ORION SERVICE digest

issue 39 OCTOBER 1981

LOCKHEED • CALIFORNIA COMPANY

P-3 IMPROVEMENTS

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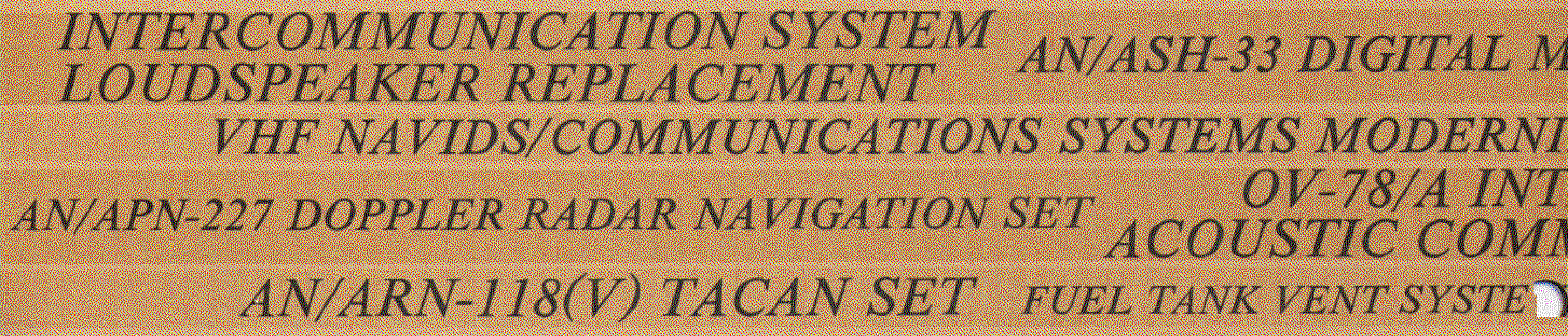
CONTENTS

NOT FOR PUBLIC RELEASE

FRONT AND BACK COVERS

Air Test and Evaluation Squadron ONE has two principal missions: the first is to evaluate antisubmarine warfare aircraft weapons systems support equipment and material in an operational environment, and the second is to develop operational tactics, doctrines, and training procedures for their use. VX-1 is directed by the Commander, Operational Test and Evaluation Force (COMOPTEVFOR).

VX-1 was originally commissioned in April 1943 at Quonset Point, Rhode Island as the Air Antisubmarine Development Detachment. Its initial purpose was to develop new antisubmarine weapons and tactics to counter the threat of German U-boats. After the war, the squadron moved to Key West Florida and was commissioned Antisubmarine Development Squadron ONE. Its mission expanded accordingly; the squadron became the Fleet's "consumer advocate," in that it was to evaluate antisubmarine equipment, determine its practical value, and develop appropriate tactics.



Over the years, the squadron's official name changed until January 1969, when its current title of Air Test and Evaluation Squadron ONE was adopted. On 15 September 1973, AIRTEVRON ONE moved to its present location at NAS Patuxent River, Maryland.

VX-1 operates various ASW aircraft to support project evaluation, including the P-3C and EP-3A Orions, S-3A Viking, SH-2F Sea Sprite, SH-3F Sea King, and SH-60B Seahawk.

Squadron personnel who test and maintain the P-3 Orions are representative of those found in operational fleet squadrons; that is, they receive no special schooling or training for their jobs except when required by new equipment. The squadron carefully selects operational environments to duplicate, as much as possible, actual operating conditions throughout the fleet to allow them to develop procedures that may be performed by regular Naval personnel.

Because most of VX-1's work is related to ASW, many of their projects are classified. The squadron is currently evaluating a satellite-directed navigation system called the global positioning system, new sonobuoys, and has begun evaluation of the P-3C Update III Orion. They are also working on two projects using P-3 aircraft that are not directly related to ASW. With the EP-3A, the squadron is involved in project EMPASS (Electromagnetic Performance of Aircraft and Ship Systems), an assessment of the performance of electromagnetic systems such as radar and radio in an operational environment. The advanced acoustics systems aboard P-3 aircraft are also being used in a project to monitor warhead reentry of ballistic missiles launched from submarines.

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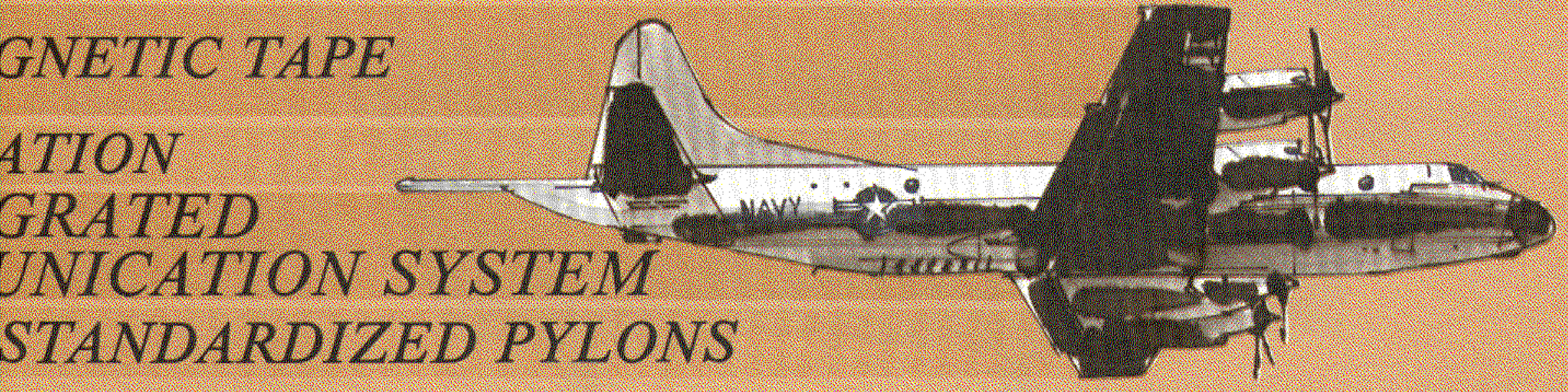

ACKNOWLEDGEMENT

This issue of the Orion Service Digest deals with eight separate aircraft modifications that, generally speaking, were all incorporated in production at P-3 Orion SERNO 161132. Producing this aircraft with its many new or modified systems and components and concurrently documenting the information in an Orion Service Digest has taken the dedicated efforts of many people throughout Lockheed. The following lists those contributors and consultants to whom we are greatly indebted.

Hank Anderson	Herb Franck	Bud Ohrenstein
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Ron Deutschman	Walt Lowe	Gary Thompson
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We may have overlooked some persons who should have been included, for example, those who corrected manuscripts anonymously as they were circulated through various offices in draft form. To these unknown contributors, we are no less indebted.

P-3 IMPROVEMENTS

FOREWORD

The P-3 Improvement Program was conceived and initiated by Captain Gordon Petri, USN (Ret.), until recently the U.S. Navy's P-3 Project Manager, and by his counterpart at the Lockheed-California Company, Mr. Sherm Mullin. Under their leadership, the Navy and Lockheed established the program objectives and determined how best to achieve them. This article describes how these objectives have been met.

INTRODUCTION
by Capt. Gordon Petri, USN (Ret.)

Since the original P-3 design circa 1960, there have been many changes to update the Orion aircraft. Much of its original equipment has been improved or, when no longer obtainable, replaced with later generation equipment. These changes have been brought about by advances in technology that have outmoded many equipments and made further production of them unprofitable. When this occurs, the aircraft must be furnished with modern obtainable equipment just to deliver it with the *same* mission capability as aircraft fitted with outmoded equipment. These changes have produced several configurations of the P-3C aircraft. Although it would be desirable to maintain only one aircraft configuration, this is simply not a practical goal. Hence, the P-3C must continue to advance with technology.

This process is not new to those who have watched the evolutionary incorporation of "minor" changes into equipment over the last few years. Most P-3C avionics equipments, including the AQA-7, ARC-143, TD-900, and AGC-6, have required these minor changes because components have become obsolete and are no longer available. Fortunately, as technology mandates that changes be made, we are also presented with the opportunity to improve equipment maintainability and reliability and to reduce unit costs, all at one time.

When the degree or number of changes becomes significant, they are consolidated and a coordinated change is made to the aircraft. These coordinated changes are made on specific production blocks of aircraft whenever possible. This practice tends to minimize the effect of these changes on fleet operations and make them manageable within the maintenance support community. This process recently dictated performance of an initially unplanned block avionics improvement on P-3C aircraft between the Update II and Update III production milestones. We have taken this opportunity to implement several changes that improve system reliability and reduce maintenance manhours.

A maintenance concept has also been initiated that is new to the P-3C aircraft: contractor warranty or maintenance contracts for selected equipments. To the fleet, application of this maintenance concept means improved repair turnaround time.

The higher reliability of advanced technology equipment components and their decreased unit cost have also allowed use of an "Organizational-to-Depot level" maintenance concept, which often eliminates the requirement for Intermediate level maintenance. The current LTN-72 Inertial Navigation System maintenance program is a prime example of how effectively this concept can be applied. The net result should be reduced maintenance manhours, decreased equipment failures, improved equipment performance and, for the taxpayer in all of us, decreased costs.

Faced with the short-notice shutdown of production lines for older equipment components, NAVAIR and Lockheed have responded rapidly to redesign the P-3C aircraft to ensure that the ASW fleet has a platform capable of supporting its missions. We feel that we have achieved that goal.

CAPT. GORDON PETRI

Captain Gordon Petri was Project Manager for P-3 aircraft at the Naval Air Systems Command from September 1977 to July 1981. As P-3 manager, Captain Petri directed all aspects of the Navy's P-3 program, including P-3 foreign military sales. He directed production of the P-3C Update II and its introduction into fleet operations, development of systems hardware, software, and procurement of the P-3C Update III, development of the P-3C Modernization program, and development of many major improvement retrofit programs for active and reserve fleet P-3 aircraft. During his tenure as P-3 Project Manager, the capability and readiness of the fleet dramatically improved, both in new aircraft and modernized fleet aircraft. He also played a major role in P-3 programs for Australia, Japan, the Netherlands, and Norway.

Captain Petri has had a long and successful career with naval patrol aviation ever since he won his pilot's wings. He served as a pilot, flight instructor and test pilot, including assignment to the P3V-1 BIS trials that led to the Navy's acceptance of the Orion ASW aircraft. He has flown over 6000 hours in P-2 and P-3 aircraft. His assignments also included serving as Assistant Operations Officer with Fleet Air Wing One, Commanding Officer of VP-24, and NAVAIR P-3 Assistant Project Manager – Engineering.

A native Pennsylvanian, Captain Petri was commissioned an Ensign in the U.S. Navy in 1955 when he received his B.S.M.E. degree from the University of Rochester. Subsequently, he has graduated from the U.S. Naval Test Pilot School, attended the Armed Forces Staff College, and graduated from the Industrial College of the Armed Forces. Captain Petri retired from the U.S. Navy in July, 1981.

INTRODUCTION
by Sherm Mullin

The P-3C Update II aircraft was introduced into the U.S. Navy's Atlantic Fleet in August 1977. The major improvements incorporated were the infrared detecting set, the sonobuoy reference system, an improved analog magnetic tape recorder for acoustic data recording, and the capability to fire the Harpoon anti-surface missile. Since that time, Update II aircraft have been delivered to VP-10, VP-23, VP-26, VP-30, VP-44 and No. 10 Squadron of the Royal Australian Air Force.

Additional major improvements are being incorporated into Update II aircraft delivered to the fleet beginning in March 1981 and in all subsequent Update II aircraft. VP-11 is the first U.S. Navy squadron to receive the improved Update II aircraft. These improvements are also included in the P-3C Update II aircraft for the Japanese Maritime Self Defense Force and the Royal Netherlands Navy.

The improvements fall into basically two categories: avionics systems improvements and aircraft configuration changes. The specific systems are listed below.

Avionics Systems Improvements	Acronym or Name	Equipment Designation
VHF Navigation Aids and VHF Communications Systems	Navaids VHF VOR	VIR-31A 618M3A (both commercial)
Doppler Radar Navigation Set	Doppler	AN/APN-227
Digital Magnetic Tape Set	DMTS	AN/ASH-33
Tactical Navigation Radio Set	Tacan	AN/ARN-118(V)
Integrated Acoustic Communication System	IACS	OV-78/A
Intercommunication System Loudspeakers	ICS	———

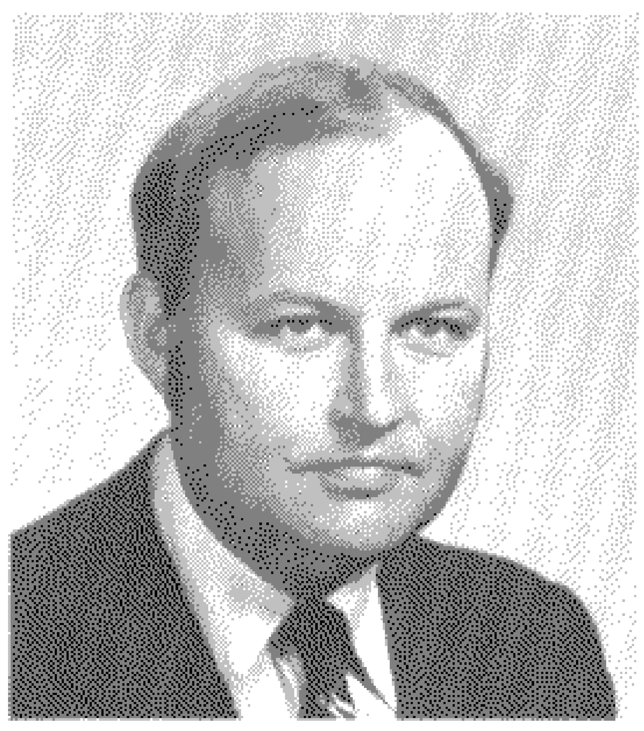
Aircraft Configuration Changes

Improved fuel tanks' venting system
Addition of standardized pylons

These improvements have been incorporated for a number of significant reasons.

- The radio navigation equipment in the P-3C aircraft, most of which has existed for over 20 years, was going out of production. Further, far more reliable equipment was available "off the shelf" that met important new NATO and commercial operational requirements.
- The current Doppler navigation radar, never very reliable, was becoming more costly to buy and support. Several new, more reliable and far less costly systems were available competitively.
- The digital magnetic tape transport was heavy, not very reliable, and would not accommodate critical planned additions to the P-3C avionics suite, such as the new ESM system and the Update III acoustics processor. New, lighter weight, more reliable equipment was available.
- The Navy had selected a new airborne tacan system that is far more reliable and less expensive than the current tacan equipment.
- The integrated acoustics communication system was completing development and was ready to be incorporated into P-3C Update II production aircraft.
- The sooner the new equipment was put into production aircraft, the less retrofit of fleet aircraft would be required.
- The avionics suppliers were willing to meet the very difficult reliability, maintainability and repair requirements of the systems on a firm, fixed price basis. The Navy and Lockheed reached agreement early on very detailed contract requirements.

These improvements were incorporated according to seemingly contradictory program objectives. It was essential that equipment not supportable over the coming decade be replaced, while at the same time the procurement and life cycle costs of new equipment had to be kept low. The nature of the changes to the aircraft had to be consistent with possible retrofit requirements, as well as accommodate future improvements, such as those planned in the Update III and P-3C Modernization programs. The changes had to have little or no effect on the aircraft's system software, yet improve the operational readiness posture of the fleet. And finally, the fleet's operational capability needed to expand to meet the increasingly sophisticated ASW threat of the 80s. This article describes how these objectives have been met.



SHERM MULLIN

Sherm Mullin was appointed Director of Planning and Advanced Programs in January 1981. In his new position, Mullin is responsible for strategic and product planning for new ASW aircraft and specifically responsible for the advanced P-3 aircraft programs. He is also playing a major role in strategic and long-range planning for other government programs for Lockheed-California Company.

Mullin has held many major management positions on the P-3 program since he joined the company in 1968. He served as P-3C Avionics Integration Manager from 1968 to 1969, P-3 Software Manager from 1969 through 1970, P-3 Chief Engineer from 1974 to 1976, and P-3 Program Manager from 1976 until his promotion to director in 1981.

Sherm Mullin, 46, grew up in Connecticut. He served in the U.S. Army from 1954 through 1957 and joined Lockheed in 1959. A self-educated engineer and manager, his main technical interest has been digital computing. He has been involved in ASW programs since 1961, initially at Lockheed Electronics and then since 1968 at Lockheed-California Company.


NAVY

ARN-118(V) TACAN

The AN/ARN-118(V) Tacan Set is a second-generation microtacan system that is a combination transmitter, receiver, decoder, digital computer, and digital-to-analog converter. On the P-3C aircraft, this tacan set acts as an airways and approach navigation system. It calculates relative bearing, course deviation, and distance (slant range) information from signals received from a selected ground or airborne tacan station. This range and bearing information is then displayed on the aircraft's horizontal situation indicators and flight director indicators. This set replaces the AN/ARN-84 Tacan Set on P-3C Update II production aircraft.

The AN/ARN-118(V) Tacan Set consists of the RT-1159/A Receiver-Transmitter, the C-10058/A Tacan Control, the MX-9577/A Digital-to-Analog Adapter, and the 993R-1 Shockmount, this last unique to the P-3C. Figure 1 shows the AN/ARN-118(V) Tacan Set.

The receiver-transmitter and D/A adapter are located in electronics rack C-2, and the tacan control unit is mounted in the cockpit center control pedestal. The existing aircraft wiring and antenna installation remain unchanged.

The ARN-118 is a commercial off-the-shelf tacan set. One advantage of the new tacan set is that it is an all solid-state system except for the transmitter tubes. As such, its operation is more precise and more reliable, a fact well proven in field use, first by the USAF and more recently by the Navy with mean times between failures of about 1000 hours.

The new tacan set contains several refinements. For example, if two signals are obtained on the same channel, the beacon's identification signal is automatically garbled. Further, the possibility of the tacan set processing an echo of the signal is eliminated because the set accepts only the first signal received.

The ARN-118 Tacan Set operates on 252 channels in the uhf band, 126 X-channels and 126 Y-channels. The X-channels are identical to the 126 uhf channels that are used by all tacan sets. The Y-channels use the same frequency pairings as the X-channels use in the air-to-air operational mode, but they use different DME (distance measuring equipment) interrogation pulse spacing and DME reply pulse delay times. The Y-channels have been reserved for special use and expansion, but are not in use at the present time. The ARN-118 Tacan Set selects the channels electronically, eliminating the possibility of incorrect station lock-on because of mechanical misalignment of a crystal frequency selector.

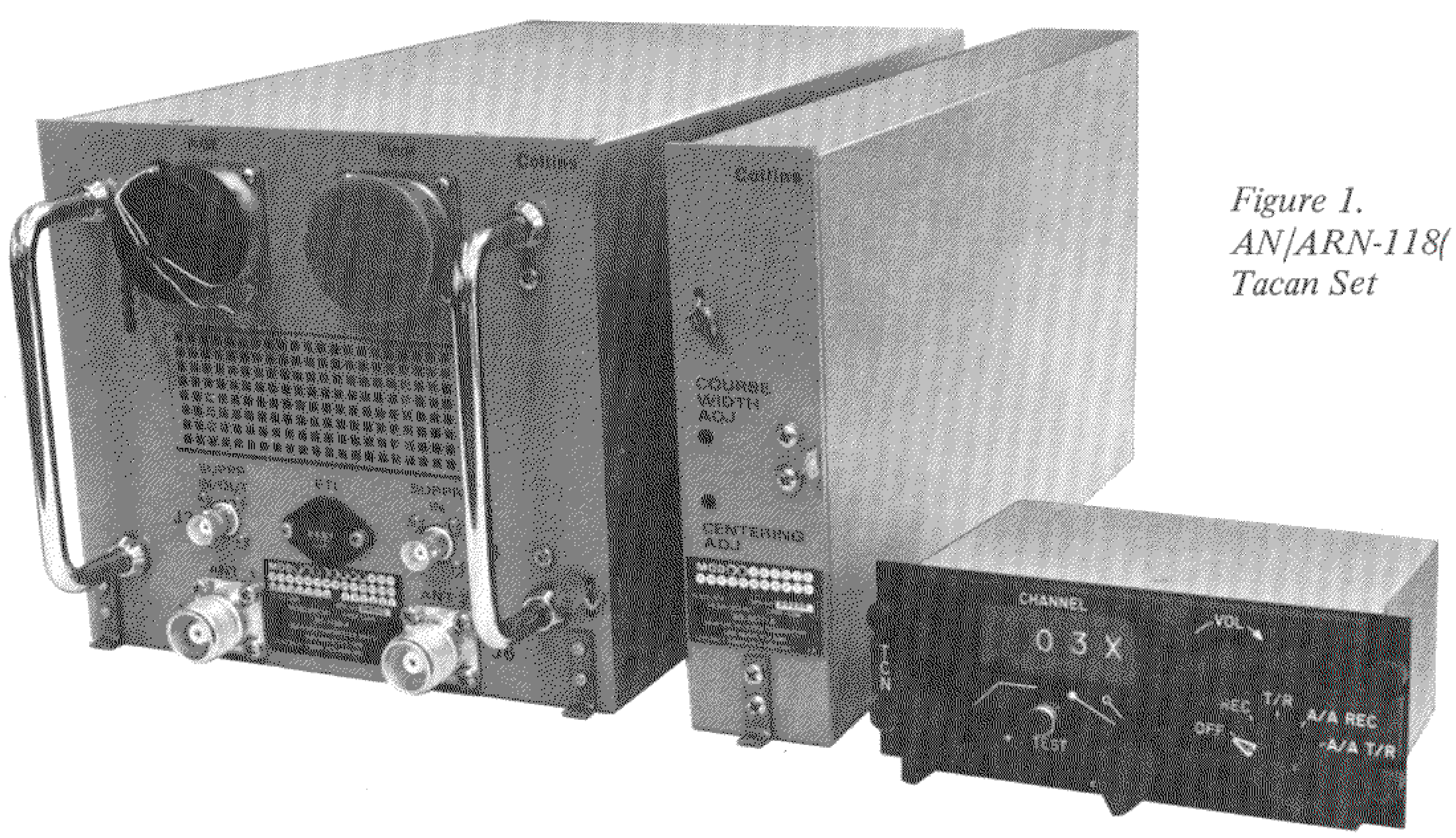


*Figure 1.
AN/ARN-118(V)
Tacan Set*

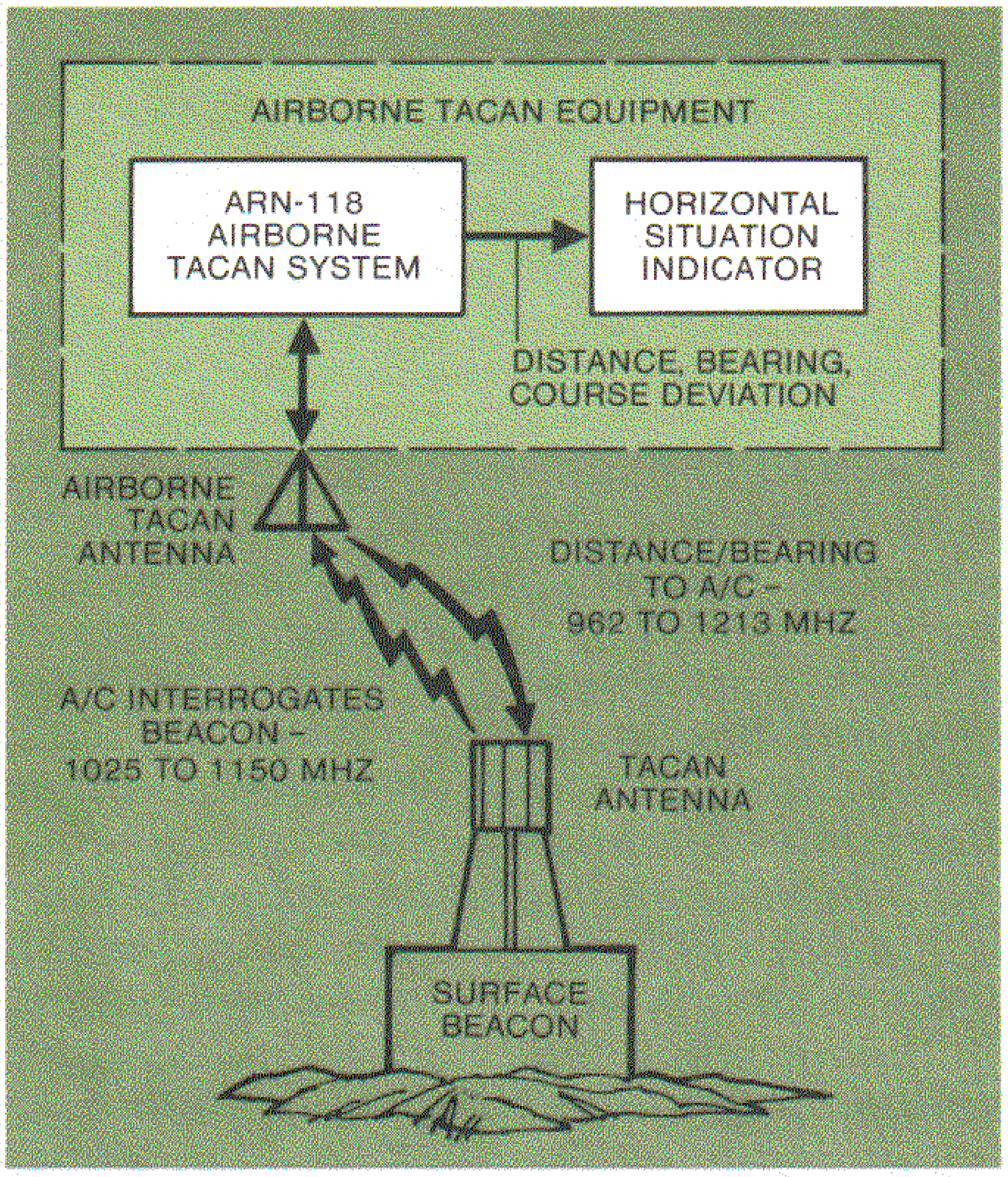


Figure 2. Air-to-Ground Tacan Operation

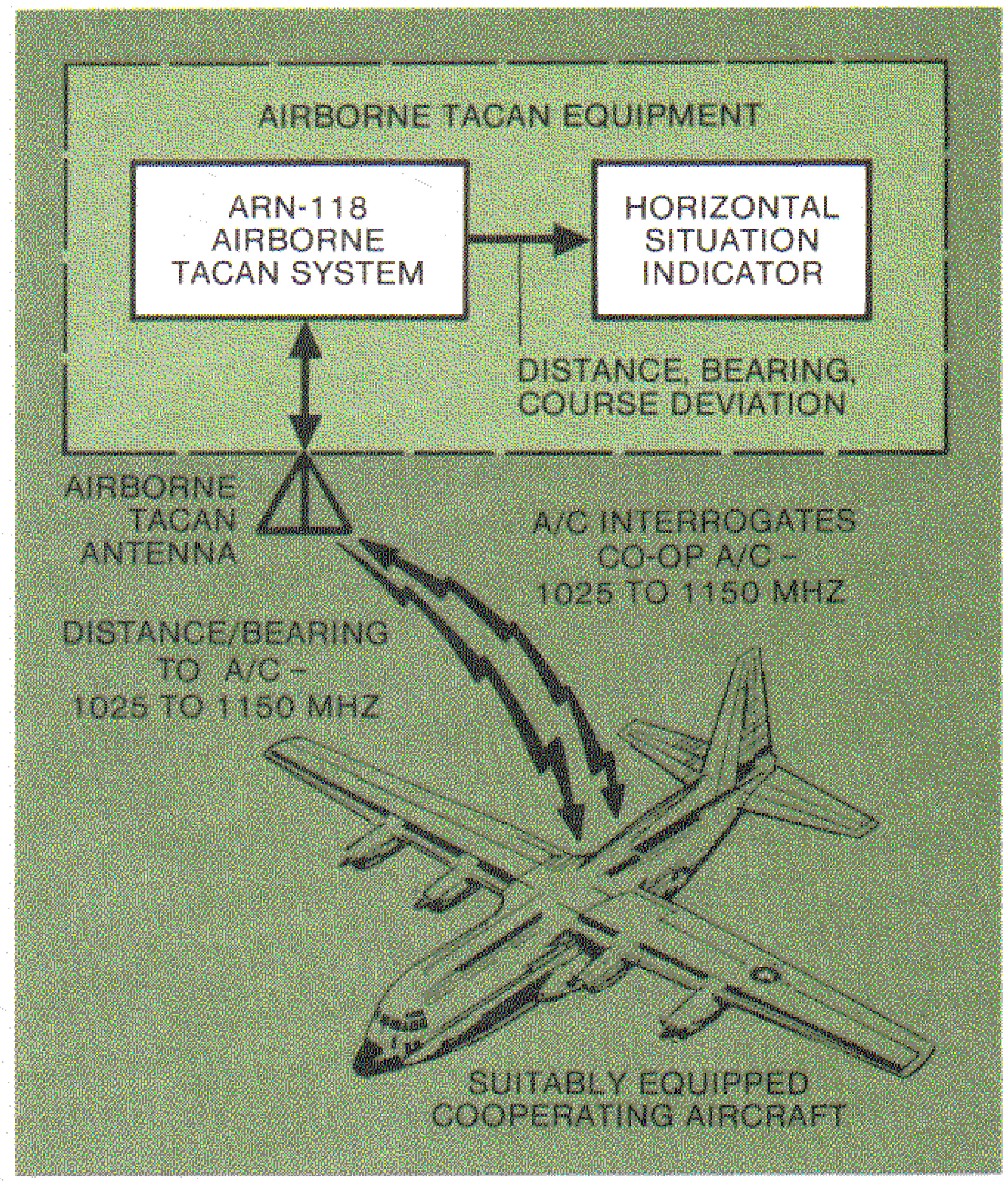


Figure 3. Air-to-Air Tacan Operation

OPERATIONAL MODES

The ARN-118 Tacan Set has four operational modes: (1) air-to-ground receive, (2) air-to-ground transmit/receive, (3) air-to-air receive, and (4) air-to-air transmit/receive. In air-to-ground modes, bearing signals are accurate to within ± 1 degree. In air-to-air modes, bearing signals are accurate to within ± 3 degrees.

Station identification tone signals may be monitored during all operational modes through the intercom system by adjusting the volume control knob on the tacan control unit. Figure 2 shows air-to-ground operation, and Figure 3 shows air-to-air operation.

REC (RECEIVE) In this passive mode of operation, the airborne tacan set receives signals from the ground tacan station. The airborne tacan set derives the magnetic radial from the ground tacan station, based upon the station's local magnetic variation.*

This signal is converted to analog data and is "added" to the aircraft's heading to provide the aircraft's bearing to the station. This bearing is then displayed on the horizontal situation indicators (HSIs). The tacan system also derives "to/from" information – whether the aircraft is approaching the ground station or heading away from it according to the operator's selected course – and displays it on the HSIs and flight director indicators. The course deviation bar on these instruments will indicate whether the aircraft is left or right of the selected course.

T/R (TRANSMIT/RECEIVE) In this active mode of operation, the airborne tacan set interrogates the ground station in addition to receiving the bearing information that is processed in the REC mode. Upon receiving a precisely timed reply, the tacan set calculates the slant range to the ground station in nautical miles and displays this information in the miles window on the HSIs.

**It must be remembered that all bearing information from tacan stations is referenced to the magnetic north pole. As such, each station location has a specific magnetic variation, which is defined as the difference in degrees between magnetic north and true north.*

A/A REC (AIR-TO-AIR RECEIVE) The tacan set receives and processes bearing signals from a "suitably equipped cooperating aircraft," much the same as from a ground station. The cooperating (transmitting) aircraft must be equipped with a bearing transmitter and antenna. At this writing, the Navy has no such aircraft available to work with P-3s during normal operations.

A/A T/R (AIR-TO-AIR TRANSMIT/RECEIVE) In this mode, the tacan set interrogates a cooperating aircraft that is suitably equipped to respond with both bearing and distance information. Upon receiving a precisely timed reply from the cooperating aircraft, the tacan set calculates the bearing and the slant range (in miles) *to the airborne station.* This information may be displayed on the aircraft's horizontal situation indicators. P-3 aircraft also may exchange slant range information through their ARN-118 tacan sets.

TEST MODES

There are two test modes available to the operator of the ARN-118 Tacan Set: manual and automatic. The manual mode serves as a confidence test to assure the crew that the tacan set is operating properly. When self-test is initiated in the T/R mode and the TEST lamp stays lit indicating a malfunction, the self-test should then be performed in the REC mode. If the TEST lamp is extinguished, the operator knows that only the transmitter is affected and the crew may continue to rely on the bearing information received. If the TEST lamp stays lit in both REC and T/R, all bearing, distance, course deviation and to/from information displayed should be disregarded.

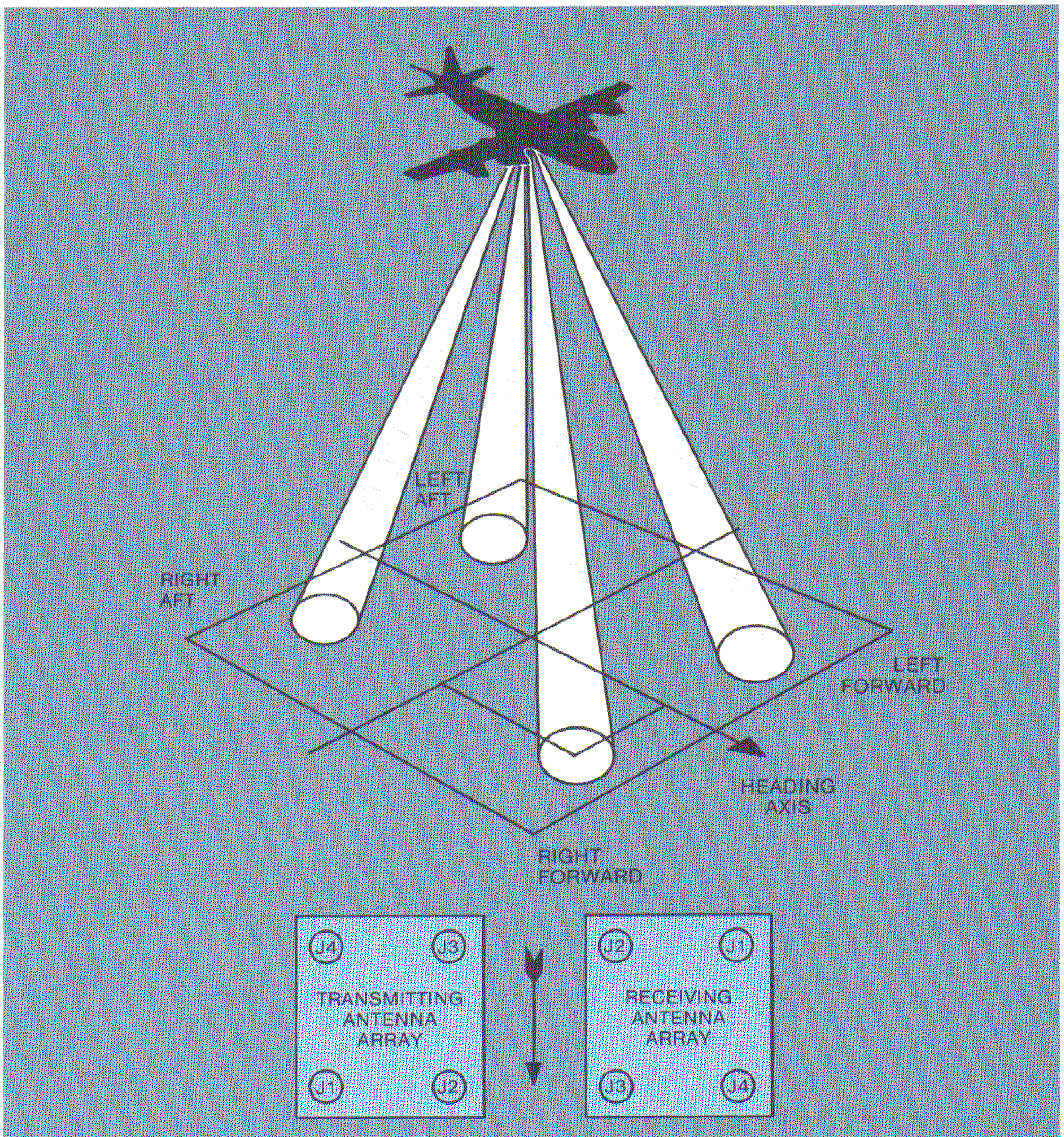
When a beacon's signal becomes unreliable or encounters interference, the tacan set switches to memory for a few seconds to allow uninterrupted display of bearing and distance information on the horizontal situation indicators. If the signal is lost and the memory time elapses (3 seconds for bearing, 15 seconds for distance), the tacan set enters the automatic test mode to determine if the set is operating correctly. The only indication that this automatic self-test is in process is a brief 270-degree bearing indication on the horizontal situation indicator with the NAV flag in view. If the signal is not reacquired following the test, the bearing pointer will rotate clockwise around the dial while the tacan set searches for a signal on the selected channel. If the tacan set's self-test routine has detected a malfunction, the TEST lamp will come on.

APN-227 DOPPLER RADAR NAVIGATION SET

Beginning with P-3C aircraft USN SERNO 161132 (LC S/N 5724), the AN/APN-227 Doppler Radar Navigation Set has been installed on production P-3C aircraft. This set replaces the AN/APN-187 Doppler Radar Navigation Set with which all earlier P-3C aircraft were equipped. The new Doppler radar set is a modification of the AN/APN-510 Doppler Radar Navigation Set used on the Canadian Forces CP-140 Aurora aircraft. Compared to the older APN-187 Doppler radar set, the APN-227 set is of improved design, based upon state-of-the-art technology. The new set offers improved reliability, maintainability, and logistics support.

The APN-227 Doppler Radar Navigation Set is a dead reckoning type aircraft navigation system. It continuously measures aircraft velocity along the aircraft heading and across the aircraft heading. To gain these measurements, the set transmits frequency modulated, continuous-wave RF signals, using two forward-looking beams and two rearward-looking beams that are in phased sequence (see Figure 4). This beam pattern is called a *Janus* configuration, after the two-faced Roman god who could look backward as well as forward.

The major design difference between the APN-227 and APN-187 Doppler sets is that the APN-227 set is a fixed-antenna type system while the APN-187 set is an earth-referenced, stabilized-antenna type system. This means that the APN-227 receiver-transmitter-antenna unit is aligned and fixed to the aircraft structure. When the attitude of the aircraft changes, the attitude of the Doppler antenna changes with respect to the plane of the earth's surface. On the other hand, the APN-187 receiver-transmitter-antenna unit is

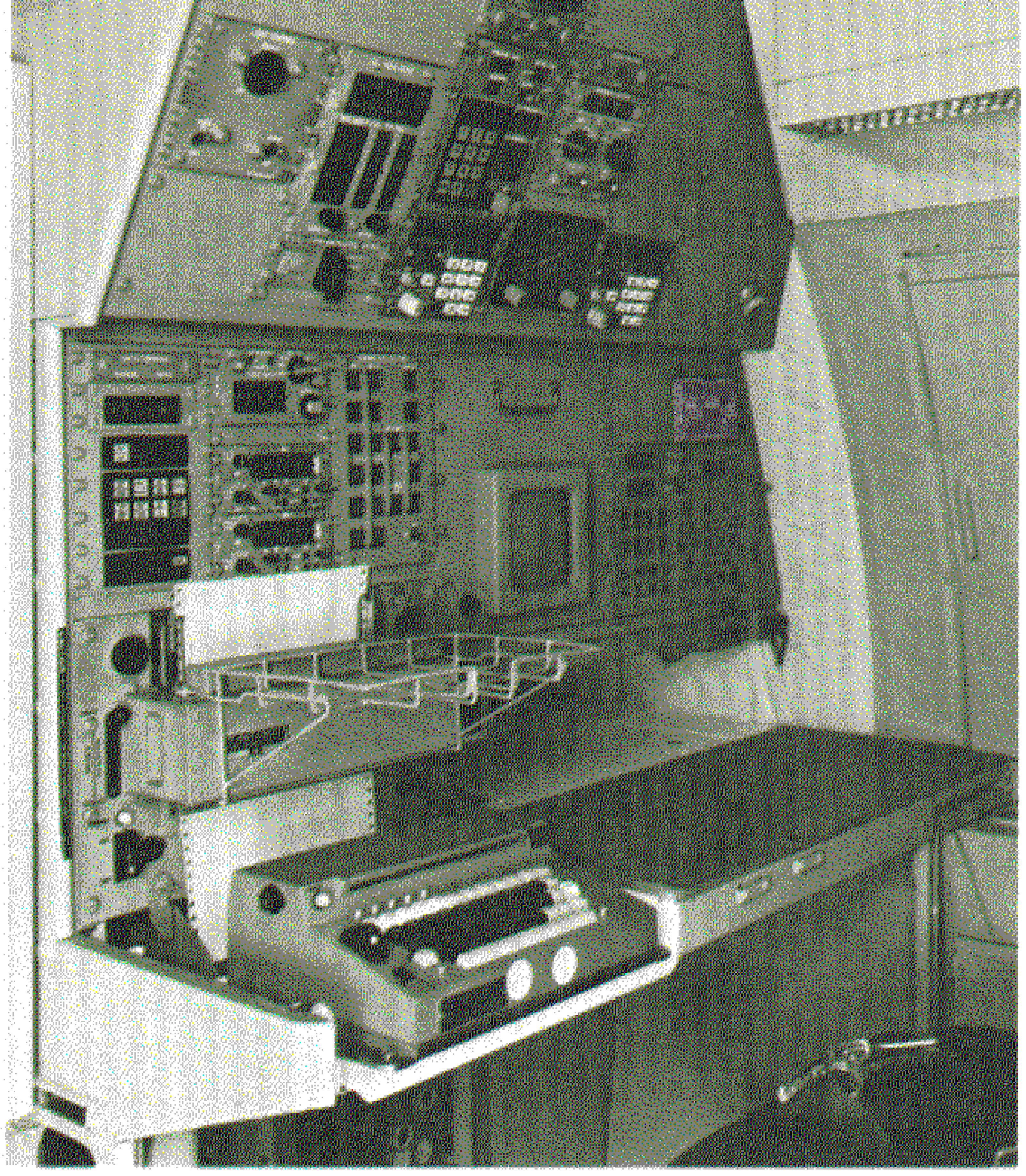


TRANSMITTING ARRAY	CONNECTOR	RECEIVING ARRAY
RADIATES LEFT FORWARD	J1	RECEIVES RIGHT AFT
RADIATES RIGHT FORWARD	J2	RECEIVES LEFT AFT
RADIATES RIGHT AFT	J3	RECEIVES LEFT FORWARD
RADIATES LEFT AFT	J4	RECEIVES RIGHT FORWARD

Figure 4. AN/APN-227 Doppler Radar Navagation Set Beam Configuration – Transmission and Reception Sequence

gimbal-mounted in the aircraft on an attitude stabilizer assembly. This installation maintains the alignment of the Doppler antenna perpendicular to the local vertical reference when the aircraft pitches or rolls.

Although a stabilized Doppler antenna platform is a desirable feature, operational experience has shown that the mechanical reliability of the fixed-antenna type system (the unit does *not* move) is a greater asset. However, selection of the



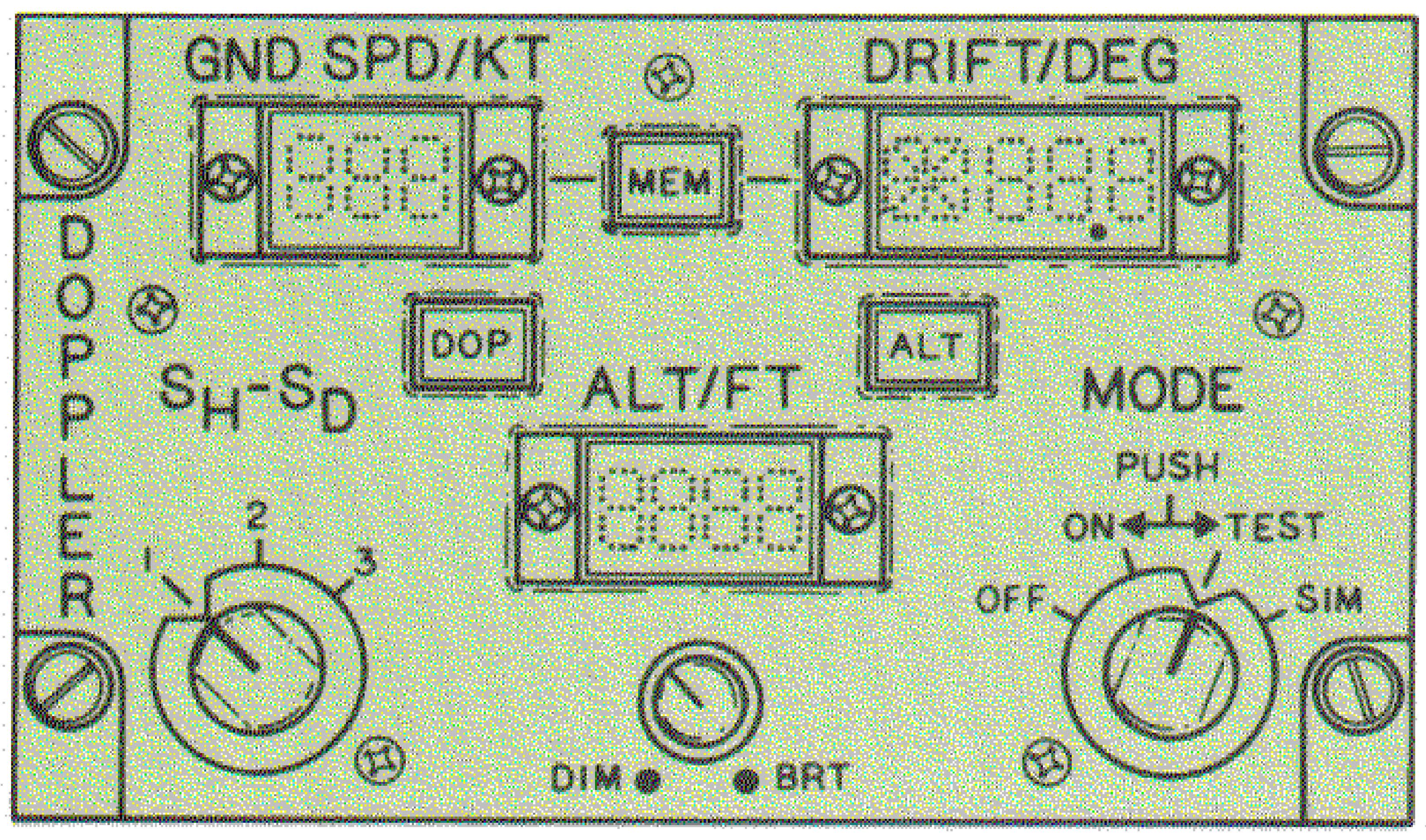


Figure 5. C-10873/APN-227 Doppler Control-Indicator Unit Panel at NAV/COMM Station

APN-227 fixed-antenna type of Doppler set required compensation for changes in aircraft attitude during flight. Without such compensation, pitch and roll changes would render aircraft track calculations based upon the Doppler system aircraft axis measurements inaccurate. Compensation for these attitude changes has been achieved by integrating pitch and roll inputs from the aircraft Inertial Navigation Systems with the APN-227 set's Doppler shift velocity measurements. From these data, the APN-227 Doppler set calculates aircraft ground speed and drift angle.

The APN-227 Doppler Radar Navigation Set does not measure aircraft altitude, but rather it receives analog altitude data from the aircraft's AN/APN-194 Radar Altimeter Set. The APN-227 Doppler set performs an analog-to-digital conversion of the radar altitude input from the APN-194 radar altimeter and sends the digital data to the aircraft CP-901 General Purpose Digital Computer and Data Processing System. A second analog altitude data signal is now routed *directly* from the APN-194 radar altimeter set to the copilot's radar altitude indicator, rather than via the Doppler set as it was with the APN-187 Doppler system installation.

A continuous readout of aircraft groundspeed, drift angle and altitude is displayed to the NAV/COMM operator by the APN-227 Doppler control-indicator. The altitude information is routed by the Doppler set from the radar altimeter to the Doppler control-indicator. The NAV/COMM Station Doppler System control panel is shown in Figure 5. The Doppler system also makes aircraft drift angle data available to the pilot's, copilot's and NAV/COMM operator's horizontal situation indicators.

DESCRIPTION

The APN-227 Doppler Radar Navigation Set is comprised of three main components called Weapons Replaceable Assemblies (WRAs): the RT-1358/APN-227 Receiver-Transmitter-Antenna, the CP-1440/APN-227 Computer-Frequency Tracker, and the C-10873/APN-227 Doppler Control-Indicator. The Doppler set features built-in-test and in-flight-performance-monitoring test routines. The built-in-test routine is initiated when the NAV/COMM operator selects TEST with the Doppler system mode select switch. The in-flight-performance-monitoring routine functions continuously during the Doppler system ON mode of operation. If either of these routines detects a Doppler system malfunction, the following fault indications will occur: the DOP fault lamp on the Doppler control-indicator (see Figure 5) will illuminate; the letter "F" will be displayed on the DRIFT/DEG fiberoptic readout of the Doppler control-indicator; and the appropriate fault indicator on the computer-frequency tracker (see Figure 6) will actuate to identify the malfunctioning unit. The Doppler system WRAs may be replaced by use of common hand tools.

RT-1358/APN-227 RECEIVER-TRANSMITTER-ANTENNA The receiver-transmitter-antenna is a solid-state electronic unit made up of the antenna arrays and the receiver-transmitter electronic modules. The antenna consists of two identical meander line (printed circuit stripline) planar antenna arrays mounted side by side, one antenna array to transmit the radar signals and the other to receive them. The electronic modules that make up the unit's receiver-transmitter include a Gunn-diode RF source, RF microcircuits, a modulator, a read-only memory (ROM), and an IF amplifier. They are mounted in the center of the platform that is formed by the two antenna arrays. The electronic modules are covered by a rectangular box, one end of which is a finned heatsink that is attached to the Gunn oscillator and the Gunn drive assembly of the RF source. The two antenna arrays are bonded together and should never be separated, since they cannot be properly aligned in the field. The receiver-transmitter-antenna is fixed-mounted on the underside of the aircraft at fuselage station 939. It is cooled by natural convection.

The receiver-transmitter-antenna unit generates a 13,325 MHz CW signal at a nominal power output of 200 mW. It frequency modulates the signal, then sequentially transmits four narrow beams of microwave energy below the aircraft. The back-scatter (reflected energy from the earth) is received by the receiver-transmitter-antenna unit in the beam sequence that it was transmitted. The received signals are coupled and mixed with a sample of the transmitted signal to produce an IF signal that contains the Doppler shift information. The IF signal is amplified to a usable output and sent to the computer-frequency tracker for further signal processing.

Each receiver-transmitter-antenna unit is subject to minute mechanical differences during manufacture that can affect the accuracy of the unit's IF signal outputs. To compensate for the effects of these differences, each receiver-transmitter-antenna unit is calibrated at the factory prior to delivery. The calibration data are programmed into the unit's read-only memory (ROM) module. During Doppler set operation, these calibration data are sent to the computer-frequency tracker unit where they are integrated with the IF output signal information from the receiver-transmitter-antenna unit. An antenna temperature sensor also sends analog temperature compensation data to the computer-frequency tracker unit.

CP-1440/APN-227 COMPUTER-FREQUENCY TRACKER

The computer-frequency tracker is a modular unit that consists of 14 printed circuit card assemblies, a power supply, and a chassis assembly. Located on the unit's front panel are three built-in-test-equipment (BITE) Weapons Replaceable Assembly fault indicators, an elapsed time indicator, a carrying handle, and four electrical connectors. The computer-frequency tracker is located in electronics rack F1, and is cooled by natural convection.

The computer-frequency tracker unit performs the APN-227 Doppler set's signal processing and system control functions. It exchanges information with the receiver-transmitter-antenna and Doppler control-indicator units, and provides data to interfacing aircraft navigation equipment. It receives aircraft attitude inputs from interfacing aircraft navigation systems, which it uses for Doppler signal processing. It also receives altitude data for analog-to-digital processing before these data are sent to the aircraft's CP-901 General Purpose Digital Computer.

The computer-frequency tracker unit generates four modulation frequencies that are used by the receiver-transmitter-antenna unit to sequentially modulate the four radar signals that it transmits. These modulation frequencies are under the control of the computer-frequency tracker unit internal timer and clock assembly, and are also

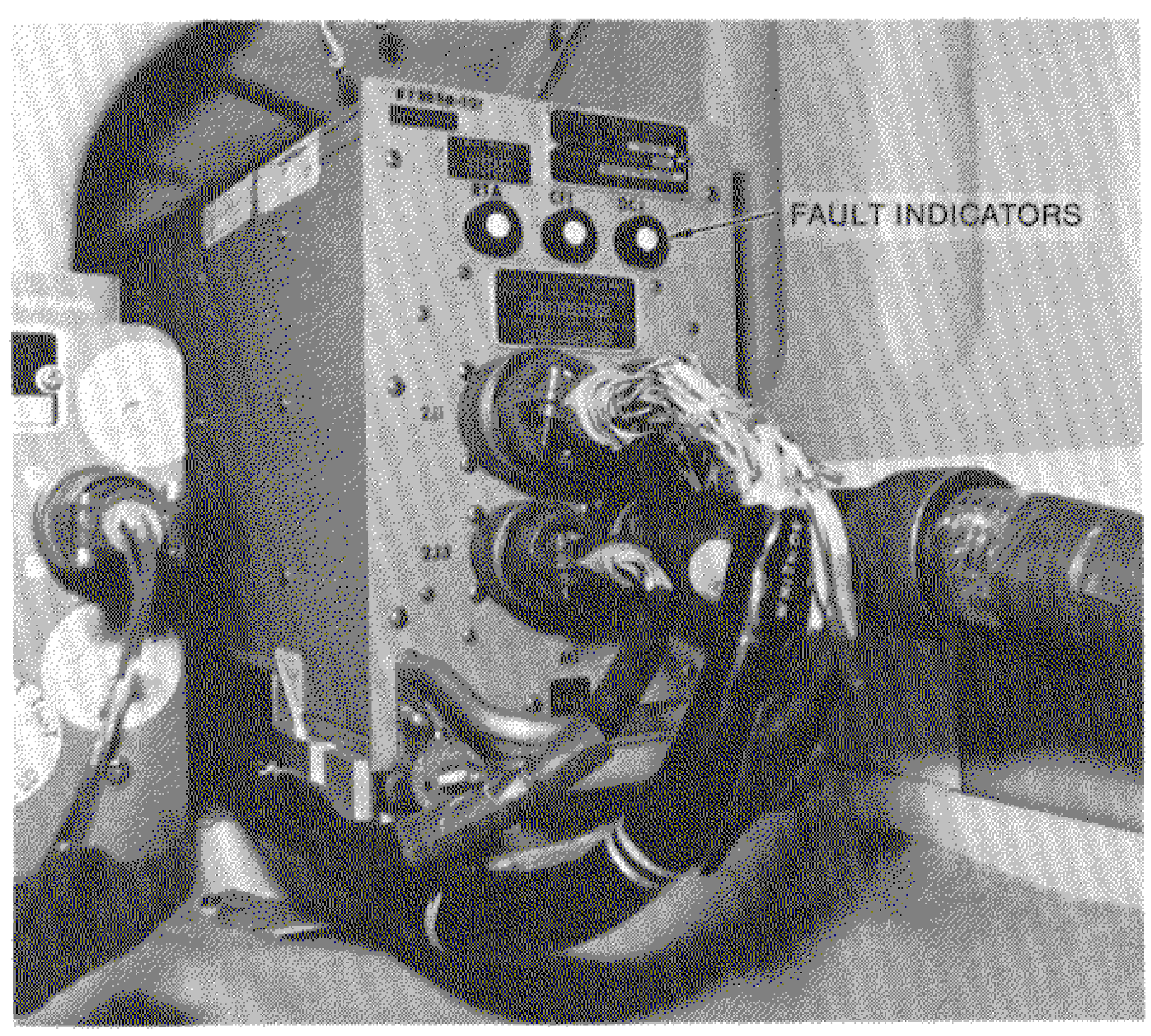
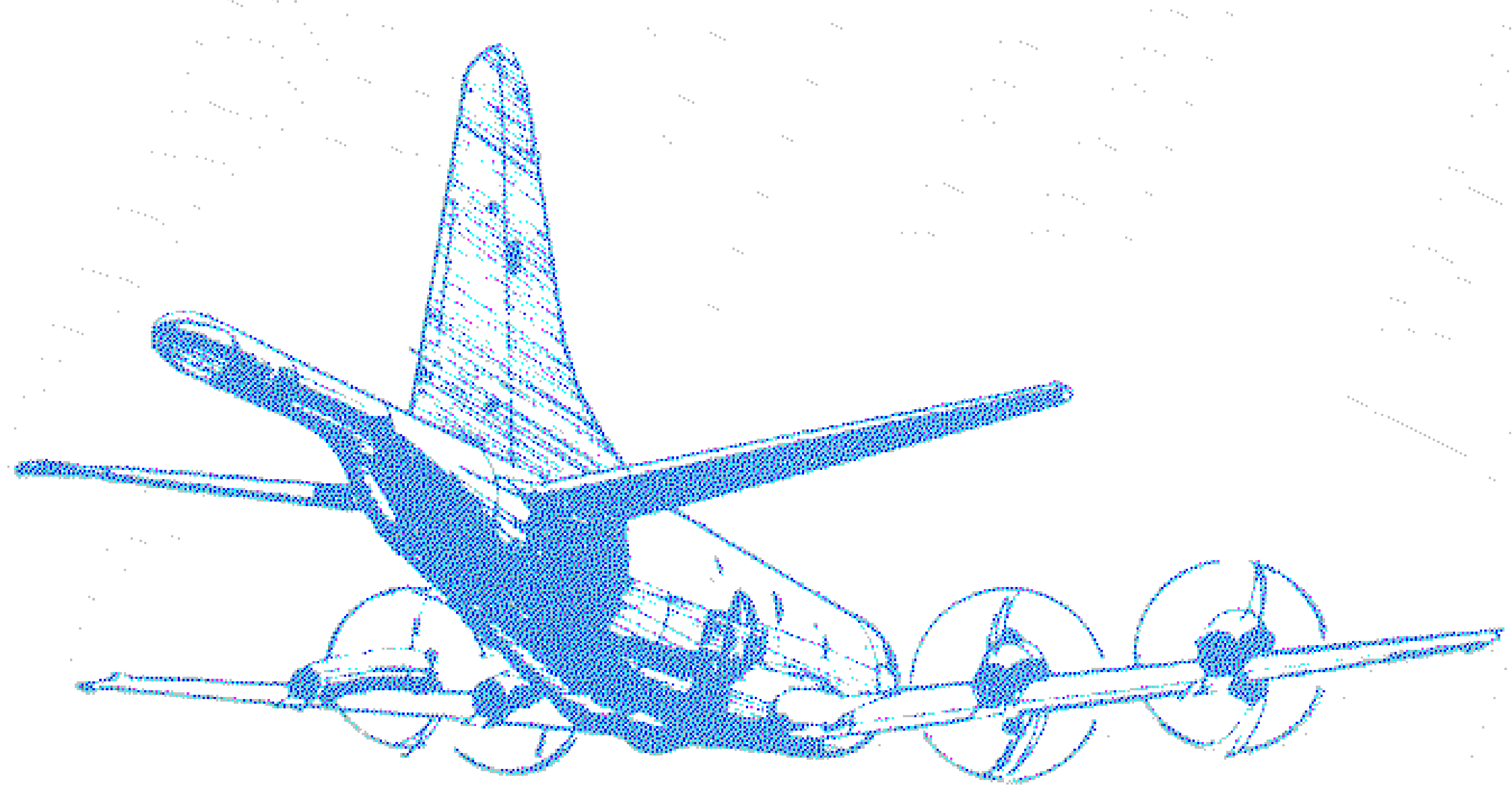


Figure 6. CP-1440/APN-227 Computer-Frequency Tracker Unit Installed at Electronics Rack F1

used by this unit to extract Doppler shift information from the radar return signals (IF signals) routed to it by the receiver-transmitter-antenna unit. The computer-frequency tracker also generates the radar beam switching command signal, which the receiver-transmitter-antenna uses to sequentially transmit the four radar beams and receive the backscatter.

The computer-frequency tracker monitors the Doppler backscatter to determine whether the return signals are typical of reflected energy from land or water. Based upon these data, a microprocessor is programmed to automatically switch to either the "land" or "sea" mode of Doppler system operation, whichever is appropriate. This applies the correct terrain calibration factor to Doppler tracking computations. Land/sea Doppler mode selection is controlled exclusively by computer-frequency tracker microprocessor software, and has no external controls or adjustments.

The computer-frequency tracker unit extracts Doppler information from the IF signal input sent from the receiver-transmitter-antenna, and uses it to derive the components of aircraft velocity. Aircraft groundspeed, drift angle, altitude, and system status information is passed from the computer-frequency tracker to the Doppler control-indicator for display to the NAV/COMM operator. This information is also sent to interfacing navigation equipment. "Distance along and across aircraft heading" data are produced by the computer-frequency tracker and are available for transmission to the aircraft Data Processing System. This information is in the form of the *accumulated distance* (not velocity) that the aircraft has traveled since the last interrogation by the Data Processing System. The interrogation rate is five times per second.



The block diagram in Figure 7 shows that the computer-frequency tracker unit receives five signals from external sources, and supplies four groups of signal outputs for aircraft navigational use. Aircraft attitude pitch and roll synchro inputs from the aircraft Inertial Navigation Systems are processed by the computer-frequency tracker and used to transform the antenna-referenced aircraft velocity components to earth-referenced aircraft velocity components.

The APN-194 radar altimeter sends a Type 1 analog altitude signal to the computer-frequency tracker (see Figure 7), which converts the signal into digital altitude data format (H_R), and then transmits the digital altitude data to the aircraft Data Processing System and to the Doppler control-indicator for display. If the APN-194 radar altimeter fails or the aircraft is more than 5000 feet above ground level, the ALT light on the Doppler control-indicator will illuminate.

The computer-frequency tracker produces three earth-referenced aircraft navigation components: distance traveled along heading (S_H), distance traveled across heading (S_D), and aircraft altitude data (H_R). Receipt of a clock interrogation signal from the Data Processing System causes the computer-frequency tracker to transmit this information to the Data Processing System. The computer-frequency tracker provides the Doppler control-indicator with digital aircraft drift angle signals, and supplies analog synchro drift angle signals for the pilot's, copilot's and NAV/COMM's horizontal situation indicators. It also supplies the following Doppler Navigation System status signals to the aircraft's Data Processing System: Doppler velocity valid or invalid, radar altimeter altitude valid or invalid, self-test underway, and Doppler system "Power ON." The Computer-Frequency Tracker also supplies the Doppler system status signals (malfunction or memory) to the Doppler control-indicator.

C-10873/APN-227 DOPPLER CONTROL-INDICATOR

The Doppler control-indicator is a modular unit that consists of six printed circuit cards, a chassis, and an integrally illuminated panel. It is located at the NAV/COMM station at the upper right

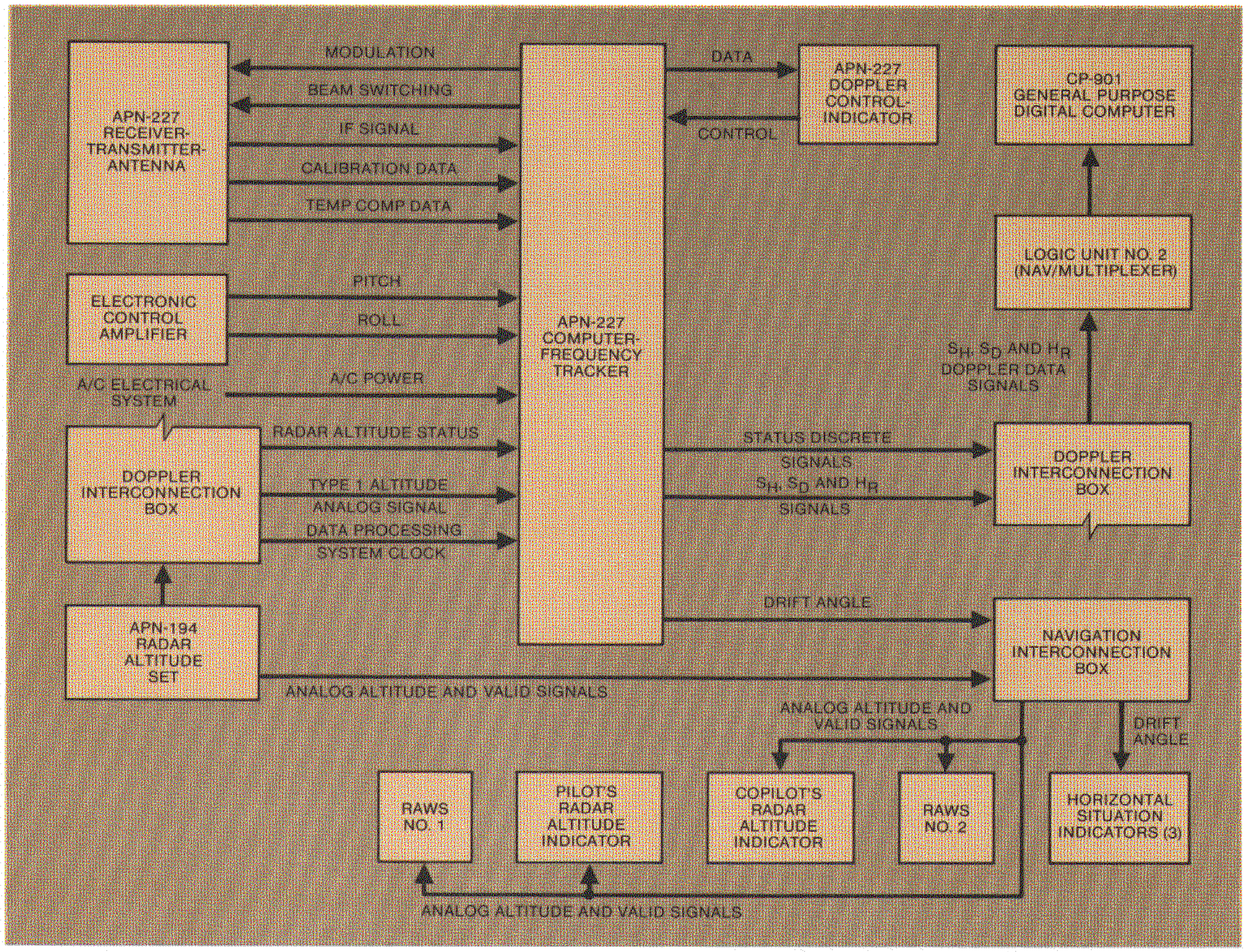


Figure 7. AN/APN-227 Doppler Radar Navigation Set Block Diagram

corner of the overhead instrument panel. The computer-frequency tracker supplies power to drive the Doppler control-indicator circuitry. The unit is cooled by natural convection.

The Doppler control-indicator enables the NAV/COMM operator to monitor and control the operations of the APN-227 Doppler Radar Navigation Set. This unit has three fiberoptic digital readouts that display aircraft groundspeed, drift angle, and altitude (see Figure 5). The MODE switch enables the operator to turn the Doppler set on and select either the normal operating mode (ON), self-test (PUSH-TEST), or simulate (SIM) mode. The S_H–S_D switch is used to select programmed heading and drift values when the Doppler system simulate mode is operative. Also located on the control panel are three annunciator lights that indicate the operational status of the Doppler system and the reliability of the radar altitude indication.

When selected ON, the Doppler system automatically operates in either the normal or memory mode. If a usable Doppler return signal is present, the system will operate in the normal mode and continuously display an accurate digital readout of aircraft groundspeed and drift angle. The Doppler drift angle (DPLR DA) light on the pilot's and copilot's navigation availability advisory lights displays will also be illuminated. The Doppler control-indicator will also display a digital readout of aircraft altitude from a signal provided by the APN-194 radar altimeter.

If a usable Doppler return signal is not present, the Doppler system will automatically switch to the memory mode of operation. The Data Processing

System will sense that the Doppler system inputs are no longer valid and switch to the backup navigation system (either the Inertial Navigation System or the Air Data System), as preselected by the operator.

When the Doppler system switches to the memory mode of operation, several events occur at the NAV/COMM station and in the flight station. At the NAV/COMM station, the MEM light will illuminate on the Doppler control-indicator, and the digital indicators will display the last valid groundspeed and drift angle information processed by the computer-frequency tracker unit. Failure of Doppler system validity also illuminates the DOP ALT DOWN switch on the NAV/COMM operator's universal keyset. In the flight station, the DPLR DA lights on both the pilot's and copilot's navigation availability advisory lights displays will be extinguished, and the computer drift angle (CMPTR DA) lights on those two displays will illuminate.

When the APN-227 Doppler system receives a valid Doppler return signal, it will automatically switch from the memory mode of operation back to the normal mode and resume processing "along heading" and "across heading" information. This will extinguish the MEM light on the Doppler control-indicator and illuminate the DPLR DA lights on both the pilot's and copilot's navigation availability advisory lights displays.

The CP-901 General Purpose Digital Computer and Data Processing System will not process inputs from the APN-194 radar altimeter when the Doppler system is operating in the memory mode. When "normal" Doppler tracking resumes, the DOP ALT DOWN switch on the NAV/COMM operator's universal keyset must be depressed to restore altitude inputs from the APN-194 radar altimeter to the Data Processing System.

Altitude measurements greater than 5000 feet above the terrain exceed the capability of the APN-194 radar altimeter. Since the Data Processing System is programmed to continuously obtain altitude information, it will automatically switch to barometric altitude inputs when the aircraft's barometric altitude exceeds 5000 feet. When the aircraft descends below 5000 feet barometric altitude, the Data Processing System will resume using radar altitude inputs.

If the APN-194 radar altimeter fails, the ALT light on the Doppler control-indicator and the DOP ALT DOWN switch on the NAV/COMM operator's universal keyset will illuminate. Failure of this system will also cause the pilot's and copilot's radar altitude indicator pointers to register "behind mask" on the instruments.

The TEST mode enables the NAV/COMM operator to initiate an end-to-end self-test procedure to verify the serviceability of the APN-227 Doppler system. This test can be performed either in flight or on the ground. When TEST is selected, all indicator lights on the Doppler control-indicator will be illuminated for approximately 8 seconds; the MEM light will remain illuminated throughout the self-test (approximately 12 seconds), and then will be extinguished. If the APN-227 Doppler system is functioning properly, the following values will be displayed on the Doppler control-indicator: drift angle, 13 (±3) degrees R; ground speed, 69 (±3) knots; and altitude, 200 (±10) feet. During TEST, the DPLR DA lights on the pilot's and copilot's navigation availability advisory lights panels will be illuminated, and the bearing pointer of *any* horizontal situation indicator that is selected to "DA" will swing 13 degrees right.

The simulate (SIM) mode provides the Data Processing System with programmed ground speed and drift angle signals. During SIM mode operation, three sets of programmed values can be selected with the S_H–S_D switch. These values are presented on the NAV/COMM and TACCO Auxiliary Readout Displays during the NAV/NAV portion of the System Test Program. The S_H–S_D selector is functional only during the SIM mode.

MAINTENANCE AGREEMENT

There is a five-year maintenance agreement between the U.S. Navy and the Canadian Marconi Co. for the repair of APN-227 Doppler Radar Navigation Set units. All failed APN-227 Doppler units are to be returned to the Canadian Marconi Co. repair facility, where they will be repaired. The turnaround time shall not exceed five working days at the repair facility. The Canadian Marconi Co. shall be responsible for repairing any and all failures, except for Weapons Replaceable Assemblies (WRAs) that have been damaged by improper handling or by alteration, repair or overhaul by unauthorized personnel.

VHF NAVAIDS/COMMUNICATIONS MODERNIZATION

The VHF Navaids/Communications Systems modernization changes bring the P-3C VHF Omnidirectional Range, Instrument Landing and VHF Communications Systems up to contemporary standards by replacing older equipment with modern equipment that has new standards of performance and improved reliability. A block diagram of the modernized VHF Navaids/Communications Systems is shown in Figure 8.

Several factors prompted modernization of these systems:

- Some equipment is no longer in production and cannot be procured for new aircraft.
- The old equipment does not meet the frequency spacing standards for vhf communications established in 1977 by the Federal Aviation Administration (FAA).
- The old equipment does not meet the split ILS channel requirement established by the FAA in 1973.
- The old equipment uses obsolete parts that are no longer in production.
- The reliability of the old equipment is extremely poor.

This change removes the existing components and hardware associated with the AN/ARN-87(V) VHF Navigation System, AN/ARC-101 VHF Communication System, AN/ARN-32 Marker Beacon Receiver, and the Instrument Landing System glideslope receiver. These components have been replaced with two VIR-31A navigation receivers, a 618M-3A vhf AM transceiver, their control units, and associated hardware. The VIR-31A navigation receiver is currently in service on various Navy aircraft, it is employed by the Canadian Forces on the CP-140 Aurora, and it is also in use on commercial aircraft. The 618M-3A AM transceiver is currently being used by commercial airlines, and has proven performance established during millions of flight hours.

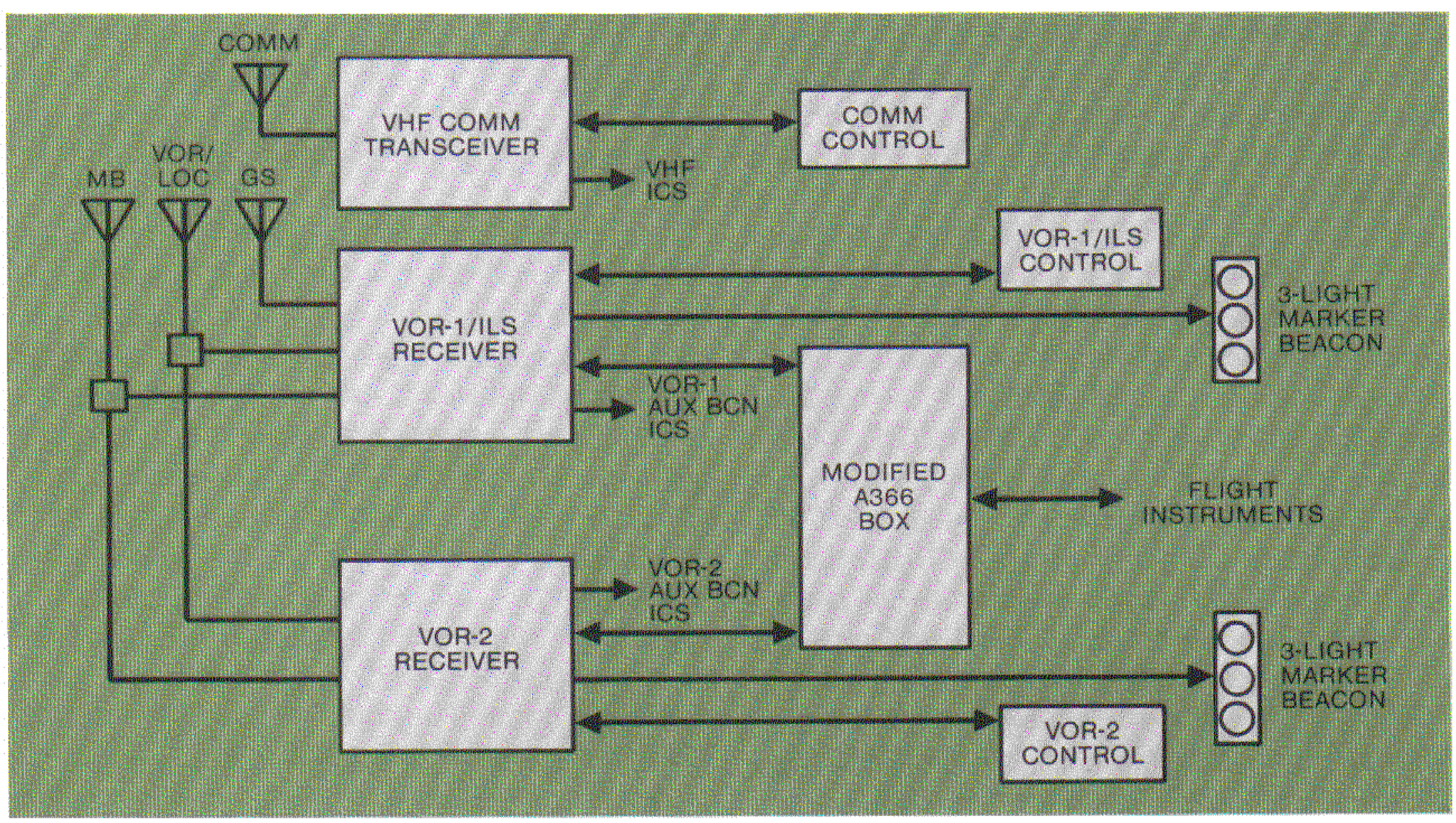


Figure 8. Modernized Navaids/Communications Systems Block Diagram

DESIGN CONSIDERATIONS

The VHF Navaids/Communications Systems modernization is the first modernization of the P-3C that is exclusively for the benefit of the pilots. The costs were minimized by avoiding changes to other aircraft systems that interface with the VHF Navaids/Communications Systems. There are no changes whatever in the following equipment:

- Central Repeater System
- Flight Director System
- Horizontal Situation Indicator
- Antennas

Changes to these systems were avoided by modifying the A366 forward navigation interconnection box and by. installing a marker beacon antenna coupler (sometimes called a power divider or splitter). Minor changes have also been made to the P-3C Intercommunication System (ICS) to implement the VHF Navaids/Communications Systems modernization.

VHF NAVIGATION SYSTEM

The P-3C VHF Navigation System receives radio navigation signals, processes the information, and then provides the flight crew with visual and aural information about the position of the aircraft relative to a selected ground navigation station. The VHF Navigation System includes the aircraft's VHF Omnidirectional Range (VOR) Systems and the Instrument Landing System (ILS). The dual VHF Omnidirectional Range Navigation System is a radio navigation aid for the flight crew to determine the bearing, "to/from" relationship, and left-right position of the aircraft with respect to a selected surface VOR radio station. The VHF Navigation System's VOR-1 and VOR-2 receivers can be operated simultaneously to receive VOR signals, and when tuned to separate VOR stations they can provide the flight crew with a radio position fix. The instrument landing system receiving equipment consists of localizer, glideslope and marker beacon receivers. This equipment enables the pilot to make precision landing approaches during low visibility conditions to airfields that have ground ILS equipment. The marker beacon system provides the pilot and copilot with a visual and aural indication when the aircraft passes over a surface facility that is transmitting on the marker beacon frequency.

The VHF Navigation System consists of two VIR-31A VHF receivers, a dual receiver mount, two 313N-4B VHF navigation system controls, two marker beacon indicator light assemblies, a marker beacon antenna attenuator, a marker beacon antenna power splitter, a marker beacon antenna, a VOR antenna, a VOR antenna coupler, and an ILS glideslope antenna. The VHF Navigation System is a dual system for all of its functions except for the ILS glideslope system. Although an ILS glideslope receiver is installed in both VIR-31A receivers, only the VOR-1 system ILS glideslope receiver is used.

VIR-31A NAVIGATION RECEIVER Each VIR-31A navigation receiver contains a VOR/ILS localizer receiver, an ILS glideslope receiver, a marker beacon receiver, a signal converter and instrumentation drive circuitry. The VOR/ILS localizer receiver operates in the 108.00 to 117.95 MHz range, with 50-kHz channel spacing. The ILS localizer uses 40 channels in the 108.10 to 111.95 MHz range. When one of the ILS localizer channels is selected, the paired ILS glideslope channel is also automatically selected. The ILS glideslope receiver operates in the 329.15 to 335.00 MHz range, with 150-kHz channel spacing. The reader will note that the ILS is not strictly a vhf system, but rather operates in both the uhf and vhf ranges. The marker beacon receiver operates at a frequency of 75 MHz.

The VOR/ILS localizer receiver supplies instrument driver outputs for selection by the pilot, copilot and the NAV/COMM operator. The VOR radio magnetic indicator (RMI) outputs can be selected to display the magnetic bearing from the aircraft to a selected VOR station on the horizontal situation indicators. The VOR/ILS localizer also provides instrumentation driver outputs to indicate course deviation, and to operate the NAV flag and To/From arrows on the pilot's and copilot's horizontal situation indicators and/or flight director indicators.

The ILS glideslope receiver provides instrumentation drive outputs to indicate glideslope deviation and to operate the glideslope deviation flag on the pilot's and copilot's flight director indicators when an ILS channel is selected on the VOR-1 receiver. The VOR/ILS localizer audio output from the VOR-2 receiver is independently selectable on the ICS master control panel with a new VOR-2 switch. This change was necessary because the new VHF Navigation System has separate vhf and VOR-2 receivers, which require separate audio output selection. In the older system, the vhf and VOR-2 functions shared the same receiver and had a common audio output.

The marker beacon lamp driver outputs are sent to the pilot's and copilot's marker beacon indicator lights from the VOR-1 and VOR-2 receivers, respectively, to show when the aircraft passes over an outer, middle, or airways (or inner) marker beacon. The marker beacon audio outputs from the VOR-1 and VOR-2 receivers are combined in the aircraft intercommunication system for aural monitoring.

When TEST is selected on the 313N-4B vhf NAV/COMM control unit, the VIR-31A navigation receiver applies test signals to the radio navigation system instrumentation drive circuits. The test signals will produce outputs in the following circuits: VOR bearing, course deviation, course deviation flag, to/from arrows, glideslope deviation, marker beacon lamp driver, and marker beacon audio. The specific test outputs will vary, depending upon whether a VOR or ILS channel is selected, and whether or not a valid signal is being received when TEST is selected. The two VIR-31A navigation receivers are installed in electronics rack B1/B2.

313N-4B CONTROL UNIT Two 313N-4B control units are installed in the flight station center pedestal, one for each VIR-31A navigation receiver. They provide the controls for vhf frequency select, vhf frequency display and for OFF/PWR/TEST. The TEST position places the related VIR-31A receiver in the TEST mode. A receiver audio gain (volume) control is also present on each unit, but neither is connected. Instead, the aircraft's A366 forward navigation interconnection box has been modified so that audio gain for these receivers is controlled from the ICS master control panel. The panels for the pilot's and copilot's 313N-4B vhf navigation receiver control units are shown in Figure 9.

MARKER BEACON INDICATOR LIGHT ASSEMBLY The new marker beacon indicator light assembly consists of three indicator lamps – blue, amber and white. This differs from the older indicator light assembly, which had only one lamp. Two such indicator light assemblies are installed in the flight station, one on the pilot's instrument panel

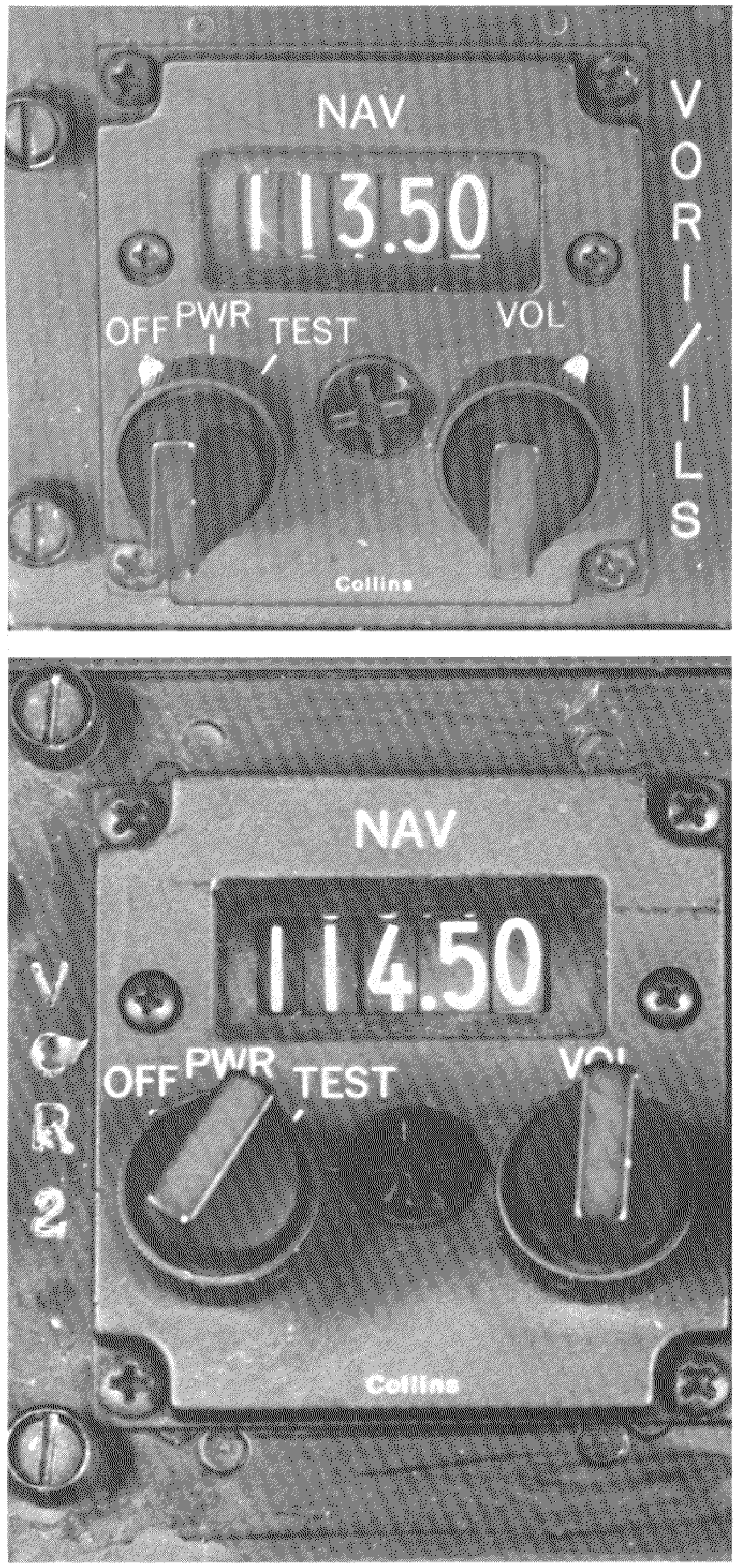


Figure 9. 313N-4B Control Unit Panels for the VOR-1 (Pilot's) and VOR-2 (Copilot's) VHF Navigation Receivers

for the marker beacon receiver in the pilot's VIR-31A (VOR-1) navigation receiver, and another on the copilot's instrument panel for the marker beacon receiver in the copilot's VIR-31A (VOR-2) navigation receiver. The appropriate indicator lamp illuminates when the marker beacon receiver detects that the aircraft is passing over a marker beacon radio transmitter. The blue lamp indicates an outer marker beacon, the amber lamp indicates a middle beacon, and the white lamp indicates an airways or inner beacon. All three lights on the indicator light assembly are illuminated when its VIR-31A navigation receiver is tested. The pilot's marker beacon indicator light assembly is shown in Figure 10.

MARKER BEACON ANTENNA COUPLER Engineering analysis showed that the aircraft's existing marker beacon antenna was suitable for the new marker beacon equipment. The only problem was that there were two marker beacon receivers rather than one. The marker beacon antenna coupler divides the signal output from the marker beacon antenna and routes the resulting signal outputs to the two marker beacon receivers. The marker beacon antenna coupler is located in electronics rack B1/B2. An 8 dB signal attenuation pad has been installed in the marker beacon antenna line. This signal attenuation pad provides the proper incoming signal level for the marker beacon receiver, which has been wired to operate at high sensitivity.

MODIFIED A366 FORWARD NAVIGATION INTERCONNECTION BOX The A366 forward navigation interconnection box has been modified, effective with P-3C aircraft SERNO 161132 (LC S/N 5724), to implement the VHF Navaids/Communications Systems modernization. This modification enables signal switching within the modernized VHF Navigation System. The modified A366 forward navigation interconnection box will be reidentified with official "AN" nomenclature.

The A366 box has been modified by adding two positive relay card assemblies (A309 and A412) and the associated chassis wiring to the unit. The A412 relay card performs signal routing functions for the pilot's horizontal situation indicator and for the VOR-1 navigation receiver. The A309 relay card performs signal routing functions for the copilot's horizontal situation indicator and for the VOR-2 navigation receiver. Three

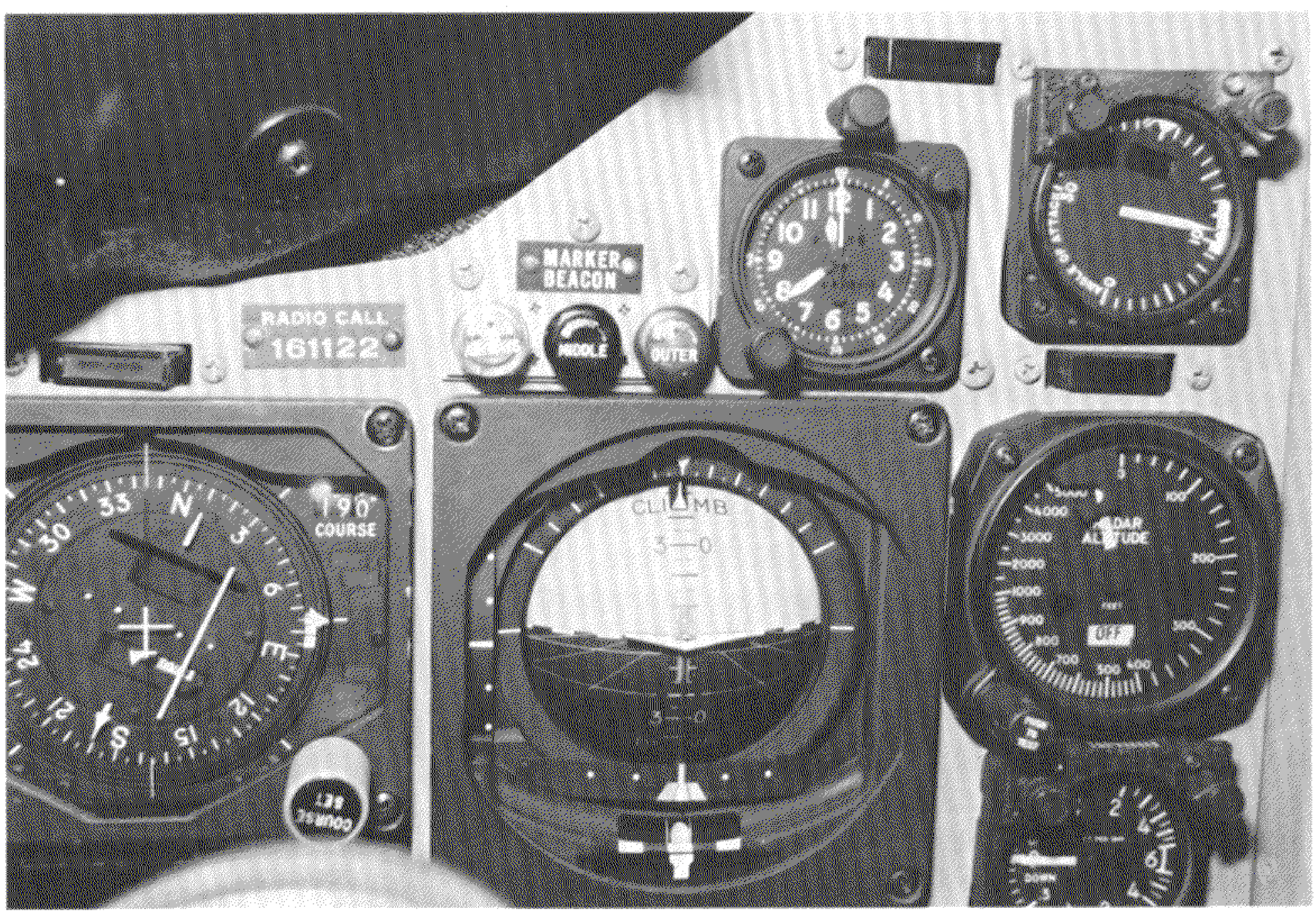


Figure 10. Marker Beacon Indicator Light Assembly on Pilot's Instrument Panel

of the five relays on each new card are used, leaving two spare relays for future applications.

Three signal switching functions have been implemented in the A366 box modification:

- Course Resolver Signal Switching
- "To/From" Signal Load Adaptation
- "On ILS" Discrete Signal Inversion

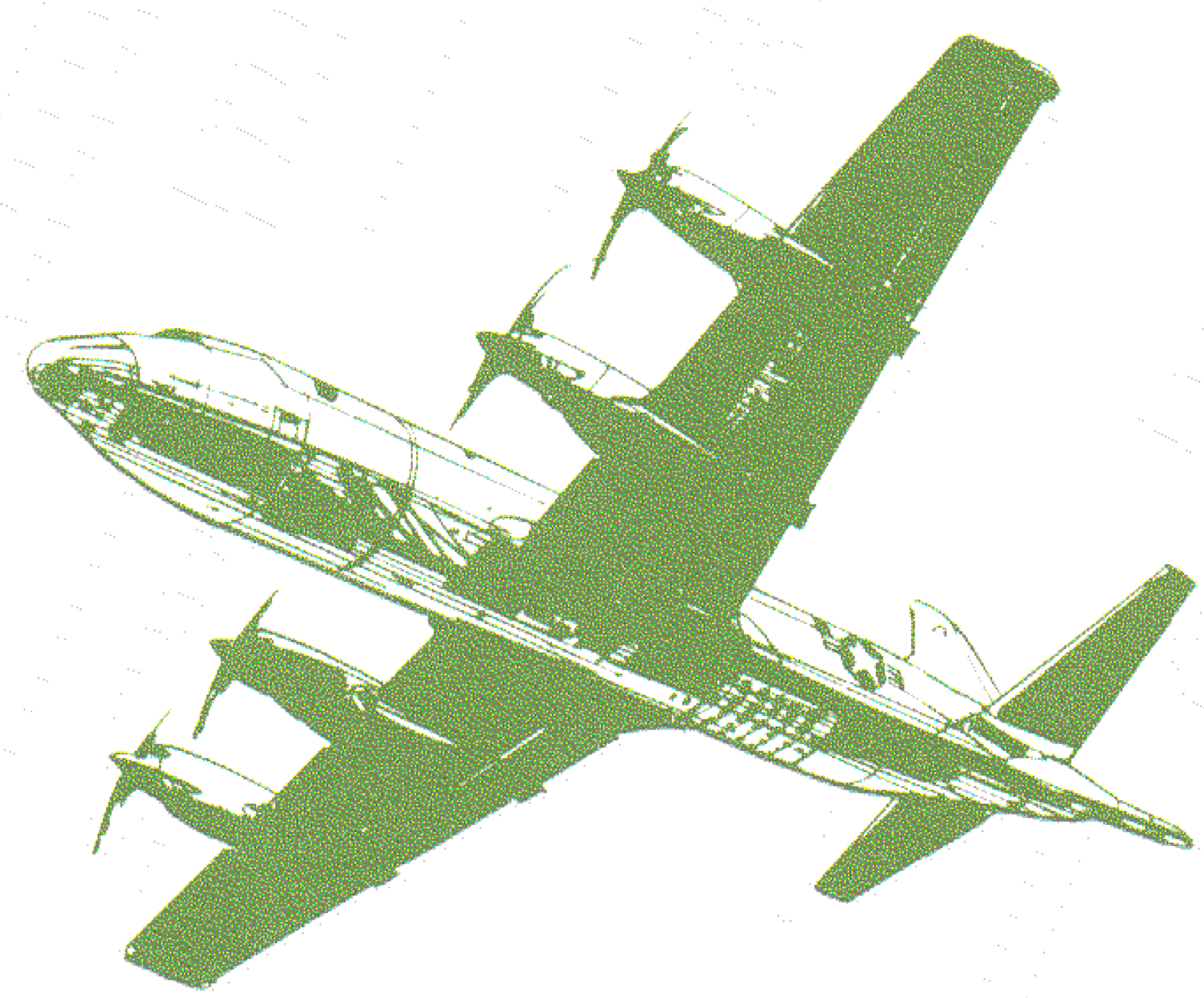
The course resolver signal switching change was required because (1) the new VOR Navigation System employs two horizontal situation indicator course resolver signal outputs, while the old VOR System uses only one output; and (2) the new VOR Navigation System requires ARINC standard connections to the horizontal situation indicator course resolver, which was not the case with the previous VOR or tacan equipment. One relay on each new card, in addition to the existing switching circuitry within the modified A366 box, is used to properly distribute the signals from the horizontal situation indicator course resolver to the VOR or tacan radio navigation equipment.

The To/From signal load adaptation bypasses an 820-ohm resistor in the To/From circuit to the horizontal situation indicator when the signal is provided by the VOR radio navigation set. The To/From signal from the new VOR set has been matched to drive the 200-ohm load that drives the To/From arrows in the horizontal situation indicator. The 820-ohm resistor was installed in this circuit to match the circuit load of the older VOR set and the tacan set, which were designed to drive a 1000-ohm load. Since the new ARN-118 tacan set recently installed in P-3C aircraft still requires a 1000-ohm load in the To/From circuit to drive the To/From arrows in the horizontal situation indicator, the 820-ohm resistor has been retained. One relay on either the A309 or the A412 relay card bypasses the 820-ohm resistor in this circuit when the To/From signal is supplied by the VOR set, and switches in the 820-ohm resistor when the To/From signal is supplied by the tacan set.

The circuits in the A366 box have been modified to manipulate the On ILS discrete signal that is provided by the new VOR radio navigation set. This modification was necessary because of differences in the old and new ILS radio equipment. The old ILS receiver sent a 28-Vdc On ILS discrete signal to the A366 box whenever an ILS frequency was selected. The new ILS receiver provides a ground in the On ILS circuit whenever an ILS frequency is selected. One relay on the A412 card is used to adapt this circuit for the VOR-1 set so that when ILS is selected, a 28-Vdc On ILS discrete signal is sent to those circuits that require it. One relay on the A309 card performs a similar function for the VOR-2 set.

VHF COMMUNICATION SYSTEM

The VHF Communication System enables the flight crew to conduct two-way voice communications with commercial airfields and airways facilities over the 116.000 to 151.975 MHz frequency range. The system consists of a 618M-3A transceiver, its mount, a 313N-5 VHF control unit, a tail cap antenna, and the associated aircraft wiring. The VHF Communication System interfaces with the aircraft Intercommunication System to provide vhf transmit and receive functions to the ICS master control boxes at the pilot, copilot, TACCO, and NAV/COMM stations. This also provides the vhf receive function to the ICS crew control boxes at all other crew stations in the aircraft.



618M-3A TRANSCEIVER The 618M-3A transceiver is located in electronics rack J1/J2. It provides vhf AM communication with 25-kHz channel spacing and bandpass over the frequency range of 116.000 to 151.975 MHz. The transceiver is a solid state design that has a main frame chassis with front panel heatsink, a power supply, a frequency synthesizer, a receiver, a modulator and a transmitter. The transceiver contains only one plug-in Shop Replaceable Assembly (SRA). All other SRAs are hard-wired.

The transmitter output is 25 watts nominal (20 watts minimum). It uses several stages of broadband IF amplification, which eliminates the need for mechanical tuning. The receiver is a single-conversion type with a 20-MHz IF. The receiver uses a combined carrier-to-noise ratio and carrier override squelch circuit to suppress background noise. The front panel of the transceiver has a headphone jack, microphone jack, squelch disable switch, and a transmitter power output indicator lamp that illuminates when the output power exceeds 10 watts.

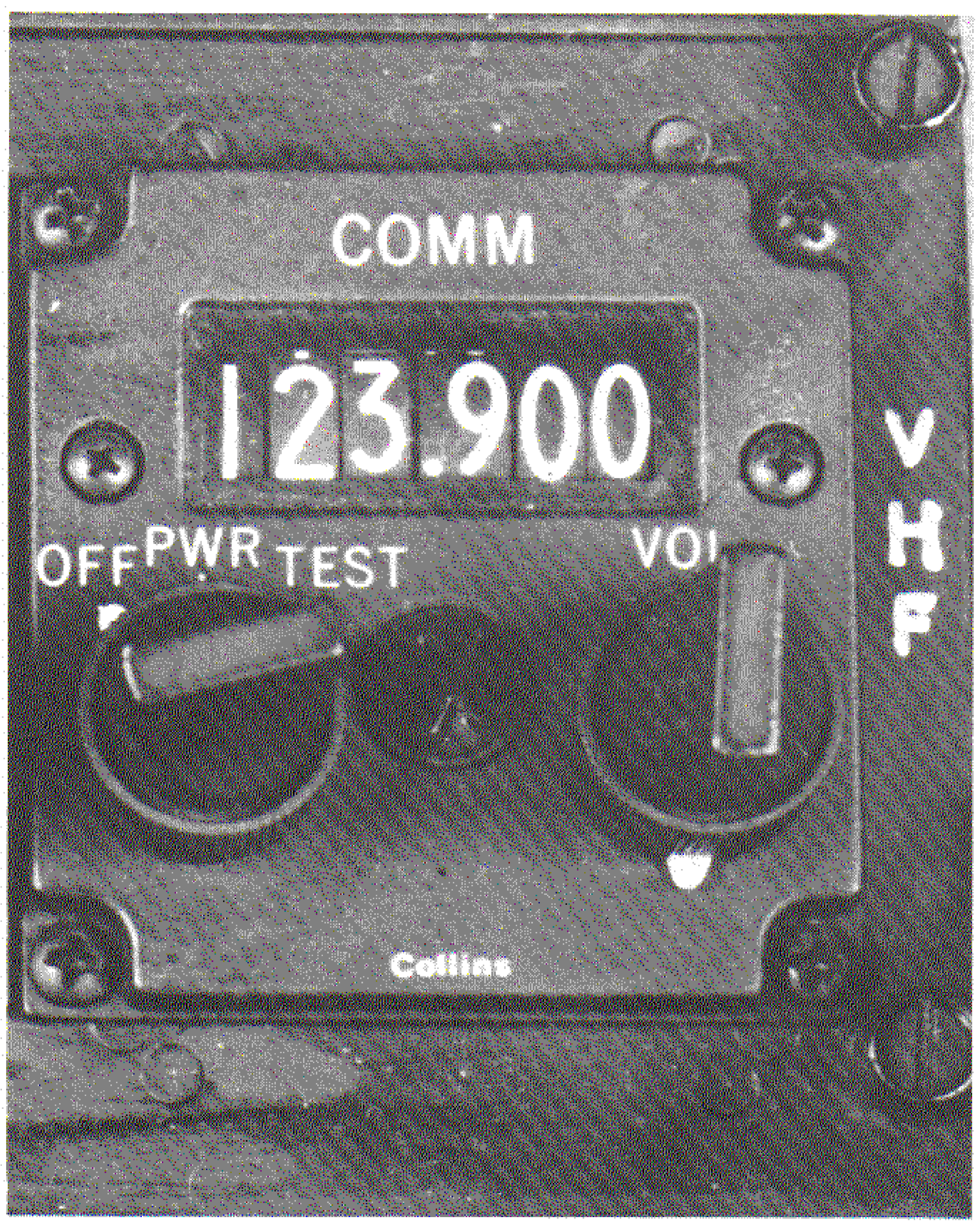


Figure 11. 313N-5 VHF Communication Receiver Control Unit Panel on Copilot's Side of Flight Station Control Pedestal

313N-5 CONTROL UNIT The 313N-5 control unit is located in the flight station center pedestal. It provides the flight crew with the following controls for the 618M-3A transceiver: OFF/PWR/TEST and frequency select. The selected radio frequency is displayed by the control unit. Selection of TEST checks the operation of the transceiver squelch circuits by disabling them. A receiver audio gain (volume) control is also present, but it is not connected. Instead, audio gain for the 618M-3A transceiver is controlled from the ICS master control panel. The 313N-5 control unit does not have any Shop Replaceable Assemblies (SRAs). The 313N-5 control unit panel is shown in Figure 11.

INTERCOMMUNICATION SYSTEM

The changes that have been made to the VHF Navaids/Communications Systems have mandated changes to the P-3C Intercommunication System. Contributing factors are (1) the audio signals for vhf communications and VOR-2 radio navigation formerly came from a common receiver, but they are now independent of one another; and (2) the marker beacon radio navigation audio signals formerly came from one receiver, but now the marker beacon audio signals can come from either or both of the new marker beacon receivers.

Since there were no spare radio receiver select switches on the existing Intercommunication System master control panels to accommodate audio outputs from two marker beacon receivers, the marker beacon audio signals have been summed with the AUX channel audio signals. The AUX audio channel was selected for this purpose because it is normally used for monitoring sonobuoy audio signals, a function that would not likely be performed during landing approach when marker beacon audio is monitored. Conversely, it would be equally unlikely to require the marker beacon function while monitoring sonobuoy audio. However, the operator must bear in mind that whatever function is selected for presentation on the AUX channel, that function will be summed

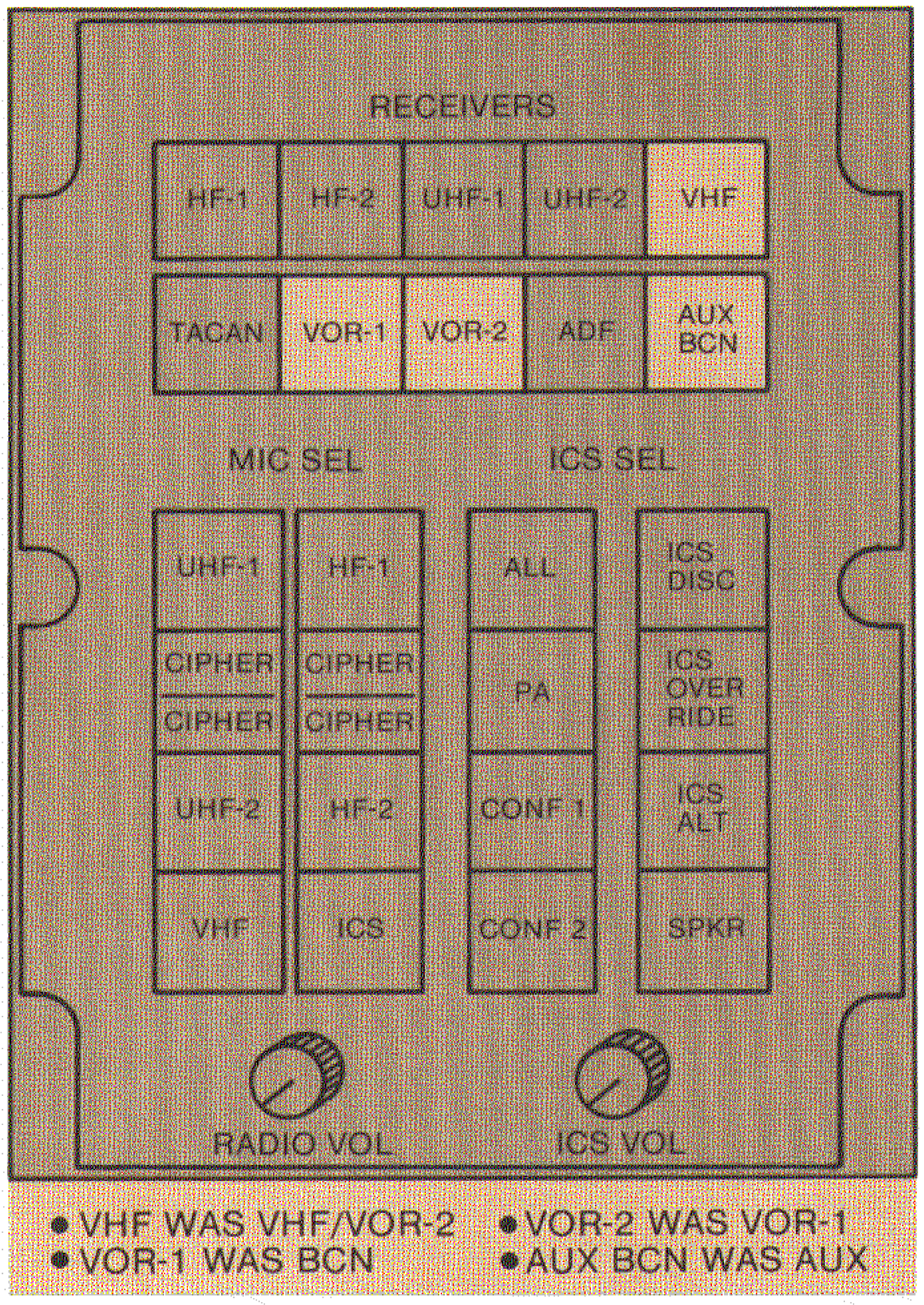


Figure 12. Intercommunication System Master Control Panel

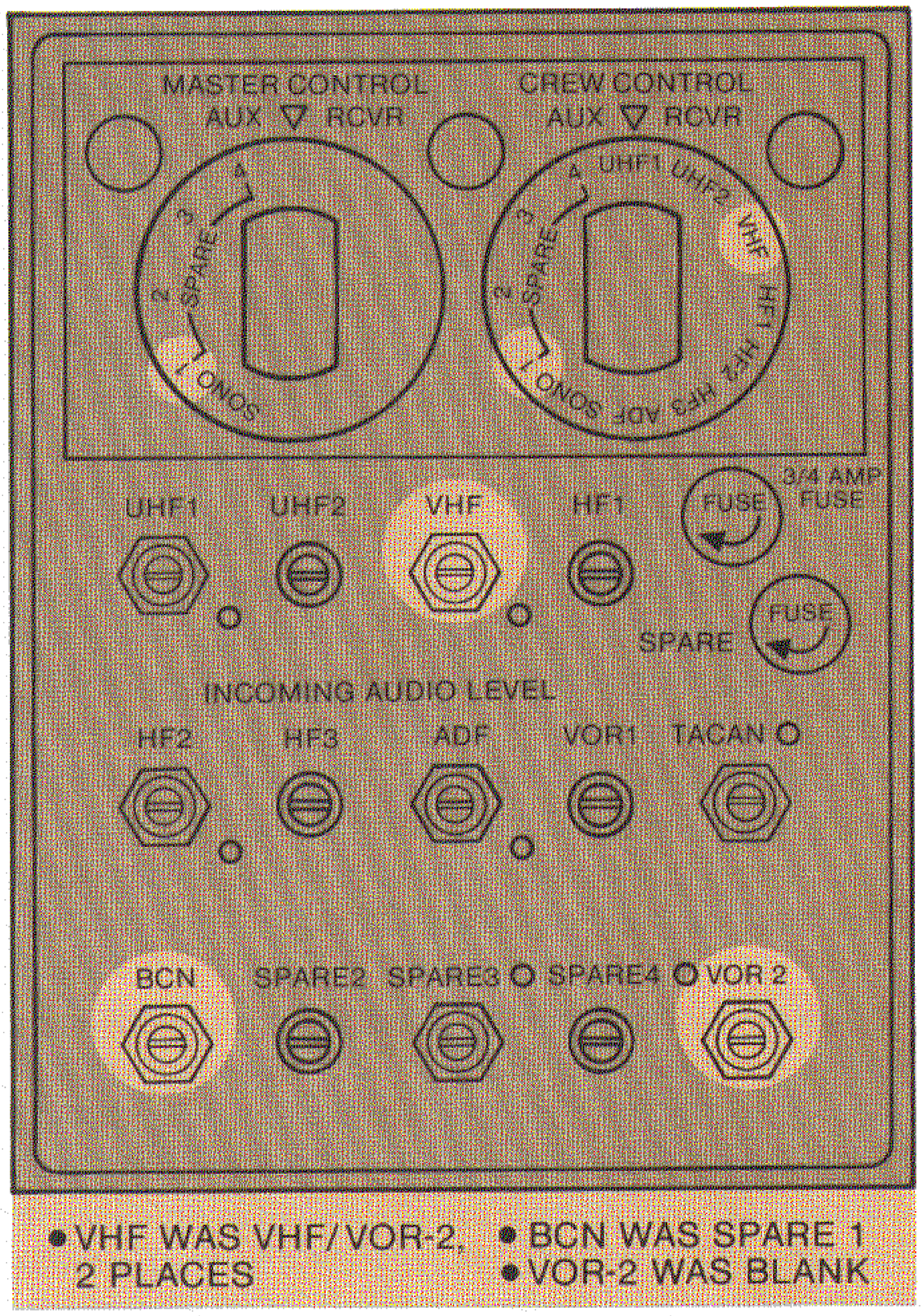


Figure 13. Intercommunication System Interconnection Box

with the marker beacon audio. Figure 12 shows which switches have been changed on the Intercommunication System master control panels to provide separate selection for the VHF and VOR-2 systems and combined AUX/BCN audio.

In addition to summing the marker beacon (BCN) audio with the AUX audio signals, the BCN audio circuit has been connected to a potentiometer on the intercommunication interconnection box to make the BCN audio adjustable. This potentiometer has been reidentified from SPARE 1 to BCN (see Figure 13). This change also connects the BCN audio circuit to the SPARE 1 positions on the master control and crew control selector switches, but these switch positions have not been reidentified. With this modification, the BCN audio is summed with *any* AUX signal that is selected at the intercommunication interconnection box. When SPARE 1 is selected, only BCN audio is available because the signal is merely summed with itself.

MAINTENANCE AGREEMENT

There is a five-year maintenance agreement between the U.S. Navy and the Collins Telecommunications Products Division of Rockwell International Corp. for repair of the VHF Communications (618M-3A) System and the VHF Navigation (dual VIR-31A) System components. All failed units of these two systems are to be returned to the Collins repair facility, where they will be repaired. The turnaround time shall not exceed ten working days after receipt of the defective unit by the repair facility. Collins shall be responsible for repairing any and all failures to the 618M-3A VHF Communications Set, the dual VIR-31A VHF Navigation Sets and their related components, except for Weapons Replaceable Assemblies (WRAs) that have been damaged during shipment, by improper handling, or by alteration, repair or overhaul by unauthorized personnel.

INTERCOMMUNICATION SYSTEM LOUDSPEAKER REPLACEMENT

The P-3C Intercommunication System (ICS) has been equipped with loudspeaker units of improved design, beginning with P-3 aircraft SERNO 161121 (LC S/N 5700) because the older loudspeakers are no longer in production. Ten units are installed in each aircraft. The new loudspeakers are lighter weight units that have been adapted from the design of a loudspeaker unit that is currently in use with commercial airlines. Their design features printed circuitry and the associated light-weight hardware. They are physically and functionally interchangeable with the older AM-3365/AIC-22(V) hardwired loudspeaker units installed on earlier P-3C aircraft. Any mix of new and old loudspeaker units may be used on a P-3C aircraft.

The new loudspeaker's volume controls are similar in function and location to those on the older type unit, but the control potentiometers are of a lighter-weight type ordinarily used with printed circuits. The controls are located under a cover labeled VOLUME ADJUSTMENTS, and consist of three potentiometers labeled MUTE, PA, and SPKR. Note that these controls are normally adjusted by maintenance personnel, and the adjustments should not be changed by the flight crew unless absolutely necessary. Figure 14 shows a typical loudspeaker installation with the volume adjustments cover both open and closed.

There is also an unused position near the volume controls of the new unit labeled FUSE, the presence of which may puzzle the inquisitive technician. In explanation, replaceable fuse protection for the new loudspeaker unit was deleted in the final design, since the likelihood of a short in the unit's power circuitry is considered very remote and use of a replaceable fuse would degrade the unit's reliability. Instead, circuit protection is provided by a one-amp diode (CR1) in the unit's 28-volt power line, mounted on the printed circuit board. In the unlikely event of a short circuit on the PC board, the diode will open. The loudspeaker unit must then be replaced with an operable unit and sent to an intermediate level maintenance facility for repair.

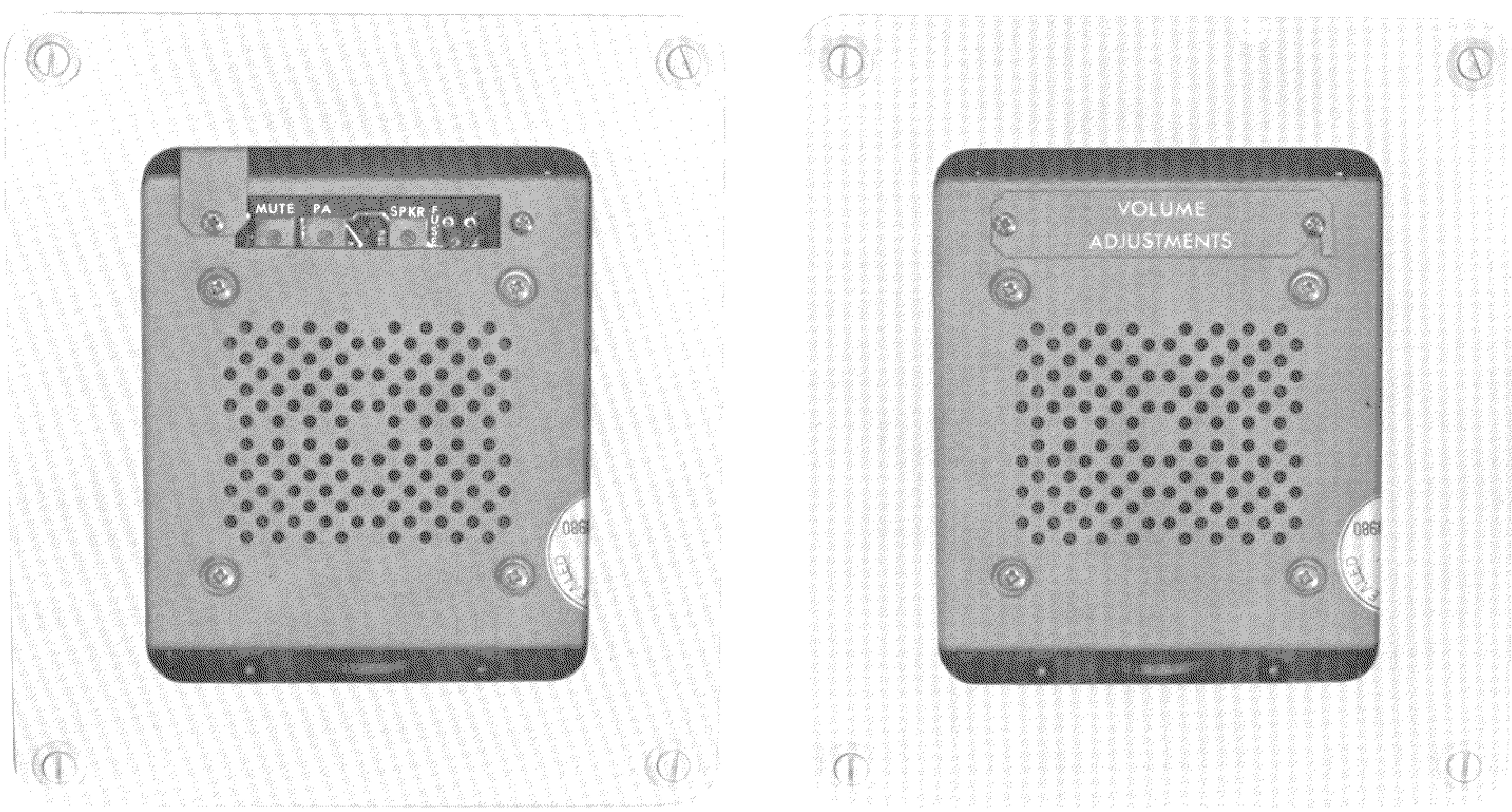


Figure 14. Typical Intercommunication System Loudspeaker Installation with the Volume Adjustments Cover Open and Closed

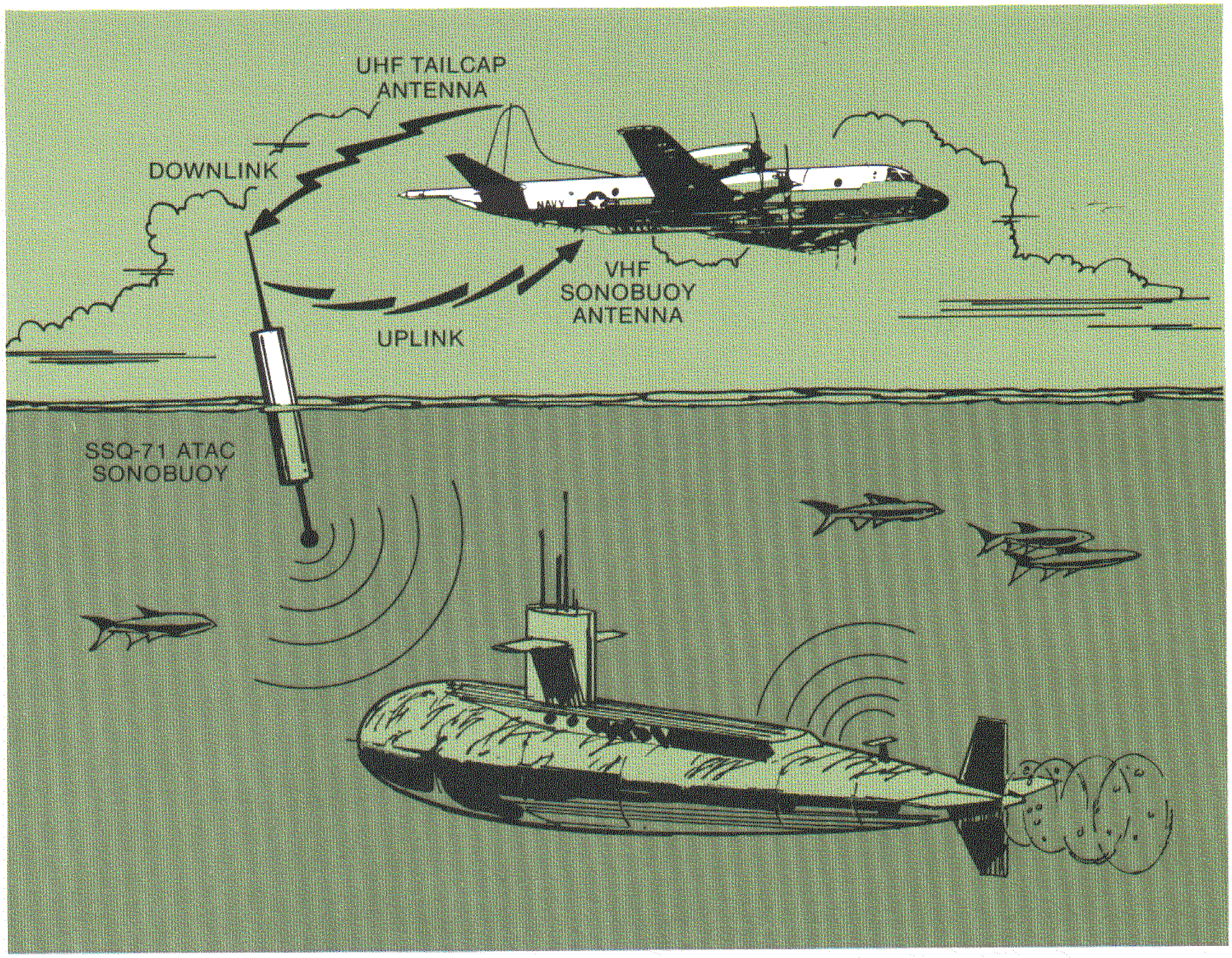


Figure 15. P-3C Integrated Acoustic Communication System

OV-78/A INTEGRATED ACOUSTIC COMMUNICATION SYSTEM

The OV-78/A Integrated Acoustic Communication System (IACS) permits two-way exchange of messages between airborne P-3C aircraft and submerged friendly submarines. This system uses a combination of radio and sonar to convey information between aircraft and submarine via a deployed special communications SSQ-71 sonobuoy that serves as a relay station. It is a *low data rate* type system based upon the earlier OV-72/A Integrated Acoustic Communication System design that has been operated on P-3C and SH-3H aircraft. Figure 15 illustrates the concept of the Integrated Acoustic Communication System.

The information conveyed by the Integrated Acoustic Communication System consists of brief tactical messages. These messages are composed and encoded by the sender, aboard either the aircraft or the submarine. The message is relayed by the sonobuoy to the receiving station, where it is displayed to the system operator. Aircraft-to-submarine communication is referred to as "downlink" operation; submarine-to-aircraft communication is called "uplink" operation.

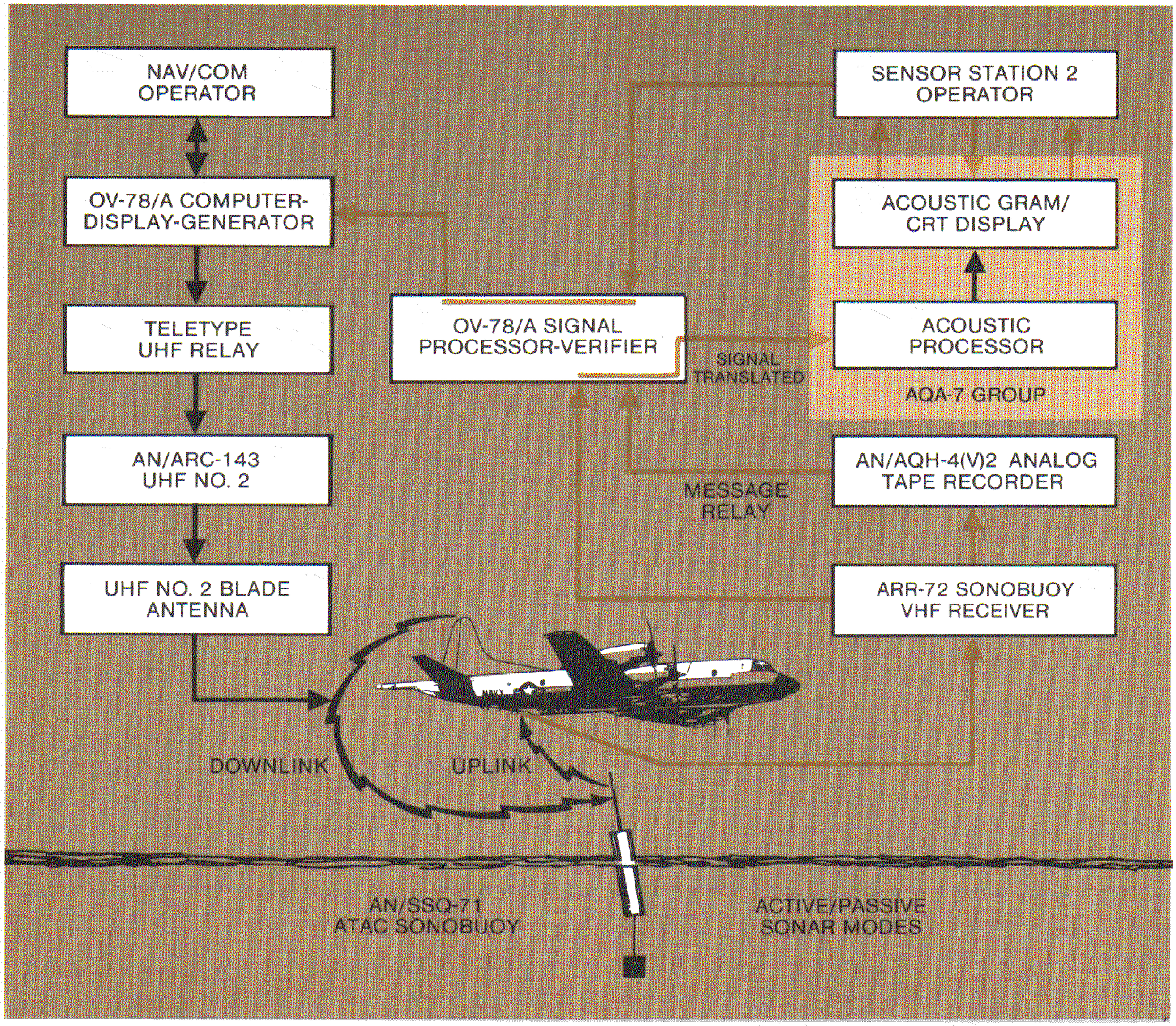


Figure 16. Integrated Acoustic Communication System

DESCRIPTION

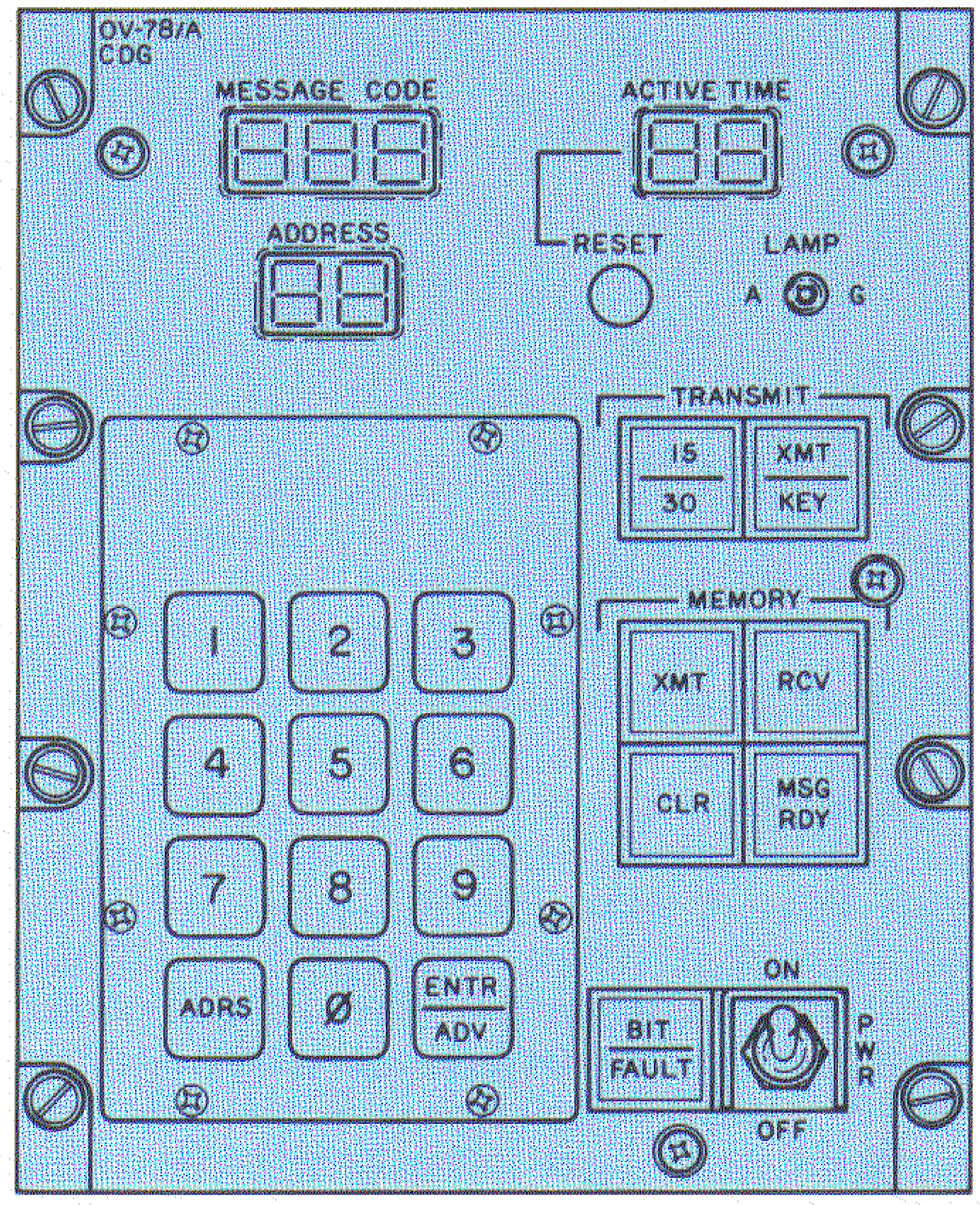
The Integrated Acoustic Communication System is composed of the C-10903/A Control-Display-Generator unit located at the NAV/COMM station and the OV-3678/A Signal Processor-Verifier unit located at Sensor Station No. 2. This system interfaces with the aircraft's existing acoustic and radio communication equipment, including the AQA-7(V) Signal Data Recorder, the bearing frequency indicator, and AQH-4(V)2 Recorder-Reproducer, the ARR-72 Sonobuoy Receiver System, the ARC-143 UHF-2 Radio Transmitter, and also with the aircraft's CP-901/ASQ-114 General Purpose Digital Computer to process received messages. A block diagram of the OV-78/A Integrated Acoustic Communication System is shown in Figure 16. This system makes maximum use of existing on-board avionics equipment, employing new equipment only where existing equipment could not be readily modified to perform unique Integrated Acoustic Communication System functions.

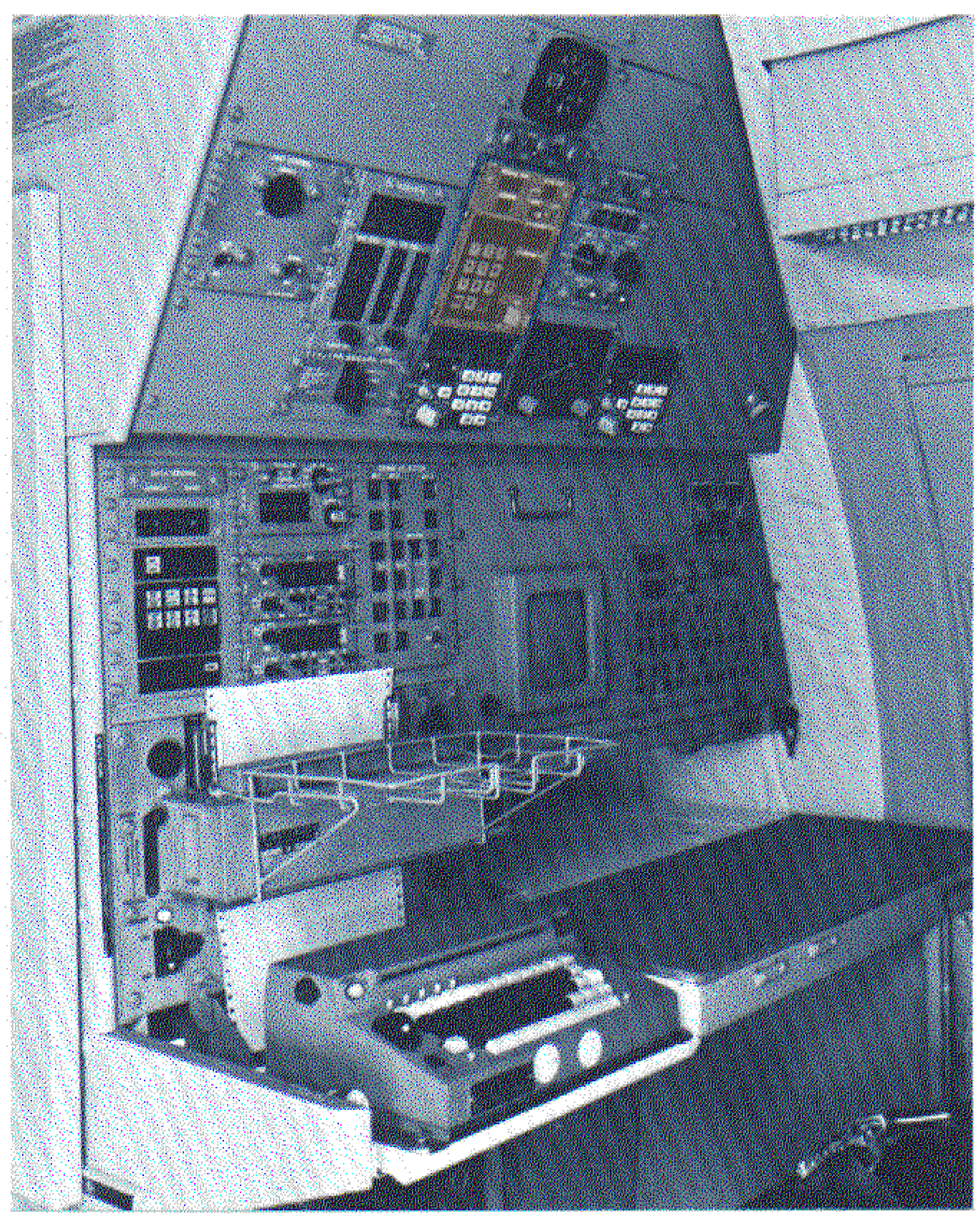
C-10903/A CONTROL-DISPLAY-GENERATOR The control-display-generator unit contains most of the Integrated Acoustic Communication System controls and performs most of the system functions. It enables the NAV/COMM operator to display received encoded messages from submerged submarines, and to compose, edit, and transmit encoded messages from the aircraft. The control-display-generator control panel is shown in Figure 17. The major functions of the control-display-generator are:

- Visually display the memory address of each message phrase, with its corresponding tones to enable review of stored information.
- Indicate ATAC (SSQ-71) sonobuoy sonar transmission time in minutes.
- Function as a tone generator, using digital frequency synthesis techniques to create tone combinations under the control of a microprocessor.
- Generate tones that amplitude modulate the RF carrier signal broadcast by the aircraft's UHF-2 radio.
- Generate a keying signal to the UHF-2 radio, and provide a keyline-active indication to the NAV/COMM operator.
- Display a "received message ready" cue from Sensor Station No. 2. This cue alerts the NAV/COMM operator that a message has been received and entered into the signal processor-verifier, and that the message is ready to be viewed by the NAV/COMM on the control-display-generator.
- Enable the NAV/COMM operator to interrupt message transmission.
- Clear the memories of the Integrated Acoustic Communication System transmit section, and of the message receive sections 1 and 2.
- Alert the NAV/COMM operator to an illegal message code entry or to a code sequence error.
- Display the "end-of-message" code to the NAV/COMM operator.

The control-display-generator power supply is integral with the control-display-generator unit.

Figure 17. C-10903/A Control-Display-Generator Unit Panel (NAV/COMM Station)





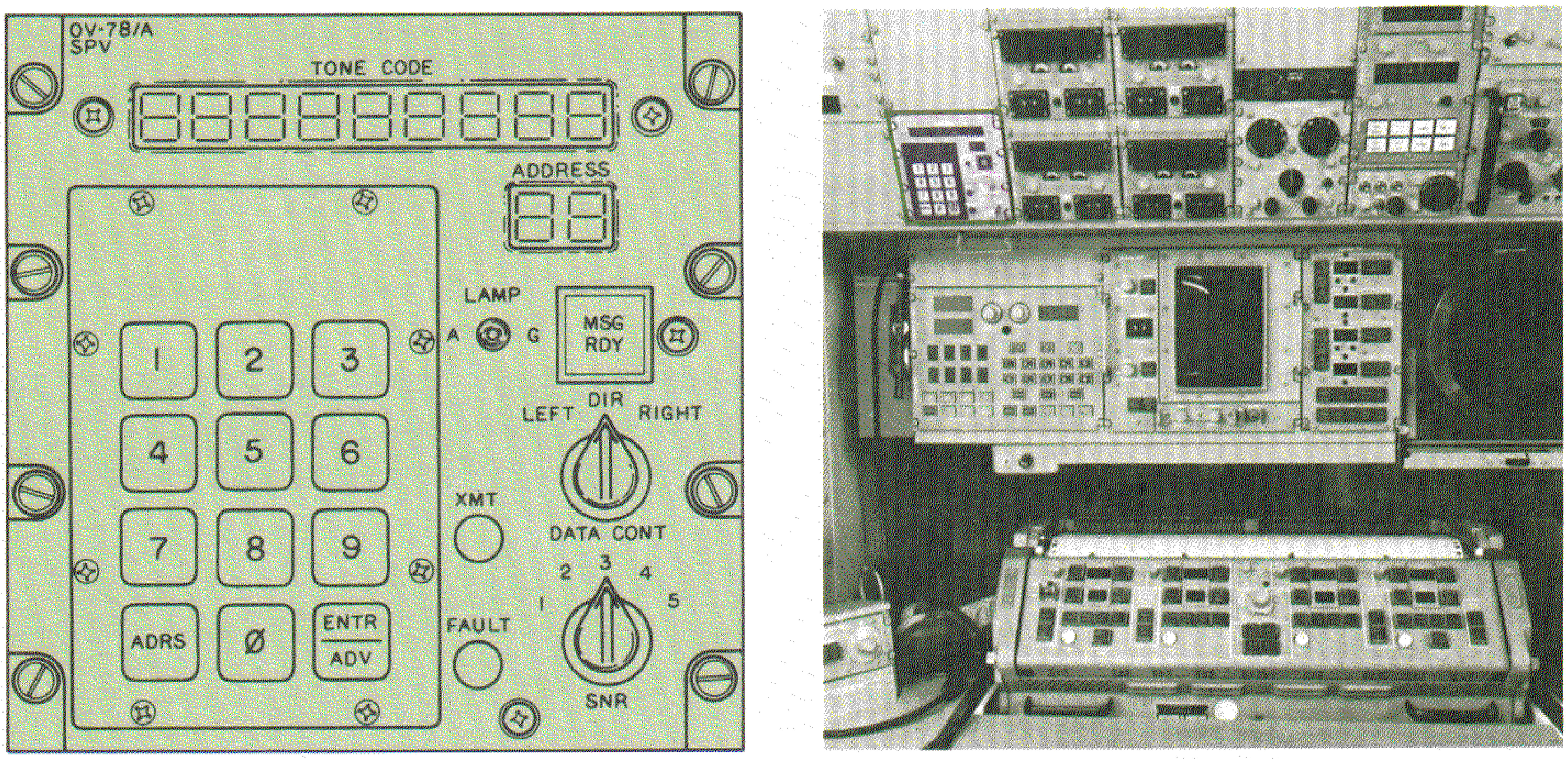


Figure 18. OV-3678/A Signal Processor-Verifier Unit Panel (Sensor Station No. 2)

It provides power for both the control-display-generator and the signal processor-verifier. The power supply has both overcurrent and short-circuit protection. It also has built-in-test protection to detect faults in the system's four regulated circuits. In addition, an overvoltage detector continuously monitors the system's logic and lamp circuits. If an overvoltage condition occurs, an orderly power shutdown is performed by a crowbar-type protection circuit that trips the CDG PWR ON/OFF circuit breaker-type switch off, which removes power from the control-display-generator.

SIGNAL PROCESSOR-VERIFIER The signal processor-verifier is an extension of the M6800 microprocessor that is contained in the control-display-generator unit. Its control panel is shown in Figure 18. The signal processor-verifier enables the Sensor Station No. 2 operator to receive incoming Integrated Acoustic Communication System messages, to pre-process them, and to enter, store and recall the messages for review by the NAV/COMM operator. Its main functions are:

- Enter two received messages of up to 16 tone sets each into the Integrated Acoustic Communication System scratchpad memory, and edit the corresponding tone messages.
- Transfer a received message to permanent memory.
- Select the optimum signal-to-noise ratio for pre-processing incoming tone-coded message signals.
- Present a "message ready" cue to the NAV/COMM operator on the control-display-generator panel.
- Interrupt presentation of "real-time" acoustic data by the AQA-7(V) Sonar Computer Recorder Group gram I display, and substitute presentation of received Integrated Acoustic Communication System message data.
- Alert the Sensor Station No. 2 operator to an illegal message entry or a message sequence error.

OPERATION

The Integrated Acoustic Communication System is a low data rate communications link-type system. Outgoing messages are sent from the aircraft by its UHF-2 radio transmitter (see Figure 15). The NAV/COMM operator composes a message of up to 16 tone messages, and enters the message via the control-display-generator keyboard into the storage memory of the system microprocessor. The storage memory of the microprocessor unit is "volatile," meaning that any data stored in the memory are lost whenever power is removed from the microprocessor. The microprocessor program also enables the NAV/COMM operator to edit the encoded outgoing message before it is transmitted. When complete, the encoded message is ready for downlink transmission from the aircraft.

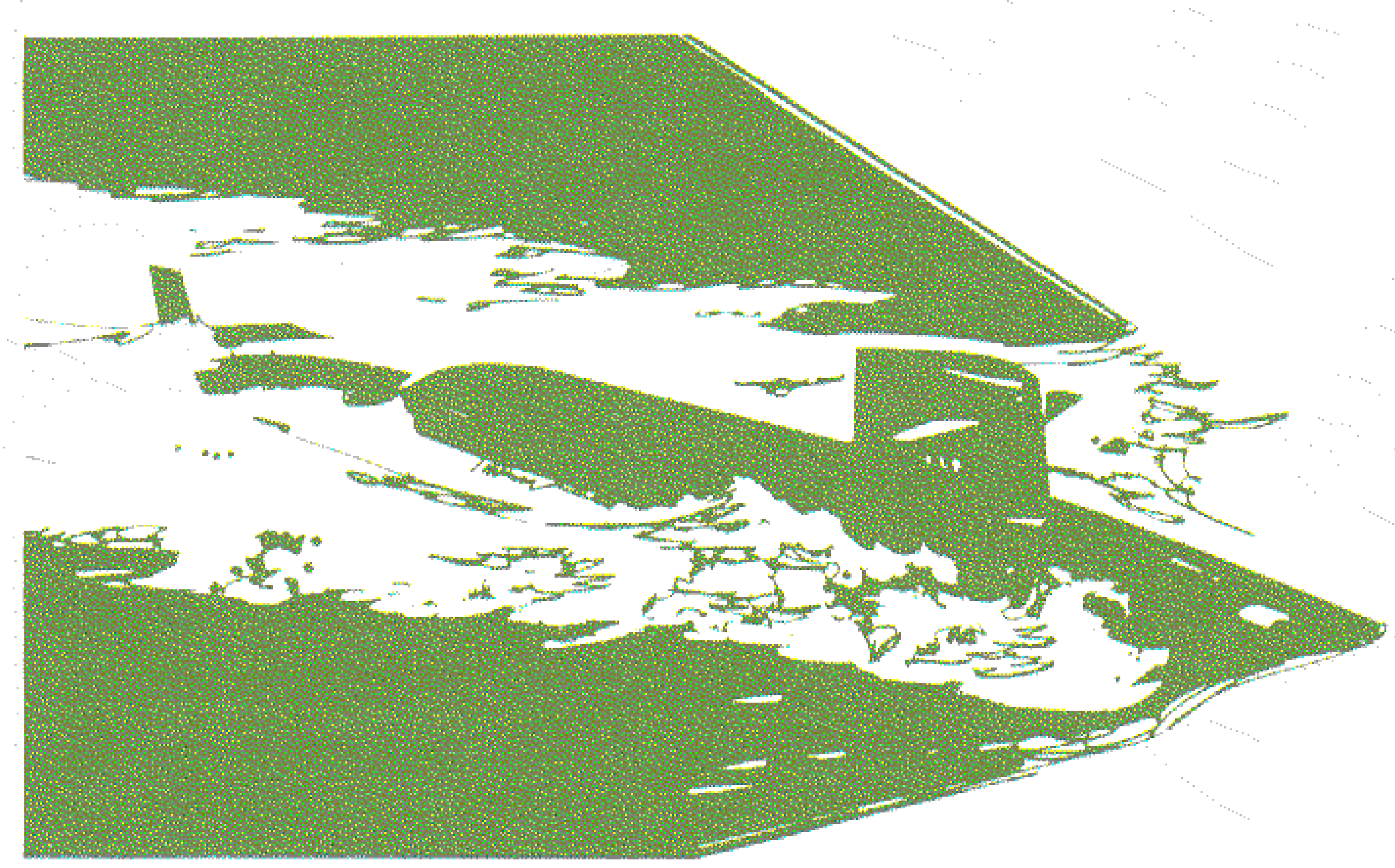
The NAV/COMM operator first selects the T/R mode on the UHF-2 radio control panel and tunes the UHF-2 radio to one of three downlink frequency channels. He then transmits the message by (1) selecting the UHF-2 TTY mode on the communications selector panel, and (2) then selecting the XMIT mode on the control-display-generator panel. The entire message is then transmitted automatically by the UHF-2 radio at one of two data transmission rates, as determined by the operator. During Integrated Acoustic Communication System data transmission, aircraft teletype system operation is preempted.

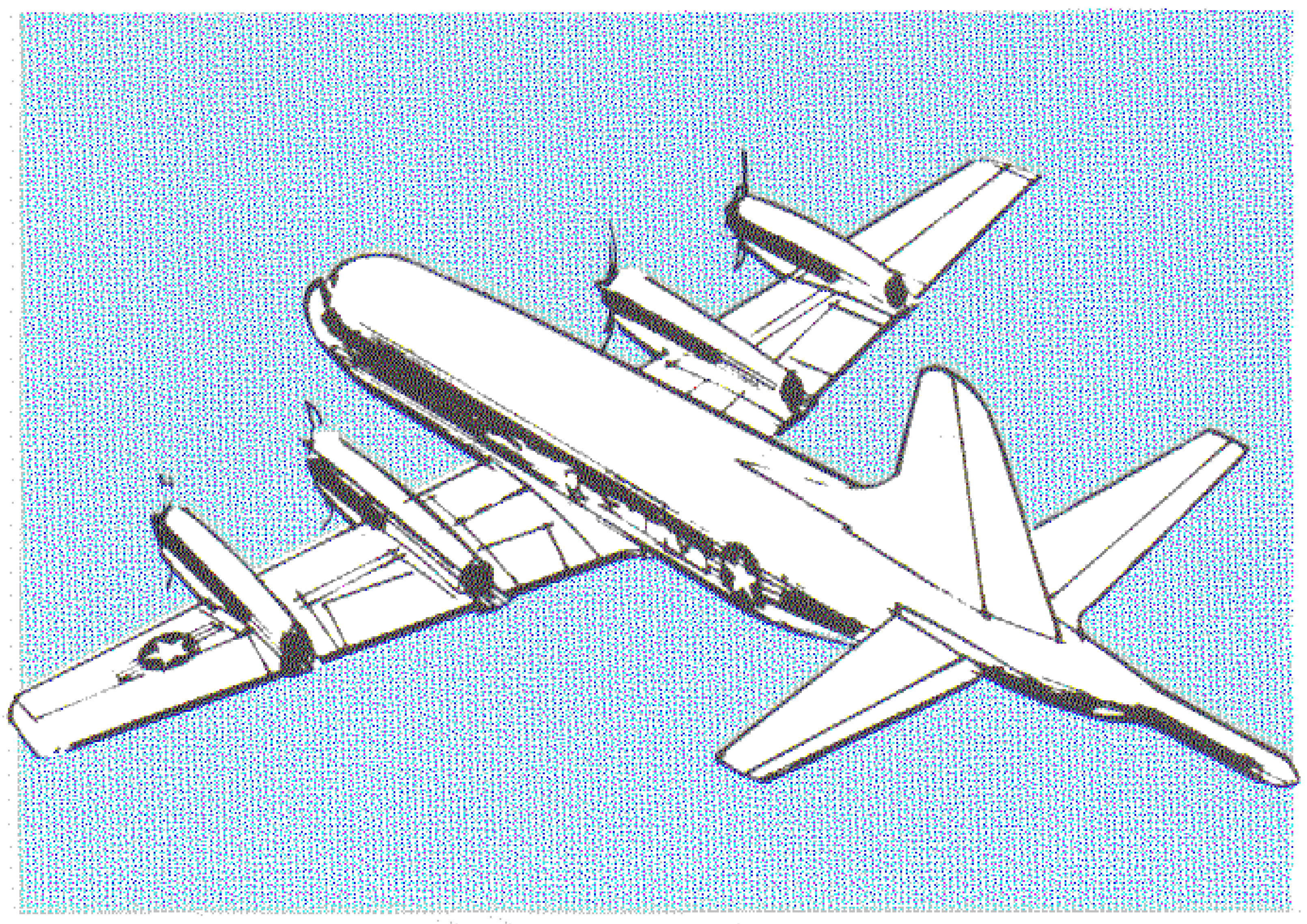
The uhf radio signals are received by a deployed SSQ-71 air transportable acoustic communications (ATAC) sonobuoy. The sonobuoy translates the encoded radio signals into sonar format, then retransmits the message to the submerged submarine at a low data rate via sonar. The sonar transmission from the SSQ-71 sonobuoy continues for a fixed number of seconds or until receipt of the next radio transmission from the aircraft, whichever occurs first. The sonar messages are received by the submarine sonar equipment. Cumulative sonobuoy sonar transmit time is maintained aboard the aircraft by the control-display-generator, and allows the NAV/COMM operator to estimate sonobuoy operating life.

Submarine-to-aircraft uplink operation is initiated when an encoded sonar transmission is sent from the submerged submarine to the SSQ-71 ATAC sonobuoy. The sonobuoy receives the broadband sound spectrum with its hydrophone, and uses this signal to frequency modulate a vhf carrier radio signal that it broadcasts to the aircraft. During uplink operation from the submarine, the ATAC sonobuoy provides automatic level (gain) control of the received sonar signal. This feature is most useful when the submarine makes sonar transmissions near the ATAC sonobuoy.

The sonobuoy's broadcast vhf carrier signal is received by the aircraft's ARR-72 Sonobuoy Receiver System. Preparatory to signal reception, the Sensor Station No. 2 operator must tune the ARR-72 sonobuoy receiver processor input channel (PIC) of gram I to the appropriate sonobuoy RF channel (either 3, 5 or 7). Following reception, the signal is routed to the signal processor-verifier where it is pre-processed to detect signals and to establish the optimum signal-to-noise ratio. During pre-processing, the frequencies of the incoming signals are also translated. The incoming signals are also tape recorded directly from the ARR-72 Radio Receiver System by the aircraft's AQH-4(V)2 Tape Recorder System before they are pre-processed.

The pre-processed incoming message is sent from the signal processor-verifier to the AQA-7(V) Sonar Computer Recorder Group, where it is processed in the same manner as incoming data from an SSQ-41 LOFAR sonobuoy. The LOFAR data processing mode is best suited to the Integrated Acoustic Communication System signal's data repetition rates, although the operator may elect to use the ALI LOFAR processing mode. Once processed, the incoming encoded message can be presented on the AQA-7(V) signal data recorder gram printout and/or on the bearing frequency indicator display. Each message presentation persists on the gram printout or display for one of two submarine-selected time durations. At any one time, the aircraft system can present a maximum of two complete encoded messages of up to 16 tone messages each.





Sensor Station No. 2 is the designated crew station for the Integrated Acoustic Communication System, but Sensor Station No. 1 can serve as a backup when necessary. During a typical "message receive" operation, the Sensor Station No. 2 operator observes receipt of the incoming message as either a gram printout or a visual gram display on the bearing frequency indicator. The Sensor Station No. 2 operator can adjust the signal-to-noise level of the incoming data processed and displayed by the AQA-7(V) Sonar Computer Recorder Group with the SNR control on the signal processor-verifier. This feature enables the operator to adjust the contrast of the hard-copy recording for optimum viewing. The operator notes the multi-tone status of each message, then enters this information into the Integrated Acoustic Communication System with the keyset on the signal processor-verifier. As with outgoing messages, incoming messages can be edited.

After the incoming message has been processed, displayed and entered into the signal processor-verifier, the Sensor Station No. 2 operator must activate an equipment alert. This alert advises the NAV/COMM operator that the message is available for callup and numerical display on the control-display-generator panel. This alert also establishes the incoming message in permanent memory until it is cleared by the NAV/COMM operator. In addition, it enables the Sensor Station No. 2 operator to enter new incoming messages into the Integrated Acoustic Communication System memory. The NAV/COMM operator completes the "message received" phase by recalling the processed incoming message phrases from system memory, then decoding the message.

TAPE RECORDING RECEIVED MESSAGES

The AQH-4(V)2 Recorder-Reproducer automatically tape records the incoming encoded messages directly from the ARR-72 Sonobuoy Receiver System, provided that the tape recorder system is operating when the message is received. The recording consists of unprocessed tone message data that can be retrieved and replayed later in the flight. When the incoming message is replayed it is pre-processed by the signal processor-verifier, then processed and displayed by the AQA-7(V) Sonar Computer Recorder Group.

MAINTENANCE CONCEPT

The Integrated Acoustic Communication System is designed to permit "on-aircraft" maintenance, with fault isolation of components to the Shop Replaceable Assembly. Printed circuit boards are keyed, and each has a top edge test connector to aid troubleshooting. This maintenance concept has been implemented by use of automatically sequenced built-in-test procedures and on-board aircraft test equipment (for example, the AN/PSM-4 multimeter). Intermediate level maintenance may also be performed for selected operations such as replacement of an LED display.

Performance of the built-in-test procedure on the control-display-generator unit also produces an automatic self-test of the signal processor-verifier unit. Should a failure be detected, the code that identifies the defective module is displayed on the ADDRESS readouts of both the control-display-generator and signal processor-verifier units. Additional test information may be obtained by analyzing the end-to-end built-in-test sequence that can be displayed by the AQA-7(V) Sonar Computer Recorder Group.

ASH-33
DIGITAL MAGNETIC TAPE SET

The AN/ASH-33 Digital Magnetic Tape Set (DMTS) is a newly designed tape recording and reproducing system introduced into the P-3C aircraft as part of the Update II Improvement Program. Although at present the digital magnetic tape set interfaces only with the CP-901 General Purpose Digital Computer, the most important design feature is its capability to handle a multiple computer configuration when future equipment is integrated into the P-3C avionics. Increased reliability, improved maintenance features, and a reduction in weight and size constitute additional design characteristics.

Superseded by the introduction of the AN/ASH-33 Digital Magnetic Tape Set are the two existing elements of the aircraft's tape system, the RD-319A/AYA-8 Magnetic Tape Transport and the MX-8024/AYA-8 Digital Magnetic Tape Controller. A nine-track tape, fully enclosed in a cartridge, replaces the reel-to-reel configuration used in the magnetic tape transport.

DESCRIPTION

The new system consists of the RD-450/ASH-33 Digital Magnetic Tape Unit (DMTU) and the C-10553/ASH-33 Digital Magnetic Tape Controller (DMTC). At present, the digital magnetic tape set operates with two digital magnetic tape units, but it has provisions for operating with up to four units. The block diagram in Figure 19 shows the system's full capability.

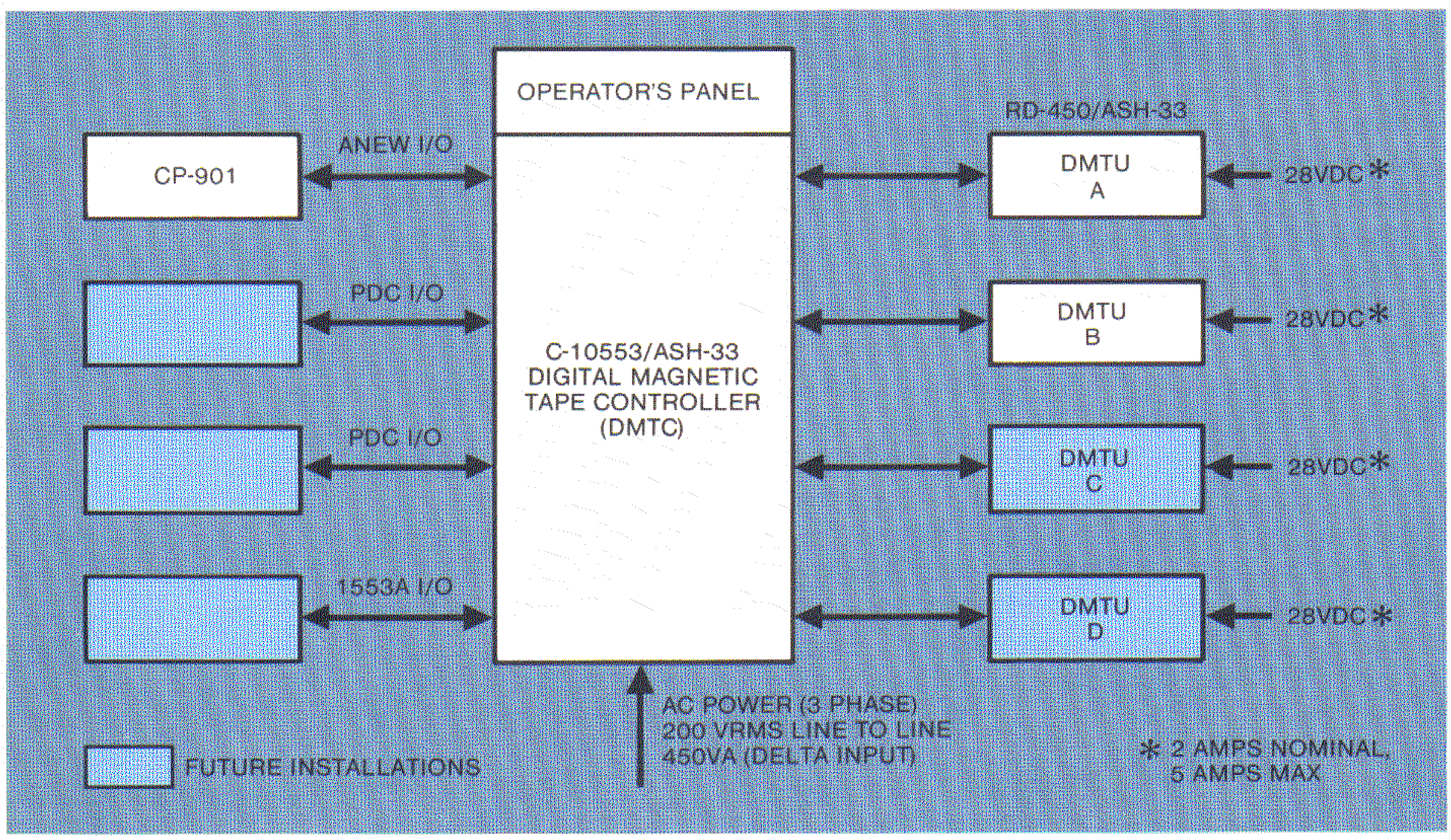


Figure 19. AN/ASH-33 Digital Magnetic Tape Set Block Diagram

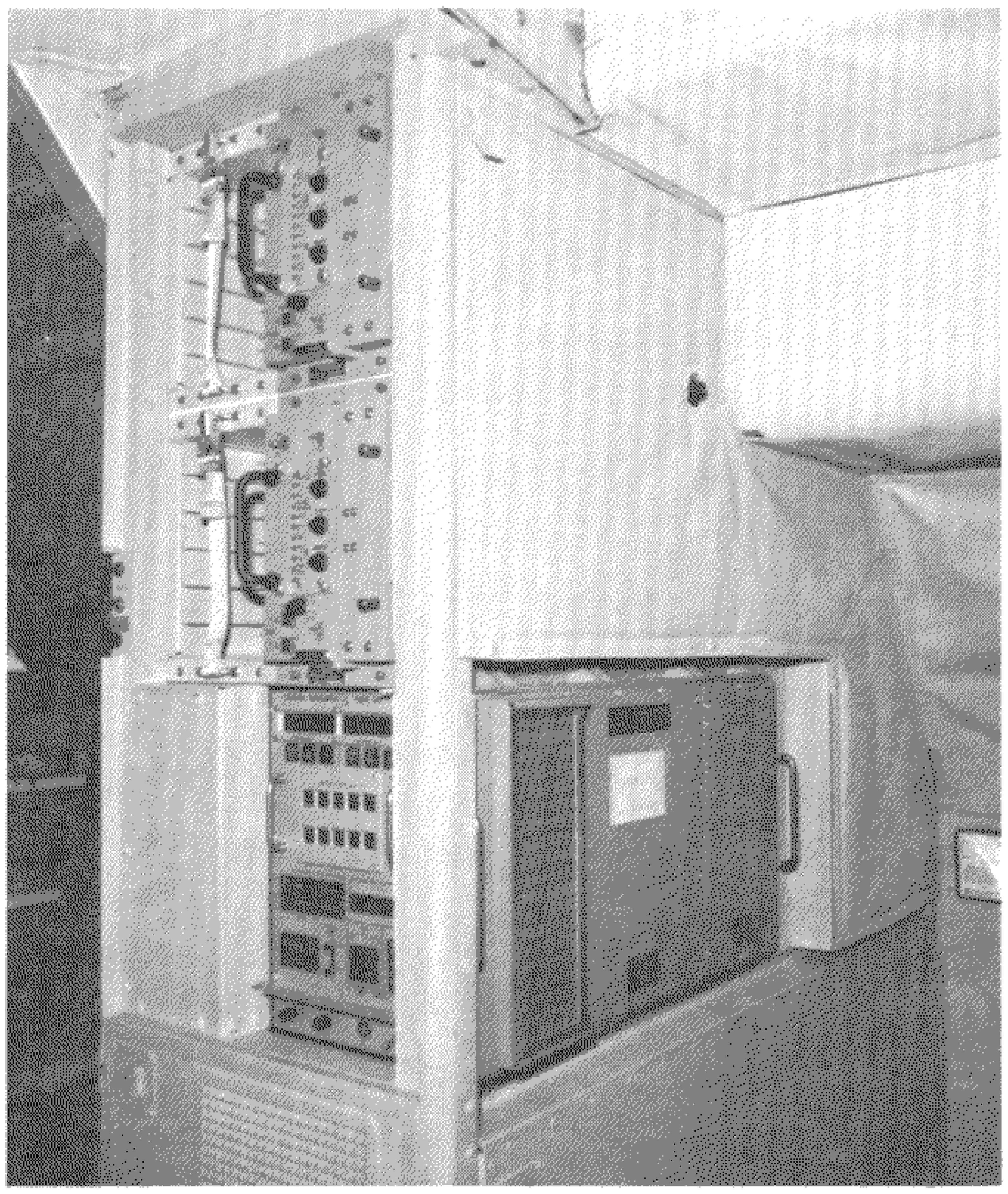


Figure 20. AN/ASH-33 Digital Magnetic Tape Set as Installed in P-3C Aircraft USN SERNO 161132

Figure 20 illustrates the arrangement of the digital magnetic tape set installation aboard the aircraft. The three boxes are mounted in electronics rack D3, in the same space the RD-319 magnetic tape transport previously occupied. Digital magnetic tape units A and B are positioned on top of the control unit, with unit A being the uppermost component. Storage space is provided on the left-hand side, adjacent to the tape units, for the 12 magnetic tape cartridges delivered with the digital magnetic tape set.

All operator controls and displays, as well as the tape cartridge access door, face inboard toward the main aisle. This arrangement enables the operator to configure and check out the system from one convenient location. Further, insertion and removal of the tape cartridge is more easily accomplished, and by removing the trim, the technician has ready maintenance access to each unit from the maintenance aisle just forward of electronics rack D3.

RD-450/ASH-33 DIGITAL MAGNETIC TAPE UNIT

Each digital magnetic tape unit contains recording and playback electronics, a magnetic head assembly with a full tape-width erase feature, control and interface electronics, capstan motor assembly, and the front panel with its manual controls and indicator lights (see Figure 21).

The digital magnetic tape unit front panel has two major functions: it enables the operator to (1) manually initiate and control tape motion, and (2) assign a specific address to each tape unit depending on the role delegated to it.

During operation in the automatic mode, the tape unit's functions are controlled by the digital magnetic tape control, and the front panel controls are disabled.

Tape motion is accomplished by a simplified capstan-to-tape drive method, whereby two capstan rollers directly contact the tape at the periphery of the spooled pack, thus eliminating the need for failure-prone drive belts and tension arms. One capstan roller provides power to the take-up reel, the other one to the supply reel. When the cartridge is inserted into the digital magnetic tape unit housing, actuators inside cause the hinged cartridge doors to open. The tape contacts the capstans and the magnetic head, and the friction effect sets the tape in motion after the cartridge is locked in place and the access door is closed and secured.

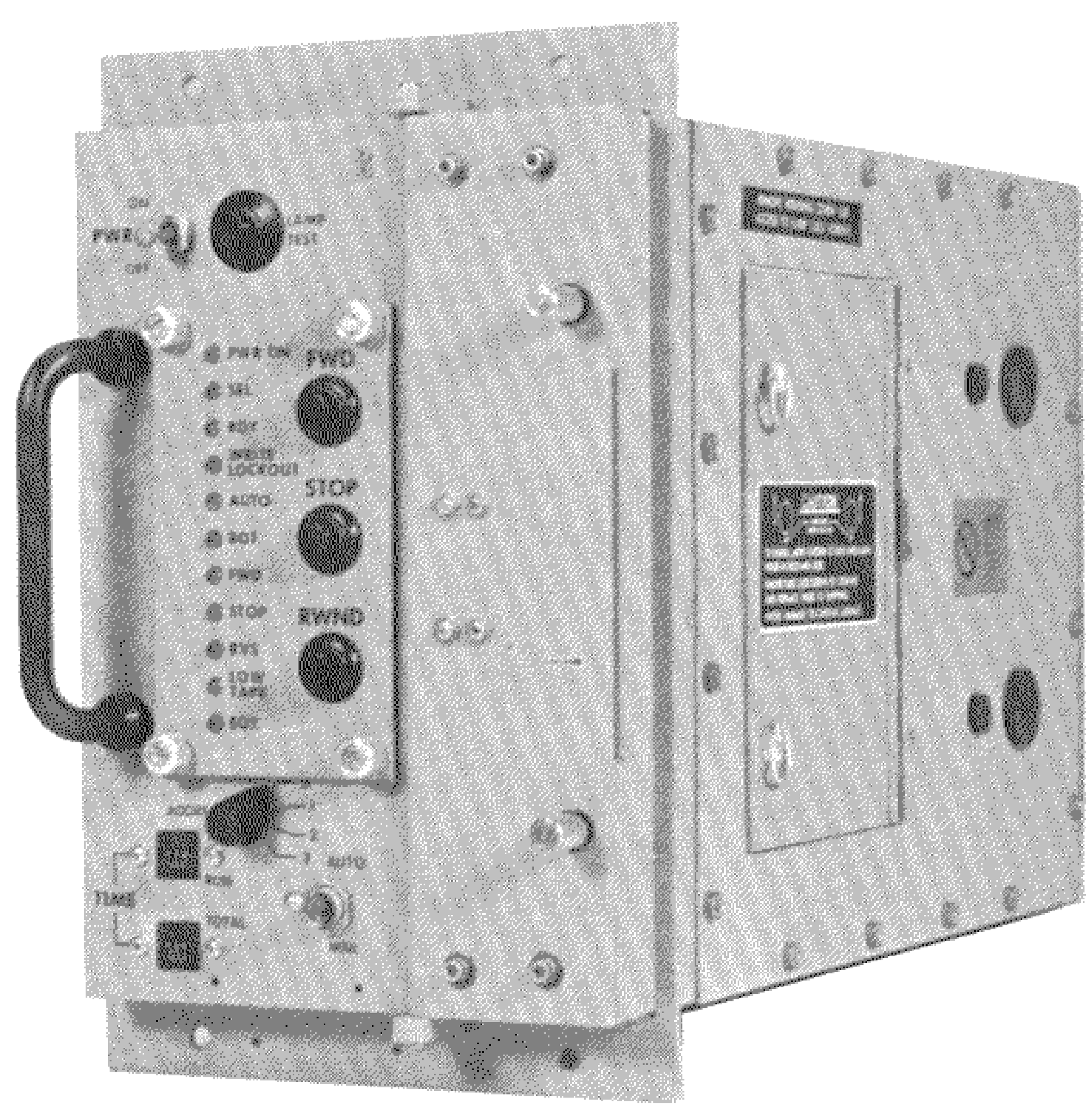


Figure 21. RD-450/ASH-33 Digital Magnetic Tape Unit

Tape tension and tape speed – 25 inches per second (ips) in forward and reverse, 50 ips in rewind – are controlled by the take-up servo operating at the tape drive speed and the supply servo at a slightly lower speed which creates the proper tape tension necessary for solid and precise tape stacking.

Tape Cartridge and Magnetic Tape The die-cast aluminum cartridge used in the digital magnetic tape unit contains 390 feet of 0.5-inch wide, 100 percent surface-tested 3M 777 magnetic tape. These dimensions allow a minimum storage capacity of 1.1 million 30-bit words organized in 512-word records.

End-of-tape (EOT) and beginning-of-tape (BOT) markers are affixed to the tape near either end. The markers are metallic strips which establish the physical limitations of the tape for data recording and provide a means for preventing despooling. Approximately 11 feet from the EOT strip, low tape quantity on the reel is sensed by a microswitch which activates the LOW TAPE indicator on the front panel. When the digital magnetic tape unit's sensors located on both sides of the magnetic head detect the EOT or BOT marker, the tape is stopped automatically.

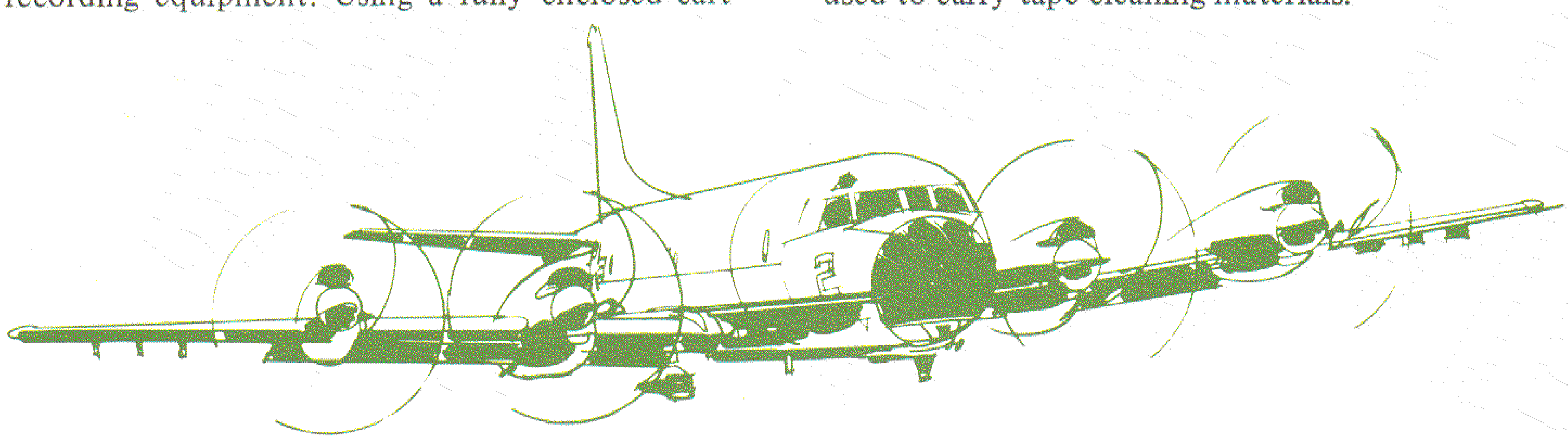
When the cartridge is removed from the digital magnetic tape unit, spring-loaded doors on the cartridge close automatically to minimize dust contamination, and self-energizing reel brakes engage to decrease the risk of despooling. In addition, a file protection feature on the cartridge prevents re-recording or erasing the tape.

Cartridge Versus Reel-to-Reel Traditionally, tape contaminants and reel defects are caused by mishandling the tape during loading, unloading and transporting, and have been major reasons for degraded system performance of reel-to-reel recording equipment. Using a fully enclosed cartridge greatly reduces these harmful conditions. Furthermore, the operator has no direct contact with the tape, since threading the tape onto the tape transport is no longer required. This virtually eliminates the possibility of transferring fingerprint oils and acids onto the tape surface, thus lessening the chances of data drop-outs caused by accumulated deposits on the tape and head assembly.

Mounting and removing the reel has become equally unnecessary. Consequently, tape and tape transport are protected from reel defects, which in the past have contributed greatly to malfunctions and subsequent loss of information.

Cartridge Transport Case ASW magnetic tape recording operations demand frequent insertion and removal of the cartridge and transport to and from the ASW Operations Center, regardless of environment and physical conditions. Exposing the tape to extreme temperatures, humidity, shock and vibration may render it unusable – possibly nullifying the efforts of an entire mission, or adversely affecting a software program contained on the tape. To protect the tape from these harmful environmental conditions, a tape cartridge transport case is provided for use whenever transporting the cartridge becomes necessary. As an additional protection against tape contamination, the cartridge should be enclosed in its plastic bag immediately upon removal from the digital magnetic tape unit.

The cartridge transport case is made of yellow, durable plastic with a polyurethane-padded lid and bottom. The storage compartment holds up to eight tape cartridges, with extra space added to each storage slot to accommodate the cartridge in its protective bag. A separate accessory compartment divides the tape storage section and may be used to carry tape cleaning materials.



C-10553/ASH-33 DIGITAL MAGNETIC TAPE CONTROL

The digital magnetic tape control (see Figure 22) contains two identical control sections, the operator panel and the circuitry that interfaces with the CP-901 General Purpose Digital Computer and the digital magnetic tape units. Redundancy is provided which, in future multiple processor systems, will allow more than one computer simultaneous access to the digital magnetic tape units and also offers a back-up in case failure occurs in either of the two control sections.

Two major functions are executed at the digital magnetic tape control front panel: (1) CP-901 computer control of digital magnetic tape set operations through a selected tape unit and either one of the redundant controllers, and (2) performance of off-line built-in-tests and functional tests via the mode display section of the front panel.

When testing the system off-line, the operator has the option of manually selecting from the mode display either individual tests for selected digital magnetic tape units or the built-in-test function.

Mode display tests give the operator the following test choices:

- To automatically cycle test loops in sequence until an error is detected or the HALT switch on the Mode Display is depressed
- To conduct single loop tests
- To cycle loop tests continuously, ignoring errors to allow for the monitoring of intermittent test faults
- To conduct an operator panel test

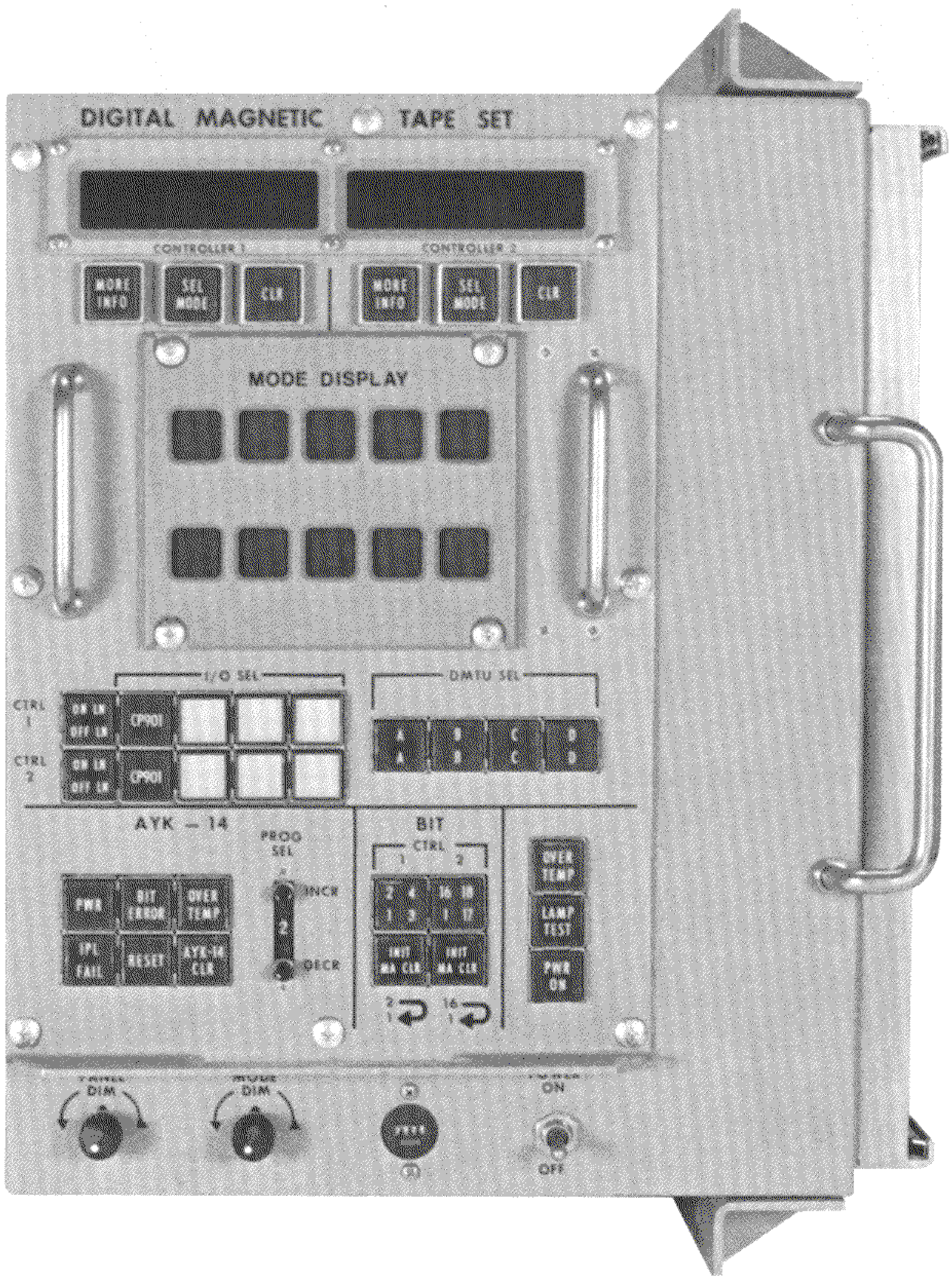


Figure 22. C-10553/ASH-33 Digital Magnetic Tape Control Unit

In addition, the mode display built-in-test verifies the capability of the digital magnetic tape units to function in the forward and reverse modes and perform write test including writing file marks.

In future expanded configurations, appropriate selections from the mode display on the digital magnetic tape control operator panel will permit program loading and diagnostics to be performed on future processor systems. When used in this manner, messages on the alphanumeric display will indicate the successful testing or call out the faulty Shop Replaceable Assembly (SRA). Figure 23 shows the digital magnetic tape control with the side panels removed.

Other test functions available on the operator panel are the panel lamp test and the built-in-test function. The latter function may be initiated automatically by the computer or manually by depressing the INIT/MA-CLR switch. In either case, the built-in-test routine executes five loop tests sequentially on a selected configuration to determine if the tape control and tape unit SRAs are operational. Again, the alphanumerics display indicates either successful testing or identifies the faulty SRA.

SUMMARY OF TAPE MAINTENANCE AND HANDLING PRECAUTIONS

The digital magnetic tape units' efficiency to record ASW mission data depends largely on the quality and condition of the tapes. High performance tapes, such as the ones used in these units, are screened by the manufacturer and, as mentioned before, certified as 100-percent surface tested when wound into the cartridge. However, certification is only valid until initial tape use; from there on it is the responsibility of the operators and technicians to maintain standards of acceptable tape quality.

The most important maintenance and handling precautions are summarized below.

- Always store the cartridges in the zippered plastic bag when the cartridge is removed from the tape unit or when the unit is not being used.
- Do not subject the tape to extreme temperatures by leaving cartridges in the aircraft between flights or overnight. The transport case should be used when transporting cartridges between the aircraft and the ASW Operations Center.
- To minimize contamination, do not operate the tape unit in a tape drive mode when the head access door is open, or when the access panel is removed.
- Clean the tape path components and capstan rollers according to established maintenance procedures and schedules.
- Do not stack, store or carry the cartridge near magnetized tools, recorder heads or other suspected sources of magnetic fields.

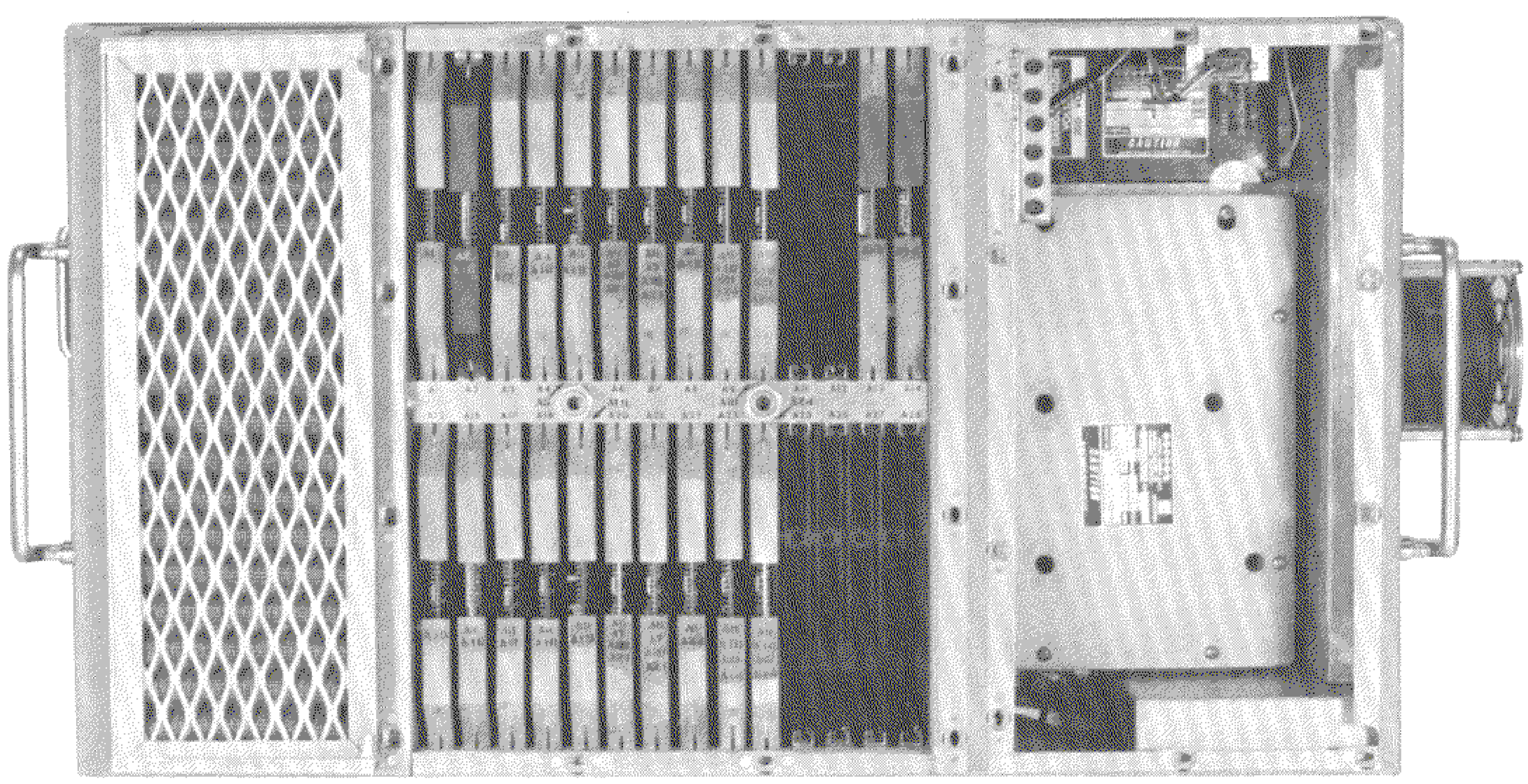


Figure 23.
Digital Magnetic Tape Control Unit.
Side panels are removed to show SRAs.

FUEL TANK VENT SYSTEM MODIFICATION

The fuel tank vent system on the P-3 Orion was designed to accommodate the maximum fuel flow rates associated with in-flight fuel transfer between tanks as well as the air flow that vents from the tank during pressurized ground fueling. The vent system will not, however, accommodate the fuel flow rates associated with ground refueling if the fuel shut-off valves within the tanks fail to close and allow fueling to continue. In this case, tanks 1, 4 or 5 could become overpressurized and damage the wing. Because tanks 2 and 3 contain heavier structure that supports the main landing gear, structural damage would not occur as long as the fueling supply pressure does not exceed 55 psi.

To protect the tanks against a single valve failure, a dual shut-off valve was incorporated as a part of the fuel fill line in each tank. If either side of the valve closes as the tank becomes full, no further fuel will be admitted into the tank. In addition, the fueling procedure requires that both sides of these valves (primary and secondary) be checked to ensure proper operation, both at the beginning of the procedure and after the tanks are about 85 percent full. If a malfunction is detected, the fueling operation must be terminated and the tanks inspected.

The design of the valves and check-out procedure should have prevented overpressurization of the fuel tanks. However, the wing rib braces in tanks 1 and 4 of several aircraft have experienced structural damage over the years. A P-3 fleet inspection conducted in 1979 revealed various faulty fuel shut-off valves on many aircraft that should have been detected during the check procedure, and it was concluded that the procedure was not being followed consistently.

Tank 5 may also be overpressurized and damaged in the same way as tanks 1 and 4. However, because tank 5 is seldom topped off in service, no damage has ever been recorded.

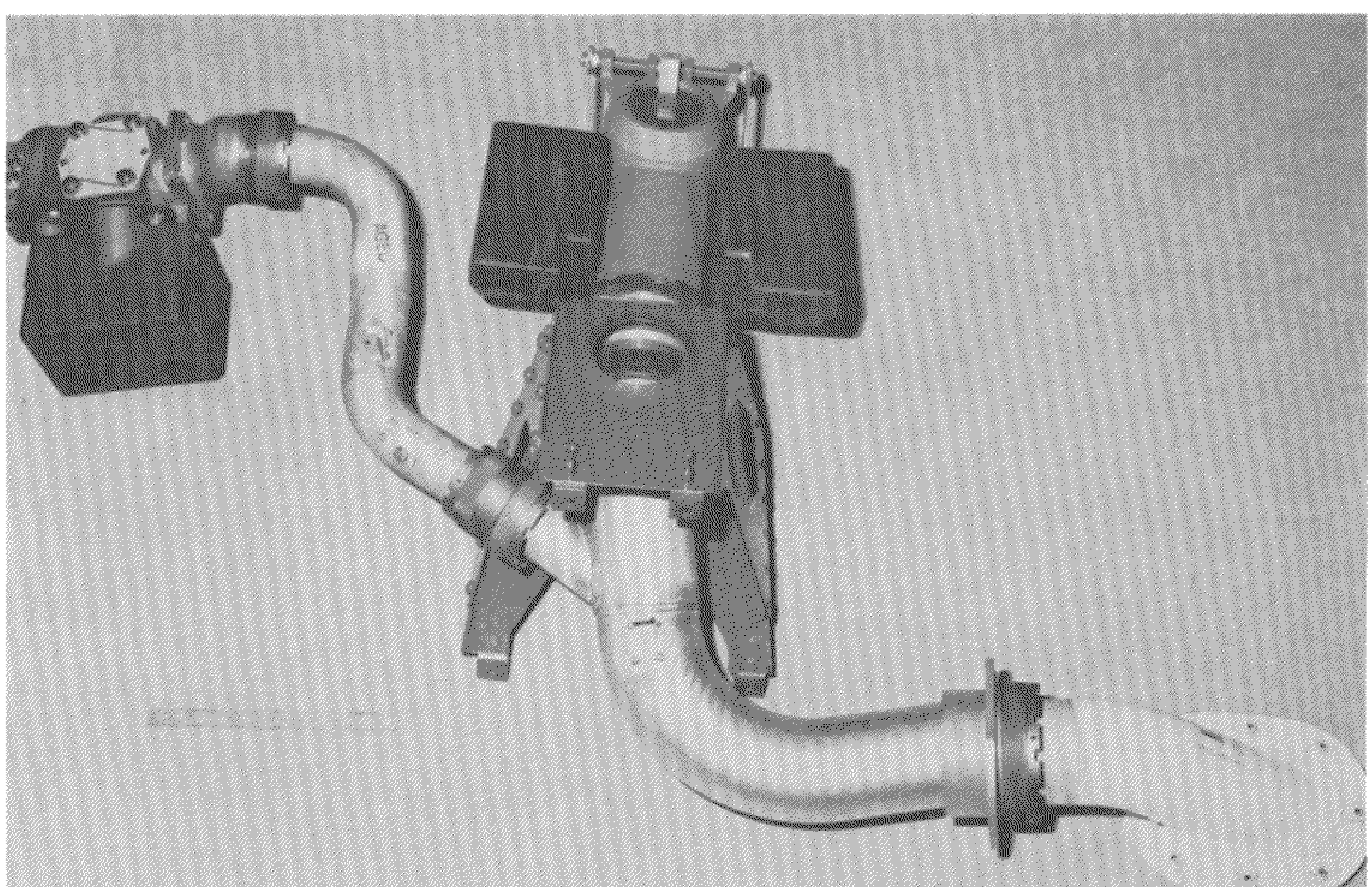


Figure 24.
New Float-Operated Fuel Relief Valve (Center)

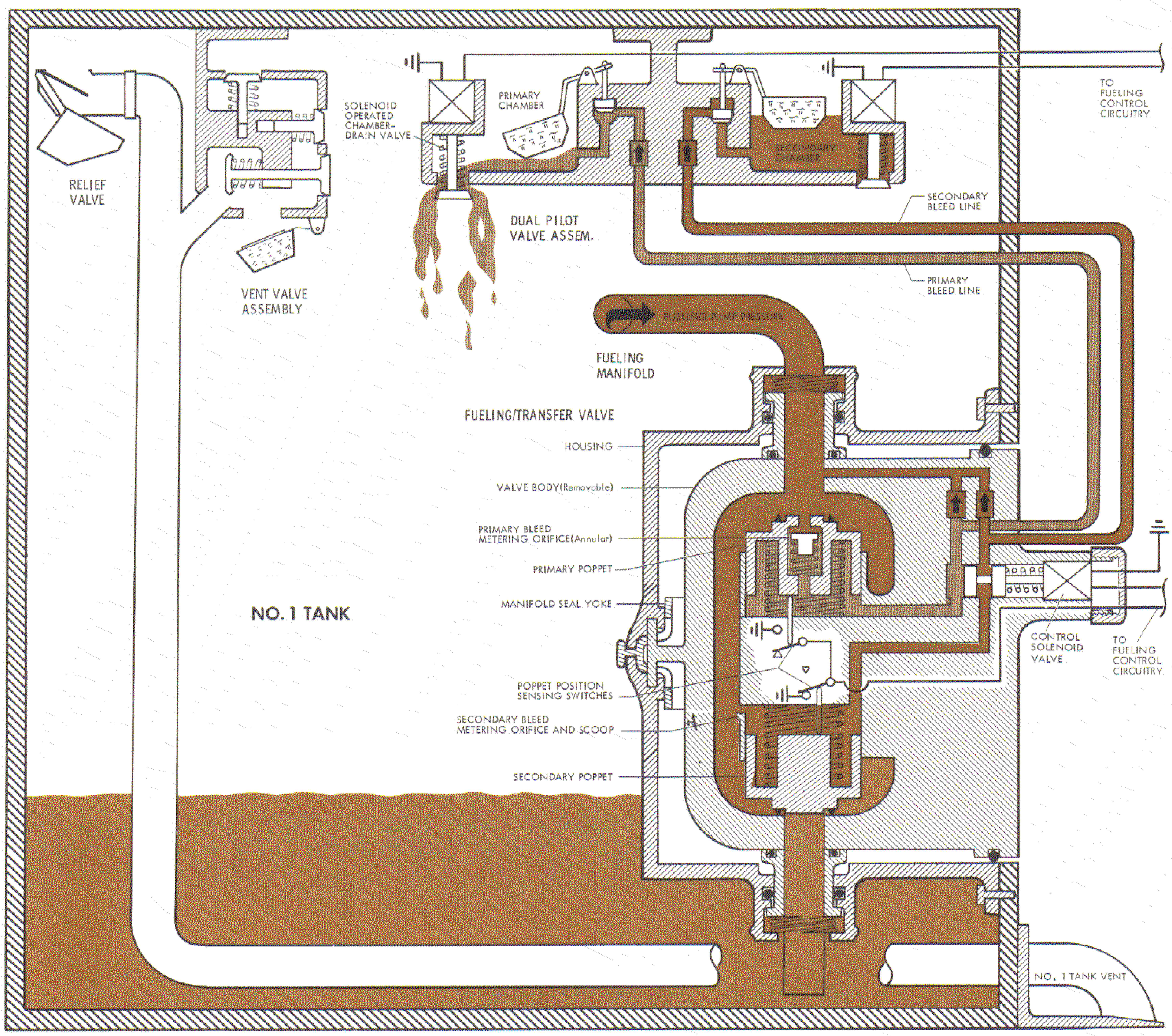


Figure 25. Fuel Shut-Off Valves in Relationship to Fuel Relief Valves

NATURE OF CHANGE

Two modifications have been incorporated into the fuel tanks. The existing vent system in tanks 1 and 4 has been modified and enlarged, and a "tattle-tale" gage that records overpressurization has been installed in tank 5.

CHANGES IN TANKS 1 AND 4 The old 1.5-inch vent line was replaced with a 2.5-inch line. The old 1.5-inch line and spring-loaded relief valve are retained as a branch of the new 2.5-inch line and are augmented by a float-operated relief valve added in parallel to the spring-loaded valve (see Figure 24). Both valves vent into the 2.5-inch line and new flame arrestor assembly. This larger line will allow sufficient fuel to vent and keep tank pressure within allowable limits in the event of a dual failure of the fuel shut-off valves. The relationship of the shut-off valves and relief valves is shown schematically in Figure 25.

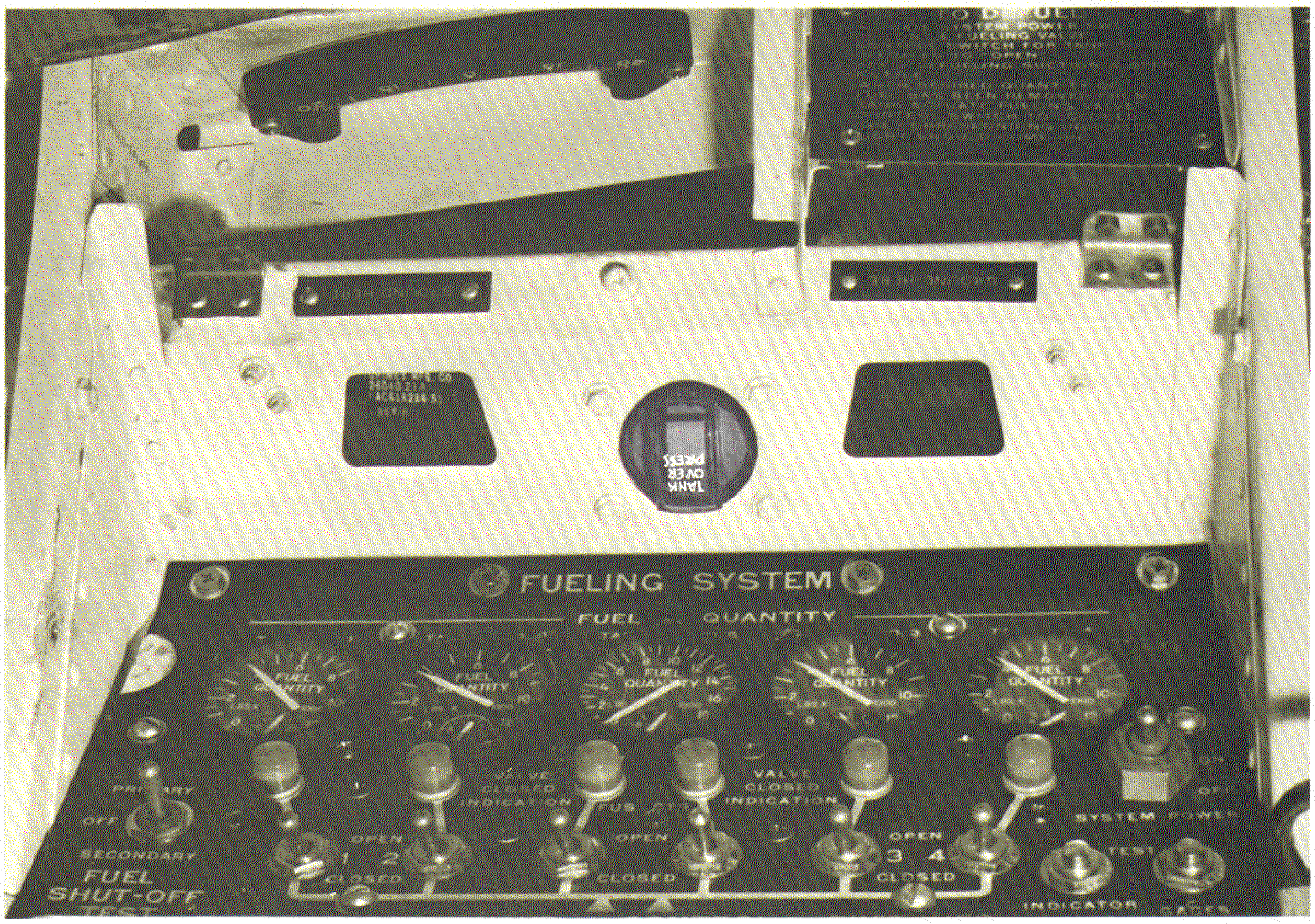


Figure 26. Fuel Tank No. 5 Tattletale Gage Adjacent to Fueling Control Panel

CHANGES TO TANK 5 The new overpressurization indicating system measures tank pressure from 0 to 12 psi within tank 5 and records any pressure that exceeds 7 psi. A simple gage has been installed next to the ground pressure fueling panel inboard of the No.3 engine in the lower aft wing-to-fuselage fillet (see Figure 26). The gage is connected to a 0.25-inch line that terminates inside tank 5. Once the gage has sensed pressure over 7 psi, the black bar on the face of the gage will remain in the red "TANK OVER PRESS" area until it is reset at an authorized rework or repair facility.

The gage is monitored during fueling and inspected during preflight. If sufficient pressure builds up during fueling to cause the black bar of the gage to enter and lock in the red range, fueling operations must be stopped immediately. If preflight inspection of the gage indicates fuel tank overpressurization, the flight crew is made aware of this condition and of possible damage to the wing. Once the gage has registered overpressurization, tank 5 must be drained and inspected for structural damage prior to flight and the gage removed and replaced.

RETROFIT PROGRAM

The modification to tanks 1, 4 and 5 are being incorporated into *all* Navy P-3 Orions with completion scheduled during 1982.

Lockheed ORION Service Digest

STANDARDIZED PLYON

The primary objective of developing a standardized pylon was to establish a single pylon configuration, one that would be usable at any of the ten wing stations and compatible with all wing stores, including the Harpoon missile. It was also desirable to produce a pylon from which the bomb rack could be removed without disassembling the pylon.

Historically, the Orion aircraft has been fitted with the Aero-15D pylon, the mining pylon, and most recently the Harpoon pylon. These pylons could be installed only at the individual stations for which they were designed. The shape of the upper edge of the pylon had to conform to the contour of the wing, which differs at each station. And of course, there had to be left-and right-hand pylons.

At P-3C SERNO 161132 (LC S/N 5724), the Harpoon pylons were replaced by the standardized pylons, a modification of the Harpoon pylon. In effect, the upper edge of the pylon was redesigned and lowered to clear the wing contour at all stations. Then appropriately sized spacers were designed that customize each of the ten different stations to the standardized pylon.

The ten spacers, five left-hand and five right-hand, fit between the pylons and the wing. Their height varies from as little as one inch for the inboard stations to five inches for the outboard stations. The spacer is guided onto the pylon with indexing pins and held in place with shoulder bolts that fit through slotted holes in the spacer. Figure 27 shows the standardized pylon and spacer.

The spacer is made of injection-molded polyurethane, reinforced with a mat of continuous-strand fiberglass. The skins of the pylon and wings are aluminum alloy. In-service temperature extremes vary at least 160 degrees, and the aluminum and polyurethane expand and contract at different rates. At the same time, it is important aerodynamically and environmentally that the surfaces mate snugly, the pylon to the spacer and the spacer to the wing. The slotted mounting holes in the spacer permit it to expand and contract as necessary. Dacron-coated rubber seals are cemented onto the two interfacing surfaces, onto the top edge of the pylon and onto the top edge of the spacer. These seals serve two purposes: to reduce the friction created by the thermal movement and to minimize water intrusion. In addition, the seal on top of the spacer compresses as necessary to compensate for wing contour variations.

Two adapters, very similar to those on earlier pylons, fit crosswise inside each spacer. The pairs of adapters fit the contour of the wing at each station, form guides for the attaching bolts, and

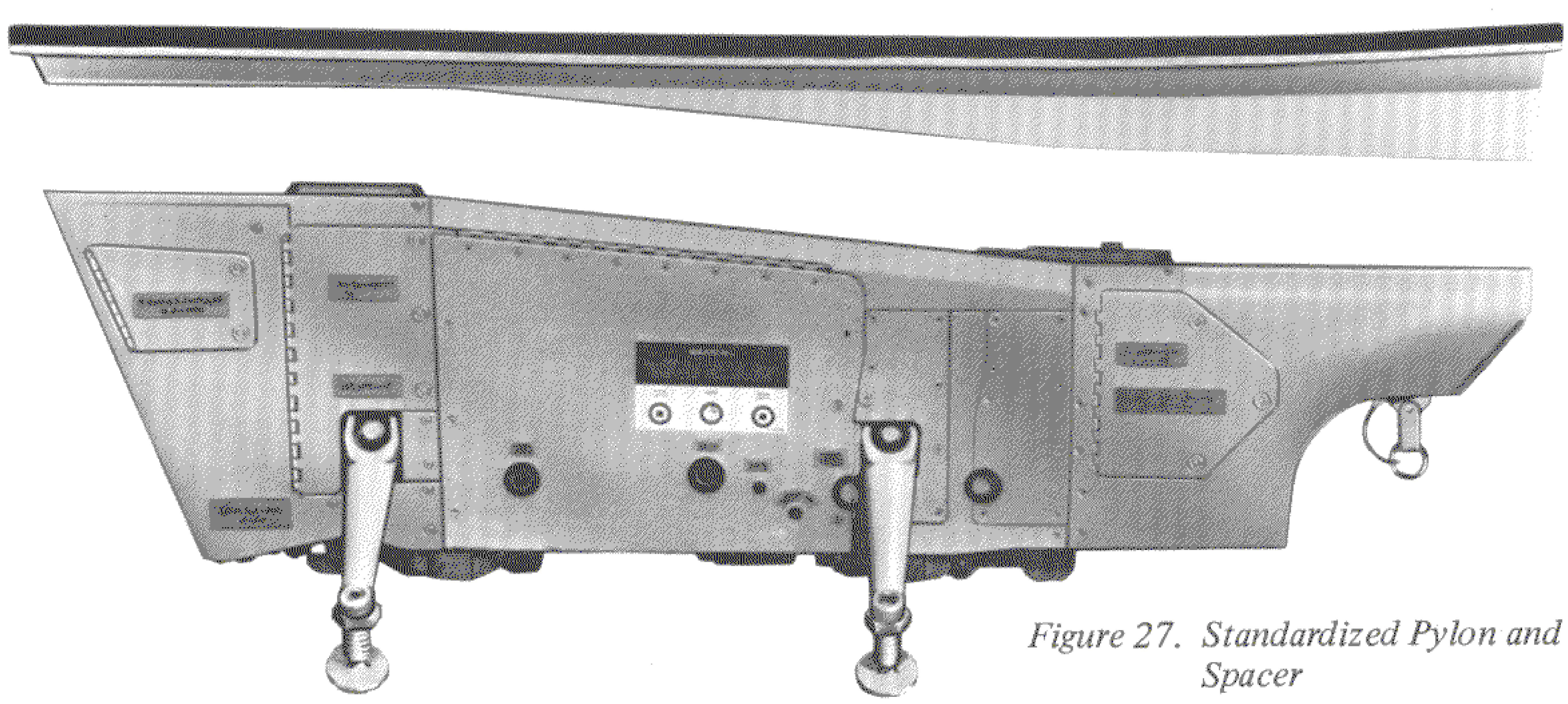


Figure 27. Standardized Pylon and Spacer

prevent compression of the light-weight spacer as the bolts are tightened. Once the spacer with the adapters in place is attached to the pylon, the entire unit is bolted to the wing with the same combination of four bolts and special washers as in the past.

Various access panels and doors on the pylon have been enlarged to improve access to the wing attaching bolts and electrical connectors inside the pylon. These modifications make the standardized pylon considerably easier to install, remove and service. The bomb racks may be removed without disassembling the pylon. In addition, corrosion protection for the pylon's internal components has been improved.

On all previous aircraft, decals placed on the pylon depicted the proper bolt with which to attach the pylon to the wing. Since the standardized pylon may be attached to any station, these bolt decals are now affixed to the wing adjacent to the attaching points.

The pylon harnesses connect the aircraft's electrical system to the bomb racks and stores. Five pairs of harnesses are required for the standardized pylon configuration.

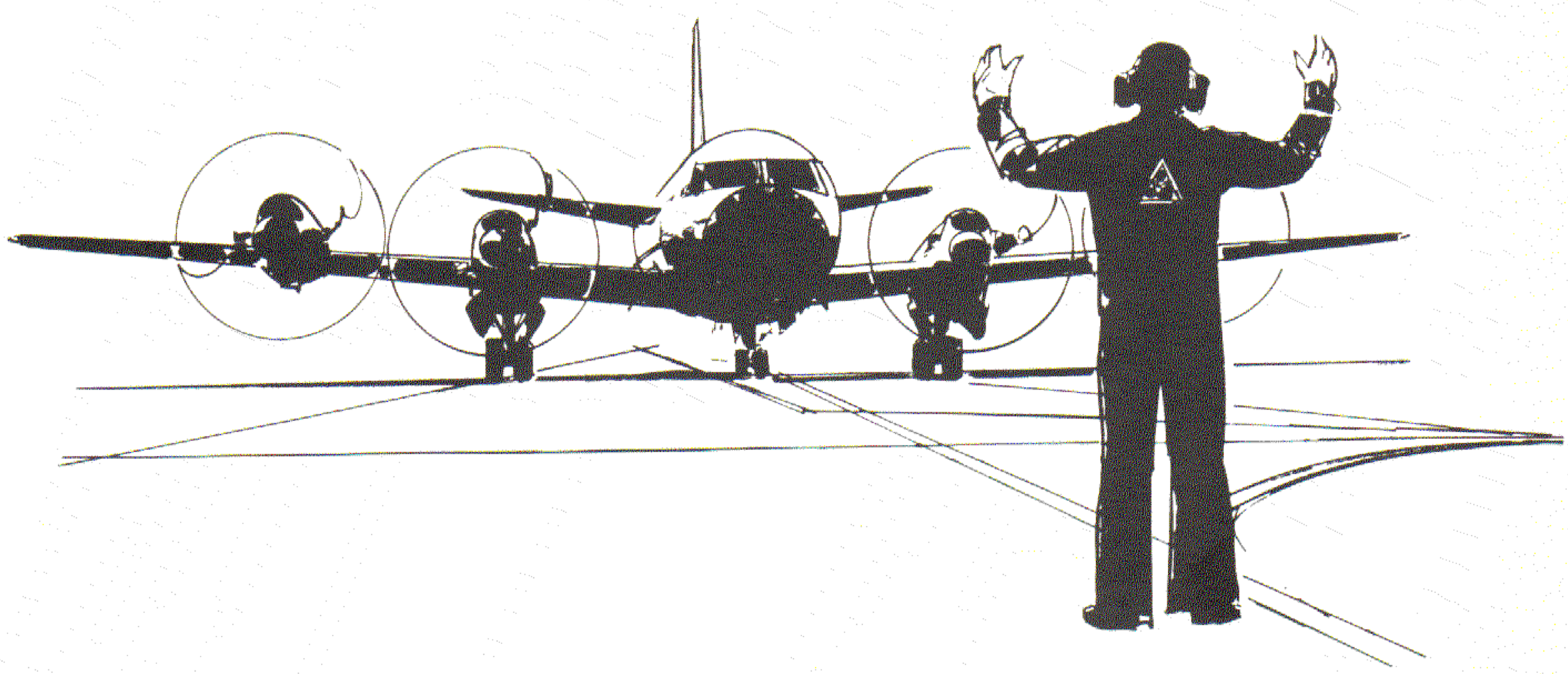
DELIVERY OF PYLONS

A production shipset consists of six standardized pylons, ten spacer/adapters, ten pylon harnesses, and installation hardware. The shipset accompanies a delivered aircraft: six pylons are installed and the four additional spacer/adapters, harnesses, and hardware are delivered as loose equipment in reusable containers. These containers are built to protect the equipment and serve as storage for the spacers in the fleet.

RETROFIT

A program to retrofit delivered P-3C aircraft with standardized pylons has been ordered with shipsets scheduled to be delivered beginning in June 1982. For the purposes of this program, a retrofit shipset consists of four standardized pylons and ten spacer/adapters, harnesses and sets of installation hardware.

Lockheed ORION Service Digest



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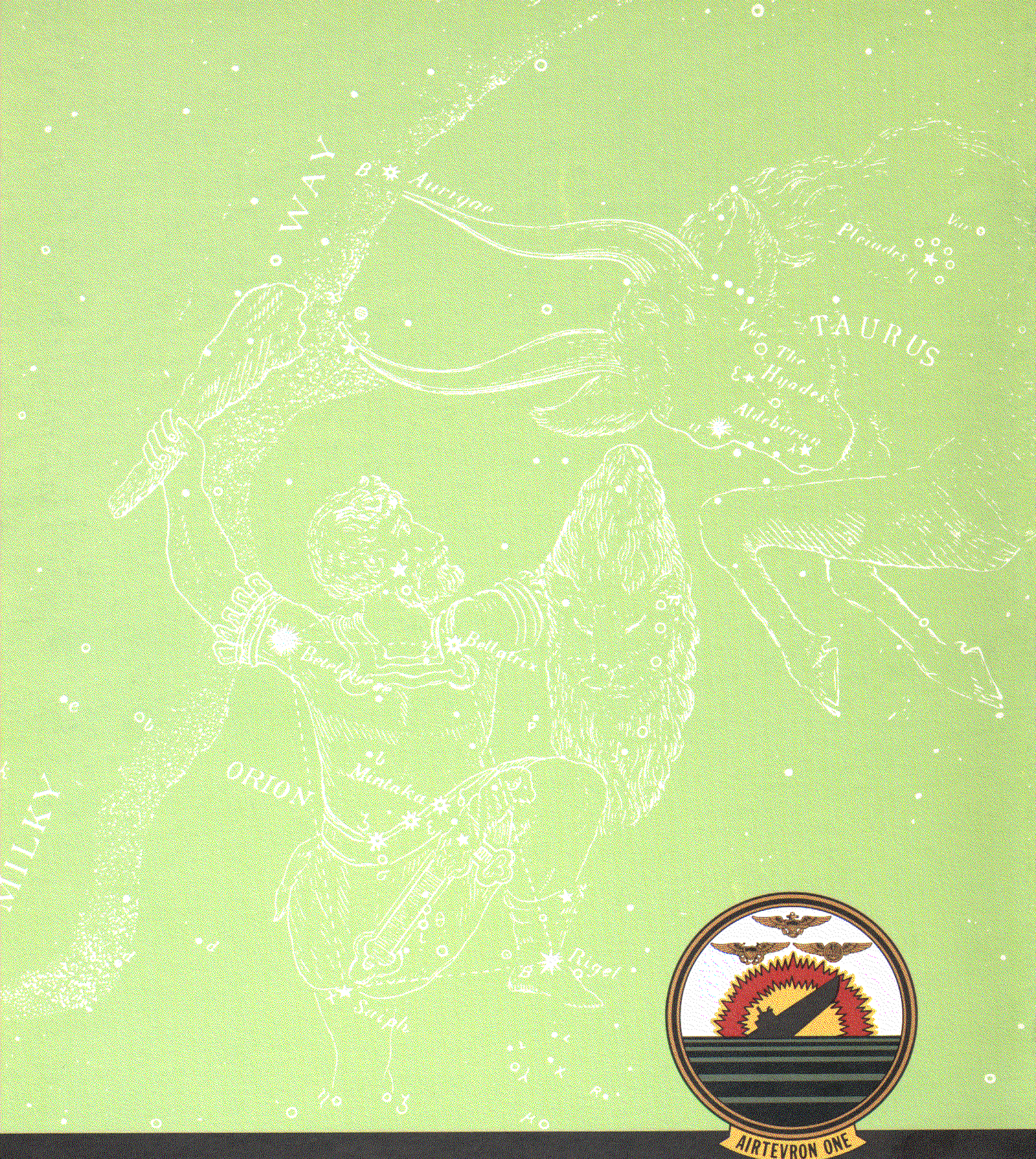

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