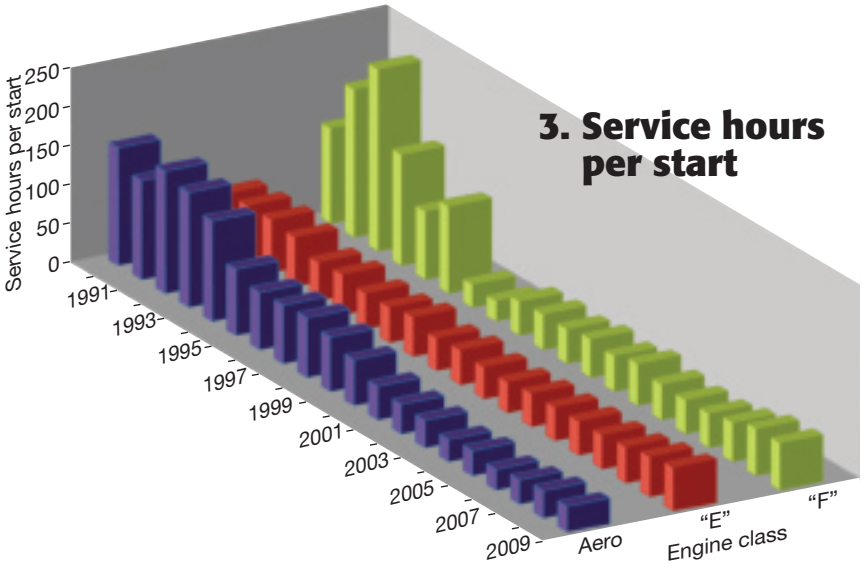

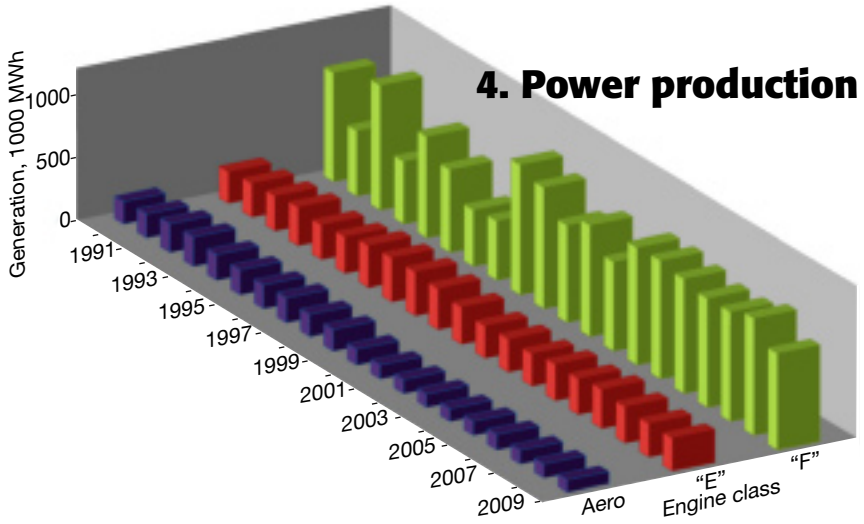

output and performance. Two 10-year periods are compared: 1991-2000 and 2001-2010. The data pool is described in the table.

Every performance assessment should begin with snapshot of how the equipment or generating facility was operated during the period under review. Service hours, or the amount of time power was supplied to the grid—that is, the elapsed time from breaker close to breaker open—is a key metric (Fig 1). Service hours also can be characterized by service factor, or the percentage of time the unit is generating power.

In addition, the number of successful starts (Fig 2), the service hours per start (Fig 3), and the power generated (Fig 4) are important considerations necessary for understanding equipment duty cycle or mission profile. Data presented in the illustrations reflect the operation of a typical (or average) unit in the specific technology class (aero, "E," "F").

The following assessment was developed using this information.

For aeros during the period 1991-2000 there was a continual year-over-year decrease in service factor, driven by a decrease in service hours. Example: In 1992, the aeros operated just over 6000 hours (85% service factor), with 126 hours per start (48 annual starts); production was 190,900 MWh.

By 2000, annual service hours would gradually, but continually, decrease to just over 4990 hours (70% service factor), and the hours per start would decrease by more than 40% to 70. However, the annual number of starts increased by 50% to 72, while power production dropped by about 12%. This was a clear shift in duty from a typical base-load paradigm to a cycling mission profile.

For the 2001-2010 period, with year 2001 excluded, service hours were more consistent on a year-over-year basis. The service factor was between 40% and 47%, with units operating between 3100 and 3300 hr/yr. Service hours per start declined (to between 25 and 40) as did annual service hours.

The number of annual starts remained high—from 65 up to 122—which is consistent with cycling duty. However, generation declined by more than 40% compared to the previous 10-yr period (1991-2000). Once again, this reflects a clear shift in operating duty.

From a reliability perspective, it is important to note that the number of trips from load have decreased significantly year over year—from a high mark of 10-15 annual trips during the 1991-2000 period to from four to nine for 2001-2010. The time to respond, or to repair also improved significantly.

"E" class units had a very consistent mission profile year over year for 1991-2000, as evidenced by the following:

- Annual service hours of 3100 to 3600 and a consistent service factor of about 49%.
- An increasing number of annual starts (from 50 to 86), and a decreasing number of hours per start (from 65 to 41).
- Increased generation—from 245,500 to just over 346,000 MWh on an annual basis.
- Two to three annual trips from load, with a time-to-repair of 30 to 100 hours—a consistently high level of reliability.

From 2001 through 2010, service factor declined and fluctuated slightly, but over time could be seen as relatively consistent in the range of 34% to 41%. Annual service hours fluctuated between 2400 and 3100, while service hours per start increased from 44 to 56.

Power production was fairly consistent throughout the period, ranging from 252,700 to 308,300 MWh annually. The reliability of "E" class machines remained high with only two trips from load on an annual basis and with the time-to-repair dropping to 30 to 60 outage hours.

The bottom line: Over the full 20-yr survey period, the duty cycle of "E" class units has remained relatively consistent across all metrics.

"F" class. Fluctuating service hours characterized the years 1991 through 2000. "F" class technology was introduced to the market in this period

and the data provide some interesting insights, as follows:

- From 1991 though 1995, (1) service hours fluctuated from a high of 6500 to a low of 3300; (2) hours per start ranged from 233 down to 90; and (3) production averaged over 728,700 MWh.

  During the next five-year period (1996-2000), service hours declined to just over 3870. A substantial change in mission was reflected by the decrease in average service hours per start to just over 50. This metric, together with an increase in annual starts to more than 90, suggest that "F" class engines typically operated in a cyclic duty cycle during the last five years of the 20th century. Interestingly, power production decreased by only 4% during the period.
- From 2001 through 2010, the operation and duty cycle of "F" class turbines can be characterized as "more consistent year over year." Service factor ranged from 50% to 60%, averaging about 55% on an annual basis. Production increased to more than 850,324 MWh annually. These units clearly remained in cyclic duty service with 60 to 90 annual starts and from 44 to 60 service hours per start.
- The reliability performance of "F" class units improved year over year. Annual trips dropped from an average of 18 to just over four during 1991-2000 and to between two and five from 2001 through 2010. The size of "F" class engines contributed a longer time-to-repair (average of 80 outage hours per trip) compared to "E" and aero units.

Clearly, the market expects units that can start faster and more frequently, and stay online for shorter missions across all technology classes. And this holds true for units in combined-cycle applications, as well as simple-cycle.

Customers will demand more challenging missions in the near future, including faster starts and load-following capability—in particular to accommodate "must take" power from intermittent renewables resources (wind and solar). For more on this subject, visit www.integrating-renewables.org. The consequent impacts on component life limits, repair cycles, and maintenance requirement are not fully understood at this time.

Back to the beginning. In 1892, Tesla's first commercial 100-hp, single-phase ac induction motor helped to launch an industry with a bent on product improvement and high reliability. The 99.3% reliability achieved on the first try wasn't too bad.

The industry definitely has come a long way since then. As a point of reference, a typical 100-hp, three-phase induction motor specified for powerplant service today has a running reliability of 99.82%.

Meet WTUI's officers, directors

Officers

Jon Kimble
President
This is Jon Kimble's 21st year working in all phases of gas-turbine powerplant development, construction, commissioning, O&M, administration, shutdown, and decommissioning. He's been a WTUI member most of that time, serving on the Board of Directors from 2004 to 2007 and as President since 2008. Jon is employed by Wellhead Electric Co.

Bill Lewis
Vice President
Bill is Plant Manager for PPL's fleet of simple-cycle peaking gas turbines. These generating facilities are located in Connecticut, Pennsylvania, and Illinois. After serving six years in the US Navy as a Gas Turbine Specialist (mechanical) and rising to the rank of Petty Officer First Class, he left the service and joined the land-based LM world—and WTUI.

Jim Bloomquist
Vice President
Jim has served as a Board Member and is now one of the organization's VPs. He has 34 years of service with Chevron specializing in major power systems, process facilities, and gas-turbine generation. His current position is the Electrical Engineering Supervisor for Chevron's San Joaquin Valley Business Unit (an upstream oil producing company).

Chuck Casey
Secretary
Chuck is Generation Manager for the Riverside (Calif) Public Utility. Riverside is the third largest municipality in the state and supplies power to over 105,000 residents and businesses. Before joining Riverside in 2006, he worked as an operator, I&E technician, and plant manager for Stewart & Stevenson, General Electric Co, and PurEnergy. Chuck began his career as a nuclear electrician on US Navy fast attack submarines. He currently serves WTUI as Secretary, Co-Exhibit Hall Manager, and Assistant Webmaster; previously Chuck was LM6000 Breakout-Session Chair and a member of the Board of Directors.

Wayne Kawamoto
Treasurer

Wayne is one of the founders of the Western Turbine Users and has served on the Board and as Treasurer since incorporation. He has a BS degree in Civil Engineering from the Univ of Hawaii and has held numerous positions in project management throughout his 36 years of professional employment. Wayne is the Plant Manager of Corona Energy Partners Ltd.

Board of Directors

David Merritt
Board Member

David recently joined Kings River Conservation District, where he manages the organization's LM engine and hydro assets. Previously, he spent 19 years in the O&M groups of GWF Power Systems/GWF Energy LLC. There David had responsibility for the maintenance of LM peakers and a solid-fuel-fired powerplant. Prior to GWF, he served in the US Navy as an aviation electrician.

John Baker
Board Member

John is O&M Manager for Calpine Corp's Bethpage Energy Center in Hicksville, NY, where he is responsible for two LM2500s and two LM6000s. He started his gas turbine career with Calpine at Watsonville, later working at the company's Agnews and Los Esteros facilities before moving to the East Coast. Prior to Calpine, John was in boiler operations at Foster Wheeler Energy Corp.

Brad Hans
Board Member

Brad is the Plant Supervisor at Terry Bundy Generating Station for Lincoln Electric System, a Nebraska municipal utility. Bundy is a 3 × 1 LM6000-powered combined-cycle facility. Brad came to LES from the John Deer Engine Works. The professional engineer began his career with the Navy Civil Engineer Corps.

Mark Breen
Board Member

Mark is Director of O&M Support for Wood Group Power Plant Services. Before Wood Group, Mark was Facility Manager and Engineer for Calpine Corp from 2001 to 2006. He started in the industry as a Project Engineer for Siemens Energy from 1997 to 2001. Mark has been attending WTUI conferences since 2001 and, in addition to serving on the Board of Directors, was the LMS100 Breakout Session Chair in 2009.

Alvin Boyd
Board Member

Alvin is the Power Production Superintendent for Pasadena Water & Power, a municipal utility that has provided power to its customers for more than 100 years. He has 23 years of service with the City of Pasadena, specializing in plant operations and management. Before joining Pasadena, Alvin spent nine years in the US Navy, mustering out as Machinist Mate First Class. He has served on the WTUI Board of Directors since 2008.

Tony Skonhovd
Board Member

Since 2005, Tony Skonhovd has worked at Basin Electric Power Co-op's Groton Generating Station as O&M Supervisor for two LMS100 engines, the first commercial units of that model series. Before moving to Groton, he worked at Basin's Spirit Mound Power Plant as operator/technician on two Brown-Boveri 11D gas turbines. Tony got his start in the industry as an I&C technician at the company's Antelope Valley Station, where he worked from 1989 to 1992.

Don Haines

Board Member

As Plant Manager at Wood Group Power Operations' Panoche Energy Center, Don is in charge of four LMS100s. Before joining Wood Group, he worked at the City of Santa Clara for more than 18 years, serving the city's generation assets in technical and management capacities. Before moving to Santa Clara, Don served for six years on the USS Ingersoll.

Supporting Members

Wayne Feragen

Webmaster

Wayne is Senior West Coast Plant Manager for Noresco, currently responsible for powerplants in Colton, Calif, and San Diego. Wayne has over 21 years of powerplant experience, starting as a Gas Turbine Electronics Technician First Class in the US Navy. After leaving the service, he went to Newark Pacific Paperboard and ran an LM2500. After that, he worked at two Sunlaw plants running LM2500s. Wayne has served as WTUI's Webmaster for the last four years.

Charlene Raaker

Conference Assistant

As WTUI's Conference Assistant (and Mike Raaker's better half), Charlene has been supporting the organization for almost as long as it has been in existence. Charlene's is the "voice on the other end of the line" whenever anyone calls the group.

Mike Raaker

Technical Consultant

What do diapers, toilet paper, jet engines, and WTUI have in common? Mike Raaker. He started his career at Procter & Gamble, assigned to install a cogeneration plant at the company's towel and tissue plant in Oxnard, Calif. The LM2500-powered facility would keep Mike busy for the next 30 years and would lead to his, and wife Charlene's, participation in WTUI.

Joella Hopkins

Conference Director

Jennifer Minzey

Conference Assistant

Joella is founder and president of Simply Mumtaz Events Inc, highly regarded for its meeting and exhibition planning and management services. The company's activities also include contract negotiation, program development, and post-conference reporting. Joella and Jennifer have produced the WTUI meeting for the last several years.

Breakout session chairs

LM2500

John Baker

Board Member

John is O&M Manager for Calpine Corp's Bethpage Energy Center in Hicksville, NY, where he is responsible for two LM2500s and two LM6000s. He started his gas turbine career with Calpine at Watsonville, later working at the company's Agnews and Los Esteros facilities before moving to the East Coast. Prior to Calpine, John was in boiler operations at Foster Wheeler Energy Corp.

LM5000

Chuck Toulou

Chuck is responsible for the gas turbine, power turbine, and generator equipment at Ripon Cogeneration Inc in Ripon, Calif. He has been working with LM5000s for 25 years and has a wealth of experience in O&M of both water- and steam-injected engines. Chuck was in the US Air Force (Viet Nam vet) and afterward completed junior college and four years of millwright training before becoming a certified welder.

LM6000

Bryan Atkisson

Bryan is the O&M Supervisor for four LM6000 peakers owned by the City of Riverside, Calif. The Marine Corps veteran has more than a decade of experience operating and maintaining LM6000s and was involved in the construction and commissioning of the four Riverside units. He has been a WTUI LM6000 session chair since 2007.

LM6000

David Merritt

Board Member

David recently joined Kings River Conservation District, where he manages the organization's LM engine and hydro assets. Previously, he spent 19 years in the O&M groups of GWF Power Systems/GWF Energy LLC. There David had responsibility for the maintenance of LM peakers and a solid-fuel-fired powerplant. Prior to GWF, he served in the US Navy as an aviation electrician.

LMS100

Don Haines

Board Member

As Plant Manager at Wood Group Power Operations' Panoche Energy Center, Don is in charge of four LMS100s. Before joining Wood Group, he worked at the City of Santa Clara for more than 18 years, serving the city's generation assets in technical and management capacities. Before moving to Santa Clara, Don served for six years on the USS Ingersoll.

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A meeting to remember

The 20th Anniversary Conference of the Western Turbine Users Inc, Mar 14-17, 2010 at the San Diego Convention Center, celebrated in fitting style the group's two decades of service to owners and operators of GE aeroderivative gas turbines on land and at sea. There was an ice sculpture, live music, and fireworks to accentuate the fine food and outdoor dinner overlooking San Diego Bay.

The weather gods showed great respect for this tight-knit group of engineers and technicians, which is more a brotherhood than a traditional gas-turbine user organization. Alumni, like Ernie Soczka, the group's first chairman of the board, now in semi-retirement, traveled halfway across the country to visit with old colleagues and recall the organization's accomplishments. In fact, more than half of the individuals named on WTUI's Honor Roll for outstanding service (p 24) were in attendance.

The San Diego meeting marked the 20th anniversary of the group as an incorporated entity. It really began several years earlier with a handful of users attending informal luncheon meetings. But by 1990 attendance had grown to about 150 participants and the decision was made to formalize the organization with regular bylaws and membership procedures.

Jim Hinrichs, today VP of operations for Fort Chicago Energy Partners LP, was elected the first WTUI president, a position he held for 17 years. Other founding members who were present at last year's celebration included Mike Raaker, Jack Dow, Jim Bloomquist, and Brian Hulse.

If you have never participated in a Western Turbine meeting, Sal DellaVilla, CEO of Charlotte-based Strategic Power Systems Inc, told the editors, it's difficult to imagine how much you have missed. His advice for first-timers: Attend the sessions and listen carefully, meet fellow users at social events, speak with vendors at the expo, and you'll leave Palm Springs with more knowledge than you ever thought you could absorb.

WTUI veterans know that the success of this conference did not just happen by accident, DellaVilla continued. The word "serendipity" does not apply to WTUI. Its success has been built on the efforts of dedicated people with vision and a long-term commitment to their industry—and to each other. Now, after two decades of hard work by an all-volunteer organization, a meeting that started out in plant conference rooms has been transformed into a world-class conference that attracts a global audience.

From the beginning, DellaVilla recalled, "the two and a half days of breakout sessions covering each LM product line have provided the foundation for sharing knowledge and solving problems. These invaluable sessions provide the opportunity for users to openly discuss installation and commissioning issues, O&M concerns, lessons learned, and the opportunities for plant improvements."

Technical discussion covers the engine, package, controls, and all

ancillary systems. The intent is to share and document, thereby creating a history through the notes of relevant and meaningful "real life" experiences to help the operating community improve as a group.

WTUI conferences continue to grow annually. Last year, attendance was an extraordinary 1219—342 above the previous record established in 2009. The nearly 200 exhibitors occupied almost 250 standard trade-show booths. Equally important is that each meeting attracts a significant percentage (30% or more) of new user and vendor attendees who bring fresh ideas and perspective vital to long-term health.

Continuing growth testifies to the Board's hard work and to the increasing value of, and need for, face-to-face information exchange. Such success, however, brings change and occasionally presents very real challenges to the relatively small group of volunteers who make the Western Turbine Users happen.

Photos by Joanna Herr Photography


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ACRONYMS TO REMEMBER

AGB—Accessory gearbox (also called the transfer gearbox)

AVR—Automatic voltage regulator

CCM—Condition maintenance manual

CCR—Customized customer repair

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)

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

LPT—Low-pressure turbine

LPTR—Low-pressure turbine rotor

LPTS—Low-pressure turbine stator

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

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

VBV—Variable bleed valve (not on LM2500; just LM5000 and LM6000)

VIGV—Variable inlet guide vanes

VSV—Variable stator vane

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CEMTEK Environmental Inc
CSE Engineering Inc
Express Integrated Technologies LLC
GasTOPS Ltd
Global Air Filtration
IHI Inc
JAD Chemical Co/GMS Industrial Supply
MTU Maintenance Berlin-Brandenberg GmbH
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Rochem Technical Services USA Ltd
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EXHIBIT HALL

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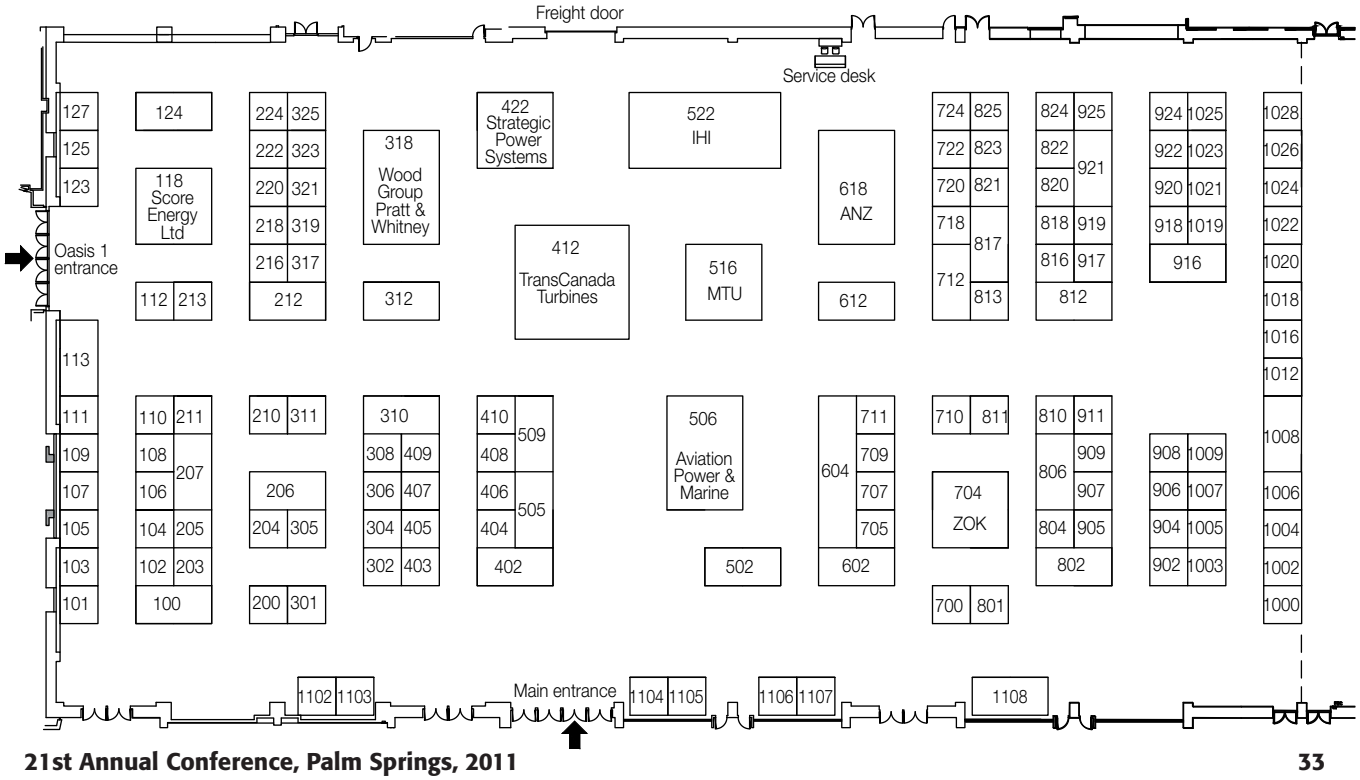
Company	Booth
GE Energy	310
Global Air Filtration	305
Global Industrial Solutions	200
Global Trade Media	902
Goodrich Corp	105
Groome Industrial Service Group	1003
Hach Co	1025
Haldor Topsoe Inc	1021



Company	Booth
Harco Laboratories Inc	100
HEICO Parts Group	920
Hill Brothers Chemical Co	409
The Hilliard Corp	410
Horiba Instruments Inc	108
HPI LLC	216
Hydranautics	1024
HY-PRO Filtration	1022
IHI Inc	522
IMR Test Labs	109
Integral Cables Inc	205
Integrated Turbomachinery Inc	925
Interlink Power Systems Ltd	718
Iris Power LP	222
JAD Chemical Co/GMS Industrial Supply	505
Jet Aviation Specialists Inc	306
Johnson Matthey plc	1028
Kellstrom Industries	212
Kobelco EDTI Compressors Inc	924
Liburdi Turbine Services Inc	820
Maxim Group	909
Maximum Turbine Support	113
Meggitt Control Systems	806
MTU Maintenance	516
Nalco Co	1023
National Electric Coil	825
National Mechanical Services Inc	110

Company	Booth
Nationwide Environmental Solutions	1019
OEM Parts Network LLC	712
Olympus NDT Inc	802
Pacific Industrial Systems Technology	812
Pall Corp	111
Parker Hannifin Corp	402
Petrochem Insulation	720
Petrotech Inc	1018
The PIC Group Inc	206
PME Babbitt Bearings	211
Pneumafil Corp	722
Power and Process Equipment Inc	102
Power Engineers	403
Power Plant Services	406
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105	Goodrich Corp
106	Diesel & Gas Turbine Worldwide
107	BASF Corp
108	Horiba Instruments Inc
109	IMR Test Labs
110	National Mechanical Services Inc
111	Pall Corp
112	Avista Technologies Inc
113	Maximum Turbine Support
118	Score Energy Ltd
123	Gas Turbine Controls Corp
124	Wood Group Gas Turbine Services
125	TVS Filters
127	Caldwell Energy Co
200	Global Industrial Solutions
203	Stork H&E Turbo Blading Inc
204	Callidus Technologies by Honeywell
205	Integral Cables Inc
206	The PIC Group Inc
207	Donaldson Company Inc
210	VIM Technologies Inc

Company	Booth
Solberg Manufacturing	302
SSS Clutch Co	1108
Standard Aero	101
Stork H&E Turbo Blading Inc	203
Strategic Power Systems Inc	422
Sulzer Turbo Services	1006
Sweeney	724
T2E3 Inc	323
Tarco Systems Inc	405
Taw Miami Service Center Inc	907
Tech Development Inc	710
Teledyne Monitor Labs Inc	1016
Tezzco Inc	711
Thermo Fisher Scientific Inc	1012
Thomas Construction Resources	1000
TIC/Kiewit	404
TransCanada Turbines	412
Turbine Air Systems Ltd	213
Turbine Technics Inc	509
Turbine Technology Services Corp	905
Turbo Machined Products LLC	311
TurboCare	804
TVS Filters	125
US Petrolon Industrial Inc	810
VIM Technologies Inc	210
Willbros Group Inc	911
Wood Group Gas Turbine Services	124
Wood Group Pratt and Whitney	318
Zokman Products Inc	704

Booth	Company
211	PME Babbitt Bearings
212	Kellstrom Industries
213	Turbine Air Systems Ltd
216	HPI LLC
218	Electrical Maintenance Consultants
220	Custom Instrumentation Services Corp
222	Iris Power LP
224	Component Repair Technologies Inc
301	ProEnergy Services LLC
302	Solberg Manufacturing
304	AGTServices Inc
305	Global Air Filtration
306	Jet Aviation Specialists Inc
308	CEMTEK Environmental Inc
310	GE Energy
311	Turbo Machined Products LLC
312	Advanced Filtration Concepts
317	Precision Engine Controls Corp
318	Wood Group Pratt and Whitney
319	Detector Electronics Corp
321	Edison ESI
323	T2E3 Inc
325	Danfoss Nessie
402	Parker Hannifin Corp
403	Power Engineers
404	TIC/Kiewit
405	Tarco Systems Inc
406	Power Plant Services
407	Rochem Technical Services USA Ltd

Booth	Company
408	Ammonia Process Safety Management
409	Hill Brothers Chemical Co
410	The Hilliard Corp
412	TransCanada Turbines
422	Strategic Power Systems Inc
502	A & I Accessory Ltd
505	JAD Chemical Co/GMS Industrial Supply
506	Aviation Power & Marine Inc
509	Turbine Technics Inc
516	MTU Maintenance
522	IHI Inc
602	Airgas Specialty Products
604	Aeroderivative Gas Turbine Support Inc
612	Avio
618	Air New Zealand
700	GasTOPS Ltd
704	Zokman Products Inc
705	ECT Inc
707	ReGENco LLC
709	SJ Turbine Inc
710	Tech Development Inc
711	Tezzco Inc
712	OEM Parts Network LLC
718	Interlink Power Systems Ltd
720	Petrochem Insulation
722	Pneumafil Corp
724	Sweeney
801	Quality Industrial & Marine
802	Olympus NDT Inc

Booth	Company
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806	Meggitt Control Systems
810	US Petrolon Industrial Inc
811	Risk Management Professionals Inc
812	Pacific Industrial Systems Technology
813	QinetiQ Ltd
816	Gas Turbine Efficiency
817	AHM Associates
818	Combined Cycle Journal
820	Liburdi Turbine Services Inc
821	Dees Fluid Power
822	Bremco Inc
823	American Air Filter
824	Braden Manufacturing LLC
825	National Electric Coil
902	Global Trade Media
904	BP/Castrol
905	Turbine Technology Services Corp
906	DRB Industries LLC
907	Taw Miami Service Center Inc
908	The Avogrado Group
909	Maxim Group
911	Willbros Group Inc
916	Esterline Sensors Services/Weston
917	ChemTreat Inc
918	EmeraChem LLC
919	Delta Air Quality Services Inc
920	HEICO Parts Group
921	Rhinestahl Corp
922	Duct Balloon/G R Werth & Associates
924	Kobelco EDTI Compressors Inc
925	Integrated Turbomachinery Inc
1000	Thomas Construction Resources
1002	ARB Inc
1003	Groome Industrial Service Group
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1005	Cormetech Inc
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1007	Camfil Farr Power Systems
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1009	SICK Mahihak Inc
1012	Thermo Fisher Scientific Inc
1016	Teledyne Monitor Labs Inc
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1019	Nationwide Environmental Solutions
1020	Arrow Products Support
1021	Haldor Topsoe Inc
1022	HY-PRO Filtration
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1024	Hydranautics
1025	Hach Co
1026	Advanced Turbine Support Inc
1028	Johnson Matthey plc
1103	Airgas West
1104	Express Integrated Technologies LLC
1105	Brush Turbogenerators
1106	CSE Engineering Inc
1107	Puretec Inc
1108	SSS Clutch Co

Six raffles at Sunday evening reception

User members are urged to keep a sharp ear Sunday evening during the welcome reception from 5:30 to 8:30. A special raffle will be conducted at the top and bottom of every hour (users only!), beginning at 6 pm. Here's the lineup of prizes:

- 6:00 Portable hard drive
- 6:30 Kindle eBook
- 7:00 GPS
- 7:30 Blu-ray Player
- 8:00 Wii
- 8:30 Netbook

Bundy Generating honors in CCJ's 2011

As the WTUI program went to press, Lincoln Electric System's Terry Bundy Generating Station was in contention for the prestigious Best of the Best award for Safety Equipment & Systems in the 2011 Best Practices judging (Fig 1). Bundy was head to head with two other plants for top recognition after five of the nine judges had posted their scores.

Safety Equipment & Systems is one of eight awards categories in this year's Best Practices program, which was launched in late 2004 by the COMBINED CYCE Journal. Goal of the program is to recognize the valuable contributions made by plant staffs—and headquarters engineering and asset-management personnel as well—to improve the performance of GT-based generating facilities.

Judging of entries is by members of the CTOTF Leadership Committee (www.ctotf.org), chaired by Bob Kirn of Tennessee Valley Authority. Presentation of awards will

1. Terry Bundy Generating Station, rated a nominal 170 MW, is located in Lincoln, Neb

WTUI officers welcome, thank exhibitors

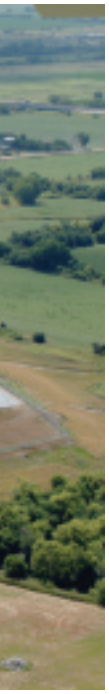
Chuck Casey and Bill Lewis, the two officers of the Western Turbine Users Inc responsible for organizing the exposition, welcome and thank the exhibitors and sponsors for their participation on behalf of the organization's leadership. Casey said 143 companies (as of March 1) would be on hand in the Convention Center to display and explain their products and services from 5:30 pm to 8:30 Sunday evening and from 8:30 am to noon and 1 pm to 5:30 both Monday and Tuesday. Casey added that there are 16 "new" exhibitors this year.

Station vies for top Best Practices judging

be at CTOTF's Spring Turbine Forum at the PGA National Resort in Palm Beach, April 10-14.

Announcement of the award recipients will be made in CCJ ONsite (visit http://combinedcyclejournal.wordpress.com) on April 12. For more information on the Best Practices program and how to enter the 2012 competition, access www.combinedcyclejournal.com/bestpractices.html.

Terry Bundy Generating Station, formerly known as Salt Valley Generating Station, is the most successful GE aero installation in terms of numbers of Best Practices awards. In 2009, the facility, managed by Bradley Hans, PE, a member of the WTUI Board of Directors, received a Best Practices Award in O&M and a Best of the Best for Environmental Stewardship. It is the only LM-powered plant to have received a Best of the Best award. Details on each of plant's entries follow.



2011 BEST PRACTICES ENTRY

Ammonia-tank leak-suppression system

Challenge. The Terry Bundy Generating Station is a four-unit combined-cycle facility which uses selective catalytic reduction to control NO_x emissions from three LM6000s. SCR is a post-combustion control process in which anhydrous ammonia is injected in the exhaust gas, upstream of the catalyst, to convert NO_x emissions to nitrogen and water. The site's air permit restricts NO_x emissions to 3.5 ppmvd (30-day rolling average).

During the plant's last Risk Management Program review, the potential for a catastrophic spill from a 12,000-gal ammonia storage tank was identified as a major concern. A large release of ammonia has the potential to impact facility staff as well as surrounding residences.

Solution. Plant personnel evaluated the potential for installing an ammonia-spill remediation system to reduce the impact of a tank breach. After reviewing remediation options, a water spray system was identified as the

2. Spray system would minimize the size and concentration of the ammonia cloud that could be released in the unlikely event of a breach in the storage tank

most economical solution. It has 34 nozzles configured on six lines surrounding the tank to provide 75 ft^2 of spray coverage. The system was designed to NFPA 15; spray density is 0.25 gpm/ft^2.

The spray system requires a nominal minimum flow of 700 gpm at 120 psig, which is supplied by the fire pump. Multiple ammonia detectors monitor the site's various ammonia systems and are used to alert plant operators to any releases. As soon as an operator confirms a major ammonia release from the storage tank, the spray system would be activated manually to minimize the size and concentration of the resulting ammonia cloud. Fig 2 shows the final flow test.

Results. Successful demonstration of the system significantly reduces both risk to plant personnel and the potential for offsite exposure. With the successful demonstration, the utility has budgeted for 2011 the installation of similar systems at the Rokeby Generating Station. It has two large ammonia systems associated with turbine inlet air chillers.

2009 BEST OF THE BEST RECIPIENT

Water-use study spurs conservation projects

Challenge. Reducing effluent pumping and treatment costs and wastewater streams provides economic and environmental relief. The Terry Bundy Generating Station, constructed in 2003, was designed to use effluent from a municipal wastewater treatment plant as its main water source. The peak water usage for the facility is 1.9 million gpd.

In 2007, more than 94 million gal of effluent was chlorinated and pumped the two miles from the water treatment plant to the generating station; over 41 million gal of powerplant wastewater was returned to the municipal treatment plant. Water-plant effluent is treated to varying degrees of purity and that process creates wastewater streams, so any reduction in plant water use reduces municipal-plant effluent supply requirements and the associated pumping and treatment costs as well as wastewater processing costs.

Solution. To reduce effluent and wastewater volumes the plant initiated a water-use study with the purpose of identifying potential water conservation, reuse, or recovery opportunities. Four water projects were identified as viable:

- Recovery of condensate from the cooling of GT inlet air.
- Reuse of water-treatment-system RO flush water.
- Recovery of water used to cool the condensate polishing system pump.
- Reuse of probe run-off water from RO and chlorine analyzers.

Results. Nearly 1000 gal/hr of condensate can be generated by the LM6000 inlet-air cooling system during a hot, humid summer day. This water is of very high quality but was being diverted to a storm water drain. To make use of the condensate, plant staff designed storage tanks, pumps, and piping to recover it from the three combustion turbines serving the site.

The high-quality water is injected into the steam-turbine cooling-water loop. Since cooling-tower evaporation is the largest use of water onsite, recovery of condensate reduces both the plant's effluent requirements and wastewater discharges: Cooling-tower water quality is improved and blowdown decreased. Condensate temperature also is lower than that of the steam-turbine cooling-water loop, thereby improving condenser performance.

The plant's water treatment system uses reverse osmosis (RO) which requires periodic flush/rinsing of the filters with high-quality deionized water. Up to 13,000 gpd of rinse water was being discharged to the wastewater drain. This water is of relatively good quality (much better than the effluent), therefore it was returned to the "medium" quality service-water storage tank.

By recovering and reusing the 4.7 million gal/yr of rinse water the plant does not have to send it back to the wastewater treatment plant for processing and reduces effluent pumping and treatment requirements for a total annual savings of over $30,000.

A steam-turbine condensate conditioning system recently was installed. It includes a gas-transfer membrane system and a vacuum pump. The water use study identified a discharge of approximately 4 gpm of high-quality condensate makeup water to drain for the vacuum pump sealing water. Plant personnel designed and installed a recovery tank, pump, and piping that allows this water to be returned to the condensate storage tank, saving 36,288 gal/yr of condensate.

The water treatment system neutralization basin was being dumped into the wastewater system. The discharge is normally just probe run off water, mainly from the RO and chlorine analyzers, etc. The plant owner is designing a system to send approximately 7500 gpd back to the main effluent storage tank.

2009 BEST PRACTICES RECIPIENT

Proper layup reduces corrosion, enables faster startups

Challenge. The cycling nature of the Terry Bundy Generating Station posed an array of problems related to corrosion, operating and layup chemistry, and layup procedures. Oxygen pitting and general corrosion that occurred in plant equipment during shutdowns were traced to less-than-ideal layup practices and to the initial system design, which allowed air-saturated makeup water to enter the HRSGs.

This resulted in elevated iron levels in the evaporator water during operation which could lead to deposition—undesirable because of efficiency loss and potential for under-deposit corrosion. Oxygen pits could lead to leaks, corrosion fatigue (CF), or stress corrosion cracking (SCC).

Also, it took a long time to achieve the permissible main-steam cation

conductivity (CC) limit during startups because of air-saturated makeup; the condensate-pump discharge (CPD) CC limit rarely was achieved, even after several hours of full-load operation. Additionally, CPD dissolved oxygen (DO) levels were as much as two to 10 times higher than recommended during operation and were near saturation when makeup was supplied to the HRSGs during shutdown. A reducing agent (oxygen scavenger) could not be used to remove the DO because of single-phase FAC concerns.

Finally, capping a wet HRSG with nitrogen from industrial-type cylinders became cost- prohibitive. A comprehensive improvement program was needed to address: (1) oxygen pitting and general corrosion in the HRSGs, steam-turbine LP blades, and condenser hotwell; (2) startup-time improvement by achieving steam purity more quickly; (3) cycle chemistry improvement.

Solution. These problems were addressed over a few years using a multi-pronged approach that followed these three basic principles as described in "Cycle Chemistry Guidelines for Shutdown, Layup and Startup of Combined Cycle Units with Heat Recovery Steam Generators," published by EPRI in 2006:

1. Maintain the same electro-chemistry of HRSG water during operation and during wet layups.
2. Keep air away from water and/or avoid water stagnation during wet layups.
3. Protect equipment (the steam turbine, for example) from moisture ingress during dry layups.

The solutions that satisfied these principles included the design and installation of equipment, optimization of chemistry, modification of operating procedures, and development of layup guidelines. Equipment installed included a (1) recirculation system (RS) for each HRSG's pressure section, (2) nitrogen generator (NG, Fig 3), (3) dehumidification system (DHS, Fig 4), and (4) gas-transfer membrane skid (GTMS, Fig 5).

The RS system allows water to be pumped from the economizer section to the evaporator section of each pressure system and includes a baffle bypass in each drum to ensure flow through the evaporator tubes (Principle 2, above).

The NG, which replaced the pressurized cylinders and paid for

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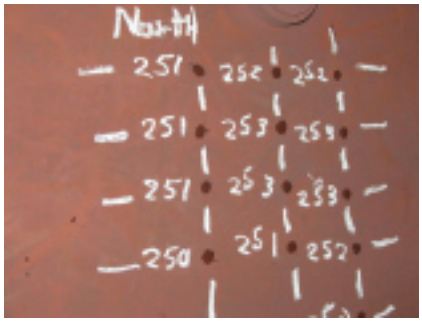
3. Nitrogen generator skid saves cost of rented, vendor-supplied compressed N_2 bottles (above left)

4. Desiccant wheel dehumidifier prevents pitting of LP steam-turbine blades which could lead to CF or SCC (above)

5. Gas-transfer membrane skid deoxygenates makeup water as it enters the steam cycle (left)

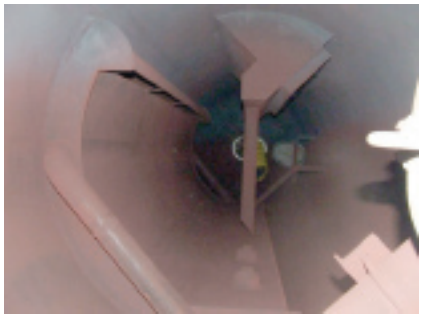
itself in less than a year, supplies 99.9% pure nitrogen at its design flow rate. Nitrogen is used to cap the HRSGs while pressure decays between runs (wet layup), and it is used to purge and blanket the HRSGs when they are drained for extended layups (Principles 2 and 3). The GTMS removes DO and CO_2 from makeup water, where DO is decreased from 8

6. Oxygen pitting in HP steam drum found during inspection in 2005



7. "Old" pits, no longer active, have been repassivated

8. LP baffle reveals protective oxide coating and no signs of FAC or oxygen pitting



9. Preferred salmon-colored protective oxide coating also is evident in HP drum

ppm to less than 5 ppb (Principle 2).

The DHS is used to circulate warm, dry air through the LP section of the steam turbine to the condenser hotwell for shutdowns longer than three days (Principle 3). The DHS maintains a relative humidity inside the turbine/hotwell of less than 15%. This reduces the chances for hotwell corrosion and turbine-blade pitting, which can lead to SCC and CF. During operation, the feedwater chemistry is AVT(O) where only ammonia is added to maintain a pH of 10. Going into wet layups, this chemistry is maintained and absolutely no reducing agent is added (Principle 1).

It was SOP to break vacuum for an overnight shutdown; however, this was changed to maintain con-

denser vacuum overnight to improve startup time and chemistry (Principle 2). Finally, a decision tree based on shutdown duration was developed to help plant operators choose between system layup options.

Results.

1. No oxygen pitting was identified during the most recent HRSG inspection last spring and a salmon-colored protective oxide characteristic of oxidizing treatments was prevalent. Inspections in years prior to the upgrades indicated a good deal of oxygen pitting and general corrosion (Figs 6-9).

2. The improvements have led to a startup time savings of about 60 minutes from wet layup. The ability to be able to safely keep the HRSGs in a wet layup—instead of dry—for long periods (months), because of the NG, GTMS, and RS, saves six to eight hours from dispatch to full load. Depending on natural-gas prices, this reduces the startup cost by up to $45,000.

3. Main steam CC improved from 0.35 to 0.1 µS/cm. CPD CC improved from 0.45 to 0.3 µS/cm and CPD DO from more than 50 ppb to less than 10 ppb. Finally, suspended iron in evaporator water was cut by more than half, reducing the risk of deposition and, therefore, under-deposit corrosion.

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