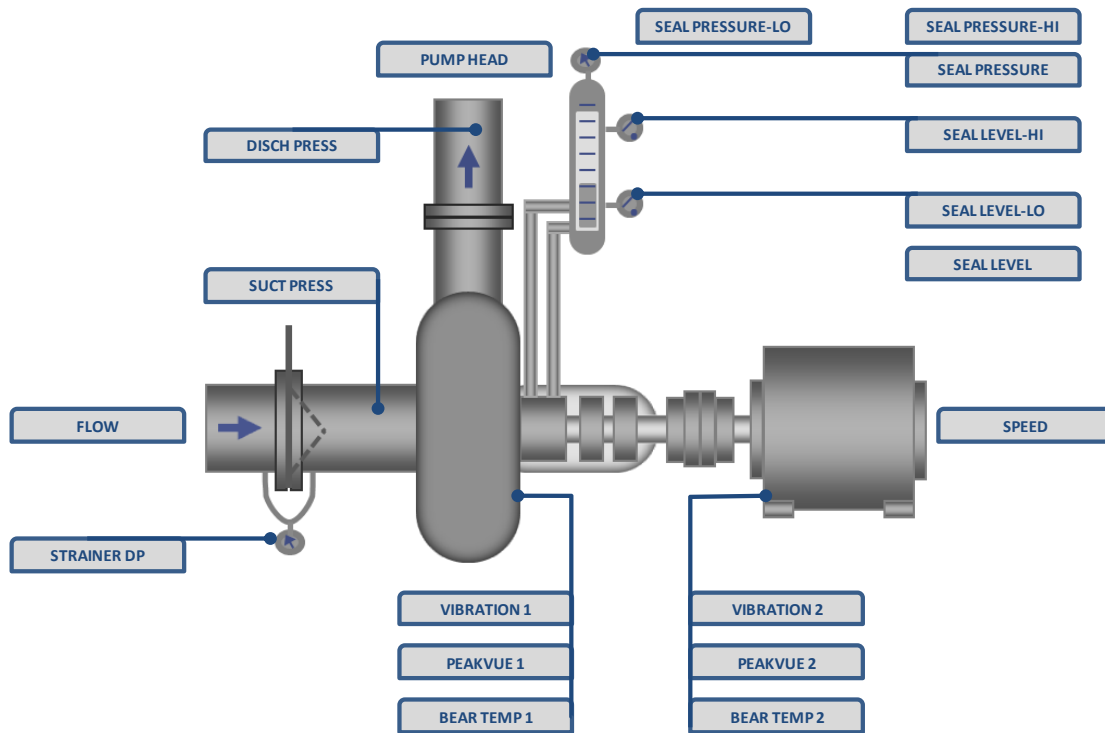


Pumps

Module Process Flow Diagram



Features

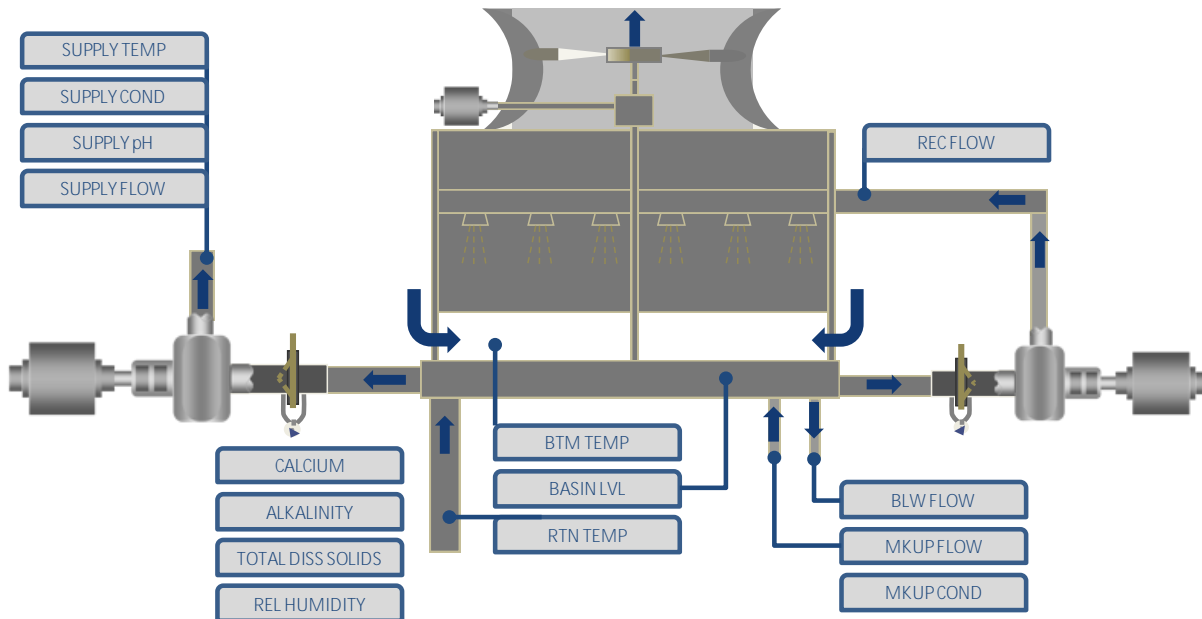
- Supports monitoring of both fixed as well as variable speed pumps
- Basic configuration supports single vibration sensor (overall and PeakVue™) and pump speed indicator for variable frequency drives
- Advanced configuration supports:
 - Additional vibration sensors
 - Two motor bearing temperature sensors
 - Suction and discharge pressure sensors
 - Strainer differential pressure sensor
 - Seal oil pressure and level switches
 - Flow sensor
 - Hydrocarbon leak detector
 - Motor run/stop indicator
- Cavitation detection a combination of PeakVue™ vibration and discharge pressure standard deviation

Calculations Alarms

- Pump Run/Stop Status
- Run Time
- Pump Pressure Differential
- Statistical Performance Calculations (Vibration Monitoring)
- Cavitation Detection
- Baseline Capture (Process alarm limits)
- Pump Health Indicator
- - Vibration Health
- - Alarm Health

Cooling Towers

Module Process Flow Diagram



Features

- Supports combination of components for cooling water basins, fans and pumps. Functionality for fans and pumps is the same as air cooled exchangers and other types of pumps
- Advanced configuration cooling water basin supports:
 - Tower bottom air temperature sensor
 - Cooling Water supply temperature sensor
 - Cooling Water return temperature sensor
 - Water Conductivity sensor
 - Water pH sensor
 - Basin Water level sensor
 - Supply Flow sensor
 - Recirculation Flow sensor
 - Blowdown Flow sensor
 - Makeup Flow sensor
 - Makeup Conductivity sensor
 - Hardness in water as CaCO₃ input
 - Alkalinity as CaCO₃ input
 - Total Dissolved Solids input
 - Relative Humidity input

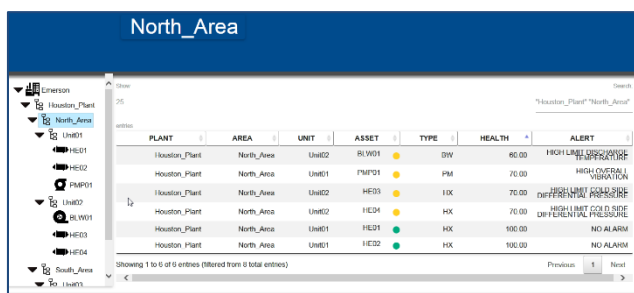
Calculations and alarms

- Baseline Capture (Process alarm limits)
- Cooling Tower Performance Index
- Evaporative Loss
- Recommended Blowdown Flow
- Recommended Makeup Flow
- Cycles of concentration
- Saturation Index
- Equipment Run Time
- Asset (pump and fan) faults
- Cooling Tower Health Indicator
 - Vibration Health
 - Alarm Health

User Interface

The primary user interface to the Health Advisor system is through a web based application designed for PCs as well as mobile device users. The web interface uses a tree structure to navigate between sites, plant areas, process units and assets. The user view has a similar look and feel at each level, with more detail added as the user drills down into the specific assets.

At the Client, Plant, Area and Unit levels of the hierarchy, a list of the assets in that part of the hierarchy is shown with their overall status, active alerts and their health values as shown below. The user can sort on any column by just clicking to column header. A search field at the top right provides a global search function.



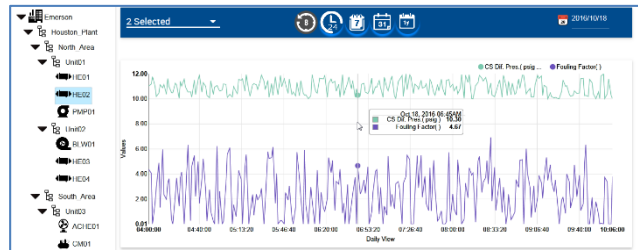
Asset Summary View

From this view, the user is allowed to search, filter and sort by any of the fields in the display. This view provides:

- Quick visual assessment of asset health through status button colors
 - Red - Critical
 - Yellow - Warning
 - Green - Healthy
- Alarm text and health status (0-100%) indications for each asset
- Icons for each asset that provide shortcuts to the detail pages
- Double-clicking on any of the lines in the display will open a detailed display for that asset.

Asset View

Each asset has a detailed view that provides a quick way to assess the health, active alerts and deviations from baseline. The asset view is divided into three main sections. At the top, a trend chart function provides trending for all the variables monitored for that asset.

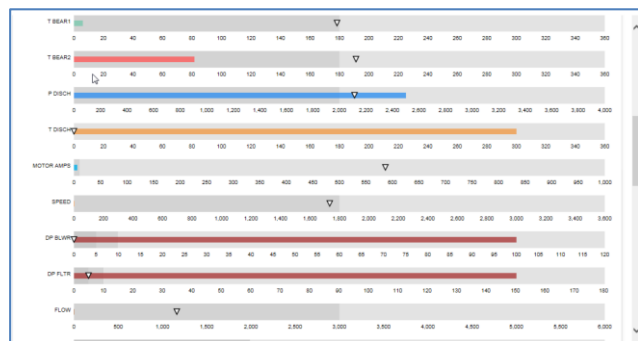


Asset Summary View

From the Trend view, a user can:

- Choose a timeframe for the chart view: 8 hr, 24 hr, 1 week, 1 month or 1 year
- Select the end-time for the chart using the calendar icon
- Select/deselect variables to be trended Use a scroll bar to look at specific values in the trend

Below the trend chart is a set of bar charts for all of the inputs and KPI calculations to provide a quick visual display of current value for all the variables along with the maximum and minimum alert limits and the baseline value. An example is shown below.



Input and KPI view

Finally, at the bottom of the Asset view is a tabular view of all the inputs, their status, current value and baseline value as shown below.

VARIABLE	STATUS	ACTUAL	BASELINE
DP BLWR	●	100.01	0.00
DP FLTR	●	150.34	4.96
FLOW	●	0.27	1102.04
LVRPOSACT	●	100.44	50.00
LVRPOSDEV	●	180.28	0.00
LVRPOSTGT	●	150.66	50.00
MOTOR AMPS	●	6.36	586.74
P DISCH	●	2500.00	2114.43
P SUCT	●	5.90	45.43
APFED	●	5.44	1734.81
T BEAR1	●	6.07	173.44
T BEAR2	●	81.66	191.28
T DISCH	●	300.00	0.00
T SUCT	●	300.00	0.00

Input status view

From the Asset view, a user can select the wrench icon at the top of the page to view and edit the alert limits. An example of the alert limits window is shown below.

Measurement	Value	Baseline	Low				High						
			Enable	Autolimit	Manual	Multipier	Flas	Enable	Autolimit	Manual	Multipier	Flas	
Coeff. Corrected	140081.30	136070.80	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0.00	0.00	0.00	0.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	150000.00	1.20	0.00
Coeff. Observed	145719.20	141400.20	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0.00	0.00	0.00	0.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	150000.00	1.20	0.00

Alarm Configuration

From the Alarm Configuration window, a user can enable/disable an alert, set the manual alert limits and configure the Auto-Limit calculation. When Auto-limit is turned on, limits are automatically calculated from the baseline value. Clicking on the Information icon at the top of the Asset view opens a window with more detailed asset information as shown below.

HE02 Health: 100.00%

Status: OK | Manufacturer: Manufacturer 1 | Starts last since maint: 0.00

Installation Date: 7/7/2016 6:00:00 AM | Run hours since installation: 2624.26 | Last maintenance: 8/3/2016 6:00:00 AM | Run hours since maintenance: 1880.26

2 Selected

From this view, a user gets an overview of the asset status, manufacturer, installation date, total number of running hours, and starts and run time since last maintenance.

Asset Tuning and Setup

The Plantweb Health Advisor application is preconfigured with default settings for process alarms defined for the asset. Before using the monitoring functions provided by the framework, it is recommended that users configure the alarm settings for the asset based on process requirements. Alternatively, an Auto-Limit calculation will set limits based on a deviation from the baseline value. These alarm settings can be adjusted online at any point in the future.

Baseline Capture

The application has the capability to capture a baseline set of inputs and key performance data during a period when the asset is running normally, which can be used to automatically set default alarms and limits. The Baseline Capture function is only available to authorized users and it requires user action and confirmation.

Baseline for an asset represents a snapshot of normal process conditions when the asset is running. Therefore, whenever the operating conditions change, it should get reflected in a new baseline. When process conditions vary frequently, it might be necessary to capture multiple baselines representing different operating conditions. Plantweb Health Advisor architecture offers a feature which allows a user to save and restore baselines along with associated configuration settings, termed as 'Snapshot'. A snapshot would typically consist of the following data:

- Static baseline values of all process parameters
- Dynamic baseline (signature curve data)
- Alarm limits for all static and dynamic alarms.

With this feature, snapshots can be saved at any point of time during runtime operation and also retrieve any of the previously stored snapshots whenever required.

Alarm Limit Configuration

Vibration parameter limits: this alarm limit will be available only for rotary type of asset (pump, blower, air cooled heat exchanger, compressor, etc.). The vibration limits are calculated based on the motor speed using IEC rotary equipment guides, for:

Overall vibration (OV)

PeakVue™ (PKV) –Emerson’s patented technology for detecting metal impacting in rolling element bearings

Each of the vibration limit values for both peak impact shown as PKV and overall vibration shown as OV can be adjusted by a user configurable parameter. This provides user flexibility to fine tune the sensitivity of the vibration alarm.

Process Parameters (Non Vibration) limits: each input variable can have high and low alarm limits. These are generally calculated from the baseline (BL), based on a calculation formula.

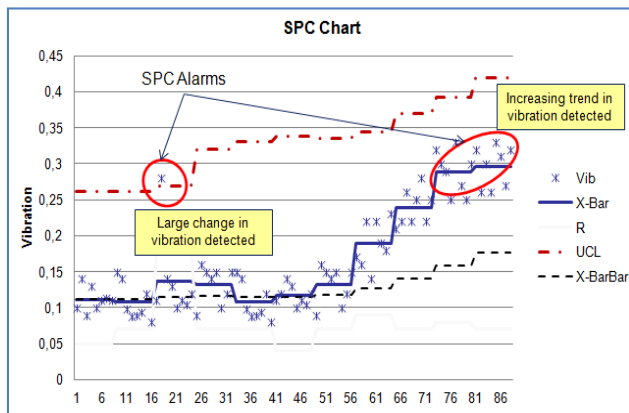
Save alarm limits: this feature allows users to save any changes made to the alarm limits

Statistical Process Control (SPC)

Statistical Process Control (SPC) techniques are used to determine when there is a statistically significant shift in the vibration readings for fixed speed assets. SPC uses average (XBAR) and ranges (R) of small sets of data compared to a "population" average (XBARBAR) and "population" range (RBAR) for all vibration measurements used. Using these values, an Upper Control Limit (UCL) is calculated.

Using these calculations, two alarms have been defined which continuously monitor the variations in vibration signals over a period of time:

- Vibration increasing trend alarm
- Vibration large change alarm



Vibration monitoring with SPC

Variable state parameter assets

There are a few asset variables like vibration, pressure, etc. that are dependent on the asset load and measured by variables such as speed, control vane, pitch and louver position, etc. (state variable). In this case, instead of a single set of baseline values, the system automatically captures a 'signature' of normal operation for each monitored parameter against its state variable. Alarms are triggered based on a deviation from the expected signature at the current load.

The signature curve can be accessed and edited from the AF configuration page. Signature for variable state parameter assets can be adjusted on-line by authorized users.

Asset Health

Asset health value is an indication of the functional performance of the asset. It is calculated from the active process alarms.

For rotating equipment, the asset health is inferred as minimum of health due to all vibration signals ('Vibration Health') and the health due to other process alarms (pressure, level, temperatures, etc. displayed as 'Alarm Health'). All the health values are scaled from 0 to 100%.

The alarm health is based on the weight of most severe active alarm. The vibration health is based on how close the current vibration value is to its baseline value and configured high alarm limit value. The color of the health value displayed shows how critical the asset condition is:

- Critical (<50%): Red
- Warning (50%-89%): Yellow
- Healthy (90%-100): Green

Hardware and Software

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 instrumentation and wireless infrastructure. While wireless devices provide an easy means of adding missing measurements, Plantweb Health Advisor solutions can make use of existing wired or wireless measurements. Emerson has created a number of tools to help determine what instrumentation and wireless capabilities are needed to support a particular site.

The Plantweb Health Advisor equipment models run on an OSIsoft Asset Framework (AF) server. Health 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.

The Health Advisor runtime license should cover the desired number of assets. These part numbers are included in the Ordering information section below.

Report Package & Notifications

Using the standard PI Datalink Excel Add-in, a user can create any number of custom reports for their assets. Standard report templates can be provided. These customizable reports can consist of a combination of graphical and tabular data. The Plantweb Health Advisor solution also has an available notification option based on PI Notifications. This function will send an email or text to specified individuals when an alert occurs.

Licensing the application

The Plantweb Health Advisor module libraries are licensed on a per-as-set basis and will be delivered ready for configuration. The Plantweb Health Advisor module library comes as a set of pre-configured templates in AF. There is a Foundation license which includes the base functions used by all the assets and an Asset license for each type of asset. These part numbers are included in the Ordering information section below. Note the Foundation license is a system-wide license and the Health Advisor asset modules are licensed per asset.

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

Foundation Licenses		
Software License Name	Size	Emerson Part Number
Single Foundation	1 asset	PAS-HA-BASE1
Small Foundation	10 assets	PAS-HA-BASE10
Medium Foundation	11-50 assets	PAS-HA-BASE50
Large Foundation	50+ assets	PAS-HA-BASEMAX
Asset Licenses		
Software License Name	Size	Emerson Part Number
Pump Asset (1st)	First pump	PAS-HA-PUMP-UNI1ST
Pump Asset (Additional)	Additional pump	PAS-HA-PUMP-ADDSIM
Heat Exchanger (1st)	First HX	PAS-HA-HX-UNI1ST
Heat Exchanger (Additional)	Additional HX	PAS-HA-HX-ADDSIM
Blower Asset (1st)	First Blower	PAS-HA-BLW-UNI1ST
Blower Asset (Additional)	Additional Blower	PAS-HA-BLW-ADDSIM
Centrifugal Compressor (1st)	First Compressor	PAS-HA-CCMP-UNI1ST
Centrifugal Compressor (Additional)	Additional Compressor	PAS-HA-CCMP-ADDSIM
Air Cooled Heat Exchanger (1st)	First Air Cooled HX	PAS-HA-ACHE-UNI1ST
Air Cooled Heat Exchanger (Additional)	Additional Air Cooled HX	PAS-HA-ACHE-ADDSIM
Cooling Towers Asset (1st)	First Cooling Tower	PAS-HA-CT-UNI1ST
Cooling Towers Asset (Additional)	Additional Cooling Tower	PAS-HA-CT-ADDSIM

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 to detect plant equipment problems before they occur and provides the information to make informed decisions.

- **Plantweb™ Performance Advisor:** Allows to run processes more efficiently, track operating performance against targets, schedule maintenance activities, and determine the root cause of production asset inefficiencies.
- **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 at all times.

AMS Asset Performance Management: Built on Meridium's APM software, enables managers to quickly access integrated information from multiple data sources, view real-time analyses and reports, and manage business goals to improve asset performance and plant reliability.

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 whether to maintain or replace field devices

AMS Machinery Health Manager: Designed for rotating equipment specialist, 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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