

Mission Operations

HONR 269i

To the Moon and Back: The Apollo Program

[The Vital Link](#)



GREENWICH MEAN TIME
17:42:31.00

COUNTDOWN
00

ELAPSED TIME
00:00:44

TIME TO REENTRY
17:44:31

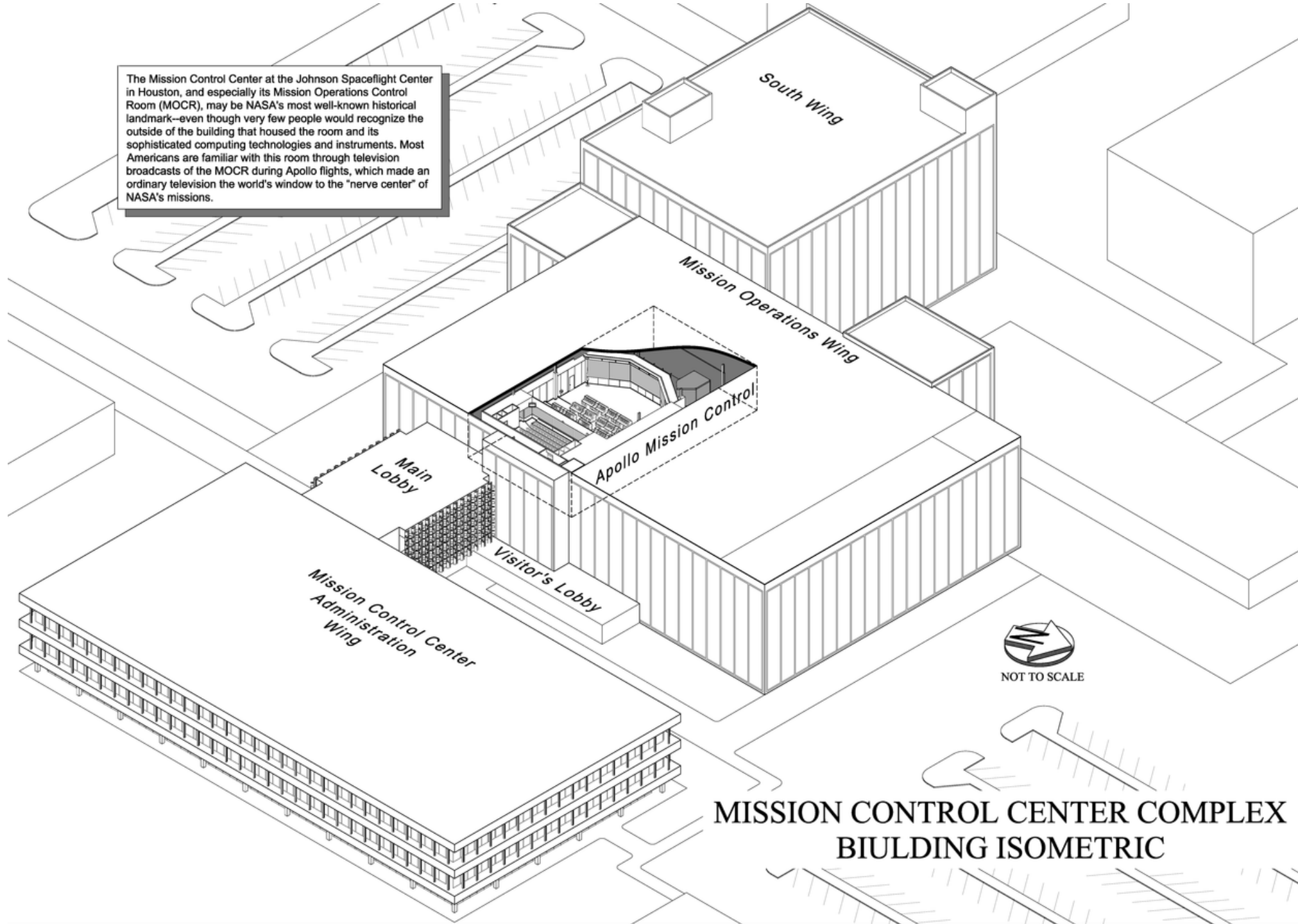


CYN HAW CAL MYA TEX CNV BCL AYS OVI

TIME	ALTITUDE	TEMPERATURE	ACCELERATION	STATUS
00:00:00	0	0	0	LAUNCH
00:00:15	100	100	100	ASCENDING
00:00:30	200	200	200	CLIMBING
00:00:45	300	300	300	CRUISING
00:01:00	400	400	400	STABLE
00:01:15	500	500	500	MONITORING
00:01:30	600	600	600	ANALYZING
00:01:45	700	700	700	REPORTING
00:02:00	800	800	800	CONCLUDING
00:02:15	900	900	900	ENDING
00:02:30	1000	1000	1000	COMPLETE



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.

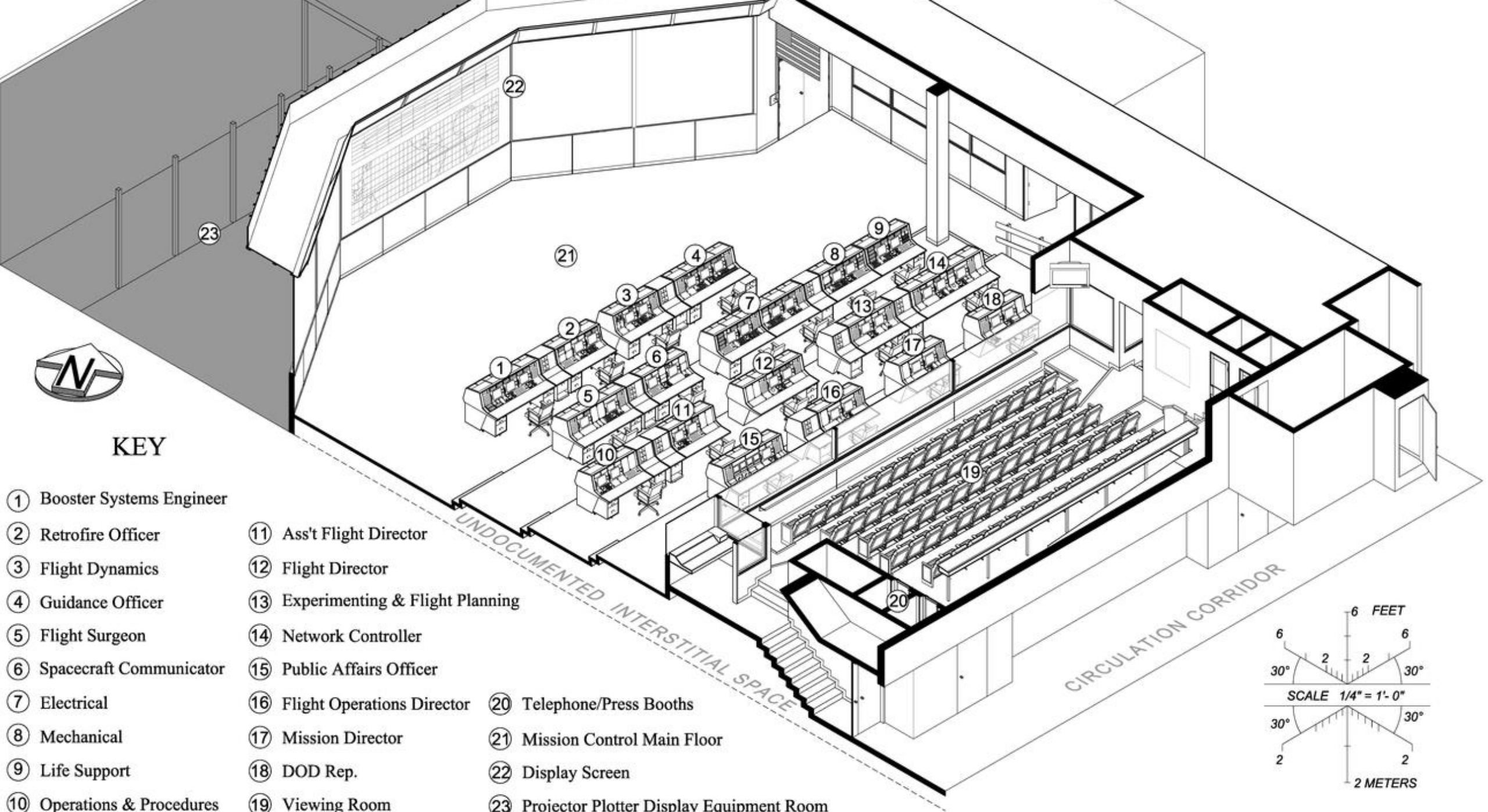


**MISSION CONTROL CENTER COMPLEX
BIULDING ISOMETRIC**



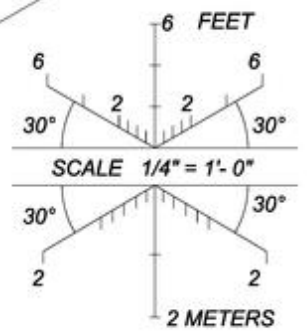
MISSION
STATUS
001 002 003 004
005 006 007 008
009 010 011 012
013 014 015 016
017 018 019 020
021 022 023 024
025 026 027 028
029 030 031 032
033 034 035 036
037 038 039 040
041 042 043 044
045 046 047 048
049 050 051 052
053 054 055 056
057 058 059 060
061 062 063 064
065 066 067 068
069 070 071 072
073 074 075 076
077 078 079 080
081 082 083 084
085 086 087 088
089 090 091 092
093 094 095 096
097 098 099 100

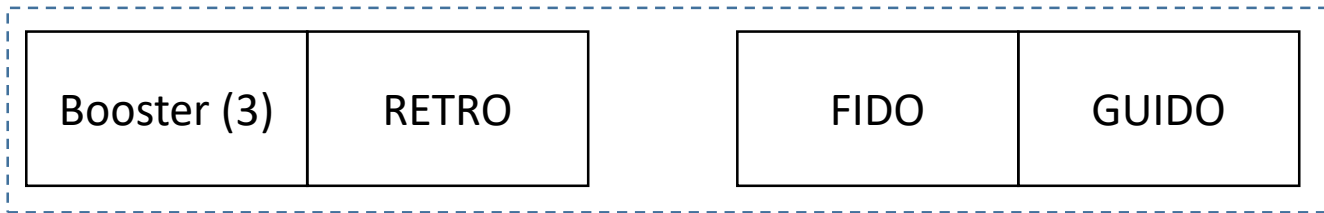




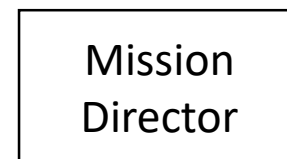
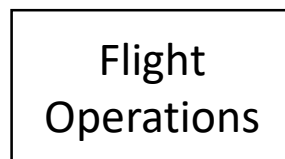
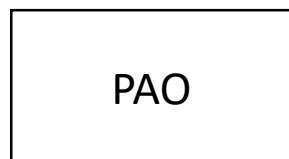
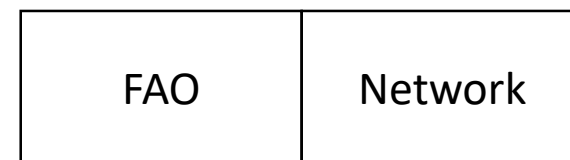
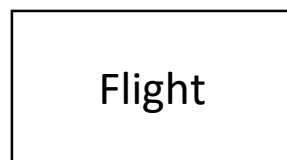
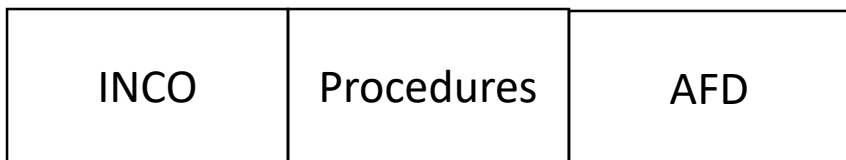
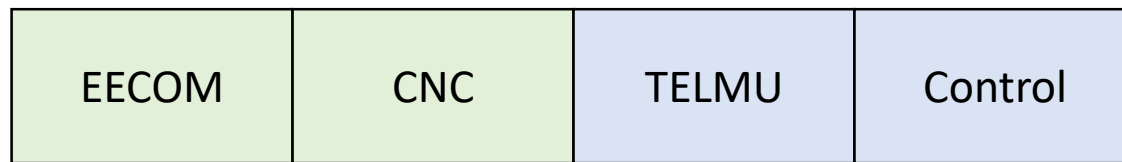
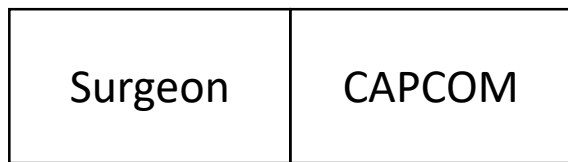
KEY

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





“The Trench”





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 PSL MSC-01807 R AS (509) MSC 079-07

NASA - Manned Spacecraft Center

MISSION RULES

SECTION 3 MISSION RULE SUMMARY

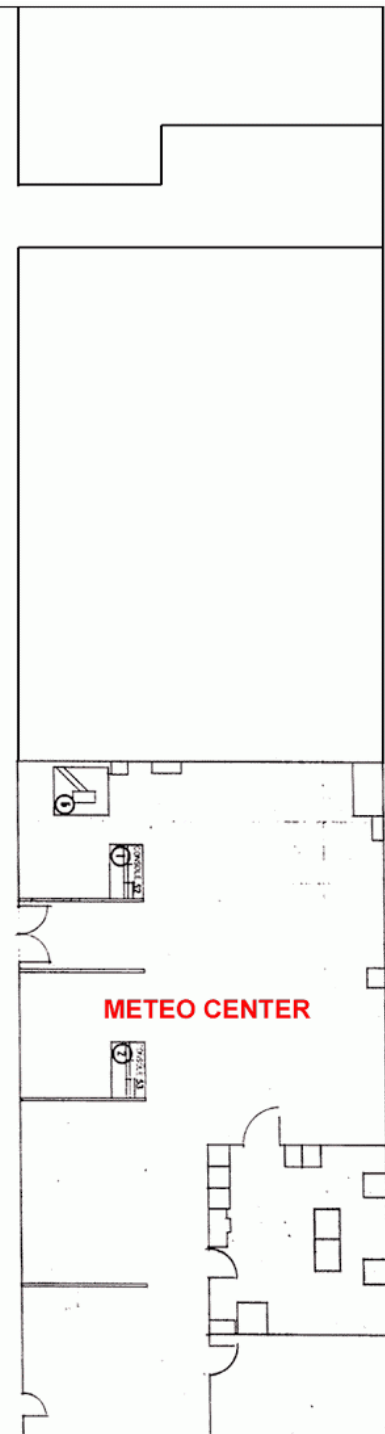
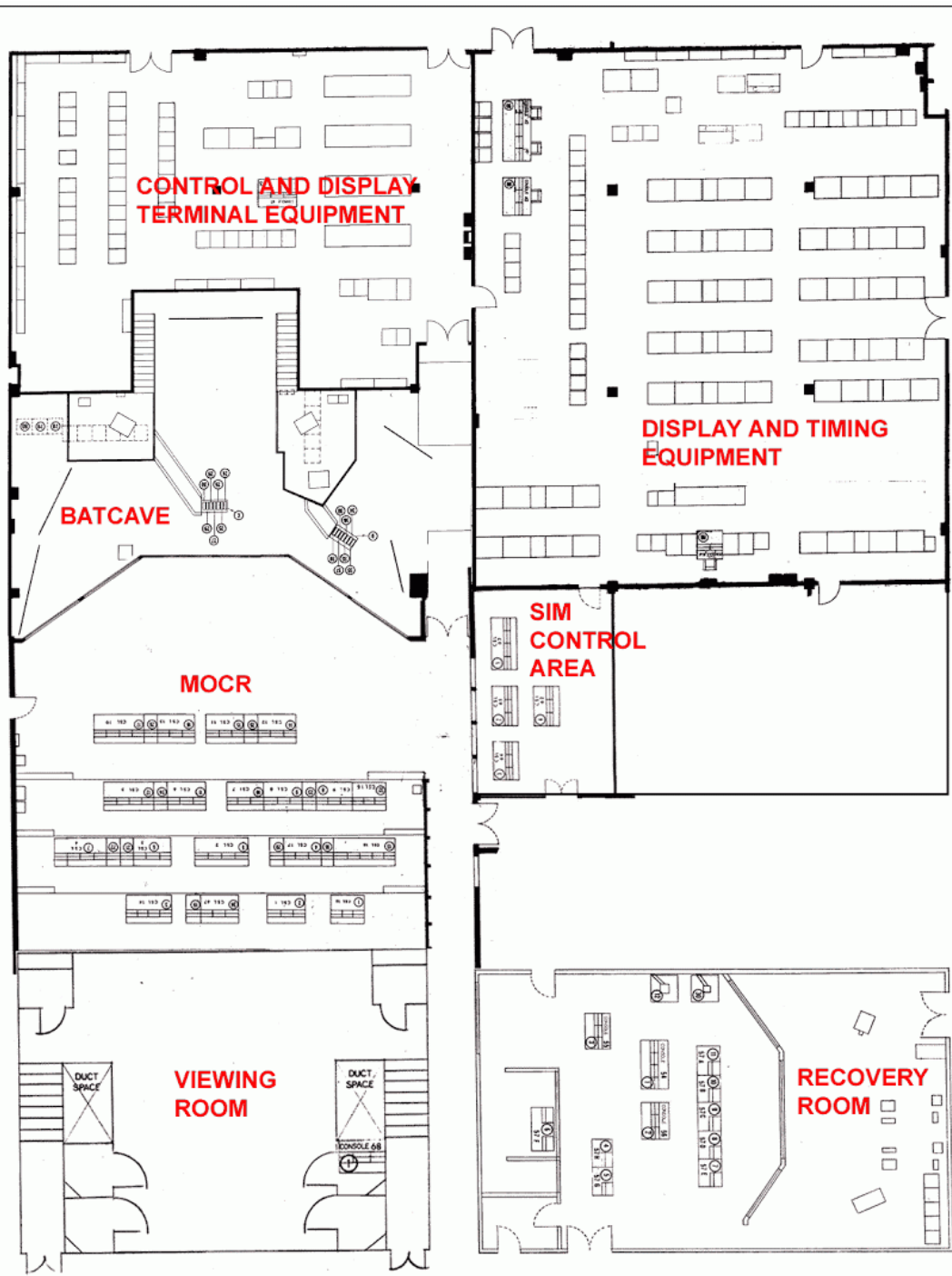
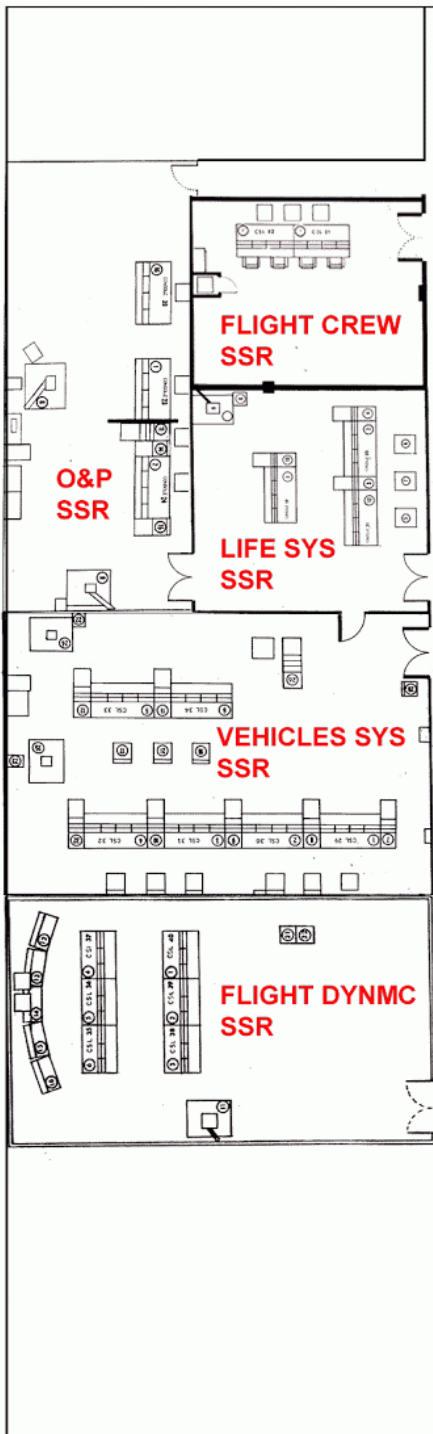
R	ITEM													
		----- ! POWERED DESCENT PHASE ! -----												
3-49	PDI IGNITION	<p>THE FOLLOWING ACTION WILL BE TAKEN---</p> <p>1. AUTO ULLAGE GOOD - IF NO AUTO DPS IGN, FLIGHT CREW PERFORM MANUAL DPS IGNITION</p> <p>2. NO AUTO ULLAGE -FLIGHT CREW BACK UP THE ULLAGE MANEUVER -IF NO AUTO DPS IGN FLIGHT CREW WILL NO-GO PDI</p>												
3-50	PDI TO LO GATE	<p>POWERED DESCENT WILL BE ABORTED FOR THE FOLLOWING---</p> <p>A. LR DATA IS REQUIRED FOR LANDING - NO LR DATA BY 10 K FT - ABORT.</p> <p>1. LR CONVERGENCE (ALTITUDE ONLY) - DATA NOT BEING ACCEPTED OR CONVERGING FOLLOWING LOCKON FOR 60 SECONDS - ABORT.</p> <p>2. LR DATA ACCEPTED AND CONVERGED CONTINUOUS TO P-64 - CONTINUE MISSION IF LOSS OF LOCK OCCURS IN P-64.</p> <p>3. LR DATA ACCEPTED AND CONVERGED WITH SUBSEQUENT DROPOUT - CONTINUE TO P-64.</p> <p>(A) LANDING RADAR REGAINED IN P-64.</p> <p>(1) DELTA H LESS THAN 1000 FT BETWEEN PGNS AND LR - CONTINUE MISSION.</p> <p>(2) DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.</p> <p>(B) LR NOT REGAINED IN P-64 - ABORT.</p> <p>4. LATE LR LOCKON WITH DATA BEING INCORPORATED AND CONVERGING - CONTINUE TO P-64.</p> <p>(A) DELTA H LESS THAN 1000 FT BETWEEN PGNS AND LR - CONTINUE MISSION.</p> <p>(B) DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.</p> <p>B. PGNS ALTITUDE LESS THAN 22,000 FEET AND PGNS 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 PGNS TRAJECTORY).</p> <p>C. PGNS NAVIGATION ERRORS, CONFIRMED BY MSFN OR DOPPLER RESIDUALS, THAT RESULT IN THE FOLLOWING AGS-PGNS VELOCITY DIFFERENCES---</p> <p>DELTA X DOT (DOWNRANGE) GREATER THAN +/- 45 FPS DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 90 FPS DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS</p> <p>D. PGNS ALTITUDE LESS THAN 18,000 FEET AND PGNS 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.</p> <p>E. PGNS NAVIGATION ERRORS CONFIRMED BY DOPPLER RESIDUALS BUT NOT BY AGS, THAT RESULT IN THE FOLLOWING MSFN-PGNS VELOCITY DIFFERENCES---</p> <p>DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 200 FPS. DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS.</p> <p>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.</p>												
		<table border="1"> <thead> <tr> <th>MISSION</th> <th>REV</th> <th>DATE</th> <th>SECTION</th> <th>GROUP</th> <th>PAGE</th> </tr> </thead> <tbody> <tr> <td>APOLLO 14</td> <td>FNL</td> <td>11/1/70</td> <td>MISSION RULE SUMMARY</td> <td>POWERED DESCENT</td> <td>3-9</td> </tr> </tbody> </table>	MISSION	REV	DATE	SECTION	GROUP	PAGE	APOLLO 14	FNL	11/1/70	MISSION RULE SUMMARY	POWERED DESCENT	3-9
MISSION	REV	DATE	SECTION	GROUP	PAGE									
APOLLO 14	FNL	11/1/70	MISSION RULE SUMMARY	POWERED DESCENT	3-9									

NASA - Manned Spacecraft Center

MISSION RULES

SECTION 5 TRAJECTORY AND GUIDANCE

R	ITEM													
5-89	LR DATA IS REQUIRED FOR LANDING--NO LR DATA BY 10K FT -ABORT.	<p>A. LR CONVERGENCE (ALTITUDE ONLY) - DATA NOT BEING ACCEPTED OR CONVERGING FOLLOWING LOCKON FOR 60 SECONDS - ABORT.</p> <p>B. LR DATA ACCEPTED AND CONVERGED CONTINUOUS TO P-64 - CONTINUE MISSION IF LOSS OF LOCK OCCURS IN P-64.</p> <p>C. LR DATA ACCEPTED AND CONVERGED WITH SUBSEQUENT DROPOUT - CONTINUE TO P-64.</p> <p>1. LANDING RADAR REGAINED IN P-64.</p> <p>(A) DELTA H LESS THAN 1000FT BETWEEN PGNS AND LR - CONTINUE MISSION.</p> <p>(B) DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.</p> <p>2. LR NOT REGAINED AT P-64 - ABORT.</p> <p>D. LATE LR LOCKON WITH DATA BEING INCORPORATED AND CONVERGING - CONTINUE TO P-64.</p> <p>1. DELTA H LESS THAN 1000 FT BETWEEN PGNS AND LR - CONTINUE MISSION.</p> <p>2. DELTA H GREATER THAN 1000 FT BETWEEN PGNS AND LR - ATTEMPT MANUAL LANDING IN AGS.</p>												
5-90	A. POWERED DESCENT WILL BE TERMINATED FOR---	<p>1. PGNS ALTITUDE LESS THAN 22,000 FEET AND PGNS 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 PGNS TRAJECTORY).</p> <p>2. PGNS NAVIGATION ERRORS, CONFIRMED BY MSFN OR DOPPLER RESIDUALS, THAT RESULT IN THE FOLLOWING AGS-PGNS VELOCITY DIFFERENCES---</p> <p>DELTA X DOT (DOWNRANGE) GREATER THAN +/- 45 FPS DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 90 FPS DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS</p> <p>3. PGNS ALTITUDE LESS THAN 18,000 FEET AND PGNS 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.</p> <p>4. PGNS NAVIGATION ERRORS CONFIRMED BY DOPPLER RESIDUALS BUT NOT BY AGS, THAT RESULT IN THE FOLLOWING MSFN-PGNS VELOCITY DIFFERENCES---</p> <p>DELTA Y DOT (CROSSRANGE) GREATER THAN +/- 200 FPS. DELTA Z DOT (RADIAL) GREATER THAN +/- 35 FPS.</p> <p>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.</p> <p>5. COMMANDED THRUST INCREASING PRIOR TO THROTTLE DOWN OR P63 TGO=80 SEC.</p> <p>6. RESERVED</p> <p>7. NO THROTTLE RECOVERY BY P63/664 PROGRAM SWITCH PLUS 15 SEC.</p> <p>8. FAILURE TO ACHIEVE FTP BY NOMINAL TIG +31 SEC. (ABORT AT GTC DIVERGENCE).</p> <p>9. FAILURE TO ENTER P64 WHEN TGO EQUALS 60 SECONDS.</p> <p>10. THE FOLLOWING PGNS ALARMS---20105, 00214, 20430, 20607, 21103, 01107, 21204, 21302, 21501, 00402 (CONTINUING).</p> <p>B. POWERED DESCENT MANEUVER WILL BE TERMINATED AND AN ABORT REQUESTED IF THE TIME BIASED DPS ABORT BOUNDARY IS VIOLATED.</p>												
5-91	AN ABORT WILL NOT BE REQUESTED FOR A PGNS FAILURE AFTER A PGNS INDICATION THAT THE HIGH GATE TARGETING CONDITIONS HAVE BEEN ACHIEVED.													
		<table border="1"> <thead> <tr> <th>MISSION</th> <th>REV</th> <th>DATE</th> <th>SECTION</th> <th>GROUP</th> <th>PAGE</th> </tr> </thead> <tbody> <tr> <td>APOLLO 14</td> <td>FNL</td> <td>11/1/70</td> <td>TRAJECTORY AND GUIDANCE</td> <td>DESCENT</td> <td>5-12</td> </tr> </tbody> </table>	MISSION	REV	DATE	SECTION	GROUP	PAGE	APOLLO 14	FNL	11/1/70	TRAJECTORY AND GUIDANCE	DESCENT	5-12
MISSION	REV	DATE	SECTION	GROUP	PAGE									
APOLLO 14	FNL	11/1/70	TRAJECTORY AND GUIDANCE	DESCENT	5-12									





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

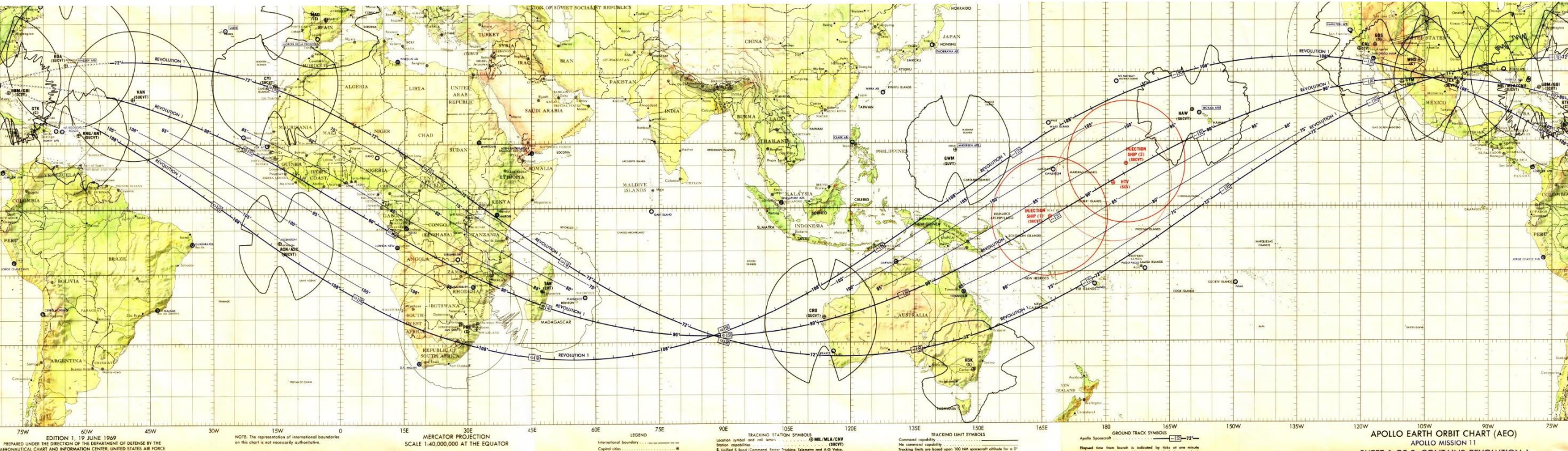
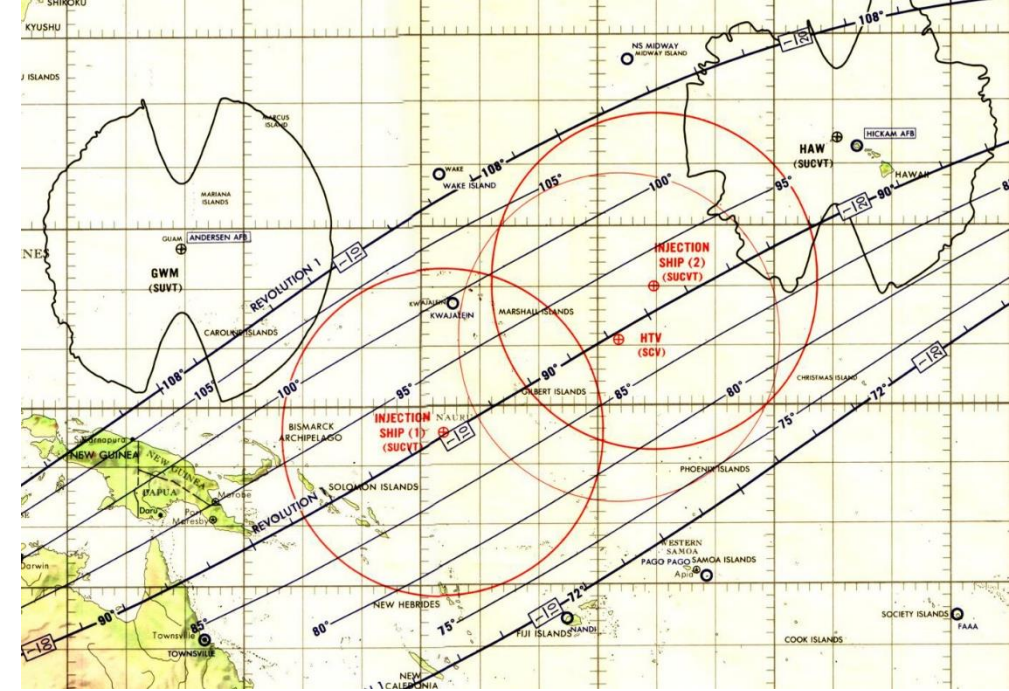
Apollo Mission	Integrated Simulation sessions, days			
	CMS/MCC	LMS/MCC	CMS/LMS/MCC	Total
7	18	0	0	18
8	14	0	0	14
9	10	2	8	20
10	11	0	7	18
11	7	4	7	18
12	10	3	12	25
13	13	5	9	27
14	15	7	13	35
15	19	5	7	31







Manned Space Flight Network



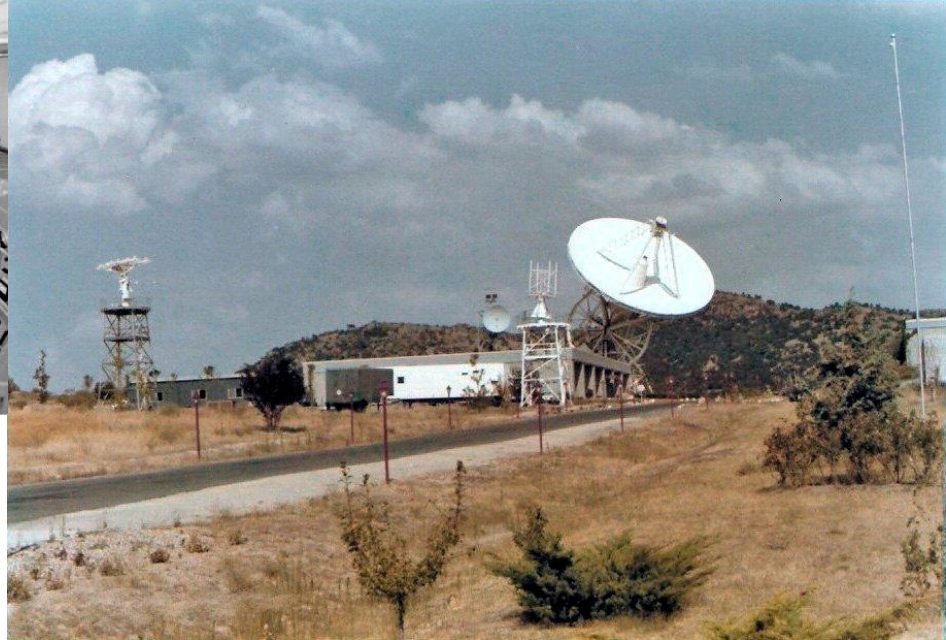
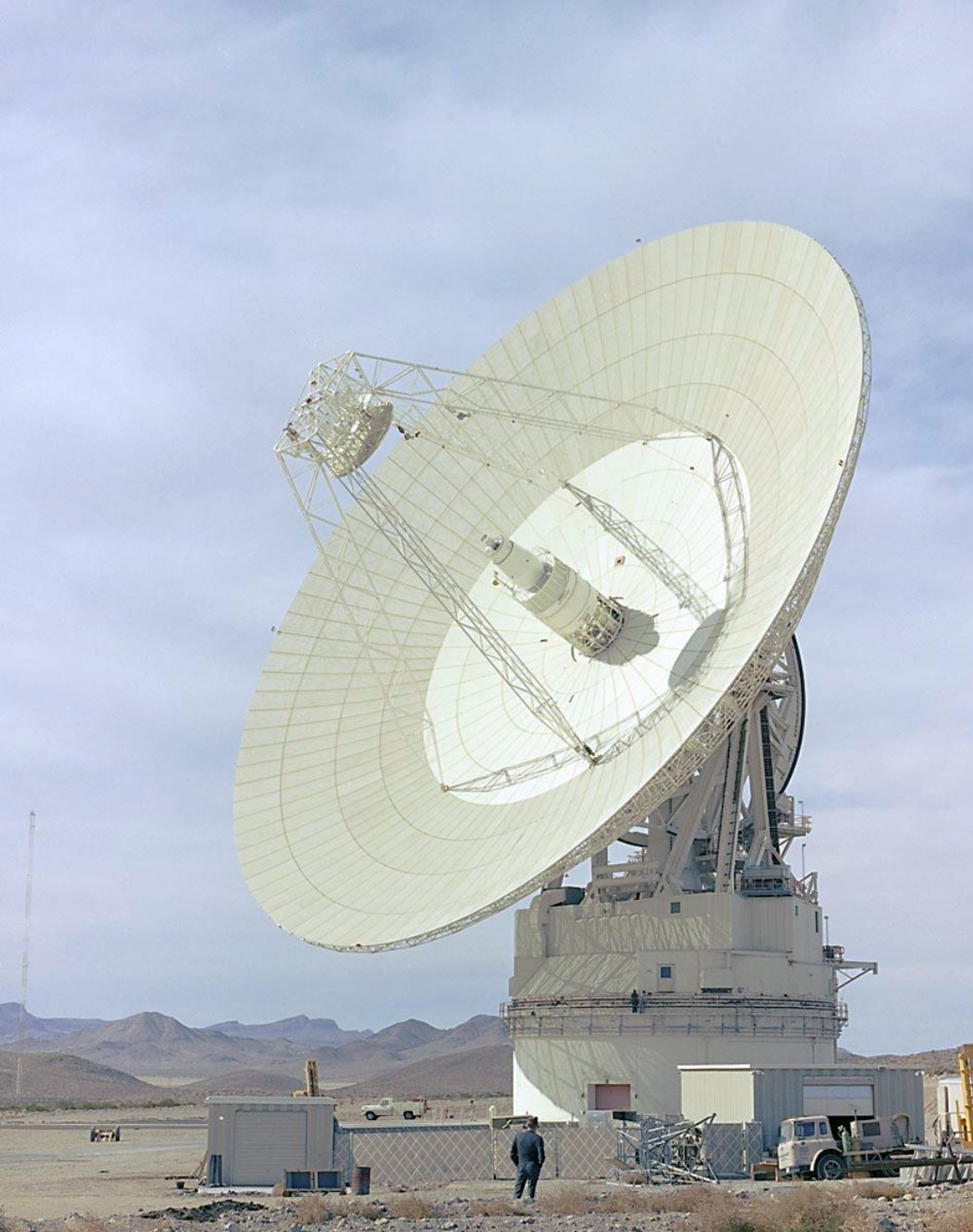
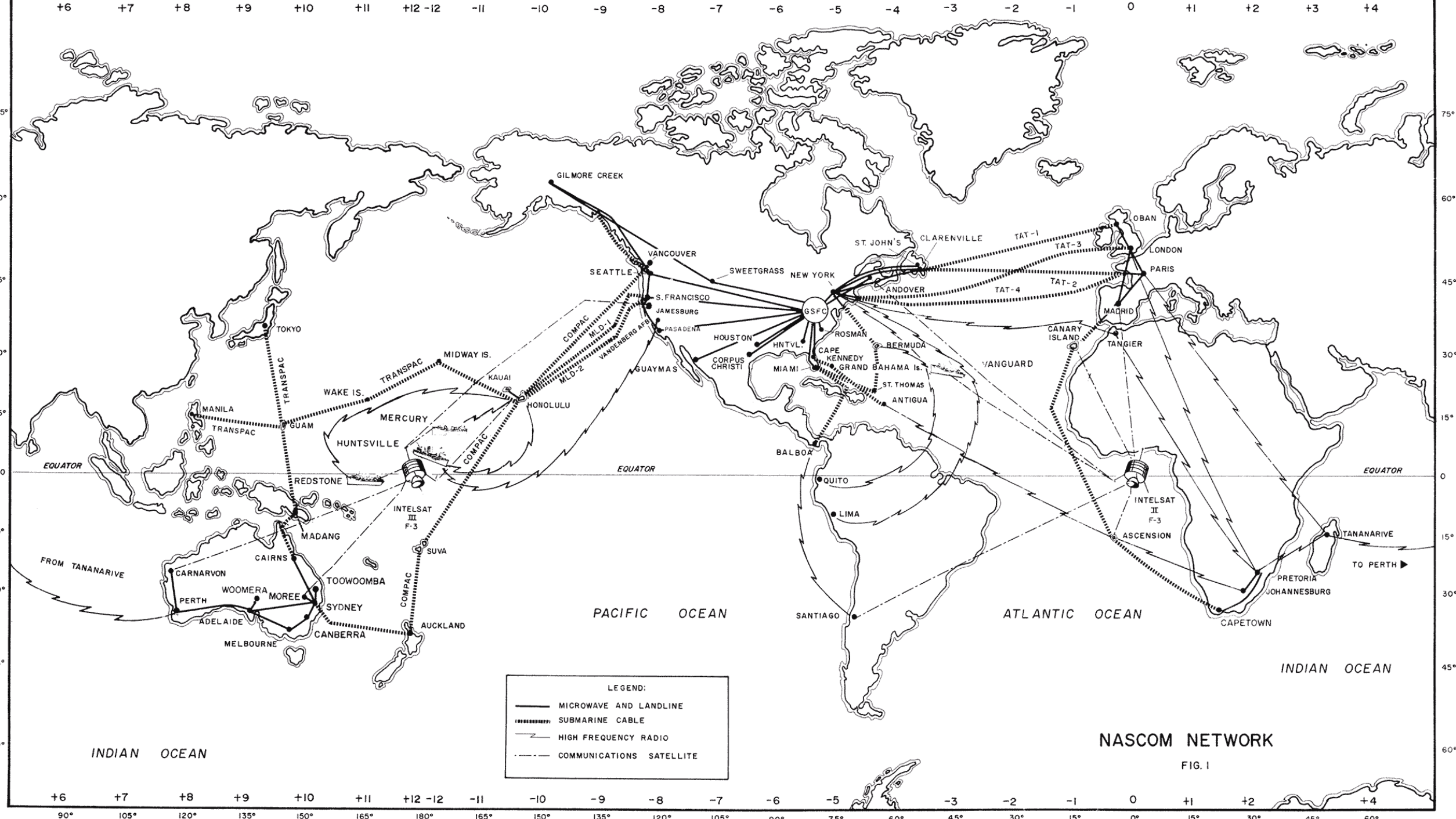


Table 1-1. Network Configuration for AS-512

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			
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				
NBE			X		X	X	X						X							
MAD			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				





LEGEND:

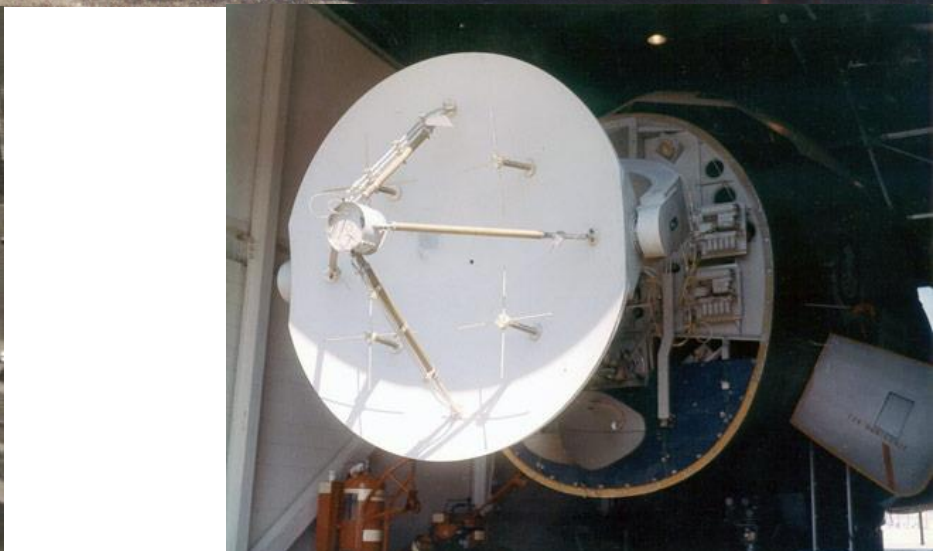
- MICROWAVE AND LANDLINE
- SUBMARINE CABLE
- - - - HIGH FREQUENCY RADIO
- - - - COMMUNICATIONS SATELLITE

NASCOM NETWORK

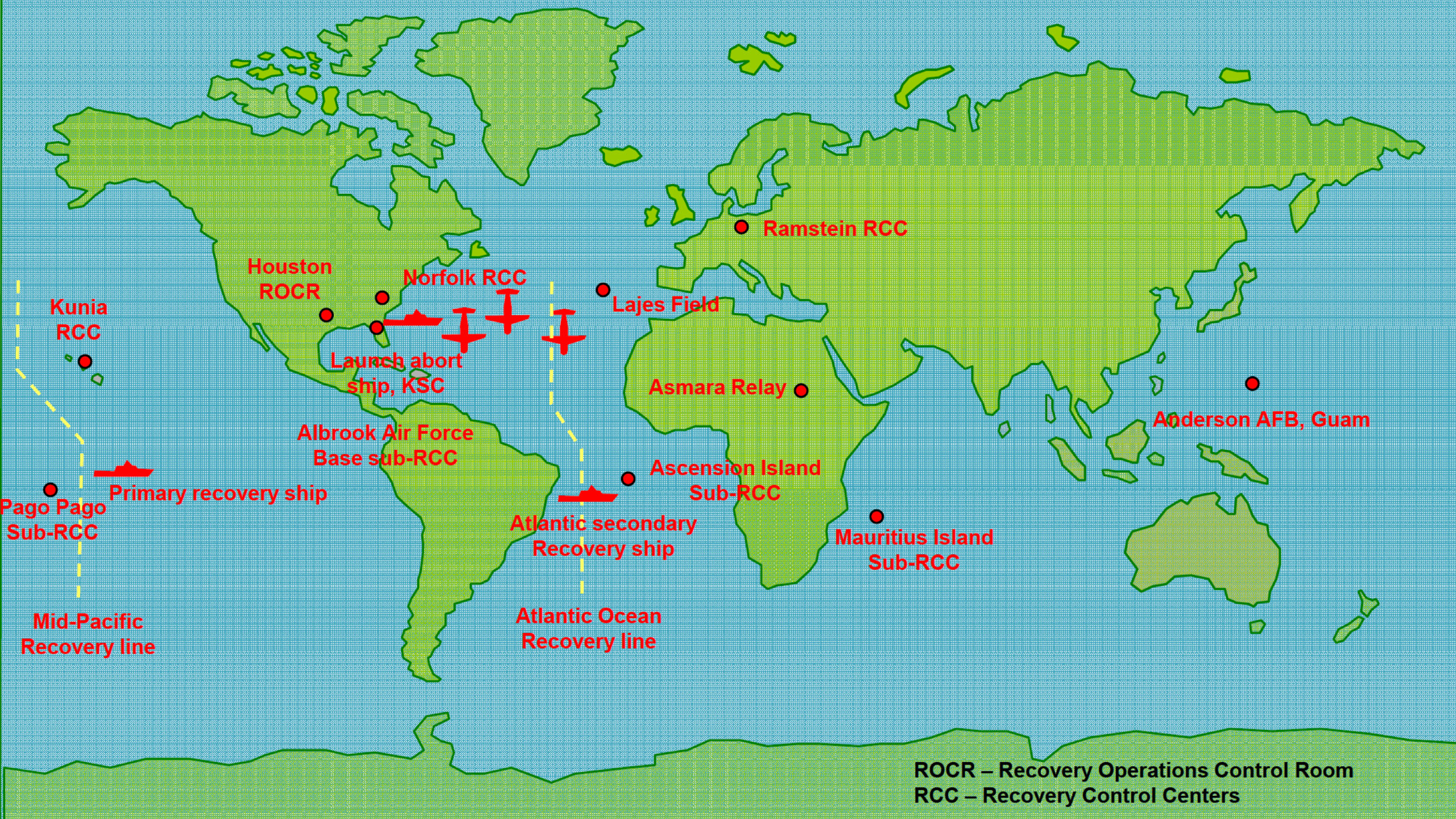
FIG. 1

+6 +7 +8 +9 +10 +11 +12 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4

90° 105° 120° 135° 150° 165° 180° 165° 150° 135° 120° 105° 90° 75° 60° 45° 30° 15° 0° 15° 30° 45° 60°







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

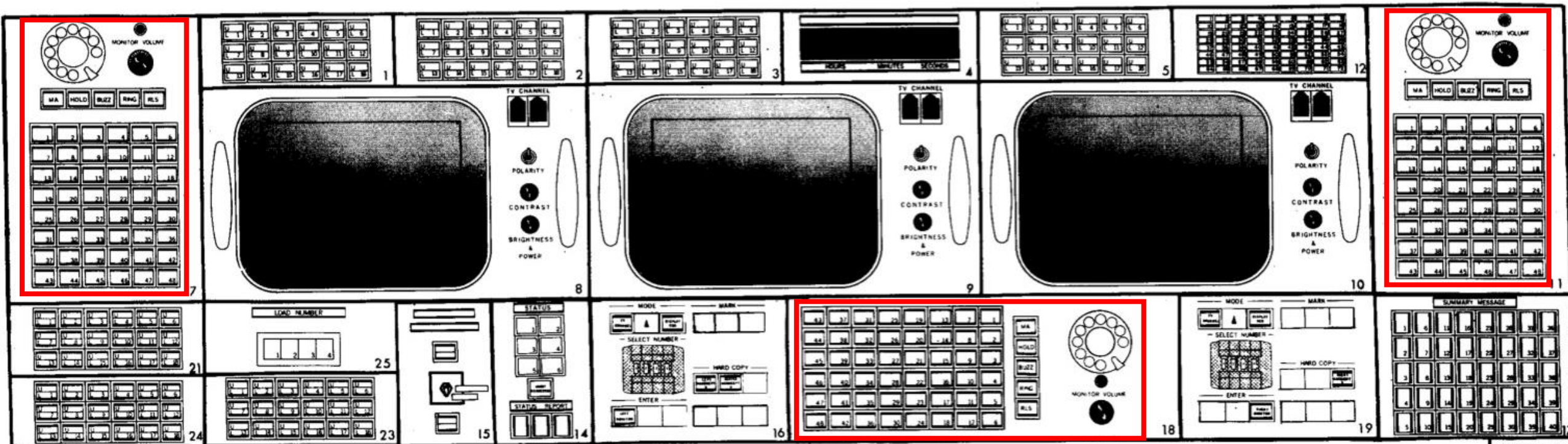
MD

DoD

BOOSTER SYSTEMS
ENGINEER



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				







MONITOR VOLUME



APOLLO 11 AS-506 3RD FL

HISTORICAL RECORDER #1

06-09-69

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

APOLLO 11 AS-506 3RD FL

HISTORICAL RECORDER #2

06-09-69

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