



**TACAMO Briefing  
for  
Southeastern Pennsylvania  
Cold War Historical Society**

**8 February 2024**

# Agenda

- **Program initiation**
- **Proof of Concept**
- **Prototype**
- **Early Operations and Fleet Testing**
- **Continual Upgrades/Tech Application**
- **NADC continuing legacy**
- **Future Outlook**
- **Pax Museum**
- **Questions**

# TACAMO and The Cold War

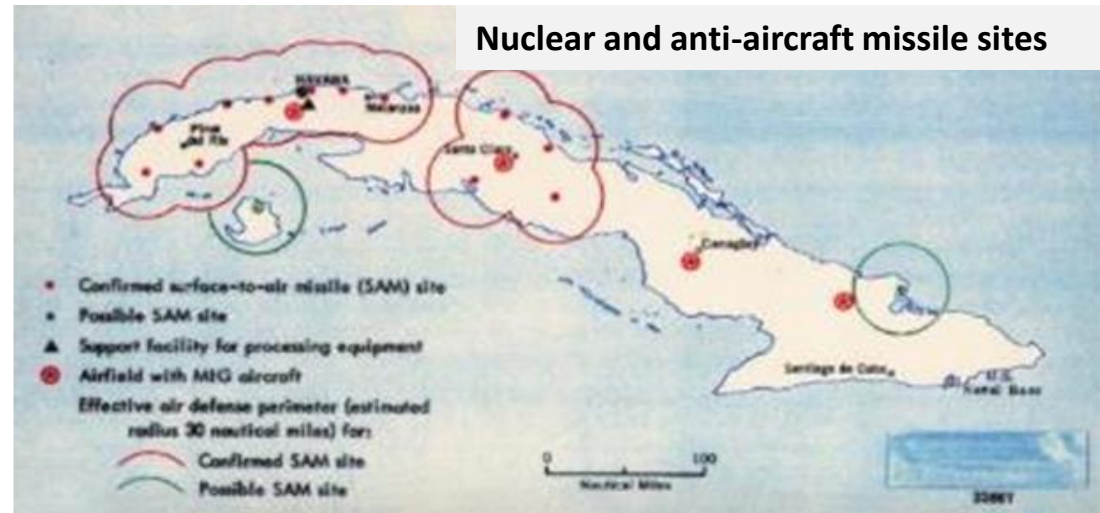


**JFK vs Khrushchev**



- **Dateline 1960**
- **US and Soviet Union in a stalemate after WW II**
- **Russia does not return territory overrun in WW II. Walled off Berlin.**
- **Iron Curtain keeping former East European nations under control**
- **US attempting to export democracy as best counter to communism**
- **Soviet leader Khrushchev –“We will bury you” = We will conquer USA**
- **JFK at Berlin Wall- “I am a Berliner” = I am held captive by Soviets**

# Cuban Missile Crisis



- **Russian nuclear missile sites discovered in Cuba in 1962– capable of striking DC**
  - **Cuba had aligned with Russia as first Communist state in the Americas**
  - **US options: Surgical airstrikes – Invasion of Cuba – Naval Blockade**
  - **Blockade ‘Quarantine’ set up until missiles withdrawn**
  - **Russians shot down a U-2 recon flight, not backing down**
  - **Defense Condition 2 declared. Near wartime posture. Strategic nuclear bombers on alert**
  - **Russians denied presence until photos shown in UN General Assembly**
  - **US President’s letters with Soviet leader reach compromise- missiles withdrawn**
  - **Hotline between Kremlin and White House installed for leaders’ talks**





# ***Proof of Concept Airborne Very Low Frequency***



- Naval Air Development Center Warminster PA project March 1962 start
- Test Pilot LCDR Walt Reese 'rescues' derelict WV-121 from Pax River rearward flight line
- Flown to NAS Johnsville where weather/Airborne Early Warning gear removed
- Very Low Frequency antenna on 'winch' installed and flown in Atlantic coastal areas
- Navy Site Chincoteague monitored, tracked on radar, and coordinated with 121 on signals
- Verticality, orbit, CV battle group avoidance, weather impacts etc learned
- **Walt's video:** [History of Navy's TACAMO \(youtube.com\)](https://www.youtube.com/watch?v=...)

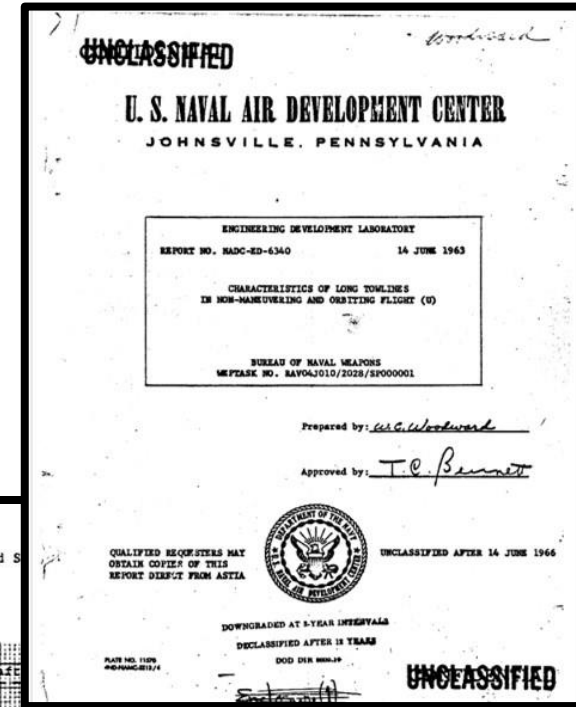
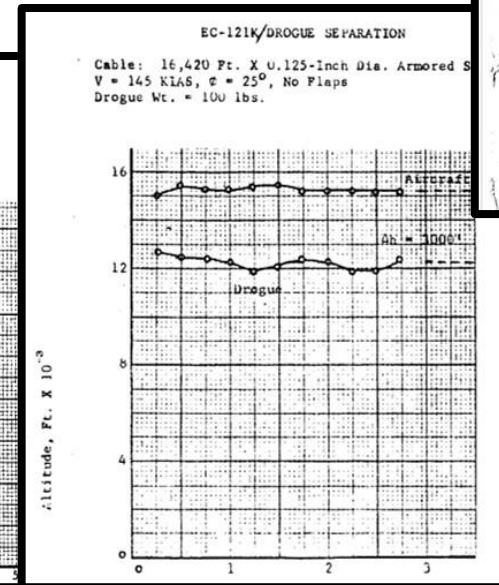
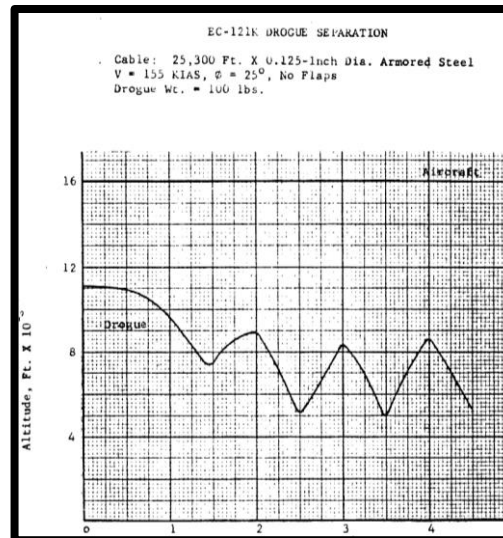


## EC-121 Ops Lessons Learned - 1962

- Orbit required to achieve VLF TWA verticality
- More V=More Signal strength
- Don't fly TWA in strong wind shears
- Avoid transmission near thunderstorms and icing
- Use moving block of air space if TWA won't retract
- Guillotine needed to separate TWA when unable to retract
- Avoid Carrier Battle Group operating areas

# Tactics Development -The WV-121 Data

- Project Engineer Leo Markushewski - Led feasibility designs, installation and tests
- VLF feasibility determined in early flight tests with one antenna - WV- 121 aircraft
- Orbit technique to increase verticality, stall the wire, increase range
- Drogue designs established= wire oscillation dampening with drag increase
- Stable wire = Stable signal
- Wire analysis/changes to reduce antenna drag/increase tensile strength
- Extension speed/orbit entry were major challenges
- Tactics adapted for use with C-130s
- Continued development work DTWA system



# TACAMO Genesis

- **TAke Charge And Move Out – direction given to LT Jerry Tuttle Tuttle (made acronym)**
- **Create reliable and assured command and control for Navy nuclear deterrence forces**
- **CNO's "Number One Priority" project – assured connectivity to SSBNs**
- **Classified Top Secret – Known only as CNO #1 Priority**
- **LT Jerry Tuttle (later VADM in charge of all Navy comms) selected to lead**
- **A-4 Attack pilot, just completed comms engineering at NPGS Monterey**
- **Assigned to OPNAV 941- Sub Comms office in Pentagon**
- **Director of Navy Comms RADM Roeder briefed the need and urgency**
- **Told LT to "Take charge and move out"-**



Jerry Tuttle – Father of TACAMO –

Guest Speaker at Wing Commissioning

- Boot camp in 54, Aviation Cadet in 56, Wings in 57
- NPGS Comm Engineering 1962
- OPNAV 94 1962-1965- TACAMO Project Leader
- Viet Nam- A-4 Skyhawk – DFC and Air Medals
- CO tours- Attack squadron supply ship, aircraft carrier
- Commander Carrier Air Group then US 6<sup>th</sup> Fleet
- JCS J-6 Comms Director, later OP 94 Director Navy Space/EW

# First Four TACAMO Aircraft

- Bureau of Weapons (BUWEPS) Lyle Bercier given responsibility to support CNO's Number 1 Priority project
- Meets with VADM Jimmy Thach in OPNAV Pentagon
- Directed to go to Marietta Georgia Lockheed plant
- Takes over control of 4 USAF C-130s on the assembly line
- First 4 aircraft, C-130G aircraft given Navy BUNOs -late 1963



- **New Navy tail numbers- BUNOs- 151888-891**

Lockheed serial #

3849  
3858  
3871  
3878



Air Force Serial #

63-7782  
63-7790  
63-7804  
63-7808

Navy BuNo

151888 - **VQ-4- Dec 63**  
151889 - **VQ-4- Dec 63**  
151890 - **VQ-3- Dec 63**  
151891 - **VQ-3- Jan 64**



**Lyle Bercier**

- Machinist Mate Manila Bay 7 Dec 1941
- Survived Japanese sinking his ship
- Sailed motor launch boat to Australia
- Senior civilian in BUWEPS

**VADM Jimmy Thach**

- CNO's Aviation Director
- WWII VF-3 CO aboard USS Lexington
- Invented fighter tactic- Thach Weave
- 6 victories at Battle of Midway
- Founded WW II version of TopGun

**JFK's priority to initiate the system is executed by WW II heroes**



# ***TACAMO I: Prototype***

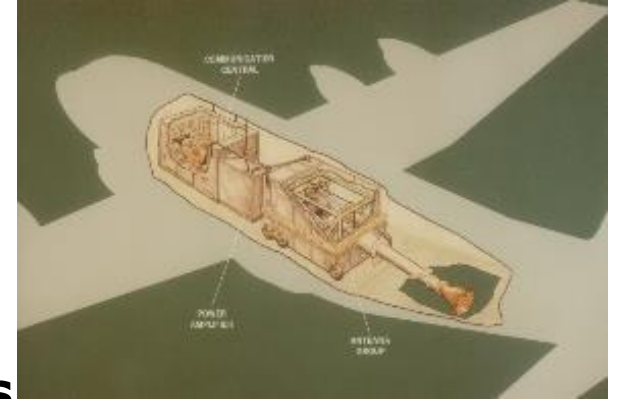
- **Program goal: Create reliable alternative to fixed submarine VLF broadcasts until large array, mid-CONUS Extremely Low Frequency (ELF) was ready**
- **Collins Radio, Dallas, contract March 1962**
- **TACAMO I installed in borrowed KC-130F 148806 at Addison Field**
- **Modular Roll On/Roll Off with three vans - Operators and radios, power amplifier, antenna reel/wire- 25 KW – single TWA – 35,000 ft of wire**
- **Van based concept developed to conceal true mission allow aircraft use for transport duties**
- **Fly off to Pax River in November 1962**
- **LT Tuttle flew as director in remote South Atlantic/Pacific areas, testing VLF propagation**
- **NADC/NAVAIR engineers, flight crew, small mission crew, and Collins technicians**
- **2-3 thousand NM ranges achieved reaching submarines, sub tenders, and variety of fixed sites**



# ***Operational TACAMO Systems***

## **TACAMO II – Production version of TACAMO I - 1964-1968**

- **EC-130G- 25 KW VLF power output**
- **35,000 ft Trailing Wire Antenna (TWA)**
- **50 KVA aircraft generators**
- **3 Roll On/Roll Off vans - Comm/Power Amp/Reel**
- **LARGELY used to prove out VLF and match opareas to sub opareas**
- **Installed at Collins then flown to TACAMO Detachments – VR-21 Hawaii and VR-1 Pax River**



## **TACAMO III – Improved and Integrated systems – 1968-1974**

- **Installed on new EC-130Q aircraft – 156XXX series – “H” models**
- **Single wire TWA**
- **25 KW VLF output power**
- **Mission systems integrated into airframe**
- **Delivered to VQ-3 Guam and VQ-4 Pax River**



**Fully operational systems fielded in 18 months – Constantly improved since then**

# Tactics Development - The C-130 Data



- Refinement of tactics for C-130 - 1971 tests

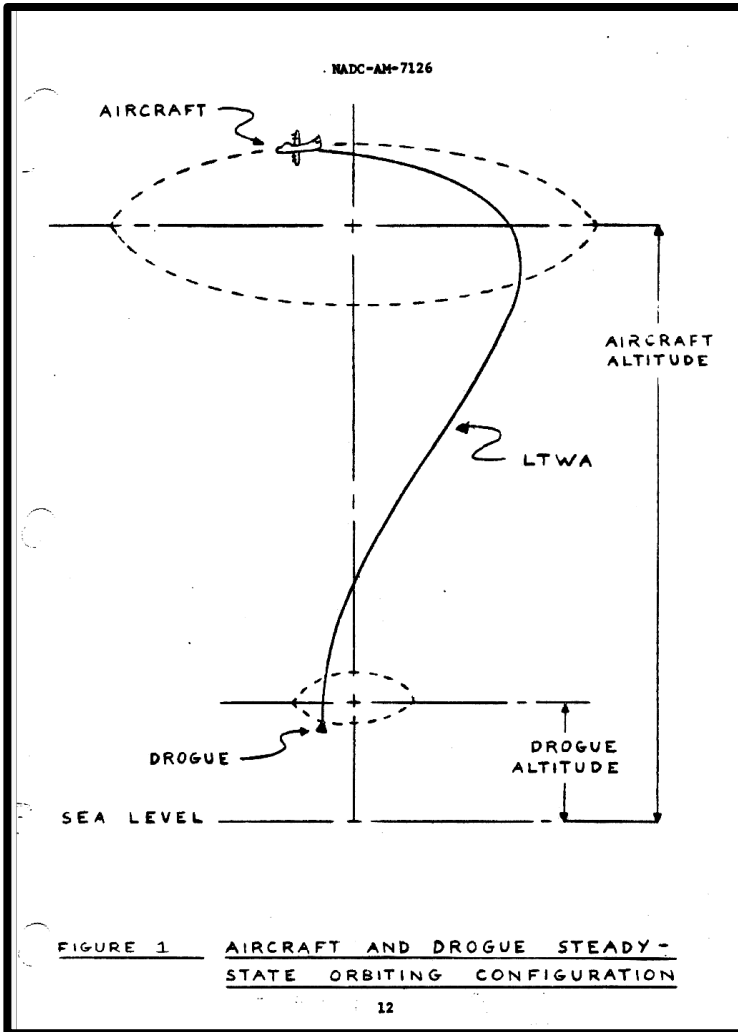
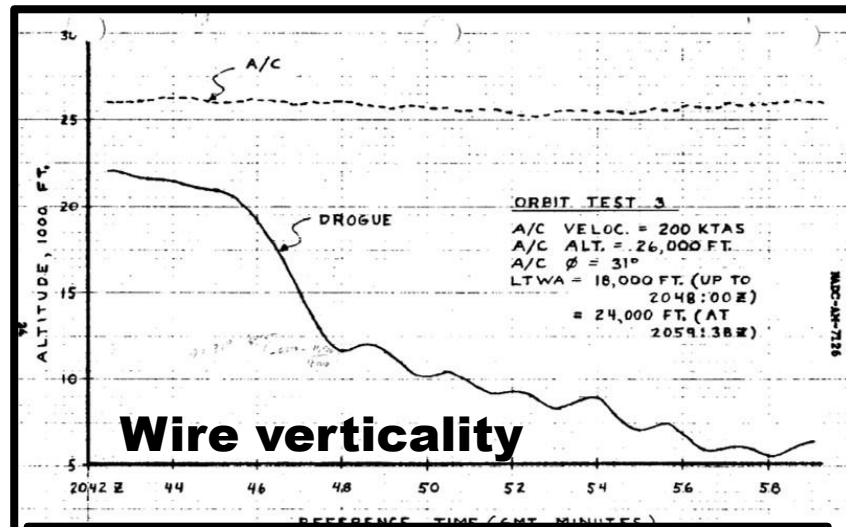


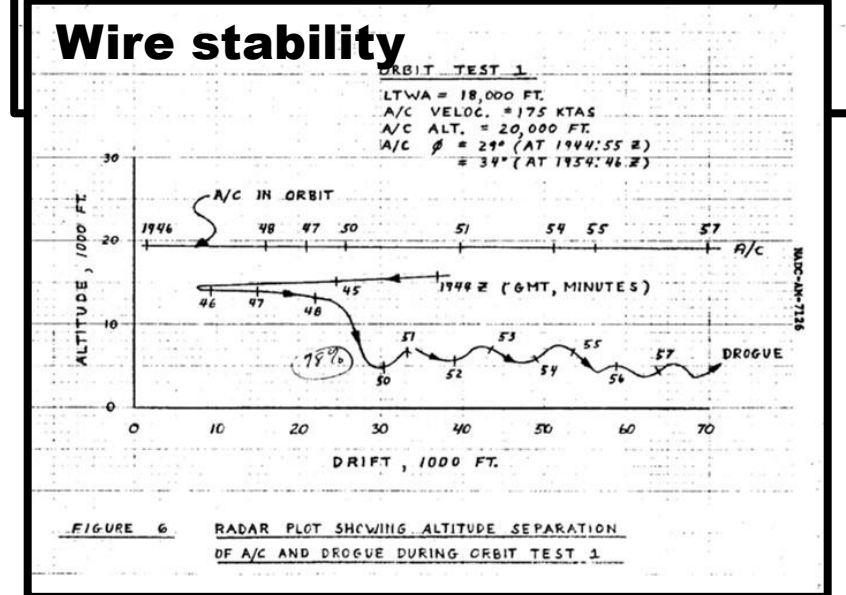
FIGURE 1 AIRCRAFT AND DROGUE STEADY-STATE ORBITING CONFIGURATION

12

Orbit side view



Wire verticality



Wire stability

FIGURE 6 RADAR PLOT SHOWING ALTITUDE SEPARATION OF A/C AND DROGUE DURING ORBIT TEST 1

**NAVAL AIR DEVELOPMENT CENTER**  
Warminster, Pennsylvania

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REPORT NO. NADC-AH-7126 23 Dec 1971

ANALYSIS OF DATA FROM ORBITING FLIGHT TESTS OF EC-130C AIRCRAFT AND LONG TRAILING WIRE ANTENNA (LTWA)

FINAL REPORT

AIRTASK NO. A05533438/2021/15080000

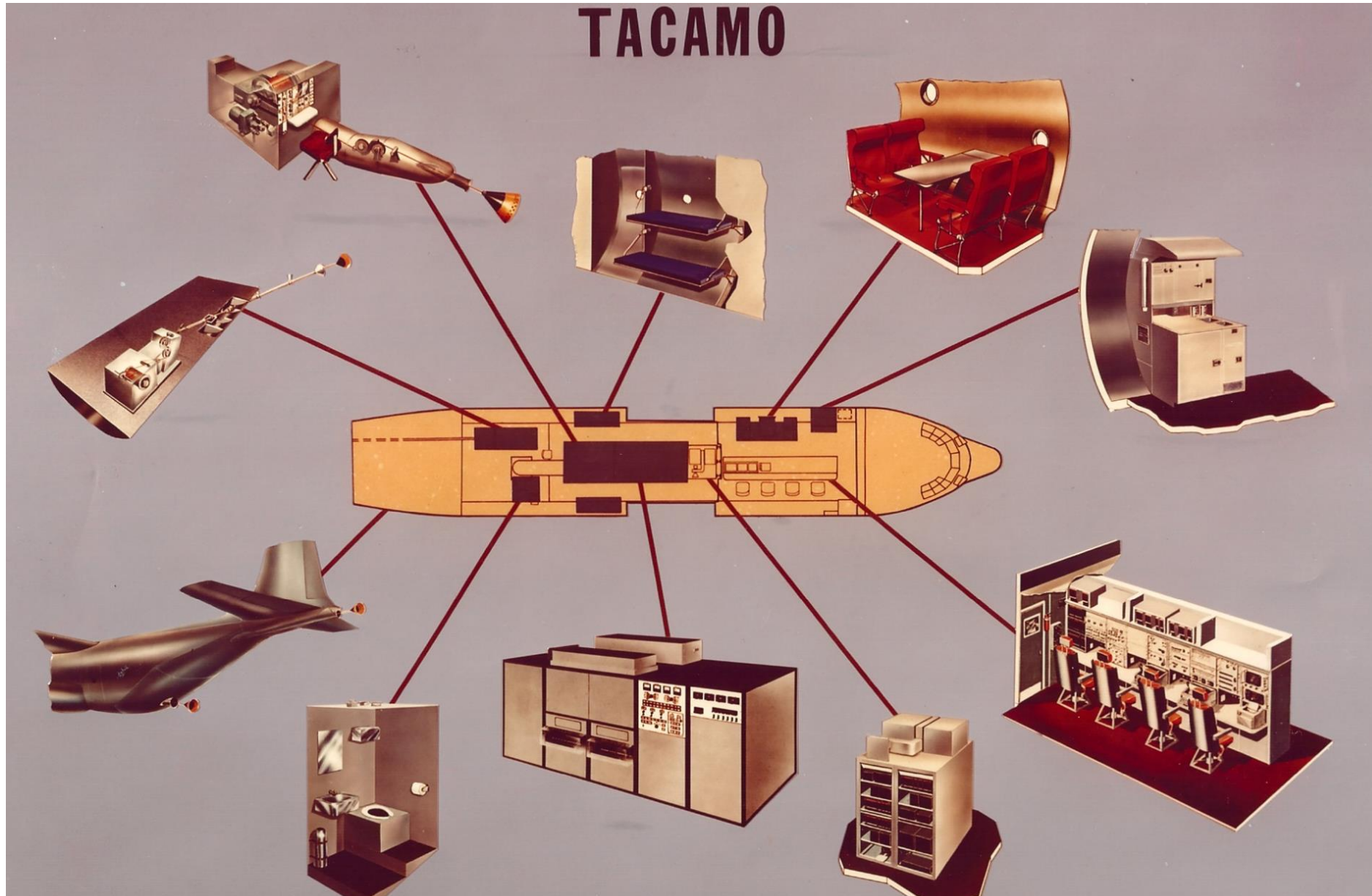
Distribution limited to U. S. Government Agencies only; Test and Evaluation; Report Issue Date; Other requests must be referred to Commander, Naval Air Development Center, Warminster, Pennsylvania 18974, or Commander, Naval Air Systems Command, Washington, D. C. 20360.



**TACAMO III EC-130**



# ***TACAMO IVB – Ultimate Herc System***



# TACAMO IVB

## Development

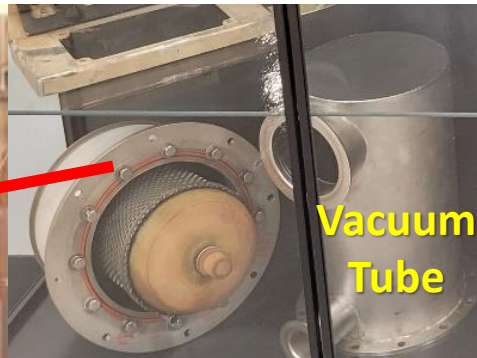
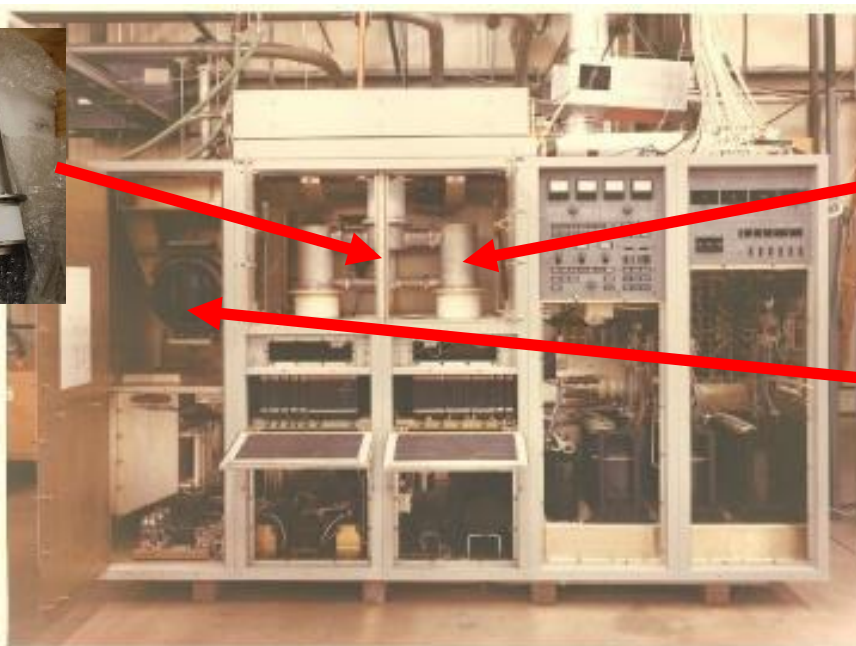
- Leveraged TACAMO III design/experience but greatly improved
- Competitive win by Collins Radio
- Built in crew rest area, bunks added aft, minimal head aft

## Features

- Added back original 40/50 Herc generators for aircraft system
- Power output 200KW, requiring larger power amplifier (PA) tubes
- Mission systems powered by legacy by 4 60/90KA generators
- LTWA=28,000 feet, STWA=3,000 feet, copper and aluminum wraps
- Water cooled PA tubes and LTWA brakes
- 6 vice two variometers to match wire length impedance



Vacuum  
Tubes in  
Ionized  
H2O



Variometer





# ***Herc Mainstay - TACAMO IV***

## **Advantages**

- **Greatly increased VLF range, impacting areas of operations**
- **Relatively shorter Dual Trailing Wire Antenna extend time= faster message delivery time**
- **VLF power output choices- Tune (25KW), 100KW, 200KW**
- **PA dummy load = pre-flight check of VLF**
- **Two wire reeling machine delivered to load/offload wires**

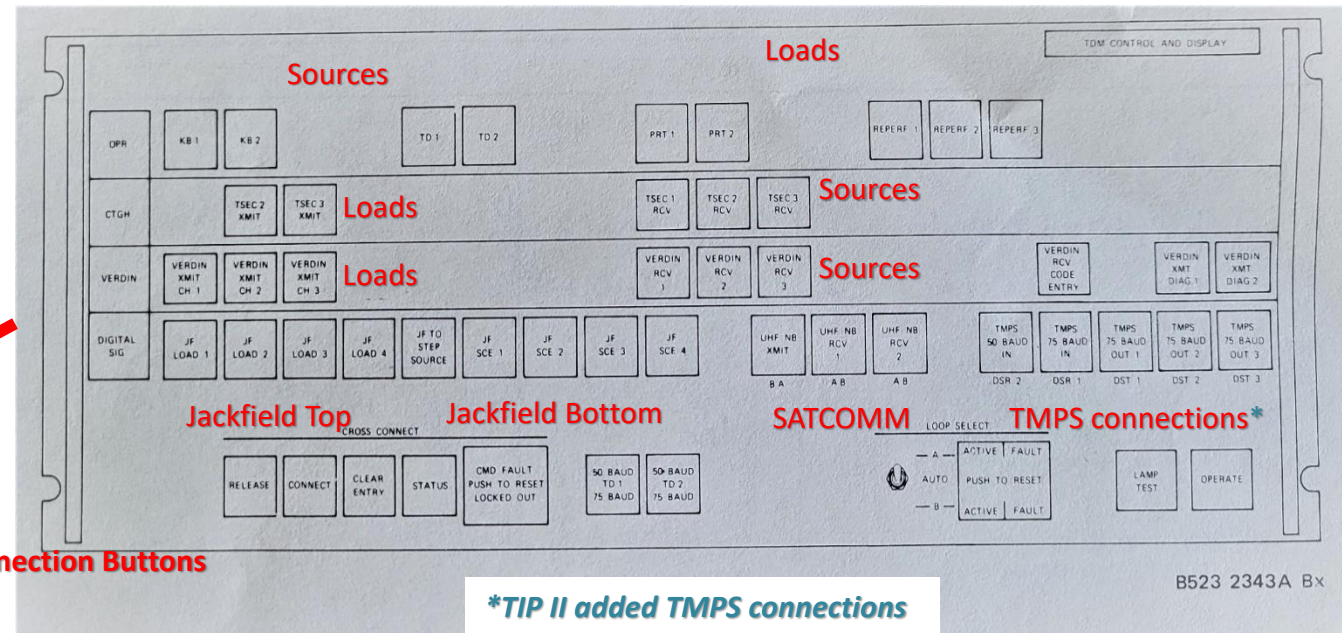
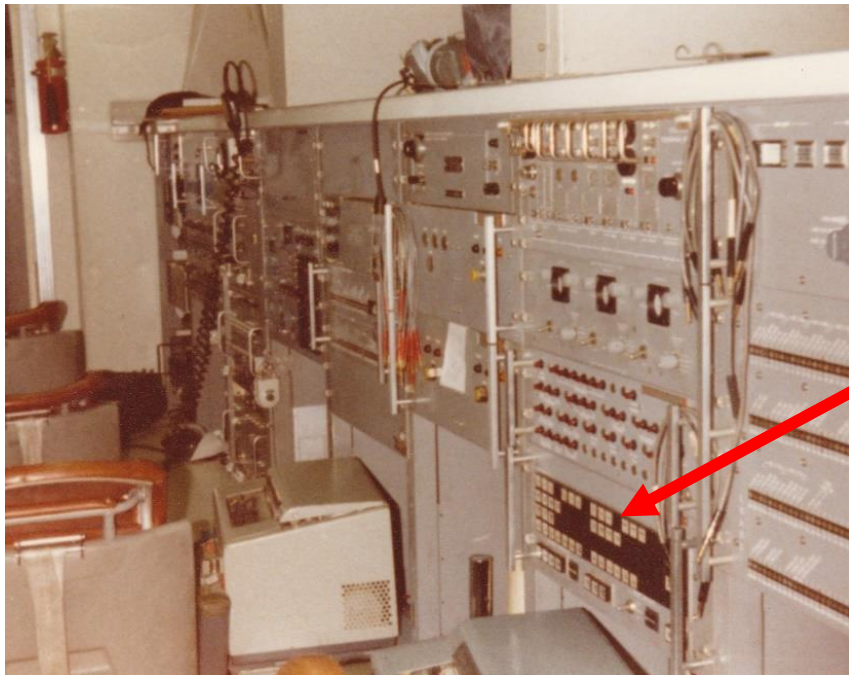
## **Disadvantages**

- **Orbit parameters had to be revised**
- **DTWA retract and stop issues with faster reel**
- **Added back 40/50 generators for aircraft systems**
- **60/90 generators totally dedicated to mission systems**
- **Loss of one generator = half power, loss of 2 = tune power**
- **Tune power = TACAMO III**



# TACAMO Improvement Program I - 1976

- Message processing focused
- "Time Division Multiplex" TDM
  - Three button push to connect source, crypto, and radio key
  - Seat 1 and 2 accessed and set up all circuits via TDM
  - Replaced some patch cord panels but locked up in power shifts
  - Maintained RED-BLACK separation via software rules
- TACSAT UHF SATCOM – EAMs and TACAMO force management
  - Lincoln Labs Experimental Satellites- "LES 8 and 9"
  - Connection to Navy Communications Stations



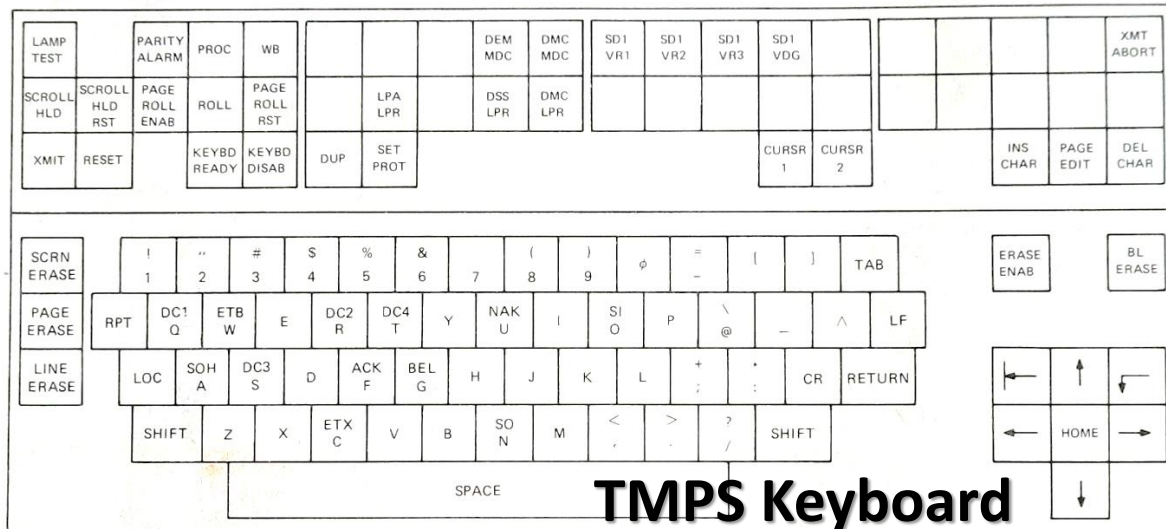
Connection Buttons

\*TIP II added TMPS connections

# TACAMO Improvement Program II - 1980

## TIP II

- UHF SATCOM wing tip antenna pods added
- 3 dish antennas kept signal connected in orbit
- Additional SATCOM networks
- TACAMO Message Processor "TMPS"- 52KB memory
  - Message receipt/editing, relay via keyboard and screen
- Electro/Mechanical Teletype keyboard/printers replaced-later ECP
- Dot matrix 'thermal' printer added

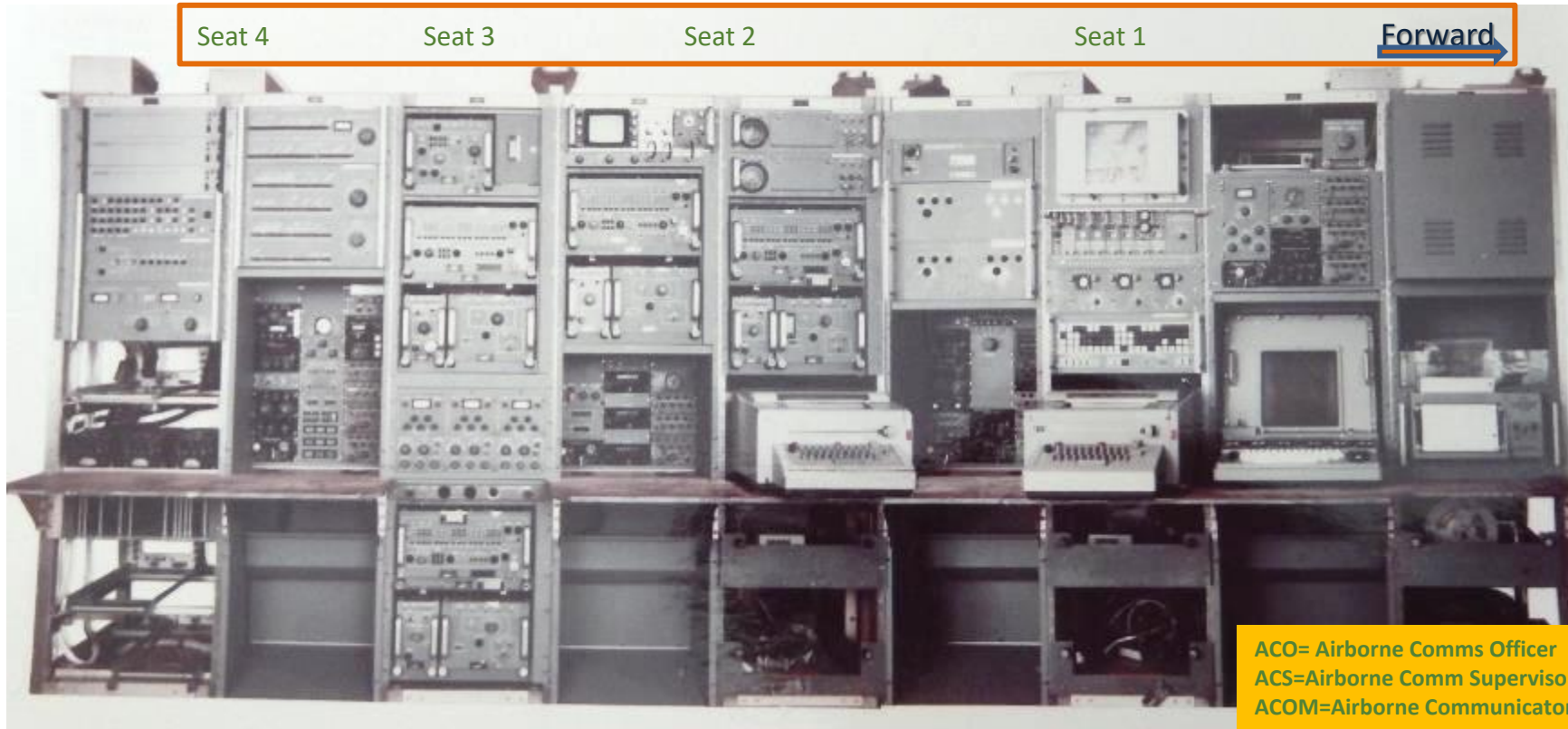


- Early Electro Magnetic Pulse protection layers added later
  - Fuselage openings and radio racks and panels





# Comm Central - TIP II



ACO= Airborne Comms Officer  
 ACS=Airborne Comm Supervisor  
 ACOM=Airborne Communicator

Power Amplifier controls

Radio controls

Message accuracy, frequency and mode selections  
 VLF

Encoding and formatting

ACOM  
 Formatting, routing to processors and transmitters, mode selection

Telegraph key to send Morse Code

ACOM  
 TTY and SATCOM  
 Message verification and circuit set up

Teletypes to create and edit

ACO and ACS  
 Message review/correction and queue management

Computer to display and select messages to send

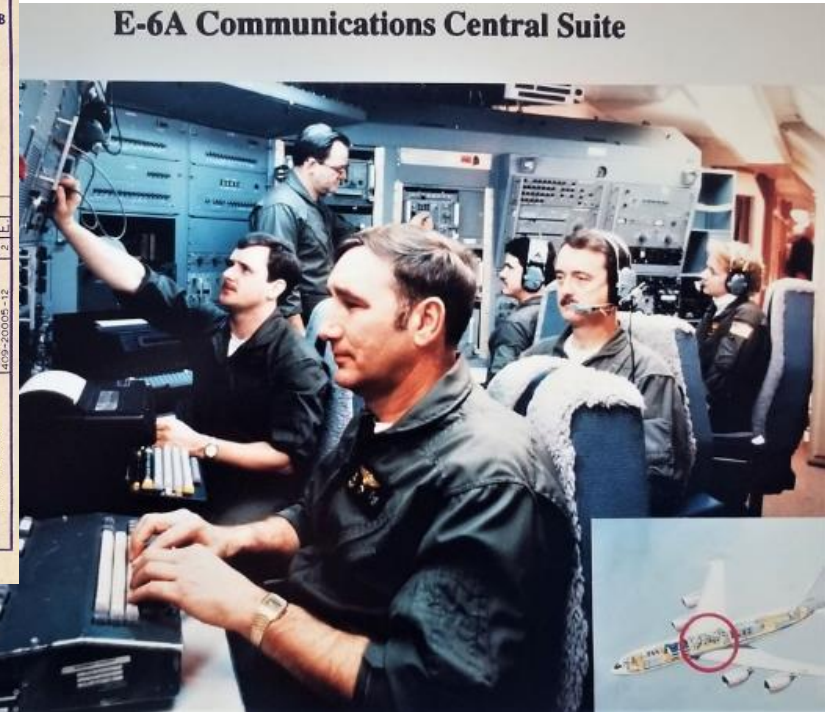
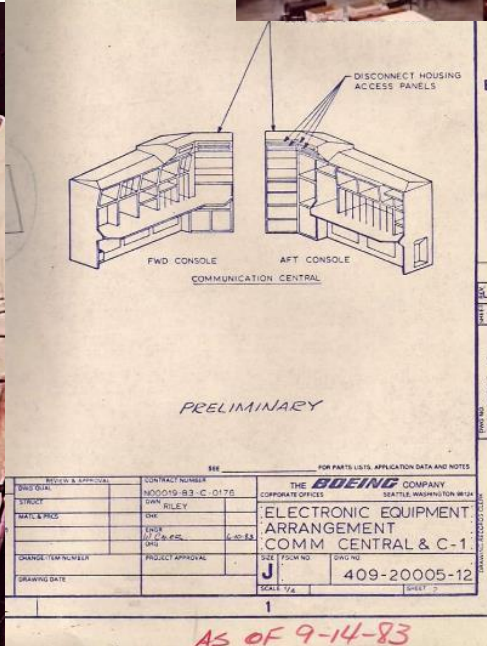
ACO and ACS  
 Decode message  
 Determine actions required  
 (Two Person Integrity-TPI)



# E-6A Mission Avionics System

## The 'V'

- Fleet Sailors: ACOs, RMs, ATs and Reel Operators evaluating and advising
- Model, then Mock Up
- V design intended to
  - Enhance crew coordination
  - ACO access to crew/gear
  - Crew access to equipment
  - Security for cryptos
- TACAMO IV cross decked into E-6A

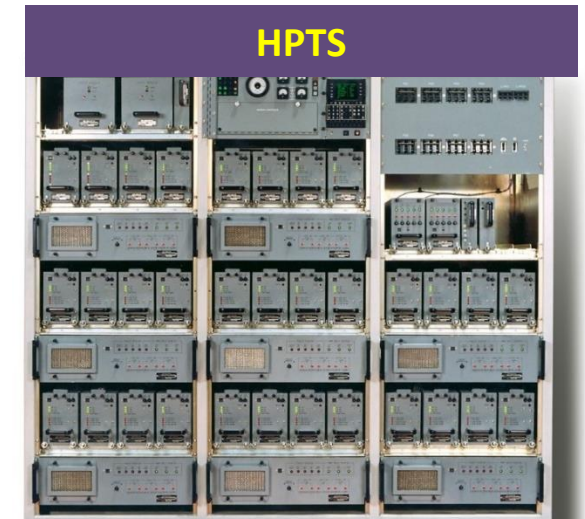




# ***Current VLF***

## **High Power Transmit System – Solid State Power Amplifier**

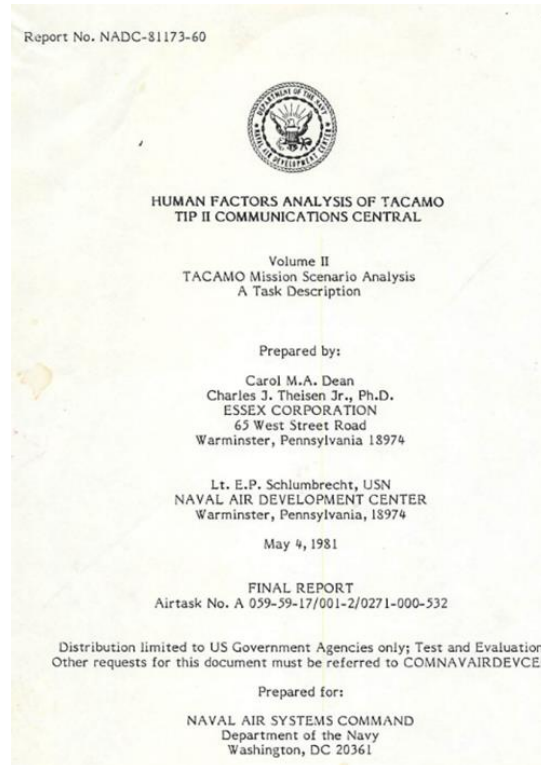
- **HPTS and SSPA developed by Collins Radio in 1985**
  - **Competitive development lost by Westinghouse Electric/Lockheed**
  - **Building block architecture (32 - 7.5 kVA modules) yields 200+ KW**
- **Contract award to Collins in 1987**
  - **HPTS intended for 30 EC-135 ABNCPs, 4 E-4B NAOCs, 16 E-6As**
  - **USAF backed out of contract after designs complete and approved**
  - **Collins additional development of 80HP hydraulic motor for E-6B**
  - **DTWA extend time no better than TAC IV but less heat factor**
- **HPTS and SSPA installation delayed until E-6B mods**
  - **MILSTAR, ABNCP module, ALCS, and HPTS/SSPA = E-6B ABNCP**
  - **Chrysler Airborne Technology Systems (CTAS) at Waco won contract**
  - **CTAS became Raytheon and later L-3**
  - **Mods in prototype in '91, production in '96**
  - **ABNCP in E-6 started in '98**



# Key NADC Contributions

- From NAVAIR TACAMO Library
- In use today to support program decisions about futures

1	Naval Air Development Center (NADC)	7/1979 and 8/1978	B-707-700 Aircraft Option Study For ECX (AVLF) Mission (TACAMO)	1310009-0 and 1310012-0	S
5	Naval Air Development Center (NADC)	6/5/1981	Navy Decision Coordinating Paper For Proposed ECX Platform	1310032-0	S
8	Naval Air Development Center (NADC)	8/9/1982 And 8/26/1982	System Concept Paper for TACAMO ECX Program (U), NADC	1310071-01 and 02	C
9	Naval Air Development Center (NADC)	9/17/1982	ECX Buy Size Requirements and Models - Boeing and Navy - Force Level analysis Mission Profile analysis	1310166-0	C
12	NADC	1984	Force Level Estimates for SECDEF TACAMO Options	1191120-0	S
21	NADC	1990s	E-6A/TACAMO Program Ref Documents (Bound volume)	1191124-01	S
22	NADC	1990s	E-6A/ECX/TACAMO Program History	Notebook 1191125-02	S
23	NADC	1990s	TACAMO Alternatives Report	1310086-87	S



## HUMAN FACTORS GUIDELINES FOR THE TACAMO EC-130 REPLACEMENT PROJECT (ECX)

Prepared By:  
Carol M. A. Dean  
Essex Corporation  
65 West Street Road  
Warminster, Pennsylvania 18974

LCDR Thomas Mitchell, MSC, USN  
Naval Air Systems Command  
Washington, DC 20361

September 11, 1981

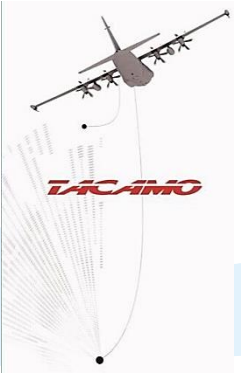
FINAL REPORT  
Contract N62269-79-C-0233, Task Order 0010

Distribution limited to US Government agencies only; test and evaluation;  
Other requests for this document must be referred to COMNAVAIRDEVCEEN.

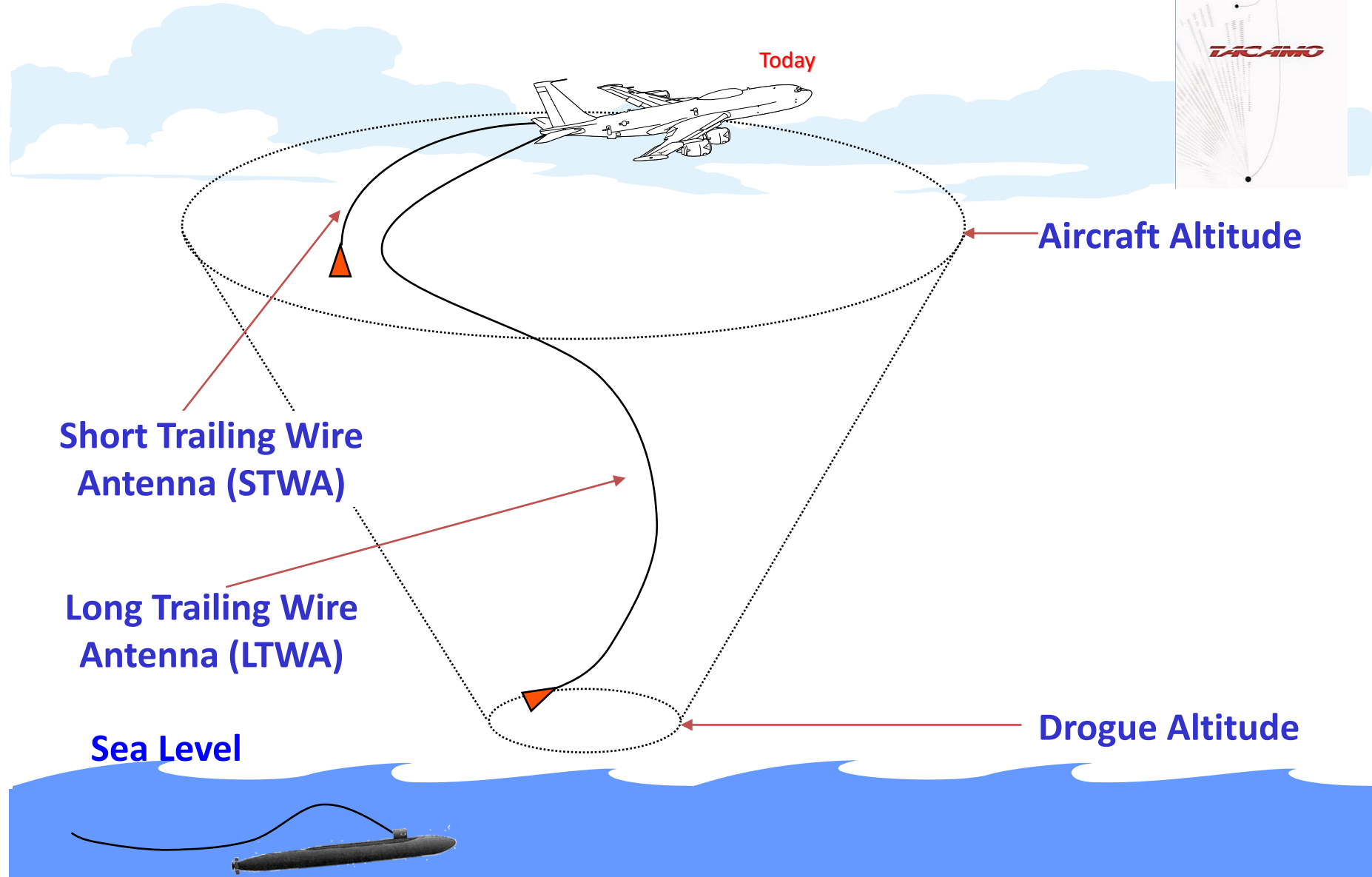
Prepared For:  
Naval Air Development Center  
Warminster, Pennsylvania 18974

# NADC Legacy Continues in TACAMO

Future



Today



Aircraft Altitude

Short Trailing Wire Antenna (STWA)

Long Trailing Wire Antenna (LTWA)

Sea Level

Drogue Altitude

62

64

69

74

80





# TACAMO Future

- **TACAMO remains critical to Nuclear Command, Control, and Communications – “NC3”**
- **E-6B Mercury is and AGING**
  - **33 years old and needs to continue for a least a decade more**
  - **Older than Hercs were at retirement**
- **Recapitalization – directed by National and Navy leaders- Read as ‘Get a New Airplane’ – ACAT 1B – NAVAIR’s largest today**
- **Replace E-6 for TACAMO mission only**
- **E-6 to CONTINUE as Looking Glass Strategic ABNCP**
- **USAF conducting studies on how to replace Looking Glass**
- **C-130J-30 “Super Hercules” is**
  - **Proven capable in past to perform mission – 60s-80s**
  - **Currently in production and more capable than EC-130**
  - **Currently in services in military applications**



THE ASSISTANT SECRETARY OF THE NAVY  
RESEARCH, DEVELOPMENT AND ACQUISITION  
1000 NAVY PENTAGON  
WASHINGTON DC 20350-1000

MEMORANDUM FOR PROGRAM EXECUTIVE OFFICER FOR AIR ANTI-SUBMARINE WARFARE, ASSAULT AND SPECIAL MISSION PROGRAMS

SUBJECT: E-6B Recapitalization Acquisition Decision Memorandum

I designate the E-6B Recapitalization a pre-Acquisition Category (ACAT) IB MDAP and concur with the proposed system integration and technical maturity plan to prepare the program for Milestone (MS) B in FY24, utilizing a Lockheed Martin C-130J-30 airframe. The program acquisition strategy prioritizes speed of execution and affordability to provide a suitable replacement TACAMO-only aircraft for the Navy. I authorize the program to enter at MS B and in the meantime address:

1. C-130J-30 airframe performance
2. Very Low Frequency (VLF) communications system upgrades
3. Third-party mission system integration

These activities will prepare the program to down-select to a single supplier to complete the Engineering and Manufacturing Development (EMD) Phase with an airframe specified by the Navy. The Navy will pursue a sole-source Justification and Approval (J&A) for procurement of the C-130J-30 airframe based on data collected from the Analysis of Alternatives (AoA). This will lead to the acquisition of test aircraft ahead of MS B to accelerate the EMD test program.

The E-6B Recapitalization program office will report to me in February 2021 to provide updates on system integration and technical maturity, acquisition strategy and funding requirements.

My point of contact for this matter is Mr. William E. Taylor, DASN (A/G), (703) 614-7794.

James F. Geurts

# ***TACAMO Future Plans Today***

- **Three C-130J aircraft ordered via USAF contract**
  - **Will be modified and tested for TACAMO mission**
  - **Delivered in FY 26**
- **VLF sole source to Collins Aerospace Systems**
- **Competitive contract for mission systems to be awarded in 2025**





# ***TACAMO History Lives On Naval Aviation Museum Pax River***



# ***TACAMO Very Low Frequency***

TACAMO IVB

Variometer

Power Amplifier Tubes

Long Wire Drogue



# ***Questions***

