Engine Health Monitoring User Guide

Version 9

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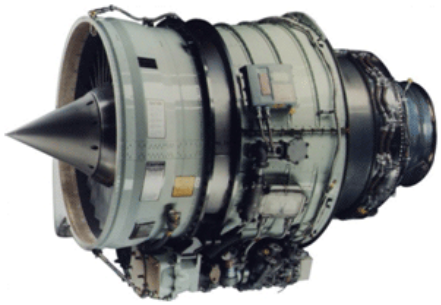
Honeywell Aerospace



Pratt & Whitney Canada

Contents

Engine Health Monitoring and Integrated Maintenance Tracking

The CAMP Engine Health Monitoring (EHM) and Integrated Maintenance Tracking application lets aircraft operators access aircraft engine trends and health information—as well as their aircraft maintenance information—from a single centralized system. Engine health status, detailed engine performance, fault code and oil analysis data are all directly accessible.
Engine data may be uploaded through the application. A variety of engine-related email alerts may be easily configured. The application allows for direct interaction with your EHM analyst regarding actionable recommendations and corrective action feedback.

EHM Interface Overview

When you first log in to the CAMP MTX Engine Health Monitoring application, you are presented with the ***EHM Overview Screen***, similar to that shown in Figure 1. In this particular case, ***Fleet*** has been selected at the top of the Left Navigation Panel [1] in the Figure. This screen shows an overview of action and status items against a current-month calendar [2] corresponding to the selection filters applied [3]. A detailed list of tracked items is displayed for each aircraft [4].

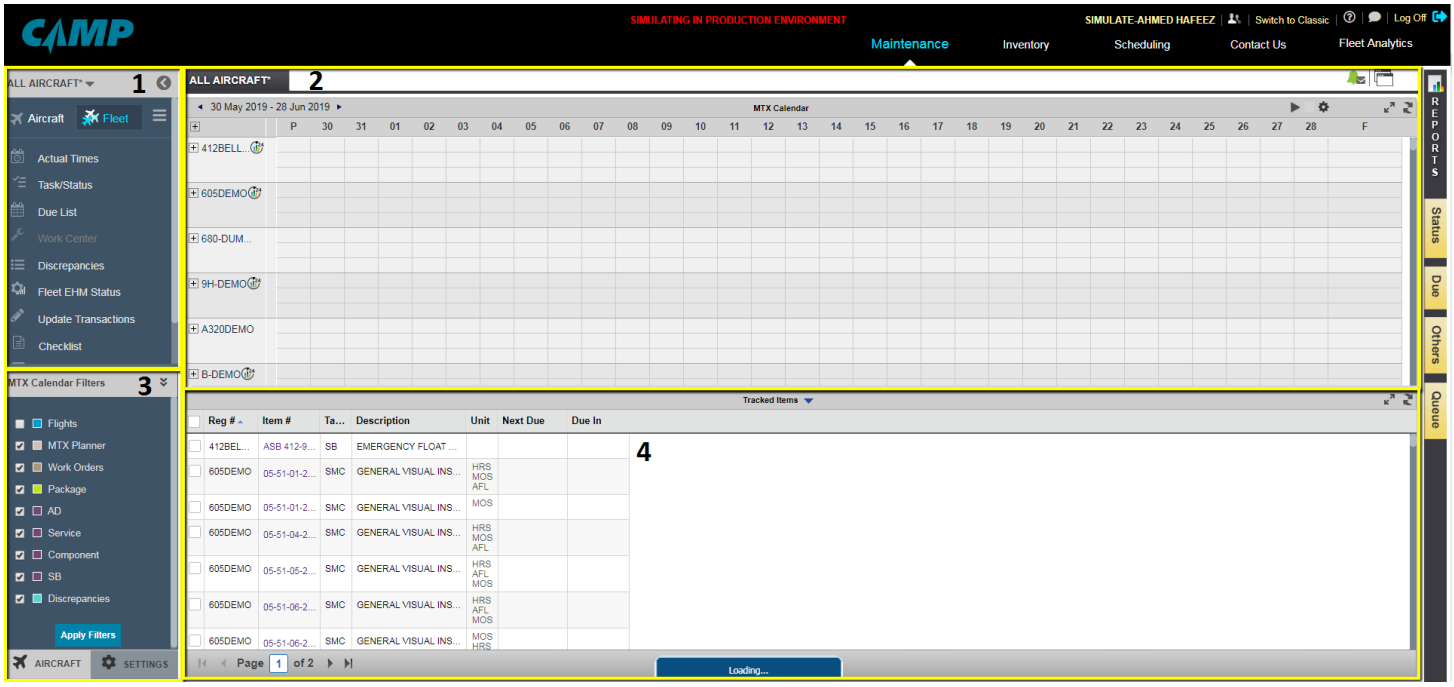
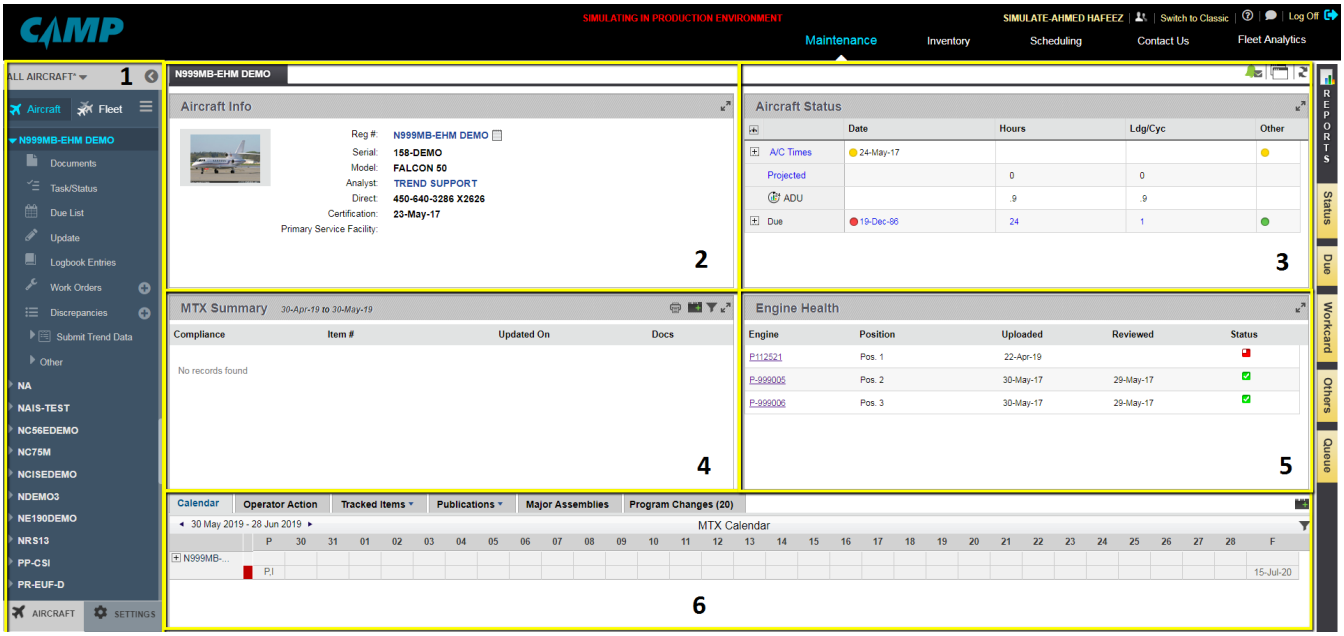


Figure 1 - EHM Overview Screen

Figure 2 - EHM Aircraft Home Screen



Click ***Aircraft*** from the Left Navigation Panel [1] to see a list of aircraft within a fleet. Select the registration number (***N999MB-EHM DEMO*** in this example) to open the ***EHM Aircraft Home Screen*** for that aircraft (shown in Figure 2). This is the main summary screen for the EHM/MTX application. The screen is broken down into several parts: [1] the Left Navigation Panel, [2] Aircraft Info, [3] Aircraft Status, [4] MTX Summary, [5] Engine Health, and [6] MTX Calendar (with several selection tabs).

The ***Aircraft Info*** section [2] provides a summary of basic aircraft information—including registration number, serial number, aircraft model, the EHM analyst's name, the certification date and in-service date.

The ***Aircraft Status*** section [3] provides summary status for each aircraft based on a number of factors—including engine health, maintenance that is due or overdue, equipment defects and work orders.

The ***MTX Summary*** section [4] provides a list of action items and access to detailed information for each item.

The ***Engine Health*** section [5] displays the color-coded status of any aircraft engine within your fleet that is not operating within the manufacturer's baseline specifications. Its status is indicated by an icon, as described in the next section.

The ***MTX Calendar*** section [6] provides a visual representation of various action items overlaid on a calendar, indicating when these items are scheduled to be completed or performed.

Note: For aircraft not enrolled in CAMP MTX, only the Aircraft Info and Engine Health sections will be available

Engine Health Status

As shown in Figure 2, the ***Engine Health*** section displays a status icon indicating individual engine health for all aircraft in your fleet. Colored icons indicate current engine health for each installed engine on the aircraft, as interpreted by your EHM analyst's comparison of recorded operating parameters versus engine manufacturer baseline recommendations. The icon color will vary depending on the engine manufacturer and current engine condition:

Honeywell Aerospace

- ***Green - indicates the overall engine health is normal (trend, faults, SOAP).***
- ***Cyan - indicates an issue related to the indication system, data quality, or a possible maintenance action. Can also indicate the presence of minor faults in the latest download. This status is used for notification purposes only.***
- ***Brown - indicates an issue related to the indication system, data quality, or a possible maintenance action. This indicates a warning that a customer action is recommended at the next convenient opportunity.***
- ***Amber - indicates a performance advisory as recommended by Honeywell. Can also indicate the presence of minor faults in the latest download or a SOAP Re-sample result.***
- ***Red - indicates a critical performance alert or the presence of a critical fault in the latest download. Can also indicate a critical SOAP result. Requires immediate attention.***

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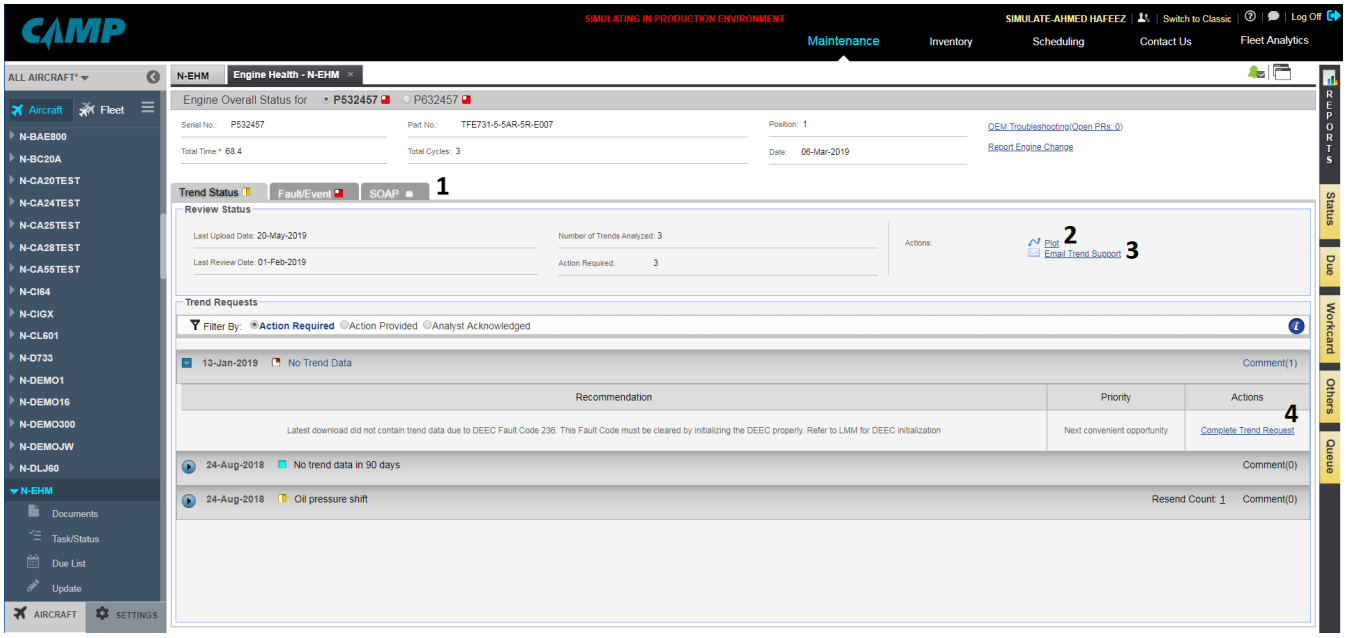
- ***Green - indicates all engine parameters are within manufacturer's normal baseline recommendations.***
- ***Blue - indicates a gradual trend shift is detected, which is considered normal deterioration. No engine troubleshooting is required. This status is used for informational purposes only.***
- ***Brown - indicates an issue related to data quality; instrumentation troubleshooting at next convenient opportunity is recommended. Unreported maintenance action is suspected of causing trend shift. Reporting of recent engine maintenance is recommended at the next convenient opportunity.***
- ***Yellow - indicates a trend shift has been detected. Engine troubleshooting to confirm the trend is recommended at the next convenient opportunity.***
- ***Red - indicates a significant trend shift has been detected. Engine troubleshooting is recommended at the earliest convenient opportunity.***

When an EHM analyst detects a situation where any engine parameter(s) begin to deviate from the manufacturer's baseline, the engine health icon will be changed to match the manufacturer's guidelines. Notification and warning states will be issued along with recommended corrective action(s) following the manufacturer's Instructions for Continued Airworthiness (ICA). All recommendations made in conjunction with state changes are designed to mitigate performance degradations before they become costly problems. When the corresponding corrective actions do not bring engine performance back within normal operating limits, the warning state(s) will be maintained and additional corrective actions will be recommended.

Note: For Honeywell engines, the Engine Health Status represents a summary of the Trend Status, Fault Status, and SOAP Status and takes on the color of the most severe of the three. Refer to Appendix C for features specific to Honeywell engines

Figure 3 - Engine Status Screen



Clicking on an engine serial number in the ***Engine Health*** section of ***EHM Aircraft Home Screen*** opens the ***Engine Status Screen*** (Figure 3) for that particular engine. Depending on the type of engine selected, various sub tabs [1] are available, detailing different engine health information.

At the top of the screen is the Engine Overall Status area for the engine currently selected. Information about the engine, its operating time and number of cycles are provided. Links are provided to report an engine change (*Report Engine Change*) and to launch an OEM troubleshooting session (*OEM Troubleshooting/Open PR*) applicable to Honeywell engines.

> ***Note: The available sub tabs on this screen depend on the type of engine selected. Please refer to Appendix B and C for features specific to P&WC and Honeywell engines respectively***

Trend Status Sub Tab

As shown in Figure 3, the ***Trend Status*** sub tab provides two primary information areas:

1. The ***Review Status*** area lists the dates for each individual data review for that particular engine, a link to a *Plot* [2] of the engine performance trend data, and a link to email CAMP Trend Support (*Email Trend Support* [3]).

Clicking the *Plot* [2] link opens a new tabbed window that displays a graphical plot of engine trend data over time (see Figure 4).

Figure 4 - Engine Data Plot

2. The ***Trend Requests*** area of the sub-tab provides a history of all outstanding and prior corrective action recommendations, operator feedback and EHM analyst acknowledgments throughout the operational life of the engine. With the Action Required filter selected, current open corrective actions (recommended by your EHM analyst) are listed.

Clicking on the *Complete Trend Request* link [4] opens the ***Trend Response Screen*** (Figure 5). In this screen, information on the completed corrective action(s) you have taken is entered into the system. This information is reviewed by the EHM analyst, and the engine status is subsequently updated as appropriate.

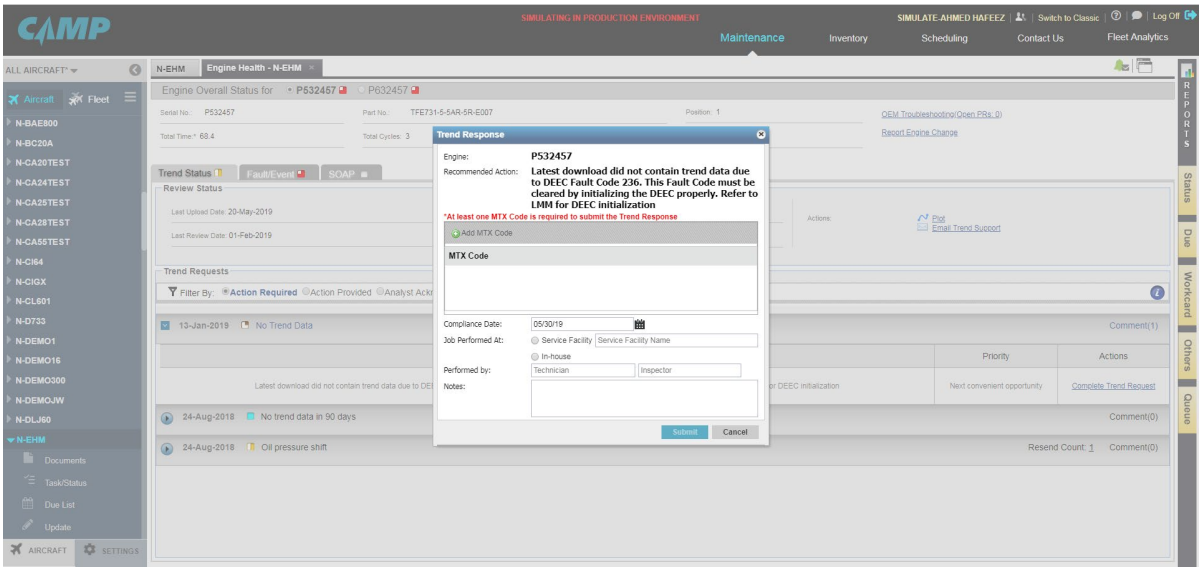
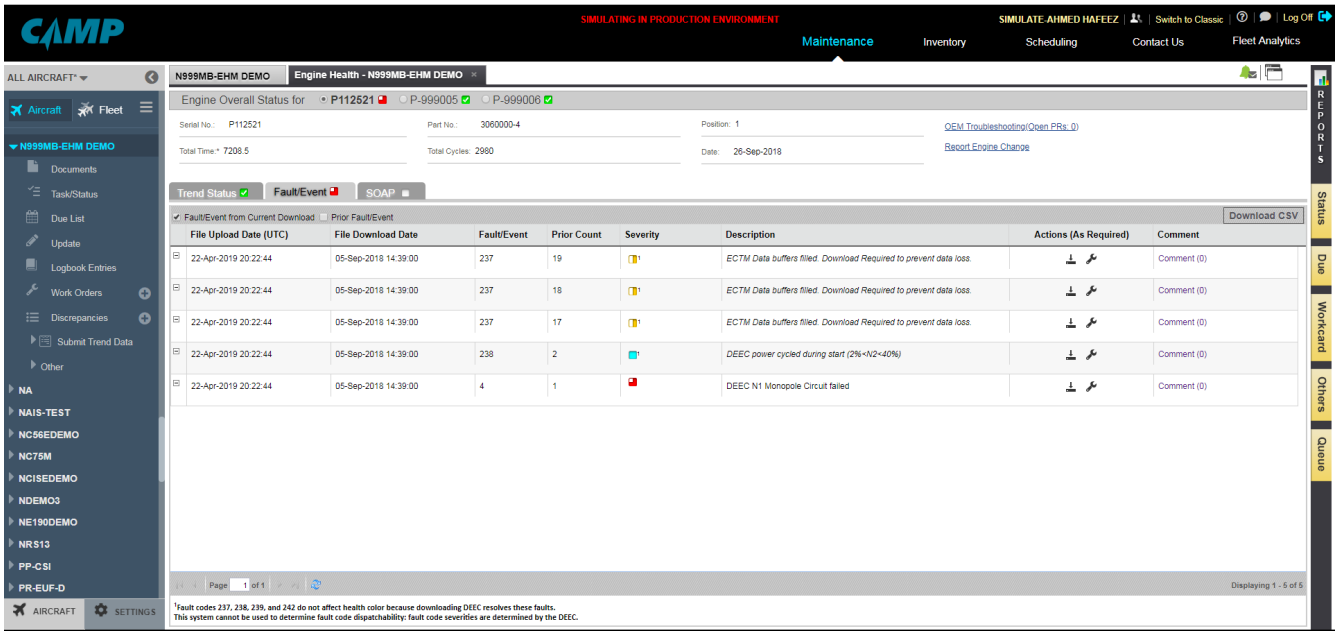


Figure 5 - Trend Response Screen

Fault Code Sub Tab

Clicking the ***Fault Code*** tab on the Engine Status Screen (refer to Figure 3) opens a history of all engine fault codes as recorded by the aircraft engine hardware (Figure 6). The data is sorted by upload date. A brief description of the nature of each detected fault is provided. Please note that the Fault Code Severity status is only available for Honeywell Aerospace engines, and the Fault Code status only affects the overall status for Honeywell TFE731 engine models.

Figure 6 – Fault Code Sub Tab



Fleet EHM Status Screen

The ***Fleet EHM Status Screen*** (Figure 7) is used to display multiple aircraft at the same time. To access the screen, set your Left Navigation Panel to ***Fleet*** [1], then select ***Fleet EHM Status***.

Engine trending information is summarized for all EHM-designated aircraft within the fleet. Here, aircraft, their engine states and trend recommendation history are displayed. Numeric values in the upper half of the display [2] summarize the number of aircraft/engines under each of the possible status icons - i.e. red/critical/ actionable, yellow/advisory, green/normal, etc. These values provide an overview of aircraft counts in each status category. Aircraft with one or more engines in critical (red) status would only appear once, under the red status icon, regardless of the status of any other engines. These numeric values represent the worst-case status for each aircraft model type listed. In the example in Figure 6, there are two aircraft in the fleet with engines in a critical (red) status.

You may select a specific status for further information on the aircraft and engines in its category. This opens an additional window on the bottom half of the screen [3] with important details.

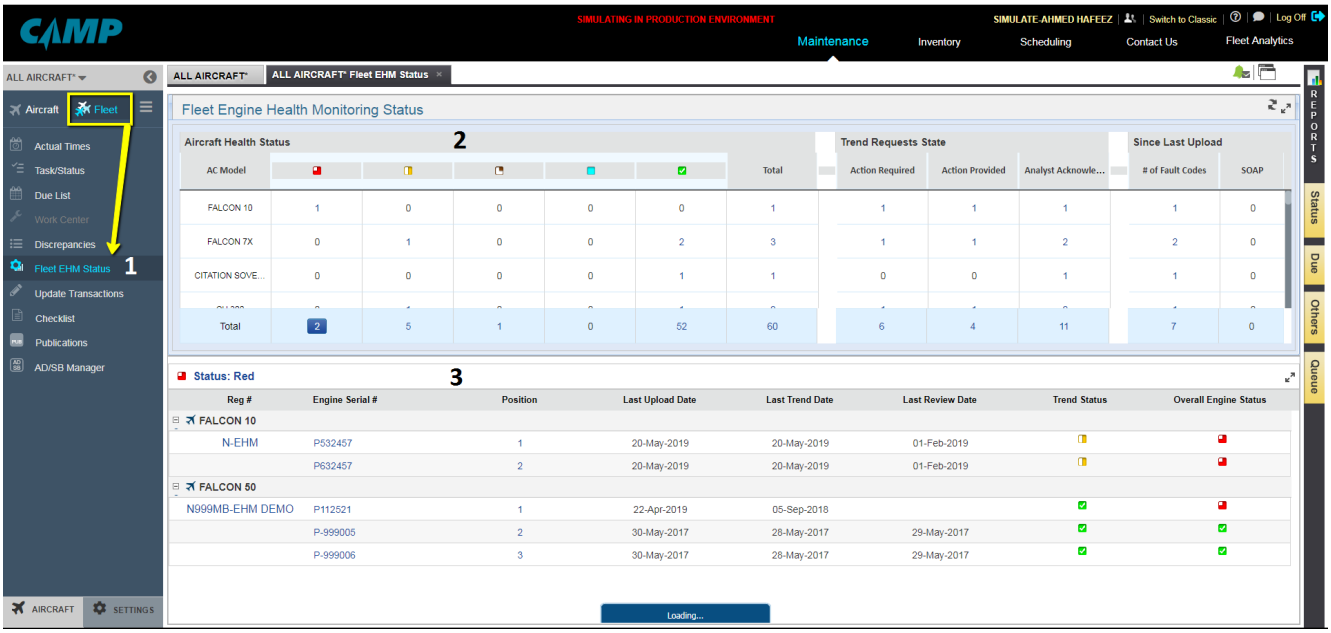


Figure 7 - Fleet EHM Status

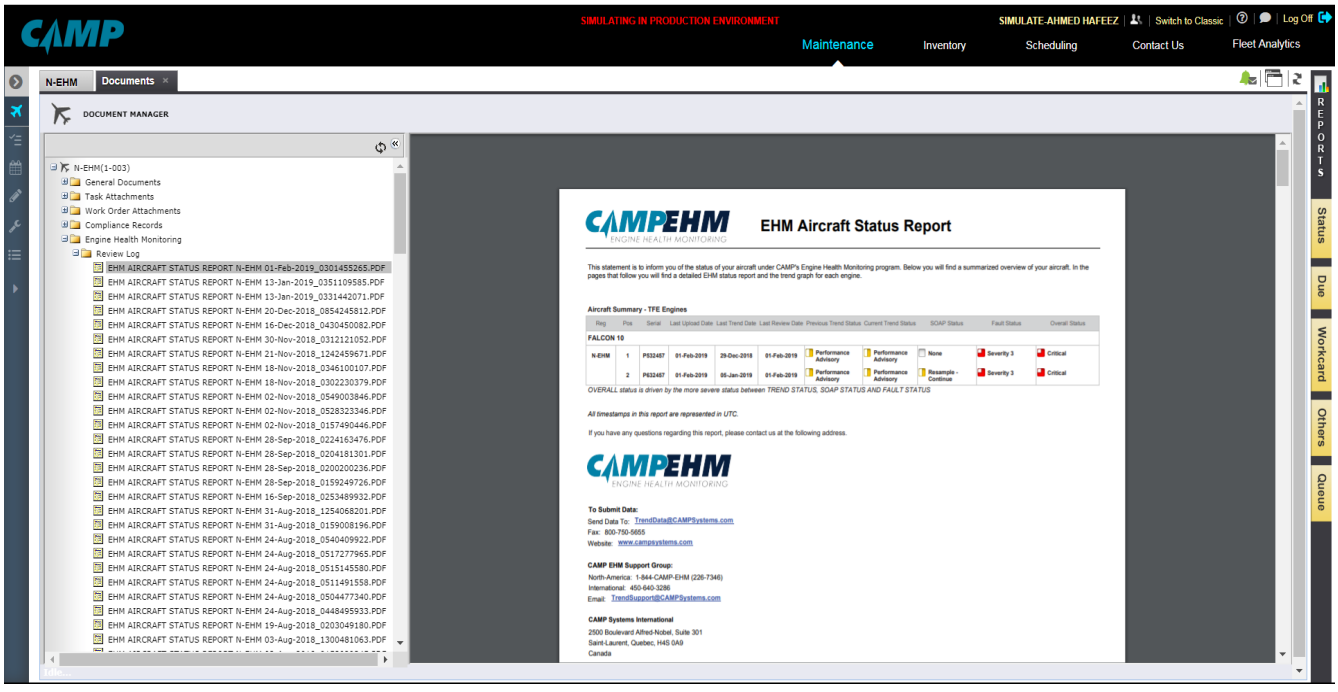


Figure 8 - Sample Aircraft Status Report

Accessing Engine Trend Review

Each time the engines are reviewed by an EHM analyst, a new report is generated and stored for the individual aircraft—providing a historical log of the health of each engine. The reports are stored in the folder in Documents > Engine Health Monitoring > Review Log. A sample report is shown in Figure 8. Reports can also be downloaded, saved, and printed.

Submitting EHM Data

The EHM System permits EHM data to be submitted in any one of two formats:

- Electronic data files recorded by the engines and uploaded into the application
- Manual cruise data (kneepad data) that is entered directly into the application

When data is manually recorded, completed forms can be delivered to *Trenddata@campsystem.com*, or by entering the information into the system using the "Cruise Trend" feature of the application.

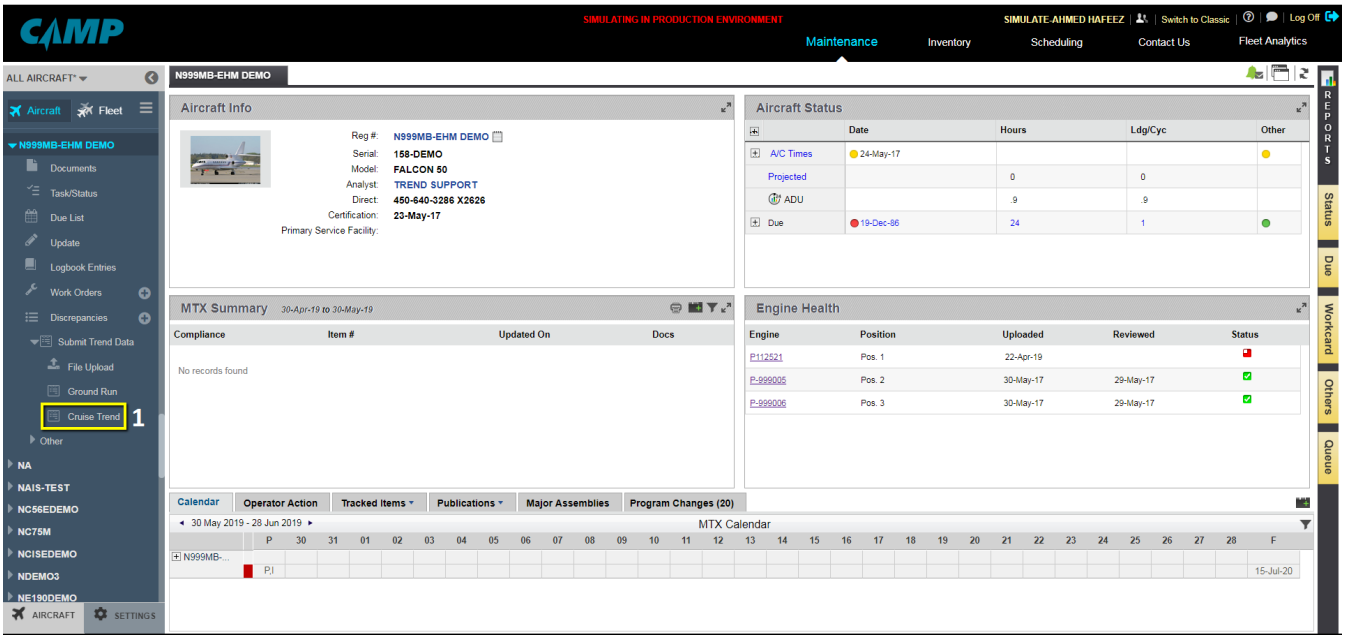


Figure 9 - Cruise Trend Data Entry Screen

To open the ***Cruise Trend Data Entry Screen***, select ***Submit Trend Data*** from the Left Navigation Panel, then select the ***Cruise Trend*** [1] from the sub-dropdown menu that opens. Please refer to Figure 9. Simply enter the data on the supplied form (see Figure 10) and click *SUBMIT*.

For fleets configured with automatic data transmission hardware (FAST/DTU), such as that available exclusively for select models of Pratt & Whitney Canada (P&WC) engines, the necessary electronic files will be gathered and loaded into the System with no manual intervention. Files can also be uploaded directly into the CAMP MTX System using the ***File Upload*** feature [1], as shown in Figure 11.

Figure 10 - EHM Data Entry Screen

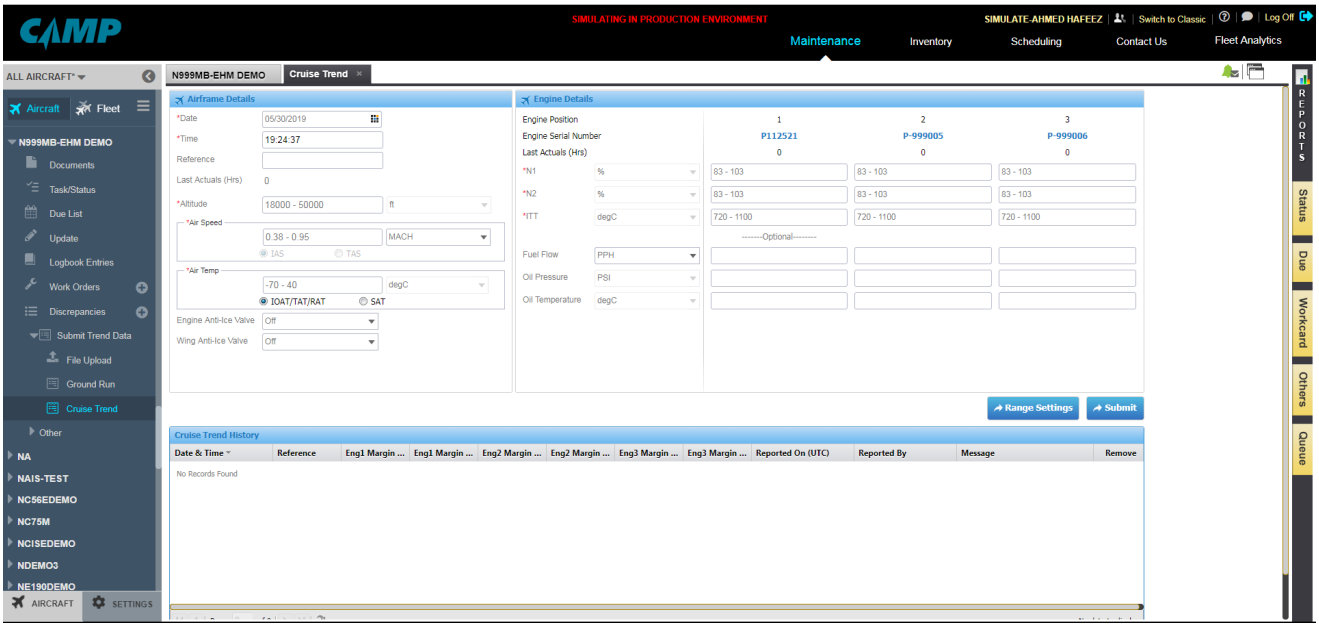


Figure 11 -File Upload

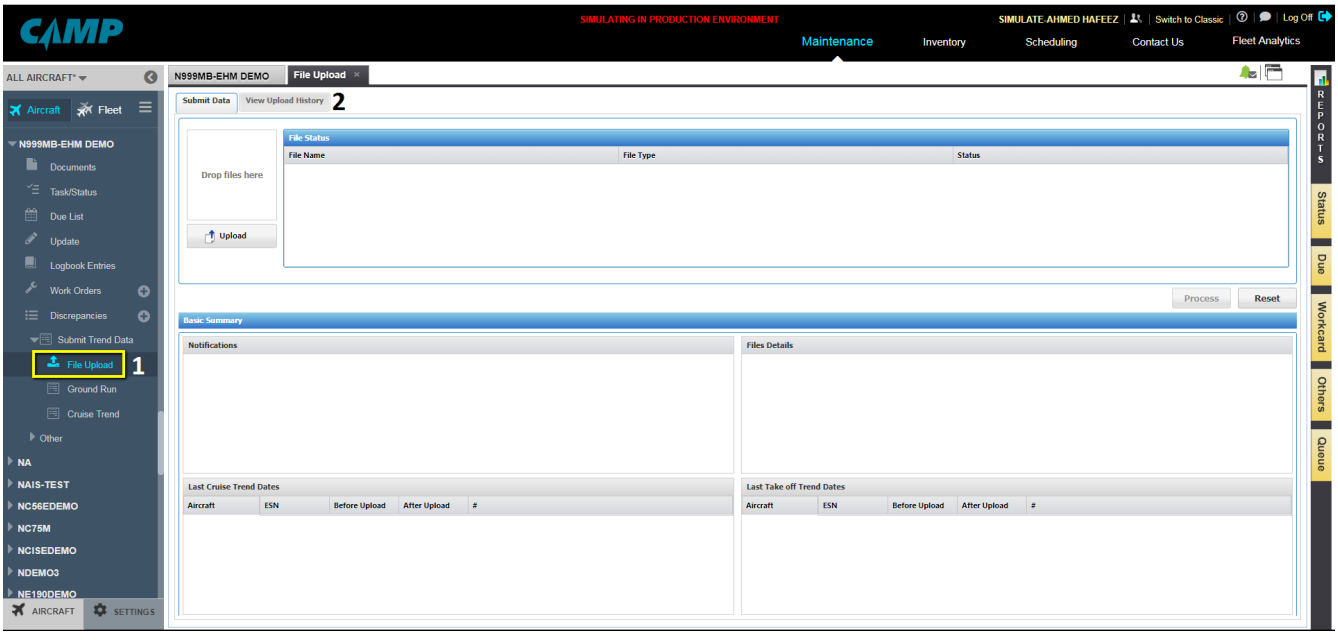
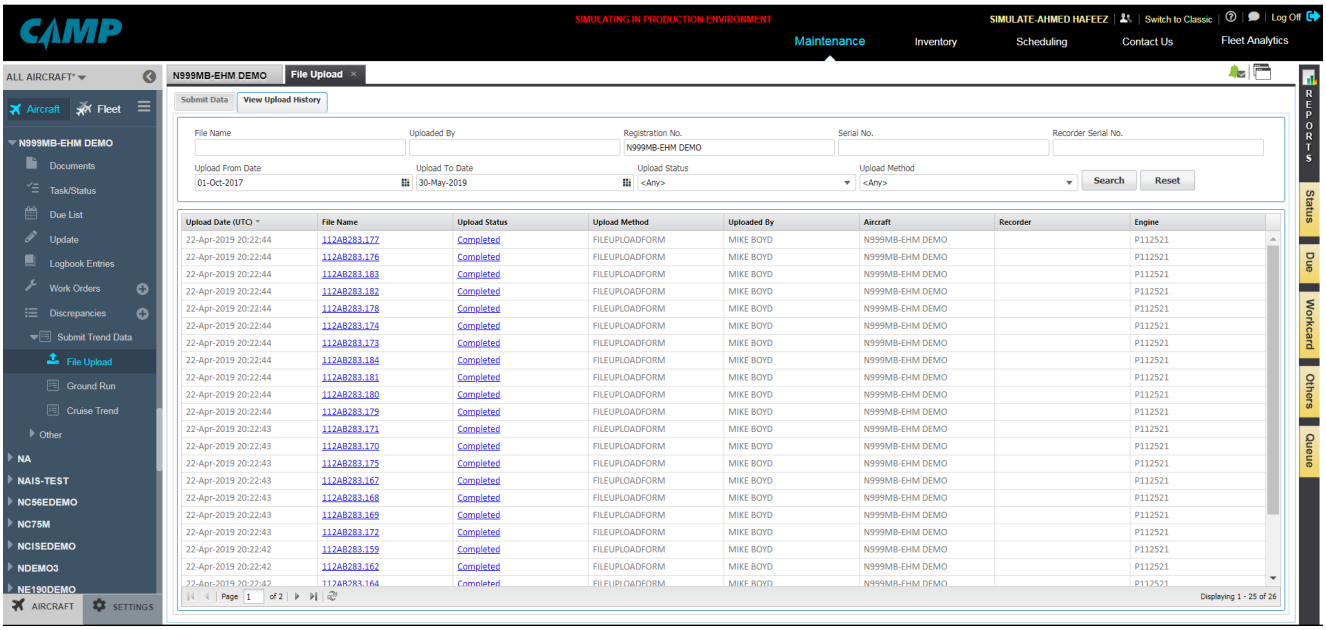


Figure 12 -View Upload History



Selecting the ***View Upload History*** tab [2] opens the ***View Upload History Screen*** (Figure 12.) By default, aircraft registration numbers and last upload date will be pre- populated. Using the search fields at the top of the screen, the results displayed on this page may be filtered by certain parameters, like date uploaded or serial number. The original file that was inputted to the System can be downloaded by clicking the file name.

Engine Calibration Run and Power Assurance Check

Engine Calibration Run and Power Assurance check information can be entered directly into the EHM application. The entry screen is accessed from the ***Submit Trend Data > Ground Run*** item in the Left Navigation Panel (See Figure 13).

EHM Fleet Status Reports

The application can generate two reports outlining fleet EHM status overview; EHM Fleet Status Summary Report and EHM Fleet Status Report. The former provides a basic overview of the fleet, displaying the current EHM status of every engine. The latter includes more detailed information, such as the trend plots and the last review. To generate the reports, click Status [1] in the Reports bar (Figure 14), then click EHM Reports [2], select the desired report to generate [3], and finally click Create Report [4].

Figure 13 - Engine Calibration Run Screen

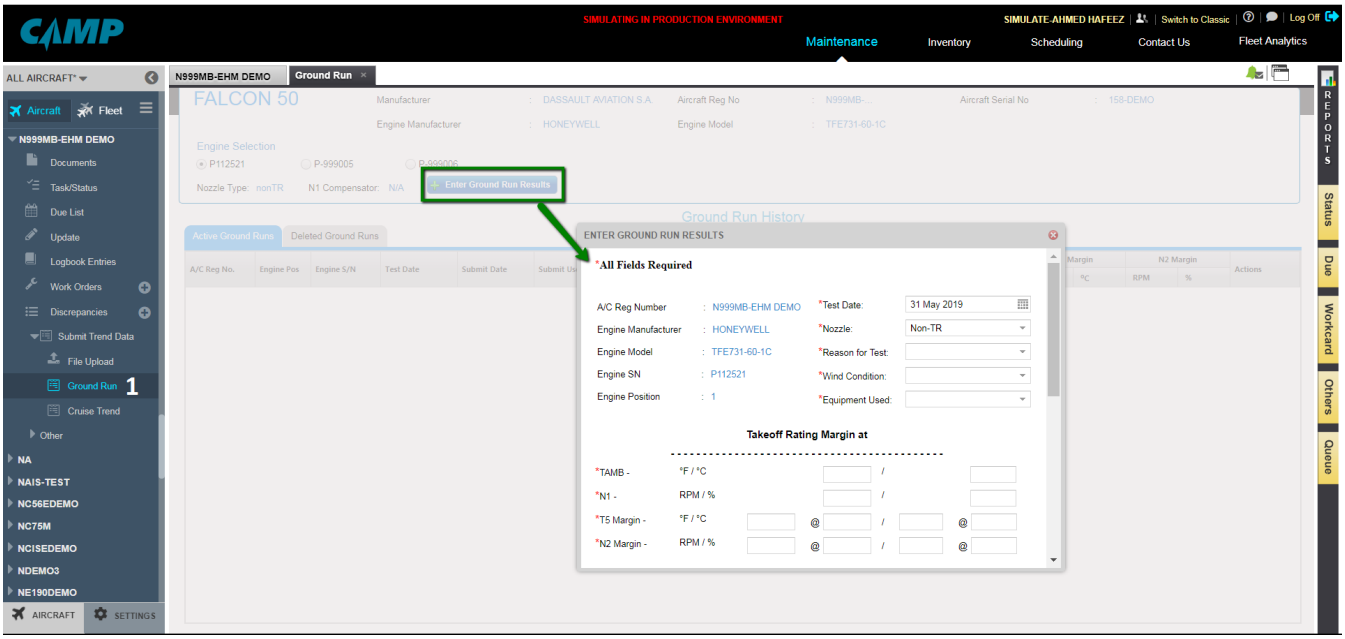
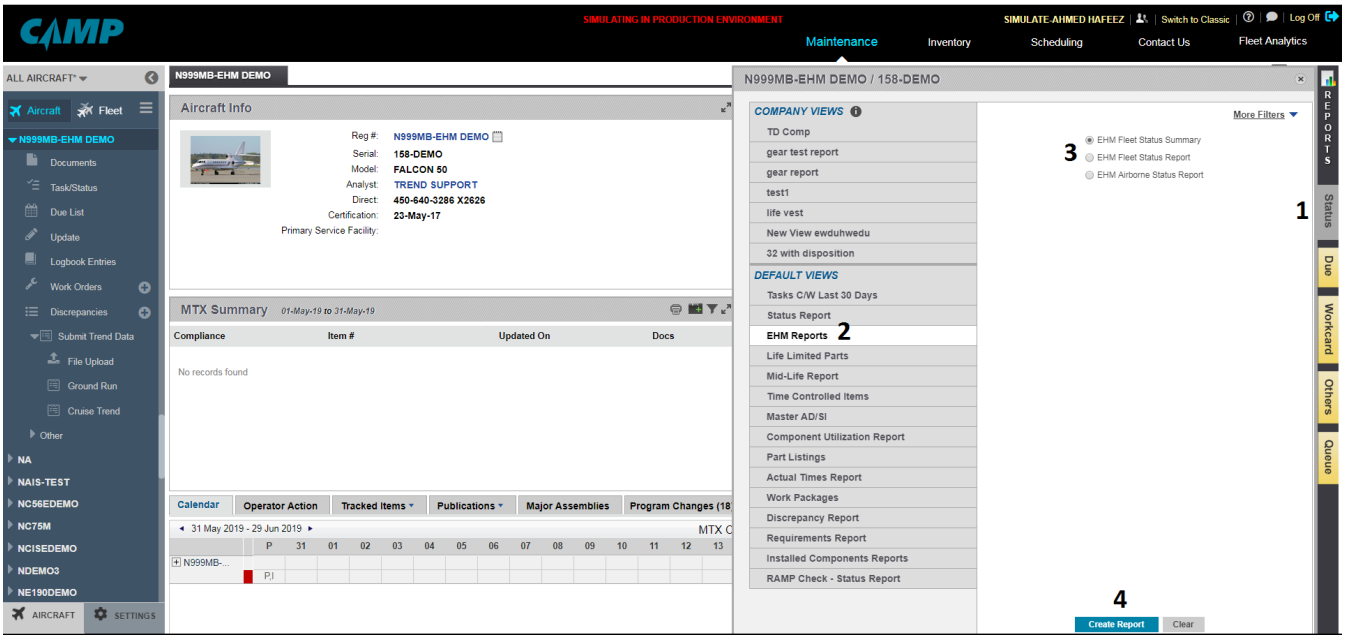


Figure 14 - EHM Fleet Summary Report



EHM-Specific Email Notifications

The EHM application allows various aircraft fleet operating personnel to receive email alerts for numerous engine trend alarm conditions. Access to set email notifications is available through your CAMP account administrator.

The available email alert notification types are as follows:

Data Receipt Alert

This triggers an email to each assigned user when data is received into the system, regardless of the delivery channel or entry source.

Trend Alert

This triggers an email whenever the status of an engine changes. The email includes the necessary details of the status change.

Note: For Honeywell engines, trend alert notifications reflect changes in Trend Status only, not the SOAP or Fault Status. This is a function of the Honeywell system, not a CAMP MTX EHM limitation.

Note: When migrating from a P&WC maintenance tracking system to the CAMP MTX system, by default, only the Trend Alert notification is enabled. The other email notifications described here can be added by either your Account Administrator or by calling CAMP SYSTEMS INTERNATIONAL (+1-450-640-3286).

Trend Update

This triggers an email each time trend data is loaded into the application and reviewed by the EHM analyst, regardless of whether or not the status has changed.

EHM Fleet Status Report

This triggers an email containing the EHM Fleet Status Report, which provides a single-page summary of each engine on an aircraft, the latest comments provided by the EHM analyst, and a summarized plot history of the engine(s) over their life in the EHM program.

EHM Fault Code Alert

This triggers an email alerting the recipient to specified fault code(s).

Deficient Data Alert

This triggers an email to customers who have not provided EHM data within the specified timeframe.

Data Flow and Responsibility

Figure 15 depicts the flow of data and responsibilities of the customer, CAMP, and OEM Technical Support.

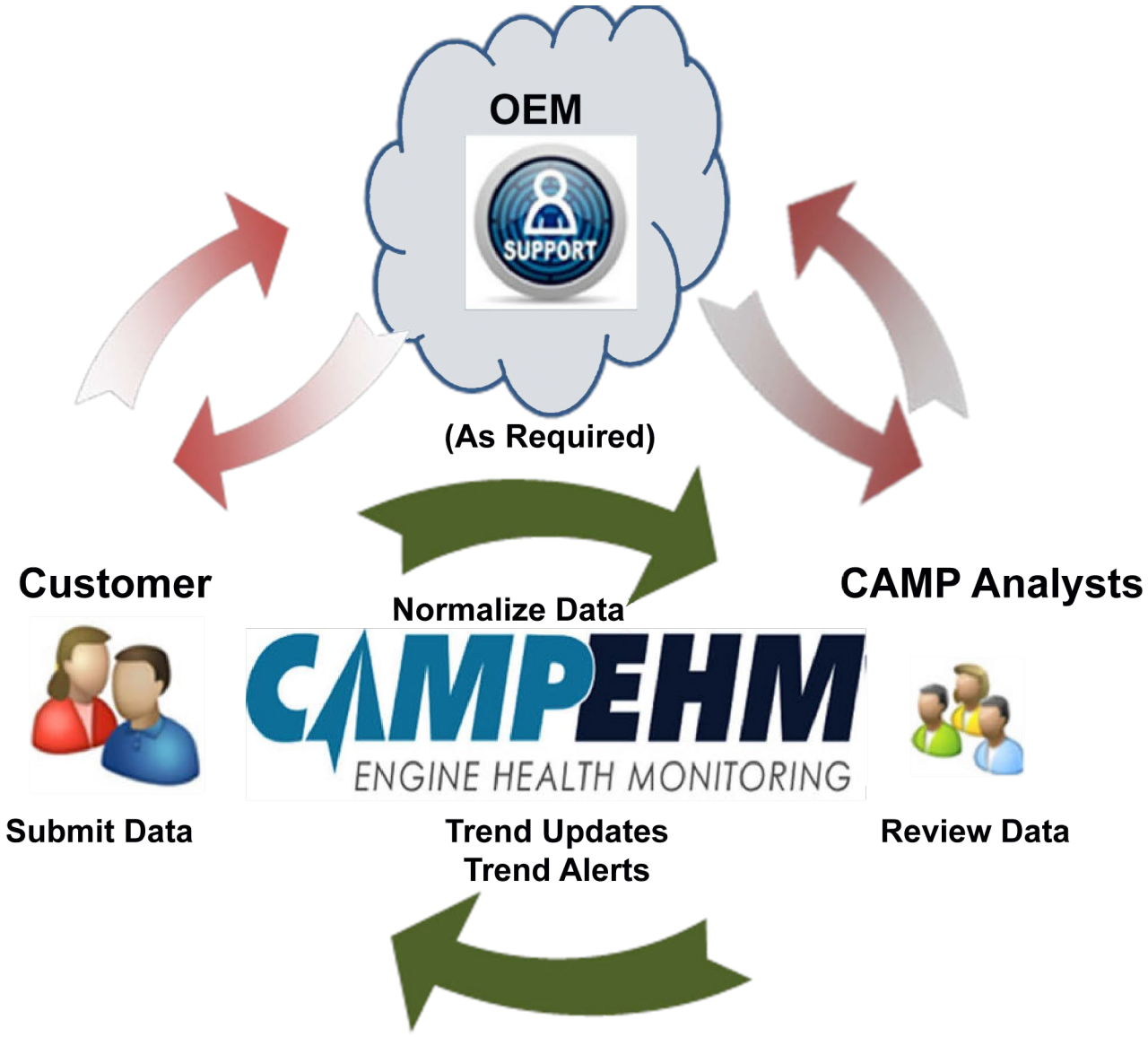
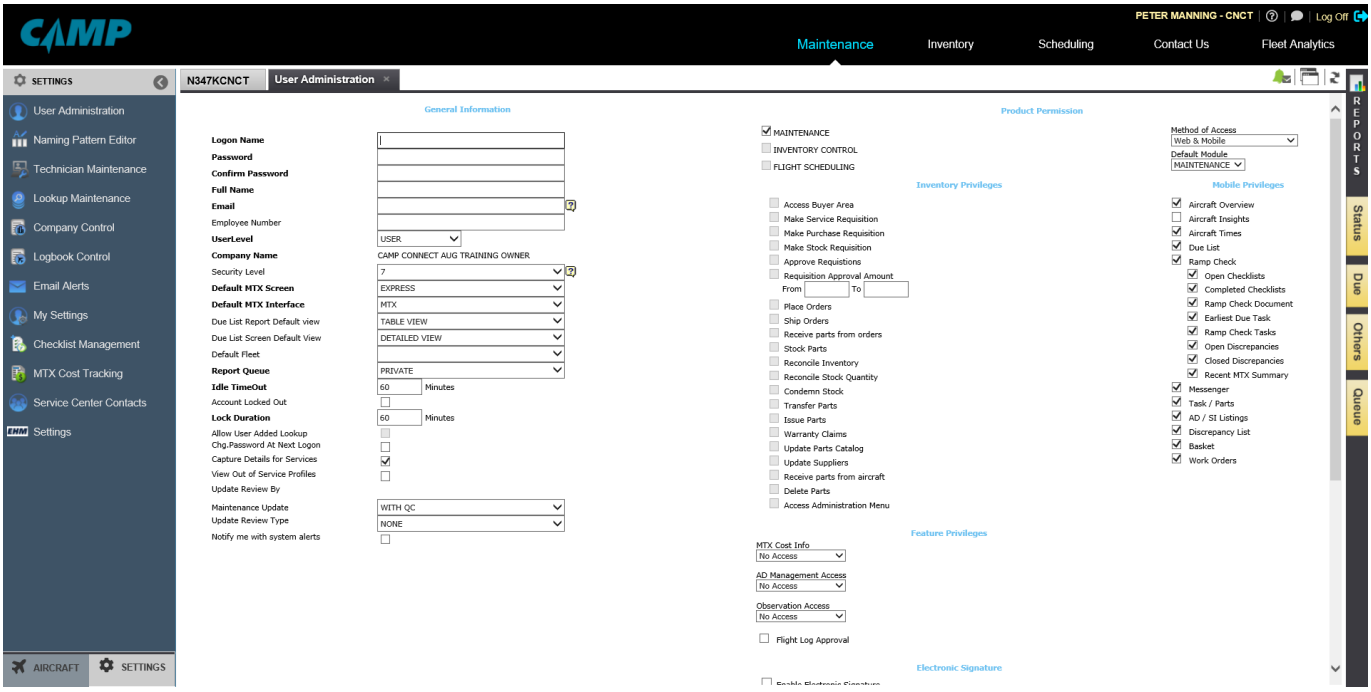


Figure 15 – Data Flow and Responsibility

Setting/Editing EHM User Privileges

Once you are in your account, select the Settings tab from the bottom of the Left Navigation Panel, and then select the User Administration tab. Once the User Administration section, please click white paper icon—located on the right-hand side of the screen. This opens the new user creation screen. After the icon is selected, you will be prompted to the following screen, which will enable you to create a user.



Enter the general information and select the EHM privileges you wish to grant users. These can be set from the checkboxes under the EHM Privileges header at the bottom of the page.

Note: *To edit an existing user's access privileges, find the user using the search functions on the User Administration screen, then follow the same steps to determine what EHM Privileges will be granted or restricted.*

APPENDIX A - Contacting CAMP SYSTEMS INTERNATIONAL

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APPENDIX B - Features Specific to P&WC Engines

ADAS Logs

ADAS Logs are available for aircraft equipped with PWC Aircraft Data Acquisition Systems (ADAS). Detailed data, recorded by the monitor, is accessed in the ADAS Logs item under the Other tab in the Left Navigation Panel (see Figure 16). The basic information provides a broad description of the aircraft, and summaries of ***Upload Date***, ***Trend Date***, ***Event Date***, ***Engine Run Date***, ***Time Since New*** (as computed by the monitor, which may not be the same as the TSN of the engine), ***Flag Date***, and ***Pilot Request***. Clicking on each of these opens new tabs with further information, demonstrated below.

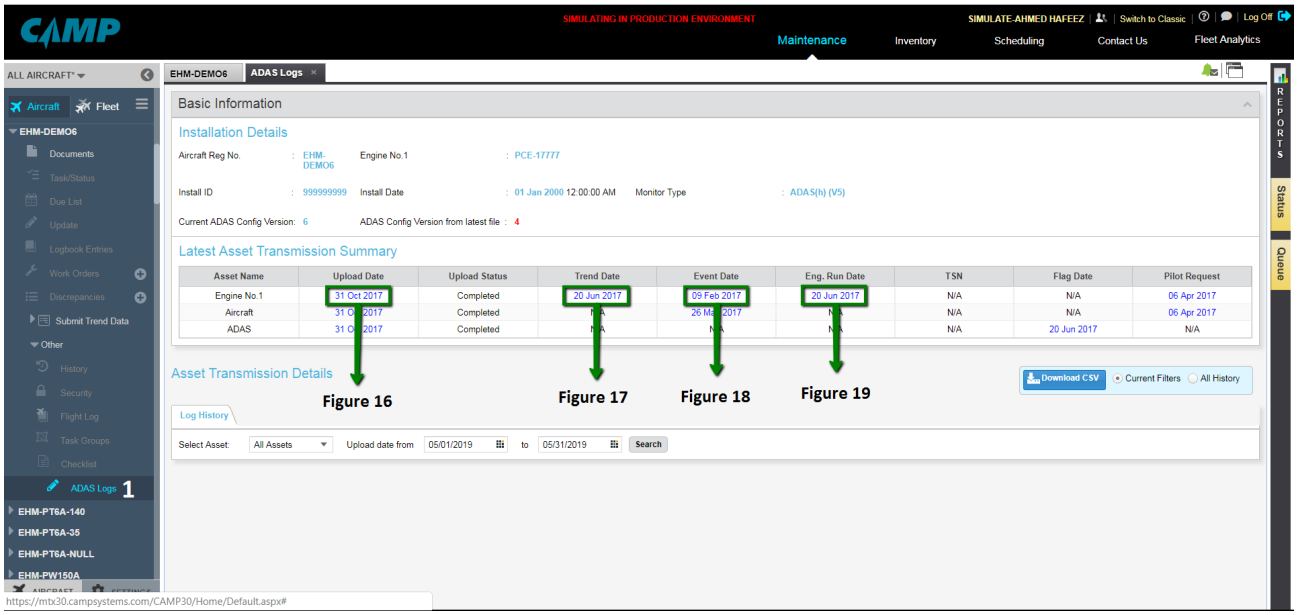


Figure 16 - ADAS Log Overview Screen

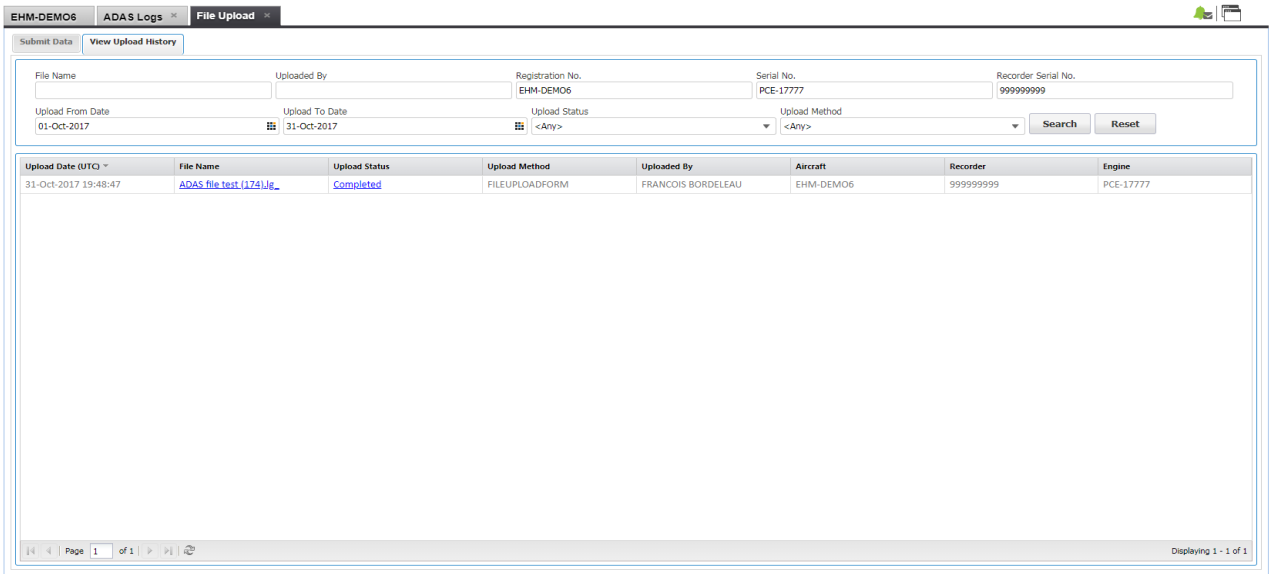
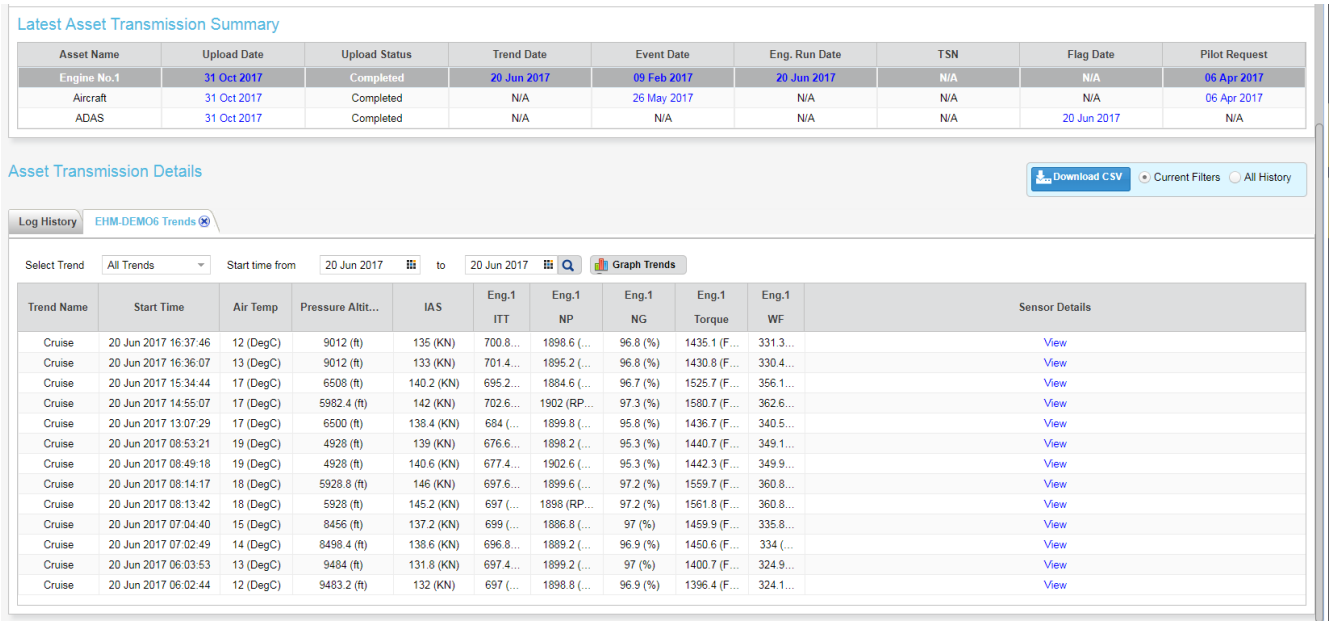


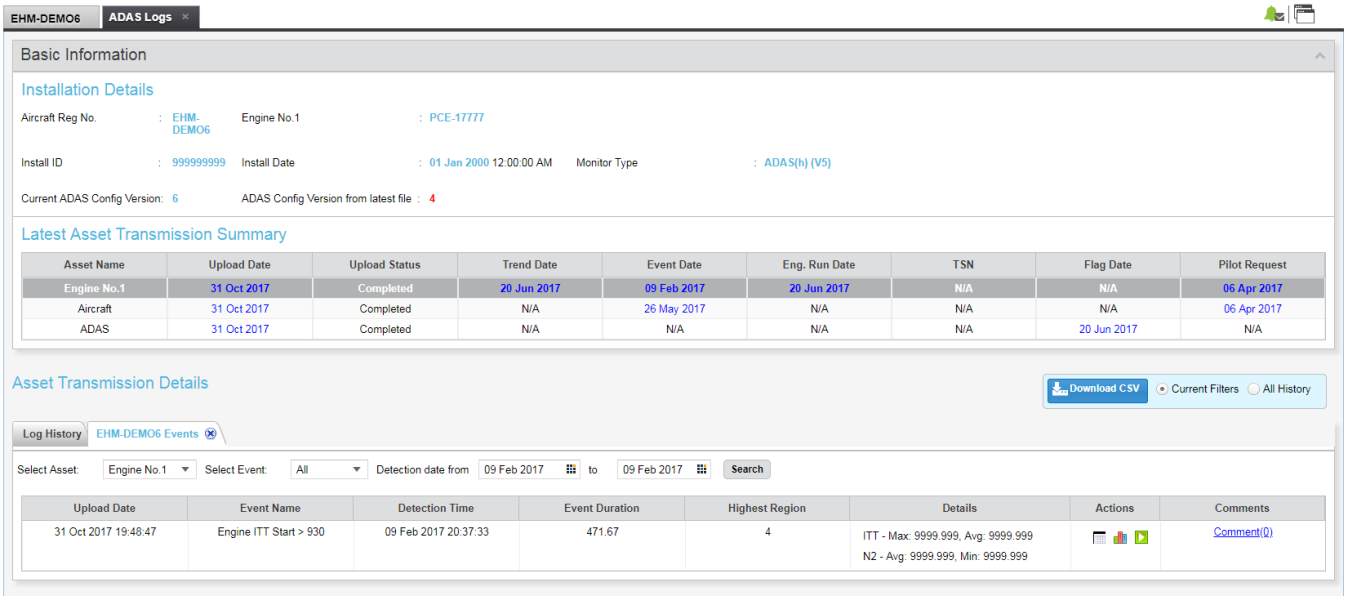
Figure 17 - View Upload History



Asset Name	Upload Date	Upload Status	Trend Date	Event Date	Eng. Run Date	TSN	Flag Date	Pilot Request
Engine No.1	31 Oct 2017	Completed	20 Jun 2017	09 Feb 2017	20 Jun 2017	N/A	N/A	06 Apr 2017
Aircraft	31 Oct 2017	Completed	N/A	26 May 2017	N/A	N/A	N/A	06 Apr 2017
ADAS	31 Oct 2017	Completed	N/A	N/A	N/A	N/A	20 Jun 2017	N/A

Trend Name	Start Time	Air Temp	Pressure Altit...	IAS	Eng.1 ITT	Eng.1 NP	Eng.1 NG	Eng.1 Torque	Eng.1 WF	Sensor Details
Cruise	20 Jun 2017 16:37:46	12 (DegC)	9012 (ft)	135 (KN)	700.8...	1898.6 (...	96.8 (%)	1435.1 (F...	331.3...	View
Cruise	20 Jun 2017 16:36:07	13 (DegC)	9012 (ft)	133 (KN)	701.4...	1895.2 (...	96.8 (%)	1430.8 (F...	330.4...	View
Cruise	20 Jun 2017 15:34:44	17 (DegC)	6508 (ft)	140.2 (KN)	695.2...	1884.6 (...	96.7 (%)	1525.7 (F...	356.1...	View
Cruise	20 Jun 2017 14:55:07	17 (DegC)	5982.4 (ft)	142 (KN)	702.6...	1902 (RP...	97.3 (%)	1580.7 (F...	362.6...	View
Cruise	20 Jun 2017 13:07:29	17 (DegC)	6500 (ft)	138.4 (KN)	684 (...	1899.8 (...	95.8 (%)	1436.7 (F...	340.5...	View
Cruise	20 Jun 2017 08:53:21	19 (DegC)	4928 (ft)	139 (KN)	676.6...	1898.2 (...	95.3 (%)	1440.7 (F...	349.1...	View
Cruise	20 Jun 2017 08:49:18	19 (DegC)	4928 (ft)	140.6 (KN)	677.4...	1902.6 (...	95.3 (%)	1442.3 (F...	349.9...	View
Cruise	20 Jun 2017 08:14:17	18 (DegC)	5928.8 (ft)	146 (KN)	697.6...	1899.6 (...	97.2 (%)	1559.7 (F...	360.8...	View
Cruise	20 Jun 2017 08:13:42	18 (DegC)	5928 (ft)	145.2 (KN)	697 (...	1898 (RP...	97.2 (%)	1561.8 (F...	360.8...	View
Cruise	20 Jun 2017 07:04:40	15 (DegC)	8456 (ft)	137.2 (KN)	699 (...	1886.8 (...	97 (%)	1459.9 (F...	335.8...	View
Cruise	20 Jun 2017 07:02:49	14 (DegC)	8498.4 (ft)	138.6 (KN)	696.8...	1889.2 (...	96.9 (%)	1450.6 (F...	334 (...	View
Cruise	20 Jun 2017 06:03:53	13 (DegC)	9484 (ft)	131.8 (KN)	697.4...	1899.2 (...	97 (%)	1400.7 (F...	324.9...	View
Cruise	20 Jun 2017 06:02:44	12 (DegC)	9483.2 (ft)	132 (KN)	697 (...	1898.8 (...	96.9 (%)	1396.4 (F...	324.1...	View

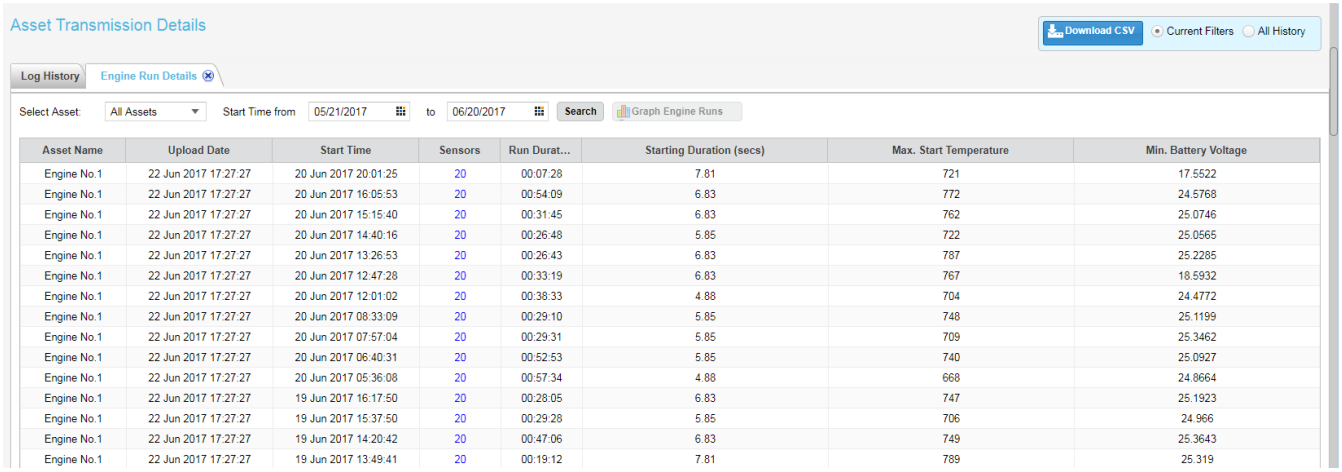
Figure 18 - Trend Date



Asset Name	Upload Date	Upload Status	Trend Date	Event Date	Eng. Run Date	TSN	Flag Date	Pilot Request
Engine No.1	31 Oct 2017	Completed	20 Jun 2017	09 Feb 2017	20 Jun 2017	N/A	N/A	06 Apr 2017
Aircraft	31 Oct 2017	Completed	N/A	26 May 2017	N/A	N/A	N/A	06 Apr 2017
ADAS	31 Oct 2017	Completed	N/A	N/A	N/A	N/A	20 Jun 2017	N/A

Upload Date	Event Name	Detection Time	Event Duration	Highest Region	Details	Actions	Comments
31 Oct 2017 19:48:47	Engine ITT Start > 930	09 Feb 2017 20:37:33	471.67	4	ITT - Max: 9999.999, Avg: 9999.999 N2 - Avg: 9999.999, Min: 9999.999		Comment(0)

Figure 19 - Event Date



Asset Name	Upload Date	Start Time	Sensors	Run Durat...	Starting Duration (secs)	Max. Start Temperature	Min. Battery Voltage
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 20:01:25	20	00:07:28	7.81	721	17.5522
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 16:05:53	20	00:54:09	6.83	772	24.5768
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 15:15:40	20	00:31:45	6.83	762	25.0746
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 14:40:16	20	00:26:48	5.85	722	25.0565
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 13:26:53	20	00:26:43	6.83	787	25.2285
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 12:47:28	20	00:33:19	6.83	767	18.5932
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 12:01:02	20	00:38:33	4.88	704	24.4772
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 08:33:09	20	00:29:10	5.85	748	25.1199
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 07:57:04	20	00:29:31	5.85	709	25.3462
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 06:40:31	20	00:52:53	5.85	740	25.0927
Engine No.1	22 Jun 2017 17:27:27	20 Jun 2017 05:36:08	20	00:57:34	4.88	668	24.8664
Engine No.1	22 Jun 2017 17:27:27	19 Jun 2017 16:17:50	20	00:28:05	6.83	747	25.1923
Engine No.1	22 Jun 2017 17:27:27	19 Jun 2017 15:37:50	20	00:29:28	5.85	706	24.966
Engine No.1	22 Jun 2017 17:27:27	19 Jun 2017 14:20:42	20	00:47:06	6.83	749	25.3643
Engine No.1	22 Jun 2017 17:27:27	19 Jun 2017 13:49:41	20	00:19:12	7.81	789	25.319

Figure 20 - Engine Run Date

Upload Date

Clicking the latest upload date opens the ***View Upload History*** tab (Figure 17). By default, the menu shows one month of data for the specific engine but may be changed with filters. (Please refer to the ***View Upload History*** section for more information).

Trend Date

Clicking the ***Trend Date*** loads a new tab on the Asset Transmission Details section (Figure 18) that outlines raw input data for the aircraft within a specified date range. Clicking the Graph Trends button opens the EHM Plot.

Clicking the "*View*" link in the right-most column under the ***Sensor Details*** opens a new Cruise Trends tab under the Asset Transmission Details, displaying more sensor information—captured by the monitor—for that particular flight.

Event Date

Clicking Event Date loads the Asset Transmission Details section with all event information for a specified date range (Figure 19). Clicking the *Plot* icon (three colored bars) will open the event graph.

Engine Run Date

Clicking Engine Run Date populates the Asset Transmission Details section with data from the engine runs of a specified date range (Figure 20). The last month's data is pre-populated by default.

Upload Date and Flag Date

The ADAS Logs page shows the latest Upload Date and Flag Date. The Upload Date indicates the last time the ADAS was connected to the CAMP EHM system. The Flag Date provides basic information on any Flags that have been recorded on the ADAS. These Flags are associated with the performance of the monitor, and not engine performance.

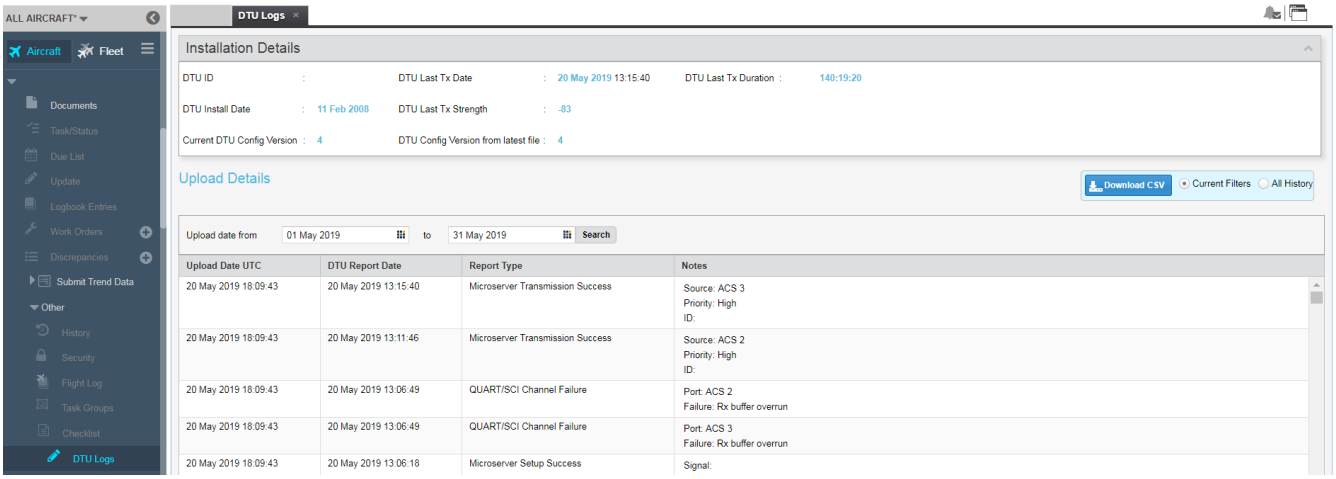


Figure 21 - DTU Logs

DTU Logs

DTU Logs are accessed within the Other folder in the Left Navigation Panel. The DTU Logs page provides DTU unit details regarding installation ID and all relevant uploads. DTU Logs are only available for aircraft equipped with this specific PWC Monitor. Please refer to Figure 21.

APPENDIX C - Features Specific to Honeywell Engines

SOAP Analysis Sub Tab

As shown in Figure 22, the SOAP (Spectrometric Oil Analysis Program) Analysis sub tab accesses both historical oil analysis data and the status of current samples out for testing. Oil analysis testing is often an integral part of an engine health monitoring program as recommended by the engine manufacturer. Samples are typically taken at the time of scheduled maintenance and shipped to manufacturer-certified labs for analysis. Premature engine wear is often indicated by materials found in the oil sample. The findings are delivered electronically to CAMP and presented through this tab. As test results are posted, a PDF copy of the lab report is made available via the View Report link to the right of each record.

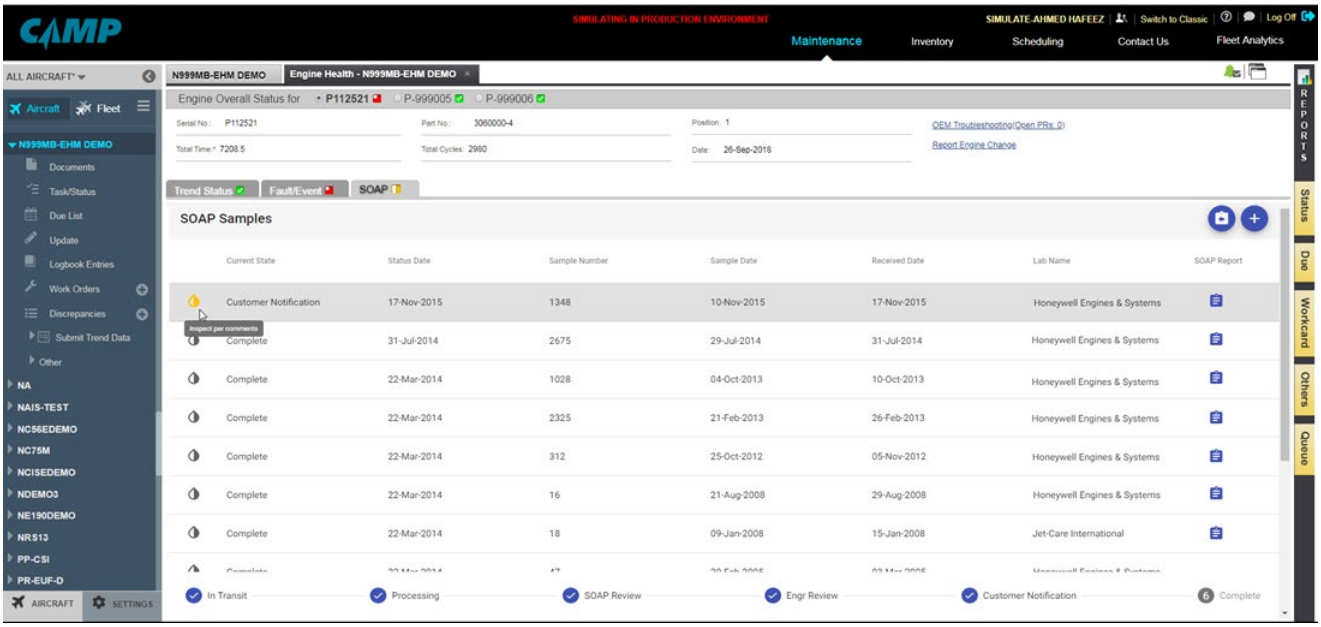


Figure 22 – SOAP Analysis Sub Tab

Submitting an Electronic SOAP form

CAMP EHM provides a connected solution for submitting oil and filter sample forms in partnership with Honeywell and its GoDirect SOAP mobile app. You can skip the paper and submit an electronic form within the SOAP sub tab in CAMP.

This feature will save you time and enable you to avoid transcription errors. If you start filling out the form in the mobile app, your progress is saved, allowing you to continue in CAMP's desktop interface. Using CAMP's SOAP digital form will also help you avoid delays by automatically ordering a kit for the next sample.

To create a new SOAP form, click the (+) button on the top-right corner of the tab. Input the SOAP kit number, if known, or press "No QR Code?" to get a kit number generated by the system. There will be instructions on how to write this new identifier on the physical SOAP kit box you're using.

Once you submit your SOAP kit number, you will navigate to a SOAP form pre-populated with information about your engine/APU and corresponding aircraft. Proceed to fill out the form as you would do with a paper form. Note some fields are required to save and/or submit the form.

Once you are ready to submit the form, click “Submit” and the form will be sent to Honeywell and the selected laboratory of your choice.

The form will be taken into consideration along with the physical sample that you send to the laboratory. You can track the status of your SOAP sample by going back to the landing page of the SOAP sub-tab.

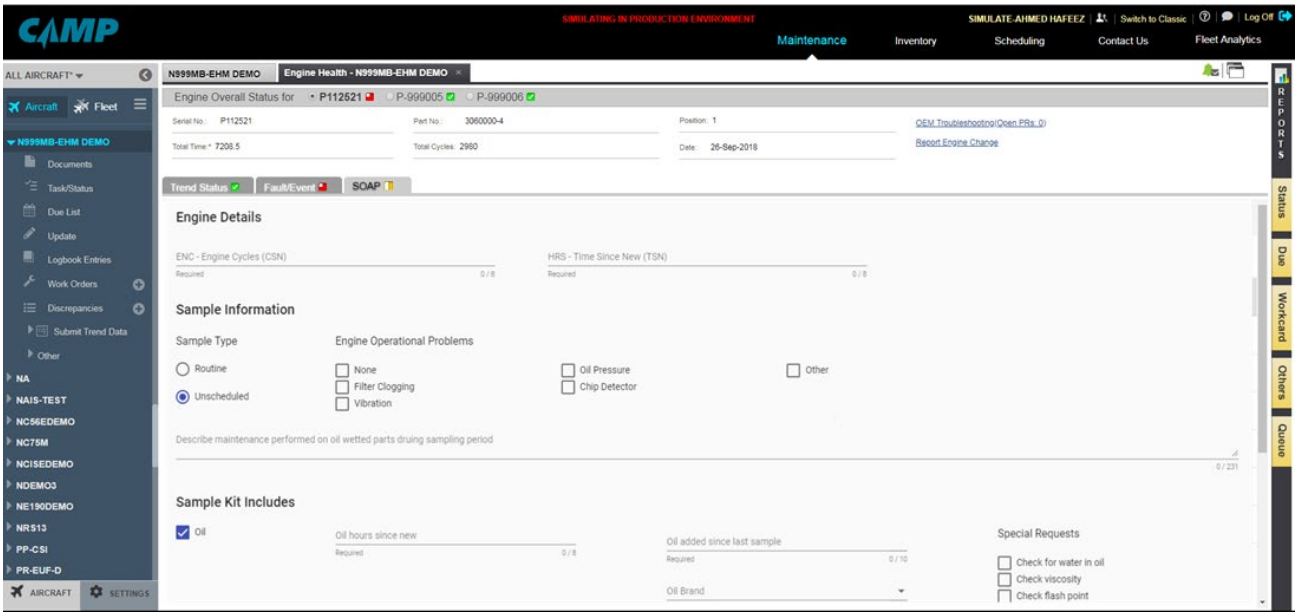


Figure 23 – SOAP Electronic Form