GRAPHICS PARTICIPATION IN THE MISSION EVALUATION REPORT AT THE MANNED SPACECRAFT CENTER

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From May 1964 to December 1966, the NASA Manned Spacecraft Center flew 12 Gemini missions, 10 of which were manned. The data obtained from these missions are indispensable in the planning of future missions. An adequate and timely system of data reduction was established to accommodate an effective evaluation and to adequately document the evaluation for future reference.

The main objectives of a mission evaluation are:

To reveal all anomalies

To determine their cause

To recommend corrective action

Because of the relatively short interval between the Gemini missions, the evaluation had to be accomplished in a timely and efficient manner. It is imperative that an evaluation be completed and a report generated in sufficient time to apply the knowledge gained to future missions.

The main objective of a Mission Evaluation Report is to assimilate all facts and figures from each mission evaluation and thoroughly document them for future reference. It is in this capacity that Graphics and Reproduction Support Services play an indispensable role.

Each Gemini Mission Evaluation Report is divided into 13 major sections which are subdivided to accommodate the complexities of a particular mission. For example, in the Gemini V Mission Evaluation Report, the vehicle-description section (section 3.0) was divided into three subsections (fig. 1).

3.0 — Vehicle description

3.1 — Gemini spacecraft

3.2 — Gemini launch vehicle

3.3 — Gemini V weight and balance data

In the Gemini XII Mission Evaluation Report, section 3.0 was expanded to include:

3.4 — Gemini Agena target vehicle

3.5 — Target launch vehicle

3.6 — Gemini Atlas-Agena target-vehicle weight and balance data

Each section or subsection is divided into three categories: text, figures, and tables (fig. 2).

A typical Mission Evaluation Report team consists of the following members (fig. 3):

Team Manager

Chief Editor

Editorial Staff Head (NASA and contractor)

Data Support Group Head

Graphics Support Group Head (NASA and contractor)

Senior Editors and Staff for all major sections

A Mission Evaluation Report team consists of personnel previously responsible for the design, testing, and qualification of the vehicle and its systems and of personnel previously responsible for conducting the flight. Support services such as Writing, Editing, Graphics, and Typing supplement the team.

The team is program oriented and consists of both NASA and contractor personnel. These personnel work independently of normal administrative lines of authority and, with some exceptions in the support areas, report directly to the Gemini Program Manager. Personnel working as part of the Mission Evaluation Report team are relieved of their regular duties to the maximum extent possible but are released when they complete their particular Mission Evaluation Report assignment or responsibility.

Graphics Support, both consultation and art production service, is available to the entire Mission Evaluation Report team from the beginning of the evaluation through final printing. Graphics Support is available to other support services (such as Writing, Editing, Typing, and Math Aids) on a consultant basis throughout the preparation of the report.

The average production schedule for a Mission Evaluation Report is 35 days from end-of-mission and includes review copies, rework, final printing, and distribution. This rigid schedule must be met with a minimal, predetermined amount of overtime. Allotted time for the Graphics production is about 30 days (26 when Sundays are discounted). During this time, an average of 265 inputs have to be scheduled through Graphics in addition to the regular workload (fig. 4). The Graphics workflow is shown on figure 5.

Each graphic input received five quality-control checks from (fig. 6):

The Quality Control man at Graphics (contractor)

The Graphics coordinator on the Mission Evaluation Report team (contractor)

The NASA Graphics coordinator on the Mission Evaluation Report team

Initiator of the input

Chief Editor

Figures for a Mission Evaluation Report include charts, graphs, photographs, technical illustrations, and/or combinations of any of these (fig. 7).

The basic format for a report figure is a 3-to-4 ratio of length to width. The image area (in printed form) is 6 inches by 8 inches. To insure conformity and to expedite production of art and printing, four format sizes were selected (fig. 8).

100 percent — 6-inch by 8-inch image area

75 percent — 8-inch by 10-1/2-inch image area

60 percent — 10-inch by 13-1/4-inch image area

50 percent — 12-inch by 16-inch image area

By limiting the format sizes, the copy preparation was greatly simplified. For expediency, "cold-type" typewritten copy on "sticky-back" paper is used. The copy using IBM registry and directory type best complemented the selected format sizes.

The initial purpose of the Gemini Mission Evaluation Report (to document the facts and figures for future reference) necessitated production of the most clear, concise figures possible within the allotted time

frame. It is for this reason that all figures in the Mission Evaluation Report are reproduced either full page (fig. 9) or as full page-height foldouts (fig. 10). Foldouts are used to graphically portray data and/or equipment too complex for a 6-inch by 8-inch image area. Foldouts are particularly adaptable to accommodate a lengthy time scale (fig. 11).

Review copies of the Mission Evaluation Report are distributed to the Program Manager and to the Senior Editors 30 days after end-of-mission. Only 15 copies are required; therefore, cheaper and faster printing methods are used to accommodate this limited short-deadline printing requirement. Xerox, Ozalid, and Itek types of reproduction equipment have been adequate to accomplish this task.

For the final printing requirement, offset lithography is used. Plates are prepared from camera negatives. Because of the short deadlines imposed on printing, the final copy is handled as an in-house printing requirement.

To reduce reproduction costs and to accommodate existing press size, foldouts are printed on either 17-inch or 22-inch paper (no trimming). Illustrations are planned accordingly by the Graphics coordinator assigned to the Mission Evaluation Report team. When illustrations require a continuous presentation of data that exceeds these limitations, a left-hand, right-hand foldout spread is prepared (figs. 12 and 13).

Distribution of the final printed Mission Evaluation Report is documented in section 13.0 of each Mission Evaluation Report. Physical distribution is handled by the responsible Program Office. Approximately 550 copies are required for each Mission Evaluation Report.

The first Gemini Mission Evaluation Report required a total of 212 pages, of which 88 were figures. The Gemini XII Mission Evaluation Report contained 520 pages, of which 164 were figures. The percentage ratio shows 68 percent text and tables to 32 percent figures (fig. 14). As the missions became longer and more complex, the demand for Graphics Services increased accordingly.

The biggest problem facing Graphics on a Mission Evaluation Report is the quantity of work involved within the short timespan. The average workload for Graphics is 1760 pieces within a 30-day time interval. A Mission Evaluation Report adds an average of 265 pieces to the workload. A typical Mission Evaluation Report workload breaks down approximately as follows (fig. 15):

Total number of pieces initiated — 160

Change requirements — 85

Corrections	— 20
Total inputs to Graphics	— 265

Many resources are employed by Graphics to meet growing Mission Evaluation Report requirements. Resources employed in MER art production are shown in figure 16. Existing art stored in the repository is updated when possible, rather than preparing an entirely new figure. This is especially beneficial in the preparation of the highly technical illustrations for the vehicle-description section (fig. 17).

Math Aid plots are utilized as original art whenever possible. A light-green grid paper with a black major grid is used. Pencil plots are prepared heavy enough to adequately reproduce in combination with the major grid (fig. 18). Preprinted maps are utilized for presenting data which involve orbital tracking (fig. 19), and photograph/artwork combinations are used to simplify illustrations (fig. 20).

Preprinted forms are designed and used when applicable to display vehicle time histories and actual flight plans. Figure 21a is an example of a preprinted form and figure 21b shows the form completed to illustrate a spacecraft test history. Similarly, figure 22a shows a preprinted form for a flight plan, while 22b is an example of the form filled in for a particular flight.

Machine plots are frequently utilized as original art (fig. 23). As you can see by the example, these data would have been difficult and costly to hand-plot and graphically reproduce. The technical accuracy would be most difficult, if not impossible, to maintain.

Production of the figures is planned with maximum flexibility to accommodate numerous changes. Flexibility is acquired through the use of overlays and by utilization of "cold-type" typewritten copy on removable "sticky-back" paper (fig. 24).

One NASA and one contractor Graphics coordinator are assigned to the Mission Evaluation Report team. The coordinators' familiarity with the Chief Editor's and/or Senior Editors' desires, plus the flexibility built into the figures, enable the coordinators to make numerous minor changes and corrections to the figures, thus eliminating a recycle back through Graphics. The coordinators are also thoroughly familiar with NASA figure standards.

With the beginning of the Apollo Missions (which have more complex systems and vehicles, larger crews, and longer and more complicated flights), it is only reasonable to expect the talents and resources of Graphics Services to be taxed more and more. In anticipation of this, we are continually seeking better and more efficient ways to meet these demands.

NASA-S-68-98

GEMINI MER

SECTION THREE BREAKDOWN

- GEMINI XII MER
  - GEMINI V MER
    - 3.1 - GEMINI SPACECRAFT
    - 3.2 - GEMINI LAUNCH VEHICLE
    - 3.3 - GEMINI V WEIGHT AND BALANCE DATA
  - 3.4 - GEMINI AGENA TARGET VEHICLE
  - 3.5 - TARGET LAUNCH VEHICLE
  - 3.6 - GEMINI ATLAS-AGENA TARGET VEHICLE WT AND BALANCE DATA

Figure 1

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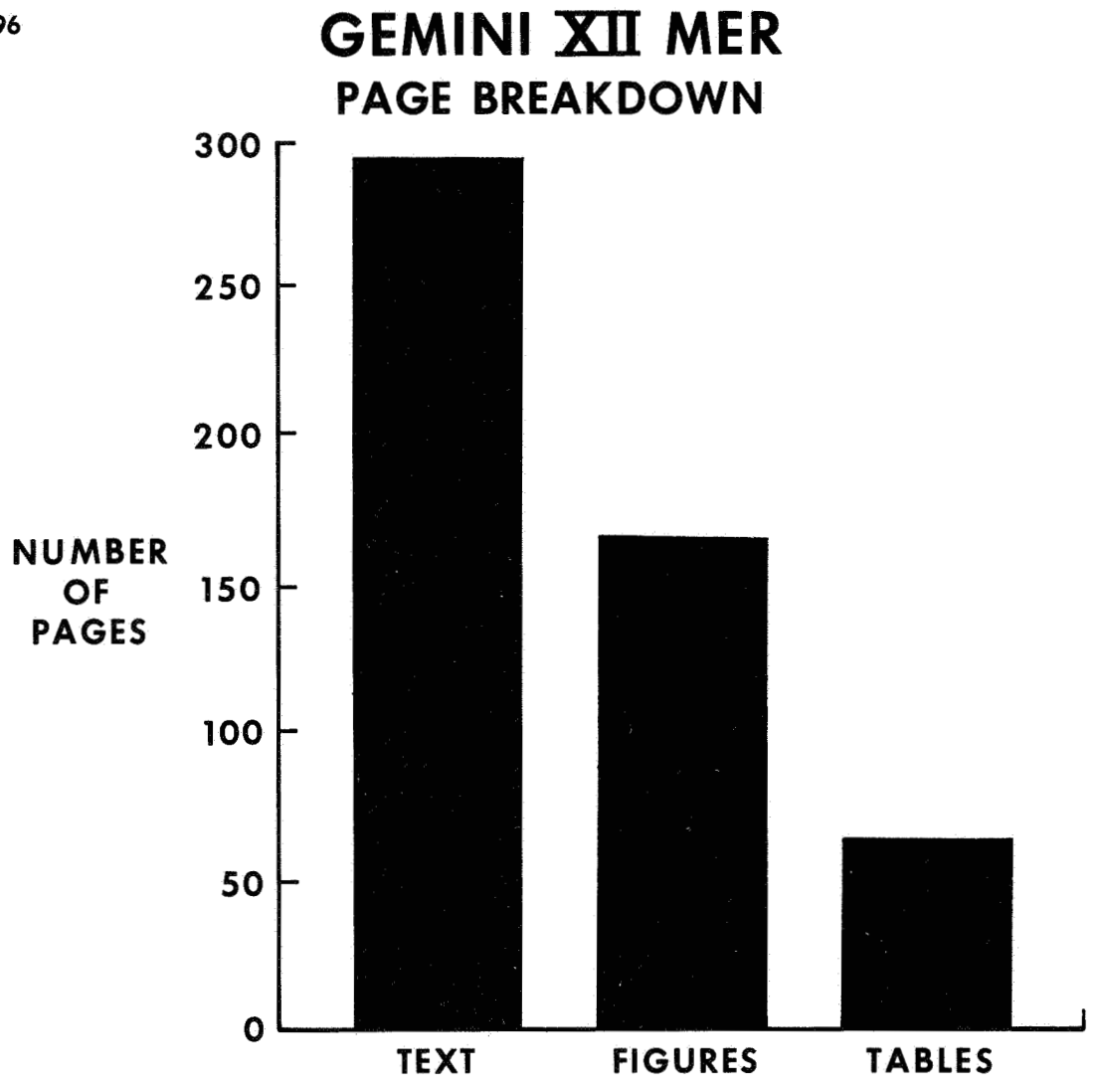

Figure 2

NASA-S-68-97

MER TEAM

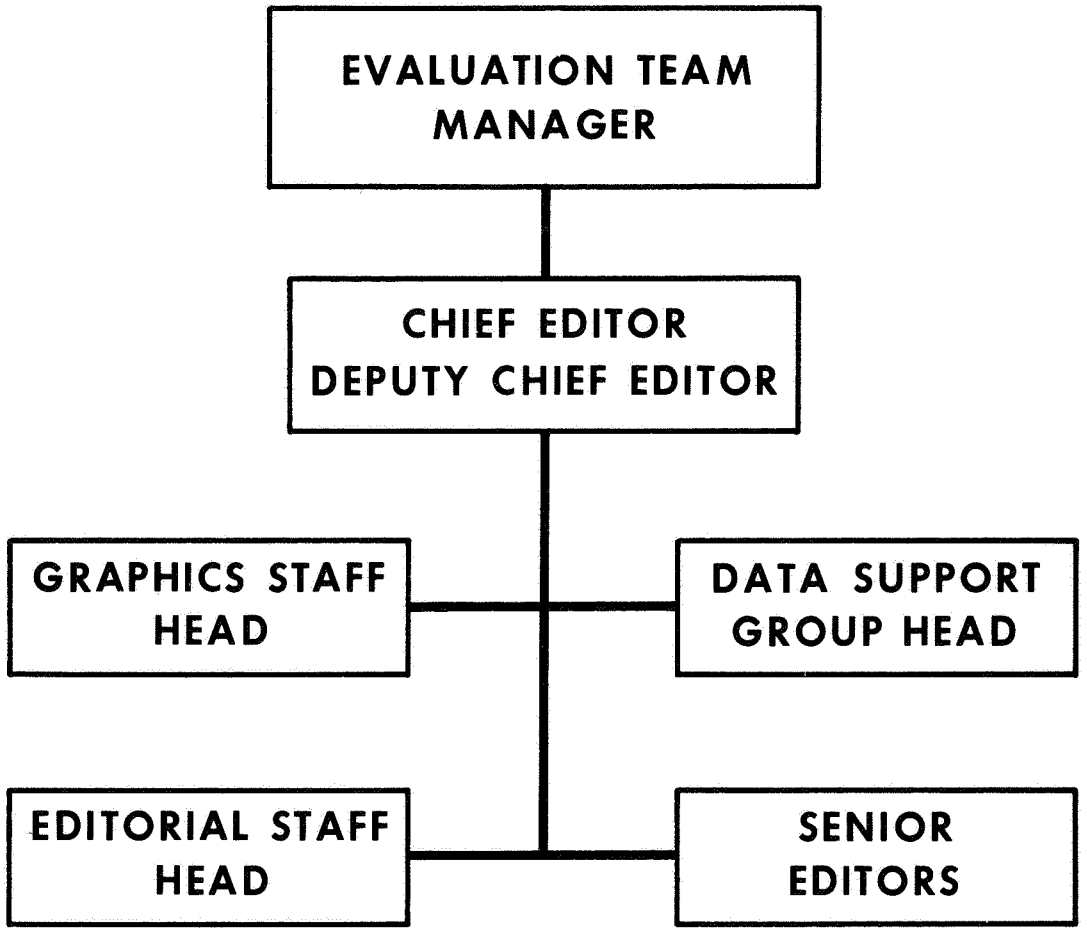

Figure 3

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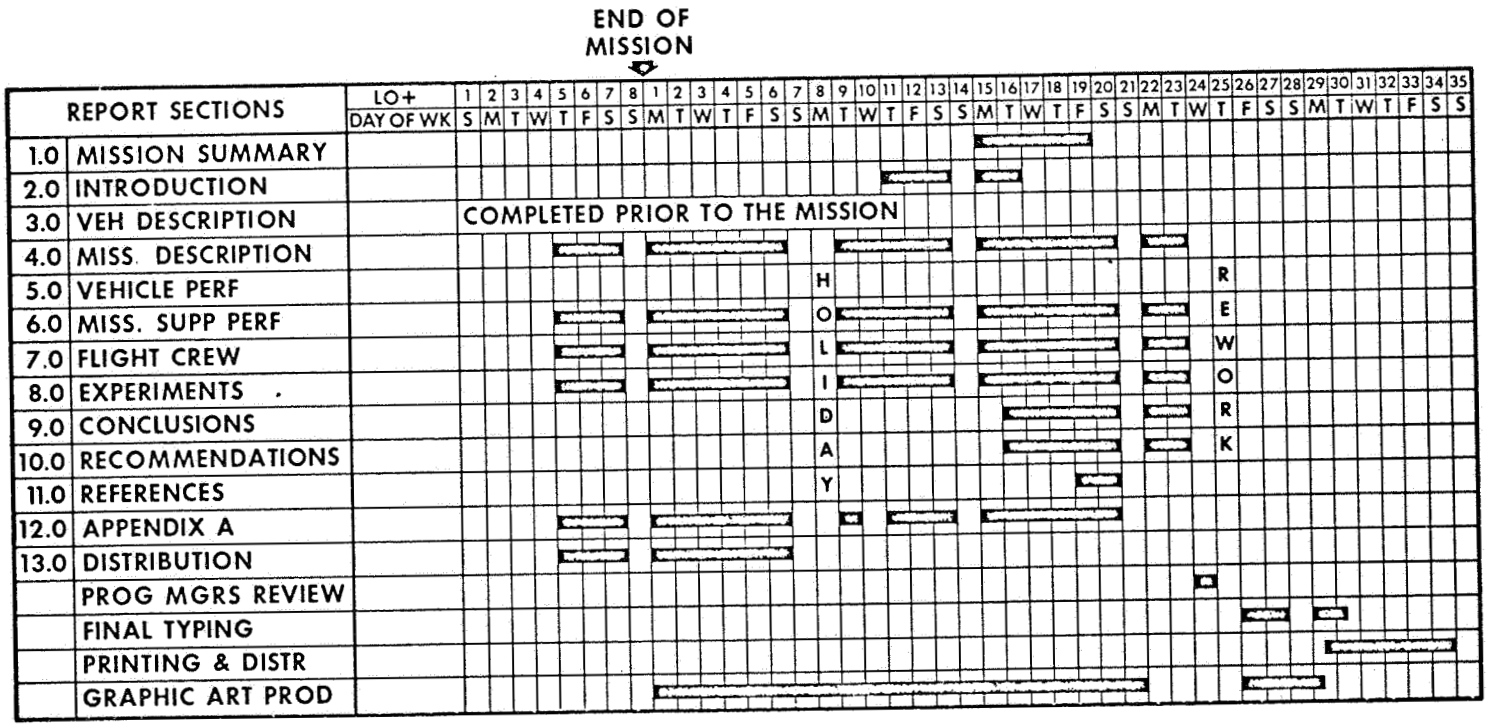
GEMINI MISSION REPORTING SCHEDULE



SLIDE 4

Figure 4

NASA-S-68-99

GEMINI MER
GRAPHICS WORKFLOW

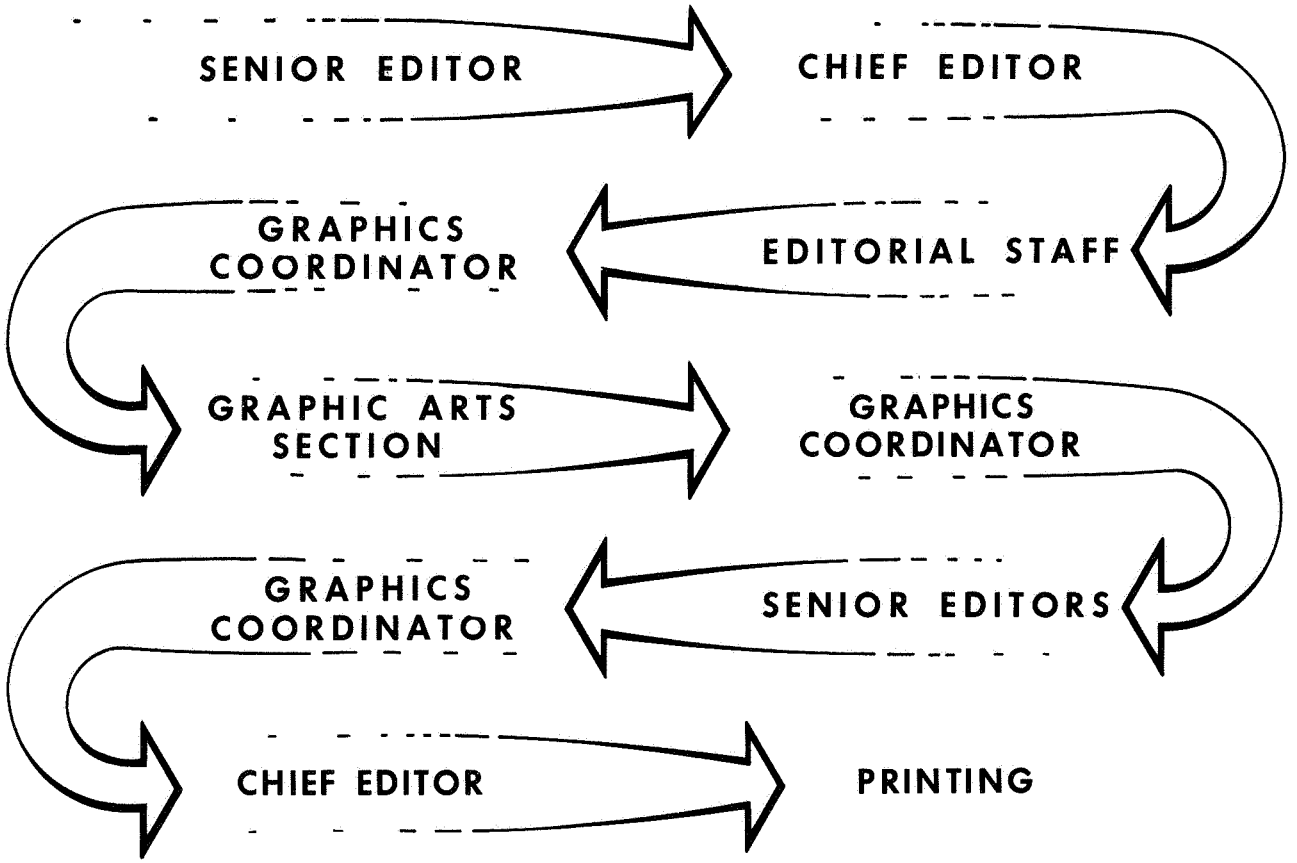


Figure 5

GRAPHICS QUALITY CONTROL POINTS

- QC MAN AT GRAPHICS (CONTRACTOR)
- GRAPHICS COORDINATOR ON MER TEAM (CONTRACTOR)
- GRAPHICS COORDINATOR ON MER TEAM (MSC)
- INITIATOR
- CHIEF EDITOR

Figure 6

3-24

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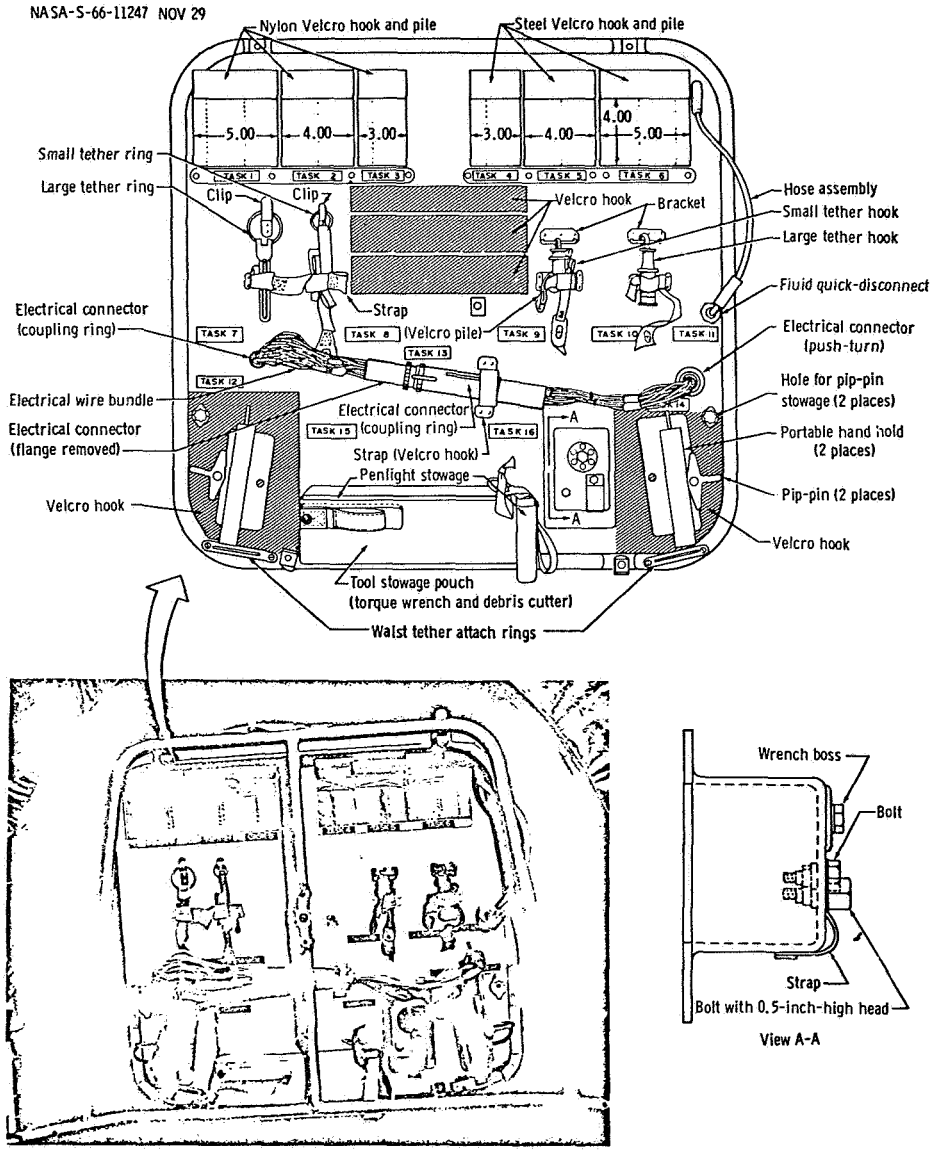

Figure 3.1-6. Adapter work station.

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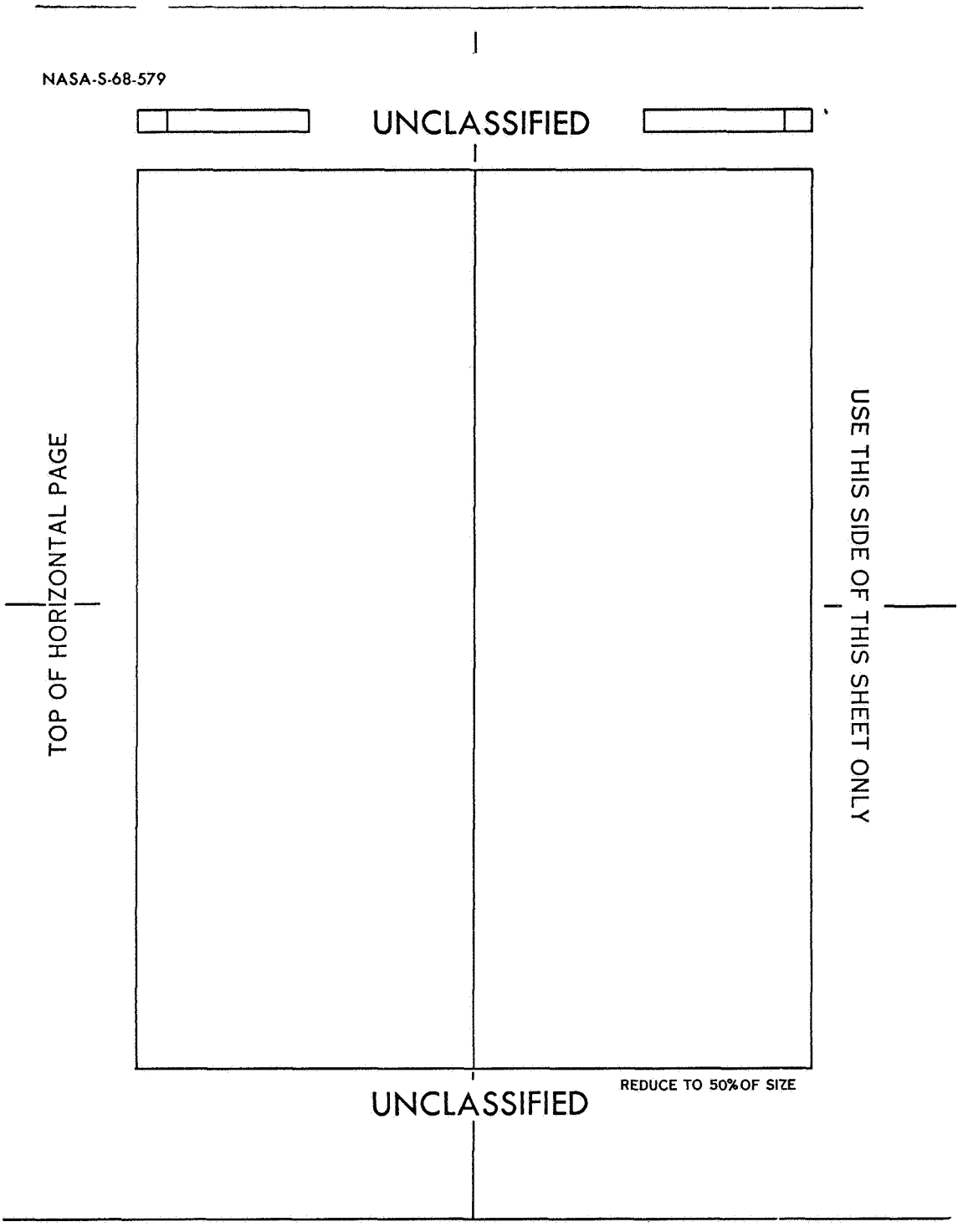
Figure 7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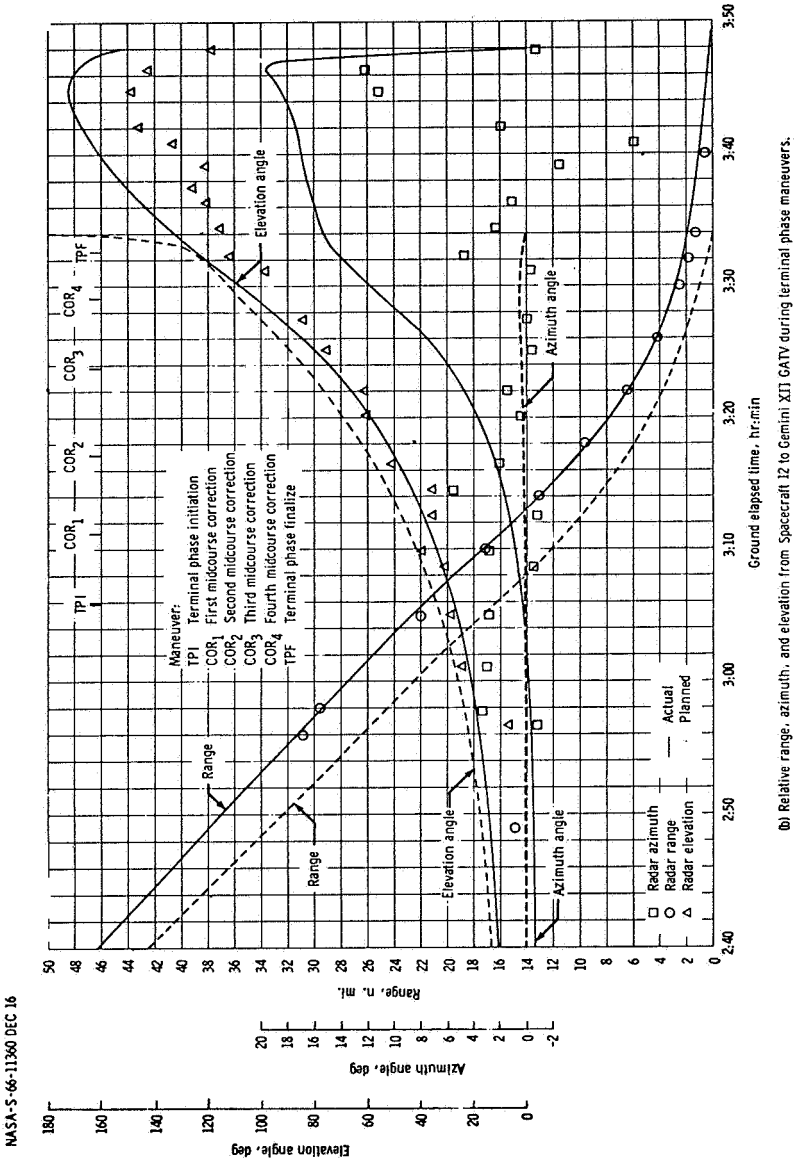
UNCLASSIFIED
TOP OF HORIZONTAL PAGE
USE THIS SIDE OF THIS SHEET ONLY
REDUCE TO 50% OF SIZE
UNCLASSIFIED

Figure 8

UNCLASSIFIED

4-49



(b) Relative range, azimuth, and elevation from Spacecraft 12 to Gemini XII GATV during terminal phase maneuvers.

Figure 4.3-4. Continued.

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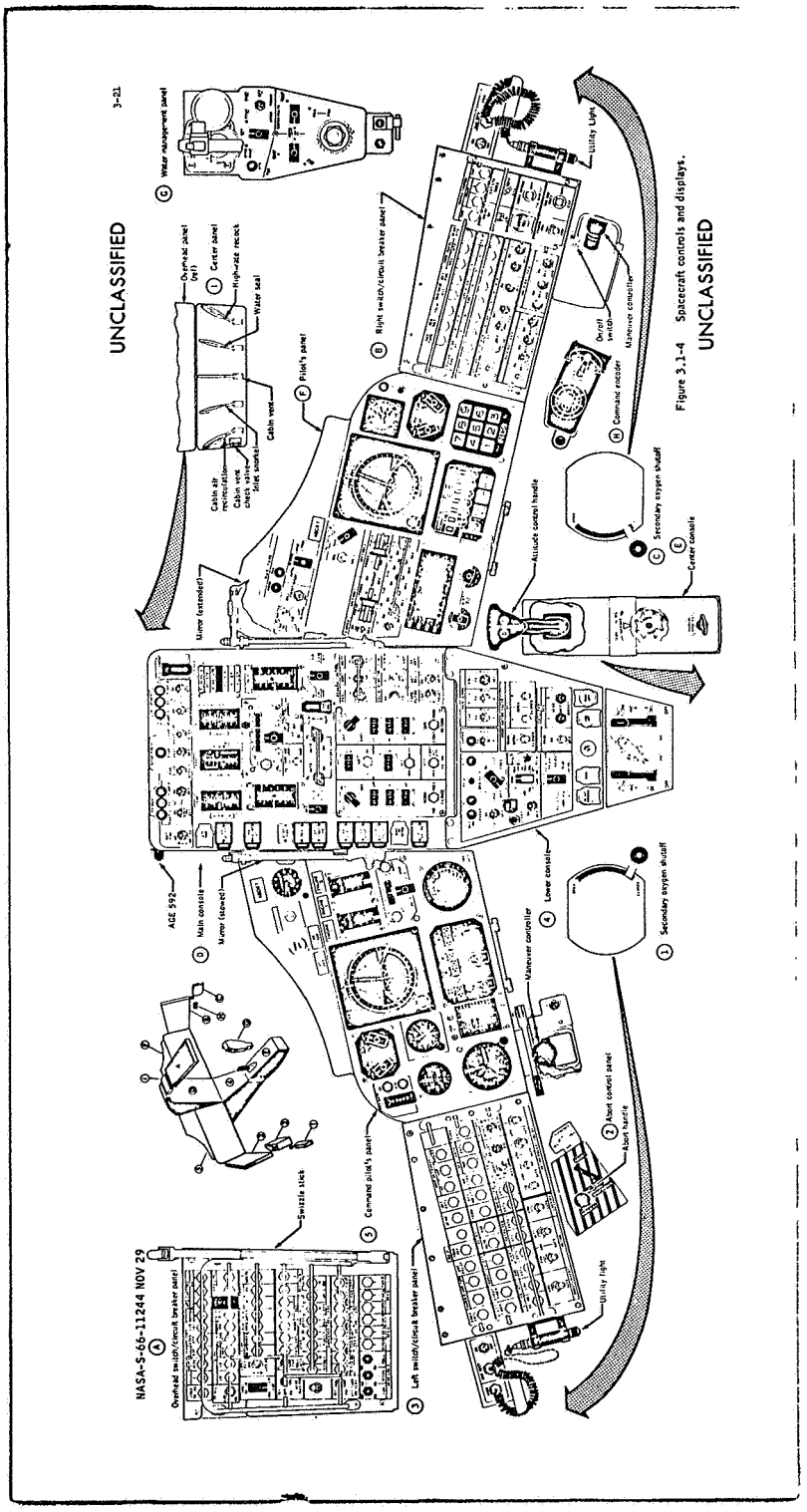
Figure 9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3-21
Figure 3.1-4 Spacecraft controls and displays.
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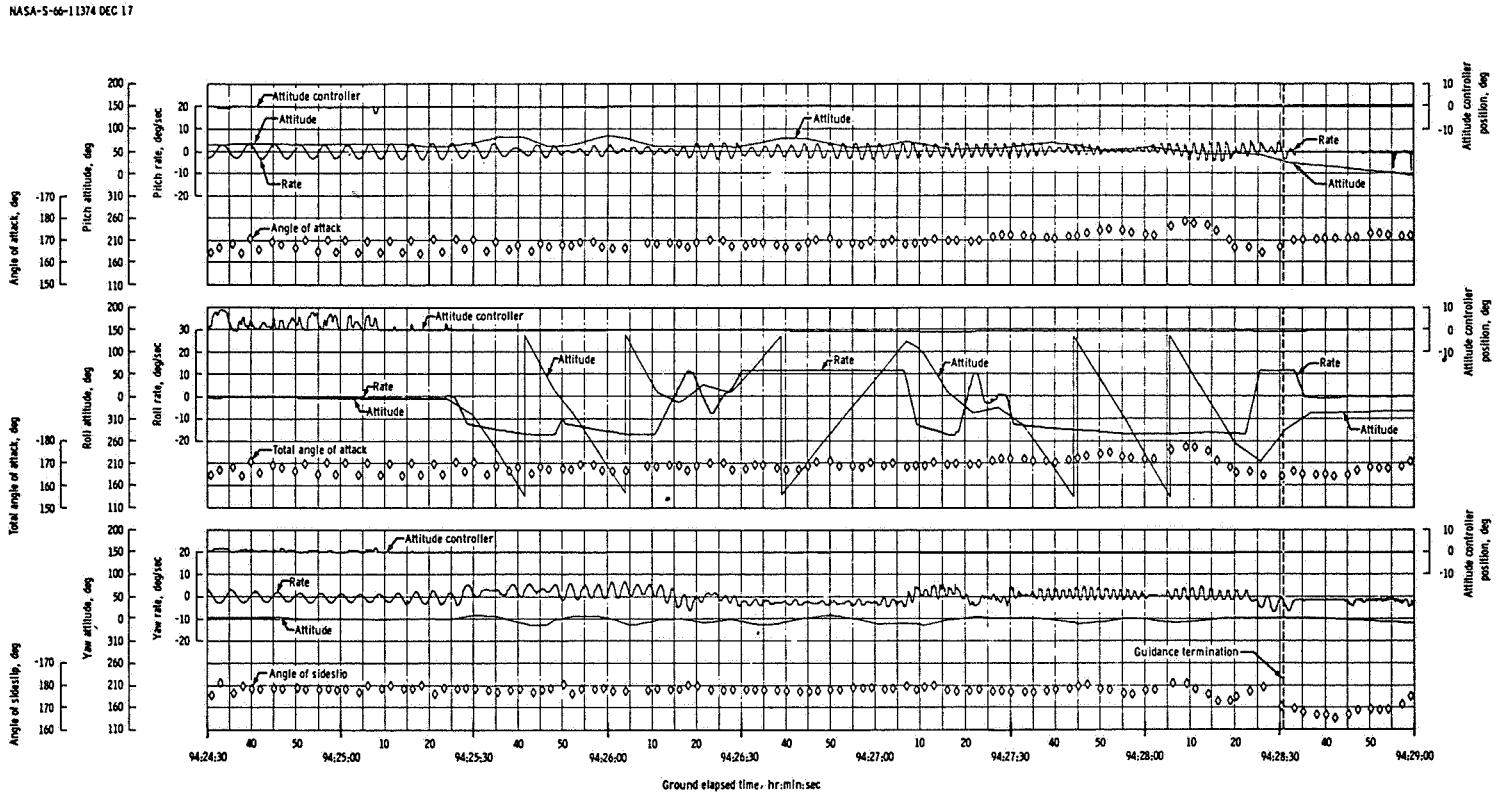
NASA-S-66-11244 NOV 29

Figure 10



(b) 94:24:00 to 94:29:00 g.e.t.

Figure 5.1.5-10. Concluded.

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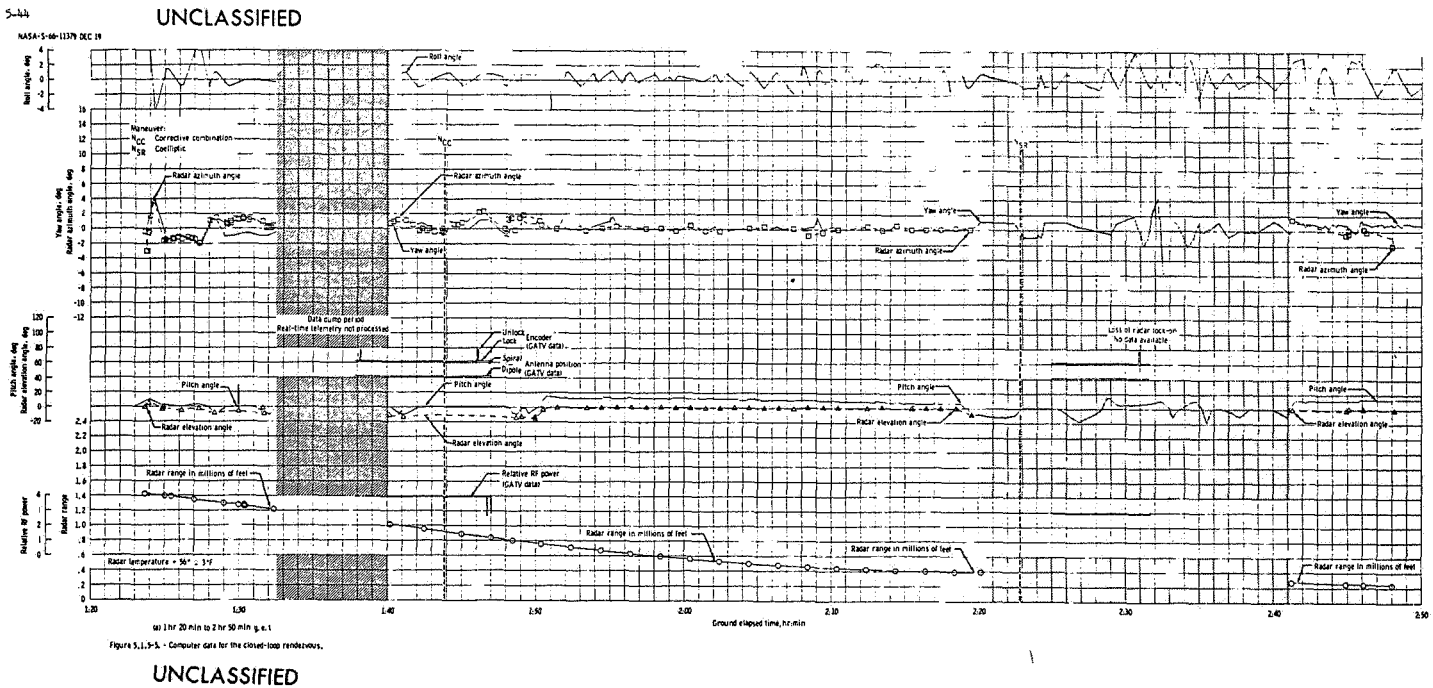
Figure 11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Roll angle
Maneuver:
N_{CC} Corrective combination
N_{SR} Coelliptic
Radar azimuth angle
Yaw angle
Data dump period
Real-time telemetry not processed
Unlock
Lock
Encoder (GATV data)
Spiral
Dipole
Antenna position (GATV data)
Loss of radar lock-on
No data available
Pitch angle
Radar elevation angle
Radar range in millions of feet
Relative RF power (GATV data)
Radar temperature = 56° ± 3°
1:20
1:30
1:40
2:50
2:00
2:10
2:20
2:30
2:40
2:50
Ground elapsed time, hr:min
(a) 1 hr 20 min to 2 hr 50 min g.e.t.
Figure 5.1.5-5. - Computer data for the closed-loop rendezvous.
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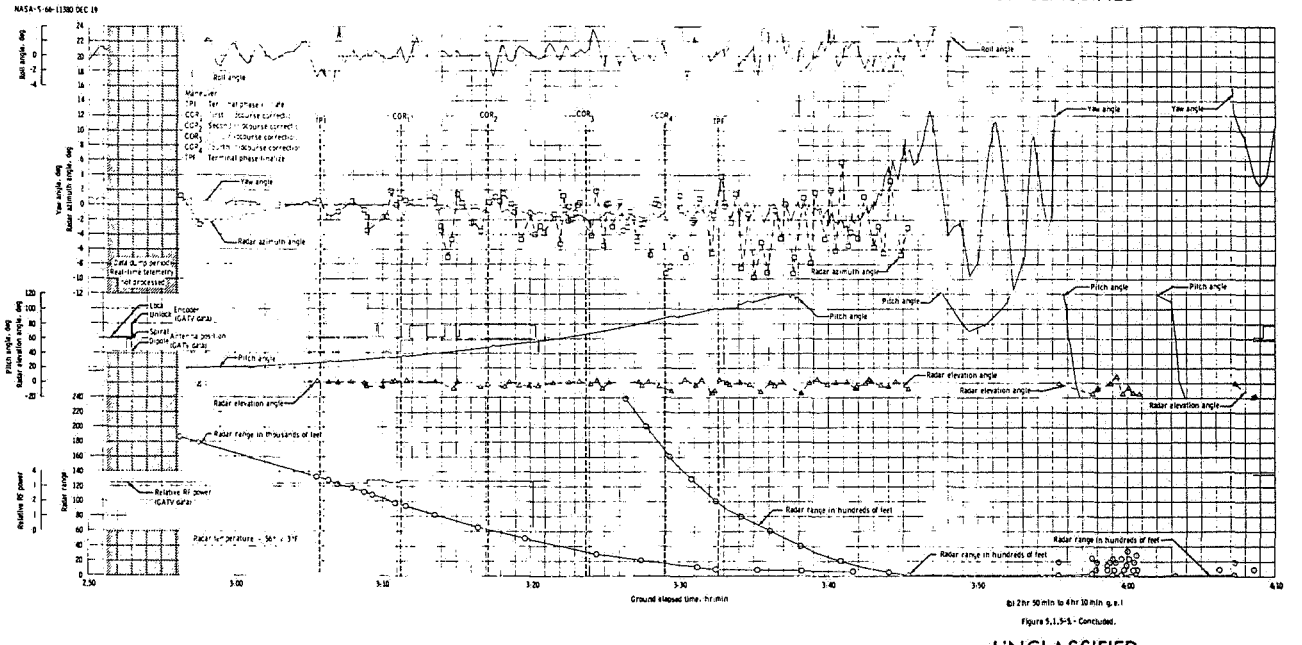
Figure 12



(b) 2 hr 50 min to 4 hr 10 min g.e.t.

Figure 5.1.5-5 - Concluded.

Figure 13

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GEMINI MER

FIGURES VS TEXT AND TABLES

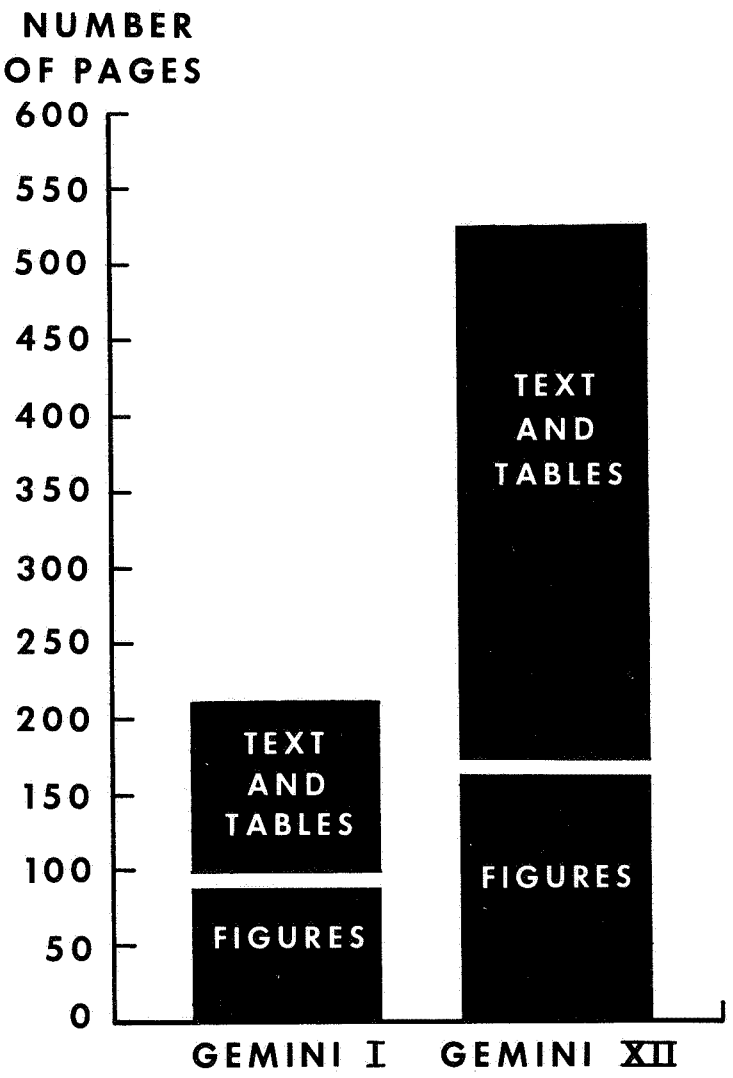

Figure 14

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TYPICAL MER WORKLOAD

- TOTAL NUMBER OF PIECES INITIATED 160
- CHANGE REQUIREMENTS 85
- CORRECTIONS 20

TOTAL INPUTS TO GRAPHICS 265

Figure 15

NASA-S-68-92

RESOURCES EMPLOYED IN MER ART PRODUCTION

- UPDATE EXISTING ART
- UTILIZATION OF MATH AID PLOTS AS ORIGINAL ART
- UTILIZATION OF PREPRINTED MAPS
- USE PHOTOGRAPH/ARTWORK COMBINATIONS TO SIMPLIFY ILLUSTRATIONS
- DESIGN PREPRINTED FORMS TO DISPLAY CERTAIN DATA
- UTILIZATION OF MACHINE PLOTS AS ORIGINAL ART
- PLAN PRODUCTION OF FIGURES WITH MAXIMUM FLEXIBILITY
- ASSIGN ONE NASA AND ONE CONTRACTOR GRAPHIC COORDINATOR TO THE MER TEAM

Figure 16

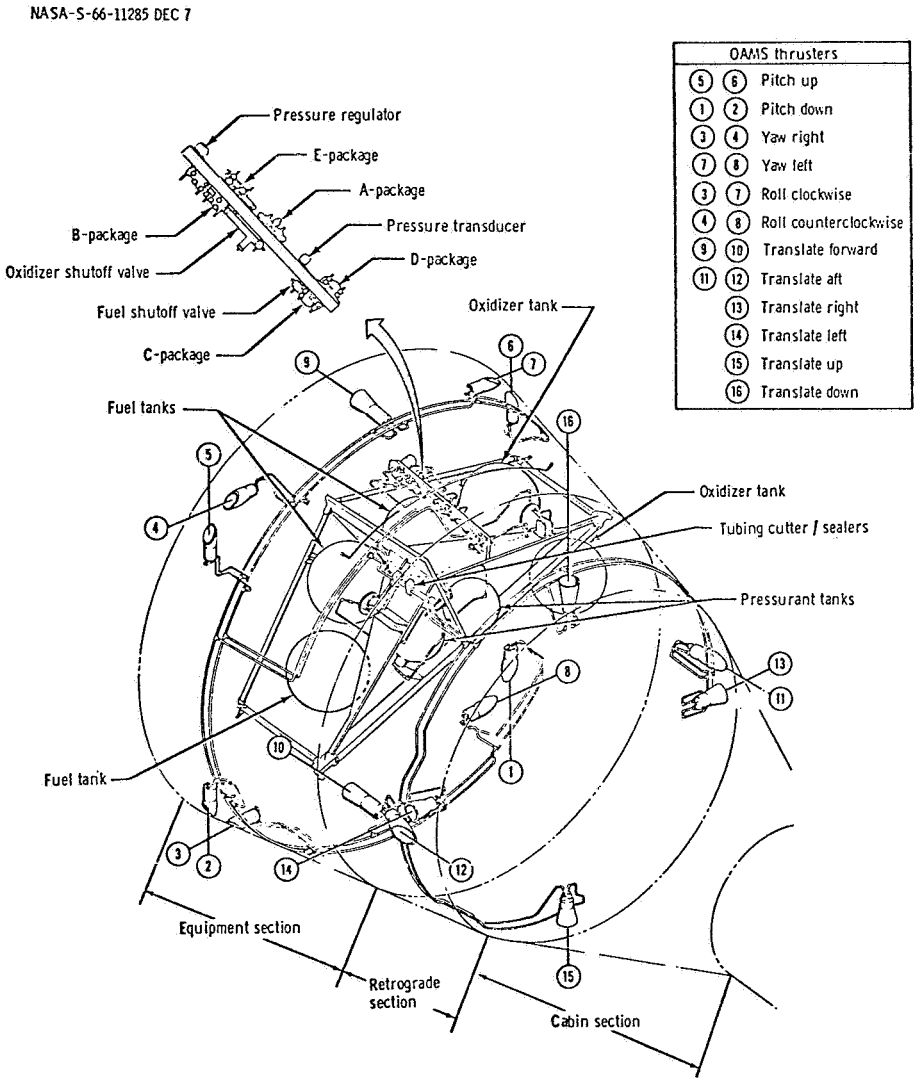

Figure 3.1-3. Orbital Attitude and Maneuver System.

Figure 17

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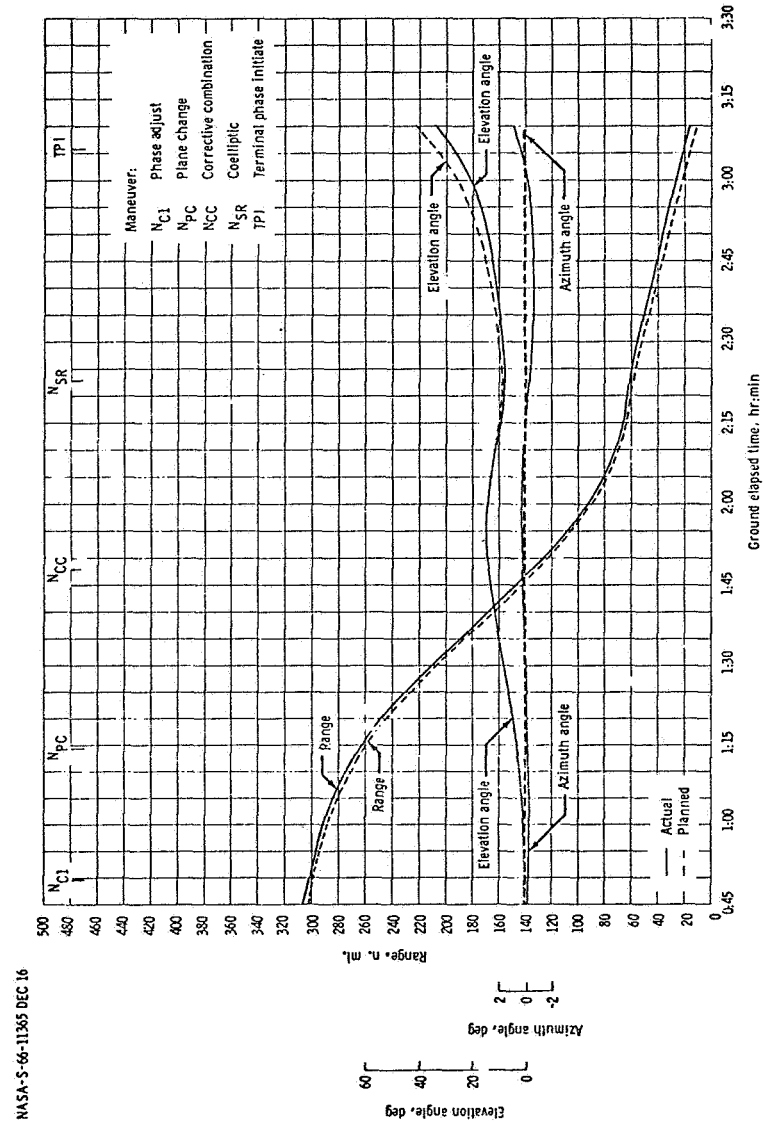

(a) Relative range, azimuth, and elevation from Spacecraft 12 to Gemini XII GATV during pretransfer maneuvers.

Figure 4.3-4. Rendezvous during the Gemini XII mission.

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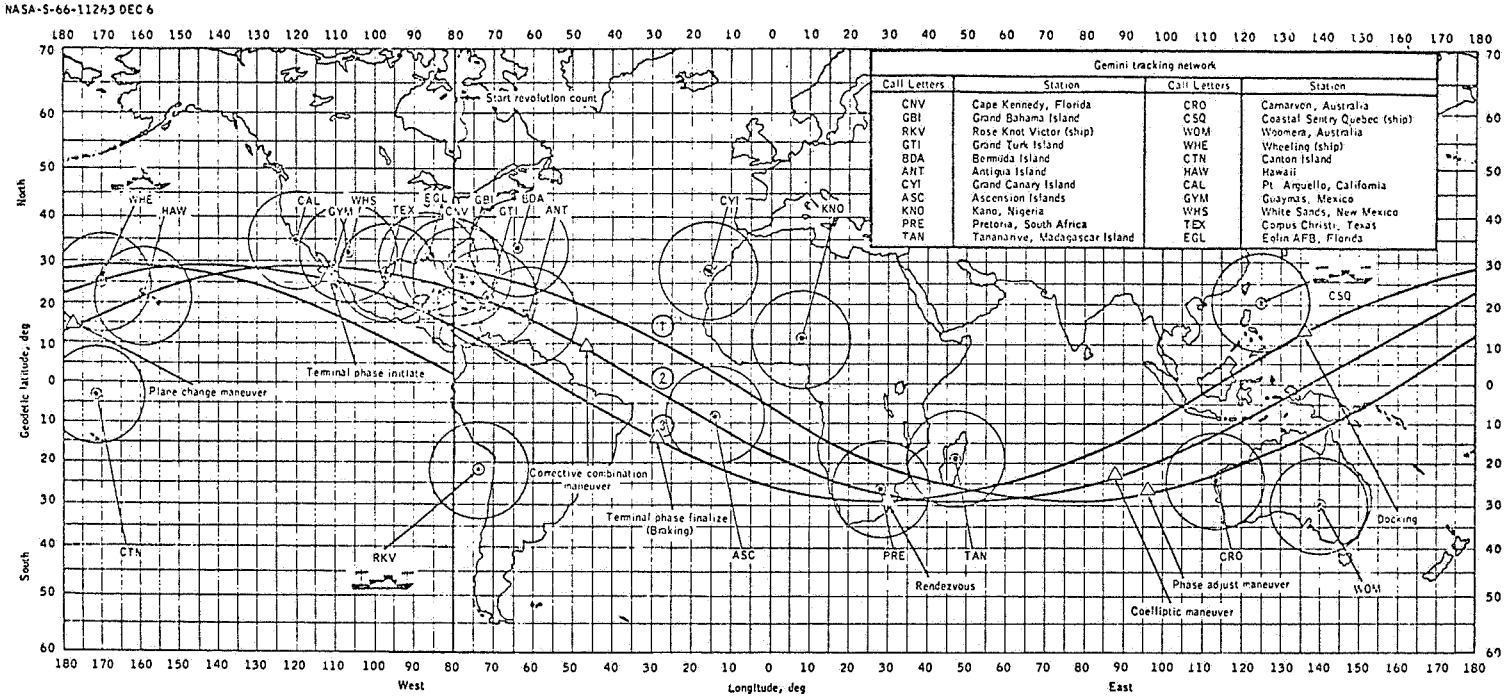
Figure 18



(a) Revolutions 1 through 3.

Figure 4.3-1.- Ground track for the Gemini XII orbital mission.

Figure 19

3-16 UNCLASSIFIED

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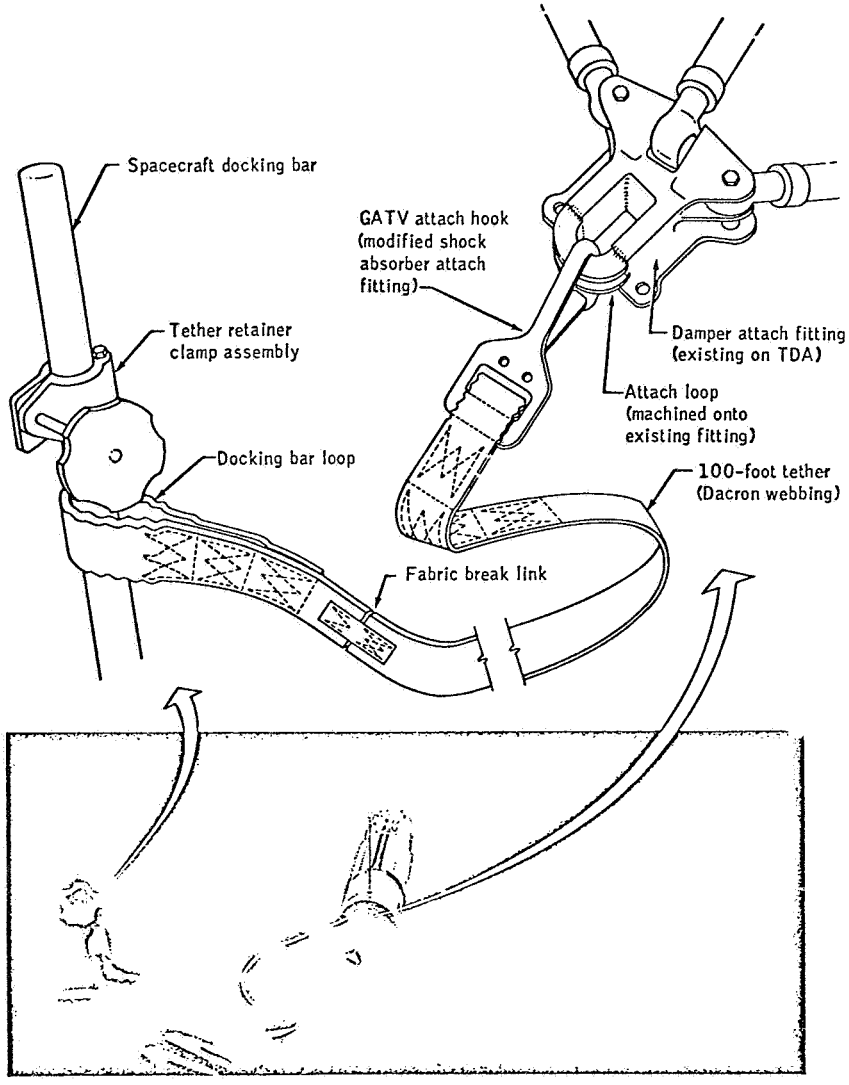

Figure 3.1-2. - Tethered vehicle evaluation equipment.

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Figure 20

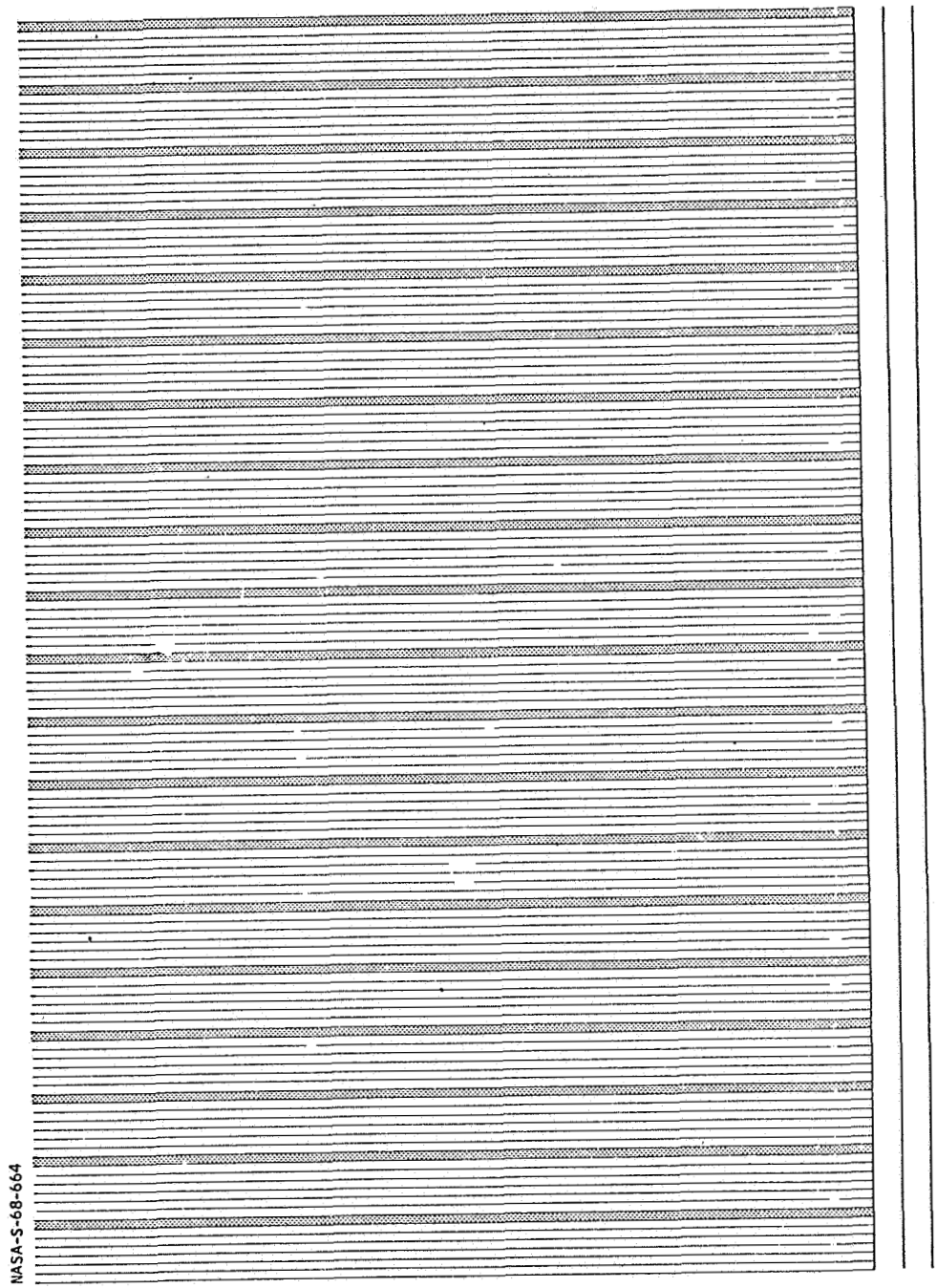

Figure 21 (a)

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12-3

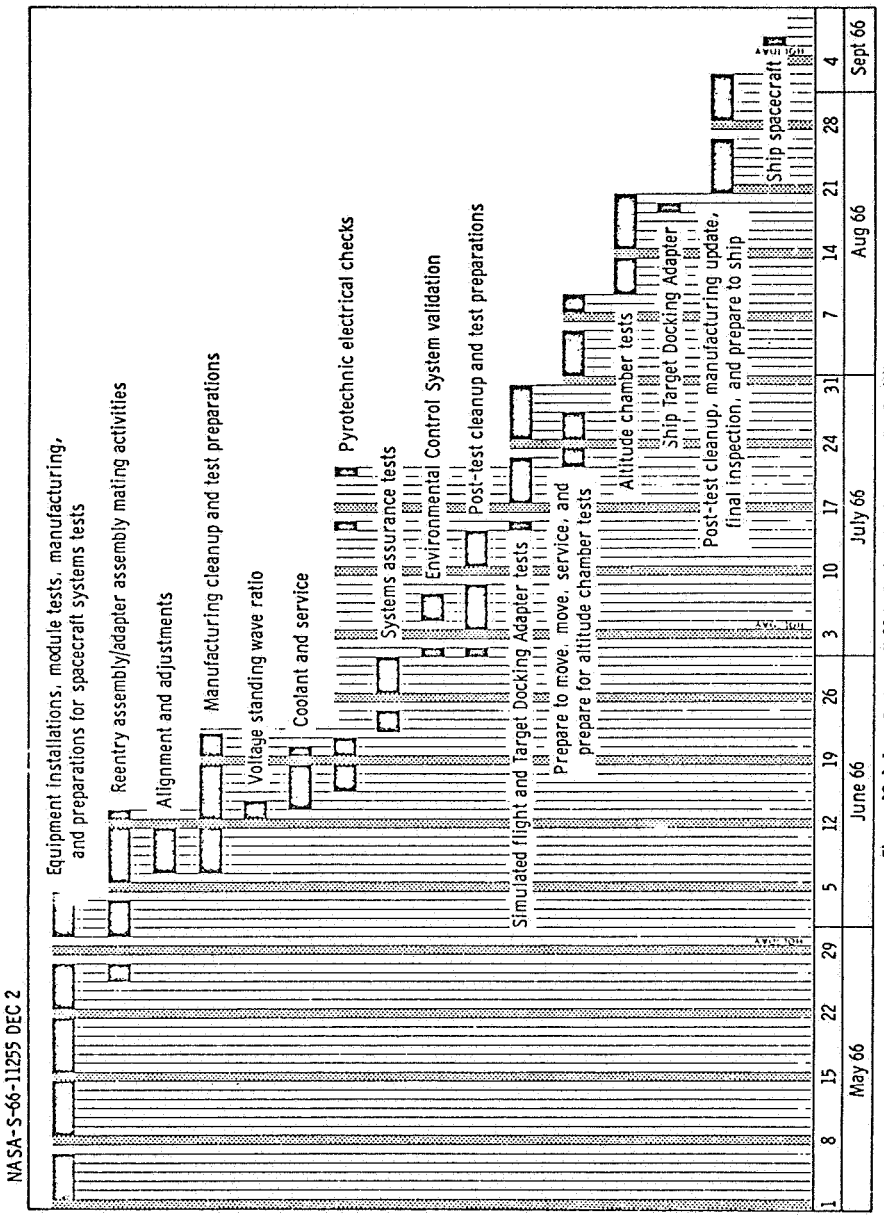

Figure 12.1-1. - Spacecraft 12 test history at contractor facility.

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Figure 21 (b)

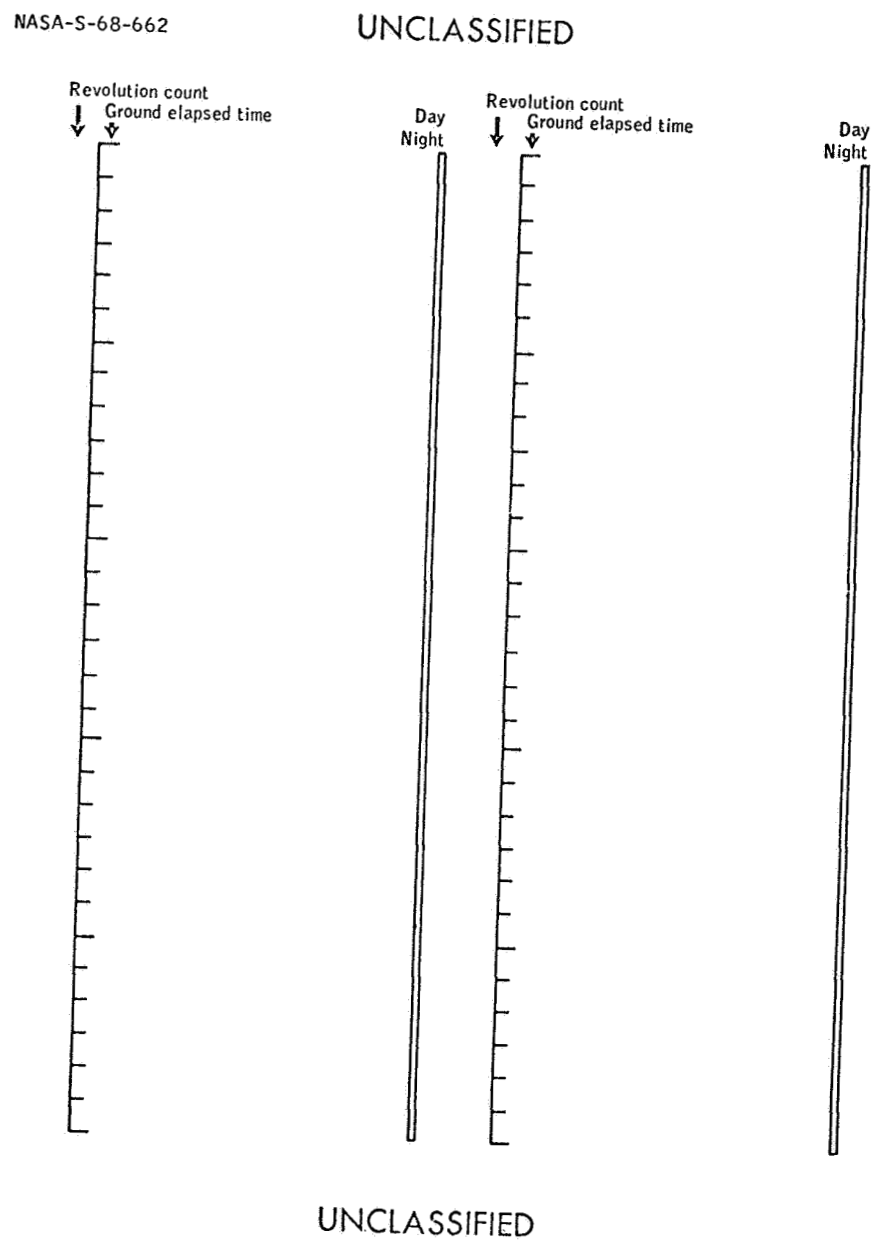
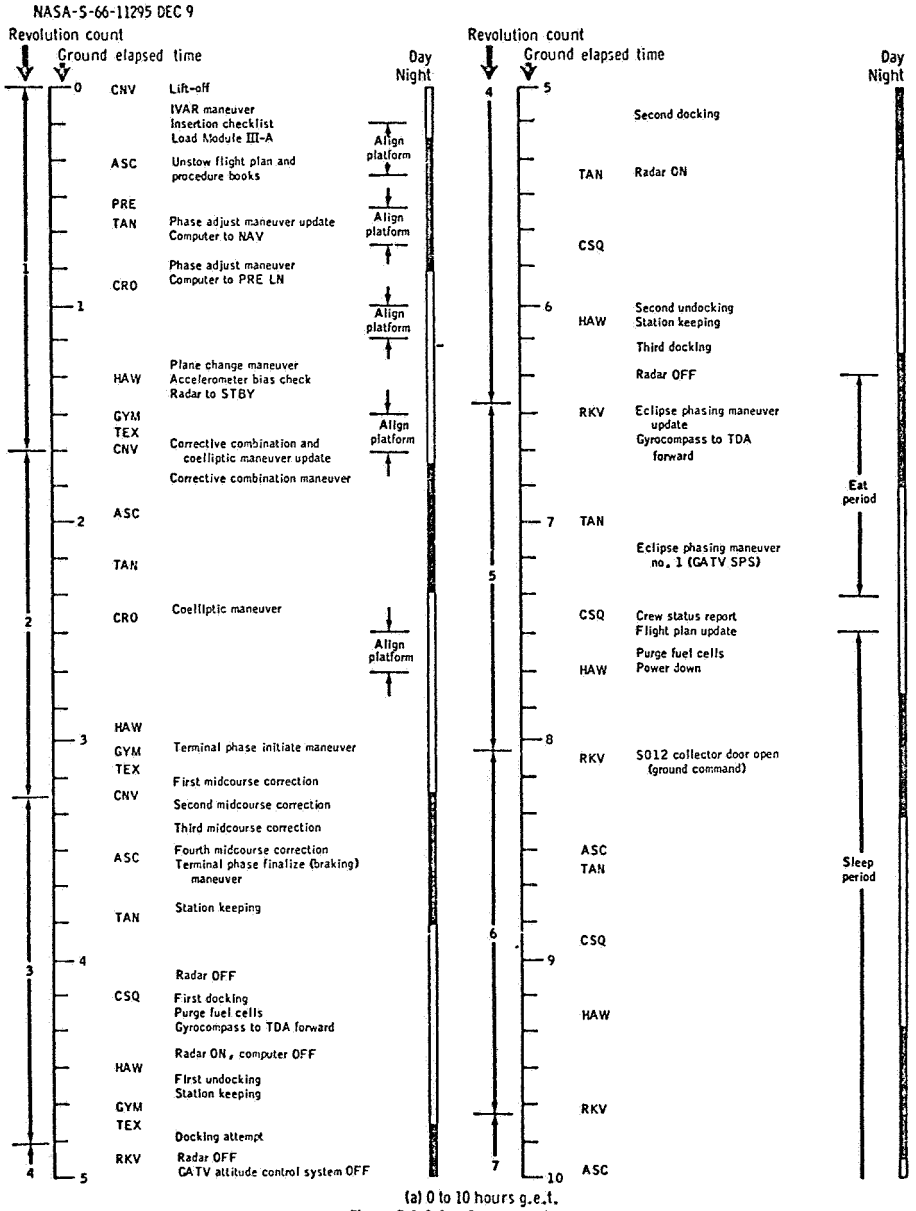

NASA-S-68-662
UNCLASSIFIED
Revolution count
Ground elapsed time
Day
Night
Revolution count
Ground elapsed time
Day
Night
UNCLASSIFIED

Figure 22 (a)

UNCLASSIFIED



(a) 0 to 10 hours g.e.t.

Figure 7.1.1-1. Summary flight plan.

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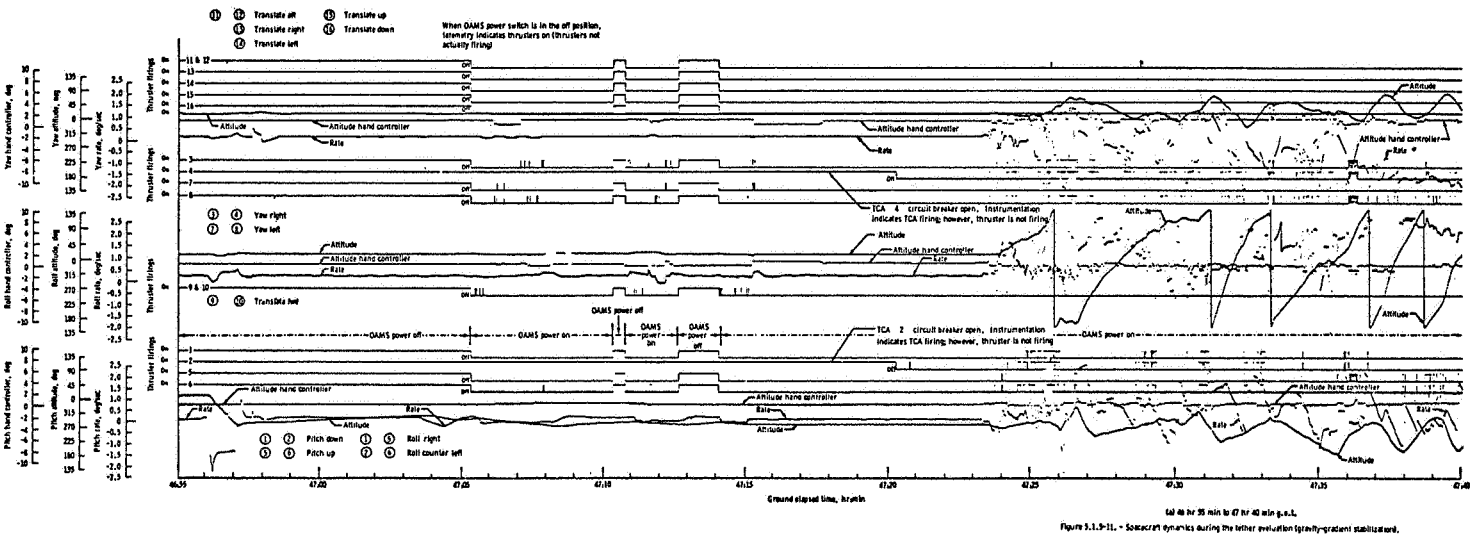
Figure 22 (b)



(a) 46 hr 35 min to 47 hr 40 min g.e.t.

Figure 5.1.9-11. - Spacecraft dynamics during the tether evaluation (gravity-gradient stabilization).

Figure 23

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7-37

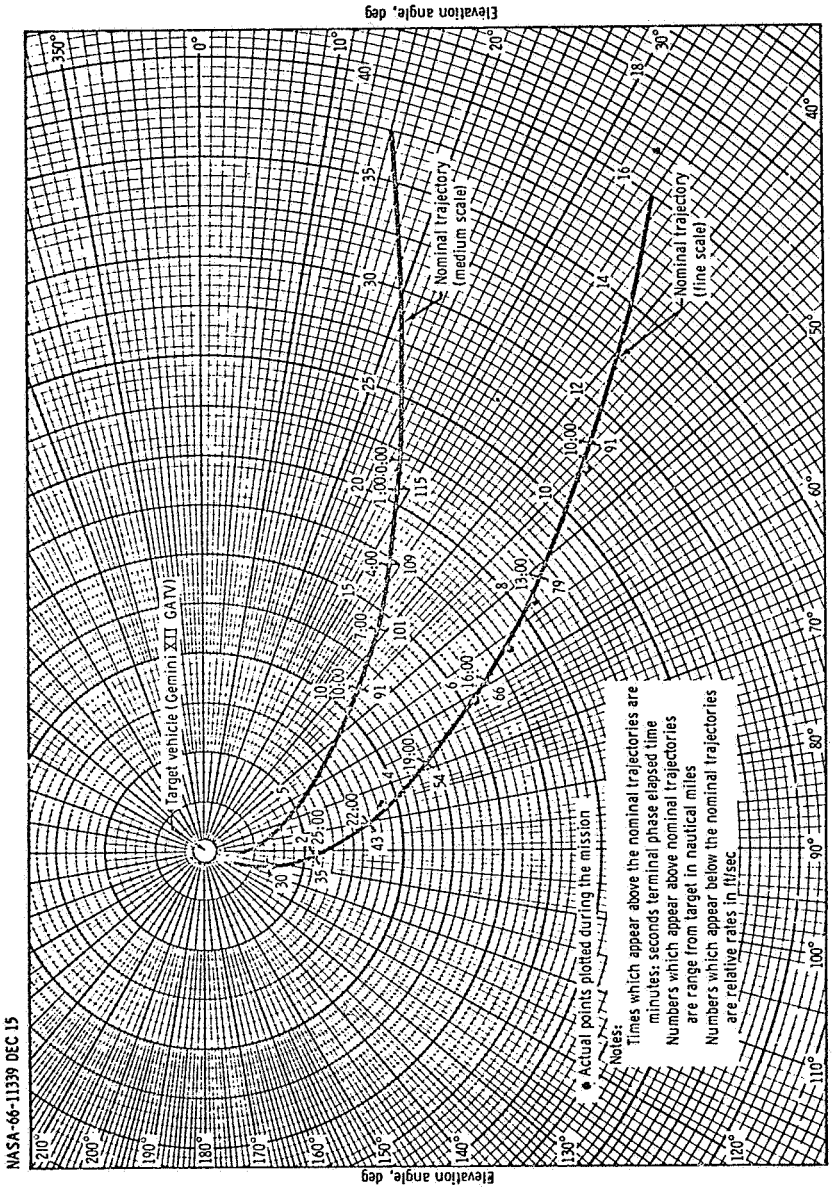

Figure 7.1.2-1. Onboard target-centered coordinate plot of rendezvous.

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Figure 24