10 Sept 69

Col Ford -

As per our telecon, enclosed herein is the briefing (A) gave to NASA which you attended last week.

I suggest we come up with a study number(s) for studies of possible use of DORIAN technology/hardware, etc. by NASA rather than proliferate DORIAN clearance OR documentation.

I would be happy to work on such a plan.

HARVEY COHEN

WORKING PAPER

~~SECRET~~ DORIAN [redacted]

HANDLE VIA BYEMAN
CONTROL SYSTEM

HANDLE VIA BYEMAN
CONTROL SYSTEM

[redacted]

9-16-69

WORKING PAPER

APPLICATIONS OF THE MOL ACQUISITION AND TRACKING SCOPE (ATS) TO NASA SPACE MISSIONS

[redacted]

BRIEFING PURPOSE

- DESCRIBE POTENTIAL UTILIZATION OF MOL ACQUISITION AND TRACKING SCOPE SYSTEM IN APOLLO LUNAR EXPLORATION AND APOLLO APPLICATIONS PROGRAMS

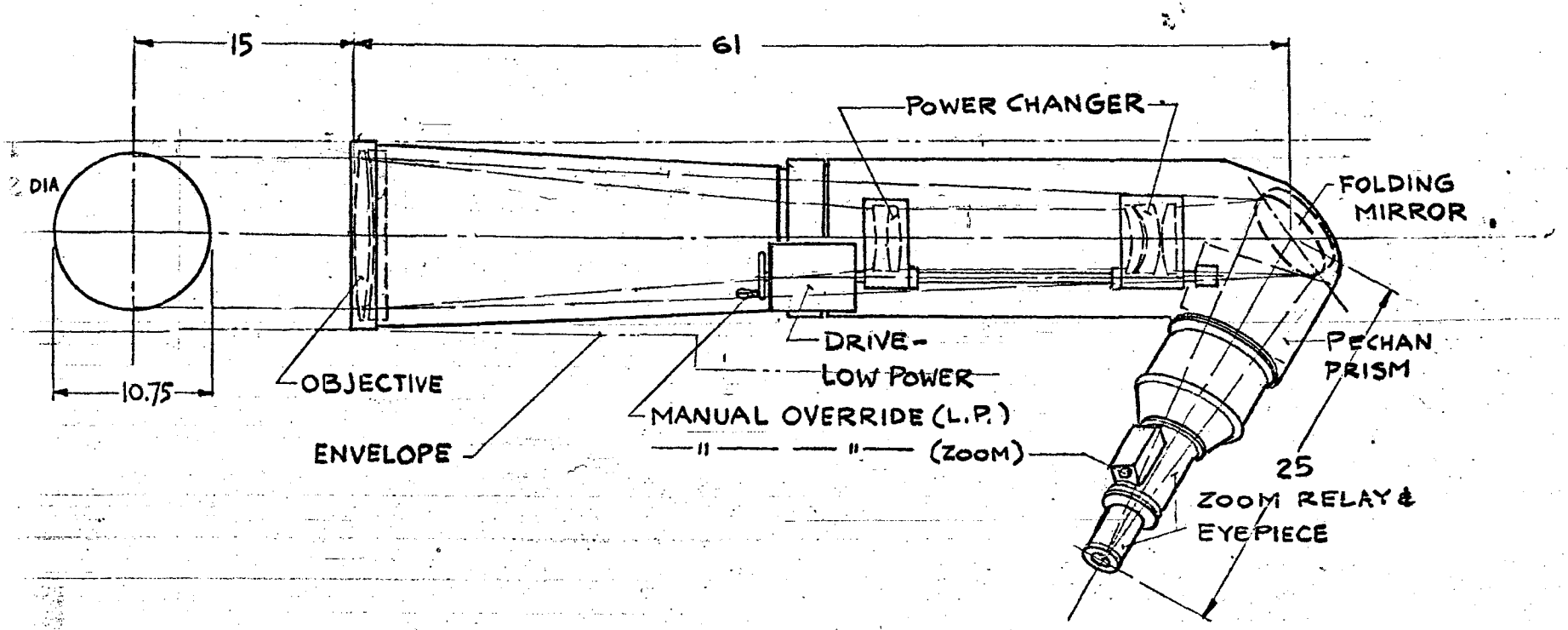
BRIEFING CONTENT

- MOL ATS DESCRIPTION AND STATUS
- POTENTIAL ATS APPLICATIONS TO NASA MISSIONS
  - ✓ VIEWING DEVICE
  - ✓ OPTICAL SENSOR
- PROPOSED STUDY BY THE AEROSPACE CORPORATION

MOL ATS DESCRIPTION AND STATUS

- PHYSICAL AND OPTICAL CHARACTERISTICS
- MOL ATS INSTALLATION
- MOL ATS OPERATIONS
- CURRENT ATS STATUS

A.T.S. PHYISICAL CHARACTERISTICS



A.T.S. WEIGHT (MOL)

OPTICS	187 LB.
CONTROLS	105 LB.
TOTAL	292 LB

A.D.M.
8.29.69

MOL ATS WEIGHTS

- OPTICS

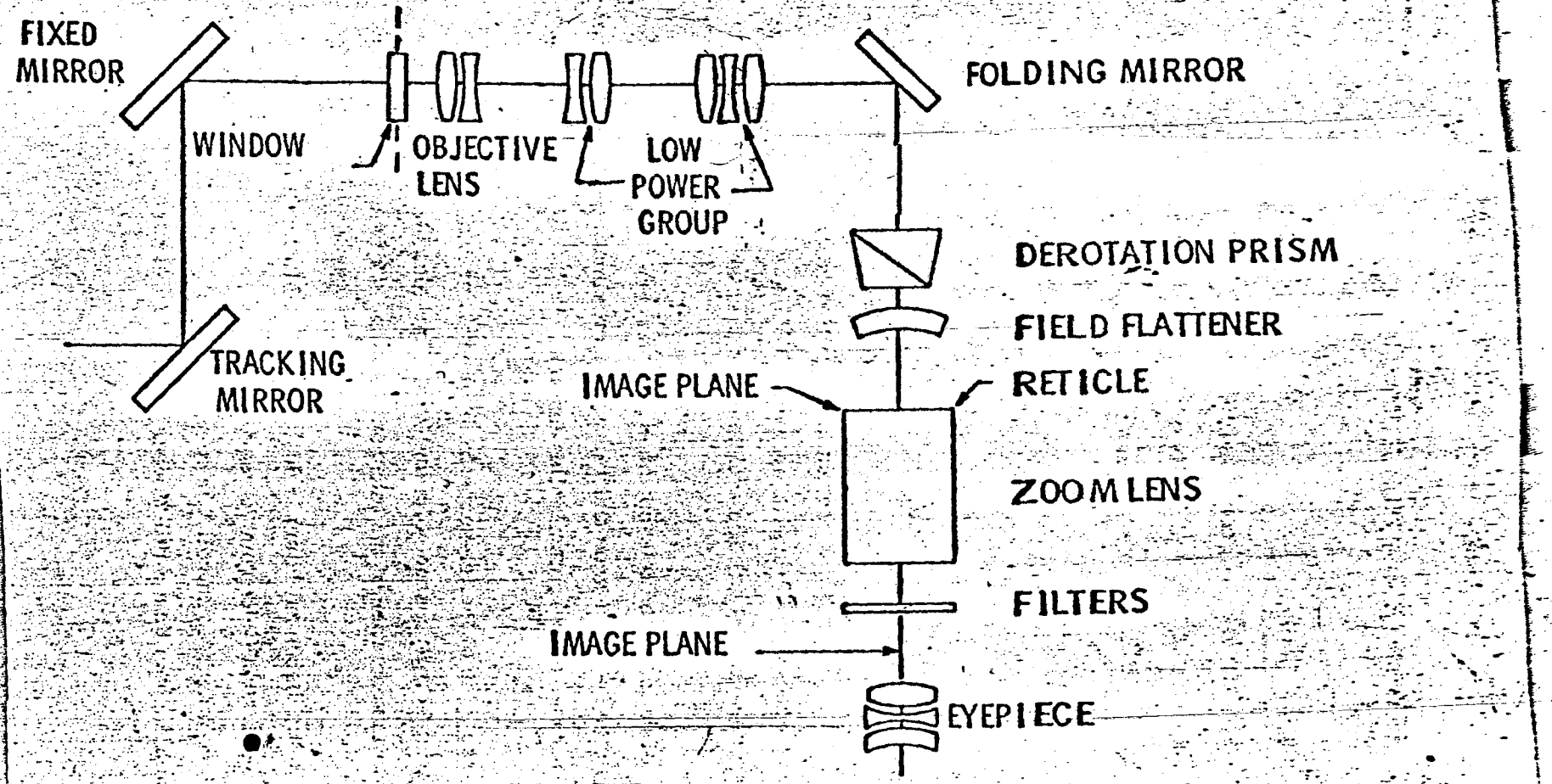
✓	TRACKING MIRROR ASSEMBLY	65 LBS
✓	TELESCOPE	78
✓	FIXED FOLD MIRROR ASSEMBLY	20
✓	SHROUD	15
✓	WINDOW AND BEZEL	9
		187 LBS

- CONTROLS

✓	GYRO AND GYRO ELECTRONICS	8 LBS
✓	CONTROL STICKS	4
✓	SUPPORT STRUCTURE	8
✓	HARNESS	25
✓	DRIVE ELECTRONICS	60
		105
		292 LBS

A.T.S.

OPTICAL SCHEMATIC



HANDLE VIA BYEMAN
CONTROL SYSTEM

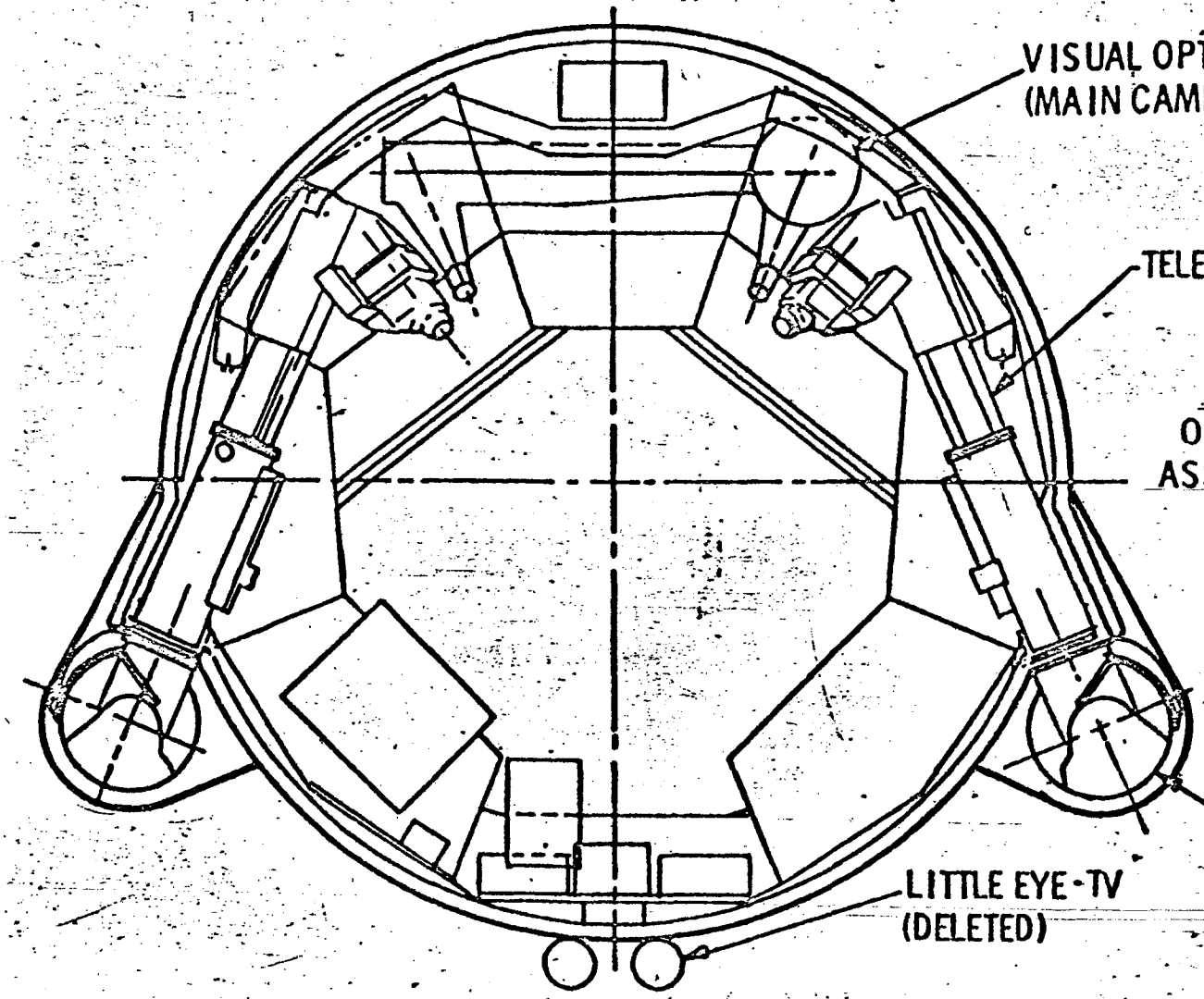
ATS OPTICAL CHARACTERISTICS

- APERTURE: 10 INCH UNOBSCURED DIAMETER
- FOCAL LENGTH: [redacted]
- MAGNIFICATION:
  - LOW POWER: 16 X TO 32 X, ZOOMCONTROL
  - HIGH POWER: 63.5 X TO 127 X,ZOOM CONTROL
- APPARENT FIELD OF VIEW: 60°
- REAL FIELD OF VIEW
  - LOW POWER: 2° (AT 32X) TO 4° (AT 16X)
  - HIGH POWER: 0.5° (AT 127X) TO 1° (AT 63.5X)
- RESOLUTION: $\approx$ 3 FT/LINE-PAIR FROM 80 N. MI.

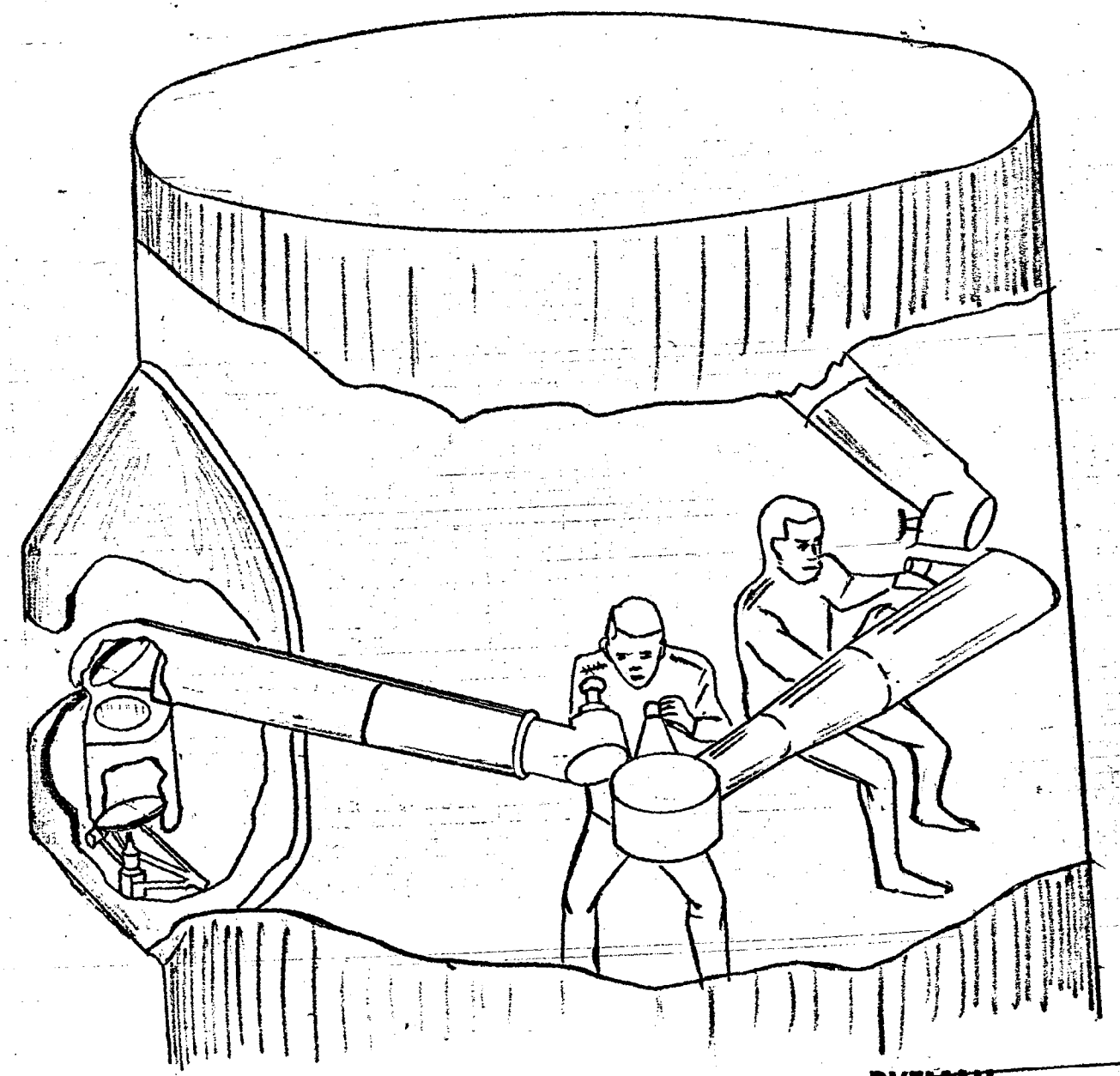
ATS SYSTEM CHARACTERISTICS

- POINTING ACCURACY: 0.1° (.95 P)
- LOS VIBRATION: $\leq$ 0.5 $\overline{\text{SEC}}$ (PEAK TO PEAK) ABOVE 6 HZ (.95 P)
- IMAGE MOTION RATES: $\leq$ 48 μRAD/SEC BELOW 6 HZ (.95 P)
- LOS SLEW CAPABILITY: $\geq 30^{\circ}$/SEC

MOL ATS INSTALLATION



MOL ATS INSTALLATION IN LAB MODULE



VISUAL DISPLAY PROJECTOR CHARACTERISTICS

MISSION FUNCTION:	PROVIDE VISUAL CUES TO ASSIST CREW IN IDENTIFICATION OF TARGET AND/OR TARGET ACTIVITY
SCREEN:	BACK-LIGHTED, 6 1/2 INCHES IN DIAMETER
SCREEN BRIGHTNESS:	0 TO 25 FOOT-LAMBERTS, ADJUSTABLE
SELECTION CAPABILITY:	COMPUTER OR CREW COMMANDS CAUSE ANY ONE OF UP TO 32,752 FRAMES TO BE PRESENTED
CUE CASETTES:	EACH CASSETTE CONTAINS 4094 - 16 MK FRAMES ON REELS
RETRIEVAL TIME:	0.45 + N/100 SECONDS, IF CASSETTE INTELLIGANCE NOT REQUIRED N = NUMBER OF FRAMES FROM PREVIOUS TO NEXT CUE
WEIGHT:	PROJECTION - 23 LBS, CASSETTE 1.2 LBS

ATS/MAN'S ROLE (MOL MISSION)

- INCREASE QUALITY OF TECHNICAL INTELLIGENCE BY REAL-TIME EVALUATION OF TARGETS

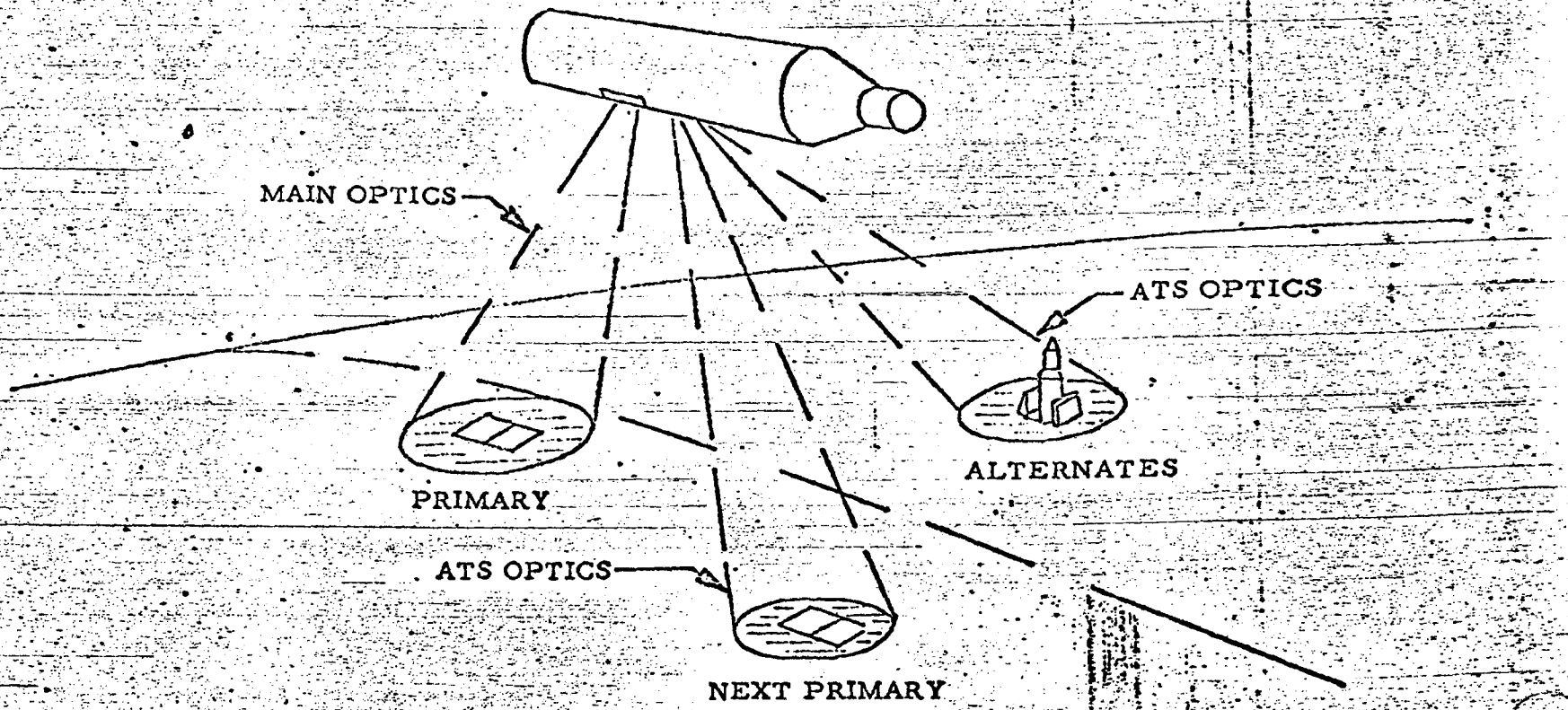
- EACH CREWMAN WITH ATS VIEWS UP TO FOUR ALTERNATE TARGETS AND "VOTES" AS FOLLOWS

  - ✓ REJECT (PROBABLY CLOUD COVERED)
  - ✓ INACTIVE (TARGET CLEAR BUT NO TI FEATURES OF INTEREST)
  - ✓ ACTIVE (TI INTEREST)
  - ✓ OVER-RIDE (INTERUPT PROGRAMMED MAIN OPTICS)

CONCEPT OF MANNED EXAMINATION

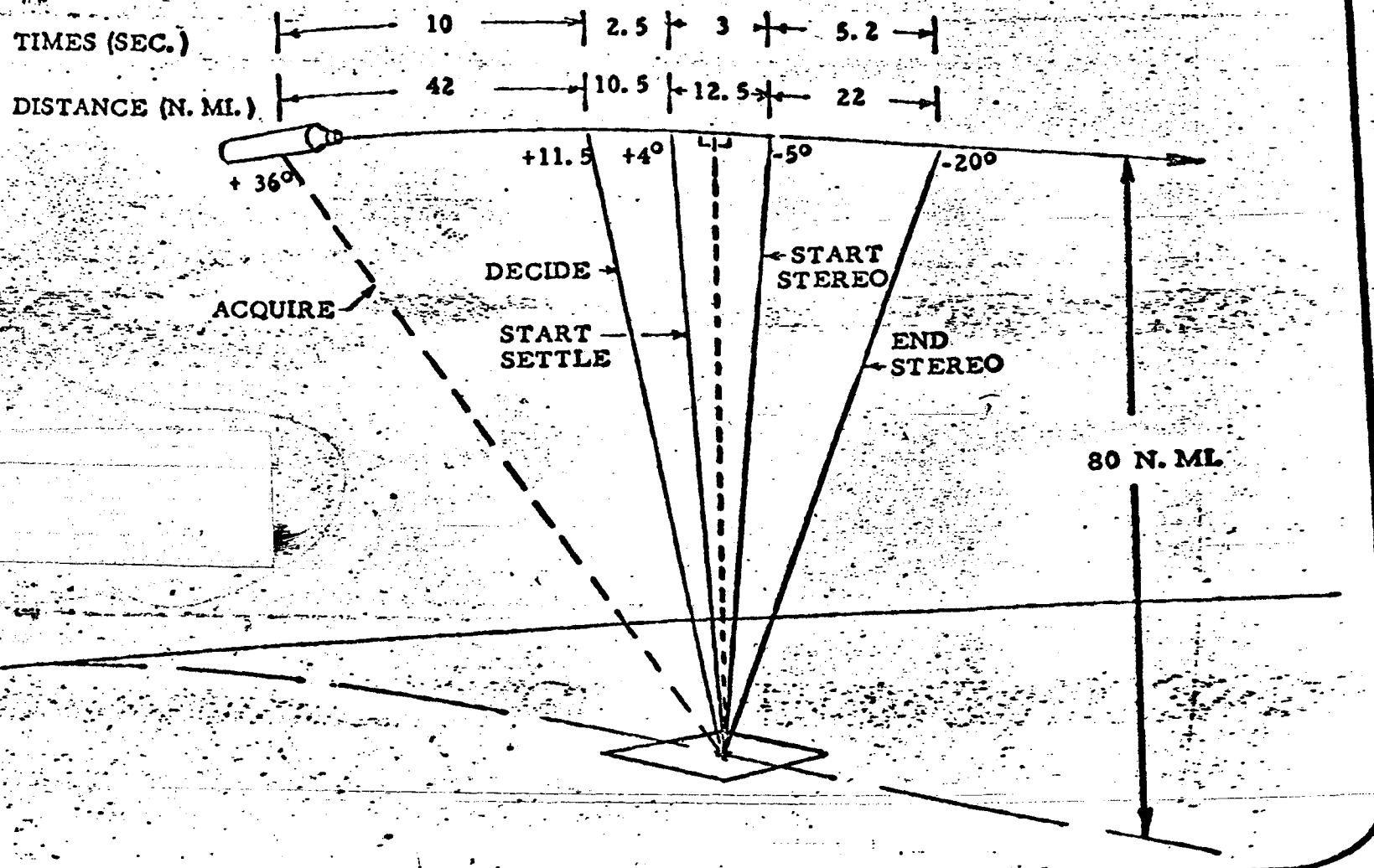
FOR

TECHNICAL INTELLIGENCE INDICATORS/WEATHER



- IF EITHER ALTERNATE HAS ACTIVE INDICATORS, TAKE IT
- IF PRIMARY COVERED AND ALTERNATE CLEAR, SWITCH TO ALTERNATE

ACTIVE INDICATOR EXAMINATION AND SPECIAL PHOTOGRAPHY SEQUENCE



ATS PROGRAM STATUS, JUNE 1969

- OPTICAL DESIGN COMPLETE
- OPTICAL TESTS ON BENCH UNIT COMPLETE
  - ✓ DESIGN PREDICTIONS VERIFIED
- FABRICATION OF OPTICAL ELEMENTS FOR TWO ENGINEERING UNITS: 95% COMPLETE
- MECHANICAL DESIGN: 75% COMPLETE
- ENGINEERING MODEL COMPLETION SCHEDULED AUGUST 1969

POTENTIAL ATS APPLICATIONS TO NASA MISSIONS

- APOLLO APPLICATIONS PROGRAM
- LUNAR EXPLORATION PROGRAM

POTENTIAL ATS RELATION TO APOLLO APPLICATIONS PROGRAM

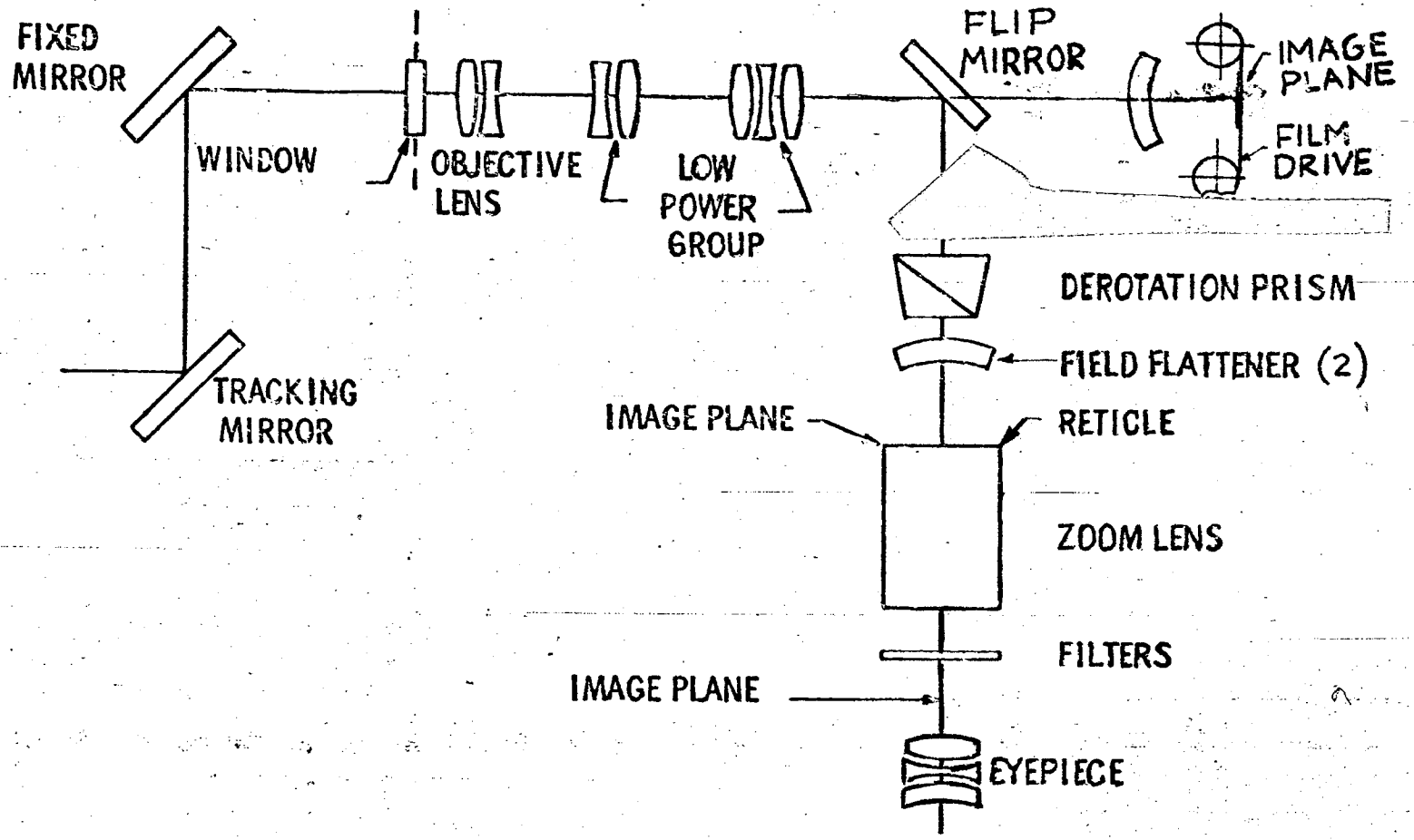
- TASKS ASSIGNED TO ATS ABOARD AAP SIMILAR TO ATS FUNCTIONS ABOARD MOL:
  - ✓ VIEW EARTH (OR SPACE) FEATURES AND RECORD DATA
  - ✓ DIRECT OTHER SENSORS TO TARGETS ACQUIRED BY ATS
- ATS CAN BE USED AS A VIEWING DEVICE BY THE CREW, AND AS A PHOTO-OPTICAL AND/OR ELECTRO-OPTICAL SENSOR
- ATS OF PARTICULAR VALUE TO EARTH SURVEY TASKS (EG: AGRICULTURAL, GEOGRAPHICAL, GEOLOGICAL, OCEANOGRAPHIC) REQUIRING LESS THAN 50 FT. GROUND RESOLUTIONS
- ATS RECORDED DATA CAN BE RETURNED TO EARTH VIA WIDE-BAND TRANSMISSION LINKS OR DIRECT RECOVERY

TYPICAL EARTH SURVEY TASKS REQUIRING LESS THAN 50 FT GROUND RESOLUTION

CATEGORY	TASK	COLOR DESIRABLE
AGRICULTURAL	Crop Identification	
	Timber Inventory	
	Land Use Surveys	X
	Rangeland Surveys	
GEOLOGICAL	Groundwater Survey	
	Volcanic Eruption Assessment	
	Mineral/Petroleum Survey	X
	Heavy Metal Survey	X
	Earthquake Assessment	
	River Basin Mapping	X
	Water Pollution Survey	X
	Sedimentation Survey	X
	Erosion Survey	X
	Flood Mapping	
	Geological Mapping, 1:250,000 Scale	X
GEOGRAPHICAL	Transportation Survey	
	Industrial Survey	
	1:24,000 Scale Mapping	
	1:62,500 Scale Mapping	X
	1:250,000 Scale Mapping	X
	Settlement Planning	
OCEANOGRAPHIC	Commercial Fish Location	
	Sea State Survey	
	Coastal Mapping	X
	Coastal Engineering Survey	X
	Navigation Hazard Survey	X
	Marine Pollutant Survey	X

REPRESENTATIVE ATS/AAP CONFIGURATION

OPTICAL SCHEMATIC



ATS CAPABILITY FROM 240 N.MI. EARTH ORBIT

F. O. V.	MAGNIFICATION	VISUAL GROUND RESOLUTION (FT.)	PROJECTED F.O.V. DIAMETER (N.MI.)	PHOTOGRAPHIC GROUND RESOLUTION (FT.)
4° ↑ ZOOM	16 x	57	18	31.0
2° ↓	32 x	30	9	--
1° ↑ ZOOM	63.5 x	15	4.5	7.8
1/2° ↓	127 x	9	2.3	--

WIDE-BAND DATA TRANSMISSION FROM LOW-EARTH ORBIT USING DATA RELAY SATELLITE

	TRANSMISSION RATE DATA	FRAME RESOLUTION (LP/MM)	FRAME AREA PER MINUTE (IN^2)
ANALOG	10 MHz	50	108
	25 MHz	50	275
	10 MHz	100	27
	25 MHz	100	67
DIGITAL*	10 MB/SEC	50	5
	50 MB/SEC	50	25
	10 MB/SEC	100	1.2
	50 MB/SEC	100	6

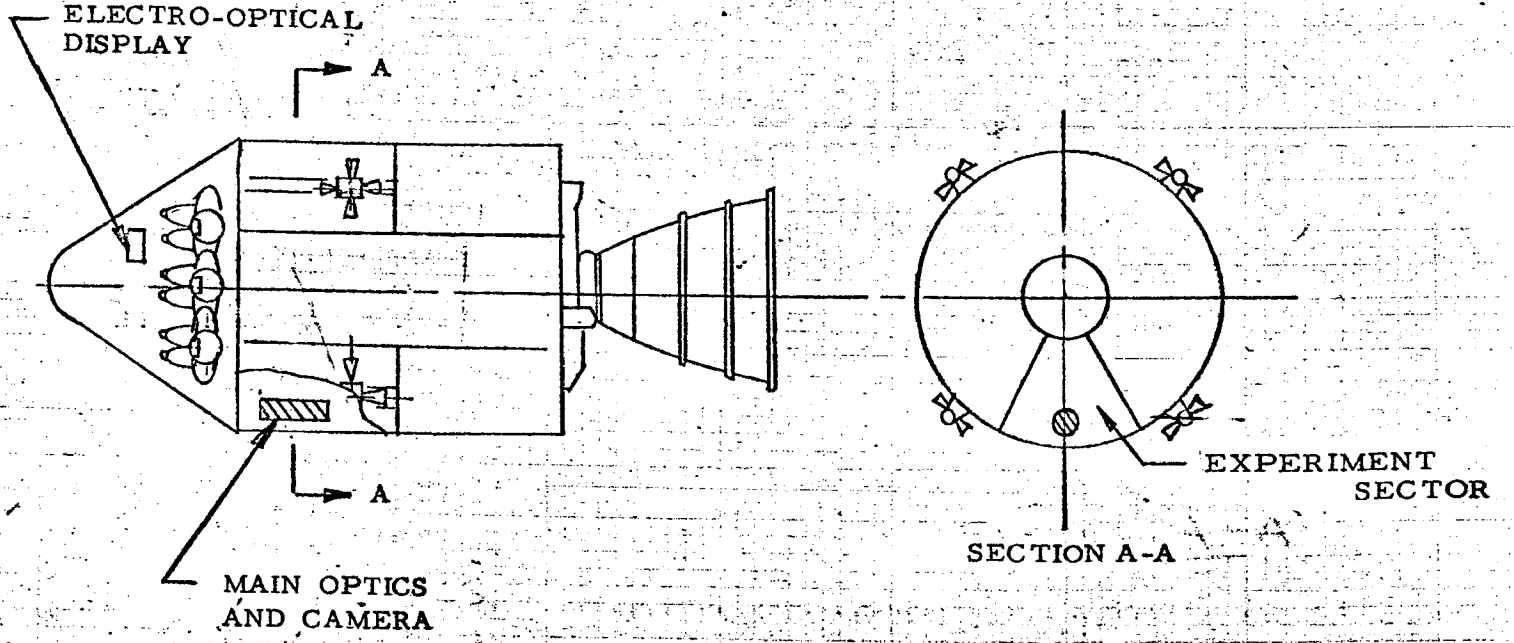
* DIGITAL BASED ON 5 BIT PCM, NO COMPRESSION

POTENTIAL ATS RELATION TO LUNAR EXPLORATION PROGRAM

- ATS CAN BE USED BY THE APOLLO CREW TO MAKE DETAILED VISUAL SURVEYS OF THE LUNAR SURFACE AND RECORD SELECTED OBJECTS, SITES, AND REGIONS
  - ✓ LANDING SITE EVALUATIONS
  - ✓ HIGH RESOLUTION MAPPING
  - ✓ LOCATION/IDENTIFICATION OF SURFACE OBJECTS (VEHICLES, GEOLOGICAL DETAILS)
- "LOW LIGHT" ELECTRO-OPTICAL SENSORS WOULD ALLOW INVESTIGATIONS OF POLAR AND TERMINATOR REGIONS AND CRATER SHADOWS
- ATS RECORDED DATA CAN BE RETURNED TO EARTH VIA WIDE-BAND TRANSMISSION LINKS OR DIRECT RECOVERY

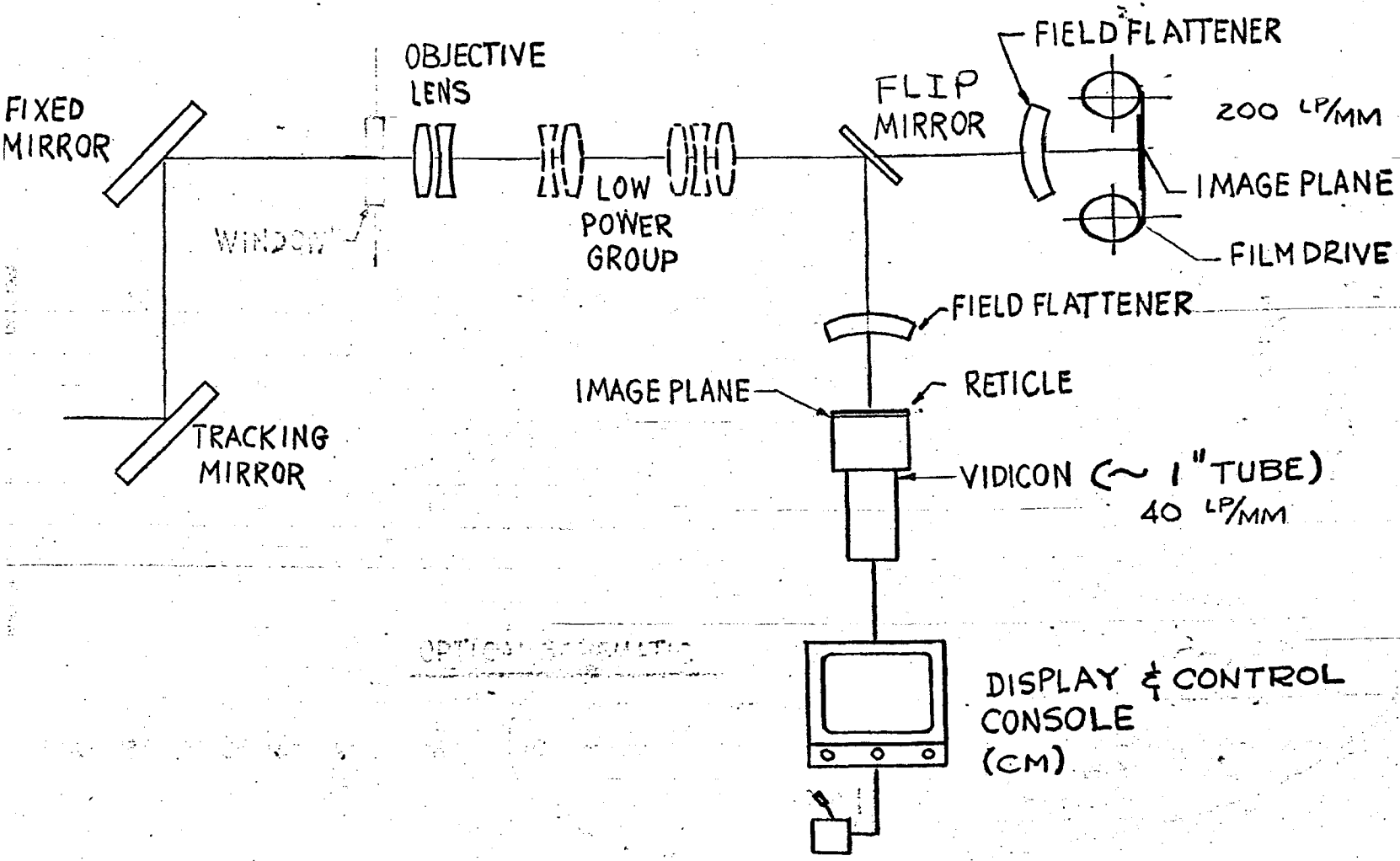
TYPICAL CSM ATS INSTALLATION

COMBINED LUNAR LANDING/MAPPING MISSION

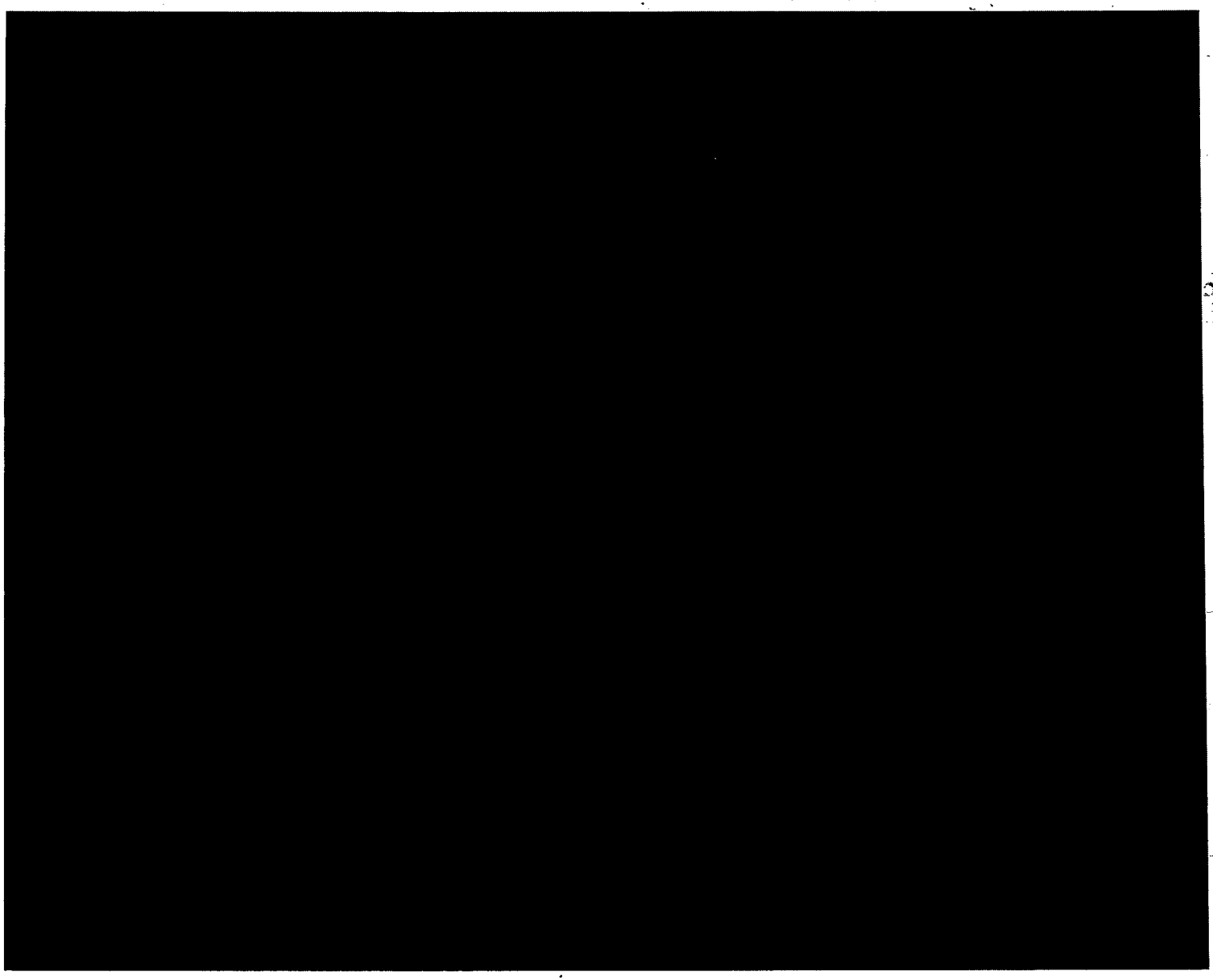


~~SECRET~~ DORIAN REPRESENTATIVE ATS/CSM CONFIGURATION

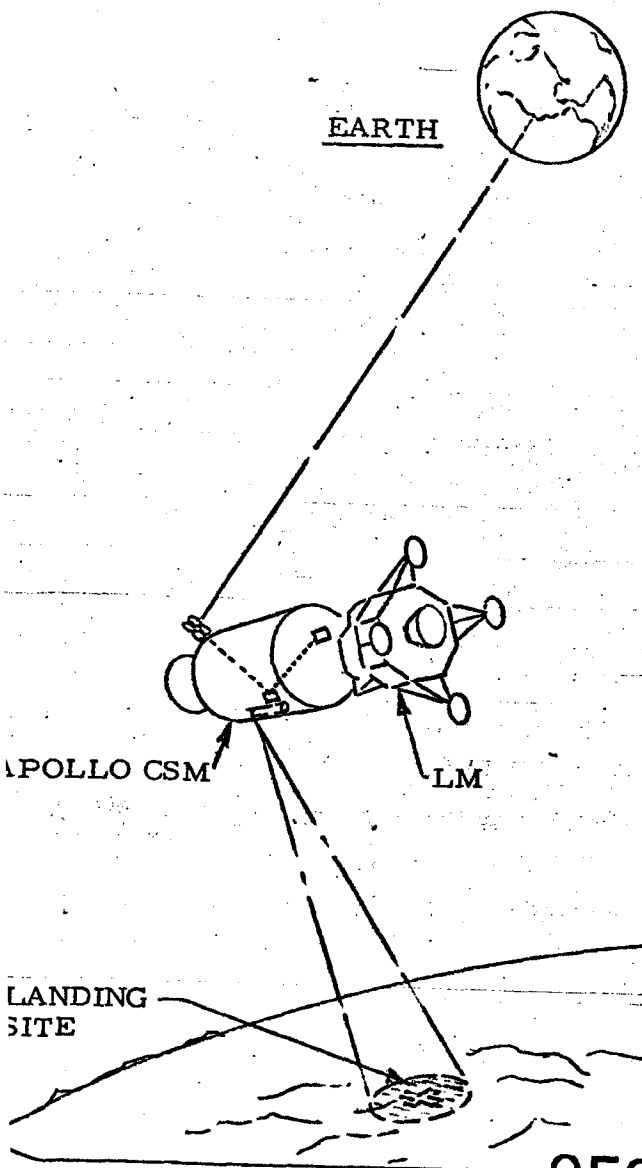
OPTICAL SCHEMATIC



TYPICAL ATS LUNAR OBSERVATION CAPABILITY



LUNAR LANDING SITE INSPECTION SCENARIO



- 10 N. M. ORBIT
- LOCATE LANDING ZONE WITH LOW POWER ATS
- DISPLAY IN CM AND MISSION CONTROL
  - √ 2400' FOV
  - √ [redacted]
- CENTER LANDING SITE SCENE ON DISPLAY
- SWITCH TO HIGH POWER ATS
  - √ 600' FOV
  - √ [redacted]
- CONFIRM LANDING SITE
  - √ MISSION CONTROL
  - √ APOLLO CREW
- LM DESCENT ON SUBSEQUENT ORBIT

  OR

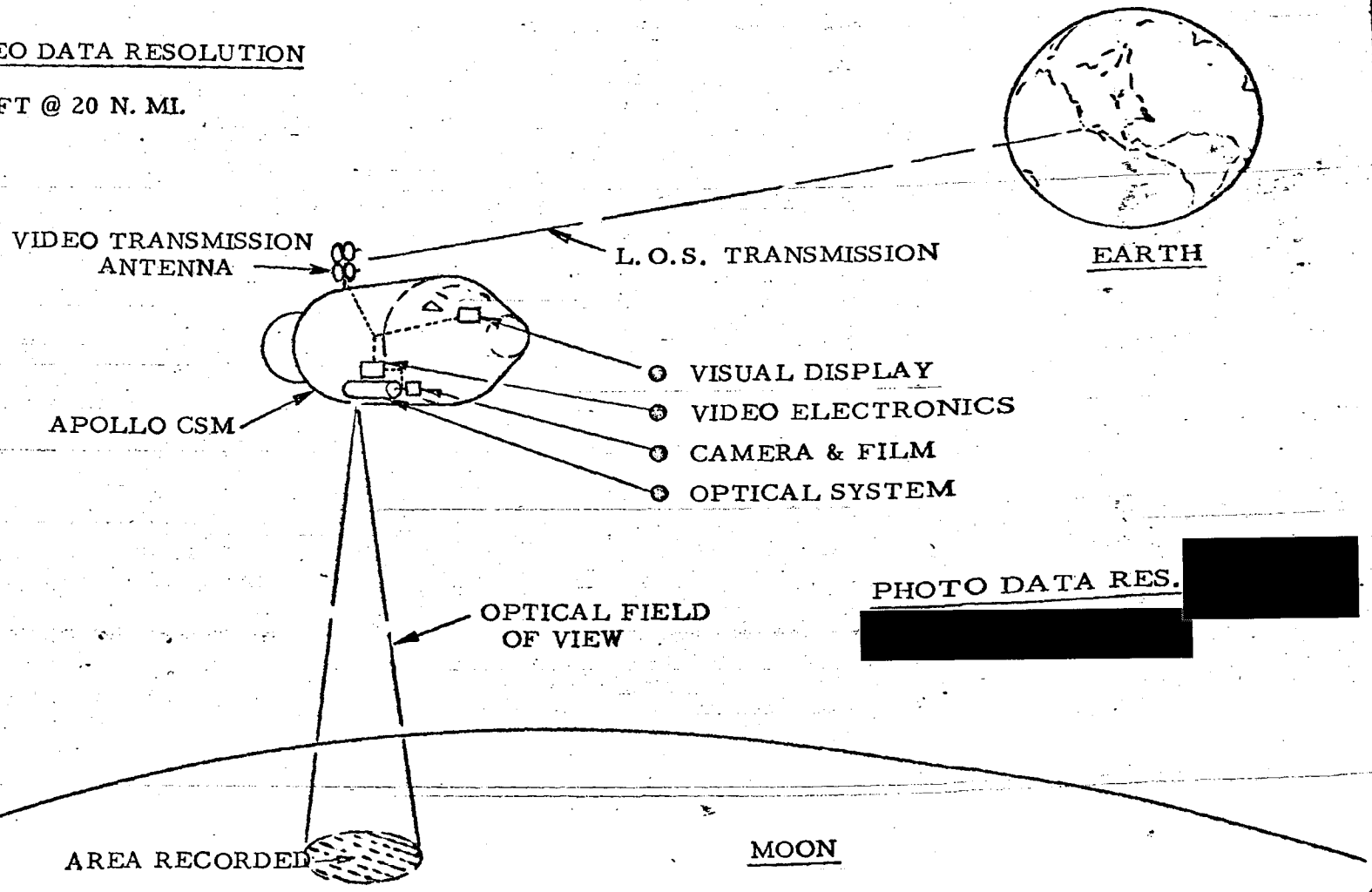
  ALTERNATIVE LANDING ZONE/SITE EXAMINE

LUNAR SURFACE OPTICAL DATA ACQUISITION

- REAL TIME VIDEO INFORMATION
- STORED FILM RECORD

VIDEO DATA RESOLUTION

2.3 FT @ 20 N. MI.



TYPICAL LUNAR SURFACE OPTICAL DATA ACQUISITION SCENARIO

- ACTIVATE SYSTEM FOR LUNAR OPERATIONS, I. E. EXPOSE OPTICAL HEAD, CHECKOUT MECHANISMS, VERIFY FILM AND ELECTRO-OPTICAL SYSTEMS OPERATION
- IDENTIFY LUNAR GEOGRAPHICAL AREA OF INTEREST USING CUE DATA
- POSITION OPTICAL SYSTEM TO PLACE AREA OF INTEREST IN OPTICAL FIELD OF VIEW
- PERFORM IMAGE CENTERING OF TARGETS AS REQUIRED
- INITIATE DATA ACQUISITION MODE(S) FOR ELECTRO-OPTICAL SCENE RECORDING OR FILM/CAMERA OPERATION
- CONTROL QUANTITY OF DATA COLLECTED BASED ON VISUAL OBSERVATION OF CONDITIONS AFFECTING PHOTOGRAPHIC OPERATIONS
- RETRIVE FILM FOR RETURN TO EARTH IN COMMAND MODULE

CONCLUSIONS

- APPARENT NEED FOR AN A.T.S. ON NASA MANNED SPACE PROGRAMS HAS BEEN IDENTIFIED
- SYSTEM DESIGN ESSENTIALLY COMPLETED ON D.O.D. MOL PROGRAM
- ADAPTABILITY OF A.T.S. TO NASA MISSIONS APPEARS FEASIBLE BUT DETAILED STUDY NEEDED TO PROVIDE IMPLEMENTATION PLANS
- INTIMATE PARTICIPATION IN ATS CONCEPT AND DEVELOPMENT MAKES AEROSPACE CORPORATION LOGICAL CONTRACTOR TO PERFORM STUDY FOR NASA ON EFFECTIVE ATS UTILIZATION

PROPOSED STUDY BY THE AEROSPACE CORPORATION

- PHASE I - SYSTEM DEFINITION
- PHASE II - GSE/TD OF CONTRACTOR EFFORT

MANNED SPACE SYSTEM BACKGROUND

THE AEROSPACE CORPORATION, SINCE ITS FOUNDING, HAS BEEN ACTIVE IN MANNED SPACE SYSTEM ANALYSES.

- COMPARATIVE STUDIES OF GEMINI, APOLLO AND DYNASOAR
- DOD/NASA GEMINI EXPERIMENTS PROGRAM
- ATLAS, GLV, TITAN III LAUNCH VEHICLES
- CONCEPTUALIZATION, GENERAL SYSTEMS ENGINEERING AND TECHNICAL DIRECTION OF USAF MANNED SPACE PROGRAMS
  - / MANNED ORBITAL LABORATORY

THE CORPORATION HAS BEEN ENGAGED IN THE DESIGN AND SIMULATION OF CREW VIEWING SYSTEMS SINCE 1964.

- POINTING AND TRACKING SCOPE (MOL EXPERIMENTS)
- ACQUISITION AND TRACKING SCOPE (MOL PROGRAM)

STUDY SCOPE

- INVESTIGATE THE APPLICATION OF THE ATS TO NASA SPACE MISSIONS AND VEHICLES
  - ✓ APOLLO APPLICATIONS PROGRAM
  - ✓ LUNAR EXPLORATION PROGRAM
- DEVELOP MULTIPLE USES OF THE ATS
  - ✓ CREW VIEWING DEVICE
  - ✓ PHOTO AND ELECTRO-OPTICAL SENSOR (NORMAL AND "LOW-LIGHT" SCENES)
  - ✓ NEAR REAL TIME DATA TRANSFER
- DEFINE NASA ATS CONFIGURATION AND OPERATIONS
  - ✓ ATS DESIGN
  - ✓ VEHICLE INTEGRATION
  - ✓ CREW TRAINING
  - ✓ COST, SCHEDULES, AND SPECIFICATIONS

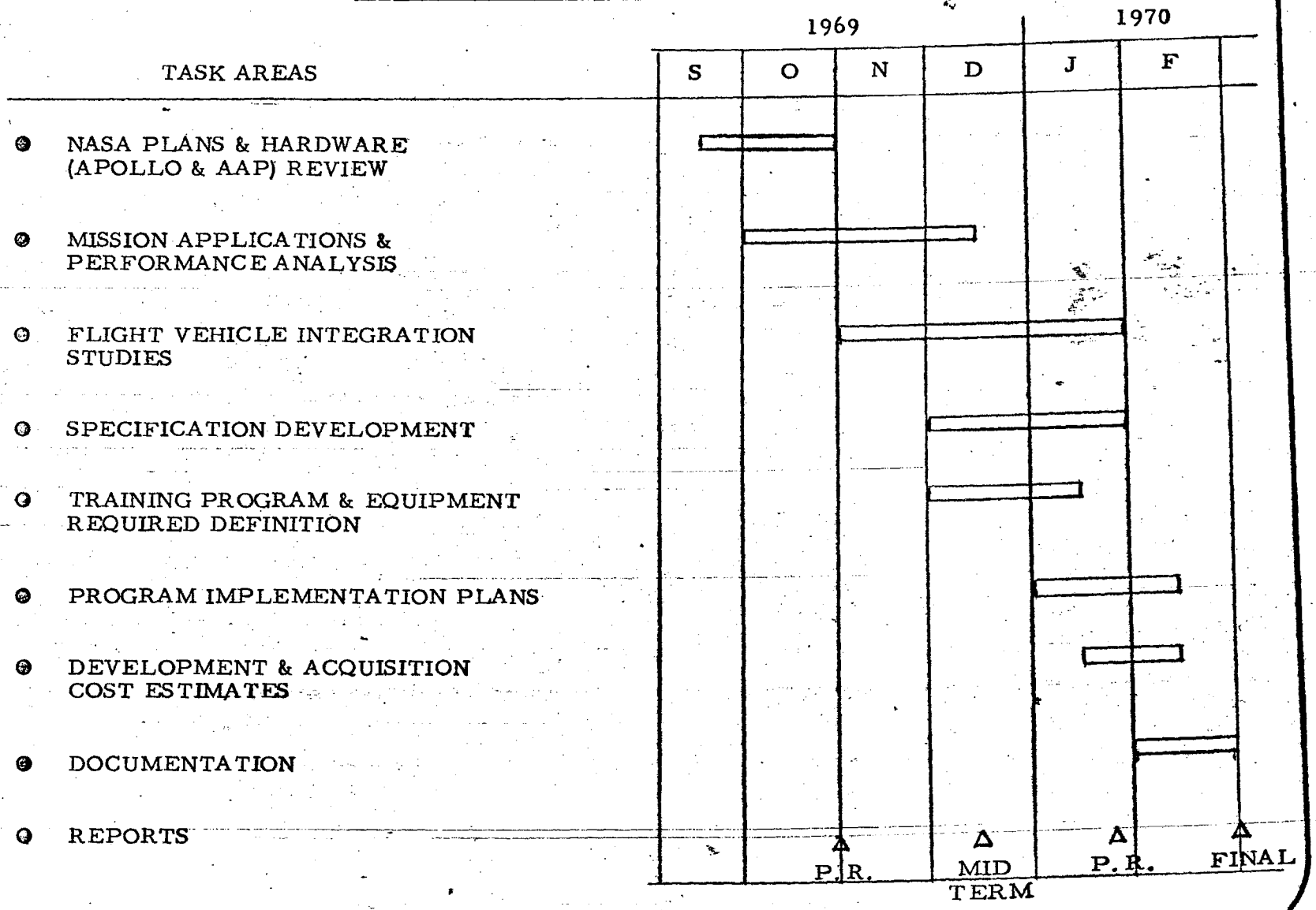
ATS APPLICATIONS

ØI STUDY TASK AREAS

- NASA PLANS AND HARDWARE (APOLLO AND AAP) REVIEW
  - / OPERATION PLANS, TIMELINES, PERFORMANCE TRADES
  - / VEHICLE SYSTEM DESIGN CHARACTERISTICS AND CONSTRAINTS
- MISSION APPLICATION AND PERFORMANCE ANALYSIS
  - / MISSION OBJECTIVES
  - / ORBIT SELECTION CRITERIA
  - / OPERATING MODES
  - / CREW TASK ANALYSIS
  - / TOP TIME LINE DEFINITION
  - / SIMULATION/TRAINING REQUIREMENTS
  - / IMPACT OF ATS ON CURRENT MISSION PLANS
- FLIGHT VEHICLE INTEGRATION STUDIES
  - / ATS CONFIGURATIONS ANALYSIS
  - / INSTALLATIONS ANALYSIS AND LAYOUTS
  - / VEHICLE SUBSYSTEM IMPACTS
  - / SYSTEM COMPATIBILITY ANALYSIS/SUMMARY
- SPECIFICATION DEVELOPMENT
  - / BASIC OPTICAL SYSTEM
  - / PERIPHERAL RECORDING EQUIPMENT
  - / INSTRUMENTATION
  - / COMPUTER HARDWARE/SOFTWARE
  - / POTENTIAL MODIFICATIONS
  - / TEST REQUIREMENTS
- TRAINING PROGRAM AND EQUIPMENT REQUIREMENTS DEFINITION
- PROGRAM IMPLEMENTATION PLAN
- DEVELOPMENT AND ACQUISITION COST ESTIMATES

ATS APPLICATIONS

PHASE I STUDY PROGRAM PLAN



ATS APPLICATIONS

PHASE I STUDY MANPOWER ESTIMATE

TASK AREAS	1969 S	1969 O	1969 N	1969 D	1970 J	1970 F
❶ NASA PLANS & HARDWARE (APOLLO & AAP) REVIEW	4	4				
❷ MISSION APPLICATIONS & PERFORMANCE ANALYSIS		2	6	2		
❸ FLIGHT VEHICLE INTEGRATION STUDIES			2	4	2	
❹ SPECIFICATION DEVELOPMENT				1	2	
❺ TRAINING PROGRAM & EQUIPMENT REQUIRED DEFINITION				1	1	
❻ PROGRAM IMPLEMENTATION PLANS					2	2
❼ DEVELOPMENT & ACQUISITION COST ESTIMATES					1	1
❽ DOCUMENTATION						3
TOTAL MAN MONTHS	4	6	8	8	8	6 (40)