



Summary

Power plant equipment that is operated continuously at nominal load typically requires maintenance or inspection after a certain time interval, based on service hours. If the equipment is run at variable loads, cycled frequently or operated in a degraded service environment, then the usable life before overhaul/replacement is generally reduced.

A useful construct that accounts for varying wear rates, as a function of operating history, is the Equivalent Operating Hour or EOH. Developed first in the aerospace industry, the concept is now widely used by power plant OEM's to give a normalized measure of service life for the gas turbine, steam turbine and generator.

Tetra Engineering has an engineering service that extends the EOH approach to cover key GTCC Plant components in the Heat Recovery Steam Generator (HRSG) and the balance-of-plant (BOP). The scope of the resulting EOH program is tailor-made to meet the requirements of the particular plant. Particularly valuable for units that are operated in cycling duty, it presents the following advantages to an operator:

- *Facilitates the scheduling of maintenance and inspection of the HRSG and BOP components*
- *Helps maintain OEM specifications (especially important during warranty period or for possible litigation)*
- *Integrates OEM-derived EOH values for the GT, STG and Generator to yield a comprehensive, self-consistent EOH-based maintenance and inspection program for the entire plant*
- *Serves as a basis for automating maintenance and inspection planning (for example with Tetra's **EOTrac** tool)*
- *Aids in standards compliance (ISO 9000)*
- *Helps to avoid unforeseen downtime by reducing the risk of component failure*

$$EOH_{GTCCOM} = \sqrt{(S * V_{GTCCOM})^2 + (OH_{NG} + OH_{FO} * Z)^2}$$

$$EOH_{GTB} = \sqrt{(S * V)^2 + ((Z * X * OH)_{HE} + (Z * X * OH)_{LE})^2}$$

Typical Scope of Work

1) Assess Key HRSG and BOP Components

The assessment uses information obtained from a site visit in conjunction with discussions with plant staff. The plant staff sets the scope of equipment covered by the assessment.

For the HRSG, the assessment encompasses the high temperature components (superheat & reheat – as applicable), steam generating components (evaporators and economizers), cold end components (FW heaters and deaerators – as applicable), supplemental firing systems, SCR and CO catalysts (as applicable), casing, liners & stack.

BOP equipment typically includes pumps, pump motors and drives, large cooling fans and electrical switchgear.



2) Develop Reference Operation

Reference operating scenarios are defined for the assessment of future operations. These operating scenarios include:

- Baseload
- Two-Shift Cycling
- Load Change Cycling
- Other as required (fuel oil firing etc.)

For each reference scenario, the projected operation profile over a 10-year period is established. This includes projected cold & hot starts, maintenance outages, and unit load and firing (duct burner operation – as applicable) assumptions.

3) Develop Equivalent Hours/Starts (EOH) Formulations

Starting from a theoretical or design life in nominal conditions, Tetra develops an EOH calculation formula for each component using data from the OEM, industry databases, actual operating repair histories and if necessary, engineering analysis. The EOH formula relates life consumption (usage) rates to operating regime.

4) Project Component Life Consumption

The life consumption (and residual life) for each component is projected using the EOH formulations and different Reference Operating Scenarios (task 2).

Life consumption in pressure parts (Drums, Headers, Drains, and Tubes) is a measure of the component reliability condition. Tetra Engineering's philosophy is to treat life consumption as an indicator of when preventive maintenance/inspection/replacement actions are required, rather than as a prediction of failure.

5) Generate Inspection and Maintenance Schedules

This task provides recommended (site-specific) component inspection plans and maintenance management schedules. The program identifies the following action levels for given levels of accumulated EOH:

1. Minor Inspection
2. Major Inspection
3. Minor Repair/Maintenance Contingency
4. Major Repair/Maintenance Contingency

The EOH formulations can also be used in the implementation of software-based maintenance scheduling for the GT, STG, Generator, HRSG and other GTCC key components. For example, Tetra's **EOTrac** spreadsheet tool Tetra calculates component EOH using the formulations and current operating data to automate inspection planning.

Deliverable

The deliverable for this service is a report that provides the engineering basis for the EOH program. The report includes the recommended intervals for the maintenance and inspection of all covered components for all relevant operating scenarios.