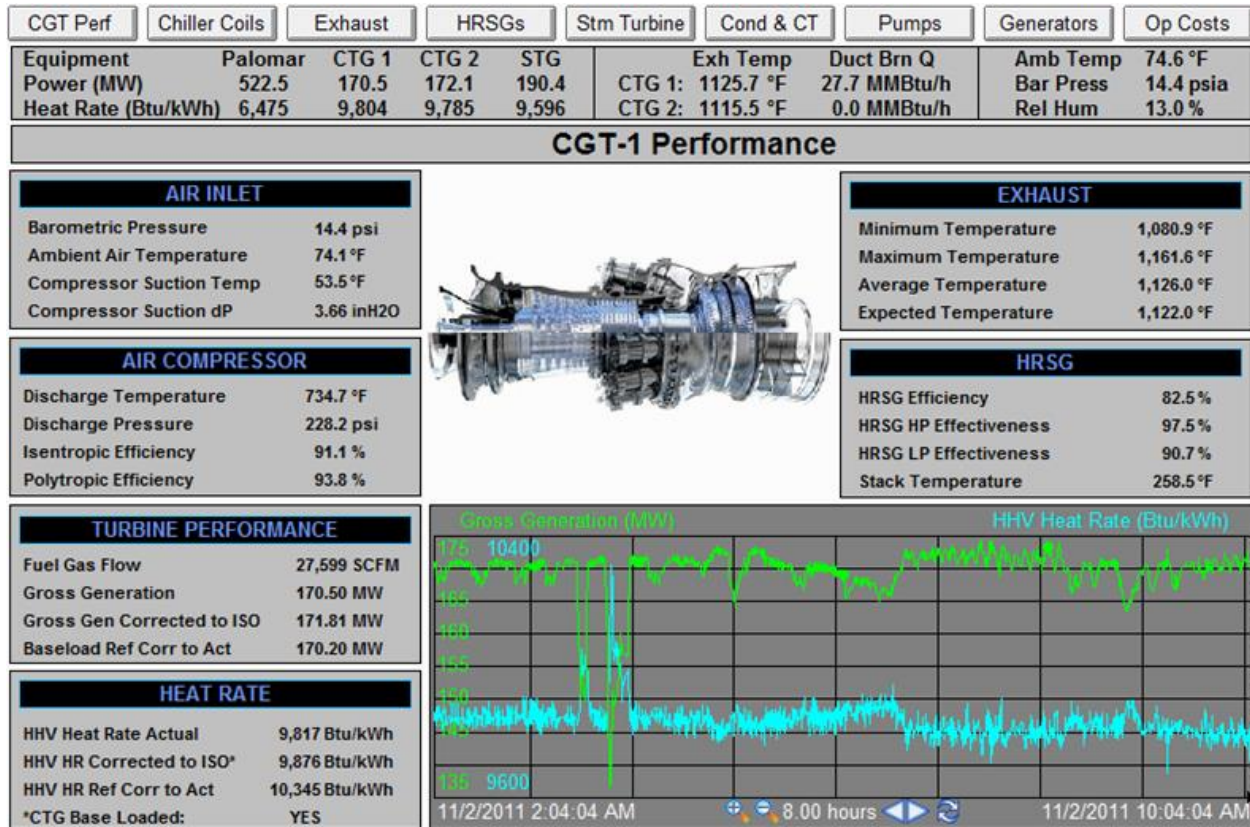


Plantweb™ Performance Advisor



Real-time equipment performance health feedback integrates with process automation so you can run your plant with confidence

- Achieve and maintain optimum equipment performance
- Track key performance indicators in real-time against target operation
- Quantify thermodynamic efficiency losses
- Prioritize and plan maintenance activities
- Determine the root cause of production inefficiencies

Introduction

The performance of all critical equipment will deteriorate over time, resulting in lost efficiency, increased energy usage, and reduced throughput. Identification of the deviation from equipment design, combined with early detection, is vital to your plant's profitability. Knowing the health and performance of your mechanical equipment allows you to be proactive with your operational and maintenance planning instead of reacting to unexpected events.

Plantweb™ Performance Advisor helps you to run your process more efficiently, track operating performance against targets, schedule maintenance activities, and determine the root cause of production asset inefficiencies. When your maintenance and operations staff are alerted to degrading asset performance, critical production decisions can be made to mitigate outages and improve your bottom line.

Benefits

Plantweb™ Performance Advisor calculates thermodynamic-based equipment performance using industry-standard ASME PTC performance calculation techniques to facilitate KPIs and metrics that can be compared to design/baseline to determine deviation from design diagnostics for your critical machinery, including turbines, compressors, boilers, and other production assets.

Specific key performance indicators combined with clear graphical operating plots show exactly where the equipment is currently operating versus expected or design condition.

Combining performance data with machinery condition, protection and prediction diagnostics helps your reliability program shift from reactive to proactive

Performance Advisor provides calculated information for common non-exhaustive key equipment types, such as:

- Compressors – Multi-stage, centrifugal and axial
- Compressors – Multi-stage, reciprocating
- Gas Turbines – Mechanical drive, generating
- Steam Turbines – Mechanical drive, generating
- Boilers
- Fired Heaters / Furnaces
- HRSGs
- Condensers – Air cooled, water cooled
- Pumps
- Cooling Towers

Benefits for the Entire Facility

Operations: Receive real-time feedback of equipment performance to influence control changes and help meet operational targets.

Maintenance: Experts can access in-depth diagnostics to understand degradation trends and status by correlating condition and performance data.

Process Engineers: Can identify potential instrument problems, pinpoint degradation sources, and evaluate the effectiveness of cost improvement actions.

Management: Understands financial impact of performance deviations.

Product Description

Plantweb™ Advisor Suite

Plantweb™ Performance Advisor is part of a suite of integrated applications that monitor the health, performance and energy intensity for a site's key production assets. The Plantweb™ Advisor Suite includes the following applications

- **Performance Advisor** – 1st principle modeling comparing actual performance against design expectations
- **Health Advisor** – Patented, statistical approach to calculating asset health using equipment sensors as well as process data
- **Energy Advisor** – Energy monitoring, consumption modelling, unit/area/site roll-up and tracking, and alerting for overconsumption events.

These solutions monitor the mechanical integrity of the assets and flag efficiency deviations that, if not acted upon, often result in an unplanned shutdown.

Real-Time Equipment Performance Monitoring

The real-time information available from Plantweb™ Performance Advisor helps you pinpoint opportunities for performance improvement that would otherwise go unnoticed. Differentiating features add value and knowledge to equipment operation.

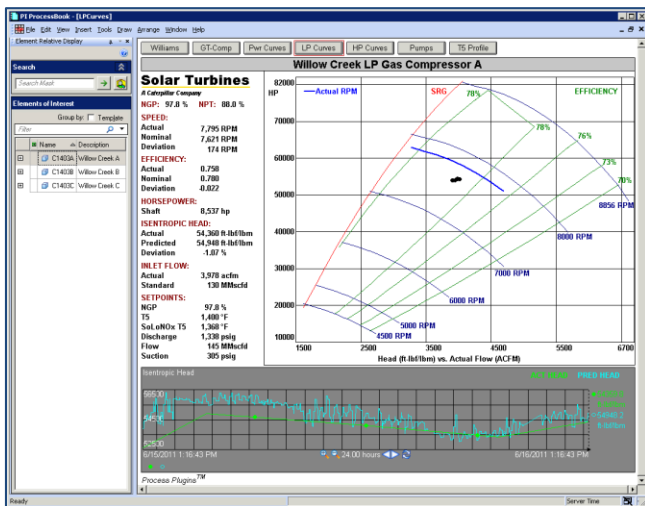
- Ability to apply KPI calculations retrospectively to view historical machinery performance
- Data connectivity to any historian or DCS regardless of vendor
- Intuitive graphical presentation clearly displays current operating point compared to design criteria in both time based, and operating envelope plots
- Facilitates integration of protection, prediction, and performance information for a complete condition and performance monitoring solution

Flexible Data Connectivity

Plantweb™ Performance Advisor receives measurement input data from existing field instrumentation web-based data (such as weather information), and user or from manually-entered values. Data can be connected to any manufacturer's DCS or data historian. This flexibility means that plants with multiple sources of input data and information systems can unify their performance calculations in a single, centralized location.

Graphical User Interface

Intuitive graphical displays provide key information to guide operations and management decisions toward managing "controllable losses" by operating closer to optimal targets. As well as the standard templates provided by Plantweb Performance Advisor, the OSI PI infrastructure means users can create their own interface to visualize the data as they want.



Multiple Users

Plantweb™ Performance Advisor communicates specific diagnostics aligned to plant roles.

- Operators obtain real-time feedback on setpoint changes to ensure optimal asset performance is achieved and maintained.
- Maintenance resources can identify impending condition and/or performance issues and prioritize planned activities.
- Process Engineers can identify assets that are developing problems and assess the cost of degradation vs. the cost to repair.

Results You Can Trust

Plantweb™ Performance Advisor has been developed by experts in applying thermodynamic models on-line and therefore includes features designed to handle common challenges using real plant data. Key features include data validation and manipulation functions, estimating accuracy of results, and proper filtering of inputs.

Input Data Validation

Plantweb™ Performance Advisor evaluates the quality of DCS/historian input signals using data quality, expected range testing, and (alternative) data substitution techniques to ensure the best data is used for the performance calculation.

Equipment efficiency changes are often tracked down to tenths of a percent, so good input measurements are essential. Plant data can be error-prone. When data is bad, Performance Advisor can be setup to estimate from last good value, a calculated value, or a default value, ensuring the accuracy of the calculations and delivering reliable results.

Analog Input Filtering

Noisy data from on-line systems often creates issues, particularly for 1st principle, heat-and-material balance models. Plantweb™ Performance Advisor data integrity is ensured through built-in analog input filtering and validation techniques. Analog signals may have a small degree of smoothing applied inside Plantweb™ Performance Advisor to improve performance analysis, particularly when noisy data is present.

A reported “poor” or “suspect” status of any input or substituted value is made visible through the graphic interface, delivering an early warning mechanism for problematic data connectivity or measurement issues.

Common View of the Truth

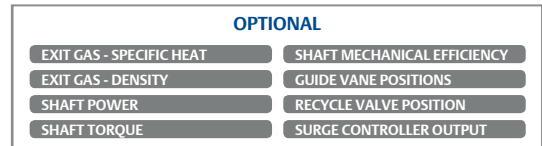
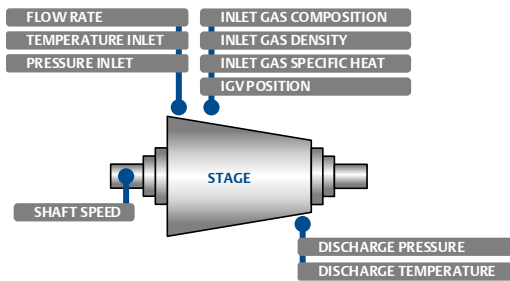
Home-grown spreadsheet applications are often used for equipment performance calculations, but most companies find they are cumbersome, hard to maintain and have limited users. Plantweb™ Performance Advisor is based on OSIsoft PI, the leading process historian in the continuous industries, with over 10,000 installations and hundreds of thousands of users.

Compared to do-it-yourself spreadsheets, Plantweb™ Performance Advisor provides overwhelming benefits.

- Full-function database and graphics engine which can be completely customized if desired
- Ability to scale up to hundreds of assets and users
- Modular structure for easy configuration and expansion
- Pre-engineered ASME performance calculations for many equipment types
- Easy comparison to reference operation at "standard conditions"
- Calculation of the economic impact of degradation
- Easy data cleaning and validation techniques
- Able to retrospectively apply performance calculations to historical data
- Model data smoothing to help understand underlying performance trends
- Easy-to-use detailed graphical interface and historian capabilities that interface with multiple external data sources
- Consistent modelling approach for similar units on a site-wide and organization-wide basis

Module: Compressor – Centrifugal/Axial

Module Process Flow Diagram



Typical single stage shown.

Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Operating Curves* – Head Versus Flow, Efficiency Versus Flow, Discharge Pressure Versus Flow**, Power Versus Flow**

Module Input Data Points

- Flow Rate (measured inside any recycle loops)
- Temperature – Inlet / Suction
- Temperature – Exit / Discharge
- Pressure – Inlet / Suction
- Pressure – Exit / Discharge
- Shaft Speed (On Variable Speed Machines)
- Inlet Gas – Composition
- Inlet Gas – Density (or Inlet Compressibility)
- Inlet Gas – Specific Heat (or Ratio of Specific Heats)

Optional Data If Available

- Exit Gas – Specific Heat
- Exit Gas – Density (or Compressibility)
- Number of Impellers
- Shaft Power
- Shaft Torque
- Reference Condition – Power
- Reference Condition – Head
- Reference Condition – Volume
- Reference Condition – Density
- Reference Condition – Speed

* At various operational speeds

** Optional

Module Calculation Method

- ASME PTC 10

Module Outputs

- ASME PTC 10
- Polytropic Efficiency – Actual
- Polytropic Efficiency – Design
- Polytropic Efficiency – Deviation
- Polytropic Head – Actual
- Polytropic Head – Design
- Polytropic Head – Deviation
- Flow Rate – Volumetric Flow Actual
- Flow Rate – Mass Flow
- Shaft Power Consumption (if not measured)
- Deviation Cost (Lost Throughput and/or Additional Power)

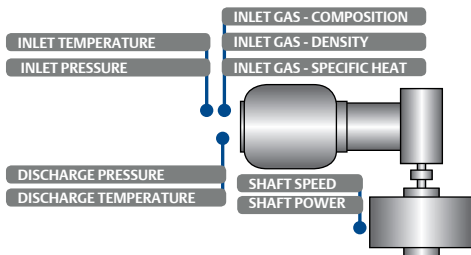
Additional Outputs (data dependent)

- Efficiency and Head – Adiabatic and Isothermal
- Power – Design
- Power – Deviation
- Compressor Gas Velocities – Inlet and Exit
- Flow Rate – Mass Design and Deviation
- Suction Stagnation Conditions
- Discharge Stagnation Conditions
- Temperature – Theoretical Rise and Ratio
- Temperature – Actual Rise and Ratio
- Pressure – Rise and Ratio
- Corrected & Normalized – Volume Flow, Head and Power
- Machine Work Coefficients & Machine Mach Number

NOTE: A turbo-compressor is a turbine module + compressor module

Module: Compressor – Reciprocating

Module Process Flow Diagram



OPTIONAL

EXIT GAS - SPECIFIC HEAT CAPACITY CONTROL
EXIT GAS - DENSITY FLOW RATE

Typical single stage shown.

Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets; Including
 - Single/Double Acting, Stroke Length, Bore, Piston Area, Con-Rod Area, valve dimensions, Capacity Control, Design Operating Points
- Operating Curves (Required): Power Versus Flow, Capacity Control Curves

Module Input Data Points

- Flow Rate
- Temperature – Inlet / Suction
- Temperature – Exit / Discharge
- Pressure – Inlet / Suction
- Pressure – Exit / Discharge
- Shaft Speed
- Inlet Gas – Molar Composition
- Inlet Gas – Density (or Inlet Compressibility)
- Inlet Gas – Specific Heat (or Ratio of Specific Heats)
- Shaft Power

Optional Data If Available

- Discharge Gas – Density
- Discharge Gas – Specific Heat
- Temperature – Cooling Jacket Coolant Inlet
- Temperature – Cooling Jacket Coolant Exit
- Capacity Control Operation
- Rod Drop Measurement
- Pipe Area – Inlet
- Pipe Area – Exit

Module Calculation Method

- ASME PTC 9

Module Outputs

- Swept Volume
- Clearance – Volume and Percent (Crank End, Head End)
- Volumetric Efficiency – Actual
- Volumetric Efficiency – Design
- Volumetric Efficiency – Deviation
- Compressor Efficiency – Actual
- Compressor Efficiency – Design
- Compressor Efficiency – Deviation
- Compressor Head – Actual
- Power – Design
- Power – Deviation from Design Power
- Flow Rate – Actual Volumetric and Mass
- Power – Specific per Mass Flow
- Flow Rate – Design and Deviation from Design Mass Flow
- Deviation Cost (Lost Throughput and/or Additional Power)

Additional Outputs (Data dependent)

- Compressor Gas Velocities – Inlet and Exit
- Shaft Efficiency
- Cylinder Suction Internal Conditions
- Cylinder Discharge Internal Conditions
- Temperature – Theoretical Rise and Ratio (with and without cooling duty)
- Temperature – Actual Rise and Ratio
- Pressure – Rise and Ratio
- Rod-loads (Head and Crank End)

Module: Gas Turbine (Electricity Generating & Mechanical Drive)

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets and Correction Curves to ISO Conditions
- GT Load Testing – Acceptance Testing Data; Design at various Gas Turbine Loads (50%, 75%, 100% load) , at various inlet temperature conditions

Module Inputs

- Flow Rate – Fuel
- Flow Rate – Fogging / Evaporative Cooling
- Flow Rate – Steam Injection (where appropriate)
- Temperature – Ambient
- Temperature – Compressor Inlet
- Temperature – Interduct and/or Exhaust Profile
- Temperature – Power Turbine Exhaust (as appropriate)
- Pressure – Ambient
- Pressure – Compressor Exit
- Pressure Drop – Inlet Filter
- Humidity – Ambient
- Shaft Speed(s)
- Shaft Power / Torque (MW, MVAR, etc)
- Fuel Characteristics (LHV, Composition)

Optional Inputs If Available

- Flow Rate – Inlet Air and Gas Exhaust
- Temperature – Fuel
- Temperature – Tmax or TIT or Turbine First Blade
- Temperature – Compressor Exit(s)
- IGV Position
- Operating Hours / No. Trips / No. Starts
- Wash Activity / Inlet Heating Activity
- Emissions Analyses (e.g. NOx / SOx / COx)

Module Calculation Method

- ASME PTC 22 – Corrected output, heat rate, and thermal efficiency are calculated based on correction curves provided by the turbine manufacturer. Design combustion turbine heat rate and efficiency are calculated based on turbine design data and compared to the corrected values.

Module Outputs

- Thermal Efficiency – Actual
- Thermal Efficiency – Design (Baseline)
- Thermal Efficiency – Deviation
- Thermal Efficiency – Corrected
- Heat Rate – Actual
- Heat Rate – Design (Baseline)
- Heat Rate – Deviation
- Heat Rate – Corrected
- Power Output – Actual
- Power Output – Design (Baseline)
- Power Output – Deviation
- Power Output – Corrected
- Deviation Cost (Increased Fuel and/or Reduced Power)

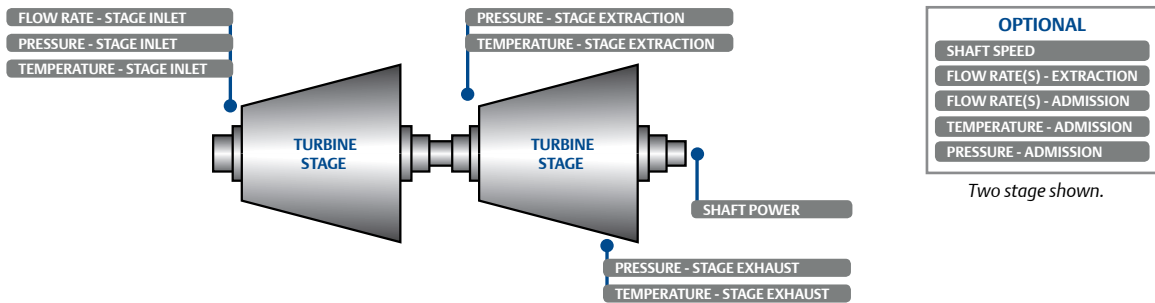
Additional Available Outputs

- Compressor Efficiency – Polytropic
- Compressor Temperature Ratio
- Compressor Pressure Ratio
- Temperature – Exhaust Spread
- Temperature Profile
- Temperature Profile – Exhaust Deviation
- Generating Capacity
- Correction Factors
- Full Load Equivalent Power/Heatrate

NOTE: A turbo-compressor is a turbine module + compressor module

Module: Steam Turbine (Mechanical Drive / Generating)

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- OEM Heatload Diagrams at Various Outputs
- Operating Curves: Efficiency Versus Steam Flow, Efficiency Versus Power Curves

Module Inputs

- Flow Rate(s) – Stage Inlet
- Temperature(s) – Stage Inlet
- Temperature(s) – Stage Exhaust
- Pressure(s) – Stage Inlet
- Pressures – Stage Exhaust
- Turbine Power (MW, Torque, or similar)

Optional Inputs If Available

- Speed
- Flow Rate(s) – Extraction
- Steam Flow(s) – Admission
- Steam Temperature – Admission
- Steam Pressure – Admission
- Feedwater flow/temperature(s) for extraction estimation

Module Calculation Method

- ASME PTC 6 – This method utilizes enthalpy drop approach.

Module Outputs

- Thermal Efficiency – Actual (per stage and overall)
- Thermal Efficiency – Design (per stage and overall)
- Thermal Efficiency – Deviation (per stage and overall)
- Power – Actual (per stage and overall)
- Power – Design (per stage and overall)
- Power – Deviation (per stage and overall)
- Steam Rate (per stage and overall)
- Deviation Cost (Increased Steam Consumption or Reduced Power)

Additional Available Outputs

- Flow Rate(s) – Turbine Section Extraction Steam
- Estimated Exhaust Quality (condensing stage)
- Expected Design Temperature(s)
- Operating Temperature Ratios
- Operating Pressure Ratio

Module: Boiler

Module Process Flow Diagram

See boiler figure on next page

Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
 - OEM Design / Equipment Specification Sheets ■
- Rated Cases: (50%, 70%, 80%, 90%, 100% load)

Module Inputs

- Fuel(s) – Feed Composition and Heating Values
- Flow Rate(s) – Fuel(s)
- Flow Rate – Reheat Steam (as appropriate)
- Flow Rate – Steam and/or Feed Water
- Flow Rate(s) – De-Superheater Spray Water
- Flow Rate(s) – Reheat De-Superheater Spray Water
- Temperature – Air Inlet
- Temperature – Feed Water
- Temperature – Stack Gas
- Temperature – Steam Exit
- Temperature(s) – De-Superheater Spray Water
- Temperature – Reheat In and Exit (as appropriate)
- Temperature – Reheat De-Superheater Spray Water (as appropriate)
- Pressure – Reheat In, Steam Exit and Drum (as appropriate)
- Analysis – Flue Gas Combustion O₂

Optional Inputs If Available

- Flow Rate(s) – Feed Air
- Flow Rate(s) – Soot Blowing Steam
- Flow Rate – Blowdown
- Temperature – Fuel Feed
- Temperature – Furnace Firing
- Temperature – Combustion Air
- Temperature(s) – Flue Along Gas Path
- Temperature(s) – Economizer Exit Water
- Temperature(s) – De-Superheater Steam Inlet/Exit
- Pressure – Boiler Feed Water
- Pressure – Steam Drum
- Pressure(s) – Intermediate Steam Superheater
- Analysis – Stack Excess O₂
- Analysis – Flue Gas (e.g. NO_x / SO_x / CO_x / H₂O)

Module Calculation Method

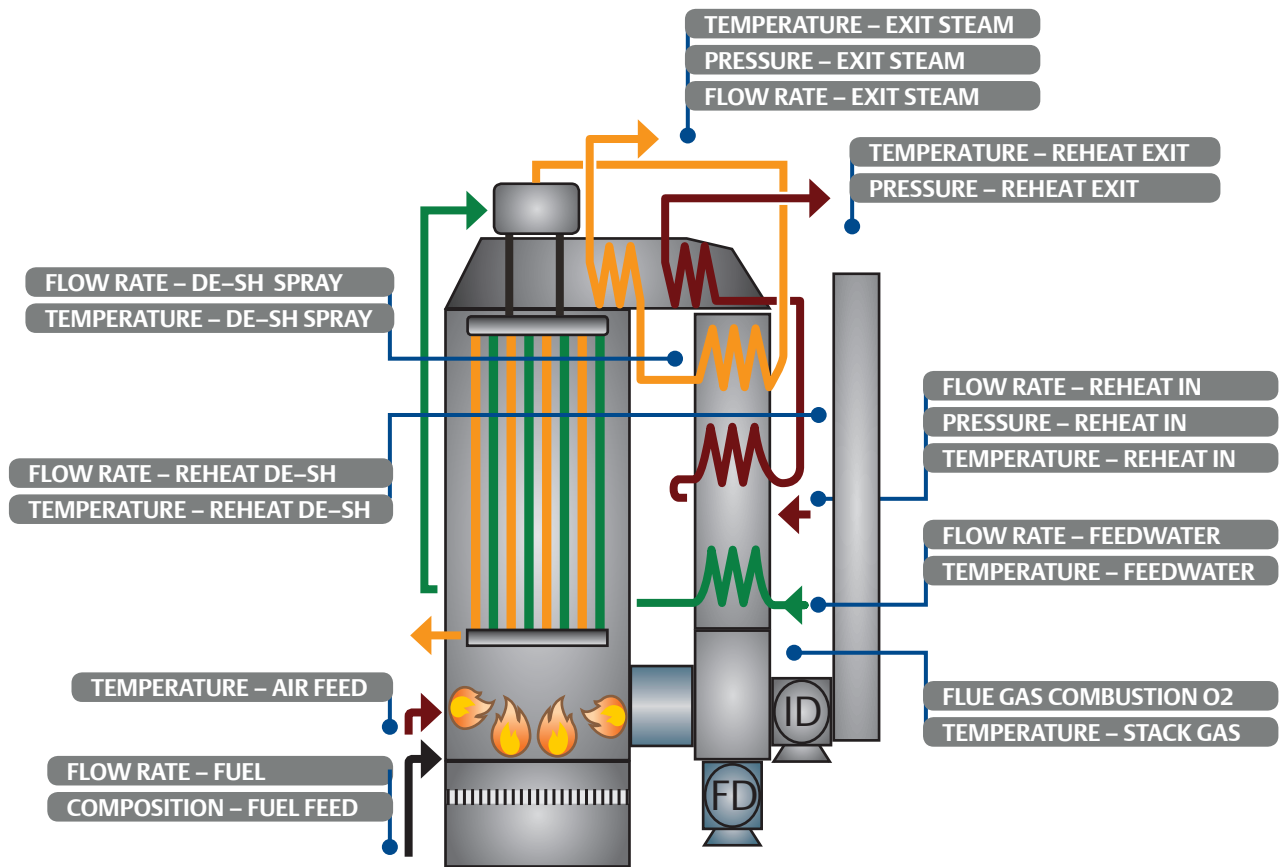
- ASME PTC 4.1 (heat loss method) – For a regenerative or tubular type air heater, the module computes corrected gas outlet temperature and air heater gas-side efficiency in accordance with ASME PTC 4.3. Design gas-side efficiency is calculated and compared to the actual efficiency. For tri-sector type air heaters, air and gas-side efficiencies are calculated and compared to design values.

Module Outputs

- Efficiency – Actual (Heat Loss and Input / Output)
- Efficiency – Design (Baseline)
- Efficiency – Deviation
- Flow Rate – Steam Actual
- Flow Rate – Steam Design (Baseline)
- Flow Rate – Steam Deviation
- Combustion O₂ – Actual
- Combustion O₂ – Design (Baseline)
- Combustion O₂ – Deviation
- Total Fired Heat
- Deviation Cost (Lost Steam and/or Additional Fuel)

Additional Available Outputs

- Heat Loss – Total
- Heat Loss in Dry Gas
- Heat Loss due to Moisture in the Fuel
- Heat Loss in the Moisture Formed from Hydrogen
- Heat Loss in the Moisture in the Supplied Air
- Heat Loss due to Ash
- Heat Loss due to Radiation
- Heat Loss due to Carbon Monoxide
- Temperature – Air Heater Air Inlet Deviation
- Temperature – Air Heater Gas Inlet Deviation
- Temperature – Air Heater Gas Outlet Deviation
- Excess Air – Actual
- Excess Air – Deviation
- Flow Rate – Blowdown (if not supplied)
- Air Heater Leakage



OPTIONAL

- | | |
|--|--|
| FLOW RATE - FEED AIR | TEMPERATURE(S) - SUPERHEATER(S) |
| FLOW RATE(S) - SOOT BLOWING STEAM | TEMPERATURE(S) - DE-SUPERHEATER STEAM INLET/EXIT |
| FLOW RATE - BLOWDOWN | PRESSURE - BOILER FEED WATER |
| TEMPERATURE - FUEL FEED | PRESSURE(S) - STEAM DRUM |
| TEMPERATURE - FURNACE FIRING | PRESSURE(S) - INTERMEDIATE SUPERHEATER STEAM |
| TEMPERATURE - COMBUSTION AIR | STACK EXCESS O ₂ |
| TEMPERATURE(S) - FLUE GAS ALONG PATH | FLUE GAS ANALYSIS |
| TEMPERATURE(S) - ECONOMIZER EXIT WATER | |

Module: Heat Recovery Steam Generator (HRSG)

Module Process Flow Diagram

See HRSG figure on next page

Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Rated Cases: (50%, 70%, 80%, 90%, 100% load)

Module Inputs

- Flow Rate – Gas Turbine Exhaust (or Estimate)
- Flow Rate* – Steam and/or Feed Water
- Flow Rate(s) – De-Superheater Spray Water (as appropriate)
- Flow Rate – Supplementary Fuel (if Duct Burners Present)
- Flow Rate – Gas Turbine Fuel
- Temperature – Gas Turbine Exhaust / Duct Inlet
- Temperature(s) – De-Superheater Spray Water
- Temperature – Stack Gas
- Temperature* – Boiler Feed Water (BFW)
- Temperature* – Steam Exit
- Pressure* – Steam Exit
- Analysis – Stack Gas Excess O₂ (or Estimate)
- Analysis – Fuel Composition, Heating Value

Optional Inputs If Available

- Flow Rate* – Blowdown
- Flow Rate* – Evaporator Circulating Water
- Temperature(s) – Flue Gas Path
- Temperature(s)* – Economizer Exit Water
- Temperature(s)* – Intermediate Superheated Steam
- Temperature – Supplementary Fuel
- Pressure* – Boiler Feed Water (BFW)
- Pressure* – Steam Drum
- Duty – Additional Heat Sinks (e.g. District or Oil Heating)
- Analysis – Flue Gas Analysis (e.g. NO_x / SO_x / CO_x / H₂O)

* Required for each steam pressure level

Module Calculation Method

- ASME PTC 4.4 (input-output and thermal-loss efficiencies)
 - The design efficiency values calculated from performance data in accordance to the PTC definitions:
- Output is the heat absorbed by the working fluids.
- Input is the sensible heat in the exhaust gas supplied to the HRSG, plus the chemical heat in any supplementary fuel, plus the heat credit supplied by the sensible heat in any supplementary fuel.

Module Outputs

- Thermal Efficiency – Actual
- Thermal Efficiency – Design (Baseline)
- Thermal Efficiency – Deviation
- Thermal Efficiency – Thermal Loss Actual
- Thermal Efficiency – Thermal Loss Design
- Thermal Efficiency – Thermal Loss Deviation
- Flow Rate(s) – Steam
- Flow Rate(s) – Steam Design
- Flow Rate(s) – Steam Deviation
- Available Heat
- Deviation Cost (Lost Steam Production)

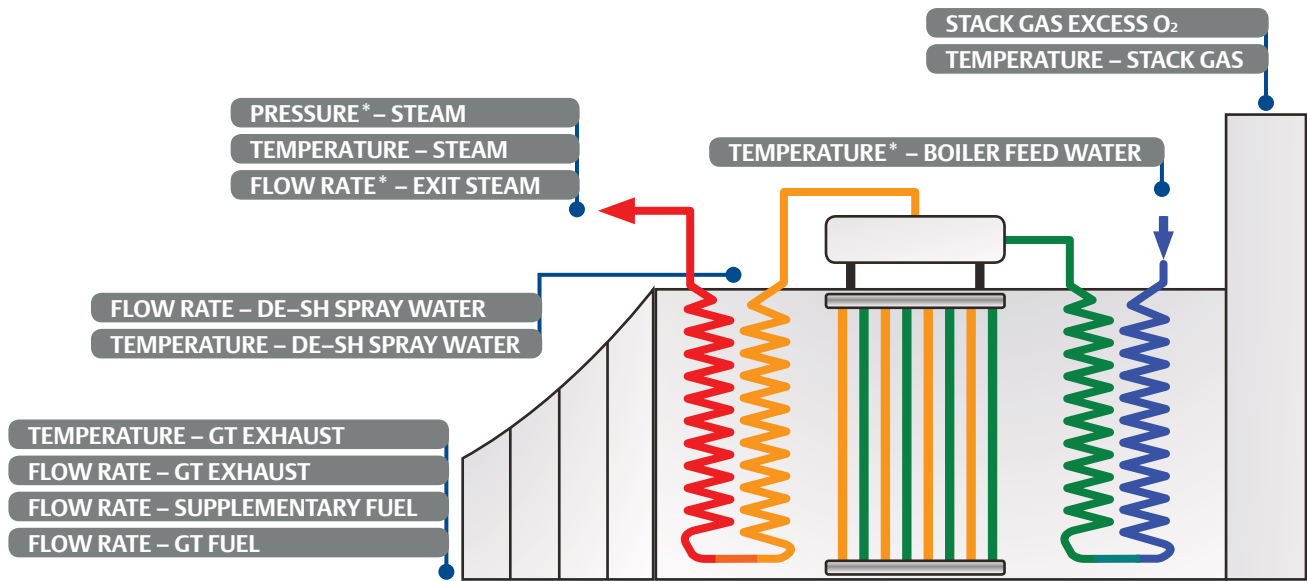
Additional Available Outputs

- Flow Rate – Blowdown (if not supplied)
- Flue Gas Path Approach Temperatures
- Pinch Point Analysis

Module: Heat Recovery Steam Generator (HRSG)

Module Process Flow Diagram

- Single pressure level



OPTIONAL

- | | |
|--|---|
| FLOW RATE* - BLOWDOWN | PRESSURE* - BOILER FEED WATER |
| TEMPERATURE(S) - FLUE GAS | PRESSURE* - STEAM DRUM |
| TEMPERATURE(S) - ECONOMIZER EXIT WATER | FUEL COMPOSITION - SUPPLEMENTARY FUEL |
| TEMPERATURE(S) - INTERMEDIATE SH STEAM | ADDITIONAL HEAT SINKS (E.G. DISTRICT HEATING) |
| TEMPERATURE - SUPPLEMENTARY FUEL | FLUE GAS ANALYSIS |

Module: Fired Heater / Furnace

Module Process Flow Diagram

- See Fired Heater Figure

Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Rated Cases: (50%, 70%, 80%, 90%, 100% load)

Module Inputs

- Fuel – Feed Composition, Heating Values
- Flow Rate(s) – Fuel
- Flow Rate(s) – Process
- Temperature – Feed Air
- Temperature – Process Inlet
- Temperature(s) – Process Exit
- Temperature – Stack Gas
- Pressure(s) – Process Inlet / Exit
- Analysis – Combustion O₂

Optional Inputs If Available

- Flow Rate – Feed Air
- Flow Rate – Heat Recovery Medium (e.g. steam)
- Temperature – Fuel Feed
- Temperature – Furnace Firing
- Temperature – Combustion Air
- Temperature(s) – Heat Recovery Medium (e.g. steam)
- Temperature(s) – Intermediate Process
- Temperature(s) – Flue Gas Path
- Pressure(s) – Intermediate Process Superheater
- Pressure(s) – Heat Recovery Medium (e.g. steam)
- Analysis – Stack Excess O₂
- Analysis – Flue Gas (e.g. NO_x / SO_x / CO_x / H₂O)

Module Calculation Method

- ASME PTC

Module Outputs

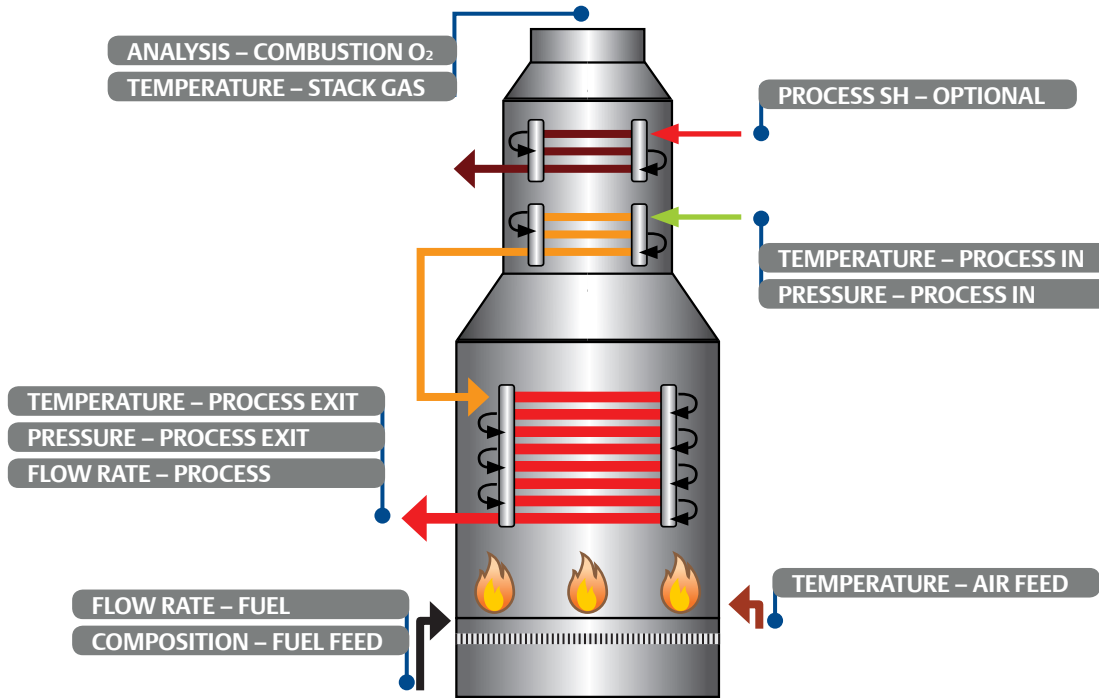
- Efficiency – Actual (Heat Loss and Input / Output)
- Efficiency – Design (Baseline)
- Efficiency – Deviation
- Flow Rate – Process Actual
- Flow Rate – Process Design (Baseline)
- Flow Rate – Process Deviation
- Combustion O₂ – Actual
- Combustion O₂ – Design (Baseline)
- Combustion O₂ – Deviation
- Total Fired Heat
- Deviation Cost (Additional Fuel Consumption)

Additional Available Outputs

- Heat Loss – Total
- Heat Loss in Dry Gas
- Heat Loss due to Moisture in the Fuel
- Heat Loss in the Moisture Formed from Hydrogen
- Heat Loss in the Moisture in the Supplied Air
- Heat Loss due to Ash
- Heat Loss due to Radiation
- Heat Loss due to Carbon Monoxide
- Process Duty
- Process Approach Temperature
- Additional Heat Recovery Duty

Module: Fired Heater / Furnace

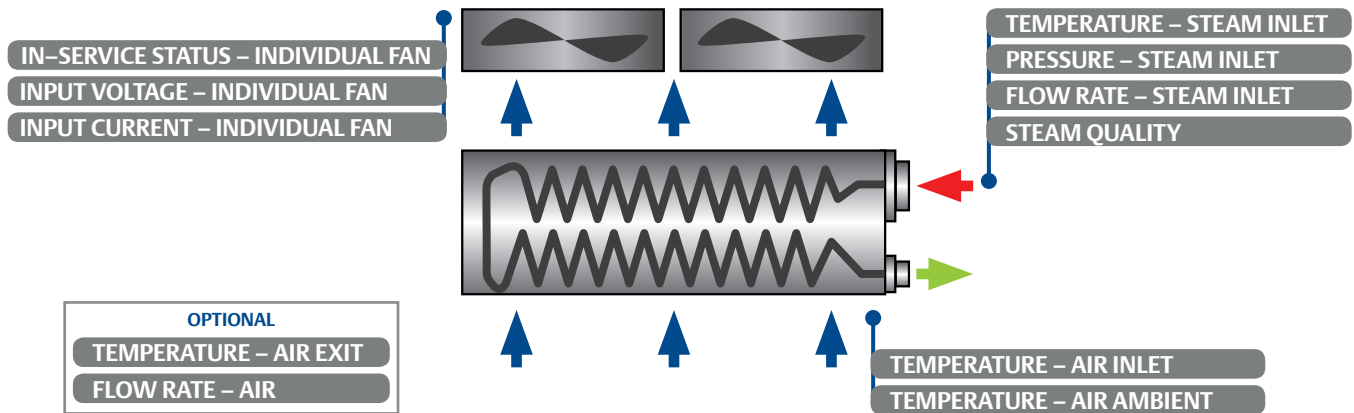
Module Process Flow Diagram



- OPTIONAL**
- FLOW RATE - FEED AIR
 - FLOW RATE - HEAT RECOVERY MEDIUM
 - TEMPERATURE - FUEL FEED
 - TEMPERATURE - FURNACE FIRING
 - TEMPERATURE - COMBUSTION AIR
 - TEMPERATURE(S) - HEAT RECOVERY MEDIUM
 - TEMPERATURE(S) - INTERMEDIATE PROCESS
 - TEMPERATURE(S) - FLUE GAS ALONG PATH
 - PRESSURE(S) - INTERMEDIATE PROCESS
 - PRESSURE(S) - HEAT RECOVERY MEDIUM
 - STACK GAS EXCESS O₂
 - FLUE GAS ANALYSIS

Module: Condenser (Air Cooled)

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Operating Curves: Capacity Versus Ambient Temperature

Module Inputs

- Flow Rate – Steam Inlet (or Condensate)
- Temperature – Steam Inlet (or Condensate)
- Temperature – Condensate (if Subcooled)
- Temperature – Air Inlet
- Temperature – Air Ambient
- Pressure – Steam Inlet
- Steam Quality (if at Saturation)
- In-Service Status – Individual Fan (as appropriate)
- Input Voltage – Individual Fan (as appropriate)
- Input Current – Individual Fan (as appropriate)

Optional Inputs If Available

- Temperature – Air Exit
- Flow Rate – Air

Module Calculation Method

- ASME PTC 12.2 – Model utilizes the standards of Heat Exchange Institute for Steam Surface Condensers.
- ASME PTC 30.1 – Utilized with forced air draft systems.

Module Outputs

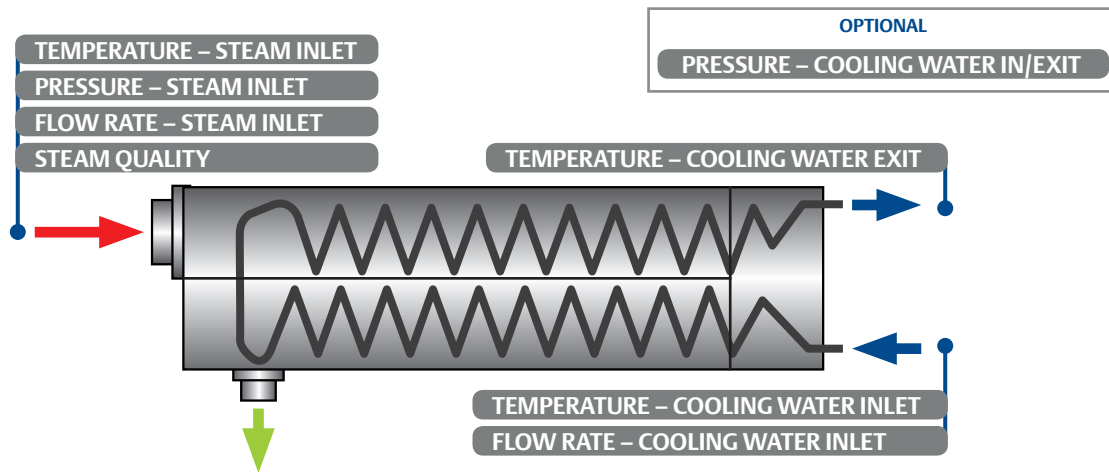
- Efficiency – Actual (Overall Duty)
- Efficiency – Design (Baseline Duty)
- Efficiency – Deviation
- Heat Transfer Coefficient – Overall
- Heat Transfer Coefficient – Design (Baseline)
- Heat Transfer Coefficient – Deviation
- Capacity (Heat Duty)
- Deviation Cost

Additional Available Outputs

- Temperature(s) – Approach
- LMTD (as appropriate)
- Air Temperature Rise

Module: Condenser (Water Cooled)

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Operating Curves: Heat Transfer Coefficient

Module Inputs

- Flow Rate – Steam Inlet
- Flow Rate – Cooling Water Inlet
- Temperature – Steam Inlet
- Temperature – Condensate (if Subcooled)
- Temperature – Cooling Water Inlet
- Temperature – Cooling Water Exit
- Pressure – Steam Inlet
- Steam Quality (if at Saturation)

Optional Inputs If Available

- Pressure(s) – Cooling Water In / Exit

Module Calculation Method

- ASME PTC 12.2 – Model utilizes the standards of Heat Exchange Institute for Steam Surface Condensers.

Module Outputs

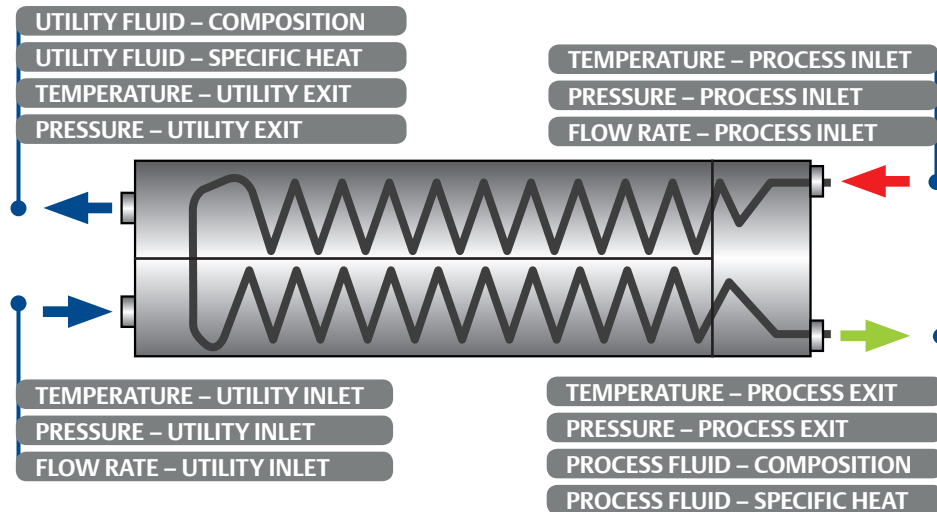
- Efficiency – Actual (Overall Duty)
- Efficiency – Design (Baseline Duty)
- Efficiency – Deviation
- Heat Transfer Coefficient – Overall
- Heat Transfer Coefficient – Design (Baseline)
- Heat Transfer Coefficient – Deviation
- Capacity (Heat Duty)
- Deviation Cost

Additional Available Outputs

- Temperature(s) – Approach
- LMTD
- Cooling Water Pressure Drop
- Water Temperature Rise

Module: Heat Exchanger

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design Specification Sheets
- Operating Curves: Duty Versus Utility Flow, Duty Versus Utility Pressure

Module Inputs

- Flow Rate – Process Inlet
- Flow Rate – Utility Inlet
- Temperature – Process Inlet
- Temperature – Process Exit
- Temperature – Utility Inlet
- Temperature – Utility Exit
- Pressure – Process Inlet
- Pressure – Process Exit
- Pressure – Utility Inlet
- Pressure – Utility Exit
- Utility Fluid Composition
- Utility Fluid Specific Heat Capacity (Cp)
- Process Fluid Composition (if available)
- Process Fluid Specific Heat Capacity (Cp)

Module Calculation Method

- ASME PTC 12.5 – Utilized in single phase applications.
- ASME PTC 30 (Air Cooled) – Utilized in air cooled single phase applications.

Module Outputs

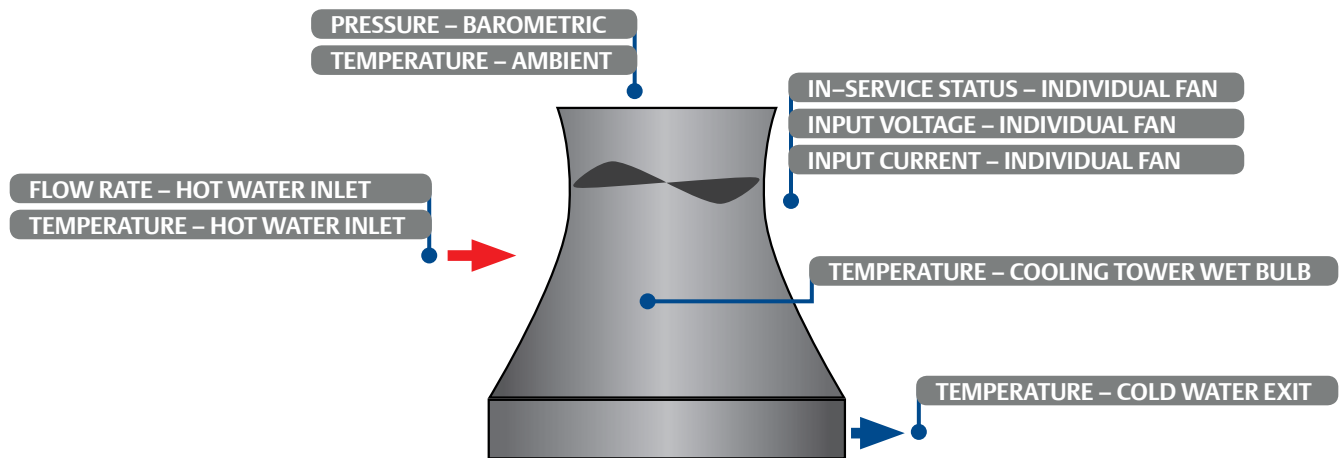
- Efficiency – Actual (Overall Duty)
- Efficiency – Design (Baseline Duty)
- Efficiency – Deviation
- Heat Transfer Coefficient – Overall
- Heat Transfer Coefficient – Design (Baseline)
- Heat Transfer Coefficient – Deviation
- Capacity (Heat Duty)
- Deviation Cost (Increased Utility Consumption)

Additional Available Outputs

- Temperature(s) – Approach
- Temperature Change – Utility
- Temperature Change – Process
- LMTD (as appropriate)

Module: Cooling Tower

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Operating Curves: Duty Versus Cooling Water Flow, Duty Versus Ambient Temp

Module Calculation Method

- ASME PTC 23

Module Inputs

- Flow Rate – Water Inlet
- Temperature – Water Inlet
- Temperature – Water Exit
- Temperature – Cooling Tower Wet Bulb
- Temperature – Ambient
- Pressure – Barometric
- In-Service Status – Individual Fan (as appropriate)
- Input Voltage – Individual Fan (as appropriate)
- Input Current – Individual Fan (as appropriate)

Module Outputs

- Cooling Tower Capability – Actual
- Cooling Tower Capability – Design
- Cooling Tower Capability – Deviation
- Capacity (Heat Duty)
- Deviation Cost (Increased Fan Power Consumption or Additional Cool Water required)

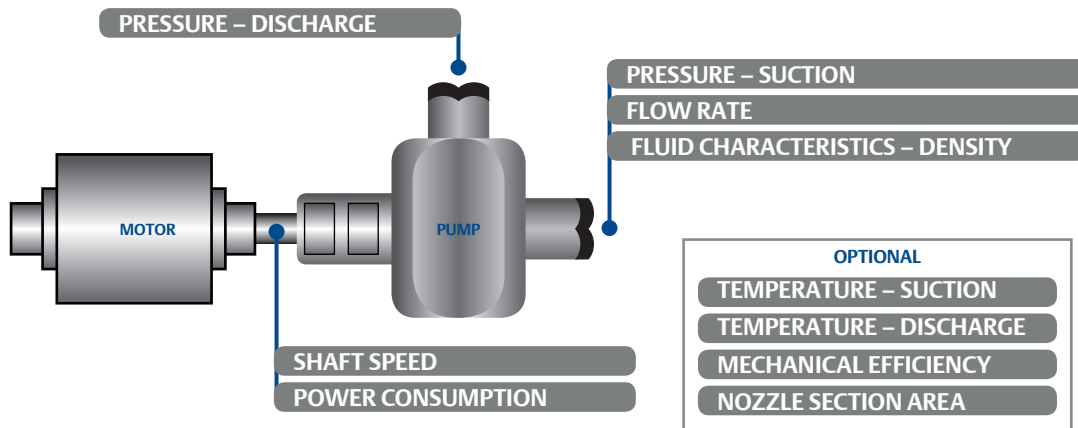
Additional Available Outputs

- Temperature(s) – Approach

Module: Pump

Module Process Flow Diagram

- Motor driven shown



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Operating Curves: Head Versus Flow, Efficiency Versus Flow, Power Versus Flow
- Rated Cases: 60%, 80%, 90%, 100% load or at a constant rated speed

Module Inputs

- Flow Rate – Measurement point inside any recycle loops
- Pressure – Inlet / Suction
- Pressure – Exit / Discharge
- Shaft Speed (on variable speed machines)
- Power Consumption (or Motor Current, Volts, and pF)
- Fluid Characteristics – Density

Optional Inputs If Available

- Mechanical Efficiency (Shaft)
- Temperature – Inlet / Suction
- Temperature – Exit / Discharge
- Nozzle Areas

Module Calculation Method

- ASME PTC 8.2 – Pump efficiency, head and corrected head are calculated. Design pump head is calculated from the pump characteristic curve.

Module Outputs

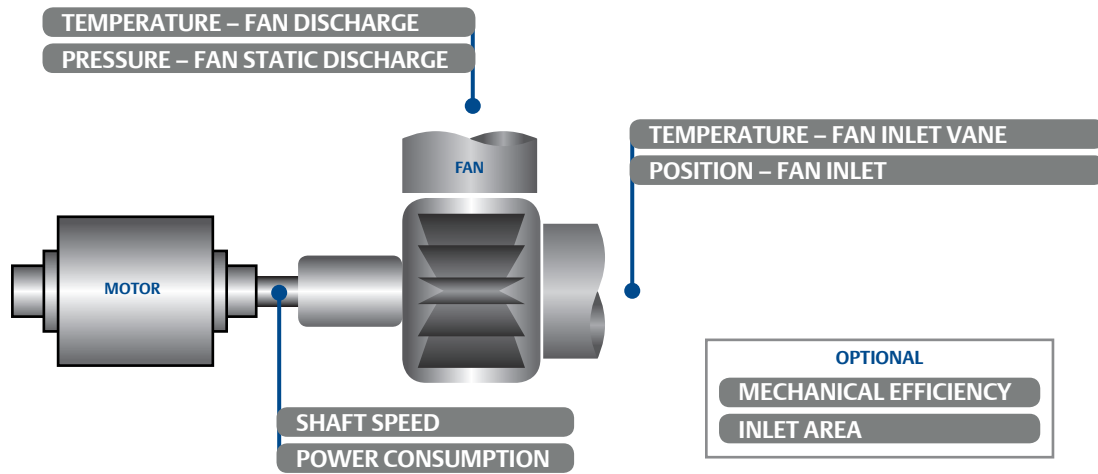
- Efficiency – Actual (Overall Duty)
- Efficiency – Design (Baseline Duty)
- Efficiency – Deviation
- Pump Head – Actual
- Pump Head – Design
- Pump Head – Deviation
- Pump Head – Corrected
- Deviation Cost (Lost Throughput and/or Additional Power Consumption)

Additional Available Outputs

- Flow Rate – Volumetric
- Velocity – Suction
- Velocity – Discharge
- Velocity Head – Suction
- Velocity Head – Discharge
- Pressure Ratio
- Speed – Design
- Power – Actual
- Power – Specific
- Power – Corrected
- Best Efficiency Point and Deviation

Module: Fan

Module Process Flow Diagram



Equipment Design Information

- Piping & Instrumentation Diagrams (P&ID)
- OEM Design / Equipment Specification Sheets
- Operating Curves: Head Versus Flow, Efficiency Versus Flow, Power Versus Flow
- Rated Cases: e.g., 100% load, 90% load, or single-speed unit

Module Inputs

- Pressure – Fan Static Discharge
- Vane Position – Fan Inlet / Suction
- Temperature – Fan Inlet / Suction
- Temperature – Fan Exit / Discharge
- Power Consumption (or Motor Current, Volts and pF)
- Shaft Speed (on variable speed machines)

Optional Inputs If Available

- Mechanical Efficiency (Shaft)
- Inlet Area

Module Calculation Method

- ASME PTC 11 – Computes the efficiency of forced draft, induced draft, and primary and secondary air fans. Design efficiencies are computed based on manufacturer's design data and deviations are reported.

Module Outputs

- Efficiency – Actual
- Efficiency – Design
- Efficiency – Deviation
- Fan Power – Actual
- Fan Power – Design
- Fan Power – Deviation
- Static Pressure – Deviation
- Deviation Cost (Lost Throughput or Additional Power Consumption)

Additional Available Outputs

- Flow Rate – Volumetric
- Velocity – Suction
- Velocity – Discharge
- Velocity Head – Suction
- Velocity Head – Discharge
- Pressure Ratio

Hardware and Software Requirements

Emerson's experts will work with the client to perform the necessary project and site scoping activities to define the hardware required, including any new recommended instrumentation and wireless infrastructure. While wireless devices provide an easy means of adding missing measurements, Plantweb Performance Advisor solutions can make use of existing wired or wireless measurements. Emerson has created several tools to help determine what instrumentation and wireless capabilities are needed to support various assets at a site.

The Plantweb Performance Advisor performance models run on an OSIsoft Asset Framework (AF) server. Performance Advisor can be installed in conjunction with an existing plant PI system, or Emerson can supply a system as a part of the project. The AF server provides the object model for the equipment monitoring algorithms and context and hierarchy for the real-time data feeding the models. The application can be easily integrated with other existing plant historians (IP21, PHD, etc.) through data connectivity solutions from OSIsoft.

System Compatibility

Recommended Microsoft Windows operating systems supported by OSIsoft PI includes Window Server 2008 R2 SP1 or later. OSIsoft Asset Framework 2015 or later is required for the modules and IIS 7.0 or later for the Web Server

Minimum system specifications for a single user system can be found on the OSIsoft Support web page listed below. Server requirements depend on the number of PI elements (or tags) in the system. AF can run on the same server or can be installed on a separate server for large systems. For the latest information on the hardware and software specification, see the OSIsoft Support page: <http://techsupport.osisoft.com>

Ordering Information

The Plantweb Performance Advisor module libraries are licensed on a per-asset basis and will be delivered ready for configuration. The Performance Advisor module library comes as a set of pre-configured templates in AF. There is also a Foundation license which includes the base functions used by all the assets.

Foundation Licence

Emerson Part Number	Product License Description
PAS-PA-BASE	Foundation (Installation & General Customization)

Asset Licenses

Emerson Part Number	Product License Description
PPI-CCP-CTG-PRF	Combustion Gas Turbine Performance Monitor & Plant Heat Rates UNIQUE 1ST
PAS-PA-CTG-PRF-ADDSIM	Combustion Gas Turbine Performance Monitor & Plant Heat Rates (Additional Similar)
PAS-PA-CCR-PRF-UNI1ST	Centrifugal Compressor Condition Monitor UNIQUE 1ST
PAS-PA-CCR-PRF-ADDSIM	Centrifugal Compressor Condition Monitor (Additional Similar)
PAS-PA-RCR-PRF-UNI1ST	Reciprocating Compressor Condition Monitor UNIQUE 1ST
PAS-PA-RCR-PRF-ADDSIM	Reciprocating Compressor Condition Monitor (Additional Similar)
PAS-PA-TEX-PRF-UNI1ST	Turbo Expander (Expansion Turbine) Condition Monitor UNIQUE 1ST
PAS-PA-TEX-PRF-ADDSIM	Turbo Expander (Expansion Turbine) Condition Monitor (Additional Similar)
PAS-PA-HRS-PRF-UNI1ST	HRSG Condition Monitor UNIQUE 1ST
PAS-PA-HRS-PRF-ADDSIM	HRSG Condition Monitor (Additional Similar)
PAS-PA-BLR-EFF-UNI1ST	Boiler Efficiency & Unit Heat Rates (Rankine Cycle Units) UNIQUE 1ST

Asset Licences (continued)

Emerson Part Number	Product License Description
PAS-PA-BLR-EFF-ADDSIM	Boiler Efficiency & Unit Heat Rates (Rankine Cycle Units) (Additional Similar)
PAS-PA-BAH-PRF-UNI1ST	Boiler & Air Heater Condition Monitor (Rankine Cycle Units) UNIQUE 1ST
PAS-PA-BAH-PRF-ADDSIM	Boiler & Air Heater Condition Monitor (Rankine Cycle Units) (Additional Similar)
PAS-PA-BAX-PRF-UNI1ST	Auxiliary Boiler Efficiency and Performance UNIQUE 1ST
PAS-PA-BAX-PRF-ADDSIM	Auxiliary Boiler Efficiency and Performance (Additional Similar)
PAS-PA-STB-PRF-UNI1ST	Steam Turbine Condition Monitor UNIQUE 1ST
PAS-PA-STB-PRF-ADDSIM	Steam Turbine Condition Monitor (Additional Similar)
PAS-PA-WCC-PRF-UNI1ST	Water Cooled Condenser Condition Monitor UNIQUE 1ST
PAS-PA-WCC-PRF-ADDSIM	Water Cooled Condenser Condition Monitor (Additional Similar)
PAS-PA-CTR-PRF-UNI1ST	Cooling Tower Condition Monitor UNIQUE 1ST
PAS-PA-CTR-PRF-ADDSIM	Cooling Tower Condition Monitor (Additional Similar)
PAS-PA-CWP-ADV-UNI1ST	Circ Water Pump Advisor UNIQUE 1ST
PAS-PA-CWP-ADV-ADDSIM	Circ Water Pump Advisor (Additional Similar)
PAS-PA-PMP-PRF-UNI1ST	Pump Condition Monitor UNIQUE 1ST
PAS-PA-PMP-PRF-ADDSIM	Pump Condition Monitor (Additional Similar)
PAS-PA-FWH-PRF-UNI1ST	Feedwater Heater Condition Monitor UNIQUE 1ST
PAS-PA-FWH-PRF-ADDSIM	Feedwater Heater Condition Monitor (Additional Similar)
PAS-PA-DEA-PRF-UNI1ST	Deaerator Condition Monitor UNIQUE 1ST
PAS-PA-DEA-PRF-ADDSIM	Deaerator Condition Monitor (Additional Similar)
PAS-PA-HX-PRF-UNI1ST	Heat Exchanger Condition Monitor UNIQUE 1ST
PAS-PA-HX-PRF-ADDSIM	Heat Exchanger Condition Monitor (Additional Similar)
PAS-PA-BLO-PRF-UNI1ST	Blower Condition Monitor UNIQUE 1ST
PAS-PA-BLO-PRF-ADDSIM	Blower Condition Monitor (Additional Similar)
PAS-PA-BBM-PRF-UNI1ST	Biomass Boiler Efficiency and Performance UNIQUE 1ST
PAS-PA-BBM-PRF-ADDSIM	Biomass Boiler Efficiency and Performance (Additional Similar)
PAS-PA-RKP-OCA-UNI1ST	Rankine Plant Operations Cost Analysis UNIQUE 1ST
PAS-PA-RKP-OCA-ADDSIM	Rankine Plant Operations Cost Analysis (Additional Similar)
PAS-PA-CHL-PRF-ADDSIM	Chiller Performance Monitor & Advisor (Additional Similar)
PAS-PA-GEN-RCP-UNI1ST	Generator Reactive Capability UNIQUE 1ST
PAS-PA-GEN-RCP-ADDSIM	Generator Reactive Capability (Additional Similar)
PAS-PA-CTG-FRC-UNI1ST	Combustion Gas Turbine Forecast UNIQUE 1ST

Asset Licences (continued)

Emerson Part Number	Product License Description
PAS-PA-CTG-FRC-ADDSIM	Combustion Gas Turbine Forecast (Additional Similar)
PAS-PA-PLT-FRC-SITE	Combined Cycle Output Forecast (Site)
PAS-PA-CTG-ETP-UNI1ST	Combustion Gas Turbine Exhaust Temperature Profile UNIQUE 1ST
PAS-PA-CTG-ETP-ADDSIM	Combustion Gas Turbine Exhaust Temperature Profile (Additional Similar)
PAS-PA-CTG-OCA-UNI1ST	Combustion Gas Turbine Operations Cost Analysis UNIQUE 1ST
PAS-PA-CTG-OCA-ADDSIM	Combustion Gas Turbine Operations Cost Analysis (Additional Similar)
PAS-PA-CTG-OWA-UNI1ST	Combustion Gas Turbine Offline Wash Advisor UNIQUE 1ST
PAS-PA-CTG-OWA-ADDSIM	Combustion Gas Turbine Offline Wash Advisor (Additional Similar)
PAS-PA-CHL-PRF-UNI1ST	Chiller Performance Monitor & Advisor UNIQUE 1ST
PAS-PA-WTB-PRF-UNI1ST	Wind Turbine Condition Monitor UNIQUE 1ST
PAS-PA-WTB-PRF-ADDSIM	Wind Turbine Condition Monitor (Additional Similar)
PAS-PA-WTB-FRC-SITE	Wind Turbine Forecast (per site)
PAS-PA-BLR-AEO	Adaptive Emissions Optimizer for Coal Boilers
PAS-PA-PLT-EPA-UNI1ST	Emissions & EPA Calculations UNIQUE 1ST
PAS-PA-PLT-EPA-ADDSIM	Emissions & EPA Calculations (Additional Similar)
PAS-PA-TTC-MDL-UNI1ST	Thermodynamic Turbine Cycle Model UNIQUE 1ST
PAS-PA-TTC-MDL-ADDSIM	Thermodynamic Turbine Cycle Model (Additional Similar)
PAS-PA-CCP-PLT-OPT	Combined Cycle Configuration Optimizer
PAS-PA-PLT-CTG-LCM-UNI1ST	Combustion Gas Turbine Stress and Life Cycle Monitor UNIQUE 1ST
PAS-PA-PLT-CTG-LCM-ADDSIM	Combustion Gas Turbine Stress and Life Cycle Monitor (Additional Similar)
PAS-PA-STB-LCM-UNI1ST	Steam Turbine Stress and Life Cycle Monitor UNIQUE 1ST
PAS-PA-STB-LCM-ADDSIM	Steam Turbine Stress and Life Cycle Monitor (Additional Similar)
PAS-PA-HRS-LCM-UNI1ST	HRSG Metal Stress and Life Cycle Monitor UNIQUE 1ST
PAS-PA-HRS-LCM-ADDSIM	HRSG Metal Stress and Life Cycle Monitor (Additional Similar)
PAS-PA-VIB-MON-UNI1ST	Vibrations Waterfall Monitor UNIQUE 1ST
PAS-PA-VIB-MON-ADDSIM	Vibrations Waterfall Monitor (Additional Similar)
PAS-PA-COK-BAT-TOT	Coking Battery and Oven Monitor and Totalizer

Bundled Package Licenses

Emerson Part Number	Product License Description
PAS-PA-RBL-PKG-UNI1ST	Rankine Boiler Solution 1st Boiler
PAS-PA-RBL-PKG-ADDSIM	Rankine Boiler Solution Additional Boiler
PAS-PA-RST-PKG-UNI1ST	Rankine Steam Turbine Solution 1st Turbine
PAS-PA-RST-PKG-ADDSIM	Rankine Steam Turbine Solution Additional Turbine
PAS-PA-CCS-PKG-UNI1ST	Combined Cycle Steam Turbine Solution 1st Turbine
PAS-PA-CCS-PKG-ADDSIM	Combined Cycle Steam Turbine Solution Additional Turbine
PAS-PA-CTG-PKG-UNI1ST	Combustion Gas Turbine Solution 1st Turbine
PAS-PA-CTG-PKG-ADDSIM	Combustion Gas Turbine Solution Additional Turbine
PAS-PA-CCP-PKG-UNI1ST	Combined Cycle Plant Solution 1st Plant
PAS-PA-CCP-PKG-ADDSIM	Combined Cycle Plant Solution Additional Plant

Related Products

Plantweb™ Advisor Suite: Uses predictive intelligence to improve the availability and performance of key production assets, including mechanical equipment, electrical systems, process equipment, instruments, and valves. This integrated family of diagnostic software applications enables users to detect plant equipment problems before they occur and provides the information to help make informed decisions.

- **Plantweb™ Health Advisor:** A cost-effective, statistically-based solution to monitor essential assets – those that have repeated failures or assets in important service areas where a failure can cause significant financial impact such as production loss, environmental or safety incidents.
- **Plantweb™ Energy Advisor:** A real-time Energy Management Information System (EMIS) that automates the process of mapping and managing energy consumption, across a site, as it is being consumed. Real-time alerts, dashboards and emails notify decision-makers when energy consumption is above expected so that actions may be taken to drive down energy costs.

Plantweb Insight: Web-based application package used for real-time monitoring of key industrial assets. Part of Emerson's Plantweb digital ecosystem, Plantweb Insight uses strategic interpretation and analytics to transform raw data into actionable information designed to improve operational areas such as health, safety, reliability, and energy usage.

AMS ARES: Emerson's ARES Platform collects asset data from field-based wired and wireless sensors and delivers information on only the most critical situations, enabling you to make well informed decisions to maintain availability. The ARES Platform utilizes modern communication tools to deliver alerts to both traditional desktop PCs and laptops as well as the tablets and smart phones available outside the office or plant. Remote accessibility to smart alerts in a secure environment means operators and maintenance personnel alike are on top of the performance of critical production assets always.

AMS Intelligent Device Manager: helps avoid unnecessary costs from unplanned shutdowns and inefficient practices, with a universal window into the health of intelligent field devices. Based on real-time condition data from intelligent field devices, plant staff can respond fast and take informed decisions on device maintenance.

AMS Machinery Health Manager: Designed for rotating equipment specialists, Machinery Health Manager diagnoses and communicates the health of mechanical and rotating machinery using data from several maintenance technologies. The result is a comprehensive view of each monitored machine and a more accurate diagnosis when developing problems are discovered.

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