

BEHIND THE SCENES OF AN AIR ASW MISSION

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Although its primary mission is air Antisubmarine Warfare (ASW), the U.S. Navy's P-3 Orion is often an integral part of a sea test or data acquisition exercise. As such, the aircraft often operates in conjunction with surface ships and submarines; and therefore, scheduling becomes a crucial part of the exercise. But planned schedules are often overcome by events and by technical decisions by personnel in charge, and therefore change. Typically, the assumption is made that the speed of an aircraft allows it great flexibility in the rescheduling process. However, what is not well understood by many participants are the constraints on the use of the aircraft which must be considered in the scheduling and planning process. This paper presents an overview of some of these constraints and describes what is involved in preparing a P-3 mission in support of an at-sea test exercise. It explains why several hours may elapse before an aircraft can be launched. It discusses aircraft and pre-flight requirements, aircrew size and qualifications, details of briefings, and real-world factors that affect missions. It is the intent of this review to provide a basic understanding of what is entailed in the preparation of a P-3 flight for an ASW field operation.

I. INTRODUCTION

The U.S. Navy's air ASW capability has been heavily borne, historically, by the P-3 aircraft. During the Cold War, this capability encompassed real-world missions, such as generally patrolling the seas from domestic as well as from overseas bases and specifically, tracking Soviet submarines. In addition, many ASW test missions were (and are) flown to support research and development programs and to conduct test and evaluation of new equipment and systems. Often, during the conduct of these missions, the aircraft works in conjunction with other assets—surface ships, submarines, and other aircraft. In coordinating the use of these assets, assumptions are made concerning the flexibility and response time of the supporting aircraft, and often decisions are made without an understanding of the process involved in launching and conducting an ASW mission.

This paper is offered as an aid to understanding this process. It is based upon the author's experience (which is admittedly limited to between 1,200 and 1,300 hours) as a project specialist in P-3 aircraft and is therefore oriented to that platform. However, even with the transition to the P-8, and the probable changes in the process, the concepts discussed will remain relevant.

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14. ABSTRACT Although its primary mission is air Antisubmarine Warfare (ASW), the U.S. Navys P-3 Orion is often an integral part of a sea test or data acquisition exercise. As such, the aircraft often operates in conjunction with surface ships and submarines; and therefore, scheduling becomes a crucial part of the exercise. But planned schedules are often overcome by events and by technical decisions by personnel in charge, and therefore change. Typically, the assumption is made that the speed of an aircraft allows it great flexibility in the rescheduling process. However, what is not well understood by many participants are the constraints on the use of the aircraft which must be considered in the scheduling and planning process. This paper presents an overview of some of these constraints and describes what is involved in preparing a P-3 mission in support of an at-sea test exercise. It explains why several hours may elapse before an aircraft can be launched. It discusses aircraft and pre-flight requirements, aircrew size and qualifications, details of briefings, and real-world factors that affect missions. It is the intent of this review to provide a basic understanding of what is entailed in the preparation of a P-3 flight for an ASW field operation.					
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II. THE P-3 AIRCRAFT

The P-3 airplane exists in a number of versions; the fleet operational version is outfitted with a number of different sensor types and payloads, while laboratory configured versions are fitted with equipment dedicated to specific studies, measurements, or research tasks.^{1,2} Figure 1 provides an image of an early model P-3.



Fig. 1 – P-3A in early paint scheme

The airplane is capable of staying in the air for a maximum of approximately 12 hours, depending upon the payload and the flight profile. However, some of this time must be reserved for emergencies, such as the need to divert to an alternative field should there be a problem at the primary field. [There are also minimum requirements (“On-Top” fuel requirements) on the amount of fuel an aircraft must have on board by the time it arrives on top of its alternate landing site]. In remote sites, such as Thule, Greenland, alternative fields which can safely handle a P-3 can be two to three flight hours away. Therefore, a flight is often planned for no more than about nine to 10 hours in the air. A heavier payload decreases the amount of air time by requiring greater fuel consumption per hour. In addition, flights which require the aircraft to operate at low altitudes consume fuel at a greater rate.

III. PERSONNEL AND REQUIREMENTS

The standard aircrew of a fleet operational P-3 consists of three pilots, two flight engineers, a navigator (who is also the radio operator or communicator), a tactical coordinator, two acoustic sensor operators, one radar operator (who also operates the infrared sensor, the magnetic sensor, and other electronic support measures), and one in-flight technician (IFT), for a total of 11 as an operational crew (in the past, there was an additional crew member, designated ordnance-man, but those responsibilities are now with an in-flight technician). During ASW test and evaluation missions, one or more project specialists (usually no more than three) are also aboard; Appendices A and B provide detail on the role of the project specialist.

Each member of the aircrew is assigned a primary location (or station), where, in general, the duties associated with that job are performed. The crew member must be at that station during take-offs, landings and, in case of emergencies, ditchings (hence they are called “ditching stations”). These stations include regular seats which are occupied by the on duty flight crew members, plus “jump seats” or floor spots. Each station is equipped with a restraint strap and a nearby parachute. The total number of official ditching stations is 23. Figure 2 shows the locations of ditching stations (based upon an older P-3 crew configuration).

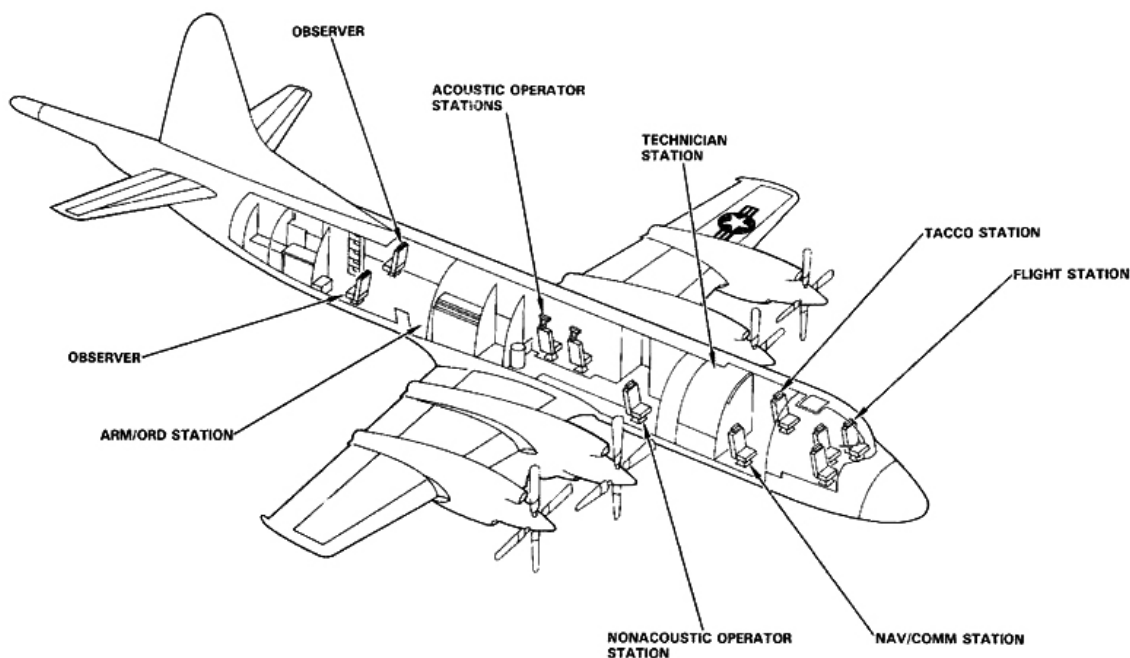


Fig. 2 – P-3 personnel stations

When a fleet aircraft is deployed to a base other than its home base, it often does so with its own maintenance crew of five to eight persons. This team prepares the aircraft for launch and maintains it after it lands. Thus, on a deployment, 17 to 20 of the possible 23 passenger slots (ditching stations) are occupied by aircraft personnel in transit. These numbers do not necessarily apply to specially configured aircraft.

Before an aircraft can take off, the flight crew must meet certain readiness requirements. First, each crew member must be authorized to fly via the successful completion of a physical examination as well as safety training on the use of survival gear and emergency procedures. [The requirements for flight certification are derived from the Naval Air Training and Operating Procedures Standardization (NATOPS) Program^{3, 4}]. In addition, on the day of the flight, each crew member must be healthy (free of sinus or congestion problems), must have refrained from alcohol for at least 12 hours prior to the pre-flight briefing, and must have been allowed to have had proper rest. Proper rest is usually defined as 12 hours, between the time the crew completes a debrief from one flight and starts the brief for the next flight. This rest period is a major factor in the planning of multiple flights. These rules apply to the projects representatives since they are considered part of the flight crew and can affect safety of flight.

IV. BRIEFING

A crew briefing is scheduled for at least three hours before the planned take-off; this means that at least 15 hours (12 + 3 for the pre-flight) may be expected to have elapsed since the end of the last debrief before the crew can participate in another flight.

The briefing is very elaborate. It consists of a formal presentation by one or more persons, each with a specialty. It includes a presentation by a meteorological or environmental specialist who provides standard weather information and, in the case of high latitude (such as the Arctic) operations, also provides information on ice types and coverage. The communications portion of the brief reviews a list of frequencies, and their alternatives, for the various aircraft systems;

it encompasses the spectrum from High Frequency (HF), Very High Frequency (VHF), and Ultra High Frequency (UHF), and includes procedures for using various secure communications. It also reviews the various call signs as well as the secure code words to be used on the various systems. Links with other aircraft, ships, satellites, and shore facilities are discussed, as well as the procedures for contacting each of those facilities, their call signs, and the timing of such contacts. In the case of the Arctic, ice camp radio frequency (RF) links are also discussed. Flight safety and emergency procedures are reviewed, along with any special circumstances associated with a particular mission.

Since one of the primary functions of fleet aircraft is the launching of acoustic devices, such as sonobuoys, an acoustic briefing is also supplied (See Appendix C for additional detail). Here, the nature of the acoustic signal propagation environment is reviewed and predictions concerning acoustic performance are offered. Radar and infrared system performance predictions are also presented. This is then coupled to a briefing by an intelligence specialist to provide information on the nature of non-U.S. ships, submarines, aircraft, and facilities that may be a factor in the mission.

Finally, the overall mission goals and objectives are presented. This is often a prelude to, or is combined with, the science briefing, given by the scientist, engineer, or project specialist in charge.

Thus, the entire multi-faceted briefing can easily consume more than an hour. Every flight, no matter how seemingly straightforward, undergoes this process to a greater or lesser extent.

V. FLIGHT PREPARATIONS

While the briefing is under way, the ground maintenance crew is preparing the airplane for the flight. (In harsh environments, such as the Arctic, the maintenance crew may have already been at the airplane for an hour or more, before the briefing has even started, to warm it up). The on-board auxiliary power unit has been turned on and electrical system checks are being performed. The maintenance crew is checking engine, oil, and hydraulic systems seals for leaks and proper pressure, and aircraft control surfaces and landing gear are being inspected.

After the briefings are concluded, each flight crew member tends to duties which are specific to that position. Pilots go to the base operations area and file flight plans, in accordance with U.S. and/or international regulations. (The navigator may also consult base operations for updated aeronautical charts and other pertinent navigation information.) The tactical coordinator (TACCO) and the navigator/communicator (NAVCOMM) are responsible for obtaining and controlling classified communication gear (Crypto equipment and codes); this is done through the local secure facility. The flight engineer, now having an idea of the operational constraints of the mission, goes to the aircraft to determine its flight readiness. The in-flight technician (who has now taken on the duties of an ordnance person) consults with the science representative or project specialist to determine the types and numbers of the various sonobuoys and other devices which are to be launched from the aircraft. In addition, the required channel, depth, and life settings on the sonobuoys for the mission are reviewed. This is especially important when more than one aircraft is involved, either to avoid interference or to ensure coordination. Then the appropriate deployables are obtained, transported from storage, and loaded aboard the aircraft.

By the time the rest of the air crew reaches the aircraft, many of the system warm-up procedures have been initiated, as well as pre-operational diagnostic checks. Often problems are found during this phase, even when the system had been operating properly during the previous flight. Some problems are easily solved, but some may require hours to repair or may result in the downing of the airplane (a declaration of the aircraft not being fit to fly until the problem is solved or equipment has been repaired or replaced).

All these checks take considerable time, and it is only when the launch of the aircraft appears likely that it is fueled, or topped off.

Then there is one more briefing to be conducted. Known as the “plane-side” brief, it is usually held in the roomiest area of the aircraft, near the port boarding door. Here, the final review of the mission takes place, and any pertinent announcements are made prior to preparations for departure, especially in terms of flight safety and emergencies.

When fueling is complete, the engines are started, one at a time, and functional checks of the engines and control systems are performed; this requires another 15 to 20 minutes to complete, and is done prior to and during, the taxiing phase. If all is in order, the aircraft may then take off, approximately three hours since the briefing started.

There can be one more step prior to take-off. If the mission includes the launch of hazardous deployables, such as SUS (officially: Signals, Underwater Sound), it must taxi to the “hot spot” to load such stores. These will have been delivered to that spot from a remote storage facility. This requires pre-flight coordination and planning. If this is not done efficiently, any delays may affect the take-off clearance window that has been issued to the aircraft, and this, in turn, can have a major impact on when the aircraft arrives at its intended operational station.

If factors affecting the nature of the mission have changed prior to take-off, then a decision might be made whether to continue as planned, delay the take-off, change the mission, or cancel the flight. This is critical. The aircraft can only be delayed a certain amount before the flight is cancelled (depending upon the nature of the mission and whether it affects other aircraft or the next planned flight for this particular aircraft and/or crew). A tolerable delay could be as much as six to eight hours. But it is not just the crew which is being affected; a fully loaded and fueled aircraft, sitting on the ground, is then undergoing large stresses, stresses which are more readily endured (and designed for) in flight. If the aircraft remains on the ground and the flight is cancelled, then it must be partially de-fueled. (This fuel is no longer re-usable since, by definition, it is now considered contaminated via the aircraft tanks.)

VI. POST FLIGHT AND DEBRIEFING

If all goes well, the aircraft performs its mission and returns six to 10 hours later. The maintenance crew meets the aircraft and begins the post-flight procedures; the aircrew and project specialists (or science crew) go to the operational control site for a debrief. This too is a formal process to review all aspects of the flight and to rate the performance of all crew members. The acoustic and non-acoustic sensor operators report to the analysis section where their data (historically recorded on magnetic tape systems aboard the aircraft) are played back and analyzed with highly sophisticated equipment. Some of the information obtained is relayed to the next aircraft about to launch, to an aircraft that may already be out in the operating area, and to the intelligence specialists for subsequent passing on. The classified communications gear is secured and a report is presented on how well (or effective) the communications were. Tactics are evaluated, and mission objectives are reviewed, and the scientific aspects of the flight are discussed with the project specialists. This debrief process is typically one hour in length. The crew is then dismissed and is advised when its next flight is to occur; if there is more than the minimum time, the crew members are relatively free to relax in their own way, keeping in mind the 12 hour rule concerning flight readiness. Thus it is very difficult to muster an aircrew much earlier than the planned time.

VII. OTHER FLIGHT PLANNING FACTORS

If the flight schedule is tight and there are several aircraft to be flown in sequence, then there is very little room for juggling flights. This is especially true if a particular airplane (because of its payload or special capabilities) is required to be at several different events in a planned sequence; it might be more desirable to cancel a flight rather than to delay one, due to the impact on the follow-on flights.

Another factor to be remembered is that aircrews are assigned to a specific aircraft; occasionally two separate crews will be deployed with one aircraft, but there is generally little or no mixing of crews from one aircraft to another. (There is

generally no mixing of aircrews from one squadron to another). This impacts some of the potential flexibility that might be assumed and must be taken into account when planning flights.

Flight operations are constrained by strict adherence to rules concerning weather and environment; such factors as snow, ice, wind, fog, and runway condition all affect flight safety. Flight operations can also be constrained by local rules concerning operations, flight hours, field personnel availability, and local union contracts with field support personnel. Such affects may be minimized by pre-deployment planning, but even then, the solution is usually dependent upon the amount of funds available to ensure that services are available to accomplish the planned missions.

VIII. SUMMARY AND CONCLUSION

Thus, when aircraft are assigned to support multi-purpose, multi-laboratory, and multi-service operations, these factors must be taken into consideration. This explains why it is extremely desirable to have a reliable communication link with various participants of a project, and why that link must be used to provide as much advance warning of scheduling changes as possible. The shorter the warning time, the more difficult it is to respond effectively.

Field test personnel who understand and adapt to the factors described above will be the most successful in achieving the goals of the mission.

Despite all of this, experienced personnel in operations planning and control, in maintenance, in the flight crews, and in the scientific staff, can accomplish very productive and worthwhile exercises.

As the Navy transitions to the P-8 (shown in Fig. 3), many of the factors presented above will remain as points to consider—even though specific details may change.



Fig. 3 – U.S. Navy P-8

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Arthur W. Horbach has over 45 years working for the Navy Laboratory community in the research and development of undersea systems, primarily in the field of underwater acoustics. His work encompasses a broad spectrum of acoustic systems: passive and active sonobuoys (and arrays), geobuoys, acoustic communications, transponders, ocean bottom penetrating systems, side-looking sonars, obstacle avoidance sonars and imaging systems. He has extensive experience in maritime patrol aircraft, accumulating over 1200 hours in flight as a project specialist, contributing to the development of a number of air deployable sensors. His field experience also includes helicopters, surface ships, submarines and deep diving submersibles. In the airborne Arctic sensors program, he has participated in over a dozen field expeditions to the Arctic. Dr. Horbach has the Bachelor and Master degrees in Electrical Engineering and the Doctorate degree in Acoustics from The Pennsylvania State University. He has taught physics at the College of New Jersey and oceanography short courses at George Washington University, The Pennsylvania State University and the United States Naval Academy. He is a member of the Acoustical Society of America, the Institute of Noise Control Engineers, and the Sigma Xi Scientific Research Society. He is currently a senior systems engineer at Navmar Applied Sciences Corporation.

Appendix A**THE AIRCRAFT PROJECT SPECIALIST ROLE IN R & D MISSIONS**

The U.S. Navy's P-3 is a very capable test and evaluation tool; it provides a realistic platform for research and development testing. But the success of an aircraft performing an ASW Research and Development (ASW R & D) mission is extremely dependent upon the effectiveness of a project specialist from the R & D community, who provides the scientific and engineering link to the operational fleet.

To be effective, the project specialist must succeed in a variety of capacities. The project specialist must:

1. Successfully complete NATOPS training and approval for flight
2. Observe all the flight regulations, requirements, and restrictions on the aircrew members
3. Be an informed, adaptable, and physically capable field director and participant
4. Be willing and able to be subjected to the conditions of deployment and testing, the irregular hours, and the discomforts of flight in rough weather and in hazardous conditions
5. Know the roles of all the crew members
6. Attend and be part of the pre-flight briefing (as well as the post-flight debrief)
7. Be able to prepare the test plans and present them not only to the engineering and scientific staff of his laboratory but also to the military personnel at both the officer and the enlisted level to ensure that the desired objectives are clearly defined and capable of being met
8. Be intimately familiar with the technical as well as the operational and programmatic aspects of the equipment or systems under development
9. Be responsible for any project installed equipment and recording needs (including tapes for tape recorders)
10. Know how project equipment or systems interface with the aircraft and its systems
11. Know what the aircraft is capable of (flight characteristics, duration, requirements, constraints, etc.)
12. Know how the aircraft systems can provide the information and assistance needed to accomplish the testing and evaluation
13. Review any special audio monitoring that may be desired during portions of the sonobuoy deployments and data acquisitions
14. Know how the receivers and processors accept reference information and how it is used aboard the aircraft, especially in the case of applications of remote sensors, such as sonobuoys
15. Ensure the RF channels in the receiver are properly dialed in and checked [such as the preferred Advanced Sonobuoy Communications Link (ASCL) settings], working with Sensor Station 1 and 2 personnel (note that presently, the ASCL has been replaced with the Software Defined Sonobuoy Receiver)
16. Review any special visual monitoring (as well as radar tracking) requirements of Sensor Station 3 personnel
17. Be able to provide the TACCO with recommended stores deployment plans and advise him of any special requirements of the crew during the flight
18. Be aware of concerns that the TACCO and pilots have concerning the flight as it evolves
19. Be interconnected with the decision making process aboard the aircraft (be on head-set throughout the flight)
20. Be familiar with the call signs of participating platforms in the event that communications with these platforms during portions of the mission might be required
21. Be aware of all that is occurring during the flight (as well as before it)
22. Stay ahead of problems by anticipation and planning and by obtaining in-flight updates of conditions that may affect the mission

23. Be prepared with alternative plans for contingencies, such as flight delay, cancellation, en-route equipment failures, delay or non presence of a participating auxiliary platform
24. Be willing to assist the in-flight technician during the loading process (previously performed by an ordnance person), ensuring all sonobuoys have been pre-set properly and loaded into the preferred sonobuoy chute positions
25. Be prepared to be responsible for unloading, transporting, and when appropriate, securing classified recorded data and recording media
26. Be responsible for arranging to ship the recorded information to its ultimate destination (especially complicated when dealing with classified information)
27. Provide feedback to the aircrew at the debrief from the project specialists point of view—what went well, what did not—and as appropriate, to thank the crew for its assistance

These suggestions are derived from the author's experience in P-3 aircraft, are far from complete, and are only offered as a guide for the role of project specialist. With the introduction of the P-8, many of the tasks listed above will remain applicable, but new issues associated with this new aircraft will have to be accommodated.

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Appendix B

A SHORT GUIDE TO A PROJECT SPECIALIST CHECKLIST FOR AN AIR ASW MISSION

Long Range Planning

Test Plan
Personnel Contacts
Coordination with Support Base (Wing, Squadron, Aircrew, Station Weapons)
Personnel Flight Qualifications
Clearances
Flight gear (Suit, Shoes, Gloves, Helmet)
Project Equipment Preparation and Shipment (Lead Times)
Transportation and Lodging Arrangements

Special Equipment Installations

Flight Certification Approval
Checkouts

Briefing

Hard Copies
Slide Presentation

Pre-flight and Warm-ups

Deployables Loading
Support Deployables Checkout (with IFT) (Settings Checkout)
Special Instructions to Pilots, TACCO, NAV/COMM, Sensor Operators
Distribute Project-specific Pre-Formatted Data Sheets
Documentation and Data Logging Requirements
Receiver Channel and Processing Channel Reference Sheets
Receiver Connections and Settings Pre-loaded
Equipment Turn-on and Checkouts

In-flight

Operations Monitoring (on Headset)
Data Logging
Support to TACCO (Stay ahead of the curve)

Post Flight

Attend Debrief
Acquire Reference Data (Logs, etc.)
Dismantling of Project Equipment
Shipping Arrangements (Equipment, Logs, Data)
Quick Look Report Preparation

Long Range Follow-ups

Wrap-up Correspondence
Closure with Support Base
Post Test Analysis and Reporting

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Appendix C

THE ACOUSTICS ASPECTS OF AN AIR ASW MISSION

The Briefing

As mentioned in the text, an elaborate crew briefing is scheduled for at least three hours before the planned take-off. Part of this briefing is conducted by an acoustics specialist; this may be tied in with the meteorological briefing.

The overall mission goals and objectives are presented. This is often a prelude to, or combined with the science briefing, given by the scientist or engineer in charge. Specific aircraft duties will then be specified. Required sonobuoy load (interior and exterior) will be specified along with all sonobuoy settings, including RF channels. Unconventional deployables will also be discussed as well as how they would interface with, or affect, conventional deployables. Timing coordination, flight profile, and duration will also be included.

An oceanographic briefing is provided. Based upon data base information, characteristics of the ocean are presented. Historical sound speed profiles (based upon historical temperature profiles) are presented for the operating area. When available, bottom topography information is presented. These features will have been input to a computer model program and acoustic propagation plots will have been generated. This oceanographic information would be related to the mission to estimate the acoustic detection ranges to be expected. These estimates are then used to suggest sonobuoy types and settings to be used, as well as a recommended sonobuoy load and deployment pattern with attendant spacing between sonobuoys. For active acoustic operations, waveforms will also be recommended.

The possibility of encountering unknown acoustic sources (intruders or other target threats, and therefore their characteristics) is discussed and specific acoustic signals to look for will be identified.

If the mission includes relieving an aircraft that might already have been on station, then updated environmental information [such as from deployed Air Expendable Bathothermographs (AXBTs)] may be available and presented. In addition, actual achieved detection range information may also be available; and if a target has been identified classified, details would have been relayed back to the Tactical Support Center (TSC).

Observed target behavior would also be reported as part of a threat assessment. (This would then be coupled to a subsequent briefing by an intelligence specialist to provide information on the nature of non-U.S. ships, submarines, aircraft, and facilities that may be a factor in the mission.)

Preparations

After the briefings are concluded, the tactical coordinator (TACCO) will include this information in the flight bag, and when aboard the aircraft, the sonobuoy load information will be placed into the computer. This would eventually be verified with the actual load.

The acoustic sensor station operators prepare for the mission by inputting receiver channels and tracks into the receivers and will cross check this with the TACCO.

Again, as mentioned previously, the in-flight technician reviews with the science representative, or project specialist, the types, numbers, and settings of the various sonobuoys and other devices which are to be launched from the aircraft. The appropriate stores are then obtained; set for their required channel, depth, and duration (life); loaded aboard the aircraft; and confirmed with the TACCO.

During the Mission

During the mission, the TACCO works with the pilots and navigator to ensure arrival at the specified location and that the deployments are executed as planned. Often the TACCO will launch an AXBT to determine if the expected sound speed profile is still valid. If necessary, the planned sonobuoy pattern would be updated as well as each of the depth settings (when and if possible) to ensure maximum detection ranges can be achieved.

Prior to departing station (as well as one or more times during the mission) the NAV/COMM will inform the TSC of mission progress and any pertinent discoveries that may affect either follow-on flights or the immediacy of the results of the mission.

If there is to be a relieving aircraft (turnover), much information is passed to the arriving aircraft. Details of deployed fields and the characteristics of all sensors in the field are relayed via an RF link directly to the computer, so that this fresh aircraft is able to reap the benefits of the earlier flight and then make an informed decision as to what the next best action would be.

Debrief

When the aircraft returns to base, certain members of the flight crew attend a debriefing. This includes delivering data (historically, these were data tapes for subsequent replay and analysis—the crew gets evaluated on how well it performed in flight based upon what is discovered on the tapes). Pertinent information is presented on the effectiveness of the pattern, details of the sonobuoy detections that were made, and specifics of target behavior.

Some of the information obtained is relayed to the next aircraft about to launch, to an aircraft that may already be out in the operating area, and to the intelligence specialists for subsequent passing on.