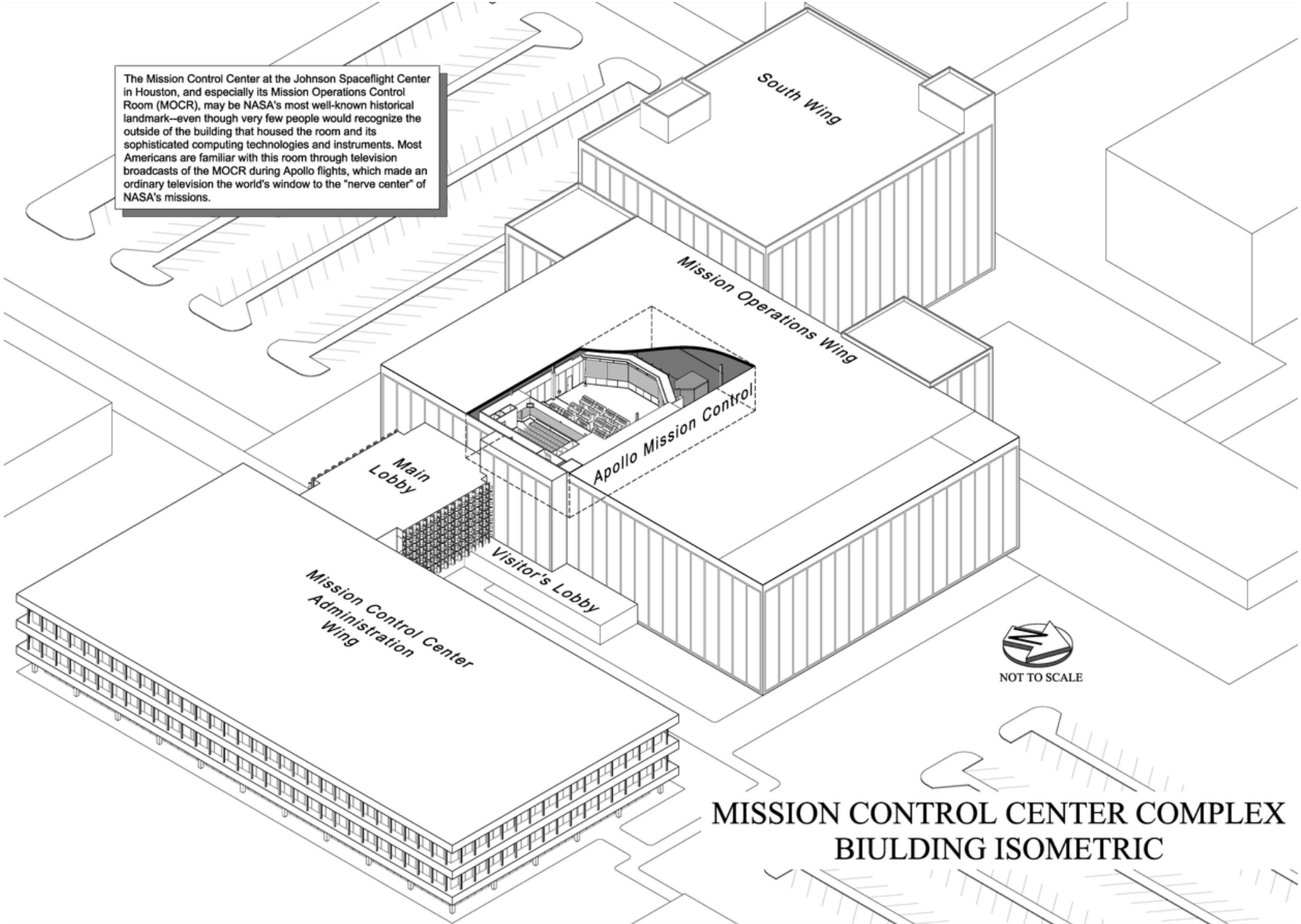
Mission Operations

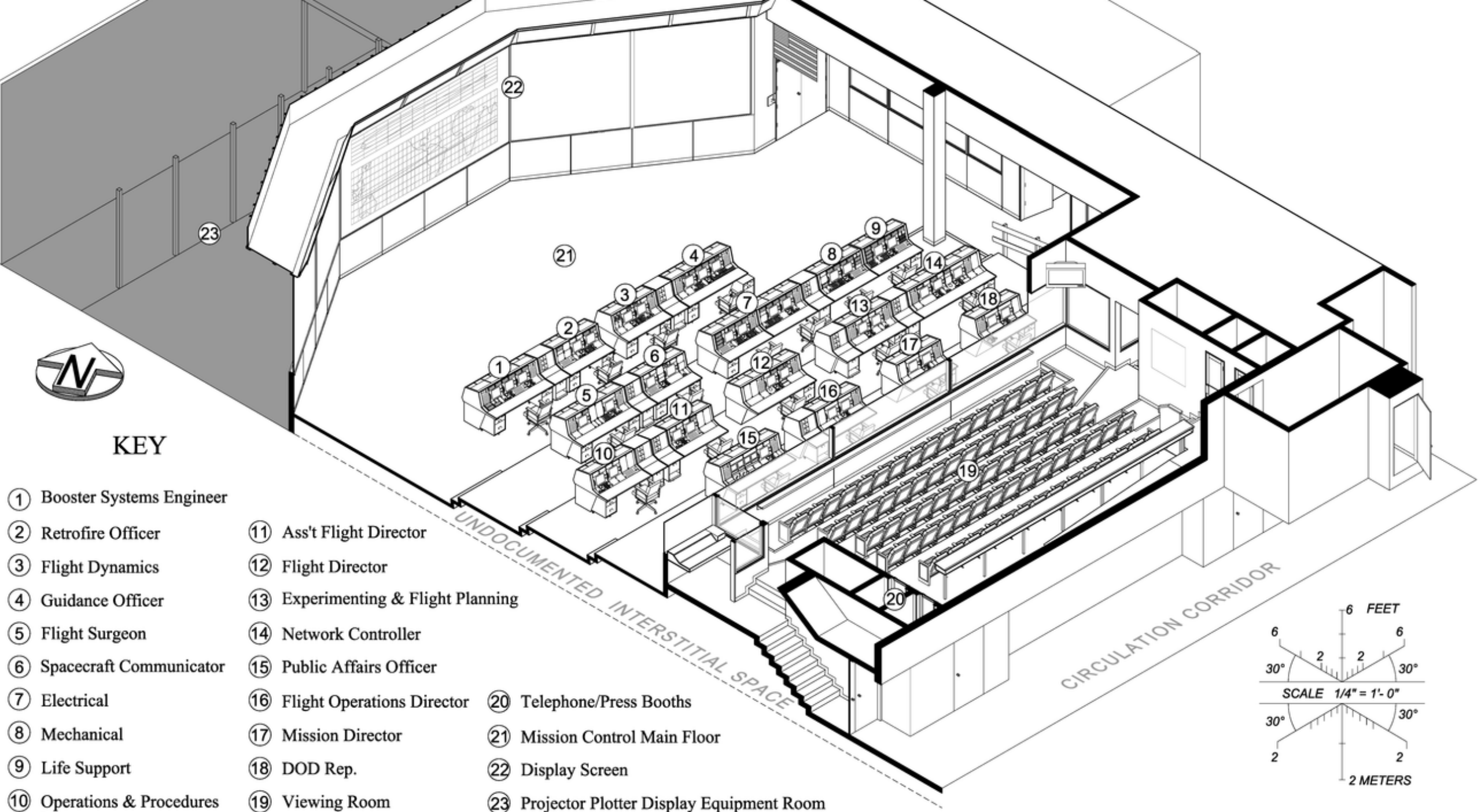
HONR 269i

To the Moon and Back: The Apollo Program

The Vital Link

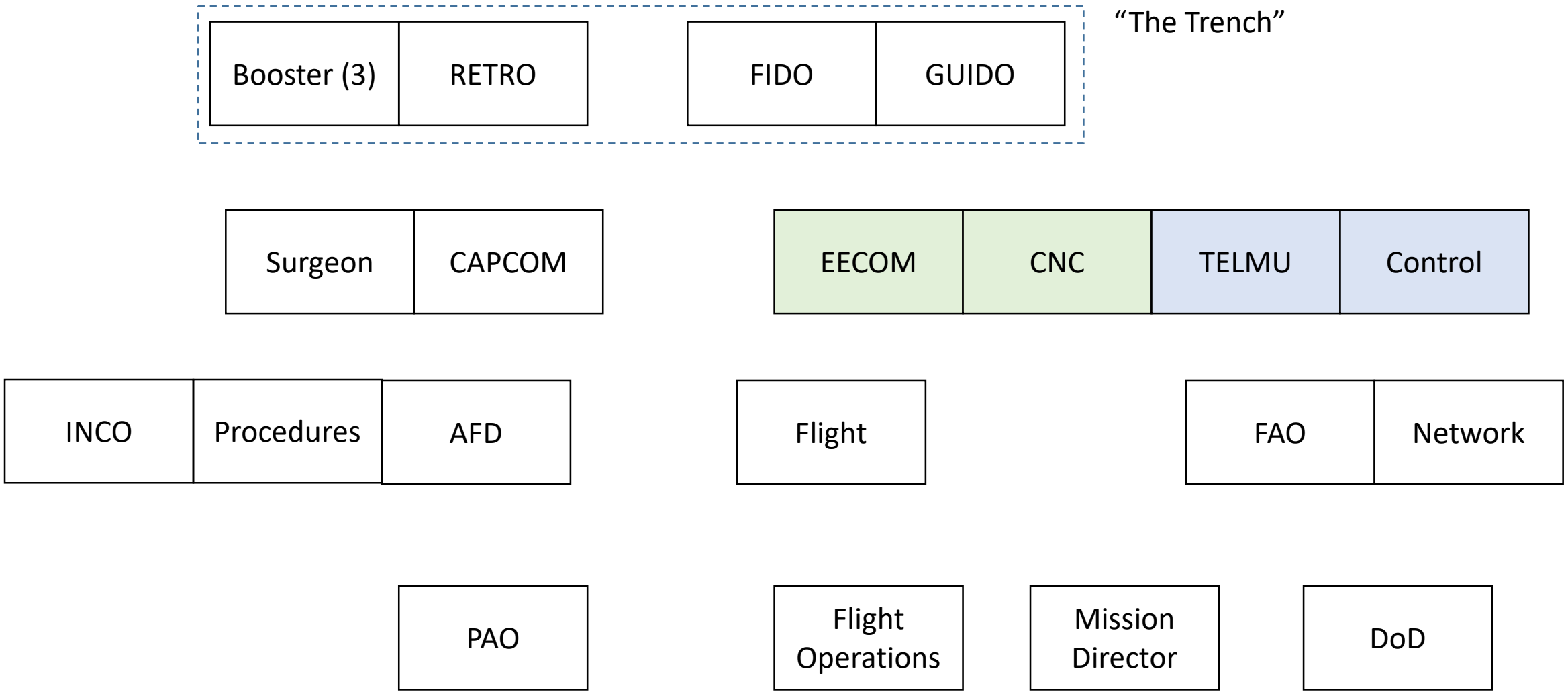

GREENWICH MEAN TIME
COUNTDOWN
ELAPSED TIME
TIME TO
CYN HAW CAL DYN TEX CNV BDA ATS CYI


The Mission Control Center at the Johnson Spaceflight Center in Houston, and especially its Mission Operations Control Room (MOCR), may be NASA's most well-known historical landmark--even though very few people would recognize the outside of the building that housed the room and its sophisticated computing technologies and instruments. Most Americans are familiar with this room through television broadcasts of the MOCR during Apollo flights, which made an ordinary television the world's window to the "nerve center" of NASA's missions.
South Wing
Mission Operations Wing
Apollo Mission Control
Main Lobby
Visitor's Lobby
Mission Control Center Administration Wing
NOT TO SCALE
MISSION CONTROL CENTER COMPLEX
BIULDING ISOMETRIC



KEY

1. Booster Systems Engineer
2. Retrofire Officer
3. Flight Dynamics
4. Guidance Officer
5. Flight Surgeon
6. Spacecraft Communicator
7. Electrical
8. Mechanical
9. Life Support
10. Operations & Procedures Manager
11. Ass't Flight Director
12. Flight Director
13. Experimenting & Flight Planning
14. Network Controller
15. Public Affairs Officer
16. Flight Operations Director
17. Mission Director
18. DOD Rep.
19. Viewing Room
20. Telephone/Press Booths
21. Mission Control Main Floor
22. Display Screen
23. Projector Plotter Display Equipment Room


Booster (3)
RETRO
FIDO
GUIDO
"The Trench"
Surgeon
CAPCOM
EECOM
CNC
TELMU
Control
INCO
Procedures
AFD
Flight
FAO
Network
PAO
Flight Operations
Mission Director
DoD

MSC-01807
11/1/70

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FINAL
FLIGHT MISSION RULES

APOLLO 14
(AS-509/110/LM-8)

NOVEMBER 1, 1970

PREPARED BY
FLIGHT CONTROL DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

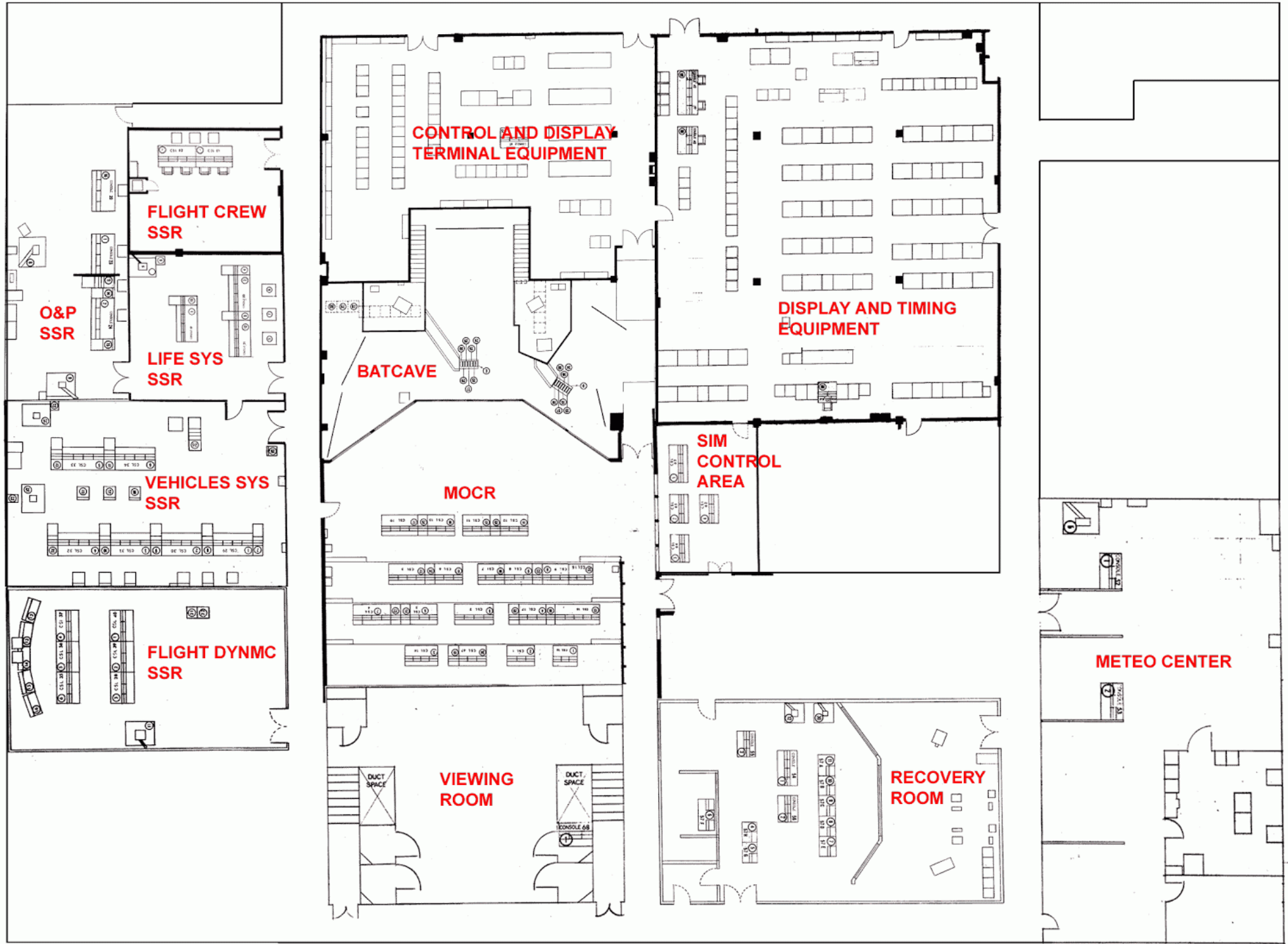
FOR NASA/DOD INTERNAL USE ONLY
INCLUDING APPROPRIATE CONTRACTORS

INDEXING DATA

DATE	OPR	#	T	PGM	SUBJECT	SIGNATOR	LOC
11-01-70	MSC	MSC-01807	R	Apo	(Index)	MSC	079-47

R	ITEM	
		' POWERED DESCENT PHASE '
	3-49	PDI IGNITION
		THE FOLLOWING ACTION WILL BE TAKEN---
		1. AUTO ULLAGE GOOD
		- IF NO AUTO DPS IGN, FLIGHT CREW PERFORM MANUAL DPS IGNITION
		2. NO AUTO ULLAGE
		-FLIGHT CREW BACK UP THE ULLAGE MANEUVER
		-IF NO AUTO DPS IGN FLIGHT CREW WILL NO-GO PDI
	3-50	PDI TO LO GATE
		POWERED DESCENT WILL BE ABORTED FOR THE FOLLOWING---
		A. LR DATA IS REQUIRED FOR LANDING - NO LR DATA BY 10 K FT - ABORT.
		1. LR CONVERGENCE (ALTITUDE ONLY) - DATA NOT BEING ACCEPTED OR CONVERGING FOLLOWING LOCKON FOR 60 SECONDS - ABORT.
		2. LR DATA ACCEPTED AND CONVERGED CONTINOUS TO P-64 - CONTINUE MISSION IF LOSS OF LOCK OCCURS IN P-64.
		3. LR DATA ACCEPTED AND CONVERGED WITH SUBSEQUENT DROPOUT - CONTINUE TO P-64.
		(A) LANDING RADAR REGAINED IN P-64.
		(1) DELTA H LESS THAN 1000 FT BETWEEN PGNS AND LR - CONTINUE MISSION.
		(2) DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.
		(B) LR NOT REGAINED IN P-64 - ABORT.
		4. LATE LR LOCKON WITH DATA BEING INCORPORATED AND CONVERGING - CONTINUE TO P-64.
		(A) DELTA H LESS THAN 1000 FT BETWEEN PGNS AND LR - CONTINUE MISSION.
		(B) DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.
		B. PGNS ALTITUDE LESS THAN 22,000 FEET AND PNGS NAVIGATION ERRORS, CONFIRMED BY MSFN OR DOPPLER RESIDUALS, THAT CAUSE THE AGS-PGNS RADIAL VELOCITY DIFFERENCE TO EXCEED MINUS 10 FPS, PRIOR TO LANDING RADAR ALTITUDE INCORPORATION AND CONVERGENCE (A MINUS VELOCITY DIFFERENCE INDICATES THAT THE AGS TRAJECTORY IS LOWER THAN THE PNGS TRAJECTORY).
		C. PNGS NAVIGATION ERRORS, CONFIRMED BY MSFN OR DOPPLER RESIDUALS, THAT RESULT IN THE FOLLOWING AGS-PNGS VELOCITY DIFFERENCES---
		DELTA X DOT (DOWNRANGE) GREATER THAN +/- 45 FPS DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 90 FPS DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS
		D. PGNS ALTITUDE LESS THAN 18,000 FEET AND PNGS NAVIGATION ERRORS, CONFIRMED BY DOPPLER BUT NOT BY AGS, CAUSE THE MSFN-PGNS RADIAL VELOCITY DIFFERENCE TO EXCEED MINUS 20 FPS PRIOR TO LANDING RADAR ALTITUDE INCORPORATION AND CONVERGENCE.
		E. PNGS NAVIGATION ERRORS CONFIRMED BY DOPPLER RESIDUALS BUT NOT BY AGS, THAT RESULT IN THE FOLLOWING MSFN-PNGS VELOCITY DIFFERENCES---
		DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 200 FPS. DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS.
		NOTE---RULES C AND E ARE INDEPENDENT OF ANY TYPE OF LANDING RADAR UPDATE. FOR RULES B AND C, SWITCHOVER TO AGS WILL BE PERFORMED.

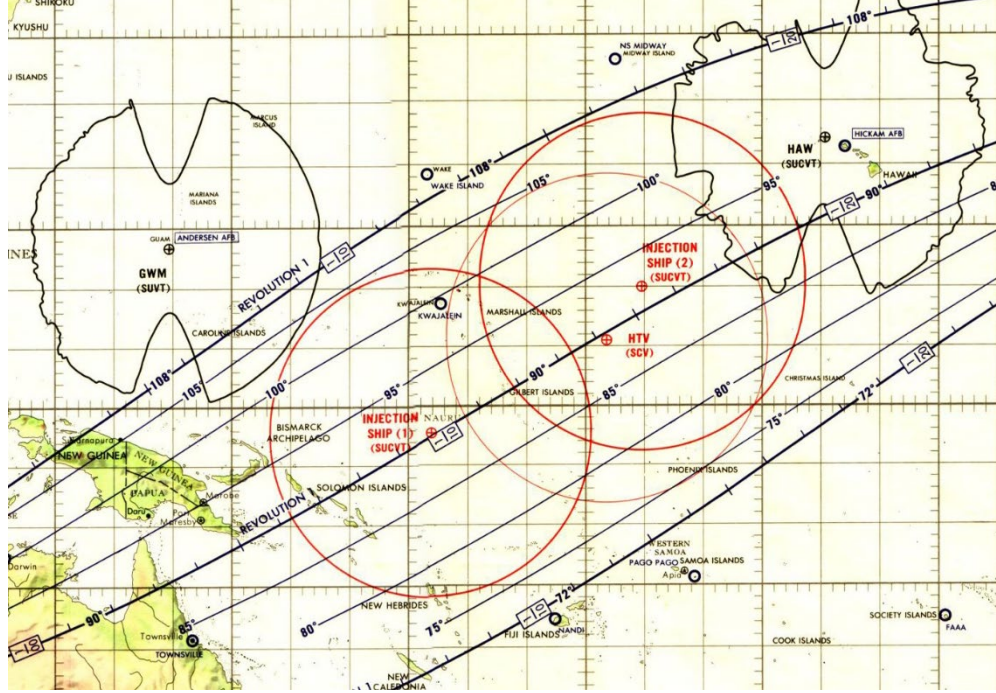
R	ITEM	
	5-89	LR DATA IS REQUIRED FOR LANDING--NO LR DATA BY 10K FT -ABORT.
		A. LR CONVERGENCE (ALTITUDE ONLY) - DATA NOT BEING ACCEPTED OR CONVERGING FOLLOWING LOCKON FOR 60 SECONDS - ABORT.
		B. LR DATA ACCEPTED AND CONVERGED CONTINUOUS TO P-64 - CONTINUE MISSION IF LOSS OF LOCK OCCURS IN P-64.
		C. LR DATA ACCEPTED AND CONVERGED WITH SUBSEQUENT DROPOUT - CONTINUE TO P-64.
		1. LANDING RADAR REGAINED IN P-64.
		(A) DELTA H LESS THAN 1000FT BETWEEN PGNS AND LR - CONTINUE MISSION.
		(B) DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.
		2. LR NOT REGAINED AT P-64 - ABORT.
		D. LATE LR LOCKON WITH DATA BEING INCORPORATED AND CONVERGING - CONTINUE TO P-64.
		1. DELTA H LESS THAN 1000 FT BETWEEN PGNS AND LR - CONTINUE MISSION.
		2. DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.
	5-90	A. POWERED DESCENT WILL BE TERMINATED FOR---
		1. PGNS ALTITUDE LESS THAN 22,000 FEET AND PNGS NAVIGATION ERRORS, CONFIRMED BY MSFN OR DOPPLER RESIDUALS, THAT CAUSE THE AGS-PGNS RADIAL VELOCITY DIFFERENCE TO EXCEED MINUS 10 FPS, PRIOR TO LANDING RADAR ALTITUDE INCORPORATION AND CONVERGENCE (A MINUS VELOCITY DIFFERENCE INDICATES THAT THE AGS TRAJECTORY IS LOWER THAN THE PNGS TRAJECTORY).
		2. PNGS NAVIGATION ERRORS, CONFIRMED BY MSFN OR DOPPLER RESIDUALS, THAT RESULT IN THE FOLLOWING AGS-PNGS VELOCITY DIFFERENCES--- DELTA X DOT (DOWNRANGE) GREATER THAN +/- 45 FPS DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 90 FPS DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS
		3. PGNS ALTITUDE LESS THAN 18,000 FEET AND PNGS NAVIGATION ERRORS, CONFIRMED BY DOPPLER BUT NOT BY AGS, CAUSE THE MSFN-PGNS RADIAL VELOCITY DIFFERENCE TO EXCEED MINUS 20 FPS PRIOR TO LANDING RADAR ALTITUDE INCORPORATION AND CONVERGENCE.
		4. PNGS NAVIGATION ERRORS CONFIRMED BY DOPPLER RESIDUALS BUT NOT BY AGS, THAT RESULT IN THE FOLLOWING MSFN-PNGS VELOCITY DIFFERENCES--- DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 200 FPS. DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS.
		NOTE---RULES 2 AND 4 ARE INDEPENDENT OF ANY TYPE OF LANDING RADAR UPDATE. FOR RULES 1 AND 2, SWITCHOVER TO AGS WILL BE PERFORMED.
		5. COMMANDED THRUST INCREASING PRIOR TO THROTTLE DOWN OR P63 TGO=80 SEC.
		6. RESERVED
		7. NO THROTTLE RECOVERY BY P63/64 PROGRAM SWITCH PLUS 15 SEC.
		8. FAILURE TO ACHIEVE FTP BY NOMINAL TIG +31 SEC. (ABORT AT GTC DIVERGENCE).
		9. FAILURE TO ENTER P64 WHEN TGO EQUALS 60 SECONDS.
		10. THE FOLLOWING PNGS ALARMS---20105, 00214, 20430, 20607, 21103, 01107, 21204, 21302, 21501, 00402 (CONTINUING).
		B. POWERED DESCENT MANEUVER WILL BE TERMINATED AND AN ABORT REQUESTED IF THE TIME BIASED DPS ABORT BOUNDARY IS VIOLATED.
	5-91	AN ABORT WILL NOT BE REQUESTED FOR A PNGS FAILURE AFTER A PNGS INDICATION THAT THE HIGH GATE TARGETING CONDITIONS HAVE BEEN ACHIEVED.

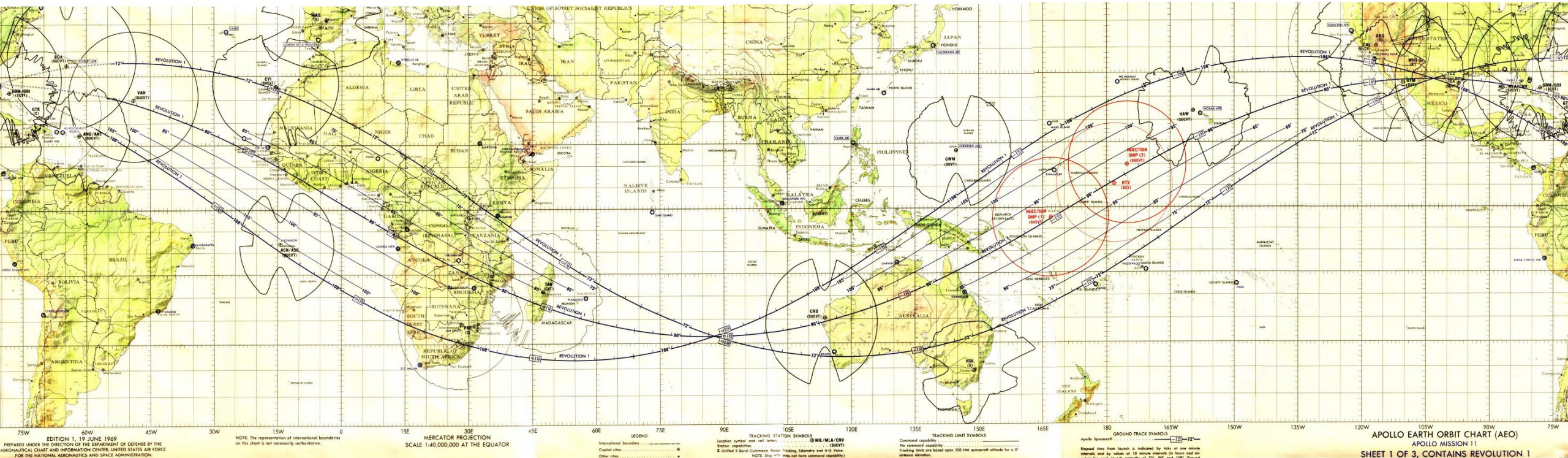

FLIGHT CREW SSR
O&P SSR
LIFE SYS SSR
VEHICLES SYS SSR
FLIGHT DYNMC SSR
CONTROL AND DISPLAY TERMINAL EQUIPMENT
BATCAVE
MOCR
VIEWING ROOM
DUCT SPACE
CONSOLE 68
DISPLAY AND TIMING EQUIPMENT
SIM CONTROL AREA
RECOVERY ROOM
METEO CENTER

Program	Number of crewmen	Simulator time, hr (a)	Simulator time per crewman (average), hr	Total training program time, hr	Simulator portion of total training program time, percent
Mercury	7	1 330	190	4 038	33
Gemini	20	6 964	348	17 991	39
Apollo (through mission 15)	32	29 967	936	69 248	43
Total	59	38 261	--	91 277	42

Apollo Mission	Integrated Simulation sessions, days			
	CMS/MCC	LMS/MCC	CMS/LMS/MCC	Total
7	18	0	0	18
8	14	0	0	14
9	10	2	8	20
10	11	0	7	18
11	7	4	7	18
12	10	3	12	25
13	13	5	9	27
14	15	7	13	35
15	19	5	7	31

Manned Space Flight Network





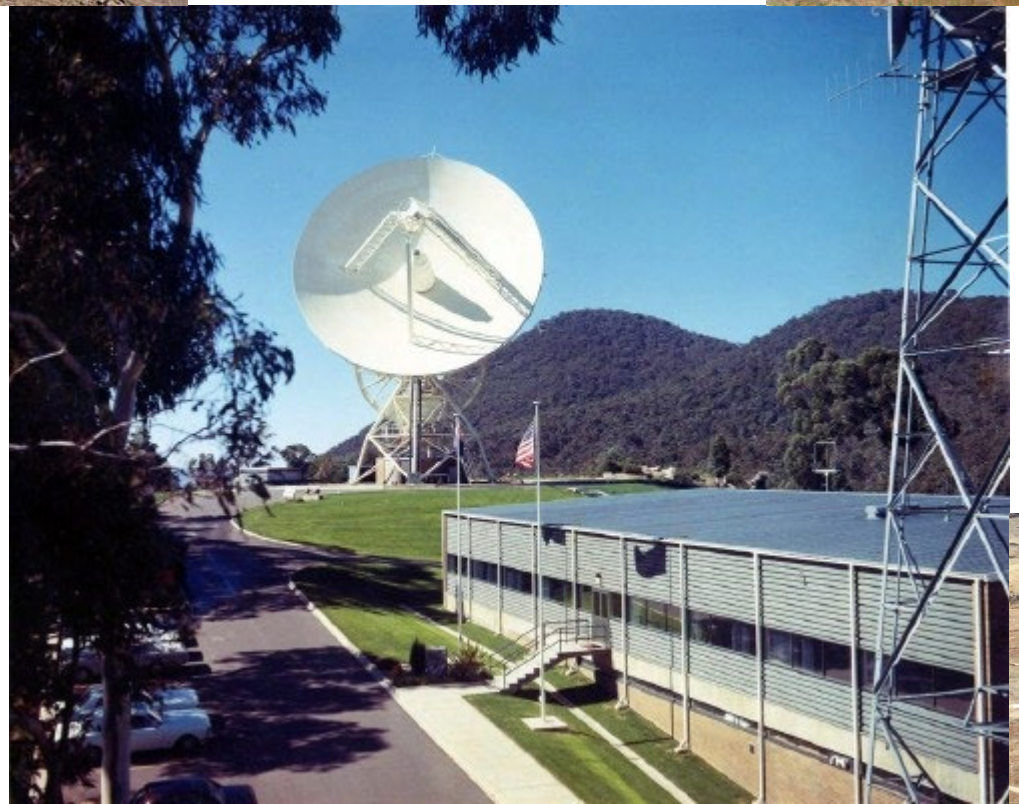
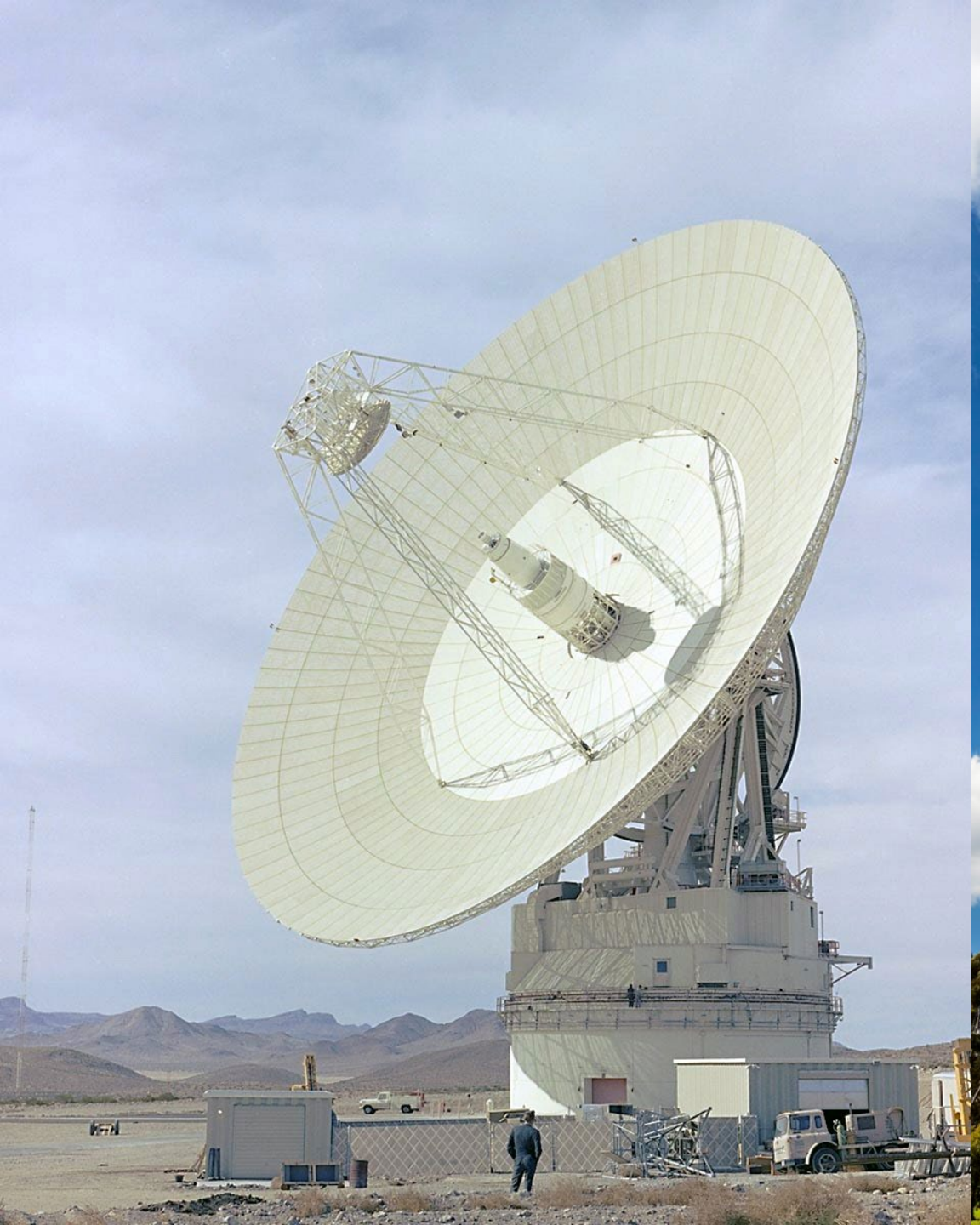
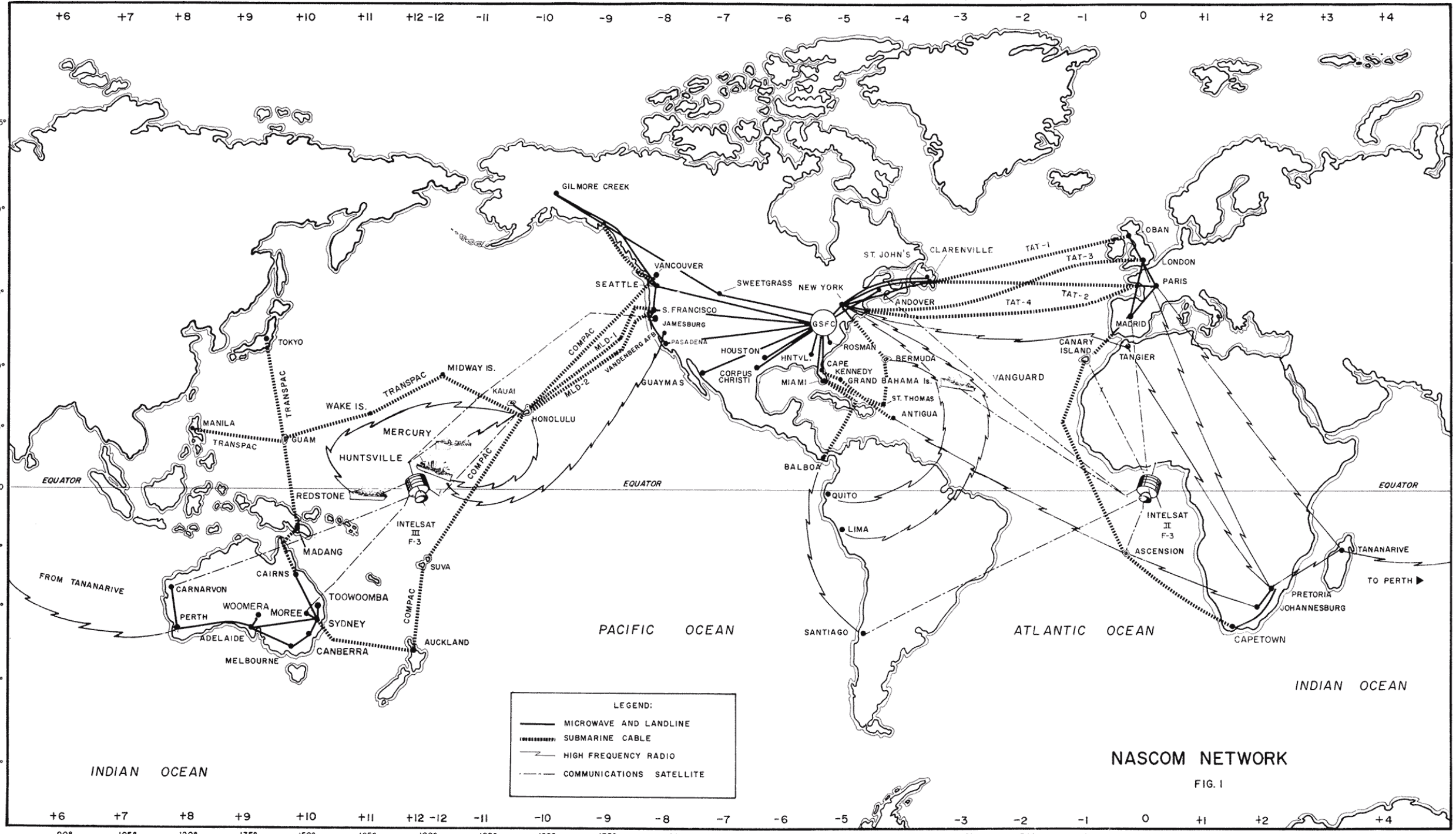


Table 1-1. Network Configuration for AS-512

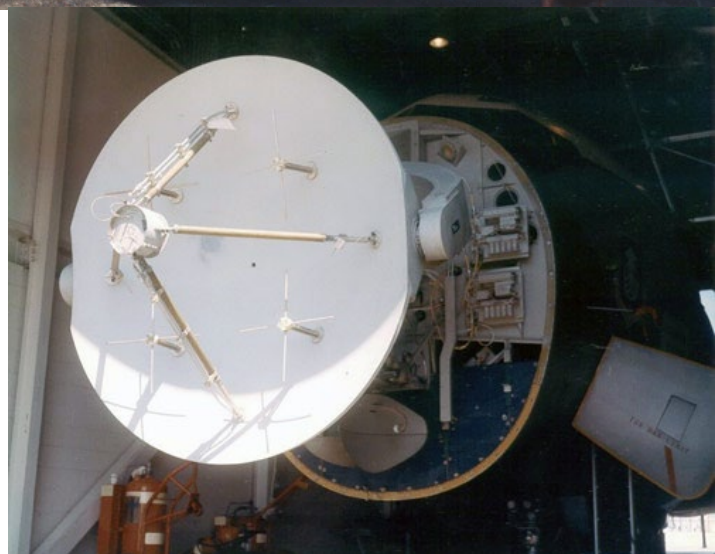
SYSTEMS / STATIONS	TRACKING			USB				TLM			DATA PROCESSING				COMM				OTHER	
	C-band (High-speed)	C-band (Low-speed)	USB	TV to MCC	Voice	TLM	Command	VHF Links	Mag Tape Recording	Decoms	642B TLM	642B CMD	CDP	Acq Computer	High-speed Data	TTY	Voice (SCAMA)	Voice VHF A/G	Range Safety	SPAN
ACN			X		X	X	X	X	X	X	X	X		X	X	X	X	X		
ANT	X	X																X	X	
ARIA(4)					X	X		X	X							X	X	X		
AOCC																X	X			
BDA	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	
CNV	X	X																	X	
CRO	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X		X
CYI			X		X	X	X	X	X	X	X	X		X	X	X	X	X		X
GBI	X	X																	X	
GDS			X	X	X	X	X		X	X	X	X		X	X	X	X	X		
PIR			X		X	X	X							X						
GTK	X	X																	X	
GWM			X		X	X	X	X	X	X	X	X		X	X	X	X	X		
HAW			X		X	X	X	X	X	X	X	X		X	X	X	X	X		
HSK			X	X	X	X	X		X	X	X	X		X	X	X	X			
NBE			X		X	X	X							X						
MAD			X	X	X	X	X		X	X	X	X		X	X	X	X			
RID			X		X	X	X							X						
MARS				X	X	X														
MIL			X		X	X	X	X	X	X	X	X		X	X	X	X	X		
MLA	X	X																	X	
PARKES				X	X	X														
TEX			X		X	X	X	X	X	X	X	X		X	X	X	X	X		
VAN	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		
ETC			X		X	X	X		X	X	X	X				X	X			

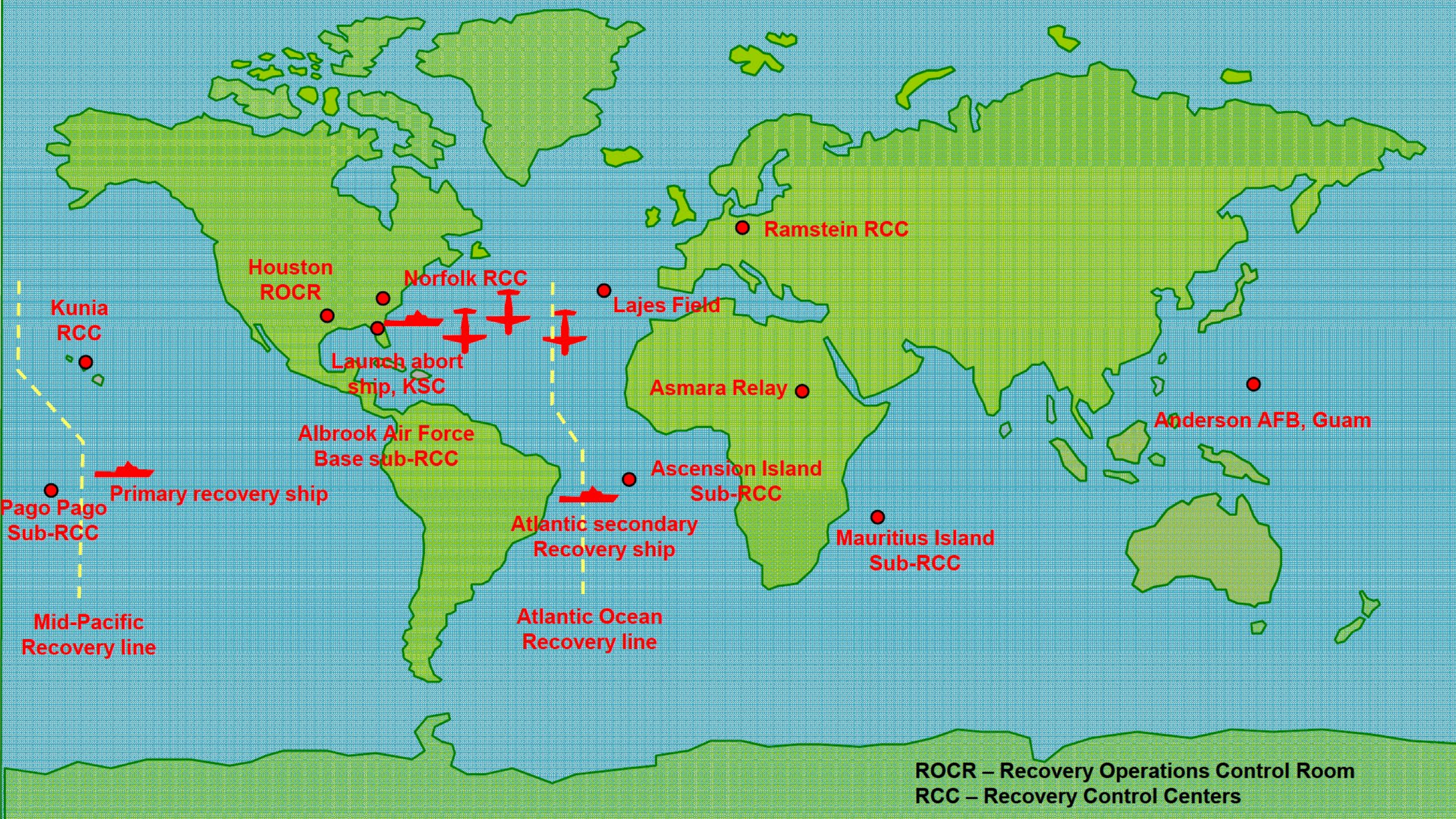




NASCOM NETWORK

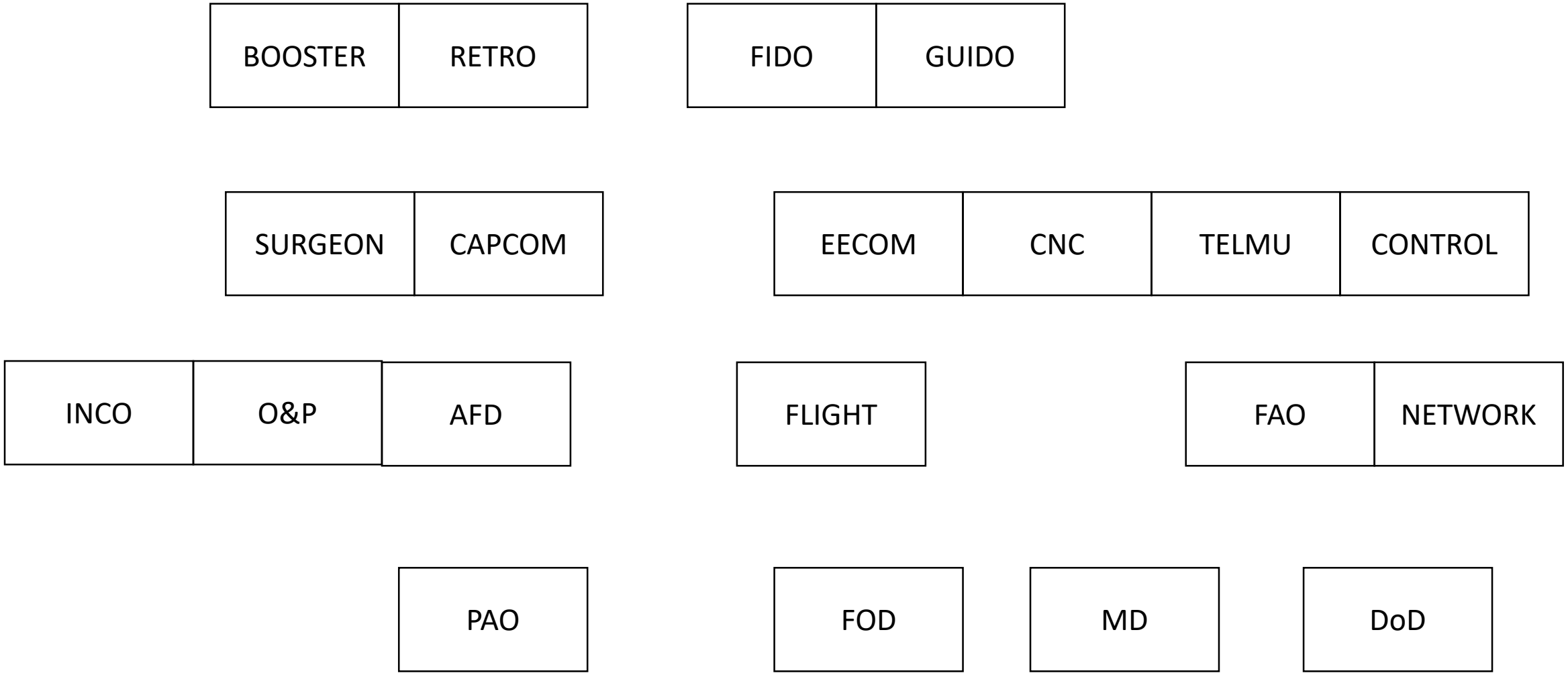
FIG. 1




Ramstein RCC
Houston
ROCR
Norfolk RCC
Lajes Field
Kunia
RCC
Launch abort
ship, KSC
Asmara Relay
Anderson AFB, Guam
Albrook Air Force
Base sub-RCC
Ascension Island
Sub-RCC
Primary recovery ship
Pago Pago
Sub-RCC
Atlantic secondary
Recovery ship
Mauritius Island
Sub-RCC
Mid-Pacific
Recovery line
Atlantic Ocean
Recovery line
ROCR – Recovery Operations Control Room
RCC – Recovery Control Centers

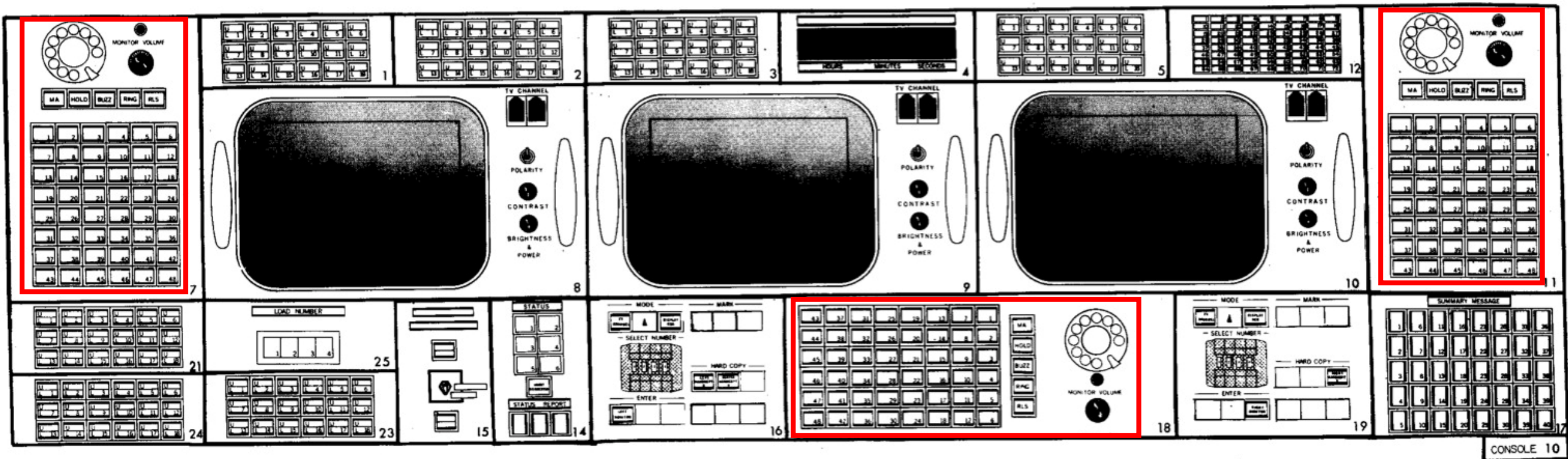
Discussion Groups

- Cox Chapters 18 and 19 (“We’re Going to Put a Guy in That Thing and Light It”, “There Will Always Be People Who Want to Work in That Room”)
  - The creation of Mission Control
- Mission Control video
  - Interviews with several flight controllers
- Woodling (“Simulation of Manned Space Flight for Crew Training”)
  - The development and use of spacecraft simulators
- Tsiao Chapter 5 (“The Apollo Years”)
  - Creation of the Manned Space Flight Network

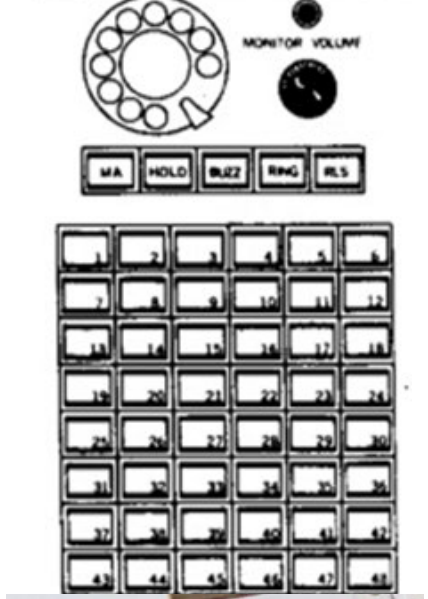

BOOSTER
RETRO
FIDO
GUIDO
SURGEON
CAPCOM
EECOM
CNC
TELMU
CONTROL
INCO
O&P
AFD
FLIGHT
FAO
NETWORK
PAO
FOD
MD
DoD


BOOSTER SYSTEMS
ENGINEER
MONITOR VOLUME
NASA
© Jim Early 2017

LOC	DESCRIPTION	TYPE	NOTE	LOC	DESCRIPTION	TYPE
01	EVENT INDICATOR	D9/5B		14	STATUS/STATUS REPORT	D9/1A
02	EVENT INDICATOR	D9/5B		15	TOGGLE SWITCH/INDICATOR	D9/9A
03	EVENT INDICATOR	D9/5B		16	MANUAL SELECT KEYBOARD	A6B/5
04	7 DIGIT CLOCK	D8/3		17	SUMMARY MSG ENABLE KEYBOARD	A19/A
05	EVENT INDICATOR	D9/5B		18	VOICE COMM POSITION-3018	H48MFD
07	VOICE COMM POSITION-3016	V48MFD		19	MANUAL SELECT KEYBOARD	A6B/6
08	TV MONITOR 14" PRECISION	C2/1		21	SWITCH MODULE	D9/40F
09	TV MONITOR 14" PRECISION	C2/1		23	SWITCH MODULE	D9/40E
10	TV MONITOR 14" PRECISION	C2/1		24	SWITCH MODULE	D9/40F
11	VOICE COMM POSITION-3017	V48MFD		25	LOAD NUMBER INDICATOR	D9/41B
12	EVENT INDICATOR (72)	D9/28				




MULTI-CHANNEL REPRODUCER
SOUNDSCRIBER
AMPEX
AMPEX
AMPEX



APOLLO 11 AS-506 3RD FL HISTORICAL RECORDER #1 06-09-69

CH 1	TIME GMT IRIG B FORMAT		CH 16	INCO	POS 009
2	FLIGHT OPS DIR	POS 608	17	EECOM	POS 638
3	MISSION DIRECTOR	POS 001	18	GNC	POS 010
4	DOD MANAGER	POS 007	19	RETRO	POS 020
5	OPS AND PRO	POS 004	20	FIDO	POS 017
6	ASST FLIGHT DIR	P6S 003	21	GUIDO [L]	POS 018
7	FLIGHT DIRECTOR [L]	POS 609	22	GUIDO [R]	POS 019
8	FLIGHT DIRECTOR [R]	POS 002	23	LOAD CONTROL	POS 825
9	FLT PLANS OFFICER	POS 005	24	RTC	POS 824
10	NETWORK CONTROLLER [L]	POS 602	25	CCATS CMD	POS 823
11	NETWORK CONTROLLER [R]	POS 008	26	TIC	POS 827
12	SURGEON [L]	POS 016	27	CCATS TM	POS 826
13	SURGEON [R]	POS 015	28	TRACK [L]	POS 836
14	CAPCOM [L]	POS 639	29	TRACK [R]	POS 837
15	CAPCOM [R]		30	VOICE ANNOTATION	

APOLLO 11 AS-506 3RD FL HISTORICAL RECORDER #2 06-09-69

CH 1	TIME GMT IRIG B FORMAT		CH 16	SPAN	POS 056
2	NASA RECOVERY COORD	POS 082	17	BOOSTER [L]	POS 013
3	ASST NASA RECOVERY COORD	POS 083	18	BOOSTER [C]	POS 640
4	RECOVERY STATUS	POS 084	19	BOOSTER [R]	POS 012
5	RECOVERY EVALUATOR	POS 641	20	3 FLIGHT DIRECTOR LOOP	I-301
6	DOD COORD	POS 076	21	3 AFD CONF LOOP	L-091
7	DOD PRIMARY OP	POS 077	22	3 GOSS 2 LOOP	I-277
8	DOD MANAGER [RCVY]	POS 074	23	ALSEP EAO 2	POS 613
9	DOD EXEC	POS 075	24	3 MOCR DYN LOOP	I-062
10	DOD ASST FOR COMM-1	POS 078	25	3 GOSS CONF LOOP	I-275
11	DOD PIO	POS 079	26	3 GOSS 4 LOOP	I-300
12	COMM TECH [3RD FL]	POS 206	27	LM GNC ENGINEER	POS 011
13	COMM CONTROLLER [3RD FL]	POS 205	28	LM EECOM ENGINEER	POS 604
14	SPACE ENVIRONMENT	POS 090	29	EXPMT ACTIVITIES OFFICER	POS 603
15	COMPUTER SUPPORT	POS 176	30	VOICE ANNOTATION	