ORION SERVICE digest

issue 35 DECEMBER 1977
LOCKHEED · CALIFORNIA COMPANY

P-3C UPDATE II

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ACKNOWLEDGEMENT

The four sections of this article were written by project engineers of the Lockheed-California Company, Military Engineering Division, with assistance from the specific equipment manufacturers. The infrared detecting set portion was written by Joe Cuda, senior electronics systems engineer, with assistance from Robert Moses of Texas Instruments, Incorporated. The sonobuoy reference system portion was written by Roy Reilly, senior research specialist, with assistance from Glenn Peters of Cubic Corporation. The Harpoon weapon system portion was written by Wally Richards and Bruce Ward, armament engineers, with assistance from Gerry Baker of McDonnell-Douglas Corporation. The recorder-reproducer portion was written by Bill Partridge, senior electronics systems engineer, with assistance from Grant Wheeler of Precision Data, Incorporated. Special assistance was provided by Lynn Woolford, and Rudy Burch, P-3 managers.

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FRONT AND BACK COVERS

PATROL SQUADRON THIRTY, nicknamed the "Pro's Nest," is based at NAS Jacksonville, Florida, and has the mission of training aircrew and maintenance personnel for service with the Atlantic Fleet operational squadrons. To accomplish this task, VP-30 has assets of over 500 personnel and 24 P-3 aircraft.

VP-30 was commissioned in June 1960 at NAS Jacksonville, Florida, and was assigned to provide training in the P-2 Neptune and P-5 Marlin. In June 1962, VP-30 Detachment ALPHA was established at NAS Patuxent River, Maryland, to commence replacement training in the new P-3. Four years later, the detachment had outgrown the parent squadron; consequently, the homeport was changed to NAS Patuxent River, and the detachment was established at Jacksonville. This detachment existed until the phasing out of VP-30's P-2s and was disestablished in 1968.

In June 1969, VP-30 received the first production model of the computerized P-3C. After developing a tactics program and training syllabus, the "Pros" commenced transitioning to the "Charlie." In 1970, VP-30 assumed new training duties when the Fleet Readiness Aviation Maintenance Training Program (FRAMP) was implemented. Prior to FRAMP's conception, the VP-30 training program concentrated on flight crew personnel. Presently, however, the squadron also trains virtually all maintenance personnel ordered to East Coast patrol squadrons.

In 1975, VP-30 moved from NAS Patuxent River to NAS Jacksonville. Throughout the move, simultaneous training was conducted at both sites, providing an uninterrupted flow of replacement personnel to the Atlantic Fleet operational patrol squadrons. Currently, the squadron is preparing for the transition of East Coast squadrons to the P-3C Update II aircraft.

VP-30 conducts training classes for flight crew and FRAMP personnel on a regular basis and ground training is given at the Naval Aviation Maintenance Training Detachment (NAMTD), and Fleet Aviation Specialized Operational Training Group, Atlantic (FASOTRAGRULANT). Familiarization, instrument, and tactics training flights are also included for flight crew personnel. Approximately 2500 officers and enlisted men and women are graduated each year.

The expertise of VP-30's ground and flight instructors and the competence of its maintenance and administrative personnel enable this rigorous training program to work effectively.

VP-30 received the coveted CNO Aviation Safety Award for 1976.

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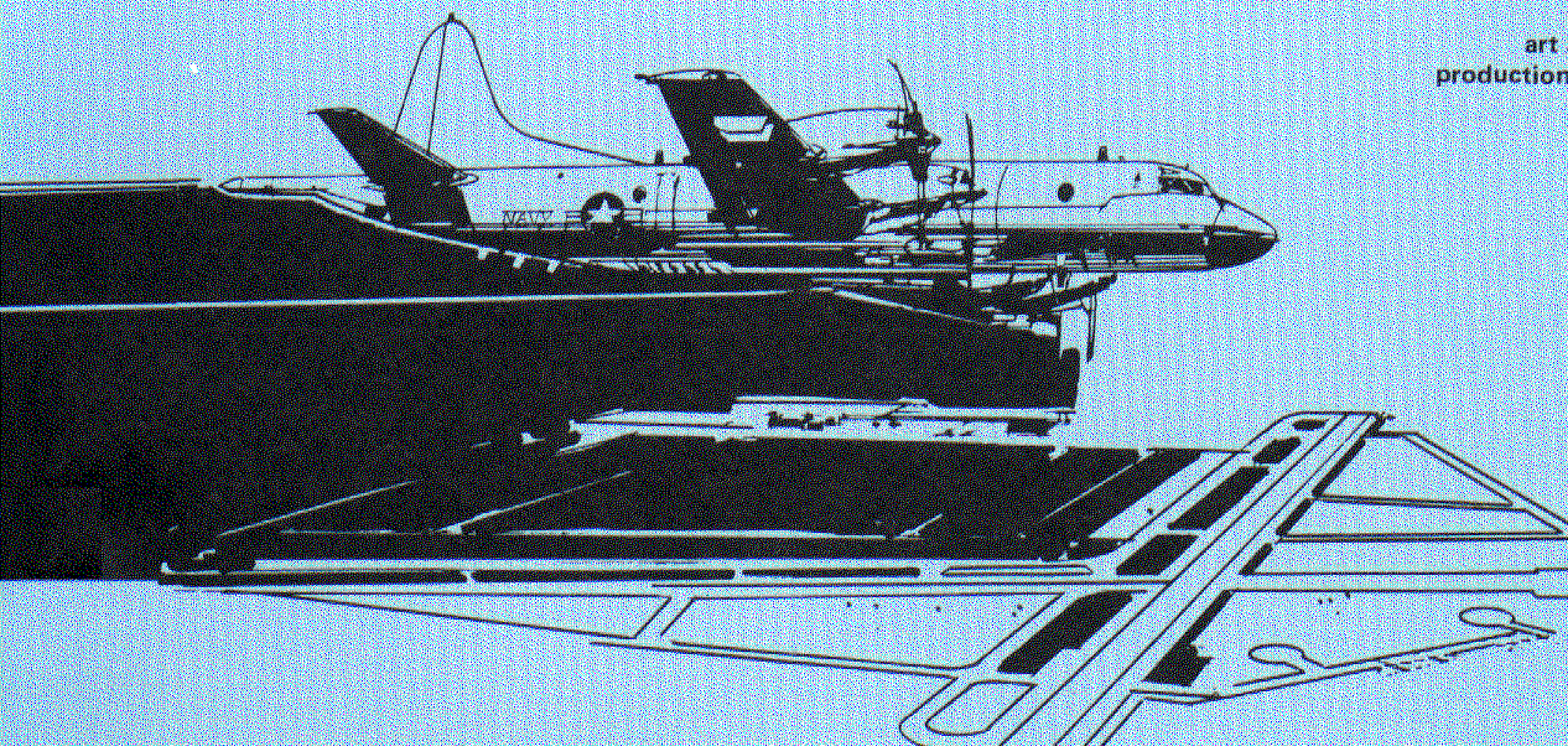
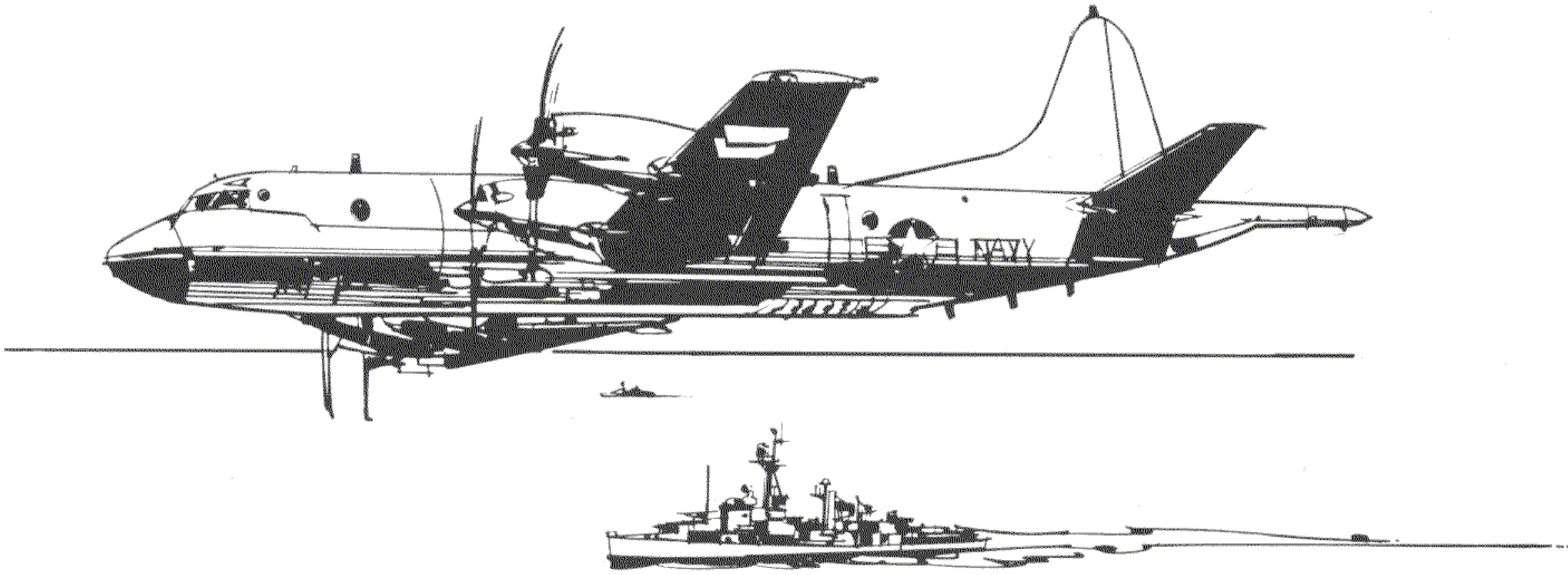


P-3C Update II



INTRODUCTION

In January 1969 the P-3C Orion was introduced into the U.S. Navy. This was the first aircraft in the history of antisubmarine warfare (ASW) to contain a central digital data processing system, a system that can process more than three million bits of information per second. Its computer couples ASW and navigation systems together and performs routine arithmetic and other computations as well as short-term record keeping. The data processing system includes a 65,000-word memory and an AN/AYA-8 Data Analysis Group. This computer installation can accept the information flow for which the P-3C was designed, but it became apparent that the spare input/output channels would soon be saturated and that the memory had little room left for growth.

P-3C Update I solved both of these capacity limitations. Logic unit 4 with an auxiliary drum memory was added and provided the central computer with an additional memory capacity of 393,000 words. The new drum memory storage device was interfaced with the computer through a multiplexer that provides eight new input/output channels. The Update I changes also required that new software routines be generated to broaden the handling of tactical data and to integrate Omega long-range navigational data into the navigation system complex. The aircraft's AN/AYA-8 Data Analysis Group accepts inputs from sensors, navigation aids, and communication equipment. These inputs are then converted into data bits and transferred into the AN/ASQ-114 Computer (CP-901) in 30-bit parallel words.

The Update II project has incorporated a series of improvements that have further enhanced the operational performance of the P-3C Orion. Included are the infrared detecting set (IRDS), the sonobuoy reference system (SRS), capability to fire the Harpoon missile, and installation of an improved acoustic recorder in the acoustic sensor system. Figure 1 shows the location of the Update II equipment in the aircraft.

Briefly, the AN/ASS-36 Infrared Detecting Set provides passive detection of surface objects that emit thermal energy. The detector unit is installed in the forward radome and is fully retractable. The KA-74 camera has been removed. An optical glass window has been installed in the escape hatch behind the pilot to allow the use of a hand-held camera.

The sonobuoy reference system is an ASW aid that provides position estimations for up to 31 sonobuoys simultaneously. Sonobuoy position estimates are derived by the aircraft's central computer and its software from the bearing information of incoming radio signals from the deployed sonobuoys.

Installation of the Harpoon weapon system provides Update II aircraft with an all-weather, long-range, air-to-surface missile strike capability. This weapon system includes the missile, support subsystems, and airborne command and launch subsystems.

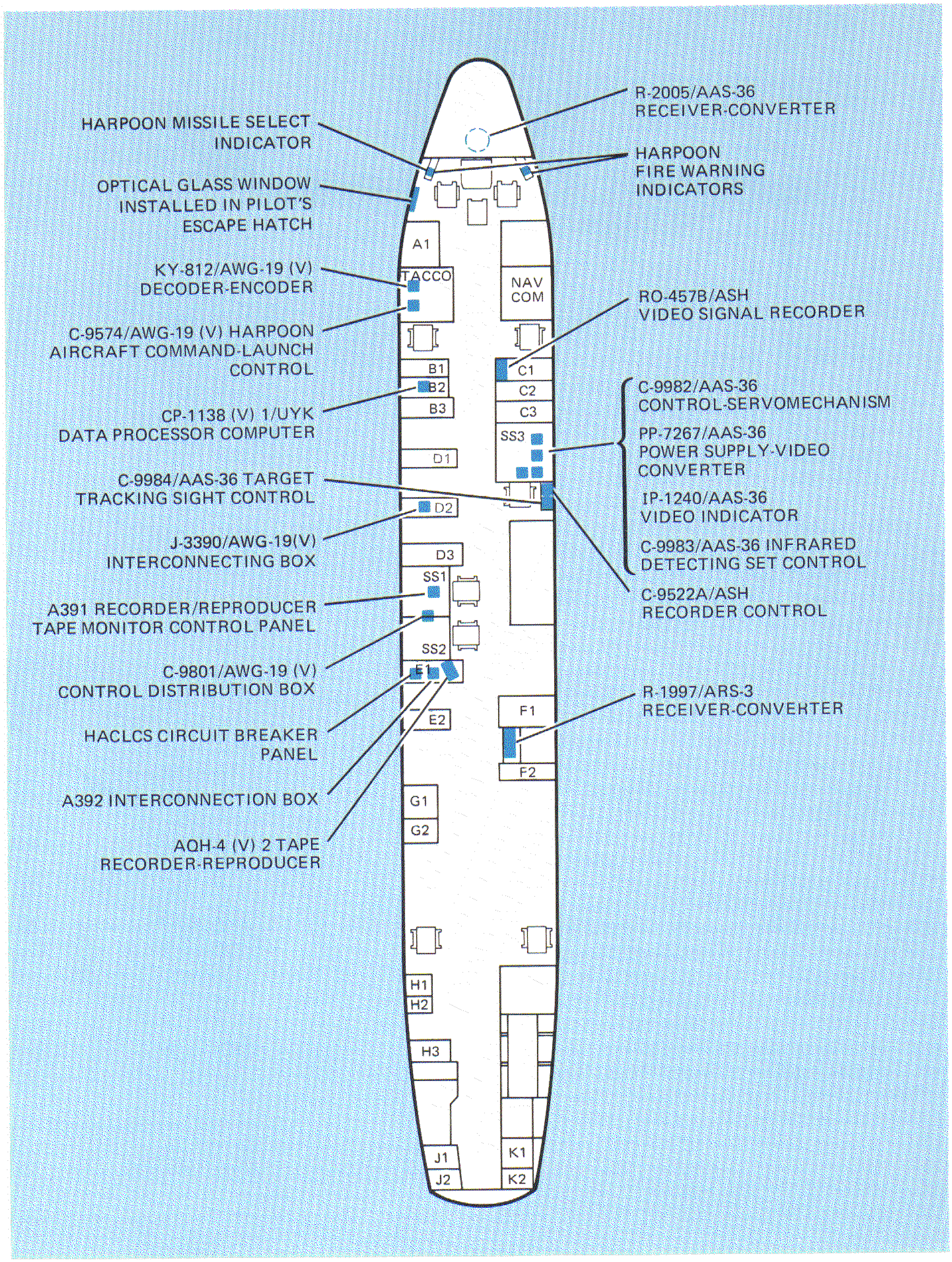


Figure 1. Location of Update II Equipment in Flight Station and Main Cabin

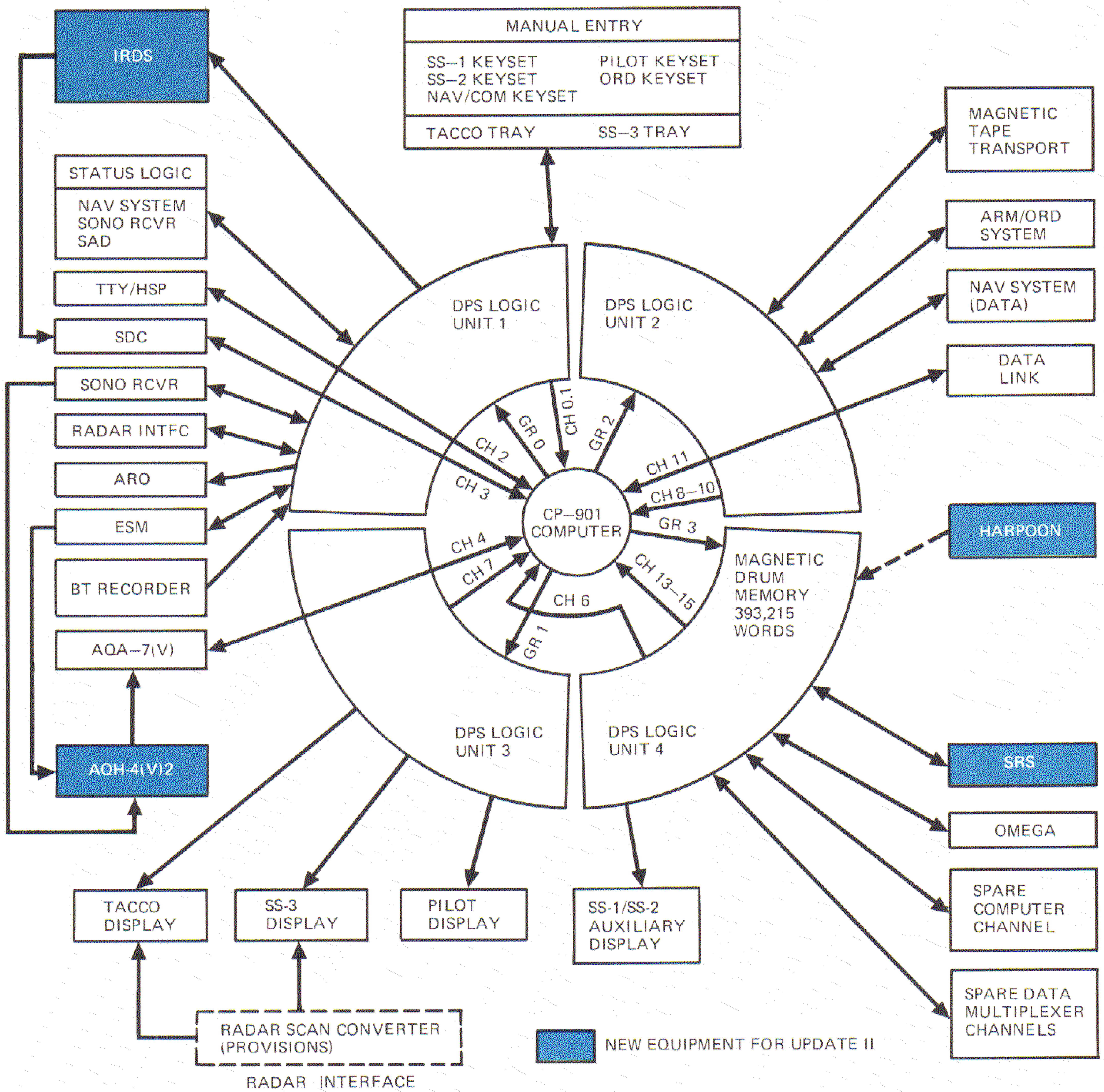


Figure 2. Data Processing System Functional Flow Diagram

The acoustic analog tape recorder replaces the acoustic sensor system's earlier AN/AQH-4(V) model. It provides wideband recording, DIFAR recording, and has growth capability for digital data recording, increased frequency response over the earlier model, and improved reliability. The Update II operational program has been created to integrate the ASW systems with the P-3C Orion aircraft.

In this article we shall discuss the IRDS, SRS, Harpoon weapon system, and the AN/AQH-4(V)2 recorder, and describe how they interface with existing P-3C systems. Figure 2 is a functional flow diagram highlighting the Update II equipment as it relates to the AN/AYA-8 Data Analysis Group, the CP-901 Computer, and the other peripheral avionics equipment.

AN/AAS-36 INFRARED DETECTING SET

The Infrared Detecting Set (IRDS) fits into the category of sensors called FLIR systems (forward looking infrared). FLIR systems are generally used to examine the earth's surface by detecting different intensities of infrared energy radiated by specific objects or ground formations. The IRDS is used to detect objects on the surface of the sea or partially submerged objects along the flight path of the P-3C Orion.

The IRDS is a passive thermal imaging device that detects infrared radiation in the 8- to 14-micron region. Since the earth's natural emissions occur in this region, the earth as "seen" by the IRDS provides a consistent background against which all objects show in relief by virtue of their normally higher intensities of IR emissions. Even an object cooler than the earth's surface will be "visible" to the IRDS because the system will detect a void against the background.

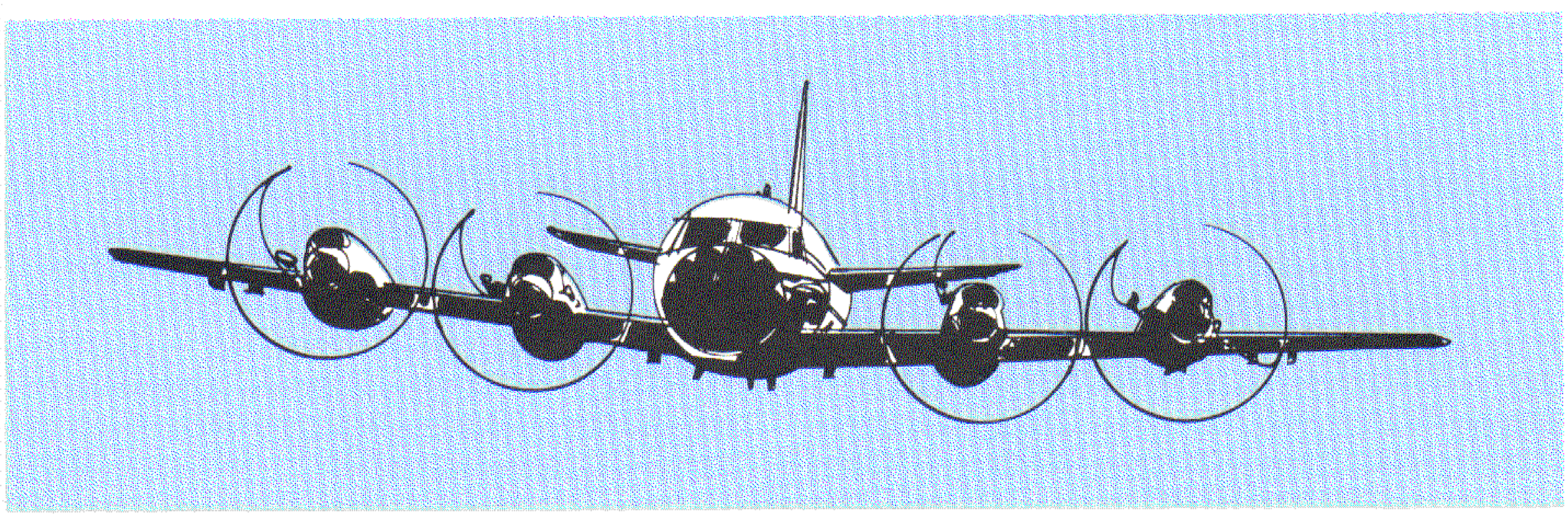
Since IR emissions are always present, the IRDS can detect objects in spite of the presence of haze, smoke, camouflage, or darkness. However, moisture (clouds, rain, fog) or large amounts of carbon dioxide absorb and scatter IR energy. Their presence in the atmosphere can degrade the system's range.

Unlike radar and active sonar detecting devices that can be located by the presence of their emissions, the IRDS is a totally passive scanning receiver/sensor that emits no energy. Therefore, it is difficult for the target to detect that it is the subject of surveillance by the IRDS. Also, since the IRDS is passive, there is no effective way to jam the system with countermeasures.

The IRDS can detect targets such as surface ships and temperature anomalies that are caused by ship bulkheads, heated and cooled ship compartments, and snorkel wakes. The system converts these variations in IR energy intensities to an electrical signal that is displayed on a television-type display. The operator viewing the display can then detect and identify targets from an ample stand-off range.

IRDS was designed to use DOD FLIR-common modules. These modules were designed by Texas Instruments, Inc., under contract to the Night Vision Laboratory in response to the military's need for broader system commonality. They are now used in all branches of the military in infrared systems for widely different applications. Figure 3 shows some of the FLIR-common modules utilized in the IRDS and their relation to system operation.

Basically, the IRDS senses heat (IR energy), converts it first to an electrical signal and then to visible light which is received by a TV camera. The infrared radiation from the target scene is collected by afocal telescopic optics and focused onto one side of an oscillating, double-faced scan mirror. From the mirror, the IR energy is reflected onto an array of IR detectors that operate at -342°F. The detector array converts the IR energy to an electrical signal that is processed and amplified. The amplified signal then modulates the light intensity of an array of light emitting diodes (LEDs) where it is converted to a visual image. The back side of the scan mirror projects the image from the LED array onto the face of the camera/vidicon. The visi-



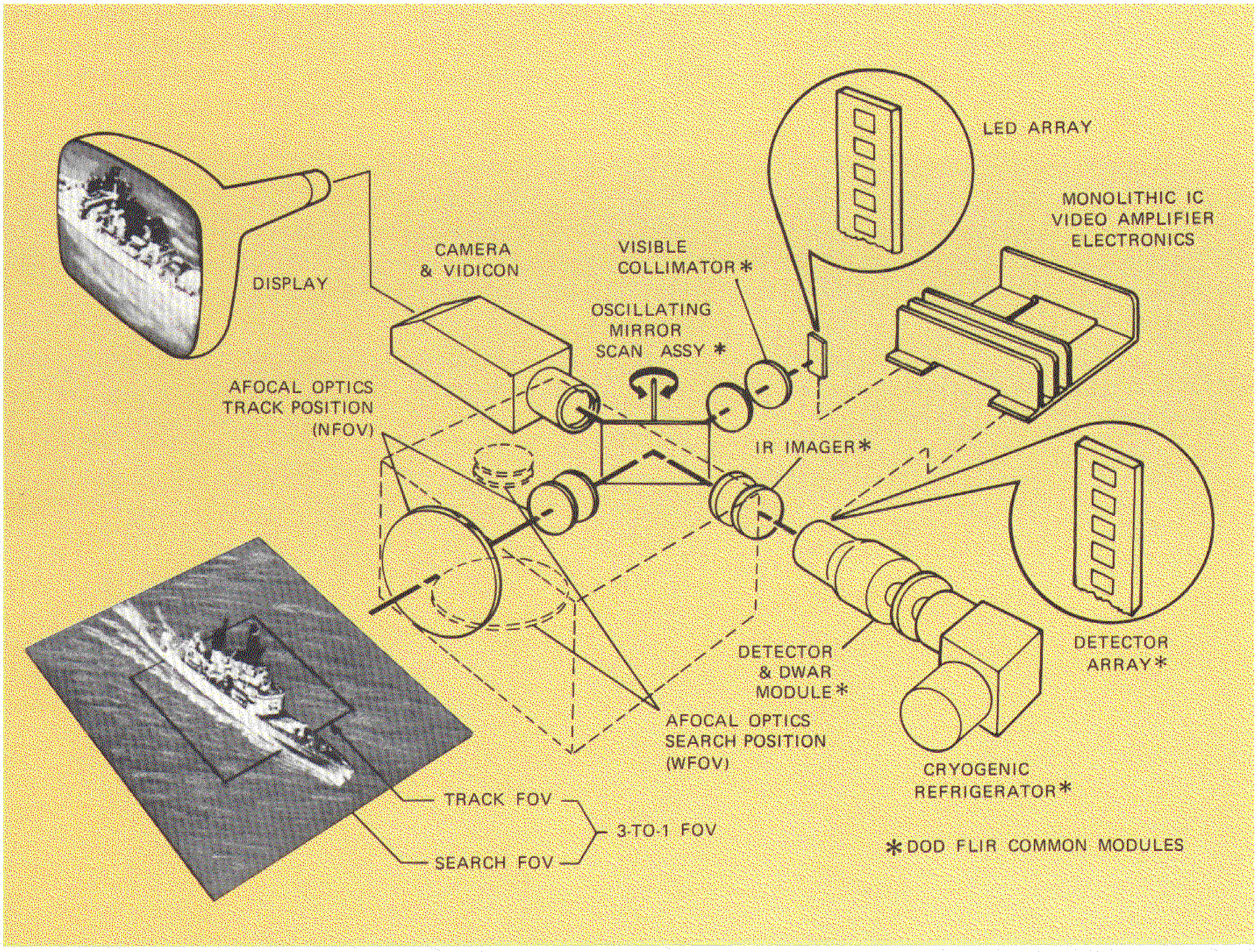


Figure 3. IR Receiver Operation

ble image is converted to a video signal that is amplified and then converted into a standard composite TV video signal that drives the 875-line display on the IRDS video indicator.

The IRDS system can scan full circle around the Orion thus providing full lower hemispheric coverage. The system's line of sight rotates a full 200 degrees both left and right of the aircraft's centerline and swivels 15 degrees up and 82 degrees down in elevation. The IRDS has two fields of view (FOV): a wide FOV (search) for initial acquisition and a narrow FOV (track) for identification and classification of a target.

EQUIPMENT DESCRIPTION Sensor Station 3 operator controls the IRDS. Figure 4 shows the station with the IRDS controls and indicators. The system is composed of the following units:

Nomenclature	*Short Name*
Receiver-Converter R-2005/AAS-36	IR receiver
Power Supply-Video Converter PP-7267/AAS-36	(none)
Control-Servomechanism C-9982/AAS-36	(none)
Infrared Detecting Set Control C-9983/AAS-36	set control
Target Tracking Sight Control C-9984/AAS-36	hand control
Video Indicator IP-1240/AAS-36	video indicator or CRT

These units together with the interconnection box, the turret extend and retract control, and the IR receiver's retractable mechanism provide IRDS operation and interface between the P-3C aircraft and the IRDS. Additional aircraft equipment is used when the IRDS is operated in the computer-aided track mode and will be discussed later in the article. Figure 5 shows the functional flow of the IRDS operation. The following paragraphs describe the functions of the components and the relationships between them.

The IR receiver is mounted in a retractable mechanism located in the nose radome. It contains the IR receiver assembly that collects IR energy and electro-optically converts it to video signals; electromechanical drive elements of the stabilized two-axis gimbals that aim the IR receiver's line-of-sight optics; rate gyros that provide axis stabilization signals for the IR receiver's platform; a heat exchanger for IR receiver temperature control; IR windows and turret housing; and the aircraft extend/retract assembly interface mounting structure.

The power supply-video converter is mounted in the upper rack area of Sensor Station 3. It

Figure 4. Sensor Station 3

regulates and conditions the aircraft power input into various voltage levels for use by the IR receiver. It also converts the TV camera video signal to a standard composite TV video format, generates synthetic gimbal position signals, and generates the gray scale for video indicator presentation.

The control-servomechanism is mounted in the upper rack area of Sensor Station 3. It processes the line-of-sight position and rate commands from the set control or aircraft computer depending upon the operational mode selected. These commands are then processed and converted to analog signals for slewing the IR receiver turret platform. The control-servomechanism also contains built-in test logic circuitry for performing the gimbal BIT operation and fault isolation sequence.

The set control is in the Sensor Station 3 console. It provides the operator with the IRDS primary controls and indicators such as mode selection, turret position, component failure, system readiness, etc.

The hand control is a rigid stick located to the right of the operator at Sensor Station 3. It has a

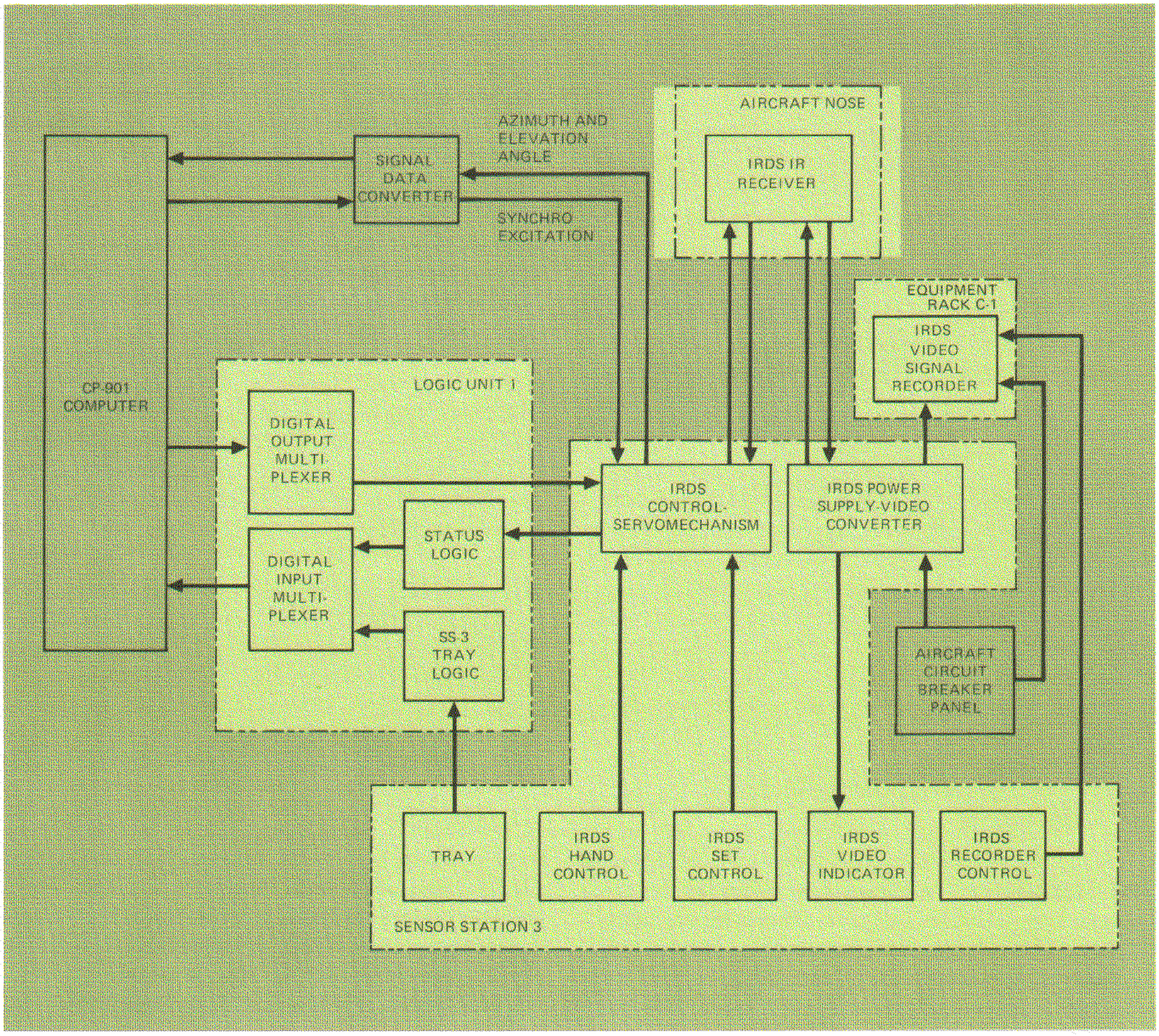
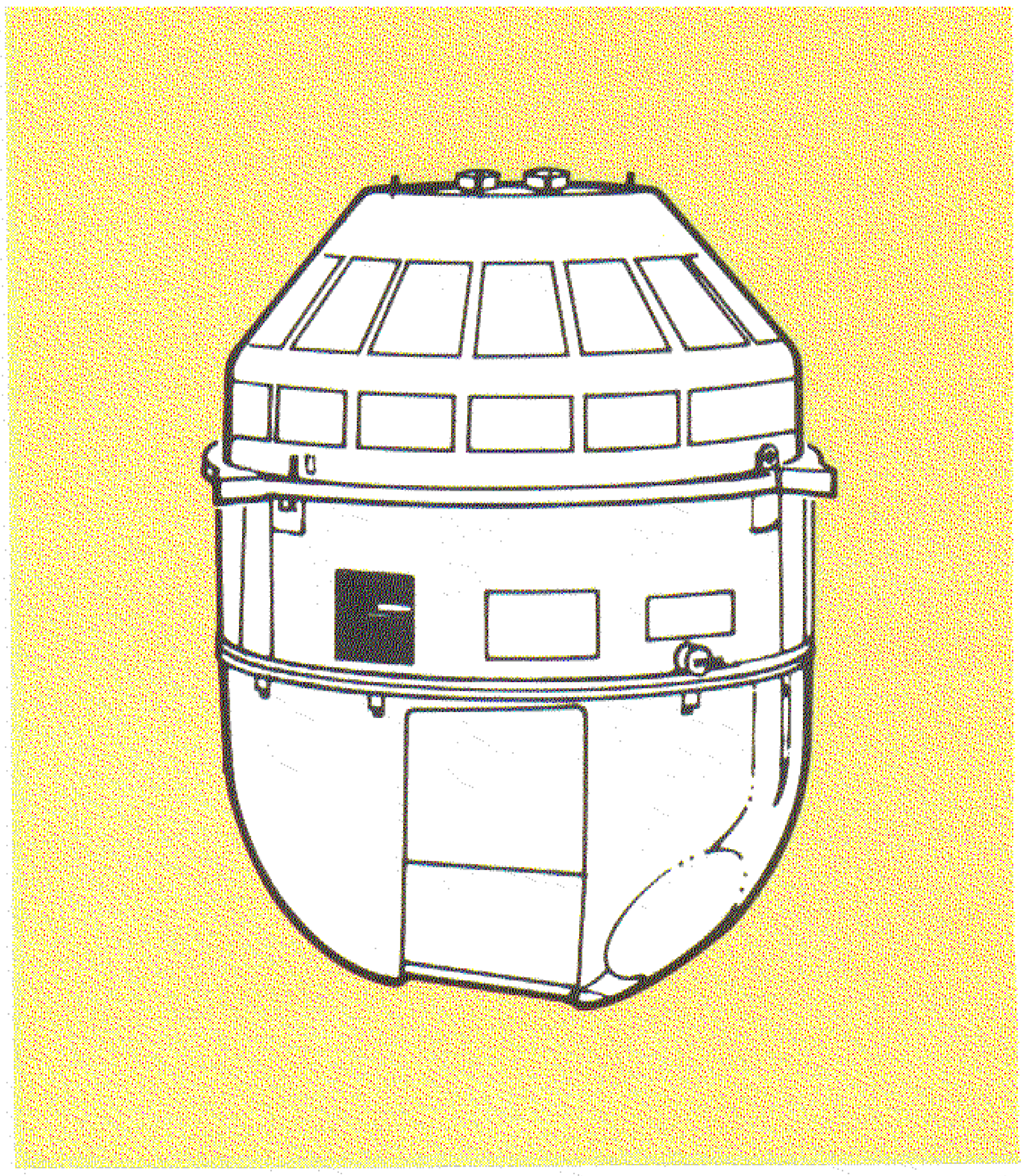


Figure 5. AN/AAS-36 IRDS Block Diagram



IR Receiver

thumb-operated control that allows the operator to manually slew the IR receiver. A trigger switch permits the operator to manually override any other active mode and place the IRDS in the Manual Track mode.

The video indicator is in the Sensor Station 3 console. It presents a real-time television-type image of the IR scene. Small white bars (cursors) are projected onto scales printed on the top (azimuth) and left side (elevation) of the CRT. These bars pinpoint the location of a target scene within ±10 degrees of the IRDS line of sight relative to the aircraft line of sight. A multistep gray scale can be displayed across the bottom edge of the CRT to aid target resolution. The video indicator has its own continuously operating BITE and a go/no go status light on its front panel.

IRDS RECORDING A video film recorder will be installed on Update II aircraft beginning with SERNO 160751 (Lockheed Serial No. 5657). This equipment will record the scene as presented on the IRDS video indicator. Earlier Update II aircraft will be retrofitted with this equipment. The OA-8770A/ASH Video Signal Recorder Group consists of the RO-457B/ASH Video Signal Recorder and the C-9522A/ASH Recorder Control. The video recorder is located in the C1 electronics rack; the recorder control is located in the Sensor Station 3 console.

The IRDS composite video signal is supplied to the video recorder by the power supply-video converter. The video recorder records the IRDS presentation of 16mm film. The Sensor Station 3 operator can record the IRDS video at 1 frame per second (fps) or at 10 fps by operating the recorder control. The recorder control also indicates the number of feet remaining in the film magazine (400-foot capacity).

Since the video recorder records on film, there is no onboard playback. The film magazine is sent to the base photo lab for processing after the flight. The film can then be projected with a standard variable speed 16mm projector.

IRDS OPERATING MODES The IRDS operating mode select switch is on the set control panel (Figure 6). When the mode switch is set to Off, no aircraft power is applied to the IRDS, and the gimbal brakes are engaged to prevent IR receiver turret rotation. Initiation of the Standby (warmup) mode starts gyro warmup, air conditioning, and cool-down (20 minutes maximum) of the detector assembly. During Standby, there is no video image and the IR receiver gimbals are braked at the stow position (full up at +15 degrees elevation and full counterclockwise at -200 degrees azimuth).

The remaining four modes, Computer Track, Manual Track, Position, and Forward, are active tracking modes. In Computer Track, the IR receiver line of sight is controlled by digital rate commands from the aircraft's CP-901/ASQ-114 Computer by way of logic unit 1. The computer-aided track mode will be discussed in detail later in the article.

In the Manual Track mode, the IR receiver line of sight is controlled by the operator's thumb control on the hand control. In the Position mode (POS), the IR receiver line of sight is chosen by the operator who selects elevation and azimuth settings from the Position Control on the set control. In the Forward mode (FWD), the IR receiver line of sight is fixed at -4 degrees elevation and zero degrees azimuth (slightly below the horizon, dead ahead).

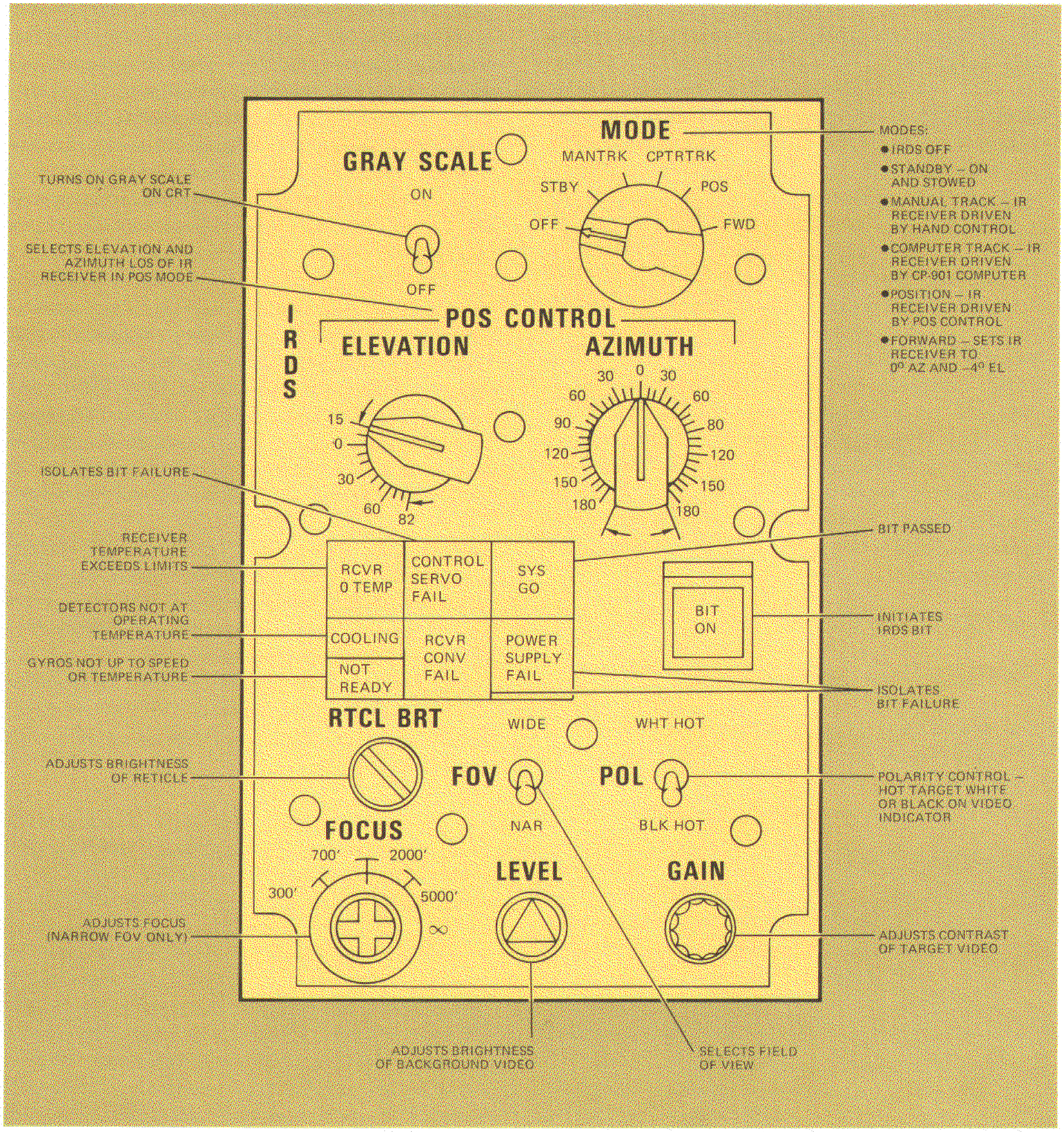


Figure 6. IRDS Set Control

The operator can override the Computer Track, Position, and Forward modes by pressing the trigger on the hand control. The IRDS will revert to Manual Track and remain in this mode until the trigger is released. The trigger has no effect upon gimbal operation when the mode switch is set to MAN TRK, STBY, or OFF.

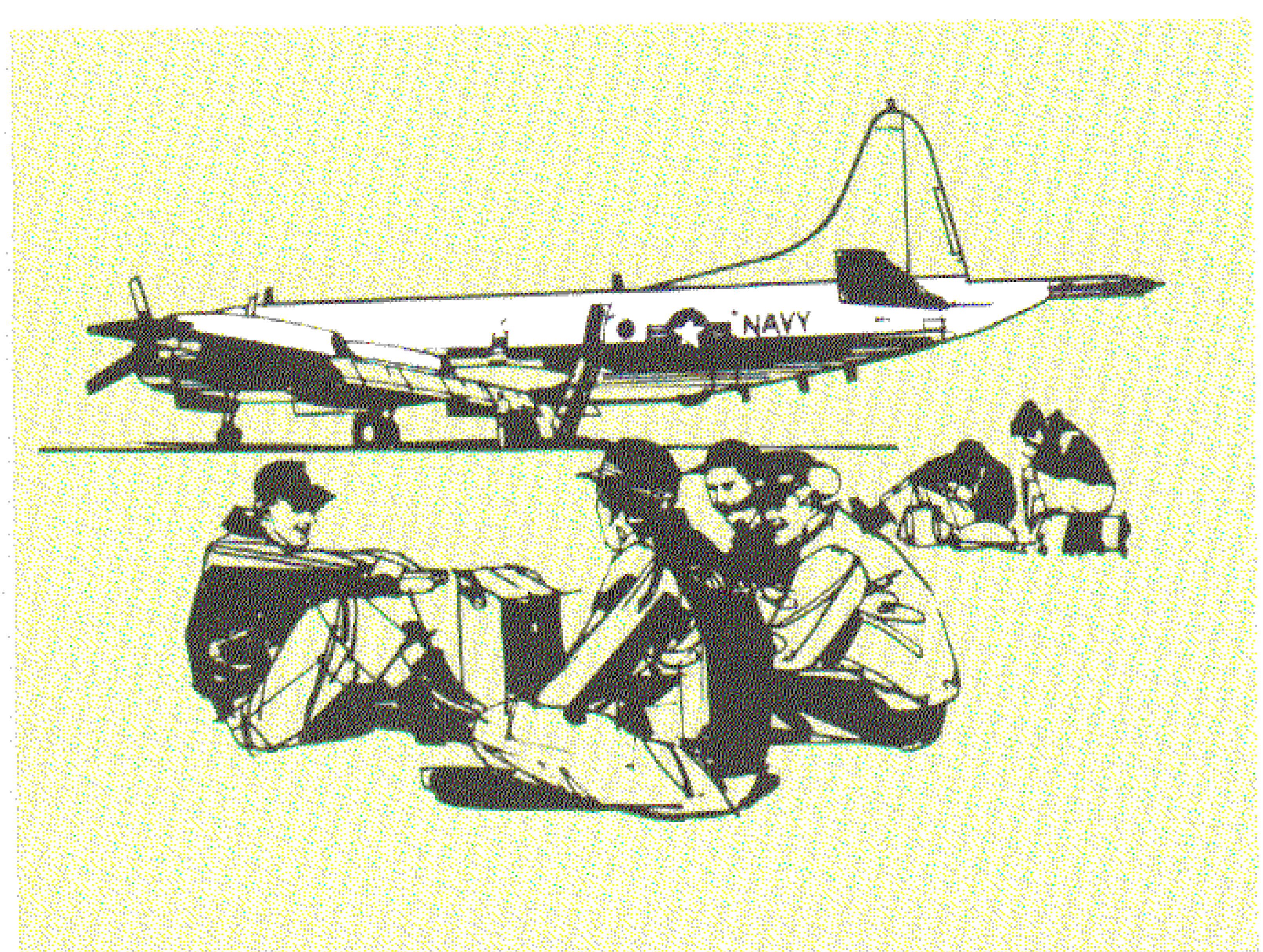
Manual Operation The Sensor Station 3 operator can observe the sea around the flight path of the P-3C Orion through the video indicator on his console, tracking objects manually or observing preselected areas in the Position or Forward mode. Generally the operator selects wide FOV for search and narrow FOV for tracking. He obtains optimum target resolution by adjusting the gray scale so that all ten shades are visible across the bottom of the video indicator.

When the operator sights an object of interest, he centers it on the CRT reticle. If the narrow FOV has been selected, the image focus can also be adjusted. Video polarity can be selected so that the target will appear as either a white or black image on the CRT. The cursors (white bars) displayed on the azimuth and elevation scales on the CRT will locate the target position in relation to the aircraft.

Computer Operation The Computer Track mode greatly enhances the Sensor Station 3 operator's ability to track an object with the IRDS and furnishes him with considerable tactical data. Once in the computer-aided mode, the operator communicates directly with the computer via the operational software. The following aircraft equipment is used in conjunction with IRDS during computer-aided operation:

- CP-901/ASQ-114 Computer
- Update II Operational Software
- Sensor Data Display (SDD), Tray, and Trackball
- CV-2461A/A Signal Data Converter
- MX-8023/AYA-8 Logic Unit 1

During all operational modes, the IRDS control-servomechanism supplies a status word to the computer via logic unit 1 telling the computer what mode the IRDS is in. When the Computer Track mode is selected, the operational software sends digital signals through logic unit 1 to the control-servomechanism. The control-servomechanism converts these signals to analog signals to operate servo motors which drive the IR receiver elevation and azimuth gimbals to the designated positions. The gimbal positions are relayed back to the computer through a feedback loop.



The operator can employ computer-aided operation either to search a specific area or to track a specific target automatically. Once in the computer-aided mode, the software allows the operator to enter the speed, range, and bearing of a target and record this information as an IRDS contact. The software also permits the operator to coordinate IRDS with other computer-aided operations on the aircraft.

Sector Scan and Auto Track are the primary computer-aided methods of operation. The Sector Scan function is used primarily for searching an area designated by the operator. To employ this function, the operator presses the Sector Scan readout switch, and then enters into the computer a bearing relative to the aircraft's line of sight, a sector width in degrees, a range in nautical miles, and a scan rate.

The operator employs the Auto Track function when he decides to track a specific target automatically. The target may be one he has spotted on the video indicator, or it may be an ESM, IRDS, radar, or MAD contact already stored in the computer. Since the computer is only tracking a target area designated by the operator, it has no sense of the actual target; the target may stray slightly from the IR receiver's line of sight. In this case, the operator can press the Trackball readout switch which will allow him to use the tray trackball to "fine tune" or recenter the image on the reticle of the video indicator. The computer will sense the correction and respond accordingly.

EXTEND/RETRACT ASSEMBLY The extend/retract assembly opens the IRDS fuselage door, lowers the IR receiver turret to the operational position, retracts it for stowage, and closes the fuselage door. Mounted at Fuselage Station 185, the extend/retract assembly includes the rotary actuator, turret platform, brackets, brakes, and interlock switches.

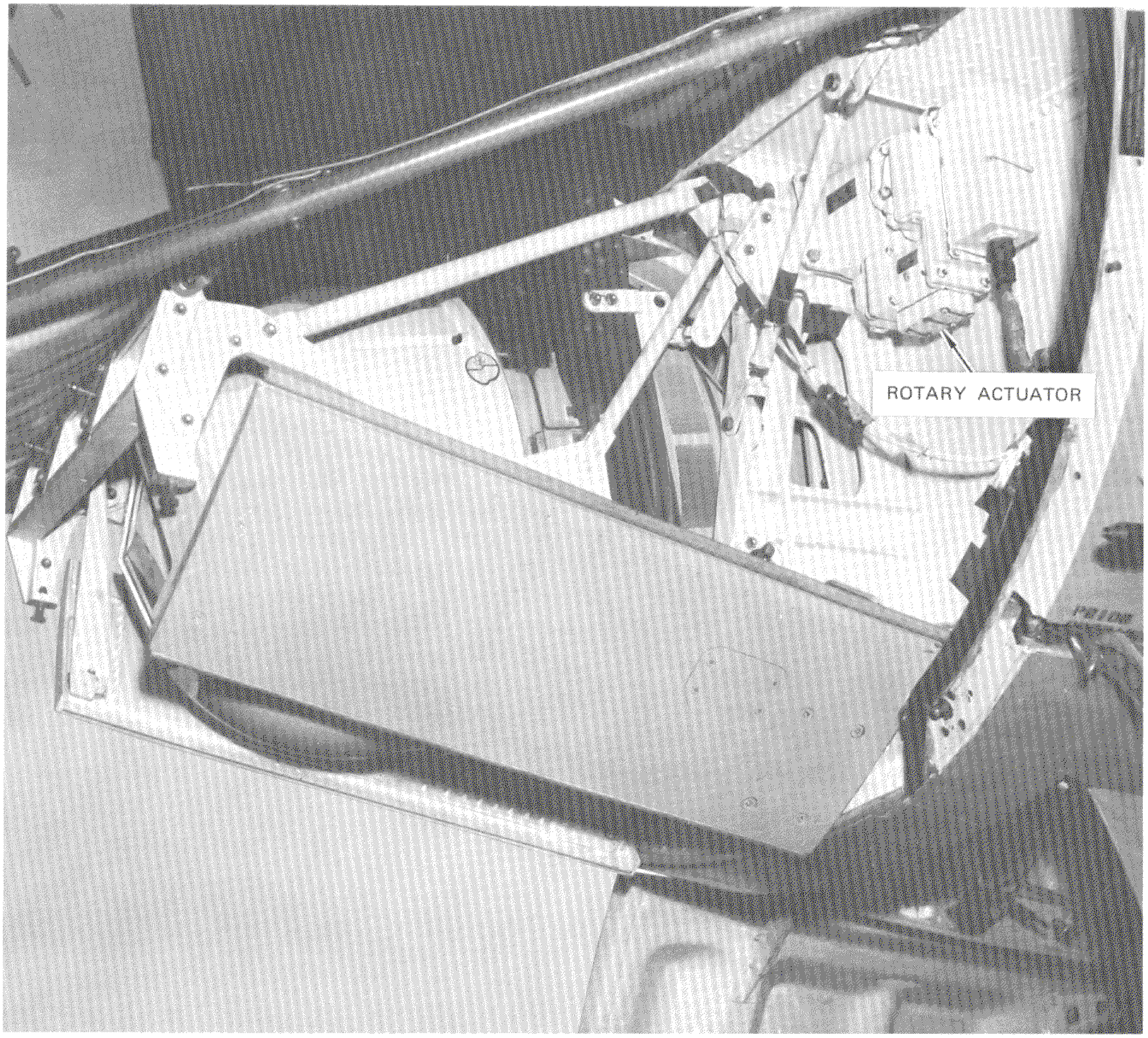


Figure 7. IR Receiver Extending (Radome Open)

The turret control is mounted at Sensor Station 3. The operator initiates the extend/retract sequence on the turret control which displays indicator lights that inform the operator whether the turret is extended, retracted, or in transit (actuator driving). An extend or retract cycle takes 20 to 30 seconds in flight. The rotary actuator has torque-limiting switches that automatically stop the extend/retract cycle when physical stops are contacted by the turret platform. Ground personnel can extend or retract the IR receiver turret by operating switches in the nosewheel well. Figure 7 shows the IR receiver just beginning the extend cycle with the nose radome open.

IRDS BUILT IN TEST (BIT) There are several different BIT paths in the IRDS. The more critical functions are monitored continuously, i.e., detector temperature, receiver temperature, gyro readiness, etc. In addition, BIT circuitry can be initiated on the set control (by pressing BIT ON) for the IR receiver, the power supply-video converter, and the control-servomechanism. A system readiness (SYS GO) or the specific unit failure indicator will light following completion of the BIT sequence. The action of the gimbals is tested by BIT circuitry in the control-servomechanism. The video indicator contains its own continuously operating BIT circuitry.

P-3C SONOBUOY REFERENCE SYSTEM

The Sonobuoy Reference System (SRS) set is an electronic phase measurement system that can provide angle-of-arrival measurements of up to a maximum of 31 sonobuoys simultaneously. The aircraft's AN/ASQ-114 Digital Computer processes these measurements and fixes the position of selected sonobuoys. Together, the SRS set, its antennas, and the computer software constitute the sonobuoy reference system. Sonobuoy identity and position are presented on CRT displays to the pilot, TACCO, and the operators at Sensor Stations 1 and 2. The SRS is passive and works in all weather and any sea state with all types and any mixture of buoys. The position of each buoy is individually and continuously updated without the necessity of flying on-top position maneuvers over the buoys. This stand-off capability of the SRS gives the P-3C Update II aircraft improved tactical flexibility.

The AN/ARS-3 Sonobuoy Reference System set consists of an R-1997/ARS-3 Receiver-Converter and ten AS-3101/ARS-3 antennas. The antennas are precisely located on the airframe in known directions and with known spacings. This arrangement enables chosen pairs of antennas to be used as baselines for making phase-difference measurements of incoming radio signals from deployed sonobuoys. The phase-difference measurements can be related to the direction (relative to the aircraft) from which the signals originated. These measurements are fed to the aircraft's digital computer, which processes them by software to compute the positions of the sonobuoys. This information can be displayed in the aircraft on the ASA-66 and ASA-70 display systems and stored in the computer memory.

SRS EQUIPMENT DESCRIPTION The R-1997/ARS-3 Receiver-Converter and its antennas are shown in Figures 8 and 9. The unit contains the circuitry to tune a selected sonobuoy channel, switch in selected antenna pairs, make the signal phase-difference measurements, report the measurements to the digital computer, and perform a self-test. The receiver-converter is installed on the right side of the aircraft in electronics rack F2 (see Figure 10). It is designed to operate with convection cooling alone.

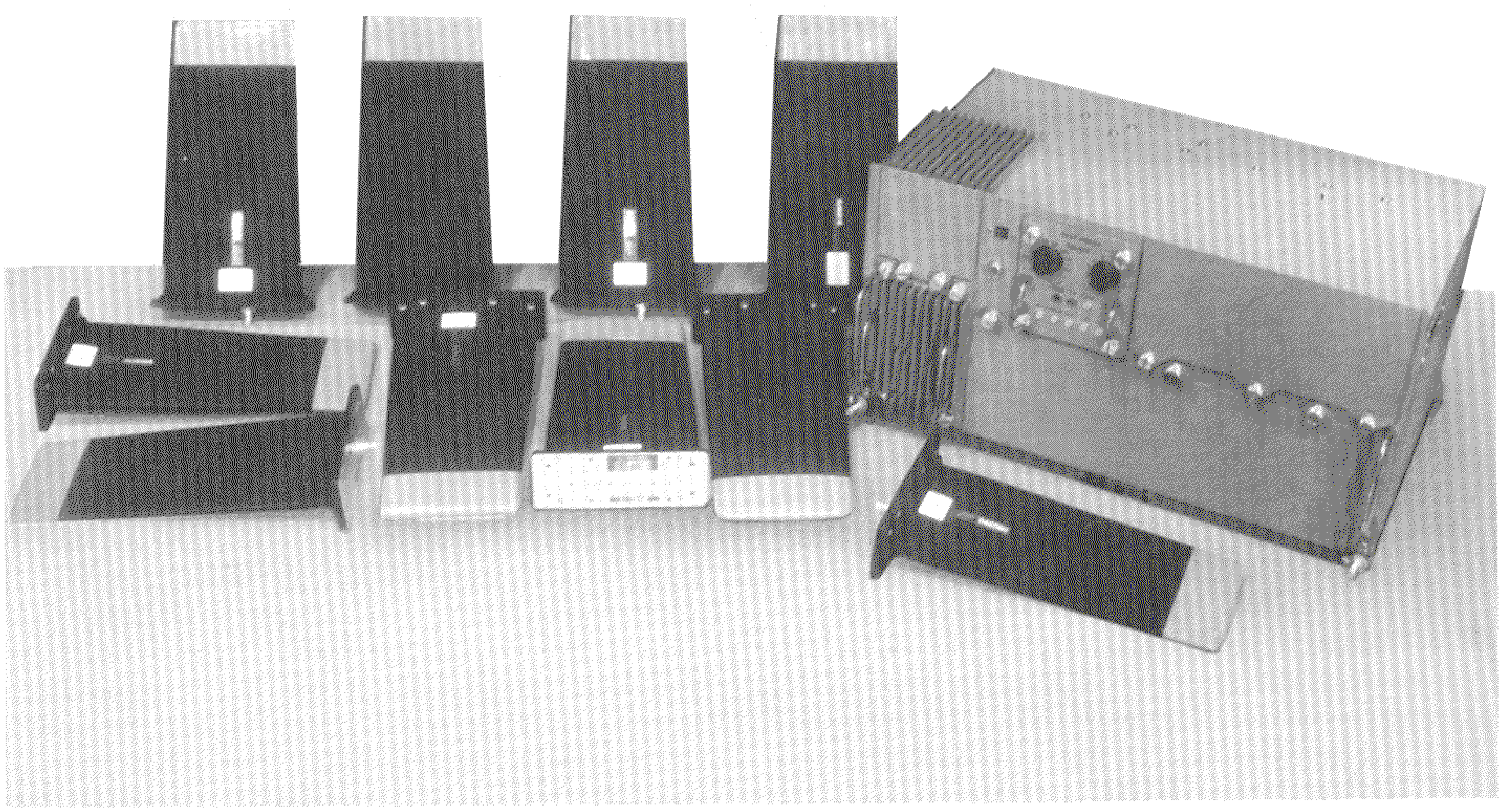
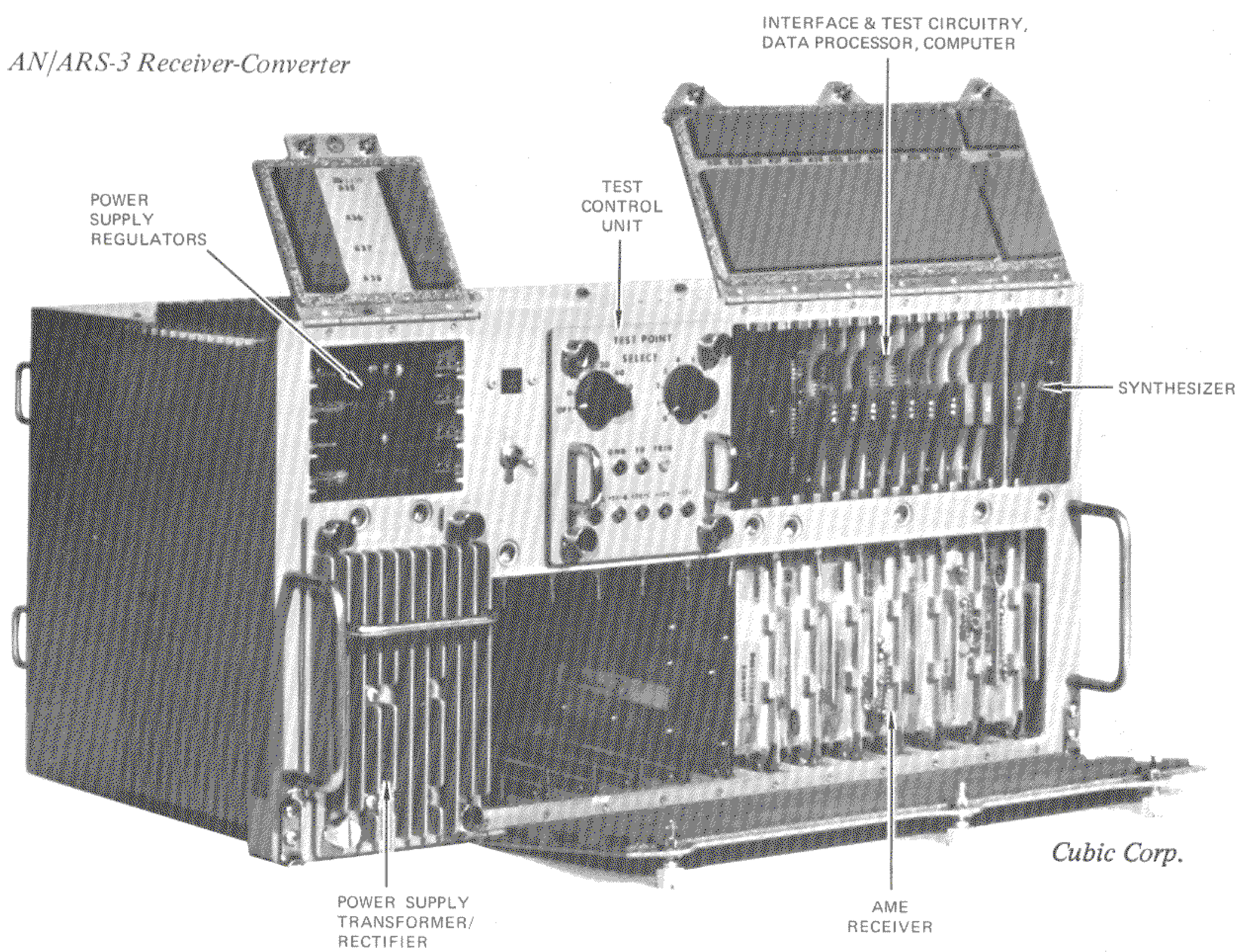


Figure 8. R-1997/ARS-3 Receiver-Converter and AS-3101/ARS-3 Antennas

Figure 9. AN/ARS-3 Receiver-Converter



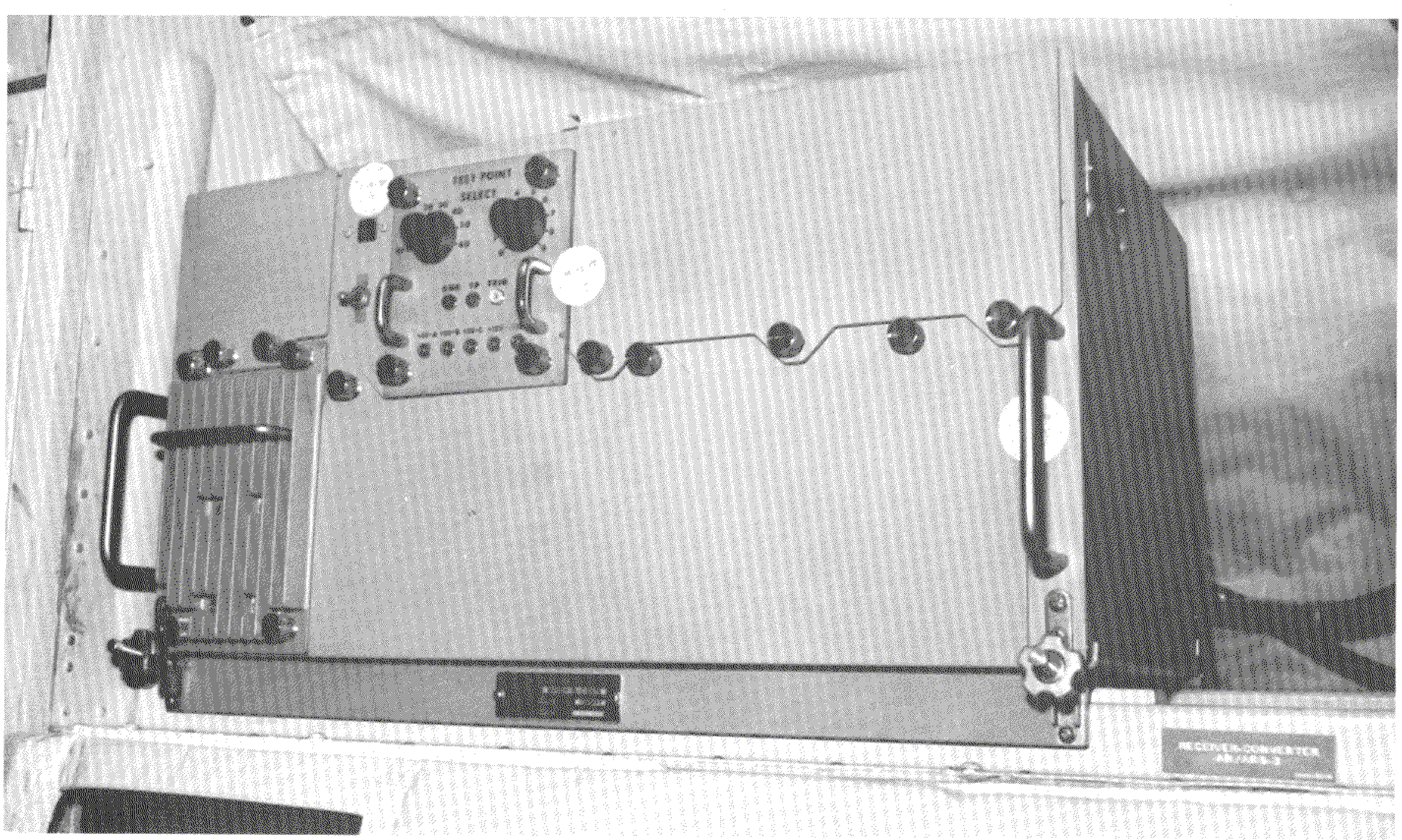


Figure 10. SRS Receiver-Converter Installation

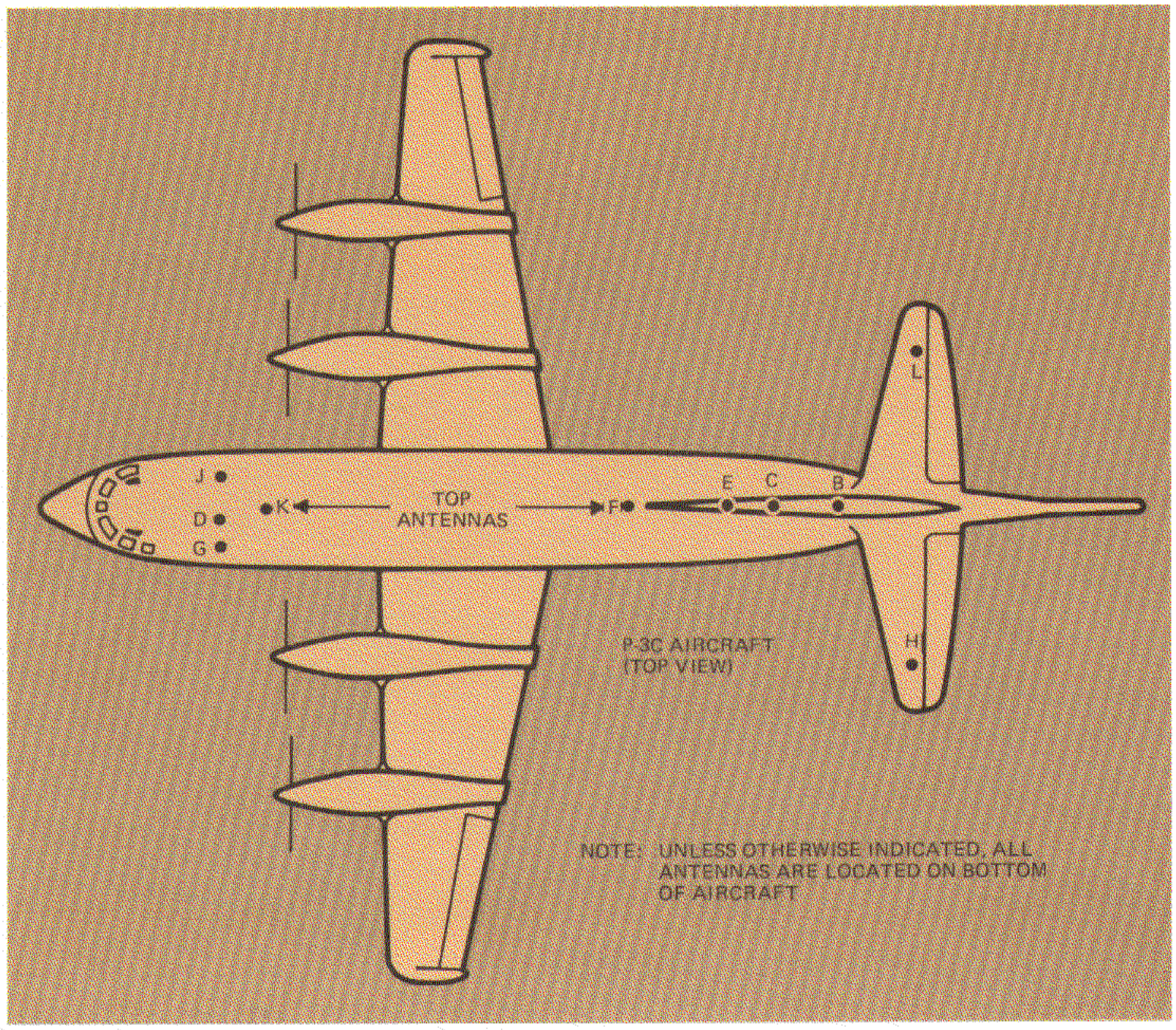


Figure 11. SRS Antenna Locations

Each AS-3101/ARS-3 Antenna (see Figure 8) is a 13-inch long blade antenna that contains the following:

- The radiating elements
- An RF filter to aid the receiver-converter's data processor to discriminate against signals from the aircraft's own UHF transmitters
- A calibration circuit to compensate for the contributions of the coaxial cable lengths to the total phase-difference measurements
- A PIN-diode switch to connect the coaxial cables to either the antenna radiating elements or to the calibration circuit

The SRS antenna locations are shown on Figure 11.

A simplified diagram of the ARS-3 Sonobuoy Reference System set is shown in Figure 12. The receiver-converter receives operating commands from the AN/ASQ-114 Digital Computer, performs the functions commanded, converts the resultant information to digital format, then reports the results of that operation to the computer. The sonobuoy reference system set has three operating modes: Angle Measuring Equipment (AME), Calibrate, and Computer-Commanded Self-Test. A combined circuit breaker/on-off switch on the receiver-converter front panel must be *on* for system operation in any mode.

Figure 13 is a block diagram of the sonobuoy reference system showing the interrelationship of its various equipments. Together, these equipments and their software comprise an Update II P-3C sonobuoy reference system.

OPERATION The ARS-3 Sonobuoy Reference System set is generally referred to as an angle measuring equipment (AME) type system. The actual measurements made are phase differences of incoming radio signals. The incoming signals are detected by antenna pairs that have fixed relation-

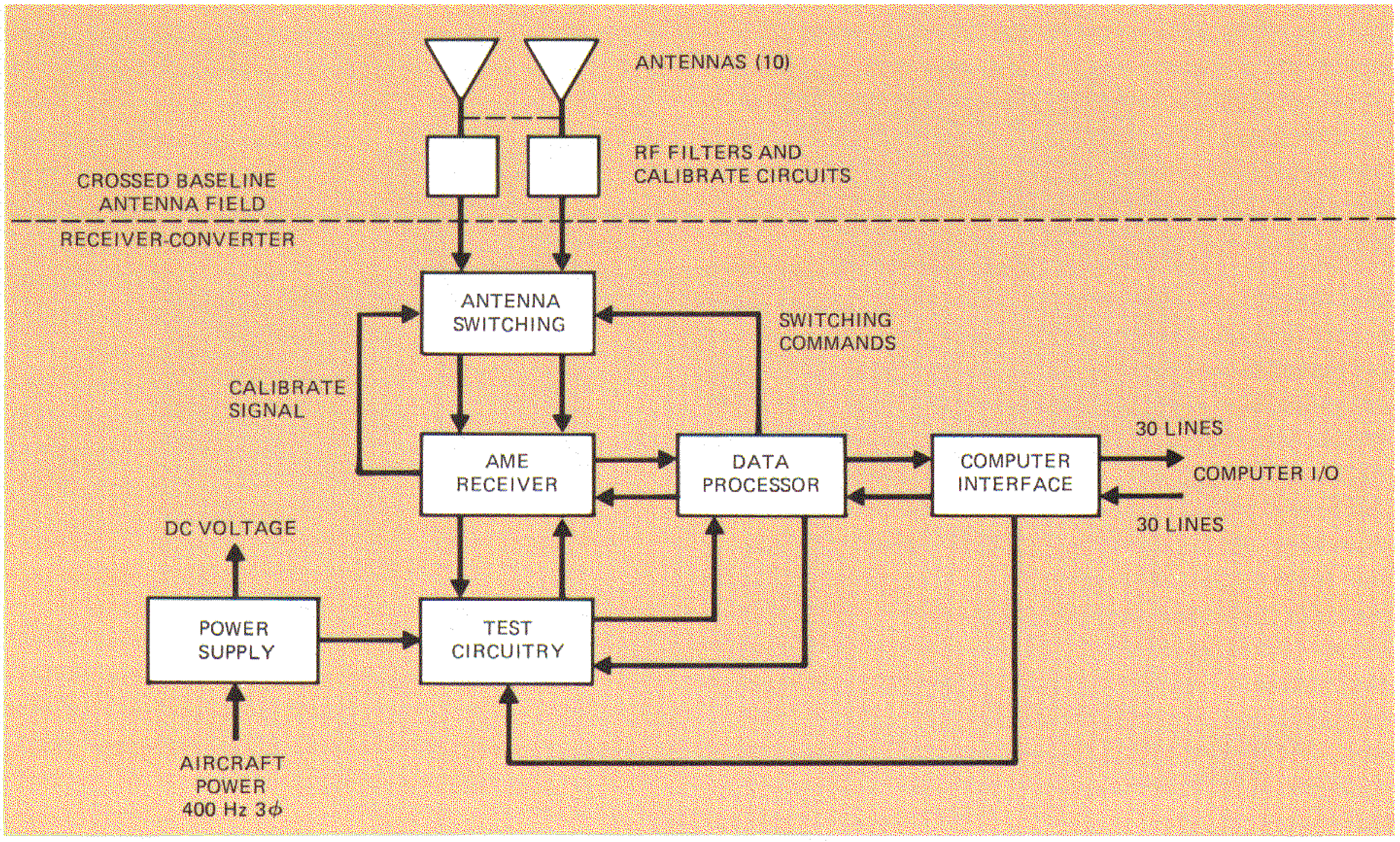


Figure 12. AN/ARS-3 Sonobuoy Reference System Set Block Diagram

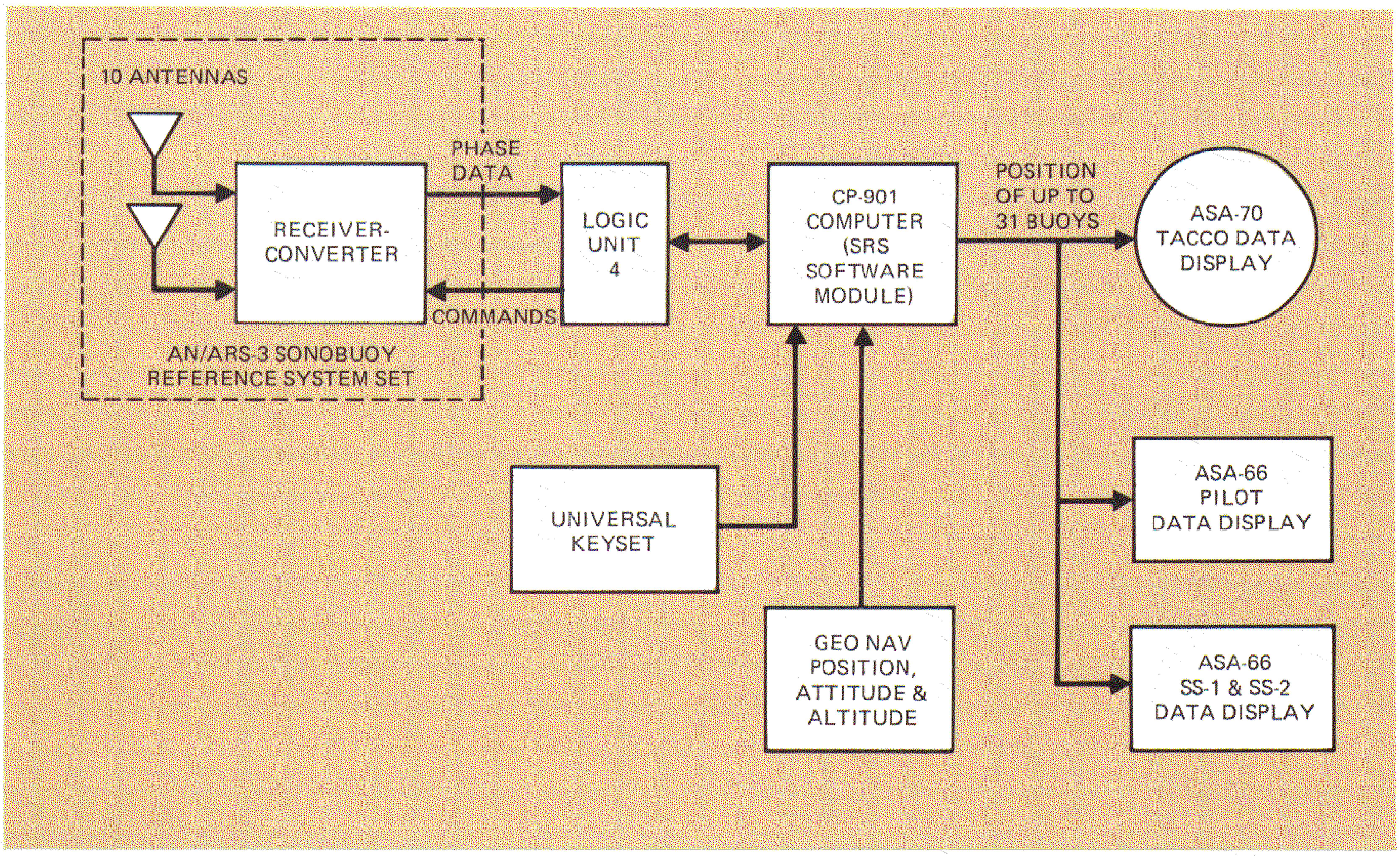


Figure 13. P-3C Update II Sonobuoy Reference System

ships to the directions from which the signals are arriving. The difference in the time-of-arrival of a signal at a closely spaced antenna pair causes a phase difference between the signals detected at each antenna. This phase difference is processed by the sonobuoy reference system to determine the direction and distance of the transmitter (sonobuoy) from the airplane.

The imaginary line between the two antennas of a pair is called a baseline. When the baseline is (a) equal to or less than one-half wavelength of the incoming signal and (b) the general direction from which the signals are coming is known (left or right, or fore or aft, relative to the airplane), the SRS will indicate that there is only one possible direction to a sonobuoy. When this is the case, the total phase difference is less than 360 degrees and the measurements are referred to as *unambiguous.* This is shown in Figure 14. However, if the antenna baseline is longer than one-half the incoming signal wavelength, the SRS could indicate that the sonobuoy is located along any one of multiple directions. In this case the total phase difference contains multiples of 360 degrees, with a residual portion that is less than 360 degrees (see Figure 15). The residual portion of the phase difference is the only part that is reported. Since the multiples of 360 degrees are not reported, they represent an ambiguity. Indications derived from such data are referred to as *ambiguous.* A short baseline measurement has low accuracy but is unambiguous. A long baseline measurement has high accuracy, but is ambiguous. A variety of antenna baseline lengths are provided to permit the use of the longest baseline for which the ambiguities can be solved.

The ARS-3 Sonobuoy Reference System uses longitudinal and transverse antenna arrays with short, medium and long baselines, both to resolve ambiguity and to provide high-accuracy angle measurements. The longitudinal antenna array is used to measure signals incoming from the left or right of the aircraft heading, and to resolve fore and aft ambiguities of the transverse antenna array measurements. The transverse antenna array is used to measure signals incoming from fore or aft of the aircraft heading, and to resolve left and right ambiguities of the longitudinal antenna array measurements. One longitudinal antenna array is mounted on top of the aircraft to enable measurements to be made when the aircraft is in a bank.

The sonobuoy receiver-converter converts the phase-difference measurements into digital format and routes the information to aircraft's ASQ-114 Digital Computer. The computer fixes the positions of as many as 31 sonobuoys through a process that is somewhat akin to triangulation, but that actually consists of a prediction of the relative position of each sonobuoy to the aircraft followed by a correction using the latest measurements. Continuous updating of the sonobuoy positions requires repetitive processing. To obtain improved accuracy, the computer program processes the AN/ARS-3 phase difference measurement data with a Kalman filter* algorithm. This algorithm permits only a partial correction of the sonobuoy position on each calculation. The degree of the cor-

**The Kalman filter is a recursive maximum likelihood estimation technique based on the assumption of normal statistics and linear relationships of the various errors. This technique was named after Dr. R.E. Kalman.*

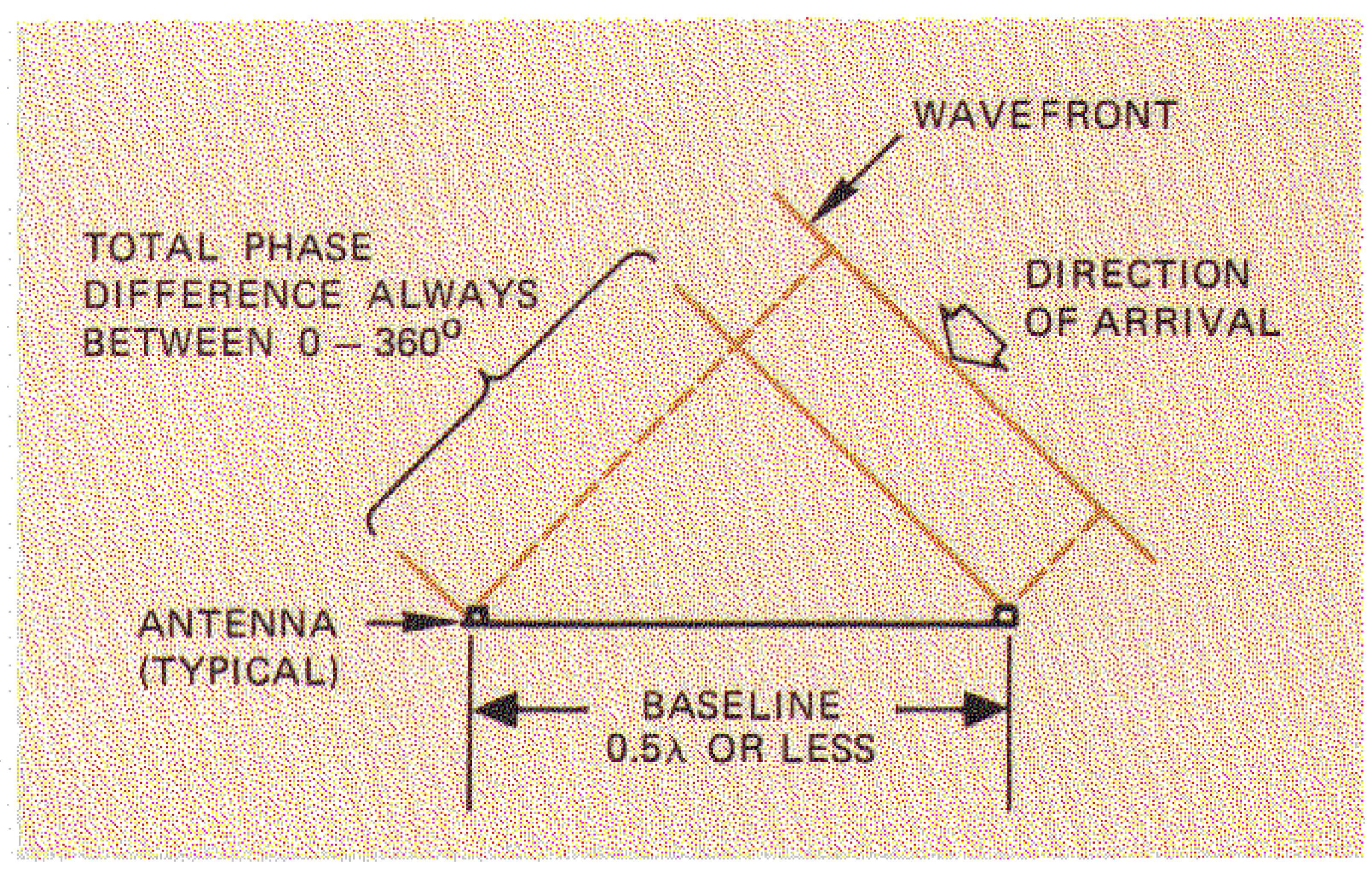


Figure 14. Unambiguous Measurements

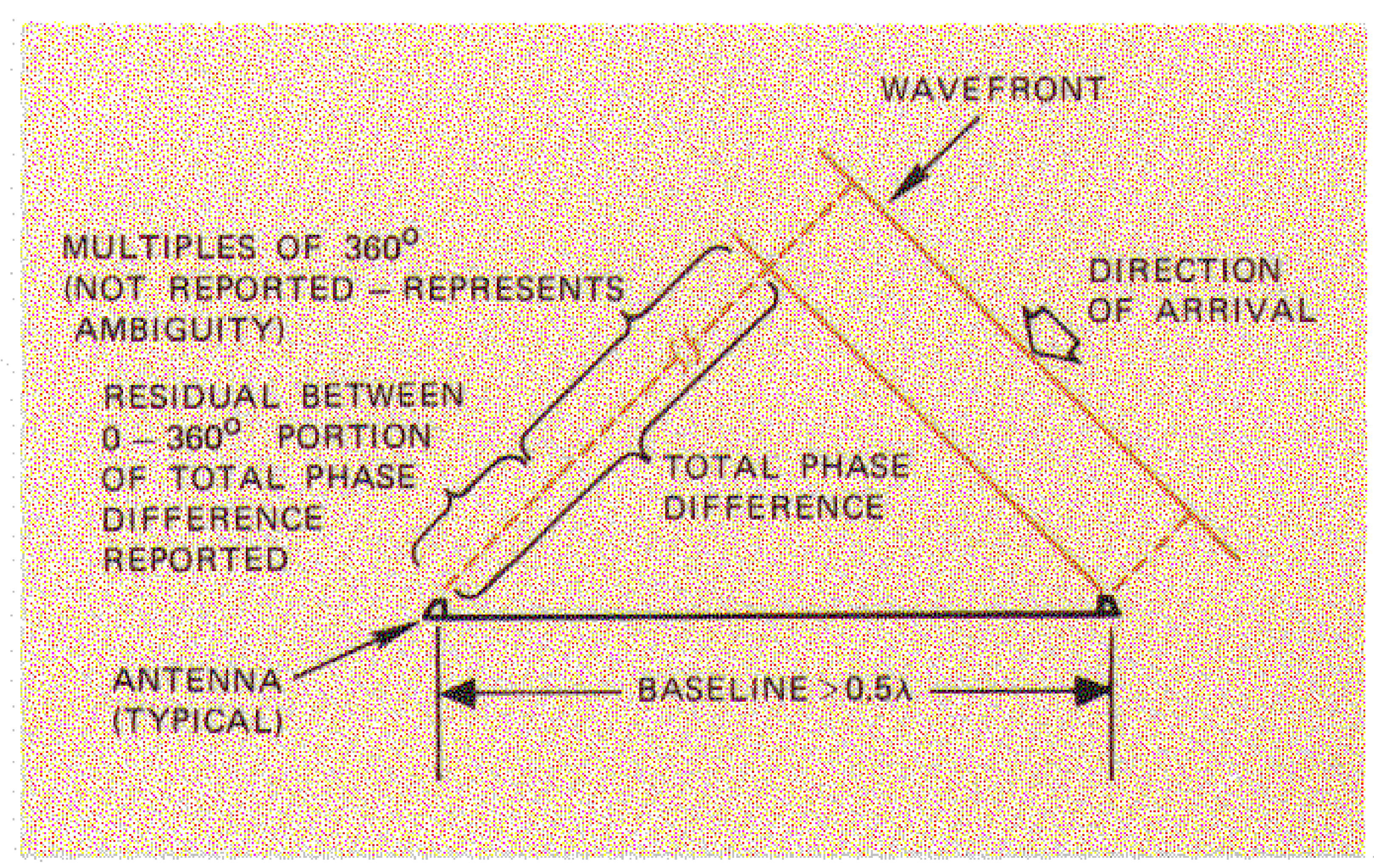


Figure 15. Ambiguous Measurements

rection to be applied is determined after an assessment of the relative statistical accuracies of the position predictions and the latest measurement. This technique provides an optimum solution when errors are random.

Once the position of a sonobuoy has been determined, it can be presented as a two-dimensional display on the TACCO's ASA-70 Auxiliary Readout Display, and on the ASA-66 Data Displays in the flight station and at Sensor Stations 1 and 2. The buoy will appear to move about on the display in a random manner at first until it settles in the most likely estimated position because the solution accuracy is improved as more measurements are made. This improvement is illustrated by Figure 16, which shows the relative solution accuracies at times t_1, t_2, and t_3. When only one buoy is deployed in the water, its position is updated once every second. If ten buoys are being monitored, the location of each buoy will be updated once every ten seconds. If the bearing of the buoy (relative to the aircraft) is changing rapidly (e.g., at short range), the computer software will cause the displayed estimated position fixes to converge rapidly and accurately – usually within a minute. If the bearing of the buoy is not changing rapidly (e.g., at long range), the displayed estimate of the buoy position will stabilize more slowly and the location will be less certain.

Computer Software The ASQ-114 Digital Computer and its software comprise the heart of the sonobuoy reference system. The software provides the following functions:

- Select buoy frequency
- Activate receiver calibration
- Activate receiver phase measurements
- Apply calibration measurements to phase measurements
- Estimate direction of signal arrival using previous buoy position and navigation data
- Select antenna array for position update use
- Select antenna pair (ambiguity resolution) for position update use
- Execute Kalman filter procedure

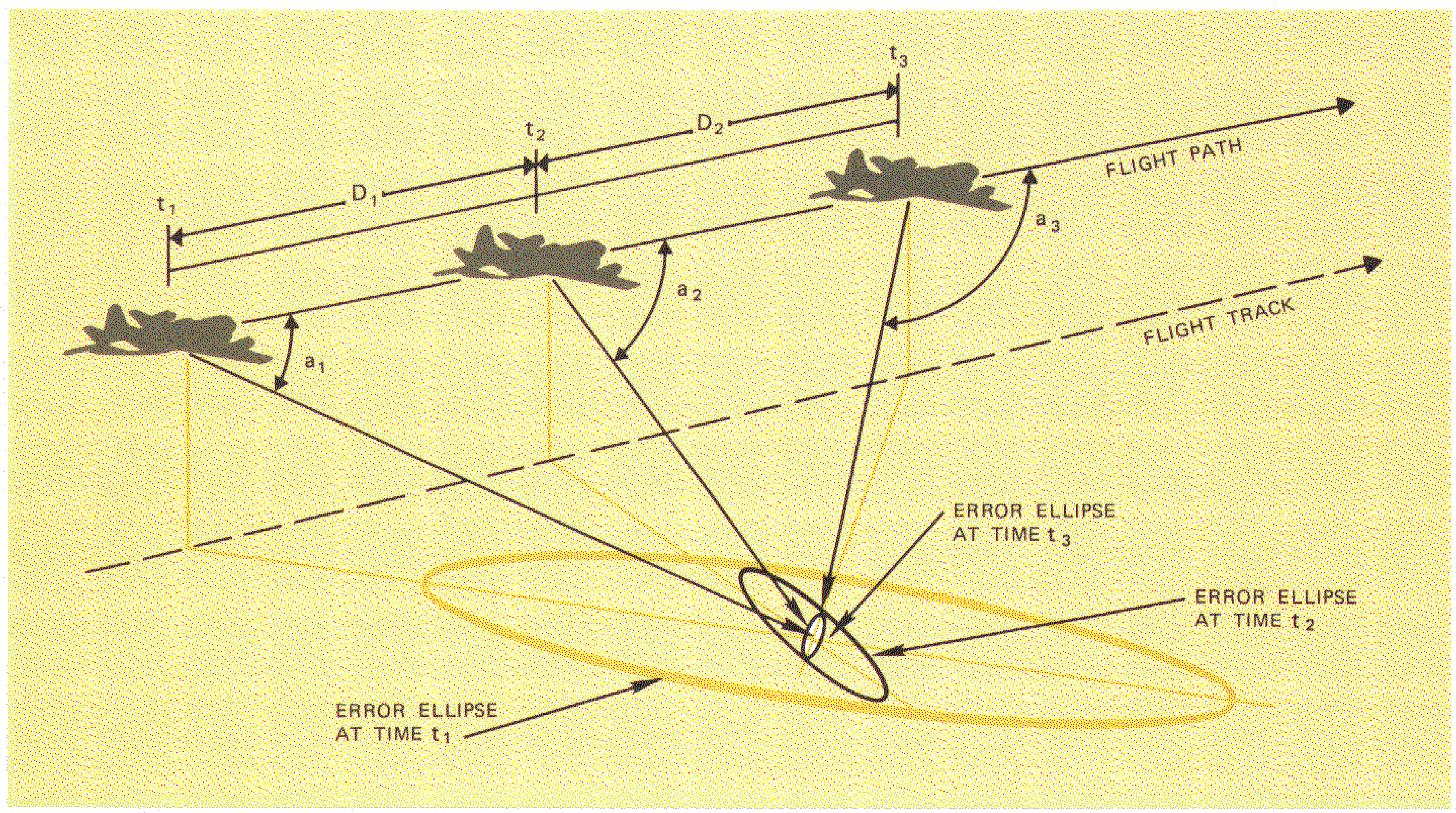


Figure 16. AME Sonobuoy Location

- Update sonobuoy position
- Output sonobuoy position to displays

The software directs the receiver-converter to make phase measurements on one sonobuoy each second. If there are ten buoys in the pattern, each buoy will be serviced once each ten seconds. At the time of data measurement, the computer stores the current values of aircraft heading, pitch, roll, altitude, and latitude and longitude. These values are used to estimate the direction-of-arrival of the incoming signal and to select the most appropriate ARS-3 antenna array. The phase-difference measurement from the selected antenna pair is routed to the Kalman filter and processed. The output from the filter is then used by the computer to update sonobuoy position on the TACCO's, pilot's, and Sensor Station 1 and 2 data displays.

SRS Calibration The ARS-3 Sonobuoy Reference System set is calibrated in order to measure the time delay (phase shift) of the receiver and all antenna transmission lines. These measurements are used to compensate for phase changes in the system, and they provide a periodic hardware check for the ARS-3 set. The measured calibration factors are applied to each sonobuoy reference system phase-difference (AME) measurement. System calibration is initialized by entering a sonobuoy into the operational program, then activating the sonobuoy reference system. The system is automatically recalibrated periodically thereafter until system operation is terminated.

Controls and Displays — One keyset select matrix and four tableaus enable the TACCO to control the sonobuoy reference system's processing functions and provide him with the information on the system operational condition. The keyset select matrix provides the TACCO access to eight functions and two tests that allow him to perform the following:

- Initiate, terminate or reinitiate sonobuoy reference system processing
- Update sonobuoy location to the latest sonobuoy reference system-generated position
- Restrict sonobuoy reference system signal processing to active (RO/CASS) sonobuoys only
- Add or delete radio frequencies (RFs) in the sonobuoy reference system processing list
- Perform noisy RF and antenna/acoustic source signal generator (ASSG) tests
- Initiate a calibration sequence

Four tableau displays are available to the TACCO:

- SRS BUOY STATUS
- SRS CALIBRATION
- SRS NOISY RF
- SRS IFPM (in-flight performance monitoring) DATA

The SRS Buoy Status tableau indicates the operational status of the sonobuoy reference system, and indicates whether or not the active-only data processing mode has been selected. It also displays one of eight sonobuoy reference system processing status states for each buoy, the time in minutes since the last data update, and the square root of one-half of the sum of the squares of the x and y variances.

The SRS Calibration tableau displays the validity of the calibration for each radio frequency and baseline. It also displays the number of calibrations performed since initial system startup or since the last restart, and the time in minutes since the last calibration.

The SRS Noisy RF tableau displays the results of the last sonobuoy reference system noise and antenna tests, and the time of the last test.

The SRS IFPM Data tableau displays the calibration word phase-measurement values for each baseline. These values change with each frequency, and are computed from data taken from over the 31-channel frequencies. In addition, this tableau presents two calibration values for each of the receiver-converter's 31 channels, the most recent calibration and the previous value. Also presented are indications that show (a) whether the latest calibration is valid, and (b) the number of valid calibrations obtained since initial system startup or the latest restart.

AN/AGM-84A HARPOON WEAPON SYSTEM

The Harpoon is an all-weather, low-altitude anti-ship cruise missile designed for launch from the P-3C aircraft. It incorporates low-level cruise trajectory, over-the-horizon range, active guidance, counter-countermeasure capability, and a contact-detonated, high-explosive blast warhead. After launch, the missile accelerates down to the surface of the sea, travels towards a preselected target up to ranges greater than 50 nautical miles, locks onto the target, and just before impact, "pops up" to assail the target from above (Figure 17). The terminal pop-up maneuver increases the effectiveness of the missile both by angling it into lightly armored deck structures and by permitting it to evade enemy countermeasures.

The Harpoon missile requires no inputs from the aircraft after launch. Missile guidance is provided by a mid-course guidance system consisting of a three-axis strapdown attitude reference assembly and a digital computer. Cruise altitude is monitored by a radar altimeter; flight control is maintained by four fins on the tail. Upon reaching the target search area, the Harpoon's active radar seeker begins its preselected search mode. When the target is detected, the seeker locks onto the target until impact.

The P-3C's ten wing stations can accommodate as many as six operational Harpoon missiles. The missile control system can fire missiles either singly or in pairs. On typical ASW missions, two Harpoons may be carried without sacrificing other mission capabilities.

MISSILE CHARACTERISTICS The Harpoon requires no assembly other than installation of missile wings and control fins at the organizational level. Missile characteristics are as follows:

• Length	151 inches
• Diameter	
without wings and control fins	13.5 inches
with wings and control fins	36 inches
• Weight with warhead	1158 pounds
• Propulsion	Turbojet engine
• Range	In excess of 50 nautical miles

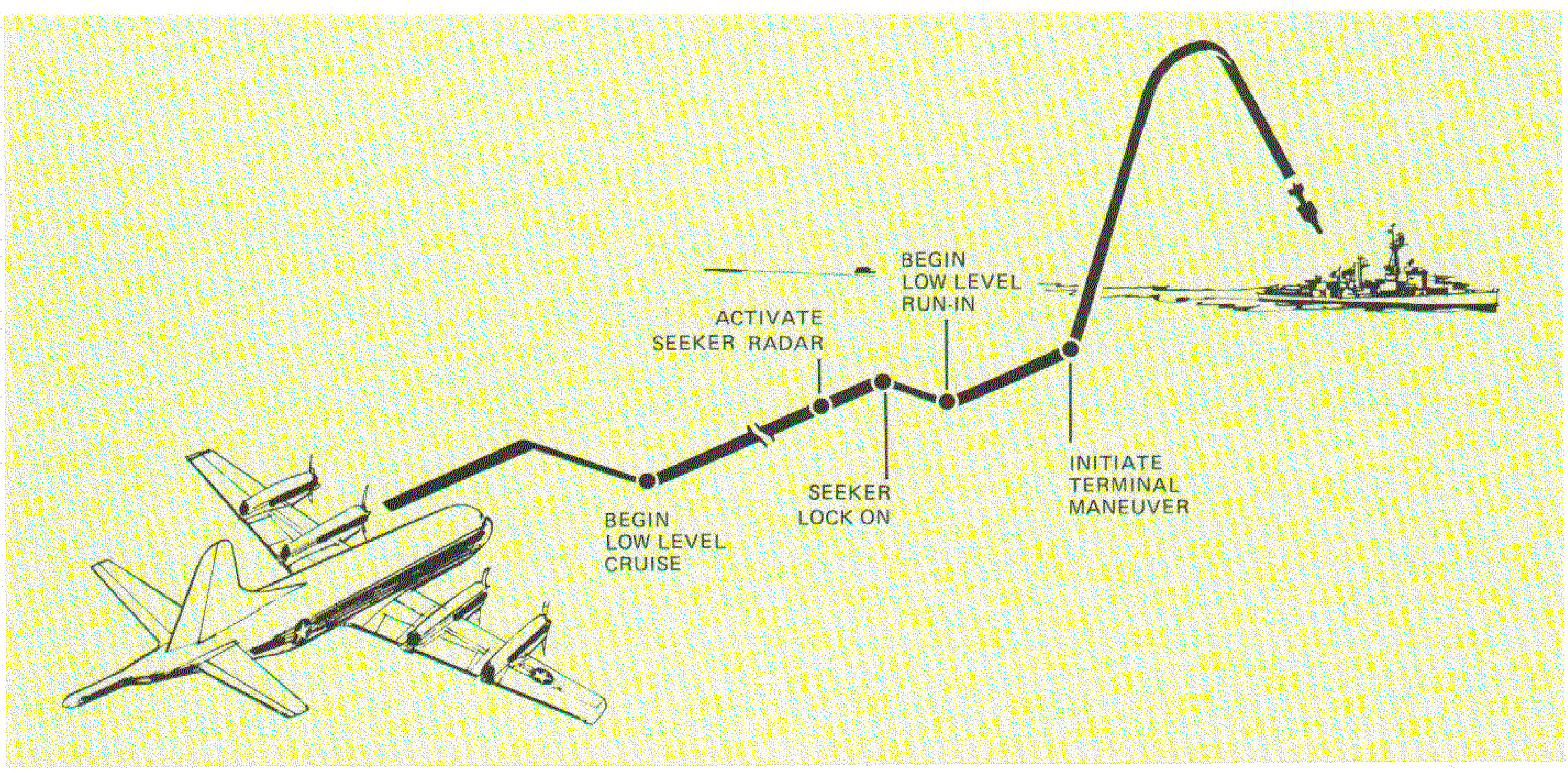


Figure 17. Harpoon Attack Scenario

The following paragraphs discuss the four sections of the Harpoon missile (Figure 18).

The guidance section contains the seeker, radar altimeter, mid-course guidance unit, and power converter. A radome forms the aerodynamic shield and protects the internal components of the seeker. The seeker is a frequency-agile active radar. The radar altimeter senses altitude by emitting short pulses. The mid-course guidance unit consists of a three-axis attitude reference assembly and a general purpose digital computer. The power converter is an AC/DC converter that is used during prelaunch operations. A transmitting altimeter antenna is mounted on the underside of the guidance section.

The warhead section contains the penetration blast type explosive, delay contact fuze, and electromechanical pressure probe assembly. The forward launch lug and arming lanyard are mounted on the warhead section. The receiving altimeter antenna is mounted on the underside of the warhead section.

The sustainer section consists of five major components: an electronic control amplifier, a battery, a pyrotechnic relay panel, the turbojet engine, and a sealed, non-vented fuel tank filled with JP type fuel. The turbojet engine is a Teledyne CAE J402-CA-400 model with 600 pounds of thrust. The engine inlet duct has an inlet duct cover that is exploded off just before engine start during the missile engine start sequence. The missile's umbilical connector, aft launch lug, and four framed honeycombed aluminum wings are mounted on the sustainer section.

The boattail section contains four electromechanical actuators onto which four cast aluminum fins are mounted. These fins steer the Harpoon to its target in response to the missile's internal guidance system.

WEAPON SYSTEM DESCRIPTION The Harpoon missile is controlled and launched from the Orion by the Harpoon Aircraft Command-Launch Control Set (HACLCS) AWG-19(V)1. The HACLCS consists of the following major units:

Nomenclature	*Short Name*
Harpoon Aircraft Command-Launch Control C-9574/AWG-19(V)	missile control panel
Data Processor Computer CP-1138(V)1/UYK	DPC

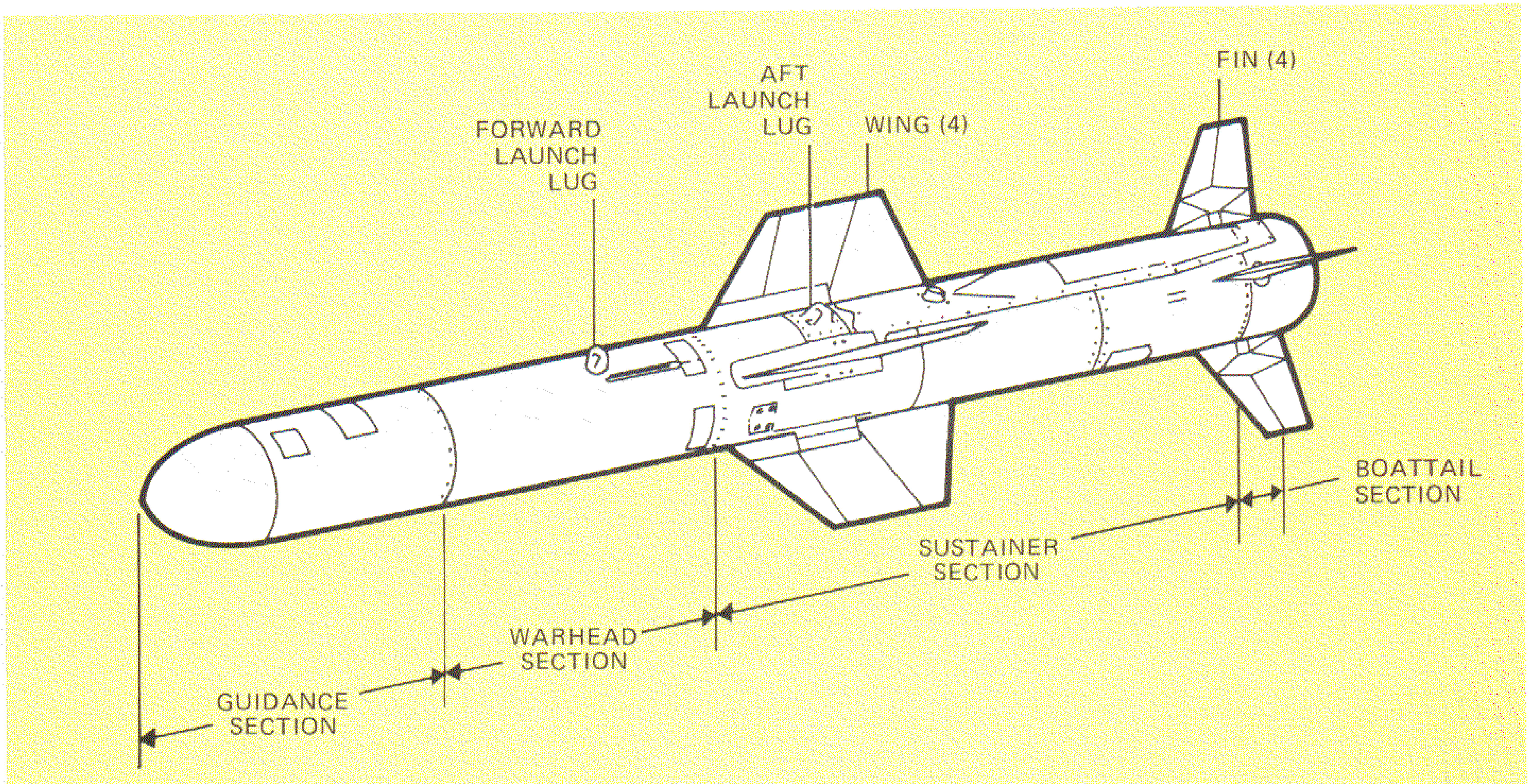


Figure 18. AN/AGM-84A Harpoon Missile

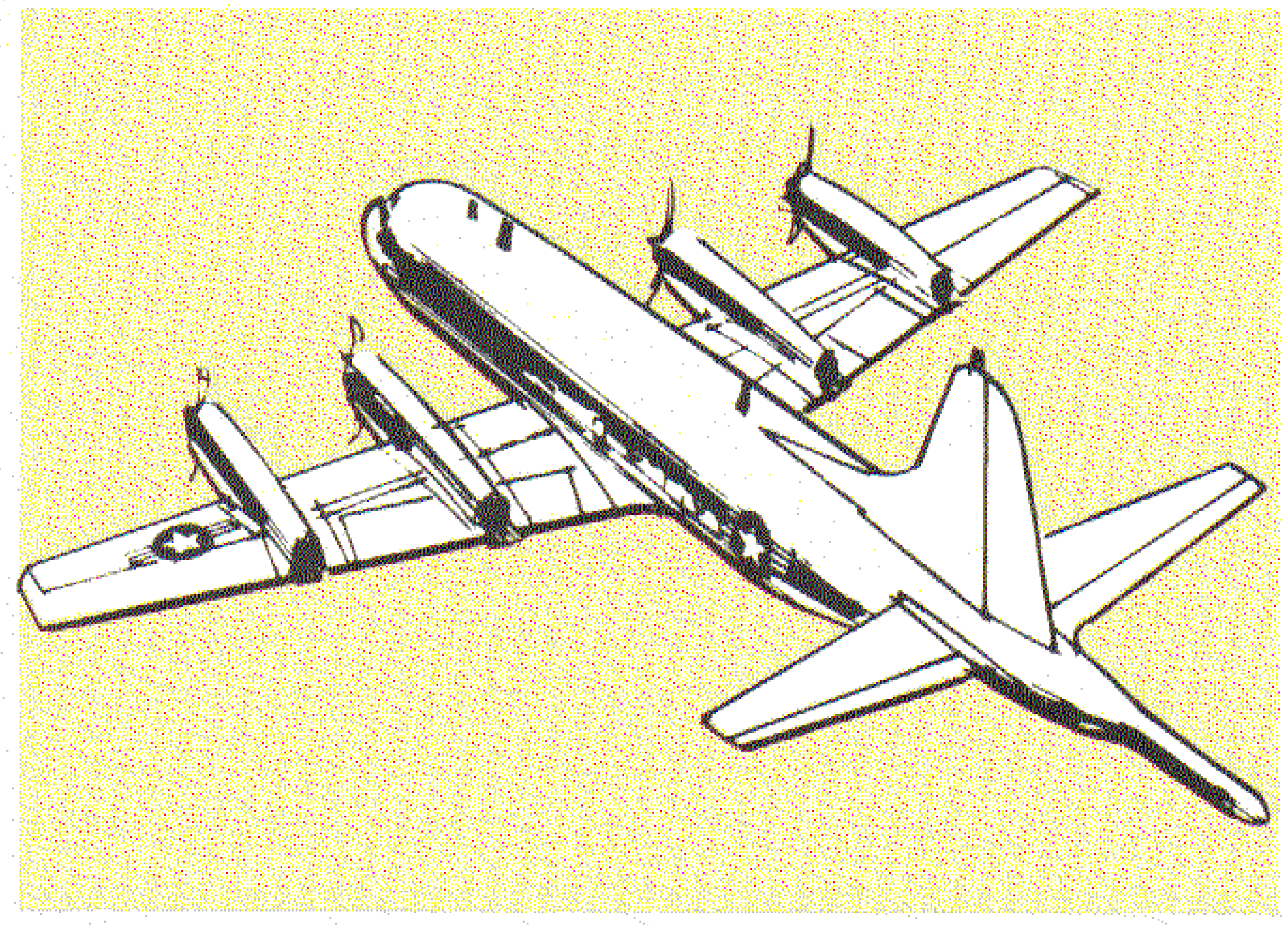
Control-Distribution Box C-9801/AWG-19(V)	distribution box
Decoder-Encoder KY-812/AWG-19(V)	(none)
Interconnecting Box J-3390/AWG-19(V)	(none)

This equipment together with the missile umbilical cables provides the interface between the P-3C aircraft and the Harpoon missile.

A Harpoon trainer simulator is an optional piece of airborne equipment that will be used for squadron in-flight crew training. The simulator is a portable, plug-in box inserted into the Sensor Station No. 1 upper console. It will permit the TACCO to perform all select, target, and launch functions for a designated wing station. Following a simulated launch, the simulator will automatically reset to allow a second launch sequence. In the event that the simulator is installed and an actual missile is connected to the same wing station, the simulator will not operate and will display a flashing red light.

The Harpoon weapon system interfaces with the armament system for weapon control and release functions, making maximum use of the current P-3C weapon launch capability and minimizing the impact on tactical operations and other weapons control. Weapon inventory is maintained by the AN/ASQ-114 Computer via logic unit 2. The prelaunch computational and interface functions are combined and executed in a single device, the DPC. The missile control panel provides independent manual controls and displays. The distribution box supplements existing armament control and release capability. The decoder-encoder provides the digital communication link between the DPC, missile control panel, and the distribution box. The interconnecting box provides for HACLCS cable routing.

OPERATION The HACLCS has three modes of operation: Manual, Manual Fly Level, and Line Of Sight. In addition, the HACLCS has the capability for computer-aided operation. Evaluation has shown the Computer mode to be impractical at this time; however, it is available for future implementation, if desired.



The Manual mode is the primary mode of operation on the Orion aircraft. The TACCO controls the prelaunch sequence, which includes applying aircraft power to the missile; selecting missile seeker modes [range and bearing launch (R/BL) with three selectable search pattern sizes or bearing only launch (BOL)] ; providing targeting, alignment, and reference data; and monitoring the HACLCS and missile status using the missile control panel. The pilot maintains command control over the launch by his operation of the MASTER ARM switch located on his armament control panel.

Upon missile selection, R MSL SEL or L MSL SEL illuminates on the pilot's instrument panel glare shield. When prelaunch preparation is complete and the missile is ready to launch, KILL READY illuminates on the pilot's armament control panel, and READY illuminates on the missile control panel at the selected station. The TACCO, pilot, and copilot have the capability to initiate missile launch: the TACCO by pressing RELEASE on the missile control panel, and the pilot and copilot by pressing the STORES REL on their respective control wheels. The pilot, copilot, and TACCO missile select indicators extinguish when one of the following occurs: (a) the missile has been released from the wing bomb rack; (b) the TACCO has deselected the missile; (c) the missile launch has aborted either in response to a fire indication or operator command.

The pilot, copilot, and TACCO have fire warning indicators. The pilot's and copilot's indicators are on their glare shields, and the TACCO's is on the missile control panel. The HACLCS will abort a launch if it detects a missile fire indication. The pilot and TACCO can coordinate selective jettison of the appropriate missile, if necessary.

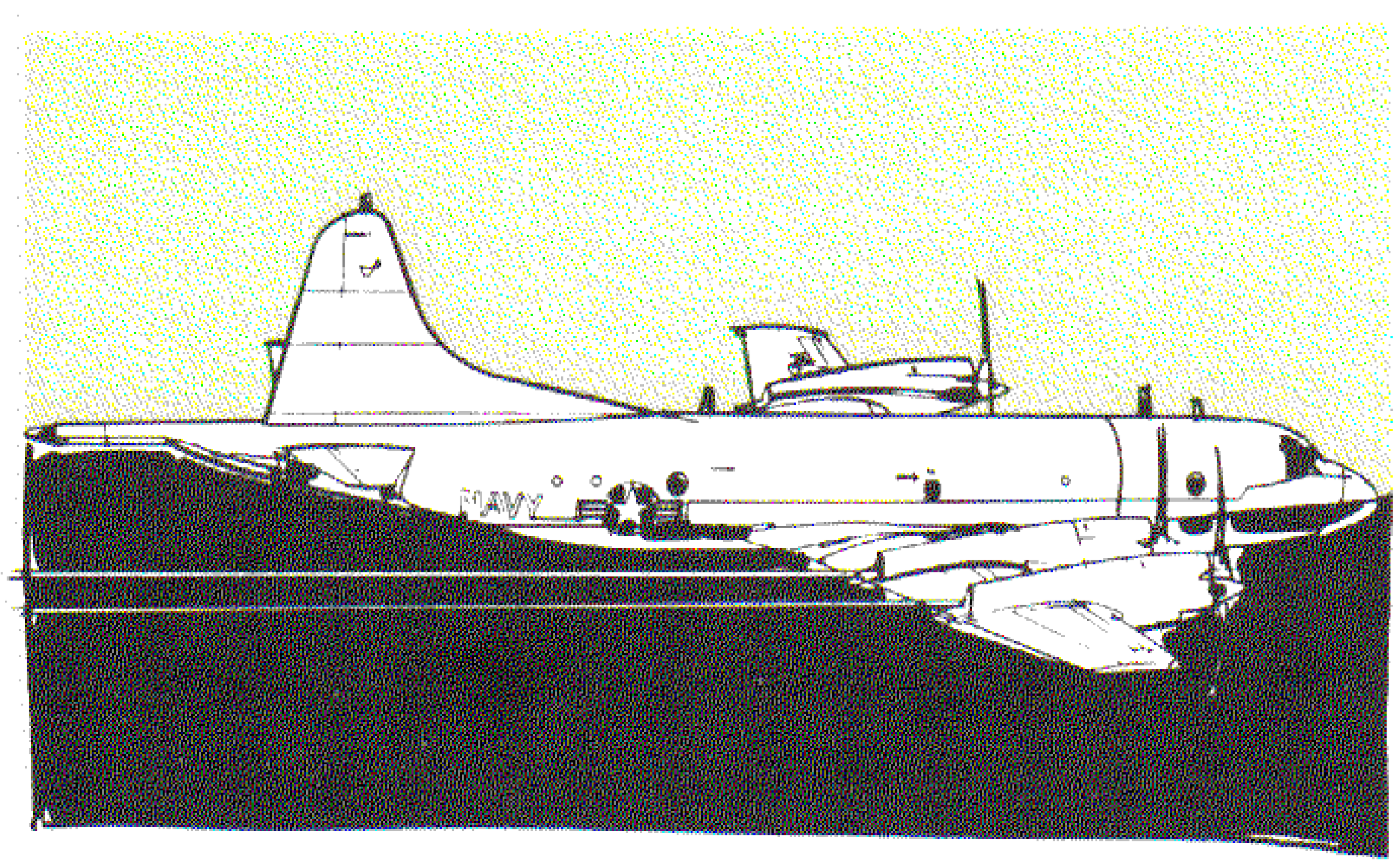
The Manual Fly Level mode is used when aircraft attitude data is unavailable to the DPC. In this mode, the Orion is required to fly level before launch for 40 seconds.

The Line Of Sight (LOS) mode is considered a casualty mode where no other launch modes are available. The TACCO must manually enter all launch parameters, and the aircraft must fly level for 40 seconds straight at the target immediately before launch.

HARPOON AIRCRAFT COMMAND-LAUNCH CONTROL SET (HACLCS) AWG-19(V)1 The following paragraphs describe the functions of the HACLCS units and the relationships between them.

The missile control panel provides power application and controls and displays for the Harpoon missile. The controls and displays are used for manually defining missile selection/deselection, warhead fuzing, target range and relative bearing, attack and seeker modes, and aircraft true airspeed and altitude inputs. Status displays for each operational Harpoon on the aircraft are provided as well as an LED display of the range and relative bearing used in DPC calculation of targeting data to the missiles. Figure 19 shows the missile control panel and its functions.

The data processor computer (DPC) is a general purpose, stored program, digital computer that provides the digital communications link between the HACLCS, Harpoon missile, and existing aircraft systems. It performs the launch interlocks and prelaunch computations for missile initialization and control of the launch sequence.



The DPC uses digital input/output circuitry, a digital processor, analog-to-digital conversion circuitry, decoding and encoding networks, discrete input/output driver and receiver circuits, program control memory, and scratch pad data memory. The processor provides the control and timing signals and all necessary computations for DCP operation.

When the HACLCS is being operated in the Manual mode, the DPC synchro-to-digital converter receives direct inputs of aircraft pitch, roll and heading from aircraft navigation system synchros via the DPC/aircraft synchro interface. The DPC receives manual inputs from the missile control panel via the decoder-encoder.

The control distribution box supplements existing aircraft systems with missile control and release capability and provides the missile initialization commands and controls. It provides the switching, sequencing, and interlock functions required to select, prepare, and launch six missiles singly or in pairs (one port and one starboard). The distribution box incorporates basic control circuitry for prelaunch control and interlock functions, logic and power control circuits for wing stations, and circuitry required to multiplex appropriate functions between port and starboard wing stations. The specific functions are as follows:

- Missile external power switching
- Missile fire detection and control
- Interconnect circuits – HACLCS/missiles/aircraft
- Missile ready and launch command control
- Interlock circuits – missile/aircraft armament system
- Fuze selection
- Power control for other HACLCS units

The decoder-encoder is an input/output device that performs the decoding, encoding, sequencing, and transfer of all HACLCS operating data. It provides binary-coded decimal inputs and outputs for manual target data insertion and display via the missile control panel.

The interconnecting box contains and routes the wiring between the HACLCS and the wing pylon umbilical harnesses that attach to the missiles.

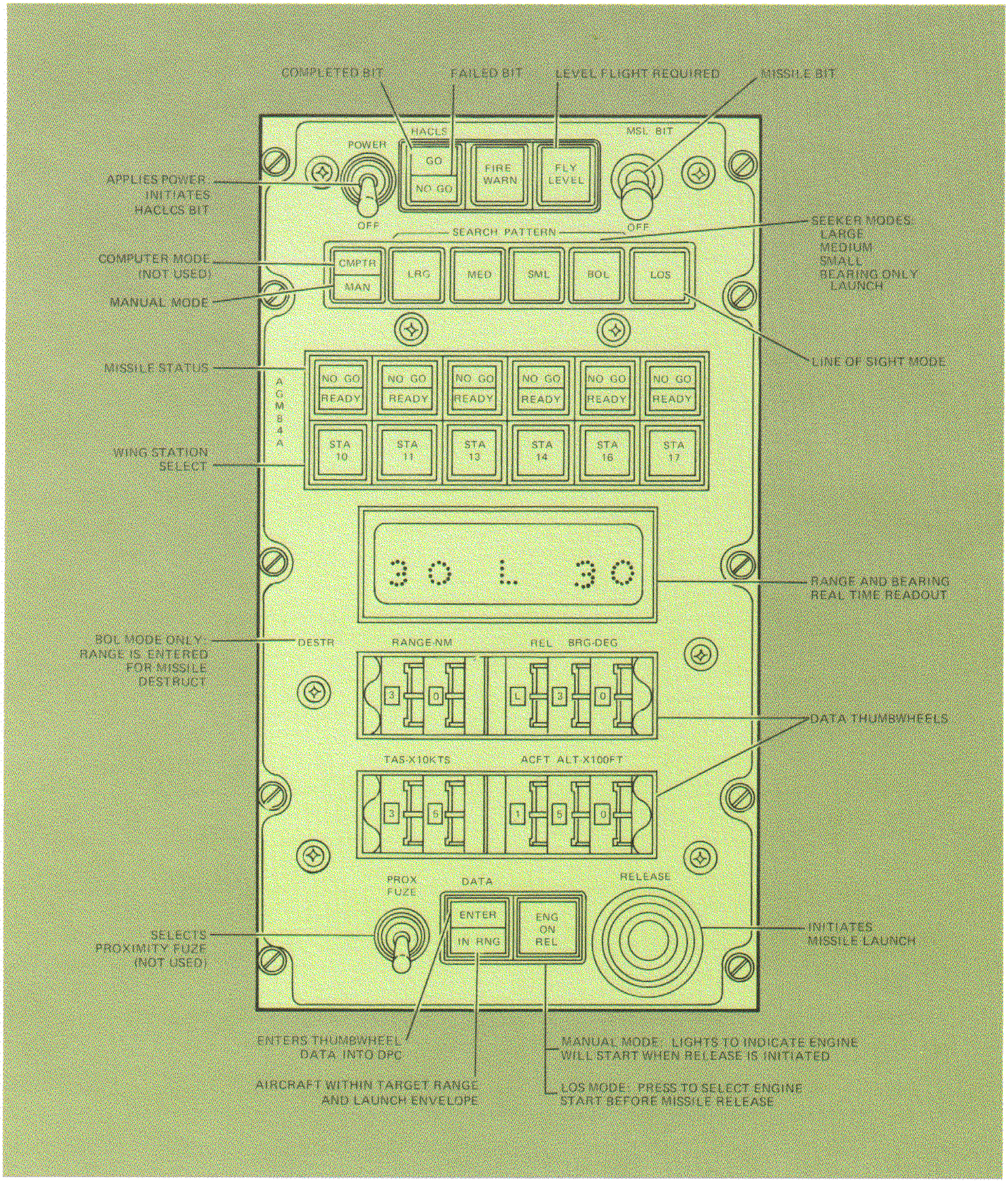


Figure 19. Missile Control Panel

TEST SET SIMULATOR The TS-3519/DSM Test Set Simulator and the HACLCS built-in test equipment will be employed for power-on functional testing, wing station checkout, and such fault isolation as required. Figure 20 shows the simulator and its connection to the aircraft.

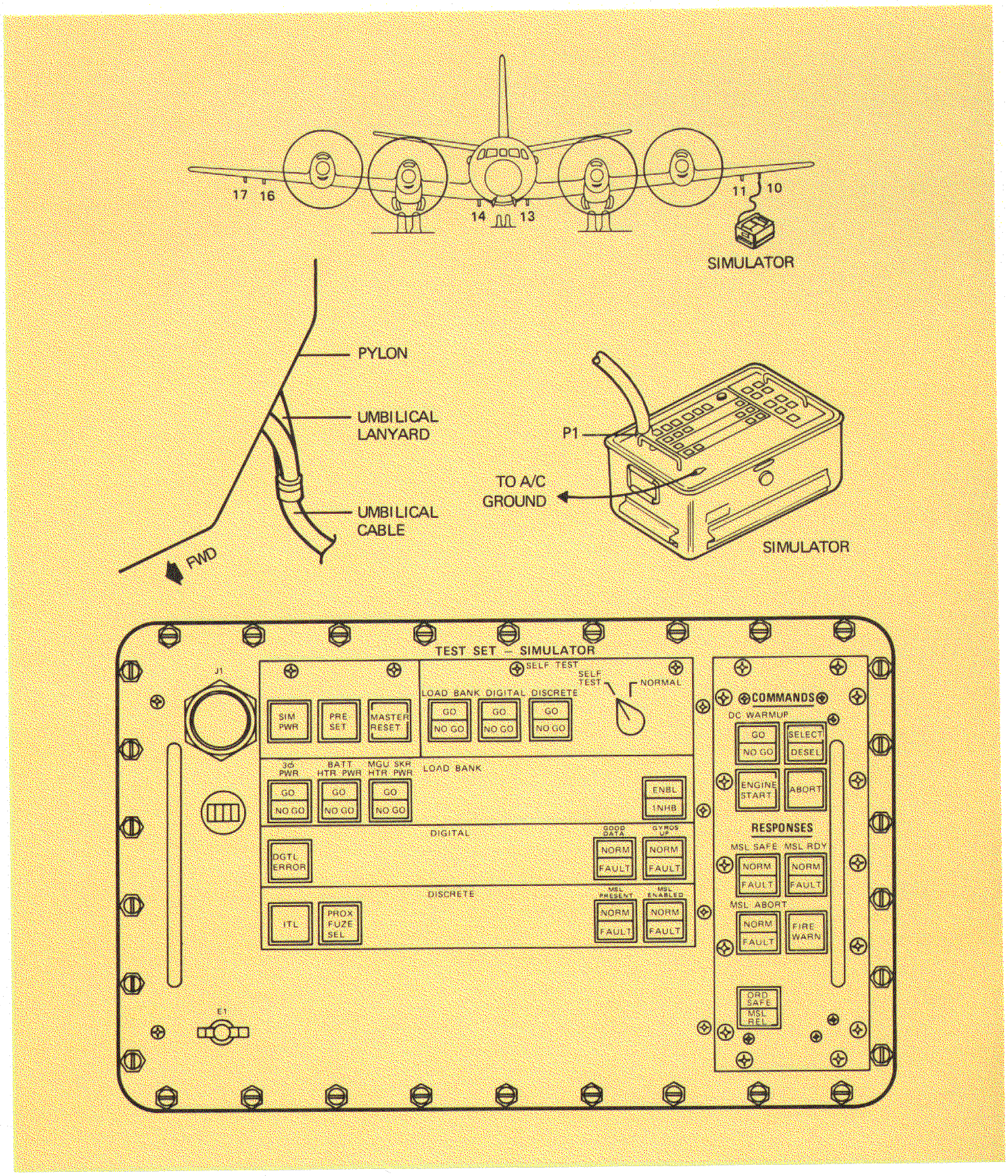


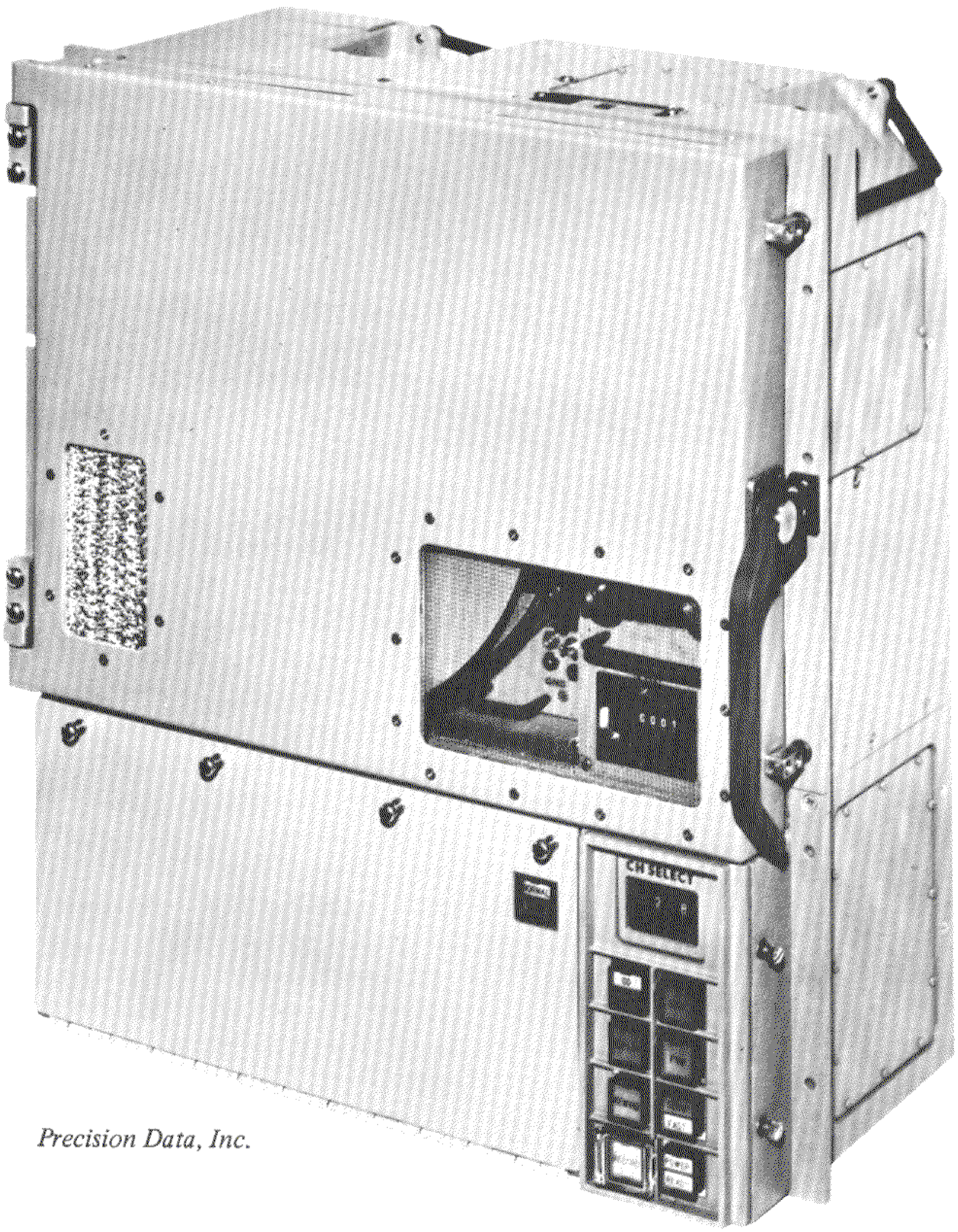
Figure 20. TS-3519/DSM Test Set Simulator

AN/AQH-4(V)2 RECORDER-REPRODUCER

The AN/AQH-4(V)2 Recorder-Reproducer, shown in Figure 21, is a 28-track instrumentation recorder-reproducer with wideband electronics and BIT (built-in test) capability. The Update II Acoustic Sensor System is equipped with this unit in lieu of the 14-track AQH-4(V) Recorder-Reproducer that is installed in the basic P-3C and Update I aircraft.

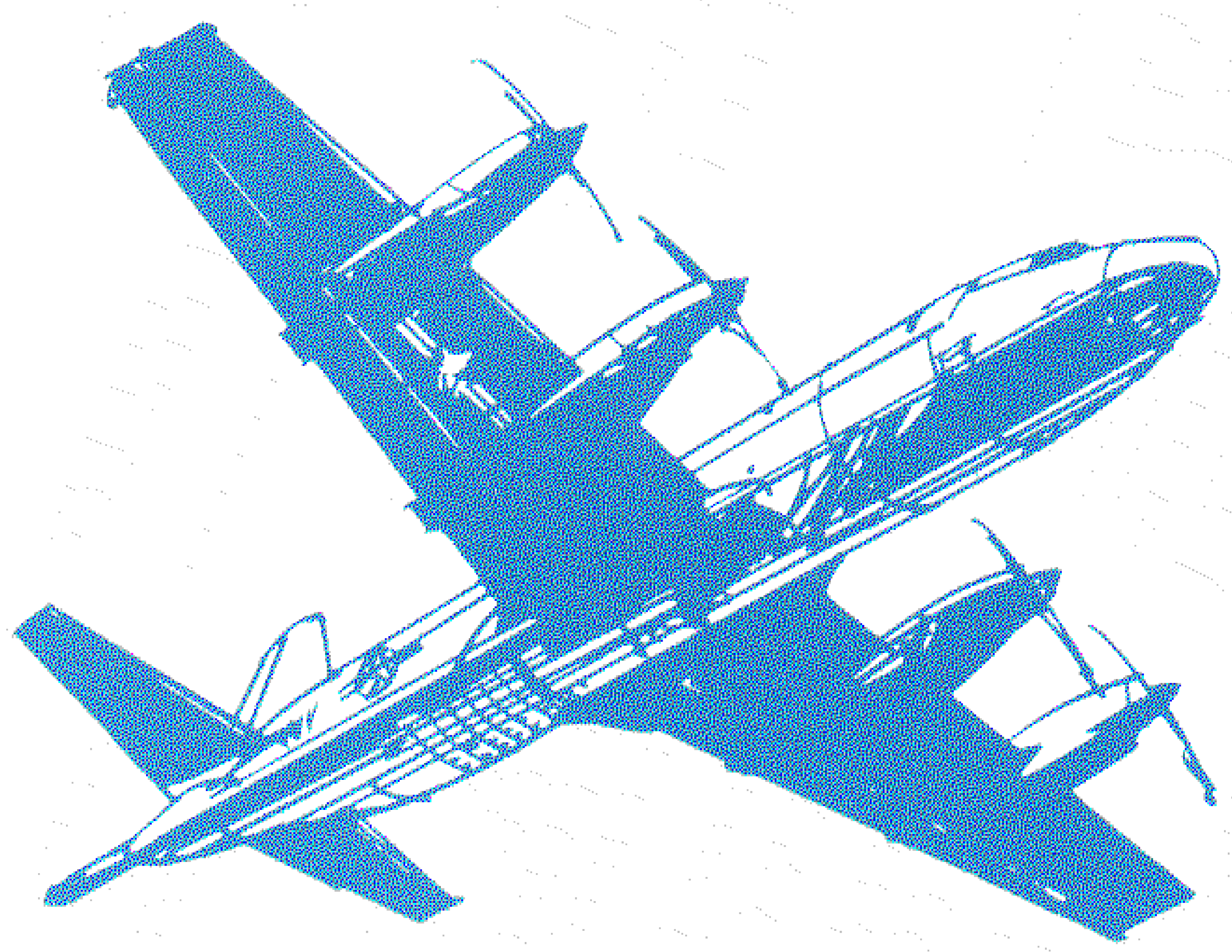
The unit is located in electronics rack E1, adjacent to Sensor Station 2. The expanded capability of the AQH-4(V)2 Recorder-Reproducer provides Update II aircraft with improved capability to record, store and reproduce ASW acoustic data.

This equipment is capable of recording data in real-time on all 28 tracks (channels) simultaneously, while the data on four of the tracks may be concurrently processed and displayed to the sensor station operators. Its 28-channel capacity gives the equipment increased capability to record both FM and direct channels. Now, 21 separate sonobuoy outputs from the AN/ARR-72(V) Sonobuoy Receiver System can be recorded simultaneously instead of the former limit of 12 sonobuoy outputs. The



Precision Data, Inc.

Figure 21.
AN/AQH-4(V)2
Recorder-Reproducer



recorder-reproducer's wideband record capability enables P-3C Update II aircraft to make permanent records of DIFAR and LOFAR contacts that can be analyzed at the Tactical Support Center or used for operator training. Because of this wideband recording capability, wideband backcoated tape must be used with the AQH-4(V)2. Another Update II feature is the recorder-reproducer's capability to record audio signals from the aircraft AN/ALQ-78 Electronic Support Measures (ESM) System.

Seven direct-record channels offer new areas of mission support and technical improvement. Four of these direct channels are used to record servo reference signals that are generated within the recorder. The reference signals are used to govern tape speed with improved accuracy during replay which, in turn, ensures accurate reproduction of analog data. Two other direct channels are used to record either the aircraft intercommunication system (ICS) voice or aircraft radio inputs (as selected by the pilot), and to record the time code signal from the TD-900A/AS Time Code Generator. The remaining direct channel is reserved as growth capability for a future digital data input.

Although the AQH-4(V)2 uses the same mainframe as the earlier AQH-4(V) Recorder-Reproducer, the internal changes to the unit are numerous. The tape path has been modified to pass over two 14-track record heads and two 14-track reproduce heads. The tape path elements have been modified to improve head-to-tape contact and to reduce edge curling. Electronic components of improved design and reliability have been incorporated into the recorder-reproducer and a cooling fan has been installed. Reduced maintenance should be realized from these changes. Improvements also have been incorporated to reduce electromagnetic emissions and system susceptibility to them.

Now, 28 record amplifiers are installed in the same mainframe that formerly housed 14 record and 14 reproduce amplifiers. This has made it necessary to reduce the number of reproduce amplifiers in the AQH-4(V)2 recorder. This does not limit the aircraft's mission capability because the primary purpose of the recorder is to *record* acoustic data. There is only minimal need to replay these data during flight.

The AQH-4(V)2 Recorder-Reproducer interfaces with the Update II Acoustic Sensor System equipment as shown in Figure 22. Sonobuoy signals are received by the ARR-72 VHF Sonobuoy Receiver, demodulated, and then routed by way of the A392 Sonobuoy Interconnection Box to the proper FM channel inputs of the recorder. Simultaneously, the demodulated sonobuoy signals are routed from the A392 box to the appropriate signal processing systems for analysis and display. The A391 Tape Monitor Control Panel enables Sensor Station 1 and 2 operators to display data visually and to monitor the LOFAR and DIFAR audio signals by headset when the recorder is operating in the Record mode. The AQH-4(V)2 Recorder-Reproducer requires the A391 and A392 boxes and associated aircraft wiring. These system components are not interchangeable with their counterparts of the earlier AQH-4(V) system.

DESCRIPTION The AQH-4(V)2 sono recorder is a modularized recorder-reproducer system that contains replaceable module assemblies and plug-in printed circuit boards. It consists of a mainframe, a card cage assembly, and a tape transport assembly. The mainframe contains both the card cage and tape transport assemblies, and provides the electrical and mechanical controls and connections to them. The card cage assembly contains the record and reproduce amplifiers, BITE circuitry, and their interfaces. The tape transport assembly contains the record and reproduce heads, bias module, head preamplifiers, reel hubs, capstan and reel motors, and other electrical and mechanical assemblies and components that move the magnetic tape over the heads and sense tape status.

The recorder utilizes two 10-1/2 inch precision reels that are mounted coaxially on the recorder's tape transport assembly. The inner reel is the tape supply reel and the outer reel is for takeup. The supply reel provides up to 4600 feet of 1-inch wide, 1-mil thick magnetic recording tape. The operator can select two tape speeds for record and replay. When Slow is selected, the transport moves the tape at 1-7/8 inches per second (ips); when Fast is selected, the transport moves the tape at 7-1/2 ips. The Fast speed is required for DIFAR recording. In the Forward and Rewind modes, the tape speed is 75 ips.

Two head assemblies are mounted on the tape transport, one for recording and the other for reproduction. Each head assembly consists of two 14-track headstacks, one for the odd numbered tracks and the other for even numbered tracks. The headstacks are arranged so that the odd and even numbered heads are interleaved in numerical order over the 28 tracks on the tape. The transport assembly also has a low tape supply warning sensor, an end-of-tape (or tape break) sensor, a tape footage counter, and two elapsed time meters – one to indicate system operating time and the other to indicate transport operating time.

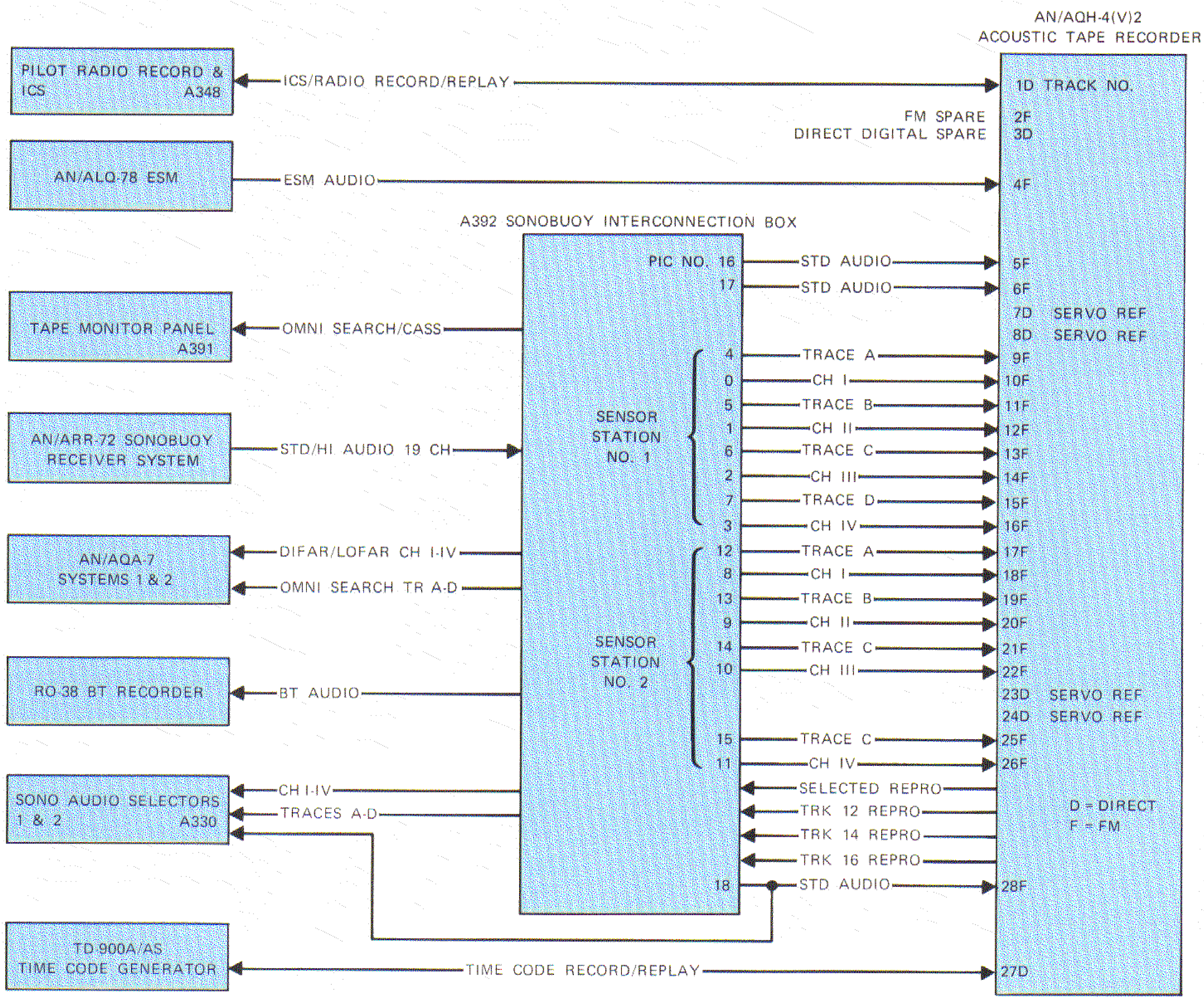


Figure 22. Recorder-Reproducer Interface Signal Flow Diagram

The recorder control panel is located on the front of the recorder in the lower right hand corner. The indicators and controls are shown in Figure 23. The recorder also has provisions for remote controls and indications. On Update II aircraft, a remote "low tape" warning indication is provided on the Sensor Stations 1 and 2 console, but remote controls for the recorder are not used. The rear of the unit contains two circuit breakers and four electrical connectors to accommodate connections to associated equipment.

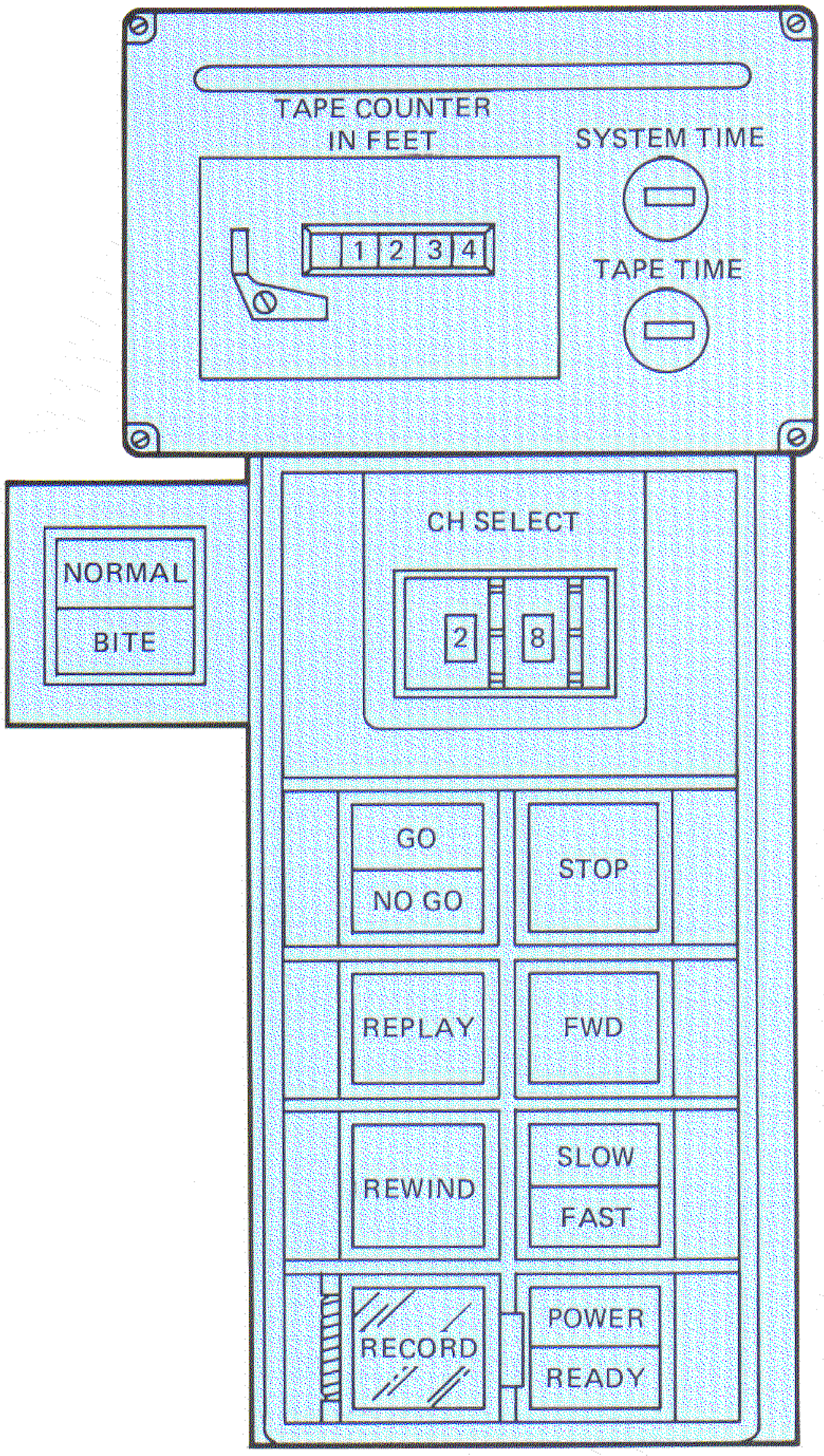


Figure 23. Recorder-Reproducer Control Panel

The card cage assembly houses 14 plug-in printed circuit boards (cards) that contain electronics for 28 record channels, one switchable and four hardwired reproduce channels, BITE, and channel switching. Their installation arrangement in the card cage is shown in Figure 24.

OPERATION The AQH-4(V)2 Recorder-Reproducer can record information from up to 28 different sources simultaneously. The unit can output information for operator monitoring as it is being recorded, or reproduce it during the selectable replay mode. LOFAR, DIFAR and range active signals from the ARR-72(V) Sonobuoy Receiver System are routed to the recorder through the A392 Sonobuoy Interconnection Box. The sonobuoy signals are recorded as they are simultaneously being processed by the AQA-7(V) Sonar Computer-Recorder Groups Nos. 1 and 2 (DIFAR), the ASA-76 Command Active Sonobuoy System (CASS), and the RO-38/SSQ-36 Bathythermograph Recorder. In addition, audio signals from the AN/ALQ-78 Electronic Support Measures set may be selected by the Sensor Station 3 operator for input to an FM record channel.

The unit's direct record channels are supplied signals from either the aircraft ICS voice audio or aircraft radio (as selected by the pilot), the time code signal from the TD-900A/AS Time Code Generator, and four channels of servo reference signals from the recorder itself. A spare direct digital channel is also available, but it is not now in use on P-3C Update II aircraft.

During the record mode, the recorded information can be immediately replayed and monitored aurally via the headsets at Sensor Stations 1 and 2, one channel at a time, as selected with the channel selector switch on the recorder control panel. There is one exception – sono active range signals (CASS) cannot be monitored during record operation, but may be monitored in the Replay mode. Controls for the monitor function are on the tape monitor control panel and on the sono audio selector panels at Sensor Stations 1 and 2.

During Replay, recorded data can be fed to the data processing equipment, it can be monitored aurally, or both functions can be performed simultaneously. The outputs from the AQH-4(V)2's three hardwired FM channels (12, 14, and 16) and an additional selected channel can be replayed for visual presentation at Sensor Stations 1 and 2. The data is presented as either four LOFAR or four DIFAR grams and as four traces on the bearing frequency indicators (BFIs). Range information may also be monitored aurally and displayed visually on two traces of each BFI at Sensor Stations 1 and 2. During Replay, any single channel may be monitored aurally by means of the sono audio selector panel (for FM channels) or through the ICS crew station control (for direct channels).

The recorder-reproducer has Forward and Rewind modes of operation that may be used to transfer tape from reel to reel, or for tape search. Tape search is performed in conjunction with the time code generator. The time code generator may be used to stop the tape transport when the tape has been driven to a position where the time-of-day recorded on the tape conforms to a preselected time code set into the time code generator by the operator.

Tape speed cannot be changed while the transport is in motion. The Stop switch must be depressed before the speed can be changed; then, a delay of up to five seconds must elapse before a new mode (i.e., Record, Replay, Fwd, Rewind) may be selected. The delay permits the transport to stop completely before operation is resumed.

Precision Data, Inc.

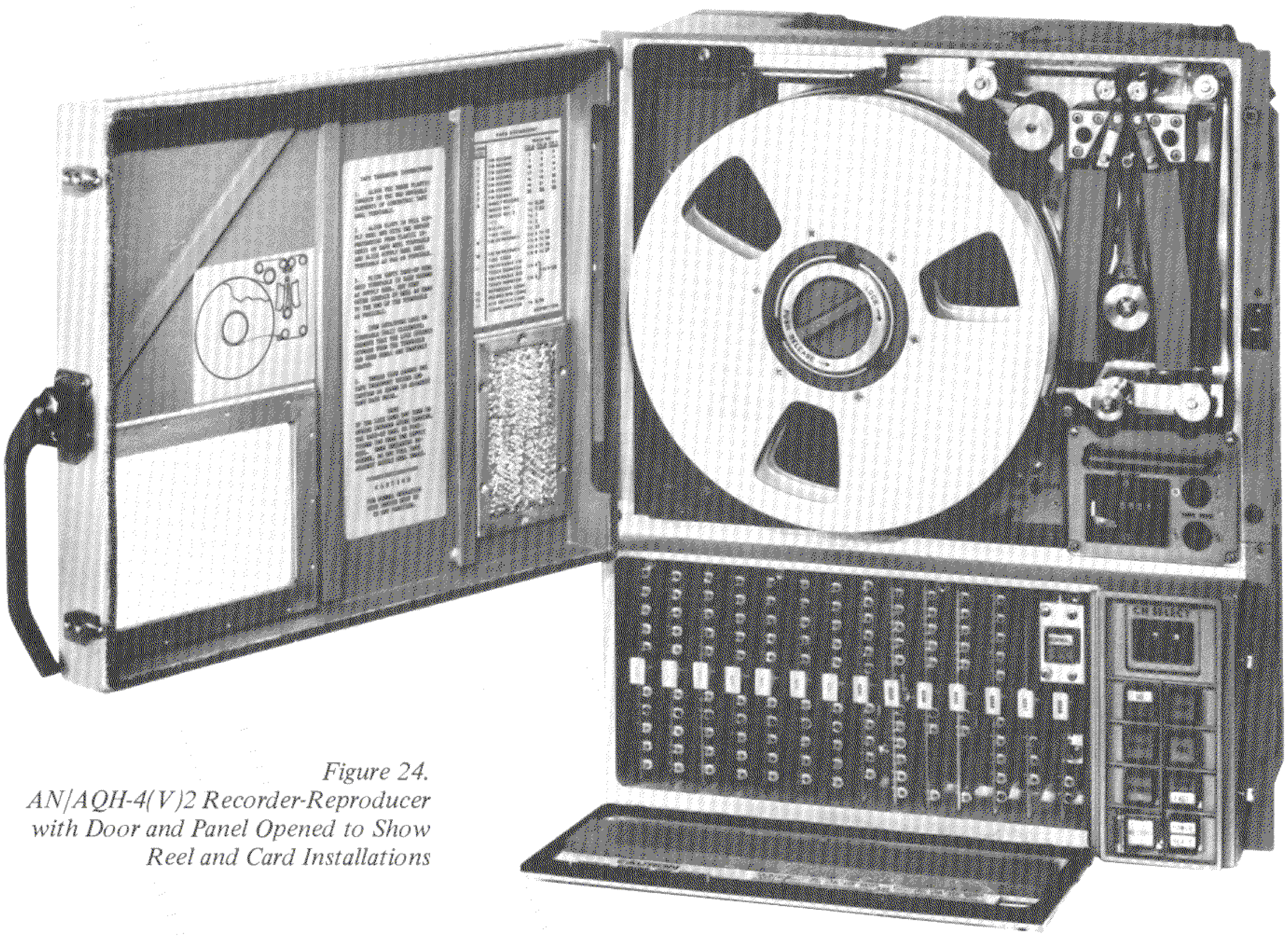
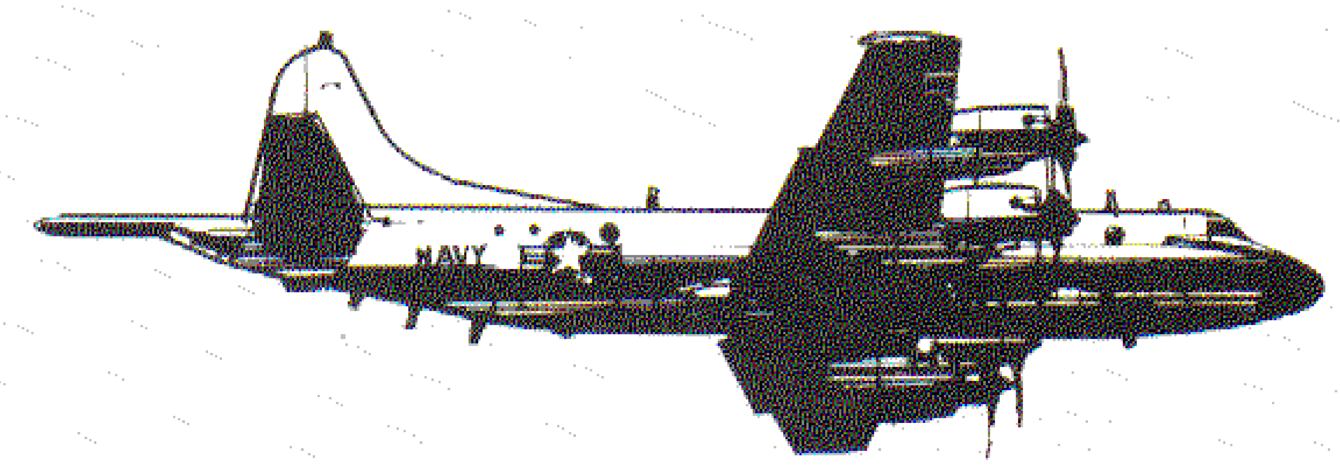


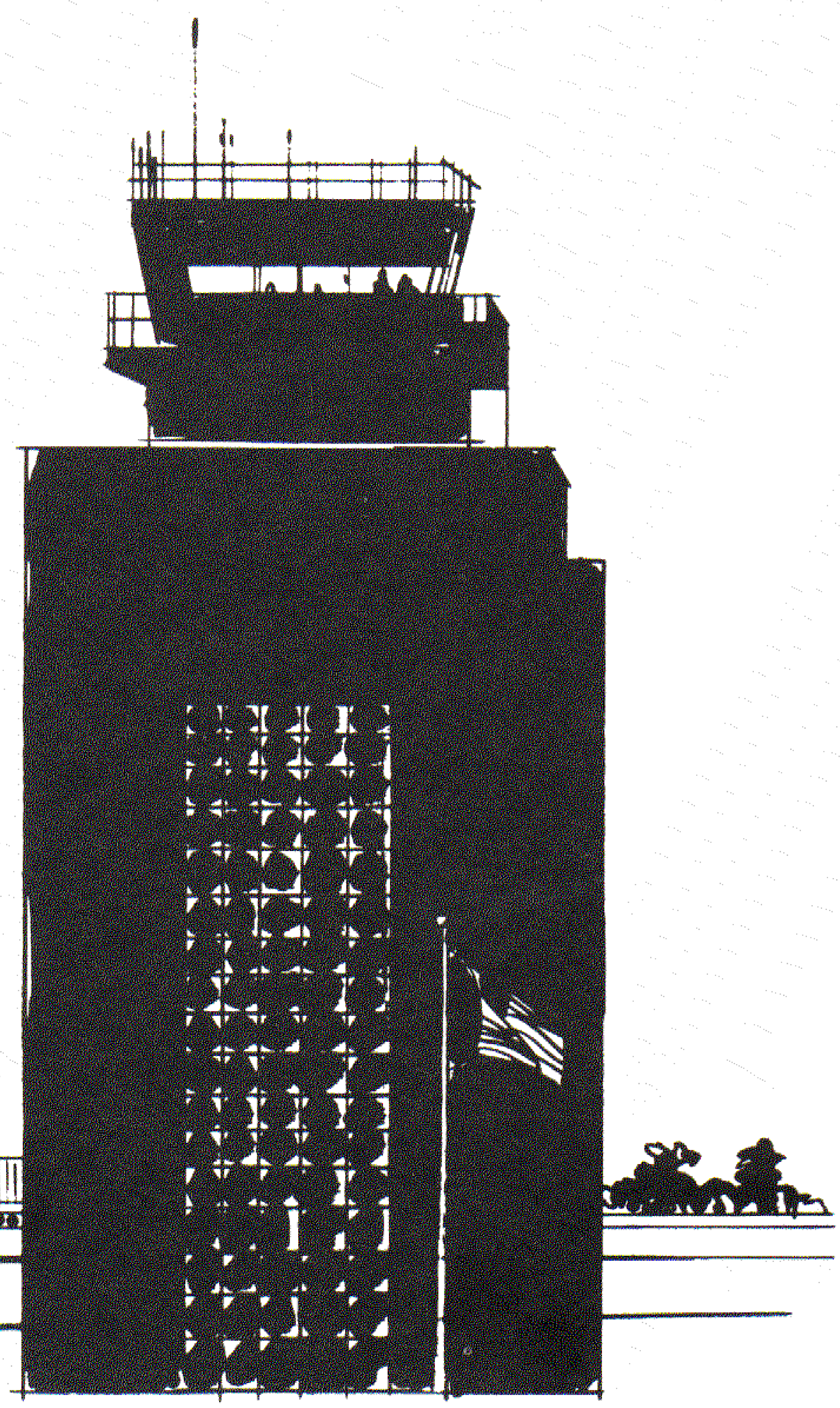
Figure 24.
AN/AQH-4(V)2 Recorder-Reproducer with Door and Panel Opened to Show Reel and Card Installations

P-3C UPDATE III

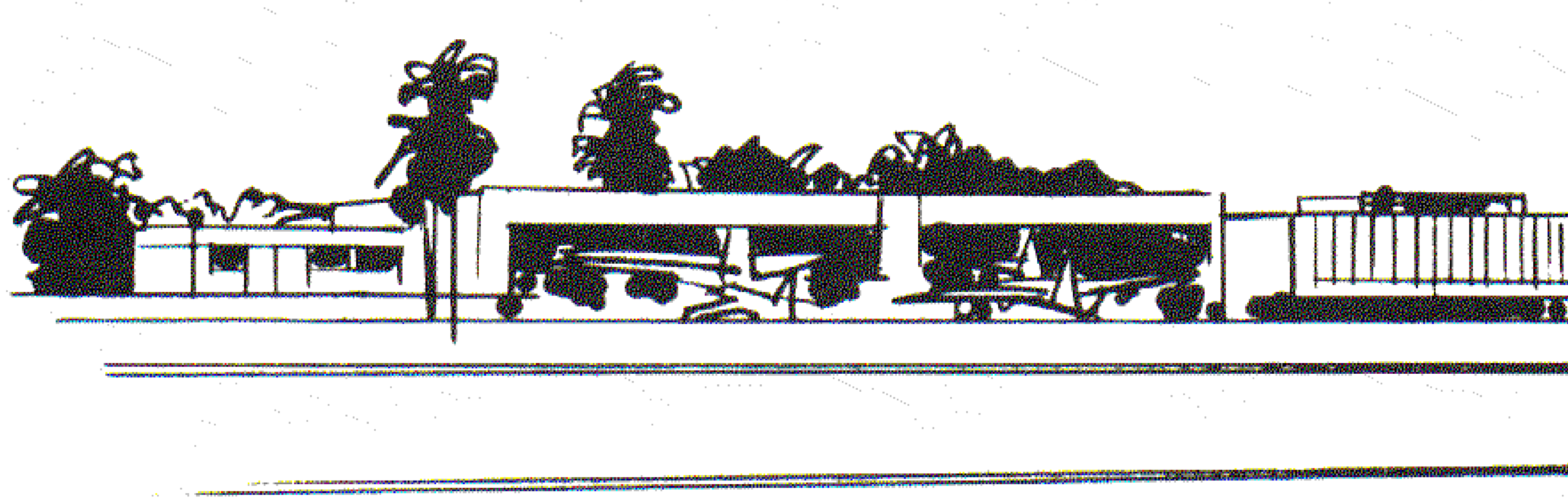
The fleet of hostile submarines continues to expand, and the nuclear powered submarines become more numerous. With their ability to launch ballistic, cruise, and surface-to-air missiles, the importance of tactical surveillance cannot be overestimated. Work has already begun on the P-3C Update III Orions, with the first delivery scheduled for 1980. Update III aircraft will consist of the Update II aircraft plus the following additions and refinements:



- Advanced Signal Processor (ASP), designated *PROTEUS*, with two to four times the processing capability of the Update II's AN/AQA-7 DIFAR System
- Advanced Sonobuoy Communication Link (ASCL)
- Adaptive Controlled Phased Array (ACPA) Sonobuoy Antennas
- Two AN/AQH-4(V)2 Recorder-Reproducers
- Digital interfaces for the Integrated Acoustic Communication System (IACS)
- Digital Magnetic Tape System (DMTS) for program loading and data extract for both the AN/ASQ-114 Computer and the Advanced Signal Processor.



Lockheed ORION Service Digest



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