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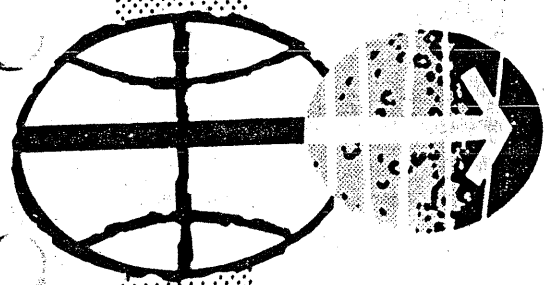
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APOLLO 15
PHOTOGRAPH EVALUATION
(APE) DATA BOOK

Mathematical Physics Branch

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS



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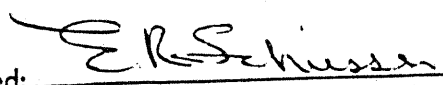
APOLLO PROGRAM
APOLLO 15 PHOTOGRAPH EVALUATION
(APE) DATA BOOK

By H. H. Cunningham
Mission Design Section
TRW Systems

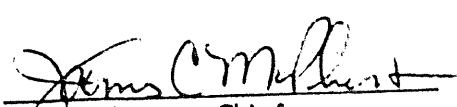
June 13, 1972

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
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REV	FRAMES	TYPE	RANGE OF LONGITUDE	
4	72-104	Vertical Strip	177.07°E - 142.6°E	3-1
15	134-162	Vertical Strip	104.5°E - 73.5°E	3-7
16	279-427	Vertical Strip	169.2°E - 13.8°W	3-13
22	457-604	Vertical Strip	161.8°E - 20.6°W	3-19
23	753-869	FWD Oblique Strip	138.15°E - 19.6°W	3-25
27	870-1013	Vertical Strip	153.9°E - 23.3°W	3-31
33	1014-1161	Vertical Strip	150.8°E - 31.3°W	3-37
34	1309-1429	AFT Oblique Strip	153.8°E - 8.9°W	3-43
35	1429-1560	N. Oblique Strip	149.2°E - 32.1°W	3-49
38	1560-1704	Vertical Strip	145.7°E - 33.6°W	3-55
44	1704-1852	Vertical Strip	139.7°E - 41.2°W	3-61
50	1852-1946	Vertical Strip	126.4°E - 13.7°E	3-67
60	1946-2019	Vertical Strip	122.6°E - 56.8°W	3-73
62	2091-2206	Vertical Strip	83.2°E - 58.9°W	3-79
63	2206-2351	Vertical Strip	120.5°E - 60.3°W	3-85
70	2351-2492	Vertical Strip	113.4°E - 65.3°W	3-91
71	2494-2623	S. Oblique Strip	80.1°E - 66.1°W	3-97
72	2623-2752	Vertical Strip	109.7°E - 68.0°W	3-103

4.0 APOLLO 15 24-INCH PANORAMIC CAMERA DATA

REV	FRAMES	TYPE	RANGE OF LONGITUDE	
4	8844-8944	Mono-Stereo	178.3°E - 141.9°E	4-1
15	9066-9151	Mono-Stereo-Mono	105.9°E - 73.0°W	4-7
16	9152-9424	Stereo	74.5°E - 14.4°W	4-13
27	9425-9433	Stereo	4.0°E - 1.04°E	4-19

CONTENTS (Continued)

SECTION

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4.0

APOLLO 15 24-INCH PANORAMIC CAMERA DATA (Continued)

<u>REV.</u>	<u>FRAMES</u>	<u>TYPE</u>	<u>RANGE OF LONGITUDE</u>	
33	9434-9578	Stereo	58.9°E - 22.1°E	4-25
38	9579-9808	Stereo	132.1°E - 0.4°W	4-31
50	9809-9827	Stereo	3.4°E - 3.1°W	4-37
60	9828-9829	Stereo/Mono Test Cycles	39.3°E - 4.6°W	4-43
61	9930-9941	Mono-Stereo	1.1°W - 5.1°W	4-49
63	9942-165	Stereo-Mono-Stereo	109.9°E - 38.7°W	4-55
72	166-372	Stereo-Mono	8.1°E - 67.8°W	4-61

APOLLO 15 PHOTOGRAPH EVALUATION (APE) DATA BOOK

By H. H. Cunningham

Mission Design Section
TRW Systems Group

1.0 INTRODUCTION

This is a catalog of the Apollo 15 photographic evaluation data available at the National Aeronautics and Space Administration, Manned Spacecraft Center. Section 2 provides explanation and definition of all the photographic evaluation data elements. Sections 3 and 4 present data summaries for all of the lightside sequences of Apollo 15 3-inch mapping camera photography and Apollo 15 24-inch panoramic camera photography respectively. Each data summary includes a brief description of the trajectory reconstruction, telemetered data used, and the constants employed for the data processing. They also contain a brief resume of the apparent data trends throughout the sequence and the data for the first and last frame of the sequence.

2.0 EXPLANATION OF DATA

The first and last frame figures which appear in this data book are consolidations of typical Apollo photograph evaluation data groups. In microfilm of the actual data, each data group occupies three or four frames. The following are frame by frame descriptions of those data.

2.1 First Frame

GMT - Sidereal time of film exposure (year, month, day, hour, minute, second) - (UT1 - USNO).

GET - Time interval from sidereal GMT time of launch to film exposure time (hours, minutes, seconds).

1950 state vector - Mean of 1950 moon centered, inertial, cartesian coordinates of the spacecraft position (km) and velocity (km/sec).

Selenographic state vector - Selenographic, instantaneous inertial cartesian coordinates of vehicle position (km) and velocity (km/sec).

Nadir Point (Longitude, Latitude) - Intersection with the mean lunar surface, of the vector from the moon's center of mass to the spacecraft.

Camera Axis Intersect (Longitude, Latitude) - Position of principal intersection point - Intersection of camera optical axis direction with mean lunar surface.

Spacecraft radius - Vector from moon center of mass to spacecraft.

Spacecraft altitude - Height of spacecraft above mean lunar surface.

Mean altitude rate - Rate of change in spacecraft altitude above the mean lunar surface.

Horizontal velocity - Component of spacecraft velocity parallel to the lunar local horizontal plane at the nadir point.

Tilt azimuth - Angle, measured positive clockwise in the local horizontal plane at the principal intersection point, between North and the projection of a vector along the camera optical axis onto that local horizontal plane.

Tilt - Angle between the camera optical axis direction and the lunar local vertical at the principal intersection point.

Sun Elevation at Prin Grnd Pnt - Angle between the vector from the sun to the principal intersection point and the lunar local horizontal plane at that point.

Sun Azimuth at Principal Grnd Pnt - Angle, measured positive clockwise in the lunar local horizontal plane, from North to the projection of the vector from the sun to the principal intersection point onto that plane.

Subsolar Point (longitude, Latitude) - Intersection with the mean lunar surface, of a vector from the moon's center of mass to the sun's center.

Alpha - Angle between the camera optical axis and the projection of the lunar local vertical at the principal intersection point onto the plane of the phase angle (measure of surface tilt toward or away from the sun).

Swing - Angle between the camera Y axis and the projection of the line between the vehicle nadir and principal intersection point onto the camera X-Y plane.

Emission Angle - Angle between the camera optical axis and the lunar local vertical at the principal intersection point.

Phase Angle - Angle between the camera optical axis and the vector from the sun to the principal intersection point.

North Deviation angle - Angle, measured positive clockwise in the camera X-Y plane, from the camera X axis to lunar North.

Phi, Kappa, Omega - Angles which rotate the camera axes coordinate system into the nadir point centered lunar local horizontal system, where:

ϕ - primary right-handed rotation about the camera Y axis.

ω - secondary right-handed rotation about the intermediate X-axis.

κ - final right-handed rotation about the local vertical (local horizontal Z-axis).

X-tilt - (Lateral tilt) Angle from the local horizontal plane at the nadir point to the camera Y-axis.

Y-tilt - (Longitudinal tilt) Angle from the local horizontal plane at the nadir point to the camera X-axis.

Heading - Angle, measured positive clockwise in the lunar local horizontal plane at the nadir point, from North to the projection of the camera X-axis onto that plane.

Scale Factor - Proportionality constant relating dimensions on the film to dimensions on the mean lunar surface.

Laser slant range - Telemetered laser altimeter readout.

Spacecraft altitude (Laser) - Vertical component of laser altimeter slant range based on the assumption that the laser altimeter was aligned along the 3-inch mapping camera optical axis.

Altitude difference - Difference between computed vehicle altitude and the vertical component of laser altimeter slant range.

Sigmas - Values of the following sigmas that appear in these data are unrealistic and are to be disregarded. Sigma (Seleno), Sigma Nadir Longitude, Sigma Nadir Latitude and Sigma Spacecraft Radius. These values were derived under an assumed doppler noise which ignores major contributions to the real data noise. An optimal system noise of approximately 0.01 Hz was assumed for the doppler noise, whereas the real data may be accurate to only 3 Hz due to large uncertainties in the lunar gravitational field and due to unmodeled vehicle thrusting.

All other sigma values appearing in these data are valid. These, associated with camera aiming parameters, properly consider uncertainties in camera mounting angles, uncertainties in vehicle attitude measurements and uncertainties in film exposure time definition.

2.2 Second Frame

The second frame of each data group contains three self explanatory entries which are:

- Definition of the vector from the spacecraft to the principal intersection point in the instantaneous inertial selenographic coordinate system.
- Relationship between the camera axes and selenocentric coordinate systems.
- Relationship between the camera axes and the nadir point centered local horizontal coordinate systems.

2.3 Third and Fourth Frames

The third and final frame entries for all 3-inch mapping camera sequences presents the positions (Latitude and Longitude) of the projections of the film corner points onto the mean lunar surface.

The third and fourth frame data for all pan camera sequences except that for REV 63 are in error and should be disregarded. The third frame of each REV 63 entry presents the positions of the projections of the corner points of the camera outer field of view onto the mean lunar surface. The fourth frame presents the positions of the projections of the camera inner field of view corner points onto the mean lunar surface.

3.0 APOLLO 15 3-INCH MAPPING CAMERA DATA

Mission: Apollo 15, Target: Strip photography

Rev: Rev 4, Camera: 3-Inch Mapping Frames: 72 Through: 104

Coverage Interval:

From: 24.96 S Lat., 177.07 E Long., To: 16.78 S Lat., 142.6 E Long.

From: 84 Hr 43 Min 19.97 Sec, To: 84 Hr 54 Min 13 Sec GET

Date Processed: 12/14/71, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 99 H 11 M 34.160 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 4. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5175791.43</u>	$\dot{X}$ = <u>582.8512</u>
Y = <u>330685.92</u>	$\dot{Y}$ = <u>5508.7802</u>
Z = <u>2492551.4</u>	$\dot{Z}$ = <u>371.0212</u>

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Sept. 1971

Edited Data Tape No. A09550 File No.: 1 Location: Bldg. 12, MSC

Remarks: There were no significant data gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary:

These photo evaluation data are for a sequence of near vertical photography starting at 175.5 deg. E. Longitude and ending at 142.6 deg. E. Longitude, taken along a line starting at 25 deg. S. Latitude and ending at 17 deg. S. Latitude. Throughout the sequence tilt was maintained near zero (less than 0.8 deg) so that the vehicle nadir and principal intersection point remain essentially coincident.

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT 71 7 30 2 17 20.758
 GET 3 12 43 19.966

STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT
1950.0	-1421.7424774	-543.1986084	-1032.0208282	-.9153199	1.1309677	.6986531
SELENOGRAPHIC	-1665.1661987	84.0931139	-775.6502380	.0088158	1.6017186	.1985808
SIGMA (SELENO)	.01	1.98	.25	.002	.000	.001

LONGITUDE OF NADIR POINT	177.1089420 DEG	LATITUDE OF NADIR POINT	-24.9486315 DEG
SIGMA NADIR LONGITUDE	.0011873 DEG	SIGMA NADIR LATITUDE	.0001415 DEG
LONG OF CAMERA AXIS INTERSECT	177.0724411 DEG	LATI OF CAMERA AXIS INTERSECT	-24.9630084 DEG
SPACECRAFT RADIUS	1838.8809967 KM	SPACECRAFT ALTITUDE	100.7909698 KM
SIGMA SPACECRAFT RADIUS	.0000036 KM	AZIMUTH OF VELOCITY VECTOR	277.4912796 DEG
MEAN ALTITUDE RATE	-.0184979 KM/SEC	HORIZONTAL VELOCITY	1.6138704 KM/SEC
TILT AZIMUTH	246.5081749 DEG	TILT ANGLE	.6221254 DEG
SIGMA TILT AZIMUTH	.1852602 DEG	SIGMA TILT ANGLE	.0019891 DEG
SUN ELEVATION AT PRIN GRND PNT	3.0106421 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	271.6881981 DEG
LONGITUDE OF SUBSOLAR POINT	90.5140724 DEG	LATITUDE OF SUBSOLAR POINT	.2581512 DEG
ALPHA	-.5958205 DEG	SWING ANGLE	238.8228798 DEG
EMISSION ANGLE	.6582311 DEG	SIGMA SWING ANGLE	.1852601 DEG
PHASE ANGLE	87.5851421 DEG	NORTH DEVIATION ANGLE	172.2976055 DEG
PHI	.5322901 DEG	X-TILT	-.3220729 DEG
SIGMA PHI	.0019999 DEG	SIGMA X-TILT	.0020002 DEG
KAPPA	-172.3158855 DEG	Y-TILT	-.5322817 DEG
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0019998 DEG
OMEGA	-.3220729 DEG	HEADING	-62.3128901 DEG
SIGMA OMEGA	.0020002 DEG	SIGMA HEADING	.0020001 DEG
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	104.6089983 KM
SPACECRAFT ALTITUDE (LASER)	104.6028357 KM	ALTITUDE DIFFERENCE	3.8118658 KM

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)
	.90780457	-.03587440	.41765630	100.797272

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-.58407100+00	.69237117+00	.42365463+00
.25911932+00	.65366594+00	-.71104001+00
-.76923227+00	-.30552077+00	-.56119413+00

LATITUDE LONGITUDE

-26.869	174.259
-22.324	175.003
-22.896	-179.994
-27.531	179.389

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.99097056+00	.13375750+00	.92899338+02
-.13370938+00	-.99100459+00	.56212032+02
.99582503+02	.43282825+02	.99994109+00

Figure 1(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
GMT	71	7	30	2	28	13.850
GET			3	12	54	13.055

STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT
1950.0	-1751.7910614	243.6745396	-430.9956245	-.0621600	1.2102269	1.0912518
SELENOGRAPHIC	-1383.4097748	1060.2915649	-525.2290955	.8302950	1.2920957	.5481262
SIGMA(SELENO)	1.03	1.60	.68	.001	.001	.001

LONGITUDE OF NADIR POINT	142.5322361 DEG	LATITUDE OF NADIR POINT	-16.7694778 DEG
SIGMA NADIR LONGITUDE	.0010863 DEG	SIGMA NADIR LATITUDE	.0003831 DEG
LONG OF CAMERA AXIS INTERSECT	142.5528831 DEG	LATI OF CAMERA AXIS INTERSECT	-16.7794547 DEG
SPACECRAFT RADIUS	1820.4137878 KM	SPACECRAFT ALTITUDE	82.3237610 KM
SIGMA SPACECRAFT RADIUS	.0000080 KM	AZIMUTH OF VELOCITY VECTOR	290.1440239 DEG
MEAN ALTITUDE RATE	-.0365472 KM/SEC	HORIZONTAL VELOCITY	1.6303101 KM/SEC
TILT AZIMUTH	116.7826557 DEG	TILT ANGLE	.4676142 DEG
SIGMA TILT AZIMUTH	.2448450 DEG	SIGMA TILT ANGLE	.0020031 DEG
SUN ELEVATION AT PRIN GRND PNT	35.9029036 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	282.9498787 DEG
LONGITUDE OF SUBSOLAR POINT	90.4216871 DEG	LATITUDE OF SUBSOLAR POINT	.2580087 DEG
ALPHA	.4752964 DEG	SWING ANGLE	96.5290003 DEG
EMISSION ANGLE	.4896893 DEG	SIGMA SWING ANGLE	.2448443 DEG
PHASE ANGLE	53.6217117 DEG	NORTH DEVIATION ANGLE	159.7528915 DEG
PHI	-.4644873 DEG	X-TILT	-.0531572 DEG
SIGMA PHI	.0019999 DEG	SIGMA X-TILT	.0020001 DEG
KAPPA	-159.7458801 DEG	Y-TILT	.4644871 DEG
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0019999 DEG
OMEGA	-.0531572 DEG	HEADING	-69.7463074 DEG
SIGMA OMEGA	.0020001 DEG	SIGMA HEADING	.0020001 DEG
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	79.6769991 KM
SPACECRAFT ALTITUDE(LASER)	79.6743488 KM	ALTITUDE DIFFERENCE	-2.6494122 KM

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)
	.75632802	-.58885279	.28499178	82.326645

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-.52403853+01	.74295538+00	.66728643+00
.26433593+00	.65469018+00	-.70817172+00
-.96300592+00	.13927684+00	-.23069812+00

-.93813821+00	.34616618+00	-.81067408+02
-.34618442+00	-.93816596+00	.92776754+03
-.72842781+02	.36767896+02	.99996674+00

LATITUDE LONGITUDE

-17.885	139.909
-14.275	141.333
-15.617	145.055
-19.201	143.705

Figure 1(b) - Last Frame

Mission: Apollo 15, Target: Strip Photography

Rev: 15, Camera: 24 Inch Panoramic Frames: 134* Through: 162

Coverage Interval:

From: 5.1 Deg. S Lat., 104.5 Deg. E Long., To: 9.6 Deg. N Lat., 73.5 Deg. E Long.

From: 106 Hr 6 Min 50.62 Sec, To: 106 Hr 18 Min 11.93 Sec GET

Date Processed: 12/22/71, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

* Only state vector data are provided for the early part of this photographic sequence (Frames 104 through 133) since telemetered vehicle attitude data are unavailable for that period of coverage.

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 120 H. 14 M. 30.2 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 15. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5417171.14

$\dot{X}$ = 332.4323

Y = 364506.69

$\dot{Y}$ = -5354.1936

Z = 2636255.82

$\dot{Z}$ = -14.8552

• Telemetered Data Tape

Data Source: Station

Bit Rate: High

Date Edited: 18 Dec. 1971

Edited Data Tape No. A09550 File No.: 2 Location: Bldg. 12, MSC

Remarks: There are no telemetered vehicle attitude data for the early part of this interval. 105 H 54 M 15 Sec - 106 H 6 M 37 Sec GET (Fms 104 through 134)

● APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of near vertical photography starting at 140.5 deg. E Long. and extending WNW to 73.5 deg. E Long. Only state vector information is provided for the initial region of coverage, 140.5 deg. E Long. - 104.5 deg. E Long. (Fms 104 through 133); where vehicle attitude data are unavailable. Full photo evaluation data are provided for the remainder of the sequence. Throughout the sequence, tilt was maintained near zero so that the principal intersection point and vehicle nadir remain near coincident.

	YEAR	MONTH	DAY	HOVR	MINUTE	SECOND			
	GMT 71	7	30	23	40	51.410			
	GET		4	10	6	50.618			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1630.2091980	863.7500534	210.8296661	.6568151	.9579859	1.1290330			
SELENOGRAPHIC	-464.1824112	1790.3902893	-164.7199039	1.4013815	.4241405	.6928877			
SIGMA(SELENO)	1.73	.52	.90	.000	.002	.000			
LONGITUDE OF NADIR POINT	104.5346718 DEG						LATITUDE OF NADIR POINT	-5.0892091 DEG	
SIGMA NADIR LONGITUDE	.0009785 DEG						SIGMA NADIR LATITUDE	.0004840 DEG	
LONG OF CAMERA AXIS INTERSECT	104.5318775 DEG						LATI OF CAMERA AXIS INTERSECT	-5.0919555 DEG	
SPACECRAFT RADIUS	1856.9047546 KM						SPACECRAFT ALTITUDE	118.8147583 KM	
SIGMA SPACECRAFT RADIUS	.0000046 KM						AZIMUTH OF VELOCITY VECTOR	295.4225540 DEG	
MEAN ALTITUDE RATE	-.0028283 KM/SEC						HORIZONTAL VELOCITY	1.6198010 KM/SEC	
TILT AZIMUTH	225.3797798 DEG						TILT ANGLE	.0576749 DEG	
SIGMA TILT AZIMUTH	2.0019340 DEG						SIGMA TILT ANGLE	.0020377 DEG	
SUN ELEVATION AT PRIN GRND PNT	64.5575018 DEG						SUN AZIMUTH AT PRINCIPAL GRND PNT	281.3684769 DEG	
LONGITUDE OF SUBSOLAR POINT	79.6227789 DEG						LATITUDE OF SUBSOLAR POINT	.2407541 DEG	
ALPHA	-.0342807 DEG						SWING ANGLE	199.5576935 DEG	
EMISSION ANGLE	.0617703 DEG						SIGMA SWING ANGLE	2.0019610 DEG	
PHASE ANGLE	25.4767296 DEG						NORTH DEVIATION ANGLE	154.1785355 DEG	
PHI	.0191473 DEG						X=TILT	-.0538980 DEG	
SIGMA PHI	.0020000 DEG						SIGMA X=TILT	.0020000 DEG	
KAPPA	-154.1788139 DEG						Y=TILT	-.0191473 DEG	
SIGMA KAPPA	.0020000 DEG						SIGMA Y=TILT	.0020000 DEG	
OMEGA	-.0538980 DEG						HEADING	-64.1787930 DEG	
SIGMA OMEGA	.0020000 DEG						SIGMA HEADING	.0020000 DEG	
SCALE FACTOR	.0000000 M/KM						LASER SLANT RANGE	116.6490002 KM	
SPACECRAFT ALTITUDE(LASER)	116.6489439 KM						ALTITUDE DIFFERENCE	-2.1658144 KM	
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				MAGNITUDE (KM)		
OF CAMERA AXIS	.25067974	-.96406131	.08800821				118.814819		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.40185915+00	.58778665+00	.70215108+00	-.90015759+00	.43556432+00	.33418265+03
.25904730+00	.66249415+00	-.70284840+00	-.43556381+00	-.90015730+00	.94069708+03
-.87829594+00	.46433640+00	.11396479+00	.71057394+03	.70121363+03	.99999952+00
LATITUDE	LONGITUDE				
-6.327	100.919				
-1.484	103.285				
-3.824	108.149				
-8.684	105.803				

Figure 2(a) - First Frame

	YEAR	MONTH	DAY	HOURL	MINUTE	SECOND		
	GMT 71	7	30	23	52	12.725		
	GET		4	10	18	11.931		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT		
1950.0	-927.1373901	1329.0637665	898.7229767	1.3460627	.3665580	.8296238		
SELENOGRAPHIC	518.2380524	1752.1688232	308.2709579	1.3863143	-.5337732	.6540215		
SIGMA(SELENO)	1.72	.66	.85	.000	.002	.000		
LONGITUDE OF NADIR POINT	73.5233898 DEG					9.5763087 DEG		
SIGMA NADIR LONGITUDE	.0010026 DEG					.0004657 DEG		
LONG OF CAMERA AXIS INTERSECT	73.4865198 DEG					9.6157198 DEG		
SPACECRAFT RADIUS	1853.0237885 KM					114.9337921 KM		
SIGMA SPACECRAFT RADIUS	.0000090 KM					294.1729774 DEG		
MEAN ALTITUDE RATE	-.0082050 KM/SEC					1.6230718 KM/SEC		
TILT AZIMUTH	317.3142853 DEG					.8108113 DEG		
SIGMA TILT AZIMUTH	.1413324 DEG					.0020003 DEG		
SUN ELEVATION AT PRIN GRND PNT	78.8635025 DEG					146.9911270 DEG		
LONGITUDE OF SUBSOLAR POINT	79.5264454 DEG					.2405943 DEG		
ALPHA	.8499444 DEG					293.1181717 DEG		
EMISSION ANGLE	.8644535 DEG					.1413322 DEG		
PHASE ANGLE	10.2854462 DEG					155.8132992 DEG		
PHI	.7456670 DEG					.3183221 DEG		
SIGMA PHI	.0020000 DEG					.0020000 DEG		
KAPPA	-.155.8018398 DEG					-.7456555 DEG		
SIGMA KAPPA	.0020000 DEG					.0020000 DEG		
OMEGA	.3183221 DEG					-.65.8059807 DEG		
SIGMA OMEGA	.0020000 DEG					.0020002 DEG		
SCALE FACTOR	.0000000 M/KM					.0000000 KM		
SPACECRAFT ALTITUDE(LASER)	.0000000 KM					-.114.9337921 KM		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z			MAGNITUDE (KM)		
OF CAMERA AXIS	-.27093488	-.94985834	-.15608785			114.946075		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.82011028+00	.23853680+00	.52011480+00	-.91208568+00	.40979316+00	.13013776+01
.26021355+00	.65406657+00	-.71027158+00	-.40988744+00	-.91211913+00	-.55557400+02
-.50961562+00	.71784195+00	.47433624+00	.95934056+02	-.10401476+01	.99989989+00
LATITUDE	LONGITUDE				
8.219	70.087				
12.940	72.232				
10.843	77.100				
6.024	74.899				

Figure 2(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

av: 16, Camera: 3-Inch Mapping Frames: 279 Through: 427

Coverage Interval:

From: 25.2 deg. S Lat., 169.2 deg. E Long., To: 25.0 deg. N Lat., 13.8 deg. W Long.

From: 107 Hr 43 Min 27.059 Sec, To: 108 Hr 43 Min 48.864 Sec GET

ate Processed: 12/14/71, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583233 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 122 H, 12 M, 41.84 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 16. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5418330.03

$\dot{X}$ = 304.2696

Y = 351625.64

$\dot{Y}$ = -5355.8441

Z = 2636094.12

$\dot{Z}$ = 15.0709

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09550 File No.: 3 Location: Bldg. 12, MSC

Remarks: There were no significant data gaps in the telemetered vehicle attitude data for this interval.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary:

These photo evaluation data are for a sequence of near vertical photography starting at 169.0 deg. E Longitude and ending at 14.0 deg. W Longitude, taken along a line starting at 25 deg. S Latitude and ending at 25 deg. N Latitude. Throughout the sequence tilt was maintained near zero (less than 0.8 deg.) so that the vehicle nadir and principal intersection point remain essentially coincident.

YEAR MONTH DAY HOUR MINUTE SECOND
 GMT 71 7 31 1 17 27.854
 GET 4 11 43 27.059

STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT
1950.0	-1351.8586121	-646.5402679	-1090.2982941	-1.0361913	1.0785546	.6306305
SELENOGRAPHIC	-1647.0096893	315.2675323	-788.8294220	.2232298	1.6004065	.1534106
SIGMA(SELENO)	.28	1.98	.19	.002	.000	.001

LONGITUDE OF NADIR POINT	169.1636353 DEG	LATITUDE OF NADIR POINT	-25.1925685 DEG
SIGMA NADIR LONGITUDE	.0011906 DEG	SIGMA NADIR LATITUDE	.0001160 DEG
LONG OF CAMERA AXIS INTERSECT	169.1712303 DEG	LATI OF CAMERA AXIS INTERSECT	-25.1977382 DEG
SPACECRAFT RADIUS	1853.1827545 KM	SPACECRAFT ALTITUDE	115.0927277 KM
SIGMA SPACECRAFT RADIUS	.0000021 KM	AZIMUTH OF VELOCITY VECTOR	276.1385384 DEG
MEAN ALTITUDE RATE	.0085689 KM/SEC	HORIZONTAL VELOCITY	1.6231136 KM/SEC
TILT AZIMUTH	126.9427872 DEG	TILT ANGLE	.1299099 DEG
SIGMA TILT AZIMUTH	.8797262 DEG	SIGMA TILT ANGLE	.0020237 DEG
SUN ELEVATION AT PRIN GRND PNT	-1.4349108 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	270.0599365 DEG
LONGITUDE OF SUBSOLAR POINT	78.8032141 DEG	LATITUDE OF SUBSOLAR POINT	.2393913 DEG
ALPHA	.1107554 DEG	SWING ANGLE	120.8843889 DEG
EMISSION ANGLE	.1384764 DEG	SIGMA SWING ANGLE	.8797229 DEG
PHASE ANGLE	90.3241558 DEG	NORTH DEVIATION ANGLE	173.9448490 DEG
PHI	.1114493 DEG	X-TILT	-.0666604 DEG
SIGMA PHI	.0020000 DEG	SIGMA X-TILT	.0020000 DEG
KAPPA	-173.9414768 DEG	Y-TILT	.1114492 DEG
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0020000 DEG
OMEGA	-.0666604 DEG	HEADING	-83.9416037 DEG
SIGMA OMEGA	.0020000 DEG	SIGMA HEADING	.0020000 DEG
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	114.3859987 KM
SPACECRAFT ALTITUDE(LASER)	114.3857098 KM	ALTITUDE DIFFERENCE	-.7070179 KM
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z
OF CAMERA AXIS	.88897315	-.17200997	.42442822
			MAGNITUDE (KM)
			115.093048

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-1.63275655+00	.66792552+00	.39178395+00
.25543030+00	.65766954+00	-.70867907+00
-.73100927+00	-.34834785+00	-.58675319+00
LATITUDE	LONGITUDE	

-.99441297+00	.10554187+00	-.19451547+02
-.10554423+00	-.99441388+00	.11634435+02
-.18114962+02	.13622297+02	.99999747+00

-27.480	165.909
-22.279	166.636
-22.830	172.278
-28.036	171.785

Figure 3(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND		
	GMT 71	7	31	2	17	49.657		
	GET		4	12	43	48.864		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT		
1950.0	1382.8614960	594.1196136	1052.7375641	.9873663	-1.1142629	-.6824263		
SELENOGRAPHIC	1617.5921021	-396.1399803	774.6026764	-.3100327	-1.5970137	-.1886967		
SIGMA(SELENO)	.38	1.98	.23	.002	.000	.001		
LONGITUDE OF NADIR POINT	-13.7606201 DEG					24.9439514 DEG		
SIGMA NADIR LONGITUDE	.0012071 DEG					.0001379 DEG		
LONG OF CAMERA AXIS INTERSECT	-13.7774681 DEG					24.9616246 DEG		
SPACECRAFT RADIUS	1836.7199860 KM					98.6299591 KM		
SIGMA SPACECRAFT RADIUS	.0000023 KM					262.8337555 DEG		
MEAN ALTITUDE RATE	-.0081832 KM/SEC					1.6376859 KM/SEC		
TILT AZIMUTH	319.1546288 DEG					.4117041 DEG		
SIGMA TILT AZIMUTH	.2803338 DEG					.0019872 DEG		
SUN ELEVATION AT PRIN GRND PNT	-1.7745771 DEG					88.9103746 DEG		
LONGITUDE OF SUBSOLAR POINT	78.2911377 DEG					.2385356 DEG		
ALPHA	.2783451 DEG					325.7203712 DEG		
EMISSION ANGLE	.4351001 DEG					.2803335 DEG		
PHASE ANGLE	91.4962626 DEG					186.5735283 DEG		
PHI	.2318979 DEG					.3402035 DEG		
SIGMA PHI	.0019998 DEG					.0020002 DEG		
KAPPA	173.4350929 DEG					-.2318938 DEG		
SIGMA KAPPA	.0020000 DEG					.0019998 DEG		
OMEGA	.3402035 DEG					-96.5662918 DEG		
SIGMA OMEGA	.0020002 DEG					.0020000 DEG		
SCALE FACTOR	.0000000 M/KM					101.6699982 KM		
SPACECRAFT ALTITUDE(LASER)	101.6673775 KM					3.0374184 KM		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z			MAGNITUDE (KM)		
OF CAMERA AXIS	-.88401792	.21165289	-.41679175			98.632660		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.60699147+00 -.68431128+00 -.40407851+00
.25705627+00 .65019055+00 -.71496447+00
.75198635+00 .33010644+00 .57056669+00

-.99343209+00 -.11435174+00 .40472990-02
.11432676+00 -.99342540+00 -.59376361-02
.46996715-02 -.54359097-02 .99997422+00

LATITUDE LONGITUDE

22.394 -15.907
26.881 -16.540
27.421 -11.501
22.889 -10.993

Figure 3(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 22, Camera: 3-Inch Mapping Frames: 457 Through: 604

Coverage Interval:

From: 25.0 Deg. S Lat., 161.8 Deg. E Long., To: 24.8 Deg. N Lat., 20.6 Deg. W Long.

From: 119 Hr 34 Min 48.944 Sec, To: 120 Hr 35 Min 4.35 Sec GET

Date Processed: 12/21/71, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: I-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 134 H, 1 M, 55.32 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 22. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5428075.02</u>	$\dot{X}$ = <u>192.7182</u>
Y = <u>346707.01</u>	$\dot{Y}$ = <u>-5353.9628</u>
Z = <u>2622460.91</u>	$\dot{Z}$ = <u>225.6916</u>

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09550 File No.: 4 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a near vertical sequence of photography starting at 161.8 deg. E. Long., 25.02 deg. S. Lat., and extending WNW to 20.6 deg. W. Long., 24.8 deg. N. Lat. Throughout the sequence a near zero (less than 1 deg.) tilt is maintained so that the principal intersection point remains essentially coincident with the vehicle nadir.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT	71	7	31	13	8	49.737		
	GET			4	23	34	48.744		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1368.4932709	-631.7159271	-1079.1252594	-1.0225044	1.0800297	.6488660			
SELENOGRAPHIC	-1595.7704010	524.0339966	-784.3821564	.4177396	1.5587112	.1700579			
SIGMA(SELENO)	.52	1.93	.22	.002	.000	.001			
LONGITUDE OF NADIR POINT	161.8203697 DEG						25.0326748 DEG		
SIGMA NADIR LONGITUDE	.0011875 DEG						.0001309 DEG		
LONG OF CAMERA AXIS INTERSECT	161.8429089 DEG						25.0162013 DEG		
SPACECRAFT RADIUS	1853.7395020 KM						115.6495056 KM		
SIGMA SPACECRAFT RADIUS	.0000055 KM						276.7927933 DEG		
MEAN ALTITUDE RATE	.0090685 KM/SEC						1.6225993 KM/SEC		
TILT AZIMUTH	51.1140924 DEG						.3944713 DEG		
SIGMA TILT AZIMUTH	.2906311 DEG						.0020017 DEG		
SUN ELEVATION AT PRIN GRND PNT	.7425528 DEG						270.5993690 DEG		
LONGITUDE OF SUBSOLAR POINT	72.7692642 DEG						.2290919 DEG		
ALPHA	.3245249 DEG						44.3125901 DEG		
EMISSION ANGLE	.4206956 DEG						.2906314 DEG		
PHASE ANGLE	88.9329147 DEG						173.2071075 DEG		
PHI	.2754670 DEG						.2821548 DEG		
SIGMA PHI	.0020000 DEG						.0020000 DEG		
KAPPA	-173.1990108 DEG						.0020000 DEG		
SIGMA KAPPA	.0020000 DEG						.83.1976519 DEG		
OMEGA	.2821548 DEG						.0020000 DEG		
SIGMA OMEGA	.0020000 DEG						118.4200001 KM		
SCALE FACTOR	.0000000 M/KM						2.7676946 KM		
SPACECRAFT ALTITUDE(LASER)	118.4172001 KM						ALTITUDE DIFFERENCE		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				MAGNITUDE (KM)		
OF CAMERA AXIS	.85740985	-.28720284	.42703966				115.652435		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.62251256+00	.66902975+00	.40605090+00	.99294919+00	.11844332+00	-.48077290-02
.25474193+00	.66380035+00	-.70310215+00	-.11841973+00	-.99295136+00	-.49245108-02
-.73998980+00	-.33430171+00	-.58365875+00	-.53571152-02	-.43204721-02	.99997636+00
LATITUDE	LONGITUDE				
-27.329	158.482				
-22.105	159.319				
-22.735	164.942				
-27.948	164.502				

Figure 4(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	71	7	31	14	9	5.147			
GMT	71	7	31	14	9	5.147			
GET			5	0	35	4.354			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	1390.3745117	587.5011139	1045.4720001	.9812188	-1.1126358	-.6950171			
SELENOGRAPHIC	1559.3576050	-588.2919617	770.4719467	-.4951290	-1.5486064	-.2011540			
SIGMA (SELENO)	.61	1.92	.26	.002	.001	.001			
LONGITUDE OF NADIR POINT	-20.6697693 DEG								24.8106763 DEG
SIGMA NADIR LONGITUDE	.0012059 DEG								.0001498 DEG
LONG OF CAMERA AXIS INTERSECT	-20.6478701 DEG								24.8041127 DEG
SPACECRAFT RADIUS	1836.1128845 KM								98.0228882 KM
SIGMA SPACECRAFT RADIUS	.0000040 KM								262.3679466 DEG
MEAN ALTITUDE RATE	-.0087325 KM/SEC								1.6381769 KM/SEC
TILT AZIMUTH	108.2716322 DEG								.3711503 DEG
SIGMA TILT AZIMUTH	.3086879 DEG								.0020027 DEG
SUN ELEVATION AT PRIN GRND PNT	-2.5419474 DEG								88.5726767 DEG
LONGITUDE OF SUBSOLAR POINT	72.2582226 DEG								.2281970 DEG
ALPHA	-.3690642 DEG								115.9520636 DEG
EMISSION ANGLE	.3921080 DEG								.3086879 DEG
PHASE ANGLE	92.9110184 DEG								187.6718121 DEG
PHI	-.3336901 DEG								.1624049 DEG
SIGMA PHI	.0020000 DEG								.0020000 DEG
KAPPA	172.3198776 DEG								.3336888 DEG
SIGMA KAPPA	.0020000 DEG								.0020000 DEG
OMEGA	-.1624049 DEG								-97.6810751 DEG
SIGMA OMEGA	.0020000 DEG								.0020000 DEG
SCALE FACTOR	.0000000 M/KM								100.4639997 KM
SPACECRAFT ALTITUDE (LASER)	100.4618959 KM								2.4390078 KM
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z						MAGNITUDE (KMI
OF CAMERA AXIS	-.84628498	.32584786	-.42145569						98.025070

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.59878980+00	-.67875858+00	-.42513243+00	-.99101061+00	-.13365655+00	-.58239345+02
.25261113+00	.66377819+00	-.70397872+00	.13364189+00	-.99102558+00	.28344944+02
.76002529+00	.31414211+00	.56892563+00	-.61505139+02	.20307075+02	.99997906+00

LATITUDE LONGITUDE

22.257	-22.785
26.738	-23.554
27.333	-18.518
22.871	-17.955

Figure 4(b) - Last Frame

Mission: Apollo 15, Target: Forward Oblique Strip Photography

Rev: 23, Camera: 3-Inch Mapping Frames: 753 Through: 869

Coverage Interval:

From: 21.3 Deg. S Lat., 138.15 Deg. E Long., To: 24.6 Deg. N Lat., 19.6 Deg. W Long.

From: 121 Hr 39 Min 46.55 Sec, To: 122 Hr 32 Min 30.53 Sec GET

Date Processed: 12/30/71, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 136 H, 0 M, 7.20 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 23. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5428943.73

$\dot{X}$ = 178.5119

Y = 349599.12

$\dot{Y}$ = -5352.9837

Z = 2618976.06

$\dot{Z}$ = 259.6515

• Telemetered Data Tape

Data Source: Station

Bit Rate: High

Date Edited: 22 Dec. 1971

Edited Data Tape No. A09556 File No.: 1 Location: Bldg. 12, MSC

Remarks: There were two significant gaps in telemetered vehicle attitude data within the interval of this sequence:

- 1) 121 H, 58 M, 51 Sec - 122 H, 3 M, 51 Sec (Frames 796 through 805)
- 2) 122 H, 8 M, 51 Sec - 122 H, 18 M, 24 Sec (Frames 818 through 837)

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary:

These photo evaluation data are for a strip of forward oblique photography starting at 138 deg. E Long., 21.3 deg. S Lat., and ending at 19.6 deg. W Long., 24.6 deg. N Lat. Throughout the sequence a forward tilt of 24.5 deg. is maintained causing the principal intersection point to lead the vehicle nadir by approximately 2 deg. throughout the sequence. For the regions between 83.8 - 70.28 deg. E Long. (Frames 796 - 805) and 56.2 - 27.4 deg. E Long. (Frames 818 - 837) where telemetered vehicle attitude data are unavailable, only vehicle state vector data are provided. State vector data only are provided for frame 847 as a result of some computer erratic.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
GMT	71	7	31	15	13	47.341	
GET			5	1	39	46.549	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	-1678.2039185	-187.1997890	-771.1396179	-5670278	1.2013841	.9275478	
SELENOGRAPHIC	-1325.1416168	1111.4311829	-674.3803711	.8836286	1.3007383	.3904734	
SIGMA(SELENO)	1.09	1.61	.50	.001	.001	.001	
LONGITUDE OF NADIR POINT	140.0125523 DEG	LATITUDE OF NADIR POINT		-21.3018453 DEG			
SIGMA NADIR LONGITUDE	.0011192 DEG	SIGMA NADIR LATITUDE		.0002068 DEG			
LONG OF CAMERA AXIS INTERSECT	138.1488533 DEG	LATI OF CAMERA AXIS INTERSECT		-21.3871021 DEG			
SPACECRAFT RADIUS	1856.3589172 KM	SPACECRAFT ALTITUDE		118.2689209 KM			
SIGMA SPACECRAFT RADIUS	.0000087 KM	AZIMUTH OF VELOCITY VECTOR		285.0790520 DEG			
MEAN ALTITUDE RATE	.0061521 KM/SEC	HORIZONTAL VELOCITY		1.6202024 KM/SEC			
TILT AZIMUTH	266.8492393 DEG	TILT ANGLE		23.8796437 DEG			
SIGMA TILT AZIMUTH	.0051369 DEG	SIGMA TILT ANGLE		.0019188 DEG			
SUN ELEVATION AT PRIN GRND PNT	21.7615480 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT		279.2605591 DEG			
LONGITUDE OF SUBSOLAR POINT	71.7094851 DEG	LATITUDE OF SUBSOLAR POINT		.2272320 DEG			
ALPHA	-25.2128444 DEG	SWING ANGLE		269.9802284 DEG			
EMISSION ANGLE	25.6175916 DEG	SIGMA SWING ANGLE		.0051698 DEG			
PHASE ANGLE	93.3743734 DEG	NORTH DEVIATION ANGLE		182.2098217 DEG			
PHI	23.8796403 DEG	X-TILT		-.0080038 DEG			
SIGMA PHI	.0019189 DEG	SIGMA X-TILT		.0020927 DEG			
KAPPA	176.8673191 DEG	Y-TILT		-23.8796413 DEG			
SIGMA KAPPA	.0019845 DEG	SIGMA Y-TILT		.0019190 DEG			
OMEGA	-.0080038 DEG	HEADING		-93.1291428 DEG			
SIGMA OMEGA	.0020927 DEG	SIGMA HEADING		.0021856 DEG			
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE		127.9600000 KM			
SPACECRAFT ALTITUDE(LASER)	117.0063543 KM	ALTITUDE DIFFERENCE		-1.2625666 KM			
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)			
OF CAMERA AXIS	.91867603	-.24296292	.31145361	130.215164			

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA		
$x = .59545732 + 00$	$y = .79298574 + 00$	$z = .12885729 + 00$
$x = .34592619 + 00$	$y = .39783766 + 00$	$z = -.84974124 + 00$
$x = .72509702 + 00$	$y = -.46140954 + 00$	$z = -.51120995 + 00$

LATITUDE	LONGITUDE
-18.807	140.845
-15.442	130.505
-27.598	130.416
-23.692	141.165

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA		
- .91303453+00	- .49913917-01	.40481669+00
.54648446-01	- .99850561+00	.13969343-03
.40420478+00	.22250114-01	.91439789+00

Figure 5(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
	71	7	31	16	6	31.319	
	GET		5	2	32	30.527	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	1324.4000397	658.5891800	1088.5119324	1.0513349	-1.0794203	-.6417864	
SELENOGRAPHIC	1579.2913361	-516.6924133	781.9854279	-.4430926	-1.5682398	-.1632051	
SIGMA(SELENO)	.55	1.94	.21	.002	.001	.001	
LONGITUDE OF NADIR POINT	-18.1164055 DEG	LATITUDE OF NADIR POINT	25.2018349 DEG				
SIGMA NADIR LONGITUDE	.0012127 DEG	SIGMA NADIR LATITUDE	.0001206 DEG				
LONG OF CAMERA AXIS INTERSECT	-19.5867558 DEG	LATI OF CAMERA AXIS INTERSECT	24.6339660 DEG				
SPACECRAFT RADIUS	1836.4730682 KM	SPACECRAFT ALTITUDE	98.3830719 KM				
SIGMA SPACECRAFT RADIUS	.0000045 KM	AZIMUTH OF VELOCITY VECTOR	263.8311157 DEG				
MEAN ALTITUDE RATE	-.0093106 KM/SEC	HORIZONTAL VELOCITY	1.6377298 KM/SEC				
TILT AZIMUTH	247.2440281 DEG	TILT ANGLE	23.9571347 DEG				
SIGMA TILT AZIMUTH	.0050929 DEG	SIGMA TILT ANGLE	.0019308 DEG				
SUN ELEVATION AT PRIN GRND PNT	-.6773539 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	89.4402399 DEG				
LONGITUDE OF SUBSOLAR POINT	71.2622757 DEG	LATITUDE OF SUBSOLAR POINT	.2264423 DEG				
ALPHA	23.3175933 DEG	SWING ANGLE	271.0583763 DEG				
EMISSION ANGLE	25.4064846 DEG	SIGMA SWING ANGLE	.0051217 DEG				
PHASE ANGLE	67.3710375 DEG	NORTH DEVIATION ANGLE	202.3854694 DEG				
3-PHI	23.9535081 DEG	X-TILT	.4297392 DEG				
30-SIGMA PHI	.0019223 DEG	SIGMA X-TILT	.0020876 DEG				
KAPPA	156.2768116 DEG	Y-TILT	-23.9527934 DEG				
SIGMA KAPPA	.0019885 DEG	SIGMA Y-TILT	.0019206 DEG				
OMEGA	.4297392 DEG	HEADING	-113.9141045 DEG				
SIGMA OMEGA	.0020876 DEG	SIGMA HEADING	.0021871 DEG				
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	111.3889999 KM				
SPACECRAFT ALTITUDE(LASER)	101.7927856 KM	ALTITUDE DIFFERENCE	3.4097137 KM				
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)			
OF CAMERA AXIS	.83874265	-.11956774	-.53123847	108.266342			

TRANSFORMATION MATRIX FROM SELENCENTRIC TO CAMERA			TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA		
.92475701+00	-.24160409+00	-.29402713+00	-.83542751+00	-.37045654+00	.40598381+00
.38212467+01	.82766750+00	-.55991627+00	.40230704+00	-.91547402+00	-.75002934+02
.37863480+00	.50655102+00	.77462366+00	.37444618+00	.15706420+00	.91384953+00
LATITUDE	LONGITUDE				
27.400	-18.263				
26.543	-27.607				
18.039	-22.748				
22.671	-16.483				

Figure 5(b) - Last Frame

Figure 5(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 27, Camera: 3-Inch Mapping Frames: 870 Through: 1013

Coverage Interval:

From: 24.68 Deg. S Lat., 153.86 Deg E Long., To: 25.05 Deg. N Lat., 23.3 Deg. W Long.

From: 129 Hr 27 Min 59.70 Sec, To: 130 Hr 26 Min 39.44 Sec GET

Date Processed: 12/15/71, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 143 H. 52 M. 43.2 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 27. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5442492.29

$\dot{X}$ = 109.9227

Y = 349488.17

$\dot{Y}$ = -5343.3417

Z = 2596805.03

$\dot{Z}$ = 400.1378

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09556 File No.: 2 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a sequence of near vertical photography starting at 154 deg. E Long. and ending at 23.3 deg. W Long., on a line beginning at 25 deg. S Lat. and ending at 25 deg. N Lat. Throughout the sequence tilt is maintained at less than 0.8 deg. so that the principal point and vehicle nadir remain essentially coincidental.

	YEAR	MONTH	DAY	HOOR	MINUTE	SECOND			
GMT	71	7	31	23	2	.494			
GET			5	9	27	59.703			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1414.5172272	-582.5801849	-1046.4925995	-.9754159	1.0966664	.6918764			
SELENOGRAPHIC	-1512.1930237	741.6766052	-773.6882324	.6140476	1.4879316	.2044787			
SIGMA(SELENO)	.76	1.84	.27	.001	.001	.001			
LONGITUDE OF NADIR POINT	153.8737030 DEG								-24.6720324 DEG
SIGMA NADIR LONGITUDE	.0011805 DEG								.0001597 DEG
LONG OF CAMERA AXIS INTERSECT	153.8609447 DEG								-24.6801836 DEG
SPACECRAFT RADIUS	1853.4846344 KM								115.3946075 KM
SIGMA SPACECRAFT RADIUS	.0000083 KM								278.1200790 DEG
MEAN ALTITUDE RATE	.0090655 KM/SEC								1.6225376 KM/SEC
TILT AZIMUTH	234.8896370 DEG								.2135211 DEG
SIGMA TILT AZIMUTH	.5335184 DEG								.0020187 DEG
SUN ELEVATION AT PRIN GRND PNT	3.4312019 DEG								271.8216133 DEG
LONGITUDE OF SUBSOLAR POINT	67.7389660 DEG								.2201185 DEG
ALPHA	-.1819900 DEG								226.3018150 DEG
EMISSION ANGLE	.2279267 DEG								.5335176 DEG
PHASE ANGLE	86.7507782 DEG								171.4069557 DEG
PHI	.1543303 DEG								-.1474707 DEG
SIGMA PHI	.0019999 DEG								.0020002 DEG
KAPPA	-171.4127007 DEG								-.1543298 DEG
SIGMA KAPPA	.0020000 DEG								.0019998 DEG
OMEGA	-.1474707 DEG								-81.4123011 DEG
SIGMA OMEGA	.0020002 DEG								.0020000 DEG
SCALE FACTOR	.0000000 M/KM								.0000000 KM
SPACECRAFT ALTITUDE(LASER)	.0000000 KM								-115.3946075 KM
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z						MAGNITUDE (KM)
OF CAMERA AXIS	.81800431	-.39780734	.41547353						115.395477

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.60094621+00 .67134200+00 .43377827+00
.24074161+00 .66953065+00 -.70268918+00
-.76217266+00 -.31784994+00 -.56397191+00

-.98878488+00 .14932256+00 .26935591+00
-.14931573+00 -.98878617+00 .25738461+00
.30476909+00 .21427753+00 .99999310+00

LATITUDE LONGITUDE

-26.821 150.554
-21.660 151.516
-22.417 157.130
-27.631 156.372

Figure 6(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT 7	1	8	1	0	0	39.440		
	GET			5	10	26	38.646		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	1340.5363464	642.7541580	1077.2768402	1.0364625	-1.0837968	-0.6591221			
SELENOGRAPHIC	1527.2378540	-658.1497955	777.8684998	-0.5769104	-1.5227722	-0.1779079			
SIGMA(SELENO)	.71	1.89	.23	.001	.001	.001			
LONGITUDE OF NADIR POINT	-23.3132019 DEG						25.0676587 DEG		
SIGMA NADIR LONGITUDE	.0012109 DEG						.0001351 DEG		
LONG OF CAMERA AXIS INTERSECT	-23.2981951 DEG						25.0521138 DEG		
SPACECRAFT RADIUS	1835.9455109 KM						97.8554840 KM		
SIGMA SPACECRAFT RADIUS	.0000073 KM						263.2683525 DEG		
MEAN ALTITUDE RATE	-0.0093989 KM/SEC						1.6380251 KM/SEC		
TILT AZIMUTH	138.8323765 DEG						.3667750 DEG		
SIGMA TILT AZIMUTH	.3111895 DEG						.0020103 DEG		
SUN ELEVATION AT PRIN GRND PNT	-0.3962450 DEG						89.5727968 DEG		
LONGITUDE OF SUBSOLAR POINT	67.2416639 DEG						.2192110 DEG		
ALPHA	-0.2527835 DEG						145.7885685 DEG		
EMISSION ANGLE	.3874645 DEG						.3111901 DEG		
PHASE ANGLE	90.6490335 DEG						186.9507484 DEG		
PHI	-0.2062041 DEG						-0.3032882 DEG		
SIGMA PHI	.0020000 DEG						.0020001 DEG		
KAPPA	173.0440922 DEG						.2062012 DEG		
SIGMA KAPPA	.0020000 DEG						.0019999 DEG		
OMEGA	-0.3032882 DEG						-96.9570065 DEG		
SIGMA OMEGA	.0020001 DEG						.0020000 DEG		
SCALE FACTOR	.0000000 M/KM						100.3979988 KM		
SPACECRAFT ALTITUDE(LASER)	100.3959465 KM						2.5404625 KM		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				MAGNITUDE (KM)		
OF CAMERA AXIS	-0.82829414	.36153420	-0.42804420				97.857620		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.63526555+00 -0.65826230+00 -0.40389161+00
 .24872337+00 .66949604+00 -0.69993687+00
 .73114595+00 .34418852+00 .58903305+00

LATITUDE LONGITUDE

22.561 -25.450
 27.034 -26.166
 27.579 -21.109
 23.109 -20.619

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-0.99263091+00 -0.12112370+00 -0.35988822+02
 .12110386+00 -0.99262568+00 .52933525+02
 -0.42134927+02 .48185200+02 .99997956+00

Figure 6(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 33, Camera: 3-Inch Mapping Frames: 1014 Through: 1161

Coverage Interval:

From: 25.0 Deg. S Lat., 150.8 Deg. E Long., To: 24.9 Deg. N Lat., 31.3 Deg. W Long.

From: 141 Hr 17 Min 39.28 Sec, To: 142 Hr 17 Min 47.805 Sec GET

Date Processed: 12/15/71, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 155 H, 41 M, 29.62 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 33. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5474202.62</u>	$\dot{X}$ = <u>9.5580</u>
Y = <u>345994.58</u>	$\dot{Y}$ = <u>-5318.0142</u>
Z = <u>2547196.41</u>	$\dot{Z}$ = <u>608.6019</u>

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 10 Dec. 1971

Edited Data Tape No. A09556 File No.: 3 Location: Bldg. 12, MSC

Remarks: There were three significant gaps in the telemetered vehicle attitude data in the time interval of this sequence.

- 1) 141 H, 25 M, 11 Sec - 141 H, 33 M, 13 Sec GET - Fms 1032 through 1051
- 2) 141 H, 35 M, 45 Sec - 141 H, 37 M, 33 Sec GET - Fms 1058 through 1061
- 3) 141 H, 44 M, 41 Sec - 141 H, 49 M, 3 Sec GET - Fms 1079 through 1088

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a sequence of near vertical photography starting at 151 deg. E Long., and ending at 31 deg. W Long., proceeding from 25 deg. S Lat. along a line to 25 deg. N Lat. Throughout the coverage tilt is maintained near zero (less than 1.0 deg.) so that the principal intersection point and vehicle nadir are essentially coincident. Only vehicle state vector data are provided for the three periods of photographic coverage for which vehicle attitude data is not available. These three periods are:

- 1) 128 deg. E Long. - 101.8 deg. E Long. (Fms 1032 - 1051)
- 2) 96 deg E Long. - 90.2 deg. E Long. (Fms 1058 - 1061)
- 3) 72 deg. E Long. - 59.4 deg. E Long. (Fms 1079 - 1088)

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT 71	8	1	10	51	40.077			
	GET		5	21	17	39.280			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1351.1351471	-650.6555023	-1086.3392944	-1.0449437	1.0619432	.6464074			
SELENOGRAPHIC	-1464.7628937	818.4455719	-783.3698807	.7055143	1.4523521	.1743450			
SIGMA(SELENO)	.87	1.80	.24	.001	.001	.001			
LONGITUDE OF NADIR POINT	150.8054466 DEG	LATITUDE OF NADIR POINT		-25.0265653 DEG					
SIGMA NADIR LONGITUDE	.0011893 DEG	SIGMA NADIR LATITUDE		.0001410 DEG					
LONG OF CAMERA AXIS INTERSECT	150.8106098 DEG	LATI OF CAMERA AXIS INTERSECT		-25.0036373 DEG					
SPACECRAFT RADIUS	1851.7698975 KM	SPACECRAFT ALTITUDE		113.6798706 KM					
SIGMA SPACECRAFT RADIUS	.0000095 KM	AZIMUTH OF VELOCITY VECTOR		276.9717369 DEG					
MEAN ALTITUDE RATE	.0100893 KM/SEC	HORIZONTAL VELOCITY		1.6239691 KM/SEC					
TILT AZIMUTH	11.5367802 DEG	TILT ANGLE		.3577958 DEG					
SIGMA TILT AZIMUTH	.3201683 DEG	SIGMA TILT ANGLE		.0020031 DEG					
SUN ELEVATION AT PRIN GRND PNT	.7379227 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT		270.5746803 DEG					
LONGITUDE OF SUBSOLAR POINT	61.7222800 DEG	LATITUDE OF SUBSOLAR POINT		.2088779 DEG					
ALPHA	.0724381 DEG	SWING ANGLE		4.8548677 DEG					
EMISSION ANGLE	.3812280 DEG	SIGMA SWING ANGLE		.3201690 DEG					
PHASE ANGLE	89.1896238 DEG	NORTH DEVIATION ANGLE		173.3198318 DEG					
PHI	-.0302787 DEG	X-TILT		.3564916 DEG					
SIGMA PHI	.0020000 DEG	SIGMA X-TILT		.0020000 DEG					
KAPPA	-173.3179989 DEG	Y-TILT		.0302781 DEG					
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT		.0020000 DEG					
OMEGA	.3564916 DEG	HEADING		-83.3178082 DEG					
SIGMA OMEGA	.0020000 DEG	SIGMA HEADING		.0020000 DEG					
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE		112.5519981 KM					
SPACECRAFT ALTITUDE(LASER)	112.5498085 KM	ALTITUDE DIFFERENCE		-1.1300621 KM					
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)					
OF CAMERA AXIS	.76812294	-.44179927	.42857395	113.682251					

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERATRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.63728010+00 .65964185+00 .39643032+00
 .25151921+00 .66674384+00 -.70156299+00
 -.72843133+00 -.34687928+00 -.59081524+00

-.99320673+00 .11636207+00 -.52845221-03
 -.11635655+00 -.99318796+00 -.62219125-02
 -.12488464-02 -.61181698-02 .99998055+00

LATITUDE LONGITUDE

-27.295 147.550
 -22.170 148.363
 -22.759 153.897
 -27.911 153.381

Figure 7(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND		
	71	8	1	11	51	48.599		
	GET		5	22	17	47.805		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT		
1950.0	1368.0713198	615.9367981	1059.1562500	1.0097055	-1.0908421	-.6889273		
SELENOGRAPHIC	1424.4996338	-864.8885269	771.7369003	-.7717914	-1.4300485	-.2015195		
SIGMA(SELENO)	.95	1.77	.27	.001	.001	.001		
LONGITUDE OF NADIR POINT	-31.2641373 DEG					24.8482716 DEG		
SIGMA NADIR LONGITUDE	.0012055 DEG					.0001560 DEG		
LONG OF CAMERA AXIS INTERSECT	-31.2651598 DEG					24.8682048 DEG		
SPACECRAFT RADIUS	1836.5209351 KM					98.4309082 KM		
SIGMA SPACECRAFT RADIUS	.0000099 KM					262.3664017 DEG		
MEAN ALTITUDE RATE	-.0098577 KM/SEC					1.6374114 KM/SEC		
TILT AZIMUTH	357.3200989 DEG					.3524234 DEG		
SIGMA TILT AZIMUTH	.3254252 DEG					.0020010 DEG		
SUN ELEVATION AT PRIN GRND PNT	-2.1602507 DEG					88.7688227 DEG		
LONGITUDE OF SUBSOLAR POINT	61.2124510 DEG					.2078987 DEG		
ALPHA	.0095071 DEG					4.8698668 DEG		
EMISSION ANGLE	.3723346 DEG					.3254245 DEG		
PHASE ANGLE	92.1507893 DEG					187.5502548 DEG		
PHI	-.0299142 DEG					.3510934 DEG		
SIGMA PHI	.0020000 DEG					.0020001 DEG		
KAPPA	172.4501457 DEG					.0299136 DEG		
SIGMA KAPPA	.0020000 DEG					.0019999 DEG		
OMEGA	.3510934 DEG					-.97.5496778 DEG		
SIGMA OMEGA	.0020001 DEG					.0020000 DEG		
SCALE FACTOR	.0000000 M/KM					100.6679983 KM		
SPACECRAFT ALTITUDE(LASER)	100.6660986 KM					2.2351904 KM		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z			MAGNITUDE (KM)		
OF CAMERA AXIS	-.77799232	.47202360	-.41463437			98.432892		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERATRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.62037449+00	-.66532087+00	-.41531150+00
.23984369+00	.66509232+00	-.70719665+00
.74673324+00	.33911694+00	.57217938+00

-.99133120+00	-.13138570+00	-.52209073+00
.13138641+00	-.99131224+00	-.61276969+00
.28753854+00	-.61431582+00	.99998113+00

LATITUDE LONGITUDE

22.257	-33.380
26.742	-34.098
27.344	-29.082
22.847	-28.490

Figure 7(b) - Last Frame

Mission: Apollo 15, Target: Aft Oblique Strip Photography

Rev: 34, Camera: 3-Inch Mapping Frames: 1309 Through: 1429

Coverage Interval:

From: 25.4 Deg. S Lat., 153.8 Deg. E Long., To: 25.9 Deg. N Lat., 8.85 Deg. W Long.

From: 143 Hr 15 Min 24 Sec, To: 144 Hr 9 Min 49.4 Sec GET

Date Processed: 1/6/72, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 157 H, 39 M, 36.52 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 34. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5479461.92</u>	$\dot{X}$ = <u>-3.2394</u>
Y = <u>349266.05</u>	$\dot{Y}$ = <u>-5313.2396</u>
Z = <u>2535865.22</u>	$\dot{Z}$ = <u>644.7040</u>

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09554 File No.: 1 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data employed for this sequence

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of aft oblique photography starting at 154 deg. E Long., 25.4 deg. S Lat., and ending at 8.8 deg. W Long., 25.9 deg. N Lat. Throughout all except the first four frames (1309 through 1312) of photography an aft tilt of 25 ± 0.6 deg. is maintained with the camera optical axis held essentially in the plane of flight. This camera attitude results in a principal intersection point which trails the vehicle nadir point by approximately 2 deg. Tilt was somewhat erratic over the first four frames of the sequence varying between 20 and 25 deg.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT 71	8	1	12	49	24.788			
	GET		5	23	15	23.994			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1306.0519104	-694.7761917	-1112.5924683	-1.0885464	1.0394323	.6114318			
SELENOGRAPHIC	-1478.7138824	784.6271210	-790.0082932	.6846650	1.4656118	.1497252			
SIGMA(SELENO)	.85	1.82	.21	.001	.001	.001			
LONGITUDE OF NADIR POINT	152.0489292 DEG			LATITUDE OF NADIR POINT	-25.2641234 DEG				
SIGMA NADIR LONGITUDE	.0011948 DEG			SIGMA NADIR LATITUDE	.0001240 DEG				
LONG OF CAMERA AXIS INTERSECT	153.8463478 DEG			L OF CAMERA AXIS INTERSECT	-25.3725352 DEG				
SPACECRAFT RADIUS	1851.0395813 KM			SPACECRAFT ALTITUDE	112.9495850 KM				
SIGMA SPACECRAFT RADIUS	.0000094 KM			AZIMUTH OF VELOCITY VECTOR	276.0233994 DEG				
MEAN ALTITUDE RATE	.0103999 KM/SEC			HORIZONTAL VELOCITY	1.6244991 KM/SEC				
TILT AZIMUTH	94.2014112 DEG			TILT ANGLE	23.4888084 DEG				
SIGMA TILT AZIMUTH	.0050185 DEG			SIGMA TILT ANGLE	.0019998 DEG				
SUN ELEVATION AT PRIN GRND PNT	-2.9095516 DEG			SUN AZIMUTH AT PRINCIPAL GRND PNT	268.8482285 DEG				
LONGITUDE OF SUBSOLAR POINT	60.7241507 DEG			LATITUDE OF SUBSOLAR POINT	.2069567 DEG				
ALPHA	25.0352194 DEG			SWING ANGLE	89.0866041 DEG				
EMISSION ANGLE	25.1171811 DEG			SIGMA SWING ANGLE	.0050184 DEG				
PHASE ANGLE	67.8762817 DEG			NORTH DEVIATION ANGLE	175.9778214 DEG				
PHI	-23.4861472 DEG			X-TILT	.3640407 DEG				
SIGMA PHI	.0020000 DEG			SIGMA X-TILT	.0020000 DEG				
KAPPA	-174.9608650 DEG			Y-TILT	23.4856458 DEG				
SIGMA KAPPA	.0020000 DEG			SIGMA Y-TILT	.0020000 DEG				
OMEGA	.3640407 DEG			HEADING	-84.8026791 DEG				
SIGMA OMEGA	.0020000 DEG			SIGMA HEADING	.0021806 DEG				
SCALE FACTOR	.0000000 M/KM			LASER SLANT RANGE	.0000000 KM				
SPACECRAFT ALTITUDE(LASER)	.0000000 KM			ALTITUDE DIFFERENCE	-112.9495850 KM				
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z						
OF CAMERA AXIS	.55735513	-.74573186	.36501951						123.919739

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-.32595009+00	.74739359+00	.57892917+00
.25918688+00	.65955646+00	-.70555462+00
-.90916355+00	-.79925191-01	-.40869754+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.91338918+00	.83081902-01	-.39851930+00
-.87834449-01	-.99611477+00	-.63536650-02
-.39749884+00	.29200347-01	.91713799+00

LATITUDE LONGITUDE

-23.009	161.298
-22.817	151.289
-27.476	150.805
-31.192	160.799

Figure 8(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT 71	8	1	13	43	50.152			
	GET		6	0	9	49.358			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	907.7172699	991.5716035	1257.1141663	1.3589641	-.8438815	-.3326719			
SELENOGRAPHIC	1627.7668152	-304.3448296	803.2747574	-.3314342	-1.5994448	.0389588			
SIGMA(SELENO)	.41	1.98	.05	.002	.000	.001			
LONGITUDE OF NADIR POINT	-10.5903625 DEG						LATITUDE OF NADIR POINT	25.8769498 DEG	
SIGMA NADIR LONGITUDE	.0012212 DEG						SIGMA NADIR LATITUDE	.0000345 DEG	
LONG OF CAMERA AXIS INTERSECT	-8.8484621 DEG						LATI OF CAMERA AXIS INTERSECT	25.8583820 DEG	
SPACECRAFT RADIUS	1840.5164642 KM						SPACECRAFT ALTITUDE	102.4264679 KM	
SIGMA SPACECRAFT RADIUS	.0000038 KM						AZIMUTH OF VELOCITY VECTOR	271.7166862 DEG	
MEAN ALTITUDE RATE	-.0116379 KM/SEC						HORIZONTAL VELOCITY	1.6338168 KM/SEC	
TILT AZIMUTH	90.2986689 DEG						TILT ANGLE	24.7612782 DEG	
SIGMA TILT AZIMUTH	.0047775 DEG						SIGMA TILT ANGLE	.0019990 DEG	
SUN ELEVATION AT PRIN GRND PNT	18.8093691 DEG						SUN AZIMUTH AT PRINCIPAL GRND PNT	99.2570324 DEG	
LONGITUDE OF SUBSOLAR POINT	60.2628222 DEG						LATITUDE OF SUBSOLAR POINT	.2060632 DEG	
ALPHA	-26.1164916 DEG						SWING ANGLE	89.7192020 DEG	
EMISSION ANGLE	26.3287418 DEG						SIGMA SWING ANGLE	.0047779 DEG	
PHASE ANGLE	97.2714777 DEG						NORTH DEVIATION ANGLE	178.7703228 DEG	
PHI	-24.7610164 DEG						X-TILT	.1176044 DEG	
SIGMA PHI	.0019992 DEG						SIGMA X-TILT	.0020010 DEG	
KAPPA	-179.4463634 DEG						Y-TILT	24.7609618 DEG	
SIGMA KAPPA	.0019998 DEG						SIGMA Y-TILT	.0019993 DEG	
OMEGA	.1176044 DEG						HEADING	-89.3921185 DEG	
SIGMA OMEGA	.0020010 DEG						SIGMA HEADING	.0022025 DEG	
SCALE FACTOR	.0000000 M/KM						LASER SLANT RANGE	.0000000 KM	
SPACECRAFT ALTITUDE(LASER)	.0000000 KM						ALTITUDE DIFFERENCE	-102.4264679 KM	
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z					MAGNITUDE (KM)	
OF CAMERA AXIS	-.72518361	.56167884	-.39827829					113.513168	

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.55604495+00	-.67934011+00	-.47886433+00	-.90801197+00	.96339788-02	-.41883346+00
.22506851+00	.67768886+00	-.70005847+00	-.96626785-02	-.99995115+00	-.20525830-02
.80009388+00	.28148672+00	.52972359+00	-.41883281+00	.21832976-02	.90806079+00

LATITUDE LONGITUDE

30.839	-1.466
27.998	-11.409
23.785	-11.422
20.318	-2.426

Figure 8(b) - Last Frame

Mission: Apollo 15, Target: North Oblique Strip Photography

Rev: 35, Camera: 3-Inch Mapping Frames: 1429 Through: 1560

Coverage Interval:

From: 21.9 Deg. S Lat., 149.2 Deg. E Long., To: 27.9 Deg. N Lat., 32.1 Deg. W Long.

From: 145 Hr 14 Min 29.45 Sec, To: 144 Hr 14 Min 7.76 Sec GET

Date Processed: 1/5/72, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozieff)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 159 H, 37 M, 41.96 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 35. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5485733.12</u>	$\dot{X}$ = <u>-12.3841</u>
Y = <u>356217.25</u>	$\dot{Y}$ = <u>-5307.3467</u>
Z = <u>2523730.72</u>	$\dot{Z}$ = <u>682.2122</u>

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 22 Dec. 1971

Edited Data Tape No. A09554 File No.: 2 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PKE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of side oblique photography starting at 149.2 deg. E Long., 22 deg. S Lat., and ending at 32 deg. W Long., 27.9 deg. N Lat. Throughout the sequence the camera is aimed Northward, essentially normal to the plane of flight, with tilt maintained at 40 ± 0.5 deg. This camera attitude yielded photo footprints whose Northward corners were above the lunar horizon. These corners are indicated in the data by having a zero longitude and ***** latitude. A computer erratic resulted in the provision of state vector data only for frames 1463 and 1541.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
STATE VECTOR	1950.0	8	1	14	48	30.246
SELENOGRAPHIC	-1348.3118439	-652.5328847	-1087.2970123	X DOT	Y DOT	Z DOT
SIGMA(SELENO)	.94	869.8651047	-783.4564819	-1.0479594	1.0600885	.6459195
		1.77	.24	.7570579	1.4267485	.1745589
				.001	.001	.001
LONGITUDE OF NADIR POINT	148.7536221 DEG			LATITUDE OF NADIR POINT	-25.0415983 DEG	
SIGMA NADIR LONGITUDE	.0011902 DEG			SIGMA NADIR LATITUDE	.0001414 DEG	
LONG OF CAMERA AXIS INTERSECT	149.1705036 DEG			LATI OF CAMERA AXIS INTERSECT	-21.9168994 DEG	
SPACECRAFT RADIUS	1850.9345703 KM			SPACECRAFT ALTITUDE	112.8445740 KM	
SIGMA SPACECRAFT RADIUS	.0000096 KM			AZIMUTH OF VELOCITY VECTOR	276.9810257 DEG	
MEAN ALTITUDE RATE	.0102256 KM/SEC			HORIZONTAL VELOCITY	1.6245055 KM/SEC	
TILT AZIMUTH	7.0604553 DEG			TILT ANGLE	39.5778451 DEG	
SIGMA TILT AZIMUTH	.0031389 DEG			SIGMA TILT ANGLE	.0020001 DEG	
SUN ELEVATION AT PRIN GRND PNT	42.822990 DEG			SUN AZIMUTH AT PRINCIPAL GRND PNT	270.3932953 DEG	
LONGITUDE OF SUBSOLAR POINT	59.7146554 DEG			LATITUDE OF SUBSOLAR POINT	.2049968 DEG	
ALPHA	4.1397471 DEG			SWING ANGLE	.1154200 DEG	
EMISSION ANGLE	42.7258425 DEG			SIGMA SWING ANGLE	.0031389 DEG	
PHASE ANGLE	85.2787390 DEG			NORTH DEVIATION ANGLE	170.7686672 DEG	
PHI	.0954104 DEG			X=TILT	39.5777535 DEG	
SIGMA PHI	.0025947 DEG			SIGMA X=TILT	.0020001 DEG	
KAPPA	-173.0893002 DEG			Y=TILT	.0735386 DEG	
SIGMA KAPPA	.0025948 DEG			SIGMA Y=TILT	.0019999 DEG	
OMEGA	39.5777535 DEG			HEADING	-83.0285082 DEG	
SIGMA OMEGA	.0020001 DEG			SIGMA HEADING	.0020000 DEG	
SCALE FACTOR	.0000000 M/KM			LASER SLANT RANGE	.0000000 KM	
SPACECRAFT ALTITUDE(LASER)	.0000000 KM			ALTITUDE DIFFERENCE	-112.8445740 KM	
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z		MAGNITUDE (KM)	
OF CAMERA AXIS	.32757943	-.29035220	.89910361		149.809784	

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

- .63952147+00	.65533119+00	.40193698+00
.65213380+00	.73930511+00	-.16777708+00
-.40710420+00	.15481907+00	-.90016512+00

LATITUDE LONGITUDE

.....	.000
.....	.000
-.24.579	146.307
-25.128	151.272

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.79260586+00	.12137541+00	-.12834900+02
-.92739707-01	-.76516099+00	-.63712475+00
-.78313337-01	-.63229468+00	.77075968+00

Figure 9(a) - First Frame

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~~TRANSFORMATION MATRIX FROM~~
~~LOCAL HORIZONTAL TO CAMERA~~

•99350821+00	•11343666+00	•85774600+02
•86753146-01	•75634418+00	•64917054+00
•80127235-01	•64426353+00	•76059458+00

~~LATITUDE LONGITUDE~~

$\begin{array}{r} \bullet \bullet \bullet \bullet \bullet \bullet \bullet \bullet \\ \bullet \bullet \bullet \bullet \bullet \bullet \bullet \bullet \\ \hline 25,006 \\ 25,456 \end{array}$
 $\begin{array}{r} \bullet \bullet \bullet \bullet \bullet \bullet \bullet \bullet \\ \bullet \bullet \bullet \bullet \bullet \bullet \bullet \bullet \\ \hline -33,916 \\ -29,560 \end{array}$

Figure 9(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 38, Camera: 3-Inch Mapping Frames: 1560 Through: 1704

Coverage Interval:

From: 25.0 Deg. S Lat., 145.7 Deg. E Long., To: 25.2 Deg. N Lat., 33.6 Deg. W Long.

From: 151 Hr 9 Min 35.86 Sec, To: 152 Hr 8 Min 53.93 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 165 H, 31 M, 53.11 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev. 38. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5507373.81 $\dot{X}$ = -56.8619

Y = 354401.39 $\dot{Y}$ = -5288.5850

Z = 2486896.38 $\dot{Z}$ = 785.4631

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: Dec. 8, 1971

Edited Data Tape No. A09554 File No.: 3 Location: Bldg. 12, MSC

Remarks: Telemetered vehicle attitude data are not available for the interval 151 H, 21 M, 29 Sec - 151 H, 23 M, 48 Sec (Fms 1589 through 1593).

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo reduction data are for a strip of near vertical photography starting at 146 deg. E Long., 25 deg S Lat., and extending WNW to 33.6 deg. W Long., 25.2 deg. N Lat. Omitted from the sequence is a 5 frame gap (Fms 1589 through 1593) covering the region, 108.8 deg. E. Long. to 101.5 deg. E Long., for which state vector data only are provided. Throughout the sequence tilt is maintained near zero (less than 1 deg.) so that the principal intersection point remains essentially coincident with the vehicle nadir.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND		
	71	8	1	20	43	35.861		
	GET		6	7	9	35.068		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT		
1950.0	-1343.0096741	-657.7243500	-1089.0276184	-1.0544398	1.0553786	.6450424		
SELENOGRAPHIC	-1385.6388855	943.0149078	-782.9337311	.8302262	1.3862515	.1754381		
SIGMA(SELENO)	1.03	1.72	.25	.001	.001	.001		
LONGITUDE OF NADIR POINT	145.7622395 DEG						LATITUDE OF NADIR POINT	-25.0381975 DEG
SIGMA NADIR LONGITUDE	.0011914 DEG						SIGMA NADIR LATITUDE	.0001465 DEG
LONG OF CAMERA AXIS INTERSECT	145.7288399 DEG						LAT OF CAMERA AXIS INTERSECT	-25.0157626 DEG
SPACECRAFT RADIUS	1849.9344330 KM						SPACECRAFT ALTITUDE	111.8444061 KM
SIGMA SPACECRAFT RADIUS	.0000113 KM						AZIMUTH OF VELOCITY VECTOR	277.0172081 DEG
MEAN ALTITUDE RATE	.0105439 KM/SEC						HORIZONTAL VELOCITY	1.6252815 KM/SEC
TILT AZIMUTH	306.5466957 DEG						TILT ANGLE	.5855064 DEG
SIGMA TILT AZIMUTH	.1961972 DEG						SIGMA TILT ANGLE	.0019962 DEG
SUN ELEVATION AT PRIN GRND PNT	.8002930 DEG						SUN AZIMUTH AT PRINCIPAL GRND PNT	270.5931625 DEG
LONGITUDE OF SUBSOLAR POINT	56.7048845 DEG						LATITUDE OF SUBSOLAR POINT	.1990513 DEG
ALPHA	-.5043251 DEG						SWING ANGLE	299.9740372 DEG
EMISSION ANGLE	.6231468 DEG						SIGMA SWING ANGLE	.1961973 DEG
PHASE ANGLE	89.7040157 DEG						NORTH DEVIATION ANGLE	173.4149227 DEG
PHI	.5071215 DEG						X-TILT	.2924746 DEG
SIGMA PHI	.0020000 DEG						SIGMA X-TILT	.0020000 DEG
KAPPA	-.173.4261398 DEG						Y-TILT	-.5071149 DEG
SIGMA KAPPA	.0020000 DEG						SIGMA Y-TILT	.0020000 DEG
OMEGA	.2924746 DEG						HEADING	-83.4287262 DEG
SIGMA OMEGA	.0020000 DEG						SIGMA HEADING	.0020001 DEG
SCALE FACTOR	.0000000 M/KM						LASER SLANT RANGE	.0000000 KM
SPACECRAFT ALTITUDE(LASER)	.0000000 KM						ALTITUDE DIFFERENCE	-111.8444061 KM
SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z				MAGNITUDE (KM)	
	.75147089	-.50149465	.42871273				111.850632	

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-1.64855609+00 .65368861+00 .38999021+00
 .24983095+00 .66678067+00 -.70213100+00
 -.71899898+00 -.35793273+00 -.59575137+00

LATITUDE LONGITUDE

-27.260 142.626
 -22.249 143.400
 -22.778 148.866
 -27.896 148.360

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.99333136+00 .11443465+00 .88507086+02
 -.11448250+00 -.99341209+00 -.51046229+02
 .82082556-02 -.60841533-02 .99994785+00

Figure 10(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	71	8	1	21	42	54.725			
GMT	71	8	1	21	42	54.725			
GET	71	8	6	8	53.928				
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	1310.7735748	676.4713135	1095.7589722	1.0692773	-1.0582781	-.6435308			
SELENOGRAPHIC	1385.8484802	-919.3733215	781.4123383	-.8408484	-1.3930547	-.1726590			
SIGMA(SELENO)	1.04	1.73	.24	.001	.001	.001			
LONGITUDE OF NADIR POINT	-33.5603371 DEG					25.1669319 DEG			
SIGMA NADIR LONGITUDE	.0012100 DEG					.0001385 DEG			
LONG OF CAMERA AXIS INTERSECT	-33.5825577 DEG					25.1905544 DEG			
SPACECRAFT RADIUS	1837.5060425 KM					99.4160156 KM			
SIGMA SPACECRAFT RADIUS	.0000109 KM					263.4802361 DEG			
MEAN ALTITUDE RATE	-.0105952 KM/SEC					1.6362240 KM/SEC			
TILT AZIMUTH	319.5938301 DEG					.5424405 DEG			
SIGMA TILT AZIMUTH	.2093221 DEG					.0020192 DEG			
SUN ELEVATION AT PRIN GRND PNT	.2790871 DEG					89.9124117 DEG			
LONGITUDE OF SUBSOLAR POINT	56.2021723 DEG					.1980431 DEG			
ALPHA	.3710906 DEG					326.4676018 DEG			
EMISSION ANGLE	.5734771 DEG					.2093217 DEG			
PHASE ANGLE	89.3498144 DEG					186.8844814 DEG			
PHI	.2996425 DEG					.4521417 DEG			
SIGMA PHI	.0019997 DEG					.0020004 DEG			
KAPPA	173.1275768 DEG					-.2996332 DEG			
SIGMA KAPPA	.0020001 DEG					.0019996 DEG			
OMEGA	.4521417 DEG					-.96.8747959 DEG			
SIGMA OMEGA	.0020004 DEG					.0020000 DEG			
SCALE FACTOR	.0000000 M/KM					.0000000 KM			
SPACECRAFT ALTITUDE(LASER)	.0000000 KM					ALTITUDE DIFFERENCE			
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z			MAGNITUDE (KM)			
OF CAMERA AXIS	-.76011378	.49689634	-.41871358			99.420731			

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.66331185+00 -.63828553+00 -.39065201+00
.23120519+00 .67127819+00 -.70422272+00
.71173140+00 .37679853+00 .59284177+00

LATITUDE LONGITUDE

22.580 -35.707
27.093 -36.366
27.666 -31.290
23.099 -30.743

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.99279653+00 -.11969844+00 .52295619+02
.11965536+00 -.99278408+00 -.78912789+02
.61363985-02 -.72086743-02 .99995523+00

Figure 10(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 44, Camera: 3-Inch Mapping Frames: 1704 Through: 1852

Coverage Interval:

From: 25.0 Deg. S Lat., 139.7 Deg. E Long., To: 25.0 Deg. N Lat., 41.2 Deg. W Long.

From: 162 Hr 59 Min 45.29 Sec, To: 163 Hr 59 Min 32.42 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 177 H, 20 M, 11.13 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 44. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5559192.33 $\dot{X}$ = -132.2273

Y = 353857.69 $\dot{Y}$ = -5243.1508

Z = 2396110.96 $\dot{Z}$ = 990.9455

• Telemetered Data Tape

Data Source: Station tapes

Bit Rate: High

Date Edited: 8 Dec. 1971

Edited Data Tape No. A09624 File No.: 1 Location: Bldg. 12, MSC

Remarks: Telemetered vehicle attitude data are unavailable for the interval 163 H, 17 M, 17 Sec - 163 H, 19 M, 2.7 Sec GET, (Frames 1748 through 1751).

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSE time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo reduction data are for a strip of near vertical photography starting at 140 deg. E Long., 25 deg. S Lat., and extending WNW to 41.2 deg. W Long., 26 deg N Lat. Coverage, except for vehicle state vectors, is omitted for the region 87 deg. E Long. to 81.2 deg. E Long. (Frames 1748 through 1751) where telemetered vehicle attitude data is unavailable.

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TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-0.9926552+00	-0.12091761+00	-0.38050788-02
-0.12090419+00	-0.99265769+00	-0.35753296-02
-0.42094613-02	-0.30890337-02	-0.99998641+00

LATITUDE _____ LONGITUDE _____

-27.199	136.470
-22.213	137.270
-22.824	142.650
-27.806	142.108

Figure 11(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
GMT	71	8	2	9	33	33.219	
GET			6	19	59	32.424	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	1333.6358643	657.3802795	1082.6330414	1.0489941	-1.0625446	-.6656144	
SELENOGRAPHIC	1255.0570679	-1097.3381348	776.8581009	-1.0091564	-1.2716976	-.1918873	
SIGMA(SELENO)	1.25	1.57	.26	.001	.001	.001	
LONGITUDE OF NADIR POINT	-41.1642838 DEG						
SIGMA NADIR LONGITUDE	.0012036 DEG						
LONG OF CAMERA AXIS INTERSECT	-41.1732712 DEG						
SPACECRAFT RADIUS	1839.2464905 KM						
SIGMA SPACECRAFT RADIUS	.0000097 KM						
MEAN ALTITUDE RATE	-.0109477 KM/SEC						
TILT AZIMUTH	201.5955048 DEG						
SIGMA TILT AZIMUTH	.3041379 DEG						
SUN ELEVATION AT PRIN GRND PNT	-1.1484499 DEG						
LONGITUDE OF SUBSOLAR POINT	50.1799941 DEG						
ALPHA	.1530957 DEG						
EMISSION ANGLE	.4028156 DEG						
PHASE ANGLE	90.9953785 DEG						
PHI	.1858451 DEG						
SIGMA PHI	.0019994 DEG						
KAPPA	172.3704662 DEG						
SIGMA KAPPA	.0020000 DEG						
OMEGA	-.3321922 DEG						
SIGMA OMEGA	.0020006 DEG						
SCALE FACTOR	.0000000 M/KM						
SPACECRAFT ALTITUDE(LASER)	.0000000 KM						
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				
OF CAMERA AXIS	-.68200586	.59305247	-.42796819				
							MAGNITUDE (KM)
							101.158829

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.65040996+00	-.64209350+00	-.40581133+00
.23709930+00	.67917977+00	-.69462124+00
.72163069+00	.35557101+00	.59398527+00

LATITUDE LONGITUDE

22.397	-43.297
26.974	-44.093
27.619	-38.888
22.987	-38.325

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.99114452+00	-.13274806+00	.32435480-02
.13276515+00	-.99113051+00	.57978147-02
.24451309-02	.61771161-02	.99997798+00

Figure 11(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 50, Camera: 3-Inch Mapping Frames: 1852 Through: 1946

Coverage Interval:

From: 26.1 Deg. S Lat., 126.4 Deg. E Long., To: 23.0 Deg. N Lat., 13.7 Deg. E Long.

From: 174 Hr 52 Min 24.95 Sec, To: 175 Hr 31 Min 59.73 Sec GET

Date Processed: 12/14/71, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 189 H, 9 M, 7.67 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 50. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5445685.09</u>	$\dot{X}$ = <u>-246.0737</u>
Y = <u>356948.16</u>	$\dot{Y}$ = <u>-5217.1922</u>
Z = <u>2619968.86</u>	$\dot{Z}$ = <u>1146.3435</u>

• Telemetered Data Tape

Data Source: Station tapes

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09624 File No.: 2 Location: Bldg. 12, MSC

Remarks: There were no telemetered vehicle attitude data gaps within the interval.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo reduction data are for a sequence of essentially vertical photography starting at 126 deg. E Long., 26 deg. S Lat., and ending at 13.7 deg. E Long., 23 deg. N Lat. Throughout all except a short interval of the sequence, tilt is maintained less than 1 deg. so that the principal intersection point and the vehicle nadir remain essentially coincident. During the excepted interval (Frames 1925 through 1934) the pitch rate of the vehicle was sharply reduced then increased back to orbital rate resulting in a steady increase of tilt to 7+ deg. then a sharp reduction back to near zero.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
GMT	71	8	2	20	26	25.744			
GET			7	6	52	24.946			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1437.6694794	-498.4774170	-1056.5066071	-.9569388	1.0394049	.7994811			
SELENOGRAPHIC	-987.0872574	1339.0660400	-814.9480591	1.1734408	1.0732483	.3262503			
SIGMA(SELENO)	1.45	1.33	.46	.001	.001	.001			
LONGITUDE OF NADIR POINT	126.3956347 DEG	LATITUDE OF NADIR POINT	-26.0993710 DEG						
SIGMA NADIR LONGITUDE	.0011766 DEG	SIGMA NADIR LATITUDE	.0002666 DEG						
LONG OF CAMERA AXIS INTERSECT	126.3592701 DEG	LATI OF CAMERA AXIS INTERSECT	-26.0710065 DEG						
SPACECRAFT RADIUS	1852.4522705 KM	SPACECRAFT ALTITUDE	114.3622742 KM						
SIGMA SPACECRAFT RADIUS	.0000201 KM	AZIMUTH OF VELOCITY VECTOR	283.0564270 DEG						
MEAN ALTITUDE RATE	.0070094 KM/SEC	HORIZONTAL VELOCITY	1.6233061 KM/SEC						
TILT AZIMUTH	310.9614258 DEG	TILT ANGLE	.6574875 DEG						
SIGMA TILT AZIMUTH	.1743532 DEG	SIGMA TILT ANGLE	.0020002 DEG						
SUN ELEVATION AT PRIN GRND PNT	7.3638391 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	273.8205986 DEG						
LONGITUDE OF SUBSOLAR POINT	44.6485791 DEG	LATITUDE OF SUBSOLAR POINT	.1736377 DEG						
ALPHA	-.5588523 DEG	SWING ANGLE	297.8695657 DEG						
EMISSION ANGLE	.7007433 DEG	SIGMA SWING ANGLE	.1743534 DEG						
PHASE ANGLE	83.1948109 DEG	NORTH DEVIATION ANGLE	166.8842640 DEG						
PHI	.5812496 DEG	X-TILT	.3072247 DEG						
SIGMA PHI	.0020000 DEG	SIGMA X-TILT	.0020000 DEG						
KAPPA	-166.8965778 DEG	Y-TILT	-.5812412 DEG						
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0020000 DEG						
OMEGA	.3072247 DEG	HEADING	-76.8996944 DEG						
SIGMA OMEGA	.0020000 DEG	SIGMA HEADING	.0020001 DEG						
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	.0000000 KM						
SPACECRAFT ALTITUDE(LASER)	.0000000 KM	ALTITUDE DIFFERENCE	-114.3622742 KM						
SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X .53783045	Y -.71500866	Z .44665537	MAGNITUDE (KM) 114.370300					

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-59415919+00	63813876+00	48964650+00
23632769+00	72038013+00	-65207484+00
-76884593+00	-27171931+00	-57883041+00

LATITUDE LONGITUDE

-23.818	130.225
-22.447	123.935
-28.232	122.308
-29.554	128.863

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

- .97392459+00	022664486+00	010144399-01
- .22670629+00	- .97394835+00	- .53620535+02
086648725-02	- .75220187-02	099993421+00

Figure 12(a) - First Frame

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TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

- .95107931+00	.30882987+00	-.85016394-02
-.30887549+00	-.95109090+00	.46825462-02
-.66398293-02	.70793977-02	.99995288+00

24.781	17.617
26.511	11.701
21.170	9.905
19.416	15.634

Figure 12(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 60, Camera: 3-Inch Mapping Frames: 1946 Through: 2091

Coverage Interval:

From: 27.15 Deg. S Lat., 122.6 Deg. E Long., To: 27.3 Deg. N Lat., 6.8 Deg. W Long.

From: 194 Hr 35 Min 34.6 Sec, To: 195 Hr 35 Min 0.4 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 208 H, 51 M, 11.11 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 60. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5574224.19

$\dot{X}$ = -354.9182

Y = 354480.73

$\dot{Y}$ = -5106.8394

Z = 2379220.06

$\dot{Z}$ = 1496.9973

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09624 File No.: 3 Location: Bldg. 12, MSC

Remarks: There are no telemetered vehicle attitude data for the interval 194 H, 40 M, 4.2 Sec - 194 H, 44 M, 17 Sec GET (Fms 1958 through 1967).

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photogrammetric position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a sequence of near vertical photography starting at 123 deg. E Long., 27 deg. S Lat., and extending WNW to 56.8 deg. W Long., 27 deg. N Lat. Vehicle state vectors only are provided for the region 109 deg. E Long. to 95 deg. E Long. (Fms 1958 through 1967) for which vehicle attitude data are unavailable.

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TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

- .98613826+00	.16591411+00	.19326766-02
- .16591026+00	- .98613872+00	.20254293-02
.22419442-02	.16707324-02	.99999613+00

-29.452	120.554
-24.343	121.644
-25.180	127.317
-30.343	126.465

Figure 13(a) - First Frame

	YEAR	MONTH	DAY	HOOR	MINUTE	SECOND			
	GMT 71	8	3	17	9	1.170			
	GET		8	3	35	.374			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	1277.8974304	646.6755295	1151.8575134	1.1102827	-.9778636	-.6495269			
SELENOGRAPHIC	893.4269791	-1366.7980957	843.5864105	-1.2840885	-.9822064	-.2543033			
SIGMA SELENO	1.59	1.22	.35	.001	.001	.001			
LONGITUDE OF NADIR POINT	-56.8287964 DEG						LATITUDE OF NADIR POINT	27.3217728 DEG	
SIGMA NADIR LONGITUDE	.0012216 DEG						SIGMA NADIR LATITUDE	.0002022 DEG	
LONG OF CAMERA AXIS INTERSECT	-56.8326001 DEG						LATI OF CAMERA AXIS INTERSECT	27.3277650 DEG	
SPACECRAFT RADIUS	1837.9300232 KM						SPACECRAFT ALTITUDE	99.8399963 KM	
SIGMA SPACECRAFT RADWS	.0000147 KM						AZIMUTH OF VELOCITY VECTOR	260.1195793 DEG	
MEAN ALTITUDE RATE	-.0104944 KM/SEC						HORIZONTAL VELOCITY	1.6364826 KM/SEC	
TILT AZIMUTH	330.5409889 DEG						TILT ANGLE	.1201279 DEG	
SIGMA TILT AZIMUTH	.9548295 DEG						SIGMA TILT ANGLE	.0020279 DEG	
SUN ELEVATION AT PRIN GRND PNT	-.7612214 DEG						SUN AZIMUTH AT PRINCIPAL GRND PNT	89.4281950 DEG	
LONGITUDE OF SUBSOLAR POINT	34.1239300 DEG						LATITUDE OF SUBSOLAR POINT	.1492977 DEG	
ALPHA	.0612102 DEG						SWING ANGLE	340.2180328 DEG	
EMISSION ANGLE	.1268618 DEG						SIGMA SWING ANGLE	.9548436 DEG	
PHASE ANGLE	90.7200127 DEG						NORTH DEVIATION ANGLE	189.6808224 DEG	
PHI	.0405456 DEG						X-TILT	.1127426 DEG	
SIGMA PHI	.0020000 DEG						SIGMA X-TILT	.0020000 DEG	
KAPPA	170.3210239 DEG						Y-TILT	-.0405455 DEG	
SIGMA KAPPA	.0020000 DEG						SIGMA Y-TILT	.0020000 DEG	
OMEGA	.1127426 DEG						HEADING	-99.6790600 DEG	
SIGMA OMEGA	.0020000 DEG						SIGMA HEADING	.0020000 DEG	
SCALE FACTOR	.0000000 M/KM						LASER SLANT RANGE	.0000000 KM	
SPACECRAFT ALTITUDE (LASER)	.0000000 KM						ALTITUDE DIFFERENCE	-99.8399963 KM	
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				MAGNITUDE (KM)		
OF CAMERA AXIS	-.48742202	.74379686	-.45736857				99.840240		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.68260330+00	-.59755858+00	-.42068560+00
.22511287+00	.71960225+00	-.65688407+00
.69525313+00	.35368957+00	.62572107+00

LATITUDE LONGITUDE

24.649	-58.892
29.157	-59.852
29.946	-54.662
25.404	-53.886

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.98576470+00	-.16812903+00	.70765318-03
.16812742+00	-.98576325+00	-.19677277-02
.10284212-02	-.18207701-02	.99999786+00

Figure 13(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 62, Camera: 3-Inch Mapping Frames: 2091 Through: 2206

Coverage Interval:

From: 15.9 Deg. S Lat., 83.2 Deg. E Long., To: 27.3 Deg. N Lat., 58.9 Deg. W Long.

From: 198 Hr 44 Min 40.7 Sec, To: 199 Hr 32 Min 2.02 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1736.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr. 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 212 H, 47 M, 33.35 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 62. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5602038.66 $\dot{X}$ = -362.7224

Y = 358193.68 $\dot{Y}$ = -5082.7231

Z = 2319751.64 $\dot{Z}$ = 1565.8407

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 7 Dec. 1971

Edited Data Tape No. A09569 File No.: 2 Location: Bldg. 12, MSC

Remarks: There were no significant gimbal data gaps within the interval.

• AIE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PKE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a near vertical strip of photography starting at 83.2 deg. E Long., 16 deg. S Lat. and extending WNW to 59 deg. W Long., 27 deg. N Lat. Throughout the sequence, a near zero (less than 1 deg.) tilt is maintained such that the principal intersection point and vehicle nadir remain essentially coincident.

Figure 14(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	71	8	3	21	6	2.815			
STATE VECTOR	GET		8	7	32	2.021			
	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	1275.2182617	649.8920441	1153.5459137	1.1129837	-.9749572	-.6983871			
SELENOGRAPHIC	845.0446930	-1397.5153198	843.8364029	-1.3176476	-.9360313	-.2543010			
SIGMA(SELENO)	1.63	1.17	.41	.001	.001	.001			
LONGITUDE OF NADIR POINT	-58.8395339 DEG					27.3251872 DEG			
SIGMA NADIR LONGITUDE	.0012219 DEG					.0002322 DEG			
LONG OF CAMERA AXIS INTERSECT	-58.8779511 DEG					27.3324347 DEG			
SPACECRAFT RADIUS	1838.2626038 KM					100.1725769 KM			
SIGMA SPACECRAFT RADIUS	.0000271 KM					260.1235046 DEG			
MEAN ALTITUDE RATE	-.0108478 KM/SEC					1.6360940 KM/SEC			
TILT AZIMUTH	282.0255051 DEG					.6039720 DEG			
SIGMA TILT AZIMUTH	.1892645 DEG					.0020061 DEG			
SUN ELEVATION AT PRIN GRND PNT	-.8173189 DEG					89.4149275 DEG			
LONGITUDE OF SUBSOLAR POINT	32.1167488 DEG					.1444284 DEG			
ALPHA	.6233665 DEG					291.7602386 DEG			
EMISSION ANGLE	.6388075 DEG					.1892647 DEG			
PHASE ANGLE	90.1939554 DEG					189.7531891 DEG			
PHI	.5608886 DEG					.2238834 DEG			
SIGMA PHI	.0020000 DEG					.0020001 DEG			
KAPPA	170.2662258 DEG					-.5608844 DEG			
SIGMA KAPPA	.0020000 DEG					.0019999 DEG			
OMEGA	.2238834 DEG					-99.7359705 DEG			
SIGMA OMEGA	.0020001 DEG					.0020001 DEG			
SCALE FACTOR	.0000000 M/KM					.0000000 KM			
SPACECRAFT ALTITUDE(LASER)	.0000000 KM					ALTITUDE DIFFERENCE	-100.1725769 KM		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				MAGNITUDE (KM)		
OF CAMERA AXIS	-.46901510	.75572323	-.45706370				100.178467		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.69106480+00 -.59183250+00 -.41492604+00
.22201976+00 .72011931+00 -.65736998+00
.68784929+00 .36216356+00 .62904770+00

LATITUDE LONGITUDE

24.658 -60.863
29.146 -61.814
29.974 -56.622
25.384 -55.827

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.98555023+00 -.16910001+00 .97891229-02
.16906917+00 -.98559639+00 -.39074928-02
.10308891-01 -.21960216-02 .99994450+00

Figure 14(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 63, Camera: 3-Inch Mapping Frames: 2206 Through: 2351

Coverage Interval:

From: 27.3 Deg S Lat., 120.5 Deg E Long., To: 27.2 Deg. N Lat., 60.3 Deg W Long.

From: 200 Hr 30 Min 48.31 Sec, To: 201 Hr 30 Min 39.29 Sec GET

Date Processed: 1/6/72, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: _____

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 63. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5615994.30

$\dot{X}$ = -367.7504

Y = 357003.71

$\dot{Y}$ = -5070.78

Z = 2289724.61

$\dot{Z}$ = 1598.78

• Telemetered Data Tape

Data Source: Station tapes

Bit Rate: High

Date Edited: 4 Jan. 1972

Edited Data Tape No. A09569 File No.: 3 Location: Bldg. 12, MSC

Remarks: There are two significant gaps in the telemetered vehicle attitude data for the interval of this sequence:

- 1) 201 H, 25 M, 34.8 Sec - 201 H, 26 M, 45 Sec (Frames 2338 - 2341)
- 2) 201 H, 28 M, 41.8 Sec - 201 H, 29 M, 51.7 Sec (Frames 2346 - 2349)

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of near vertical photography starting at 120.5 deg. E Long., 27.3 deg. S Lat., and ending at 60.3 deg. W Long., 27.2 deg. N Lat. Throughout the sequence tilt is maintained essentially zero such that the principal intersection point and vehicle nadir remain near coincident. State vector data are provided for the two regions of coverage where vehicle attitude data are unavailable. The intervals are:

- 1) 41.4 deg. W Long., 29 deg. N Lat. - 48.2 deg. W Long., 28.6 deg. N Lat. (Frames 2338 through 2341).
- 2) 52.3 deg. W Long., 28.3 deg. N Lat. - 59 deg. W Long., 27.4 deg. N Lat. (Frames 2346 through 2349).

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT 71	8	3	23	4	40.079			
	GET		8	9	30	39.287			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	1282.2721710	645.0618744	1148.7116394	1.1071329	-.9768112	-.7046881			
SELENOGRAPHIC	811.0405426	-1419.2486420	841.3154755	-1.3382519	-.9045516	-.2595321			
SIGMA(SELENO)	1.66	1.13	.38	.001	.001	.001			
LONGITUDE OF NADIR POINT	-60.2538643 DEG			LATITUDE OF NADIR POINT	27.2339211 DEG				
SIGMA NADIR LONGITUDE	.0012194 DEG			SIGMA NADIR LATITUDE	.0002184 DEG				
LONG OF CAMERA AXIS INTERSECT	-60.2977018 DEG			LATI OF CAMERA AXIS INTERSECT	27.2022154 DEG				
SPACECRAFT RADIUS	1838.4409637 KM			SPACECRAFT ALTITUDE	100.3509674 KM				
SIGMA SPACECRAFT RADIUS	.0000207 KM			AZIMUTH OF VELOCITY VECTOR	259.9208641 DEG				
MEAN ALTITUDE RATE	-.0108467 KM/SEC			HORIZONTAL VELOCITY	1.6359320 KM/SEC				
TILT AZIMUTH	230.8914719 DEG			TILT ANGLE	.8704033 DEG				
SIGMA TILT AZIMUTH	.1321684 DEG			SIGMA TILT ANGLE	.0019929 DEG				
SUN ELEVATION AT PRIN GRND PNT	-1.1891136 DEG			SUN AZIMUTH AT PRINCIPAL GRND PNT	89.2290545 DEG				
LONGITUDE OF SUBSOLAR POINT	31.1122980 DEG			LATITUDE OF SUBSOLAR POINT	.1419648 DEG				
ALPHA	.7219683 DEG			SWING ANGLE	240.8578453 DEG				
EMISSION ANGLE	.9206064 DEG			SIGMA SWING ANGLE	.1321683 DEG				
PHASE ANGLE	90.4672041 DEG			NORTH DEVIATION ANGLE	189.9827919 DEG				
PHI	.7601545 DEG			X-TILT	-.4238113 DEG				
SIGMA PHI	.0020000 DEG			SIGMA X-TILT	.0020001 DEG				
KAPPA	170.0308304 DEG			Y-TILT	-.7601338 DEG				
SIGMA KAPPA	.0020001 DEG			SIGMA Y-TILT	.0019999 DEG				
OMEGA	-.4238113 DEG			HEADING	-99.9635515 DEG				
SIGMA OMEGA	.0020001 DEG			SIGMA HEADING	.0020002 DEG				
SCALE FACTOR	.0000000 M/KM			LASER SLANT RANGE	.0000000 KM				
SPACECRAFT ALTITUDE(LASER)	.0000000 KM			ALTITUDE DIFFERENCE	-100.3509674 KM				
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)					
OF CAMERA AXIS	-.44916341	.76224121	-.46609071	100.363220					

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERATRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.69011587+00 -.59151094+00 -.41695899+00
.22839890+00 .72472198+00 -.65008406+00
.68671247+00 .35340181+00 .63524266+00

-.98483130+00 -.17300638+00 .13266448-01
.17311357+00 -.98487404+00 .73968355-02
.11786091-01 .95812071-02 .99988469+00

LATITUDE LONGITUDE

30.121 -57.919
29.265 -63.746
24.136 -62.637
25.678 -57.013

Figure 15(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 70, Camera: 3-Inch Mapping Frames: 2351 Through: 2492

Coverage Interval:

From: 27.2 Deg. S Lat., 113.4 Deg. E Long., To: 27.4 Deg. N Lat., 65.3 Deg. W Long.

From: 214 Hr 20 Min 18.35 Sec, To: 215 Hr 19 Min 32.56 Sec GET

Date Processed: 12/15/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 228 H. 32 M. 49.06 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 70. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5715995.09

$\dot{X}$ = -363.6069

Y = 363293.87

$\dot{Y}$ = -4985.8444

Z = 2051514.40

$\dot{Z}$ = 1824.5026

• Telemetered Data Tape

Data Source: MSFN

Bit Rate: High

Date Edited: 10 Dec. 1971

Edited Data Tape No. A09578 File No.: 1 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a sequence of near vertical photography starting at 113 deg. E Long., 27 deg. S Lat., and extending WNW to 65 deg. W Long., 27 deg. N Lat. Throughout the sequence a near zero tilt is maintained exceeding 1 deg. only for short intervals and never in excess of 2 deg. The principal intersection point and the vehicle nadir remain essentially coincident throughout the sequence.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND		
GMT	71	8	4	11	54	19.141		
GET			8	22	20	18.347		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT		
1950.0	-1275.3837891	-665.3931122	-1160.1049347	-1.1314700	.9512390	.6808473		
SELENOGRAPHIC	-655.1160049	1507.9464264	-843.8695679	1.4145445	.7660435	.2467272		
SIGMA (SELENO)	1.75	.95	.36	.001	.001	.001		
LONGITUDE OF NADIR POINT	113.4821711 DEG							
SIGMA NADIR LONGITUDE	.0012060 DEG							
LONG OF CAMERA AXIS INTERSECT	113.4348583 DEG							
SPACECRAFT RADIUS	1848.0246735 KM							
SIGMA SPACECRAFT RADIUS	.0000198 KM							
MEAN ALTITUDE RATE	.0109609 KM/SEC							
TILT AZIMUTH	270.8436584 DEG							
SIGMA TILT AZIMUTH	.1717071 DEG							
SUN ELEVATION AT PRIN GRND PNT	.9755068 DEG							
LONGITUDE OF SUBSOLAR POINT	24.5958192 DEG							
ALPHA	-.7076981 DEG							
EMISSION ANGLE	.7077590 DEG							
PHASE ANGLE	89.7321920 DEG							
PHI	.6569196 DEG							
SIGMA PHI	.0019997 DEG							
KAPPA	-109.8916912 DEG							
SIGMA KAPPA	.0020000 DEG							
OMEGA	-.1071616 DEG							
SIGMA OMEGA	.0020003 DEG							
SCALE FACTOR	.0000000 M/KM							
SPACECRAFT ALTITUDE (LASER)	.0000000 KM							
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z					
OF CAMERA AXIS	.36509372	-.81122240	.45675464					
								MAGNITUDE (KM)
								109.942581

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-.69863498+00 .56153757+00 .41346565+00
 .21384920+00 .72547387+00 -.65418351+00
 -.66256734+00 -.36810555+00 -.63134794+00
 LATITUDE LONGITUDE

-24.855 117.022
 -23.824 110.903
 -29.440 109.605
 -30.412 116.072

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.98440921+00 .17651909+00 .11465139+01
 -.17550926+00 -.98447595+00 .18703210+02
 .11615439-01 -.17104687-03 .99993257+00

Figure 16(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
GHT 71	8	4	12	53	33.351	
GET	8	23	19	32.556		

	X	Y	Z	X DOT	Y DOT	Z DOT
STATE VECTOR	1235.4175873	673.0732574	1177.1957855	1.1510994	-.9455634	-.6685892
SELENOGRAPHIC	683.2570267	-1485.1902924	848.3906555	-1.4179564	-.7741305	-.2371775
SIGMA(SELENO)	1.75	.96	.35	.001	.001	.001

LONGITUDE OF NADIR POINT	-65.2953606 DEG	LATITUDE OF NADIR POINT
SIGMA NADIR LONGITUDE	.0012198 DEG	SIGMA NADIR LATITUDE
LONG OF CAMERA AXIS INTERSECT	-65.3105888 DEG	LATI OF CAMERA AXIS INTERSECT
SPACECRAFT RADIUS	1841.8460999 KM	SPACECRAFT ALTITUDE
SIGMA SPACECRAFT RADIUS	.0000196 KM	AZIMUTH OF VELOCITY VECTOR
MEAN ALTITUDE RATE	-.0110304 KM/SEC	HORIZONTAL VELOCITY
TILT AZIMUTH	222.6690731 DEG	TILT ANGLE
SIGMA TILT AZIMUTH	.3447401 DEG	SIGMA TILT ANGLE
SUN ELEVATION AT PRIN GRND PNT	.5854769 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT
LONGITUDE OF SUBSOLAR POINT	-24.0943229 DEG	LATITUDE OF SUBSOLAR POINT
ALPHA	.2392623 DEG	SWING ANGLE
EMISSION ANGLE	.3543613 DEG	SIGMA SWING ANGLE
PHASE ANGLE	89.1752548 DEG	NORTH DEVIATION ANGLE
PHI	.2619195 DEG	X-TILT
SIGMA PHI	.0019999 DEG	SIGMA X-TILT
KAPPA	171.0730495 DEG	Y-TILT
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT
OMEGA	-.2076280 DEG	HEADING
SIGMA OMEGA	.0020001 DEG	SIGMA HEADING
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE
SPACECRAFT ALTITUDE(LASER)	.0000000 KM	ALTITUDE DIFFERENCE

	X	Y	Z	MAGNITUDE (KM)
SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	-.37372291	-.80289863	-.46441096	103.757980

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERATRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.71147785+00	-.57849690+00	-.39892419+00
.2224744+00	.72368757+00	-.65343028+00
-.66690397+00	.37632116+00	.64334151+00

-.98787918+00	-.15515712+00	.45713109+02
.5517413+00	-.9878804+00	.30237839+02
.39536557+02	.42891778+02	.99998304+02

LATITUDE LONGITUDE

30.423	-62.749
29.595	-68.829
24.312	-67.770
25.147	-61.938

Figure 16(b) - Last Frame

Mission: Apollo 15, Target: South Oblique Strip Photography

Rev: 71, Camera: 3-Inch Mapping Frames: 2494 Through: 2623

Coverage Interval:

From: 21.7 Deg. S Lat., 80.1 Deg. E Long., To: 24.5 Deg. N Lat., 66.1 Deg. W Long.

From: 216 Hr 28 Min 36.04 Sec, To: 217 Hr 18 Min 7.10 Sec GET

Date Processed: 1/5/72, APE Version Used: 7.

INPUT DATA

• Trajectory Tape:

HOPE Version Used: E-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 230 H, 30 M, 56.42 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 7L. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X =	<u>5729308.51</u>	$\dot{X}$ =	<u>-357.7284</u>
Y =	<u>366059.75</u>	$\dot{Y}$ =	<u>-4974.3685</u>
Z =	<u>2013057.85</u>	$\dot{Z}$ =	<u>1855.8189</u>

• Telemetered Data Tape

Data Source: MSFN

Bit Rate: High

Date Edited: 27 Dec. 1971

Edited Data Tape No. A09668 File No.: 1 Location: Bldg. 12, MSC

Remarks:

Telemetered vehicle attitude data are not available for the initial nine minutes nor for the final minute of this photographic sequence. Valid vehicle attitude data were available only for the interval 216 H, 28 M, 34 Sec to 217 H, 18 M, 26 Sec (Frames 2514 through 2621).

● APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of side oblique photography. For approximately the initial nine minutes of photographic coverage vehicle attitude data are unavailable. This is also the case for the final one minute of the sequence. Only vehicle state vector information are provided at film exposure times throughout these intervals (Frames 2494 through 2514, Frames 2622 and 2623). Throughout the sequence the camera optical axis is directed Southward, essentially normal to the plane of flight, at a tilt of 40 deg. ± 0.5 deg. As a result of this camera attitude, the principal intersection point position falls slightly to the rear and approximately 3 deg. South of the vehicle nadir, with the Southward edge of the photograph above the horizon. The above horizon photo frame corners are indicated by a Long=000, Lat=****.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND		
	GMT 71	8	4	14	2	36.839		
	GET		9	0	28	36.042		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT		
1950.0	-1743.6876373	-44.1845874	-625.3069839	-4304136	1.1159646	1.0969571		
SELENOGRAPHIC	260.7190971	1735.5970154	-594.2526703	1.5148414	-0.0194621	.5820862		
SIGMA(SELENO)	1.87	.10	.177	.000	.002	.001		
LONGITUDE OF NADIR POINT	81.4569788 DEG							
SIGMA NADIR LONGITUDE	.0010579 DEG							
LONG OF CAMERA AXIS INTERSECT	80.0963192 DEG							
SPACECRAFT RADIUS	1852.9456635 KM							
SIGMA SPACECRAFT RADIUS	.0000203 KM							
MEAN ALTITUDE RATE	.0082373 KM/SEC							
TILT AZIMUTH	202.6587048 DEG							
SIGMA TILT AZIMUTH	.0030974 DEG							
SUN ELEVATION AT PRIN GRND PNT	30.7138262 DEG							
LONGITUDE OF SUBSOLAR POINT	23.5096893 DEG							
ALPHA	-24.0449944 DEG							
EMISSION ANGLE	43.4967542 DEG							
PHASE ANGLE	74.0301771 DEG							
3-PHI	.0005229 DEG							
101 SIGMA PHI	.0026187 DEG							
KAPPA	-157.3421192 DEG							
SIGMA KAPPA	.0026189 DEG							
OMEGA	-40.2142863 DEG							
SIGMA OMEGA	.0020003 DEG							
SCALE FACTOR	.0000000 M/KM							
SPACECRAFT ALTITUDE(LASER)	.0000000 KM							
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z					
OF CAMERA AXIS	.11013735	-.94118448	-.31943938					
								MAGNITUDE (KM)
								154.140656

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-.26156850+00 .68393036+00 .68104415+00
-.44372828+00 .54141113+00 -.71412825+00
-.85713892+00 -.48899205+00 .16186303+00

LATITUDE LONGITUDE

-19.782 83.635
-18.000 79.127
..... .000
..... .000

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.92281920+00 .38523326+00 .69698330+05
-.29417346+00 -.70469881+00 .64364810+00
.24873012+00 .59581435+00 .76363511+00

Figure 17(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
STATE VECTOR	1950.0	1241.5170135	688.1011810	1173.9053650	1.1460474	-.9475880
SELENOGRAPHIC	647.5558777	-1501.8650513	847.3336411	-1.4344566	-.7412194	-.2412677
SIGMA (SELENO)	1.77	.93	.38	.001	.001	.001
LONGITUDE OF NADIR POINT	-66.6758537 DEG	LATITUDE OF NADIR POINT	27.3878586 DEG			
SIGMA NADIR LONGITUDE	.0012186 DEG	SIGMA NADIR LATITUDE	.0002121 DEG			
LONG OF CAMERA AXIS INTERSECT	-66.1418224 DEG	LAT OF CAMERA AXIS INTERSECT	24.4607861 DEG			
SPACECRAFT RADIUS	1841.9830322 KM	SPACECRAFT ALTITUDE	103.8930359 KM			
SIGMA SPACECRAFT RADIUS	.0000234 KM	AZIMUTH OF VELOCITY VECTOR	260.6201897 DEG			
MEAN ALTITUDE RATE	-.0109193 KM/SEC	HORIZONTAL VELOCITY	1.6325029 KM/SEC			
TILT AZIMUTH	170.5586739 DEG	TILT ANGLE	40.2558537 DEG			
SIGMA TILT AZIMUTH	.0030947 DEG	SIGMA TILT ANGLE	.0020703 DEG			
SUN ELEVATION AT PRIN GRND PNT	7494345 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	90.2072601 DEG			
LONGITUDE OF SUBSOLAR POINT	23.0904865 DEG	LATITUDE OF SUBSOLAR POINT	1216654 DEG			
ALPHA	-6.9033188 DEG	SWING ANGLE	179.9404850 DEG			
EMISSION ANGLE	43.2220974 DEG	SIGMA SWING ANGLE	.0030945 DEG			
PHASE ANGLE	95.8823013 DEG	NORTH DEVIATION ANGLE	192.4818325 DEG			
PHI	.0503903 DEG	X-TILT	40.2558346 DEG			
SIGMA PHI	.0026203 DEG	SIGMA X-TILT	.0020003 DEG			
KAPPA	170.6366558 DEG	Y-TILT	.0384562 DEG			
SIGMA KAPPA	.0026205 DEG	SIGMA Y-TILT	.0019997 DEG			
OMEGA	-40.2558346 DEG	HEADING	-99.3959112 DEG			
SIGMA OMEGA	.0020003 DEG	SIGMA HEADING	.0020000 DEG			
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	.0000000 KM			
SPACECRAFT ALTITUDE (LASER)	.0000000 KM	ALTITUDE DIFFERENCE	-103.8930359 KM			
SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X -.05485425	Y .39494833	Z -.91706423	MAGNITUDE (KM) 139.185547		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.70612212+00	-.57798845+00	-.40904865+00
.60035308+00	.79499239+00	-.86967166+01
.37545668+00	-.18416412+00	.90835887+00

LATITUDE LONGITUDE

27.515	-64.313
26.835	-68.945
.....	.000
.....	.000

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

.98658355+00	-.16325547+00	-.67118726+03
.12416328+00	-.75279859+00	.64620169+00
-.10600138+00	.63744855+00	.76316645+00

Figure 17(b) - Last Frame

Mission: Apollo 15, Target: Strip photography

Rev: 72, Camera: 3-Inch Mapping Frames: 2623 Through: 2752

Coverage Interval:

From: 26.8 Deg. S Lat., 109.7 Deg. E Long., To: 27.3 Deg. N Lat., 68.0 Deg. W Long.

From: 218 Hr 17 Min 46.74 Sec, To: 219 Hr 16 Min 38.92 Sec GET

Date Processed: 12/14/71, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at each film exposure time

Integration Interval: Variable (1×10^{-14} - 64 Min)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 232 H, 29 M, 2.0 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 72. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5743623.34 $\dot{X}$ = -352.7828

Y = 366342.93 $\dot{Y}$ = -4962.4335

Z = 1975192.34 $\dot{Z}$ = 1885.7199

• Telemetered Data Tape

Data Source: MSFN

Bit Rate: High

Date Edited: 9 Dec. 1971

Edited Data Tape No. A09668 File No.: 2 Location: Bldg. 12, MSC

Remarks: There are no gimbal data for the interval 218 H, 19 M, 0.5 Sec - 218 H, 20 M, 56 Sec (Frames 2626 through 2630).

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis (camera positioning angle) was 37.75 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

- ± 20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of near vertical photography starting at 110 deg. E Long., 27 deg. S Lat., and extending WNW to 68 deg. W Long., 27 deg. N Lat. Omitted from the sequence is the region 106 deg. E Long. - 99 deg. E Long. (Frames 2626 through 2630) where vehicle attitude data are not available. Throughout the sequence a near zero (less than 1 deg.) tilt is maintained so that the principal intersection point and vehicle nadir remain essentially coincident.

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TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

- .97990587+00	. 19941370+00	. 43069077-02
- .19942498+00	- .97991022+00	- .23528868-02
. 37509993-02	- .31654652-02	. 99998800+00

-28.752	106.345
-23.923	107.573
-24.873	112.920
-29.784	111.932

Figure 18(a) - First Frame

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TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

- .98606873+00	- .16537360+00	. 17886308+01
. 16531248+00	- .98622923+00	- .48562512-02
. 18443100-01	- .18317990-02	. 99982829+00

24.548	-70.049
29.187	-71.008
30.060	-65.612
25.250	-64.801

Figure 18(b) - Last Frame

4.0 APOLLO 15 24-INCH PANORAMIC CAMERA DATA

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 4, Camera: 24 Inch Panoramic Frames: 8844 Through: 8944

Coverage Interval:

From: 25.1 Deg. S Lat., 178.3 Deg. E Long., To: 16.5 Deg. S Lat., 141.9 Deg. E Long.

From: 84 Hr 42 Min 57.64 Sec, To: 84 Hr 54 Min 15.25 Sec GET

Date Processed: 12/7/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 99 H 11 M 34.160 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 4. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5175791.43</u>	$\dot{X}$ = <u>582.8512</u>
Y = <u>330685.92</u>	$\dot{Y}$ = <u>5508.7802</u>
Z = <u>2492551.4</u>	$\dot{Z}$ = <u>371.0212</u>

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Sept. 1971

Edited Data Tape No. A09550 File No.: 1 Location: Bldg. 12, MSC

Remarks: There were no significant data gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary These photo evaluation data are for a strip of panoramic photography starting at 178.3 deg. E Long., 25.1 deg. S Lat. and ending at 141.9 deg. E Long., 16.5 deg. S Lat. The coverage from 178.3 deg E Long. to 169.6 deg. E Long. (Frames 8844 through 8857) was vertical - over the remainder of the sequence the camera was in its oscillating mode starting in its forward position at Frame 8858 and ending in its forward position at Frame 8944.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
	71	7	30	2	16	58.433	
	GET		3	12	42	57.642	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	-1401.0300140	-568.3391571	-1047.4143677	-.9401571	1.1211926	.6803441	
SELENOGRAPHIC	-1665.0387573	48.2216115	-779.9307632	-.0205812	1.6028825	.1848801	
SIGMA(SELENO)	.03	1.98	.23	.002	.000	.001	
LONGITUDE OF NADIR POINT	178.3411064	DEG		LATITUDE OF NADIR POINT	-25.0899169	DEG	
SIGMA NADIR LONGITUDE	.0011895	DEG		SIGMA NADIR LATITUDE	.0001317	DEG	
LONG OF CAMERA AXIS INTERSECT	178.3080826	DEG		LATI OF CAMERA AXIS INTERSECT	-25.0991023	DEG	
SPACECRAFT RADIUS	1839.2855377	KM		SPACECRAFT ALTITUDE	101.1955109	KM	
SIGMA SPACECRAFT RADIUS	.0000035	KM		AZIMUTH OF VELOCITY VECTOR	276.9711609	DEG	
MEAN ALTITUDE RATE	-.0177414	KM/SEC		HORIZONTAL VELOCITY	1.6135138	KM/SEC	
TILT AZIMUTH	252.9166775	DEG		TILT ANGLE	.5373211	DEG	
SIGMA TILT AZIMUTH	.2142239	DEG		SIGMA TILT ANGLE	.0019921	DEG	
SUN ELEVATION AT PRIN GRND PNT	1.8908682	DEG		SUN AZIMUTH AT PRINCIPAL GRND PNT	271.1713409	DEG	
LONGITUDE OF SUBSOLAR POINT	90.5172310	DEG		LATITUDE OF SUBSOLAR POINT	.2581561	DEG	
ALPHA	-.5400218	DEG		SWING ANGLE	245.6706505	DEG	
EMISSION ANGLE	.5686371	DEG		SIGMA SWING ANGLE	.2142238	DEG	
PHASE ANGLE	88.6491451	DEG		NORTH DEVIATION ANGLE	172.7395191	DEG	
PHI	.4895799	DEG		X-TILT	-.2213493	DEG	
SIGMA PHI	.0019999	DEG		SIGMA X-TILT	.0020001	DEG	
KAPPA	-172.7552643	DEG		Y-TILT	-.4895762	DEG	
SIGMA KAPPA	.0020000	DEG		SIGMA Y-TILT	.0019999	DEG	
OMEGA	-.2213493	DEG		HEADING	-82.7533693	DEG	
SIGMA OMEGA	.0020001	DEG		SIGMA HEADING	.0020001	DEG	
SCALE FACTOR	.0000000	M/KM		LASER SLANT RANGE	.0000000	KM	
SPACECRAFT ALTITUDE(LASER)	.0000000	KM		ALTITUDE DIFFERENCE	-101.1955109	KM	

SELENOGRAPHIC DIRECTION COSINES
OF CAMERA AXIS

X
.90665117

Y
-.01729036

Z
.42152663

MAGNITUDE (KM)
101.200226

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-.59879788+00 .68565332+00 .41390897+00
.25964424+00 .65508366+00 -.70954221+00
-.75764504+00 -.31740332+00 -.57028870+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.99197616+00 .12613606+00 .85446131+02
-.12610695+00 -.99200907+00 .38632650+02
.89636348-02 .27547188-02 .99995607+00

Figure 19(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
STATE VECTOR	71	7	30	2	28	16.043	
1950.0	GET		3	12	54	15.249	
SELENOGRAPHIC	X	Y	Z	X DOT	Y DOT	Z DOT	
SIGMA(SELENO)	-1751.9239502	246.3280869	-428.6016655	-.0590365	1.2097896	1.0920188	
	-1381.5800171	1063.1311188	-524.0260239	.8327674	1.2901978	.5490625	
	1.03	1.60	.68	.001	.001	.001	
LONGITUDE OF NADIR POINT	142.4215794	DEG	LATITUDE OF NADIR POINT	-16.7306933	DEG		
SIGMA NADIR LONGITUDE	.0010859	DEG	SIGMA NADIR LATITUDE	.0003837	DEG		
LONG OF CAMERA AXIS INTERSECT	141.8546124	DEG	LATI OF CAMERA AXIS INTERSECT	-16.5322666	DEG		
SPACECRAFT RADIUS	1820.3335724	KM	SPACECRAFT ALTITUDE	82.2435455	KM		
SIGMA SPACECRAFT RADIUS	.0000080	KM	AZIMUTH OF VELOCITY VECTOR	290.1758499	DEG		
MEAN ALTITUDE RATE	-.0365908	KM/SEC	HORIZONTAL VELOCITY	1.6303821	KM/SEC		
TILT AZIMUTH	289.9841003	DEG	TILT ANGLE	12.0292675	DEG		
SIGMA TILT AZIMUTH	.0095976	DEG	SIGMA TILT ANGLE	.0019998	DEG		
SUN ELEVATION AT PRIN GRND PNT	36.6100721	DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	283.0837593	DEG		
LONGITUDE OF SUBSOLAR POINT	90.4213762	DEG	LATITUDE OF SUBSOLAR POINT	.2580082	DEG		
ALPHA	-12.5360638	DEG	SWING ANGLE	269.6926918	DEG		
EMISSION ANGLE	12.6076188	DEG	SIGMA SWING ANGLE	.0095974	DEG		
PHASE ANGLE	65.9141369	DEG	NORTH DEVIATION ANGLE	159.9943104	DEG		
PHI	12.0290976	DEG	X-TILT	-.0640437	DEG		
SIGMA PHI	.0019999	DEG	SIGMA X-TILT	.0020001	DEG		
KAPPA	-159.7153549	DEG	Y-TILT	-12.0290903	DEG		
SIGMA KAPPA	.0020000	DEG	SIGMA Y-TILT	.0019999	DEG		
OMEGA	-.0640437	DEG	HEADING	-69.7017059	DEG		
SIGMA OMEGA	.0020001	DEG	SIGMA HEADING	.0020449	DEG		
SCALE FACTOR	.0000000	M/KM	LASER SLANT RANGE	.0000000	KM		
SPACECRAFT ALTITUDE(LASER)	.0000000	KM	ALTITUDE DIFFERENCE	-82.2435455	KM		

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)
	.84550074	-.40347721	.34976367	84.180603

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

-.25767038+00	.75552694+00	.60231641+00
.26415783+00	.65470012+00	-.70822898+00
-.92742275+00	-.23383056+01	-.36827523+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

.91730477+00	.33929033+00	.20840828+00
-.34668411+00	-.93798123+00	.1117727+02
.19586234+00	-.71226520+01	.97804131+00

Figure 19(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 15, Camera: 24 Inch Panoramic Frames: 9066* Through: 9151

Coverage Interval:

From: 5.7 Deg. S Lat., 105.9 Deg. E Long., To: 9.8 Deg. N Lat., 72.97 Deg. E Long.

From: 106 Hr 6 Min 38.72 Sec, To: 106 Hr 18 Min 6.23 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

* Photo coverage starts at 139 deg. E Long. (Frames 8945). Only state vector data are provided for Frames 8945 through 9065 since vehicle attitude data are not available for the time interval of those photos.

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 120 H. 14 M. 30.2 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 15. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5417171.14 $\dot{X}$ = 332.4323

Y = 364576.69 $\dot{Y}$ = -5354.1936

Z = 2636255.82 $\dot{Z}$ = -14.8552

• Telemetered Data Tape

Data Source: Station

Bit Rate: High

Date Edited: 8 Dec. 1971

Edited Data Tape No. A09550 File No.: 2 Location: Bldg. 12, MSC

Remarks: There are no telemetered vehicle attitude data for the early part of this interval. 105 H 54 M 15 Sec - 106 H 6 M 37 Sec GET (Fms 8945 through 9065)

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used: .582563 .4761836 .6586878
 -.2518852 -.6647384 .7033325
 .7727705 -.5756492 .2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo reduction data are for a sequence of stereo and vertical panoramic photography starting at approximately 139 deg. E Long. and ending at 73 deg. E Long. (Frames 8945 through 9151). Only state vector data are provided for the first 121 frames (8945 through 9065) where gimbal data are not available. Photo evaluation data are then provided for two sequences of stereo photography; for the coverage intervals 105.9 deg. E Long. through 98.5 deg. E Long. (Frames 9066 through 9087) and 83 deg. E Long. through 73 deg. E Long. (Frames 9119 through 9151). In addition, data are provided for the vertical coverage from 99 deg. E Long. through 81.7 deg. E Long. (Frames 9088 through 9118). Coverage starts near 5 deg. S Lat. and extends in a direction slightly North of West to near 8 deg. N Lat. The corner points of the inner and outer fields of view provided in the data are in error.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT 71	7	30	23	40	39.513			
	GMT		4	10	6	38.719			
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	-1637.9348297	852.3062744	197.3863754	.6419267	.9658069	1.1308933			
SELENOGRAPHIC	-480.8857307	1785.2321014	-172.9541378	1.3970648	.4404762	.6913487			
SIGMA(SELENO)	1.73	.55	.89	.000	.002	.000			
LONGITUDE OF NADIR POINT	105.0758610 DEG						LATITUDE OF NADIR POINT	-5.3442425 DEG	
SIGMA NADIR LONGITUDE	.0009793 DEG						SIGMA NADIR LATITUDE	.0004830 DEG	
LONG OF CAMERA AXIS INTERSECT	105.8635464 DEG						LATI OF CAMERA AXIS INTERSECT	-5.7213563 DEG	
SPACECRAFT RADIUS	1856.9377441 KM						SPACECRAFT ALTITUDE	118.8477173 KM	
SIGMA SPACECRAFT RADWS	.0000048 KM						AZIMUTH OF VELOCITY VECTOR	295.3734512 DEG	
MEAN ALTITUDE RATE	-.0027184 KM/SEC						HORIZONTAL VELOCITY	1.6197745 KM/SEC	
TILT AZIMUTH	115.7252741 DEG						TILT ANGLE	12.4992284 DEG	
SIGMA TILT AZIMUTH	.0092410 DEG						SIGMA TILT ANGLE	.0020000 DEG	
SUN ELEVATION AT PRIN GRND PNT	63.1335163 DEG						SUN AZIMUTH AT PRINCIPAL GRND PNT	281.9534035 DEG	
LONGITUDE OF SUBSOLAR POINT	79.6244593 DEG						LATITUDE OF SUBSOLAR POINT	.2407568 DEG	
ALPHA	12.0733056 DEG						SWING ANGLE	89.8858662 DEG	
EMISSION ANGLE	13.3692256 DEG						SIGMA SWING ANGLE	.0092410 DEG	
PHASE ANGLE	14.2082783 DEG						NORTH DEVIATION ANGLE	154.8454895 DEG	
PHI	-12.4992089 DEG						X-TILT	.0247017 DEG	
SIGMA PHI	.0020000 DEG						SIGMA X-TILT	.0020000 DEG	
KAPPA	-154.1633015 DEG						Y-TILT	12.4992080 DEG	
SIGMA KAPPA	.0020000 DEG						SIGMA Y-TILT	.0020000 DEG	
OMEGA	.0247017 DEG						HEADING	-64.1578226 DEG	
SIGMA OMEGA	.0020000 DEG						SIGMA HEADING	.0020485 DEG	
SCALE FACTOR	.0000000 M/KM						LASER SLANT RANGE	.0000000 KM	
SPACECRAFT ALTITUDE(LASER)	.0000000 KM						ALTITUDE DIFFERENCE	-118.8477173 KM	

SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)
	0.06684009	-0.99776030	-0.00260106	121.938156

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.57429636+00	.47825880+00	.66441876+00
.26063262+00	.66255936+00	-.70220055+00
-.77605049+00	.57644043+00	.25585559+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA		
01+00	.42556265+00	-.21642611+00
06+00	-.90003966+00	-.43112643+03
05+00	.93941347+01	.97629892+00

Figure 20(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
	71	7	30	23	52	7.027	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
150.0	-934.7956314	1326.9585114	893.9845581	1.3419758	.3723883	.8335595	
SELENOGRAPHIC	510.3057632	1755.1960754	304.5404930	1.3885803	-.5260531	.6553672	
SIGMA(SELENO)	1.72	.65	.85	.000	.002	.000	
LONGITUDE OF NADIR POINT	73.7887354	DEG	LATITUDE OF NADIR POINT	9.4591120	DEG		
SIGMA NADIR LONGITUDE	.0010019	DEG	SIGMA NADIR LATITUDE	.0004664	DEG		
LONG OF CAMERA AXIS INTERSECT	72.9705229	DEG	LATI OF CAMERA AXIS INTERSECT	9.8388119	DEG		
SPACECRAFT RADIUS	1853.0704498	KM	SPACECRAFT ALTITUDE	114.9804230	KM		
SIGMA SPACECRAFT RADIUS	.0000089	KM	AZIMUTH OF VELOCITY VECTOR	294.2167244	DEG		
MEAN ALTITUDE RATE	-.0081702	KM/SEC	HORIZONTAL VELOCITY	1.6230313	KM/SEC		
TILT AZIMUTH	295.2754784	DEG	TILT ANGLE	13.2123165	DEG		
SIGMA TILT AZIMUTH	.0087504	DEG	SIGMA TILT ANGLE	.0020000	DEG		
SUN ELEVATION AT PRIN GRND PNT	78.3947468	DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	145.4159622	DEG		
LONGITUDE OF SUBSOLAR POINT	79.5272522	DEG	LATITUDE OF SUBSOLAR POINT	.2405956	DEG		
ALPHA	-8.1382646	DEG	SWING ANGLE	271.0721560	DEG		
EMISSION ANGLE	14.1038470	DEG	SIGMA SWING ANGLE	.0087504	DEG		
PHASE ANGLE	7.0858087	DEG	NORTH DEVIATION ANGLE	156.6016254	DEG		
PHI	13.2100832	DEG	X-TILT	.2450385	DEG		
SIGMA PHI	.0020000	DEG	SIGMA X-TILT	.0020000	DEG		
KAPPA	-155.7683010	DEG	Y-TILT	-13.2099603	DEG		
SIGMA KAPPA	.0020000	DEG	SIGMA Y-TILT	.0020000	DEG		
OMEGA	.2450385	DEG	HEADING	-65.8258171	DEG		
SIGMA OMEGA	.0020000	DEG	SIGMA HEADING	.0020544	DEG		
SCALE FACTOR	.0000000	M/KM	LASER SLANT RANGE	.0000000	KM		
SPACECRAFT ALTITUDE(LASER)	.0000000	KM	ALTITUDE DIFFERENCE	-114.9804230	KM		
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)			
OF CAMERA AXIS	-.07411074	-.99521145	-.06373188	118.322876			
TRANSFORMATION MATRIX FROM				TRANSFORMATION MATRIX FROM			
SELENOCENTRIC TO CAMERA				LOCAL HORIZONTAL TO CAMERA			
.68737436+00	.39898971+00	.61208138+00	-.88816444+00	.39867602+00	.22852011+00		
.25944512+00	.65495317+00	-.70973550+00	-.41042387+00	-.91188478+00	-.42767160+02		
-.67838393+00	.64665551+00	.34875766+00	.20667900+00	-.97588527+01	.97352981+00		

Figure 20(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 16, Camera: 24 Inch Panoramic Frames: 9152 Through: 9424

Coverage Interval:

From: 8.8 Deg. N Lat., 74.5 Deg. E Long., To: 24.9 Deg. N Lat., 14.4 Deg. W long.

From: 108 Hr 15 Min 42.26 Sec, To: 108 Hr 43 Min 45.3 Sec GET

Date Processed: 12/3/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 122 H, 12 M, 41.84 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 16. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5418330.03</u>	$\dot{X}$ = <u>304.2696</u>
Y = <u>351625.64</u>	$\dot{Y}$ = <u>-5355.8441</u>
Z = <u>2636094.12</u>	$\dot{Z}$ = <u>15.0709</u>

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09550 File No.: 3 Location: Bldg. 12, MSC

Remarks: There were no significant data gaps in the telemetered vehicle attitude data for this interval.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 12 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSYMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic stereo photography starting at 74.5 deg. E Long., 8.8 deg. N Lat., and extending to 14.4 deg. W Long., 24.9 deg. N Lat. Until late in the sequence (Frame 9371) the scan direction of the camera is such that the principal intersection point falls slightly NW of nadir in the fore position and SE of nadir in the aft position. For the remainder of the sequence it falls NE of nadir in the fore position and SW of nadir in the aft position. The field of view corner point positions included in these data are in error.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
STATE VECTOR	71	7	31	1	49	43.050
1950.0						
SELENOGRAPHIC						
SIGMA(SELENO)						
	Y	Z	X DOT	Y DOT	Z DOT	
	1302.6460724	850.1793365	1.3014529	.4284295	.8691668	
	1773.5749512	271.8599472	1.4001206	-.4781284	.6662116	
	.59	.83	.000	.002	.000	
LONGITUDE OF NADIR POINT	75.2930918 DEG	LATITUDE OF NADIR POINT	8.4333290 DEG			
SIGMA NADIR LONGITUDE	.0009955 DEG	SIGMA NADIR LATITUDE	.0004544 DEG			
LONG OF CAMERA AXIS INTERSECT	74.5082006 DEG	LATI OF CAMERA AXIS INTERSECT	8.7978178 DEG			
SPACECRAFT RADIUS	1853.6941681 KM	SPACECRAFT ALTITUDE	115.6041412 KM			
SIGMA SPACECRAFT RADIUS	.0000037 KM	AZIMUTH OF VELOCITY VECTOR	294.5712318 DEG			
MEAN ALTITUDE RATE	-.0081459 KM/SEC	HORIZONTAL VELOCITY	1.6225352 KM/SEC			
TILT AZIMUTH	295.2169342 DEG	TILT ANGLE	12.6582110 DEG			
SIGMA TILT AZIMUTH	.0091271 DEG	SIGMA TILT ANGLE	.0019999 DEG			
SUN ELEVATION AT PRIN GRND PNT	80.5503864 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	154.7136326 DEG			
LONGITUDE OF SUBSOLAR POINT	78.5296001 DEG	LATITUDE OF SUBSOLAR POINT	.2389345 DEG			
ALPHA	-9.7735834 DEG	SWING ANGLE	270.0613785 DEG			
EMISSION ANGLE	13.5155782 DEG	SIGMA SWING ANGLE	.0091272 DEG			
PHASE ANGLE	8.6324805 DEG	NORTH DEVIATION ANGLE	155.5745640 DEG			
PHI	12.6582042 DEG	X-TILT	.0134501 DEG			
SIGMA PHI	.0019999 DEG	SIGMA X-TILT	.0020001 DEG			
KAPPA	-154.8429508 DEG	Y-TILT	-12.6582040 DEG			
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0019999 DEG			
OMEGA	.0134501 DEG	HEADING	-64.8453682 DEG			
SIGMA OMEGA	.0020001 DEG	SIGMA HEADING	.0020000 DEG			
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	.0000000 KM			
SPACECRAFT ALTITUDE(LASER)	.0000000 KM	ALTITUDE DIFFERENCE	-115.6041412 KM			
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)		
OF CAMERA AXIS	-.05674566	-.99709839	-.05074179	118.683390		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.65817666+00	.40850569+00	.63239755+00
.26362019+00	.66175987+00	-.70183913+00
-.70520062+00	.62864690+00	.32786456+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.88316797+00	.41472219+00	.21913451+00
-.42510091+00	-.90514588+00	-.23474832+00
.19825136+00	-.93361594+00	.97569484+00

Figure 21(a) - First Frame

Figure 21(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 27, Camera: 24 Inch Panoramic Frames: 9425 Through: 9433

Coverage Interval:

From: 25.4 Deg. N Lat., 4 Deg. E Long., To: 25.6 Deg. N Lat. 1.04 Deg. E Long.

From: 130 Hr 18 Min 21.05 Sec, To: 130 Hr 19 Min 13.69 Sec GET

Date Processed: 12/3/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 143 H. 52 M. 43.2 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 27. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5442492.29 $\dot{X}$ = 109.9227

Y = 349488.17 $\dot{Y}$ = -5343.3417

Z = 2596805.03 $\dot{Z}$ = 400.1378

● Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09556 File No.: 4 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each

tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic stereo photography starting at 4 deg. E Long., 25.4 deg. N Lat., and ending at 1 deg. E Long. 25.6 deg. N Lat. Throughout the sequence the principal intersection falls slightly NW of nadir when the camera is in the fore position and slightly SE of nadir when it is in the aft position. All field of view corner point locations included in these data are in error.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
	GHT 71	7	31	23	52	21.838
	GET		5	10	18	21.046
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT
1950.0	712.3837738	1102.8189697	1290.9724121	1.4464128	-0.7356125	-0.1864190
SELENOGRAPHIC	1657.8755035	140.7086487	788.6443710	0.0609347	-1.6266798	-0.1348614
SIGMA(SELENO)	.08	2.01	.17	.002	.000	.001
LONGITUDE OF NADIR POINT	4.8512306 DEG					
SIGMA NADIR LONGITUDE	.0012099 DEG					
LONG OF CAMERA AXIS INTERSECT	4.0094337 DEG					
SPACECRAFT RADIUS	1841.2794342 KM					
SIGMA SPACECRAFT RADIUS	.0000042 KM					
MEAN ALTITUDE RATE	-0.0116809 KM/SEC					
TILT AZIMUTH	275.4650383 DEG					
SIGMA TILT AZIMUTH	.0091433 DEG					
SUN ELEVATION AT PRIN GRND PNT	24.0407801 DEG					
LONGITUDE OF SUBSOLAR POINT	67.3119869 DEG					
ALPHA	13.2761325 DEG					
EMISSION ANGLE	13.3986644 DEG					
PHASE ANGLE	52.6701221 DEG					
PHI	12.6347919 DEG					
SIGMA PHI	.0020000 DEG					
KAPPA	-174.2319832 DEG					
SIGMA KAPPA	.0020000 DEG					
OMEGA	-0.0679170 DEG					
SIGMA OMEGA	.0020000 DEG					
SCALE FACTOR	.0000000 M/KM					
SPACECRAFT ALTITUDE(LASER)	.0000000 KM					
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z			
OF CAMERA AXIS	-0.86906517	-0.29228745	-0.39911624			
						MAGNITUDE (KM)
						105.908554

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

•94995834+00	-•30817953+00	•51035017-01
•25298386+00	•66316511+00	-•70442253+00
•18324400+00	•68208311+00	•70794373+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

- .97081765+00	.98325246-01	.21873566+00
- .10050092+00	-.99493621+00	.11853743-02
.21774456+00	-.20832333-01	.97578347+00

Figure 22(a) - First Frame

	YEAR	MONTH	DAY	HOOR	MINUTE	SECOND		
STATE VECTOR	71	7	31	23	53	14.479		
1950.0	X	Y	Z	X DOT	Y DOT	Z DOT		
SELENOGRAPHIC	787.7212982	1062.9092407	1279.7570343	1.4153766	-0.7804182	-0.2396203		
SIGMA(SELENO)	1659.2849884	54.7239094	794.8821335	-0.0079269	-1.6307290	0.1020849		
	.02	2.02	.13	.002	.000	.001		
LONGITUDE OF NADIR POINT	1.8889537 DEG	LATITUDE OF NADIR POINT	25.5846632 DEG					
SIGMA NADIR LONGITUDE	.0012152 DEG	SIGMA NADIR LATITUDE	.0000811 DEG					
LONG OF CAMERA AXIS INTERSECT	1.0398587 DEG	LATI OF CAMERA AXIS INTERSECT	25.6203737 DEG					
SPACECRAFT RADIUS	1840.6680603 KM	SPACECRAFT ALTITUDE	102.5780334 KM					
SIGMA SPACECRAFT RADIUS	.0000034 KM	AZIMUTH OF VELOCITY VECTOR	274.1664429 DEG					
MEAN ALTITUDE RATE	-0.0115431 KM/SEC	HORIZONTAL VELOCITY	1.6338699 KM/SEC					
TILT AZIMUTH	272.8535118 DEG	TILT ANGLE	12.7536358 DEG					
SIGMA TILT AZIMUTH	.0090597 DEG	SIGMA TILT ANGLE	.0020000 DEG					
SUN ELEVATION AT PRIN GRND PNT	21.3823013 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	100.5565710 DEG					
LONGITUDE OF SUBSOLAR POINT	67.3045464 DEG	LATITUDE OF SUBSOLAR POINT	.2193260 DEG					
ALPHA	13.3541849 DEG	SWING ANGLE	268.3075485 DEG					
EMISSION ANGLE	13.5201923 DEG	SIGMA SWING ANGLE	.0090597 DEG					
PHASE ANGLE	55.2479758 DEG	NORTH DEVIATION ANGLE	175.8897800 DEG					
PHI	12.7482564 DEG	X-TILT	-0.3735724 DEG					
SIGMA PHI	.0020000 DEG	SIGMA X-TILT	.0020000 DEG					
KAPPA	-175.4957714 DEG	Y-TILT	-12.7479814 DEG					
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0020000 DEG					
OMEGA	-0.3735724 DEG	HEADING	-85.4112511 DEG					
SIGMA OMEGA	.0020000 DEG	SIGMA HEADING	.0020505 DEG					
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	.0000000 KM					
SPACECRAFT ALTITUDE(LASER)	.0000000 KM	ALTITUDE DIFFERENCE	-102.5780334 KM					
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)				
OF CAMERA AXIS	-0.87669314	-0.24951920	-0.41127765	105.332321				
TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA		TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA						
.94048457+00	-0.33923320+00	.20239657-01	-0.97222374+00	.78031154-01	.22066307+00			
.25530667+00	.66598959+00	-0.70091102+00	-0.78531075-01	-0.99689029+00	.65200225-02			
.22429293+00	.66436333+00	.71296150+00	.22048562+00	-0.10989969-01	.97532834+00			

Figure 22(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 33, Camera: 24 Inch Panoramic Frames: 9434 Through: 9578

Coverage Interval:

From: 8.5 Deg. N Lat., 58.9 Deg. E Long., To: 21.6 Deg. N Lat., 22.1 Deg. E Long.

From: 141 Hr 46 Min 27.5 Sec, To: 142 Hr 1 Min 33.44 Sec GET

Date Processed: 12/13/71, APE Version Used: 7

INPUT DATA

• Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 155 H, 41 M, 29.62 Sec.

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 33. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5474202.62

$\dot{X}$ = 9.5580

Y = 345994.58

$\dot{Y}$ = -5318.0142

Z = 2547196.41

$\dot{Z}$ = 608.6019

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 10 Dec. 1971

Edited Data Tape No. A09556 File No.: 3 Location: Bldg. 12, MSC

Remarks: There was one significant gap in the telemetered vehicle attitude data in the time interval of this sequence, 141 H, 46 M, 27.5 Sec - 141 H, 49 M, 3.84 Sec GET - Fm 9434 through 9457.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used: .582563 .4761836 .6586878
 - .2518852 - .6647384 7033325
 .7727705 - .5756492 - .2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition
± 5 ms in onboard clock drift rate definition
± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic stereo photography starting at approximately 66.5 deg. E Long., and ending at 22.1 deg. E Long., 21.6 deg. N Lat. Only state vector data are provided for the first 24 frames of this sequence, since vehicle attitude data are not available for that interval. Evaluation data coverage starts at 58.9 deg. E Long., 8.5 deg. N Lat. and continues to 22.1 deg. E Long., 21.6 deg. N Lat. (Frames 9458 through 9578). Throughout the sequence the principal intersection point falls slightly NW of nadir when the camera is in the fore position and slightly SE of nadir when in the aft position. All field of view corner point locations included in these data are in error.

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

• 63530859+00	• 44091319+00	• 63401785+00
• 24473890+00	• 66372163+00	- 70680717+00
- 73245198+00	• 60420950+00	• 31375946+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

- .88959344+00	.40540740+00	.21040061+00
- .41571111+00	- .90948153+00	- .52440602-02
.18922951+00	- .92130952-01	.97760120+00

Figure 23(a) - First Frame

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	GMT	YEAR 71	MONTH 8	DAY 1	HOUR 11	MINUTE 35	SECOND 34.235				
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT					
1950.0	21.7386916	1335.5624390	1276.5935974	1.5783166	-.2957856	.2658131					
SELENOGRAPHIC	1584.8715363	669.5357971	673.6429901	.4602048	-1.5121360	.3884394					
SIGMA(SELENO)	.57	1.87	.50	.002	.001	.001					
LONGITUDE OF NADIR POINT	22.9018323 DEG			LATITUDE OF NADIR POINT			21.3823624 DEG				
SIGMA NADIR LONGITUDE	.0011309 DEG			SIGMA NADIR LATITUDE			.0002892 DEG				
LONG OF CAMERA AXIS INTERSECT	22.0692596 DEG			LATI OF CAMERA AXIS INTERSECT			21.6210334 DEG				
SPACECRAFT RADIUS	1847.6717224 KM			SPACECRAFT ALTITUDE			109.5816956 KM				
SIGMA SPACECRAFT RADIUS	.0000090 KM			AZIMUTH OF VELOCITY VECTOR			285.0157280 DEG				
MEAN ALTITUDE RATE	-.0115789 KM/SEC			HORIZONTAL VELOCITY			1.6275744 KM/SEC				
TILT AZIMUTH	287.2767296 DEG			TILT ANGLE			12.6272051 DEG				
SIGMA TILT AZIMUTH	.0091465 DEG			SIGMA TILT ANGLE			.0020005 DEG				
SUN ELEVATION AT PRIN GRND PNT	46.1308651 DEG			SUN AZIMUTH AT PRINCIPAL GRND PNT			113.9962254 DEG				
LONGITUDE OF SUBSOLAR POINT	61.3501101 DEG			LATITUDE OF SUBSOLAR POINT			.2081635 DEG				
ALPHA	13.2565271 DEG			SWING ANGLE			272.1702194 DEG				
EMISSION ANGLE	13.4377657 DEG			SIGMA SWING ANGLE			.0091465 DEG				
PHASE ANGLE	30.5678403 DEG			NORTH DEVIATION ANGLE			165.6376171 DEG				
PHI	12.6184379 DEG			X-TILT			.4743200 DEG				
SIGMA PHI	.0020000 DEG			SIGMA X-TILT			.0020001 DEG				
KAPPA	-164.8410625 DEG			Y-TILT			-12.6179987 DEG				
SIGMA KAPPA	.0020001 DEG			SIGMA Y-TILT			.0019999 DEG				
OMEGA	.4743200 DEG			HEADING			-74.9472427 DEG				
SIGMA OMEGA	.0020001 DEG			SIGMA HEADING			.0020495 DEG				
SCALE FACTOR	.0000000 M/KM			LASER SLANT RANGE			.0000000 KM				
SPACECRAFT ALTITUDE(LASER)	.0000000 KM			ALTITUDE DIFFERENCE			-109.5816956 KM				
SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS	X	Y	Z	MAGNITUDE (KM)							
	-.77759143	-.55510289	-.29531735	112.476074							
TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA				TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA							
.94879539+00	-.14841446-01	.31554256+00	-.94236403+00	.25343596+00	.21844780+00						
.24592906+00	.66162580+00	-.70835732+00	-.26148858+00	-.96517101+00	-.82783514-02						
-.19825804+00	.74968726+00	.63139749+00	.20874337+00	-.64923327-01	.97581310+00						

Figure 23(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 38, Camera: 24 Inch Panoramic Frames: 9579 Through: 9808

Coverage Interval:

From: 22.8 Deg. S Lat., 132.1 Deg. E Long., To: 24.7 Deg. N Lat., 0.4 Deg. E Long.

From: 151 Hr 13 Min 29.21 Sec, To: 151 Hr 59 Min 5.93 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 165 H, 31 M, 53.11 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 38. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5507373.81</u>	$\dot{X}$ = <u>-56.8619</u>
Y = <u>354401.39</u>	$\dot{Y}$ = <u>-5288.5850</u>
Z = <u>2486896.38</u>	$\dot{Z}$ = <u>785.4631</u>

• Telemetered Data Tape

Data Source: MSFN and station tapes

Bit Rate: High

Date Edited: 8 Dec. 1971

Edited Data Tape No. A09554 File No.: 3 Location: Bldg. 12, MSC

Remarks: Telemetered vehicle attitude data are not available for the interval 151 H, 21 M, 29 Sec - 151 H, 23 M, 48 Sec (Fms 9658 through 9681).

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.582563	.4761836	.6586878
	-.2518852	-.6647384	.7033325
	.7727705	-.5756492	-.2673084

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

±20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic stereo data starting at 132 deg. E Long., 22.8 deg. S Lat., and extending to 0.4 deg. E Long., 24.7 deg. N Lat. Only state vector data are provided for the interval 108 deg. E Long. through 102.4 deg. E Long. (Frames 9658 through 9681) since vehicle attitude data are unavailable for that interval. Throughout the sequence the principal intersection point falls slightly NW of the nadir point when the camera is in the fore position and slightly SE of the nadir point when in the aft position. Photography was omitted for the interval 151 H, 37 M through 151 H, 57 M, 28 Sec the interval between Frames 9790 and 9791; 65.4 deg E Long. to 4.1 deg. E Long. All field of view corner location point locations contained in these data are in error.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
	71	8	1	20	47	30.003	
	GET		6	7	13	29.209	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	-1559.7831116	-398.4685822	-916.0392914	-7908188	1.1512532	.8272564	
SELENOGRAPHIC	-1162.5683441	1246.1074371	-725.5891571	1.0624588	1.1868509	.3125660	
SIGMA(SELENO)	1.31	1.47	.42	.001	.001	.001	
LONGITUDE OF NADIR POINT	133.0136299 DEG						
SIGMA NADIR LONGITUDE	.0011521 DEG						
LONG OF CAMERA AXIS INTERSECT	132.1320438 DEG						
SPACECRAFT RADIUS	1852.2495575 KM						
SIGMA SPACECRAFT RADIUS	.0000144 KM						
MEAN ALTITUDE RATE	.0091608 KM/SEC						
TILT AZIMUTH	284.4961090 DEG						
SIGMA TILT AZIMUTH	.0092114 DEG						
SUN ELEVATION AT PRIN GRND PNT	13.2971115 DEG						
LONGITUDE OF SUBSOLAR POINT	56.6718125 DEG						
ALPHA	-13.2416029 DEG						
EMISSION ANGLE	13.3888720 DEG						
PHASE ANGLE	89.9362545 DEG						
PHI	12.5426588 DEG						
SIGMA PHI	.0019997 DEG						
KAPPA	-167.4151821 DEG						
SIGMA KAPPA	.0020001 DEG						
OMEGA	.4253767 DEG						
SIGMA OMEGA	.0020003 DEG						
SCALE FACTOR	.0000000 M/KM						
SPACECRAFT ALTITUDE(LASER)	.0000000 KM						
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				
OF CAMERA AXIS	.75194203	-.49759226	.43241776				
							MAGNITUDE (KM)
							117.144791

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.65488012+00	.64367367+00	.39600031+00
.24428760+00	.87616314+00	-.69507320+00
-.71516120+00	-.35845160+00	-.60004749+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.95303378+00	.21111128+00	.21716081+00
-.21787870+00	-.97594756+00	-.74241548+00
.21036991+00	-.54390127+00	.97610772+00

Figure 24(a) - First Frame

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TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-0.96814956+00	0.13381890+00	-0.21161041+00
-0.13571961+00	-0.99073149+00	-0.55844205-02
-0.21039644+00	0.23313150-01	0.97733818+00

Figure 24(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 50, Camera: 24 Inch Panoramic Frames: 9809 Through: 9827

Coverage Interval:

From: 25.7 Deg. N Lat., 3.4 Deg. E Long., To: 27 Deg. N Lat., 3.1 Deg. W Long.

From: 175 Hr 34 Min 56.12 Sec, To: 175 Hr 36 Min 53.71 Sec GET

Date Processed: 12/3/71, APE Version Used: 7.

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 189 H, 9 M, 7.67 Sec .

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 50. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = <u>5445685.09</u>	$\dot{X}$ = <u>-246.0737</u>
Y = <u>356948.16</u>	$\dot{Y}$ = <u>-5217.1922</u>
Z = <u>2619968.86</u>	$\dot{Z}$ = <u>1146.3435</u>

• Telemetered Data Tape

Data Source: Station tapes

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09624 File No.: 2 Location: Bldg. 12, MSC

Remarks: There were no gimbal data gaps within the interval.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic stereo photography starting at 3.4 deg. E Long., 25.7 deg. N Lat., and extending to 3.07 deg. W Long., 27 deg. N Lat. Throughout the sequence the principal intersection point falls slightly NW of nadir when the camera is in its fore position and slightly SE of nadir when it is in its aft position. All field of view corner point positions included in these data are in error.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND	
	71	8	2	21	8	56.910	
	GET		7	7	34	56.118	
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	30.4401097	1238.1742076	1368.0065002	1.5845859	-0.3051848	.2274717	
SELENOGRAPHIC	1660.6746368	123.2761488	795.2398758	-0.0638333	-1.5889282	.3544070	
SIGMA(SELENO)	.08	1.97	.44	.002	.000	.001	
LONGITUDE OF NADIR POINT	4.2454236 DEG						
SIGMA NADIR LONGITUDE	.0011751 DEG						
LONG OF CAMERA AXIS INTERSECT	3.4269552 DEG						
SPACECRAFT RADIUS	1845.3844147 KM						
SIGMA SPACECRAFT RADIUS	.0000047 KM						
MEAN ALTITUDE RATE	-0.0100000 KM/SEC						
TILT AZIMUTH	283.3484268 DEG						
SIGMA TILT AZIMUTH	.0095578 DEG						
SUN ELEVATION AT PRIN GRND PNT	43.0617847 DEG						
LONGITUDE OF SUBSOLAR POINT	44.2883787 DEG						
ALPHA	12.2661870 DEG						
EMISSION ANGLE	12.8368119 DEG						
PHASE ANGLE	34.5530534 DEG						
PHI	12.0778297 DEG						
SIGMA PHI	.0020000 DEG						
KAPPA	-165.9175797 DEG						
SIGMA KAPPA	.0020000 DEG						
OMEGA	-0.1570695 DEG						
SIGMA OMEGA	.0020000 DEG						
SCALE FACTOR	.0000000 M/KM						
SPACECRAFT ALTITUDE(LASER)	.0000000 KM						
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z				
OF CAMERA AXIS	-0.88567323	-0.26991000	-0.37779824				
							MAGNITUDE (KM)
							109.879135

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.95471501+00	-0.37690403-01	.29512492+00
.23054515+00	.72072797+00	-0.65375838+00
-0.18806427+00	.69219261+00	.696777915+00

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-0.94833668+00	.23848785+00	.20923941+00
-0.24331656+00	-0.96994300+00	.27413764+02
.20360399+00	-0.48311697-01	.97786061+00

Figure 25(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND			
	GMT GET	71	8	2	21	10	54.506		
				7	7	36	53.708		
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT			
1950.0	216.2817268	1195.6721191	1387.3274384	1.5732434	- .4170491	.1007908			
SELENOGRAPHIC	1644.2038574	-64.4191380	832.7850418	- .2162465	-1.5915888	.2815422			
SIGMA(SELENO)	.27	1.97	.35	.002	.000	.001			
LONGITUDE OF NADIR POINT	-2.2436752 DEG	LATITUDE OF NADIR POINT	26.8443866 DEG						
SIGMA NADIR LONGITUDE	.0012037 DEG	SIGMA NADIR LATITUDE	.0002153 DEG						
LONG OF CAMERA AXIS INTERSECT	-3.0714267 DEG	LATI OF CAMERA AXIS INTERSECT	26.9662631 DEG						
SPACECRAFT RADIUS	1844.2036285 KM	SPACECRAFT ALTITUDE	106.1136017 KM						
SIGMA SPACECRAFT RADIUS	.0000031 KM	AZIMUTH OF VELOCITY VECTOR	281.3400192 DEG						
MEAN ALTITUDE RATE	-.0100840 KM/SEC	HORIZONTAL VELOCITY	1.6306396 KM/SEC						
TILT AZIMUTH	279.5625343 DEG	TILT ANGLE	12.0557355 DEG						
SIGMA TILT AZIMUTH	.0095760 DEG	SIGMA TILT ANGLE	.0019999 DEG						
SUN ELEVATION AT PRIN GRND PNT	37.2501926 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	112.4973059 DEG						
LONGITUDE OF SUBSOLAR POINT	44.2717748 DEG	LATITUDE OF SUBSOLAR POINT	.1728011 DEG						
ALPHA	12.2969745 DEG	SWING ANGLE	268.2585793 DEG						
EMISSION ANGLE	12.8038797 DEG	SIGMA SWING ANGLE	.0095760 DEG						
PHASE ANGLE	40.3668861 DEG	NORTH DEVIATION ANGLE	169.2953491 DEG						
PHI	12.0503353 DEG	X-TILT	- .3636653 DEG						
SIGMA PHI	.0020000 DEG	SIGMA X-TILT	.0020000 DEG						
KAPPA	-168.7344475 DEG	Y-TILT	-12.0500891 DEG						
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0020000 DEG						
OMEGA	-.3636653 DEG	HEADING	-78.6568117 DEG						
SIGMA OMEGA	.0020000 DEG	SIGMA HEADING	.0020451 DEG						
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	.0000000 KM						
SPACECRAFT ALTITUDE(LASER)	.0000000 KM	ALTITUDE DIFFERENCE	-106.1136017 KM						
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)					
OF CAMERA AXIS	-.89560835	-.17102941	-.41065145	108.658249					

TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA

96870403+00	-11089157+00	22207110+00
23195219+00	72295024+00	-65080029+00
-88377983-01	68194280+00	72604638+00

TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA

-0.95886256+00	0.19235142+00	0.20876672+00
-0.19535267+00	-0.98071247+00	0.63471140+02
0.20596091+00	-0.34697164-01	0.97794489+00

Figure 25(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 60, Camera: 24 Inch Panoramic Frames: 9828 Through: 9929

Coverage Interval:

From: 8.1 Deg. N Lat., 39.3 Deg. E Long., To: 25.3 Deg. N Lat., 4.6 Deg. W Long.

From: 195 Hr 4 Min 30.21 Sec, To: 195 Hr 19 Min 45.95 Sec GET

Date Processed: 12/3/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: J-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozieff)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 208 H, 51 M, 11.11 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 60. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5574224.19 $\dot{X}$ = -354.9182

Y = 354480.73 $\dot{Y}$ = -5106.8394

Z = 2379220.06 $\dot{Z}$ = 1496.9973

• Telemetered Data Tape

Data Source: Station tape

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09624 File No.: 3 Location: Bldg. 12, MSC

Remarks: There were no significant gaps in the telemetered vehicle attitude data for this interval.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic stereo photography starting at 39.3 deg. E Long., 8.1 deg. N Lat. and extending to 12.7 deg. E Long., 20.1 Deg. N Lat. (Frames 9828 through 9919) and for two mono test cycles. Frames 9920 through 9924 and Frames 9925 through 9929. Throughout the stereo coverage the principal intersection point falls slightly NW of the nadir point when the camera is in its fore position and slightly SE of the nadir point when in the aft position. Throughout the test cycles, nadir and the principal intersection point are essentially coincident. All field of view corner point locations included in these data are in error.

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Figure 26(a) - First Frame

Figure 26(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 61, Camera: 24 Inch Panoramic Frames: 9930 Through: 9941

Coverage Interval:

From: 24.1 Deg. N Lat., 1.07 Deg. W Long., To: 25.2 Deg. N Lat., 5.14 Deg. W Long.

From: 197 Hr 16 Min 51.57 Sec, To: 195 Hr 18 Min 24.29 Sec GET

Date Processed: 12/6/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 210 H, 49 M, 22.63 Sec

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 61. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5588264.69

$\dot{X}$ = -3584.7096

Y = 357332.44

$\dot{Y}$ = -5094.6204

Z = 2349669.17

$\dot{Z}$ = 1531.8581

• Telemetered Data Tape

Data Source: MSFN

Bit Rate: High

Date Edited: 1 Dec. 1971

Edited Data Tape No. A09569 File No.: 1 Location: Bldg. 12, MSC

Remarks: There were no gaps in the gimbal data used for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PKI = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a strip of panoramic photographs starting as vertical photography at 1.07 deg. W Long. (Frame 9930), remaining vertical through 4.5 deg. W Long. (Frame 9933); then stereo coverage from 3.2 deg. W Long. through 5.14 deg. W Long. (Frames 9934 through 9941). Throughout the vertical coverage the principal intersection points and vehicle nadir remain essentially coincident. Throughout the stereo coverage the principal intersection point is slightly NW of the nadir point when the camera is in its fore position and slightly SE of the nadir point when it is in its aft position. All field of view corner points included in these data are in error.

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
STATE VECTOR	1950.0					
SELENOGRAPHIC	1661.4529877					
SIGMA(SELENO)	.43					
LONGITUDE OF NADIR POINT						
SIGMA NADIR LONGITUDE						
LONG OF CAMERA AXIS INTERSECT						
SPACECRAFT RADIUS						
SIGMA SPACECRAFT RADIUS						
MEAN ALTITUDE RATE						
TILT AZIMUTH						
SIGMA TILT AZIMUTH						
SUN ELEVATION AT PRIN GRND PNT						
LONGITUDE OF SUBSOLAR POINT						
ALPHA						
EMISSION ANGLE						
PHASE ANGLE						
PHI						
SIGMA PHI						
KAPPA						
SIGMA KAPPA						
OMEGA						
SIGMA OMEGA						
SCALE FACTOR						
SPACECRAFT ALTITUDE(LASER)						
SELENOGRAPHIC DIRECTION COSINES OF CAMERA AXIS						
TRANSFORMATION MATRIX FROM SELENOCENTRIC TO CAMERA						
TRANSFORMATION MATRIX FROM LOCAL HORIZONTAL TO CAMERA						

Figure 27(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 63, Camera: 24 Inch Panoramic Frames: 9942 Through: 165

Coverage Interval:

From: 25.2 Deg. S Lat., 109.9 Deg. E Long., To: 6.9 Deg. N Lat., 38.7 Deg. E Long.

From: 200 Hr 33 Min 45.86 Sec, To: 200 Hr 59 Min 42.9 Sec GET

Date Processed: 1/4/72, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: B-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Koziell)

Lunar Radius: 1738.02 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: _____

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 63. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5615994.30 $\dot{X}$ = -367.7504

Y = 357003.71 $\dot{Y}$ = -5070.78

Z = 2289724.61 $\dot{Z}$ = 1598.78

• Telemetered Data Tape

Data Source: Station tapes

Bit Rate: High

Date Edited: 4 Jan. 1972

Edited Data Tape No. A09569 File No.: 3 Location: Bldg. 12, MSC

Remarks: There are no significant gaps in the telemetered vehicle attitude data for the interval of this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

±0.2 mrad in each gimbal angle

±21.2132034 ms film exposure RSS time uncertainty including:

- ±20 ms in onboard clock bias definition
- ± 5 ms in onboard clock drift rate definition
- ± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for two strips of stereo panoramic photography and a single sequence of mono panoramic photography. The first stereo strip starts at 109.9 deg. E Long., 25.2 deg. S Lat (Frame 9942) and ends at 65.4 deg. E Long., 7.6 deg. S Lat. (Frame 93). The sequence of mono photography starts at 64.1 deg. E Long., 6.9 deg. S Lat. (Frame 94) and ends at 51.5 deg. E Long., 0.1 deg. S Lat. (Frame 117). The second strip of stereo photography starts at 50.4 deg. E Long., 0.5 deg. N Lat. (Frame 118) and ends at 38.7 deg. E Long., 6.9 deg. N Lat. (Frame 165). All stereo photography is essentially along the plane of flight with the camera optical axis in its central position directed approximately at the vehicle nadir. Throughout the mono sequence, a near zero tilt is maintained so that the principal intersection point and vehicle nadir remain near coincident.

	YEAR	MONTH	DAY	HOURL	MINUTE	SECOND
GMT	71	8	3	22	7	46.650
GET			8	8	33	45.857
STATE VECTOR	X	Y	Z	X DOT	Y DOT	Z DOT
1950.0	-1468.3203888	-476.5245628	-1025.9140930	-0.9301719	1.0376278	0.8315570
SELENOGRAPHIC	-594.7404175	1565.0153351	-795.3307419	1.4059661	0.7274131	0.3570824
SIGMA(SELENO)	1.74	.91	.50	.001	.001	.001
LONGITUDE OF NADIR POINT	110.8078995 DEG	LATITUDE OF NADIR POINT	-25.4099398 DEG			
SIGMA NADIR LONGITUDE	0.0011622 DEG	SIGMA NADIR LATITUDE	0.0002912 DEG			
LONG OF CAMERA AXIS INTERSECT	109.9030561 DEG	LATI OF CAMERA AXIS INTERSECT	-25.1943185 DEG			
SPACECRAFT RADIUS	1853.5209961 KM	SPACECRAFT ALTITUDE	115.4309998 KM			
SIGMA SPACECRAFT RADIUS	0.000220 KM	AZIMUTH OF VELOCITY VECTOR	284.2702293 DEG			
MEAN ALTITUDE RATE	0.0098348 KM/SEC	HORIZONTAL VELOCITY	1.6227094 KM/SEC			
TILT AZIMUTH	284.6727196 DEG	TILT ANGLE	12.5139679 DEG			
SIGMA TILT AZIMUTH	0.0092315 DEG	SIGMA TILT ANGLE	0.0019998 DEG			
SUN ELEVATION AT PRIN GRND PNT	10.5033073 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	275.1651993 DEG			
LONGITUDE OF SUBSOLAR POINT	31.5940280 DEG	LATITUDE OF SUBSOLAR POINT	0.1431485 DEG			
ALPHA	-13.1779509 DEG	SWING ANGLE	269.9883232 DEG			
EMISSION ANGLE	13.3599437 DEG	SIGMA SWING ANGLE	0.0092314 DEG			
PHASE ANGLE	92.4664842 DEG	NORTH DEVIATION ANGLE	165.4162579 DEG			
PHI	12.5139657 DEG	X-TILT	-0.0025283 DEG			
SIGMA PHI	0.0019998 DEG	SIGMA X-TILT	0.0020002 DEG			
KAPPA	-165.4158821 DEG	Y-TILT	-12.5139663 DEG			
SIGMA KAPPA	0.0020000 DEG	SIGMA Y-TILT	0.0019998 DEG			
OMEGA	-0.0025283 DEG	HEADING	-75.4153214 DEG			
SIGMA OMLGA	0.0020002 DEG	SIGMA HEADING	0.0020486 DEG			
SCALE FACTOR	0.0000000 M/KM	LASER SLANT RANGE	0.0000000 KM			
SPACECRAFT ALTITUDE(LASER)	0.0000000 KM	ALTITUDE DIFFERENCE	-115.4309998 KM			
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z			
OF CAMERA AXIS	0.50096675	-0.72792544	0.46814192			
			MAGNITUDE (KM)			
			118.434067			

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TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

-0.72773574+00	0.56617004+00	0.38710731+00
0.21902473+00	0.72670315+00	-0.65108953+00
-0.64994526+00	-0.38904240+00	-0.65285318+00

LATITUDE LONGITUDE

-25.952	114.614
-21.388	99.056
-22.687	98.561
-26.516	114.469

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-0.94478523+00	0.24582838+00	0.21667758+00
-0.25180115+00	-0.96777894+00	0.41126790-00
0.20970688+00	-0.54517948-01	0.97624326+00

LATITUDE LONGITUDE

-25.489	112.596
-23.810	106.341
-24.681	106.058
-26.110	112.426

Figure 28(a) - First Frame

	YEAR	MONTH	DAY	HOUR	MINUTE	SECOND
STATE VECTOR	71	8	3	22	33	43.649
GMT	71	8	3	22	33	43.649
GET	71	8	3	22	33	43.649
X	Y	Z	X DOT	Y DOT	Z DOT	
1950.0	-1344.2013550	1062.2916107	718.4116745	1.0618682	.6239626	1.0508976
SELENOGRAPHIC	1454.7137909	1131.3334351	235.2626362	.7969704	-1.1901707	.7547258
SIGMA(SELENO)	.99	1.47	.95	.001	.001	.000
LONGITUDE OF NADIR POINT	37.8722682 DEG	LATITUDE OF NADIR POINT	7.2751516 DEG			
SIGMA NADIR LONGITUDE	.0009590 DEG	SIGMA NADIR LATITUDE	.0005180 DEG			
LONG OF CAMERA AXIS INTERSECT	38.6720014 DEG	LAT OF CAMERA AXIS INTERSECT	6.8787040 DEG			
SPACECRAFT RADIUS	1857.8094635 KM	SPACECRAFT ALTITUDE	119.7194672 KM			
SIGMA SPACECRAFT RADIUS	.0000050 KM	AZIMUTH OF VELOCITY VECTOR	298.0569305 DEG			
MEAN ALTITUDE RATE	-.0051444 KM/SEC	HORIZONTAL VELOCITY	1.6189989 KM/SEC			
TILT AZIMUTH	116.4938068 DEG	TILT ANGLE	12.6472787 DEG			
SIGMA TILT AZIMUTH	.0091362 DEG	SIGMA TILT ANGLE	.0019997 DEG			
SUN ELEVATION AT PRIN GRND PNT	80.0818453 DEG	SUN AZIMUTH AT PRINCIPAL GRND PNT	227.5172558 DEG			
LONGITUDE OF SUBSOLAR POINT	31.3742905 DEG	LATITUDE OF SUBSOLAR POINT	.1426091 DEG			
ALPHA	-9.9365975 DEG	SWING ANGLE	88.5611610 DEG			
EMISSION ANGLE	13.5344275 DEG	SIGMA SWING ANGLE	.0091361 DEG			
PHASE ANGLE	13.5671563 DEG	NORTH DEVIATION ANGLE	152.6092720 DEG			
PHI	-12.6434153 DEG	X-TILT	.3149966 DEG			
SIGMA PHI	.0020000 DEG	SIGMA X-TILT	.0020000 DEG			
KAPPA	-152.1022549 DEG	Y-TILT	12.6432204 DEG			
SIGMA KAPPA	.0020000 DEG	SIGMA Y-TILT	.0020000 DEG			
OMEGA	.3149966 DEG	HEADING	-62.0315948 DEG			
SIGMA OMEGA	.0020000 DEG	SIGMA HEADING	.0020497 DEG			
SCALE FACTOR	.0000000 M/KM	LASER SLANT RANGE	.0000000 KM			
SPACECRAFT ALTITUDE(LASER)	.0000000 KM	ALTITUDE DIFFERENCE	-119.7194672 KM			
SELENOGRAPHIC DIRECTION COSINES	X	Y	Z	MAGNITUDE (KM)		
OF CAMERA AXIS	-.87456107	-.43190894	-.22044862	122.910065		

TRANSFORMATION MATRIX FROM
SELENOCENTRIC TO CAMERA

.79642309+00	.25375618+00	.54892454+00
.22427616+00	.71903414+00	-.65779177+00
-.56161415+00	.64699126+00	.51574189+00

LATITUDE LONGITUDE

2.094	49.099
9.223	34.823
8.689	34.546
.825	48.354

TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

-.86179032+00	.45761269+00	-.21887935+00
-.46788798+00	-.88377061+00	-.54976994+00
-.19595500+00	.97673121+00	.97573639+00

LATITUDE LONGITUDE

5.573	42.113
8.350	36.580
7.763	36.270
4.744	41.676

Figure 28(b) - Last Frame

Mission: Apollo 15, Target: Panoramic Strip Photography

Rev: 72, Camera: 24 Inch Panoramic Frames: 166 Through: 372

Coverage Interval:

From: 17.17 Deg. N Lat., 8.06 Deg. E Long., To: 27.3 Deg. N Lat., 67.8 Deg. W Long.

From: 218 Hr 53 Min 12.67 Sec, To: 219 Hr 16 Min 35.24 Sec GET

Date Processed: 12/14/71, APE Version Used: 7

INPUT DATA

- Trajectory Tape:

HOPE Version Used: R-6.1

Constants Used:

Lunar Potential Model: L-1

Ephemeris: JPL DE 19 (Double Precision)

Libration Model: RTCC (Kozie11)

Lunar Radius: 1738.09 Km

Ephemeris-Universal Time Difference: 0.69583333 Min.

Base Time: Yr 1971 Month 7 Day 26 Hr 0 Min 0 Sec 0

Computation Interval: Computation at midpoint of each camera sweep

Integration Interval: Variable (1×10^{-14} - 64 Min.)

Initial State Vector Used:

Coordinate System: Selenographic (Instantaneous Inertial)

Time From Base: 232 H. 29 M. 2.0 Sec-

Type: One Revolution Solution

Description: This vector was determined from a solution based on a fit of data from Rev 72. For the solution the energy of the orbit was constrained to be an analytically determined value.

Units: Feet, Second, Degree

Components:

X = 5743623.34 $\dot{X}$ = -352.7828

Y = 366342.93 $\dot{Y}$ = -4962.4335

Z = 1975192.34 $\dot{Z}$ = 1885.7199

• Telemetered Data Tape

Data Source: MSFN

Bit Rate: High

Date Edited: 9 Dec. 1971

Edited Data Tape No. A09668 File No.: 2 Location: Bldg. 12, MSC

Remarks: There were no significant data gaps in the telemetered vehicle attitude data employed for this sequence.

• APE Card Inputs:

Time Of Launch: Yr 1971 Month 7 Day 26 Hr 13 Min 34 Sec 0

Range Zero-Clock Zero Time Difference 0.79 Sec

REFSMAT Used:	.0550754	.6626837	.7468715
	-.2300948	-.7194511	.6553216
	.9716085	-.2079433	.1128561

Camera Positioning Angles Used: The angle from the spacecraft body X-Z plane to the camera optical axis when positioned for vertical or "mono" photography (camera positioning angle) was 37.75 degrees.

The angle between the camera optical axis central position and its fore or aft positions (excursion angle) was 12.5 degrees.

Uncertainties Assumed:

± 1 degree in camera positioning angle

± 0.2 mrad in each gimbal angle

± 21.2132034 ms film exposure RSS time uncertainty including:

± 20 ms in onboard clock bias definition

± 5 ms in onboard clock drift rate definition

± 5 ms in universal to sidereal time conversion

OUTPUT

General Description:

The output is a listing of two-page tabulations of computed spacecraft state camera orientation and photograph position and lighting data. Each tabulation presents the results of computations for a specified time within the range covered by the magazine.

Format:

Generally the format will be that shown in Figures 1 and 2. However, when the calculated camera aiming direction is above the lunar horizon, a message to that effect along with the computed value of the tilt angle are substituted for the tabulation.

With the exception of its initial line, the first page of each tabulation is self explanatory. The initial line contains six entries that are from left to right:

1. Mission title
2. Magazine identification
3. State vector identification
4. Date of data origin
5. Status of data PRE = preliminary, FIN = final
6. Frame number within the sequence

All entries of the second page of each tabulation are self explanatory except the photograph frame corner locations. These appear above or below the corresponding frame corner number on the left-hand side of the page.

OUTPUT Summary: These photo evaluation data are for a sequence of panoramic photography starting at 8.06 deg. E Long. (Frame 166) as stereo and remaining stereo through 56.5 deg. W Long. (Frame 357); then changed there to vertical and remaining vertical over the remainder of the sequence until 67.84 deg. W Long. (Frame 372). Data for frame 310 are omitted since vehicle attitude data are unavailable for that time. Throughout the stereo sequence the principal intersection point falls slightly WNW when the camera is in the fore position and slightly ESE when the camera is in the aft position. Throughout the vertical photography the principal intersection point and nadir remain essentially coincident. All field of view corner point locations included in these data are in error.

Figure 29(a) - First Frame

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TRANSFORMATION MATRIX FROM
LOCAL HORIZONTAL TO CAMERA

- .98629286+00	- .16402939+00	- .17906631-01
- .16394421+00	- .98645046+00	- .61381478-02
- .18670845-01	- .31183546-02	- .99982087+00

NASA — MSC

END

DATE

FILMED

AUG 11