



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

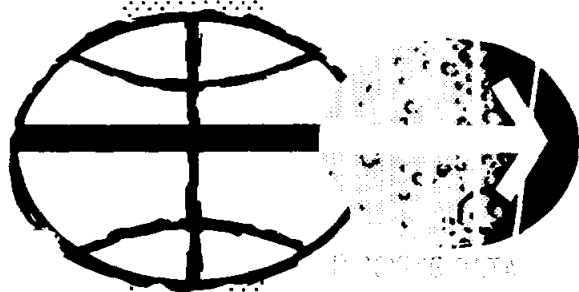
FINAL

PHOTOGRAPHIC AND TV
OPERATIONS PLAN

APOLLO 8

EXPERIMENTS SECTION
MISSION OPERATIONS BRANCH
FLIGHT CREW SUPPORT DIVISION

November 18, 1968



MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

APOLLO 8
FINAL PHOTOGRAPHIC AND TV OPERATIONS
PLAN

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I.

INTRODUCTION

The Photographic Operations Plan delineate the operational and scientific photographic objectives for mission Apollo 8 and describes the equipment required to accomplish these objectives.

In comparing the available crew time and operational requirements in lunar orbit with time and operational requirements to meet all the objectives that have been identified, it is apparent that unprecedented requirements will be placed on the crew. Also, due to the peculiarity of the lunar photometric function and to the nature of some of the heretofore inaccessible celestial phenomena, unprecedented skill levels will be required of the crew. Because of these demands on the crew and the operational requirements, there is no basis upon which to assess and predict the successful accomplishment of all the objectives. The photographic operations have been sequenced so as to maximize the probable data return. However, due to the necessity for careful and strict sequencing it must be expected that unknowns in flight are likely to prevent the attainment of some objectives and to degrade the data return on other objectives.

The objectives in this plan that aid the assessment of this and future missions and the planning of future missions are given first priority and are listed as operational objectives. Other objectives are listed as targets of opportunity and, while they will be scheduled, they will be attempted in real time only if operational considerations indicate no interference with other vital mission operations and if successful achievement of the objective appears probable.

The sequence of photographic operations and camera configurations are listed in the Flight Plan. The lunar surface target sequencing will be available on the photographic target chart prepared by Mapping Sciences Branch, Lunar and Earth Sciences Division.

Section IV gives a brief description of the cameras, lenses, film magazines, film types, and filters to be used on this flight to meet the photographic objectives. For more detailed information on photographic equipment, see "Photo Equipment for Manned Space Flight Handbook", prepared by the Flight Equipment Section, Mission Operations Branch, Flight Crew Support Division.

The table in Section III shows how the equipment is to be used and how the film is allocated to meet the photographic objectives.

Section V is the TV Operations Plan.

II. PHOTOGRAPHICS OBJECTIVES

A. Operational Objectives

1. Lunar Stereo Strip Photography

Still camera photography of the lunar surface from terminator to terminator so as to obtain: (1) A continuous series of photographs with 60° overlap with the camera axis approximately perpendicular to the lunar surface. (2) A continuous series of overlapping low oblique photographs with the camera optical axis 20° forward of the local vertical in the first half of the pass and 20° behind the local vertical in the last half of the pass.

a. Purpose

- 1) Improve the selenodetic network on the east limb and on the far side of the moon.
- 2) Obtain data on the appearance of landmark-size features under various lighting conditions.
- 3) Obtain photographs of the lunar terrain at sun elevations of less than five degrees to evaluate their use in detecting regional slope and subdued topographic features.
- 4) Obtain photographs of eastern limb landmarks for crew training in identification of landmarks to support future lunar landing missions.
- 5) Document the appearance of the lunar far side under oblique and vertical viewing and various illumination conditions for crew training support.
- 6) Obtain stereophotographic coverage of the radar ground track for which the Apollo 8 mission is targeted.
- 7) Provide zero phase-angle photography from which albedo studies can be made.

b. Onboard photographic procedures on following page

APOLLO 8 PHOTOGRAPHICS OPERATIONS PLAN

LUNAR STEREO STRIP - S20.115

MODE A - Vertical Photography

The following are required:

H-blad cam (80 mm lens)

Fresh mag 3400 film

TV cam mount

Still cam adapter

Intervalometer

Photo target chart

Photo log

Cam settings: f 2.8 (initially), 1/250,
infinity T_o is 6 min after sunrise

(ground update if desired).

176 frames allocated.

- (1) At $T_o - 3$ maneuver to P 280°, Y 0°, R 180°
from SEF-heads-up orientation and
maintain orb rate.
- (2) At T_o INITIATE intervalometer
(record GET).
- (3) Change f-stop as required, per photo
target chart schedule.
- (4) At approximately 5 min intervals, watch
for film advance, note (and record
later) GET, and quickly make an extra
exposure manually.
- (5) At $T_o + 30$ min maneuver to P 260°,
Y 0°, R 0° from SEF-heads-up
orientation and maintain orb rate.
- (6) Continue photography until required
attitude change for communications.
- (7) Record in photo log:
 - (a) Film mag ID
 - (b) GET first exposure
 - (c) GET exposure immediately preceding
each extra exposure.

MODE B - Oblique Photography

The following are required:

H-blad cam (80 mm lens)
Fresh mag S0368 film
TV cam mount
Still cam adapter
Intervalometer
Photo target chart
Photo log
Cam settings: f 2.8 (initially),
1/250, infinity.
 T_o is 6 min after sunrise (ground
update if desired).
188 frames allocated.

- (1) At $T_o - 3$ min maneuver to P300°, Y 0°,
R 180° from SEF-heads-up orientation
and maintain orb rate.
- (2) At T_o INITIATE intervalometer.
- (3) Change f-stop as required per photo
target chart schedule.
- (4) At approximately 5 min intervals,
watch for film advance, note (and
record later) GET, and quickly make an
extra exposure manually.
- (5) At $T_o + 30$ min maneuver to P 240°, Y 0°,
R 0° from SEF-heads-up orientation and
maintain orb rate.
- (6) Continue photography to terminator.
- (7) Record in photo log:
 - (a) Film mag ID
 - (b) GET first exposure
 - (c) GET exposure immediately preceding
each extra exposure.

2. SC Exterior Atmosphere Particulate Matter

Still photography of any visible particles resulting from venting.

a. Purpose

To document and analyze the nature of particles (if present) around the spacecraft that might interfere with daytime star sightings and other operations.

b. Onboard photographic procedures on following page

SC EXTERIOR ATMOSPHERIC
PARTICULATE MATTER - S20.115

The following are required:

H-blad cam (80 mm lens)
Mag 2485 film
Photo log
Interior lights subdued
Cam settings: f 2.8, B (initially),
infinity.

The following sequence is to be done once
in total darkness, once in sunshine and,
if possible, once in earthshine alone.

Photography window in shade during sunlit
and earthlit sequences.

9 frames allocated.

- (1) Photograph stars in constellation
ursa major with the following exposures,
in order: 6 sec, 1 sec, 1/60 sec.
- (2) Record in photo log:
 - (a) GET first exposure in each sequence.
 - (b) Frame number first exposure in each
sequence.
 - (c) Target ID
 - (d) Comments on window degradation and
visible debris particles.

3. Exhaust Effects on CM Windows

Photograph and take photometric measurements of sun-illuminated windows with the data acquisition camera and spotmeter.

a. Purpose

To document and examine the effects of thruster plumes and waste dumps upon the CM windows.

b. Onboard photographic procedures on following page

EXHAUST EFFECTS/CSM WINDOWS - S20.116

The following are required:

IMU - ON

16 mm D.A. Camera: 5 mm lens

S0368 film, F/11, 1/250, 1 fps.

Spotmeter

Ground update: R, P, Y if desired.

2 feet allocated

DURING TL AND TE FLIGHT:

- (1) Maneuver S/C so that sun angle on window is approximately 85°.
- (2) Hold D.A. Camera 1 foot from LH Rendz window (other windows HD).
- (3) Turn on camera for approximately 10 seconds.
- (4) Immediately after photography scan window (4 spots) with spotmeter.
 - (a) Set objective focus on 3 ft.
 - (b) Set ASA on 100
 - (c) Hold spotmeter at a distance from window (approx 3 ft.) such that window frame is in focus.
 - (d) Read light level in foot-lamberts, from intensity scale.

Record in Photo log:

- (a) GET of photography
- (b) Magazine number
- (c) Film footage
- (d) Activity photographed
- (e) Window photographed
- (f) Spotmeter readings and window scanned.

4. Separation/S-IVB Inspection

Sequence Camera mounted in right hand rendezvous window to record relative motion following CSM/S-IVB separation and during formation flying. Still photography of any visible anomalous conditions.

a. Purpose

- 1) Obtain data on S-IVB stability.
- 2) Document any visible anomalous conditions.

b. Onboard photographic procedures on following page.

SEPARATION/S-IV B INSPECTION - P 7.33/S20.104

The following are required:

D.A. Cam
18 mm lens
Mag S0368 film
D.A. Cam mount
Photo log
Cam settings: f 11, 1/250, infinity
(initially), 6 FPS.
130 feet allocated.

- (1) Mount cam in rh rendz window.
- (2) When S IV B comes into view,
D.A. Cam - ON.
- (3) Adjust focus as necessary.
- (4) Record in photo log:
 - (a) Film mag ID
 - (b) Estimated remaining film at
beginning and end of sequence.
 - (c) GET of cam - ON.
 - (d) Exposure settings and frame rate
if not nominal.
 - (e) Anomalous conditions observed.

5. Still Camera Lunar Landmark Photography

Still camera photography of lunar landmarks used in navigation.

a. Purpose

- 1) Verification of visibility and recognizability of lunar landmarks at various sun angles and from various relative SC positions.
- 2) Determination of lighting constraints for lunar landmark tracking.
- 3) Crew training aids in lunar landmark recognition in support of future missions.

b. Onboard photographic procedures on following page

STILL CAMERA LUNAR LANDMARK PHOTOGRAPHY - S20.115

The following are required:

Hasselblad cam (80 mm lens)
Magazine 3400 film
Photography to be done during
familiarization pass.
Photography window shaded from direct
sunlight if possible.
Photo log
Photo target chart
Cam settings: f-stop from photo target
chart, 1/250, infinity; or use
spotmeter - ASA 75.
16 frames allocated.

- (1) Determine target times and locations
from lmk chart or as per ground update
if desired.
- (2) Photograph at 5 sec intervals while
target is in range.
- (3) Record in photo log:
 - (a) Film mag ID
 - (b) GET first exposure
 - (c) f-stop
 - (d) Frame number first and last
exposures.
 - (e) Spotmeter reading in foot-lamberts
if spotmeter used.

6. Lunar Landmark/Sextant Photography

Photograph landmarks with the data acquisition camera mounted on the sextant while the crew tracks landmarks through the telescope.

a. Purpose

- 1) Evaluation of landmark tracking capabilities.
- 2) Possible crew training aids.

b. Onboard photographic procedures on following page

LUNAR LANDMARK/SEXTANT PHOTOGRAPHY - S20.115

The following are required:

D.A. Cam
Mag S0368 film
Sxt adapter
Cam settings: shutter speed per
lmk tracking exposure schedule
(following), 12 fps.
Photo log
Tracking lmk through Sct

- (1) When lmk is in Sct field of view, D.A. cam - ON.
- (2) Adjust shutter speed per lmk tracking exposure schedule.
- (3) Continue photography while tracking lmk.
- (4) Record in photo log
 - (a) Film mag ID
 - (b) GET cam - ON
 - (c) Initial shutter speed
 - (d) Final shutter speed
 - (e) Estimated remaining film at beginning and end of a sequence.

LANDMARK TRACKING EXPOSURE SCHEDULE

(to be added later)

7. Star/Horizon Sextant Photography

Photograph star/horizons with the data acquisition camera mounted on the sextant following a star/horizon sighting and in attitude hold.

a. Purpose

- 1) Earth horizon model verification
- 2) Evaluation of star/horizon sighting capabilities
- 3) Possible crew training aids

b. Onboard photographic procedures on following page

STAR/HORIZON SEXTANT PHOTOGRAPHY - S20.115

The following are required:

D.A. Cam

Mag S0368 film

Sxt adapter

Cam settings: shutter speeds for
earth horizon, for lunar horizon,
1 fps.

Photo log

Photography done immediately following
star/horizon sighting while holding
same attitude.

- (1) When star/earth horizon sightings have been completed install D.A. cam and Sxt adapter.
- (2) Turn D.A. Cam ON for 10 seconds.
- (3) Record in photo log:
 - (a) Film mag ID
 - (b) GET cam - ON
 - (c) Estimated remaining film at beginning of sequence.
 - (d) Target ID

8. Sequence Photography of Lunar Surface

Photograph the lunar surface with the data acquisition camera mounted in a rendezvous window whenever attitude and time permits.

a. Purpose

- 1) Motion picture photography of the passing lunar surface scene for crew training
- 2) Possible zero-phase photography
- 3) Evaluation of surface feature recognizability under various lighting conditions

b. Onboard photographic procedures on following page

SEQUENCE PHOTOGRAPHY OF LUNAR SURFACE - S20.115

The following are required:

D.A. Cam
18 mm lens
Fresh mag S0368 film
D.A. Cam mount
Photo target chart
Photo log
Photography to be done during
familiarization pass.
Photography window shaded from
direct sunlight if possible.
Camera mounted in most convenient
rendz window.
Cam settings: f-stop per photo target
chart, or from spotmeter - ASA 64,
1/250, 1 fps.
 T_o is 6 min after sunrise
(ground update if desired).

- (1) At T_o , D.A. Cam - ON.
- (2) Adjust f-stop per T_o chart.
- (3) Continue photography through daylight
to second terminator.
- (4) Record in photo log:
 - (a) Film mag ID
 - (b) Time of D.A. Cam - ON and OFF.
 - (c) Spotmeter readings in foot-lamberts
if spotmeter used.

9. Photo Target Chart Exposure Schedule Check

Take photometric measurements of the lunar surface with the spotmeter.

a. Purpose

- 1) Verify exposure schedule on photographic target chart
- 2) Verify usefulness and validity of preplanned exposure schedules for future mission photography

b. Onboard photographic procedures on following page

PHOTO TARGET CHART EXPOSURE SCHEDULE CHECK -
S20.115

The following are required:

Spotmeter

Photo target chart

Photo log

Exposure schedule check is to
be done during familiarization pass.

Spotmeter settings: ASA 75 for 3400
film, and ASA 64 for S0368 film;
focus to infinity.

Target window to be shaded from direct
sunlight.

T_o is 12 min after sunrise (ground
update if desired).

Concentrate on homogeneous areas.

- (1) At T_o begin taking spotmeter readings
for 3400 film at 4 different spots
estimated to be near the nadir point
and centered near an exposure schedule
zone on the photo target chart.
- (2) Repeat step 1 for S0368 except that
spotmeter is to be pointed 20° forward
of track on first half of pass and 20°
behind track on second half.
- (3) Perform the check on as many exposure
schedule zones as time permits.
- (4) Record in photo log:
 - (a) GET of each sequence (of 4)
readings.
 - (b) Record ASA used and f-stop
reading assuming 1/250 sec exposure.

10. Terminator Photography

Photograph the terminator with the still camera on as many terminator crossings as possible.

a. Purpose

- 1) Analysis of subdued terrain features
- 2) Analysis of visibility and recognizability of features near the terminator

b. Onboard photographic procedures on following page

TERMINATOR - S20.115

The following are required:

H-blad cam
Med Telephoto Lens
Mag 3400 film
Photo log
Ring sight
Cam setting: f 5.6, 1/60, infinity.

- (1) Orient cam north or south of track as close to nadir as possible and take rapid sequence of photographs at approximately (10° increments toward horizon with telephoto lens, 15° increments with 150 mm lens or 30° increments for 80 mm lens) from the local vertical.
- (2) Record in photo log:
 - (a) Mag ID
 - (b) Frame number first exposure
 - (c) GET first exposure
 - (d) Number of exposures
 - (e) Target ID

NOTE: This procedure is to be repeated on as many terminator crossings as possible.

11. Crew Activities Evaluation

Photograph crew activities and controls and displays with the data acquisition camera.

a. Purpose

- 1) Evaluation of crew tasks in a zero-gravity environment.
- 2) Documentation of systems performance.

b. Onboard photographic procedures on following page

Crew Activities Evaluation

MODE A - D.A Camera

The following are required:

D.A Cam: Wide Angle 5 mm lens, S0168
film, f 2.8, 1/50, 6 fps.
Spotmeter

Photo objectives scheduled at crew option
as needed for coverage of internal
operation.

- (1) Folding and unfolding the CM couch as required for routine flight operations.
- (2) Crewman obtaining the required position within the couch for a CM active rendez with the S-IV B.
- (3) Attaching crew restraint system in the LM.
- (4) Stowing or unstowing equipment on the aft bulkhead.

MODE B - D.A. Camera (12 or 24 frames/second)
(only used if crewman has difficulty in performing his objectives).

Same objective as Mode A.

12. Image Motion Compensation/Training Photography

Photograph a landmark with a still camera and the data acquisition camera while the crew tracks the landmark. The crew will track a landmark with the COAS (an optical instrument mounted in either rendezvous window and boresighted to the SC X-axis) and the cameras will be mounted and boresighted to the COAS line of sight.

a. Purpose

- 1) Training in landmark tracking
- 2) Evaluation of capability to provide image motion compensation by maneuvering the spacecraft

b. Onboard photographic procedures on following page

IMAGE MOTION COMPENSATION/TRAINING
PHOTOGRAPHY - S20.115

The following are required:

H-blad cam
Med Telephoto Lens
Mag 3400 film (70 mm)
TV cam mount
Still cam adapter
Intervalometer
D.A. cam
200 mm lens
Mag S0368 film (16 mm)
D.A. cam mount
Photo log

Cam settings:

H-blad cam
f _____ (initially), 1/60,
infinity.

D.A. cam
F 8 (initially), 1/250,
infinity.

COAS mounted in either rendz
window.

Tracking attitude 55° pitch
down.

- (1) When tracking attitude is
achieved start both cameras.
- (2) If time permits change f-stops
as follows:

H-blad cam
When target comes into
view, f _____,

D.A. cam
When target comes into
view f _____,

- (3) When target comes into view, stop intervalometer on H-blad cam and make exposures every 5 seconds.
- (4) Continue photography until tracking is completed.
- (5) Record in photo log:
 - (a) Mag ID's
 - (b) GET target acquired
 - (c) Frame number first exposure on H-blad.
 - (d) Estimated film remaining in D.A. cam mag at beginning of sequence.

NOTE: If time does not permit changing f-stops, open apertures wide open for duration of photography.

B. Targets of Opportunity

1. Long Distance Earth Still Photography

Photograph the earth from various translunar/transearch distances with a still camera.

a. Purpose

- 1) Weather and terrain analysis with global coverage and from a long distance perspective
- 2) Horizon and high atmosphere studies
- 3) Earth terminator studies

b. Onboard photographic procedures on following page

LONG DISTANCE EARTH STILL PHOTOGRAPHY - S20.115

MODE A - Still Camera - S0121 film -

The following are required:

H-blad cam (80 mm lens)
Mag S0121 film
Photo log
Spotmeter
Photar 2A filter
Photography window shaded from
direct sunlight.
Cam settings: infinity;
Use 2A filter and cam setting from
exposure table (on magazine) or;
Use spotmeter, ASA 45 without filter
Photograph at approximately the
following GET's:

Record in photo log:

- (a) Film mag ID
- (b) Frame number
- (c) Cam settings
- (d) Spotmeter readings in foot-lamberts if spotmeter used.
- (e) Target ID
- (f) GET first exposure.

MODE B - Still Camera - S0368 film

The following are required:

H-blad cam (80 mm lens)

Mag S0368 film

Photo log

Spotmeter

Photography window shaded from
direct sunlight.

Cam settings: f-stop and shutter
speeds from spotmeter-ASA 64,
infinity.

Photograph at approximately the
following GET's:

Record in phot log:

(a) Film mag ID

(b) Frame number

(c) Cam settings

(d) Spotmeter readings in foot-lamberts.

(e) Target ID

(f) GET first exposure.

MODE C - Still camera - 3400 film

The following are required:

H-blad cam (80 mm lens)

Mag 3400 film

Photo log

Spotmeter

Red 25A filter

Photography window shaded from
direct sunlight.

Cam settings: infinity.

Use Red filter and cam settings
from exposure table (on magazine) or:

Use spotmeter, ASA 75 without filter.

Photograph at approximately the
following GET's:

Record in photo log:

(a) Film mag ID

(b) Frame number

(c) Cam settings

(d) Spotmeter readings in foot-lamberts
if spotmeter used.

(e) Target ID

(f) GET first exposure.

2. Long Distance Lunar Photography

Photograph the moon from various translunar/transearch distances with a still camera.

a. Purpose

General interest

b. Onboard photographic procedures on following page

LONG DISTANCE LUNAR PHOTOGRAPHY - S20.115

The following are required:

H-blad Cam
Med Telephoto Lens
Mag S0121, S0368, or 3400 film
Photo log
Spotmeter
Photography window shaded from
direct sunlight.
Cam settings: infinity, f-stop and
shutter speed from spotmeter with
the following ASA numbers:
S0121 film ASA 45
S0368 film ASA 64
3400 film ASA 75
Photograph at approximately the
following GET's:

Record in photo log
(a) Film mag ID
(b) Frame number
(c) Cam settings
(d) Spotmeter readings in foot-lamberts
(e) Target ID
(f) GET first exposure

3. Long Distance Earth/Lunar Sequence Photography

Photograph the moon and earth from various translunar/
transearth distances with the data acquisition camera.

a. Purpose

- 1) Weather and terrain analysis with global coverage
and from a long distance perspective
- 2) General interest

b. Onboard photographic procedures on following page

LONG DISTANCE EARTH/LUNAR SEQUENCE PHOTOGRAPHY

The following are required:

D.A. Cam

Any lens—except, do not use 200 mm
lens for earth photos

Photo log

Spotmeter

Photography window shaded from
direct sunlight.

Cam settings: f-stop and shutter speed
from spotmeter - ASA 64, infinity,
1 fps.

Photograph at approximately the
following GET's:

Record in photo log:

- (a) Film mag ID
- (b) Estimated film remaining at
beginning of sequence.
- (c) Cam settings
- (d) Spotmeter reading in foot-lamberts
- (e) Target ID
- (f) GET at beginning of sequence

4. Lunar Surface in Earthshine

Overlapping still camera coverage of the lunar surface
in earthshine

a. Purpose

To provide additional photometric information about the
lunar surface under low-level illumination.

b. Onboard photographic procedures on following page

LUNAR SURFACE IN EARTHSHINE - S20.115

The following are required:

H-blad cam (80 mm lens)
Mag 2485 film
TV cam mount (if attitude constraints permit).
Still cam adapter
Photo log
Cam settings: f 2.8, 1/4, infinity.
 T_0 is 6 min after sunset - nominally.
50 frames allocated.

- (1) At T_0 - 3 min maneuver to R 0° , P 280° , Y 0° and maintain orb rate if cam used on mount.
- (2) At T_0 begin shutter actuations by hand every 20 second and continue for 18 minutes.
- (3) Record in photo log:
 - (a) GET first and last photos
 - (b) Frame number first and last photos
 - (c) Target ID

5. Transient Luminescent Phenomena

Photograph new or previously observed regions of abnormal luminescence with a still camera.

a. Purpose

Documentation and analysis of the phenomenon at close range

b. Onboard photographic procedures on following page

TRANSIENT LUMINESCENT PHENOMENA - S20.115

The following are required:

H-blad cam (80 mm lens)
Mag 2485 film
Photo log
Photo target chart
Ring sight
Photography to be done during dark
portion of a lunar orbit.
Cam settings: f 2.8, 1/4, infinity.

- (1) Determine target time and location from photo target chart.
- (2) Locate target visually if possible with ring sight, otherwise point camera at estimated position.
- (3) Take 4 exposures at 5 to 10 second intervals.
- (4) Record in log:
 - (a) GET first exposure
 - (b) Frame number first and last exposure.
 - (c) Target ID

6. Gegenschein

Still camera photography of a region in space 180° from the sun

a. Purpose

- 1) To study the nature and position of the gegenschein
- 2) Correlation with simultaneous earth based observations for positional determination from the parallactic angle provided by the long base obtained through the simultaneous observations

b. Onboard photographic procedures on following page

GEGENSCHEIN - S20.115

MODE A - Hand-held

The following are required:

H-blad cam (80 mm lens)
Mag 2485 film
Photo log
SC in lunar orbit and not in
earthshine if possible.
Any convenient window oriented for
a view of anti-solar point in
constellation Gemini or to RA
6h Dec +23°.
Interior lighting subdued
Cam settings: f 2.8, B, infinity.
Att hold.

- (1) Aim cam at constellation Gemini or to
RA 6h Dec +23°.
- (2) Take one 1 min exposure, one 6 sec
exposure and one 1 sec exposure.
- (3) Record in photo log:
 - (a) Frame numbers
 - (b) GET first exposure
 - (c) Target ID

MODE B - Bracket-Mounted

The following are required:

Same as Mode A except that in this
mode the camera is to be mounted
in the rh rendz window and
photography can be done during
translunar or transearth coast.
3 frames allocated.

7. Zodiacal Light

Still camera photography of the ecliptic 35° from the sun
using a polarizing filter

a. Purpose

To obtain additional information on the nature of the zodiacal light. The use of a polarizing filter will increase the information content of the photographs.

b. Onboard photographic procedures on following page

ZODIACAL LIGHT - S20.115

MODE A - Hatch Window (preferred mode)

The following are required:

H-blad cam
Mag 2485 film
Polarizing filter-index to left hand
index (index mark that is nearest
thumb tab).
Interior lights subdued
 T_0 is 12 min before sunrise - nominally
near the end of rev 8.
At T_0 - 3 maneuver to R 0°, P-70°,
Y°, attitude hold.
Cam settings: f 2.8, B, infinity
Lens axis normal to hatch window
Photo log
3 frames allocated

- (1) At T_0 take 1-min exposure
- (2) Rotate filter 60° and take a second
1-min exposure.
- (3) Rotate filter 60° more and take last
1-min exposure.
- (4) Record in photo log:
 - (a) Frame number first exposure
 - (b) GET first exposure
 - (c) Target ID

MODE B - Rh rendz. Window (this mode to be used in case hatch window is unacceptably degraded).

The following are required:

H-blad cam
Mag 2485 film
TV cam mount
Still cam adapter
Polarizing filter - index to 0° rotation.
LV alignment
T_o is 12 min before sunrise
At T_o - 3 maneuver to R 0°, P-10°, Y 0°.
Cam settings: f 2.8, B, infinity
Photo log

- (1) At T_o take 1-min exposure
- (2) Rotate filter 60° and take second 1-min exposure.
- (3) Rotate filter 60° more and take last 1-min exposure.
- (4) Record in photo log:
 - (a) Frame number first exposure
 - (b) GET first exposure
 - (c) Target ID

8. Solar Corona

Still photography of the solar corona with a polarizing filter and using the lunar horizon as an occulting object.

a. Purpose

To study the electron density in the solar streamers

b. Onboard photographic procedures on following page

SOLAR CORONA - S20.115

MODE A - Hatch Window (Preferred Mode)

The following are required:

H-blad cam

Mag 3400 film

Polarizing filter - initially indexed to left hand index (index mark that is nearest thumb tab).

Photo log

Cam optical axis normal to hatch window.

Cam settings: f 4 (initially), 1/4, infinity.

T_0 is 4 min before sunrise (ground update if desired) - nominally near the end of rev 8.

- (1) At T_0 - 3 min maneuver to R 0°, P-70°, Y 0° and maintain orb rate.
- (2) At T_0 take first exposure.
- (3) Rotate filter 60° and take second exposure.
- (4) Rotate filter an additional 60° and take third exposure.
- (5) Rotate filter back to initial position and change f-stop to f 5.6.
- (6) Repeat sequence in steps (2),(3),(4).
- (7) Rotate filter back to initial position and change f-stop to f 8.
- (8) Repeat sequence in steps (2),(3),(4).
- (9) Repeat step (7) until sunrise
- (10) Record in photo log:
 - (a) GET first exposure
 - (b) Frame number first and last exposures.
 - (c) Target identification

MODE B - Rh rendz window (This mode to be used only in case hatch window is intolerably degraded).

The following are required:

H-blad cam

Mag 3400 film

Polarizing filter - initially indexed to left hand index (index mark that is nearest thumb tab).

TV cam mount

Still cam adapter

Photo log

Cam settings: f 4 (initially), 1/4, infinity.

T_0 is 4 min before sunrise (ground update if desired).

- (1) At T_0 - 3 min maneuver to R 0° , P- 10° , Y 0° , and maintain orb rate.
- (2) Steps (2) through (10) same as in mode A.

9. Lunar Surface Targets of Opportunity

Still camera photography of specific features and areas, exploration sites, Surveyor sites. Targets are identified on the photographic target chart prepared by Mapping Sciences Branch, Lunar and Earth Sciences Division.

a. Purpose

- 1) To augment existing lunar surface photography
- 2) To obtain photography for analysis of future potential landing sites
- 3) To obtain photographs for correlation with Surveyor data

b. Onboard photographic procedures on following page

LUNAR SURFACE TARGETS OF OPPORTUNITY - S20.115

MODE A - 80 mm lens, 3400 film.

The following are required:

H-blad cam (80 mm lens)
Mag 3400 film
Photo log
Photo target chart
Ring sight
Cam settings: f-stop from photo target
chart, 1/250, infinity.

MODE B - 80 mm lens, S0368 or S0121 film.

The following are required:

H-blad cam (80 mm lens)
Mag S0368 or S0121 film
Photo log
Photo target chart
Ring sight
Cam settings: f-stop from photo target
chart schedule for oblique b/w film,
1/250, infinity.

MODE C - Telephoto Lens, 3400 film.

The following are required:

H-blad cam
_____ mm lens
Mag 3400 film
Photo log
Photo target chart
Ring sight
Cam settings: f-stop from photo
target chart, 1/250, infinity.

MODE D - Med Telephoto Lens, S0368 or S0121 film.

The following are required:

H-blad cam
Med Telephoto lens
Mag S0368 or S0121 film
Photo log
Photo target chart
Ring sight
Cam settings: f-stop from photo
target chart schedule for oblique
b/w film, 1/250, infinity.

- (1) Select targets for current rev from photo target chart.
- (2) Orient cam optical axis as close as possible to N or S of track.
- (3) Change f-stop per schedule on photo target chart.
- (4) Record in photo log:
 - (a) Mode
 - (b) Mag ID
 - (c) Target ID numbers
 - (d) GET first exposure of a sequence.
 - (e) Frame number of first and last exposures of a sequence.

10. Zero Phase Angle

Still camera photography of the lunar surface in the direction of the sun's rays

a. Purpose

Obtain additional data about the reflective properties of the lunar surface

b. Onboard photographic procedures on following page

ZERO PHASE ANGLE - S20.115

The following are required:

H-blad cam
Mag 3400 film
Med Telephoto lens
Ring sight
Photo target chart
Photo log
Cam settings: f 11, 1/250, infinity

- (1) Locate zero-phase point from photo target chart.
- (2) Aim cam at target and take photos at 5- to 10-sec intervals.
- (3) Record in photo log:
 - (a) Film mag ID
 - (b) Frame number first and last photos.
 - (c) GET first and last exposures.
 - (d) Target ID

11. Dim Light Earth Photography

Still camera photography of the nightside of the earth

a. Purpose

- 1) To obtain wide area coverage of the earth darkside to study lightning distribution over water and land masses
- 2) To obtain photographs of the air glow and upper atmosphere to extend studies begun during the Gemini program

b. Onboard photographic procedures on following page

DIM LIGHT EARTH PHOTOGRAPHY - S20.115

MODE A - Air Glow (Do before Mode B).

The following are required:

H-blad cam (80 mm lens)
Mag 2485 film
TV cam mount
Still cam adapter
Photo log
Cam settings: f 2.8, B, infinity.
Interior lighting subdued
Photography window shaded from
earthshine and sunshine.

- (1) Maneuver SC to get only the dark side of earth in field of view of camera.
- (2) Take 5 exposures of 3 seconds each.
- (3) Record in photo log:
 - (a) Frame number first and last photos.
 - (b) GET first and last exposures.
 - (c) Target ID

MODE B - Lightning

The following are required:

Same as for Mode A.

- (1) Maneuver SC to get only the dark side of earth in field of view of camera.
- (2) Take 1 min and 5 min exposures.
- (3) Record in photo log:
 - (a) Frame numbers
 - (b) GET first exposure
 - (c) Target ID

12. Crew Observations

Still camera photography of interesting phenomena observed by the crew

a. Purpose

To provide documentation of visually observed phenomena, features selected by the crew

b. Onboard photographic procedures on following page

CREW OBSERVATIONS - S20.115

The following are required:

H-blad cam
Mag S0121, S0368, or 3400 film
Ring sight
Spotmeter
Photo log
Cam settings: f-stop and shutter speed
from spotmeter, focus as required -
use ASA 45 for S0121 film ASA 64 for
S0368 film and ASA 75 for 3400 film.

- (1) Photo as time, consumables, and film permit.
- (2) Record in photo log:
 - (a) Mag ID
 - (b) Frame number first exposure of a sequence.
 - (c) Exposure settings
 - (d) GET first exposure of a sequence.
 - (e) Target description.

13. Red-Blue Surface Study

Still camera photography of the lunar surface alternately through red and blue filters

a. Purpose

- 1) To determine the detectability color discontinuities on the lunar surface
- 2) Obtain data to study the significance of such discontinuities observed from earth
- 3) Improve geologic mapping of the moon

b. Onboard photographic procedures on following page

RED - BLUE SURFACE STUDY - S20.115

The following are required:

H-blad cam (80 mm lens)
Mag 3400 film
Ring sight
Twin filter slide holder with filters
installed.
Photo log
Photo target chart
Com settings: f-stop and shutter speed
equivalent to four aperture stops
wider open than target chart or
spotmeter indication, infinity.

- (1) Attach filter holder to lens in
position square to camera body.
- (2) Slide filter holder to right,
positioning the left hand filter over
lens.
- (3) Aim camera at target and expose.
- (4) Rapidly slide filter to extreme left
and repeat exposure.
- (5) Slide filter to extreme right.
- (6) Expose single pair or sequence of
pairs as indicated on target chart.
- (7) Record in photo log:
 - (a) Mag ID
 - (b) Target ID
 - (c) GET first exposure
- (d) Frame number first exposure.

SUPPLEMENTARY DIM LIGHT
PHOTO PROCEDURES - S20.115

GET
76:20

Prepare H-blad #1 with HS film for lunar surface
in earthshine photography (80mm lens)

GET
76:30

Lunar Surface in Earthshine - H-blad #1:

Cam settings: f2.8, 1/4, infinity
Interior lights subdued
Hand-held vertical photography (no intervalometer)
Manual exposures every 20 sec
50 frames max
Log: GET start time, target ID, frame number
at start

Transient Luminescent Phenomena - H-blad #1:

Do concurrently with or following earthshine
Targets from target chart or crew observed
targets
Cam settings f2.8, 1/4, infinity
Interior lights subdued
Two photos each target

Log: GET, target ID, frame numbers

Between GET 76:30 and GET 83:00 perform
the following when opportunity exists with
either H-blad and HS film

Gegenschein:

Cam settings: f2.8, B (initially), infinity

Attitude hold

Interior lights subdued

Aim cam at constellation Gemini or to estimated
RA6h, Dec +23°

Take one 1-min exposure, one 6-sec exposure
and one 1-sec exposure.

Aim cam at constellation _____ or to
estimated RA ___ Dec _____

Repeat sequence

6 frames

Log: GET start, target ID, frame number
first exposure

SC Exterior Atmosphere

Cam settings: f2.8, B (initially), infinity

Interior lights subdued

Do following once in total darkness and, if
possible, once in earthshine

Photograph stars in constellation

Ursa Major with the following exposures,
in order: 6 sec, 1 sec, 1/60 sec

6 frames

Log: GET start, target ID, frame number
first exposure

GET

84:30

Unstow:

Polarizing filter

Fresh mag S0368

Install color mag on H-blad #1

Install HS film and polarizing
filter on H-blad #2

Temp stow H-blad #1 and one mag b/w film

Install intervalometer on H-blad #1

Index polarizing filter to left hand index
(index mark that is nearest to thumb tab)

GET
84:47

Prep for zodiacal light:

Maneuver to R 0°, P 290°, Y 0° from heads-up-
SEF orientation if hatch window is to be used,
R 0°, P 350°, Y 0° from heads-up-SEF orientation
if cam mounted in rendz window to point camera
at horizon - hold attitude

GET
84:50

Zodiacal Light - H-blad #2:

Cam settings: f2.8, B, infinity

Interior lights subdued

Take 1-min exposure

Rotate filter 60°

Take 1-min exposure

Rotate filter another 60°

Take 1-min exposure

3 frames

Log: GET start, target ID, frame number first
exposure

GET
84:55

Install mag 3400 film (b/w) on H-blad #2

Index filter to left hand index (index mark
that is nearest to thumb tab)

Maneuver to R 0°, P 290°, Y 0° from heads-up
SEF orientation if cam mounted in rendz window
to point camera at horizon - begin orb rate

GET
84:58

Solar corona - H-blad #2
Cam settings: f4 (initially), 1/4, infinity
Interior lights subdued
Take one exposure (f-4 first sequence)
Rotate filter 60°
Take second exposure
Rotate filter another 60°
Take third exposure
Rotate filter back to initial position
Change f-stop to f5.6
Repeat exposure sequence
Rotate filter back to initial position
Change f-stop to f8
Repeat exposure sequence
Cycle through last sequence until SR
15 frames
Log: GET start, target ID, frame number
first exposure

GET
85:02

Mount H-blad #1 in rendz window (S0368 color)
in prep for stereo photography (with
intervalometer)
Stow polarizing filter
Maneuver to P 300°, Y 0°, R 180° from SEF
heads-up-orientation and maintain orb rate

GET
85:08

Start H-blad #1

III. REQUIREMENTS AND ALLOCATION OF EQUIPMENT AND FILM

The photographic objectives enumerated in the preceding section have been used as guidelines for defining the type and quantity of cameras, lenses, film types and other associated equipment for the Apollo 8 mission. Two basic camera systems are required to meet these objectives: 16mm Data Acquisition Camera and the 70mm Hasselblad Electric Camera.

The following table lists equipment and film with the photographic objectives for which the items are allocated.

APOLLO 8
MISSION ACTIVITIES AND EQUIPMENT
REQUIRED FOR COVERAGE OF
PHOTOGRAPHIC OBJECTIVES

EQUIPMENT ACTIVITY	Hasselblad El Cam With 80mm Lens (2)	20 Second Intervalometer	Still Camera Mount	Med telephoto lens Photar 2A Filter	Red (25A) Filter	Polarizing Filter	Red-Blue Filter	Ring Sight	Spotmeter	16mm Data Acq Camera	200mm Lens	75mm Lens	18mm Lens	5mm Lens	Right Angle Mirror	CM Boresight Bracket	16mm Power Cable	Sextant Adapter			70mm Film (Frames)				16mm Film (Feet)	
																					S0121	S0368	3400	2485	S0368	S0168
A.1. Lunar Stereo Strip Photography	X	X	X						X													176	176			
A.2. SC Exterior Atm. Particulate Matter	X																							9		
A.3. Exhaust Effects on CM Windows									X	X				X			X								2	
A.4. Separation/S-IVB Inspection										X			X		X	X	X								130	
A.5. Still Cam Lunar Lmk Photography	X							X	X													30				
A.6. Lunar Lmk/Sextant Photography										X							X	X							130	
A.7. Star/Horizon Sextant Photography										X							X	X							130	
A.8. Sequence Photog Lunar Surface									X	X	X	X		X	X	X									260	
A.9. Photo Target Chart Exposure Check									X																	
A.10. Terminator	X			X					X														50			
A.11. Crew Activities Evaluation										X				X			X								260	
A.12. Image Motion Comp/ Training Photography	X	X	X	X						X	X				X	X	X						18		325	
B.1. Long Distance Earth Still Photography	X				X	X			X	X											80	80	60			
B.2. Long Distance Lunar Photography	X			X					X												10	10	10		100	

APOLLO 8
MISSION ACTIVITIES AND EQUIPMENT
REQUIRED FOR COVERAGE OF
PHOTOGRAPHIC OBJECTIVES CONT'D

EQUIPMENT ACTIVITY	Hasselblad El Cam With 80mm Lens (2)	20 Second Intervalometer	Still Camera Mount	Med telephoto lens	Photar 2A Filter	Red (25A) Filter	Polarizing Filter	Red-Blue Filter	Ring Sight	Spotmeter	16mm Data Acq Camera	200mm Lens	75mm Lens	18mm Lens	5mm Lens	Right Angle Mirror	CM Boresight Bracket	16mm Power Cable	Sextant Adapter	70mm Film (Frames)				16mm Film (Feet)	
																				S0121	S0368	3400	2485	S0368	S0168
B.3. Long Distance Earth/ Lunar Seq. Photography									X	X	X	X	X										93		
B.4. Lunar Surface in Earthshine	X								X														50		
B.5. Transient Luminescent Phenomena	X																						10		
B.6. Gegenschein	X																						9		
B7. Zodiacal Light	X						X																3		
B.8. Solar Corona	X						X																18		
B.9. Lunar Surface Targets of Opp	X			X					X	X													9	170	
B.10. Zero Phase Angle	X			X					X														5		
B.11. Dim Light Earth Photography	X																						4		
B.12. Crew Observations	X																						70	60	43
B.13. Red-Blue Surface Study	X							X															20		

Totals

160 335 600 85 1170 260

Magazines

1 2 3 1 9 2

IV. CAMERAS AND ASSOCIATED EQUIPMENT

A. 16mm Data Acquisition Camera - P/N SEB33100100-201

Camera characteristics - capable of time exposures; frame rates of 1, 6, and 12 frames per second automatic; and 24 frames per second semi-automatic. Shutter speeds 1/60, 1/125, 1/250, 1/500 and 1/1000 second may be selected. Accepts various lenses. Accepts film magazine, P/N SEB33100125-202, which can be supplied in quantity with a variety of film types. Cameras are intended for boresighted, mounted operations from the left or right rendezvous window, and handheld operation. The camera bodies are interchangeable with all the lens systems and mountings provided. One camera is stowed in the CSM at launch.

Lenses and Associated Attachments

1. 200mm lens - P/N SEB33100045-301

200mm focal length, aperture range from f5.5 to f32; can be focused from 7 feet to infinity; field of view of 2.1 by 2.9°; can be used in boresight mount; 1 unit in CSM for launch.

2. 75mm lens - P/N SEB33100078-202

75mm focal length, aperture range from f2.5 to f32; can be focused from 42 inches to infinity; field of view of 7.9° by 5.7°, can be used in boresight mount; 1 unit in CSM for launch.

3. 18mm lens - P/N SEB33100023-204

18mm focal length, aperture range from t2.0 to t22; can be focused from 12 inches to infinity; field of view of 32.3° by 23.3° can be used in boresight mount or handheld; 1 unit in CSM for launch.

4. 5mm lens - P/N SEB33100056-206

5mm focal length, aperture range from f2.0 to f16; fixed focus field of view of 118° by 80° used handheld; 1 unit in CSM for launch.

5. Right Angle Mirror - P/N SEB33100051-204

Right angle mirror used on 200mm, 75mm, and 18mm lenses when boresight mounted to properly align the optical axis out the rendezvous windows; one unit in CSM.

6. 16mm Power Cable - P/N SEB33100026-206

Supplies CSM power to camera; one unit in CSM.

7. Camera Bracket - P/N N/A (CFE item)

The bracket is used to mount and position the sequence camera for boresight operation through the rendezvous window, one unit in the CSM.

8. 16mm Magazines - P/N SEB33100125-202

Characteristics - interchangeable with all sequence camera units; contains 130 feet of thin base film, 11 units in CSM.

B. 70mm Hasselblad Electric Camera - P/N SEB33100102-203

Characteristics - A motor drive mechanism powered by two sealed nickel-cadium batteries advances the film to the next frame and cocks the shutter whenever the camera button is actuated, normal 80mm lens can be easily replaced with a telephoto lens and accepts any number of the 70mm Hasselblad film magazines. Two cameras are stowed in the CSM at launch.

1. Medium telephoto lens - P/N SEB33100032-201

Medium focal length aperture range f5.6 to f45; can be focused from 8.5 feet to infinity; field of view 12.5° side, 17.6° diagonal; 1 unit in CSM.

2. 80mm lens - Attached to Hasselblad Electric Camera -

80mm focal length, aperture range f2.8 to f22; can be focused from 3 feet to infinity; field of view 37.9° side, 51.8° diagonal, 2 units in the CSM.

3. Photar 2A filter - P/N SEB33100050-206

Used with S0121 film, fits 250mm and 80mm lens.

4. Red Filter - P/N SEB33100050-204

A number 25A filter used with black and white film to improve contrast.

5. Ringsight - P/N SEB33100031-204

Required for sighting Hasselblad Electric Camera with 250mm lens and can also be used with Data Acquisition Camera when handheld.

6. Lunar Surface Film Magazines - P/N SEB33100082-203

Capable of 200 frames of thin base black and white film or 160 frames of thin base color film, frame counter indicates every fifth frame with a line and every tenth with a line and number to a maximum of 200 frames.

C. Automatic Spotmeter - P/N SEB33100104-201

Characteristics - Completely automatic reflectance light meter with an angle of acceptance of 1° , meter scales are automatically rotated to give the correct aperture/shutter speed values for the selected photographic subject.

D. Film

1. S0368 film - Ektachrome MS, color reversal, ASA 64, 2.5 mil Estar polyester base, haze filter required for earth terrain, good resolution.
2. S0121 film - Ektachrome, color reversal, to be exposed at ASA 45 for operational photography (air to air only with no filter), 2.5 mil Estar polyester base, high resolution. For earth photography with 2A or lunar photography without filter use exposure table.
3. S0168 film - Ektachrome EF, high speed color reversal, exposed and developed at ASA 1000, 2.5 mil Estar polyester base, and used for spacecraft interior. No filter.
4. 3400 film - Panatomic X, black and white to be exposed at ASA 75 without filter for operational air to air and lunar terrain photography only, 2.5 mil Estar polyester base, high resolution. For earth photography with red filter use exposure table.
5. 2485 film - Very high speed black and white to be exposed and developed at ASA 6000 for low light level photography, 4 mil Estar polyester base, low resolution.

E. Intervalometer - P/N SEB33100043-301

Actuates Hasselblad camera every 20 seconds. No SC electrical interface. Uses camera battery power.

F. Still camera Adapter P/N SEB 39103439

Adapts Hasselblad camera to the TV camera mount for a field of view through the right hand rendezvous window. The camera's optical axis is near to a parallel to the SC X-axis. The still-camera-adapter/TV-camera-mount assembly is called the still camera mount.

G. Polarizing Filter - P/N SEB33100039-301

Filter material is glass laminated neutral linear polarizer. Rotates from 0° index to 60° index and to 120° index.

H. Red-Blue Filter - P/N SEB33100012-301

Filter holder fits on Hasselblad camera lens and holds a red filter and a blue filter, either of which can be slid into position over the camera lens. Filter characteristics are as follows:

29 Red Filter

Upper cutoff - at unknown wavelength above 700 milimicrons

90% transmissivity at 700 milimicrons

87.8% transmissivity at 650 milimicrons

45.0% transmissivity at 620 milimicrons

0% transmissivity at 600 milimicrons

47B Blue Filter

Lower cutoff - at unknown wavelength below 400 milimicrons

16% transmissivity at 400 milimicrons

43.6% transmissivity at 420 milimicrons

50% transmissivity at 430 milimicrons

25% transmissivity at 460 milimicrons

0% transmissivity at 500 milimicrons

(peak)

I. Sextant Adapter - P/N (not Available)

Adapts the Data Acquisition Camera to the sextant for a view of the sextant's two lines of sight. The adapter places the film plane at the focal plane of the sextant optics so that no camera lens is used. For this reason the only exposure variable is the shutter speed.

V. TV OPERATIONS PLAN

1. Purpose

To provide information which will assist in evaluation of the potential usefulness of TV from lunar distance

2. Requirements

- a. Exterior views of the lunar surface and earth from lunar distance
- b. Interior views of crew at their option

3. Equipment required

- a. CM TV camera
- b. TV camera cable
- c. Wide angle lens (160° FOV)
- d. 100mm lens (9° FOV)

4. Constraints

- a. GLD and MAD are the only stations capable of live TV transmissions.
- b. Steerable S-band antenna required when transmitting from lunar distance

Onboard Crew Procedures

TV OPERATIONS

Unstow Equipment

Volume A7
 TV camera
 Camera cable
 Camera lens
 100mm
 wide angle

TV Camera Operation

Connect TV camera cable

S BD AOX TV - TV

TV CAM ALC - IN

TV CAM - ON

EXTERIOR VIEWS - 100mm lens

INTERIOR VIEWS - WIDE ANGLE LEN

NOMINAL MISSION TV TIMELINE

MSFN STATION	GET ACQUISITION	ΔT (MIN)
GLD	31:00:00	15
GLD	55:00:00	15
MAD	72:10:00	15
GLD	85:37:00	15
MAD	98:00:00	15
GLD	128:00:00	15