The concept of equivalent operating hours is extensively used in steam turbine applications where frequent start-ups of the turbines can be very taxing on the turbine internals. Steam turbines typically operate under very high internal pressures which result in hefty casing cross sections and require slow start-ups in order not to experience excessive thermally induced stress.

Gas turbines in contrast have smaller cross sections and can tolerate quicker start-ups and, therefore, may be not as sensitive to start-up cycles when compared to steam turbines. In a combined cycle plant (steam turbine and gas turbine), the recommended start-up time is usually set by the limitations of the steam turbine when starting up from cold. It may take 4 to 12 hours to start a steam turbine, while a gas turbine usually can be brought to full load in less than one hour.

Some manufacturers distinguish between fired hours (sustained operating hours) and equivalent operating hours. The thought is that a turbine experiencing frequent starts exhausts more quickly the useful life of internal parts (especially combustors and turbine blading). A turbine being overhauled at 25,000 equivalent operating hours (a standard interval often used in the overhaul business) may, therefore, have lower actual operating hours. The purpose of the equivalent operating hour concept is to avoid turbine failures that may result because of severe operating conditions. For example, a turbine being started every day and run for 3 years (at 12 hours per day) accumulates 13,140 actual operating hours and will have 1,095 starts during this time period. One method to account for frequent starts is to use a “load factor.” If a factor of 10 is used in our example, it will add 10,950 hours for a total of 24,090 equivalent hours. This is a substantial increase over the 13,140 actual hours. It means that the plant needs to spend money for inspection and overhaul much sooner than if only operating hours are considered. This example is somewhat extreme since most of the larger gas turbine installations are more likely to run in a base-load mode (24 hours, 7 days each week) with infrequent shut-down periods.

The “load factor” varies by manufacturer depending on the particular operating experience of their turbine models. (Siemens-Westinghouse Power seems to be using a load factor of 10.)
erected and commissioning/testing of a unit, the turbine will see an unusually high number of starts (as many as 400 starts in less than a year, especially when software bugs are encountered). There are no typical numbers for starts during field test because each installation may have unique circumstances as well as the need to test instrumentation. Once in operation, the turbine will usually experience much fewer starts.

Some turbine manufacturers do not use equivalent operating hours, and they adjust their maintenance schedules depending on operating specifics (base load or frequent starts). While the reason for not using equivalent operating hours is not entirely known, it’s probably because gas turbines start are not as stressful to the hardware as steam turbine starts.

Furthermore, according to statistics collected and published by a major insurance company, about 2/3 of all gas turbine failures are product failures (design, installation errors, repair and material faults) with only about 10% caused by operational influences.

Conclusions

The absence of a common industry standard in measuring operating hours (equivalent or otherwise) leaves underwriters with no simple means of evaluating the performance of gas turbine technology and equipment. One can only utilize the data available on a particular model when attempting to determine if a certain model is “proven.” However, there are a number of other factors to consider in the evaluation process. After reaching an initial conclusion based on the operational experience of a model, the individual unit with its own local operating characteristics should be looked at in consideration of the following factors:

- Operational mode (base load versus peaking mode) determines maintenance schedules.
- Some manufacturers may also track equivalent operating hours to determine a suitable maintenance schedule.
- Manufacturer’s maintenance schedules must be followed.
- Scheduled internal inspections (especially hot gas path inspections) to validate the condition of turbine parts and to make or schedule the necessary repairs. This should be done for turbines that are new, and is especially recommended before the manufacturer’s warranty period expires.

“2/3 of all gas turbine failures are product failures”

Passing Grades

A critical point in the construction of a new power plant is the passing of a series of performance or “hot” tests after the initial plant operation is achieved. The purpose of these tests is for the plant contractors and equipment suppliers to demonstrate that the new plant meets or exceeds the performance levels stated in the project’s contracts. Once successfully shown, the contractors generally receive their final payment, the owners accept the project, and the unit enters into Commercial Operation (CO).

The power plant owner’s Boiler & Machinery and Property policies usually start upon Commercial Operation as the Builders’ Risk policy terminates.

There are several aspects of performance tests that have significant insurance implications. Although losses during the actual physical construction of the power plant are not unusual, the test period often represents the maximum exposure under the Builders’ All Risk Policy for several reasons.

Any boiler & machinery occurrences or property damages during the test period are normally covered under Builders’ All Risk or EAR Policies. Since the equipment is operated in a manner to pass its performance tests which are at or beyond normal operating levels, the power generated is generally sold to the electric grid. During this test period operational stops and starts can be more numerous than the expected during normal operation as equipment is often “tweaked” to optimize performance. The unit’s operational control is typically shared between new operators learning the systems and the contractors/ manufacturers start-up representatives. Delays incurred in completing the tests may result in liquidated damages for the contractors, and if an insurable claim occurs, significant business interruption (ALOP or DSU) losses may result as well.

There are generally several performance tests conducted. Heat Rate, environmental emissions, and reliability are among the performance-related parameters verified. The actual procedures for these tests must be well-defined upon signing the contract for construction, equipment procurement and installation for a new power plant. The justification for this requirement is to avoid claims resulting from contract interpretation issues such as those associated with test run durations (and how to deal with interruptions), number of stops or restarts allowed before starting over, the extent of contractor/manufacturer control of operations, and the test methods especially for some very low quantities of emissions. Since it is not normal duty, a high number of stops/stops adds stress to the machinery and can possibly contribute to premature failures in the “bathtub curve” of a power plant’s life cycle.

Underwriting exposures can be limited by verifying that the performance test procedures and remedies are well-defined, contractual responsibilities are identified, and that insurance coverages are sufficient to address all possible loss scenarios.
What To Do With “Retired” or “Old” Boilers?

There are many factors that caused older boilers to be retired or “mothballed.” The significant ones include:

- **Uncompetitive Heat Rates** (require more BTUs to make Kw-Hr; therefore more costly to operate)
- **Environmental Compliance Issues** (require adding expensive control systems)
- **Condition**—not simply the age of the equipment!

The last factor directly impacts insurance issues. Just because equipment is old does not necessarily make it unfit for its intended duty. In fact, older equipment may have been designed with more robustness than newer components due to the philosophies of boiler designers of that period. Routinely, boilers were operated at 20% (or more) over capacity because everyone knew that safety margins were built into the design to handle these conditions. However, this is not the case with newer equipment, primarily due to increased market competitiveness and lack of favorable evaluations for these factors by buyers.

**Underwriting Impact**

As stated in the GeneralCologne Re Boiler & Machinery Utilities Reference Manual, the average age of coal-fired boilers is more than 37 years, exceeding the conventional design life of 30 years. Although on the surface this sounds bad, the fact is that many of these assets have been well maintained, with judicious replacements of worn components over the years under the regulated utility environment.

With the advent of deregulation and competitive power, the same level of investment in maintaining these units becomes a serious question. With the shortage of power and peak reserve capacity, power plant owners are assessing the value of returning these previously retired units to service. This is the case for seasonal peak applications where the high sale price for peak power allows for compensation despite their inherent operating inefficiencies.

**Prudent Underwriting Questions**

- When were the boilers last inspected and by whom? (Obtain a copy of the report.)
- Were the boilers truly mothballed, or were they kept on standby readiness with or without partial load being maintained? Or worse case scenario, were they simply abandoned and left to rust? If on standby, how often are they used and to what capacity?
- Does the original owner, who knows their history, still own the boilers?
- What are the operating demands on the boilers?
- Has environmental control equipment been added or updated to current environmental standards? If yes, this reflects a significant commitment on the part of the owners to operate these units well into the future.
- Were there any scheduled or unplanned outage reports that would provide insights into persistent equipment problems?

Old isn’t necessarily bad. What is important is how the boilers have been maintained.
Wind farms are appearing with far more regularity on the landscape of many countries and throughout the United States. During 1998-99, 1,000 Mw of new wind projects were installed in the U.S., with the European Community continuing to be the world leader of installed capacity.

Wind turbine capacities are increasing, but a typical unit size is 225-300 Kw. Although efforts are being made to develop larger capacity machines, there has been only one 1 Mw unit in successful commercial operation. Lower operating and maintenance costs and greater content of locally manufactured components (which are helping to lower capital costs), plus increased reliability, are expected market drivers to realize a 25% annual growth rate of installed capacity. Still, wind power accounts for only 0.3% of the global installation generation capacity.

Technology issues that contribute to underwriting concerns involve: unit capacity scale-up; sophisticated blading designs; and variable speed and pitch designs that impact gearbox designs.

Other factors to be assessed include:

- The intermittent nature of wind—there are additional costs if replacement power must be provided.
- Average wind speed dictates production and costs, making wind’s competitiveness volatile and business interruption very difficult to evaluate.
- Staying power of the smaller manufacturers of smaller firms in the wake of large companies such as Siemens, BP, Shell and Enron becoming actively involved.
- Offshore locations are increasingly being considered—potentially impacting the appropriateness of the type of insurance coverages required.
- Environmental concerns about birds and noise lead to possible unique environmental exposures.

The important aspect of harvesting the wind is that the technology is rapidly evolving with prototype machines, on-shore and off-shore applications—and costs that are as variable as the wind.

More Gas Turbine News

Thriving Gas Turbine Repair Business

While OEMs (Original Equipment Manufacturers) still perform most of the repairs on large gas turbines; operators of gas turbine plants are utilizing an ever-increasing number of non-OEM shops. This is especially the case once the OEM’s warranty period has expired. Even a capability of refurbishing or repairing single crystal blades is currently being developed by some of the non-OEM repair firms. There are at least 14 such companies within the continental USA that can refurbish and repair most of the heavy-duty gas turbines. Because they are relatively new and employ sophisticated technology, almost all of the F and G class gas turbines are still being serviced by the OEMs.

(Source: POWER, March/April 2001)

Fuel Availability & Prices

In North America there is growing concern, especially among analysts, that natural gas fired power plants are being constructed so fast that the fuel supply and infrastructure may not keep up. As reported in the July 9 issue of Engineering News Record, the Williams Capital Group, New York City claims that fewer than half of the powerplants now being developed are likely to be completed because they will not be able to procure fuel. Moreover, what natural that is available will cost more. During the 1990s, wellhead gas prices (in 1999 dollars) hovered between $1.61 to $2.32 per million Btu. Even until mid-April 2000, the spot prices in Louisiana were under $3 per million Btu but later broke the $4 barrier. After the 2000-2001 heating season, prices are expected to average near $4.38 per million Btu for the spring and summer season. Extreme summer weather could aggravate this situation even further. (Source: Engineering News Record & Energy Information Administration, U.S. DOE)

In either case, financial balance sheets of potential projects will undoubtedly be getting a second look.

About This Newsletter

The Power RE-View reports on evolving issues of interest to underwriters relevant to today’s global electric power generation industry.

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