ENGINE - FUEL AND CONTROL - TO PROVIDE A NEW ELECTRONIC ENGINE CONTROL (EEC) WITH THE SN11 SOFTWARE CONFIGURATION - CATEGORY CODE 3 - MOD.ENG-73-0065

1. Planning Information

A. Effectivity

(1) Aircraft: McDonnell Douglas MD-90

(2) Engine: V2525-D5 Engines before Serial No.V20012
V2528-D5 Engines before Serial No.V20012

B. Reason

(1) Condition

(a) CONTROL SOFTWARE - C

1 WOW AND IDLE SELECTION LOGIC UPDATE RATE: The selection logic for WOW AND IDLE is being done at a a rate twice as fast as required by the PPS.

2 STATOR VANE TRACK CHECKS: Track check faults are being set during rejected takeoff rapid decels. The transient tolerance is too tight for stator vane system operation during these maneuvers.

3 NI MODE REVERSIONS DUE TO DEP: The EEC reverts to the NI mode in flight if the DEP is faulted. The DEP should be ignored at this point because the information has already been stored in memory.

4 WEIGHT -ON- WHEELS INPUT PROCESSING: A momentary loss of the ARINC input lable for the weight-on-wheels indication can cause the selected signal, used internally to the EEC, to toggle to indicate air instead of ground as determined from synthesis based on Mn.

5 N1 TOPPING LOOP OVERSHOOT: N1 overshoot is greater than the available redline margin for 30-31K thrust ratings.

6 EXTRANEOUS PATH IN THE REJECTED TAKEOFF LOGIC: There is a redundant logic path in the RTO logic.

7 P2 TOLERANCE: High angle of attack aircraft stall tests led to failures of P2 which caused reversion to N1 mode.

8 N1 ICING LOOP LEAD/LAG RESET: The N1 loop lead/lag is not reset when the N1 signal is failed. This could cause an undesirable disturbance to the loop.

9 MINIMUM BURNER PRESSURE SCHEDULE SELECTION: Switching between minimum burner pressure schedules can occur due to intermittent ARINC input faults which commands the selection. This is not a functional operability problem because the current schedules are the same.

(b) ENGINE OPERATION/PERFORMANCE - P

1 POWERBACK EGT SPIKING: Short duration EGT spikes exceeding the cockpit redline limit occur during initial accel off-idle, to reverse powerback thrust.

2 N1 SYNTHESIS CURVE: Present synthesis curves are not necessarily representative of real engine characteristics.

3 N2 SYNTHESIS CURVE: Present synthesis curves are not necessarily representative of real engine characteristics.

4 PB SYNTHESIS CURVE: Present synthesis curves are not necessarily representative of real engine characteristics.

5 EPR SYTHESIS CURVE: Present synthesis curves are not necessarily representative of real engine characteristics.

6 DEFAULT ALTITUDE FOR MINIMUM PB LOOP: The present default altitude for the minimum Pb loop is sea level which will result in an unnecessarily high engine idle for end of cruise and descent if altitude is faulted.

(c) IAE 1010 SECTION 6: EECS ANALOG INPUTS FROM AIRCRAFT

1 TRA RATE CHECK VALUE: During rejected takeoff flight testing the TRA rate limit was exceeded. This can affect the overall stopping disturbance of the aircraft since TRA is held to past value during a rate fault.

(d) IAE 1010 SECTION 8: EEC DIGITAL DATA BUS INPUTS

1 AIR DATA FAULT LATCHING:

a ADC P2 can be prematurely excluded from the circulation of Mach number used in ther calculation of EPR limits.

b ADC altitude can be prematurely excluded from selection. Loss of ADC altitude is not a latched failure in itself, that is, loss of the input will not permanently latch. However, if the ambient pressure probe was previously lost, loss of ADC altitiude will cause reversion to the N1 mode.

2 MIN LIMITS FOR TAT AND ALT INPUTS: The minimum limits for both ADC T2 and alitude are not low enough to process the input signal properly.

3 4-POSITION IGNITION SWITCH: The software processes the two ARINC bits ssociated with the 4-position ignition switch and will not be part of production.

4 FAIL/HEAL TIME FOR DFGC LABEL 341: The input logic only takes 2-3 seconds to fail/heal label 341 from the DFGC. It should take 10 seconds to fail/heal.

5 DFGC BUS SWITCHING: A DFGC bus transfer accomplished via the select bit, causes certain input signals to toggle to their failsafe values during the bus transfer. The inputs should be held to past value.

(e) IAE 1010 SECTION 9: EEC DIGITAL DATA BUS OUTPUTS

1 FALSE INDICATIONS OF FUEL FLOW DURING FIRE HANDLE SHUTDOWNS: Erroneous fuel flow indications have been observed at flight test when the engine is shut down using the fire handle.

2 HIDE-THE NEEDLE-LOGIC: The hide-the-needle logic is interacting with the autothrottle system under certain flight conditions. This is causing excessive throttle lever activ

3 AIRING OUTPUT OF ENGINE SERIAL NUMBER: The feedback of the flight test stator vane and bleed overrides is being output on label 047 in place of the 5th digit of the engine serial number.

4 N2 COCKPIT DISPLAY: The N2 cockpit display periodically remains at 5-6% after shutdown instead of displaying 0% once the speed signal has gone out-of-range.

(f) 1010 SECTION 10: ENGINE STARTING SYSTEM

1 START INITIATION: The logic will not enter a start mode if the start switch is ON when the EEC comes out of initialization.

2 AUTOSTART LOCKED ROTOR DETECTION: Starts have occured in production where the low rotor initially began to rotate but later bound-up prior to attaining idle. The software did not detect the locked rotor. The intent of the auto start locked low rotor abort logic is to prevent engine starting to idle with the low rotor not turning.

3 INFLIGHT QUICK RELIGHT LOGIC:

a There are two ways for the EEC to delay or inhibit inflight engine restart:

-The logic will not enter the start mode if the fuel switch is ON when the EEC comes out of initialization.

-The logic will not enter the start mode if the fuel switch is turned ON before the engine drops below idle.

b The EEC can inhibit fuel from being turned on above starter cutout while inflight.

4 IN-FLIGHT START ABORT MOTORING: Starter-assisted inflight starts continue to motor after fuel is turned off with the start switch left on. The requirement is to not motor.

5 'MANUAL START' COCKPIT INDICATION:

a The requirement to clear the ARNC bit which drives the cockpit message indicating only ground manual starts are available has not been met.

b The ARINC bit which drives the cockpit message indicating only ground manual starts are available must be modified to include flight crew selection in the manual start mode.

6 ABORT ANNUNCIATION: The ARINC output start abort indication is set in both the controlling and the non-controlling channel. This can create confusion in the cockpit if the non-controlling channel sets the abort indication while the channel controlling the start successfully starts the engine. The cockpit computer logically or's both channel's outputs to determine the cockpit 'start aborted' message.

(g) IAE 1010 SECTION 11.0 through 11.4 - 11: POWER SETTING

1 GROUND MINIMUM IDLE: Ground idle is higher than desired for proper aircraft handling.

2 UPPER LIMIT FOR EPR SELECT AND AUTO-CUTBACK: The upper limit for EPR select and auto-cutback EPR ARINC outputs needs to be TOGA EPR instead of the selected EPR limit to increase the user friendliness of the cutback system during preflight setup.

3 REVERSE IDLE: The engine reverse transient thrust response needs enhancement to reduce aircraft landing field length requirements.

4 EPR TO N1 BUMPLESS REVERSION: Transfer from EPR to N1 mode is not "bumpless" for all operation as required per the ICD.

5 EPR MODIFIER: The MD-90 needs additional thrust at specific power conditions to satisfy DAC guarantees to its customers.

(h) IAE 1010 SECTION 11.5: TRANSIENT OPERATION

1 REJECTED TAKEOFF DECELERATION SCHEDULE: If altitude is faulted during a takeoff roll, the rejected takeoff deceleration schedule is not disabled from selection.

(i) IAE 1010 SECTION 11.7: ENGINE SYCHRONIZATION SYSTEM

1 N1 AND EPR SYCHRONIZATION:

a During EPR synchronization, the EPR command can oscillate around the low end (idle) of the system's operation range.
b During N1 synchronization, TRA can oscillate when the system operation is inhibited for go-around.

(j) IAE SECTION 1010 SECTION 12: REVERSER SYSTEM

1 EMERGENCY REVERSE/THROTTLE SCHEME: Emergency reverse thrust may be required to stop the aircraft in unusual circumstances (e.g., brake failure, icy runway, etc.) at pilot discretion.

(k) IAE SECTION 1010 SECTION 13: FUEL OIL HEAT MANAGEMENT SYSTEM

1 RETURN-TO-TANK UTILIZATION: Ice can form on the MD90 wings under high humidity conditions with super-cooled fuel in the wing tanks, as can occur after landing with the fuel having been cooled during descent.

2 WING TANK FUEL TEMPERATURE FAULT DETECTION: The logic can not detect certain wing tank thermocouple faults which could prevent the EEC from inhibiting return-to-tank fuel flow for the high fuel temperature case. This could lead to engine flameout.

3 FUEL AND ENGINE OIL T/C FAILSAFE CLOSES AIR VALVE: The following discussion applies to both the engine oil and the fuel thermocouples. If the fuel thermocouple is faulted, the failsafe value for the input causes the logic to think the fuel is too cold. The logic responds by closing the air valve.

4 FUEL TEMPERATURE CONTROL LIMITS: The fuel temperature maintenance limits were not revised in SCN-10 when the control limits were revised.

(l) IAE SECTION 1010 section 15.A: EEC MAINTENANCE FUNCTIONS - AUTOMATIC MODE

1 HEAT MANAGEMENT FLIP MODE FAULT RECORDING: The nuisance fault, "HMS-VSCF OCTMP W/RECIRC" can be set after engine shutdown. This fault is recorded in EEROM and will set class II. This fault is intended to indicate a heat management system malfunction.

2 ADC FAILURE FAULT RECORDING: There is no fault recorded in the EEC if the ADC input is completely lost. This is a problem because there is no easy means from any aircraft computer to identify that there is a problem.

3 FLIGHT PHASE COMPUTATION: The flight phase computation, which is based on ICD requirements, is not compatible with the DC command from the aircraft.

4 ACOC SPRING VALVE NUISANCE FAULT: The air valve spring fault detection logic has been inappropriately flagging the spring fault.

5 ACTUATOR-TO-SERVICE TEST: There is no return-to-service for actuators.

(m) IAE 1010 SECTION 15.D: EEC MAINTENENACE FUNCTIONS - DISPATCH

1 FAULT RECORDING OF DISPATCH FAULTS: Some dispatch indiactions can be set without any fault being recorded to memory thus making it difficult to identify its origin. Specifically an auto-redeploy or an auto-restow, which set the reverser system failed but, are not fault recorded.

2 SETTING CLASS 1 INAPPROPRIATELY: The class 1 fault flag can be set inappropriately due to the ACU going into a self-test.

3 NEW CLASS II FAULT: A fuel diverter valve feedback crosscheck fault does not set the CLASS II dispatch flag.

4 REDUNDANCY TO COCKPIT INDICATIONS: Non-dispatchable (Class I) failures that have cockpit indications independent of the no dispatch cockpit message should be removed from the Class I fault ogic in the EEC. Dual-channel EGT failuires fit this description.

5 ELEVATE SINGLE-CHANNEL FAULTS IN CRITICAL LOOPS TO CLASS II: Based on field experience, certain faults should be considered Class II instead of Class III faults to provide increased airline maintenance flexibility.

6 CLASS I LOGIC ERROR: Certain failures with the crosslink down will not set the class I fault bit.

7 INLCUDE DELAY BEFORE SETTING CLASS III: Both Class II and Class III can be set at the same time.

8 LATCHING OF OAP DISPATCH MESSAGES: The No dispatch indication will clear in the cockpit once the EEC is reset. If the flight crew does not observe the message before the engine is shutdown, there will be no record of the non-dispatchable situation.

(n) IAE 1010 SECTION 15.I: EEC MAINTENANCE FUNCTIONS - INTERACTIVE MODE

1 INPUT/OUTPUT TEST: The Input/Output test does not check the health of the DFGC buses.

2 REVERSER RETURN-TO-SERVICE TEST: No problem.

(2) Background

(a) CONTROL SOFTWARE - C

1 WOW AND IDLE SELECTION LOGIC UPDATE RATE: Implementation error.

1 STATOR VANE TRACK CHECKS: The overall stator vane system transient response capability was not taken into account in the present design, only the stator vane actuator characteristics were considered when the logic was designed.

3 N1 MODE REVERSIONS DUE TO DEP: Implementation error.

4 WEIGHT - ON-WHEELS INPUT PROCESING: The weight-on-wheels input selection logic sets the selected signal to indicate air while its confirming the accuracy of the raw input.

5 NI TOPPING LOOP OVERSHOOT: N1 loop compensation carried over from -A1 engine is optimized for -A5/D5 engine at high power.

6 EXTRANEOUS PATH IN THE REJECTED TAKEOFF LOGIC: Implementation error.

7 P2 TOLERANCE: The P2 engine probe exceeded the tolerance with respect to the ADC P2 due to inlet distortion by the wing and/or fuselage during the angle of attack stalls.

8 N1 ICING LOOP LEAD/LAG RESET: Implementation error.

9 MINIMIMUM BURNER PRESSURE SCHEDULE SELECTION: The switching logic reacts to intermittent faults of the input word from the DFGC.

(b) ENGINE OPERATION/PERFORMANCE - P

1 POWERBACK EGT SPIKING: EGT spikes are caused by initial fuel addition to accelerate the engine off-idle where the LPT initially extract little to no work, thus resulting in momentarily high gas temperature spike passing the EGT sensors. This is not harmful to engine hardware based on service experience.

2 N1 SYNTHESIS CURVE: Present curves are based on a preliminary pre-flight test engine model.

3 N2 SYNTHESIS CURVE: Present curves are based on a preliminary pre-flight test engine model.

4 PB SYNTHESIS CURVE: Present curves are based on a preliminary pre-flight test engine model.

5 EPR SYNTHESIS CURVE: Present curves are based on a preliminary pre-flight test engine model.

6 DEFAULT ALTITUDE FOR MINIMUM PB LOOP: Incomplete original design considerations.

(c) IAE 1010 SECTION 6: EECS ANALOG INPUTS FROM AIRCRAFT

1 TRA RATE CHECK VALUE: Improperly defined requirement.

(d) IAE 1010 SECTION 8: EEC DIGITAL DATA BUS INPUTS

1 AIR DATA FAULT LATCHING:

a The EEC fault logic for total loss of the ADC bus does not take advantage of both DFGC buses before declaring the bus failed.

b The EEC fault logic for total loss of the ADC bus does not take advantage of both DFGC buses before declaring the ADC bus failed.

2 MIN LIMITS FOR TAT AND ALT INPUTS: The software was designed to the ICD requirements but the IDC was not in compliance with the original requirements from the airframer.

3 4-POSITION IGNITION SWITCH: When the processing of the two bits was removed in SCN-10, the fault accomodation logic was left in the software.

4 FAIL/HEAT TIME FOR DFGC LABEL 341: Implementation error.

5 DFGC BUS SWITCHING: Implementation error.

(e) IAE 1010 SECTION 9: EEC DIGITAL DATA BUS OUTPUTS

1 FALSE INDICATIONS OF FUEL FLOW DURING FIRE SHUTDOWNS: Sudden changes in the flow rate through the fuel flow meter during fire handle shutdowns cause the fuel flow meter to operate improperly and give a false indication of fuel flow.

2 HIDE-THE-NEEDLE LOGIC: The autothrottle system drives the throttle to below the hide-the-needle logic TRA thresholds. At this point, EPR command is no longer a direct function of the throttle. This essentially opens the control loop of the auto throttle system.

3 ARINC OUTPUT OF ENGINE SERIAL NUMBER: The feedback has been used in flight test.

4 N2 COCKPIT DISPLAY: The characteristic of the N2 speed signal during the last part of a shutdown is not predictable. The current design is not robust enough to handle all possible situations.

(f) 1010 SECTION 10: ENGINE STARTING SYSTEM

1 START INITIATION: The starting logic looks for a transition in the start switch from off to on to initiate a start.

2 AUTOSTART LOCKED ROTOR DETECTION: The present logic design only considered the case where the low rotor never turns at all from the beginning oft he autostart sequence. The possibility of building-up later in the start sequence was not anticipated.

3 INFLIGHT QUICK RELIGHT LOGIC:

a The starting logic looks for a transition in the fuel switch discrete from OFF to ON to initiate a start.

b The described scenario was not considered during the development of the starting logic.

c The present design does not accommodate turning fuel on above starter cutout.

4 IN-FLIGHT START ABORT MOTORING: The present design does not properly distinguish between in-flight and ground start abort motoring.

5 'MANUAL START' COCKPIT INDICATION:

a Implementation error.

b New requirement.

6 ABORT ANNUNCIATION: New requirment.

(g) IAE 1010 SECTION 11.0 through 11.4 - 11: POWER SETTING

1 GROUND MINIMUM IDLE: The requirements could be finalized until flight testing was done.

2 UPPER LIMIT FOR EPR SELECT AND AUTO-CUTBACK: New requirement.

3 REVERSE IDLE: The requirement could not be finalized until flight testing was done.

4 EPR TO N1 BUMPLESS REVERSION: The present reversion bias limiting is based on the A5 engine model. The D5 engine EPR versus N1 characteristic is slightly different.

5 EPR MODIFIER: The aircraft performance characteristics could not be finalized until flight testing was done.

(h) IAE 1010 section 11.5: TRANSIENT OPERATION

1 REJECTED TAKEOFF DECELERATION SCHEDULE: The potential loss of altitude during a takeoff roll was not adequately addressed.

(i) IAE 1010 SECTION 11.7: ENGINE SYNCHRONIZATION SYSTEM

1 N1 NAD EPR SYNCHRONIZATION:

a Per requirement, the EPR sychronization inhibit logic uses a check on EPR feedback.
b Per requirement, the N1 synchronization inhibit logic checks for EPR command (calculated based on trimmed TRA) being greater than maximum climb.

(j) IAE SECTION 1010 SECTION 12: REVERSER SYSTEM

1 EMERGENCY REVERSE/THROTTLE SCHEME: New DAC requirement.

(k) IAE SECTION 1010 SECTION 13: FUEL OIL HEAT MANAGEMENT SYSTEM

1 RETURN-TO-TANK UTILIZATION: New requirement.

2 WING TANK FUEL TEMPERATURE FAILURE DETECTION: The EEC/aircraft fuel system interface allows for the latent failure of the wing tank fuel temperature input to the EEC.

3 FUEL AND ENGINE OIL T/C FAILSAFE CLOSES AIR VALVE: The current heat management design does not completely accommodate faults of the fuel and engine oil thermocouples.

4 FUEL TEMPERATURE CONTROL LIMITS: The development of the maintenance fuel temperature limits could not be finalized until SGN-10 software was available for flight test.

(1) IAE SECTION 1010 SECTION 15.A: EEC MAINTENANCE FUNCTIONS - AUTOMATIC MODE

1 HEAT MANAGEMENT FLIP MODE FAULT RECORDING: On engine shutdown during soakback, it may be possible for the VSCF oil temperature to rise over and stay above the maintenance limit long enough to set the fault flag. At shutdown, there is no fuel flow to use as a cooling medium for the VSFC oil.

2 ADC FAILURE FAULT RECORDING: New requirement.

3 FLIGHT PHASE COMPUTATION: The DC command input does not follow what is described in the ICD. The EEC software meets the requirements of the ICD but the ICD does not reflect the actual DC command sequence sent from the aircraft.

4 ACOC SPRING VALVE NUISANCE FAULT: The current design does not properly distinguish between normal and failed operation effectively.

5 ACTUATOR-TO-SERVICE TEST: New requirement.

(m) IAE 1010 SECTION 15.D: EEC MAINTENENACE FUNCTIONS - DISPATCH

1 FAULT RECORDING OF DISPATCH FAULTS: The recording of these faults were not included in the original design.

2 SETTING CLASS 1 INAPPROPRIATELY: The #4 bearing scavenge valve failure bits can be set by the ACU during its self-test or when the engine is spooling down.

3 NEW CLASS II FAULT: The fault inadvertently left out of the original design.

4 REDUNDANCY TO COCKPIT INDICATIONS: The requirement could not be developed until the aircraft system eas fully defined.

5 ELEVATE SINGLE-CHANNEL FAULTS IN CRITICAL LOOPS TO CLASS II: New requirement.

6 CLASS 1 LOGIC ERROR: Coding error.

7 INCLUDE DELAY BEFORE SETTING CLASS III: Certain combinations of faults can cause both Class II and Class III to set.

8 LATCHING OF OAP DISPATCH MESSAGES: New requirement.

(n) IAE 1010 SECTION 15.I: EEC MAINTENANCE FUNCTIONS - INTERACTIVE MODE

1 INPUT/OUTPUT TEST: The logic was not designed to cover this new requirement.

2 REVERSER RETURN-TO-SERVICE TEST: New requirement.

(3) Objective

(a) CONTROL SOFTWARE - C

1 WOW AND IDLE SELECTION LOGIC UPDATE RATE: Modify the update rate of the WOW and ID meet requirements.

2 STATOR VANE TRACK CHECKS: Modify the tack check rate limit to be +/- 0.4 inch/sec (trimmable) so that the overall system transient operation will be accounted for.

3 N1 MODE REVERSIONS DUE TO DEP: Modify the DEP processing logic such that once a valid DEP is recognized, faults of the DEP will not cause reversion to the N1 mode.

4 WEIGHT -ON- WHEELS INPUT PROCESSING: Modify the selection logic for weight-on-wheels to use synthesis based on Mn until the accuracy of the raw input word is confirmed.

5 N1 TOPPING LOOP OVERSHOOT: Revise the N1 compensation via trim to prevent redline overshoot for 30-31K thrust rating.

6 EXTRANEOUS PATH IN THE REJECTED TAKEOFF LOGIC: Remove the redundant path in the RTO logic.

7 P2 TOLERANCE: Based on previous experience, modify the tolerance to be a percent of point instead of a constant.

8 N1 ICING LOOP LEAD/LAG RESET: Include reset logic on the N1 icing loop similar to that currently on the N1 topping loop.

9 MINIMUM BURNER PRESSURE SCHEDULE SELECTION: Modify the logic to not switch between schedules until the input word is latched failed.

(b) ENGINE OPERATION/PERFORMANCE - P

1 POWERBACK EGT SPIKING: Modify the design as follows to eliminate EGT spikes during initial accel off-idle to reverse powerback thrust. Close the engine 7A bleed at reverse idle on the ground for airfields below 5500 ft elevation and raise reverse idle speed to lower the basic reverse idle steady state EGT level to gain margin for the spikes. Note that the stator vanes also need to be reset closed when the engine 7A bleed is closed to offset the HPC surge margin loss due to closing the bleed. Also, bias cockpit EGT at low power to take full advantage of the 650 degC certified EGT redline limit without affecting the cockpit gagae readout. In addition, lag cockpit EGT at low power, but not for starting, to attenuate the spike magnitude to the cockpit gage.

2 N1 SYNTHESIS CURVE: Review and update synthesis, as required, based on flight test data.

3 N2 SYNTHESIS CURVE: Review and update synthesis, as required, based on flight test data.

4 PB SYNTHESIS CURVE: Review and update synthesis, as required, based on flight test data.

5 EPR SYNTHESIS CURVE: Review and update synthesis, as required, based on flight test data.

6 DEFAULT ALTITUDE FOR MINIMUM PB LOOP: Change the default altitude for the minimum Pb loop to 35000 feet so that an appropriate engine idle for cruise and descent will be scheduled if altitude is faulted.

(c) IAE 1010 SECTION 6: EECS ANALOG INPUTS FROM AIRCRAFT

1 TRA RATE CHECK VALUE: Change the rate check limit on TRA from 600 to 10000 deg Res/sec so that normal operation will not rate fault TRA.

(d) IAE 1010 SECTION 8: EEC DIGITAL DATA BUS INPUTS

1 AIR DATA FAULT LATCHING:

a Modify the ADC bus fault logic to take advantage of both DFGC buses before declaring the ADC bus fault.
b Modify the ADC bus fault logic to take advantage of both DFGC buses before declaring the ADC bus fault.

2 MIN LIMITS FOR TAT AND ALT INPUTS: Modify the input processing logic to account for the originally intended required input range.

3 4-POSITION IGNITION SWITCH: Do no process the input bits associated with the 4-position ignition switch since it will not be used in production.

4 FAIL/HEAL TIME FOR DFGC LABEL 341: Correct the implementation of the software so that it will take 10 seconds to fail/heal label 341.

5 DFGC BUS SWITCHING: Modify the DFGC bus transfer logic to meet the requirements of the ICD.

(e) IAE 1010 SECTION 9: EEC DIGITAL DATA BUS OUTPUTS

1 FALSE INDICATIONS OF FUEL FLOW DURING FIRE HANDLE SHUTDOWNS: Modify the existing cockpit display logic to include use of the feedback signal from the fuel on/off solenoid to mask the false indication of fuel flow.

2 HIDE-THE-NEEDLE LOGIC: Remove the hide-the-needle logic so that EPR command is a direct function of the throttle for the entire forward thrust range.

3 ARINC OUTPUT OF ENGINE SERIAL NUMBER: Remove the flight tets stator vane and bleed overrides and reestablish the output of the 5th digit of the engine serial number on output label 047 for use in revenue service.

4 N2 COCKPIT DISPLAY: Modify the N2 cockpit display logic to improve the handling of the characteristics of the N2 signal and eliminate the potential for latching a non-zero value of N2 on engine shutdown.

(f) IAE 1010 SECTION 10: ENGINE STARTING SYSTEM

1 START INITIATION: Change the starting logic such that it is not dependant on a start switch transition from off to on so that all start initiations will be successful.

2 AUTOSTART LOCKED ROTOR DETECTION: Change the autostart locked low rotor logic to abort any start where the low rotor does not rotate or stops rotating during any start sequence prior to attaining idle.

3 INFLIGHT QUICK RELIGHT LOGIC:

a Change the logic so that the EEC will not delay or inhibit an inflight engine restart no matter when the fuel switch is turned ON.

b Change the logic so that EEC cannot inhibit fuel from being turned on above starter cutout inflight.

4 IN-FLIGHT START ABORT MOTORING: Modify the starting logic to meet the ICD requirement to not motor the engine after an aborted inflight start.

5 'MANUAL START' COCKPIT INDICATION:

a Modify the logic so that the cockpit message indicating that only ground manual starts are available will only appear below idle on the ground.

b Modify the logic so that the 'manual start' cockpit message will be set due to selection of or failure into manual start mode.

6 ABORT ANNUNCIATION: Modify the ARINC output start abort indication so that it is set only by the channel controlling the start.

(g) IAE 1010 SECTION 11.0 through 11.4 - 11: POWER SETTING

1 GROUND MINIMUM IDLE: Incorporate seperate minimum burner pressure schedules for ground and air operation so that proper aircraft handling can be maintained.

2 UPPER LIMIT FOR EPR SELECT AND AUTO-CUTBACK: Modify the output logic to limit the cutback EPR ARINC outputs to TOGA EPR.

3 REVERSE IDLE: Provide a 50% N1 idle (via EEROM trim) for reverse so that desired thrust reverser responce can be achieved. Raising reverse idle will reduce the time it takes to reach maximum reverse thrust.

4 EPR TO N1 BUMPLESS REVERSION: Revise the D5 reversion bias limiting EPR versus N1, based on D5 flight test data, so that it does not interfere with "bumpless" transition.

5 EPR MODIFIER: Change the EPR modifier trim table as required to meet the latest requirements.

(h) IAE 1010 SECTION 11.5: TRANSIENT OPERATION

1 REJECTED TAKEOFF DECELERATION SCHEDULE: Modify the rejected takeoff deceleration schedule selection logic to disallow selection of the schedule if altitude is not available.

(i) IAE 1010 SECTION 11.7: ENGINE SYNCHRONIZATION SYSTEM

1 N1 AND EPR SYCHRONIZATION:

a Inhibit EPR synchronization at the low end by checking untrimmed EPR command instead of EPR feedback.

b Inhibit N1 synchronization for go-around by checking for untrimmed TRA being in the maximum power flat instead of EPR command being greater than maximum climb.

(j) IAE SECTION 1010 SECTION 12: REVERSER SYSTEM

1 EMERGENCY REVERSE/THROTTLE SCHEME: Implement emergency reverse capability, including monitoring of its usage for maintenance and dispatch annunciation as required.

(k) IAE SECTION 1010 SECTION 13: FUEL OIL HEAT MANAGEMENT SYSTEM

1 RETURN-TO-TANK UTILIZATION: Maximize the heat-rejection to the fuel tanks by incorporating the following changes. Schedule the spill valve to its maximum position when the wing tank fuel temperature is less than 10 degC. Inhibit return-to-tank if engine fuel flow exceed 8000 pph.

2 WING TANK FUEL TEMPERATURE FAILURE DETECTION: Compare the temperature of one wing tank to the other. Based on comparison with the local temperature, inhibit RTT as appropriate to increase the reliability of the fuel system.

3 FUEL AND ENGINE OIL T/C FAILSAFE CLOSES AIR VALVE: Modify the design to failsafe the fuel temperature to the proper failsafe value, so that the fuel will not be inappropriately declared too cold.

4 FUEL TEMPERATURE CONTROL LIMITS: Based on flight test experience, modify the fuel temperature maintenance limits to reflect the control limits introduced by SCN-10 software.

(l) IAE SECTION 1010 SECTION 15.A: EEC MAINTENANCE FUNCTIONS - AUTOMATIC MODE

1 HEAT MANAGEMENT FLIP MODE FAULT RECORDING: Modify the logic such that the Flip mode nuisance fault will not get set after engine is shutdown.

2 ADC FAILURE FAULT RECORDING: Include the loss of all ADC inputs from a DFGC to the Class III logic. Fault record these faults using the same CLM as used for the loss of the DFGC bus.

3 FLIGHT PHASE COMPUTATION: Use weight-on-wheels ad a check on N2 above idle to calaculatre flight phase. Do not use the DC command from the aircraft for the calculation of phase.

4 ACOC SPRING VALVE NUISANCE FAULT: Remove the air valve spring failed detection logic. The logic has been a source of nuisance faults without providing much benefit.

5 ACTUATOR-TO-SERVICE TEST: Add an Actuator-To-Service test. This test will be run during engine motoring, using existing aircraft inputs to the EEC. Each modulated loop will be cycled from stop to stop to verify proper operation.

(m) IAE 1010 SECTION 15.D: EEC MAINTENANCE FUNCTIONS - DISPATCH

1 FAULT RECORDING OF DISPATCH FAULTS: Modify the fault recording logic to include all faults that set class I, II, or III to aid in troubleshooting.

2 SETTING CLASS 1 INAPPROPRIATELY: Inhibit the #4 bearing scavenge valve failure bits from affecting dispatch when the data is unreliable.

3 NEW CLASS II FAULT: Modify the CLASS II dispatch logic to include the fuel diverter valve feedback crosscheck fault.

4 REDUNDANCY TO COCKPIT IDICACTIONS: Remove the dual-channel EGT faults from the EEC Class I logic so that the no dispatch cockpit message is not redundant to other cockpit indications.

5 ELEVATE SINGLE-CHANNEL FAULTS IN CRITICAL LOOPS TO CLASS II:

Elevate the following faults to Class II:

-Crosslink faults
-Single channel processor/memory faults
-Single channel component faults of critical loops: Fuel flow, Stator vanes, 2.5 bleed, torque motors, LVDT,s

6 CLASS I LOGIC ERROR: Modify the code to meet requirements.

7 INCLUDE DELAY BEFORE SETTING CLASS III: Add a delay to the Class III logic to prevent more than one class of dispatch from being set.

8 LATCHING OF OAP DISPATCH MESSAGES: Modify the EEC logic to set the no dispatch indication on power-up if it was set prior to EEC reset. Allow the fault to be cleared only if the maintenance mode is utilized, indicating maintenance action has been taken.

(n) IAE 1010 SECTION 15.I: EEC MAINTENANCE FUNCTIONS - INTERACTIVE MODE

1 INPUT/OUTPUT TEST: Modify the Input/Output test so that the health of the DFGC buses will be checked.

2 REVERSER RETURN-TO-SERVICE TEST: Provide TRA & reverser LVDT position during the reverser R-T-S test to assist in execution of aircraft OATP's.

(4) Substantiation

The flight simulation and flight testing of the SCN11 version 022 software logic was accomplished at McDonnell Douglas.

(5) Effects of Bulletin on Workshop Procedures:

Removal/Installation	Not affected
Disassembly/Assembly	Not affected
Cleaning	Not affected
Inspection/Check	Not affected
Repair	Not affected
Testing	Not affected

(6) Supplemental Information

None.

C. Description

(1) Provide a new Electronic Engine Control (EEC) incorporating D5SCN11, version 022 and 022 Trims. This software version provides code changes to address either requirement changes or flight test identified problems, from D5SCN10.

D. Approval

The Part Number Changes and/or part modifictations described in Section 2 and 3 of this Service Bulletin have been shown to comply with the applicable Federal Aviation Regulations and are FAA-APPROVED for the Engine Model listed.

E. Compliance

Category Code 3.

Accomplish before entry into revenue service.

F. Manpower

Estimated Manhours to incorporate the full intent of this Bulletin:

Venue	Estimated Manhours
(1) In Service	TOTAL: 1 hour 16 minutes
(a) To gain access	
(i) Install warning notices ..	5 minutes
(ii) Open the fan cowls	7 minutes
(iii) Remove the EEC	23 minutes
	TOTAL 35 minutes
(b) To return to flyable status	

(i) Install the EEC .. .. 28 minutes

(ii) Close the fan cowls .. 8 minutes

(iii) Remove the warning notices 5 minutes

TOTAL 41 minutes

(2) At Overhaul .. .. .. Not Applicable

G. Material - Price and Availability

(1) Modification Kit not required.

(2) See "Material Information" section for prices and availability of future spares.

H. Tooling - Price and Availability

None.

I. Weight and Balance

(1) Weight change .. .. .. None

(2) Moment arm .. .. .. No effect

(3) Datum .. .. .. Engine front mount Centreline (Powerplant station P.P.S.100)

J. Electrical Load Data

This Service Bulletin has no effect on the aircraft electrical load.

K. Reference

(1) Internal Reference No.

94VZ035

(2) Other References

MD-90 Aircraft Maintenance Manual.

V2500-D5 Engine Illustrated Parts Catalog.

L. Other Publications Affected

(1) The V2500-D5 Engine Illustrated Parts Catalog, Chapter/Section 73-22-34, Figure 1, to add the new parts.

2. Accomplishment Instructions

A. Pre-Requisite Instructions

(1) On the aircraft panel 115VU, put a warning notice to tell the persons not to start the engine.

(2) On the aircraft panel 50VU, make sure that the ON legend on the ENG FADEC GND PWR push button switch is OFF and install a warning notice.

(3) Open the Fan Cowls by the use of the approved procedure in Reference (1), Chapter/Section 71-13-00.

B. Removal/Instructions

(1) Remove the 2A2864 Electronic Engine Control by the approved procedure given in Reference (1), Chapter/Section 73-21-34, Removal/Installation. Refer to Figure 1.

C. Installation Instructions

(1) Install the 2A3130, Electronic Engine Control (1 off) by the approved procedure given in Reference (1), Chapter/Section 73-21-34, Removal/Installation. See Figure 1.

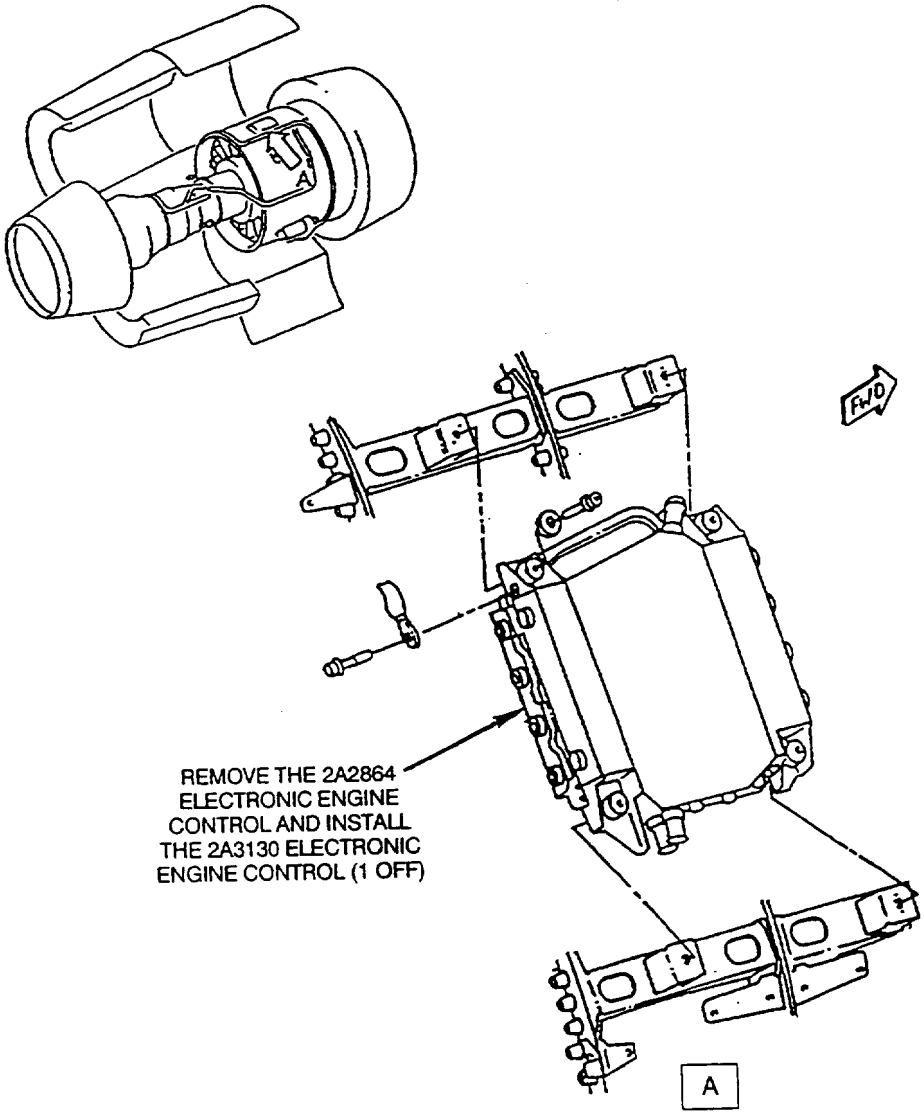
D. Post Requisite Instructions

(1) Close the Fan Cowls by use of the approved procedure in Reference (1), Chapter/Section 71-13-00.

(2) Remove the warning notices.

I. Recording Instructions

(1) A record of accomplishment is necessary.



ded0001986

Location of Electronic Engine Control (EEC)
Fig.1

3. Material Information

A. Kits associated with this Bulletin:

None

B. Parts affected by this Bulletin:

New Part No. (ATA No.)	Qty	Est'd Unit Price ($)	Keyword	Old Part No. (IPC No.)	Instructions/ Disposition
2A3130 (73-22-34)	1		Control, Electronic Engine	2A2864 (01-280)	(A) (B) (C)

C. Instruction/Disposition Code Statements:

(A) New part is currently available.
(B) The Old part will no longer be available.
(C) HSD P/L 808050-04-025L4

Note (C) gives the new Hamilton Standard part number.

NOTE: The Estimated 1994 unit prices shown are provided for planning purposes only and do not constitute a firm quotation. Consult the IAE Price Catalog or contact IAE's Spare Parts Sales Department for information concerning firm prices.

MODIFICATIONS	PART NUMBER CHANGE
BASE LINE	2A2864
V2500-ENG-73-0065 ENGINE - FUEL AND CONTROL - TO PROVIDE A NEW ELECTRONIC ENGINE CONTROL(EEC) WITH THE SCN11 VERSION 022 SOFTWARE CONFIGURATION	2A3130

d0002003

Family Tree - Electronic Engine Control (EEC) Catalog Sequence No. 73-22-34, Fig 01, Item 280
Fig.2