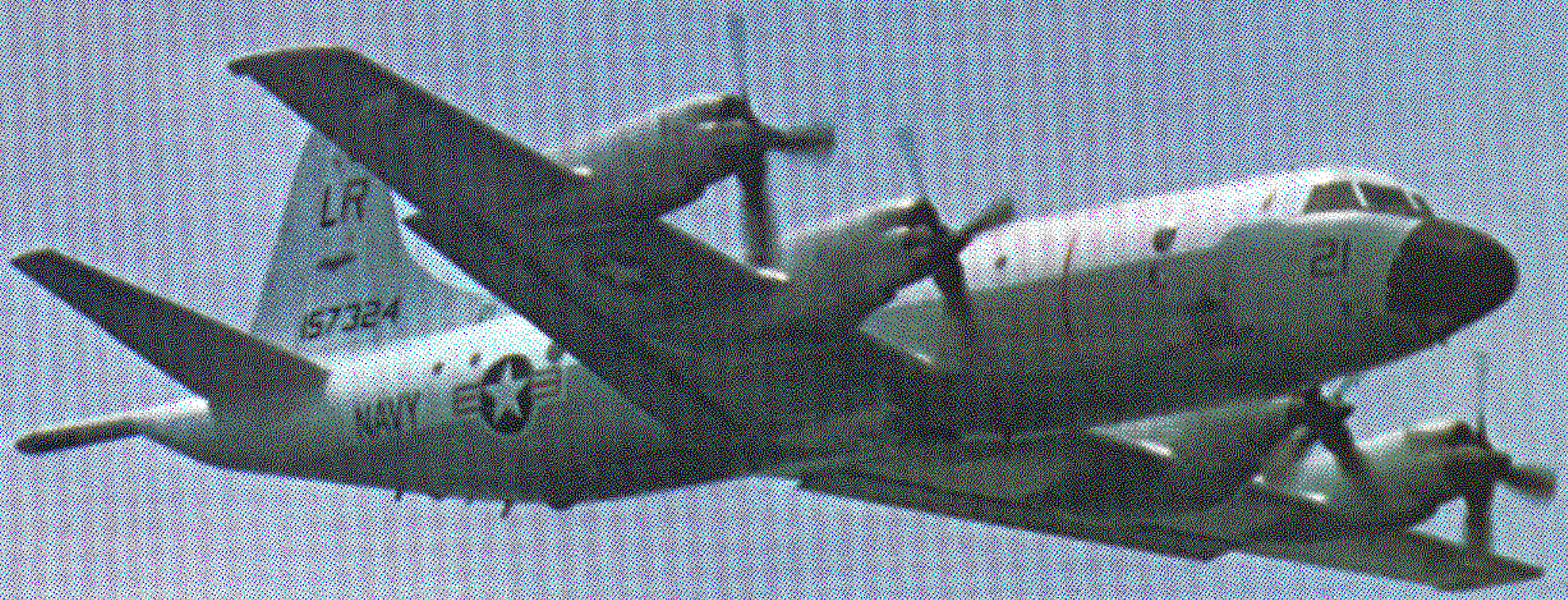

ORION

SERVICE DIGEST

LOCKHEED
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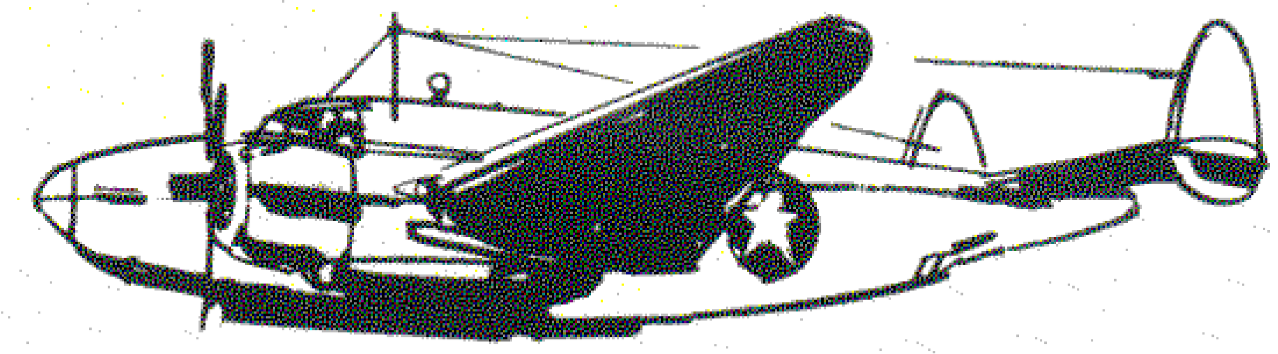
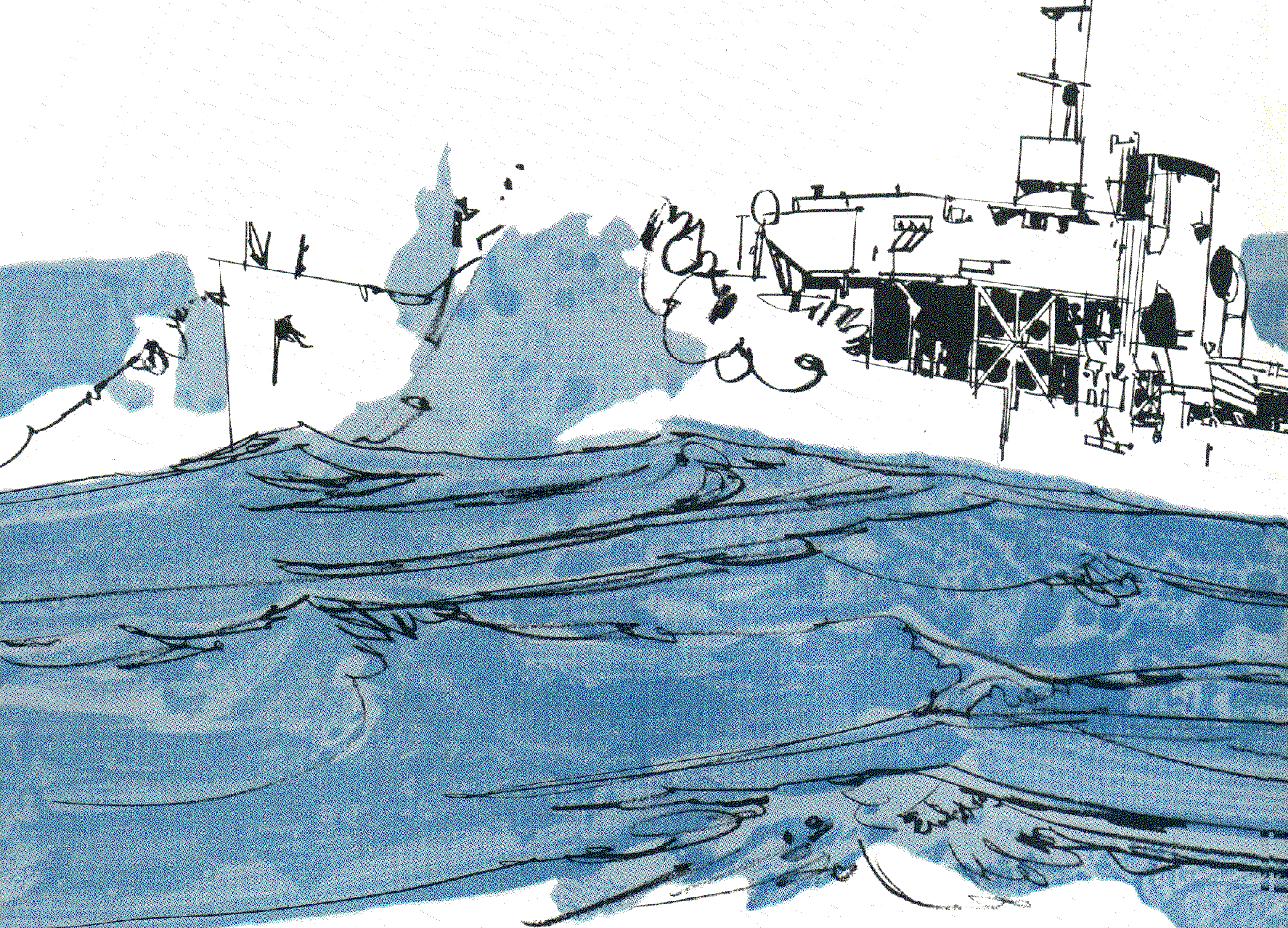
issue 25 AUGUST 1972



Lockheed ORION Service Digest

THE P-3C ORION



THE LOCKHEED PV-1 VENTURA

NOT FOR PUBLIC RELEASE

FRONT AND BACK COVERS Patrol Squadron Twenty-Four, based at NAS Jacksonville, Florida, engages in anti-submarine warfare as its primary mission and aerial mine warfare as its secondary mission.

Patron Twenty-Four was commissioned in 1943 as Bombing Squadron One Hundred Four, redesignated Heavy Patrol Squadron Four in 1946, and in 1948 assumed its present designation of VP-24. Its twenty-nine year history progresses from the PBY Catalina to the computerized P-3C Orion in 1970.

During World War II the squadron established an enviable record in the Pacific. For daring raids at Guadalcanal and the Phillipines, the squadron received two Presidential Unit Citations, the only squadron in the history of Patrol Aviation to receive this coveted award twice. VP-24 was also instrumental in initiating the effective mast level bombing technique which accounted for the sinking of many enemy ships.

Following World War II, the squadron participated in the testing and development of the "Bat", the Navy's first air to surface guided missile. As a result the nickname "Bat Squadron" and "Batmen of VP-24" has carried down through the years. The famous Batgirl insignia is unique as the only authorized U.S. Naval squadron insignia displaying a member of the fair sex. The squadron's recent deployments have been to Keflavik, Iceland, where they performed ice patrols in support of Naval Oceanographic Office research efforts in addition to their regular ASW functions.

Recent citations include the Meritorious Unit Citation for special ASW projects, and the Navy Unit Citation for sensitive ASW operations. The squadron has also received the Captain Arnold J. Isbell Trophy for ASW excellence, the Battle Efficiency Award, the COMNAVAIRLANT Safety Award, and most recently, the CNO Maintenance Excellence Award.

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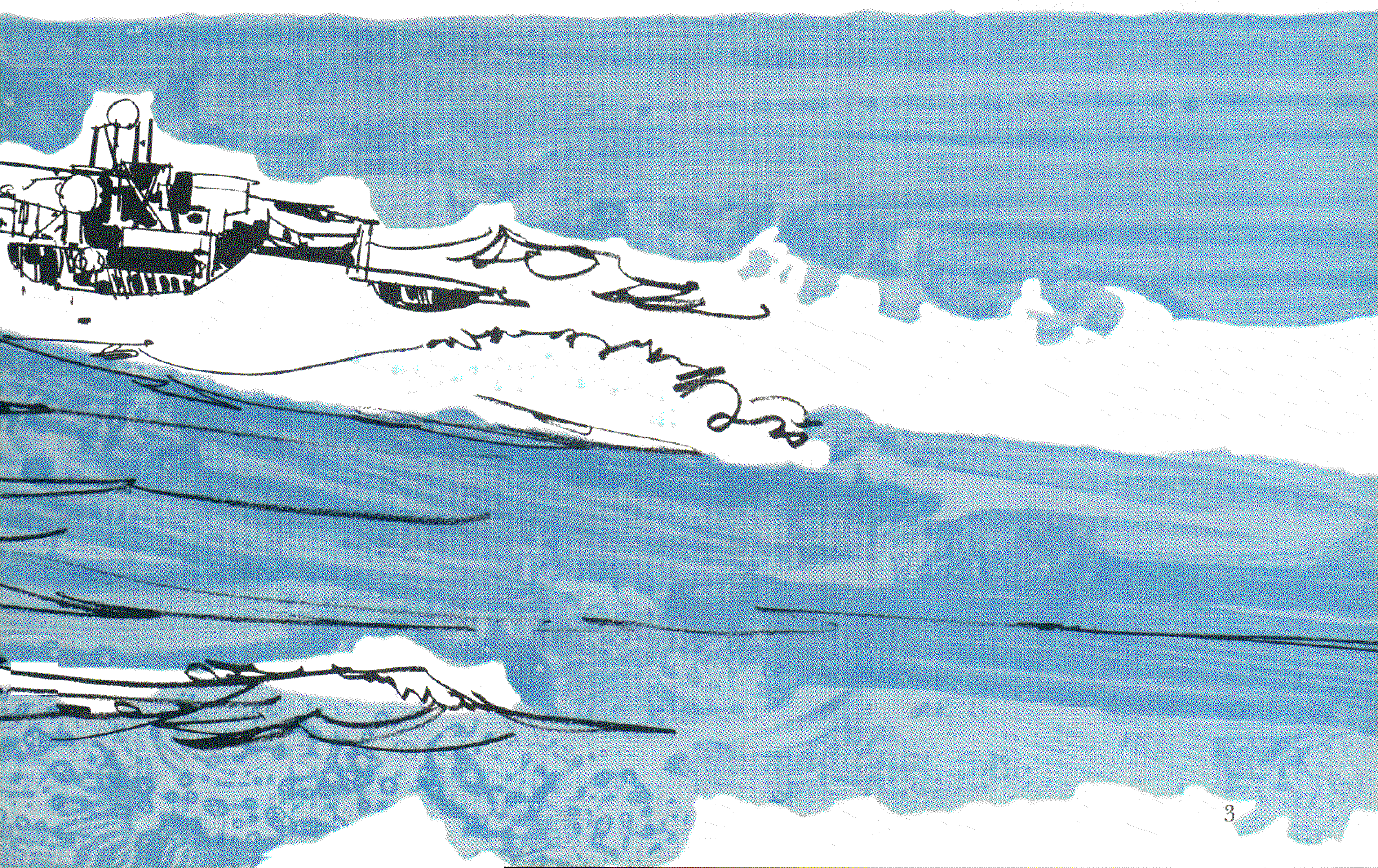
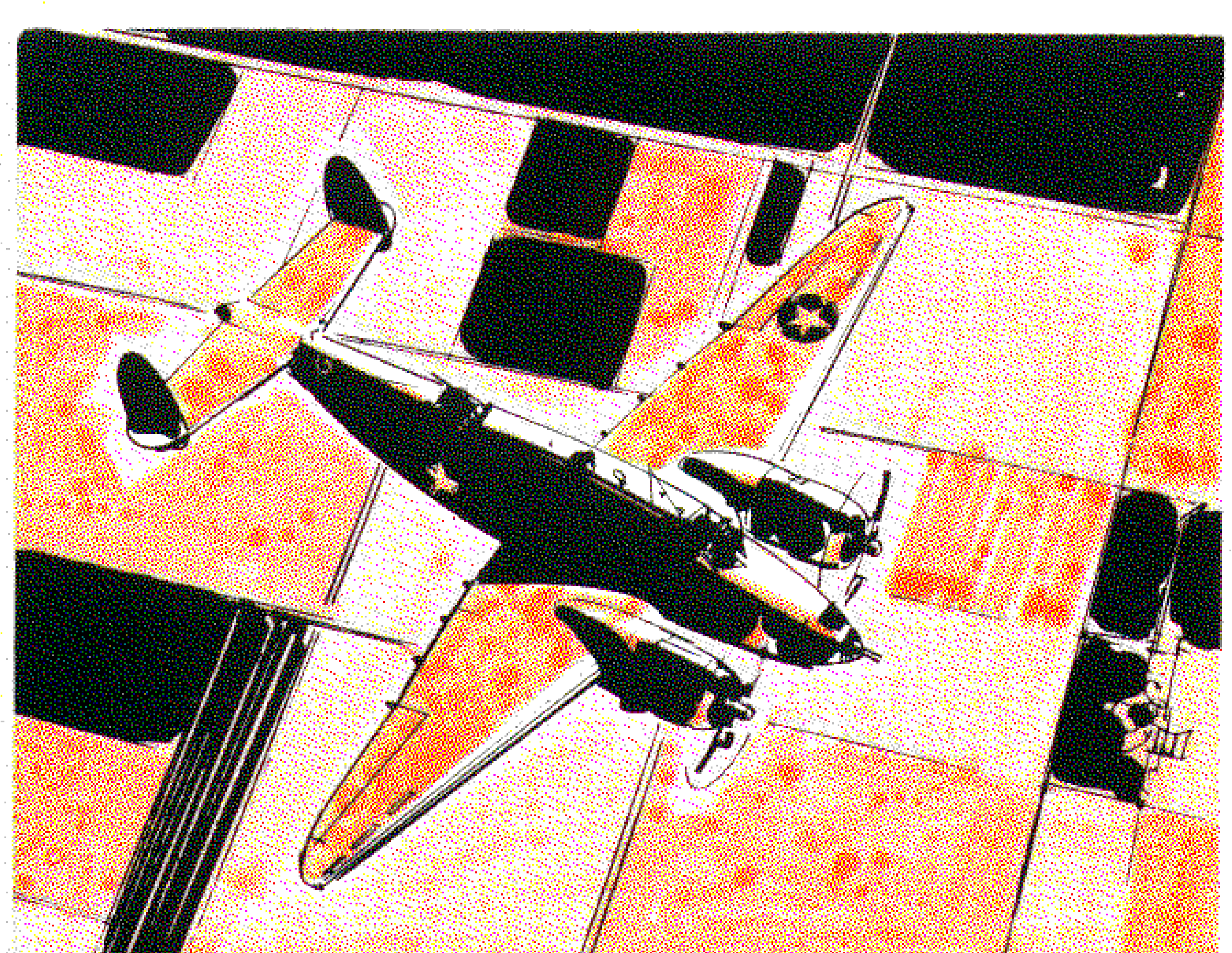
editor WAYNE CRADDUCK
assistant editor LUCILE HEMANN
art and production by FORREST LINDSEY



THE P-3C ORION

EVOLUTION



PV-2 HARPOON

During the first half of World War II, Lockheed built over 1600 PV-1 Venturas – one of the world's first successful land-based ASW patrol bombers. Development of a larger and longer-range replacement, the PV-2 Harpoon, resulted in the production of 535 additional aircraft of advanced ASW design. Late in 1942, preliminary design began on the world-famed P2V Neptune with 17 years of production and seven models to accommodate the steady advancement in the state-of-the art in ASW electronics equipment.

By 1958, the P2V Neptune had outgrown the reserve load-carrying capacity of the basic airframe, and a follow-on airplane was needed. The new airplane, the P-3 Orion, went into service in 1962, carrying the most advanced ASW equipment available. The P-3 was capable of longer range and endurance, operation from shorter fields, greater speed, and higher ceiling. A strengthened and modified version of the Lockheed Electra, the Orion airframe included structural redesign to produce a highly efficient fail-safe construction, long fatigue life, and overall strength to meet the requirements for U. S. Naval aircraft.

P-3A The P-3A incorporated advanced engines, and the latest equipment for acoustical analysis, navigation, and ECM direction finding. The P-3A could accommodate the electronic developments becoming available to the ASW forces. Powered by four T56-A-10W turboprop engines, it has a top speed of over 400 knots but can loiter for long periods at speeds of under 200 knots, permitting high speed transit to submarine datum areas with long on-station time. The navigation system provides a capability for precise, long range, point-to-point navigation. Turboprop cruise economy at low altitude permits extended low altitude approach to the mining area and penetration under radar defenses.

Mine Laying Beginning with SerNo 150506 (Lockheed Serial 5032) the Orion was provided with a mine laying capability. Mining enemy waters is an effective method of restricting movement or destroying enemy submarines, warships, and cargo vessels.

The Deltic Installation Deltic was a major ASW system improvement that was accomplished beginning with aircraft SerNo 152140 (Lockheed Serial 5110) and up and SerNo 150509 (Lockheed Serial 5035). The major equipments installed were the AQA-5 Sonobuoy Indicator-Jezebel (in lieu of the

AQA-3A or 4), the AQH-1 Tape Recorder, and the ASA-50 Ground Speed and Tactical Bearing Computer.

Auxiliary Power Unit (APU) An auxiliary power unit was installed during production beginning with aircraft SerNo 152141, 152164, and subsequent (Lockheed Serial 5111, 5124, and subsequent). Aircraft not production-equipped with APU's were retrofitted. The APU can provide the aircraft with electric power and pneumatic power for either air conditioning or engine starting while on the ground, and with emergency electrical power during flight.

P-3B The main changes in the P-3B's from the P-3A's were the improved engines and the radar altitude warning system (RAWS). Design improvements were incorporated during production of later P-3B aircraft to give them higher gross weight takeoff capability.

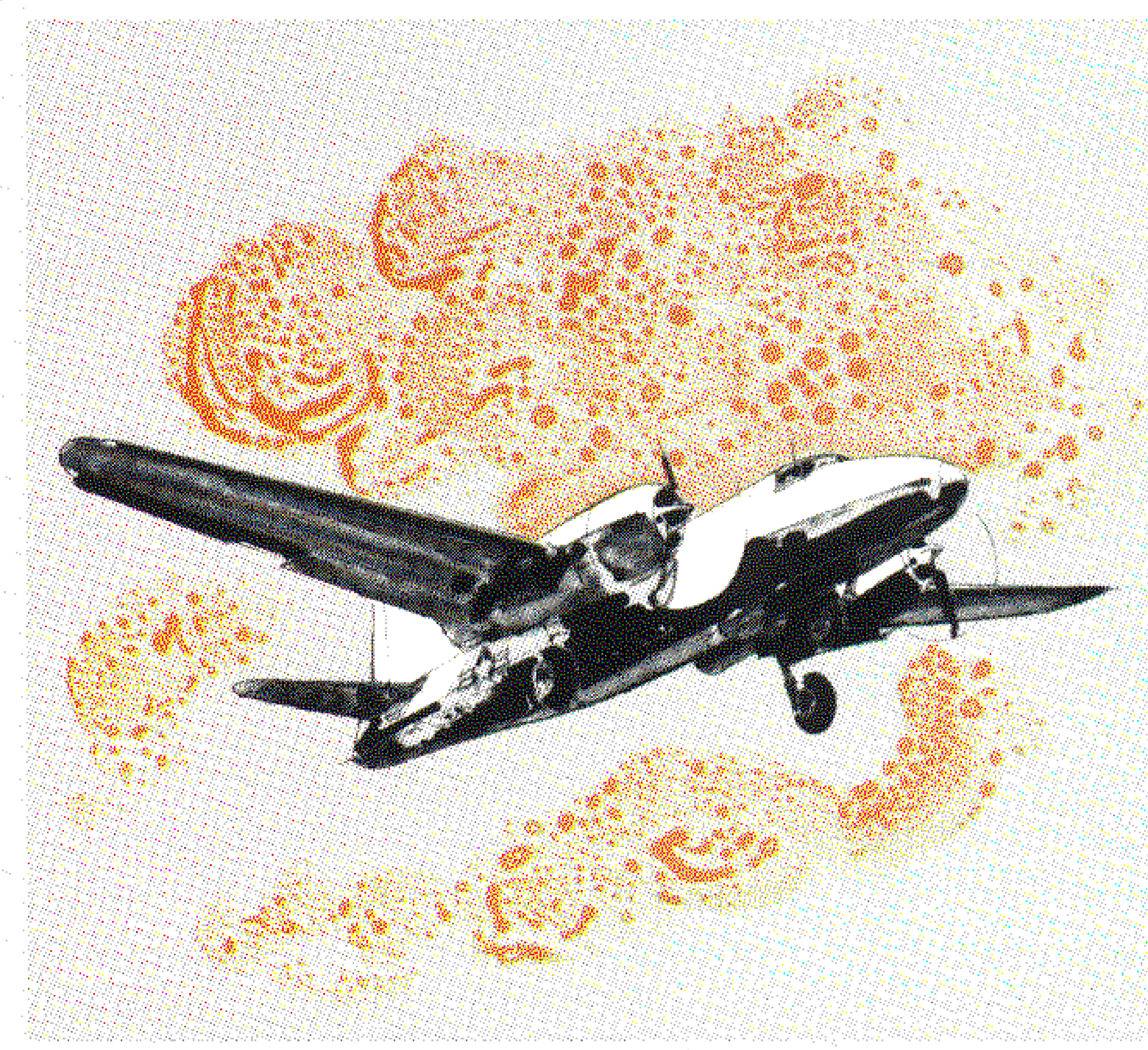
T56-A-14 Engine The P-3B aircraft are powered by T56-A-14 engines rather than water-alcohol injection augmented T56-A-10W engines. The T56-A-14 engine produces 4910 equivalent shaft horsepower (ESHP). Approximately 4591 horsepower is delivered to the propellers, and the exhaust produces 797 pounds jet thrust which is equivalent to another 319 horsepower. The T56-A-14 engines provide increased rate of climb, shorter takeoff distance, increased maximum cruise speed, and higher cruise ceiling. Table 1 gives the static-rated performance specifications for both engines, while Table 2 gives their actual performance characteristics.

Radar Altitude Warning System (RAWS) An APQ-107 radar altitude warning system was added to the first P-3B, SerNo 152718 (Lockheed Serial 5158), to operate in conjunction with the APN-141(V) radar altimeter and the PB-20N autopilot. The APQ-107 presents a visual and an aural low altitude warning to the pilot and copilot. This system is being retrofitted on all P-3A aircraft.

Increased Gross Weight Takeoff (GTO) With the many improvements incorporated through the years, 2500 lb were added to the empty weight of the original configuration of the P-3, while the recommended gross weight maximums remained fixed: 127,500 lb takeoff and 105,000 lb landing.*

**Landings at gross weights in excess of 91,320 lb shall be made at a minimum rate of descent.*

Although the weapon system capabilities were enhanced as this weight was added, the useful load was penalized. Thus, design changes were made in early 1966 to increase the empty weight of the P-3 from that first calculated in 1960. As a result, the recommended maximum takeoff weight gained 7500 lb (from 127,500 to 135,000); and landing weight gained 9000 lb (from 105,000 to 114,000).† In addition, a new maximum overload takeoff weight, carrying external stores, was established at 142,000 lb (with reduced load factor).



P2V NEPTUNE

A few of the changes affected the main landing gear assemblies (for soft landings) and provided a fuel dump capability for the center section tank. However, most of the changes were to structural elements distributed throughout the airframe (mostly the wing) which were redesigned to accommodate the higher loads. Incorporation of these changes was begun during P-3B production with SerNo 153442 (Lockheed Serial 5239). As the added weight of new avionics and armament equipments was introduced, these structural improvements obviated potential overload operation for the later P-3B and all of the P-3C aircraft.

Bullpup Missile Capability The AN/ARW-77 Bullpup Guidance Missile System was installed on the P-3B aircraft early in production with SerNo 152740, 152749, and up (Lockheed Serial 5180, 5189 and

†Landings in excess of 103,880 lb shall be made at a minimum rate of descent

Table 1. T56-A-10W and - 14 Static Rated Performance Specification Comparison

POWER CONDITION	T56-A-10W SHP	T56-A-10W TIT	T56-A-14 SHP	T56-A-14 TIT
TAKEOFF	4200 (WET)	971°C	4591	1077°C
MILITARY	3755	971°C	4368	1049°C
NORMAL	3443	932°C	4061	1010°C

up). Those P-3B aircraft on which the Bullpup system was not installed in production were equipped by retrofit, as were most P-3A aircraft per airframe change No. 117.

P-3C CONCEPT – A-NEW In 1960 the Navy initiated a program to develop *a new* integrated ASW avionics system. The Bureau of Naval Weapons assigned the task to the Naval Air Development Center at Johnsville, Pennsylvania. This program, with subsequent modifications and increasing scope, became the A-NEW ASW avionics system. The main thrust of the effort involved incorporation of a general purpose digital computer to interconnect the various ASW systems and improve the speed and accuracy of information processing through transmission, display, and retrieval of tactical ASW information.

Meanwhile, as the ASW system in the P-3A and P-3B increased in complexity, the burden on the airborne crew increased correspondingly. With complex equipment to handle, and with requirements for better documented records of flight and ASW contacts, the time remaining to concentrate on tactics was becoming marginal.

The A-NEW concept initiated a series of laboratory and flying test bed development sequences which eventually resulted in the P-3C airplane design and production. Figure 1 shows interior and exterior views of the flying test bed. The P-3C concept enables the crew to devote more time for processing sensor data and making tactical decisions. Principal systems of P-3A/B and P-3C aircraft are compared in Table 3.

The P-3C system is basically the integration of the crew and airborne sensors through the use of a digital computer. Considerable improvements have been made in the sensor systems themselves, but the big advantage of the system lies in the computer's ability to process many bits of information to assist the crew in making decisions faster and more accurately than can be done otherwise. Its

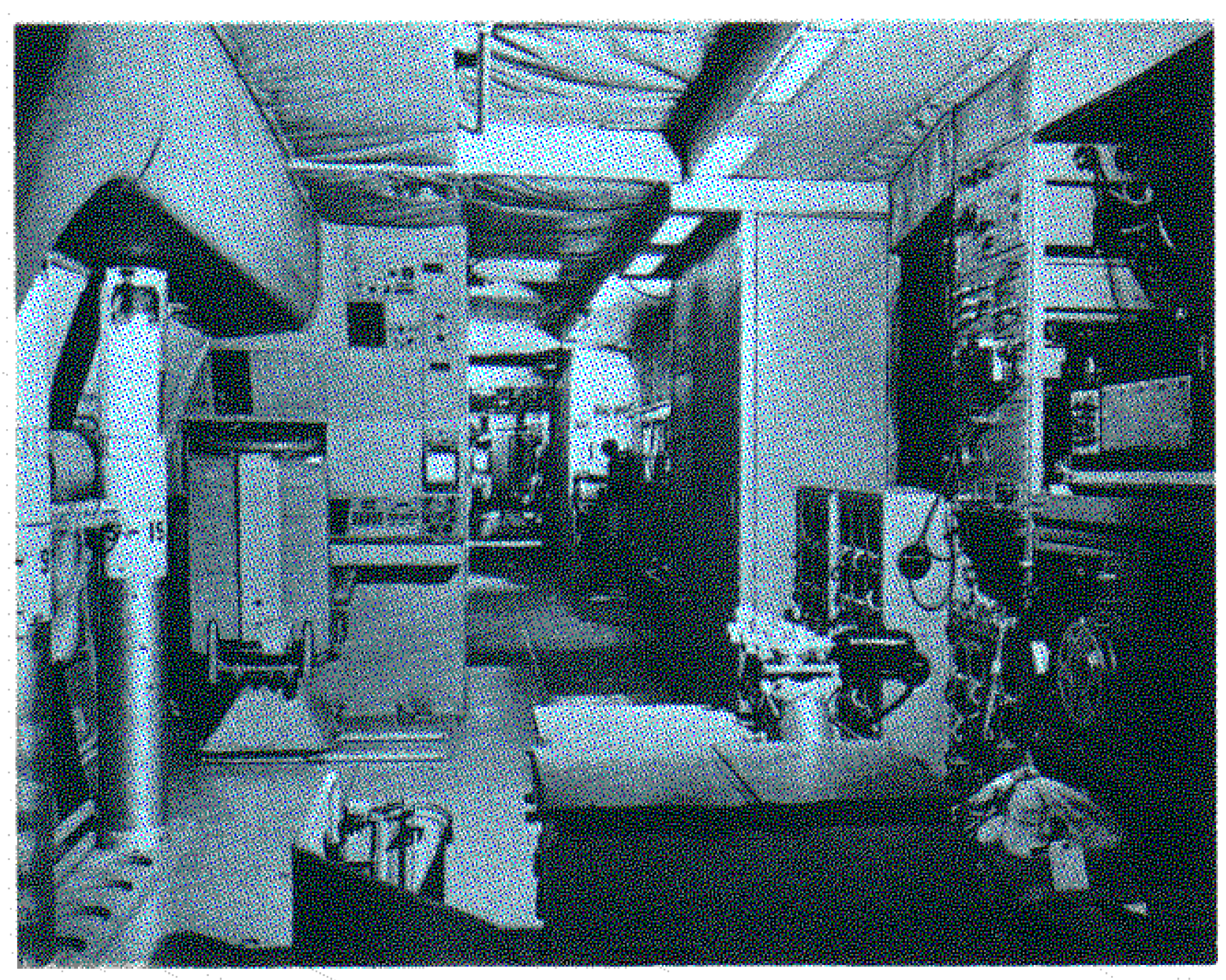
Table 2. T56-A-10W and - 14 Engine Operating Limits Comparison

POWER CONDITION	T56-A-10W SHP	T56-A-10W TIT	T56-A-14 SHP	T56-A-14 TIT
TAKEOFF	4300 – 4500 (3 SECONDS)	977°C (5 MINUTES MAX. DRY; 3 MINUTES MAX., WET)	4600 (AIRCRAFT LIMITING, 5 MINUTES) – 5300 (ENGINE LIMITING, 3 SECONDS)	1083°C (5 MINUTES, MAX.)
MILITARY	3950 – 4300 (30 MINUTES) – 4300 – 4500 (3 SECONDS)	977°C (30 MINUTES)	4600 (30 MINUTES)	1049°C (30 MINUTES)
NORMAL/ MAXIMUM CRUISE	3950 (CONTINUOUS OPERATION)	932°C	4600 (CONTINUOUS	1010°C
DURING GROUND OR AIR STARTS, LEAVE THE POWER LEVER AT THE START POSITION UNTIL THE OIL TEMPERATURE IS ABOVE 0°C; WITH OIL TEMPERATURE BETWEEN 0° AND 40°C, POWER LEVERS MAY BE SET TO 1000 HP MAXIMUM DURING WARMUP.				

large memory allows computation and storage of innumerable details concerning the mission. These are kept readily available for real time computation and later use.

The system incorporates computer-controlled displays at the Tactical Coordinator (TACCO) Station, Pilot Station, and Sensor Station No. 3 for presentation of tactical and sensor information. The arrangement of the crew stations in the P-3C is shown in Figure 2. The digital displays are continuously updated to present the current flight situation and provide the operator with amplifying information about the mission. Keyset switches at each of seven stations enable the operator to communicate with the digital computer which, in turn, can modify his display and/or perform those functions initiated at his station.

An additional display at the TACCO and Navigation/Communication (NAV/COMM) stations enables the operator to view and/or modify numerous tableaus containing data pertinent to the mission. The displays are controlled by the operator's keyset switches which are used to enter data into the computer memory regarding status of equipment, weapons and search stores, inventories, sonobuoy audio system status, and navigation data. Corrections and revisions to the tableaus can be made manually by the operator through the computer or automatically by the computer upon a change in status.



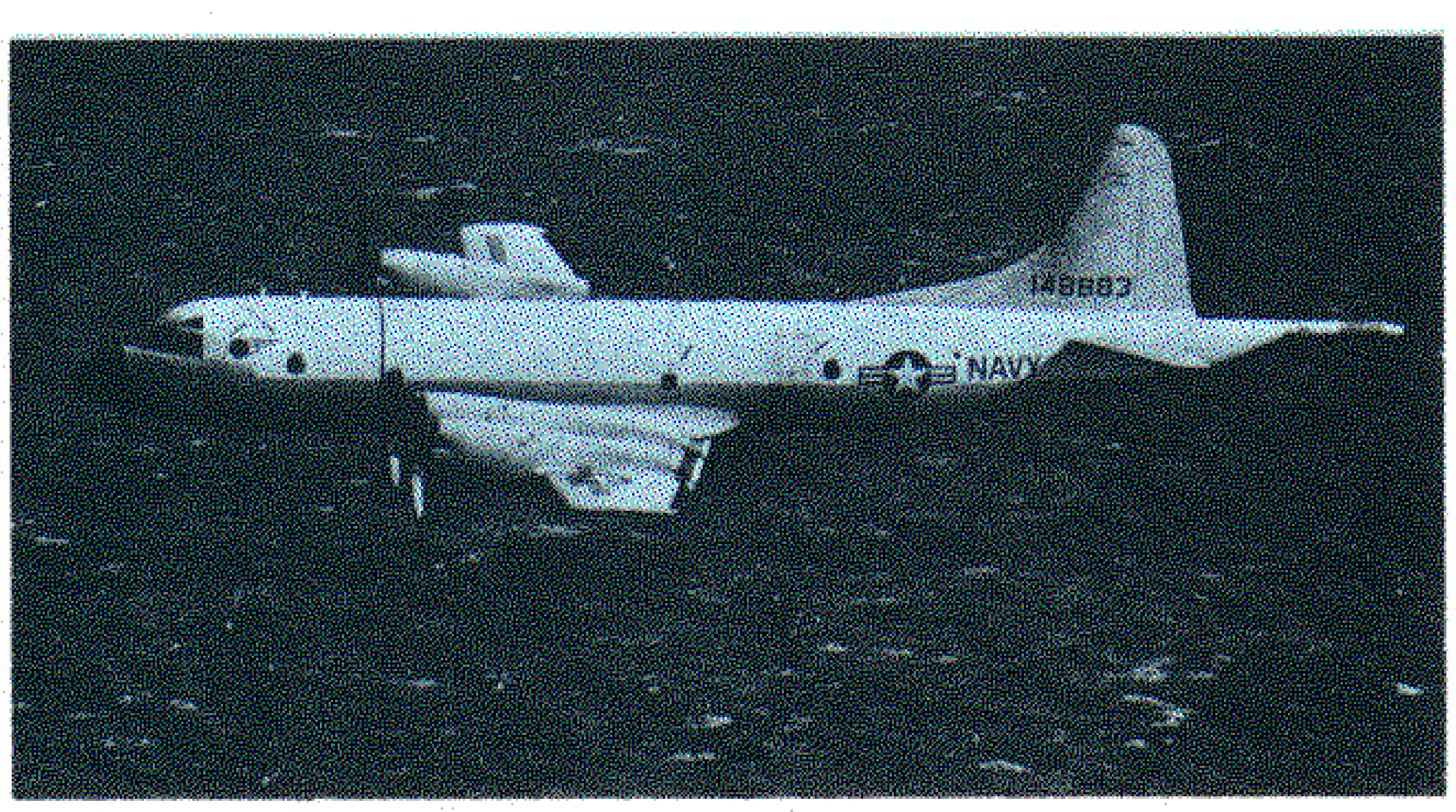


Figure 1. P-3C Flying Test Bed

Table 3. Comparison of Principal Systems on P-3A/B and P-3C Aircraft

P-3A/B*	P-3C
NAV SYSTEM	
ASN-42 INERTIAL	ASN-84 INERTIAL
APN-153A DOPPLER	APN-187 DOPPLER
ASA-47 D/AM COMPUTER	–
ASN-50 AHRS	–
APN-70 LORAN	ARN-81 LORAN
ARN-52 TACAN	ARN-52 TACAN
ARD-13 ADF	ARN-83 ADF
ARN-32 MARKER BEACON	ARN-32 MARKER BEACON
APN-141 RADAR ALT	APN-141 RADAR ALT
ARA-25A UHF DF	ARA-50 UHF DF
APQ-107 RAWS	APQ-107 RAWS
PB-20N AUTOPILOT	ASW-31 AFCS
ARN-87 VOR	ARN-87 VOR
ASA-50 GND SPD/BRG CMPTR	–
–	51V-4 GLIDESLOPE (NEW)
–	AJN-15 FDS (NEW)
COMMUNICATIONS SYSTEM	
ARC-94 HF	ARC-142 HF
ARC-51A UHF	ARC-143 UHF
AIC-22 ICS	AIC-22 ICS
TT-264/AG TTY	AGC-6 TTY
UNH-6 TAPE RECORDER	–
ARN-87 VHF	ARN-87 VHF
APX-7 IFF	APX-72 IFF
APX-6 SIF	APX-76A SIF
–	ACQ-5 DATA TERMINAL (NEW)
ACOUSTIC SENSORS	
AQA-3, 4, 5 JEZ	AQA-7 DIFAR
AQA-1 SONO IND	–
ASA-20 JULIE	–
ARR-52A SONO REC	ARR-72 SONO REC
AQH-1 RECORDER	AQH-4 RECORDER
–	RO-308 BT (NEW)
NON-ACOUSTIC SENSORS	
APS-80 RADAR	APS-115 RADAR
ALD-2B ECM	ALQ-78 ECM
ASQ-10A MAD	ASQ-81 MAD
ASR-3 TRAIL	–
AVQ-2C SEARCHLIGHT	AXR-13 LLLTV
–	ASA-64 SAD (NEW)
DATA PROCESSING	
–	ASQ-114 COMPUTER (NEW)
–	AYA-8 DATA PROC GRP (NEW)
DISPLAY SYSTEM	
ASA-16 TACTICAL DISPLAY	ASA-70 MULTI-PURPOSE (TACCO) DISPLAY
APA-125A RADAR DISPLAY	ASA-70 MULTI-PURPOSE (SS-3) DISPLAY
OA-1768 PLOTTER (PILOT)	ASA-66 TACTICAL DISPLAY
PT-396 PLOTTER (NAV)	–
ARMAMENT SYSTEM	
MANUAL CONTROL	COMPUTER CONTROL
PHOTO SYSTEM	
KB-10A CAMERA	K-18 AFT CAMERA
–	KA-74 FWD CAMERA (NEW)

*P-3A IS EQUIPPED WITH T56-A-10W ENGINES
P-3B IS EQUIPPED WITH T56-A-14 ENGINES

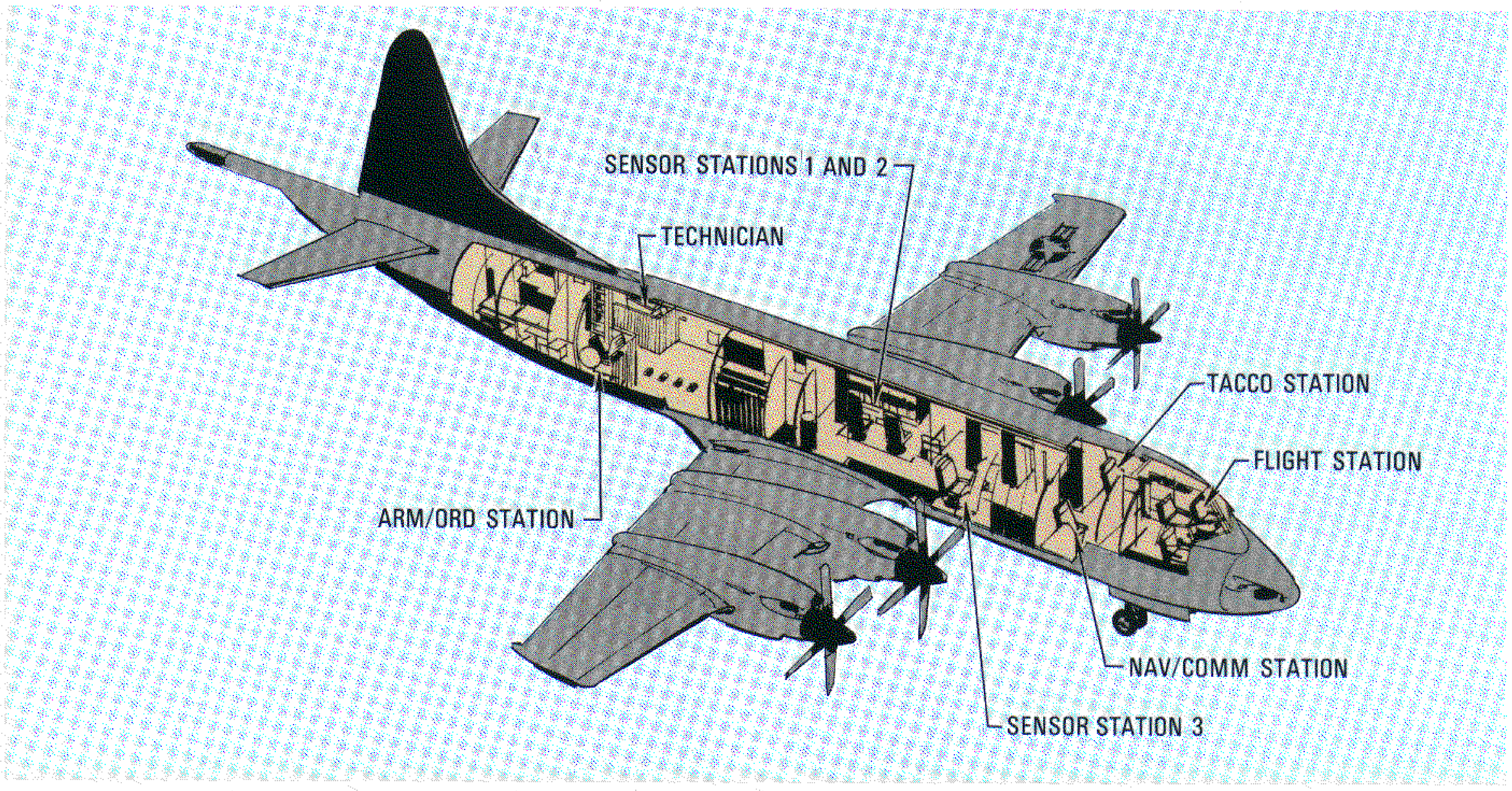


Figure 2. P-3C Crew Stations

The computer assumes a great number of the navigation functions previously handled manually. It continuously checks navigation system operation and automatically selects an alternate system in event of malfunction. It updates the displays to maintain a current geographical or tactical position for the airplane. It computes latitude-longitude for the airplane and displays latitude-longitude for sonobuoys, sensor contacts, and other selected positions upon TACCO request.

The computer assists the TACCO in directing the airplane by providing precise steering instructions for the pilot to selected points through a flight director system. Several kinds of fly-to-points (FTP's) are available, including two which control automatic release of weapons or search stores. FTP's are entered by the TACCO to direct the pilot through sonobuoy fields, through area searches, and to enter orbit patterns around selected buoys or positions, etc. Designated FTP's direct the pilot across selected positions on preselected bearings.

The computer performs most of the weapon and stores management. It monitors sonobuoy launch tubes and wing and bomb bay stations and maintains current kill and search stores inventories. The TACCO can have these inventories displayed at his command. The computer automatically checks to determine if desired drops can be made and presents alternatives, and cues the TACCO to make necessary selections for the drops. It warns of errors made during selection sequences and of discrepancies existing in the armament/ordnance systems. It computes splash points for all released weapons and search stores, and automatically presents the appropriate symbol at the proper position on the TACCO and Pilot displays. It directs the pilot to desired drop points and releases stores automatically if requested by the TACCO.

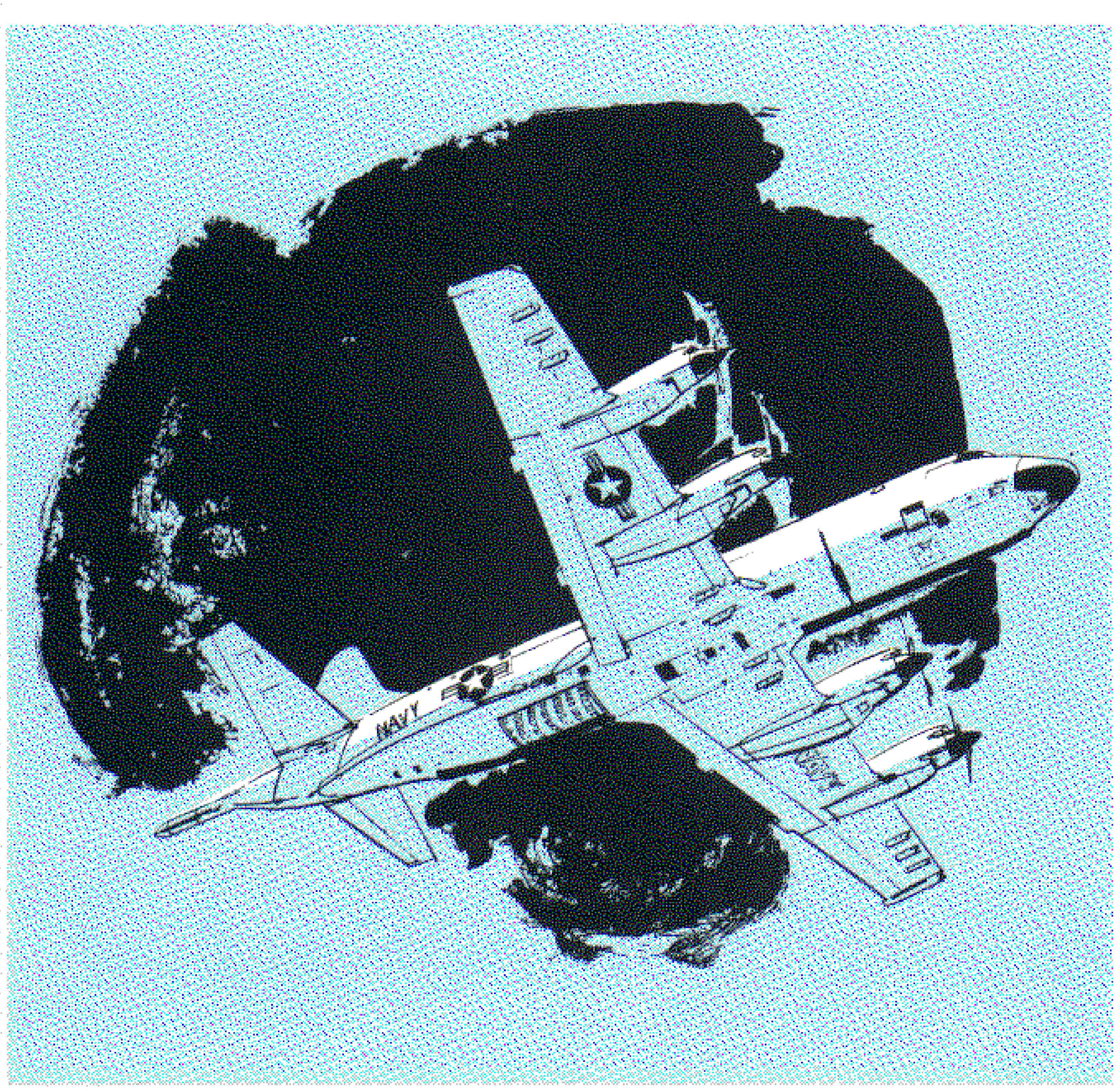
The computer can control the sonobuoy audio system by automatically connecting the sonobuoy audio to an available acoustic processor channel. The Sensor 1 or 2 acoustic operators can override the computer control. The computer, with TACCO in control, automatically selects and drops sonobuoys and tunes the sonobuoy audio signal to the appropriate black box for acoustic processing. The computer also assists the NAV/COMM in external airplane communications by storing and transmitting message traffic. An accurate high speed data transfer rate is therefore assured. Automatic coding/decoding units provide for secure tactical communication in real time.

The P-3C has a greatly improved capability to handle contacts. Radar, acoustic, ECM, MAD, and visual contacts are presented on the appropriate displays. Amplifying data, which include time of contact and aircraft position at time of contact, are stored in the computer memory. These amplifying data can also be displayed under operator control. Contacts are recalled for display at operator discretion or may be removed entirely from memory by the TACCO.

Essential mission data are automatically recorded on digital magnetic tape at regular intervals during flight and whenever a significant event occurs. This relieves the crew of burdensome record-keeping requirements and simplifies later reconstruction of the flight.

Tactical data can be relayed automatically to relieving aircraft, a Naval Tactical Data System (NTDS) ship, or the tactical support center via a data link system.

DESCRIPTION



AIRFRAME CHANGES The outside appearance of the P-3C remains relatively unchanged from that of earlier A and B models; however, the interior has been completely reorganized to take advantage of the airborne digital computer and its associated systems, to provide increased crew comfort, and to provide additional accessibility for maintenance purposes. A comparison of the P-3B/P-3C interiors is shown in Figure 3.

Exterior External changes which distinguish the P-3C include the installation of a two-camera photography system, a low-light-level television system pod (LLLTV), an improved ECM system pod, an improved sonobuoy launch system, redesigned sonobuoy antennas, and three new windows. Some equipment deletions include: lower mid-fuselage camera, searchlight, photoflash cartridges, retro-launcher, SUS launcher, aft stores observing window, driftmeter, ASR-3 nuclei detection (particle detector) system, and wing tip ECM antennas. Typical P-3B and P-3C aircraft are shown in Figure 4.

Interior Internal changes are more extensive due to inclusion of new avionic systems and provisions for increased crew comfort. The arrangement of crew stations within the P-3C (Figure 2) is designed to provide greatest efficiency in man-to-man and man-to-machine relationships. Crew comfort has been increased by fore-and-aft seating wherever possible, and improved operator efficiency and inflight convenience are assured through more efficient controls.

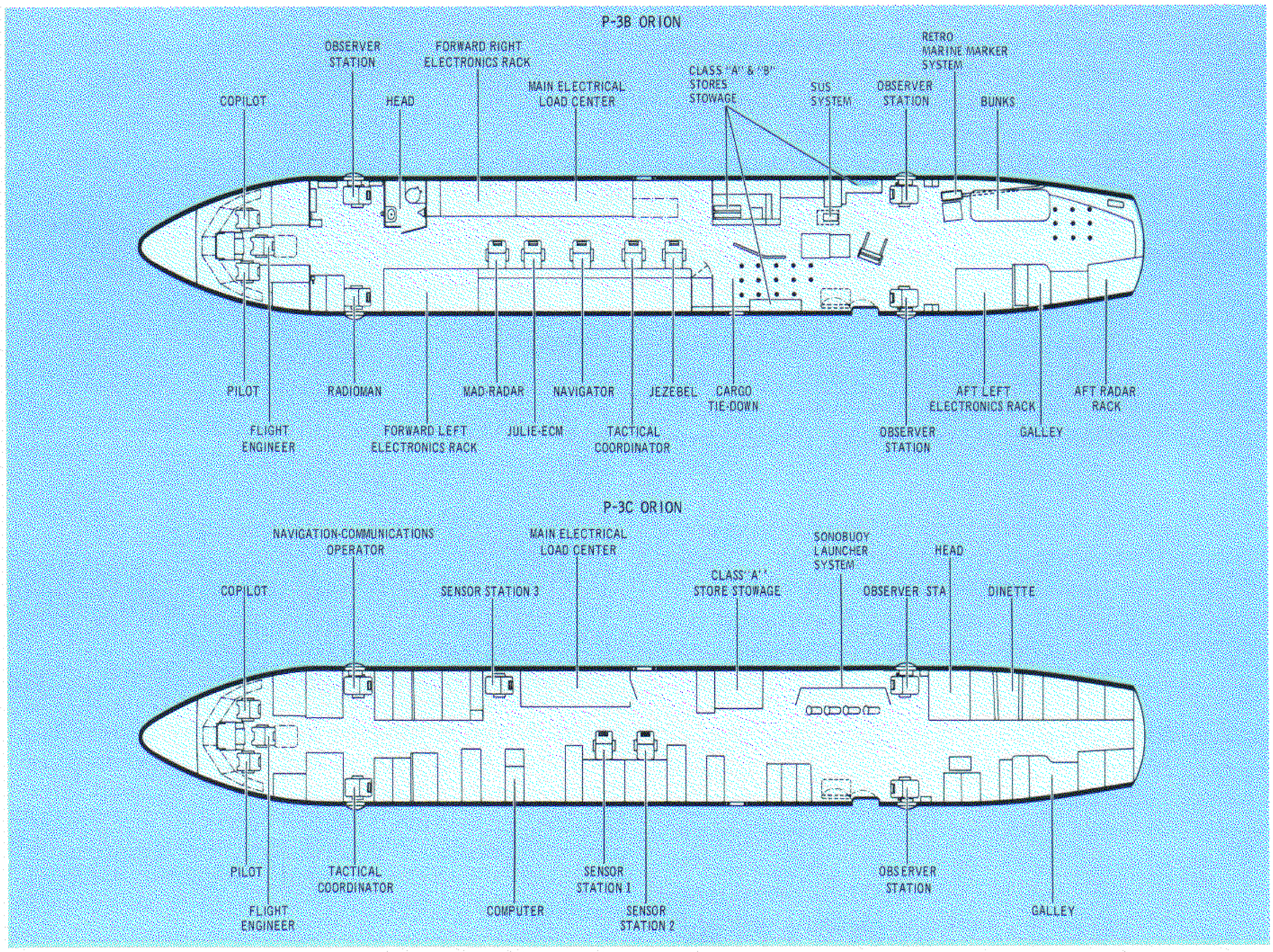
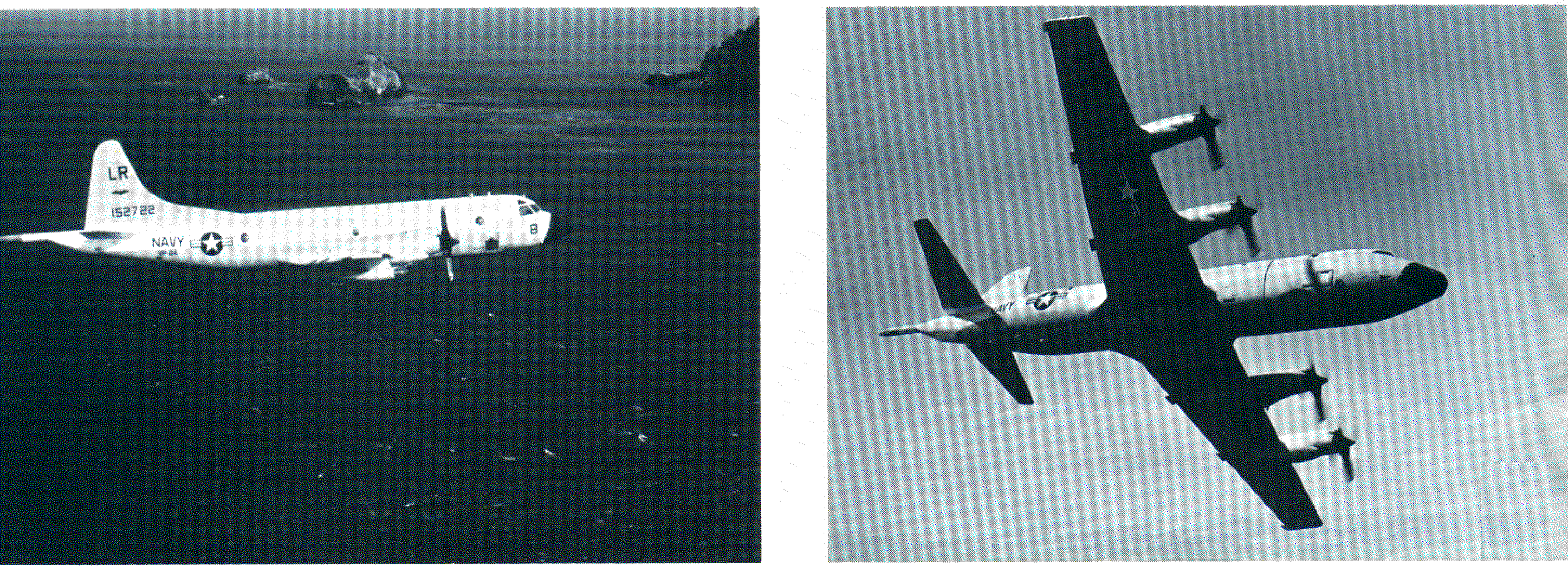


Figure 3. Comparison of P-3B/P-3C Interiors

Figure 4. Typical P-3B (left) and P-3C (right) Aircraft



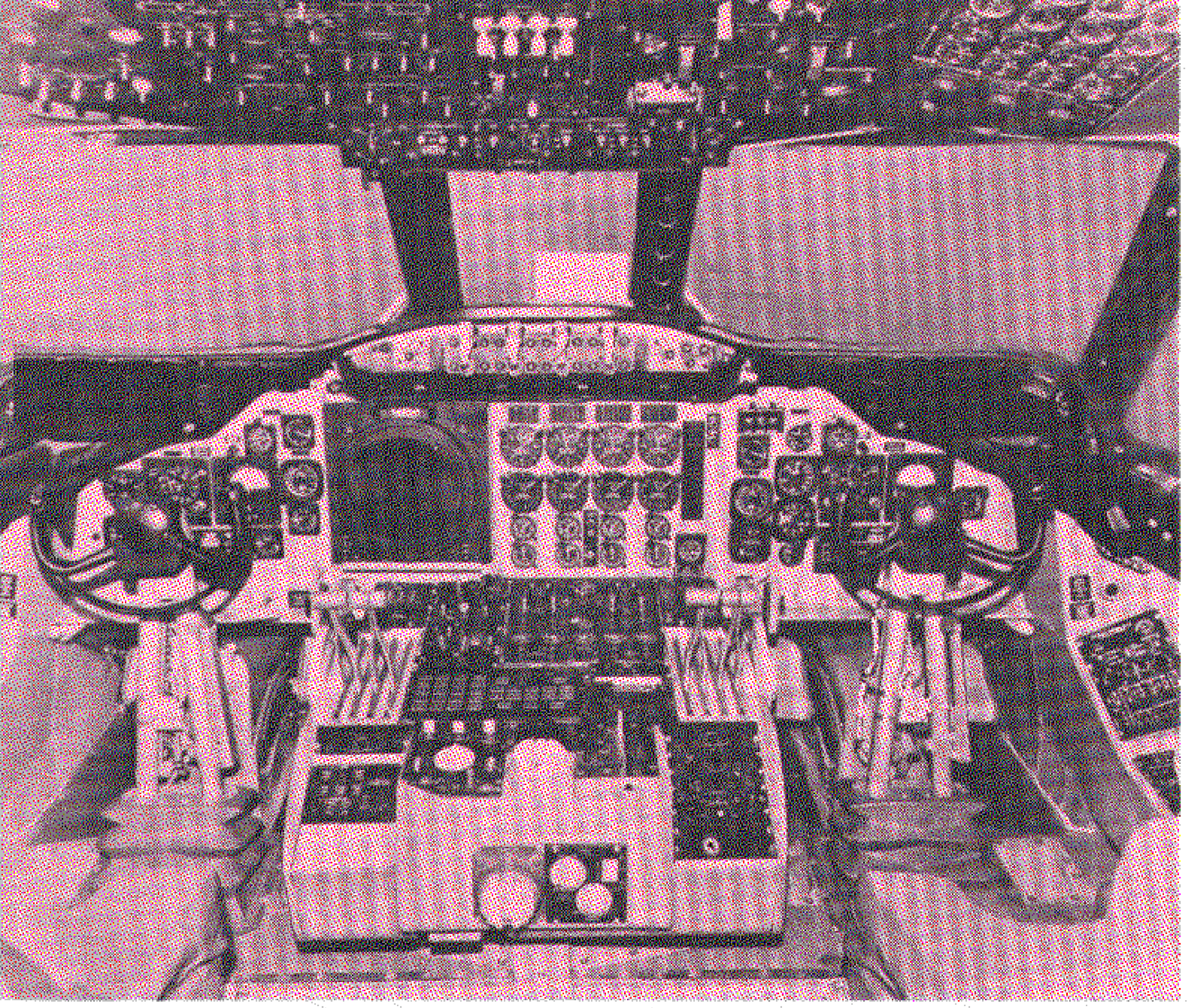
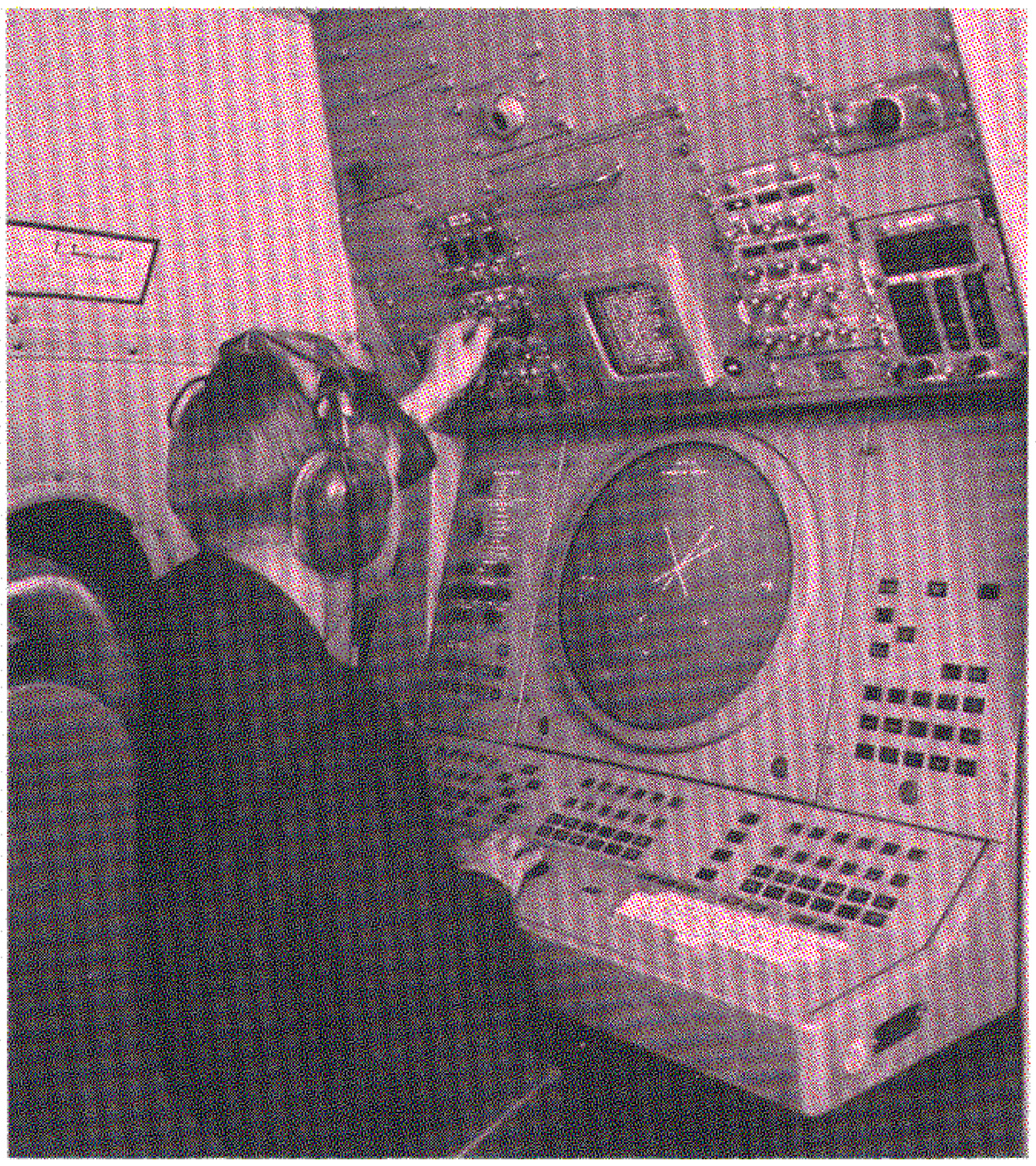


Figure 5. P-3C Flight Station

A minimum aircrew for the P-3C includes the Pilot, Copilot, Flight Engineer, and one additional crewmember. The tactical aircrew for the P-3C consists of 12 stations and includes the Pilot, Copilot, Tactical Coordinator, Navigation/Communications Officer, Flight Technician, Flight Engineer, Second Mechanic, Sensor Station 1 and 2 Operators (Acoustic), Sensor Station 3 Operator (Non-Acoustic), Ordnanceman, and Observer. The crew complement may vary with operational requirements.

Figure 6. P-3C TACCO Station



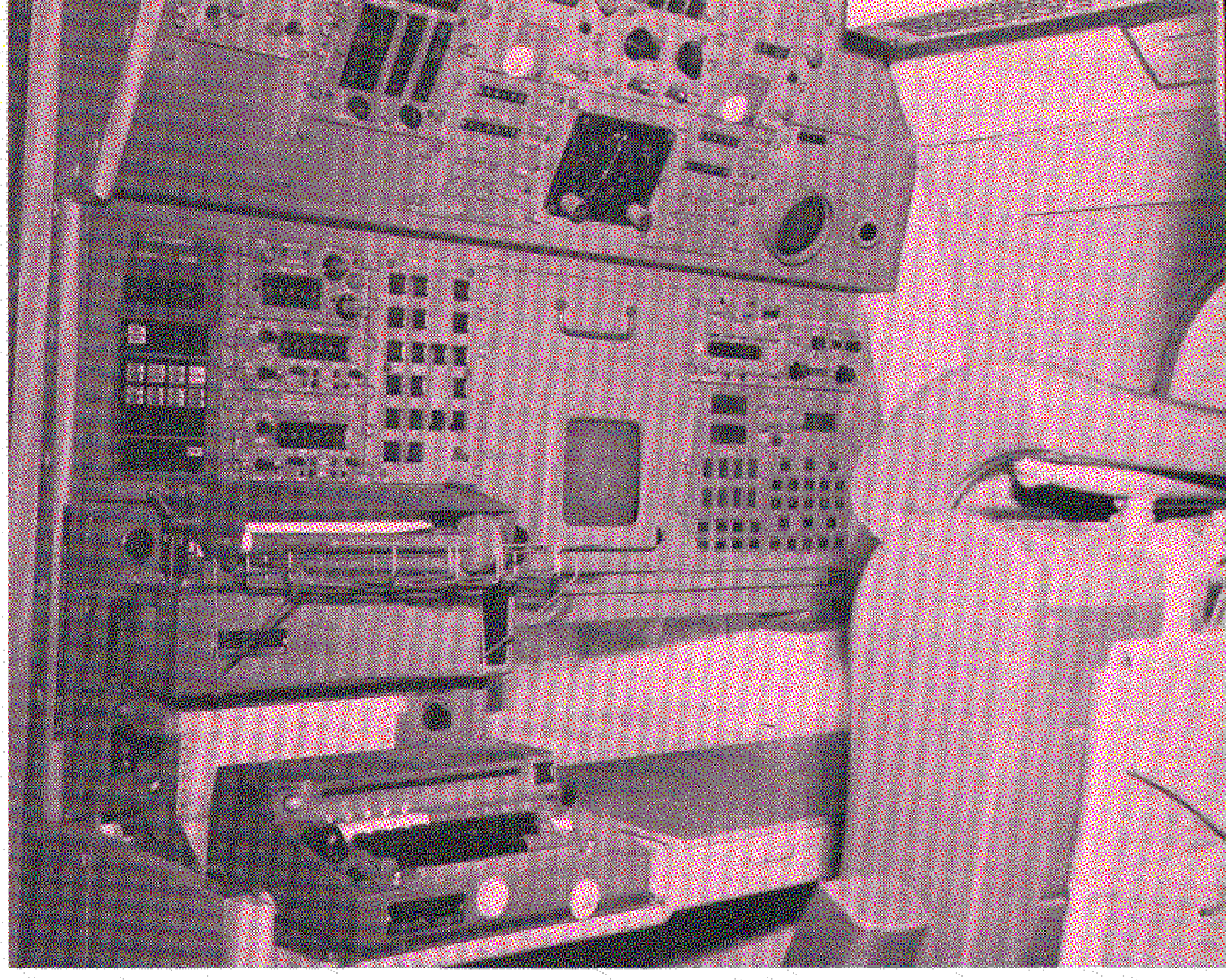
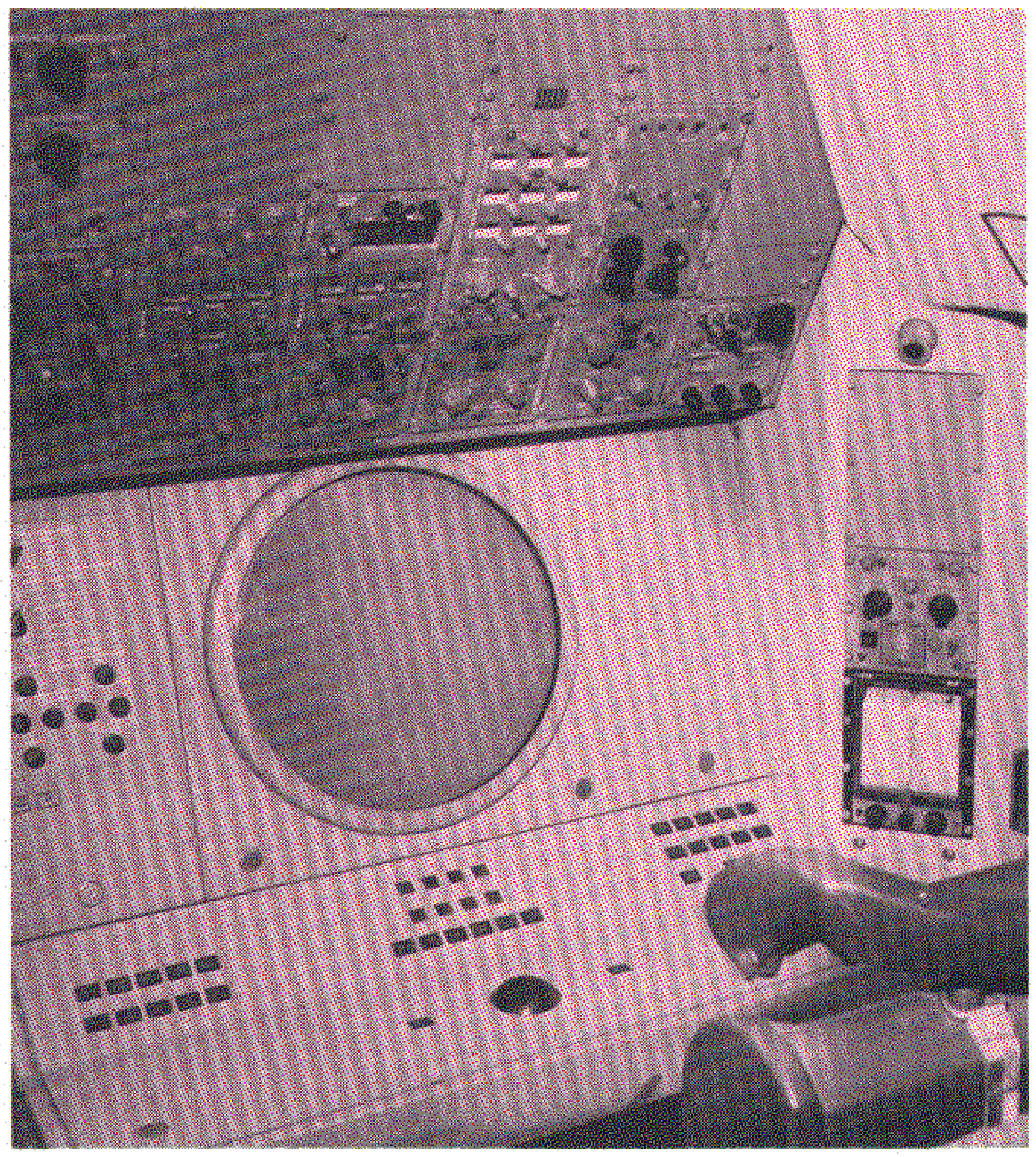


Figure 7. P-3C NAV/COMM Station

Although the basic arrangement of the P-3C Flight Station is essentially the same as the P-3B, the P-3C incorporates many improvements. The key changes are the addition of the new ASA-66 multipurpose tactical data display, a Flight Director System, a redesigned Automatic Flight Control System, and a new Armament Management System. The Flight Station is shown in Figure 5.

The TACCO console (Figure 6) is located forward on the port side immediately aft of the Flight

Figure 8. Sensor Station 3



Station. Across the aisle from the TACCO is the NAV/COMM Station (see Figure 7). Further aft, on the starboard side is Sensor Station 3 (SS-3), which contains controls and displays for all the non-acoustic sensors (Figure 8). Across the aisle from SS-3 is the general purpose digital computer.

Sensor Stations 1 and 2 (SS-1, SS-2), each of which is a complete acoustic data station with equipments that are essentially identical (Figure 9), are located amid-ships on the port side. This side-by-side seating arrangement was determined to be the optimum for communications between acoustic operators and for the cross-training capability afforded.

The area of the main cabin opposite from the entrance door has been designed to accommodate the new sonobuoy launching system. The Ordnanceman performs the loading and unloading of the three pressurized sonobuoy launch tubes as required by the TACCO. He also doubles as the aft starboard observer. The Armament/Ordnance Station is shown in Figure 10.

Figure 9. Sensor Stations 1 and 2

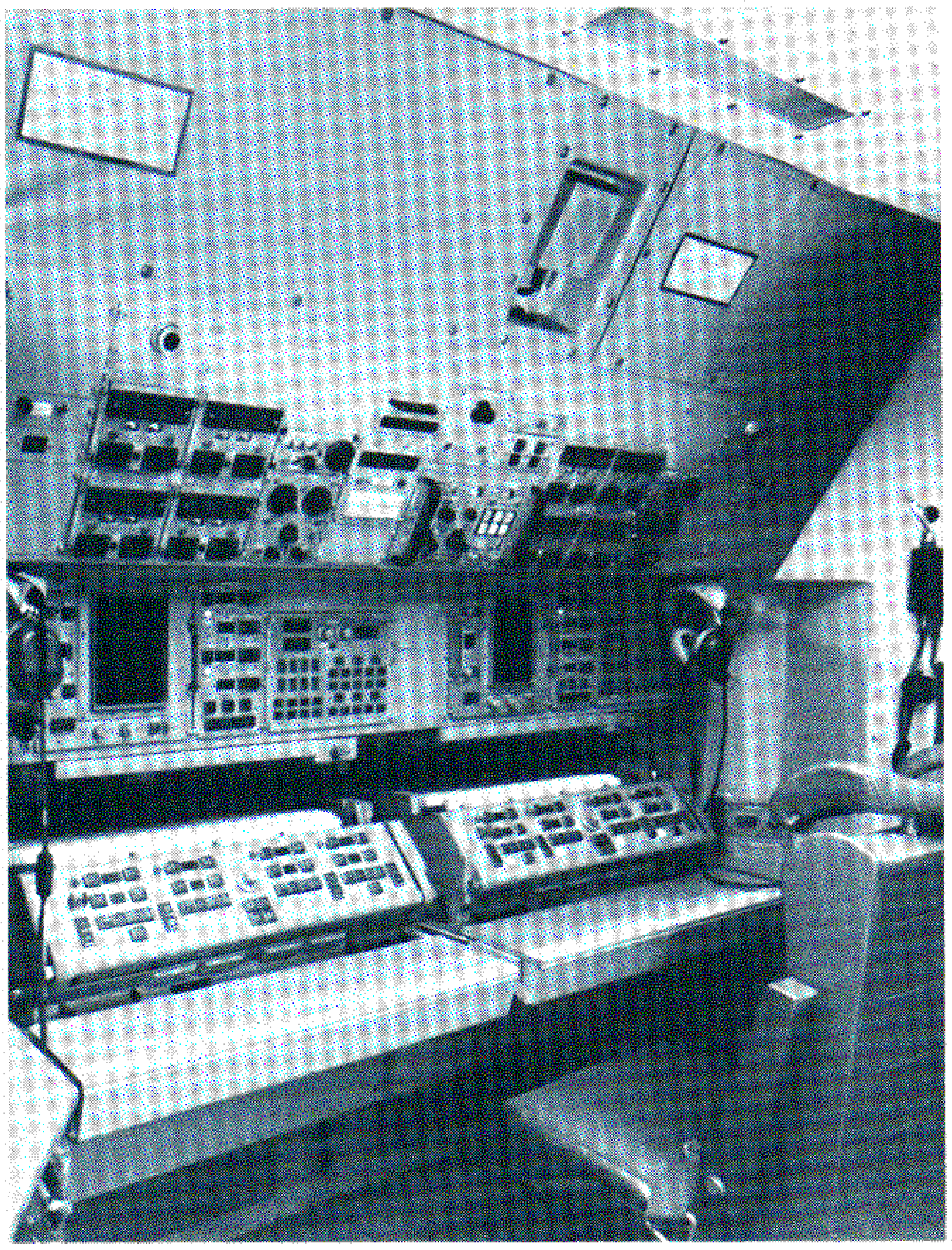
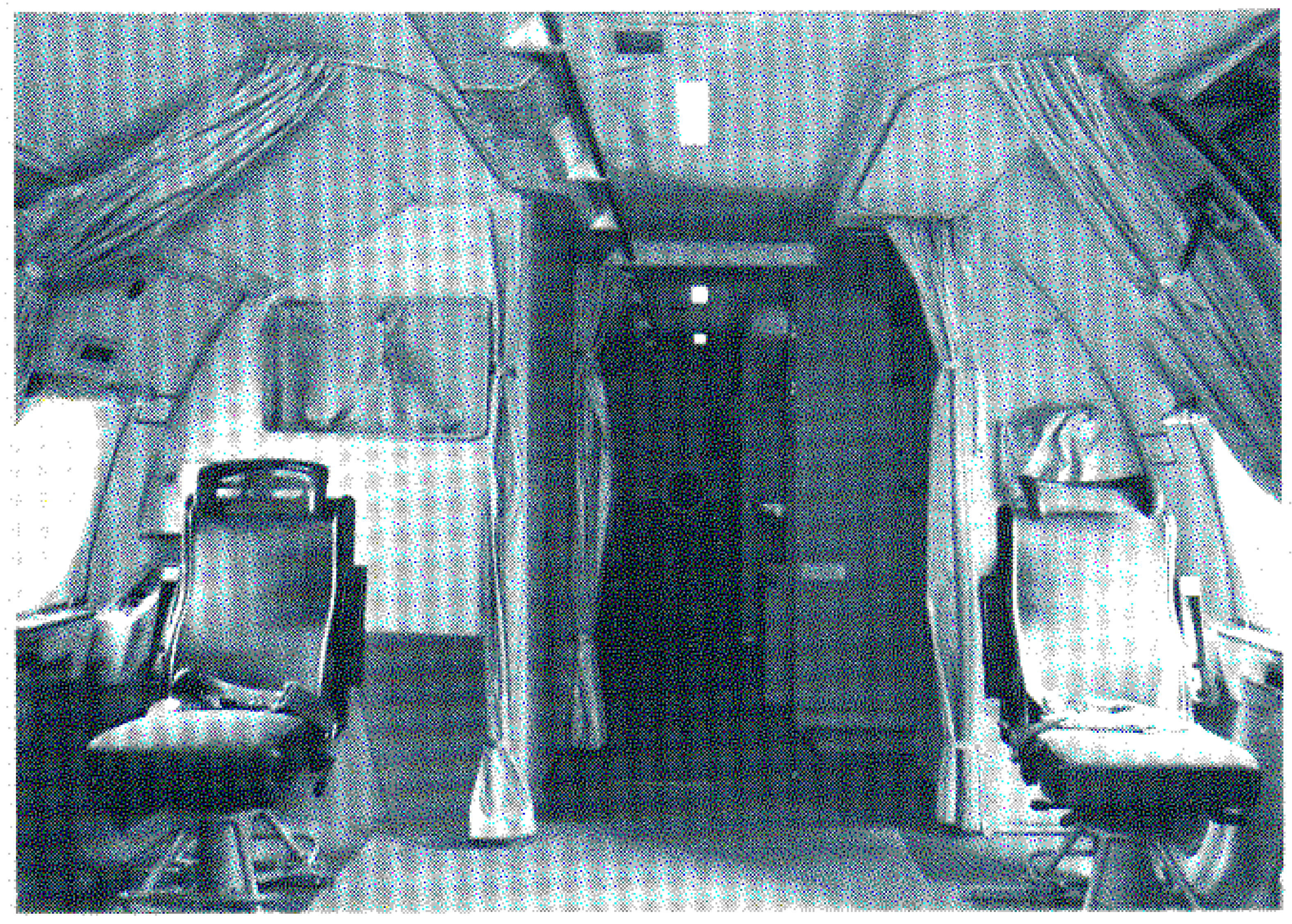


Figure 10. Armament/Ordnance Station. This photograph does not show incorporation of P-3 Airframe Change No. 253 which rotates the hinged breech of the pressurized sonobuoy launch tubes 180^{o}. The new configuration is shown in Figure 30.

The Flight Technician is responsible for preflight checkout of most of the avionics, including the computer and its interfaces. The major avionics preflight can be accomplished via use of the System Test Program. The Flight Technician also performs inflight repair of equipment when possible and doubles as the aft port observer. The aft observers' stations are shown in Figure 11.

Figure 11. Aft Observers' Stations



The aft area of the airplane has been equipped with a dinette, a workbench, a dual-compartment refrigerator for separate freezing and cooling storage, an oven for simultaneous preparation of seven meals, a 36-cup automatic coffeemaker, and two non-flammable garbage containers. (The galley is shown in Figure 12.)

The manually-operated P-3A/B entrance ladder has been replaced with an electrically powered folding boarding ladder which can be relocated for loading aircraft equipment or cargo. The ladder is shown in Figure 13. The lower portion of the entrance door is hinged to allow closure of the door when the ladder is extended. The lower end of the ladder is hinged to permit moving the airplane on the ground without retracting the ladder.

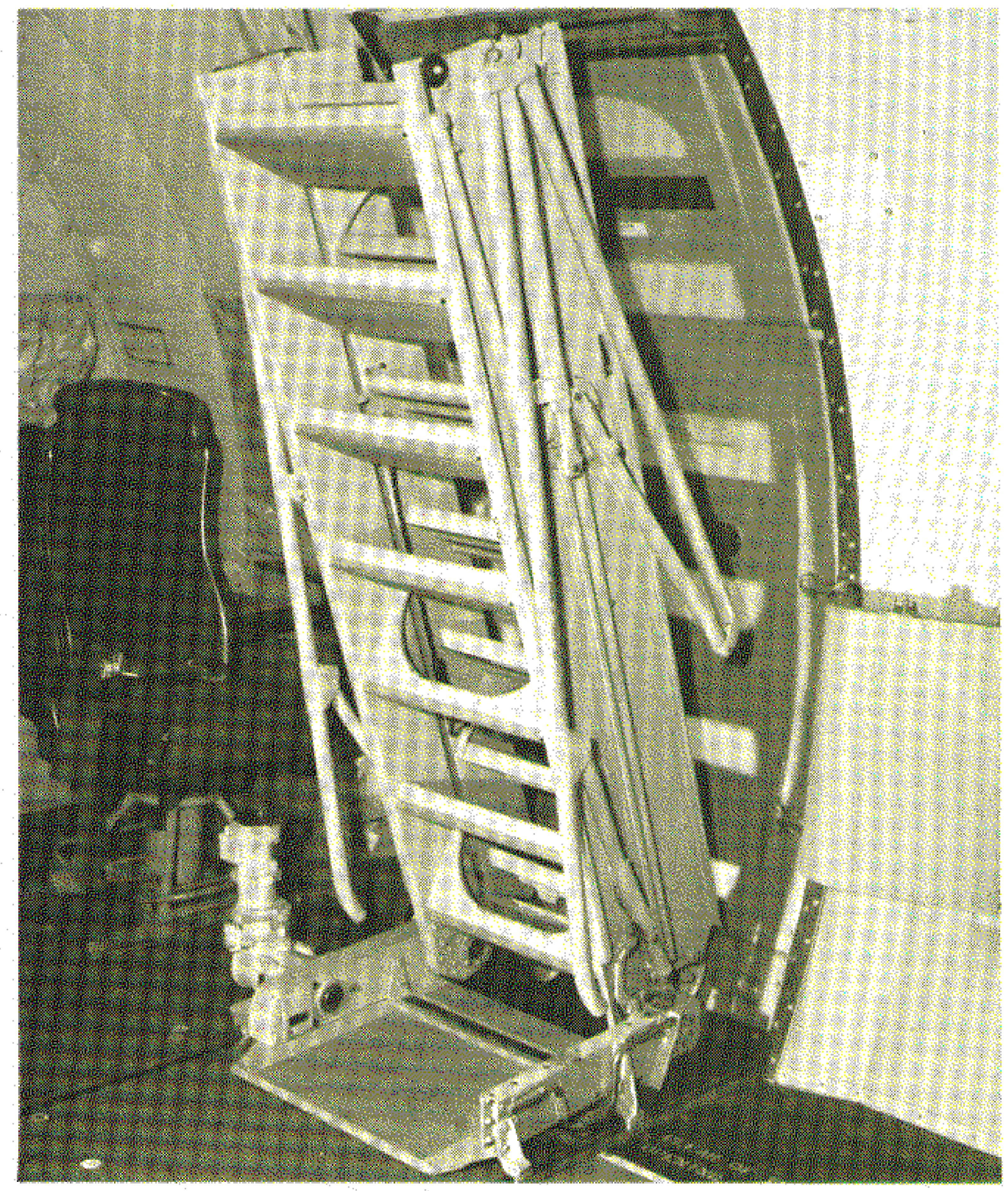


Figure 13. Boarding Ladder

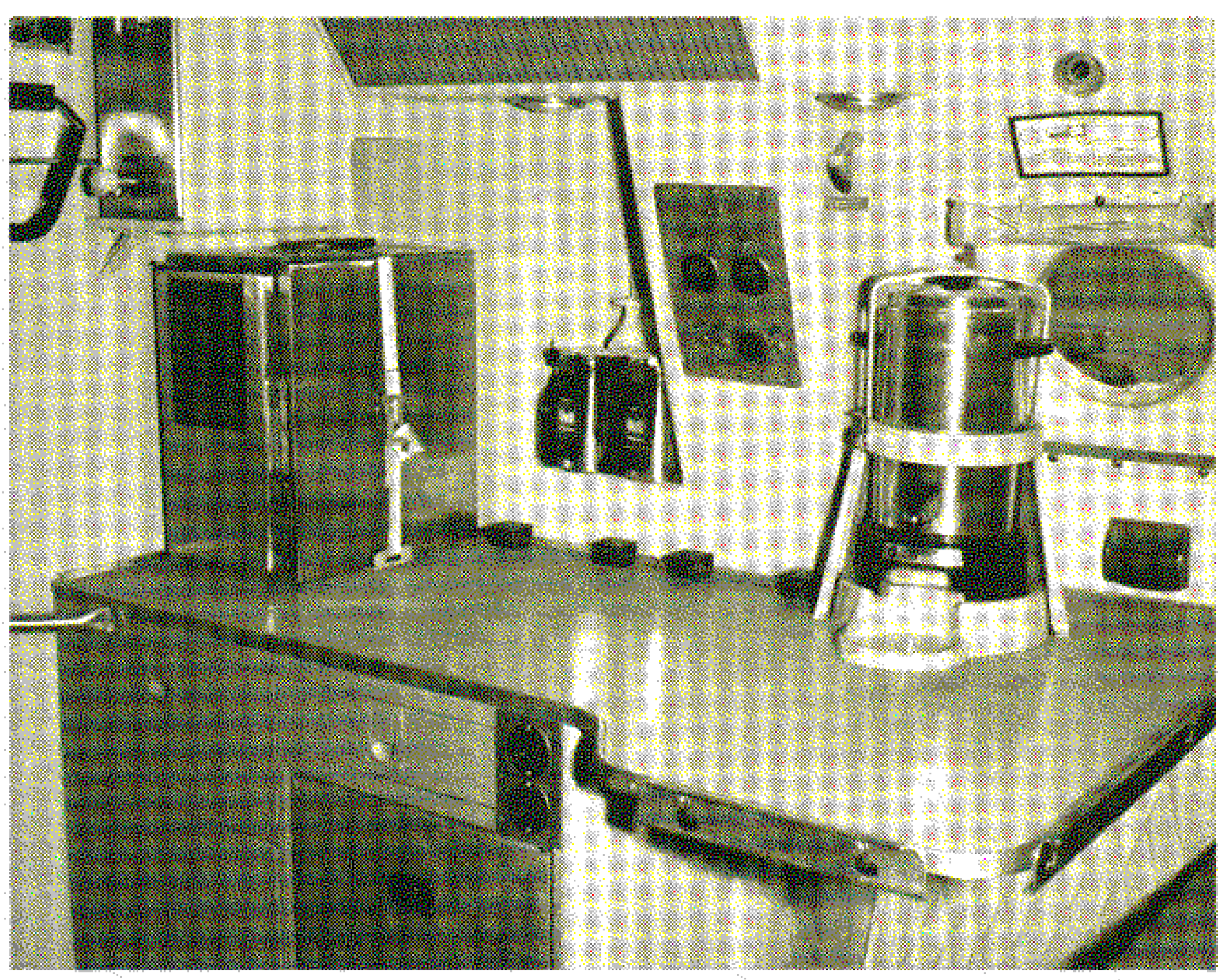


Figure 12. P-3C Galley (oven is on the counter to the left and refrigerator is below the counter)

AVIONIC SYSTEM CHANGES The heart of the P-3C avionics system is the ASQ-114(V) Digital Computer and the AYA-8 Data Processing System, which under control of an Operational Program accomplish the computerized communication and processing of the mission.

Computer The ASQ-114(V) airborne, general purpose computer (Figure 14) can handle more than 3 million bits of data per second. The computer can be used to check the on-line avionics systems, both for "go" or "no-go" status, and to further diagnose equipment "no-go" conditions in order to isolate a faulty module.

Figure 14. ASQ-114(V) Computer

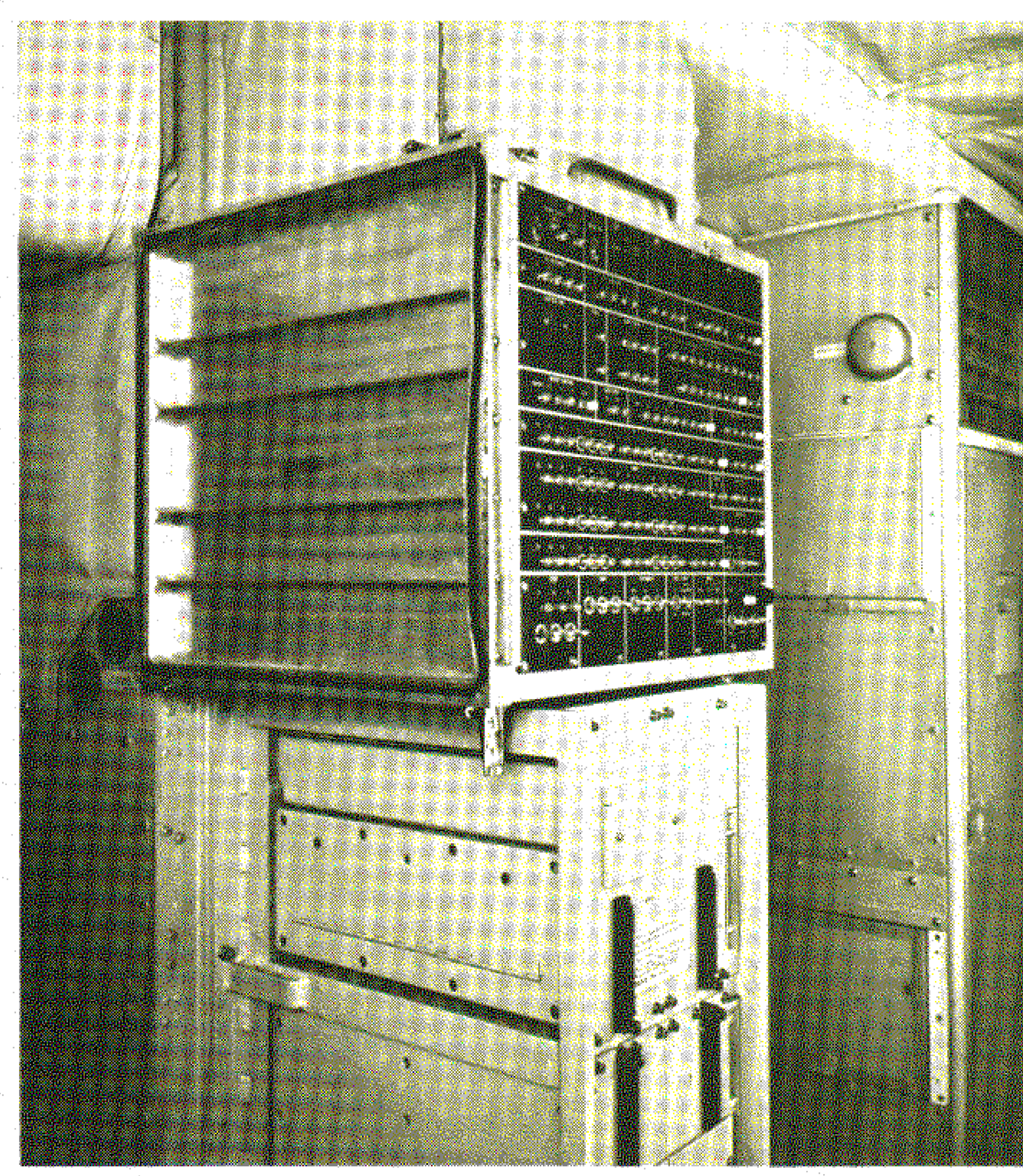


Figure 15. RD-319/AYA-8 Magnetic Tape Transport

In the past, advancement in airborne ASW avionic equipment resulted in either expanded capabilities or development of new equipment. As a result, crews have become burdened with more capability than can be utilized to maximum efficiency. To remedy this situation, the P-3C coordinates all major airborne ASW components into a single, highly efficient weapon system. Three benefits important to the accomplishment of the ASW mission have resulted: (1) all functional capabilities can be utilized quickly and efficiently, (2) operators have nearly five times more time for making tactical decisions, and (3) overall mission effectiveness has been increased significantly.

Although addition of the new computer has brought about major changes in many areas of airborne ASW, the basic P-3C design philosophy has not changed from the P-3B. It still maintains that the all-important key to mission success is the aircrewman. As a result, the computer and all new sensors have been designed principally to serve as useful tools for maximum operator utilization and efficiency.

Computer Programs (Software) All the computer functions are made possible by the provision of two computer programs, the P-3C Operational Program, and the P-3C System Test Program. These programs provide the computer with the instructions that are necessary for it to carry out the assigned tasks. The capabilities of these two programs are described in the following paragraphs.

P-3C Operational Program The P-3C Operational Program is stored on magnetic tape and is loaded into the central computer memory from either of two tape transports (see Figure 15). Automatic program initialization routines commence and peripheral equipments are functionally brought on-line with the computer for data processing.

Prior to the beginning of a flight, the "on-top" switch can be depressed to initialize various program computations from a geographically known position. Navigational tracks are initiated from this known geographical origin, displays are also centered on this origin, and other operational program functions are updated by this reference. The on-top switch can be actuated by the Pilot or the function can be performed by the NAV/COMM prior to taxiing, during lift-off, or during flight.

Upon TACCO command a sonobuoy pattern can be deployed utilizing three types of sonobuoys and processing techniques. The basic sonobuoy types are DIFAR, LOFAR, and RO (Range Only). The selection of these buoys by the TACCO is dependent upon mission objectives and tactics to be used by the TACCO. Additionally, the computer assures that no conflicting sonobuoy RF channels are dropped. SS-1 and -2 monitor sonobuoy information on their acoustic processors for entries into the computer. If the processor input channel (PIC) controls are in the automatic mode, the computer will automatically tune the PIC to the deployed sonobuoys.

Acoustic contacts from SS-1 and SS-2, non-acoustic contacts from SS-3 and the TACCO, visual contacts from the pilot, and Data Link information are all stored in the computer and presented to the TACCO along with reference and amplifying data. Computer correlation of these data aid the TACCO in making tactical decisions. The pilot can on-top sonobuoys for computer determination of a bias drift velocity (which is necessary to stabilize the sonobuoy field) and certain types of contact data during tactical navigation.

Pertinent data necessary to reconstruct the ASW mission are periodically extracted and recorded on a magnetic tape for postflight analysis. Any ARO tableau can be extracted and reproduced by the High Speed Printer (HSP) as hardcopy printout or recorded on the data extraction tape for postflight analysis.

Periodically, recovery data such as navigation parameters and sonobuoys deployed are recorded on a second magnetic tape to be utilized in the event of a computer program fault or temporary shutdown. These data are then recalled to reinitialize the computer to the last tactical situation, less the program downtime, when the computer returns to normal operation.

P-3C System Test Program A vital requirement in support of the computerized weapon system is the capability of testing the equipment in the aircraft in order to verify and maintain operational readiness. The P-3C Systems Test Program provides this capability.

Tests are made of individual equipment modules and their system interfaces to afford a rapid assessment of system readiness. Fault isolation ambiguity is minimized to reduce the amount of manual troubleshooting during pre- and postflight maintenance.

The P-3C System Test Program is stored on magnetic tape and consists of three major subprograms for operational readiness testing and fault isolation testing. These subprograms are: either Automatic or Simultaneous System Go, No-Go Tests (SYGNOG); Diagnostic Tests; and Special Tests. All subprograms may be selected by the operator upon a successful completion of computer diagnostic and control key checks. If a malfunction should be detected either automatically through program tests or via operator observation, Diagnostics or Special test routines can then be called in to fulfill a maintenance action.

If the Automatic SYGNOG mode, test command and control words are sent from the central computer to a peripheral subsystem (stimulus), the peripheral sends words to the computer (response), and the result is compared with programmed limits and expected responses. The expected and received test response words are printed on the High Speed Printer (HSP) only if there is an error. The HSP printout provides a hard copy report of the test results.

The only stops in Automatic SYGNOG are for operator observation of HSP or Auxiliary Readout (ARO) and/or for program-detected errors. For an operator-observed error the program waits for operator-keyed instructions to continue the current test or proceed to the next test.

The entire set of Automatic SYGNOG tests may be automatically completed in sequence if no errors are encountered. If the Selectable Automatic SYGNOG mode is chosen, the System Test Executive Program will permit the test operator to select an individual test from a tableau of available tests. The operator then has the option of running any selected Automatic test and returning to System Test Executive to select any subprogram.

Simultaneous SYGNOG tests use the operator's response to test the open-ended functions of the equipment. The program includes functional checks of all available keyset background lights and other visual indicators at the various crew stations. Individual testing at the TACCO, NAV/COMM, ARM/ORD, Pilot and Sensor Stations (1, 2, and 3) is performed simultaneously.

The Diagnostic Test Programs are designed to provide fault detection and isolation capability using the ASQ-114(V) computer. Isolation and replacement of a malfunctioning module can usually be accomplished in 15 minutes or less for 50 percent of the faults detected, and in 30 minutes or less for 95 percent of the faults detected. The diagnostic tests are individually loaded into memory. The tests are similar to those in the SYGNOG program, but activate functions and signal flow paths in greater detail. When a fault is isolated, error cues and module replacement messages are provided on the HSP.

Special Tests are designed to fill special purpose requirements. These tests are processed by program control the same as with diagnostics. However, they generally involve tests which require special

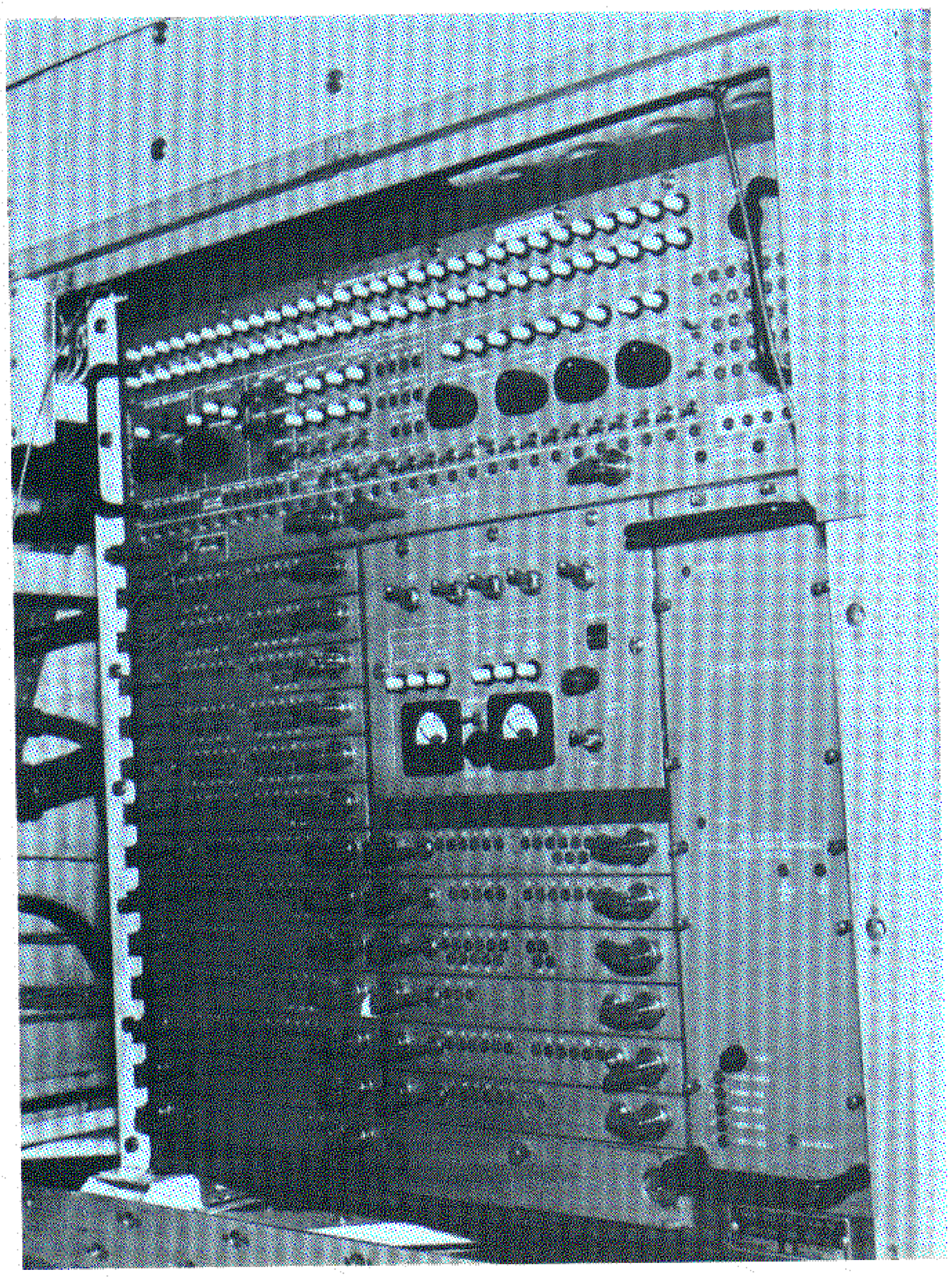


Figure 16. Logic Unit No. 2

Figure 17. ASA-70 Display Tube. Radar and contacts shown.

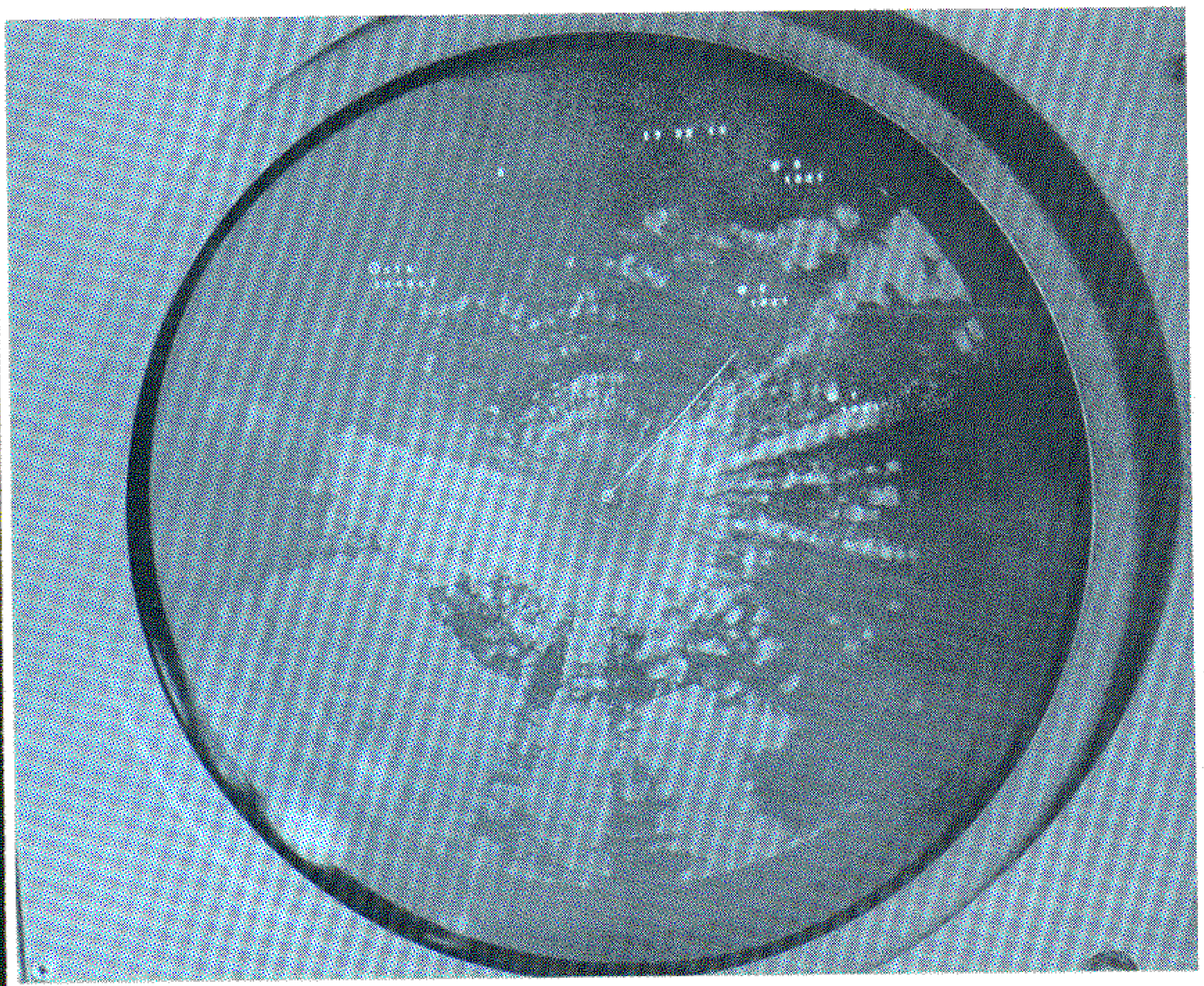
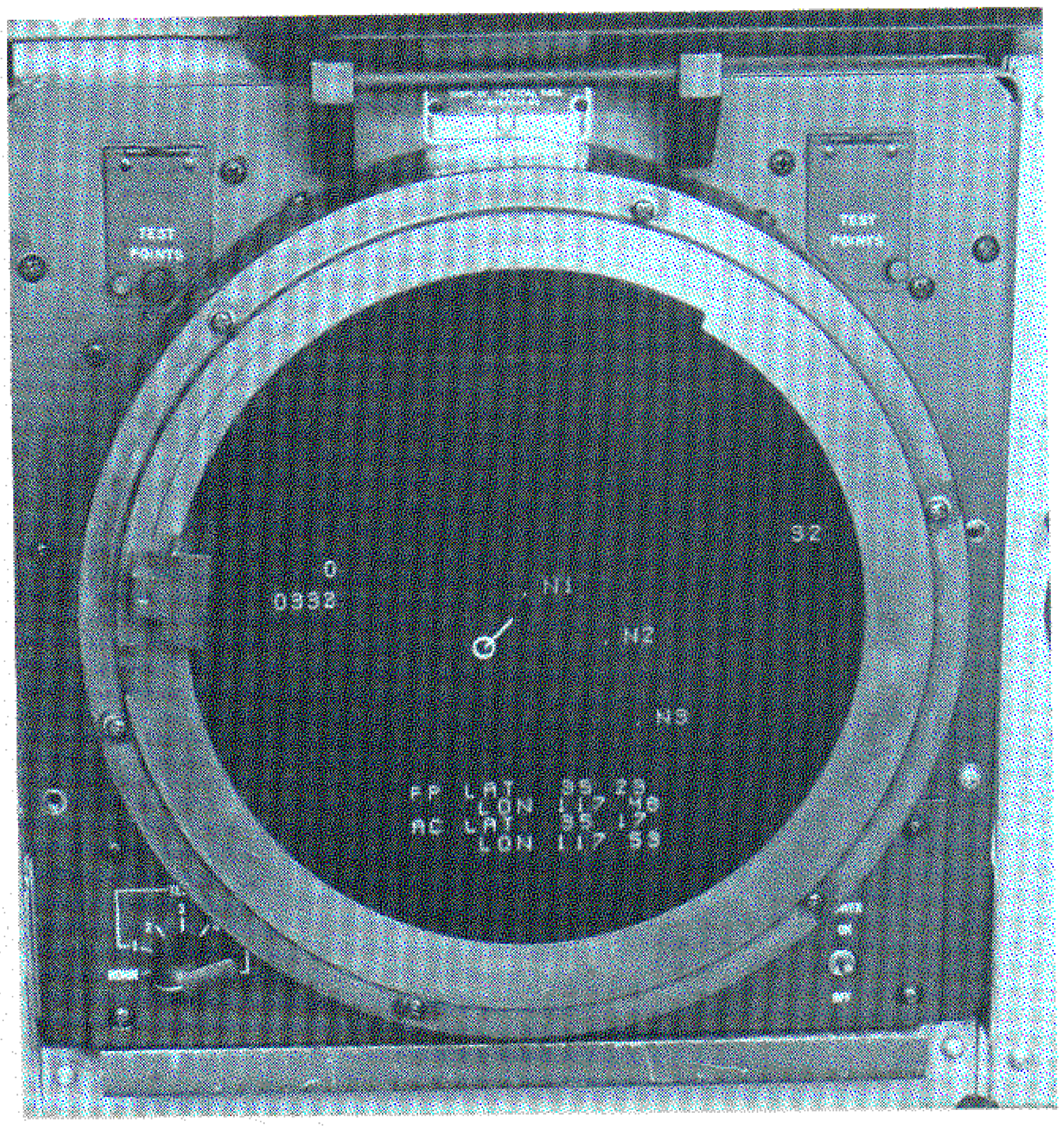
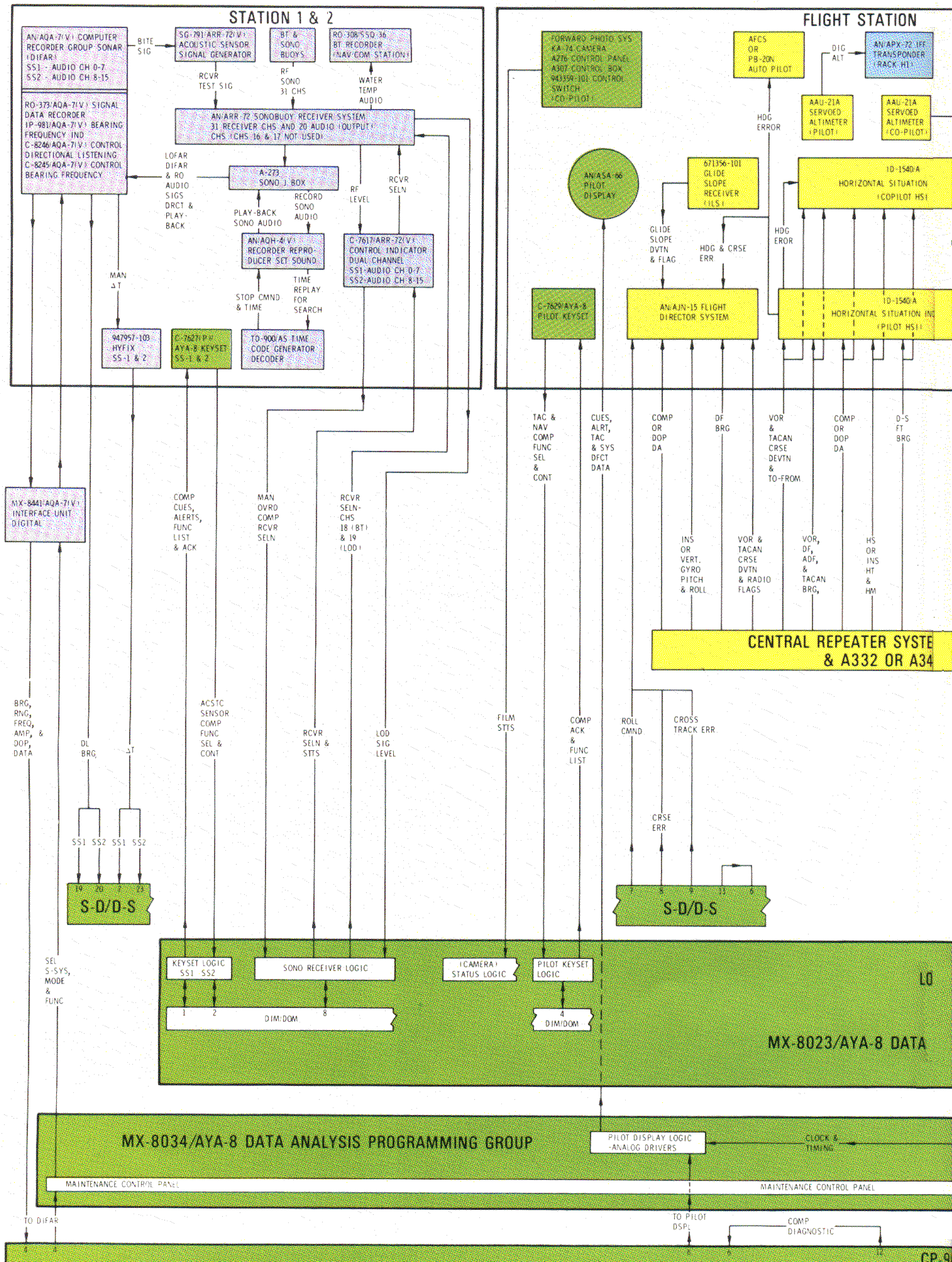
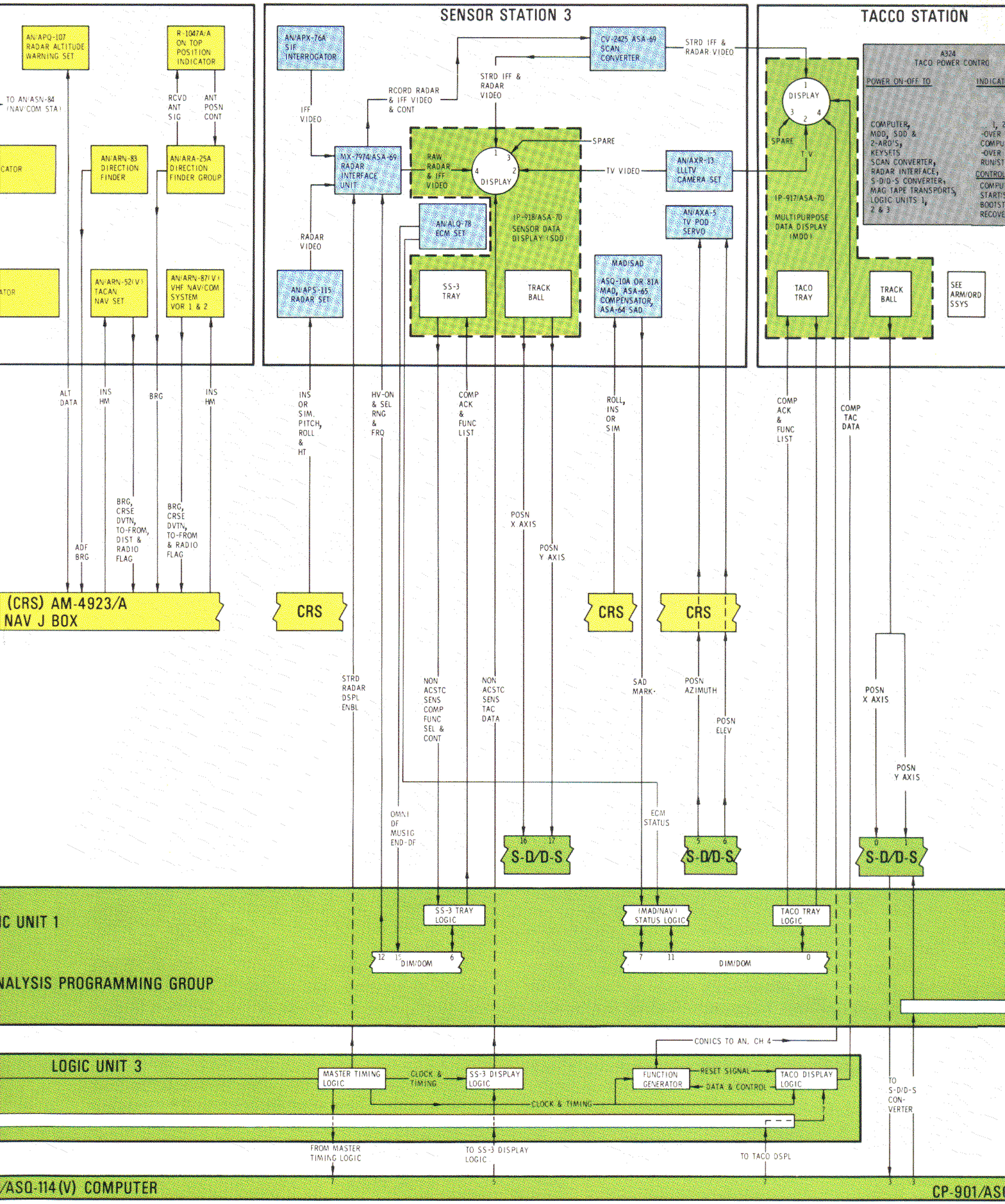


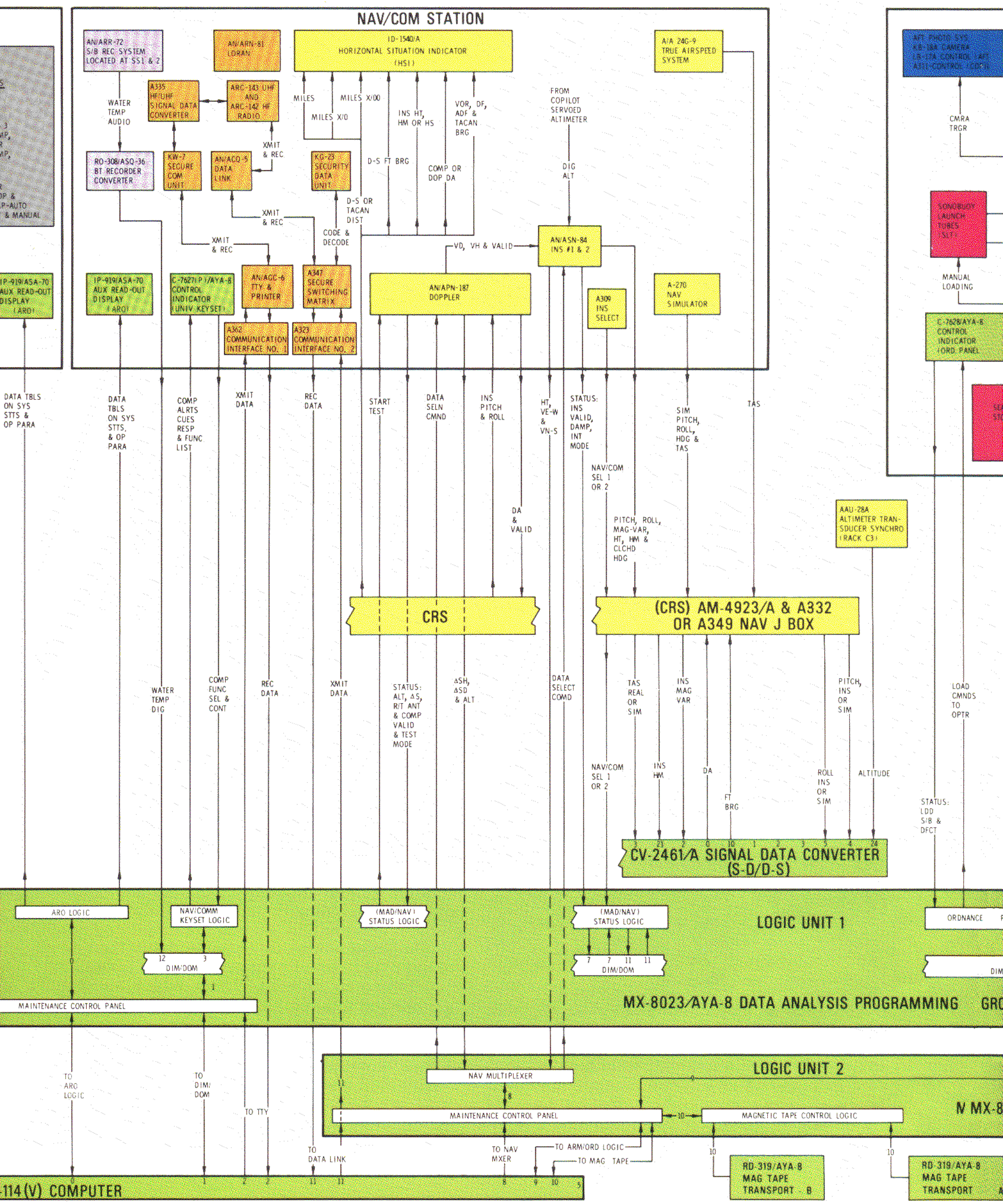
Figure 18. ASA-66 CRT Display



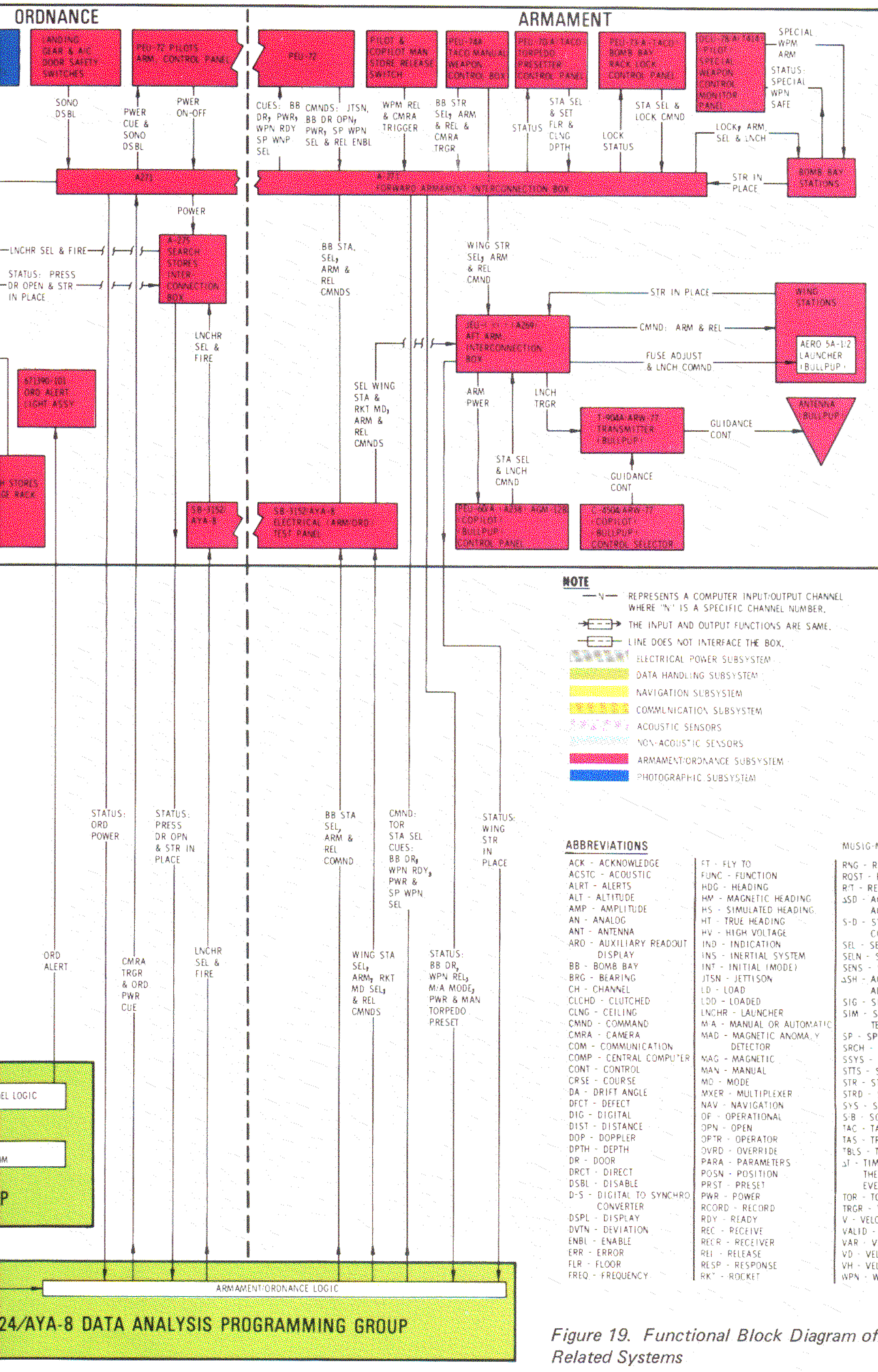

STATION 1 & 2
AN/AQA-7(V) COMPUTER RECORDER GROUP SONAR (DIFAR) SS1 - AUDIO CH 0-7 SS2 - AUDIO CH 8-15
RO-373/AQA-7(V) SIGNAL DATA RECORDER IP-981/AQA-7(V) BEARING FREQUENCY IND C-8246/AQA-7(V) CONTROL DIRECTIONAL LISTENING C-8245/AQA-7(V) CONTROL BEARING FREQUENCY
BITE SIG
SG-791/ARR-72(V) ACOUSTIC SENSOR SIGNAL GENERATOR
BT & SONO BUOYS
RO-308/SSQ-36 BT RECORDER (NAV/COM STATION)
RCVR TEST SIG
RF SONO 31 CHS
WATER TEMP AUDIO
AN/ARR-72 SONOBUOY RECEIVER SYSTEM 31 RECEIVER CHS AND 20 AUDIO (OUTPUT) CHS (CHS 16 & 17 NOT USED)
LOFAR DIFAR & RO AUDIO SIGS DRCT & PLAY-BACK
A-273 SONO J BOX
RF LEVEL
RCVR SELN
PLAY-BACK SONO AUDIO
RECORD SONO AUDIO
AN/AQH-4(V) RECORDER REPRODUCER SET SOUND
C-7617/ARR-72(V) CONTROL INDICATOR DUAL CHANNEL SS1-AUDIO CH 0-7 SS2-AUDIO CH 8-15
MAN ΔT
STOP CMND & TIME
TIME REPLAY FOR SEARCH
947957-103 HYFIX SS-1 & 2
C-7627(P)/AYA-8 KEYSET SS-1 & 2
TD-900/AS TIME CODE GENERATOR DECODER
FLIGHT STATION
FORWARD PHOTO SYS KA-74 CAMERA A276 CONTROL PANEL A307 CONTROL BOX 943359-101 CONTROL SWITCH (CO-PILOT)
AFCS OR PB-20N AUTO PILOT
DIG ALT
AN/APX-72 IFF TRANSPONDER (RACK H1)
AAU-21A SERVOED ALTIMETER (PILOT)
AAU-21A SERVOED ALTIMETER (CO-PILOT)
HDG ERROR
AN/ASA-66 PILOT DISPLAY
671356-101 GLIDE SLOPE RECEIVER (ILS)
ID-1540/A HORIZONTAL SITUATION (COPILOT HSI)
GLIDE SLOPE DVTN & FLAG
HDG & CRSE ERR
HDG EROR
C-7629/AYA-8 PILOT KEYSET
AN/AJN-15 FLIGHT DIRECTOR SYSTEM
ID-1540/A HORIZONTAL SITUATION IND (PILOT HSI)
TAC & NAV COMP FUNC SEL & CONT
CUES, ALRT, TAC & SYS DFCT DATA
COMP OR DOP DA
DF BRG
VOR & TACAN CRSE DEVTN & TO-FROM
COMP OR DOP DA
D-S FT BRG
MX-8441/AQA-7(V) INTERFACE UNIT DIGITAL
COMP CUES, ALERTS, FUNC LIST & ACK
MAN OVRD COMP RCVR SELN
RCVR SELN-CHS 18 (BT) & 19 (LOD)
INS OR VERT. GYRO PITCH & ROLL
VOR & TACAN CRSE DVTN & RADIO FLAGS
VOR, DF, ADF, & TACAN BRG,
HS OR INS HT & HM
CENTRAL REPEATER SYSTE & A332 OR A34
BRG, RNG, FREQ, AMP, & DOP, DATA
DL BRG
ΔT
ACSTC SENSOR COMP FUNC SEL & CONT
RCVR SELN & STTS
LOD SIG LEVEL
FILM STTS
COMP ACK & FUNC LIST
ROLL CMND
CROSS TRACK ERR
CRSE ERR
SS1 SS2 SS1 SS2
S-D/D-S
S-D/D-S
SEL S-SYS, MODE & FUNC
KEYSET LOGIC SS1 SS2
SONO RECEIVER LOGIC
(CAMERA) STATUS LOGIC
PILOT KEYSET LOGIC
DIM/DOM
DIM/DOM
LO
MX-8023/AYA-8 DATA
MX-8034/AYA-8 DATA ANALYSIS PROGRAMMING GROUP
PILOT DISPLAY LOGIC -ANALOG DRIVERS
CLOCK & TIMING
MAINTENANCE CONTROL PANEL
MAINTENANCE CONTROL PANEL
TO DIFAR
TO PILOT DSPL
COMP DIAGNOSTIC
CP-9



SENSOR STATION 3
TACCO STATION
AN/APQ-107 RADAR ALTITUDE WARNING SET
R-1047A/A ON TOP POSITION INDICATOR
TO AN/ASN-84 (NAV/COM STA)
RCVD ANT SIG
ANT POSN CONT
AN/ARN-83 DIRECTION FINDER
AN/ARA-25A DIRECTION FINDER GROUP
AN/ARN-52(V) TACAN NAV SET
AN/ARN-87(V) VHF NAV/COM SYSTEM VOR 1 & 2
AN/APX-76A SIF INTERROGATOR
IFF VIDEO
RCORD RADAR & IFF VIDEO & CONT
CV-2425 ASA-69 SCAN CONVERTER
STRD IFF & RADAR VIDEO
MX-7974/ASA-69 RADAR INTERFACE UNIT
RAW RADAR & IFF VIDEO
DISPLAY
SPARE
TV VIDEO
AN/AXR-13 LLLTV CAMERA SET
AN/ALQ-78 ECM SET
IP-918/ASA-70 SENSOR DATA DISPLAY (SDD)
AN/AXA-5 TV POD SERVO
RADAR VIDEO
AN/APS-115 RADAR SET
SS-3 TRAY
TRACK BALL
MAD/SAD ASQ-10A OR 81A MAD, ASA-65 COMPENSATOR, ASA-64 SAD
TV
IP-917/ASA-70 MULTIPURPOSE DATA DISPLAY (MDD)
A324 TACO POWER CONTRO
POWER ON-OFF TO
INDICAT
COMPUTER, MDD, SDD & 2-ARD'S, KEYSETS SCAN CONVERTER, RADAR INTERFACE, S-D/D-S CONVERTER, MAG TAPE TRANSPORTS, LOGIC UNITS 1, 2 & 3
CONTROL
TACO TRAY
SEE ARM/ORD SSYS
ALT DATA
INS HM
BRG
ADF BRG
BRG, CRSE DVTN, TO-FROM, DIST & RADIO FLAG
BRG, CRSE DVTN, TO-FROM & RADIO FLAG
INS OR SIM, PITCH, ROLL & HT
HV-ON & SEL RNG & FRQ
COMP ACK & FUNC LIST
ROLL, INS OR SIM
COMP TAC DATA
POSN X AXIS
POSN Y AXIS
(CRS) AM-4923/A NAV J BOX
CRS
STRD RADAR DSPL ENBL
NON ACSTC SENS COMP FUNC SEL & CONT
NON ACSTC SENS TAC DATA
SAD MARK
POSN AZIMUTH
POSN ELEV
ECM STATUS
OMNI DF MUSIC END-DF
S-D/D-S
IC UNIT 1
SS-3 TRAY LOGIC
(MAD/NAV) STATUS LOGIC
TACO TRAY LOGIC
DIM/DOM
NALYSIS PROGRAMMING GROUP
CONICS TO AN, CH 4
LOGIC UNIT 3
MASTER TIMING LOGIC
CLOCK & TIMING
SS-3 DISPLAY LOGIC
FUNCTION GENERATOR
RESET SIGNAL
DATA & CONTROL
TACO DISPLAY LOGIC
TO S-D/D-S CON-VERTER
FROM MASTER TIMING LOGIC
TO SS-3 DISPLAY LOGIC
TO TACO DSPL
/ASQ-114(V) COMPUTER
CP-901/ASQ



NAV/COM STATION
AN/ARR-72 S/B REC SYSTEM LOCATED AT SS1 & 2
AN/ARN-81 LORAN
ID-1540/A HORIZONTAL SITUATION INDICATOR (HSI)
A/A 24G-9 TRUE AIRSPEED SYSTEM
WATER TEMP AUDIO
A335 HF/UHF SIGNAL DATA CONVERTER
ARC-143 UHF AND ARC-142 HF RADIO
MILES
MILES X/00
MILES X/0
INS HT, HM OR HS
VOR, DF, ADF & TACAN BRG
FROM COPILOT SERVOED ALTIMETER
XMIT & REC
RO-308/ASQ-36 BT RECORDER CONVERTER
KW-7 SECURE COM UNIT
AN/ACQ-5 DATA LINK
KG-23 SECURITY DATA UNIT
D-S FT BRG
COMP OR DOP DA
DIG ALT
D-S OR TACAN DIST
XMIT & REC
CODE & DECODE
XMIT & REC
VD, VH & VALID
AN/ASN-84 INS #1 & 2
IP-919/ASA-70 AUX READ-OUT DISPLAY (ARO)
IP-919/ASA-70 AUX READ-OUT DISPLAY (ARO)
C-7627(P)/AYA-8 CONTROL INDICATOR (UNIV KEYSET)
AN/AGC-6 TTY & PRINTER
A347 SECURE SWITCHING MATRIX
AN/APN-187 DOPPLER
A309 INS SELECT
A-270 NAV SIMULATOR
A362 COMMUNICATION INTERFACE NO. 1
A323 COMMUNICATION INTERFACE NO. 2
DATA TBLS ON SYS STTS & OP PARA
DATA TBLS ON SYS STTS, & OP PARA
COMP ALRTS CUES RESP & FUNC LIST
XMIT DATA
REC DATA
START TEST
DATA SELN CMND
INS PITCH & ROLL
HT, VE-W & VN-S
STATUS: INS VALID, DAMP, INT MODE
SIM PITCH, ROLL, HDG & TAS
TAS
NAV/COM SEL 1 OR 2
DA & VALID
PITCH, ROLL, MAG-VAR, HT, HM & CLCHD HDG
AAU-28A ALTIMETER TRANSDUCER SYNCHRO (RACK C3)
CRS
(CRS) AM-4923/A & A332 OR A349 NAV J BOX
WATER TEMP DIG
COMP FUNC SEL & CONT
REC DATA
XMIT DATA
STATUS: ALT, ΔS, R/T ANT & COMP VALID & TEST MODE
ΔSH, ΔSD & ALT
DATA SELECT COMD
TAS REAL OR SIM
INS MAG VAR
PITCH, INS OR SIM
NAV/COM SEL 1 OR 2
INS HM
DA
FT BRG
ROLL INS OR SIM
ALTITUDE
CV-2461/A SIGNAL DATA CONVERTER (S-D/D-S)
ARO LOGIC
NAV/COMM KEYSET LOGIC
(MAD/NAV) STATUS LOGIC
(MAD/NAV) STATUS LOGIC
LOGIC UNIT 1
DIM/DOM
DIM/DOM
MAINTENANCE CONTROL PANEL
MX-8023/AYA-8 DATA ANALYSIS PROGRAMMING GRO
TO ARO LOGIC
TO DIM/DOM
TO TTY
TO DATA LINK
LOGIC UNIT 2
NAV MULTIPLEXER
MAINTENANCE CONTROL PANEL
MAGNETIC TAPE CONTROL LOGIC
TO NAV MXER
TO ARM/ORD LOGIC
TO MAG TAPE
RD-319/AYA-8 MAG TAPE TRANSPORT B
RD-319/AYA-8 MAG TAPE TRANSPORT
-114(V) COMPUTER
AFT PHOTO SYS KB-18A CAMERA LS-17A CONTROL AFT A311 CONTROL (DC)
CMRA TRGR
SONOBUOY LAUNCH TUBES (SLT)
MANUAL LOADING
C-7628/AYA-8 CONTROL INDICATOR (ORD. PANEL
LOAD CMNDS TO OPTR
STATUS: LDD S/B & DFCT
ORDNANCE



NOTE

—N— REPRESENTS A COMPUTER INPUT/OUTPUT CHANNEL WHERE "N" IS A SPECIFIC CHANNEL NUMBER.

THE INPUT AND OUTPUT FUNCTIONS ARE SAME.

LINE DOES NOT INTERFACE THE BOX.

ELECTRICAL POWER SUBSYSTEM

DATA HANDLING SUBSYSTEM

NAVIGATION SUBSYSTEM

COMMUNICATION SUBSYSTEM

ACOUSTIC SENSORS

NON-ACOUSTIC SENSORS

ARMAMENT/ORDNANCE SUBSYSTEM

PHOTOGRAPHIC SUBSYSTEM

ABBREVIATIONS

ACK - ACKNOWLEDGE
ACSTC - ACOUSTIC
ALRT - ALERTS
ALT - ALTITUDE
AMP - AMPLITUDE
AN - ANALOG
ANT - ANTENNA
ARO - AUXILIARY READOUT DISPLAY
BB - BOMB BAY
BRG - BEARING
CH - CHANNEL
CLCHD - CLUTCHED
CLNG - CEILING
CMND - COMMAND
CMRA - CAMERA
COM - COMMUNICATION
COMP - CENTRAL COMPUTER
CONT - CONTROL
CRSE - COURSE
DA - DRIFT ANGLE
DFCT - DEFECT
DIG - DIGITAL
DIST - DISTANCE
DOP - DOPPLER
DPTH - DEPTH
DR - DOOR
DRCT - DIRECT
DSBL - DISABLE
D-S - DIGITAL TO SYNCHRO CONVERTER
DSPL - DISPLAY
DVTN - DEVIATION
ENBL - ENABLE
ERR - ERROR
FLR - FLOOR
FREQ - FREQUENCY
FT - FLY TO
FUNC - FUNCTION
HDG - HEADING
HM - MAGNETIC HEADING
HS - SIMULATED HEADING
HT - TRUE HEADING
HV - HIGH VOLTAGE
IND - INDICATION
INS - INERTIAL SYSTEM
INT - INITIAL (MODE)
JTSN - JETTISON
LD - LOAD
LDD - LOADED
LNCHR - LAUNCHER
M/A - MANUAL OR AUTOMATIC
MAD - MAGNETIC ANOMALY DETECTOR
MAG - MAGNETIC
MAN - MANUAL
MD - MODE
MXER - MULTIPLEXER
NAV - NAVIGATION
OP - OPERATIONAL
OPN - OPEN
OPTR - OPERATOR
OVRD - OVERRIDE
PARA - PARAMETERS
POSN - POSITION
PRST - PRESET
PWR - POWER
RCORD - RECORD
RDY - READY
REC - RECEIVE
RECR - RECEIVER
REL - RELEASE
RESP - RESPONSE
RKT - ROCKET
MUSIG-MULTIPLE SIGNAL
RNG - RANGE
RQST - REQUEST
R/T - RECEIVER/TRANSMITTER
ΔSD - ACCUMULATED DISTANCE ACROSS HEADING
S-D - SYNCHRO-TO-DIGITAL CONVERTER
SEL - SELECT
SELN - SELECTION
SENS - SENSOR
ΔSH - ACCUMULATED DISTANCE ALONG HEADING
SIG - SIGNAL
SIM - SIMULATED (FOR TEST PURPOSES)
SP - SPECIAL
SRCH - SEARCH
SSYS - SUBSYSTEM
STTS - STATUS
STR - STORE
STRD - STORED
SYS - SYSTEM
S/B - SONOBUOY
TAC - TACTICAL
TAS - TRUE AIR SPEED
TBLS - TABLES
ΔT - TIME DURATION BETWEEN THE ARRIVAL OF SAME EVENT AT 2 BUOYS
TOR - TORPEDO
TRGR - TRIGGER
V - VELOCITY
VALID - VALIDITY
VAR - VARIATION
VD - VELOCITY ACROSS HEADING
VH - VELOCITY ALONG HEADING
WPN - WEAPON

Figure 19. Functional Block Diagram of P-3C Avionics and Related Systems

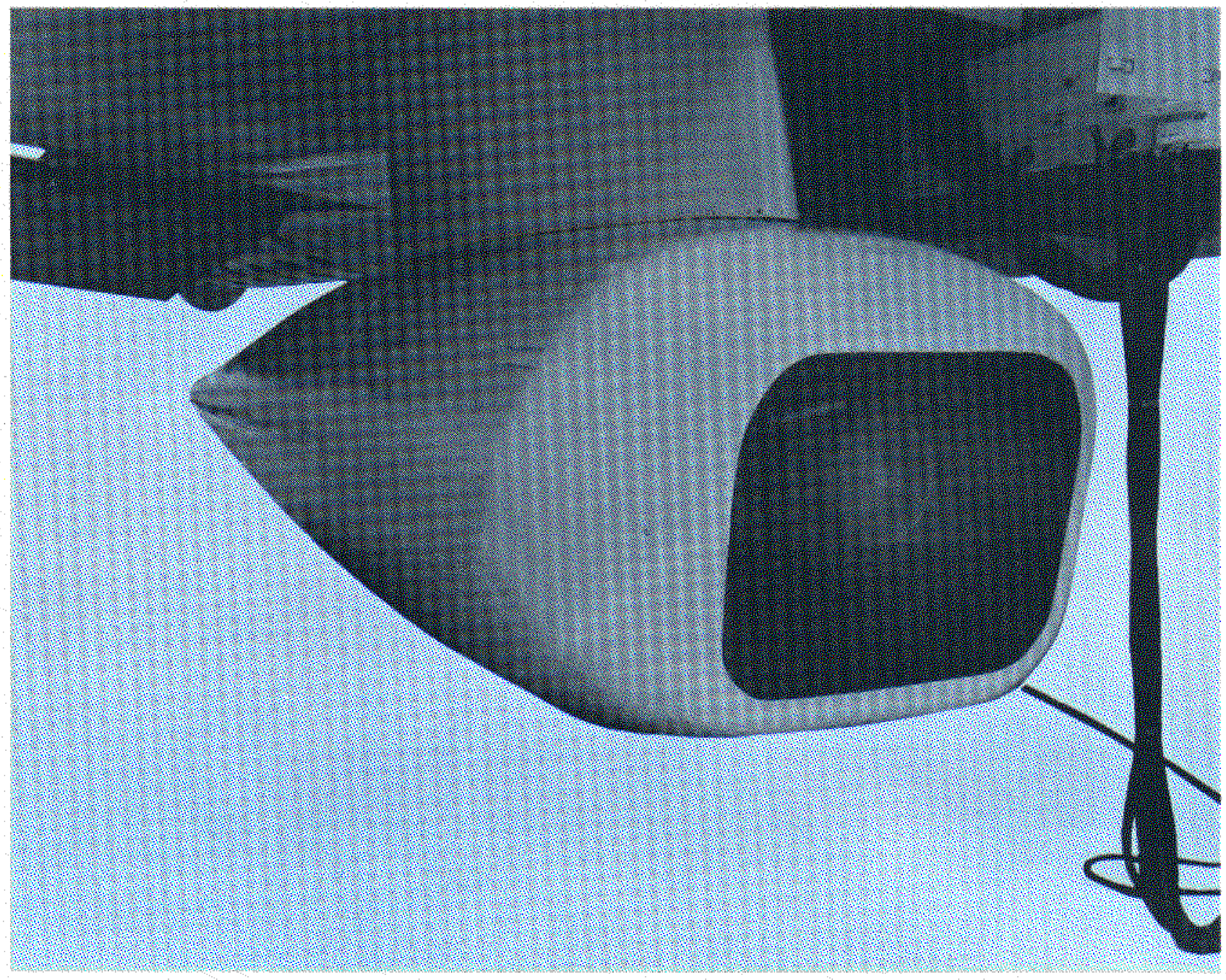


Figure 20. LLLTV Pod

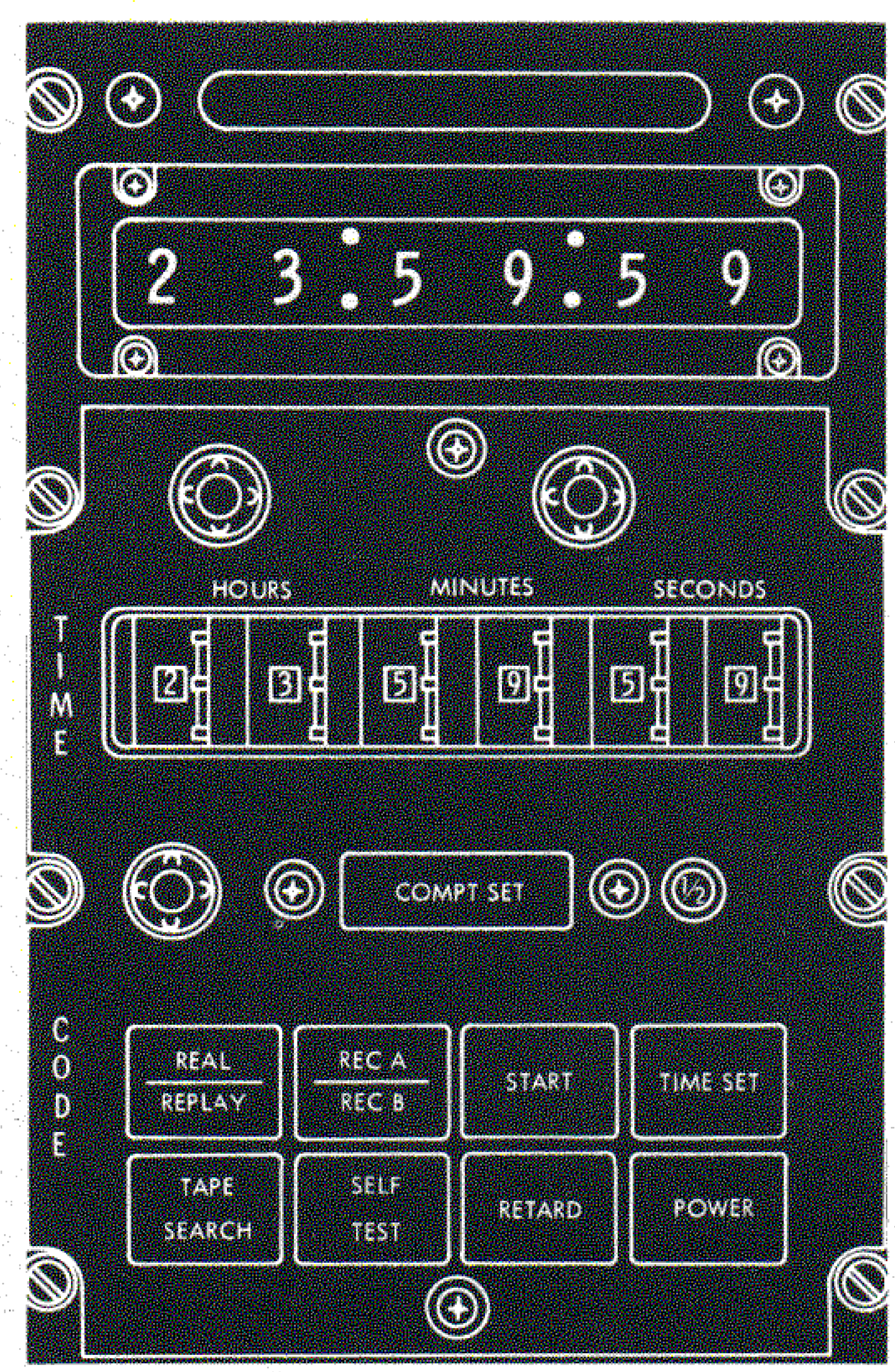


Figure 21. Time Code Generator Panel

or extensive operator responses, and dedicated use of the Computer, Logic Units, Displays, Teletypewriter, and High Speed Printer.

Special Tests currently included in the program are:

1. Radar Alignment – Provides test patterns for alignment of the Scan Converter and the TACCO and Sensor Station 3 MPD's.

2. ARM/ORD – Checks and tests of the ordnance and weapon release circuits in the ARM/ORD system which are not included in the digital logic units.

3. INS Loader/Verifier – Tests for the correctness of programs stored in the INS computers. If found to be incorrect, a correct version may be loaded in the INS computer and then verified to assure the program is correct.

4. Data Link System – Checks the capability to link and exchange data between the aircraft and other P-3C's, Tactical Support Centers, or NTDS ships with compatible data link systems.

Data Processing System The AYA-8 Data Analysis Programming Group interfaces the ASQ-114(V) computer with the flight crew stations and peripheral avionic equipments (see Figure 19). The programming group is comprised of three logic units, operator keysets and trays, and two magnetic tape transports. The logic units translate the output data from the computer to the peripheral equipments into the language of the peripheral equipments, and put the input data from the peripheral equipments into the language of the computer. The logic units also provide timing for synchronizing the data transfer between the computer and peripheral devices. The operator keysets and trays enable data inputs from the crew stations, and the magnetic tape transports provide for recording pertinent flight data for use in inflight recovery and postflight data reduction.

AYA-8 Logic Unit 1 provides the digital communication between the ASQ-114(V) computer and the keyboard/keyset switches of the P-3C crew stations (operator interface to computer memory). It also provides control and monitor functions for the sonobuoy receiver system (ARR-72). In addition, it monitors navigation system and SAD system status, and updates Radar Scan Converter display positions. Bathythermograph (BT) and ECM data are transferred to the computer via Logic Unit 1. This is accomplished by multiplexing 16 peripheral channels to one computer input/output channel, thus providing the necessary interface and control logic for all of these input/output data. A separate computer channel enables Logic Unit 1 to output messages to the 5-inch rectangular Auxiliary Readout Displays (ARO) located at the TACCO and NAV/COMM stations.

AYA-8 Logic Unit 2 (Figure 16) provides the required data flow between the computer and the Armament/Ordnance system. It also allows the computer to control the flow of data to and from the magnetic tape transports. In addition, it allows the computer to obtain navigational data from the Doppler navigator (APN-187) and the two ASN-84 inertial navigation sets.

AYA-8 Logic Unit 3 provides an interface between the ASQ-114(V) computer and the primary P-3C Display Systems. These displays include the Pilot's Display, the TACCO Multipurpose Display, and the Sensor Station 3 Multipurpose Display. Logic Unit 3 also provides timing and MPD display interface with the radar scan converter and the low-light-level TV.

Data Display Units The ASA-70 is a multipurpose display system capable of showing alphanumerics, tactical symbols, conics, variable cursors, low-light-level TV, and raw* or scan converted radar. The ASA-70 offers ground-stabilized or aircraft-centered displays of radar or LLLTV pictures with associated symbology via the computer. The ASA-70 Display Tube is shown in Figure 17. The tactical situation is presented in the largest inscribed square on the scope. On the areas outside the imaginary square of the scope the operator is provided with: (1) Greenwich Mean Time, (2) wind direction and velocity, and (3) range scale, plus cues and alerts.

To display stored data on the ARO, the operator accesses one of numerous possible tableaus in the computer memory. These tableaus include parameters such as navigation and stores inventories. The operator uses his keyboard with the ARO to construct and edit messages, to update computer memory, or dump the ARO displayed message on the HSP. The TACCO can override some of the functions performed by the Sensor

**Sensor Station 3 only.*

Station 3 operator and affect some of the symbology appearing on his display.

The ASA-66 Pilot's Tactical Data Display (Figure 18) provides the pilot and copilot with a presentation of the tactical situation. Sonobuoy positions, FTP's, aircraft position and track, fixes and predicted target position are displayed. Information is provided on the display periphery as to range scale selected, ground speed, ETA's and cues and alerts. Utilizing keyset switches on the center pedestal, the pilot can communicate with the computer by visual contact entries, by controlling the display, armament and ordnance selections, and updating tactical sonobuoy positions.

The computer, data processing system, and data displays have replaced the following P-3A/B systems: the ASA-47 air mass computer, PT-396 and OA-1768 plotters, APA-125 indicator, ASA-50 bearing data converter, and ASA-16 display system.

OTHER NEW AVIONICS SYSTEMS Major new systems, in addition to the computer and data processing systems, include the following:

1. **LLLTV** A low-light-level AXR-13 TV camera permits visual contact with surface targets in conditions ranging from dusk to starlit night conditions. The camera is guided by the P-3C computer or controlled manually. Thus, a target can be tracked and displayed on the TACCO and/or the SS-3 ASA-70 display either automatically or by SS-3 operator control. The LLLTV pod is shown in Figure 20.

2. **Radar Scan Converter (RSC)** The ASA-69 RSC stores radar video for presentation on the TACCO and/or SS-3 display. It is capable of storing and presenting video after a single sweep of the radar.

3. **Radar** The new radar (APS-115B) represents a significant improvement in reliability and capability over the older APS-80. The primary improvements in performance have been an increase in resolution to provide greater target detail and greater reduction in interference caused by sea return.

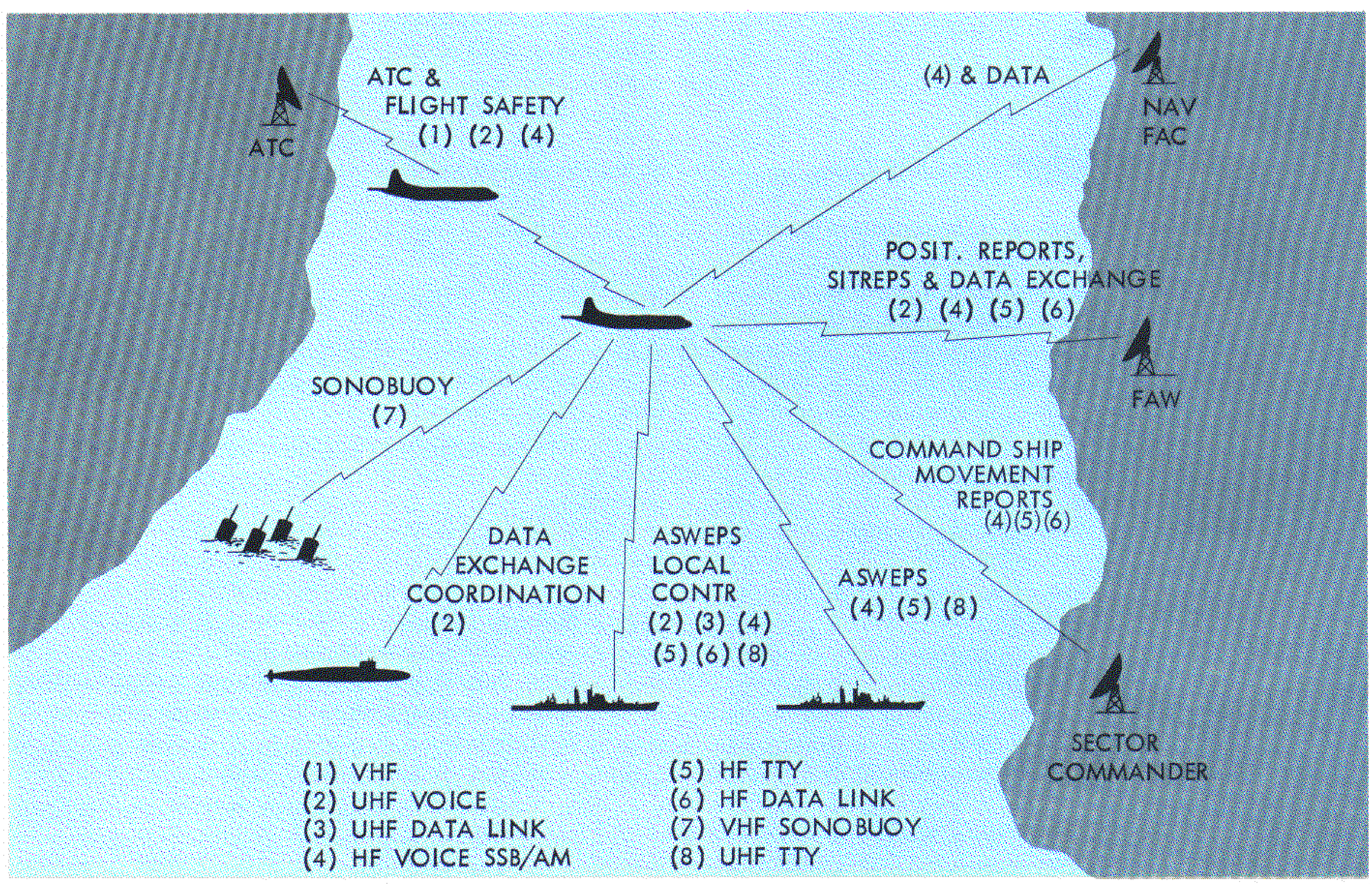


Figure 22. P-3C ASW Communications

Figure 23. TT-567/AGC-6 Teleprinter (above) and TT-568/AGC-6 Teletypewriter (below)

4. **Time Code Generator** The TD900AS Time Code Generator marks one of the AQH-4 acoustic tape recorder tracks with time in hours, minutes, and seconds. The automatic time mark allows either acoustic sensor station operator to quickly and accurately retrieve taped signals for analysis during or after a mission. The Time Code Generator Control Panel is shown in Figure 21.

5. **Communications System** The communications system designed for the P-3C ASW aircraft provides for transmission, reception, and processing of intelligence and tactical data. These data can be transmitted to a controller for interpretation into tactical mission instructions. This is accomplished in the P-3C by advanced state-of-the-art equipments with the following features:

   UHF, VHF, and HF voice

   UHF and HF digital data link (plain and cipher)

   UHF and HF cipher voice

   HF and UHF teletype (plain and cipher)

   Intercommunications voice for crew

   UHF Sono Command Function (back-up only)

The P-3C communication subsystem is comprised of both new and existing equipment. The new equipment is unique to the P-3C aircraft and updates that aircraft to a more flexible and superior performing ASW weapon system.

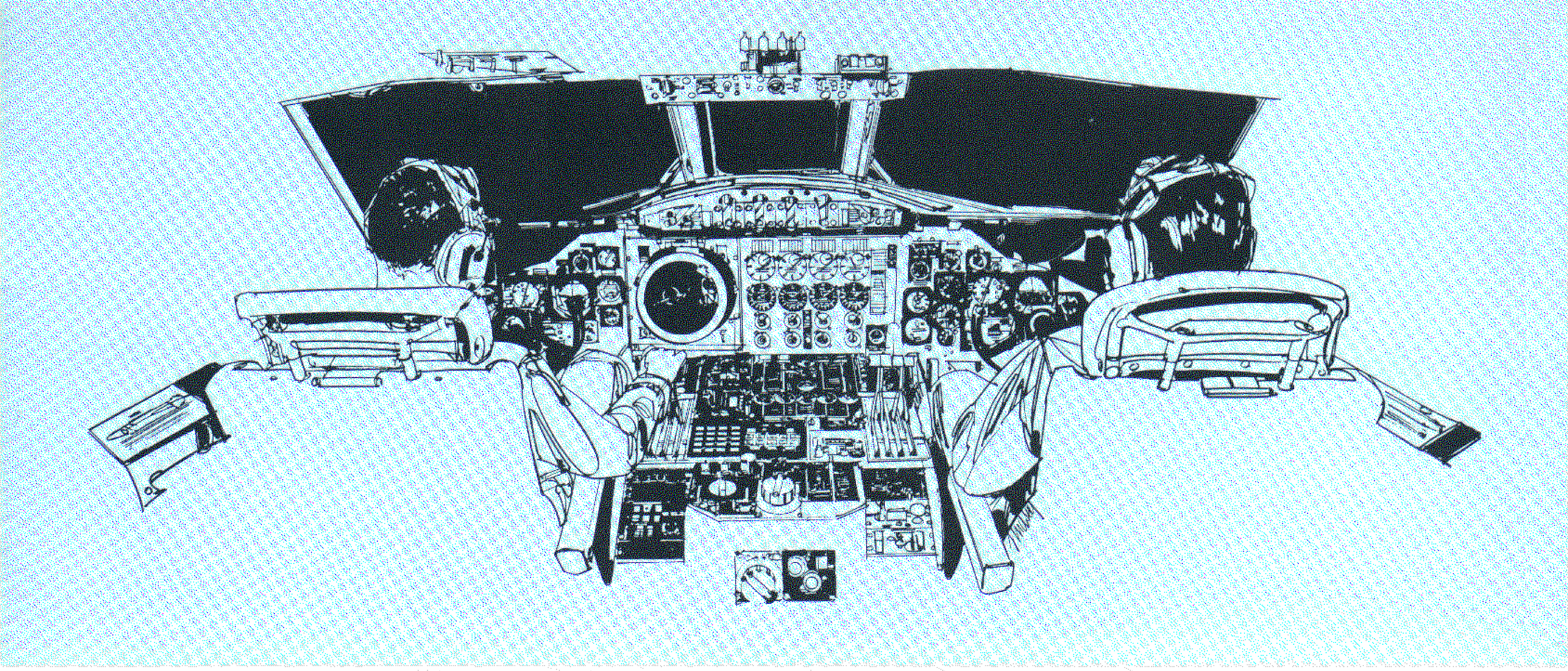
6. **Data Link System** The ACQ-5 Data Link System provides digital data handling of Link 11 communication between the aircraft and similarly equipped ground, ship, and aircraft stations (see Figure 22). When used with the HF or UHF radio sets, digital computer, and associated security units, the AN/ACQ-5 Data Terminal Set transmits and receives secure Link 11 information.

7. **Teletypewriter System** The new Teletypewriter System, AN/AGC-6, (Figure 23) consists of a keyboard and a high speed printer. The HF and UHF-2 transceivers are used in conjunction with this system. Reception and transmission of data is at 60 or 100 wpm and the printer can print out data recalled from the computer memory at the rate of 3000 words per minute. Use of the high speed printer eliminates most of the need to keep handwritten records, and also provides a permanent, hard copy of operator selected mission data and equipment status for inflight or postflight analysis.

8. **KW-7 (TTY) and KY-28 (UHF)** Installation provisions have been made in the P-3C for these communications security systems which can automatically code/decode tactical communications.

9. **DIFAR Acoustic Processing System** DIFAR gives the P-3C a considerably improved monitoring capacity and a target bearing capability which results in greater probability of detection of submarines. The P-3C's new acoustic sensor stations permit both operators to analyze data utilizing new functions and modes representing the latest developments in acoustic detection systems.

To provide maximum reliability and to expedite maintenance of the acoustic system, the P-3C has been equipped with an SG-791/ARR-72(V) Acoustic Sensor Signal Generator, a built-in testing device.



Controlled by the SS-1 and 2 operators, the signal generator permits testing the entire sono-receiver acoustic processor loop quickly and easily before takeoff and during flight.

The P-3C's new AQH-4(V) tape recorder stores acoustic data for inflight playback and for postflight reference and analysis.

10. **Automatic Flight Control System (AFCS)** The new ASW-31 AFCS is a fail-passive dual channel or fail-safe single channel system in the yaw, pitch, and roll axes. The system incorporates full-time altitude controls and full-time proportional control wheel steering. It also permits independent use of the yaw damping mode during manual flight. In addition, the new AFCS improves aircraft ride in turbulent air by limiting pitch-rate and roll-rate. The AFCS, via its MAD maneuver programmer, controls the aircraft through a series of standard maneuvers providing calibration reference for the MAD. Built-in test equipment (BITE) for preflight check and inflight and ground troubleshooting simplifies system maintenance.

11. **Flight Director System (FDS)** The AJN-15 FDS displays steering commands to the pilot for cruise, instrument landing system (ILS), and tactical navigation, in addition to aircraft attitude (see Figure 24). Instructions from the NAV/COMM operator and the TACCO feed through the computer and are automatically displayed on the pilot's tactical display and the new flight director indicator.

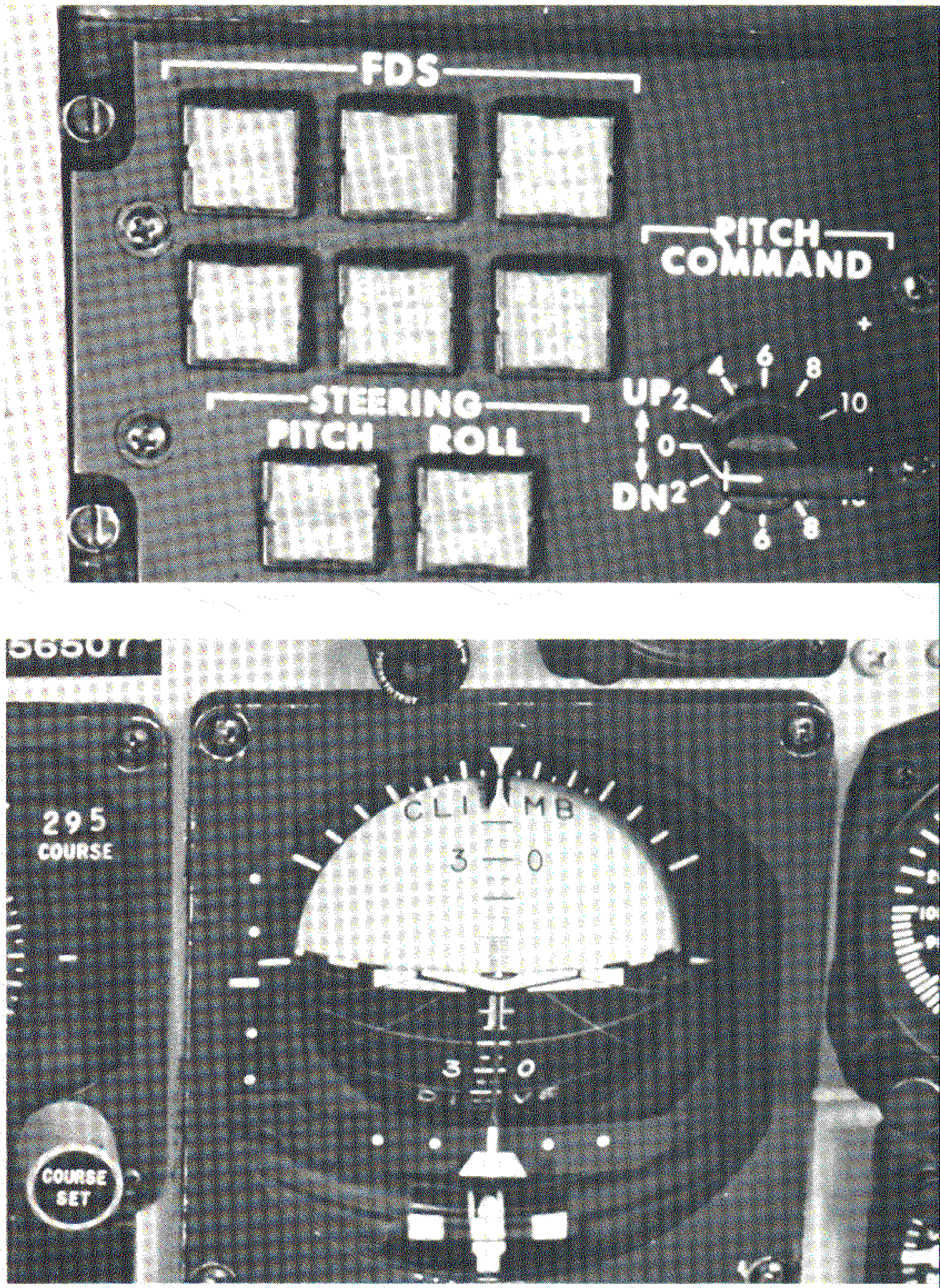


Figure 24. Flight Director Indicator and Control Panel

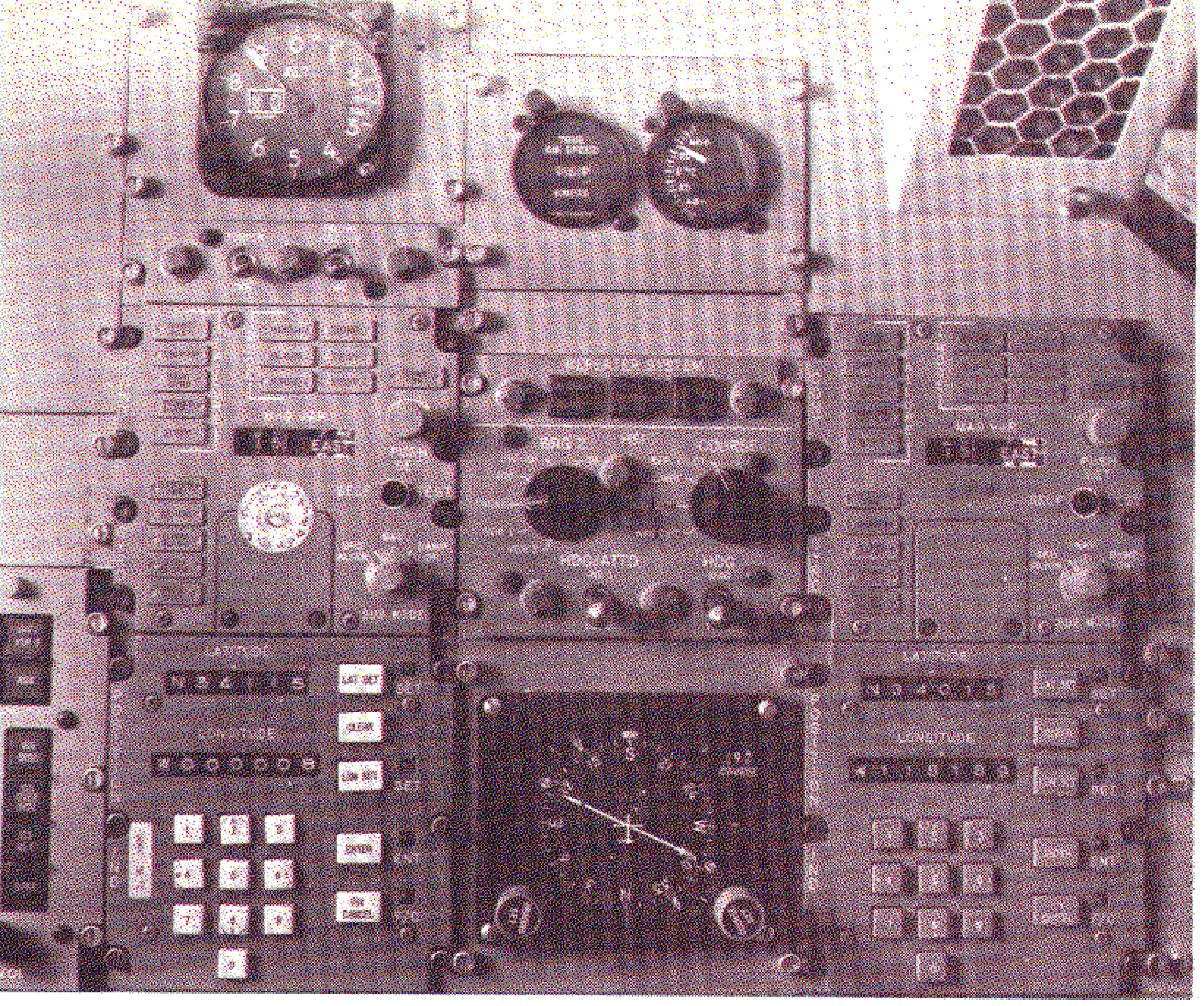


Figure 25. NAV/COMM Station Inertial Navigation Equipment

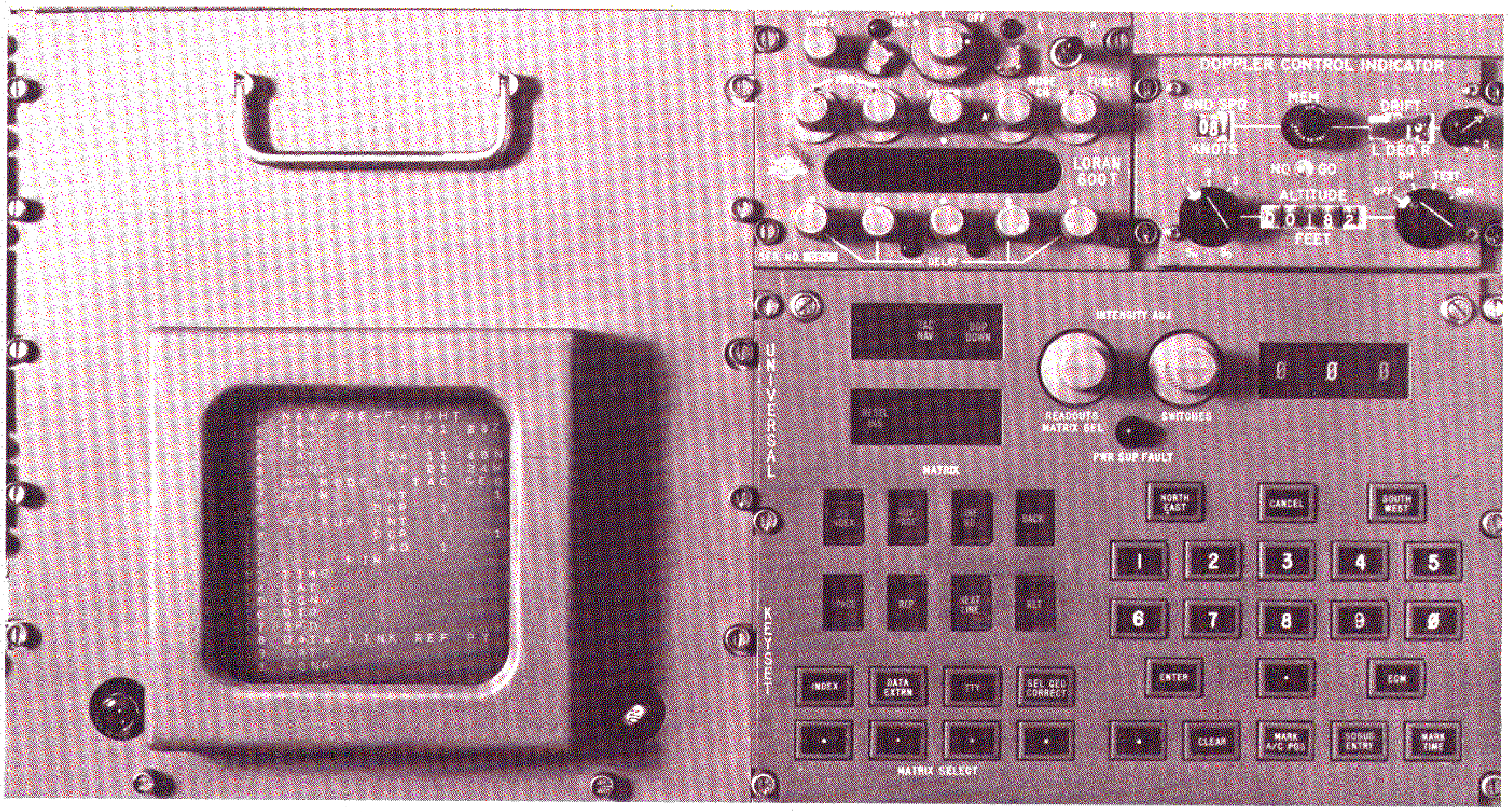
12. **Glideslope System** The Glideslope System, with the FDS, enables the pilot to make instrument landings at fields using ILS as a primary landing aid.

13. **Navigation Equipment** Two ASN-84 inertial navigation sets, each equipped with an independent digital computer, provide latitude and longitude position, heading, and attitude reference as shown in Figure 25.

The P-3C's Doppler radar – the APN-187 Doppler velocity altimeter radar set (DVARS) – displays drift angles and ground speed to the operator and sends accumulated along and across heading distance data to the central computer. Electrical signals representing along and across heading velocities are provided to the inertial navigation sets for Doppler damping. The DVARS also generates an absolute altitude signal for the navigator's Doppler control indicator, copilot's radar altimeter, and for use in the central computer. The Doppler control indicator is shown in the upper right-hand corner of Figure 26. The P-3C navigation system includes the new ARN-81 LORAN receiver which can receive signals from the longer range and more accurate LORAN C stations and from the standard LORAN A system stations.

14. **Submarine Anomaly Detection System (SAD)** The ASA-64 submarine anomaly detector has been added to the MAD system to increase reliability and accuracy of target identification and evaluation. The MAD system transmits received signals to the new SAD system, which then automatically compares the signal against aircraft maneu-

Figure 26. Doppler Control Indicator, LORAN Controls, Universal Keyset, and Auxiliary Readout



vers and known submarine magnetic profiles, and notifies the computer of suspected contacts.

15. **Mad System** Early P-3C's are equipped with an AN/ASQ-10A Magnetic Anomaly System, while later P-3C's are equipped with the more sensitive AN/ASQ-81(V) MAD system which permits detection of deeper targets. Both MAD systems are further refined by an improved ASA-65 Magnetic Compensator, controlled by the operator to adjust for the aircraft magnetic environmental conditions. The system displays aural and visual indications of a MAD signal. Once two or more consecutive SAD signals are detected, the computer predicts the next contact position. The TACCO may then supply steering commands to the pilot for interception of the ASW contact based on the predicted position. The MAD Control Panels are shown in Figure 27.

16. **Electronic Counter Measures (ECM)** The new AN/ALQ-78 is a sophisticated direction-finding ECM which is interfaced with the central digital computer for contact analysis. These contacts are displayed to the SS-3 operator and made available to the TACCO if considered significant.

17. **Sonobuoy Launching System** The revised sonobuoy launching system provides for versatile stores loading and greater inflight flexibility in releasing stores. (This system is covered in more detail later in this issue in the section, "Sonobuoy Launch System".)

OTHER SYSTEMS

Electrical The electrical power generating system on the P-3C is the same as the P-3B except that three, rather than two, electronic power feeders provide electrical power, and side windshield heat is included for the flight station. A simplified schematic of the P-3C electric power distribution system is shown in Figure 28. Included in the P-3C electrical system is an electronics rack overheat warning system. Ambient air temperature sensing elements in each electronics rack close at approximately 130°F when a rack overheat condition exists. This illuminates warning lights in the cockpit and on the aisle side of the overheated rack; when the aircraft is on the ground, a warning horn is also sounded in the nose wheel well.

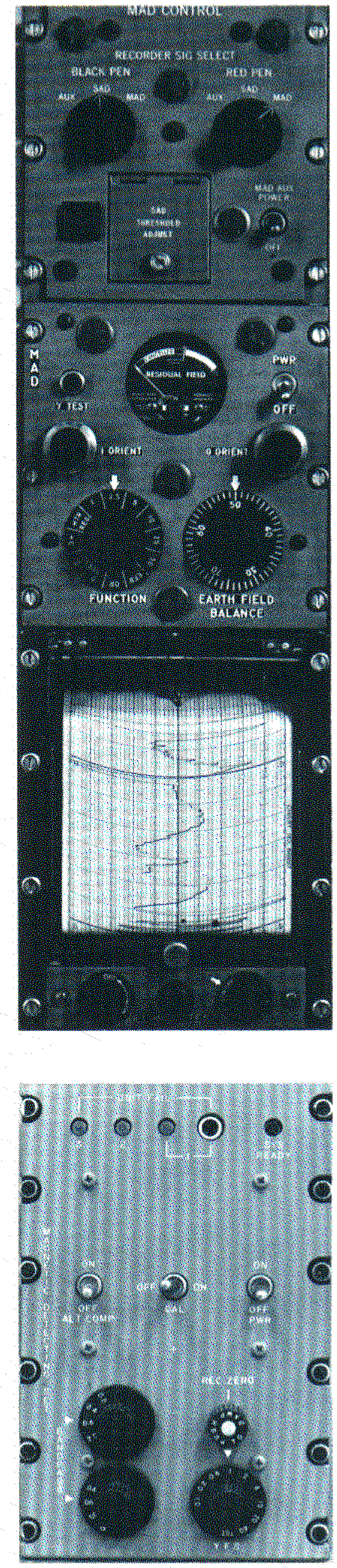


Figure 27. MAD Control Panels. Center panel on main illustration is the control panel for the AN/ASQ-10A Magnetic Detector Set installed on P-3C aircraft, SerNo 156507 through 156513, and 156515 through 157331 (Lockheed Serial 5501 through 5508, and 5510 through 5546). Panel below shows the control panel for the AN/ASQ-81(V) Magnetic Detection Set installed on P-3C aircraft, SerNo 156514 157332, and subsequent (Lockheed Serial 5508, 5547, and subsequent).

Environmental Control System (ECS) The capacity of the ECS has remained the same throughout the history of the P-3; however, changes in the cabin exhaust system have raised the size of avionic heat load which can be cooled. The nominal capacity of the exhaust fan was increased from 1800 cfm in earlier P-3 aircraft to 2500 cfm in the P-3C. This was accomplished using a fan with a larger capacity. The exhaust ducting was completely redesigned for the P-3C because of avionic heat load redistribution. In addition to the main exhaust branch and the smaller branch from the aft radar rack to the fan, the P-3C has two secondary branches on the right side of the airplane. The exhaust tuskers have been relocated to draw air through each of the avionic equipment racks.

The P-3C engine-driven compressors are the same as those on the P-3A/B as are the "bootstrap" air cycle systems. The cabin air temperature sensor is installed at basically the same station in both aircraft; however, because of changes in the avionic arrangement, the P-3C temperature sensor is in the B-3 rack. The B-3 rack door must be in the closed position for the auto mode to operate, and for the cabin temperature indicator to read correctly.

The flight station air distribution system is unchanged, but the cabin system has been modified and the outlets redesigned in the P-3C to draw aspirated mixing air from the cabin space through a second row of slant-mounted grilles.

Recirculation of avionic exhaust was increased under the floor because of the enlarged capacity of the P-3C fan. Approximately 1000 cfm of avionic exhaust enters the cabin through an opening in the floor.

Effective with P-3C SerNo 157327 (Lockheed Serial 5542) and up, the aft electrically heated wall and floor panels were deleted. A hot air supply duct was added in the dinette area and floor-level recirculation grilles were added in the ordnance area.

Armament With the exception of the early P-3A aircraft, the P-3A/B and P-3C airplanes kill-stores provisions and capabilities are basically the same for loading and conveying torpedoes, mines, rockets, parachute flares, and missiles externally on the wings.

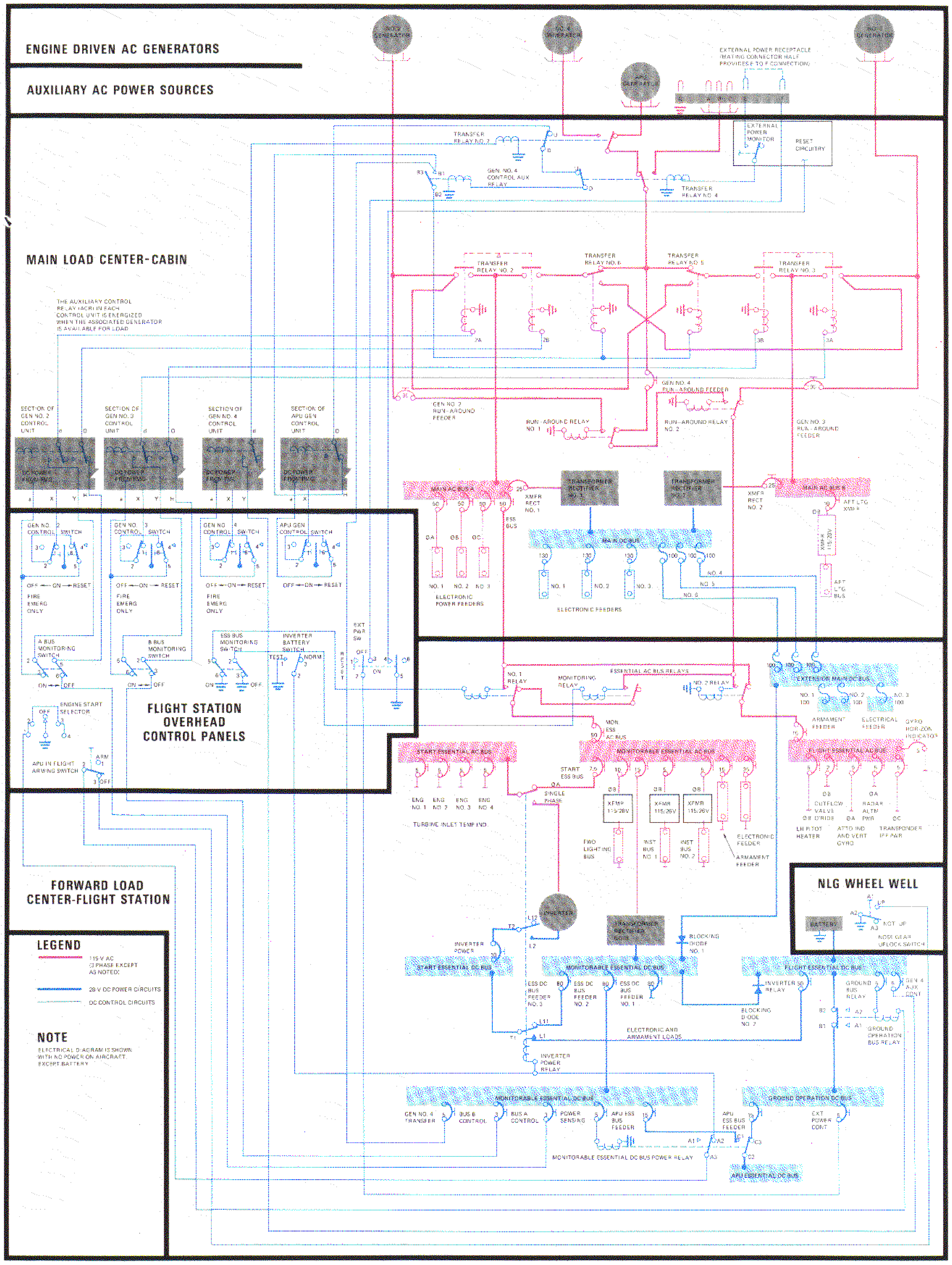
Although temporary, a difference between the P-3A/B and P-3C airplanes' external kill stores capability is the modification of the four outboard mining/Bullpup launchers (wing store Stations 9, 10, 17, and 18) to an all-purpose (universal) type launcher (ECP 590) at P-3C SerNo 158204 (Lockheed Serial 5548) and subsequent. These launchers now have the capability to carry and fire rockets from rocket pods and to carry and eject parachute flares from parachute flare dispensers in addition to the previous capability to carry mines and the Bullpup A guided missile. This eliminates the need for Aero 15D combination bomb rack and rocket launchers to carry rockets and parachute flares. Eventually, all four outboard mining/Bullpup launchers on P-3's prior to SerNo 158204 will be modified for an all-purpose capability per P-3 AAC 570.

Sonobuoy Launch System The sonobuoy launch system installed in the P-3C includes the following system, subsystems, and components:

1. Launch Chutes

   a. 48 "A" size unpressurized, preloaded

Figure 28. P-3C Electric Power Distribution System



ENGINE DRIVEN AC GENERATORS
AUXILIARY AC POWER SOURCES
EXTERNAL POWER RECEPTACLE
EXTERNAL POWER MONITOR
RESET CIRCUITRY
TRANSFER RELAY NO. 2
GEN. NO. 4 CONTROL AUX RELAY
TRANSFER RELAY NO. 4
MAIN LOAD CENTER-CABIN
TRANSFER RELAY NO. 6
TRANSFER RELAY NO. 5
TRANSFER RELAY NO. 3
GEN NO. 2 RUN-AROUND FEEDER
GEN NO. 4 RUN-AROUND FEEDER
RUN-AROUND RELAY NO. 1
RUN-AROUND RELAY NO. 2
GEN NO. 3 RUN-AROUND FEEDER
MAIN AC BUS A
MAIN AC BUS B
MAIN DC BUS
ELECTRONIC POWER FEEDERS
ELECTRONIC FEEDERS
FLIGHT STATION OVERHEAD CONTROL PANELS
ESSENTIAL AC BUS RELAYS
EXTENSION MAIN DC BUS
START ESSENTIAL AC BUS
MONITORABLE ESSENTIAL AC BUS
FLIGHT ESSENTIAL AC BUS
TURBINE INLET TEMP IND
FORWARD LOAD CENTER-FLIGHT STATION
NLG WHEEL WELL
INVERTER
BATTERY
START ESSENTIAL DC BUS
MONITORABLE ESSENTIAL DC BUS
FLIGHT ESSENTIAL DC BUS
ELECTRONIC AND ARMAMENT LOADS
INVERTER POWER RELAY
MONITORABLE ESSENTIAL DC BUS
GROUND OPERATION DC BUS
MONITORABLE ESSENTIAL DC BUS POWER RELAY
APU ESSENTIAL DC BUS
LEGEND
115 V AC (3 PHASE EXCEPT AS NOTED)
28 V DC POWER CIRCUITS
DC CONTROL CIRCUITS
NOTE
ELECTRICAL DIAGRAM IS SHOWN WITH NO POWER ON AIRCRAFT, EXCEPT BATTERY

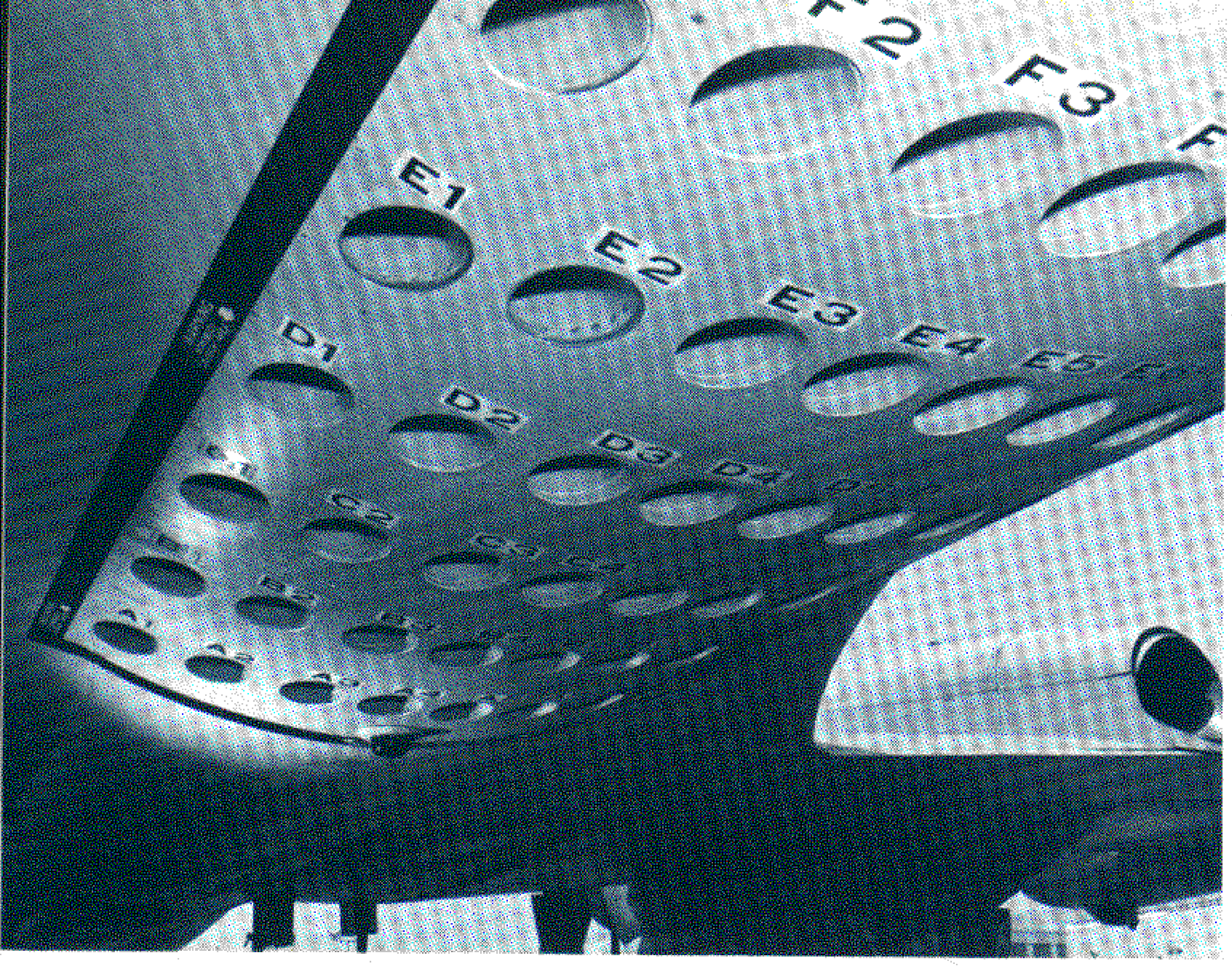


Figure 29. Exterior View of Sonobuoy Launch Tubes

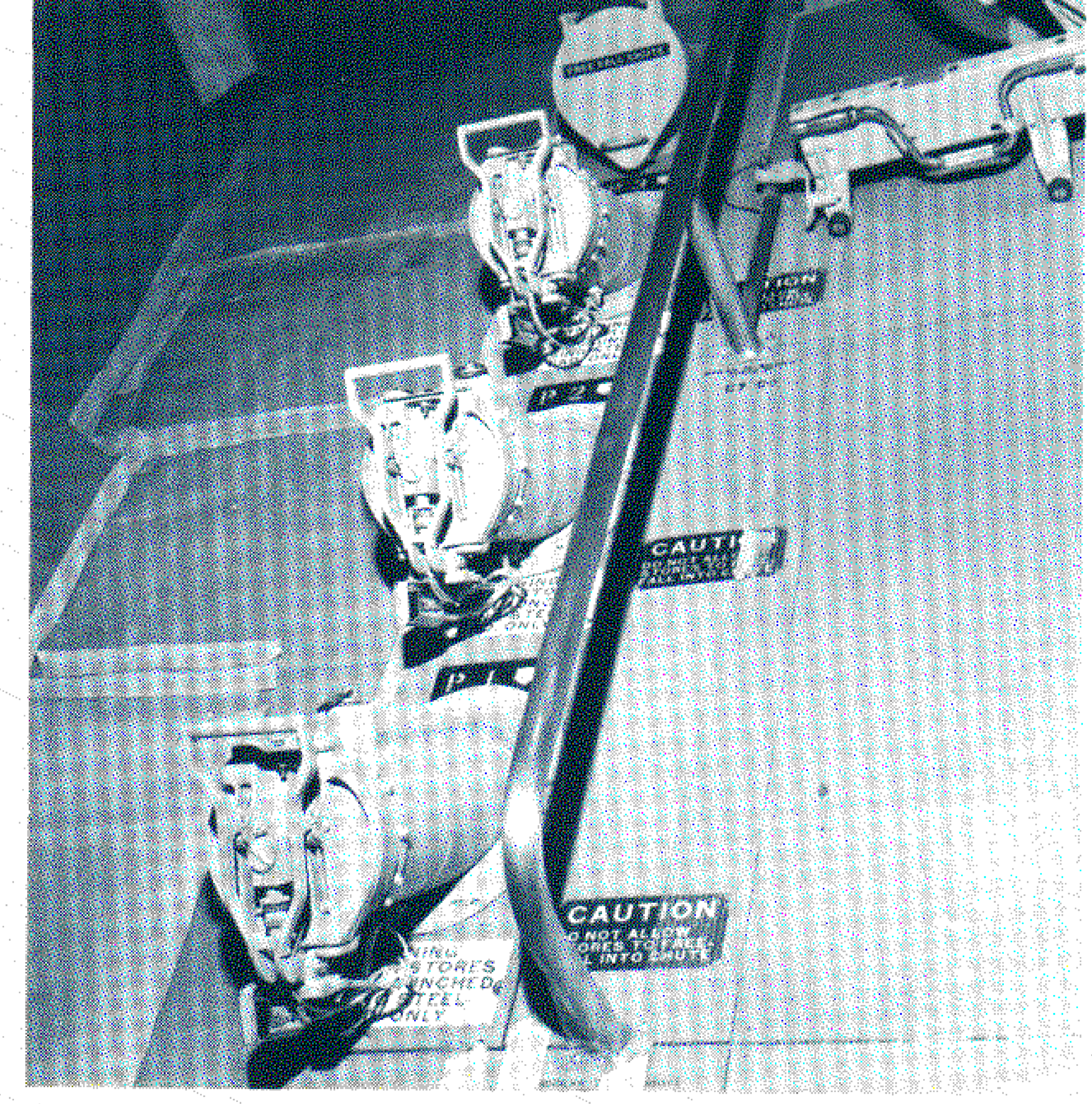


Figure 30. Pressurized Launch Tubes and Free Fall Chute Installation

   b. One "B" size free fall

   c. Three "A" size pressurized, reloadable

2. Stowage Rack – 36 "A" size store capacity (in launch containers)

3. Launch Container – 84 containers provided with each P-3C airplane.

Unpressurized Launch Chutes There are 48 unpressurized "A" sonobuoy launch chutes installed under the floor in the aft section of the cabin. These chutes have a fixed breech installed at the upper end of the chute, and are loaded and unloaded from outside the airplane only. An exterior view of the sonobuoy launch tubes installation is shown in Figure 29. The stores and cartridge activated devices are loaded in launch containers and placed into the launch chutes. An electrical impulse, initiated by either the computer or manually when in the manual mode, is required to actuate a cartridge activated device (CAD) to launch the store. The chutes are loaded to conform to the mission and the load is entered into the computer for operational program use. Once the computer memory contains data that certain stores are loaded in specific chutes, it then can launch the proper store automatically when a predetermined point is reached. Stores also can be selected and launched from the Pilot's and TACCO's control panels through the computer. As an emergency backup to the on-line mode, stores in these chutes also may be selected and launched from a manual control panel in the main cabin.

Pressurized Launch Chutes There are three pressurized launch chutes installed in the airplane (see Figure 30). These chutes extend above the floor of the cabin and may be loaded from inside the airplane only. These chutes are equipped with a hinged breech which allows the ordnanceman to load and launch any type of store stowed in the rack. A pressure door is installed at the lower end of the chute to allow the chute to be loaded when the cabin is pressurized. Launching of stores from these pressurized chutes may be computer controlled or accomplished by manually switching from the Pilot's and TACCO's control panel.

Free Fall Sonobuoy Chute There is a single "B" sized free fall chute installed aft of the three pressurized launch chutes. The chute is open to the airstream at the bottom and can be used only when the cabin is unpressurized.

Sonobuoy Launch Container and Cartridge Actuated Device (CAD) A launch container is required to launch a sonobuoy from the P-3C airplane. At this writing, an aluminum, reusable launch container with a steel CAD is being used. A new plastic shipping/launch container is being considered by the Navy. The CAD is an assembly which provides the motive power to launch the sonobuoy out of the container. When the CAD is ignited, gas pressure is built up within its chamber and is metered into the launch container causing the breakout cap pins to shear and the sonobuoy to be ejected.

Cameras A photographic system is provided in the aircraft for aerial surveillance, making a record of

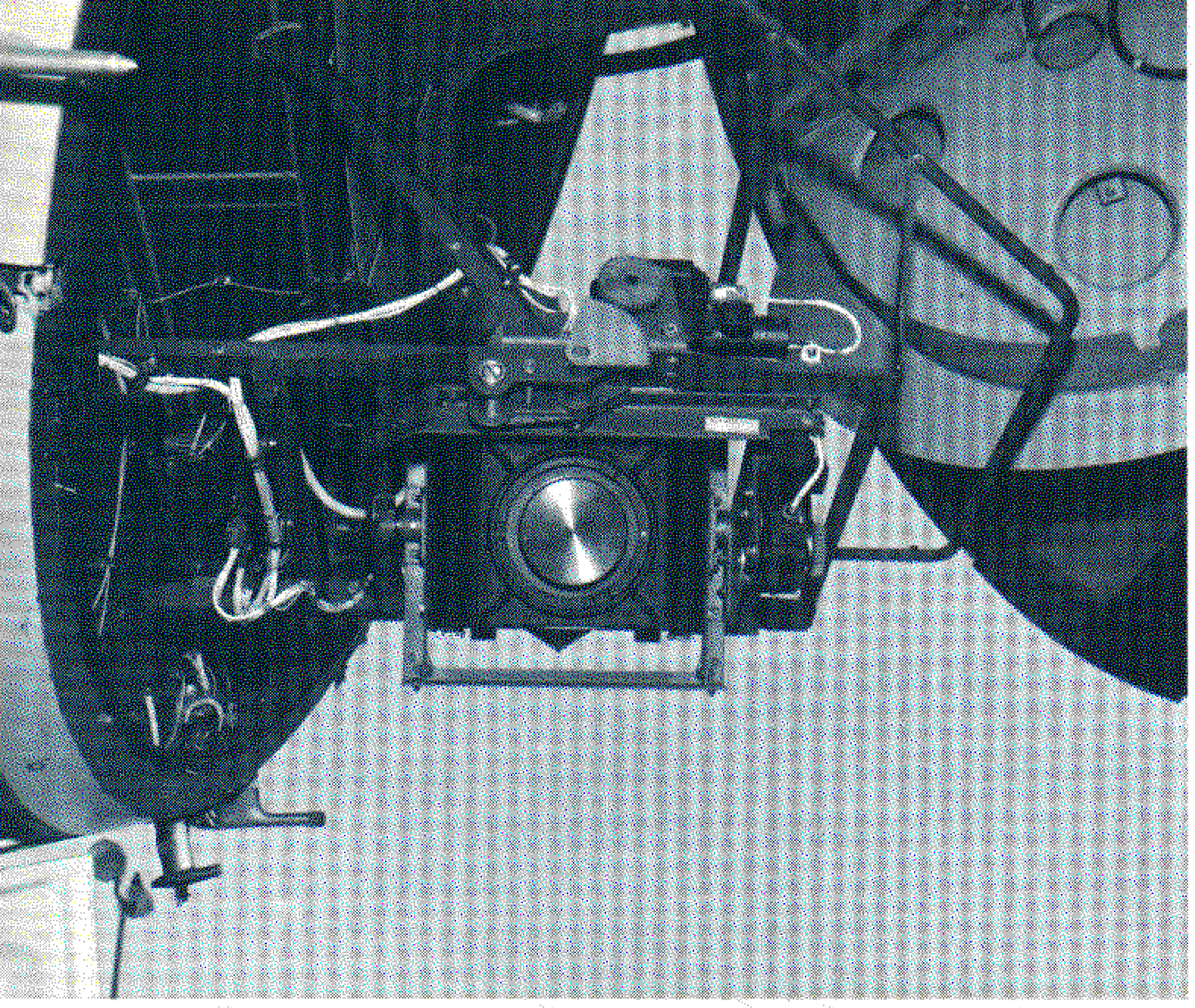


Figure 31. KA-74A Forward Camera Installation

Figure 32. KB-18A Aft Camera Location

aerial reconnaissance surveillance, and assessing the results of armament drops. The system consists of two separate and independently operated camera installations – a forward and an aft camera. The forward camera possesses day/night capability, although only the day capability is currently used. The aft camera is for day use only. The cameras are electrically heated internally to permit normal photography at outside ambient temperatures as low as -65°F.

Forward Camera The forward, KA-74A surveillance camera (Figure 31) is located in an aluminum housing containing four glass windows on the bottom aft surface of the nose radome. When the nose radome is open the camera is accessible from the outside for loading film and for maintenance. The camera is gimbal-mounted with four different positions determined by operating controls in the flight station: vertical, forward (depressed 30° from horizontal), and left and right oblique (depressed 30° from horizontal).

The camera provides a 4.5 x 4.5 inch still picture format and is capable of obtaining single exposures or operating automatically at a rate of up to 4 exposures per second. The film magazine capacity is 100 feet of 5 inch standard base film.

As each frame of the forward camera is exposed, the status is transmitted to the computer for data extraction annotation.

Aft Camera The KB-18A still picture camera is mounted in the bottom aft fuselage and is used for assessing the results of bombing of surface targets. The camera is installed in its own pressure dome, accessible from the outside through a hinged housing that contains two viewing windows (see Figure 32).

Photographic coverage is panoramic over an area 180 degrees fore and aft and 40 degrees left and right of aircraft flight path. The film magazine holds 250 feet (300 exposures) of 70-mm perforated film giving a picture size of 9.40 x 2.25 inches. The camera is activated automatically when kill stores are released. It may also be operated manually from the copilot's side console.

MAINTAINABILITY

The new sophisticated systems that comprise the P-3C Integrated Avionics System have required use of technology that has not been employed previously on ASW aircraft. The central computer, microcircuitry, diagnostic software, and built-in test equipment (BITE) give the P-3C system greater capability and flexibility than the P-3A/B systems; however, use of this technology has required a new approach to system maintenance.

EQUIPMENT DESIGN P-3C avionic equipments are of modular construction and are functionally grouped in the aircraft. They are designed to permit troubleshooting down to the level of the failed module, an improvement over the P-3A/B systems which could be maintained to the black box level only. When practicable, the equipments have been designed for maintenance without removal from their installed positions. If an equipment must be removed, it can be placed on a maintenance tray provided with each aircraft as on-board equipment (see Figure 33). Aircraft harnesses are of sufficient length so that it is unnecessary to disconnect equipments. Support equipment available for each aircraft to facilitate on-board (and inflight) maintenance include a multimeter, oscilloscope, light assembly, breakout adapter box, tools, and spares.

MAINTENANCE PROCEDURES Most avionics equipments are maintained on board the aircraft by corrective procedures that consist of fault isolation, replacement of defective modules, and system checkout. Where there is a computer interface, fault isolation is computer-initiated, utilizing the diagnostic test program. Where diagnostics are not feasible, equipments have self-test features or readily accessible points to accommodate standard test equipment. Off-line tests are performed with BITE and the equipment controls and meters which are used in conjunction with step-by-step procedures in the appropriate Crew Station Maintenance Manual.

MODULE CADDY Assortments of spare avionics modules are packaged in several portable maintenance kits called "caddies" which the technician can take to the work location on the aircraft. The module assortment in each caddy is tailored to troubleshooting a particular system or equipment. Two basic types of caddies are used during P-3C avionics maintenance: one for ground maintenance, and the other to be stowed aboard the aircraft for use during inflight maintenance.

Thus, most avionics maintenance can be performed on board the aircraft by Organizational level personnel. Avionics equipments are not scheduled for removal and bench check except for such maintenance as periodic lubrication of electromechanical units.

INFLIGHT MAINTENANCE Since most avionics maintenance is performed aboard the aircraft, and since test equipment, tools, and spares can be stowed aboard, it was feasible to develop a program of inflight maintenance for selected P-3C avionics equipments. After analysis of such factors as mission requirements, equipment reliability, and time required to perform corrective maintenance, inflight avionics maintenance was grouped into the following three categories:

1. **Essential equipment without parallel or back-up systems, and whose failure would result in mission failure or abort.** This equipment is maintained in flight by (a) detecting and isolating defective modules and replacing them with spare modules carried on board the aircraft; or (b) by interchanging them with modules that are common to less essential equipment or circuits.

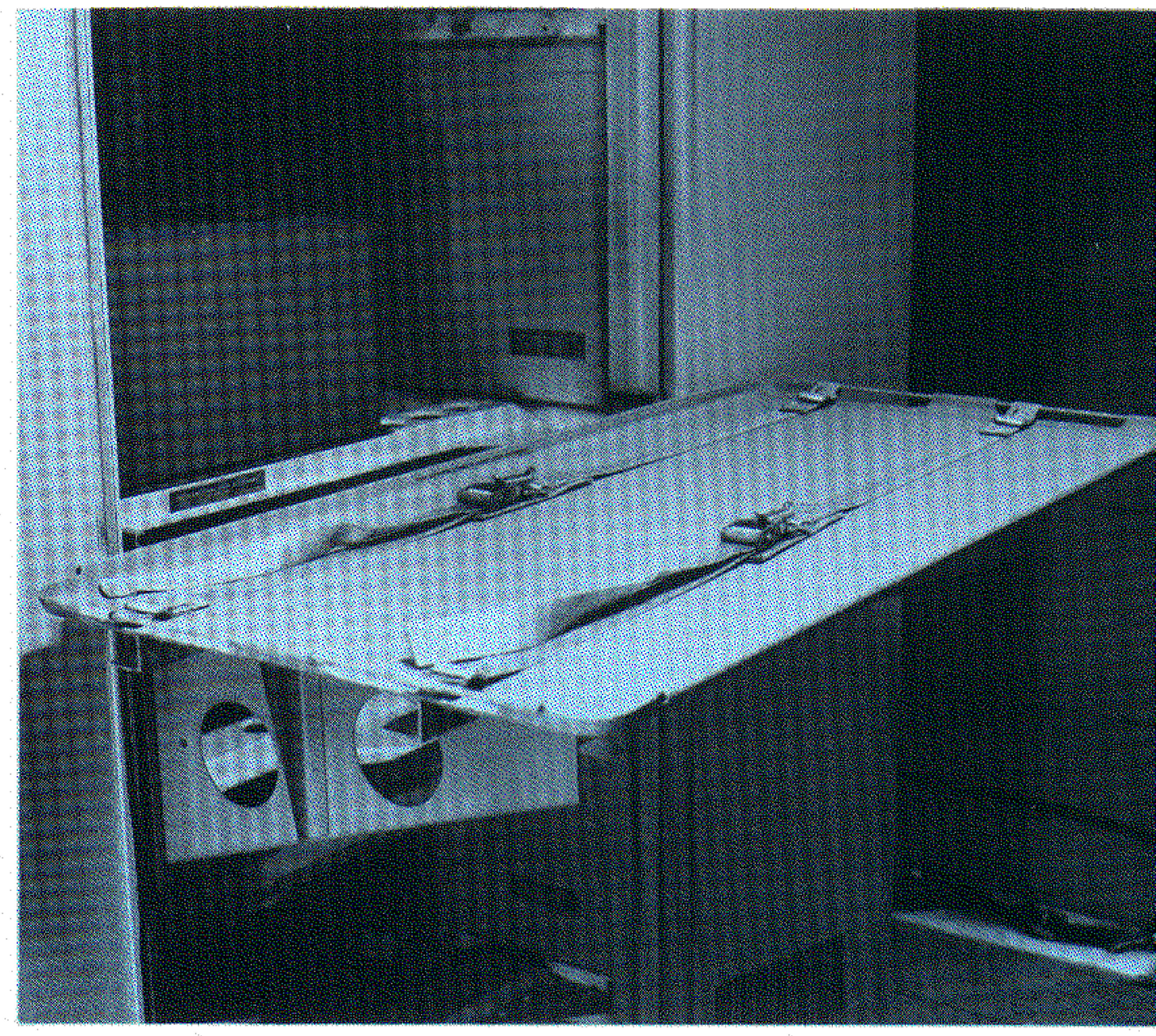
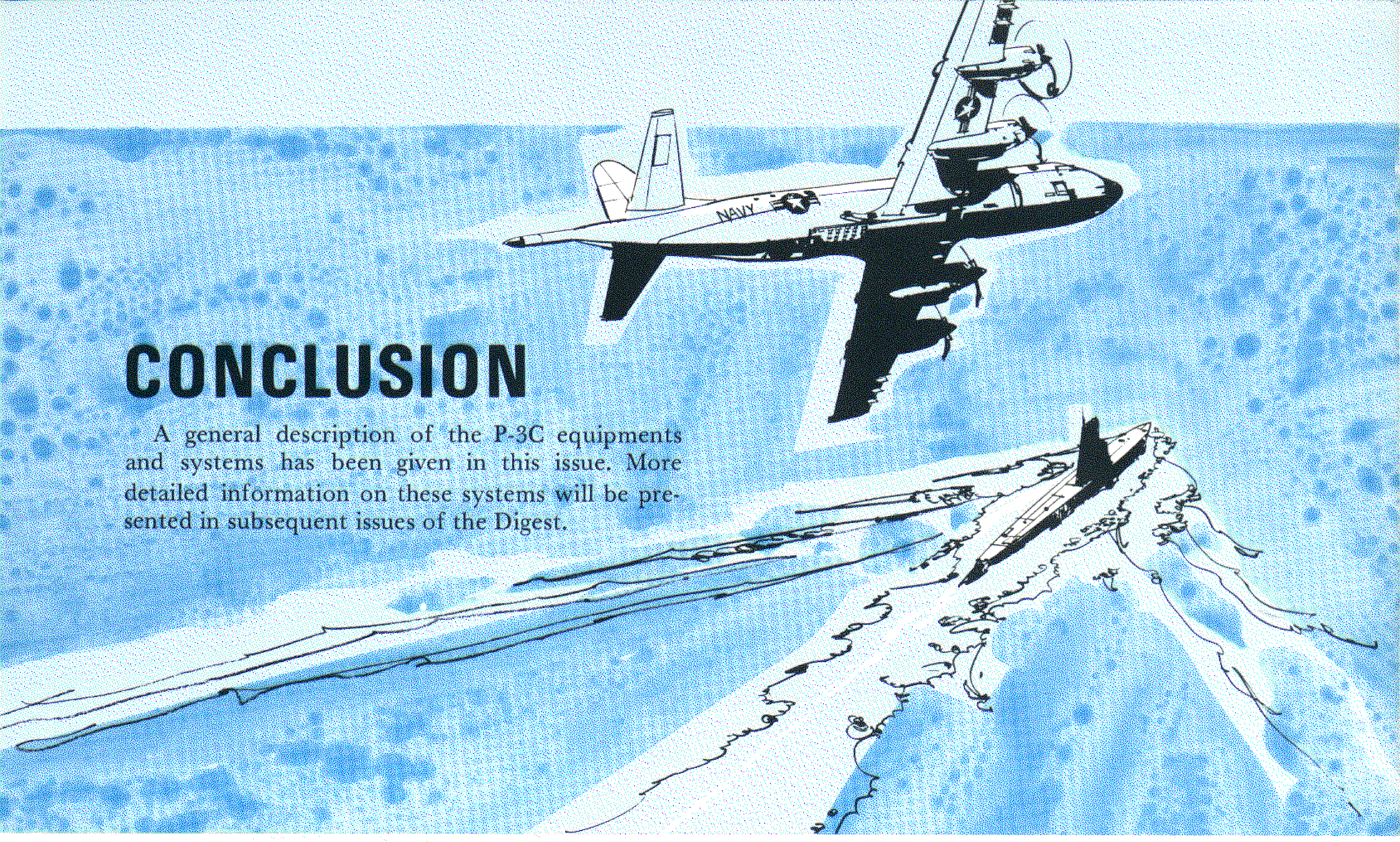


Figure 33. Avionic Equipment Maintenance Tray

2. **Systems having duplicate systems, and whose failure would result in a mission failure or significant degradation.** This equipment is maintained by detecting and isolating defective modules or units, and restoring one system to operation by module or black box interchange.

3. **Systems and equipments whose failure would result in mission degradation, but would not result in mission failure or abort.** Inflight maintenance on this equipment is limited to checking fuses, circuit breakers, connectors, etc. In addition, fault isolation is performed to module or black box level to decrease the turnaround time during subsequent maintenance.

The complement of spare modules in the caddies stowed aboard the aircraft was developed by analysis of actual fleet failure data and assessment of mission criticality. Substitution or replacement of fault modules with these spares should permit repair of a large number of inflight failures.



CONCLUSION

A general description of the P-3C equipments and systems has been given in this issue. More detailed information on these systems will be presented in subsequent issues of the Digest.

This article was prepared from material supplied by the staff of D. H. Daniels, Chief Engineer, P-3. Special assistance in the review and organization of this material was provided from personnel from Lockheed-California Company's P-3 Engineering, Flying Operations, and Navy Logistic Support Organizations. The following alphabetized list contains the names of those consultants and contributors to whom we are principally indebted:

R. H. Bauer	H. A. Franck	R. E. Kananen	C. R. Riege
S. H. Beecher	I. Z. Frank	J. P. Kilman	J. Robinson
H. D. Bergener	S. Gaspar	J. C. Luethi	G. J. Ruppert
R. A. Blay	R. F. Goldman	R. S. Leventhal	P. Scelsi
G. Burns	E. Hackbarth	C. Malkow	P. M. Schrimscher
J. Carpentieri	G. C. Harris	G. Markoe	A. B. Stacey
A. V. Christophersen	T. K. Harrison	M. Mitchell	J. Stewart
J. C. Chung	R. E. Heffern	R. R. Norris	G. P. Terdik
I. D. Curnutt	L. E. Horn	H. W. Obenchain	P. H. Tyree
J. P. Eligh	L. R. Johnson	D. M. Putnam	J. A. Van Aken
W. H. Fleeson	A. W. Kalisuch	G. W. Reed	S. Vernon

T. F. Weber V. Willson L. Woolford

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The Editors

Lockheed - California Company
Product Support - Government Programs

R. A. BARNARD, DIRECTOR

NAVY LOGISTICS SUPPORT .... W. C. BOWDEN, DIRECTOR

D. A. NORTHCOTT, ASSISTANT DIRECTOR – S-3 A. B. STACEY, ASSISTANT DIRECTOR – P-3

LOGISTICS CONTRACTS DEPT.
S. KNEE, MGR.

FIELD SERVICE DEPT.
R. E. KANANEN, MGR.

MAINTENANCE TRAINING DEPT.
A. V. CHRISTOPHERSEN, MGR.

NAVY SERVICE PROJECT GROUP
P. TYREE, SUPERVISOR

NAVY PLANNING AND CONTROL GROUP
P. SCHRIMSCHER, SUPERVISOR

S-3 AND P-3 SERVICE PERSONNEL

LOCATION	NAME	MAILING ADDRESS	TELEPHONE
NATC Patuxent River, Maryland	W. R. Wilken, Resident Service Manager, S-3	P.O. Box 218, NATC Patuxent River, Maryland 20670	(301) 863-8186 Patuxent River, Md.
NATC Patuxent River, Maryland	M. D. Garino, Resident Service Manager, P-3	P.O. Box 218, NATC Patuxent River, Maryland 20670	(301) 863-8186 Patuxent River, Md.
NAS Brunswick, Maine	F. Hampton, Resident Service Manager, P-3	P.O. Box 38 Brunswick, Me. 04011	(207) 729-0000
NAS Norfolk, Virginia	A. Barber, Resident Service Manager, P-3	P.O. Box 8127, Ocean View Station Norfolk, Virginia 23503	(703) 423-8321
NAS Jacksonville, Florida	J. Gipson, Resident Service Manager, P-3	P.O. Box 1300, Yukon, Yukon, Florida 32230	(904) 772-3535 NAS Jacksonville
NAS Key West, Florida	J. Berezonsky, Resident Service Manager, P-3	P.O. Box 1087 Key West, Florida 33040	(305) 294-4417, Key West
NAS Moffett Field, Calif.	F. Hays, Resident Service Manager, P-3	Lockheed P-3 Office Unit One P.O. Moffett Field, Calif. 94035	(415) 966-5461 or 8-322-8591 Mountain View, Calif.
NAS North Island, San Diego, Calif.	R. B. Hedin, Resident Service Manager, P-3	NAS Box 5 San Diego, Calif. 92135	(714) 435-8910 San Diego, Calif.
NAS Barbers Point Honolulu, Hawaii	J. Shovald, Resident Service Manager, P-3	Lockheed-California Co., P.O. Box 268 FPO San Francisco, Calif. 96611	(808) 681-3444, 682-3671 Honolulu, Hawaii
NADC Warminster, Pa.	W. Sneddon, Rep., P-3	P.O. Box 220 Warminster, Pa. 18974	(215) 672-9000, Ext. 2977, 2471, 2686 NADC, Warminster, Pa.

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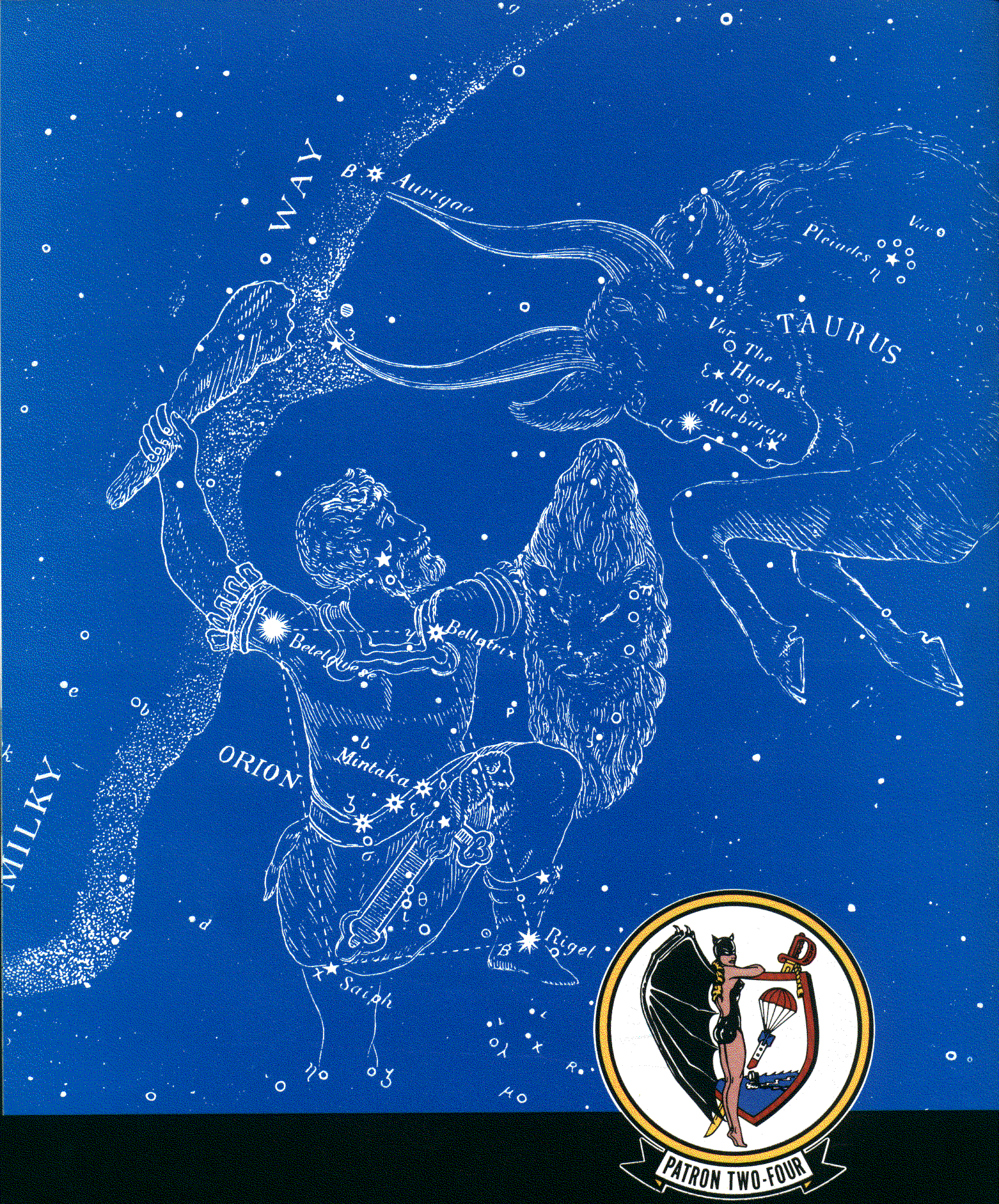
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