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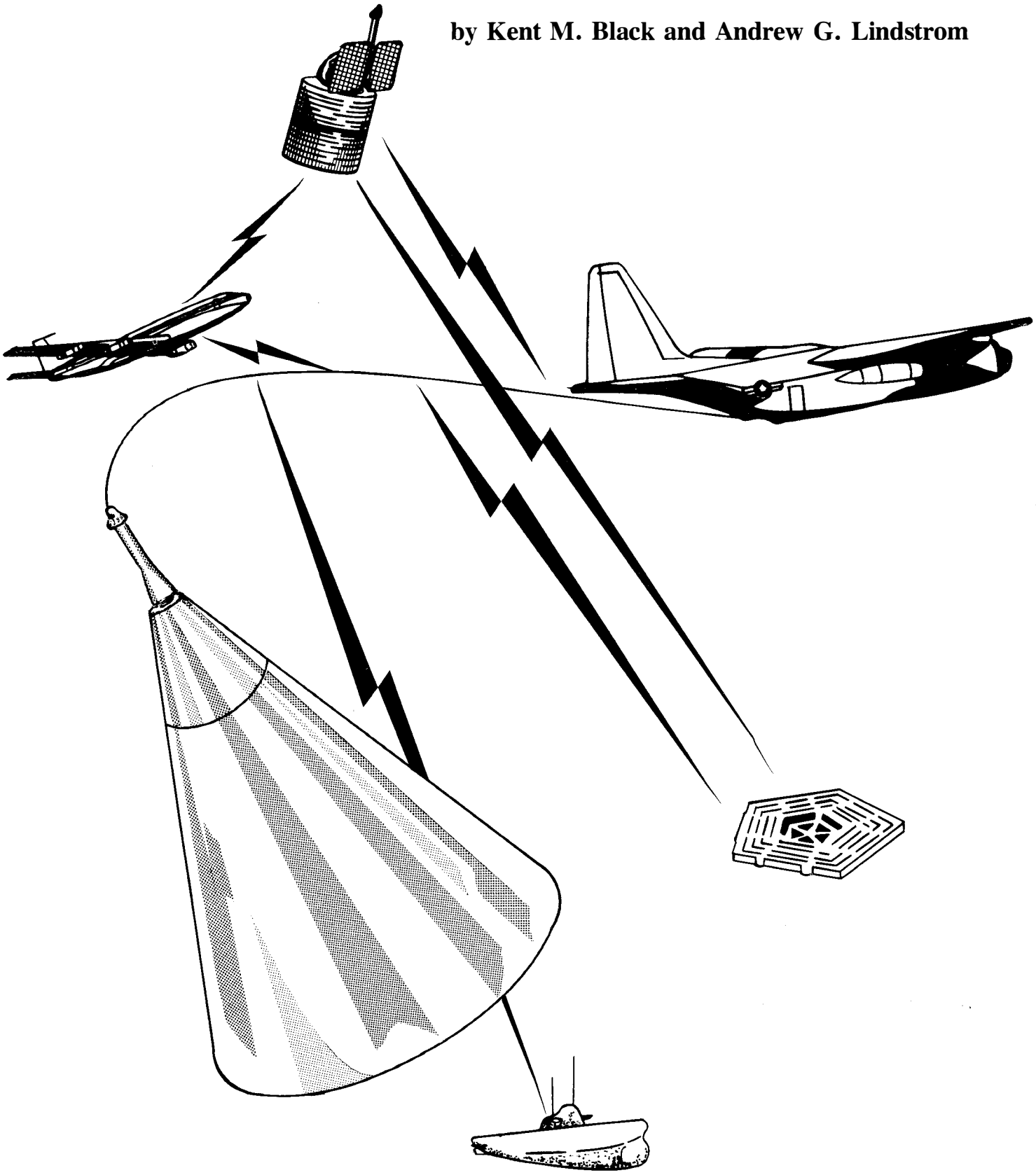
TACAMO: A Manned Communication Relay Link To The Strategic Forces

TACAMO

by Kent M. Black and Andrew G. Lindstrom



"THERE HAVE BEEN no brass bands for the U.S. Navy's VQ-3 and VQ-4 Squadrons . . . no glowing reports of singular accomplishments, missions or heroism," a Navy Commander recently said.

Yet, he pointed out, these two squadrons provide the only around-the-clock airborne VLF communications relay system to ensure that the Commander-in-Chief will always be able to communicate with his deployed strategic submarine forces.

This airborne communications relay system is commonly referred to as TACAMO. Not surprisingly, the question most frequently asked about the squadrons concerns the origin of the word TACAMO.

The name is an acronym derived from the challenge to "Take Charge And Move Out." The dedication and professionalism exhibited by the men who fly the missions and others who support TACAMO, and the record that they have compiled in terms of mission accomplishment, have proven that TACAMO lives up to the challenge by day and by night on a continuing basis.

The complex TACAMO communications system, developed for the Naval Air Systems Command by Rockwell International's Electronic Systems Group, is incorporated in a specially modified Lockheed C-130.

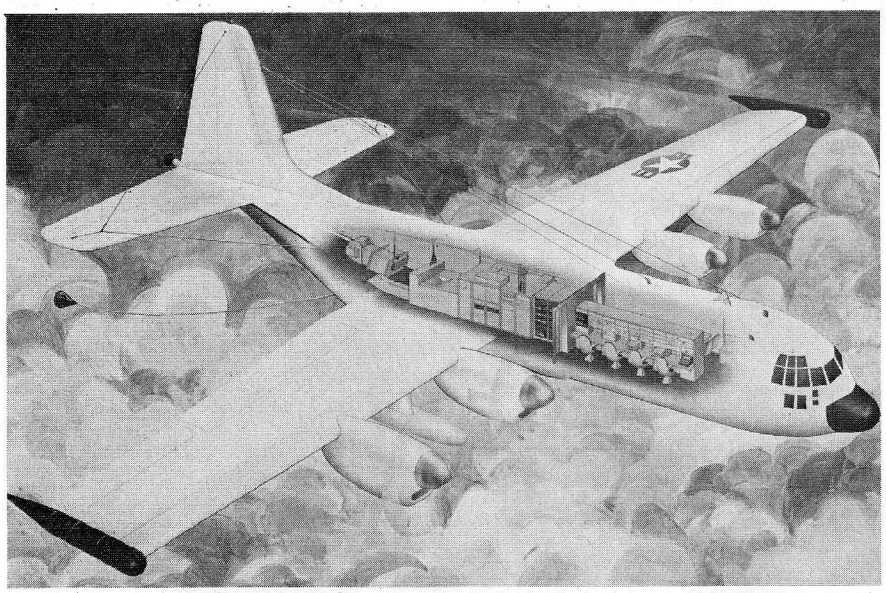
TACAMO is a manned communication relay link to strategic forces. Generally, TACAMO passes communications only one way—from the National Command Authority or other sources (uplink) to the submarines and other strategic forces (downlinks).

TACAMO is a component of the Minimum Essential Emergency Communications Network (MEECN) which operates with other DoD systems.

There are several redundant uplinks from the ground to the TA-

TACAMO crew members in the Communications Central receive, analyze, process and transmit messages over the frequency range from VLF to UHF.

The TACAMO system provides the communication link between the National Command Authority and various command souces with the nuclear submarine forces via a five-mile training wire antenna and drogue. The orbiting C-130 aircraft permits the required antenna verticality to be achieved.



Major components of the TACAMO system are the Communications Central (far right), the VLF Power Amplifier and Antenna Coupler (center) and the VLF short and long trailing wire antenna system (at the rear of the aircraft).

CAMO aircraft on frequencies ranging from VLF through UHF. All uplinks may transmit the same message to ensure proper reception.

The TACAMO system was developed in 1962 to meet an increasing requirement for survivable communication between the Command Forces and nuclear submarines capable of launching Polaris and Poseidon missiles.

Today, a complete communications center is installed in all of the TACAMO aircraft, permitting simultaneous receive and transmit throughout the frequency range from VLF to UHF.

TACAMO receives multiple frequency low level signals while simultaneously transmitting at high power in a stressed environment—a significant contribution to MEECN.

Major components of the TACAMO system are the Communications Central and Receiver/Transmitter Group, the VLF Power Amplifier and Antenna Coupler, and the dual, VLF short and long trailing wire antenna system.

Communications Central

The Communications Central provides the following system assets which are message processor—or time division multiplex—controlled from four operator positions:

- VLF transmit and receive systems
- HF and UHF receiver/transmitters, modems and controls
- TACAMO Message Processing System
- Communications Security Devices
- Interior Communications Systems
- Ancillary Control and Monitor equipments

TACAMO receives and demodulates uplink messages using various types of modulation over the following range of frequencies in either encrypted or non-secure mode:

VLF—Spread-spectrum MSK, FSK, CW
HR—Voice, FSK, CW
UHF—Air Force Satellite Communications System
—Fleet Satellite Communications System
—LOS voice

Received messages are input into the TACAMO Message Processing System for automatic message security and priority recognition, classification, formatting, display, text editing and storage. By use of the computer-aided display/keyboard terminal, the aircraft Communications Officer controls the routing and transmission of messages to the selected VLF/HF/UHF transmitters.

For downlink relay, messages are routed to the VERDIN transmit terminal for anti-jam MSK coding and modulation, and security encryption.

VLF Power Amplifier

The VLF Power Amplifier provides amplification of the VLF transmit signal to 200 KW average power and autotune coupling of the high-power signal to the dual trailing wire antenna system. The vertically polarized signal is transmitted to the submarines with the C-130 flying in a continuous tight turn. This allows the antenna to hang vertically from the aircraft.

In peacetime, communication with the submarine is augmented through the use of shore stations transmitting in the VLF range.

VLF was chosen for these shore stations because of three distinct advantages. First, and most important, is its ability to penetrate sea water efficiently, to enable a submerged submarine to receive radio transmissions.

Secondly, it has extreme long range capability and, in fact, has been propagated around the world. Lastly, VLF can penetrate even severe atmospheric disturbances and is, therefore, reliable under all seasonal conditions.

Because shore stations are vulnerable sites, it was determined that an alternate means of communication on VLF was necessary to ensure reliable communications with the strategic submarine fleet. Navy researchers considered several alternate airborne VLF systems.

Helicopters were studied, but they lacked the power or stability necessary to maintain the altitude needed to carry the 20,000 lbs. of communications electronics and to trail a wire antenna from 10,000 to 35,000 feet long required for VLF transmission.

Researchers even considered blimps but they couldn't reach the required altitudes and proved to be too slow and cumbersome.

Finally, the decision was made to use fixed-wing, multi-engine aircraft because they had the power to carry the equipment and antenna to the necessary altitudes.

Initial experiments at the Naval Air Development Center in 1962 demonstrated the aerodynamics of a trailing-wire antenna system. In May 1962, the Bureau of Naval Weapons awarded a contract to

Collins Radio Company (which in 1973 merged with Rockwell International) to prove the feasibility of extending and retracting the antenna and of radiating significant power in the 14 to 30 KHz VLF range.

TACAMO I

Five months later, flight testing of the completed communications system began. In December 1962, TACAMO I was delivered to the Naval Air Test Center at Patuxent River, MD.

TACAMO I electronics were packaged in three mobilized shelters or vans that could be readily loaded on and off the C-130 allowing the aircraft to be returned to its cargo configuration.

The first van contained operator positions, transmitter controls, HF and UHF transceivers, receivers for VLF, LF, HF, and provisions for transmitting FSK and CW signals.

The second van contained a high power VLF transmit amplifier and antenna impedance-matching unit. The choice of a linear tube-type power amplifier permitted use of low-level RF filtering, thus making possible simultaneous VLF reception while transmitting. The antenna coupler was designed to automatically compensate for inflight variations of antenna impedance.

The third shelter housed the antenna and reeling mechanism. Weighing 10,000 lbs. the reeling mechanism provided for the deployment and retrieval of 35,000 feet of copper-covered steel wire at high speeds.

TACAMO II

Following a successful demonstration and flight testing in the Lockheed C-130 Hercules of the TACAMO I system, the Bureau of Naval Weapons in 1964 awarded a contract to Collins for the development of TACAMO II. This system proved the operational value of airborne VLF communication.

TACAMO II was functionally similar to TACAMO I, but was redesigned for improved capability and reliability. The TACAMO II system included an expanded communications central, a separate high-power VLF power amplifier unit, and improved antenna reeling mechanism with dual electric drive systems, each individually capable of extending and retracting the 35,000 foot antenna.

TACAMO II systems were operational from 1964 through 1968. By 1966 they had demonstrated such a high degree of reliability and effectiveness that the Navy initiated the development of a third generation system.

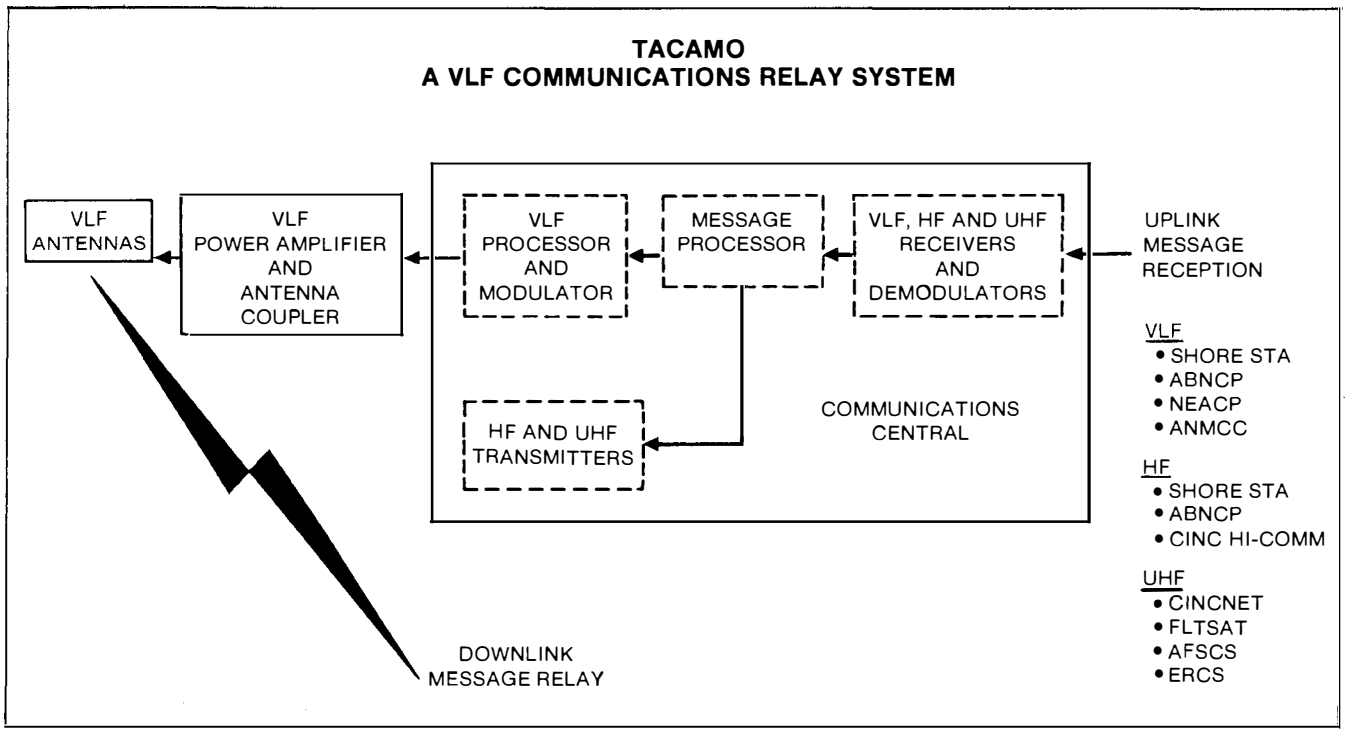
TACAMO III

In April 1967, the Naval Air Systems Command awarded a contract for the development of the TACAMO III system (AN/USC-13). TACAMO III consisted of eight new EC-130Q Lockheed airplanes and communications systems, as well as an upgrade of the four TACAMO II systems to the new configuration. This system, unlike its predecessors, was integrated into the airframe of a dedicated mission aircraft, which allowed a substantial reduction in system weight while providing improved crew station operability and comfort.

Numerous advances in system design were incorporated in TACAMO III, which resulted in increased mission reliability, operational efficiency, mission duration and compatibility.

Recognizing the need for higher VLF radiated power and lower VLF antenna deployment time to enhance communication and operational capability, the Naval Air Systems Command contracted to demonstrate the feasibility of a very high power (200 KW) VLF transmitter and high speed deployable dual trailing-wire antenna system. In 1971, Collins received a contract to incorporate a very high power VLF amplifier and a dual trailing-wire antenna system into the 12 existing systems.

Additional generators were in-



Fleet Air Reconnaissance Squadrons Three and Four (VQ-3 and VQ-4) operate and maintain the Navy's TACAMO technologically advanced communications system.

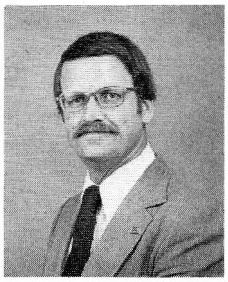
corporated in the aircraft engines to provide the increased power required. This system, called TACAMO III, has been further updated to the current system level by the addition of TDM control, message processing and other system enhancements.

TACAMO IV

This TACAMO IV system has been updated to the current system level previously described.

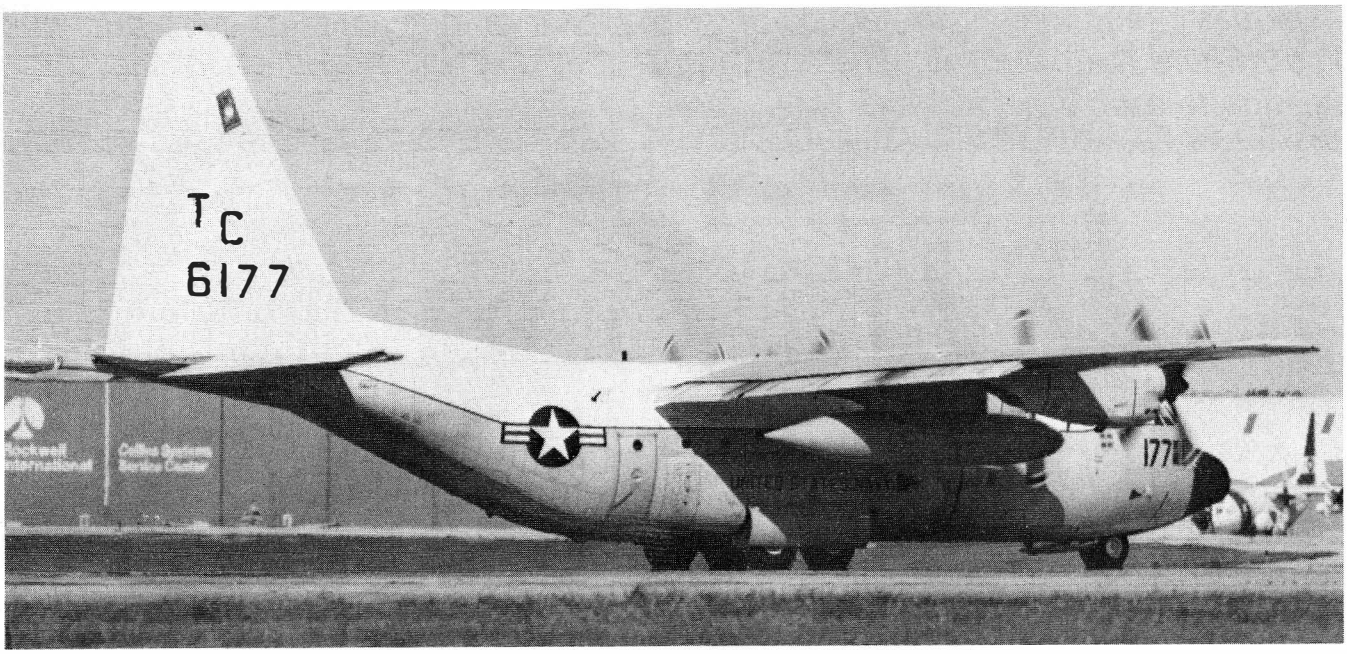
Normal flight operations for the TACAMO squadrons involve crew deployments throughout the North Atlantic and the Pacific regions. Flights are scheduled from various bases each day to ensure that there will always be a TACAMO aircraft airborne.

Dr. Gerald Dinneen, Assistant Secretary of Defense for Communication, Command, Control and Intelligence, recently commented on the TACAMO Program in written testimony to the Defense Appropriations Committee. "The need to maximize the covert nature of TACAMO operations and the methods to reduce the aircraft's vulnerability to detection are recognized and practiced . . . The problem of avoiding a stereotyped pattern is recognized and fleet commanders routinely review this risk to preclude and minimize its occurrence."



Kent M. Black is Vice President and General Manager of the Collins Telecommunications Systems Division of Rockwell International's Electronic Systems Group. He received a B.S. degree in Electrical Engineering at the University of Illinois. Mr. Black was appointed to his present position in 1976. Previously, he served in a number of other key management posts with Collins, which merged with Rockwell in 1973. His assignments included Director, Government Telecommunications Division/Satellite Communications Systems; Program Director, Satellite Systems; and various engineering management positions in ultra high frequency design equipment engineering.

Andrew G. Lindstrom is TACAMO Programs Manager at Collins Telecommunications Systems Division of Rockwell International's Electronic Systems Group. Since joining Rockwell in 1962, Mr. Lindstrom has served in various management positions. He assumed his current responsibilities at the division's Airborne Systems Center at Dallas Love Field in 1973. During a four-year assignment with the U.S. Navy, he served as an electronics technician. Prior to joining Rockwell, Mr. Lindstrom was a Branch Manager for Remington Rand Univac.



The complex system integration aboard the Lockheed C-130 TACAMO aircraft is performed by Rockwell-Collins at its Airborne Systems Center in Dallas, TX.

The 12 TACAMO systems are deployed for up to two weeks duration with daily missions lasting 10½ hours. The crews remain on an alert status ready to launch within 15 minutes of notification, even during rest periods between missions.

The TACAMO aircraft, like a ship at sea, must carry a crew to not only operate but to maintain the electronics and airframe during these extended periods of deployment.

A typical crew of 15 includes pilots, navigators, a communications officer, flight engineers, radiomen, avionics technicians, metalsmiths and aviation electricians. More than 1,000 officers and enlisted personnel are assigned to the TACAMO squadrons.

Working with a base of only 12 aircraft throughout the world, which fly more than 135 hours per month, requires a mammoth around-the-clock maintenance effort to maintain the required high availability.

Summary

The performance of the TACAMO Program has ensured its role in the Naval Communications System, and the Navy is continuing to expand its TACAMO fleet. Existing aircraft will be replaced as they reach the limit of their service lives.

Additionally, the deployment of the Trident to the submarine fleet will also require an expanded TACAMO fleet. According to a 1977 Navy staff study, "The deployment of Trident will significantly increase the importance of assuring communications capability against an enemy pre-emptive attack and impose new requirements for the TACAMO aircraft.

"No system is currently in existence or under development which can be considered as an acceptable replacement for the TACAMO aircraft system in meeting the current Navy requirement," the study stated.

In written testimony submitted to the Defense Appropriations Committee, Vice Admiral Robert Kaufman, Director of Navy Command, Control and Communications Programs, said the "lack of adequate TACAMO force levels has been a long standing problem."

The TACAMO link is extremely critical to the nation's vital MEECN resources. The successful operation of the high technology system in this difficult operating environment has proven that airborne VLF systems will continue to fulfill a vital role for years. Present plans for fleet expansion will allow TACAMO to meet the MEECN requirements.

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