Expanding performance while resetting the clock on old assets

By Victor de Biasi

Advanced gas path upgrades coupled with model-based controls software can improve performance and value of old 9F and 9B/E gas turbine units.

GE has introduced separate technology upgrade programs for its large 50 Hz fleets of Fr 9B/E and Fr 9F-class gas turbine installations in service around the world.

Both programs combine hardware and software technologies to enhance power plant performance, operation and durability. And both incorporate advanced gas path upgrades (similar to the 7F upgrade GE introduced 2-3 years ago) designed to increase power output, efficiency and operational profitability of old units:

□ Frame 9F-3. Up to 6 percent more power, 2 percent higher fuel efficiency and 33 percent greater outage intervals (32,000 hours) for maintenance.

□ Frame 9B/E. Up to 3.8 percent more power, 0.9 percent higher fuel efficiency and 33 percent greater outage intervals (32,000 hours/1,300 starts).

□ Investment. Fully upgrading a 500MW plant could be worth over $500,000 annually in extra revenue and up to $1.25 million a year in fuel savings.

New controls software that go with gas path upgrading have been developed to help satisfy a growing variety of operational needs. “We are seeing huge value in combining hardware with software,” says Fintan Tuffy, General Manager, responsible for gas turbine fleet analysis and performance management services.

“Ten years ago, customers were just interested in output and efficiency. Now, depending on where you are in the world and what type of customer you are – whether a merchant, state-owned utility or cogen operator – you may be looking for slightly different results.”

Primary interest one day might be peak firing; another time it may be to bring down operating costs and extend maintenance intervals. Ultimately, the shared goal is to deliver technologies blended through a collaborative process between GE and owner-operators to identify customized solutions that best achieve desired outcomes.

Fr 9B/E program
GE refers to the improvement program for 9B/E-class gas turbines as a “LifeMax Advantage” platform (LMA) configured to reset the clock and significantly extend the life cycle of aging assets which typically average over 17 years in service.

“These units are coming to the end of their original design life, so we are really looking at life extension strategies,” notes Tuffy. “Owner-operators have access to a suite of upgrade solutions that will enable 9B/E-class gas turbines recapture lost performance and lower operating costs.”

LifeMax blends advancements in hot gas path components with OpFlex model-based controls software to increase power output, fuel efficiency and maintenance intervals. The portfolio of options includes:

- Dry Low NOx1+ combustion which allows operators to run their gas turbines up to 32,000 hours between scheduled overhaul maintenance intervals,
- broader suite of OpFlex controls which help expand operating profiles across all modes of power plant operation, and
- flange-to-flange replacement components for core engine upgrades including compressor and combustion systems.

Dubai Aluminium (Dubal) is the first GE customer for an LMA upgrade. In April 2013, Dubal installed an advanced gas path upgrade plus DLN1+ and OpFlex advance controls systems on one of three 9E gas turbine units.

This was carried out as part of a scheduled engine maintenance overhaul. Since its return to service, gas turbine output has increased by 3.4 percent (generating an additional 5,880kW) while fuel efficiency has increased by approximately 1.5 percent.

The other two 9Es are scheduled for this same upgrade when overhauled. Across all three units, the site expects to increase its output capacity by 17.64MW, reduce its fuel use by 1.5 percent, and extend major overhaul intervals to 32,000 hours (equivalent to almost an additional year of operation).
The extra power will be used to increase smelter production while also reducing operating costs. "Incorporating these new technologies into our power station is central to our long-term strategy of producing aluminum products as efficiently and cost-effectively as possible for our customers," says Tayeb Al Awadi, Dubal's vice president, power & desalination.

Dubal is also installing new OpFlex AutoRecover and Peak Fire software plus a Mark VIe controls upgrade to drive further output and efficiency site improvements while holding down overall maintenance costs.

AutoRecover, based on GE’s high-load pre-mix transfer technology, enables gas turbines to recover from lean-lean operation to pre-mixed operation without any change in load, typically in as little as 10-15 seconds. Project engineers explain that this capability can help avoid load interruption, emissions spikes and longer term maintenance costs.

OpFlex Peak Power technology enables operation at higher firing temperatures, without increases in emissions or combustion instability. It is expected that up to 8 percent additional output can be achieved on 9E-class gas turbines by installing the Peak Power option.

All five LMA options are scheduled for installation on Dubal’s second 9E gas turbine in November 2013, with installations on the remaining unit to follow in 2014.

Fr 9F-3 program
GE refers to the improvement program for 9F-class gas turbines as a “FlexEfficiency Advantage” platform (FEA) configured to expand gas turbine output, efficiency and operating windows.

Owner-operators can benefit from an extension of maintenance intervals and parts life through more durable hardware components and software technology that automate operational adjustments to reduce stresses on parts.

In addition to gas path upgrades, the FEA portfolio includes Dry Low NOx combustion technologies and a broad suite of controls software options that can expand the operational flexibility of F-class machines.

New features will be added in the future as a result of ongoing collaboration between GE and customers. For example, many 9F-3 gas turbine power plants today are running in cyclic operation. As a result, says GE, they are investigating how to start up faster and turn down to minimum loads at night.

Turkish power producer, Enka, recently placed the first order for GE’s 9f-class advanced gas path upgrades on 10 gas turbine installations (at Gebze, Adapazar and Izmir power stations) which, when completed, will deliver close to 150MW of additional capacity.

Enka will also lower its emissions footprint by retrofitting the gas turbine units with a Dry Low NOx (DLN)2.6+ combustion system upgrade. Installation of the technologies is scheduled to begin in late 2015, during the second major inspection of all ten units, with a targeted completion date of 2018 for the last one.

“The performance improvements this solution delivers to our plants will allow us to maximize the value of the energy we provide through power purchase agreements,” said Enka O&M Chairman Mr. Tahsin Kösem. “This collaborative effort with GE will also put our sites in a better position with more available power and flexibility for electricity markets with

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**Advanced Gas Path upgrades**

An AGP upgrade essentially involves applying the latest hot gas path technology to the three rotating and stationary sets of components in the hot gas path section – buckets, shrouds and nozzles – to improve gas turbine efficiency and output.

It includes the use of new materials that allow higher firing temperatures; as well as better cooling and sealing processes to minimize the energy wasted as a result of cooling.

Explaining the expansion to cover the 9F and 9E, Fintan Tuffy, General Manager, Fleet Analytics & Performance Management Power Generation Services GE Power & Water said: “We wanted to initially focus on our F technology, so we started with the 7F.

“With 900 units around the world, it is probably our single biggest fleet in our 60 Hz market. Now we are taking some of the lessons learned and some of the technologies from our 7F introductions and applying them to our 50 Hz equipment.”

Depending on gas turbine frame type and configuration, the AGP upgrade increases output of the 9F-3 by up to 6 per cent and fuel efficiency by up to 2 per cent. At the same time, maintenance intervals can be extended by up to 33 per cent or as long as 32,000 hours.

On the 9E, output increases up to 3.8 per cent and fuel efficiency by up to 0.9 per cent. Maintenance intervals can be as long as 32,000 hours with 1300 starts (extending outage intervals up to 33 per cent).

The upgrade is typically carried out during a major inspection or when the hot section of the machine is open. Here, the three rows of components would be removed and replaced with newer technologies.

The case for AGP upgrades in Europe and the Middle East is driven by the changing market conditions. With older fleets struggling to compete in a market where performance is key, the AGP upgrades will help the installed base compete in the market.
demand increases being forecasted across Turkey.”

Large data pool
As of September 2013, GE says it has achieved 100 million hours of operational data documented on its globally monitored gas turbine fleet of more than 1600 units.

The insights derived from analysis of this operational “big data” can be applied to help customers expand their earning power while reducing operational costs and risk.

As these “intelligent” machines communicate their operating statistics through an average of 100 physical sensors and 300 virtual sensors on each gas turbine, the GE team can help operators translate that information into actionable decisions.

Armed with these data-driven insights, says GE, operators can more effectively identify potential barriers before they occur, treat minor issues before they lead to catastrophic events, and dynamically adjust performance to improve efficiency and reduce parts wear and tear.

GE says it is tapping into knowledge gained from this data analysis to develop new technology breakthroughs, both hardware- and software-based, that enable customers to unleash more potential from their existing gas turbine and balance of plant assets.

Program engineers estimate that unlocking the full capacity of a 500MW power plant could be worth more than $500,000 annually in increased revenue, while a public utility could reduce its heat rate efficiency curve by 1 percent and save up to $1.25 million annually in fuel costs.

Performance advancements based in part on extensive data analytics of its global installed gas turbine fleet are being integrated into 9F-3 and 9E new gas turbines units, says GE. These platforms feature technology innovations, both hardware and software, derived from extensive data analytics of the GE fleet’s real-world operating data.

9F gas path upgrade. Power output of the 9F-3 can be increased by up to 6% and fuel efficiency by up to 2%.

9E gas path upgrade. Power output of the 9E can be increased by up to 3.8% and fuel efficiency by up to 0.9%.

Tracking center. GE’s Monitoring & Diagnostics Center in Atlanta, Georgia collects around 30,000 hours of operating data daily for storage and evaluation that is generated by more than 1600 gas turbines across the globe.