

CHAPTER

77

Engine Indicating GE 115

(GE90-100 SERIES ENGINES)

CHAPTER 77
ENGINE INDICATING GE 115

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CHAPTER 77
ENGINE INDICATING GE 115

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ENGINE INDICATING GE 115**

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ENGINE INDICATING - INTRODUCTION

Purpose

The engine indicating system supplies engine performance data to the AIMS for display on the primary display system. The indicating system has these subsystems:

- N1 and N2 tachometer
- Exhaust gas temperature (EGT)
- Airborne vibration monitoring (AVM)
- Airplane condition monitoring (ACMS).

The ACMS data is available from the AIMS through the MAT.

Abbreviations and Acronyms

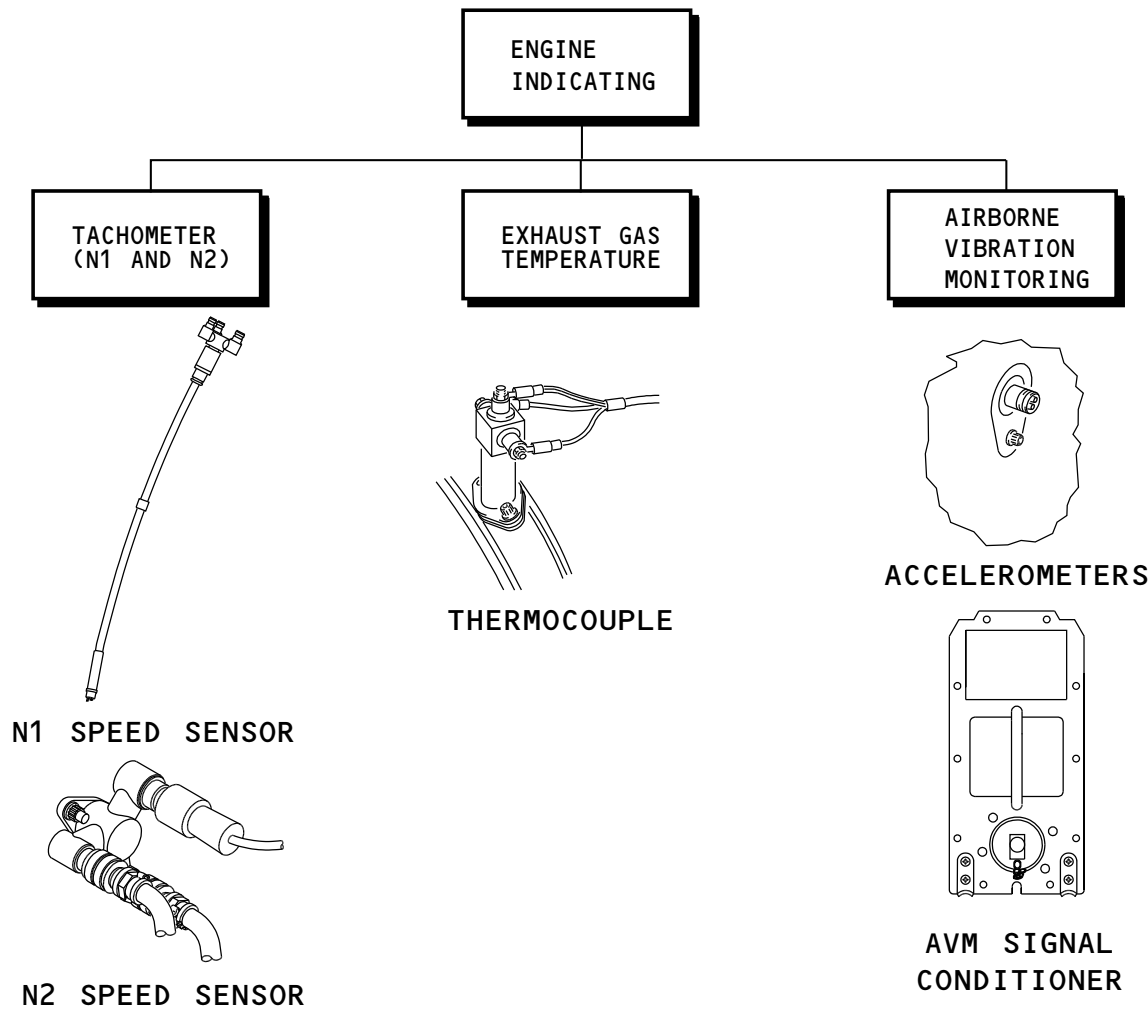
- AIMS - airplane information management system
- ACMF - airplane condition monitoring function
- ACMS - airplane condition monitoring system
- AVM - airborne vibration monitoring
- CMCF - central maintenance computing function
- EBS - engine balancing system
- EDIU - engine data interface unit
- EEC - electronic engine control
- EGT - exhaust gas temperature
- EPCS - electronic propulsion control system
- HPC - high pressure compressor
- HPT - high pressure turbine
- LPC - low pressure compressor
- LPT - low pressure turbine
- MFD - multi-function display
- N1 - low pressure rotor speed
- N2 - high pressure rotor speed
- PDS - primary display system
- PT25 - total pressure LPC exit

- RCC - remote charge converter
- TCF - turbine center frame
- TRF - turbine rear frame
- T/R - thrust reverser
- T49 - HPT exit or LPT inlet temperature
- QAR - quick access recorder.

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ENGINE INDICATING - INTRODUCTION

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ENGINE INDICATING COMPONENT LOCATIONS (LEFT SIDE)

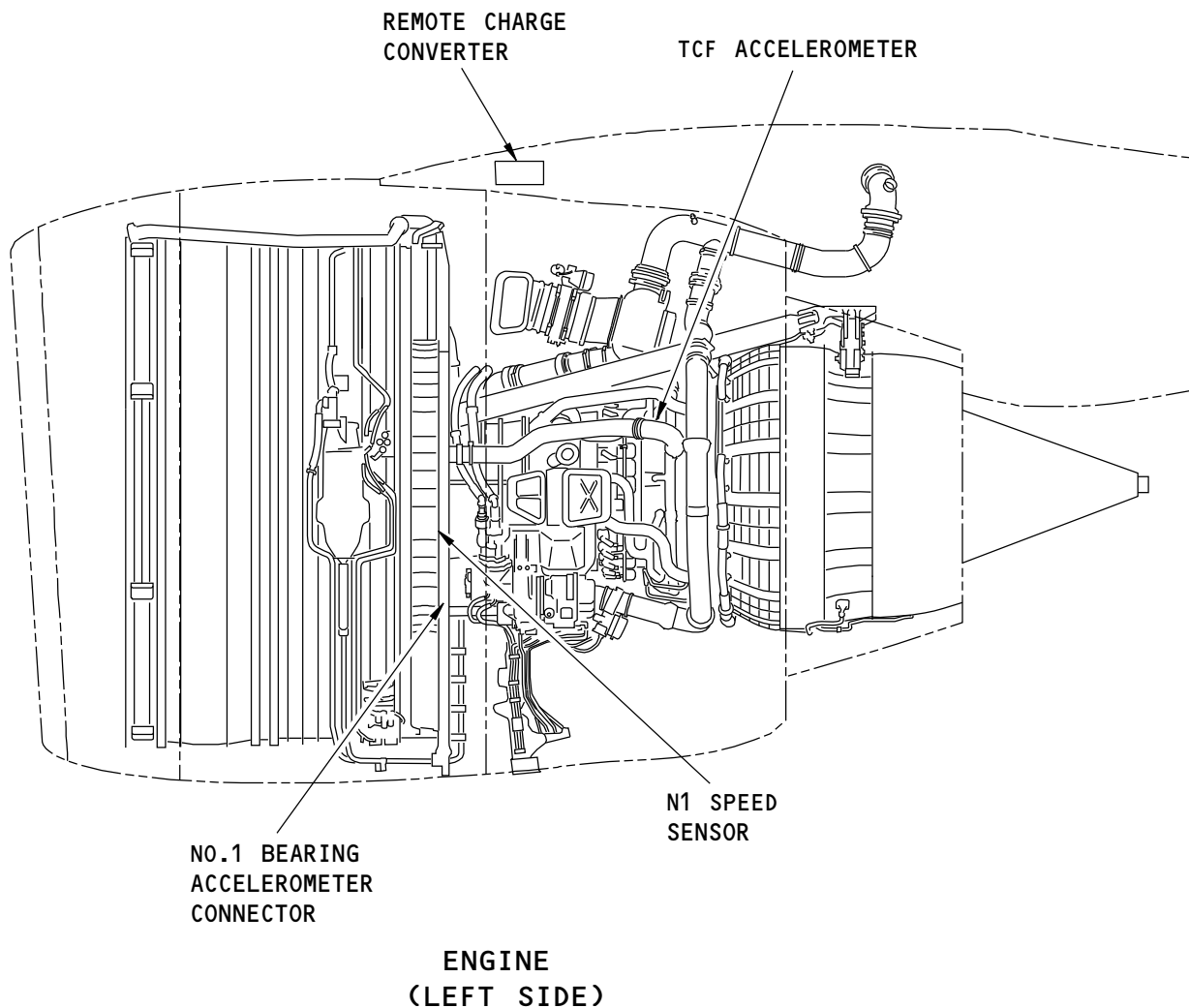
General

These engine indicating components are on the left side of the engine:

- (1) No. 1 Bearing Accelerometer Connector
- (2) N1 Speed Sensor
- (3) TCF Accelerometer.

The No. 1 bearing accelerometer is inside the engine on the No. 1 bearing housing. You can only get access to the accelerometer connector.

The Remote Charge Converter (RCC) is in the strut under the No. 2 fairing.



ENGINE INDICATING COMPONENT LOCATIONS (LEFT SIDE)

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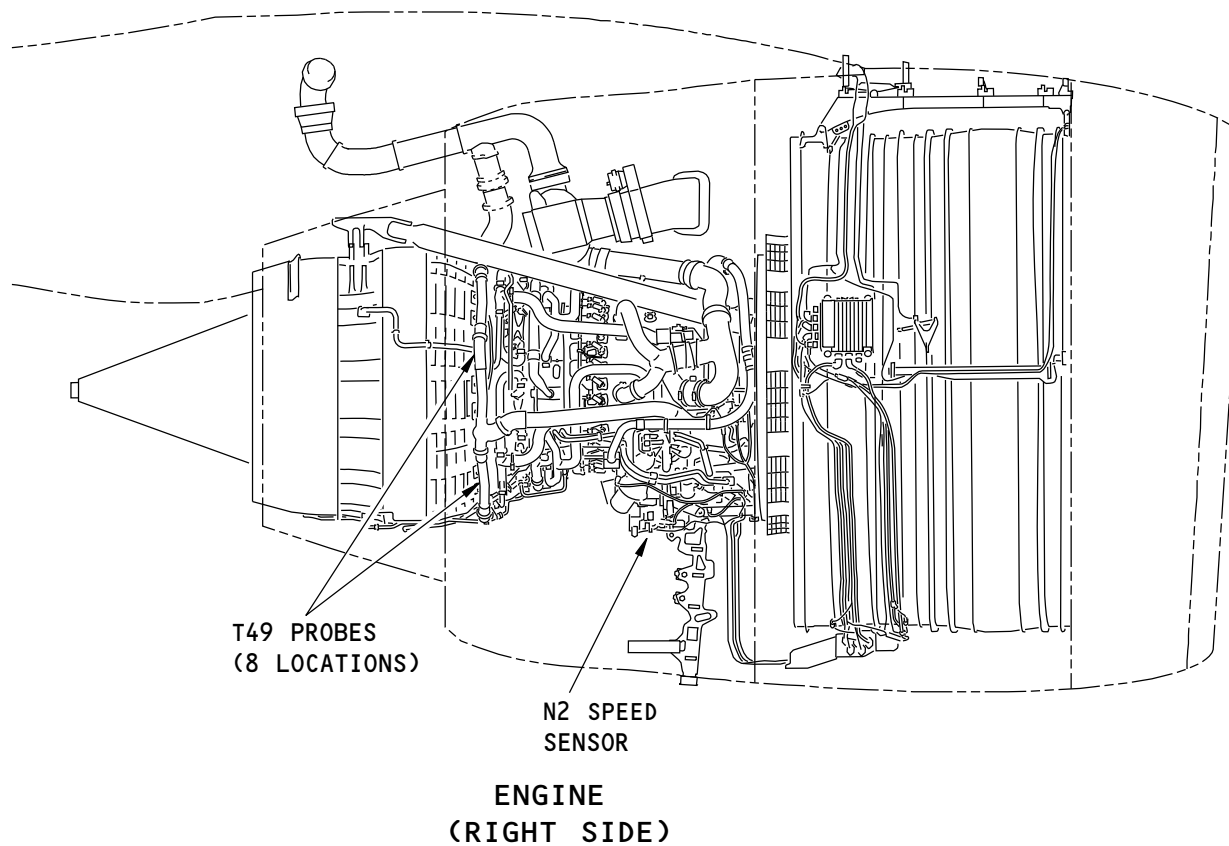
ENGINE INDICATING COMPONENT LOCATIONS (RIGHT SIDE)

General

These engine indicating components are on the right side of the engine:

- (1) N2 Speed Sensor
- (2) T49 Probes.

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ENGINE INDICATING COMPONENT LOCATIONS (RIGHT SIDE)

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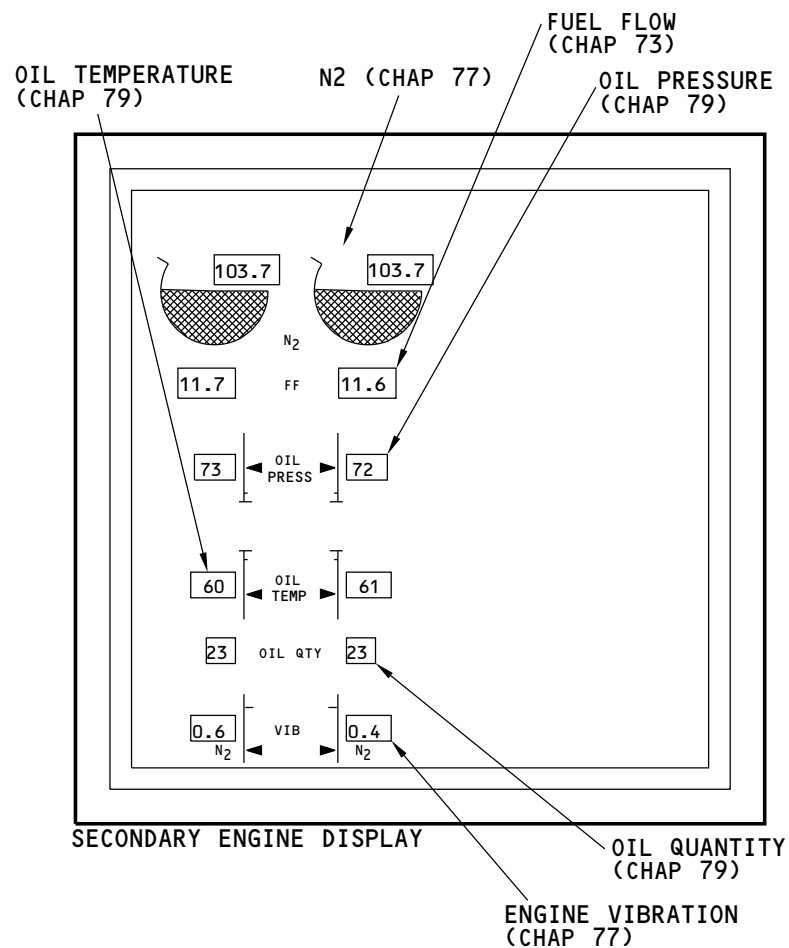
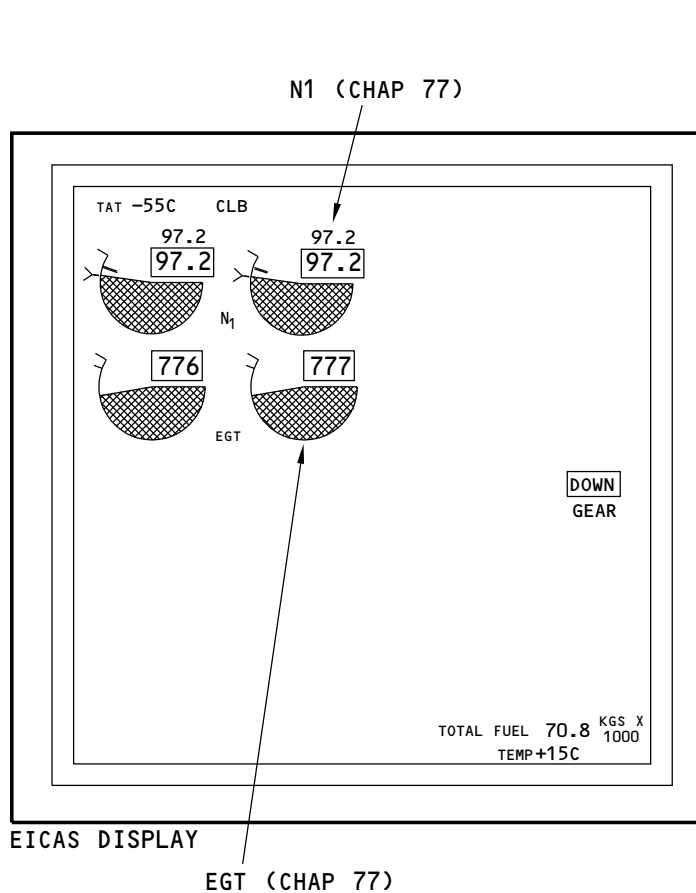
ENGINE INDICATING - EICAS & SECONDARY ENGINE DISPLAYS

Indications

The EICAS display and the secondary engine display show these engine parameters:

- N1, LPC rotor speed
- EGT, exhaust gas temperature
- N2, HPC rotor speed
- FF, fuel flow
- OIL PRESS
- OIL TEMP
- OIL QTY
- VIB, engine vibration.

Refer to the related ATA chapter for more information about these indications.



ENGINE INDICATING - EICAS & SECONDARY ENGINE DISPLAYS

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ENGINE INDICATING - PERFORMANCE & ENGINE EXCEEDANCE MAINTENANCE PAGES

Performance Maintenance Page

The top part of the performance maintenance page shows some general airplane and environment data. GROSS WT is the gross weight of the airplane that the dispatch agent puts in. SAT is the static air temperature and TAT is the total air temperature. Both show in degrees Celsius. GS is the ground speed and CAS is the calibrated air speed. Both show in knots. ALT is the altitude in thousands of feet.

The bottom part of the performance maintenance page shows the same engine parameters as the EICAS display and the secondary engine display. These indications are described in their related sections.

The performance maintenance page also shows the value for these indications:

- PS3
- P-BLEED
- DUCT PRESS.

PS3 is the static pressure from the HPC exit. The EEC gets PS3 from the PS3 sensor. The units are in psi.

P-BLEED is the flow rate of the air in the high stage bleed duct. The EEC uses the pressure from the bleed bias sensor to calculate P-BLEED. The units are in percent of core air flow.

DUCT PRESS is the manifold duct pressure. It comes from the air system cabin pressure controller (ASCPC). The units are in psi.

Engine Exceedance Maintenance Page

The N1 and N2 exceedance displays show the redline for the LP and HP rotors. If a rotor speed goes more than the redline, the exceedance display shows the maximum rotor speed, and the time that the rotor speed was above the redline.

The EGT exceedance display shows an EGT profile if the EGT goes above the redline. This display can show as many as four EGT profiles. The most recent profile is on the left. The oldest profile is on the right. If a new EGT exceedance occurs, the profile shows on the left and the oldest profile goes out of view.

There are two separate profiles for each engine. One profile is for the engine run redline. The other profile is for the engine start redline. If the EGT exceeds the redline while the engine is running, the profile shows the EGT in increments up to the maximum actual EGT. It also shows the time that the EGT was at or above each increment.

If the EGT exceeds the redline during an engine start, the profile shows the EGT in increments up to the maximum actual EGT. It also shows the time that the EGT was at or above each increment.

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PERFORMANCE									
					GROSS WT 187.6				
SAT -23.0		CAS 245		TAT -25.0					
GS 245.6		MACH 0.615		ALT 21030					
					101.4	N ₁ MAX	101.4		
					97.2	N ₁ CMD	97.2		
					97.2	N ₁	97.2		
					776	EGT	777		
					103.7	N ₂	103.7		
					11.769	FF	11.630		
					276.9	P _{S3}	276.9		
					3.50	P _{BLEED}	3.50		
					73	OIL PRESS	72		
					60	OIL TEMP	61		
					23	OIL QTY	23		
					35	DUCT PRESS	35		
DATE 02 SEP 94 UTC 18:54:04									

PERFORMANCE MAINTENANCE
PAGEVIBRATION
(CHAP 77)MANIFOLD DUCT
PRESSURE
(CHAP 36)FUEL FLOW
(CHAP 73)ENGINE INDICATIONS
(CHAP 77)ENGINE AIR PRESSURES
(CHAP 73)OIL INDICATIONS
(CHAP 79)

L ENG EXCD			
01 SEP 94		01 SEP 94	
12:05:45		12:05:55	
N ₁ REDLINE		N ₂ REDLINE	
109.0		117.0	
114.4 :5.5		121.2 :03.5	
02 SEP 94			
12:10:47			
EGT REDLINE			
1070	:00.8		
1069	:01.3		
1067	:02.1		
1065	:04.5	02 SEP 94	
1055	:06.3	12:00:33	
1045	:08.4	EGT START	
1045	:08.4	789	
1035	:09.6	780	:01.3
1025	:10.5	765	:02.5
1015	:11.2	750	:03.8

ENGINE EXCEEDANCE MAINTENANCE PAGE

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ENGINE INDICATING - PERFORMANCE & ENGINE EXCEEDANCE MAINTENANCE PAGES

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ENGINE INDICATING - EPCS MAINTENANCE PAGES

Indications

The EPCS maintenance pages show engine parameters from many engine sensors. The parameters show for channels A and B of the EEC. There is a box around the channel that the EEC is using to control the engine.

These are the parameters that show on the EPCS maintenance page 1:

- N1: LPC rotor speed (percent)
- N2: HPC rotor speed (percent)
- TRA: thrust resolver angle (degrees)
- T/R: left and right thrust reverser position (percent deployed)
- PAMB: ambient pressure (psi)
- PS3: compressor discharge pressure (psi)
- T12: fan inlet temperature (degrees Celsius)
- T25: core engine inlet temperature (degrees Celsius)
- T3: compressor discharge temperature (degrees Celsius)
- VB: variable bypass valve position (percent open)
- VSV: variable stator vane position (percent open)
- STB: start/transient bleed valve position (percent open)

These are the parameters that show on the EPCS maintenance page 2:

- SV: Staging Valve
- LPC Low Pressure Compressor
- HPT ACC: HPT active clearance control valve position (percent open)
- LPT ACC: LPT active clearance control valve position (OPEN or CLOSED)
- CCC: core compartment cooling valve position (OPEN or CLOSED)
- OIL T: oil temperature (degrees Celsius)
- OIL P: oil pressure (psi)
- OIL FLT: oil filter differential pressure (psi)
- FUEL FLT: fuel filter differential pressure (psi).

Refer to the related ATA chapter for more information about these indications.

Status Words

The status words at the bottom of the page show data about the EEC. Each word is a four character hexadecimal number. When decoded, each word shows 16 different parameters.

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EPCS PG 1/2									
LEFT ENGINE					RIGHT ENGINE				
A	B	TACH			A	B	TACH		
97.2	97.2	97.2	N ₁	97.2	97.2	97.2	N ₁	97.2	97.2
103.7	103.7	103.7	N ₂	103.7	103.7	103.7	N ₂	103.7	103.7
72.0	72.0		TRA	72.0	72.0		TRA	72.0	72.0
0.0	0.0		T/RL	0.0	0.0		T/RL	0.0	0.0
0.0	0.0		T/RR	0.0	0.0		T/RR	0.0	0.0
4.7	4.7		P _A MB	4.7	4.7		P _A MB	4.7	4.7
276	276		P _S 3	276	276		P _S 3	276	276
-17	-17		T ₁₂	-17	-17		T ₁₂	-17	-17
39	39		T ₂₅	39	39		T ₂₅	39	39
528	528		T ₃	528	528		T ₃	528	528
0	0		VBV	0	0		VBV	0	0
81	81		VSV	81	81		VSV	81	81
0	0		STB	0	0		STB	0	0
DATE 02 SEP 94 UTC 18:54:04									

EPCS MAINTENANCE PAGE 1

ROTOR SPEEDS (CHAP 77)

THRUST LEVER ANGLE (CHAP 76)

T/R POSITION (CHAP 78)

ENGINE PRESSURES AND
TEMPERATURES (CHAP 73)COMPRESSOR CONTROL COMPONENTS
(CHAP 75)ENGINE FUEL SYSTEM
VALVES (CHAP 73)ENGINE COOLING VALVES
(CHAP 75)OIL SYSTEM PARAMETERS
(CHAP 79)FUEL FILTER
(CHAP 73)

EPCS PG 2/2									
LEFT ENGINE					RIGHT ENGINE				
A	B				A	B			
52	52		FMV	52	52		FMV	52	52
100	100		BSV	100	100		BSV	100	100
100	100		MSV	100	100		MSV	100	100
30	30		HPT ACC	30	30		HPT ACC	30	30
OPEN	OPEN		LPT ACC	OPEN	OPEN		LPT ACC	OPEN	OPEN
CLOSED	CLOSED		CCC	CLOSED	CLOSED		CCC	CLOSED	CLOSED
60	60		OIL T	61	61		OIL T	61	61
73	73		OIL P	72	72		OIL P	72	72
4	4		OIL FLT	4	4		OIL FLT	4	4
3	3		FUEL FLT	3	3		FUEL FLT	3	3
0000	0000		STATUS 1	0000	0000		STATUS 1	0000	0000
0000	0000		STATUS 2	0000	0000		STATUS 2	0000	0000
0000	0000		STATUS 3	0000	0000		STATUS 3	0000	0000
0000	0000		STATUS 4	0000	0000		STATUS 4	0000	0000
DATE 02 SEP 94 UTC 18:54:04									

EPCS MAINTENANCE PAGE 2

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ENGINE INDICATING - EPCS MAINTENANCE PAGES

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ENGINE INDICATING - PROPULSION DATA LIMITS MAINTENANCE PAGES

Propulsion Data Limits - Page 1

The propulsion data limits maintenance page 1 shows data limits for these engine parameters:

- Rotor speeds
- EGT
- Oil pressure
- Oil temperature.

Propulsion Data Limits - Page 2

The propulsion data limits maintenance page 2 shows these limits:

- Exceedance profiles
- Takeoff thrust
- Minimum idle
- Oil quantity
- Vibration
- In-flight relight
- Cross-bleed start.

The exceedance profile display shows the limits for the EGT profiles. The EGT profiles show on the engine exceedance maintenance page (not shown). EGT OPER ORIGIN is the temperature at which the EGT exceedance profile starts when the engine is running. EGT START ORIGIN is the temperature at which the EGT exceedance profile starts during an engine start. DELTA is the temperature increment for the related exceedance profile.

TAKEOFF THRUST is the N1 value at which the AIMS sets the takeoff thrust discrete. The AIMS shows a takeoff warning if the takeoff thrust discrete is set and the airplane is not in the correct takeoff configuration.

NOTE: For the N1 value, refer to "PROPULSION DATA LIMITS MAINTENANCE PAGE 2".

The MINIMUM IDLE and DELAY display show data that the AIMS uses to find if the engine is running. MINIMUM IDLE is an N2 reference value. DELAY is a time delay in seconds. The AIMS usually gets an engine run discrete signal from the EEC. If that signal is invalid, it uses N2. If N2 is above minimum idle for more than the time delay shown, then AIMS sets the engine run discrete.

The OIL QTY: LOW display shows the low limit, in quarts, for engine oil quantity. When the quantity gets below the low limit, the oil quantity display on the secondary engine page (not shown) shows in reverse video (black letters on a white background). The letters LO also show next to the oil quantity display.

The VIB: WHITE display shows the vibration level that causes the vibration display on the secondary engine page (not shown) to show in reverse video (black letters on a white background). This vibration level also causes the secondary engine page to show automatically.

In-Flight Relight Data

The IN-FLIGHT RELIGHT display shows data points that the AIMS uses to make the in-flight relight envelope (not shown). The in-flight relight envelope shows on the EICAS display.

Cross-Bleed Start Data

The CROSS-BLEED START display shows data points that define the cross-bleed start envelope. If the airplane is in the cross-bleed start envelope, the cross-bleed start annunciation (not shown) shows with the relight start envelope on the EICAS display.

APU Data Limits

The APU display shows data limits for these APU parameters:

- RPM
- EGT
- Oil pressure
- Oil temperature
- Oil quantity.

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PROPULSION DATA LIMITS PAGE 1/2

N ₁ :	L	R
REDLINE	109.0	109.0
AMBER BAND	--	--
EGT:		
REDLINE	980	980
AMBER BAND	965	965
START	750	750
N ₂ :		
REDLINE	114.7	114.7
AMBER BAND	--	--
OIL PR:		
LOW AMBER	40	40
LOW REDLINE	10	10
OIL T:		
HIGH REDLINE	135	135
HIGH AMBER	118	118
LOW AMBER	--	--

PROPULSION DATA LIMITS MAINTENANCE PAGE 1

PROPULSION DATA LIMITS PAGE 2/2

EXCD PROFILE:	L	R	IN-FLIGHT RELIGHT DATA PTS
EGT OPER ORIGIN	985	985	(CAS,ALT)
DELTA	10	10	1 0, 0 0,140
EGT START ORIGIN	750	750	3 150,140 150,300
DELTA	15	15	5 335,300 365,286
			7 365, 0 --, --
			9 --, -- --, --
TAKEOFF THRUST	60.0		11 --, -- --, --
FUEL ON CMD: GND	--		13 --, -- --, --
AIR	--		15 --, -- --, --
MINIMUM IDLE	60.0		
DELAY	5.0		CROSS-BLEED START DATA PTS
OIL QTY: LOW	4.0		(CAS,ALT)
			1 0, 0 0,300
VIB: REDLINE	--		3 220,300 220, 0
WHITE	4.0		5 --, -- --, --
WHITE DELAY	0		7 --, -- --, --
			9 --, -- --, --
			APU
			AMBER REDLINE
			RPM -- 106.0
			EGT 650 710
			OIL PRESS 55 35
			OIL TEMP 135 155
			OIL QTY 4.4 3.8

PROPULSION DATA LIMITS MAINTENANCE PAGE 2

ENGINE INDICATING - PROPULSION DATA LIMITS MAINTENANCE PAGES

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PROPULSION DATA LIMITS PAGE 1/2

N ₁ :	L	R
REDLINE	109.0	109.0
AMBER BAND	--	--
EGT:		
REDLINE	1030	1030
AMBER BAND	1015	1015
START	750	750
N ₂ :		
REDLINE	117.0	117.0
AMBER BAND	--	--
OIL PR:		
LOW AMBER	40	40
LOW REDLINE	10	10
OIL T:		
HIGH REDLINE	135	135
HIGH AMBER	118	118
LOW AMBER	--	--

PROPULSION DATA LIMITS MAINTENANCE PAGE 1

PROPULSION DATA LIMITS PAGE 2/2

EXCD PROFILE:	L	R	IN-FLIGHT RELIGHT DATA PTS
EGT OPER ORIGIN	1015	1015	(CAS,ALT)
DELTA	10	10	1 0, 0 0,140
EGT START ORIGIN	750	750	3 150,140 150,300
DELTA	15	15	5 335,300 365,286
			7 365, 0 --, --
			9 --, -- --, --
TAKEOFF THRUST	60.0		11 --, -- --, --
FUEL ON CMD: GND	--		13 --, -- --, --
AIR	--		15 --, -- --, --
MINIMUM IDLE	60.0		CROSS-BLEED START DATA PTS
DELAY	5.0		(CAS,ALT)
OIL QTY: LOW	4.0		1 0, 0 0,300
			3 220,300 220, 0
VIB: REDLINE	--		5 --, -- --, --
WHITE	4.0		7 --, -- --, --
WHITE DELAY	0		9 --, -- --, --

APU	AMBER	REDLINE
RPM	--	106.0
EGT	650	710
OIL PRESS	55	35
OIL TEMP	135	155
OIL QTY	4.4	3.8

PROPULSION DATA LIMITS MAINTENANCE PAGE 2

ENGINE INDICATING - PROPULSION DATA LIMITS MAINTENANCE PAGES

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**ENGINE INDICATING - FUNCTIONAL DESCRIPTION****General**

The engine indicating system supplies engine data to the EEC. The EEC monitors the engine parameters and sends them to the AIMS and the AVM signal conditioner unit. The AIMS shows the engine parameters on the EICAS and secondary engine displays.

These are the engine parameters that engine indicating system monitors:

- N1 (LPC rotor speed)
- N2 (HPC rotor speed)
- EGT (T49)
- Engine vibration
- HPC inlet pressure (P25)

Engine Tachometer System

The engine tachometer system monitors N1 and N2. The system has an N1 and an N2 speed sensor. The N1 sensor sends signals to the EEC, EDIU, AVM signal conditioner, and the AIMS. The N2 sensor sends signals to the EEC, AVM signal conditioner and the AIMS.

Temperature Sensing System

The EEC uses T49 sensors to monitor EGT. The T49 sensors are thermocouples. They measure the temperature between the LPT and HPT.

Airborne Vibration Monitoring (AVM) System

The AVM system measures engine vibration. The two engine accelerometers send electrical charges to the remote charge converter (RCC). The RCC changes the accelerometer electrical charges to voltage signals and sends them to the AVM signal conditioner. The signal conditioner uses the voltage signals and engine speed signals to calculate engine vibration.

The AVM signal conditioner unit also contains engine balancing system (EBS) functions. It uses speed and vibration signals to calculate a balance solution. You use the EBS to correct high engine vibration caused by the fan or the LPT. The signal conditioner sends the EBS data to the AIMS.

Engine Mounted Sensors

The engine mounted sensors supply this data to the EEC:

- P25

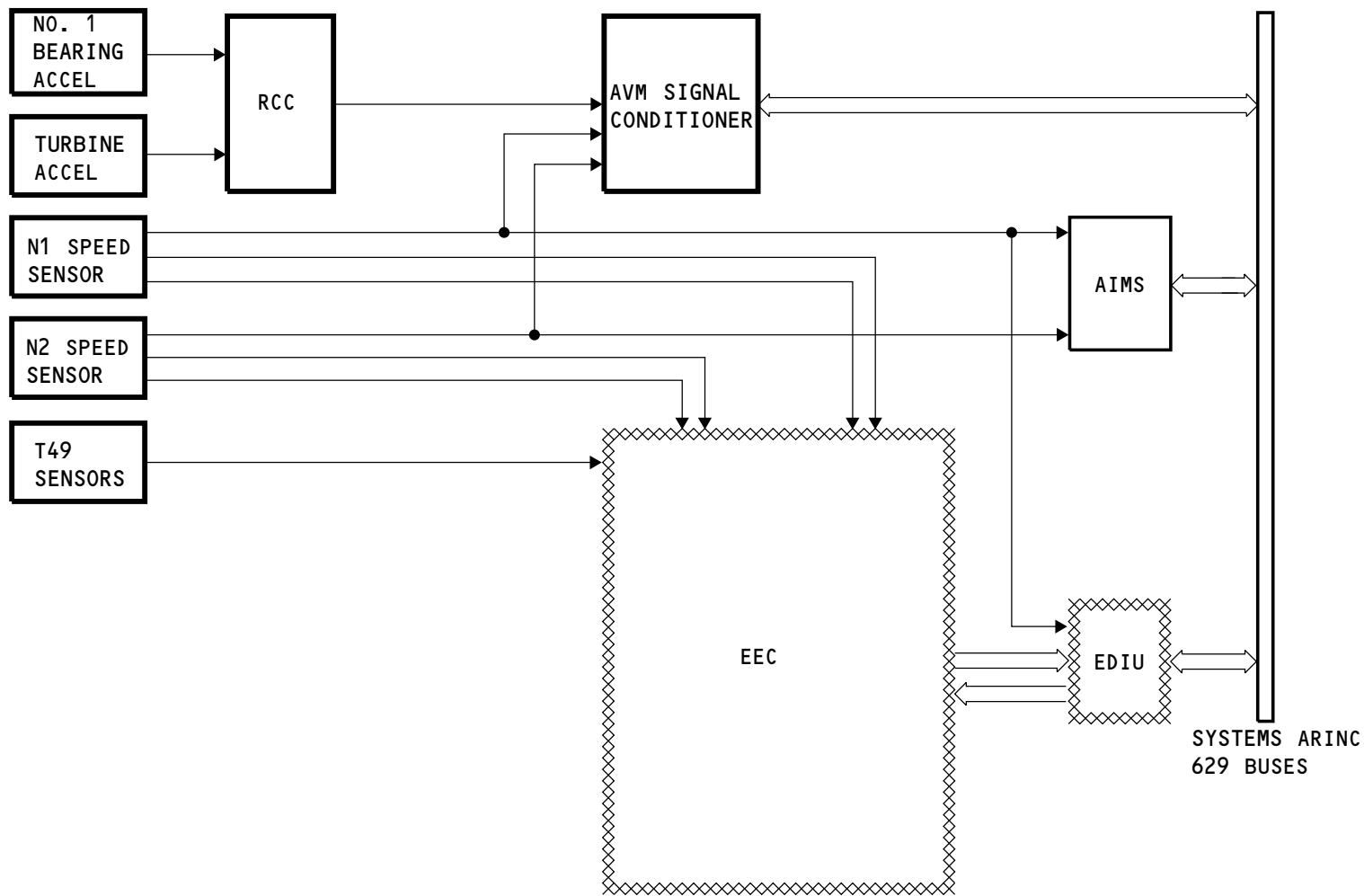
This data goes to the ACMS function in the AIMS. You can get reports from the ACMS for engine condition monitoring.

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ENGINE INDICATING - FUNCTIONAL DESCRIPTION

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**ENGINE INDICATING - ENGINE TACHOMETER - GENERAL DESCRIPTION****Purpose**

The engine tachometer system supplies N1 and N2 signals to the engine and airplane systems. The engine and airplane systems use N1 and N2 for control, indication, and monitoring.

General Description

The N1 and N2 speed sensors each send three analog speed signals. Two signals from each sensor go to the EEC channels A and B.

The EEC changes the analog speed data into ARINC 429 digital data. The EDIU receives the digital data and sends ARINC 629 data to the AIMS.

The N1 speed sensor also sends analog signals to the AIMS, the AVM signal conditioner, and the EDIU. The N2 speed sensor sends analog signals to the AIMS and the AVM signal conditioner.

The AIMS uses the analog speed signals when there is no digital engine speed data.

The AVM signal conditioner uses the analog speed signals in its vibration calculations.

The EDIU uses the analog N1 signal for Thrust Asymmetry Compensation (TAC).

See the rudder control section for more information on the TAC (SECTION 27-21).

Indication

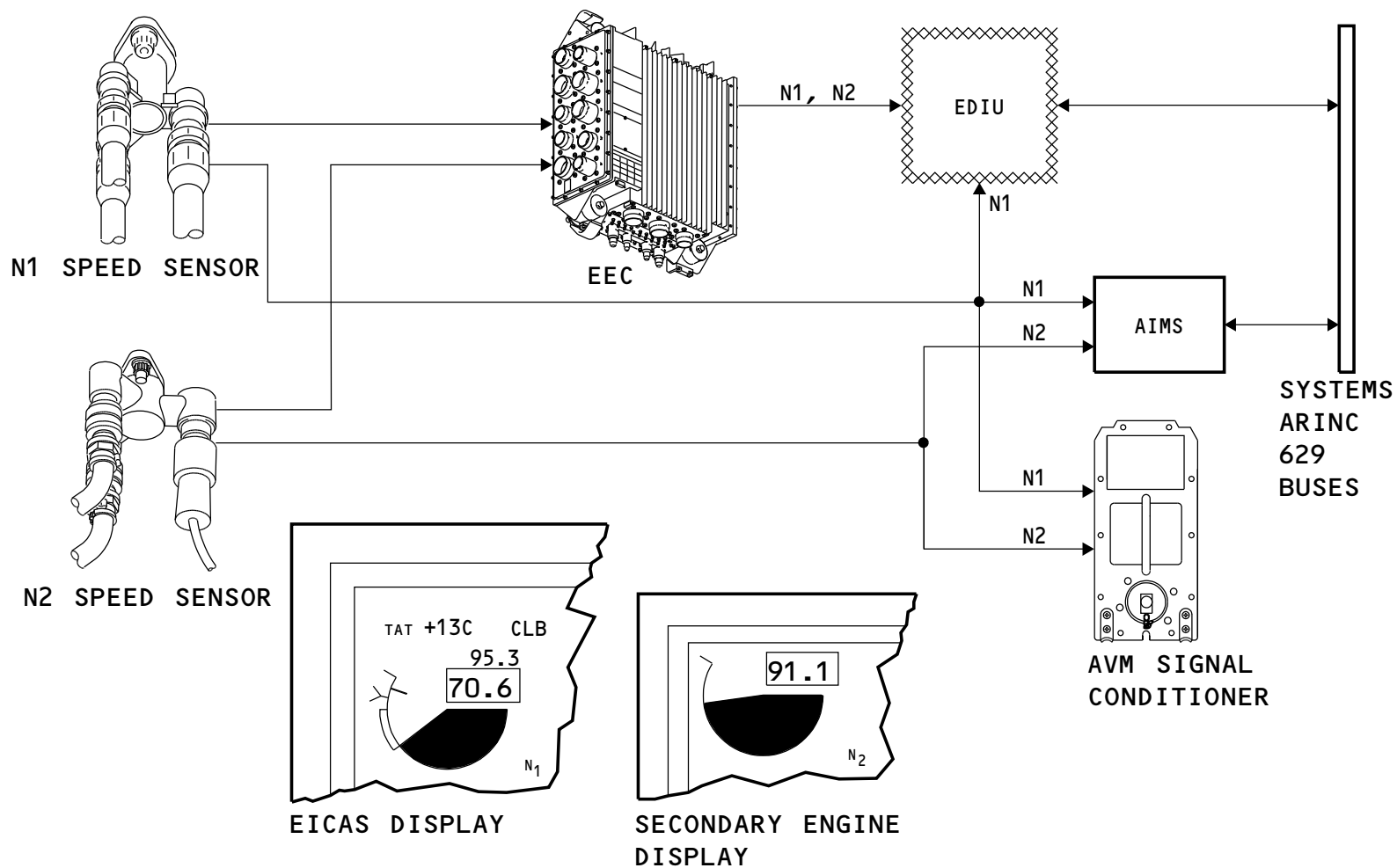
The EICAS display and the secondary engine display show N1 and N2 data. The data also shows on the performance maintenance page. Percent rpm are the units for the data.

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ENGINE INDICATING - ENGINE TACHOMETER - GENERAL DESCRIPTION

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**ENGINE INDICATING - ENGINE TACHOMETER - N1 SPEED SENSOR****General**

The N1 speed sensor uses signal pulses to measure N1 rotor speed.

The N1 sensor is at the 8:30 position on the fan hub frame aft side. You get access to the sensor with the left T/R half open.

Physical Description

The N1 sensor has a rigid probe that goes inside the fan hub frame. The outer end of the probe has three electrical connectors. Two bolts hold the sensor on the fan hub frame.

Functional Description

A sensing head on the inner end of the probe is near a wheel with teeth on the N1 shaft. The speed sensor receives electromagnetic pulses from the teeth as they go by the sensing head.

Training Information Point

The N1 speed sensor is about 2 feet (600 mm) long. You should be careful when you remove or install the sensor.

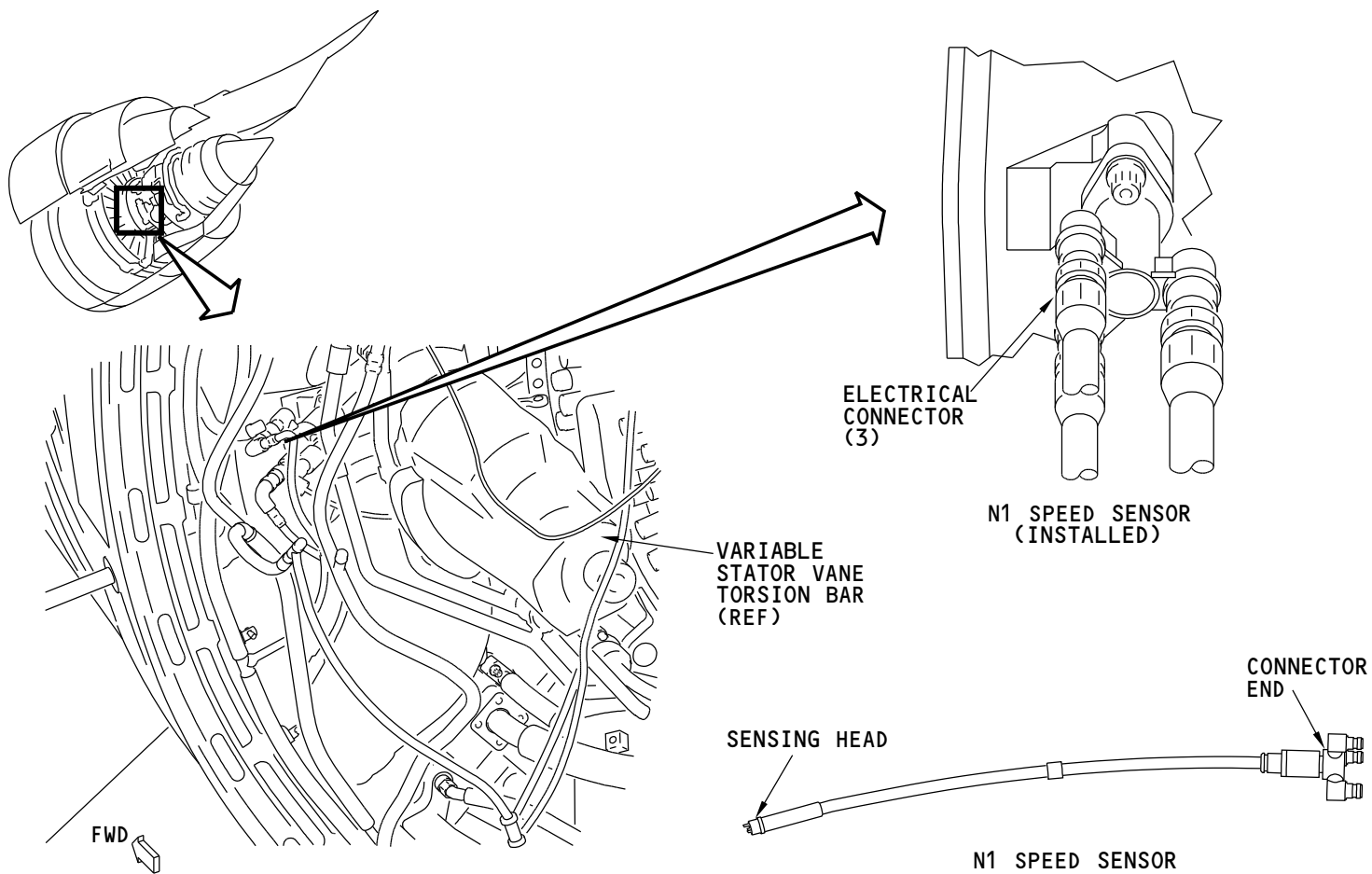
When you remove the N1 speed sensor, approximately one cup of oil comes out.

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ENGINE INDICATING - ENGINE TACHOMETER - N1 SPEED SENSOR

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ENGINE INDICATING - ENGINE TACHOMETER - N2 SPEED SENSOR

General

The N2 speed sensor uses signal pulses to measure N2 rotor speed.

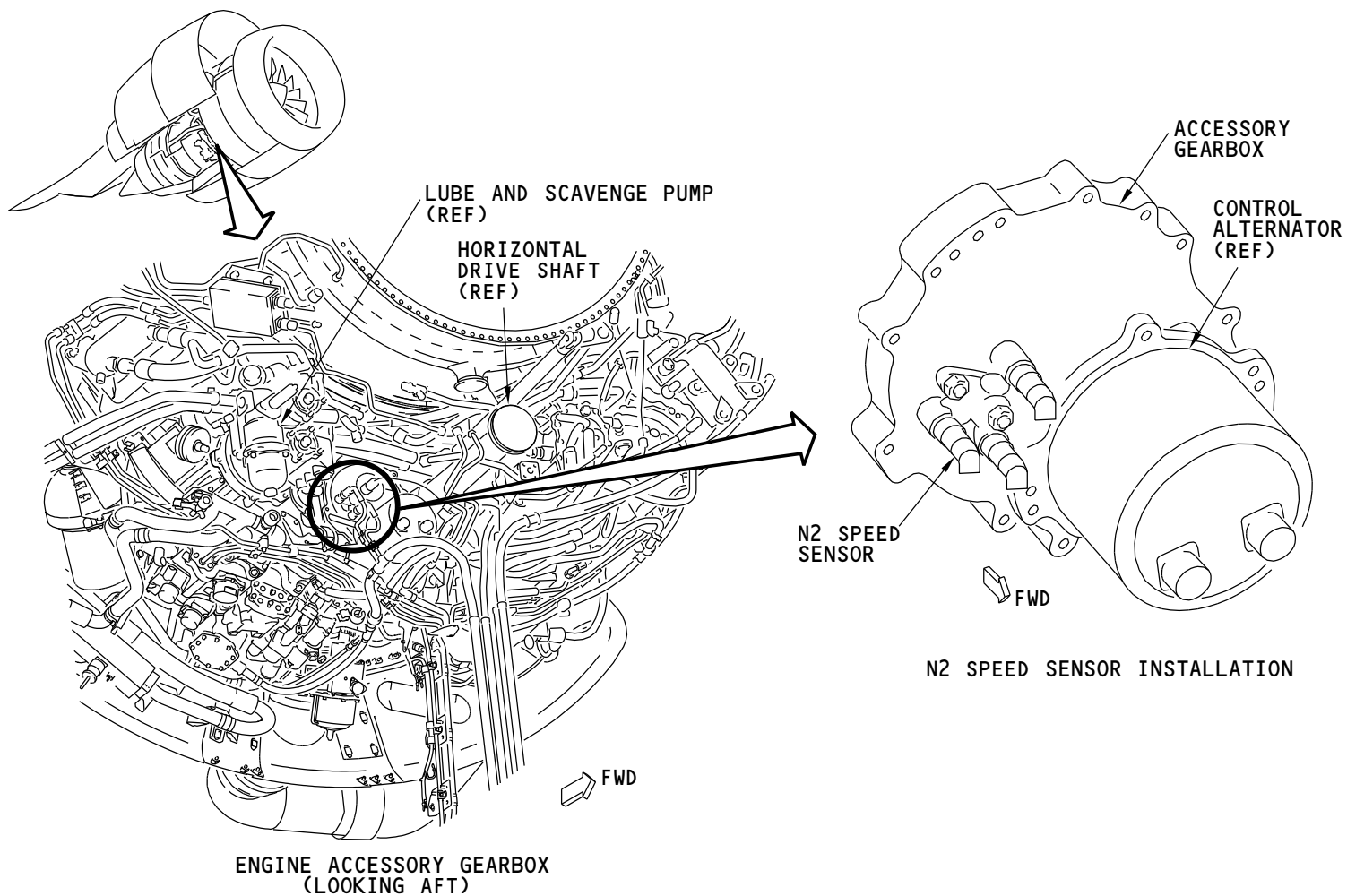
The N2 sensor is at the 5:30 position on the front of the accessory gearbox. You get access to the sensor with the right T/R half open.

Physical Description

The N2 sensor has a short probe that fits into the accessory gearbox. The outer end has three electrical connectors. Two nuts hold the sensor on the gearbox.

Functional Description

A sensing head on the inner end of the N2 sensor probe is near a gear in the accessory gearbox. The speed sensor gets electromagnetic pulses as the gear teeth go by sensing head.



ENGINE INDICATING - ENGINE TACHOMETER - N2 SPEED SENSOR

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ENGINE INDICATING - ENGINE TACHOMETER - INDICATIONS

N1

The EEC uses N1 to set engine thrust. These N1 indications show on the EICAS display:

- N1 redline
- Maximum N1
- Reference/target N1
- N1 command sector
- Actual N1.

N1 redline is the maximum speed limit for the N1 rotor.

Maximum N1 is the highest rotor speed that will not cause the engine to exceed maximum rated thrust. The EEC calculates maximum N1.

Reference/target N1 is the best N1 for the selected thrust reference mode. The flight management computing function of the AIMS supplies the reference/target N1.

N1 command sector is a function of thrust lever position, air data, and altitude. The EEC calculates N1 command. A command sector shows the difference between N1 command and actual N1.

N2

You use N2 during engine start and to monitor HPC rotor speed when the engine operates. The engine secondary display shows actual N2 and N2 redline.

N2 redline is the maximum speed limit for the N2 rotor.

N1 or N2 Exceedance

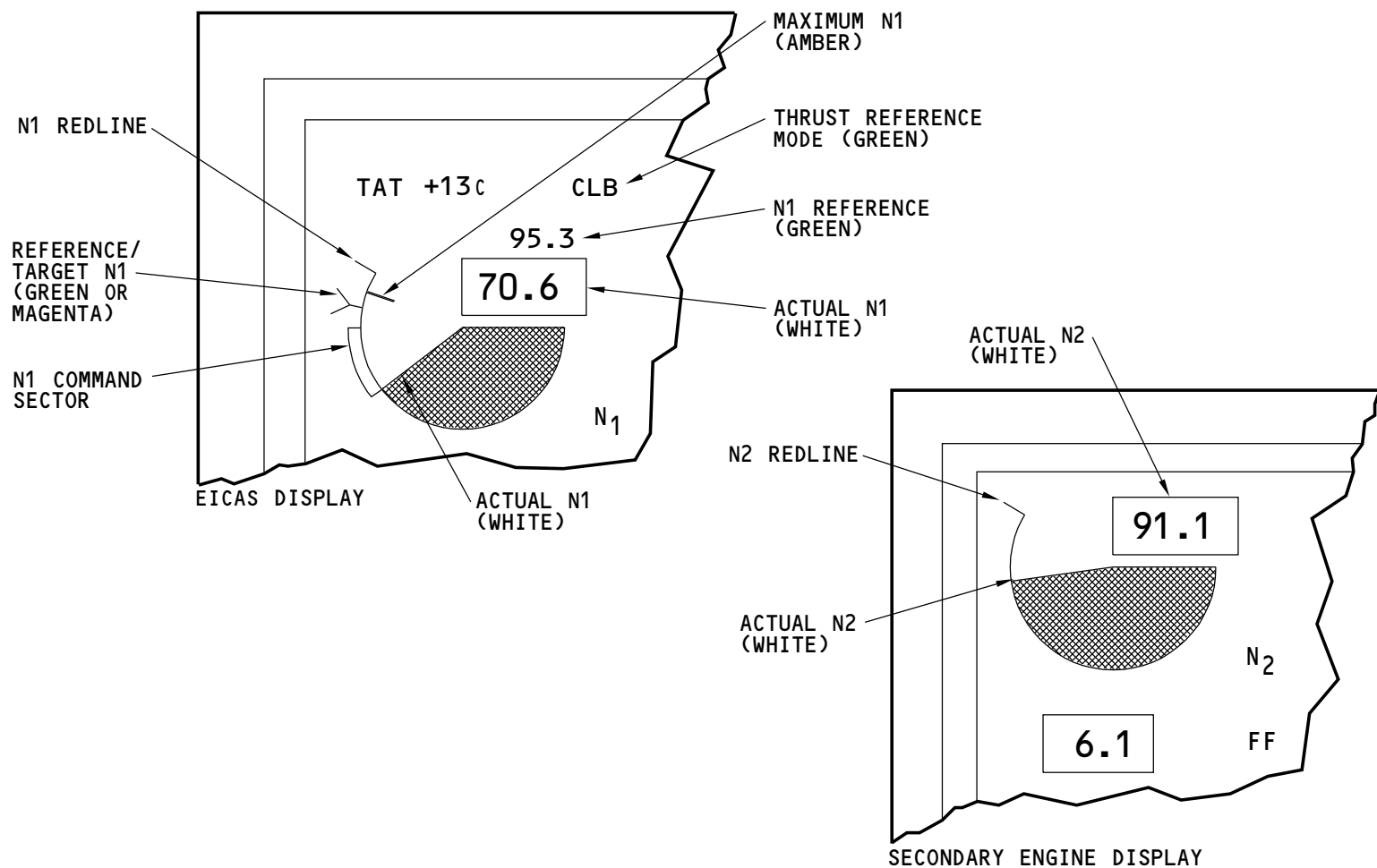
If N1 or N2 goes above the redline the display turns red. When N1 or N2 goes back to a value below the limit, the display turns to the normal color. The box around the readout, however, stays the exceedance color until you push the CANCEL/RECALL switch on the display select panel (DSP).

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ENGINE INDICATING - ENGINE TACHOMETER - INDICATIONS

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ENGINE INDICATING - ENGINE TACHOMETER - FUNCTIONAL DESCRIPTION

Speed Signals

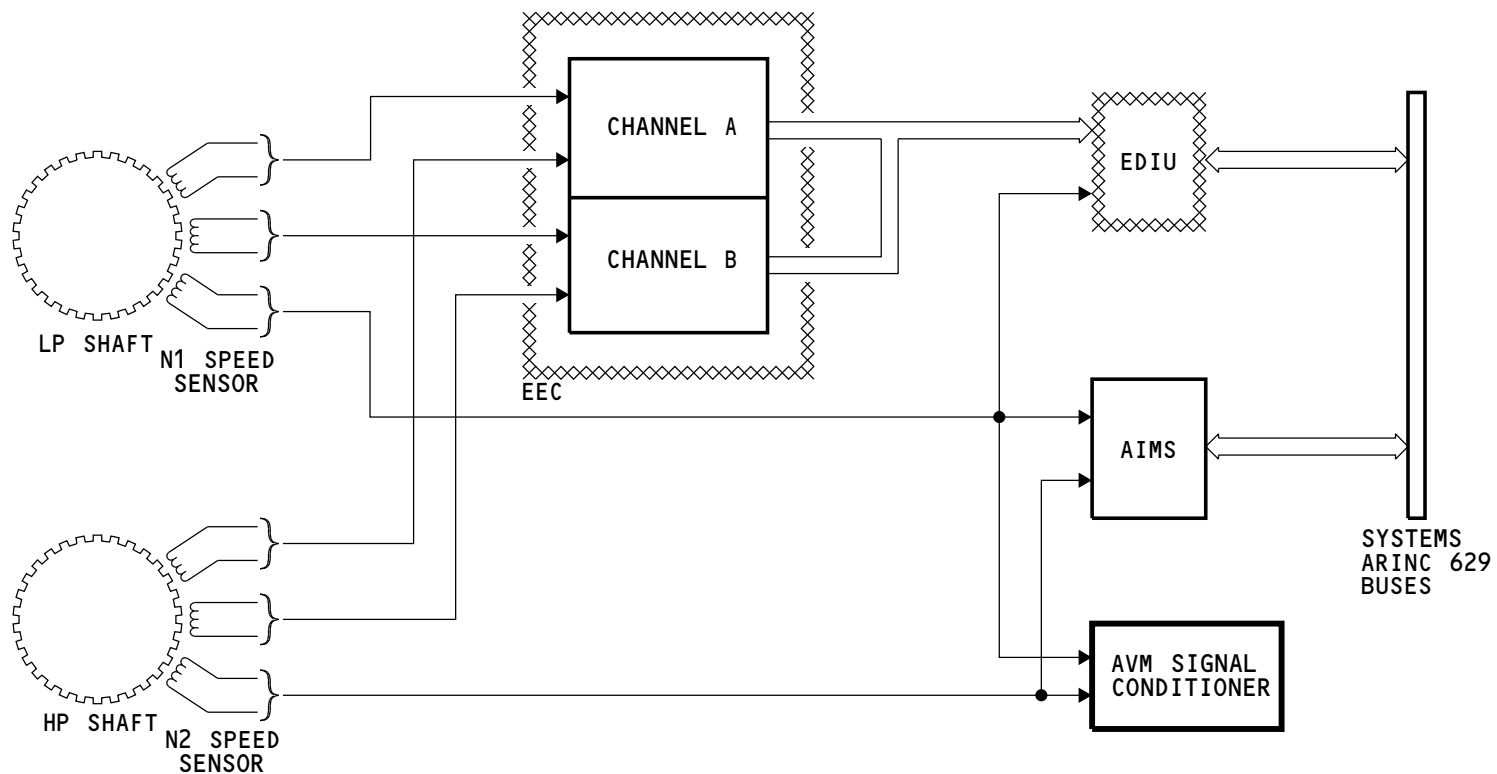
N1 and N2 speed signals come from speed sensors, each with three outputs. The LP and HP shafts each have a wheel with teeth that cause electromagnetic pulses as they go by the speed sensors.

One N1 speed sensor output goes to channel A of the EEC. The other goes to channel B. The third speed sensor output goes to the EDIU, AIMS, and AVM signal conditioner.

One N2 speed sensor output goes to channel A of the EEC. The other goes to channel B. The third speed sensor output goes to the AIMS and AVM signal conditioner.

EEC Outputs

The EEC sends digital speed signals to the AIMS on the systems ARINC 629 buses.



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ENGINE INDICATING - ENGINE TACHOMETER - FUNCTIONAL DESCRIPTION

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ENGINE INDICATING - EGT - GENERAL DESCRIPTION

General

The EGT indicating system measures the temperature at the LPT inlet (engine station 49) air. The system uses thermocouples to measure EGT.

EGT Probes

Eight EGT thermocouples measure the exhaust gas temperature (EGT). They send analog EGT signals to the EEC. The EEC sends digital signals to the AIMS for display and monitoring functions.

Indications

The EGT indication on the EICAS display shows these temperature limits and readouts:

- (1) Actual EGT
- (2) Redline
- (3) Amber Band
- (4) Start Limit.

The EGT start limit shows when the fuel control switch is in CUTOFF and during engine start. It goes out of view after engine starter cutout.

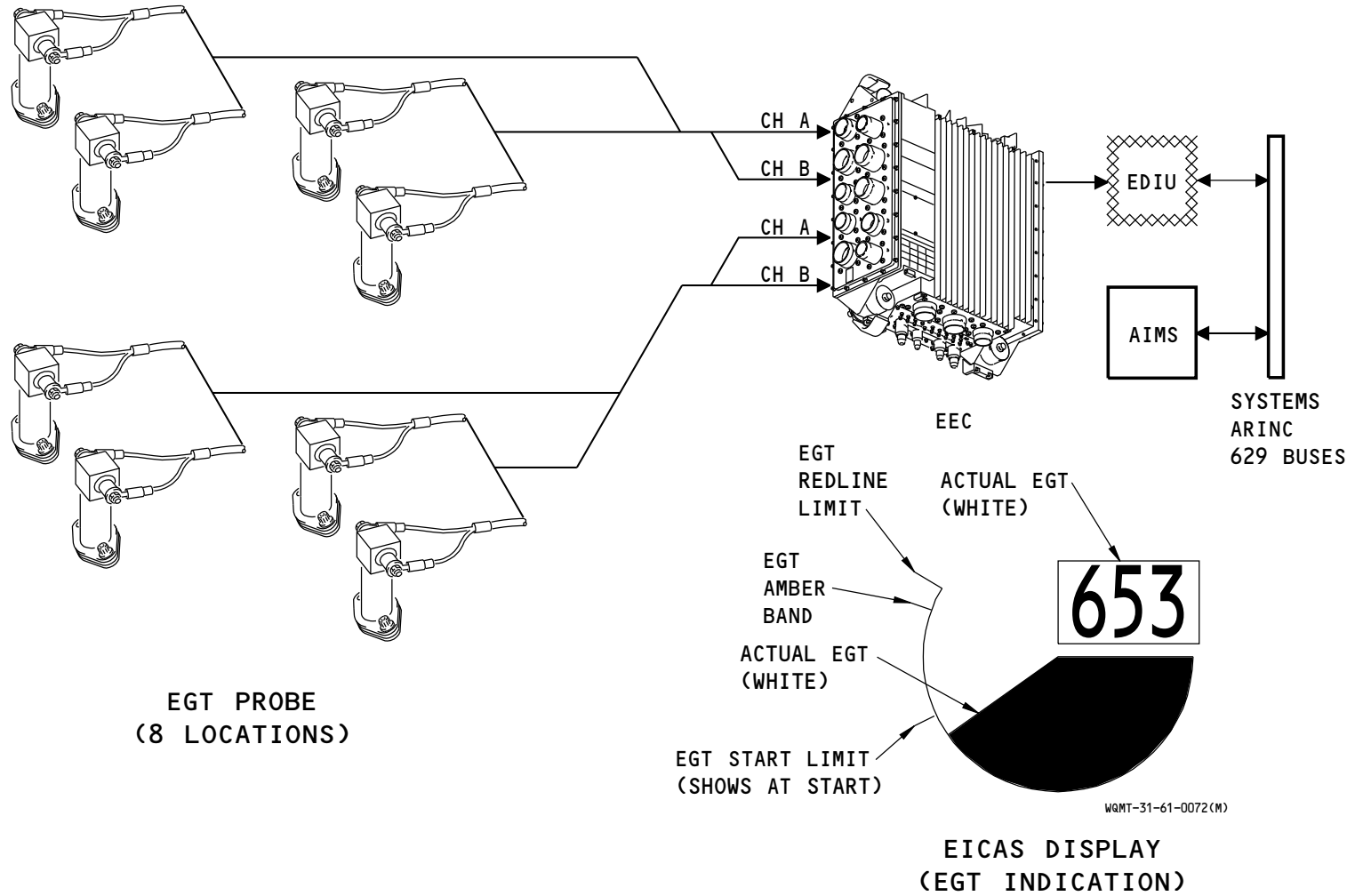
If the EGT goes above the amber band, the display color changes to amber. If EGT goes above the redline or the start limit, the display color changes to red. When the EGT goes back to a value below the limit, the display color changes to the normal color. The box around the readout, however, stays red until you push the CANCEL/RECALL switch on the DSP.

You can see the value of the temperature limits on the propulsion data limits maintenance page 1, shown later in this chapter.

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ENGINE INDICATING - EGT - GENERAL DESCRIPTION

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ENGINE INDICATING - EGT - PROBE

Purpose

The probes make analog electrical signals in proportion to EGT. The signals go to the EEC for engine control and indicating.

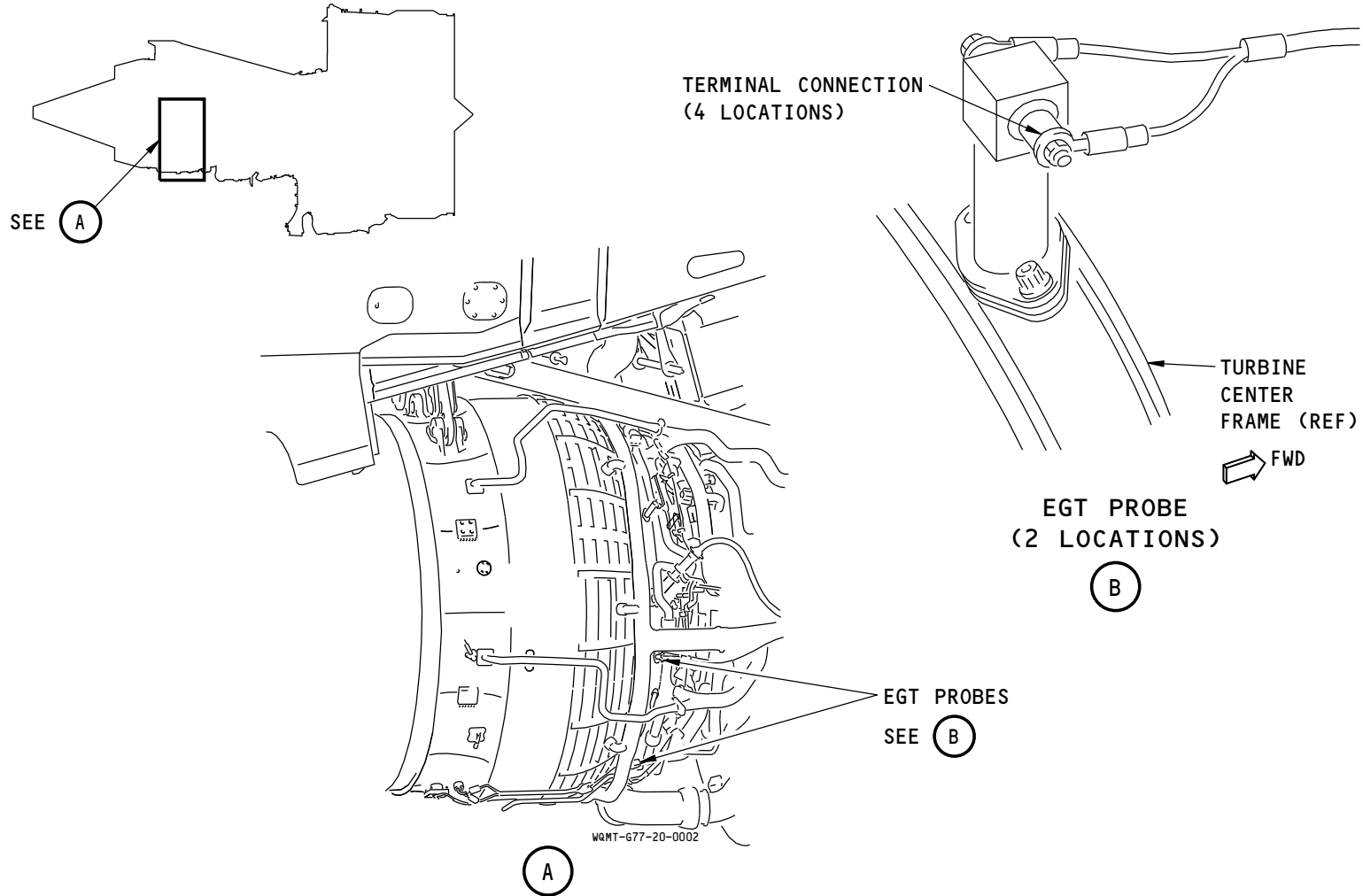
Location

There are eight EGT probes on the turbine center frame of the engine. They are at the following positions: Probe 1 (12:45 ALF), Probe 2 (1:45 ALF), Probe 3 (3:45 ALF), Probe 4 (4:45 ALF), Probe 5 (5:45 ALF), Probe 6 (6:45 ALF), Probe 7 (9:00 ALF) and Probe 8 (10:00 ALF). The thermocouple leads run forward along the HPC case at the 10:00 o'clock position.

Physical Description

Each EGT probe has a connector end with two terminal connections, and a sensing probe. The sensing probe is in the turbine gas stream. The sensing probe has thermocouple junctions. One junction is set further into the gas stream.

The chromel wires connect to the side terminal connections. The terminal connections have different size studs with captive nuts.



ENGINE INDICATING - EGT - PROBE

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**ENGINE INDICATING - EGT - FUNCTIONAL DESCRIPTION****General**

The EGT indicating system measures the temperature at the LPT inlet (engine station 49) air. The system uses alumel-chromel thermocouples to measure the EGT. There are four sectors of two EGT probes each mounted around the turbine center frame. Within each sector each pair of EGT probes is averaged.

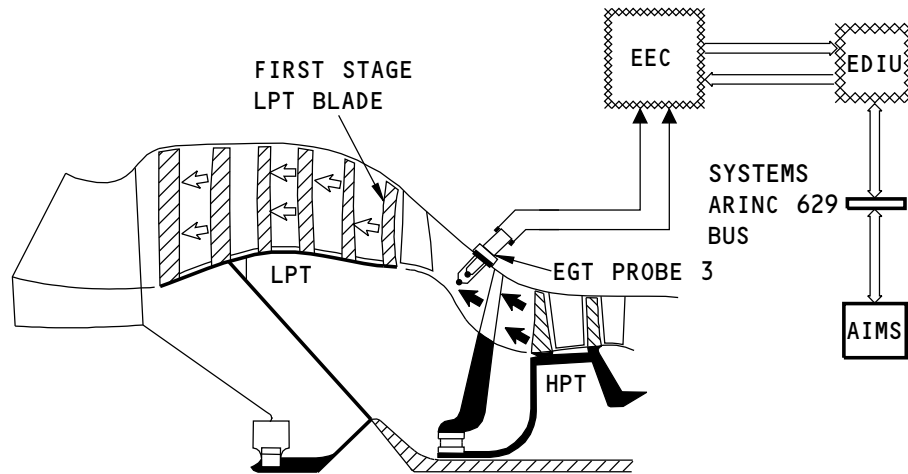
EEC channel A receives EGT data from sectors 1, 2, and 4. Data from sector 3 is received via the EEC digital cross-link. EEC channel B receives EGT data from sectors 1, 3, and 4. Data from sector 2 is received via the EEC digital cross link.

EGT Probes

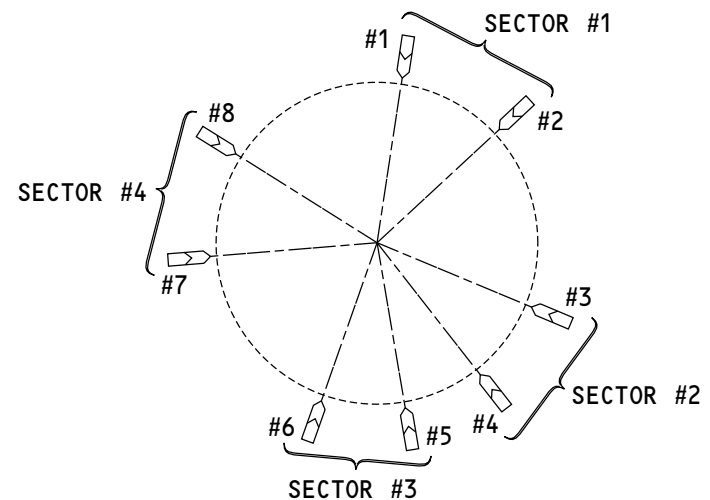
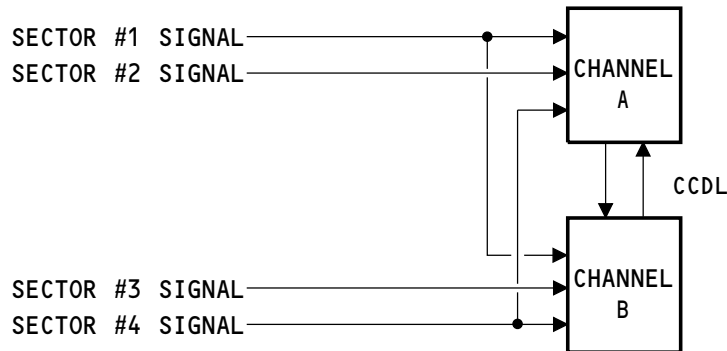
The EGT probes provide low pressure turbine inlet temperature (EGT) to the EEC. Each EGT probe contains two probes which are averaged in the sensor. They send analog signals to the EEC. The EEC sends digital signals to the AIMS for display and monitoring functions.

EEC

The EEC sends a digital EGT signal to the AIMS on the systems ARINC 629 buses.



LOC.	ANGLE
#1	9.660
#2	47.554
#3	113.870
#4	142.291
#5	170.712
#6	199.133
#7	265.449
#8	303.344



(VIEW IN THE FORWARD DIRECTION)

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ENGINE INDICATING - EGT - FUNCTIONAL DESCRIPTION

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ENGINE INDICATING - AVM - GENERAL DESCRIPTION

Purpose General

The airborne vibration monitoring (AVM) system monitors and records the engine vibration levels.

General Description

There is one AVM system for each engine. Each AVM system has these components:

- No. 1 bearing accelerometer
- Turbine accelerometer
- Remote charge converter (RCC)
- AVM signal conditioner unit.

The accelerometers send signals that are proportional to the engine vibration. Each accelerometer signal goes to the RCC for signal conversion and amplification. The RCC sends amplified vibration signals to the AVM signal conditioner unit.

If the No. 1 bearing accelerometer fails, turbine center frame accelerometer will be used to extract the vibration signal for N1 data with the given software installed.

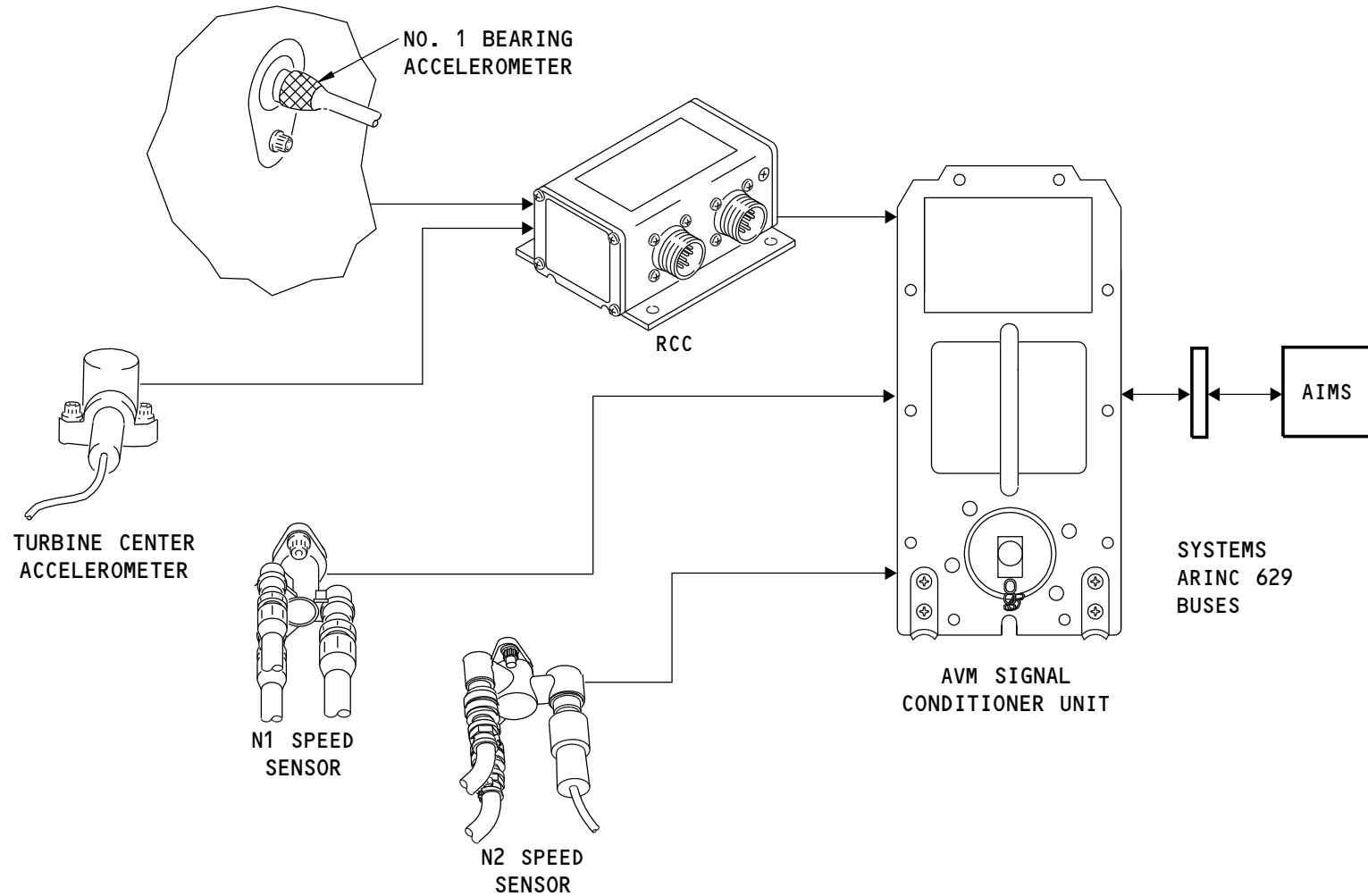
The signal conditioner unit uses the accelerometer signals and N1 and N2 speed signals to calculate the engine vibration levels for each rotor. The AVM signal conditioner unit sends the vibration data to the AIMS. The AIMS shows the vibration data on the primary display system.

The signal conditioner unit also stores the vibration data for use with the engine balancing system (EBS). The EBS is a function of the signal conditioner unit and the AIMS. You get access to it through the MAT.

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ENGINE INDICATING - AVM - ACCELEROMETERS AND REMOTE CHARGE CONVERTER

Accelerometers

The accelerometers use piezoelectric crystals to get input for engine vibration and send it to the remote charge converter (RCC).

The No. 1 bearing accelerometer connector is on the fan frame hub at the 7:00 position. The No. 1 bearing accelerometer is inside the engine on the No. 1 bearing housing. If the No. 1 bearing accelerometer fails, you can use the turbine center accelerometer to measure the vibration data.

NOTE: The No. 1 bearing accelerometer gives indications of Fan Vibration. It does not give indications for Core or LPT Vibrations. For LPT and Core Vibration, use the turbine accelerometer indication.

The turbine center accelerometer is on the turbine center frame at the 11:30 position.

The accelerometers make electrical charge signals that change in proportion to the engine vibration level. The signals go to the RCC.

Remote Charge Converter

The RCC amplifies accelerometer charge signals and changes the signals into voltage signals. It sends the voltage signals to the AVM signal conditioner unit.

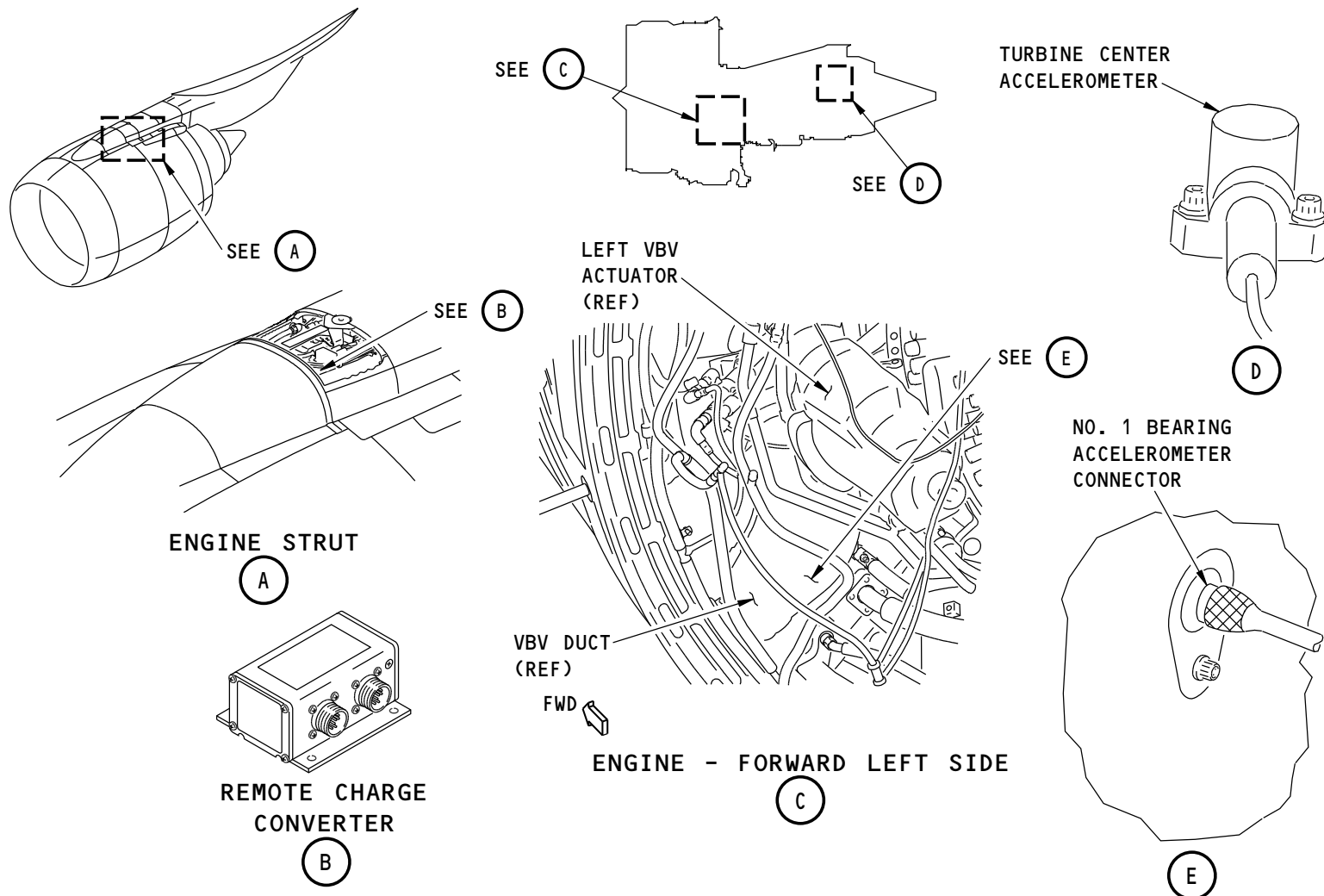
The RCC is in the engine strut. You get access to it through the forward access fairing.

The RCC has self-test circuits to continually monitor vibration amplitude and phase accuracy.

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ENGINE INDICATING - AVM - ACCELEROMETERS AND REMOTE CHARGE CONVERTER

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ENGINE INDICATING - AVM - SIGNAL CONDITIONER UNIT

General

The AVM signal conditioner unit uses vibration and speed signals from engine sensors to calculate engine vibration levels. The signal conditioner unit also does these functions:

- Compares the N1 and N2 vibration levels to find which is highest
- Keeps in memory the vibration data for the last six flight legs
- Calculates engine balance solutions
- Self-test.

Each engine has one AVM signal conditioner unit. The signal conditioner units are in the main equipment center.

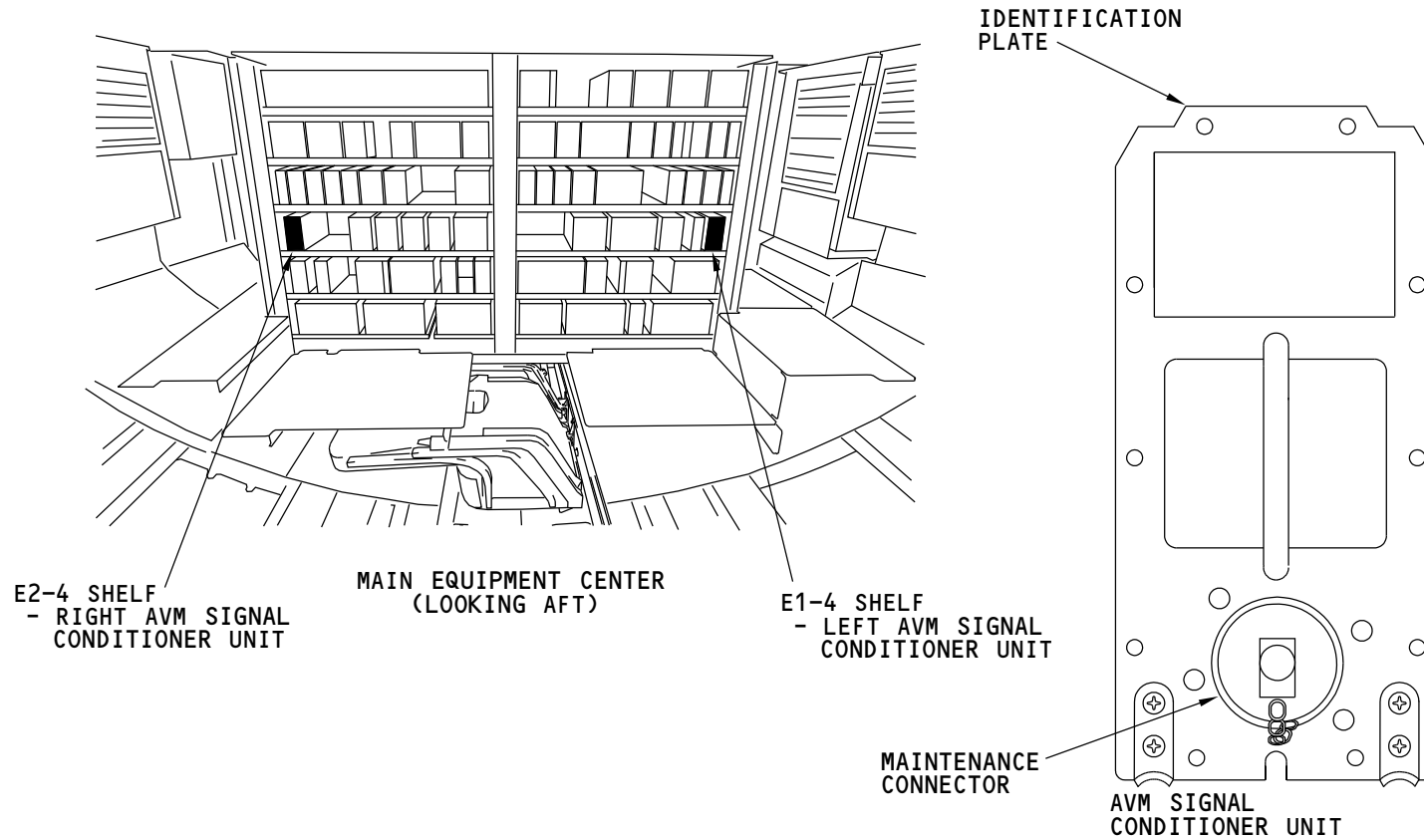
Maintenance Connector

The AVM signal conditioner unit has a maintenance connector on the front. The maintenance connector supplies alternative access for the engine balancing system (EBS) and for data loading. Normal access for these functions is on the MAT.

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ENGINE INDICATING - AVM - SIGNAL CONDITIONER UNIT
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**ENGINE INDICATING - AVM - FUNCTIONAL DESCRIPTION****General**

The AVM system uses vibration and speed signals to calculate engine vibration data and engine balancing system (EBS) data.

Accelerometers

The two engine accelerometers make electrical charges from engine vibration in the radial direction. They send signals proportional to engine vibration to the RCC.

Remote Charge Converter (RCC)

The RCC changes the accelerometer charge signals to voltage signals. The RCC amplifies the voltage signals and sends them to the AVM signal conditioner unit.

AVM Signal Conditioner Unit

The signal conditioner unit has two channels. Each channel uses the RCC signals and engine speed signals to calculate engine vibration. Channel A calculates these vibration levels:

- N1 LPT
- N2
- Broadband.

For the Ametek AVM: Channel B calculates the N1, N2, and Broadband vibration level. N2 and BB vibration levels are not displayed in EICAS for channel B.

For the Vibro-Meter AVM: Channel B only calculates the N1 fan vibration level.

The signal conditioner unit also does these functions:

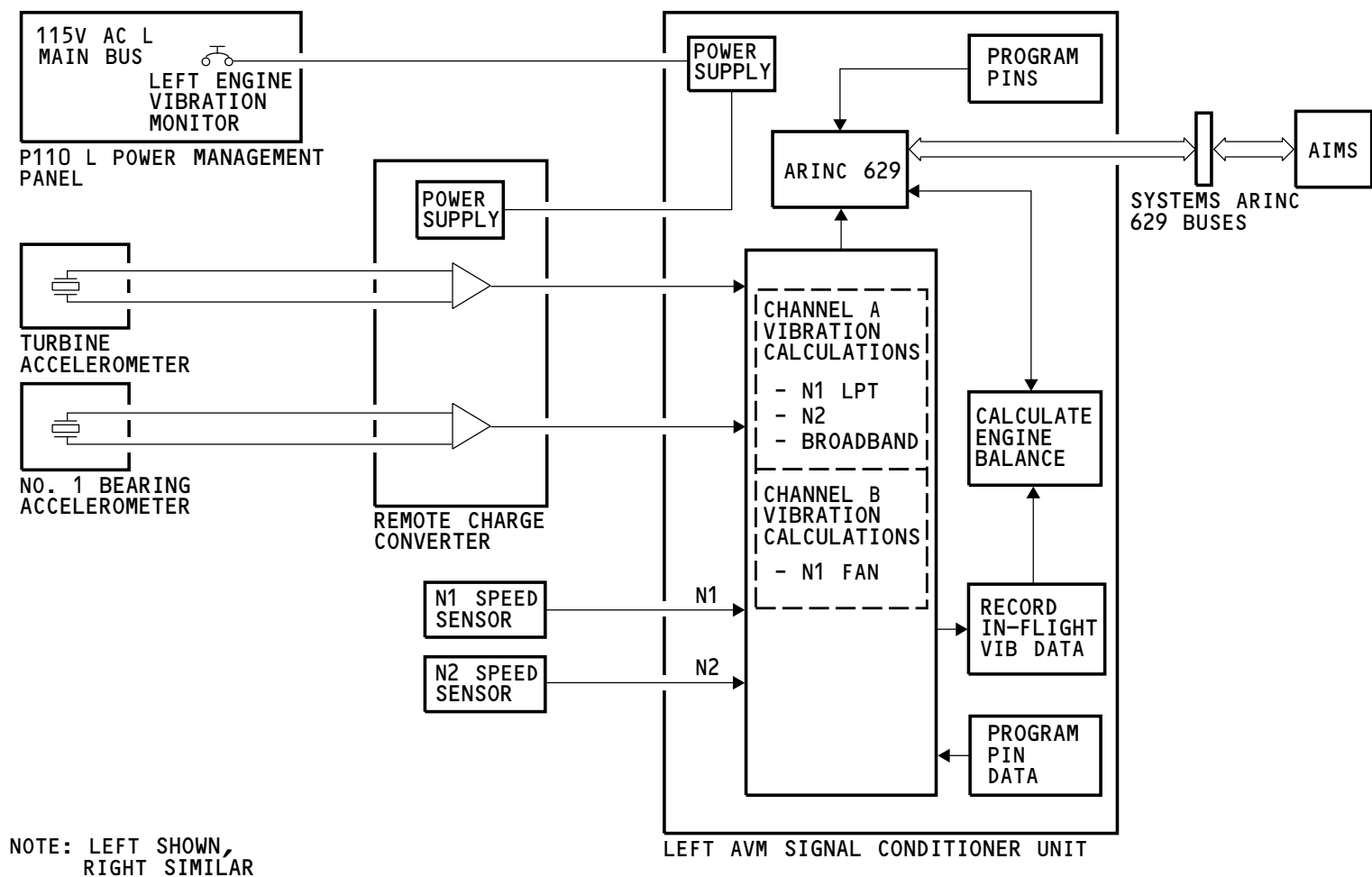
- Compares the N1 and N2 vibration levels to find which is highest
- Keeps in memory the vibration data for the last six flight legs
- Calculates engine balance solutions.

All vibration data goes to the AIMS. Program pins on the signal conditioner unit identify the engine position, engine manufacturer, and engine model.

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ENGINE INDICATING - AVM - FUNCTIONAL DESCRIPTION

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ENGINE INDICATING - AVM - INDICATION

Secondary Engine Display

The secondary engine display shows the highest vibration level for each engine. The rotor identification is below the vibration data. If the N1 or N2 speed signal fails, the rotor identification shows broadband (BB) vibration.

If the vibration level is equal to or more than 4.0 scalar units, the vibration display automatically shows on the secondary engine display. Also, the digital display will show in reverse video format (black numbers on a white background).

When an engine is shut down, the vibration data on the secondary engine display will show 0.0 and on the performance maintenance page will show 0.00.

Performance Maintenance Page

The performance maintenance page shows all the engine vibration data. N1 fan vibration shows under channel B for the AVM signal conditioner unit. The other vibration data shows under channel A.

If the N1 or N2 speed signal fails, only the broadband vibration data shows.

Training Information Point

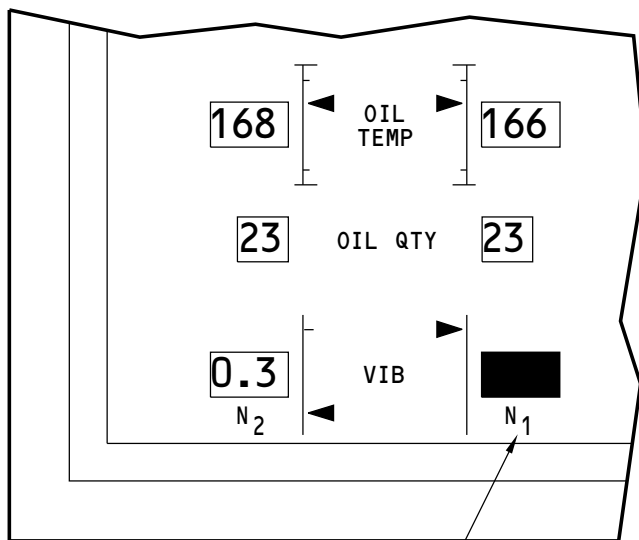
At low engine speeds, the N1 FAN and N1 LPT data change to dashes. This is because the broadband vibration is too large in proportion to the N1 vibration.

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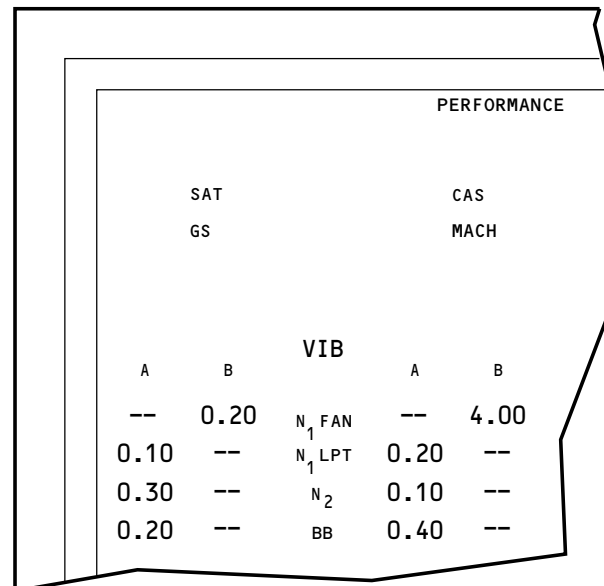
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SECONDARY ENGINE DISPLAY

ROTOR IDENTIFICATION



PERFORMANCE MAINTENANCE PAGE

ENGINE INDICATING - AVM - INDICATION

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**ENGINE INDICATING - AVM - ENGINE BALANCING SYSTEM (EBS)****General**

The engine balancing system (EBS) permits you to select which balance weights on the engine to change to decrease engine vibration. The AVM signal conditioning unit for each engine and the AIMS central maintenance computing function (CMCF) make up the EBS.

The AVM signal conditioner unit supplies the data for the engine balancing displays. You use the MAT to operate the EBS.

Engine Balancing Main Menu

You use the MAT to select the OTHER FUNCTIONS menu. The ENGINE BALANCING function shows on the OTHER FUNCTIONS menu.

The HELP selection is active if there is help text in the airline data base.

To start the engine balancing process you must choose these selections:

- ENGINE 1 or ENGINE 2
- PERFORM BALANCE or CALCULATE SPECIFIC BALANCE COEFFICIENTS/GROUND RUN
- CONTINUE.

Perform Balance

The PERFORM BALANCE selection of the EBS calculates a balance solution that corrects high engine vibration. The solution identifies the balance weights that you should remove and install in the aft spinner or on the LPT blades.

Calculate Specific Balance Coefficients/Ground Run

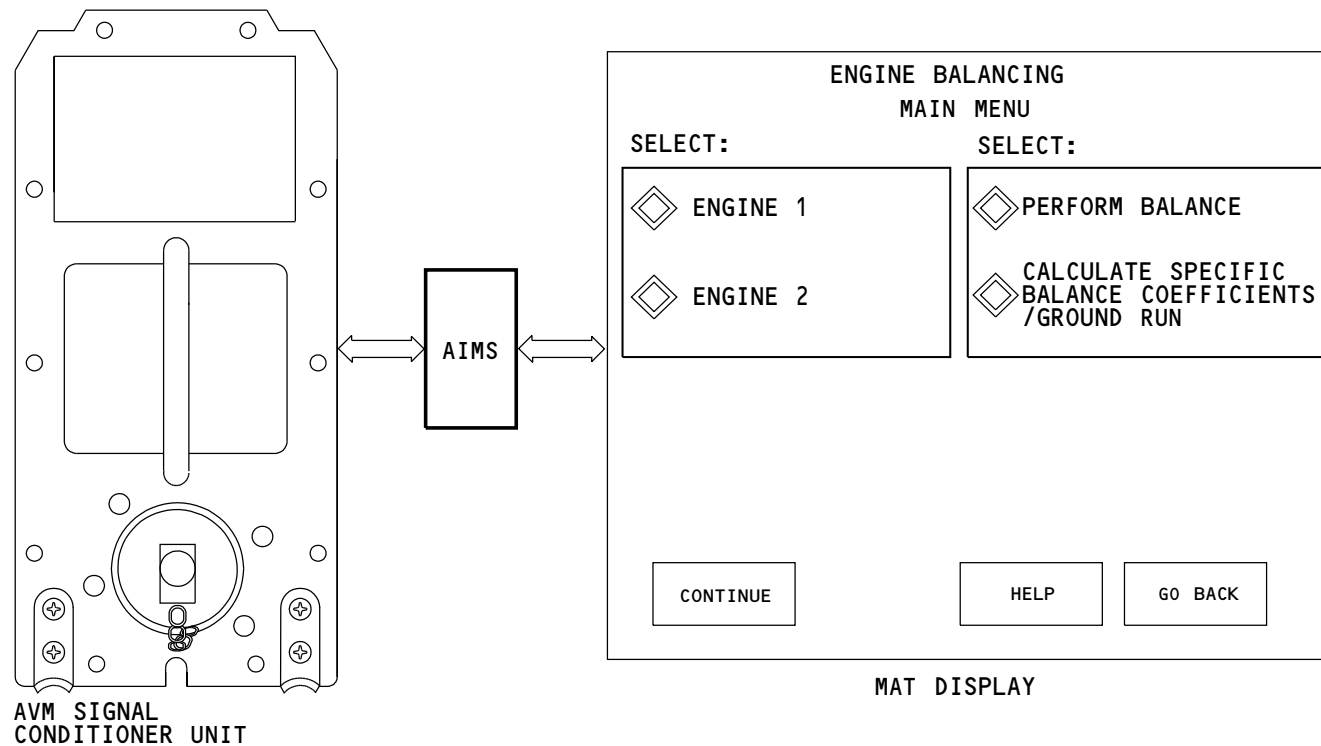
The CALCULATE SPECIFIC BALANCE COEFFICIENTS/GROUND RUN selection of the EBS lets you do these functions:

- Calculate new specific balance coefficients
- Record ground run data for the EBS to use.

When you calculate specific balance coefficients, the EBS replaces the existing balance coefficients. The AVM signal conditioner unit can use ground run data, or both flight data and ground run data, to calculate the new coefficients.

Continue

When you select CONTINUE, the MAT shows the EXISTING BALANCE WEIGHTS display. The CONTINUE selection becomes active after you make the first two selections.



ENGINE INDICATING - AVM - ENGINE BALANCING SYSTEM (EBS)

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ENGINE INDICATING - AVM - EBS - PERFORM BALANCE - 1

Existing Balance Weights Display

The EXISTING BALANCE WEIGHTS display shows the part number and location of the fan and LPT balance weights. The data is in the AVM signal conditioner unit memory.

NOTE: The holes in the aft spinner that do not have balance weights contain a standard weight. The EBS part number for this weight is P01. The EXISTING BALANCE WEIGHTS display does not show P01 weights.

You use this data to make sure the balance weight data in the AVM signal conditioner unit memory matches the weights on the engine. This is necessary for the AVM signal conditioner unit to calculate a correct balance solution. If the balance weight data is not correct, you must change the data. When you select the data or a blank text field, an edit dialog box shows.

On the EXISTING BALANCE WEIGHTS display, you can make two selections:

- CONTINUE
- FLIGHT HISTORY.

When you select CONTINUE, the AVM signal conditioner unit calculates a balance solution and the MAT shows the SOLUTION SUMMARY display.

When you select FLIGHT HISTORY, the MAT shows the N1 VIBRATION FLIGHT HISTORY display.

N1 Vibration Flight History Display

The N1 VIBRATION FLIGHT HISTORY display shows the fan (Front) and LPT (Rear) vibration data and phase angle for six flight legs. The data shows for different N1 speeds. Vibration data shows in reverse video format (black numbers on a white background) when the vibration level is more than the recommended vibration guideline.

You select AVERAGE to cause the AVM signal conditioner unit to use that data to calculate a solution for engine balancing. You may also select a specific flight leg to cause the AVM signal conditioner unit to use that data.

You select GO BACK to return to the EXISTING BALANCE WEIGHTS display.

You select N2 FLIGHT HISTORY to show the N2 VIBRATION FLIGHT HISTORY display (not shown). The N2 VIBRATION FLIGHT HISTORY display shows the N2 rotor vibration data for six flight legs. You use the N2 vibration data to make sure N2 vibration is less than the recommended vibration guideline. You cannot balance the N2 rotor with the EBS.

Training Information Point

When the AVM signal conditioner unit calculates the leg average it uses only the legs or ground runs with the same weight configuration as the present leg (LG 0). When you do a PERFORM BALANCE, the EBS will not let you select legs with weights that are different from the present leg (LG 0).

Some legs may not have data for one or more engine speeds. This occurs if the engine does not operate at that speed for 30 seconds or more. The AVM signal conditioner unit must have vibration data for a minimum of four speeds to calculate the balance solution.

The N1 VIBRATION FLIGHT HISTORY display shows N1 vibration data in mils S.A. (single amplitude). These are different than the scalar units for N1 vibration on the secondary engine display and the performance maintenance page.

The N2 VIBRATION FLIGHT HISTORY display shows N2 vibration data in scalar units.

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ENGINE BALANCING PERFORM BALANCE EXISTING BALANCE WEIGHTS			
AIRCRAFT ID: N123456		ENGINE TYPE: GE115	
ENGINE POSITION: L		ENGINE SERIAL NUMBER: 123456	
MAKE SURE THAT THE PART AND HOLE/BLADE NUMBERS AGREE WITH THE BALANCE WEIGHTS AND THEIR LOCATIONS ON THE ENGINE. EDIT THE PART AND HOLE/BLADE NUMBERS AS NECESSARY.			
FAN		LPT	
PART NUMBER	HOLE NUMBER	PART NUMBER	BLADE NUMBER
P02	3	P01	12
P04	10		
P02	19		
CONTINUE		FLIGHT HISTORY	

ENGINE BALANCING PERFORM BALANCE N1 VIBRATION FLIGHT HISTORY													
AIRCRAFT ID: N12345		ENGINE TYPE: GE115											
ENGINE POSITION: L		ENGINE SERIAL NO.: 123456											
SELECT A LEG OR THE LEG AVERAGE. SELECT GO BACK TO CONTINUE.													
		ENGINE SPEED (%N1)											
		60		84		86		89		95		98	
		FRONT	REAR	FRONT	REAR	FRONT	REAR	FRONT	REAR	FRONT	REAR	FRONT	REAR
◇ LG-5	N1	0.4	0.1	0.3	0.1	0.7	0.2	0.9	0.4	0.6	0.3	0.4	0.2
22DEC95	PHASE	193	355	261	074	253	087	295	113	332	062	315	045
09:20													
◇ LG-4	N1	0.3	0.1	0.4	0.1	0.6	0.2	0.9	0.4	0.6	0.2	0.4	0.3
22DEC95	PHASE	196	001	258	076	255	092	302	110	336	063	313	042
13:20													
◇ LG-3	N1			0.4	0.1	0.7	0.2	0.9	0.4	0.5	0.3	0.4	0.2
23DEC95	PHASE			259	073	252	088	294	112	332	065	315	043
09:20													
◇ LG-2	N1	0.4	0.1	0.4	0.1	0.8	0.2	1.0	0.4	0.6	0.3	0.4	0.2
23DEC95	PHASE	195	002	258	081	251	087	291	115	332	062	317	045
13:20													
◇ LG-1	N1	0.5	0.2	0.6	0.1	0.9	0.3	1.2	0.5	0.8	0.5	0.7	0.3
24DEC95	PHASE	198	358	262	090	262	101	341	124	285	061	304	042
09:20													
◆ LG-0	N1	0.7	0.3	0.8	0.2	1.3	0.2	1.6	0.5	1.4	0.4	1.0	0.2
24DEC95	PHASE	187	355	257	083	294	095	312	102	298	054	310	044
13:20													
◇ AVERAGE	N1	0.5	0.2	0.5	0.1	0.8	0.2	1.1	0.4	0.8	0.3	0.6	0.2
	PHASE	194	358	259	080	261	092	306	113	319	061	312	044
GO BACK		N2 FLIGHT HISTORY											

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ENGINE INDICATING - AVM - EBS - PERFORM BALANCE - 1

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ENGINE INDICATING - AVM - EBS - PERFORM BALANCE - 2
Solution Summary Display

The SOLUTION SUMMARY display lets you select a one-plane or two-plane solution.

When you select ONE PLANE, the AVM signal conditioner unit finds the weights you must change in the front balance plane (FAN) to correct high N1 vibration. The SOLUTION SUMMARY display shows the part numbers and locations of the fan balance weights you must remove and install. The display also shows the predicted overall vibration reduction.

When you select TWO PLANE, the AVM signal conditioner unit finds the weights you must change in the front and rear balance planes (FAN and LPT) to correct high N1 vibration. In this case the SOLUTION SUMMARY display also shows the part numbers and locations of the LPT weights you must remove and install.

A message shows at the bottom of the SOLUTION SUMMARY display. This message tells you when:

- An engine check run is not necessary
- A low power engine check run is recommended
- A high power engine check run is recommended
- No solution is available

After you select ONE PLANE or TWO PLANE, you must select CONTINUE or SOLUTION PREDICTION.

When you select CONTINUE, the MAT shows the NEW BALANCE WEIGHTS display.

When you select SOLUTION PREDICTION, the MAT shows the N1 VIBRATION PREDICTION display.

N1 Vibration Prediction Display

The N1 VIBRATION PREDICTION display shows the front and rear vibration at different N1 speeds. It shows the actual and the predicted vibration levels.

The actual vibration comes from the leg average or the specific flight leg you selected on the N1 VIBRATION FLIGHT HISTORY display.

The predicted vibration shows what the vibration will be if you make the balance solution weight changes.

You select GO BACK to return to the SOLUTION SUMMARY display.

Training Information Point

The N1 VIBRATION PREDICTION display shows N1 vibration data in mils S.A. (single amplitude). These are different than the scalar units for N1 vibration on the secondary engine display and the performance maintenance page.

The N1 VIBRATION PREDICTION display shows predicted vibration that is higher than the recommended vibration guideline in reverse video format (black letters on a white background). The display does not show actual vibration in reverse video format.

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ENGINE BALANCING PERFORM BALANCE SOLUTION SUMMARY																	
AIRCRAFT ID: N123456		ENGINE TYPE: GE115															
ENGINE POSITION: L		ENGINE SERIAL NUMBER: 123456															
BALANCE COEFFICIENTS: GE001																	
SELECT A ONE OR TWO PLANE SOLUTION. INSTALL AND REMOVE ALL BALANCE WEIGHTS SHOWN IN SELECTED LIST.																	
☒ ONE PLANE ☐ TWO PLANE	<table border="1" style="width: 100%; border-collapse: collapse;"><thead><tr><th colspan="3" style="text-align: center;">FAN</th></tr><tr><th></th><th style="text-align: center;">PART NUMBER</th><th style="text-align: center;">HOLE NUMBER</th></tr></thead><tbody><tr><td style="text-align: center;">INSTALL</td><td style="text-align: center;">P03</td><td style="text-align: center;">35</td></tr><tr><td style="text-align: center;">INSTALL</td><td style="text-align: center;">P06</td><td style="text-align: center;">41</td></tr><tr><td style="text-align: center;">REMOVE</td><td style="text-align: center;">P02</td><td style="text-align: center;">3</td></tr></tbody></table>	FAN				PART NUMBER	HOLE NUMBER	INSTALL	P03	35	INSTALL	P06	41	REMOVE	P02	3	PREDICTED OVERALL VIBRATION REDUCTION 54%
FAN																	
	PART NUMBER	HOLE NUMBER															
INSTALL	P03	35															
INSTALL	P06	41															
REMOVE	P02	3															
WITH ABOVE SOLUTION NO POST BALANCE ENGINE CHECK RUN IS NECESSARY.																	
CONTINUE		SOLUTION- PREDICTION															

ENGINE BALANCING PERFORM BALANCE N1 VIBRATION PREDICTION						
AIRCRAFT ID: N123456		ENGINE TYPE: GE115				
ENGINE POSITION: L		ENGINE SERIAL NUMBER: 123456				
BALANCE COEFFICIENTS: GE001		SOLUTION CONFIGURATION: ONE PLANE				
ENGINE SPEED (%N1)						
	50	60	70	80	90	100
FRONT VIBRATION	0.7	0.8	1.3	1.6	1.4	1.0
PREDICTED FRONT VIBRATION	0.2	0.3	0.4	0.6	0.5	0.2
REAR VIBRATION	0.3	0.2	0.2	0.5	0.4	0.2
PREDICTED REAR VIBRATION	0.0	0.1	0.2	0.3	0.2	0.2
GO BACK						

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ENGINE INDICATING - AVM - EBS - PERFORM BALANCE - 2

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ENGINE INDICATING - AVM - EBS - PERFORM BALANCE - 3

New Balance Weights Display

The NEW BALANCE WEIGHTS display shows the part number and location of the new FAN and LPT balance weights. This is what the balance weight configuration will be after you change the weights. The display does not show P01 weights.

When you select KEEP WEIGHTS, the MAT shows the ENGINE BALANCING EXIT APPROVAL display.

Engine Balancing Exit Approval

The EXIT APPROVAL display permits the approval of the balance weights shown on the NEW BALANCE WEIGHTS display.

When you select KEEP WEIGHTS on the EXIT APPROVAL display the new balance weight data goes into the AVM SCU memory. After you select KEEP WEIGHTS, the EXIT APPROVAL display goes away and you return to the NEW BALANCE WEIGHTS display.

If you select GO BACK on the EXIT APPROVAL display, you return to the NEW BALANCE WEIGHTS display. You select GO BACK to look at any of the data again or to reject the new weights.

Training Information Point

To exit the NEW BALANCE WEIGHTS display, you select another function from the menu. The ENGINE BALANCING/NOTICE display shows (not shown). You must select STOP on this display to complete the EBS procedure.

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ENGINE BALANCING PERFORM BALANCE NEW BALANCE WEIGHTS			
AIRCRAFT ID: N123456		ENGINE TYPE: GE115	
ENGINE POSITION: L		ENGINE SERIAL NUMBER: 123456	
MAKE SURE THAT THE PART AND HOLE/BLADE NUMBERS AGREE WITH THE BALANCE WEIGHTS AND THEIR LOCATIONS ON THE ENGINE WHEN BALANCING IS COMPLETED. EDIT PART AND HOLE/BLADE NUMBERS AS NECESSARY. WHEN PART AND HOLE/BLADE NUMBERS AGREE, SELECT KEEP WEIGHTS.			
FAN		LPT	
PART NUMBER	HOLE NUMBER	PART NUMBER	BLADE NUMBER
P04	10	P01	12
P02	19		
P03	35		
P06	41		

**ENGINE BALANCING
EXIT APPROVAL**

NOTICE: THIS FUNCTION WILL COMPLETE.

- IF THE BALANCE WEIGHTS LIST HAS NOT BEEN CHECKED, SELECT GO BACK
- TO COMPLETE THIS FUNCTION, SELECT KEEP WEIGHTS

KEEP WEIGHTS

HELP

GO BACK

KEEP WEIGHTS

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ENGINE INDICATING - AVM - EBS - PERFORM BALANCE - 3

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