



913200

**Engine Trend Monitor
Pilot's Operation Manual**



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INTRODUCTION

The Engine Trend Monitor (ETM), manufactured by Shadin Avionics, provides maintenance and engine condition monitoring. It provides automatic cycle and engine start counting, and automatic data collection for the Pratt & Whitney ECTM program. The ETM provides a log which contains detailed records of each event in a flight from power on and engine start, to engine stop and power off. The ETM also keeps a complete record of each flight for later review and analysis. The system also provides a record of fuel used, cycle counts, total hours, and engine and airframe exceedances.

IMPORTANT PROCEDURES

The ETM monitors certain engine parameters and uses them to determine the engine status: stopped, running, starting, etc. This data is used for later trend analysis. For the ETM to accurately report the information, you must adhere to these startup, takeoff, cruise, and shutdown procedures.

START UP PROCEDURE

CAUTION: IF THE PILOT STARTS THE ENGINE BEFORE THE ETM HAS FINISHED ITS POWER-UP SEQUENCE, THE SYSTEM WILL NOT RECORD THE ENGINE START. THIS WILL RESULT IN INACCURATE CYCLE COUNTS, ENGINE START COUNTING, AND TREND ANALYSIS.

1. Set the aircraft master power switch to on.
2. Wait ten seconds minimum for the ETM to complete its startup procedure.
3. Start the engine.

SHUTDOWN PROCEDURE

CAUTION: IF THE PILOT TURNS OFF POWER TO THE ETM BEFORE THE GAS GENERATOR SPEED IS LESS THAN 13%, THE SYSTEM WILL NOT RECORD THE ENGINE SHUTDOWN. THIS WILL RESULT IN INACCURATE CYCLE COUNTS AND TREND ANALYSIS.

1. Wait until the gas generator speed is less than 13%. The ETM records an engine shutdown when the gas generator speed drops below the engine-off threshold in ETM software. The threshold is determined by the aircraft model.
2. Set the aircraft master power switch to off.

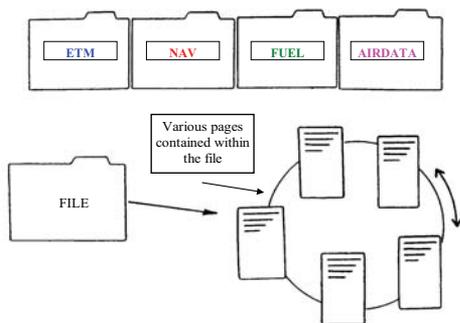
TAKEOFF AND CRUISE NOTES

During takeoff, apply power gradually to keep the propeller speed from going beyond the exceedances limit. The propeller governor will not react fast enough to prevent the propeller from momentarily going over speed. Generally, this condition will go unnoticed. The ETM however, records this event as an exceedances.

ETM TERMINOLOGY

This manual uses terms to designate features or functions of the ETM. These paragraphs describe the terms.

- "File"- A file is the broadest category of organization in the ETM. Each location on the rotary switch (located on the lower left side of the ETM) corresponds to a file.
- "Page"- This is the next category of organization after a file. Each file generally contains 5 to 10 pages. The PAGE UP/DOWN switch, located in the lower center of the ETM, scrolls through the various pages. See below for an example of file and page organization.



913200-0001A

- "Indicator Face"- The indicator face is the entire faceplate of the ETM. It includes the controls and display.
- "Display"- The display is the small screen in the center of the ETM. The display has two, 12-character lines to show data.
- "Exceedance"- The ETM has specific manufacturer's data for the aircraft in which it is installed. This body of data provides the ETM with the aircraft performance parameters. If the aircraft exceeds or violates the parameters, the ETM records the exceedance on the output device. If enabled by the installer, the exceedance is also displayed by the ETM.
- "Mode"- The ETM has three modes: Data Entry, Diagnostic, and Operational. Each of these modes has different file and control assignments. This manual describes the Operational Mode. Data Entry and Diagnostic Modes are used by installation and maintenance personnel.
- "Operator" - The terms pilot, user, and operator are interchangeable.

MANUAL CONTENT

This manual provides the following:

- A system overview (Section 1)
- A description of the ETM operational mode (Section 2)
- A description for each File (Sections 3 through 6)
- A description of Automatic Functions (Section 7)
- A description of Auxiliary Functions (Section 8).

NOTE: Example displays shown in this manual are from twin engine aircraft and show two parameters. Displays for single engine aircraft are the same but show no left or right engine indication and show one parameter.

Twin Engine



Single Engine



The following shows parameter symbols that show in the displays.

Symbol	Description
	Inter-turbine temperature
	Gas generator speed (also known as NG)
	Propeller speed (also known as NP)
	Gas generator speed (also known as N1)

Symbol	Description
	Propeller speed (also known as N2)
	Torque
	Turbine outlet temperature

SECTION 1 - SYSTEM OVERVIEW

The Engine Trend Monitor (ETM) provides the aircraft owner, operator, and maintenance personnel with a complete, accurate, and detailed record of the aircraft's operation. A complete range of data is recorded; including engine and airframe data which can be used to optimize the aircraft's maintenance.

1. Parts Breakdown

The ETM consists of several physical components. The number of parts in the overall system varies with the type of ETM. There are two types of ETM systems: integral and remote. Both types are identical in function and operation. The two systems differ in the physical arrangement of components.

The integral ETM system, has three major components:

- Panel mounted indicator and computer: this contains the main components and processor for the system, controls, and display
- Engine and environment sensors: these are the various probes and sensors from which the ETM collects data.=
- External data recorder: this part of the system is used for data storage.

The remote ETM system has a separate display and processor unit. The processor portion of the system is typically mounted in the aircraft's avionics bay. The display and controls are mounted in the cockpit panel.

The remote ETM system consists of four components:

- Panel mounted indicator: contains the controls and display
- Remote mounted computer: contains the main components and processor for the system.
- Engine and environment sensors: these are the various probes and sensors from which the ETM collects data.
- External data recorder: this part of the system is used for data storage.

2. System Capabilities and Features

The Engine Trend Monitor serves a multitude of functions for both the pilot and operator of the aircraft. The ETM monitors, displays, and records engine and airframe parameters. If desired, the system can also give an alert to the pilot when those parameters exceed established limits. The system provides the pilot with:

- A centralized location for engine monitoring
- Navigation data received from a GPS receiver
- A complete fuel management system
- Continuously updated air data. The air data is displayed and is transmitted in serial formats.

The ETM provides the maintenance personnel with:

- A complete log of engine starts and total time
- A complete log of airframe total cycles and total time

- A complete and detailed record of every engine and airframe exceedance.

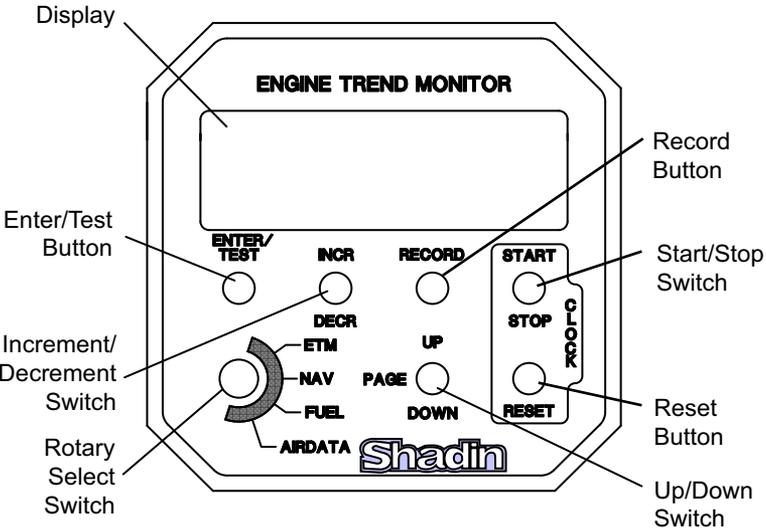
The ETM collects and records data for use with the Pratt & Whitney ECTM program in the form of power assurance checks.

The Engine Trend Monitor System provides the following functions:

- Monitor and display primary engine data: this includes engine temperature, torque, propeller and turbine speeds.
- Monitor and display primary air data: this includes pressure altitude, indicated air speed, and outside air temperature.
- Calculate and display secondary engine data: this includes shaft horsepower and specific fuel consumption.
- Calculate and display secondary air data: this includes density altitude, true airspeed, wind speed and direction, mach, and drift.
- Interface with a long range navigational receiver: the system displays the aircraft position in latitude and longitude, ETE and ETA to next waypoint, magnetic track, ground speed, aircraft heading, drift angle, rate of turn, waypoint ID, and distance to destination data.
- Detect and record exceedances: both engine and airframe exceedances are recorded on the data output device and in the ETM.
- Priority display exceedances: if desired, the ETM can display exceedances to the pilot as they occur. If this function is enabled, the exceedance warning will override any other display, regardless of its function.
- Automatically keeps a log: engine total time, and number of starts as well as airframe total time and total cycles are automatically updated.
- Data Sampling: engine power check data, which is required as an input for subsequent analysis by the Pratt & Whitney ECTM program is automatically recorded by the ETM.
- Provides the pilot with a complete fuel management system: includes fuel flow, full fuel, added fuel, fuel remaining, fuel used, fuel at destination, and fuel to destination.
- Records events: engine starts, takeoffs, landings, engine shutdowns, engine power checks and user requested data are recorded in the form of printouts and key reports.
- Provides a multifunction clock and calendar: the clock displays both GMT and local time to the second. The calendar is used when entering the date into a report on the key. The stopwatch is an auxiliary feature and is not tied to a specific function.

SECTION 2 - OPERATIONAL MODE

In Operational Mode, ETM front panel switches function according to the front panel labels. The following describes the switch functions.

Switch/Display	Description
 <p>The diagram shows the front panel of the Engine Trend Monitor (ETM). At the top is a rectangular display area labeled 'ENGINE TREND MONITOR'. Below the display are several controls: an 'ENTER/TEST' button, an 'INCR' button, a 'RECORD' button, and a 'START' button. Below these are a 'DECR' button, a rotary select switch with positions for 'ETM', 'NAV', 'FUEL', and 'AIRDATA', a 'PAGE' button, an 'UP' button, and a 'DOWN' button. On the right side, there is a vertical panel with a 'STOP' button, a 'RESET' button, and a 'STOP' label. The 'Shadin' logo is at the bottom center. Labels with leader lines point to the Display, Enter/Test Button, Increment/Decrement Switch, Rotary Select Switch, Record Button, Start/Stop Switch, Reset Button, and Up/Down Switch.</p>	<p>913200-0002A</p>
Display	The display of the ETM. Contains two lines, 12 characters per line.
Enter/Test Button	Activates the self test
Increment/Decrement Switch	Scrolls through sub pages and increments or decrements an input value.
Rotary Select Switch	Select one of the four files from which to display pages.
Up/Down Switch	Scrolls through pages in a file
Reset Button	Activates the stopwatch. Resets the stopwatch.
Start/Stop Switch	Starts and stops the stopwatch
Record Button	Generates an output report

When the ETM is turned on, the system begins a startup sequence. This sequence begins with the ETM title page.



ENGINE TREND
MONITOR

The next screen displays the software version in the ETM. The following shows an example of the display.



Prog80.30.04
Data82.30.04

Next, the aircraft model and the ETM specifications revision number are displayed. The following shows an example of the display (XXXX -YY is the aircraft model.).



Model Number
XXXX -YY

Next a copyright message displays. The following shows an example of the display.



Copy. 1988-07
Shadin

After the startup sequence is finished, the unit enters the Operational Mode.

In the operational mode, the ETM display pages are separated into four main files, with each file corresponding to one position of the rotary switch. The files are ETM, NAV, FUEL, and AIRDATA. Within each file the PAGE UP and PAGE DOWN switches are used to cycle through the various pages which can be displayed in each file. A description of the data to be viewed on each page and the procedures for any actions which can be performed on each page is given in the sections that follow.



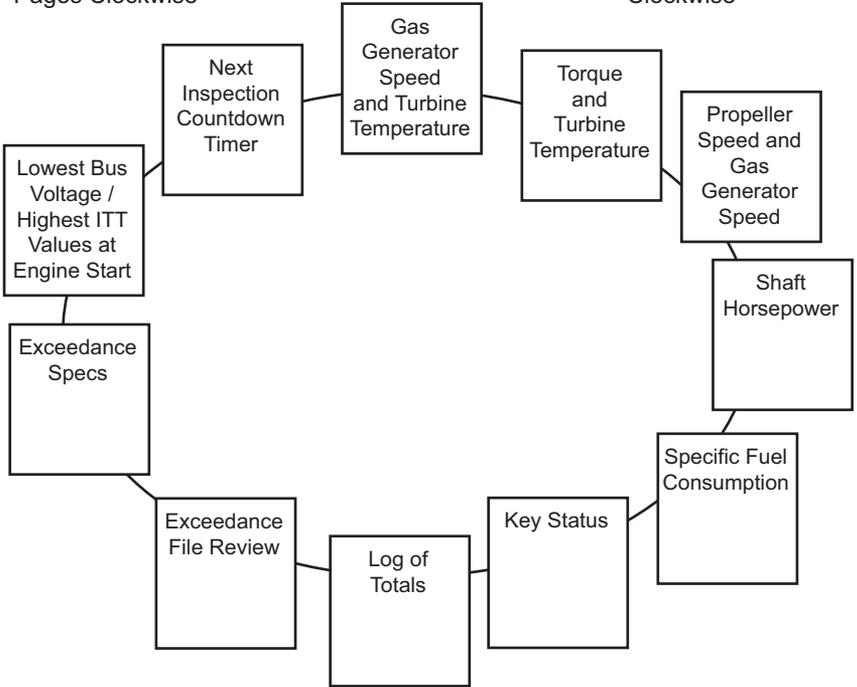
Blank Page

SECTION 3 - ETM FILE

The ETM file contains pages which display information related to engine functions. The monitored parameters range from gas generator speed to fuel consumption. The ETM pages are shown below.

Press PAGE UP
Switch to Cycle
Pages Clockwise

Press PAGE DOWN
Switch to Cycle
Pages Counter-
Clockwise



1. Gas Generator Speed (NG or N1) and Turbine Temperature (ITT or TOT)

The tachometer is displayed in the ETM as NG or N1, displayed as a percent (%). Also displayed on this page is the inter-turbine temperature (ITT) or turbine outlet temperature (TOT), displayed in degrees Celsius.



2. Torque (TQ) and Turbine Temperature (ITT or TOT)

The torque page displays the torque (in foot-pounds) for the engine(s). If the engine is off, the display shows a series of dashes.



3. Propeller Speed (NP or N2) and Gas Generator Speed (NG or N1)

The propeller speed is displayed on the lower line of this page as NP, and the value is given in RPM.



4. Shaft Horsepower (HP)

The shaft horsepower is calculated for the engine(s) from the NP and the torque. This display is enabled in ETM software based on aircraft model. This is a real-time calculation of the engine output in horsepower.



SHAFT HP:
L602.0 R603.0

5. Specific Fuel Consumption

Specific fuel consumption is a calculated value that measures the engine efficiency. The display indicates the number of pounds of fuel required by the engine to produce one horsepower. This page shows only if the shaft horsepower page is enabled in ETM software.

In general the smaller the number, the more efficient the engine. For example, an engine with a specific fuel consumption of 0.500, is operating more efficiently than an engine with a specific fuel consumption of 0.600. What this comparison means is that, to produce the same amount of horsepower, the first engine is burning less fuel than the second.



SFC:
L.454 R.454

6. Ground Power Check

NOTE: The ground power check function is not available in all ETM. Availability is shown by a Ground Check page in the ETM file.

A. General Description

All forms of engine deterioration will be accompanied by an increase in inter-turbine temperature and fuel flow at a given power setting. Compressor deterioration in most cases is due to dirt and sand ingestion and will increase the gas generator speed to obtain a given power setting. Power turbine deterioration will cause a decrease in the gas generator speed required for a given power setting. All of these symptoms are easily identified by ground power checks.

Ground power checks are performed to evaluate the engine condition and the effects of maintenance, or to analyze faults due to engine deterioration. These performance checks are a normal maintenance procedure that must be carried out frequently and any changes in engine performance should be noted. (Please refer to your approved aircraft maintenance procedures to perform the ground power check.)

There are three parts to the ground power check. First, the operator calculates input and output values for the engine. Second, the actual power check is performed, and data is collected. Third, the calculation of the "delta" values is performed.

Part 1

Before the test is performed, the operator must determine what the input and output values will be. The inputs are the values the operator will set, and the outputs are the values the operator will record at the end of the test to evaluate the condition of the engine. There are two input values and three output values. The inputs are: the torque (TQ) and propeller speed (NP). The outputs are: the gas generator speed (NG), inter-turbine temperature (ITT), and fuel flow.

The torque and propeller speed are the values the operator will set. The operator must calculate a target torque and target propeller speed. The target torque is dictated by the ambient pressure conditions, while the target propeller speed is a predetermined value and is always the same RPM.

For the output values, two different methods of measurement are used. For the gas generator speed and inter-turbine temperature, a maximum allowable value is determined. For the fuel flow, a target value is calculated based on the ambient pressure conditions.

Part 2

After all the calculations are done, the operator can perform the ground power check. First, the operator runs the engine up to the calculated torque and propeller speed. Once the engine has matched the targets, the operator begins the stabilization countdown timer.

At the end of the stabilization period, the three output values for the engine are recorded. The operator then shuts down the aircraft and proceeds to the next phase of the test.

Part 3

In part 3, the operator determines the deltas for each of the output values. A delta is the difference between the actual value recorded and the maximum allowable or target value that was calculated by the operator at the beginning of the ground power check. These deltas are used to determine the condition of the engine.

The calculations of the deltas for each of the output values are handled in different manners. For the NG and ITT, they are the same. The fuel flow delta is calculated differently.

The operator compares the NG and ITT values that were recorded during the power check to the maximum allowable figures that were calculated before the test. The NG and ITT values should be less than the maximum allowable values. The better the condition of the engine, the larger the difference in these values. The aircraft manufacture defines the maximum values.

The fuel flow has no maximum allowable value, but rather, a target fuel flow. The delta for the fuel flow is how far away from the target the actual flow is. This number could be more or less than the target fuel flow. Once all of the deltas are calculated the operator uses them to determine the engine condition. The aircraft manufacture defines the target fuel flow.

The ETM simplifies this entire process and makes the job much less time consuming. Before the test is started, the ETM automatically calculates the target torque and all of the maximum allowable and target output values.

During the test, the system displays the target torque and propeller speed as well as the current engine torque and propeller speed. The target and current values are located in the same display. When each value is matched, the ETM automatically notifies the operator and goes on the next part of the test. (Throughout the test, the propeller speed and torque are constantly monitored in case the value of either one goes outside its test parameter.)

The ETM displays the stabilization timer and automatically snapshots the output values at the end of the waiting period. The system then calculates the deltas for each value, displays them in the cockpit, and writes them to the Datakey. The information can later be transferred to a ground based PC for evaluation, tracking, and comparison.

This procedure allows the maintenance personnel to perform ground power checks more often. As more checks are performed, more data is collected. This increase in data helps in the analysis of problems with the engine and helps keep it in the best condition possible. The maintenance personnel can also identify faults more easily.

The criteria for evaluating the engine data is up to the maintenance personnel. The ETM is simply providing an automated way to obtain the target torque and the maximum allowable limits from the charts; and an audit trail for data by printing all of the involved parameters. The system does not perform any type of engine analysis.

B. Ground Power Check Procedure

CAUTION: When performing a ground power check, always follow the aircraft manufacturer's approved instructions.

- (1) Select the Ground Power Check page of the ETM. After five seconds, this page will flash once, then go on to the next display.



- (2) The ETM will briefly display the pressure altitude and outside air temperature. These values are part of the criteria the ETM uses for calculating the target torque and resulting values.



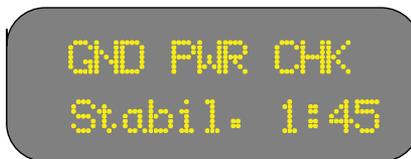
- (3) The ETM will now prompt you to bring your propeller speed within test parameters. The display below shows the target propeller speed and the current propeller speed. Bring the propeller speed to the target RPM. When they have been matched, the display will flash several times, then go on to the next display.



- (4) The ETM will display the target torque on the upper line of this display and the current torque on the lower line of this display. Match the engine torque to the target torque as indicated by the ETM. When they have been matched, the display will flash several times, then go on to the next display.



- (5) The conditions for the ground power check have now been satisfied. The ETM will start the stabilization timer. All engine parameters must remain constant and stable for the specified length of time.



- (6) When the waiting period has elapsed, the ETM will record the N1, ITT, and fuel flow. It will then calculate the differences between the resultant engine values and the maximum allowable values, and the actual fuel flow and the target fuel flow.



```
Delta NG- 3.8
ITT-20.2F+ 24
```

In the above example, the dashes preceding the numbers are minus signs, not dashes. Therefore, ITT-20.2 indicates that the ITT is -20.2°C less than the maximum allowable.

NOTE: ITT is always in °C.

7. Key Status

This page displays the status of the key. When the key is inserted, and is being written to properly, the following display is shown.



```
Key 42.6%used
Status: Init
```

In the above example, the top line of the display indicates the amount of space on the key that has been used. The bottom line indicates the status of the key. In this case, the key is initialized.

If there is a problem with the key, a popup error message shows nature of the error. The various displays are shown and described in detail in Section 7.

8. Log of Totals

The Log of Totals page is a centralized location for the pilot or maintenance personnel to quickly and easily view the total cycles and time for the airframe, and the total starts and time for the engine.

This page has three sub page displays which are accessed by using the INCR switch. The DECR switch does not function in the Log of Totals display.



* Hold the INCR switch to see a description of the subpage to be viewed. Press and release the switch to see the subpage.

Each press of the INCR switch advances the display to the subpages in the following order:

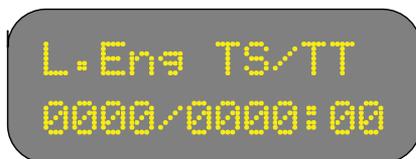
AF=Airframe
TC=Total Cycles
TT=Total Time



AF TC/TT
0000/0000:00

of Cycles / Hours : Minutes of Flight

TS=Total Starts
TT=Total Time



L.Eng TS/TT
0000/0000:00

of Starts / Hours : Minutes of Flight
for this Engine

TS=Total Starts
TT=Total Time



R.Eng TS/TT
0000/0000:00

of Starts / Hours : Minutes of Flight
for this Engine

9. Exceedance File Review

The Exceedance File Review pages allow the operator to check the number of exceedances recorded by the ETM, and to view the data pertinent to those exceedances. The title page is shown below:



By pressing the INCR switch, the operator can progress through the title pages for the airframe and engine exceedance reviews. These pages display the type of exceedance, and the number of occurrences. For each file, the ETM numbers the exceedances up to 99 and stores data on the most recent 20.

Once you have found the file review title page you want to view, press the DECR switch to review the details of each exceedance. For example, pressing the switch while in the "left engine exceedance" file review (the second review displayed) shows details on the most recent exceedance; LE for left engine, RE for right engine, and AF for airframe. The following shows an example of the left engine exceedance display.



The number in the upper right corner indicates the number of exceedances the ETM has recorded for that particular item.

The following list describes the different parts of the exceedance display. Refer to the example display given below for a visual representation of what is being described.



- The Number in the top left of the screen, indicates the order in which the exceedance took place (i.e. #02 was the second exceedance).
- The Date and Time (Local) alternately flash in the upper right corner. The time recorded is the point at which the exceedance reached its maximum value.
- The Limitation that was exceeded is shown in the lower left corner. This describes what was exceeded and gives the highest value reached (i.e. NG% 101.8 indicates that the NG exceedance peaked at 101.8%).
- The Duration, in the bottom right corner of the screen, indicates how long the given value was in exceedance. The duration is determined from the time the exceedance began, to the time the value dropped back down below the exceedance limit.

In the above example, the gas generator speed went too high, which peaked at 101.8%, and lasted 13 seconds. The exceedance was the second to occur. It happened on 5 November, 1996.

If a grace period is set for the exceedance parameter, the ETM does not count the time of the grace period. Using the above example, if the system considers 101.5% the exceedance limit, and the grace period is 10 seconds, the system will not record the first ten seconds the aircraft is in exceedance of 101.5%. Therefore, if the aircraft is physically in exceedance for 23 seconds, the ETM will not count the 10 second grace period, and will display a 13 second exceedance.

The ETM has a safeguard to prevent registering a false exceedance due to noise from the transducer. After the grace period has elapsed, the ETM will wait for one second to be sure the aircraft is really in exceedance. At that point the exceedance will register.

10. Exceedance Specifications

This section of the ETM contains the specifications for the exceedance values that apply to the aircraft model selected. The title page for these displays looks like this:



To cycle through the exceedance specs, press the INCR switch. Examples of typical exceedance specifications are given below.



- "NG fwd" This item indicates which parameter the spec is for. In this case, it is the gas generator speed while using forward thrust.
- "L1/2" This item indicates how many levels the exceedance has, and which level the operator is currently looking at. In this case, there are two levels to the exceedance, and the operator is looking at a level one exceedance (1/1 indicates only one level of exceedance. 2/2 indicates that the operator is viewing the second level exceedance).
- 0s, This indicates a 0 second grace period for the exceedance.
- 10s, This indicates whether or not there is a grace period for the exceedance. The aircraft can exceed the value given for the specified time before the system registers an exceedance. In the above example, the NG value can exceed 101.5% for 10 seconds before the system will register an exceedance.
- 101.5%, This indicates the value at which the ETM will register an exceedance. In the above example, the unit would alarm the pilot when the NG value exceeds 101.5%.

The following shows other possible exceedances that may be displayed:

IAS	N1 fwd	NP fwd	TOT rev
ITT fwd	N1 rev	NP rev	TOT start
ITT idle	N2 fwd	SHP fwd	TQ fwd
ITT rev	N2 rev	SHP rev	TQ rev
ITT start	NG fwd	TOT fwd	
MACH	NG rev	TOT idle	

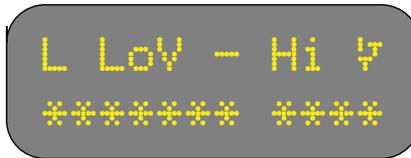
* Based on the software in the ETM which is determined by the aircraft application,
NG or N1 is displayed
NP or N2 is displayed
ITT or TOT is displayed

11. Lowest Bus Voltage / Highest ITT Values at Engine Start

A major contributor to hot starts is the gradual degradation in the performance of the fuel control unit. By keeping a close watch on the maximum start temperature, the maintenance crew can more easily diagnose any degradation in the fuel control unit early on, before any serious damage can be incurred.

The second major contributor to the occurrence of hot starts is a low charge on the aircraft's battery. A low battery charge results in a low bus voltage. This may cause a hot start. The ETM monitors this bus voltage during the startup procedure. The maintenance crews can then use these records to determine if the battery requires maintenance.

This display has three different aspects depending on the status of the engine: before startup, during startup, and running. For example, before startup, the left engine display looks like this:



Note the "-" symbol in the middle of the upper line. This symbol indicates the condition of the engine. When a dash appears, as above, the engine is off.

During start up, the left engine display changes to this:



Note that the "-" symbol has changed to a "\". This indicates that the engine is performing the start up.



The "\" symbol has now changed to a "!" symbol indicating the engine has completed the start up procedure, and is now running.

12. Next Inspection Countdown Timer

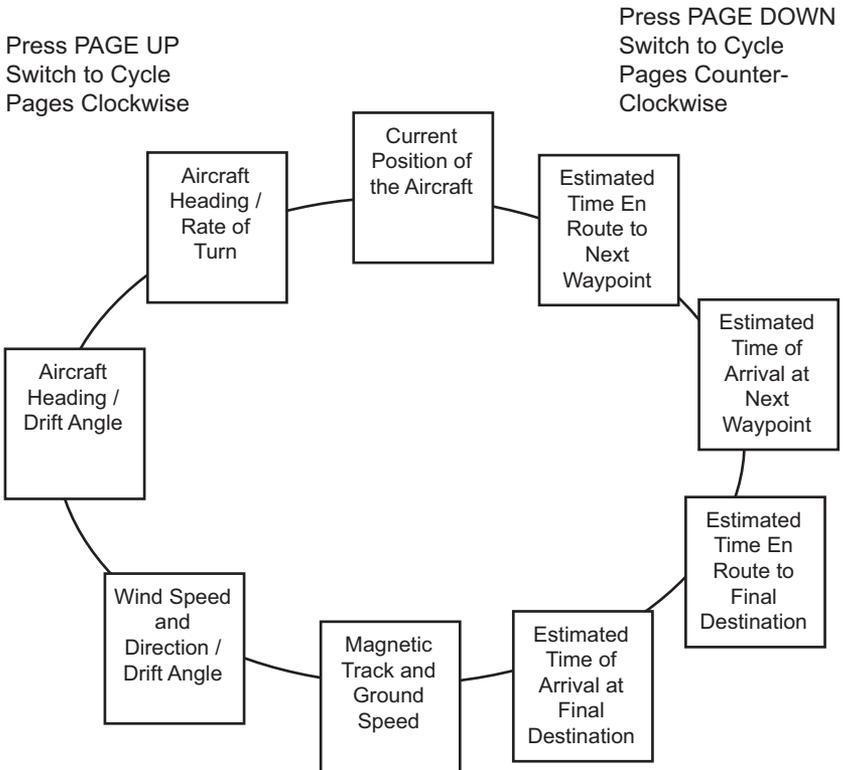
This is an optional page that acts as a countdown timer to the aircraft's next inspection. Unless the install specifically selects this page to be shown, it will not appear in the normal cycle of pages. Time is shown in hours, minutes and seconds.



SECTION 4 - NAV FILE

The navigation functions rely on data received from the heading of the aircraft and GPS or other long range navigation systems. If the selected function displays dashes in place of data, the ETM is not receiving valid GPS or heading data. The ETM pages are shown below.

CAUTION: THE GPS MUST BE ON, WITH CURRENT POSITION AVAILABLE AND A "TO" WAYPOINT SELECTED FOR ALL FUNCTIONS TO BE OPERATIVE.



1. Current Position of the Aircraft

The present position of the aircraft is taken directly from the NAV receiver. The system displays the aircraft position in standard latitude, longitude coordinates. For example:



Pos N 44°53,1
W093°12,2

2. Estimated Time En Route to Next Waypoint

The estimated time en route (ETE) page contains three pieces of data:

- The waypoint identifier
- The estimated time en route to the current waypoint
- The distance to waypoint.

The waypoint identifier displays in the upper left hand corner of the screen. The estimated time en route displays on the lower right hand side, and the distance to the waypoint is just below the waypoint identifier. The display continuously updates according to changes in speed and course.



WMSP ETE
50.0% 1:30

In the above example, the aircraft is flying to the Minneapolis/St. Paul International Airport. Its flight will take one hour and thirty minutes at the current ground speed.

3. Estimated Time of Arrival at Next Waypoint

This is the estimated time of arrival (ETA) at the next waypoint. The ETM assumes that the arrival and departure locations are in the same time zone.



In the above example, the aircraft will arrive at Minneapolis/St. Paul at 11:35 local time.

4. Estimated Time En Route to Final Destination

This display is identical to the ETE for the next waypoint, except that it displays data for the final destination, as defined by the flight plan.

5. Estimated Time of Arrival at Final Destination

This display is identical to the ETA for the next waypoint, except that it displays data for the final destination, as defined by the flight plan.

6. Magnetic Track and Ground Speed

This page shows the magnetic track, ground speed, and magnetic variation of the aircraft.



7. Wind Speed and Direction / Drift Angle

The true wind direction and speed are calculated from two different vectors: the true track/ground speed vector, and the true heading/TAS vector. Also shown in this display is the drift angle in relation to the true track. A typical Wind/Drift display looks like this:



In the above example, the wind is coming from ten degrees at twelve knots. "04L" represents the amount of drift from the magnetic track. Here the aircraft is four degrees off from its track. The "L" means that the track is to the left of the heading. (Note: wind heading is estimated to the nearest 10°, and wind speed is estimated to the nearest 5kts.) If the rate of turn exceeds three degrees per second, the wind display will turn to dashes. Once the aircraft settles onto a new course, the NAV system recalculates the data and the display will return. The process takes about thirty seconds to a minute after the aircraft completes its turn.

8. Aircraft Heading / Drift Angle

This display is a combined reiteration of the aircraft heading and drift angle.



9. Aircraft Heading / Rate Of Turn (ROT)

The Heading/ROT display is similar to the heading/drift page in that it restates the heading but, rather than showing the drift, it shows the rate of turn for the aircraft in degrees per second. If the aircraft is turning to the left, a minus sign (-) precedes the ROT value. If the aircraft is turning to the right, a plus sign (+) precedes the ROT value.



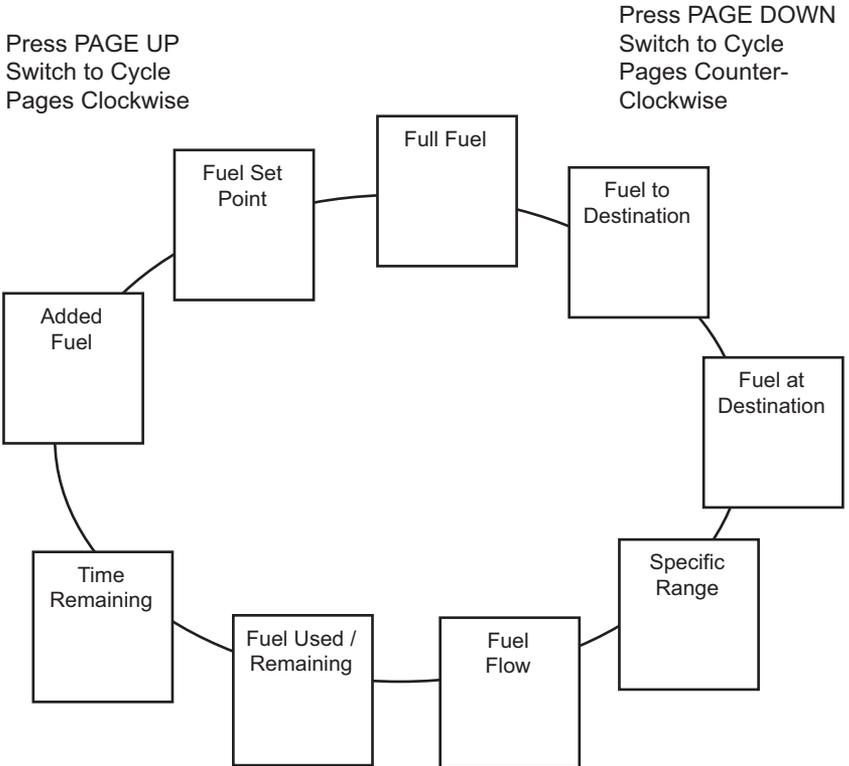
In the above example, the aircraft is heading 10 degrees, and is turning left at 1.2 degrees per second.



Blank Page

SECTION 5 - FUEL FILE

The pages of this file represent a complete fuel management system. The pages display data computed from the fuel flow transducers, and an existing GPS or other long range navigation system. Operation of the totaling functions depends on the pilot entering accurate fuel on board information each time the aircraft is refueled or defueled. The ETM pages are shown below.



NOTE: Displayed units of measure such as gallons, pounds, and liters are set by the installer and maintenance personnel. In this section only one unit of measure, gallons, is used.

1. Full Fuel

This page allows the operator to enter the maximum capacity of all the fuel tanks onboard. This includes the main and auxiliary tanks.



Entering the full fuel amount is only necessary during the initial setup. The ETM stores this value in its memory, permanently.

The procedure is described below:

- A. Select the "Full Fuel" page.
- B. Press and hold both the ENTER and RECORD buttons for 10 seconds. Two chevrons will appear on the left side of the display. The system is now ready to accept input.



- C. Use the INCR/DECR switch to enter the fuel amount.



- D. When the correct full fuel amount is reached, press ENTER.

NOTE: If the aircraft is being refueled to the full fuel value, the fuel remaining can be quickly and easily input by pressing the ENTER button while in the "Full Fuel" page. "TAKEN" will flash briefly on the lower line.

2. Fuel to Destination

The fuel to destination is a calculation of how much fuel is required to reach the desired destination. It is determined by using the fuel remaining, and input from the NAV system. As an example, when the ETM is receiving NAV data, and a destination has been selected, the display shows:



If no NAV data is being received, dashes appear in place of data.

3. Fuel at Destination

The fuel at destination page displays the amount of fuel that will be onboard once the destination, as defined in the flight plan, has been reached.

CAUTION: THIS CALCULATION IS BASED ONLY ON THE CURRENT FUEL FLOW. THE ETM DOES NOT TAKE INTO ACCOUNT ANY PLANNED REDUCTION OR INCREASE IN FUEL FLOW.

This function is calculated using the current fuel consumption, and time to destination. As an example, when the ETM is receiving data from a NAV system, and a destination is selected, the display shows:



If no NAV data is being received, dashes appear in place of data.

4. Specific Range

The specific range value is useful in determining the overall performance of the aircraft under the prevailing wind conditions and the current cruise power setting. The specific range is a calculated value derived from the aircraft's ground speed, and rate of fuel consumption. Any change in the wind condition or the power setting, will be reflected in the ground speed, which in turn will affect the specific range.

A strong tailwind or a lower power setting will result in a higher specific range. A strong headwind or a higher power setting will result in a lower specific range.



Specific Range
2.30NM/GAL

This display can provide a reference to determine the optimum cruise power setting to yield the best mileage under the current wind conditions. This can be done by selecting the specific range page, then adjusting the power setting until the optimum value has been reached. The power adjustments should be done in small increments and roughly two minutes apart from each other. This pause allows enough time for the GPS to stabilize the ground speed.

5. Fuel Flow

This page displays the current rate of fuel flow for the engine(s). It is measured by the fuel flow transducer and is displayed.



F/Flow GPH
L 20.0 R 20.0

Gallons per Hour

6. Fuel Used / Remaining (total)

This page displays the total amount of fuel used and the total amount of fuel remaining in the units currently selected.



F/Use 108.4GL
F/Rem 68.5GL

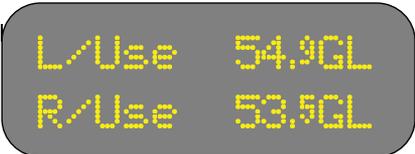
These values are automatically calculated by the system based on the rate of fuel flow and the fuel amounts entered by the pilot at the beginning of the flight. It is possible, however, to manually change the fuel remaining value if the plane has been defueled.

The following procedure tells how to decrease the fuel onboard from the Fuel Used / Remaining page.

- A. Select the "Fuel File" using the rotary switch.
- B. Select "fuel remaining" page.
- C. Use INCR/DECR switch to change the fuel amount. A * replaces the / while the value is being changed.
- D. When the correct onboard remaining fuel amount is reached, press ENTER.

7. Fuel Used (per engine)

This page displays the amount of fuel used by the engine(s) in the units currently selected. It is important that this page is not confused with the previous page which displays the total amount of fuel used rather than the fuel used by the engine(s).



L/Use 54.9GL
R/Use 53.5GL

8. Time Remaining

This page displays the flight time remaining based on current fuel flow rate. In addition, the total amount of fuel remaining is displayed on the second line.



In the above example, the aircraft has about five hours of flight time, and one hundred gallons of fuel remaining.

9. Added Fuel

This page allows for the input of the amount of fuel added onboard the aircraft. This is often useful if a small amount of fuel is added after the fuel onboard has been entered.

This value is limited to less than or equal to the full fuel amount. For example, suppose the full fuel capacity is 120 gallons, and the aircraft has 100 gallons onboard. The added fuel value cannot be more than 20 gallons.



The entry procedure is as follows:

- A. Select the Fuel File using the rotary switch.
- B. Use the PAGE UP/DOWN switch to select the fuel added page.
- C. Use the INCR/DECR switch to enter the added fuel amount.
- D. When the correct fuel amount is reached, press ENTER.

10. Fuel Set Point

In the course of everyday operation, most aircraft are not fueled to full capacity. Often, there is a standard amount that the aircraft is fueled to. The fuel set point page is a way to enter the fuel onboard if the standard amount is being used.

For example, suppose the full fuel capacity of the aircraft is 200 gallons, but it is usually fueled to only 120 gallons. The fuel set point allows the pilot to press one button to enter the fuel onboard.

The following procedure changes the set point from 100.0 gallons to 120.0 gallons.

- A. Press and hold the ENTER/TEST and RECORD buttons for 5 seconds. Two chevrons will appear on the left side of the display. The current fuel set point appears on the right side of the display



- B. Use the INCR/DECR switch to increase the current value.



- C. When the desired value is showing, press the ENTER/TEST button. (The maximum allowable value is limited to the full fuel amount.)

When the Fuel Set Point is entered, press the ENTER button to set the fuel remaining to the fuel set point value.

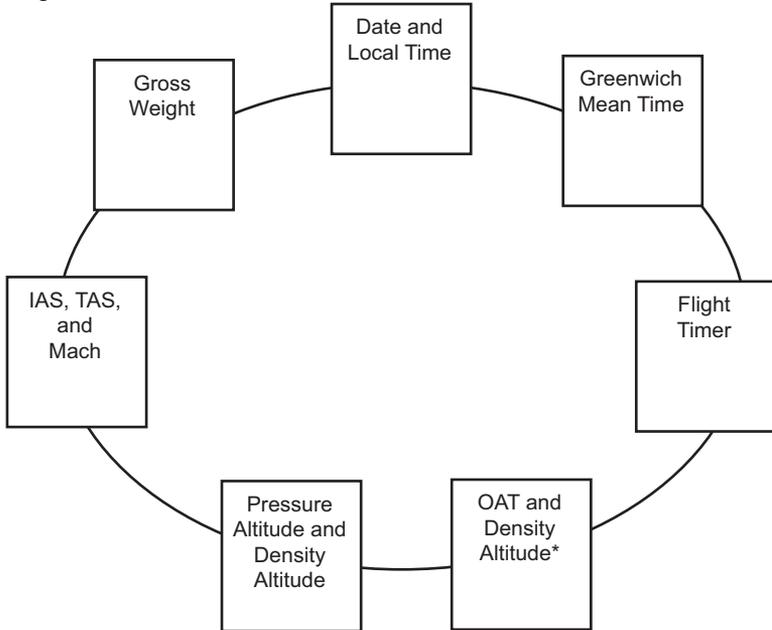
Blank Page

SECTION 6 - AIRDATA FILE

The Air Data pages display information from the pitot/static system and an external OAT probe. The ETM pages are shown below.

Press PAGE UP
Switch to Cycle
Pages Clockwise

Press PAGE DOWN
Switch to Cycle
Pages Counter-
Clockwise



*The page is OAT and SAT on some aircraft installations

NOTE: Displayed units of measure such as pounds and kilograms for gross weight are set by the installer and maintenance personnel. In this section only one unit of measure, pounds, is used.

1. Date and Local Time

This page displays the date and local time.



FRI 16 AUG96
11:02:26 CST

2. Greenwich Mean Time

This page displays the Greenwich Mean Time. Display of this page is enabled/disabled by the installer and maintenance personnel. This value is calculated from the local time.



TIME
16:11:42 GMT

3. Flight Timer

The flight timer shows the time that the aircraft is in flight. The timer takes its queues to start and stop from the IAS. It begins running when the IAS is greater than the takeoff threshold value and stops running when IAS drops below the landing threshold value. The takeoff threshold and landing threshold values are in software specific to the aircraft.

The flight duration is recorded on the output device in the landing report. The flight timer does not record the time for take-off or landing, only the duration of the flight.

CAUTION: IF THE PILOT ENTERS THE DATA ENTRY MODE WHILE IN FLIGHT, THE FLIGHT TIMER RESETS TO ZERO.

The flight timer displays hours, minutes, and seconds.



FLIGHT TIMER
04:14:32

In the above example, the aircraft has been flying for four hours, fourteen minutes, and thirty two seconds.

4. Outside Air Temperature and Density Altitude or Outside Air Temperature and Static Air Temperature

This page displays the outside air temperature (OAT) and the density altitude (D.ALT), or the outside air temperature (OAT) and static air temperature (corrected air temperature). The OAT is taken directly from the OAT probe. The density altitude is calculated from the OAT and pressure altitude. A typical OAT and density altitude display looks like this:



■ A typical OAT and static air temperature (SAT) display looks like this:



5. Pressure Altitude and Density Altitude

The pressure altitude page displays the input received from the static line connected to the airframe. The pressure altitude is used to calculate the density altitude (also displayed on this page).



6. IAS, TAS, and MACH

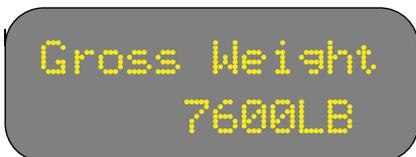
This page displays three different speed values: IAS, TAS, and Mach. The indicated air speed is received from the pitot line. The true air speed is calculated from the IAS and the density altitude. Pressure altitude and IAS are used to calculate Mach.



7. Gross Weight

Use this page to view and enter the gross weight before takeoff. You must take into account all factors that affect the weight of the aircraft (fuel, baggage, passengers, etc.). The ETM automatically adjusts the gross weight according to the rate of fuel used.

A base gross weight function is included in the system. The base gross weight is a number entered by the installer or maintenance personnel and is the default weight when the gross weight is entered. When START is pressed, the ETM displays default gross weight. From this point, increment or decrement the gross weight to any number.



To enter the gross weight:

- A. Select the Air Data file
- B. Select the gross weight page.
- C. Use the INCR/DECR switch to update the current gross weight.
- D. When the correct gross weight is reached, press ENTER.

To jump to the base gross weight:

- A. Select Air Data file
- B. Select gross weight page
- C. Press the START switch
- D. Use INCR or DECR to fine tune the weight.
- E. When the correct gross weight is reached, press ENTER.

SECTION 7 - AUTOMATIC FUNCTIONS

Certain functions are performed independently of user settings and automatically displayed at the appropriate time by the ETM. These include:

- Power Checks
- Exceedance Alarms
- Popup Messages
- Output Reports

1. Power Check

A power check is a data sampling performed by the ETM for use by the Pratt & Whitney ECTM program. The ECTM program uses power checks to measure and graph deviations from an established norm in the NG, ITT, and fuel flow. This deviation gives a clear indication of the engine condition.

For the ETM to perform a power check, the aircraft must be cruising at a stable altitude and speed. After a preset time flying at those stable values, the ETM will automatically perform a power check at the interval set by the installer.

2. Exceedance Alarms

An exceedance is a condition the aircraft can enter into if any of the monitored parameters have a value greater than the FAA approved flight manual limitations and the manufacturer's limits. The ETM constantly watches the engines and airframe for exceedances.

An exceedance is always recorded by the system, however, the installer and maintenance personnel can disable the display of exceedances during normal operation.

If the exceedance display option is enabled, each time an exceedance occurs, the current display will be overridden by the exceedance display. As long as the display remains flashing, the aircraft is still in exceedance. When the parameter that is in exceedance has become less than the threshold limit, the display stops flashing. At this point, the exceedance must be acknowledged by the pilot. To acknowledge an exceedance, press the DECR switch.

3. POPUP MESSAGES

The popup message function is designed to alert the pilot or operator of system errors and for notification of particular events.

- A. This example shows that the key recorder is physically disconnected from the ETM.



Key Recorder
Disconnected

- B. This example shows that the key recorder does not have a key inserted.



Key
Not Inserted

- C. This example shows that the key has been filled to 80% or more.



Key 92.6%used
Advisory

- D. This example shows that the power check was logged. This display shows power check is set by the installer to one per flight or one per day.



Power check
Completed

E. This example shows that internal clock has failed.





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SECTION 8 - AUXILIARY FUNCTIONS

The system has the following additional capabilities that do not apply to any of the four files or their related pages. They function independently of the various modes and files.

1. Stopwatch

The stopwatch function is accessed from any page in normal operational mode. Press the RESET button and the following page displays.



Press START/STOP switch to operate the stopwatch. The RESET button resets the timer. Use the PAGE/UP DOWN or rotary switch to return to the main display functions.

2. Self Test

To do a self-test the engines must be off. If an engine is running, the self-test feature will not function. Press and hold the ENTER/TEST button for about 5 seconds start the self test. "SYSTEM TEST" flashes on the screen followed by the aircraft model. The unit will then begin checking its inputs channels. If any channel fails, the system notifies the operator. For example:



"CHECK FF L" indicates a bad fuel flow input channel for the left engine. Other possible error messages are listed below:

5V rev	FF L	N1 R
6.9V ref	GROUND	N2 L
8V ref	N1 L	No 19200Hz
10V ref		

The following message shows that all tests passed.



SECTION 9 - PARAMETER RECORD

If the aircraft needs maintenance because of inaccurate parameter readings, record the ETM and indicator parameter values on a copy of the following table. Give the record to the maintenance personnel for an aid to fault isolation.

Parameters

Parameter	ETM Value		Indicator Value	
	Left (or Single)	Right	Left (or Single)	Right
Gas Generator Speed (NG)				
Inter-Turbine Temperature (ITT)				
Torque (TQ)				
Propeller Speed (NP)				
Fuel Flow				
Altitude		X		X
Airspeed		X		X
OAT		X		X
Heading		X		X

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