AD-A100 730 GRUMMAN AEROSPACE CORP BETHPAGE NY F/G 14/2

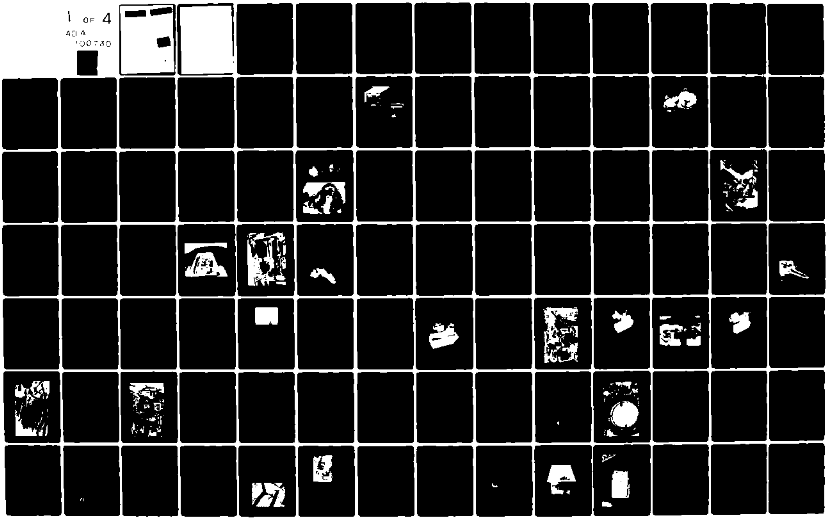
HYDRAULIC DIAGNOSTIC MONITORING SYSTEM.(U)

MAR 81 J J DUZICH N62269-78-C-0041

UNCLASSIFIED NADC-TR-81073-60 NL

1 OF 4

AD A
100730



AD [illegible] 8 9

III 12

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) (11) TR 81073-60

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER (18) NADC 81073-60	2. GOVT ACCESSION NO. AD-A100730	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Hydraulic Diagnostic Monitoring System • FINAL REPORT		5. TYPE OF REPORT & PERIOD COVERED (9) Final rept. T[redacted] Jan 79 – Oct 80 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) John J./Duzich	(15)	8. CONTRACT OR GRANT NUMBER(s) N62269-78-C-0041
9. PERFORMING ORGANIZATION NAME AND ADDRESS Grumman Aerospace Corporation Bethpage N.Y. 11714		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Air Systems Command Washington D.C. Code 340	(11)	12. REPORT DATE 2 Mar[redacted]81 13. NUMBER OF PAGES 316
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Air Development Center Warminster Pennsylvania 18974	(12) 323	15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release
Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Hydraulic	Pressure Temperature	Pumps	Display Panel
Monitoring	Fiber Optics	Displacement	Analog
Flow	Reservoir	Accumulators	Discrete
Level	Desiccant Filters	Microprocessor	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents a second twelve month summary of a two year effort of a HYCOS hydraulic diagnostic monitoring system. The program was broken down into three tasks:

(See Over)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

388847

Task I encompassed the design, development and procurement of hardware, sensors, and microprocessors for two diagnostic monitoring systems. The first system was installed on the F-14 Hydraulic Flight Simulator on Task II of the program.

Task II Installed one system on the F-14A Hydraulic Simulator for System component reliability demonstrations. The task also covered simulated component failures and diagnostic system reaction.

TaskIII Integrated the Diagnostic System into A6E B/N 155628 Debugged the system and ran a 12 month flight test schedule. This report covers Task III.

SUMMARY

This program was based on the feasibility study of a hydraulic monitoring system described in NADC report number TR75168-30 published in July 1976. The interim report, NADC TR76389-30, was published in May 1979 and covered Tasks I and II.

The purpose of the Hydraulic Diagnostic Monitoring System (HYCOS) is to warn of impending failure of hydraulic system components by onboard sensors continuously monitoring failure-indicating parameters.

The monitoring system consists of three basic types of sensors: analog, discrete, and fiber-optic. These sensors feed information to a self-contained, centrally located display panel through interface circuits that are easily accessible to ground maintenance personnel. The panel has circuit and system test capability which detects malfunctions of electronic equipment, sensor circuits, and display indicators.

The Sensor List includes the following types:

- Displacement:
  - (a) Potentiometer - rotary and linear (analog)
  - (b) Photo-optic (reflective)
  - (c) Hall Effect (magnetic)
- Temperature:
  - (a) Pressurized gas (discrete)
  - (b) Bimetallic (discrete)
  - (c) I/C transducer (analog)
- Differential Pressure, Filter: Spring biased piston (discrete)
- Pressure:
  - (a) Gas and spring biased switch (discrete)
  - (b) Semiconductor strain gage (analog)
- Liquid Detection: Fiber-optic probe using refractive index coupling (discrete)
- Flow: Orifice with bypass shunt for higher flows (discrete)
- Desiccant Color Detection: Fiber-optic color transmission using reflected light. Optical properties of irregular granules (analog - color spectrum)

Displacement sensors of the variable-resistance type were used to measure reservoir piston, accumulator, rudder, and rudder pedal displacements. Two other concepts evolved in the accumulator application, a reflective photo-optic type and a magnetic Hall Effect type. Since they are experimental in nature and require development, they were not used in the prototype system.

Three types of temperature sensors (one analog and two discrete) were chosen and utilized in the pneumatic, fluid, and surface temperature circuits. Their performance was satisfactory during simulator testing. Filter differential pressure indicators were of the spring biased magnetically latching type. Their performance was satisfactory.

Two types of pressure-sensor devices were utilized. In one pneumatic circuit, a temperature-compensated pressure switch performed as predicted over a broad temperature range. In another pneumatic hydraulic circuit, a semiconductor strain-gage type also performed according to specification.

Liquid detection circuits in high-pressure pneumatic bottles proved to be a challenge in the area of pressure sealing and liquid detection using the optical properties of liquids, solids, and gases. All major problems were overcome after extensive development effort.

The use of shunt orifice flow measuring devices proved satisfactory in three hydraulic subcircuits. In two of the three cases, the indicator was immobilized during normal system operation.

Desiccant color detection utilizing color transmission proved difficult due to the irregular desiccant particles. A high-intensity light source was required to achieve sufficient color transmission. An improved sensor was developed for the A-6E installation.

The diagnostic system monitors the hydraulic system during flight as well as on the ground. Any flight discrete failures are displayed when the aircraft is interrogated on the ground. Discrete sensors are manually resettable.

An onboard preprogrammed microprocessor handles all the analog inputs through A/D converters and determines the condition of components with multiple sensors.

Task I defined and procured hardware sensors for two diagnostic monitoring systems. After individual component acceptance testing, the system was interfaced with a F-14A hydraulic simulator.

Task II consisted of installing the system on the F-14A hydraulic simulator in order to demonstrate system/component reliability under simulated conditions. A baseline was established and various failure modes and diagnostic system reactions determined.

The scope of the Interim Report covered only the development and integration of the F-14 hydraulic monitoring system.

Task III of the hydraulic monitoring system contract consisted of procuring, building, installing, and testing in a bailed A-6E flight test vehicle for a duration of at least 6 months.

To accomplish these objectives:

- Bracketry was designed and fabricated to support the system components. The combined hydraulic fluid distribution system was modified to accept pressure, flow, and temperature sensors
- Electrical and fiber-optic cable runs were designed, fabricated, and installed between the HYCOS display panel and sensors
- The HYCOS system was installed only in the combined hydraulic system and did not affect system operation
- Representative system components and parameters were monitored. These included
  - Hydraulic reservoir
  - Filters
  - Accumulator
  - Pneumatic bottles
  - Hydraulic pump
  - Rudder actuator
  - Relief valve
  - System operational hours
- The microprocessor program was written to apply specifically to the A-6E requirements

- The vehicle received normal ground tests prior to being cleared for its normally scheduled flight program
- During the flight program (installed January 1979, removed November 15, 1980) the system accumulated over 160 flight hours. First flight occurred on October 31, 1979.

A Navy A-6E bailed aircraft was designated as the official test vehicle in January 1979. By May 1979, the modified hydraulic system was initially pressurized to check for system compatibility. During the latter part of the year, the system was modified to improve reliability and maintainability.

Improvements were made to both the display panel and sensors. In the area of light sensing, transmission of colored light proved difficult since, during installation of the fiber-optic cables, excessive bends were made creating unacceptable light losses. However, the concept was verified.

During the test program, the system continuously detected low pneumatic bottle pressures and low reservoir level during calibration and system operation. No other system abnormalities or malfunctions were detected.

The total time for interrogating the system is 1-1/2 minutes. This significantly reduces turnaround time and increases aircraft availability.

PREFACE

This report was prepared by the Grumman Aerospace Corporation under a Naval Air Development Center, Contract Number N62269-78-C-0041, entitled "Hydraulic Diagnostic Monitoring System".

The program was based on a previous feasibility study conducted by Grumman Aerospace Corporation and reported in NADC TR 75168-30.

Task I of this program covered procured hardware, sensors, and microprocessors for two monitoring systems. One system was installed in a F-14 Flight Simulator and the other scheduled for an A-6 aircraft. The work reported in the report covers the November 1977 to December 1978 timeframe.

Task II covered the results of installing the system in an F-14A hydraulic simulator, integrating and debugging the system, and finally simulating various failure modes in order to demonstrate diagnostic system reaction.

Interim Report NADC TR 76389-30 Hydraulic Diagnostic Monitoring System was published 31 May 1979, covered Tasks I and II.

Task III encompassed the basic integration, debugging, and flight test of the A-6 System.

The sponsoring agency is the Naval Air Systems Command, Washington, D.C. Mr. Steve Hurst, AIR 340C, was the Program Manager

The work was administered under the technical direction of:
Mr. Douglas O. Bagwell
Naval Air Development Center, Warminster, PA 18974

Program Manager for this effort was Mr. Edwin A. Anderson

Project Engineer for this contract was Mr. John J. Duzich

The author wishes to acknowledge the significant support and contributions made by the following Grumman disciplines:

- Aircraft Programs
- Aircraft Project Office
- Controls and Mechanisms
- Electronic Design and Development
- Equipment Lines
- Flight Development Group
- Fluid Power
- Mechanical Design
- Mechanical/Fluid Systems Test
- Quality Control
- Structural Design.

Daily HYCOS System recording, performed by Mr. Frank Martella, Plane Captain, was invaluable in assessing this phase of the program.

CONTENTS

CONTENTS (Cont)

ILLUSTRATIONS

ILLUSTRATIONS (Cont)

ILLUSTRATIONS (Cont)

TABLES

Section 1

HYDRAULIC DIAGNOSTIC MONITORING SYSTEM

1.1 VEHICLE DESIGNATION

On 31 January 1979, Naval Air Systems Command Selected A-6 Bureau Number 155628 as the vehicle to be used as a flight test bed for the hydraulic monitoring system. The vehicle, which was being modified/updated, arrived at the Grumman facility during the preceding year and started through the modification line in February as MOD 229.

1.2 VEHICLE MODIFICATION

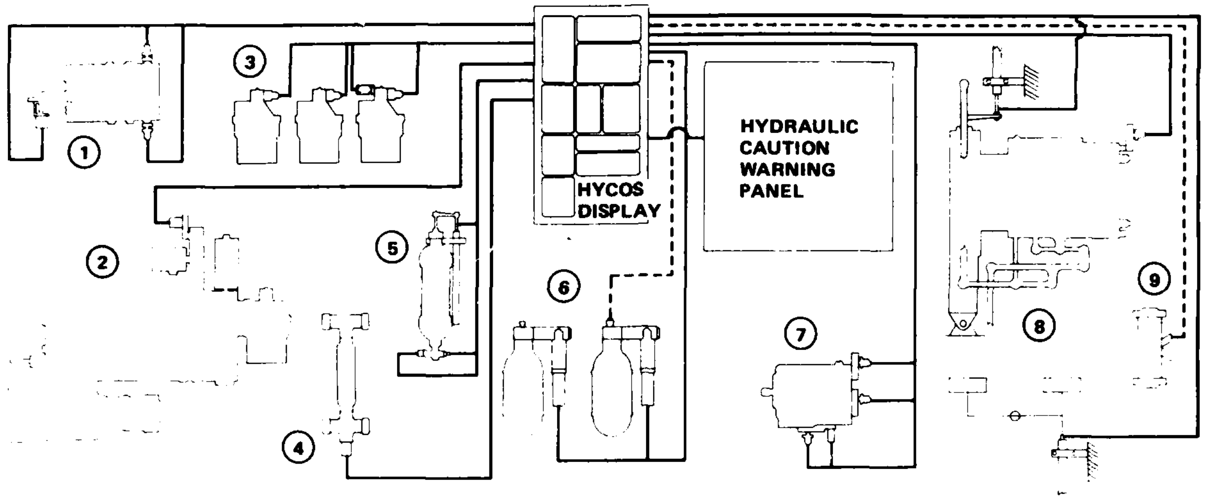
During the time the vehicle was being upgraded to an A-6E configuration, the HYCOS system was installed since all necessary areas were accessible. The HYCOS A-6E block diagram is shown in Figure 1.

Installation was accomplished through the issuance of both Record and Flight Test Engineering Orders (EO) to minimize the impact of the normal buildup. This approach led to an efficient and expeditious system installation. All EOs are listed in Appendix G.

Vehicle modifications included provisions for mounting the HYCOS panel in a ground-accessible area on the port side of the engine duct. Mounting brackets and an access panel door were fabricated and installed. Since the selected surface area is a load-bearing member, Calfax fasteners were used for easy access.

Both wire and fiberoptic line runs were installed in the vehicle at this time in conjunction with the other wiring circuits. New lines were fabricated as required for sensors installed in the pressure system.

All HYCOS sensor line runs terminated at the test panel through the use of three electrical connectors and two fiberoptic connectors. Figure 2 shows the access area with the wire bundles before modification.

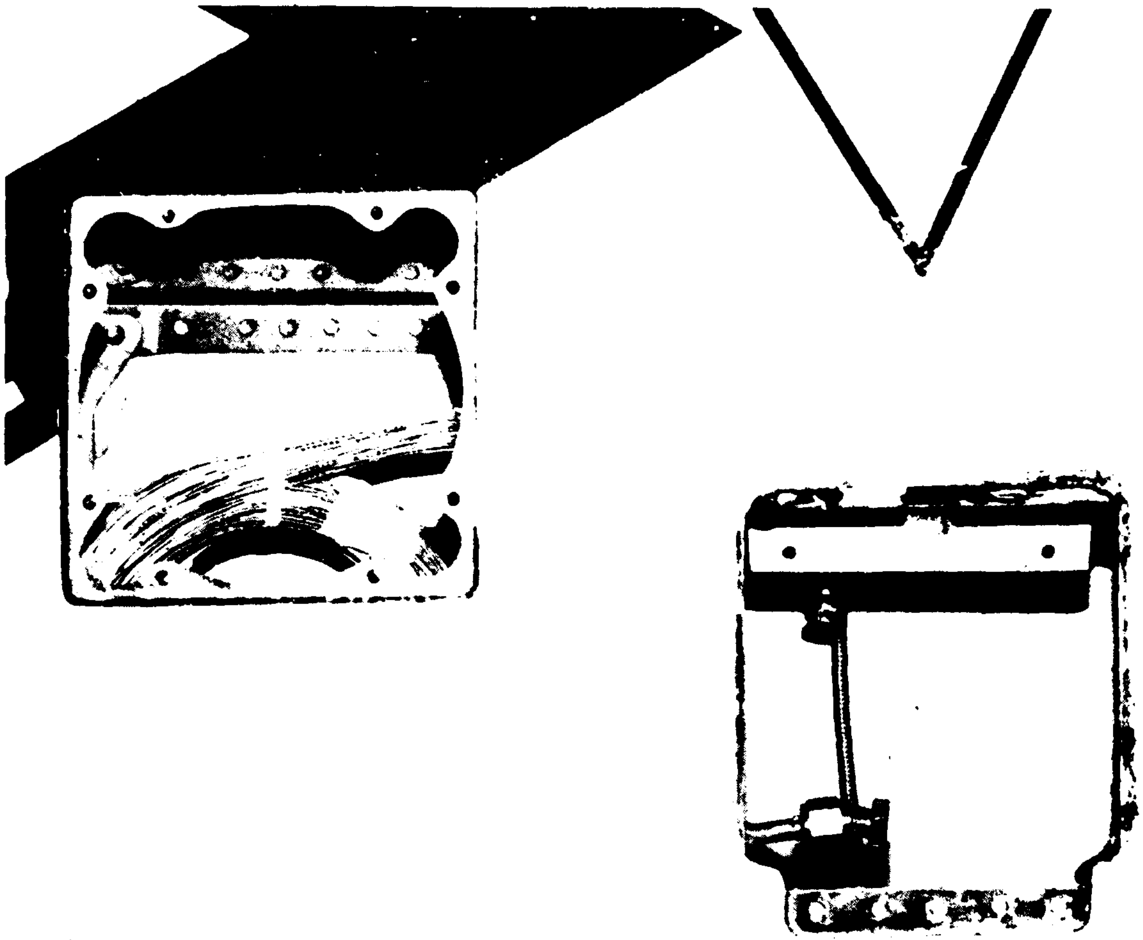


ITEM	DESCRIPTION	SENSOR	TYPE
1.	RESERVOIR	LEVEL	POTENTIOMETER
		TEMP	IC
		PRESS.	
2.	BACK UP PACKAGE	TEMP	SWITCH
3.	FILTERS		
	PRESS.	DELTA P	SWITCH
	RETURN	DELTA P	SWITCH
	CASE	DELTA P	SWITCH
		(SAMPLING VALVE)	
4.	RELIEF VALVE	TEMP	SWITCH
5.	ACCUMULATOR	PRESS	TRANSDUCER
		TEMP	TRANSDUCER
		DISPL	TRANSDUCER

ITEM	DESCRIPTION	SENSOR	TYPE
6.	PNEUMATIC BOTTLE	PRESS.	SWITCH
		LIQUID	OPTICAL PROBE
7.	PUMP		
	OUTLET	PRESS.	SWITCH
	CASE	FLOW	SWITCH
		TEMP	SWITCH
8.	FLOW	QUIESCENT	SWITCH
	RUDDER ACTUATOR	DIFF DISPL	POTENTIOMETER
	FLOW	QUIESCENT	SWITCH
	PEDALS	DIFF DISPL	POTENTIOMETER
9.	DESICCANT CONDITION	COLOR	OPTICAL

R80-2038-001(T)

Figure 1. A-6E HYCOS block diagram.



R80-2038-002(T)

Figure 2. Access panel before modification.

1.3 VEHICLE COMPONENT INSTALLATION

As specified in the statement of work, various components were modified to sense variables as determined during the previous program. The parameters included:

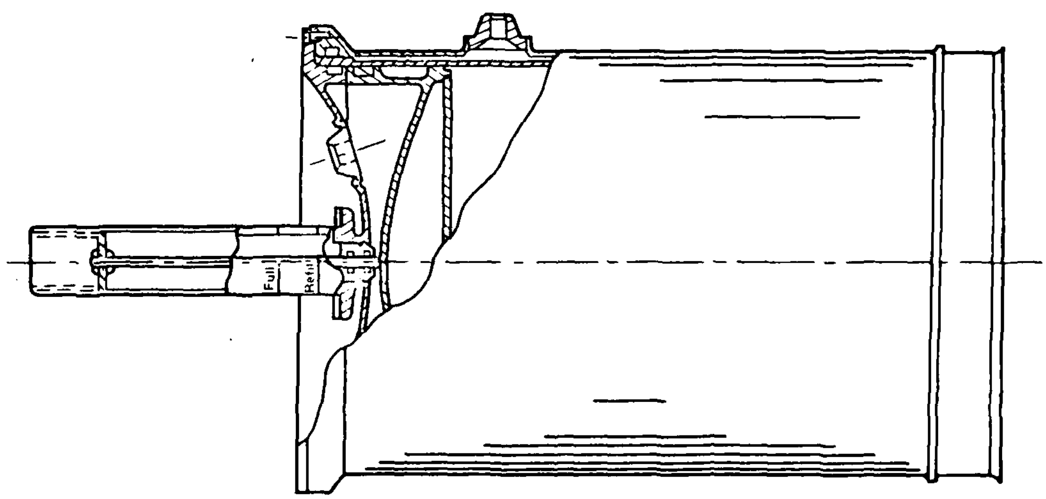
- Level
- Temperature
- Air Content

- Differential Pressure
- Liquid Detection
- Flow
- Desiccant Saturation
- Total System Operating Hours

1.3.1 Hydraulic Reservoir

1.3.1.1 Description

The combined system reservoir was designed to meet the requirements of Specification MIL-R-5520A-1 for a "Class II" separated air and oil reservoir. A "Type B" reservoir pressurized with air to a nominal operating value of 40 psi was used. The detail design configuration is that of a welded and machined outer casing with concave hemispherical ends enclosing a cantilevered, pressure-balanced sleeve. This configuration is not subjected to distortions produced by pressure surges and structural deflection. A free-floating piston separates system oil from pressurizing air. Both return and suction ports are located in the side of the outer shell. Returning oil impinging on the outer surface of the piston sleeve provides natural air separation characteristics. The concave ends minimize weight by reducing the volume of non-usable oil. Figure 3 shows the typical construction.



R80-2038-003(T)

Figure 3. A-6 reservoir typical construction (before modification).

1.3.1.2 Reservoir Sensing Logic

The purpose of the reservoir sensing logic is to:

- Detect the presence of entrained air
- Detect low oil level
- Detect extensive leakage during the previous flight.

Figure 4 shows the A-6E hydraulic reservoir sensing logic. The logic employs variables of fluid temperature and piston displacement. Piston placement during the nonpressurized to pressurized condition gives an indication of entrained air. Fluid thermal expansion is automatically taken into account during microprocessor programming.

1.3.1.3 Displacement Sensor

An external 10-turn potentiometer was driven via a cable attached to the modified piston. Tensioning of the cable was accomplished by a negator spring motor contained in a pressure housing. One pulley on the motor drove an externally mounted potentiometer through a lip type seal. Reservoir pressurization was accomplished through the normal pressure housing port.

This configuration minimized the rework modification required for providing remote reservoir level sensing capability. Figure 5 shows a cross-section of the modification and the adapter ring added to the reservoir piston. Figure 6 shows details and subassembly of the modified reservoir.

The negator motor model number ML-2918, manufactured by the Hunter Spring Division of Ametek, was selected because of its constant-torque characteristics. Pertinent motor assembly details are listed below:

- Physical Dimensions . . . . 2-1/2 x 3-3/4 x 1-3/16 in.
- Materials:

  Base . . . . Zinc-plated steel

  Drums . . . . Delrin or nylon

  Spring . . . . 301 stainless steel

  Cable . . . . 0.024 in. dia stainless steel

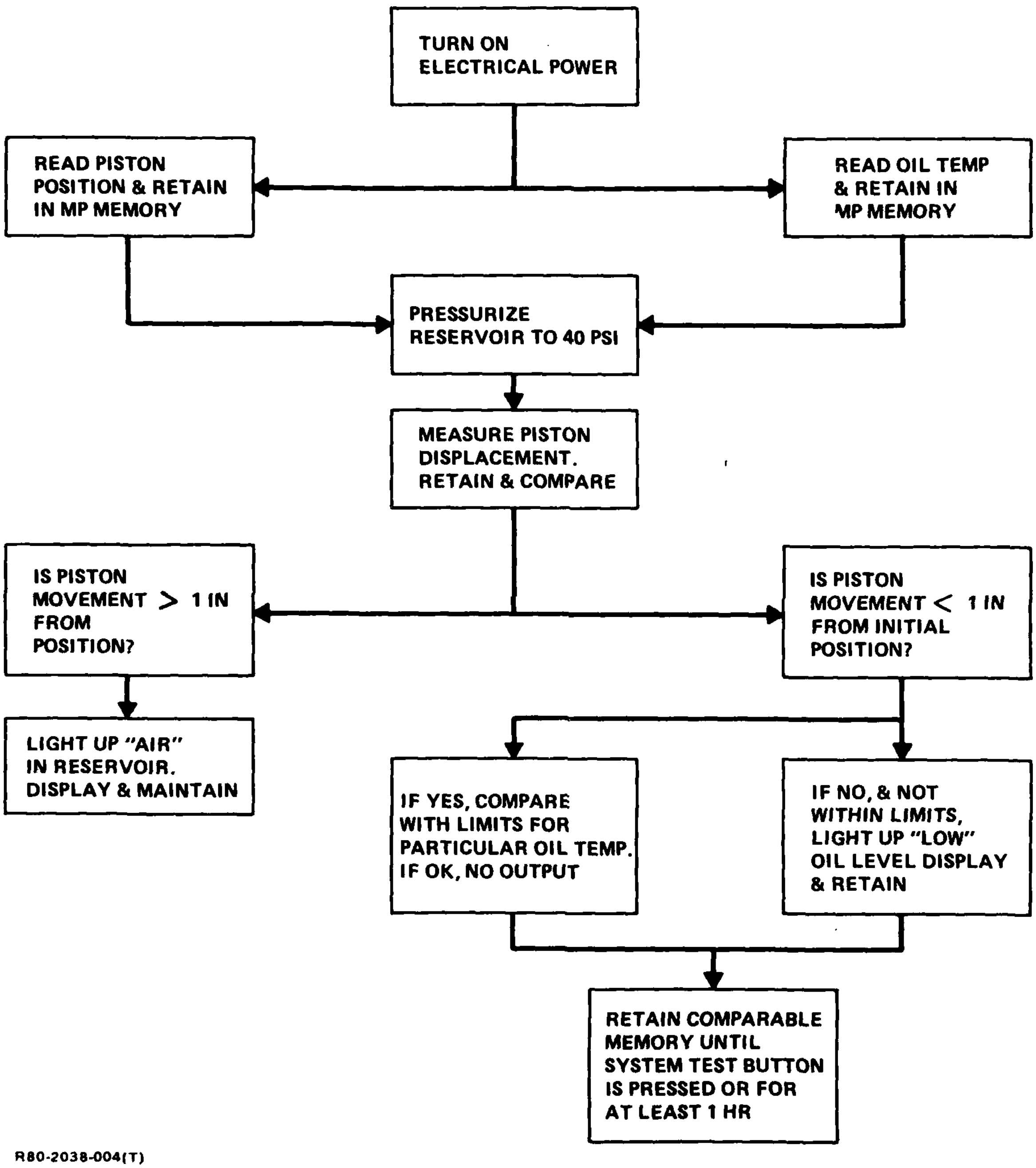


Figure 4. A-6E reservoir sensing logic.

- Spring Torque . . . . 1.56 lb-in.
- Cable Tension . . . . 2 lb
- Cable Length . . . . 72 in.
- Number of Revolutions 15
- Min Endurance Cycles 2500

The motor assembly was mounted in the 1491-901-306 remote sensor housing with the cable terminal modified from a coil to a bead. This cable bead was free to float in the modified piston adapter ring.

A rotary potentiometer was attached to the driving end of the motor assembly as specified in Grumman Specification 209. Some pertinent data includes:

- Type: 10-Turn

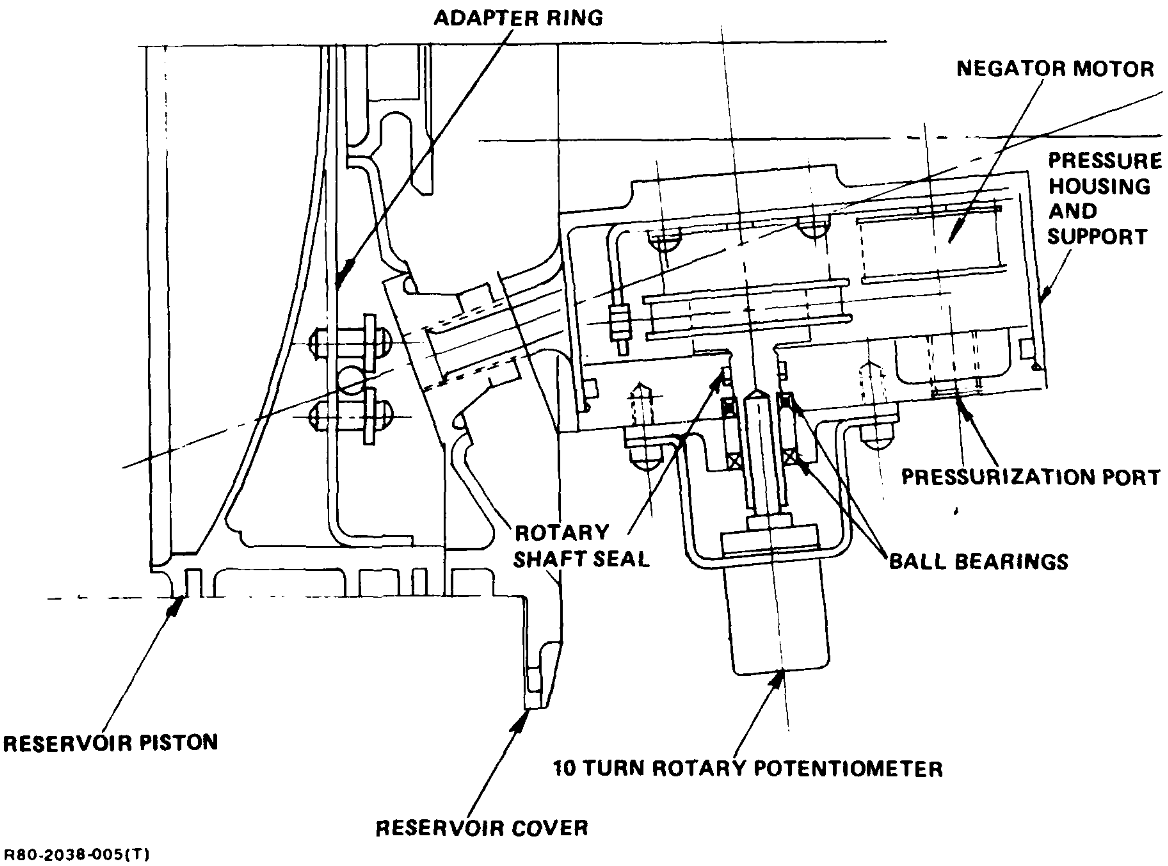
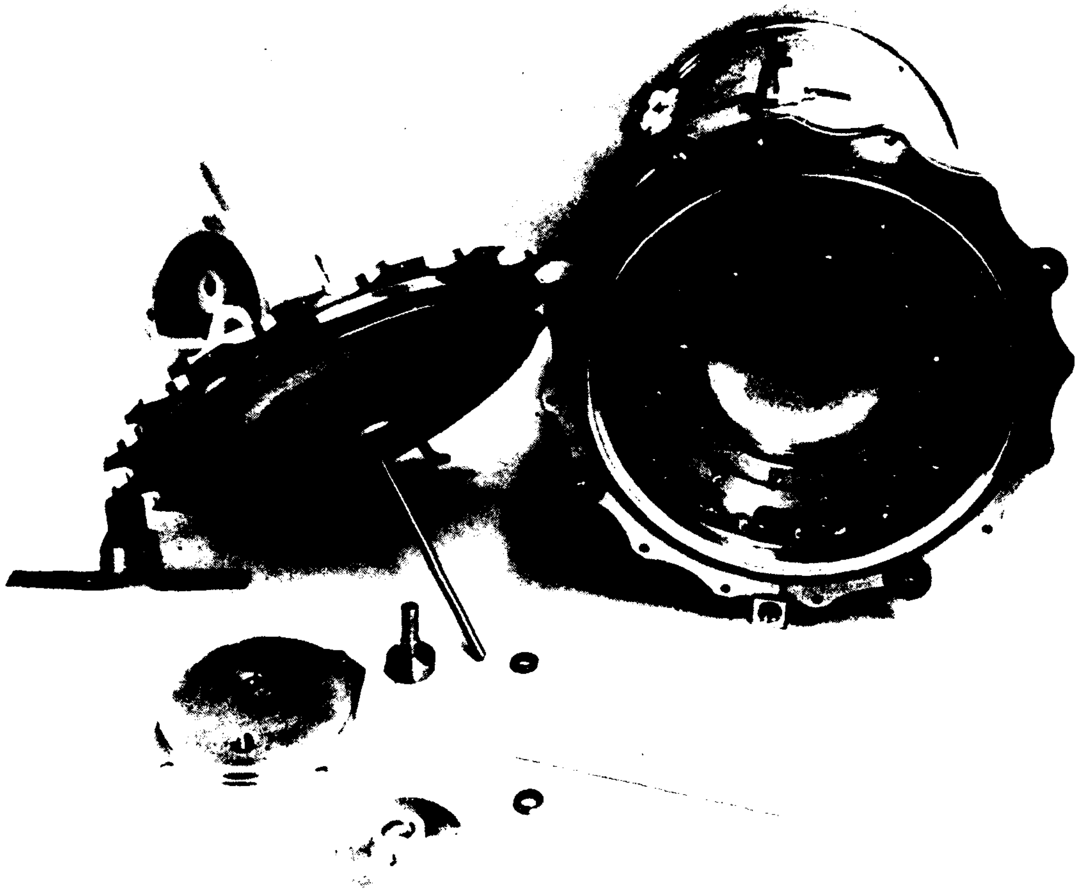


Figure 5. Modified reservoir (level sensing).



R80-2038-006(T)

Figure 6. Modified reservoir subassembly and details.

- Element: Wirewound
- Dimensions: 0.875 in. OD
  1.00 in. long
- Resistance: 20,000 Ohms
- Power Rating: 2 W
- Temperature Range: -65 to 255°F
- Torque: 0.60 oz-in. maximum
- Weight: 1 oz
- Resolution: 0.014%

Full travel of the hydraulic reservoir piston is 13.31 in. This piston movement relates to approximately three turns of the potentiometer, which is approximately 6000 Ohms. Figure 7 shows a calibration curve prepared in the Plant 14 Laboratory.

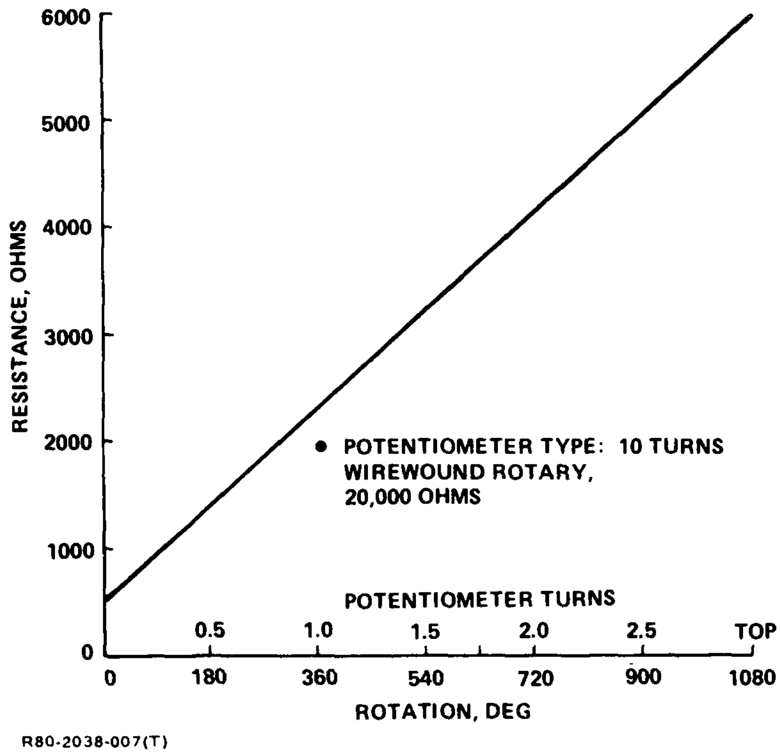
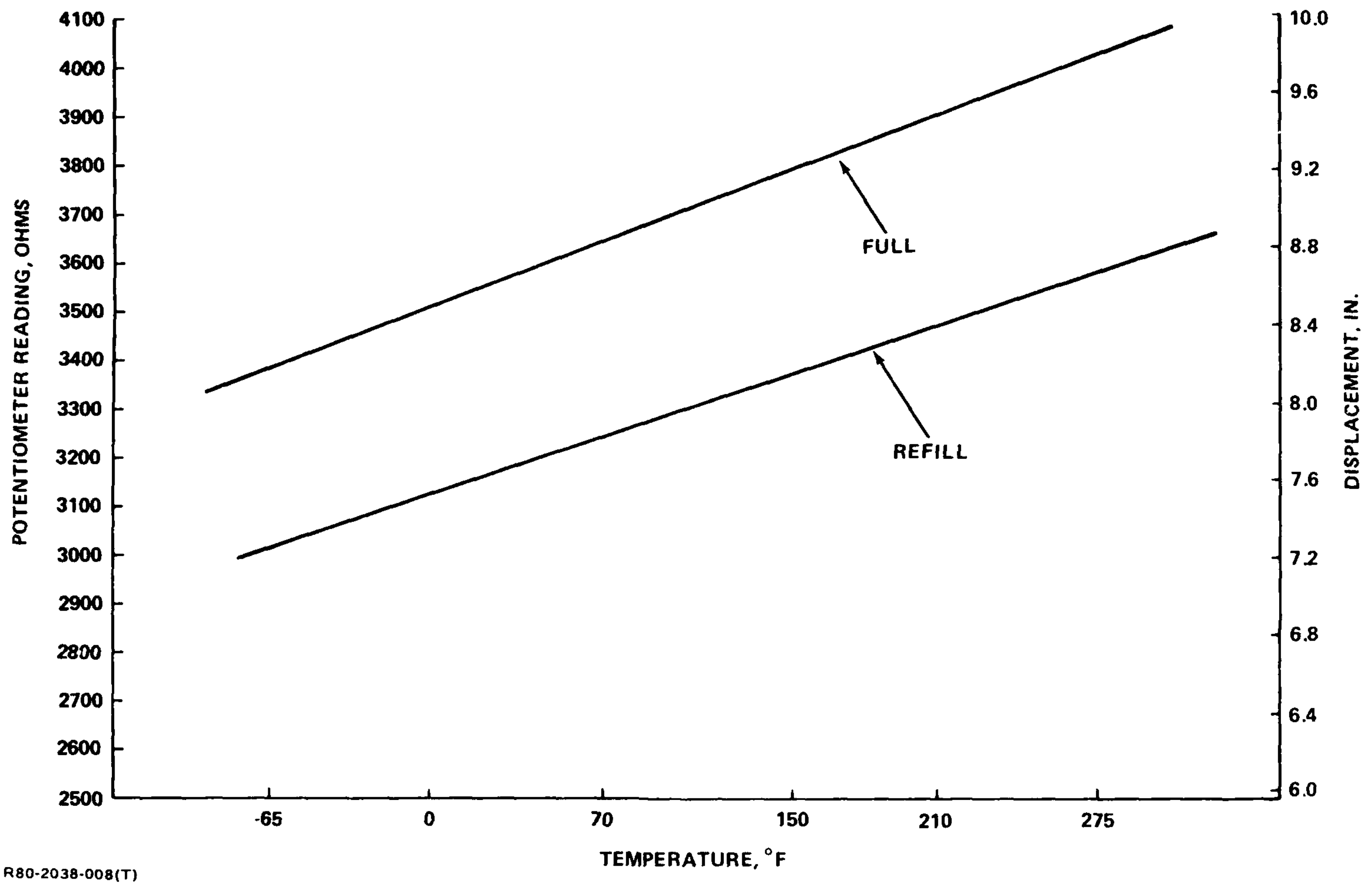


Figure 7. Hydraulic reservoir (laboratory calibration curve).

Considerations of temperature and entrained air variations provide the curves shown in Figures 8 and 9. Since the reservoir pressurization is only 40 psi, significant volumes of entrained air are required to cause measurable piston displacements between the pressurized and nonpressurized state. Hysteresis is limited to 2 psi in either direction.

Another factor considered but not applied in reservoir level sensing is piston movement/depletion time versus leak rate for both the combined and flight system. These curves (Figures 10 and 11) give an indication of reservoir depletion time in minutes versus varying leak rates. The initial datum point is taken at the refill mark of each reservoir. If each respective reservoir is full, the time to depletion is proportionately longer.



R80-2038-008(T)

Figure 8. Reservoir calibration curve considering fluid temperature variation.

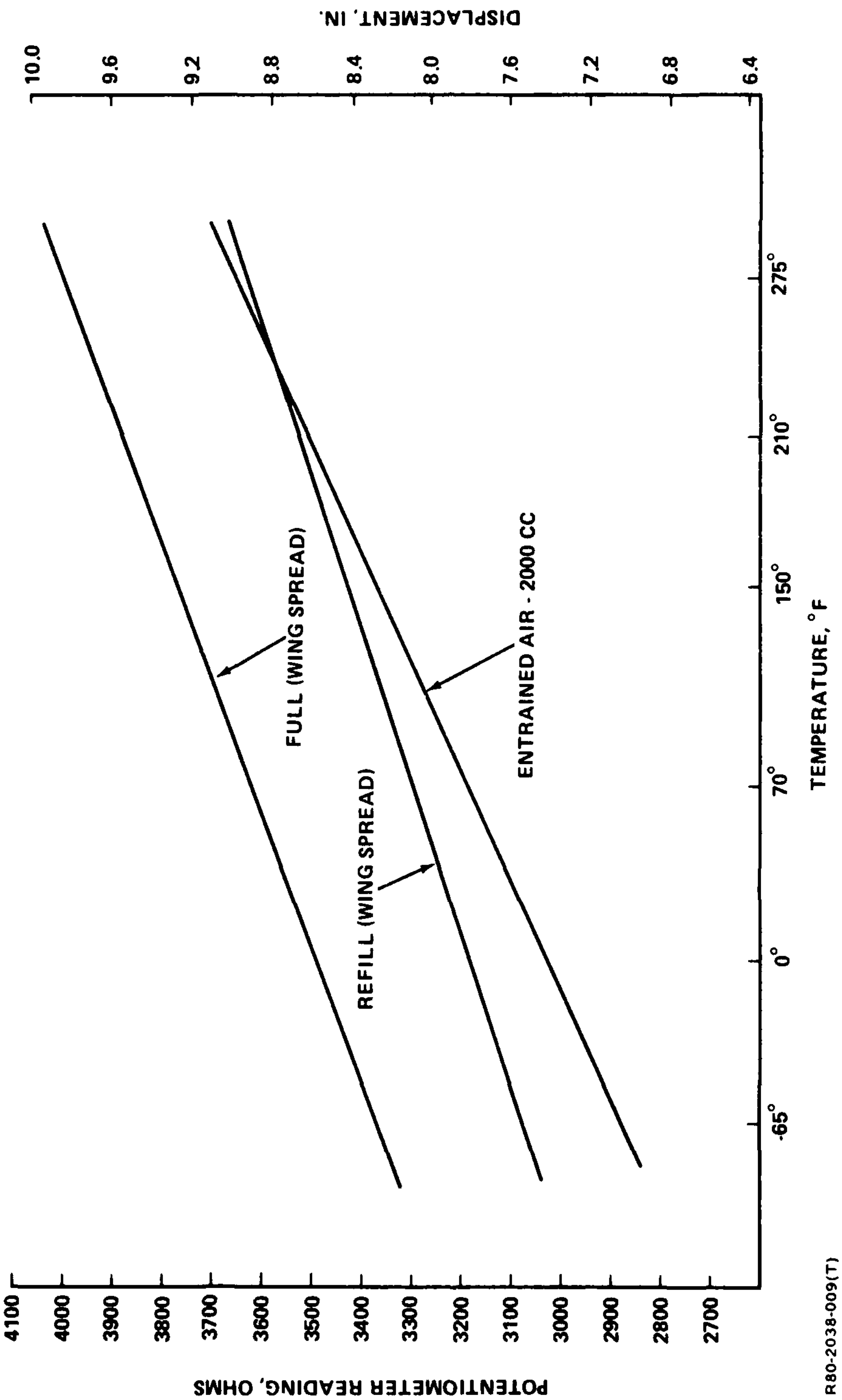


Figure 9. Calibration curve considering entrained air and temperature variation.

1.3.1.4 Temperature Transducer

The temperature sensor utilized a two-terminal I/C temperature transducer manufactured by Analog Devices of Norwood, Massachusetts.

The transducer, part no. AD590.C, produces an output current proportional to absolute temperature. With a supply voltage of 5 VDC, the device acts as a high-impedance, constant-current regulator passing 1μA/°K. Table 1 (extracted from Ref. 1) shows pertinent technical data.

TABLE 1. IC TEMPERATURE TRANSDUCER DATA.

- TYPE: ANALOG DEVICES AD 590.C
- OUTPUT: 1 μA/°K
- OPERATING TEMP RANGE: -55°C TO 150°C (-67°F TO 302°F)
- TWO-TERMINAL DEVICE: VOLTAGE IN/CURRENT OUT
- CALIBRATION ACCURACY: ±1°C
- LINEARITY: ±0.5°C OVER FULL RANGE
- POWER SUPPLY RANGE: +4 VDC TO +30 VDC
- SIZE: TO -52 PACKAGE

R80-2038-012(T)

Figure 12 (extracted from Ref. 1) shows a voltage-current plot for a typical transducer. Note that the current is essentially flat with an input voltage of 3 to 30 VDC.

The transducer was selected for its small size, performance, and compatability. Figure 13 shows the actual calibration for the unit.

The final subassembly is shown in Figure 14 before potting and assembly. This sensor is used both in the reservoir-level sensing circuit (Figure 15) and in the accumulator circuit discussed in a later section.

1.3.1.5 Optical Desiccant Sensor

Some hydraulic systems (such as the A-6E) are pneumatically pressurized, utilizing regulated engine compressor bleed air.

A desiccant is used to dry the makeup air used to pressurize the reservoir. The cartridges are replaced on periodic intervals predicated on vehicle system usage. In order to remotely detect a saturated condition, a colored desiccant cartridge is placed in series with the existing unit since the latter could not be readily modified.

The selected sensor was made by Delaval Special Products Division and conforms to Grumman Specification Number 205. The sensor measures approximately 5 in. x 3 in. long, has a transparent housing, and is rated for 100 psi operating pressure. The unit

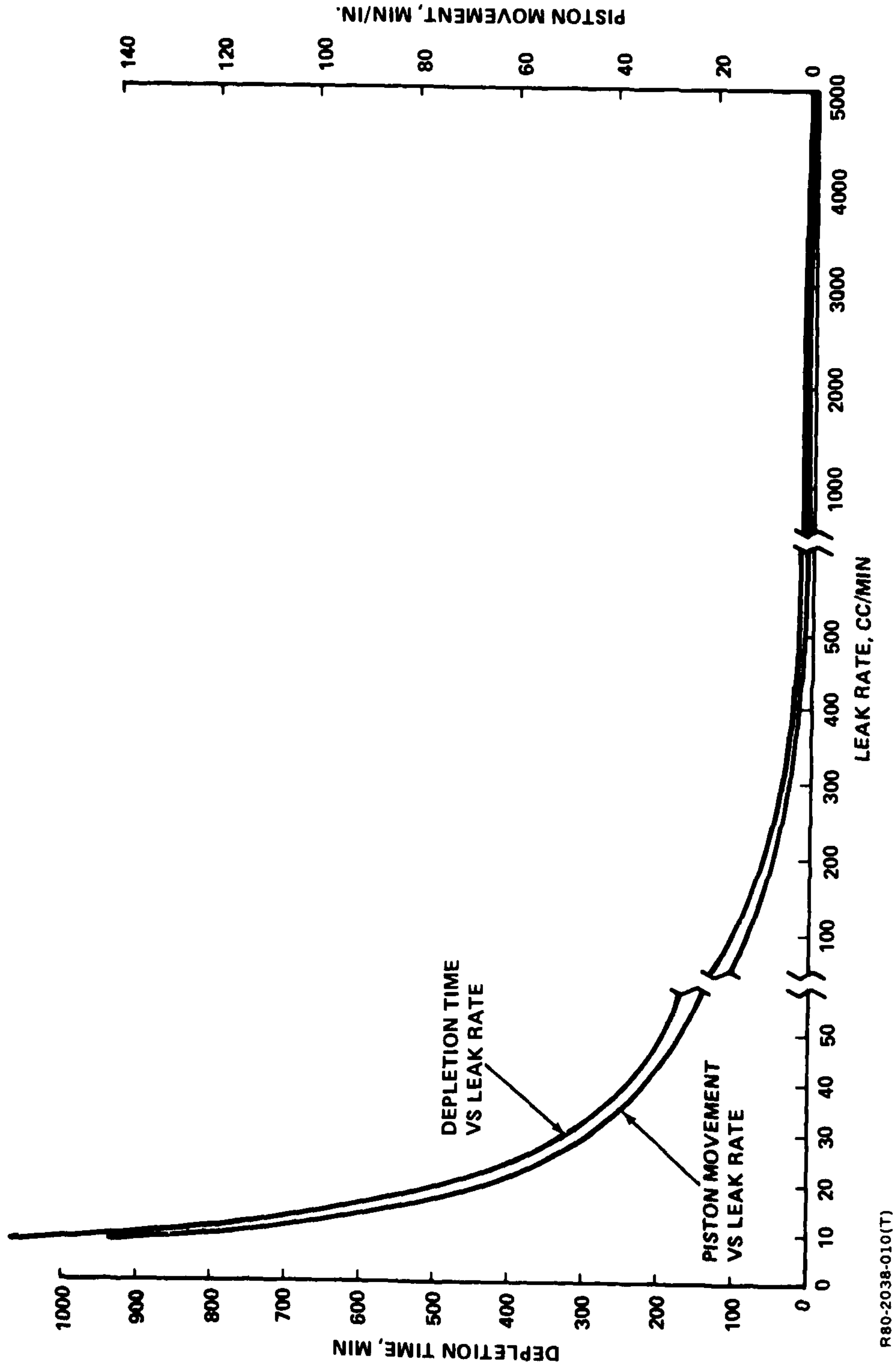


Figure 10. Combined reservoir depletion rate vs time.

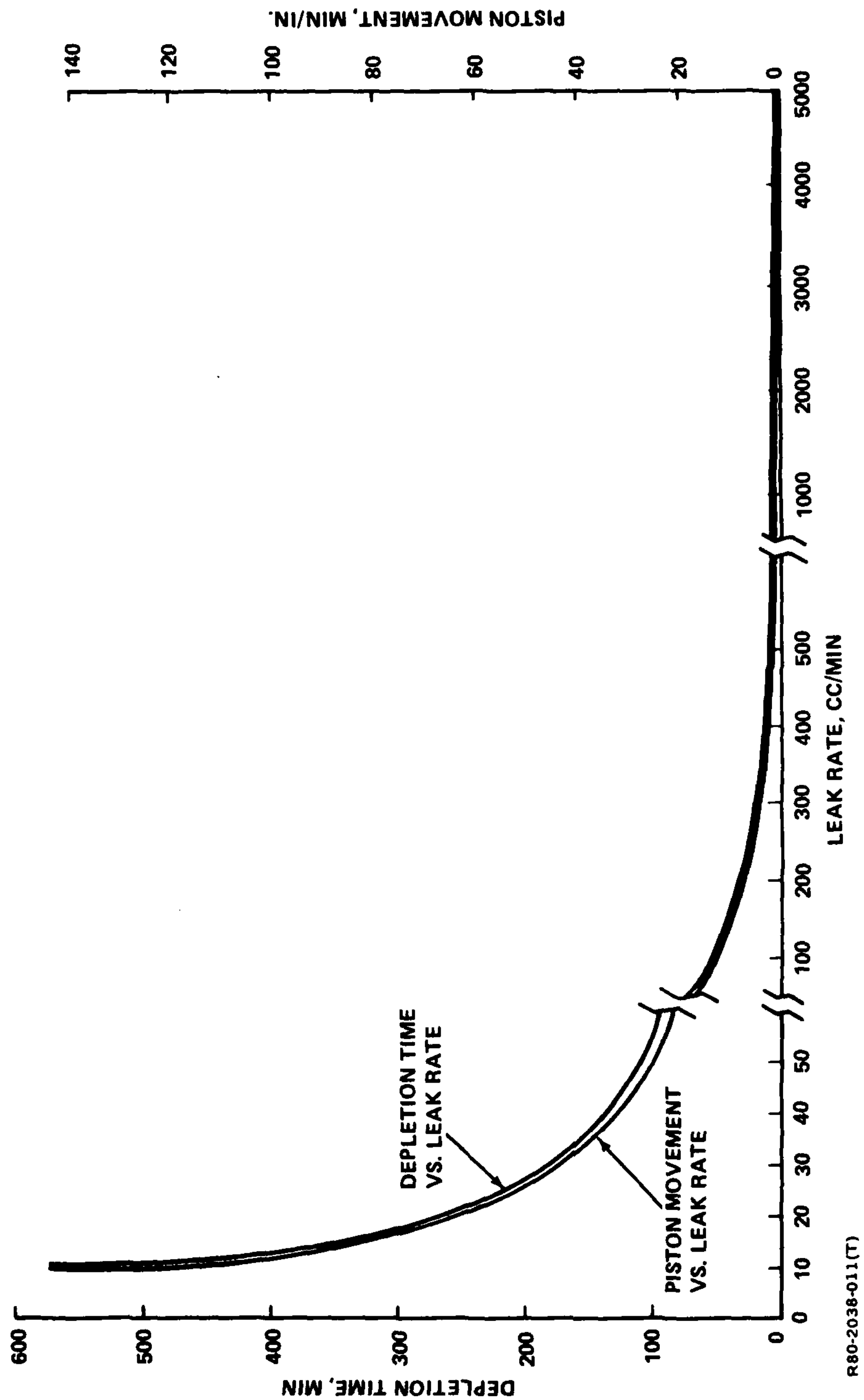
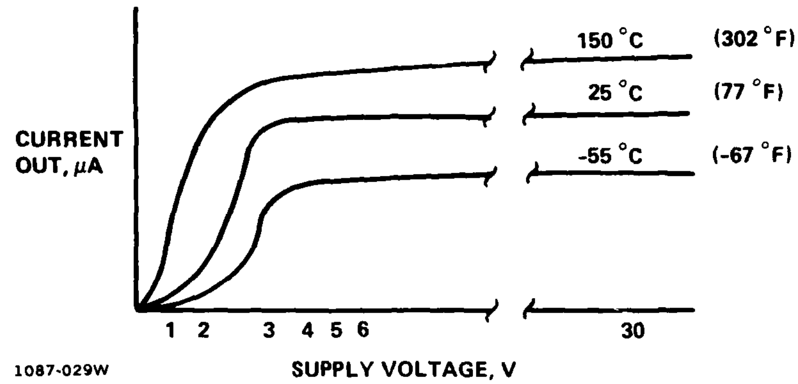
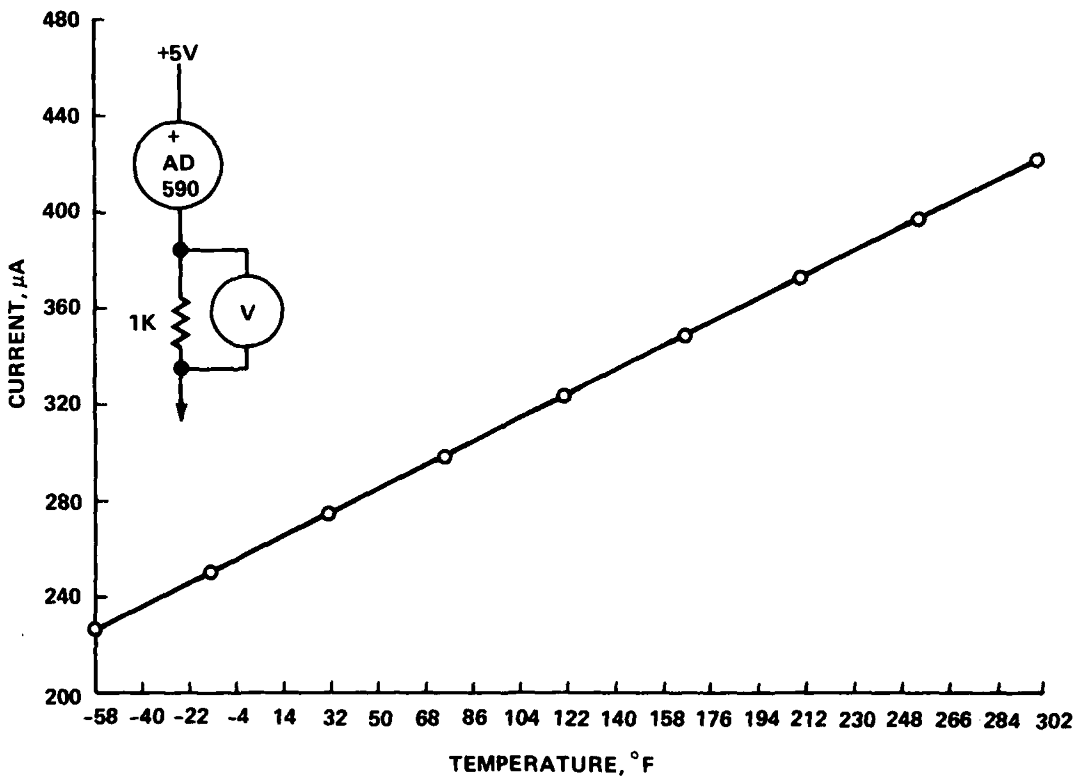


Figure 11. Flight reservoir depletion rate vs time.



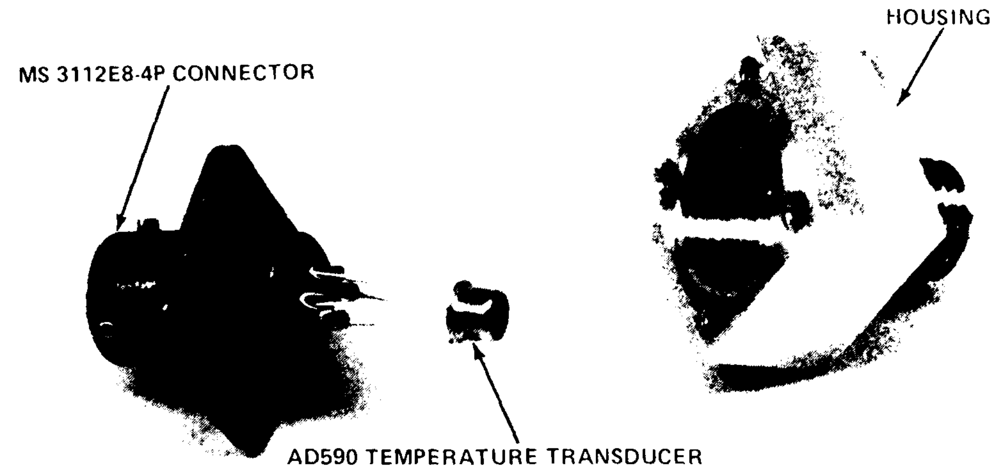
R80-2038-013(T)

Figure 12. Voltage-current plot for an IC transducer.



R80-2038-014(T)

Figure 13. Calibration curve for an IC transducer.



R80-2038-015(T)

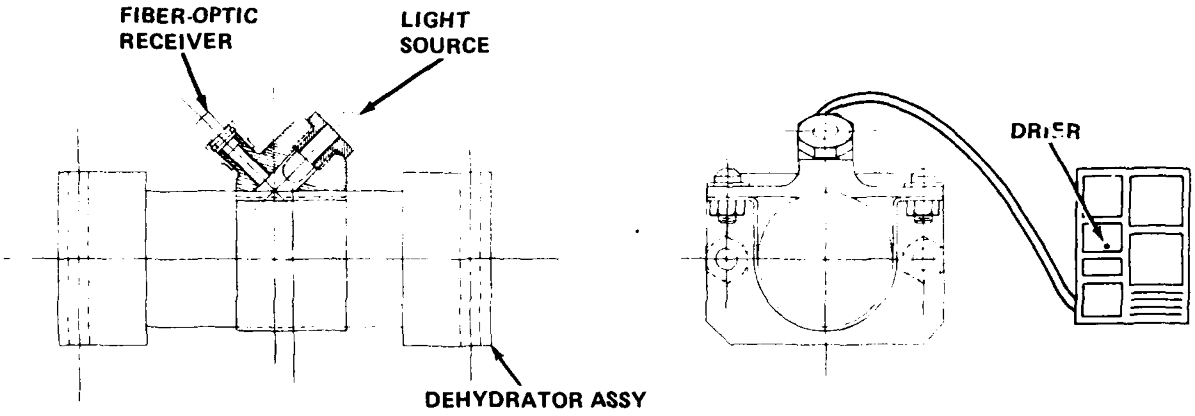
Figure 14. Temperature transducer assembly.

R80-2038-016(T)

Figure 15. Reservoir temperature sensor installation.

contains approximately 2.6 $in.^3$ of dyed silica gel conforming to Military Specification MIL-D-3716, Type IV. The initial color of the desiccant is deep to pale blue, depending on the desiccant condition. The color changes from pale blue to pink as the unit becomes saturated.

Reading desiccant condition remotely is accomplished by using reflected colored light from the irregular desiccant granules through the transparent housing. Figure 16 shows the concept employed to accomplish this objective.



R80-2038-017(T)

Figure 16. Optical desiccant sensor (early approach).

Initial test results revealed that a major portion of the light was being reflected by the transparent housing since the light transmitter and receiver were on the same axis. The light source transmitter-receiver angle was changed from 13° to 30°. No substantial improvements were noted. Various reflected angles were tested with the transmitter and receiver perpendicular to the desiccant housing axis in order to determine the maximum reflected light. This condition occurred with an included angle of 30 degrees between the transmitter and receiver. A second sensor housing (Figure 17) was originally made to support the grain of wheat light source and the fiber-optic terminal receiver. Subsequent testing revealed that color transmission became apparent but the intensity was not discernable to the viewer at the display panel.

Additional development effort dictated that the light source be brought closer to the transparent housing in order to increase the intensity of reflected light. A light source with a condensing lens was obtained to focus the light rays to one point. This change improved the reflective properties but, due to the irregular shape of the desiccant, the reflected light scatters in many directions and makes reflected colored light difficult. As a final attempt a condensing lens was used on the reflected light source to intensify the reflected color.

The light source for the sensor was originally a grain-of-wheat bulb, but its intensity after passing through the desiccant was not strong enough to be seen at the display panel. The grain-of-wheat bulb was then replaced by a General Electric No. 2701

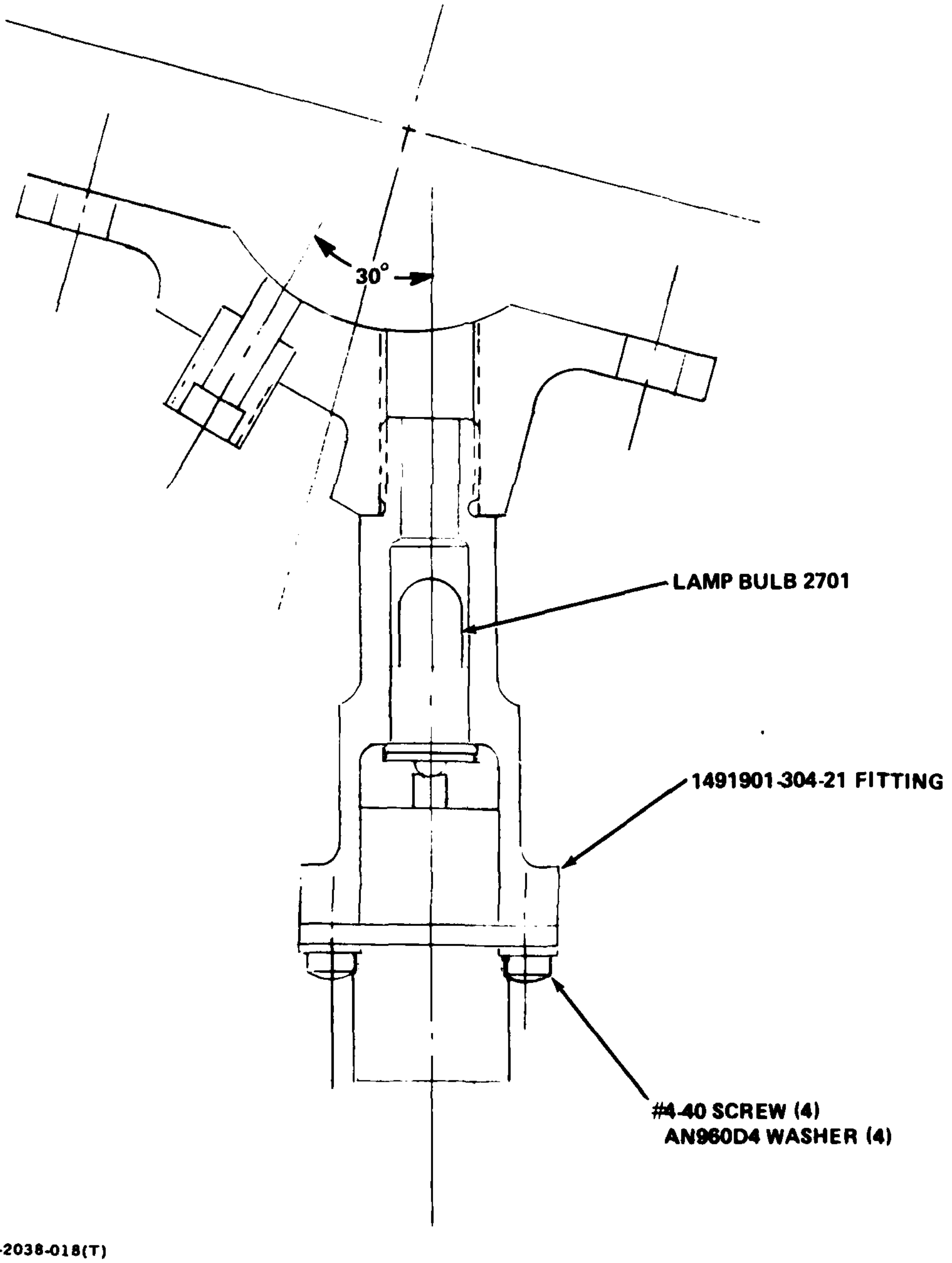


Figure 17. Sensor assembly.

halogen lamp requiring an operating voltage of 3.5 VDC and developing a maximum of 3.5 W, increasing the intensity by a factor of 20. Figure 18 shows plots of voltage, current, and power versus light intensity of the grain-of-wheat bulb; similar plots for the halogen bulb are shown in Figure 19. A comparison of the power versus light intensity of the grain-of-wheat and halogen bulbs is given in Figure 20.

ven with the halogen lamp, the reflected color properties were affected by the irregular angles of the desiccant crystals. Figure 21 shows the interim desiccant sensor installation. A decision was made to eliminate the desiccant and develop a moisture sensor. After several laboratory attempts, a disc was developed.

The desiccant sensor is a mixture of potassium bromide and cobaltous chloride, in a two-to-one ratio by weight, respectively. A description of the two components used in the desiccant is given in Table 2 (extracted from Ref. 2). The mixture is compressed into a half-inch diameter disc under a pressure of 22,000 psi and a vacuum of 25 in. mercury for 2 min. In order to focus the translucent disc color to a narrow point, a condensing lens was used adjacent to the disc support.

The lens is a condensing plano-convex lens Stock No. 10.0015 made by Rolyn Optics Company, Arcadia, California. The lens is made of spectacle crown glass (B-270) having a diameter of 0.295 ± .02 in. and a focal length of 0.512 in. ± 5%, as shown in Figure 22. The power of this lens is the reciprocal of the focal length, which gives a power of approximately 2 $in.^{-1}$ or 76.9 diopters.

The lens and desiccant disc are mounted inside the cartridge by a slide type assembly, shown in Figure 23. The slide is secured in position by the gasket, screen filter, and felt rings in the end covers. The complete assembly is coupled with two through bolts.

Since no suitable halogen bulb lamp holders were available, one had to be designed and fabricated to support the bulb and provide the proper mechanical/electrical interface. The resultant design was the 1491-304-21 optical desiccant fitting shown in Figure 24. A modified MS connector supplied power to the lamp. In order to reduce the voltage from 5 VDC to approximately 3.5 V, a 20-Ohm, 5-W resistor was used in the mating connector.

Specifications for the light source are as follows:

- GE Lamp Number 2701
- Voltage . . . . 3.5 V

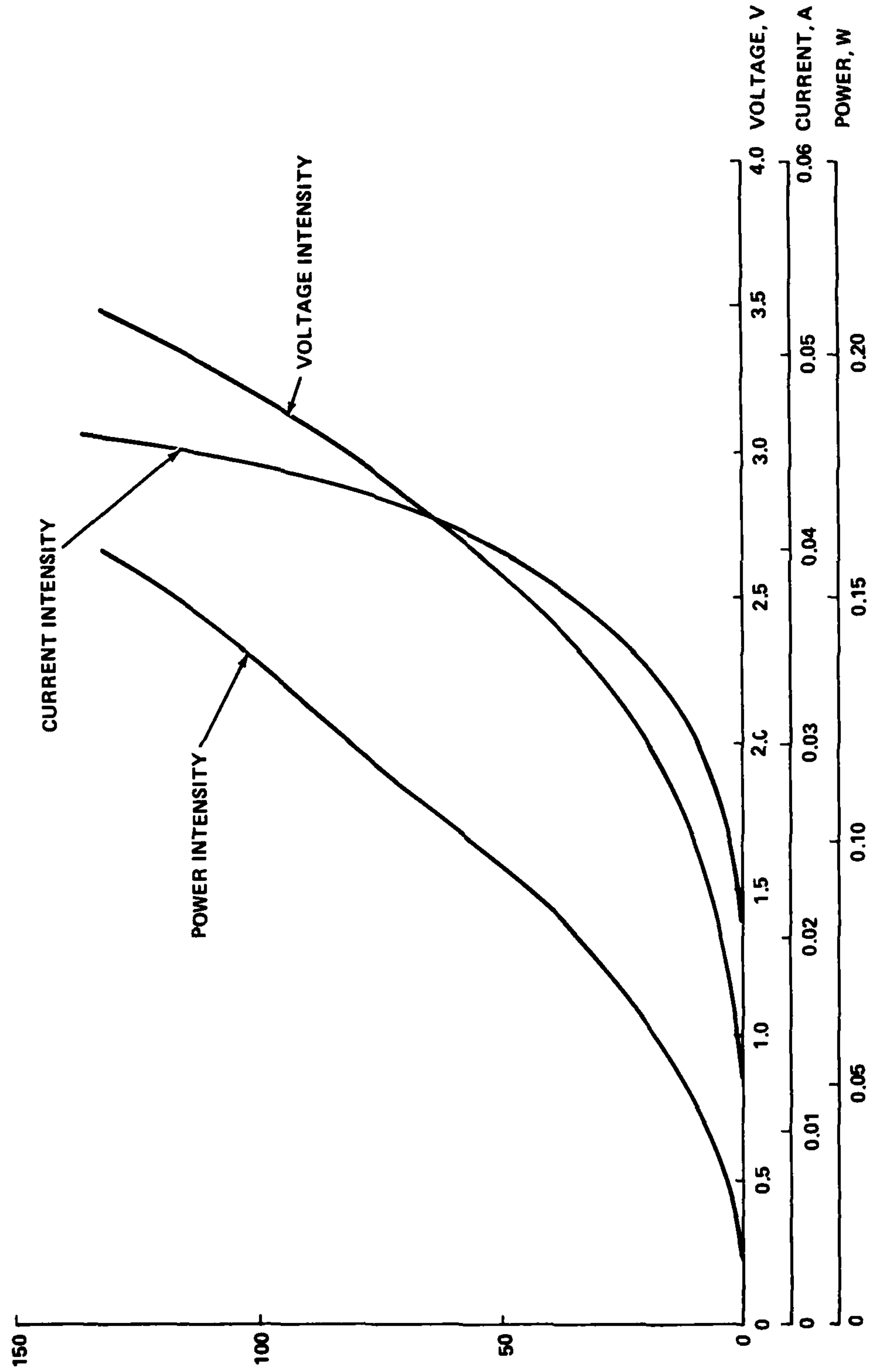


Figure 18. Grain-of-wheat bulb characteristic.

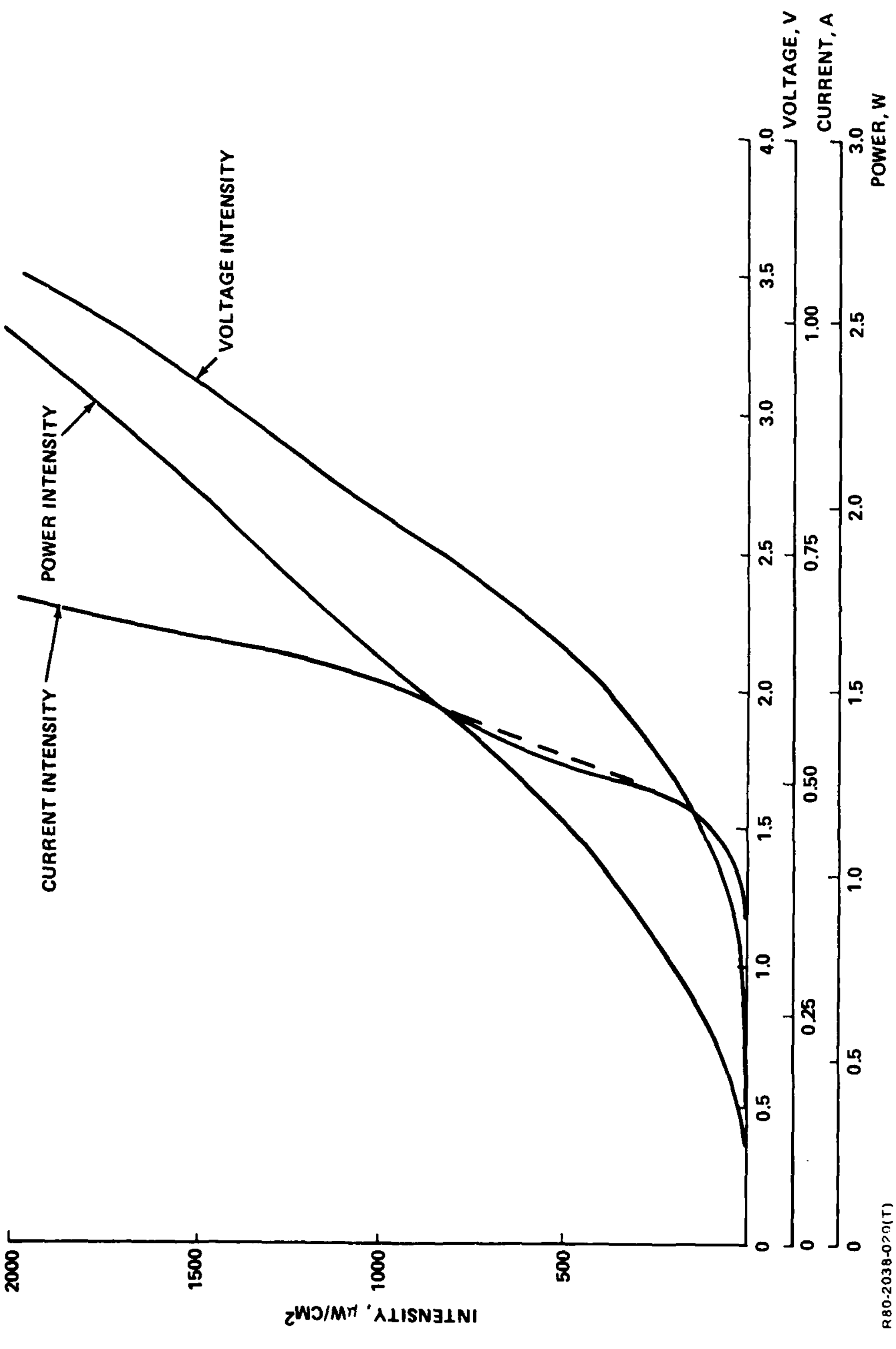


Figure 19. Halogen bulb characteristic.

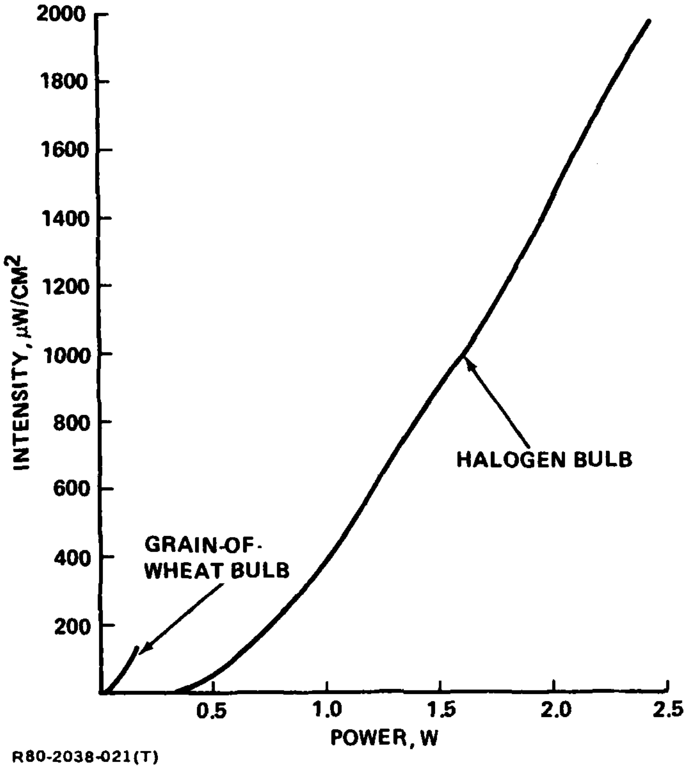


Figure 20. Grain-of-wheat bulb/halogen bulb comparison.

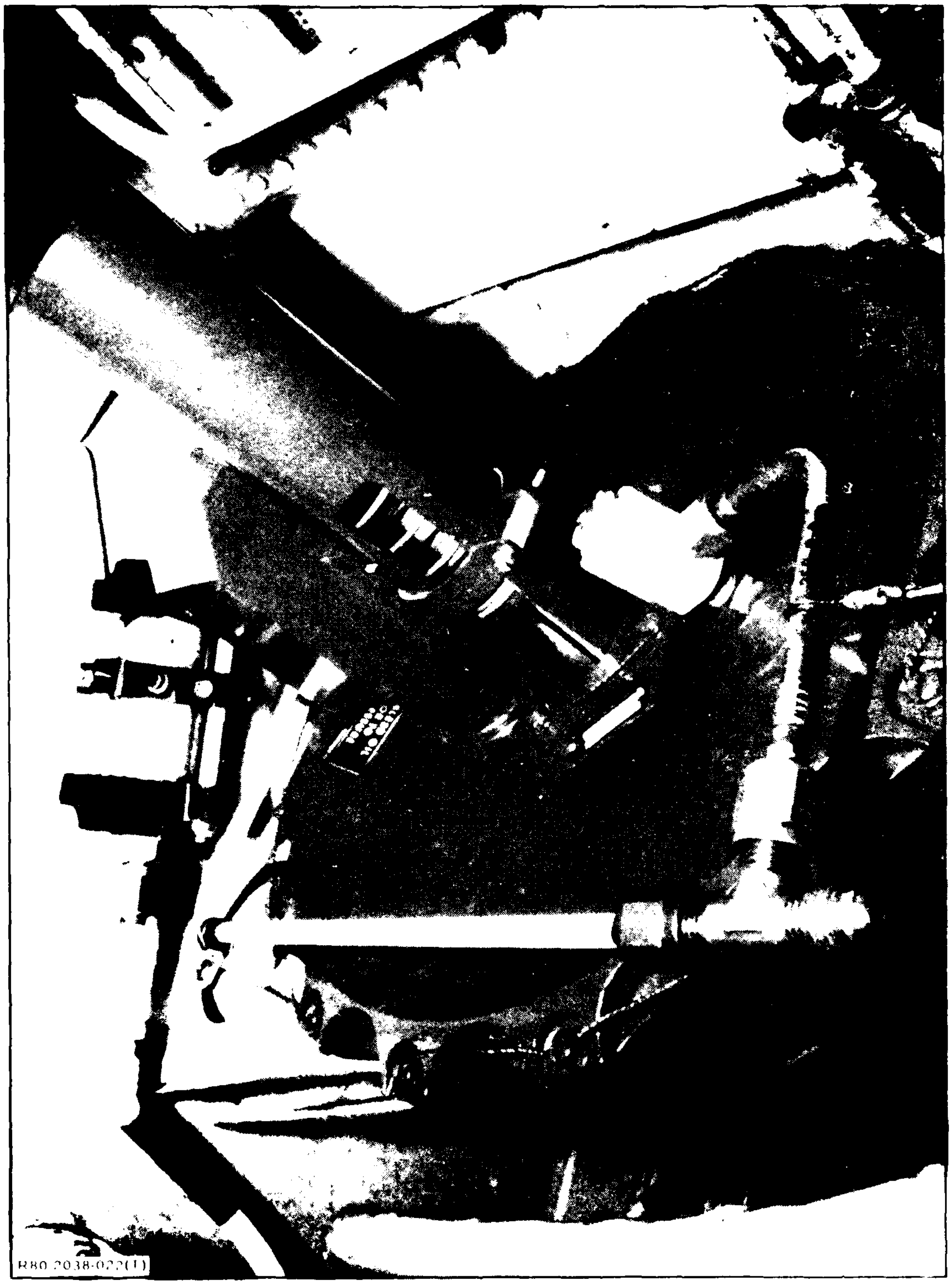
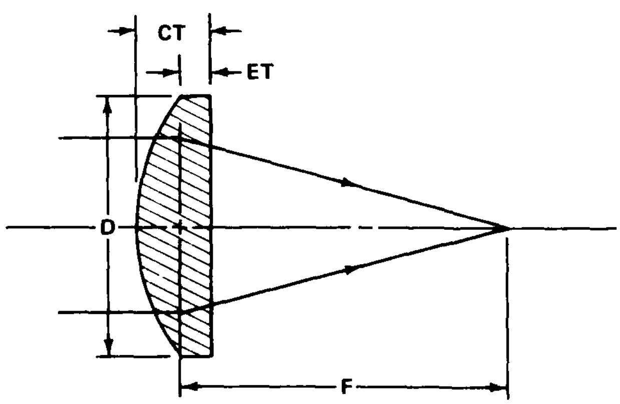


Figure 21. Interim desiccant sensor installation.

TABLE 2. DESICCANT COMPONENTS.

POTASSIUM BROMIDE, KBr	COBALTOUS CHLORIDE (COBALT CHLORIDE (A) $CoCl_2$ (B) $CoCl_2$ 6H)
PROPERTIES: WHITE, CRYSTALLINE GRANULES OR POWDER; PUNGENT, STRONG, BITTER SALINE TASTE; SOMEWHAT HYGOSCOPIC. SOLUBLE IN WATER AND GLYCERIN; SLIGHTLY SOLUBLE IN ALCOHOL AND ETHER; SP GR 2.749; M.P. 730°C; H.P. 1435°C.	PROPERTIES: (A) BLUE (B) RUBY–RED CRYSTAL. SOLUBLE IN WATER AND ALCOHOL; ALSO SOLUBLE IN ACETONE. SP GR (A) 3.348 (B) 1.924; M.P. (A) SUBLIMES (B) 86.75°C.
DERIVATION: SOLUTIONS OF IRON BROMIDE AND POTASSIUM CARBONATE ARE MIXED AND HEATED THE SOLUTION FILTERED AND CONCENTRATED AND THE BROMIDE CRYSTALLIZED OUT.	DERIVATION: BY THE ACTION OF HYDROCHLORIC ACID ON COBALT, ITS OXIDE, HYDROXIDE OR NATE. CONCENTRATION GIVES (B) AND DEHYDRATION (A).
GRADES: TECHNICAL, C. P. N.F.; REAGENT; SINGLE CRYSTALS.	USES: ABSORBENT FOR AMMONIA; GAS-MASKS; ELECTROPLATING, SYMPATHETIC INKS, HYGROMETER IN SOILS AND ANIMAL FEEDS; VITAMIN B_{12}; FOR MAGNESIUM REFINING; SOLID LUBRICANT; MORDANT; CATALYST; BAROMETERS.
HAZARD: MODERATELY TOXIC BY INGESTION AND INHALATION.	
USES: MEDICINE; PHOTOGRAPHY (GELATIN BROMIDE PAPERS AND PLATES); PROCESS ENGRAVING AND LITHOGRAPHY; SPECIAL SOAPS, LABORATORY REAGENT.	

R80-2038-023(T)



CT = 0.079 in.

ET = 0.035 in.

D = 0.295 in.

F (Focal Length)

= 0.512 in.

R80-2038-024(T)

Figure 22. Plano-convex lens.

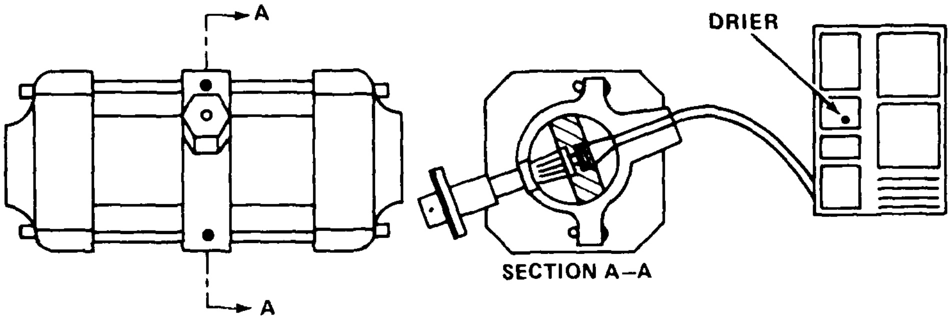


Figure 23. Moisture detector fiber-optic circuit.

- Power . . . . 2.5 W
- Life . . . . 20 hr
- Bulb Type . . . . TL 1/2
- Dimensions . . . . 0.625 x 0.285 in.

Desiccant Fiber-Optic Link. In an effort to improve visibility at the display, power optical measurements were taken using a recently purchased Photodyne Model 22XL optical multimeter. The results indicated that the cable running from the optical sensor to the display unit had an unsatisfactory 32 db/m optical loss instead of 10 db/m, which would normally be expected with a properly installed line run. The fact that the cable run was installed during vehicle buildup precluded improvements in this area.

1.3.2 Pneumatic Bottles

1.3.2.1 Description

Pneumatic bottles are energy storage devices which are used as an emergency backup to a principal system. Servicing these bottles requires that the maintenance technician compensate for topping pressure as a function of ambient temperature. A typical nitrogen bottle service card is shown in Figure 25 (Ref. 3).

In this flight test program, two of the eight stored energy sources were modified to accept HYCOS sensors. One landing gear door dump bottle (Figure 27) was modified to accept a temperature-compensated pressure switch and a fiber-optic liquid detection circuit. The second emergency canopy dump bottle (Figure 26) was modified to accept another temperature-compensated pressure switch. Special fittings were manufactured to provide sensor bosses.

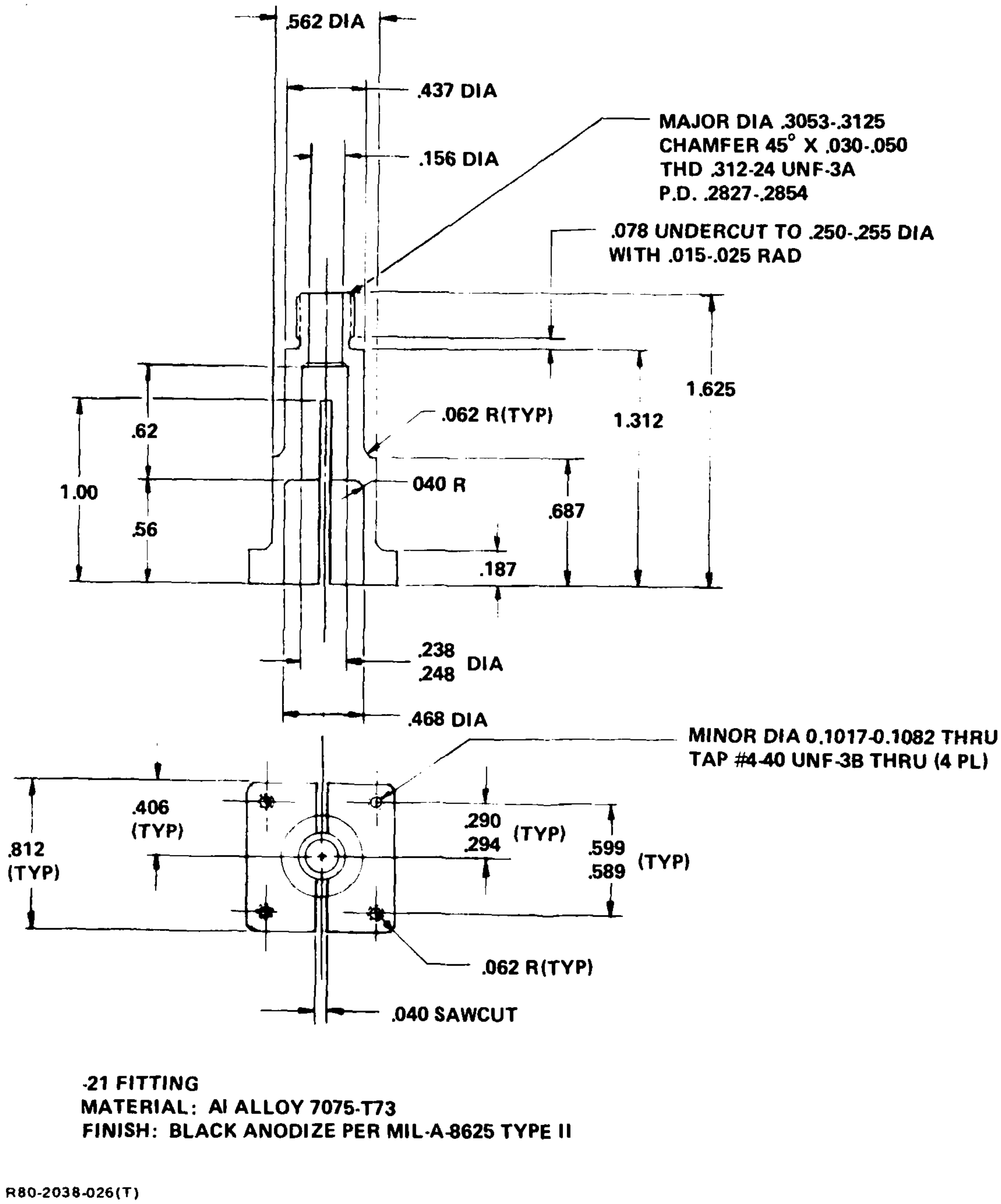


Figure 24. No. 1491901-304-21 optical desiccant fitting.

CARD A-13	NAVAIR 01-85ADA-6-4 Date: 1 December 1977				CHANGE NO.	PHASE A	ELEC PWR ON
ZONE AREA	WORK UNIT CODE	CREW	TIME 01:30	RIG NO. AMH 1	MOS. NO. 6053 1	LANDING GEAR EMERGENCY OPERATIONAL CHECK	HYD PWR ON COND AIR NA

Assisted by AMH-2 (90.0 Min)
AMH-3 (90.0 Min)
AMH-4 (90.0 Min)

GROUND SUPPORT EQUIPMENT REQUIRED

Adapter, External Hyd Power	128GT10154
Power Source, Electric	
Power Source, Hydraulic	
Trailer, Nitrogen	515R100
Wrench, Torque (0-150 in-lb)	

CONSUMABLES/REPLACEMENT PARTS

Fluid, Hydraulic	MIL-H-83282

WARNING: Insure wheel well areas are clear of personnel and equipment.

Do not turn off elec power source, elec power shall remain on during entire operational check.

2,4/9 1. Operation Check Emergency Landing Gear system IAW NA 01-85ADA-2-2.2, SECT 3.

NOTE: QA (Card A-23) witness task 2 (bottle servicing, swivel nut torque, for pressure loss).

1,4/9 2. Service landing gear emergency extension bottles IAW NA 01-85ADA-2-1, SECT 6.

End of Card
(Card A-13.1 Blank)

R80-2038-027(T)

Figure 25. Typical service card.

1.3.2.2 Temperature-Compensated Pressure Switch

At the onset of the program, it became evident that temperature-compensated pressure switches were not off-the-shelf hardware. NeoDyn Incorporated of Chatsworth, California, was contracted to develop and build temperature-compensated pressure switches for the hydraulic monitoring system program. An initial Grumman sensor specification (Number 204) was prepared.

Switch Description. The switch is an all-welded, hermetically sealed unit which physically conforms to Figure 28. The switch senses applied pressure and compares it to an internal sealed self-contained reference pressure within the probe, which is at the same temperature as the sensed media. A proprietary, welded stainless-steel sensing diaphragm is exposed to the probe reference pressure on one side and to the sensed pressure on the other side. Pressure settings, which vary as a function of sensed and reference pressure, are accomplished through a force balance interaction between a sensing diaphragm and a Belleville spring reference load. Since the reference pressure varies directly with sensed temperature, pressure settings are a function of temperature. Variation of reference pressure with temperature is shown graphically in Figure 29.

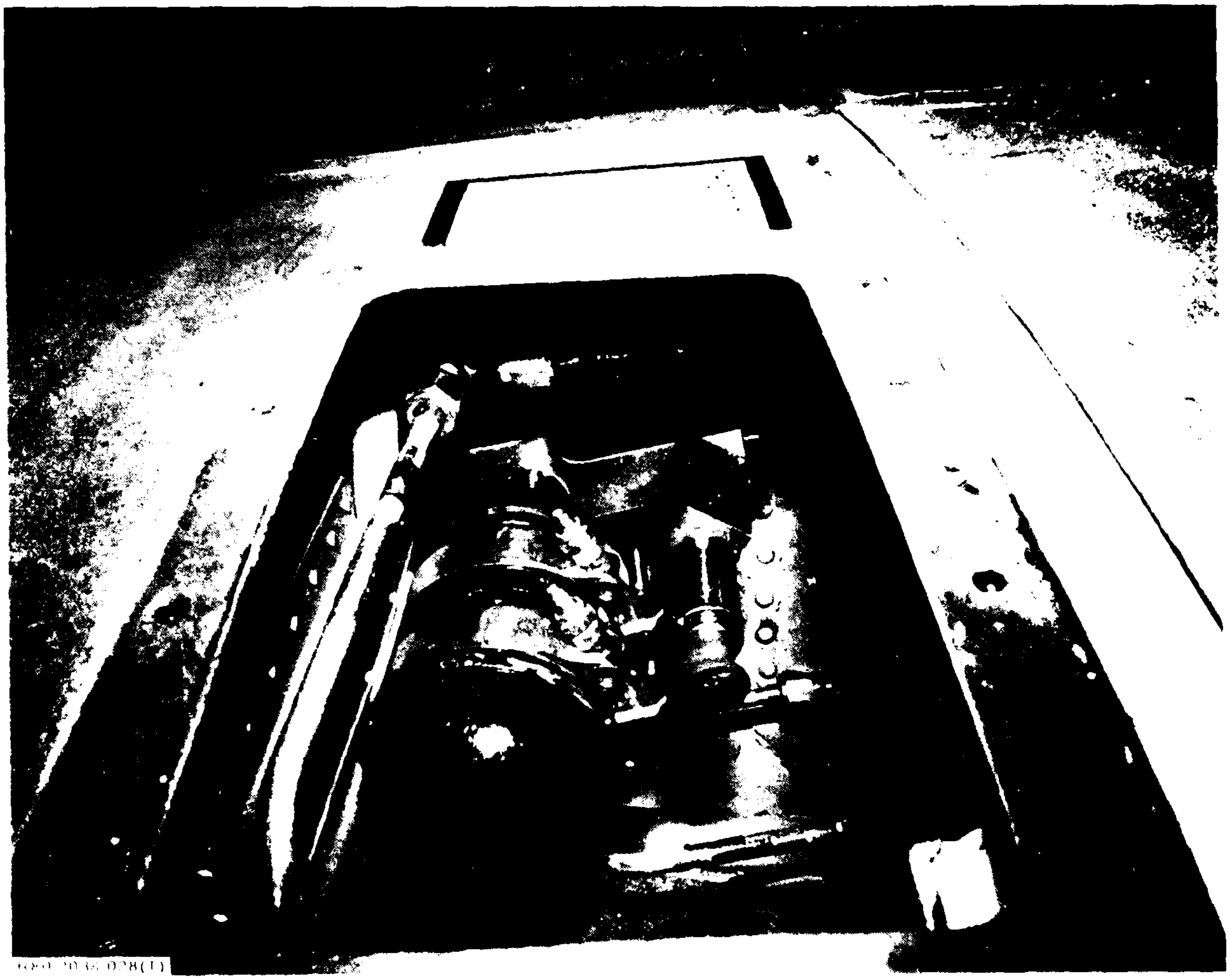


Figure 26. Emergency canopy dump bottle installation.

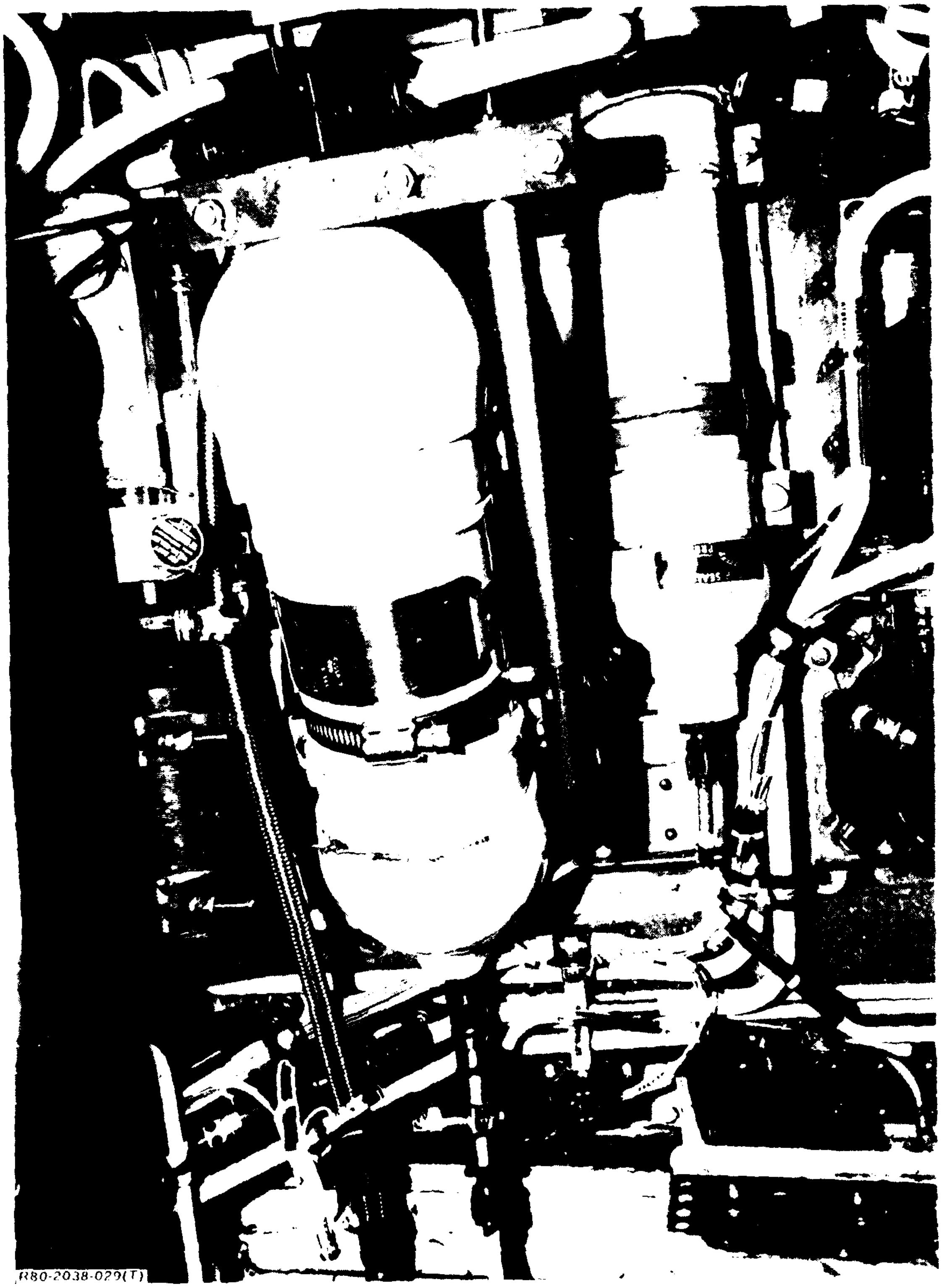
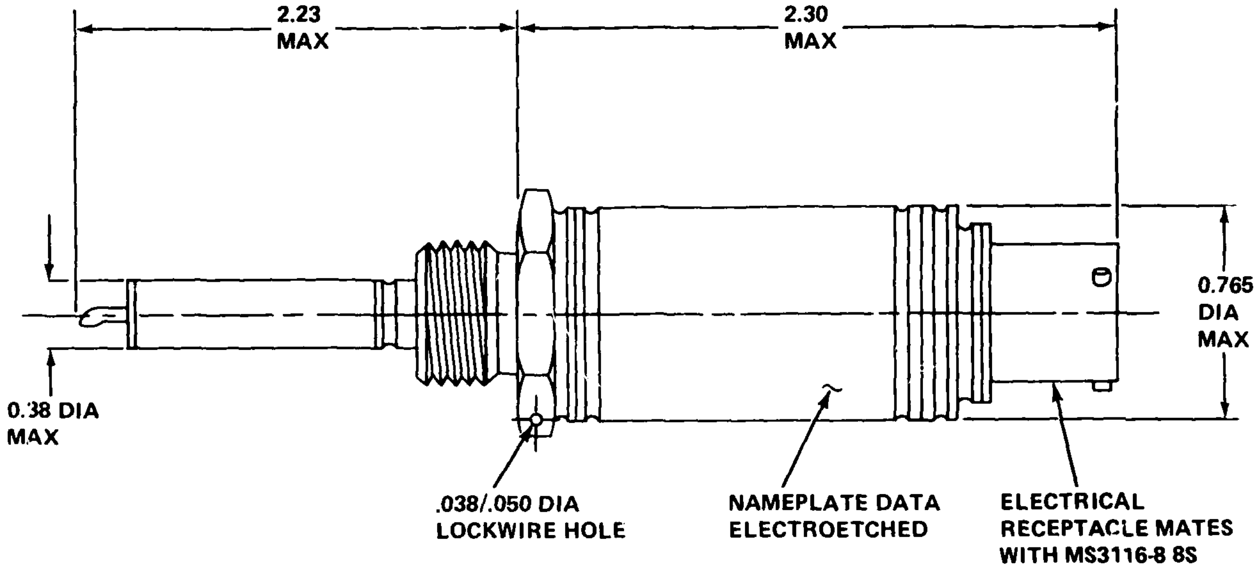
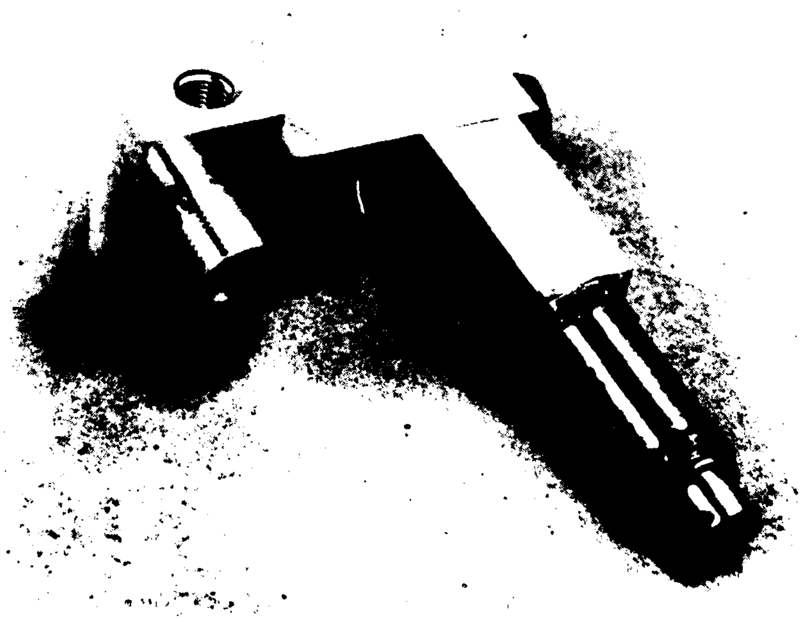


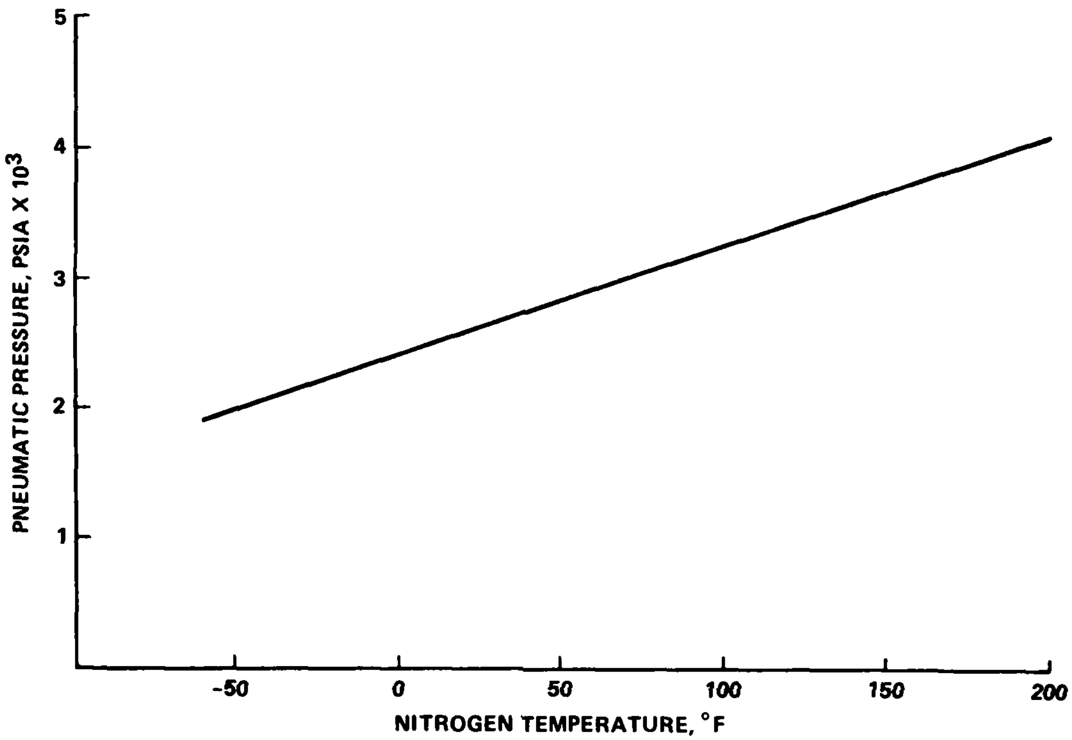
Figure 27. Landing gear door dump bottle installation.





R80-2038-030(T)

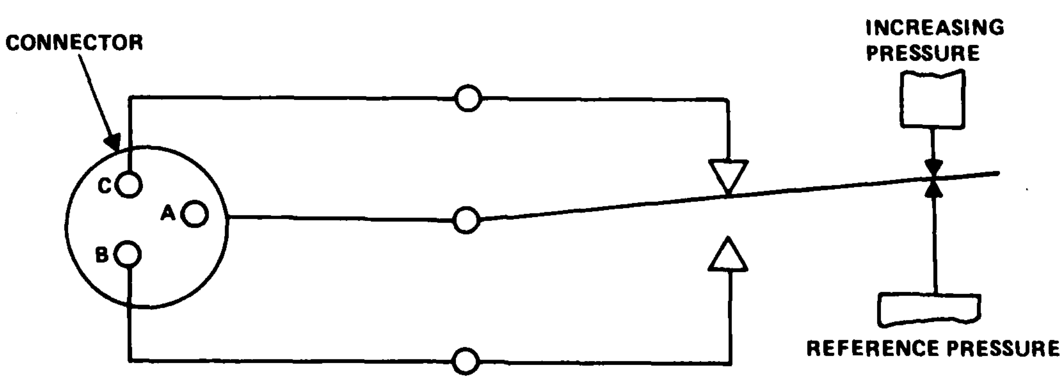
Figure 28. Temperature-compensated pressure switch.



R80-023-031(T)

Figure 29. Plot of pressure vs temperature for nitrogen.

A precision snap-action electrical switch exposed to sensed pressure is positioned within the mechanism stroke limits to provide electrical circuit control at predetermined differences between sensed and reference pressure. The complete assembly is housed within an all-welded, high-pressure hermetically sealing housing. Figure 30 shows the diagrammatic circuit.



R80-2038-032(T)

Figure 30. Temperature-compensated pressure switch: diagrammatic circuit.

Laboratory testing of a penumatic charge at variable temperatures verified the pressure switch temperature concept. Data for this switch (Grumman specification 204-1) is shown in Figure 31.

The reference temperature compensating gas is dry nitrogen that is hermetically sealed within the unit.

Switch Testing. Switch testing was conducted and found to fall within acceptable limits as defined by source control specification 204-2. The test results are listed in Table 3 and plotted in Figure 32.

1.3.2.3 Fiber-Optic Liquid Detection Circuit

The fiber-optic fluid detection circuit employs the properties of refractive index. If a diagonal gap exists between two fibers, light transmission will not jump the gap and will be absorbed by the core. In the presence of suitable fluid, the light will pass through the fluid and appear at the display panel. Water will be indicated by a white light and hydraulic oil will appear as a red light.

The liquid detector concept uses the optical properties of the light-conducting media. It is necessary to determine not only the properties of the light-conducting cables but also those of the fluids.

One of the important parameters of any fluid or light-conducting medium is its refractive index, defined as the ratio of the velocity of light in air to that in a given

- ACTUATION POINTS (SEE GRAPH)
- INCREASING PRESSURE: BY "A" MAX
- DECREASING PRESSURE: WITHIN BAND "B-C"

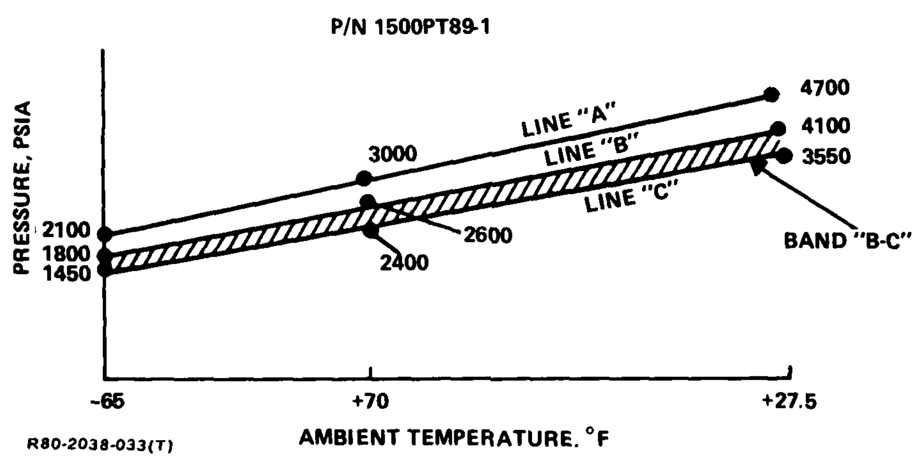
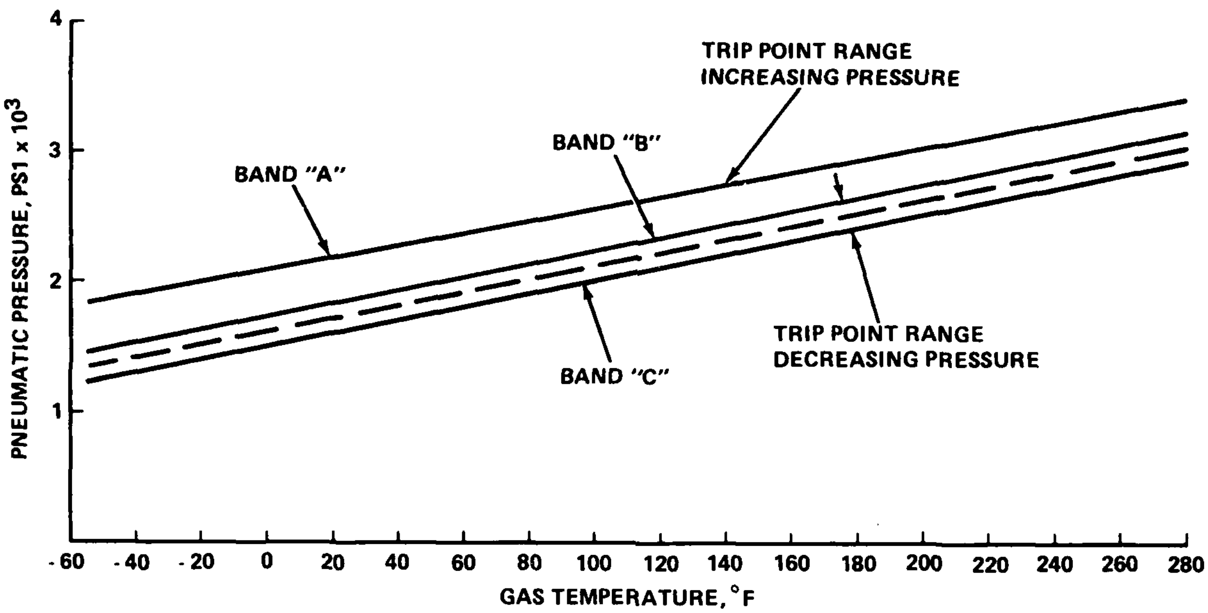


Figure 31. Switch actuation points vs temperature (Specification 204-1)

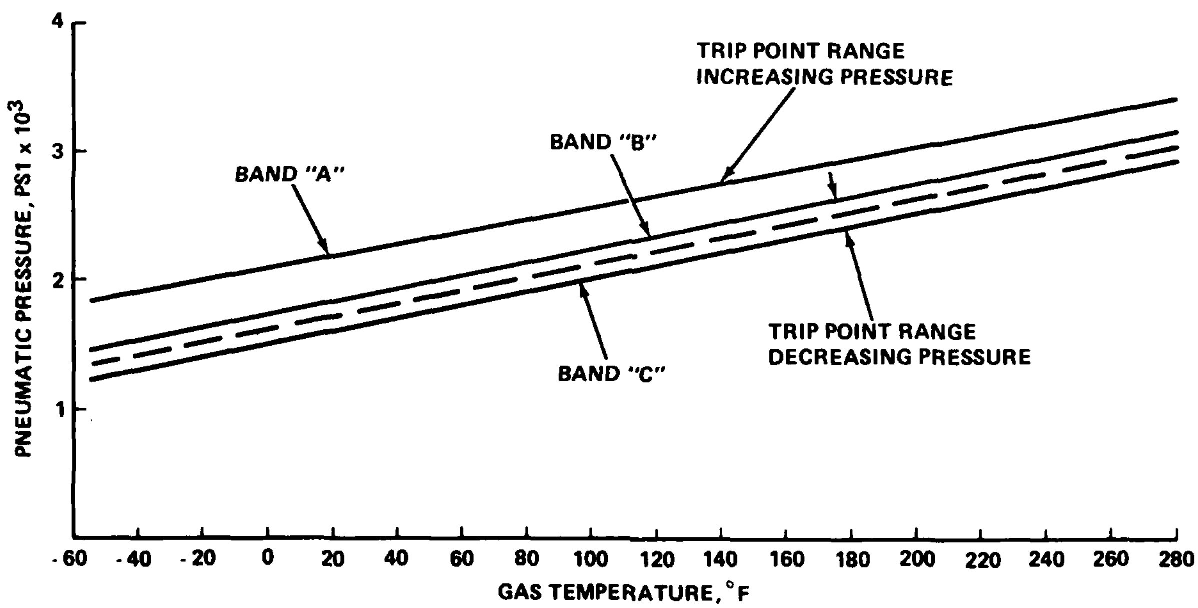
TABLE 3. TEMPERATURE-COMPENSATED PRESSURE SWITCHES (GRUMMAN SPECIFICATION 204-2).

P/N 1500 PT89-2, S/N 001			
• AMBIENT	+69°F	1950 PSIG	
	69°F	2000 PSIG	
• HOT	273°F	3000 PSIG	
	275°F	3000 PSIG	
• COLD	−48°F	1525 PSIG	
	−55°F	1325 PSIG	
P/N 1500 PT89-2, S/N 002			
• AMBIENT	69°F TO 73.5°F	INCREASING PRESS. TRIP	2025 PSIG
		DECREASING PRESS. TRIP	1975 PSIG
• COLD	−64.5°F TO −68°F	INCREASING PRESS. TRIP	1450 PSIG
		DECREASING PRESS. TRIP	1175 PSIG
• HOT	+274.5°F TO +272°F	INCREASING PRESS. TRIP	3020 PSIG
		DECREASING PRESS.TRIP	2960 PSIG

R80-2038-035(T)



A. P/N 1500 PT 89-2, S/N 001



B. P/N 1500 PT 89-2, S/N 002

R80-2038-034(T)

Figure 32. Switch actuation points vs temperature (Grumman Specification 204-2).

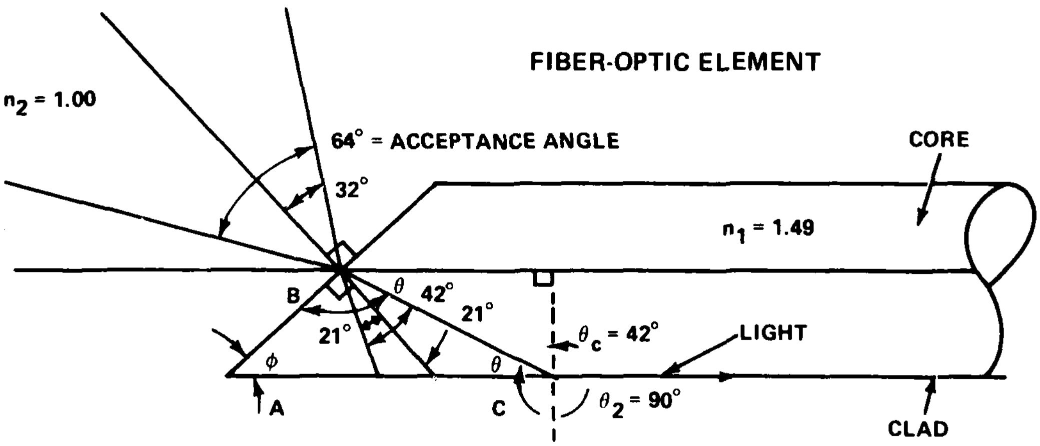
solid or fluid taking into account the angle at which the light beam travels. Willebrond Snell's Law of Sines states that the index of refraction is a constant, equal to the sine of the angle of incidence divided by the sine of the angle of refraction. Table 4 lists the refractive indices of various materials.

TABLE 4. REFRACTIVE INDICES OF VARIOUS ELEMENTS.

• WATER: 1.330	• MIL-H-83282 – 1.456
• AIR: 1.003	• MIL-H-6083 – 1.468
• MIL-H-5606: 1.463	
• CROFON (DUPONT)	• CABLE, FIBER-OPTIC TRANSMISSION
– CORE: 1.490	– CORE: 1.62
– CLAD: 1.392	– CLAD: 1.52
• LUCITE/PLEXIGLASS: 1.51	

R80-2038-036(T)

During the course of development, it became apparent that a single large-diameter fiber would be placed within the pneumatic bottle to detect the presence of a liquid, using the properties of the liquid for light coupling. The fiber angle in which a light ray would be lost when traveling through the conduit, unless the presence of water and/or hydraulic oil were available to permit optical coupling, was then derived mathematically. An analsysis of the derivation follows:



$$\frac{\sin\theta_c}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\sin\theta_2 = \frac{n_1}{n_2}\sin\theta_c$$

$$\sin 90^\circ = \frac{n_1}{n_2}\sin\theta_c$$

$$\frac{\sin 90^\circ}{\sin\theta_c} = \frac{n_1}{n_2}$$

$$\frac{1}{\sin\theta_c} = \frac{1.49}{1.00}$$

$$\sin\theta_c = \frac{1.00}{1.49} \quad (1)$$

$$\theta_c = \sin^{-1}\frac{1.00}{1.49} = 42^\circ$$

$\theta = 90^\circ - \theta_c$ $\quad \angle A = \phi$

$\angle B = 90^\circ + 21^\circ$

$\theta = 90^\circ - 42^\circ$ $\quad \angle C = \theta$

$\theta = 48^\circ$

$\Delta ABC = \theta + (90^\circ + 21^\circ) + \phi$

$180 = \theta + (90^\circ + 21^\circ) + \phi$

$180 = 48 + 90 + 21 + \phi$

$\phi = 21^\circ$

Any beveled cut less than 21° will result in having light absorbed by the core.

Definitions

θ_c = critical angle

ϕ = angle required (beveled cut angle)

n = refractive index

θ = angle used in solving ϕ

Assume $n_2 = 1.33$ (index of refraction for water)

$$\sin\theta_c = \frac{1.33}{1.49} \quad (1)$$

$$\theta_c = \sin^{-1}\frac{1.33}{1.49} = 63^\circ$$

Since θ_c (63°) exceeds the critical angle (42°), light will be transmitted through the light guide.

$\theta = 90^\circ - \theta_c$

$\theta = 90^\circ - 63^\circ$

$\theta = 27^\circ$

$180^\circ = \theta + (90^\circ + 21^\circ) + \phi$

$180^\circ = 27^\circ + 90^\circ + 21^\circ + \phi$

$\phi = 42^\circ$; beveled angle is increased, resulting in light being transmitted.

$$\sin\theta_c = \frac{1.4635}{1.49} \quad (2)$$

$$\theta_c = \sin^{-1}\frac{1.46}{1.49} = 79.2^\circ$$

Since θ_c (79.2°) exceeds the critical angle (42°), light will be transmitted through light guide with a <u>MIL-H-5606</u> coupling.

It has been shown in the laboratory that this approach works in the presence of either fluid. However, instead of using one multistrand fiber-optic cable it became necessary to employ two single-fiber cables with an external light source, with the flexible sensing probe at the bottom of the bottle. Figure 33 shows the concept of an early liquid sensor (Ref. dwg 1491901-307). This approach had screw-on terminals attached to the fiber-optic cables at both the sensing proble and a lucite conductor. The lucite conductor provided an optical means of passing light out of the pneumatic bottle while still retaining the pressure seal. This method proved unacceptable as losses through the fittings and connectors were so drastic that no detectable amount of light could be found at the output fiber. Modifications were made and all unnecessary connectors removed. The result was a design which had one continuous fiber carrying inputted light, a gap allowing fluid detection, and another continuous fiber carrying outputted light. This design (Figure 34) combined the sensor with the fiber-optic cables and greatly reduced transmission losses.

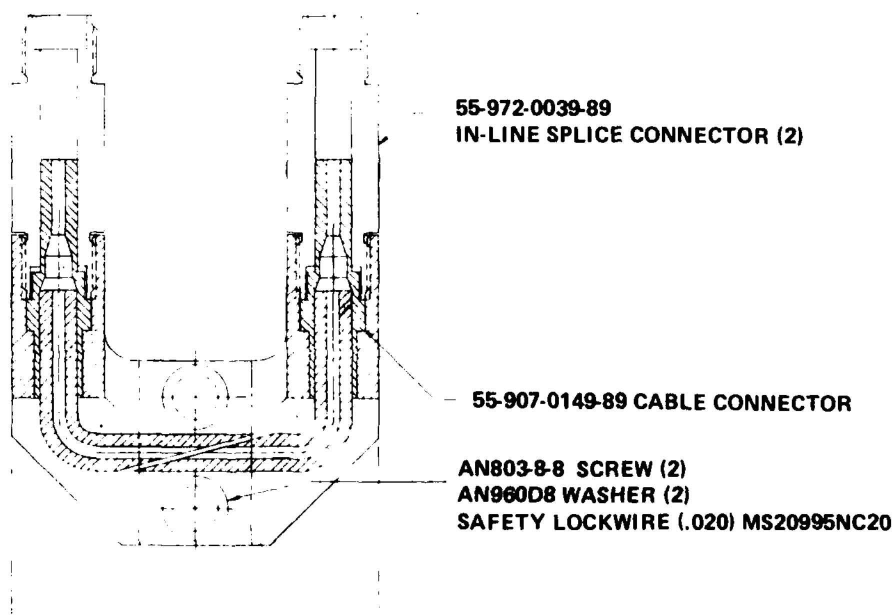
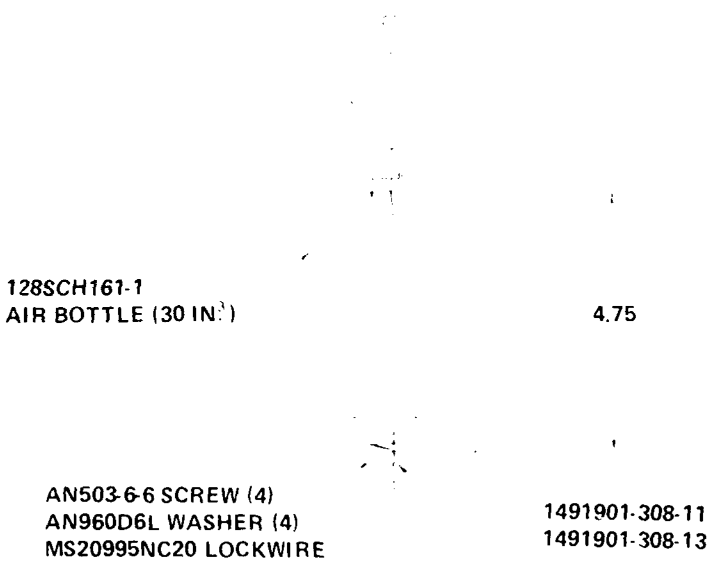
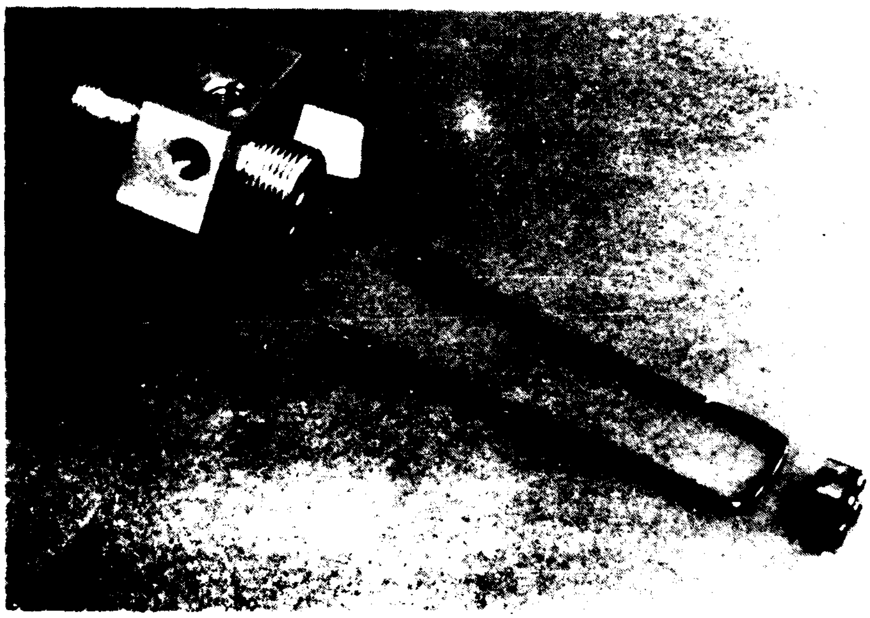


Figure 33. Liquid sensor assembly (early version).





R80-7038-038(T)

Figure 34. Liquid sensor assembly (improved version).

Two types of fiber-optic cables were purchased from Valtec Corporation, West Boylston, Massachusetts. The transmission cables were of the bifurcated and the single cable types. The bifuracted cabled type is used on the pneumatic bottle detection loop, whereas the single cable is used on the desiccant color-detection circuit.

Some of the parameters include:

- Number of fibers: 222-234
- Fiber diameter: 0.0031
- Bundle diameter: 0.045
- Acceptance cone angle: 68°
- Cone index of refraction: 1.62.

Additional cable information is provided in Appendix B, Specification No. 206. All cables use fiber-optic connectors in accordance with MIL-L-85044/1, developed by the Naval Ocean Systems Laboratory in San Diego, California. MIL-L-85044/1 covers pressurized bulkhead connectors, Type 1, for relatively low-pressure systems. These stainless steel connectors were manufactured and supplied by the Sealectro Corporation in Mamaroneck, New York.

The cable terminal ends were installed in accordance with the procedure specified on Page 6 of MIL-C-85044 using an epoxy bonding agent to fasten the assembly together.

Properties of Crofon Light Guides. Crofon is a Dupont registered trade name for plastic fiber light guides. The data in Table 5 were taken from a Dupont publication on Crofon Fiber Optics (Ref. 4) and a Machine Design article (Ref. 5). Table 5 shows some properties of the Crofon Fibers and their polyethylene jackets. Figure 35 shows a light ray entering the light guide.

Transmission of light through Crofon varies as a function of length. It is also dependent on input light intensity, output light interfaces, and any gap through the optic circuit. Figure 36 shows the transmission efficiency of white light through fully polished light guides.

Single bends are employed in the liquid detection circuit at the sensor end. It is desirable to ascertain the minimum bend radius for the single 1056 light guide. Too severe a bend will cause a significant light loss due to degradation of the cladding fiber itself. Figure 37 shows typical light transmission for several grads of Crofon light

TABLE 5. PROPERTIES OF CROFON FIBERS WITH POLYETHYLENE JACKETS.

A. IDENTIFICATION: CROFON 1056

- NUMBER OF FIBERS: 1
- OD: 0.111 ±.005 IN.
- FIBER DIAMETER: 0.056 IN.
- JACKET MATERIAL: POLYETHYLENE
- FIBER: POLYMETHYL METHACRYLATE
- ACCEPTANCE ANGLE: 64°
- CRITICAL ANGLE: 69°
- INDEX OF REFRACTION:
  - CORE N_D = 1.490
  - CLAD N_D = 1.392
- OPERATING TEMPERATURE LIMITS:
  -40 °F TO 175 °F

B. TYPICAL PROPERTIES OF POLYETHYLENE

ASTM TEST	PROPERTY	LOW DENSITY	MEDIUM DENSITY	HIGH DENSITY	ULTRAHIGH MOLECULAR WEIGHT
	PHYSICAL				
D792	SPECIFIC GRAVITY	0.910-0.925	0.926-0.940	0.941-0.965	0.928-0.941
–	SPECIFIC VOLUME (IN.^{3}/LB)	30.4-29.9	29.9-29.4	29.4-28.7	29.4
D570	WATER ABSORPTION, 24 HR, 1/8-IN. THK (%)	<0.01	<0.01	<0.01	<0.01
	MECHANICAL				
D638	TENSILE STRENGTH (PSI)	600-2,300	1,200-3,500	3,100-5,500	4,000-6,000
D638	ELONGATION (%)	90-800	50-600	20-1,000	200-500
D638	TENSILE MODULUS (10^5 PSI)	0.14-0.38	0.25-0.55	0.6 - 1.8	0.20-1.10
D785	HARDNESS, ROCKWELL R	10	15	65	55
D790	FLEXURAL MODULUS (10^5 PSI)	0.08-0.60	0.60-1.15	1.0-2.0	1.0-1.7
D256	IMPACT STRENGTH, IZOD (FT-LB/IN. OF NOTCH)	NO BREAK	0.5-16	0.5-20	NO BREAK
	THERMAL				
C177	THERMAL CONDUCTIVITY (10^{-4} CAL-CM/SEC-CM^2-°C)	8.0	8.0-10.0	11.0-12.4	11.0
D696	COEF OF THERMAL EXPANSION (10^{-5} IN./IN. - °C)	10-22	14-16	11-13	14
D648	DEFLECTION TEMPERATURE (°F)				
	AT 264 PSI	90-105	105-120	110-130	118
	AT 66 PSI	100-121	120-165	140-190	170
–	CONTINUOUS, NO-LOAD SERVICE TEMP (°F)	180-212	220-250	250	–
	ELECTRICAL				
D149	DIELECTRIC STRENGTH (V/MIL) SHORT TIME, 1/8-IN. THK	460-700	460-650	450-500	900*
D150	DIELECTRIC CONSTANT				
	AT 60 Hz	2.25-2.35	2.25-2.35	2.25-2.35	–
	AT 10^3 Hz	2.25-2.35	2.25-2.35	2.30-2.35	2.30-2.35
D150	DISSIPATION FACTOR AT 10^3 Hz	0.0002	0.0002	0.0003	0.0002
D257	VOLUME RESISTIVITY (OHM-CM) AT 73°F, 50% RH	10^{15}	10^{15}	10^{15}	10^{15}
D495	ARC RESISTANCE (SEC)	135-160	200-235	–	–
	OPTICAL				
D542	REFRACTIVE INDEX	1.51	1.52	1.54	–
D1003	TRANSMITTANCE (%)	4-50	4-50	10-50	–

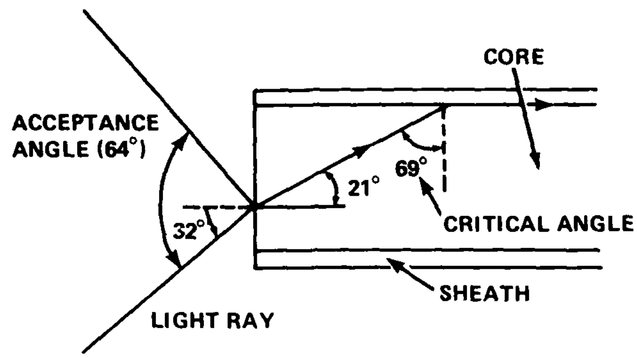
*kV/CM

1087-052W

R80-2038-039(T)

guides. It becomes evident that bend radius should be as large as possible to minimize transmission loss.

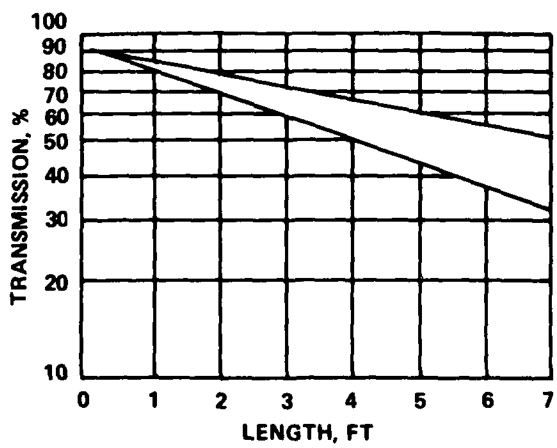
Fiber-Optic Connectors. Numerous types of fiber-optic connectors were considered for use in HYCOS. The major concern was the availability of a high-pressure bulkhead fitting capable of sealing 3000 psi pneumatic pressure. As of February 1978, no bulkhead connectors on the market were capable of withstanding this high pneumatic pressure differential without leakage.



CORE INDEX OF REFRACTION n_D = 1.490
SHEATH INDEX OF REFRACTION n_D = 1.392

R80-2038-040(T)

Figure 35. Crofon light guide properties.



NOTE: TRANSMISSION VALUES ARE FOR LIGHT GUIDES WITH CAREFULLY POLISHED ENDS.

R80-2038-041(T)

Figure 36. Transmissivity of Crofon light guides.

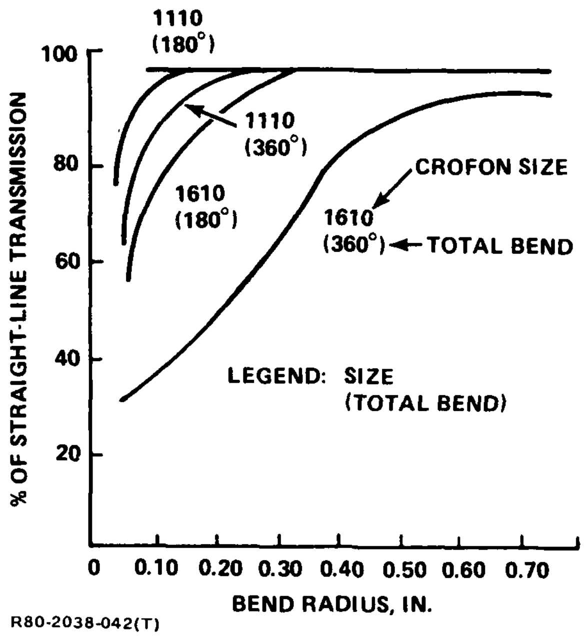


Figure 37. Effect of bend radius on light transmissivity.

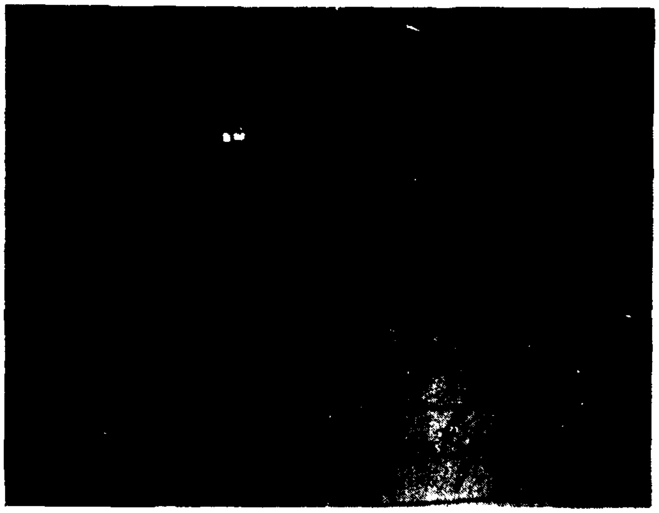
Grumman was informed that the proposed MIL-C-85044/1 Connector, Fiber-Optic, Pressurized Bulkhead, Type I, Class I was being manufactured by Sealectro Corporation, Mamaroneck, New York. Sealectro indicated that the connectors were in stock.

Sealectro part numbers and unit weights are:

• Cable Connector:	55-907-0149-89	0.1056 Oz
• In-Line Splice:	55-972-0039-89	0.1746 Oz
• Bulkhead Mounting Connector:	55-975-0049-89	0.3527 Oz

All parts are made of corrosion-resistant stainless steel. Figure 38 shows a typical fiber-optic terminal used in HYCOS. The connector has a fiber terminal diameter of 0.0465 in. (area = 0.001698 in.^{2}). For HYCOS, special connector interfaces were designed to withstand the intended environment. Figure 39 shows a Display Panel fiber-optic terminal.

Pressure Seal. In order to transport light through a pressure seal, it became necessary to design a seal that would satisfy system integrity and provide maximum light transmissivity. Concept Number One, shown in figure 40A, employed a transfer tube containing machined and polished clean acrylic rod for light transmission. Although



R80-2038-043(T)

Figure 38. Assembled fiber-optic connector.

initial pressure testing at 3000 psi revealed good results, the optical transmission properties were very poor. Almost all of the light generated at the outside source was lost due to the optical properties of the acrylic rod. A revised approach, shown in Figure 40B, eliminated the acrylic rod and utilized the fiber-optic cable up to the external connector interface. Initial testing revealed that the plastic tended to creep and extrude under prolonged exposure to pressure. Additional development effort overcame this problem and considerably improved the overall transmission efficiency. Limited operational cycling and proof testing verified this approach. No problems were encountered during the flight test program.

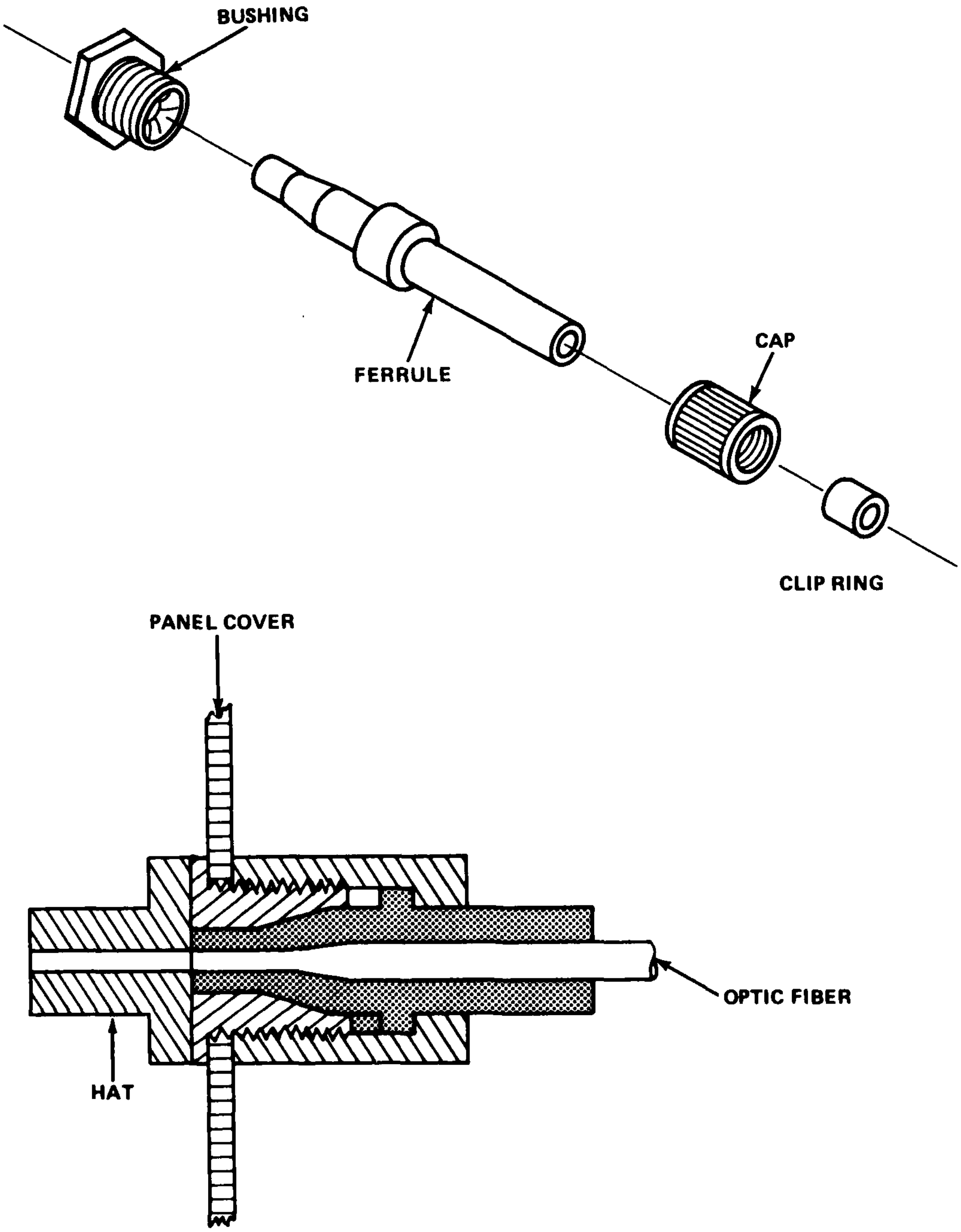
1.3.3 Hydraulic Pump/System

1.3.3.1 Flow Sensor Description

The flow sensor is a device placed in series with a hydraulic system or component which gives an external indication when a specific flow value has been exceeded under controlled conditions.

1.3.3.2 System Quiescent Flow Sensor

System quiescent flow values for the A-6E system were established at 0.5 to 1.5 gpm. This will vary depending on which system components are on the line during a no-input system demand condition. For the A-6E combined system, quiescent flow limits of 4.5± 1 gpm were established as excessive internal flow.



R80-2038-044(T)

Figure 39. Display panel fiber-optic terminal.

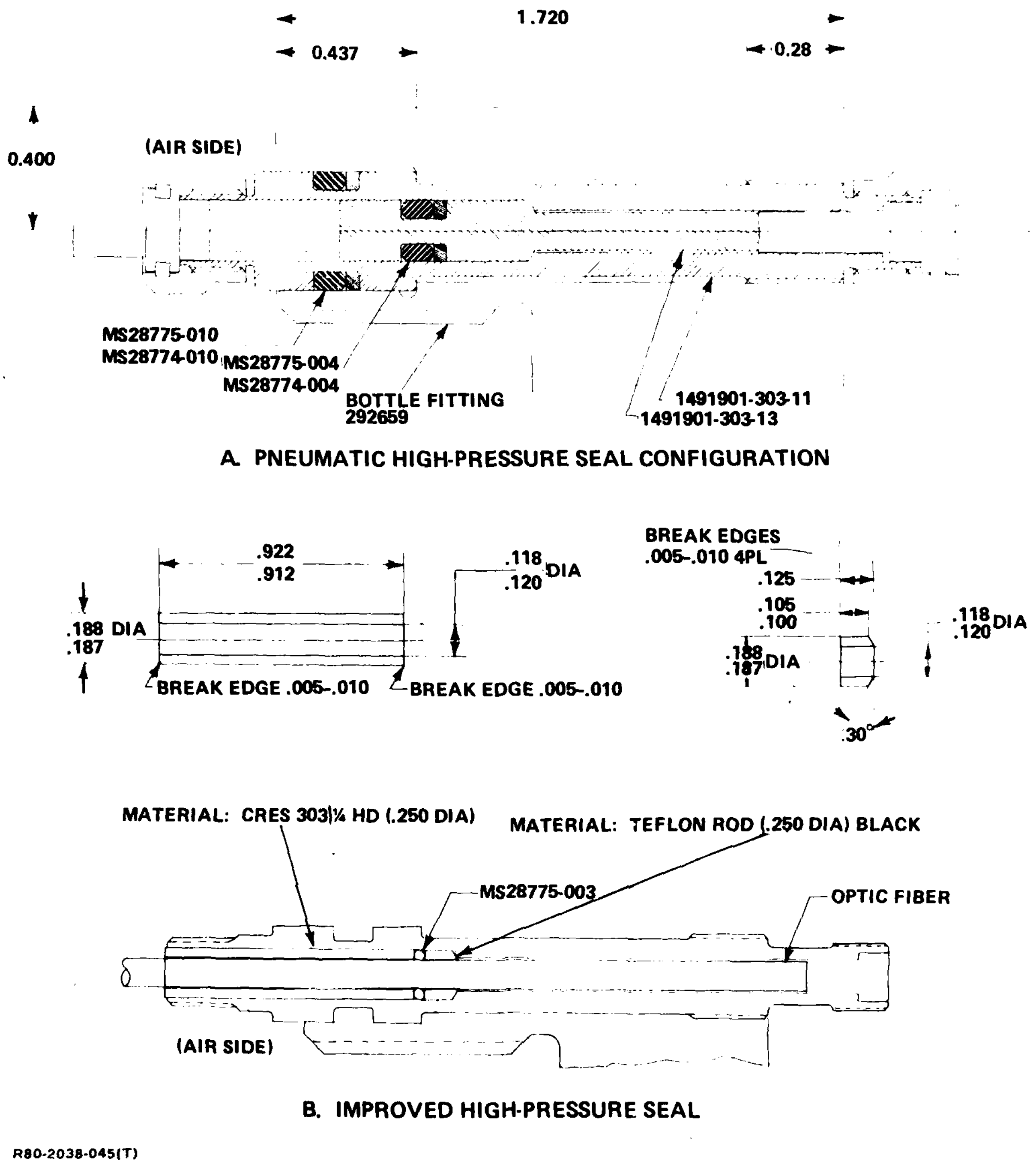
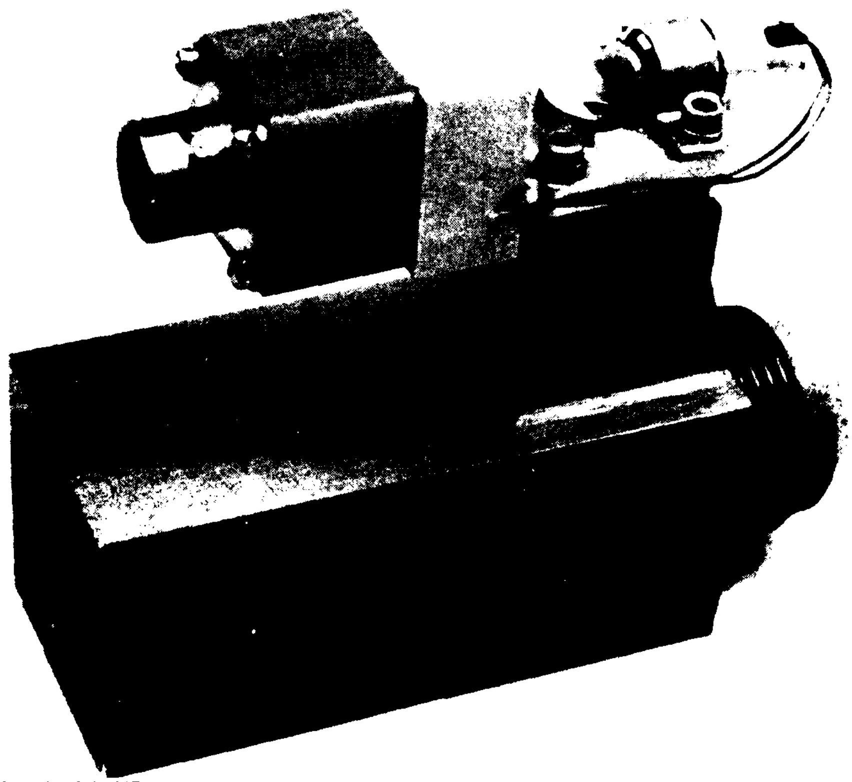


Figure 40. Pressure seal.

The system flow sensor incorporates an electrically actuated locking device which prevents indicator actuation during normal system flow demands. Under quiescent flow conditions, the flow is measured through a movable orifice. Flows beyond the required measured values are shunted across the movable orifice. Figure 41 shows a typical quiescent flowmeter used in the flight test program. Once the indicator trips due to excessive flow conditions, it must be manually reset.



R80-2038-046(T)

Figure 41. Quiescent flow sensor.

The flow sensor meters actual quiescent flow through a flow resistor that produces a desired differential pressure. The differential pressure, equated to a specific maximum permissible quiescent flow leakage, generates a signal. During normally higher system flow demand, the calibrated restrictor bypasses through additional flow passages at acceptable additional pressure differentials across the entire sensor.

Plant 14 Hydraulic Laboratory generated calibration data that produced the curve shown in Figure 42. The curve shows a trip point of 4.18 gpm which is within the design limits. It should be noted that the curve flattens out above 8 gpm.

The actual installation on the flight test vehicle is shown in Figure 43.

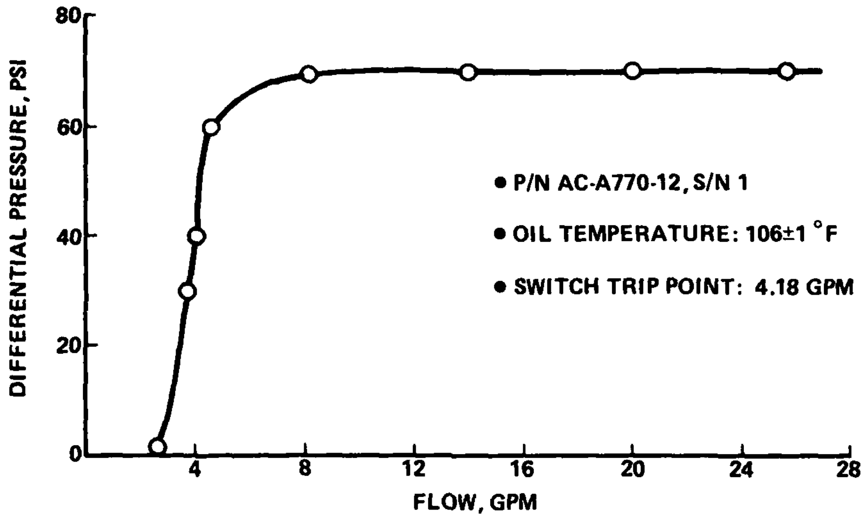


Figure 42. Calibration: flow sensor, bypass type, quiescent flow.

1.3.3.3 Pump Case Drain Flow Sensor

The pump case drain flow sensor is similar to the system quiescent flow sensor in design but does not incorporate a lockout device since pump case flow does not significantly vary over the hydraulic pump flow range. A failsafe bypass device is incorporated, however, to preclude high back pressure due to inadvertent momentary block liftoff. Excessive pump case flow was established at 1.25 to 1.75 gpm. Figure 44 shows a typical pump case flow sensor. A case drain flow calibration curve is presented in Fig. 45. Actual switch trip occurred at 1.47 gpm, Figure 46 shows a partially obscured installation in the A-6E test vehicle.

1.3.3.4 Rudder Actuator Quiescent Flow Sensor

Excessive rudder actuator internal leakage is detected by an in-line flow sensor located in the pressure line. The unit is similar in construction to the system quiescent flow sensor, but is sized for a lower flow. Since normal rudder actuator quiescent leakage rates are very low, a value of 0.625 to 0.875 gpm was selected for the A-6E rudder actuator. Figure 47 shows the rudder actuator quiescent flow sensor.

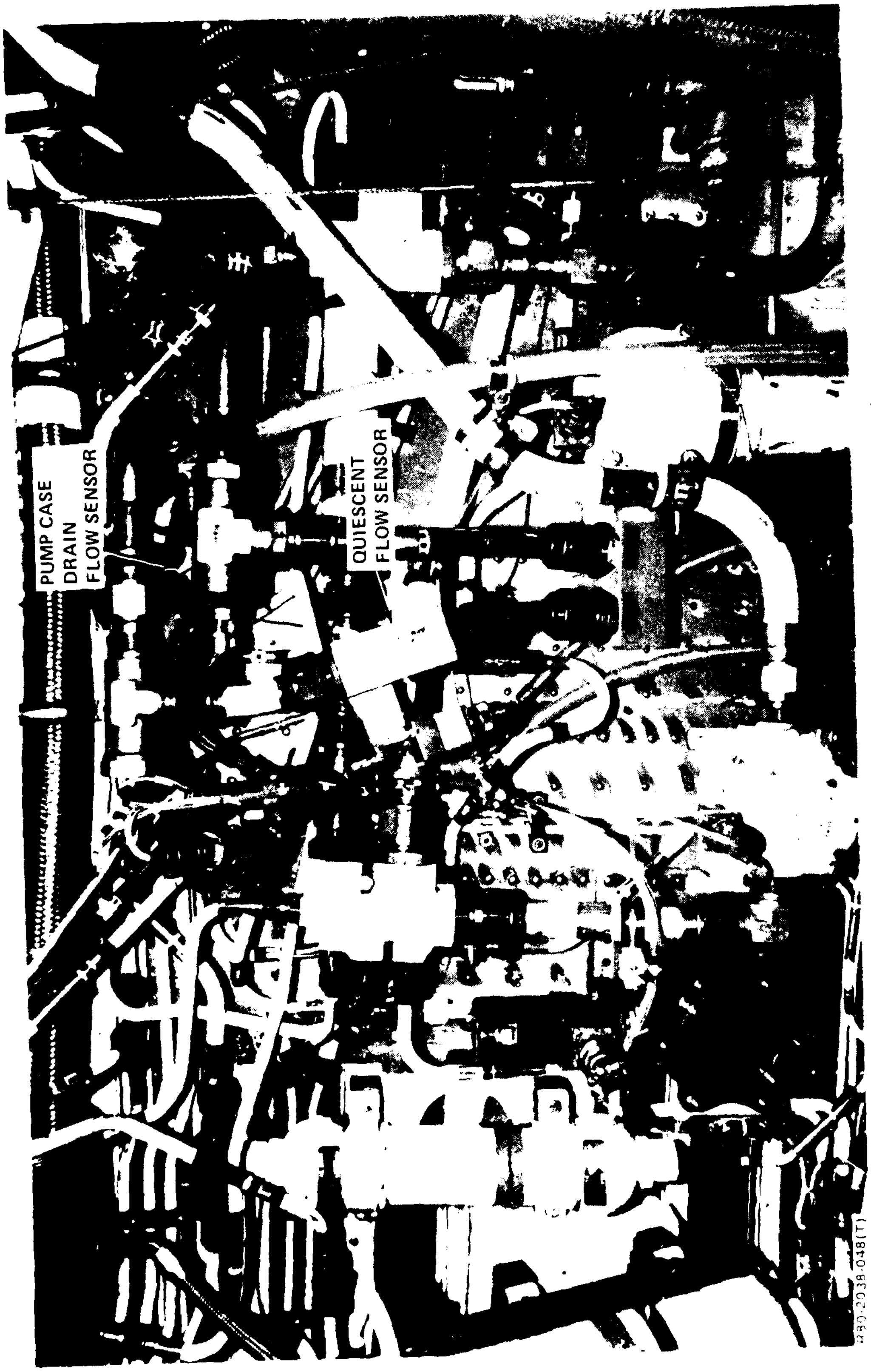
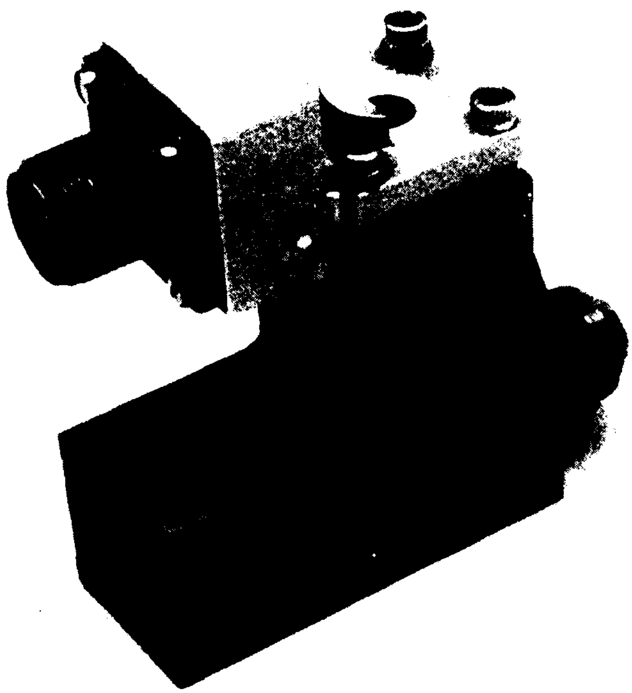
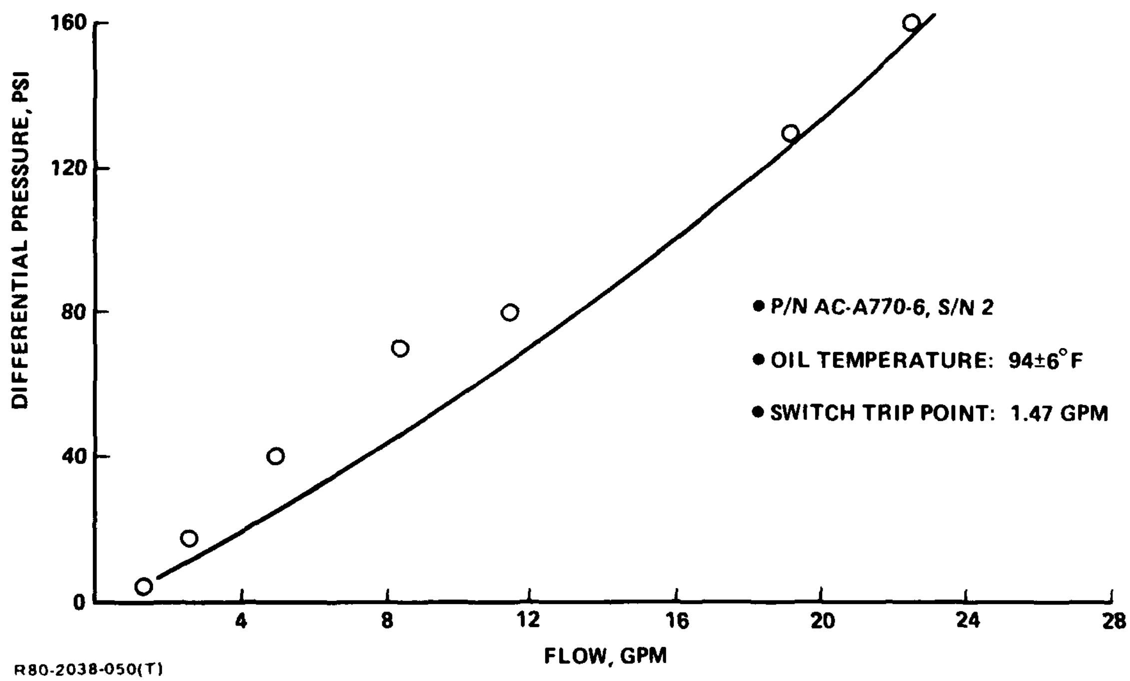


Figure 43. System quiescent flow sensor installation.



R80-2038-049(T)

Figure 44. Pump case drain flow sensor.



R80-2038-050(T)

Figure 45. Calibration: pump case drain flow sensor, bypass type.

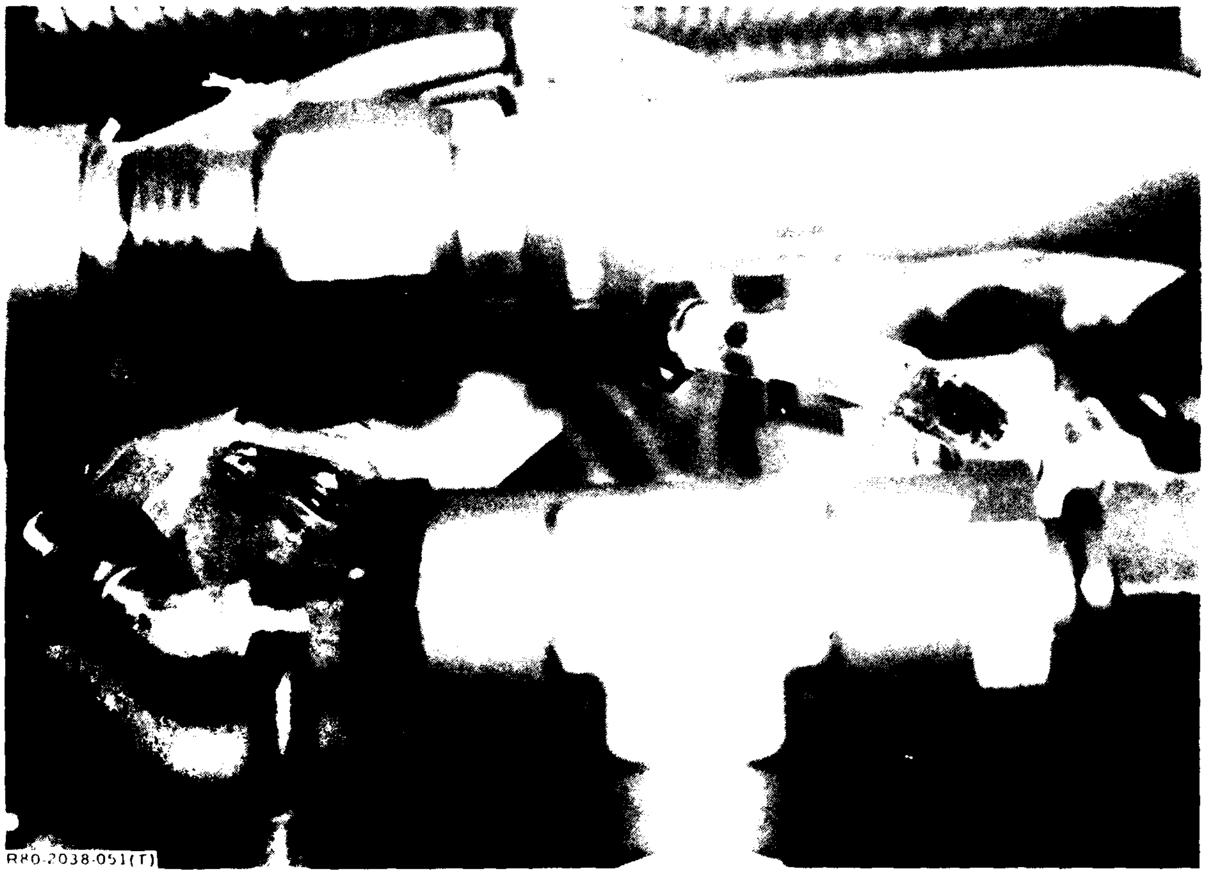
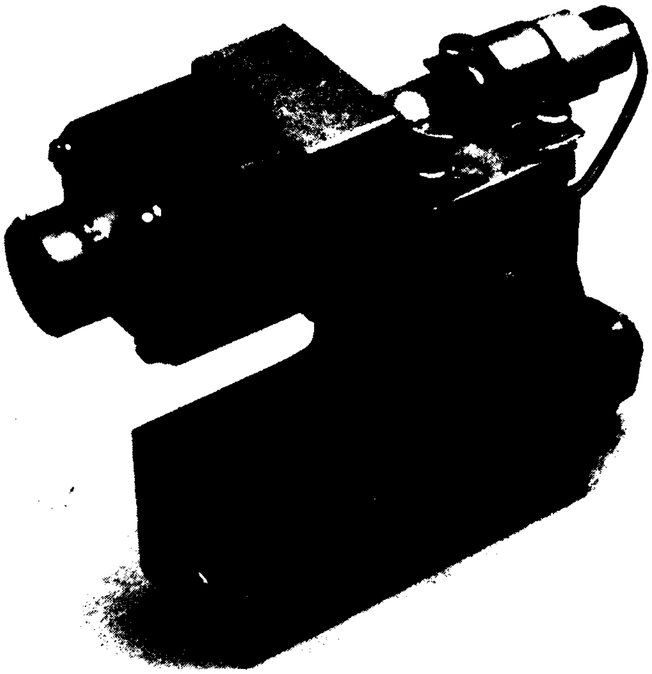


Figure 46. Pump case drain flow sensor installation.



R80-2038-052(T)

Figure 47. Rudder actuator flow sensor.

Flow versus pressure drop data produced the curve shown in Figure 48. The installation is shown in Figure 49. Note that the sensor was installed in the pressure line.

1.3.3.5 System Pressure Switch

The system pressure switch serves two functions: it indicates low system pressure during system operation and provides panel circuitry to the flow sensors and elements.

The elapsed time meter on the panel is actuated by the pressure switch; the flow sensor circuits are dependent on the pressure circuit being on.

For this purpose, a switch (Figure 50) manufactured by Sigmanetics of Mountain Lakes, New Jersey, was incorporated. The switch weighs less than 0.085 lb and actuates on decreasing pressure of 2300 ± 100 psi. The switch installation is shown in Figure 51.

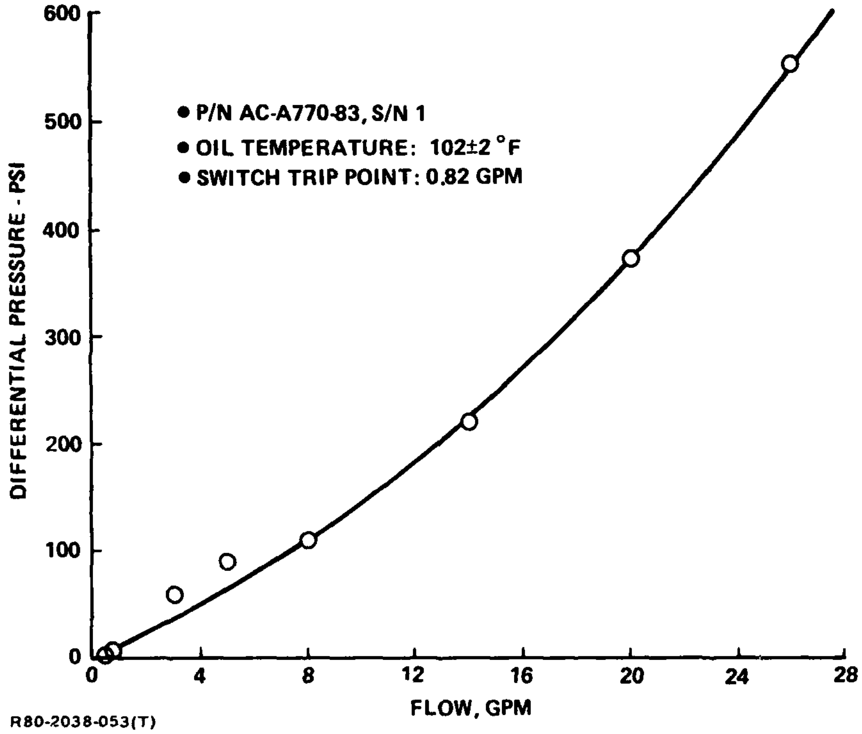


Figure 48. Calibration: rudder actuator quiescent flow sensor, bypass type.

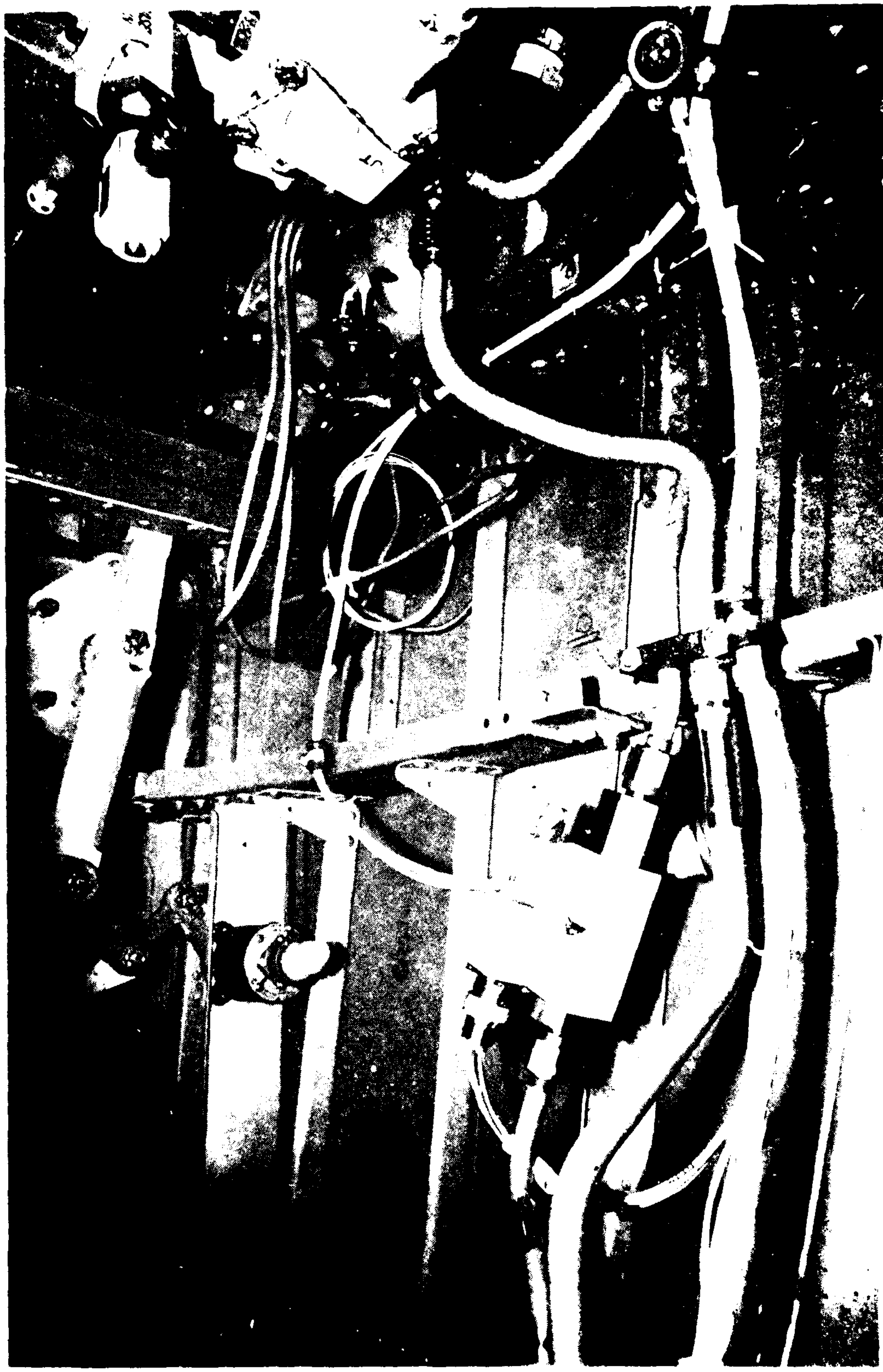


Figure 19. Rudder actuator quiescent flow sensor installation.

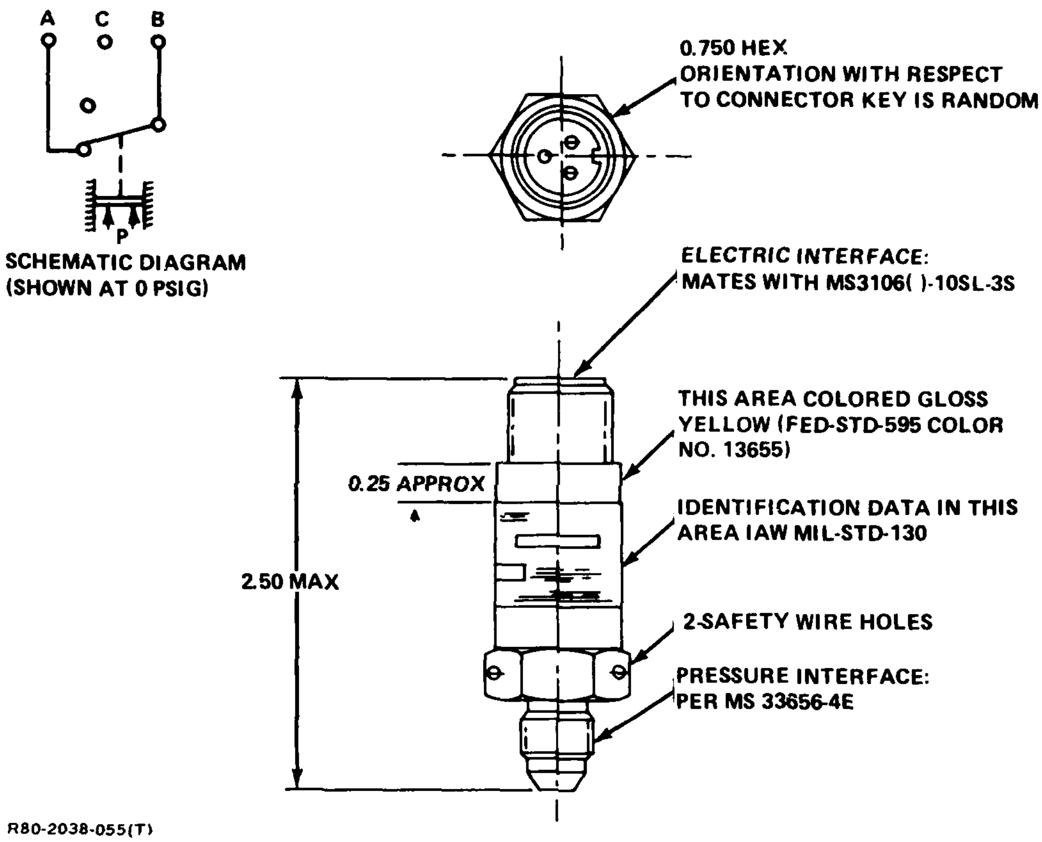


Figure 50. System pressure switch.

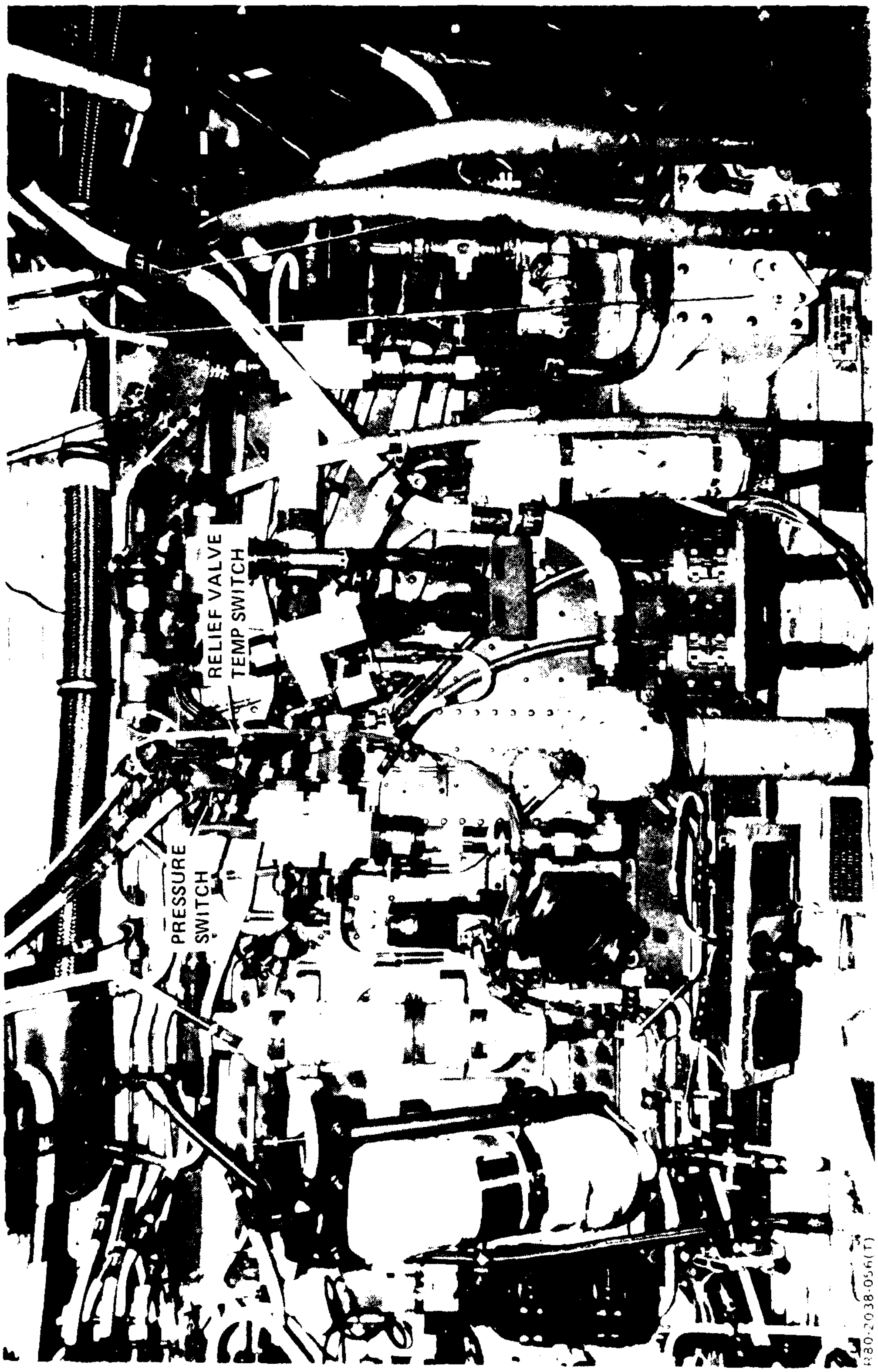


Figure 51. Relief valve temperature and system pressure switch installation.

1.3.3.6 Case Drain Flow Temperature Switch

Excessive case drain flow indicates hydraulic pump degradation, resulting in system fluid temperature rise. By installing a fluid temperature switch in series with the flow sensor, an excessive temperature limit can be detected.

Type II hydraulic systems operate at a 275°F maximum. A value of 300 ± 20°F was selected as the trip limit on a Texas Instrument Klixon manual reset temperature switch. switch.

The switch was mounted to the case drain line near the pump by using a clamp-on adaptor. This switch must be manually reset after being tripped.

1.3.3.7 Relief Valve Leakage

Relief valve leakage was measured with a probe-type manual reset temperature switch as used to measure pump case drain flow. Trip setting for this switch was 300 ± 20°F.

Type II hydraulic systems operate at 275°F maximum. A value of 300°F was selected as the trip limit on a Neo-Dyne model 1103TR119 manual reset temperature switch.

The switch probe is immersed in the fluid flow and contains n-propyl alcohol as the sensing medium. Temperature sensing is accomplished by exposing a welded corrosion-resistant steel diaphram to changes in pressure created by expanding fluid in the probe. Figure 52 shows pressure versus temperature slot for this fluid at constant volume. Temperature settings are determined by a force-balance interaction between the sensing diaphragm and a snap-action Belleville spring system. An electrical switch assembly positioned within the mechanism's stroke limit provides electrical circuit control at predetermined temperatures. The manual reset button functions as both a visual indication and a mechanism reset after switch actuation. The temperature switch is illustrated in Figure 53. Installation is shown in Figure 51.

1.3.4 Hydraulic Accumulators

1.3.4.1 Description

Hydraulic accumulators are energy storage devices used in many aircraft hydraulic systems. They usually employ stored gas as the variable energy source. Their applications include hydraulic pump ripple attenuation, momentary system power overdemand conditions, and performance of emergency actuation functions such as deploying a ram air turbine via a hydromechanical actuator.

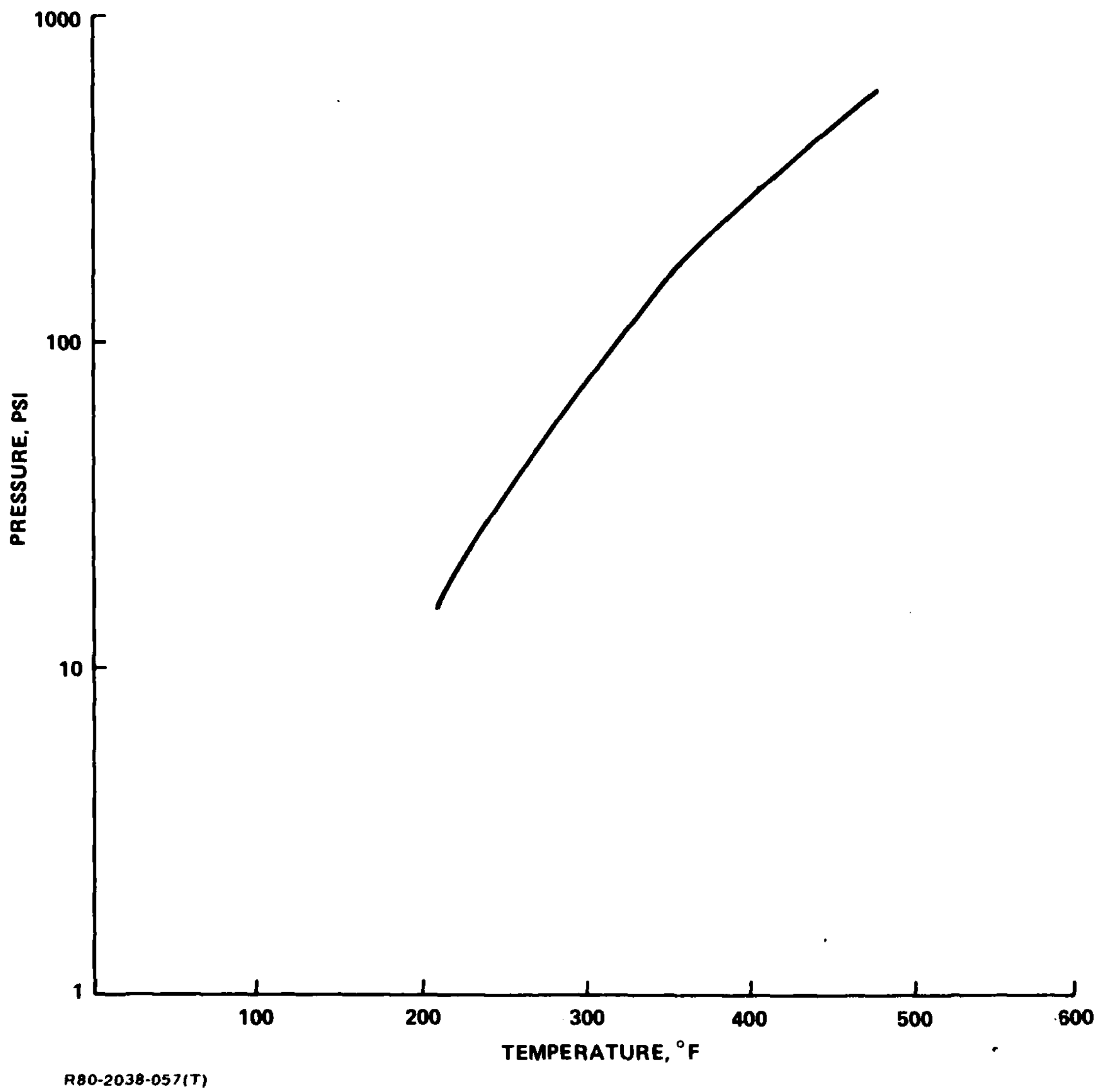


Figure 52. Pressure versus temperature of n-propyl alcohol at constant volume.

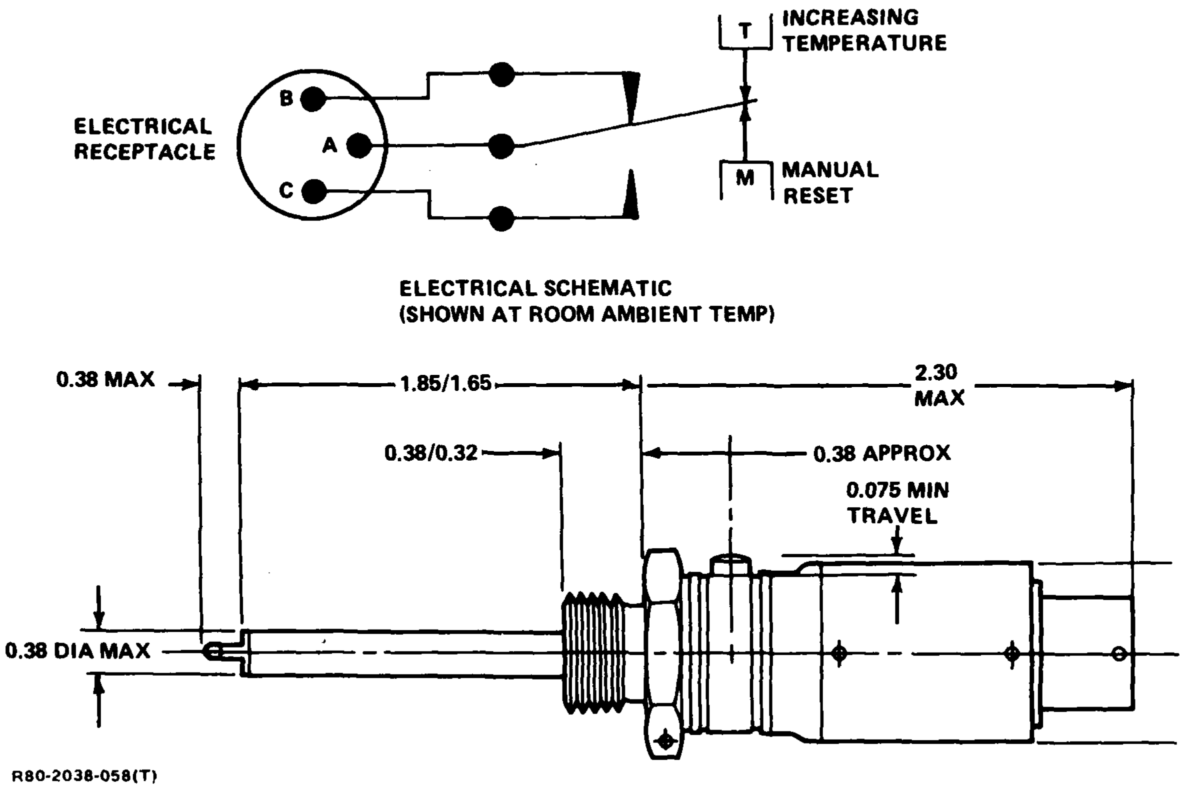


Figure 53. Manual reset temperature switch.

The work output is dependent on initial precharge pressure, precharge temperature, and delta volume change caused by piston movement under constant temperature conditions:

$$P_1V_1 = P_2V_2$$

and

$$W = \int_{V_1}^{V_2} P\,dv$$

If we consider an isentropic (no heat flow condition), then

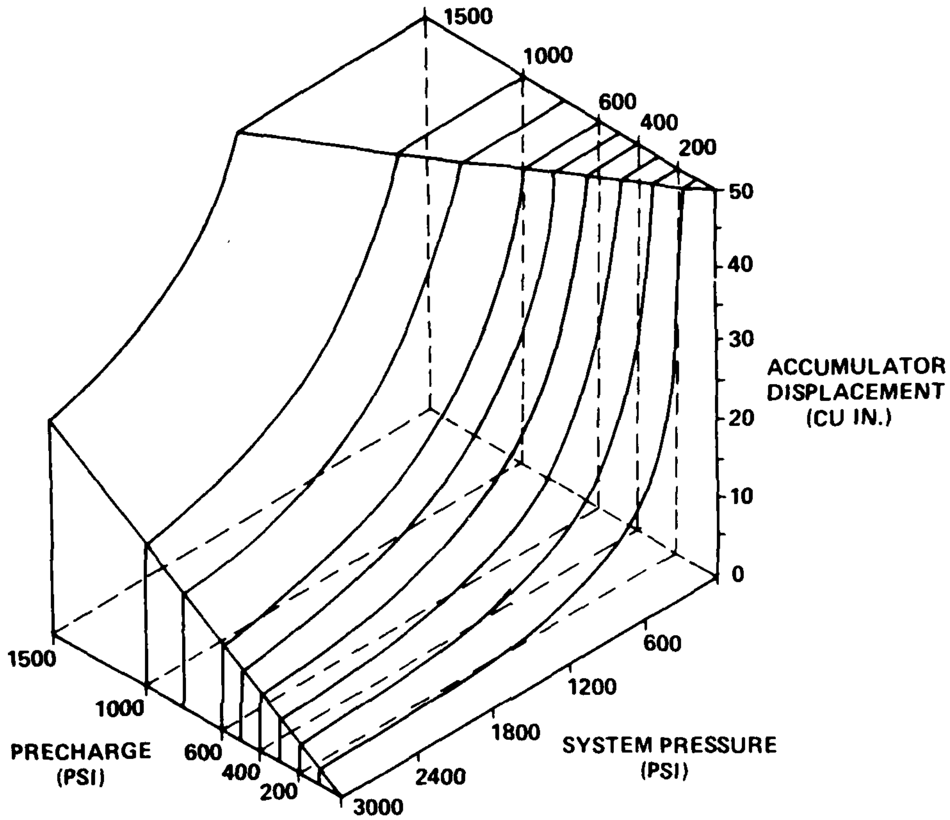
$$W = K \int_{V_1}^{V_2} \left[\frac{dv}{V^{1.4}} \right.$$

Since the variables are precharge pressure, precharge temperature, and piston displacement, the piston displacement for a final hydraulic system pressure of 3000 psi is a function of initial precharge conditions (Ref. 6, NADC TR 75168-30-Pg 33).

This monitoring effort was initiated to develop a method of determining accumulator precharge irrespective of whether the accumulator is fully or partially discharged. The variables required to determine this condition are charging pressure, temperature, and piston displacement.

Figure 54 shows the variation of piston displacement versus precharge pressure for a 50 in^3. accumulator. Figure 55 shows a plot of piston displacement versus precharge pressure versus temperature at constant 3000 psi pressure. Figure 56 is a nomograph developed to determine precharge pressure.

In order to measure accumulator piston displacement, precharge pressure (accumulator pressure), and precharge temperature, various methods were investigated to ascertain their suitability to accumulator applications. These specific sensing methods will be defined in subsequent paragraphs.



R80-2038-060(T)

Figure 54. Accumulator piston displacement versus precharge and system pressures at constant (70°F) temperature.

1.3.4.2 Piston Displacement Sensors

Several methods of determining piston displacement within a pressurized accumulator were investigated. They include:

- A direct type in which a rod attached to the piston passes through a dynamic seal
- A reflected energy type which measures reflected IR energy from a movable surface.

The first direct type seemed to offer less development risk than the other method since the output could be processed easier with the microprocessor circuits. This direct type included a linear potentiometer with its axis parallel to the accumulator piston axis. By affixing the movable piston rod to the linear potentiometer, a direct

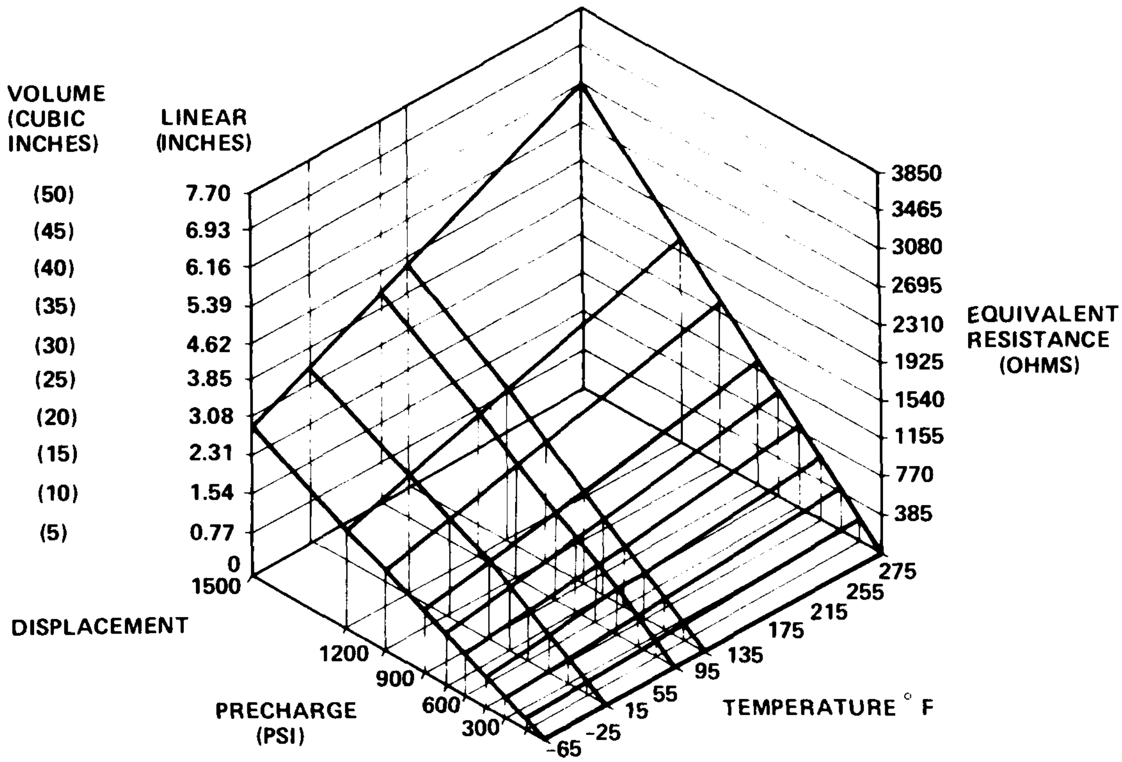


Figure 55. Accumulator piston displacement versus precharge pressure versus temperature at constant (3000 psi) system pressure.

relationship can be obtained by measuring resistance versus displacement. A 4 k Bournes potentiometer was chosen for this application. Figure 57 shows this configuration installed in the A-6E test vehicle. In order to provide for potentiometer extension clearances, the mounting bracket was offset.

Normally, it has been necessary to empty the fluid from the accumulator to measure precharge pressure. However, utilizing a newly developed equation involving system pressure, volume, temperature, and displacement it is now possible to determine precharge pressure without displacing the fluid. Displacement is expressed as a ratio of resistances measured by a linear potentiometer. The equation, graphically displayed in the nomograph of Figure 56, is derived as follows:

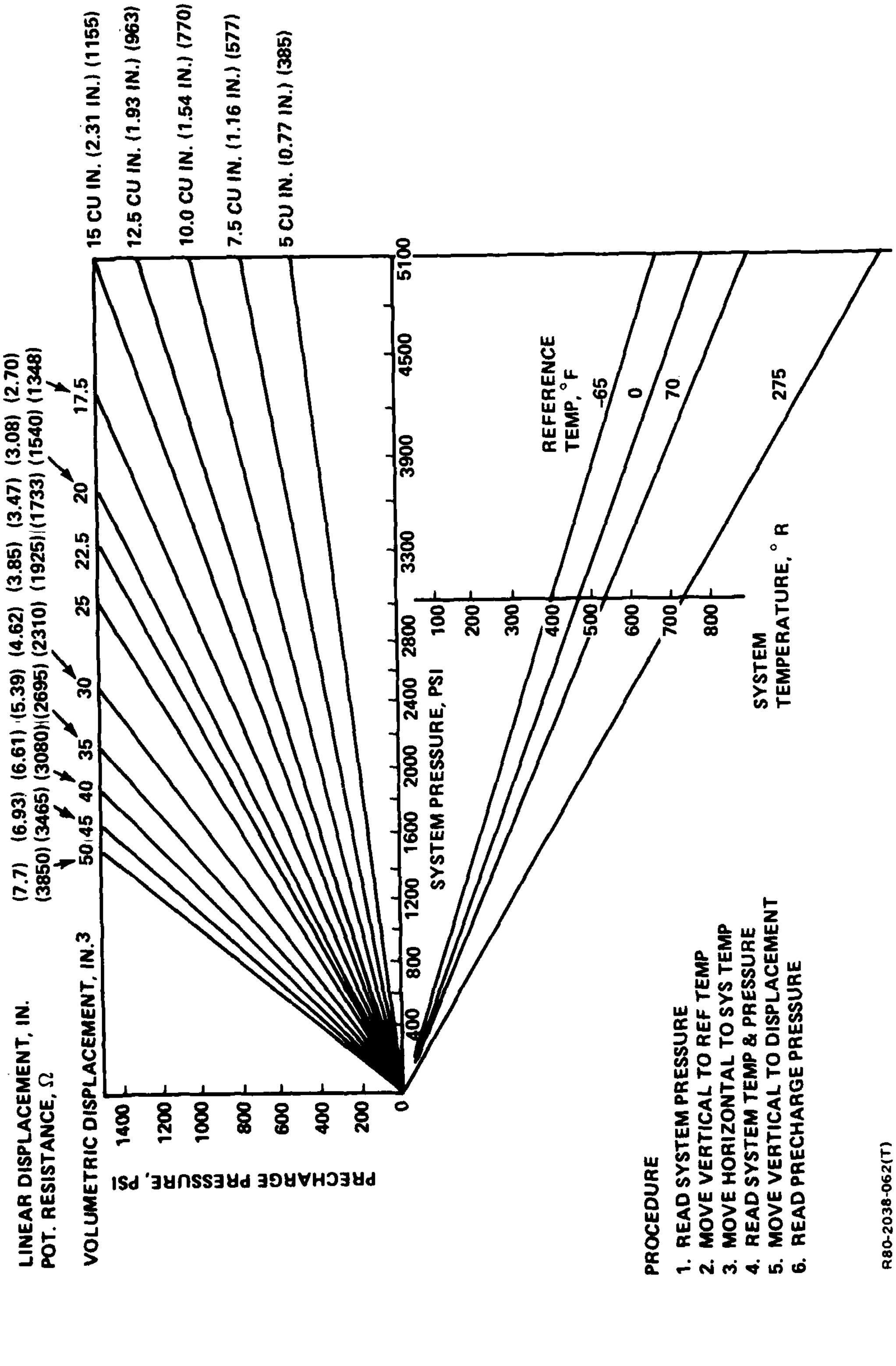


Figure 56. Precharge pressure nomograph.

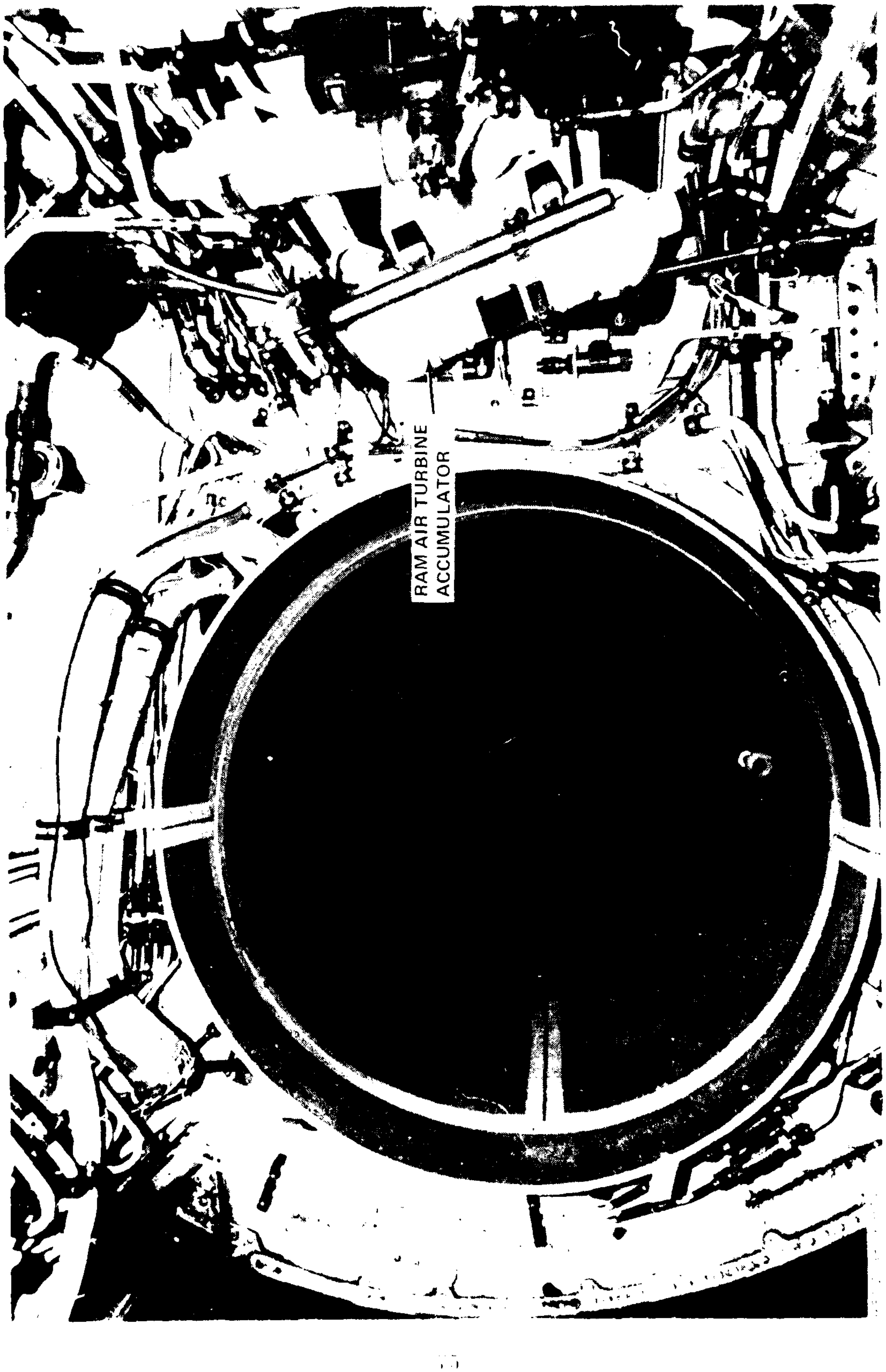


Figure 57. Ram air turbine accumulator installation.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$P_1 = P_{Precharge}$ (P_{pr}), $V_1 = 50$ in^3., $T_1 = 70$ °F $= 530$ °R

$P_2 = P_{system}$ (P_{sys}), $V_2 =$ Volumetric Displacement $= 50\left(\frac{R}{3850}\right)$

$T_2 = (T_2 + 460)$°R

$$\frac{(P_{pr})\,(50)}{530} = \frac{(P_{sys})\,(50)\,(R/3850)}{(T_2 + 460)°R}$$

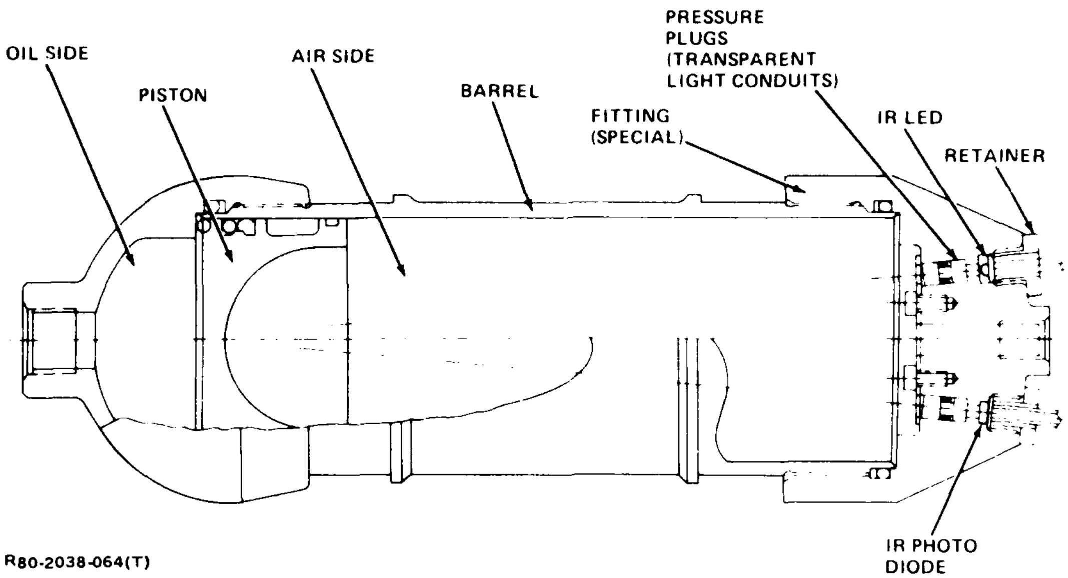
$$(530)\,(P_{sys})\,(50)\,(R/3850) = (P_{pr})\,(50)\,(T_2 + 460)$$

$$P_{pr} = \frac{(530)\,(P_{sys})\,(R/3850)}{(T_2 + 460)}$$

Another indirect method of determining piston position using reflected IR energy was investigated. This concept, shown in Figure 58, utilizes an external IR light source whose energy is reflected from the bottom side of the accumulator piston and picked up by an IR photodiode. Preliminary nonpressurized test results are plotted in Figure 59. It should be noted that the curve is relatively flat up to approximately 4 in. of stroke and then changes markedly. The test circuit wiring is shown in Figure 60.

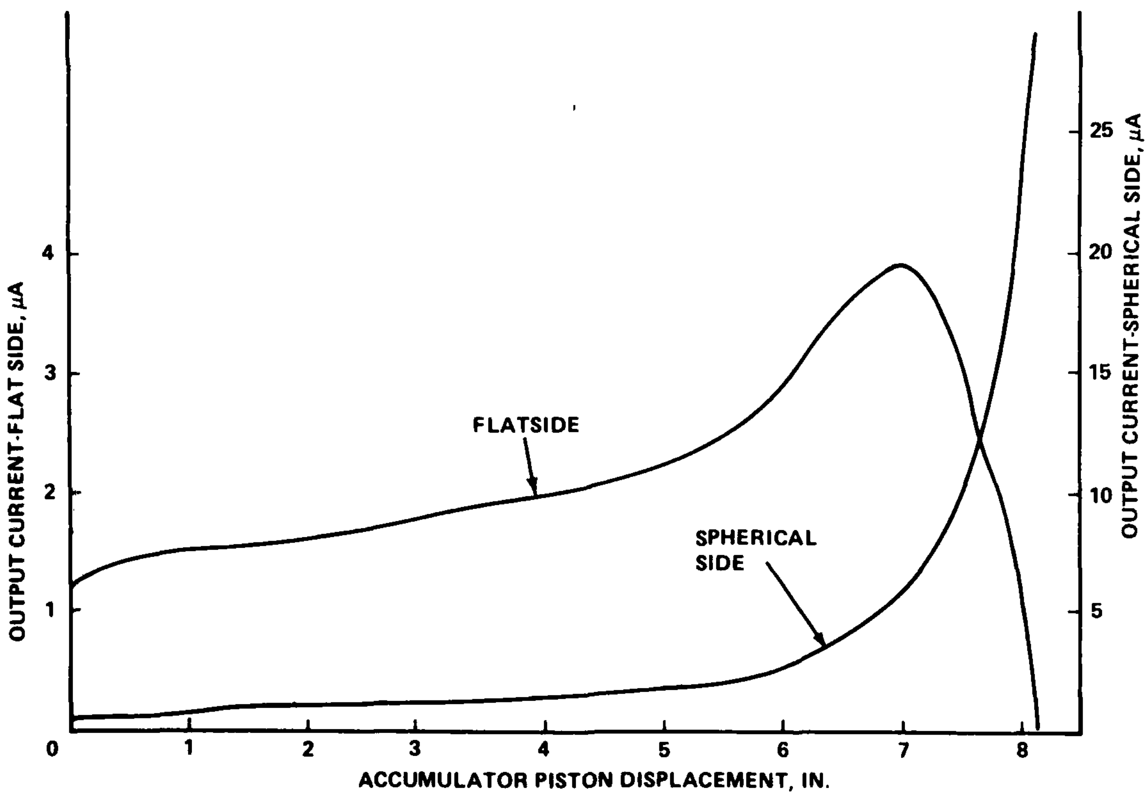
1.3.4.3 Pressure Transducers

The Entran EPS-1032 (Entran Devices, Little Falls, New Jersey) miniature pressure transducer is a thread-mounted semiconductor strain-gage sensor which fits into a 10-32 UNF threaded boss. The transducer employs a face seal and has a full-scale output of 143 mV at 3000 psi pressure with 5 V input (room temperature). There is, however, a temperature shift when tested at -40 and 250°F. Calibration curves for this unit, shown in Figure 61, are very linear over the normal operating range (0-3000 psi). Sensitivity of the transducer is 0.0485 mV/psi. The unit is normally compensated for linearity by using an external compensation module from 80 to 180°F. The wiring diagram is shown in Figure 62.



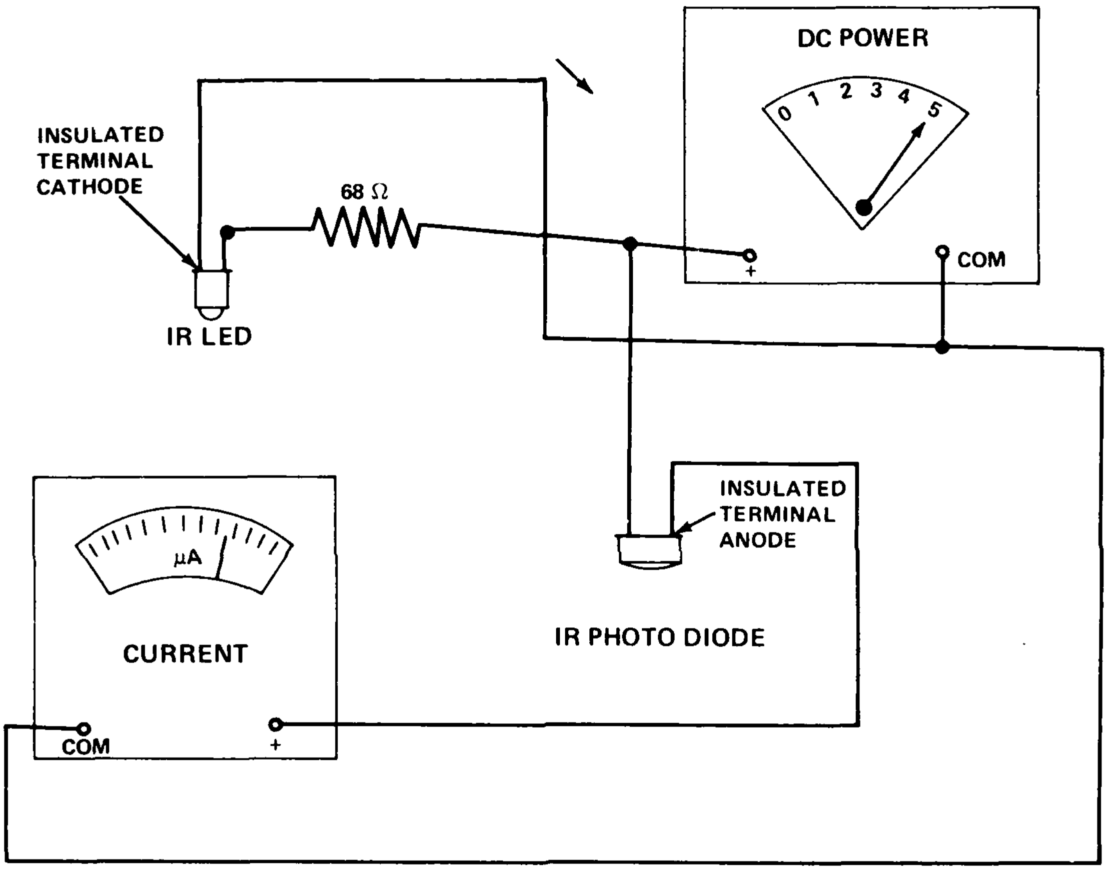
R80-2038-064(T)

Figure 58. Photo-optic accumulator piston displacement sensor.



R80-2038-065(T)

Figure 59. Photo-optic accumulator piston sensor test results.



R80-2038-066(T)

Figure 60. Photo-optic displacement sensor wiring diagram.

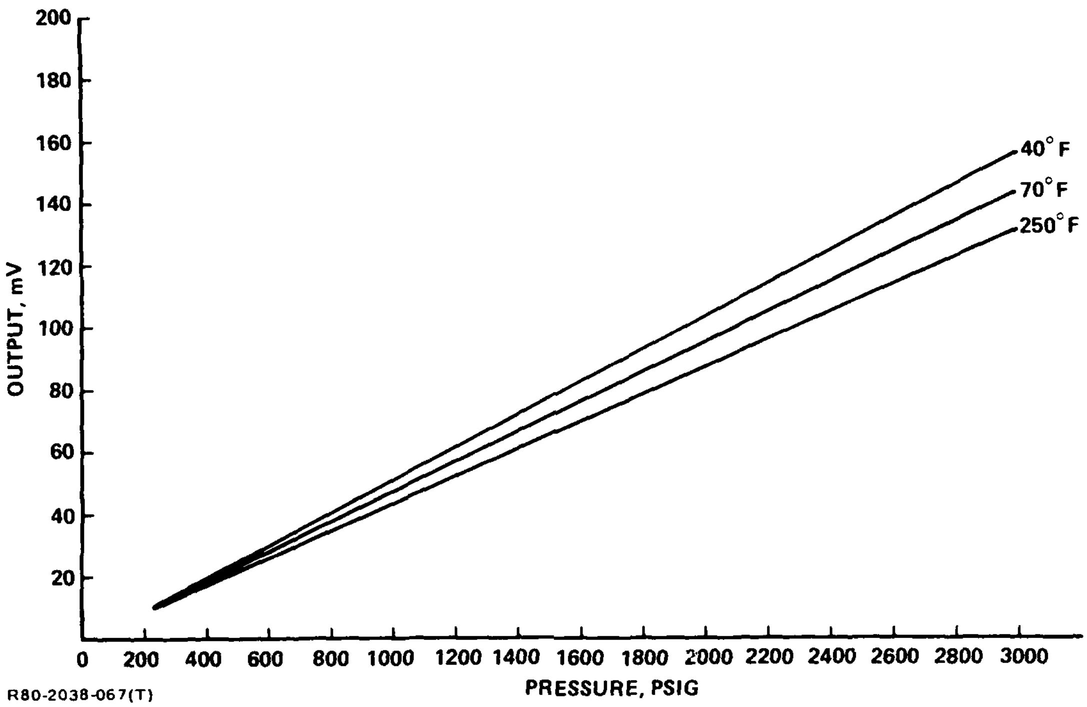


Figure 61. Entran transducer: output voltage versus pressure.

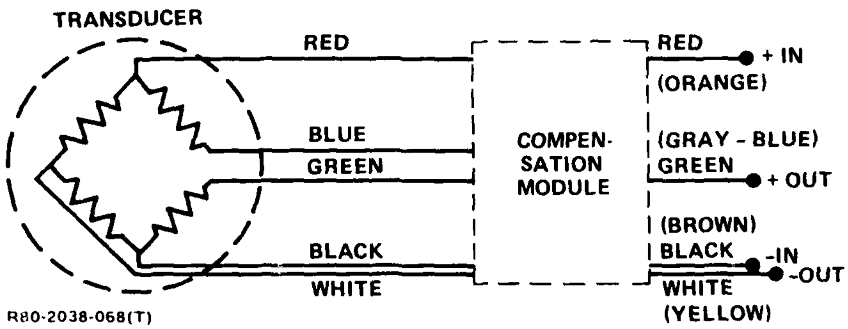


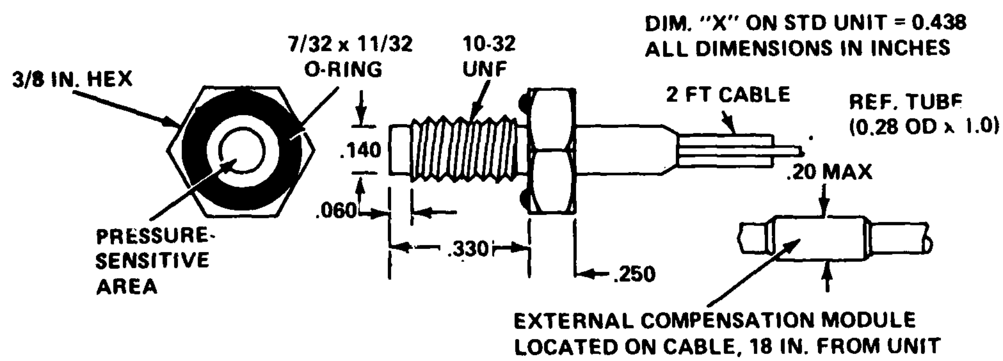
Figure 62. ESP-1032 pressure transducer wiring diagram.

Since the intended application encompassed broader temperature ranges, an extended calibrated temperature range was made. Table 6 shows performance data for the Entran ESP-1032 transducer. Envelope dimensions for a typical unit are shown in Figure 63 (Ref. 7).

TABLE 6. ENTRAN ESP-1032 TRANSDUCER DATA

• MODEL: EPS -1032-2500 (.33), S/N 10 H8H-C1-1	
• TYPE: MINIATURE PRESSURE	• RANGE: 2500 PSIG
• EXCITATION: 6.0 TO 8.0 V	• OVERPRESSURE: 4000 PSIG
• OPERATING TEMPERATURE: -60 TO 250 °F	
• TEMPERATURE COMPENSATION: -60 TO 250 °F	
• EXCITATION: 6 VDC	
• SENSITIVITY: 0.0469 mV/PSIG AT 77 °F	
• THERMAL SENSITIVITY SHIFT, mV/100 °F: < ± 2%/100 °F	
• THERMAL ZERO SHIFT, mV/100 °F: < ± 1.5% FS/100 °F	
• INSTALLATION TORQUE: 15 IN.-LB	
• IMPENDANCE: INPUT: 430 Ω	
OUTPUT: 239 Ω	

R80-2038-070(T)



R80-2038-069(T)

Figure 63. Pressure transducer envelope.

1.3.4.4 Temperature Sensor

The temperature sensor used in the accumulator circuit is the same as that used in the hydraulic reservoir circuit. This sensor assembly uses an analog device: the AD540C integrated circuit temperature transducer. A complete description and test data can be found in Subsection 1.3.1.4.

1.3.5. Rudder

1.3.5.1 Description

As part of the control logic, the rudder was selected to demonstrate the disconnect logic. The concept was to measure and compare input-output signals at or close to the input source rudder pedal and rudder pivot axis.

Since accessibility of the rudder pedal area was not prevalent, the input potentiometer was installed in the turtle deck area.

1.3.5.2 Rudder Differential Displacement Circuit

In some aircraft systems, mechanical disconnects have occurred due to disengagement of a bolt or clevis pin in the mechanical/electromechanical linkage. This would not be evident in aircraft which do not have flight-control surface display indicators on the cockpit panel.

System disconnects can be detected by comparing an input signal to a corresponding output signal. If the output signal does not follow or null out the input signal, microprocessor circuitry will indicate a disconnect condition until corrective action is taken.

Linear or rotary potentiometers are another type of displacement measuring device. Rotary or rectilinear movement of the input shaft positions a contactor (wiper) along or around a continuous resolution resistance element. These devices have practically zero backlash, are insensitive to vibration, and are compact and lightweight. In addition, their cost is low. Rotary transducers are made in multiples of 360° rotation; some cover 3600° (10 turns). Figure 64 shows typical transducer wiring diagrams and a representative plot.

The signal on both transducers are fed to a bridge circuit which detects a variation or omission of an input signal. When this imbalance occurs, the HYCOS circuit is energized.

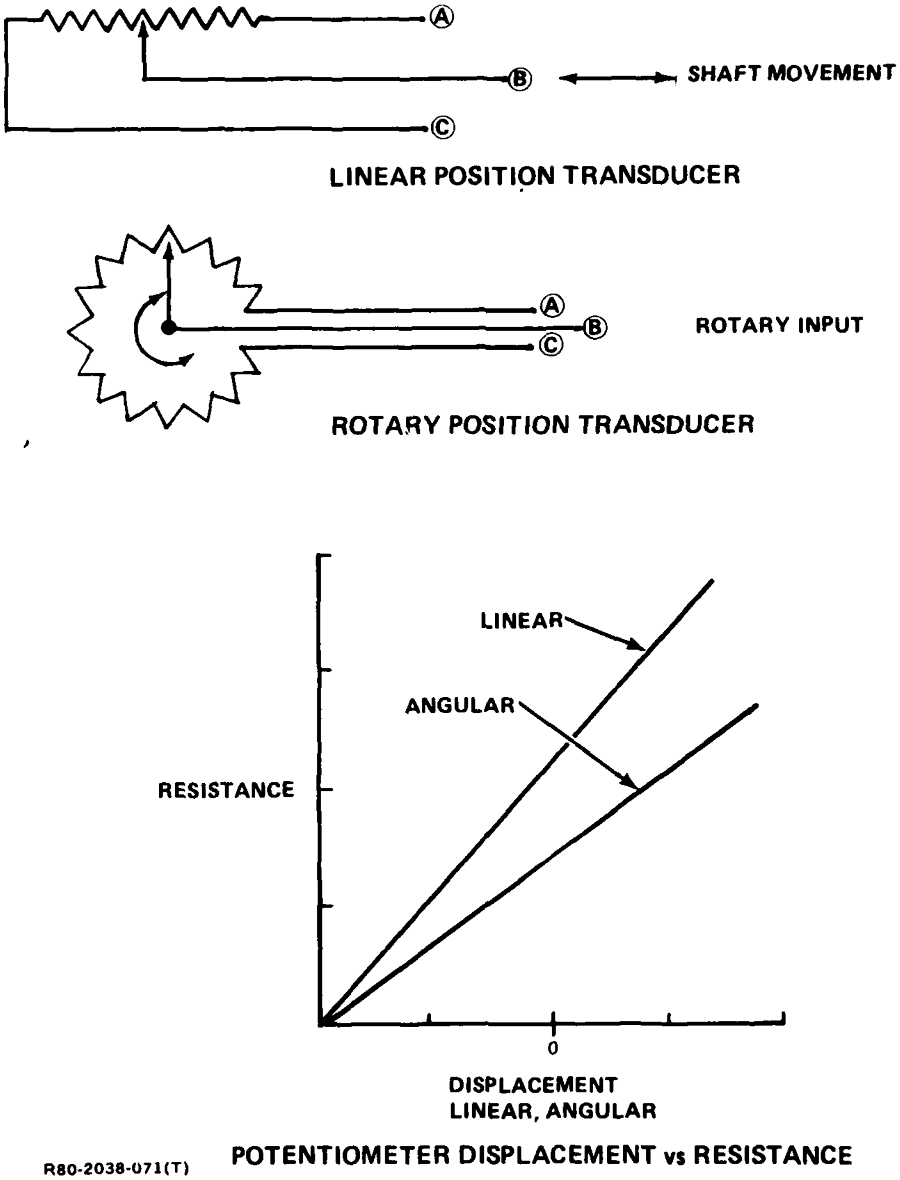


Figure 64. Potentiometer transducers.

Table 7 lists pertinent information on transducers used on the A-6E rudder actuator circuit. Figure 65 shows the turtle-deck potentiometer installation, and Figure 66 shows the rudder position potentiometer installation.

Calibration curves for the installations are shown in Figure 67.

TABLE 7. A-6E RUDDER POTENTIOMETER TRANSDUCERS.

TRANSDUCER	MANUFACTURER	SPEC NO.	TYPE	VALUES	LINEARITY
RUDDER POSITION POTENTIOMETER	ALLEN BRADLY	MIL-R-94	RV45A45D103A	10,000 Ω 2 W	± 10%
TURTLE DECK BELLCRANK POTENTIOMETER	ALLEN BRADLY	MIL-R-94	RV45A45D103A	10,000 Ω 2 W	± 10%
R80-2038-093(T)					

Figure 65. Turtle deck bell crank potentiometer installation.

Figure 66. Rudder position potentiometer installation.

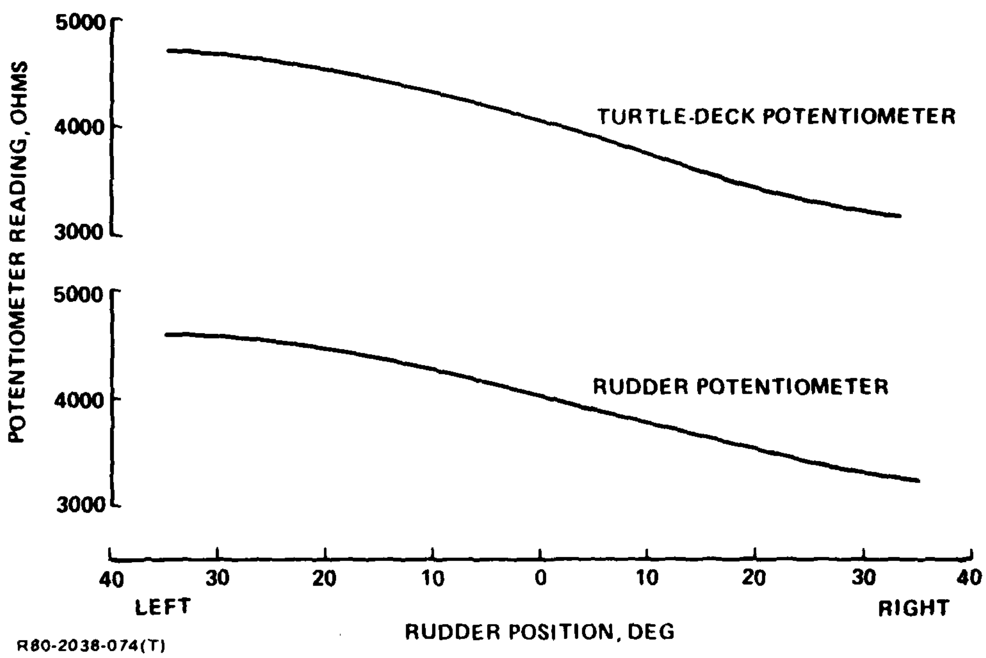
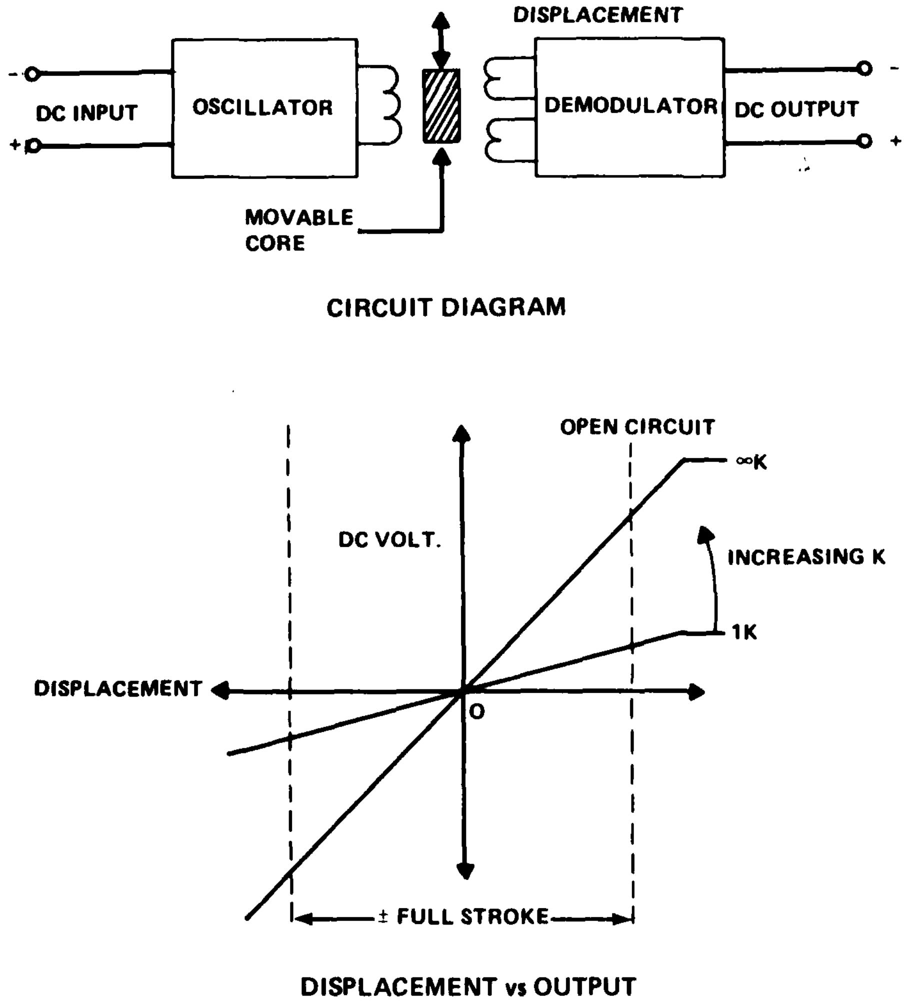


Figure 67. Rudder differential displacement potentiometer calibration.

Two basic types of systems were originally considered:

- DC-DC displacement transducers
- Linear or rotary potentiometers.

In DC-DC displacement transducers, an oscillator is used to generate an AC signal which then couples a multiple-leg transformer to a moveable core. The coupling efficiency of the core then determines the position of the element being measured. The signal is then demodulated or rectified to a DC output. Figure 68 shows a typical circuit diagram and output curve.



R80-2038-075(T)

Figure 68. DC-DC displacement transducer.

1.3.6 Display Panel

1.3.6.1 Description

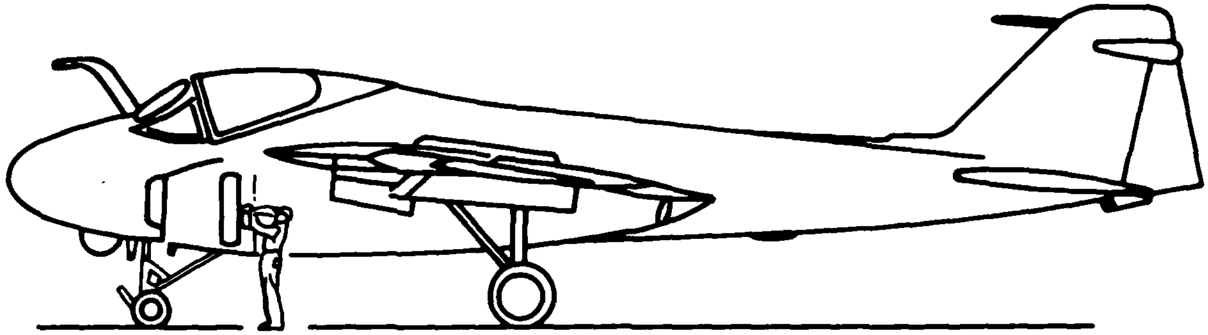
The readout panel is a ground-accessible unit which has clearly labeled lights for indicating component failure conditions. The panel is not accessible to the pilot during normal flight, although certain circuits could be interfaced with a caution-warning panel in the cockpit. Figure 69 shows a typical accessible HYCOS panel location on an operational aircraft. The panel can be interrogated both with and without aircraft or ground-support power.

The primary display panel is a self-contained unit measuring approximately 12 in. by 6.5 in. by 4.5 in. This size was chosen primarily to fit into an available existing space in the proposed flight-test vehicle. When required the size, shape, and weight could be configured to specific vehicle installations. The panel weighs 6.0 lb and contains microelectronic circuits and associated interface elements which are described in detail in subsequent subsections.

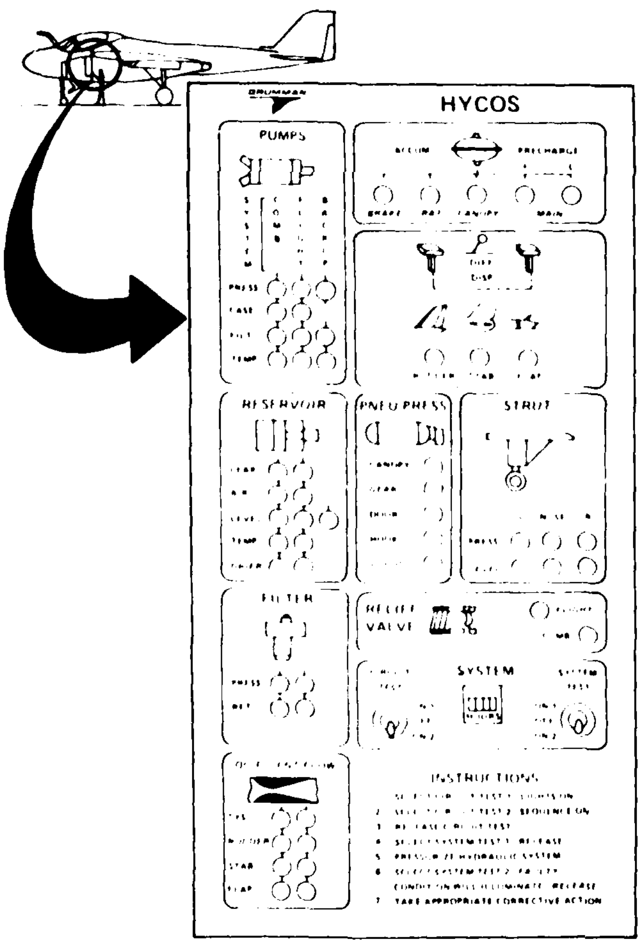
Basically, the panel houses:

- Display grain of wheat lamps
- Fiber-optic interface outlets
- Lamp drivers
- Counters
- Shift registers
- Power interface
- Sensor and system test circuits
- Microprocessor
- Analog-to-digital converters
- Memories
- Rechargeable NiCd batteries
- Battery heating and charging circuits.

Figure 70 shows the display panel connector interfaces, while Figure 71 shows the panel installed on the flight test vehicle.

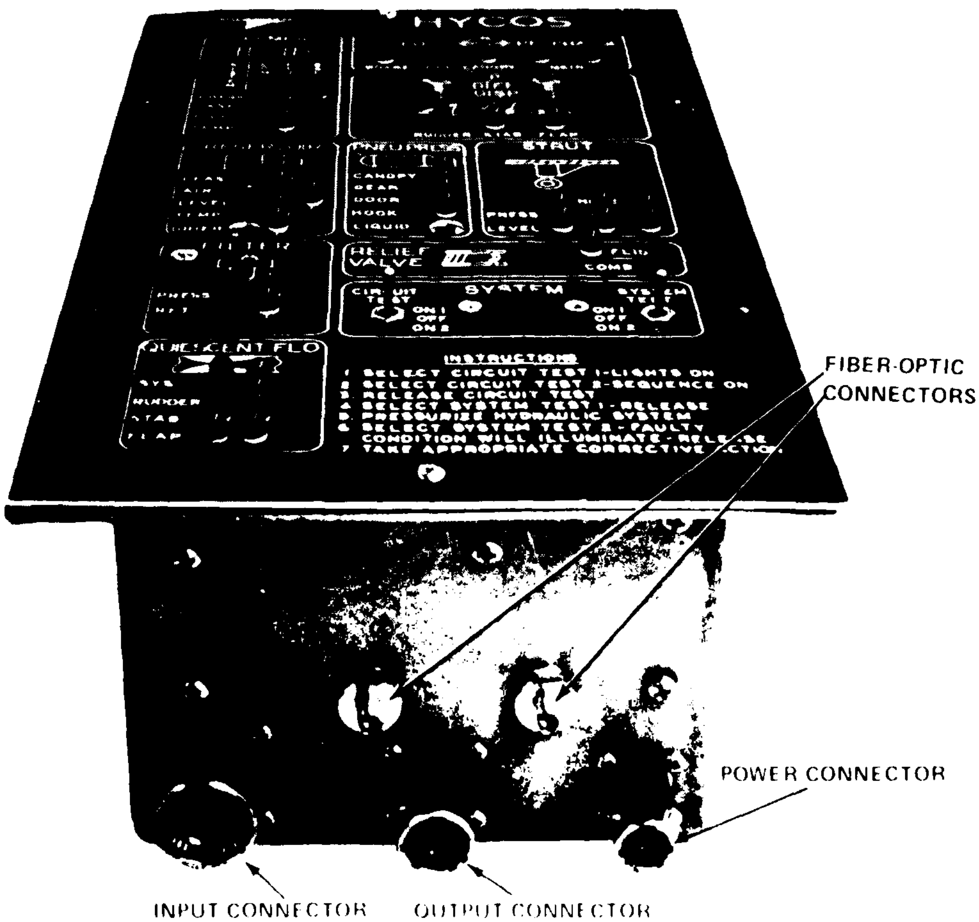


TYPICAL HYCOS ACCESS LOCATION



R80-2038-076(T)

Figure 69. HYCOS panel location on typical aircraft.



R80-2038-077(1)

Figure 70. HYCOS panel showing bottom connectors.

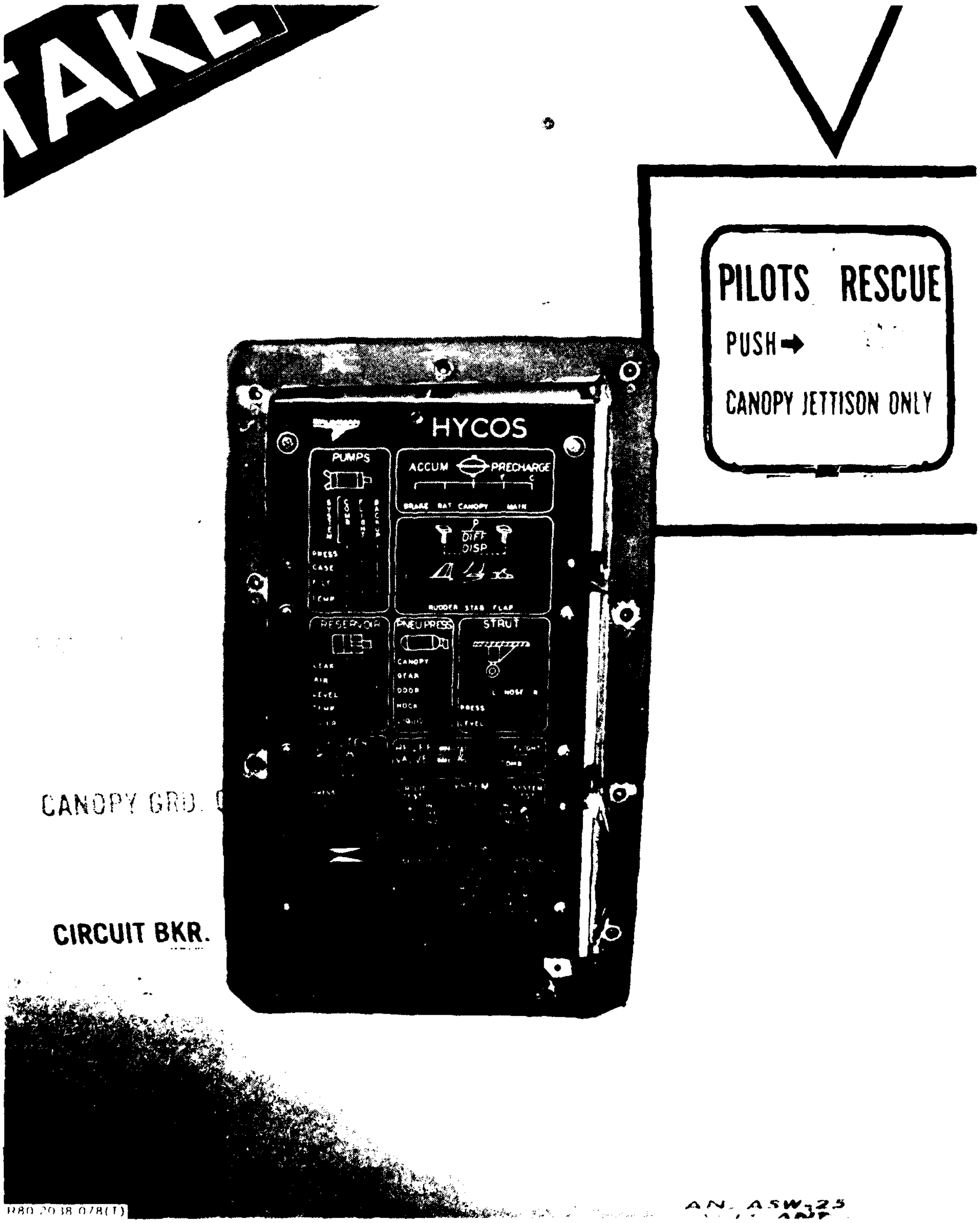


Figure 71. HYCOS installation in flight test vehicle.

1.3.6.2 Display Panel Indicators

Several types of display indicators were considered at the beginning of the program. These included LEDs, LCDs, LCDs with backscatter lighting, and subminiature incandescent lamps. Subminiature incandescent lamps are called "grain of wheat" bulbs due to their small size. After careful evaluation, the decision was made to utilize subminiature incandescent lamps since they offer good visibility during daylight and have an acceptable operating temperature range.

LEDs have some advantages but are not readily visible during daylight high-sun conditions. Since the intent of HYCOS is to place the display panel in an external ground-accessible area, the subminiature incandescent lamp was selected.

Table 8 compares the indicators considered. Size-for-size, the subminiature incandescent lamps exhibit good visibility under sunlight conditions. Although their current drain is higher than the other types considered, their ability to provide good daylight visibility became an overpowering factor. The use of lamps with a 60 mA rating would provide good service life (5000 hr average) and adequate illumination under sunlight conditions. Figure 72 illustrates the basic types of indicator displays (Ref. 8). Figure 73 is a plot of spectral output for various display types as observed by human eye response.

Since as many as 50 display indicators could light up under circuit test conditions, the NiCd battery momentary current drain could be 3 A or higher, neglecting the power requirements for the microprocessor and associated circuits. This condition occurs when the ship's battery and/or engine electrical power is on. This is a momentary high drain for the NiCd battery and did not significantly affect service life. With ship's power on, adequate monitoring panel and sensor current is available.

Another technique for reducing power drain is to use the microprocessor timer to sequentially test each subsection when the circuit test button is depressed. Under system test conditions, it is highly unlikely that more than five components would indicate failure modes and require power at any one time.

All grain of wheat bulbs are replaceable from the front of the panel by first removing the red plastic cover. Individual and collective circuit and bulb tests can be performed to verify the integrity of each indicator bulb.

TABLE 8. HYCOS DISPLAY INDICATOR CONSIDERATIONS.

DISPLAY TYPE	POWER REQUIREMENTS		VISIBILITY			COMMENTS
	VOLTAGE, V	CURRENT, mA	SUNLIGHT	NIGHT	BRIGHTNESS	
LED (LIGHT-EMITTING DIODES)	5	20	POOR LIMITED WITH LIGHT FILTER	GOOD	30-300 FOOT-LAMBERTS	• OPERATING TEMPERATURE RANGE: 58 TO 212°F • LONG LIFE • LOW OPERATING VOLTAGE • RUGGED • SMALL SIZE • RESPONSE TIME, NANOSECONDS
LCD (LIQUID CRYSTAL DISPLAYS)	5	30 (6 SEGMENTS)	GOOD	POOR	PASSIVE DISPLAY REQUIRES AMBIENT OR SEPARATE LIGHT SOURCE	• OPERATING TEMPERATURE RANGE: 14 TO 140°F (0 to 60° C) • *BECOMES SLUGGISH* AT LOWER TEMPERATURES • RELIES ON EXTERNAL LIGHT SOURCE FOR VIEWING AT NIGHT
LCD WITH BACK SCATTER LIGHTING	5	30+ (15 FOR BACKSCATTER LAMP)	GOOD	GOOD TO FAIR	SIMILAR TO INCANDESCANT	COMPLEX, BULKY. TEMPERATURE-LIMITED
SUBMINIATURE INCANDESCANT LAMPS	5	15 TO 60	GOOD	GOOD	> 1000 FOOT-LAMBERTS	• LIMITED BY MULTIPLE LAMP CURRENT DRAIN DURING BATTERY OPERATION • HEAT DISSIPATION A SIGNIFICANT CONSIDERATION • BRIGHTEST OF ALL DISPLAYS • LOW VOLTAGE REQUIREMENTS • RESPONSE TIME IN MILLISECONDS • VIBRATION-RESISTANT IN SMALL SIZES

R80-2038-079(T)

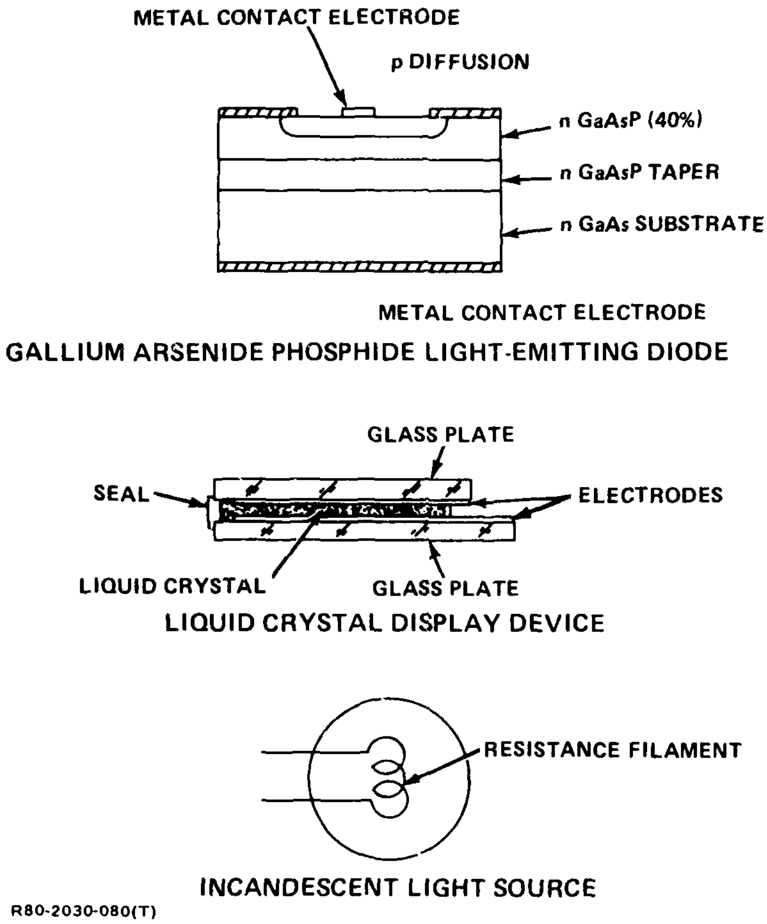
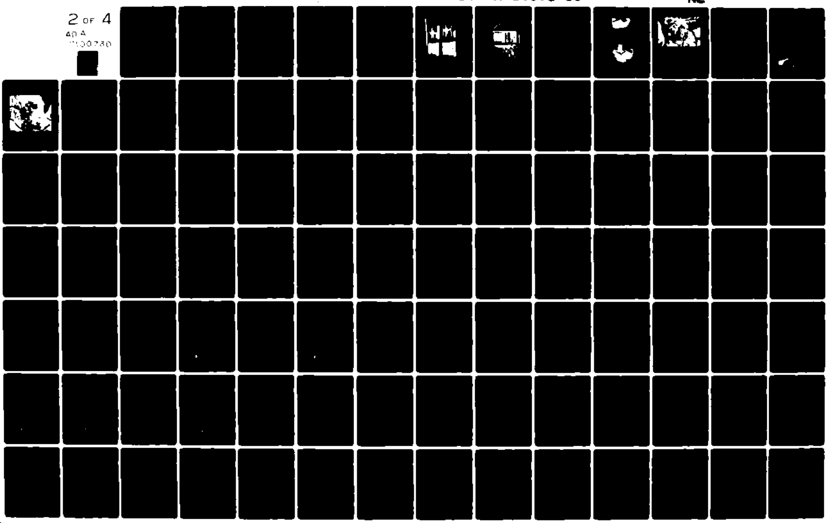


Figure 72. Types of display indicators.

AD-A100 730 GRUMMAN AEROSPACE CORP BETHPAGE NY F/G 14/2
HYDRAULIC DIAGNOSTIC MONITORING SYSTEM.(U)
MAR 81 J J DUZICH N62269-78-C-0041

UNCLASSIFIED NADC-TR-81073-60 NL

2 OF 4
AD A
100730



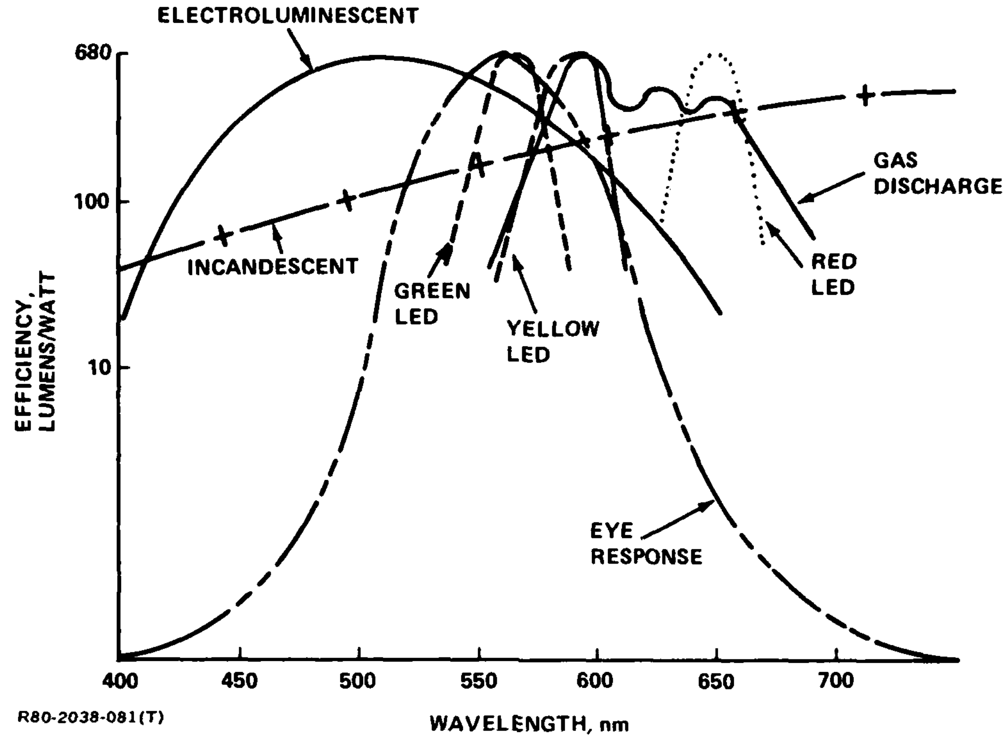


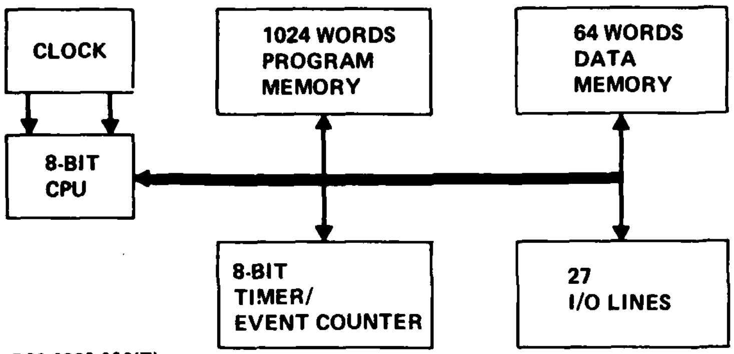
Figure 73. Spectral output of various displays compared to response of human eye.

1.3.6.3 Microprocessor

The Intel 8748 (Ref. 9) is a single-component, 8-bit microcomputer fabricated on a single silicon chip using the N-channel silicon gate MOS process. Unlike the 8048, the 8748 has an erasable program memory which can be varied for tests and evaluation during the prototype and reproduction stages. The 8748 is eaily programmable and has sufficient room for additional programs and/or add-on functions. In particular, it:

- Is an 8-Bit CPU containing ROM, RAM, I/O, and a Timer in a single package
- Is powered by a single 5 VDC power supply
- Responds in a 5.0 μsec cycle. All instructions use one or two cycles
- Has a 1K by 8-bit EPROM, 64 by 8-bit RAM, and 27 I/O lines
- Contains an internal timer/event counter
- Has a single-level interrupt.

A block diagram of the 8748 is shown in Figure 74. Figure 75 shows a typical pin arrangement for this unit.



R80-2038-082(T)

Figure 74. Intel 8748 block diagram.

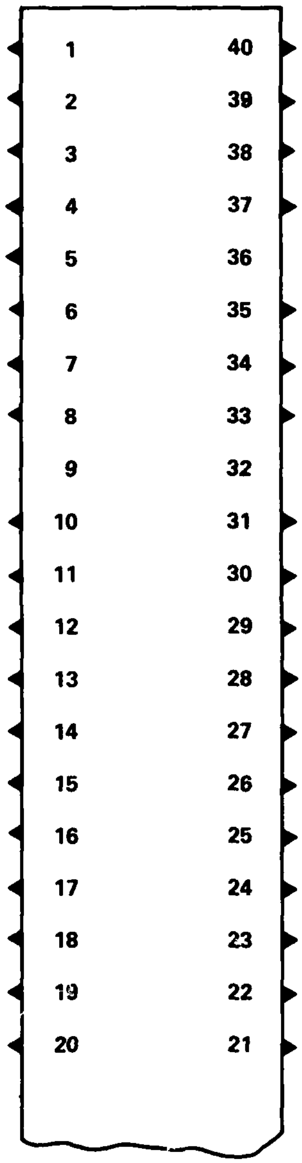
1.3.6.4 Charging Circuit

A charging circuit was designed into the system to keep the twelve nickel-cadmium batteries charged when the vehicle is on ground-support power or on an operational mission.

A transformer is used to step-down the 115 VAC, 400 Hz power supply. Rectification is accomplished by a diode to a DC value slightly higher than the 5 VDC system. Since nickel-cadmium batteries are difficult to charge below 0°C, external heaters are used to maintain battery temperatures above this value.

1.3.6.5 Heating Circuit

Since the NiCd batteries must be charged with the vehicle flying at various altitudes, thermostat-controlled battery strip heaters are incorporated. When the temperature drops below 0°, the heating strip functions until the surface temperature reaches 32°F. This thermal cycling enables the batteries to achieve and retain a full charge. Figure 76 shows charging characteristics of NiCd batteries as a function of temperature (Ref. 10). During the flight test programs, modifications were made to the battery charging circuit to reduce the charging rate and provide for an external access connector. This connector was used to check status on battery voltages and provide an external dedicated recharge capability. Both battery analysis and external battery charging circuits are discussed in Appendix I.



PIN	
1	TO INPUT PIN
2	XTAL1 – INTERNAL OSCILLATOR
3	XTAL2 – OTHER SIDE OF CRYSTAL INPUT
4	RESET – INPUT USED TO INITIALIZE PROCESSOR
5	$\overline{SS}$ – SINGLE STEP INPUT
6	$\overline{INT}$ – INTERRUPT INPUT
7	$\overline{EA}$ – EXTERNAL ACCESS INPUT
8	$\overline{RD}$ – OUTPUT STROBE ACTUATED DURING A BUS READ
9	$\overline{PSEN}$ – PROGRAM STORE ENABLE
10	$\overline{WR}$ – OUTPUT STROBE DURING BUS WRITE
11	ALE – ADDRESS LATCH ENABLE OCCURS ONCE DURING EACH CYCLE
12-19	DB_0 – DB_7 – DATA BUS BIDIRECTIONAL PORT
20	V_{SS} CIRCUIT GND POTENTIAL
21-24	P20-P27 8-BIT QUASI-BIDIRECTIONAL PORT
25	PROG – PROGRAM PULSE
26	V_{DD} – PROGRAMMING POWER SUPPLY
27-34	P10-P17 8-BIT QUASI-DIRECTIONAL PORT
35-38	PORT 2 – P20-P23 CONTAIN THE FOUR HIGH-ORDER PROGRAM COUNTER BIT DURING AN EXTERNAL PROGRAM MEMORY FETCH
39	T1 INPUT PIN TESTABLE USING THE JT1 & TNT1 INSTRUCTIONS
40	V_{CC} – MAIN POWER SUPPLY (+5V) DURING OPERATION & PROGRAMMING

R80-2038-083(T)

Figure 75. Intel 8748 pin configuration.

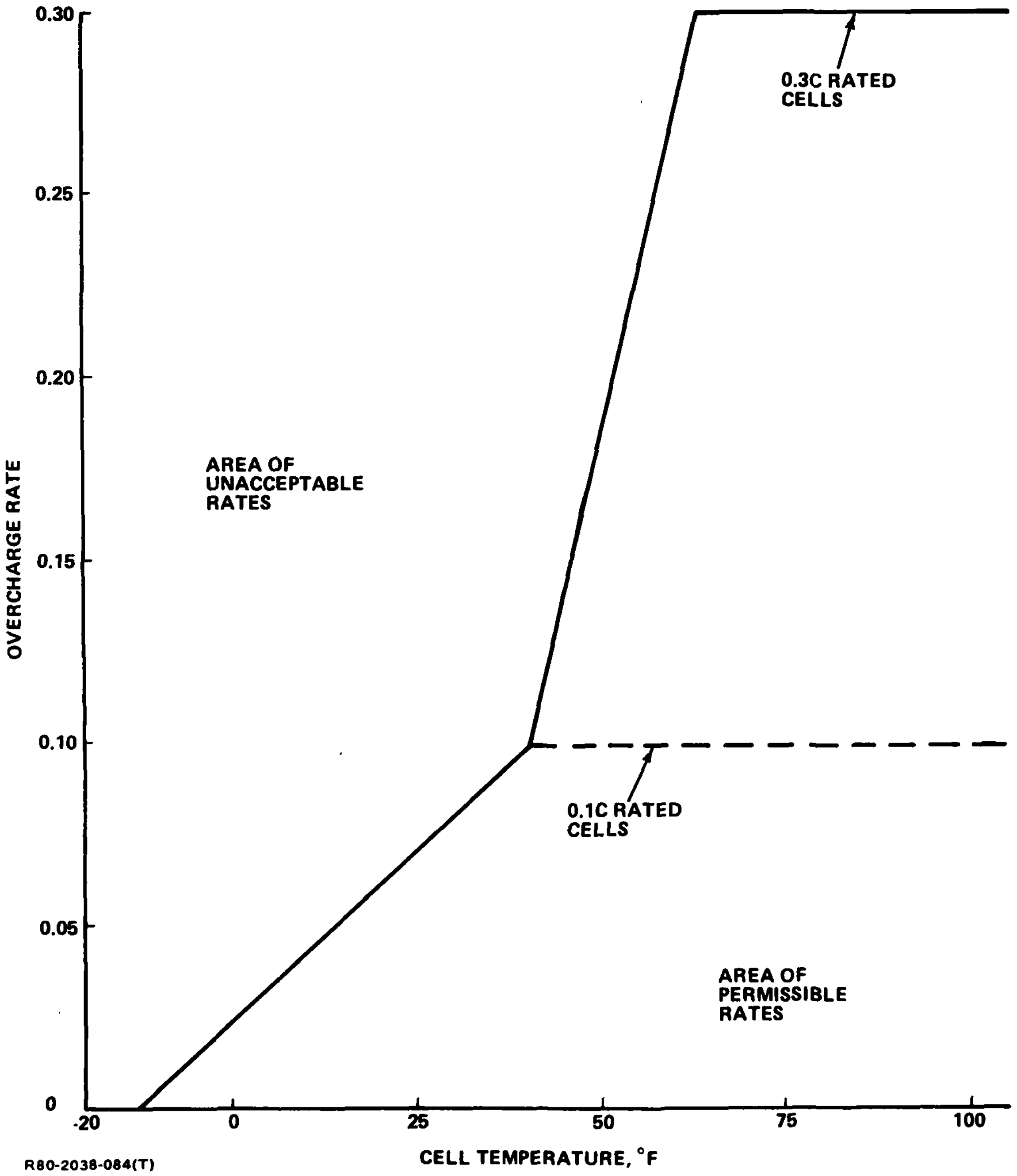


Figure 76. Nickel-cadmium battery charge characteristics.

1.3.6.6 Wiring Circuit

The basic wiring circuit is shown in Appendix I. Four removable display cards (Figure 77) comprise the major portion of the circuit and consist of the following:

- Card No. 1: Microprocessor - memory and display drivers
- Card No. 2 & 3: Counters and A/D converters
- Card No. 4: Interface circuits.

Figure 78 shows the HYCOS panel with its cover removed.

Basic card element functions are as follows:

- Microprocessor - unit, controls all calcuations
- Lamp Drivers - supplies current to display lamps
- Output expanders - receives three inputs and delivers eight different outputs
- Dual flip-flops - used for data storage
- A/D converters - receives analog data and converts it to a 8-bit digital word
- Hex Buffer - used to drive data bus
- Counter latch; seven-segment driver - counts pulses, stores value, and drives seven-segment display
- Transistors - amplifies pulse input and potentiometer signals
- Schmitt Trigger - used to square waveshapes
- Diodes - used for lamp test isolation and to rectify AC for battery charging
- Batteries - 1 A-hr battery drives high-power circuits and 100 mA-hr battery supplies low-power requirements.

1.3.6.7 HYCOS Flow Diagram and Program Limits

Program limits are established for the particular subsystem in question. A math model was first established which defines the normal operating parameters. When these limits are exceeded either individually or collectively, the program subroutine detects the discrepancy and provides the proper circuit response.

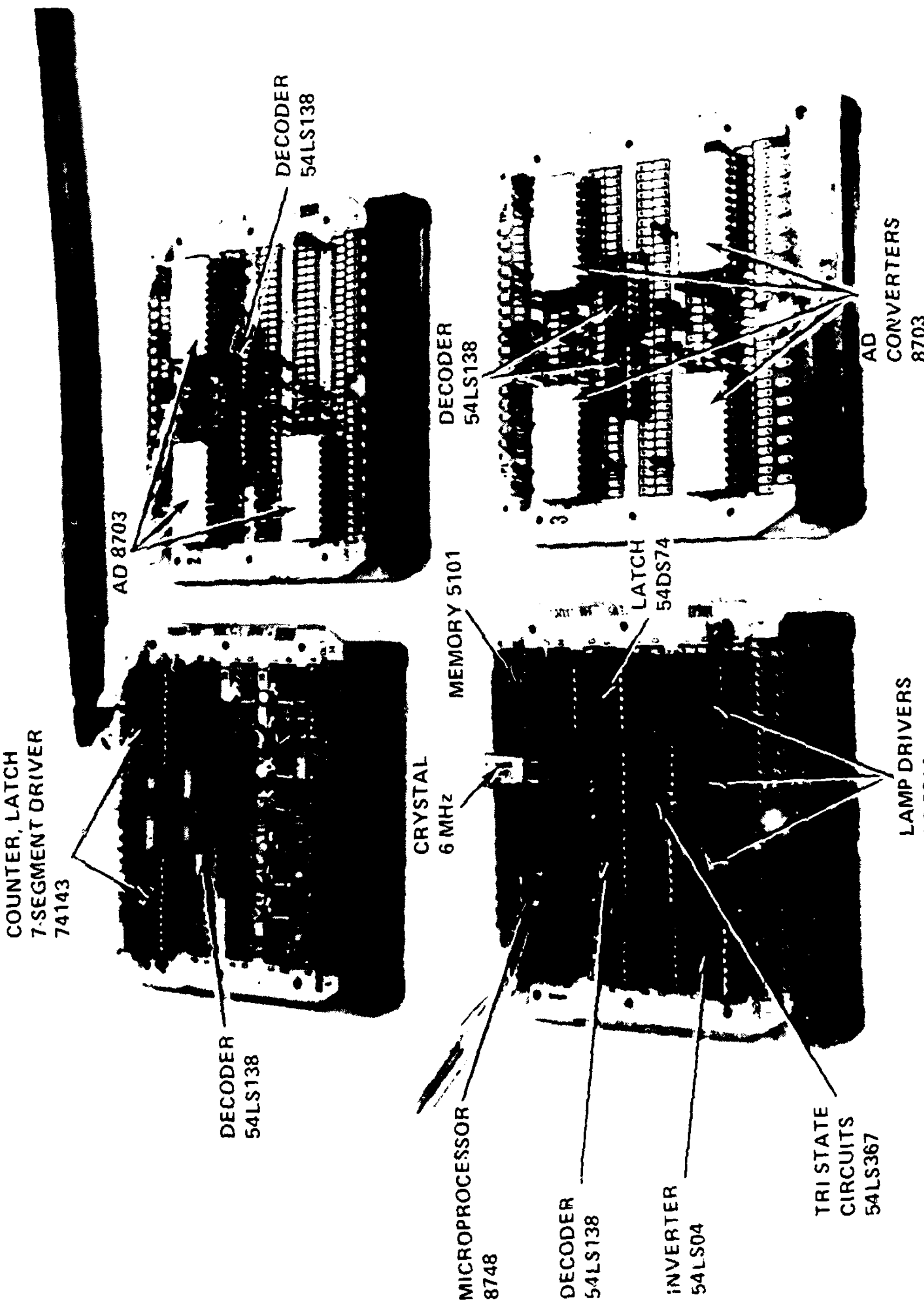
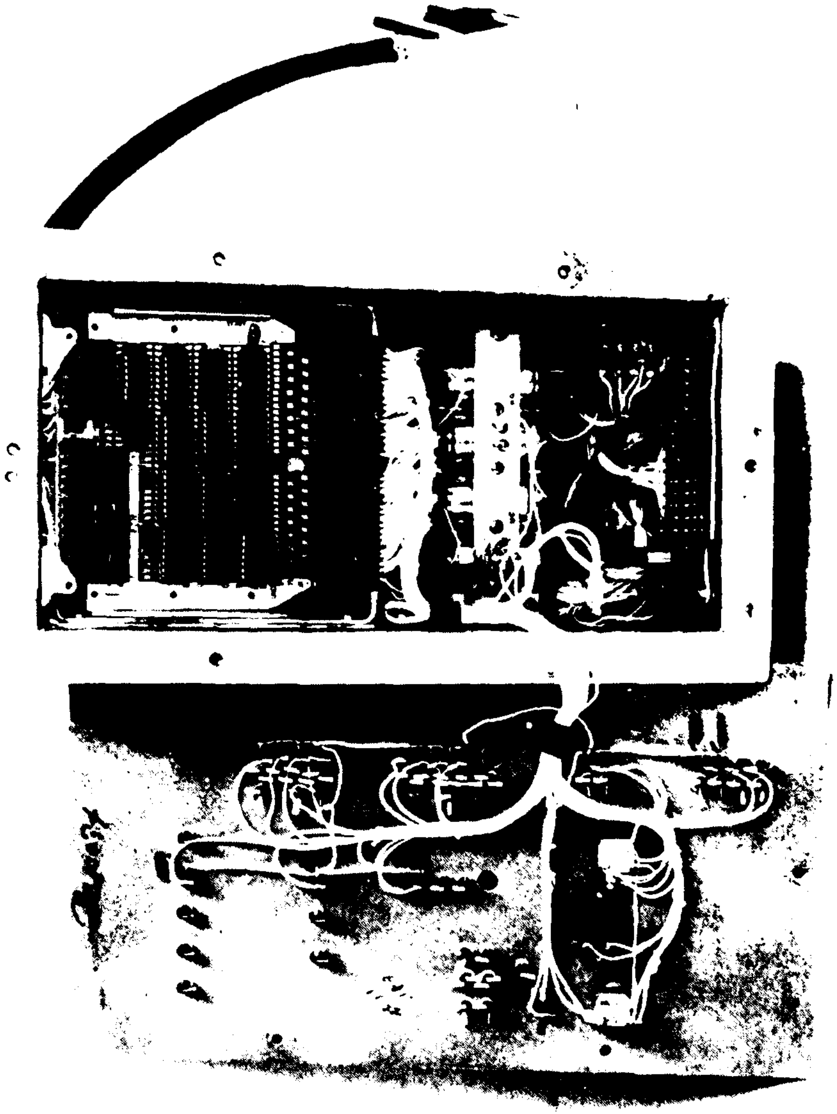


Figure 77. Removable display cards.



R80-2038-086(T)

Figure 78. HYCOS panel with cover removed.

The program flow diagram is broken down into six basic routines:

- Executive Routine
- Sequence Routine
- RAM Load Routine
- Rudder Routine
- Reservoir Routine
- RAT Routine.

Additional details of the flow diagram and the microprocessor program are listed in Appendix K.

1.3.7 Hydraulic Filters

1.3.7.1 Filter Differential Pressure Indicators

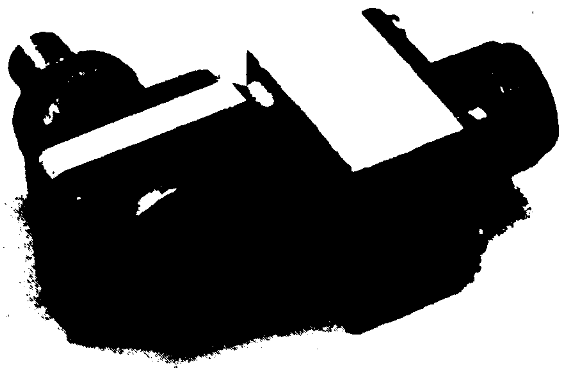
Filter differential pressure indicators, commonly used in the fluid power industry, are an indirect means of identifying contaminated filter elements which require servicing. The indicator is usually mounted to the filter head or bowl and provides a visual signal whan a predetermined element differential pressure has been exceeded. In order to take into account fluid viscosity changes due to thermal conditions, various means are employed to preclude indicator operation before the system reaches normal operating temperature. One method uses a bimetallic sensing unit placed in close proximity to the visual indicator; another employs a temperature-sensitive gas, fluid, or elastomer.

To provide remote indication capability, an electrical switch may be mechanically or otherwise actuated by the primary sensor indicator. Resetting the mechanical indicator also resets the electrical circuit.

A boot or transparent cap is provided over the indicator to improve reliability by making it less susceptible to extrinsic debris and fluid. This cap is physically restrained or bonded to the adjacent element. Figure 79 shows a typical interchangeable differential pressure indicator. An actual installation photograph is shown in Appendix J.

1.3.7.2 System Fluid Sampling

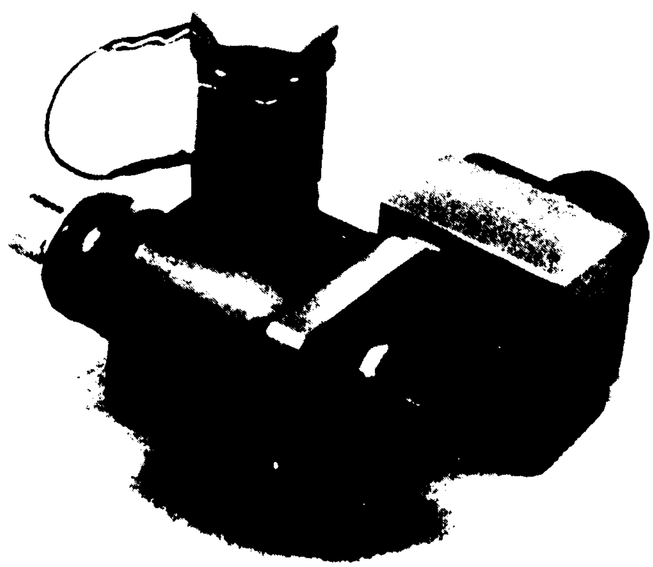
Another version of the delta-p indicator contains a sampling port which permits fluid extraction from the upstream side of the filter element while the system is pres-



R80-2038-087(T)

Figure 79. Filter differential pressure indicator.

surized. One such type of "Multicator"* is shown in Figure 80. Figure 81 shows an installation in the pump case drain filter.



R80-2038-088(T)

Figure 80. Filter differential pressure indicator with sampling valve.

-----

* Multicator is an APM Trademark

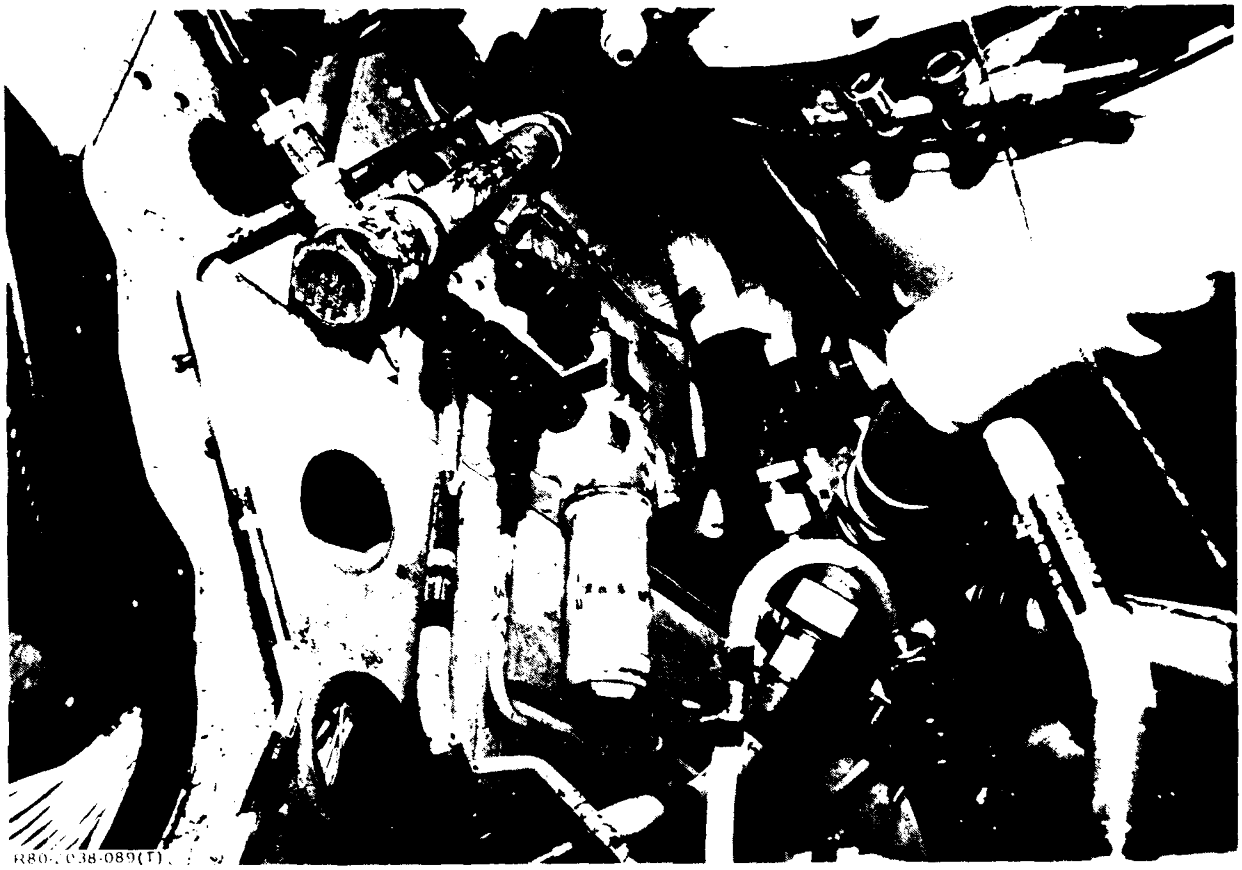


Figure 81. Multicator indicator installation in pump case drain filter.

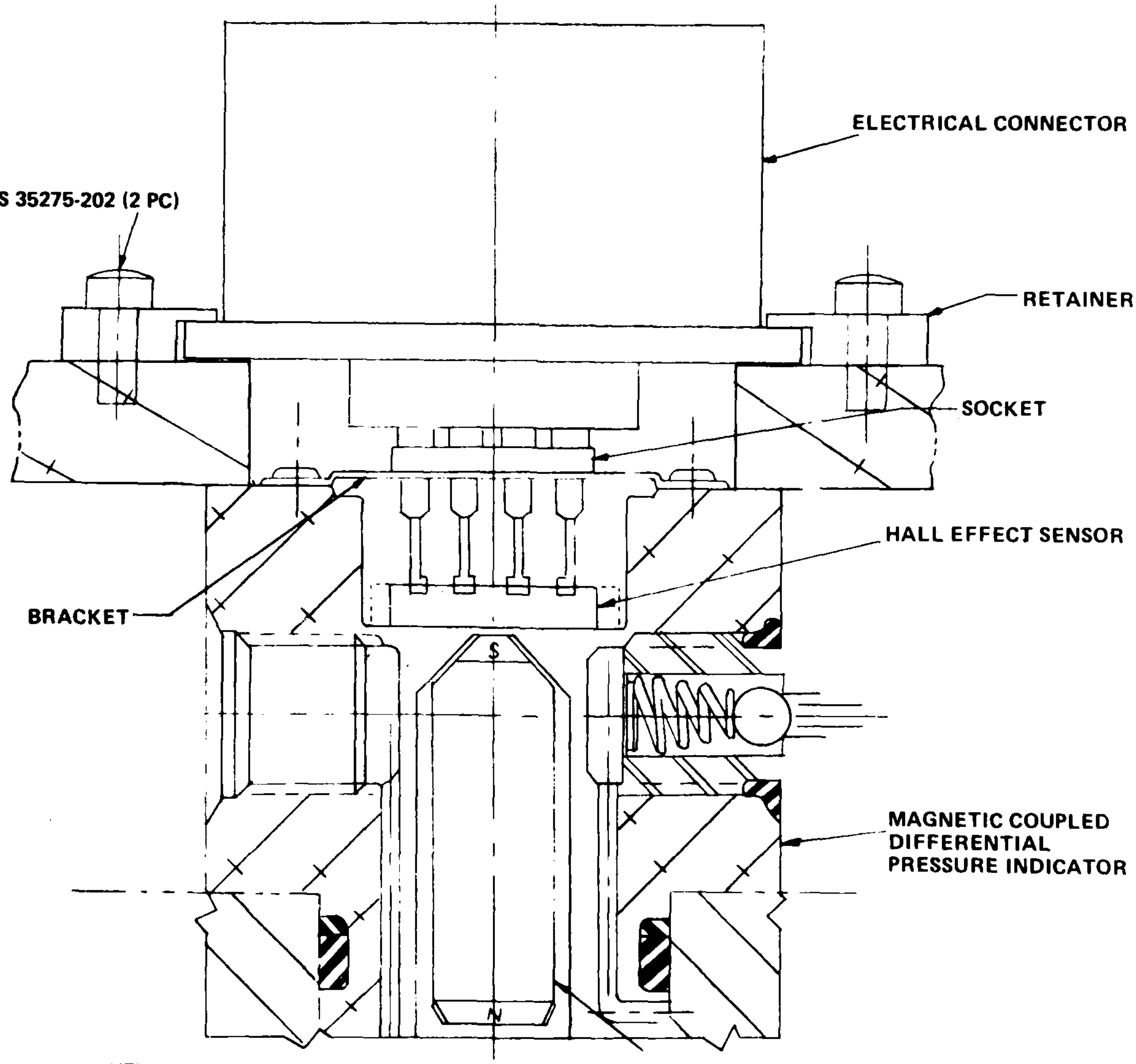
A special wired plug is used to protect the sampling port when not in use, and also acts as a redundant pressure seal.

Grumman Specification 202 defined the pertinent parameters of each unit used for the HYCOS Program.

It should be noted that most visual and electrical indicators are usually discrete signals (Go/No-Go type). In cases where an analog signal is required, this may be provided by using the approach shown in Figure 82. This concept utilizes a linear output Hall Effect sensor actuated by a movable permanent magnet which is coupled to a spring-biased piston. Movement of the sensing piston magnet affects the magnetic flux density seen by the Hall Effect sensor, reducing the output signal. Since the sensor output varies as a function of ambient temperature, temperature compensation must be provided.

1.3.8 Flight Control Hydraulic Backup Package

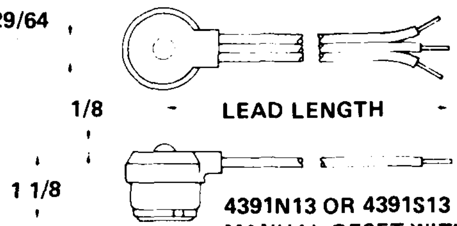
A Klixon overtemperature switch was bonded to the flight control backup module to measure system and closed-loop surface overtemperature conditions. The switch conforms to Grumman Specification 201 and has a trip setting of 300 ± 20°F. It is manually resettable through a neoprene overmold. Figure 83 (Ref. 11) shows typical switch characteristics. Actual installation on the flight control backup module is shown in Figure 84. Operation of the hydraulic backup package occurs during preflight check and only if one hydraulic system is lost.



R80-2038-090(T)

Figure 82. Linear output Hall Effect differential pressure indicator.

- SNAP-ACTION SWITCHING
- NORMALLY OPEN OR NORMALLY CLOSED
- AUTOMATIC OR MANUAL RESET
- SPST OR SPDT
- OVERMOLD OPTIONAL



4391N13 OR 4391S13 STYLE SPDT
MANUAL RESET WITH OVERMOLD

PERFORMANCE CHARACTERISTICS

DIELECTRIC STRENGTH:
1250 VAC, RMS, 60 CYCLES FOR ONE MINUTE (1500 VAC RMS AVAILABLE ON SPECIAL REQUEST)

AMBIENT TEMPERATURE RANGE:
NON OVERMOLD – 65°F TO 450°F
NEOPRENE OVERMOLD – 65°F TO 160°F
SILICONE OVERMOLD – 65°F TO 450°F

SWITCH ACTION:
SPST OR SPDT (SNAP-ACTION)

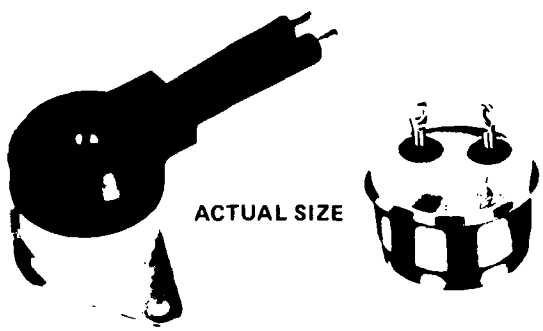
LIFE CYCLE:
SEE ELECTRICAL RATING TABLE

VIBRATION:
STANDARD CONSTRUCTION 5-500 CPS, 3G's
HIGH VIBRATION CONSTRUCTION 5-500 CPS, 5G's

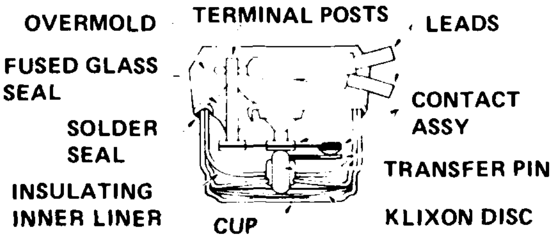
WEIGHT:
WITHOUT OVERMOLD 21 GRAMS AVERAGE
WITH OVERMOLD 56 GRAMS AVERAGE

ELECTRICAL RATINGS (RESISTIVE)

AMPERES			LIFE CYCLES
30 VAC/DC	125 VAC	250 VAC	
10	4	2	100,000
11	6	3	50,000
12	8	4	25,000
13	10	5	10,000
14	12	6	5,000



CROSS-SECTION VIEW OF TYPICAL UNIT WITH OVERMOLD (AUTOMATIC RESET)



R80-2038-091(T)

Figure 83. Resettable temperature switch characteristics.

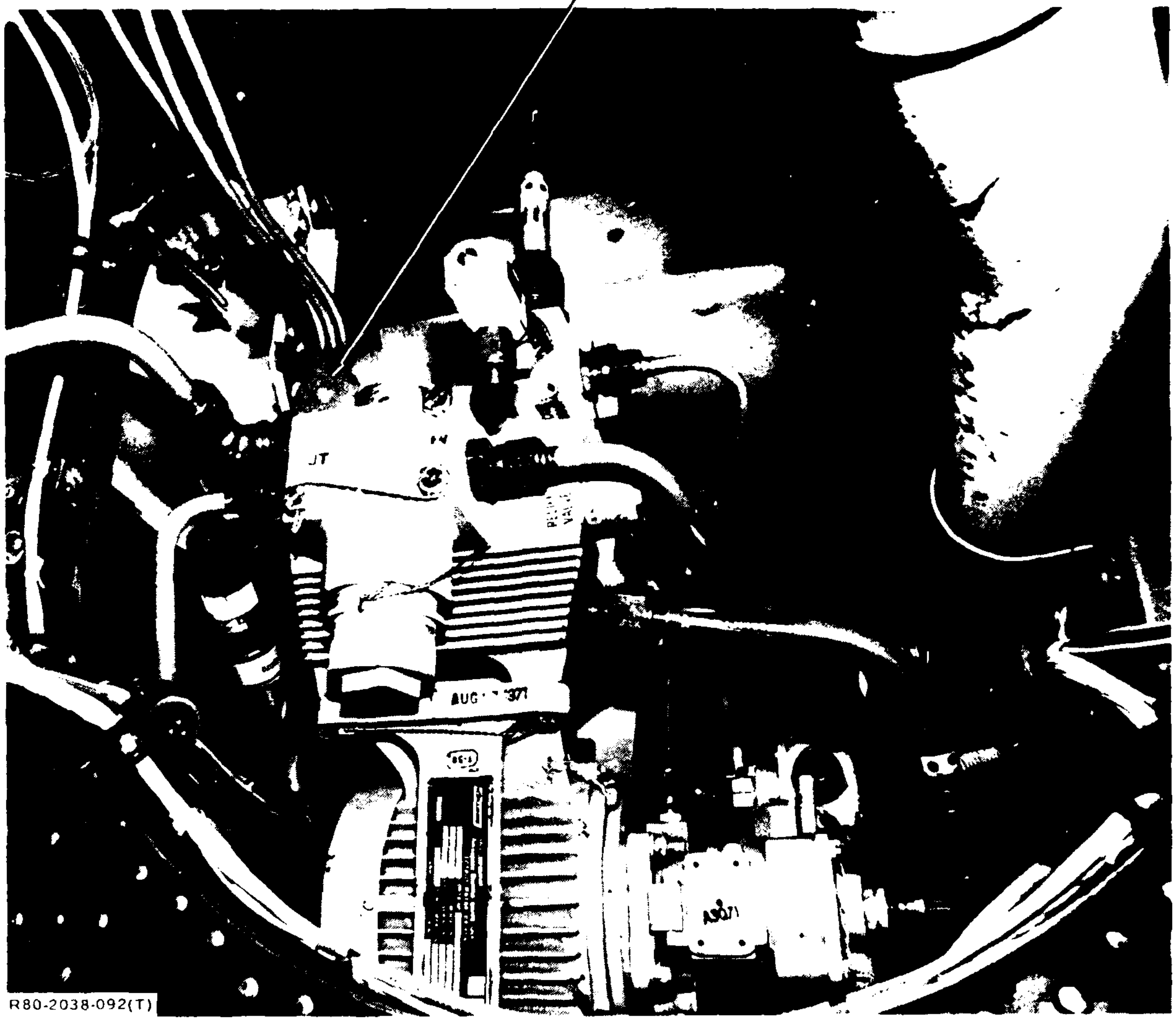


Figure 84. Flight control backup module installation.

Section 2

GROUND AND FLIGHT TESTS

2.1 SYSTEM DEBUGGING

During the early part of 1979 all sensors, hard lines and wiring were installed during vehicle buildup. In mid-May, the vehicle with sensors and HYCOS wiring was subjected to and passed the hydraulic ground check and acceptance testing. These tests verified hydraulic system integrity on both the flight system and the combined system on which HYCOS was installed.

Debugging included rerunning hydraulic reservoir displacement calibration to verify the laboratory values. All HYCOS wiring was checked between the sensor interface and display panel for continuity. A rudder differential displacement check was made after calibrating both potentiometers. Continuity checks were also made on the fiber-optic circuits. After the first flight in October 1979 it was found that the elapsed time meter (ELT) was not functioning. Investigation showed that the ELT operated through a relay after the panel switch was energized. A wiring change was made to the ELT circuit. This enabled the ELT to register every time the combined system was monitored or AC power was available on the aircraft. While the panel was being rewired, an IC chip was also replaced. Details of the wiring change is shown in the appendix.

2.2 DEVELOPMENTAL MODIFICATIONS AND IMPROVEMENTS

2.2.1 HYCOS Display Panel

Modifications were made at the onset of the program to the battery charging circuits to improve NI-CAD battery reliability. During the early phases of the program the NI-CAD batteries discharged when the aircraft was stored in the hangar over the weekend. A HYCOS battery analysis was conducted (See Appendix K) which indicated that the batteries were adequately sized and that the charging rates should be reduced from 100 mA-hr to 50 mA-hr for the 5-volt battery. The charging rates for the 3.6V and - 6V batteries was reduced from 10 mA-hr to 5 mA-hr.

The analysis also indicated that the panel should be equipped with an external accessible connector to provide direct connections to the battery plus and minus terminals. The connector would then allow external monitoring of battery voltages without removing the panel from the vehicle, and it would also provide charging access to the NI-CAD batteries using a dedicated ground support charger.

Both improvements were incorporated. A dedicated battery charger was fabricated but seldom used since, after subsequent initial charging, the ship's electrical buss maintained the batteries in a usable state.

Another improvement area was in modifying the internal power circuit to the elapsed time meter. This was done so that power to the elapsed time meter would occur when both AC and hydraulic system power was available. When the system is interrogated on the ground in the static condition no power reaches the elapsed time meter. In the same circuit, the relay was replaced with a heavy duty Leach DM 2-5.

In order to reduce the number of sequential operations, the system test switch was modified by replacing the ON, center OFF, ON configuration to an ON momentary at the panel. This reduced the system test functions to only 1:

- With the system test switch in its ON position, power is supplied to the elapsed time indicator if hydraulic power is on
- System test "ON 2" without hydraulic power checks air in the reservoir and discrete circuits
- System test "ON 2" with hydraulic power checks the reservoir, ram air turbine accumulator, and rudder differential circuit.

The addition of a top hat to the desiccant color detector terminal improved color transmission visibility at the panel.

2.2.2 Panel Support Structure

During the early part of the program, a doubler plate was added to the access plate to provide additional clearance for the load bearing fasteners. This improvement corrected the fastener retention problem caused by marginal material thickness.

2.2.3 Sensor Light Sources

As the flight test program evolved, it was determined that a more intense light source was needed at the desiccant color detector and pneumatic liquid bottle detection circuits. Three halogen lamps were added with specially designed housings for this purpose. There was a significant improvement in available light intensity.

2.2.4 Flow Sensor Indicators

Environmental vibration during a normal flight schedule caused two of the flow sensors to indicate incorrectly. After investigation and vibration testing, it was found that the resonant frequencies of the lockout solenoid armature/spring occurred. The armature/spring mass was redesigned to move the resonant frequency out of the operational envelope.

2.2.5 Desiccant Color Detector

Several improvements were made to this sensor. These included increasing the light intensity at the surface, optimizing the reflected transmitter, receiver angle, and finally developing a new desiccant color disc mounted internally in the air stream. Color transmission from irregular granular surfaces proved difficult because of the irregular granular surfaces.

Fiber-optic cable junctions should be minimized and cable runs must be carefully laid to avoid sharp bends.

Crazing of the transparent plastic tube developed later in the program. This tube was replaced with another unit of the same type. Examination of the part indicated that crazing was caused by over torquing the sensor body to its outside diameter.

Section 3

PERFORMANCE AND EVALUATION/ASSESSMENT

3.1 PROCEDURES AND METHODS

3.1.1 Objective

The purpose of the Flight Test Program is to evaluate the HYCOS System under actual operating conditions and to determine its effectiveness in detecting system and component malfunctions. It in no way replaces the normal maintenance schedules, but may be used in conjunction with such maintenance actions.

3.1.2 Procedure

This procedure defines a systematic method of conducting a "HYCOS" Interrogation. All data is to be recorded on the provided HYCOS Log Sheet and HYCOS Check-out Logic Sheet.

Three (3) checks are required:

- "A" Preflight static check is conducted with the flight vehicle in the hangar prior to towing to flight line. This provided the initial condition prior to flight. Any abnormalities or malfunctions would be corrected at this time.
- "B" Postflight dynamic check is required to measure internal system and pump leakage with no mechanical input into the control surfaces. During the time the system is pressurized, power is supplied to the elapsed time meter which keeps track of system operational time.
- "C" Postflight static check is conducted after the vehicle was moved to the hangar. This approach was used to detect any changes that may have occurred since the preflight static check.

3.1.3 Log Sheet Description

Using the HYCOS LOG SHEET:

- Enter DATE System is integrated
- Enter FLIGHT NUMBER
- Enter FLIGHT DURATION in hours
- Enter Elapsed Time Meter reading
- Enter CHECK in applicable Flight Interrogation column
- MALFUNCTION - List ANY Hydraulic System Malfunction that occurs on the combined or Flight Hydraulic System
- MAINTENANCE ACTIONS - List any maintenance actions taken on either Combined or Flight Hydraulic Systems.
- Check if malfunction or maintenance action was indicated by or on HYCOS Panel
- Plane Captain/Technician - Write name of plane captain conducting interrogation and technician performing maintenance action.

3.1.4 HYCOS Interrogation Procedure

This sheet is used in conjunction with the Log Sheet but presents more detailed information. The switch positions are broken down into three categories:

- Category "A" designates a pre-flight static check.
- Category "B" designates a post-flight dynamic check (right engine running - no power control input).
- Category "C" designates a post-flight static check.

In conducting the preflight static check, select CIRCUIT TEST ON 1 and hold. Record by code those display lights that do and do not illuminate, in column "A". Release switch.

Select and hold Circuit Test On 2. All red lights should sequence in a sub-block order. Record. This check verifies that the microprocessor timer is functioning. Release switch.

Select and hold Systems Test On 2. Record illuminated lights. This step illuminates those sensors that are out of tolerance and require visual verification. Upon visual verification conduct necessary repair or maintenance action. Record all information in Log Sheets.

3.1.5 HYCOS Display Criteria

- PUMP (Sub-Category)
  - PRESS - Illuminates when system pressure drops below approximately 2,200 psi in the combined Hydraulic System. The light extinguishes when the system is pressurized
  - CASE - Illuminates when pump case flow is excessive and may require pump removal. Excessive pump case flow is an indication of a worn or degraded pump
  - FILT - Illuminates when case drain flow filter button pops indictating required maintenance action. After performing maintenance action, reset the visual filter delta "P" button. This rests the electrical circuit
  - TEMP - Illuminates when the pump case drain fluid temperature is excessive (caused by high bypass). This is used in conjunction with pump case flow circuit
- RESERVOIR (Sub-Category)
  - LEAK - Illuminates when level drops two inches or more during flight. Also, illuminates if reservoir is not filled to specification
  - AIR - Illuminates if reservoir piston moves greater than one inch from unpressurized to pressurized
  - TEMP - Illuminates if reservoir level temperature is excessive. Indicates possible fault in system and requires additional troubleshooting
  - DRIER - When pale blue desiccant is still serviceable, when color changes to pink or pale pink, replace desiccant cartridge in system and desiccant in sensor

- FILTER (Sub-Category)
  - PRESS - Illuminates when pressure filter is clogged and requires replacement. When filter is serviced and indicator button is reset, light will extinguish
  - RET - Illuminates when return filter is clogged and requires replacement. When filter is serviced and indicator button is reset, light will extinguish
- QUISCENT FLOW (Sub-Category)
  - SYSTEM - Indicates excessive internal system leakage. This is taken during dynamic check with no control input. Flow sensor must be manually reset after taking corrective action
  - RUDDER - Indicates excessive rudder actuator internal leakage. Also taken during dynamic check with not control input. Flow sensor must be manually reset after taking corrective action. Note: Flow sensors will not indicate properly unless system is pressurized
- ACCUM PRECHARGE (Sub-Category)
  - RAT - Indicates low accumulator precharge irrespective of accumulator piston position. If light illuminates with system test "ON 2", service accumulator
- DIFF DISP (Sub-Category)
  - RUDDER - Indicates disconnect between push pull rods on and rudder actuator. Combined system must be pressurized. Rudder position follow rudder pedal inputs
- PNEU PRESS (Sub-Category)
  - CANOPY - Illuminates when canopy bottle (15 $in.^3$) pressure is low and requires servicing
  - GEAR - Indicates when gear door bottle (30 $in.^3$) pressure is low and requires servicing
- RELIEF VALVE (Sub-Category)
  - COMBINED - Indicates when main system relief valve is leaking (failure or improper seating)

- SYSTEM (Sub-Category)
  - CIRCUIT TEST ON 1 - Checks discrete circuits to sensors thru common and on leg
  - CIRCUIT TEST ON 2 - Checks microprocessor and lights in sub-block sequence
  - SYSTEM TEST ON 1 - Programs the microprocessor when system is pressurized
  - SYSTEM TEST ON 2 - Interrogates entired combined system (red lights only). When red lights illuminates this indicates a malfunction or requires maintenance action
  - ELAPSED TIME METER - Runs when combined system is pressurized.

3.2 OVERALL EVALUATION OF HYCOS SYSTEM

As a preventative maintenance tool, the HYCOS System performed exceedingly well in determining the condition of the system. During the course of its program, it consistently detected:

- Low canopy and door gear dump pressures
- Low reservoir level during initial calibration
- Low system pressure during start up conditions
- Continuous elapsed time on system components.

There were no indications of hydraulic pump excessive case flow or case flow oil temperatures since the sensor limits were not exceeded.

Fiber-optic desiccant color detection proved difficult, even with the addition of more intense light sources. This was attributed to the improper installation of fiber-optic runs in which the bend radius were exceeded, causing excessive light loss. Another area requiring improvement is in optical terminal coupling, where losses can be considerable. Color transmission of red and pink is excellent; however, pale blue is not readily detectable.

The filter subsection gave no indication of tripped delta "p" indicators. This may be due to the fact that the vehicle flew over 150 hours and did not experience any hydraulic subsystem failures. Quiescent and rudder actuator flow sensors, when interrogated under dynamic conditions, did not indicate excessive flows as originally established. There were, however, developmental problems caused by vibration which were subsequently solved.

The ram air turbine (RAT) accumulator functioned flawlessly with no indication of precharge loss. Pressure, temperature, and displacement sensors functioned as advertised. This component is used as an energy storage device and retains this capability even when the system is shut down.

Except for initial calibration, the differential displacement sensors operated satisfactorily since the rudder output follows the mechanical input. This portion of the circuit is not activated until the combined system is pressurized.

Indications of low pneumatic system pressure worked effectively and repeatedly within limits. Minor system leakage was detected after the vehicle remained in an inactive flight status for several days. Topping the bottles corrected this condition.

Since the relief valve did not malfunction, no indication was apparent on the display. Relief valves are usually passive devices until excessive pressures are exceeded. If this occurs and instability prevails, seat or poppet damage can occur. This results in leakage with subsequent system fluid temperature rise.

The circuit and system test switches functioned satisfactorily, but the system test switch was modified to a continuous ON 1 when the battery charging circuit was modified. Future procedures would eliminate the need for first selecting ON 1 followed by ON 2.

The lay-over time between flights determines the condition of the NI-CAD storage batteries. Although the battery charging circuit is adequate, infrequent ground charges may be necessary. This was readily accomplished by using the ground battery changer through the added electrical panel interface. This connector also provided test points to determine battery condition without removing power from the vehicle.

Section 4

RESTORATION OF THE AIRCRAFT

The flight test program terminated on November 15, 1980 when the aircraft was subjected to a debailment inspection before being turned over to Navy inventory as an updated A-6E. The inspection involved the following activities:

- The following special components were removed from the vehicle:
  - HYCOS Display Panel
  - Quiescent, rudder actuator, and pump case drain flow sensors
  - Pressure, filter, and temperature switches on the combined system pump
- The combined system reservoir was replaced with the original unit kept in storage
- Remote reading delta "P" indicators were replaced with original units
- The ram air turbine accumulator and supporting bracket was replaced with a standard unit.
- Potentiometers located on the turtle deck and rudder were removed in the differential displacement circuit
- Both the pneumatic pressure canopy and emergency gear door pump bottles were replaced with standard units
- The fluid thermal switch was removed downstream of the combined system relief valve
- All wire leads and fiber-optic cables peculiar to the HYCOS system were capped and lagged at both the panel and sensor interface
- The surface temperature switch was removed from the flight control backup module.

The power supply cable (110V 400 ~ AC) from the circuit breaker to the HYCOS panel was disconnected. The HYCOS access cover was permanently attached to the structure in accordance to an EO issued by the Structural Design Group.

After installation of standard production components, lines, and fittings, the vehicle was subjected to a hydraulic ground check to substantiate system integrity in accordance with the ATP. No problems were encountered during this refurbishment.

In addition, an engine ground run was successfully accomplished to verify flight worthiness since the port engine was removed to provide access to the keel where most of the HYCOS sensor components were located.

Section 5

CONCLUSIONS

- The flight test program met all the requirements of the work statement
- The HYCOS accumulated over 150 hours flight time during a 1-year flight test program
- Preflight checkout time takes only 1-1/2 minutes using the HYCOS, as compared to 20 - 30 minutes for a manual checkout
- The HYCOS consistently identified:
  - Low pneumatic bottle pressure
  - Low reservoir level
  - Low system pressure
  - System operating hours
  - Malfunctioned components on a post-flight check
- All other sensors operated normally and did not indicate malfunctions
- The microprocessor functioned flawlessly after final programming and integration. It also has capacity for additional fault-detection via changes in microprocessor programming
- The system is capable of detecting the health or malfunctions of components located in hazardous areas, such as when engines are operating
- The HYCOS did not impair or restrict the normal function or the combined hydraulic system
- HYCOS has demonstrated its capability as a preventative, failure, and maintenance tool
- HYCOS sensors were of the prototype configuration and were not optimized for size or weight

- As a result of the test program, it was found that the system can be further improved by:
  - Relocating the panel away from the inlet duct area
  - Reducing fiber-optic coupling & terminations and optimizing bend radii
  - Utilizing a dedicated disc detector and selecting fiber-optic cable having wider bandwidth to provide more efficient color transmission
- Since prime contractor service and maintenance is excellent, few hydraulic system malfunctions occurred during the test program. In actual squadron use, the benefits of such a system would be realized in:
  - Reduced preflight checkout time
  - Increased availability
  - Reduced turnaround time
  - Extended service intervals
  - Radio component fault indication
  - Utilization of less-skilled personnel
  - Ability to readily check inaccessible components on a preflight basis.

Section 6

RECOMMENDATIONS

- Continue developmental effort on alphanumeric (smart) terminal displays to provide quantitative information on status or malfunction in terms of order of magnitude
- Continue sensor development specifically adapted for lightweight hydraulic system vehicles with continuous monitoring
- Incorporate sensors or make provisions for adaptation/inclusion of sensors in selected components within redundant and dedicated power systems
- Expand the use of fiber-optic circuits in conjunction with digital sensors
- Determine the feasibility of a universal microprocessor display capable of multiple vehicle use
- Incorporate several advanced systems in a training squadron in order to obtain a more representative evaluation (larger statistical sample)
- Update current military component specifications to provide for optional (dedicated) sensors in major flight-critical components.

Section 7

REFERENCES

1. Analog Devices, Norwood, Mass., Technical Data Sheets.
2. The Condensed Chemical Dictionary, 8th Edition, Van Nostrand Zeinhold Company, Pages 223 and 719.
3. NAVAIR 01-85ADA-6-4 Landing Gear Emergency Operational Check.
4. Designing with Dupont "Croron" Fiber Optics (11/76)
5. Machine Design, March 16, 1978, Page 130.
6. NADC TR 75168-30 Final Engineering Report, Phase I, HYCOS (Hydraulic Check Out System), Page 33.
7. Entran Devices, Little Falls, N.J., Technical Data Sheets.
8. Nolan, J.F., "Survey of Electronic Displays," Owens Illinois Technical Center, Toledo, Ohio.
9. Intel MCS-48 Microcomputer Product Description, Pages 23 - 24.
10. Nickel-Cadmium Battery Application - Engineering Handbook, General Electric Company, Pages 4 - 36.
11. Texas Instruments, Attleboro, Mass., Technical Products Literature.

APPENDIX A

HYCOS LOG SHEET FORMAT AND TYPICAL FLIGHT LOG SHEET

DATE: ____________________

FLIGHT NO. ________________

HYCOS CHECKOUT LOGIC
A6E MOD 229 B/N 155628

REVISION "A" SENSOR	CIRCUIT TEST						SYSTEM TEST					
	SWITCH POSITION						SWITCH POSITION					
	ON1			ON2			ON1			ON2		
PUMPS	A	B	C	A	B	C	A	B	C	A	B	C
PRESS.												
CASE												
FILT												
TEMP												
RESERVOIR												
LEAK												
AIR												
LEVEL												
TEMP												
DRIER												
FILTER												
PRESS.												
RETURN												
QUIESCENT FLO												
SYS												
RUDDER												
ACCUMULATOR												
RAT												
DIFF DISP												
RUDDER												
PNEU PRESS												
CANOPY												
GEAR												
LIQUID												
RELIEF VALVE												
COMBINED												

NOTES:
1. DRIER LIGHT TRANSMITS COLOR LIGHT BLUE TO PINK
2. "A" DESIGNATES PREFLIGHT CHECK (STATIC)
   "B" DESIGNATES POSTFLIGHT CHECK (DYNAMIC)
   "C" DESIGNATES POSTFLIGHT CHECK (STATIC)
3. MARK "X" IN BOX TO INDICATE LIGHT ON.

R80-2038-099(T)

Figure A-1. HYCOS log sheet format used during program.

DATE: 08/06/80
FLIGHT NO. 77

HYCOS CHECKOUT LOGIC
A6E MOD 229 B/N 155628

FLT TIME
1.8 HR

REVISION "A"

SENSOR	CIRCUIT TEST SWITCH POSITION ON1 A	ON1 B	ON1 C	ON2 A	ON2 B	ON2 C	SYSTEM TEST SWITCH POSITION ON1 A	ON1 B	ON1 C	ON2 A	ON2 B	ON2 C
PUMPS												
PRESS.												
CASE	X	X	X							X		X
FILT	X	X	X									
TEMP	X	X	X									
RESERVOIR												
LEAK	X	X	X									
AIR	X	X	X									
LEVEL	X	X	X									
TEMP	X	X	X	ALL LIGHTS SEQUENCE OK	ALL LIGHTS SEQUENCE OK	ALL LIGHT SEQUENCE OK						
DRIER	X	X	X							O	O	O
FILTER												
PRESS.	X	X	X									
RETURN	X	X	X									
QUIESCENT FLO												
SYS	X	X	X									
RUDDER	X	X	X									
ACCUMULATOR												
RAT	X	X	X									
DIFF DISP												
RUDDER	X	X	X									
PNEU PRESS												
CANOPY	X	X	X									
GEAR	X	X	X									
LIQUID										O	O	O
RELIEF VALVE												
COMBINED	X	X	X									

NOTES:
1. DRIER LIGHT TRANSMITS COLOR LIGHT BLUE TO PINK
2. "A" DESIGNATES PREFLIGHT CHECK (STATIC)
   "B" DESIGNATES POSTFLIGHT CHECK (DYNAMIC)
   "C" DESIGNATES POSTFLIGHT CHECK (STATIC)
3. MARK "X" IN BOX TO INDICATE LIGHT ON.

ELT PRE-FLT 89.6 HR
ELT POST-FLT 91.8 HR

R80-2038-099(T)

Figure A-2. Typical HYCOS flight log sheet.

APPENDIX B

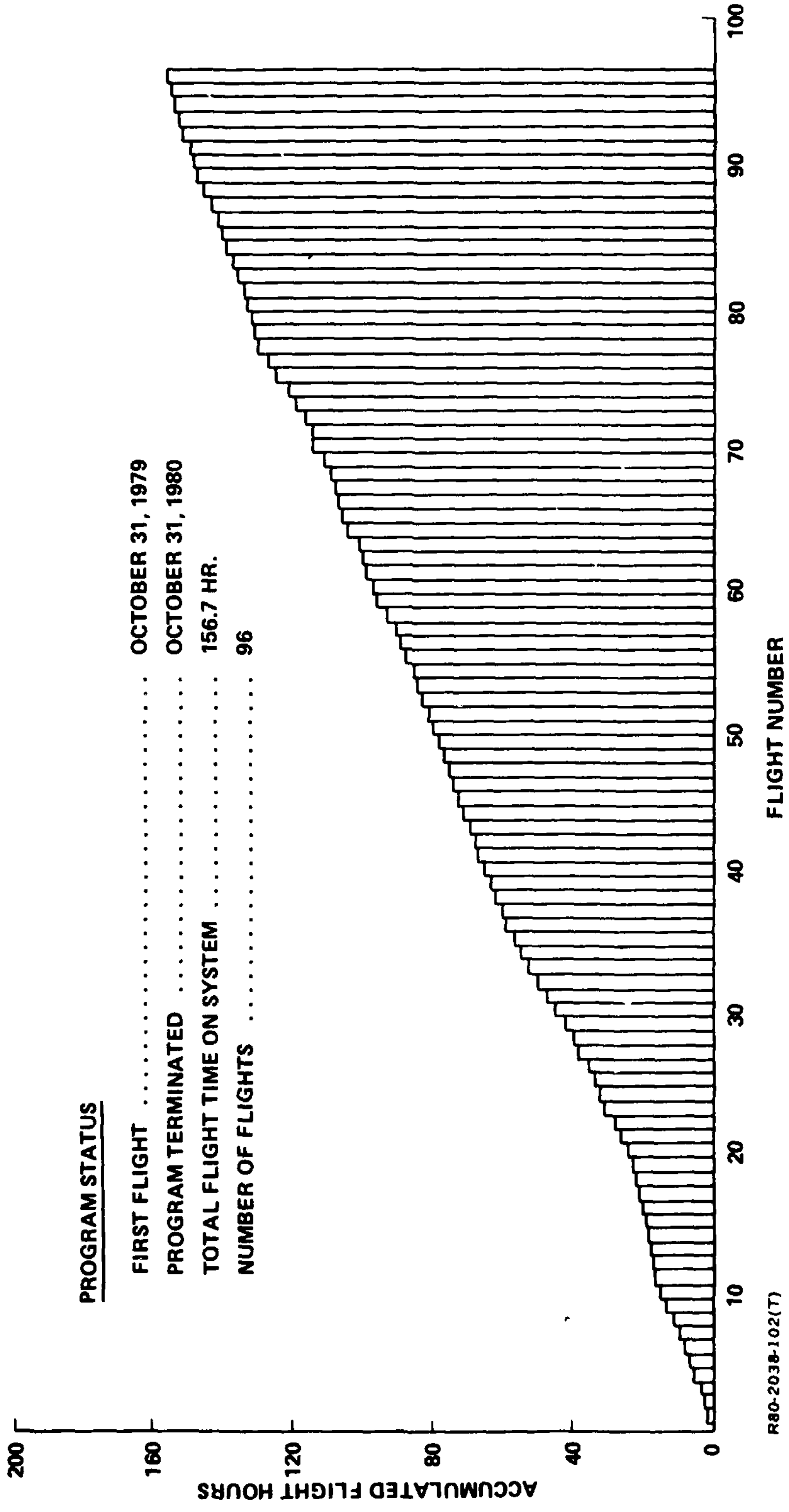
FLIGHT-HOUR ACCUMULATED LOG

FLIGHT-HOUR ACCUMULATED LOG

SHIP # M229		MODEL A-6E		BUREAU # 155628	
FLT NO.	FLT-HR	ACCUM FLT-HR	FLT NO.	FLT-HR	ACCUM FLT-HR
1	1.5	1.5	49	1.4	79.2
2	.5	2.0	50	1.7	80.9
3	.7	2.7	51	1.7	82.6
4	2.2	4.9	52	1.5	84.1
5	1.5	6.4	53	1.4	85.5
6	1.5	7.9	54	1.1	86.6
7	1.4	9.3	55	2.0	88.6
8	2.0	11.3	56	1.2	89.8
9	2.2	13.5	57	2.5	92.3
10	1.6	15.1	58	2.2	94.5
11	1.3	16.4	59	2.4	96.9
12	1.1	17.5	60	0.8	97.7
13	1.0	18.5	61	2.0	99.7
14	.6	19.1	62	1.0	100.7
15	1.0	20.1	63	1.4	102.1
16	1.0	21.1	64	3.6	105.7
17	.6	21.7	65	1.4	107.1
18	1.6	23.3	66	0.8	107.9
19	.3	23.6	67	0.9	108.8
20	1.3	24.9	68	1.2	110.0
21	2.0	26.9	69	2.4	112.4
22	1.6	28.5	70	2.8	115.2
23	2.3	30.8	71		
24	1.8	32.6	72	2.5	117.7
25	1.7	34.3	73	2.5	120.2
26	2.3	36.6	74	2.3	122.5
27	2.1	38.7	75	3.0	125.5
28	1.5	40.2	76	3.0	128.5
29	2.5	42.7	77	1.8	130.3
30	3.0	45.7	78	1.0	132.3
31	2.4	48.1	79	1.2	132.5
32	2.1	50.2	80	1.3	133.8
33	2.9	53.1	81	1.2	135.0
34	1.9	55.0	82	1.3	136.3
35	2.1	57.1	83	1.9	138.2
36	2.7	59.8	84	1.4	139.6
37	.5	60.3	85	1.1	140.5
38	2.2	62.5	86	1.5	142.2
39	1.2	63.7	87	1.9	144.1
40	2.3	66.0	88	2.0	146.1
41	1.6	67.6	89	2.1	148.2
42	.9	68.5	90	1.0	149.2
43	1.4	69.9	91	1.0	150.2
44	1.8	71.7	92	1.7	151.9
45	1.6	73.3	93	1.6	153.5
46	1.6	74.9	94	0.3	153.8
47*	1.0	75.9	95	1.4	155.2
48	1.9	77.8	96	1.5	156.7

*HYCOS REMOVED FOR REPAIR

R80-2038-101(T)


PROGRAM STATUS
FIRST FLIGHT .... OCTOBER 31, 1979
PROGRAM TERMINATED .... OCTOBER 31, 1980
TOTAL FLIGHT TIME ON SYSTEM .... 156.7 HR.
NUMBER OF FLIGHTS 96
ACCUMULATED FLIGHT HOURS
0
40
80
120
160
200
FLIGHT NUMBER
10
20
30
40
50
60
70
80
90
100
R80-2038-102(T)

APPENDIX C

ABBREVIATED CHRONOLOGICAL LOG

Dec. '77

- Kickoff meeting
- Display panel daylight visibility
- Started specifications

Jan. '78

- Generated specifications for sensor
  - Thermal switch
  - Delta p indicators
  - Flow sensors
  - Pressure switch

Feb. '78

- Continue sensor specification generation
- Start RLS layout defining panel block diagram
- Proceed with panel layout

May '78

- Review flow sensor; develop pressure probes
- Established display panel size and configuration

April '78

- Reservoir sensor development continues
- Mockup model of panel fabrication

May '78

- Installed sensors in F-14 reservoir
- Started A-6 reservoir layout
- Desiccant color detector
- Pressure transducer investigations
- Started installation of F-14 simulator

June '78

- Calibrated F-14 reservoir, issued P/O for A-6 reservoir parts
- Started testing pressure tranducers at high and low temperatures
- Flow sensor manufacturing is in progress
- E.E.D. manufactured panel test set

July '78

- Started modification of A-6 reservoir
- Installed panel on F-14A hydraulic simulator

August '78

- Received flow sensors
- Received optical sensors
- Acceptance-tested thermal switches
- Completed F-14 simulator wiring

September '78

- Develop desiccant color detector
- Develop liquid detector
- Started programming microprocessor for F-14 system

October '78

- Completed A-6 reservoir modifications
- A-6 flow sensors at vendors test

Nov. '78

- Ran displacement calibration on A-6 reservoir
- Ran F-14A HYCOS simulator demo

Dec. '78

- Flight-test vehicle tentatively established Mod 229
- Continue sensor development

Jan. '79

- Authorization received from NAVAIR to install HYCOS on Mod 229
- Vehicle is in second stage of buildup
- Issued Engineering Orders for
  - Brackets
  - Lines
  - Component modification
  - Sensor installation in keel area

Feb. '79

- Installation continues on wiring and hardware installation
- Continue sensor development and integration
- Conducted pressure seal tests

March '79

- Start hydraulic hard lines mockup
- Wiring runs for sensor installation begun
- Start sensor installations on port keel

April '79

- All hydraulic hard lines fabricated
- All wiring before sensor and display panel completed
- System pressurized

- Start electrical run line check
- Submitted interim report

May '79

- Completed hydraulic ground check and acceptance testing
- Instrumentation lines with exception of F/O circuit installed
- Vehicle passed through paint shop
- Vehicle ground run tested

June '79

- Vehicle delayed 5 weeks due to structural bulkhead repairs
- Continue fiber-optic color detection development; investigate halogen lamp

20 June '79

- Investigate halogen lamps
- Added resistor to reduce voltage from 5 VDC to 3.5 VDC

30 July '79

- Ordered incandescent lamps
- Started interface and ground checkout on bailed A/C

August '79

- Structural mods made to vehicle to accept panel
- Started debugging system

Sept. '79

- Started rudder differential displacement calibration
- Reservoir calibration information supplied to E.E.D. for burn-in

Oct. '79

- Calibration rudder differential displacement
- Run circuit check using panel jumper
- Flew A/C for 1-1/2 hr
- ELT not operational

Nov. '79

- Removed panel
- Replaced I/C chip for ELT problem
- NICAD batteries nearly discharged. Changed battery charging rate from 0.100 A to 0.200 - 0.300 A

Dec. '79

- Rudder and quiescent flow sensor found tripped after flight
- Modified optical viewing port at panel terminal
- Conducted lab tests on halogen lamp; 20 to 1 improvement verified
- Received solenoid rework to negate armature resonance on flow sensors

Jan. '80

- Reduced NICAD battery charging rate (50 MAH for 5 V batteries and 5 MAH for +3.6 and 6 V batteries)
- Added regulated power supply to ELT circuit
- Modified system test switch from 2 momentary ON (ON center of ON) to ON - ON (ON momentary ON)
- Added battery test plug on panel face for external charging and battery checking
- Reprogramed M/P to eliminate erroneous over temp light (Rev. 18, Jan. 80)
- EO 128FT80001 installs improved light source on reservoir pressurization circuit
- 128FT80002 installs wiring to light sources
- 128FT80003 changes flow sensor locking solenoids
- 128FT80005 supplies BATT power instead of transformer power to both light sources
- Conducted resonance vibration test on flow sensors - 18-25 Hz resonance occured. Made improvements. Modified solenoid has no resonance points at 5-2000 Hz @ 5, 10, 15 G ranges

Feb. '80

- High intensity of F/O pneumatic circuit improved at display panel
- Color intensity transmission requires additional development

- External battery charger completed at Plant 14
- ELT stops functioning - suspected relay
- Generated EO 128FT80006 which installs second high-intensity light at pneumatic bottle test circuit
- Issued EO 128B1636 to add spacer on access door

March '80

- Dessicant sensor approach using internal fiber investigation not successful
- Fabricated third high-intensity source for pneumatic bottle circuit; EO 128FT8006 will install unit in vehicle
- Procured high-capacity ELT relay

April '80

- Developed new dessicant sensor (cobalt chloride/potassium bromide disc)
- Installed access door spacer

May '80

- Improved optical dessicant sensor with plastic spacer for isolation due to chemical reaction

June '80

- Added short fiber cable link between modified dessicant optic receiver and junction
- Increased light loss

July '80

- Detected poor F/O cable runs with 32 dbm losses instead of 10 dbm, which might be expected
- Investigate F/O improvements

August '80

- Continue flight test program

Sept. '80

- Continue system interrogation and assessment

Oct. '80

- Continue system flight test and assessment

Nov. '80

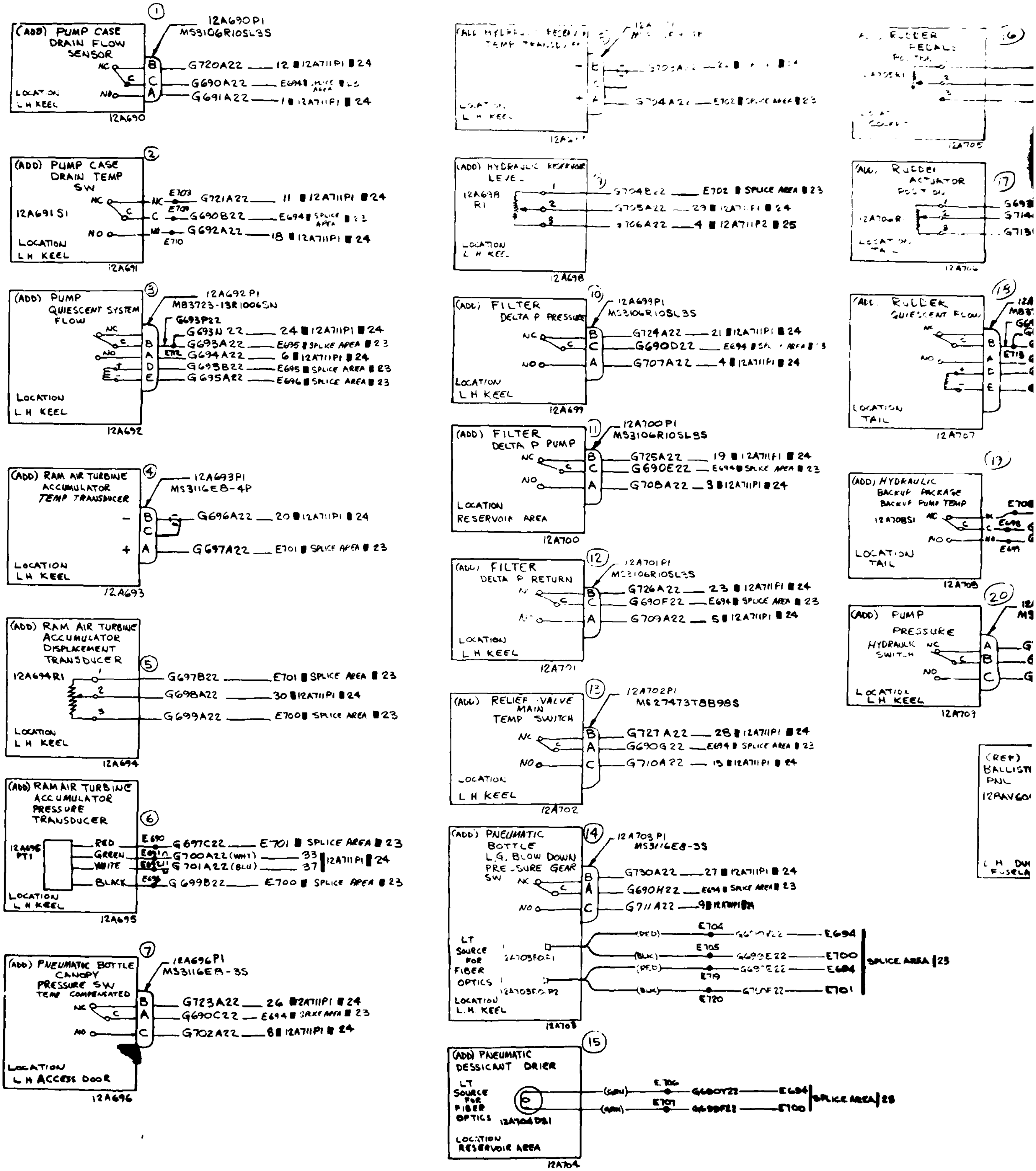
- Issue system debailment EO for HYCOS

Dec. '80

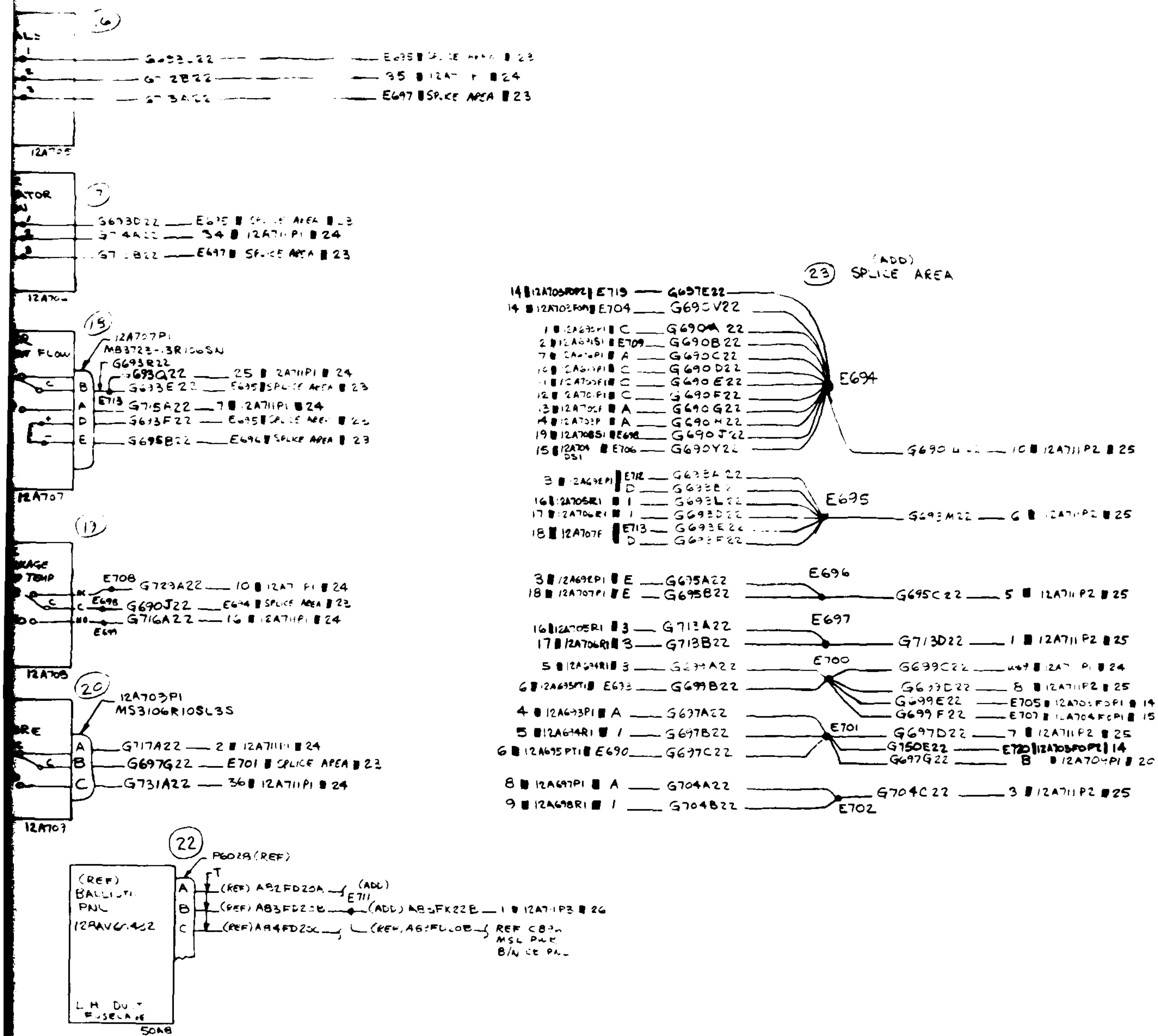
- Return test vehicle to U.S. Navy
- Complete final report

APPENDIX D

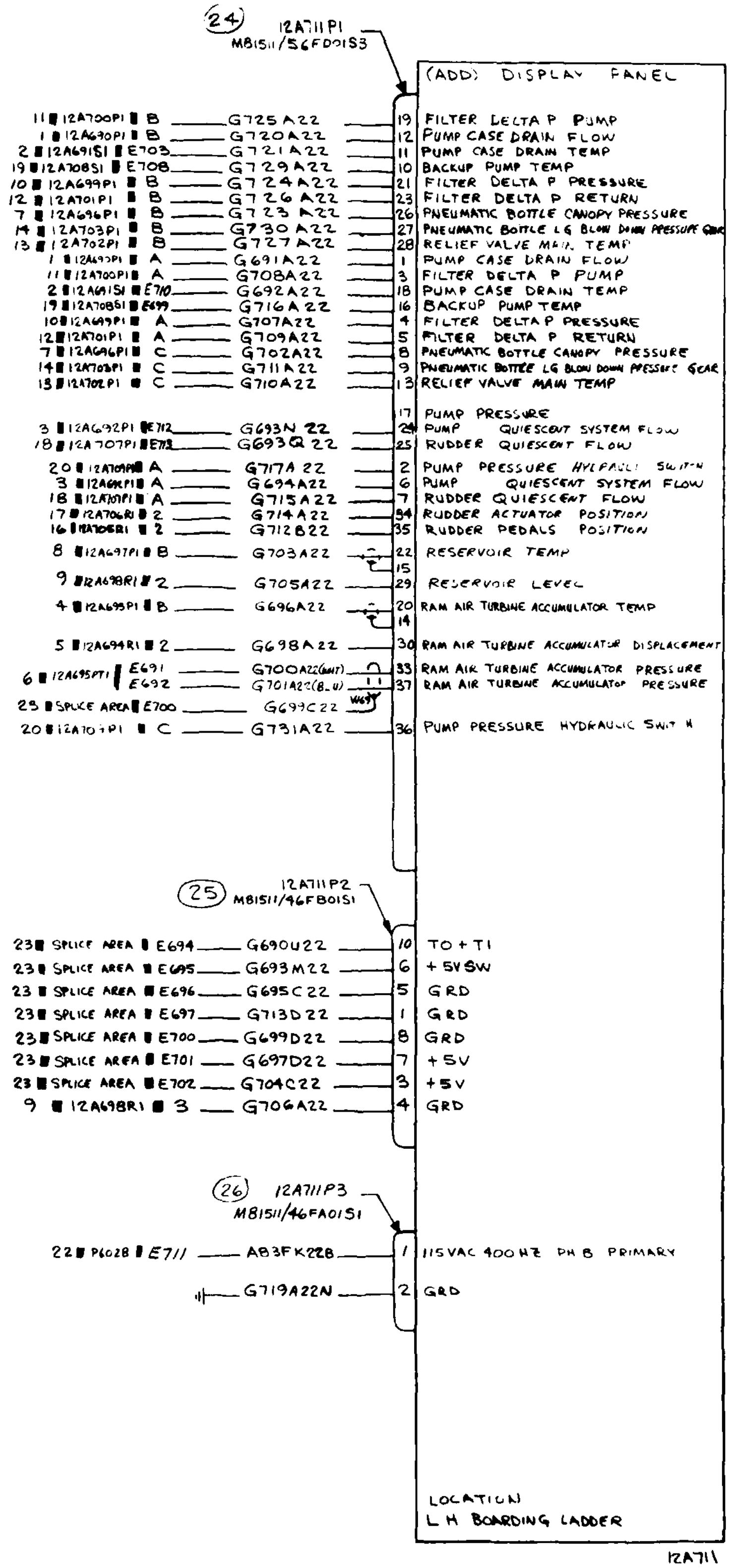
HYCOS WIRING DIAGRAM



R80-2038-098(T)



12A705
12A707
12A708
12A709
12A707P1
G693R22
G715A22
G695B22
E713
E708
G723A22
G690J22
G716A22
12A703P1
MS3106R10SL3S
G717A22
G697G22
E701 SPLICE AREA 23
G731A22
P602B (REF)
(REF)
BALLISTIC
PNL
(ADD)
E711
REF CB
L.H. DUCT
FUSELAGE
50A8
(ADD)
SPLICE AREA
E694
E695
E696
E697
E700
E701
E702
G695C22
G713B22
G699B22
G697A22
G697B22
G750E22
G697G22
G704A22
G704B22
G704C22
12A711P2 25



(24) 12A711P1
M81511/56FD01S3
(ADD) DISPLAY PANEL
11 12A700P1 B — G725A22 — 19 FILTER DELTA P PUMP
1 12A690P1 B — G720A22 — 12 PUMP CASE DRAIN FLOW
2 12A691S1 E703 — G721A22 — 11 PUMP CASE DRAIN TEMP
19 12A708S1 E708 — G729A22 — 10 BACKUP PUMP TEMP
10 12A699P1 B — G724A22 — 21 FILTER DELTA P PRESSURE
12 12A701P1 B — G726A22 — 23 FILTER DELTA P RETURN
7 12A696P1 B — G723A22 — 26 PNEUMATIC BOTTLE CANOPY PRESSURE
14 12A703P1 B — G730A22 — 27 PNEUMATIC BOTTLE LG BLOW DOWN PRESSURE GEAR
13 12A702P1 B — G727A22 — 28 RELIEF VALVE MAIN TEMP
1 12A690P1 A — G691A22 — 1 PUMP CASE DRAIN FLOW
11 12A700P1 A — G708A22 — 3 FILTER DELTA P PUMP
2 12A691S1 E710 — G692A22 — 18 PUMP CASE DRAIN TEMP
19 12A708S1 E699 — G716A22 — 16 BACKUP PUMP TEMP
10 12A699P1 A — G707A22 — 4 FILTER DELTA P PRESSURE
12 12A701P1 A — G709A22 — 5 FILTER DELTA P RETURN
7 12A696P1 C — G702A22 — 8 PNEUMATIC BOTTLE CANOPY PRESSURE
14 12A703P1 C — G711A22 — 9 PNEUMATIC BOTTLE LG BLOW DOWN PRESSURE GEAR
13 12A702P1 C — G710A22 — 13 RELIEF VALVE MAIN TEMP
17 PUMP PRESSURE
3 12A692P1 E712 — G693N22 — 24 PUMP QUIESCENT SYSTEM FLOW
18 12A707P1 E713 — G693Q22 — 25 RUDDER QUIESCENT FLOW
20 12A709P1 A — G717A22 — 2 PUMP PRESSURE HYDRAULIC SWITCH
3 12A692P1 A — G694A22 — 6 PUMP QUIESCENT SYSTEM FLOW
18 12A707P1 A — G715A22 — 7 RUDDER QUIESCENT FLOW
17 12A706R1 2 — G714A22 — 34 RUDDER ACTUATOR POSITION
16 12A705R1 2 — G712B22 — 35 RUDDER PEDALS POSITION
8 12A697P1 B — G703A22 — 22 RESERVOIR TEMP
15
9 12A698R1 2 — G705A22 — 29 RESERVOIR LEVEL
4 12A695P1 B — G696A22 — 20 RAM AIR TURBINE ACCUMULATOR TEMP
14
5 12A694R1 2 — G698A22 — 30 RAM AIR TURBINE ACCUMULATOR DISPLACEMENT
6 12A695P1 E691 — G700A22(WHT) — 33 RAM AIR TURBINE ACCUMULATOR PRESSURE
E692 — G701A22(BLU) — 37 RAM AIR TURBINE ACCUMULATOR PRESSURE
25 SPLICE AREA E700 — G699C22
20 12A709P1 C — G731A22 — 36 PUMP PRESSURE HYDRAULIC SWITCH
(25) 12A711P2
M81511/46FB01S1
23 SPLICE AREA E694 — G690U22 — 10 TO + TI
23 SPLICE AREA E695 — G693M22 — 6 + 5V SW
23 SPLICE AREA E696 — G695C22 — 5 GRD
23 SPLICE AREA E697 — G713D22 — 1 GRD
23 SPLICE AREA E700 — G699D22 — 8 GRD
23 SPLICE AREA E701 — G697D22 — 7 + 5V
23 SPLICE AREA E702 — G704C22 — 3 + 5V
9 12A698R1 3 — G706A22 — 4 GRD
(26) 12A711P3
M81511/46FA01S1
22 P6028 E711 — A83FK22B — 1 115VAC 400HZ PH B PRIMARY
G719A22N — 2 GRD
LOCATION
L H BOARDING LADDER
12A711

APPENDIX E

PARTICIPATING FIRMS

Aircraft Porous Media	Glen Cove, N.Y.
Walter Kidde & Company	Belleville, N.J.
Valtec	West Boyleston, Mass.
Sigma-Netics	Mountain Lakes, N.J.
Sprague Engineering Corporation	Gardena, California
Bourns Incorporated	Riverside, California
Neo-Dyn Inc.	Chatsworth, California
De Laval Special Products Division	Cleveland, Ohio
Entran Devices	Norwood, Massachusetts
Frisby Airborne Hydraulics	Freeport, N.Y.
E.I. du Pont de Nemours	Wilmington, Delaware
Intel Corporation	Santa Clara, California
Texas Instruments	Attleboro, Mass.
Hunter Spring Division of Ametek	Hatfield, PA
Russel Associates	Bay Shore, N.Y.
Eagle Technology	Arlington, Virginia
Kulite Semiconductor Products	Ridgefield, N.J.
Sealectro Corporation	Mamaroneck, N.Y.
Ultra Sensors	Minneapolis, Minnesota
Resistoflex Corporation	Vineland, N.J.
Analog Devices	Norwood, MA
Photodyne Incorporated	West Lake Village, CA
Polaroid Corporation	Cambridge, MA
Roylan Optics Company	Arcaria, CA

APPENDIX F

ESTIMATED WEIGHT OF PROTOTYPE FULL-BLOWN SYSTEM

ITEM	DESCRIPTION	COMBINED	FLIGHT
1	DISPLAY PANEL	6.00	–
2	RESERVOIR		
	• PISTON DISPLACEMENT		
	– POTENTIOMETER	0.08	0.08
	– BRACKETS, ADAPTORS, & HOUSING	2.38	2.38
	• TEMPERATURE TRANSDUCER	0.12	0.12
3	FILTER DIFFERENTIAL PRESSURE		
	• INDICATORS	0.57 (6)	0.57 (5)
	• MULTICATORS	0.36 (1)	0.36 (1)
4	PRESSURE SWITCH		
	• TEMPERATURE COMPENSATED	0.25 (5)	–
5	FLOW SENSORS		
	• QUIESCENT	1.39	1.39
	• RUDDER ACTUATOR	0.57	–
	• PUMP CASE	0.52	0.52
6	PRESSURE SWITCH SYSTEM	0.09	0.09
7	TEMPERATURE SWITCH		
	• CASE DRAIN FILTER MODULE (R.V.)	0.13 (2)	0.13 (2)
	• FLIGHT CONTROL BACKUP MODULE, TEMPERATURE SWITCH		–
8	POTENTIOMETER ROTARY		
	• RUDDER PEDALS	0.08	–
	• RUDDER ACTUATOR	0.08	–
9	TRANSDUCER, PRESSURE	0.18 (3)	0.18
10	TRANSDUCER, TEMPERATURE	0.12 (3)	0.12
11	WIRING, CLAMPS & CONNECTORS, BRACKETS	3.00	3.00
12	DETECTOR, LIQUID	0.03 (5)	–
		20.78	11.35
		TOTAL: 32.13	

R80-2036-096(T)

APPENDIX G

ENGINEERING ORDERS

NUMBER	TITLE
128FT80001A	Sensor, Optical Desiccant
128FT80002A	Installation Dwg, Fuselage
128FT80003A	Flow Sensor, Bypass Type
128FT80005A	Installation Dwg, Fuselage
128FT80006	Installation Dwg, Fuselage
128FT80007	Sensor, Optical Desiccant
128FT81003	Hycos, Removal
128EL10401AFZ	Lines Installation, Fuselage
128EL10401AF3	Lines Installation, Fuselage
128EL10401 -	Lines Installation, Fuselage
128EL4118T4	Lines Installation, Fuselage
128EL4222 -	Lines Installation, Fuselage
128EL10403T4	Lines Installation, Fuselage
128EL10403T5	Lines Installation, Fuselage
128EL66010L4	Lines Installation, Fuselage
128EL66013M1	Lines Installation, Fuselage
128EL66021L2	Lines Installation, Fuselage
128EL66041K5	Lines Installation, Fuselage
128EL66047M2	Lines Installation, Fuselage
128EL66053K5	Lines Installation, Fuselage
128EL66058F2	Lines Installation, Fuselage
128EL66060L4	Lines Installation, Fuselage
128AB60012	Exterior Markings
128AV66014U5	Installation Drawing, Fuselage
128AV66014V2	Installation Drawing, Fuselage
128B11380AB1	Duct Assembly, Fuselage
128C130001P1	Controls Installation, Directional

NUMBER	TITLE
128CS10000 -	Potentiometer Installation, Rudder
128CS10000W1	Potentiometer Installation, Rudder
128H10009V1	Components Installation
128H10009V2	Components Installation
128H10009V3	Components Installation
128H10049J1	Components Installation
128H10127F1	Reservoir Installation
128H10127F2	Reservoir Installation
128H10136N1	Regulator Installation
128H10136N2	Regulator Installation
128H10312G1	Installation, Components
128H10009W2	Components Installation

GRUMMAN AEROSPACE CORPORATION

SEQ NO | CODE IDENT 26512 | EO | 128FT80001 | DASH NO | M/D | REV A

MFG PART NO | MCO REV ACD | ECP | PRIORITY | ☐ ACTION ☐ NO ACTION | DET SPEC | CHG CL | EO CONT NO

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY EI
						ACFT NO. CONFIG REQ'D/CONFIG NOT REQ'D	

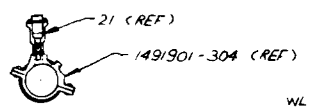
CONTRACT NO N62269-78C-0041

REPLACES PART NO | SH 1 OF 1

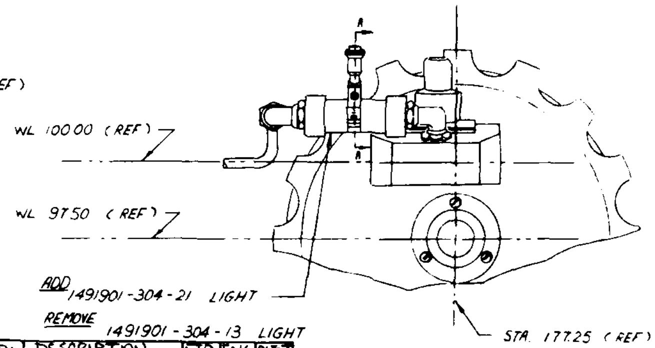
DWG TITLE SENSOR, OPTICAL DESICCANT

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411: TK79-143	A6E		M229



SECTION A-A



FLIGHT TEST INFO

NOT TO BE INCORPORATED ON DRAWING

" TO BE REMOVED AT TIME OF HYCOS REMOVAL, PRIOR TO MAY 1980, OR AS EXTENDED BY REVISION TO THIS E.O."

REV	DESCRIPTION	FTD	ENG	CUST
A	EXTEND TO 8-31-80	DAS 4/4/79	N/A	[illegible]

VIEW LOOKING INBOARD

FWD

ACTION	QTY PER ASSY				QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
ADD					1	1491901-304-21		LIGHT									1
REMOVE					1	1491901-304-13		LIGHT									1
~					.901	-901		RESERVOIR INSTL								2	1

REASON FOR CHANGE

TO USE NEW IMPROVED LIGHT SOURCE
INITIAL LIGHT SOURCE HAD INSUFFICIENT INTENSITY.

DESCRIPTION OF CHANGE

NOTED

PREPARED BY	JOHN [illegible]ZICH	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	FTD	PROJ ENGRG	RELEASE	CUSTOMER
SECTION	FLUID POWER	SIGNATURE	[signature]					[signature]	[signature]		[signature]
PLANT GROUP	351 357	DATE	1-17-80					1/21/80	21/1/80		1/21/80
DATE · EXT	1-17-80 5978	EO TYPE	DIRECT DWG CHG (DOC) ☐	REV DWG ☑	PROD ENGRG ☐	RECORD EO ☑		IAD I = INSTL, A ASSY, D DETAIL, M = MAKE FROM			

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 USE, 6 HOLD, 7 = NO ACTION 8 = ACCEPT | I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 8-77(PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO | MODEL | PART NUMBER | CONTROL MAP REFERENCE DRAWING NO | EO | DISP | INSP | PART SERIAL NO | PART LOT NO | END ITEM NO | TYPE | VEHICLE S/N | MAJOR ASSY

REWORK RESPONSIBILITY

PLT	DEPT		MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI SEC

PROCESSED BY | INSP PLT | DATE

ADD'L ORDERS

REMARKS

DATE | DUE IN STOCK DATE | DATE REC'D

GAC 3844 REV 1 8-77(PART B)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GAC 3844 REV 1 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
	26512	EO	128FT80002			A

MFG PART NO — MCO REV: ACD — ECP — PRIORITY: ☐ ACTION ☐ NO ACTION — DET SPEC — CHG CL — EO CONT NO

PLT DEPT — OPERATIONS — INSP — PLT/DEPT — OPERATIONS — INSP — END ITEM NO — QTY/EI — ACFT NO — CONFIG REQ'D/CONFIG NOT REQ'D

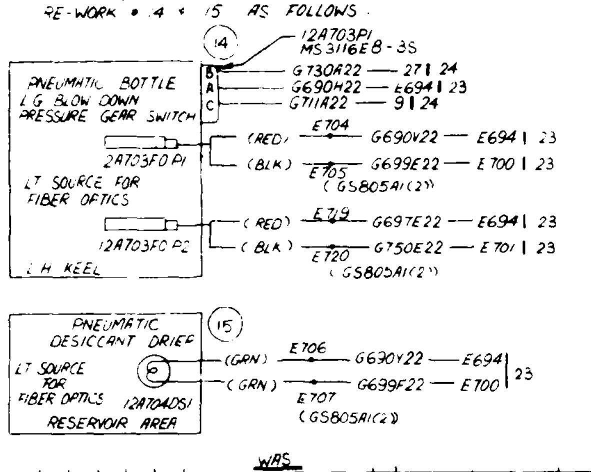
CONTRACT NO: N62269-78C-0041 — REPLACES PART NO — SH 1 OF 2

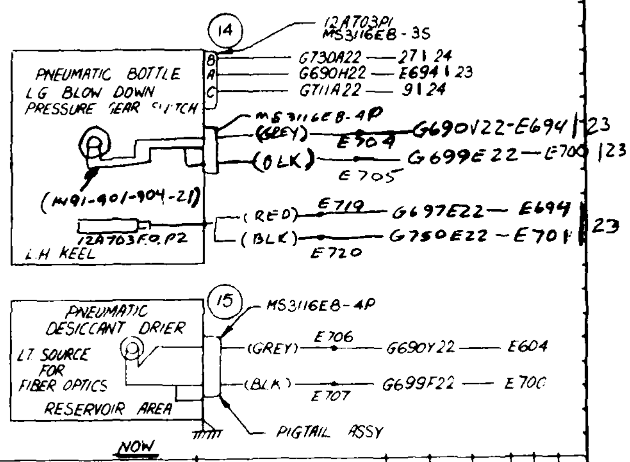
DWG TITLE: INSTALLATION DWG : FUSELAGE

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411 TK79-143	A6E		M229

RE-WORK 14 & 15 AS FOLLOWS:





ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F

REASON FOR CHANGE: TO IMPROVE THE INTENSITY OF THE LIGHT SOURCE. INITIAL LIGHT SOURCE HAD INSUFFICIENT INTENSITY

DESCRIPTION OF CHANGE: NOTED

PREPARED BY: JOHN DUZICH
SECTION: FLUID POWER
PLANT GROUP: 35/357
DATE: 1-7-80 EXT: 5976

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	ETD	PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]					[signature]	[signature]		TB
DATE	21 Jan 80					1/21/80	21 Jan 80		1/21/80

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☑ PROD ENGRG ☐ RECORD EO ☑ — IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT — I&T = IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO	128FT60002	DASH NO	REV A
			MFG PART NO	SER NO	
			EO CONT NO	SH NO 2	

FLIGHT TEST E.O. NOT TO BE INCORP ON DWG REMOVE PRIOR TO 1 MAY 80.

REV	DESCRIPTION	FTD	ENG	CUST
A	EXTEND TO 8-31-80	DAS 4/30/80	N/A	4/30/80

GAC 3046 REV 1 7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

PLT	DEPT	C C C	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PN SEC

PLT DEPT	OPERATIONS	REF

REMARKS

GAC 3046 10-72 (PART B)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO — PART NUMBER — CONTROL WAR REFERENCE DRAWING NO — PART SERIAL NO — PART LOT NO — END ITEM NO — MAJOR ASSY D — REWORK RESPONSIBILITY — MODEL — TYPE — EFFECTIVITY FROM & THRU — PROJECT PM-SEC — PROCESSED BY — DATE — ADDITIONAL COPIES TO — REMARKS — DATE ISSUED — DUE IN STOCK DATE — DESTINATION — DATE REC'D — COVERAGE

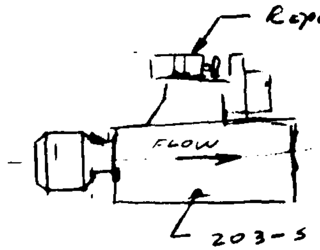
GAC 3844 REV 1 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT 26512	EO	128FT80003
DASH NO	M/S	REV A	
MFG PART NO	MCD REV ACD	ECP	PRIORITY ☐ ACTION ☐ NO ACTION
DET SPEC	CHG CL	EO CONT NO	
PLT/DEPT — OPERATIONS — INSP	PLT/DEPT — OPERATIONS — INSP	END ITEM NO	QTY/EI
ACFT NO	CONFIG REQ'D/CONFIG NOT REQ'D		
CONTRACT NO N62269-78C-0041	REPLACES PART NO	SH 1 OF 2	
DWG TITLE FLOW SENSOR, BYPASS TYPE			

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF
					128EL401-AF3	-	—
					129ELA03TS	-	—

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO.
1	21411:TK79143	ALE	—	M229



REPLACE -11 SOLENOID WITH -13 SOLENOID (2 PLACES)

203-5 & -6 FLOW SENSOR

FLIGHT TEST INFO: MODIFICATION IS A VENDOR DETAIL PART. NOT TO BE INCORPORATED ON DRAWING

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
ADD		203-13		SOLENOID									
REMOVE		203-11		SOLENOID									
—		203-6		FLOW SENSOR		AC A270-83							
ADD		203-13		SOLENOID									
REMOVE		203-11		SOLENOID									
—		203-5		FLOW SENSOR									

REASON FOR CHANGE: TO USE IMPROVED LOCKING SOLENOID. ORIGINAL SOLENOID WAS VIBRATION SENSITIVE

DESCRIPTION OF CHANGE: NOTED

PREPARED BY JOHN DUZICH	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	FTD	PROJ ENGRG	RELEASE	CUSTOMER
SECTION FLUID POWER	SIGNATURE	[signature]					[signature]	[signature]		[signature]
PLANT GROUP 35-357	DATE	1-19-80					1/31/80	21 JAN 80		4/21/80
DATE - EXT 1-19-80 X5978	EO TYPE: DIRECT DWG CHG (DOC) ☐	REV DWG ☑	PROD ENGRG ☐	RECORD EO ☑						

IAD I - INSTL A ASSY D DETAIL M MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 USE; 6 HOLD; 7 NO ACTION 8 = ACCEPT I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO	126FT 80073	DASH NO	REV A
			MFG PART NO	SER NO	
			EO CONT NO.	SH NO 2	

FLIGHT TEST E.O. - NOT TO BE INCORPORATED ON DRAWING REMOVE FROM AIRCRAFT PRIOR TO 19 MAY 80

REV	DESCRIPTION	FTD	ENG	CUST
A	EXTEND TO 9-19-80	DAS 4/3/80	N/A	4/3/80

GAC 3846 REV 1
7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

			MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PHASE

FLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3846
10-72 (PART B)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO		DASH NO	M B	REV
	26512	EO	128FT80005			A

MFG PART NO — MCO REV: ACD — ECP

CONTRACT NO: N62269-78C-0041 — SH 1 OF 2

DWG TITLE: INSTALLATION DWG FUSELAGE

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	2/411: TK 79-143	A6E		M229

FLIGHT TEST INFO:

NOT TO BE INCORPORATED ON DRAWING

" TO BE REMOVED AT TIME OF HYCUS REMOVAL, PRIOR TO MAY 1980 OR AS EXTENDED BY REVISION TO THIS EO "

REV	DESCRIPTION	FTO	ENG	CUST
A	EXTEND TO 5 31 80	4/3/80	N/A	4/3/80

SPLICE AREA CHANGES

(INFO ONLY, NOT TO BE INCORPORATED ON DWG)

SPLICE	REMOVE WIRE #	CONNECT WIRE #
E694	G697E22	
E694	G690Y22	
E696	G695A22	G750E22
E696	G695B22	
E697		G695A22
E697		G695B22
E700	G699E22	G697E22
E701	G750E22	
E702		G699E22
E702		G690Y22

REASON FOR CHANGE: TO SUPPLY BATTERY POWER TO HALOGEN LAMPS INSTEAD OF TRANSFORMER - CHARGED POWER

DESCRIPTION OF CHANGE: NOTED

PREPARED BY: JOHN DUZICH

SECTION: FLUID POWER

PLANT GROUP: 35/357

DATE - EXT: 2-1-80 5978

APPROVED BY: GROUP LDR — DATE 04 Feb 80; CUSTOMER — 2/4/80

EO TYPE: REV DWG ☒

GAC 3844 REV 1 6-77 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GAC 3844 REV 1 6-77 (PART B)

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO	128FT80005	DASH NO	REV A
			MFG PART NO.	SER NO	
			EO CONT NO.	SH NO 2	

REVISE DWG AS FOLLOWS

WAS

(14)

— G699E22 — E700 | SPLICE AREA | 23
— G697E22 — E694 | SPLICE AREA | 23
— G750E22 — E701 | SPLICE AREA | 23

(15)

— G690Y22 — E694 | SPLICE AREA | 23

NOW

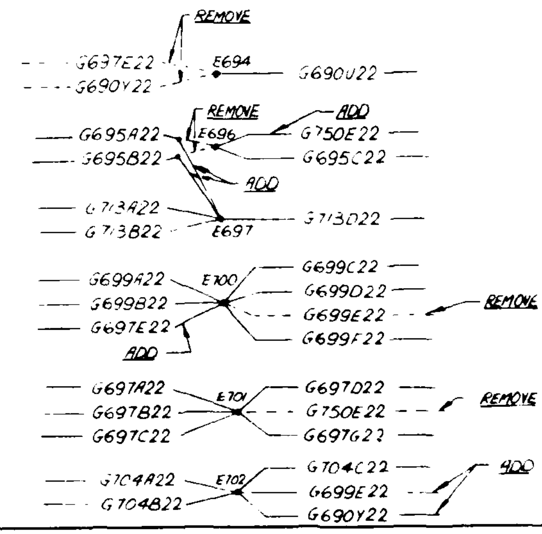
(14)

— G699E22 — E702 | SPLICE AREA | 23
— G697E22 — E700 | SPLICE AREA | 23
— G750E22 — E696 | SPLICE AREA | 23

(15)

— G690Y22 — E702 | SPLICE AREA | 23

(23) SPLICE AREA



GAC 3046 REV 1
7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3046
10-72 (PART B)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/0	REV
	26512	EO	128FT80006			

MFG PART NO	MCO REV		PRIORITY	DET SPEC	CHG CL	EO CONT NO
	ACD	ECP	☐ ACTION ☐ NO ACTION			

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY EI
						ACFT NO / CONFIG REQ D/CONFIG NOT REQ D	

CONTRACT NO N62269 - 78C - 0041

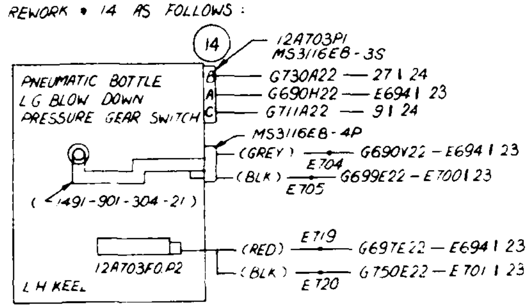
REPLACES PART NO — SH 1 OF 1

DWG TITLE INSTALLATION DWG FUSELAGE

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

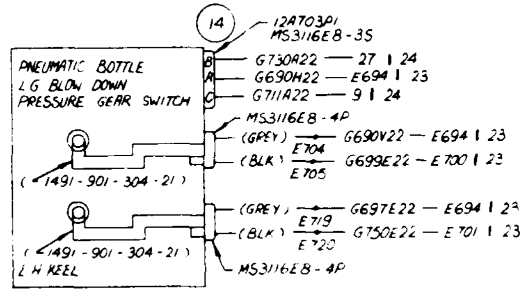
EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411 · TK 79-143	A6E		M229

REWORK # 14 AS FOLLOWS :



WAS

(REF 12AFT 1002)



NOW

FLT TEST EO - NOT TO BE INCORP ON DWG RETURN TO PROD CONFIG PRIOR TO SEC BO

NOTE THIS EO REQUIRES LH ENGINE REMOVAL.

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F

REASON FOR CHANGE
TO IMPROVE THE INTENSITY OF THE LIGHT SOURCE. INITIAL LIGHT SOURCE HAD INSUFFICENT INTENSITY

DESCRIPTION OF CHANGE
NOTED

PREPARED BY LEUNG LEE
SECTION FLUID POWER
PLANT GROUP 4C/357
DATE EXT 2-20-80 6189

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]						[signature]		[signature]
DATE	[illegible]						2/11/80		3/11/80

EO TYPE: DIRECT DWG CHG (DOC) · REV DWG ✓ · PROD ENGRG · RECORD EO ✓ · IAD 1 - INSTL A · ASSY D · DETAIL M · MAKE FROM

SD - RECM STK DISPN 1 - DISPOSE 2 - REWORK 3 - INCREASE 4 CREATE 5 USE 6 - HOLD 7 · NO ACTION 8 - ACCEPT · I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO | C/C | MODEL | PART NUMBER | QTY | CONTROL MAN/REFERENCE DRAWING NO | EO | DISP | INSP | I/T | PART SERIAL NO | PART LOT NO | END ITEM NO | MOD TYPE | VEHICLE S/N | MAJOR ASSY ID | REWORK RESPONSIBILITY | PLT | DEPT | C C C | MODEL | TYPE | EFFECTIVITY FROM & THRU | PROJECT PH-SEC | PROCESSED BY | INSP PLT | DATE | ADDITIONAL COPIES TO | REMARKS | DATE ISSUED | DUE IN STOCK DATE | DESTINATION | DATE REC'D | COVERAGE

GAC 3845 REV 1 7-74 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	
CODE IDENT	26512
	EO
	128FT80007
DASH NO	
M/B	
REV	
MFG PART NO	
MCO REV	ACD
	ECP
PRIORITY	☐ ACTION ☐ NO ACTION
DET SPEC	
CHG CL	
EO CONT NO	
END ITEM NO	
QTY/EI	
ACFT NO	
CONFIG REQ'D/CONFIG NOT REQ'D	
CONTRACT NO	N62269-78C-0041
REPLACES PART NO	
SH	1 OF 1
DWG TITLE	SENSOR, OPTICAL DESICCANT

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO.
1	21411:TK79-143	A6E		M229

FLIGHT TEST INFO:
NOT TO BE INCORPORATED ON DRAWING
TO BE REMOVED AT TIME
OF "HYCOS REMOVAL PRIOR TO
SEPTEMBER 1980 OR AS EXTENDED
BY REVISION TO THIS EO.

ACTION	QTY PER ASSY				PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN.	ZONE	I A D	S D	E F F
ADD				1	1491-901-316		SENSOR OPTICAL									1
REMOVE				1	1491-901-304		SENSOR OPTICAL									1
~				-901	-901		RESERVOIR INSTL								2	1

REASON FOR CHANGE: TO USE NEW IMPROVED MOISTURE DETECTOR INITIAL DETECTOR HAD INSUFFICIENT COLOR INTENSITY

DESCRIPTION OF CHANGE: NOTED

PREPARED BY	JOHN DURICH
SECTION	FLUID POWER
PLANT/GROUP	35 - 357
DATE - EXT	6/9/80 X5978

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	FTD	PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]								[signature]
DATE	6/9/80								6/9/80

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☑ PROD ENGRG ☐ RECORD EO ☐

I&D: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 = USE; 6 = HOLD; 7 = NO ACTION; 8 = ACCEPT I&T = IDENT AND TRACEABILITY

GAC 3845 REV 1 7-74 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SITE NO	DOCUMENT 26512	EO	12BFT81003
	ACD	ECP	
CONTRACT NO	N62269-80-C-0041	REPLACES PART NO	SH 1 OF 1
DWG TITLE	MICOS REMOVAL EO		

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	[illegible]	116E		[illegible]

NOTE: THIS EO IS FOR RECORD PURPOSES ONLY. ALL WORK HAS BEEN ACCOMPLISHED AND AUTHORIZED BY MICOS RECORD EO'S

1. RETURN FOLLOWING EOs TO ORIGINAL CONFIG:
   12BFT80001 A
   12BFT80002 A
   12BFT80003 A
   12BFT80006
   12BFT80007

2. TRANSFER SPLICE CHANGES AUTHORIZED BY 12BFT80005 TO RECORD EO 12BAV66014 Y2 FOR PERMANENT RECORD OF THIS CONFIGURATION.

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF

REASON FOR CHANGE: TO DISABLE MICOS

DESCRIPTION OF CHANGE: RECORD CHANGE ONLY

PREPARED BY	D.A. SCHMIDT
SECTION	FLT TEST
PLANT GROUP	[illegible] 706
DATE	7-11-81 EXT 7866

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	[illegible]	PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]					[illegible]			[illegible]
DATE	[illegible]					[illegible]			[illegible]

EO TYPE: DIRECT DWG CHG (DOC) [ ] REV DWG [ ] PROD ENGRG [ ] RECORD EO [ ] — IAD: I INSTL, A ASSY, D DETAIL, M MAKE FROM

SD RECM STK DISPN: 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 ACCEPT — I&T IDENT AND TRACEABILITY

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO		DASH NO	M/B	REV
131	26512		128EL10401			AFO

MFG PART NO: | MCO REV: ACD | ECP | PRIORITY: C | ☐ ACTION ☐ NO ACTION | DET SPEC: | CHG CL: 1 | EO CONT NO: 128EL4119

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI

ACFT NO | CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO: N62269-78-C-0041 | REPLACES PART NO: | SH 1 OF 5

DWG TITLE: LINES INSTL-HYD-FUS FWD & MID SECT STA 139-285 | 593

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO.
1	21411:TK79-143 31 JAN 79	A6E		M229

THIS IS A RECORD E.O.

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG / NOMENCLATURE	SD	EFF	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
ADD	1		128EL10401-915P-6		TUBE ASSY								A	4	1
	1		-914R-4										A	4	1
	1		-913LG-4										A	4	1
	1		-912LG-4										A	4	1
	1		-911AR-4										A	4	1
	1		-910R-12										A	4	1
	1		-909R-6										A	4	1
	1		-908P-6										A	4	1
	1		-907R-6										A	4	1
	1		-906R-6										A	4	1
	1		-905P-12										A	4	1
	1		-904P-12										A	4	1
	1		-903P-6										A	4	1
	1		-902AP-4										A	4	1
ADD	1		128EL10401-901RP-6		TUBE ASSY								A	4	1
~			-1		LINES INSTL								I	2	1

QTY PER ASSY: -1

REASON FOR CHANGE: HYDRAULICS CHECKOUT SYSTEM (HYCOS)

DESCRIPTION OF CHANGE: ADDED 128EL10401-901 THRU -915 TUBE ASSYS REMOVED 128H10014-996, -2367-1777, -1776 -2318 -2360 -2125, -2297, -1626, -1763, -2298 -995 TUBE ASSY'S

PREPARED BY	J. Bolun	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SECTION	E/M LINES	SIGNATURE	[signature]	[signature]		[signature]			[signature]	[signature]	[signature]
PLANT GROUP	40 - 332	DATE	2-20-79	2-22-79		2/.../79			2-21-79	2-28-79	3-1-79
DATE · EXT	2-16-79 X6170										

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒

IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT

I&T IDENT AND TRACEABILITY

GAC 3845 REV 1 7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO | MODEL | PART NUMBER | QTY | CONTROL WRB REFERENCE DRAWING NO | E.O. | DISP | PART SERIAL NO | PART LOT NO | END ITEM NO | MOD TYPE | VEHICLE S/N | MAJOR ASSY ID

REWORK RESPONSIBILITY

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI SEC

PROCESSED BY | INSP PLT | DATE

ADDITIONAL COPIES TO

REMARKS

DATE SELECT | DUE-IN STOCK DATE | TEST RATION | DATE REC'D | COVERAGE

GAC 3845 REV 1 7-74 (PART B)

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT			DASH NO	REV
		26512	EO	128EL10401		AF2
				MFG PART NO	SER NO	
				EO CONT NO 128EL4119	SH NO 2	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	2141I:TK79-143	A-6E		M229

THIS IS A RECORD E.O.

PART NUMBER		REPLACES	MAT.	SIZE	B.R.	FINISH	F	DF	PHOTO SH.
128EL10401-901RP-6	REPLACES	128H10014-995RP-6	6061-T6	.38D.X.049TH	1.12	76,175	✓		116
-902AP-4		-2298AP-4	6061-T6	.25DX.035TH	.75	76,175,147		✓	116
-903P-6		-1703P-6	6061-T6	.38DX.049TH	1.12	76,175,147	✓		116
-904AR12-905R12		-2297P-12	18-8SST	.75DX.049TH	2.25	NONE	✓		200.005
-906AR6,-907R-6		-2125R-6	6061-T6	.38DX.049TH	1.12	76,175,147	✓		205.009
-908P-6,-909P-6		-2360P-6	6061-T6	.38DX.049TH	1.12	76,175,147	✓		205.009
-910R-12		-2318R-12	5052-0	.75DX.049TH	2.25	76,161,147	✓		200.005
-911AR4		-1776AP-4	6061-T6	.25DX.035TH	.75	76,175,147		✓	205.009
-912LGE-4		-1777LGE-4	6061-T6	.25DX.035TH	.75	76,175,147		✓	205.009
-913LGE-4		-2367LGE-4	6061-T6	.25DX.035TH	.75	76,175,147		✓	205.009
-914R-4		-996R-4	6061-T6	.25DX.035TH	.75	76,175		✓	116
128EL10401-915P-6	REPLACES	128H10014-1626P-6	6061-T6	.38DX.049TH	1.12	76,175,147	✓		116

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
											A	6	1
REMOVE		128H10014-996R-4		TUBE ASSY							A	6	1
		-2367LGE-4									A	6	1
		-1777LGE-4									A	6	1
		-1776AR-4									A	6	1
		-2318R-12									A	6	1
		-2360R-6									A	6	1
		-2125R-6									A	6	1
		-2297R-12									A	6	1
		-1626R-6									A	6	1
		-1703R-6									A	6	1
		-2298AR-4									A	6	1
REMOVE		128H10014-995RP-6		TUBE ASSY							A	6	1
	1	-1		LINES INSTL							I	2	1

GAC 3847 10-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY						
PLT	DEPT	MODEL	TYPE	EFFECTIVITY FROM	THRU	PROJECT PRI SEL

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3847 10-73 (PART B)

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL10401	DASH NO	REV AF2
					MFG PART NO	SER NO	
					EO CONT NO 128EL4119	SH NO 3	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

ACTION	QTY PER ASSY 905	904	903	902	901	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
ADD	2	2				MS20819-12		SLEEVE		GOV'T STD							
ADD			2		2	MS20819-6		SLEEVE								3	1
ADD				2		MS20819-4		SLEEVE								3	1
ADD	2	2				AN818-12D		NUT								3	1
ADD			2		2	AN818-6D		NUT								3	1
ADD				2		AN818-4D		NUT		GOVT STD						3	1

GAC 3841 10-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY					
			EFFECTIVITY FROM	THRU	

OPERATIONS	

REMARKS

GAC 3841 10-73 (PART B)

REWORK RESPONSIBILITY

EFFECTIVITY FROM THRU

OPERATIONS

REMARKS

GAC 3047 10-73 (PART B)

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO	128EL10401		AF2
				MFG PART NO	SER NO	
				EO CONT NO 128EL4119	SH NO 4	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

ACTION	QTY PER ASSY 910	909	908	907	906	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	EFF
ADD	2					MS20819-12		SLEEVE		GOV'T STD						3	1
ADD		2	2	2	2	MS20819-6		SLEEVE								3	1
ADD	2					AN818-12D		NUT								3	1
ADD		2	2	2	2	AN818-6D		NUT		GOV'T STD						3	1

GAC 3047 10-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL10901	DASH NO	REV AF2
					MFG PART NO	SER NO	
					EO CONT NO 128EL4119	SH NO 5	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

ACTION	QTY PER ASSY 915	914	913	912	911	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
ADD	2					MS20819-6		SLEEVE								3	1
ADD		2	2	2	2	MS20819-4		SLEEVE								3	1
ADD	2					AN818-6D		NUT								3	1
ADD		2	2	2	2	AN818-4D		NUT								3	1

GAC 3847 10-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

EFFECTIVITY FROM THRU

PROJECT PRESET

OPERATIONS

INSP

REMARKS

GAC 3847 10-73 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
132	26512	EO	128EL10401			AF3

MFG PART NO — MLC REV: ACD — ECP — PRIORITY: C — ACTION / NO ACTION — DET SPEC — CHG CL: 1 — EO CONT NO: 128-EL-4157

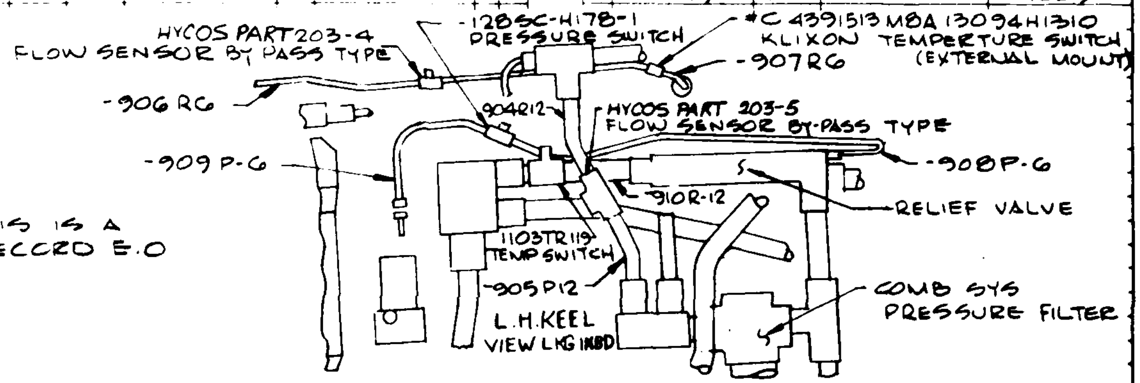
PLT DEPT — OPERATIONS — INSP — PLT DEPT — OPERATIONS — INSP — END ITEM NO — QTY E

ACFT NO — CONF'S REQ'D/CONFIG NOT REQ'D

CONTRACT NO: N00019-77-C-0317 — REPLACES PART NO — SH 1 OF 1

DWG TITLE: LINES INSTL-HYD.-FUS. FWD & MID. SECT STA. 139-285 — 565

ACTION	QTY NA	QTY E	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21411-TK79-143	A-6E		M229



THIS IS A RECCRD E.O

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO.	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		-1		LINES INSTL								2	1

REASON FOR CHANGE: HYDRAULIC CHECK-OUT SYS (HYCOS)

DESCRIPTION OF CHANGE: ON -1 INSTL ADDED FLOW SENSORS & PRESSURE & TEMP SWITCHES AS SHN

PREPARED BY: J.Bohun / Bohun
SECTION: ELECTRO-MECH LINES
PLANT GROUP: 40-332
DATE: EXT 3-2-79 X6169

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	V.P.	[signature]		[signature]			[signature]	[signature]	GAC
DATE	3-2-79	3/2/79		3/1/79			3/2/79	3-2-79	

EO TYPE — DIRECT DWG CHG (DDC) ☐ — REV DWG ☐ — PROD ENGRG ☐ — RECORD EO ☒ — IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT — I&T = IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

REWORK RESPONSIBILITY

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PR-SEC

PROCESSED BY — IMP PLT — DATE

GAC 3844 REV 1 (PART B)

refer to 567

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

CODE IDENT	26512
EO	128ELID401
MCO REV	ACD
ECP	
PRIORITY	C
CHGE	1
CONT NO	128EL4710
CONTRACT NO	N62269-78-C-0041
SH	1 OF 2
DWG TITLE	LINES INSTL-HYD-FUS FWD & MID SECT STA 139-285
EFF	1
AUTHORITY	2141: TK79-143 31 JAN 79
MODEL	A6E
GAC UNIT NO	M229

THIS IS A RECORD E.O.
THIS E.O. RE-INSTALLS THE ORIGINAL PRODUCTION HYD LINES IN THIS AIRCRAFT

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE	ZONE	I A D	S D	E F F
REMOVE	1	128ELID401-915P-6	TUBE ASSY		A	6	1
	1	-914P-4			A	6	1
	1	-913GE-4			A	6	1
	1	-912GE-4			A	6	1
	1	-911AP-4			A	6	1
	1	-910R-12			A	6	1
	1	-909P-6			A	6	1
	1	-908H-6			A	6	1
	1	-907R-6			A	6	1
	1	-906R-6			A	6	1
	1	-905P-12			A	6	1
	1	-904P-12			A	6	1
	1	-903P-6			A	6	1
	1	-902AP-4			A	6	1
REMOVE	1	128ELID401-901RP-6	TUBE ASSY		A	6	1
	-1	-1	LINES INSTL		I	2	1

REASON FOR CHANGE: DEBAILED AC BACK TO PRODUCTION CONFIGURATION

DESCRIPTION OF CHANGE: ON -1 INSTL REMOVED 128ELID403 -901 THRU -915 TUBE ASSYS ADDED - 128ELID401 -916, -2367, -1626, -1776, -1777, -2318, -2360, -2125, -2297, -2303, -2298 & -935 TUBE ASSYS

PREPARED BY	J Behun
SECTION	E/M LINES
PLANT GROUP	40-332
DATE EXT	10 29 80 x6170
APPROVED BY / GROUP LDR SIGNATURE	R. Johnson
DATE	10-29-80
EO TYPE	RECORD EO ✓

ENGINEERING ORDER
MANUFACTURING CHANGE ORDER

PLT DEPT | OPERATIONS

REMARKS

GAC 3567 10-72 (PART B)

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT			DASH NO	REV
		26512	EO	128EL10401		

MFG PART NO — SER NO

EO CONT NO 128EL4710 — SH NO 2

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21911:TK79-143	A6-E		M229

THIS IS A RECORD E.O.

128H10014		128EL10401
-995RP-6	REPLACES	-901RP-6
-2278HP-4		-902AP-4
-1703P-6		-903P-6
-2297P-12		-905P12 & -905P-12
-2125R-6		-906R-6 & -907P-6
-2360P-6		-908P-6 & -909P-6
-2318R-12		-910R-12
-1776AP-4		-911AP-4
-1777LGE-4		-912LGE-4
-2367LGE-4		-913LGE-4
-996R-4		-914R-4
128H10014 -1626P-6	REPLACES	128EL10401 -915P-6

ACTION	QTY PER ASSY					PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
ADD					1	128H10014-996R-4		TUBE ASSY							A	5	1
					1	-2367LGE-4									A	5	1
					1	-1777LGE-4									A	5	1
					1	-1776AP-4									A	5	1
					1	-2318R-12									A	5	1
					1	-2360P-6									A	5	1
					1	-2125R-6									A	5	1
					1	-2297P-12									A	5	1
					1	-1626P-6									A	5	1
					1	-1703P-6									A	5	1
					1	-2298AR4									A	5	1
ADD					1	128H10014-995RP-6		TUBE ASSY							A	5	1
					-1	-1		LINES INSTL							I	2	1

GAC 3567 10-72 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION — EO 128EL10403

CODE IDENT	26512
PRIORITY	C
ECP	
MCO REV	ACD
CHG	1
EO CONT NO	128EL4711
CONTRACT NO	N62269-78-C-0041
SH	1 OF 1
DWG TITLE	LINES INSTL-HYD-FUS AFT SECT STA 451-AFT
EFF	1
AUTHORITY	21411:TK79-143 31 JAN 79
MODEL	A6-E
GAC UNIT NO	M229

THIS IS A RECORD E.O.

THIS E.O. RE INSTALLS THE ORIGINAL PRODUCTION HYD LINE IN THIS AIRCRAFT

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE	ZONE	SO	EFF
ADD	1	128H10014-3336P-6	TUBE ASSY	H	5	1
REMOVE	1	128EL10413-901P-6	TUBE ASSY	A	6	1
REMOVE	1	128EL10413-903P-6	TUBE ASSY	A	6	1
	-1	-1	LINES INSTL	1	2	1

REASON FOR CHANGE: DE-BAILED A/C BACK TO PRODUCTION CONFIGURATION

DESCRIPTION OF CHANGE: ON 1 INSTL ADDED 128H10014-3336P-6 REMOVED 128EL10413-901P-6, -903P-6

PREPARED BY	J. Bohun
SECTION	E/M LINES
PLANT GROUP	45 332
DATE	EXT 10-23-80 X6100
APPROVED BY: GROUP LDR — SIGNATURE	[illegible]
DATE	10-23-80

ENGINEERING ORDER
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO · CC · NO. · PART NUMBER · QTY · CONTROL MAP REFERENCE DRAWING NO · EO · DISP · INSP · PART SERIAL NO · PART LOT NO · END ITEM NO · MOD TYPE · VEHICLE S/N · MAJOR ASSY ID · REWORK RESPONSIBILITY

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI SEC

PROCESSED BY · IMP PLT · DATE · ADDITIONAL COPIES TO · REMARKS · DATE SOLD · DUE IN STOCK DATE · DESTINATION · DATE REC'D · COVERAGE

GAC 3845 REV 1 7 74 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
28	26512	EO	128EL10403			T4

MFG PART NO · MCO REV ACD · ECP · PRIORITY C · ☐ ACTION ☐ NO ACTION · DET SPEC · CHG CL 1 · EO CONT NO 128EC4118

PLT/DEPT · OPERATIONS · INSP · PLT/DEPT · OPERATIONS · INSP · END ITEM NO · QTY EI · ACFT NO · CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO N62269-78-C-0041 · REPLACES PART NO · SH 1 OF 1

DWG TITLE LINES INSTL-HYD-FUS AFT SECT-STA 451-AFT · 59

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411.TK79-143 31-JAN-79	A-6E		M229

ACTION	QTY/NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

THIS IS A RECORD E.O.

· 128EL10403-900 & -901 REPLACES 128H10014-2236 (REF PHOTO SH 204.001)

MAT:-6061-T6, B.R 1.2, .38 DIA X .049 TH, FLARE BOTH ENDS & FINISH 76 & 175

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
ADD	2 2	MS20819-6		SLEEVE		GOV'T STD						3	1
ADD	2 2	AN818-6D		NUT		GOV'T STD						3	1
REMOVE	1	128H10014-2236P6		TUBE ASSY							A	6	1
ADD	1	128EL10403-901P-6		TUBE ASSY							A	4	1
ADD	1	128EL10403-900P-6		TUBE ASSY							A	4	1
~	901 900	-1		LINES INSTL							I	2	1

REASON FOR CHANGE: HYDRAULIC CHECK-OUT SYS (HYCOS)

DESCRIPTION OF CHANGE CN-1: ADDED 128EL10403-900 & -901 TUBE ASSYS; REMOVED 128H10014-2236 TUBE ASSY

PREPARED BY J. Bohun · SECTION E/M LINES · PLANT GROUP 40 332 · DATE - EXT 2-16-79 X6170

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]	[signature]		[signature]			[signature]	[signature]	[signature]
DATE	2-20-79	2-22-79		2/21/79			2-24-79	2-28-79	3-1-79

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ · IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT · I&T = IDENT AND TRACEABILITY

GAC 3845 REV 1 7 74 (PART A)

ENGINEERING ORDER/MANUFACTURING CHANGE ORDER

WORK ORDER NO

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

PART NUMBER

CONTROL MAN REFERENCE DRAWING NO

PART SERIAL NO — PART LOT NO

END ITEM NO

MOD TYPE — VEHICLE S/N — MAJOR ASSY I.D.

REWORK RESPONSIBILITY

PLT	DEPT	C/C/C	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI-SEC

PROCESSED BY — MP PLT — DATE

ADDITIONAL COPIES TO

REMARKS

DATE ISSUED — DUE IN STOCK DATE

DESTINATION — DATE REC'D

COVERAGE

GAC 3844 REV 1 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	REV
29	26512	EO	128EL10403		T5

MFG PART NO — MCO REV: ACD — ECP — PRIORITY: C — ☐ ACTION ☐ NO ACTION — DET SPEC — CHG CL: 1 — EO CONT NO: 128-EL-4158

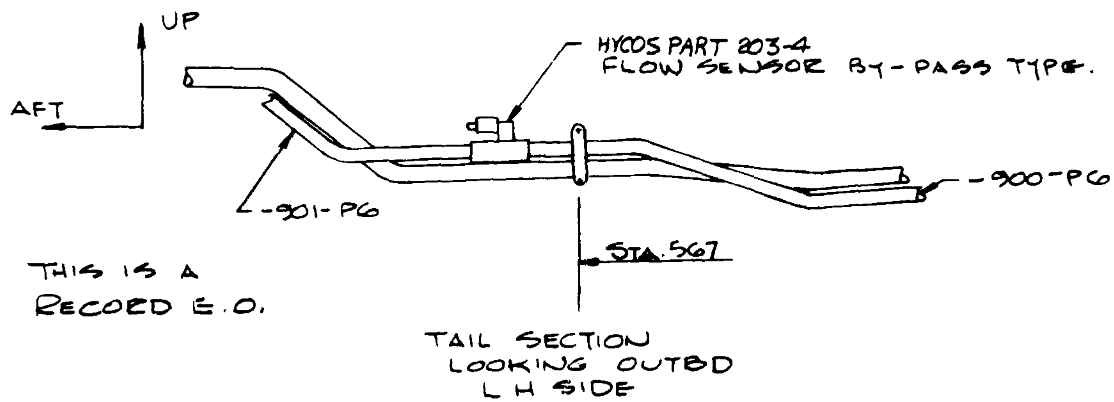
PLT/DEPT — OPERATIONS — INSP — PLT/DEPT — OPERATIONS — INSP — END ITEM NO — QTY EI

ACFT NO — CONFIG REQ D/CONFIG NOT REQ D

CONTRACT NO: N00019-77-C-0317 — REPLACES PART NO — SH 1 OF 1

DWG TITLE: LINES INSTL-HYD-FUS AFT SECT - STA 451 - AFT — 565

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21411-TK79-143	A-6E		M229



THIS IS A RECORD E.O.

ACTION	QTY PER ASSY	PART NUMBER	S/T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		-1		LINES INSTL								2	1

REASON FOR CHANGE: HYDRAULIC CHECK-OUT SYS. (HYCOS)

DESCRIPTION OF CHANGE: ON -1 INSTL. ADDED FLOW SENSOR BY PASS AS SHN.

PREPARED BY: J. Bohun/Bohun

SECTION: ELECTRO-MECH LINES

PLANT GROUP: 40-332

DATE - EXT: 3-1-79 X6169

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE 63	CUSTOMER
SIGNATURE									(GAC)
DATE	3-2-79	3/6/79		3/1/79			3/8/79	3-29	

EO TYPE — DIRECT DWG CHG (DOC) ☐ — REV DWG ☐ — PROD ENGRG ☐ — RECORD EO ☒ — IAD I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT — I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SER NO | CODE IDENT 26512 | EO NOTED | 128 EL 66010 | DASH NO | M/A | REV L4

MFG PART NO | MLO REV ACD | ECP | PRIO-RITY C | I ACTION / I NO ACTION | DET SPEC | CHG LT 2 | LI CONT NO 128EL-1221

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI

ACFT NO | CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO N62269-78 C-0041 | REPLACES PART NO | SH 1 OF 1

DWG TITLE SEE DWGS.

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21411-TK79-143 31-JAN-79	A6E		M229

THIS IS A RECORD E.D.

THIS E.D CANCELS
128EL66010 L1
128EL 66013 L4
128EL 66047 L4
128EL 66060 L1

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DOC	REF EO SH
EO	128EL 66010	L4	47	✓		
EO	128EL66013	M1	34	✓		
ED	128EL66047	M2	60	✓		
ED	128EL66060	L4	41	✓		

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
~		128EL66060-1									1	2	1
~		128EL66047-1									1	2	1
~		128EL66013-1									1	2	1
~		128EL66010-1									1	2	1

REASON FOR CHANGE
RELOCATED INSTRUMENTATION FOR HYCOS CHECK-OUT SYS FROM COCKPIT RUDDER PEDALS TO AILERON CONTROLS ON TOP DECK

DESCRIPTION OF CHANGE
CANCELED EO 128EL66010 L1, 128EL66013 L4
128EL66047 L4 & 128EL66060 L1

PREPARED BY J. Bohun
SECTION E/M LINES
PLANT GROUP 40 - 332
DATE EXT 4-17-79 X6170

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	GAC
DATE	4-25-79	4 26 79		[illegible]			4/26/79	5-8-79	

EO TYPE | DIRECT DWG CHG (DOC) | REV DWG ☒ | PROD ENGRG | RECORD EO | IAD 1 - INSTL A | ASSY D | DETAIL M | MAKE FROM

SD | RECM STK DISPN 1 | DISPOSE 2 | REWORK 3 | INCREASE 4 | CREATE 5 | USE 6 | HOLD 7 | NO ACTION 8 | ACCEPT | I&T | IDENT AND TRACEABILITY

GAC 3044 REV 1 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO NOTED		DASH NO	M/B	REV
	26512	EO NOTED	128EL66013			M1

MFG PART NO: | MCO REV: ACD | ECP | PRIORITY: C | ☐ ACTION ☐ NO ACTION | DET SPEC: | CHG CL: I | EO CONT NO: 128EL 4221

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI

ACFT NO | CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO: N62269-78-C-0041 | REPLACES PART NO: | SH 1 OF 1

DWG TITLE: SEE DWGS.

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411: TK 79-143 31-JAN 79	A6E		M229

THIS IS A RECORD E.O.

THIS E.O CANCELS
128EL66010 L1
128EL 66013 L4
128EL 66047 L4
128EL 66060 L1

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DOC	REF EO SH
EO	128EL66010	L4	47	✓		
EO	128EL66013	M1	94	✓		
EO	128EL66047	M2	60	✓		
EO	128EL66060	L4	41	✓		

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO.	MATERIAL SPECIFICATION	PROC	FIN	ZONE	A D	S B	E F F
~		128EL66060-1									1	2	1
~		128EL66047-1									1	2	1
~		128EL66013-1									1	2	1
~		128EL66010-1									1	2	1

REASON FOR CHANGE: RELOCATED INSTRUMENTATION FOR MYCOS CHECK-OUT SYS FROM COCKPIT RUDDER PEDALS TO RUDDER CONTROLS ON TOP DECK

DESCRIPTION OF CHANGE: CANCELED EO 128EL66010 L1, 128EL66013 L4, 128EL66047 L4 & 128 66060 L1

PREPARED BY: J. Bohun
SECTION: E/M LINES
PLANT GROUP: 40 - 332
DATE - EXT: 4-17-79 X6120

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE		RWP/WIEN						GAC
DATE	4-25-79	4 26 79				4/26/79	5-8-79	

EO TYPE: DIRECT DWG CHG (DOC) ☐ | REV DWG ☑ | PROD ENGRG ☐ | RECORD EO ☐ | IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT | I&T = IDENT AND TRACEABILITY

GAC 3044 REV 1 8-77 (PART A)

GAC 3044 REV 1 8-77 (PART B)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT		DASH NO	REV
		26512	EO NOTED		

MFG PART NO		SER NO	
EO CONT NO.	128EL4116	SH NO	2

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	2M4I: TK 79-143	A-6E		M229

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DOC	REF EO SH
EO						
EO						

THIS IS A RECORD E.O.

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
~		128EL66060-1											
~		128EL66047-1									I	2	1
~		128EL66010-1									I	2	1
~		128EL66013-1									I	2	1
~		128EL66058-1									I	2	1
~		128EL66033-1									I	2	1

GAC 3847 10-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

PLT	DEPT	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PR-SEC

PLT DEPT	OPERATIONS	HRS

REMARKS

GAC 3847 10-73 (PART B)

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512		128EL66D41		K2
				MFG PART NO	SER NO	
				EO CONT NO 128EL4116	SH NO 3	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

EQUIP INSIDE AREA	EQUIP OUTSIDE AREA
9 - BALLISTIC PANEL-50AB-P6028	35 - CASE DRAIN FLOW SENSOR - L.H.KEEL - 12A690-P1
30 - SPLICE AREA	36 - CASE DRAIN - TEMP SW - L.H.KEEL - 12A691-S1
31 - PNEU BOTTLE - CANOPY - 12A696-P1	37 - PUMP QUIESCENT FLOW - L.H.KEEL - 12A692-P1
32 - DISPLAY PANEL - 12A711-P1	38 - RAM AIR TURB ACCUM. TEMP XDUCER - L.H.KEEL - 12A693-P1
33 - DISPLAY PANEL - 12A711-P2	39 - RAM AIR TURB ACCUM DISPL XDUCER - L.H.KEEL - 12A694-R1
34 - DISPLAY PANEL - 12A711-P3	40 - RAM AIR TURB ACCUM PRESS XDUCER - L.H.KEEL - 12A695-PT1
	41 - ~~HYDRAULIC RESERVOIR - TEMP XDUCER - L.H.FILLET~~ - 12A697-P1
	42 - HYDRAULIC RESERVOIR - LEVEL - L.H.FILLET - ~~12A698-P1~~
	43 - FILTER - DELTA P PREST. - L.H.KEEL - ~~12A699-P1~~
	44 - FILTER - DELTA P - PUMP - L.H.FILLET - 12A700-P1
	45 - FILTER - DELTA P - RETURN - L.H.KEEL - 12A701-P1
	46 - RELIEF VALVE - MAIN TEMP SW - L.H.KEEL - 12A702-P1
	47 - PNEU BOT. - L.G BLOW DN - PRESS GEAR SW - L.H.KEEL - 12A703-P1
	48 - PNEU DESSICANT DRIER - L.H. FILLET - 12A704-P1
	50 - RUDDER ACTUATOR POSITION - TAIL SECT - 12A706-P1
	51 - RUDDER QUIESCENT FLOW - TAIL SECT - 12A707-P1
	52 - HYD BACK-UP PUMP TEMP SW - TAIL SECT - 12A708-S1
	53 - PUMP PRESS HYD SW - L.H.KEEL - 12A709-P1
	54 - STA 139 BLKHD - L.H. FILLET - P6045

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F

GAC 3047 10-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

PERFORM RESPONSIBILITY

OPERATIONS

REMARKS

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO 128EL66041	DASH NO / REV K2
				MFG PART NO	SER NO
				EO CONT NO 128EL4116	SH NO 4

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
ADD	1	128AV66014-901		WIRING HARNESS						A	3	1	
	-1	-1		LINES INSTL									

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

OPERATIONS

INSP

REMARKS

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL66041	DASH NO	REV K2
					MFG PART NO	SER NO	
					EO CONT NO 128EL4116	SH NO 5	

CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12BAV

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE	9	30	31	32	33	34	B	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (AA)		T		F								
			(AB) *		T			F							
			(AC) *	T					F						
			(AD) *			T	F								
			(AE) *		T	F									
			(AF) *						F		1				
	35		(AG) *				F			X					
	35		(AH) *		F					X					
	36		(AJ) *				F			X					
	36		(AK) *		F					X					
	37		(AL) *				F			X					
	37		(AM) *		F					X					
	38		(AN) *				F			X					
	38		(AP) *		F					X					
	39		(AR) x				F			X					
	39		(AS) *		F					X					
	40		(AT) *				F			X					
	40		(AU) *		F					X					
	41		(AV) *				F			X					
	41		(AW) *		F					X					
	42		(AX) *				F			X					
	42		(AY) *		F					X					
	42		(AZ) *					F		X					
	43		(BA) *				F			X					
ADD	43		(BB) *		F					X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

GAC 3046 4-73 (PART 4)

REWORK RESPONSIBILITY

PLT	DEPT		MODEL	TYPE	EFFECTIVITY FROM	THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3046 4-73 (PART 8)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO	128EL66041		K2
				MFG PART NO	SER NO	
				EO CONT NO 128EL4116	SH NO 6	

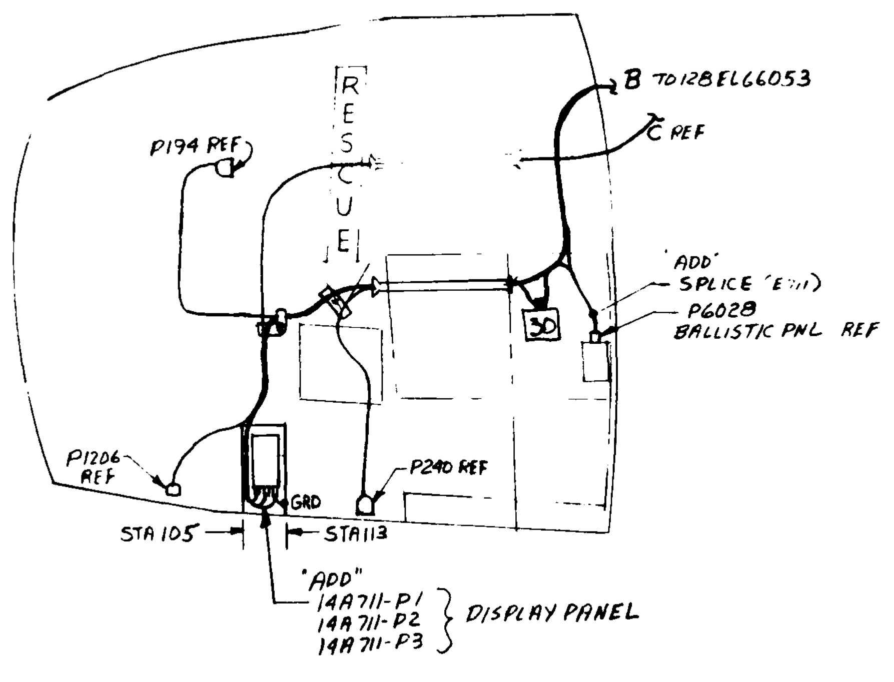
ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS 9	30	31	32	33	34	B	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	44		66014 (BC) *				F			X					
	44		(BD) *		F					X					
	45		(BE) *				F			X					
	45		(BF) *		F					X					
	46		(BG) *				F			X					
	46		(BH) *		F					X					
	47		(BJ) *				F			X					
	47		(BK) *		F					X					
	48		(BL) *		F					X					
	50		(BM) *				F			X					
	50		(BN) *		F					X					
	51		(BP) *				F			X					
	51		(BR) *		F					X					
	52		(BS) *				F			X					
	52		(BT) *		F					X					
	53		(BU) *				F			X					
	53		(BV) *		F					X					
	54		(BW) *				F			X					
ADD	54		(BX) *		F					X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION

CODE IDENT		DASH NO	REV
26512	EO 12BEL66041		K2
MFG PART NO		SER NO	
EO CONT NO. 12BEL4116		SH NO	7



VIEW LKG INBD
L.H. INLET DUCT

GAC 3040 REV 1 7-74 (PART A)

GAC 3040 10-72 (PART B)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

PLT	DEPT		MODEL	TYPE	EFFECTIVITY FROM	THRU	PROJECT

PLT DEPT	OPERATIONS	INSP

REMARKS

GRUMMAN AEROSPACE CORPORATION | PRIORITY | SEQ NO | CODE IDENT 26512 | EO 128EL 66053 | DASH NO | REV K2

MFG PART NO | SER NO

EO CONT NO 128EL 4116 | SH NO 8

EQUIP INSIDE AREA: 1 = P6045; □ = 12A698-R1; ◖ = 12A700-P1; ⊗ = 12A697-P1; ⊠ = 12A704-P1

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	1	⊗	□	⊠	◖	BI	Y	U	C	A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	Δ		66014 (BW)*	T					X			X						
	⊘		(BX)*	T					X			X						
	Δ		(AV)*		T				X	X		X						
	⊘		(AW)*		T				X	X		X						
	Δ		(AX)*			T			X	X		X						
	⊘		(AY)*			T			X	X		X						
	∇		(AZ)*			T			X	X		X						
	⊘		(BL)*				T		X	X		X						
			(AG)*						X				X					
			(AH)*						X				X					
			(AJ)*						X				X					
			(AK)*						X				X					
			(AL)*						X				X					
			(AM)*						X				X					
			(AN)*						X				X					
			(AP)*						X				X					
			(AR)*						X				X					
			(AS)*						X				X					
			(AT)*						X				X					
			(AU)*						X				X					
			(BA)*						X				X					
			(BB)*						X				X					
	Δ		(BC)*					T	X	X		X						
ADD	⊘		(BD)*					T	X	X		X						

ACTION	ITEM NO.	HARDWARE REQUIREMENTS
EQUIP OUTSIDE AREA		Δ = 12A711P1 ⊘ = SPICE AREA ∇ = 12A711P2

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO	12BEL66053		K2
				MFG PART NO	SER NO	
				EO CONT NO 12BEL4116	SH NO 9	

CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 2BAV

REFERENCE DESIGNATOR/ROUTE LETTERS

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE	BI	Y	U	C	A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BE) *	X				X					
			(BF) *	X				X					
			(BG) *	X				X					
			(BH) *	X				X					
			(BJ) *	X				X					
			(BK) *	X				X					
			(BM) *	X	X	X	X						
			(BN) *	X	X	X	X						
			(BP) *	X	X	X	X						
			(BR) *	X	X	X	X						
			(BS) *	X	X	X	X						
			(BT) *	X	X	X	X						
			(BU) *	X				X					
ADD			(BV) *	X				X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

GAC 3040 4-73 PART A

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

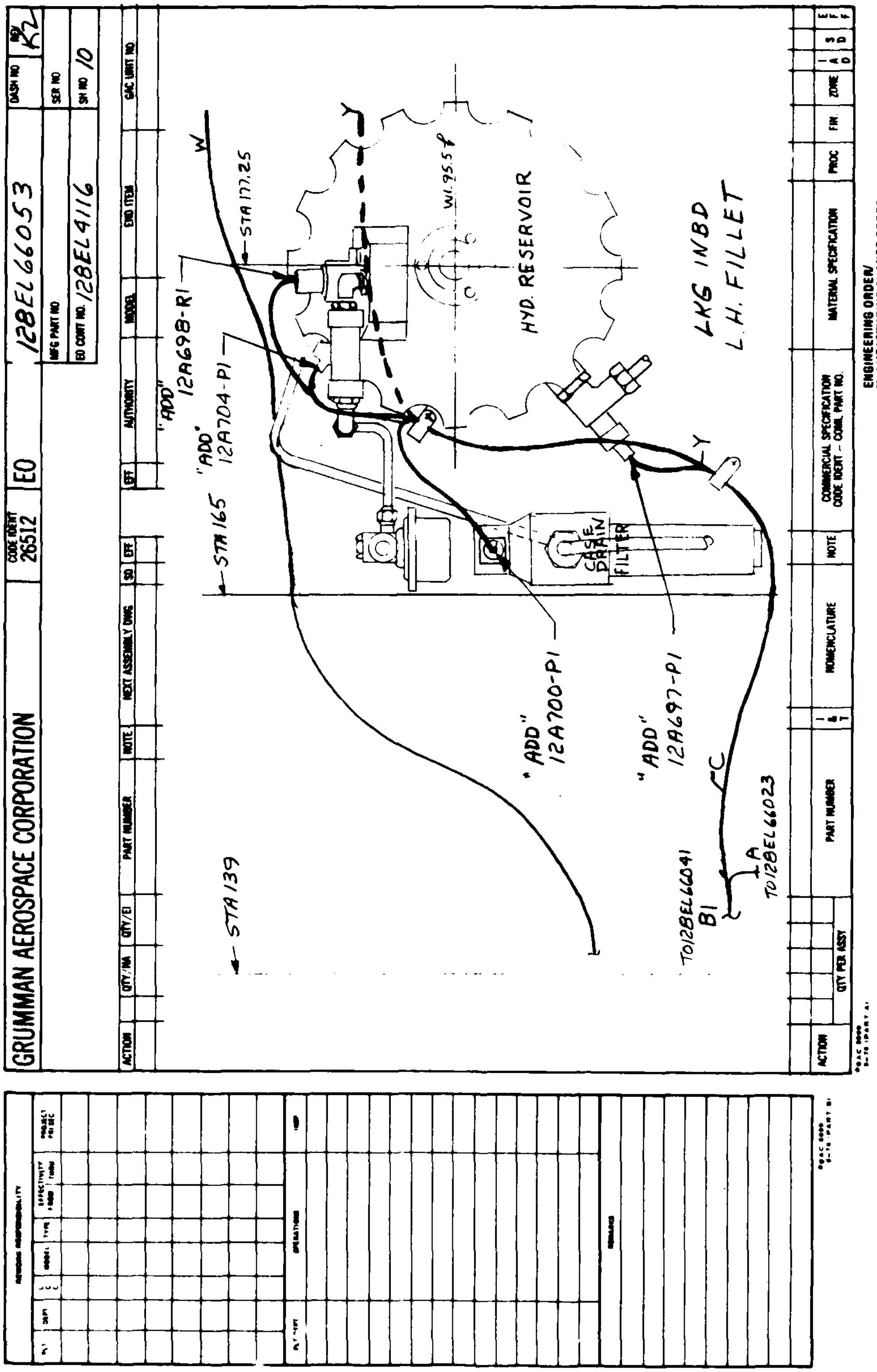
REWORK RESPONSIBILITY

PLT	...	MODL	TYPE	EFFECTIVITY FROM	THRU	PROJECT PH/SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3040 4-73 PART B


GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
12BEL66053
EO CONT NO. 12BEL4116
SH NO 10
HYD. RESERVOIR
WL 95.5
STA 177.25
STA 165
STA 139
CASE DRAIN FILTER
"ADD" 12A698-R1
"ADD" 12A704-P1
"ADD" 12A700-P1
"ADD" 12A697-P1
LKG INBD L.H. FILLET
TO 12BEL66041 B1
TO 12BEL66023 A
ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	12BEL66023	DASH NO	REV M7

EQUIP INSIDE AREA { a = 12A6090-P1, b = 12A691-S1, c = 12A692-P1, d = 12A693-P1, e = 12A694-R1, f = 12A695-PT1, g = 12A699-P1, j = 12A701-P1, k = 12A702-P1, l = 12A703-P1, m = 12A707-P1

MFG PART NO — SER NO

EO CONT NO 12BEL4116 — SH NO 11

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12BAV	a	b	c	d	e	f	g	j	k	l	m	Y	C	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	Δ		66014 (AG)*	F											X	X					
↑	Ø		(AH)*	F											X	X					
	Δ		(AJ)*		F										X	X		1			
	Ø		(AK)*		F										X	X		2			
	Δ		(AL)*			F									X	X		3			
	Ø		(AM)*			F									X	X					
	Δ		(AN)*				F								X	X					
	Ø		(AP)*				F								X	X					
	Δ		(AR)*					F							X	X					
	Ø		(AS)*					F							X	X					
	Δ		(AT)*						F						X	X		4			
	Ø		(AU)*						F						X	X		5			
	Δ		(BA)*							F					X	X					
	Ø		(BB)*							F					X	X					
	Δ		(BE)*								F				X	X					
	Ø		(BF)*								F				X	X					
	Δ		(BG)*									F			X	X					
	Ø		(BH)*									F			X	X					
	Δ		(BJ)*										F		X	X					
	Ø		(BK)*										F		X	X		6			
↓	Δ		(BU)*												X	X					
ADD	Ø		(BV)*																		

ACTION	ITEM NO	HARDWARE REQUIREMENTS
EQUIP OUTSIDE AREA		Δ = 12A711-P1 Ø = SPLICE AREA

GAC 3046 6-73 (PART A)

REWORK RESPONSIBILITY

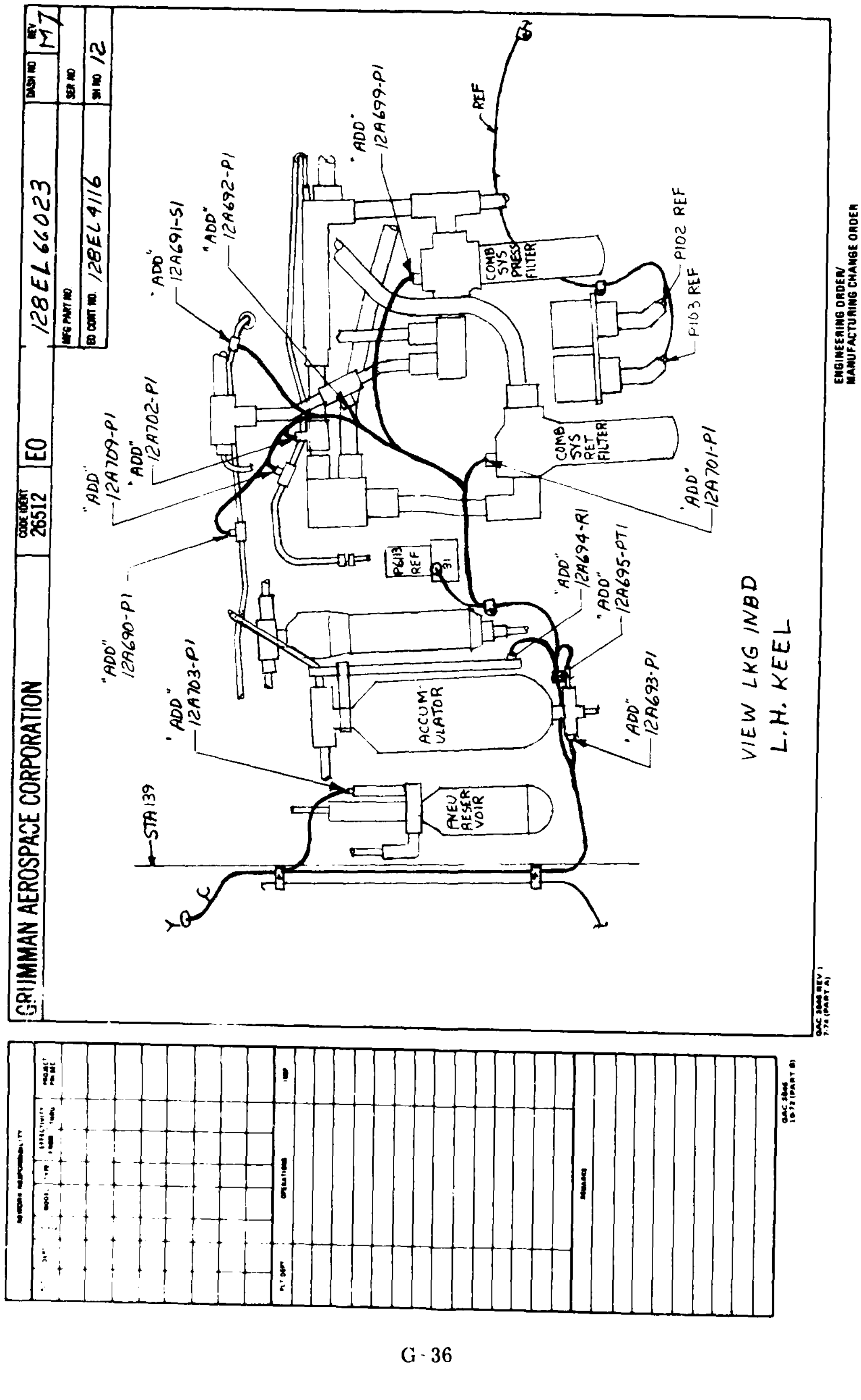
		MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PRIORITY PR/SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3046 6-73 (PART B)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER SUPPLEMENT


GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
128EL66023
MFG PART NO
EO CONT NO. 128EL4116
DASH NO
REV M7
SER NO
SH NO 12
'ADD' 12A691-S1
'ADD' 12A692-P1
'ADD' 12A699-P1
REF
COMB SYS PRESS FILTER
P102 REF
P103 REF
'ADD' 12A709-P1
'ADD' 12A702-P1
COMB SYS RET FILTER
'ADD' 12A701-P1
'ADD' 12A690-P1
P6113 REF
'ADD' 12A694-R1
'ADD' 12A695-PT1
'ADD' 12A703-P1
ACCUMULATOR
'ADD' 12A693-P1
VIEW LKG INBD
L.H. KEEL
STA 139
PNEU RESERVOIR
ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
OPERATIONS
REMARKS

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SFQ NO	CODE IDENT			DASH NO	REV
		26512	EO	128EL66D21		L2
				MFG PART NO	SER NO	
				EO CONT NO 128EL4116	SH NO 13	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS: Z	REFERENCE DESIGNATOR/ROUTE LETTERS: D	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BP) *	X	X					
↓			(BR) *	X	X					
			(BM) *	X	X					
			(BN) *	X	X					
↓			(BS) *	X	X					
ADD			(BT) *	X	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS

GAC 3046 4-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY							
FLT	DEP		MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

FLT DEPT	OPERATIONS	HRP

REMARKS

GAC 3046 4-73 (PART B)

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL66052	DASH NO	REV H3
					MFG PART NO	SER NO	
					EO CONT NO 128EL4116	SH NO 14	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12BAV	REFERENCE DESIGNATOR/ROUTE LETTERS: M	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BP) *	X					
			(BR) *	X					
			(BM) *	X					
			(BN) *	X					
			(BS) *	X					
ADD			(BT) *	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS

GAC 3046 6-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY						
PLT	DEPT	MODEL	TYPE	EFFECTIVITY FROM	THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	MSP

REMARKS

GAC 3046 6-73 (PART B)

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	12BEL66030	DASH NO	REV HL
					MFG PART NO	SER NO	
					EO CONT NO 12BEL4116	SH NO 15	

REFERENCE DESIGNATOR/ROUTE LETTERS

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12BAV	HI	V	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BP) *	X	X					
			(BR) *	X	X					
			(BM) *	X	X					
			(BN) *	X	X					
			(BS) *	X	X					
ADD			(BT) *	X	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS

GAC 3046 6-73 (PART A)

REWORK RESPONSIBILITY

	DEPT		MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3046 6-73 (PART B)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL66032	DASH NO	REV H4
					MFG PART NO	SER NO	
					EO CONT NO 128EL4116	SH NO 16	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS K	REFERENCE DESIGNATOR/ROUTE LETTERS H	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BP) *	X	X					
			(BR) *	X	X					
			(BM) *	X	X					
			(BN) *	X	X					
			(BS) *	X	X					
ADD			(BT) *	X	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS

GAC 3046
6-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY						
PLT	DEPT	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3046
6-73 PART B

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO	128EL66059		K5
				MFG PART NO	SER NO	
				EO CONT NO 128EL4116	SH NO 17	

CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE	REFERENCE DESIGNATOR/ROUTE LETTERS K	REFERENCE DESIGNATOR/ROUTE LETTERS E	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BP) *	X	X					
			(BR) *	X	X					
			(BM) *	X	X					
			(BN) *	X	X					
			(BS) *	X	X					
ADD			(BT) *	X	X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY

PLT	DEPT	MODEL	TYPE	EFFECTIVITY FROM	THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT			DASH NO	REV
		26512	EO	128EL66 033		K2

MFG PART NO

SER NO

EO CONT NO. 128EL4116

SH NO 18

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS T	K	E	C	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFEC TIVITY
ADD			66014 (BP) *	X	X	X	X					
			(BR) *	X	X	X	X					
			(BM) *	X	X	X	X					
			(BN) *	X	X	X	X					
			(BS) *	X	X	X	X					
ADD			(BT) *	X	X	X	X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

GAC 3046 6-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL66058	DASH NO	REV F1
⊘ = 12A707-P1 ⊠ = 12A708-S1 □ = 12A706-R1 } EQUIP INSIDE AREA					MFG PART NO	SER NO	
					EO CONT NO 128EL4116	SH NO 19	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS ⊘	□	⊠	D	A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	Δ		66014 (BP) *	F			X	X		1			
	⊗		(BR) *	F			X	X					
	Δ		(BM) *		F		X	X					
	⊗		(BN) *		F		X	X					
	Δ		(BS) *			F		X		2			
ADD	⊗		(BT) *			F		X		3			

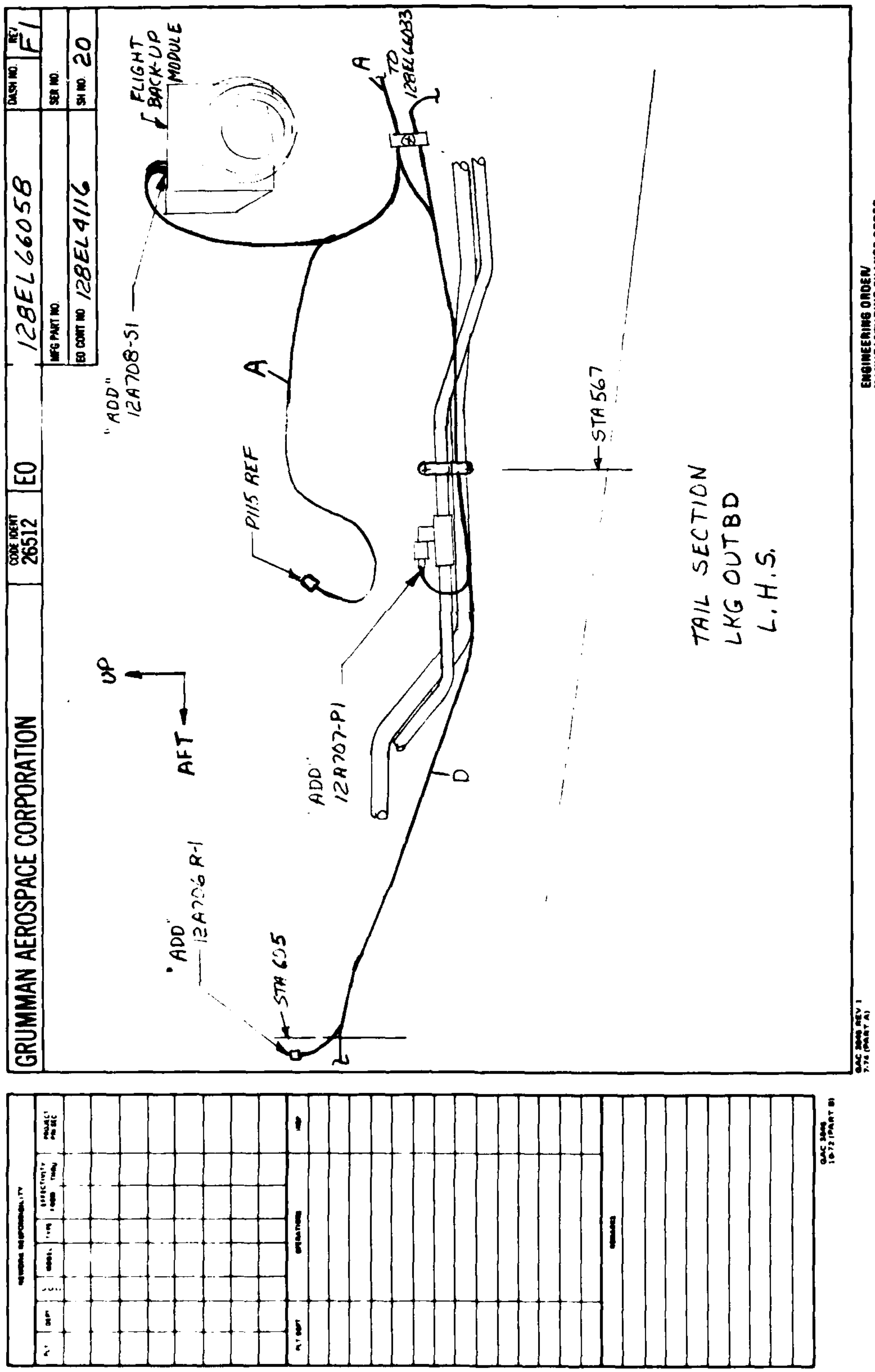
ACTION	ITEM NO	HARDWARE REQUIREMENTS
EQUIP OUTSIDE AREA		Δ = 12A711-P1 ⊗ = SPLICE AREA

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY

OPERATIONS

REMARKS


GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
128EL6605B
MFG PART NO.
EO CONT NO 128EL4116
DASH NO.
REV F1
SER NO.
SH NO. 20
FLIGHT BACK-UP MODULE
A
TO 128EL6033
"ADD" 12A708-51
A
P115 REF
STA 567
TAIL SECTION
LKG OUTBD
L.H.S.
UP
AFT
'ADD' 12A707-P1
D
'ADD' 12A706 R-1
STA 635
ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO	12BEL66047		L4

EQUIP INSIDE AREA } 3 = J6045

MFG PART NO

EO CONT NO 12BEL4116

SER NO

SH NO 21

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS: 3	REFERENCE DESIGNATOR/ROUTE LETTERS: A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	Δ		6601 (BY) *	F	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS
EQUIP OUTSIDE AREA		Δ = 12A705-R1

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY					
PLT	DEP	MODEL	TYPE	EFFECTIVITY FROM / THRU	PROJECT PRI. SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3846 4-73 (PART B)

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT			DASH NO	REV
		26512	EO	128EL66010		L1
				MFG PART NO	SER NO	
				EO CONT NO 128EL4116	SH NO 22	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS F	REFERENCE DESIGNATOR/ROUTE LETTERS C	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BY) *	X	X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

GAC 3846 4-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128EL66013	DASH NO	REV L4
					MFG PART NO	SER NO	
					EO CONT NO 128EL4116	SH NO 23	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS: F	REFERENCE DESIGNATOR/ROUTE LETTERS: B	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BY)*	X	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS

GAC 3048 6-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

REWORK RESPONSIBILITY							
PLT	DEPT	C	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PH SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3048 6-73 (PART B)

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO	12BEL 66060		L1

EQUIP INSIDE AREA } Δ = 12A705-R1

MFG PART NO | SER NO

EO CONT NO 12BEL 4116 | SH NO 24

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12BAV	REFERENCE DESIGNATOR/ROUTE LETTERS Δ	E	C	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	Ø		66014 (BY)*	F	X	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS
EQUIP OUTSIDE AREA		Ø = J6045

GAC 3046 6-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

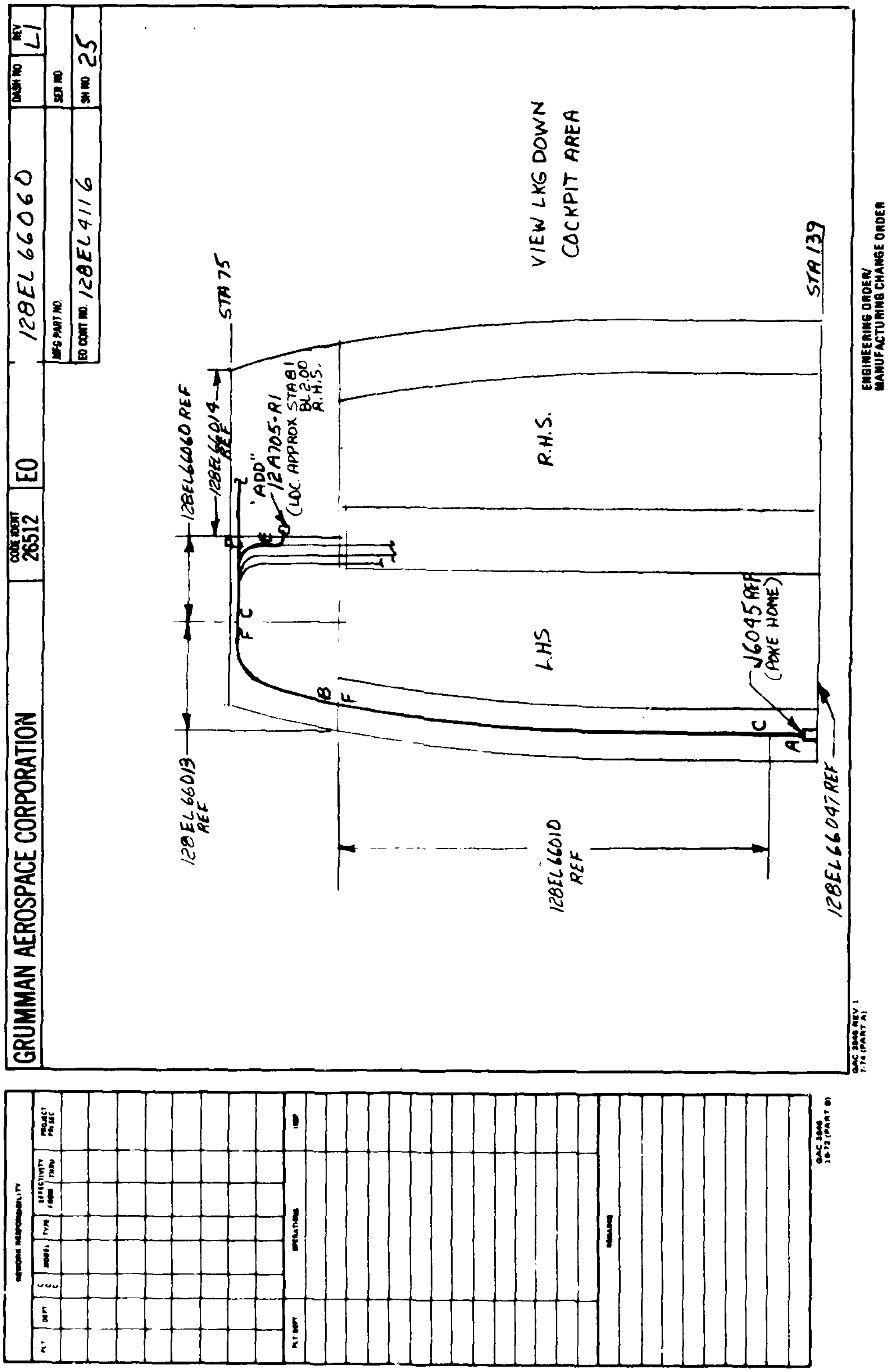
REWORK RESPONSIBILITY

PLT	DEPT		MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

PLT DEPT	OPERATIONS	INSP

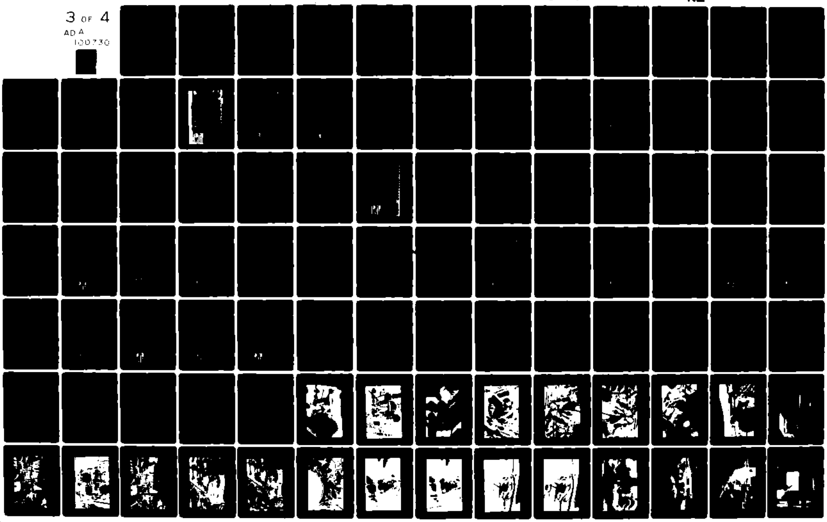
REMARKS

GAC 3046 6-73 (PART B)


GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
128EL66060
DASH NO
REV L1
MFG PART NO
SER NO
EO CONT NO. 128EL4116
SH NO 25
VIEW LKG DOWN COCKPIT AREA
STA 75
STA 139
R.H.S.
L.HS
128EL66060 REF
128EL66014 REF
"ADD" 12A705-R1
(LOC. APPROX STA 81 BL 2.00 R.H.S.
J6045 REF (POKE HOME)
128EL66013 REF
128EL66010 REF
128EL66047 REF
ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

AD-A100 730 GRUMMAN AEROSPACE CORP BETHPAGE NY F/G 14/2
HYDRAULIC DIAGNOSTIC MONITORING SYSTEM.(U)
MAR 81 J J DUZICH N62269-78-C-0041
UNCLASSIFIED NADC-TR-81073-60 NL

3 OF 4
AD A
100730



GRUMMAN AEROSPACE CORPORATION | SEQ NO | CODE IDENT 26512 | EO NOTED 128 EL 6604 | DASH NO | W/O | REV K5

MFG PART NO | MCO REV ACD | ECP | PRIORITY C | ☐ ACTION ☐ NO ACTION | DET SPEC | CHG CL I | EO CONT NO 128EL4222

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI | ACFT NO | CONFIG REQ D/CONFIG NOT REQ D

CONTRACT NO N62269-78-C-0041 | REPLACES PART NO | SH 1 OF 7

DWG TITLE SEE DWGS

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	NAVAIR LTR 21411:TK,79-149, 1-31-79	A-6E		M229

THIS IS A RECORD E.O.

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DDC	REF EO SH
EO	128EL66053	K5	52	✓		1,3
EO	128EL66019	M3	44	✓		1,4
EO	128EL66024	M3	46	✓		1,5
EO	128EL66038	J2	26	✓		1,6,7
EO	128EL66041	K5	28	✓		1,2

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		128EL66041-1									I	2	1
		128EL66038-1									I	2	1
~		128EL66024-1									I	2	1
~		128EL66019-1									I	2	1
~		128EL66053-1									I	2	1

REASON FOR CHANGE
INSTL OF HYDRAULIC CHECK-OUT SYSTEM (HYCOS) IN A/C FOR INSTRUMENTATION PURPOSES

DESCRIPTION OF CHANGE
ON DWGS NOTED ABOVE ADDED WIRING RUNS

PREPARED BY J. Bohn
SECTION E/M LINES
PLANT/GROUP 40 332
DATE – EXT 4-19-79 x 6170

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]	RWD/WEA		[illegible]			[illegible]	[illegible]	[illegible]
DATE	4-25-79	4-26-79		4/5/79			4/26/79	5-9-79	5-21-79

EO TYPE: DIRECT DWG CHG (DDC) [ ] REV DWG [ ] PROD ENGRG [ ] RECORD EO [X] IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 = USE; 6 = HOLD; 7 = NO ACTION 8 = ACCEPT I&T IDENT AND TRACEABILITY

GAC 3044 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128FL66041	DASH NO	REV K5
					MFG PART NO	SER NO	
					EO CONT NO 128EL4222	SH NO 2	

ACTION		QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF		EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
										1	2M11-TK79143 31-JAN'79	A-6E		M229

FOR DWG 128EL66041 REF E.O. K2
ON SH 3: FOR CALLOUT "54" IN EQUIP OUTSIDE OF AREA
REMOVE "STA 139 BLKHD - L.H. FILLET - P6045 &
ADD: RUDDER CONTROL SYS - TOP DECK STA 233 - 12A705A-1 FOR C/O "54"

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F

GAC 3047 10-72 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SFO NO	CODE IDENT	EO	NUMBER	DASH NO	M/B	REV
	26512	EO NOTED	128 EL 66047			M2

MFG PART NO | MCO REV ACD | ECP | PRIORITY C | DET SPEC | CHG EI I | EO CONT NO 128EL 4224

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI | ACFT NO | CONFIG REQ D/CONFIG NOT REQ D

CONTRACT NO N62269-78-C-0041

REPLACES PART NO | SH 1 OF 1

DWG TITLE SEE DWGS.

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411:TK79-143 31-JAN-79	A-6E		N239

THIS IS A RECORD E.O.

THIS E.O CANCELS
128EL66010 L1
128EL 66013 L4
128EL 66047 L4
128EL 66060 L1

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DDC	REF EO SH
EO	128EL66010	L4	47	✓		
EO	128EL66013	M1	34	✓		
EO	128EL66047	M2	60	✓		
EO	128EL66060	L4	41	✓		

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		128EL66060-1									1	2	1
~		128EL66047-1									1	2	1
~		128EL66013-1									1	2	1
~		128EL66010-1									1	2	1

REASON FOR CHANGE
RELOCATED INSTRUMENTATION FOR HYCOS CHECK-OUT SYS FROM COCKPIT RUDDER PEDALS TO AILERON CONTROLS IN 70P DECK

DESCRIPTION OF CHANGE
CANCELED EO 128EL66010 L1 128EL66013 L4
128EL66047 L4 & 128EL66060 L1

PREPARED BY J. Bohun
SECTION E/M LINES
PLANT/GROUP 40 - 332
DATE - EXT 4-17-79 X6120

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	GAC
DATE	4-25-79	4 26 79		4/5/79			4/26/79	5.8.79	

EO TYPE: DIRECT DWG CHG (DDC) [ ] REV DWG [X] PROD ENGRG [ ] RECORD EO [ ]
IAD 1 = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM
SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT I&T IDENT AND TRACEABILITY

GAC 3044 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO NOTED		DASH NO	M/R	REV
	26512	128 EL 66053				K5

MFG PART NO: | MCO REV: ACD | ECP | PRIORITY: C | ☐ ACTION ☐ NO ACTION | DET SPEC: | CHG CL: I | EO CONT NO: 128EL4222

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY/EI
						ACFT NO / CONFIG REQ D/CONFIG NOT REQ D	

CONTRACT NO: N62269-78-C-0091 | REPLACES PART NO: | SH 1 OF 7

DWG TITLE: SEE DWGS

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	NAVAIR LTR 21411: TK, 79-148, 1-31-79	A-6E		M229

THIS IS A RECORD E.O.

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DDC	REF EO SH
EO	128EL66053	K5	52	✓		1, 3
EO	128EL66019	M3	44	✓		1, 4
EO	128EL66024	M3	46	✓		1, 5
EO	128EL66038	J2	26	✓		1, 6, 7
EO	128EL66041	K5	28	✓		1, 2

ACTION	QTY PER ASSY					PART NUMBER	G/T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO.	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~						128EL66041-1									I	2	1
						128EL66038-1									I	2	1
~						128EL66024-1									I	2	1
~						128EL66019-1									I	2	1
~						128EL66053-1									I	2	1

REASON FOR CHANGE: INSTL OF HYDRAULIC CHECK-OUT SYSTEM (HYCOS) IN A/C FOR INSTRUMENTATION PURPOSES

DESCRIPTION OF CHANGE: ON DWGS NOTED ABOVE ADDED WIRING RUNS

PREPARED BY: J. Bohun

SECTION: E/M LINES

PLANT GROUP: 40 332

DATE - EXT: 4-19-79 X 6170

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASED	CUSTOMER
SIGNATURE	[illegible]	RWD/NCA		[illegible]			[illegible]	[illegible]	[illegible]
DATE	4-25-79	4-26-79		[illegible]			4/26/79	5-9-79	5-21-79

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ | IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT | I&T IDENT AND TRACEABILITY

GAC 3044 REV 1 8-77 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CO...ENT	EO		DASH	REV
		26512	EO	12BEL 66053		K5

EQUIP INSIDE AREA { 1 = P6145

AEF EO K2 (SH B.00)

MFG PART NO | SER NO

EO CONT NO 12BEL 4222 | SH NO 3

REFERENCE DESIGNATOR/ROUTE LETTERS

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12BAV	1	BI	D	C	A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BW)*		X	X	X						
ADD			(BX)*		X	X	X						
REMOVE	Δ		(BW)*	T	X		X						
REMOVE	Ø		66014 (BX)*	T	X		X						

ACTION	ITEM NO.	HARDWARE REQUIREMENTS
EQUIP OUTSIDE AREA		Δ - 12N711-P1 Ø = SPLICE AREA

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION

FSCM IDENT	26512
EO	NOTED
EO NO.	128 EL 66058
REV	F1
MFR/REV	ACD
	ECP
PRIORITY	C
	128EL4116
CONTRACT NO	N62269-78-C-0041
DWG TITLE	SIE DWGS
SH	1 OF 25
AUTHORITY	21411 TN 79-143 3/ 12-1-79
MODEL	A6E
GAC UNIT NO	M229

THIS IS A RECORD E.O.

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DDC	REF EO SH
EO	128EL66041	K2	25	✓		1,3,4,5,6,7
EO	128EL66053	K2	49	✓		1,8,9,10
EO	128EL66023	M7	57	✓		1,11,12
EO	128EL66021	L2	53	✓		1,13
EO	128EL66052	H3	36	✓		1,14
EO	128EL66030	H6	38	✓		1,15
EO	128EL66032	H4	33	✓		1,16
EO	128EL66059	K5	34	✓		1,17
EO	128EL66033	K2	27	✓		2,18
EO	128EL66058	F1	7	✓		2,13,20
EO	128EL66013	L4	31	✓		2,23
EO	128EL66010	L1	44	✓		2,22
EO	128EL66047	L4	56	✓		2,21
EO	128EL66060	L1	38	✓		2,24,25

ACTION	PART NUMBER	I A B	S B	E F F
~	128EL66059-1			
~	128EL66032-1			
~	128EL66030-1			
~	128EL66052-1			
~	128EL66021-1			
~	128EL66023-1	I	2	1
~	128EL66053-1	I	2	1
~	128EL66041-1			

REASON FOR CHANGE: INSTL OF HYDRAULIC CHECKOUT SYS (HYCOS) IN A/C FOR INSTRUMENTATION PURPOSES

DESCRIPTION OF CHANGE: ON DWGS NOTED ABOVE ADDED WIRING RUNS

PREPARED BY	J. BoHUN
SECTION	E/M LINES
PLANT GROUP	40 332
DATE / EXT	2-20-79 X6170

	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
DATE	2-20-79	2-22-79		2-1-79			2-21-79	2-23-79	3-1-79

EO TYPE: DIRECT DWG CHG (DDC) ( ) REV DWG ( ) PROD ENGRG ( ) RECORD EO (X) — IAD 1 INSTL A ASSY D DETAIL M MAKE FROM

SD RECM STK DISPN 1 DISPOSE 2 REWORK 3 INCREASE 4 CREATE 5 USE 6 HOLD 7 NO ACTION 8 ACCEPT I&T IDENT AND TRACEABILITY

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
		26512	EO NOTED	128 EL 66058		F1
				MFG PART NO	SER NO	
				EO CONT NO 128 EL 4116	SH NO 2	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21411: TK 77-143	A 6E		M227

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DDC	REF EO SH
EO						
EO						

THIS IS A RECORD E.O.

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL CODE IDENT	SPECIFICATION COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		128EL66060-1												
~		128EL66047-1										I	2	1
~		128EL 66010-1										I	2	1
~		128EL 66013-1										I	2	1
~		128EL 66058-1										I	2	1
~		128EL 66033-1										I	2	1

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SEQ NO | CODE IDENT 26512 | EO NOTED | 128 EL 66060 | DASH NO | M-B | REV L4

MFG PART NO | MCO REV ACD | ECP | PRIORITY C | ( ) ACTION ( ) NO ACTION | DET SPEC | CHG CL I | EO CONT NO 128EL-1221

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI

ACFT NO | CONFIG REQ D/CONFIG NOT REQ D

CONTRACT NO N62269-78 C-0041 | REPLACES PART NO | SH 1 OF 1

DWG TITLE SEE DWGS.

ACTION	QTY/NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21411: TK 79-143 31-JAN 79	A6E		M229

THIS IS A RECORD E.D.

	ENGINEERING ORDER DRAWING NUMBER	REV	SEQ NO	REV DWG	DDC	REF EO SH
EO	128EL66010	L4	47	✓		
EO	128EL66013	M1	34	✓		
EO	128EL66047	M2	60	✓		
EO	128EL66060	L4	41	✓		

THIS E.O CANCELS
128EL66010 L1
128EL 66013 L4
128EL 66047 L4
128EL 66060 L1

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	A D	S D	E F F
~		128EL66060-1									1	2	1
~		128EL66047-1									1	2	1
~		128EL66013-1									1	2	1
~		128EL66010-1									1	2	1

REASON FOR CHANGE
RELOCATED INSTRUMENTATION FOR HYCOS CHECK-OUT SYS FROM COCKPIT RUDDER PEDALS TO AILERON CONTROLS ON TOP DECK

DESCRIPTION OF CHANGE
CANCELED EO 128EL66010 L1 128EL66013 L4 128EL66047 L4 & 128EL66060 L1

PREPARED BY J. Bohun
SECTION E/M LINES
PLANT/GROUP 40 - 332
DATE - EXT 4-17-79 X6120

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE									(GAC)
DATE	4-25-79	4 26 79		4/31/79			4/26/79	5-8-79	

EO TYPE | DIRECT DWG CHG (DDC) ( ) | REV DWG (X) | PROD ENGRG ( ) | RECORD EO ( ) | IAD: I - INSTL, A - ASSY, D - DETAIL, M - MAKE FROM

SD - RECM STK DISPN 1 - DISPOSE, 2 - REWORK, 3 - INCREASE, 4 - CREATE, 5 - USE, 6 - HOLD, 7 - NO ACTION 8 ACCEPT | I&T IDENT AND TRACEABILITY

GAC 3044 REV 1 9-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SEQ NO | CODE IDENT 26512 | EO NOTED | DASH NO | M & | PLV

MFG PART NO | MCO REV ACD | ECP | PRIO-RITY C | ACTION / NO ACTION | OFT SPEC | CHG CL I | EO CONT NO 129EL4222

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI

ACFT NO | CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO N62269-78-C-0091 | REPLACES PART NO | SH 1 OF 7

DWG TITLE SEE DWGS

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	NAVAIR LTR 21441:TK,79-148,1-31,79	A-6E		M229

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DOC	REF EO SH
EO	128EL66053	K5	52	✓		1,3
EO	128EL66019	M3	44	✓		1,4
EO	128EL66024	M3	46	✓		1,5
EO	128EL66038	J2	26	✓		1,6,7
EO	128EL66041	K5	28	✓		1,2

THIS IS A RECORD E.O.

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
~		128EL66091-1									I	2	1
		128EL66038-1									I	2	1
~		128EL66024-1									1	2	1
~		128EL66019-1									1	2	1
~		128EL66053-1									1	2	1

REASON FOR CHANGE
INSTL OF HYDRAULIC CHECKOUT SYSTEM (HYCOS) IN A/C FOR INSTRUMENTATION PURPOSES

DESCRIPTION OF CHANGE
ON DWGS NOTED ABOVE ADDED WIRING RUNS

PREPARED BY J. Buhon
SECTION F/M C.INC.
PLANT GROUP 4
DATE - EXT

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE GB	CUSTOMER
SIGNATURE	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]
DATE	4-5-79	4-6					4/6/79	5-9-79	5-21-79

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ | IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD: RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT | I&T = IDENT AND TRACEABILITY

GAC 3944 REV 1

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	12BEL66091	DASH NO	REV K5
					MFG PART NO	SER NO	
					EO CONT NO 12BEL4222	SH NO 2	

ACTION	QTY/NA	QTY. EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
								1	21411-TK79143 31-JAN'79	A-6E		M229

FOR DWG 12BEL66091, REF E.O. K2
ON SH 3 - FOR CALLOUT "59" IN EQUIP OUTSIDE OF AREA
REMOVE "STA 139 BLKHD-L.H. FILLET - P6045 ℄
ADD: RUDDER CONTROL SYS-TOP DECK STA 233 - 12A705A-1 FOR C/O "59"

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT · COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I & D	S D	EFF

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION | PRIORITY | SEQ NO | CODE IDENT 26512 | EO 12BEL 66053 | DASH NO | REV K5

EQUIP 1 = P6045 } REF EO K2 (SH 8.00)

MFG PART NO | SER NO

EO CONT NO 12BEL 4272 | SH NO 3

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 12AAV	REFERENCE DESIGNATOR/ROUTE LETTERS: 1	B1	D	C	A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BW)*		X	X	X						
ADD			(BX)*		X	X	X						
REMOVE	Δ		(BW)*	T	X		X						
REMOVE	⊘		66014 (BX)*	T	X		X						

ACTION	ITEM NO	HARDWARE REQUIREMENTS
[illegible]	[illegible]	[illegible]

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT	EO		DASH NO	REV
			26512	EO	128EL66019		M3
					MFG PART NO	SER NO	
					EO CONT NO 128EL1222	SH NO 4	

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS: N	H	F	D	A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66014 (BW)*	X	X	X	X	X					
ADD			66014 (BX)*	X	X	X	X	X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

GAC 7995 6-73 PART 4

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION

PRIORITY	SEQ NO	CODE IDENT			DASH NO	REV
		26512	EO	128EL 66024		M3
			MFG PART NO		SER NO	
			EO CONT NO	128EL ????	SH NO	5

ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY: 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS: E	REFERENCE DESIGNATOR/ROUTE LETTERS: A	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD			66019 (BW) *	X	X					
ADD			66014 (BX) *	X	X					

ACTION	ITEM NO	HARDWARE REQUIREMENTS

GAC 2046 6-73 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION | PRIORITY | SEQ NO | CODE IDENT 26512 | EO 12BEL66038 | DASH NO. | REV J2

EQUIP INSIDE AREA } △ = 12A705R-1 RUDDER CONTROL SYS

MFG PART NO | SER NO

EO CONT NO 12BEL1222 | SH NO 6

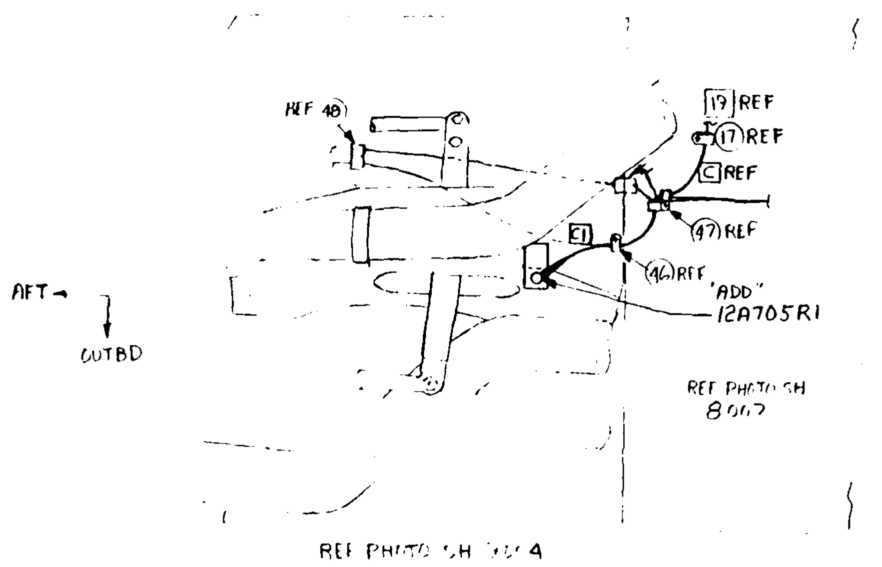
ACTION	REFERENCE DESIGNATION	ELECTROMAGNETIC COMPATIBILITY	CABLE ASSEMBLY AND ROUTING CODE ALL CABLES ARE PREFIXED BY 128AV	REFERENCE DESIGNATOR/ROUTE LETTERS: △	C1	C	G (GROUND)	S (SPLICE)	SEE NOTE	STOCK DISPOSITION	EFFECTIVITY
ADD	⊘		66014 (AW)*	F	X	X					
ADD	⊠		66C14 (BX)*	F	X	X					

ACTION	ITEM NO.	HARDWARE REQUIREMENTS
EQUIP INSIDE AREA		⊘ = 12A7171 DISPLAY PANEL ⊠ = SPARE AREA (LH DOOR)

GAC 7946

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER
SUPPLEMENT

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO	128EL66038	DASH NO	REV J2
			MFG PART NO	SER NO	
			EO CONT NO 128EL4222	SH NO 7	



GAC 3846 REV 1

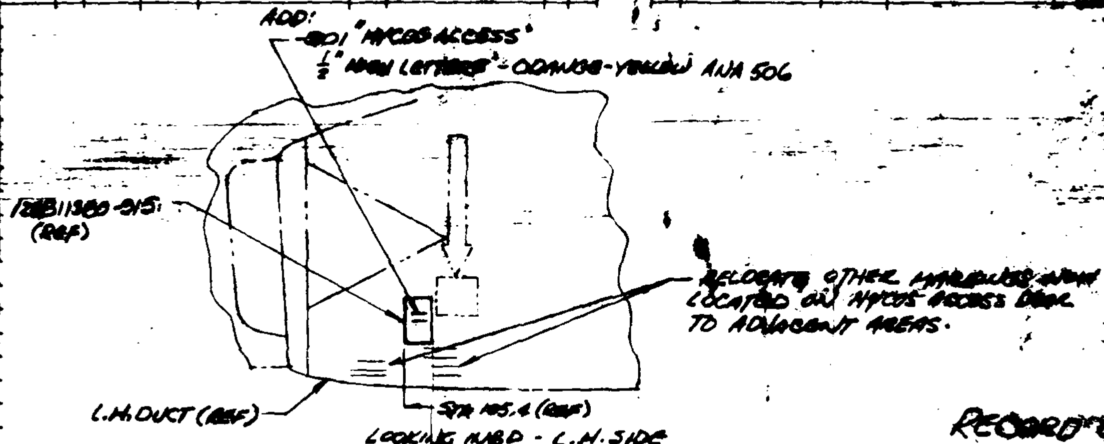
ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONTRACT NO N62269-78-C-0041

E.O. TITLE EXTERIOR MARKINGS - A-6E

REPLACES PART NO.

ACTION	QTY/ASSY	QTY/E	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SH	EFF	EFF	AUTHORITY	MODEL	
								/			



RECORD E.O.

ACTION	QTY PER ASSY	PART NUMBER		NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO.	MATERIAL SPECIFICATION	PROC	FIN.	
		-901		MARKING						
		-5		EXTERIOR MARKINGS						

REASON FOR CHANGE: ADD HYCOS ACCESS MARKING TO PANEL

DESCRIPTION OF CHANGE: ADD -901 "HYCOS ACCESS"

PREPARED BY	R. ELLINGSON	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGR
SECTION	CREW SYSTEMS	SIGNATURE	[illegible]			[illegible]	
PLANT/GROUP	40 356	DATE	9-26-79			9/26/79	
DATE - EXT	9/25/79 15-6/80						

GRUMMAN AEROSPACE CORPORATION

SEQ NO	
CODE IDENT	26512
EO NOTED	128ELCC021
DASH NO	
M/B	
REV	L2
MFG PART NO	
MCO REV	ACD
ECP	
PRIORITY	C
ACTION / NO ACTION	
DET SPEC	
CHG CL	1
CONT NO	128EL4116
CONTRACT NO	N62269-78-C-0041
REPLACES PART NO	
SH	1 OF 25
DWG TITLE	SEE DWGS
	559
EFF	1
AUTHORITY	21411-TK79-143 31-JAN-79
MODEL	A-6E
END ITEM	
GAC UNIT NO	M229

THIS IS A RECORD E.O.

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO	REV DWG	DOC	REF EO SH
EO	128EL66041	K2	25	✓		1,3,4,5,6,7
EO	128EL66053	K2	40	✓		1,8,9,10
EO	128EL66023	M7	57	✓		1,11,12
EO	128EL66021	L2	53	✓		1,13
EO	128EL66052	H9	96	✓		1,14
EO	128EL66030	H6	38	✓		1,15
EO	128EL66032	H4	33	✓		1,16
EO	128EL66059	K5	34	✓		1,17
EO	128EL66033	K2	27	✓		2,18
EO	128EL66058	F1	7	✓		2,19,20
EO	128EL66013	L4	31	✓		2,23
EO	128EL66010	L1	44	✓		2,22
EO	128EL66047	L4	56	✓		2,21
EO	128EL66060	L1	38	✓		2,24,25

ACTION	QTY PER ASSY	PART NUMBER	I&T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		128EL66059-1											
~		128EL66032-1											
~		128EL66030-1											
~		128EL66052-1											
~		128EL66021-1											
~		128EL66023-1									I	2	1
~		128EL66053-1									I	2	1
~		128EL66041-1											

REASON FOR CHANGE: INSTL OF HYDRAULIC CHECKOUT SYS (HYCOS) IN A/C FOR INSTRUMENTATION PURPOSES

DESCRIPTION OF CHANGE: ON DWGS NOTED ABOVE ADDED WIRING RUNS

PREPARED BY: J. BOHUN
SECTION: E/M LINES
PLANT GROUP: 40 332
DATE – EXT: 2-20-79 X6170

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]	[signature]		[signature]		[signature]	[signature]	[signature]
DATE	2-20-79	2-22-79		2/26/79		2-27-79		3-1-79

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ IAD: I = INSTL; A = ASSY; D = DETAIL; M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 = USE; 6 = HOLD; 7 = NO ACTION 8 = ACCEPT I&T = IDENT AND TRACEABILITY

GAC 3844 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

PART NUMBER

CONTROL NOR REFERENCE DRAWING NO

DISP / INSP

PART SERIAL NO / PART LOT NO

END ITEM NO

VEHICLE S/N / MAJOR ASSY ID

VENDOR RESPONSIBILITY

PT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PROJEC

INSP PLT / DATE

DUE IN STOCK DATE

DATE RECD

GAC 3844 REV 1 6-77 (PART B)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO | PART NUMBER | CONTROL WORK REFERENCE DRAWING NC | DISP | NSP | PART SERIAL NC | PART LOT NO | END ITEM NO | MOD TYPE | VEHICLE S N | MAJOR ASSY ID | REVIEW RESPONSIBILITY

PLT	DEPT	C C C	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI-SEC

PROCESSED BY | INSP PLT | DATE
ADDITIONAL COPIES TO
REMARKS
DATE ISSUED | DUE IN STOCK DATE
DESTINATION | DATE REC D
COVERAGE

GAC 3844 REV 1 8-77 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO 88	CODE IDENT 26512	EO	128AV66014	DASH NO	M-B	REV U5
MFG PART NO	MCO REV ACD	ECP	PRIORITY C	☐ ACTION ☐ NO ACTION	DET SPEC	CHG CL 1	EO CONT NO 128EAV:678
PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY EI
						ACFT NO	CONFIG REQ D CONFIG NOT REQ D
CONTRACT NO N62269-78-C-0041					REPLACES PART NO	SH 1 OF 8
DWG TITLE INSTALLATION DWG: FUSELAGE						

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
ADD	1	1	-901		128EL66041	4	1	1	*	A6E		M229

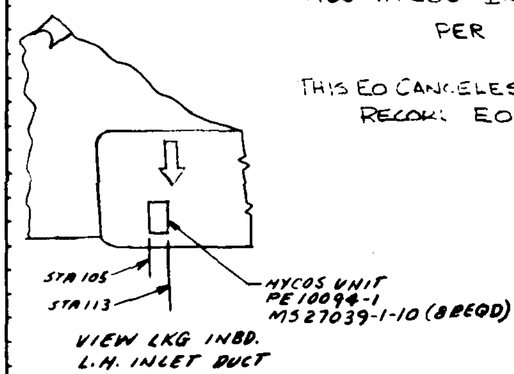
CREATE -901 AS SHOWN

*AIR21411: TK 79-143 JAN 31, 1979

ADD HYCOS INSTRUMENTATION WIRING AS SHOWN
PER ATTACHED SHEETS

THIS EO CANCELES AND SUPERSEDES
RECORD EO U3

NOTE: REVISED WIRING CHANGES ARE
ON THE FOLLOWING SHEETS 3,4,5,6 & 7



DO NOT INCORPORATE ON DWG NOTE:
A/C WILL BE RETURNED TO ORIGINAL
CONFIGURATION PRIOR TO COMPLETION
OF CONTRACT N62269-78-C-0041

"RECORD EO"

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F

REASON FOR CHANGE
INSTALLATION OF HYDRAULIC CHECK OUT SYSTEM (HYCOS) IN A/C FOR INSTRUMENTATION PURPOSES

DESCRIPTION OF CHANGE
ADDED HYCOS WIRING

PREPARED BY M MILIORE	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE 63	CUSTOMER
SECTION EED	SIGNATURE	[signature]	[signature]					[signature]	[signature]	GAC
PLANT GROUP 40-543	DATE	4-27-79	4/4/79						4-27-79	
DATE – EXT 4-27-79 115-6171	EO TYPE	DIRECT DWG CHG (DDC) ☐	REV DWG ☐	PROD ENGRG ☐	RECORD EO ✓		IAD, I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM			
	SD = PECM STK DISP: 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION						R = ACCEPT	I&T = IDENT AND TRACEABILITY		

GAC 3844 REV 1 8-77 (PART A)

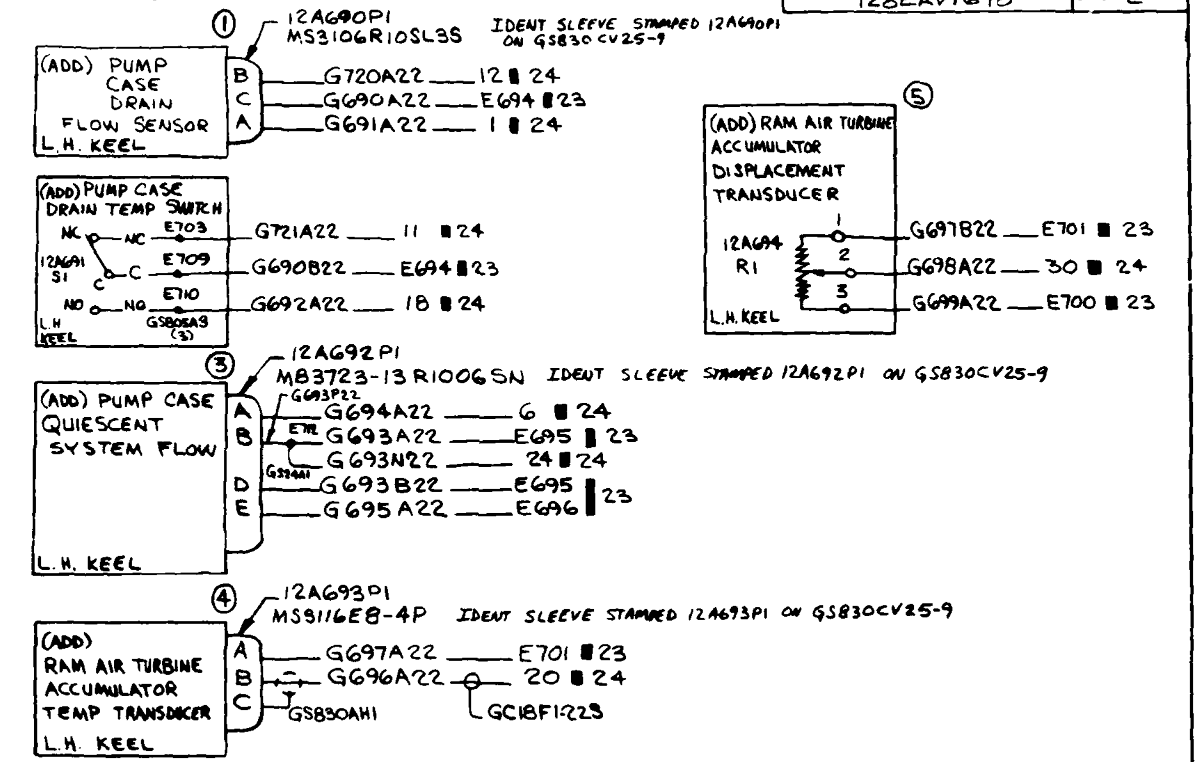
ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION | CODE IDENT 26512 | EO | 128AV66014 | DASH NO | REV U5

MFG PART NO. | SER NO.

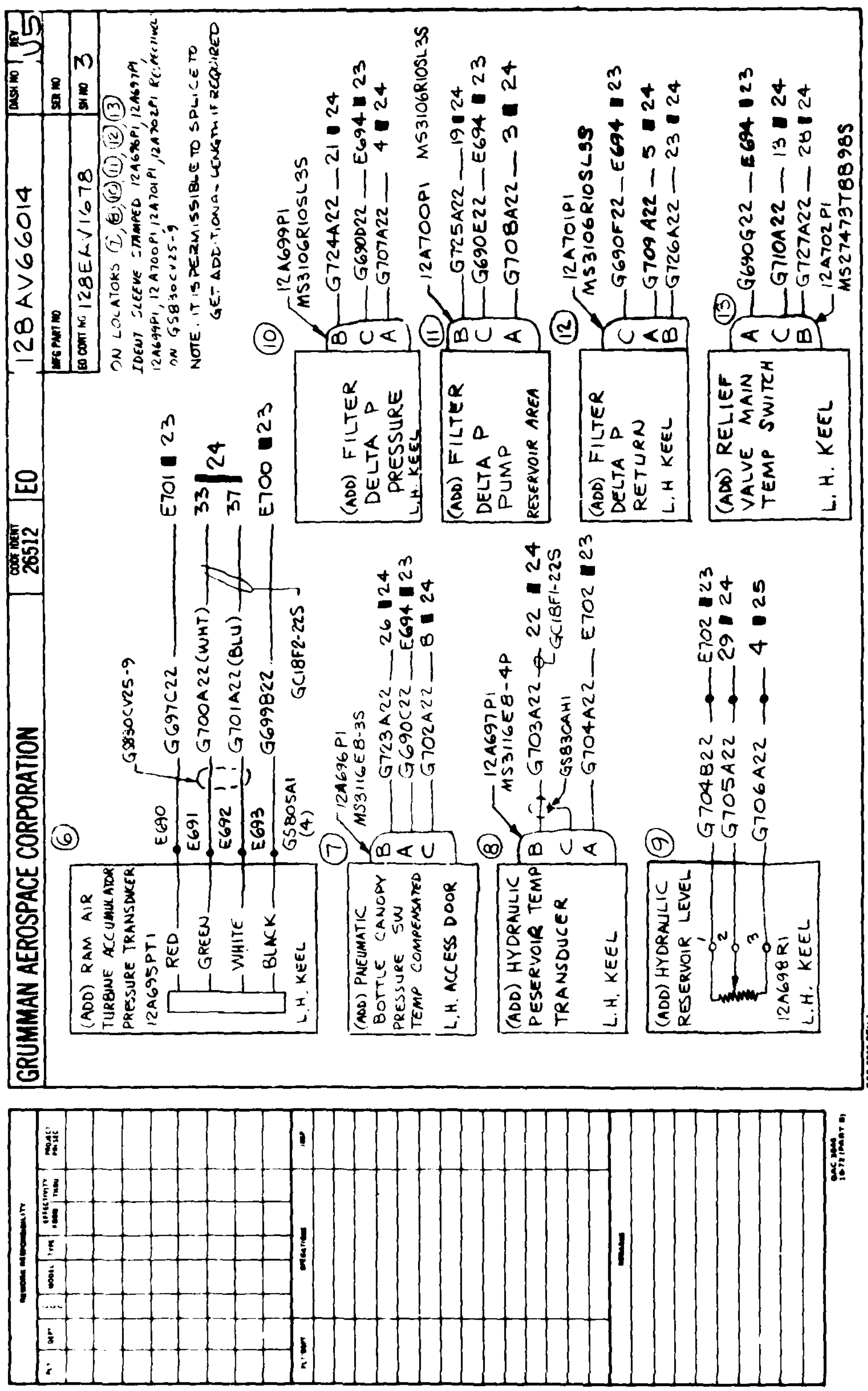
EO CONT NO 128EAV1678 | SH NO 2

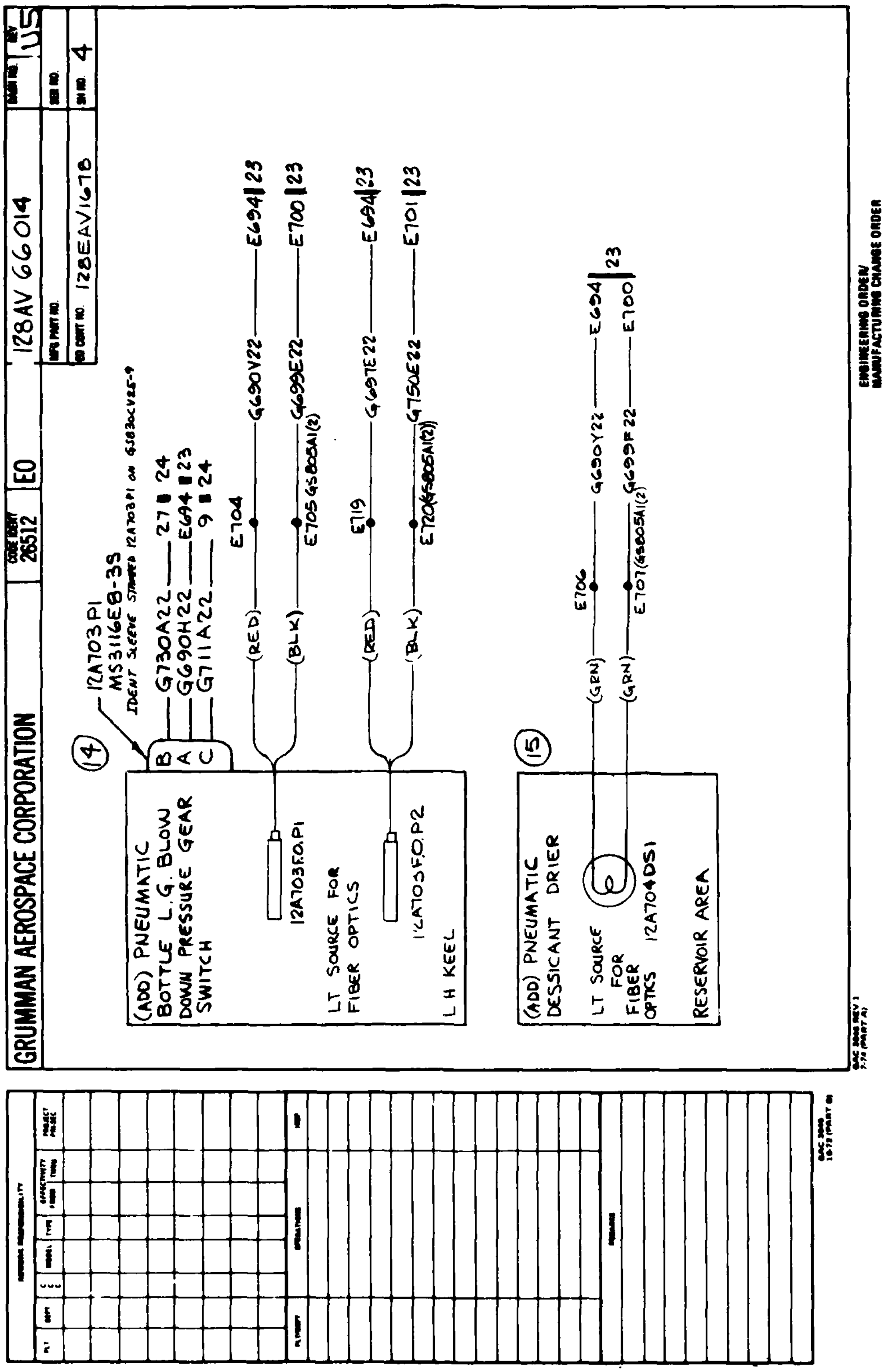
NOTE: ALL WIRES TO BE GW805BS22-9 UNLESS OTHER WISE NOTED

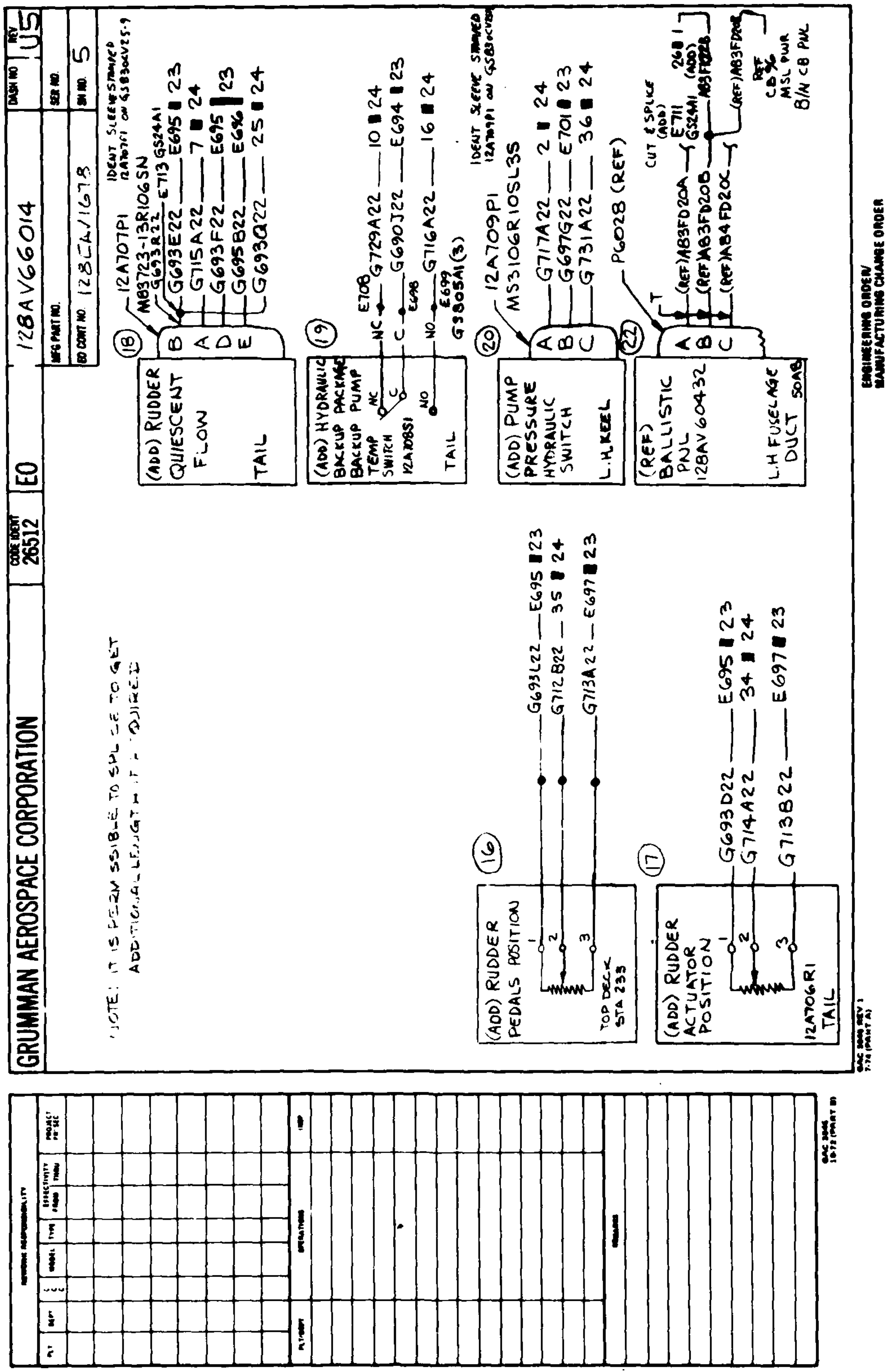


GAC 2065 REV 1 7-74 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER


GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
128AV66014
EO CONT NO 128EA/1678
SH NO 3
ON LOCATORS 7, 8, 10, 11, 12, 13 IDENT SLEEVE STAMPED 12A696P1, 12A697P1, 12A699P1, 12A700P1, 12A701P1, 12A702P1 RESPECTIVELY ON GS830CV25-9
NOTE: IT IS PERMISSIBLE TO SPLICE TO GET ADDITIONAL LENGTH IF REQUIRED
(ADD) RAM AIR TURBINE ACCUMULATOR PRESSURE TRANSDUCER 12A695PT1
RED
GREEN
WHITE
BLACK
L.H. KEEL
G697C22
G700A22 (WHT)
G701A22 (BLU)
G699B22
E701 23
E700 23
GC18F2-22S
GS805A1
(ADD) PNEUMATIC BOTTLE CANOPY PRESSURE SW TEMP COMPENSATED
L.H. ACCESS DOOR
12A696P1
MS3116E8-3S
G723A22
G690C22
G702A22
(ADD) HYDRAULIC RESERVOIR TEMP TRANSDUCER
12A697P1
MS3116E8-4P
G703A22
G704A22
GS830AH1
GC18F1-22S
(ADD) HYDRAULIC RESERVOIR LEVEL
12A698R1
G704B22
G705A22
G706A22
(ADD) FILTER DELTA P PRESSURE
L.H. KEEL
12A699P1
MS3106R10SL3S
G724A22
G690D22
G707A22
(ADD) FILTER DELTA P PUMP
RESERVOIR AREA
12A700P1
MS3106R10SL3S
G725A22
G690E22
G708A22
(ADD) FILTER DELTA P RETURN
L.H. KEEL
12A701P1
MS3106R10SL3S
G690F22
G709A22
G726A22
(ADD) RELIEF VALVE MAIN TEMP SWITCH
L.H. KEEL
12A702P1
MS27473T8B98S
G690G22
G710A22
G727A22
ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER


GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
128AV66014
REV U5
SH NO 4
EO CERT NO 128EAV1678
(ADD) PNEUMATIC BOTTLE L.G. BLOW DOWN PRESSURE GEAR SWITCH
12A703P1
MS3116E8-3S
B A C
G730A22 27 24
G690H22 E694 23
G711A22 9 24
(RED) E704 G690Y22 E694 23
(BLK) E705 G699E22 E700 23
(RED) E719 G697E22 E694 23
(BLK) E720 G750E22 E701 23
12A703F.O.P1
12A705F.O.P2
LT SOURCE FOR FIBER OPTICS
L H KEEL
(ADD) PNEUMATIC DESSICANT DRIER
LT SOURCE FOR FIBER OPTICS
12A704DS1
(GRN) E706 G690Y22 E694 23
(GRN) E707 G699F22 E700
RESERVOIR AREA
ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

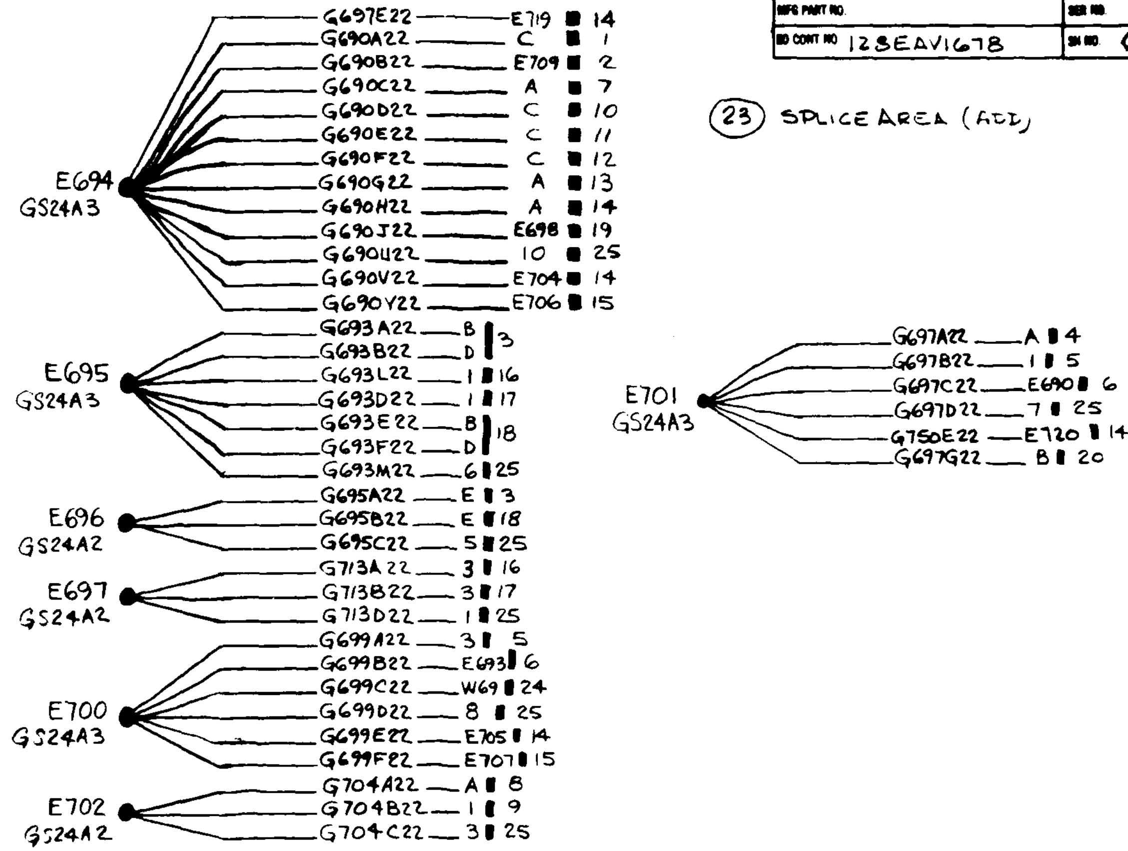

GRUMMAN AEROSPACE CORPORATION
CODE IDENT 26512
EO
12BAV66014
REV U5
SH NO. 5
EO CONT NO. 12BLV1678
NOTE: IT IS PERMISSIBLE TO SPLICE TO GET ADDITIONAL LENGTH IF REQUIRED
(ADD) RUDDER PEDALS POSITION
TOP DECK STA 233
G693L22 — E695 ■ 23
G712B22 — 35 ■ 24
G713A22 — E697 ■ 23
(ADD) RUDDER ACTUATOR POSITION
12A706R1
TAIL
G693D22 — E695 ■ 23
G714A22 — 34 ■ 24
G713B22 — E697 ■ 23
(ADD) RUDDER QUIESCENT FLOW
TAIL
12A707P1
MS3723-13R10GSN
G693E22 — E695 ■ 23
G715A22 — 7 ■ 24
G693F22 — E695 ■ 23
G695B22 — E696 ■ 23
G693Q22 — 25 ■ 24
(ADD) HYDRAULIC BACKUP PACKAGE BACKUP PUMP TEMP SWITCH
12A708S1
TAIL
G729A22 — 10 ■ 24
G690J22 — E694 ■ 23
G716A22 — 16 ■ 24
G3805A1(3)
(ADD) PUMP PRESSURE HYDRAULIC SWITCH
L.H. KEEL
12A709P1
MS3106GR10SL3S
G717A22 — 2 ■ 24
G697G22 — E701 ■ 23
G731A22 — 36 ■ 24
(REF) BALLISTIC PNL 12BAV60432
L.H FUSELAGE DUCT
P602B (REF)
CUT & SPLICE (ADD)
(REF) A83FD20A
(REF) A83FD20B
(REF) A84FD20C
REF CB MSL PWR B/N CB PNL
ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION | CODE IDENT 26512 | EO | 128AV66014 | REV U5

MFG PART NO. | SER NO.

EO CONT NO 12SEAV1678 | SH NO. 6

(23) SPLICE AREA (ADD)



GAC 3046 REV 1 7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GAC 3046 10-72 (PART B)

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO	128AV66014	DASH NO	REV U5
			MFG PART NO	SER NO	
			ED CONT'N 128EAV:678	SH NO 7	

(24) 12A711P1 M81511/56FD01S3

(ADD) HYCOS DISPLAY PANEL

L H BOARDING LADDER

		IDENT SLEEVE STAMPED 12A711P1 ON GS830CV50-9	
19	G725A22	B	11
12	G720A22	B	1
11	G721A22	E703	2
10	G729A22	E708	19
21	G724A22	B	10
23	G726A22	B	12
26	G723A22	B	7
27	G730A22	B	14
28	G727A22	B	13
1	G691A22	A	1
3	G708A22	A	11
18	G692A22	E710	2
16	G716A22	E699	19
4	G707A22	A	10
5	G709A22	A	12
8	G702A22	C	7
9	G711A22	C	14
13	G710A22	C	13
24	G693N22	E712	3
25	G693Q22	E713	18
2	G717A22	A	20
6	G694A22	A	3
7	G715A22	A	18
34	G714A22	2	17
35	G712B22	2	16
22	G703A22 (GC18F1-22S)	B	8
15	GS830AH1		
29	G705A22	2	9
20	G696A22 (GC18F1-22S)	B	4
14	GS830AH1		
30	G698A22	2	5

GAC 3046 REV 1 7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY

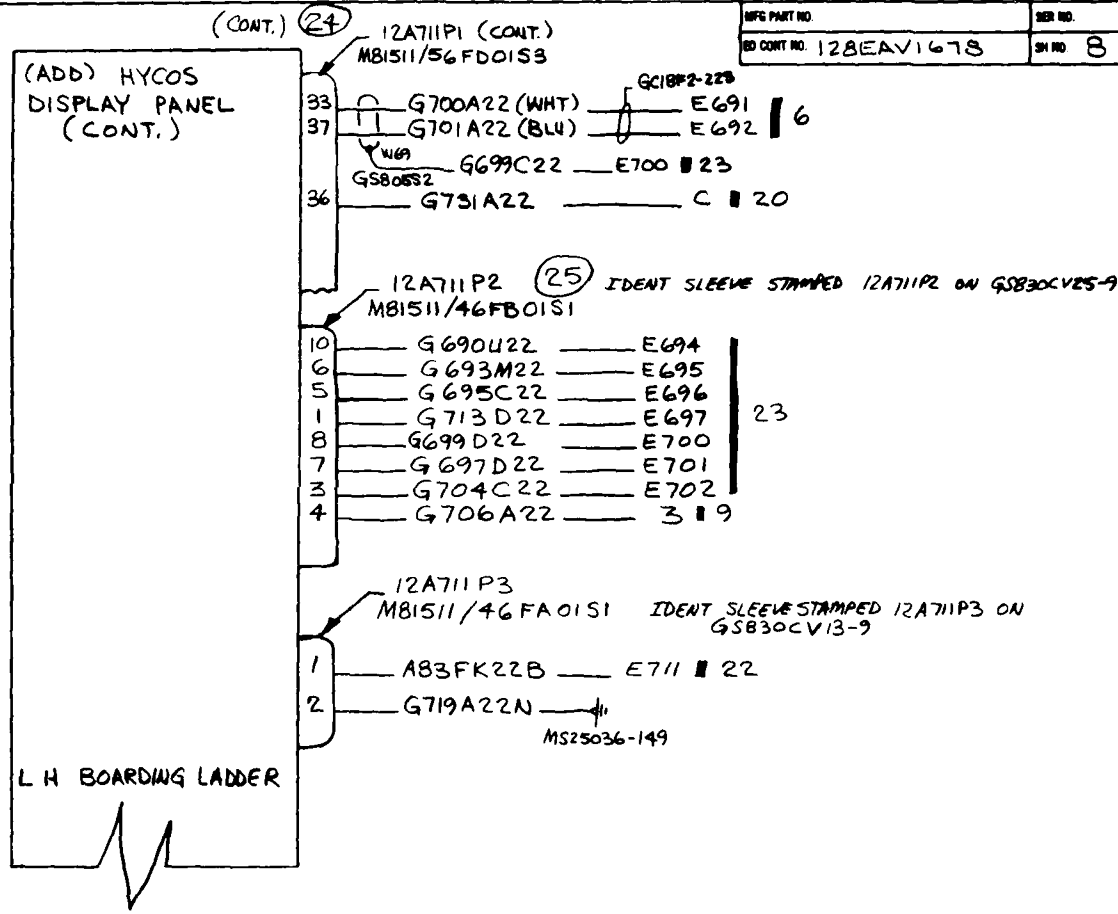
PLT	DEPT		MODEL	TYPE	EFFECTIVITY FROM	THRU	PROJECT PR SEC

PLT DEPT	OPERATIONS	INSP

REMARKS

GAC 3046 10-72 (PART B)

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO	128AV66014	DASH NO.	REV U5
			MFG PART NO.	SER NO.	
			EO CONT NO. 128EAV1678	SH NO. 8	



GAC 3046 REV 1
7-74 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PGI-SEC

PLT/DEPT	OPERATIONS	HRS

REMARKS

GAC 3046
10-72 (PART B)

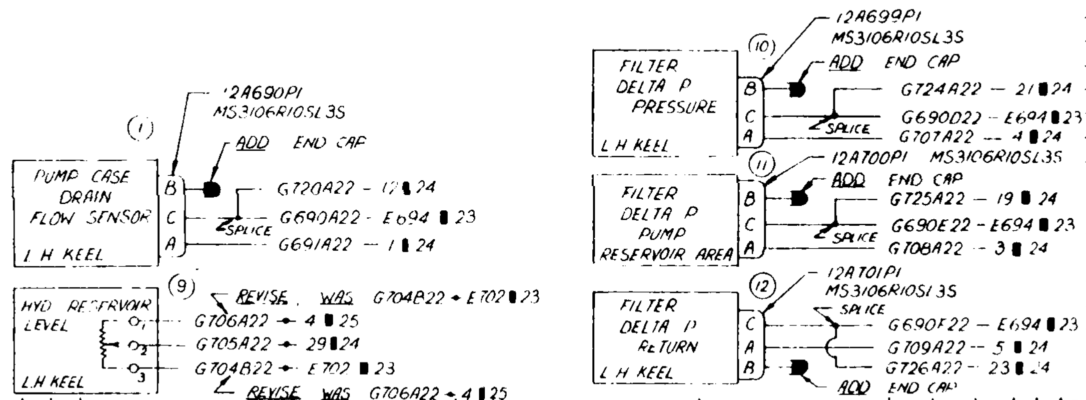
GRUMMAN AEROSPACE CORPORATION

SEQ NO	92
CODE IDENT	26512
	EO
	128AV66014
DASH NO	
REV	V2
MFG PART NO	
MCO REV	ACD
	ECP
PRIORITY	C
GET SPEC	
CHG CL	I
EO CONT NO	128H791
CONTRACT NO	N62269-78-C-0041
REPLACES PART NO	
SH	1 OF 1
DWG TITLE	INSTALLATION DWG - FUSELAGE

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
I	*	A6E		M229

* AIR 21411 TK 79-143 JAN 31, 1979

THIS EO REVISES RECORD EO U5 (CONTROL NO 128EAV1678)



ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		-901										2	I

REASON FOR CHANGE (1) SINGLE - THROW SWITCHES WERE INSTALLED INSTEAD OF REQUIRED DOUBLE - THROW. (2) INCREASED THE SENSITIVITY OF HYD RESERVOIR LEVEL MEASUREMENT

DESCRIPTION OF CHANGE: NOTED

PREPARED BY	JOHN DUZICH
SECTION	FLUID POWER
PLANT GROUP	35/ 3?7
DATE - EXT	9-20-79

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE 63	CUSTOMER
SIGNATURE	[signature]	[signature]					[signature]	[signature]	GAC
DATE	9-21-79	9/21/79					9-21-79	9-21-79	

EO TYPE: DIRECT DWG CHG (DDC) ( ) REV DWG ( ) PROD ENGRG ( ) RECORD EO (✓)

IAD: 1 INSTL, A ASSY, D DETAIL, M MAKE FROM

SD: RECM STK DISPN 1 DISPOSE 2 REWORK 3 INCREASE 4 CREATE 5 USE 6 HOLD 7 NO ACTION 8 ACCEPT I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 8-77 (PART A)

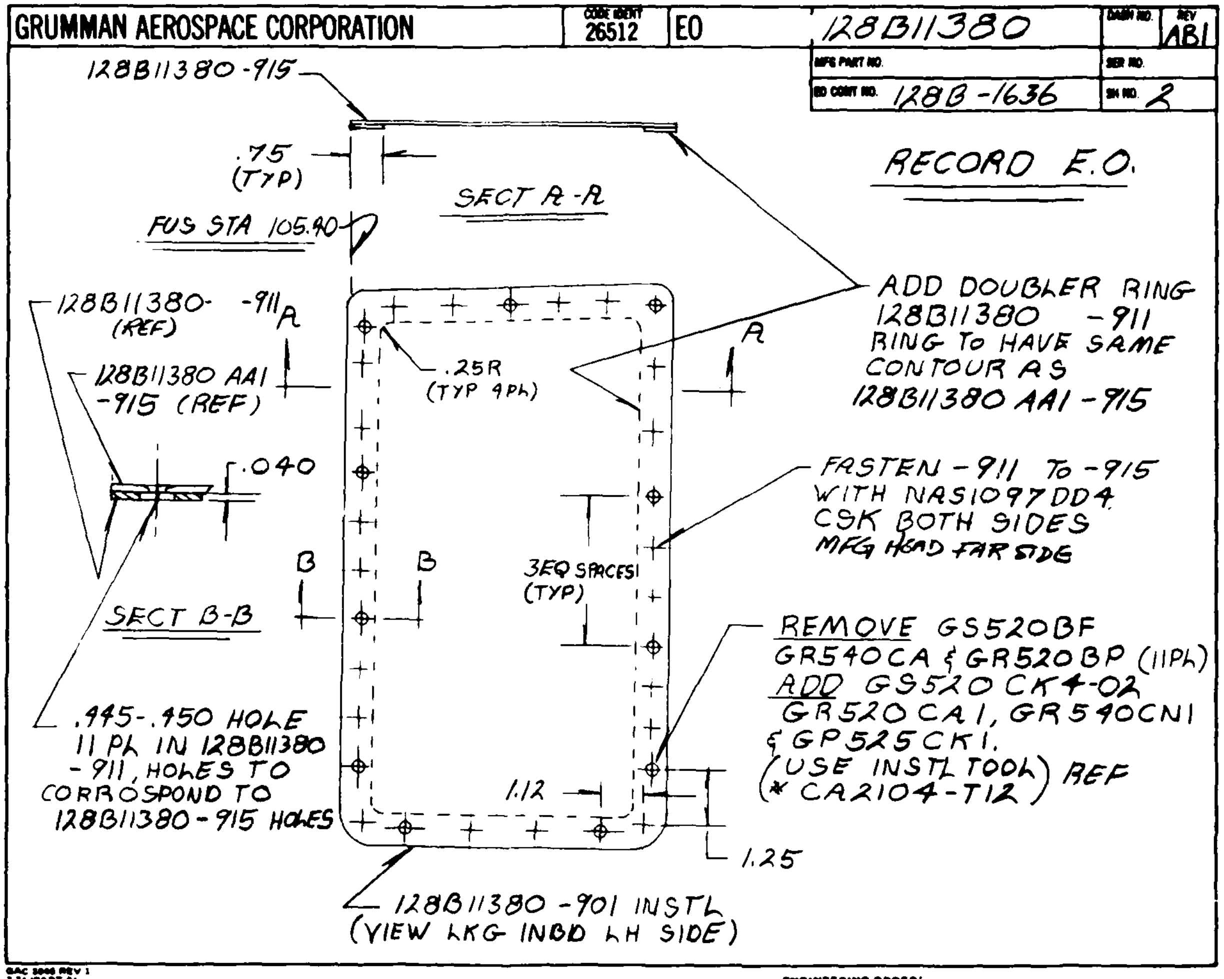
ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY							
PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

PLT/DEPT	OPERATIONS	HRS

REMARKS

GAC 3046 10-72 (PART B)



GAC 3046 REV 1 7-74 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO | CC | MODEL | PART NUMBER | QTY | CONTROL (MRB REFERENCE DRAWING NO) | PART SERIAL NO | PART LOT NO | END ITEM NO | PROD TYPE | VEHICLE S/N | MAJOR ASSY-D | REWORK RESPONSIBILITY | PLT | DEPT | MODEL | TYPE | EFFECTIVITY FROM & THRU | PROJECT NO SEC | PROCESSED BY | INSP PLT | DATE | ADDITIONAL COPIES TO | REMARKS | DATE ISSUED | DUE IN STOCK DATE | DESTINATION | DATE REC'D | COVERAGE

GAC 3845 REV 1 7-74 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO		DASH NO	M/B	REV
32	26512	EO	128B11380			ABI

MFG PART NO: | MCO REV: ACD | ECP | PRIORITY: C | ☐ ACTION ☐ NO ACTION | DET SPEC: | CHG CL: 1 | EO CONT NO: 128B-1636

PLT/DEPT | OPERATIONS | INSP | PLT/DEPT | OPERATIONS | INSP | END ITEM NO | QTY/EI | ACFT NO | CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO: N62269-78C-0041 | REPLACES PART NO: | SH 1 OF 2

DWG TITLE: DUCT ASSY, FUSELAGE STA 80-137 5/16 L INLET

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	AIR-21411:TK 79-143	A-6E		M229

(RECORD EO.)

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I/A/D	S/D	EFF
ADD	20	NAS1097DD4	RIVET								3	1
CREATE	1	-911	DOUBLER		QQ-A-250/13, 7075-O (AL CLAD) .040X9X15	T6 76-161				D	4	1
ADD	11	GS520CK4-02	STUD								2	1
ADD	11	GR520CA1	RECEPTACLE								2	1
ADD	11	GR540CN1	RETAINING RING								2	1
ADD	11	GP525CK1	PLUG								2	1
REM	11	GS520BF	STUD								1	1
REM	11	GR540CA	RETAINER RING								1	1
REM	11	GR520CK4	RECEPTACLE								1	1
	-901											

REASON FOR CHANGE: TO PROVIDE IMPROVED PANEL FASTENER FOR longer SERVICE LIFE. (HYCOS INSTL)

DESCRIPTION OF CHANGE: ADD -911 DOUBLER REM GS520BF, GR540CA GR520CK4, ADD GS520CK4, GR520CA1, GR540CN1 & GP525CK1

PREPARED BY: G BARES
SECTION: STRUCT SYST
PLANT GROUP: 40-335
DATE - EXT: 2/21/80 - 6173

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE 3.3	CUSTOMER
SIGNATURE	[signature]	[signature]		[signature]			[signature]	[signature]	(GAC)
DATE	2-21-80	2/26/80		2/21/80			2-26-80	3-6-80	

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☑

SD - RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION; I/A/D: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM, 8 = ACCEPT; I&T = IDENT AND TRACEABILITY

GAC 3845 REV 1 7-74 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SEQ NO.	CODE IDENT	EO			REV
17	26512	EO	129C13001		P1

ECP

NAME: [illegible] CONT, FLT CONT, DIRECTIONAL

SH 1 OF 4

FIND NO. / QTY	PART NUMBER	NOMENCLATURE
2	[illegible]10061-SC2	WASHER
2	[illegible]	SPACER
1	[illegible]	BOLT
1	[illegible]	BOLT
	[illegible]	COTTER PIN
1	[illegible]	NUT
	[illegible]	BOLT
2	[illegible]	NUT
1	[illegible]	WASHER
3	[illegible]	WASHER
1	[illegible]	[illegible]
101	-901	[illegible]

MATERIAL SPECIFICATION: STL (EXCEPT AS NOTED)

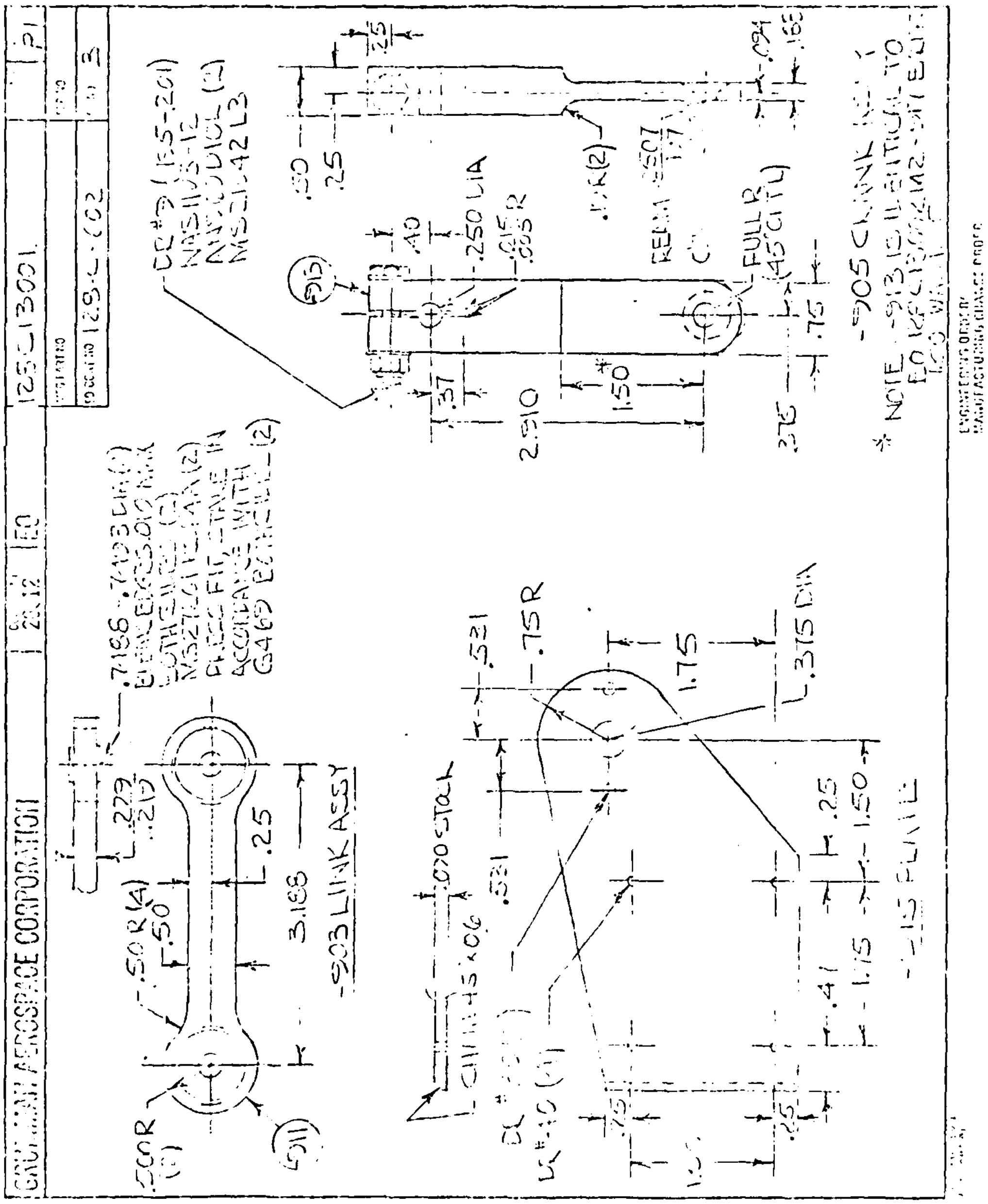
DESCRIPTION OF CHANGE: [illegible]

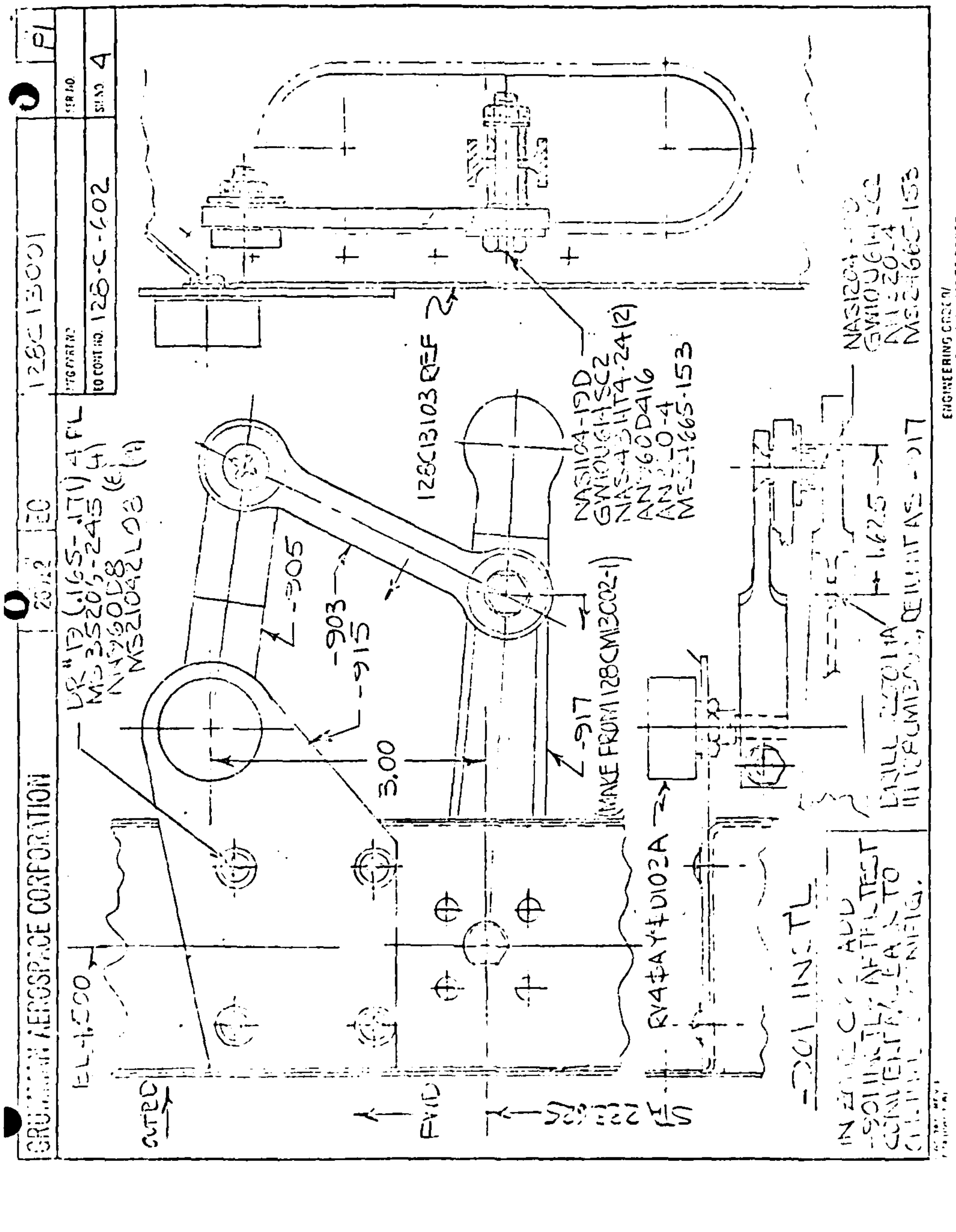
GRUMMAN AEROSPACE CORPORATION	PRIORITY	SEQ NO	CODE IDENT 26512	EO	128C13001	DASH NO	REV P1
					MFG EXT NO	SER NO	
					EO CONT NO. 128-C-602	SHEET 2	

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

NOTE "A" -913 MAY BE MADE BY REWORKING [illegible] EO128C13002M2-917

ACTION	QTY PER ASSY				PART NUMBER	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE			
ADD	1				MS21042L3	NUT									
ADD	1				NAS1103-12	BOLT									
ADD	2				AN960D10L	WASHER									
ADD		2			MS27641K514A	BEARING									
[illegible]			1		-917	CRANK		MAKE FROM 128CM13002-1							
[illegible]			1		-915	PLATE		7075T73	QQ-A-250/12		[illegible]		D	[illegible]	1
[illegible]	1				-913	[illegible]	A	7075-T7351	QQ-A-2[illegible]/9		[illegible]		[illegible]	2	1
[illegible]		1			-911	LINK		7075T73	QQ-A-250/12		[illegible]		[illegible]	[illegible]	1
[illegible]			1		-9[illegible]	CRANK ASSY							[illegible]		
[illegible]			1		-9[illegible]	[illegible] ASSY							[illegible]		


GRUMMAN AEROSPACE CORPORATION
-903 LINK ASSY
-905 CRANK
-915 PLATE
3.188
2.910
1.75
.375 DIA
.75 R
.250 DIA


GRUMMAN AEROSPACE CORPORATION
128C13001
128-C-602
128C13103 REF
NAS1104-19D
GW10UGH-SC2
AN960D416
MS21042L08
3.00
-903
-915
-905
-917
(MAKE FROM 128CM13C02-1)
RV4E4Y4D102A
EL 4.500
FWD
OUTBD
1.625
ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

CODE IDENT 26512 | EO | 128CS10000

MFG PART NO | MCO REV ACD | ECP | PRIORITY C | DET SPEC 1 | EO CONT NO 128C637

CONTRACT NO N62269-76-C-0041

REPLACES PART NO | SH 1 OF 1

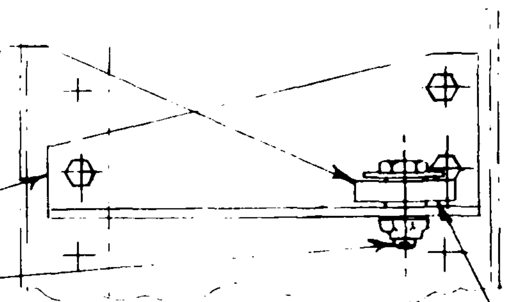
DWG TITLE POTENTIOMETER INSTL - LIK SYS - RUDDER

EFF 1 | AUTHORITY LTR2441 TR 79-143, 31 JAN 79 | MODEL A6E | CAL UNIT NO M223

128CM13234-1 MAY BE INSTALLED AS SHOWN AS AN ALTERNATE TO INSTALLATION SHOWN IN EO128CS10000W1

128CS10000-913 BKLT (REF)

NAS1104-7D KEF
AN960D416L KEF
GW10U614SC2 KEF
AN320-4 KEF
MS24665-151 KEF



128CM13234-1 REF

VIEW ⊛ ⊛
(FROM EO 128CS10000 W1)

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	A/D	S/D	I/F
~		-201								1	5	1

REASON FOR CHANGE PROVIDE ALT. INSTALLATION TO PERMIT CHOICE OF OPTIMUM LINK POSITION

THIS EO REVISES EO W1

DESCRIPTION OF CHANGE ADD ALT. METHOD OF INSTALLATION

PREPARED BY W. MISAK

CONTROLS & MECH 351

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG	PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE								
DATE	10-2-79			10/3/79				

GRUMMAN AEROSPACE CORPORATION

ACD	ECP	26512	12A CS 10000 (?)

A) 07220-[illegible]-0041

INSTALLATION ... INSTL. - DIR. SYS. - [illegible]

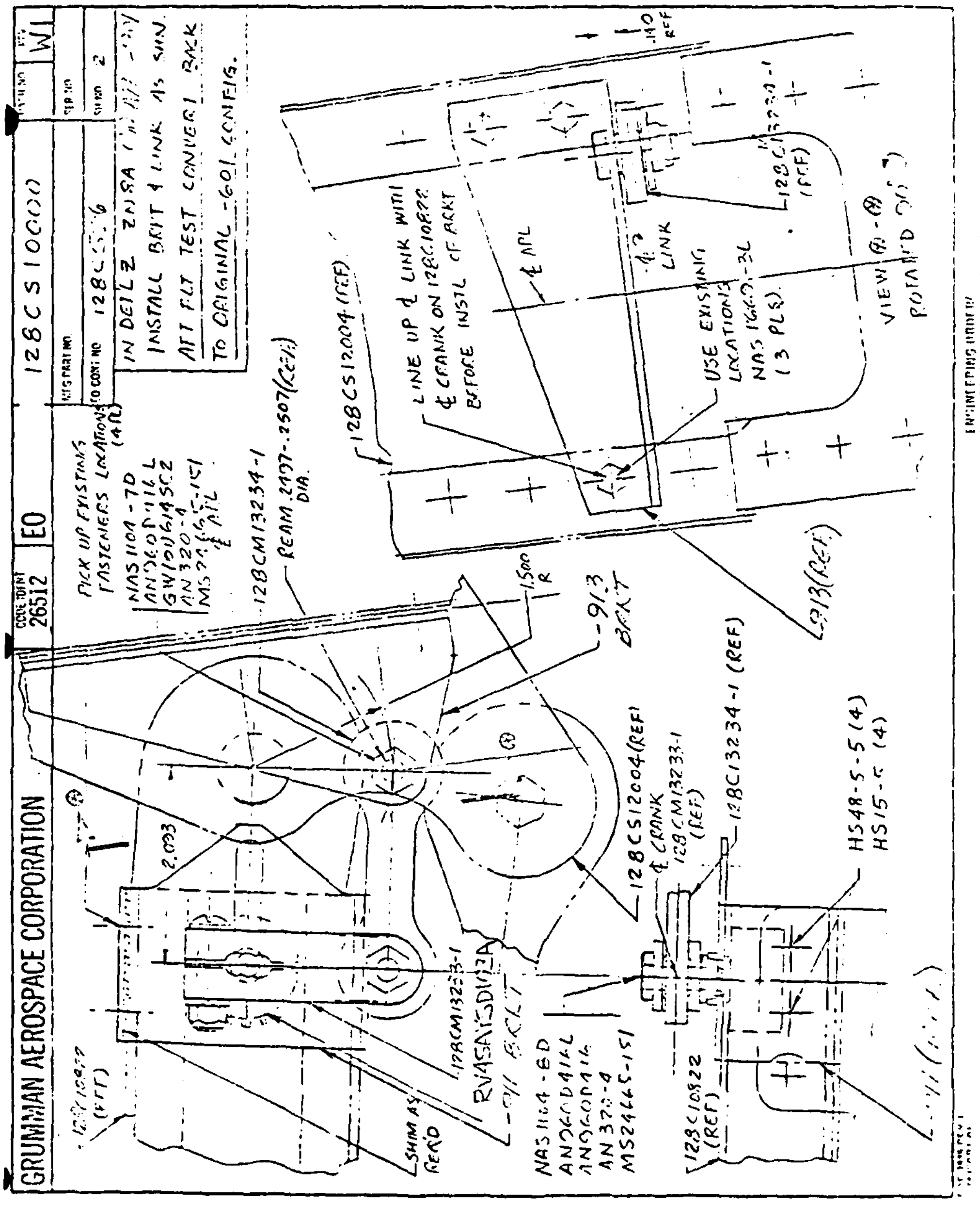
MODEL: A6E

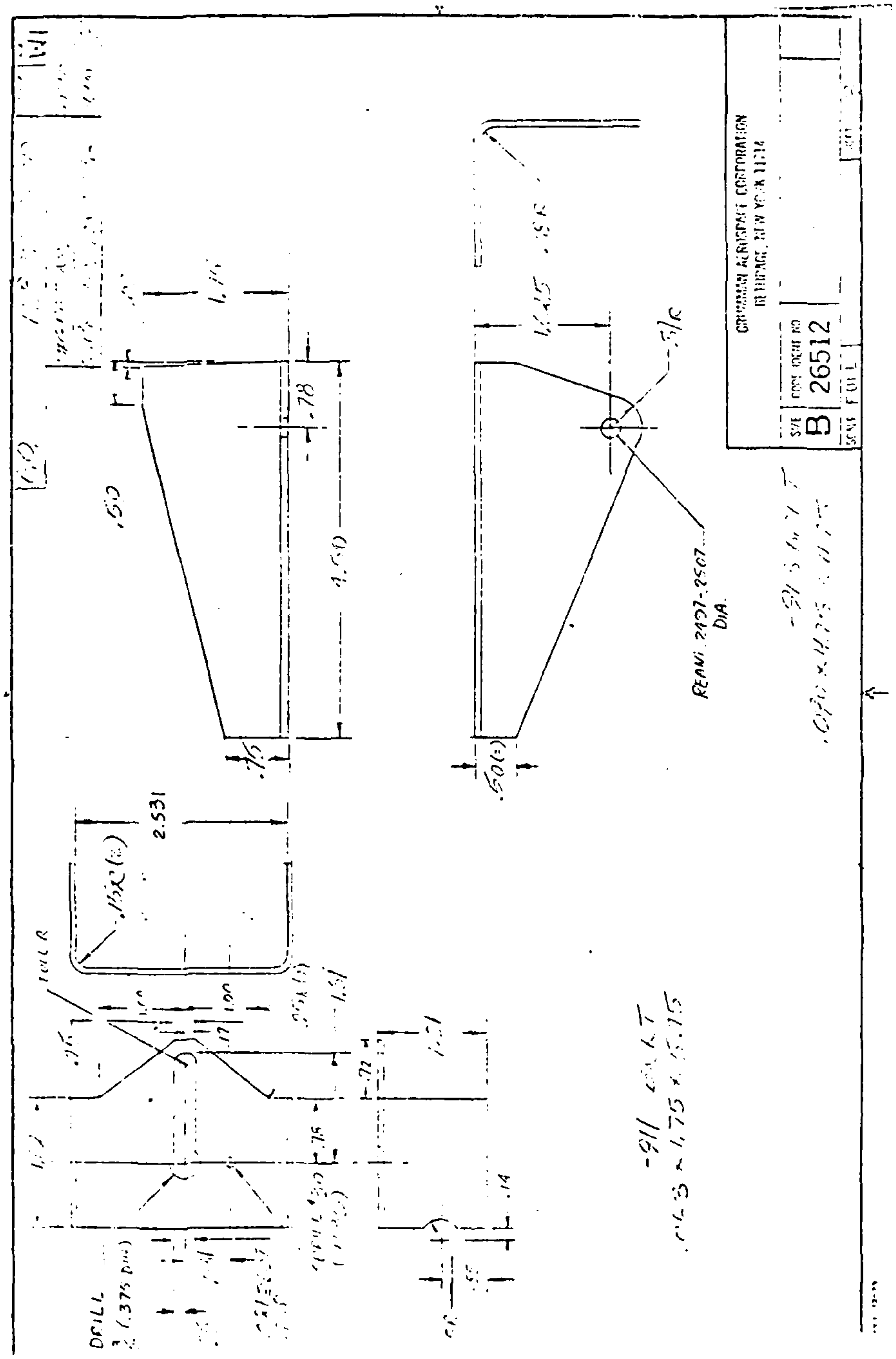
QTY	PART NUMBER	NOMENCLATURE	MATERIAL SPECIFICATION
2	[illegible]	[illegible]	
2	AN320-4 (?)	NUT	
1	AN960D416	WASHER	
2	AN960D416L	WASHER	
4	NAS1[illegible]-5-3	RIVET	
4	NAS1[illegible]-5	COLLAR	
3	NAS1669-3L	FASTENER-BLIND	
1	NAS1104-8D	BOLT	
1	NAS1104-7D	BOLT	
1	AN960-C616 SC2 (?)	WASHER	
AR	AKIPS (?)	SHIM	66013 (?)
1	[illegible]Y4003A	POTENTIOMETER	
1	[illegible]13234-1	LINK	
1	[illegible]13233-1	CRANK	
1	-903	[illegible]	QQ-A-250/[illegible]
1	-911	[illegible]	QQ-A-250/[illegible]
	-901	TAIL ERECTION (?)	[illegible]

HYD CHECK OUT SYS. INSTL (HYCOS)

ADDED MOUNTING BRKT & LINK FOR POT INSTL.

ENGINEERING ORDER


GRUMMAN AEROSPACE CORPORATION
26512
EO
128CS10000
W1
IN DETL Z, ZNRA
INSTALL BRKT & LINK AS SHN.
AFT FLT TEST CONVERT BACK
TO ORIGINAL -601 CONFIG.
PICK UP EXISTING FASTENERS LOCATIONS (4 PL)
128CM13234-1
REAM .2497-.2507 (REF) DIA.
128CS12004 (REF)
LINE UP ¢ LINK WITH ¢ CRANK ON 128C10822 BEFORE INSTL OF BRKT
USE EXISTING LOCATIONS NAS 1660-3L (3 PLS)
VIEW A-A ROTATED
-913 BRKT
128C13234-1 (REF)
128CS12004 (REF)
HS48-5-5 (4)
HS15-5 (4)
128C10822 (REF)
SHIM AS REQ'D
2.093
1.500 R
-911 BKLT
NAS1104-8D


GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
B
26512
2.531
DRILL

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
26	26512	EO	128H10009			VI

MFG PART NO	MCO REV	ACD	ECP	PRIORITY C	[ ] ACTION [ ] NO ACTION	DET SPEC	CHG CL 1	EO CONT NO 128H755

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY/EF
						ACFT NO	CONFIG REQ D/CONFIG NOT REQ D

CONTRACT NO N62269-78C-0041 REPLACES PART NO SH 1 OF 6

DWG TITLE COMPONENTS INSTL, HYDRAULICS - COMBINED SYSTEM - L.H. KEEL

ACTION	QTY/NP	QTY/EF	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
					128EL10401			1	21411:TK79-143	A6E		M229

ACTION	QTY PER ASSY	-901	PART NUMBER	T&T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
CREATE		1	-911		BRACKET ASSY							A	4	1
		1	-909		AIR BOTTLE ASSY							A	4	1
		1	-907		RETURN FILTER ASSY							A	4	1
		1	-905		PRESS FILTER ASSY							A	4	1
		1	-903		ACCUMULATOR ASSY							A	4	1
CREATE			-901		COMPONENTS INSTL							I	4	1

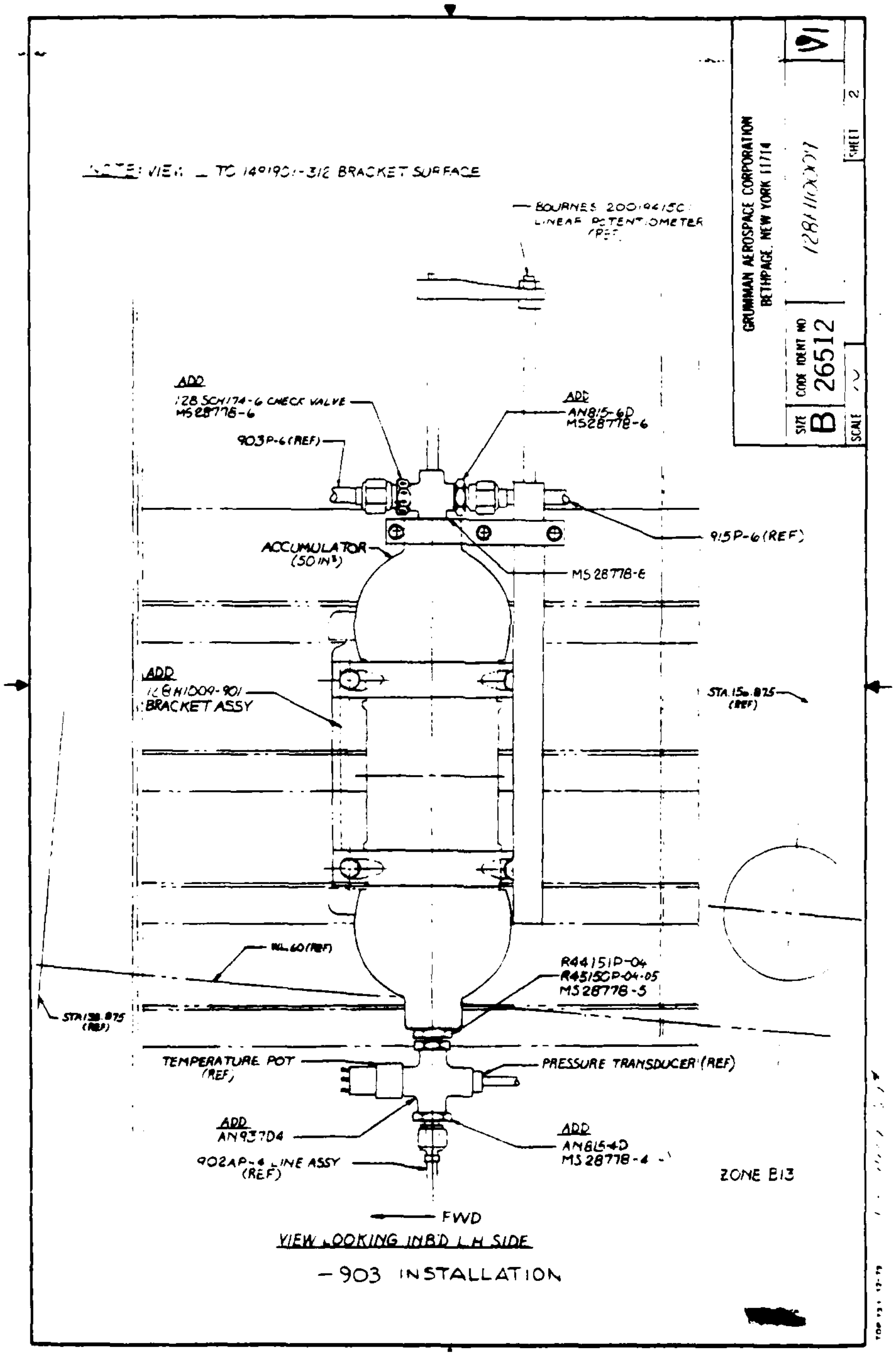
REASON FOR CHANGE: HYDRAULIC CHECK OUT SYSTEM INSTALLATION

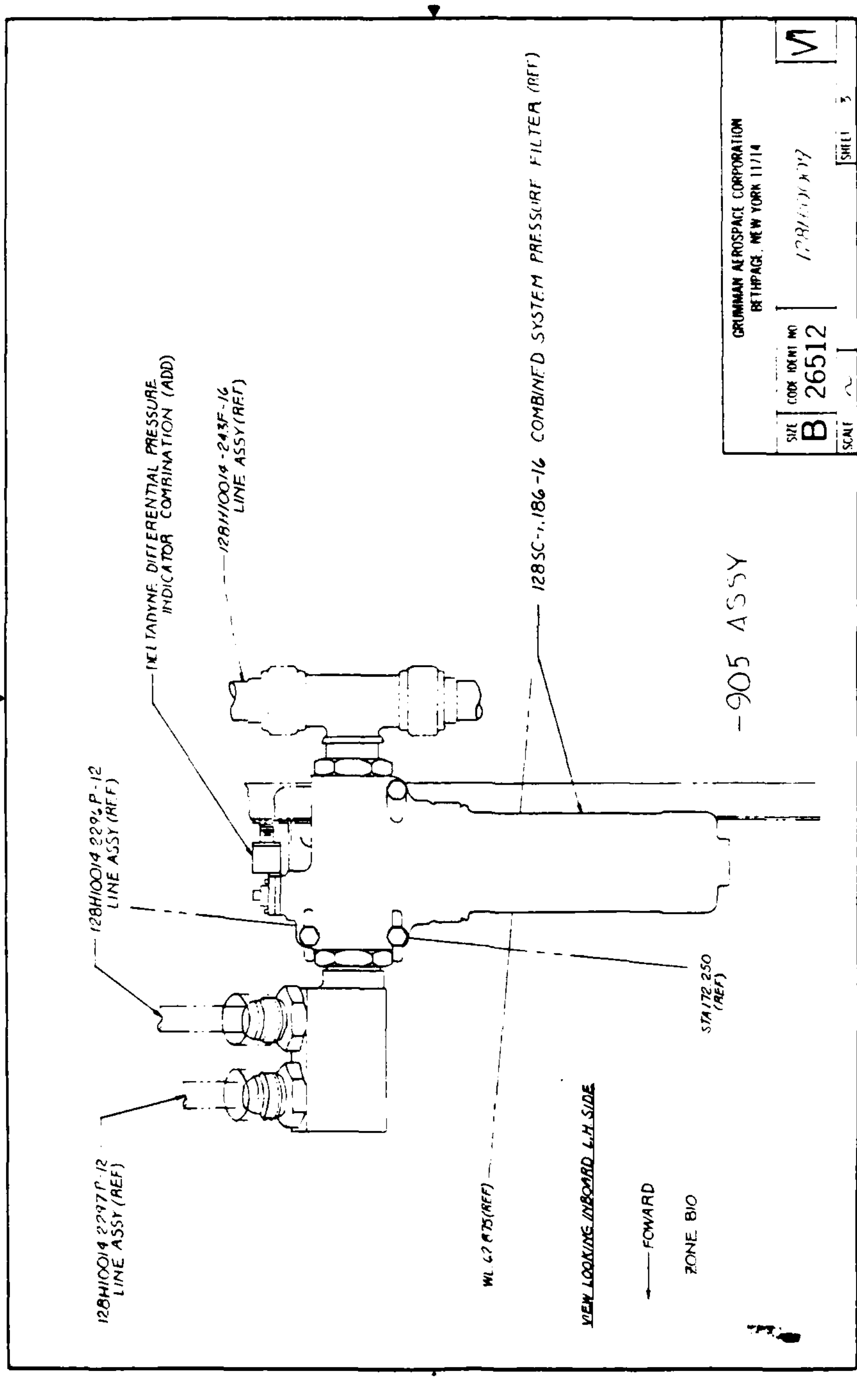
DESCRIPTION OF CHANGE: NOTED ON SHEETS 2 THRU 6

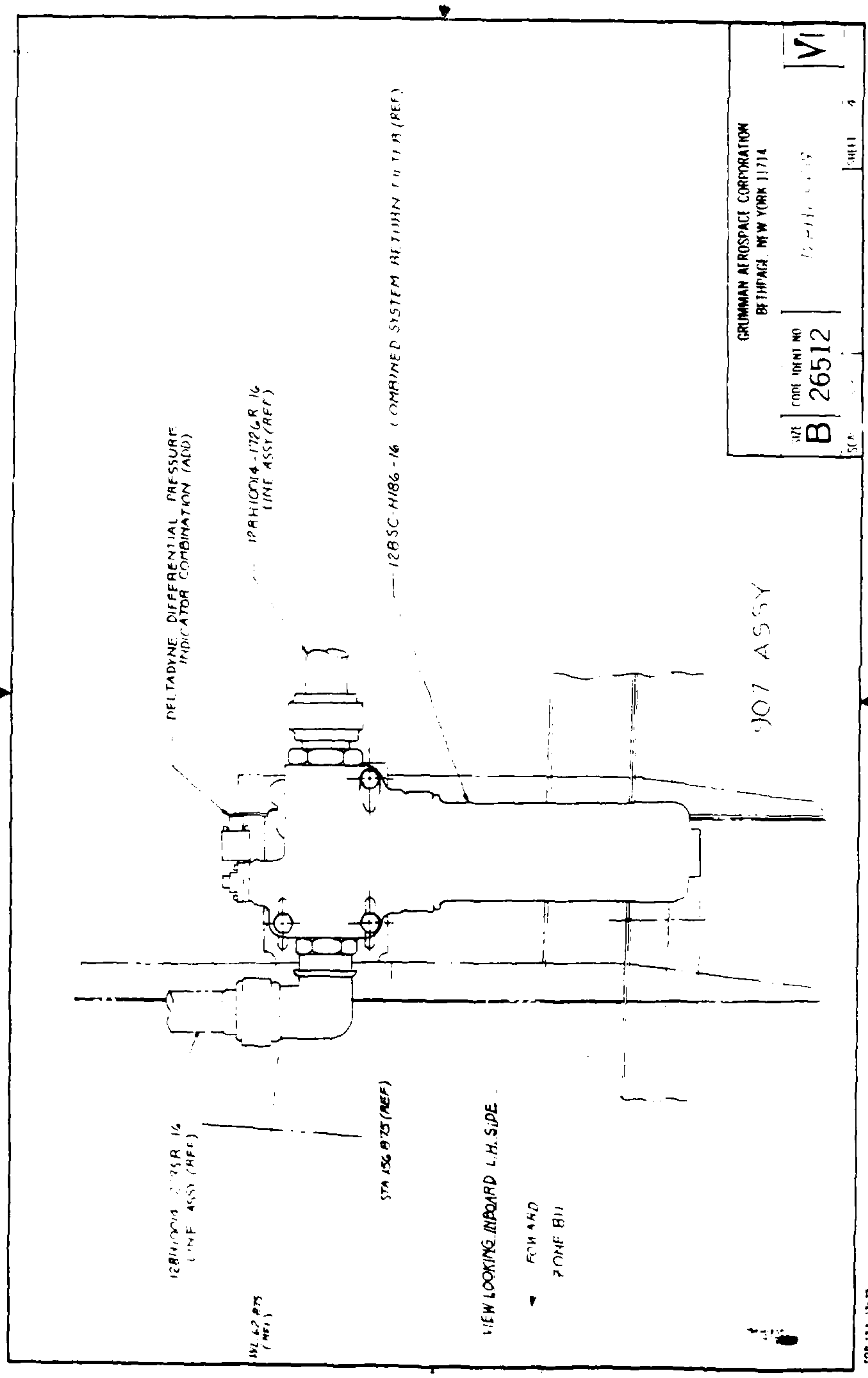
PREPARED BY	WALTER MOORE	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SECTION	FLUID POWER	SIGNATURE	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
PLANT GROUP	040/0357	DATE	2-7-79	2/13/79		2/1/79			2/23/79	2-28-79	3-1-79
DATE	EXT 1-23-79 6189	EO TYPE	DIRECT DWG CHG (DOC) [ ]	REV DWG [ ]	PROD ENGRG [ ]	RECORD EO [X]		IAD I - INSTL, A - ASSY, D - DETAIL, M - MAKE FROM			
		SD	RECM STK DISPN 1	DISPOSE 2 - REWORK 3	INCREASE 4	CREATE 5	USE 6	HOLD 7 - NO ACTION 8	ACCEPT	I&T	IDENT AND TRACEABILITY

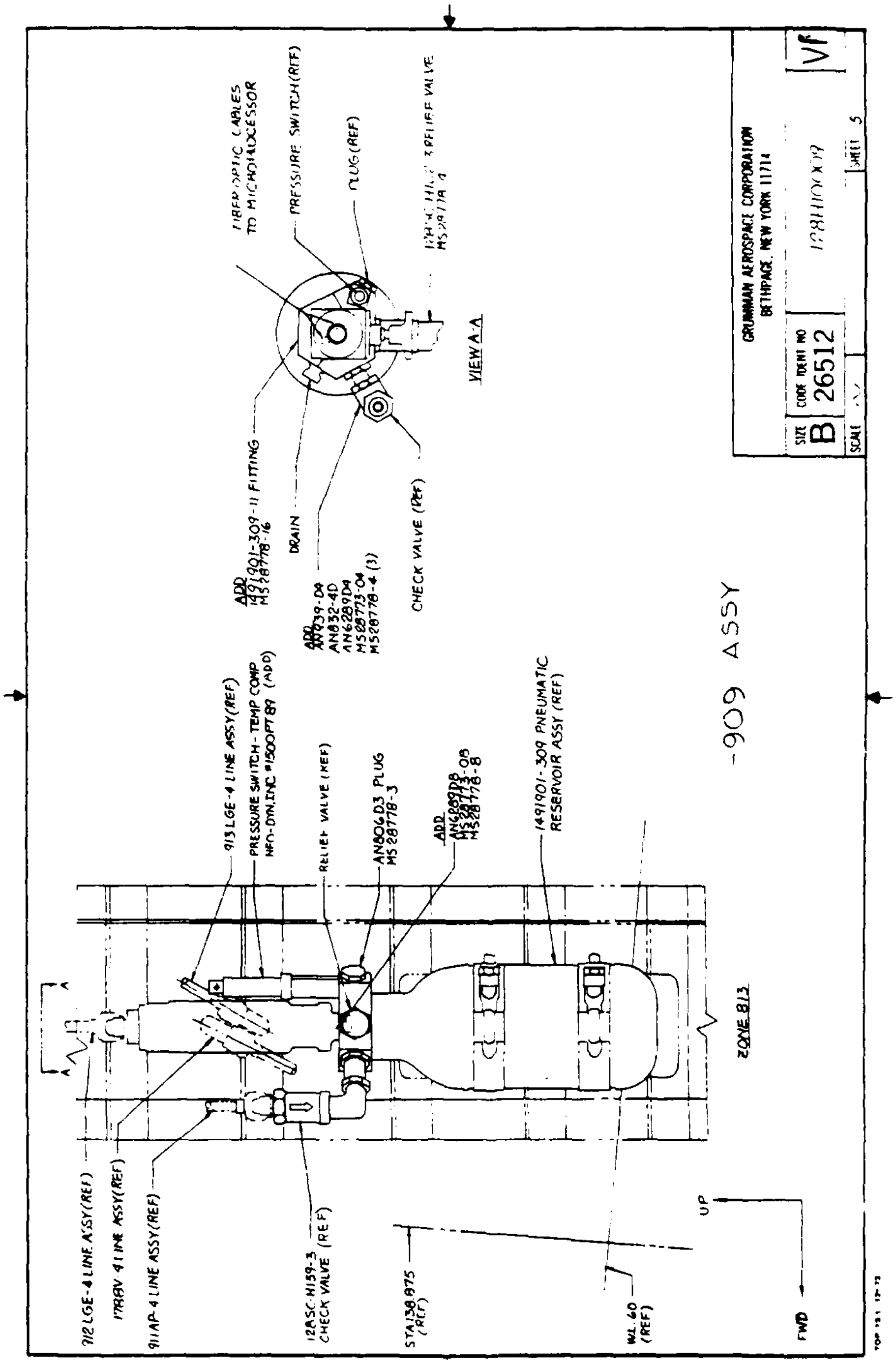
GAC 3944 REV 1

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER


GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE B
CODE IDENT NO 26512
SHEET 2
BOURNES 200-94150 LINEAR POTENTIOMETER (REF)
ADD
128SCH174-6 CHECK VALVE
MS28778-6
903P-6(REF)
ADD
AN815-6D
MS28778-6
915P-6(REF)
ACCUMULATOR (50 IN³)
MS28778-6
ADD
128H1009-901 BRACKET ASSY
STA.156.875 (REF)
R44151P-04
R45150P-04-05
MS28778-5
STA138.875 (REF)
TEMPERATURE POT (REF)
PRESSURE TRANSDUCER (REF)
ADD
AN937D4
902AP-4 LINE ASSY (REF)
ADD
AN815-4D
MS28778-4
ZONE B13
FWD
VIEW LOOKING INB'D L.H SIDE
-903 INSTALLATION


DELTADYNE DIFFERENTIAL PRESSURE
INDICATOR COMBINATION (ADD)
128H10014-243F-16
LINE ASSY (REF)
128SC-1,186-16 COMBINED SYSTEM PRESSURE FILTER (REF)
-905 ASSY
LINE ASSY (REF)
STA172.250
(REF)
128H10014-2297P-12
LINE ASSY (REF)
VIEW LOOKING INBOARD L.H. SIDE
FOWARD
ZONE B10
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE
B
CODE IDENT NO
26512
SCALE
SHEET 3


DELTADYNE DIFFERENTIAL PRESSURE
INDICATOR COMBINATION (ADD)
128SC-H186-16
STA 156.875 (REF)
VIEW LOOKING INBOARD L.H. SIDE
FORWARD
ZONE B11
907 ASSY
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE
B
CODE IDENT NO
26512
VI


912LGE-4 LINE ASSY(REF)
178BV 41 LINE ASSY(REF)
911AP-4 LINE ASSY(REF)
12ASC-H159-3 CHECK VALVE (REF)
STA138.875 (REF)
WL 60 (REF)
FWD
UP
ZONE B13
913LGE-4 LINE ASSY(REF)
PRESSURE SWITCH-TEMP COMP
RELIEF VALVE (REF)
AN806D3 PLUG
MS28778-3
ADD
1491901-309 PNEUMATIC RESERVOIR ASSY (REF)
-909 ASSY
ADD
1491901-309-11 FITTING
MS28778-16
DRAIN
ADD
AN739-D4
AN832-4D
AN6289D4
MS28773-04
MS28778-4 (3)
CHECK VALVE (REF)
FIBER OPTIC CABLES TO MICROPROCESSOR
PRESSURE SWITCH(REF)
PLUG(REF)
VIEW A-A
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE
B
CODE IDENT NO
26512
SCALE
SHEET 5

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

WORK ORDER NO | CC | MODEL | PART NUMBER | CONTROL DWG/REFERENCE DRAWING NO | EO | INSP | PART SERIAL NO | PART LOT NO | END ITEM NO | VEHICLE S/N | MAJOR ASSY ID | REWORK RESPONSIBILITY

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI-SEC

PROCESSED BY | PLT | DATE
ADDITIONAL COPIES TO
REMARKS
DATE ISSUED | DATE IN STOCK DATE
DESTINATION | DATE REC'D
COVERAGE

GAC 3844 REV 1 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	MB	REV
27	26512	EO	128H10009			V2

MFG PART NO	MCO REV		PRIORITY	DET SPEC	CHG CL	EO CONT NO
	ACD	ECP	C ☐ ACTION ☐ NO ACTION		1	128H771

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY/EI
						ACFT NO / CONFIG REQ'D/CONFIG NOT REQ'D	

CONTRACT NO N62269-78C-0041 | REPLACES PART NO | SH 1 OF 1

DWG TITLE COMPONENTS INSTL, HYDRAULICS - COMBINED SYSTEM - L.H. KEEL 365

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411:TK79-143	A6E		M229

ON RECORD E.O. 128H10009-901, REV V1 (E.O. CONTROL NUMBER 128H755), REVISE AS FOLLOWS:

1. ON SHT 2, IDENTIFICATION OF BRACKET ASSEMBLY SHOULD READ, "ADD 128H10009-911 BRACKET ASSEMBLY" WAS "ADD 128H10009-901 BRACKET ASSEMBLY".

2. ON SHT 3, IDENTIFICATION OF FILTER SHOULD READ, "128SC-H133-16 COMBINED SYS PRESS FILTER (REF)", WAS "128SC-H186-16 COMBINED SYS PRESS FILTER (REF)".

3. ON SHT 4, INDENTIFICATION OF FILTER SHOULD READ, "128SC-H133-16 COMBINED SYS RETURN FILTER (REF)", WAS "128SC-H186-16 COMBINED SYS RETURN FILTER (REF)".

ACTION	QTY PER ASSY	PART NUMBER	B/T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		-901		COMPONENTS INSTL								2	1

REASON FOR CHANGE: TO CORRECT BRACKET ASSY NUMBER AND (HYC+S) IDENTIFICATION OF PRESS & RETURN FILTERS

DESCRIPTION OF CHANGE: REVISED NOTE

PREPARED BY W. MOORE
SECTION FLUID POWER
PLANT GROUP 040/0357
DATE - EXT 3-2-79 6189

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE 63	CUSTOMER
SIGNATURE	[signature]	[signature]		[signature]			[signature]	[signature]	(GAC)
DATE	3-2-79	3/2/79		3/2/79			3/2/79	3-2-79	

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ IAD: 1 - INSTL, A - ASSY, D - DETAIL, M - MAKE FROM
SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

PART NUMBER
CONTROL MAN REFERENCE DRAWING NO
PART SERIAL NO
PART LOT NO
END ITEM NO
MOD TYPE | VEHICLE S/N | MAJOR ASSY ID
REWORK RESPONSIBILITY

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI SEC

PROCESSED BY | MP PL | DATE
ADDITIONAL COPIES TO
REMARKS
DATE ISSUE | DUE IN STOCK DATE
DESTINATION | DATE REC'D
COVERAGE

GAC 3844 REV 1 6-77 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
28	26512	EO	128H10009			V3

MFC PART NO	MFG REV	ECP	PRIORITY	ACTION / NO ACTION	DET SPEC	CHG CL	EO CONT NO
	ACD		C			1	128H776

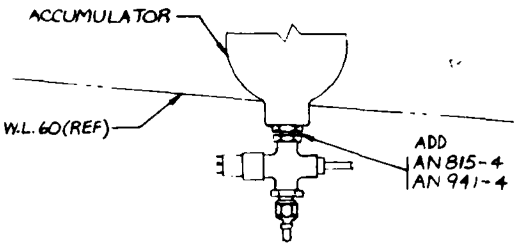
PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY/EI
						ACFT NO / CONFIG REQ'D/CONFIG NOT REQ'D	

CONTRACT NO N62269-78C-0041 | REPLACES PART NO | SH 1 OF 1

DWG TITLE COMPONENTS INSTL, HYDRAULICS - COMBINED SYSTEM - L.H. KEEL

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF
					128EL10401		

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411:TK79-143	A6E		M229



THIS IS A RECORD E.O.

VIEW LOOKING INBOARD L.H. SIDE
FWD

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		-903		COMPONENTS INSTL							I	2	1

REASON FOR CHANGE: FITTINGS NEEDED FOR EXTENDED CLEARANCE BETWEEN CROSS AND KEEL

DESCRIPTION OF CHANGE: ADDED FITTINGS TO ACCUMULATOR

PREPARED BY	W. MOORE
SECTION	FLUID POWER
PLANT GROUP	040/0357
DATE - EXT	3-22-79 6189

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE 67	CUSTOMER
SIGNATURE	[illegible]	[illegible]					[illegible]	[illegible]	(GAC)
DATE		6 Apr 79					4-6-79	4-9-79	

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG RECORD EO ☒ | IAD: I - INSTL, A - ASSY, D - DETAIL, M - MAKE FROM

SD = RECM STK DISPN 1 - DISPOSE, 2 - REWORK, 3 - INCREASE, 4 - CREATE, 5 - USE, 6 - HOLD, 7 - NO ACTION, 8 - ACCEPT | I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
10	26512	EO	128H10049			J1

MFG PART NO	MCO REV		PRIORITY	ACTION / NO ACTION	DET SPEC	CHG CL	EO CONT NO
	ACD	ECP	C			1	128H756

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY EI
						ACFT NO	CONFIG REQ'D-CONFIG NOT REQ'D

CONTRACT NO N62269-78C-0041 — REPLACES PART NO — SH 1 OF 2

DWG TITLE COMPONENTS INSTL, PNEUMATICS - CANOPY JETTISON SYS.

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
					128EL10410			1	21411:TK79-143	A6E		M229

ACTION	QTY PER ASSY	PART NUMBER	& T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	A D	S D	E F F
CREATE	-901	-901		COMPONENTS INSTL							1	4	1

REASON FOR CHANGE: HYDRAULIC CHECK OUT SYSTEM INSTALLATION

DESCRIPTION OF CHANGE: NOTED ON SHEET 2

PREPARED BY WALTER MOORE
SECTION FLUID POWER
PLANT GROUP 040/0357
DATE EXT 1-26-79 6189

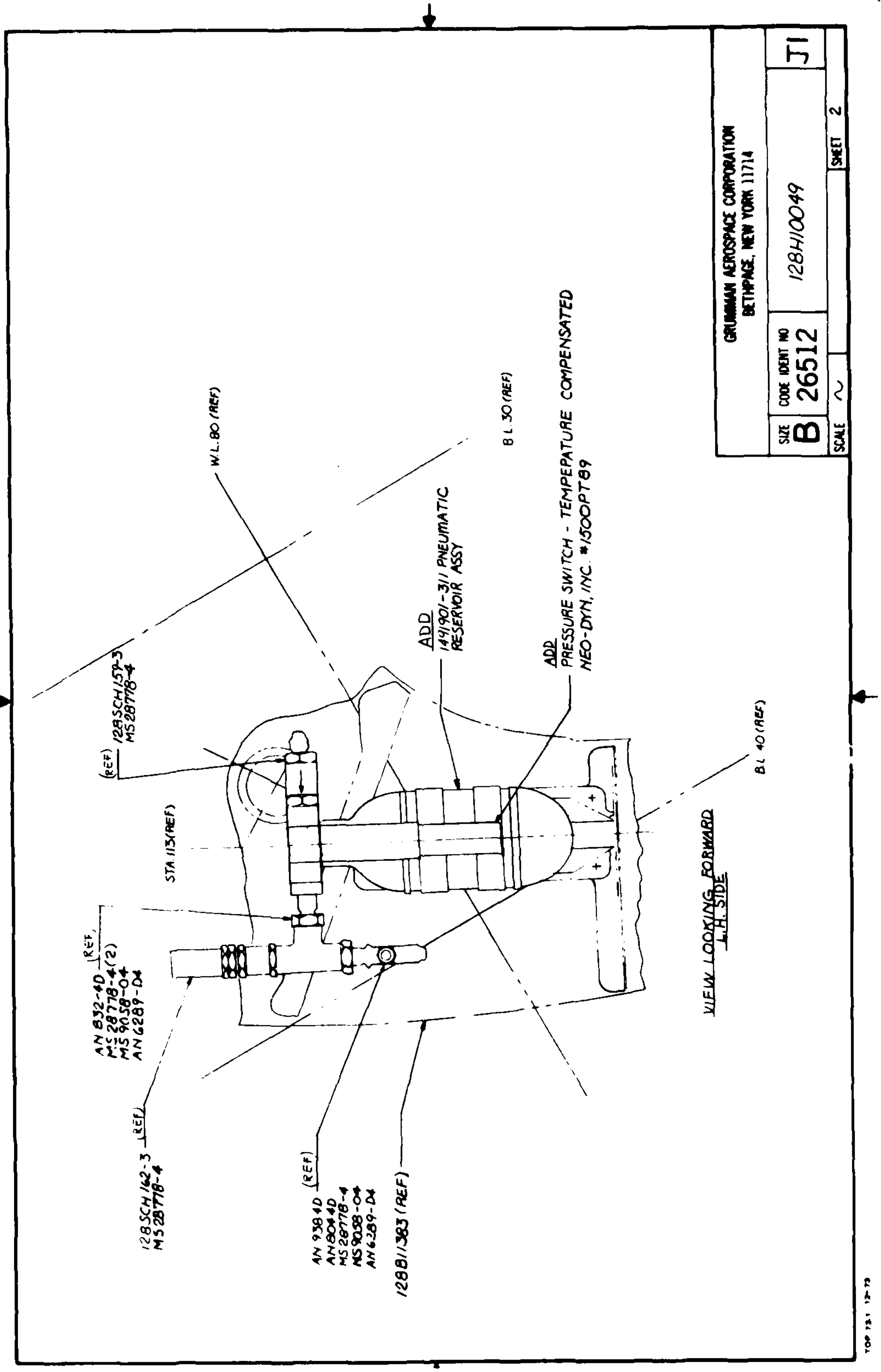
APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
DATE	[illegible]	2-22-79		[illegible]			2-21-79	2-28-79	3-1-79

EO TYPE — DIRECT DWG CHG (DDC) — REV DWG — PROD ENGRG — RECORD EO — IAD I — INSTL A — ASSY D — DETAIL M — MAKE FROM

SO RECM STK DISPN 1 DISPOSE 2 REWORK 3 INCREASE 4 CREATE 5 USE 6 HOLD 7 NO ACTION 8 ACCEPT I&T IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER


GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE B
CODE IDENT NO 26512
128H10049
SCALE ~
SHEET 2
J1
W.L. 80 (REF)
B.L. 30 (REF)
ADD
141901-311 PNEUMATIC RESERVOIR ASSY
ADD
PRESSURE SWITCH - TEMPEPATURE COMPENSATED
NEO-DYN, INC. #1500PT89
128SCH159-3
MS28778-4
(REF)
STA 113 (REF)
B.L. 40 (REF)
VIEW LOOKING FORWARD
L.H. SIDE
AN 832-4D
MS 28778-4 (2)
MS 9058-04
AN 6289-D4
(REF)
128SCH162-3
MS28778-4
(REF)
AN 9384D
AN 804D
MS 28778-4
MS 9058-04
AN 6289-D4
(REF)
128B11383 (REF)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M B	RE
6	26512	EO	128H10127			F:1

MFG PART NO	MCO REV		PRIORITY	DET SPEC	CHG CL	EO CONT NO
	ACO	ECP	C		1	128H727

CONTRACT NO N62269-78C-0041

REPLACES PART NO — SH 1 OF 2

DWG TITLE RESERVOIR INSTL, HYDRAULIC-COMBINED SYSTEM

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF
					128EL10401		

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411:TK79-143	A6E		M229

ACTION	QTY PER ASSY	PART NUMBER	I&T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	USD	EFF
CREATE		-901		RESERVOIR INSTL							I	4	1

REASON FOR CHANGE: HYDRAULIC CHECK OUT SYSTEM INSTALLATION

DESCRIPTION OF CHANGE: NOTED ON SHEET 2

PREPARED BY WALTER MOORE

SECTION FLUID POWER

PLANT GROUP 040/0357

DATE EXT 1-26-79 6164

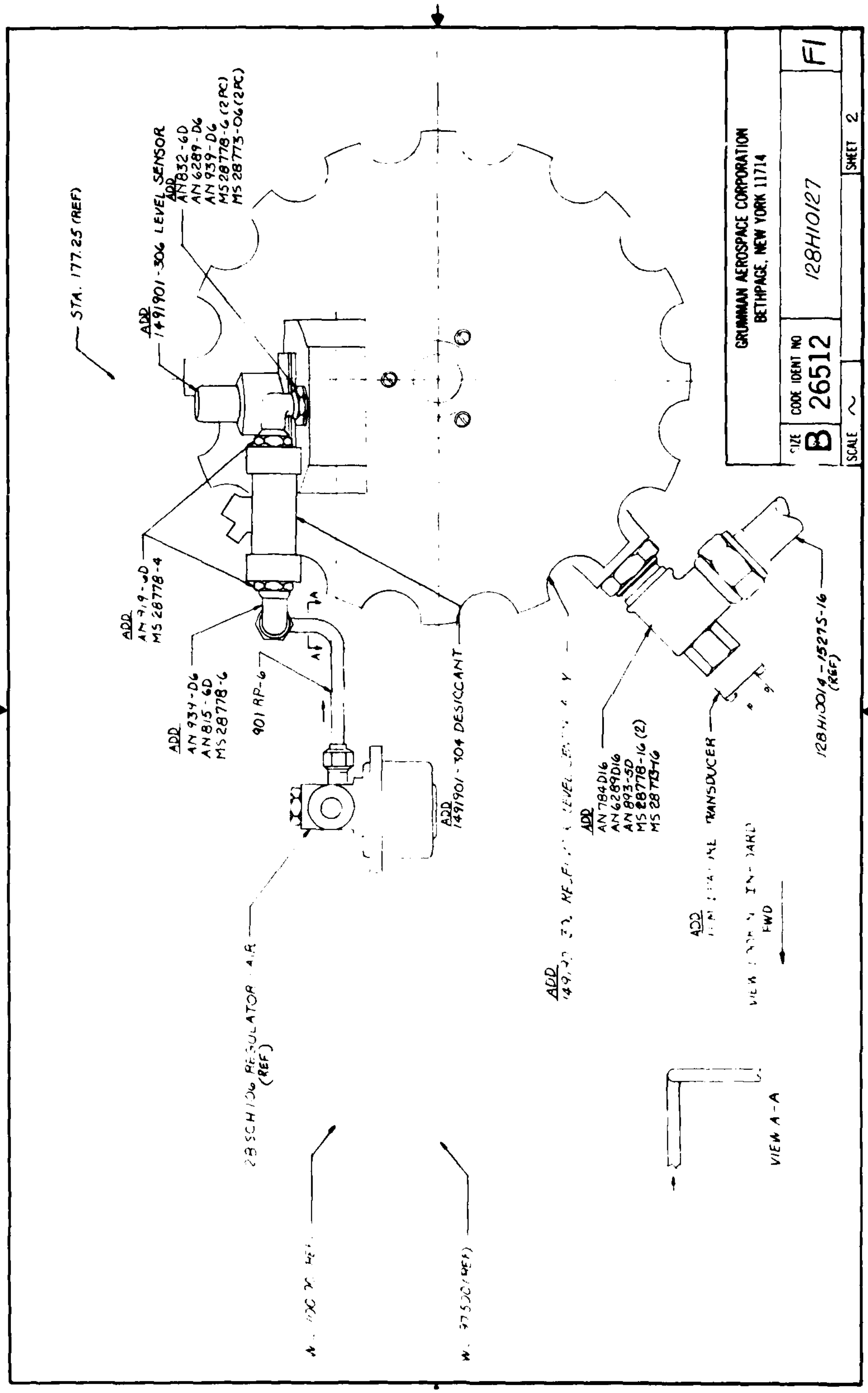
APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
DATE	[illegible]	2-22-79		3/1/79			2-21-79	2-28-79	3-1-79

EO TYPE: DIRECT DWG CHG (DDC) — REV DWG — PROD ENGRG — RECORD EO

SD: RECM STK DISPN 1, DISPOSE 2, REWORK 3, INCREASE 4, CREATE 5, USE 6, HOLD 7, NO ACTION 8 — ACCEPT

IAD: I — INSTL, A — ASSY, D — DETAIL, M — MAKE FROM; I&T — IDENT AND TRACEABILITY

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER


GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE
B
CODE IDENT NO
26512
128H10127
FI
SCALE
SHEET 2
STA. 177.25 (REF)
ADD
1491901-306 LEVEL SENSOR
ADD
AN832-6D
AN6289-D6
AN939-D6
MS28778-6 (2PC)
MS28773-06 (2PC)
ADD
MS28778-4
ADD
AN934-D6
AN815-6D
MS28778-6
901 RP-6
1491901-304 DESICCANT
ADD
AN784D16
AN6289D16
AN893-5D
MS28778-16 (2)
MS28773-16
TRANSDUCER
128H10014-15275-16
(REF)
(REF)
VIEW A-A
FWD

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO		DASH NO	M/B	REV
7	26512		128H10127			F2

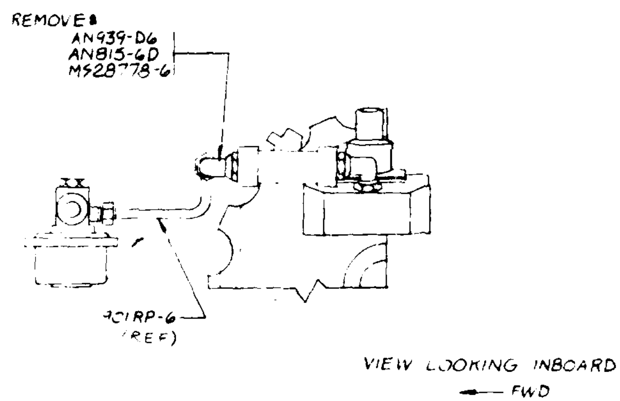
MFG PART NO	MCO REV	ECP	PRIORITY	DET SPEC	CHG CL	EO CONT NO
	ACD		C		1	128H775

CONTRACT NO: N62269-78C-0041

REPLACES PART NO: SH 1 OF 1

DWG TITLE: RESERVOIR INSTL, HYDRAULIC - COMBINED SYSTEM

NEXT ASSEMBLY DWG	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
128EL10401	1	21411:TK79-143	A6E		M229



THIS IS A RECORD E.O.

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT / COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
✓		-901	RESERVOIR INSTL							I	2	1

REASON FOR CHANGE: 90° PNEUMATIC LINE BEND REPLACED 90° ELBOW

DESCRIPTION OF CHANGE: REMOVED FITTINGS FROM 901RP-6 LINE

PREPARED BY: W. MOORE
SECTION: FLUID POWER
PLANT GROUP: 040/0357
DATE EXT: 3-22-79 6189

APPROVED BY — SUPPORT: DATE 6/11/79; PROJ ENGRG: DATE 4-6-79; RELEASE 67: 4-9-79; CUSTOMER: GAC

EO TYPE: DIRECT DWG CHG (DDC) / REV DWG / PROD ENGRG / RECORD EO R
IAD: INSTL A, ASSY D, DETAIL M, MAKE FROM
SD: RECM STK DISPN 1, DISPOSE 2, REWORK 3, INCREASE 4, CREATE 5, USE 6, HOLD 7, NO ACTION 8, ACCEPT, I&T IDENT AND TRACEABILITY

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

PART NUMBER

CONTROL MAR REFERENCE DRAWING NO

PART SERIAL NO — PART LOT NO

END ITEM NO

MAJOR ASSY

REWORK RESPONSIBILITY

PLT	DEPT		MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI SEC

GAC 3844 REV 1 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO. 16 | CODE IDENT 26512 | EO | 128H10136 | DASH NO | M/B | REV NI

MFG PART NO | MCO REV ACD | ECP | PRIORITY C | ☐ ACTION ☐ NO ACTION | DET SPEC | CHG CL 1 | EO CONT NO 128H758

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO.	QTY/EI
						ACFT NO	CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO N62269-78C-0041 | REPLACES PART NO | SH 1 OF 2

DWG TITLE REGULATOR INSTALLATION, HYDRAULIC ~ AIR COMBINED

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF
					128EL10401		

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411:TK79-143	AGE		M829

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
CREATE	-901	-901		REGULATOR INSTL							I	4	1

REASON FOR CHANGE: HYDRAULIC CHECK OUT SYSTEM INSTALLATION

DESCRIPTION OF CHANGE: NOTED ON SHEET 2

PREPARED BY WALTER MOORE

SECTION FLUID POWER

PLANT GROUP 040/0357

DATE EXT 1-26-79 6189

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]	[signature]		[signature]			[signature]	[signature]	[signature]
DATE	1-27-79	2-22-79		2/21/79			2-21-79	2-28-79	3-1-79

EO TYPE | DIRECT DWG CHG (DDC) ☐ | REV DWG ☐ | PROD ENGRG ☐ | RECORD EO ☒

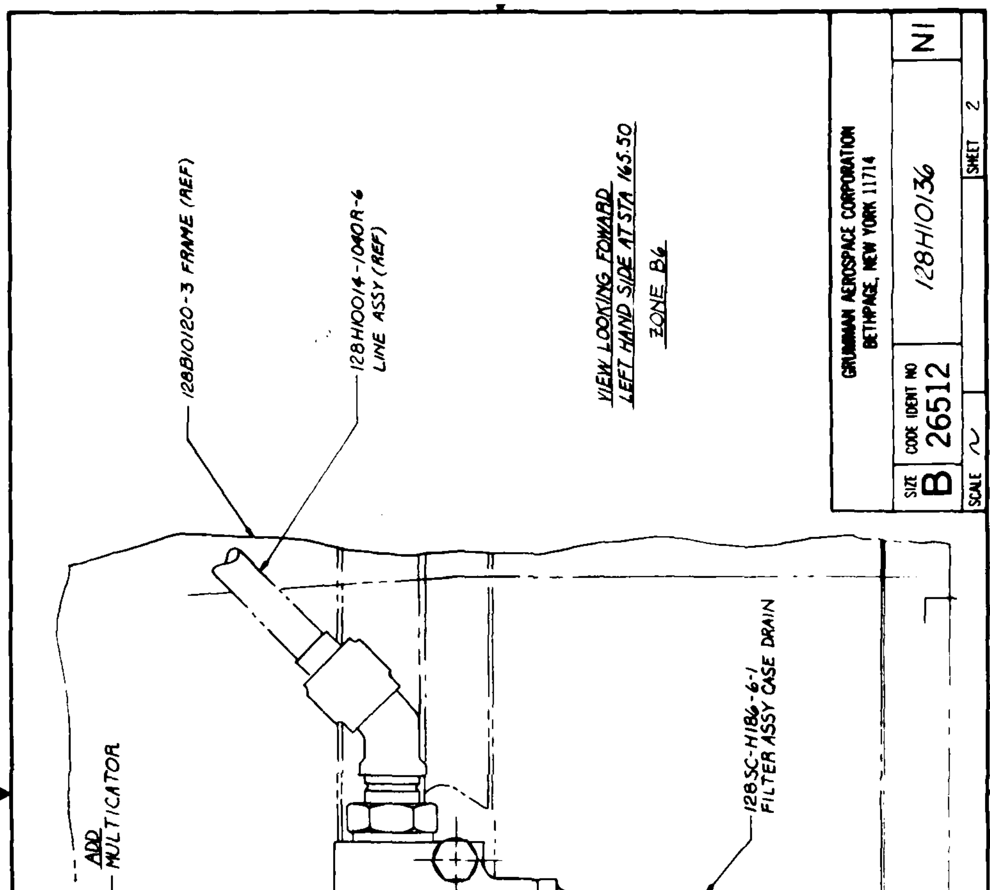
IAD 1 = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT

I&T = IDENT AND TRACEABILITY

GAC 3844 REV 1 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER


128B10120-3 FRAME (REF)
128H10014-1040R-6
LINE ASSY (REF)
VIEW LOOKING FOWARD
LEFT HAND SIDE AT STA 165.50
ZONE B6
ADD
MULTICATOR
128SC-H186-6-1
FILTER ASSY CASE DRAIN
128H10014-276R-6
LINE ASSY (REF)
128H10014-1027R-4
LINE ASSY (REF)
GRUMMAN AEROSPACE CORPORATION
BETHPAGE, NEW YORK 11714
SIZE
B
CODE IDENT NO
26512
128H10136
N1
SCALE
~
SHEET
2

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GAC 3664 REV 1 6-77 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT			DASH NO	M/B	REV
17	26512	EO	128H10136			N2

MFG PART NO	MCO REV		PRIORITY	DET SPEC	CHG CL	EO CONT NO
	ACD	ECP	C		1	128H772

CONTRACT NO: N62269-78C-0041 — SH 1 OF 1

DWG TITLE: REGULATOR INSTL, HYDRAULIC ~ AIR COMBINED — 565

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411: TK79-143	A6E		M229

ON RECORD E.O. 128H10136 - 901, REV N1 (E.O. CONTROL NUMBER 128H758) REVISE AS FOLLOWS:

ON SHT 2, IDENTIFICATION OF CASE DRAIN FILTER SHOULD READ "128SC-H135-6-1 FILTER CASE DRAIN"

WAS "128SC-H186-6-1 FILTER CASE DRAIN".

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO.	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
~		-901		REGULATOR INSTL								2	1

REASON FOR CHANGE: TO CORRECT CASE DRAIN P/N (HYCOS)

DESCRIPTION OF CHANGE: NOTED

PREPARED BY: W. MOOKE
SECTION: FLUID POWER
PLANT GROUP: 040 / C357
DATE – EXT: 3-2-78 61F9

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE									(GAC)
DATE	3-2	3/2/79		3/2			3/2/79	3-27	

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ — IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT — I&T IDENT AND TRACEABILITY

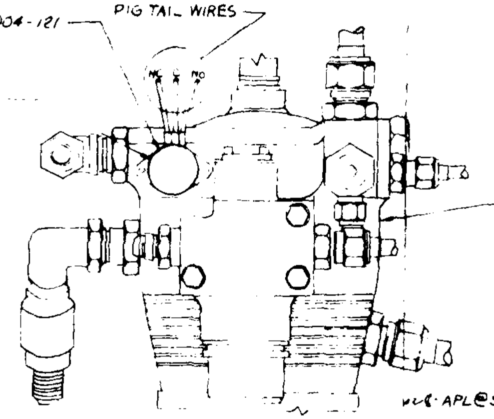
GAC 3664 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

SEQ NO	16
CODE IDENT	26512
EO	128H10312
REV	G1
MFG PART NO	
MCO REV	ACD
ECP	
PRIORITY	C
CHG CL	1
EO CONT NO	128H762
CONTRACT NO	N62269-78C-0041
REPLACES PART NO	
SH	1 OF 1
DWG TITLE	INSTALLATION - COMPONENTS, BACKUP FLIGHT CONTROL HYDRAULIC SYSTEM
NEXT ASSEMBLY DWG	128EL10403
EFF	1
AUTHORITY	21411:TK79-143
MODEL	A6E
GAC UNIT NO	M229



ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT COMM'L PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	ASD	EFF
CREATE		-901	COMPONENTS INSTL							I 4	1

REASON FOR CHANGE	DESCRIPTION OF CHANGE
HYDRAULIC CHECK OUT SYSTEM INSTALLATION	ADDED TEMPERATURE SWITCH

PREPARED BY	WALTER MOORE
SECTION	FLUID POWER
PLANT GROUP	040/0357
DATE EXT	2-8-79 6189
SUPPORT DATE	2 22 79
PROJ ENGRG DATE	12.2.79
RELEASE DATE	2-28-79

EO TYPE: DIRECT DWG CHG (DDC) / REV DWG / PROD ENGRG / RECORD EO

SD: RECM STK DISPN 1, DISPOSE 2, REWORK 3, INCREASE 4, CREATE 5, USE 6, HOLD 7, NO ACTION 8, ACCEPT; I&T IDENT AND TRACEABILITY

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI-SEC

PROCESSED BY | INSP PLT | DATE

ADDITIONAL COPIES TO

REMARKS

DATE ISSUED | DUE IN STOCK DATE

DESTINATION | DATE REC'D

COVERAGE

GAC 3044 REV 1 6-77 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO	DASH NO	M/B	REV
	26512	NOTED			

MFG PART NO | MCO REV ACD | ECP | PRIORITY C | ☐ ACTION ☐ NO ACTION | DET SPEC | CHG CL / | EO CONT NO 128H811

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY/EI

ACFT NO. | CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO N00019-79-C-0041 | REPLACES PART NO | SH 1 OF 7

DWG TITLE

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF

EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
1	21411 TK79-143	A6E		M229

ENGINEERING ORDER

	DRAWING NUMBER	REV	SEQ NO.	REV DWG	DOC	REF EO SH
EO	128H10009	W2	30			1,2,3
EO	128H10049	J2	11			1,4
EO	128H10127	G1	8			1,5
EO	128H10136	P1	18			1,6
EO	128H10312	H1	17			1,7

THIS IS A RECORD EO

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO.	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF

REASON FOR CHANGE
TO RESTORE AIRCRAFT M229, BACK TO ORIGINAL CONFIGURATION (REMOVAL OF HYDRAULIC CHECK OUT SYSTEM)

DESCRIPTION OF CHANGE
NOTED

PREPARED BY L LEE
SECTION FLUID POWER
PLANT GROUP 040/0357
DATE – EXT 10/28/80 X6185

APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SIGNATURE	[signature]	[signature]		[signature]			[signature]	[signature]	[signature]
DATE	10/30/80			10/30/80			10-30-80	11-4-80	11-5-80

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☒ | IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 = USE; 6 = HOLD; 7 = NO ACTION 8 = ACCEPT | I&T = IDENT AND TRACEABILITY

GAC 3044 REV 1 6-77 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GAC 3844 REV 1 8-77 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO NOTED		DASH NO	REV
	26512		128H10009		W2

MFG PART NO	MCO REV	ECP	PRIORITY	DET SPEC	CHG CL	EO CONT NO
	ACD					128H81

CONTRACT NO | REPLACES PART NO | SH 2 OF

DWG TITLE: COMPONENTS INSTL, HYDRAULICS - COMBINED SYSTEM - L H KEEL

ACTION	QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF
					128EL10401		

1 -903 ASSY - RAM AIR TURBINE ACCUMULATOR 128SC-H137-3

REMOVE BRACKET ASSY 128H10009-911 & HARDWARES, AN4-4A(4), AN960D4-6(4)

FROM OIL PORT REMOVE LINEAR POTENTIOMETER AND ASSOCIATED SUPPORT, HARDWARES AN815-6D, MS28778-6(2)

REPLACE WITH PARTS PER 128H10009-3 INSTL

FROM GAS PORT REMOVE TEMPERATURE POT, PRESSURE TRANSDUCER & HARDWARES AN941-4, AN937D4, AN815-4D AN815-4, MS28778-4(4)

REPLACE WITH PARTS PER 128H10009-3 INSTL

2 -905 ASSY - COMBINED SYSTEM PRESSURE FILTER 128SC-H133-1F

REMOVE DELTADYNE DIFFERENTIAL PRESSURE INDICATOR COMBINATION

REPLACE WITH ORIGINAL ΔP INDICATOR ASSEMBLY

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE
REMOVE	1	-911	BRACKET ASSY
REMOVE	1	-909	AIR BOTTLE ASSY
REMOVE	1	-907	RETURN FILTER ASSY
REMOVE	1	-905	PRESS FILTER ASSY
REMOVE	1	-903	ACCUMULATOR ASSY
REMOVE	1	-901	COMPONENTS INSTL

REASON FOR CHANGE | DESCRIPTION OF CHANGE

PREPARED BY | SECTION | PLANT GROUP | DATE EXT

APPROVED BY: GROUP LDR, SUPPORT, RELIABILITY, STRESS, PROD ENGRG, PROJ ENGRG, RELEASE, CUSTOMER

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION, 8 = ACCEPT; I&T = IDENT AND TRACEABILITY

IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

GAC 3844 REV 1 8-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION	CODE IDENT 26512	EO NOTED 128H-0009	DASH NO	REV W2
		MFG PART NO	SER NO	
		EO CONT NO 128H811	SH NO 3	

ACTION		QTY NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO

3 -907 ASSY - COMBINED SYSTEM RETURN FILTER 128SC-H...
REMOVE ...ACYNE DIFFERENTIAL PRESSURE INDICATOR COMBINATION
[illegible] ΔP INDICATOR ASSEMBLY
4 -909 ASSY - REMOVE PNEUMATIC RESERVOIR ASSY 149190-309 .
INSTAL FWD DOOR EMERGENCY AIR BOTTLE 128SC-H161-1 / 128N40026-1 PER 128H10009 INSTL

ACTION	QTY PER ASSY					PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN.	ZONE	I A D	S D	E F F

GAC 9099

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

REWORK RESPONSIBILITY							
PLT	DEPT	CCC	MODEL	TYPE	EFFECTIVITY FROM	EFFECTIVITY THRU	PROJECT PRI SEC

PLT/DEPT	OPERATIONS	ISSP

REMARKS

GAC 9099

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

PART NUMBER

CONTROL WBS REFERENCE DRAWING NO

E O | DISP | INSP

PART SERIAL NO | PART LOT NO

END ITEM NO

MOD TYPE | VEHICLE S/N | MAJOR ASSY I D

REWORK RESPONSIBILITY

PLT	DEPT	C C C	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PRI SEC

PROCESSED BY | INSP PLT | DATE

ADDITIONAL COPIES TO

REMARKS

DATE ISSUED | DUE IN STOCK DATE

DESTINATION | DATE REC D

COVERAGE

GAC 3044 REV 1 6-77(PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT 26512	EO NOTED	[illegible]	DASH NO	M B	REV J2

MFG PART NO	MCO REV ACD	ECP	PRIORITY	☐ ACTION ☐ NO ACTION	DET SPEC	CHG CL	EO CONT NO [illegible]

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY EI
						ACFT NO	CONFIG REQ'D/CONFIG NOT REQ'D

CONTRACT NO | REPLACES PART NO | SH 1 OF

DWG TITLE COMPONENT INSTL [illegible]

ACTION		QTY NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
						[illegible]							

REMOVE ONE [illegible] RESERVOIR [illegible] FROM [illegible]

& RE-INSTALL AIR BOTTLE [illegible] PER [illegible]

ACTION	QTY PER ASSY		PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT - COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
REMOVE			[illegible]		COMPONENT INSTL									

REASON FOR CHANGE

DESCRIPTION OF CHANGE

PREPARED BY	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SECTION	SIGNATURE									
PLANT GROUP	DATE									

DATE - EXT

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☐ IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT I&T = IDENT AND TRACEABILITY

GAC 3044 REV 1 6-77(PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GAC 3044 REV 1 6-77 (PART B)

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT 26512	EO NOTED	128H10127	DASH NO / M/B	REV G1
MFG PART NO	MCO REV ACD	ECP	PRIORITY / ☐ ACTION ☐ NO ACTION	DET SPEC / CHG CL	EO CONT NO 128H811
PLT/DEPT / OPERATIONS / INSP	PLT/DEPT / OPERATIONS	INSP	END ITEM NO	ACFT NO / CONFIG REQ'D/CONFIG NOT REQ'D	QTY/EI
CONTRACT NO		REPLACES PART NO		SH 5 OF	

DWG TITLE RESERVOIR INSTL - HYDRAULIC - COMBINED SYSTEM

ACTION	QTY/NA	QTY/EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
					128EL10401							

(HYCOS)

REMOVE RESERVOIR ASSY, 128H10125-1, RESERVOIR LEVEL SENSOR ASSY, 149190-306, TEMPERATURE TRANSDUCER, DESICCANT, 1491901-304 & ALL ASSOCIATED HARDWARES AN919-6D, AN832-6D, AN6289-D6, AN939-D6, MS28773-06(2), MS28778-4 MS28778-6(2), MS28776-16(2), MS28773-16, AN784D16, AN6289D16, AN893-5D

RE-INSTALL RESERVOIR ASSY, 128H10125-1, PER 128H10127-1 INSTL

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	IAD	SD	EFF
REMOVE	-901	-901		RESERVOIR INSTL								/	/

REASON FOR CHANGE

DESCRIPTION OF CHANGE

PREPARED BY	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SECTION	SIGNATURE									
PLANT/GROUP	DATE									

DATE – EXT

EO TYPE: DIRECT DWG CHG (DOC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☐ IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 = USE; 6 = HOLD; 7 = NO ACTION 8 = ACCEPT I&T = IDENT AND TRACEABILITY

GAC 3044 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

GRUMMAN AEROSPACE CORPORATION

SEQ NO	CODE IDENT	EO NOTED		DASH NO	M B	REV
	26512		128H10136			P1

MFG PART NO	MCO REV	ACD	ECP	PRIORITY	☐ ACTION ☐ NO ACTION	DET SPEC	CHG CL	EO CONT NO	26HB

PLT/DEPT	OPERATIONS	INSP	PLT/DEPT	OPERATIONS	INSP	END ITEM NO	QTY EI
						ACFT NO	CONFIG REQ'D/CONFIG NOT REQ'D
CONTRACT NO						REPLACES PART NO	SH 6 OF

DWG TITLE REGULATOR INSTALLATION - HYDRAULIC - A.F. COMB. VEC

ACTION	QTY/NA	QTY EI	PART NUMBER	NOTE	NEXT ASSEMBLY DWG	SD	EFF	EFF	AUTHORITY	MODEL	END ITEM	GAC UNIT NO
					28EE1343							

REMOVE MULTIPATH FROM FILTER & ... CASE DRAIN
& REPLACE WITH ORIGINAL LINE ATTACH PER FILTER ASSY, 12ESC-H33-6-1, PER 128H10136-3 INSTL

ACTION	QTY PER ASSY	PART NUMBER	I & T	NOMENCLATURE	NOTE	COMMERCIAL SPECIFICATION CODE IDENT – COML PART NO	MATERIAL SPECIFICATION	PROC	FIN	ZONE	I A D	S D	E F F
REMOVE	-90	-90		REGULATOR INSTL									

REASON FOR CHANGE

DESCRIPTION OF CHANGE

PREPARED BY	APPROVED BY	GROUP LDR	SUPPORT	RELIABILITY	STRESS	PROD ENGRG		PROJ ENGRG	RELEASE	CUSTOMER
SECTION	SIGNATURE									
PLANT GROUP	DATE									

DATE – EXT

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☐ IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE, 2 = REWORK, 3 = INCREASE, 4 = CREATE, 5 = USE, 6 = HOLD, 7 = NO ACTION 8 = ACCEPT I&T = IDENT AND TRACEABILITY

GAC 3844 REV 1 6-77 (PART A)

ENGINEERING ORDER/
MANUFACTURING CHANGE ORDER

CONFIGURATION VERIFICATION
AND TRACEABILITY RECORD

PART NUMBER

CONTROL DWG REFERENCE DRAWING NO

PART SERIAL NO | PART LOT NO

END ITEM NO

MOD TYPE | VEHICLE S/N | MAJOR ASSY ID

REVIEW RESPONSIBILITY

PLT	DEPT	C C C	MODEL	TYPE	EFFECTIVITY FROM & THRU	PROJECT PROJ-EC

PROCESSED BY | PLT | DATE

ADDITIONAL COPIES TO

REMARKS

DATE ISSUED | DUE IN STOCK DATE

DESTINATION | DATE REC'D

COVERAGE

GAC 3844 REV 1 6-77 (PART B)

CONFIGURATION VERIFICATION AND TRACEABILITY RECORD

GRUMMAN AEROSPACE CORPORATION

CODE IDENT	26512
EO NOTED	128H10312
REV	H1
MCO REV	ACD
	ECP
EO CONT NO	128H811
SH	7 OF
DWG TITLE	INSTALLATION - COMPONENTS BACKUP FLIGHT CONTROL HYDRAULIC SYSTEM
NEXT ASSEMBLY DWG	128EL10403

REMOVE KLIXON TEMPERATURE SWITCH , P/N C4391513 M8A13094H1310 , FROM RESERVOIR ASSY , 128H10316 -1

ACTION	QTY PER ASSY	PART NUMBER	NOMENCLATURE
REMOVE	-901	-901	COMPONENTS INSTL

REASON FOR CHANGE

DESCRIPTION OF CHANGE

PREPARED BY / SECTION / PLANT GROUP / DATE - EXT

APPROVED BY: GROUP LDR, SUPPORT, RELIABILITY, STRESS, PROD ENGRG, PROJ ENGRG, RELEASE, CUSTOMER

EO TYPE: DIRECT DWG CHG (DDC) ☐ REV DWG ☐ PROD ENGRG ☐ RECORD EO ☐

IAD: I = INSTL, A = ASSY, D = DETAIL, M = MAKE FROM

SD = RECM STK DISPN 1 = DISPOSE; 2 = REWORK; 3 = INCREASE; 4 = CREATE; 5 = USE; 6 = HOLD; 7 = NO ACTION 8 = ACCEPT I&T = IDENT AND TRACEABILITY

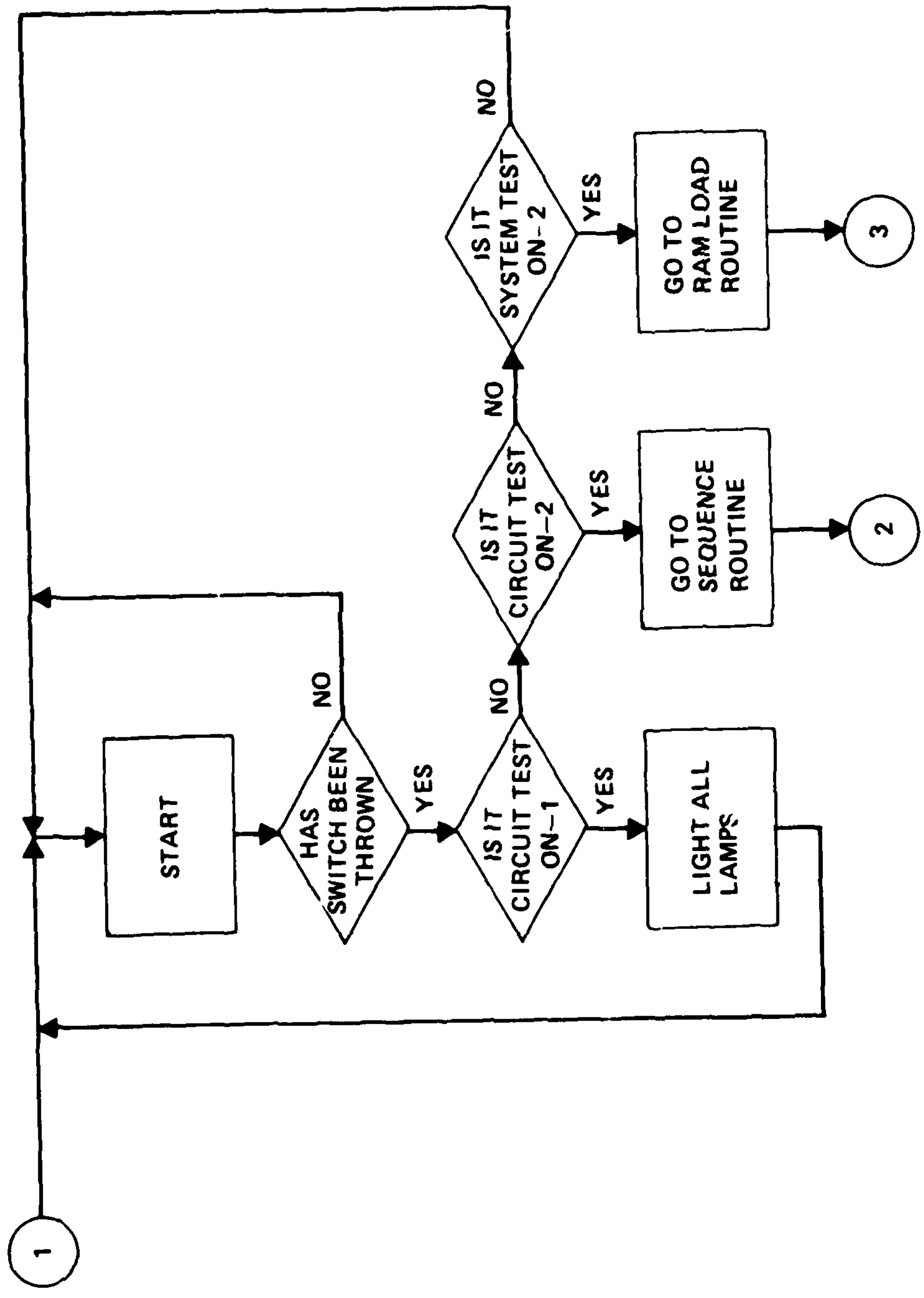
GAC 3044 REV 1 6-77 (PART A)

ENGINEERING ORDER/ MANUFACTURING CHANGE ORDER

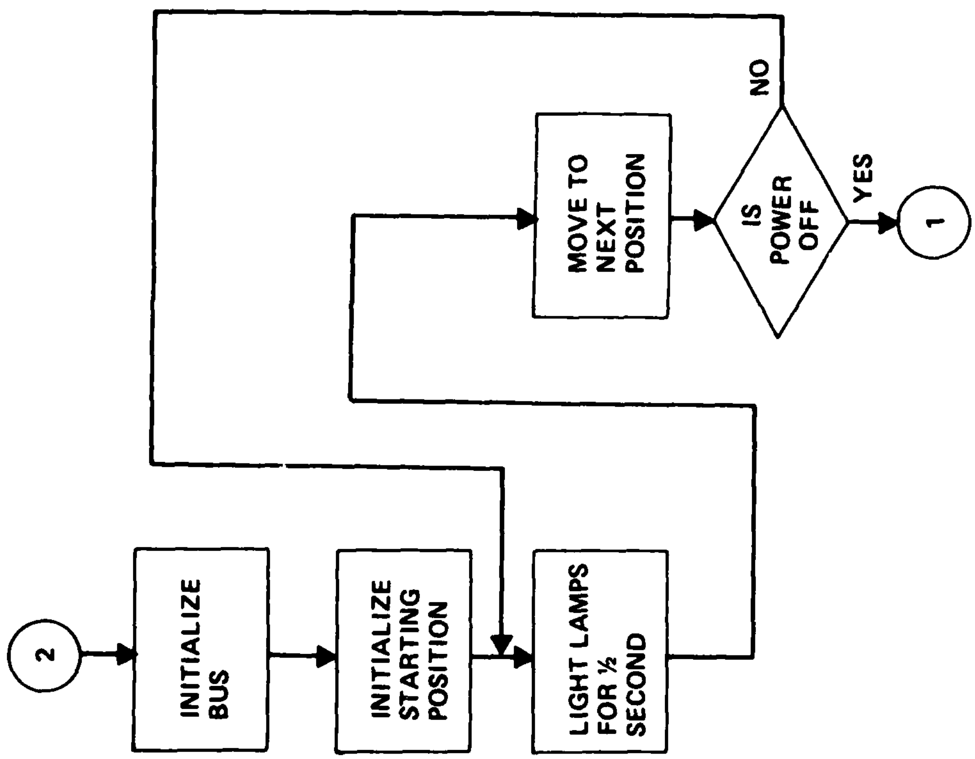
APPENDIX H

HYCOS PROGRAM FLOW DIAGRAM

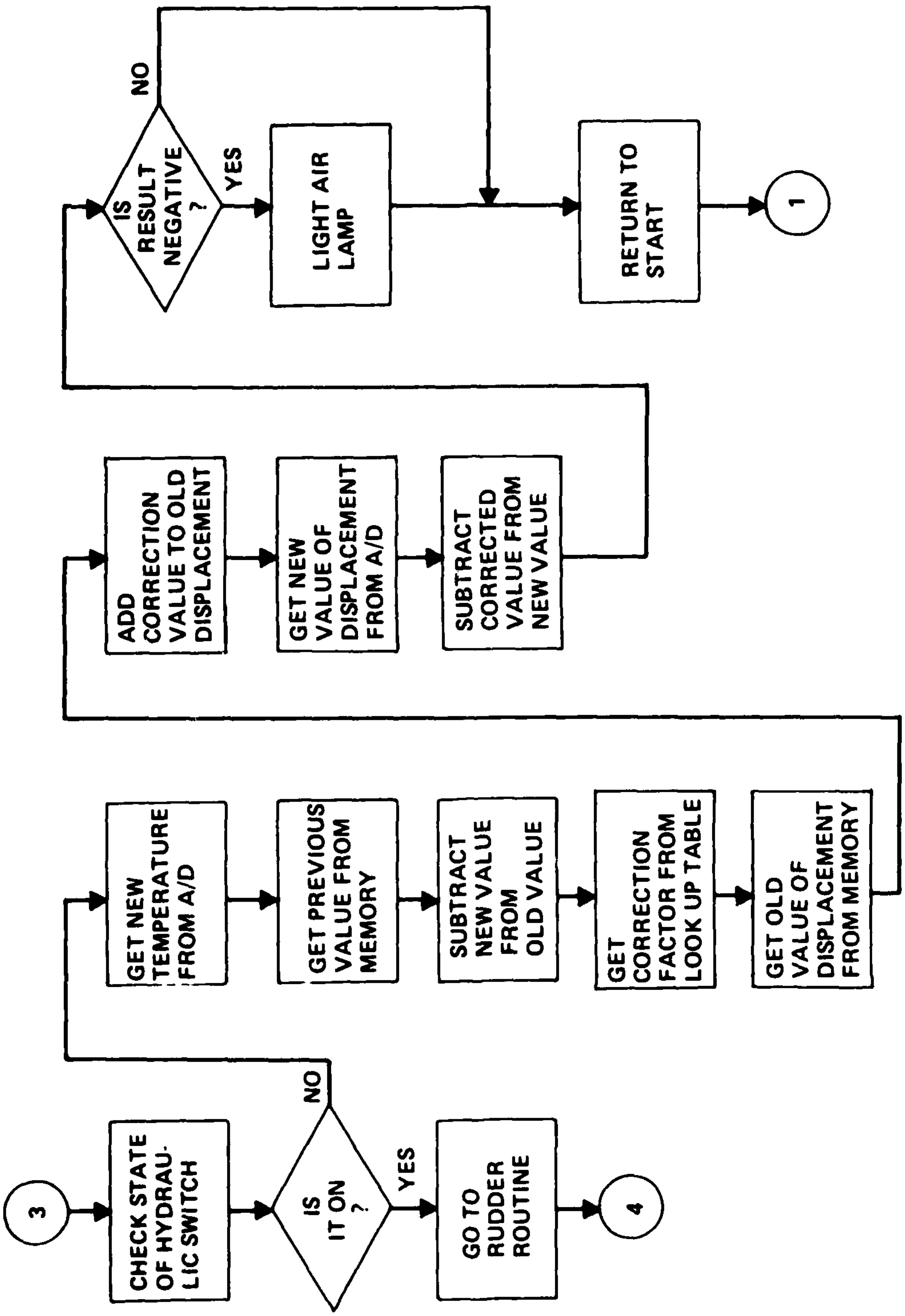
EXECUTIVE ROUTINE



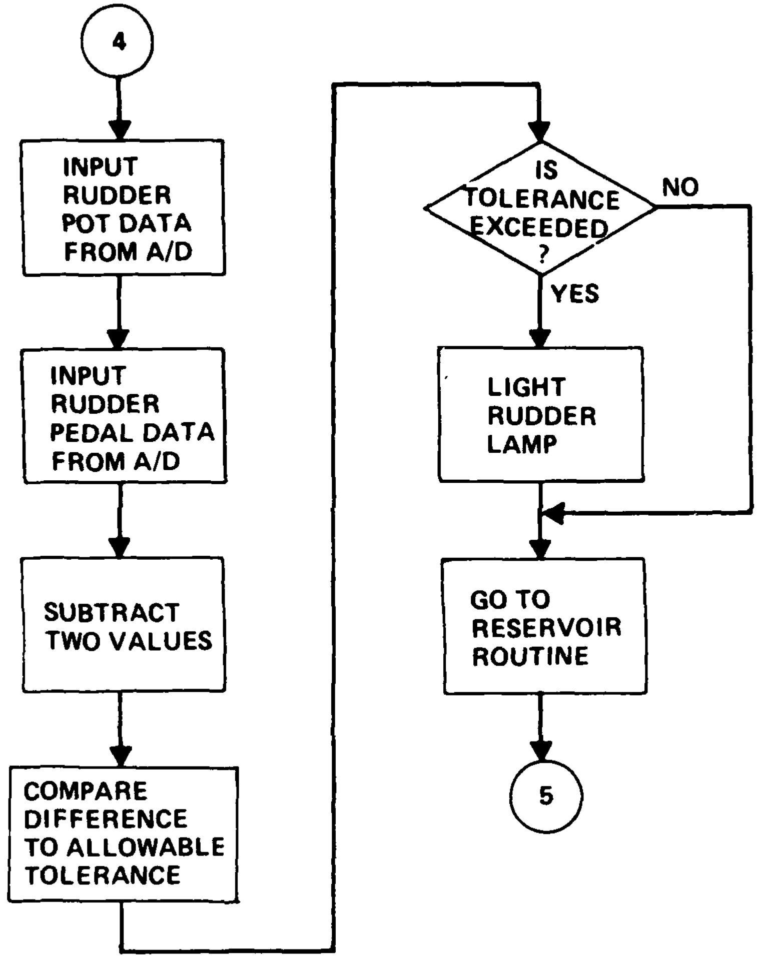
SEQUENCE ROUTINE



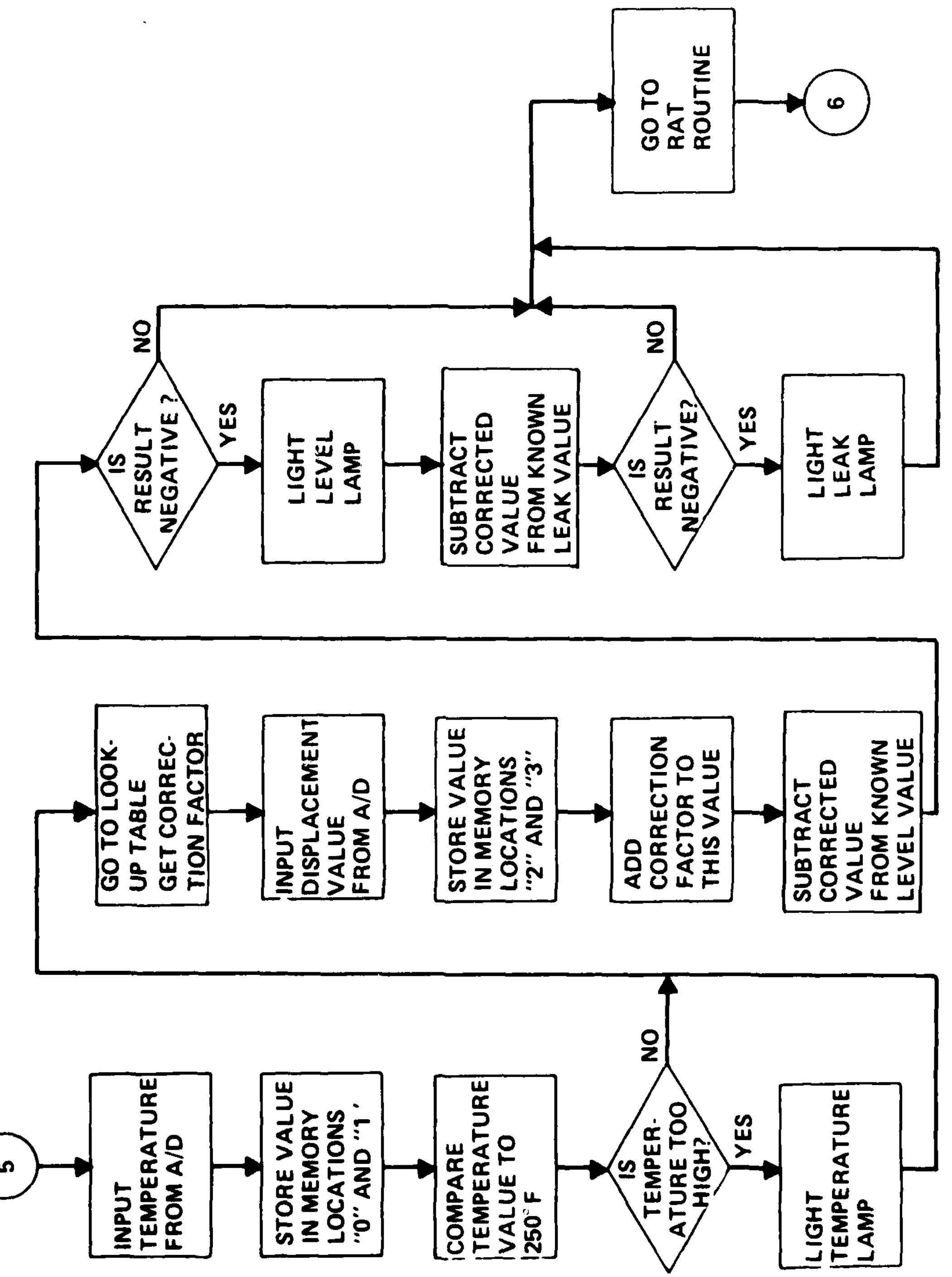
RAM LOAD ROUTINE



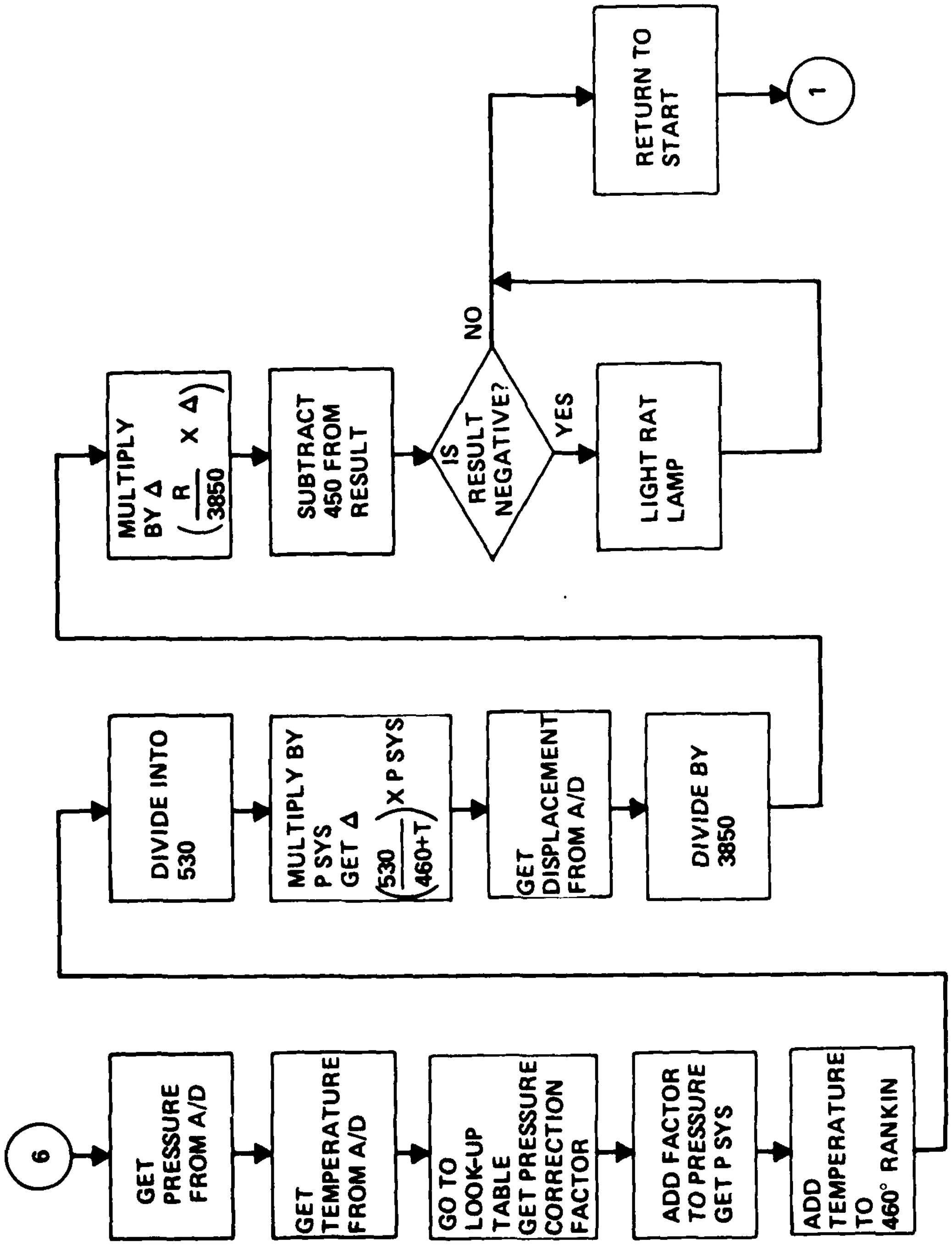
RUDDER ROUTINE



RESERVOIR ROUTINE



RAT ROUTINE


6
GET PRESSURE FROM A/D
GET TEMPERATURE FROM A/D
GO TO LOOK-UP TABLE GET PRESSURE CORRECTION FACTOR
ADD FACTOR TO PRESSURE GET P SYS
ADD TEMPERATURE TO 460° RANKIN
DIVIDE INTO 530
MULTIPLY BY P SYS GET Δ $\left(\frac{530}{460+T}\right) \times$ P SYS
GET DISPLACEMENT FROM A/D
DIVIDE BY 3850
MULTIPLY BY Δ $\left(\frac{R}{3850} \times \Delta\right)$
SUBTRACT 450 FROM RESULT
IS RESULT NEGATIVE?
YES
NO
LIGHT RAT LAMP
RETURN TO START
1

APPENDIX I

HYCOS BATTERY ANALYSIS AND CHANGER WIRING DIAGRAM

The Hydraulic Checkout/Diagnostic Monitoring System (HYCOS) includes the following nickel-cadmium batteries:

- +5V Battery; 4 Series-connected, 1 A-H, G.E. cells (Gold Top type X GCR 1.0ST)
- +3.6V Battery; 3 Series-connected, 100 mA Hr GE cells (Gold Top type X GCR 100ST)
- -6V/-4.8V Battery; 5 Series-connected (-6.0V) cells with a 4-cell tap for -4.8V. Cells are the same as the +3.6V battery cells.

These batteries are located within the HYCOS panel (box) and are not readily accessible.

I.1 GENERAL HYCOS POWER UTILIZATION

When installed in an aircraft, HYCOS uses 115 VAC, 400 Hz ship's power (when "on") to support HYCOS functional requirements and to recharge the batteries. When ship's power is "off" or otherwise not available, HYCOS power is supplied by the batteries.

A typical checkout test will last about 1/2 to 1 minute. It is estimated that up to six of these tests could be performed over a period of up to 6 weeks where no battery charging takes place.

I.2 BATTERY DISCHARGE

I.2.1 +5V Battery

This battery (now) only supplies power during the actual test period. Loads on this battery include:

- All power to logic circuits which, based on H. Dreksler's analysis, is approximately 500 mA

- Power for a maximum of five 'grain-of-wheat' lamps/test at approximately 50 mA each, or 250 mA total
- Power for two fiber optic light source lamps at approximately 750 mA each, or 1500 mA total.

The total current drain on the +5 battery during the test period is approximately 2.25 A. Assuming a realistic maximum test period of one (1) minute, the energy output per test is approximately 3.75% of the nameplate capacity of the battery.

I.2.2 +3.6V Battery

This battery is used to sustain the CMOS RAM (M5101). It supplies current of between 2-200μ A essentially all the time. Assuming a nominal current of 100μ A, the battery energy output would be approximately 2.4 mA-hr per day. At this rate the 100 mA-hr battery, if initially fully charged, could operate up to about 6 weeks without charging.

I.2.3 -6V/-4.8V Battery

This battery supplies power only during the actual test period to seven (7) 8703 A/D converters. The -6V output supplies approximately 7 x 20μA or 140μA, while the -4.8V output, obtained by tapping into the -6V battery, supplies 7 x 5 mA or 35 mA. Thus, the cells that form the -4.8V battery have a total current drain of 35 mA + 140μA, or essentially 35 mA. On the basis of a one-minute test period, this -4.8V battery supplies about 0.6% of the nameplate capacity per test, while the additional cell used to obtain the -6V output supplies negligible energy/test (0.0023%/test).

On the basis of energy output requirements, each HYCOS battery would appear to be adequately sized. Even accounting for self-discharge of the batteries, which could range up to a loss of perhaps 50% capacity over a 6-week period (at normal storage temperatures of about 20°C), the batteries should have adequate capacity.

> Note: The +3.6V battery, which is supplying memory-sustaining power while the other batteries are idle, should be marginally acceptable for a 6-week storage.

I.3 BATTERY CHARGING

The circuit used for battery charging is shown in Fig. I-1. Figure I-2 depicts the HYCOS Battery Charger. The recommended (by G.E.) constant current charge rate for the Gold Top batteries is between C/10 and C/20. These batteries can supposedly safely handle continuous overcharge at these rates.

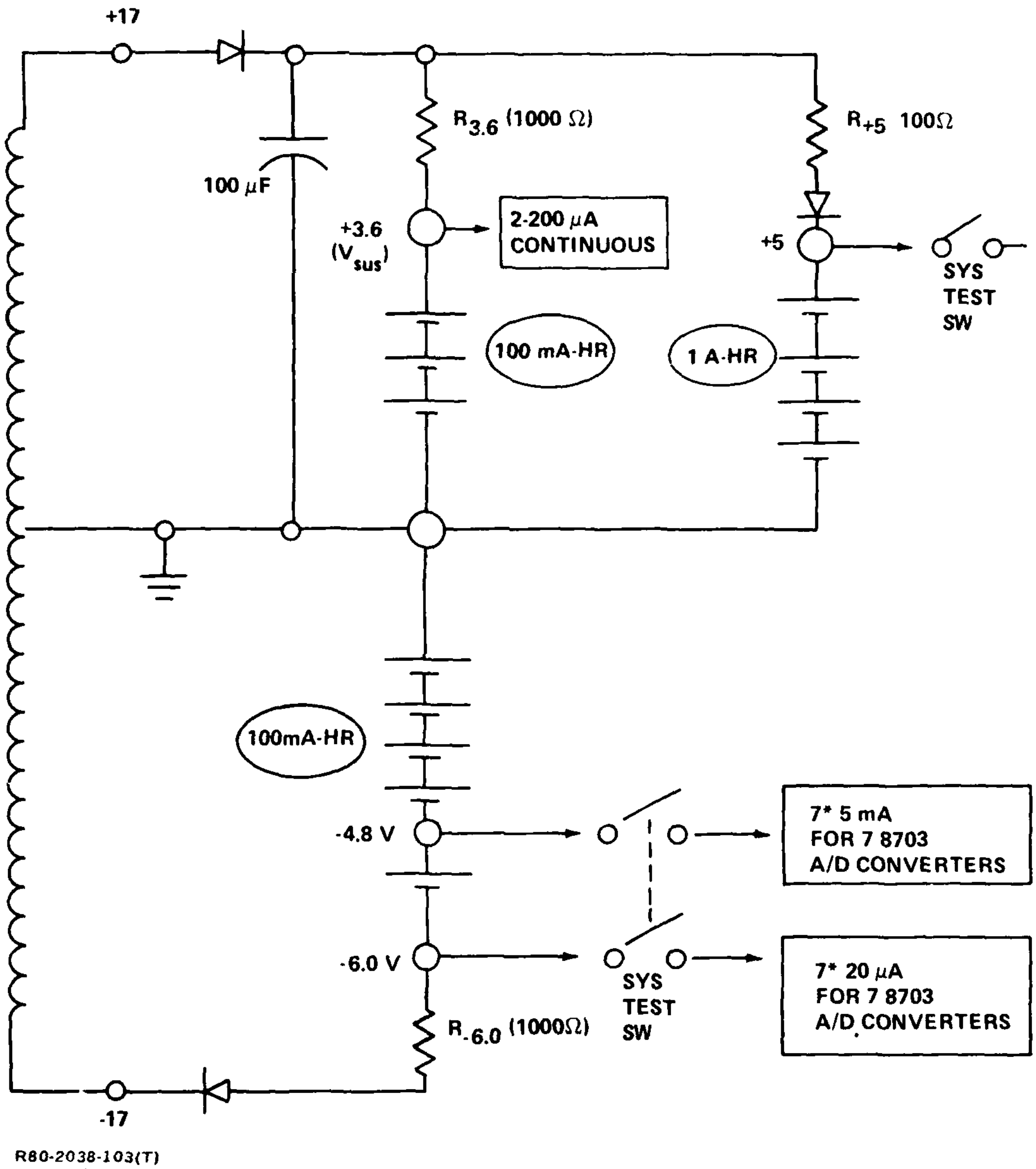
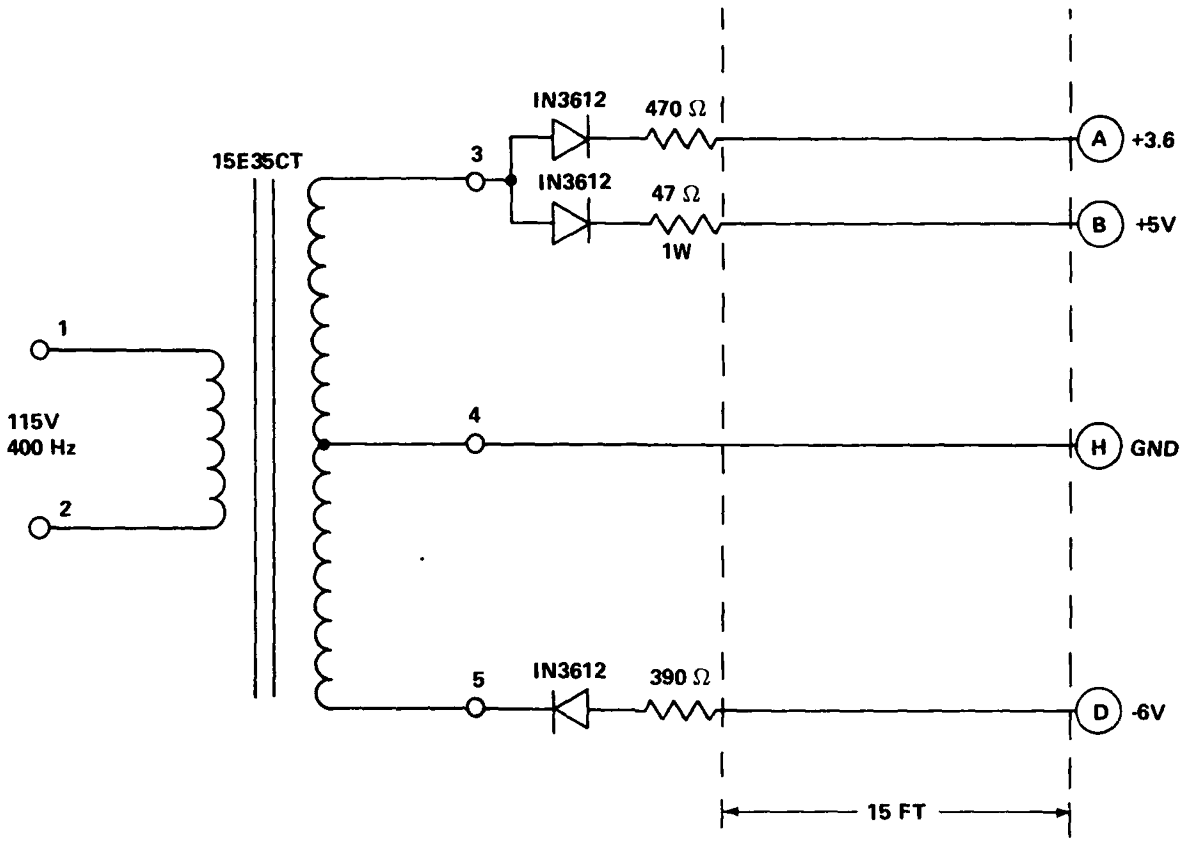


Figure I-1. Battery charging circuit.



R80-2038-104(T)

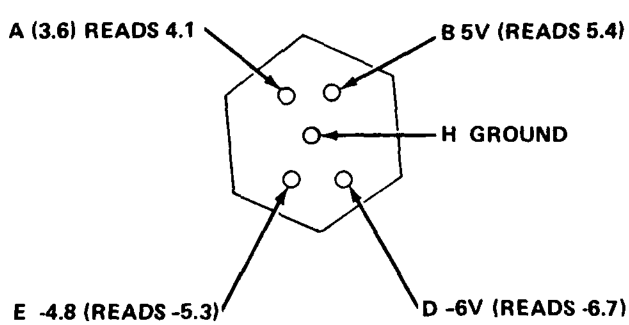
Figure I-2. HYCOS battery charger.

A fully depleted battery, in order to be fully charged at C/10, will require 14-18 hr of charge time and 30-35 hr of charge time at C/20. It is unlikely that HYCOS batteries will be provided this much time if charging is to be accomplished during aircraft flight.

Based on the questionable time available for recharge, it is recommended that the HYCOS panel be equipped with an externally accessible connector (Fig. I-3) that provides direct connection to battery + and - terminals, or connections to the input of the HYCOS battery charging circuit (i.e., 115 VAC, 400 Hz to transformer primary). The preferred approach is direct connection to the battery terminals. This connector would then allow :

- Monitoring or a status check on battery voltages
- Battery charging using a dedicated ground support charger.

A	+3.6	A5-85
B	+5V	A5-81
E	-4.8	A5-7
D	-6V	A5-84
H	GROUND	CHASSIS ANYWHERE 1/16/80



R80-2038-105(T)

Figure I-3. Battery Test Panel Connector Interface.

APPENDIX J

SYSTEM INSTALLATION AND VEHICLE PHOTOS

PHOTO NO.	DESCRIPTION
J- 1	View showing temperature-compensated pressure switch mounted to 15 cubic inch pneumatic bottle.
J- 2	Port keel area showing quiescent flow sensor, system pressure switch, and pressure filter remote reading Delta P indicator.
J- 3	View showing temperature transducer in return line to reservoir.
J- 4	Combined system reservoir showing remote reading potentiometer and desiccant saturation detection unit.
J- 5	Port keel area showing probe-type temperature switch in pump case drain line. Also shown is system pressure switch.
J- 6	Port keel area showing probe-type temperature switch in pump case drain line. Also shown is system pressure switch. (Same as J-5.)
J- 7	Case drain filter showing APM multicator installation (provisions for fluid sampling case drain line).
J- 8	View looking forward at 30-cubic inch gear door dump bottle with temperature-compensated pressure switch on pedestal.
J- 9	View showing duct access area where HYCOS panel is to be mounted. Wire bundles are shown in area.
J-10	View showing bottom of Ram Air Turbine Accumulator with temperature and pressure transducer.
J-11	Forward port keel area showing Ram Air Turbine Accumulator with linear displacement transducer.
J-12	View showing bottom of Ram Air Turbine Accumulator with temperature and pressure transducer. (Same as J-10.)
J-13	Closeup of displacement rod on Ram Air Turbine Accumulator.
J-14	Closeup of displacement rod on Ram Air Turbine Accumulator (Same as J-13.)

PHOTO NO.	DESCRIPTION
J-15	View looking forward at RAT accumulator mounting.
J-16	Surface temperature switch mounted on flight control backup module.
J-17	Surface temperature switch mounted on flight control backup module (Same as J-16.)
J-18	Rudder actuator flow sensor on pressure line.
J-19	Rudder actuator flow sensor on pressure line. (Same as J-18.)
J-20	Pump case drain flow sensor instellation.
J-21	A-6E Mod 229 flight test vehicle.
J-22	Plane Captain interrogating HYCOS system.
J-23	Closeup on HYCOS Display panel in flight test vehicle.

Photo J-1

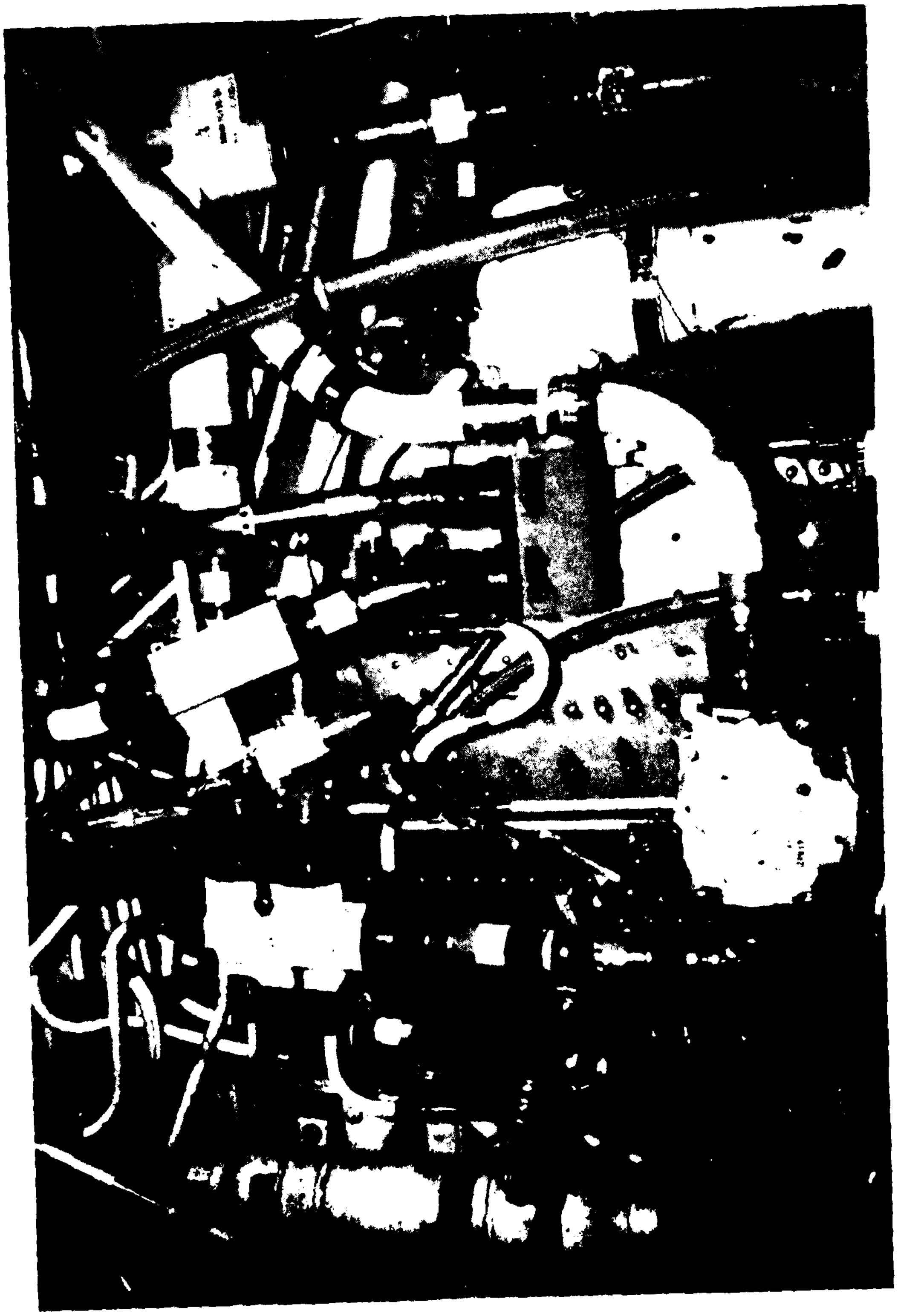


Photo J-2

Photo J-3

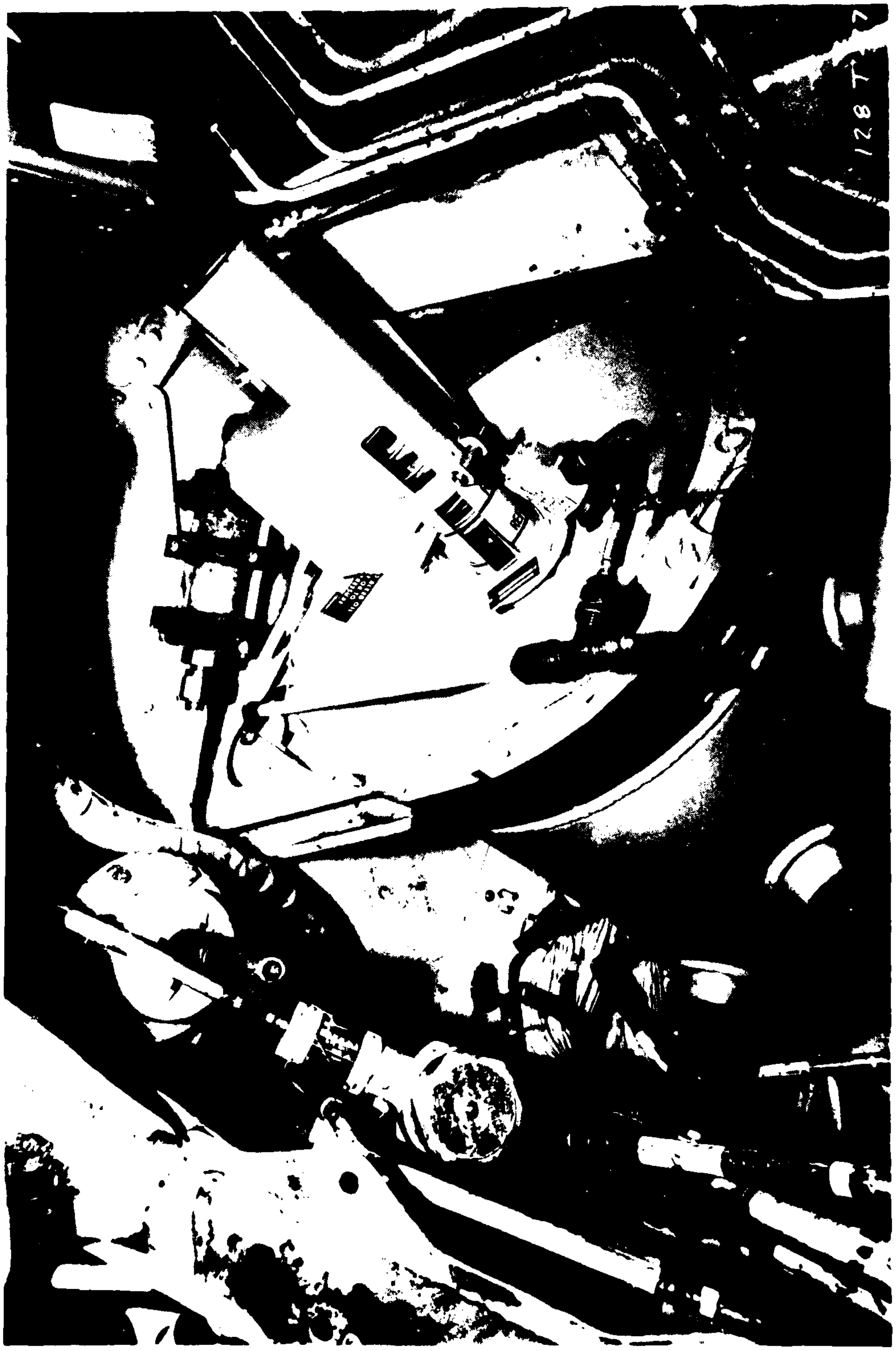


Photo J-4

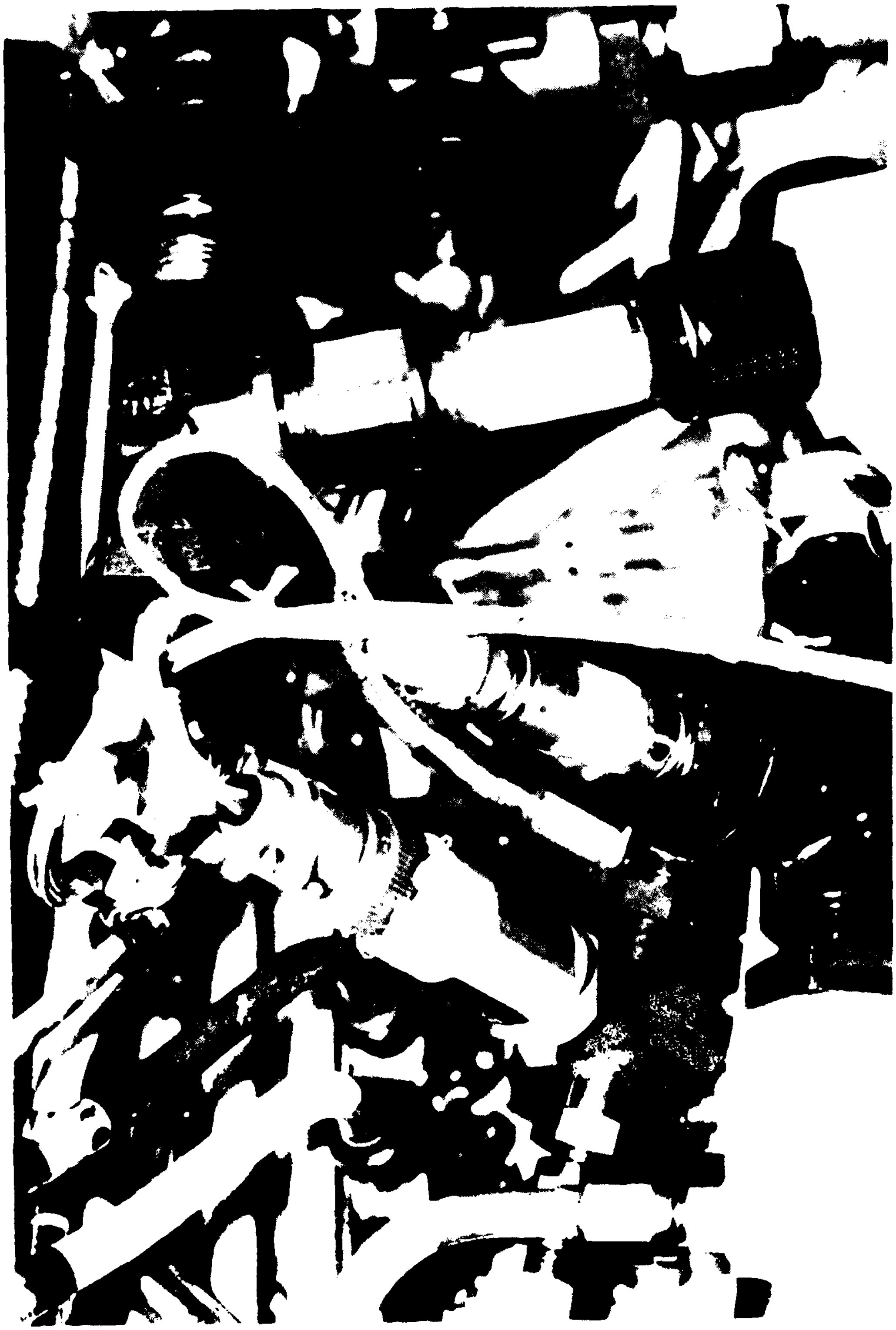


Photo J-5

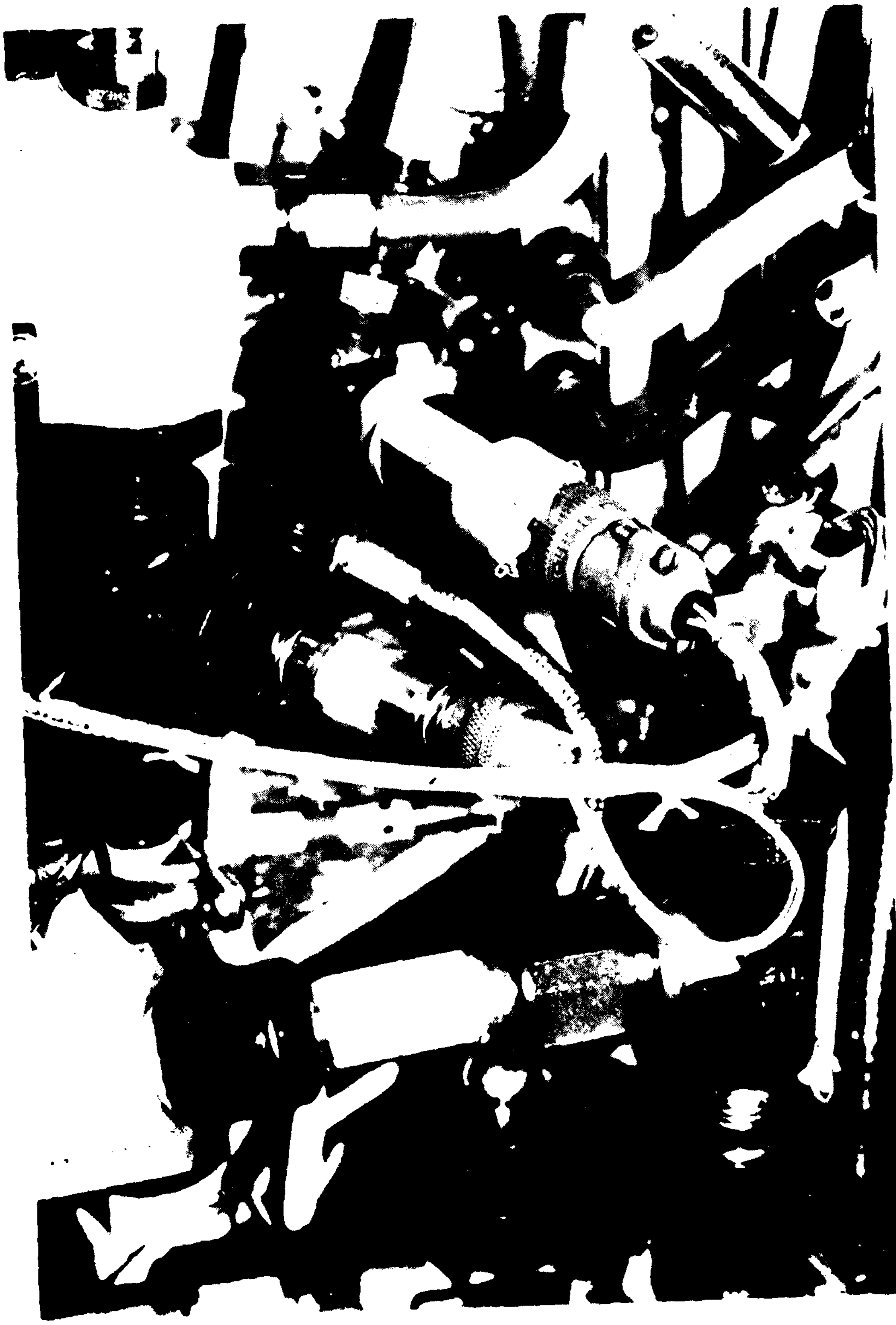


Photo J-6

Photo J-7

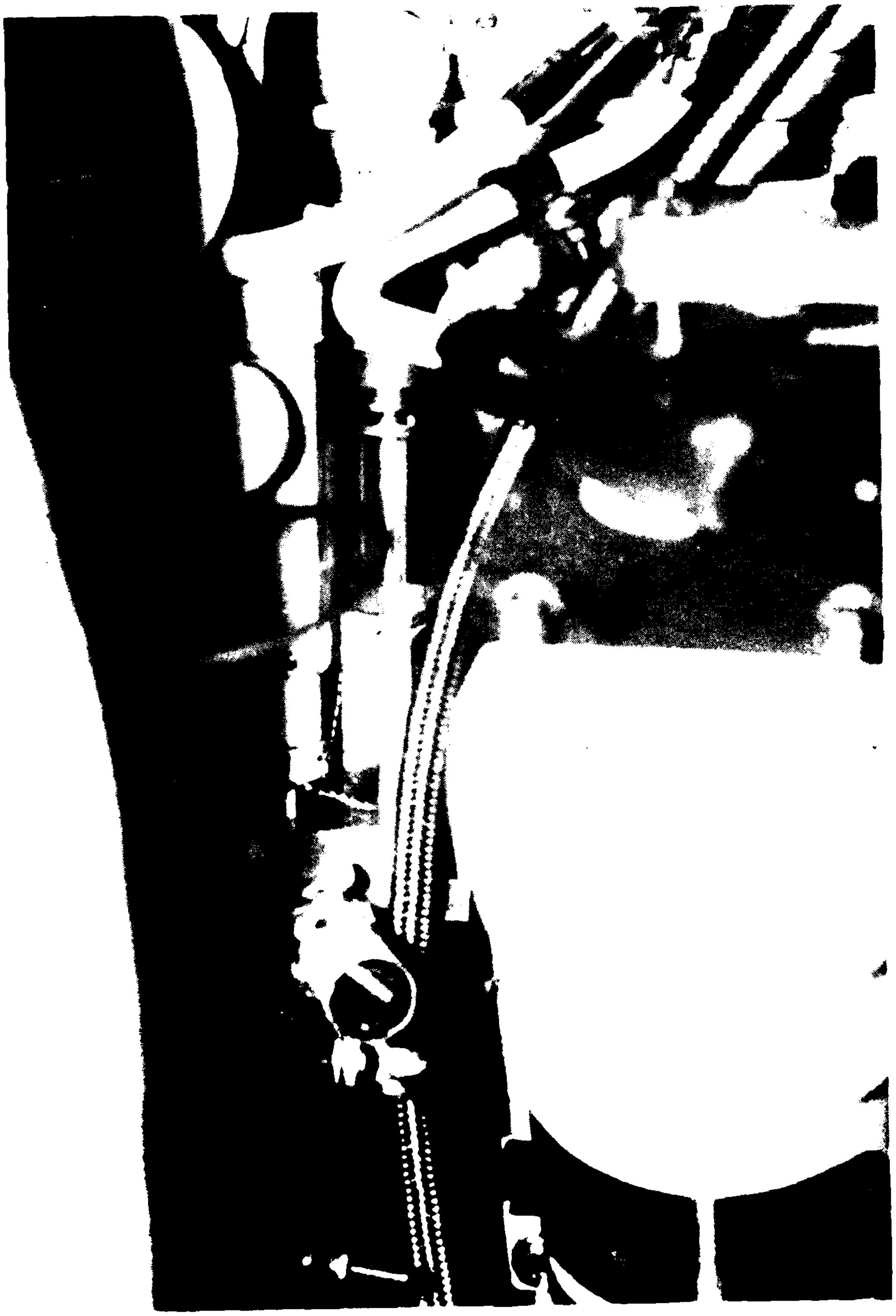


Photo J-8

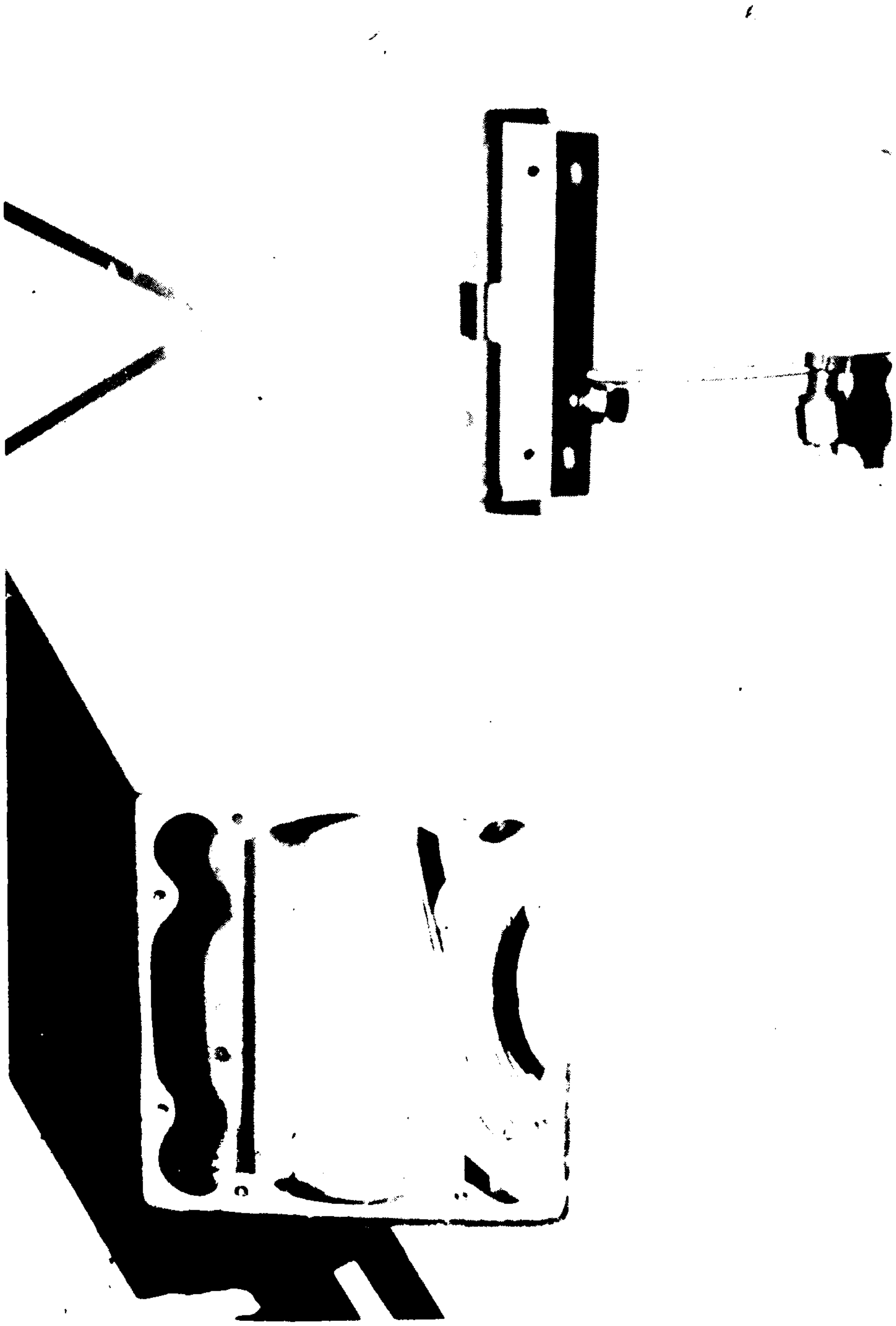


Photo J-9

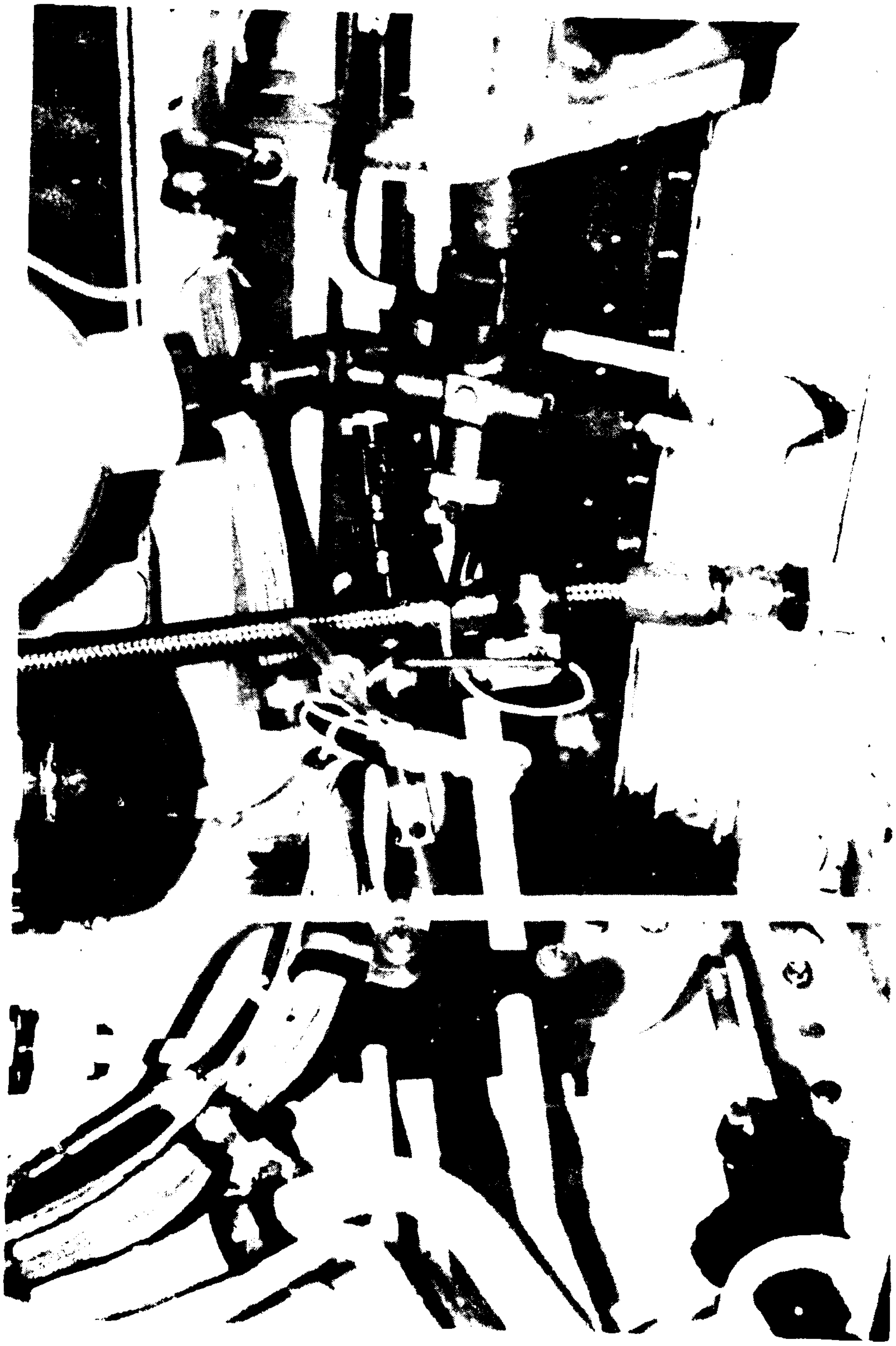


Photo J-10

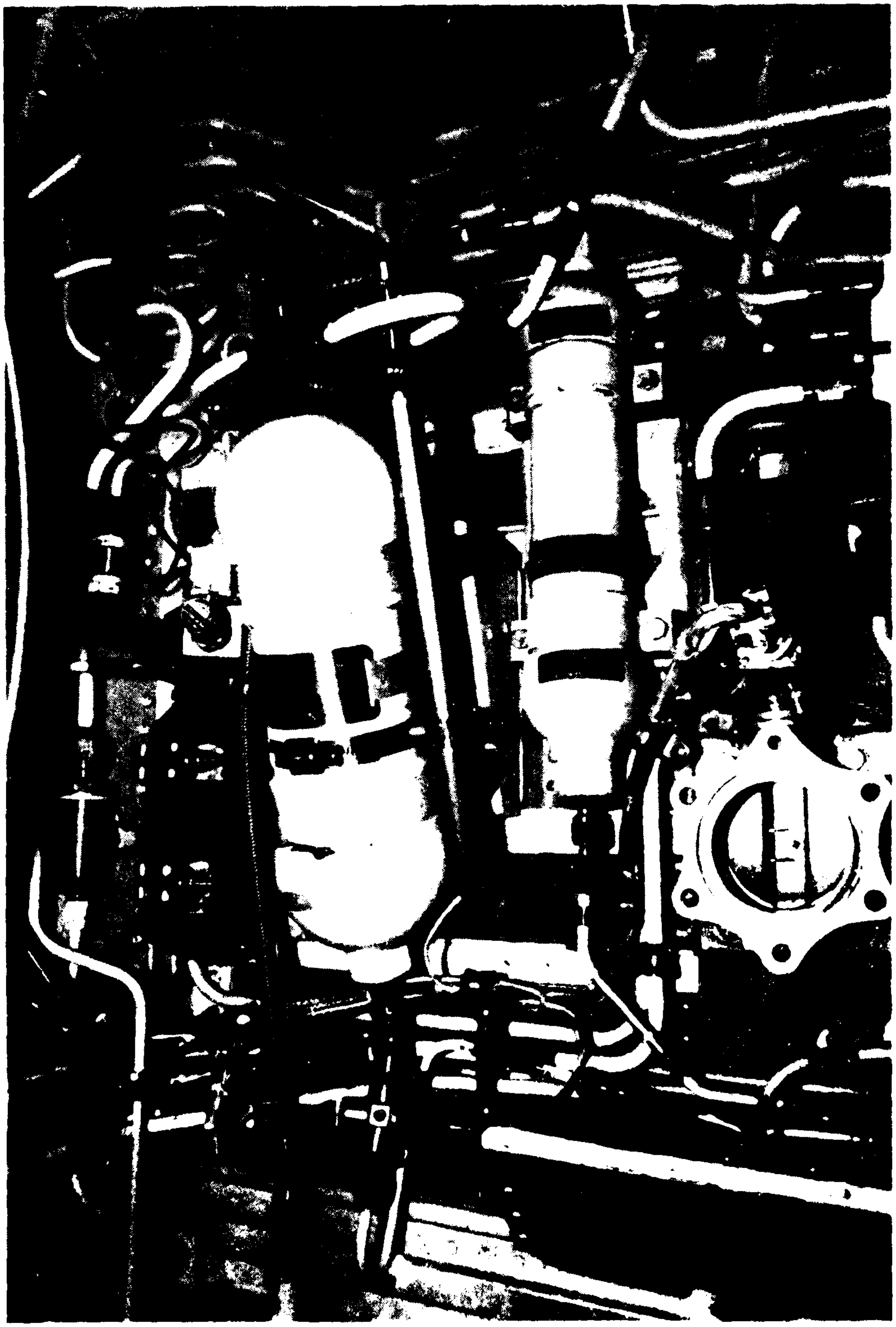


Photo J 11

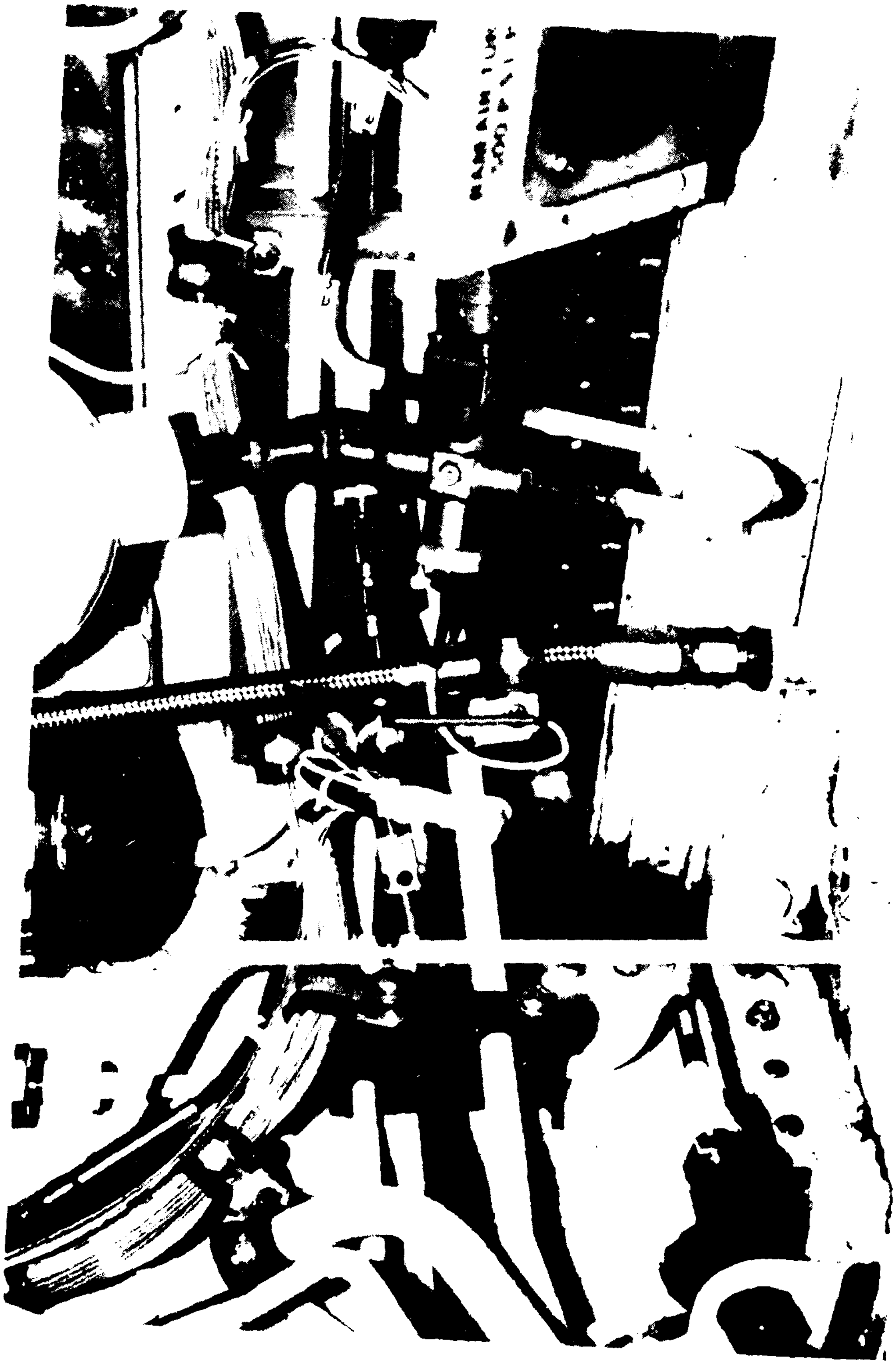


Photo J-12

Photo J-13

Photo J-14

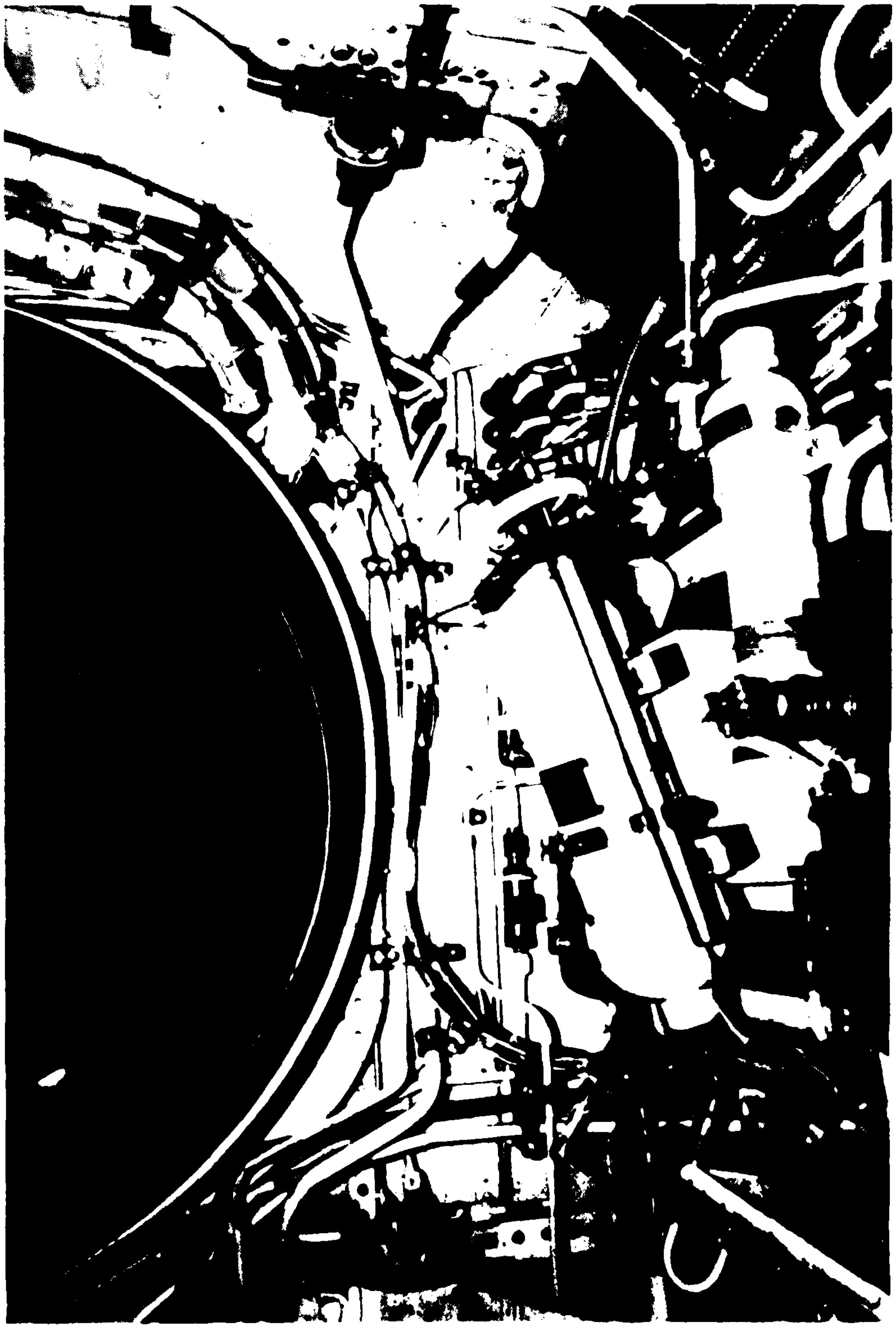


Photo J-15

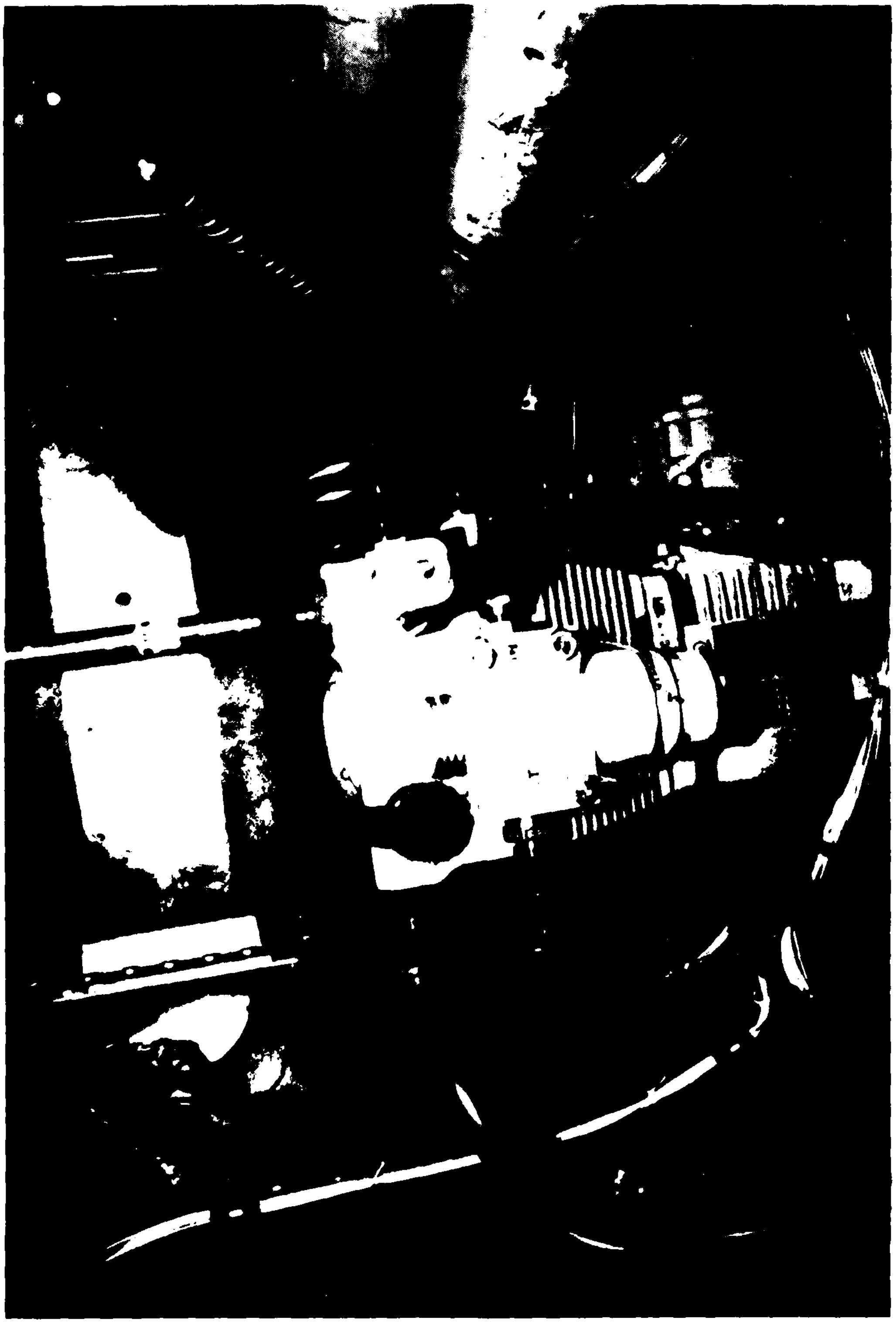


Photo J-16

Photo J-17

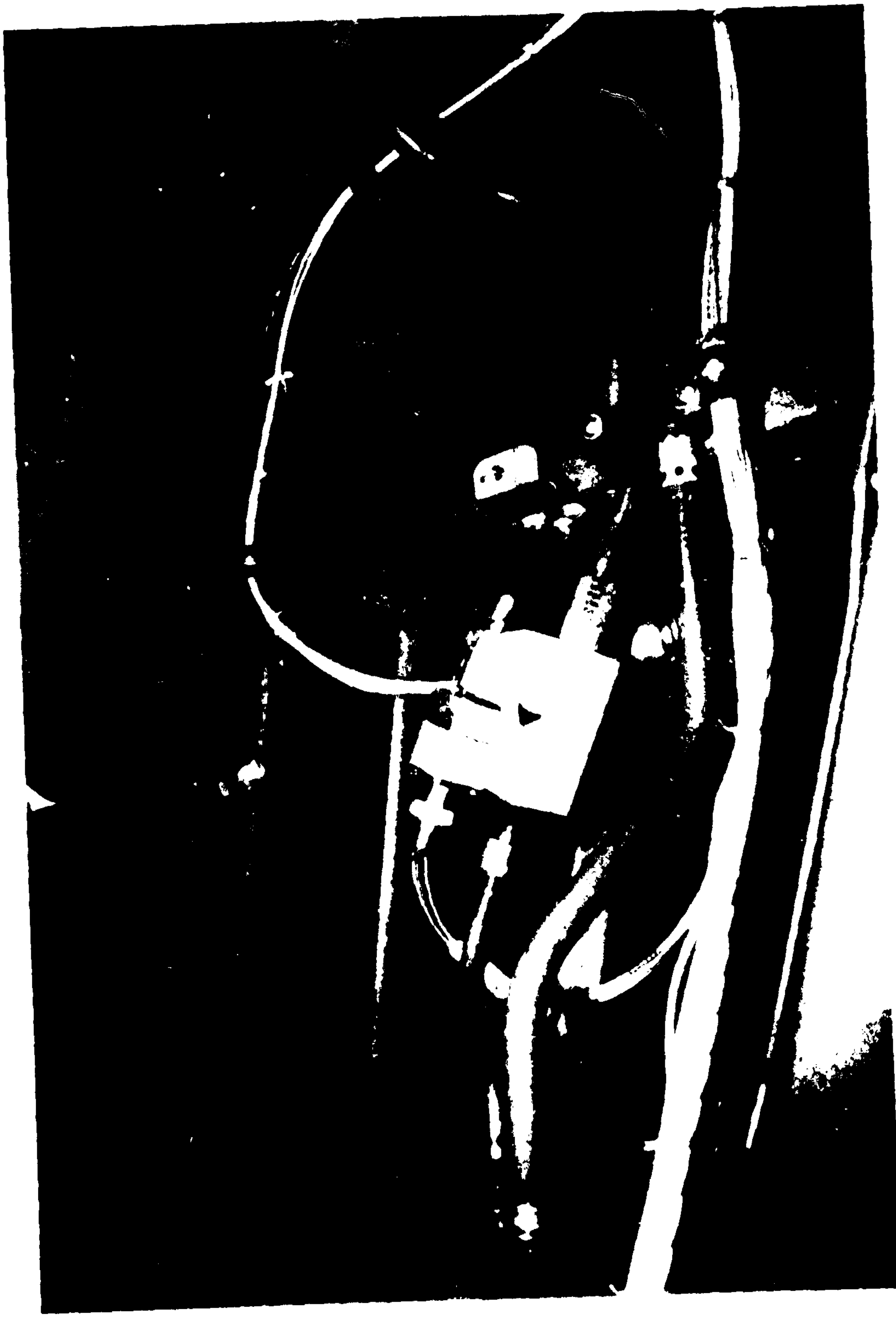


Photo J-18

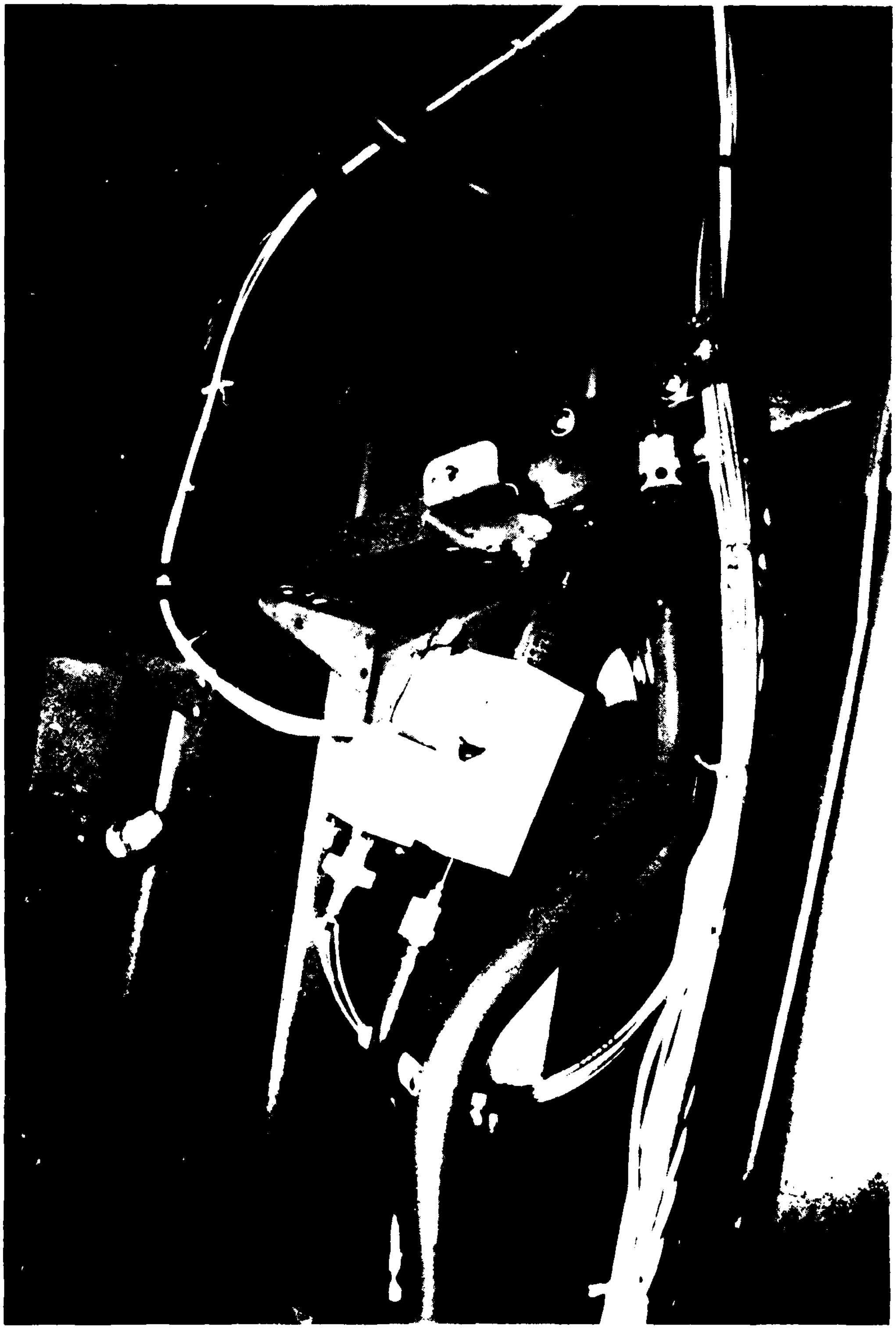


Photo J-19

Photo J-20

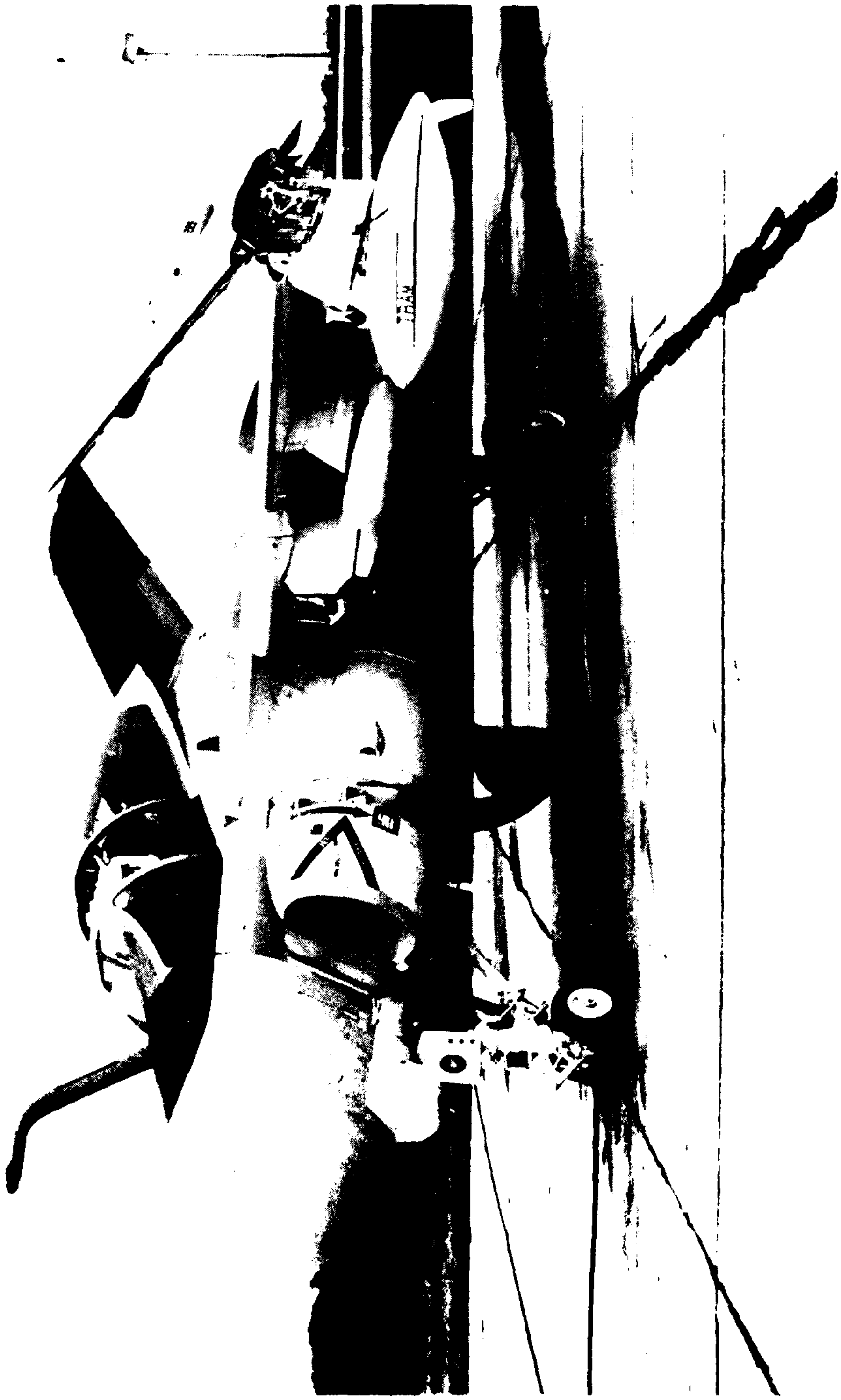


Photo J-21

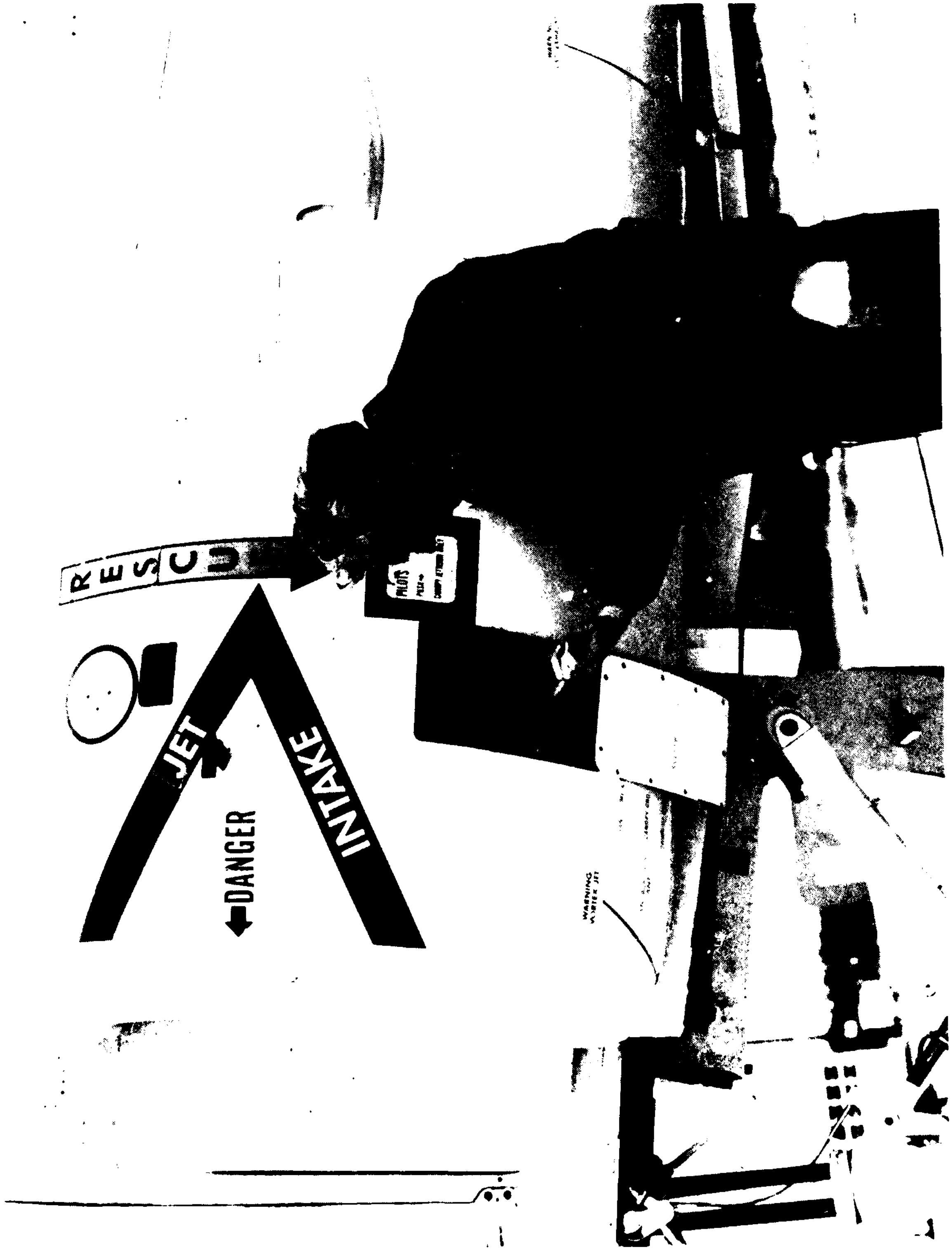
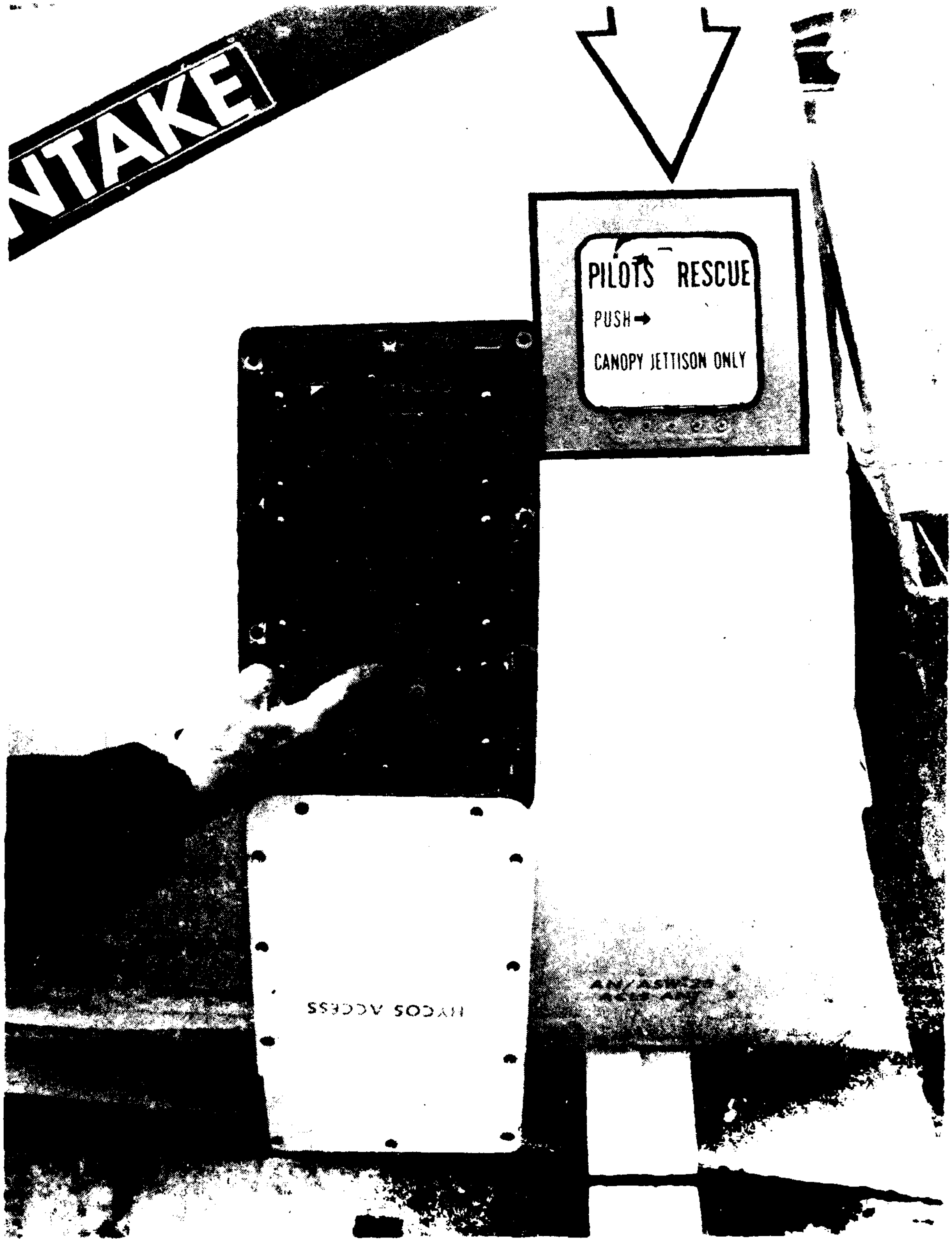


Photo J-22


NTAKE
PILOTS RESCUE
PUSH
CANOPY JETTISON ONLY

AD-A100 730 GRUMMAN AEROSPACE CORP BETHPAGE NY F/G 14/2
HYDRAULIC DIAGNOSTIC MONITORING SYSTEM.(U)
MAR 81 J J DUZICH N62269-78-C-0041
UNCLASSIFIED NADC-TR-81073-60 NL

4 OF 4
AD A
100730

END
DATE
FILMED
7-81
DTIC

APPENDIX K

MICROPROCESSOR PROGRAM

```
ASM48 HYCOS SRC TITLE ( HYCOS - A6 REV 18 1/19/80 ') PRINT ( LP )

ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0          PAGE    1
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ        SEQ        SOURCE STATEMENT

 0000                                 ORG 0H
 0000 E5                              SEL MB0        ;INITIAL CONDITION
 0001 C5                              SEL RB0        ;MEMORY AND REGISTER BANK 0
                              ;EXECUTIVE ROUTINE
                              ;ROUTINE TO BE FOLLOWED EVERY TIME POWER IS
                              ;APPLIED. WE CHECK TO SEE IF CIRCUIT TEST
                              ;SWITCH IS IN THE DOWN POSITION WHICH GENERATES
                              ;(T0). THIS SENDS THE PROCESSOR TO THE SEQUENCE
                              ;LOOP AND CHECKS TO SEE IF ALL THE RED LAMPS ARE
                              ;WORKING AND IF THE MICROPROCESSOR IS FUNCTIONAL
                              ;IF SYSTEM TEST SWITCH IS IN THE DOWN POSITION WE DO
                              ;A SYSTEM TEST. IF THE PRESSURE SWITCH IS ON WE DO A
                              ;RUDDER CHECK FOLLOWED BY AN OVER TEMPERATURE TEST,
                              ;A RESERVOIR LEVEL AND LEAK TEST, AND FINALLY A RAT
                              ;TEST. IF THE PRESSURE SWITCH IS OFF WE DO A RESERVOIR
                              ;AIR TEST.

 0002 80                 START:  MOVX A,@R0             ;DISABLE BUS
 0003 2310                       MOV A,#10H             ;DISABLE MEMORY
 0005 3A                         OUTL P2,A              ;DISABLE MEMORY
 0006 27                         CLR A                  ;SET INITIAL CONDITIONS
 0007 39                         OUTL P1,A              ;INITIAL CONDITIONS
 0008 17                         INC A                  ;RESET FF
 0009 39                         OUTL P1,A              ;  "   "
 000A 39                         OUTL P1,A              ;EXTRA SHOT
 000B 3616                       JT0 SQNCE              ;IF T0 DO SEQUENCE ROUTINE
 000D 5625                       JT1 RMLD               ;IF T1 DO AIR ROUTINE
 000F 17                         INC A                  ;CHECK STATE
 0010 39                         OUTL P1,A              ;    OF SYSTEM
 0011 08                         INS A,BUS              ;        TEST SWITCH
 0012 3225                       JB1 RMLD               ;IF SWITCH IS ON1 DO RAM LOAD
 0014 0402                       JMP START

                                 ;SEQUENCE SUBROUTINE
                                 ;THIS SUBROUTINE WILL LIGHT ALL THE LAMPS BY BLOCKS,
                                 ;FIRST THE PUMPS (5 LAMPS), THEN RESERVOIR (4 LAMPS),
                                 ;ETC LAMPS WILL STAY ON FOR 1/2 SECOND THEN SEQUENCE
                                 ;TO NEXT BLOCK


 0016 2380               SQNCE:          MOV A,#080H     ;OUTPUT TO GET P27 AND TO
 0018 3A                                 OUTL P2,A       ;    DISABLE MEMORY FROM BUS
 0019 2301                               MOV A,#01H      ;START BUS AT BEGINNING
 001B 02                 TSTUT           OUTL BUS,A      ;OUTPUT TO BUS TO LIGHT LAMPS
 001C BA32                               MOV R2,#32H     ;PRELOAD R2 FOR 1/2 SECOND TIMING
 001E AB                                 MOV R3,A        ;SAVE POSITION OF LAMPS IN R3
 001F 343B                               CALL MS10       ;GET 1/2 SECOND TIMING SUBROUTINE
 0021 FB                                 MOV A,R3        ;RESTORE ACCUMULATOR
 0022 E7                                 RL A            ;MOVE BIT IN ACCUM TO LEFT
 0023 041B                               JMP TSTUT       ;REPEAT TEST

                                 ;RAM LOAD SUBROUTINE
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    2
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ        SEQ        SOURCE STATEMENT

                            ;IF HYDRAULIC SWITCH IS AT A "0" WE GO TO THE AIR ROUTINE.
                            ;IF AT A "1" WE DO RESERVOIR ROUTINE
                            ;(FOLLOWING THE RUDDER ROUTINE)
 0025 2302                  RMLD:       MOV A,#02       ;ENABLE STATE OF HYDRAULIC SWITCH
 0027 39                                OUTL P1,A       ;           TO BUS
 0028 08                                INS A,BUS       ;AND INPUT TO ACCUMULATOR
 0029 125D                              JB0 RUDDER      ;IF A "1" DO RUDDER ROUTINE
                            ; AIR ROUTINE:
                            ;THE SYSTEM IS UNPRESSURIZED , THE SYSTEM TEST SWITCH IS
                            ;UP OR DOWN. TEMPERATURE T1 AND DISPLACEMENT R1 ARE IN
                            ;MEMORY LOCATIONS 0 & 1 AND 2 & 3 RESPECTIVELY. THE PRESENT
                            ;TEMPERATURE T2 IS INPUTTED FROM THE TRANSDUCER THRU ITS A/D
                            ;CONVERTER AND CHECKED FOR OVERTEMP . THEN T1 IS SUBTRACTED FROM
                            ;T2 TO GIVE DELTA T (%T). %T = T2 - T1. %T IS MULTIPLIED BY
                            ;CONSTANT 3.78 TO GET TEMPERATURE CORRECTION FACTOR. THE RESULT
                            ;IS ADDED TO OR SUBTRACTED FROM R1 DEPENDING ON THE SIGN OF %T
                            ;NEXT ADD 400 TO R1 TO ALLOW FOR A 1 INCH DISPLACEMENT AND GET
                            ;R1' . DISPLACEMENT R2 IS INPUTTED FROM THE RESERVOIR POT AND ITS
                            ;A/D. R1' IS SUBTRACTED FROM R2 . IF RESULT IS POSITIVE DISPLACE-
                            ;MENT WAS MORE THAN 1 INCH AND WE LIGHT THE AIR LAMP.
                            ;
                            ;EXAMPLE
                            ;
                            ;ASSUME          T1=135 C        T2=21 C
                            ;                R1=5500         R2=5600
                            ;
                            ;       AIR=R2 - (R1 + 400 + (T2 - T1) X 3.78)
                            ;
                            ;       R1 + 400 + (T2 - T1) X 3.78 = R1'
                            ;
                            ;       T2 - T1 = 21 - 135 = -114
                            ;
                            ;       -114 X 3.78 = -430
                            ;
                            ;       AIR = 5600 - ( 5500 +400 - 430 )
                            ;           = 5600 - 5470
                            ;           = + 130
                            ;
                            ; ANSWER IS POSITIVE SO AIR LAMP LIGHTS
                            ;
                            ;START WITH EQUATION ( T2-T1 ) X 3.78
 002B 348A                              CALL TMPCK      ;GET T2 FROM TEMP A/D CONVERTER
                                                        ;INPUT TO ACCUM AND R2
                                                        ;CHECK FOR OVERTEMP
 002D 27                                CLR A           ;INITIAL CONDITION
 002E AD                                MOV R5,A        ;  "       "
                                                        ;R5 SETS UP MEMORY ADDRESS
 002F BE30                              MOV R6,#30H     ;  "       "
                                                        ;R6 OUTPUT USED FOR READ
 0031 39                                OUTL P1,A       ;CLEAR PORT 1 FROM BUS
 0032 345C                              CALL LSD        ;GET T1 FROM MEMORY
 0034 34B2                              CALL SBTCT      ;%T = T2 - T1
 0036 B901                              MOV R1,#01H     ;SETTING UP SIGN OF SUBTRACTION
 0038 B63B                              JF0 NEG1        ;IF NEGATIVE REG 1 = 1
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0          PAGE    3
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ         SEQ       SOURCE STATEMENT

 003A C9           108             DEC R1          ;ELSE REG 1 = 0
 003B 543A         109 NEG1:       CALL LKUP1      ;GET BINARY VALUE FOR %T X 3.78
                   110        ;BINARY RESULT STORED IN REGISTER 4   RESISTOR R1 IS IN MEMORY
                   111        ;AND WE WILL ADD IT TO 400 ( = 08H ) AND %T VALUE
 003D 345C         112             CALL LSD        ;GET R1 FROM MEMORY
 003F 0308         113             ADD A,#08H      ;R1 + 424 (COULD NOT GET 400 EXACT)
 0041 29           114             XCH A,R1        ;EXCHANGE SUM WITH SIGN OF %T
 0042 53FF         115             ANL A,#0FFH     ;AND TO SEE IF 0
 0044 C64C         116             JZ POS1         ;IF 0 IT WAS POSITIVE
                   117                             ;ELSE NEGATIVE
 0046 FC           118             MOV A,R4        ;GET %T
 0047 37           119             CPL A           ;ONES COMPLEMENT
 0048 17           120             INC A           ;2'S COMPLEMENT
 0049 69           121             ADD A,R1        ;SUM - %T
 004A 044E         122             JMP SUM1        ;SUBTRACTION COMPLETE
 004C FC           123 POS1:       MOV A,R4        ;GET %T
 004D 69           124             ADD A,R1        ;SUM + %T
 004E AA           125 SUM1:       MOV R2,A        ;R1' INTO REG 2
 004F 2320         126             MOV A,#20H      ;R2 A/D
 0051 34A9         127             CALL GONOGO     ;   INTO ACCUM
 0053 2A           128             XCH A,R2        ;SWAP R2 AND R1'
 0054 34B3         129             CALL SBTCT      ;R2 - R1'
 0056 B602         130             JF0 START       ;IF NEGATIVE NO ERROR
                   131                             ;REPEAT WHOLE OPERATION
 0058 2307         132             MOV A,#07H      ;ELSE LIGHT
 005A 39           133             OUTL P1,A       ;     AIR LAMP
 005B 0402         134             JMP START       ;REPEAT WHOLE OPERATION
                   135
                   136
                   137        ;RUDDER CIRCUITRY
                   138        ;TAKE ANALOG OUTPUTS OF 2 POTS ,A/D CONVERT,
                   139        ;SUBTRACT FROM EACH OTHER,THEN SUBTRACT DIFFERENCE
                   140        ;FROM A GIVEN TOLERANCE. IF DIFFERENCE IS
                   141        ;TOO HIGH LIGHT RUDDER LAMP
                   142
 005D 2318         143 RUDDER:     MOV A,#18H      ;RUDDER POT DATA
 005F 34A9         144             CALL GONOGO     ;    FROM A/D
 0061 AA           145             MOV R2,A        ;PUT INTO R2
 0062 2338         146             MOV A,#38H      ;RUDDER PEDAL DATA
 0064 34A9         147             CALL GONOGO     ;    FROM A/D
 0066 34B3         148             CALL SBTCT      ;R2-A=DELTA
 0068 23F4         149             MOV A,#0F4H     ;2'S COMPLEMENT OF 12
 006A 6A           150             ADD A,R2        ;SUBTRACT 12 FROM DELTA
 006B E670         151             JNC RSRVR       ;IF NO CARRY RUDDERS OK
 006D 2305         152             MOV A,#05H      ;CALL RUDDER LAMP
 006F 39           153             OUTL P1,A       ;AND LITE IT
                   154
                   155
                   156
                   157
                   158        ;RESERVOIR ROUTINE
                   159        ;DUE TO SETTING OF POT THE FOLLOWING CONSTANTS ARE USED
                   160        ;EACH BIT IS 53 OHMS  6700/127
                   161        ;SLOPE FOR NORMAL DISPLACEMENT IS 1.85 OHMS /DEGREE F =
                   162        ;3.33 OHMS / DEGREE C = 16 DEG C / BIT
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    4
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ         SEQ        SOURCE STATEMENT

                        ;5420 OHMS AT -54 C =LEVEL MINIMUM
                        ;5070 OHMS AT -54 C =LEAK MINIMUM
                        ;TEMPERATURE TRANSDUCER READS IN DEG C AND IS SET SO THAT
                        ;-54C IS EQUAL TO 0.   EQUATIONS ARE
                        ;
                        ;LEVEL = 5420 + 3.33 X %T - R (IF POSITIVE WE LIGHT LAMP)
                        ;LEAK =  5070 + 3.33 X %T - R (IF POSITIVE WE LIGHT LAMP)

                    RSRVR:
 0070 BD00                      MOV R5,#0H              ;INITIAL ADDRESS OF MEMORY
 0072 BE10                      MOV R6,#10H             ;INITIAL CONDITION
 0074 348A                      CALL TMPCK              ;GET TEMPERATURE , CHECK FOR
                                                        ;OVERTEMPERATURE STORE IN R2 & A
 0076 3447                      CALL BYTST              ;PUT IN MEMORY LOCATIONS '0' & '1'
 0078 F8                        MOV A,R0                ;TEMP BACK TO ACCUM
 0079 5450                      CALL LKUP2              ;GET BINARY EQUIVALENT OF TEMP
                                                        ;AND STORE IN R4
 007B 2320                      MOV A,#020H             ;DISPLACEMENT VALUE
 007D 34A9                      CALL GONOGO             ;INTO ACCUM
 007F BD02                      MOV R5,#02H             ;INITIAL CONDITIONS
 0081 AA                        MOV R2,A                ;STORE DISPLACEMENT IN R2
 0082 3447                      CALL BYTST              ;PUT DISPLACEMENT IN MEMORY
                                                        ;LOCATIONS "2" & "3"
 0084 FC                        MOV A,R4                ;GET % T
 0085 34B3                      CALL SBTCT              ;DISPLACEMENT - %T = %R
 0087 AC                        MOV R4,A                ;STORE % R IN R4
 0088 BA66                      MOV R2,#66H             ;5420 OHMS
 008A 34B3                      CALL SBTCT              ;5420 - % R
 008C B69B                      JF0 RAT                 ;IF F0 %R > 5420
 008E 2303                      MOV A,#03H              ;ELSE LIGHT RESERVOIR
 0090 39                        OUTL P1,A               ;     LEVEL LAMP
 0091 BA60                      MOV R2,#060H            ;5070 OHMS
 0093 FC                        MOV A,R4                ;GET % R
 0094 34B3                      CALL SBTCT              ;5070 - %R
 0096 B69B                      JF0 RAT                 ;IF F0 %R > 5070
 0098 2380                      MOV A,#080H             ;ELSE LIGHT RESERVOIR
 009A 39                        OUTL P1,A               ;     LEAK LAMP

                        ;RAT ROUTINE
                        ;THIS ROUTINE SOLVES THE EQUATION
                        ;
                        ;PPR = (R/3850) X (530/(T + 460)) X PSYS
                        ;
                        ;PSYS = PRESSURE READING + TEMPERATURE CORRECTION FACTOR
                        ;R = RESISTANCE IN OHMS
                        ;3850 = RESISTANCE AT STP
                        ;530 = 70 DEGREES F + 460 TO MAKE DEGREES RANKIN
                        ;T = MEASURED TEMPERATURE IN DEGREES F
                        ;
                        ;FIRST WE SOLVE FOR PSYS,AND STORE RESULT IN MEMORY.THEN WE
                        ;PERFORM 2 DIVISIONS,THEN 2 MULTIPLICATIONS.WE THEN SUBTRACT
                        ;450 PSI FROM THE RESULT TO TEST IF OUR PRECHARGE PRESSURE IS ADEQUATE
                        ;FOR THE SYSTEM . IF NOT WE LIGHT THE RAT LAMP.
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    5
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ         SEQ        SOURCE STATEMENT

                  218
                  219
009B 3400         220 RAT:          CALL PRSCLC       ;SOLVE FOR PSYS
009D 2385         221               MOV A,#85H        ;PUT 400 INTO ACCUM
009F 6E           222               ADD A,R6          ;ADD TO GET RANKIN
00A0 E6A4         223               JNC NOCA          ;IF NO CARRY NO OVERFLOW
00A2 23FF         224               MOV A,#0FFH       ;ELSE PUT FF INTO CARRY
00A4 BAB1         225 NOCA:         MOV R2,#0B1H      ;PUT 530 R IN R2
00A6 B821         226               MOV R0,#21H       ;INITIALIZE TO ADDRESS 33
00A8 5400         227               CALL DIVIDE       ;PERFORM 530/(T+460)
                  228                                 ;STORE T IN 34 & 35
00AA 2328         229               MOV A,#28H        ;GET DISPLACEMENT FROM
00AC 34A9         230               CALL GONOGO       ;    A/D CONVERTER
00AE AA           231               MOV R2,A          ;AND PUT IN R2
00AF 2378         232               MOV A,#78H        ;PUT 3850 INTO ACCUM
00B1 5400         233               CALL DIVIDE       ;PERFORM R/3850
                  234                                 ;STORE IN 36 & 37
00B3 27           235               CLR A             ;WANT 0 IN
00B4 AC           236               MOV R4,A          ;R4 AND
00B5 AD           237               MOV R5,A          ;R5
00B6 B820         238               MOV R0,#20H       ;ADDRESS 32
00B8 F0           239               MOV A,@R0         ;MSBYTE OF PRESSURE
00B9 AE           240               MOV R6,A          ;TO R6
00BA 18           241               INC R0            ;ADDRESS 33
00BB F0           242               MOV A,@R0         ;LSBYTE OF PRESSURE
00BC AF           243               MOV R7,A          ;TO R7
00BD 18           244               INC R0            ;ADDRESS 34
00BE F0           245               MOV A,@R0         ;MSBYTE OF TEMP
00BF C6C5         246               JZ NOMLT          ;IF 0 NO MULTIPLY
00C1 FE           247               MOV A,R6          ;MSBYTE OF PRESS
00C2 AC           248               MOV R4,A          ;TO R4
00C3 FF           249               MOV A,R7          ;LSBYTE OF PRESSURE
00C4 AD           250               MOV R5,A          ;TO R5
00C5 18           251 NOMLT:        INC R0            ;ADDRESS 35
00C6 F0           252               MOV A,@R0         ;LSBYTE OF TEMP
00C7 5466         253               CALL QUADM        ;MULTIPLY TEMP & PRES
00C9 18           254               INC R0            ;ADDRESS 36
00CA F0           255               MOV A,@R0         ;MSBYTE
00CB C6D0         256               JZ NMLT1          ;IF 0 CONTINUE
00CD FE           257               MOV A,R6          ;MSBYTE TO A
00CE 04D4         258               JMP NMLT2         ;NO MULTIPLY
00D0 18           259 NMLT1:        INC R0            ;ADDRESS 37
00D1 F0           260               MOV A,@R0         ;LSBYTE OF DISPLACEMENT
00D2 5466         261               CALL QUADM        ;MULT PREV RESULT
00D4 53FF         262 NMLT2:        ANL A,#0FFH       ;WANT TO CHECK Z FLAG
00D6 96E4         263               JNZ END2          ;GREATER THAN 512
00D8 FF           264               MOV A,R7          ;LSBYTE OF PPR
00D9 AA           265               MOV R2,A          ;PUT IN R2
00DA 2386         266               MOV A,#086H       ;PUT 400 INTO A
00DC 34B3         267               CALL SBTCT        ;REMAINDER - 400
00DE 95           268               CPL F0
00DF B6E4         269               JF0 END2                  ;IF CARRY REM>400
00E1 2304         270 END3          MOV A,#04H        ;ADDRESS RAT LAMP
00E3 39           271               OUTL P1,A         ;TURN IT ON
00E4 0402         272 END2          JMP  START        ;REPEAT
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    6
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ         SEQ        SOURCE STATEMENT

                   273
0100               274        ORG 0100H
                   275        ;PRESSURE CALCULATION
                   276        ;THIS CALCULATION TAKES THE PRESSURE READING IN MV,TAKES
                   277        ;A TEMPERATURE READING ,ADDS OR SUBTRACTS A TEMPERATURE
                   278        ;CORRECTION TO AN INITIAL SLOPE READING,MULTIPLIES THE NEW
                   279        ;SLOPE BY THE MV READING AND ADDS AN INITIAL OFFSET.THE MSBYTE
                   280        ;IS STORED IN R5,AND THE LSBYTE IN R3
                   281        ;POSITIVE TEMPERATURE
                   282        ;PRESSURE = (21 + (3T')X0.011) X MV + 23
                   283        ;NEGATIVE TEMPERATURE
                   284        ;PRESSURE = (21 - (3T')X0.017) X MV + 23
                   285
0100 2330          286 PRSCLC:        MOV A,#30H      ;GET PRESSURE DATA FROM
0102 34A9          287                CALL GONOGO     ;       A/D CONVERTER
0104 A8            288                MOV R0,A        ;SAVE VALUE
0105 BA0A          289                MOV R2,#0AH     ;429 PSI
0107 34B3          290                CALL SBTCT      ;429 - P
0109 B60D          291                JF0 END4        ;IF CARRY P < 429
010B 04E1          292                JMP END3        ;LIGHT LAMP
010D F8            293 END4:          MOV A,R0        ;GET VALUE BACK
010E AF            294                MOV R7,A        ;STORE
010F 2310          295                MOV A,#10H      ;GET TEMPERATURE DATA FROM
0111 34A9          296                CALL GONOGO     ;       A/D CONVERTER
0113 AE            297                MOV R6,A        ;STORE
0114 AA            298                MOV R2,A        ;  "   ALSO IN R2
0115 232B          299                MOV A,#2BH      ;GET 70 F IN ACCUM
0117 34B3          300                CALL SBTCT      ;T-70 = T'
0119 77            301                RR A            ;
011A 77            302                RR A            ;
011B 77            303                RR A            ;
011C 77            304                RR A            ;DIVIDE BY 16
011D 530F          305                ANL A,#0FH      ;4 SHIFTS SHOULD BE 0
011F B629          306                JF0 NTMPTR      ;IF NEGATIVE TEMPERATURE
0121 77            307                RR A            ;ELSE DIVIDE BY 32
0122 5307          308                ANL A,#07H      ;5 SHIFTS SHOULD BE 0
0124 0316          309                ADD A,#16H      ;ADD 22 TO DELTA
0126 AD            310                MOV R5,A        ;SAVE IN R5
0127 242E          311                JMP MVMPLY      ;GO TO MULTIPLY
0129 BA16          312 NTMPTR:        MOV R2,#16H     ;GET 22
012B 34B3          313                CALL SBTCT      ;22 MINUS DELTA
012D AD            314                MOV R5,A        ;SAVE IN R5
012E FF            315 MVMPLY:        MOV A,R7        ;GET MILLI VOLTS
012F AA            316                MOV R2,A        ;AND PUT IN R2
0130 FD            317                MOV A,R5        ;GET DELTA
0131 A9            318                MOV R1,A        ;AND PUT IN R1
0132 34BE          319                CALL BMPY       ;MULTIPLY
0134 B820          320                MOV R0,#20H     ;ADDRESS #32
0136 A0            321                MOV @R0,A       ;MSBYTE IN 32
0137 18            322                INC R0          ;ADDRESS #33
0138 F9            323                MOV A,R1        ;GET LSBYTE
0139 A0            324                MOV @R0,A       ;STORE IN 33
013A 83            325                RET
                   326
                   327
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    7
HYCOS - A6 REV 18 1/19/80

LOC  OBJ        SEQ        SOURCE STATEMENT

                           ;10 MILLISECOND SUBROUTINE
                           ;THIS SUBROUTINE USES THE 8748 BUILT IN TIMER  THE
                           ;T COUNTER IS LOADED TO 80HCH .
                           ;THIS GIVES A 10 MILLISECOND COUNTDOWN EACH TIME WE
                           ;REACH COUNTDOWN WE DECREMENT A COUNT IN R2 SO THAT
                           ;WE CAN GET MULTIPLES OF 10 MILLISECONDS.

013B 2380          MS10:        MOV A,#80H
013D 62                         MOV T,A         ;LOAD MAX COUNT IN T,ALL 0'S
013E 55                         STRT T          ;START COUNTDOWN
013F 1643          CONT:        JTF DECR        ;LOOP FOR 10 MILLISECONDS
0141 243F                       JMP CONT        ; "    "    "         "
0143 65            DECR:        STOP TCNT       ;STOP COUNTER
0144 EA3B                       DJNZ R2,MS10    ;LOOP TILL R2 = 0
0146 83                         RET



                           ;BYTE STORE SUBROUTINE
                           ;BYTE STORE TRANSFERS THE FIRST 4 BITS INTO THE NEXT RAM
                           ;ADDRESS , THEN THE SECOND 4 BITS INTO THE NEXT RAM ADDRESS.

0147 A8            BYTST:       MOV R0,A        ;STORE VALUE IN R0
0148 344F                       CALL WRITE      ;WRITE LSD INTO MEMORY
014A F8                         MOV A,R0        ;GET WORD BACK INTO ACCUMULATOR
014B 47                         SWAP A          ;PUT MSD INTO LSD POSITION
014C 344F                       CALL WRITE      ;WRITE MSD INTO MEMORY
014E 83                         RET


                           ;WRITE SUBROUTINE
                           ;WRITE DATA INTO RAM. FIRST PUT DATA ON BUS WITH CE1 ,OD.
                           ;AND RW ALL HIGH. THEN ADDRESS WITH ONLY OD HIGH  THEN ADDRESS
                           ;WITH ALL HIGH TO TURN OFF MEMORY.R6 HAS 10H STORED AS AN
                           ;INITIAL CONDITION.
014F 02            WRITE        OUTL BUS,A      ;OUTPUT DATA ON BUS
0150 FD                         MOV A,R5        ;PUT INTO ACCUM
0151 4E                         ORL A,R6        ;PUT A 1 IN FRONT OF ADDRESS
0152 3A                         OUTL P2,A       ;OUTPUT TO MEMORY
0153 4350                       ORL A,#50H      ;TURN ON WRITE
0155 3A                         OUTL P2,A       ;AND OUTPUT TO MEMORY
0156 531F                       ANL A,#1FH      ;PUT 1 IN FRONT OF ADDRESS
0158 3A                         OUTL P2,A       ;OUTPUT TO MEMORY
0159 80                         MOVX A,@R0      ;PUT BUS IN TRI STATE
015A 1D                         INC R5          ;GET NEXT ADDRESS
015B 83                         RET

                           ;LSD SUBROUTINE
                           ;THIS SUBROUTINE GOES TO MEMORY AND FETCHES A NIBBLE AND
                           ;STORES IT IT THEN GETS THE SECOND NIBBLE COMBINES THEM
                           ;AND WE GET THE WHOLE BYTE

015C 3464          LSD          CALL READ       ;GET LSD
015E 47                         SWAP A          ;PUT LSD IN LSD POSITION
015F A8                         MOV R0,A        ;STORE IN R0
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    8
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ         SEQ        SOURCE STATEMENT

 0160 3464        383                CALL READ      ;GET MSD
 0162 48          384                ORL A,R0       ;PUT BYTE TOGETHER
 0163 83          385                RET
                  386
                  387        ;READ SUBROUTINE
                  388        ;READ DATA OUT OF RAM. INITIAL CONDITIONS R5=00 ;,R6=30
                  389
 0164 80          390 READ:          MOVX A,@R0     ;DISABLE BUS
 0165 27          391                CLR A          ;ZERO ACCUM
 0166 39          392                OUTL P1,A      ;CLEAR BUS
 0167 FD          393                MOV A,R5       ;PUT INTO ACCUM
 0168 4E          394                ORL A,R6       ;PUT A 3 IN FRONT OF ADDRESS
 0169 3A          395                OUTL P2,A      ;AND OUTPUT TO RAM
 016A 532F        396                ANL A,#2FH     ;ENABLE READ
 016C 4340        397                ORL A,#40H     ;60 IN FRONT OF ADDRESS
 016E 3A          398                OUTL P2,A      ;  "      "
 016F 08          399                INS A,BUS      ;GET WORD FROM RAM
 0170 08          400                INS A,BUS      ;TWICE
 0171 53F0        401                ANL A,#0F0H    ;MASK OUT LSD
 0173 AF          402                MOV R7,A       ;STORE IN R7
 0174 FD          403                MOV A,R5       ;GET ADDRESS BACK
 0175 4E          404                ORL A,R6       ;PUT 7 IN FRONT OF ADDRESS
 0176 533F        405                ANL A,#3FH     ;3 IN FRONT OF ADDRESS
 0178 3A          406                OUTL P2,A      ;TURN OFF MEMORY
 0179 FF          407                MOV A,R7       ;PUT WORD BACK IN ACCUM
 017A 1D          408                INC R5         ;GET NEXT ADDRESS
 017B 83          409                RET
                  410
                  411        ;MULTIPLY SUBROUTINE
                  412        ;MULTIPLY SUBTRACTS T0 IN ACCUM FROM T1 IN R2 TAKES THE
                  413        ;DIFFERENCE AND MULTIPLIES IT BY CONSTANT (SLOPE) TO GET
                  414        ;DELTA RESISTANCE . CONSTANT = 3/8.
                  415        ;FIRST DIVIDE BY 8 THEN MULTIPLY BY 2 AND ADD 1
                  416
                  417
 017C 3483        418 MLTPLY:        CALL SBTCT     ;T1-T0=T'
 017E B903        419                MOV R1,#03H    ;NEED 3 SHIFTS
 0180 97          420 MULT:          CLR C          ;SET CARRY = 0
 0181 67          421                RRC A          ;DIVIDE BY 2
 0182 E980        422                DJNZ R1,MULT   ;DIVIDE 3 TIMES
 0184 A9          423                MOV R1,A       ;STORE RESULT IN R1
 0185 97          424                CLR C          ;SET CARRY = 0
 0186 F7          425                RLC A          ;MULTIPLY BY 2
 0187 69          426                ADD A,R1       ;AND ADD 1
 0188 A9          427                MOV R1,A       ;STORE IN R1
 0189 83          428                RET
                  429
                  430        ;TMPCK SUBROUTINE
                  431        ;GETS TEMPERATURE DATA FROM A/D (FOR RESERVOIR AND AIR
                  432        ;CHECKS) TESTS TO SEE IF IT IS ABOVE 250F (= 121C). IF
                  433        ;IT IS TOO HIGH WE LIGHT THE TEMP LAMP
                  434
 018A 2300        435 TMPCK:         MOV A,#00H     ;CALL T1 A/D CONVERTER
 018C 34A9        436                CALL GONOGO    ;GET T1 DATA
 018E AA          437                MOV R2,A       ;WANT T1 IN R2
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE    9
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ         SEQ        SOURCE STATEMENT

 018F AB          438             MOV R3,A       ;SAVE IN R3
 0190 2368        439             MOV A,#68H     ;68 = 121C =250F INTO ACCUM
 0192 34B3        440             CALL SBTCT     ;121-T1
 0194 B699        441             JF0 EXCH       ;IF CARRY T1<250F
 0196 2340        442             MOV A,#40H     ;ELSE ENABLE TEMP LAMP
 0198 39          443             OUTL P1,A      ;LIGHT IT
 0199 2B          444 EXCH:       XCH A,R3       ;GET T1 FROM R3
 019A 2A          445             XCH A,R2       ;PUT IT IN R2
 019B 83          446             RET
                  447
                  448
                  449        ;RESISTOR SUBROUTINE
                  450        ;FINDS CALCULATED VALUE OF RESISTANCE AND SUBTRACTS IT FROM
                  451        ;ACTUAL VALUE
                  452
 019C B6A2        453 RSTR:       JF0 SBRTN      ;IF F0 IS SET WE HAVE TO SUBTRACT
 019E 6A          454             ADD A,R2       ;ELSE WE ADD
 019F AA          455             MOV R2,A       ;STORE IN R2
 01A0 24A4        456             JMP FINI       ;ADDITION COMPLETE
 01A2 34B3        457 SBRTN:      CALL SBTCT     ;STEP 1 ABOVE
 01A4 2320        458 FINI:       MOV A,#20H     ;GET ACTUAL R FROM A/D
 01A6 34A9        459             CALL GONOGO    ;AND PUT IN ACCUM
 01A8 83          460             RET
                  461
                  462
                  463
                  464
                  465        ;GONOGO SUBROUTINE
                  466        ;THIS SUBROUTINE ENABLES THE SELECTED A/D CONVERTER
                  467        ;TO PUT DATA ON THE BUS. THE DATA VALID OUTPUT OF THE A/D
                  468        ;IS CHECKED AND DATA IS ACCEPTED IF TRUE.
                  469
 01A9 39          470 GONOGO:     OUTL P1,A      ;SELECT A/D CONVERTERS
 01AA 08          471 NOK:        INS A,BUS      ;INPUT DATA FROM BUS
 01AB 08          472             INS A,BUS      ;TWICE
 01AC F2B0        473             JB7 OK         ;CHECK BIT 7 DATA VALID BIT
 01AE 24AA        474             JMP NOK        ;IF NOT VALID GET NEW DATA
 01B0 537F        475 OK:         ANL A,#7FH     ;IF OK MASK OUT MSB
 01B2 83          476             RET
                  477
                  478        ;SUBTRACT SUBROUTINE
                  479        ;SUBTRACTS NUMBER IN ACCUMULATOR FROM NUMBER IN REGISTER R2
                  480        ;AND STORES THE RESULT IN R2. FLAG F0 IS "0" FOR POSITIVE
                  481        ;RESULTS AND "1" FOR  NEGATIVE
                  482
 01B3 85          483 SBTCT:      CLR F0         ;SET FLAG F0 TO 0
 01B4 37          484             CPL A          ;COMPLEMENT ACCUM
 01B5 6A          485             ADD A,R2       ;AND ADD TO R2
 01B6 F6BB        486             JC PLUS        ;IF A CARRY RESULT IS PLUS
 01B8 95          487             CPL F0         ;SET FLAG F0 TO "1"
 01B9 37          488             CPL A          ;COMPLEMENT ANSWER
 01BA 07          489             DEC A          ;SUBTRACT 1 AS WE ADD 1 NEXT STEP
 01BB 17          490 PLUS:       INC A          ;ADD 1 TO GET CORRECT ANSWER
 01BC AA          491             MOV R2,A       ;STORE ANSWER IN R2
 01BD 83          492             RET            ;RETURN
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0          PAGE   10
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ             SOURCE STATEMENT



                   ;BINARY MULTIPLY SUBROUTINE
                   ;THIS ROUTINE ASSUMES A 1-BYTE MULTIPLIER AND A 1-BYTE
                   ;MULTIPLICAND. THE PRODUCT THEREFORE IS 2 BYTES LONG.
                   ;THE ALGORITHM FOLLOWS THESE STEPS:
                   ;(1) THE REGISTERS ARE ARRANGED AS FOLLOWS:
                   ;       ACC = 0
                   ;       R1 = MULTIPLIER
                   ;       R2 = MULTIPLICAND
                   ;       R3 = LOOP COUNTER (=8)
                   ;THE ACCUMULATOR AND REGISTER R1 ARE TREATED AS A REGISTER
                   ;PAIR WHEN THEY ARE SHIFTED RIGHT.
                   ;(2) THE ACCUMULATOR AND R1 ARE SHIFTED RIGHT 1 PLACE. THUS THE
                   ;LSB OF THE MULTIPLIER GOES INTO THE CARRY.
                   ;(3) THE MULTIPLICAND IS ADDED TO THE ACCUMULATOR IF THE CARRY
                   ;BIT IS A '1'. NO ACTION IF CARRY IS A '0'.
                   ;(4) DECREMENT THE LOOP COUNTER AND LOOP (RETURN TO STEP 2) UNTIL
                   ;IT REACHES ZERO.
                   ;(5) SHIFT  THE RESULT RIGHT 1 LAST TIME JUST BEFORE EXITING
                   ;THE ROUTINE.

                   ;THE RESULTS WILL BE FOUND MSBYTE IN THE ACCUMULATOR AND
                   ;LSBYTE IN R1.
01BE BB08      BMPY:        MOV R3,#08H     ;SET LOOP COUNTER TO 8
01C0 27                     CLR A           ;CLEAR ACCUMULATOR
01C1 97                     CLR C           ;CLEAR CARRY BIT
01C2 34CC      BMP1:        CALL DBLRT      ;DOUBLE SHIFT RIGHT ACC
                                            ;AND R1 INTO CARRY
01C4 E6C7                   JNC BMP2        ;IF CARRY = 1 ADD ELSE DON'T
01C6 6A                     ADD A,R2        ;ADD MULTIPLICAND TO ACCUMULATOR
01C7 EBC2      BMP2:        DJNZ R3,BMP1    ;DECREMENT LOOP COUNTER AND
                                            ;LOOP IF NOT ZERO
01C9 34CC                   CALL DBLRT
01CB 83                     RET



01CC 67        DBLRT:       RRC A           ;ROTATE RIGHT THRU CARRY
01CD 29                     XCH A,R1        ;GET R1 IN ACCUM
01CE 67                     RRC A
01CF 29                     XCH A,R1        ;PUT R1 BACK
01D0 83                     RET

               MRK1:
01D1 2320                   MOV A,#20H      ;GET  R VALUE FROM A/D
01D3 34A9                   CALL GONOGO     ;PUT IN ACCUMULATOR
01D5 BA5C                   MOV R2,#05CH    ;IF R MUST BE LESS THAN
                                            ;11.5V OUT OF 15.7V A/D
                                            ;VALUE MUST BE LESS THAN
                                            ;11.5/15.7 X 127 =92=05CH
01D7 34B3                   CALL SBTCT      ;05CH - R VALUE
01D9 95                     CPL F0
01DA B6DF                   JF0    MRK2     ;IF A CARRY NO ERROR
01DC 2303                   MOV A,#03H      ;ELSE LIGHT RESERVOIR
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE   11
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ          SEQ        SOURCE STATEMENT

 01DE 39           548               OUTL P1,A        ;     LEVEL LAMP
 01DF 049B         549 MRK2:         JMP   RAT
                   550
                   551
                   552        ;DIVIDE ROUTINE
                   553        ;WE DIVIDE A 16 BIT DIVIDEND BY AN 8 BIT DIVISOR
                   554        ;MSBYTE OF DIVIDEND IS IN R2
                   555        ;LSBYTE OF DIVIDEND IS IN R3
                   556        ;DIVISOR IS IN THE ACCUMULATOR
                   557        ;WE CHECK FOR THE FIRST '1' IN THE DIVISOR WHICH TELLS US HOW
                   558        ;MANY DIVISIONS. WE ADD THE 2'S COMPLEMENT OF THE DIVISOR TO
                   559        ;THE DIVIDEND. THE RESULTING CARRY IS SHIFTED INTO THE LSB
                   560        ;POSITION OF THE LSBYTE THAT RESULTING CARRY IS SHIFTED INTO
                   561        ;THE LSB POSITION OF THE MSBYTE. THE FINAL ANSWER IS STORED
                   562        ;IN MEMORY
 0200              563        ORG 0200H
 0200 BB00         564 DIVIDE:       MOV R3,#0        ;CLEAR R3
 0202 BD00         565               MOV R5,#0        ;CLEAR R5
 0204 85           566               CLR F0           ;CLEAR FLAG F0
 0205 97           567               CLR C            ;CLEAR CARRY
 0206 B908         568               MOV R1,#08H      ;INITIAL # OF DIVIDE STEPS
 0208 53FF         569               ANL A,#0FFH      ;TO SEE IF ACCUM = 0
 020A C632         570               JZ X7            ;WANT TO AVOID DIVIDE BY 0
 020C F7           571 X1:           RLC A            ;WANT FIRST '1' SO WE KNOW
 020D 19           572               INC R1           ;HOW MANY DIVIDE STEPS
 020E 1D           573               INC R5           ;SAME AS ABOVE
 020F E60C         574               JNC X1           ;FIRST ONE
 0211 67           575               RRC A            ;RETURN '1' TO ACCUM
 0212 37           576               CPL A            ;1'S COMPLEMENT
 0213 17           577               INC A            ;2'S COMPLEMENT
 0214 AC           578               MOV R4,A         ;SAVE DIVISOR
 0215 27           579               CLR A
 0216 97           580 X6:           CLR C
 0217 A7           581               CPL C
 0218 F7           582               RLC A
 0219 ED16         583               DJNZ R5,X6
 021B AE           584               MOV R6,A
 021C FC           585               MOV A,R4
 021D 6A           586 X2:           ADD A,R2         ;SUBTRACT DIVISOR FROM DIVIDEND
 021E F622         587               JC X5            ;IF FLAG SET WAS A CARRY
 0220 E625         588               JNC X3           ;IF NO CARRY NO CHANGE
 0222 97           589 X5:           CLR C            ;WANT TO SET CARRY TO 1
 0223 A7           590               CPL C
 0224 AA           591               MOV R2,A         ;ELSE PUT NEW RESULT IN R2
 0225 FB           592 X3            MOV A,R3         ;LSBYTE IN ACCUM
 0226 F7           593               RLC A            ;SHIFT CARRY INTO LSB
 0227 AB           594               MOV R3,A         ;PUT BACK
 0228 85           595               CLR F0           ;CLEAR FLAG F0
 0229 FA           596               MOV A,R2         ;MSBYTE IN ACCUM
 022A F7           597               RLC A            ;SHIFT CARRY INTO LSB
 022B E62E         598               JNC X4           ;NO CARRY DON'T SET F0
 022D 95           599               CPL F0           ;IF CARRY SET F0
 022E AA           600 X4            MOV R2,A         ;PUT BACK
 022F FC           601               MOV A,R4         ;GET DIVISOR BACK
 0230 E91D         602               DJNZ R1,X2       ;CONTINUE DIVISION
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE   12
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ        SEQ       SOURCE STATEMENT

 0232 FE             X7:         MOV A,R6
 0233 5A                         ANL A,R2
 0234 18                         INC R0          ;GET NEXT MEMORY POSITION
 0235 A0                         MOV @R0,A       ;STORE IN MEMORY
 0236 18                         INC R0          ;NEXT MEMORY LOCATION
 0237 FB                         MOV A,R3        ;LSBYTE TO ACCUM
 0238 A0                         MOV @R0,A       ;AND STORE IN MEMORY
 0239 83                         RET
                           ;LKUP1
                           ;AIR LOOK UP TABLE TO GET ( T2 - T1 ) X 3.78 INTO THE BINARY
                           ;EQUIVALENT OHMS  EACH BIT IS 53 OHMS. THIS MAKES EVERY 14 DEGREES
                           ; C EQUAL TO 1 BIT ASSUMING A TEMPERATURE SWING MAX OF FROM -54
                           ;C TO + 135 C OR 189 DEGREES. 189/14 = 13.5  THIS PROGRAM WILL
                           ;LET T' = 13 FOR %T > 182 AND WILL SUBTRACT 1 FOR EACH 14 DEGREE
                           ;LOWERING . %T IS STORED IN REG 3  THE ANSWER IS IN REG 4
                           ;( 182 - 14 N ) WHERE N = NUMBER OF SUBTRACTIONS
 023A AB             LKUP1:      MOV R3,A              ;STORE %T IN R3
 023B BC0E                       MOV R4,#0EH           ;START WITH 14 IN R4
 023D BDB6                       MOV R5,#0B6H          ;START WITH 182 IN R5
 023F FB             REPT1:      MOV A,R3              ;%T IN ACCUM
 0240 AA                         MOV R2,A              ;AND PUT IN R2
 0241 FD                         MOV A,R5              ;182 -14N
 0242 34B3                       CALL SBTCT            ;%T - ( 182 - 14N )
 0244 FD                         MOV A,R5              ;GET 182 -14N
 0245 03F2                       ADD A,#0F2H           ;SUBTRACT ANOTHER 14
 0247 AD                         MOV R5,A              ;NEW VALUE BACK IN R5
 0248 FC                         MOV A,R4              ;PUT R4 INTO ACCUM
 0249 07                         DEC A                 ;A CONTAINS ANSWER
 024A C64F                       JZ NOMR1              ;IF R4 = 0 END ROUTINE
 024C AC                         MOV R4,A              ;ELSE PUT RESULT BACK IN R4
 024D B63F                       JF0 REPT1             ;IF F0 %T < ( 182 - 14N )
 024F 83             NOMR1:      RET
                           ;LKUP2
                           ;NORMAL DISPLACEMENT LOOKUP TABLE .  THIS ROUTINE WILL TAKE
                           ;%T X 3.33 DIVIDE BY 53 AND GIVE THE BINARY EQUIVALENT OF THE
                           ;ANSWER JUST AS FOR LKUP1 ABOVE EACH TEMPERATURE DELTA IS 16
                           ;DEGREES.  AS ABOVE %T MAX = 189 .  189/16 = 11.8  WE LET THE
                           ;MAX BINARY # = 11 FOR %T > 176 AND WE SUBTRACT 1 FOR EVERY
                           ;16 DEGREE LOWERING.
                           ;%T IS STORED IN R3.
                           ;FINAL ANSWER STORED IN R4
 0250 AB             LKUP2:      MOV R3,A              ;STORE  %T IN REG 3
 0251 BC0C                       MOV R4,#0CH           ;START WITH 12 IN R4
 0253 BDB0                       MOV R5,#0B0H          ;START WITH 176 IN R5
 0255 FB             REPT2:      MOV A,R3              ;%T IN ACCUM
 0256 AA                         MOV R2,A              ;AND INTO R2
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0            PAGE   13
HYCOS - A6 REV 18 1/19/80

 LOC  OBJ        SEQ       SOURCE STATEMENT

 0257 FD          658               MOV A,R5            ;176 - 16N INTO ACCUM
 0258 34B3        659               CALL SBTCT          ;%T - ( 176 - 16N )
 025A FD          660               MOV A,R5            ;GET 176 -16N
 025B 03F0        661               ADD A,#0F0H         ;SUBTRACT ANOTHER 16
 025D AD          662               MOV R5,A            ;AND STORE RESULT IN R5
 025E FC          663               MOV A,R4            ;R4 INTO ACCUM
 025F 07          664               DEC A               ;A HAS ANSWER
 0260 C665        665               JZ NOMR2            ;IF R4 IS 0 END ROUTINE
 0262 AC          666               MOV R4,A            ;ELSE PUT RESULT BACK IN R4
 0263 B655        667               JF0 REPT2           ;IF F0 %T < ( 176 - 16N )
 0265 83          668 NOMR2:        RET
                  669
                  670
                  671
                  672
                  673
                  674 ;QUAD MULTIPLY
                  675 ;FIRST MULTIPLY # AND R7 (LSBYTE) DROP LSBYTE OF RESULT
                  676 ;AND ADD MSBYTE OF RESULT TO R5.
                  677 ;THEN MULTIPLY # AND R6 (MSBYTE). ADD LSBYTE OF RESULT
                  678 ;TO R5 AND MSBYTE OF RESULT TO R4.
                  679
                  680
 0266 AA          681 QUADM:        MOV R2,A       ;GET MULTIPLIER IN R2
 0267 FF          682               MOV A,R7       ;LSBYTE
 0268 A9          683               MOV R1,A       ;TO R1
 0269 34BE        684               CALL BMPY      ;MULTIPLY
 026B 6D          685               ADD A,R5       ;ADD MSBY OF CALC TO R5
 026C AD          686               MOV R5,A       ;STORE IN R5
 026D E670        687               JNC Y1         ;IF CARRY
 026F 1C          688               INC R4         ;ADD 1 TO R4
 0270 FE          689 Y1:           MOV A,R6       ;MSBYTE
 0271 A9          690               MOV R1,A       ;TO R1
 0272 34BE        691               CALL BMPY      ;MULTIPLY
 0274 29          692               XCH A,R1       ;MSBY TO R1 LSBY TO A
 0275 6D          693               ADD A,R5       ;ADD LSBYTES
 0276 BD00        694               MOV R5,#0H     ;CLEAR R5
 0278 AF          695               MOV R7,A       ;RESULT TO R7
 0279 E67C        696               JNC Y2         ;IF CARRY
 027B 1C          697               INC R4         ;ADD 1 TO MSBY
 027C F9          698 Y2:           MOV A,R1       ;MSBYTE TO A
 027D 6C          699               ADD A,R4       ;ADD MSBYTES
 027E BC00        700               MOV R4,#0H     ;CLEAR R4
 0280 AE          701               MOV R6,A       ;RESULT TO R7
 0281 83          702               RET
                  703
                  704
                  705
                  706
                  707
                  708               END

USER SYMBOLS
BMP1  01C2   BMP2  01C7   BMPY  01BE   BYTST  0147   CONT  013F   DBLRT  01CC   DECR  0143   DIVIDE 0200
END2  00E4   END3  00E1   END4  010D   EXCH   0199   FINI  01A4   GONOGO 01A9   LKUP1 023A   LKUP2  025A
```

```
ISIS-II MCS-48/UPI-41 MACRO ASSEMBLER, V2.0             PAGE   14
HYCOS - A6 REV 18 1/19/80

LSD     015C   MLTPLY 017C   MRK1   01D1   MRK2   01DF   MS10   013B   MULT   0180   MVMPLY 012E   NEG1   003B
NMLT1   00D0   NMLT2  00D4   NOCA   00A4   NOK    01AA   NOMLT  00C5   NOMR1  024F   NOMR2  0265   NTMPTR 0129
OK      01B0   PLUS   01BB   POS1   004C   PRSCLC 0100   QUADM  0266   RAT    009B   READ   0164   REPT1  023F
REPT2   0255   RMLD   0025   RSRVR  0070   RSTR   019C   RUDDER 005D   SBRTN  01A2   SBTCT  01B3   SQNCE  0016
START   0002   SUM1   004E   TMPCK  018A   TSTUT  001B   WRITE  014F   X1     020C   X2     021D   X3     0225
X4      022E   X5     0222   X6     0216   X7     0232   Y1     0270   Y2     027C

ASSEMBLY COMPLETE,   NO ERRORS
```

DAT

FILM