# S-3A—A New Dimension in Airborne Sea Control

R. R. Heppe,* L. E. Channel,† and C. W. Cook‡
*Lockheed-California Company, Burbank, Calif.*

**Rapid development of potential threats to U.S. Navy control of the seas vary from advanced submarine capability to surface and subsurface launched antiship missiles with large strike range. Our sea control capability is challenged both in conventional submarine warfare and task force survivability. Concurrently, our Navy is transitioning to the new multipurpose CV concept placing deck space at a greater premium than ever. Joining the fleet in 1974, the S-3A will provide a new dimension in airborne sea control. This new weapon system and its present and future ability to deal with this environment are described.**

## I. Introduction

AFTER a drought of some twenty years in the development of carrier-based, antisubmarine warfare weapon systems, a new dimension in airborne sea control is about to enter the fleet of the U.S. Navy. The new S-3A patrol aircraft, Fig. 1, has been under development for the past four years to fill the urgent requirement to replace the venerable, but obsolescent and operationally inadequate S-2. No longer in production, a limited number of these aircraft is being updated with improved avionics systems in the S-2G series to provide an interim capability. It is this most modern version which is used as a reference for comparison in this paper. The S-3A is now in full production with 101 aircraft currently authorized and additional quantities under option. It will join the fleet in 1974.

## II. Threat Considerations

The requirement for improved ASW capabilities stems from increasing Soviet threat trends in every significant technical area as shown in Fig. 2. Newer submarine classes continue to display the Soviet emphasis on higher speeds and greater depths which make it increasingly difficult for ASW systems to avoid being out-run and outmaneuvered by an illusive and evasive target. Similarly, the trend of progressive quieting has been clearly evidenced in each successive new generation of submarine classes. This quieting generates a major technical demand for improved ASW sensors and total systems capabilities, particularly passive acoustic systems which continue to be the primary ASW sensor.

Finally, the effective range of missiles (strategic submarine-launched types as well as tactical antishipping types launched from submarines, surface ships, and aircraft) has not only increased, but the threat has become more lethal. Guidance systems have become more sophisticated, accurate, and resistant to countermeasures. Submarines have been armed with submerged-launch tactical missiles. The technical advances, the high quality, the remarkable missile attack capabilities, the high rate of new construction, and the expanding world-wide operations of Soviet submarine forces underscore with unmistakable clarity the serious threat to the sea control capability of the United States.

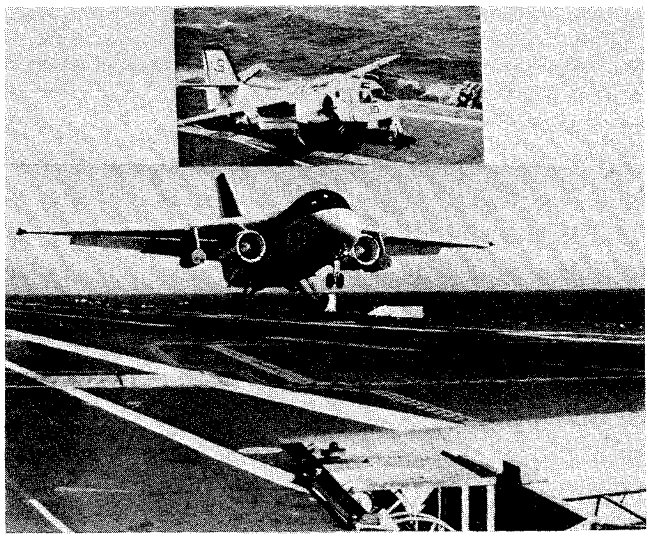

Fig. 1 A new dimension in airborne sea control.

The multiple dimensions and scope of the threat can be seen in the context of naval task force operations and the problem of defending the force from enemy attack as shown in Fig. 3. First, the threat can range from close-in submarine-launched torpedoes and short-range missile attack to an array of submarine, surface ship, and aircraft armed with long-range missiles having effective standoff ranges extending out to 100 to 400 naut miles from force center. The tactical problem is not merely the classic submarine defense requirement, but a composite of this with antiship missile defense and the need for advanced warning which, in combination, comprise the total task force defense problem. The requirement is to provide defense in depth to detect and attack submarines, as well as surface ships, at long range from the force. The requirement also

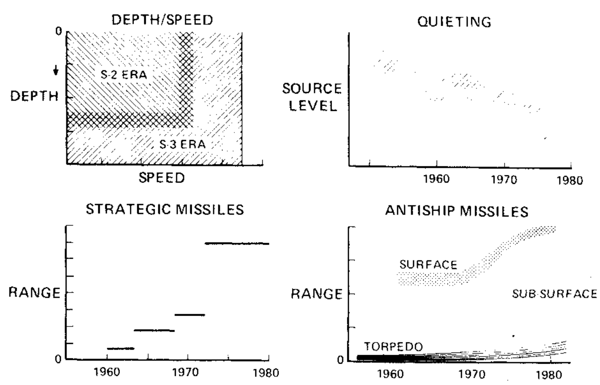


**Fig. 2 Increasing threat trends.**

Presented as Paper 74-239 at the AIAA 10th Annual Meeting and Technical Display, Washington, D.C., January 25-30, 1974; submitted February 14, 1974; revision received May 25, 1974.
Index categories: Aircraft Performance; Aircraft Subsystem Design; Military Aircraft Missions.

*Vice President and General Manager—Navy Programs. Fellow AIAA.
†Division Engineer, ASW Systems Analysis. Member AIAA.
‡Senior Research And Development Engineer.

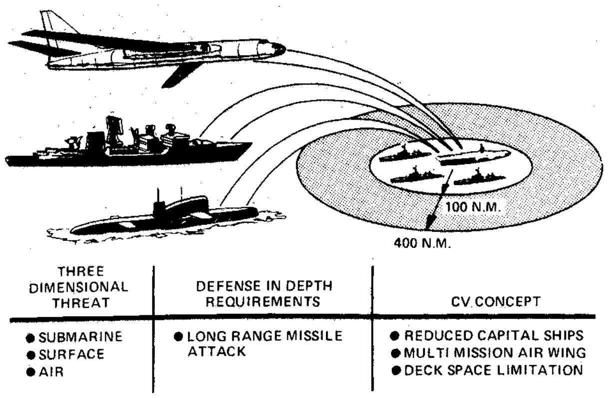


**Fig. 3 Task force defense problem.**

includes the interception of air attack, as well as prevention of coordinated attack by enemy air-surface-submarine units. The air intercept requirement is not an S-3A mission.

Another facet of the task force problem concerns what is now generally known as the CV concept as related to the S-3A aircraft. In short, the CV concept is the Navy's current carrier equipment and operating doctrine which arose as a result of the programed reduction in total numbers of active carriers in the fleet. In order to meet a variety of mission requirements and contingencies, the multimission air wing concept was established in which the complement of different aircraft types embarked on a carrier will be tailored in accordance with the requirements of the specific mission. This has resulted in attack carriers (CVA) being redesignated as CV's as they become outfitted to handle ASW aircraft in addition to the fighter and attack aircraft for which they were originally designed. A matter of concern with a mixed complement of ASW and tactical aircraft aboard the same ship is the potential for reduced capability in both areas because of the fixed amount of deck space available. Finite deck space resources place a very high premium on minimizing the deck space required for each aircraft type, on achieving high unit effectiveness, and upon maximizing aircraft utilization. In point of fact, the CV concept is dependent upon the ASW aircraft embarked taking up as little of the total deck space as possible. Otherwise, the number of attack and fighter aircraft that would be displaced could seriously compromise the tactical air strike capability of the task force. Conversely, inadequate ASW protective forces significantly increase carrier vulnerability.

## III. Operational Considerations

The Navy's primary sea control responsibilities require an ability to conduct world-wide naval operations in consonance with national objectives. As presented in Fig. 4, these include operations of naval task forces for power projection and the protection of principal shipping lanes of supply to our allies and overseas forces. The principal role of the S-3A in performing the sea control mission would be ASW operations from CV carriers. When the CV is deployed in a strike role, its normal situation, the S-3A is primarily concerned with the ASW defense of the force. But in the context of the CV concept, an increased complement of S-3A aircraft can be embarked to perform shipping lane defense and area search hunt and kill missions much as the previous antisubmarine carriers (CVS) and hunter-killer (HUK) groups performed. Conversely, the S-3A can also be shore-based when mission priorities call for reduction of ASW aircraft on board the carriers. When shore based, the S-3A augments the long-range P-3 ASW patrol aircraft forces.

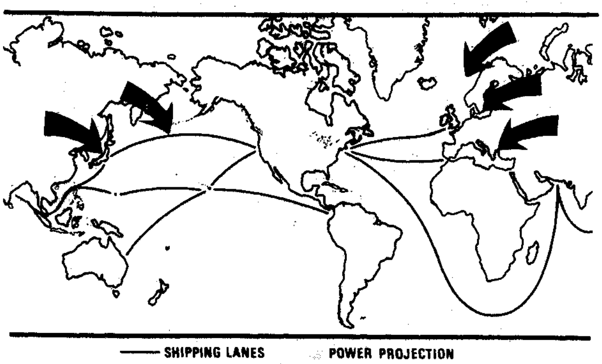


**Fig. 4 Sea control requirements.**

Soviet submarine bases are located on the peripheral of the Eurasian land mass. Certain of these bases are contiguous to the Pacific Ocean and provide access to operating areas off the west coast of the United States. Others are contiguous to the Atlantic Ocean and Mediterranean, and, similarly, provide the Soviets with a blue ocean capability off our east coast—and against the Sixth Fleet. Nevertheless, these same bases impose certain political as well as geographical restrictions on Soviet submarine operations—factors which influence our own sea control concepts. They suggest, for example, those areas where intense application of ASW forces can serve to blockade or exact heavy attrition losses against enemy submarines attempting to reach their patrol stations. The S-3A aboard CV carriers also offers substantial flexibility to maintain capability even in the event of foreign base denial situations.

## IV. System Description

The S-2, the Navy's present carrier-based ASW aircraft, is a piston-engined aircraft first flown in 1952. This aircraft will be replaced by the S-3A which is powered by two General Electric TF-34 high by-pass ratio turbofans. It was first flown in 1972. Comparison of certain important characteristics of the two aircraft is outlined in Fig. 5. The S-3A was specifically designed to provide the Navy with a medium-altitude, long-endurance, and maximum-effective cruise speed aircraft to meet carrier-based ASW mission requirements.

The S-3A was designed as a logical outgrowth of the land-based P-3C with a highly integrated system and minimum crew. The extraordinary degree of integration was dictated by the deck space resources available in the CV era. This concept involves tying together men and machine in a manner which optimally uses the unique capabilities of each. To that end, the "machine" reduces much of the routine workload which consumed the majority of effort in the S-2. The freedom gained by machine automation is utilized by the operators for those things which man does best: evaluation of the over-all situation, synthesis of appropriate tactics, and judgment of the results obtained in terms of mission priorities, etc.

In order to handle the wide range of sensor types and large quantities of data, the S-3A crew stations are multifunctional, highly integrated, and have extensive display capacity and tableaux and cueing formats to facilitate data processing, decision making, and record keeping. Over-all system/crew integration is described in Fig. 6.

The pilot has over-all command responsibility for the aircraft, crew, and mission. The pilot has a tactical display which presents an overview of the tactical situation, aircraft and target fixes and tracks, and fly-to-points selected by the tactical coordinator (TACCO). The TACCO has primary control of the data displayed to the pilot.

The copilot, in addition to his duties as a pilot, performs the duties of navigator, communicator, and non-

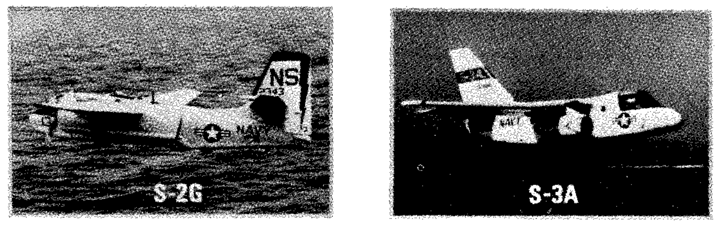


Fig. 5 Aircraft characteristics.

| CHARACTERISTICS | S-2G | S-3A |
|---|---|---|
| SPOT FACTOR (A-7) | 1.27 | 1.37 |
| PROPULSION | PISTON-PROP 2 R-1820-82A | TURBOFAN 2 TF-34 |
| TOS @ 200 N.M. (SEARCH MILES) | 3.5 HR @ 160 KTAS (560 N.M.) | 4.5 HR @ 370 KTAS (1665 N.M.) |
| DASH SPEED | 210 KTAS | 447KTAS |
| CRUISE SPEED | 160 KTAS | 370 KTAS |
| COMBAT CEILING | 18,000 FT. | 40,000 FT. |
| SONOBUOYS A-SIZE | 32 | 60 |
| TORPEDOES MK 46 | 2 | 4 |
| ASM | 2 BULLPUP | 2 HARPOON |

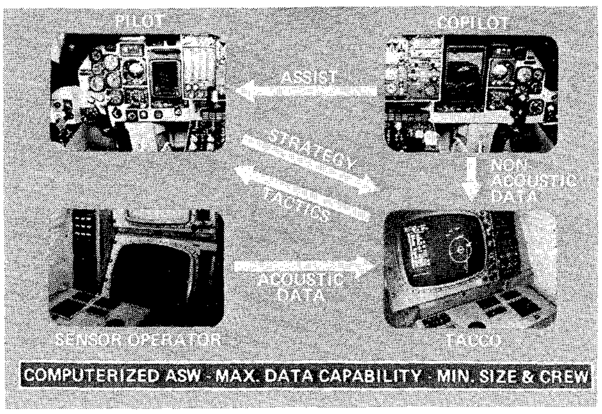


Fig. 6 S-3A system integration.

acoustic sensor operator. The nonacoustic sensor systems (radar, forward looking infrared, electronic surveillance, and magnetic anomaly detection) are almost completely automated through computer management. Their signals are presented to the copilot on his multipurpose display and can be transferred to the tactical plot.

In coordination with the pilot and TACCO, the copilot can manually select and release all free-falling weapons (except special weapons) through controls and indicators within the armament control panel located on the cockpit center console, or through his integrated control system.

The sensor operator (SENSO) is primarily responsible for the operation of the acoustic data processor. The combined facilities of an automatic target detection and computer-aided classification program, expanded frequency coverage, and a full range of acoustic signal-processing functions significantly increase the effectiveness of the S-3A against quiet submarines.

As the sonobuoy detection specialist in the S-3A, the SENSO monitors omnidirectional passive acoustics (LOFAR) and directional acoustics (DIFAR) from sonobuoy fields, reports detections, classifications, and lines of bearing or fixes in the search phase of the ASW mission. He also monitors active sonobuoys (CASS) in later localization phases. The SENSO can also function as nonacoustic sensor operator during periods when acoustic activities are minimal.

The S-3A tactical coordinator (TACCO) is responsible for tactics, coordination, data processing system management, sensor systems management, and weapon systems management during a mission. With the multipurpose display at his station, the TACCO concentrates on tactical mission accomplishment.

Contact data generated by the copilot and SENSO, and inserted by keyset into the operational program data base, are displayed and interpreted by the TACCO. With the software tactical aids provided, he is able to compute target fixes and tracks, determine optimal tactics, and ultimately specify the attack solution in the form of weapon release points. These are displayed to the pilot as fly-to-points for execution.

The S-3A avionics system is the most extensive, multimode, sophisticated application of electronic, sensor, and software technology in any tactical airplane. The over-all system shown in Fig. 7 is capable of self-sufficiency, rapid

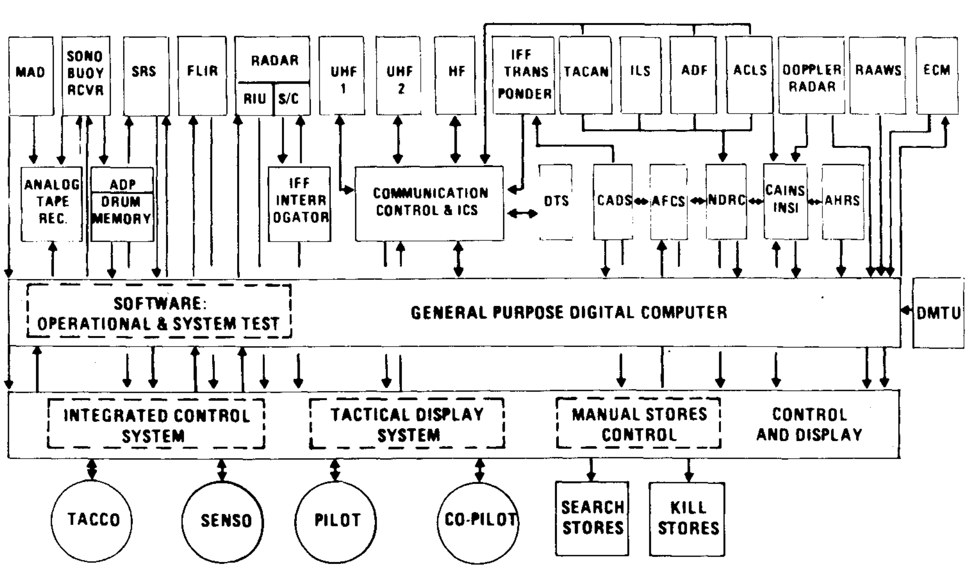


Fig. 7 S-3A avionic system.

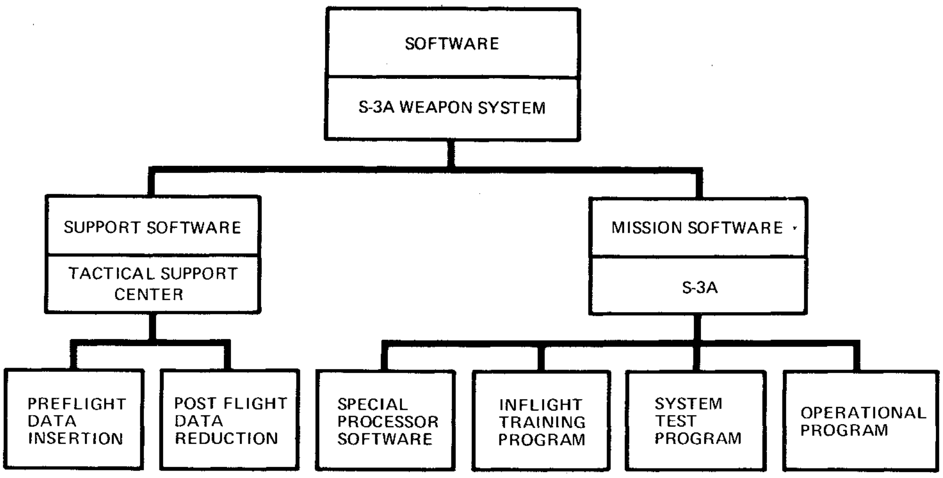


**Fig. 8 S-3A software.**

and reliable communication, and tactical cooperation with other ASW units. Eighteen sets of equipment interface directly with the central computer over a single twisted wire pair by means of a biphase serial Manchester communication link operating at a 6 MHz bit rate.

Significant new developments in system design have been made in the acoustic data processor, tactical display system, sonobuoy reference system, central computer, and the software for both the central computer and acoustic data processor. Key systems such as the acoustic data processor, central computer, and drum memories are dual partitioned to increase sharply mission reliability. The avionics equipment is installed in specially designed racks and is temperature regulated by a cold plate cooling system.

The equipment is designed with computer controlled, built-in test capability for preflight check out and in-flight monitoring. With the exception of portions of the radar and inertial navigation systems, the equipment is supported on board ship by automatic test equipment known as VAST (Versatile Avionics Shop Test). The same test equipment, under the Navy's avionics maintenance program for the CV's, will also support the F-14 and E-2C.

The S-3A weapon system software represents the most extensive application of general purpose and real time digital computer programs operational in any tactical aircraft to date. The system concept includes integration and control of ASW systems, sensors, and displays. It also manages the processing of data to facilitate calculations, bookkeeping, and tactical decisions. The two major categories of software are shown in Fig. 8 and consist of *support* software which resides in the tactical support center on board the carrier, and *mission* software which is utilized within the S-3A.

The support programs are used to generate or build the specifically necessary and changing mission software, insert pertinent preflight data onto the mission digital magnetic program tape, and reconstruct the mission by postflight reduction and analysis of that data which is placed on the tape during the mission.

Mission software provides the system and its crew members with the capability to complete any ASW mission successfully. If has several components which are described in the following paragraphs.

Special processor software is used by the acoustic data processor and the inertial navigation computer to manipulate data peculiar to those equipments prior to sending the data to the central computer.

The system test program is used during preflight to give each of the peripheral avionics subsystems a GO/NO-GO readiness check. Diagnostic subprograms can analyze any discovered failure down to a weapon replaceable assembly.

The in-flight training program is used to train the crew using simulated mission data. The crew exercises its functions and options in response to simulated data just as it would respond to real mission data.

The operational program is the key to mission success in combat situations. It allows the S-3A crew to manage the tactical ASW program by providing the capability to collect, store, analyze, process, correlate, and display tactical data. It rapidly processes signals from deployed sonobuoys, integrates acoustic and nonacoustic sensor information, and presents a complete tactical and environmental picture to the tactical coordinator for decision. These tasks, in their totality, are distributed over 21 subprograms, associated with particular subsystems or groups of functions. An important feature of the operational program is its segmentation to permit degraded mode operation following certain computer hardware or computer software failures. This operational program approaches 150K words as compared to the 65K word program operational in the P-3C today.

Numerous major improvements or uniquely new capabilities are provided in the S-3A communication and navigation systems as compared to the S-2G. Highlights are summarized in Fig. 9.

Communications in the S-3A are provided through UHF and HF links. The UHF systems provide short range air-to-air and air-to-surface capability. Utilizing the appropriate interface equipment, the UHF is capable of clear or secure voice two-way communication, Link 11, data link net and swap operations, direction finding, sonobuoy command transmissions, and may be used as a back up receiver for the automatic carrier landing system (ACLS). The HF system provides long-range communications and, utilizing the appropriate interface equipment, is capable of clear voice, secure voice, and Link 11 data link.

Integrated control and digital tuning features are designed for timely and reliable transfer of data at both short and long ranges, to enable assured command and

| | S2G | S3A |
|---|---|---|
| PRIMARY COMMUNICATION | | |
| LONG RANGE | 1 HF<br>1 UHF | 1 HF<br>2 UHF } INTEGRATED CONTROL DIGITAL TUNING |
| TACTICAL DATA LINK | NONE | HF/UHF LINK 11 |
| NAVIGATION | | |
| LONG RANGE | AIR MASS DEAD RECKONING: >3 N.M./HR | INERTIAL-DOPPLER: APPROXIMATELY 1 N.M./HR |
| TACTICAL | DOPPLER/AIR MASS: >65 YDS/MIN | DOPPLER/INERTIAL: APPROXIMATELY 20 YDS/MIN |
| SONOBUOY LOCATION | BUOY POSITION BY FLYING ON TOP | CONTINOUS AUTOMATIC BUOY POSITIONING |
| CARRIER LANDING AIDS | NONE | AUTOMATIC CARRIER LANDING SYSTEM |

**Fig. 9 Communication and navigation improvements.**

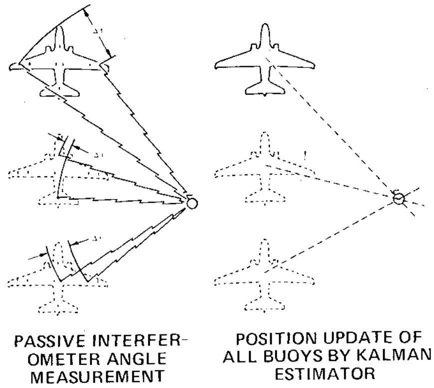


Fig. 10 Sonobuoy reference system.

control, and to enhance over-all carrier mission effectiveness.

The S-3A navigation system equipment includes carrier aligned inertial navigation system (CAINS), doppler radar, attitude and heading reference set (AHRS), airspeed and attitude computer set (AACS), and sonobuoy reference set (SRS). Data from the CAINS, or from doppler damped CAINS, may be used in the CAINS computer to provide the basic navigation (GEONAV) calculations. CAINS, doppler, AHRS, and AACS provide inputs to a separate central computer program which maintains a tactical plot for display to crew stations.

Navigation has a major impact on the operational effectiveness of the aircraft. Accurate navigation enables the S-3A to operate at long ranges from the carrier under EMCON conditions, and to maintain accurate data on the tactical ASW situation under all conditions. In the tactical navigation situation, the sonobuoy location system updates buoy positions and enables the S-3A to localize, track, and attack with accuracies substantially bettering those of any previous ASW aircraft.

The sonobuoy reference system (SRS) is a VHF interferometer system which periodically measures the direction of arrival of each sonobuoy RF signal as shown in Fig. 10. As such, it remains passive and requires no modification to sonobuoys. The position of a sonobuoy relative to the aircraft is updated by processing the measured information in a Kalman filter technique which computes a best estimate of sonobuoy position and drift.

The SRS provides a badly needed capability which is not incorporated in any other ASW aircraft. The system enables the aircraft to determine buoy positions without the necessity for flyover and on-topping which is inaccurate, time consuming, and risks losing the contact because of diversion off station. The S-3A SRS system enables submarine track and weapon aim point predictions to be sufficiently more precise as to significantly enhance kill capability.

The primary nonacoustic ASW sensors are radar, forward looking infrared (FLIR), magnetic anomaly detector (MAD), and electronic support measures (ESM) equipment. Of these, only the radar is active (signal emitting); the other three are passive and nondetectable by the enemy. Significant areas of improvement are shown in Fig. 11.

The APS-116 radar is a sophisticated multimode, high-power system with pulse compression and integration features permitting periscope detection in medium sea states and small craft detection in high sea states at tactically useful ranges. As such, it can deny submarines uninhibited use of surface exposures. The APS-116 can also detect surface craft at standoff ranges sufficient to attack and destroy them before they can close to missile attack range against task forces and shipping.

| | S2G | S3A |
|---|---|---|
| RADAR | APS-88 WEATHER RADAR | APS-116 HIGH RESOLUTION PERISCOPE DETECTION |
| FLIR | NONE | DAY AND NIGHT PASSIVE DETECTION AND CLASSIFICATION |
| MAD | ASQ-10 MANUAL DETECTION ONLY | ASQ-81 MANUAL AND AUTOMATIC DETECTION |
| ESM | WIDE OPEN ALD-2B MANUAL TUNE SIGNAL SATURATED | ALR-47 PROGRAMMABLE THREAT COMPUTER SIGNAL SORT |

Fig. 11 Nonacoustic sensor improvements.

FLIR provides a day and night optical imaging capability which is useful tactically for classification and identification of surface contacts.

MAD is used in the terminal phase of ASW localization and attack to refine the position and confirm the classification of the target. S-3A MAD signals can be automatically analyzed in the computer to determine target classification (submarine or nonsubmarine), submarine confidence level, and estimated target slant range. The combination of sensitivity in the magnetometer, compensation, and computer-aided features in the S-3A system give it a detection range twice that of the S-2G.

The ALR-47 ESM system detects, analyzes, obtains bearings, and sorts electromagnetic emissions in selected frequency bands. It incorporates computer signal sorting features using apriori threat signals in its memory. It provides a tactically useful passive intercept capability for detecting and identifying threat radars by type and operating mode.

The APS-88 radar on the S-2 is essentially a weather radar, has low power, and is severely affected by sea clutter in high sea states. The APS-116 radar on the S-3A is a high power, high resolution, multimode system with pulse compression and integration features which give it detection capabilities against small targets in adverse sea clutter. Some measures of detection range improvement are summarized in Fig. 12 and discussed below.

A mode of operation provides high resolution, pulse compression, high pulse repetition frequency, and high antenna rotation rate. This mode of operation is used to detect very small targets in medium sea states. As shown in Fig. 12, the higher resolution provides an added capability at high sea states.

The APS-116 can be operated with lower resolution, low PRF and low antenna rotation rate with frequency agility when used primarily for long-range search and navigation.

In addition, the APS-116 can provide high resolution and pulse compression with low pulse repetition frequency and slow antenna rotation rates. This mode of operation facilitates surface target detection and long-range navigation. As indicated in Fig. 12, the detection range of the S-3A radar provides a significant improvement in detec-

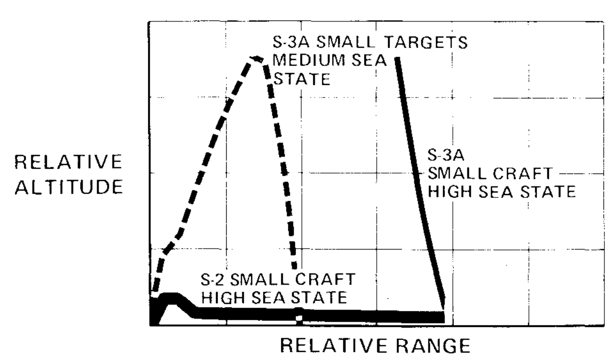


Fig. 12 Multimode radar.

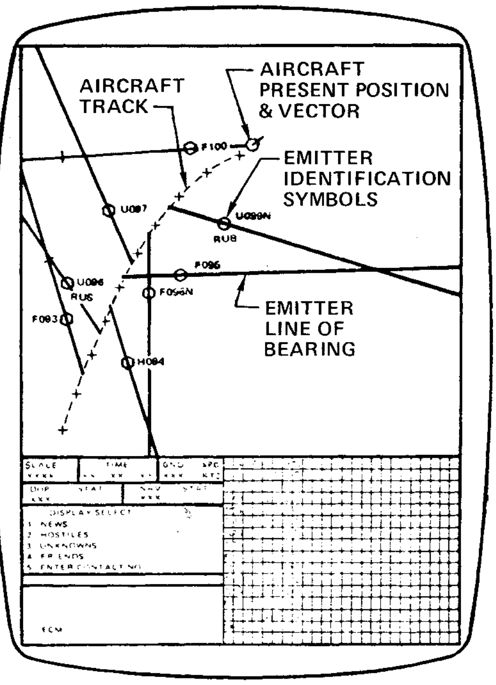


Fig. 13 Electronic Support Measures (ESM) System.

tion of small surface targets in high sea states and low grazing angles. The APS-116 retains most of its capability at altitude.

The salient features of the S-3A ESM equipment are highlighted in Fig. 13 including a typical operator's display format. With the assistance of the S-3A's digital computer, emitter identifications and lines of bearing from the aircraft, together with the aircraft's position and heading vector are displayed. The aircraft track has been sketched in to assist orientation. Using analysis and comparison capabilities of the computer, emitter lines of bearing are displayed along with emitter intelligence information. These lines, which display the aircraft's last contact on a particular emitter, remain until a new contact is made on that emitter, at which time the superseded line is erased. However, historical intelligence on an emitter remains in computer storage and can be recalled at any time.

The S-3's ALR-47 system detects, analyzes, and sorts radar emissions in selected frequency bands. The resulting signal data descriptions are sent to the general purpose digital computer for further processing to yield an updated list of radar emitters which are active in a tactical area. This signal information is filtered, processed, and transmitted to a signal comparator where further processing, digitizing, and sorting take place, subject to control information from the computer. The signal comparator, in turn, transmits the emitter reports to the GPDC.

| | S-2G | S-3A |
|---|---|---|
| ACOUSTIC DATA PROCESSOR | MANUAL<br>SHARED DISPLAYS<br>DISCRETE BANDS<br>8 BUOYS<br>RANGE INDEX: 1 | COMPUTER-AIDED<br>FULL DISPLAYS<br>FULL FREQUENCY<br>16 BUOYS<br>RANGE INDEX: 3 |
| GENERAL PURPOSE DIGITAL COMPUTER | NONE | 65K CORE+DRUM<br>INTEG. CONTROLS<br>145K OP PROG. |
| DIGITAL MAGNETIC TAPE UNIT | NONE | MISSION DATA INSERTION<br>MISSION RECORD/ RECONSTRUCT |
| ANALOG TAPE RECORDER | LOFAR | 6 HR. STORAGE<br>DIFAR CAPABLE |

Fig. 14 Acoustic sensors and data processing improvements.

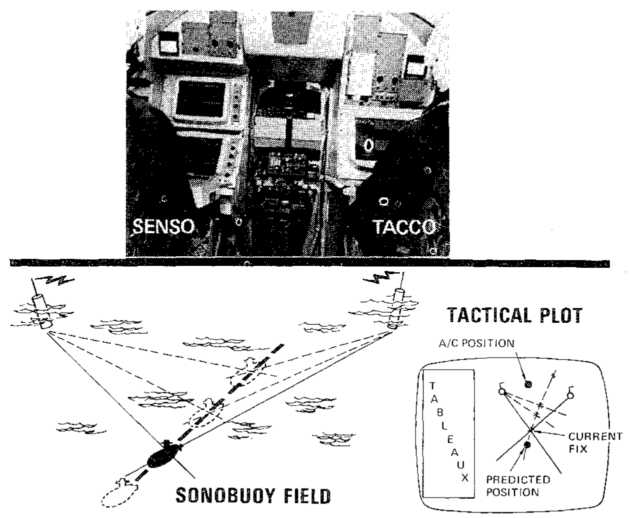


Fig. 15 DIFAR sonobuoy search.

The acoustic data processing subsystem of the S-3A is the most significant area of technical advance directly related to countering the ever-increasing submarine threat. Figure 14 calls attention to some of the major improvements in this subsystem. The acoustic data processor improvements in the S-3A over the S-2G include interface with and use of the central computer; full display of data from all sonobuoys and all band-widths simultaneously; processing of the entire acoustic frequency band; monitoring 16 sonobuoys simultaneously; and detection range improvement by a factor of 3.

While the S-2G has no central general purpose digital computer or associated digital magnetic tape unit, the S-3A has a computer with 65K words of core memory, two drum memories, an integrated control system, and an operational program of 145K words. The digital magnetic tape unit stores important preflight mission data and records the key mission events for later reconstruction in the shipboard tactical support center. The S-3A analog tape recorder is capable of recording 16 channels of raw acoustic data throughout the mission, and is capable of handling DIFAR data.

The SENSO and TACCO stations are shown in Fig. 15 as the tactical problem depicted below it unfolds. The SENSO monitors those acoustic data provided by DIFAR buoys through the acoustic data processor; the TACCO sees the problem unfold in real time as sensor data is inserted by the SENSO.

Directional frequency analysis and recording (DIFAR) enables the aircraft to remain passive yet obtain directional information on the target. These buoys provide all LOFAR data plus the additional directional information as desired. In the scenario pictured in Fig. 15, the submarine is contained within the DIFAR buoy field. This picture, in effect an image of the spatial relationships in the actual tactical problem, has been generated by the S-3A computer. The pilot's job is to fly from the aircraft's present position, seen at the top of the plot, to the predicted position, for further close-in localization or weapon drop—or both.

The S-3A data processing system exploits the use of software routines to assist the human operator in detecting and classifying targets of interest. The acoustic data processor in the aircraft analyzes the energy content of sound received by sonobuoy hydrophones in a series of cells or bins across the sound spectrum. With computer assistance, target detections are made and tactical data are provided to the TACCO. Typical steps used by the S-3A in acoustic signal analysis are based on sound and demonstrated analytical techniques. Notwithstanding the fact

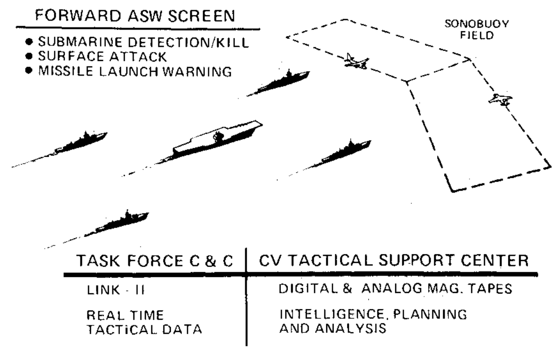


**Fig. 16 S-3A in task force operations.**

that today's acoustic data processing technology has recognized limitations, the S-3A joins the Navy's carrier force with the most advanced acoustic processing system yet produced for fleet use. Its full operational potential will emerge from practical at-sea experience coupled with continued analytical and processing equipment requirements.

An important mission application of the S-3A is screening a carrier task force by means of advancing fields of passive sonobuoys as shown in Fig. 16. For the first time, the task force commander is provided with an ASW aircraft capable of operating outside the envelope of noise generated by the force itself. Typically, the field is placed well in advance of the moving force.

S-3A's on screen stations are in position to detect and kill threat submarines, conduct missile attacks against surface targets, and provide early warning of impending or actual missile launches against the force. Under nominal EMCON plans, the S-3A's may be linked to task force command and control by Link 11. Under restrictive EMCON plans, they must operate autonomously.

Within the tactical support center on board the CV, and by the use of digital and analog magnetic mission tapes, mission planning and brief, and postmission reconstruction and analysis are accomplished. A typical mission sequence begins with preflight data insertion, covering such inputs as ordnance loads, sonobuoy frequencies, and a priori threat knowledge. After launch, through the autopilot, the computer may fly the aircraft in accordance with an optimized flight plan. Via Link 11, the communications system can receive or transfer tactical data between tactical units. While on station, oceanographic conditions can be sampled, and sonobuoy field designs finalized.

Throughout the mission, the TACCO display provides all information necessary for timely decisions, leading to increasing precision in the knowledge of enemy submarine positions and tracks. Each crew member converses with the peripheral subsystems and the computer data base, while digital and analog tapes relieve the crew of the requirement for manual log keeping. Computer-to-computer data dump can be effected with relieving aircraft to insure uninterrupted prosecution of the submarine target.

| | CURRENT | FUTURE |
|---|---|---|
| GROSS WEIGHT | 43,491 LB | 52,539 LB |
| VOLUME, POWER, ETC. | BASE SYSTEM | 20 - 50% MARGIN |
| COMPUTER CORE | 65K WORDS | 96K |
| COMMUNICATION | HF/UHF/LINK-11 | FLTSATCOM |
| NAVIGATION | CAINS/AHRS/ DOPPLER | OMEGA |
| ACOUSTIC SENSORS | DIFAR & LOFAR CASS | NEW PASSIVE BUOYS (ARRAY) DICASS |
| ARMAMENT | TORPEDOES, ROCKETS, BOMBS | HARPOON |

**Fig. 17 S-3A built-in growth potential.**

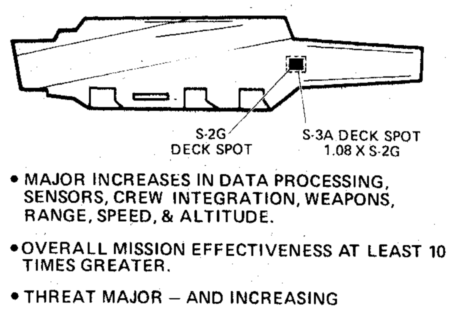


**Fig. 18 Summary.**

Long experience with ASW weapon systems led to the firm requirement for initial design of the S-3A with significant preplanned growth potential as summarized in Fig. 17. The maximum design gross weight, compared to the current operational gross weight, provides for 20% increase in payload. This allows for incorporation of additional advanced sensors, weapons, and systems as they become available. This can be done without modification to the existing S-3A structure. The initial fleet aircraft delivers with preplanned compartment growth volume to provide space for future equipment. Similarly, the basic electrical system has been sized to provide a minimum of 30% excess power to support future growth.

Provisions for the OMEGA navigation system and fleet satellite communications have been incorporated. The acoustic and central computer systems have been designed from the outset to facilitate adaptation to new passive array buoys and directional command active buoys in the future. Finally, the large twin bomb bays and two heavy external pylon stations are available for future weapons.

Together with an already tested airframe fatigue life and an engine just at the beginning of its application life, these preplanned growth features insure the S-3A of an active service life of 15–20 yr.

## V. Summary

In summary, the S-3A has been shown to offer major performance gains in all systems areas having significant impact on mission effectiveness. A measure of this capability is indicated in Fig. 18 for the S-3A which has a deck spot 8% greater than the S-2's, but an effectiveness increase of at least 10 times.

The gains in S-3A effectiveness are primarily attributable to the advanced data processing, sensors, and crew integration features which, in combination, comprise the central most important system capability in the S-3A. These additional capabilities, in turn, make it possible to utilize increased numbers of sonobuoys and additional weapons capabilities to further enhance effectiveness. Finally, the expanded range, speed, and altitude capabilities of the basic S-3 aircraft also contribute through increased mission radius, time on station, and payload for better defense in-depth coverage against the long-range missile threat.

The combined impact of these S-3A performance gains provides a significant new dimension in fleet airborne sea control. Despite this fact, the simple truth is that the current magnitude and continuing growth of the threat in the future gives ASW forces only a thin edge of superiority. As the threat continues to increase in the future, all of the built-in growth potential of the S-3A will be needed to keep pace with the trend. Improved acoustic and ESM sensors, expanded and refined software and data processing, and possible wide-band command and control, and remote data relay communications links are potential areas for significant performance gains and system growth.