



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

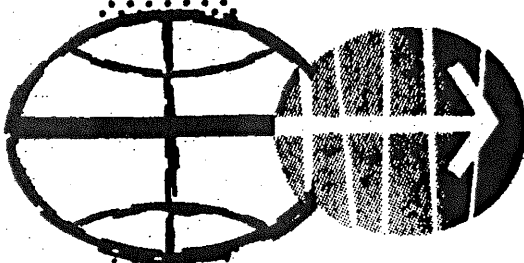
# Apollo Lunar Surface Experiments Package

## **ALSEP Familiarization Course Handout**

1 May 1970

Contract NAS9-5829

**BSR 2832-A**



Prepared for

**MANNED SPACECRAFT CENTER  
HOUSTON, TEXAS**



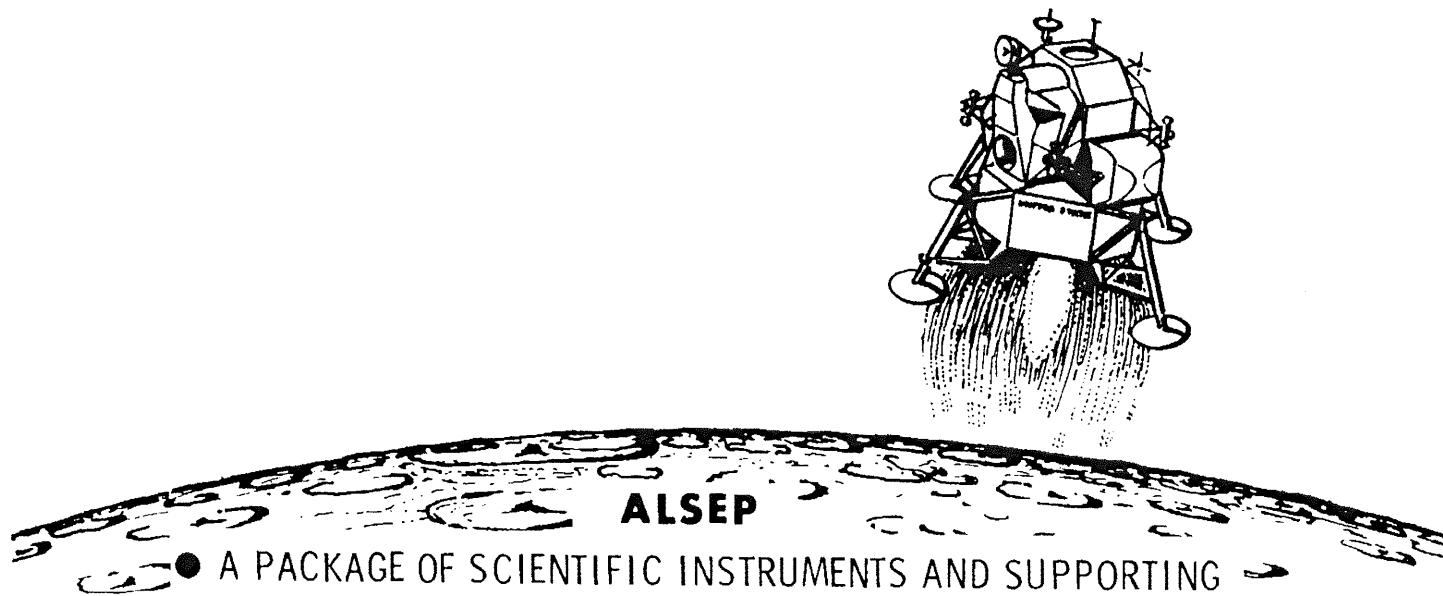
**Aerospace  
Systems Division**

## Table of Contents

	Page
Introduction.....	1
Physical Characteristics .....	5
Deployment Considerations.....	20
Power Subsystem .....	43
Data Subsystem .....	47

**CIRS/LIBRARY**  
**LUNAR AND PLANETARY INSTITUTE**  
3800 BAY AREA BOULEVARD  
HOUSTON TX 77058-1113

# APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE



- A PACKAGE OF SCIENTIFIC INSTRUMENTS AND SUPPORTING SUBSYSTEMS FOR USE ON THE LUNAR SURFACE
- CARRIED ON APOLLO, DEPLOYED BY ASTRONAUT
- ONE YEAR CONTINUOUS OPERATION (2 YEAR MAXIMUM)

DEC 69 7399.1

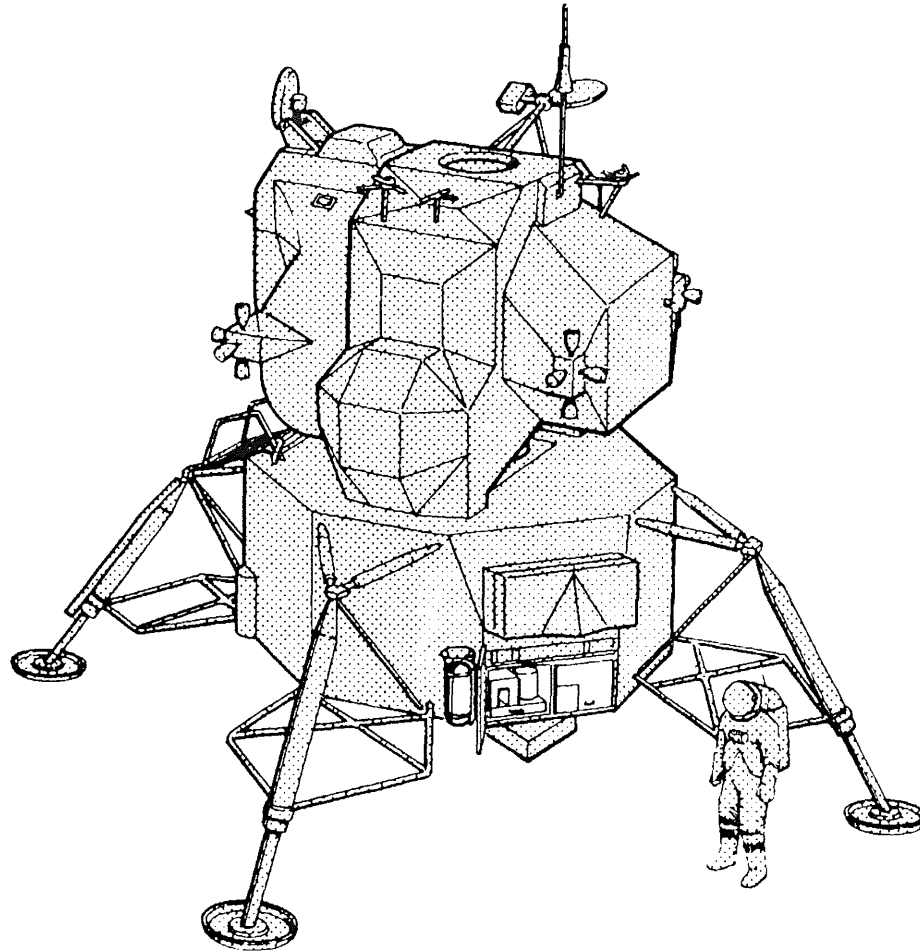
# EXPERIMENT FLIGHT ASSIGNMENTS

NASA NO.	EXPERIMENT	ABBR	APOLLO NUMBER				PRINCIPAL INVESTIGATOR
			11	12	13	14	
S031	PASSIVE SEISMIC	PSE	X	X	X	X	DR. G. V. LATHAM, COLUMBIA
S033	ACTIVE SEISMIC	ASE				X	DR. R. L. KOVACH, STANFORD
S034	MAGNETOMETER	LSM		X			DR. C. P. SONNETT, ARC
S035	SOLAR WIND	SWS		X			DR. C. W. SNYDER, JPL
S036	SUPRATHERMAL ION	SIDE		X		X	DR. J. W. FREEMAN, RICE
S037	HEAT FLOW	HFE			X		DR. M. G. LANGSETH, COLUMBIA
S038	CHARGED - PARTICLE	CPLLE			X	X	DR. B. J. O'BRIEN, RICE
S058	COLD CATHODE GAUGE*	CCIG			X		DR. F. S. JOHNSON, SCAS
S059	LUNAR FIELD GEOLOGY**		X	X	X	X	DR. E. M. SHOEMAKER, USGS
S078	LASER RANGING RETRO-REFLECTOR	LRRR	X				DR. J. W. FOWLER, WESLEYAN

\* INCLUDED IN SUPRATHERMAL ION ON CERTAIN FLIGHTS

\*\* EQUIP PARTIALLY CARRIED BY ALSEP

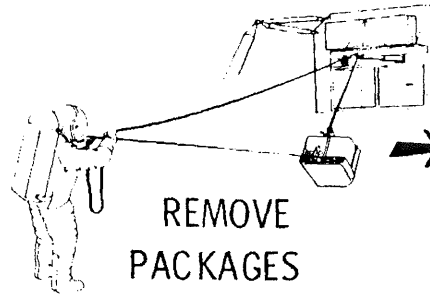
# INSTALLATION IN LUNAR MODULE



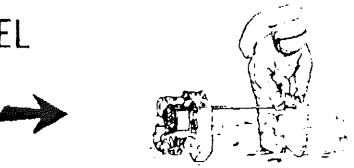
DEC 69 7399.3

# LUNAR SURFACE ACTIVITY

ALSEP  
DEPLOYMENT  
TASKS  
ASSOCIATED  
WITH LM



TRANSFER  
FUEL

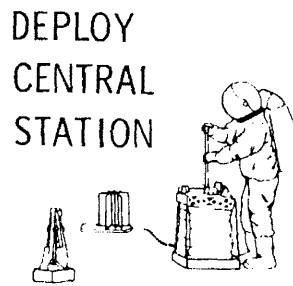


PREPARE FOR TRAVERSE

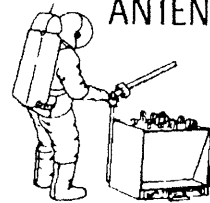


TRAVERSE

ALSEP  
DEPLOYMENT  
TASKS AT  
EXPERIMENT  
SITE



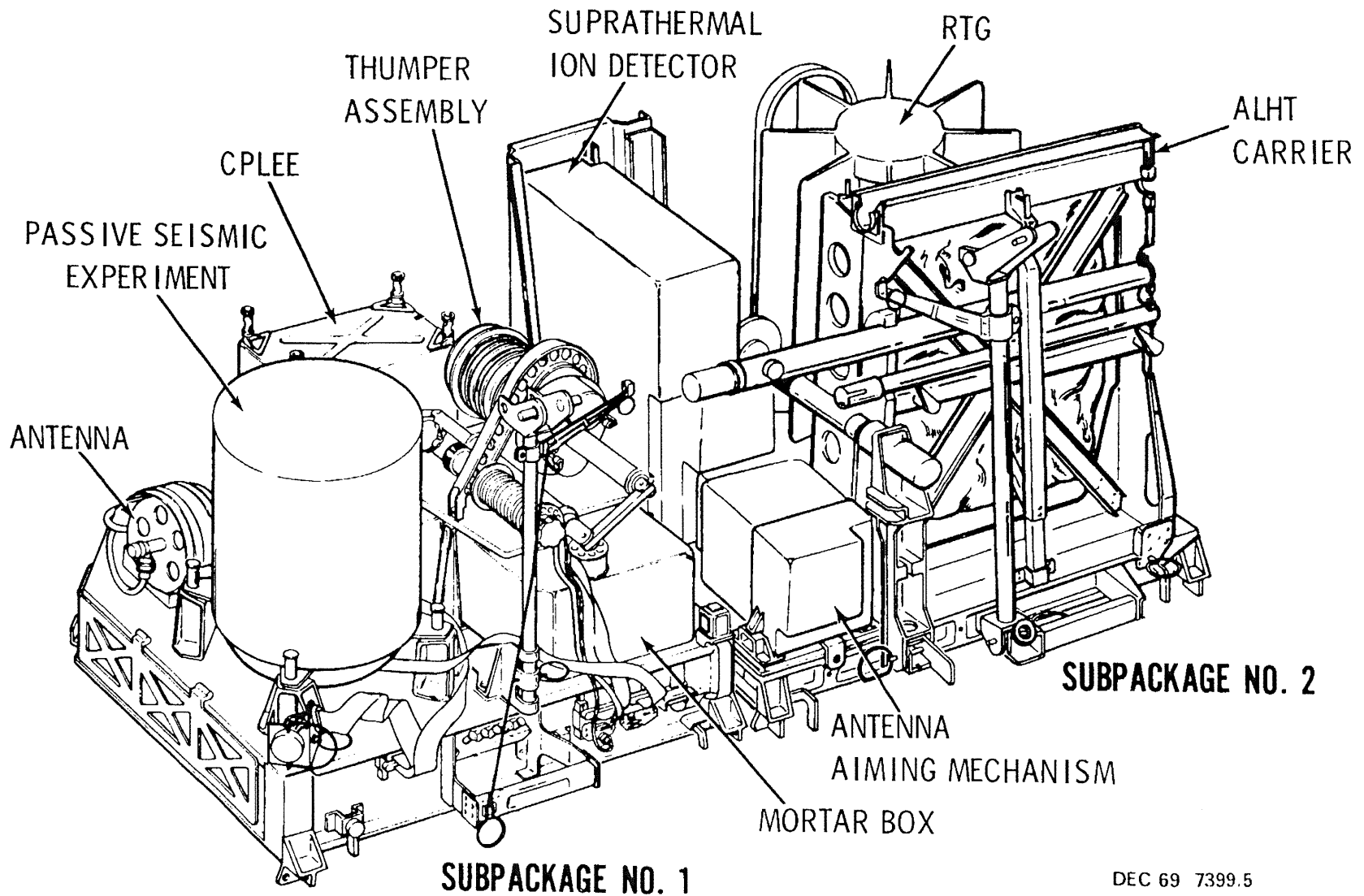
DEPLOY  
ANTENNA



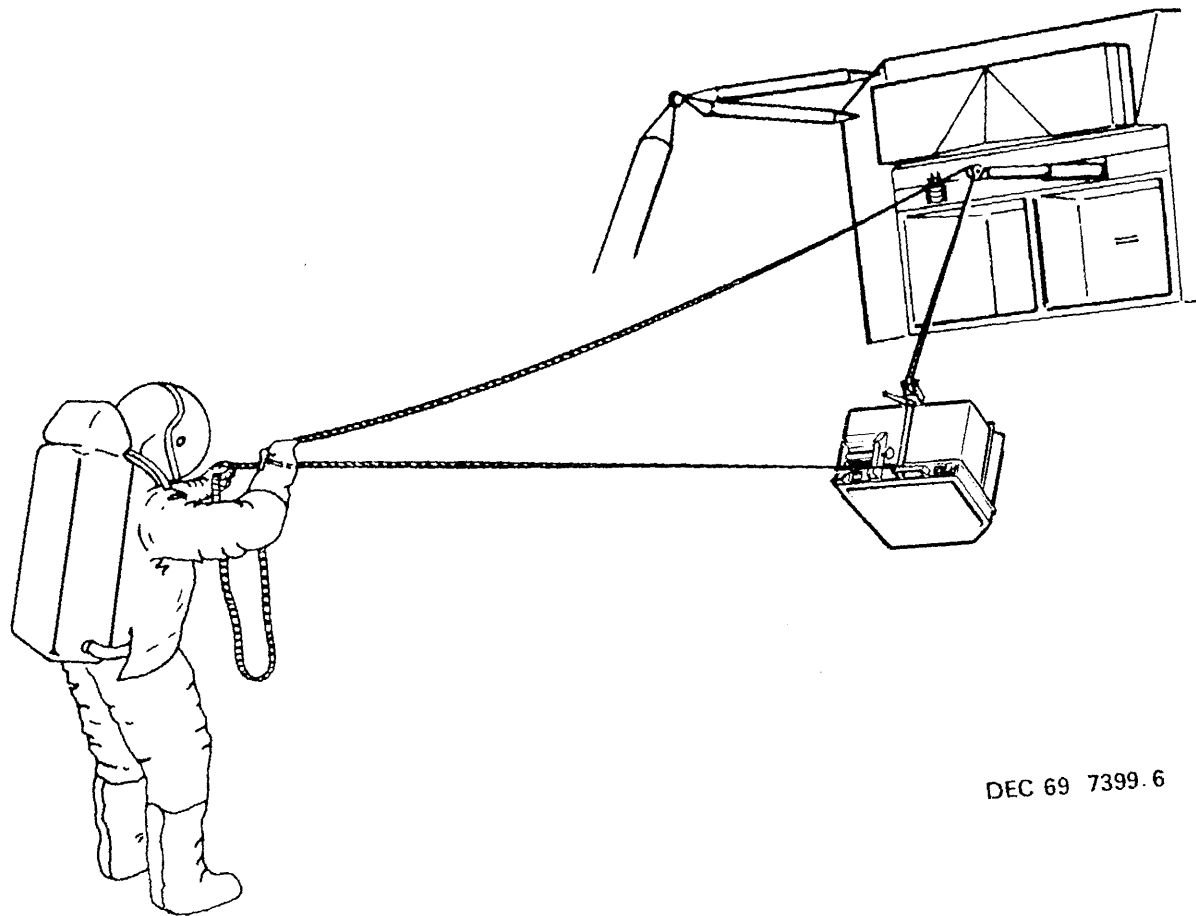
DEPLOY  
EXPERIMENTS

# STOWED CONFIGURATION

ALSEP 4



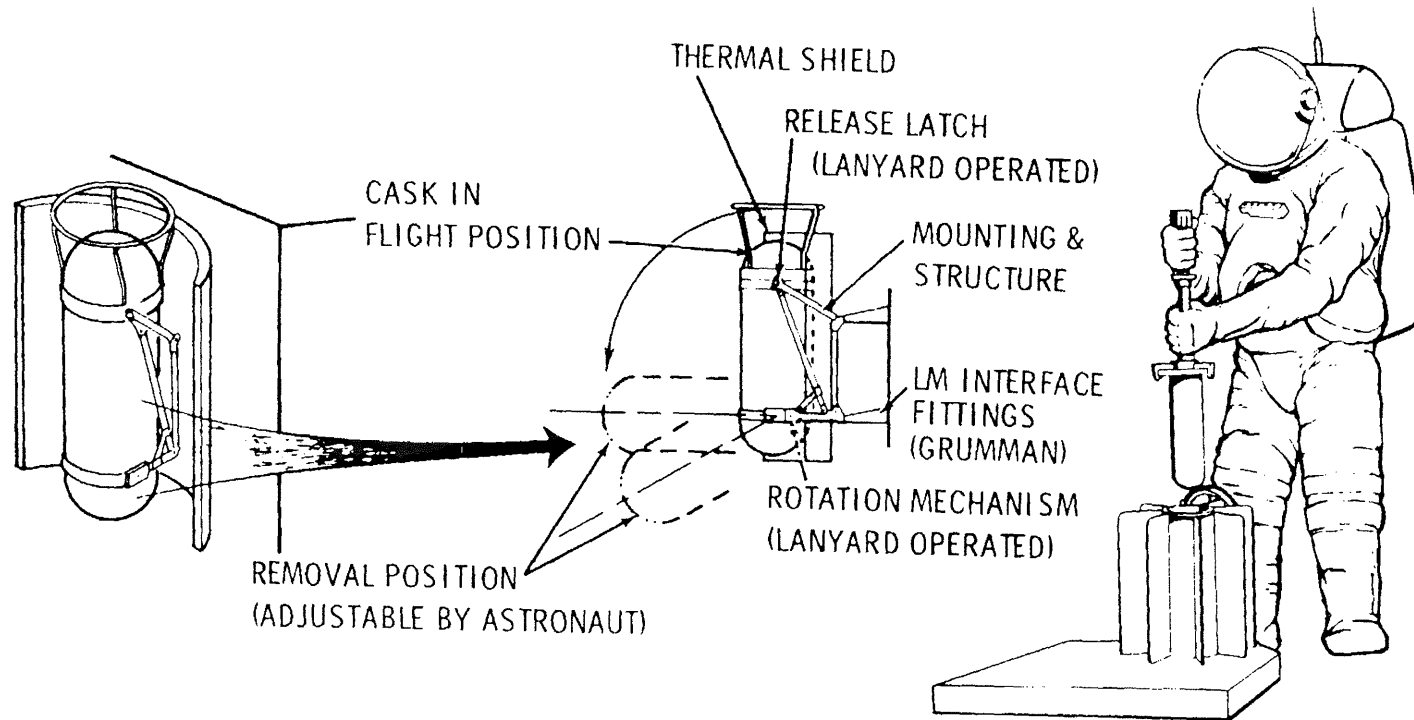
# REMOVE PACKAGES



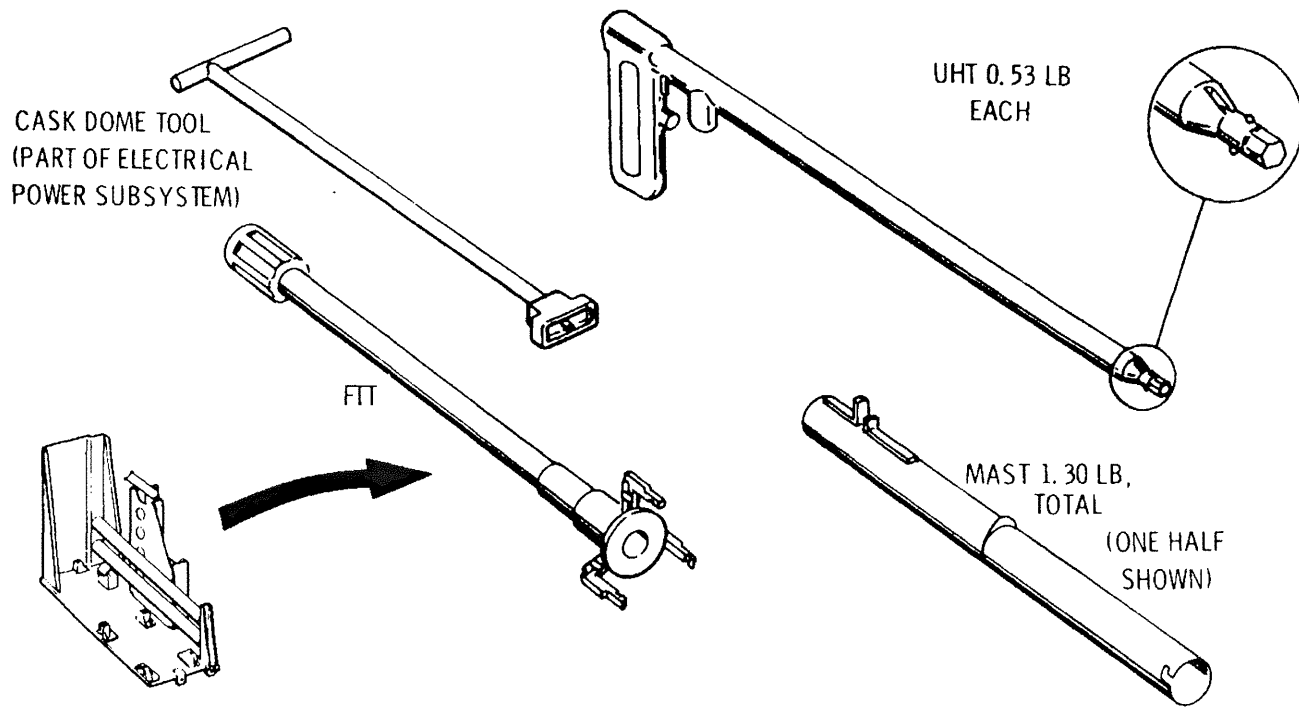
DEC 69 7399.6



# RTG FUELING



# SPECIAL TOOLS



CASK DOME TOOL  
(PART OF ELECTRICAL  
POWER SUBSYSTEM)

UHT 0.53 LB  
EACH

FTI

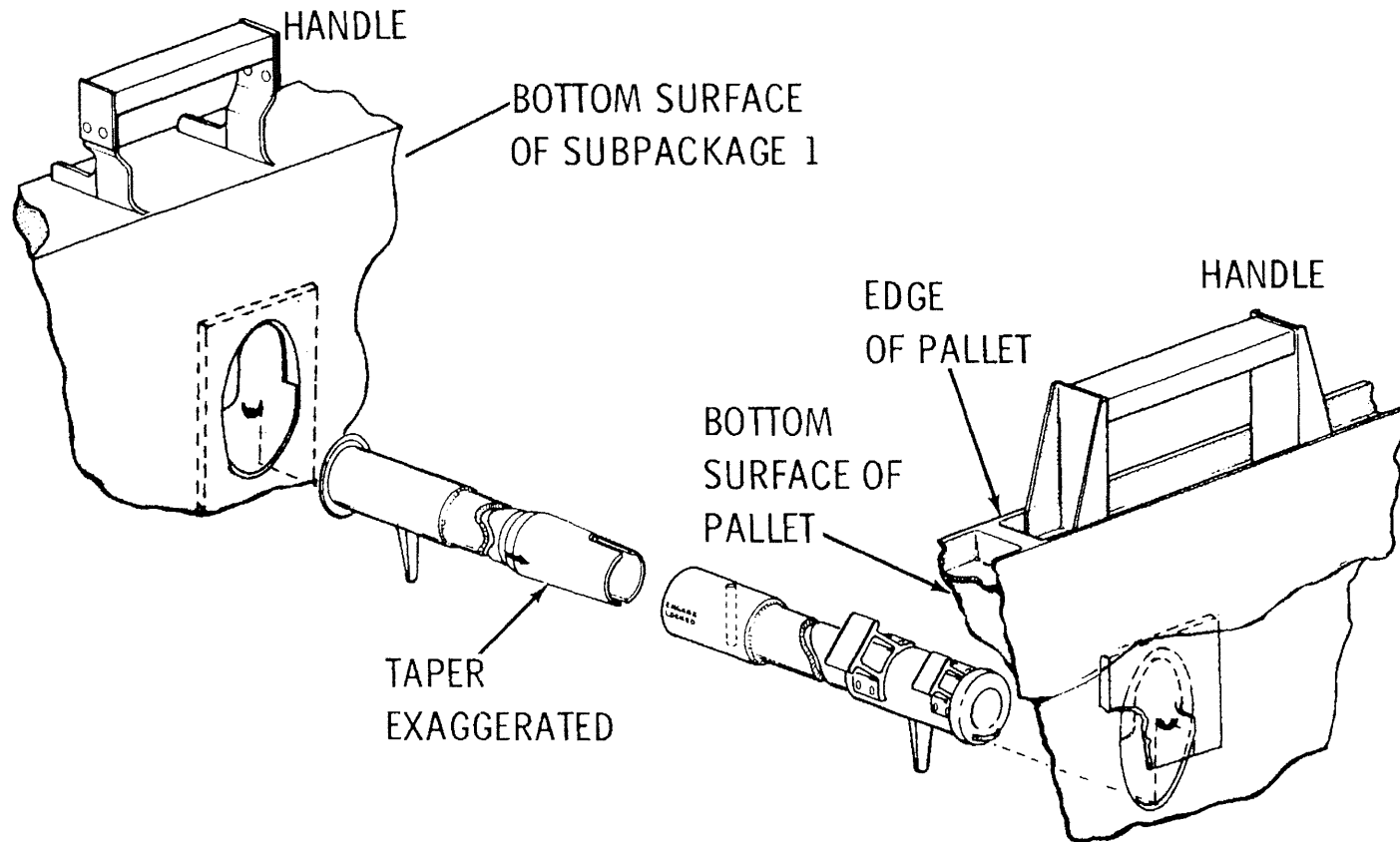
MAST 1.30 LB,  
TOTAL  
(ONE HALF  
SHOWN)

ALL WEIGHTS ARE EARTH LB

14.6 LB FUEL CASK MOUNT & INSULATION, PART OF STRUCTURE/THERMAL  
SUBSYSTEM, COVERED UNDER ELECTRICAL POWER SUBSYSTEM

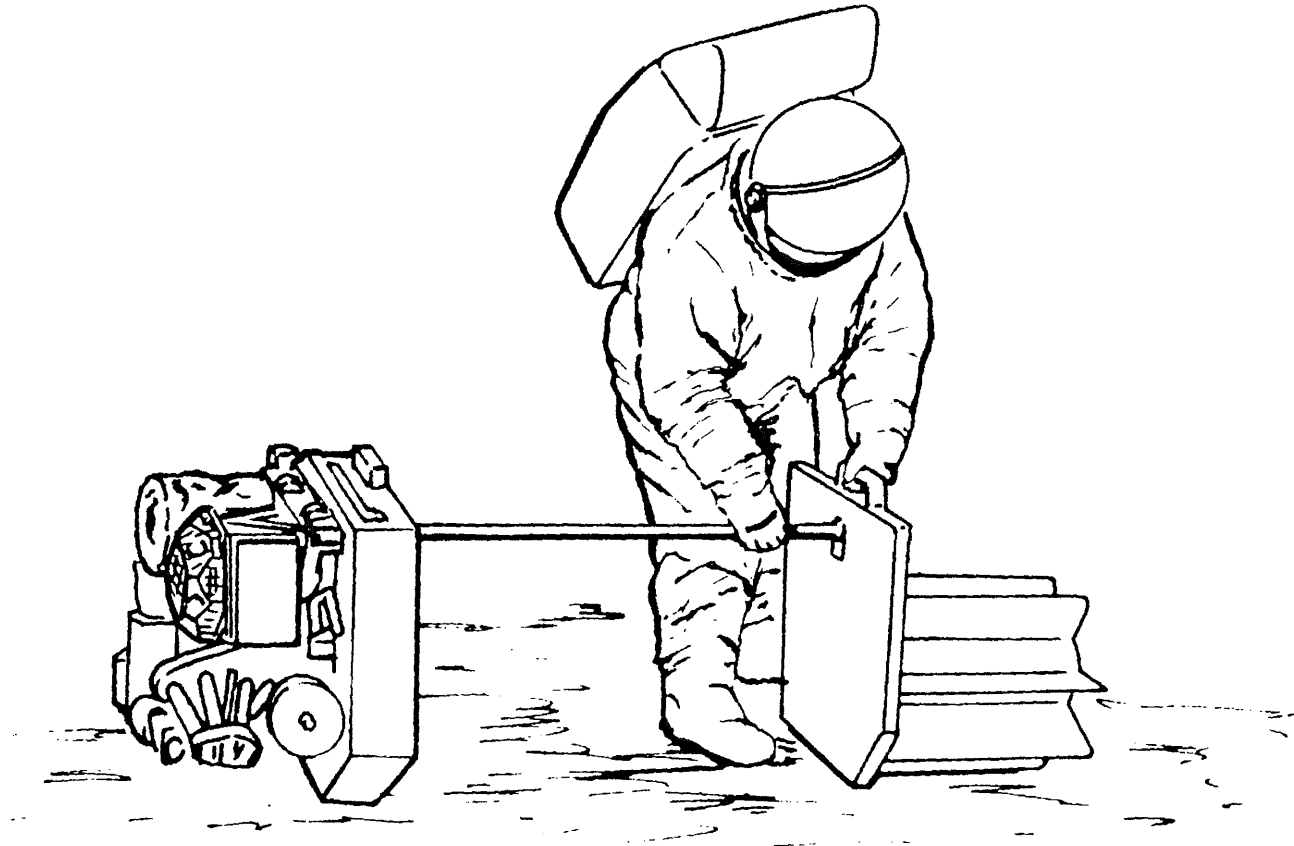
APRIL 70 7399. 8

# MAST/CARRY BAR



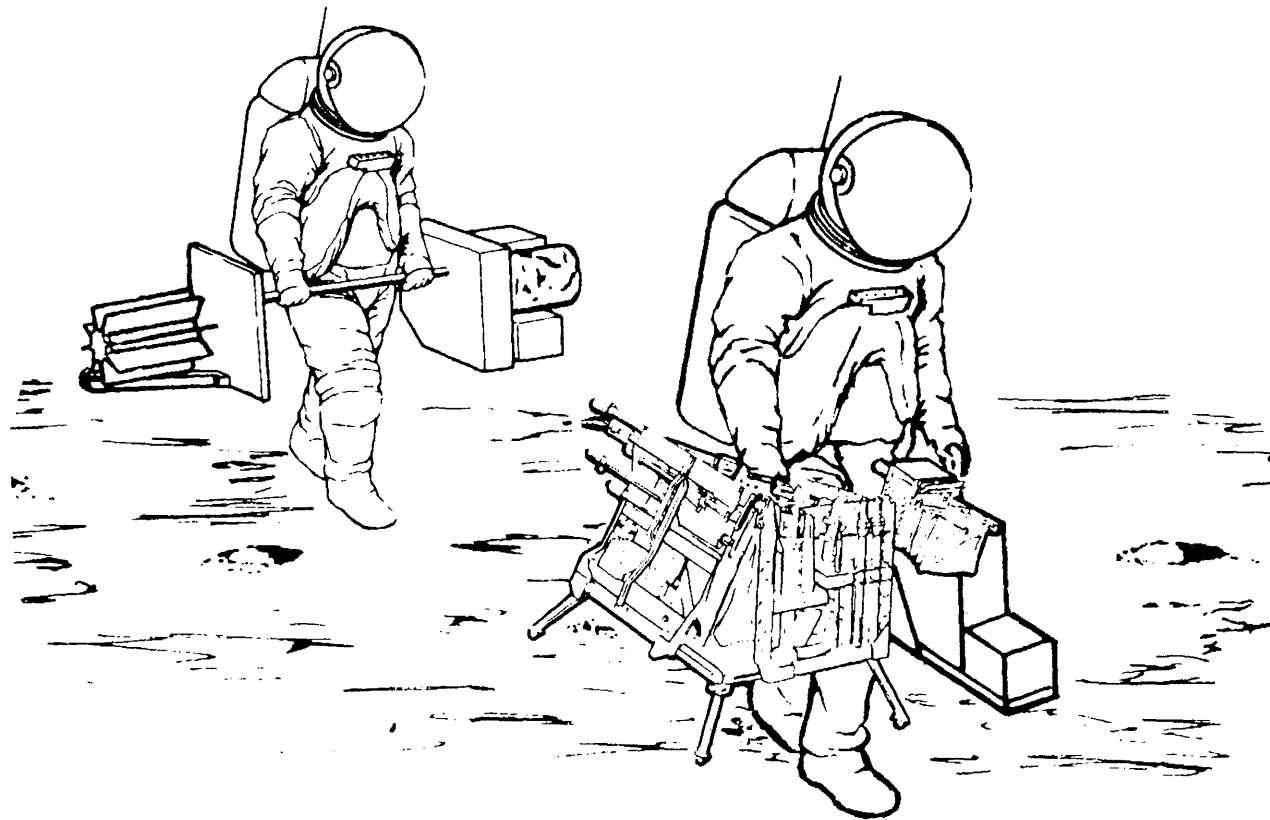
APRIL 70 7399.9

# PREPARE FOR TRAVERSE



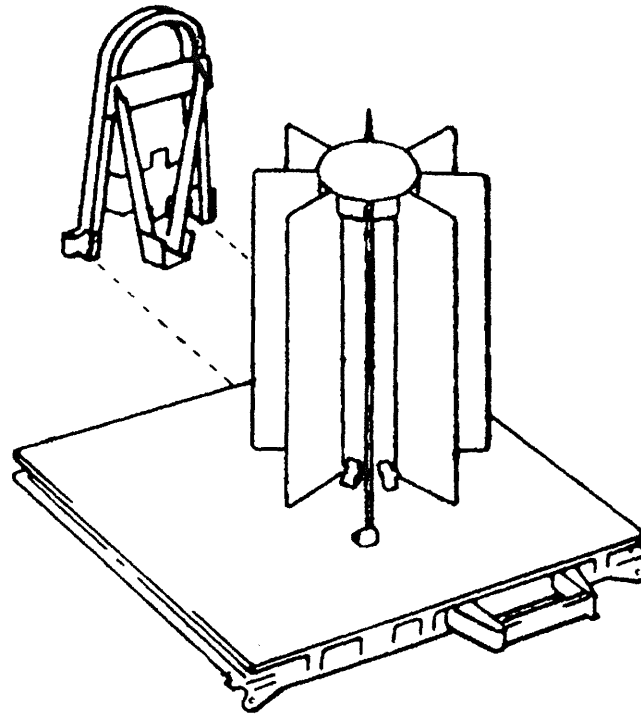
DEC 69 7399.10

# TRAVERSE

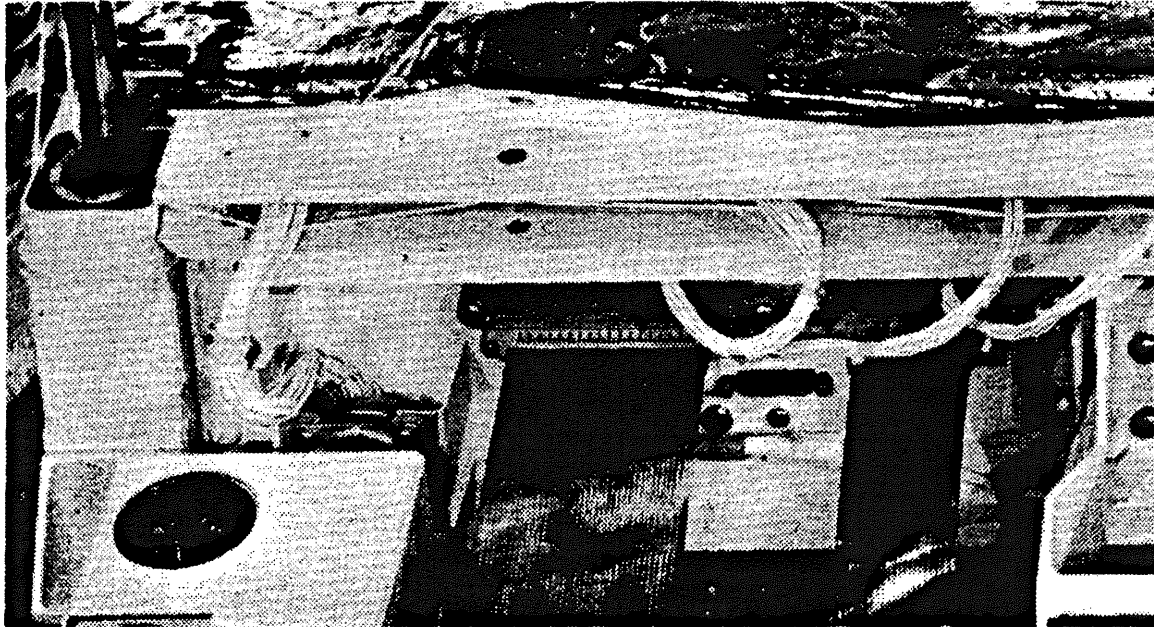


DEC 69 7399.11

# RTG CABLE

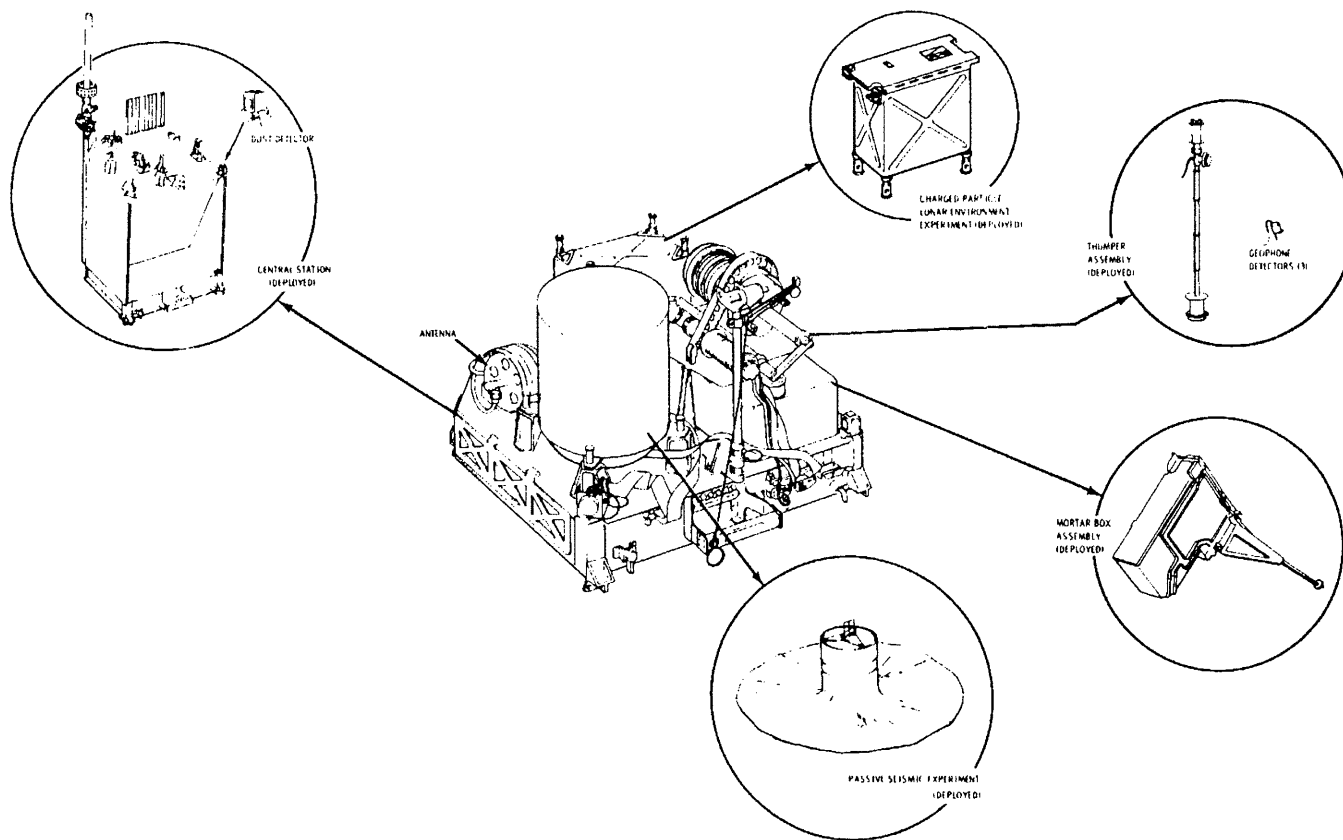


# RTG CABLE CONNECTION



DEC 69 7399.13

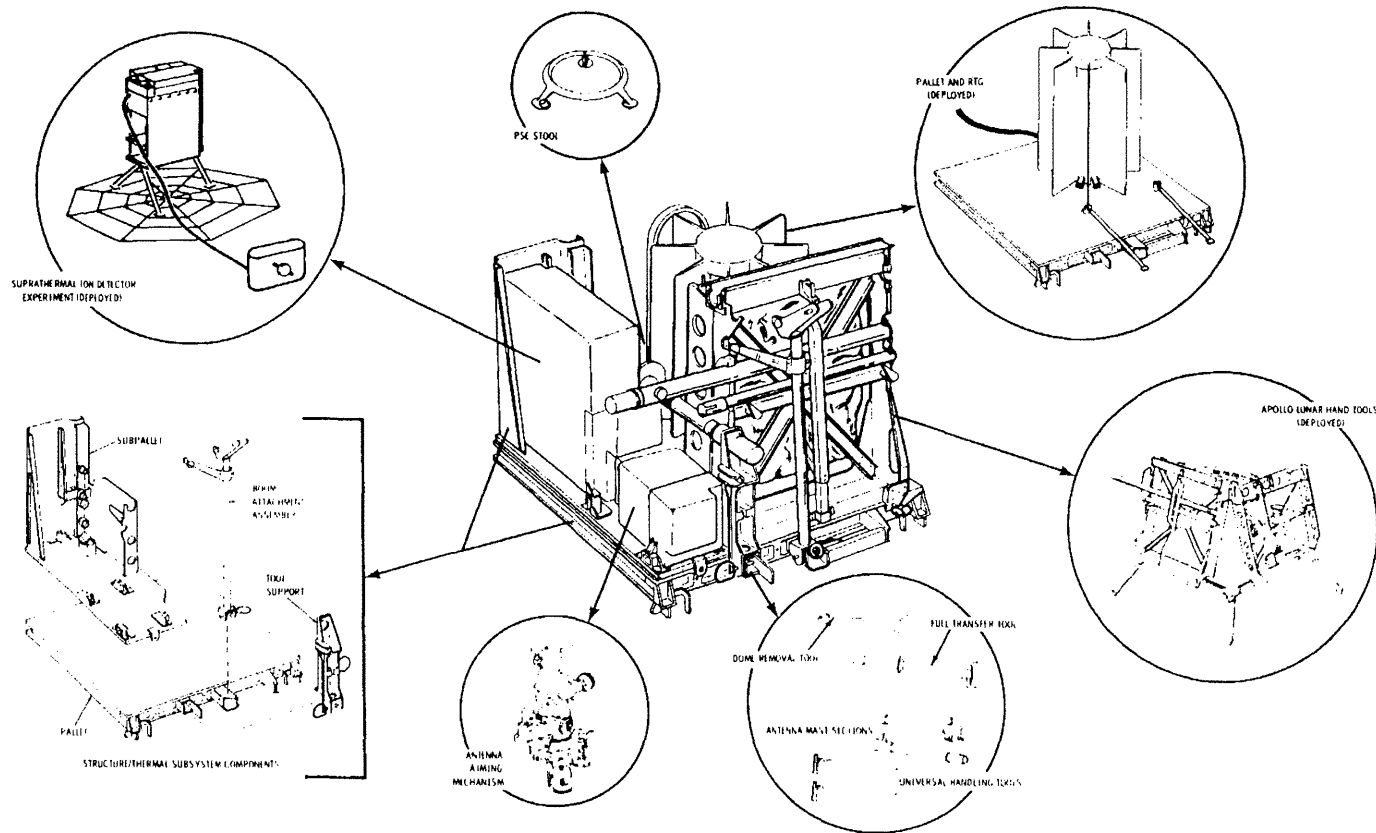
# ALSEP SUBPACKAGE NO. 1



DEC 69 7399.14

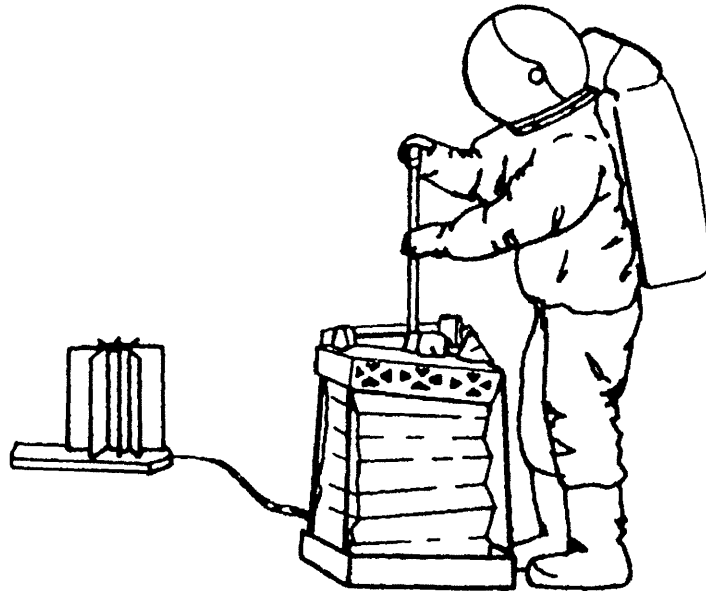


# ALSEP SUBPACKAGE NO. 2



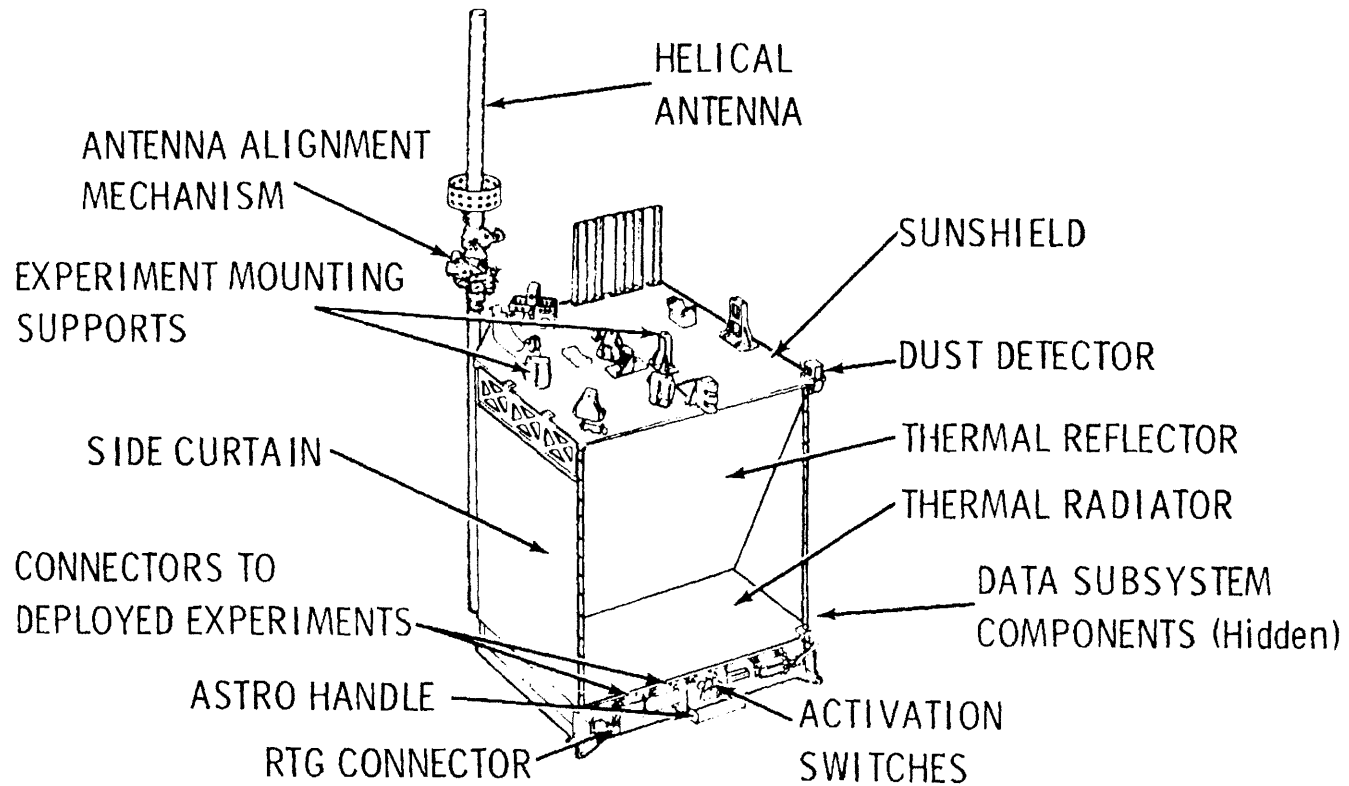
DEC 69 7399.15

# DEPLOY CENTRAL STATION

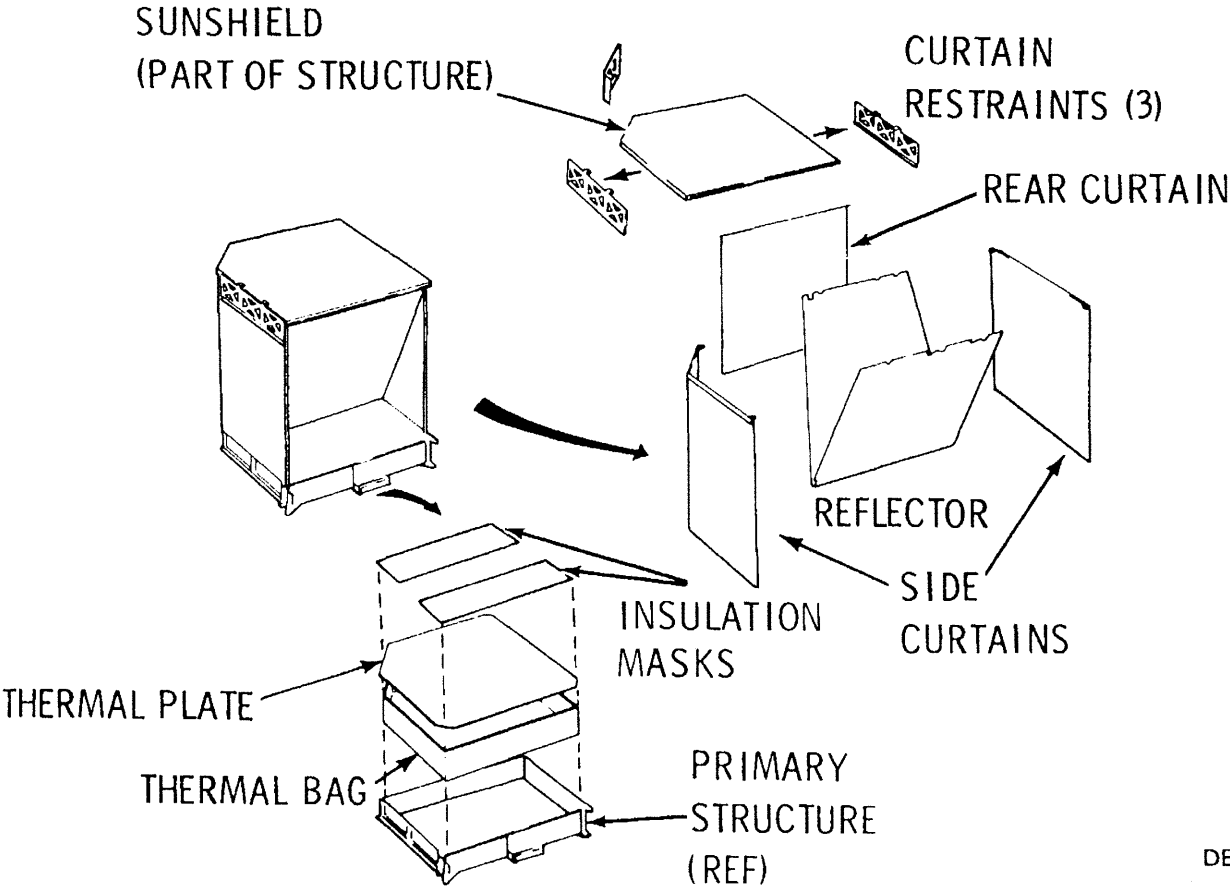


DEC 69 7399.16

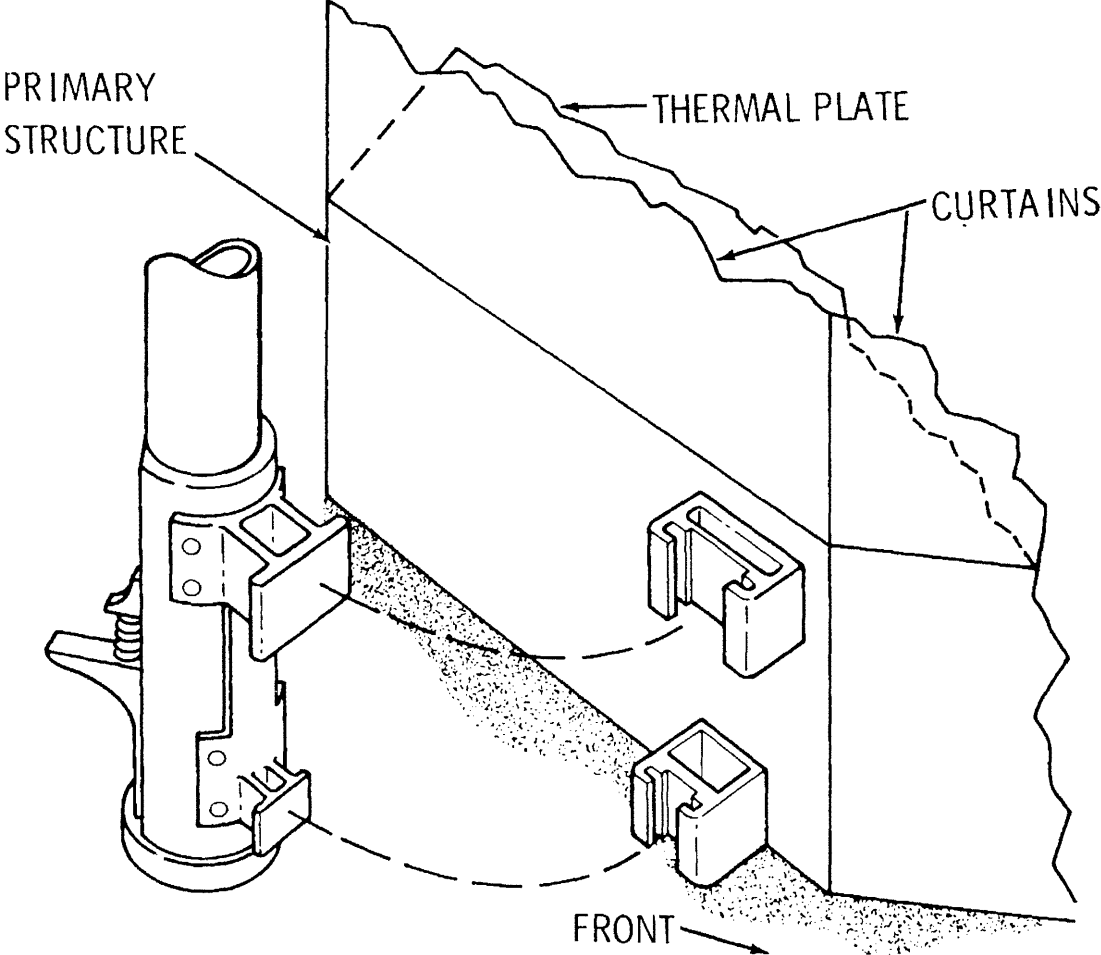
# CENTRAL STATION DEPLOYED CONFIGURATION



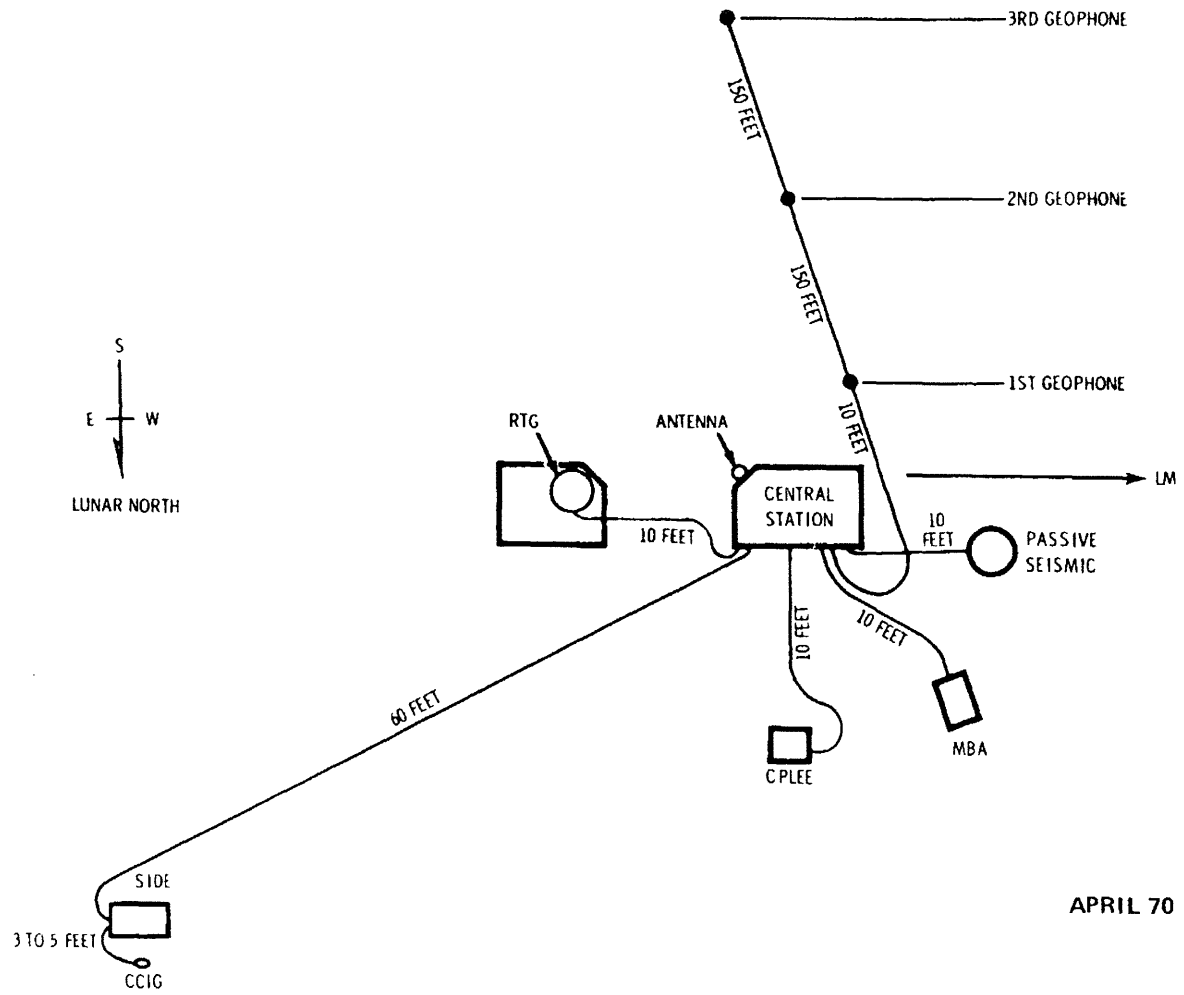
# SUBPACKAGE #1 THERMAL COMPONENTS



# MAST/PRIMARY STRUCTURE

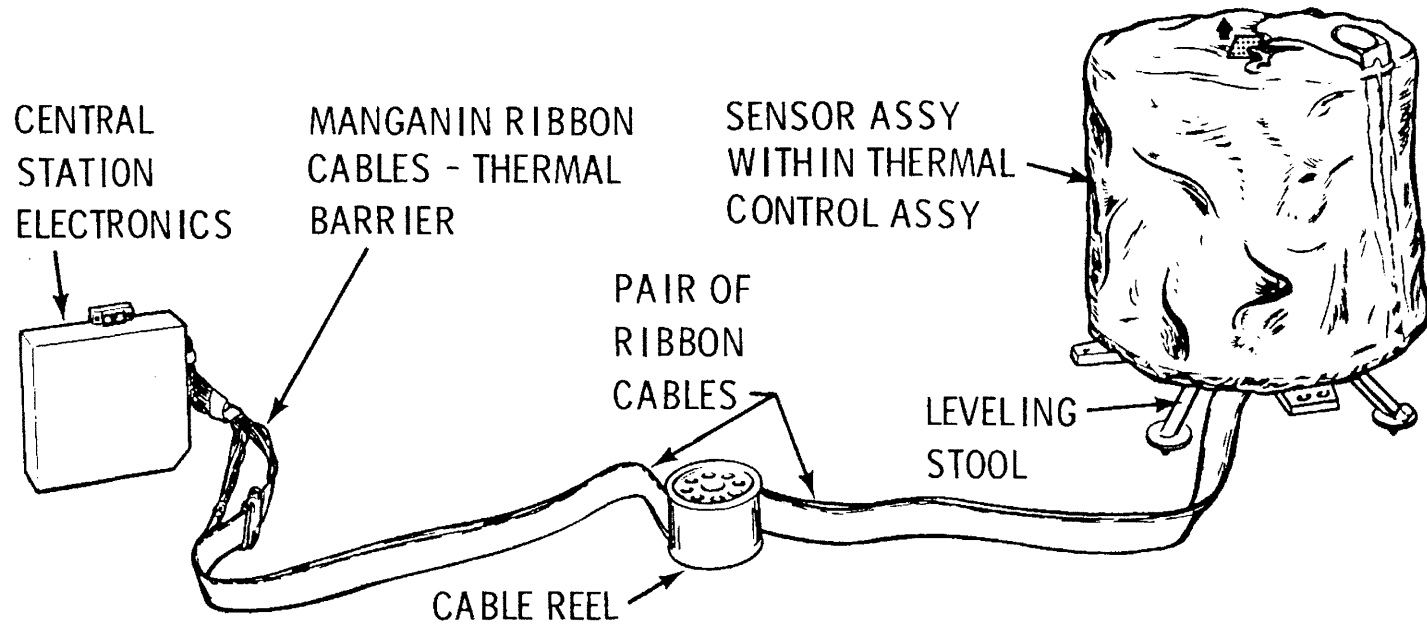


# DEPLOYMENT ARRANGEMENT FLIGHT 4

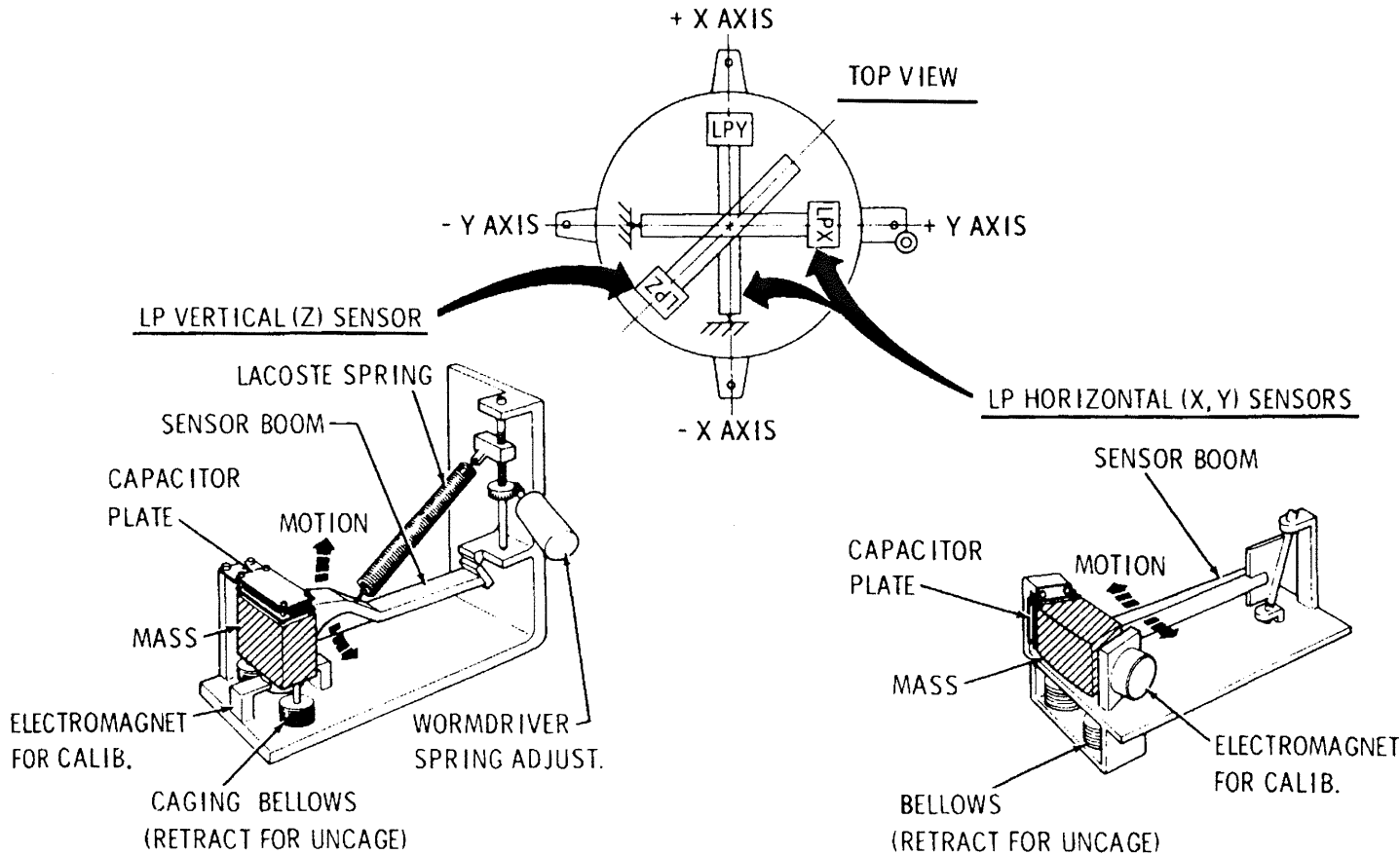


APRIL 70 7399.20

# PASSIVE SEISMIC EXPERIMENT



# INSTRUMENT DETAILS



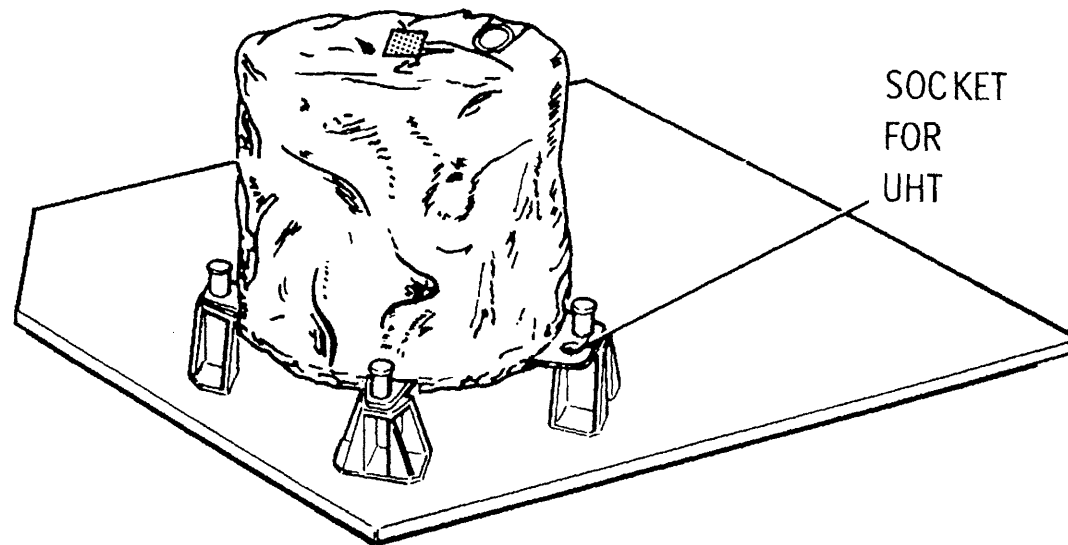


# PSE REMOVAL

RELEASE 4 FASTENERS

INSERT UHT

LIFT EXPERIMENT

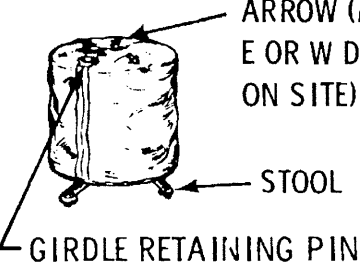
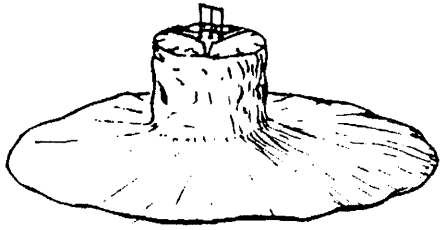


# PSE EMPLACEMENT CRITERIA

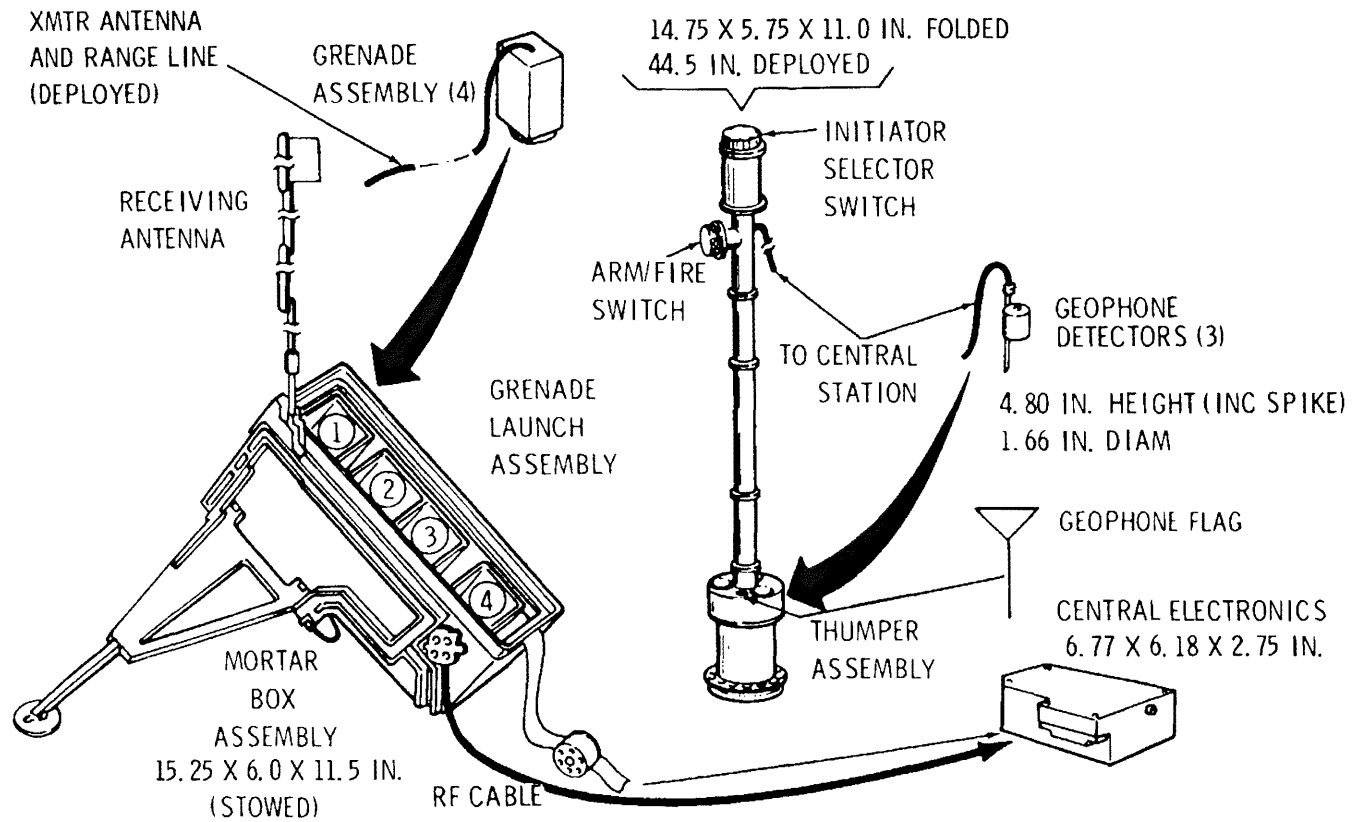
PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
DISTANCE FROM SUBPACKAGE 1	9 ± 1 FT	1	10 FT CABLE	15 FT SEPARATION REQUIREMENT FROM RTG FOR THERMAL REASONS
DIRECTION FROM SUBPACKAGE 1	DUE E OR W*	1	EYEBALL	OUT OF FIELD OF VIEW OF CENTRAL STATION RADIATOR
SITE SELECTION	'QUIET' LOCATION	1	EYEBALL	FREE FROM LOOSE RUBBLE
LEVEL, WRT INDICATOR	±5° OF HORIZONTAL	1	BUBBLE LEVEL	INTERACTS WITH ALIGNMENT; INSTRUMENT FINE-LEVELS INTERNALLY
ROUGH ALIGN	±20° OF E-W	2	ARROW**	BEFORE OPENING SHROUD
READOUT OF ALIGNMENT WRT SHADOW	±5° OF E-W	1	FULL ROSE	AFTER OPENING SHROUD
EXPERIMENT INTERRELATION	*NO LESS THAN 10 FT FROM OTHER SUBSYSTEMS TO MINIMIZE PICKUP OF STRAY VIBRATIONS.			
SPECIAL REQUIREMENTS	**ARROW NOMINALLY POINTS WEST ALTHOUGH SCIENTIFIC OUTPUT DEPENDS ONLY ON KNOWING FINAL ALIGNMENT. FINAL READING IS ACCOMPLISHED WITH ASSISTANCE OF AZIMUTH GNOMEN MOUNTED ON TOP OF THERMAL SHROUD.			

APRIL 70 7399.24

# PSE ALIGNMENT MARKINGS

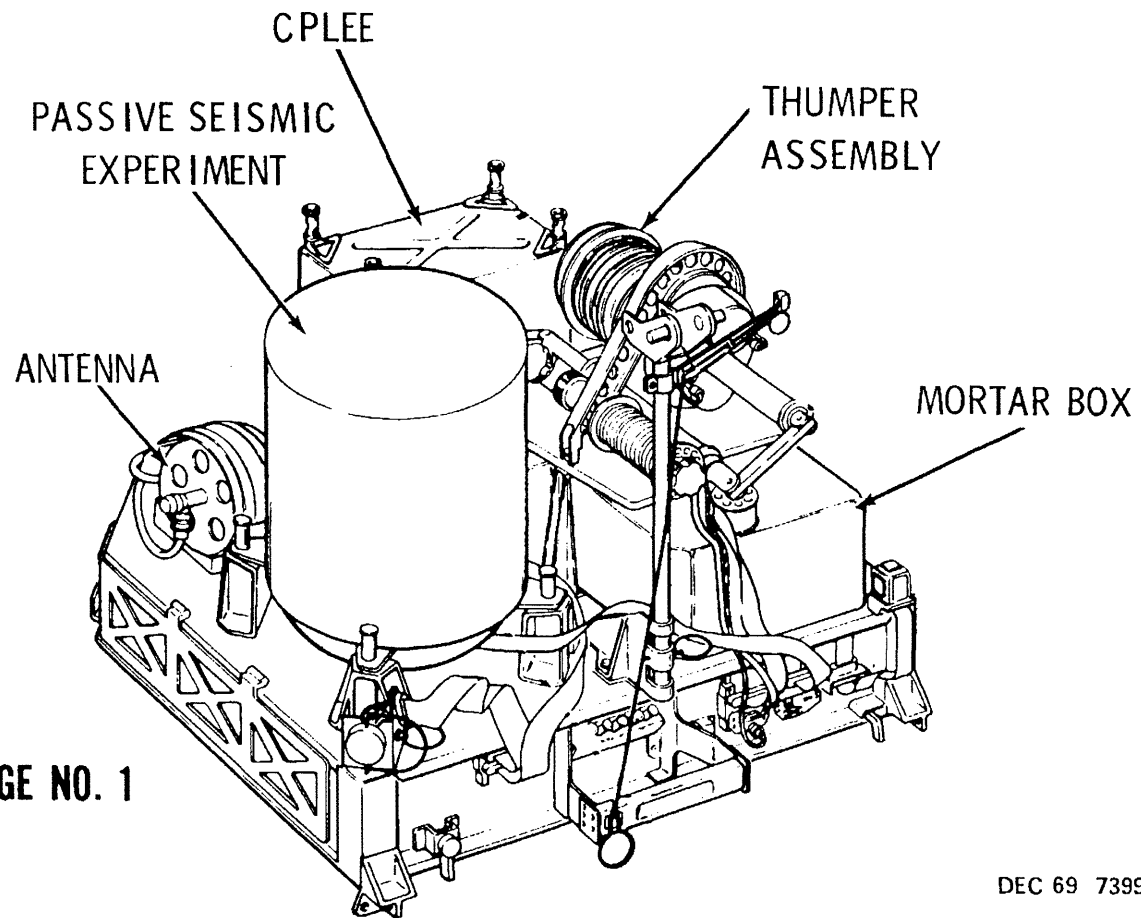
PHASE	CONFIGURATION	TASK	MARKING
INITIAL	CYLINDRICAL SENSOR ASSY INSIDE THERMAL CASE, ENCLOSED IN THERMAL SHROUD WITH GIRDLE OVER SHROUD	ROUGH ALIGN VIA ARROW ON TOP OF GIRDLE	 <p>ARROW (MAY POINT E OR W DEPENDING ON SITE)</p> <p>STOOL</p> <p>GIRDLE RETAINING PIN</p>
FINAL	SHROUD OPENED & ASSY LEVELED	READOUT VIA SHADOWS WRT COMPASS MARKINGS ON TOP	

# ACTIVE SEISMIC EXPERIMENT SUBSYSTEM



APRIL 70 7399.26

# ACTIVE SEISMIC EXPERIMENT REMOVAL



**SUBPACKAGE NO. 1**

DEC 69 7399.27

# ASE DETECTION SYSTEM

## GEPHONE (SENSORS)

TYPE: ELECTROMAGNETIC

NATURAL FREQUENCY: 7.5 CPS

SENSITIVITY: 250 VOLT/METER/SEC

WEIGHT: 6 OZ EACH SENSOR

## AMPLIFIER

3 CHANNELS EACH WITH PREAMP, FILTER AND LOG COMPRESSOR

80 DB DYNAMIC RANGE LOG COMPRESSED TO 40 DB

LOG COMPRESSOR TEMPERATURE CONTROLLED

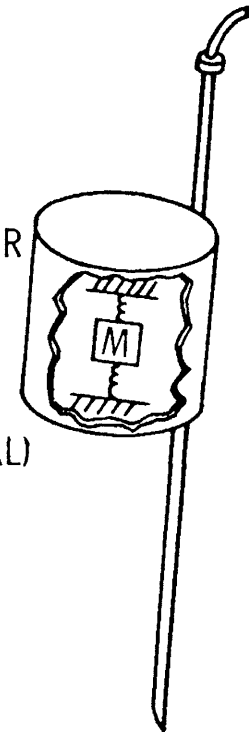
## GEPHONE & AMPLIFIER

SENSITIVITY:  $5 \text{ m}\mu$  PEAK DISPLACEMENT AT 10 Hz ( $1 \text{ m}\mu$  GOAL)  
AT A SIGNAL TO NOISE RATIO OF 18 db

BANDWIDTH: 3 TO 250 Hz WITH RESPECT TO VELOCITY

## BASIC DATA WORD

5-BIT WORD FOR EACH SENSOR READING AT 500 SAMPLES/SEC  
(EACH CHANNEL)



# ASE DEPLOYMENT SEQUENCE

1. VERIFY THAT CENTRAL STATION  
ASTRONAUT SWITCH IS IN OPEN POSITION
2. REMOVE THUMPER & PLACE IN TEMPORARY LOCATION
3. REMOVE MORTAR BOX & PLACE 10 FT FROM CENTRAL STATION  
IN OPPOSITE DIRECTION TO THAT SELECTED FOR GEOPHONES
4. ALIGN TO FIRE AWAY FROM GEOPHONES & ERECT ASE RECEIVING  
ANTENNA (INC FLAG)
5. ERECT CENTRAL STATION SUNSHIELD & ANTENNA
6. AFTER ALSEP COMMUNICATIONS HAVE BEEN ESTABLISHED, PLACE  
CENTRAL STATION ASTRONAUT SWITCH IN CLOSED POSITION AND  
SWITCH TO ASE HBR.
7. UNFOLD THUMPER & WALK OUT IN SELECTED DIRECTION PLACING  
GEOPHONES AT 10, 160, & 310 FT FROM CENTRAL STATION & IN LINE  
+ 3<sup>0</sup> USING FLAG ON MORTAR BOX (PLUS FLAG PLACED AT 160-FT  
GEOPHONE LOCATION ) AS REFERENCE
8. RETURN ALONG GEOPHONE CABLE ACTUATING THUMPER AT 15-FT  
INTERVALS AS INDICATED BY CABLE MARKINGS
9. PLACE CENTRAL STATION ASTRONAUT SWITCH IN OPEN POSITION
10. REMOVE GRENADE RETAINING ROD ASSY FROM MORTAR BOX
11. ACTUATE MORTAR BOX SAFETY SWITCHES (2) REMOVING SHORTS  
FROM GRENADE ARWFIRE CIRCUITS
12. PLACE CENTRAL STATION ASTRONAUT SWITCH IN CLOSED POSITION

THIS PAGE INTENTIONALLY BLANK

APRIL 70 7399.30

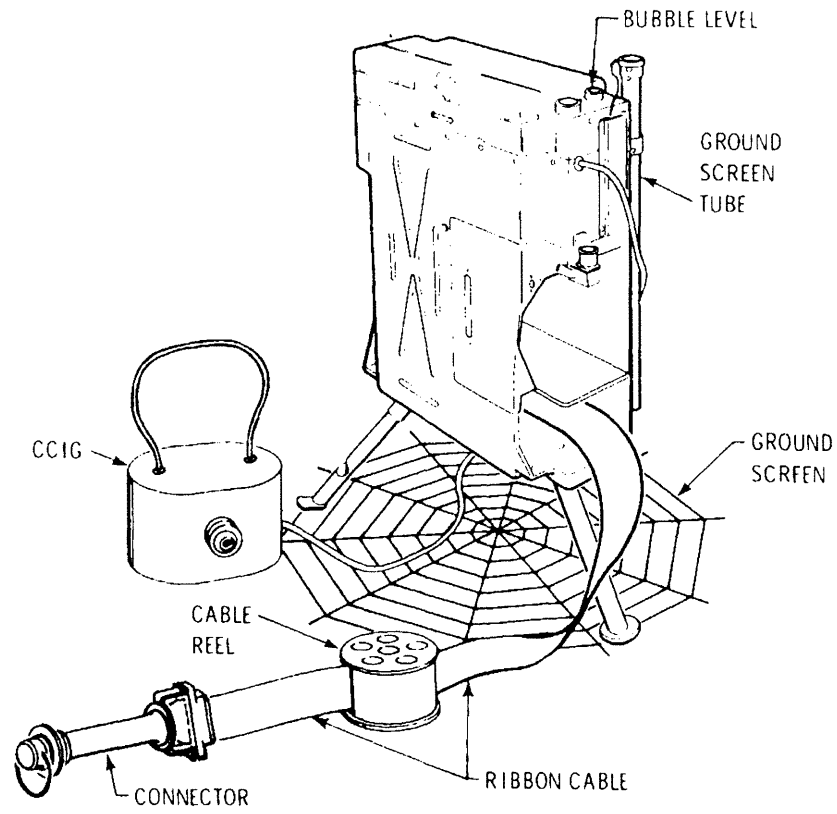


# ASE EMPLACEMENT CRITERIA

	PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
MORTAR PKG	SITE SELECTION	LEVEL (UPRANGE & DOWNRANGE)	1	EYEBALL	SELECTION MUST CONSIDER BOTH GRENADE IMPACT & GEOPHONE AREAS
	DISTANCE FROM SUBPACKAGE 1	10 + 1 FT (11 FT CABLE)	2	PACED OFF	AT LEAST 10 FT FROM RTG
	DIRECTION FROM SUBPACKAGE 1	DEPENDS ON SITE/ SCIENCE CONSTRAINTS			
	LEVEL	+ 10° OF HORIZONTAL	1	EYEBALL	INTERNAL LEVEL SENSORS
	ALIGN	+ 3° FROM ASSUMED GEOPHONES DEPLOY- MENT LINE	1	EYEBALL	FIRES AWAY FROM LM & GEOPHONES
GEOPHONES	DISTANCE FROM SUBPACKAGE 1	12 + 2 FT TO 1ST 150 + 1.5 FT 1ST TO 2ND 300 + 3 FT 1ST TO 3RD	1	314 FT CABLE	GEOPHONES SET LATERALLY FROM CABLE ON 3-FT PIGTAILS
	DIRECTION FROM SUBPACKAGE 1		2	EYEBALL	OPPOSITE MORTAR PACKAGE
	LEVEL GEOPHONE	+ 7° OF HORIZONTAL	2	EYEBALL	GEOPHONE RESPONSE REQUIREMENT
	ALIGN CABLE	+ 3° FROM STRAIGHT	1	FLAGS *	VARIATION OF 2ND GEOPHONE FROM LINE BETWEEN 1ST & 3RD
SPECIAL REQUIREMENTS		* 2 FLAGS: MORTAR BOX AND 2ND GEOPHONE (USED FOR ALIGNMENT) ANTENNA MOUNTED ON MORTAR BOX (OMNI-DIRECTIONAL).			
EXPERIMENT INTERRELATION		GEOPHONES AT LEAST 10 FT FROM RTG AND SUBPACKAGE 1			

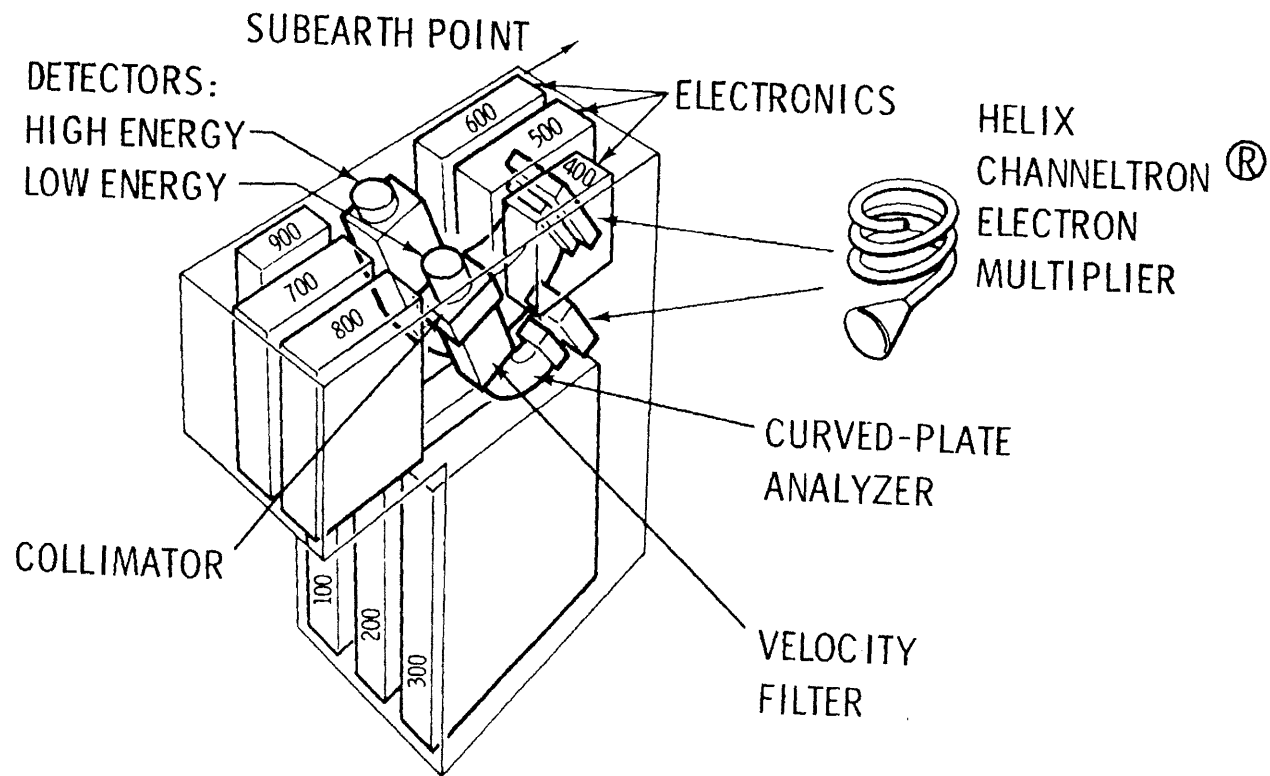
APRIL 70 7399.31

# SIDE

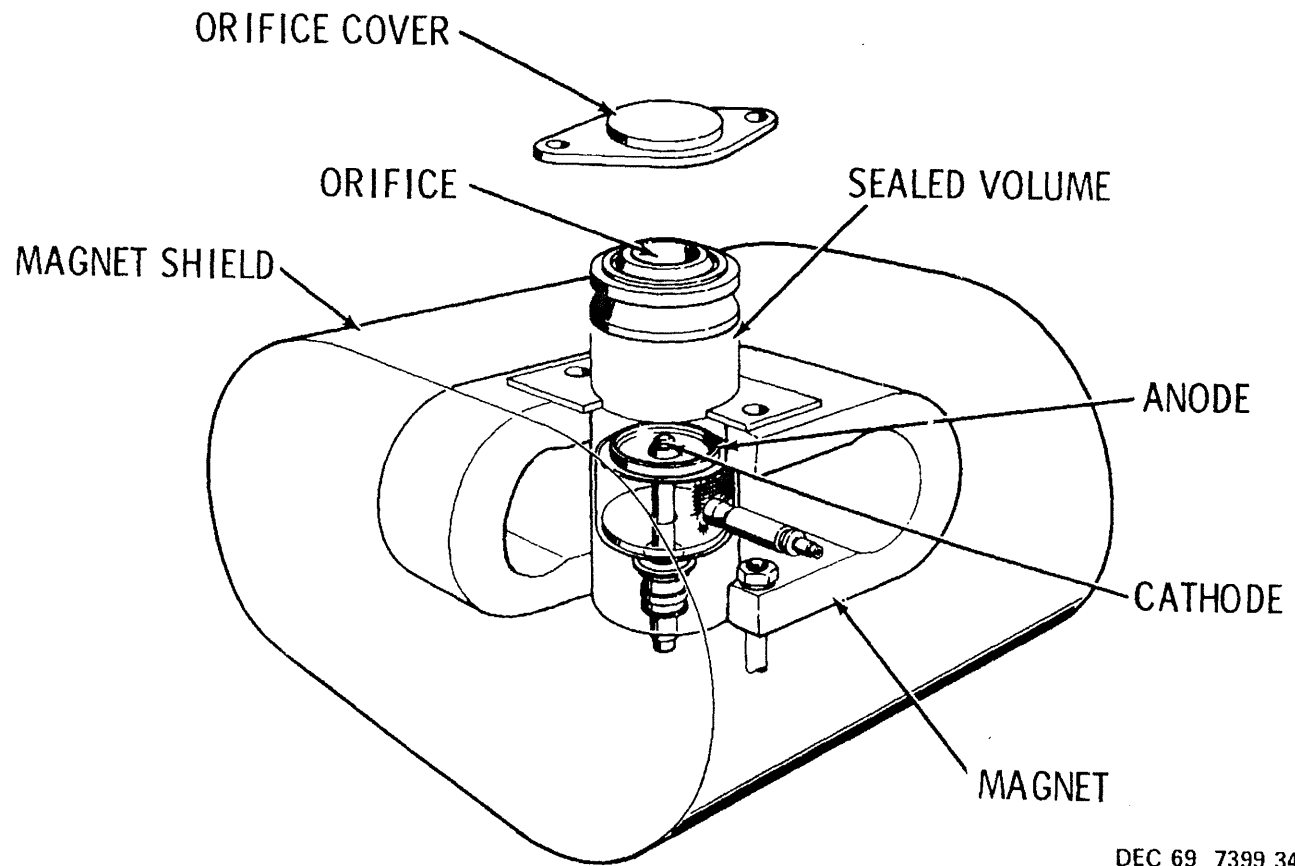


DEC 69 7399.32

# ION DETECTOR INSTRUMENT



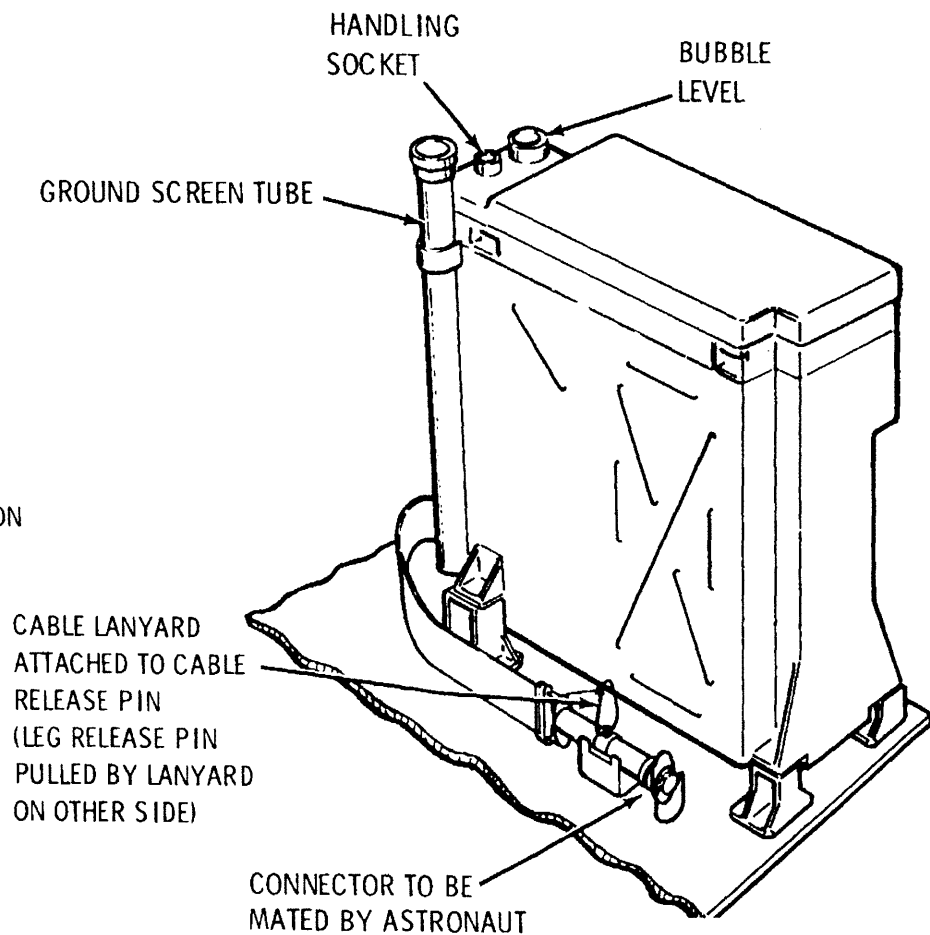
# CCIG INSTRUMENT



DEC 69 7399.34

# SIDE REMOVAL

- SIDE ON SUBPALLET OF SUBPACK 2
- ASTRONAUT RELEASES 5 FASTENERS
  - 1 EXPER TIE-DOWN RELEASED BY ROTATING GROUND SCREEN TUBE
  - 4 EXPER TIE-DOWNS RELEASED BY USING UHT
  - CONNECTOR RELEASED BY USING UHT
- EXPERIMENT LIFTED USING UHT IN HANDLING SOCKET
- CONNECTOR LIFTED BY LANYARD
- ASTRONAUT DEPLOYS LEGS BY PULLING LANYARD
- PLACES EXPER ON LUNAR SURFACE
- PLUGS CONNECTOR INTO CENTRAL STATION
- REMOVES SCREEN FROM TUBE & DEPLOYS SCREEN
- LIFTS EXPER
- REMOVES CC IG
- STANDS EXPER ON SCREEN
- DEPLOYS CC IG (OFF SCREEN)



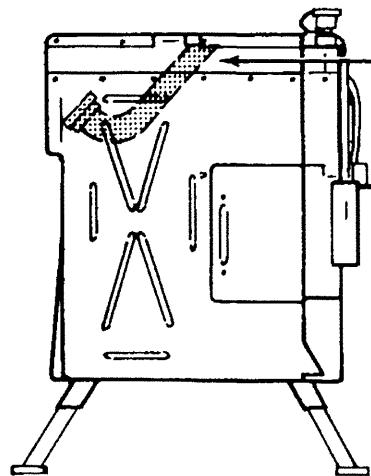
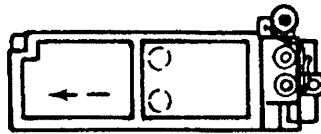
DEC 69 7399.35

# SIDE EMPLACEMENT CRITERIA

	PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
DETECTOR	DISTANCE FROM SUBPACKAGE 1	55 ± 5 FT	2	60 FT CABLE	
	DIRECTION FROM SUBPACKAGE 1		2	EYEBALL	
	SITE SELECTION	SMOOTH	1	EYEBALL	SUITABLE FOR SCREEN
	LEVEL, WRT INDICATOR	5° OF HORIZ	1	BUBBLE	INTERACTS WITH ALIGNMENT
	ALIGN, WRT SHADOW	5° OF E-W	2	ARROW*	THERMAL & SCIENTIFIC REQUIREMENT
ION GAUGE	POSITION	OFF SCREEN, OPPOSITE LM, 5 FT FROM DETECTOR	1	5 FT CABLE	TO SATISFY ALIGNMENT REQUIREMENTS
	ALIGN ORIFICE	20° OF N OR S	2	PAINT	AWAY FROM (±90°) ALL SUBSYSTEMS, LM, SUN & EARTH
	EXPERIMENT INTERRELATION	HEAVY MAGNET IN ION GAGE IS SHIELDED.			
	SPECIAL REQUIREMENTS	*ARROW MUST POINT TOWARD SUBEARTH POINT (E OR W); HENCE, EXPERIMENT IS NOT BIDIRECTIONAL. FINAL ALIGNMENT IS BY SHADOWS ON LONG SIDES OF DETECTOR.			

APRIL 70 7399.36

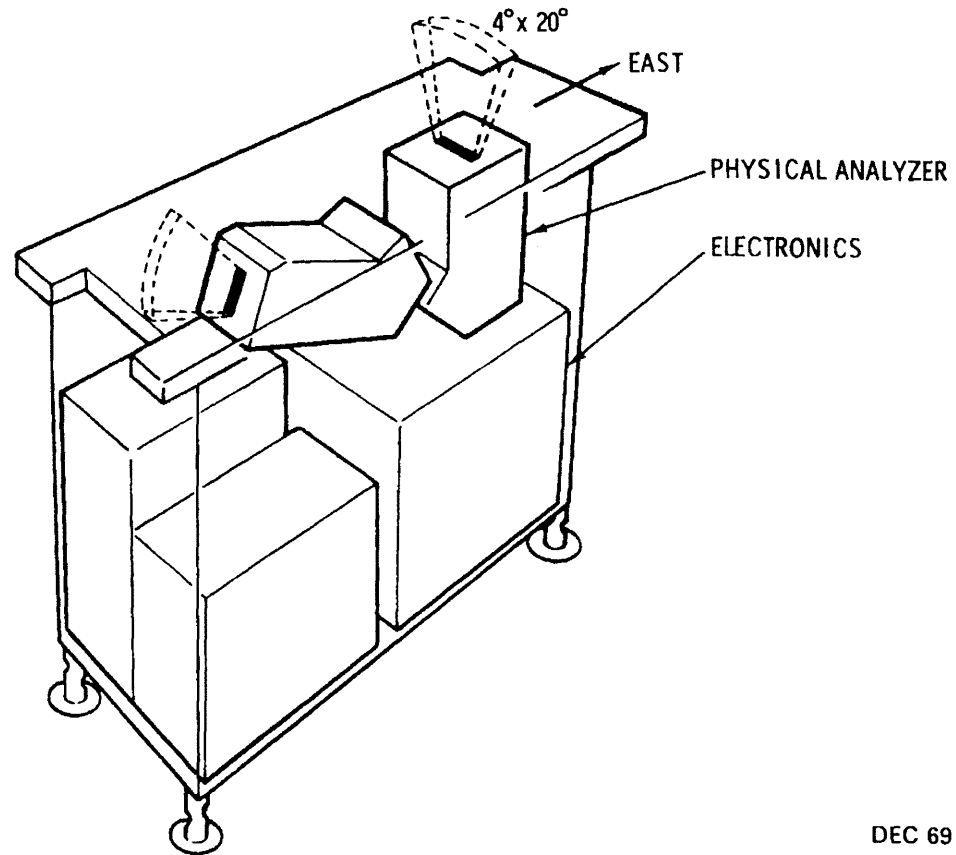
# SIDE ALIGNMENT MARKINGS



## DETECTORS

- ARROW POINTS EAST OR WEST: ( $\pm 5^\circ$ )  
BUT TOWARD THE SUBEARTH POINT
- DETECTORS POINT AWAY FROM SUBEARTH POINT

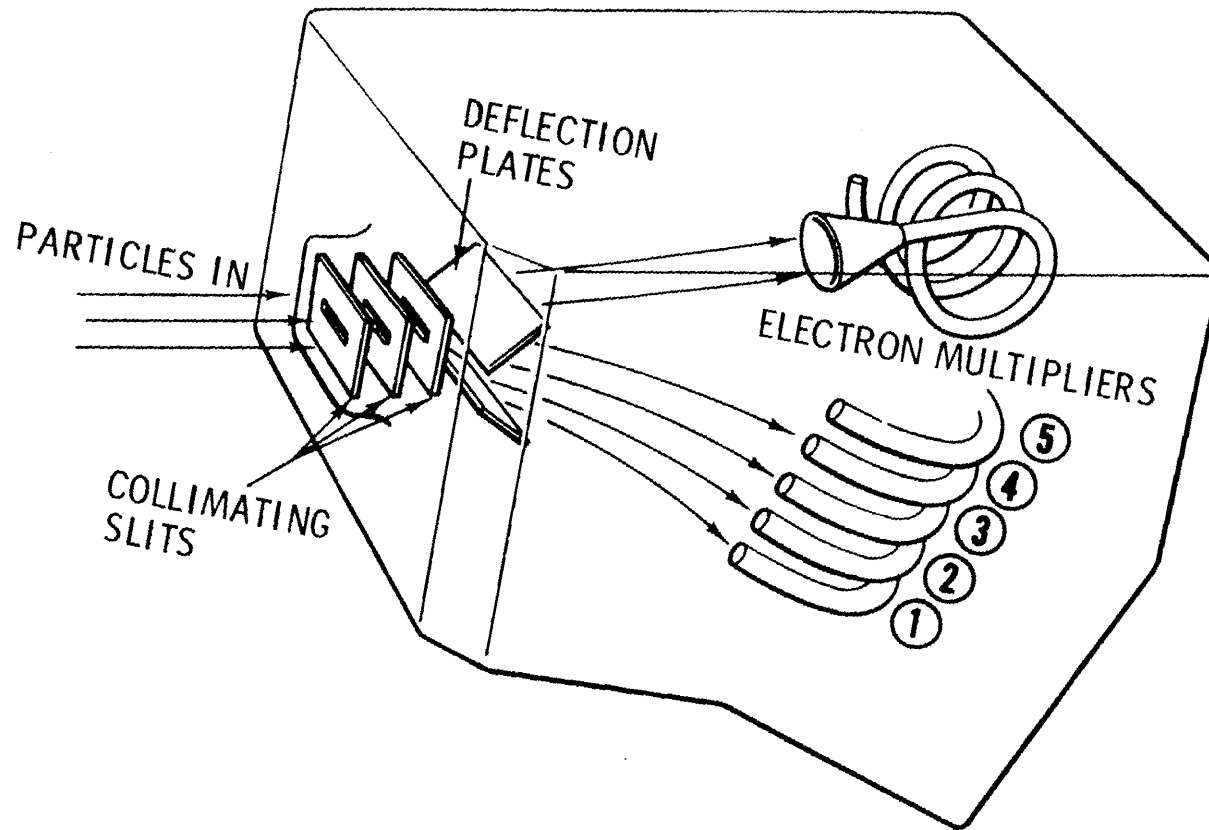
# CHARGED-PARTICLE LUNAR ENVIRONMENT EXPERIMENT SUBSYSTEM



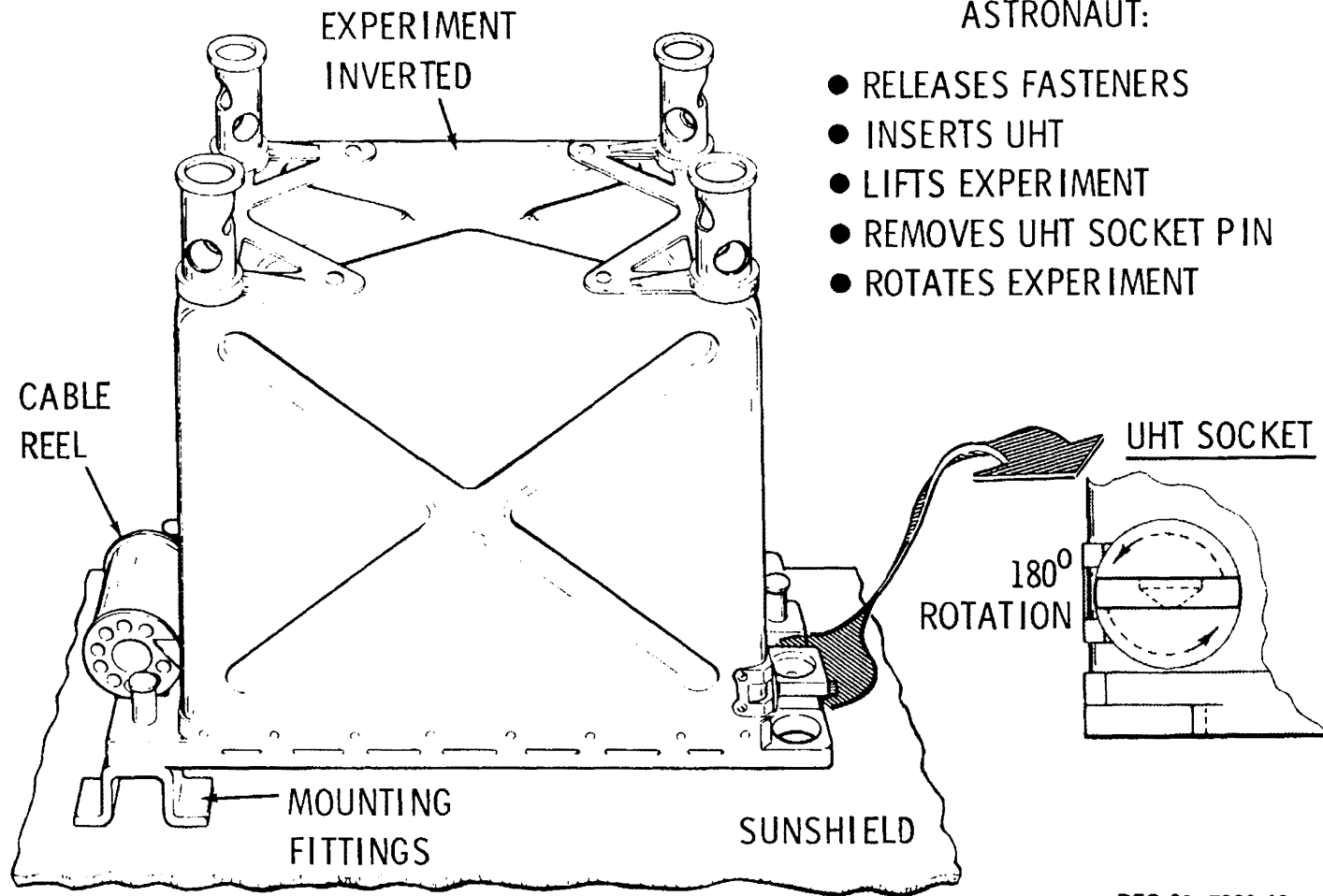
DEC 69 7399.38



# CPLP PHYSICAL ANALYZER



# CPLLEE REMOVAL



ASTRONAUT:

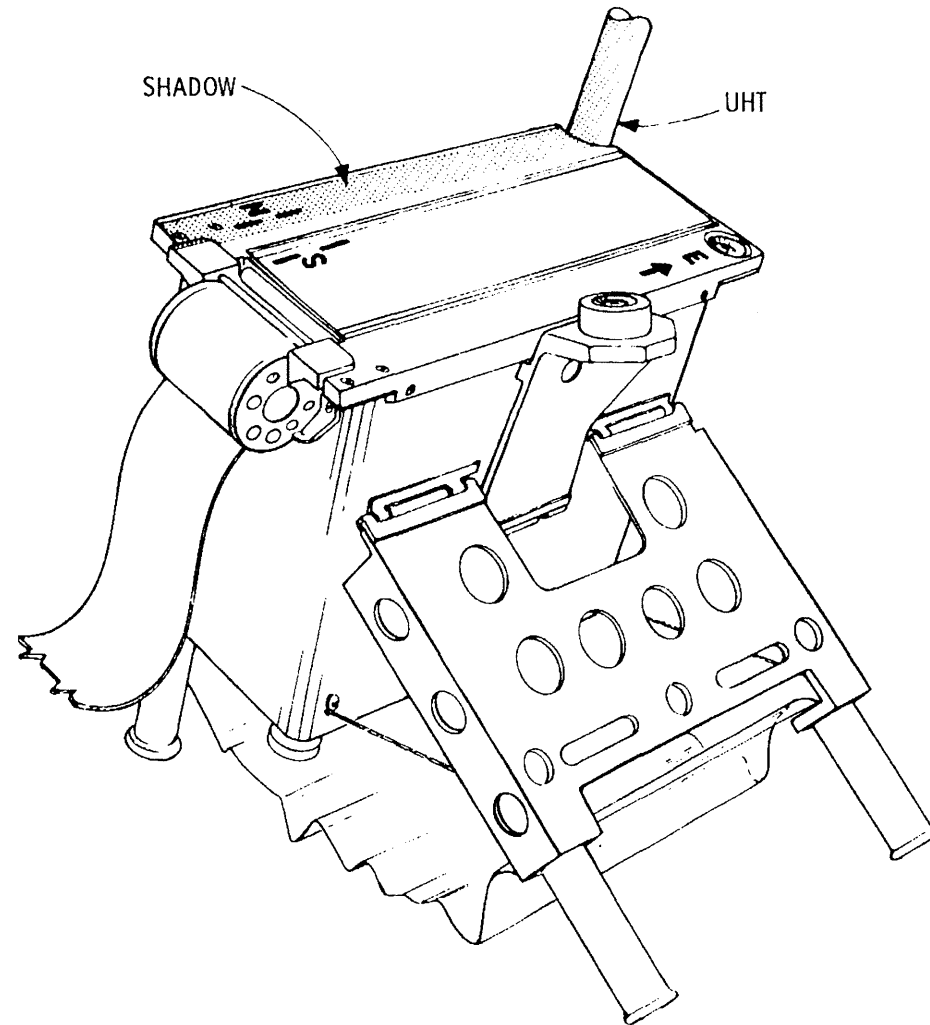
- RELEASES FASTENERS
- INSERTS UHT
- LIFTS EXPERIMENT
- REMOVES UHT SOCKET PIN
- ROTATES EXPERIMENT

# CPLEE EMPLACEMENT CRITERIA

PARAMETER	REQUIREMENT	PRIORITY	INDICATOR	COMMENTS
DISTANCE FROM SUBPACKAGE 1	10 ± 1 FT (11 FT CABLE)	1	PACED OFF	CRITICAL SEPARATION IS FROM RTG AND SUBPACKAGE 1
DIRECTION FROM SUBPACKAGE 1	WITHIN SE (OR NW) QUADRANT FROM CENTRAL STATION	1	EYEBALL	AT LEAST 14 FT FROM RTG AND PREFERABLY 20 FT* AVOID FIELD OF VIEW OF CENTRAL STATION RADIATOR
SITE SELECTION	APPROX. HORIZ.	2	EYEBALL	75° (HALF-ANGLE) VERTICAL CONE MUST BE CLEAR EXCEPT FOR ALSEP ANTENNA
LEVEL, WRT INDICATOR	±2.5° OF HORIZ	1	BUBBLE	INTERACTS WITH ALIGNMENT
ALIGN, WRT SHADOW	± 2° OF E-W	2	ARROW**	THERMAL REQUIREMENT
READOUT OF ALIGNMENT	± 1° OF E-W	1	GNOMON & ROSE	SCIENTIFIC REQUIREMENT**
EXPERIMENT INTERRELATION	*CONTAMINATING RADIOACTIVE FIELD AT CPLEE CAUSED BY OTHER SUBSYSTEMS MUST BE LESS THAN 0.1 COUNT/SEC IN ALL CHANNELS.			
SPECIAL REQUIREMENTS	**EXPERIMENT IS BIDIRECTIONAL FOR SCIENTIFIC OUTPUT BUT ARROW POINTS EAST			

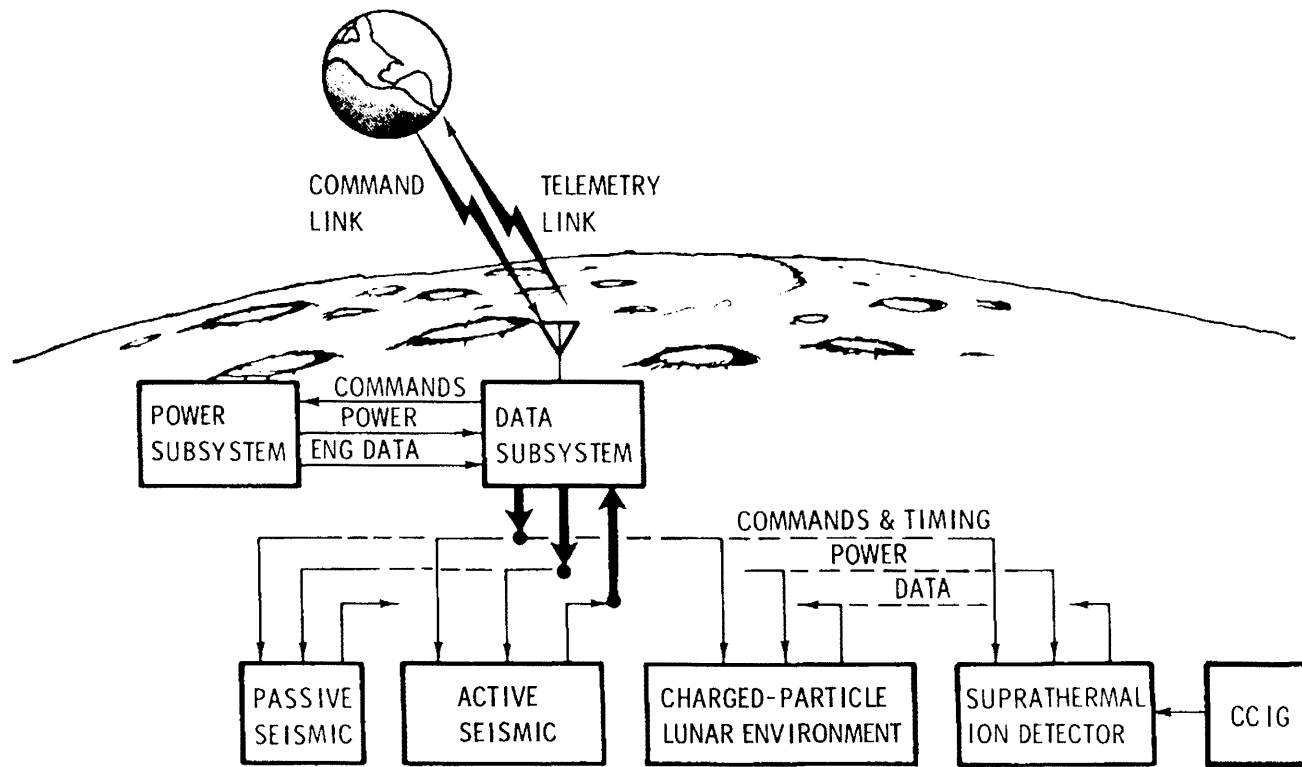
APRIL 70 7399.41

# CPLEE ALIGNMENT MARKINGS



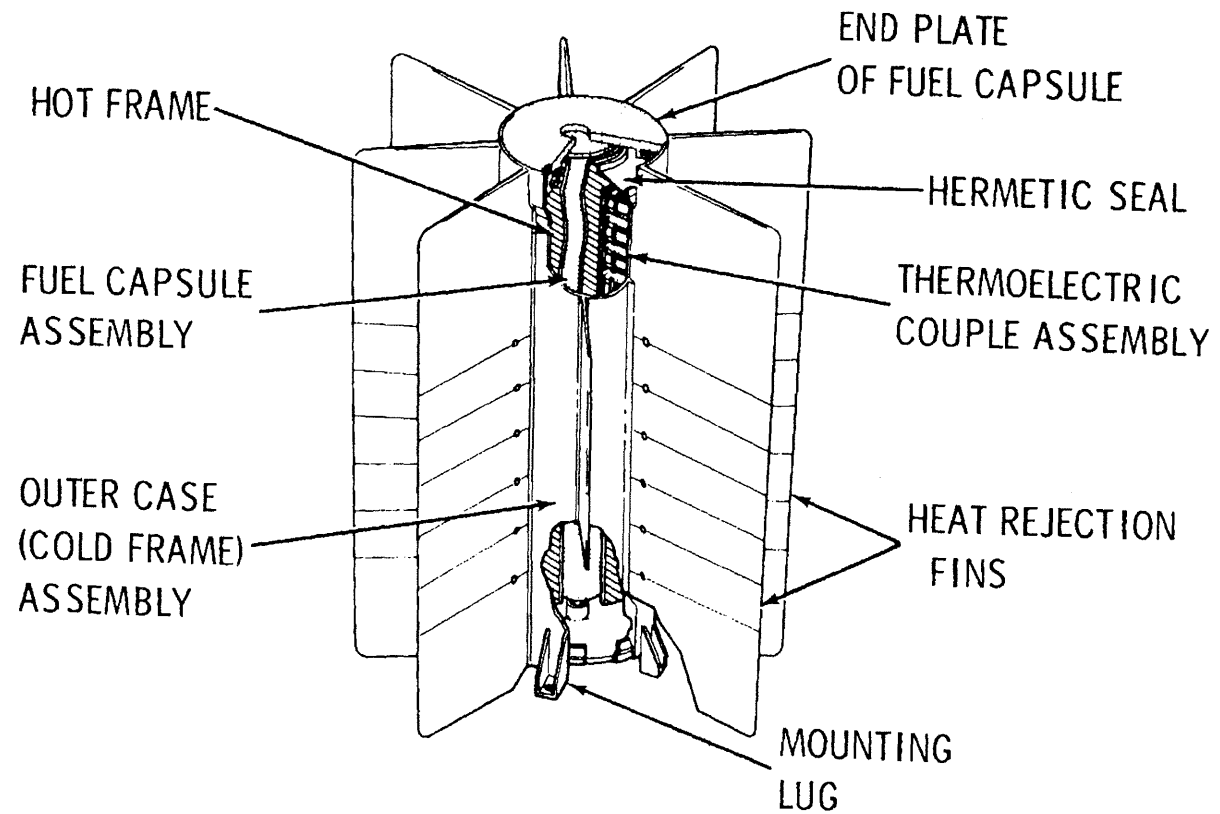
APRIL 70 7399.42

# SYSTEM LEVEL DESCRIPTION



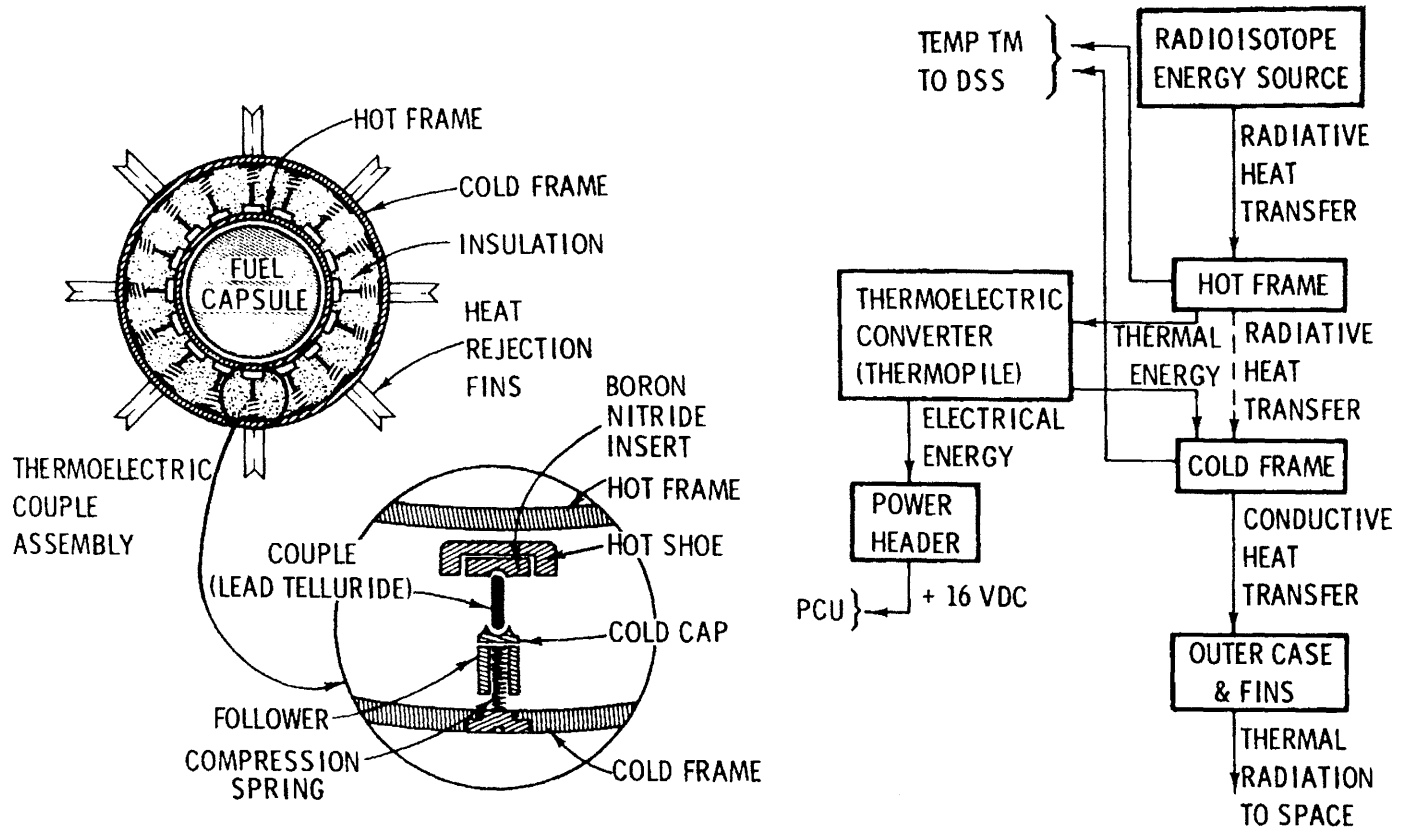
APRIL 70 7399.43

# RTG CUTAWAY

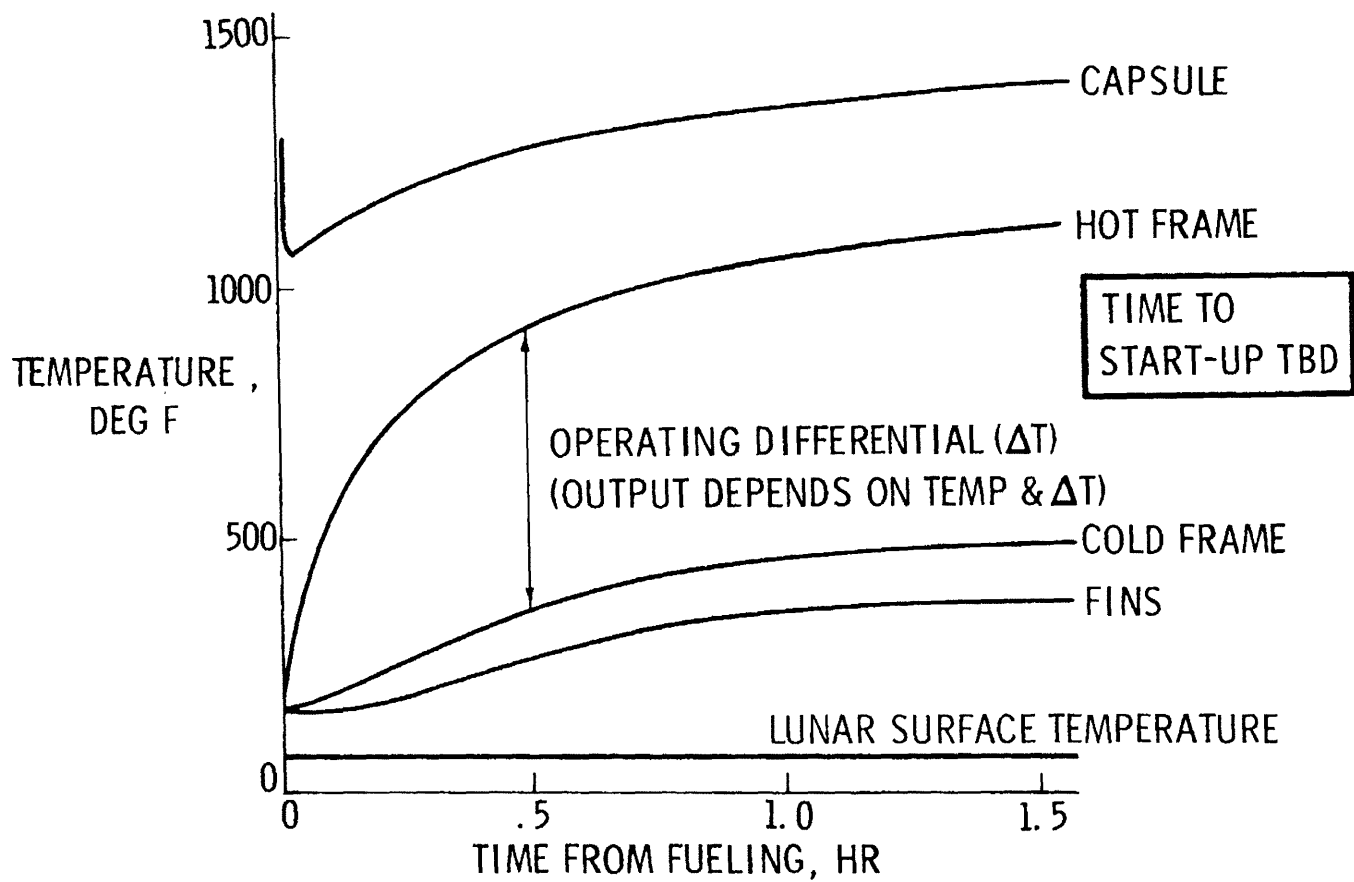


DEC 69 7399.44

# POWER GENERATING FUNCTION

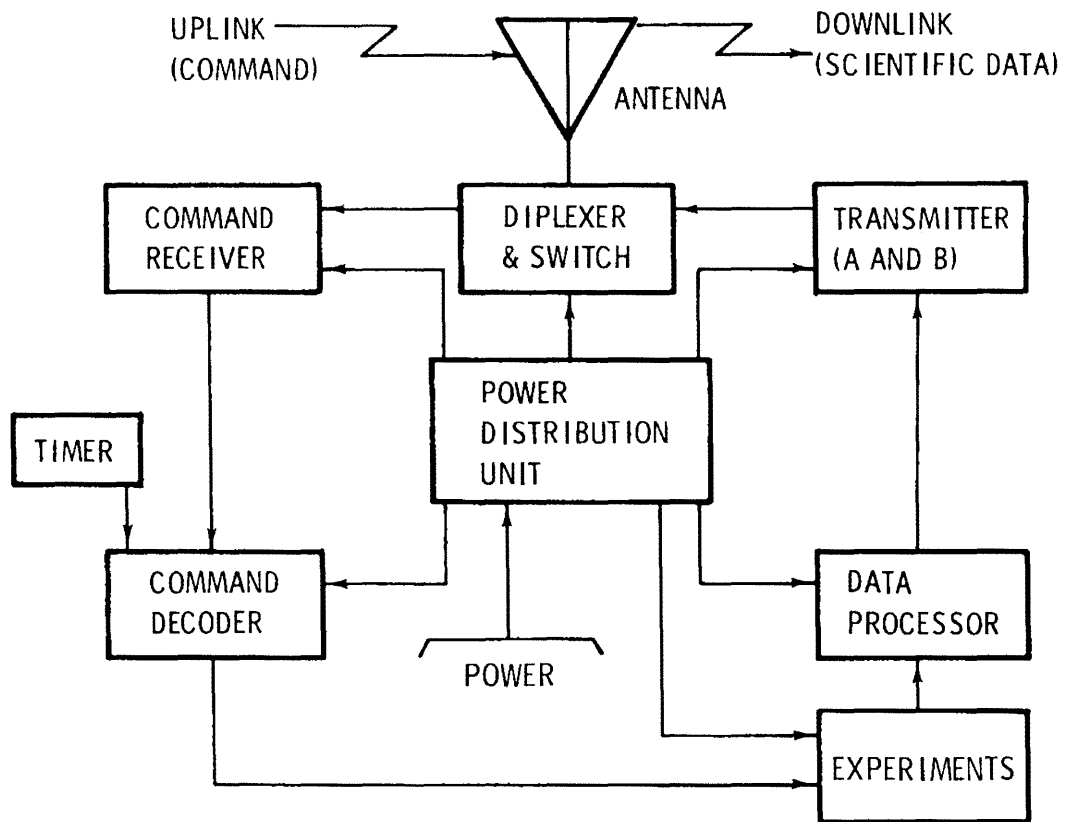


# RTG WARM-UP CYCLE





# COMMAND AND TELEMETRY LINKS

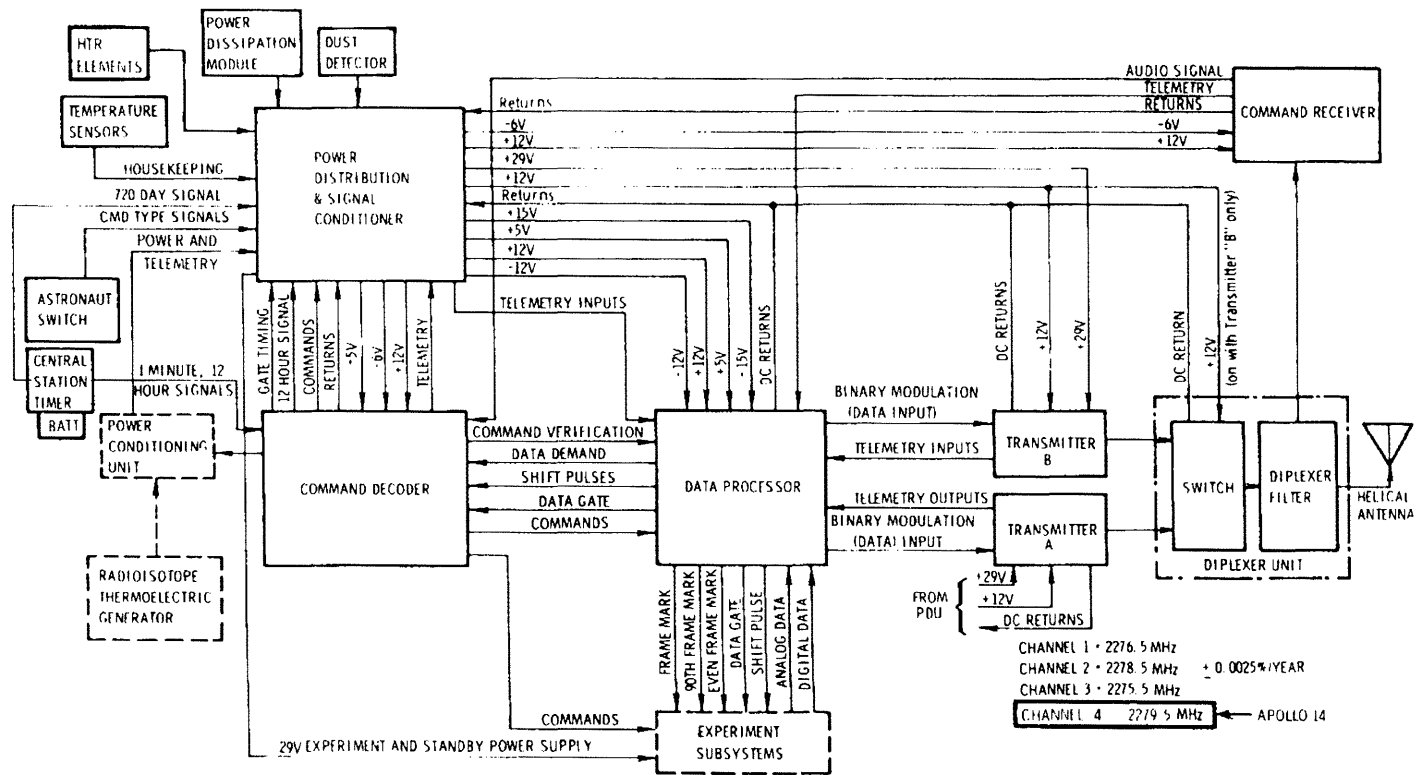


APRIL 70 7399.47

# ALSEP COMMAND LINK

- \* ANTENNA
- \* DIPLEXER
- \* COMMAND RECEIVER
- \* COMMAND DECODER

# DATA SUBSYSTEM BLOCK DIAGRAM

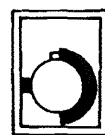
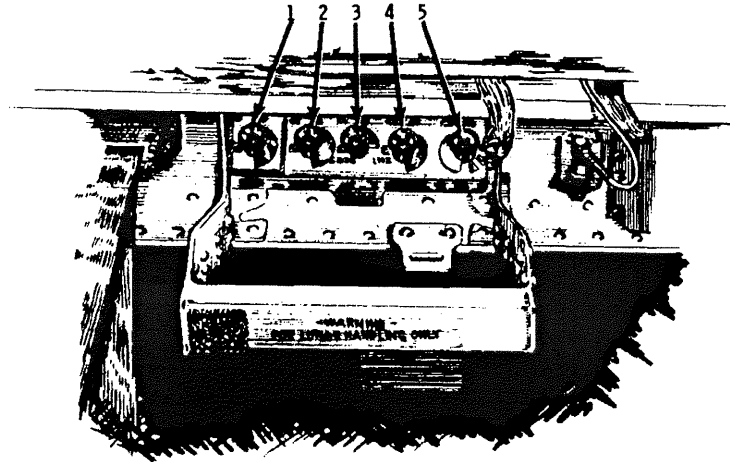


APRIL 70 7399.49

# ALSEP TELEMETRY LINK

- \* DIGITAL DATA PROCESSOR (DDP)
- \* MULTIPLEXER/CONVERTER
- \* TRANSMITTERS (TWO)
- \* DIPLEXER/SWITCH
- \* ANTENNA

# ASTRONAUT SWITCHES



SWITCH  
NUMBER

1

INITIAL POSITION

SEE NOTE 1  
CCW  
ORANGE CRESCENT TO RIGHT

ASTRONAUT

ROTATE 180° CW  
(COVER RECTANGLE)

FUNCTION

DISABLES THE HOLD OFF CIRCUIT  
MUST BE OPERATED BY THE ASTRONAUT



2

CCW  
ORANGE CRESCENT TO RIGHT

ROTATE 180° CW  
(COVER RECTANGLE)

BACKUP ONLY

- SELECT XMTR B "ON"
- SELECT DATA PROCESSOR Y "ON"
- RESET RCVR CKT BKR



3

CCW  
ORANGE FLAG TO UPPER RIGHT

ROTATE 270° CW  
(ORANGE FLAG TO  
UPPER LEFT)

BACKUP ONLY

SEQUENTIALLY ACTIVATES EXPS IN  
1, 4, 3 ORDER TO OPER SELECT



4

CCW  
ORANGE CRESCENT TO RIGHT

ROTATE 180° CW  
(COVER RECTANGLE)

ACTIVATED DURING DEPLOYMENT

- ACTIVATE ASE OPER SELECT
- SWITCH DATA PROCESSOR TO  
ASE HBR ON



5

CW  
UNPAINTED CRESCENT TO LEFT

ROTATE 180° CCW  
COVER ALL FOUR  
TRIANGULAR  
SHAPES

MUST BE CCW TO OPERATE ASE (SEE NOTE 2)

- ACTIVATE ASE STBY SELECT
- SWITCH DATA PROCESSOR TO ASE HBR OFF
- 1. CLOSE ASE 29V OPER LINE IN CCW POSITION
- 2. OPEN ASE 29V OPER LINE IN CW POSITION

NOTE: 1. SWITCH 1 IS ENCLOSED BY ORANGE PAINT  
2. SEQUENCE REQUIRED TO PLACE ASE IN OPERATE: ROTATE S5 FULL CCW;  
EITHER REQUEST ASE GND CMDS OR ROTATE S4 IN EITHER DIRECTION.

APRIL 70 7399.51

# ANTENNA POINTING CONSTRAINTS

LUNAR LIBRATION: AN APPARENT WOBBLING MOTION AS VIEWED FROM THE EARTH; CAUSES EQUIVALENT EARTH MOTION IN LUNAR COORDINATES

PRINCIPAL EFFECTS:

$\pm 7.5^\circ$  LUNAR LONGITUDE DUE TO:

CONSTANT ANGULAR RATE OF MOON ABOUT ITS AXIS

VARIABLE ANGULAR RATE IN ELLIPTICAL ORBIT AROUND EARTH

$\pm 6.5^\circ$  LUNAR LATITUDE DUE TO:

INCLINATION OF MOON'S ROTATION AXIS TO ITS ORBITAL PLANE

SECONDARY EFFECTS:

NON-SPHERICAL EARTH & MOON

SOLAR PERTURBATIONS

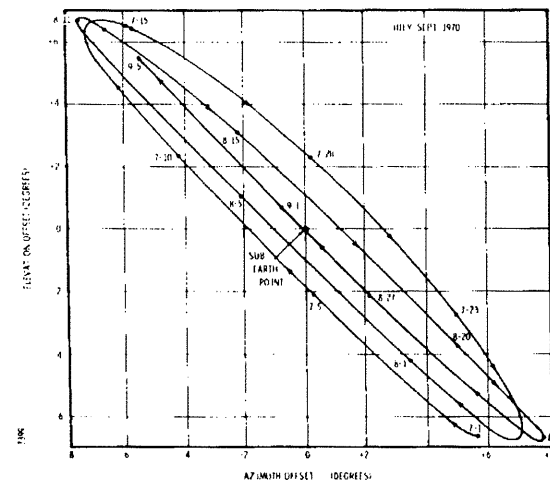
GYROSCOPE & PENDULUM COUPLING

COMBINED EFFECTS: PATTERN CHANGES

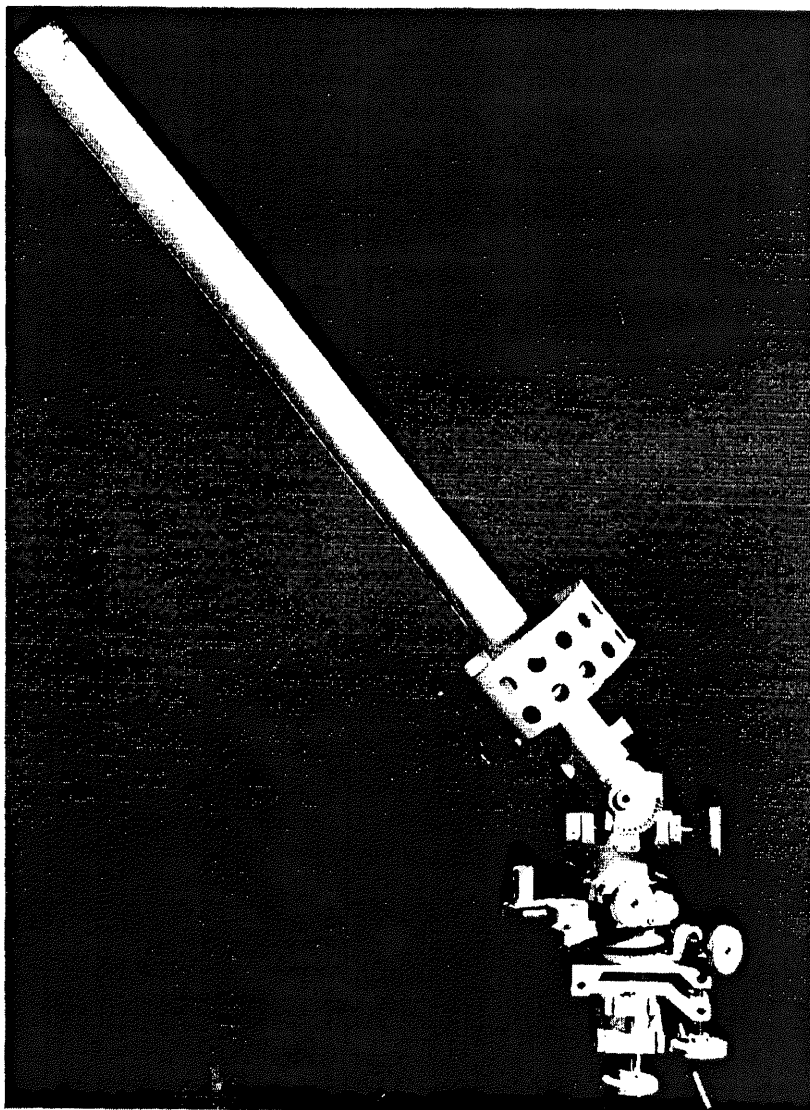
MONTHLY & YEARLY

ALSEP ANTENNA:  $22^\circ$  BEAM WIDTH DOWN

4.2 db AIMED AT MEAN CENTER OF PATTERN



APRIL 70 7399.52



# **ANTENNA AND AIMING MECHANISM**

DEC 69 7399.53