

Collins Role in Space Communications



Mercury



Gemini



Apollo

Presented for Historical &
Educational Purposes

James "Jim" Robert Shanklin
Rockwell Collins, Retired 1996



Manned Space Programs Value

1960s Dollars **\$ 287 Million (Plus)**

2012 Dollars ***\$ 2 Billion (Plus)***

Project Mercury

1959 – 1963

Vostok 1
1st Russia Flight
Orbital
Yuri Gagarin
April 12, 1961

Six Mercury Man Flights
Nine Russian Man Flights

Mercury Capsule
Worn – Not Ridden



Friendship 7
3rd U.S. Flight
First Orbital
John H. Glenn, Jr.
February 20, 1962

Freedom 7
1st U.S. Flight
Suborbital
Alan B. Shepard Jr.
May 6, 1961

McDonnell Selected as Prime Contractor
January 1959

Project Mercury

Award Jan 1959
\$ 4.0 Million

Schedule
High Priority – DX Rating

1st Delivery
June 1959

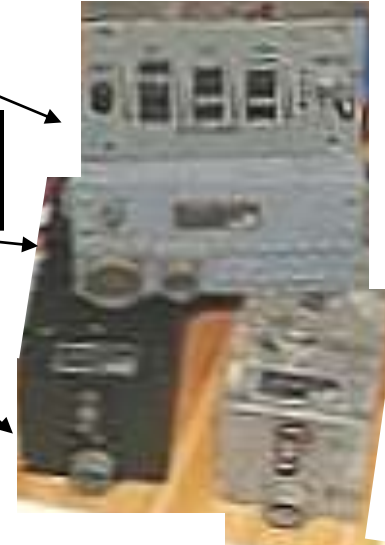


714U-1 Voice Control Panel

50W-1A UHF FM Command Receiver (2)
406–549 Mhz

618H-1 UHF Transmitter -- Receiver (2)
Main Voice, Secure, Rescue – 296.8 Mhz

618V-1 HF Transmitter – Receiver (2),
Voice Backup, Rescue – 15.016 Mhz



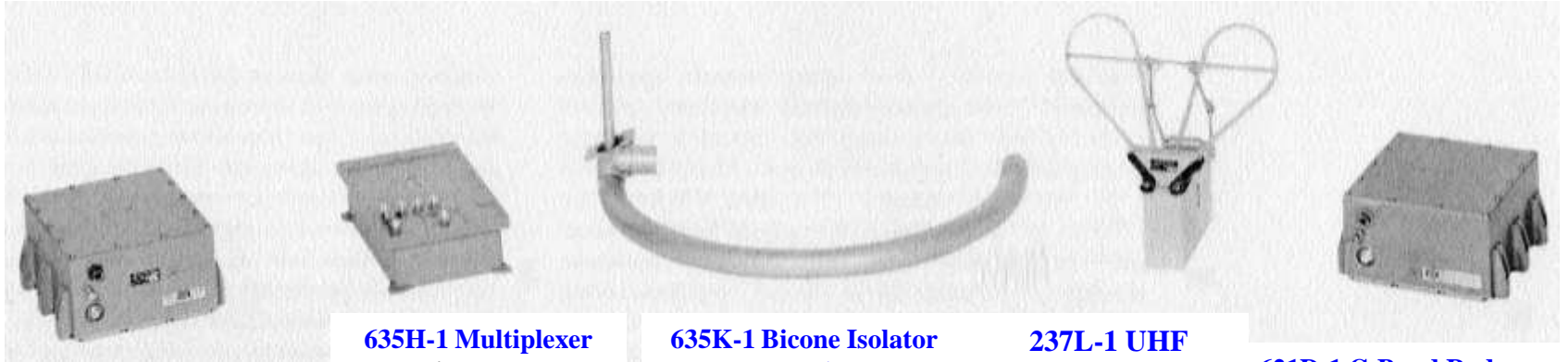
Collins Responsibilities

Voice
Telemetry
Rescue
Tracking
Command

Valuable
Experience
System
Schedule
Subcontract
Cost Mgt

Existing Technology
14 Systems
30 Items/ System
10 Subcontractors
Bench Test Sets

Mercury Communication Equipment



**621D-2 S-Band
Radar Beacon**
Avion Div. ACF

**635H-1 Multiplexer
Microphase**

**635K-1 Bicone Isolator
HF – UHF Antenna**
Collins Design
McDonnell Build

**237L-1 UHF
Rescue Antenna**
Collins

**621D-1 C-Band Radar
Beacon**
Avion Div. ACF



**618H-1 UHF
Transmitter-Receiver**
Collins

**56D-1 HF/UHF
Rescue Beacon**
Simmonds

**714U-1
Control Panel**
Collins

**237K-1 HF Rescue
Antenna System**
Collins Design
General Mills Build

**346E-1 Audio
Center**
Andrea

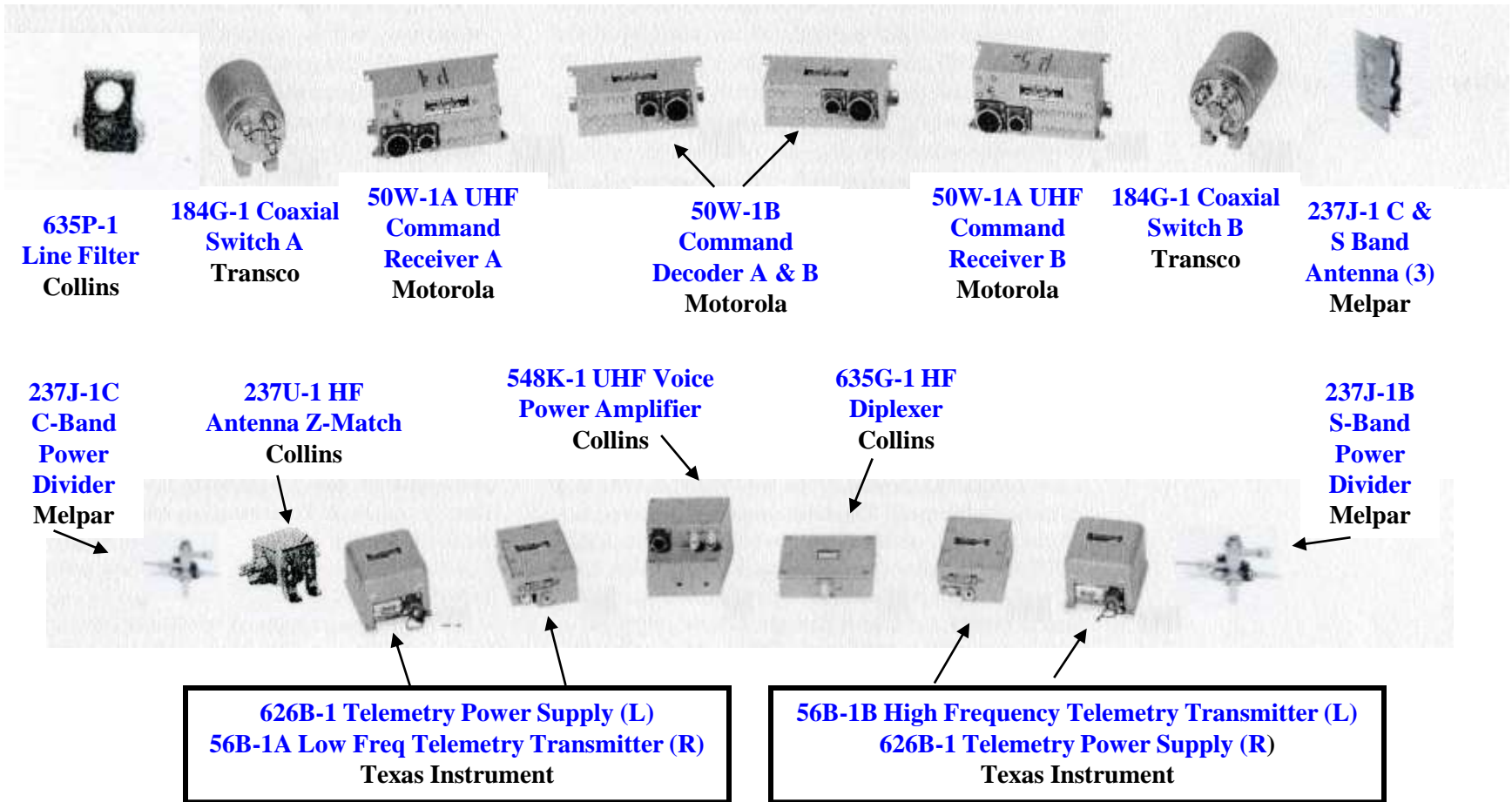
**618V-1 HF
Transceiver –
Receiver**
Collins

HF Antenna
Collins Design
General Mills
Build

56C-1 VHF AM Tracking Beacon
Mercury Scout 1 – Failed Tracking Station Test
Cooper Development

Mercury Communication Equipment

(Continued)



Ground Command Equipment Mercury and Gemini

Secure Commands

Prevent Intelligence Gathering
Prevent Signal Jamming Attempts
Prevent False Commands

AN/FRW-2 UHF Radio Set

*1956 Collins Cedar Rapids Design
406 – 549 Mhz 500 Watts
17 Ground Stations – 2 Relay Ships
2 Systems Per Site
Telemetry – UHF Voice Backup*

T-560B/FRW UHF Transmitter
C-1669/FRW Coder Control
R-669A/FRW UHF Receiver

Navy – AN/FRW-2 Collins C.R.
Bendix – 240D-2 Collins (Alpha)
\$ 2.0 M Estimate



**KY-171/URW Audio Frequency Coder
Serial 8**

KY-172/URW Audio Frequency Decoder



**240D-2 UHF 10 KW PAs – 400–550 Mhz
Relay Commands to Capsule – 2 per Ship
Rose Knot Victor – Costal Sentry Quebec**

Project Gemini

1962 – 1966

3 to 4 Year Gap
Maneuvering
Rendezvous
Long Flights
Lifting
Re-entry
Space Walking

Two Man Capsule
Record 10 Successful Flights
206 Orbits – Longest Flight
Two Unmanned Flights



*Gemini VI & VII
Docking*

Collins Responsibilities
UHF – Main Orbit Voice
UHF -- Launch – Reentry
Back Up
HF – Voice Back Up
Rescue
Bench Test Sets

*Gemini VIII
Pacific Ocean*

*David Scott
Neil Armstrong*



*1st Acquisition
Collins' "Liberty" Station*

McDonnell Letter Contract Acceptance – December 22, 1961

Project Gemini

Gemini I Thru V



76H-1 VCC



618N-1 HF Xmitter -Rcvr - 1 - 15.016 Mhz
618L-1 UHF Xmitter - Rcvr - 2 - 296.8 Mhz

Gemini VI Thru XII



76H-1 VCC

Added Circuitry
15% Larger
10% Heavier
Solid State
Foam Filled
Hermetically Sealed

March 28, 1962 Award
\$ 3.0 Million
20 Systems

978J-1 HF & Audio Bench Test Sets

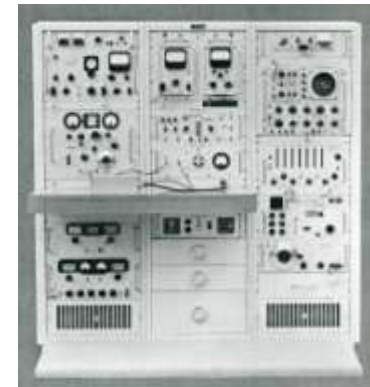
HF

Voice Control



978H-1 UHF Radio

Bench Test Set



Manned Orbiting Laboratory (MOL)

Air Force Program

Douglas Prime

Two Man 30 Day Reconnaissance

Gemini B – Shuttle



1st Gemini II/B

NASA 1965 Refurbishment



2nd Gemini B

1967 AF – McDonnell – Procured Five

Collins Dallas 1965 & 1967 Awards

Communications & Data System

\$ 100.0 Million – Estimated Termination



Mockup Flight – Nov 3, 1966

Released 3 Satellites



Project Apollo

1961 – 1972

Apollo 17

Last Flight -- Dec 7, 1972



Collins' Award – Dec 21, 1961

North American Aviation
Space & Information System
Award – Nov 24, 1961

Block I -- \$ 40.0 Million
Grew to \$ 73.0 Million

Block I

Apollo 1 Thru 6

“I want to Go to the Moon in a Volkswagen”

Joe Shea – NASA Program Manager

NASA Asked for the Moon

What Part of the Moon

Block I Increase – \$ 33.0 Million

Negotiation Teams

Base Line Finalization

Hundreds of Changes

SCD – Specifications – SOW

Design

Existing Technology

Solid State – Plug in Modules

Fixed Frequency – Crystal Control

Quick Disconnect Connectors

Rail – Rack Mounted Boxes

High Quality Parts

On Board Module Spares

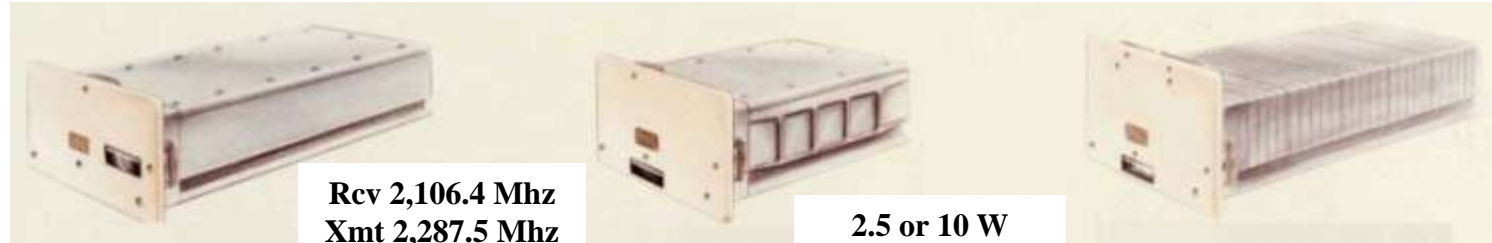
Program Office

System – Cost – Schedule – Data

Skilled Management – Over 800 Dedicated Employees

High Standards – Committed to Purpose – Team Effort

Block I – Equipment



**Rcv 2,106.4 Mhz
Xmt 2,287.5 Mhz**

2.5 or 10 W

621F-2 Unified S-Band Xponder – Motorola

548N-1 S-Band P. A.

960B-1 PCM Telemetry – Radiation



960B-1 PCM Telemetry – Radiation

76J-1 Audio Center

683E-1 Signal Conditioner



**960C-1 Pre-
Modulation
Processor**

**635Q-1 VHF
Multiplexer**

621G-1 C-Band Xponder – ACF



718P-1

**VHF AM Xmtr/Rcvr – 253.7 & 296.8 Mhz
VHF Recovery Beacon – 243.0 Mhz**

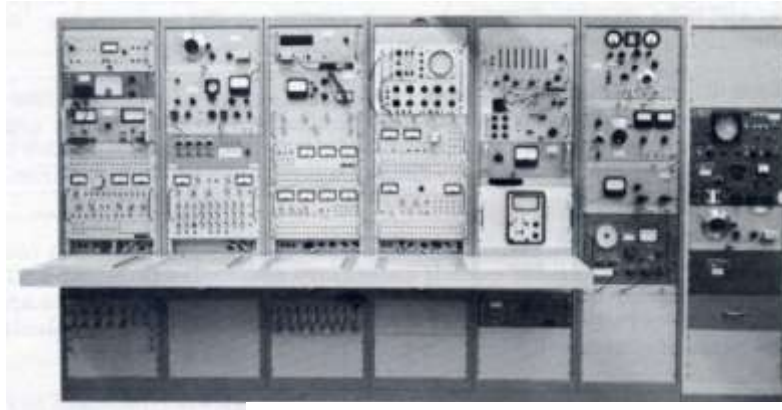
**342B-1
Data
Storage
Leach**

718N-1

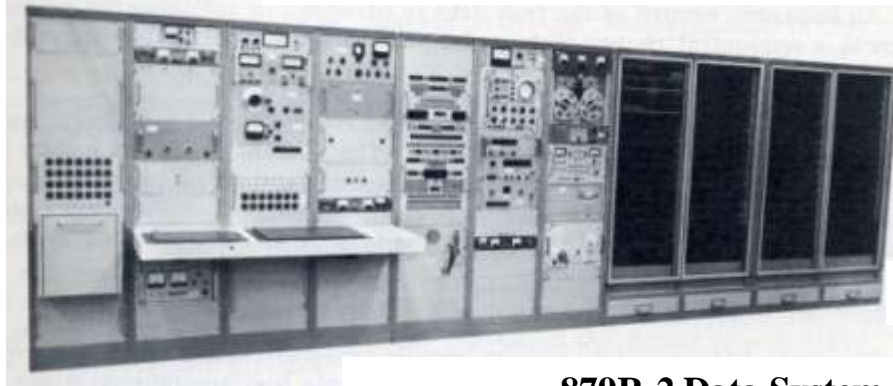
**VHF FM Xmtr – 257.8 Mhz
HF Transceiver – 15.016 Mhz**

Additional Block I Tasks

Antenna Study – Dallas
Digital & Data – Newport Beach
Bench Maintenance Equipment (BME)



879S-1 Communications Equipment, BME



879R-2 Data System, BME
Single Channel Decommulator Portion – Radiation



879N-1 C-Band Transponder, BME
STMU Portion – ACF



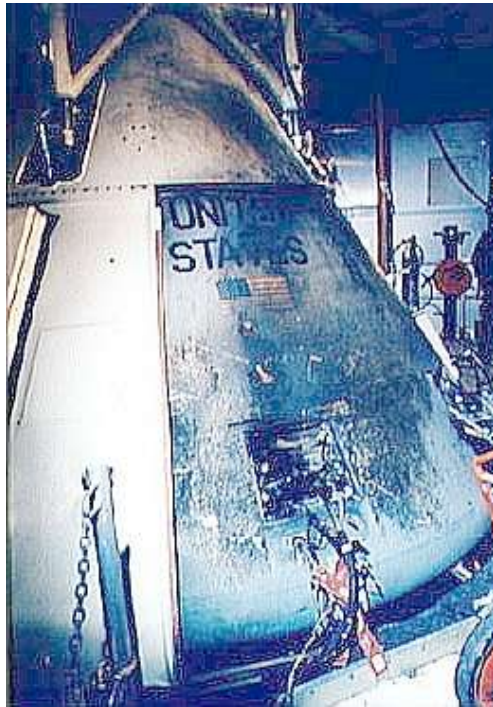
879C-1 S-Band Equipment, BME

Apollo 1 Tragedy

The Fire



Virgil I. "Gus" Grissom – Commander
Edward H. White – Command Pilot
Roger B. Chaffee – Pilot



Apollo 1
Jan 1, 1967

Right Hand Section
Lower Equip Bay



Block II Changes

Reduce Weight – Increase Reliability

Apollo 7 Thru 17

S-Band for All Deep Space Communications

Elimination of C-Band Tracking Radar (25 lbs)

2nd S-Band Power Amplifier

Eliminate Plug in Modules

Eliminate On Board Spare Modules

Incorporate Redundancies

Gas Filled & Hermetically Sealed

Eliminate Quick Disconnect Connectors – Encapsulated Pin Terminal

MERCURY “FAITH 7” BUS FAILURE

\$ 53.0 Million Major Redesign
25% to 50% Reduction of Weight & Bulk

Command Module – Block II Equipment



Unified S-Band Transponder

**Redundancy – Voice, TV, Telemetry, Data,
Command, Tracking**

Transmit 2,200 – 2,290 Mhz 275 – 400 Milliwatts

Receive 2,025 – 2,110 Mhz

S-Band Power Amplifier

Redundancy

Two Independent Amplifiers

Power Outputs – 2.5/2.8 & 11.2 W Min



Premodulation

Processor

Redundancy

Data Gathering

Signal Modulation

Signal Demodulation

S-Band Interface

System Brain



PCM Telemetry

Dual with Redundancy

Biomedical, Operational & Scientific Data

Command Module – Block II Equipment

(Continued)



VHF AM Transmitter-Receiver

Redundancy

Voice – LEM/Moon Earth Recovery

Extravehicular, Docking

SSB 5 Watts 253.7 & 296.8 Mhz

VHF Recovery Beacon

Manual or Automatic Activation

243.0 Mhz

3 Watts

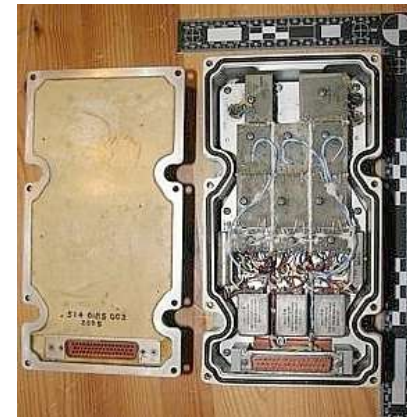
Audio Center

3 Independent Circuits

Voice Distribution

Astronauts – LEM – CM

HF, VHF, or S-Band



Command Module – Block II Equipment

(Continued)



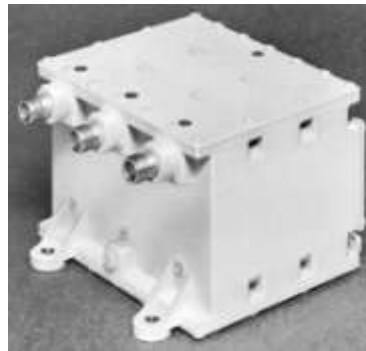
Data Storage

**Record Voice & Data – 4 Hour Storage
Dual Reels Record During Lunar Orbit**



HF Transceiver

**Near Earth – Post Landing
SSB – Voice & Direction Finding
20 Watts 15.016 Mhz**



VHF Triplexer

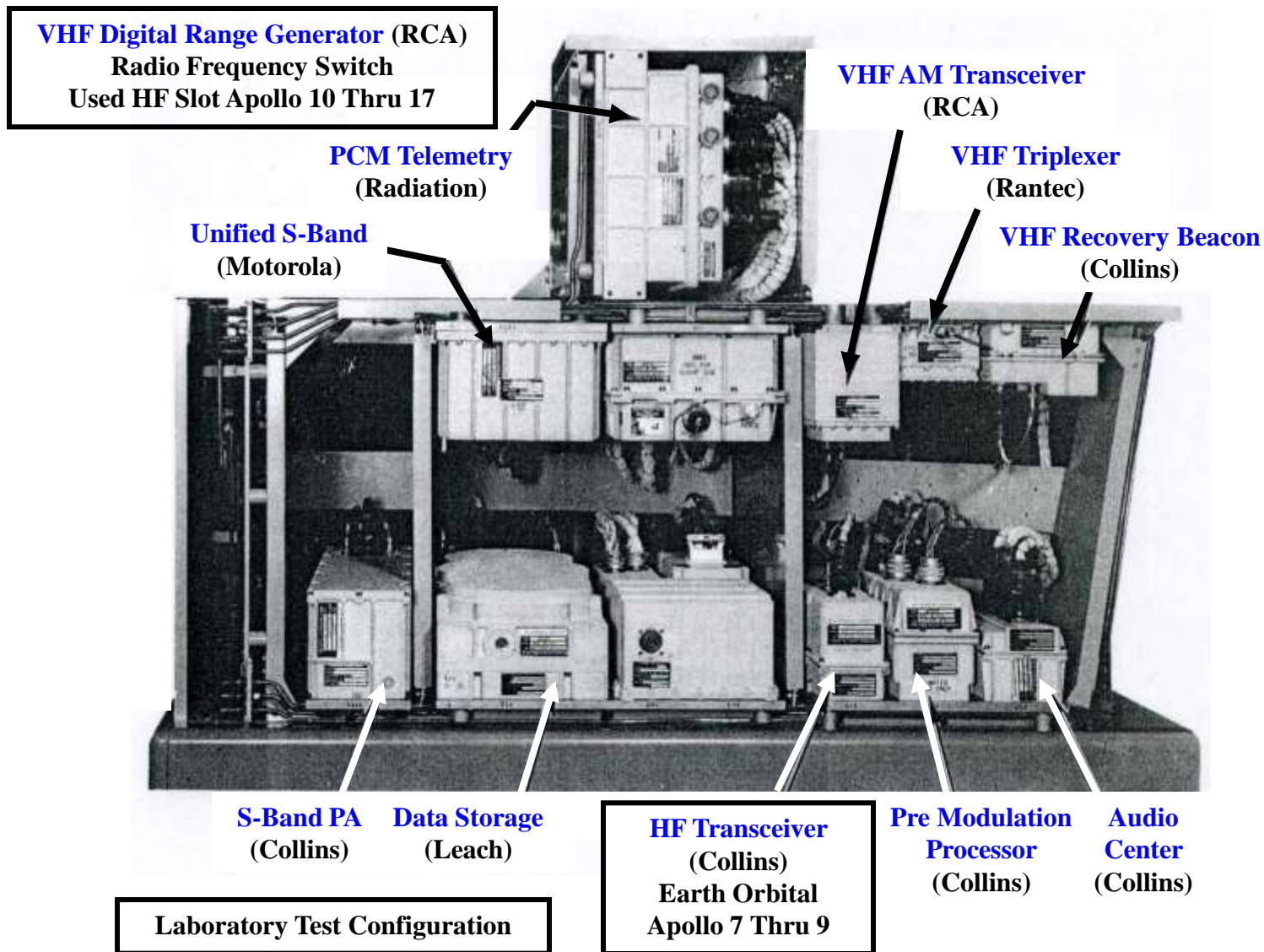
3 VHF – 1 Antenna



VHF Digital Range Generator

**Extend VHF/AM Transmit
Radar Range
LEM – CM Rendezvous**

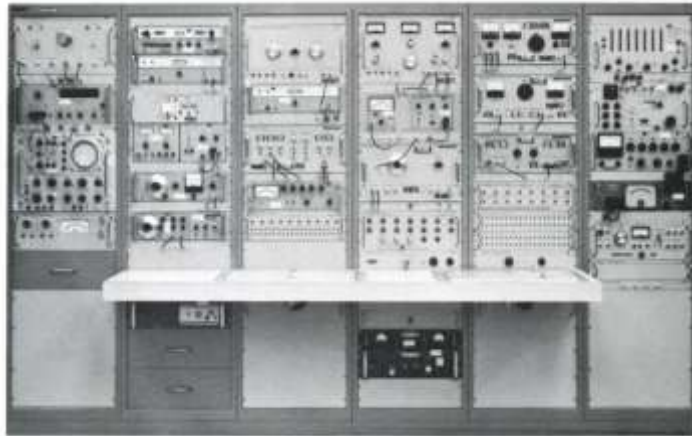
Block II Equipment



Block II

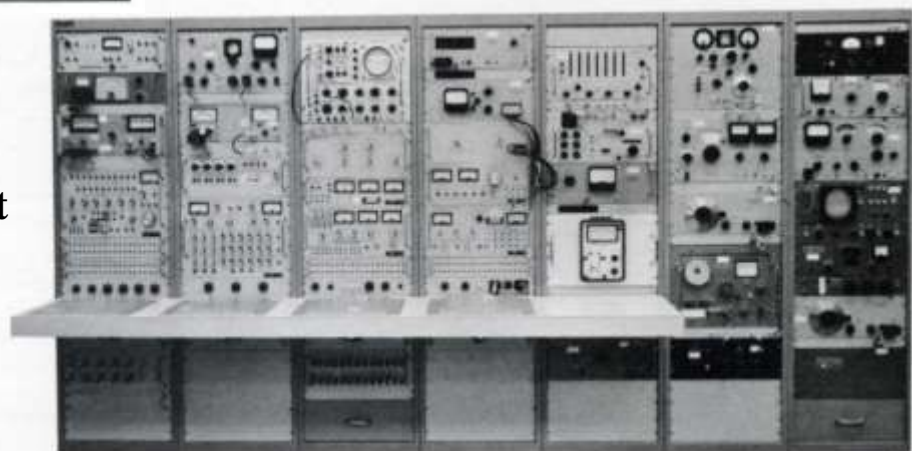
Bench Maintenance Equipment

Updates



**879C-2 S-Band
Bench Maintenance Equipment
Block I & II**

**879S-2 Communication
Bench Maintenance Equipment
Block I & II**



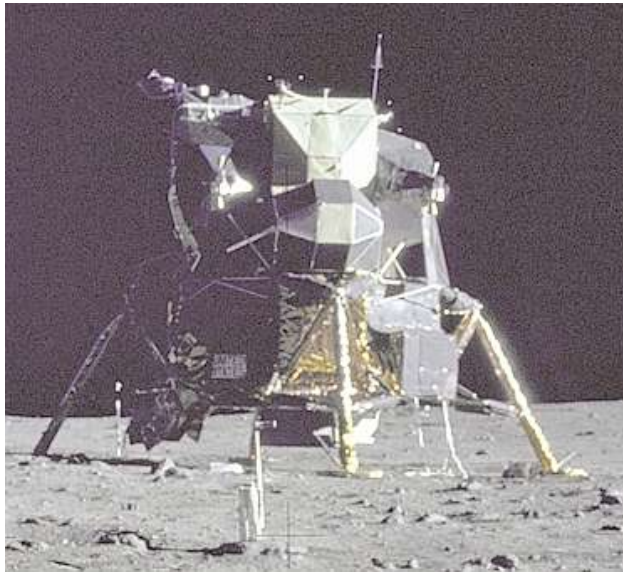
Lunar Excursion Module

Apollo 9 Thru 17

Grumman – November 1962

RCA – July 1963

Collins – June 1964 – \$ 3.0 Million



LEM – Nine Flights



Signal Processor

Audio Center & Premodulation Processor

Mix & Process

LEM Voice – Telemetry – TV – Data

Signal Modulation & Demodulation

Distribution

Intercom – S-Band & VHF AM Transmission

CM – Moon – Earth

System Brain

Apollo Unified S Band Ground

Collins Dallas/Alpha – One of 14 Bidders
June 17, 1964 Award – \$ 28.0 M (Plus)

Deep Space Communication

Three Deep Space S-Band “Dual” 85 Ft Stations
Fourteen 30 Ft (Five “Dual”) Tracking Systems
Training & Three 85 Ft Backups Sites

85 Ft “Dual” Stations

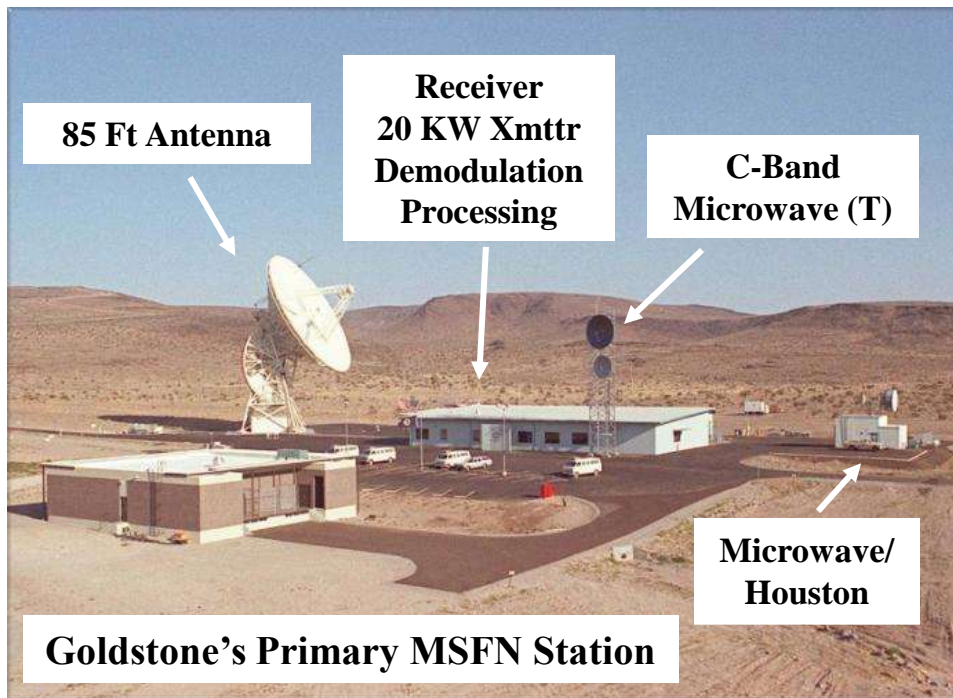
120 Degrees Apart

Goldstone, Madrid, Canberra
Same Time Transmit & Receive

Television, Voice, Data

CM – LEM – Moon

Completed – Spring 1967



30 Ft Antenna

3 Ships – 11 Ground

Apollo Unified S – Band Ground

Enhance TV Quality
Existing 210 Ft – Backup to 85 Ft
Signal 10 db Greater

Collins Advanced C– Band Microwave

Two Repeaters to/from MSFN

Modifications Completed June 1969

Apollo 11

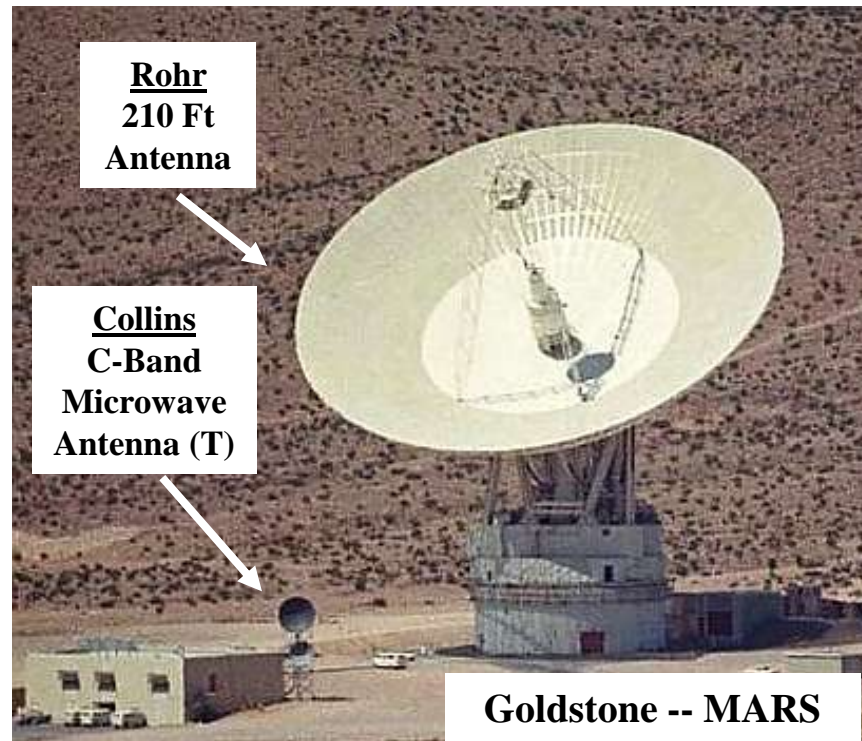
LEM Power Descent

Antenna Pointing Problem

210 Ft Provided Better Data

Iowan – Stephen G. Bales' Decision

Houston “GO” for Moon Landing



Collins
RF Equipment

July 1969 Award
\$20.0 Million
Two 210 Ft
“Dual” Systems
Australia & Spain
Apollo 17

National
Historic
Landmark

Apollo Pre-Launch – Kennedy Space Center

Linked Launch Area Complex Facilities

Vehicle Assembly Building – Saturn V Launch Pads & Towers

Launch Control Center

Apollo Range Instrumented Aircraft (ARIA)

Air Force – \$ 1.0M Est.
Update Eight EC-135N
All Collins Equipment
100 Days to Update
82 Days Actual



*ARIA – Cedar Rapids Airport
Collins Evaluation – August 1968*

Apollo 13

ARIA 4

1st Reacquisition
Collins' HF ARC-58
Houston Direct
*“Hello, Houston,
This is Odyssey,
Its Good to See You Again”*

Squelch System

Up-Link – Only When Receiving Ground
Down-link – Only When Receiving Spacecraft

Automatic Switching Matrix System

Ground HF Voice to Spacecraft S-Band or VHF
Spacecraft VHF & S-Band Voice to Ground HF
ARC-58 – 3 ea 1KW SSB HF & TACSAT



Apollo 11

“The Eagle Has Landed”

July 20, 1969



We Have Lift Off
July 16, 1969



Columbia



5 Aug 1930
25 Aug 2012



“Buzz” Aldrin – Eagle
Sea of Tranquility

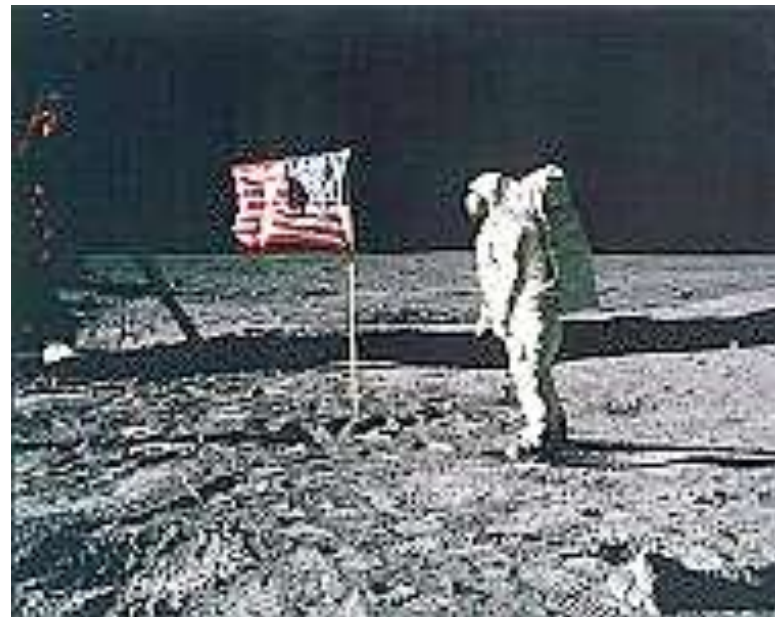
Neil Armstrong (L), Commander
Michael Collins (C), CM Pilot
Edwin “Buzz” Aldrin (R), LEM Pilot

“One Small Step for a Man
One Giant Leap for Mankind”

*Collins Provided Voice Communication for
Every American Astronaut Traveling Through Space*



*Many
Memories*



Giant Leap
MARS ?