The GE 7EA User Group met in early November in San Antonio, Texas. Some 100 users gathered to discuss all things related to the 85.1 MW MS7001EA turbine, which can accommodate a wide range of fuels, including natural gas, distillate oil, naphtha, crude oil and syngas. With more than 900 units in service, the 7EA/EA fleet has accumulated over 20 million of hours of service.

Battery health and longevity, lube oil varnish, generator reliability, filter house best practices, Dry Low NOx (DLN) and combustor refurbishment were just a few of the topics under review. User discussion and questioning was encouraged by Pat Myers, plant manager at AEP’s Ceredo Generating Station in Huntington, West Virginia, and a member of the 7EA User Group steering committee.

**Eliminating varnish**

The event kicked off with a day focused on reliability. Initial talks centered on a major turbomachinery issue — varnish.

David Kirkwood, Business Development Manager for Insight Services, spoke for much of the first morning on the importance of proper lubrication maintenance. He covered the basics of oil analysis testing and advanced fluid study beyond routine analysis, such as the analyses of varnish potential and filter debris.

Dow Chemical followed with a possible solution to varnish issues. Instead of using mineral oils or Polyalphaolefin (PAO) synthetic oils, which are both hydrocarbon-based, the company is promoting Polyalkylene Glycol (PAG) synthetic turbine fluids as a non-varnishing lubricant for gas and steam turbines. This approach has been used for years in metal-working fluids, fire resistant hydraulic fluids, compressor and gear oils, and now catching the eyes of the turbomachinery sector, said Govind Khemchandani, Senior Technical Specialist at Dow.

High temperatures are believed to be one of the key factors leading to oxidation, said Khemchandani. Petroleum-based oils and synthetic hydrocarbons degrade at high temperatures due to oxidation, which creates decomposition byproducts of high molecular weight and the agglomeration of salt contaminants. This is what forms an insoluble varnish that adheres to surfaces. “Varnish leads to trips,” he said. “Yet traditional tests are incapable of detecting the onset of varnish.”

PAGs, on the other hand, are less likely to produce varnish. With PAGs, every third atom is oxygen, and this provides polarity that promotes their non-varnishing capability. With PAGs, degradation products may exist, but they do not agglomerate and remain in solution rather than being deposited on metal surfaces as a varnish. “PAGs also have a lower coefficient of friction than hydrocarbons,” said Khemchandani.

He made the distinction between foaming of lube oil and aeration. The former is not an issue, he said, as the foam dissipates. Aeration, on the other hand, means that micro-bubbles remain trapped within the fluid and this heightens oxidation of the lube oil.

“PAG fluids can absorb water without degradation,” he said. “Hydrocarbon lubes can’t.”

PAGs, it turns out, can absorb significantly more water, at least 7,500 ppm without issues compared to 500 ppm for conventional mineral oil-based turbine lubricants.

Since 2007, Dow Chemical has converted eight gas turbines to the use of PAGs. All fluid monitoring conditions track well. The “last chance” filter showed no gelling, deposits or varnish after three years of continuous use in GE 7 FA gas turbines.

Khemchandani advised users to clear their systems before the switch, to minimize residual contaminants and pre-existing varnish. This approach has been applied by Dow to four sites using a variety of gas turbines. (See page 34 for more on varnish)

Some sessions dealt with rotor breakage and reassembly during outages, while others delved into the intricacies of the 7EA exhaust system. W. Howard Moudy, Director of Service Management for National Electric Coil, however, concentrated upon generator reliability.

The primary factors affecting reliability, he said, include the unique design characteristics of each machine, its age and condition, history, operational and operator actions (cycling, loading, trips, restarts, synchronous condensing, motoring, and so on), as well as environment, external events and acts of God.

The smart approach is to formulate a maintenance plan and carry it out systematically. “A lot of people work out a fine maintenance plan and then file it away,” said Moudy. “A great plan is worthless if you never execute it.”

**Generator concerns**

He also said that generators have changed dramatically over the last 30 years. Generator insulation systems have shifted from asphalt to polymer systems, and coil geometry has evolved. The generators are being cycled more, and they are producing more power out of the same footprint. These changes have lead to increased incidences of some generator concerns such as partial discharge, spark erosion, and stator end winding vibration, looseness, and resonance issues.

Moudy expressed that some aspects of Reliability Centered Maintenance (RCM) are more applicable or valuable than others but certainly some aspects are well worth implementing. For instance, many users only consider one failure pattern — years of dependable service followed by the onset of deterioration and end of life.

RCM, on the other hand, describes six possible patterns of failure. Moudy found the Bell Pattern most illuminating because it better illustrates fleet data patterns with some early failures followed by a long period of reliability then late in the cycle, increasing failures.

He advised users not to get so wrapped up in methodology that they forget the basics: Starting with general characteristics (name plate) and the operational characteristics and idiosyncrasies of each generator. Make the best use of online monitoring tools for temperature, vibration, and other characteristics. A visual inspection by experienced personnel is in most cases the most cost effective tool. Findings should be documented in the outage report and any areas of concern investigated further.

The importance of keeping accurate and thorough records was pointed out
along with the need for trending key information. Raw information is helpful to understand the past or where you may be, but trended information offers great insight into where you are heading.

When generators are manufactured, the OEMs usually retain and rarely share specific manufacturing data that are necessary for other companies to be able to address higher level maintenance, repair, rewind, overhaul, and uprate functions. Shidler suggested that when units are opened up, owners should consider giving access to companies (other than the OEM) to collect data. By doing so, owners are no longer tied to just one source, the OEM, and they also will benefit from access to generator technical solutions other than just what the OEM has to offer.

**More source materials**

On the education side, the talk laid out a variety of places that users can go to learn about their machines such as vendors, manuals, instruction book, past outage reports, trended information, user groups, technical papers, conferences, IEEE and websites.

Following Moudy’s mantra about looking often, Rod Shidler of Advanced Turbine Support, outlined his company’s borescope findings based on the past year’s inspections — an annual feature at the 7EA user meeting.

He took Moudy’s message a step further by saying that it was a mistake to rely only on vibration as an indicator of machine health. By the time those vibrations are apparent, it may already be too late to avoid major damage.

Most users do at least an annual borescope inspection, said Shidler. If you run turbines, you need to look at them. “If you live by vibration, you will die by it.”

Shidler’s 7EA report covered the clashing of stator vanes and rotor blades as a major issue; instances of inlet guide vane (IGV) damage; shim migration; R17 blade movement; compressor rotor blade to case rubs, leading to liberations; and cracking, R2 tip liberation, transition piece cracking, and more (Figure 1).

Shidler advised users to keep costs down and turbomachinery availability up: Do a shim map and monitor/trim the shims if they are migrating; check final cleanliness after an outage to prevent ingestion of tools and other material; if the 7EA is running a lot, switch from annual to bi-annual inspections; and perform a baseline inspection of new parts and then again a month before warranty expires to avoid the discovery of issues when the OEM is no longer accountable.

“The Achilles’ heel is the compressor, where we are seeing a lot more clashing in the 7EA fleet,” said Shidler. “Therefore, it is wise to put your maintenance dollars where they are most needed — by looking often at the compressor.”

Several talks centered on the combustor — a more important issue as the U.S. Environmental Protection Agency continues to choke down NOx emission limits. Jeff Benoit of PSM briefed users on the potential impact of the new Cross State Air Pollution Rule (CSAPR) legislation, aimed at reducing heavy levels of ozone that are apparently being transported from the Midwest into the Northeast. After some back and forth, power producers have been given until 2014 to be in compliance with published NOx quotas. “This seems to impact peakers the most,” said Benoit, “especially mature Frame B & E machines.”

Instead of installing an SCR that may prove to be costly and force significant facility redesign, he suggested a combustor upgrade. PSM offers its ultra-low emission LEC-III combustion system, which can achieve sub-5ppm of NOx over the premixed combustion lead range with low CO. This is achieved by improved cooling and mixing features, a pilotless secondary fuel nozzle and a transition piece redesign.

Benoit, recommended a combustion inspection interval of 24,000 hours or 900 starts. To date, over 40 GTs globally are equipped with this technology and have run up a combined 800,000 fired hours/90,000 starts.

Other vendors had different ideas. Mike Gabriel of Gas Turbine Efficiency (GTE; now part of Wood Group) suggested tuning the DLN combustor to ensure emissions compliance and to extend hardware life. Further, tuning has value when a turbine experiences significant changes in ambient conditions, shifts in fuel composition, or when new (or refurbished) combustion hardware is installed (as well as power augmentation), he said. Types of tuning included liner tuning and software tuning.

He provided a chart on the relationship of NOx and CO emissions limits. (Figure 2)

“In tuning, you are balancing combustor dynamics, flame stability, NOx and CO,” said Gabriel. At base load, it is mainly NOx that is being tuned by adjusting the fuel split between the primary and secondary nozzles. In that case, CO is typically not much of an issue. At part load, however, adjustments for CO are typically also required.

The combustor theme continued with a joint presentation by Robert Farthing of TransAlta Services and John Bottoms of Liburdi Turbine Services. In 2011, TransAlta had three GE 7EAs operating at two co-gen plants in Alberta and Saskatchewan (Canada). These units operated on natural gas under base load (2,035°F firing temperature) conditions with DLN1 combustion systems.

Since they came online in 1999, TransAlta performed combustion inspections on a 12,000-hour basis. One of the combustion sets achieved five service intervals with additional life remaining as a result of the service strategy used under the terms of the agreement with Liburdi Turbine Services. “We have far exceeded OEM recommended repairs for the TP, liner and fuel nozzle assemblies by refurbishing them in this manner,” said Farthing.

To monitor and predict component life of components, Liburdi removes sample material in a non-destructive manner and examines metallurgically the base material structure, and the coating performance aspects. This is done, for example, at hot spots on the TP or liner to determine the extent of oxidation and aging. “If the coatings are lasting well and the base microstructure is fine, then we can refurbish,” said Bottoms. “We also add advanced coatings such as aluminate coatings to reduce oxidation levels where possible.”

GE, too, got in on the DLN act. GE was allocated an entire afternoon of closed-door, user-only sessions at the conference to go over 7EA-related TILs, clashing, NERC testing requirements, controls upgrades, rotor life management, and the latest component updates for the 7EA. This included data on DLN, high-load premix transfer and an enhanced Stage 2 bucket.

**Fuel system upgrades**

The final morning of the 7EA User Group event continued the rapid pace, with valve automation and fluid detection on the agenda. Paul Boeckerman, a Sales Engineer at Young & Franklin of Fort Collins, CO, began with a short presentation on fuel system upgrades. He explained some of the reasons for varnish problems in the Frame 7E and F fleet.

“By sharing the lube oil sump for hydraulic control oil duty, varnish created by the bearings gets into the hydraulic controls,” said Boeckerman. “At the same time, these turbines rely on sensitive hydraulic servo control valves for the fuel valves and...
Young & Franklin developed a way to eliminate the servo control valves for many fuel valves by leveraging electrically powered actuators that use no control oil. By then installing a separate hydraulic power unit with its own sump to support the remaining hydraulic equipment no lube oil varnish can get to the controls. The electric actuators and hydraulic power units (HPUs) have been uniformly successful on more than 100 CTs for more than 10 years.

On the maintenance side, Young & Franklin recommends teardown inspections at 24,000 equivalent operating hours to look for signs of accelerated wear, and a time-zero overhaul to as-new warranty condition at 48,000 equivalent operating hours.

Schuyler McElrath, of Jansen’s Aircraft Systems Controls, (JASC), followed with a harrowing story of a water-leak incident that damaged turbomachinery to the tune of $14.5 million. JASC has developed a smart fluid monitor to prevent such occurrences. Customer programming determines the system response. The flow can be shut off at .1 gpm increments up to 1 gpm. Alerts are sent to the operator. “This is an easy way to prevent thousands of gallons of water from dumping into expensive systems,” he said.

**Air filter roundtable**

The last afternoon of the 7EA User Group featured a lively roundtable with representatives from WL Gore, Donaldson, Pneumafil, American Air Filter, Braden Manufacturing, Integrity Power Solutions, InletAir, TVS Filters, TDC Filters, Gulf Coast Filter and Camfilter Farr.

While Myers of the 7EA Steering Committee continually prompted users to ask questions during the three days of sessions, this was one forum where the entire room became animated. Question after question was fired at the filter manufacturers and distributors. Myers, though, was never far from the spotlight, recounting stories from his own experience.

One time, for instance, a leak had caused rust and paint to flake into the filter house which got into the machine. He also noted that filter houses are usually out of the way and hard to get to. “If you don’t put in stairs to the filter house, nobody will pay any attention,” he said. “You can buy the best filter in the world but if it isn’t sealed up tight, stuff will get through.”

Panelists handed out a heap of good advice related to filters, maintenance and saving money. If filters are not tightly installed, they are not sealing the filter house. If you can spin them, material will get into the compressor. Bolts need to be tightened and periodically replaced. Filter life depends on usage, number of annual hours and other factors.

Therefore, going by a set number of years is not always the best index — being conscientious with maintenance and inspection assures longer life. Pre-filters are generally advisable as they prevent large particles or insects from getting to the main filters. And if moisture is prevalent, a pre-filter, mist eliminator or coalescer should be deployed. Sub-micron particulate sticks to the media and won’t easily come out. Washing the filters doesn’t really work. At end of life, however, a spike in pressure drop will be observed.

Not surprisingly, High Efficiency Particulate Arrestor (HEPA) filters were a hot topic (Nov/Dec10, p. 18). Some users asked if they really needed them while others asked about trends. The general consensus was that Europe had already adopted HEPA and that this trend was taking root in North America.

One manufacturer said that not everyone needed the highest levels of filtration as that would drive up costs. Peakers, for instance, probably do not need to use HEPA, he suggested. If the environment is dirty or the compressor is fouling, though, it might be cheaper to install better filters than to suffer performance degradation, or add outages to clean the compressor.

For more information on the GE 7EA User Group or annual conference, visit http://ge7ea.users-groups.com/.
Crude oil–gas–water mixtures produced from wells are generally directed, through flow lines and manifold system, to a central processing and treatment facility normally called the gas–oil separation plant (GOSP). The first step in processing of the produced stream is the separation of the phases (oil, gas, and water) into separate streams. This takes place in mechanical devices known as two-phase gas–oil separators when the produced stream contains no water or three-phase separators when the produced stream contains water. Gas–oil separation carried out in these separators is recognized as the niche setting offered by the 7EA Users Group is a long-awaited event by power plant managers and gas turbine operators, whose capital investment in this type of equipment requires keeping up with the knowledge and best practices of companies like TTS. With an installed base of several thousand machines, the GE MS7001E/EA is an established workhorse of the electrical generating sector, thanks to its reliability, flexibility, emissions and efficiency. Most 7EA users have seen a drastic increase in operating hours over the past couple of seasons primarily due to lower fuel prices and efficiency of the operations of the oil and gas operations. Running of the operation will be less risky and more efficient. Efficiency of an oil and gas industry highly dependent on the success or the completion of several small project. According to research you need on ResearchGate. Running of the operation will be less risky and more efficient. Efficiency of an oil and gas industry highly dependent on the success or the completion of several small project. According to research you need on ResearchGate. The findings will be useful for local authorities, public transport providers, and community.