NASA CR-145271

Flight Control Electronics Reliability/Maintenance Study

(NASA-CR-145271) FLIGHT CONTROL ELECTRONICS N78-14055
RELIABILITY/MAINTENANCE STUDY (Boeing
Commercial Airplane Co., Seattle) 364 p
HC A16/MF A01 CSCL 01C Unclas
G3/08 55540

W.W. Dade; R.H. Edwards; G.T. Katt; K.L. McClellan;
and H.A. Shomber

Boeing Commercial Airplane Company
Seattle, Washington

Prepared for
Langley Research Center
under contract NAS1-13654

National Aeronautics and
Space Administration

1977

1. Report No
NASA CR-145271

2. Government Accession No

3. Recipient's Catalog No

4. Title and Subtitle
FLIGHT CONTROL ELECTRONICS
RELIABILITY/MAINTENANCE STUDY

5. Report Date
December 1977

6. Performing Organization Code

7. Author(s)
Flight Control Technology

8. Performing Organization Report No.
D6-46346

9. Performing Organization Name and Address
The Boeing Commercial Airplane Company
P.O. Box 3707
Seattle, Washington 98124

10. Work Unit No

11. Contract or Grant No
NAS1-13654

12. Sponsoring Agency Name and Address
National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23665

13. Type of Report and Period Covered
Contractor Report

14. Sponsoring Agency Code

15. Supplementary Notes
Technical monitor, A. H. Lindler, FID
NASA Langley Research Center
Hampton, VA 23665

16. Abstract

This study involved the collection and analysis of data concerning the reliability and maintenance experience of flight control system electronics currently in use on a contemporary passenger carrying jet aircraft.

Two airlines (United Airlines and Pan American World Airways) B-747 airplane fleets were analyzed to assess the component reliability, system functional reliability, and achieved availability of the CAT II configuration flight control system. Also assessed were the costs generated by this system in the catagories of spare equipment, schedule irregularity, and line and shop maintenance.

The results indicate that although there is a marked difference in the geographic location and route pattern between the airlines studied, there is a close similarity in the reliability and the maintenance costs associated with the flight control electronics.

17. Key Words (Suggested by Author(s))
Reliability
Availability
Maintenance cost

18. Distribution Statement
Unclassified-Unlimited

19. Security Classif (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
360

22. Price*

*For sale by the National Technical Information Service, Springfield, Virginia 22151

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

FLIGHT CONTROL ELECTRONICS RELIABILITY/MAINTENANCE STUDY

W.W. Dade; R.H. Edwards; G.T. Katt; K.L. McClellan; and H.A. Shomber

Boeing Commercial Airplane Company

1.0 SUMMARY

The flight control electronics reliability/maintenance study is a modification of the ARCS (Airborne Advanced Reconfigurable Computer) program (NASA Contract NAS1-13654). This study expands the effort involving the collection and analysis of data concerning the reliability and maintenance experience of flight control system electronics currently in use on today's passenger-carrying jet transports.

United Airlines was selected to provide information on reliability, availability and maintenance parameters on the flight-control electronics system of their fleet of Boeing 747 airplanes. This study was further expanded to include operational data from the Pan American World Airways 747 fleet. These two airlines operate in different areas of the world and with widely different route systems. Major differences if any in the reliability/maintenance cost between these two airlines might be due to these operating differences.

The results show that there is a close similarity in component failure rates and even closer similarity in system reliability as it relates to Category II Auto land capability. The actual in-service CAT II availability for both airlines shows little difference.

Time between removals was tabulated as well as time between failures. The failure data supports the assumption of a Poisson process using the chi squared test.

There are some differences in the maintenance assessment, particularly in the component overhaul category. Any relationship between these differences and the operating environment for each airline as described in this study could be rationalized. However, there are many other influences that bear on costing figures such as accounting procedures, level of in-house repair capability and size and maturity of airplane fleets.

2.0 INTRODUCTION

This study is a follow-on to the Airborne Advanced Reconfigurable Computer System, or ARCS, program (NASA contract NAS1-13654) and expands the effort involving the collection and analysis of data concerning the reliability and maintenance experience of flight control system electronics currently in use on today's passenger-carrying jet transports.

The ARCS program was a one year study, part of which was to apply methods for assessing potential benefits and costs of fault tolerant computer technology as applied to future commercial transport avionics. Sponsorship was from NASA Langley Research Center under the Terminal Configured Vehicle (TCV) program. The program joined a team of airline, aircraft manufacturer and avionic systems manufacturer personnel to formulate a new fault-tolerant airborne computer system architecture. The resulting conceptual design was compared with contemporary system technology to determine its impact on airline profitability.

It was understood that a need existed to establish a baseline assessment of flight control system avionics which included operational aspects, as well as a reliability analysis.

Follow-On Study

The scope of this follow-on study was to bring together specific information on reliability, availability and maintenance parameters for a selected avionic control system and identify how they are influenced by the maintenance philosophy and policy of the using airline. United Airlines was identified as the source for this airline operational data.

If it is a fact that each airline's maintenance and operating methods differ widely, then the reliability and maintenance assessment established in this study would only be representative of an airline whose operating methods closely match those of United. With the above statement held to be true, the ARCS follow-on study was further modified to include Pan American as a second source airline to provide operational data. With United being a domestic operator and Pan American an overseas operator, any difference in maintenance and operating practices should stand out clearly.

The purpose of this modified study was to present the analyses for the two airlines with a view to highlight differences where they exist.

Report Structure

This report is organized into four major sections with a concluding cost summary and several appendixes. Section 3 covers the Automatic Flight Control System (AFCS) description with emphasis on individual component identifications and their relationship with the AFCS system and other systems. Section 4 describes the operating environment for each of the two airlines that provided data support involving flight control electronics. In Section 5 the AFCS component failure rates are established and the system reliability is calculated in terms of functional failure of the Category II autoland capability. Section 6 presents the basic cost elements such as manhours and material expenditure and delay costs as part of the maintenance assessment. The last section gives a summary of the total costs associated with the flight control system electronics.

As the analysis and results of this study were dependent on raw data extraction from airline records, much of this material is presented as appendixes.

The Boeing Commercial Airplane Company wishes to acknowledge United Airlines and Pan American World Airways for their support during this program. Messrs. A. Miller and R. Valeika of Pan American and Mr. H. Takeuchi of United deserve recognition for their contributions involving their airline operating procedures and maintenance philosophies.

3.0 747 SYSTEM DESCRIPTION

The flight control electronics for the 747 airplane consists of four separate automatic control systems: autopilot/flight director system, automatic stabilizer trim system, yaw damper system, and auto throttle system. These systems provide automatic airplane stabilization about the pitch, roll and yaw axes and control the airplane with selective guidance from radio, compass, inertial navigation, and air data command inputs. The autopilot system is a two-axis (pitch and roll) system which operates the elevators and ailerons to automatically maintain altitude, airspeed and/or guide the airplane to designated locations and make automatic landings. Control functions are also translated into flight director commands for display on the pilots attitude director indicators (ADI's), thereby providing the pilots flight attitude commands during manual operation or allowing the pilots to monitor autopilot operation. The yaw damper system operates the rudders to correct any periodic yaw oscillation (dutch roll) and assists in making corrdinated turns. Automatic stabilizer trimming relieves sustained elevator loads which might be incurred due to fuel burnoff. The auto throttle system automatically maintains selected airspeeds and assists the autopilot when making automatic landings by adjusting engine thrust levers.

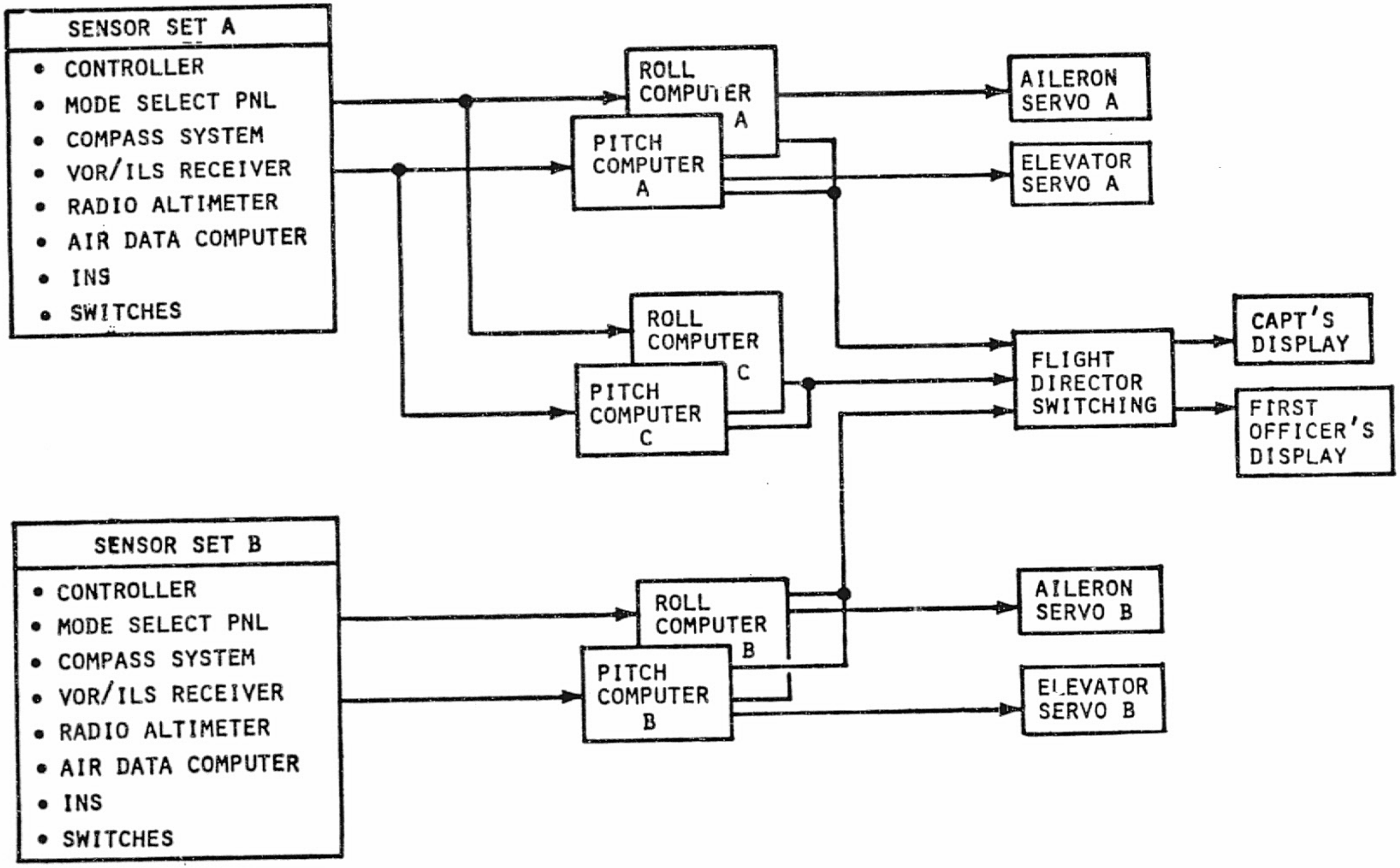
The following discussion has been subdivided into five subsections dealing with the Autopilot/Flight Direction System (section 3.1), Automatic Stabilizer Trim System (section 3.2), Yaw Damper (section 3.3), Auto Throttle (section 3.4), and Category II Operation (section 3.5).

3.1 AUTOPILOT/FLIGHT DIRECTOR SYSTEM

The Sperry SPZ-1 fail passive autopilot/flight director (AP/FD) system, as illustrated in figure 3-1, is an integrated autopilot and flight director system using common computational components. The AP/FD system provides three independent F/D channels and two A/P channels (brickwall). Either A/P channel, as selected on an AP/FD mode select panel, can control the airplane roll and pitch axes control surfaces to selected automatic path guidance commands for all cruise modes of operation. Dual channel engagement is allowed only for automatic landing. A flight controller with pitch and turn knobs is provided for manual autopilot guidance. Any one of the three F/D channels can be selected by the captain or first officer for flight director guidance commands as indicated on attitude director indicators.

Independence of each AP/FD channel is assured by isolation of power supplies, sensors, computers, aircraft wire bundles and shelf wire harnesses. Two hydraulic systems supply pressure for the elevator power control units (PCU's) and aileron central control actuators (CCA's) which are controlled by the autopilot channels.

Output of the autopilot systems control electrohydraulic transfer valves on autopilot modules which are part of the PCU's and CCA's. Output of the modules mechanically control the hydraulic actuators through linkage which is balanced against spring-loaded detents in each module. During dual channel approaches, control surface commands generated by each A/P control module are force-summed into a nonjammable mechanical



ORIGINAL PAGE IS OF POOR QUALITY

Figure 3-1.—Basic 747 AFCS Configuration least value voter. The mechanical voter linkage is balanced against the feel unit; failure of one channel is force-summed by the linkage to provide a least value movement of the control surfaces. A failure of any component is balanced out by the mechanical voter thereby preventing unwanted control surface movement. During single channel or dual channel A/P operation, the pilot can override any unwanted commands without disengaging the A/P system(s) by moving his control wheel/column with sufficient pressure to cam-out the A/P module(s). Pressure transmitted through the control cables and feel unit causes the spring-loaded detents to unlock the mechanical linkage of the A/P module for as long as the pressure is held above the detent range. Releasing control wheel/column pressure allows the linkage to be locked by the spring-loaded detent and operation returns to normal. This same cam-out action is what allows the two A/P modules to operate together and operate as a least value voter during dual channel operation.

The relationship between the Autopilot system and the primary or manual control system (ATA 27) is illustrated by the lateral and elevator control system block diagrams in figures 3-2 and 3-3 respectively.

The major electronic elements comprising the autopilot/flight director system for the 747 aircraft are the following:

AP/FD mode select panel (1)
Flight controller (1)
Flight mode annunciators (2)
Pitch computers (3)
Roll computers (3)
Monitor and logic unit (1)
Autopilot accessory boxes (2)
Normal accelerometers (2)

Each autopilot/flight director channel is integrated into the airplane navigation systems (ATA 34) to provide the required variety of autopilot functional capabilities. These systems, though not a dedicated part of the AP/FD system, provide navigational information required for aircraft path command computation. The following sensor systems interface with the autopilot/flight director systems:

Central Air Data Computer System (CADC)
Magnetic Heading Reference System (MHRS)
VOR/ILS Navigation System (NAV)
Low Range Radio Altimeter (LRRA)
Inertial Navigation System (INS)

There are two each of these sensor systems in the basic 747 aircraft.

ORIGINAL PAGE IS OF POOR QUALITY

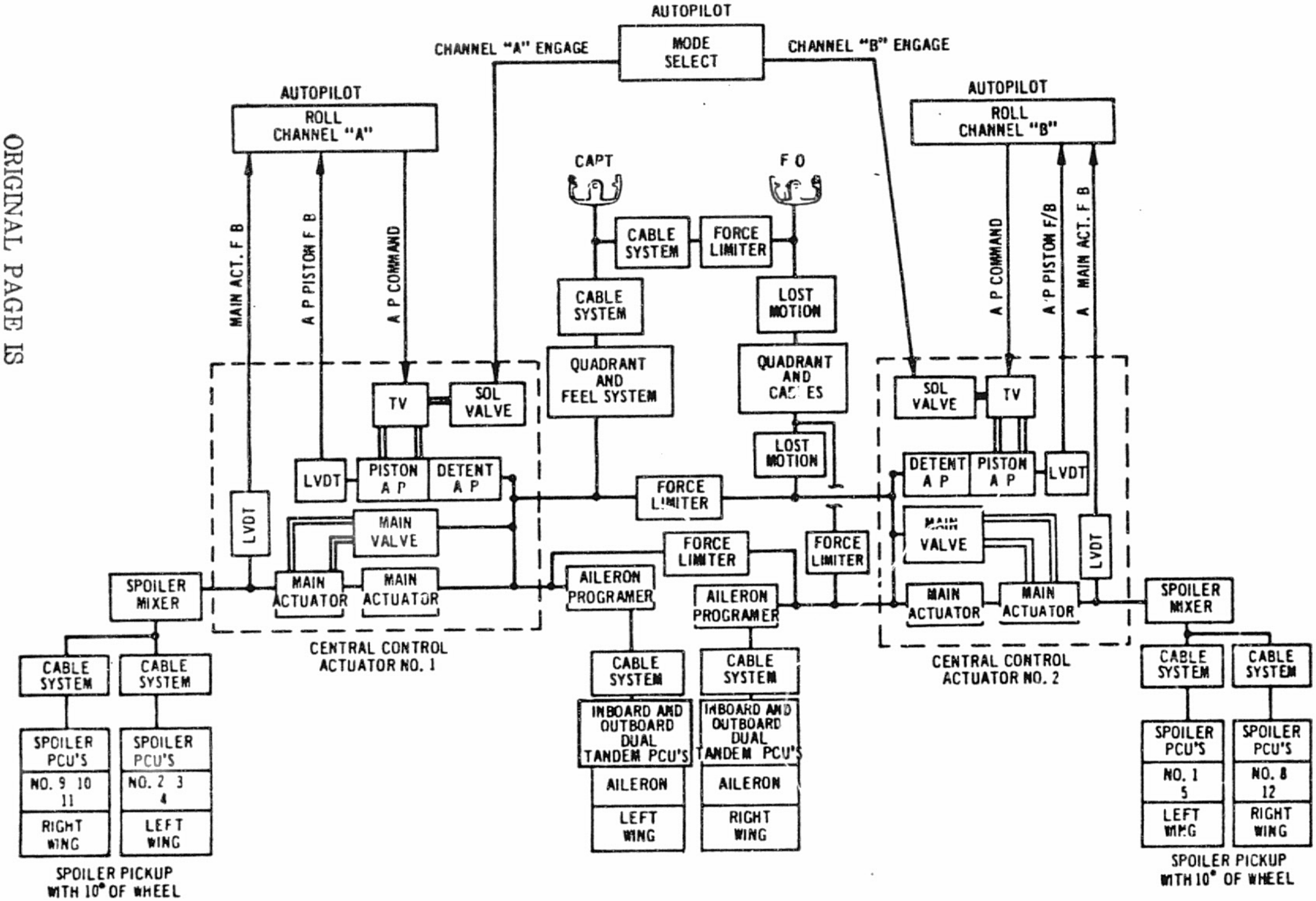


Figure 3-2.—Lateral Control System Block Diagram

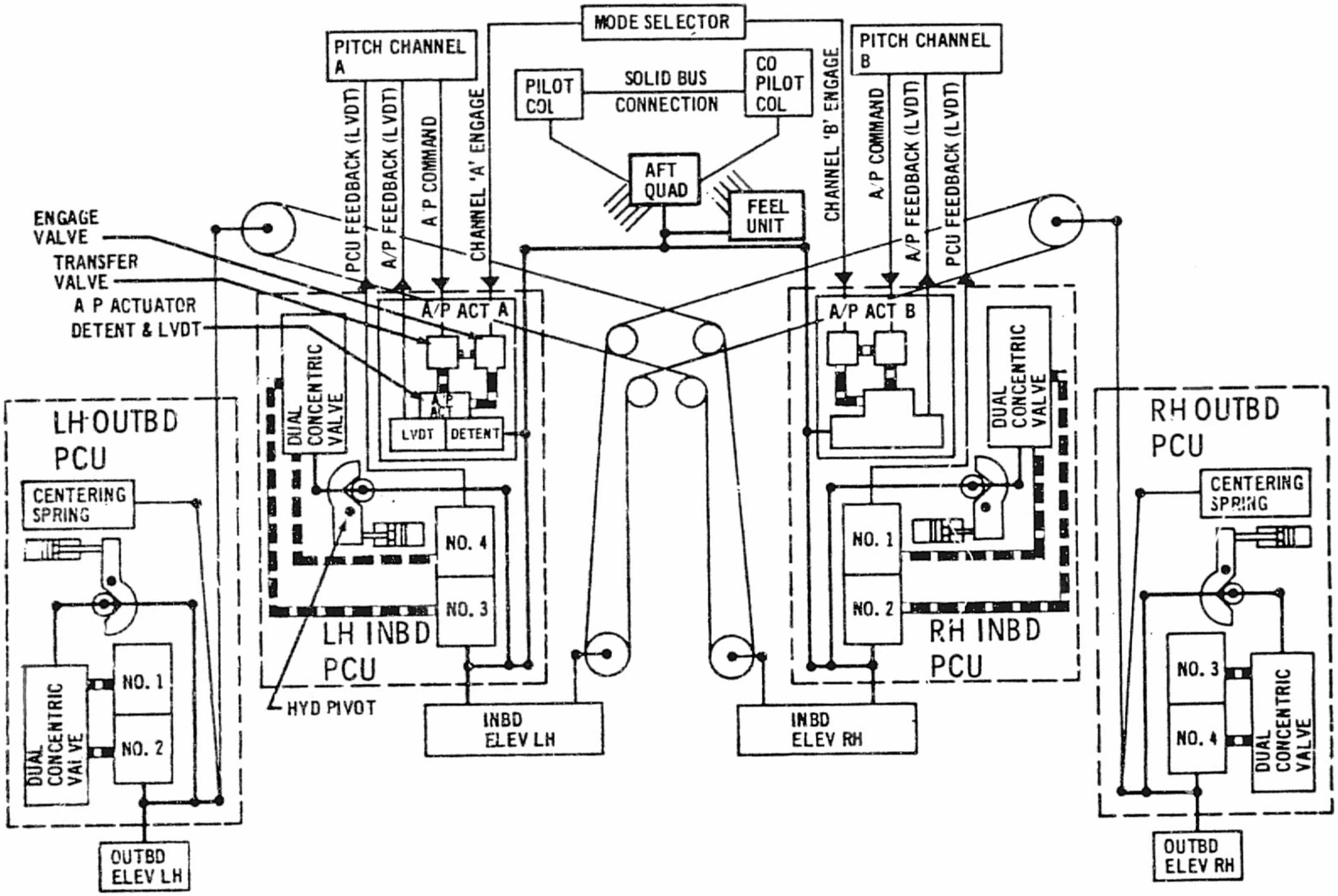


Figure 3-3.—Elevator Control System Block Diagram

The autopilot/flight director block diagram, shown in figure 3-4, illustrates the interference between the various dedicated and shared elements of the 747 system. It should be noted here that, as was shown in figure 3-1, for the dualized sensor systems the number one or "A" channel sensor interfaces with both the "A" and "C" channel AP/FD computer while the number two or "B" channel provides data only to the B channel AP/FD computer.

Control and Display

For the following discussion refer to figures 3-5 and 3-6 for control and display component layout and location.

Mode Select Panel–The AP/FD mode select panel (MSP) is centered on the lightshield section above the instrument panels and contains all switches required for autopilot and flight director mode selection, flight director operation and autopilot engagement. The MSP contains two solenoid held-three position A, P engage switches, two flight director switches, one auto throttle switch with speed control and indicator, two course select controls with indicators, a three-position solenoid held course select switch, a rotary five-position mode select switch, a solenoid held back beam switch, an altitude select control with indicator, a three-position solenoid held altitude switch, and a three-position solenoid held TURB/speed switch. Associated green indicator lights illuminate when the auto throttle switch is on, back beam is on, or the altitude switch is positioned to ALT SEL or ALT HOLD.

Flight Controller–The flight controller is installed on the aft electronic section of the control stand. A turn knob and two pitch wheels on the controller provide attitude commands proportional to their position during manual control of the engaged A/P channel. The controller is normally used when one A/P channel is engaged in MAN.

Flight Mode Annunciator Panel–One AP/FD flight mode annunciator panel is installed on the captain's and one on the first officer's instrument panel. Each panel is compsed of two sections; one section provides F/D flight mode annunciation, the other A/P warning and flight mode annunciation. An auto throttle warning light is on the left side of the annunciator panel. The flight director annunciators on the left side are: ALT SEL, NAV, G/S, FLARE and GO-AROUND. The autopilot annunciators on the right side area: ALT SEL, NAV, G/S, and FLARE. One A/P warning light is on the right. One AUTO THROT warning light is on the left.

Pitch Channel Description and Operation

The autopilot/flight director (AP/FD) pitch channel essentially comprises an electronic computer and a hydraulically operated control unit to automatically control the airplane in the pitch axis during autopilot operation. During flight director operation, the pitch channel visually relates to the pilot through instrumentation readout, the proper method to manually control the airplane in the pitch axis.

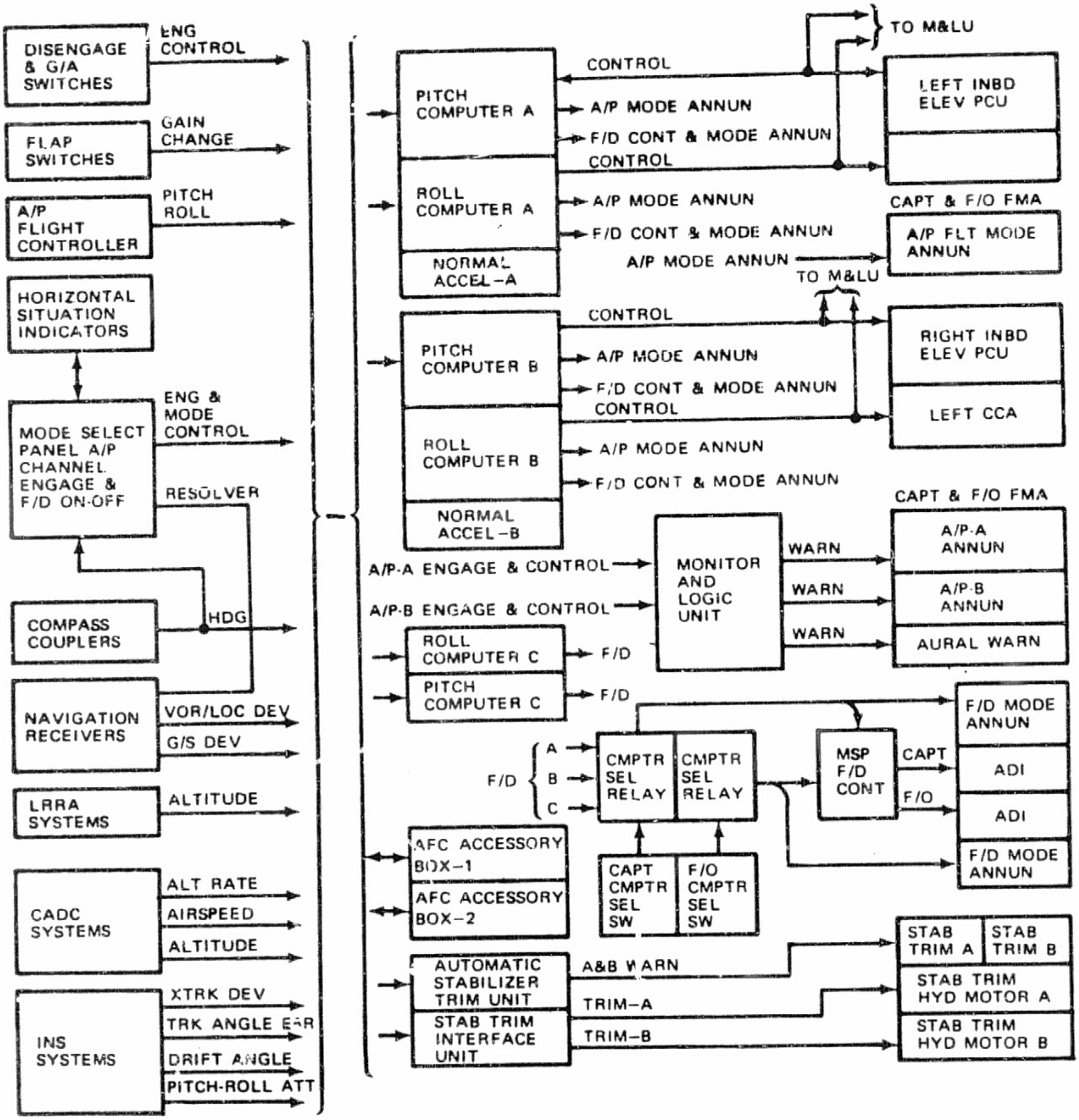
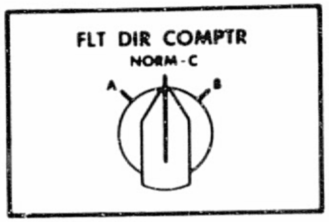
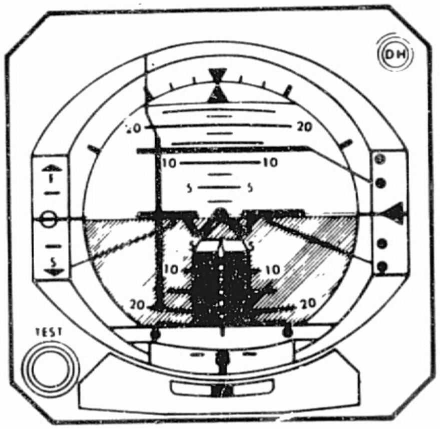


Figure 3-4.—AP/FD Component Interface Block Diagram

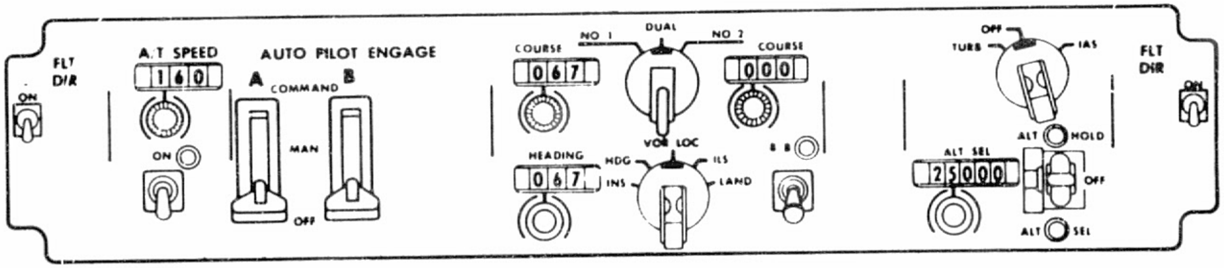
ORIGINAL PAGE IS
OF POOR QUALITY



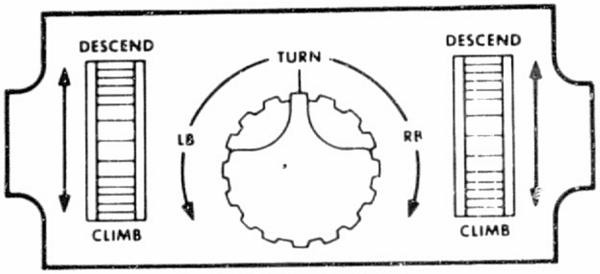
TYPICAL COMPUTER SELECT SWITCH



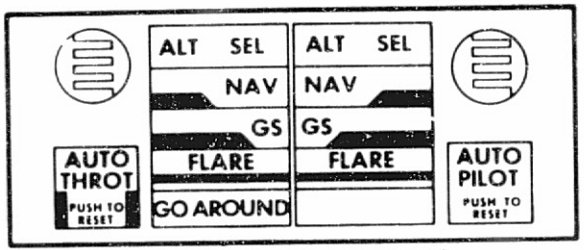
TYPICAL ADI



MODE SELECT PANEL



FLIGHT CONTROLLER



FLIGHT MODE ANNUNCIATOR

Figure 3-5.—AP/FD System Control and Display Components

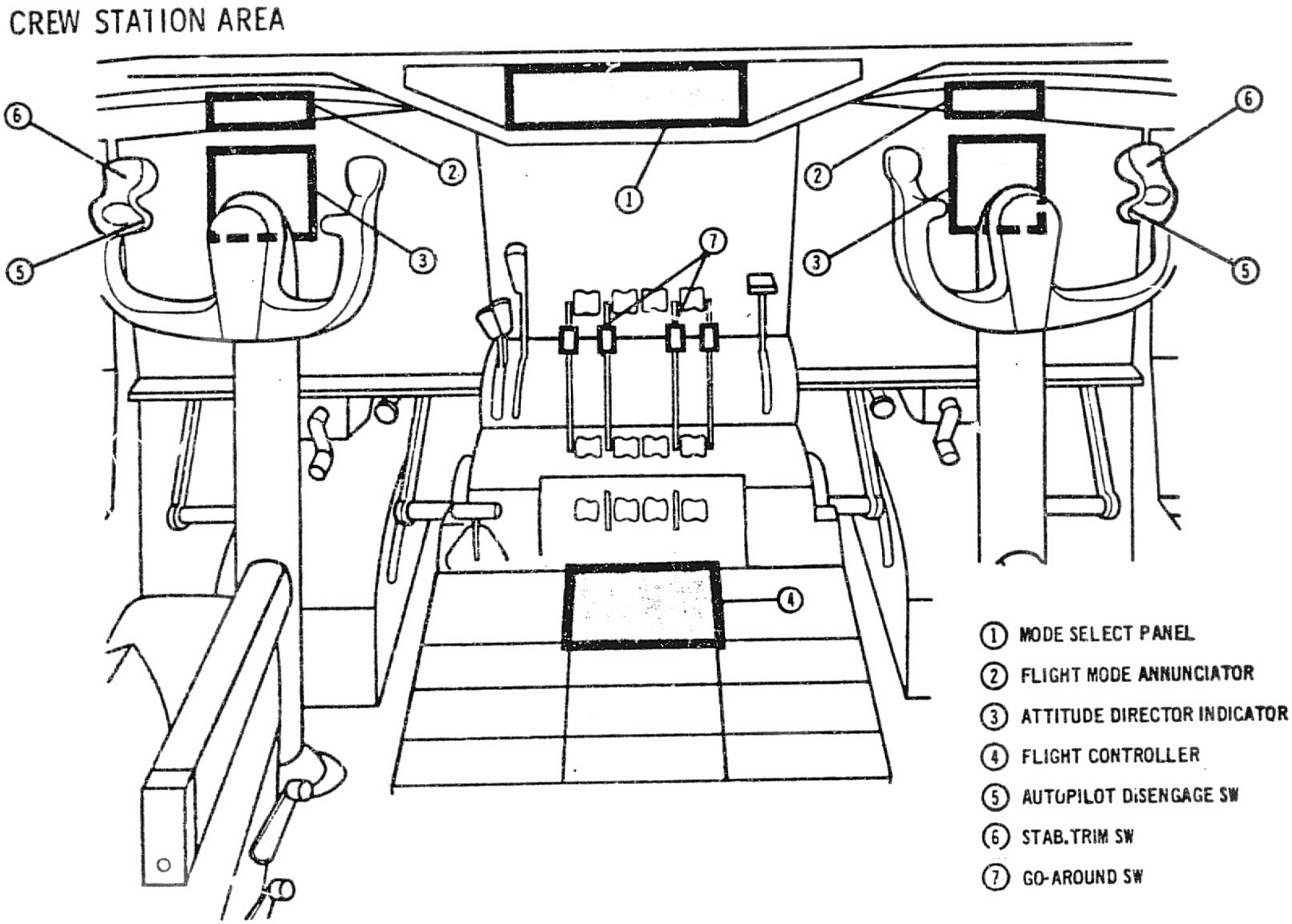


Figure 3-6.—AP/FD Control and Display Equipment Layout

The pitch channel comprises the AP/FD pitch computer, two linear variable differential transformer (LVDT), an autopilot transfer valve, autopilot engage solenoid valve, time delay bypass valve, two flight director go-around mode switches and two flap actuated switches. The three AP/FD pitch computers are identical. Computers A and B are connected to autopilot/flight director channels A and B, while computer C is used for flight director operation only.

The pitch control channel receives input data from the following sources:

Central air data computer (CADC)
Low range radio altimeter
VOR/ILS receiver
Normal accelerometer
Inertial navigation unit (Pan Am only)
Pitch attitude gyro
Pitch rate gyro
Flight controller (pitch command wheels)

The pitch channel computes the input data to a composite command that is used to actuate the following indicators and controls:

Attitude director indicator (ADI)
Flight mode annunciator lights
Autopilot warning lights
Elevator control surfaces

As the PCU positions the elevator control surfaces in response to the composite command signal, the autopilot and elevator LVDT positions are electrically compared at a summing point. Any difference between their positions greater than the design tolerance is fed back through the pitch computer to equalize both LVDT outputs (during dual channel LAND mode). The autopilot LVDT signal is also fed back to null out the command signal.

The pitch computer is designed using solid-state devices and integrated circuits. The computer contains a pitch rate gyro and eight subassembly plug-in component cards. The plug-in cards are: power supply card, pitch logic card, vertical path conditioner card, flare card, gain calibrator card, gain control and sensor card, pitch servocontrol card, and flight director card. The signal flow section of the pitch computer is of the analog design which computes a command from three basic airplane derivatives: displacement, rate, and acceleration. The command signal computation relies on the use of high-gain operational amplifiers, summing amplifiers and integrators. The various input sensing signals are amplified, summed and integrated where necessary (with respect to time) to provide the composite command signal to the PCU and ADI inputs. Pitch synchronization modulation, demodulation, and loop feedback also assist the command signal in accurately controlling the aircraft.

ORIGINAL PAGE IS
OF POOR QUALITY

The pitch computer contains common circuits for autopilot and flight director operation up to a separation point at which the command signal is applied to the PCU for autopilot operation and to the ADI for flight director operation. Pitch interlocks are solid-state digital circuits provided for all operating modes.

Roll Channel – Description and Operation

The roll A/P and F/D automatically controls the airplane in the roll axis during A/P operation. During F/D operation, the Roll Computer provides a display CMD to aid the pilot in manually controlling the airplane in the roll axis.

The roll channel receives input data from the following sources:

True airspeed from the central air data computer
Altitude data and logic from the low range radio altimeter
Deviation signals from the VOR/ILS receiver
Roll attitude gyro signals from the inertial navigation system
Roll rate from the roll rate gyro (in Roll Computer)
Manual roll commands from the flight controller turn knob
Track and drift data from the inertial navigation system
Magnetic heading from the magnetic heading reference system
Course and heading select synchro inputs from the mode select panel

The Roll Computer supplies a command to the central control actuator (CCA) package. As the CCA positions the aileron and spoiler control surfaces in response to the composite command signal, the A/P and aileron LVDT positions are electrically compared by the Roll Computer (during dual channel LAND mode) and any differences between their positions greater than a predetermined tolerance is fed back through the Roll Computer to equalize both LVDT outputs. The A/P LVDT output is also fed back to null out the CMD signal. The F/D commands are displayed on the ADI. Flight mode annunciator lights and warning lights display the roll channel status.

The operating modes for both the A/P and F/D as controlled by the Roll Computer are the following: INS, heading hold with turn control (MAN) and heading select (CMD), VOR/LOC, ILS, and LAND. Additional modes for F/D commands are go-around and back-beam control.

The Roll Computer contains computing and logic circuitry that translates information received from the airplane sensors into commands that control the autopilot (A/P) aileron hydraulic package and the flight director (F/D) attitude director indicator (ADI). The Roll Computer contains common circuits for A/P and F/D computations up to a separation point at which the command (CMD) signal is applied to a F/D CMD section and an A/P CMD section for further processing.

The signal computation portion of the Roll Computer is of analog design and functions to compute a CMD signal from three basic airplane derivatives, displacement, rate, and acceleration. The command signal relies on the use of high-gain operation amplifier, summing amplifiers, and integrators. The various input sensing signals are amplified, summed, and integrated to provide the composite command signal to the A/P and F/D sections.

Monitor and Logic Unit

The monitor and logic unit controls operation of the warning lights and autopilot engages switches. As a result, it is involved in both engage requirements and in the disengage/warning circuits.

The unit contains logic circuits for single and dual-channel status monitoring and provides signals to actuate the autopilot warning lights and wailer (Aural Warning Device).

Autopilot Accessory Boxes

Two autopilot accessory boxes provide the necessary switching and signal conditioning required for autopilot operation. Accessory box no. 1 provides the following functions:

- Yaw damper–autopilot gain change interlock
- Compass coupler synchro excitation switching
- Standby power interlock–autopilot disconnect
- Dimming control and dimming override of flight mode annunciator lights
- Resistive loads for pitch and roll attitude gyro, elevator LVDT no. 1 and go-around switches
- Back beam–ADI localizer needle bias interlock

Accessory box no. 2 provides the following functions:

- Dimming control for autopilot and auto throttle disengage warning lights
- Disengage and flasher control for auto throttle warning lights
- Instrument transfer interlock return A/P switch to MAN
- Nav test inhibit when A/P radio mode selected
- Low range radio altimeter (LRRA) test inhibit when glide slope captured
- Flare arm and flare initiate control for auto throttle system
- Glide slope and localizer arm control for central instrument warning system (CIWS) computer
- CIWS inhibit by LRRA 50-foot trip
- VOR/LOC antenna transfer after localizer capture
- Resistive loads for nav receiver accelerometers, roll and pitch attitude gyros and, elevator LVDT no. 2.

3.2 AUTOMATIC STABILIZER TRIM SYSTEM

The automatic stabilizer trim system positions the horizontal stabilizer to relieve elevator loads. The system is a dual channel (A and B) computer system providing stabilizer trim whenever the autopilot is engaged.

One automatic stabilizer trim unit (ASTU) and one stab trim interface unit contain circuits to both trim channels A and B.

The automatic stabilizer trim system receives input data from feel pressure transducers (LVDT's Feel Computer) and elevator position LVDT's. The ASTU provides a discrete command signal to actuate the horizontal stabilizer. Stabilizer limit switches and elevator-operated switches prevent the stabilizer from trimming if the stabilizer trim-up or trim-down limit is reached or if the control column (elevator) is moved in opposition to stabilizer trimming action.

Each channel of the ASTU provides trim arm and trim control functions in addition to fault detection and warning control. During single channel autopilot operation, the trim channel associated with the engaged AP/FD channel provides stabilizer trimming. During dual-channel autopilot operation (LAND mode), the channel engaged first provides stabilizer trimming and the remaining channel is placed in standby; if the active trim channel detects a failure the standby channel is automatically transferred into the system.

The stabilizer trim interface unit contains interlock relays for controlling manual trim automatic trim channel transfer and interlocking functions.

3.3 YAW DAMPER SYSTEM

Two identical yaw damper systems control the upper and lower rudders. Each system monitors airplane yaw rate and positions the rudder to compensate for periodic yaw oscillations (dutch roll). Correction signals are applied to the rudder packages during manual and autopilot controlled flight to displace the upper and lower rudders sufficiently to damp out any yaw oscillations of the airplane. Rudder displacement is limited to 3.6 degrees. The yaw damper system also provides a turn coordination feature which improves airplane response during turn maneuvers when the flaps are down at least 1°. System gains are also changed as a function of flap position. When the flaps are down, the roll attitude signal from the INS is introduced to provide rudder displacement proportional to roll rate. The roll attitude signal is not used when the flaps are up. The yaw damper system is normally engaged for all flight modes and operates full time.

Each system includes one engage switch and a test switch (on yaw damper control panel), a yaw damper computer, and a rudder power control unit.

Control and test of each yaw damper system is accomplished from the flight compartment by means of two engage and two confidence test switches (one for each channel) located on the yaw damper control panel as illustrated in figure 3-7. The captain's and first officer's rate-of-turn indicators use signals provided by a rate gyro in the yaw damper computer.

3.4 AUTO THROTTLE SYSTEM

The auto throttle system automatically moves all four thrust levers, in response to preselected airspeed commands, thereby causing the airplane to acquire and maintain the selected airspeed. The system is normally used during approach maneuvering and the landing phases of flight. If two autopilot channels are engaged, the auto throttle automatically retards the thrust levers as the airplane descends through the final 30 feet of the flare maneuver. The pilot can manually override auto throttle thrust lever positioning. Clutches between the thrust levers and auto throttle drive mechanism drive the thrust levers when pressure is applied from the drive mechanism. The clutches slip when a small amount of pressure is applied directly to the thrust lever handles.

The auto throttle system is engaged with a switch on the autopilot/flight director (AP/FD) mode select panel. (See figure 3-8, sheets 1 and 2.) Reference airspeeds are selected with a rotary control on the AP/FD mode select panel. A digital readout ranging from 101 to 259 knots is presented in a window above the control and by a servo-driven bug (pointer) in the airspeed indicators (ASI). Stops on the control are at 101 knots and at approximately 395 knots as indicated by the servo-driven bug on the ASI's. Small overspeed and underspeed indications are provided by a fast-slow pointer on the captain's and first officer's attitude director indicators (ADKI's). Pitch attitude signals used by the auto throttle computer are obtained from inertial navigation system no. 2. Flare logic is obtained from the AP/FD systems. Altitude data is obtained from low range radio altimeter no. 2. Limit switches installed on a microswitch assembly on the forward end of the control stand monitor thrust lever position and automatically stop auto throttle operation. The primary elements of the auto throttle system are one auto throttle computer and an auto throttle servo. The computer contains nine modules: a calibrator module, computation module, command module, self-test module, switching module, servo module, auxiliary module, power supply and accelerometer module. Solid-state analog computational and logic circuits are used throughout for signal processing.

The auto throttle system components are: one auto throttle computer in the main electronic equipment rack E1, an auto throttle, on-off switch, airspeed select control and digital indicator on the AP-FD mode select panel on the P10 panel; an auto throttle warning light on the captain's and first officer's flight mode annunciators, eight limit switches in the microswitch assembly on the forward end of the control stand, four disconnect switches (one on each thrust lever), one servomotor-generator, thrust lever drive mechanism and clutch pack assembly in the control stand, circuits in AFC accessory box-2 and one relay in instrument switching accessory box P73 in the main electronic equipment center, an airspeed bug and servo-driven synchrotel in the captain's airspeed indicator, an airspeed bug on the first officer's airspeed indicator, and fast-slow indicators in the captain's and first officer's ADI's.

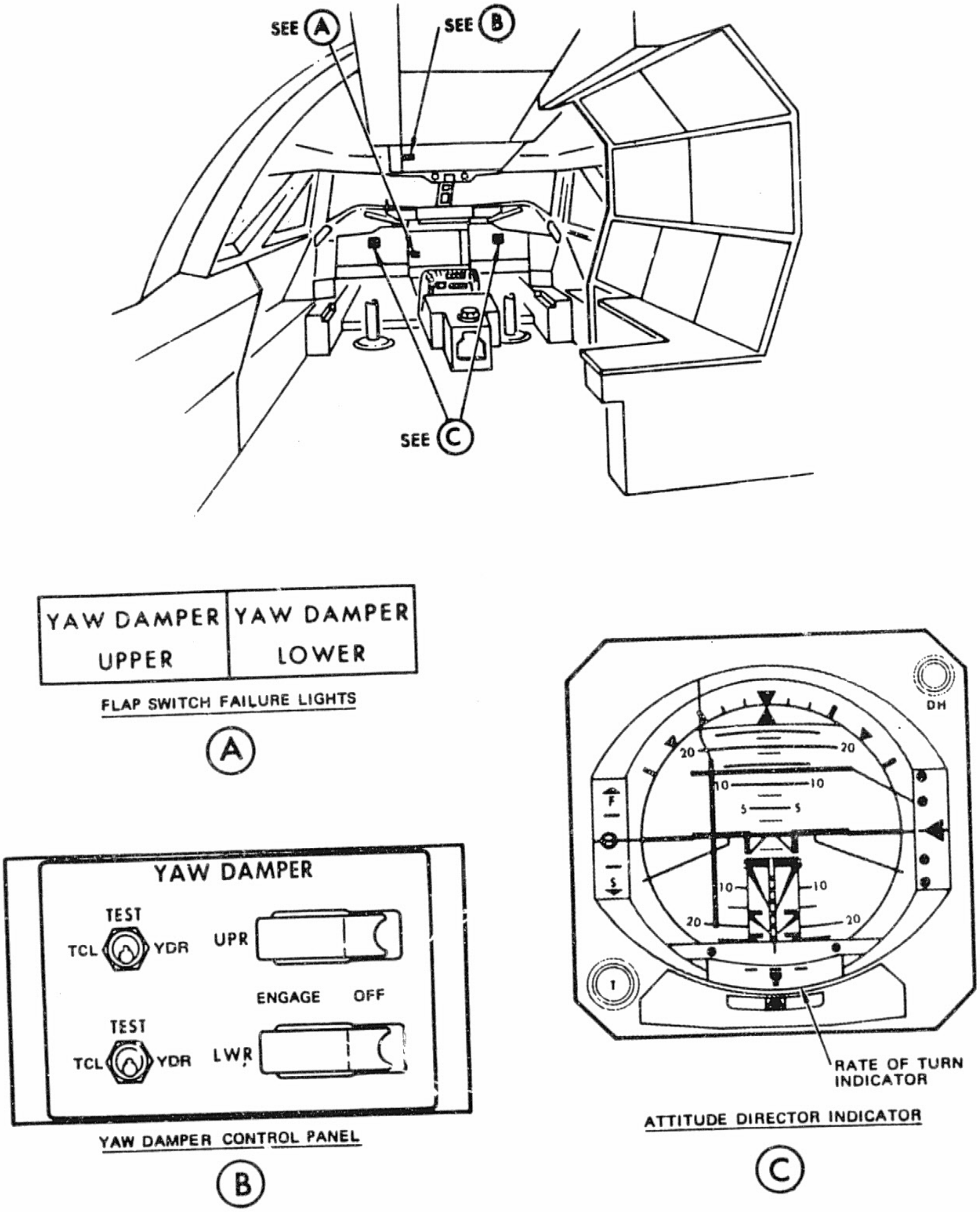


Figure 3-7.—Yaw Damper System Component Location

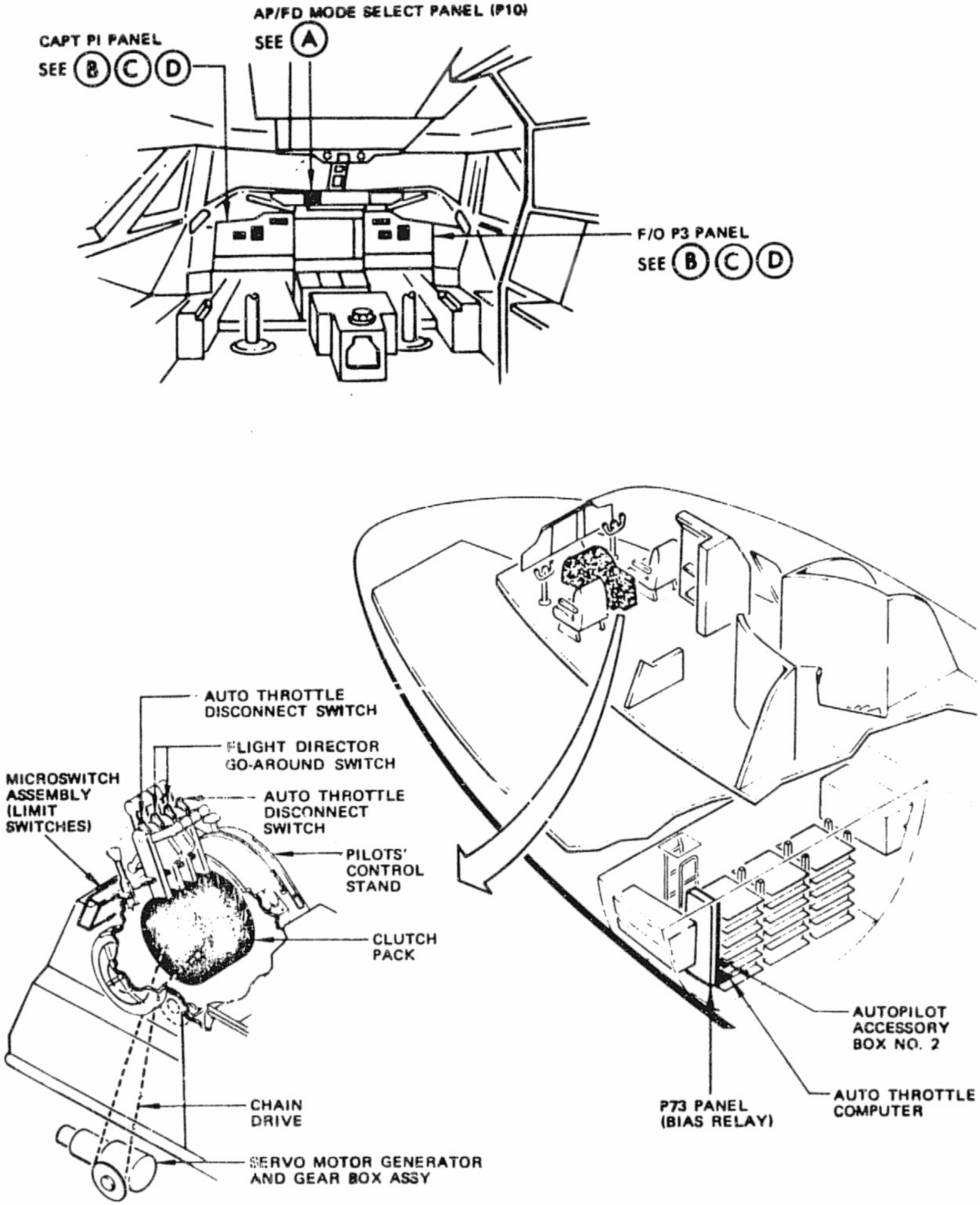
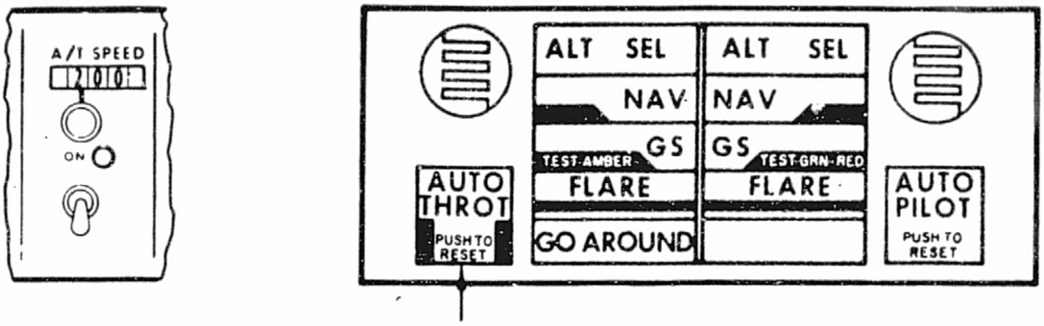


Figure 3-8.—Auto Throttle System Component Location

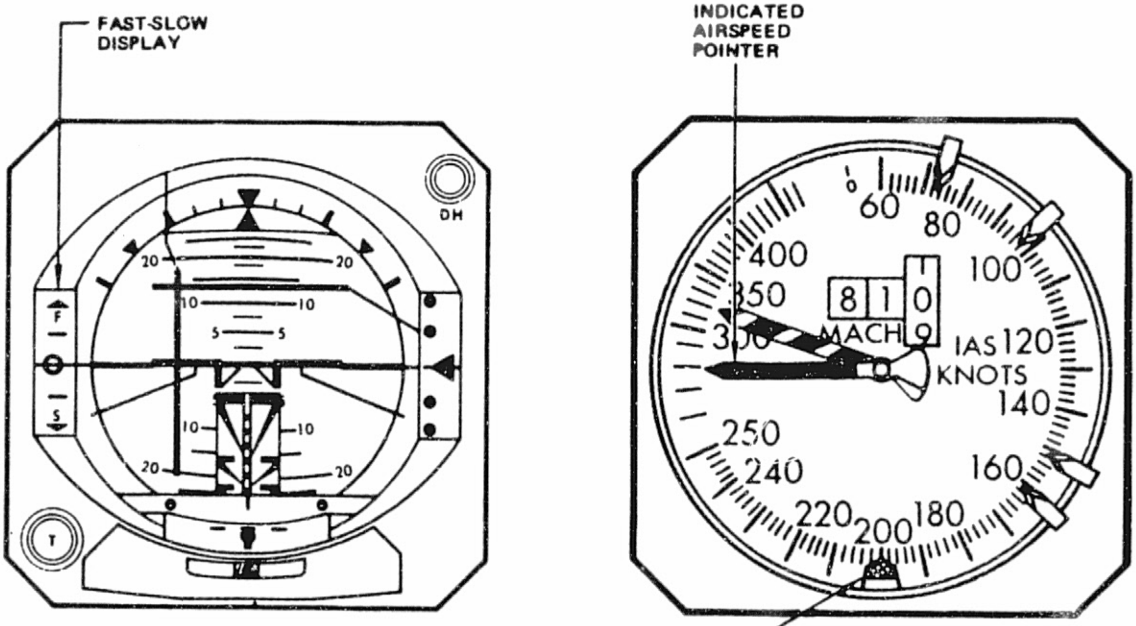


AUTO THROTTLE ENGAGE AND AIRSPEED SELECT CONTROL

Ⓐ

FLIGHT MODE ANNUNCIATOR

Ⓑ



ATTITUDE DIRECTOR INDICATOR

Ⓒ

AIRSPEED INDICATOR

Ⓓ

Figure 3-8.—(Concluded)

3.5 CATEGORY II SYSTEM DESCRIPTION

Authority for full Category II operations down to 1200-ft runway visual range (RVR) and a decision height (DH) of 100 ft for the 747 airplane is contingent upon the dual channel automatic land mode being fully operative. Failure of any element, real or nuisance (transient), which results in a loss of full dual channel operational capability necessarily results in the affected aircraft being restricted from operating into such low visibility weather condition. For the sake of completeness, it should be noted here that there is a restricted Category II operational classification which permits operations down to 1600 ft RVR and DH of 150 ft with one autopilot channel inoperative provided the "C" channel flight director is operative in the ILS mode.

To satisfy the full Category II criteria defined above requires that the following avionic equipment be installed and operational:

Pitch Computer (A&B channel)
Roll Computer (A&B channel)
Monitor and Logic Unit
Mode Select Panel
Autopilot Accessory Boxes #1 and #2
Automatic Stabilizer Trim Unit
Stabilizer Trim Interface Unit
Normal Accelerometers #1 and #2
VOR/ILS Receivers #1 and #2 (Localizer and Glideslope beam error)
Radio Altimeter #1 and #2
Central Air Data Computers #1 and #2 (Altitude rate)
INS's #1 and #2 (roll and pitch attitude)

This configuration is illustrated by the Category II system interface block diagram on figure 3-9. For the sake of clarity, the interface between the AFCS accessory boxes and the various sensor and computer elements has been deleted from this figure. Yaw damper and auto throttle systems are not required for Category II operations.

Other avionic equipment required for Category II operations though not associated with the flight control system include: Marker Beacon Receiver, Instrument Comparator and Warning System, ADI (radio altitude display, and windshield wipers and rain repellent).

Even in the dual LAND mode of operation the AFCS is a "brickwall" system employing a single mechanical voter at the servo actuator. Because of the "brickwall" nature failure of any single element causes the system to fail passively in a safe manner. Such failure conditions are detected either by in-line monitoring within the individual channels or by "cam-out" of the dual actuator mechanism.

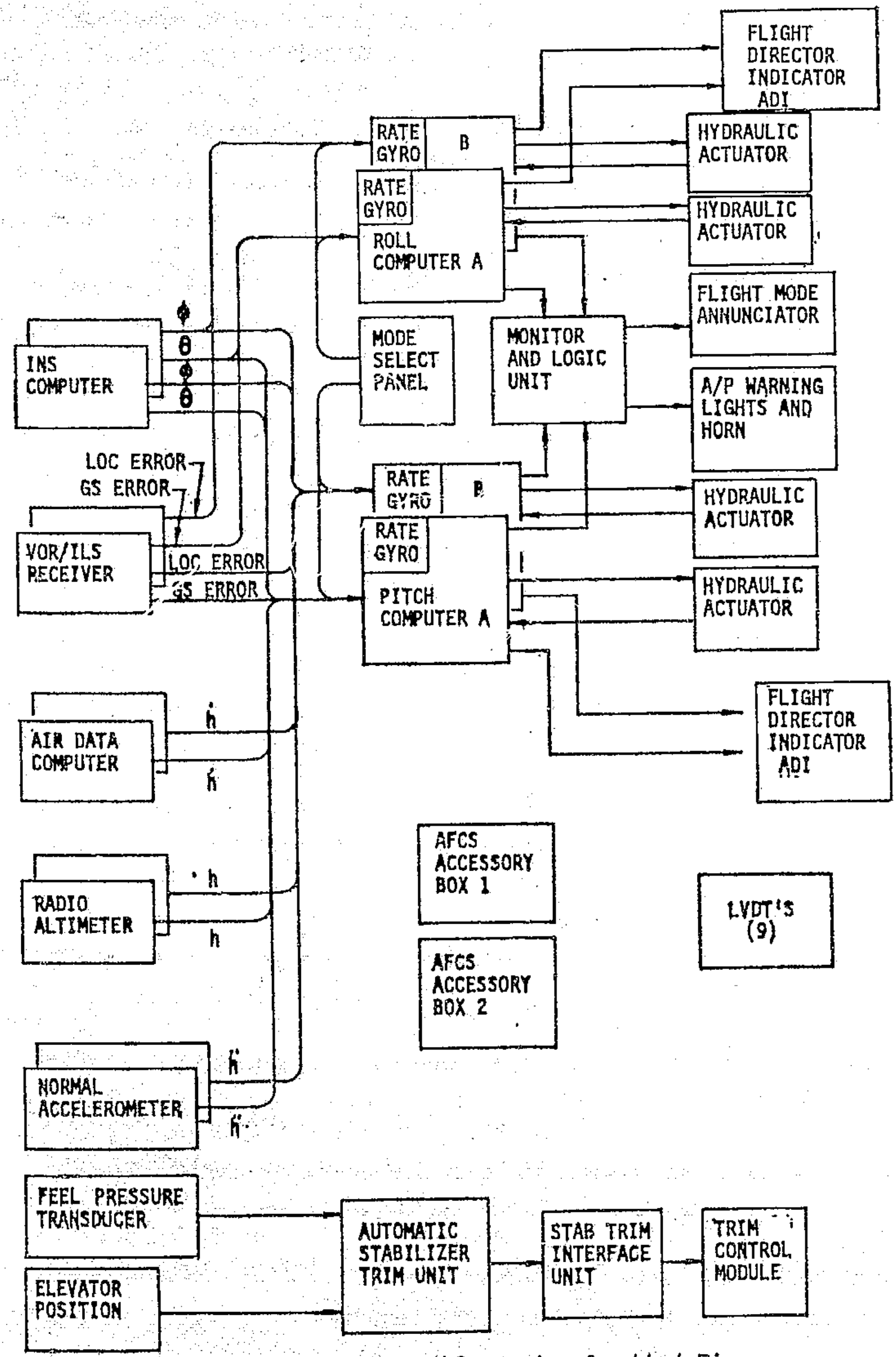


Figure 3-9.—747 Category II System Interface block Diagram

4.0 OPERATING ENVIRONMENT

4.1 UNITED OPERATING ENVIRONMENT

The UA Maintenance program as it relates to the components in this study is basically one of condition monitoring rather than time replacement. UA has developed the LIBRA (Logical Information Based on Reliability Analysis) system for monitoring which depends on a first stage of performance measure through unscheduled removal rates and effect on flight by schedule interruptions. If a trend of that data indicates a need for further amplification of data it is possible to add confirmed failures, failure modes, line reported deficiencies and their corrections and pilot reports either by fleet, by airplane tail number or component serial number. UA does not preestablish alert levels in their data systems but base their action on logic using as much data as is feasible to determine the cause when a trend indicates such a study is desirable.

The MEL (Minimum Equipment List for Flight Release) is a list approved by the FAA which permits revenue flight w[illegible] items inoperative when remaining operative equipment provides for continued sa[illegible]n. In some instances the flight may be restricted as a result of such inoperative items.

FAA Regulatory implementation as related to these components is established by the FAA's acceptance of the UA monitoring system and they are only involved when UA proposes a change to the system at which time UA uses whatever data is required to establish that change. Such a change could involve parts modifications or revisions to maintenance procedures.

The FAA also makes periodic audit of all airlines maintenance programs by means of a team of FAA specialists who study the airlines data and facilities to check the validity and effectiveness of the airline's procedures and compliance with the approved maintenance program. The UA 747 schedule operation and related maintenance facilities involve twelve stations, all located in cities within the United States. Four stations with 67% of the revenue flights are related as "prime" where manpower and facilities permit all discrepancies to be fixed, four stations with 6% of flights are rated as "support" where items required for dispatch are fixed but which are equipped to do a bare minimum of work, two stations with 25% of flights are rated as "service" where items required for dispatch are fixed but are equipped to do other specialized work as instructed by the operations center, two stations have no maintenance capability and are serviced as required by nearby stations with adequate facilities.

San Francisco is the main base for UA 747's and all overhaul work is accomplished there. San Francisco as an operating station is handled as a separate organizational entity and is classed as one of the prime stations.

4.2 PAN AMERICAN OPERATING ENVIRONMENT

The PA maintenance program as it relates to the components in this study, is also one of condition monitoring rather than time replacement. PA monitors their fleet on a monthly and year-to-date review of schedule interruptions by system, with prescribed tolerance levels to provide an alert warning. An alert obligates PA to make a further study of removal rates, shop findings or line discrepancies either by total fleet, individual airplane or individual serial number component to establish the need and nature of corrective action to be initiated.

The FAA regulatory implementation is by means of the maintenance program. They receive the monthly reports with the alerts flagged and any further studies or corrective actions are included to show resolution of those and earlier alerts.

The FAA audit team visits PA the same as UA.

The PA 747 schedule operation and related maintenance facilities involved with this study include some 42 stations. 50% of all flights are out of U.S. stations, 29% out of European stations, 14% out of stations in the Orient, 4% out of Pacific stations and 3% out of Central and South American stations. (Fig. 4-1)

Two base stations with facilities to correct all discrepancies have about 21% of all flights. Six additional stations with avionics specialists and spares have 43% of flights. Five additional stations have limited spares capabilities in these components and have 11% of the flights. In summary thirteen stations with 75% of the scheduled flights have some level of capability to correct problems in this system. Other stations may be required to make corrections as directed by PA's Technical Center by swapping parts from one plane to another depending on schedule overlap times or on the difference in the needs of flights to different destinations per the MEL. JFK (New York) is the Main Base for PA 747's and all overhaul work is accomplished there. As an operating station it is classed with SFO (San Francisco) as a Base station.

4.3 DIFFERENCES IN OPERATING ENVIRONMENT

Differences in maintenance practices between UA and PA are as follows: Both airlines maintain a close surveillance of each airplane on a 24-hour basis through a central technical control and by the use of technical specialists who monitor all problems that are encountered. The significant difference seems to be that PA due to their route network (figure 4-2) have developed a system of auditing the problem resolutions and issuing direct requests or orders to the stations as to progressive trouble snooting and corrective actions where as UA maintains more of the authority at each station, but provides their stations with a computer terminal through which they can review all related problems on any airplane for several earlier flights.

PA OPERATING AND MAINTENANCE CONTRACT STATION
* MAINTENANCE CONTRACT STATIONS ONLY
■ 747
■ ■ CARGO ONLY

42 stations marked with X used in study

ABIDJAN	ABJ		
ACCRA	ACC		
AMSTERDAM	AMS	■	X
ANCHORAGE	ANC		
ANKARA	ANK		
AUCKLAND	AKL	■	X
BAHRAIN	BAH	■	
BANGKOK	BKK	■	X
BELGRADE	BEG		
BERGEN	BGO		
BERLIN	BER		
BOGOTA *	BOG	■	
BOSTON	BOS	■	X
BRASILIA	BSB		
BRUSSELS	BRU	■	X
BUCHAREST #	BUH		
BUDAPEST	BUD		
BUENOS AIRES	BUE		
CARACAS	CCS	■	X
CHARLESTON	CHS		
CHICAGO	ORD	■ ■	X
COPENHAGEN	CPH	■	
COTONOU	COO		
DACCA *	DAC		
DAKAR	DKR		
DALLAS/FT. WORTH	DFW	■	X
DAMASCUS (S)	DAM		
DAR ES SALAAM	DAR		
DELHI	DEL	■	X
DETROIT	DTW	■ ■	X
DOULA	DLA		
ENTEBBE *	EBB		
FAIRBANKS	FAI	■	X
FRANKFURT #	FRA	■	X
GEORGETOWN	GEO		
GLASGOW	GLA	■ ■	X
GUAM	GUM	■	X
GUATEMALA	GUA	■	X
HAMBURG	HAM		
HONG KONG	HKG	■	X
HONOLULU	HNL	■	X
HOUSTON	HOU		
ISTANBUL #	IST	■	X
JOHANNESBURG	JNB		
KABUL *	KBL		
KARACHI	KHI	■	X
KINSHASA			
KUALA LUMPUR	KUL	■ ■	X
LAGOS	LOS		
LIBREVILLE	LBV		
LISBON	LIS		
LONDON	LON	■	X
LOS ANGELES	LAX	■	X
MADRID	MAD	■	
MANAGUA	MGA		
MANILA #	MNL	■	X
MARACAIBO	MAR		
MCGUIRE AFB	WRI		
MELBOURNE	MEL	■	X
MERIDA	MID		
MEXICO CITY	MEX		
MIAMI	MIA	■	X
MONTEVIDEO	MVD		
MOSCOW	MOW		
MUNICH	MUC	■	X
NAIROBI	NBO		
NANDI	NAN	■	X
NUREMBURG	NUE		
OKINAWA	OKA		
OSAKA	OSA	■	X
OSLO	OSL		
PAGO PAGO	PPG	■	X
PANAMA CITY	PTY	■	X
PHILADELPHIA	PHL		
PORT AU PRINCE	PAP		
PORTLAND	PDX	■	
PORT OF SPAIN	POS		
PRAGUE	PRG		
RIO DE JANEIRO	RIO	■	X
ROBERTS FIELD	ROB		
ROME	ROM	■	X
SAN JOSE	SJO	■	X
SAN JUAN	SJU		
SAN SALVADOR	SAL		
SANTO DOMINGO	SDO		
SAO PAULO	SAO	■	X
SEATTLE	SEA	■	X
SINGAPORE	SIN	■ ■	X
STOCKHOLM	STO		
STUTTGART	STR		
SYDNEY	SYD	■	X
TAIPEI	TPE	■	X
TAHITI	PPT	■	X
TAMPA	TPA		
TEHRAN #	THR	■	X
TOKYO	TYO	■	X
WARSAW	WAW		
WASHINGTON	WAS	■	X
YOKOTA	OKO		

JUNE 1977
B200

Figure 4-1.—Pan American Line Stations

ORIGINAL PAGE IS
OF POOR QUALITY

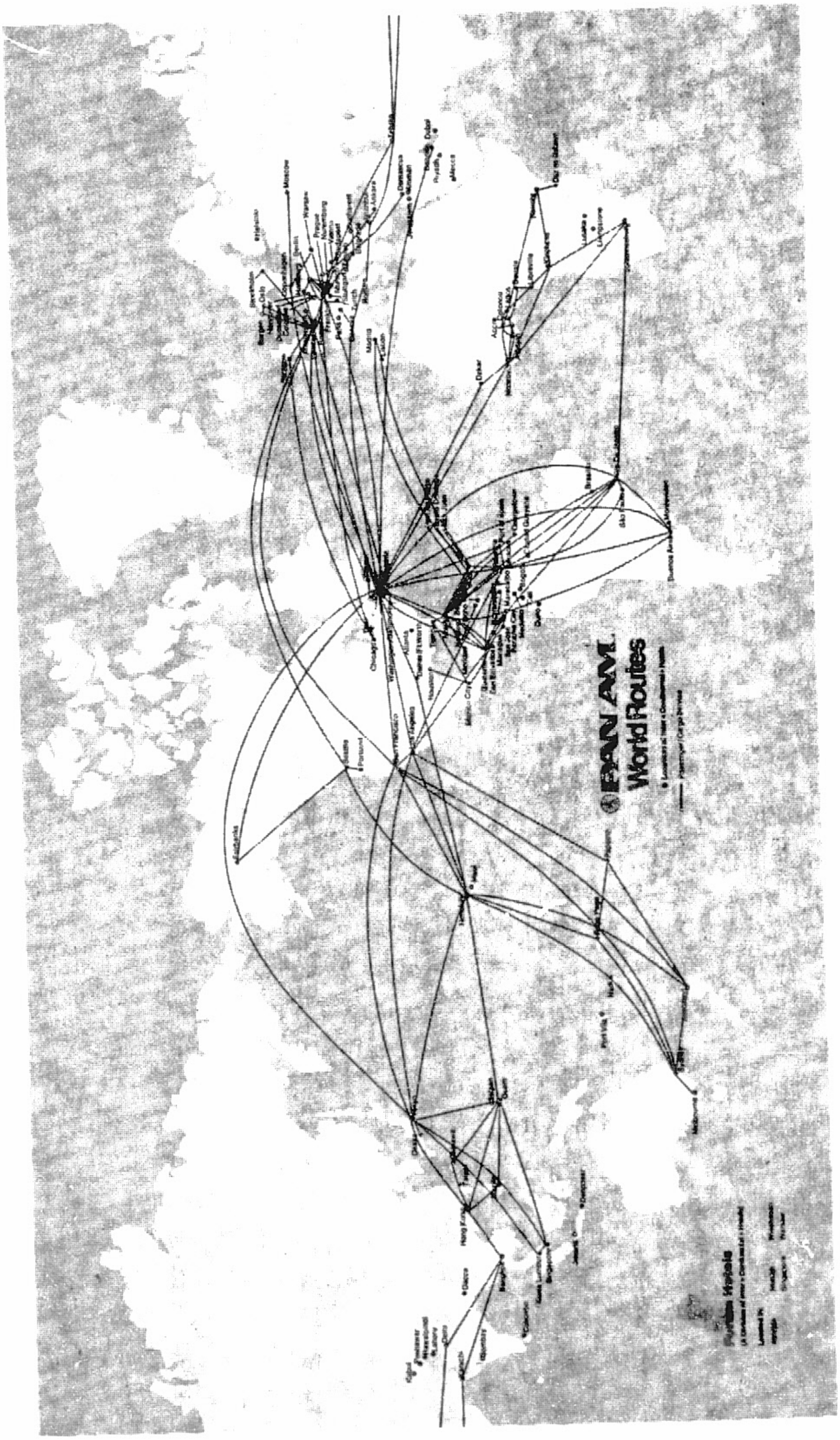


Figure 4-2.—Pan Am World Routes

Although PA uses an alert system to originate studies it is much more likely for the problem/component in this study to become apparent to the Technical Control Center when a problem is developing and they in turn will refer the problem to the engineer and/or quality controller involved for a coordinated study and resolution. For longer range review a computerized system of capturing log page information is used (figure 4-3). In addition PA uses a documented Malfunction Reporting System in their flight operations which provides a well defined statement of the problem for the mechanic after the flight crew has exhausted all possible inflight tests.

Because of the distance between PA maintenance base and its stations they have developed a probability analysis approach to station spares replenishment. The analysis is further refined by an engineering judgment overview that may alter the amount for some spares and/or at some stations. Only 68% of PA's flights are into stations with facilities for automatic landing which reduces their exposure to problems. There appears to be no major difference in the two airlines' maintenance philosophy and regulatory constraints as applied to the Automatic Flight Control system.

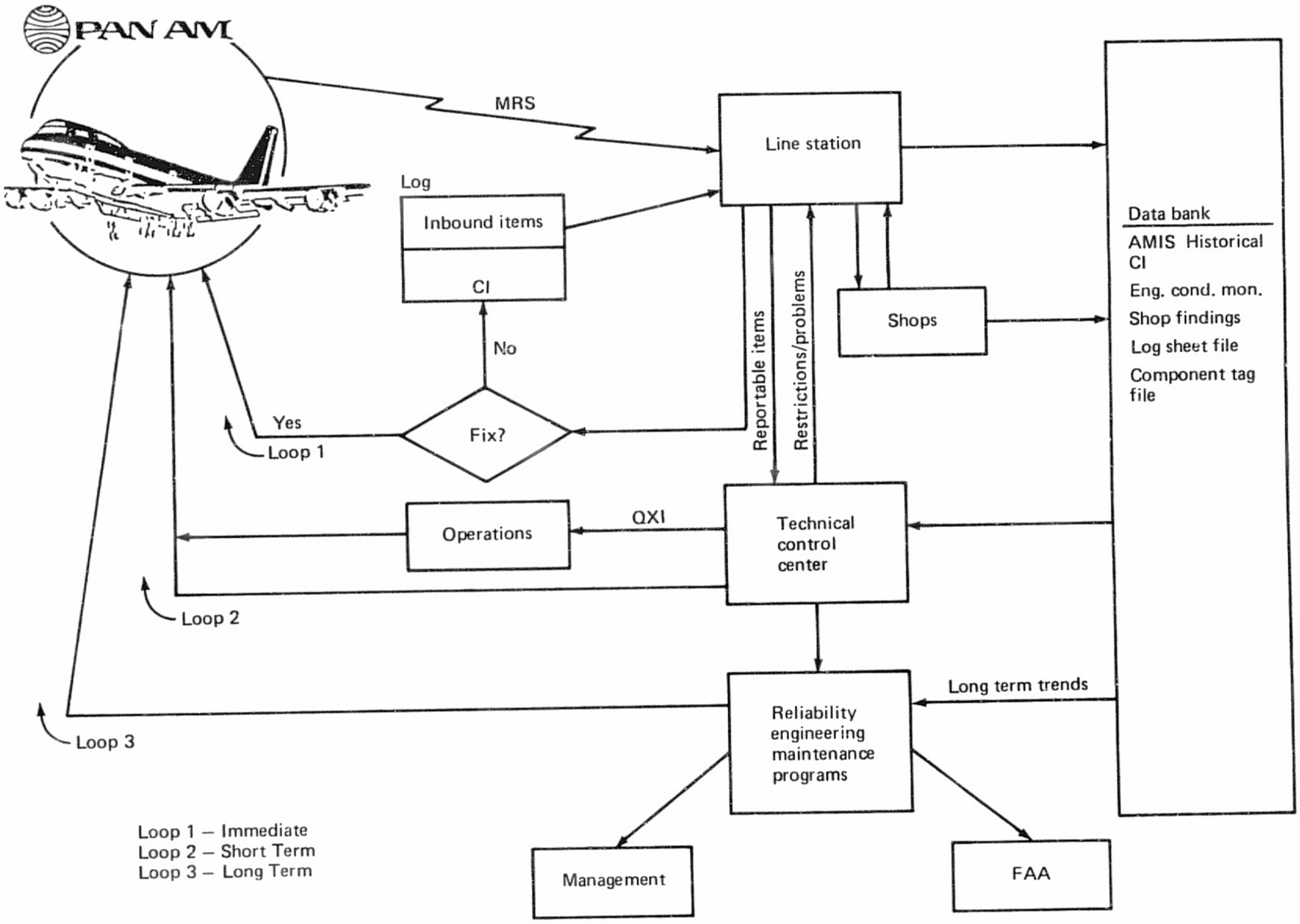


Figure 4-3.—A/C Problem Isolation and Correction

5.0 RELIABILITY ASSESSMENT

5.1 RELIABILITY ASSESSMENT – UNITED

The reliability of the 747 flight control system electronics can be evaluated from several viewpoints, e.g., failure rates of individual elements, system functional reliability, availability, etc. For the purposes of this study we have attempted to evaluate the system reliability from all aspects for which sufficient data was available from United Airlines operating and maintenance records. This includes an assessment of the individual failure rates of each of the elements associated with the electrical flight control system, an assessment of the failure characteristics of each element, an evaluation of the full category II system functional reliability as projected from the failure rates of the individual components, and an evaluation of the achieved availability of the full cateogry II configuration flight control system.

In the course of this study two parameters which are fundamental to the study of reliability were found to have different definitions depending on who is doing the evaluation. These two ambiguous areas are the definition of failure and the definition of time. To some investigators, an element is only considered to have failed for reliability purposes when that failure can be directly related to the flight log entry from which it was removed. If this relationship cannot be directly identified, i.e., the failure was found incidentally to the reason for removal, the failure is not counted for purposes of reliability determination. Furthermore, the parameter of time can be defined in two ways: equipment operating time and airplane flight time. These two time measurements are not the same, though they are proportional. Studies at United Airlines have shown that the ratio of operating to flight time is approximately 1.3 to 1.

In general for this study, any failure found by the maintenance shop was considered in deriving unit failure rates and failure rate characteristics. Where a distinction has been made between the two classifications of failures for purposes of clarification, the two are clearly designated as "verified" failures and "incidental" failures. Time values used in this study are all based on airplane flight time. Conversion to operating times can be made simply by applying the 1.3 to 1 time factor.

The discussion which follows is subdivided into four major sections dealing with component failure characteristics (section 5.1.1), system functional reliability (sections 5.1.2 and 5.1.3), and system availability (section 5.1.4).

5.1.1 COMPONENT RELIABILITY EVALUATION

In the tables and discussion which follows, the failure characteristics for each of the line replaceable units (LRU's) associated with the 747 flight control system electronics are described. These discussions have been subdivided into separate sections dealing with major computers dedicated sensors, servo and control and display elements and shared sensor.

Failure information on each of the LRU's was initially obtained by reviewing component inspection and removal (I&R) tag histories for all removals during the period from July 1975 through June 1976. A summary of the information obtained from these reviews is contained in appendix A. From the I&R tag histories the following information was obtained:

- Number of removals
- Number of failures
- Number of verified failures
- Failure manifestation (verified failures only)
- Causes for unverified/unjustified equipment removals

Where required, or at least desired, this information was supplemented by a review of the shop maintenance records dating back, in many cases, to 1970 and 1971.

Where a 1 year failure history was used as the sole source of failure rate information, the failure rate with appropriate confidences levels were computed based on the total operating time during the sample period and the total number of failures observed. This calculation begins with the assumption that for electronic equipment failures are generally Poisson distributed. For large values of $\bar{\lambda}T$, where:

$\bar{\lambda}$ = mean failure rate

T = observation time.

The Poisson distribution tends to a normal distribution. Since:

mean $= \bar{\lambda} \cdot T$

variance $= \sigma^2 = \bar{\lambda} \cdot T$

The number of failures F inside an interval will, if they are many, tend to a normal distribution.

The confidence interval is found from tables over the normal distribution. As an example:

90% confidence

$$\frac{F - (\bar{\lambda} \cdot T)}{\sqrt{\bar{\lambda} \cdot T}} > -1.2816$$

$$\sqrt{\bar{\lambda} \cdot T} = \frac{1.2816}{2} + \sqrt{\left(\frac{1.2816}{2}\right)^2 + F}$$

60% confidence

$$\sqrt{\overline{\lambda} \cdot T} = \frac{0.2533}{2} + \sqrt{\left(\frac{0.2533}{2}\right)^2 + F}$$

This approximation gets better for large values of $\overline{\lambda} \cdot T$. By inserting into the above equations the observation time period and the number of failures incurred, it is then a simple calculation to find $\overline{\lambda}$. This approach has been followed in all of the following component reliability computations.

Major Computers

Being the core or foundation of the flight control system for the 747 airplane, a major effort was expended analyzing the major computer elements. Those LRU's considered to fall into this category are the following:

Pitch Computer
Roll Computer
Yaw Computer
Monitor and Logic Unit (MLU)
Auto Stab Trim Unit
Auto Throttle Computer

In order to assess in greater detail the failure characteristics of the above listed equipment, we attempted to compute the actual number of hours from one failure to the next. A one year historical record proved to be too short a period of time in which to do this since most items under study had no more than one failure during that time. Therefore the study scope was expanded to include the installation and removal records for each unit dating back to the beginning of shop maintenance records (1970-71). An example of one of these shop records is shown in figure 5-1. These shop records were translated into a chronological history of each unit, by serial number, by tracing individual unit serial numbers installation and removal histories. This complete translation for each of the major computer units is given in the tables of appendix B.

As can be seen in appendix B a great deal of information was found to be either missing or conflicting making it difficult at best to accurately track unit "times-to-failure."

Because of that we were forced to do some estimating and extrapolating to fill in operating times where the records were incomplete. Using this approach then provided us with enough data points on which to base some meaningful failure rate calculations.

The summarized failure times for the computer units is given in the table in each section. In these tables the LINE column refers to the line of the complete table (appendix B) from which the failure time has been derived. The DATA SOURCE column identifies where the data was obtained empirically based on actual (A) records or estimated (E) because of missing information.

ORIGINAL PAGE IS
OF POOR QUALITY

<table>
<tr><th rowspan="2">Plane</th><th rowspan="2">Date</th><th rowspan="2">TSO</th><th rowspan="2">Unit on</th><th rowspan="2">Reason for Removal</th><th colspan="2">Verified</th><th rowspan="2">File No.</th><th rowspan="2">Date</th></tr>
<tr><th>Yes</th><th>No</th></tr>
<tr><td>8003</td><td>10-7-70</td><td>678</td><td>1</td><td>A/P flare made will not arm. Failed #3 test</td><td></td><td>X</td><td>VDROH 17612</td><td>10-21-70</td></tr>
<tr><td colspan="9">Repairs made: Unit passed all tests.</td></tr>
<tr><td>––</td><td>––</td><td>––</td><td>––</td><td>Removed from stock for checking on AIE.</td><td></td><td>X</td><td>17612</td><td>11-25-72</td></tr>
<tr><td colspan="9">Repairs made: Checked O'K on ATE.</td></tr>
<tr><td>8016</td><td>11-28-71</td><td>3069</td><td>13</td><td>No A/P flare armed. Only 1/2 light in A/P disconnect light.</td><td>X</td><td></td><td>5889</td><td>12-3-71</td></tr>
<tr><td colspan="9">Repairs made: A5A8 replaced a/c failed #193 ATE.
A4A8 replaced a/c failed 71-66 on card and 133.1 and 135.1 ATE.</td></tr>
<tr><td>801D</td><td>5-30-72</td><td>5553</td><td>G</td><td>No A/P flare capture.</td><td></td><td>X</td><td>16008</td><td>6-8-72</td></tr>
<tr><td colspan="9">Repairs made: Normal overhaul comp mod B COA S-0587.</td></tr>
<tr><td>8026</td><td>6-7-73</td><td>6822</td><td>20</td><td>Time</td><td>X</td><td></td><td>01624</td><td>6-7-73</td></tr>
<tr><td colspan="9">Repairs made: Repl A-7 card (SH0050276) a/c fails 244, -245, -245.1, -246, -247, -248, -249, -249.1, -251, -250.1 (found A7A1 bad) PDH</td></tr>
<tr><td>8004</td><td>8-29-74</td><td>13714</td><td>14</td><td>Time</td><td></td><td>X</td><td>88349</td><td>8-30-74</td></tr>
<tr><td colspan="9">Repairs made: Normal overhaul</td></tr>
<tr><td>8019</td><td>4-16-75</td><td>13186143</td><td>18</td><td>"A" A/P will not eng and fails self test 3, 6 & 7</td><td></td><td>X</td><td>E2834</td><td>4-19-75</td></tr>
<tr><td colspan="9">Repairs made: With this unit installed. No mal found. C/H</td></tr>
</table>

Figure 5-1.—Monitor and Logic Unit Shop Record

Failure rate characteristics are illustrated by plotting the number of failure occurrences which were observed within a certain time-to-failure window. In other words the number of failures from the table which occurred within a time window of 200 to 400 hours has been plotted as a magnitude at 400 hrs. etc.

This method of computing mean failure rates has been defined as method I. Method II is an estimate based on a one year sample period from 7/1/75 through 6/30/76. These failure rates are therefore given with appropriate confidence levels where the confidence applies to the probability that the computed failure rate is less than or equal to the calculated value.

Pitch Computer

a) Failure Rate (refer to table 5-1 and appendix A)

Method I (complete history)

425 failures/10^6 hrs MTBF = 2354 hrs

Method II ('75/'76 data)

(3 units/airplane) (53808 airplane flt hrs) = 161424 unit hrs

(58 verified failures + 26 incidental failures) = 84 total failures

90% confidence — $\bar{\lambda} \leqslant$ 598 failures/10^6 hrs
MTBF $\geqslant$ 1671 hrs

60% confidence — $\bar{\lambda} \leqslant$ 535 failures/10^6 hrs
MTBF $\geqslant$ 1869 hrs

Method III

$$\frac{84 \text{ total failures x } 10^6 \text{ hrs}}{161424 \text{ unit hrs}} = \frac{520 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Rate Characteristics — figure 5-2.

c) Failure Manifestations

Performance Anomally	42%
Failure/Warning Indication	26%
Fails BITE Test	16%
Inoperative	10%
Engage/Disengage Problem	4%
Other	2%

Table 5-1.—Pitch Computer Failure Times

90 Entries
$\bar{\lambda}$ = 2354
s = 2289

Sperry Part No. — 2590622-908
United MR No. — 22093

LINE	UNIT S/N	DATA SOURCE	TIME
4-7	2	E	4200
8		E	599
11-13	3	E	2869
14-17		E	1165
18-19		E	844
20		A	231
26	4	E	3719
32	5	E	308
33-35		E	7765
40	6	E	1747
41-43		E	2909+
52-53	8	E	2442
54		E	10516
55		E	1345
56		E	1064
57		A	430
58-66	9	E	9870+
68	10	E	616
69		A	1382
70		A	1357
76-79	11	E	3516
80		E	2128
81		A	1111
85-87	12	E	1664
89-90	Invalid - Same Problem		
95-96	13	A	3210
108-109	15	E	1512
113-114		E	1860+
117-120	17	A	6547
130-131	19	E	9779
132		A	1762
137-138	20	E	684
139-140		A	2672
142-150	Invalid - Same Problem		
153-154	22	A	230
158-165	Invalid - Same Problem		
167-168	24	E	2189
173-175	25	E	667
176-178	Invalid - Same Problem		
185	26	A	75
196	28	E	272
197		A	1561
198-199		E	1710
200		E	36
211	30	A	343
216	31	E	2830
217		E	4307
218		A	630
219		E	5410
220		A	1010
223	32	E	2964
224		E	1886
239	35	E	2855
244-247	36	E	1067+
249-252	37	E	6432
254		A	3857
260	38	E	532
261	Invalid - Same Problem		
264-265	39	E	4400
269-272	40	E	4738
275-276	41	E	2956
277		A	1133
278		A	224
279-280		A	1464
284	42	E	5368
298-300	44	E	3241
303-304	45	E	4756
305		A	51
309-310	46	A	282
317	47	E	2592
319-320		E	3105
324	48	E	912
328	49	A	2751
329		E	68
342	51	E	1782
343		E	3702
344		A	272
346-348	52	E	4910

Table 5-1.—(Concluded)

Sperry Part No. — 2590622-908
United MR No. — 22093

90 Entries
$\bar{\lambda}$ = 2354
s = 2289

LINE	UNIT S/N	DATA SOURCE	TIME
186		A	2089
190	27	E	1196
191		E	8290
364	55	E	272
365		E	1712
370-371		E	60
379	57	A	8
380-381		A	1318
384	58	E	3264
407	61	E	1819
415	62	E	2172
417	63	E	1396
433-435		E	1213
437		E	354
353	53	E	2111
358	54	A	130
363	55	E	3048

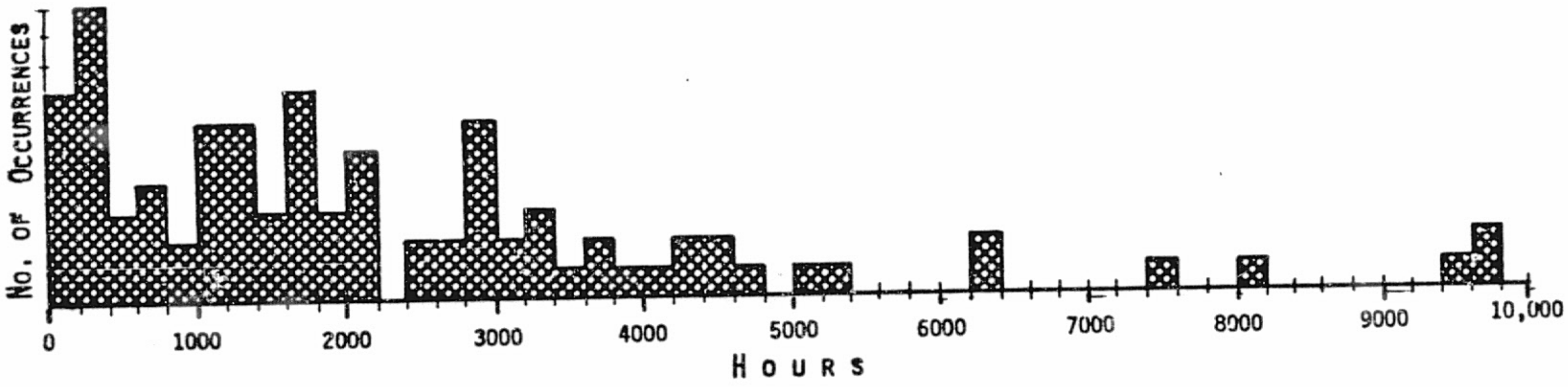


Figure 5-2.—Pitch Computer Failure Time Distribution

Roll Computer

a) Failure Rate (refer to table 5-2 and appendix A)

Method I (complete history)

383 failures/10^6 hrs MTBF = 2613 hrs

Method II ('75/'76 data)

(3 units/airplane) (53808 flt hrs) = 161424 unit hrs

(58 verified failures + 13 incidental failures) = 71 failures

90% confidence – $\lambda \leqslant$ 512 failures/10^6 hrs
MTBF $\geqslant$ 1953 hrs

60% confidence – $\lambda \leqslant$ 453 failures/10^6 hrs
MTBF $\geqslant$ 2206 hrs

Method III

$$\frac{71 \text{ total failures x } 10^6 \text{ hrs}}{161424 \text{ unit hrs}} = \frac{440 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Rate Characteristics – figure 5-3.

c) Failure Manifestations

Performance Anomally	25%
Failure/Warning Indication	9%
Fails BITE Test	38%
Inoperative	6%
Engage/Disengage Problem	17%
Other	5%

Table 5-2.—Roll Computer Failure Times

Sperry Part No. — 2590623-907
United Airlines No. — 22092

121 Entries
$\bar{\lambda}$ = 2613
s = 2455

LINE	UNIT S/N	DATA SOURCE	TIME
2	1	E	2220
3		E	1915
4		A	2416
5-7		E	6898
11	2	E	1800
12		E	3388
13		A	5480
16-20	Invalid - Same Problem		
23	4	A	897
24		E	946
25-26		E	13500
32-33	6	E	1485
34		E	1276
35-36		E	7120
37		A	1670
39	Invalid - Same Problem		
40	7	E	271
41		E	3100
42		A	2559
60-62	10	E	699
63		A	1914
64-65		E	2052
66		A	49
70	Invalid - Related Problem		
71	11	E	1595
72		A	531
73	Invalid - Same Problem		
74		E	2214
79-84	12	E	3450+
85-89		E	610
90	Invalid - Same Problem		
101-102	14	E	2868
103		A	102
108	15	E	4147
109-112		E	4842
113-114		E	912
135-137	16	E	7020
139		A	600
142-143		A	3524
144-145		E	5166
146		E	532
151-152	18	E	616
153-156		E	2214
157		E	2176
159		A	3117
166	20	E	1782
167		E	1914
170		E	9140
171		A	504
173	21	E	1782
174		E	2871
175		E	1276
176-177		E	3690
178		E	4942
185	23	A	143
186		E	1626
187		A	1417
188-189		E	4930
190		A	1126
193	24	A	1665
194-196		E	5756
197		A	1673
201	25	A	164
202		E	930
203-205		E	3640
206		E	3000
210	26	A	6921
211		A	1437
214-216	27	E	550
217-219		E	570
220-221		E	4892
222		A	91
225-230	28	E	5996
238-239	29	E	3137
240-242		A	4209
244	30	A	4554
245		E	123
246		A	6624
247		A	47
248-249		E	718
250		A	1275

Table 5-2.—(Concluded)

121 Entries
$\bar{\lambda}$ = 2613
s = 2455

Sperry Part No. — 2590623-907
United Airlines No. — 22092

LINE	UNIT S/N	DATA SOURCE	TIME
253	31	E	297
254		E	6452
255		E	3208
256		E	3234
257		A	2374
261-264	32	E	3594
265		A	1403
270-272	33	E	13500
279-280	35	E	503
281		E	912
282		A	570
283-284		E	1744
287	36	E	1276
291-292		E	3351
293		A	294
294		A	639
298	38	A	1767
299		A	224
300-301		E	171
302		E	228
303		A	892
313-317	Invalid - Same Problem		
318	40	E	1140
320-321	Invalid - Same Problem		
322	41	E	5014
323		E	1632
324		A	590
325-326		E	3298
338	43	A	1679
342	44	A	4462
343		E	1904
344-348		E	4480
349-351		E	9044+
353	45	A	352
356	46	E	319
357-358		E	8750
373-376	49	E	8640
383	52	A	1250
384-385	Invalid - Same Problem		
390-391	53	E	5980
393-394	53	E	798
396-401	54	E	3809+
402-405	Invalid - Same Problem		
407-411	55	E	7130
413-414	56	A	694
413-420	57	A	4696
424-425	58	A	1052
426		A	171
427-428		E	1368
441-442	Invalid - Same Problem		

ORIGINAL PAGE IS
OF POOR QUALITY

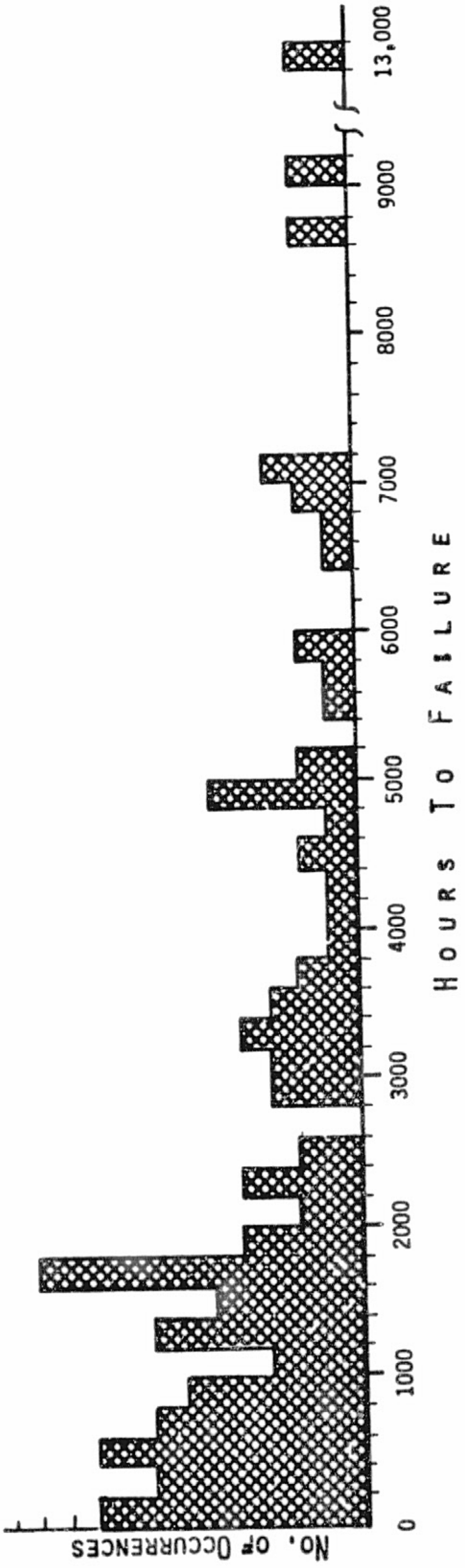


Figure 5-3.—Roll Computer Failure Time Distribution

Yaw Computer

a) Failure Rate (refer to table 5-3 and appendix A)

Method I (complete history)

232 failures/10^6 hrs MTBF = 4305 hrs

Method II ('75/'76 data)

(2 units/airplane) (53808 airplane hrs) = 107616 unit hrs

(16 verified failures + 4 incidental failures) = 20 failures

90% confidence – $\bar{\lambda} \leqslant$ 247 failures/10^6 hrs
MTBF $\geqslant$ 4044 hrs

60% confidence – $\bar{\lambda} \leqslant$ 197 failures/10^6 hrs
MTBF $\geqslant$ 5085 hrs

Method III

$$\frac{20 \text{ total failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{186 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Rate Characteristics – figure 5-4.

c) Failure Manifestations

Performance Anomally(1)	33%
Failure/Warning Indication	20%
Fails BITE Test	20%
Inoperative	13%
Engage/Disengage Problem	0%
Other(2)	13%

(1) Intermittent turns ("kick) either left or right
(2) Mostly Oscillatory

ORIGINAL PAGE IS
OF POOR QUALITY

Table 5-3.—Yaw Computer Failure Times

Bendix Part No. — 1964212-2
United Airlines Part No. — 22138

Entries
$\bar{\lambda}$ = 4305
s = 4125

LINE	UNIT S/N	DATA SOURCE	TIME	LINE	UNIT S/N	DATA SOURCE	TIME
2-6	1	E	7717	132	16	A	2539
7-9		E	7623+	135-139	17	E	7930
11	2	E	16241	141	18	E	2675
13	3	E	10462	149	19	E	1914
14-15		E	3144	150-152		A	9136
21	4	A	324	157-159	21	E	1330
23		A	224	160		E	2788
26		A	48	161	21	E	9515+
27		A	11499	163-164	22	A	6347
28		E	510	170-172	23	A	4479
30-31	5	E	2473	175-176	24	A	352
32-33		E	3219	177-178		E	13197+
34-35		E	919	180-181	25	A	9307
41	6	A	6052	184		A	329
42-43		A	3175	187	26	A	183
47	7	A	3003	190	26	E	13171+
48		A	8708	192	27	A	1479
54		A	1156	193-194		E	1270
56-57		E	8035+	195-196		E	2848
59-63	9	E	380	197-200	28	E	14827
64		A	8307	207	31	A	118
65		E	2875	209		A	71
68	10	A	105	210-212	31	E	6158
71-72		A	426	219-221	33	A	3895
73		A	621	222		A	4020
74		E	1848	224	27	A	1413
75		A	14	227	34	A	157
77		A	8702	228-233		E	4795
79	11	A	1845	235-236	35	A	2418
80		E	14888	237	35	E	6074+
85	12	A	2063	239-240	36	E	5259
86-88		E	1326	242	37	A	2781
89		E	6826	243	35	A	727
96-97	13	A	543	244	37	A	825
98		A	924	245		E	4711+
99-100		E	12176	246	38	A	3225
102	14	A	1535	247	38	A	588
104-105		A	4517	249-250		E	3922
106-108		E	11538+	254-255	40	E	6210+
109-116	15	E	3175+	259	42	E	4456+
117		E	10	261-262	43	E	3685+
121-122	15	E	7106+				

ORIGINAL PAGE IS
OF POOR QUALITY

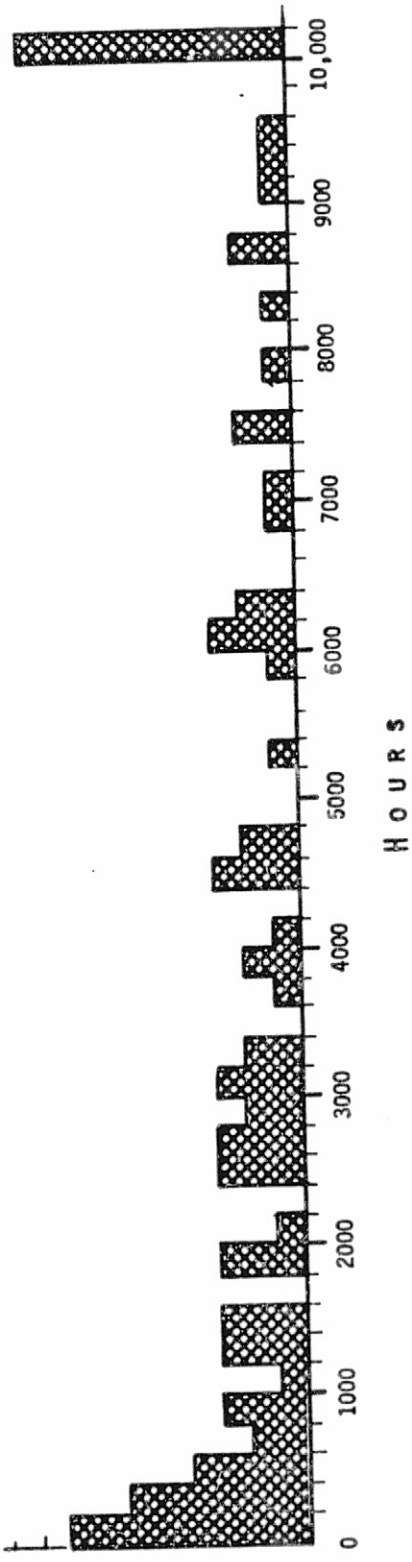


Figure 5-4.—Yaw Computer Failure Time Distribution

Although the pitch, roll, and yaw computer all include a rate gyro as an integral part of the LRU, in the case of the pitch and roll computers it is not a significant contributor to the unit failure rate. However, in the case of the Yaw Computer its rate gyro contributed to between 65 and 90% of all unit failures.

Monitor and Logic Unit

a) Failure Rate (refer to table 5-4 and appendix A)

Method I (complete history)

407 failures/10^6 hrs	MTBF = 2455 hrs

Method II ('75/'76 data)

1 unit/airplane	53808 unit hrs.

(15 verified failures + 1 incidental failure) = 16 failures

90% confidence – $\overline{\lambda} \leqslant 409/10^6$ hrs
MTBF $\geqslant$ 2445 hrs

60% confidence – $\overline{\lambda} \leqslant 317/10^6$ hrs
MTBF $\geqslant$ 3157 hrs

Method III

$$\frac{16 \text{ total failures x } 10^6 \text{ hrs}}{53808 \text{ unit hrs}} = \frac{297 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Rate Characteristics – figure 5-5.

c) Failure Manifestations

Engage/Disengage	33%
Warning Function	33%
Mode Light Function	13%
Fail BITE	13%
Camout Detection	7%

Table 5-4.—Monitor and Logic Unit Failure Time Summary

Sperry Part No. 2591027-902
United Airlines No. 22091

$\overline{\lambda}$ = 2455 Hrs

LINE	UNIT S/N	DATA SOURCE	TIME
3-4	1	A	1741
5	1	A	1512
6	1	A	766
8-11	1	E	4379
15-16	2	A	5727+
19	2	A	1133
20-21	2	E	227
22	2	A	1996
23-26	2	E	3171+
27-29	3	A	2734
30-31	3	E	1812
32-34	3	E	5134+
35-38	4	E	2190+
39	Invalid - Same Problem		
40-47	4	E	6946+
49	5	E	1823
50-51	5	E	151
52	5	E	2918
53-54	5	E	1260
55-57	5	E	2114
61-64	6	E	204
65-67	6	E	3613
68	Invalid - Same Problem		
69-70	6	E	332
73-74	Invalid - Same Problem		
75-77	6	E	1510
78	Invalid - Same Problem		
80-85	7	E	2114+
86	7	E	668
87	7	A	2982
88	7	A	965
89-93	7	A	1675
94	7	A	571
99	8	A	1599
100-103	8	E	7576+
105-106	9	A	985
107-114	9	E	4983
115	9	E	1337
116-118	9	E	453
119-121	9	A	1106
122	9	A	211

LINE	UNIT S/N	DATA SOURCE	TIME
125	10	A	2273
126-127	10	E	1963
128-131	10	E	2122
132	10	A	1204
133-134	10	E	3076
138-140	11	E	2152
141	11	A	1613
142	11	E	1944
143-146	11	E	2567
147-148	Invalid - Same Problem		
153	12	A	284
154-159	12	E	5433
160-161	12	A	682
165-167	13	E	2743
169-171	13	A	1002
172-176	14	E	7714+
178-181	14	E	1510
182-184	14	E	1057
185-187	14	E	9000+
191-195	15	E	3926
196-201	15	E	4077+
203	16	A	3395+
204	16	E	182
205 & 206	Invalid - Same Problem		
207-210	16	A	797
211-217	16	E	6167+
219-221	17	E	2430+
222	17	A	416
223	17	A	1864
224-227	17	E	4530+
230	Invalid - Same Problem		
231	18	A	362
232-234	Invalid - Same Problem		
235-236	18	A	3044+
239-246	19	E	5440+
248-256	20	E	6040+
258-267	21	E	4228
268	Invalid - Same Problem		
269	21	A	92
273	22	E	302
277-281	23	E	3473+
285-287	24	E	2699+
292	25	A	564

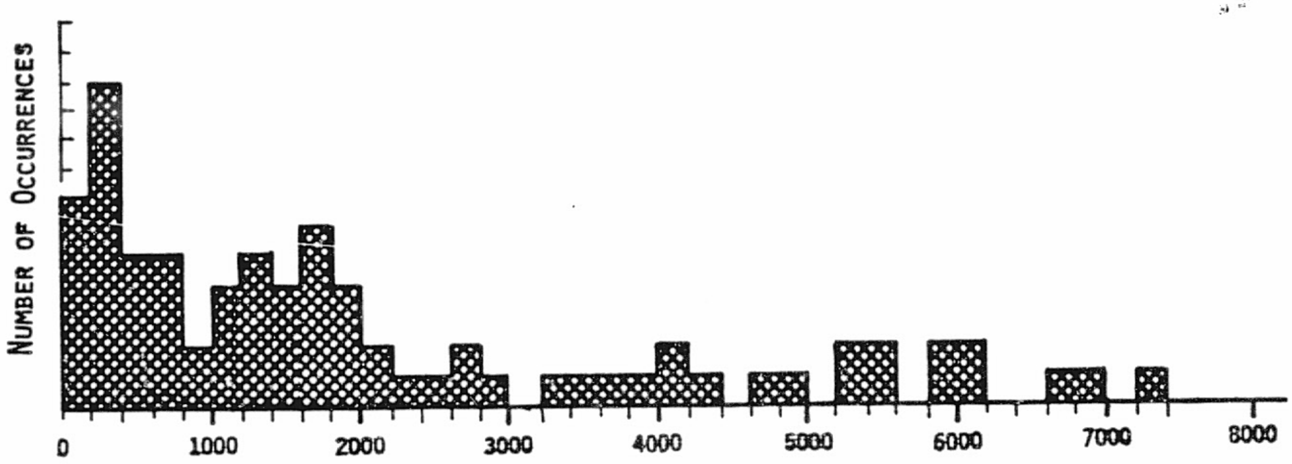


Figure 5-5.—Monitor and Logic Unit Failure Time Distribution

Automatic Stabilizer Trim Computer

a) Failure Rate (refer to table 5-5 and appendix A)

Method I (complete history)

404 failures/10^6 hrs MTBF = 2476 hrs

Method II ('75/'76 data)

1 unit/airplane 53808 unit hrs

(22 verified failures + 3 incidental failures) = 25 failures

90% confidence – $\bar{\lambda} \leqslant$ 600 failures/10^6 hrs
MTBF $\geqslant$ 1667 hrs

60% confidence – $\bar{\lambda} \leqslant$ 489 failures/10^6 hrs
MTBF $\geqslant$ 2046 hrs

Method III

$$\frac{25 \text{ total failures x } 10^6 \text{ hrs}}{53808 \text{ unit hrs}} = \frac{465 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Rate Characteristics – figure 5-6.

c) Failure Manifestations

Performance Anomally	0%
Failure/Warning Indication	54%
Fail BITE Test	34%
Inoperative	11%
Engage/Disengage Problem	0%
Other	1%

ORIGINAL PAGE IS
OF POOR QUALITY

Table 5-5.—Auto Stab Trim Unit Failure Time Summary

69 Entries
$\bar{\lambda} = 2476$
$s = 1991$

Sperry Part No. — 2591415-902
United Airlines No. — 22123

LINE	UNIT S/N	DATA SOURCE	TIME
4-6	1	E	846
7-10		E	7662
11		A	362
12-13		A	92
15-18	2	E	410
19		A	535
23	3	A	4296
24-25		A	3949
26-28		E	3285
29-31		E	1194
32		A	984
35	4	E	4378
36-37		A	4144
38		A	4965
39		E	1944
40-41		E	647
47-50	5	E	1791
51		A	1319
52-53		E	1692
54-55		E	3781
56		A	3068
57		E	796
58	6	A	3572
59		A	90
60-68		E	5075
69		E	243
72-73	7	E	796
74-77		E	2868
78-80		E	1450
81-84	8	E	698+
85-91		E	8528
92		A	296
93		A	1048
94		A	219
96-103	9	E	3818
104-106		E	1996
107-108		E	2818
109	Not Valid - Same Problem		
111-114	10	A	5210
115-119		E	3582
122-127	11	E	2786
128-133		E	2488
134-138		E	6368
139-140	12	A	2517
141		E	896
142-149		E	5558
150		A	1884
152-153		E	817
154-159	13	E	420
160		A	2057
162-163		A	3180
164		E	1094
165			280
166			665
168-169	14	A	2598
170		E	2673
171-172		A	2307
174	15	A	1816
176	Not Valid - Same Problem		
177-178		A	2167
179-184		E	2572
185-186	Not Valid - Same Problem		
187-189	Not Valid		
193	16	A	5159
194-200		E	5373
201		E	5250
203-204	17	A	2296
207-210		E	2056
212	18	A	7310
213		A	154
214-216		E	1411
217-218		E	1144
231	21	A	1088

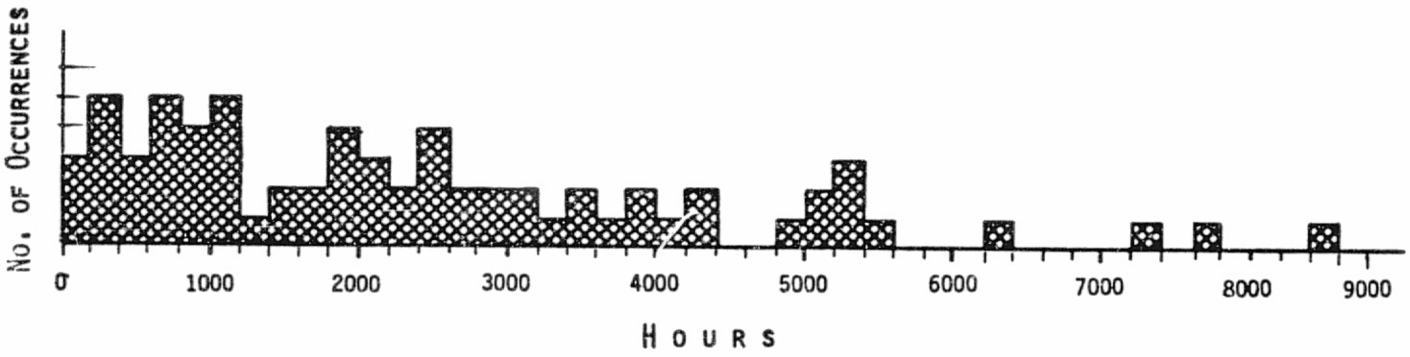


Figure 5-6.—Auto Stab Trim Unit Failure Time Distribution

Autothrottle Computer

a) Failure Rate (refer to table 5-6 and appendix A)

Method I (complete history)

181 failures/10^{-6} hrs MTBF = 5538 hrs

Method II ('75/'76 data)

1 unit/airplane 53808 unit hours

(9 verified failures + 5 incidental failures) = 14 failures

$$90\% \text{ confidence} - \overline{\lambda} \leqslant 336 \text{ failures}/10^{6} \text{ hrs}$$
$$\text{MTBF} \geqslant 2733 \text{ hrs}$$

$$60\% \text{ confidence} - \overline{\lambda} \leqslant 278 \text{ failures}/10^{6} \text{ hrs}$$
$$\text{MTBF} \geqslant 3592 \text{ hrs}$$

Method III

$$\frac{14 \text{ total failures} \times 10^{6} \text{ hrs}}{53808 \text{ unit hrs}} = \frac{260 \text{ failures}}{10^{6} \text{ hrs}}$$

b) Failure Rate Characteristics – figure 5-7.

c) Failure Manifestations

Performance Anomally(1)	44%
Failure/Warning Indication	22%
Fail BITE Test	0%
Inoperative	11%
Other	23%

(1) Typically overboosts.

Table 5-6.—Auto Throttle Computer Failure Time Summary

34 Entries
$\bar{X}$ = 5538
s = 3867

Sperry Part No. — 1964693-1
United Airlines MR No. — 22312

LINE	UNIT S/N	DATA SOURCE	TIME	LINE	UNIT S/N	DATA SOURCE	TIME
1	1	A	56				
4-6	2	E	6845				
11	3	A	8394				
15	4	A	16403				
19	5	E	5680+				
20-21	6	E	8477				
23	7	A	3309				
24-29	7	E	7296+				
30	8	A	2203				
31		E	3229				
32		E	10364				
33-34	Invalid - Same Problem						
35		A	888				
36-37	9	E	658				
38-41		E	3139+				
43	10	A	1476				
44		E	12034+				
46-48	11	E	8788				
55-57	12	A	7630				
58-60		A	1089				
63	13	E	8320				
65	14	A	4098				
66-67		E	2328+				
68	15	A	8435				
69		A	235				
76-77	16	A	4882				
78	17	A	8706				
79		A	1611				
80		A	3856				
88	19	E	3126+				
45	11	A	3241				
84-86	17	E	5544+				
89	20	A	6727				
99	23	A	8332				
101	24	A	10905				

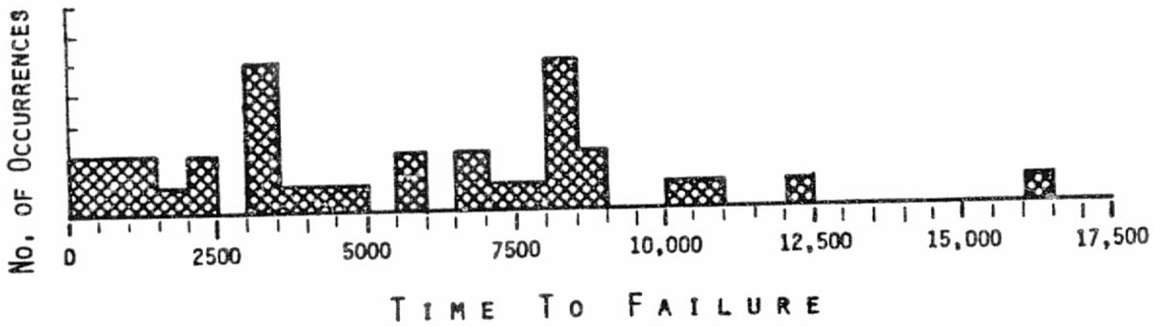


Figure 5-7.—Auto Throttle Computer Failure Time Distribution

Dedicated Sensor, Servo, and Control/Display Elements

The following list identifies those LRU's which have been classified as dedicated sensor, servo, and control and display elements in the 747 flight control system electronics:

Mode Select Panel (MSP)
Controller
Normal Accelerometer
Trim Interfaced Uit
AFCS Accessory Boxes
Elevator, Aileron & Rudder LVDT
Autostab Trim Pot
Autothrottle Servo

The functions of each of these elements has been defined in the system description (section 3).

Except where specifically noted otherwise all of the reliability derivations are based on a one year sample period from 7/1/75 through 6/30/76.

Mode Select Panel

a) Failure Rate (refer to appendix A)

1 unit/airplane 53808 unit flying hours

18 verified failures + 4 incidental failures = 22 failures

90% confidence – $\bar{\lambda} \leqslant$ 540 failures/10^6 hrs
MTBF $\geqslant$ 1863 hrs

60% confidence – $\bar{\lambda} \leqslant$ 431 failures/10^6 hrs
MTBF $\geqslant$ 2317 hrs

Point estimate

$$\frac{22 \text{ total failures} \times 10^6 \text{ hrs}}{53808 \text{ unit hrs}} = \frac{409 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Manifestations

Altitude Select Function	22%
Heading Select Function	17%
Course Select Function	11%

(b) Failure Manifestations (Continued)

Auto Throttle Function	11%
Pitch Mode Selector Function	11%
Flight Director	11%
Engage/Disengage	6%
Other/Unknown	11%

c) Comments

The AFCS mode select panel is considered to be one LRU, yet it controls a wide variety of different functions.

Controller

a) Failure Rate (refer to appendix A)

1 unit/airplane 53808 unit flying hrs

2 verified failures + 1 incidental = 3 failures

90% confidence(1) – $\bar{\lambda} \leqslant$ 124 failures/10^6 hrs
MTBF $\geqslant$ 8055 hrs

60% confidence(1) – $\bar{\lambda} \leqslant$ 78 failures/10^6 hrs
MTBF $\geqslant$ 12872 hrs

Point Estimate

$$\frac{3 \text{ failures} \times 10^6 \text{ hrs}}{53808 \text{ unit hrs}} = \frac{56 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Manifestations

Aileron Hardover	50%
No Manual Modes (Inop.)	50%

c) Comments

In addition to the two verified failures used here, appendix B shows a third as a unit physically damaged out of stock. This was not considered in computing unit failure rate.

The sample size (3 failures) for this unit is so small as to leave some question as to the validity of the results. No further shop records were available at United and besides, the controller is an insignificant contributor to system functional failure rates.

Normal Accelerometer

a) Failure Rate (refer to appendix A)

2 unit/airplane   107616 unit flying hrs

1 verified failure + 0 incidental failures = 1 failure

90% confidence $-\overline{\lambda} \leqslant$ 36 failures/10^6 hrs
MTBF $\geqslant$ 27665 hrs

60% confidence $-\overline{\lambda} \leqslant$ 19 failures/10^6 hrs
MTBF $\geqslant$ 53275 hrs

Point estimate

$$\frac{1 \text{ failure x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{9 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Manifestation

Pitch Down + Oil Leak

c) Comments

These units are returned to the vendor (Sperry) for repair, hence UA has no information regarding the shop findings. Since this unit was leaking oil, it appears reasonable to assume that it was in fact failed.

Trim Interface Unit

a) Failure Rate (refer to appendix A)

1 unit/airplane   53808 unit flying hrs

0 failures

90% confidence $-\overline{\lambda} \leqslant$ 43 failures/10^6 hrs
MTBF $\geqslant$ 23395 hrs

60% confidence $-\overline{\lambda} \leqslant$ 17 failures/10^6 hrs
MTBF $\geqslant$ 58487 hrs

b) Failure Manifestations – None.

c) Comments

No shop data available prior to 7/75.

ORIGINAL PAGE IS
OF POOR QUALITY

AFCS Accessory Boxes

a) Failure Rates (refer to appendix A)

Box 1 – 1 failure/53808 unit flight hrs

90% confidence – $\bar{\lambda} \leqslant$ 72 failures/10^6 hrs
MTBF $\geqslant$ 13832 hrs

60% confidence – $\bar{\lambda} \leqslant$ 38 failures/10^6 hrs
MTBF $\geqslant$ 26638 hrs

Point estimate*

$$\frac{3 \text{ failures x } 10^6 \text{ hrs}}{289395 \text{ unit hrs}} = \frac{10 \text{ failures}}{10^6 \text{ hrs}}$$

Box 2 – 0 failures/53808 unit flying hrs

90% confidence – $\bar{\lambda} \leqslant$ 43 failures/10^6 hrs
MTBF $\geqslant$ 23395 hrs

60% confidence – $\bar{\lambda} \leqslant$ 17 failures/10^6 hrs
MTBF $\geqslant$ 58487 hrs

Point estimate**

$$\frac{1 \text{ failure x } 10^6 \text{ hrs}}{289395 \text{ unit hrs}} = \frac{3 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Manifestation

Box 1 – Intermittent warning light

c) Comments

*AFCS Accessory Box 1 has only shown three failures since approximately 1970 (289395 flight hrs).

**AFCS Accessory Box 2 has had only one failure since approximately 1970 (289395 flight hrs).

Therefore:

90% confidence

Box 1 – $\overline{\lambda} \leqslant$ 23 failures/10^6 hrs t = 0
MTBF $\geqslant$ 43423 hrs

Box 2 – $\overline{\lambda} \leqslant$ 13 failures/10^6 hrs
MTBF $\geqslant$ 74395 hrs

60% confidence

Box 1 – $\overline{\lambda} \leqslant$ 14 failures/10^6 hrs
MTBF $\geqslant$ 69233 hrs

Box 2 – $\overline{\lambda} \leqslant$ 7 failures/10^6 hrs
MTBF $\geqslant$ 143265 hrs

LVDT's

a) Failure Rate

(9 units/airplane) (53808 airplane hrs/yr) = 484272 unit hrs

There were five removals during the time period of interest for which there is no data available showing the number of actual failures. The following is based on the conservative assumption that all five removals were also failures.

90% confidence – $\overline{\lambda} \leqslant$ 19 failures/10^6 hrs
MTBF $\geqslant$ 52241 hrs

60% confidence – $\overline{\lambda} \leqslant$ 13 failures/10^6 hrs
MTBF $\geqslant$ 76991 hrs

Point estimate

$$\frac{5 \text{ failures x } 10^6 \text{ hrs}}{484272 \text{ unit hrs}} = \frac{10 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Manifestation: Unknown – no information.

c) Comments

The assumption that all removals were verified failures is probably reasonable since, due to the difficulty in removing elements of the servo actuation package, mechanics are likely to take great care to be sure its bad before making the removal.

Automatic Stabilizer Trim Pot

No data.

Auto Throttle Servo

a) Failure Rate

No failures in 53808 unit flying hrs.

$$90\% \text{ confidence} - \bar{\lambda} \leqslant 43 \text{ failures}/10^6 \text{ hrs}$$
$$\text{MTBF} \geqslant 23395 \text{ hrs}$$

$$60\% \text{ confidence} - \bar{\lambda} \leqslant 17 \text{ failures}/10^6 \text{ hrs}$$
$$\text{MTBF} \geqslant 58487 \text{ hrs}$$

b) Failure Manifestations - none.

c) Comments

Based on one year I&R tag history – no complete shop records available.

Attitude Director Indicators (ADI's)

a) Failure Rate

2 unit/airplane 107616 unit flight hrs

33 verified failures + 1 incidental failure = 34 failures

$$90\% \text{ confidence} - \bar{\lambda} \leqslant 393 \text{ failures}/10^6 \text{ hrs}$$
$$\text{MTBF} \geqslant 2542 \text{ hrs}$$

$$60\% \text{ confidence} - \bar{\lambda} \leqslant 330 \text{ failures}/10^6 \text{ hrs}$$
$$\text{MTBF} \geqslant 3031 \text{ hrs}$$

Point estimate

$$\frac{34 \text{ failures} \times 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{316 \text{ failures}}{10^6 \text{ hrs}}$$

b) Failure Manifestations

F/D flag	61%
Command bar(s) will not bias out-of-view	15%
Command bar erratic/sticks	24%

c) Comments

The ADI provides a vehicle for displaying roll and pitch command information to the flight crew either for manual airplane control or for monitoring autopilot performance. In addition to command information, it also displays such situation information as aircraft roll and pitch attitude, localizer and glidescope error, radio altitude, etc. For this analysis, only those failures/removals relating to its flight director function are evaluated, for more general information refer to appendix A.

Shared Sensor Systems

Shared sensor systems are those avionic systems (generally ATA chapter 34) which provide airplane state and/or guidance information to the flight control system yet are not a part of it. Such systems would be installed in the airplane even if there were no automatic control systems because they also provide information required by the flight crew for manual flight.

The avionic systems on the 747 airplane which fall into this category are the following:

VOR/ILS Receiver
Radio Altimeter
INS
Air Data Computer
Compass Coupler

The major difficulty encountered in evaluating the reliability aspects of these systems from the standpoint of the flight control system, is in trying to distinguish between those unit failures which have an impact on the flight control system and those which do not. Many of these avionic systems measure several parameters each of which may be output through several isolated output channels. Wherever possible in the following discussions, both the overall failure rate and that portion which potentially has an impact on the automatic flight control system are calculated separately.

VOR/ILS Receiver

a) Total Failure Rate

(2 unit/airplane) (53808 airplane hrs) = 107616 hrs

(19 verified failures + 4 incidental) = 23 total failures

90% confidence – $\overline{\lambda} \leqslant$ 279 failures/10^6 hrs
MTBF $\geqslant$ 3585 hrs

60% confidence – $\overline{\lambda} \leqslant$ 225 failures/10^6 hrs
MTBF $\geqslant$ 4438 hrs

ORIGINAL PAGE IS
OF POOR QUALITY

b) AFCS Related Failure Rate

15 failures have a potential AFCS impact

90% confidence – $\bar{\lambda} \leqslant$ 194 failures/10^6 hrs
MTBF $\geqslant$ 5160 hrs

60% confidence – $\bar{\lambda} \leqslant$ 149 failures/10^6 hrs
MTBF $\geqslant$ 6720 hrs

Point estimate

$$\frac{15 \text{ failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{139 \text{ failures}}{10^6 \text{ hrs}}$$

c) Failure Manifestations

Flag/Warning Indication	53%
Weak	32%
Inop/Erratic	15%

Radio Altimeter

a) Total Failure Rate

2 unit/airplane 107616 unit flying hrs

(16 verified failures + 7 incidental failures) = 23 total

90% confidence – $\bar{\lambda} \leqslant$ 279 failures/10^6 hrs
MTBF $\geqslant$ 3585 hrs

60% confidence – $\bar{\lambda} \leqslant$ 225 failures/10^6 hrs
MTBF $\geqslant$ 4438 hrs

b) AFCS Related Failure Rate

16 failures have a potential AFCS impact

90% confidence – $\bar{\lambda} \leqslant$ 205 failures/10^6 hrs
MTBF $\geqslant$ 4889 hrs

60% confidence – $\bar{\lambda} \leqslant$ 158 failures/10^6 hrs
MTBF $\geqslant$ 6313 hrs

Point estimate

$$\frac{16 \text{ failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{149 \text{ failures}}{10^6 \text{ hrs}}$$

c) Failure Manifestations

Inoperative	40%
Erratic Altitude	20%
Flag/Warn Indication	27%
AFCS Warning	7%
Fails BITE	7%

d) Comment

3 failures were caused by external short.

Inertial Navigation System (INS)

a) Total Failure Rate

2 units/airplane 107616 unit hours

(69 verified failures + 3 incidental failures) = 72 total

90% confidence – $\bar{\lambda} \leqslant$ 778 failures/10^6 hrs
MTBF $\geqslant$ 1286 hrs

60% confidence – $\bar{\lambda} \leqslant$ 689 failures/10^6 hrs
MTBF $\geqslant$ 1451 hrs

b) AFCS Related Failure Rate

Since the only functions required by the AFCS from the INS for Cat II operation are attitude and heading references, the total list of INS failures was reviewed to eliminate those failures which, based on engineering judgment, should not have affected these references. This left a total of 38 failures, primarily associated with the platform/gimbal assembly itself.

90% confidence – $\bar{\lambda} \leqslant$ 435 failures/10^6 hrs
MTBF $\geqslant$ 2301 hrs

60% confidence – $\bar{\lambda} \leqslant$ 368 failures/10^6 hrs
MTBF $\geqslant$ 2718 hrs

Point estimate

$$\frac{38 \text{ failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{353 \text{ failures}}{10^6 \text{ hrs}}$$

c) Failure Manifestations

Flag/Warning Indication	81%
Navigation Error	4%
Inoperative	10%
Fail Self Test	1%
Other	4%

Air Data Computer (CADC)

a) Total Failure Rate

2 units/airplane 107616 flight hrs

(37 verified failures + 22 incidental failures) = 59 total failures

90% confidence – $\bar{\lambda} \leqslant$ 648 failures/10^6 hrs
MTBF $\geqslant$ 1544 hrs

60% confidence – $\bar{\lambda} \leqslant$ 567 failures/10^6 hrs
MTBF $\geqslant$ 1765 hrs

Point estimate

$$\frac{59 \text{ failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{548 \text{ failures}}{10^6 \text{ hrs}}$$

b) AFCS Cat II Related Failure Rate

For Category II autoland operations the only CADC output required is altitude rate ($\dot{H}$). In this case all CADC failures were reviewed to separate out only those which affect the altitude function from which H is derived. There were 24 failures judged to be in this category.

90% confidence – $\bar{\lambda} \leqslant$ 289 failures/10^6 hrs
MTBF $\geqslant$ 3454 hrs

60% confidence – $\bar{\lambda} \leqslant$ 235 failures/10^6 hrs
MTBF $\geqslant$ 4258 hrs

Point estimate

$$\frac{24 \text{ failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{223 \text{ failures}}{10^6 \text{ hrs}}$$

c) Failure Manifestation

Altitude/Mach Performance	24%
Altitude Mach Flag	24%
TAS/SAT/TAT	14%
Inop-All Flags	22%
AFCS Performance	5%
Fail BITE Test	8%
Other	3%

Compass Coupler

a) Total Failure Rate

2 units/airplane 107616 unit flying hrs

(7 verified failures + 2 incidental failures) = 9 failures

90% confidence – $\bar{\lambda} \leqslant$ 132 failures/10^6 hrs
MTBF $\geqslant$ 7573 hrs

60% confidence – $\bar{\lambda} \leqslant$ 97 failures/10^6 hrs
MTBF $\geqslant$ 10279 hrs

b) AFCS Related Failure Rate

7 failures with possible AFCS/Cat II impact

90% confidence – $\bar{\lambda} \leqslant$ 109 failures/10^6 hrs
MTBF $\geqslant$ 9143 hrs

60% confidence – $\bar{\lambda} \leqslant$ 78 failures/10^6 hrs
MTBF $\geqslant$ 12827 hrs

Point estimate

$$\frac{7 \text{ failures x } 10^6 \text{ hrs}}{107616 \text{ unit hrs}} = \frac{65 \text{ failures}}{10^6 \text{ hrs}}$$

c) Failure Manifestations

Heading Flag	29%
No Slave/Inop/Erratic	57%
AFCS Heading Hold	14%

Component Reliability Summary

Table 5-7 summarizes the failure rates of the various elements which comprise the 747 flight control system electronics. The rates shown have been derived from the one year observation period and have a 60% confidence factor.

Table 5-7.—Failure Rate Summary, United Airlines

Note: 60% confidence level

Element	Failures/10^6 flt hrs
I. Major Computers	
Pitch computer	535
Roll computer	453
Yaw computer	197
MLU	317
Auto stab trim unit	489
Auto throttle comp	278
II. Dedicated Sensor, Servo and Display Elements	
Mode select panel	431
Controller	78
Normal accelerometer	19
Trim interface unit	17
AFCS access box 1	38
AFCS access box 2	7
LVDTS	13
Auto throttle servo	17
ADI	330
III. Shared Sensor Systems	
VOR/ILS receiver	149
Radio altimeter	158
INS	368
Air data computer	235
Compass coupler	78

Poisson Failure Process Verification

A test was conducted on the United time-to-failure data in this section for the five components (Yaw Computer, Monitor and Logic Unit. Autothrottle Computer, Pitch Computer and Roll Computer) to determine if the observed data is Poisson distributed. Time-to-failure data defines a probability of failure distribution for each of the components. The number of failures in the time period is Poisson distributed if and only if time-to-failure is exponentially distributed.

The exponential distribution is a special case of the Weibull distribution wherein the hazard function is a constant. Hence, the procedure of the investigation was to fit a Weibull to the time-to-failure data and verify the constant hazard assumption. The hazard is commonly referred to as the instantaneous failure rate and different from the average failure rate which is based on observed data by dividing the total number of failures by the total unit hours of operation or flying.

A two parameter Weibull distribution was fitted to each of the five sets of time-to-failure data, i.e., a Weibull distribution with a scale parameter (θ) and shape parameter (b). The value of the shape parameter provides a sufficient test to determine the nature of the hazard. If the reliability function is defined as

$$R = e^{-\left(\frac{t}{\theta}\right)^{b}}$$

where t = time, b = shape and θ = scale then the following can be said of the hazard as the parameter b takes on various values:

$b > 1$	implies time dependent increasing hazard such as that associated with wear out,
$b < 1$	implies time dependent decreasing hazard such as that associated with improvements in equipment or maintenance procedures.
$b = 1$	implies constant hazard or no dependence on time.

A constant hazard (constant failure rate) defines an exponential failure distribution which in turn defines a poisson distribution for the number of failures in the time period.

The resultant Weibull parameters using an HP-55 calculation(1) to fit the data are as follows.

Component	b	θ
Yaw Computer	0.78	4250.10
Monitor & Logic Unit	1.17	2587.82
Autothrottle Computer	0.99	6443.41
Pitch Computer	0.91	2411.00
Roll Computer	1.03	2716.57

(1) HP-55 Statistics Program, page 62, Weibull Distribution Parameter Calculation.

ORIGINAL PAGE IS
OF POOR QUALITY

Conclusions from the above results are that, with the exception of the Yaw Computer, the value of b is sufficiently close to one to indicate a poisson distribution for the number of failures in the samples. The fact that b for the Yaw Computer is less than 1 (opposite of wear) implies the equipment itself was not constant over the time period or that the data sample is not sufficiently large or accurate to indicate a conclusion. Since the hazard appears to be decreasing for this component the average failure rate will be conservative.

5.1.2 SYSTEM FUNCTIONAL RELIABILITY – FULL CATEGORY II

An assessment of the functional reliability of the full category II control system can be made by combining the failure rates (λ's) of each of the individual elements required for such operations. The following paragraphs discuss the functional reliability and functional readiness characteristics of the 747 full Cat II configuration flight control system.

Functional Reliab

Figure 5-8 illustrates the flight control system equipment required for operations into defined minimum category II weather conditions. Also included in figure 5-8 are the individual failure rates determined in section 5.1.1. Since a failure of any one of these elements results directly in a loss of full category II capability, the reliability model is a series string of elements. Hence the system functional reliability can be expressed as

$$\lambda_{cat\ II} = \sum_{i=1}^{n} \bar{\lambda}_i$$

where $\bar{\lambda}_i$ = mean failure rate (/10^6 hrs) of each element
n = total number of elements

Using the individual failure rates shown in figure 5-8 the system functional reliability for this defined configuration is:

$$\bar{\lambda}_{cat\ II} = 5650 \text{ failures}/10^6 \text{ hrs}$$

Functional Readiness

Functional Readiness has been defined as the probability that the prescribed function is available after some time (t) of system operation. Thus, the functional readiness (FR) is equal to unity at time zero and decreases towards zero for long exposure times. For the 747 full Category II flight control system configuration, since every element must operate:

$$FR(t) = \prod_{i=1}^{n} R_i$$

where R_i = probability of module i surviving = $e^{-\lambda_i t}$
n = number of modules
t = mission length

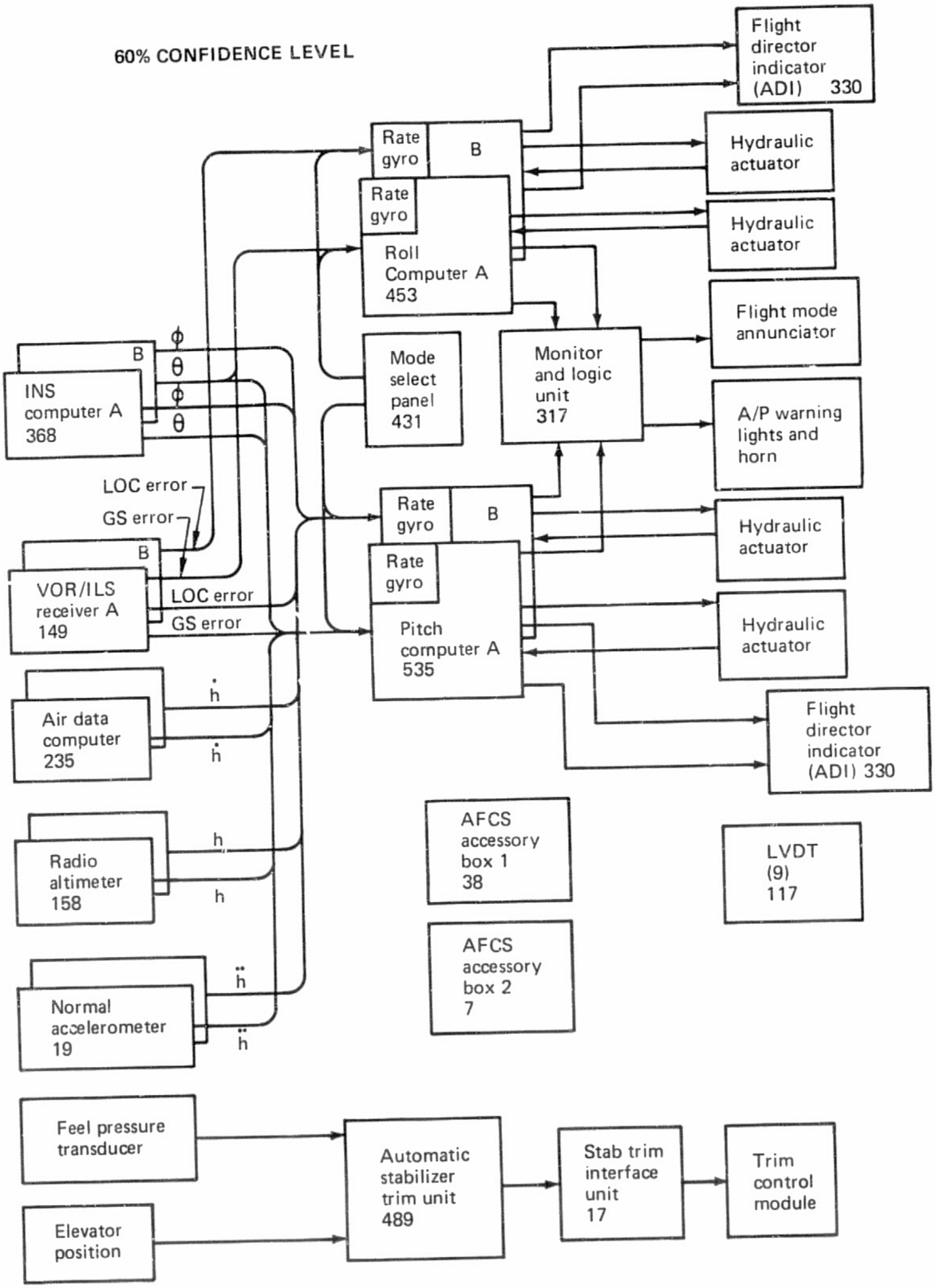


Figure 5-8.—747 Category II System Interface Block Diagram

ORIGINAL PAGE IS OF POOR QUALITY

For those modules which include two identical elements, $\lambda_i = 2\bar{\lambda}$ where $\bar{\lambda}$ is the mean unit failure rate calculated in section 5.1.1.

For example for the 747 configuration described in figure 4.2-1:

$$FR_{\text{Full Category II}} = R_{\text{Radio Alt}} \cdot R_{\text{INS}} \cdots\cdots R_{\text{Pitch Computer}} \cdot R_{\text{Roll Computer}}$$

Using as the time interval (t) the average mission time for United 747 fleet of 4.02 hrs this results in a 97.75% probability that the system will be capable of full category II operation at the end of the flight given that it was fully operational at the start.

5.1.3 SYSTEM FUNCTIONAL RELIABILITY – RESTRICTED CATEGORY II

As previously described, the 747 flight control system is qualified for restricted Category II operation with either the A or B channel autopilot inoperative provided the C channel flight director is operational or with A and B channels operative and C channel inoperative. Minimum weather conditions for restricted Category II operations are defined as 150 feet decision height and 1600 feet RVR. This says in effect that weather conditions at or above these minimums can be entered with any one of the three roll and/or pitch computers inoperative. For restricted Cat II operations the pitch and roll computer stages can therefore be viewed as TMR (Triple Modular Redundancy) for reliability assessment purposes.

The following paragraphs discuss the functional reliability and functional readiness characteristics of the 747 restricted Cat II configuration flight control system.

Functional Reliability

The only difference in dealing with the restricted Cat II system as opposed to the full Cat II is in modeling the failure rate of the pitch and roll computer modules. In the case of a module containing two identical elements, e.g. pitch computers for which both are required for functional success λ dual = 2λ element. However, with redundant systems, single failures can occur which do not cause system failure. In order to determine the system failure rate a measure of how failures are treated must be made. In other words inspection intervals have to be established where all components are checked for function and any failed components are replaced.

In general failure rate is defined by

$$\lambda(t) = \frac{-1}{R}\frac{dR}{dt}$$

where R is the probability of survival and $\lambda(t)$ is the failure rate which is dependent on time t.

With a regularly inspected and repaired redundant system, the system will have the same probability of failure in each interval of length T. Hence, over long periods of time it will fail exponentially (a constant average failure rate) with an MTBF given by

$$M_T = \frac{\int_0^T R\,(t)\,dt}{1 - R\,(T,0)}$$

M_T is the system MTBF when the system is inspected and repaired, if necessary every, T hours.

For a TMR stage (3 pitch or 3 roll computers), two must operate for system operation. The survival probability of the TMR stage

$$R_{TMR} = 3\,e^{-2\lambda_c t} - 2e^{-3\lambda_c t}$$

where $\lambda_c = \lambda_{\text{COMPUTATION CHANNEL}}$

$= \lambda_{\text{ROLL COMPUTER}} + \lambda_{\text{PITCH COMPUTER}}$

The MTBF of the TMR stage is a constant and given by

$$M_T = \frac{1}{\lambda_c}\left[\frac{5/6 - 3/2\,e^{-2\lambda_c T} + 2/3\,e^{-3\lambda_c T}}{1 - 3\,e^{-2\lambda_c T} + 2\,e^{-3\lambda_c T}}\right]$$

Also the average failure rate

$$\lambda(t) = \frac{6\lambda_c\,(1 - e^{-\lambda_c t})}{3 - 2e^{-\lambda_c t}}$$

A test of the MTBF equation shows that as the inspection interval T approaches infinity ie single failures are not repaired, then the MTBF approaches $5/6\ \lambda_c$. However, as the inspection interval reduces towards every flight the MTBF becomes a very large number (M_T for TMR = 127,690 Hrs).

For restricted Cat II operation, as the MTBF for the pitch and roll computer stages is much greater than the MTBF for all the other elements, the system functional reliability can be expressed as the sum of the individual failure rates as calculated for the full Cat II reliability less the pitch and roll failure rates.

$$\lambda_{\text{Restricted Category II}} \begin{array}{l} = 5650 - 2[425 + 383]\ /10^6 \\ = 4034\ \text{failures}/10^6\ \text{hrs.} \end{array}$$

ORIGINAL PAGE IS
OF POOR QUALITY

This failure rate is a constant when the computation channel failure rate is not included.

Functional Readiness

Functional readiness of at least the restricted Category II configuration is computed in the same manner as for the full Category II system except for the survival probability of the TMR stages. In the TMR case:

$$R = r^3 + 3r^2 (1-r)$$

where R = probability of module surviving

r = probability of an element surviving = $e^{-\lambda t}$

Using a mission time of 4.02 hours:

$$FR(t) = \Pi R_i = .9839$$

or a probability that the system will be at least capable of operating into restricted Category II conditions of approximately 98.39% given that it was fully operational at the start of the mission.

5.1.4 CATEGORY II AVAILABILITY

The availability of the 747 Category II autoload function is assessed empirically from information extracted from United Airlines flight log records. An example of a flight log showing the type of information is shown in figure 5-9. The flight log provides information relative to the occurrence of a reported malfunction as reported by the flight crew and the corrective action taken by line maintenance.

When reviewing system availability the question of true hardware availability versus legal functional availability arises. If a malfunction is reported on an approach, whether it is a true failure or not, the system is considered legally unavailable until line maintenance either repairs the system or verifies via ground test its fault-free status.

The Category II availability is expressed in terms of the proportion of time for which the flight control system is in Category II status. United Airlines has identified availability as reported, legal and actual for both full Category II and restricted Category II. A summary of a one year survey (appendix C) is shown in table 5-8.

A/C	DATE	TSO	STA	IN-FLIGHT PROBLEM	AFCS	OTHER	MAINTENANCE ACTION	CAT II AVAILABILITY					
								REPORTED		LEGAL		ACTUAL	
								R	F	R	F	R	F
8003	10/17	1625:43	LAX	1ST OFFICER WINDSHIELD WIPER BLADE STICKS OUT IN FLT		X	DEF #460 NOT CAT II	N/A		N/A			✓
	10/20	1661:01	SFO	(CORRECTION OF DEF #460)			REPLACED BLADE	N/A			✓		✓
	10/21	1664:36	ORD	NOTE - CAPT INST PNL HAS "NOT CAT II" PLACARD			CORRECTED TO CAT II		✓		✓		✓
8011	06/12	18346:31	ORD	CAPT F/D ANNUNCIATOR LATE WOULD NOT ILLUMINATE DURING APPROACH	X		REPLACE MALU. NOT CAT II NEED CAT II CHECK. DEF #598	N/A		N/A			✓
	06/13	18369:15	LAX	(CORRECTION OF DEF #598)			MALU BITE OK CAT II		✓		✓		✓
8014				(PREVIOUS WRITE-UP'S ON WARNING LIGHTS)					✓		✓		✓
	03/18	17238:15	ORD	WITH "A" A/P IN CMD & VOR/LOC, HAD STEADY RED A/P WARN LITE. "B" A/P OK	X		UNABLE TO DUP BITE CKS OK ROLL & PITCH		✓		✓	✓	
	03/19	17240:26	ORD	SAME AS ABOVE	X		REPLACED A/P ROLL CHANNEL. CKS OK		✓		✓		✓
				(NO MORE PROBLEM)									

Figure 5-9.—Category II Availability, Sample Entries

ORIGINAL PAGE IS
OF POOR QUALITY

Table 5-8. System Availability, United Airlines

Percentage of time for which flight control system is in Category II status

Reported Category II Availability:	
Full	89.45%
Full/restricted	97.19%
Legal Category II Availability:	
Full	90.57%
Full/restricted	98.25%
Actual Category II Availability:	
Full	91.41%
Full/restricted	98.86%

5.2 RELIABILITY ASSESSMENT – PAN AMERICAN

A similar approach to United Airlines has been taken in evaluating the system reliability using available data from Pan American. The same four sections dealing with component failure characteristics (section 5.2.1), system functional reliability (section 5.2.2 and 5.2.3) and system availability (section 5.2.4) are discussed as follows.

5.2.1 COMPONENT RELIABILITY EVALUATION

Failure information on each of the component LRU's was obtained from shop records (component "B" tags). A count of the findings for each record according to number of failures (confirmed and incidental) and number of units that tested OK gave the percentage of records that were failed.

The component removal rates including the number of units removed and the flight hours accumulated over the six month period were extracted straight from the computer summaries. Component times to failure were not obtainable from Pan American records.

From the above number of removals and percentage of units in the shop that fail, the expected number of failures can be obtained. By inserting this number and the hours flown in the 60% confidence interval equation the failure rate for each LRU can be obtained.

Major Computers

Pitch Computer PA No. 72201

		Count	%
1. No. of records examined – 111			
2. Findings:	Test ok	50	45
	Confirmed failure	34	31
	Incidental failure	27	24

3. Failure manifestation (confirmed failures only)

Performance anomaly	50
Failure/warning indication	21
Failure BITE test	12
Inoperative	11
Engage/disengage problem	6

4. Failure rate

(3 units/airplane) (61,944 airplane flight hours) = 185,832 unit hours

Number of removals in time period = 148

Percentage failures (confirmed + incidental) = 55%

60% confidence – $\overline{\lambda} \leqslant$ 442 failures/10^6 hours
MTBF $\geqslant$ 2231 hours

Roll Computer PA No. 72202

		Count	%
1. No. of records examined – 146			
2. Findings:	Test ok	73	50
	Confirmed failure	59	40
	Incidental failure	14	10

3. Failure manifestation (confirmed failures only)

Performance anomaly	62
Failure/warning indication	12
Failure BITE test	14
Inoperative	3
Engage/disengage problem	7
Other/unknown	2

4. Failure rate

(3 units/airplane) (61,944 airplane flight hours) = 185,832 unit hours

Number of removals in time period = 149

Percentage failures (confirmed + incidental) = 50%

60% confidence – $\overline{\lambda} \leqslant$ 416 failures/10^6 hours
MTBF $\geqslant$ 2406 hours

Yaw Computer PA No. 72221

			Count	%
1.	No. of records examined – 35			
2.	Findings:	Test ok	12	34
		Confirmed failure	17	49
		Incidental failure	6	17

3. Failure manifestation (confirmed failures only)

Performance anomaly	29
Failure/warning indication	47
Fail BITE test	6
Inoperative	18
Engage/disengage problem	0

4. Failure rate

(2 units/airplane) (61,944 Airplane Flight Hours) = 123,888 unit hours

Number of removals in time period = 38

Percentage failures (confirmed + incidental) = 66%

60% confidence – $\overline{\lambda} \leqslant$ 212 failures/10^6 hours
MTBF $\geqslant$ 4711 hours

Monitor and Logic Unit PA No. 72204

			Count	%
1.	No. of records examined – 62			
2.	Findings:	Test ok	37	60
		Confirmed failure	20	32
		Incidental failure	5	8

3. Failure manifestation (confirmed failures only)	Count	%
Engage/disengage		65
Warning function		20
Mode light function		5
Fails BITE test		5
Camout detection		5

4. Failure rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 46

Percentage failures (confirmed + incidental) = 40%

60% confidence – $\bar{\lambda} \leqslant$ 325 failures/10^6
MTBF $\geqslant$ 3076 hours

Automatic Stabilizer Trim Unit PA No. 72224

		Count	%
1. No. of records examined – 64			
2. Findings:	Test ok	37	58
	Confirmed failure	23	36
	Incidental failure	4	6

3. Failure manifestations (confirmed failures only)

Performance anomaly	13
Failure/warning indication	30
Fails BITE test	44
Inoperative	9
Engage/disengage problem	0
Other	4

4. Failure rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 55

Percentage failures (confirmed + incidental) = 42%

60% confidence – $\bar{\lambda} \leqslant$ 391 failures/10^6 hours
MTBF $\geqslant$ 2555 hours

Auto Throttle Computer PA No. 72220

			Count	%
1.	No. of records examined – 29			
2.	Findings:	Test ok	7	24
		Confirmed failure	21	72
		Incidental failure	1	4

3. Failure manifestation (confirmed failures only)

Performance anomaly	19
Failure/warning indication	14
Failed BITE test	5
Inoperative	62
Other/Unknown	0

4. Failure rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 10

Percentage failures (confirmed + incidental) = 76%

60% confidence – $\lambda \leqslant$ 141 failures/10^6 hours
MTBF $\geqslant$ 7080 hours

Dedicated Sensor, Servo, and Control and Display Elements

Mode Select Panel PA No. 72222 MFR No. 2590624-924

			Count	%
1.	No. of records examined – 81			
2.	Findings:	Test ok	31	38
		Confirmed failure	46	57
		Incidental failure	4	5

3. Failure manifestation (confirmed failures only)

Altitude selection function	20
Heading select function	4
Course selection function	7
Auto throttle function	7
Pitch mode select function	30
Flight Director	13
Engage/Disengage	17
Other/Unknown	2

4. Failure rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 66

Percentage failures (confirmed + incidental) = 62%

60% confidence – $\overline{\lambda} \leqslant$ 689 failures/10^6 hours
MTBF $\geqslant$ 1452 hours

Flight Controller PA No. 72203 MFR No. 2590625-902

	Count	%
1. No. of records examined -- 27		
2. Findings: Test ok	14	52
Confirmed failure	10	37
Incidental failure	3	11

3. Failure manifestation (confirmed failures only)

No manual modes (inop)	10
Turn function	50
Pitch function	40

4. Failure rate

(1 unit/airplane) (61, 944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 11

Percentage failures (confirmed + incidental) = 48%

60% confidence – $\overline{\lambda} \leqslant$ 95 failures/10^6 hours
MTBF $\geqslant$ 10470 hours

Normal Accelerometer P/N 57381 MFR No. 2588696-904 Mod A

There were no removals of this component in the six month period reviewed.

Review of component tag "B" stubs shows 3 removals since 1971.

This unit is not repaired in house. It is sent to the vendor for repair. The vendor does not indicate findings on the tag when the unit is returned to Pan Am.

There were no removals of this component in the period 12/01/77 thru 05/31/77.

Failure Rate

(2 units/airplane) (61,944 airplane flight hours) = 123,888 unit hours

Number of removals in time period = 0

Percentage failures (confirmed + incidental) = 0

60% confidence – $\bar{\lambda} \leqslant$ 0.5 failures/10^6 hours
MTBF $\geqslant$ 1,930,900 hours

Auto Stabilizer Trim Accessory Box

PA No. 72215 MFR P/N 65B47519-9

Our shop does not keep records on this item.

A review of B component tags going back to 1974 shows the following:

No. of tags reviewed – 59

No. of unconfirmed (test ok) units – 54 (91.5%)

No. of confirmed failure units – 2 (3.4%)

No. of incidental failure units – 3 (5.1%)

Failure Rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 18

Percentage failures (confirmed + incidental) = 8.5%

60% confidence – $\bar{\lambda} \leqslant$ 30 failures/10^6 hours
MTBF $\geqslant$ 33,593 hours

Autoflight Accessory Box #1

PA No. 72223/72217 MFR No. 65 B47520-14/13

Shop does not keep records on this unit.

#1-review of B component tags going back to 1974 shows the following:

No. of tags reviewed – 31

No. of unconfirmed (test ok) units – 24 (77.4%)

No. of confirmed failure units — 7 (22.6%)

Failure Rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 6

Percentage failures (confirmed + incidental) = 22.6%

60% confidence – $\bar{\lambda} \leqslant$ 28 failures/10^6 hours
MTBF $\geqslant$ 35,733 hours

Auto Flight Accessory Box #2

PA No. 72216 MFR No. 65B47521-18

#2-review of B component tags going back to 1974 shows the following:

No. of tags reviewed — 33

No. of unconfirmed (test ok) units – 28 (85%)

No. of confirmed failure units — 5 (15%)

Note: 3 of the 5 confirmed failures were due to mechanical failure (damage to connector/pin), not electronic/electrical failure.

Failure Rate

(1 unit/airplane) (61,944 airplane flight hours) = 61,944 unit hours

Number of removals in time period = 2

Percentage failures (confirmed + incidental) = 15%

60% confidence – $\bar{\lambda} \leqslant$ 8 failures/10^6 hours
MTBF $\geqslant$ 130,551 hours

LVDT's

Rudder Control Power Package PA No. 72705

			Count	%
1.	No. of records examined — 31			
2.	Findings:	Test ok	5	16
		Confirmed failure	23	74
		Incidental failure	33	10

3. Failure manifestation (confirmed failure only)

	Count	%
Transducer (LVDT)		0
Other auto flight control system		0
Other		100

Note: There were no removals for autoflight control system problems.

Inboard Elevator Control Power Package PA No. 72703

1. No. of records examined – 37

2. Findings:	Count	%
Test ok	2	5
Confirmed failure	29	79
Incidental failure	6	16

3. Failure manifestation (confirmed failures only)

	Count	%
Transducer (LVDT)		0
Other auto flight control system		24
Other		76

Note: There were 7 removals for auto flight control problems. None had a confirmed transducer (LVDT) failure.

Central Lateral Control Actuator PA No. 70717

1. No. of records reviewed – 8

2. Findings:	Count	%
Test ok	1	13
Confirmed failure	5	62
Incidental failure	2	25

3. Failure characteristics (confirmed failures only)

	Count	%
Transducer (LVDT)		0
Other auto flight control system		20
Other		80

Elevator Feel Computer PA No. 72711/70772

1. No. of records reviewed – 22

2. Findings:	Count	%
Test ok	1	5
Confirmed failure	21	95
Unrelated failure	0	0

3. Failure characteristics (confirmed failure only)

	Count	%
Transducer (LVDT)		14
Other auto flight control system		5
Other		81

4. Failure rate – LVDT's

(9 units/airplane) (61,944 airplane flight hours) = 557,496 unit hours

Number of removals in time period = 1

Percentage failures (confirmed + incidental) = 95%

60% confidence – $\overline{\lambda} \leqslant$ 0.5 failures/10^6 hours
MTBF $\geqslant$ 2,153,500 hours

Auto Throttle Servo PA No. 72207

This unit is repaired by the vendor who does not supply findings. There were no records of any removals during 1976-1977.

Attitude Director Indicator PA No. 73407 MFR No. 2590281-905

		Count	%
1.	No. of records examined – 48		
2.	Findings: Test ok	18	38
	Confirmed failure	25	52
	Incidental failure	5	10

3. Failure manifestation (confirmed failures only)

Flight director flag	12
Command bar(s) will not bias out	0
Command bar(s) erratic	16
Other*	72

*Note: The *other* category includes non flight director items such as pitch/roll attitude, expanded localizer/glide slope, radio altitude, etc. indication.

4. Failure rate

(2 units/airplane) (61,944 airplane flight hours) = 123,888 unit hours

Number of removals in time period = 32

Percentage failures (confirmed + incidental) = 62%

60% confidence – $\overline{\lambda} \leqslant$ 169 failures/10^6 hours
MTBF $\geqslant$ 5911 hours

Annunicator PA No. 73422 MRF No 75-0147-9

1. No. of records examined – 31

		Count	%
2. Findings:	Test ok	14	45
	Confirmed failure	17	55
	Incidental failure	0	0

3. Failure manifestation (confirmed failures only)

Autopilot function	0
Flight director function	12
Auto throttle function	0
Other*	88

*Note: Most reported failures were for mechanical, test, or dimming problems rather than functional discrepancies.

Failure rate

(2 units/airplane) (61,944 airplane flight hours) = 123,888 unit hours

Number of removals in time period = 3

Percentage failures (confirmed + incidental) = 55%

60% confidence – $\overline{\lambda} \leqslant$ 16 failures/10^6 hours
MRBF $\geqslant$ 61,665 hours

Shared Sensor Systems

For the shared components there was no shop data available from Pan American to make a determination of specific AFCS related failures. The same ratio of failures having a potential AFCS impact for each LRU as determined from the United Airline data is applied to the Pan American data.

Navigation Receiver PA No. 73458

1. No. of records reviewed – 126

		Count	%
2. Findings:	Test ok	91	72
	Confirmed failure	31	25
	Incidental failure	4	3

3. Failure manifestation (confirmed failures only)	Count	%
Flag/warning indication		39
Weak		0
Inoperative/erratic		61

4. Failure rate

(2 units/airplane) 61,944 airplane flight hours) = 123,888 unit hours

Number of removals in time period = 103

Percentage failures (confirmed + incidental) = 28%

Assume 65% of failures have a potential AFCS impact

60% confidence – $\overline{\lambda} \leqslant$ 160 failures/10^6 hours
MTBF $\geqslant$ 6248 hours

Low Range Radio Altimeter Transceiver PA No. 73432

	Count	%
1. No. of records examined – 97		
2. Findings: Test ok	54	56
Confirmed failure	41	42
Incidental failure	2	2

3. Failure manifestation (confirmed failures only)		
Inoperative		34
Erratic Altitude		12
Auto flight control system warning		0
Flag/warning indication		49
Fails BITE test		5

4. Failure rate

(2 units/airplane) (61,944 airplane flight hours) – 123,888 unit hours

Number of removals in time period = 55

Percentage failures (confirmed + incidental) = 44%

Assume 70% of failures have a potential AFCS impact

60% confidence – $\overline{\lambda} \leqslant$ 145 failures/10^6 hours
MTBF $\geqslant$ 6893 hours

Inertial Navigation Unit PA No. 73458

1. No. of records examined – 148

2. Findings:	Count	%
Test ok	16	11
Confirmed failure	96	65
Incidental failure	36	24

3. Failure manifestation (confirmed failures only)

Flag/warning indication	60
Navigation error	22
Inoperative	12
Fails self test	2
Other	4

4. Failure rate

(3 units/airplane) (61,944 airplane flight hours) = 185,832 unit hours

Number of removals in time period = 258

Percentage failures (confirmed + incidental) = 89%

Assume 53% of failures have a potential AFCS impact

60% confidence – $\bar{\lambda} \leqslant$ 670 failures/10^6 hours

MTBF $\geqslant$ 1492 hours

Central Air Data Computer PA No. 73404/73460

1. No. of records examined – 137 .

2: Findings:	Count	%
Test ok	62	45
Confirmed failure	51	37
Incidental failure	24	18

3. Failure manifestation (confirmed failures only)

Altitude/Mach performance	33
Altitude/Mach flag	8
True air speed/static air temp/Total air temp	10
Inoperative/all flags	27
Auto flight control system performance	12
Fails BITE test	2
Other	8

4. Failure rate

(2 units/airplane) (61,944 airplane flight hours) = 123,888 unit hours

Number of removals in time period = 185

Percentage failures (confirmed + incidental) = 55%

Assume 40% of failures have a potential AFCS impact

60% confidence – $\bar{\lambda} \leqslant$ 342 failures/10^6 hours
MTBF $\geqslant$ 2924 hours

Magnetic Heading Reference Compass Coupler PA No. 73412

1. No. of records examined – 64

		Count	%
2. Findings:	Test ok	24	38
	Confirmed failure	40	62
	Incidental failure	0	0

3. Failure manifestation (confirmed failures only)

Heading flag	43
No. Slaving/inop/erratic	52
Auto flight control system heading ref.	5

4. Failure rate

(2 units/airplane) (61,944 airplane flight hours) = 123,888 unit hours

Number of removals in time period = 40

Percentage failures (confirmed + incidental) = 62%

Assume 77% of failures have a potential AFCS impact

60% confidence – $\bar{\lambda} \leqslant$ 163 failures/10^6 hours
MTBF $\geqslant$ 6122 hours

Component Reliability Summary

The rates shown in the table 5-9 have been derived from the 6 month observation period and have a 60% confidence factor.

Table 5-9. Failure Rate Summary, Pan American

Note: 60% confidence level

Element	Failures/10^6 flt hrs
I. Major Computers	
Pitch computer	448
Roll computer	416
Yaw computer	212
MLU	325
Auto stab trim unit	391
Auto throttle comp	141
II. Dedicated Sensor, Servo and Display Elements	
Mode select panel	689
Controller	95
Normal accelerometer	0.5
Trim interface unit	30
AFCS access box 1	28
AFCS access box 2	8
LVDTS	0.5
Auto throttle servo	1
ADI	169
III. Shared Sensor Systems	
VOR/ILS receiver	160
Radio altimeter	145
INS	670
Air data computer	342
Compass coupler	163

5.2.2 SYSTEM FUNCTIONAL RELIABILITY – FULL CATEGORY II

There are three Inertial Navigation Units installed on each Pan American airplane. However the third INU is not tied into the autoland function and therefore for reliability purposes the Inertial Navigation System (INS) input will be regarded as a dual system equivalent to that used on the United airplanes. Full Category II is lost if either of the two INU's fail.

Functional Reliability

Figure 5-10 illustrates the flight control system equipment required for operations into defined minimum category II weather conditions. Also included in figure 5-10 are the individual failure rates determined in section 5.2.1. Since a failure of any one of these elements results directly in a loss of full category II capability, the reliability model is a series string of elements. Hence the system functional reliability can be expressed as

$$\lambda_{\text{cat II}} = \sum_{i=1}^{n} \overline{\lambda}_i$$

where $\overline{\lambda}_i$ = mean failure rate (10^6 hrs) of each element

n = total number of elements

Using the individual failure rates shown in figure 5.2.1 the system functional reliability for this defined configuration is:

$$\lambda_{\text{cat II}} = 6176 \text{ failures}/10^6 \text{ hrs}$$

Functional Readiness

Functional readiness has been defined as the probability that the prescribed function is available after some time (t) of system operation. Thus, the functional readiness (FR) is equal to unity at time zero and decreases towards zero for long exposure times. For the 747 full Category II flight control system configuration, since every element must operate

$$FR(t) = \prod_{i=1}^{n} R_i$$

where R_i = probability of module i surviving = $e^{-\lambda_i t}$

n = number of modules

t = mission length

For those modules which include two identical elements, $\lambda_i = 2\overline{\lambda}$ where $\overline{\lambda}$ is the mean unit failure rate calculated in section 5.1. For example for the 747 configuration described by figure 5-10:

$$FR_{\text{Full Cat II}} = R_{\text{Radio Alt}} \cdot R_{\text{INS}} \cdots R_{\text{Pitch Computer}} \cdot R_{\text{Roll Computer}}$$

ORIGINAL PAGE IS
OF POOR QUALITY

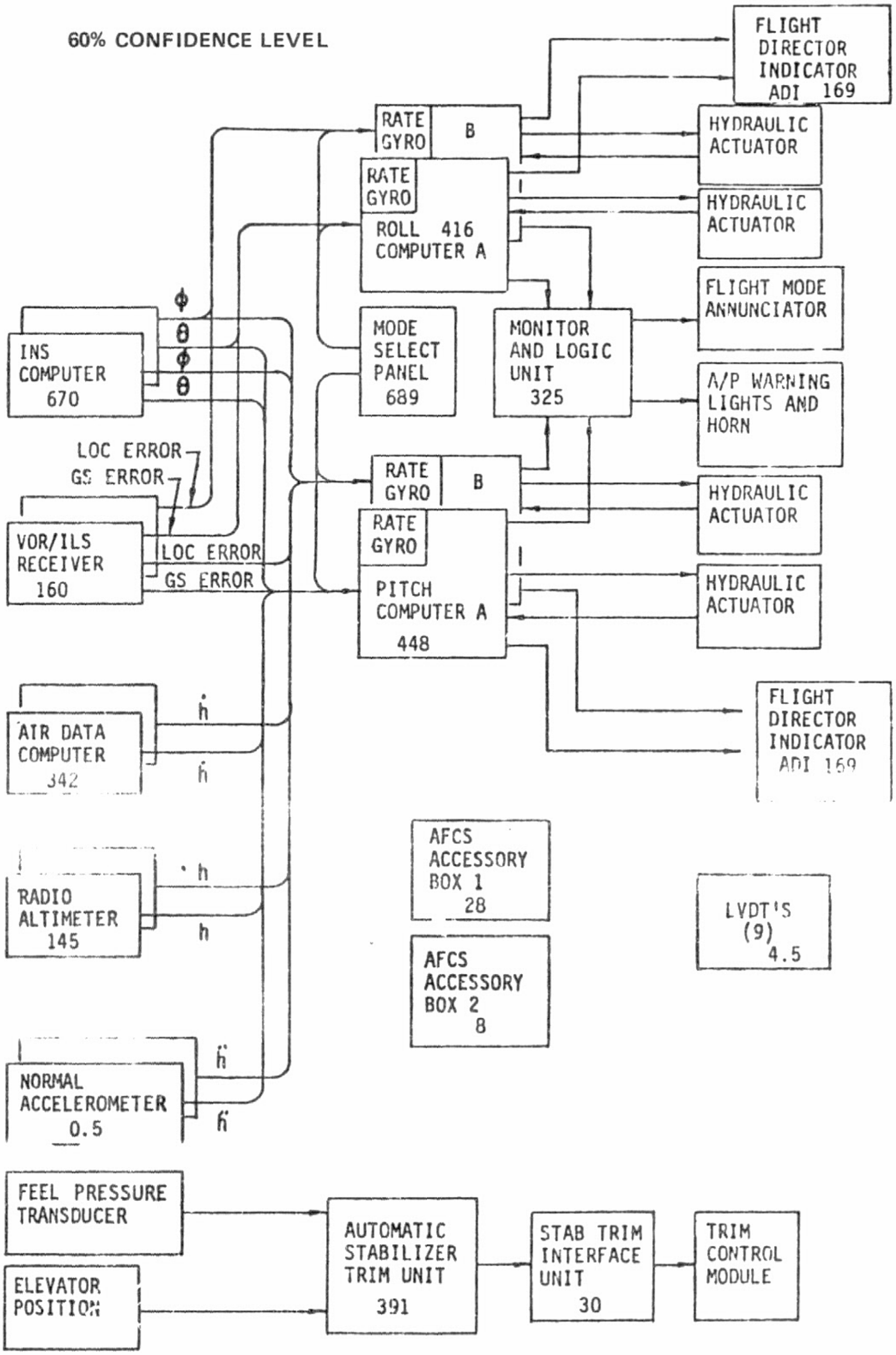


Figure 5-10.—747 Category II System Interface Block Diagram

Using as the time interval (t) the average mission time for Pan American 747 fleet of 4.27 hrs (appendix D) this results in a 97.40% probability that the system will be capable of full category II operation at the end of the flight given that it was fully operational at the start.

5.2.3 SYSTEM FUNCTIONAL RELIABILITY – RESTRICTED CATEGORY II

As previously described, the 747 flight control system is qualified for restricted Category II operations with either the A or B channel autopilot inoperative provided the C Channel flight director is operational. Minimum weather conditions for restricted Category II operations are defined as 150 feet decision height and 1600 feet RVR. This says in effect that weather conditions at or above these minimums can be entered with any one of the three roll and/or pitch computers inoperative. For restricted Cat II operations the pitch and roll computer stages can therefore be viewed as TMR (Triple Modular Redundancy) for reliability assessment purposes.

The following paragraphs discuss the functional reliability and functional readiness characteristics of the 747 restricted Cat II configuration flight control system.

Functional Reliability

The only difference in dealing with the restricted Cat II system as opposed to the full Cat II is in modeling the failure rate of the pitch and roll computer modules. In the case of a module containing two identical elements, e.g. pitch computers for which both are required for functional success $\lambda dual = 2\lambda element$. However, with redundant systems, single failures can occur which do not cause system failure. In order to determine the system failure rate a measure of how failures are treated must be made. In other words inspection intervals have to be established where all components are checked for function and any failed components are replaced.

In general failure rate is defined by

$$\lambda(t) = \frac{-1}{R}\frac{dR}{dt}$$

where R is the probability of survival and $\lambda(t)$ is the failure rate which is dependent on time t.

With a regularly inspected and repaired redundant system, the system will have the same probability of failure in each interval of length T. Hence, over long periods of time it will fail exponentially (a constant average failure rate) with an MTBF given by

$$M_T = \frac{\int_0^T R(t)\,dt}{1 - R(T,0)}$$

M_T is the system MTBF when the system is inspected and repaired, if necessary every, T hours.

ORIGINAL PAGE IS
OF POOR QUALITY

For a TMR stage (3 pitch or 3 roll computers), two must operate for system operation. The survival probability of the TMR stage

$$R_{TMR} = 3\,e^{-2\lambda_c t} - 2e^{-3\lambda_c t}$$

where $\lambda_c = \lambda_{COMPUTATION\ CHANNEL}$

$$= \lambda_{ROLL\ COMPUTER} + \lambda_{PITCH\ COMPUTER}$$

The MTBF of the TMR stage is a constant and given by

$$M_T = \frac{1}{\lambda_c}\ \frac{5/6 - 3/2\,e^{-2\lambda_c T} + 2/3\,e^{-3\lambda_c T}}{1 - 3\,e^{-2\lambda_c T} + 2\,e^{-3\lambda_c T}}$$

Also the average failure rate

$$\lambda(t) = \frac{6\lambda_c\left(1 - e^{-\lambda_c t}\right)}{3 - 2e^{-\lambda_c t}}$$

A test of the MTBF equation shows that as the inspection interval T approaches infinity ie single failures are not repaired, then the MTBF approaches $5/6\lambda_c$. However, as the inspection interval reduces towards every flight the MTBF becomes a very large number (M_T for TMR = 105,216 hrs).

For restricted Cat II operation, as the MTBF for the pitch and roll computer stages is much greater than the MTBF for all the other elements, the system functional reliability can be expressed as the sum of the individual failure rates as calculated for the full CAT II reliability less the pitch and roll failure rates.

$$\lambda_{Restricted\ Cat\ II} \begin{aligned} &= 6176 - 2\,[484 + 416]\ /10^6 \\ &= 4448 \text{ failures}/10^6 \text{ hrs.} \end{aligned}$$

This failure rate is a constant when the computation channel failure rate is not included.

Functional Readiness

Functional readiness of at least the restricted Category II configuration is computed in the same manner as for the full Category I except for the survival probability of the TMR stages. In the TMR case:

$$R = r^3 + 3r^2 (1-r)$$

where R = probability of module surviving

r = probability of an element surviving = $e^{-\lambda t}$

Using a mission time of 4.27 hours:

$$FR(t) = \Pi R_i = .9812$$

or a probability that the system will be at least capable of operating into restricted Category II conditions of approximately 98.12% given that it was fully operational at the start of the mission.

5.2.4 CATEGORY II AVAILABILITY

The Category II availability is based on a daily QXI (MEL tracking) report for the 6 months period March thru August 1977.

Full Category II is defined as autoland (dual) availability with minimums of 1200 Ft. RVR and 100 Ft. DH. Restricted Category II is defined as single channel autoflight control with minimums of 1600 Ft. RVR and 150 Ft. DH.

Review of the QXI sheets shows that all restrictions were dual (autoland) operation not available. There were no items in which both autoflight control systems were inoperative.

Tabulation of the daily average percentage of the fleet with full Category II availability is as follows:

March	96.05%	June	92.48%
April	93.29%	July	89.91%
May	91.35	August	91.16%

6 months average availability = 92.37%

The stations in which Pan Am flies, on its scheduled routes, which are Category II certificated are:

JFK	New York, N.Y.	DTW	Detroit, Mich.
IAD	Washington, D.C.	ORD	Chicago, Ill.
DFW	Dallas/Ft. Worth	TXL	Berlin (Tegal)
SFO	San Francisco, CA	MUC	Munich, Germ.
LAX	Los Angeles, CA	LHR	London, U.K.
SEA	Seattle/Tacoma, WA	AMS	Amsterdam, Neth.

ORIGINAL PAGE IS
OF POOR QUALITY

6.0 MAINTENANCE ASSESSMENT–UNITED AND PAN AMERICAN

The major elements of maintenance assessment are line maintenance, shop maintenance, delays and cancellations, and the sparing activity. Each of these elements contributes to maintenance cost.

Line Maintenance

The measure of line maintenance cost is given by the manhours expended to remove and replace components on the airplane. Included is the time spent for test and check of components and system. Each component replacement is considered a line maintenance event. The manhours can be expressed in terms of maintenance events and also in terms of airplane flight time.

One measure of the maintenance effectiveness achieved at the line level is what is commonly referred to as the verification rate. Quite simply, the verification rate is the ratio of verified equipment removals to the total number of removals. A removal is verified if the removal and replacement corrects the malfunction and/or the stop maintenance operation finds the removed unit to have a failure which can be directly related to the noted reason for removal.

Shop Maintenance

As with line maintenance, the shop maintenance is expressed in manhours expended in restoring/overhauling components. A major contributor to shop maintenance also are the material costs associated with overhaul. The shop maintenance costs are thus a sum of the manhour costs and the associated material costs.

When components are returned to the vendor for overhaul or work, the cost is not included in the data.

PA shop material cost was provided in cost per unit removed and routed through the shop. UA only used material charges against verified failures so the PA data was developed to show these same unit costs per verified failure using the percent failures provided in the data.

6.1 LINE MAINTENANCE

The United Airlines line maintenance assessment is presented in the form of manhours expended and total maintenance events on a monthly basis split up by ATA 100 chapter headings (see Appendix C). Twelve months results from July 1975 through June 1976 are totaled for the autopilot system (ATA Chapter 22) as shown. The shared components and servo components are not included in Chapter 22.

Autopilot System Components--Average Manhour per Event = 1.53 (ATA Chapter 22)

For Pan American the component replacement, check and test times have been identified for each AFCS component (see Appendix D). In order to arrive at an average manhour per event for comparison with United Airlines results, the total removals for the period December 1976 through May 1977 are used as a data base.

For ATA Chapter 22 components

$$\text{Avg. Manhour per event} = \sum \frac{\text{(Component manhour/event x no. of removals)}}{\text{Total number of removals}}$$

$$= \frac{842}{583} = 1.44 \text{ manhours per event}$$

Removal/Verification Rates

For United Airlines the following sections identify, for each electronic element in the 747 flight control system, the removal rate, the reasons for removal and the associated verification rates. This information has been derived from the one-year I&R tag removal histories as documented in appendix A.

Pitch Computer

Symptom	Removals	Verified	Unverified
A/P performance	43	20	23
Failure warning	23	12	11
Engage/disengage	13	4	9
BITE	41	16	25
Inoperative	6	4	2
Other	7	2	5
Total	133	58	75

$$\text{MTBR} = \frac{\text{161424 unit flight hrs}}{\text{133 removals}} = \text{1214 hrs}$$

Verification rate = 58/133 = 43.6%

Roll Computer

Symptom	Removals	Verified	Unverified
A/P performance	38	16	22
Fails BITE	35	19	16
Engage/disengage	15	10	5
Warning indication	12	8	4
Inoperative	6	3	3
Other	2	1	1
Total	108	57	51

$$\text{MTBR} = \frac{\text{161424 unit flt hrs}}{\text{108 removals}} = \text{1495 hrs}$$

Verification rate = 57/108 = 53%

Yaw Computer

Symptom	Removals	Verified	Unverified
Fails BITE	5	3	2
Warning light	11	4	7
Turn indication	6	5	1
Erratic/kicks	3	0	3
Inop	4	4	0
Other	5	0	5
Total	34	16	18

$$\text{MTBR} = \frac{\text{107616 hrs}}{\text{34 removals}} = \text{3165 hrs}$$

Verification rate = 16/34 = 47%

Monitor and Logic Unit

Symptom	Removals	Verified	Unverified
Engage/disengage	12	5	7
Warning light/horn	13	5	8
Fails BITE	4	2	2
Mode lights	7	2	5
Camout	1	1	0
Other/unknown	5	0	5
Time	10	0	10
Total	52	15	37

$$*\text{MTBR} = \frac{53808 \text{ hrs}}{52 \text{ removals}} = 1035 \text{ hrs}$$

*Verification rate = 15/52 = 28.8%

*Excludes scheduled or time controlled removals.

Auto Stab Trim Computer

Symptom	Removals	Verified	Unverified
Fail light	21	13	8
Fail BITE	4	4	0
Inoperative	7	5	2
Causes A/P disconnect	1	0	1
Other	1	0	1
Total	34	22	12

$$\text{MTBR} = \frac{53808 \text{ hrs}}{34 \text{ removals}} = 1583 \text{ hrs}$$

Verification rate = 22/34 = 65%

ORIGINAL PAGE IS
OF POOR QUALITY

Auto Throttle Computer

Symptom	Removals	Verified	Unverified
Does not respond properly (overboosts)	17	4	13
Warning light	2	2	0
Inoperative	3	1	2
Other	4	2	2
Total	26	9	17

$$\text{MTBR} = \frac{53808 \text{ hrs}}{26 \text{ removals}} = 2070 \text{ hrs}$$

Verification rate = 9/26 = 35%

Mode Select Panel

Symptom	Removals	Verified	Unverified
A/T control	2	2	0
Alt select functions	6	4	2
Course select function	5	2	3
Hdg select function	3	3	0
Pitch mode sw	2	2	0
Lateral mode sw	0	0	0
F/D bars	7	2	5
Engage/disengage	10	1	9
Other	13	2	11
Total	48	18	30

$$\text{MTBR} = \frac{53808 \text{ hrs}}{48 \text{ removals}} = 1121 \text{ hrs}$$

Verification rate = 18/48 = 38%

Controller

Symptom	Removals	Verified	Unverified
Aileron hardover	1	1	0
No manual modes	1	1	0
Physically damaged	1	1	0
A/P warn/disengage	4	0	4
Heading error	1	0	1
Porpoising	1	0	1
Rough pots	1	0	1
Total	10	3	7

$$\text{MTBR} = \frac{53808 \text{ hrs}}{10 \text{ removals}} = 5381 \text{ hrs}$$

Verification rate = 3/10 = 30%

Accelerometer–1 Removal

Trim interface unit

Symptom	Removals	Verified	Unverified
Warn light	7	0	7
Erratic/inoperative	2	0	2
Other	1	0	1
Total	10	0	10

$$\text{MTBR} = \frac{53808 \text{ hrs}}{10 \text{ removals}} = 5381 \text{ hrs}$$

Verification rate = 0%

ORIGINAL PAGE IS
OF POOR QUALITY

AFCS Accessory Box 1

Symptom	Removals	Verified	Unverified
A/P warning/disengage	2	1	1
F. D. annunciator inop	1	0	1
Total	3	1	2

$$\text{MTBR} = \frac{53808 \text{ hrs}}{3 \text{ removals}} = 17936$$

Verification rate = 33%

AFCS Accessory Box 2

Symptom	Removals	Verified	Unverified
Chronic P/A test	1	0	1
A/P disengage	1	0	1
Causes pitch comp. to fail	1	0	1
Total	3	0	1

$$\text{MTBR} = \frac{53808 \text{ hrs}}{3 \text{ removals}} = 17936$$

Verification rate = 0%

Auto Throttle Servo

Symptom	Removals	Verified	Unverified
A/T inop	1	0	1
Other	2	0	2
Total	3	0	3

$$\text{MTBR} = \frac{53808 \text{ hrs}}{3 \text{ removals}} = 17936$$

Verification rate = 0%

ILS Receiver

Symptom	Removals	Verified	Unverified
Warning indication	24	10	14
Weak output	27	6	21
Inoperative	9	3	6
Fails BITE	2	0	2
Autoland disconnect	3	0	3
Other	4	0	4
Total	69	19	50

$$\text{MTBR} = \frac{107616 \text{ hrs}}{69 \text{ removals}} = 1560 \text{ hrs}$$

Verification rate = 19/69 = 28%

Radio Altimeter

Symptom	Removals	Verified	Unverified
Inoperative	17	7	10
Erratic/erroneous altitude	12	3	9
Fail warning	15	5	10
GPWS	3	0	3
Autoland warn	2	1	1
Fails BITE	4	1	3
Other	8	1	7
Total	61	18	43

$$\text{MTBR} = \frac{107616 \text{ hrs}}{61 \text{ removals}} = 1764 \text{ hrs}$$

Verification rate = 18/61 = 30%

INS Computer

Symptom	Removals	Verified	Unverified
Malf. code/warn	64	56	8
Error	7	5	2
Inop	7	7	0
A/P performance	8	0	8
Other	8	1	7
Total	94	69	25

$$\text{MTBR} = \frac{107616 \text{ hrs}}{94 \text{ removals}} = 1145 \text{ hrs}$$

Verification rate = 69/94 = 73%

Air Data Computer

Symptom	Removals	Verified	Unverified
Alt/Mach perf	26	9	17
Alt/Mach flag	19	9	10
TAS/SAT/TAT	8	5	3
Inop/all flags	19	8	11
A/P perf	9	2	7
BITE	4	3	1
GPW/ATC	4	1	3
Other	10	0	10
Total	99	37	62

$$\text{MTBR} = \frac{107616 \text{ hrs}}{99 \text{ removals}} = 1087 \text{ hrs}$$

Verification rate = 37/99 = 37%

Compass Coupler

Symptom	Removals	Verified	Unverified
Hdg Flag	4	2	2
No slave/inop/erratic	8	4	4
A/P hdg hold	2	1	1
Hdg error	2	0	2
Other	3	0	3
Total	19	7	12

$$\text{MTBR} = \frac{107616 \text{ hrs}}{19 \text{ removals}} = 5664 \text{ hrs}$$

Verification rate = 7/19 = 37%

Attitude Director Indicator

Symptom	Removals	Verified	Unverified
ILS display	9	8	1
Attitude display/flag	27	10	17
Rwy display/flag	35	22	13
Turn and bank ind.	6	3	3
Flight director flag	29	20	9
Flight director display	20	13	7
Other	1	0	1
Total	127	76	51

$$\text{MTBR} = \frac{107616 \text{ hrs}}{127 \text{ removals}} = 847 \text{ hrs}$$

Verification rate = 76/127 = 60%

Summary of Verification Rates -- United Airlines and Pan American

The verification rates for Pan American were extracted from the shop finding results identified in Section 5.2.

$$\text{Verification rate} = \frac{\text{confirmed failures}}{\text{number of records examined}} \times 100\%$$

	Verification rate percent	
	United	Pan American
Major Computers		
Computer, pitch	44	31
Computer, roll	53	40
Computer, yaw damper	47	49
Unit, monitor and logic	29	32
Unit, auto stabilizer trim	65	36
Computer, auto throttle	35	72
Dedicated Sensors		
Box, accessory stabilizer trim	0	3
Box, accessory #1	33	23
Box, accessory #2	0	15
Control/Display Units		
Panel, mode select	38	57
Control, A/P flight	30	37
Indicator, attitude director	60	52
Shared Sensors		
Receiver, navigation	28	25
Transceiver, low range radio alt.	30	42
Unit, inertial navigation	73	65
Computer, central air data	37	37
Coupler, MHR compass	37	62

6.2 SHOP MAINTENANCE

The basic cost elements that make up shop maintenance cost are labor manhours per removal and material cost per failure. Both these cost elements have been extracted from the maintenance assessment appendixes (United Airlines-Appendix C and Pan American-Appendix D). The results are shown in Table 6-1.

Total shop maintenance costs can be computed from the manhour and material cost for each component as follows:

Shop cost/year = labor manhours per removal
x labor rate ($/Hour)
x no. of removals per year
+
material cost per failure
x no. of failures per year

Table 6-1.—Shop Maintenance Costs

	Labor manhour per removal		Material cost per failure	
	United	Pan Am	United	Pan Am
Major Computers				
Computer, pitch	10.0	7.3	265.78	107.13
Computer, roll	9.6	5.9	260.90	86.28
Computer, yaw damper	2.9	4.7	6.17	10.20
Unit, monitor and logic	4.5	5.0	213.92	42.10
Unit, auto stabilizer trim	4.5	7.2	159.67	26.38
Computer, auto throttle	4.5	17.1	42.04	261.86
Dedicated Sensors				
Accelerometer, normal	6.0	—	—	—
Box, accessory stabilizer trim	1.6	3.2	0	0
Box, accessory #1	5.7	3.5	0	0
Box, accessory #2	5.5	3.8	54.64	8.40
Control/Display Units				
Panel, mode select	6.8	4.7	61.81	70.30
Control, A/P flight	5.0	5.3	89.06	.85
Light Set, flight mode annunciator	—	5.1	—	—
Indicator, attitude director	4.3	8.7	20.79	267.37
Shared Sensors				
Receiver, navigation	8.0	12.3	20.90	15.64
Transceiver, low range radio alt.	5.1	7.8	15.98	5.34
Unit, inertial navigation	21.2	56.6	(571.90)	0.00*
Computer, central air data	12.8	13.0	53.92	141.18
Coupler, MHR compass	4.4	12.6	16.44	2.69
			1282.02	1045.72

*Returned to vendor

6.3 SCHEDULE IRREGULARITY

When an airborne system failure results in an interruption of scheduled operation, such as delay or cancellation of scheduled flight, additional cost would be incurred. An industry survey made in early 1976 shows the following delay and cancellation costs for 747 aircraft:

Cost for typical delay of 40 min:	$ 550 - $1,190
Cost for cancellation of flight:	$1,500 - $5,000

The composition of these costs includes extra ground transportation, hotel and meal accomodations for passengers, overtime pay for maintenance and flight crews, etc. In addition, many intangible items such as competitors reliability, schedule similarity, load factors, etc. are important factors, although difficult to substantiate. All these items have different values depending upon the individual case, and the difficulty is evidenced by the large spread as shown in the industry survey. At United, costs of flight schedule interruptions as cited below are being used only for the purpose of engineering work estimates:

747 delay cost per hour per delay:	$ 300
747 cancellation cost per departure:	$3,600

Boeing has, since the introduction of 747's, maintained a computerized file of schedule interruptions for all operators using operator data. This data is filed by component and for this study the 24 units for which reliability data was collected were included in the search.

Because of the difference in route structure a different value was used for delays and cancellations for the two airlines.

	PA	UA
Average cost per delay hour for delays	$ 500.00	$ 300.00
Average cost per flight cancellation	$ 4,000.00	$ 3,600.00
No. of delays	15	51
No. of cancellations	2	2
Resulting cost for all interruptions	$14,780.00	$13,251.00
Total flight hours in study	61,943	53,808
Interruption cost per flight hour	$ 0.24	$ 0.25
Total flights in study	14,405	13,304
Interruption cost per flight	$ 1.02	$ 1.00

ORIGINAL PAGE IS
OF POOR QUALITY

7.0 FIRST COST SUMMARY

The costs examined to this point are direct maintenance costs involving line and shop labor and material. From a broader viewpoint of assessing a total cost of owning the AFCS, other costs such as hardware acquisition costs, initial maintenance and flight crew training costs must be taken into consideration. A detailed cost-of-ownership computation is out of the scope of this study; however, a summary of each item should serve to illustrate the magnitude of line and shop cost as compared to the total cost. The following first cost items are divided into two broad categories: hardware costs and spares costs.

The following costs are those from United Airlines.

One Time Costs

Hardware acquisition cost	$2,809,399
Spares acquisition cost	$ 867,161
Initial cost of maintenance crew training	$ 65,800
Initial cost of flight crew training	$ 368,520
	$4,110,880
Inventory cost per airplane in fleet is	$ 204,254

Note:

Above costs are for AFCS computers, servos, and dedicated sensors to support the fleet of 18 747's.

Similar inventory data from Pan American includes:

Hardware acquisition cost	$4,284,992
Spares acquisition cost	$1,256,967
Total inventory	$5,541,959
Inventory cost per airplane in fleet is	$173,186

APPENDIX A

UNITED AIRLINES

COMPONENT INSPECTION AND REMOVAL (I&R) TAG HISTORIES

UNIT. PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8018	14188	7/1/75	HNL	FAILED TEST #2 TESTED A/C COA-1747-1	B		OH RPL A9A3 FAILED CARD TEST 39 & ATE STEPS 94-95-96-98		✓	✓		41	49	
2	8004	106728	7/2	HNL	UNIT VERY NOISY (GYRO) FAILS TEST #6	A		A9A5 SATURATED GYRO ERRATIC COMPL COA 8-1530 RPL A9A5 + GYRO	✓				19	62	BITE V
3	8028	7452	7/3	SFO	RED & AMBER A/P LITE ON AT SAME TIME. FAILED BITE 3	C		UNABLE TO DUPLICATE ALL PINS & CARDS CHECKED		✓		✓	14	23	BITE U.V
4	8028	7452	7/3	SFO	FAILED BITE #2 & #6. RED & AMBER ON AT THE SAME TIME	B		FAILED BITE #7. PIN A749 BENT. REPL A6A1 & PIN		✓	✓		36	6	BITE U.V
5	8003	680	7/4	SFO	FAILED BITE #5-7 ALSO MAKES A/P HORN SOUND	A		A7A12 FAILED ATE 26 ALSO ATE 144 RPL A7A12 + A4A7 + A12	✓				33	12	
6	JAC	—	7/7	—	#N78 ON LR-20725 (POOL LOAN)	—	—	NORMAL OH				✓	—	—	
7	JAC	—	7/13	—	POOL LOAN ON LR-20694	—	—	A9A2 FAILED BITE #8 RPL A9A2			✓		—	—	
8	8003	727	7/13	SFO	CAUSES A/C TO PITCH UP WHEN ENG. ALSO ROLL BAR CMDS LT TURN	A? B		A12J1 OPEN, PRIMARY & SECONDARY RPL A12J1 E S 1	✓		✓		12	41	
9	8011	15850:23	7/16	SFO	FAILED BITE, FAILED AUTOLAND DURING TEST FLT	B		A7A8 & A6A5 FAILED BITE A/C A22235:02 RPL A6A5 + A6A8	✓		✓		26	18	BITE V.
10	8003	727	7/13	SFO	CAUSES A/C TO PITCH UP WHEN ENG. ALSO ROLL BARS TO MOVE ONLY LT	B? A		A12J1 BURNT FAILED ATE #4. BAD SOLDER JOINT ON A1A8. FAILED ATE 345	✓		✓		56	2	
11	8011	15851:11	7/16	SFO	FAILED BITE. NO FLARE	A		A7A9 FAILED BITE 8, TEST 12 ON ATE. RPL A7A9 A7A7 & A2A2	✓		✓		55	19	BITE ✓
12	8017	15451:56	7/20	SFO	F/D FLAG IN VIEW, NO CMD BARS	C		A6A2 FAILED 256, 20N ATE RPL A6A2. A9A5 RATE GYRO	✓		✓		37	56	
13	8010	1950	7/21	LAX	HOLD FOR G. BAIT IN CMD ALT HOLD IS RCVING PITCH UP SIG. BITE OK. PREV F/D PROB	B		DID COA 8-1530 RPL A2A5 A/C FAILED BITE 2 5 + 7		✓	✓		5	14	BITE PROB
14	8028	7666:14	7/22	SFO	FLT DIR FLAG ON C	C		TESTED OK		✓		✓	23	26	
15	8028	7741	7/30	JFK	"B" A/P RED WARN LITE ON, BITE FAILED #2	B		A-8 CARD FAILED 129-135 ON ATE RPL A8	✓				26	25	BITE V
16	8013	16156:26	7/31	HNL	F/D BAR 3-4° LOW ON B OK ON A + C IN ILS	B		A2A1 FAILED STEP 296 ON ATE RPLD A2A1	✓				58	33	
17	—	—			SERVICE TAG MISSING			OH- RPL A6P10			✓		41	41	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8027	10844:05	8/4	LAX	CAPT F/D PEAKS OK ON A OR B. FAIL BITE #3	C		TESTED OK		✓		✓	13	55	BITE U.V.
19	8016	15736:06	8/5	LAX	WILL NOT ENG IN CLIMB. CRUISE OK	A		TESTED OK		✓		✓	68	27	
20	8028	7884:06	8/11	HNL	F/D FLAG FAIL TO RETRG FAIL BITE 2-5-6-8	B		TESTED OK		✓		✓	25	5	BITE U.V.
21	8028	7938:27	8/14	HNL	INOP ON TEST 2.5.6.8			TESTED OK		✓		✓	5	67	BITE U.V
22	8028	7914:45	8/14	HNL	DOES NOT GO THRU TEST CYCLE. STAYS ON YELLOW LT	A		A7A5 FAILED ATE 116 + 51 A7A12, A4A8 & A6A4 ALSO FAILED ATE		✓	✓		61	26	BITE U.V
23	8020	14324:45	8/21	LAX	PITCH INOP. STAB OUT OF TRIM LITE ON	A		UNIT OK PER ATE. NOTE FREQ STAB GRIPES ON 8020		✓		✓	53	13	
24	8019	14406	8/31	SFO	SEE LINE REJECT TAG	A B C		A4A5 FAIL SELF TEST #2 RPL A4A5 A2A1	✓		✓		36	36	
25	8019	14461	8/31	SFO	A/P TRIP OFF AT 150' FAIL STEP B	C		A6 CARD RPL A6A3	✓				3	37	BITE V.
26	8019	14406	8/31	SFO	FAIL STEP 8 EVERY TIME	C		A6A5 FAILED ATE # 257 & CD CK #17 RPL A6A5		✓			11	53	BITE U.V
27	8017	15891:16	9/3	ORD	WONT ENG. FAILS BITE NO. 1 CONSISTENTLY	B		RATE GYRO PER BITE #1 RPL A1A2, A6A10, RATE GYRO	✓		✓		16	22	BITE V.
28	8017		9/3	ORD	FAILS BITE #8 STOCK REJECT			ATE OK		✓		✓	21	21	BITE U.V
29	8016	15945	9/6	HNL	WHEN TURB SELECTED, ENG LEVER WILL NOT DROP TO MAN.	A		CAN NOT DUPLICATE ATE OK		✓		✓	27	25	
30	8032	8613	9/7	SFO	FAILED BITE #5.6, 7.8.9	C		UNABLE TO VERIFY		✓		✓	57	16	BITE U.V
31	8012	16598	9/22	HNL	A/P PITCHES HARD DOWN ON G/S. WONT FOLLOW G/S BITE OK	A		FAILED S.T. 5 & ATE 239 RPL A7A2 & A9A9	✓		✓		8	27	(PROB) BITE U.V
32	8032	881950	10/1	ORD	A/P & F/D PITCHES IN ALT HOLD			TESTED OK		✓		✓	16	36	
33	8028	3242	10/2	LAX	FAILS TEST #7, GIVES F/D FLAG WHEN SELECTED FOR FD	7 8 A		A6 CARD FAILED BITE 7 RPL A6A10	✓			✓	67	5	BITE V.
34	8012	16649	10/3	SFO	"B" A/P GIVES ABRUPT PITCH AT TIMES	B		A7A2 FAILED ATE 108.1 REPL A7A2	✓				28	57	

FORM ARCS UA-2 9/27/76

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POE	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
18	8027	10844:05	8/4	LAX	CAPT F/D PERKS OK ON A OR B. FAIL BITE #3	C		TESTED OK		✓		✓	13	55	BITE U.V.
19	8016	15736:06	8/5	LAX	WILL NOT ENG IN CLIMB. CRUISE OK	A		TESTED OK		✓		✓	68	27	
20	8028	7884:06	8/11	HNL	F/D FLAG FAIL TO RETRY FAIL BITE 2-5-6-8	B		TESTED OK		✓		✓	25	5	BITE U.V.
21	8028	7938:27	8/14	HNL	IN OP ON TEST 2.5.6.8			TESTED OK		✓		✓	5	67	BITE U.V
22	8028	7944:45	8/14	HNL	DOES NOT GO THRU TEST CYCLE. STAYS ON YELLOW LT	A		A7A5 FAILED ATE 116+51 A7A12, A4A8 & A6A4 ALSO FAILED ATE		✓	✓		64	26	BITE U.V.
23	8020	14324:45	8/21	LAX	PITCH INOP. STAB OUT OF TRIM LITE ON	A		UNIT OK PER ATE. NOTE FREQ STAB GRIPES ON 8020		✓		✓	53	13	
24	8019	14406	8/31	SFO	SEE LINE REJECT TAG	A B C		A4A5 FAIL SELF TEST #2 RPL A4A5 A2A1	✓		✓		36	36	
25	8019	14461	8/31	SFO	A/P TRIP OFF AT 150' FAIL STEP B	C		A-6 CARD RPL A6A3	✓				3	37	BITE V.
26	8019	14406	8/31	SFO	FAIL STEP 8 EVERY TIME	C		A6A5 FAILED ATE # 257 & CD CK #17 RPL A6A5		✓			11	53	BITE U.V
27	8017	15891:16	9/3	ORD	WONT ENG. FAILS BITE NO. 1 CONSISTENTLY	B		RATE GYRO PER BITE #1 RPL A1A2, A6A10, RATE GYRO	✓		✓		16	22	BITE V.
28	8017		9/3	ORD	FAILS BITE # 8 STOCK REJECT			ATE OK		✓		✓	21	21	BITE U.V
29	8016	15945	9/6	HNL	WHEN TURB SELECTED, ENG LEVER WILL NOT DROP TO MAN.	A		CAN NOT DUPLICATE ATE OK		✓		✓	27	25	
30	8032	8613	9/7	SFO	FAILED BITE #5.6, 7.8.9	C		UNABLE TO VERIFY		✓		✓	57	16	BITE U.V.
31	8012	16598	9/22	HNL	A/P PITCHES HARD DOWN IN G/S. WONT FOLLOW G/S BITE OK	A		FAILED S.T. 5 & ATE 239 RPL A7A2 & A9A9	✓		✓		8	27	(PROB) BITE U.V
32	8032	881950	10/1	ORD	A/P & F/D PITCHES IN ALT HOLD			TESTED OK		✓		✓	16	36	
33	8028	3242	10/2	LAX	FAILS TEST #7, GIVES F/D FLAG WHEN SELECTED FOR FD	7 B A		A6 CARD FAILED BITE 7 RPL A6 A10	✓			✓	67	5	BITE V.
34	8012	16649	10/3	SFO	"B" A/P GIVES ABRUPT PITCH AT TIMES	B		A7A2 FAILED ATE 108.1 REPL A7A2	✓				28	57	

FORM ARCS UA-7 9/27/78

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
35	8073	12966	10/4	JFK	ALT SEL OVERSHOOTS AFTER CLIMBING TO SEL ALT. BITE OK OUT WHIT HOLD SEL ON	A		UNABLE TO DUPLICATE		✓		✓	40	12	BITE PROB BITE V.
36	8013	16790:53	10/5?	HNL	A/P RED LITE COMES ON IN CMD FAILS BITE #7	A		A2 CARD. A2A4 FAIL BITE RPL A2A2. ALSO A6A10 + A6A4 FAIL ATE	✓		✓		31	61	BITE V.
37	8032	8934:33	10/16	LAX	A/P ELEV CHNL JERKY FAILED BITE #2	B		RPL A4A8 (FOR OTHER REASON)		✓	✓		38	16	BITE UV
38	8003	1754:57	10/30	HNL	BITE CK INOP. AMBER LITE STAYS ON	A		LOOSE SCREW ON AMBER LITE HOLDER	✓			✓	41	11	BITE V.
39	8016	11631:40	10/31	ORD	PITCHES UP ON ENGAGING	A		UNABLE TO VERIFY		✓		✓	25	40	
40	8012		10/31	SFO	F/D PITCH BAR DOES NOT SHOW IN F/O OR CAPTAIN IN ALT HOLD			A9A10. FAILED 145.4 ON ATE, 33 ON CARD TEST	✓			✓	59	28	
41	8012		10/31	SFO	PITCH BAR OUT OF VIEW ON APPROACH	B		REPL A10A-2 - BITE FAIL		✓	✓		57	23	
42	8014	16176	11/3	LAS? LAX	"B" COMPTR INOP FAILS BITE 2-5-6-7	B		A4A8. FAILED #170 ON ATE. RPL A4A8	✓			✓	10	3	BITE V.
43	8012	16882:49	11/4	SFO	FAILS BITE STEP 6. ALT HOLD INTERMITT INOP	A C		A9A6 FAIL #126 ON ATE. RPL A9A6	✓			✓	28	57	BITE V
44	8012	16883:38	11/5	HNL	F/D FLAG, NO TIME FOR BITE CHECK. COMP FROM "C" BITE OK	B		A6A5 FAILED CK 13 & 19 A7A11 FAIL BITE 2 & 76. A9A9 FAIL BITE 7	✓		✓		67	67	
45	8012	16911	11/8	CLE	BOTH F/D INOP BITE OK	C		A7A9 (INTMT) FAIL ATE 221, 223.1 A7A10, A9A1 ALSO FAIL	✓		✓		23	8	BITE UV
46	8029	8993:29	11/8	HNL	WHEN "A" IN CMDE IAS SEL STEADY RE A/P LITE ON	A		A7 CARD A7A4 FAIL ATE #40 RPL	✓				30	68	
47	8013	17094	11/14	SFO	COMP BITE CHKS OK, BUT LOCKS OUT "B" A/P AFTER 2 HR WARM UP	B		UNABLE TO VERIFY		✓		✓	21	25	BITE U.V.
48	8013	17159	11/24	HNL	FAIL BITE #7 ALSO GIVES SUDDEN PITCH UP	B		A7A7. FAILED #17 ON ATE RPLD	✓				25	30	BITE V.
49			11/26	HNL	ON ILS AFTER G/S CAP BAR PITCHES UP TO G/A. PROB AFTER A/P ACC'NISL			A7 CARD. FAILED #219 ON ATE. RPLD A7A9	✓			✓	33	33	
50	8010	3045	11/27	LAX	F/O'S PITCH BAR BIASED OUT	B		A7A4 INTERMITTENT RPLD	✓			✓	14	41	
51	8014	16407:48	11/29	LAX	NO AMBER LITES FAILED BITE #8. 10 AMBER FLARE LITES	B		A6A5. FAILED #77. ALSO A6A1 FAIL 261.6 RPLD	✓		✓		3	46	BITE V.

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52	JAL				(POOL) ON LR-16863 POOL NO. M78			NO TROUBLE				✓	?	23	
53			12/1	CLE	FAILED #8 REPEATEDLY			RPL A7A11 + A7A12 FAILD TESTS 22-25, 27-32		✓	✓		21	21	BITE U.V.
54			12/2	SFO	A & C CMPTRS WONT CAP ALT SEL. BITE OK BUT WONT CAPT. B&K	C		REPL A7A10, A9A11, A6A10 A6A1 FAIL STEPS 66, 70.1, 272-5	✓				47	59	(UNIT BAD BITE GOOD) BITE U.V
55			12/2	SFO	THIS UNIT WOULD NOT PASS BITE. OR CAPT ALT SEL			A7A11. RPLD A7A11	✓			✓	34	33	BITE V.
56	8004	2411	12/3	SEA	"A" A/P & F/D WILL NOT CAP ALT SEL BITE OK BUT NEW PITCH FIXED IT	A		A7A4 FAILED ATE 26 A7A10 FAILED ATE 27 A9A2 FAILED ATE 68 A9A6 & A4A1: ALSO	✓		✓		7	28	(UNIT BAD BITE GOOD) BITE U.V.
57	8004	2418	12/4	LAX	BAD OUT OF STOCK. ALT SEL COULD NOT CAPTURE	C		A7A3 FAILED STEPS 2 & 3 RPL		✓	✓		14	14	
58	8004	2418	12/4	LAX	ALT SEL WILL NOT CAPT	C		REPAIRED LOOSE CONNECTOR A1A4-16		✓	✓		59	22	VERIFIED ? MUST HAVE CORRECTED !
59	8032	9366	12/26	SFO	FAILED BITE #8	B		TESTED OK		✓		✓	36	33	BITE U.V.
60	8020	15345:07	12/29	SFO	FAILS BITE 2-6-7-8 IN FLT. A/C HOLDS 2° NOSE DN IN ALL MODES, DIVES IN ALT HLD	A		A9A6. FAILS BITE 2-8 RPLD	✓			✓	13	31	BITE V.
61	8004	2591	1/11	SFO	"NO TEST LITE "B" PITCH	B		A6BD MARGINAL FAILURE ON ATE 286.3 RPL A6BD		✓	✓		22	13	BITE UV
62	8013	17502	1/20	SFO	NO DISENGAGEMENT WITH RED LITE ON. REPLACED PRECAUTIONARY	B		A4 CARD RPL A4A8. FAILED ATE 169	✓			✓	30	3	
63	8027	12209:36	1/24	LAX	REPORTED "A" PITCH JERKS WHEN USED. BITE CKS OK WITH ALL CHKS WITH INS OFF	A		A4A12 FAIL ATE138 RPL A4A12	✓			✓	4	22	(UNIT BAD BITE OK) BITE U.V.
64	8012	17341	1/26	SFO	FAILED BITE #7	A							8	7	
65	8023	13229	1/26	LAX	"A" A/P WOULD NOT [illegible]	A		UNABLE TO VERIFY		✓		✓	12	59	
66	8013	17551:46	1/27	HNL	RPL PER SPEC'G [illegible] PER [illegible]	B		RATE GYRO. FAILED BITE #1, A4A7 FAILED ATE 108 RPLD GYRO & A4A7	✓		✓		39	23	
67	8035	[illegible]33:46	1/28	HNL	UNABLE TO ENG "B" A/P VERIFIED BY UNIT SWAP. [illegible] BITE OK	B		NO TROUBLES		✓			21	25	
68	8035	3257	1/31	SFO	WILL NOT CAPT ACT SEL FAILED BITE LAND #8	C		A7A8 FAIL 259.1 ON ATE RPLD		✓	✓		58	54	BITE U.V

FORM ARCS UA-3 5/27/76

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
69	8027	12266:34	1/30	LAX	A/P OSCILLATES IN PITCH ALSO FAILS BITE	A		GYRO. RATE GYRO FAIL S.T. #1 & A2A5 FAIL RPLD	✓		✓		22	38	
70			1/30	SFO	NO DATA			SHOP TEST OK		✓		✓	36	—	
71	8035	8862	2/1	HNL	A/P DISCONNECTS IN CMD OR MAN. FAIL BITE No. 7	A		UNABLE TO VERIFY		✓		✓	64	8	BITE U.V.
72	8013	17601	2/3	SFO OV	INTERMITTENTLY INOP RED FLAG	B		A7A4 FAILED ATE 39 ALSO A7A3 RPLD	✓		✓		23	36	
73	8020	15629	2/6	SFO	FAILS BITE 8. F/D FLAG REMAINS IN VIEW	C		UNABLE TO VERIFY		✓		✓	63	58	BITE U.V.
74	8010	3479	2/8	SFO	LINE REJECT - SEE LINE REJ. TAG			UNABLE TO VERIFY		✓		✓	23	23	
75	8010	3482	2/8	SFO	STEP 8 FAIL EVERY TIME	B		NO TROUBLES		✓		✓	9	4	BITE U.V
76	8010	3482	2/8	SFO	BITE TEST WON'T INITIATE	A		A10C1 BAD RPLD A10C1	✓			✓	41	30	BITE CKT BITE V.
77	8023	13885:24	2/8	SFO	(ROBBED UNIT) INSTALLED ON 8010	B							44		
78	8010	3479	2/8	SFO	ROBBED FROM 8023	B								44	
79	8023	13885:24	2/8	SFO	(ROBBED UNIT) INSTALLED ON 8010	A							59		
80	8010	3479	2/8	SFO	ROBBED FROM 8023	A								59	
81	8035	8987	2/17	SFO	BITE OK BUT HAS CONT. NOSE SIG IN MAN OR CML. SNAPPING NOSES PROB	B		FAIL ATE 233.3 RPL A1A11 & A1A9	✓			✓	25	63	(UNIT BAD BITE OK) BITE U.V.
82	8010	3528:05	2/13	HNL	"A" CHNL WILL NOT HOLD ALT	A		A2A8 FAIL S.T. #1 & ATE 16 RPLD	✓			✓	15	39	
83	8035	8987	2/18	SFO	FAIL BITE STEP 8	C		A1A7 FAILED ST #5 & CD CK #42 RPL A1A7		✓	✓		54	23	UNIT BAD BITE OK ALSO REVERSE IS TRUE BITE U.V.
84	8004	2832	2/20	LAX	FAILS BITE #3	A		GYRO FAILS #1 RPL RATE GYRO		✓	✓		28	9	UNIT BAD BITE OK 5 V.V. BITE U.V.
85	8027	12485	2/22	CLE	FAILS BITE #2	?A C		A4A5 FAIL ST#2 & ATE 55 GYRO FAIL ST #1 RPLD A4A5 & GYRO	✓		✓		38	21	BITE PART V

FORM ARCS UA-2 5/27/76

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
86	8032	9843	2/24	HNL	F/D GOES TO G/A MODE FOR NO REASON	C		A4A5 FAIL ST#2 & ATE "55" RPL A4A5		✓	✓		17	12	
87	8027	12517:38	2/25	ORD	PITCH OVER AT ALT NO ENG, "B" SYS	A B		UNABLE TO VERIFY		✓		✓	21	22	
88	8010	3655	2/27	SFO	BITE OK. BUT PITCH BAR IS BIASED OUT	C		UNABLE TO VERIFY		✓		✓	59	25	GOOD UNIT BITE V.
89	8010	3655	2/2[illegible]	SFO	FAIL BITE #7 & 8	C		A6A9 A6A3, A7A2, A7A5 A7A9 & A10C1 RPLD	✓		✓		44	15	BITE V.
90	8011	17470:00	2/28	JFK	FAIL TEST #1, WIGGLE AROUND LATERAL AXIS WHEN ENG OR THEREAFTER	B		A10A2 FAIL ALL ST. RPL A10A2		✓	✓		51	44	BITE V
91	8032	9864	2/28	SFO	STEP #8 OF BITE NO GOOD	B C		NO TROUBLES		✓		✓	33	54	BITE UV
92	8032	9864	2/28	SFO	FAIL BITE 2. 7. & 8	C		A9A5 FAIL CARD TEST 33 & A9A10 FAIL BITE 2-7-8 RPLD	✓		✓		12	17	BITE V.
93	8003	2628:00	TURN		FAILED STEP 1 OF S.T.	C		A7A7 & A6A2 & A1A4 + RATE GYRO: RPLD	✓		✓		38	38	BITE V.
94	8035	9112:23	3/1	HNL	UNABLE TO ENGAGE FIRST 2 HRS. WORKED OK REST OF TRIP, UNABLE TO DUAL	B		UNABLE TO VERIFY		✓		✓	23	64	
95	8010	3719:18	3/5	LAX	A/P STARTS CLIMBING WHEN ENG	B		UNABLE TO VERIFY RPL A1A12		✓	✓		25	67	
96	8003	2628	3/6	SFO	FAILED SELF TEST #2	B C		A1A4 FAIL S.T. 5 & ATE 35 RPLD A1A4		✓	✓		2	41	FAILED OTHER PART BITE UV
97	8032	9935	3/7	HNL	"UNS PER ATTACHED MESSAGE"	B		A7A9 RPLD A/C ATE 21 & 22 A1A11 STEP 212 A1A4 STEP 91 & A9A10, A9A11, A9A12		✓	✓		17	51	
98	8035	[illegible]	3/13	HNL	A/P A[illegible] LITE ON IN ALT HOLD	A		A7A11 FAIL STEP 36 ON ATE RPLD	✓			✓	63	21	
99	8035	[illegible]	3/16	LAX	FAILS TEST 8 & DROPS TO OFF OCCASIONALLY	A		A7A7 FAIL #12 ON ATE RPLD	✓			✓	21	38	BITE V.
100	8027	12709:37	3/18	HNL	RED WARN LITE ON IN IAS MODE. OTHERWISE OK	A C		UNABLE TO VERIFY		✓		✓	55	23	
101	8017	17364	3/20	SFO	BITE FAILED #8	A		UNABLE TO VERIFY		✓		✓	10	21	BITE UV
102	8011		3/27	SFO OT	ALT SEL DOES NOT CAPTURE ALT	A		UNABLE TO VERIFY		✓		✓	14	55	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
103	8011	17613	3/27	SFO	WILL NOT CAPT ALT. CHA RPLD IN FLT (TEST FLT) OP CKD OK. NO S.T. PHASE	A		A7A2 FAIL BITE #2 RPLD A7A2, A1A6 + A1A4	✓		✓		19	59	
104	8011	1761304	3/28	SFO GT	WILL NOT PASS SELF TEST (FROM STOCK)	B		UNABLE TO VERIFY		✓		✓	55	47	BITE U.V.
105	8012	17913:36	4/2	LAX	WHEN SWITCHED TO ILS, A/P KICKS OFF. BITE FAIL #3	A		RPLD A1A9, A6A10 + A4A2 A/C FAILD STEPS ATE 91, 42, 16, 319.3, 324		✓	✓		7	33	(OTHER BITE CKT FAIL) BITE U.V
106	8010	3975	4/3	JFK	"B" A/P CAUSES INTERM HARD PITCH UP & DN IN IAS. FAIL S.T. #8	B		UNABLE TO VERIF RPL A7A4 DUE TO STEP 39 FAIL			✓		67	44	(OTHER CKT FAIL) BITE U.V
107	8003	2865	4/8	SFO	FAIL BITE #5 & 7	A		A6A10 FAIL 5 & 7, ALSO RPL A1A4 FOR ATE #16 & A9A12 FOR ATE 74 + 77	✓		✓		11	19	BITE V.
108	8032	10,191	4/8	LAX	FAILED SELF TEST #7	C		UNABLE TO VERIFY		✓		✓	54	25	BITE U.V.
109	8028	9787	4/9	HNL	ALT HOLD TRIPS OFF WHENEVER "A" A/P GOES FROM MAN TO CMD. BITE OK	A		UNABLE TO VERIFY		✓		✓	6	14	BITE V.
110	8013	17997	4/9	LAX	FAILS TEST #8	B		UNABLE TO DUPLICATE		✓		✓	36	28	BITE U.V.
111	8013	17997	4/9	LAX	FAILS TEST #8	C		RPL A1A4 INOP ON TEST 128 ATE		✓	✓		3	2	(OTHER CKT FAIL) BITE U.V
112	8032	10207:17	4/9	DEN	PER SFOEG RQST BECAUSE OF ALT SEL LEVEL OFF EARLY	~~B~~ C		FAILED 55, 56 + ~~25~~ ON ATE RPL A4A5 + A4A1		✓	✓		51	55	
113	8023	14322:24	4/9	HNL	UNIT PREV IN "B" POS. DEFERRED TO RPL "C" A/C: PREV LOG: RED STEADY WARN FLAG WITH "B" A/P.	C		NONE A6 CARD CHGD PRECAUT.		✓		✓	30	63	
114	8020	16190:14	4/12	HNL	HORIZ BAR ON F/D DOES NOT CAP ALT SEL	C		A6A7 FAIL BITE #7	✓				58	54	BITE V ?
115	8032	10258:59	4/15	HNL	RED A/P LITE ON WHEN IAS SELECTED	B		A7A10 + A6A1 FAIL A6R1, K5 OUT OF TOL RPLD	✓		✓		55	6	
116	8012	1801-	4/17	CLE	NO PITCH BAR AT TIMES BITE OK	C		A4 CARD CHGD TO -27 PRECAUTIONALLY		✓		✓	57	10	BITE V
117	8012	18001:35	4/18	HNL	FAILED SELF TEST #2	C		UNABLE TO DUPLICATE		✓		✓	10	3	BITE UV
118	8032	10291:53	4/20	HNL	A/P ALT SEL INOP REPL PITCH PER SFOEG	A		UNABLE TO DUPLICATE		✓			16	7	
119	8013	18029	4/24	SFO	THIS IS A GOOD UNIT - CHGD PER SFOLM. STRONG PITCH UP	B		FAILED CARD TEST 45 A9 CARD RPL A9A12		✓	✓		28	10	

FORM ARCS UA-2 5/27/76

UNIT: PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
120	8032	10736:00	4/24	ORD	FAILED BITE 4+5	A		RPL A9A3 FAIL ATE 170 + CARD TEST 26		✓	✓		7	17	(WRONG CKT) BITE U.V
121	8032	10353:59	4/25	HNL	ALT SEL - NO CAP	B		NO ENTRY							
122	8032	10373:03	4/27	LAX	GLIDE SLOPE HIGH OK ON B	C		A6A10 FAIL 291.9.1. 291.10. 291.11. 291.12 RPLD	✓			✓	25	7	
123	8032	10388:22	4/29	HNL	FAIL BITE 5 + 6	B		UNABLE TO VERIFY		✓		✓	36	6	BITE U.V.
124	8028	10004	4/30	SFO	F/D INOP. FAIL BITE 2 + 7	C		A4 + A9 CARDS RPLD	✓			✓	5	11	BITE V
125	8028	10004	4/30	SFO	FAIL BITE TEST 2-4-8	B		A2A1 FAIL + RPLD	✓			✓	26	25	BITE V
126	8012	HMV	5/1	SFO	NO FLARE AMBER AT 1500'	A		NO PROB FOUND		✓	✓		27	67	
127	8010	4219	5/2	LAX	A/P ERRATIC CODE 2.3.6.7.8	A		A9A2 FAIL BITE 2-7-8	✓			✓	12	55	BITE V
128	8032	10456:11	5/7	LAX	WOULD NOT CAPT ALT IN ALT SEL ON GND TEST	A		NORMAL OH		✓		✓	17	36	
129	STOCK	—	5/14	HNL	FAIL BITE #2	—		RATE GYRO NOISY	✓			✓	58	58	BITE V
130	8011	18093:34	5/16	ORD	PITCHED UP TWICE AT CRUISE ALT AT 33K	B		UNABLE TO VERITY		✓		✓	47	16	
131	8012	117	5/16	LAX	ERRATIC IN CRUZ	A		A6A4 FAILED		✓	✓		67	30	
132	8023	14751	5/24	HNL	CAUSES INTMTNT RAPID SHARP PITCH DOWN IN ALT SEL OR HOLD	A		UNABLE TO VERIFY		✓		✓	52	58	
133	8010	1486-4	6/1	HNL	ELEV HAS SLIGHT TWITCHING	A		UNABLE TO VERIFY		✓		✓	58	22	
134	8032	10769	6/1	SFO	ERRATIC PITCH	B		"		✓		✓	7	52	
135	8020	16642	6/14	SFO	INTERMIT. INT A/P RED LITE. WON'T TRK GLIDE SLOPE	A		A6A6 & A4A2 INOP A10 CR42 RPLD	✓		✓		35	5	BITE V
136	8010	4591	6/15	HNL	WHEN IAS SELECTED RED A/P ON STEADY	A		UNABLE TO VERIFY		✓		✓	55	26	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT PITCH COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
137	8025	14987	6/23	SFO	FAILS BITE 2, 7+8 BAD FROM STOCK	A		A9A1 FAIL RPLD	✓			✓	12	12	BITE V
138	8023	19787	6/23	SFO	INTLK NO GO AND F/D FLAG	–		UNABLE TO VERIFY		✓		✓	22	5	
139	8017	18228	6/24	SFO	BITE INOP. TEST LITE ON ALL THE TIME.	B		A10A2 INOP RPLD	✓			✓	42	22	BITE V
140	8020	16735	6/26	HNL	FAIL BITE TEST 2 + 7	A		A6-A9 FAIL CARD TEST 57 BROKEN WIRE, RPRD	✓			✓	58	55	BITE V

FORM ARCS UA-2 5/27/76

UNIT: ROLL COMPUTER (SOS ITEM)

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
1	8028	7433:13	7/1/75	LAX	HOLD FOR Q WHEN BOTH A/P ENG. RED WARN COME ON	A		UNABLE TO DUPLICATE		✓		✓	42	39	
2	8004	1067:78	7/2	HNL	VERY ERRATIC A A/P. FAILS BITE 4-5 .78	A		A6A2 RPLD	✓			✓	47	54	BITE V.
3	8003	680	7/4	SFO	FAILED BITE 3 THRU 8	B		A4A2 RPLD	✓			✓	78? 18	53	BITE V
4	8003	680	7/4	SFO	FAILED BITE 6	C		UNABLE TO DUPLICATE		✓		✓	24	30	BITE UV.
5	8004	1086		HNL	WHEN PLACED IN A POS. WAILER WONT CANCEL WITH DISCONN. WHEN IN A POS. B WONT ENG	A?		UNABLE TO VERIFY		✓		✓	42	42	
6	8016	1540	7/7	SFO	SELF TEST INOP. TEST AMBER LITE STAYS ON	C		A10A2 MODULE. ALSO RPL A4A11 FAIL ATE 255&57 A6A11 FAIL CARD 27	✓		✓		35	27	BITE V.
7	8004	1110:29	7/7	HNL	WILL NOT CAPT INS	A		A4A2 FAIL ST 91 RPLD		✓			54	22	BITE V?
8	8019	13877	7/10	HNL	FAILS TEST #5. A/P FLARE COMP INOP	A		J2 PIN 1 CRUSHED. RPD RPLD A7A2. A7A10. A6A10	✓		✓		40	7	BITE V.
9	8003	727	7/12	SFO	GYRO EXTREMELY NOISY			GYRO RPLD	✓			✓	41	4	
10	8003	727	7/13	SFO	FAILS BITE 3.6 & 7	C		A9A5 FAIL BITE 3 6 & 7 RPL A9A5	✓			✓	30	24	BITE V
11	8029	7936:42	7/14	LAX	ERRATIC & INOP	C		A9A8 INTERMITTENT RPLD	✓				38	55	
12	8011	15850:23	7/16	SFO OT	FAILED BITE. FAILED AUTOLAND DURING TEST FLT	A		A6A3 FAIL STEP 400 ATE RPLD	✓			✓	58	59	BITE V.
13	8028	7642:01	7/19	HNL	TWO REPORTS F/D FLAG SHOWING BOTH SIDE. GND CHK & BITE OK	C		SHOP TEST OK		✓		✓	47	30	BITE V
14	8010	1959:34	7/22	LAX	IN MANUAL MODE A/P DRIFT TO LEFT OK ON CMD MODE.	A		SHOP TEST OK		✓		✓	15	18	
15	8020	14041:5	7/23	SFO OV	PRECAUT. REPLD LOG: ON INS, FOLLOWS HDG BUG	B		A4A7 INS CAP INOP RPLD	✓				3	42	
16	8012	16057	7/26	SFO	LOST INS CAP AFTER APPROX 1 HR OPERATION	C		SHOP TEST OK		✓		✓	12	41	
17	8011	15968	7/31	SFO	PREV. RPTS OF ERRATIC ROLL SIG BITE OK EVERY TIME	B		A7A11 FAIL 87 ON ATE RPLD	✓			✓	36	47	(UNIT BAD) BITE UV

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: ROLL COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	QUANTAS				RETURN OF LOAN			NO TROUBLE					38		
19			7/?		FAIL BITE 5. UNIT RCVD OUT OF BOX			A6A4 FAIL S.T. #5 RPL A6A4, A6A2, A6A12	✓		✓		40	40	
20	8004	1375:50	8/2	HNL	FAIL BITE 1, 2 + 8	A		A6A4 FAIL BITE 1,2,8 RPLD	✓			✓	22	38	BITE V
21	8029		8/4	SFO	FAIL BITE 4-5-8	B.		UNABLE TO VERIFY		✓		✓	58	58	
22	8017	15597	8/4	SFO	"A" A/P HOLDS PLN ½ DOT TO LT OF CRS ON WEST HDG. BITE FAIL 3-6-7?	A		A6A10 FAIL BITE 6 + ATE 20 A4A1, A4A2, ALSO FAIL ATE RPLD	✓!		✓		26	3	(OTHER BITE FAIL) BITE P.V.
23	8016	1574:28	8/6	SFO	INTERMITTENT ENG PROB	C		A2 CARD A2A11 FAIL ATE 12 RPLD	✓			✓	27	22	
24	8016	1574:28 ?	8/9	SFO	FAILS BITE 2+8 NEW UNIT OK	C		A6A1 FAIL ATE 110 A6A10 FAIL CARD 23 RPLD	✓			✓	22	27	BITE V
25	8011	16036	8/9	LAX	OCCATIONAL HARD A/L BOTH DIRECTIONS	A		UNABLE TO VERIFY RPL A9A11 C4 + C3		✓	✓			40	
26	8029		8/9	SFO	FAIL BITE #3+6	A?		A6A9 FAIL BITE 3 A6A10 FAIL CD CK 24 A1A5 FAIL CD CK 4	✓		✓		61	17	BITE V
27	8004	1463	8/12	JFK	DEFERRED BY LAX "A" CHNL ROLL CMPTR INOP	A		A6 CARD RPLD A6A10	✓			✓	38	12	
28	8004	1536	8/20	LAX	A/P PADDLE WONT UNLOCK (INTMTNT)	A		A4A10 FAIL CD CK #56 + ATE 250-254 RPLD		✓	✓		12	22	
29	8003	1107:23	8/25	JFK	"A" WOULD ENG & DROP TO MAN OK BUT WONT TURN HDG	A		A1A5 FAIL ATE 165.1 + CARD CK6 A1A5 RPLD	✓			✓	24	54	
30	8003	1113:35	8/25	HNL	"A" A/P DOES NOT CAPT INS SWAP VERIFIES.	A		RPLD A4A7 PRECAUTIONARY CoA8-1807 CKD OK		✓		✓	54	15	
31	8017	15849	8/30	LAX	INTMTNT F/D FLAG. A/P WANDERS OFF HDG	B		A1A5, A9A10, A5A2 FAIL ATE. RPLD	✓		✓		6	12	
32	8028	8094:36	8/31	LAX	"B" A/P IN MAN. HAD A RED LITE WENT OUT WHEN IN CMD. BITE OK. RPLD AND CORRECTED.	B		UNABLE TO VERIFY		✓		✓	30	33	(AT LEAST LINE/SHOP) — SOME THING MAY BE BAD — BITE V.
33	8019	14413	9/1	HNL	FAIL OP TEST 3D7A OF MM 22-10-00 BITE OK. SWAP VERIF	B		UNABLE TO VERIFY		✓		✓	10	24	BITE V.
34	8017	15947	9/7	HNL	"B" A/P NEEDS CMPTR IN ILS POS, TURNED OFF CRS 2 DEG TO LT	B		UNABLE TO VERIFY		✓		✓	12	26	

FORM ARCS UA-2 5/27/76

UNIT: ROLL COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8032	8613	9/7	SFO	"B" ROLL BITE OK BUT CAUSES "B" PITCH TO FAIL BITE B	B		FAIL ATE # 332 CONT 1807 RPL A9A9 + A9A10	✓			✓	62	45	
36	8014	15689:48	9/8	HNL	AIL KICK ON INS. FAILS BITE 2, 3, 5, 6, 8	A		A6A9 & A6A10, A6A1 FAILS, T & BIPIS. RPLD	✓			✓	46	–	BITE V
37	8016	15983:58	9/9	ORD	TURN KNOB WILL NOT KICK A/P FROM CMD TO MAN	A ?		UNABLE TO VERIFY		✓		✓	27	38	
38	8014	15767	9/17	SFO	PRE CANT, OVER SENS AILERON			UNABLE TO VERIFY		✓		✓	56	36	
39	8017		9/18	HNL	FAIL BITE 2-3-5-6-7-8	C		4BD UNSEATED FAIL ATE 2+4 RESEATED & RPL A2A4	✓		✓		14	27	BITE V
40	8012		9/26	SFO	FAIL BITE 8	C		A4A1 FAIL ATE 265 + 266 RPLD		✓	✓		41	54	BITE V
41	8012		9/26	SFO	FAIL BITE 3-6-7	B		RPL RATE GYRO NOISY		✓	✓		1	58	BITE UV
42	8003	1439	9/28	HNL	FAIL BITE #9	B		A2A2 FAIL BITE 9 ATE 305, 306.1, 309, 319. RPL A9A12 & A2A2	✓		✓		53	52	BITE V
43	8013	16756	10/2	SFO	FAIL BITE 5 & 6	A B ?		UNABLE TO DUPLICATE		✓		✓	5	12	BITE UV
44	8029	8688	10/5	SFO	FAIL BITE 2	B		A7A11 FAIL BITE A6A10 FAIL ATE 146 RPLD	✓		✓		17	5	BITE V
45	8016	16272	10/8	ORD	FLT DIR BAR DISAPPEARS IN HDG MODE ONLY	A		A4A10 + A6A10 FAIL ATE 243, 369 RPLD	✓			✓	38	14	
46	8035	8008	10/11	LAX	STAB TRIM LITE ON WITH "B" A/P ALSO SOME ROLLING MOTION	B		REUSED ———— SOS —					51	30	REUSED PER SOS 10/12/75
47	8035	8017.36	10/13	LAX	RED LITE WITH "B" A/P ENG IN MAN. OK CMD BITE OK	B		A7A4 FAIL ATE 32 CARD TEST 50 RPLD	✓			✓	30	51	(UNIT BAD) BITE U.V
48	8020	1467	10/20	HNL	SHOWS LT TORT & CAUSES A/P "B" TO MAKE RT TURN WHEN INS BUG	B		NO TROUBLES		✓		✓	42	53	
49	8016	16374:29	10/23	LAX	A/P HARD TO ENGG. HAD TO TRY SEVERAL TIMES. WILL NOT STAY IN CMD. BITE FAIL 3-5-7-8.	A		A4A1 FAIL ATE 441 RPLD	✓			✓	14	30	BITE V
50	8018	15311	10/25	SFO	FAIL BITE #5	A		UNABLE TO VERIFY		✓		✓	40	17	BITE UV
51	8013	16936:37	10/27	LAX	2ND WRITE UP. ON APPROACH A/C LANDS LT OF RWY & FAIL BITE #6	B		UNABLE TO VERIFY !		✓			12	46	BITE UV

FORM ARCS UA-2 5/27/75

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: ROLL COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING .	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52			11/3	HNL	BAD FROM STOCK. WHEN A/P RELEASED, CAN NOT SILENCE HORN WITH BUTTON			NO TROUBLES		✓		✓	–	42	
53	8027	11678:32	11/5	LAX	F/D STEER CMD INOP SWITCH TO A OR C OK BITE OK	B		UNABLE TO VERIFY COA 8-1807		✓		✓	63	12	BITE UV
54	8016	16482:05	11/7	HNL	PADDLE DOES NOT DROP OFF TO MAN WHEN T/K DISPL. VERIF BY SMAP	A		A1A5 FAIL BITE P #6 CARD TEST RPLD	✓			✓	27	42	
55	8027	11710:57	11/8	HNL	A/P NO ENGT	B		A7A11 + A5A2 FAIL ATE 107.1 + 441.6.442 RPLD	✓			✓	2	62	
56	8013	17056	11/9	SFO	FAIL 3. 6 + 7 ON BITE TWICE	A		UNABLE TO VE[illegible]Y		✓		✓	49	38	BITE UV
57	8016	16584	11/18	HNL	BITE OK. INS MODE PROB WITH AMB/GRN LITES. WONT COUPLE, (TROUBLE FOLLOWS UNIT)	A		FAIL ATE [illegible] A4A7 [illegible]LD	✓				42	49	(UNIT BAD) BITE DIDNT V.
58	8014	16407	11/29	LAX	A/P, F/D ON APP. AMBER LITE FAIL TO COME ON	A		UNABL[illegible]ERIFY		✓		✓	61	48	
59	8014	16407	11/29	LAX	FAIL BITE #6 SAME AS ABOVE	B		A10A2 FAIL ALL S.T. RPLD	✓				36	63	BITE P.V.
60	8027	11734	12/5	LAX	WOULD NOT CAPT INS	A		UNABLE TO VERIF		✓		✓	12	36	
61	8014	16455	12/5	HNL	ROLL BAR INOP	B		GYRO FAIL ST-1		✓	✓		63	42	
62	8032	9337	12/6	SFO	"A" WONT TRIP FROM CMD TO MAN IN TURB	A		RPLD A7A4 FAIL ATE 40. RPL A6 INTMT FAIL		✓	✓		10	2	
63	8003		12/16	SFO OV	-14 CMPTR FAIL BITE STEPS 2-5-7	A		POOR SOLDER JOINT ON A7BD. REPAIRED	✓			✓	15	14 ?	BITE V
64	8004				JITTERING AILERONS			NORMAL		✓		✓	43	27	
65	8003	[illegible]	1/2	SFO	FAIL-STEP #6	A		UNABLE TO VERIFY		✓		✓	35	35	BITE UV
66	8003		1/2	SFO	WILL ARM FOR BUT NOT CAPT INS	A		A7A10 FAIL BITE 2-5-7 + 8. RPLD	✓			✓	14	63	
67	8004	2578:42	1/9	ORD	ON DESCENT "A" A/P WOULDN'T KEEP A/C LEVEL TURNS TO RT	A?		UNABLE TO VERIFY		✓		✓	27	1	
68	8010	3263:43	1/11	HNL	F/D SHOWS TURN WITH NEEDLE AT HDG. NO TIME FOR BITE	B		UNABLE TO DUPLICATE RPL A7A4 FAIL ATE 40		✓	✓		28	43	

FORM ARCS UA-2 5/27/76

UNIT: ROLL COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
69	8011	17099	1/11	SFO	WOULD NOT FOLLOW LOC FAIL BITE #5	A		A6A4 FAIL BITE, RPL A6A4 & RATE GYRO ROUGH	✓		✓		40	20	BITE V.
70	8014	16649	1/12	SFO	WHEN ILS SELECTED, A/P "A" DROPS TO MAN	A		UNABLE TO VERIFY		✓		✓	29	35	
71	8012	17283	1/20	LAX	FAILS TEST # 1. FOLLOWS VOR IN ILS	A		RATE GYRO FAIL BITE #1 A2A3 FAIL	P. V.		✓		16	12	(PARTIALLY VERIF ILS PROB NOT VERIF) BITE V.
72	8035	8787.14	1/23	HNL	FAIL BITE 1 AK INPUTS LAGS AND OVER CORRECTS	A? C		UNABLE TO VERIF		✓		✓	51	27	BITE U.V
73	8012	17341	1/26	SFO	FAIL BITE 6	A		UNABLE TO VERIF		✓		✓	12	29	BITE UV
74					LINE REJ. CAUSES "B" A/P TO LOCK OUT AFTER 30MIN	B?		FAIL BITE #6. A6A9 RPLD	✓			✓	12	12	
75	8020	15629	2/6	SFO	FAILS STEP 1 FLAG IN VIEW	C		GYRO RPLD ALSO A7A10 FAIL BITE 2	✓		✓		52	40	BITE V.
76	8012	17473	2/1	LAX	ROLL BAR STAYS BIASED OUT IN HDG MODE	B? C		A7A3 FAIL ATE 81 RPLD	✓			✓	58	51	
77	8018	1619:54	2/13	ORD	A/P WARN LT ON IN VOR/LOC	A		A7A4 A6A11 & A6A3 FAIL ATE 40,58. 60,63, 65 RPLD	✓			✓	31	14	88349 -
78	8018	1614664	2/15	HNL	FAIL BITE # 9	A		A2A2 FAIL ATE CARD 34 ALSO RPL A4A11 & A2A9	✓		✓		11	10	BITE V
79	8004	2832	2/20	LAX	NO GREEN LITE ON BITE. LIC PROB	A		LIGHT SOCKETS BAD	✓			✓	1	61	
80	8018	16195	2/21	LAX	DUTCH ROLL. SWAP TRANSF PROB	B		RATE GYRO. FAIL S.T. 2 & 5 ATE 161,163.114 RPLD GYRO & A6A	✓		✓		10	15	
81	8035	9071:4	2/26	ORD	GREEN LITE AS SOON AS CRS SELECTED	B		A2A9 & A6A1 RPLD FAIL ATE 203, 204 217.219	✓		✓		60	58	88349
82	8004	289:42	2/28	ORD	"INOP"	C		NO TROUBLE		✓		✓	61	12	
83	8032	9804	2/28	SFO	FAIL BITE STEP 6	B		NO TROUBLE		✓		✓	57	50	
84					UNIT BAD FROM STOCK FAILS BITE 3-5			A6A12 & A2A4 FAIL 537 536 540 542.1 RPLD		✓	✓		16	16	(FAIL OTHER STEPS) BITE UV
85	8035	9135	3/14	SFO	INTMTNTLY LOCKS "B" A/P OFF	B		A7A2 FAIL ATE 1, A6A12 ATE 542.1 RATE GYRO ALSO RPLD	✓		✓		58	1	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: ROLL COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
86	8003	2628	3/6	SFO	FAIL BITE #1	A		RATE GYRO RPLD	✓				63	16	BITE V.
87	8035	9159:35	3/7	SFO	PADDLE DOES NOT DROP TO MAN WHEN T/K MOVED	A		A6A4, A2A12, A748 RPLD ALL ATE 519, 519.1, 49, 501, 19, 14.		✓	✓		27	57	
88	8004	02981	3/13	HNL	UNABLE TO ENG	A		A1A9 FAILED RPLD	✓			✓	62	12	
89	8014	17240	3/11	ORD	"HAS RED LITE" WENT IN CMD + SW TO LOC/VOR OR ILS (?)	A		A6A9 FAIL ATE 163, 414 ALSO RPL A6A9 FOR 4/4,	✓			✓	35	61	
90	8011	17603	3/14	LAX	"A" A/P WON'T GO TO MAN WHEN IN TURB BITE OK	A		A9A10 FAIL ATE 292 ALSO A1A7 FAIL RPLD	✓		✓		20	10	(UNIT BAD) BITE UV.
91	8017	17356:27	3/16	LAX	(ROBBED)	A							3	=	
92	8004	3010:09	3/16	LAX	(ROBBED)	B							=	3	
93	8035	94015:23	3/30	ORD	FAIL BITE.	A		FAIL ATE 376.2 BITE DID NOT FAIL. RPL A2A1		✓	✓		57	21	(UNIT BAD) BITE U.V.
94	8013	17948	4/1	SFO	INOP IN MAN + CMD	A		A1A5 INOP FAIL ST. 5 ATE 375 ALSO RPL A7A3	✓		✓		38	77	
95	8012	17987:05	4/8	SFO	"A" A/P ~~WON'T~~ DROP TO MAN WHEN ILS SELCTD	A		A9A9 FAULTY ALSO A4A1 RPLD ALL PIN, JACKS & PLUGS CLEANED	✓		✓		29	38	
96	8019	16044	4/11	SFO	FAILS BITE 3 + 4.6 FAILED 3 TIME IN A ROW	C		A9A9 FAULTY RPLD	✓			✓	44	60	BITE V.
97	8019	16086:42	4/16	LAX	A/P DOES NOT FOLLOW INS. STARTS RT TURN OFF CRS	B		NOT VERIFIED RPLD A6A10		✓	✓		24	35	
98	8012	18081:35	4/18	HNL	FAIL S.T #1	C 78		RATE GYRO RPLD	✓				51	31	BITE V
99	8012		4/19	SFO OV	AIL ACTIVITY EXCESSIVE	U B		— SERVICEABLE —						51	"NEED R/R #"
100	8012	18250	4/20	SFO OV	OLD UNIT ROBBED FOR A/C 8023	C		- NONE —					UK	20	
101	8012	18050	4/20	SFO OV	CONDITION UNKNOWN			TESTED OK		✓		✓	28	28	
102	8012	18080	4/20	SFO OV	OLD UNIT ROBBED FOR 8023	A								24	

FORM ARC3 UA-2 5/27/76

UNIT: ROLL COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
103	8016	17649:19	4/28	LAX	WON'T HOLD INS HDG	A		A4A7 Repl FAIL ATE 217	✓			✓	30	12	
104	8016	17571	4/29	SFO	FAIL BITE # 1-3-7 NO FLARE ARM LITE	A		A9A7 FAIL BITE 1 + 4 A6A9 ATE 329, 331 A 9A5 500,501	✓		✓		49	26	BITE P.V.
105	8023				VERY SLUGGISH IN TURN CONTROL IN MAN OR CMD IN HDG SEL WITH BUG			UNABLE TO VERIFY		✓		✓	24	38	
106	8017	17753	5/1	SFO	BITE OK BUT F/D ON AND BARS OUT OF VIEW!	A		A7A3 BAL RPL	✓			✓	63	30	BITE ENV
107	8010	4776:06	5/3	LAX	ERRATIC INS TRK	A		A1A5 INOP		✓	✓		18	28	
108	8010	4247:19	5/4	HNL	WONT FOLLOW INS FAIL TEST 1 + 2	A		BITE SWITCH RPLD	✓			✓	28	32	BITE V
109	8023	14528:07	5/5	HNL	INTMTNT FAIL BITE #1	C		RATE GYRO NOISY		✓	✓		38	41	BITE UV
110	8018	16939	5/15	LAX	"ERRATIC"	B		NOTHING FOUND		✓		✓	15	18	
111	8032	10559	5/18	LAX	A/C WONT INITIATE BITE TEST	B		NORMAL		✓		✓	45	50	BITE FAIL
112	8020	16643	6/14	SFO	HDG SEL ERRATIC	B		A2A4 INOP ALSO A7A2 RPLD	✓		✓		53	27	
113	8020	16735	6/26	HNL	FAIL BITE 5 & A/P DROPS OFF INTMIT	B		A6 CARD FAIL BITE 5 RPD	✓			✓	27	24	BITE V
114															
115															
116															
117															
118															
119															

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: YAW COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8013	15314:24	7/5	ORD	FAILED BITE TEST	UPPER		UNABLE TO VERIFY		✓		✓	40	3	BITE UV.
2	17? 8017	15335	7/7	LAX	YAW DAMP LITE ON IN CRUISE FAILED SELF TEST	U		RATE GYRO LOW OUTPUT RPLD	✓			✓	3	25	NO SHOP VERIF ENTRY BITE V
3	8010	153600	7/18	HNL	TURN IND SHOWS CONST LT TURN	U		RATE GYRO HIGH NULL RPLD	✓			✓	25	5	NO SHOP VERIF ENTRY
4	8012	15508	7/27	LAX	LITE ON IN CLIMB	U		CALIBRATOR MODULE NOT FASTENED DOWN. RATE GYRO CONV NULL RPL GYRO	✓		✓		5	25	IN-FLT BITE V.
5	8004	1311:29	7/28	BOS	JUMP UPPER YAW DAMP LT, RT SEVERAL TIMES	U		UNABLE TO VERIFY		✓		✓	18	7	
6	8011	15974	8/2	HNL	LITE STAYS ON	L		RATE GYRO HIGH NULL RPLD		✓	✓		9	3	IN-FLT BITE U.V
7	8032	8309	8/3	HNL	UPPER YD LITE ON APPROACH	U		UNABLE TO VERIFY		✓		✓	36	34	IN-FLT BITE UV
8	8011	16055	8/11	LAX	LITE ON IN FLT	L		UNABLE TO VERIFY		✓		✓	3	45	IN-FLT BITE UV
9	8017	15664	8/11	SEA	UPPER Y/D INOP TE'S IND OK BUT NO RUDD. IN TEST	U		HIGH RATE GYRO NULL (222 MV) RPLD	✓			✓	25	16	BITE V
10	8013	16429	8/27	ORD	TURN NEEDLE BIASED OUT OF VIEW ON CAPT ADI	U		RATE GYRO INOP	✓			✓	12	40	
11	8032	8048:47	9/13?	HNL	DOES NOT TEST PROP. LITE ON DURING TEST	U		UNABLE TO VERIFY		✓		✓	34	18	BITE UV
12	8011	16415:26	9/29	SFO	CHRONIC LOWER Y/D FAILURE LITE WITH FLAPS UP	L		UNABLE TO VERIFY		✓		✓	45	25	BITE UV
13	QUANTAS EBH		9/24		RETURN OF LOAN			NO TROUBLE					1		
14			10/?		NO INFO			NO TROUBLE		✓		✓	12		
15	8013	17080	11/12	SFO	FAILED COMP BITE	L		RATE GYRO NOISY RPLD GYRO	✓			✓	8	36	BITE V
16	8011	16711:38	11/14	LAX	NO TURN IND VISIBLE IN CAPT ATT IND	U		RATE GYRO INOP RPLD	✓			✓	27	19	
17	8013	17117	11/17	HNL	KICK BACK & FORTH 5° EITHER SIDE AFTER FLAPS LOWERED TO 5°	L		UNABLE TO VERIFY RATE GYRO HI NULL FAIL TEST 3055 RPLD		✓	✓		36	5	

FORM ARCS UA-2 5/27/76

UNIT: YAW COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
18	8029	9056:30	11/18	HNL	LITE COMES ON INTERMITTENTLY	U		NOT ABLE TO VERIFY		✓		✓	15	34	IN-FLT BITE UV
19	8013	17233	12/5	LAX	LOWER Y/D SWITCHED OFF A/C OSCILLATES WHEN A/P DISENG	L		RATE GYRO HIGH NULL (INCREASED AS TEMP RISE) RPLD	✓			✓	5	3	
20	8016	16893	1/5	HNL	RUDDER C/B PULLED @ BELOW 240 KTS. YD [illegible]	L		UNABLE TO VERIFY		✓		✓	38	27	
21	8010	3268	1/12	LAX	C/B POPPED. RESET C/B OK. PRECAUTIONARY	U A	60	UNABLE TO VERIFY RATE GYRO HIGH NULL RPLD		✓	✓		28	36	
22	8027	17774:11	1/25	HNL	INTERMITTENT CAUTION LITE	U		UNABLE TO VERIFY		✓		✓	41	5	IN-FLT BITE U.V
23	8027	12486:46	2/22	ORD	C/B POPPED. RQD 5° RT RUD TRIM	U		UNABLE TO VERIFY		✓		✓	5	1	
24	8017	17203	2/27	LAX	INOP LITE ON IN CRUIZE	U		RATE GYRO HIGH NULL	✓			✓	16	38	IN-FLT BITE V
25	8017	17251	3/6	ORD	INOP	U		Q5 ON J5 (MOTOR SPD) INOP. FAR TEST 6013 RPLD	✓				38	28	IN-FLT BITE V
26	8017	17274	3/8	CLE	GREEN LITE WONT COME ON WHEN TESTING	L		J4 CARD CAUSED S.T. TO BE INOP. RATE GYRO HI NULL. RPLD J4 & GYRO	✓		✓		33	44	BITE V
27					NO INPUT			TESTED O/C		✓		✓	33	33	
28	8027	12912	4/8	LAX	FAIL TO TEST IN COCKPIT. CMPTR FAIL SELF TEST	L		RATE GYRO INOP RPLD GYRO + C9 + C3 PWR SUPP	✓		✓		4	5	BITE V.
29	8027	13119	4/27	LAX	CAUSES LOWER RUD KICK WHEN FLAPS EXT OR RETARDED	L		UNABLE TO VERIFY		✓		✓	5	38	
30	8035	9837	[illegible]/13		CAPT TURN IND INOP	U		RATE GYRO INOP C3 + C9 PWR SUPPLY LEAK RPLD	✓		✓		10	9	
31	8029	[illegible]	5/19	SFO	[illegible] AMPL FLUCTUATE [illegible]	L		RATE GYRO [illegible] BEARING RPLD	✓			✓	34	12	
32	8011	[illegible]	[illegible]	HNL	CAPT TURN IND INOP "[illegible] SIG"	U		RATE GYRO INOP NOISY BEARING RPLD	✓			✓	19	16	
33	8014		5/20	SFO	AT STOP & LOW SPD RUD [illegible] 350, 2½° RT	L		RAD APR & R[illegible] ON J4 A/C [illegible] STEP 3056		✓	✓		24	33	
34	[illegible]	1354[illegible]	6/10	LAX	LITE ON APPROACH	U		NONE UNTV		✓		✓	1	4	

FORM ARCS UA-2 5/27/76

[illegible]

ORIGINAL PAGE IS OF POOR QUALITY

UNIT: YAW COMPUTER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8027	13676i2	6/22	HNL	4/B LITE ON APP & LANDING	U		SERVO AMP CARD FAIL STEPS SD30 & SD35. RPLD	✓			✓	4	10	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: A/T CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8016	16101	9/4	HNL	RED A/P LT FLASHES - WILL NOT SHUT OFF - A/T CONTROLS DEAD			F1 OPEN C2 OPEN	✓			✓	8	14	
2	8011	16402 15	9/26	ORD	THROTTLE DOES NOT STOP AT "BUG" SETTING FAILED ST			ACC ALL CONS F1 OPEN, C2 OPEN ON J4	✓				4	21	RITE VER
3	8011	16415 26	9/26	SFO	A/T DOES NOT STOP AT RED BUG - TO MAX			UNABLE TO VERIFY		✓		✓	21	20 12	
4	8011	16486	10/10	HNL	A/T ADVANCE WHEN SPEED IS FAST			UNABLE TO VERIFY		✓		✓	12	15	
5	8011	16538	10/18	HNL	A/T DOES NOT RESPOND PROP TO SPD COMMANDS			NONE		✓		✓	15	12	
6	8011	16633 17	11/6	LAX	ADVANCES THROTTLE REGARDLESS OF BUG SETTING			NONE		✓		✓	8	—	
7	8023	13287 58	11/10	DEN	A/T UNUSEABLE - EXCESS CHANGE			NONE		✓		✓	11	18	
8	8003	1889 14	11/13	LAX	A/T INOP - FAILED SERVO ST SERVO NO HELP			UNABLE TO VERIFY FAILED STEP 4015 SLIGHTLY		✓	✓		20	12	
9	8011	16749	11/18	LAX	WHEN A/T ON THROTTLES MOVE MAX THRUST W/ A/S BUG ALIGNED W/ NEEDLE			K1 OPEN TEST 2014, 4004, 6001, 6002 ETC	✓			✓	22	11	
10	8035	8332 42	11/19	ORD	THROTTLES GO TO FULL POWER			FUSE (F1) ON J5 OPEN	✓			✓	23	2	
11	8032	9218	11/20	ORD	UNIT INSTALLED 8032 ORIGINAL ROBBED								—	9	
12	8023	13467	11/[illegible]	LAX	UNREL IN CRUISE-POWER TO IDLE - NO REASON			UNABLE TO VERIFY		✓		✓	18	20	
13	8011	16880	12/3	JFK	A/T OVERSHOOTS BUG SPD			SHOP TEST OK		✓		✓	11	22	
14	8035	8531 59	12/26	LAX	WANTS TO ADD POWER			NONE		✓		✓	2	18	
15	8011	16951	12/26	SFO	LOG - A/T OVERBOOST				✓			✓	22	8	
16	8023	13638	1/4	CLE	ERRATIC SERVO ACTION			NONE		✓		✓	20	23	
17	8035	8638	1/5	LAX	GOES TO FULL THROT WHEN ENG			UNABLE TO VERIFY SELF TEST FAILED CMPTR TEST		✓	✓		18	2	

FORM ARCS UA-2 5/27/76

UNIT: A/T CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8017	16603 17	1/10	HNL	A/T WARN FLASH CONST FAILED CMPTR S.T			FAILED 8001, 4027	✓			✓	13	22	BITE VER
19	8011	17109	1/12	LAX	A/T APPLIED POWER ABOVE BUG SPD FAIL S.T.			UNABLE TO VERIFY NULL OF LAG LIMITER 2MV HIGH		✓	✓		8	20	BITE IN
20	8019	15462 19	1/27	HNL	A/T INOP			PHYSICAL DAMAGE - CASE		✓	✓		7	13	
21					BAL OUT OF STOCK FAILS CMPTR TEST			ST TIME TOO FAST	✓			✓	15	15	BITE ?
22	8011	17252	2/4	JFK	A/T OVERBOOSTED ON AUTO APPROACH			UNABLE TO VERIFY FAILED ATE 4015 - CARD J7		✓	✓		—	11	
23	8019	15516 19	2/4	ORD	RED WARN LT IN			CARD J5 INOP	✓			✓	13	18	
24	8011	17287	2/9	LAX	A/T ADVANCES WITH BUG SET BELOW PTR			NONE		✓		✓	11	8	
25	8003	2729 44	3/19	LAX	SLUGGISH LAST 300' OF AUTOLAND - #3 THROTTLE STIFF			C5 OPEN + C2 LEAKY ON J5	✓			✓	12	11	
26	8010	3904	3/26	LAX	A/C WORK BACKWARDS + FAILS S.T.			F1 J5 CARD OPEN	✓			✓	17	20	
27	8003	2855	4/6	SFO	A/T OP ON AUTOLAND WOULD ACC PWR WHEN ON TARGET SPD			NONE		✓		✓	11	12	
28	8032	10251 04	4/14	LAX	AUTOLAND OK BUT SENSITIVE			NONE		✓		✓	9	7	
29		NONE THRU 6/30/76													
30															
31															
32															
33															
34															

FORM ARCS UA-2 5/27/76

UNIT: AUTO STAB TRIM CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8020	14002 58	7/17	LAX	AST "A" WARN LITE ON FWD PNL FOR MUCH LONGER THAN NORMAL	A		OK		✓		✓	18	13	
2			8/					CHNL "A" FAIL ATE 32-40+ CD CK #69 "B" ATE 35+36 CD CK #29			✓		12	12	
3?	8038	7445 02	8/2	ORD	LT ON			RPLD A9A8	✓			✓	9	11	
4	8020	14282	8/17	SFO	"A" STAB LT ON ALL TIME ASTS FAILED ALL "A" BITES	A		A7A5 BAD	✓			✓	13	18	BITE VER
5	8029	8316 48	8/21	CLE	AST "A" LT ON "C" OK	A		A7A5 BAD	✓			✓	22	9	
6	8029	8321 18	8/21	ORD	ST "A" LT ON	A		A7A5 + A7A2 MODULE BAD	✓			✓	9	1	
7	8020	14382 21	8/27	LAX	"A" AST LT INTERM BITE FAILED "A"	A		A9A4 BAD	✓			✓	18	8	BITE VER
8	8020	14601	9/20	JFK	AS "B" INOP ST OK	B		A9A3 CUBE BAD WHEN HOT	✓			✓	8	13	BITE FAIL
9	8004	1827	9/24	LAX	A/P KICKS OFF FAILS ST	A		OK		✓		✓	19	9	BITE UV
10	8029	8683 39	10/4	HNL	FAILED BITE # 3	A		A7A6 BAD	✓			✓	1	15	BITE VER
11	8029	8688	10/5	SFO	ALL BITES FAILED FOR "B" DOWN	B		LOOSE PIN	✓			✓	15	12	BITE VER
12	8013	16820 44	10/14	HNL	DOWN TRIM ("B") LT NOT ILLUMINATE	B		A9A5 INOP	✓			✓	3	19	
13	8029	8837	10/19	LAX	A/C "A" STAB TRIM LT ON FAILS TESTS	A		NO TROUBLES		✓		✓	12	8	BITE UV
14	801	17094	11/12	SFO	FAILS BITE #1 "B" NOSE DOWN — NO LOG	A		UNABLE TO VERIFY		✓		✓	19	3	BITE UV
15					"B" OUT OF TRIM LT ON ALL TIME			A9A[illegible] INOP	✓			✓	15	15	
16	8020	15256	12/2	JFK	"A" A/P STAB TRIM INOP AND STAB "A" INOP LT ON	A		NO TROUBLES		✓		✓	12	3	
17	8020	15266 45	12/2	HNL	AST "A" LT ON W/ "A" A/P OFF ON "B" A/P	A		A7A3 + A4A2	✓			✓	13	15	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS OF POOR QUALITY

UNIT: AUTO STAB TRIM CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8010	2321	1/18	LAX	BOTH STAB LT ON W/ RED A/P LT DURING AUTOLAND			A9A4 FAILED "B" ATE 27, 28, 29		✓	✓		5	12	
19	8010	3374	1/24	LAX	AUTOSTAB TRIM "A" LT COMES ON OCCASIONALLY	A		A9A2 FAILED "B" ST + ATE 29, 30, 33		✓	✓		12	22	
20	8023	13838	1/27	LAX	"B" A/P AUTOTRIM INOP	B		A7A8	✓			✓	16	5	
21	8029	9481 12	1/28	LAX	"B" A/P STAB TRIM INOP BITE ERRATIC ON UP - POS 2	B		A9A4 FAILED "36" ATE	✓			✓	8	21	BITE VER
22	8019	17036	2/7	SFO	"B" STAB TRIM LT ON W/ B ENG. FAILS 1+2	B		A9A5 FAILED 45	✓			✓	15	16	BITE VER
23	8029	9576 13	2/10	HNL	STAB TRIM "A" LT ON	A		OK		✓		✓	21	18	
24	8035	9401	3/30	ORD	S/T B LT ON STEADY FAILED BITE	A		OK		✓		✓	11	1	BITE UV
25	8035	9409	3/30	HNL	TRIM "A" LT ON - TRIM SLUGGISH	A		OK		✓		✓	1	21	
26	8035	9450	4/3	HNL	BITE TEST FAIL	B		A9A3 INOP	✓			✓	21	15	~~BITE VER~~
27	8035	9605 03	4/19	ORD	AST "A" LT ON AND OFF IN CRUISE	A		OK		✓		✓	15	18	
28	8012	HMV	4/30	SFO	"A" A/P ENG TO MAN- AUTO STAB WILL NOT FOLLOW PITCH WHEEL BITE OK	A		A6 CARD	✓			✓	14	15	BITE FAIL ?
29	8013	18078	5/3	ORD	"B" AST LT ON AT TIMES FAILED SELF TEST 2ND OK	B		FAILED ATE 38 HOT 31 ON CD TEST	✓			✓	3	1	BITE ?
30	8013	18162	5/12	HNL	AST "B" LT ON PART OF TIME - BITE OK	B		FAILED 51, 51 - 53	✓			✓	1	11	BITE FAIL
31	8013	18179	5/14	SFO	SAME AS ABOVE	B		ATE 33, 35, 37 38, 39 + 41 45, 46 49 TEST	✓			✓	11	3	
32	8023	14764 14	5/[illegible]	ORD	AUTOTRIM INOP ON "B" A/P - FAIL SELF TEST	B		A7A2 BURNT UP SHORT	✓			✓	5	14	BITE VER
33	8010	4462 48	5/30	[illegible]	"A" LT OCCASIONALLY ON			A7A5 MODULE BAD ATE # 61	✓			✓	22	2	
34	8032	10963	6/29	LAX	WITH "A" A/P ON CMD, STAB TRIM LITE COMES ON	–		ATE STEPS 39 40. 42 FAIL A7A2 INOP [illegible]	✓			✓	12	11	

FORM ARCS UA-2 5/27/76

UNIT: MONITOR & LOGIC UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8028	7433	7/1/75	LAX	WHEN A/P POSITIONED TO LAND, UNABLE TO ENG BOTH A/P BITE OK			UNABLE TO VERIFY		✓		✓	7	16	BITE V
2	8028	7452	7/3	SFO	IN AUTOLAND, RED & AMBER LITE ON AT SAME TIME AND FLASHING			NO TROUBLES		✓		✓	16	9	
3	8028	7461	7/4	LAX	A/C FAILS BITE 3-4 & "B" A/P OCCASSIONAL RED LT			NO TROUBLES RPLD A4K8 PRECAUT		✓		✓	9	15	
4	8016	15461	7/7	SFO	BITE OK BUT AFTER 30 MIN WARM UP IT LOCKS OUT "B" A/P (MORE)			FAIL BITE 5 & ATE 138 RESOLDERED A6A4, A6A7	✓			✓	25	30	BITE UV
5	8003	727	7/12	SFO	FAILS STEPS 2-3 ON S.T.			NO TROUBLES		✓		✓	6	9	BITE UV
6	8028	7672	7/23	SFO				NO TROUBLES		✓		✓	15	3	
7	8016	15622	7/23	SFO	BITE OK BUT A/P "A" DISPLAY LITES INOP. NO AMBER OR GRN IN HDG			NO TROUBLES		✓		✓	3	6	
8	8016	15632	7/25	LAX	UNABLE TO ENG "A" A/P INTMTNT Lout CAPT DISC.			NO TROUBLES		✓		✓	6	16	
9					BAD FROM STOCK FAIL BITE #1			NO TROUBLES		✓		✓	7	7	
10	8013	16815	8/14	LAX	STEADY RED LITE ON "A": "B" WONT ENG			REPL A6A1 & A6A2 PRECAUTIONARY		✓		✓	23	1	
11	8029	8436	9/5	SFO				CHECKED OK		✓		✓	13	6	
12	8013	16609	9/17	HNL	FAILED TEST #3 WONT CAP G/S			A4A2 & A5A8 FAIL S.T. 1,2,3,6. RPL	✓		✓		2	23	BITE P.V.
13	8012	16603	9/26	SFO	SUSPECT FAILURE PITCH CAM OUT			A2A2 REPLD FAIL BITE 3 AFTER WARMUP	✓			✓	10	2	
14	8004	1928	10/5	LAX	A/P "A" DISCONNECTS BITE OK			A7A1 FAIL ATE & B1P8	✓			✓	1	25	
15	8029	8688	10/5	SFO	BITE GOOD BUT WHEN A/P ENG DISC HORN COMES ALSO AMB LITE IN LAND			A8A2 FAIL ATE 22.4 & CD CK 16 RPLD	✓				6	7	(UNIT BAD) BITE U.V
16	8019	14704	10/10	SFO	TIME			TESTED OK		✓		✓	20	10	
17	8013	16889	10/22	SFO	CHRONIC A/P RED WARN LITE ON INTMTNT			NO TROUBLES		✓		✓	1	15	

FORM ARCS UA-2 5/27/76

UNIT: MONITOR & LOGIC U

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8003	17945	11/2	HNL	A/C NOT CAT II - WHEN "B" A/P IN NAV. MODE BOTH AMBER + GRN - FAIL BITE #8			A2A4 FAILED # 303 + #305 ON ATE - #2 ON CARD TESTER	✓			✓	9	13	BITE VER.
19	8032	9144	11/5	SFO	TIME			NO TROUBLE	N/A			✓	5	6	
20	8019	11736	11/16	LAX	FAILS TEST 3 RED LT ON AUTOLAND			A6A2 FAILED ATE 146+157	✓			✓	10	20	BITE VER
21	8032	9246	11/27	SFO	BITE OK - BUT CAUSES RED LT ON IN AUTOLAND WHEN 2ND A/P ENG			A9A5 FAILED ATE 205 +206		✓		✓	6	23	BITE ?
22	8004	2492	12/28		LINE REJECT - CAUSES BOTH A/P TO LOCKOUT			A6A4 FAIL ATE # 138 + CD CK 106	✓			✓	25	25	
23					—			OK ON ATE	N/A				4	4	
24					NEW UNIT			NO TROUBLES					29		
25	8010	3469	2/7	LAX	A/P DISENGAGE LT (LOWER) + WARN HORN WOULD NOT RESET W/NORMAL POWER			A6A2 FAIL ATE 32+ CD CK 37 + 44	✓			✓	29	25	
26	8013	1750156	2/13	LAX	A/P WARN HORN, STEADY RED LT - UNABLE TO KILL			A4A2 INOP	✓			✓	9	7	
27	8012	18072	4/17	CLE	FAIL TEST 3			A9A5 FAULTY	✓			✓	7	23	BITE VER
28	8016	16871	5/6	SFO	—			OK	N/A			✓	22	8	
29	8013	55	5/9	SFO	CAUSE A/P "B" RED LT TO COME ON WHEN ENG			NO MAL FOUND		✓		✓	23	16	
30	8022	4651	5/14	SFO	—			TIME NORMAL OV.	✓			✓	18	7	
31	8014		5/29	SFO	AUTOLAND A/P LT WOULD COME ON AT 7500'			BROKEN WIRE STEP 125 ATE	✓			✓	25	9	
32	—	—	6/?		NONE ON TAG			NO TROUBLE FOUND		✓		✓	4	4	
33					ADDITIONAL REMOVALS (I+R TAG MISSING)										
34	8029	9209	12/12/75		CILA [illegible]				✓			✓	7	16	

FORM ARCS UA-2 5/27/76

UNIT: MONITOR & LOGIC UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
35	8032	9366	12/26/75		FAIL BITE. ALSO A/P RED LITE			NO TROUBLE		✓		✓	23		BITE UV
36	8010	3221	1/5/76		TIME.			O/H CHECKER OK.				✓	4	23	
37	8012	17219	1/16		"B" A/P WON'T ENG			O/H UTV		✓		✓	2		
38	8012	[illegible]	1/20		"B" A/P NO AMBER LITE.			[illegible] RPL	✓			✓	27	9	
39	8035	8795	1/24		KICKS OFF WITHOUT WARN. WON'T PASS BITE			UTV		✓		✓	17	21	BITE UV
40	-	-	1/23		NO I+R TAG			TEST OK				✓	2	—	
41	8035	8887	2/5		TIME			FAIL A4A1 + A8A2 RPLD		✓	✓		21	27	
42	8010	3366	2/6		WITH "B" A/P ENG RED LITE STAYS ON			UTV		✓		✓	23	29	
43	8020	15633	2/7		FLARE AMBER LITE ON ALL TIMES W/ F.D. ON			TESTED OK		✓		✓	19	17	
44	8011	17617	3/26		TIME.			TESTED OK				✓	8	11	
45	8027	12618	3/8		TIME			TESTED OK				✓	11	2	
46	8014	17321	3/29		TIME			TESTED OK				✓	12	29	
47	[illegible]	[illegible]	4/19		"B" A/P ANNUNCIATOR LIGHTS INOP			UTV		✓		✓	16	4	
48	8035	[illegible]	4/21		"B" A/P WON'T ENG [illegible] PROB			UTV		✓		✓	27	19	SUGGESTS MATING PROB
49	8016	17777	5/13		F/O A/P ARM [illegible] LITE DON'T AGREE WITH [illegible]			UTV		✓		✓	4	12	
50	8033	[illegible]	5/18		A/P "A" WON'T ENG. BITE OK			UTV		✓		✓	7	5	
[illegible]	8012	165	5/20		DISENG RESET INOP			UTV		✓		✓	18	10	

FORM A[illegible] UX-2 5/27/76

8011 1836 6/2 GREEN MIN LTS INOP UTV ✓ ✓ 11 27

ORIGINAL PAGE IS OF POOR QUALITY

UNIT: MODE SEL PNL

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1					RCVD IN SHOP – NO INFO			MODE CONTROLLER NOT GOOD	✓		✓		32		
2	8028	7495	7/6	HNL	A/T SET KNOB			KNOB	✓			✓	30	22	
3	8001	1180 21	7/12	HNL	"A" A/P DISENG TO MAN IN FLT			OK		✓		✓	23	20	
4	8003	727	7/12	SFO	ANNUNCIATOR LT ERRATIC			DEFECT. MODE CONT MODULE	✓			✓	16	13	
5	8016	15551 40	7/16	HNL	"B" A/P WILL NOT ENG IN FLT			OK		✓		✓	19	3	
6	8023	12275 49	7/19	HNL	CAPT PITCH BAR DOES NOT BIAS OUT OF VIEW WHEN IT SHOULD			C2 + C1 CONDENSOR LEAKAGE	✓			✓	9	30	
7	8017	15...	7/20	SFO	PITCHES NOSE UP IN ALT HOLD			OK		✓		✓	24	12	
8	8017	15500 15	7/26	LAX	UNIT, OKAY TROUBLESHOOTING			OK	N/A			✓	12	16	
9	8012	1605	7/26	SFO	"B" PITCH CMPTR WILL NOT BITE – INS TRACK ERRATIC			30HZ -L-2 OUT OF TOL		✓		✓	8	17	
10	8016	15818	8/14	HNL	3 REP – UNABLE TO ENGAGE "A" A/P – ALL CK OK ON GND			UTV		✓		✓	3	19	
11	8003	1015	8/15	HNL	F/O DEV NEEDLE ON HSI STICKS IN CENTER POS			OK		✓		✓	13	32	
12					HDG COUNTER INOP			TRI GEAR BROKEN ON HDG COUNTER	✓			✓	6		
13	8020	14586 40	9/7	HNL	ALT HOLD INOP BOTH A/P'S			OK		✓		✓	31		
14	8003	1310	9/14	LAX	F/O CRS KNOB HARD TO TURN			GEARS BINDING	✓			✓	32	24	
15	8032	8724	9/21	HNL	"B" PADDLE DROPS TO ATT WHEN TURN KNOB MOVED			TEST 931		✓	✓		2	12	
16	8029	8644	9/29	HNL	UNABLE TO ENGAGE ALT HOLD - FUNCTION OK BUT WON'T HOLD IN			BAD SOLAND SWITCH	✓			✓	21	32	
17	8013	6879	10/21	LAX	A/C STEADY RED LT IS OCCASIONALLY								18	3	

FORM ARCS UA-2 5/27/76

UNIT: MODE SEL PNL

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
18	8012		10/31	SFO	F/O PITCH COMMAND BAR OUT OF VIEW IN APP			OK		✓		✓	17	21	
19	8020	14791 39	10/10	HNL	COURSE TRANSFER SW WILL NOT LOCK IN EITHER #1 OR #2 POS			BROKEN WIRE	✓			✓	23	2	
20	8032	9144	11/5	SFO	NO ALT CAPTURE "B" CMPTR			UTV		✓		✓	12	6	
21	8004	2288 24	11/18	ORD	# PITCH BAR FOR F/D HANGS UP ON INDICATOR WHEN ALT SEL IS OFF			A1 + A2 MODULE BAD		✓	✓		20	15	
22	8004	2305 07	11/20	ORD	A/P INOP IN AUTOLAND			ENGAGE SWITCH BAD	✓		✓		15	12	
23	8029	9757 09	11/30	SFO	HDG SEL KNOB VERY LOOSE, NO FRICTION IN TURNING			KNOB LOOSE	✓			✓	32	9	
24	8029	19314	12/4	ORD	ALT ALERT INOP + #1 F/D VERT NEEDLE WILL NOT RETRACT			OK		✓		✓	9	4	
25	8029	9209 25	12/12	HNL	CH "B" WILL NOT ALWAYS REMAIN LOCKED INTO MAN OR COM			OK		✓		✓	4	31	
26	8004	2483	12/26	LAX	HOR F/D BAR BIASED OUT + F/D FLAG ON CAPT ADI ALL THREE CMPTR			OK		✓		✓	12	18	
27	8012	17283 12	1/20	LAX	"A" A/P CHANGES CLS WHEN IN INS MODE			OK		✓		✓	21	29	
28	8012	17252 29	1/24	LAX	A/P WILL NOT TRK INS ALT HOLD DOES NOT OFF A/P FAILED BITE A/L			OK		✓		✓	29	17	
29	8035	8813	1/25	HNL	"B" A/P KICKS OFF WITHOUT WARNING			"A" A/P ENGAGES AT TIMES WITH NO POWER APPLIED		✓	✓		1	15	
30	8004	282	2/24	ORD	ALT SEL IS UNREL ON BOTH A/P CMPTR			ALT SEL SWITCH BAD	✓			✓	8	10	
31	8035	9135	3/4	SFO	"B" A/P TRIPS OFF FOR NO REASON - STAYS LOCKED OUT								15	32	
32	8004	2952 33	3/3	HNL	A/T ON-OFF SW HANG LOOSE IN HOLE			BROKEN	✓			✓	0	21	
33	80[illegible]	3764	3/10	SFO	"B" A/P STARTS CLB WHEN PITCHING BITE CK OK			OK		✓		✓	12	15	
34	8035	9206 51	3/11	LAX	HDG SEL NUMBERS JUMPED FROM 159° TO 040 ETC			HDG COUNTER BROKEN	✓			✓	32	9	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: MODE SEL PNL

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8004	2976	3/12	SFO	A/P "A" DROPS OFF AND WILL NOT ENGAGE			OK		✓		✓	21	20	
36	8011	17613 01	3/14	SMB	ALT SEL SLIP ON DIGITAL			COUNTER BINDING	✓			✓	25	4	
37	8012	17809	3/15	HNL	ALT SEL FUNCTION INCORRECT CAPTURE			OK		✓		✓	17	8	
38	8035	9245	3/15	LAX	A/C CAPT F/D ROLL STEER BAR WILL NOT BIAS OUT OF VIEW			BAD SUM AMP AI + AIRSPD MODULE	✓			✓	9	10	
39	8017	17338	3/15	LAX	A/C ALT SEL GEARS SLIPPING			OK		✓		✓	16	4	
40	8035	9276 42	3/18	HNL	ALT SEL KNOB BROKEN			GEARS BINDING	✓			✓	10	18	
41	8017	17374	3/19	LAX	ALT ALERT KNOB WILL NOT GO BELOW 1000' OUT OF STOCK			OK		✓		✓	4	16	
42	8017	17374	3/19	LAX	"A" A/P WILLNOT ENGAGE ALT SEL NOT BELOW 1000'			COUNTER STICKS	✓			✓	4	21	
43	8032	10064 08	3/22	ORD	"B" A/P CAPTURED AND LEVELED OFF AT 30,500 SET FOR 31,000			OK		✓		✓	6	1	
44	8032	10180	4/6	HNL	CAPT ALT 500' LOW ERRATIC. BOTH A + B			NO FAULT FOUND		✓		✓	1	17	
45	8032	10200	4/8	LAX	CAPT PITCH BAR WILL NOT BIAS OUT OF VIEW W/ F/D OFF			OK		✓		✓	17	23	
46	8010	4161 02	4/26	ORD	WILL NOT HOLD ALT IN "AORB"			OK		✓		✓	15	25	
47	8020	1636 16	4/30	HNL	SOLENOID DOES NOT CLR "B" PADDLE SW - DIFF TO ENG TO MAN POS			DUAL SW WOULD NOT RELEASE		✓	✓		2	1	
48	8027	13233	5/9	LAX	ALT SEL BINDING			COUNTER BINDING	✓			✓	27	6	
49	8010		5/13	SFO	—			OK		✓		✓	25	2	
50	8022	14658 17	5/17	SEA	UNABLE TO ENG EITHER A/P			OK		✓		✓	10	25	
57			NONE	THRU	6/30/76										

FORM ARCS UA-2 5/27/76

UNIT: CONTROLLER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8028	7976	7/20/75	SFO	"B" A/P HAS STEADY RED LITE ON IN MAN			RPL PITCH POT		✓	✓		7	12	
2	8027	10844:05	8/4	LAX	A/P DRIFTS OFF HDG 4~5° PER MIN IN MAN MODE			CANNOT VERIFY		✓		✓	S/N 11204[illegible]	2	
3	8011	16041:20	8/10	JFK	A/P AIL GIVES HARD SIG AT SLOW SPDS			BAD PITCH POT		✓	✓		1	10	
4	8013	16835	10/16	LAX	"B" A/P WILL NOT RELEASE PADDLE			CAN'T VERIFY		✓		✓	23	19	
5	8027	11756	11/15	LAX	"A" CHNL WILL NOT ENG IN CRID			CAN NOT DUPLICATE		✓		✓	2	7	
6	8028	8208	11/24	SFO	"A" A/P PORPOISING			CAN NOT VERIFY		✓		✓	12	1	
7	8027	12517	2/25/[illegible]	ORD	ROUGH PITCH POTS			SHOP TEST OK		✓		✓	7	23	
8	8035	9126	3/3	LAX	"B" A/P WILL NOT ENG			CAN'T DUPLICATE		✓		✓	9	8	
9			3/3	LAX	BAD OUT OF STOCK			DAMAGED	✓		✓		22	22	
10	8010	3728:52	3/6	SFO	NO MAN MODES			BAD A POT	✓			✓	14	12	
11															
12															
13															
14															
15															
16															
17															

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: TRIM INTERFACE U.

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8029	8107 30	7/20	LAX	AUTO TRIM LT ON + NO STAB TRIM WHEN USING "A" A/P - STAB BITE OK			UNABLE TO VERIFY		✓		✓	18	13	
2	8010	2094 11	8/9	ORD	STAB TRIM ERRATIC			UNABLE TO VERIFY		✓		✓	16	12	
3	8020	19340 35	8/23	LAX	"A" AST LT ON			UTV		✓		✓	6	3	
4	8029	8436	9/5	SFO	TRIM LT ON IN FLT			UTV		✓		✓	13	1	
5	2768	1471017	9/9	ORD	NO CHANNEL	2		ADJUSTED - OUT OF SPECS	✓			✓	120	126	
6	8035	278008	10/12	LAX	REMOVED FROM A/C DOCS FROM UNKNOWN			UTV		✗					
7	8016	16564 46	11/16	HNL	STAB TRIM SEEMED TO HANG UP MOM WHEN USING WHEEL TRIM SW			OK		✓		✓	15	20	
8	8029	9700 48	3/4	JFK	STAB TRIM "A" LT ON INTERM BITE OK			UTV		✓		✓	15	19	
9	8035	9615	4/20	SFO	AUTO STAB TRIM "A" LT ON + OFF - A/P "A"			UTV		✓		✓	11	16	
10	8035	9634	4/22	LAX	"A" AST LT FLICKERS					✓		✓	16	7	
11	8013	18094 49	5/6	HNL	STAB TRIM "B" LT ON AT TIMES			TEST OK		✓		✓	9	6	
12	8023	14767 48	5/28	LAX	"A" STAB TRIM WILL NOT TRIM NOSE UP			UTV		✓		✓	21	13	
		NONE.	THRU	6/30/76											

FORM ARCS UA-2 5/27/76

UNIT: AFC - BOX 1

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8016	15823	8/15	SFO	"A" A/P WON'T ENG	#1		OK		✓		✓	3	8	
2	8013	17013 52	11/4	HNL	"A" A/P RED LT FLICKER	#1		K1 OPEN	✓			✓	10	11	
3	8013	17654 40	2/10	ORD	#1 F.D ANN INOP	#1		OK		✓		✓	11	10	
			Nav: [illegible]	6/[illegible]/76											

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: AF C - BOX 2

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8013		7/8	SFO	CHRONIC P/A TEST			CK OK		✓		✓	7	4	
2	8016	15662	7/28		"A" A/P WOULD NOT ENG INTERMITTENT	2		CK OK		✓		✓	6	8	
3	~~8025~~	~~6551~~	~~9/19~~	~~SFO~~	~~ALT SEL IND MUST BE SET 400' LOW FOR COR ALT~~			~~COUNTER MECH SLIPS~~	~~✓~~			~~✓~~	~~55~~	~~47~~	
4			11/24	HNL	AFTER INSERTION A/P "B" PITCH CMPTR FAILED			CK OK.		✓		✓	9	9	
		NONE THRU	6/30/76												

FORM ARCS UA-2 5/27/76

UNIT: ACCELEROMETER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8013	1727	12/26	HNL	CAUSING A/P - F/D TO GIVE 5° PITCH DOWN OIL LEAK	3		RETURN TO VENDOR					07 3315	6	
			NONE	THKI	6/30/76										

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: A/T SERVO

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1					NO INFO			OK						1	
2	8003	1889 14	11/13	LAX	A/T INOP - SERVO FAIL ST.			UTV		✓		✓	6	5	
3	8011	11755	11/19	LAX	SFOEG REG.			OK	N/A			✓	7	3	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: INS CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8028	7447	7/7	LAX	AT TIMES # 2 INS XTK – 39.7L+ DIS 400/UNABLE TO ENG A/P IN INS MODE	2		UTV ON INS		✓		✓	25	2	
2	8032	799928	7/7	ORD	CODE 0136	2		BAD GT CARD	✓			✓	52	61	BITE V
3	8003	703 01	7/8	HNL	186 K –180° A/C - 30° OFF HDG	1		Z GYRO	✓			✓	28	39	
4	8003	707	7/9	SFO	"B" A/P WILL NOT LOCK ON INS COURSE – PRODUCES 10° BANK ACROSS COURSE	2				✓		✓	46	71	BITE V
5	8032	8028	7/10	LAX	RED LT ON ACTION CODE 02, MALF 13-14 + INS UNRELIABLE	2		Y GYRO	✓			✓	61	30	BITE V
6	8003	727 07	7/12	SFO	CODE 00 43-63 + WOULD NOT CLR	2		P1 CARD BAD	✓			✓	59	13	BITE V
7	8017	15482 56	7/24	HNL	MALF CODE 01-18-34-35	1		Y GYRO A10-3 CARD BAD	✓			✓	74	20	
8	8032	8180	7/23	LAX	INSERT LT NO GO OUT	2				✓		✓	30	26	BITE NoGO
9	8018	14392 05	7/23	HNL	ACT 01 MALF 23	1		P-1 CARD CMPTR SCRAMBLE PITCH GB	✓			✓	26	4	BITE ✓
10	8011	15947 03	7/28	HNL	RED LT ACT 01	2		Z GYRO	✓			✓	75	47	BITE ✓
11	8028	7726	7/28	SFO	"B" A/P GETS STEADY, RED WARN LT WHEN IN COM + INS FUNCTION	2		UTV		✓		✓	2	30	BITE NoGo
12	8011	15968	7/31	SFO	CODE 01 c̄ RED WARN AT ALL TIMES	2		4 LOCATIONS SCRAMBLED MEMORY ELECTRONICS INTERMITTENT	✓			✓	47	76	BITE ✓
13	8023	12414 23	8/4	SEA	NAV UNIT GAVE AN 001 ACTION CODE	1		Z GYRO P-2 CARD DEFECTIVE	✓			✓	15	75	BITE ✓
14	8028	7807 55	8/4	HNL	RED WARN LT COMES ON CODES [illegible] + 95	1		OVEN	✓				70	22	BITE ✓
15	8012	16136	5/6	LAX	RED WARN LT AT B CODE 05-16	2		GB	✓			✓	9	67	BITE ✓
16	8023	12463 59	8/8	ORD	MALF CODE 01 - 33,39,55 05-18	1		Y GYRO BAD	✓			✓	75	35	BITE ✓
17	8023	12477 28	8/10	SFO	STUCK IN TEST MODE	1		DIGITAL MOTHER BD D10-2 FAILS INTERFACE TEST	✓			✓	35	24	BITE PROB

FORM ARCS UA-2 5/27/76

UNIT: INS CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8016	15779	8/9	SFO	CHRONIC "A" A/P STAYS LOCKED OUT CODE 04-41	1		UTV IN INS		✓		✓	7	8	BITE NOGO
19	8035	7493 32	8/11	SFO	WARN LT JUST BEFORE BLOCKING	2		UTV		✓		✓	69	9	BITE NOGO
20	8011	16064	8/12	SFO	A/P HARD KICKS	1		OK		✓		✓	76	47	BITE ✓
21	8014	2843	8/14	HNL	ON DISPATCH 01-33-34-35	1		GYRO FAILURE (Y)	✓			✓	8	40	BITE ✓
22	8011	16080	8/14	SEA	001-54	2		SA IR BAD	✓			✓	51	51	
23	8011	16083 56	8/15	ORD	#2 A/P ERRATIC	2		OK		✓		✓	35	68	
24	8011	16115 50	8/17	ORD	02-63	2		P-1, HE, STACK	✓			✓	47	15	BITE ✓
25	8011	16099	8/16	ORD	COMP INOP	2		SHORT IN TC, BURNT OUT AC/DC	✓			✓	68	61	
26	8028	7967 17	8/19	LAX	UNRELIABLE 02-42	2		DZ DRIFT Z GYRO	✓			✓	30	58	BITE ✓
27	8023	12564	8/19	HNL	NO DISPLAY ON CDU AT ALL	1		AC/DC FAILED AD CARD	✓			✓	24	74	
28	8011	16139 52	8/20	SFO	RED WARN LT ON 004 - 40-41-45-60	2		IN STORAGE BAD X GYRO	✓			✓	11	76	BITE ✓
29	8028	7987 09	8/21	SFO	02 ACT CODE 19 MALF	1		XSRA OUT OF TOLERANCE	✓			✓	22	19	BITE ✓
30	8028	8039 06	8/26	SFO	UNRELIABLE	1		OK		✓		✓	19	102	
31	8011	16229	8/30	ORD	INS WARN LT 01 - 32-02-62	2		SAR INTERM	✓			✓	15	75	BITE ✓
32	8028	8117 54	9/2	HNL	WARN LT CODE 04-45	2		OPEN AC + 1 2 INTERM	✓			✓	56	24	BITE ✓
33	8010	2341	9/3	LAX	RED WARN LT ON WHEN ACCURACY DOWN TO 65	1		Z GYRO SHORTED THERMISTOR	✓			✓	2	2	BITE ✓
34	8012	16422	9/4	LAX	01 - 18 - 33-34-35	2		BALL TUMBLED Y GYRO	✓			✓	67	103	BITE ✓

FORM ARCS UA-2 5/27/76

UNIT: INS CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8027	11154 48	9/4	HNL	02 - 13+ 14 4X	2		30 VDC TO AD FLUCTUATING OVEN	✓			✓	34	35	BITE ✓
36	8011	16291 15	9/5	LAX	ATT + COMPASS FLAG	2		MODE LOGIC CARD	✓			✓	75	18	
37	8027	11180 31	9/6	HNL	OH - ONE	2		GYRO	✓			✓	33	108	
38	8028	8165	9/6	LAX	INOP NO DISPLAY	1		Q1 SHORTED IN AC/DC	✓			✓	24	105	
39	8011	16304	9/7	ORD	F/O ATT FLAG SHOWS INTERM ALONG W/"B" CMPTR FLAG	2		GBP BAD	✓			✓	18	7	
40	8029	8481 19	9/9	HNL	01 - 39	1		UTV		✓		✓	37	104	BITE NO GO
41	8011	10947	9/10	SFO	RED WARN LT - BLOWER FUSE MISSING - STILL RED LT	1		OK		✓		✓	76	47	BITE NOGO
42	8011	16322 41	9/12	ORD	INOP IN NAV MODE	1		DCU AC/DC FAILED	✓			✓	47	67	
43	8013	16568	9/12	SFO	MALF CODE 14 CHRONIC	2		AMB 1-2 CARD	✓		✓	✓	22	2	BITE ✓
44	8017	15984 17	9/14	ORD	MALF 02, 13, 14	2		OK		✓		✓	54	106	BITE NOGO
45	8014	15786 41	9/19	LAX	A/P INTERM SHARP ROLLS	1		NO TROUBLES		✓		✓	16	58	
46	8003	1350	9/19	JFK	"B" A/P WALLOWS WANDERS	2		LOOSE PIN. AJ6.4 8 11 . ON RELAY ASSY		✓	✓	✓	17	18	
47	8018	14944	9/20	LAX	F/O ATT INS SHOWS LEFT WING DN	2		GBR	✓			✓	14	15	
48	8004	1807	9/21	LAX	WARN LT	1		F-1	✓			✓	23	107	BITE ✓
49	8019	14601	9/22	SFO	HDG FLAG	1		SYNC MOTOR + BEARINGS DEFECTIVE	✓			✓	77	69	
50	8027	11323 27	9/23	ORD	INS ACC WENT TO 799 ABOUT 50 MI OUT	1		HAD MC 27 NO OTHER DEFECTS		✓	✓		59	51	
51	8028	8184	9/24	SFO	RDOUT LOCKED	2		DIOLA FAILED	✓			✓	102	56	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: INS CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
52	8013	16681	9/25	LAX	INOP 6-3	1		A2 CARD	✓			✓	12	17	B-V
53	8016	16153 37	9/25	HNL	02 - 13+14	2		OVEN	✓			✓	50	24	B-V
54	8018	15601	9/25	LAX	P/O 451 DISP HDG FLAG MOMENTARILY	2		MODE LOGIC CARD	✓			✓	75	47	
55	8028	8202	9/27	SFO	REMOTE FUNCTION WILL NOT FEED OTHER UNIT	2		Y GYRO		✓	✓		56	25	
56	8016	16167 28	9/27	LAX	RED FAIL LT	1		ME + P1	✓			✓	40	101	B-V
57	8013	16719 10	9/27	HNL	RED WARN LT	2		DC/DC PBC FAILED	✓			✓	2	77	B-V
58	8018	15052 19	9/29	HNL	SHOTS DN AS IT GOES THROUGH BATTERY CYCLE	2		OK.		✓		✓	27	110	
59	8018	15020	9/29	HNL	#2 WARN LT ALL FLAGS F/O CDU INOP	2		UNKNOWN		✓		✓	47	27	B-NoGO
60	8016	16233 00	10/3	LAX	RED LT - ALL DIGITAL INFO DISAPPEARED	2		DIG DC TO DC CONVERTER DEF	✓			✓	24	40	B-V
61	8023	12961 30	10/3	LAX	WARN LT 02 + 42 04 + 57	2		INTERM 3.2 SQUARE XY PLATFORM QUIT ROTATE	✓			✓	57	113	B-V
62	8016	16241	10/5	LAX	02 - 63 + RED LT	2		P1 CARD SCRAMBLED	✓			✓	40	115	B-V
63	8013	16786	10/5	SFO	"A" A/P RED LT "A" A/P IN COMMAND INS MODE	1		OK		✓		✓	17	112	
64	8028	2299 59	10/6	LAX	ON GND MALF CODE	2		INTERM PLUG F-25	✓			✓	105	116	B-V
65	8023	12988 47	10/7	OKD	C2 CODE	2		SAR BAD	✓			✓	113	12	B-V
66	8035	13023 01	10/12	HNL	01 - 34 - 35	2		Y GYRO	✓			✓	9	56	B-V
67	8032	5934 33	10/16	LAX	RED WARN LT 01 43.8	1		GIMBAL BUFFER	✓			✓	26	2	B-V
68	8019	14776 55	10/17	LAX	RED WARN LT 02 - 14 + 49	1		Z GYRO DRIFT	✓			✓	22	62	B-V

FORM ARCS UA-2 5/27/76

UNIT: INS CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
69	8028	8898	10/20	JFK	MTR PER SFOEG ADZ RON HUNT	1		RETESTED UNIT		✓		✓	25	118	
70	8019	14777	10/21	LAX	03- 24 "A" N/P RED LT	1		A10 - 3(-S) PV A10-3 MALF 2H	✓			✓	62	50	B-V
71	8013	16708	10/24	SFO	004 CODE	2		09-41 IN STORAGE	✓			✓	77	29	B-V
72	8013	16918	10/25	LAX	RED LT ON AP	1		UT ✓		✓		✓	112	36	
73	8017	16365	10/31	LAX	2ND REPORT WOULD ONLY GO DOWN TO 75 IN 25 1ST TRY	2		UT ✓		✓		✓	106	41	
74	8035	8168 10	10/31	SFO	INOP ON NORMAL GYRO AUX GYRO OK	1		MC CARD	✓			✓	111	28	
75	8027	11618 39	10/31	HNL	02 42+33	1		BEARINGS	✓			✓	51	113	B-V
76	8017	16230	11/2	LAX	ACT CODE 01 FAIL CODE 33	2		BEARINGS	✓			✓	41	75	B-V
77	8017	16401	11/5	ORD	HORIZON ERRATIC CODE 001	2		X GYRO	✓			✓	75	54	B-V
78	8004	2222 05	11/6	ORD	#2 INS INOP	2		CMPTR DEAD	✓			✓	66	52	
79	8013	17056	11/9	SFO	STEADY RED WARN LT	1		OK		✓		✓	36	31	B. N.G.
80	8019	14923 06	11/11	HNL	EXCESSIVE NAV ERROR 001 33,42,49	2		BEARINGS	✓			✓	1	26	B-V
81	8019	14933	11/12	LAX	RED WARN LT	1		CMPTR SCRAMBLED	✓			✓	50	106	B-V
82	8017	16468	11/13	SFO	RED LT 001	1		AC 01- 33,34,35 BALL TUMBLED X GYRO	✓			✓	20	66	B-V
83	8013	17127 56	11/22	HNL	RED WARN LT PLATFORM MALF	2		A10-1 CARD BAD	✓			✓	29	25	B-V
84	8022	10314 48	12/11	LAX	01- 33,37 RED LT	2		XY PLATFORM RUB	✓			✓	41	56	B-V
85	8035	8853	1/26	HNL	RED WARN LT 004 - 06	1		"X" ACCEL BAD MC 60	✓			✓	5	73	B-V

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: INS CMPTR

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING .	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
86	8023	13900 02	2/11	ORD	02+42	2		INTERM X ELECTRONICS	✓			✓	12	69	B-V
87	8020	16023	3/22	HNL	RED WARN LT 04-41	1		ROUGH BEARINGS 1RUG + SYNC MOTOR "4" GYRO	✓			✓	44	38	B-V
88	8029	10186 18	4/20	LAX	#1 INS DIS IN ERROR 50 MI	1		"2" GYRO DRIFT	✓			✓	49	38	B-V
89	8019	16211	4/29	LAX	WARN LT ON - UNABLE TO TEST - UNABLE TO CHANGE DATA SEL	2		P 2 CARD	✓			✓	61	57	B-V
90	8012	58	5/9	SFO	DISTANCE ERRORS	1		2 GYRO LADDERS RATTY	✓			✓	2	7	
91	8032	10523 49	5/15	LAX	#2 INS TO SS - DISPLAYS ERR INFO - WARN LT	2		UTV		✓		✓	113	21	B-N.G.
92	8014	18775	6/12	LAX	A/C RED LT ON DISPLAY STUCK	2		UNIT SCRAMBLED P2	✓			✓	52	70	
93	8011	18426	6/18	LAX	RD WARN LT ON 02, 42 CODE	1		UTV		✓		✓	14	56	B-N.G.
94	8016	1879036	6/25	HNL	CODE 01, 36, RESTART NO HELP	2		AD CARD SATURATED	✓			✓	63	115	B-V

FORM ARCS UA-2 5/27/76

UNIT: CADC

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
1	8012	15829:49	7/3/75	SFO	INTMTNT OFF FLAGS ON CAPT ALT / MACH MTR	1		UTV ALT RDS LOW RECALIB ALT		✓	✓		42	24	
2	8073	12107:48	7/4	ORD	HIGHER THAN F/O MACH METER	1		UTV ALT RDS HIGH RECALIBTD		✓	✓		57	52	
3	8019	12807:54	7/4	LAX	INOP - CHRONIC			MKII SERVO AMP RPLD	✓			✓	26	61	
4	8013	15920	7/8	HNL	POOL COMP TO JAL AC #8111. LR 13,199	2		AIRSPD READS LOW RECALIB.		✓	✓		62	28	
5	8013	16047	7/20	SFO	INOP FLAG IN ALT/MACH & TAS	1		PWR SUPPLY	✓			✓	64	43	
6	8013	16061:39	7/21	HNL	ALL FLAGS SHOWED ON DESCENT	1		AIRSPEED HIGH RECALIB		✓	✓		43	37	
7	8010	1964	7/23	HNL	ALT HOLD PITCH UP RD LITE IN CMD	2		ALT MOTOR BEARING BAD ALT & A/S CALIB		✓	✓		4	59	AFCS
8	8003	870:52	7/30	HNL	DEAD ABOVE 10,000 FT OK AT 14800. ALT RPTG	1		UTV CALIB ALT & A/S		✓	✓		57	34	
9					WILL NOT SELF TEST			ALT SERVO AMP	✓			✓	15	15	B-V
10	8016	15722:11	8/4	HNL	FLAGS ON ALL IND	2		POWER SUPPLY	✓			✓	21	28	
11	8013	16214	8/5	SFO	ALT ERR			BAD ENCODER	✓			✓	57	26	
12	8020	14189	8/8	SFO	A/P WONT HOLD ALT IN ALT HOLD OK IN ALT SEL	1		ALT RD APP 2° HIGH		✓	✓		27	57	AFCS
13	8029	15341	8/12	LAX	TAT GAUGE INOP	2		UTV		✓		✓	69	8	
14	8017	5765:54	8/22	HNL	GIVES [illegible] UP "E" A/P IN ALT HOLD	2		UTV. TAS SEL [illegible] INOP		✓	✓		25	4	AFCS
15	80[illegible]	[illegible]	8/30	SFO	[illegible] FLAGS IN VIEW			POWER SUPPLY BAD ALT READ 15° LOW		✓	✓		57	21	
16	[illegible]	[illegible]	9/[illegible]	SFO	[illegible] BELOW SEA LVL AT [illegible]	2		ALT LOW A/S HIGH	✓		✓		61	48	
17	8018	14829	9/8	SFO	TAS FLAG COMES INTO VIEW	1		BAD AR3	✓			✓	29	50	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: CADC

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
18	8018	14833	9/9	BOS	CAPT ALT, MACH TAS IND INOP	1		UTV		✓		✓	50	67	
19	8017	·	9/9	HNL	SELF TEST ALT & MACH INOP	1		BAD S.T. SYNCH	✓			✓	22	12	BITE V.
20	8019	144954	9/12	LAX	F/O'S ALT READS 400' DIFF THAN CAPT'S STBY	2		UTV		✓		✓	48	15	
21	8018	14533:30	9/13	LAX	SHUT-DOWN - RESET C/B + THEN O.K. FOR A WHILE THEN SHUTS DOWN	1		UTV SERVO BAD ALT MACH + TAS		✓	✓		36	55	?
22	8019	14539:54	9/17	LAX	MACH FAILS LOW	1		UTV		✓		✓	53	22	
23	8019	14574:09	9/19	DEN	MACH IND READS .005 TO .008 LOW	1		UTV		✓		✓	22	49	
24	8019	14576:04	9/20	LAX	MACH HIGHER THAN CAPT'S	2		UTV		✓		✓	15	43	
25	Stock		9/29	HNL	AFTER TEST SAT MACH + ALT FLAGS STAY IN			BAD AG LOGIC BOARD RPLD	✓			✓	69	69	
26	8019	146493	9/29	HNL	CO PILOT SAT MACH & ALT FLAGS IN VIEW	2		A/S READS LOW UTV RECALIB		✓	✓		43	64	
27	PAN AM				RTN OF LOAN. RPTD INOP ABOVE 15000'			UTV		✓		✓	50	–	
28	8003	1547:18	10/9	ORD	PER SFOEG	1		UTV RECAL (BTI)		✓	✓		34	42	
29	8003	1547 8	10/9	ORD	PER SFOEG	2		UTV RECAL BTI		✓	✓		63	57	
30	8032	8934:35	10/[illegible]	LAX	GIVES ERRONEOUS WIND INFO TO INS, ALSO A/P ELEV NERVE!	1		UTV		✓		✓	13	2[illegible]	[illegible]
31	8022	8884	10/17	LAX	F/O ALT FLAGS	2		BAD #1 COARSE SYNCH & SERVO MOTOR	✓			✓	4[illegible]	36	
32	8027	11506	10/18	LAX	ALT ERRATIC	2		BAD ENCODER	✓			✓	54	1	
33	Stock	–	?		ALT RED FLAG	1		UTV		✓		✓	31	31	
34	8012	15785:52	10/22	SFO	CAPT ALT FLAG AND READS 300' LOW	1		ALT FINE SYNCH BAD	✓			✓	24	21	

FORM ARCS UA-2 5/27/76

UNIT: CADC

LINE NO.	A/C	YSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8019	14854:	10/31	ORD	FLAGS ON #1 MACH IND. ALT & INS ERRATIC	2		BAD LOG Q. DIFF SYNCH BRUSHES, ENCODER	✓			✓	49	69	
36	8014	16159	11/1	LAX	MACH .013 SLOW ALT 180' LOW	1		UTV		✓		✓	16	43	
37	8010	2838:01	11/3	LAX	ALT 300' HIGH & MACH .018 HIGH	2		UTV		✓		✓	59	31	
38	8014	16203	11/7	SFO	CAPT'S ALT SHOWS INTMT'NT FLAG. LOSS OF ALT CONTROL WITH 'A' A/P	1		UTV		✓		✓	43	25	AFCS
39	8013	17063	11/9	SEA	INOP ALL FLAGS	2		BAD PWR SUPPLY. ALSO BENT P.V. IN REAR CONNECTOR	✓			✓	62	58	
40	8017	16444:44	11/9	ORD	INOP	1		UTV		✓		✓	12	38	
41	8010	2901	11/10	SFO	CREW RPT FALSE GPW JUST AFTER T.O.	1		BAD REAR CONNECTOR & ENCODER	✓			✓	32	54	
42	8017	16473:12	11/13	HNL	#1 CADC PWR FAIL. CAPT MACH, ALT & TAS INOP	1		UTV DIRTY FOLLOW-UP RESOLVER		✓	✓		38	55	
43	8010	2944	11/15	LAX	#2 ALT READS 80' HIGH	2		UTV		✓		✓	31	24	
44	8014	16285	11/16	ORD	ALT IND HIGH. MACH & A/S HIGH	2		UTV ALT MODULE OUT OF TOL CALIB		✓	✓		17	22	
45		- NO - INFO -						NONE		✓		✓	40	40	
46	STOCK		12/1	HNL	"PRECAUTIONARY"			TESTED OK		✓		✓	28	28	
47	8011	16890	12/4	LAX	MACH READS HIGH AT 370	2		UTV BAD CAPACITOR IN PWR SUPP RPLD		✓	✓		19	62	
48	8010	16738	12/5	LAX	INOP MOST OF FLT	2		UTV		✓		✓	42	63	
49	8004	24312	12/5	ORD	ALL DATA INOP FLAGS	2		PWR SUPPLY 28VDC LOSS CAPACITOR RPLD [illegible]	✓			✓	11	12	
50	[illegible]	8816 46	12/6	LAX	"B' A/P WILL NOT CAP ALT	2		OPEN [illegible] SERVO MOTOR	✓			✓	36	13	FCS
51	8021	2435	12/7	SEA	F/O ALT INOP	2		BAD PWR SUPPLY	✓			✓	12	37	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: CADC

LINE NO.	A/C	TSC	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52	8011	16978 40	12/29	SFO	FLAG IN ALT AT ALL TIMES	1		BAD PWR SUPPLY + ALT MODULE OUT OF CALIB	✓			✓	66	38	
53	8027	12007 50	12/31	HNL	ALT FLAG SHOWS	2		C.A.S. OUT OF ADJ GEAR TRAIN STOP CALIB	✓			✓	1	49	
54	80[illegible]	9335	1/[illegible]	SFO	FLAG [illegible] MACH + TAS IND			BAD CAPACITOR 11 MF IN PWR SUPPLY	✓			✓	8	12	
55	[illegible]		1/8	SFO	(A/C 81[illegible] LR10228)			TESTED OK		✓		✓	43	43	
56	8012	17179	1/10	SFO	ALT READS 6[illegible] FT LOW	2		ALT MODULE OUT OF TOL BAD ALT SERVO MOTOR	✓			✓	51	57	
57	8011.	17104	1/11	LAX	CAPT'S TAT IND INOP FLAG INTERMITTEN	1		UTV		✓		✓	38	11	
58	8027	12110	1/13	LAX	ALT RED FLAG. ALT 25~30 FT UP + DN	1		UTV		✓		✓	45	28	
59	8027	12152	1/18	SFO	ALT STICKS + JUMPS UP + DN	2		BAD ALT SSEC POT	✓			✓	49	66	
60	8029	9438:12	1/19	ORD	MACH + ALT IND READ LOW	1		ALT SENS RESOLVER BAD	✓			✓	56	23	
61	8004		1/21	SFO	A/P ALT HOLD ERRATIC	1		UTV		✓		✓	37	45	AFCS
62	8011	17152 01	1/21	LAX	ALL #2 ADC INST INOP OK WITH NEW CADC	2		BAD [illegible] K SUPPLY, ALT. MOD[illegible], CAS TAS BEARINGS	✓		✓		62	42	
63	8011	12209 36	1/24	LAX	GIVES ERRONEOUS ALT [illegible]	2		UTV		✓		✓	66	16	
64	80[illegible]	[illegible]	1/24	[illegible]	[illegible] WATER FLAG IN CAPT ALT. CLIMBING THRU 36K	1		UTV		✓		✓	45	34	
65	80[illegible]	12229	1/2[illegible]	LAX	"A" A/P [illegible] ALT HOLD. [illegible]	1		UTV		✓		✓	26	19	AF[illegible]
66	801[illegible]		1/27	SFO	[illegible]		1	[illegible]		✓		✓	67	[illegible]	
67	[illegible]	[illegible]	[illegible]	LAX	A A/P [illegible] 37000	1		?					19	8	AFCS
68	8011	17207 21	1/29	ORD	CAPT ALT + A/C MACH FLAGS [illegible] T.O., OK ABOVE 3800'	2		UTV		✓		✓	4[illegible]	15	

FORM ARCS UA-2 5/27/76

UNIT: CADC

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
69	8016	17174	2/6	LAX	ALT SYNCH OUTPUT TO FLT RCDR ERRATIC	1		UTV✓ MACH • TAS OUT OF TOL		✓	✓		53	19	
70	8028	9253:11	2/10	DEN	FLAGS IN CAPT ALT & MACH IND	1		PWR SUPPLY	✓			✓	13	29	
71	8029	9626:44	2/16	HNL	ALT SEL CAUSES ABRUPT CLIMB	1		CLUTCH STICKING	✓			✓	23	17	AFCS
72	8019	15625:11	2/18	HNL	ALL FUNCT INOP AFTER T.O	1		PWR SUPPLY	✓				69	32	
73	8035	9094:07	2/28	HNL	SAT READS 6.0 ON GRND SWAP FIXES	2		MACH MODULE OUT OF CALIB	✓			✓	46	53	
74	JAL (POOL)							TESTED OK		✓		✓	38	—	
75	NORTH WEST (POOL)							"		✓		✓	36	—	
76	AAL (POOL)							"		✓		✓	69	—	
77	8012	17636:15	3/1	ORD	INS RDOUT INOP	2				✓		✓	59	37	
78	8019	15843:21	3/14	SFO	MACH FUNCT INTMTNT SLEW OK	2		UTV ALT RDG LOW RECALIBRATE		✓	✓		64	40	
79	8032	10022	3/20	HNL	INTMTNT FLAGS ON MACH & ALT	1		UTV✓		✓		✓	42	66	
80	8032	10066:48	3/22	ORD	ALT READ 300' HIGH AT FL 330	2		UTV✓		✓		✓	27	49	
81	8032	10067	3/23	LAX	PEEKING FLAG ON ALT AND ALT ALERT AT [illegible]	2		UTV✓		✓		✓	49	45	
82	8032	10077:19	3/24	HNL	#2 MACH .005 HIGH & #2 ALT FLAG	2		UTV✓		✓		✓	45	62	
83	8032	10106	3/27	HNL	FLAG IN VIEW- MACH, SAT, ALT	2		UTV✓ MISSING RATE OUTPUT		✓	✓		67	?	
84	8032	10110:40	3/28	SFO	REPLACEMENT FOR PAN AM LOAN	2		—					69	—	
85	STOCK	—			SAT IND FLAG OSC. OK WITH OTHER CADC	–		UTV✓		✓		✓	27	27	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: CADC

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
86	AAL LAN	-	4/1	JFK	—			TESTED OK		✓		✓	59	—	
87	8027	12895:41	4/6	ORD	NO WIND IND FLAGS ALT, MACH & TAS	1		DEFECTIVE MONITOR AMP ACT OUT OF TOL	✓		✓		8	1	
88	8010	4018	4/9	LAX	SELF- TEST INOP ALC LAMP TEST	2		PWR SUPPLY	✓			✓	24	42	BV
89	8010	4033:33	4/10	HNL	FLAG MACH FLAG [illegible] INFO ON INS	1		POT- BAD [illegible] MACH MODULE	✓			✓	4:	[illegible]	
90	STOCK		4/13	LAX	SOS	--		UTV		✓		✓	(42)		
91	8010	41047	4/18	LAX	FLAGS EVERY 15 MIN IN CAPT MACH MTR [illegible]	1		UTV RPLD MACH MODULE PRECAUT		✓		✓	49	24	
92	8012	18077	4/21	SFO	FLAGS & FAIL LITE ON CAS	2		CAS MODULE OVER PRESS	✓			✓	37	43	
93	8032	10573:03	4/27	LAX	ALT WARN COMES ON APP. 400' LOW	2		UTV		✓		✓	69	42	
94	8032	10410	5/2	SFO	INOP FOR 45 MIN	2		UTV		✓		✓	42	27	
95	8012	46:06	5/8	LAX	INTERMITTENTLY INOP	2		UTV CAS READ HIGH		✓	✓		43	69	
96	8028	101723	5/12	LAX	WIND RDG ON INS (3) ALSO TAS	2		DEFECTIVE TAS POT RPLD ACT MOD	✓		✓		41	62	
97	8032	10528.4	5/15	HNL	BOTH TRANSPONDERS WERE RPTD TO GIVE ERRONEOUS RDG	2		UTV		✓		✓	27	38	
98	8014		5/30	SFO	TAIL ST.	1		UTV		✓		✓	25	43	B/I E LN
99	JAC P			[illegible]	—			[illegible] BRKED					8		
100	[illegible]	18320	6/6	[illegible]	ALT RPTING INOP ON TRANSPONDERS	2		PWR SUPPLY BAD RPLCD [illegible]		✓	✓		26	31	
101	[illegible]	[illegible]	6/7	HNL	SAT [illegible]	2		[illegible]		✓		✓	[illegible]	[illegible]	
102	8027	13535.4	6/13	LAX	ALTMETER [illegible] 35[illegible] B A/P	2		[illegible] ALT CAPT ARM	✓			✓	16	13	ARCS

FORM ARCS UA-2 5/27/76

PORPOISE

UNIT: CADC

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
103	8013	18457.7	6/13	HNL	CHRONIC. REPTS OF #1 + #2 TRANSPONDER WRONG ENC ALT	1		ENCODER FAIL + ALT LOW CHANGED	✓			✓	27	45	
104	8020	16668	6/19	SFO	ALT KNB INOP	1		UTV PWR SUPPLY BAD		✓	✓		21	25	AFCS
105	8013	14538.4	6/22	HNL	FLAG IN CAPT ALT AT CRUISE	1		UTV		✓		✓	45	28	
106	8035	10197.3	6/24	SFO	#1 INS WIND FUNCT INOP TAS + TAT INOP	1		PS1 PWR SUPPLY AR1 CKT BAD RPLD	✓			✓	68	49	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: RADIO ALT R/T UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8013	15864:39	7/3/76	CLE	CHRONIC ERRATIC	1		UTV		✓		✓	1282	1137	
2	8013	15879:59	7/4	ORD	INOP	2		TX ERRATIC, MONITOR COUPLER SIGNAL INTMITT RPLD A1CR12	✓			✓	2063	1239	
3	8013	15911:44	7/7	HNL	WOULD NOT TEST	1		UTV ✓		✓		✓	1239	1065	
4	8029	7919:24	7/8	ORD	ERRATIC	1		UTV ✓		✓		✓	1222	1145	
5	8028	7591:25	7/15	SFO	ERRATIC INDICATIONS ON GND. ALSO A/P RED WARN IN LAND	2		TX OUT OF ALIGN	✓			✓	1218	1071	AFCS
6	8019	14026:58	7/25	LAX	INOP	1		UTV NOISY I.F. RPLD A2CR2		✓	✓		1283	1341	
7	8004	1345:01	7/31	HNL	— NONE —	1		SIGNAL PRES. CKT A4Q46 LEAKY	✓			✓	2112	1077	
8	8032	8383	8/8	LAX	RWY FLAG INTERMITTENT	1		WEAK I.F. SIGNAL A3C45, A4 CR7 RPLD	✓			✓	1062	1025	
9	8020	14219	8/11	CLE	INOP	2		UTV ✓		✓		✓	2040	1055	
10	8020	14220	8/11	ORD	"NO HELP"	2		UTV ✓		✓		✓	1055	1008	
11	8028	7934	8/12	ORD	RWY FLAG IN VIEW ALL THE TIME ON F/O ADI	2		UTV ✓ MOD MONIT OUT OF CALIB		✓	✓		1071	1106	
12	8014	15440	8/13	SFO	WHEN "G" [illegible] UP FOR CAT — CK. R/A [illegible] WORK	1		UTV ✓		✓		✓	2084	1263	AFCS
13	[illegible]	16116	[illegible]	SFO	FLICKERING [illegible] FLAG	2		UTV ✓		✓		✓	1345	1167	
14	8032	85[illegible]	9/4	ORD	FLAG STAYED [illegible] & UNABLE TO ACHIEVE [illegible] A.E. [illegible]	2		UTV ✓		✓		✓	[illegible]	120[illegible]	AFCS
15	8035		9/14	LAX	[illegible]	–		UTV ✓		✓		✓	1137	1320	
16	8019	14[illegible]	9/5	SFO	BOTH R/A [illegible] SHAKE [illegible] + OR [illegible]	1		UTV ✓		✓		✓	[illegible]	2014	
17	8035	7730	9/7	ORD	ALT INOP ABOVE 2500	1		UTV COMPARATOR OUT OF ADJ		✓	✓		1370	1608	

FORM ARCS UA-2 5/27/76

UNIT: RADIO ALT R/T UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8019	14520	9/15	LAX	INOP FLAG SHOWS, ALSO RWY FLAG ON ALI	1		UTV		✓		✓	2014	2116	
19	8020	14601	9/19	JFK	CAPT SYS INOP	1		UTV		✓		✓	1248	1299	
20	8023	12840 49	9/21	LAX	2500' WRN LITE INOP	1		UTV RPLD A4C100		✓	✓		1072	2075	
21	8023	12868	9/24	LAX	RADIO ALT DID NOT COME ON AT 2500	1		UTV		✓		✓	2075	2055	
22	8012		9/27	SFO	A/P WARN IN LAND MODE	1		A5C1+C2	✓			✓	1347	105	AFCS
23	8016	16452	10/3	HNL	REMOVED FOR CoA 8-1806	1						✓	1301	2015	
24	8016	16452	10/3	HNL	REMOVED FOR CoA 8-1806	2						✓	1182	2022	
25	8016	16452	10/3	HNL	FLAG, FAULT OVER 2500'	2		30VDC HIGH RPLD A6R13 + A6R9	✓			✓	2022	1343	
26	8014	15938	10/5	SFO	INOP BELOW 300'	1		A5R156 OPEN. RPLD	✓			✓	1067	1068	
27	8014	15933	10/4	SFO	ERRATIC BELOW 300'	1		A5C19 INTERMITTENTLY BAD	✓			✓	1108	1067	
28	8016	16286	10/10	SFO	INTERMIT FLAG	2		UTV		✓		✓	2067	1301	
29	8012	16764	10/17	ORD	INTERMITTENT FLAG	1		UTV		✓		✓	1015	2025	
30	8013	16904	10/23	HNL	CoA 8-1806	2						✓	1065	2006	
31	8029	8860	10/23	HNL	CoA 8 1806	1						✓	1145	2001	
32	8013	16904	10/23	HNL	CoA 8 1806	1						✓	1137	2016	
33	8029	8860	10/23	HNL	CoA 8 1806	2					✓		2026	2010	
34															

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: RADIO ALT R/T UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8023	15303 11	10/23	HNL	COA 8-1806	2			N/A				7201	2201	COA
36	8023	15303 11	10/23	HNL	COA 8-1806	1			N/A				2035	2004	COA
37	8014		10/28	HNL	COA 8-1713	2			N/A				1263	2011	COA
38	8028	115380	10/28	HNL	COA 8-1806	1			N/A				2048	2204	COA
39	8014		10/28	HNL	COA 8-1713	1			N/A				1068	2002	COA
40	8020	1211	10/31	HNL	COA 8-1806	2			N/A				1206	2035	COA
41	8010	11334	10/31	HNL	COA 8-1806	2			N/A				1003	2030	COA
42	8003	1791 45	11/2	HNL	INOP FROM STOCK BLACK INDICATOR TAPE - FLAG SHOWS	1		MOD GATE VOLTAGES HIGH	✓			✓	2029	2029	
43	8014	16210 47	11/7	SEA	ERRATIC - LOWER BY 200' THAN F/O ON APPROACH	1		OK ON ATE		✓		✓	2002	2026	
44	8017		11/10	HNL	COA 8-1806	2			N/A				2058	2207	COA
45	8028	18589 18	11/12	LAX	IND BURNED OUT TX	1		A6R41 FUSED	✓			✓	2204	2029	
46	8028	18589	11/12	LAX	IND BURNED OUT T/R UNIT	2		A6R41 OPEN	✓			✓	2008	2008	
47	8028	18589 40	11/12	LAX	IND BURNED UP TX	2		NO 26 VAC TO IND	✓			✓	2019	2013	
48	8017	16473 12	11/13	HNL	#1 RAD ALT INOP MOST OF TIME RESET CIRCUIT BREAKER - NO HELP	1		UTV		✓		✓	2017	2036	
49	8010	2944	11/15	LAX	GPWS ACTIVATED AT 150 FT AFTER T/O CHRONIC	1		UTV		✓		✓	2005	2047	
50	8018	15511	11/17	LAX	GPWS FAIL LT CAME ON PRIOR TO T/O - RAD ALT FLAG INTERM	1		UTV		✓		✓	2007	2096	
51	8016	16609 28	11/21	DEN	ERRATIC BETWEEN ALT OFF 500'-700' (WINDOW SHADED WITH FLAG)	2		A4Q83 SHORTED	✓			✓	2015	2092	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: RADIO ALT R/T UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52	8004	2326	11/23	SFO	1500 CUTS OUT	1		OK ON BENCH		✓		✓	2009	2040	
53	8010	3081	12/2	SFO	INOP	1		ALL SHOP TESTS PASSED		✓		✓	2047	2028	
54	8004	2411	12/3	SEA	A/C UNABLE TO USE RAD ALT TESTER TO CK APC TEST - 200' RUNS TO TOP	2		ALL SHOP TESTS OK		✓		✓	2024	2002	
55	8016	16713 14	12/4	DEN	200'-300' ERROR AT 900'-500' ABOVE GND 30' ERROR AT 300' ABOVE	2		OFF-SCALE OSC FREQ HIGH		✓	✓		2042	2007	
56	8032	9412	12/30	ORD	ERRATIC ON TEST	1							2021	2008	
57	8012	17118 03	1/1	BOS	ERRATIC OPERATION	1		OK		✓		✓	2025	2045	
58	8017	16720	1/3	DEN	SCRATCHY	1		UTV		✓		✓	2058	2093	
59	8004	2599	1/5	SFO	USING TESTER - READ 2100 INSTEAD OF 2500	2		OK		✓		✓	2002	2017	
60	8020	15441	1/12	LAX	GPWS GAVE UNWANTED WARNING AT 400' ALT RADAR IND	1		TRANSMITTER OUTPUT LOW		✓	✓		2205	2204	
61	8013	17451	1/13	LAX	PRECAUTIONARY FLAG IN VIEW (RWY)	1		PRE-AMP GAIN + #1 TRIP	✓			✓	2016	2206	
62	8014	16690	1/16		FLAG SHOWING 90% OF FLT - OK ON T/O, APP + LAND	1		OK		✓		✓		2019	
63	8004	2591	1/11	SFO	INDICATOR GOES TO BLACK WITH FLAG - WILL NOT OPERATE ON ALT TEST	2		OK ON ATE		✓		✓	2017	2038	
64	8012	17442	2/7	HNL	IND INOP GPWS INOP (FAIL LT)	1		BAD SOLDER CONNECTION AT A5A2	✓			✓	2095	2039	
65	8004	2822 59	2/10	SFO	AF TONE VERY DISTORTED	2		NOISY IF OUT OF MIXER		✓	✓		2038	2027	
66	8016	17224	3/4	SFO	INTERM FLAG	2		OK		✓		✓	2033	2021	
67	8014	17122	3/7	SFO	RAD ALT ERRATIC RT	2		UTV		✓		✓	2040	2017	
68	8011		3/24	SFO	INOP	1		OK	N/A			✓	2032	2009	

FORM ARCS UA-2 5/27/76

UNIT: RADIO ALT R/T UNIT

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
69	8018	16533 55	3/29	LAX	F/O DH LT COMES ON IN FLT INTERM	2		UTV		✓		✓	2203	2025	
70	8035	9529 37	4/12	ORD	IND DOES NOT TEST PROPERLY	2		30 V SUPPLY DRIFTING + ERRATIC	✓			✓	2027	2029	
71	8018	16517	4/29	LAX	INTERM FLAG	2		OK		✓		✓	2025	2030	
72	8012	18000	4/30	SFO	A/P TEST TEST CABLE SHORTED OUT AND R/T TRIP CANNOT BE RESET	1		OK	✓			✓	2039	2045	AFCS
73	8012	18250	4/30	SFO	ERRATIC SOMETIMES PWR OFF FLAG - NEVER BIAS OUT -	2		UTV		✓		✓	2045	2042	
74	8012		5/2	SFO	F/O FLAG SHOWS WITH DH (T/O) LT AT 1500 FT + STAYED ON REST OF FLT	2		ASCI CORRODED + LEAKY	✓			✓	2005	2203	
75	8012	30	5/6	ORD	RADIO ALT FLAG + DH LT ACTIVATE ERRATICALLY IN CRUISE	2		AGR13 INTERM	✓			✓	2205	2038	
76	8014	1'5	5/29	2	RT FAULT SHOW - ON AUTO LAND AP RED LT ON + OFF AT 1500, 800 + 400	2		UTV		✓		✓	2016	2015	
77	8014	17763 57	5/30	2	DH LT AT 1500 ON CLIMB ON ONE DESCENT DH LT ON AT 2700	2		UTV		✓		✓	2015	2042	
		NONE	THRU	6/30/	76										

FORM ARCS UA-2 5/27/76

UNIT: RCVR NAV/GS

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8020	13914	7/7	LAX	NAV FLAG SHOWS IN RAD POS	#1	5	BAD FILTER	✓			✓	175	234	
2	8010	1835 01	7/8	LAX	ON APP LAX G/S FLAG	#1	2	NO TROUBLES		✓		✓	45	269	
3	8013	15915	7/11	SFO	G/S FLAGS G/S INOP ON ILS	#2		INTERMITTENT RELAY	✓			✓	145	34	
4	8020	13943	7/11	SFO	NO G/S CAPTURE ON A/P OR F/D AND NAV FLAG ON ADI + HSI	#2		VHF RCVR ALIGNMENT	✓			✓	84	129	
5	8017	15400 48	7/13	ORD	NAV FLAG SHOWS	#1	1	A-101	✓			✓	82	158	
6	8017	15420	7/14	ORD	WEAK	#1	4	UTV		✓		✓	131	14	
7	8017	15417	7/14	ORD	WEAK	#1	3	UTV		✓	✓		158	131	
8	8010	1897 18	7/15	LAX	NO RECEPTION ON GS UNTIL CLOSE TO TX	#1	5	UTV		✓		✓	269	42	
9	8020	13988 13	7/15	JFK	WEAK ON ALL FREQ.	#1	12	UTV		✓		✓	234	311	
10	8017	15425 33	7/15	ORD	WEAK	#1		FL-1 OPENS ON WARM-UP	✓			✓	14	30	
11	8011	15851	7/16	SFO	INTERM G/S + RWY FLAGS	#1		UTV		✓		✓	55	232	
12	8023	17244	7/16	HNL	WEAK	#1		NO TROUBLE		✓		✓	349	319	
13	8028	7610	7/17	SFO	W/A A/P ENG AND ILS CAPT "A" DROPS OUT	#1	13	NO DEFECTS FOUND		✓		✓	180	20	
14	8010	1926	7/18	ORD	INTERM VOR FLAG	#1	6	COULD NOT VER		✓		✓	42	285	
15	8016	15573	7/18	LAX	GS WEAK AT LAX	#1	6	NO PROBLEMS		✓		✓	60	103	
16	8017	15452	7/19	SFO	LOCALIZER FLAG ON 109.5 CAME ON ON AP	#1		UTV		✓		✓	30	158	
17	8017	15464	7/22	ORD	WEAK	#1		UTV		✓		✓	158	347	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS OF POOR QUALITY

UNIT: RCVR - NAV/GS

LINE NO.	A/C	TBO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING .	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8017	15960 45	7/22	ORD	WEAK	#1		INT TRANSISTOR Z-3-Q-3 OF RCVR	✓			✓	349	180	
19	8027	10729	7/24	ORD	WEAK	#1		UTV		✓		✓	331	159	
20	8016	15680	7/29	LAX	WEAK	#1		Z-1-FL-81 OF RCVR FILTER INTERM PHASE SHIFT	✓			✓	102	268	
21	8013	16199 05	8/4	ORD	FLAG SHOWS	#1		UTV		✓		✓	289	131	
22	8027	10844	8/4	LAX	VOR FLAG IN HDG IND			CONDUCTIVE LIQUID COAT ON P.C. BD	✓			✓	159	180	
23	8017	15630	8/8	LAX	WEAK ON ILS/GS	#2		UTV		✓		✓	213	145	
24	8023	12461	8/8	ORD	WEAK VOR	#1		UTV		✓		✓	319	297	
25	8013	16253	8/9	ORD	F/O HAD NAV "OFF" ON 109.7 TO 2300 FT THEN FLAGS DISAPPEARED	#2		UTV		✓		✓	16	336	
26	8023	12496	8/11	ORD	OCCASIONAL FLAG OTHERWISE OK	#1		UTV		✓		✓	297	189	
27	8016	15808	8/14	JFK	A/C CRS IND GETS NAV FLAG + #1 VOR PTR ON RMI INOP W/ FLAG	#1	26	BAD SOLDER JOINT PIN 2 OF F 1-1	✓			✓	268	162	
28	8029	8259 13	8/14	ORD	WEAK	#2		NO PROBLEMS		✓		✓	32	103	
29	8017	15722 42	8/17	BAS	LOC WEAK	#2		UTV		✓		✓	308	265	
30	8017	15728	8/17	SFO	ILS INOP ON APP	2		C-15 ON Z-5 OF G/S RCVR SHORTING	✓			✓	143	308	
31	8016	15886 54	8/22	LAX	G.S. WEAK	1		UTV		✓	✓		162	326	
32	8035	7618	8/23	ORD	#1 SEEKING NEEDLES ERRATIC ON RMI'S	1		UTV		✓		✓	286	75	
33	8020	14373	8/25	SFO	VERY WEAK			DEFECTIVE PL CONNECTOR	✓			✓	129	221	
34	8020	14430	9/1	LAX	#1 12° OFF ON VOR TEST	1		NO TROUBLE		✓		✓	311	6	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: RCVR - NAV/GS

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERI.		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8126	—	9/3	BAL	F/O VOR WEAK - FLAG APPEARS UNLESS NEAR STATION			OK		✓		✓	144	158	
36	8012	16447	9/7	LAX	F/O REPORTS WEAK G/S	#2		UTV		✓		✓	34	54	
37	8012	16451	9/8	JFK	RCLD PREC #2 VOR RMI REPORTED 20° OFF ACTUAL COURSE	#2		NO TROUBLE		✓		✓	54	297	
38	8010	12438	9/12	ORD	G/S SHOWS 1 DOT ABOVE TO 1 DOT BELOW NORMAL	1		UTV		✓		✓	285	397	
39	8010	12470	9/16	LAX	CAPT ILS SHOWED FLAGS IN G/S + LOC ON APP LAX	1				✓		✓	397	230	
40	8016	16062	9/17	ORD	INTERM	1		UTV		✓		✓	326	311	
41	8018	14916	9/17	ORD	RWY FLAG ON APP	2				✓	✓		320	394	
42	8018	14924	9/18	ORD	G/S WEAK	2		UTV		✓		✓	394	209	
43	8017	16024 27	9/18	LAX	#2 G/S FLAG SHOWS MOST OF THE TIME	2		C-2 SHORTING OUT INTERM	✓			✓	269	299	
44	8012	16610	9/27	SFO	A/P WARN IN LAND MODE	2		NO TROUBLES		✓		✓	332	183	AFCS
45	8012		9/27	SFO	A/P WARN IN LAND MODE	1		NO TROUBLES		✓		✓	297	124	AFCS
46	8013	16753 08	10/1	SFO	G/S FLAG IN VIEW 50% OF THE TIME ON ILS APPROACH AT SFO	2		UTV		✓		✓	336	54	
47	8035	7930 59	10/2	ORD	INOP	2		UTV		✓		✓	75	48	
48	8014	159[illegible] 05	10/2	LAX	F/O RWY FLAG IN VIEW ALL TIMES - THEN INTERM	2		UTV		✓		✓	244	[illegible]60	
49	8013	16770 59	10/4	ORD	G/S ERRATIC WITH AFC COUPLER	1		UTV		✓		✓	13[illegible]	285	
50	8014	1194[illegible] 54	10/5	HNL	TEST SIGNAL PRESENT WHEN SOME FREQ	2		UTV		✓		✓	2[illegible]	169	
51	8010	2636	10/6	LAX	G/S DID NOT DISAPPEAR UNTIL REAL CLOSE IN	1		UTV		✓		✓	230	183	

FORM ARCS UA-2 5/27/76

UNIT: RCVR NAV/GS

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	PGS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52	8018	1556	10/10	LAX	#1 PTR 10° OFF #2 PTR VOR			NO TROUBLE		√		√	314	67	
53	8012	16215 53	10/13	BOS	HSI FLAG SHOWS AT TIMES IN RADIO ONLY	2		FL-1 IN VHF RCVR VERY NOISY + INTERM	√			√	299	147	
54	8012	16638 43	10/1	LAX	G/S WEAK	2		UTV		√		√	183	383	
55	8003	1668 10	10/21	LAX	COURSE BAR ON #2 FLAG CKS IND IS ERRATIC - NO FLAG	2		DEF SUB-ASSY BEARING MECH MODULE LEAD ROUGH REVOLVER	√			√	23	334	
56	8019	14823 25	10/26	LAX	G/S FLAG APPEARS INTERM ON APP	2				√		√	155	112	
57	8023	13211 36	10/31	HNL	AURAL + VISUAL WEAK	1		UTV		√		√	375	82	
58	8020	14980 13	11/2	LAX	WEAK ON 108.6 MORE THAN 12 N M FROM STAT	2		G/S RCVR OUT OF ALIGNMENT	√			√	6	230	
59	8010	2838 10	11/3	LAX	G/S RCVR WEAK	1		UTV		√		√	183	157	
60	8014	16185	11/4	LAX	REPORTED WEAK - DID NOT CAPTURE UNTIL 15 FROM STATION	1		FOUND 844B-1 2485 BACKLASH SPRING NOT PROPERLY LOADED		√	√		218	377	
61	8010	2860 22	11/5	ORD	VOR TEST OUT OF LIMITS	2				√		√	83	207	
62	8010	2863	11/6	LAX	WEAK G/S RECEPTION ON APP WITH FLAG IN VIEW	1		CAPACITOR Z6C13 IN POWER SUPPLY OPEN - BEARING MECH OUTPUT ERRATIC	√			√	157	85	
63	8014	16193 49	11/6	LAX	FLAG INTERM	1		LOOSE CONNECTOR ZBL3 VHF RCVR SLICE	√			√	377	257	
64	8004	2248 30	11/11	ORD	RWY FLAG EXTENDED + NO RWY SYMBOL	2		UTV		√		√	113	68	
65	8019	14971	11/15	ORD	WEAK + CUTS OUT INTERM	1		SOLDER CONNECTION TO 844A-1 FL-② LOOSE	√			√	258	253	
66	8019	14971	11/15	ORD	NAV "OFF" FLAG	1		UTV		√		√	297	297	
67	8014	17371 23	4/2	LAX	#2 VHF NAV INOP AT TIMES ON SOME FREQ	2		OK		√		√	182	20	
68	8014	17393 05	4/5	LAX	RPTD #2 G/S INOP	2		UTV		√		√	20	297	

FORM ARCS UA-2 5/27/76

UNIT: RCVR - NAV /GS

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
69	8012	18068	4/16	ORD	INTERM VOR FAIL FLAG + RMI NEEDLES START SPIN - VOR TEST	2		2-1-FL-1 INTERM	√			√	154	214	
			NONE	THRU	6/30/76										

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: COMPASS COUPLER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8018	15845 17	7/14	HNL	WILL NOT SLAVE	1		OK		✓		✓	22	12	
2	8028	7572 30	7/14	LAX	PRECAUTIONARY #1 HSI INOP	1		OK		✓		✓	69	26	
3	8004	1255	7/21	SFO	MOUNTS, EXTERNAL SHORT PLUG "B" PINS 15 + 16	1		UTV RESISTOR R2BG OUT A2 CARD		✓	✓		61	22	
4	8010	1964 31	7/23	HNL	"A" A/P DRIFTS TO LEFT IN MAN	2		CAPACITOR C225 SHORTED ON A2	✓			✓	45	69	AFCS
5	8003	1398 16	9/24	ORD	HDG BUG ON #2 HSI IND HUNTING	2		B-12 MOTOR BEARINGS BAD C114 ON A-2 BOARD LEAKS	✓		✓		1	53	
6	8017	16348 34	10/30		WON'T SLAVE	1		OK		✓		✓	16	68	
7	8012	16946	11/11	LAX	COMPASS CARD INOP + NO SLAVE	2		MOTOR BEARINGS	✓			✓	41	9	
8	8028	90152 28	1/13		F/O COMPASS FLAG SHOWS IN TURNS INTER	2		DIRTY 8-10	✓			✓	26	28	
9	8028	9036	1/15	LAX	DC 10° IN ERROR	1		STICKY		✓		✓	28	16	
10	8016	16499	1/19	ORD	HDG FLAG ON F/O HSI IND + VOR FLAG ON CAPT RMI ALSO ON AUX DC	2		OK		✓		✓	56	45	
11	8029	9472 12	1/27	LAX	IND INOP OCCASIONALLY WITH FLAG	2		MGI BEARINGS ROUGH	✓			✓	50	26	
12	8012	17557	2/20	SFO	HDG INFO TO FLT RECORD ERRATIC	2		B 10 NOISY	✓			✓	4	62	
13	8014	17123 21	3/7	SFO	CAPT HDG FLAG PEEKS AT HIGH FREQ DURING 30° BANK LEFT TURNS	1		SOME NOISE B 10		✓		✓	2	1	
14	8003	2900	4/16	SFO	F/O COMPASS APPEARS ERRATIC	2				✓		✓	14	3	
15	8035	9691 57	4/20	LAX	HDG FLAG ON APP LAX MANEUVERING A/C SLOW TO SLAVE	1		MOTOR BEARINGS STIFF	✓			✓	42	8	
16	8004	8516	5/18	SFO	CRS READS 226° VS 228° ON MAG COMPASS OK ON DESCENT	2				✓		✓	22	57	
17	8017	17980	5/25	LAX	PREC - CRS BUG OSCILLATES ON RADIO MODE	1		OK		✓		✓	59	14	

FORM ARCS UA-2 5/27/76

UNIT: COMPASS COUPLER

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8010	4295:2	5/31	ORD	A/P TURNS 3° LT OF HDG SEL ON CAP BUG			MOTOR RUNS TOO FAST RPLD A-1		✓	✓		15	43	AFC!
19	JA (RPLD)		6/23		—			TESTED OK		✓		✓	59	—	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: ADI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8028	7433	7/1	LAX	RWY FLAG INTERM SHOWS AND WILL NOT BIAS OUT OF VIEW	1		ALT BRUSHES STICKING	✓			✓	8	27	
2	8018	14202	7/2	HNL	G/S FLAG SHOWS AT ALL TIMES OTHERWISE OK	1		NEEDLE NOT TOUCHING OFF STOP CAUSING VIBRATION AND FLAG TO BE OUT	✓			✓	55	5	
3	8032	7992	7/6	HNL	VOR D/R TEST INOP	2		A-3 CIRCUIT BOARD FAULTY	✓			✓	31	51	
4	8014	15112	7/7	HNL	F/O FLAG IN VIEW + PITCH BAR BIASED OUT WHEN F/D SWITCH IN "ON" POS	2		UTV		✓		✓	4	31	ATCS
5	8032	8002	7/7	ORD	ON TEST BANK INDICATE 5° AND STICKS RETURNS TO NORMAL W/TAP	2		UTV		✓		✓	51	17	
6	8014	15116 40	7/8	LAX	F/O ATT IND STICKS	2		OK		✓		✓	31	1	
7	8032	8024	7/9	HNL	F/O F/D FLAG DOES NOT BIAS OUT + PITCH BAR QUIVERS	2		A-6 CARD	✓			✓	17	8	AFCS
8	8020	3938 23	7/13	JFK	RWY DISPLAY STAYS IN VIEW - STICKING	2		A-5 CARD ERRATIC	✓			✓	21		
9	8013	15972 34	7/13	LAX	ON ILS TEST RWY SYMBOL DOES NOT TEST PROPERLY ON DN/RT	2		A-2 AND A-3 CARD BURNED	✓			✓	35	51	
10	8003	727	7/14	SFO	"C" ROLL BAR HANGS UP ON RT SIDE	1		ROLL TORQUER DIRTY	✓			✓	40	33	AFCS
11	8020	13968	7/14	HNL	F/D FLAG INTERM SHOWS	2		UTV		✓		✓	52	13	
12	8032	8078 20	7/14	HNL	ATT FLAG ON DESCENT + INACCURATE ATT IND	2		F/D PITCH + ROLL BAR ZERO NULL OFF TOL WIRE BUNDLE OBSTRUCTION	✓			✓	8	55	
13	8032	3085 17	7/14	DEN	F/D FLAG ON F/O ADI CONSTANT	2		INCLONOMETER BALL FLAT		✓	✓		55	42	AFCS
14	8011		7/16	SFO	TURN NEEDLE TO LEFT - RWY FLAG STICKS	1		BALL FLAT TURN NEEDLE OFF	✓			✓	15	40	
15	8011	15851 10	7/16	SFO	TURN NEEDLE INDICATES 1/4 NEEDLE RIGHT TURN WHEN A/C IS LEVEL	2		TURN NEEDLE OFF A-3 CARD BURNED	✓			✓	26	21	
16	8013		7/17	LAX	F/O ATT IND FLAG ON IN RT TURN [illegible]° BANK	2		OK		✓		✓	51	24	
17	8023	12253	7/18	LAX	F/D PITCH COMMAND BAR IS IN VIEW - IT SHOULD NOT	1		OK		✓		✓	24	19	AFCS

FORM ARCS UA-2 5/27/76

UNIT: ADI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY Y	VERIFY N	OTHER Y	OTHER N	SERIAL OFF	SERIAL ON	COMMENTS
18	8012	15983	7/19	ORD	ROLL COMMAND BAR JERKY	1		ROLL TORQUER	✓			✓	41	4	AFCS
19	8029	86423 32	7/20	ORD	HORIZ WARN FLAG SHOWS INTERM	1		LOC STICKS + RWY FLAG SHOWS		✓	✓		25	7	
20	8010	1978 22	7/24	HNL	F/D RWY SYS STUCK	2		A2 RADIO ALT CIRCUIT BD AMP OUT	✓			✓	29	37	
21	8011	15926	7/25	HNL	ROLL BAR INOP	2		OK		✓		✓	21	52	AFCS
22	8013	16114	7/27	HNL	HZI STICKS IN TURNS	2		PRECAUTIONARY M-4		✓		✓	34	41	
23	8032	8289	8/1	SFO	F/D FLAG COMES INTO VIEW OCCASION	1		PITCH TORQUER ROLL TORQUER OUT	✓			✓	22	35	AFCS
24	8004	1367 36	8/2	ORD	SHOWS PITCH UP MOST OF TIME	2		ROLL TORQUER OUT	✓			✓	32	2	
25	8018	14483 55	8/2	HNL	RWY FLAG DOES NOT RETRACT	2		SET SCREW BROKE LOOSE	✓			✓	5	21	
26	8028	7830 19	8/6	HNL	RWY FLAG WON'T RETRACT	2		PITCH TORQUER OUT OF TOL. F/D CIR OUT OF TOL	✓			✓	47	55	
27	8032	8361	8/8	ORD	RWY SYMBOL WILL NOT TEST IN DOWN POS OK IN UP - LEFT	1		F/U PITCH + ROLL TORQUERS ERRATIC		✓	✓		35	25	
28	8028	7860 49	8/9	LAX	PITCH BAR STICKS AT TOP + F/D FLAG SHOWS AT ALL TIMES	2		OK		✓		✓	33	8	AFCS
29	8035	7493 32	8/11	SFO	F/O F/D PITCH BAR IS IN VIEW EVEN WITH F/D SW OFF	2		A-6 AMPLIFIER BOARD	✓			✓	6	34	AFCS
30	8004	1459 01	8/11	LAX	F/D FLAG IN SIGHT AT ALL TIMES	1		B-1 TORQUER ROTOR SHAFT LOOSE	✓			✓	9	56	AFCS
31	8004	1462	8/12	JFK	ATT FLAG + F/D FLAG ALSO FOR F/D BAR IN VIEW	2		A-6 CIRCUIT BD	✓			✓	2	38	
32	8032	8385 14	8/12	LAX	RWY SYMBOL STAYS ON LEFT SIDE	2		A-3 LOC/RWY CIR BD INTERM WHEN HEATED UP	✓			✓	42	29	
33	8011	16112	8/6	LAX	A/C F/D FLAG STICKS	2		PITCH BAR STOP NEEDED ADJ	✓			✓	40	32	AFCS
34	8017	15742 59	8/19	HNL	COMMAND BAR ERRATIC	2		PITCH TORQUER, ROLL TORQUER NEED CLEAN ALL CIR BD - NO NULL RTN	✓			✓	503	9	AFCS

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: ADI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8028	7938	8/16	SFO	F/D FLAG STUCK	2		M-5 TORQUE POT DIRTY	✓			✓	8	42	AFCS
36	8017	15728	8/17	SFO	G/S FLAG STICKS	1		OK		✓		✓	501	47	
37	8035	7368 47	8/18	ORD	ROLL BAR ACTION JERKY HOR BAR WILL NOT PHASE OUT	2		M-4 TORQUER POT DIRTY	✓			✓	34	5	AFCS
38	8004	1510 54	8/18	SEA	INTERM ATT FLAG	2		A-1 CIR BD OPEN AMP A1 AR2	✓			✓	38	36	
39	8003	1102 27	8/24	LAX	REPORTED TURN IND INOP	1		CLEANED UNIT		✓		✓	17	31	
40	8004	1546	8/21	LAX	G/S FLAG STICKS	2		TIME WORN G/S TORQUER	✓			✓	36	6	
41	8035	7599	8/22	SFO	INDICATOR ROLLS OCCASIONALLY WITH EITHER INS OR AUX GYRO	2		UTV		✓		✓	5	40	
42	8027	11081 03	8/28	ORD	F/D FLAG INTERM	1		DIRTY TORQUER	✓			✓	48	38	AFCS
43	8003	1178	8/31	LAX	STICKS IN LEFT TURN + FLAG SHOWS	1		UTV		✓		✓	31	503	
44	8011	16275	9/3	ORD	INTERM FLAGS ON "A" & "C"	1		NORMAL		✓		✓	52	36	
45	8003	1228 43	9/5	PIT	ERRATIC ATT FLAG + ATT TILTS	1		A-1 CIR BD, PINS	✓			✓	503	15	
46	8017	15947	9/7	HNL	F/D FLAG STAYS IN VIEW ON ALL 3 CMPTR	2		PITCH TORQUER NOT GOOD	✓			✓	9	34	AFCS
47	8010	4972	9/16	SFO	ROLL COMMAND BAR CHATTER - W/ FLAG	2		DIRTY ROLL BAR TORQUER	✓			✓	37	9	AFCS
48	8016	16062 20	9/17	ORD	F/D NEEDLE INTERM	1		NORMAL		✓		✓	16	57	
49	8035	7888	9/26	LAX	NO RWY SYMBOL	1		A-2 CARD ERRATIC	✓			✓	28	8	
50	8010	2566 45	9/28	LAX	PITCH COMMAND BAR WON'T BIAS OUT OF VIEW	2		NORMAL		✓		✓	33	15	AFCS
51	8010	2564 53	9/28	DEN	F/D ERRONEOUS IND	2		ROLL TORQUER ERRATIC	✓			✓	9	35	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS OF POOR QUALITY

UNIT: AD I

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52	8016	16189	9/30	LAX	TURN + SLIP BALL 1/2 OFF IN LEVEL FLT	1		NORMAL		✓		✓	57	44	
53	8014	15911 05	10/2	LAX	RWY RPTR IN VIEW ALL TIME - DEC HT LT CAP ASSY LEF	2		A-2 CARD ERRATIC DA CAP MISSING	✓			✓	1	33	
54	8014	15923 42	10/3	ORD	PITCH BAR DOES NOT BIAS OUT OF VIEW	2		NORMAL		✓		✓	39	2	AFCS
55	8010	2632 14	10/6	LAX	RWY SYMBOL STICKS	2		REPEAT REPORT		✓		✓	15	16	
56	8013	16795	10/8	SFO	RWY SYMBOL STICKS DOWN	2		OK		✓		✓	41	501	
57	8035	7991	10/8	SFO	CAPT F/D FLAG SHOWS ANY TIME ALT HOLD USED ALSO NO HOR BAR	1		UTV		✓		✓	8	5	AFCS
58	8014	16034 33	10/16	LAX	F/D FLAG SHOWS AT ALL TIMES ATT FLAG STUCK	2		PITCH COM TORQUE + G/S TORQUER NG.	✓			✓	2	52	AFCS
59	8035	8077	10/22	LAX	F/D FLAG SHOWS WITH F/D OFF	2		G/S TORQUER + PITCH COM TORQUER	✓			✓	55	15	AFCS
60	8013	16936 37	10/27	LAX	RWY SYMBOL INOP	1		NO DEFECT FOUND		✓		✓	49	59	
61	8035	8168	10/31	SFO	HORIZON WILL NOT ERECT	1		A-1 CARD INSTALLED OR SHIPPED FROM CHANNEL GUIDES	✓			✓	5	2	
62	8004	2162 20	10/31	LAX	F/D FLAG SHOWS WHEN F/D SWITCH TURNED OFF	2		ROLL BAR OUT OF CALIB.		✓		✓	6	1	AFCS
63	8014	16166	11/2	LAX	F/D FLAG APPEARS INTERM	2		OK		✓		✓	32	55	AFCS
64	8014	16175	11/3	SFO	G/S FLAGS ALWAYS IN VIEW	2		A-1, A-2 CARD INOP	✓			✓	55	33	
65	8020	15000 56	11/4	ORD	RWY FLAG	1		UTV		✓		✓	11	9	
66	8004	2448	11/8	SFO	RWY FLAG STUCK TO LEFT	1		RWY DRIVER [illegible] GR LOOSE [illegible]	✓			✓	56	43	
67	8029	2997 54	11/9	PIT	RWY SYMBOL FLICKS ON	2		UTV		✓		✓	7	31	
68	8013	17075 31	11/11	HNL	RATE OF TURN NEEDLE FLUX	2		OK		✓		✓	501	24	

FORM ARCS UA-2 5/27/76

UNIT: ADI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
69	8010	2890	11/9	LAX	RWY FLAG SHOWS	2		RWY FLAG GAP CLEARANCE TO BEZEL HOLD-DOWN CLIP OBSTRUCT FLAG PTR	✓			✓	16	22	
70	8004	2255 05	11/12	ORD	#1 F/D FLAG SHOWS INTERM ON ALL MODES	1		G/S FLAG STICKING		✓		✓	48	5	AFCS
71	8028	3679	11/21	LAX	RWY FLAG IN VIEW WITH ILS FREQ SEL	1		STOP BROKEN ON RWY GEAR ROD	✓			✓	27	56	
72	8003	1925	11/22	ORD	CAPT HOR IND 2½ OFF FROM F/O IN STRAIGHT + LEVEL	1		GULL WINGS INDEX OFF K-4 RELAY	✓			✓	20	501	
73	8013	17159	11/24	HNL	ATT FLAG STICKS UP AND PITCH BAR ERRATIC AND BOUNCING	2		PITCH TORQUER NG.	✓			✓	24	11	
74	8013	17168 54	11/25	HNL	G/S FLAG OUT ALL THE TIME	2		OPEN A-4 CIR BD	✓			✓	11	503	
75	8016	16664 48	11/27	ORD	TURN + SLIP SHOW ½ BALL RT WING LOW IN LEVEL FLT	1		RECALIBRATE BALL/BANK	✓			✓	44	40	
76	8029	9169 00	12/2	ORD	VERT F/D NEEDLE WILL NOT BIAS OUT FULLY WITH F/D SW IN OFF POS	1		ATT FLAG RUBS F/D PITCH BAR	✓			✓	41	20	AFCS
77	8016	16738	12/5	LAX	ERRATIC EVEN W/ AUX GYRO	1		PRECAUTIONARY K-4, K-9, K-10	✓			✓	40	6	
78	8012	17035 04	12/21	LAX	RWY SYMBOL INOP – FLAG SHOWS	1		RAD ALT OUT OF CALIB	✓			✓	4	48	
79	8020	15320 05	12/26	ORD	RWY SYMBOL IN VIEW AT ALL TIMES	2		RWY CALIB SLIGHTLY OFF	✓			✓	13	24	
80	8014	16535 34	12/31	HNL	SHOWS A FULL UP TILT – RADIO TO INS	2		PITCH, SPD, G/S OUT OF CALIB		✓	✓		33	7	
81	8019	15253 00	12/31	ORD	RWY FLAG SHOWS	2				✓		✓	54	34	
82	8012	17120 13	1/1	ORD	PEEKING F/D FLAG	1		MS – PITCH TORQUER	✓			✓	43	28	AFCS
83	8018	5805 46	1/8	JFK	INTERMITTENT F/D FLAG ON CAPT ATT IND	1		A6 BD INTERM	✓			✓	4.	35	AFCS
84	8018	15369 13	1/15	ORD	ILS INOP DN/RT	1		F/D FLAG STICKING ON CAR	✓			✓	35	40	
85	8016	16955	1/16	HNL	ROLL BAR STICK F/D FLAG IN VIEW	1		ROLL BAR HITTING STOPS	✓			✓	6	4	AFCS

FORM ARCS UA-2 5/27/76

UNIT: ADI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
86	8027	12138 21	1/17	ORD	FLAG SHOWS INTERMIT BITE OK #2 ROLL	2		ROLL TORQUER DIRTY	✓			✓	23	26	BITE
87	8020	15494 50	1/18	HNL	F/D. FLAG STICKS	1		A-5 AMP BOARD BAD	✓			✓	9	17	AFCS
88	8018	15938	1/19	LAX	CAPT HOR SHOWS ATT FLAG	1		CASE SCREW SHORT + CIR BD #2 RWY PEAKS					40	41	
89	8012	17220 52	1/20	LAX	RWY SYMBOL + FLAG INOP	2		SHOP TEST OK		✓		✓	58	8	
90	8012	17238 15	1/22	HNL	RWY FLAG WILL NOT RETRACT - SYMBOL OK	2		A-2 CARD BAD	✓			✓	54	21	
91	8012	17238 15	1/22	HNL	RWY SYMBOL WILL NOT COME UP - MOVES SIDE TO SIDE OK	2		UNIT DROPPED - BACK PLUGS ALMOST TOUCH EACH OTHER		✓		✓	49	49	
92	8012	17227 55	1/22	JFK	F/O ADI SHOWING OFF FLAG	2		RWY FLAG SHOWS		✓		✓	8	54	
93	8035	8838	1/29	SFO	G/S FLAG SHOWS ALMOST CONT DURING APP IN INS MODE	1		TORQUER BAD (G/S)	✓			✓	2	55	
94	8035	8841	1/29	ORD	RWY SYMBOL STAYS UP IN VIEW AT ALL TIMES	1		WIRE SHORTING ON CASE SCREW A-2	✓			✓	55	33	
95	8035	5844 10	1/30	ORD	CAUSES "A" A/P TO BE INOP	1		OK		✓		✓	33	11	AFCS
96	8004	2717	1/31	SFO	AFTER 3 HR RWY FLAG IN AND RWY RISES OUT OF VIEW	2		A2-WIRE SHORTED ON CARD	✓			✓	1	44	
97	8020	15629	2/3	SFO	REMOVED PREC F/D FLAG IN VIEW	1		F/D FLAG STICKING	✓			✓	17	33	AFCS
98	8035	8887 44	2/5	SFO	RWY FLAG INTO VIEW WHEN ILS FREQ SEL	2		OK		✓		✓	15	55	
99	8020	15633 07	2/7	ORD	HORIZON SHOWS 40°-60° NOSE UP ATTITUDE	1		OK		✓		✓	33	6	
100	8020	17682	2/8	HNL	VERT BAR IS STUCK	1		M-4 TORQUER NG	✓			✓	6	8	
101	8016	17157	2/9	HNL	ON VOR DOWN TEST NO RWY APPEARS + FLAG STAYS	1		OK		✓		✓	35	23	
102	8016	17147 30	2/9	JFK	RWY + LOC FLAG HOWLING	1		BAR HITTING CASE	✓			✓	4	35	

FORM ARCS UA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: AD I

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING .	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
103	8035	8937	2/12	HNL	RWY FLAG DOES NOT BIAS OUT	2		CASE SCREW OF A-2 CARD TOO LONG + SHORTS OUT RWY SIGNAL	✓			✓	55	40	
104	8020	15670 20	2/13	HNL	RWY WARN FLAG DOES NOT BIAS OUT ON ILS/VOR	1		GLASS BROKEN	✓			✓	8	33	
105	8035	8945	2/13	ORD	F/D PITCH BAR DOES NOT BIAS OUT COMP	1		OK		✓		✓	40	58	AFCS
106	8020	15674	2/14	LAX	HORIZON TUMBLES + ATT FLAG WHEN SW TO INS	1		Q 2 TRANSISTOR BAD	✓			✓	33	31	
107	8029	9648	2/15	CLE	VERT NEEDLE JUMPS + STICKS	1		BAD TORQUER (PITCH + ROLL)	✓			✓	20	3	
108	8027	12446 07	2/17	HNL	RWY SYMBOL WILL NOT COME INTO VIEW	2		A2 CARD BAD	✓			✓	26	48	
109	8012	17570 25	2/24	ORD	ROLL BAR DOES NOT ALWAYS GO OUT OF VIEW	2		FLAG HITTING BAR					21	15	AFCS
110	8020	15796	3/1	SFO	ON APP ATT FLAG CAME IN VIEW SWITCHING AUX GYRO NO HELP	2		OK		✓		✓	31	54	AFCS
111	8003	2628	3/6	SFO	RWY SYMBOL JUMPS CONT UP/DN WHENEVER LRRA C/B IS PULLED	1		PITCH BAR STICKING		✓		✓	501	55	
112	8017	9808	3/14	LAX	RWY FLAG IN VIEW ON DN/RT VOR TEST	1		A3 CARD SHORTING	✓			✓	35	4	
113	8032	10004	3/16	ORD	STICKS AT 10° RT TURN	1		NO FAULT FOUND		✓		✓	25	49	
114	8029	9851	3/20	SEA	PITCH BAR STICKS AT TOP OF IND, NO PITCH SIGNAL TO HOR	1		OK		✓		✓	40	13	AFCS
115	8011	17613 01	3/27	SFO	F/O F/D FLAG IN VIEW WHEN F/D SWITCH IS OFF	2		A5 CARD BAD PITCH METER STICKING	✓			✓	32	33	AFCS
116	8011		3/28	SFO	SPHERE MOVES IN 3° JERKS IN BANK	1		RWY MTR OUT OF ADJ G/S BAR TORQUER STICKS		✓	✓		36	31	
117	8011	18256	3/29	SFO	FROM STOCK - G/S NEEDLE ON TEST GOES FULL & SET DOWN	1		ROD SLIPPED SET SCREW	✓			✓	31	25	
118	8022	10188 02	4/7	ORD	RWY STUCK DOWN	1		N/A					49	40	
119	8011	17737	4/9	HNL	F/D SHOWS - SWITCHING CMPTR NO HELP	2		A2 CARD BAD	✓			✓	33	21	AFCS

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: ADI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
120	8032	10200	4/9	LAX	A/C PITCH BAR WILL NOT BIAS OUT OF VIEW	1		PITCH BAR TORQUER BAD	✓			✓	40	9	AFCS
121	8012	18034	4/14	LAX	GOT FLAGS ON FINAL APP + GYRO STARTED SPINNING	1		G/S BAR TORQUER STICKS PITCH BAR JITTERS		✓	✓		28	17	
122	8032	10258 59	4/15	HNL	F/D FLAG SHOWS MOST OF TIME	1		PITCH BAR TORQUER BAD	✓			✓	9	33	AFCS
123	8018	16701	4/16	SFO	INTERM ATT FLAG	2		OK		✓		✓	18	31	
124	8011	17843 50	4/19	ORD	STEER BAR WILL NOT BIAS OUT OF VIEW	2		DIRT ON MAGNET OF R/T G/S BAR TORQUER BAD	✓		✓		21	32	AFCS
125	8032	10313	4/19	LAX	ATT FLAG FLICKERS INTERM	1		OK		✓		✓	33	501	
126	8010	416102	4/26	ORD	F/D FLAG W/ VISIBLE P+R - UNA TO REMOVE	2		METER BARS HANG UP CAP BLOWN ON A3 BD A6 BAD	✓			✓	22	1	AFCS
127	8018	16788	4/27	LAX	ATT FLAG COMES OUT IN LT TURN + WILL NOT SHOW BANK ANGLE	2		OK		✓		✓	31	36	

FORM ARCS UA-2 5/27/76

UNIT: HSI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
1	8019	13843	7/8	HNL	FLAG IN VIEW - COMPASS INOP	1		OK		✓		✓	21	43	
2	8004	1184	7/13	LAX	DEV NEEDLE STICKS + HANGS UP	2		UTV		✓		✓	14	39	
3	8017	15441	7/16	ORD	INTERMITTENT VOR FLAG AT 50 MILE			UTV		✓		✓	27	11	
4	8017	15500 18	7/26	HNL	VOR FLAG INTERM	1		OK		✓		✓	30	52	
5	8013	16118	7/27	SFO	NAV FLAG STICKS	2		G/S FLAG METER STICKS + OSCILLATES	✓			✓	49	21	
6	8013	16114	7/27	HNL	HSI STICKS ON BANKS	2		BURNT POWER SUPPLY CIRCUITS	✓			✓	18	49	
7	8027	10849	8/5	JFK	VOR-LOC FLAG PEEKS	1		PRECAUTIONARY - NEW METER FLAG	✓			✓	22	4	
8	8035	7584	8/20	HNL	LOC BAR STICKS AT SIDES	2		DIRTY - OILY STOPS	✓			✓	13	6	
9	8029	14369 18	8/25	HNL	VOR FLAG INTERMITTENT	1		SERVO - AMP CIRCUIT FAULTY FILTERING FEEDBACK	✓			✓	29	13	
10	8019	14335 59	8/25	SFO	CRS IND HDG BUG IS 4°-5° IN. ERROR	2		OPEN TB 4 - C50	✓			✓	43	49	
11	8003	1748	9/6	LAX	COMPASS CARD JITTERS	2		SERVO AMP FILTER CIRCUIT PROBLEM	✓			✓	20	10	
12	8035	7910	9/30	SFO	MILES 1 + 2 BOTH ERRATIC	1		LEAKY CAPACITORS	✓			✓	53	30	
13	8035	8072	10/4	HNL	TRUE MAG ANN FLAG DOES NOT PRESENT ITSELF FULLY	2		STICKY METER	✓			✓	24		
14	8028	6840	10/11	LAX	COMPASS 20° OFF	2		LEAKY CAPACITORS + POWER SUPPLY CIRCUIT	✓			✓	1	10	
15	8028	8425 19	10/22	HNL	FLAG IN VIEW COMPASS INOP	1				✓		✓	41	38	
16	8020	14895	10/23	LAX	POPS C/B	1		TB-6 HI LI POWER SUPPY + LOGIC CIRCUITS BLOW	✓			✓	13	53	
17	8014	16185	11/4	LAX	#2 INS MILES TO GO READOUT NO GOOD - WON'T TEST SHOWS DASHES	2		A-26 BAD	✓			✓	2	24	

FORM ARCS UA-2 5/27/76

UNIT: HSI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
18	8014	16223 02	11/9	HNL	VERT BAR STICKS	2		DIRTY METER STOPS	✓			✓	24	22	
19	8019	1491[illegible] 23	11/10	ORD	HDG SELECT BUG LOOSE	1				✓		✓	37	41	
20	8023	13310 39	11/12	ORD	COMPASS CARD ROTATES AT ALL TIMES - SMELLS OF BURNING	1		BURNT OUT TRANSFORMERS	✓			✓	3	7	
21	8023	13347 26	11/17	ORD	INOP	2		12 V DC CIRCUIT FAILURE	✓			✓	45	14	
22	8023	13388 00	11/19	HNL	TO-FROM IND + CCS BAR STICKS	2		T/F METER STICKY	✓			✓	14	10	
23	8023	13401 36	11/21	SFO	RH DIGIT INOP	2		INS + DME TRANSFER MODE INOP	✓		✓		10	6	
24	8003	1925	11/22	ORD	#1 MILES TO GO HAS LT OUT ON UPPER SIDE LAST DIGIT	1		LAMPS	✓			✓	19	3	
25	8029	9125	11/26	ORD	COMPASS INOP	2		OK		✓		✓	15	29	
26	8016	16700 36	12/1	LAX	#2 MILES TO GO DISPLAY IN F/O HSI ERRATIC + HANGS UP	2		PROBABLE POWER SUPPLY - G/S METER	✓			✓	23	13	
27	8018	15716 23	12/27	LAX	#2 DME LT INOP	1		OK		✓		✓	35	15	
28	8033	8693 46	1/12	HNL	CRS NEEDLE HANGS UP IN CENTERED POS	1		DIRTY METER STOPS HDG BUG JUMPS		✓	✓		30	2	
29	8029	7159 16	1/22	HNL	OCC HDG FLAG + INST WARN	2		FLOATING COMPONENT LEAD END		✓	✓		29	35	
30	8014	16760 46	1/26	HNL	CRS NEEDLE STUCK MIDDLE	2		METER STOPS DIRTY		✓	✓		22	19	
31	8017	16930	1/26	LAX	HDG BUG 4° LESS THAN SET	1		HDG BUG JUMPS FLAG STICKS		✓	✓		11	23	
32	[illegible]	16965	1/30	LAX	# 2 INS DISPLAY - MILES TO GO INOP	1				✓		✓	[illegible]	[illegible]	
33	8[illegible]	17602	2/5	SFO	HDG BUG INOP	2		L5 BURNT OUT + C20 SHORTED	✓			✓	46	8	
34	8016	17147	2/8	JFK	RIGHT SIDE 1ST DIGIT OUT	1		BULB	✓			✓	31	1	

FORM ARCS IIA-2 5/27/76

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: HSI

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
35	8010	3486 22	2/9	ORD	#2 INS MILEAGE IND ERRATIC	1		DIRTY STOPS		✓	✓		5	10	
36	8023	73937	2/14	ORD	#2 DISPLAY LT OUT	1		BULB	✓			✓	7	15	
37	8023	13957 46	2/16	HNL	RAD IND DOES NOT COVER INS WITH SW IN RADIO POS	2		METER STOPS		✓	✓		6	11	
38	8013	17761 59	2/22	ORD	LOC BAR HUNG UP	2		BRUSH & SLIP RING FAULTY CONTACT	✓			✓	8	46	
39	8013	17765	2/22	SFO	HDG FLAG DOES NOT FULLY RETRACT	2		HDG METER SHORTING TO FRAME	✓			✓	46	23	
40	8013	17775	2/24	SFO	#2 INS DIS DISP ON #2 HSI IS STUCK	2		UTV		✓		✓	23	7	
41	8013	17839	3/10	LAX	ERRATIC RDOUT MILES TO GO	2		C15, C17, C16, L7 + L8 CR 3, 4, 5+6 BAD	✓		✓		7	30	
42	8035	9240 31	3/14	HNL	HDG BUG 5° LESS THAN HDG SEL ON GLARE SHIELD PANEL	2		LT BLOCK BAD METER STOPS		✓	✓		43	31	
43	8004	2996 50	3/15	ORD	#2 MILES IND ERRATIC LT	2		A44 MODULE BAD	✓			✓	21	5	
44	8029	9912 40	3/25	LAX	F/O HDG FLAG STICKS IN VIEW	2		STICKY STOPS	✓			✓	35	46	
45	8019	15941 11	3/30	HNL	POPS C/B	1		L7, C8, CR14 BURNT OUT	✓		✓		41	43	
46	8004	3092 22	3/30	LAX	#2 INS MILES KEEPS FLICKERING	1		LT BLOCK BAD		✓	✓		5	29	
47	8017	17633	3/31	CLE	HDG BUG JUMPS 30° WHEN SET	1		DIRTY BRUSHES ON HDG SYNCHRO	✓			✓	25	24	
48	8019	16052	4/12	ORD	INTERM HDG FLAG	1		UTV		✓		✓	45	6	
49	8003	2932 30	4/19	ORD	CARD HANGS UP	2				✓		✓	18	37	
50	8018	16756 29	4/23	SFO	INS #2 RDOUT FLASHES ALL "O"S	2		A2 BOARD BAD	✓			✓	48	43	
51	8035	9672	4/26	LAX	INC HANGS UP IN TURN	1		UTV		✓		✓	2	5	

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT: HSI

LINE NO.	A/C	T30	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING.	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	
52	8035	9682 23	4/27	SFO	#2 MILES WINDOW KEEPS REPEATING 2 MI	1		UTV		✓		✓	5		
53	8035	9850	5/14	ORD	#1 INS 1ST DIGIT HOR LT INOP	1		MOUNTING SCREW	✓			✓	19	7	
54	8016	17853	5/20	LAX	MILES TO GO RDOUT INOP	2		POWER SUPPLY CIRCUIT BURNT OUT	✓			✓	13	48	
55	8032	10656 06	5/30	LAX	MILES #1 RDOUT INOP	1		POWER SUPPLY AC FILTER OUT	✓			✓	38	2	
56	8032	10722 03	6/6	JFK	CAPT ROLL BAR VIBRATES OUT F/D OFF	1		AG CARD	✓			✓	21	40	
57	8014	17805 52	6/6	HNL	ERRATIC IN CLIMB	2		UTV		✓		✓	41	21	
58	8023	19782	6/23	SFO	#1 DME LT BLINK ON + OFF	2		C15, C16, C17 BURNT	✓			✓	11	45	

FORM ARCS UA-2 5/27/76

APPENDIX B

UNITED AIRLINES

INSTALLATION AND REMOVAL HISTORIES FOR MAJOR COMPONENTS

PITCH COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
1	1				8003	07-14-70		FV
2	2				8013	01-04-71		
3					03	07-18-73	[illegible]14	FV
4					18	04-10-74	10444	OK
5					19	09-13-74	11308	OK
6					19	12-10-74	12147	OK
7		8012	02-14-75	14678	12	09-29-75	14684	FV
8		03	04-18-75		03	06-26-75	627	FV
9		03	07-13-75	727	03	03-06-76	2628	OK
10		13	04-09-76	17997	03	03-06-76	2628	OK
11		11	09-06-73	11011	11	09-09-73	10148	OK
12		20	09-19-73	7907	20		9809	OK
13		11	07-09-74	12485	11	09-07-74	13415	FV
14		13	10-20-74	13702	13	11-27-74	14037	OK
15		12	01-08-75	14820				
16					3	02-18-75	14670	OK
17		32	03-18-75	7075	32	04-14-75	7335	FV
18		32	04-25-75	7358	32	04-25-75	7358	FV
19					19	08-31-75	14461	FV
20		14	11-03-75	16176	14	12-16-75	16407	FV
21		13	01-20-76	17502	13	04-09-76	17997	OK
22		12	04-18-76	18031				
23		27	11-08-74	8555				
24	4	29	08-27-74	5067	29	09-14-74	5228	OK
25					JAL LOAN	10-18-74		FV
26					27	01-24-76	12209	FV
27	5				03	11-11-72	7261	OK
28		04	12-17-72	7711	04	12-20-72	7741	OK
29					LOAN TO N.W.			OK
30					?			OK

ORIGINAL PAGE IS
OF POOR QUALITY

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
31					10	03-05-73	8473	FV
32					23	05-01-73	4495	FV
33					10	07-21-75	1950	OK
34		28	08-11-75	7884	28	08-14-75	7938	OK
35		28	10-02-75	8292	28	04-30-76	10004	FV
36		20	06-14-76	16643	20	06-15-76	?	OK
37	6	14	01-14-79	10540				
38					11	08-18-74	13254	OK
39					JAL LOAN			FV
40		13	09-22-74	13565	13	03-05-75	148	FV
41		17	03-30-75	14548	17	06-06-75	15088	OK
42		28	07-03-75	7452	28	04-09-76	9787	OK
43		32	04-29-76	10388				
44		13	01-21-79	11317				
45	7				04	12-03-76	2411	FV
46		12	01-26-76	17341	12	04-02-76	17913	OK
47		32	04-20-76	10292	32	04-24-76	10336	OK
48		32	04-27-76	10373	32	06-11-76	10769	OK
49	8				8012	09- -70	48	OK
50					04	10-21-70	643	OK
51					13	12-30-70		FV
52					14	05-17-71		OK
53					19	11-29-71	1480	FV
54					19	10-31-74	11748	FV
55					03	04-18-75	3 ?	FV
56					12	09-22-75	16598	FV
57		12	11-08-75	16911	12	01-26-76	17341	FV
58	9				14	01-07-72	3721	OK
59					20	06-24-72	3284	OK
60		10	06-28-75	1773	10	10-19-72	7062	OK

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIPRLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
61						?		OK
62					11	01-09-74	11327	OK
63					17	06-04-75	15078	OK
64					32	06-18-75	7808	OK
65					10	02-08-76		OK
66		04	02-20-76	2832				
67	10				13	04-14-73	8521	FV
68					23	07-01-73	5162	FV
69		23	12-19-74	10391	23	05-27-75	11773	FV
70		14	06-07-75	14819	14	11-03-75	16176	FV
71		17	11-11-75	16453	17	3-20-76	17384	OK
72		12	04-17-76	18072	12	04-18-76	18081	OK
73		13	04-24-76	18029				
74		13	04-14-73	8521				
75	11	23	07-01-73	5162	23	07-03-73	5188	FV
76					20	02-17-74	9406	OK
77		03	04-06-74	12265				
78					23	11-10-74	10100	OK
79					10	12-03-74	14459	FV
80		19	12-10-74	12147	19	08-31-75	14406	FV
81		03	10-30-75	1754	03	04-08-76	2865	FV
82		28	04-30-76	10004				
83	12	11	09-07-74	13415				
84		03	07-04-75	680	03	07-15-75	727	FV
85					QANTAS LOAN	07-28-75		OK
86		23	10-04-75	12966	23	01-26-76	13029	OK
87		32	02-24-76	09843	32	03-03-76	?	FV
88		09	03-13-76	2981				
89					10	05-02-76	4219	FV
90					23	06-23-76		FV

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
91		23	12-02-72	2966				
92	13	17	06-03-74	11843	17	07-20-74	12257	OK
93		12	08-08-74	13135	12	08-14-74	13191	OK
94					13	10-20-74	13702	FV
95		27	11-08-74	3655	27	08-04-75	10841	OK
96		20	08-21-75	14321	20	12-29-75	15345	FV
97		04	01-11-76	2591				
98	14	11	07-32-72	5912				
99					8003	07-09-74	13041	OK
100		28	07-27-74	4512	28	07-03-75	7452	OK
101		10	07-21-75	7950	10	11-27-75	3045	FV
102		04	12-04-75	2418	04	12-04-75	2418	FV
103		8011	02-28-76	17470	11	03-27-71	HMV	OK
104		28	04-09-76	9787				
105	15				11	02-15-74	11639	OK
					17	05-06-74	11594	OK
107					16	07-14-74	12282	FV
108		11	08-14-74	13254				
109					10	02-13-75	3528	FV
110		10	02-27-75					
111	16				27	04-30-75	11773	OK
112		17	06-10-75	15122	17	09-03-75	15892	FV
113		32	09-07-75	8613	32	10-01-75	8819	OK
114		32	10-16-75	8934				
115		35	07-15-74					
116	17				33	12-19-74	4439	FV
117		18	01-06-75	12624	18	04-27-75	13628	OK
118		18	05-21-74	10521	18	06-10-75	13964	OK
119		32	06-18-75	7808	32	02-24-76	9843	OK
120		32	02-28-76	9870	32	03-01-76	9935	FV

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
121		32	04-24-76	10336	32	05-07-76	10456	OK
122		10	03-13-74	12177				
123	18	10	01-16-75	296	10	06-28-75	1773?	OK
124		11	07-16-75	15850	JAL LOAN	07-15-75		OK
125		14	05-17-71	?				
126	19				11	06-20-72	5457	OK
127					12	06-24-72	5844	OK
128		11	07-31-72	5907	11	07-32-71	5912	OK
129					04	08-28-72	6981	FV
130					04	12-17-72	7711	OK
131					04	07-02-75	1067	FV
132		11	07-16-75	15851	11	03-27-76	17613	FV
133		03	04-08-76	2865				
134	20				20	07-17-73	7277	FV
135					14	08-13-73	9140	FV
136					?	09-06-73		FV
137					12	10-21-73	10515	OK
138					14	12-03-73		FV
139		29	01-09-74	2847	29	08-27-74	5067	OK
140		27	09-01-74	7950	27	10-21-74	8402	FV
141		19	11-08-74	11835				
142		18	04-23-75	13586				
143	21	17	06-06-75	15088	17	06-10-75	15122	FV
144					17	09-03-75	?	
145					13	11-04-75	17094	
146						12-01-75		
147		35	01-18-76	8746	35	01-28-76	8833	
148		27	02-22-76	12485	27	02-25-76	12517	
149					35	03-10-76	9245	
150		35	03-13-76	9229				

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
151	22	32	04-26-75	7358	8032	05-18-75	7521	OK
152		17	09-03-75	15892	17	11-11-75	16453	FV
153		04	12-04-75	2418	04	01-11-76	2591	OK
154		27	01-24-76	12209	27	01-30-76	12266	FV
155		27	02-25-76	12517	27	05-22-76	13351	OK
156		10	06-07-76	14860				
157		17	06-26-75	18228				
158	23	32	04-14-75	7325	32	05-13-75	7476	FV
159		28	07-03-75	7452	28	07-22-75	7666	OK
160		12	10-31-75		12	11-08-75	16911	FV
161					LOAN JAL	8 Hrs		OK
162		13	01-27-76	17551	13	02-03-76	17601	FV
163					10	02-08-76	3479	OK
164		35	02-18-76	8987	35	03-01-76	9112	OK
165		27	03-18-76	12729				
166	24				12	07-05-74	12812	FV
167					28	01-05-75	6159	OK
168		12	02-21-75	14688	12	04-09-75	15517	FV
169					18	4-16-75	13579	FV
170		18	04-27-75	13628				
171		12	02-21-75	14688				
172	25				14	06-07-75	14819	FV
173		28	07-30-75	7741	28	08-11-75	?	OK
174		16	09-06-75	15945	16	10-31-75	16414	OK
175		13	11-04-75	17094	13	11-24-75	17159	FV
176		35	01-28-76	8833	35	02-17-76	8987	FV
177		10	02-27-76	3655	10	03-05-76	3719	FV
178		32	04-08-76	10191	32	04-27-76	10373	FV
179		18	11-07-73	8814				
180	26	14	01-14-74	10540	14	02-22-74	10895	OK

PITCH COMPUTER (CONTINUED)

LINE	UNIT S/N	ON AIRPLANE	ON DATE	ON TIME	OFF AIRPLANE	OFF DATE	OFF TIME	STATUS
181		32	02-27-74	3607	32	04-15-75	7333	OK
182		14	05-02-75	14523				
183					12	05-09-75	15501	OK
184					11	07-16-75	15850	FV
185		28	07-22-75	7666	28	07-30-75	7741	FV
186		28	08-19-75	7915	28	04-30-76	10004	FV
187		10	06-15-76	4591				
188		14	05-05-71	1363				
189	27				11	07-31-72	5907	FV
190					23	12-02-72	2966	FV
191					04	05-05-75	58??	FV
192		16	08-05-75	15736	16	09-06-75	15945	OK
193		12	09-22-75	16598	12	05-01-76		OK
194		12	06-29-72	5844				
195	28				18	05-21-74	10521	FV
196					03	07-26-74	13216	FV
197		12	08-06-74	13127	12	02-21-75	14688	FV
198		20		13327	20	05-07-75	?	OK
199		12	05-09-75	15501	12	10-03-75	16649	FV
200		12	10-31-76		12	11-04-75	16882	FV
201		04	?		04	02-20-76	2832	OK
202		13	07-07-76	17997	13	04-24-76	18029	OK
203		16	09-30-73	5723				
204	29	28	07-13-74	4400	8028	07-27-74	4512	FV
205		32	08-01-74	5040	32	03-18-75	7075	FV
206		14	04-01-75	14286				
207		17	07-05-73	8678				
208	30				27	11-20-74	8671	OK
209		13	11-27-74	14037	13	02-07-75	14651	OK
210					29	11-08-75	8993	FV
211		13	11-24-75	17159	13	01-20-76	17502	FV

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
212		10	02-08-76	3482				
213					23	04-09-76	14322	OK
214		12	05-16-76	117				
215	31				14	05-05-71	1363	FV
216					10	03-27-72	5107	FV
217					17	07-05-73	8678	FV
218		20	07-17-73	7277	20	09-19-73	7907	FV
219					23	05-27-75	11773	FV
220		13	06-25-75	15786	13	10-06-75	16796	FV
221		20	12-19-75	15345				
222	32	23	09-18-73	6009	23	09-21-73	6048	FV
223		35	09-27-73	1239	35	07-15-74	?	FV
224					12	02-12-75	11463	FV
225		13	03-05-75	148				
226	33				18	06-21-71	200	FV
227					03	02-12-73	8263	OK
228					19	04-14-74	9950	OK
229					16?	05-17-74	11762	OK
230					03	07-04-75	680	FV
231					?	?	?	FV
232		32	12-26-73	9366	32	02-28-76	9864	OK
233		20	03-15-74	3274				
234	34	23	11-20-74	10100	23	12-28-74	10386	FV
235					LOAN JAL			OK
236					?	12-16-75	?	?
237		12	04-26-76	17913				
238	35				20	06-16-75	3690	FV
239					20	06-14-76	16643	FV
240		14	01-31-74	10715				
241	36	28	01-05-75	6159	28	07-03-75	7452	OK
242					LOAN JAL			FV

PITCH COMPUTER (Continued)

	NIT	ON			OFF			
LINE	S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
243		19	08-31-75	14406	19	08-31-75	14406	FV
244		32	10-01-75	8819	32	12-26-75	9366	OK
245					?	01-30-76	?	?
246		13	02-03-76	17601	13	04-07-76	17997	OK
247		32	04-15-76	10259	32	04-29-76	10383	OK
248		32	05-07-76	10456				
249	37				20	08-18-71	236	FV
250					12	04-04-72	5044	OK
251					18	11-07-73	8814	OK
252					?7	01-21-74	10682	FV
253					LOAN ITEM			FV
254		17	05-06-74	11594	17	07-20-75	15451	FV
255		19	08-31-75	14461				
256		12	10-21-73	10515				
257	38	29	08-26-74	5058	8029	11-18-74	5843	OK
258		10	12-03-74	14460	10	01-16-75	296	OK
259		13	02-07-75	14651	13	07-31-75	16156	FV
260					32	10-16-75	8934	FV
261		27	01-30-76	12266	27	02-22-76	12485	FV
262		03	03- -76	2628	03	03- -76	2628	FV
263		03	08-02-73	9970				
264	39	28	05-09-74	3813	28	07-13-74	4400	FV
265					13	01-27-76	17551	FV
266		10	02-13-76	3528				
267		35	03-10-76	9245				
268		19	11-29-71	1480				
269	40	18	05-10-74	10444	29	08-26-74	5058	FV
270		18	01-19-75	12753	18	04-23-75	13586	OK
271		23	04-30-75	11773	23	10-04-75	12966	OK
272		16	10-31-75	16411				
273	41				11	09-96-73	11011	OK

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
274					29	10-15-73	2039	FV
275		14	12-03-73	?	14	01-26-74	10664	OK
276					27	11-08-74	8655	FV
277		27	11-20-74	8671	27	04-08-75	9809	FV
278		18	06-10-75	13964	18	07-01-74	14188	FV
279		03	07-17-75	727	03	10-30-75	1754	OK
280		10	11-27-75	3045	10	01-08-76	3482	FV
281		03	03-06-76	2628				
282		11	03-28-76	17613				
283	42				17	01-23-72	3551	FV
284					14	07-11-73	8803	FV
285		03	07-18-73	9814	03	08-02-73	9970	OK
286		23	09-21-73	6048				
287					12	08-08-74	13135	FV
288					11	04-29-75	14825	OK
289		32	05-13-75	7476				
290					17	06-26-76	18228	FV
291	43	03	07-09-74	13041	03	08-22-74	13182	OK
292		19	09-13-74	11308	19	11-08-74	11835	OK
293		12	08-14-72	13191				
294	44				16	10-16-73	9882	OK
295		11	01-09-74	11327	03	03-27-74	12185	OK
296		32	07-09-74	3991	32	08-01-74	5040	OK
297					12	08-16-74	13205	FV
298		19	10-31-74	11748	19	05- -75	13266	OK
299		23	05-27-75					
300					10	02-27-76	3655	FV
301	45				23	03-08-72	222	OK
302					19	04-08-72	2784	FV
303					23	06-02-72	1070	OK
304					14	01-14-74	10540	FV

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
305		14	01-26-74	10664	14	01-31-74	10715	FV
306					27	11-08-74	8555	OK
307		17	06-04-75	15078				
308	46				10	03-13-74	12177	FV
309		03	03-27-74	12185	03	04-06-74	12265	OK
310		28	04-17-74	3611	28	05-09-74	3813	OK
311					14	04-01-75	14286	OK
312		32	04-16-75	7340				
313		14	12-16-75	16407	14	05-29-76	?	FV
314		32	06-29-75	7931				
315	47				03	02-21-73	8345	OK
316					10	08-12-73	10137	FV
317					11	07-09-74	12486	FV
318		04	05-05-75	?				
319		17	07-20-74	12257	17	08-25-75	14497	OK
320						12-02-75		FV
321					11	05-16-76	18093	OK
322		27	05-22-76	13351				
323	48				32	04-12-73	205	FV
324					11	08-15-73	9853	FV
325		20	10-11-73	1986				
326	49				32	04-27-73	369	OK
327					18	08-25-73	8046	FV
328		11	09-09-73	10148	11	07-05-74	12899	FV
329					12	08-06-74	13122	FV
330		12	08-16-74	13205	12	01-03-75	14820	OK
331		12	02-12-75	11463	12	02-19-75	14678	OK
332					13	06-25-75	15786	OK
333		18	07-01-75	14188				
334	50				27	05-07-73	3320	FV
335					13	01-21-74	11317	OK

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
336		32	11-04-74	5899				
337		14	05-29-76	?				
338	51				29	06-09-73	477	OK
339					16	09-30-73	5723	FV
340					29	01-09-74	2847	FV
341		32	01-17-74	3245	32	02-27-74	3607	FV
342					32	11-04-74	5899	FV
343					11	02-28-76	17476	FV
344		32	03-01-76	9935	32	04-09-76	10207	FV
345	52				35	07-01-73	314	FV
346					14	01-14-74	10540	OK
347		20	02-17-74	1 9406	20	10-17-74	11541	OK
348					32	04-14-75	7325	FV
349					14	05-02-75	11523	OK
350		23	05-27-75	11773	23	05-17-76	14737	OK
351		32	06-11-76	10769				
352	53				13	10-02-73	01292	FV
353					13	08-14-74	13106	FV
354					20	08-21-75	14322	OK
355		19	08-31-75	14406				
356	54				23	09-18-73	6009	OK
357					35	01-18-76	8746	FV
358		35	01-31-76	8857	35	02-18-76	8987	FV
359		32	02-28-76	9864	32	04-08-76	10191	OK
360		20	04-12-76	16190				
361					10	06-07-76	14860	OK
362	55				35	04-27-73	1239	FV
363					32	04-09-74	3991	FV
364					18	05-27-74	11787	FV
365					18	01-19-75	12753	FV
366		20	02-28-75	12747	20		13327	OK

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
367		12	05-12-75	15404				
368		11	06-08-75	15601	11	07-16-75	15851	FV
369		27	08-04-75	10844				
370		11	03-27-76	HMV	11	03-28-76	17613	OK
371		32	04-09-76	10207	32	04-15-76	10259	FV
372		10	05-02-76	4219	10	06-15-76	4591	OK
373		20	06-26-76	16735				
374	56	19	04-14-74	9950				
375					03	07-13-75	727	FV
376		17	07-20-75	15451				
377	57				29	01-11-73	1986	FV
378		10	12-03-74	14460	10	12-03-74	14460	FV
379		32	04-14-75	7332	32	04-16-75	7340	FV
380		32	05-18-75	7521	32	09-07-75	8613	OK
381		12	10-03-75	16649	12	10-31-75	16875	FV
382		12	11-04-75	16882	12	04-17-76	18072	OK
383	58				20	11-19-73	8592	FV
384					10	12-03-74	14460	FV
385		35	12-22-74	5436				
386		13	07-31-75	16156				
387					35	11-31-76	8857	FV
388		20	02-06-76	15629	20	04-12-76	16190	FV
389		23	05-17-76	14237				
390		26	06-15-76	HMV	20	06-26-76	16735	FV
391	59				27	12-29-73	5667	FV
392					FROM STOCK (SAME PROBLEM)			
393					13	09-22-74	13565	OK
394					JAL LOAN			FV
395		12	12-28-74	10386	23	12-29-74	10391	OK
396		12	02-19-75	14684	12	10-31-75		FV
397					04	12-04-75	2418	FV

PITCH COMPUTER (CONTINUED)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
398		23	01-26-76	13029				
399					10	02-27-76	3655	OK
400		11	03-27-76	17613				
401	60				32	01-17-74	3245	OK
402		18	05-27-74	11787	18	06-03-74	11843	OK
403					16	04-02-75	14576	OK
404					32	04-26-75	7358	OK
405	61				20	03-15-74	3274	OK
406					?	05-10-74	?	FV
407					18	01-21-75	12770	FV
408		28	03-19-75	6505				
409		03	06-26-75	6271				
410					28	8-18-75	7915	FV
411		13	10-06-75	16796				
412		12	05-01-76	--				
413	62				28	04-17-74	3611	OK
414					11	06-08-75	15601	FV
415					04	03-13-76	2981	FV
416	63				27	09-01-74	7950	FV
417					20	02-28-75	12747	FV
418		17	03-25-75	14497	17	03-30-75	14548	FV
419		32	04-15-75	7332				
420		20	05-07-75	?				
421		04	07-02-75	1667				
422					20	02-06-76	15629	OK
423		35	02-17-76	8987	35	03-13-76	9229	FV
424		23	04-29-76	14322				
425	64	33	12-19-74	4439				
426					35	02-01-76		OK
427		35	03-01-76	09112				
428	65				35	12-22-74	5436	OK

PITCH COMPUTER (Continued)

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
429		27	04-08-74	9809				
430	66				NA LOAN			FV
431		18	01-21-75	12770				
432	67				18	01-06-75	12624	FV
433					12	02-21-75	14688	OK
434		12	04-09-76	15517	12	05-12-75	15404	OK
435					32	06-29-75	7931	FV
436		13	07-18-75	14670				
437		28	08-14-75	7938	28	10-02-75	8292	FV
438					12	11-03-75	16883	FV
439		10	03-05-76	3719	10	04-03-76	3975	FV
440					12	05-16-76	117	FV
441	68				28	03-19-75	6505	FV
442		29	04-08-75	8993				
443		16	04-02-75	14576	16	08-05-75	15236	OK

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
1	1				8010	11-17-70	838	FV
2					8011	10-22-71	3498	FV
3					8013	07-27-72	6163	FV
4		8004	08-17-72	6446	8004	04-12-73	8862	F
5					8020	06-05-73	6812	OK
6					8012	06-10-74	12504	OK
7		8012	07-06-74	12828	8012	09-26-75	16618	F
8		8004	01-09-76	2578	8004	02-20-76	2832	OK
9		8035	03-04-76	9135				
10	2				8003	05-05-72	5297	FV
11					8003	11-11-72	7261	FV
12					8003	10-22-73	10803	FV
13		8027	02-26-74	6230	8027	11-08-75	11710	FV
14		8032	12-06-75	9307				
15	3	8010	12-03-74	14459				
16					8019	02-13-75	12640	OK
17		8029	03-07-75	6783	8029	03-23-75	6428	OK
18		8003	04-18-75	4	8003	04-22-75	17581	OK
19		8019	05-04-75	13266	8019	05-06-75	13287	OK
20					8012	05-21-75		F
21					8020	07-23-75	1404	FV
22	4				8003	11-01-70	897	FV
23					8014	12-16-70	150	FV
24		8016	01-11-71	261	8016	05-04-71	1207	FV
25		8011	06-04-71	2261	8011	07-15-71	2637	OK
26					8011	06-15-75	15674	FV
27	5	8029	10-11-73	1986				
28					8013	02-07-75	14651	OK
29		8013	02-25-75	14775	8013	10-02-75	16756	OK
30		8029	10-05-75	8688				
31	6				8012	08-14-71	2913	F
32					8012	09-02-71	3089	OK
33					8016	02-01-72	3120	FV
34					8020	06-30-72	3354	FV
35					8010	08-01-72	6292	OK
36					8013	01-31-75	14675	FV
37		8017	02-19-75	14179	8017	08-22-75	15849	FV
38	7				8019	06-04-72	3337	F
39					8012	06-27-72	5848	FV
40					8013	08-08-72	6287	F

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
41					8019	10-19-73	8334	FV
42		8035	11-74-74	4451	8035	06-16-75	7010	OK
43	8				8003	10-20-70		FV
44					8013	07-27-71	2557	FV
45		8019	02-29-72	2369				
46					8010	05-22-72	5473	F
47		8013	08-08-72	6287				
48		8017	08-22-72	5648				
49		8010	05-30-72	5553	8010	06-19-72	5813	OK
50		8020	06-30-72	3354	8020	06-30-72	3354	F
51								F
52		8013	07-27-72	6163	8013	08-07-72	6279	OK
53		8011	09-20-73	10258				
54	9				8027	03-09-73	2483	FV
55		8011	04-27-73	8735				
56	10	8011	12-25-72	7412	8011	09-09-72	10148	OK
57					8020	10-04-73	8048	F
58					8029			FV
59					8010	02-20-74		FV
60		8019	03-04-74	9584				
61					8027	02-27-76	6230	OK
62					8014	06-09-74	10417	F & FV
63		8017	07-21-74	12265	8017	02-19-75	14179	F
64					8019	09-01-75	14413	OK
65					8032	12-06-75	9337	F
66		8018	02-15-76	16146	8018	02-21-76	16195	FV
67		8011	03-14-76	17603				
68	11				Loan	02-08-71		OK
69		8004	03-16-71		8004	11-21-71	4031	FV
70					8014	12-19-71	3302	FV
71					8011	06-19-72	5442	F
72		8012	06-24-76	5840	8012	08-17-72	6371	FV
73					8010	09-30-72	6844	FV
74					8017	07-05-73	8678	F
75		8032	07-14-73	1221				
76		8016	04-27-75	14825				
77					8018	02-15-76	16146	FV
78		8013	04-01-76	17948				
79	12	8018	05-17-74	10487				
80					8011	12-13-74	14157	OK

ORIGINAL PAGE IS
OF POOR QUALITY

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
81		8013	01-31-75	14075	8013	02-02-75	14590	OK
82					8019	05-04-75	13266	
83		8012	05-12-75		8012	07-26-75	16057	OK
84		8004	08-12-75	1463	8004	08-20-75	1536	FV
85		8017	08-22-75	15849	8017	09-07-75	15947	OK
86		8013	10-02-75	16756	8013	10-27-75	16936	OK
87		8027	11-05-75	11678	8027		11734	OK
88		8012	01-20-76	17283	8012	01-26-76	17341	OK
89						02-26-76		FV
90		8004	02-28-76	2890	8004	03-16-76	3010	FV
91		8016	04-28-76	17649				
92	13	8010	11-17-70	838				
93		8003	09-11-71	3445				
94		8019	12-26-72	5522				
95		8019	04-16-73	6400				
96					8010	11-15-74		OK
97					8010	11-30-74	2	FV
98		8029	03-25-75	6943				
99	14	8029	08-28-74	5026				
100		8014	11-11-74	13208	8014	11-20-74	13768	F
101		8010	11-30-74	13643	8010	12-03-74	14459	OK
102					8017	09-18-75		FV
103		8016	10-08-75	16272	8016	10-23-75	16374	FV
104		8003	12-16-75		8003	01-02-76		FV
105		8018	02-13-76	16129				
106	15	8012	08-31-71	3077				
107					8011	11-01-72	6584	FV
108					8004	01-02-73	7847	F
109					8027	02-26-74	6730	OK
110		8010	03-13-74	12177				
111					8029	10-25-74	5611	OK
112					8010	06-07-75	1512	F
113		8010	06-28-75	1728	8010	07-22-75	1959	OK
114					8003	12-16-75		FV
115		8018	02-21-76	16195	8018	05-15-76	16939	OK
116	16	8003	12-23-70	1260				
117		8004	04-19-71					
118		8017	07-16-71	1903				
119		8014	12-19-71	3302				
120		8010	08-01-72	6292				
121		8010	09-30-72	6844	8010	03-29-73	8741	OK
122					8004	06-13-73	9461	OK
133		8012	07-09-73	9420				
134		8029	08-22-73	1370	8029	10-06-73	1918	F
135					8028	03-01-74	3150	OK

		ON			OFF			ROLL COMPUTER
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
136		8003	04-05-74	12265	8003	08-04-74	13296	OK
137					8012	01-20-76	17283	FV
138					Bad from stock			F
139		8003	03-06-76	2628	8003	05-26-76	3228	FV
140		8020	06-15-76	HMV				
141	17				3	12-23-70	1260	FV
142		4	02-19-71	1084	4	03-16-71	1864	OK
143		16	05-04-71	1270	16	03-10-72	4014	FV
144		20	06-05-73	6812				
145					16	04-29-75	14825	FV
146		29	08-09-75		29	10-05-75	8688	FV
147		18	10-25-75	15311				
148	18				16	01-11-71	261	OK
149					11	06-04-71	2261	OK V*
150					4	07-06-72	6005	FV
151					18	11-18-72	6381	OK
152					3	02-08-73	8209	FV
153					14	04-01-73	7703	OK
154					19	04-16-73	6400	OK
155		16	04-27-73	8024	16	05-21-73	8217	OK
156					20	11-13-73	8479	FV
157					32	07-29-74	5007	F
158		3	04-22-75	17518	3	07-04-75	680	FV
159		10	07-22-75	1659	10	05-03-76	4776	F
160		18	05-15-76	16939				
161	19	19	06-04-72	3337				
162					12	07-09-73	9420	OK
163		16	08-01-73	9045	16	06-15-74	11971	OK
164		35	07-13-74	3928				
165	20				4	02-19-71	1084	FV
166					3	09-11-71	3445	FV
167					17	04-05-72	4231	FV
168		18	05-10-72	3228				
169					3	06-02-72	5584	F
170					10	01-18-75	508	F
171		11	01-11-76	17099	11	03-14-76	17603	FV
172	21				16	04-04-71	1024	FV
173					2	10-17-71	3652	FV
174					4	08-17-72	1446	FV
175					19	12-26-72	5522	FV
176					7	01-12-73		OK
177					3	04-05-74	12265	FV
178					23	01-20-76	13029	FV
179		35	03-30-76	94013				
180	22	10	06-19-75	1634				
181		4	07-07-75	1110	4	08-02-75	0	FV

ORIGINAL PAGE IS
OF POOR QUALITY

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
182		4	08-20-75	1536				
183		16	08-06-75	1574	16	08-09-75	15774	FV
184	23				16	05-05-71	291	F
185		12	07-24-71	2764	12	08-13-71	2907	F
186					18	03-07-72	2517	FV
187		17	04-05-72	4231	17	08-22-72	5648	FV
188					18	05-08-74	10434	OK
189					14	11-11-74	13208	FV
190		10	01-18-75	508	10	06-19-75	1634	F
191		4	03-16-76	3010				
192	24				17	11-06-72	6435	FV
193		18	11-18-72	6381	18	08-25-73	8046	F
194					27	02-26-74	6221	OK
195					3	07-04-75	680	OK
196		3	07-13-75	727	3	08-25-75	1107	FV
197		19	09-01-75	14413	19	04-16-76	16086	F
198						06-01-76		OK
199		20	06-08-76	16733				
200	25				4	04-19-71	2151	FV
201		12	08-14-71	2913	12	08-31-71	3077	FV
202					19	02-29-72	2369	FV
203					10	05-30-72	5553	OK
204		10	06-19-72	5813	10	07-11-72	6061	OK
205					11	04-27-73	8735	FV
206					10	03-13-74	12177	F
207	26	12	09-04-71	3108				
207						01-05-73	2	F
208		3	02-08-73	8209				
209						05-17-73		F
210		17	07-05-73	8678	17	08-04-75	15597	FV
211		17	09-07-75	15947	17	03-20-76	17384	FV
212		16	04-29-76	17571				
213	27	20	04-29-74	10037	20	05-01-75		FV
214		11	05-07-75	15357	11	06-16-75	15679	OK
215		18	07-07-75	15411				
216					16	08-06-75	1574	FV
217					16	09-11-75	15984	OK
218		17	09-18-75					
219					16	11-07-75	16482	FV
220		4	11-11-75		4	01-09-76	2578	OK
221		35	01-12-76	4787	35	03-16-76	9159	F
222		20	06-16-76	16643	20	06-28-76	16733	FV
223	28	12	09-02-71	3089				
224		10	07-11-72	6061	10	10-11-73	10794	FV
225		13	11-24-73	10741	13	04-02-74	11916	OK

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
226		10	03-07-75	757				
227					14	04-28-75	14499	OK
228		16	08-09-75	15774				
229		28	08-14-75	8094				
230					10	01-11-76	3263	F
231		23	01-20-76	13029				
232					12	04-20-76	18000	OK
233		10	05-03-76	4776	10	05-04-76	4247	FV
234		3	05-26-76	3228				
235		10	03-29-73	8741				
236	29					04-17-73		OK
237					10	08-19-73	10774	F
238					11	09-20-73	10258	OK
239		20	10-04-73	8048	20	08-27-74	11062	F
240		29	08-31-74	5104	29	11-11-74	5786	OK
241		14	11-12-74	13763	14	01-12-76	16649	OK
242		12	01-26-76	17341	12	04-08-76	17987	FV
243	30				17	07-16-71	1903	F
244		16	02-01-72	3120	16	04-27-73	8074	F
245					20	05-12-73	6649	FV
246		16	05-21-73	8217	16	05-01-75	14841	FV
247		3	07-04-75	680	3	07-13-75	727	FV
248		28	07-14-75	7642	28	08-14-75	8094	OK
249					35	10-13-75	8027	FV
250		16	10-23-75	16374	16	04-28-76	17649	FV
251		17	05-01-76	17759				
252	31				12	07-24-71	2764	F
253					12	09-04-71	3108	F
254					12	06-05-73	9075	FV
255					18	05-10-74	10444	F
256					11	05-07-75	15357	FV
257		18	05-14-75	13755	18	02-13-76	16129	FV
258		12	04-18-76	18081				
259	32	14	08-14-71	2274	14	08-14-71	2274	OK
260		17	09-13-71	2429	17	03-13-72	3994	OK
261					12	06-04-72	5601	F
262		11	06-19-72	5442	11	12-25-72	7412	OK
263		12	08-17-72	6371				
264					16	08-01-73	9045	F
265		10	08-19-73	10774	10	03-13-74	12177	F
266		16	06-15-74	11971				
267					12	04-20-76	18000	OK
268		10	05-04-76	4247				
269	33				17	09-13-71	2429	FV
270					13	11-19-71	3508	OK

ORIGINAL PAGE IS

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
271		20	12-28-71	1505				
272		11	12-13-74	14157	11	06-26-75	18684	FV
273	34	10	03-13-74	12177				
274					29	03-07-75	6783	OK
275		29	03-23-75	6428	29	03-25-75	6943	FV
276					20	06-15-76	HMV	OK
277	35	14	04-01-73	7703				
278					STOCK	08-08-74		F
279		29	08-27-74	5067	29	08-31-74	5104	OK
280					10	11-15-74		FV
281					10	03-07-75	757	F
282		16	05-01-75	14841	16	07-07-75	15411	FV
283					3	01-02-76	0	OK
284		14	01-12-76	16649	14	03-10-76	17240	FV
285		19	04-16-76	16086				
286	36				20	12-28-71	1505	OK
287					12	04-04-72	5053	F
288		10	05-22-72	5473	10	05-25-72	5510	
289					14	08-26-72	5761	OK
290					13	02-14-74	11536	FV
291		13	04-02-74	11916	13	08-15-74	13115	OK
292					19	05-03-75	13266	FV
293		11	06-15-75	15674	11	07-31-75	15968	FV
294		14	09-17-75	15768	14	11-29-75	16407	FV
295	37				14	02-03-72	2100	FV
296		14	05-08-74	10434				
297	38	14	09-16-74	12740	14	09-17-74	12746	FV
298		29	10-25-74	5611	29	05-09-75	7378	F
299		29	06-16-75	7702	29	07-14-75	7926	FV
300					Return from Quantus	07-28-75		OK
301		4	08-02-75		4	08-12-75	1463	FV
302					16	10-08-75	16272	FV
303		13	11-07-75	17056	13	04-01-76	17948	FV
304		12	04-08-76	17987				
305					23	05-05-76	14563	F
306	39	3	10-22-73	10803				
307					29	08-28-74	5026	OK
308					19	11-05-74	11806	FV
309					29	06-10-75	7702	OK
310		28	07-01-75	7433				
311	40				18	03-24-72	2158	OK
312					19	09-20-73	8019	FV
313						10-09-73		FV
314					3	04-18-75	4	OK

ROLL COMPUTER

LINE	UNIT S/N	ON AIRPLANE	ON DATE	ON TIME	OFF AIRPLANE	OFF DATE	OFF TIME	STATUS
315		12	05-06-75	13287				
316					19	07-10-75	13853	FV
317						07-28-75		FV
318					11	01-11-76	17099	FV
319		20	02-06-76	15629				
320	41				18	05-10-72	3228	FV
321					12	06-24-72	5840	F
322					17	10-25-73	9852	FV
323					18	05-17-74	10487	FV
324		29	06-01-74	4180	29	07-28-74	4770	FV
325		3	08-04-74	13296				
326		12	07-26-75	16057	12	09-26-75		F
327		23	05-05-76	14560				
328	42	4	12-13-72	7684				
329		28	01-12-75	5987				
330		16	04-07-75	16482				
331					28	07-01-75	7443	OK
332					4	07-05-75	1086	OK
333		26	07-23-75	1404	20	10-20-75	14872	OK
334					STOCK	11-03-75		OK
335					16	11-10-75	16584	FV
336		14	12-05-75	16455				
337	43					06-21-72		F
338		4	07-06-72	6005	4	12-13-72	7684	FV
339		10	01-11-76	3263				
340					4	11-11-75		OK
341					13	06-10-72		F
342		13	08-07-72	6279	13	11-24-73	10741	FV
343					11	07-05-74	12899	FV
344					12	08-16-74	13209	OK
345					29	09-19-74	5295	OK
346					18	02-02-75	12888	OK
347		13	02-07-75	14651	13	02-25-75	14775	OK
348					19	04-11-76	16044	FV
349	45				27	07-30-72	397	OK
350		12	08-17-72	6371	12	06-27-73	9281	OK
351					12	05-20-75	15478	FV
352					11	06-08-75	15601	FV
353		11	06-26-75	15684	11	08-09-75	16036	F
354		32	09-07-75	8613	32	05-18-76	10559	OK
355	46				19	08-25-72	4275	FV
356					10	10-03-72	6879	FV
357					12	01-19-73	7677	OK
358					14	09-08-75	15689	FV
359		13	10-27-75	16936				

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
360	47	4	02-24-75	2:33				
361		28	07-13-75	7565	28	07-19-75	7642	OK
362		11	07-31-75	15968				
363	48	4	04-12-73	8862				
364		12	06-05-73	9074				
365					29	08-22-73	1370	FV
366		29	10-06-73	1918	29	10-11-73	1986	FV
367					Back from JAL	11-29-73		OK
368					20	04-29-74	10037	FV
369					18	10-25-75	15311	OK
370		14	11-29-75	16407				
371						06-02-76		OK
372	49				27	02-02-73	2400	FV
373					32	12-08-73	2854	OK
374		16	04-10-75	16584				
375					13	11-07-75	17056	OK
376					16	04-29-76	17571	FV
377	50	4	06-13-73	9461	4	02-24-75	2:33	FV
378		4	03-14-75	118	4	02-20-76	2832	OK
379		32	02-28-76	9864				
380	51				35	05-31-73	0	FV
381*		35	10-13-75	8028	35	01-12-76	8787	OK
382		12	01-26-76	17493	12	04-18-76	18081	FV
383	52	19	10-19-73	8334	19	03-04-74	9584	FV
384		32	07-29-74	5007	32	08-01-74	5040	FV
385					STOCK	08-12-74		FV
386		20	08-27-74	11062				
387		14	04-28-75	14499				
388					20	02-06-76	15629	FV
389		4	02-20-76	2832				
390	53				32	07-14-73	1221	F
391					4	03-14-75	118--	F
392					STOCK	05-02-75		FV
393					10	06-28-75	1728	OK
394		3	07-04-75	680	3	09-28-75		FV
395		20	10-20-75	14872				
396	54				28	09-03-73	1398	OK
397		10	10-11-73	10794				
398						08-20-74		OK
399					14	09-16-74	12740	OK
400					19	12-24-74	12182	OK
401		10	06-07-75	1512	10	06-09-75	1541	FV
402		35	06-16-75	7010	35	06-21-75	7021	OK
403					4	07-07-75	1110	F
404		3	08-25-75	1107	3	08-25-75	1113	F

ROLL COMPUTER

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
405		12	09-26-75					
406	55				35	01-04-74	2273	FV
407					10	11-14-74	14451	OK
408		10	11-30-74	2	10	11-30-74	3	OK
409		20	12-12-74	11910	20	06-09-75	13643	OK
410		29	07-14-75	7926				
411					20	06-16-76	16643	FV
412	56				29	06-01-74	4180	FV
413		12	06-10-74	12504	12	07-06-74	12828	OK
414		32	08-01-74	5040	32	09-11-74	5410	FV
415		14	09-17-74	12746	14	09-17-75	15768	OK
416		3	09-28-75					
417	57				35	07-13-74	3928	OK
418					17	07-21-74	12265	F
419		32	09-11-74	5410	32	02-28-76	9864	OK
420		35	03-07-76	9159	35	03-30-76	9401	F
421					12	09-17-76	18072	F
					Back from stock			
422	58				29	08-27-74	5067	FV
423					20	12-12-74	11910	FV
424		19	12-24-74	12182	19	01-09-75	12347	OK
425		18	02-02-75	12888	18	05-14-74	13775	FV
426		11	06-11-75	15679	11	07-10-75	15850	FV
427					29	08-06-75		OK
428		12	09-26-75		12	01-26-76	17493	FV
429		35	02-26-76	8071	35	03-04-76	9135	FV
430	59				28	01-12-75	5987	OK
431					28	07-13-75	7565	OK
432	60				35	02-26-76	8071	FV
433		19	04-11-76	16044				
434	61	29	05-09-75	7378	29	08-09-75		FV
435					14	11-29-76	16407	OK
436		4	02-20-76	28320	4	02-28-76	28904	OK
437	62				32	09-07-75	8613	FV
438		27	11-08-75	11710				
439	63				27	11-05-75	11678	OK
440		14	11-29-75	16407	14	12-05-75	16455	F
441		3	01-02-76		3	03-06-76	2628	FV
442					17	05-01-76	17759	FV

ORIGINAL PAGE IS
OF POOR QUALITY

YAW COMPUTER

		ON			OFF				
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
1	1	10	06-24-71	2687	10	07-01-71	2759	72	FV
2					LOAN	08-18-71	?	?	OK
3						10-08-71	?	?	OK
4					DROPPED	10-08-71	?	0?	OK
5		13	10-22-71	3332	13	10-25-71	3356	20	OK
6					11	11-15-73	10775	?	FV
7		11	07-27-74	13054	11	07-30-74	13056	4	OK
8					LOAN	09-24-75			OK
9		27	02-22-76	12406					
10	2	11	11-20-70	567	11	08-05-71	2853		FV*
11		4	10-18-71	3761					
12	3				4	08-24-71	3400		FV*
13				13001	12	07-10-74			FV
14					LOAN	11-02-74			OK
15					17	07-07-75	15335		FV
16		11	07-05-75	15314	11	?			
17				16058	11	08-11-75	15974		OK
18		13	12-05-75	17233	13	?	?	?	?
19	4			389	13	12-27-70	460	71	OK
20		10	06-29-71*	2675	10	06-24-71	2687	12	FV
21		4	08-24-71	3400	4	10-13-71*	3724	324	FV
22				3731	11	11-29-71	?		FV
23		18	01-09-72	2077	18	04-16-72	2301		FV
24		4	06-18-72	5794	4	07-03-72	5983		OK
25					17	07-29-72	3441		FV
26		18	10-07-72	4964	18	10-11-72	5012		FV
27		27	11-02-72	1413	27	04-08-76	12912		FV**
28					27	06-22-76	13676		FV
29	5	14	12-31-70	284	14	11028072	6530	6246	FV*
30					LOAN	04-30-73			OK
31		17	07-06-73	8082	17	10-24-73	9845	763	FV**
32		32	12-21-73	2828	32	07-05-74	4766	1938	OK
33		10	01-30-75	419	10	06-21-75	1700		FV
34		10	07-08-75	?					
35		13	11-17-75	17112	13	12-5-75	17233	121	FV*
36		27	01-25-76	12224	27	02-22-76	12406	182	OK
37		27	04-08-76	12912	27	04-27-76	13119	1107	OK
38	6	16	06-04-71	1587	16	06-27-71	1748	161	OK
39		10	11-27-71	3983	10	01-16-72	4387	404	OK
40					12	02-04-72	4460		FV
41		16	02-16-72	3778	16	10-10-73	9830	5052	FV*
42		32	12-01-73	2779	32	12-05-73	2828	59	OK
43		28	01-20-74	2781	28	01-03-75	5907	3126	FV**
44		3	06-29-75	632					
45	7	12	06-21-71	2438	12	12-18-70	890		OK
46					LOAN	03-26-71*			FV
47				2438	12	07-29-72	5441	3003	FV*

YAW COMPUTER (Continued)

		ON			OFF				
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
48		19	09-19-72	4566	19	01-02-75	12269	8708	FV
49		4	07-28-75	1311					
50	8				?	11-30-70	?		OK
51	8	12	12-18-70	890	12	10-07-71	3394		FV*
52		17	12-09-71	3083	17	01-05-72	3369		FV**
53					LOAN	03-20-72*			?
54		17	07-04-72	5160	17	10-22-72*	6316		FV*
55		35	06-29-73	294	35	07-24-73*	447		FV**
56		12	09-05-73	10032	12	09-11-73	10092		OK
57		13	12-21-73	11051					
58	9	13	12-24-70	460	13	10-22-71	3333		FV*
59		4	11-17-71	4001	4	11-19-71	4011		OK
60					LOAN	12-20-71			OK
61					LOAN	01-09-92			OK
62		10	02-01-72	4559					
63		10	02-05-72	4604	10	02-25-72	4809	250	FV
64		11	03-19-72	4747	11	07-27-74	13054	8307	F*
65		11	10-29-74	?	11	08-08-75*	15974	2167	F*
66		35	05-13-76	9037					
67	10				11	11-20-70	567	567	F*
68		16	01-14-71	295	16	01-28-71	399		FV
69					LOAN	03-26-71			F**
70					LOAN	07-06-71			F
71		13	10-25-71	3352	13	11-23-71	3539		OK
72		16	01-23-72	3539	16	02-16-72	3778		FV
73	*	20	12-03-72	5122	20	12-07-72	5743		FV
74					13	07-05-73	9377		FV
75				7277	20	07-19-73	7291	23	F*
76					?	08-04-73			FV*
77				1135	35	05-13-76	9837	8702	FV**
78	11				?	06-09-71			F
79		10	07-01-71	2759	10	02-05-72	4604		F
80		14	02-11-72	3769					
81	12				13	12-17-70	389		ROBBED
82					?	03-19-71*		?	OK
83					LOAN	06-08-71*			OK
84		4	07-09-71	2984	4	11-17-71	4001		FV
85		13	12-01-71	3618	13	06-05-72	5681		F
86		4	07-03-72	5983					
87		18	10-11-72	5012	18	11-28-72	5499	487	OK
88		35	07-05-73*	284	35	06-19-73	294	10	FV**
89					13	07-18-75	16429		FV*
90					?	10-09-75	?		OK
91		29	05-19-76	10422					
92	13				14	12-17-70	164		OK
93					LOAN	03-05-71*			OK
94		4	10-13-71*	3724	4	10-18-71	3761	37	OK

YAW COMPUTER (Continued)

		ON			OFF				
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
95		11	11-05-71	3540	11	11-08-71	3559	19	FV
96		17	01-05-72	3369	17	01-16-72	3458	89	OK
97		12	02-18-72	4608	12	04-05-72	5062	454	FV
98		16	04-12-72	4331	16	07-12-72	5255	924	F*
99		19	08-16-72	4172	19	09-08-72	4448	276	OK
100		17	10-27-72	6316					
101	14				14	12-31-70	284		FV
102		4	01-24-71	1449	4	07-09-71	2984	1535	
103					LOAN	08-15-71			F
104					LOAN	09-23-71*			OK
105		20	09-28-71	605	20	12-03-72	5122		FV*
106				7089	20	07-09-73	7181	92	OK
107		11	07-13-74	12947	11	07-15-74	12966	19	OK
108		23	09-08-74	9434					
109	15				16	01-14-71	294		OK
110		16	01-28-71	399	16	06-04-71	5187	1188	OK
111					LOAN	07-20-71*			OK
112					LOAN	08-31-71*			OK
113					?	09-28-71	?		OK
114		11	11-29-71	3739	11	01-04-72	4033	1294	OK
115		17	11-08-71	3458	17	01-28-72	3563	105	OK
116		12	02-04-72	4460	12	02-18-72	4608		F
117					LOAN	03-14-72			F
118					LOAN	04-10-72			OK
119				6814	13	?	?		?
120					17	10-25-73	9852		F
121		29	02-19-74	3225	29	11-18-75	9056	5831	OK
122		11	05-22-76	18167					
123	16				4	01-24-71	1449		FV**
124					LOAN	07-29-71*			OK
125		11	08-05-71	2853					
126				3739	11	12-30-71	3974	235	FV*
127		11	01-04-72	4033					
128					10	02-07-72	4618		FV*
129		10	02-24-72	4798					
130		35	09-20-73		10	01-30-75	419		FV*
131				632	3	06-29-75	?		FV*
132		17	08-11-75	15669	17	02-27-76	17203	2539	F*
133				18167	11				
134	17				12	06-21-71	2438		FV*
135		16	06-27-71	1748	16	04-16-72	4285		OK
136					LOAN	05-11-72*			
137					LOAN	06-01-72*			OK
138		17	07-29-72	3441					
139				5681	13	12-21-73	11051		FV*
140		35	06-22-74	3770					

YAW COMPUTER (Continued)

		ON			OFF				
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
141	18				10	06-29-71*	2675	2675	FV**
142					LOAN	09-27-71*			F**
143					LOAN	10-14-71	3515		OK
144		17	10-20-71	7836					
145		4	11-19-71	4011					
146		17	01-28-72	3563	17	07-04-72	5160	1597	FV**
147					4	07-28-75	1377		OK
148	19				20	09-28-71	605		
149					4	06-18-72	5794		FV
150		12	07-28-72	6169	12	07-21-73	9531	3362	OK
151	19	17	10-25-73	9852	17	02-17-75	14170		OK
152		11	11-14-75	16711	11	05-22-76	18167		FV*
153	20				17	10-20-71	2836		FV**
154					11	11-29-71	3739		FV*
155	21				11	11-05-71	3540		OK
156		13	11-23-71	3539	13	12-01-71	3618		F
157		11	02-02-72	4305	11	03-19-72	4747	442	OK
158		16	04-08-72	4306	16	04-12-72	4331	25	OK
159		17	07-29-72	5441	17	10-23-72	6296	855	FV**
160					20	07-16-73	499		F
161		35	07-24-73*	447					
162	22				10	11-27-71	3983		FV*
163					LOAN	02-01-72			OK
164		23	02-22-72	47	23	10-26-63	6394	6347	FV**
165					LOAN	09-10-74			OK
166		17	10-28-74	13213	17	11-02-74	13254	41	F
167		28	01-30-75	6100					
168	23				17	12-09-71	3083		OK
169		11	12-13-71	3974	11	02-02-72	4305		FV**
170		16	04-16-72	4286	16	04-08-72	4306		OK
171		18	04-16-72	2301	18	10-07-72	4964		OK
172		17	10-23-72	6292	17	07-06-73	8088	1796	FV
173		20	07-19-73	7291					
174	24				18	01-09-72	2077		FV**
175		10	01-16-72	4387	10	02-01-72	4559		OK
176		10	02-07-72	4218	10	02-24-72	4798		FV
177		24	04-05-72	5062	12	07-28-72	6169		OK
178		14	11-28-72	6530	?	06-30-76	?		OK
179	25				16	01-23-72	3539		FV*
180		10	02-25-72	4809	10	09-28-72	6821		OK
181		20	12-07-72	5743	20	04-01-75	13038		FV
182		17		15335					
183				153600?	10	07-08-75	?		FV*
184		17	07-07-75	15335	17	08-11-75	15669	329	FV*
185		17	01-21-72	3515					
186	26				14	02-11-72	3769		FV*
187		19	04-02-72	2726	19	04-21-72	2909		FV*

ORIGINAL PAGE IS
OF POOR QUALITY

YAW COMPUTER (Continued)

		ON			OFF				
LINE	LINE S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
188					LOAN	05-22-72			OK
189					LOAN	06-09-7?			OK
190		16	07-12-72	5255					
191	27			0?	23	02-02-72	47	47	FV
192		20	04-13-72	2554	20	06-27-73	4033	4033	FV**
193					32	12-01-73	2779		OK
194		11	07-06-74	12909	11	07-13-74	12947	38	FV
195					LOAN	09-18-74			OK
196		11	10-29-74	13883	11	11-14-75	16711	2828	FV*
197	28				19	04-02-72	2726		OK
198		19	04-21-72	2909	19	08-16-72	4172		OK
199					STOCK	09-13-72			OK
200		10	09-28-72	68?	10	01-12-76	3268		FV
201	28	17	03-06-76	17250	17				
202	29				20	04-13-72	2554		FV
203		18	07-11-72	3935	18				
204	30				LOAN	08-08-72	11		?
205		23	10-14-72	?					
206	31				18	07-11-72	3935		FV*
207		19	09-02-72	4448	19	09-19-72	4566		FV*
208			02		LOAN	10-15-72			F*
209		12	08-31-73	9961	12	09-05-73	10032		F*
210		16	10-10-73	9830	16	09-30-74	12995	3165	OK
211					LOAN	10-22-74			OK
212		10	06-21-75						
213	32	18	11-28-72	5499					
214				2490	23	10-14-72	?	2490	FV*
215		23	10-26-73	6394					
216	33				13	10-25-72	6814		FV**
217		20	06-27-73	4033	20	07-01-73	2089		FV*
218				9033	20				
219		20	07-09-73	7181	20	07-17-73	7277		OK
220		12	07-21-73	9531	12	08-31-73	9961	431	OK
221		17	10-24-73	9845	17	10-28-74	13213	3368	FV
222		17	11-02-74	13254	17	03-18-76	17274	4020	F**
223		14	05-30-76						
224	34				27	11-02-72	1413		FV**
225		20	07-16-73	499	20				
226				1135	35	09-20-73	?		F*
227		32	12-05-73	2828	32	12-21-73	2985		F
228		35	02-22-74	2675	35	03-11-74	2866		OK
229		35	06-10-74	3543	35	06-22-74	3770		OK
230		11	07-15-74	12966	11	10-19-74	13807		OK
231					LOAN	02-20-75			OK
232		32	08-03-75	?					
233		29	11-18-75	9056	29	05-19-76	10422	1365	FV*

YAW COMPUTER (Continued)

LINE	LINE S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
234					LOAN	07-16-76			FV*
235	35				35	07-05-73	284		OK
236		11	11-15-73	10775	11	07-06-74	12909		FV*
237		12	07-10-74	13001					
238	36				19	01-21-74	?		FV*
239		32	02-23-74	3582	32	08-03-75	8309		OK
240					13	11-17-75	17112		F*
241		10	01-12-76	3268					
242	37				28	01-20-74	2781		FV
243		35	02-11-74	2861	35	06-10-74	3593		FV
244		11	07-30-74*	13058	11	10-29-74	13883		F
245		19	01-02-75	12264					
246	38				29	02-19-74	3225	3225	FV*
247		23	04-27-74	8146	23	09-08-74	9434	588	F*
248		16	09-30-74	12995					
249		17	02-27-76	17203	17	03-06-76	17250	47	FV
250		27	04-27-76	13119	27				
251	39				35	02-12-74	2675	2675	OK
252		32	07-05-74	9845					
253	40				32	02-23-74	3582		FV*
254		28	05-25-74	3947	28	01-30-75	6100	2153	OK
255					11	07-05-75	15314		OK
256	41				23	04-27-74	8146	8146	FV
257		27	11-27-74	8732	27	01-25-76	12229		OK
258	42				28	05-25-74	3947		FV
259		28	01-03-75	5908					
260	43				27	11-27-74	8732		FV**
261					LOAN	01-23-75			OK
262		20	04-01-75	13038					
263	44	17	07-15-75	17274	NEW				
264	45				3	06-29-75	630		FV*
265		11	08-11-75	16055	11	?	16415	460?	?
266					LOAN	05-04-76*			F*

ORIGINAL PAGE IS
OF POOR QUALITY

MLU

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
1	1				8003	09-13-70	513	OK
2					8003	04-03-71	2089	FV
3		8019	08-17-71	567	8019	11-15-71	1344	OK
4		8019	11-29-71	1480	8019	03-07-72	2444	FV
5		8019	04-12-72	2825	8019	08-30-72	4337	FV
6		8011	11-11-72	6992	8011	01-17-73	7768	F
7		8016	03-27-73	7696	8016	04-02-73	7774	FV
8					8003	08-17-73	10110	OK
9		8003	09-05-73	10349	8003	12-17-74	14475	OK
10		8012	01-08-75	14320	8012	02-18-75	14670	OK
11		8004	02-27-75	3	8004	10-05-75	1928	FV
12		8013	10-14-75	16875	8013	10-22-75	16889	OK
13		8029	12-12-75	9209				
14	2	8016	01-11-71	261				
15						01-22-71		OK
16		8010	06-03-71	2511	8010	12-28-71	8238	FV
17		8012	04-07-72			02-16-73		
18					8019	04-12-73	6549	FV
19		8004	04-18-73	8923	8004	08-03-73	10056	FV
20					8020	10-04-73		OK
21		8012	11-08-73	10660	8012	11-12-73	10699	F
22		8012	12-02-73	10888	8012	07-11-74	12884	FV
23		8012	08-05-74	13122	8012	01-08-75	14316	OK
24		8013	01-23-75	14522	8013	09-11-75	16609	FV
25		8012	09-26-75		8012	01-14-76	17219	OK
26		8027	03-08-76	12618		01-23-76		OK
27	3	8003	09-13-70	513	8003	10-07-70	678	OK
28					Stock	11-25-70		OK
29		8016	02-05-71	499	8016	11-28-71	3069	FV
30		8010	12-28-71	8238	8010	05-30-72	5553	OK
31					8026	06-07-73	6822	FV
32		8004	08-03-73	10056	8004	08-29-74	13714	OK
33		8019	10-24-74	11680	8019	04-16-75	13186	OK
34		8016	07-07-75	15411	8016	07-23-75	15622	OK
35	4	8014	02-08-71	658	8014	09-30-71	2676	OK
36					Loan	01-20-72		OK
37					8014	02-18-72	3835	OK
38					Stock	04-25-72		FV
39		8014	06-10-72	4954	8014	06-23-72	5094	F
40		8018	07-02-72	3826	8018	07-05-73	7506	OK

MLU

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
41	4				8020	11-19-73	8542	OK
42		8019	06-09-74	10416	8019	10-02-74	11483	OK
43		8018	10-23-74	17923	8018	05-01-75	13674	OK
44		8010	06-03-75	1484	8010	01-05-76	3221	OK
45						03-05-76		OK
46		8016	04-19-76	17571	8016	05-13-76	17777	OK
47						06-23-76		OK
48	5				8016	02-05-71	499	FV
49		8017	02-19-71	460	8017	10-08-71		FV
50					8004	10-23-71	3791	OK
51		8019	11-15-71	1344	8019	11-29-71	1480	FV
52					8016	12-21-72	6654	FV
53		8012	03-08-73	8147	8012	04-29-73	8707	OK
54					8011	08-08-73	9764	FV
55					8018	03-29-74	10063	OK
56		8032	11-07-74	5913				
57		8020	04-14-74	9923	8020	11-18-74	11549	FV
58					8032	11-05-75	9144	OK
59		8023	05-18-76	14664				
60	6	8004	11-21-71	4031	8004	12-29-71	4383	FV
61		8011	12-30-71	3974				
62		8011	01-13-72	4103	8011	01-13-72	4103	OK
63		8019	04-10-72	2800	8019	04-12-72	2825	OK
64		8010	05-30-72	5553	8010	06-10-72		FV
65		8014	06-23-72	5094	8014	04-20-73	7914	OK
66					8013	09-12-73	10059	OK
67		8012	11-12-73	10699	8012	12-02-73	10888	F
68		8020	12-05-73	8717	8020	04-14-74	9923	FV
69		8018	05-10-74	10444		06-19-74		OK
70		8011	07-31-74	13083	8011	08-15-74	13226	FV
71		8018	09-28-74	11677	8018	10-23-74	11923	OK
72		8010	11-14-74	14451	8010	11-15-74		F
73					8010	11-28-74	000	F
74		8017	12-12-74		8017	12-31-74	13726	FV
75		8003	01-10-75	11695	8003	07-12-75	727	OK
76		8016	07-23-75	15622	8016	07-25-75	15632	OK
77		8029	09-05-75	8436	8029	10-05-75	8688	FV
78		8032	11-05-75	9144	8032	11-27-75	9246	FV
79		8004	12-28-75	2492				
80	7				8012	02-27-71	1533	OK

ORIGINAL PAGE IS
OF POOR QUALITY

		MLU						
		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
81	7	8003	04-29-71	2288	8003	05-01-71	2304	OK
82		8012	05-08-71	2125	8012	07-02-71	2569	OK
83		8018	07-23-71	511	8018	08-08-71	665	OK
84		8014	11-02-71	2962	8014	06-10-72	4954	OK
85		8018	06-28-72	3773	8018	07-02-72	3826	FV
86		8010	10-24-72		8010	03-14-73	8596	FV
87		8027	04-13-73	3062	8027	02-07-74	6044	FV
88		8023	05-15-74	8339	8023	08-25-74	9304	FV
89		8010	11-23-74	00	8010	04-07-75	1019	OK
90		8016	04-29-75	14820	8016	04-29-75	14825	OK
91		8028	06-19-75	7303	8028	07-01-75	7433	OK
92					Stock	07-25-75		OK
93		8029	10-05-75	8688	8029	12-12-75	9209	FV
94		8012	02-13-76	17501	8012	04-17-76	18072	FV
95		8023	05-14-76	14651	8023	05-18-76	14669	OK
96	8	8018	08-08-71	665	8018	06-28-72	3773	OK
97		8010	07-07-72	6010	8010	07-11-72	6061	
98					8004	12-23-72	7791	FV
99		8017	01-30-73	7079	8017	07-06-73	8678	FV
100		8016	08-04-73	9094	8016	06-20-74	12042	OK
101		8012	07-11-74	12884	8012	08-05-74	13122	OK
102		8011	08-15-74	13226	8011	03-26-76	17617	OK
103		8010	05-06-76	16871				
104	9				8016	01-11-71	261	FV
105		8012	02-27-71	1533	8012	05-08-71	2125	OK
106		8018	06-14-71	118	8018	07-23-71	511	FV
107					8012	08-26-71	3026	OK
108		8014	10-07-71	2730	8014	11-02-71	2962	OK
109		8004	11-19-71	4011	8004	11-21-71	4031	OK
110					8019	04-10-72	2800	OK
111		8004	05-28-72	5545	8004	09-01-72	6628	OK
112						09-25-72		OK
113		8011	01-17-73	7768	8011	03-30-73	8425	OK
114		8023	04-12-73	4794	8023	05-15-74	8339	FV
115		8017	06-26-74	12028	8017	12-12-74		FV
116					8014	02-16-75	13907	OK
117		8014	02-19-75	13951	8014	03-13-75	14132	OK
118						03-31-75		FV
119		8010	04-07-75	1019	8010	04-09-75	1052	OK
120		8028	07-03-75	7452	8028	07-04-75	7461	F

		ON		MLU	OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
121	9	8003	07-12-75	727	8003	11-02-75	1791	FV
122		8012	01-20-76	17290	8012	02-13-76	17501	FV
123		8014	05-29-76					
124	10				8014	02-08-71	658	FV
125		8003	05-01-71	2304	8003	01-21-72	4577	FV
126					8017	01-30-73	7079	OK
127					8016	02-27-73	7402	FV
128					8003	05-27-73	9298	OK
129		8018	07-05-73	7506				
130		8035	11-22-73	1839	8035	11-27-73	1886	OK
131		8019	03-20-74	9700	8019	06-09-74	10416	FV
132		8023	08-25-74	9304	8023	12-20-74	10508	FV
133		8035	01-14-75	5686	8035	02-03-75	5820	OK
134		8012	02-18-75	14670	8012	09-26-75		FV
135		8019	10-10-75	14704	8019	11-16-75	14995	FV
136		8012	05-20-76	165				
137	11				8017	02-19-71	460	FV
138					8004	06-14-71	2709	OK
139		8012	07-02-71	2569	8012	07-09-71	2629	OK
140		8011	07-28-71	2773	8011	12-30-71	3974	FV
141		8003	01-21-72	4577	8003	07-28-72	6190	FV
142					8023	04-12-73	4794	FV
143		8012	06-11-73	9117	8012	10-05-73	10366	OK
144					8019	03-20-74	9700	OK
145					8018	09-28-74	11677	OK
146		8032	10-19-74	5741	8032	11-07-74	5913	FV
147					8012	01-08-75	14320	OK
148					8004	02-24-75	3	FV
149					8027	03-08-76	12618	OK
150		8011	03-26-76	17617	8011	06-02-76	18346	OK
151	12					03-17-71		F
152		8003	04-03-71	2089	8003	04-29-71	2288	F
153		8012	07-09-71	2629	8012	08-13-71	2913	FV
154					8020	05-25-72	2973	OK
155		8010	07-11-72	6061	8010	07-29-72	6262	OK
156					8027	04-13-73	3062	OK
157		8012	04-29-73	8707	8012	06-03-73	9039	OK
158					8016	08-04-73	9094	OK
159		8029	08-17-73	1300	8029	09-09-74	5190	FV
160		8019	10-02-74	11483	8019	10-24-74	11680	OK

		MLU						
		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
161	12	8013	11-27-74	14037	8013	01-23-75	14522	FV
162		8014	03-17-75	14175	8014	03-29-76	17327	OK
163		8016	05-13-76	17777				
164	13				8010	06-03-71	2511	FV
165		8004	06-14-71	2709	8004	10-18-71		OK
166					Loan	11-26-71		OK
167		8016	11-28-71	3069	8016	05-14-72	4624	FV
168		8020	05-25-72	2973		07-04-72		F
169		8013	08-22-72	6418	8013	11-09-72	6914	OK
170					JAL	12-10-72		OK
171		8004	12-23-72	7791	8004	07-10-73	8297	FV
172		8004	03-28-73	8713	8004	04-18-73	8923	OK
173		8032	06-28-73	1039	8032	08-30-74	5297	OK
174		8011	05-01-73	8767				
175		8029	09-09-74	5190	8029	09-05-75	8436	OK
176		8003	11-02-75	1791				
177	14				8018	06-14-71	118	FV
178		8012	08-26-71	3026	8012	04-07-72		OK
179					Loan	04-25-72		OK
180					8027	07-13-72	138	OK
181		8010	07-29-72	6262	8010	10-24-72		F
182						11-07-72		OK
183					8012	03-08-73	8147	OK
184		8012	06-09-73	9097	8012	06-11-73	9117	FV
185		8017	07-06-73	8678	8017	06-26-74	12028	OK
186		8004	08-29-74	13714	8004	02-15-75	15108	OK
187		8017	02-19-75	14179				
188	15				8011	07-28-71	2773	OK
189		8012	08-13-71	2913	8012	08-15-71		OK
190		8004	10-23-71	3791	8004	11-19-71	4011	FV
191						11-30-71		OK
192		8004	12-29-71	4383	8004	05-28-72	5545	OK
193		8010	06-10-72		8010	07-07-72	6010	OK
194		8003	07-28-72	6190	8003	11-20-72		OK
195					8019	01-25-74	9260	FV
196					8027	03-06-74	6303	OK
197					8010	11-14-74	14451	OK
198		8020	12-12-74	11990				
199					8010	06-27-75	13804	OK
200		8028	07-04-75	7461		08-01-75		OK

		MLU						
		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
201	15	8013	10-22-75	16889				
202	16				8019	08-17-71	5167	OK
203		8013	09-15-71	3023	8013	08-22-72	6418	FV
204					8016	10-24-72	7072	FV
205		8003	11-20-72		8003	02-09-73	8219	F
206		8016	02-27-73	7402	8016	03-27-73	7696	FV
207		8011	03-30-73	8425	8011	05-11-73	8767	OK
208		8012	06-03-73	9039	8012	06-09-73	9097	OK
209		8003	08-11-73	10110	8003	09-05-73	10349	OK
210		8012	10-05-73	10366	8012	10-23-73	10524	FV
211		8020	11-19-73	8542	8020	12-05-73	8717	OK
212					8011	01-14-74	11372	OK
213		8018	[illegible]	10063	8018	05-10-74	10444	OK
214		8028	05-[illegible]	3911	8028	06-19-75	7303	OK
215		8028	07-01-75	7433	8028	07-03-75	7452	OK
216		8016	07-25-75	15632	8016	04-19-76	17571	OK
217		8012	05-09-76	55	8012	05-20-76	165	OK
218	17				8013	09-15-71	3023	OK
219		8014	09-30-71	2676	8014	10-07-71	2730	OK
220					8011	11-11-72	6992	OK
221					8016	12-29-72	6747	FV
222		8004	02-10-73	8297	8004	03-28-73	8713	FV
223		8014	04-20-73	7914	8014	10-17-73	9778	FV
224		8012	10-23-73	16524	8012	11-08-73	16660	OK
225					8035	01-14-75	5656	OK
226		8035	02-03-75	5829	8035	01-27-76	8795	OK
227		8020	02-07-76	15633				
228	18	8010	03-14-73	8596				
229						05-23-74		FV
230		8013	08-21-74	13174	8013	08-25-74	13217	FV
231		8032	09-08-74	5379	8032	10-16-74	5741	FV
232		8020	11-25-74		8020	11-25-74	11869	F
233		8003	12-17-74	11475	8003	01-10-75	11695	OK
234		8016	02-13-75	14162	8016	02-19-75	14215	FV
235		8003	04-16-75	13186	8019	05-05-75	13272	
236		8023	05-13-75	11693	8023	05-14-76	14651	OK
237	19				8023	10-02-72	2377	OK
238		8013	11-09-72	6914	8013	05-10-73	8776	OK
239		8003	05-27-73	9298	8003	06-18-73	8449	FV
240		8011	08-08-73	9764	8011	01-09-74	11327	OK

MLU

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
241	19	8029	01-25-74	9260	8019	03-05-74	9589	OK
242	↓	8027	03-06-74	6363	8027	03-13-75	7624	OK
243	↓	8016	03-24-75	14497	8016	04-29-75	14820	OK
244	↓	8019	05-05-75	13272		05-08-75		OK
245	↓	8020	06-27-75	13804	8020	02-07-76	15633	OK
246	↓	8035	04-21-76	9625				
247	20				8027	10-20-72	1263	FV
248	↓	8016	12-21-72	6655	8016	12-24-72	6685	
249	↓	8016	12-29-72	6747				
250	↓				8012	02-03-73		OK
251	↓	8003	02-09-73	8219		03-14-73		OK
252	↓	8016	04-02-73	7774	8016	04-19-73	7939	OK
253	↓	8020	06-07-73	6822	8020	07-07-73	7161	OK
254	↓	8014	12-07-73	10236	8014	12-20-74	13542	OK
255	↓				8019	10-10-75	14707	OK
256	↓	8019	11-16-75	14736				
257	21				8032	06-28-73	1039	FV
258	↓	8014	10-17-73	9778	8014	12-07-73	10236	OK
259	↓	8027	02-07-74	8044	8027	03-06-74	6303	OK
260	↓				Stock	08-14-74		OK
261	↓				Stock	08-28-74		OK
262	↓	8032	08-30-74	5297	8032	09-08-74	5379	OK
263	↓	8020	10-18-74	11549	8020	10-25-74		OK
264	↓	8020	11-25-74	11869	8020	12-12-74	11990	OK
265	↓	8023	01-02-75	10569	8023	01-04-75	10554	OK
266	↓	8035	02-03-75	5820	8035	02-03-75	5829	OK
267	↓	8014	02-16-75	13907	8014	02-19-75	13951	F
268	↓	8014	03-13-75	14132	8014	03-17-75	14175	F
269	↓	8035	01-24-76	8795	8035	02-05-76	8887	F
270	↓				8029	08-17-73	1300	OK
271	22	8013	09-12-73	10059	8013	08-21-74	13174	OK
272	↓				8013	11-27-74	14037	FV
273	↓				8017	02-19-75	14179	FV
274	↓					04-23-75		F
275	↓	8018	05-01-75	13674				
276	↓				8010	05-06-76	16871	OK
277	23				8035	11-22-73	1839	OK
278	↓	8011	01-14-74	11372	8011	07-31-74	13083	OK
279	↓	8016	12-09-74	13602	8016	02-13-75	14162	OK
280	↓	8010	04-09-75	1052	8010	06-03-75	1484	OK

MLU

		ON			OFF			
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	STATUS
281	23				8013	10-14-75	16875	F
282	↓	8032	11-27-75	9246	8032	12-26-75	9366	OK
283	↓	8010	01-05-76	3221	8010	02-06-76	3366	OK
284	↓	8012	04-17-76	18072	8012	05-09-76	55	OK
285	24				8028	05-21-74	3911	OK
286	↓	8016	06-20-74	12042	8016	12-09-74	13602	OK
287	↓	8024	01-04-75	10554	8023	05-13-75	11693	FV
288	25	8023	12-20-74	10508	8023	01-02-75	10569	OK
289	↓	8016	02-19-75	14215	8016	03-24-75	14497	OK
290	↓				8007	03-31-75		OK
291	↓	8016	04-29-75	14825	8016	07-07-75	15411	FV
292	↓	8004	10-05-75	1928	8004	12-28-75	2492	FV
293	↓	8010	02-07-76	3469		01-13-76		FV
294	26				Loan	03-31-75		FV
295	27	8012	01-14-76	17219	8012	01-20-76	12200	FV
296	↓	8035	02-05-76	8887	8035	04-21-76	9625	OK
297	↓	8011	06-02-76	18346				
298	28	8032	12-26-75	9366				
299	29				New	01-13-76		OK
300	↓	8010	02-06-76	3366	8010	02-07-76	3469	FV
301	↓	8014	03-29-76	17327	8014	05-29-76	17767	FV

AUTO STAB TRIM UNIT

		ON			OFF				
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS	
1	1	12	11-21-70	673					
2		20	9-17-71	497	20	2-2-72	1840	OK	
3					12	2-22-72	?	FV	
4		19	3-4-72	2413					
5		13	4-18-72	5060					
6					19	4-30-72	2999	F	
7					14	7-11-73	8803	OK	
8		18	8-25-73	8046	18	6-23-74	10729	OK	
9		17	7-1-74	12078	17	6-14-75	15160	OK	
10					RETURN QUANTAS	7-30-75		FV	
11		29	8-21-75	8321	29	10-4-75	8683	FV	
12		35	3-30-76	9401	35	3-30-76	9409	OK	
13		13	4-3-76	18078	13	5-13-76	18162	FV	B
14	2				10	4-24-71	2184	FV	
15		18	6-7-71	44	18	6-21-71	200	OK	
16		20	9-16-71	461	20	9-17-71	497	OK	
17					4	9-27-71	3647	OK	
18		16	10-27-71	2851	16	11-27-71	3069	FV	
19		10	12-8-71	4083	10	2-7-72	4618	FV	
20		10	3-30-72	5169	10	8-27-72	6526	OK	
21		3	2-18-73	8311					
22	3				4	6-14-70	605	FV	
23		14	2-8-71	658	14	6-10-72	4954	FV	
24		18	6-28-72	3773	18	7-5-2	3852	OK	
25		18	7-25-72	4097	18	8-25-73	8046	FV	
26		16	9-22-73	9636	16	8-18-74	12623	OK	
27					35	9-14-74	4551	OK	
28					FROM JAL	10-29-74		F	
29		13	4-20-75	13231					
30		29	6-16-75	7702					
31					13	10-14-75	16820	FV	
32		13	11-14-75	17094	13	4-3-76	18078	FV	
33		13	5-14-76	18174					

		ON			OFF				
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS	
34	4				12	11-21-70	673	OK	
35					13	11-28-71	3594	FV	
36		13	4-23-71	1636	13	4-17-72	5037	OK	
37		19	5-31-72	3279	19	8-3-72	4022	FV	
38		13	9-8-72	6639	13	2-25-74	11605	F	
39		10	3-12-74	12177	10	11-15-74	?	FV	
40					10	1-7-75	253	OK	
41		29	2-18-75	6673	29	3-7-75	?	F	
42		19	6-11-75	13504					
43	5				14	2-8-71	658	OK	
44		13	3-14-71	1203	13	4-13-71	1524	OK	
45		3	5-26-71	2518	3	6-3-71	2518	FV	
46		11	6-30-71	2493					
47		12	8-22-71	2996	12	9-18-71	3258	OK	
48		4	9-27-71	3647	4	10-9-71	3706	OK	
49					RETURN NW	11-16-71		OK	
50		10	2-7-72	4618	10	3-30-72	5169	FV	
51		12	4-7-72	5081	12	8-20-72	6400	FV	
52		4	9-7-72	6684					
53					16	5-24-73*	8178	FV	
54					R FROM NW	6-12-73		OK	
55		20	7-17-73	7277	20	1-2-75	12204	FV	
56		10	1-7-75	253	10	1-18-76	3321	F	
57					23	5-27-76	14764	FV	
58	6	18	6-21-71	200	18	6-28-72	3772	FV	
59		16	7-10-72	5215	16	7-18-72	5305	F	
60		19	8-3-72	4022	19	8-10-72	4098	OK	
61					12	4-20-73	8621	OK	
62		16	5-24-73	8262	16	8-8-73	9122	OK	
63		10	10-11-73	10794	10	3-12-74	12177	OK	
64					13	5-6-74	12176	OK	
65		17	5-22-74	11721					
66		35	8-13-74	4258	?	8-28-74	?	OK	
67					R.F. AMERICAN	9-6-74	?	OK	
68		35	9-14-74	4551	35	9-18-74	4572	FV	B

		ON			OFF			
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS
69	6	(continued)			29	10-31-74	5676	FV
70		32	1-15-75	6549				
71	7	3	10-9-70	698	3	5-26-71	2518	FV
72					RETURN FROM LOAN	6-28-71		OK
73					16	10-27-71	2851	FV
74					12	3-12-72	4816	OK
75					13	4-21-72	5085	OK
76		19	4-30-72	2999	19	5-31-72	3279	OK
77		20	6-30-72	3354	20	11-28-72	5096	FV
78					16	5-24-73	8262	OK
79		10	5-27-73	9356	10	5-29-73	9371	OK
80		14	12-16-73	10313	14	1-14-74	10554	FV
81	8				12	9-10-70	76	OK
82		13	4-13-71	1524	13	4-20-71	1599	OK
83					12	7-3-71	2577	OK
84					12	8-09-71	2883	FV
85					RET.F.A.	9-1-71	?	OK
86					"	9-24-71	?	OK
87					19	11-19-71	?	OK
88		16	11-27-71	3069	16	5-11-72	4601	OK
89		16	6-25-72	5069	16	6-29-72	5103	OK
90		18	7-5-72	3852	18	7-25-72	4097	OK
91		19	8-10-72	4098	19	6-9-74	10417	F
92		19	9-11-74	11295	19	10-15-74	11591	F
93		20	2-22-75	12678	20	6-20-75	13726	F
94		20	8-27-75	14382	20	9-20-75	14601	FV
95		29	10-19-75	8837				
96	9	4	6-14-70	605	4	6-30-71	2893	OK
97		12	7-15-71	2682				
98		12	9-18-71	3258	12	9-26-71	3319	OK
99		13	11-28-71	3594				
100		19	2-19-72	2273	19	3-4-72	2413	OK
101		12	3-12-72	4816	12	4-7-72	5081	OK
102		13	4-21-72	5085	13	5-14-72	5326	OK

		ON			OFF				
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS	
	9	(continued)							
103		14	6-10-72	4954	14	6-28-72	?	FV	
104		3	7-4-72	5938	3	2-18-73	8311	OK	
105		16	3-19-73	7602					
106					13	5-5-73	?	FV	
107		19	6-9-74	10417	19	8-27-74	11145	OK	
108		35	9-18-74	4572	35	8-2-75	7445	FV	
109		29	8-25-75	8316	29	8-21-75	8321	FV	
110		19	9-24-75	1827					
110	10				3	10-9-70	698	OK	
112		10	4-24-71	2184	10	12-8-71	4083	OK	
113		20	2-2-72	1840	20	6-30-72	3354	OK	
114		11	7-3-72	5601	11	10-17-72	6700	FV	
115		11	12-27-72	7442	11	8-15-73	9857	OK	
116					16	9-22-73	9636	OK	
117					?	2-25-74	?	OK	
118		13	3-17-74	11759					
119					17	7-1-74	12078	FV	
120		16	8-18-74	12623					
121	11				?	12-15-70	?	OK	
122		13	4-20-71	1599	13	4-23-71	1636	OK	
123					3	6-31-71	2567	OK	
124					LOAN	7-22-71		FV	
125					LOAN	5-27-71		OK	
126					LOAN	9-22-71		OK	
127		16	5-29-72	4710	16	6-25-72	5069	F	
128					20	7-18-72	3576	OK	
129		4	8-17-72	6446	4	9-7-72	6684	OK	
130					LOAN	10-14-72		OK	
131		12	4-20-78	8621					
132		10	5-29-73	9371	10	6-4-73	9428	OK	
133		14	8-2-73	9005	14	8-21-73	9227	F	
134		10	9-9-73	10458	10	10-11-73	10794	OK	
135					4	5-7-74	12641	OK	
136		29	10-31-74	5676	29	2-18-75	6673	OK	
137					35	3-30-76	9401	OK	
138		13	5-13-76	18162	13	5-14-76	18174	FV	B

ORIGINAL PAGE IS
OF POOR QUALITY

		ON			OFF			
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS
139	12				13	3-14-71	1203	OK
140		3	6-3-71	2567	3	11-9-71	3881	F
141					13	4-17-72	507	FV
142		4	5-6-72	5764	4	8-17-72	6446	OK
143		10	8-27-72	6526	10	10-4-72	6879	OK
144		11	10-17-72	6700	11	12-27-72	7442	OK
145		10	4-29-73	4085				
146					12	5-14-73	8846	OK
147					10	5-27-73	9356	OK
148		10	6-4-73	9428	10	9-9-73	10458	OK
149					35	8-13-74	4258	F
150		19	10-18-74	11620	19	6-11-75	13504	FV
151					?	8-15-75*	?	F
152		29	10-5-75	8688	29	10-19-75	8837	OK
153					10	1-24-76	3374	F
154	13				18	6-7-71	44	OK
155		4	6-30-71	2893	4	6-30-71	2902	OK
156					12	8-22-71	2996	OK
157		20	9-4-71	389	20	9-16-71	491	OK
158		12	9-26-71	3319	12	10-6-71	3386	OK
159					LOAN	11-2-71		F
160		3	11-9-71	3881	3	7-4-72	5938	F
161		14	12-1-73	10160				
162		14	12-8-73	10240	14	12-16-73	10313	OK
163		32	2-9-74	3442	32	1-15-75	6549	FV
164					29	6-16-75	7702	FV
165		20	7-17-75	14002	20	8-17-75	14282	FV
166		20	9-20-75	14601	20	12-2-75	15266	FV
167		10	5-30-76	4462				
168	14				11	6-30-72	2493	OK
169		12	7-3-71	2577	12	7-15-71	2682	FV
170					11	7-3-72	569	FV
171		16	8-16-72	5605	16	8-25-72	5716	OK
172		10	10-5-72	6889	10	4-29-73	9085	FV
173		12	5-22-73	8916				

		ON			OFF				
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS	
174	15				16	7-4-71	1816	FV	
175					LOAN	7-17-71		OK	
176		20	8-10-71	5159	20	9-4-71	5389	F	
177		4	10-9-71	3706	4	5-6-72	5764	OK	
178		16	5-11-72	4601	16	5-29-72	4710	FV	
179		16	6-29-72	5103	16	7-10-72	5215	OK	
180		12	5-14-73	8846	12	5-22-73	8916	OK	
181		14	7-11-73	8503	14	7-31-73	8984	OK	
182		16	8-8-73	9122					
183					14	12-8-73	10240	OK	
184		23	1-31-74	7310	23	4-22-74	8101	FV	
185		19	8-27-74	11145	19	9-11-74	11295	OK	
186					19	10-18-74	11620	FV	
187		20	2-18-75	12694	20	2-22-75	12678	OK	
188		29	10-4-75	8683	29	10-5-75	8688	FV	G
189					OUT OF STOCK	11-14-75		FV	
190					17	2-7-76	17036	FV	
191		29	2-23-76	968:41G	29	3-25-76	9907	OK	
192		35	4-3-76	9450	35	4-19-76	9605	OK	
193	16				20	8-10-71	5159	FV	
194					LOAN	9-13-71		OK	
195		12	10-6-71	3386					
196		13	5-14-72	326	13	9-8-72	6639	OK	
197		10	10-4-72	6879	10	10-5-72	6889	OK	
198					20	7-17-73	7277	OK	
199					STOCK	8-17-73		OK	
200		14	8-21-73	9227	14	12-1-73	10160	FV	
201		23	4-22-74	8101	23	1-27-76	13838	F	
202		17	2-7-76	17036					
203	17				19	2-19-72	2273	OK	
204		13	4-17-72	5037	13	4-18-72	5060	FV	
205					LOAN	6-23-72		OK	
206		16	7-18-72	5305	16	8-16-72	5605	F	
207		16	8-25-72	5716	16	3-19-73	7602	OK	

ORIGINAL PAGE IS
OF POOR QUALITY

			ON			OFF		
	S/N	PLANE	DATE	TIME	PLANE	DATE	TIME	STATUS
208	17	(continued)			LOAN	6-12-73		OK
209					LOAN	6-21-73		OK
210		14	7-31-73	8984	14	8-2-73	9005	FV
211		11	8-15-73	9857				
212	18				23	1-31-74	7310	FV
213		13	2-25-74	11605	13	3-17-74	11759	FV
214		13	5-6-74	12176	13	4-20-75	13231	OK
215		20	6-20-75	13726	20	7-17-75	14002	OK
216		20	8-17-75		20	8-27-75	14382	F
217					20	12-2-75	15256	OK
218		29	2-10-76	9576	29	2-23-76	968	FV
219	19				32	2-9-74	3442	OK
220		4	5-7-74	12641	4	9-24-75	1827	OK
221		13	10-14-75	16820	13	11-14-75	17094	OK
222		19	12-2-75	15266				
223					17	5-22-74	11721	OK
224	20	18	6-23-74	10729				
225	21				20	2-18-75	12694	FV
226		17	6-14-75	15160				
227					29	2-10-76	9576	OK
228					LOAN	3-9-76		F
229		35	3-30-76	9409	35	4-3-76	9450	FV
230	22				29	8-25-75	8316	FV
231		10	1-24-76	3374	10	5-30-76	4462	FV

AUTO THROTTLE COMPUTER

LINE	UNIT S/N	ON			OFF				
		AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
1	1	12	05-18-71	2203	12	05-24-71	2259	56	FV
2	2	12	05-24-71	2259	12	05-26-71	2266	7	OK
3					LOAN	08-18-71			F
4		14	02-10-72	3754	14	10-20-72	6345	2591	OK
5					20	09-18-73	7905		OK
6		12	11-08-73	10666	12	04-22-74	12148		FV
7		32	10-08-74	5665	32				
8		35	11-19-75	8552.					
9		39	01-05-76	8638	34				
10	3				out of stock	02-08-71			FV
11		12	05-26-71	2266	12	11-08-73	10660	8394	FV
12		13	11-27-73	5561					
13		4	03-09-75	7916	4				
14		28	04-14-75	6727					
15	4				11	07-26-75	16403		FV
16	5				LOAN	03-25-71*			OK
17		14	12-11-71	3241	14	01-06-72	3458		FV
18		10	09-16-72	6705	10	09-28-72	6821		FV
29		20	08-17-74	10995	20				
20	6	13	06-04-72	5561	13	11-27-73	10774		OK
21		10	12-06-73	11335	10	11-31-74	0		FV
22	7	14	01-06-72	3458	14	02-10-72	3754	296	FV
23		16	05-30-72	4766	16	06-15-73*	8075		FV
24					LOAN	07-24-73			OK
25		20	12-01-73	8659					
26		32	06-28-74	4716	32	10-08-74	5665	949	OK
27					19	01-27-76	154162		OK
28		32	04-14-76	10254					
29		11	07-15-76	18675	11	08-03-76			OK
30	8			NEW	12	05-18-71	2203	2203	F
31					13	06-04-72	5561		F
32					16	09-09-75	16101		FV
33		11	11-04-75	16616	11	11-06-75	16633	17	OK
35					11	01-02-76	17109		F
35		11	02-09-76	17787	11	07-15-76	18675	888	FV
36	9			6141	LOAN	06-08-73	6181		OK
37		20	12-01-73	8659	20	01-30-74	9277	618	F
38		20	08-07-74	10888	20	08-17-74	10995		OK
39					LOAN	02-03-75*			
40		4	03-15-75	130	4	03-17-75	142	12	OK
41					32	04-14-76	10254		OK
42	10				EXCHANGE	06-21-71			FV
43		16	12-24-71	3290	16	05-30-72	4766		FV
44		14	10-20-72	6345	14				
45	11				14	12-11-71	3271		F
46		3	07-11-73	4743	3	09-09-73	10450		OK
47		19	11-26-73	8706	19	01-10-75			OK
48				13023	4	03-15-75			FV
49		23	04-12-75	11443					
50		11	11-18-75	16779	11	12-03-75	16880		OK

ORIGINAL PAGE IS
OF POOR QUALITY

AUTO THROTTLE COMPUTER

		ON			OFF				
LINE	UNIT S/N	AIRPLANE	DATE	TIME	AIRPLANE	DATE	TIME	ΔT	STATUS
51					11	02-09-76	17787		OK
52		3	03-19-76	2729	3	04-06-76	2855		OK
53		29	07-08-76	10905	29				
54	12				16	12-24-71	3290		FV
55		10	09-28-72	6821	10	11-10-73	11097		OK
56		20	11-30-73	8653	20	12-01-73	8659		OK
57		12	04-22-74	12148	12	05-24-75	15496		FV
58		11	09-28-75	16415	11	10-10-75	16486	71	OK
59		11	10-18-75	16538	11	11-04-75	16616	78	OK
60		3	11-13-75	1889	3	03-19-76	2729	940	FV
61		3	04-06-76	2855					
62	13				10	09-16-72	6705		FV
63		17	06-14-73	8435	17	01-10-76			FV
64		19	01-27-76	15462	19	02-04-76	15516	54	FV
65	14	3	09-19-73	10480	3	12-27-73	14578	4098	FV
66		12	05-29-75	15541	12	05-30-75	15548	7	OK
67		16	09-09-75	16101					
68	15				17	06-14-73	8435	8435	FV
69		10	11-10-73	11097	10	12-06-73	11335	235	FV
70		10	11-31-74	00	10	12-06-74	48	48	OK
71		12	05-24-75	15496	12	05-29-75	15541	45	OK
72		11	10-10-75	16486	11	10-18-75	16538	52	OK
78					STOCK	02-01-76			FV
74		11	08-03-76		11	08-05-76	18887		OK
75	16				3	07-11-73	4743		FV
76		20	09-18-73	7905	20	11-30-73	8653		OK
77		4	03-17-75	142	4	08-06-76	4276		FV
78	17				19	11-26-73	8706	5706	FV
79		20	01-30-74	9271	20	08-07-74	10888	1611	FV
80		10	12-10-74	48	10	03-26-76	3904		FV
81		4	08-06-76	4276					
82	18	3	12-27-73	14578					
83					32	06-28-74	4716		FV
84					23	11-30-75	13467		OK
85					35	01-05-76	8638		OK
86		19	02-04-76	15516	19				
87	19				4	03-09-75	79		FV
88		12	05-30-75	15548	12				
89	20				28	04-14-75	6727		FV
90		11	09-28-75	16415	11	09-28-75	16415		OK
91				1889	3	11-13-75			F
92		23	11-30-75	13467	23	01-04-76	13658	171	OK
93				17109	11				
94		20	08-07-74	3904	10				
95	21				23	04-13-75	11443		FV
96		11	07-26-75	16403	11	09-28-75	16415		OK
97	22	11	12-03-75	16779	11	11-18-75	16680		F
98		17	01-10-76	16803	17				
99	23				35	11-19-75	8332	8332	FV
100		23	01-04-76	13658	23				
101	24				29	07-08-76	10905		FV

APPENDIX C

UNITED AIRLINES REPORT

UA FLIGHT CONTROL ELECTRONICS
RELIABILITY/AVAILABILITY STUDY

(ARCS FOLLOW-ON STUDY)

Prepared under Contract UA 32646 (Boeing P. O. No.
Y-304805-0935N) by
United Airlines Engineering
San Francisco International Airport
San Francisco, California 94128

for

Boeing Commercial Airplane Company
P. O. Box 3707
Seattle, Washington 98124

Prepared by H Takeuchi H. Takeuchi Date 2/17/77
Checked by T. H. Hammond Date 2/23/77
Approved by MW Brecht M. W. Brecht Date 2/25/77

TABLES

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURES

(

ATTACHMENTS

I AIRBORNE EQUIPMENT REQUIREMENT

II AFPAM DISPLAY

III 9 DIGIT ATA LINE MAINTENANCE SUMMARY

IV ATA CHAPTER CLASSIFICATION

V MAINTENANCE HISTORY BY AIRCRAFT (SEPARATE PACKAGE)

VI MAINTENANCE HISTORY BY UNIT (SEPARATE PACKAGE)

TABLE OF CONTENTS

ORIGINAL PAGE IS
OF POOR QUALITY

INTRODUCTION

During 1975 and 1976, United Airlines participated, as a subcontractor to Boeing, in the NASA sponsored Airborne Advanced Reconfigurable Computer System, or ARCS, program. The primary task assigned to United Airlines in the ARCS program was to assist Boeing in the development of system test design criteria, system test function, and its cost-of-ownership effects.

The ARCS program was completed in the summer of 1976 with a finding that the ARCS type system design and its system test concept has a potential annual saving to an airline operator of $4,000 per aircraft when compared to a system representing today's technology.*

Upon completion of the ARCS program, it became apparent that further development of the ARCS type concept would benefit from a detailed analysis of the reliability and availability of a contemporary analog AFCS.

United Airlines accepted, under a new contract agreement (UA Contract No. 32646, Boeing Purchase Order No. Y-304805-0935N), the task of collecting maintenance and operational data and of assisting Boeing in the assessment of the reliability and availability of the contemporary flight control electronics.

2. PURPOSE

The purpose of this report is to satisfy the output requirement as called for by the Statement of Work for United Airlines. The Statement of Work specifies United's responsibility to be as follows:

1. Describe United Airlines Maintenance policies and present their underlying rationale.
2. Describe maintenance requirements established by the FAA and their interface with the maintenance procedures at United.
3. Select a contemporary flight control system for reliability and maintenance analysis.
4. Examine United Airlines maintenance records and extract and document the data required for computation of the selected flight control system reliability, availability and maintenance parameters.
5. United Airlines shall prepare and submit a report covering the work defined by Items 1 through 4. The report can be of United Airlines internal engineering report format and transmitted by cover letter.

---

* General Electric MCP-703 triply redundant Whole Word Computer System (WWCS) and not the analog systems on today's wide-bodied jets.

3. SCOPE

It is assumed that the readers of this report are not intimately familiar with airline operations. For this reason, the report discusses relatively fundamental concepts and practices with respect to the maintenance operation at United Airlines.

Furthermore, this report is a summary of data collection done on a strictly engineering level. Maintenance philosophies discussed in this report, therefore, are somewhat localized to specific programs such as the CAT II program in which engineering plays a key role at United.

4. SUMMARY

A. The basic objective of maintenance is to provide a safe, reliable airplane for an on-time departure in a manner that is cost effective. United has a special interest in being a leader of the industry in terms of the quality of maintenance work performed at the Maintenance and Operations Center at San Francisco. The Center is the largest of its kind in the world and serves a number of other airlines on a contract basis. United actively searches for innovative ideas to improve industry standards. A large amount of R&D type contributions made to the industry through ATA, ARINC and other industry organizations is evidence of this philosophy.

A key concept of the United Maintenance policies are represented by various maintenance programs as discussed in section 6 below. The backbone of the avionic component maintenance is United's LIBRA maintenance management program. Section 7 discusses this program and its condition monitoring concept which governs all AFCS components. In short, condition monitoring assures adequate maintenance without resorting to periodic removal of components or periodic testing of the system. United's objection to pre-flight test requirements for future AFCS is supported by this program.

B. The airline industry is rigidly controlled by regulatory agencies. Federal Aviation Regulations (FAR) cover practically all aspects of airline operation and compliance is monitored by the FAA inspectors assigned to each airline. There is a considerable amount of interface between these inspectors and the airline to which they are assigned. Many operations such as Category II lower weather minima operation require establishment of a special maintenance program. The individual airline is responsible for establishment of such a program within the guidelines defined by the Advisory Circulars. Due to difference in the personnel skill level, overhaul facility, schedule frequency and availability of repair equipment, these programs vary from airline to airline. The philosophy of each FAA inspector also

ORIGINAL PAGE IS
OF POOR QUALITY

affects the nature of the program as he has the power to approve the program. A detailed discussion of the 747 CAT II maintenance program is given in sections 8 through 11.

C. The Boeing 747 AFCS has been chosen as a candidate system. The reasons are as follows:

(1) Represents one of the latest analog AFCS's.

(2) Used by a large number of operators, both domestic and world wide.

(3) Boeing has access to detailed system & hardware data.

(4) Fleet of 18 at United is adequate for data collection within the time frame of this study.

The AFCS on DC-10 fleet is the latest at United but does not satisfy (3) & (4) above.

D. Data collection consumed a large percentage of the labor involved in the study. More than 10,000 flight log pages, covering the 12 month period between July 1, 1975 and June 30, 1976, have been examined. Over 1000 tags which were removed from replaced units, and which also indicate shop test results, were reviewed. One year of station maintenance records were also examined to extract line maintenance manhours. Based on the data collected, the following maintenance information was obtained.

(1) Average time for AFCS line maintenance is 1.50 hours per event per mechanic.

(2) Typical CAT II test time, including unit replacement, is between 2 and 2 1/2 hours.

(3) During the 12 month period, 1758 manhours were charged against ATA Chapter 22 by line stations.

(4) MTBF of AFCS major computers range from 1922 hours (pitch) to 5381 (yaw).

(5) MTBUR (Mean Time Between Unit Removal) of AFCS major computers range from 1153 hours (pitch) to 3075 hours (yaw).

(6) Shop testing time for above computers range from 10 hours (pitch) to 3 hours (yaw).

(7) In terms of cost per 100 flying hours, shop cost for pitch computer is the highest among AFCS computers at $20.95. Of shared sensors, INS shop cost is highest at $53.48 per 100 flying hours.

(8) AFCS related problems caused 76 delays of which 13 were caused by AFCS components. Average delay was 1/2 hour long.

(9) Line Maintenance cost charged to ATA Chapter 22 was $42,192. Shop labor cost was $97,225. (Both include overhead). Shop material cost was $51,844.

(10) Overall BITE effectiveness was 54% for the pitch computer and 75% and 50% for the roll and yaw computers, respectively. INS, the only digital system examined, had a high 84% effectiveness for the period examined.

(11) CAT II system availability was very high.

Full CAT II was available 90% of the time. When Restricted CAT II is added, the availability improved to approximately 98%.

E. It is recognized by the industry that the reliability and availability of avionics system, hence MTBF and MTBUR of most components, are affected by the route structure. Length of flight, airport facility and maintenance availability are important factors to be considered when the data of one airline are to be compared to that of another. For this reason, sections 12 & 13 are devoted to the route structure of United 747 fleet.

5. REGULATORY REQUIREMENTS

United Airlines, being a certified scheduled U.S. air carrier, operates under a set of regulatory requirements known as Federal Aviation Regulations (FAR's). The FAR's are published by the Federal Aviation Administration (FAA) and they regulate practically all aspects of airline operations, ranging from facilities and airline management to in-flight food and beverage services. In addition, the FAA publishes the Advisory Circulars (AC's) which also define, specify and provide guidelines for specific areas of airline operation. Thus, these regulatory requirements as represented by the FAR's and AC's make air transport the most rigidly regulated private industry in the United States.

There are some sixty FAR's that are being kept current by the FAA; however, only six of them apply specifically to United Airlines. These six FAR's are:

FAR PART 25 Airworthiness Standards: Transport Category Airplanes

Specifies airworthiness standards, including such items as load distribution, takeoff speeds, structural strength, cockpit control knob shape, etc. This FAR is primarily for airframe designers, but operators are also subjected to the FAR, particularly at time of major modification to the aircraft.

FAR PART 43	Maintenance, Preventive Maintenance, Rebuilding & Alteration Rules as to who can perform maintenance and rework on aircraft or its components, who can return them to service. Also specifies record keeping requirements including content and format of the recorded data.
FAR PART 65	Certification: Airmen Other than Flight Crew Members Prescribes requirements for issuing of certification to air traffic control tower operators, aircraft dispatchers, mechanics, repairmen, and parachute riggers.
FAR PART 91	General Operating and Flight Rules Pertains to general operating procedures and pilot responsibilities. Flight rules under VFR and IFR are also a part of this document.
FAR PART 121	Certification & Operations: Domestic, Flag and Supplemental Air Carriers and Commercial Operators of Large Aircraft The most extensive of all FAR's applicable to commercial operators. Establishes certification rules including airline management and organization requirements, servicing and maintenance facilities, and in-flight services such as food and beverages. Also covered are airplane performance limitations, special airworthiness requirements such as emergency evacuation procedures, airborne instrument and equipment requirements, maintenance requirements, flight crew training, flight operations rules, dispatching rules, etc.
FAR PART 145	Repair Stations Requirements for issuing repair station certificates. Establishes rating and classes of stations, inspection system, and reporting of serious defects found by the station. Requires that once a unit is removed from the aircraft and sent to a repair station, it cannot be made serviceable unless it is checked by an acceptable technical document.

The rules and regulations contained in the above documents dictate the conduct of airline operation, and because they apply equally to all commercial operators, there is no basic difference between the way United operates as compared to the way, for example, Delta or Eastern operates. On the other hand, however, specific method of compliance to the FAR's may vary considerably from airline to airline. The rules and regulations in the FAR's are often stated in a manner which permits diversity: "... each person maintaining or altering, or performing preventive maintenance, shall use method, techniques, and practices acceptable to the administrator..." This diversity is frequently noticeable in the maintenance area. How each airline maintains its fleet of aircraft, components and power plants depends largely upon the size of fleet, schedule frequency, skill level and staffing of maintenance personnel, availability of certain tools and facilities.

The following example illustrates the point: compared to United, a small operator such as regional charter operators is likely to have stricter shop overhaul requirements imposed by the FAA on certain line replaceable units. The difference may be such that the small operator is not permitted to install those units that have been overhauled by United without additional testing. The rationale is that, in the FAA's viewpoint, the line personnel skill level at airports served by United is comparatively higher than of other airlines which leads to an early detection of faults, and hence, less stringent overhaul requirements for United.

In other areas, however, the situation may be reversed. The Category II (CAT II) maintenance program for United fleets, for example, is considerably more stringent than similar programs in the industry. This particular case reflects somewhat conservative views of the local FAA inspector and UA engineering with respect to the reliability of the self test built into the contemporary Automatic Flight Control Systems (AFCS). Details of the CAT II maintenance program will be described later in this report.

The FAA enforces and monitors the maintenance aspect of the FAR compliance of each airline through the Primary Maintenance Inspectors (PMI's) assigned to the locality of each airline and they are often referred to as "local FAA". As described briefly in the above illustration of the CAT II maintenance program, it is through these local FAA's that airlines interpret regulatory requirements and establish maintenance programs and procedures. Each inspector appears to exercise some autonomy in the interpretation of the FAR's or AC's which, in many instances, serves well with the airlines as airlines are very sensitive to any move which would confine the maintenance to one particular method.

Although the FAA attempts to monitor regulatory compliance, it is impractical to monitor all activities of an airline. To facilitate this problem, airlines often act as an arm of the FAA in sharing the inspection and monitoring responsibilities. A good example of this is the fact that United Airlines Maintenance and Operations Center, at San Francisco, is a qualified Designated Alteration Station (DAS), meaning that it is authorized by the FAA to issue Supplementary Type Certificates (STC's) based on its engineering modification, and inspection capabilities.

Because of the nature of the air transport business, safety has always been the utmost corporate goal. Whatever maintenance action is required, if it is safety related, it will be done. Having accomplished that primary objective, other maintenance actions may follow based on the "philosophy" that the purpose of maintenance is to provide reliable departure and arrival schedules with a minimum amount of mechanical irregularities in the most economical manner. This process involves close examination of past experience both in terms of hardware reliability and maintenance cost. The DC-8 aircraft when first introduced in 1959 was being overhauled every 2500 hours. Today, the same aircraft has an overhaul period of 25000 hours. Similarly, the first 727 aircraft had an overhaul period of 3000 hours in 1964. This has expanded over the years to 20,000 hours. A new concept of dividing the overhaul activities into smaller segments at short intervals has also emerged and become an important part of the cost effective maintenance at United.

The overall philosophy of United maintenance is reflected by a set of unique maintenance programs developed at United and will be explained later. Although cost effectiveness, after safety, is basic to all maintenance decision making, one important consideration is that United strives to be the industry leader in achieving high quality maintenance. Generally speaking, a demand for a high level of performance from the equipment United operates calls for tighter tolerances in shop specifications. This voluntary restriction is evident in many areas: Accelerometers are tested in four different positions instead of two. Capacitors discharge are monitored at more frequent intervals that what manufacturers call for, etc.

In addition to the FAR's and AC's there are other documents that provide specific information and limitations necessary for establishment of appropriate maintenance programs. These documents are:

Type Certificate Data Sheet (FAA publication)

Prescribes conditions and limitations under which aircraft meet the airworthiness requirements of the FAR's. May include total time limits on certain aircraft components.

Maintenance Review Board Document (FAA)

Defines the initial maintenance program for new aircraft. Includes all initial overhaul time limits except those contained in the Type Certificate Data Sheet.

Airworthiness Directive (FAA)

Provides the specifications and timetable for correcting conditions which may affect the airworthiness of aircraft.

Service Bulletin (Manufacturer)

Provides specifications and procedures for modifying hardware to correct defects or improve reliability.

Manufacturers Manual (Manufacturer)

Provides description, operation and maintenance instructions for a particular aircraft or component.

Industry Performance Report (ATA)

Describes the airlines experience concerning aircraft systems, components and engines. Typical of these reports, generated within the industry, are the Mechanical Reliability Reports and Mechanical Interruption Summary.

6. MAINTENANCE PROGRAMS

It appears to be beyond the scope of this report to describe all the programs currently implemented at United; however, the following brief description of six key programs may serve as an overview.

A. Initial Maintenance Program

Preliminary maintenance program developed by airlines in collaboration with the airframe and engine manufacturers and approved by the Maintenance Review Board (MRB) which is composed of FAA inspectors. Projected reliability data supplied by airframe manufacturers is used to calculate spares requirements during this phase.

B. Airframe Maintenance Program

Scheduled, routine maintenance of aircraft at intervals established jointly by United and the FAA. The Line Maintenance Manual specifies current times between maintenance checks and stations qualified to perform scheduled tasks. The FAA approved frequencies for 747 now are:

"A" Check 125 Hr (Maximum time between checks)
"B" Check 900 Hr
"C" Check 3600 Hr

Many airborne system and components that require periodic inspection or testing are inspected or tested at above intervals or their multiples. Because of different skill levels, "A" checks for 747 are currently performed at HNL, JFK, LAX, ORD and SFO while "C" checks are performed at SFO only.

C. Airframe Structures Maintenance Program

Utilizing sampling and inspection, it provides continuing knowledge of structural conditions and the means of detecting signs of trouble at an early stage.

D. Powerplant Maintenance Program

Detailed scheduled maintenance requirements of the basic engine and description of the reliability analysis required to support the program.

E. Airframe and Powerplant Components Maintenance Program

Routine maintenance of aircraft and engine components. One unique concept in this program is called LIBRA. LIBRA is an FAA approved maintenance management technique. Under provisions of the LIBRA, United may vary overhaul or inspection intervals without FAA approval if there is no change in the component maintenance process (Condition Monitor, On Condition, Hard Time). The concept covered by LIBRA is important in that all avionic components are affected by this. Therefore, LIBRA will be described in detail in the next chapter.

F. Change Order Authorization (COA)

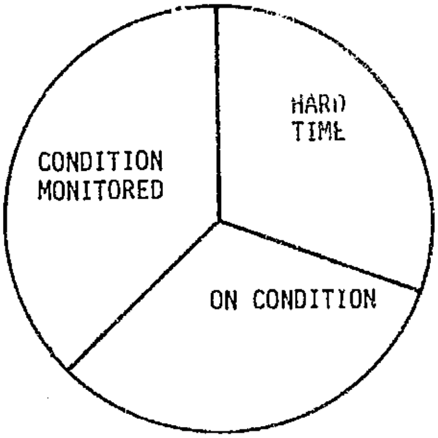
Conversion of Airwothiness Directives, Service Bulletins, or UA Engineering originated modification into accomplishment instructions.

7. LIBRA MAINTENANCE MANAGEMENT

As discussed above, the backbone of the airframe and powerplant components maintenance is called LIBRA, an acronym for Logical Information Based on Reliability Analysis.

Three Primary Maintenance Processes

LIBRA identifies that there are three types of maintenance; i.e. Hard Time, On Condition, and Condition Monitored. Most components fit a single primary maintenance process.



Historically, the concept of maintenance progressed, in a clockwise direction, from Hard Time to On Condition to Condition Monitored. This evaluation can be closely tied with technological innovations as each new concept was needed to deal with new hardware installed in aircraft. For example, there is no merit in overhauling solid state devices at fixed intervals as the failure pattern of these items is not as time dependent as the failure patterns of bearings or pulleys.

The explanation of each of the three primary maintenance processes is as follows:

A. Hard Time Maintenance

The concept of hard time maintenance has been in existence since the beginning of the century. It is based on the theory that 1) Mechanical parts wear out 2) wear outs cause failures 3) failures degrade safety. The solution, therefore, is to overhaul the mechanical parts at predetermined intervals, hence the term hard time maintenance. Specifically, under LIBRA, units are assigned to hard time maintenance if:

1) The failure of the units has a direct adverse effect on airworthiness and engineering judgement indicates that the units are subject to wear out, or

2) There is evidence from real and applicable data that a wear out zone exists and that a sufficient number of units survive to the wear out zone to make a hard time limit economically desirable.

3) There is a hidden function that cannot be checked while the unit is installed in the aircraft.

Under this concept, units must be removed from service before they exceed the specific limit (e.g. certain flight hours, number of landings or take-off's). They are returned to zero TSO (Time Since Overhaul) by accomplishment of the specified overhaul.

B. On-Condition Maintenance

In the mid 50's, the original theory used for the hard time maintenance evolved to describe a new concept called on-condition maintenance which is based on a theory that, in some cases, in-position inspection can intercept potential failures. Thus, on-condition maintenance requires repetitive inspections or tests to determine condition. To be sufficient for on-condition, the test and inspections must provide reasonable assurance that the unit will continue to operate satisfactorily until the next scheduled inspection. If there is no physical test or inspection for determining the level of failure resistance of a unit, then an on-condition program is impossible and is not an alternative. If the units exhibits no adverse age-reliability relationship, then regardless of how low a hard time limit is established, the reliability of the unit will not be improved. For such a unit, Condition Monitoring is the only feasible maintenance process.

C. Condition Monitoring Program

Although the concept of condition monitoring has been in existence since 1960, the scheduled overhaul (hardtime maintenance) and on-condition maintenance have been the only formally recognized primary processes of reliability management. The maintenance program for the 747 fleet gave formal recognition to the condition monitoring. The goal of Condition Monitoring is to obtain information from operations in a way that experience has shown is effective at United Airlines. Thus, condition monitoring consists of data collection and data analysis systems which portray information upon which judgements relative to the safe condition of the airplane can be made.

Under LIBRA, the following performance measures are the basic elements of the condition monitoring program:

1. Unscheduled removals
2. Confirmed removals
3. Deficiencies observed and corrected
4. Pilot reports
5. Sample inspection
6. Functional checks
7. Shop findings
8. Bench checks
9. Mechanical Reliability Reports
10. Mechanical Irregularity Summary

D. Avionics Systems and Condition Monitoring

Most present day avionics systems are free of mechanical components which exhibit age-reliability relationships. Thus, practically all avionic components are maintained under the Condition Monitoring program of LIBRA.

One of the requirements developed for System Test under the ARCS contract was that autoland system reliability should not be predicated upon routine maintenance such as a pre-flight test. The LIBRA concept is the underlying reason for this requirement. Furthermore, any additional routine test, no matter how short, would impact the total maintenance cost.

8. CATEGORY II MAINTENANCE PROGRAM

A specific operation such as Category II (CAT II) operation serves to illustrate the interface between the airline and the FAA. To begin with the airborne system must be certified. Normally, this comes with the aircraft at time of purchase. Secondly, pilots must be trained and be qualified. Finally, airlines must prove that the level of maintenance is adequate to support the CAT II operation. In other words, the fact that CAT II certification was obtained for a certain AFCS does not mean that airlines can operate it in CAT II weather. This point is often misunderstood by many designers. To be successful, manufacturers must support airlines by providing adequate maintenance tools and procedures. The present CAT II operation is based on the regulatory guidelines in AC120-29, Certification for Approving Category I and Category II Landing Minima for FAR 121 Operators..

The CAT II maintenance certification process consists of establishing a program and obtaining approval from the local FAA inspector. A typical program at United includes the following steps:

1) Define and describe system components and system operation.

2) Define methods and standards by which components are to be overhauled by various shops.

3) Establish tools and methods of supporting the system at the line station level.

4) Establish the level of training required to qualify CAT II maintenance personnel.

In the four steps described above, the methods of line station support (third step) deserves further discussion as it is the single most important item which will affect the maintenance actions and, therefore, the maintenance cost.

Figure 1 on the following page is a typical maintenance flow chart representing the course of action a line mechanic would follow when faced with an AFCS related problem. The task of maintenance engineering, then, is to define the type of test required for a specific problem and the personnel qualification necessary. In the case of the 747 AFCS, some 300 man hours were devoted to this task before the program was approved by the FAA.

In general, there are two levels of test:one for cruise modes and the other for approach/land modes. We are concerned with the latter when we speak of the "CAT II TEST" in the flow chart. Many components of the contemporary AFCS's contain some type of built-in self test, or BITE. If designed and used properly, the BITE would be an ideal tool for the complicated systems particularly during short turn-arounds of 30 minutes or less. However,in the past, none of the built-in type tests that have been provided by manufacturers has been sufficient as a CAT II maintenance tool without additional testing, or at least this has been the position of the local FAA. These additional tests may take the form of an operational nature with some degree of dynamic simulation such as varying radio altitudes and ILS beam deviations, and are performed to assure over-all system integrity and proper interface with peripheral sensors that provide inputs to the AFCS.

Usually, the FAA audits classroom training as well as the practical training (OJT) to monitor the skill level of personnel and adequacy of procedures. Once the program is approved, performance data collection becomes an important part of the engineering activity. The data source is the autopilot/flight director section of the flight log sheet where pilots are requested to report such pertinent data as runway number, RVR, disconnect altitude, and performance judgement (satisfactory or unsatisfactory). A sample flight log sheet (Figure II) is shown on page 14.

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE I

MAINTENANCE FLOWCHART

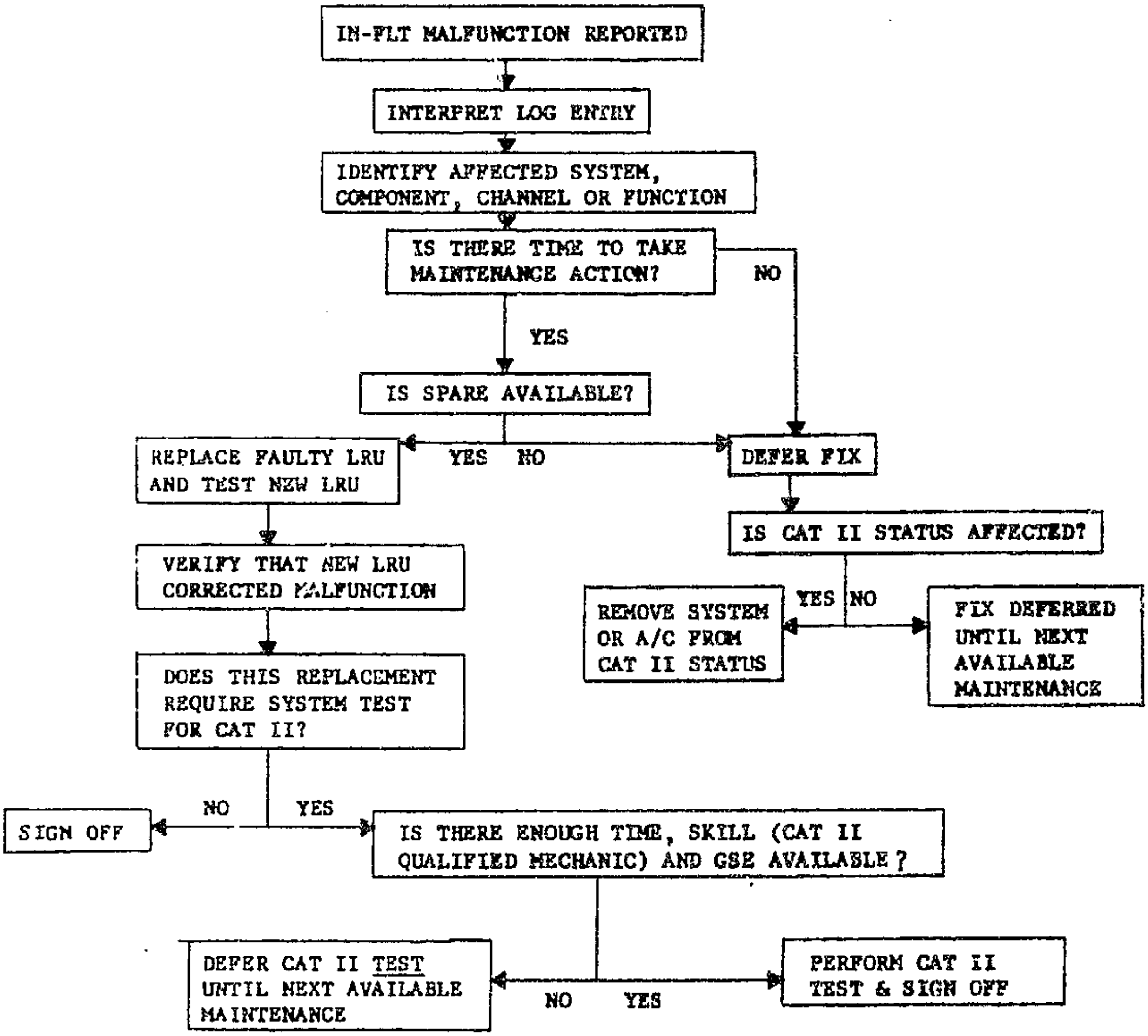
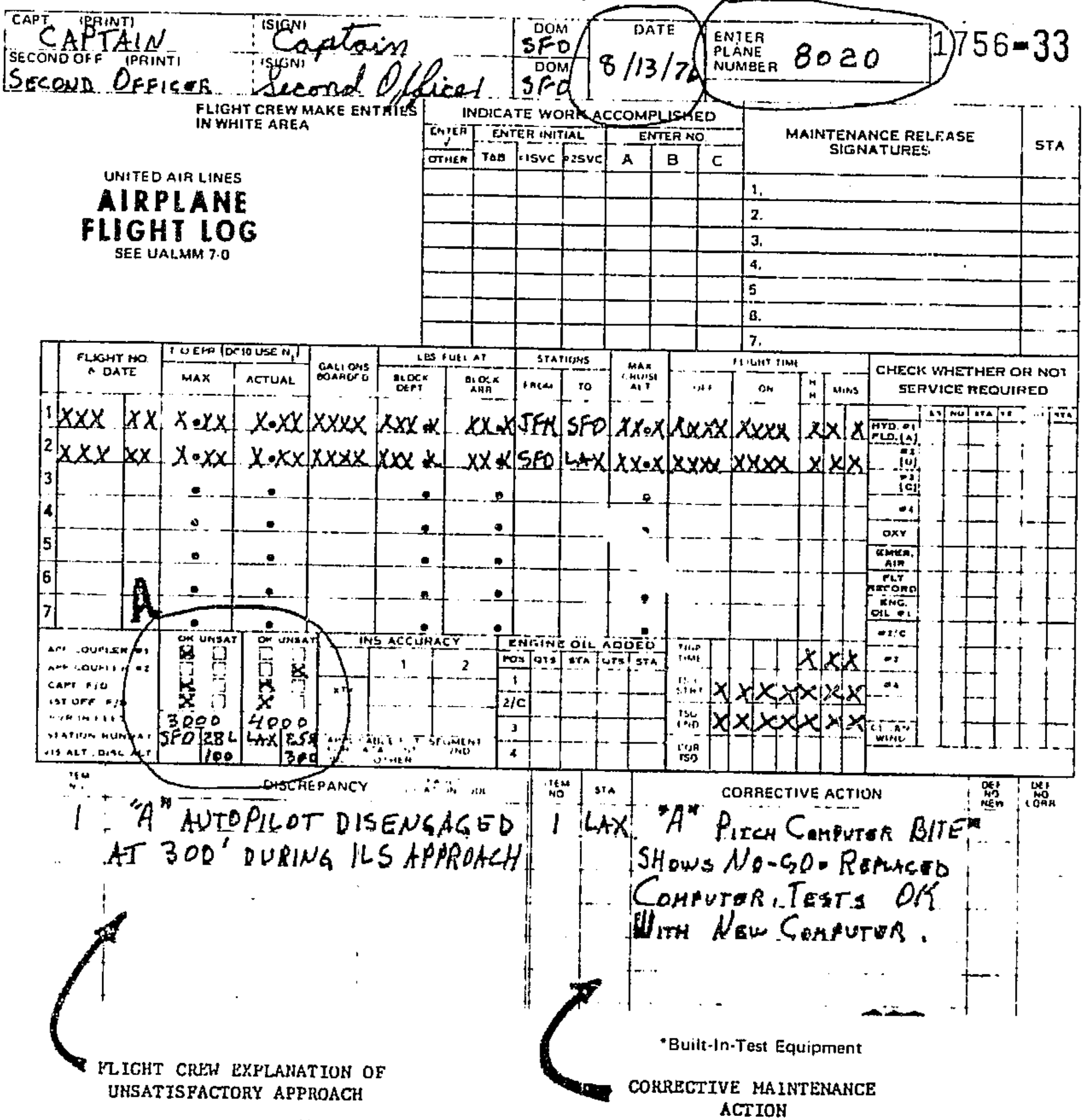


FIGURE II
SAMPLE LOG SHEET

Note: All data circled are key-punched on IBM cards.



CAPT (PRINT) CAPTAIN (SIGN) Captain
SECOND OFF (PRINT) SECOND OFFICER (SIGN) Second Officer
DOM SFO
DOM SFO
DATE 8/13/76
ENTER PLANE NUMBER 8020
1756-33

FLIGHT CREW MAKE ENTRIES IN WHITE AREA

UNITED AIR LINES
AIRPLANE FLIGHT LOG
SEE UALMM 7.0

INDICATE WORK ACCOMPLISHED							MAINTENANCE RELEASE SIGNATURES	STA
ENTER ✓	ENTER INITIAL			ENTER NO				
OTHER	TAB	#1SVC	#2SVC	A	B	C		
							1.	
							2.	
							3.	
							4.	
							5	
							6.	
							7.	

	FLIGHT NO & DATE		T O EPR (DC10 USE N1) MAX	T O EPR ACTUAL	GALLONS BOARDED	LBS FUEL AT BLOCK DEPT	LBS FUEL AT BLOCK ARR	STATIONS FROM	STATIONS TO	MAX CRUISE ALT	FLIGHT TIME OFF	FLIGHT TIME ON	H H	MINS
1	XXX	XX	X•XX	X•XX	XXXX	XXX•X	XX•X	JFK	SFO	XX•X	XXXX	XXXX	XX	X
2	XXX	XX	X•XX	X•XX	XXXX	XXX•X	XX•X	SFO	LAX	XX•X	XXXX	XXXX	X	XX
3			•	•		•	•			•				
4			•	•		•	•			•				
5			•	•		•	•			•				
6			•	•		•	•			•				
7			•	•		•	•			•				

A

	OK	UNSAT	OK	UNSAT
APP COUPLER #1	☒	☐	☐	☐
APP COUPLER #2	☐	☐	☐	☒
CAPT F/D	☒	☐	☒	☐
1ST OFF F/D	☒	☐	☒	☐
RVR IN FEET	3000		4000	
STATION RUNWAY	SFO	28L	LAX	25R
VIS ALT / DISC ALT		100		300

INS ACCURACY 1 2

ENGINE OIL ADDED

POS	QTS	STA	QTS	STA
1				
2/C				
3				
4				

TRIP TIME XXX
TSO STRT XXXXXXX
TSO END XXXXXXX
COR TSO

CHECK WHETHER OR NOT SERVICE REQUIRED
HYD. #1 FLD. (A)
#2 (U)
#3 (C)
#4
OXY
EMER. AIR
FLT RECORD
ENG. OIL #1
#2/C
#3
#4
CLEAN WIND

ITEM NO	DISCREPANCY	ITEM NO	STA	CORRECTIVE ACTION
1	"A" AUTOPILOT DISENGAGED AT 300' DURING ILS APPROACH	1	LAX	"A" PITCH COMPUTER BITE* SHOWS NO-GO. REPLACED COMPUTER, TESTS OK WITH NEW COMPUTER.

*Built-In-Test Equipment

FLIGHT CREW EXPLANATION OF UNSATISFACTORY APPROACH

CORRECTIVE MAINTENANCE ACTION

A AUTOPILOT AND FLIGHT DIRECTOR APPROACH PERFORMANCE

ORIGINAL PAGE IS
OF POOR QUALITY

9. AIRBORNE EQUIPMENT REQUIREMENT FOR CAT II OPERATION

Advisory Circular 120-29 (Ref: Attachment I) defines the minimum equipment for CAT II operation to be as follows:

1. Instrument Failure Warning System.
2. Dual ILS and Glideslope Receivers.
3. Single Flight Director with Dual Displays and Single Automatic Approach Coupler or two independent Flight Director Systems.
4. Equipment for identification of Decision Height (can be Radar Altimeter or Inner Marker).
5. Missed approach attitude guidance (can be attitude gyros with calibrated pitch markings or Flight Director Command, or computed pitch command.)
6. Autothrottle System (required if operation based on dual flight directors), also required any aircraft using split axis couplers if applicant cannot show that it does not significantly reduce pilot workload.
7. Rain Removal Equipment

In addition, United MEL specifies the following systems/components/functions to be a part of the total CAT II equipment:

1. Control wheel disengage switch.
2. Disengage lights.
3. Approach Progress Display Annunciator
4. Marker System.
5. Heading function of INS.
6. Attitude function of INS
7. Rising Runway Display in ADI

United has traditionally elected to use the autopilot as a primary, and the Flight Director as a monitoring means for the ILS approach/landing. Thus, the autothrottle system is not required for CAT II at United.

The B-747 AFCS is unique in that dual channel autoland is required for a CAT II approach with weather minima of 1200 feet RVR and 100 feet decision height.

The FAA Operations Specifications limits 747 lower weather operations as follows:

MINIMUMS	FLIGHT CONTROL GUIDANCE EQUIPMENT
FROM 1600 FEET RVR, DH150 DOWN TO 1200 FEET RVR DH 100.	DUAL CHANNEL AUTOMATIC LANDING SYSTEM MUST BE USED THROUGHOUT APPROACH AND LANDING.
FROM 2000 FEET RVR, DH 200 DOWN TO 1600 FEET RVR, DH 150.	SINGLE CHANNEL AUTOPILOT WITH FLIGHT DIRECTOR MONITOR.

At United, 1200 feet RVR and 100 feet DH is referred to as "Full CAT II" and 1500 feet RVR and 150 feet DH as "Restricted CAT II", for convenience. How these two sets of CAT II minima effects dispatch requirements is fully covered by the Minimum Equipment List which will be described below.

10. MINIMUM EQUIPMENT LIST

The Minimum Equipment List (MEL), as the name implies, is a list of minimum airborne equipment required for an aircraft to continue with safe flight. This list, originally prepared by the airframe manufacturer and approved by the FAA, is continually revised by the airline to reflect the operating environment.

As a general policy, it is intended that the MEL be used to continue operation of an airplane until maintenance can be accomplished. Every deferred item will be corrected as soon as possible consistent with the availability of parts, manpower and adequate ground time.

Whenever an airplane is reported to have a malfunction which cannot be corrected due to unavailability of any of the items above, a determination must be made as to the airworthiness of the airplane for continued service. This will be done first at station level by the use of MEL. If any maintenance action is to be deferred, a proper authorization by a local Foreman is needed. For those items requiring higher authorization, the System Maintenance Controller's permission is needed. The System Maintenance Controller possesses the final decision power concerning the dispatchability of the aircraft.

It is not uncommon, however, that pilots refuse to accept an airplane which has been determined to be airworthy by the controller. In this regard, pilots have the ultimate responsibility.

When an agreement is reached that the airplane will be flown with an inoperative unit or system, a deferred item is initiated to ensure correction of the discrepancy at the earliest possible time. As an example, the first page of the MEL covering Chapter 22 Autoflight is shown on the following page. The first column describes sytem and component. The second column, STD EQUIP identifies total number of system or components installed, followed by the column specifying minimum requirement. The number in this column is often followed by a letter which corresponds to further explanation in the Supplemental Procedures Column. The next two columns pertain to handling of partially or completely inoperative systems.

Thus, the sample MEL for autopilot system indicates that; there are two systems installed, none of which is required for dispatch but certain procedure "A" is to be followed."#" indicates that the system affects the conduct of next flight and local dispatch is to be advised. @ denotes AFPAM, or Automatic Flight Planning and Monitoring, meaning that an entry into the AFPAM system is required. This automated system allows dispatcher to monitor selected items which restrict flight capabilities and routings. An example of AFPAM display is shown in Attachment II. The column under DEF AUTH indicates that System Maintenance Controller must authorize deferral. For items of lesser importance, "f" or the local Foreman is designated as an authority.

UNITED AIRLINES

B-747

SYS & COMP	STD EQUIP	MIN EQUIP	DISPATCH TO BE ADV	DEF AUTH	SUPPLEMENTAL PROCEDURES
22 AUTOFLIGHT Autopilot Systems	2	0A	# @	c	A. REQUIREMENTS (1) There are three channels designated as follows: Channel A - Autopilot/Flight Director Channel B - Autopilot/Flight Director Channel C - Flight Director Only (2) To maintain full Category II status down to 1200 ft. RVR DH 100, the dual channel automatic land mode must be operative. (a) If the Channel C Flight Director is inoperative. 1) Trip the "C" channel Pitch and Roll DC circuit breakers on P7 panel. Safety circuit breaker per GN/MM-1-0-12-7. 2) Place placard on mode select panel stating:"CHANNEL C INOP." NOTE: Auto throttle not required for Category II status. Refer to Auto Throttle requirement in this chapter when inoperative. (3) To maintain Restricted Category II status down to 1600 ft. RVR DH 150, a single channel Autopilot/Flight Director (A or B) and C channel Flight Director must be operative in the ILS mode. (a) If either A or B inoperative: 1) Trip affected Pitch DC circuit breaker on P7 panel. Safety circuit breaker per GN/MM-1-0-27-7. 2) Remove aircraft from full Category II status. Select proper restricted Category II status placard. Refer to Special Procedure #1 in 5-8-2-22.
Flight Director System	3	0A	# @	c	

CONTINUED

II CAT II MAINTENANCE REQUIREMENTS

Earlier, in the Category II Maintenance Program discussion, the process of obtaining FAA approval of the maintenance program was described. This section describes the detailed requirements under the 747 CAT II Maintenance Program. It should be noted that the requirements covered here are strictly for 747 fleet. Not only do the CAT II programs differ among airlines, but the difference also exists among fleets at an airline.

Simply stated, the CAT II maintenance consists of:

1. System/Component test when a malfunction is reported.
2. Identification and replacement of a faulty unit.
3. Verification test.
4. CAT II status annunciation by placards.

It should be noted that the above actions are taken only upon receipt of a malfunction report. There is no periodic test required under the present program.

Basic to CAT II maintenance is that both stations and personnel must be qualified to perform any CAT II related maintenance actions. Once the aircraft or system is taken out of CAT II status, only those qualified can restore the status. There is a minimum amount of testing needed to assure the integrity of the system and its availability. Components and systems that must be tested by CAT II qualified personnel are:

1. Pitch Computer
2. Roll Computer
3. Monitor and Logic Unit
4. Mode Selector Panel
5. Accessory boxes
6. Accelerometer
7. Automatic Stabilizer Trim Unit
8. Stabilizer Trim Interface Unit
9. Central Control Actuator, or Inboard Elevator Control Unit, or any components of these units.

With the exception of Items 4,5 and 8,tests required for the above units are based primarily on BITE, provided that a malfunction reported is not related to land functions. If the malfunction is in the land mode (dual channel mode), the system must pass an operational test which simulates an ILS approach with artificial radio altitudes and ILS signals.

There are other systems and components that supply inputs to the AFCS but are not actually a part of the AFCS. Maintenance of these systems does not require the use of CAT II qualified personnel as long as the malfunction is not related to CAT II performance. Equipment in this category is:

1. VOR/ILS Receivers
2. Radio Altimeters
3. Central Air Data Computers
4. Marker Beacon Receivers
5. INS Systems (INS qualified personnel are required)
6. Windshield Wipers and Rain Repellent

As stated above, placarding of CAT II system status is one of the requirements by the AC 120-29. The method used at United is a set of rectangular placards, approximately 1" x 2" in size, which read:

1) (Gray) - this airplane is equipped to operate to Category II minimums of RVR 1200 DH 100. Use dual autoland mode.

2) (Yellow) - this airplane is equipped to operate to Category II minimums of RVR 1600 DH 150. Use channel A A/P and C F/D.

3) (Yellow) - this airplane is equipped to operate to Category II minimums of RVR 1600 DH 150. Use channel B A/P and C F/D.

4) (Black) - this airplane is NOT in Category II status. Refer to Minimum Equipment List and deferred section of Logbook.

In the course of the CAT II maintenance, CAT II personnel are faced with answering questions such as:

1) Does the malfunction require a CAT II test? If so how much testing is required?

2) If deferred, will it affect CAT II status?

Knowledge required to answer these questions appears to be fundamental, yet sometimes confusion is created due to the complexity of the contemporary AFCS. To illustrate the point, the following is given as an example: If one of the two autopilot channels becomes "inoperative", the status must be changed from Full CAT II to Restricted CAT II. Obviously, the system may be malfunctioning only in certain mode of operation and the problem may be quite isolated from the ILS or autoland mode. Failure of a sensor not involved in the ILS or autoland mode is one example. Some part of the Altitude Hold function may share the same circuits with autoland function, while failure of the cruise mode gain compensation by airspeed has no effect on the autoland. Clearly, the MEL cannot provide answers under all circumstances.

12. LINE MAINTENANCE STATIONS

Of approximately 114 cities United serves, 747 fly into and out of the 12 cities as listed in Table I. Although these 747 stations are relatively major ones compared to numerous regional stations such as Fresno or South Bend, they do not all have the same level of maintenance capability. Each station is assigned one of the three levels of classification (prime, service, and support) based on the need and economic justification. The explanation of each level is as follows:

Prime - Fix all discrepancies

Service - Fix dispatch required items, perform periodic maintenance such as an "A" check, plus other specialized work instructed by the Operations Center

Support - Fix dispatch required items. Normally support stations are equipped to do bare minimum work just to "get the plane out of town".

The Table also identifies those stations that are qualified to do CAT II maintenance and INS maintenance both of which require specially trained personnel

Stations usually plan to work dispatch critical items and MEL flight restrictive items first and perform other work consistent with the availability of time, manpower, parts in stock, tools, and skills.

13. 747 ROUTE STRUCTURE

Dependency of a maintenance program upon the frequency of service and availability of spare parts and maintenance skill level has already been discussed. Another interesting point is that the reliability of much avionics hardware is proportionally related to average trip length. These facts make it almost mandatory to examine route structures before any comparison study is made, whether in terms of cost-of-ownership or reliability.

What follows is a presentation of route structure for United's 747 fleet. Due to seasonal demand, the schedule varies from time to time. This study covers spring to summer season of 1976.

On any given day, each of the fleet of 18 747's is flying a segment of the basic pattern as shown in Table II. If there are no schedule changes due to mechanical irregularities, every aircraft will eventually complete the basic pattern which starts at SFO and returns to SFO every 18 days.

On a map, the pattern looks like FigureIV. Table III on the following page shows the air miles and typical flying time between city pairs. Average flight time, from Table III, is 4 hours and 33 minutes. Between flights, the 747 stays an average of 5 hours and 54 minutes on the ground. The flying time shown is <u>block</u> time; that is, gate departure to gate arrival.

TABLE I

MAINTENANCE CLASSIFICATION OF STATIONS (747)

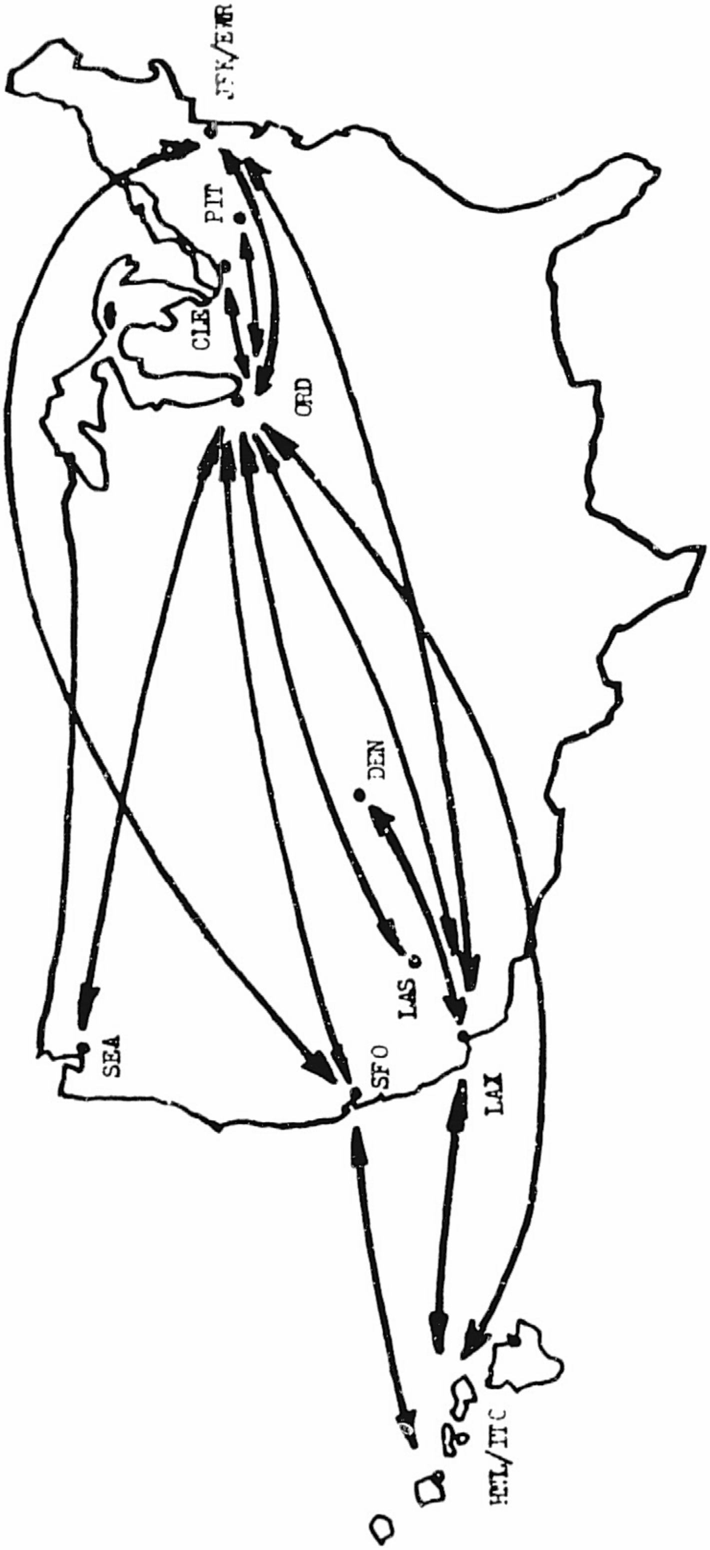
CITY	STATION CODE	CLASSIFICATION	CAT II	INS
Cleveland	CLE	Support		
Newark	EWR	Support		
New York	JFK	Prime	X	X
Pittsburgh	PIT	Support		
Denver	DEN	Service		X
Chicago	ORD	Service	X	X
Honolulu	HNL	Prime	X	X
Los Angeles	LAX	Prime	X	X
Seattle	SEA	Support	X	X
San Francisco	SFO	Prime	X	X
Las Vegas	LAS	None (Served by LAX)		
Hilo	ITO	None (Served by HNL)		

747 ROUTE PATTERN

On any given day, each of the fleet of 18 747s is flying a segment of the following basic pattern. If there is no schedule changes due to mechanical irregularities, every aircraft will eventually complete the basic pattern which starts at SFO and returns to SFO every 18 days.

FLT	STA	FLT TIME (MIN)	GRD TIME (MIN)
	SFO		
34	EWR	305	730
35	SFO	335	85
35	HNL	305	175
992	ORD	480	150
723	LAS	215	85
218	ORD	205	60
218	CLE	72	648
953	ORD	77	78
953	HNL	525	150
990	ORD	480	440
993	HNL	525	325
100	LAX	310	85
100	ORD	225	125
111	LAX	245	1070
197	ITO	310	85
118	LAX	290	80
118	ORD	220	90
118	PIT	81	89
107	ORD	83	77
107	LAX	250	1100
191	HNL	325	85
96	SFO	290	785
126	ORD	240	130
157	SEA	245	685
140	ORD	215	130
129	SFO	255	80
129	HNL	305	105
22	SFO	290	125
181	HNL	305	85
194	LAX	310	725
6	JFK	310	1145
5	LAX	325	95
5	HNL	325	875
114	LAX	315	65
114	DEN	122	458
9500	DEN	195	135
193	LAX	134	76
193	HNL	325	1085
180	SFO	295	1220
TOTAL		10664	13816
AVERAGE		273	354
		(4 HR 33 MIN)	(5 HR 54 MIN)

FIGURE IV



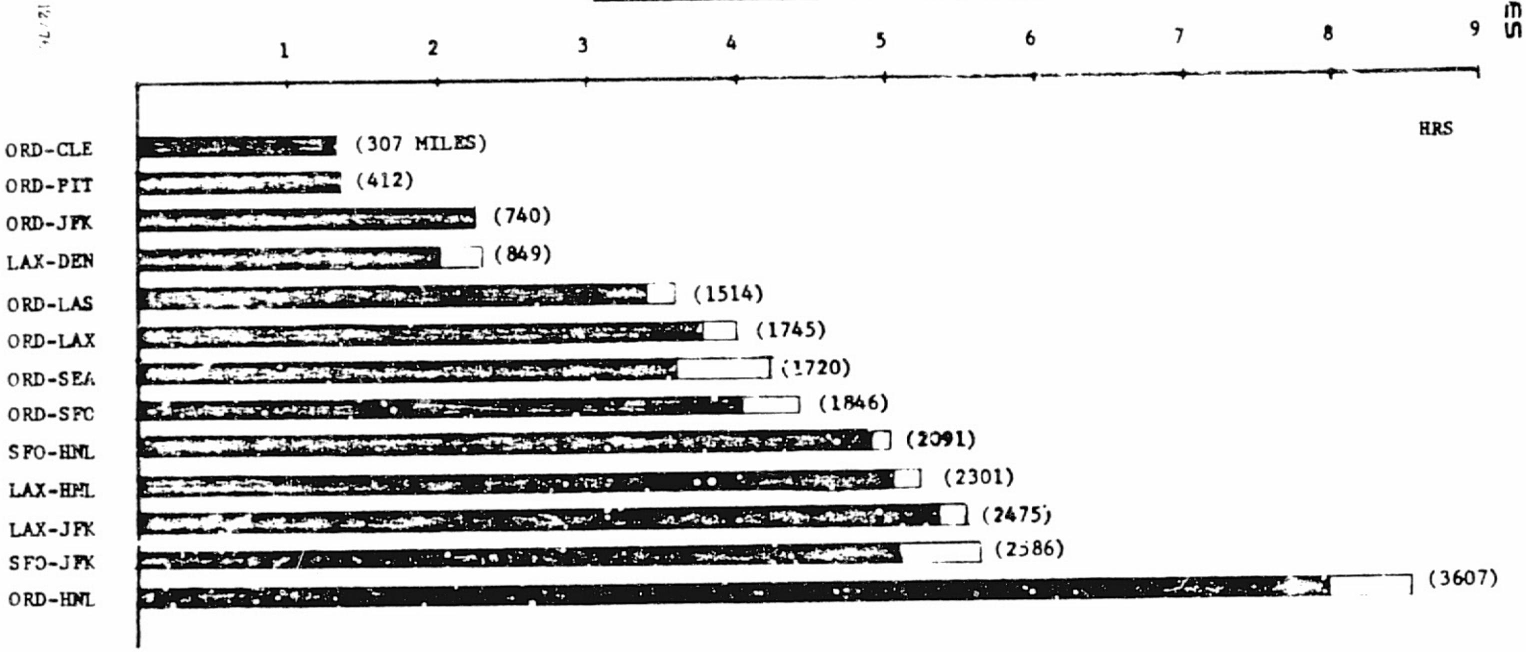
747 ROUTE MAP

ORIGINAL PAGE IS
OF POOR QUALITY

UNITED AIRLINES

TABLE III

TYPICAL FLYING TIME - 747 CITY PAIRS



NOTE: ▬☐ Unshaded area represents variance from flight to flight. The flight time also varies depending on EAST/WEST bound directions.

ENGINEERING DEPARTMENT
REPORT F-1806 DATE 12-77
PAGE 24

Table IV is another way of showing the daily departure schedule. As indicated in this Table, 747s operate most frequently in and out of HNL, LAX, SFO and ORD.

For the 12 month study period, between July '75 and June '76, the 747 fleet accumulated 53,808 flying hours, with each airplane flying 8 hours and 10 minutes per day on the average, as shown in Table V. The fleet accumulated 13,304 departures, or 2.02 daily departures per aircraft. The average flying time per departure was 4 hours and 2 minutes (not block time, but take-off to touch down).

DAILY DEPARTURES, 747 FLEET

TO FROM	CLE	DEN	EWR/JFK	HNL/ITO	LAS	LAX	ORD	PIT	SEA	SFO	TOTAL
CLE							1				1
DEN						1					1
EWR/JFK						1	1			1	3
HNL/ITO						5, 2C 2M	1, 1F 1C			4	10, 2M, 3C, 1F
LAS							1				1
LAX		1	1	6, 1C			2				10, 1C
ORD	1		2	2	1	2		1	1		10
PIT							1				1
SEA							1				1
SFO				2, 1F 1W			1				3, 1F, 1W
TOTAL	1	1	3	10, 1C 1F, 1W	1	9, 2M 2C	9, 1F 1C	1	1	5	41, 2F, 2M, 4C, 1W

NOTES: M = MONDAY ONLY
C = SUBJECT TO CHANGE
F = NOT ON FRIDAY
W = NOT ON SATURDAY OR SUNDAY

TABLE IV

UNITED AIRLINES

TABLE V

ENGINEERING DEPARTMENT
REPORT F-1806 DATE 2-17-77
PAGE 27

747 FLYING HOURS & DEPARTURES

MONTH	FLEET A/C DAYS	FLEET TIME-IN-SERVICE (HRS)	DAILY A/C UTILIZ	DEPARTURES	FLT HR PER DEPARTURE
Jul 75	558	5318	9:32	1315	4:02
Aug	558	5278	9:27	1309	4:02
Sep	540	4440	8:13	1099	4:02
Oct	558	4605	8:15	1144	4:02
Nov	540	4428	8:12	1100	4:02
Dec	558	2183	3:55	545	4:01
Jan 76	558	4494	8:03	1109	4:03
Feb	522	4141	7:59	1045	3:58
Mar	558	4532	8:07	1140	3:59
Apr	540	4503	8:20	1113	4:03
May	558	4838	8:40	1208	4:00
Jun	540	5048	9:21	1177	4:17
TOTAL:	6588	53808	8:10	13304	4:02

(Average Daily Departures/ A/C = 2.02)

14. MAINTENANCE ASSESSMENT

The objective of this section is to describe the method used to collect maintenance parameters and to present the result of the data collection relative to:

- Maintenance Time Characteristics
- Line Maintenance Labor
- Shop Maintenance Labor/Materials
- Spare Equipment
- Schedule Irregularity
- CAT II Availability

To understand how data is transmitted at United, it may be helpful to review the general means of communication between various organizations. Figure V shows that, starting from flight crew, data flows via the flight log sheet to the line maintenance crew. The line crew, after replacement of repairable equipment, communicates to the shop maintenance crew via the Inspection and Repair (I&R) tag, which is attached to each unit returning to its home repair shop. Engineers function as a quarterback in this process, directly communicating with other segments of the maintenance organization.

The flight log sheet, as shown earlier, contains following AFCS related data:

- In-flight malfunction (system, channel, mode)
- CAT II data (runway, RVR, disconnect alt)
- Time Since Overhaul (TSO) - of aircraft
- Flight number, date

When the aircraft is turned over to line maintenance crew, the following data may be added:

- Maintenance actions
- Deferred maintenance code
- Maintenance station code

When the shop repair/overhaul is completed, the following items will be added before the tag is sent to central files.

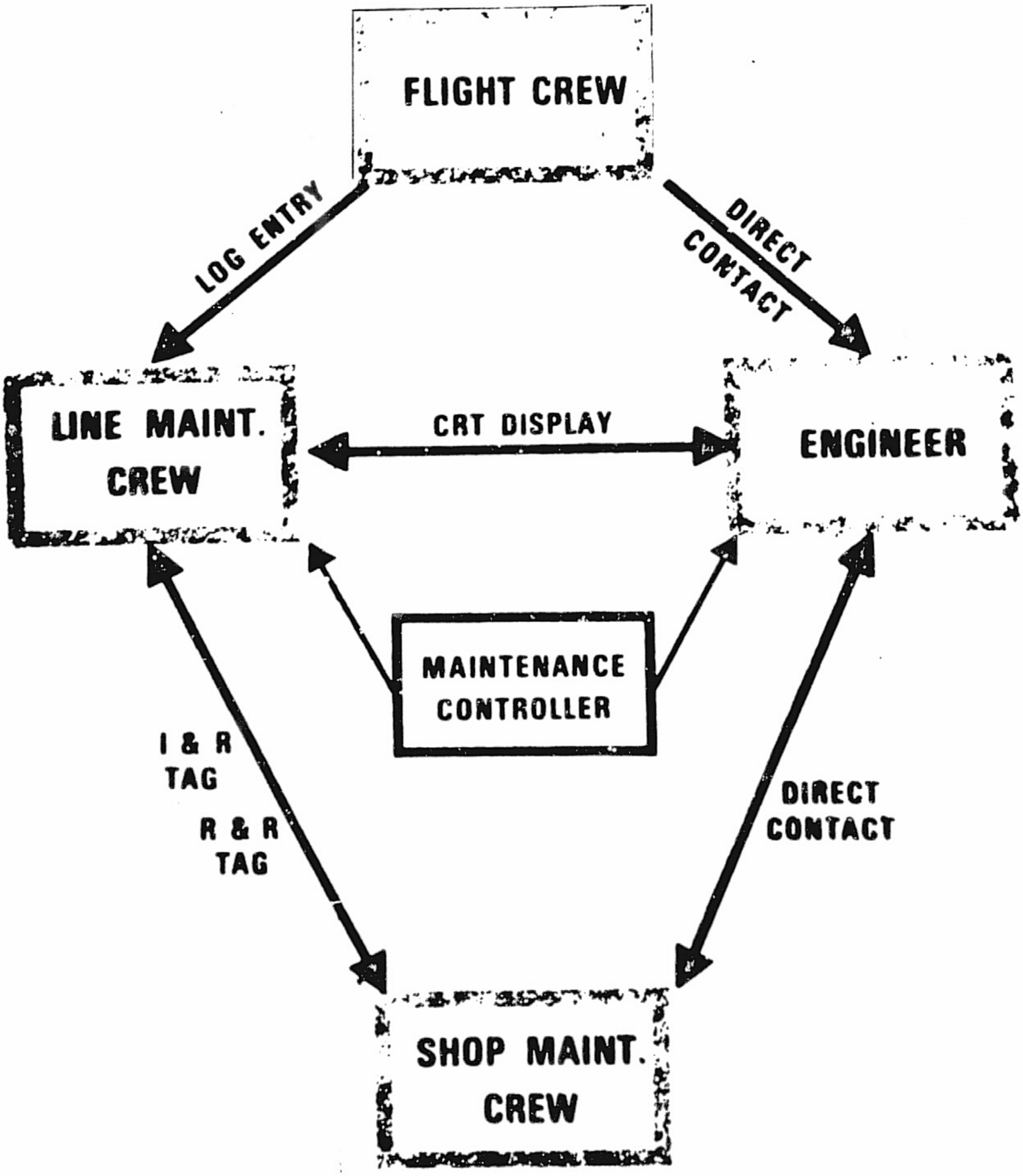
- Shop finding, failed test number, failed component parts, etc.
- Verification of line maintenance action.

When a unit is overhauled (i.e., tested per applicable document) a fresh I&R tag is attached to the unit. When the unit is installed in the aircraft the tag is transferred to the replaced unit and returned to the shop with data described above.

The bulk of data collected for this study comes from the two primary data sources mentioned above. Other sources are: Line maintenance labor record (9 Digit ATA Line Maintenance Summary (Ref. Attachment III) which keeps the line station labor expenditure by aircraft, date, time, station and ATA Chapter; Shop Maintenance Cost Summary which keeps an accounting of labor and

FIGURE V

DATA FLOW



material expenditure by unit, and the Mechanical Irregularity Report.

The data collection involved a review of 10,500 log sheets, 1,020 I&R tags, 12 cartridges of microfilm (for line labor), covering the 12 months from July '75 to June '76. Two record keeping forms have been developed to record all the data collected from the log sheets and I&R tags. These forms are shown in Figure VI.

Explanation of each column on the Aircraft History form, from left to right: Data line number, aircraft number, date, aircraft flight time since last overhaul, maintenance station, AFCS related or non-AFCS related equipment, maintenance action, engineering judgement as to validity of maintenance action (problem corrected - yes or no), manhour spent on the problem, line replaced unit, CAT II availability and CAT II performance parameters including pilot judgement (satisfactory or unsatisfactory).

Explanation of each column, from left to right, on the Unit Removal History: Data line number, aircraft number, aircraft TSO, date, station, description of in-flight problem and results of ground tests, position of the replaced unit (system 1, system 2, etc), corresponding line from Aircraft History form, shop finding, verification of removal reason (yes or no), other failures not related to removal reason found in shop (yes or no), serial number of newly installed (on) and removed (off) units, additional comments.

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE VI

MAINTENANCE DATA COLLECTION FORM

AIRCRAFT HISTORY

LINE	A/C	DATE	TSO	STA	IN FLIGHT PROBLEM	[illegible]	[illegible]	MAINTENANCE ACTION	[illegible]	[illegible]	UNITS REMOVED	CRUISE MODE AVAILABILITY				LAT & [illegible]			
									Y	N		REPORTED		ACTUAL		REPORTED		[illegible]	
												NA	FA	NA	FA				

UNIT REMOVAL HISTORY

[illegible] ______________

LINE NO.	A/C	TSO	DATE	STA	PROBLEM	POS	CORRESP LINE	SHOP FINDING	VERIFY		OTHER		SERIAL		COMMENTS
									Y	N	Y	N	OFF	ON	

[illegible] 12/76

A. Maintenance Time Characteristic

The maintenance flowchart and MEL showed that, depending on the nature of the in-flight malfunction, a CAT II operational test may or may not be required. Cruise mode problems, such as HEADING SELECT or ALTITUDE HOLD mode anomalies, for example, do not usually require any more testing than BITE. Thus, maintenance actions may last as short as a few minutes of BITE to as long as several hours of BITE, operational tests, unit replacement and final verification tests. Typically speaking, however, composition of line maintenance action is as follows:

LINE MAINTENANCE TEST TIME

BITE TEST TIME (INCLUDE ACCESS)	20 MIN
WAIT TIME FOR REPLACEMENT	45 - 75 MIN
TEST EQUIPMENT SETUP	15 MIN
CAT II AUTOLAND TEST	30 MIN
CLEAN-UP AND RETURN TO NORMAL	15 MIN

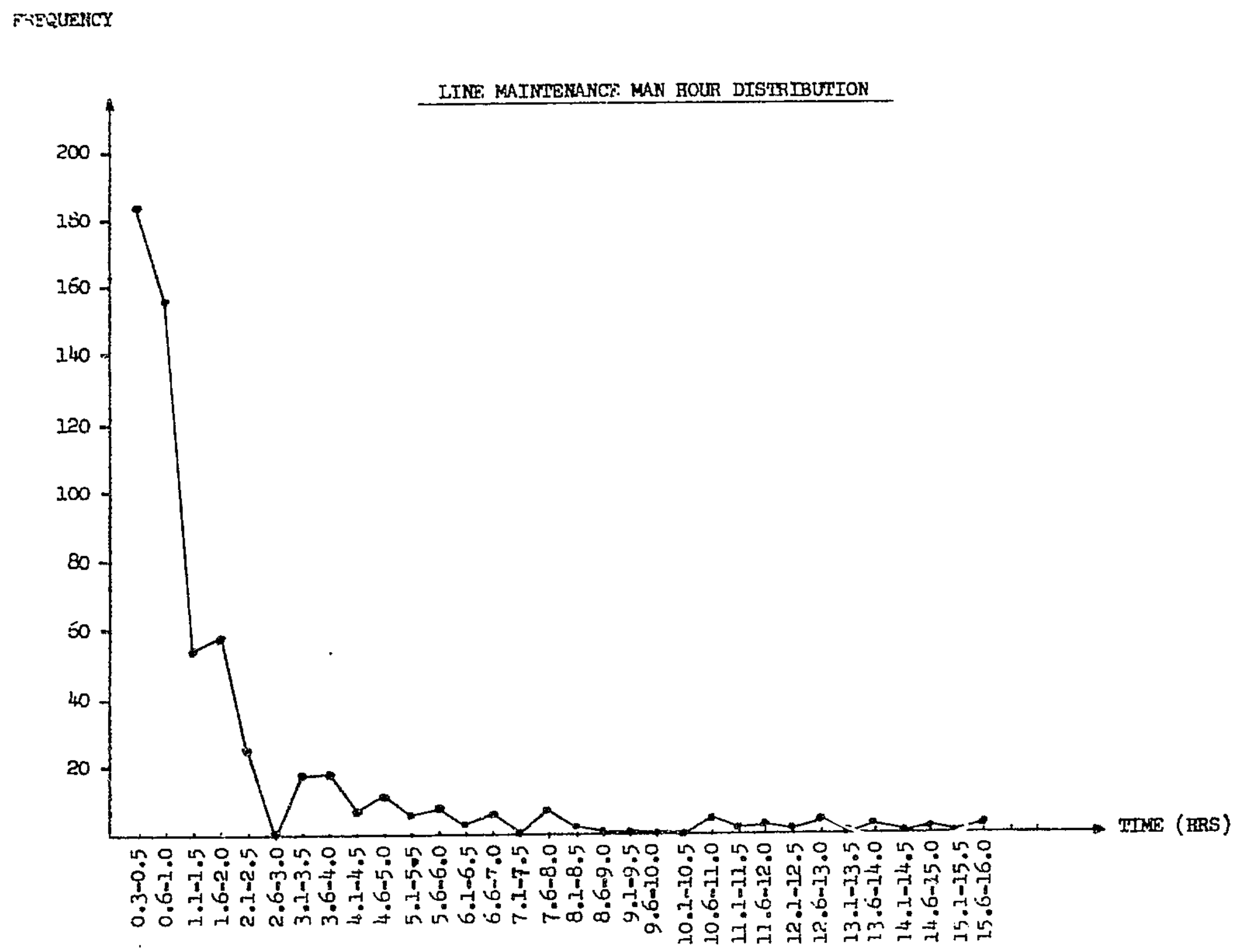
WITH AUTOLAND TEST 2:05-2:35
WITHOUT AUTOLAND TEST 1:20-1:50

These figures indicate that the reduction of BITE testing time alone does not significantly affect the total maintenance time. Quality of BITE, however, does contribute to a great extent as it would eliminate a need for additional tests.

FIGURE VII shows a distribution of line maintenance manhours charged against ATA Chapter 22, Autoflight. The distribution curve, plotted in 30 minute increments, reflects the typical line maintenance time as described above. It is evident that those problems that cannot be solved by routine maintenance require extensive troubleshooting, such as aircraft on wiring check, accumulating as long as 16 hours of line time.

B. Line Maintenance Manhours

ATA Chapter 22 covers only one system - autoflight. This makes it relatively simple to monitor the AFCS labor costs. However, Chapter 22 is limited in that it includes only the major AFCS computers and dedicated sensors. Those shared sensors that are not strictly AFCS components are in Chapters other than 22. Servo components fall under Chapter 27. The shared sensors are normally covered by ATA Chapter 34. At United, Navigation units/systems are classified into UA's own codes, Chapters 40 through 43 in lieu of 34. Classification of the UA designated chapters is shown in ATTACHMENT IV.


FREQUENCY
LINE MAINTENANCE MAN HOUR DISTRIBUTION
200
180
160
140
120
100
80
60
40
20
TIME (HRS)
0.3-0.5
0.6-1.0
1.1-1.5
1.6-2.0
2.1-2.5
2.6-3.0
3.1-3.5
3.6-4.0
4.1-4.5
4.6-5.0
5.1-5.5
5.6-6.0
6.1-6.5
6.6-7.0
7.1-7.5
7.6-8.0
8.1-8.5
8.6-9.0
9.1-9.5
9.6-10.0
10.1-10.5
10.6-11.0
11.1-11.5
11.6-12.0
12.1-12.5
12.6-13.0
13.1-13.5
13.6-14.0
14.1-14.5
14.6-15.0
15.1-15.5
15.6-16.0

Unfortunately the present accounting system does not breakdown the line maintenance labor expenditure by component. Therefore. the data shown in Table VI does not give a clear picture of total AFCS cost, as far as shared sensors and servos are concerned.

C. Shop Maintenance Labor and Material

Unlike line maintenance cost, shop labor and material expenditures are closely monitored by individual unit type (Ref. Attachment V). Table VII shows a summary of 12 months removal and failure of AFCS computers, servos and shared sensors. "Verified Removals" mean that shop findings matched the removal reasons. Other failures found in shop but not matched against the removal reasons are included in the "Total Failures" column, from which Mean Time Between Failures (MTBF) are computed. The formula for MTBF computation is a standard method commonly used by the industry:

$$\text{MTBF} = \frac{\text{Unit Flying Hours}}{\text{Number of failures}}$$

Shop maintenance costs associated with these removals are shown in Table VIII. Total shop cost is a sum of total labor cost and total material cost. The cost is shown in direct labor cost and does not include overhead. This table does not include Automatic Test Equipment (ATE) cost, which will be treated separately. The costs for shared sensors (INS computer, CADC, Radio Altimeter, ILS/NAV receiver, compass coupler and ADI) are based on total shop transactions. Each removal reason for these sensors has been further examined in order to arrive at AFCS related costs. Table IX is an an attempt to compute the portion of the total shared sensor costs attributable to the AFCS.

During the period that this study covered, there were seven AFCS related airborne equipments that were tested on ATE. These seven units and associated ATE costs are shown in Table X. In this table the second column shows average ATE time per test. Due to troubleshooting and repair while the unit is on the ATE, it usually takes twice as long on the ATE. Thus, pitch computer ATE time is 5 hours, on the average, per removal. The total ATE hour column reflects this.

LINE MAINTENANCE MAN HOUR

ATA CHAPT. / MONTH	22		27		41		42		43	
	EVENT	HR	EVENT	HR	EVENT	HR	EVENT	HR	EVENT	HR
JULY 75	147	216	135	266	186	190	22	14	73	51
AUG *	123	151	194	373	165	128	23	18	29	30
SEPT	100	154	120	345	120	114	18	12	51	71
OCT *	82	161	200	509	117	108	15	35	30	25
NOV	109	140	88	316	116	216	22	24	65	77
DEC *	50	61	101	261	61	73	4	3	19	25
JAN 76	89	127	144	389	128	187	16	20	73	68
FEB *	80	177	126	242	97	158	13	41	18	15
MAR	127	194	121	408	130	168	20	23	70	110
APR *	71	107	98	110	118	172	3	3	18	17
MAY	116	203	74	161	117	153	12	9	70	72
JUNE *	55	67	76	173	102	101	4	9	19	21
TOTAL	1,149	1,758	1,477	3,553	1,457	1,768	172	211	535	588
AVE MH/EVENT	1.53		2.41		1.21		1.23		1.10	

* For these months with asterisks, Maintenance Man Hours are not fully coded by ATA chapters.

ORIGINAL PAGE IS
OF POOR QUALITY

UNIT REMOVAL SUMMARY

UNIT	TOTAL REMOVALS	VERIFIED REMOVALS	(%)	TOTAL FAILURES	UNIT FLYING HOUR	MTBUR	MTBF
PITCH COMPUTER	140 (3 POOL)	58	(41%)	84	161424	1153 HR	1922 HR
ROLL COMPUTER	113 (1 POOL)	58	(51%)	71	161424	1429	2274
YAW COMPUTER	35 (1 POOL)	16	(46%)	20	107616	3075	5381
A/T COMPUTER	28	9	(32%)	14	53808	1922	3843
AUTO STAB TRIM	34	22	(64%)	25	53808	1583	2152
MONITOR & LOGIC	51	15	(29%)	16	53808	1055	3363
MODE SEL PANEL	50	18	(36%)	22	53808	1076	2446
CONTROLLER	10	2	(20%)	4	53808	5381	13452
TRIM INTERFACE UNIT	12	1	(8%)	1	53808	4484	53808
AFC-BOX 1	3	1	(33%)	1	53808	17963	53808
AFC-BOX 2	4	0	(25%)	0	53808	13452	∞
ACCELEROMETER	1	N/A			107616	107616	N/A
A/T SERVO	3	0	(0%)	0	53808	17936	∞
INS COMPUTER	94	69	(73%)	72	107616	1145	1495
CADC	106 (7 POOL)	37	(35%)	59	107616	1015	1824
RADIO ALT R/T UNIT	62	16	(25%)	23	107616	1736	4679
ILS/NAV RECEIVER	69	19	(28%)	23	107616	1560	4679
COMPASS COUPLER	19	7	(37%)	9	107616	5664	11957
ADI	127	74	(58%)	80	107616	847	1345

TABLE VII

SHOP C

COMPONENT	LABOR HR/UNIT	LABOR COST/UNIT	MATERIAL COST/FAIL	TOTAL LABOR COST	TOTAL MAT'L COST	TOTAL SHOP COST	COST PER 100 UNIT FLY HOUR
PITCH COMPUTER	10:02	$ 83.91	$265.78	$11,496.35	$22,325.36	$33,821.71	$20.95
ROLL COMPUTER	9:37	86.42	260.90	9,679,08	18,524.50	28,203.58	17.47
YAW COMPUTER	2:53	25.69	6.17	873.35	123.37	996.72	0.93
A/T COMPUTER	4:54	41.88	42.04	1,172.50	588.50	1,761.00	3.27
AUTO STAB TRIM	4:46	39.62	159.67	1,347.13	3,991.85	5,338.98	9.92
MONITOR & LOGIC UNIT	4:31	37.96	213.92	1,936.12	3,422.64	5,358.76	9.96
MODE SEL PNL	6:47	58.05	61.81	2,902.46	1,359.87	4,262.33	7.92
CONTROLLER	5:00	41.21	89.06	412.15	356.24	768.39	1.43
TRIM INTERFACE UNIT	1:38	16.71	0	200.50	0	200.50	0.37
AFC-BOX 1	5:40	48.15	0	144.44	0	144.44	0.27
AFC-BOX 2	5:30*	44.96*	54.64*	0	0	0	0
ACCELEROMETER	6:00	53.00	N/A	53.00	197.00	250.00	0.23
A/T SERVO	2:20	20.67	0	62.00	0	62.00	0.12
INS COMPUTER	21:10	177.16	571.90	16,371.40	41,177.13	57,548.53	53.48
CADC	12:49	119.04	53.92	11,189.94	3,181.34	14,371.28	13.35
RADIO ALT R/T UNIT	5:06	42.87	15.98	2,657.94	367.50	3,025.44	2.81
ILS/NAV RECEIVER	8:00	67.59	20.90	4,663.71	480.70	5,144.41	4.78
COMPASS COUPLER	4:24	37.56	16.44	713.64	147.93	861.57	0.80
ADI	4:18	36.18	20.79	4,594.86	1,663.20	6,258.06	5.82

* Averages based on previous experience

TABLE IX

SHOP COST (DUE TO AFCS RELATED REMOVALS)

UNIT	AFCS RELATED REMOVALS	VERIFED REMOVALS	(%)	TOTAL LABOR	TOTAL MATERIAL	TOTAL SHOP COST	COST PER 100 FLIGHT HOURS
INS COMPUTER	0	N/A	(N/A)	0	0	0	0
CADC	21	3	(14%)	$1,266.78	$257.95	$1,524.73	$1.42
RADIO ALT	5	3	(60%)	214.35	68.91	283.26	0.26
ILS/NAV RCVR	2	0	(0%)	135.18	0	135.18	0.13
COMPASS COUPLER	2	1	(50%)	75.12	21.13	96.25	0.09
ADI	43	27	(63%)	1,555.74	606.84	2,162.58	2.01

ORIGINAL PAGE IS
OF POOR QUALITY

TABLE X

ATE COST

COMPONENT	ATE TIME/TEST	TOTAL HOUR	COST
PITCH COMPUTER	2.5 HR	700	$16,100
ROLL COMPUTER	2.5	566	13,018
YAW COMPUTER	0.5	36	828
MONITOR LOGIC UNIT	0.5	52	1,196
AUTO STAB TRIM	0.75	52	1,196
A/T COMPUTER	0.5	28	644
ILS RECEIVER	1.25	172	3,956

D. Schedule Irregularity

When an airborne system failure results in an interruption of scheduled operation, such as delay or cancellation of scheduled flight, additional cost would be incurred. An industry survey made in early 1976 shows the following delay and cancellation costs for 747 aircraft:

Cost for typical delay of 40 min: $550 - $1,190

Cost for cancellation of flight: $1,500 - $5,000

The composition of these costs includes extra ground transportation, hotel and meal accommodations for passengers, overtime pay for maintenance and flight crews, etc. In addition, many intangible items such as competitors reliability, schedule similarity, load factors, etc. are important factors, although difficult to substantiate. All these items have different values depending upon the individual case, and the difficulty is evidenced by the large spread as shown in the industry survey. At United, costs of flight schedule interruptions as cited below are being used only for the purpose of engineering work estimates:

747 delay cost per hour per delay: $ 300

747 cancellation cost per departure: $3,600

During the 12 month period, 155 delays were registered against Chapters 22, 27, 34, 41, 42 and 43. (See Table XI). Of these, 76 were AFCS related. The AFCS caused no cancellation in this period. The delay hours caused by the 76 incidents totaled 41 hours and 14 minutes, or an average of 33 minutes per delay.

MECHANICAL IRREGULARITY SUMMARY
(747: July 75 - June 76)

ATA CHAPTER	ITEM	DL	CX	SUB	TOTAL DELAY	AVE DELAY
22	CAT II	1	0	0	0:05	0:05
	A/P PITCH	1	0	0	0:14	0:14
	A/P ROLL	2	0	0	0:57	0:29
	FLT DIR	1	0	0	0:12	0:12
	YAW DAMP	1	0	0	2:12	2:12
	TOTAL	6	0	0	3:40	0:37
27	YAW DAMP	7	0	2	3:58	0:34
	OTHERS	55	3	12	72:26	1:19
	TOTAL	62	3	14	76:24	1:14
34	INS	21	0	1	11:20	0:32
	ADI/RWY SYMBOL	4	0	0	1:01	0:15
	HSI/COMPASS	6	0	0	5:20	0:53
	RADIO ALT	1	0	0	0:03	0:03
	CADC	3	0	0	2:36	0:52
	G/S	1	0	0	0:25	0:25
	SUB TOTAL	36	0	1	20:45	0:35
	OTHERS	13	0	1	8:44	0:40
	TOTAL	49	0	2	29:29	0:36
41	INS	16	0	0	5:21	0:20
	G/S	1	0	0	1:26	1:26
	HSI/COMPASS	2	0	0	0:56	0:28
	ADI/RWY SYMBOL	4	0	1	2:49	0:42
	RADIO ALT	1	0	0	0:25	0:25
	SUB TOTAL	24	0	1	10:57	0:27
	OTHERS	9	0	0	7:16	0:48
	TOTAL	33	0	1	18:13	0:33
42	G/S	1	0	0	0:38	0:38
	INS	1	0	0	1:05	1:05
	TOTAL	2	0	0	1:43	0:52
43	ADI/RWY	1	0	0	0:11	0:11
	OTHERS	2	0	0	0:52	0:26
	TOTAL	3	0	0	1:03	0:21
TOTAL AFCS RELATED		76	0	4	41:14	0:33
TOTAL ALL ITEMS		155	3	17	130:32	0:51

15. 747 AFCS COST SUMMARY

The costs examined to this point are direct maintenance costs involving line and shop labor, material and test equipment. From a broader viewpoint of assessing a total cost of owning the AFCS, other costs such as hardware acquisition costs, spares inventory and holding costs, pipeline transportation costs, maintenance and flight crew training costs must be taken into consideration. A detailed cost-of-ownership computation is out of the scope of this study; however, a summary of each item should serve to illustrate the magnitude of line and shop cost as compared to the total cost. The following cost items are divided into two broad categories: one time costs and continuous (annual) costs.

One Time Costs

Hardware Acquisition Cost	$2,809,399
Spares Acquisition Cost	$ 867,161
Initial Cost of Maintenance Crew Training	$ 65,800
Initial Cost of Flight Crew Training	$ 368,520
	$4,110,880

NOTE:

Above costs are for AFCS computers, servos and dedicated sensors to support the fleet of 18 747s.

Continuing Costs (Annual)

Line Maintenance cost (ATA Chapter 22- Includes Overhead)	$ 42,192
Shop Labor Cost (Includes Overhead)	$ 97,225
Shop Material Cost	$ 51,844
ATE Cost	$ 32,982
Recurrent Training Cost of Maintenance Crew	$ 6,080
Recurrent Training Cost of Flight Crew	$ 46,080
Delay, Cancellation, Substitution Cost	$ 12,300
Spares Holding Cost	$ 466,760
	$ 755,463

Due to extremely high cost of AFCS hardware, the spares holding cost dominates the annual cost of owning AFCS. When this spares holding cost is excluded, the next highest cost item is shop related, occupying 63% of the remaining cost.

16 BITE EFFECTIVENESS

An earlier, ARCS study identified the reliability, or effectiveness of BITE as a key design goal for future system test. In contemporary avionics, the effectiveness of BITE has been ranging from as low as 30% to a high of 84%. The effectiveness of BITE for the 747 AFCS, as shown in Table XII, is better than that of any other AFCS's. Yet, half of the units listed here average around 50% effectiveness. Considering the fact that 50% is the level of pure guesswork, it is clear that the BITE needs a drastic improvement.

17 CAT II AVAILABILITY

The CAT II system status of each aircraft is displayed by a so called "CAT II status placard" installed on Captain's instrument panel. CAT II availability can be assessed by accumulating the number of flying hours during which these placards are indicating Full or Restricted CAT II. Table XIII shows sample entries as an illustration of the method used. In this study, the availability was judged by three criteria: Reported, Legal and Actual. The Reported column shows availability as reported by the line maintenance crew. The Legal column is for an engineering judgement, so as to correct possible errors in line maintenance actions. Acutal column was added to indicate availability of strictly AFCS components, as compared to windshield wiper and other non AFCS systems that could cause aircraft to be out of CAT II status. R stands for Restricted CAT II and F stands for Full CAT II. There are three kinds of entries shown here to illustrate the possible differences in reported, legal and actual columns.

Example 1 Proper correction of in-flight malfunction was made, but line maintenance failed to adjust the placard.

Example 2 Temporary failure. Legally out of CAT II because of testing requirements. Actually the system was available.

Example 3 Testing showed that the system was good - satisfied legal requirements. But, fault did exist and was eventually corrected.

Table XIV and Table XV are summaries of the CAT II availability study. Although CAT II system is not dispatch required at this moment, it is significant that the CAT II system on 747 is being maintained to consistently high levels of availability in all three categories examined.

ORIGINAL PAGE IS
OF POOR QUALITY

BITE EFFECTIVENESS

Unit	Total Bite Entry	Bite Match Shop Finding (%)	Bite Fail But Unit OK (%)	Bite Pass But Unit Bad (%)	Adjusted Bite Effectiveness
Pitch Computer	69	28 (41%)	24 (35%)	17 (24%)	54%
Roll Computer	47	30 (64%)	10 (21%)	7 (15%)	75%
Yaw Computer	16	8 (50%)	8 (50%)	0	
Alt Computer	4	3 (75%)	1 (25%)	0	
Auto Stab Trim	15	8 (53%)	4 (27%)	3 (20%)	67%
Monitor & Logic	11	5 (45%)	4 (36%)	2 (19%)	56%
INS Computer	62	52 (84%)	10 (16%)	0	
CADC	4	3 (75%)	1 (25%)	0	

NOTES

1. First three percentage columns are expressed as % of total BITE entry.
2. ADJUSTED BITE EFFECTIVENESS is expressed as % of (TOTAL BITE ENTRY - BITE PASS BUT UNIT BAD).

For example, pitch computer calculation: $\frac{28}{(69-17)}$ X 100 = 54%.

TABLE XII

CAT II AVAILABILITY: SAMPLE ENTRIES

TABLE XIII

A/C	DATE	TSO	STA	IN-FLIGHT PROBLEM	AFCS	OTHER	MAINTENANCE ACTION	CAT II AVAILABILITY					
								REPORTED		LEGAL		ACTUAL	
								R	F	R	F	R	F
8003	10/17	1625: 43	LAX	1ST OFFICER WINDSHIELD WIPER BLADE STICKS OUT IN FLT		X	DEF #460 NOT CAT II	N/A		N/A			✓
	10/20	1661: 01	SFO	(CORRECTION OF DEF #460)			REPLACED BLADE	N/A			✓		✓
	10/21	1664: 36	ORD	NOTE - CAPT INST PNL HAS "NOT CAT II" PLACARD			CORRECTED TO CAT II		✓		✓		✓
8011	06/12	18346: 31	ORD	CAPT F D ANNUNCIATOR LATE WOULD NOT ILLUMINATE DURING APPROACH	X		REPLACE MALU. NOT CAT II NEED CAT II CHECK. DEF #598	N/A		N/A			✓
	06/13	18369: 15	LAX	(CORRECTION OF DEF #598)			MALU BITE OK CAT II		✓		✓		✓
8014				(PREVIOUS WRITE-UP'S ON WARNING LIGHTS)					✓		✓		✓
	03/18	17238: 15	ORD	WITH "A" A/P IN CMD & VOR/LOC, HAD STEADY RED A/P WARN LITE. "B" A/P OK	X		UNABLE TO DUP BITE CKS OK ROLL & PITCH		✓		✓	✓	
	03/19	17240: 26	ORD	SAME AS ABOVE	X		REPLACED A/P ROLL CHANNEL. CKS OK		✓		✓		✓
				(NO MORE PROBLEM)									

TABLE XIV

747 CAT II AVAILABILITY

TOTAL FLYING HR: 53[illegible]08
(JULY 75 - JUNE 76)

A/C	REPORTED		LEGAL		ACTUAL	
	N/A	RESTRICTED	N/A	RESTRICTED	N/A	RESTRICTED
8003	78:44	291:28	68:49	243:19	12:34	150:00
8004	167:19	452:23	122:11	455:49	49:21	210:21
8010	62:54	182:49	43:01	192:09	-	101:15
8011	42:09	77:03	7:51	83:06	7:51	10:05
8012	13:13	201:24	13:13	201:52	13:13	252:44
8013	107:43	240:15	107:43	303:44	51:42	301:00
8014	3:45	46:05	3:45	46:05	3:45	125:1[illegible]
8016	26:15	383:30	8:52	279:01	-	519:55
8017	-	342:32	10:59	413:51	10:59	399:10
8018	-	59:21	-	60:26	-	268:28
8019	199:01	228:37	146:32	232:08	146:32	206:25
8020	116:19	516:00	73:24	376:08	62:32	357:49
8023	153:57	202:43	46:54	281:34	72:05	404:36
8027	64:37	241:16	42:04	134:22	7:57	125:06
8028	124:26	193:21	60:57	193:21	60:57	198:13
8029	215:35	639:45	87:48	201:21	88:06	142:34
8032	99:45	265:22	81:33	303:42	27:02	33:01
8035	38:36	137:10	18:25	131:15	-	153:21
FLEET	1514:18	4701:04	944:01	4133:13	614:36	4009:14
% OF TOTAL FLYING HR	2.81%	8.74%	1.75%	7.68%	1.14%	7.45%

TABLE XV

REPORTED CAT II AVAILABILITY:

FULL----------------- 89.45%

FULL/RESTRICTED ----- 97.19%

LEGAL CAT II AVAILABILITY:

FULL----------------- 90.57%

FULL/RESTRICTED ----- 98.25%

ACTUAL CAT II AVAILABILITY:

FULL ---------------- 91.41%

FULL/RESTRICTED------ 98.86%

ATTACHMENT J

AIRBORNE EQUIPMENT REQUIREMENTS

(AC 120-29)

MINIMUM REQUIREMENTS	CAT II (ALL AIRCRAFT)
SINGLE FLIGHT DIRECTOR 1/ OR SINGLE AUTOMATIC APPROACH COUPLER 2/	MINIMUM REQUIREMENT - TWO - ENGINE PROPELLER AIRCRAFT ONLY.
INSTRUMENT FAILURE WARNING SYSTEM	REQUIRED PLUS FLIGHT CREW ASSIGNMENTS AND PROCEDURES SPECIFIED IN NOTE 3/ BELOW.
DUAL ILS AND GLIDESLOPE RECEIVERS	REQUIRED
SINGLE FLIGHT DIRECTOR WITH DUAL DISPLAYS 1/ AND SINGLE AUTOMATIC APPROACH COUPLER 2/ OR TWO INDEPENDENT FLIGHT DIRECTOR SYSTEMS	REQUIRED
EQUIPMENT FOR IDENTIFICATION OF DECISION HEIGHT	REQUIRED. CAN BE: (1) RADAR ALTIMETER, OR (2) INNER MARKERS.
MISSED APPROACH ATTITUDE GUIDANCE	REQUIRED. CAN BE: (1) ATTITUDE GYROS WITH CALIBRATED PITCH MARKINGS, OR (2) FLIGHT DIRECTOR PITCH COMMAND, OR (3) COMPUTED PITCH COMMAND.
AUTOTHROTTLE SYSTEM	REQUIRED ALL TURBOJETS IF OPERATIONS BASED ON DUAL FLIGHT DIRECTORS. ALSO REQUIRED ANY AIRCRAFT USING SPLIT AXIS COUPLERS IF APPLICANT CAN'T SHOW IT DOES NOT SIGNIFICANTLY REDUCE PILOT WORKLOAD.
RAIN REMOVAL EQUIPMENT	REQUIRED

NOTES: 1/ SINGLE AXIS FLIGHT DIRECTORS IF BASIC GLIDESLOPE INFORMATION DISPLAYED ON SAME INSTRUMENT.

2/ SPLIT AXIS ACCEPTABLE

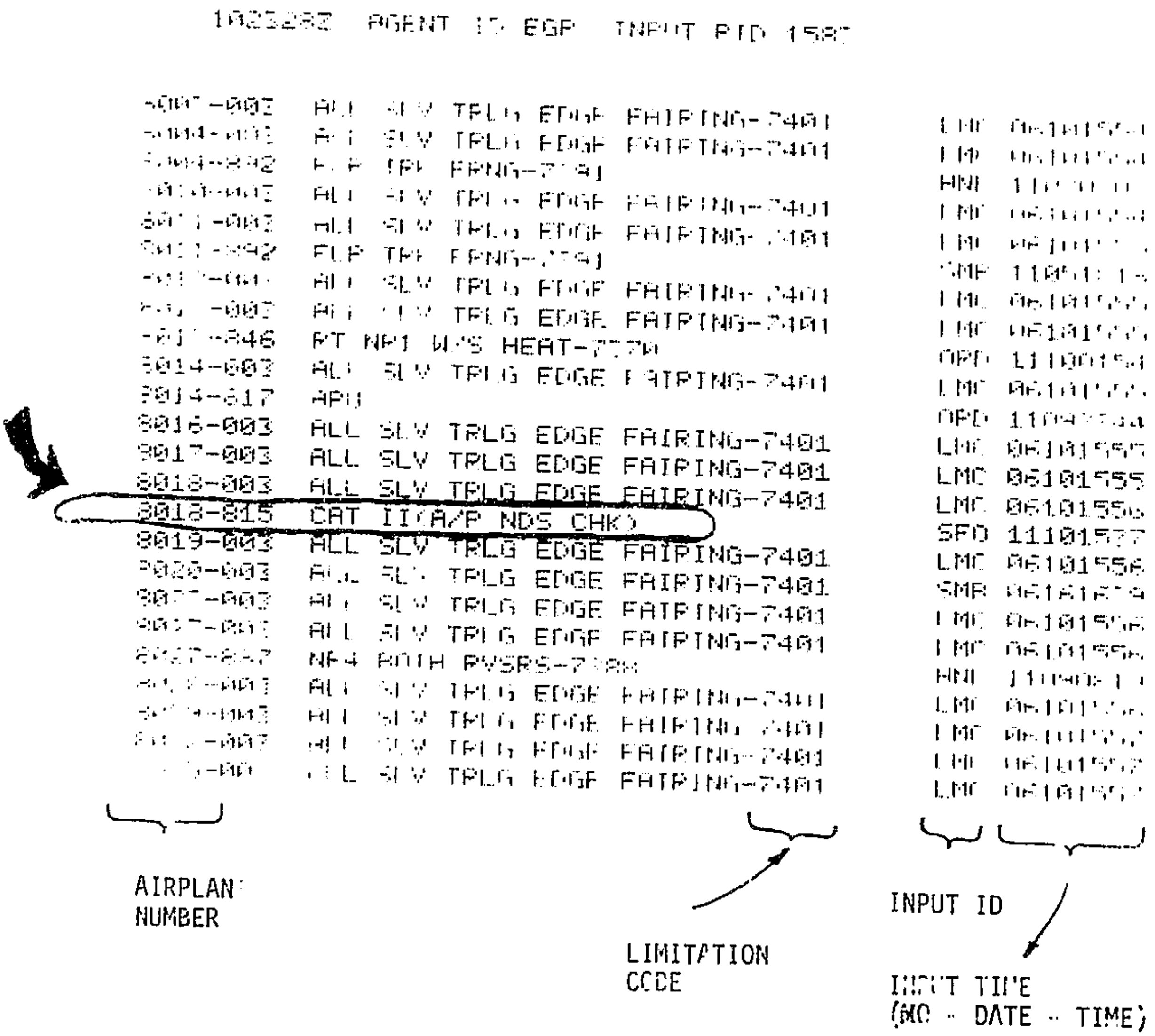
3/ IF IMPROVED FAILURE WARNING SYSTEM NOT PROVIDED FOR CAT I OPERATIONS APPLICANT MUST ESTABLISH FLIGHT CREW PROCEDURES AND DUTY ASSIGNMENTS TO PROVIDE IMMEDIATE DETECTION OF ESSENTIAL INSTRUMENT AND EQUIPMENT FAILURES. SUCH PROCEDURES AND ASSIGNMENTS ARE REQUIRED FOR CATEGOR II OPERATIONS.

ORIGINAL PAGE IS
OF POOR QUALITY

ATTACHMENT II

ORIGINAL PAGE IS
OF POOR QUALITY

AFPAM DISPLAY



```
1023282  AGENT ID EGP  INPUT PID 158[illegible]

[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
[illegible]-042   FLP TRK FRNG-7[illegible]             HNL 11[illegible]
[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
80[illegible]-003 ALL SLV TRLG EDGE FAIRING-[illegible] LMC 061015[illegible]
[illegible]-042   FLP TRK FRNG-[illegible]              SMF 1105[illegible]
[illegible]       ALL SLV TRLG EDGE FAIRING-[illegible] LMC 061015[illegible]
[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
[illegible]-046   RT NR1 W/S HEAT-7[illegible]          OPD 111001[illegible]
8014-003          ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
8014-017          APU                                   OPD 1104[illegible]
8016-003          ALL SLV TRLG EDGE FAIRING-7401        LMC 06101555
8017-003          ALL SLV TRLG EDGE FAIRING-7401        LMC 06101555
8018-003          ALL SLV TRLG EDGE FAIRING-7401        LMC 06101556
8018-015          CAT II(A/P NDS CHK)                   SFD 11101577
8019-003          ALL SLV TRLG EDGE FAIRING-7401        LMC 06101556
8020-003          ALL SLV TRLG EDGE FAIRING-7401        SMR 06101[illegible]
80[illegible]-003 ALL SLV TRLG EDGE FAIRING-7401        LMC 0610155[illegible]
80[illegible]-003 ALL SLV TRLG EDGE FAIRING-7401        LMC 0610155[illegible]
[illegible]       NR4 BOTH RVSRS-7[illegible]           HNL 1104[illegible]
[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
[illegible]-003   ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
[illegible]       ALL SLV TRLG EDGE FAIRING-7401        LMC 061015[illegible]
```

9 DIGIT ATA SUMMARY

```
JOB 4273-1          RESOURCE  EVALUATION   6-DIGIT  DETAIL  ANALYSIS  NON-ROUTINE  MAINTENANCE
DATE=04/06/76
TYPE  PLANE              TYPE O  JOB     ORIGINATED  ARR-FLT   MAN
EQUIP  NO    TSO   STA CHK R  NO      DATE  TIME  & DATE  HOURS      SYSTEM CODE           DESCRIPTION

                                                                     2210           AUTOFLIGHT-AUTOPILOT

DC850 2862 18685 ORD 1    L C100-0  02-28 11,00       .      1.3     2210 01 01 0
    ORD       TOTALS                  7                   8.4

DC862 2275 19706 PDX 1    L 0000-0  03-16 23.75                .6     2210 01 05 7 A/P OPERATIONAL CHK/ANALYZER CHK/SELF

DC8F  2043 17243 PHL 1    D 0000-0  03-02 19.00                      2210 01 07 7 A/P OPERATIONAL CHK/ANALYZER CHK/SELF
DC8F  2043 17243 PHL 1    L 0000-0  03-02 19.00                      2210 01 07 7
DC8F  2045 19205 PHL 2    D 0000-0  03-10 21.00                      2210 01 07 7
DC850 2617 13598 PHL 1    L 0000-0  03-16 10.30                      2210 01 05 7
DC850 2619  0402 PHL 2    L 0000-0  02-27 10.30                      2210 01 02 1
DC850 2625 13089 PHL 1    L 0000-0  02-22                            2210 01 07 7
DC850 2629 13032 PHL 2    L 0000-0  03-15 22.30                      2210 01 07 7
DC850 2861  1989 PHL 1    L 0000-0  03-03                            2210 01 07 7
DC850 2861  1999 PHL 2    D 0000-0  00-00                            2210 01 07 7
    PHL       TOTALS                  9

DC850 2311 10823 SEA A    C 0000-0  00-00                     1.5    2210 01 62 0 A/P OPERATIONAL CHK/ANALYZER CHK/SELF
DC861 2472 13533 SEA 2    M 0000-0  00-00                      .3    2210 01 04 7
DC861 2475 16974 SEA A    D 0000-0  00-00                            2210 01 09 7
DC850 2606 13035 SEA A    D 0000-0  00-00                     1.5    2210 01 01 0
DC850 2612  6411 SEA A    C 0000-0  00-00                     1.5    2210 01 05 7
DC850 2616 18509 SEA 2    L 0000-0  00-00                     1.0    2210 01 01 0
DC850 2617 13611 SEA 807  L 0315-0  00-00                     1.7    2210 01 01 0
DC850 2617 13652 SEA 2    C 0000-0  00-00                     1.3    2210 01 60 0
DC850 2624  9317 SEA 1    L 0000-0  00-00                      .5    2210 01 02 7
    SEA       TOTALS                  9                   9.3

DC8F  2053 18978 SFO 2    D 0100-0  03-04  8.00               7.0    2210 01 01 0 A/P OPERATIONAL CHK/ANALYZER CHK/SELF
DC862 2270  0388 SFO 1    L 0100-0  03-11 13.00                      2210 01 02 7
DC850 2310 14905 SFO 2    D 0100-0  03-21 15.50                      2210 01 09 7
DC850 2612  6392 SFO 1    L 0100-0  03-05 14.45                      2210 01 02 7
    SFO       TOTALS                  4                   7.0

    2210 C1   TOTALS                 66                  49.1

              TOTALS                 76                 -50.9
```

ORIGINAL PAGE IS
OF POOR QUALITY

ATTACHMENT IV

ATA CHAPTER INDEX

---

22 AUTOFLIGHT

AUTOPILOT
AUTOPILOT/
FLIGHT DIRECTOR (747/DC-10)
SPEED-ATTITUDE CORRECTION
AUTOTHROTTLE
SYSTEM MONITOR

---

27 FLIGHT CONTROLS

AILERON & TAB (MECHANICAL, HYDRAULIC, ELECTRICAL)
RUDDER & TAB
ELEVATOR & TAB
HORIZONTAL STABILIZERS
FLAPS
SPOILER, DRAG DEVICES & VARIABLE AERODYNAMIC FAIRINGS
GUST LOCK & DAMPENER
LIFT AUGMENTATION

---

34 NAVIGATION

FLIGHT ENVIRONMENT/AIR DATA (UA)
ATTITUDE AND DIRECTION
LANDING AND TAXIING AIDS
INDEPENDENT POSITION DETERMINING
GROUND PROXIMITY WARNING (UA)
DEPENDENT POSITION DETERMINING
POSITION COMPUTING

---

40 (UA) NAVIGATION - GENERAL

ALL WEATHER LANDING
ALTERNATE TRACK COMPUTER
HOLDING PATTERN PROGRAMMER
PROXIMITY WARNING
PICTORIAL DISPLAY
ALTITUDE REPORTING
CLEAR AIR TURBULENCE DETECTION
NOISE ABATING APPROACH

ATTACHMENT IV (CONTINUED)

ATA CHAPTER INDEX

---

41 (UA) NAVIGATION - INSTRUMENTS

AIR DATA INSTRUMENTATION
ATTITUDE INSTRUMENTATION
DIRECTION INSTRUMENTATION
POSITION COMPUTING
INERTIAL NAVIGATION
FLIGHT COMMAND INSTRUMENTATION
STANDBY ATTITUDE INDICATOR SYSTEM

42 (UA) NAVIGATION - RADIO

AUTOMATIC DIRECTION FINDING
VHF (VOR/LOC/GS) SYSTEMS
MARKER
LORAN
GROUND GUIDANCE
MICROWAVE LANDING SYSTEM
OMEGA NAVIGATION SYSTEM

43 (UA) NAVIGATION - RADAR

WEATHER MAPPING
TRANSPONDER
DME
DOPPLER
RADAR ALTIMETERS

ORIGINAL PAGE IS
OF POOR QUALITY

UNITED AIRLINES

ENGINEERING DEPARTMENT
REPORT F-1806 DATE 2-17-77
PAGE

ATTACHMENT V

SHOP COST SUMMARY EXAMPLE

SFORG - PART NUMBER COST REPORT
PART NUMBER SEQUENCE FOR MONTH OF DECEMBER

PART NUMBER	DESCRIPTION	CLS	INVT	COST CONTROL	UNITS	MAN HOURS	LABOR DOLLARS	MATERIAL DOLLARS	TOTAL DOLLARS	AVERAGE PAID	COST PER UNIT
MF22198	D10 Y/D CMPTR	421	9027	14203491101	3.0	7.99	61.04	1.00-	60.04	15523.24	20.01
MF22199	D10 PTCH CMPTR	421	9047	14203491103	6.0	47.00	359.08	504.37	863.45	27619.01	143.91
MF22223	727 PTCH TR SEF	420	9776	12307491204	4.0	18.10	137.20	363.51	500.71	1614.37	125.18
M-22291	D10 LSSAS CMPTR	421	9028	14203492001	11.0	28.75	211.53	580.22	791.75	8575.20	71.98
MF22305	727 PED CONTRLR	420	9652	14207491301	20.0	28.36	216.68	.00	216.68	2949.07	10.83
MF22306	D8 PED CONTRLP	420	9774	14202491303	3.0	3.23	24.68	.00	24.68	5707.00	8.23
M 22307	D8 PED CONTRLP	420	9715	14202491302	6.0	6.55	50.05	3.31	53.36	1537.75	8.89
MF22311	747 A/T SERVO	480	9033	15109520201	.0	.00	.00	.00	.00	1019.90	.00
MF22312	747 A/T CMPTR	480	9031	14208520102	2.0	18.50	141.34	116.01	257.35	7642.01	128.68
MF22313	D10 AT-SC CMPTR	421	9059	14203520104	8.0	35.03	267.63	27.80	295.43	10400.00	36.93
MF22314	D10 AT-SC CMPTR	421	9600	14203520105	1.0	4.00	30.56	.00	30.56	23000.00	30.56
M-22391	D10 A/T CON PAN	421	9032	13103520001	4.0	12.65	95.89	.00	95.89	4005.57	23.97
MF22409	27 FL/RU PSN IN	420	9061	13507491405	4.0	5.98	45.33	.00	45.33	684.15	11.33
MF22501	D8 YA/ROL ACCEL	420	9179	13302491508	7.0	21.35	161.83	85.74	247.57	406.61	35.37
MF22504	D8 AIR DATA CCM	420	9773	13302491509	.0	.00	.00	.00	.00	7886.78	.00
MF22505	D86 YA/ROL ACCL	420	9096	13302491508	45.0	145.90	1052.45	829.11	1881.56	650.55	41.81
MF22506	D86 ACCEL PTCH	420	9095	13302491508	7.0	21.35	161.83	85.74	247.57	1205.21	35.37
MR22516	D8 ACCEL PITCH	420	9589	13302491508	7.0	21.35	161.83	85.74	247.57	852.49	35.37
MR22517	727 AIR DAT SEN	420	9650	13307491108	3.0	34.50	261.51	29.31-	232.20	4486.03	77.40
MP22518	2737 POSTN SENS	420	7079	13309491502	8.0	34.14	258.79	95.85	354.64	210.32	44.33
M 23221	VHF RECEIVER	530	9198	1410J431201	37.0	249.57	1906.71	664.50	2571.21	1760.16	69.49
MR23231	G8D6B VHF PNL	530	2646	1420J431301	29.0	123.03	939.95	607.45	1547.40	307.43	53.36
MR23233	G17281A VHF PNL	530	9006	1420E431303	57.0	137.45	1050.12	268.25	1318.37	434.72	23.13
MP23281	VHF TRANSCEIVER	530	9005	1410E431701	45.0	185.19	1414.85	458.16	1873.01	2595.22	41.62
MR23282	VHF TRANSCEIVER	530	9035	1410J431702	101.0	379.32	2898.01	737.43	3635.44	2415.72	35.99
MP23403	CENTRAL SK UNIT	580	9004	15208432104	4.0	33.50	254.27	.00	254.27	12898.72	63.57
MF23711	RECORDER VOICE	530	9026	1520J433101	847.0	3806.96	27268.74	29919.79	57188.53	937.08	67.52
MF24145	GEN DRV/SBY PWR	420	9502	14109611001	4.0	18.11	138.36	35.95	174.31	2835.10	43.58
MF24230	PNL-GEN C/VR	560	9026	153C2611306	333.0	1357.42	9663.54-	3924.93-	13588.47-	2990.03	40.81
MR24249	GEN CONT UNIT	560	9052	15302611218	14.0	30.38	206.51-	367.55-	574.06-	2130.92	41.00
MR24253	PANEL GEN CONT	560	9032	15307611203	430.0	1149.66	8208.38-	404.77-	8613.15-	4151.68	20.03
MF24254	REGULATOR-VOLT	560	9033	15307611201	55.0	83.35	629.76-	113.52-	743.29-	1171.21	13.51
MR24290	BUS CONT UNIT	586	9014	15303611205	47.0	277.64	2014.60-	880.90-	2895.50-	4021.36	61.61
M-24291	CONTROL-GEN	560	9607	153C9611202	237.0	734.67	5342.51-	4511.47-	9853.98-	3843.21	41.58
MP24293	AC SYS GEN APU	420	9496	14109611002	6.0	19.05	145.54	.00	145.54	3851.77	24.26
MF24297	REG/VOLT	560	9080	153C2611222	173.0	621.47	4428.77-	6218.90-	10647.67-	1205.84	61.55
MF24298	PNL-GEN CONT	560	9081	15302611221	323.0	754.71	5334.99-	4762.71-	10097.70-	3790.00	31.26
MF24299	GEN CONT UNIT	586	9013	15303611201	140.0	693.65	4901.82-	4327.44-	9229.26-	3938.48	65.[illegible]
M-24312	BATTERY CHARGER	560	9519	15307612101	102.0	150.65	1097.87-	25.02-	1122.89-	556.9[illegible]	11.[illegible]
MF24316	BATTERY CHARGER	585	9013	15308612102	4.0	35.00	263.28-	21.90-	285.18-	699.13	71.3[illegible]
M-24317	BATTERY CHARGER	561	7199	15309612102	29.0	25.31	184.29-	33.71-	218.00-	283.03	7.52
-8	BATTERY CHARGER	586	9000	15303612401	11.0	44.31	311.77-	15.04-	326.81-	2131.5[illegible]	29.71
	BATTRY				[illegible].0	48.00	363.84	16.67	380.51	629.11	13.55
	---T 73747					00	00	.00	.00	.00	.00
							44	1113.00	1249.44	1767.24	138.[illegible]
								[illegible]5.40-	65.23-	757.12	[illegible]
									35.00-	2860.07	

C-4

ORIGINAL PAGE IS
OF POOR QUALITY

ATTACHMENT V

C-4

SHOP COST SUMMARY EXAMPLE

SFR 2090 12/76

SFOR6 - PART NUMBER COST REPORT
PART NUMBER SEQUENCE FOR MONTH OF DECEMBER

PART NUMBER	DESCRIPTION	CLS INVT	COST CONTROL	UNITS	MAN HOURS	LABOR DOLLARS	MATERIAL DOLLARS	TOTAL DOLLARS	AVERAGE PAID	COST PER UNIT
MF22198	D10 Y/D CCMPTR	421 9027	14203491101	3.0	7.99	61.04	1.00-	60.04	15523.24	20.01
MF221--	D10 PTCH CCMPTR	421 9047	14203491103	6 0	47 00	359.08	504.37	863.45	27619.01	143.91
MR22273	727 PTCH TR SEP	420 9776	12307491201	4.0	18.10	137.20	361.51	500.71	1614.37	125.16
M-22291	D10 LSSAS CMPTR	421 9028	14203492001	11.0	28.75	211.53	580.22	791.75	8575.20	71.98
MF22305	727 PED CONTRLR	420 9652	14207491301	20 0	78 36	214 68	.00	216.68	2949.07	10.83
MF22306	D8 PED CONTRLP	420 9774	14202491303	3.0	3.23	24.68	.00	24.68	5707.00	8.23
M 22307	D8 PED CONTRLP	420 9715	14202491302	6.0	6.55	50.05	3.31	53.36	1537.75	8.89
MF22311	747 A/T SERVO	480 9C??	15109520201	0	00	00	00	.00	1019.90	.00
MF22312	747 A/T CMPTR	480 9071	14208520102	2.0	18.50	141.34	116.01	257.35	7642.01	128.65
MF22313	D10 AT-SC CMPTR	421 9059	14203520104	8.0	35.03	267.63	27.80	295.43	10500.00	36.93
MF22314	D10 AT-SC CMPTR	421 9600	14203520105	1.0	4 00	30 56	00	30 56	23000.00	30.56
M-22391	D10 A/T CON PAN	421 9032	13103520001	4.0	12.65	95.89	.00	95.89	4005.57	23.97
MF22429	27 FL/RU PSN IN	420 9061	13507491405	4.0	5.98	45.33	.00	45.33	684.15	11.33
MF22501	D8 YA/ROL ACCEL	420 9179	13302491508	7.0	21.35	161 83	85 74	247 57	406.61	35 37
MF22504	F8 AIR DATA CCM	420 9773	13302491509	.0	.00	.00	.00	.00	7886.78	.00
MF22505	D86 YA/ROL ACCL	420 9056	13302491508	45.0	145.90	1052.45	829.11	1881.56	650.55	41.81
MF22506	D86 ACCEL PTCH	420 9055	13302491508	7.0	21 35	161 83	85 74	247.57	1205.21	35.37
MR22516	D8 ACCEL PITCH	420 9589	13302491508	7.0	21.35	161.83	85.74	247.57	852.49	35.37
MR22517	727 AIR DAT SEN	420 9650	13307491108	3.0	34.50	261.51	29.31-	232.20	4486.03	77.40
MF22518	2737 POSTN SENS	420 7079	13305491502	8.0	34.14	258 79	95 85	354.64	210 32	44.33
MF23221	VHF RECEIVER	530 9198	1410J431201	37.0	249.57	1906.71	664.50	2571.21	1760.16	69.49
MR23231	G8068 VHF PNL	530 2646	1420J431301	29.0	123.03	939.95	607.45	1547.40	307.43	53.36
MR23233	G17281A VHF PNL	530 9006	1420E431303	67.0	137.45	1050.12	268 25	1318.37	434.72	23.13
MF23281	VHF TRANSCEIVER	530 9005	1410E431701	45.0	185.19	1414.85	458.16	1873.01	2595.22	41.62
MR23282	VHF TRANSCEIVER	530 9035	1410J431702	101.0	379.32	2898.01	737.43	3635.44	2415.72	35.99
MR23403	CENTRAL SW UNIT	580 9004	15208432104	4.0	33.50	254.27	.00	254.27	12898.72	63.57
MF23711	RECORDER VOICE	530 9026	1520J433101	847.0	3806.96	27268.74	29919.79	57188.53	937.08	67.52
MF24145	GEN DRV/SBY PWR	420 9502	14109611001	4.0	18.11	138.36	35.95	174.21	2835.10	43.58
MF24230	PNL-GEN C/VR	560 9026	153C2611306	333.0	1357.42	9663.54-	3924.93-	13588.47-	2990.03	40.81
MR24249	GEN CONT UNIT	560 9052	15302611218	14.0	30.38	206.51-	367.55-	574.06-	2138.92	41.00
MR24253	PANEL GEN CONT	560 9032	15307611203	430.0	1149.66	8208.38-	404.77-	8613.15-	4151.68	20.03
MF24254	REGULATOR-VOLT	560 9033	15307611201	55.0	83.35	629.76-	113.52-	743.29-	1171.21	13.51
MR24290	BUS CONT UNIT	586 9014	15303611205	47.0	277.64	2014.60-	880.90-	2895.50-	4021.35	61.61
M-24291	CONTROL-GEN	560 9607	153C9611202	237.0	734.67	5342.51-	4511.47-	9853.98-	3843.21	41.58
MR24293	AC SYS GEN APU	420 9496	14109611002	6.0	19.05	145.54	.00	145.54	3851.77	24.26
MF24297	REG/VOLT	560 9080	153C2611222	173.0	621.47	4428.77-	6218.90-	10647.67-	1205.84	61.55
MF24298	PNL-GEN CONT	560 9081	15302611221	323.0	754.71	5334.99-	4762.71-	10097.70-	3790.00	31.26
MF24299	GEN CONT UNIT	586 9013	15303611201	140.0	693 65	4901 82-	4327 44-	9229 26-	3938.48	65.9[illegible]
M-24312	BATTERY CHARGER	56C 9519	15307612101	102.0	150.65	1097.87-	25.02-	1122.89-	556.93	11.01
MF24316	BATTERY CHARGER	585 9013	15308612102	4.0	35.00	263.28-	21.90-	285.18-	699.13	71.30
M-24317	BATTERY CHARGER	561 7199	15309612102	29 0	25 31	184 29-	33.71-	218.00-	283.03	7.52
-K	BATTERY CHARGER	586 9000	15303612401	11.0	44.31	311.77-	15.04-	326.81-	2131.52	29.71
	BATTRY	F		[illegible].0	48.00	363.84	16.67	380.51	675.11	13.55
	TTT 73747				00	00	.00	.00	.00	.0[illegible]
						44	1113.00	1249.44	1767.24	138.[illegible]
							75.40-	65.23-	757.12	3[illegible].6[illegible]
								35.C0-	2860.07	

APPENDIX D

PAN AMERICAN DATA

Pan American Data

Component Reliability and Maintenance Data

Line Station Support for Avionic Equipment

Operating Restrictions

Maintenance Program

SHOP COST

REF. NASA-1-13654

AFCS COMPONENTS

Major Computers	PA P/N	Mfr P/N	Sample	Qty	Labor MH	Material $
Computer, Pitch	72201	2590622-908	117	3	7.3	48.92
Computer, Roll	72202	2590623-908	120	3	5.9	43.14
Computer, Yaw Damper	72221	1964212-1	35	2	4.7	6.73
Unit, Monitor & Logic	72204	2591027-902	51	1	5.0	16.84
Unit, Auto Stabilizer Trim	72224	2591415-902 Mod A	38	1	7.2	11.08
Computer, Auto Throttle	72220	1964693-1	.5	1	17.1	199.01
Dedicated Sensors						
Accelerometer, Normal	57381	2588696-904 Mod A	--	2	--	--
Box, Accessory Stabilizer Trim	72215/223	65B47519-9	8	1	3.2	0
Box, Accessory #1	72217	65B47520-13	8	1	3.5	0
Box, Accessory #2	72216	65B47521-18	5	1	3.8	1.26
Control/Display Units						
Panel, Mode Select	72222	2590624-924	55	1	4.7	43.59
Control, A/P Flight	72203	2590625-902	10	1	5.3	.41
Light Set, Flight Mode Annunciator	73422	75-0147-9	2	2	5.1	42.44
Indicator, Attitude Director	73407	2590281-905	27	2	8.7	165.77
Shared Sensors						
Receiver, Navigation	73458	522-4280-108	31	2	12.3	4.38
Transceiver, Low Range Radio Alt.	73432	2067631-5114	34	2	7.8	2.35
Unit, Inertial Navigation	73402	7886580-011	14	3	56.6	37.35
Computer, Central Air Data	73460 73404	3757163-1 1903925-3	98 40	2	6.9 6.1	77.65
Coupler, MHR Compass	73412	2591201-911	30	2	12.6	1.67
Servo Components						
Power Pkg, Inboard Elev Control	72703	93600-5027	4	2	162.0	1,981.99
Power Pkg, Inboard Ail Control	72706	3170120-2	2	2	72.4	2,647.29
Power Pkg, Rudder Control	72705	3822000-16	1	2	81.2	10,655.80
Servo, Auto Throttle	72207	1903896-1	0	1	--	--
Elev Feel Computer	70772		3	1	39.5	60.22

PAN AM RELIABILITY July 1, 1977

REMOVAL RATE

AFCS COMPONENTS

REF. NASA-1-13654

Major Computers	PA P/N	Mfr P/N	QTY.	P.R.*	P.R.R.**
Computer, Pitch	72201	2590622-908	3	148	2.389/.794
Computer, Roll	72202	2590623-908	3	149	2.405/.802
Computer, Yaw Damper	72221	1964212-1	2	38	0.613/.306
Unit, Monitor & Logic	72204	2591027-902	1	46	0.743
Unit, Auto Stabilizer Trim	72224	2591415-902 Mod A	1	55	0.888
Computer, Auto Throttle	72220	1964693-1	1	10	0.161
Dedicated Sensors					
Accelerometer, Normal	57381	2588696-904 Mod A	2	0	----
Box, Accessory Stabilizer Trim	72215/223	65B47519-9	1	18	0.290
Box, Accessory #1	72217	65B47520-13	1	6	0.096
Box, Accessory #2	72216	65B47521-18	1	2	0.032
Control/Display Units					
Panel, Mode Select	72222	2590624-924	1	66	1.065
Control, A/P Flight	72203	2590625-902	1	11	0.177
Light Set, Flight Mode Annunciator	73422	75-0147-9	2	3	0.048/.024
Indicator, Attitude Director	73407	2590281-905	2	32	0.516/.258
Shared Sensors					
Receiver, Navigation	73458	522-4280-108	2	103	1.663/.831
Transceiver, Low Range Radio Alt.	73432	2067631-5114	2	55	0.888/.444
Unit, Inertial Navigation	73402	7886580-011	3	258	4.165/1.388
Computer, Central Air Data	73460 73404	3757183-1 1903925-3	2	185	2.986/1.493
Coupler, MHR Compass	73412	2591201-911	2	40	0.646/.323
Servo Components					
Power Pkg, Inboard Elev Control	72703	93600-5027	2	5	0.081/.040
Power Pkg, Inboard Ail Control	72706	3170120-2	2	1	0.016/.008
Power Pkg, Rudder Control	72705	3872000-16	2	1	0.016/.008
Servo, Auto Throttle	72207	1903896-1	1	0	
Elevator Feel Computer	70772		1	1	0.016

* Premature Removal

** Premature Removal Rate

PAN AMERICAN WORLD AIRWAYS

REF. NASA-1-13654

Summary of B747-121, 121F Aircraft Times

No. of A/C	Mo/Yr	Total Hours	Utilization Per Day	Total Cycles/ Mo.	*Departures	Avg. Cycles Per A/C Per Day	Hrs. Per Cycle	Hrs. Per Departure
32	Dec/76	9,895.65	9.98	2496	2271	2.52	3.96	4.4
32	Jan/77	10,364.70	10.45	2621	2385	2.64	3.95	4.3
32	Feb/77	9,339.79	10.42	2387	2172	2.66	3.91	4.3
32	Mar/77	10,432.85	10.57	2701	2458	2.72	3.88	4.3
32	Apr/77	10,583.67	11.02	2720	2475	2.83	3.89	4.3
32	May/77	11,276.87	11.70	2905	2644	2.93	3.88	4.3
Total PA 5824 AP Days		61,943.53	10.64	15830	14405	2.72	3.91	4.3
otal UA 6588 AP Days		53,808.00	8.17	14597	13304	2.22	3.69	4.0

*Departures for PA calculated at same ratio to cycles as UA, i.e. 91%.

PAN AM RELIABILITY July 1, 1977

PAN AM.

RELIABILITY

- B747 AFCS
COMPONENT REPLACEMENT TIMES

MAJOR COMPUTERS

AFCS COMPONENT	72201 PITCH COMPUTER		72207 ROLL COMPUTER		72221 YAW DAMPER COMPUTER		72204 MONITOR & LOGIC UNIT		72224 AUTO STABILIZER TRIM UNIT		72220 AUTO THROTTLE COMPUTER	
	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
OBTAIN REPLACEMENT PART	←30 to 90 Mins→											
REPLACEMENT TIME (IF SIGNIFICANT)	-	-	-	-	-	-	-	-	-	-	-	-
PERFORM BITE TEST OR SYSTEM TEST	-	15	-	15	-	20	-	20	-	20	-	15
TEST EQUIPMENT SET-UP (IF REQUIRED)	-	-	-	-	-	-	-	30	-	30	-	-
AUTOLAND OPERATIONAL CHECK (IF REQUIRED)	-	-	-	-	-	-	-	45	-	45	-	-
RETURN SYSTEM TO NORMAL	-	10	-	10	-	10	-	30	-	30	-	10
TOTAL TASK TIME *	1	25	1	25	1	30	3	05	3	05	1	25

*Assumed average 60 minutes to obtain replacement.

ORIGINAL PAGE IS
OF POOR QUALITY

REF. NASA-1-13654

PAN AM.

B747 AFCS
COMPONENT REPLACEMENT TIMES

DEDICATED SENSORS

AFCS COMPONENT	57381 NORMAL ACCELEROMETER		72215 STABILIZER TRIM INTERFACE UNIT		72217/72223 #1 ACCESSORY BOX		72216 #2 ACCESSORY BOX					
	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
OBTAIN REPLACEMENT PART	← 30 to 90 Mins →											
REPLACEMENT TIME (IF SIGNIFICANT)	-	45	-	-	-	-	-	-				
PERFORM BITE TEST OR SYSTEM TEST	-	-	-	15	-	30	-	30				
TEST EQUIPMENT SET-UP (IF REQUIRED)	-	30	-	-	-	-	-	-				
AUTOLAND OPERATIONAL CHECK (IF REQUIRED)	-	45	-	-	-	-	-	-				
RETURN SYSTEM TO NORMAL	-	10	-	10	-	10	-	10				
TOTAL TASK TIME *	3	10	1	25	1	40	1	40				

*Assumed average 60 minutes to obtain replacement.

ORIGINAL PAGE IS
OF POOR QUALITY

PAN AM.

B747 AFCS
COMPONENT REPLACEMENT TIMES

CONTROL/DISPLAY UNITS

AFCS COMPONENT	72222 MODE SELECT PANEL		72203 A/P FLIGHT CONTROLLER		73422 A/P - F/D ANNUNCIATOR PANEL		73407 ATTITUDE DIRECTOR INDICATOR					
	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
OBTAIN REPLACEMENT PART	← 30 to 90 Mins →											
REPLACEMENT TIME (IF SIGNIFICANT)	–	45	–	–	–	–	–	–				
PERFORM BITE TEST OR SYSTEM TEST	–	30	–	15	–	25	–	20				
TEST EQUIPMENT SET-UP (IF REQUIRED)	–	45	–	–	–	10	–	10				
AUTOLAND OPERATIONAL CHECK (IF REQUIRED)	–	45	–	–	–	–	–	–				
RETURN SYSTEM TO NORMAL	–	10	–	10	–	10	–	10				
TOTAL TASK TIME *	3	55	1	25	1	45	1	40				

*Assumed average 60 minutes to obtain replacement.

REF. NASA-1-13654

PAN AM.

B747 AFCS
COMPONENT REPLACEMENT TIMES

SHARED SENSORS

AFCS COMPONENT	73458 NAVIGATION RECEIVER		73432 LOW RANGE RADIO ALTIMETER XCVR		73402 INERTIAL NAVIGATION UNIT		73460/73404 CENTRAL AIR DATA COMPUTER		73412 MAGNETIC HEADING REFERENCE CPLR			
	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
OBTAIN REPLACEMENT PART	← 30 to 90 Mins →											
REPLACEMENT TIME (IF SIGNIFICANT)	-	-	-	-	-	-	-	-	-	-		
PERFORM BITE TEST OR SYSTEM TEST	-	25	-	10	-	30	-	15	-	10		
TEST EQUIPMENT SET-UP (IF REQUIRED)	-	10	-	-	-	-	-	-	-	-		
AUTOLAND OPERATIONAL CHECK (IF REQUIRED)	-	-	-	-	-	-	-	-	-	-		
RETURN SYSTEM TO NORMAL	-	10	-	10	-	10	-	10	-	10		
TOTAL TASK TIME *	1	45	1	20	1	40	1	25	1	20		

*Assumed average 60 minutes to obtain replacement.

PAN AM.

B747 AFCS
COMPONENT REPLACEMENT TIMES

SERVO COMPONENTS

AFCS COMPONENT	72703 INBD ELEV CNTL PWR PKG		72705 RUDDER CONTROL POWER PACKAGE		72207 AUTO THROTTLE SERVO		72711/70772 ELEVATOR FEEL COMPUTER		70717 CENTRAL LATERAL CNTL ACTUATOR			
	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN	HR	MIN
OBTAIN REPLACEMENT PART	←30 to 90 Mins→											
REPLACEMENT TIME (IF SIGNIFICANT)	8	-	4	-	2	-	2	30	4	-		
PERFORM BITE TEST OR SYSTEM TEST	-	45	-	20	-	15	-	45	-	30		
TEST EQUIPMENT SET-UP (IF REQUIRED)	-	45	-	-	-	-	-	45	-	15		
AUTOLAND OPERATIONAL CHECK (IF REQUIRED)	-	-	-	-	-	-	-	-	-	-		
RETURN SYSTEM TO NORMAL	-	45	-	40	-	10	-	45	-	20		
TOTAL TASK TIME *	11	15	6	-	3	25	5	45	6	05		

*Assumed average 60 minutes to obtain replacement.

REF. NASA-1-13654

ORIGINAL PAGE IS
OF POOR QUALITY

AFCS COMPONENTS INVENTORY VALVE FOR A 32 AIRPLANE FLEET

	PA P/N	Unit Cost	No. Plane	Installed Units	Cost	Spare Units	Fleet
Computer, Pitch	72201	11,647.00	3	96	1,118,112.00	28	326,116.00
Computer, Roll	72202	12,099.00	3	96	1,161,504.00	24	290,376.00
Computer, Yaw Damper	72221	4,510.00	2	64	288,640.00	12	54,120.00
Unit, Monitor and Logic	72204	9,892.00	1	32	316,544.00	16	158,272.00
Unit, Auto Stabilizer Trim	72224	5,690.00	1	32	182,080.00	13	73,970.00
Computer, Auto Throttle	72220	6,500.00	1	32	208,000.00	4	26,000.00
Accelerometer, Normal	57381	660.00	2	64	42,240.00	5	3,300.00
Box, Accessory Stabilizer Trim	72215	2,384.00	1	32	76,288,00	8	19,072.00
Box, Accessory #1	72217	3,386.00	1	32	108,352.00	6	20,316.00
Box, Accessory #2	72216	5,909.00	1	32	189,088.00	6	35,454.00
Panel, Mode Selector	72222	15,120.00	1	32	483,840.00	15	226,800.00
Control, A/P Flight	72203	2,489.00	1	32	79,648.00	7	17,423.00
Servo, Auto Throttle	72207	958.00	1	32	30,656.00	6	5,748.00
				32	4,284,992.00		1,256,967.00
					133,906.00/Plane		39,280.00/ Plane

Total Inventory Cost 5,541,959

Total Inventory/Plane 173,186.00

SUMMARY OF PAA SUPPORT FOR AVIONICS SYSTEMS AT LINE STATIONS

PAA 747 aircraft operate thru 47 locations in addition to the NYC and SFO bases.

Of the 47 classified PAA B747 stations, 14 are in the U.S.A. or possessions and 33 are in foreign countries.

Other type aircraft B707/B727 operate thru 46 additional stations for a total of 93 Pan Am stations. (Attachment - "Pan American Line Stations".) ①

Operating schedules and aircraft patterns are seasonal with two major changes per year in April and November to accommodate passenger demand. Additional minor changes occur during the Spring and Fall months.

During a schedule period, a specific repetitive pattern is assigned to each aircraft in the fleet with provisions for phase-in and phase-out as dictated by scheduled service requirements and equipment breakdowns.

For purposes of denoting station capability for service to the aircraft, including spares provisioning, each station is assigned a classification. Class 1 thru 5. Class 1 having the least capability and Class 5 the greatest. (Attachment - B747 Station Classification List.) ④

Class 5 and 4 stations have capability for full service to all aircraft systems and include avionics specialist crews. Lower classified stations have overall specially qualified personnel, each of whom may do work on all systems including avionics. Continuous training programs maintain personnel qualifications at the required level.

At some locations service to the aircraft is contracted to other airlines or agencies under Pan Am direction.

Some of the factors for determining station classifications and distribution of spares are contained in the attached. (Attachment - Aircraft Spare Parts Allocations - Line Stations.) ⑤

The content of individual station kits may also be adjusted within the assigned classification by selective addition or deletion of parts. Studies have been made

..../

of mathematical concepts for station parts allocations. However, due to practical considerations which cannot be given mathematical values, all require a practical overlay and manual review for optimum parts distribution. (Attachment - Problem Statements, Variables, Relationship, Solution Method.) ⑥

A typical Pan Am spare parts kit publication currently in use is attached. Note the selective variations from the assigned classifications. Also, note a Pool Item number opposite various items. An international organization of some 70 airlines provides for pre-contracted borrows and loans of station spare parts by the various airlines. The concept is mutually beneficial to all participants from a standpoint of economics. (Attachment - Pan Am 747 Line Station Aircraft Parts Kit.) ⑦

An extracted listing shows some typical current station holdings of Automatic Flight Control spares including whether owned by Pan Am or provided by another airline through pooling. (Attachment - 747 Station Parts Allocation.) ⑧

For those avionics parts provisioned mainly by operational/geographic factors and not necessarily related to station size, a completely selective distribution is used using a different kit format. (Attachment - Line Station Avionic Kit.) ⑨

PAN AMERICAN LINE STATIONS

PA OPERATING & MAINTENANCE CONTRACT STATION
* MAINTENANCE CONTRACT STATIONS ONLY

ABIDJAN	ABJ	
ACCRA	ACC	
AMSTERDAM	AMS	
ANCHORAGE	ANC	
ANKARA	ANK	
AUCKLAND	AKL	
BAHRAIN	BAH	
BANGKOK	BKK	
BELGRADE	BEG	
BERGEN	BGO	
BERLIN	BER	
BOGOTA *	BOG	
BOSTON	BOS	
BRASILIA	BSB	
BRUSSELS	BRU	
BUCHAREST #	BUH	
BUDAPEST	BUD	
BUENOS AIRES	BUE	
CARACAS	CCS	
CHARLESTON	CHS	
CHICAGO	ORD	
COPENHAGEN	CPH	
COTONOU	COO	
DACCA *	DAC	
DAKAR	DKR	
DALLAS/FT.WORTH	DFW	
DAMASCUS (S)	DAM	
DAR ES SALAAM	DAR	
DELHI	DEL	
DETROIT	DTW	
DOULA	DLA	
ENTEBBE *	EBB	
FAIRBANKS	FAI	
FRANKFURT #	FRA	
GEORGETOWN	GEO	
GLASGOW	GLA	
GUAM	GUM	
GUATEMALA	GUA	
HAMBURG	HAM	
HONG KONG	HKG	
HONOLULU	HNL	
HOUSTON	HOU	
ISTANBUL #	IST	
JOHANNESBURG	JNB	
KABUL *	KBL	
KARACHI	KHI	
KINSHASA	FIH	
KUALA LUMPUR	KUL	
LAGOS	LOS	
LIBREVILLE	LBV	
LISBON	LIS	
LONDON	LON	
LOS ANGELES	LAX	
MADRID	MAD	
MANAGUA	MGA	
MANILA #	MNL	
MARACAIBO	MAR	
MCGUIRE AFB	WRI	
MELBOURNE	MEL	
MERIDA	MID	
MEXICO CITY	MEX	
MIAMI	MIA	
MONTEVIDEO	MVD	
MOSCOW	MOW	
MUNICH	MUC	
NAIROBI	NBO	
NANDI	NAN	
NUREMBURG	NUE	
OKINAWA	OKA	
OSAKA	OSA	
OSLO	OSL	
PAGO PAGO	PPG	
PANAMA CITY	PTY	
PHILADELPHIA	PHL	
PORT AU PRINCE	PAP	
PORTLAND	PDX	
PORT OF SPAIN	POS	
PRAGUE	PRG	
RIO DE JANEIRO	RIO	
ROBERTS FIELD	ROB	
ROME	ROM	
SAN JOSE	SJO	
SAN JUAN	SJU	
SAN SALVADOR	SAL	
SANTO DOMINGO	SDQ	
SAO PAULO	SAO	
SEATTLE	SEA	
SINGAPORE	SIN	
STOCKHOLM	STO	
STUTTGART	STR	
SYDNEY	SYD	
TAIPEI	TPE	
TAHITI	PPT	
TAMPA	TPA	
TEHRAN #	THR	
TOKYO	TYO	
WARSAW	WAW	
WASHINGTON	WAS	
YOKOTA	OKO	

JUNE 1977

④

747 STATION CLASSIFICATION AUG '97

5	4	3	2	1
LON	FRA	ROM	PPT	BGR
HKG	HNL	DEL	AKL	SNN
LAX	TYO	RIO	FAI	MAD
		GUM	DFW	SJO
		SYD	TPE	
		MNL	AMS	
		PTY	KHI	
		DTW	MUC	
		CLS	BAH	
		SAO	BOS	
		BRU	GUM	
		WAS	BKK	
		SEA	NAN	
		MIA	IST	
		THR	OKA	
		PPG	MEL	
		BOG	PDX	
		CPH	ORD.	
			GLA	
			CLO	
			SIN	
			KUL	

LINE STATION CLASSIFICATIONS

1. Introduction

A. All stations which handle aircraft maintained according to Pan Am Maintenance policies are classified, provisioned, and staffed for each type of aircraft to be serviced according to the degree of service to be rendered.

B. This publication denotes the classifications of all Line Stations for the purpose of allocating spare parts, tool, ground maintenance equipment, and Maintenance Manuals. In addition, Station Maintenance personnel will be qualified to handle the applicable type of aircraft equipment.

C. These classifications are governed largely by Schedule Frequency, Aircraft Routing, Servicing, Maintenance Requirements, and the Station geographic location in relation to supply points. Other considerations are but are not limited to, Crew change point, Passenger Density, Locked Pattern Aircraft, Main Base for another airline, Special navigational problems, Commissary provisioning point, etc. A station may hold any combination of classifications depending on the above variables as they affect each type of aircraft.

D. Flight spare parts kit handling is detailed in TOM 30-05-35.

2. Description of Classifications

Class 5 - High frequency station staffed, stocked and equipped to perform transit and A services. May perform scheduled time limited services and include support shop activities, provide maintenance support at other locations, scheduled non-routine maintenance during layover periods. Staffing may include an inspection unit.

Class 4 - High frequency station staffed, stocked and equipped to perform transit and A services. Non-routine maintenance limited to minimum equipment list continued items and those affecting passenger comfort/convenience. May provide area support to other stations.

Class 3 - Moderate frequency station staffed, stocked and equipped to perform transit and/or A services. These stations normally handle higher frequency than class 2 and/or are isolated from nearby support from another station. Non-routine maintenance limited to mandatory items.

ORIGINAL PAGE IS
OF POOR QUALITY

Class 2 - Low or moderate frequency station with limited maintenance personnel and spare parts. These stations normally handle a higher frequency than class 1 or are more isolated from stations of a higher classification, or both.

Class 1 - Low frequency transit or alternate station with limited or no maintenance personnel and spare parts. These stations are normally located within close proximity to stations of higher classification and in some cases handle diversions only.

AIRCRAFT SPARE PARTS ALLOCATIONS - LINE STATIONS

I. OBJECTIVE

(a) To provide, at the most reasonable cost, the spare parts needed to satisfy demands at specific locations in order to maintain schedules, provide for passenger comfort and insure the mechanical integrity of the aircraft while operating away from main base locations.

(b) To facilitate periodic re-analysis of parts levels, so that they reflect current operating requirements and removal rates

III DETERMINING STATION CLASSIFICATIONS

The following factors are considered in determining the classification of each station for spare parts allocations:

1. Type of equipment
2. Frequency of flights.
3. Service requirements (Transit - A - B etc).
4. Termination and/or layover locations.
5. Jump-off point (over water or long overland).
6. Flight crew change or slip point.
7. Proximity to base or large station
8. Aircraft routing (locked pattern considerations)
9. Technical personnel assigned (Maintenance resources).
10. Maintenance facilities (Maintenance resources).
11. Through-flight maintenance station.
12. Main base - other operator:
    1. Similar equipment.
    2. Non-similar equipment.
13. Station or airport geographic conditions (i.e. field elevation, extreme climatic conditions).
14. Passenger loads - seasonal traffic.

continued...

ORIGINAL PAGE IS
OF POOR QUALITY

15. Commissary provisioning point.

16. Configuration change point.

17. Geographic remoteness.

18. Equipment substitution (historical and/or probable).

19. Geographical coverage.

    (a) EMG (engine and/or EMG crew)

    (b) Parts.

    (c) Maintenance

20. Operational and Navigational requirements.

21. Delay or flight cancellation impact.

    (a) Passenger loss.

    (b) Flight crew time limitation.

    (c) Airport curfew

    (d) Passenger considerations (hotels etc.).

22. Multiple models of FAA aircraft operating into or through station.

23. FAA Maintenance Contract support station (i.e. MNL - [illegible] etc)

24. Cover aircraft availability.

25. Schedule aircraft ground time - assigned aircraft washing, C.R., and appearance work.

26. Flight kit supplements - peculiar to specific aircraft or small number of aircraft.

27. Three engine ferry practicability.

IV DETERMINING KIT CONTENT

Factors considered in determining what specific parts are included in station kits, selective supplements and/or flight spares kits

1. MEL/CDL publications (go, no-go list).

continued. ....

2. Unit reliability (failure rate).

3. Unit cost vs. delay cost/exposure.

4. Unit replacement time (elapse time).

5. Redundancy of system or parts.

6. Passenger convenience items.

7. Crew convenience items.

8. Spare engine allocation (parts source-robbing).

9. EA's planned - parts effect.

10. QCA's or QCSI's - parts required and or parts exposure.

11. Pooling considerations (provide or participate).

12. Special tools or equipment required.

13. Number of aircraft vs. number of units required vs. flight spare kit allocation.

14. C.I. clean up responsibility (aircraft).

15. Appearance and cabin C.I. clean up responsibility.

16. Support from nearby station.

17. Operational penalty.

18. Usage rates

    (a) Probability factor of failure rate at station.

19. Resupply point.

V. INFORMATION SOURCES

Some or all of the following information sources are used to determine spares allocations:

1. Unscheduled removal inputs.
2. Line Station turnover information.
3. Engineering failure rate (reliability) estimates.
4. Operating plan.

continued........

ORIGINAL PAGE IS
OF POOR QUALITY

5. Minimum Equipment List (1-5-0).
6. Configuration Deviation List (1-5-1).
7. Restricted Flight Assignments (QXI). Publication (1-5-5).
8. Crew scheduling.
9. Monthly Maintenance Reports.
10. Rapid microfilm.
11. Vendors publications.
12. Parts manuals.
13. Overhaul manuals.
14. Wiring manuals.
15. Component manuals.
16. Repairable parts manuals.
17. Maintenance manuals.
18. Training manuals.
19. Line station recommendations.
20. Main Base experience (inputs).
21. Flight Operations experience (inputs).
22. Surplus information from Component Control.
23. Component Control reviews (prior new purchases).
24. Component Overhaul shop experience.
25. Tooling Documents.
26. Direct contact with other airlines.
27. For new type aircraft - like item or presen. aircraft.
28. Maintenance Delay Reports:
    (a) Delay causes.

continued.....

(b) N I.S delays.

(c) Non-kit delays.

29. Technical Operations Control Center experience recommendations

(a) Logistics for follow up maintenance.

(b) Lending/Borrowing activity.

(c) Chronic Technical problem.

30. Manufacturers spares recommendations.

31. Prolonged period no-usage inputs from stations.

ORIGINAL PAGE IS
OF POOR QUALITY

PROBLEM STATEMENTS
VARIABLES
RELATIONSHIPS/SOLUTION METHOD

PROBLEM STATEMENTS:

1. What is the probability that a demand will be made? (Assuming no regeneration).

2. What is the probability that demands will exceed the allocated quantity in an interval of time? (assuming a regenerative process).

VARIABLES:

1. Lambda - T (λ_T) = (1/MTBR) (Total Hours per week).
2. Lambda - s (λ_s) = (1/MTBR) (Total Hours per week into a location).
3. T-Out (τ out) = (Out-transit time to a location.
4. Dτ-BAR ($\overline{D\tau}$) = Mean waiting time (for a unit to be produced).
5. Tsubs (Ts) = Total support time (τ_{out} + $\overline{D\tau}$).
6. Ssub c(Sc) = Shop cycle time.
7. P = Steady-state in-process quantity (Sc X λt)
8. Isub τ (I_τ) = Intransit time.
9. I = Steady-state intransit quantity ($I_\tau \lambda_T$).
10. Mu (μ) = Expected demands during resupply time (λ_s X Ts).

RELATIONSHIPS:

1. The probability of no demands when the allocation is 0:
   $P(x=0;\lambda) = (e^{-\mu})$

2. The probability that the number of demands will not exceed an allocation:
   $P(x \leq s;\lambda) = \left(\sum_{i=0}^{s} \frac{e^{-\mu}\mu^{i}}{i!}\right)$

ORIGINAL PAGE IS
OF POOR QUALITY

Pan American World Airways, Inc.

* ATA CHAPTER INDEX REPAIRABLE COMPONENT *
ATA CHAPTER 22 - AUTO PILOT

LINE STATION 747 A/C PART KIT

DATE:

PAGE:

CLASS	MANUFACTURER'S PART NUMBER	PAA CODE NUMBER	DESCRIPTION	UNIT OF ISSUE	UNIT COST	TYPE AIRCRAFT	STATION ALLOCATION								POOL ITEM NUMBER
									SFO	5	4	3	2	1	
411	2588696-904MOD	057381	Accelerometer Auto Pilot	ea	660.00	25 27 26			1						83
411	2590622-908	072201	Computer Pitch Auto Pilot	ea	11647.00	25			4	1	1				78
									SAO 001	GUM 001	LAX +1	HNL +1	HKG +1	ROM 001	
									SYD 001	SEA 1	TYO +1				
411	2593545-905	072202	Computer Roll Auto Pilot	ea	12099.00	25			4	1	1				79
									HKG +1	ROM 001	GUM 001	SYD 001	SAO 001	LAX +1	
									HNL +1	SEA 1					
411	2590625-902	072203	Controller Auto Pilot	ea	2489.00	25			1	1	1		SAO 001	SEA 1	81
411	2591027-902	072204	Unit Monitor Logic	ea	9892.00	25			2	1	1	SEA 1	TYO +1		82
									SYD 001	GUM 001	ROM 001		HNL +1	SAO 001	
405	1903896-1	072207	Servo Auto Throttle	ea	958.00	25			1						77
121	65B47519-9	072215	Unit Assy Accy Stab Trim	ea	2384.00	25			1	1					87
									FRA 001	HNL 001					
121	65B47521-18	072216	Accy Unit 2 Auto Pilot	ea	5909.00	25			1						88
									LAX 001						
405	1964693-1	072220	Computer Auto Throttle	ea	6500.00	25			1						76
405	1964212-1	072221	Computer Yaw Damper	ea	4510.00	25			1	1					75
									HNL 001	ROM 001					

9257-2057B

Pan American World Airways, Inc.

* ATA CHAPTER INDEX REPAIRABLE COMPONENT *

ATA Chapter 22 - Auto Pilot

LINE STATION 747 A/C PART KIT

DATE:

PAGE:

CLASS	MANUFACTURER'S PART NUMBER	PAA CODE NUMBER	DESCRIPTION	UNIT OF ISSUE	UNIT COST	TYPE AIRCRAFT	STATION ALLOCATION							POOL ITEM NUMBER
								SFO	5	4	3	2	1	
411	2590624-924	072222	Panel Sel Auto Pilot	ea	15120.00	25		2	1					
								HNL 001						
121	65847520-14	072223	Accy Unit 1 Auto Pilot	ea	3386.00	25		1	1					89A
								HNL 001						

Pan American World Airways, Inc.

* ATA CHAPTER INDEX REPAIRABLE COMPONENT *
ATA CHAPTER 34 - NAVIGATION

747
LINE STATION A/C PART KIT

DATE:

PAGE:

CLASS	MANUFACTURER'S PART NUMBER	PAP CODE NUMBER	DESCRIPTION	UNIT OF ISSUE	UNIT COST	TYPE AIRCRAFT	STATION ALLOCATION								POOL ITEM NUMBER
									SFO	5	4	3	2	1	
000	7883460-031	073401	Unit Display Ins CDU	ea	50210.00	25			3	2	1				G782
									HKG -1	HNL +1	RIO 001				
000	7883450-041	073402	Unit Navigation INS	ea	73850.00	25			2	2	1				G783
										HNL +1	TYO +1	RIO 001			
000	A12158-1	73460	Computer Central Air Data	ea	14926.00	25			4	2	1				576
									ROM 001	SYD 001		GUM 001	SAO 001	THR 001	
									DEL 001	SEA 002	HNL +1	HKG +1	TYO +1		
000	2590281-905	C[illegible]07	Ind Attitude Director	ea	652600	25 KUL 0	DFW 0	MUC 0	2	2	1	1	1	CPH 0	578B
							BOS 0	PDX 0		HNL +1	BOG 0	CLO 0	ORD 0	GLA 0	
411	A12345-1	73462	Coupler Magnetic Compass	ea	4232.00	25 23 21 24			2	2	1	SEA 1	BRU 1	AMS 1	561
										RIO 001	GUM 001	SYD 001	HNL +1	ROM 001	
605	75-0147-9	073422	Annunciator Flt Mode	ea	646.00	25			1	1	1				91

ORIGINAL PAGE IS
OF POOR QUALITY

⑧

747 STATION PARTS ALLOCATION

LASS	PART NBR	DESC.	STN	QTY	REMARKS
411	2588696-904 MOD	ACCELEROMETER	SFO	1	
411	2590622-908	COMPUTER, PITCH	SFO	4	
			LON	1	PROVIDE POOL
			HKG	2	
			LAX	2	PROVIDE POOL
			FRA	1	
			HNL	2	SHARE POOL (1) UA
			TYO	2	SHARE POOL (1) JL
			SAO	1	
			GUM	1	
			ROM	1	
			SYD	1	
			SEA	1	SHARE POOL (1, NW
			BRU	1	SHARE POOL(1) SN
411	2593545-905	COMPUTER, ROLL.	SFO	4	
			LON	1	SHARE POOL (1 BA
			HKG	2	
			LAX	2	
			FRA	1	
			HNL	2	SHARE POOL (1) UA
			TYO	1	SHARE POOL (1) JL
			ROM	1	
			GUM	1	
			SYD	1	
			SAO	1	
			SEA	1	SHARE POOL (1) NW
			BRU	1	SHARE POOL (1)

747 STATION PARTS ALLOCATION

CLASS	PART NBR	DESC.	STN	QTY	REMARKS
411	2590625-902	CONTROLLER, A/P	SFO	1	
			LON	1	
			HKG	1	
			LAX	1	
			FRA	1	
			HNL	1	
			TYO	1	
			SAO	1	
			SEA	1	
411	2591027-902	UNIT, M + L.	SFO	2	
			LON	1	
			HKG	1	
			LAX	1	
			FRA	1	
			HNL	2	
			TYO	2	
			SEA	1	
			SYD	1	
			GUM	1	
			ROM	1	
			SAO	1	
405	1903896-1	SERVO, AUTO THROTTLE	SFO	1	

⑨

LINE STATION AVIONIC KIT

CLASS	PART NUMBER	CODE	DESCRIPTION	UNIT COST	POOL ITEM NUMBER
000	2067631-5114	73432	Altimeter Unit. ALA-51A	5157.00	G-451

TYPE AIRCRAFT			
720-023B -10		707-321B-19	x
707-139 -11		727-21 -27	x
707-321C -14	x	727-21C -28	x
707-321 -16		747-121 -25	x
720-030B -17		747SP -21	
707-121 -15			

CONTAINER NUMBER

KCR NUMBER					
304	450	585			
330	443	600			
377	511	637			
379	531				
416	556				
431	579				

REMARKS :

	TOTAL	POOL			TOTAL	POOL			TOTAL	POOL			TOTAL	POOL			TOTAL	POOL			TOTAL	POOL	
		TO	FROM			TO	FROM			TO	FROM			TO	FROM			TO	FROM			TO	FROM
ABJ								GUA				MAR											
ACC								GUM	1							PAP				SFO	8		
AKL	1			CCS								MEL											
AMS								HAM				MEX								SIN			
AMM																							
ANC				COO								MGA				PDX				SJO			
ANK				CPH				HKG	1			MIA	2			PHL				SJU			
				DAM				HNL	2			MID				POS							
				DAR				HOU				MNL				PPG				SNN			
BAH				DAC																			
				DEL				IST				MOW				PPT							
BAQ				DKR				JFK								PRG				STR			
				DLA				JKT															
				DPS				JNB				MUC				PTY							
				DFW				KBL															
BEG				DTW				KUL				MVD				RIO	1			SYD	1		
BER	3			DUS								NAN				ROB				THR			
BEY								KHI								ROM				TPA			
BGO				FAI				LAX	2											TYO	2		
BOG												NBO								TPE			
BKK								LBV								SAL							
BOS				FIH				LIS				NUE				SAO				WAS			
BRU				FPO				LON	6	1		OKO								WAW			
BSB				FRA	3			LOS				ORD				SDQ				WRI			
BUD												OKA											
BUE				GEO				MAD				OSA				SEA	1						
BUH				GLA								OSL											

DATE: 6/10/77

PAGE: 34-6-[illegible]

LINE STATION AVIONIC KIT

CLASS	PART NUMBER	CODE	DESCRIPTION	UNIT COST	POOL ITEM NUMBER
00C	522-4280-108	73458	Receiver, VHF NAV 51RV -2B	4152.00	G-310 G-308

TYPE AIRCRAFT				CONTAINER NUMBER	KCR NUMBER					
720-023B -10		707-321B-19		7A	293	395	481	637		
707-139 -11		727-21 -27			302	450	494			
707-321C -14		727-21C -28			304	441	528			
707-321 -16		747 -25	x		310	447	551			
720-030B -17		747SP -21	x		325	470	593			
707-121 -15					363	479	623			

REMARKS:

Group B stations reorder from JFK

	TOTAL	POOL			TOTAL	POOL			TOTAL	POOL			TOTAL	POOL			TOTAL	POOL			TOTAL	POOL	
		TO	FROM			TO	FROM			TO	FROM			TO	FROM			TO	FROM			TO	FROM
BJ								GUA	1			MAR											
ACC								GUM	1							PAP				SFO	3		
AKL	1			CCS	1			HAJ				MEL	1										
AMS	1							HAM				MEX								SIN	1		1
AMM																							
ANC				COO								MCA				PDX				SJO			
ANK				CPH	1		1	HKG	2			MIA	1		1	PHL				SJU			
				DAM				HNL	2			MID				POS							
				DAR				HOU				MNL	1		1	PPG	1			SNN			
				DAC																			
BAH	1		1	DEL	1			IST				MOW				PPT	1						
BAQ				DKR				JFK								PRG				STR			
				DLA				JKT															
				DPS				JNB				MUC	1		1	PTY	1						
				DFW	1			KBL															
BEG				DTW	1			KUL				MVD				RIO	1			SYD	2		1
BER				DUS								NAN	1			ROB				THR	1		
BEY								KHI	1		1					ROM	1		1	TPA			
BGO				FAI	1			LAX	2											TYO	1		
BOG												NBO								TPE	1		
BKK	1							LBV								SAL							
BOS	1		1	FHI				LIS				NUE				SAO	1			WAS	1		
BRU	1		1					LON	3			OKO								WAW			
BSB				FRA	3		1	LOS				ORD	1		1	SDQ				WRI			
												OKA	1										
BUE				GEO				MAD				OSA				SEA	1						
				GLA	1							OSL											

DATE: 6/10/77

PAGE: 34-1-20

ORIGINAL PAGE IS
OF POOR QUALITY

RETURN OR REUSE (ROR) PROGRAM

1. Scope

This publication describes the RETURN OR REUSE (ROR) Program, the method of determining serviceability of ROR units, and the handling and tagging of removed units.

2. Policy

A. The ROR Program permits the direct return to stock of components or parts that have been removed in the course of correcting a non-routine discrepancy but have subsequently been found serviceable.

B. The ROR Program may be applied whenever a line-replaceable component or part cannot be functionally checked on the ground and subsequent in-flight analysis is needed to confirm corrective maintenance action.

NOTE: Restrictions specified by the applicable 1-5-0 publication must be observed.

C. The Maintenance Supervisor has been assigned the authority and responsibility to certify the serviceability of ROR Units returned to stock.

D. The serviceability of an ROR Unit is established prior to its return to stock and is based on one or more of these methods:

(1) Maintenance Analysis, I.E., visual examination, review of Aircraft Maintenance Log, etc.

(2) Functional Check

(3) Operational Check

(4) Bench Check.

E. Removed ROR Units, while awaiting analysis or check, must be considered unserviceable and segregated from serviceable units. The quarantined unit must be identified as "ROR Unit Awaiting Analysis" and remain under the control of the Maintenance Supervisor until its serviceability has been confirmed.

F. Components and Repairable Parts are tagged per standard practices except that "ROR HANDLING" should be entered on "B" Stub of removed unit.

(1) On units found serviceable and being returned to inventory the Mechanic must enter on "B" Stub in WORK ACCOMPLISHED space "Serviceability Confirmed per TOM 30-20-45" and sign WORK ACCOMPLISHED BY. The Maintenance Supervisor must sign the OK TO INSTALL space on "B" and "C" Stubs and handle per TOM 30-15-05.

(2) If removed unit is obviously unserviceable (e.g. housing cracked, leaking seals, sealed adjustments broken, etc.) return unit to Prime Supply point. If unit is not obviously unserviceable, request FEO to confirm corrective action via Pan-Op Radio.

3. Procedure

A. Replace component/part per applicable Maintenance Manual Publication.

B. Request that the FEO confirm corrective action via Pan-Op Radio during the next flight leg.

C. Response from FEO via Pan-Op should be received within 20 minutes after departure, if no reply is received send Telex per Figure 1 to next Downline Station requesting confirmation.

D. If confirmation of the corrective action is dependent upon inflight operation of the corrected system (e.g. autopilot or navigational systems) or where telecommunication problems exist, the request may have to be directed to Stations beyond the next Downline Station.

NOTE: If reply not received within 4 hours after aircraft arrival at Downline Station, send follow-up message. If reply not received in a reasonable time consider the part unservicable and return to Prime Supply Point. On "B" Stub of component or repairable tag, in addition to discrepancy information, note, "ROR Reply Not Received".

E. Upon receipt of the confirmation request from an Upline Station, the Senior Maintenance Supervisor reviews the A/C Maintenance Log and discusses the performance of the corrected system with the Flight Crew. Based on his findings, the Senior Maintenance Supervisor prepares an appropriate reply per Figure 1.

NOTE: If the request refers to an A/C that has already transited or was diverted to another Station, the request must be redirected to the next Station that can provide the confirmation. Copy NYCMJ and MM at Station that originated message.

F. If response from Downline Station indicates that discrepancy was corrected, quarantined unit must be returned to Prime Supply Point; if discrepancy was not corrected, unit may be returned to local inventory.

QF (Downline Station) MMPA

(Originating Station) MMPA (File Time)

ROR (Key Word) C/N (Code Number if Applicable)

S/N (Serial Number if Applicable) POS (Position) INSTALLED

N (A/C Reg. Number) FLT (Number and Date) TO CORRECT

(Quote Log Item and Give Details on Checks and Corrective

Action Taken). ADVISE IF OUR ACTION CORRECTED

(CONFIRMATION REQUEST)

QF ____________________ MMPA

(Originating Station) MMPA (File Time)

ROR YT (File Time of Message from Upline Station)

N (A/C Reg. Number) FLT (Number and Date)

ACTION (Enter "Corrected" or "Did not Correct"

as Applicable).

(CONFIRMATION REPLY)

Sample Teletype Message
Figure 1

END

RELEASE OF AIRCRAFT WITH RESTRICTED FLIGHT ASSIGNMENT

1. General

A. Systems or units, when partially or wholly inoperative or replaced by substitute units, can cause restrictions to station dispatch or down line schedule freedom of the aircraft involved. This publication lists systems or units involved and describes notification requirements.

B. Sections 3 and 4 supplement, but do not replace Aircraft Minimum Equipment List (MEL) For Flight Release, 1-5-0, Configuration Deviation List, 1-5-1 or other Maintenance Manual Publications.

2. Notification Requirements

A. When an aircraft is released by Maintenance with a restriction to its schedule freedom, Maintenance will immediately notify affected functions as follows:

(1) Prior to aircraft departure, notify Sta. Operations office of all details of restriction, since restriction may require flight plan revision.

(2) Prepare a wire message addressed to QXIOWPA and QXMMMPA. Use priority QF.

NOTE: This action will cause Communications to switch message to all flight Dispatch Centers plus NYCOXPA, NYCMJPA, FRAMMPA, LONMMPA, NYCMMPA, MIAMMPA, LAXMMPA, SFOMMPA, HNLMMPA AND TYOMMPA.

(3) Include all pertinent data such as aircraft number, etc. Add the specific MEL/CDL ATA section and item numbers to end of message.

(4) Describe in detail conditions causing restriction.

(5) Enter item in Continued Item section of Aircraft Maintenance Log, TOM 15-10-05.

(a) Include the following additional information in the continued item entry in double space block letters:
QXI SENT
This entry advises that it is a restricting item and confirms that a telex message has been sent per item (2) above.

NOTE: This is necessary in order that the aircraft may be restored to normal scheduling pattern.

(6) Sample message: QF QXIOWPA, QXMMMPA

.BEYMMPA 011519

N732PA RELEASED FLT 00201 WITH CENTER TANK

FUEL BOOST PUMP INOPERATIVE. MEL 28-2.

ORIGINAL PAGE IS
OF POOR QUALITY

B. When corrective action has been accomplished on an item which caused aircraft schedule restriction, Maintenance will immediately notify affected functions as follows:

(1) Prepare a wire message addressed to QXIOWPA and QXMMMPA as outlined in 2.A., (1) thru (4).

(2) Enter corrective action in Continued Item section of Aircraft Maintenance Log, TOM 15-10-05.

(a) Indicate in corrective action entry that the required message has been sent by the following statement in double space block letters: QXI LIFTED.

(3) Sample message: QF QXIOWPA, QXMMMPA

.THRMMPA 021535

N732PA FLT 00201 CENTER TANK FUEL BOOST

PUMP REPLACED SYSTEM CHECKS OK.

3. Conditions Which May Result In Restricted Flight Assignment

A. The following is a list of systems and units which, when partially or wholly inoperative or replaced by substitute units, can cause an aircraft to be operated with restricted flight assignments.

SYSTEM	REFERENCE	POSSIBLE RESTRICTION
21 AIRCONDITIONING & PRESSURIZATION		
Outflow Valves - Cabin Pressure Control System - Automatic Control Manual Control	1-5-0	May restrict to unpressurized flight and limit lower cargo compt. loading.
Cabin Alt. Warning Horn System	1-5-0	Limits flight altitude
Main Equip. Ctr. Cooling Flow Control Valve	1-5-0	Reduces range over water.
Flight Deck Equip. Cooling Dump Valve	1-5-0	Reduces range over water.
Galley/Lav Vent Valve	1-5-0	Limits flight altitude.
Cabin Pressure Relief Flapper Doors	1-5-1	Reduces performance and structurally limited weight requirements.
Ram Air Outlet Assemblies	1-5-1	Reduces performance and structurally limited weight requirements. Affects fuel requirements.
Aft Cargo Heating System Inoperative	NONE 1-5-0	Prohibits carriage of live animals.
Ram Air Inlet Doors	1-5-1	Reduces performance and structurally limited weight requirements. Affects fuel requirements.
Ram Air Vent Heater (200C and 100F)	1-5-0	Affects crew equipment for cold air.
22 AUTO FLIGHT CONTROL		
Auto-Pilot	(See Section 4) 1-5-0	Affects landing minimums.
Autopilot Disengaged Lights	1-5-0	May restrict use of Autoland operation.

ORIGINAL PAGE IS
OF POOR QUALITY

SYSTEM	REFERENCE	POSSIBLE RESTRICTION
33 LIGHTS		
Passenger Notice Signs	1-5-0	Affects Passenger Seating/Notification requirements.
Wing Illumination Light Covers	1-5-1	Reduces performance and structurally limited weight requirements.
Overwing Emergency Light Covers	1-5-1	Reduces performance and structurally limited weight requirements.
Wing Illumination Light	1-5-0	Requires portable lamp for night operations in icing condition.
34 NAVIGATION		
Flight Director Systems	1-5-0	Affects weather minimums.
Master Instrument Warning Sys.	1-5-0	Affects weather minimums.
Flight Mode Annunciator	1-5-0	Affects weather minimums.
Distance Measuring Equip.	1-5-0	Affects operating routes.
Weather Radar	1-5-0	Changes route to avoid hazardous weather.
ADF Radio Compass	1-5-0	Requires extra fuel for alternate.
VHF Navigation Receivers - VOR/ILS	1-5-0	Affects ILS minimums.
Low Range Radio Altimeter	1-5-0	Affects weather minimums.
ATC Transponder (and Altitude Reporting System)	1-5-0	Requires notification in flight plan.
Inertial Navigation System (Navigational Info Only)	1-5-0	Changes route if predicated on INS.
Mach Indicators	1-5-0	Limits flight altitude.

SYSTEM	REFERENCE	POSSIBLE RESTRICTION
34 NAVIGATION (Cont'd)		
Mach/Airspeed Warning System	1-5-0	Restricts airspeed.
Standby Attitude Indicator	1-5-0	Affects VFR flights.
Magnetic Heading Reference System	1-5-0	Affects IFR and VFR flight.
Central Air Data Computer Systems	1-5-0	Limits flight altitude.
Automatic Altitude Reporting	1-5-0	Same as for ATC·Transponder
35 OXYGEN		
Passenger and Crew Oxygen Sys.	1-5-0	Limits flight altitude.
Portable Oxygen Bottles (Bottle and Mask)	1-5-0	Limits flight altitude.
36 PNEUMATIC SYSTEM		
Bleed Air Precooler Systems (Temp. control function)	1-5-0	Restricts flight operation into icing conditions.
Intermediate Bleed Check Valves	1-5-0	Restricts flight operation into icing conditions.
Engine Bleed Air Systems	1-5-0	Restricts flight operation into icing conditions.

ORIGINAL PAGE IS
OF POOR QUALITY

(c) 1 each Monitor and Logic Unit.

(d) 1 each Mode Select Panel.

(e) 1 each Automatic Stabilizer Trim Unit.

(f) 2 each HZ-6F indicators (with Flight Director and expanded localizer needles).

(g) 2 each Flight Mode Annunciators.

(h) AFCS Accy Boxes #1 and #2 and Stab Trim Accy Box.

(3) Low Range Radio Altimeter Systems.

(a) A Decision Height (DH) light for each pilot's panel.

(b) 2 each low range altimeter systems.

(4) Central Air Data Systems.

(a) 2 each Central Air Data Systems.

(5) Rain Repellent Systems.

(6) Central Instrument Warning System.

(a) 1 each CIWS Computer.

(b) 2 each Warning Light Modules.

Contents

For	Refer to	Section
SP Certificate Limitations	Supplement	244.040
200C Certificate Limitations	Supplement	254.040
100F Certificate Limitations	Supplement	254.045

ORIGINAL PAGE IS
OF POOR QUALITY

LOCATION GUIDE FOR MEL ITEMS IN NONOBVIOUS LOCATIONS

Oct 28, 1976

Minimum Equipment List (MEL)

AIRCRAFT MINIMUM EQUIPMENT LIST (MEL) FOR FLIGHT RELEASE

ATA CHAPTERS

21— AIRCONDITIONING & PRESSURIZATION
22— AUTOPILOT
23— COMMUNICATIONS
24— ELECTRICAL POWER
25— EQUIPMENT & FURNISHINGS
26— FIRE PROTECTION
27— FLIGHT CONTROLS
28— FUEL
29— HYDRAULIC POWER
30— ICE & RAIN PROTECTION
31— INSTRUMENTS
32— LANDING GEAR
33— LIGHTS
34— NAVIGATION
35— OXYGEN
36— PNEUMATIC
49— AIRBORNE AUX POWER
52— DOORS
73— ENGINE FUEL & CONTROL
74— ENGINE IGNITION
75— ENGINE AIR
76— ENGINE CONTROLS
77— ENGINE INDICATING
78— ENGINE EXHAUST
79— ENGINE OIL
80— ENGINE STARTING
82— ENGINE WATER INJECTION

GENERAL

An airplane is type certificated with all required equipment in an operating condition. However, the FAA permits revenue dispatch with some of these items inoperative when the remaining operative instruments and equipment provide for continued safe operations.

This section lists instruments and items of equipment which the FAA allows to be inoperative, and highlights some of the units and systems which must be operative.

For the sake of brevity, the MEL does not include obviously required items such as wings, rudders, flaps, engines, landing gear, etc. Also, the list does not include items which do not affect the airworthiness of the aircraft such as galley equipment, entertainment systems, passenger convenience items, etc. However, it is important to note that all items which are related to the airworthiness of the aircraft and not included on the list are automatically required to be operative.

An inoperative instrument or item of equipment not listed in this publication on which there may be a question of airworthiness is to be referred to the appropriate Operations Headquarters authority through NYC Technical Operations Control Center (Tech Center).

Training and ferry flights may be dispatched, when necessary, with less than the equipment herein specified provided all equipment required to assure airworthiness and all equipment expected to be utilized on the flight is operable. This determination will be made by the appropriate Operations Headquarters Authority.

RESPONSIBILITY

It shall be the joint responsibility of the incoming captain, flight engineer, and senior maintenance supervisor to determine that all required maintenance is programmed prior to next flight. The minimum equipment list is designed to provide coverage for individual inoperative items in non-related systems. No publication can adequately cover the innumerable combinations of multiple discrepancy items which may require attention in order to conduct a flight safely. It is particularly in this area of multiple discrepancies and especially discrepancies in related systems, that good judgment, based on the circumstances of the case, including climatic and enroute conditions, must be used in deciding to hold or release a flight. The decision of the captain in command of the flight to have allowable inoperative items corrected prior to flight will take precedence over the provisions contained in this publication.

ACTION

When the airplane is to be operated with any instrument or item of equipment inoperative, the pilot in command shall comply with the approved procedures specified in the Aircraft Operating Manual for such operation.

Appropriate action must be taken to assure that no secondary hazard can be introduced by an inoperative component. Therefore, the cause of the trouble must be neutralized, if necessary, by disconnection or removal in order to eliminate any further failures in the system involved.

Inoperative or malfunctioning instruments or items of equipment must be adequately placarded at the appropriate control or instrument. An entry shall also be made in the appropriate section of the Aircraft Maintenance Log detailing any inoperative instrument or item of equipment. The Continued Item entry must include instructions to notify interested groups when continued item has been corrected; (MM 1-5-5 and FOM chapter 8, Aircraft Airworthiness).

RELEASING AIRCRAFT WITH ITEMS INOPERATIVE

If a flight is to be released with an inoperative (inop) item or items, the flight engineer will advise all other crewmembers whose work may be affected in any way by the inoperative item. The senior maintenance supervisor shall notify the Operations office who shall notify the next responsible dispatch center of items affecting clearance or passenger service. See MM 1-5-5 for notification requirements for Release of Jet Aircraft with Restricted Flight Assignments.

DEFINITIONS

- **Extended overwater operation** means a flight conducted over water at a distance in excess of 50 nautical miles from the nearest shore line.
- **VFR flight conditions** means VFR atmospheric conditions for the area of flight and does not pertain to the dispatch release, flight plan or clearance.
- **Icing condition** means the atmospheric environment is such that ice can form on the aircraft or in the engine.
- **Inoperative** means any time a system and/or component malfunctions to the extent that it does not accomplish its intended purpose and/or is not consistently functioning within its designed operating limit(s) or tolerance(s).

WEIGHT AND FUEL PENALTIES

Several MEL items require reduction of takeoff, landing and enroute weights and the addition of extra fuel. The application of these weight and fuel penalties is described below.

TAKEOFF WEIGHT PENALTY

The takeoff weight penalty is subtracted from the performance limited TOGW (not the max structural TOGW). With long runways and/or cool OAT's, the performance limited TOGW can be high enough to absorb the weight penalty and still permit takeoff at the maximum structural TOGW.

- If the MEL item specifies only one takeoff weight penalty, it is subtracted from both the TOGW limited by runway and TOGW limited by climb.
- Some MEL items specify one takeoff weight penalty for TOGW limited by runway and another for TOGW limited by climb; in this case, subtract each penalty from related TOGW.

LANDING WEIGHT PENALTY

The landing weight penalty is subtracted from the performance limited LGW (not maximum structural LGW). With long runways and/or cool temperatures, the performance limited LGW can be high enough to absorb the weight penalty and still permit landing at the maximum structural LGW.

- When the penalty is given in pounds, it is subtracted from the LGW limited by climb (not LGW limited by runway).
- When the penalty is given in feet, it is subtracted from the available landing field length (or added to the required landing field length) on the LGW Limited by Runway chart.

ENROUTE WEIGHT PENALTY

The enroute weight penalty is applicable to flights that are forecast to be longer than three hours.

The weight penalty is subtracted from the "Enroute Limitations (formerly 2 Engine Enroute) max DTW" as published in the Route and Airport manual "T" page for the particular route sector. If there is no "Enroute Limitations max DTW" published for the particular route sector, subtract the weight penalty from the maximum structural ZFW.

FUEL PENALTY

The fuel penalty is the percentage of total required fuel that must be added. Total required fuel consists of estimated fuel burn plus reserve (excluding taxi and stored fuel). In calculating max TOGW for the case where TOGW is limited by max Landing Weight (max TOGW = max Landing Weight + estimated Fuel Burn), be sure that this estimated fuel burn is increased by the percentage of fuel penalty, otherwise a payload penalty could result.

PAN AM ADDITIONS

This section contains information beyond that required by the master FAA Minimum Equipment List, identified as follows:

- (*) **Asterisk** indicates a Pan Am item not included in the master FAA Minimum Equipment List.
- **QXI Reqd** is an item that may restrict dispatch or downline schedules. A QXI Required item must be transmitted to downline stations, to NYC Tech Center, and a logbook notification made by Maintenance as indicated in MM 1-5-5.
- **Notify NYCMJ** indicates an item that the Technical Operations Control Center (Tech Center) wants to be aware of for planning purposes. If entered on the Continued Item sheet, it should be brought to the attention of maintenance at the next station for transmission to the Tech Center.

SYSTEM OR UNIT & NUMBER INSTALLED		REQUIREMENTS FOR FLIGHT
21 **AFT CARGO AIRCONDITIONING**		
–54 Aft Cargo Airconditioning Trim Air Modulating Valve Position Indication (747SP)	1	May be inop.
–55 Aft Cargo Airconditioning Compt and Duct Temperature Indications (747SP)	1	May be inop provided: – Duct overheat protection system is inoperative, OR – Trim air modulating valve is kept in full cool (closed) position.
–56 Aft Cargo Airconditioning Overheat Protective System (747SP)	1	May be inop provided: – Duct temperature indication is operative, OR – Trim air modulating valve is kept in full cool (closed) position.
22 **AUTOMATIC FLIGHT CONTROL**		
–1 Autopilot System (QXI Reqd)	2	One may be inop. Any mode which functions normally may be used – One required for CAT II operation to 1600 RVR; two required for CAT II operation to 1200 RVR. See RAM 1/301 and 1/401 (747) for other CAT II requirements. One control wheel disengage switch may be inop provided the autopilot is not utilized below initial approach altitude.
–2 Autopilot Disengaged Lights → See 34-19 for Progress Display Lights	2	Both lights must be operative for autoland operation (747SP: four lights) – One light must be operative for all other autopilot modes or functions. (747SP: one light for the autopilot being used.) – All lights may be inop if the autopilots are not used.
–3 Yaw Damper	2	One may be inop.
–4 Auto Throttle	1	May be inop.
–5 Airspeed Command Bugs	2	First officer's bug may be inop. Captain's bug may be inop provided autothrottle not used. Use the white airspeed bugs if the command bug(s) is inop.
–6 Not Applicable		
–7 Autoland Bias Actuator (747SP autoland only)	1	May be inop and autoland used, provided the flare and touchdown are controlled manually.

SYSTEM OR UNIT & NUMBER INSTALLED		REQUIREMENTS FOR FLIGHT
26 FIRE PROTECTION		
–18 thru –21 Not Applicable		
–22 Wing Leading Edge Overheat Warning System		The two detectors in each pylon (if installed) may be inop. The remainder of the system must be operative (747SP and 200C: Test B may be inop).
–23 Master Fire Warning Lights (forward glareshield)	2	One may be inop provided all other fire warning devices, both visual and aural, are fully operative. The airplane may not depart a station where repairs or replacements can be made. If the bell reset feature is also inop, flight engineer must be prepared to silence the fire bell from his station if the pilot on the operative side is absent.
–24 Lower Cargo Smoke Detector No-Airflow Light (747SP)	1	May be inop provided: – System is checked before each flight, AND – Smoke is introduced into fwd or aft cargo sampling orifice and normal warning indication verified.
–25 Auto Discharge Fire Extinguishing (747SP lavs)	–	May be inop.
27 FLIGHT CONTROLS		
–1 Control Surface Position Indicating System	1	May be inop provided a positive visual check of affected surface movement is made prior to departure.
–2 Leading Edge Flap Position Light Systems (Notify NYCMJ)	2	Amber light on the fwd panel, must be operative. Green light on the fwd panel, may be inop provided the leading edge flaps module on the flight engineer's panel is completely operative. Leading edge flaps module on the flight engineer's panel, may have either the amber or green light inop for each flap segment, provided both fwd panel lights (amber and green) are operative. With any light inop, monitor the operative lights on the flight engineer's panel when transitioning to flaps 0, 1 or 5.
–3 Takeoff Warning Horn System	1	Must be operative. (747SP: see 27-22 for partially inop stabilizer portion)
–4 Hydraulic Power Valve Closed Lights	8	One per axis may be inop provided the related valve is verified in the open position prior to initial departure. – To verify wing valves, see MM 27-13-01. – To verify tail valves, see MM 27-23-01.
–5 Hydraulic Power Valves	8	May be inop in open position. – To verify valve position, see item 27-4 above for MM reference.
–6 Stabilizer Brake Rel Lights	2	May be inop.
–7 Lateral Trim System	1	May be inop provided: – One autopilot is operative, AND – Lateral trim system is centered. See MM 27-11-00.
–8 Stall Warning System	1	Must be operative.

Minimum Equipment List (MEL)

Dec 16, 1976

.YSTEM OR UNIT & NUMBER INSTALLED			REQUIREMENTS FOR FLIGHT
30	**ICE & RAIN PROTECTION**		
–12	Number One Window Heat Override Function	2	May be inop.
–13	Window Heat Power Lights	6	Lights for windows No. 1 and No. 2 may be inop provided window heat functions properly prior to each takeoff. Lights for No. 3 windows may be inop. Not required for Inop No. 1 or No. 2 window heaters.
–14	Window Heat Overheat Test Feature	1	May be inop.
–15	Rain Repellent Systems (QXI Reqd)	2	May be inop provided airplane is not operated in precipitation within airport traffic areas. – Both systems required for CAT II operation with moderate to heavy rain.
–16	Windshield Wipers (QXI Reqd)	2	May be inop provided aircraft is not operated in precipitation within airport traffic areas.
–17	Windshield Washer Systems	2	May be inop.
–18	Windshield Air (Anti-Fog) System	1	Must be operative.
31	**INSTRUMENTS**		
–1	Clock	2	One must be operative.
–2	Flight Recorder (Notify NYCMJ)	1	In event of malfunction or failure of the flight recorder, the airplane may continue the flight or series of flights, but may not depart a station where repair or replacements can be made.
–3	Voice Recorder (Notify NYCMJ)	1	In event of malfunction or failure of the voice recorder, the airplane may continue the flight or series of flights, but may not depart a station where replacements can be made.
–4	Weight and Balance Indicator (QXI Reqd for 100F & 200C)	1	**Passenger Airplane:** May be inop (presently deactivated). **Cargo Airplane:** May be inop with no restrictions if pallets/containers are weighed by Pan Am, OR – If pallets/containers are not weighed by Pan Am, reduce performance limited TOGW by 20,000 lb. – See AOM/ALM 252.105 (200C), 252.705 (100F).
–5	Not applicable		

214.010 and MM 1-5-0 p 32 LIMITATIONS

Minimum Equipment List (MEL)

Oct 28, 1976

SYSTEM OR UNIT & NUMBER INSTALLED		REQUIREMENTS FOR FLIGHT
33 LIGHTS		
–9 Anti-Collision Lights (QXI Reqd)	2	May be inop for day operations.
–10 Wing Illumination Lights	2	May be inop for day or night operations provided a portable lamp is available for night operations in icing conditions.
–11 Position Lights - Wing Tips and Tail (QXI Reqd)	4	May be inop for daylight operations. – One of two tail lights may be inop for night flight.
–12 Exterior Emergency System Lights (QXI Reqd)	1	May be inop for daylight operations only.
–13 Interior Emergency System Lights	1	A random 25% of lights may be inop provided: – The inop lights are not adjacent, AND – At least two of the three lights at each entry door are operative.
–14 Logo Lights	2	May be inop.
34 NAVIGATION		
–1 Airspeed Indicators	–	True Airspeed (TAS) and Computed Airspeed (CAS) may be inop.
–2 Mach Indicators (one inop, Notify NYCMJ) (two inop, QXI Reqd)	2	One may be inop. – Altitude must be limited to a maximum of 29,000 ft if failure of the second indicator occurs in flight. Two may be inop provided: – Airplane altitude is limited to a maximum of 29,000 ft, AND – A placard which sets forth this limitation is affixed to the instrument panel. See AOM 213.030 for IAS-Mach conversion chart.
–3 Mach/Airspeed Warning System (QXI Reqd)	1	When an aural warning sounds early, the airplane must be operated at speeds below this warning indication. – Fifth-pod, gear down or auxiliary fuel airspeed warning system, if installed and operative, may be used in lieu of the normal mach/airspeed warning system. The speed at which the substitute warning sounds must be observed as limit airspeed.
-4 Altimeter (servo-pneumatic) (Pan Am standard)	2	One required at each pilot station. – In standby mode, use AOM 207.088 for altitude correction.
–5 Altimeter (electric) (AA 123F only)	2	One required at each pilot station.
–6 Altimeter (standby pneumatic) (AA 123F only)	1	Must be operative.

SYSTEM OR UNIT & NUMBER INSTALLED			REQUIREMENTS FOR FLIGHT
34	**NAVIGATION**		
–7	Altimeter Vibrators		
	a. Servo-pneumatic altimeter	2	One may be inop provided related air data computer is operative.
	b. Not Applicable		
	c. Standby pneumatic altimeter	1	May be inop provided VFR conditions exist at departure and arrival airports.
–8	Static Air Temperature Indicator	1	May be inop provided total air temperature indicator is operative.
–9	Total Air Temperature Indicator	1	May be inop provided static air temperature indicator is operative.
–10	ADI Bank-and-Pitch Functions (Horizon Indicators)	2	Bank and pitch functions must be operative in both ADI's, AND – At least two INS systems must be operative in NAV or ATT mode, AND – Each ADI must be supplied by a different INS system, AND – See item 34-11 Standby Attitude Indicator for other requirements.
–11	Standby Attitude Indicator (Standby Horizon) (OXI Reqd)	1	May be inop provided: – Operation is limited to day VFR conditions only, AND – Three INS systems are operative in NAV or ATT mode, AND – Attitude transfer switching to each pilot's ADI is operative, AND – At least one ADI has an operative rate-of-turn indication. The airplane may continue the flight or series of flights but may not depart a station where repairs or replacements can be made.
–12	Flight Director Systems (all inop, OXI Reqd) (one inop, Notify NYCMJ)	3	All may be inop provided the visibility at the destination is forecast to be one mile or more. – If the visibility at the destination is forecast to be less than one mile, at least one flight director system with dual displays must be operative.
–13	ADI Turn & Bank (Slip) Indications	2	Rate-of-turn indication may be inop in both ADI's provided the standby attitude indicator (standby horizon) is operative. – See item 34-11 Standby Attitude Indicator for other requirements.
–14	ADI Test Switch	2	May be inop.
–15	ADI Slow/Fast Indicator	2	May be inop.
–16	Magnetic Heading Reference Systems - MHRS (Compass 1 and 2) (OXI Reqd)	2	One may be inop for IFR conditions provided: – Both HSI compass cards are operative, AND – Operative compass system can be transferred to the HSI and RMI on the inop side, AND – True heading is available from the INS on the inop side. One may be inop for VFR flight conditions provided the operative compass system can be transferred to the HSI or RMI on the inop side.
–17	Magnetic Standby Compass (Notify NYCMJ)	1	May be inop provided: – Both compass-1 and compass-2 systems are operative, AND – Three INS's are operative, at least one providing true heading, AND – The airplane may continue the flight or series of flights but may not depart a station where repairs or replacements can be made.

SYSTEM OR UNIT & NUMBER INSTALLED		REQUIREMENTS FOR FLIGHT
34 NAVIGATION		
–18 Master Instrument Warning Systems (QXI Reqd)	–	May be inop except for CAT II operation.
–19 Flight Mode Annunciator (QXI Reqd)	–	May be inop except: – If the autopilot and/or flight director is to be used in ILS or land mode, the lights associated with the mode to be used must be operative.
–20 Central Air Data Computer Systems (CADC) (Notify NYCMJ)	2	One may be inop provided following systems are operative: – TAT gage if CADC-2 is inop. – Altimeter vibrator on the side with the inop CADC, – Mach indicator on the opposite side or altitude is limited to 29,000 ft. – Related autopilot is available except for altitude, IAS, and V/S control. At glideslope engage, initial pitchover may be more abrupt than normal (for 8-10 seconds) – Automatic altitude reporting (or check item 34-26). – Ground proximity warning test normal (or check item 34-32).
–21 VHF Navigation Receivers—VOR/ILS (QXI Reqd)	–	Two VOR systems must be operative. Both ILS systems may be inop except: – One must be operative for CAT I operation. – Two must be operative for CAT II operation. VOR and ILS test switch may be inop. 200C: VOR-3 may be inop or may be used to meet any of the requirements above.
–22 DME Systems (QXI Reqd)	2	Both may be inop except: – One must be operative for operation in the continental U.S., Alaska and Hawaii.
–23 Weather Radar (both inop, QXI Reqd) (one Inop, Notify NYCMJ)	2	Operative weather radar is required for routes between the Tokyo and Anchorage FIR's if the route flown is north of NOPAC 1. One system required when current weather reports indicate thunderstorms or other potentially hazardous weather conditions, which can be detected by airborne weather radar, may be expected along the route to be flown. Under the following conditions, inop weather radar may be continued to the next scheduled stop where parts are available and repairs can be made: – If no potentially hazardous weather conditions detectable by radar are forecast for the route to be flown, OR – The aircraft can proceed through areas of hazardous weather under day VFR conditions, OR – The route to be flown is altered to avoid hazardous forecast weather without relying solely on the altitude capability of the airplane.

SYSTEM OR UNIT & NUMBER INSTALLED		REQUIREMENTS FOR FLIGHT
34 NAVIGATION		
–24 ADF Radio Compass (QXI Reqd)	2	Two systems required over routes on which navigation is based on ADF, EXCEPT – One system required over routes on which navigation is based on ADF, provided that the airplane is equipped with two operating VOR systems and VOR navigational aids are so located and the airplane so fueled that in case of failure of the ADF receiver, the flight may proceed safely to a suitable airport by means of VOR aids and complete an instrument approach by use of the remaining airplane radio system.
-25 Marker Beacon Receiver	1	May be inop except where fan marker(s) are a required part of the airways or instrument approach system to be used.
–26 ATC Transponder and Altitude Reporting System (both sys inop, QXI Reqd) (one inop, Notify NYCMJ)	2	One required for all flights dispatched into positive control areas and terminal control areas (TCA's), EXCEPT that if inop, the requirement may be waived by the inclusion of "Transponder Inop" (or "Automatic Altitude Reporting Inop") in the Remarks section of the flightplan. The airplane may continue the flight or series of flights, but may not depart a station where repairs or replacements can be made.
–27 Inertial Navigation Systems (navigational info only) (INS-3, Notify NYCMJ) (INS-1 or 2 Nav mode inop, QXI Reqd) See 34-10 for attitude requirements.	3	INS-3 may be inop. INS-1 and INS-2 must be operative in NAV mode over any route for which INS navigation is required. – Over routes authorized for cockpit navigation, INS-1 and INS-2 must be operative in at least ATT mode. NAV mode may be considered operative with all following functions inop: – Wind display inop on both CDU's. – Either TK/GS or DIST/TIME display inop on one CDU. – Alert light inop on one CDU, provided DIST/TIME is operative. – Up to four waypoint positions on each system. However, for autopilot-coupled operation, at least five consecutive waypoint positions must be operative.
–28 Altitude Alerting System (Notify NYCMJ)	1	If inop, the airplane may continue the flight or series of flights but may not depart a station where repairs or replacements can be made.
–29 Low Range Radio Altimeter (QXI Reqd)	2	No. 2 may be inop, except two systems required for CAT II operation. If No. 1 is inop, check limitation in 34-32 Ground Proximity Warning.
–30 Radio Altimeter Altitude Display (in ADI)	2	May be inop.
–31 Not Applicable		
–32 Ground Proximity Warning System (Notify NYCMJ)	1	In event of malfunction or failure, the airplane may continue the flight or series of flights but may not depart a station where repairs or replacements can be made

ORIGINAL PAGE IS
OF POOR QUALITY

Minimum Equipment List (MEL)

Oct 28, 1976

SYSTEM OR UNIT & NUMBER INSTALLED		REQUIREMENTS FOR FLIGHT
34 **NAVIGATION**		
–33 *Vertical Speed Indicators (pilots')	2	Must be operative.
35 **OXYGEN**		
–1 Passenger and Crew Oxygen Systems (QXI Reqd)	2	Crew system must be operative. Passenger system may be inop at flight altitudes of 10,000 ft or below. See AOM 207.140 or MM 12-15-15 for minimum pressure requirements. – See Aircraft Loading Manual 212.050 for passenger mask requirements.
–2 Portable Oxygen Bottles (Bottle and Mask) (QXI Reqd)	–	Must be operative for flight over 25,000 ft. – See AOM 207.140 for number of bottles and minimum pressures
–3 Dual Oxygen Pressure Indicator (flight engineer's panel)	1	May be inop provided all oxygen cylinder gages are checked to ensure pressure is above the required amount. See AOM 207.140 or MM 12-15-15 for minimum pressure requirements
–4 Not Applicable		
36 **PNEUMATIC SYSTEM**		NOTE Items –2, –5, –6 and –7 may not simultaneously affect more than one engine, and on remaining engines the starter valves must be operative. (Notify NYCMJ)
–1 High-Stage Bleed Air Valves	4	One may be inop secured in the closed position per MM 36-11-05. – Maintain at least 70% N1 on the affected engine when in icing conditions
–2 Bleed Air Precooler System (temp control function) (QXI Reqd)	4	One may be inop provided: – Items 36 –5, 6 and 7 are operative on other three engines, AND – Flight is not operated in icing condition, AND – Related bleed air switch is kept in off position after engine start, AND – Related nacelle anti-ice switch is kept in off position.
–3 Engine Bleed Air Pressure Relief Valves	4	One may be inop in the closed position provided the related high stage valve is secured in the closed position per MM 36-11-05.
–4 Engine Bleed Air Pressure Relief Lights (if installed)	4	May be inop.
–5 Pylon Bleed Air Valves	4	One may be inop (secured in closed position per MM 36-11-04 after engine start), provided items 36 –2, 6 and 7 are operative on other three engines. – If only the start solenoid is inop, see MEL item 36-13. – For Manual Start, see AOM 207.163 and MM 36-11-04. – Wing isolation valve switches must be in the open position for takeoff and all flap operations. – APU may not be used for cabin ventilation and pressurization when making a packs-off takeoff.

PAN AM MAINTENANCE PROGRAM

I. Introduction

Pan Am's aircraft are maintained in a continuous state of airworthiness by means of scheduled and unscheduled maintenance. Scheduled maintenance consists of tasks scheduled at designated time intervals, component changes, scheduled inspections, and modifications. Unscheduled maintenance results from scheduled task findings, malfunction reports and condition monitoring.

The Pan American Maintenance Program has been uniquely developed to meet the requirements of B747 A/C. Pan Am was the world's first 747 operator. Our fleet has accumulated nearly a million operating hours and is the largest in the world. It consists of passenger, cargo and SP aircraft.

Pan Am has long recognized the importance of effective maintenance programs, both from safety and economic viewpoints. Consequently, it has established an organization to exclusively develop, implement and maintain the maintenance program.

The Pan Am Maintenance Program is FAA approved in accordance with FAA Advisory Circular 120-17. This allows Pan Am to add and delete items, change time limits and establish service patterns without prior FAA approval.

There are four fundamental parts in a maintenance program. These are:

a) Development of the tasks and categorizing of the processes, i.e., on-condition, hard time, condition monitoring.

b) The packaging of the items and developing a servicing pattern, i.e., when, where, & how often the aircraft must be serviced to accomplish these tasks.

c) Monitoring. The development of an effective feedback system to measure the effectiveness of the maintenance program.

d) Adjusting of the program to respond to results of monitoring and to changes in operating requirements.

Discussion

Development of the program

The B747 maintenance program was developed using an MSG-2 analysis. This program was part of the original FAA MRB program. As service experience was gained, new requirements became obvious and the program underwent substantial changes. The present program has been refined by experience gained in nearly a million operating hours. It is no longer controlled by the MRB program but is on Pan Am's FAA Approved Maintenance Program.

The Pan Am approach to developing a maintenance program is to review each item both from the necessity and effectiveness standpoints and develop an optimum time limit. The items are treated independently of services. Each stands on its own technical justification.

Packaging of items

Once all the items have been established at their optimized time limit, they can be packaged in a manner which will meet the objectives of the operating plan. Basically, Pan Am develops the maintenance program to fit into and to complement the operating requirements. Pan Am does not take an aircraft out of service for maintenance except for heavy service. Routine maintenance is accomplished so as not to conflict with operating requirements. Specifically, there is always an aircraft that overnights in New York. Proper scheduling insures that a specific A/C is scheduled into this slot to perform a service.

The services consists of:

- Transit: Prior to each flight.
- A Service: More comprehensive. Includes some routine work items when aircraft are on the ground over four hours.
- Base Check: Scheduled at 225±30 hours. Accomplished at Pan Am base, and includes non routine and routine work items.
- B Check: Scheduled at 450±45 hours. Accomplished at Pan Am Base and consists of additional routine and non routine items.

- Heavy Service: No specific time limit, includes the above plus refurbishing, high time routine items, modifications and heavy structural inspection.

Since the service schedule is designed to accommodate Pan Am operating requirements and since the individual items are not tied to specific services, the maintenance program is extremely flexible. It is readily revised to meet changes in operating requirements.

The Pan Am "B" service concept is the result of an evolutionary process. The traditional servicing concepts employ letter checks at increasing intervals such as A, B, C, etc., checks at 175, 350, 1400 hour intervals respectively. Each higher letter check consists of larger and more complex service packages. Other than tradition, there is no technical justification for such rigid maintenance schedules. With these traditional concepts, a maintenance program is imposed upon operational requirements instead of being built around them.

Pan Am analyzed the maintenance requirements vis-a-vis the operating requirements. The fallout of this analysis is a service concept whereby service packages of approximately equal manhours, elapsed time and work skills are developed to be performed at relatively small increments of time. Scheduling is based on total air time on the A/C rather than time since last service. The advantages of this are:

- Assures "averaging" of specified service interval, i.e., no service time is thrown away.
- Makes more A/C available for operations since no excess services are done.
- Determines more precisely when services are required. Eases scheduling constraints.
- Frequent servicing reduces unscheduled maintenance or surprises, and produces more timely feed-back to the system.
- Better utilizes individual time limits.

Monitoring:

Any effective maintenance program requires good feed-back to measure how well it is performing.

ORIGINAL PAGE IS
OF POOR QUALITY

Again, Pan Am has undergone the development, implementation and abandonment of numerous monitoring systems. A description of the various systems which were utilized and which led to the present system will not be made. The systems which are now in effect, and which were developed through evolutionary process utilizes the following philosophy:

- Use only the information which has greatest impact for improvement.

In addition to the structural findings, many techniques have been developed which facilitate inspections. Again the trail and error of new operations can be avoided.

Landing Gear -- The gear is maintained throughout the life of the aircraft by servicing, corrosion prevention and limited repair. Overhaul, the complete disassembly and reassembly with zero time parts, is not required by the Pan Am program. The condition of the gear is monitored by routine inspection and by sampling. The tanker fleet will benefit greatly from the sample program because improvements already found necessary on the older aircraft will have been incorporated, and service experience will have demonstrated the performance of these improvements.

COMPONENTS AND PARTS - OVERHAUL AND RELATED WORK TIME LIMITS

1. GENERAL POLICIES
2. TIME LIMITS
3. ENGINE LIFE LIMITS
4. Deleted.

1. General Policies

A. Included herein are components, overhaul time limits and related work time limits. These data establish PAA approved time limits for overhaul and related work. Important "Condition Monitoring" items are listed in this publication. Components of lesser importance that are "Condition Monitoring" are not listed.

B. A 90,000 hour time limit, when shown, is a temporary time limit used to satisfy EDP requirements until a technical time limit can be determined in accordance with the M-246 procedures. This procedure has been adopted in order to speed-up the listing of a new component in this publication for effectivity purposes. A technical time limit will supersede the 90,000 hour time limit in the near future.

C. All reference to time limits means aircraft air time unless otherwise noted.

D. C.M. signifies Condition Monitoring. O.C. signifies On Condition. (TOM 25-15-10)

E. References directly below those items that are listed as On Condition refer to the supporting work item.

F. Publication reference shows applicable Maintenance Manual publication containing specifications.

G. The results of the sampling program on landing gears will be reported to Boeing on forms 9242-3759 and 9242-3760, in the same manner as Structural Inspection Items.

H. Time Record Type column shows time record requirement "On Condition" and "Condition Monitoring" items, as stipulated in TOM 10-60-70.

I. Unless effectivity limitations are indicated, items are applicable to all airplanes listed under Section 2.B.

1. J. Intentionally left blank.

K. In any item where a sampling program is required, the sampling time limit is to be considered the limiting time limit, unless otherwise specified in this publication.

L. Multiple Time Limit Program

Description

In order to fully utilize the time limits, i.e., schedule as near to a limit as feasible, a multiple time limit is established. Multiple time limits are provided in addition to the specified time limit. Multiple time limits may be used providing that specified supplementary tasks are performed, with satisfactory resolution of any discrepancies. Supplementary tasks are identified by a suffix to the multiple time limit, and are listed below. Supplementary tasks must be accomplished within 500 hours prior to an item reaching its time limit, unless otherwise specified. Multiple time limits will not be used to routinely schedule services. They will be used only to alleviate difficulties in aircraft scheduling, as limiting time limits are approached. Reliability must be notified each time a multiple time limit is used.

TOM 10-60-73 contains the policy and procedures for the Multiple Time Limits.

SUPPLEMENTARY TASKS

The task(s) number(s) will appear as Slash/Number after the multiple time limit in the appropriate publication.

1. Review available log book activity for preceding 10 days to detect any deterioration related to this item. Accomplish within 225 hours of the item reaching its time limit.

2. Review continued item and maintenance service item files for discrepancies related to this item. Accomplish within 225 hours of the item reaching its time limit.

3. Perform operational check to assure satisfactory functioning of components/systems related to this item.

4. Perform a physical examination and shake check to determine the condition of this item.

5. Perform an area level inspection of the area related to this item.

6. Perform a detail level inspection of the area related to this item.

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY								
						121	121F	SP21	WA	CI	AV			
	22 - AUTOFLIGHT													
01	Box, Accessory #1, Auto Flight	TR-0			C.M.	X	X	X	X	X	X			
02	Box, Accessory #2, Auto Flight Control	TR-0			C.M.	X	X	X	X	X	X			
02A	Box, Accessory #3, Auto Flight Control	TR-0			C.M.	-	-	X	-	-	-			
03	Clutch Pack Assembly, Engine Control See 747 5-2-2, Item 22-300	TR-0			C.M.	X	X	X	X	X	X			
04	Accelerometer, Normal, Auto Pilot	TR-0			C.M.	X	X	X	X	X	X			
04A	Accelerometer, Lateral, Auto Pilot	TR-0			C.M.	-	-	X	-	-	-			
05	Box Assy, Accessory Stab Trim	TR-0			C.M.	X	X	X	X	X	X			
06	Computer, Auto Throttle	TR-0			C.M.	X	X	X	X	X	X			
09	Computer, Pitch	TR-0			C.M.	X	X	X	X	X	X			
12	Computer, Roll	TR-0			C.M.	X	X	X	X	X	X			

ORIGINAL PAGE IS
OF POOR QUALITY

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	CODE NUMBER OR PART NUMBER	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY					
						121	121F	SP21	WA	CI	AV
	22 - AUTOFLIGHT (cont'd)										
15	Computer, Yaw Damper	TR-0		2	C.M.	X	X	X	X	X	X
16	Control, Flight, Auto Pilot	TR-0		1	C.M.	X	X	X	X	X	X
21	Unit, Monitor & Logic, Auto Pilot	TR-0		1	C.M.	X	X	–	X	X	X
22	Unit, Landing Control & Logic	TR-0		1	C.M.	–	–	X	–	–	–
24	Panel, Mode Select	TR-0		1	C.M.	X	X	X	X	X	X
25	Light Set, Flight Mode Annunciator	TR-0		2	C.M.	X	X	X	X	X	X
27	Servo, Auto Throttle, Auto Pilot	TR-0		1	C.M.	X	X	X	X	X	X
30	Unit, Trim, Auto Stabilizer	TR-0		1	C.M.	X	X	X	X	X	X

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	CODE NUMBER OR PART NUMBER	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY									
						121	121F	SP21	WA	CI	AV				
	31 - INSTRUMENTS (cont'd)														
12D	Accelerometer, Three (3) Axis. See 5-2-2 Item 31-302.	TR-1	73124	1	.C.	X	X	X	X	X	X				
12E	Transmitter, Stabilizer Position. See 5-2-2 Item 31-302.	TR-0			O.C.	X	X	X	X	X	X				
12F	Time Display Unit (1310003J)	TR-0			C.M.	X	X	X	-	-	-				
12G	Time Base Unit (1310003J)	TR-0			C.M.	X	X	X	-	-	-				
12H	Transmitter, Control Wheel Position See 5-2-2 Item 31-302	TR-0			O.C.	-	-	X	-	-	-				

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY					
						I2I	I2IF	SP2I	WA	CI	AV
	34 - NAVIGATION										
09	Altimeter, Servo Pneumatic	TR-0			C.M.	X	X	X	X	X	–
09A	Altimeter, Electric	TR-0			C.M.	–	–	–	–	–	X
09B	Altimeter, Pneumatic	TR-0			C.M.	–	–	–	–	–	X
11	Annunciator-Central Instrument Warning	TR-0			C.M.	X	X	X	X	X	X
12	Antenna, Loop	TR-0			C.M.	X	X	X	X	X	X
15	Antenna. Low Range Radio Altimeter *Bench check concurrent with 5-2-2 item 34-407 (1340018J)	TR-0			*	X	X	X	X	X	X
18	Antenna, Marker	TR-0			C.M.	X	X	X	X	X	X
21	Antenna, Weather Radar NOTE: Avianca Only: Overhaul at Shop visit if removal date exceeds 24 months since last overhaul.	TR-0			C.M.	X	X	X	X	X	X

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY I21	I21F	SP21	WA	CI	AV				
	34 - NAVIGATION (cont'd)														
24	Battery, INS Bench Check	TR-0			O.C. 1100 500	X -	X -	X -	X -	X -	- X				
25	Compass, Magnetic Standby	TR-0			C.M.	X	X	X	X	X	X				
26	Compensator-Remote Magnetic Compass	TR-0			C.M.	X	X	X	X	X	X				
27	Computer, Central Air Data MPA 1340024J	TR-0			C.M.	X	X	X	X	X	X				
28	Computer-Altitude Alert	TR-0			C.M.	X	X	X	X	X	X				
29	Computer - Central Instrument Warning	TR-0			C.M.	X	X	X	X	X	X				
30	Coupler, Magnetic Compass	TR-0			C.M.	X	X	X	X	X	X				
33	Coupler, Sense, ADF	TR-0			C.M.	X	X	X	X	X	X				

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY									
						121	121F	SP21	WA	CI	AV				
	34 - NAVIGATION (cont'd)														
35	Computer, Ground Proximity Warning MPA 1340024J	TR-0			O.C. ~~C.M.~~	X	X	X	X	X	X				
36	Feed Assembly, Weather Radar Antenna	TR-0			C.M.	X	X	X	X	-	-				
40	Indicator - True Airspeed	TR-0			C.M.	X	X	X	X	X	X				
42	Indicator, Attitude Director	TR-0			C.M.	X	X	X	X	X	X				
45	Indicator, DME	TR-0			C.M.	X	X	X	X	X	X				
48	Indicator, Gyro Horizon Standby	TR-0			C.M.	X	X	X	X	X	X				
51	Indicator, Horizontal Situation	TR-0			C.M.	X	X	X	X	X	X				
54	Indicator, Instant Vert. Velocity	TR-0			C.M.	X	X	X	X	X	X				

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY									
						121	121F	SP21	WA	CI	AV				
	34 - NAVIGATION (cont'd)														
57	Indicator-Low Range Radio Altimeter	TR-0			C.M.	X	X	X	X	X	X				
60	Indicator, Mach	TR-0			C.M.	X	X	X	X	-	-				
60A	Indicator, Mach/Indicated Airspeed	TR-0			C.M.	-	-	-	-	X	X				
63	Indicator, Airspeed	TR-0			C.M.	X	X	X	X	-	-				
64	Indicator, INS Time To Go	TR-0			C.M.	X	X	X	X	-	-				
66	Indicator, RMI	TR-0			C.M.	X	X	X	X	X	X				
67	Indicator - Static Air Temp	TR-0			C.M.	X	X	X	X	X	X				
68	Indicator - Total Air Temp	TR-0			C.M.	X	X	X	X	X	X				

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY									
						121	121F	SP21	WA	CI	AV				
	34 - NAVIGATION (cont'd)														
69	Indicator, Weather Radar * Bench Check NOTE-For Avianca Only: Overhaul at shop visit if removal date exceeds 24 months since last overhaul.	TR-0			C.M.	X	X	X	X	*X	X				
70	Inverter - Solid State	TR-0			C.M.	X	X	X	X	X	X				
72	Panel, Control ADF	TR-0			C.M.	X	X	X	X	X	X				
75	Panel, Control ATC	TR-0			C.M.	X	X	X	X	X	X				
78	Panel, Control VOR/ILS	TR-0			C.M.	X	X	X	X	X	X				
81	Panel, Control Weather Radar NOTE-For Avianca Only: Overhaul at shop visit if removal date exceeds 24 months since last overhaul.	TR-0			C.M.	X	X	X	X	X	X				
84	Receiver, ADF	TR-0			C.M.	X	X	X	X	X	X				

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	PAA CODE NO. OR PART NO.	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY									
						121	121F	SP21	WA	CI	AV				
	34 - NAVIGATION (cont'd)														
87	Receiver, Marker	TR-0			C.M.	X	X	X	X	X	X				
90	Receiver, VOR/ILS	TR-0			C.M.	X	X	X	X	* X	X				
	* Bench Check				9000*										
92	Reflector-Weather Radar Antenna	TR-0			C.M.	X	X	X	X	–	–				
93	Sensor, Magnetic Field (Flux Valve)	TR-0			C.M.	X	X	X	X	X	X				
95	Sensor, Total Air Temp LH & RH	TR-0			C.M.	X	X	X	X	X	X				
96	Switch, Antenna VOR/ILS	TR-0			C.M.	X	X	X	X	X	X				
97	Switch - Mach Airspeed Warning	TR-0			C.M.	X	X	X	X	X	X				
99	Transceiver, DME Interrogator	TR-0			C.M.	X	X	X	X	X	X				

ORIGINAL PAGE IS
OF POOR QUALITY

ITEM	KEYWORD AND DESCRIPTION	TIME RECORD TYPE	CODE NUMBER OR PART NUMBER	QTY PER A/C	MAINTENANCE PROCESS	EFFECTIVITY					
						121	121F	SP21	WA	CI	AV
	34 - NAVIGATION (cont'd)										
102	Transceiver, Low Range Radio Altimeter *Bench Check	TR-0			C.M. 4500*	X	X	X	X	* X	X
105	Transceiver, Weather Radar	TR-0			C.M.	X	X	X	X	X	X
108	Transponder, ATC Beacon	TR-1	59652 63424 97637-101	2	24 Calendar Months**	X - -	X - -	X - -	- X -	- - X	X - -
	**Bench Check. FAA Mandatory. After January 1, 1976, ATC Transponders may not be used unless they have been Bench Checked within the preceding 24 Calendar Months. (FAR's 91.177 & 43, Appendix F). (1050020J)										
111	Unit, Control/Display INS	TR-0			C.M.	X	X	X	X	X	X
112	Unit, INS Mode Select	TR-0			C.M.	X	X	X	X	X	X
114	Unit, Navigation INS	TR-0			C.M.	X	X	X	X	X	X

SERVICE ITEM TIME LIMITS

1. General

A. This publication lists the service checks to be performed at routine service periods. Work items must be scheduled for accomplishment within the time periods shown.

B. All reference to time limits means aircraft air time unless otherwise noted.

C. Publication reference shows applicable Maintenance Manual publication containing specifications.

D. In any item where a sampling program is required, the sampling time limit is to be considered the limiting time limit, unless otherwise specified in this publication.

E. When an item in this publication is required to support the time limit of a component listed in the 747 aircraft 5-2-1 publication, a note to this effect is inserted directly below the item. Such items cannot be extended or deleted without considering the component time limit requirement.

F. Unless effectivity limitations are indicated, items are applicable to all airplanes listed under section 2.B.

G. Multiple Time Limit

Description

In order to fully utilize the time limits, i.e., schedule as near to a limit as feasible, a multiple time limit is established. Multiple time limits are provided in addition to the specified time limit. Multiple time limits may be used providing that specified supplementary tasks are performed, with satisfactory resolution of any discrepancies. Supplementary tasks are identified by a suffix to the multiple time limit, and are listed below. Supplementary tasks must be accomplished within 500 hours prior to an item reaching its time limit, unless otherwise specified. Multiple time limits will not be used to routinely schedule services. They will be used only to alleviate difficulties in aircraft scheduling, as limiting time limits are approached. Reliability must be notified each time an multiple time limit is used.

TOM 10-60-73 contains the policy and procedures for the Multiple Time Limits.

1. G. Continued

SUPPLEMENTARY TASKS

The task(s) number(s) will appear as Slash/Number after the multiple time limit in the appropriate publication.

1. Review available log book activity for preceding 10 days to detect any deterioration related to this item. Accomplish within 225 hours of the item reaching its time limit.
2. Review continued item and maintenance service item files for discrepancies related to this item. Accomplish within 225 hours of the item reaching its time limit.
3. Perform operational check to assure satisfactory functioning of components/systems related to this item.
4. Perform a physical examination and shake check to determine the condition of this item.
5. Perform an area level inspection of the area related to this item.
6. Perform a detail level inspection of the area related to this item.

ITEM	SERVICE/INSPECTION	PUBLICATION	TIME LIMIT	EFFECTIVITY									
				I2I	I2IF	SP2I	WA	CI	AV				
	22 - AUTO FLIGHT												
300	Perform functional check of Limit Switches on Clutch Pack Assembly of the Auto Throttle. (0050028J) Support item for 5-2-1 item 22-03.		5,100	X	X	X	X	X	X				

ITEM	SERVICE/INSPECTION	PUBLICATION	TIME LIMIT	EFFECTIVITY									
				121	J21F	SP21	WA	CI	AV				
	34 - NAVIGATION												
406	Deleted MPA 1340024J												
407	Low range radio altimeter antenna and coaxial cable check. See 5-2-1 item 34-15. (2340004J)		7,500	X	X	X	X	-	x				
408	Test the following ground proximity warning system functions: 1. Altitude rate 2. Glide slope deviation #Sample 5 aircraft. To be eligible as a sample, item must be scheduled at +0 -20% of the present time limit. For additional instructions on future scheduling, reference General Section 1. D., Page 1. MPA 234006J	34-46-00	4,000#	X	X	X	X	X	x				
505	Check electrical bonding between the ADF antennas and aircraft structure. (2340002J)		6,000	X	X	X	X	X	x				