

Updating gas-turbine reliability, availability

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

Preparation by Strategic Power Systems Inc (SPS) for the CCJ's annual By the Numbers report normally begins with a careful look at ORAP® (Operational Reliability Analysis Program) performance metrics for aeroderivative (aero), "E" class, and "F" class technologies across all OEMs and a wide range of owner/operators. For 25 years, SPS's ORAP data have provided the opportunity to assess and understand trends in equipment duty and performance.

The table presents ORAP data for 2011, 2006 to 2010, and 2001 to 2005. The intent of using these three time periods is to highlight performance trends over significant periods of time—including the most current.

The reliability/availability/maintainability (RAM) metrics discussed below include service factor (the percentage of time a unit is generating power) and the ratio of service hours (the amount of time power was supplied to the grid) to starts. These numbers are indicative of the duty cycle or period of demand filled by the generating equipment.

Don't confuse service factor with capacity factor, which also appears in the table. The latter is the ratio of the power an engine produced in a given time period to that which it was capable of generating. Finally, availability and forced-outage factor show the impact of lost time and generation attributed to outages—both planned and forced.

Aero metrics

The aeroderivative metrics show a decreasing service factor, period over period, since 2001-2005. In 2011, aeroderivatives operated 3539 annual service hours, a decrease of 192.8 hours when compared with 2006-2010, and a decrease of 332.9

hours when compared with 2001-2005.

- The service hours/start ratio decreased as well—from 37.1 hours/start for 2001-2005 to 34.2 in 2011. Annual starts were relatively constant for 2011 when compared with 2001-2005 (104 annual starts). However, 2011 starts were substantially lower when compared with 2006-2010 (average of 117 annual starts).
- Capacity factor shows a continual decrease, period over period, since 2001-2005. This indicates a reduced level of power output.
- Availability continually decreased, period over period. Annual outage hours increased from 516.8 hours in 2001-2005 to 657 in 2006-2010 to 788.4 in 2011. Annual forced-outage hours and maintenance outage hours increased, period over period.
- Forced-outage hours represented 45.6% of all outage time in 2011 compared with 44% in 2006-2010 and 39% in 2001-2005.



Data in this report are SPS ORAP Verified

"E" class metrics

- The "E" class metrics show an increasing service factor, period over period, since 2005. In 2011, "E" class units operated 3434 hours, an increase of 192.7 hours when compared with 2006-2010 and an increase of 254 hours when compared with 2001-2005.
- The service hours/start ratio increased from 42.4 hours/start in 2001-2005 to 56.0 in 2011. Annual starts decreased, period over period, from 75 in 2001-2005 to 68 in 2006-2010 to 63 in 2011.
- Capacity factor increased, period over period, since 2001-2005. This indicates an increased level of power output.
- Availability decreased slightly, period over period. Unavailability went from 5.3% in 2001-2005 to 5.5% in 2006-2010 to 6.0% in 2011. Unavailability was driven by an increase in maintenance outage hours, period over period.
- Forced-outage hours represented 19% of all outage time in 2011 compared with 23.6% in 2006-2010 and 20.8% in 2001-2005.

ORAP RAM metrics: Historical perspective

	2011	2006-2010	2001-2005
Aeroderivative			
Service factor, %	40.3	42.6	44.2
Service hours per start	34.2	32.0	37.1
Capacity factor, %	30.5	33.5	36.0
Availability, %	90.7	92.5	94.1
Forced outage factor, %	4.1	3.3	2.3
"E" class			
Service factor, %	39.3	37.0	36.3
Service hours per start	56.0	47.9	42.4
Capacity factor, %	37.2	35.0	34.1
Availability, %	94.0	94.5	94.7
Forced outage factor, %	1.1	1.3	1.1
"F" class			
Service factor, %	55.1	53.9	55.2
Service hours per start	68.3	53.7	47.5
Capacity factor, %	49.0	47.2	50.1
Availability, %	91.4	93.0	92.6
Forced outage factor, %	2.6	1.7	2.0

"F" class metrics

- The "F" class metrics show the highest level of service factor when compared with both aero and "E" class units, period over period. In 2011, "F" class units operated 4853 hours in 2011, compared with 4721.6 in 2006-2010 and 4835.5 in 2001-2005.
- The service hours/start ratio increased, period over period, from 47.5 hours/start in 2001-2005 to 53.7 in 2006-2010 to 68.3 in 2011. Annual starts decreased from a high of 102 in 2001-2005 to 72 in 2011. The nominal 30% decrease in annual starts in the last 11 years reduces the

Long-term view

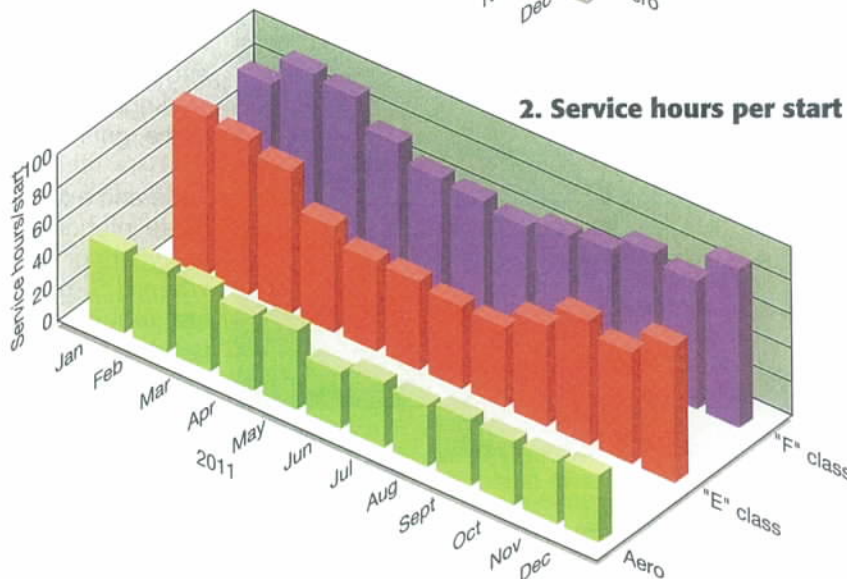
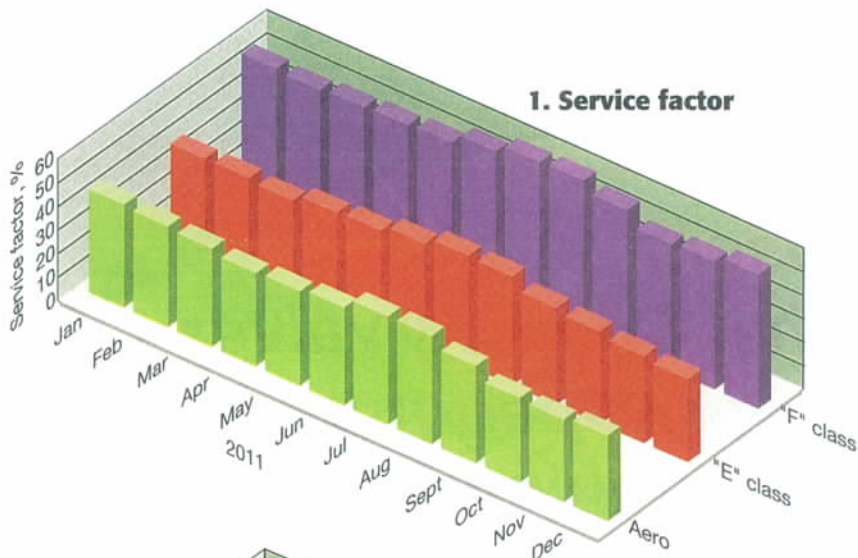
Black & Veatch, Kansas City, made some bold predictions in its December 2011 *Energy Strategies Report* regarding how the energy mix for power generation in 2036 would compare with that for 2012.

Over the next 25 years, the company expects the share of electric power generated from natural gas in the US to increase from 24% to 44% while coal drops from 41% to 16%. Renewables' share of electric power production would increase from 6% to 13% over the same period.

Robert Patrylak, managing director of B&V's Energy Market Perspective (EMP) service, was quoted in the article as saying that up to 61,500 MW (approximately 20% of today's coal fleet) could be retired by 2020. This is in close agreement with the EVA data presented in the first article for this special section.

The EMP forecast predicts renewable generating capacity to more than triple over the 25-yr period, mostly from wind resources.

Generation mix	Production, % of kWh generated	
	2012	2036
Natural gas	24	44
Coal	41	16
Renewables	6	13
Nuclear	20	19
Hydro	9	8



adverse impacts of cyclic duty for these "F" class units.

- Capacity factor was higher than it was for the aero and "E" class units.
- Availability was relatively consistent, period over period, with 2011 showing the lowest level of any reporting period. In 2011, "F" class units were unavailable 8.6% of the time, or 753.4 outage hours. This was an increase of 140 outage hours when compared with 2006-2010 and an increase of 105 hours when compared with 2001-2005.
- Forced-outage hours represented 30.2% of all outage time in 2011, compared with 24.3% in 2006-2010 and 27% in 2001-2005.

End notes

The illustrations show 2011 ORAP data on a monthly basis. Note from Fig 1 that there is little variability in service factor in each of the three

technology classes. This indicates that service hours and starts are relatively uniform on a monthly basis by engine class. No significant summer or winter peak is evident from the metrics.

Interestingly, however, both "E" and "F" class units have higher ser-

vice hours per start ratios in both the first and last three months of 2011 (Fig 2). Perhaps this reflects the need for longer run cycles without increasing monthly service hours. The service hours per start ratio for aeros is relatively consistent month-to-month. CCJ

SUBSCRIBE TODAY **COMBINED CYCLE Journal**

The authoritative information resource for owner/operators of gas-turbine-based peaking, cogen, and combined-cycle plants.

Subscribe via the Internet, access: www.ccj-online.com/subscribe