RΞNTRY

AN ORBITAL SIMULATOR

PROJECT GEMINI

FLIGHT MANUAL

REENTRY

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I. INTRODUCTION

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1. ABOUT

Project Gemini for Reentry is one of the spacecrafts available for flight in the space simulator "Reentry – An Orbital Simulator" by Wilhelmsen Studios. It comes with a study level version modelled after the real spacecraft.

The goal of the Gemini spacecraft in Reentry is to create a gamified experience based on the real spacecraft flown by astronauts. The capsule is modelled after the Project Gemini Familiarization Manual SEDR 200 – RENDEZVOUS and DOCKING CONFIGURATIONS (Vol. 2). The implementation is focused on the Capsule 8+ configuration, containing Fuel Cells as the main power source, as well as 4 main batteries and 3 squib batteries. The differences between the configurations with Fuel Cells are minor, so with the configuration implemented here, all the Gemini missions could be flown.

All training needed to fly the capsule is available in this manual and in-game. If you want to study the spacecraft down to the lowest details, I highly recommended to read the manual by NASA. The manual is divided into two different manuals. The reason for this was that Chapter 8 (Guidance and Navigation) was confidential.

You can find the manual in the library section of reentrygame.com or below:
Project Gemini Familiarization Manual, Vol 2, section 1:
https://www.scribd.com/document/11507935/Project-Gemini-Familiarization-Manual-Vol2

Project Gemini Familiarization Manual, Vol 2, section 2:
https://www.scribd.com/document/11507785/Project-Gemini-Familiarization-Manual-Vol2-Sec2

NOTE
Not all of the components described in this document is simulated. Some might have been simplified or is a placeholder for a future update, while some will never be implemented. They are described because they are needed to complete the descriptions of systems and its operation, or for historical accuracy. This is a computer game meant for the general user, so some simplifications have been made to make it better suited for a computer game.

GET THE GAME
The game can be purchased from https://reentrygame.com/buy - the Project Gemini for Reentry is included in this package.

JOIN THE COMMUNITY

An important aspect of virtual space flight is the community – learning to operate these crafts yourself can be very complex. I recommend you join the official "Reentry – An Orbital Simulator" server on Discord, accessible from the in-game menus or http://discord.gg/reentrygame! Ask for help, find multiplayer sessions, get roles for your game progress, share clips, screenshots and meet fellow virtual astronauts and mission controllers.

WHAT IS THIS MANUAL?

This manual contains most of the information you need to successfully master the Gemini Spacecraft in Reentry. This manual is specific to the Gemini Spacecraft. For generic Reentry information, please see the **Reentry – An Orbital Simulator: User Manual**.

DONATE TO SUPPORT THE DEVELOPMENT OF THE GAME

If you wish to support the development of this game, or if you enjoy playing it, please consider giving a small donation. Creating a game like this is a lot of fun, but also takes up a lot of my spare time and my limited resources to fund it.

Any donations will help me cover costs for development, assets, server hosting, and coffee for staying up late.

You can donate from the Main Menu of the game, or online using PayPal on the following page:
http://reentrygame.com/donate

From one space enthusiast to another, thank you again for considering giving a donation!

LEGAL

Images and information in the manual, as well as in the **Project Gemini for Reentry** module is based on information made public by NASA. Images and references from various NASA documents are used.

The images in this guide and game are using public domain images from NASA.
https://www.jsc.nasa.gov/policies.html#Guidelines

The information described here is tailored to the simulation and my implementation of the spacecraft for Reentry – An Orbital Simulator. Some systems are simplified or made different due to being used in a computer software.

Both public documents released by NASA and Wikipedia has been used as a reference in my implementation of Project Gemini, as well as writing the education material for the game, including this manual, in-game academy, and mission flow.

This module is subject to change and/or removal at any time.

2. A BRIEF HISTORY

Many classify Project Gemini as the Bridge to the moon. It was NASA's second human spaceflight program and was started in 1961 and concluded in 1966. During this period, 10 missions were flown, putting United States in the lead during the Cold War Space Race against the Soviet Union.

Project Mercury was all about getting a two-manned spacecraft into a semi-permanent orbit around Earth and learn how to perform advanced space tasks. Project Gemini was designed to learn and understand how to perform EVAs (Extravehicular activity), do orbital maneuvers, and rendezvous with another satellite in space. Gemini also added an extra seat to carry two astronauts to space.
These were all critical activities that needed to be perfectioned before they could start the Apollo program.

To do this, the Gemini spacecraft needed to be able to change the orbit at any time (Mercury could only modify the attitude, not the orbit shape itself). A set of thrusters were given to the Spacecraft called OAMS (Orbital and Attitude Maneuvering System) that enabled the spacecraft to both rotate and translate.

The Spacecraft also had to include hatches that could be opened in space to add the capability of EVAs. During an EVA, one of the astronauts would exit the spacecraft during orbit and perform experiments and maintenance. This was all about being able to understand how and if a human could perform work outside the spacecraft.

Rendezvousing was also important. In Apollo, there would be multiple cases where a rendezvous was critical. This was during the moon landing, ascent from the moon and on the lunar coasting phase where the Lunar Module had to be extracted from the launch vehicle. During Gemini, a few satellites were launched so the Gemini spacecraft could practice catch-up and docking. One of the satellites was named Agena and was launched so it would be inserted in an orbit that was a few minutes ahead of the Gemini mission. The spacecraft would then catch-up with Agena, and dock with it.

All Gemini missions were launched from Launch Complex 19 at Cape Canaveral, FL.

MISSION OBJECTIVES

The four main objectives for Project Gemini were:

1) To demonstrate endurance of humans and equipment in spaceflight for extended periods, at least eight days required for Moon landing, to a maximum of two weeks
2) To effect rendezvous and docking with another vehicle, and to maneuver the combined spacecraft using the propulsion system of the target vehicle
3) To demonstrate Extra-Vehicular Activity (EVA), or space-“walks” outside the protection of the spacecraft, and to evaluate the astronauts’ ability to perform tasks there
4) To perfect techniques of atmospheric reentry and touchdown at a pre-selected location on land

3. INTERACTING WITH THE COCKPIT

When you load a Gemini mission form the Main Menu, you will be seated inside the cockpit. To look around, you can use the mouse while holding in the middle mouse button/scroll wheel. You can use the arrow keys to move the camera around.

Use F5 to F12 to move the camera to predefined spots in the cockpit view. You can use F1 to switch to an external view and F3 to enter orbital view.

There are multiple controls you can interact with in the cockpit, as well as two joysticks to orient and translate the spacecraft. This section describes how you can use the mouse/keyboard to interact with these controls.

<table>
<tr><th>SWITCH</th><th>DESCRIPTION</th></tr>
<tr><td>
</td><td>Protected Button
Covers over buttons and switches are opened with a single left click and closed with a single right click.

This applies to all the different types of covers in the spacecraft panel</td></tr>
<tr><td>
</td><td>Opening a cover will expose the trigger button below it.</td></tr>
<tr><td>
</td><td>Trigger Buttons
Trigger buttons are pressed once and will activate the system function. Some trigger buttons will trigger an irreversible function, while others can be pressed at any time.</td></tr>
<tr><td>
</td><td>Switch
Multiple switches are used to configure various onboard systems. A label is usually describing the function of the switch and what positions it can be set to. A switch can either go in a vertical direction, or a horizontal direction.

Vertical switches are pushed upwards using a single left mouse click, and downwards using a single right click.</td></tr>
</table>

Horizontal switches are pushed left using the left mouse button, and right using the right mouse button.

A switch can have two or three positions. When a three-position switch occurs, the same logic applies.

Selectors
A selector can be rotated to configure a system or select the source sensor an indicator will use.

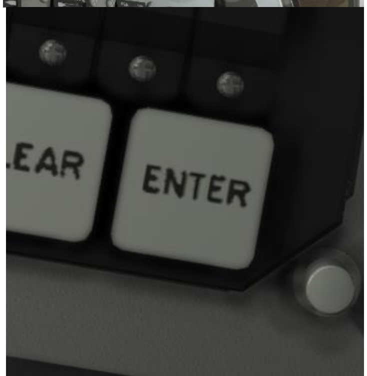
If can rotate both left and right:

- Right click moves the selection rightwards (counterclockwise).
- Left click moves it leftwards (clockwise).

A selector is usually identified by a label with marks showing what the selector is configured to.

Pull handles are pulled down with the left mouse button and pushed up with right mouse button.

Pulling the handle down will activate the system and pushing it up will deactivate the system.



Computer Buttons
The computer buttons function in the same was as a trigger button and is used to operate the onboard computer.

Gauges
Gauges are used to show the status or signal from sensors located throughout the capsule. Circular gauges and vertical gauges exist in the Gemini craft.

A gauge can consist of one or multiple needles showing the current signal, typically the amount of fuel left, oxygen levels, and pressure and temperature of various onboard systems.

Some gauges can be controlled by a selector, where the selector chooses the input/source of the gauge.

This shows a circular gauge.

This shows a vertical gauge.

Status Lights

Multiple lights are used to show the status of various systems. They come in various shapes.

Illuminated lights shows that a system is ON or requires attention.

An integrated light.

A light inside a covered button, typically used by the sequencer.

4. KEYBOARD CONTROLS

MANEUVERING

Maneuvering is done using the keyboard or joysticks. The input is configured through the Reentry – An orbital simulator settings dialogue.

ATTITUDE

W: Pitch Up

S: Pitch Down

A: Yaw Left

D: Yaw Right

Q: Roll Left

E: Roll Right

TRANSLATE

I: Up

K: Down

J: Left

L: Right

H: Forward

N: Backwards

TOOLS

T: Flashlight (move it around by using the mouse)

C: Show/Hide Radio Communication menu (circular buttons below the radio panel)

M: Show/Hide Mission Pad

V: Show/Hide view menu

ESC: Show/Hide in-game menu

II. MAJOR COMPONENTS

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The Gemini capsule is a two-manned cone-shaped spacecraft. It has 3 main sections:
1) Equipment Section
2) Retrograde Section
3) Reentry module (the capsule itself)

ADAPTER

The Equipment and Retrograde section are grouped into a module named the Adapter module. The Adapter also has the launch vehicle mating ring. The equipment section contains the major components of the Electrical, Propulsion, and Cooling Systems, as well as the primary oxygen supply for the Environmental Control System.

RE-ENTRY MODULE

The Reentry module is the capsule itself, including the head shield used for protection during reentry, a special module called the Re-entry Control System, and a Rendezvous and Recovery System (R&R).
The Re-entry Control System contains the components for re-entry, and the R&R system contains a rendezvous radar and other equipment for rendezvous and docking, as well as recovery systems such as the landing drogue, pilot parachute and the main parachute. The R&R system is jettisoned with the deployment of the drogue system, with exception of the parachutes.

GENERAL

Unlike the Mercury Spacecraft, Gemini didn't have a Launch Escape tower - it relied instead on aircraft-style ejection seats where the astronauts would be ejected from the spacecraft during an abort.

Gemini was also the first spacecraft that carried an onboard computer that would aid the astronauts during the various mission stages and orbital maneuvers. It was called the Gemini Spacecraft On-Board Computer (OBC).

The spacecraft was launched on a TITAN II launch vehicle. It had its own guidance computer that would insert it in an orbit and was a two-stage launch vehicle.

The spacecraft has two different systems for attitude control named the Reaction Control System (RCS) and the Orbital Attitude Maneuvering System (OAMS). The RCS system is used during reentry, and after Adapter separation, while the OAMS system is used in all other cases.

Fig 2.0.1 shows the different components of the spacecraft.

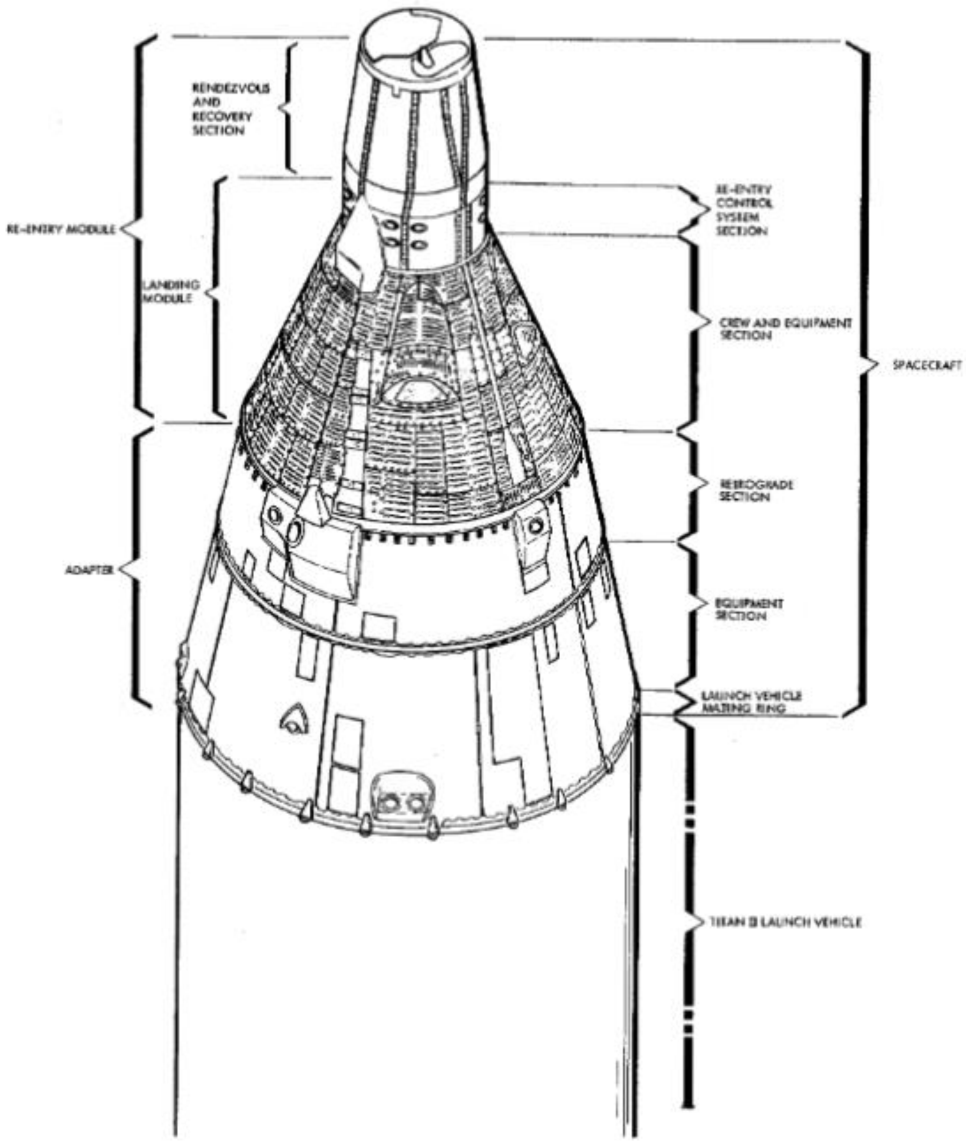


Fig 2.0.1 – Major components, from SEDR 300, Vol 2

1. THE SPACECRAFT

This section will describe the major components of the spacecraft itself in detail. The entire spacecraft with all the sections can be seen in figure 2.1.0.1.

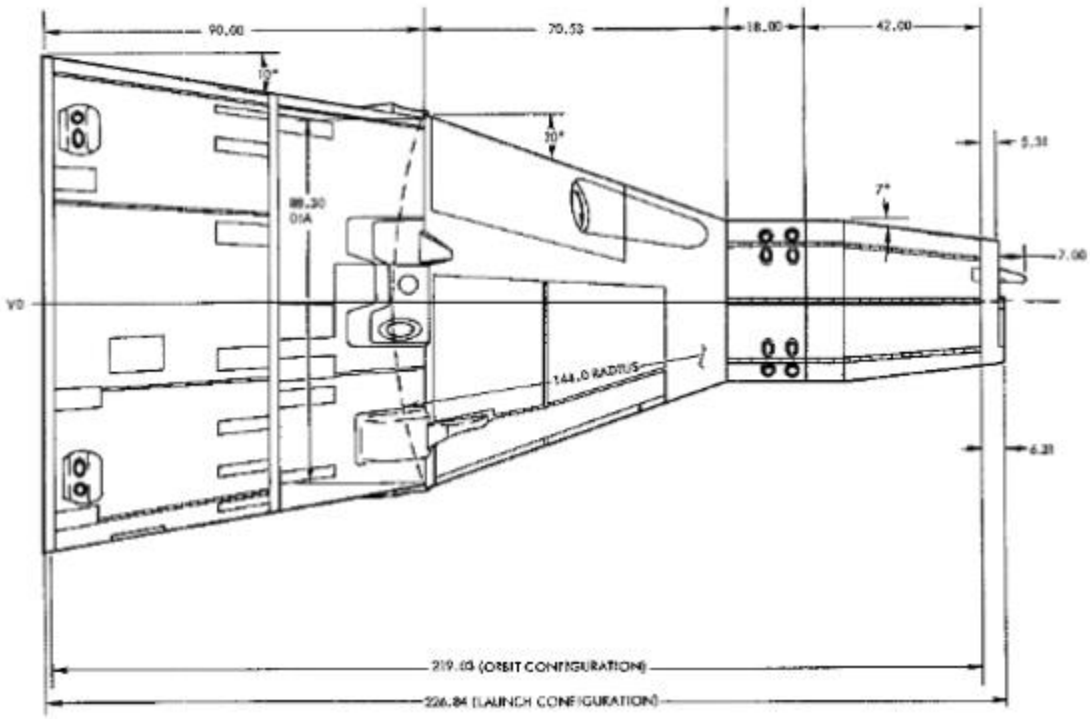


Figure 2.1.0.1 – The Gemini Spacecraft, from SEDR 300, Vol 2

1.1 – RE-ENTRY MODULE

The Re-entry module contains three primary sections, namely the Rendezvous and Recovery section (R&R), the Re-entry Control System (RCS), and the landing module. Let's take a closer look at each of these sections. Figure 2.1.1.1 shows the module with all the components.

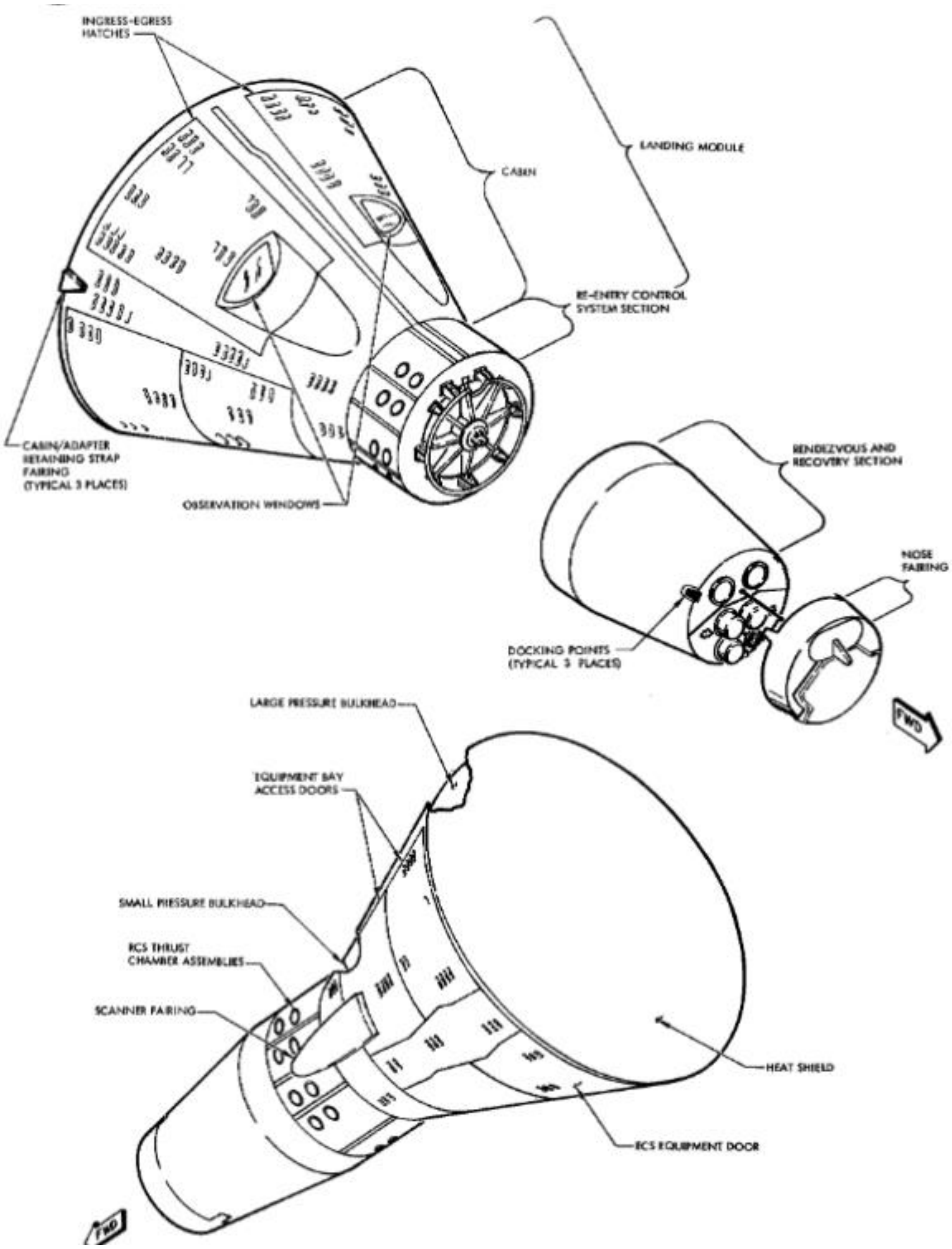


Fig 2.1.1.1 – Re-entry Module, from SEDR 300, Vol 2.

RENDEZVOUS AND RECOVERY

The Rendezvous & Recovery (R&R) is the forward section of the spacecraft. When the drogue parachute is deployed, it will jettison this system. This system contains a radar that is used to measure the range to the vehicle to rendezvous/dock with, as well as sending commands to is using an encoder. It also contains the landing systems needed to deploy the parachutes: a drogue parachute, pilots parachute and a main parachute.

RE-ENTRY CONTROL SYSTEM
This section sits on top of the landing module, and contains the fuel and oxidizer tanks, valves and thrust chambers for the reaction control system.

LANDING MODULE
The landing module is the capsule itself, containing all the necessary equipment needed after separating from the Adapter, to reentry, and splashdown. It has hatches for EVA, one for each astronaut. Each hatch has a window with reflection and UV filter.

A heat shield is attached to the blunt end of the capsule and will protect it from the extreme thermal conditions during reentry.

1.2 – ADAPTER

The adapter contains the necessary equipment for orbital flight before reentry. It's used to mate the spacecraft to the launch vehicle, house the retrograde rocket section, and the equipment section. Figure 2.1.2.1 shows the capsule with the Adapter module separated below. Notice the two sections of the adapter.

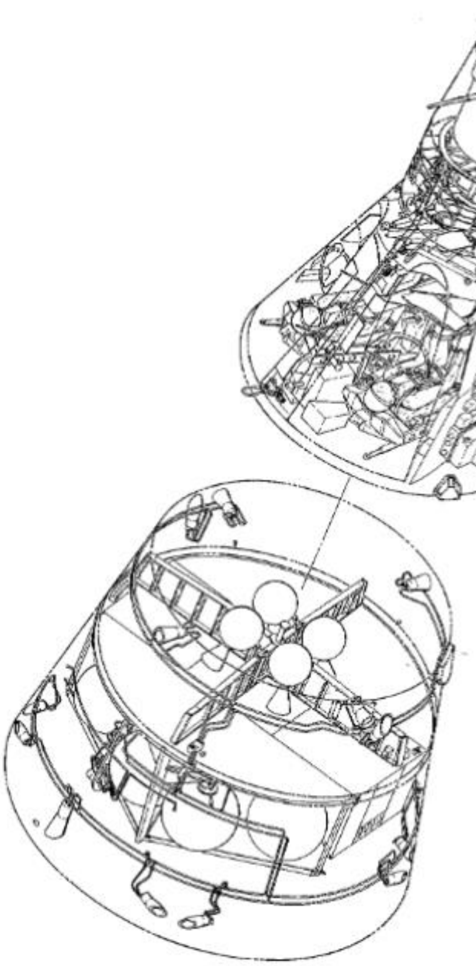


Fig 2.1.2.1 – The Capsule and the Adapter section, from SEDR 300, Vol 2.

RETROGRADE SECTION

The section attached to the blunt end of the spaceship is called the retrograde section. It is the last section that will be separated before reentry. It contains four retrograde rockets, as well as six Orbital Attitude Maneuvering System thrusters. The retrograde engine is used to bring the spacecraft back to Earth and consists of 4 rocket engines.

EQUIPMENT SECTION

This section contains the radiators needed by the coolant flow of the Environment Control System, as well as the Fuel Cells and the main electrical system, and the Substance systems. This section is jettisoned before retrograding, so it is important to switch to internal capsule batteries to avoid power loss.

2. ATTITUDE CONTROL

Multiple thrusters are used for attitude control. Both the OAMS and RCS systems has all the jets required to change attitude. The OAMS also has the capability to maneuver the craft in all directions.

3. CABIN

The panels are divided in into 7 sections. The far left and right panels, as well as the overhead panel is mostly for circuit breakers and system power control. On the far-left side, you have circuit breakers and squib control for launch, ascent and radio communication systems. The panel layout can be seen in fig 2.3.1.

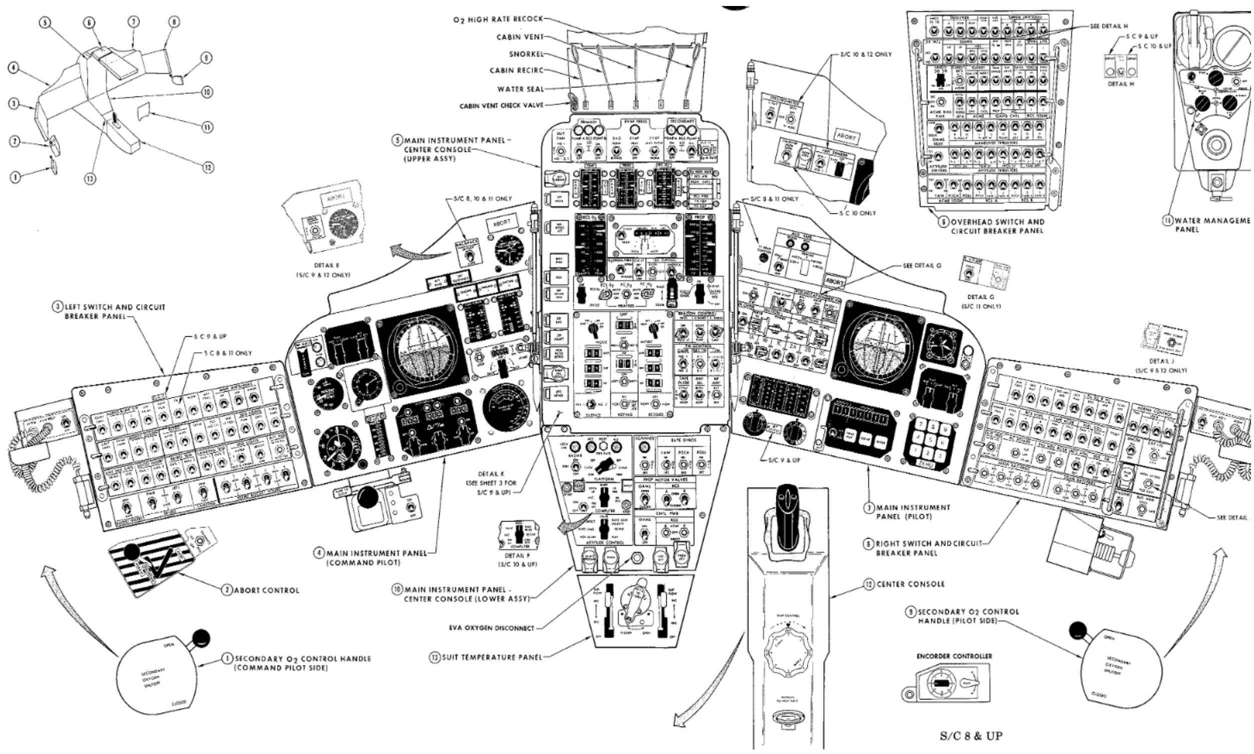


Fig 2.3.1 – Main panels of the Gemini Spacecraft, from SEDR 300, Vol 2.

The overhead panel has fuses and switches for controlling thrusters, thruster logic, lights and so on, while the far-right panel has fuses and switches for controlling the batteries, docking, encoder and so on.

The main panels consist of 4 sections. The center panel, center pedestal panel, then the commanders panel and the pilot panel.

The commanders panel has the IVI displays, a flight director and attitude indicator (FDAI), event timer, and gauges to monitor the launch vehicle stages.

The pilots panel has another FDAI, the OBC (on-board computer) input and display unity, Fuel Cell control, the auxiliary tape memory controls, and other various mission specific controls.

The center panel has controls for the communication equipment, elapsed time system, and controls for the environmental control system.

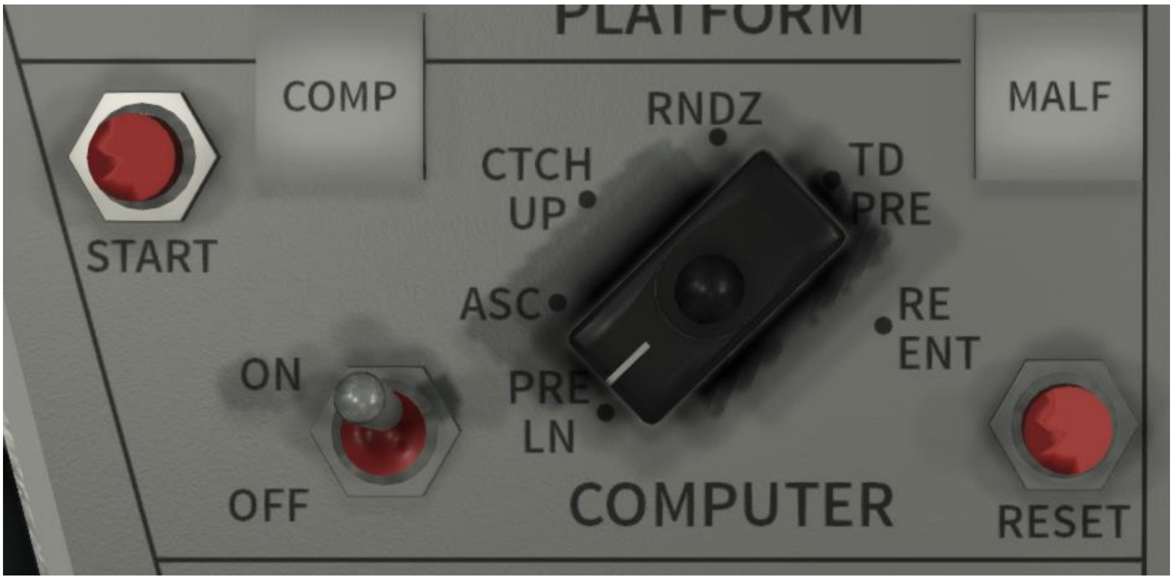
The center pedestal has maneuvering controls and mode switches, as well as computer mode control.

4. MAJOR CONTROL SYSTEMS

There are many controls the astronauts can interact with in the cabin. This section is meant to quickly give you an overview of the components for use in later chapters.

ON-BOARD COMPUTER

The On-Board Computer (OBC) is a computer use to aid with flight operations. The computer has 6 modules (programs) it can run.



Each of these programs, with exception of the Pre-Launch module and the Ascent module is stored on an Auxiliary Tape system and will automatically be loaded when the modules are selected.

The Auxiliary Tape system is automatically operated but can also be operated manually if needed. If manual mode is desired, the IVI's can be used to read the tape location.

Note: If the RUN light is green, the tape is running and indicates that a program is currently loading. Do not operate the computer.

Two Flight Director and Attitude Indicators are available. It shows the attitude of the spacecraft, as well as pointers that guide you to a set attitude.

It shows the attitude relative to a selected inertial platform, and error/rate needles what will point the spacecraft towards a specific direction, or show the attitude rate of the spacecraft.

III. GEMINI-TITAN II LAUNCH VEHICLE

III. GEMINI-TITAN II LAUNCH VEHICLE

Unlike during the Mercury Program, the Gemini Program only uses one type of a launch vehicle named the Gemini-Titan II, and is built by the Martin Company.

The launch vehicle is a two-stage launch vehicle, and is 90 ft. high (27.4 meters).

Both the engines in the launch vehicle are using hypergolic propellants where Nitrogen tetroxide is used as the oxidizer and unsymmetrical dimethylhydrazine is used as the fuel. When they mix, they are automatically ignited.

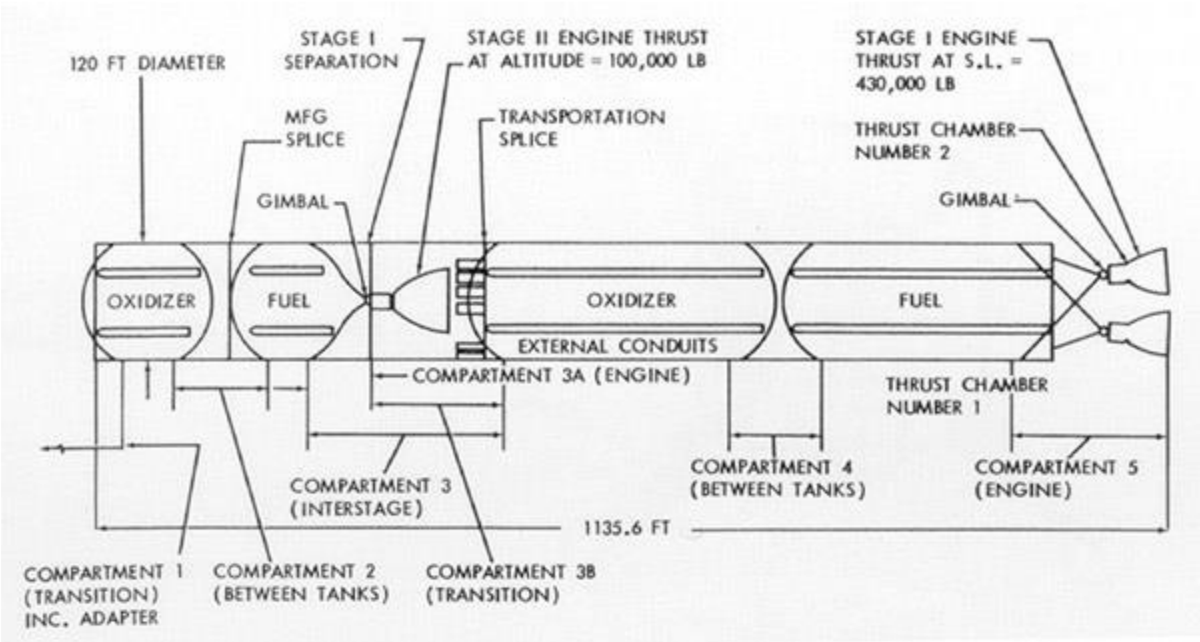


Figure 3.0.1 – Components of Stage I and Stage II, from https://history.nasa.gov/SP-4002/images/fig9.jpg

3.1 STAGE I

The first stage consists of two tanks and an engine. One tank is used for the oxidizer, and the other is used for the fuel. The engine is of the type LR87-AJ-7, and produced 430,000 pounds of thrust (1,913 kN) with a burn time of 156 seconds.

3.2 – STAGE II

The second stage is connected to the first stage using an adapter. This is a ring that keeps the second engine away from the stage I tanks, as well as holding the two stages together.

This stage also contains two tanks, and one engine. Again, one tank is for the oxidizer, and the other is for the fuel. It is powered by one LR91-AJ-7 engine producing 100,000 pounds of thrust (445 kN) for 316 seconds.

IV. ENVIRONMENTAL CONTROL SYSTEM

IV. ENVIRONMENTAL CONTROL SYSTEM

1. GENERAL

The ECS is the system that keeps the cabin pressurized, maintains temperature, removes odors and CO2, and provides oxygen and water to the astronauts. Basically, the ECS is what keeps you alive.

It is therefore very important to pay attention the ECS. The system is semi-automatic, but provides for manual control if needed. The system consists of two coolant loops that passes coolant through all the systems and panels in the spacecraft. A radiator, evaporator and heat exchanger are being used to cool the fluid down, and heat the oxygen flow. The radiator is usually warm during launch and ascent and needs 30 minutes of cooling in space before being used. Bypass the radiator if the radiator temperature is too hot.

All the pumps are being used throughout the mission, until retrograde separation where the coolant and pumps are jettisoned (they are in the adapter section). Before separation, cool down the cabin for reentry.

The Cryogenic Oxygen tank used for the Electrical System is also used as the oxygen supply for the astronauts and the environment.

Two fans are also available to maintain temperature and airflow. A set of pull-switches are available to circulate the cabin when CO2 levels get high, compress/recompress the cabin and recook hi-rate oxygen flow. Hi-rate oxygen flow is used during reentry and cabin cooldown to maximize oxygen flow.

There are 4 systems that operate somewhat independently:
1) The oxygen supply system
2) The cabin loop
3) The suit loop
4) The water management loop

Figure 4.1.1 shows this setup. Please note the systems for S/C 8 or 10 and UP.

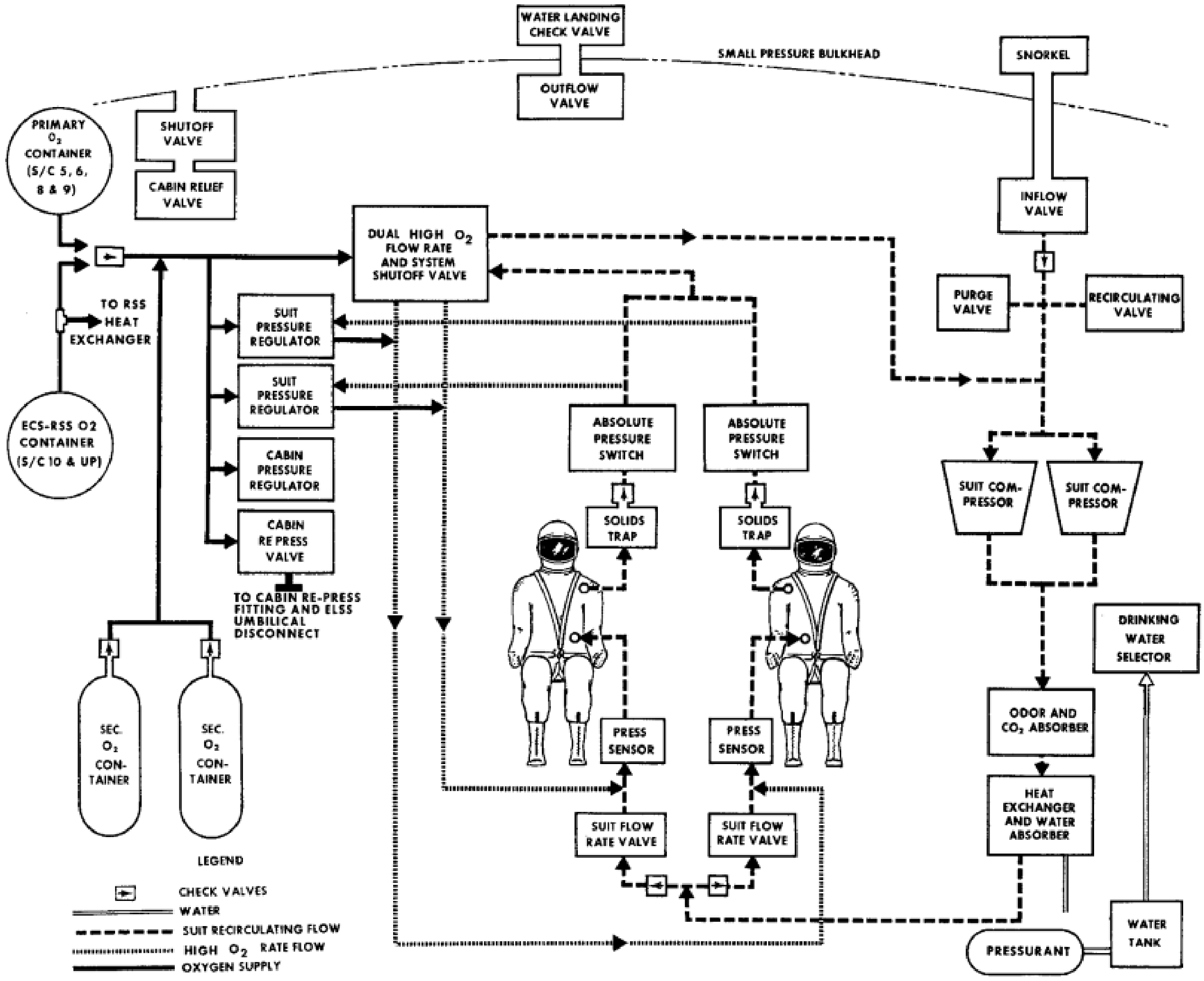


Figure 4.1.1 – ECS Block Diagram, from SEDR 300

Two independent cooling systems are in operation to provide the required cooling for the spacecraft. The coolant fluid is the Monsanto MCS 198. Each of these circuits consists of a pump that pumps the coolant through the system, as well as radiators and an evaporator to control the coolant loop and cooling amount.

Radiators are located on the Adapter, and the coolant will radiate excess heat into space using these. During ascent and initial orbit, these radiators are very hot and will require time to cool down before the coolant can enter. This is controlled on the main ECS panel.

The coolant flows through the water evaporator, to the suit and cabin manual control calves, who meters the coolant flow through the cabin and suit heat exchangers.

2. OXYGEN SUPPLY SYSTEM

There are two oxygen systems. The primary system is stored in the Adapter module, while a secondary system is stored in the Reentry module.

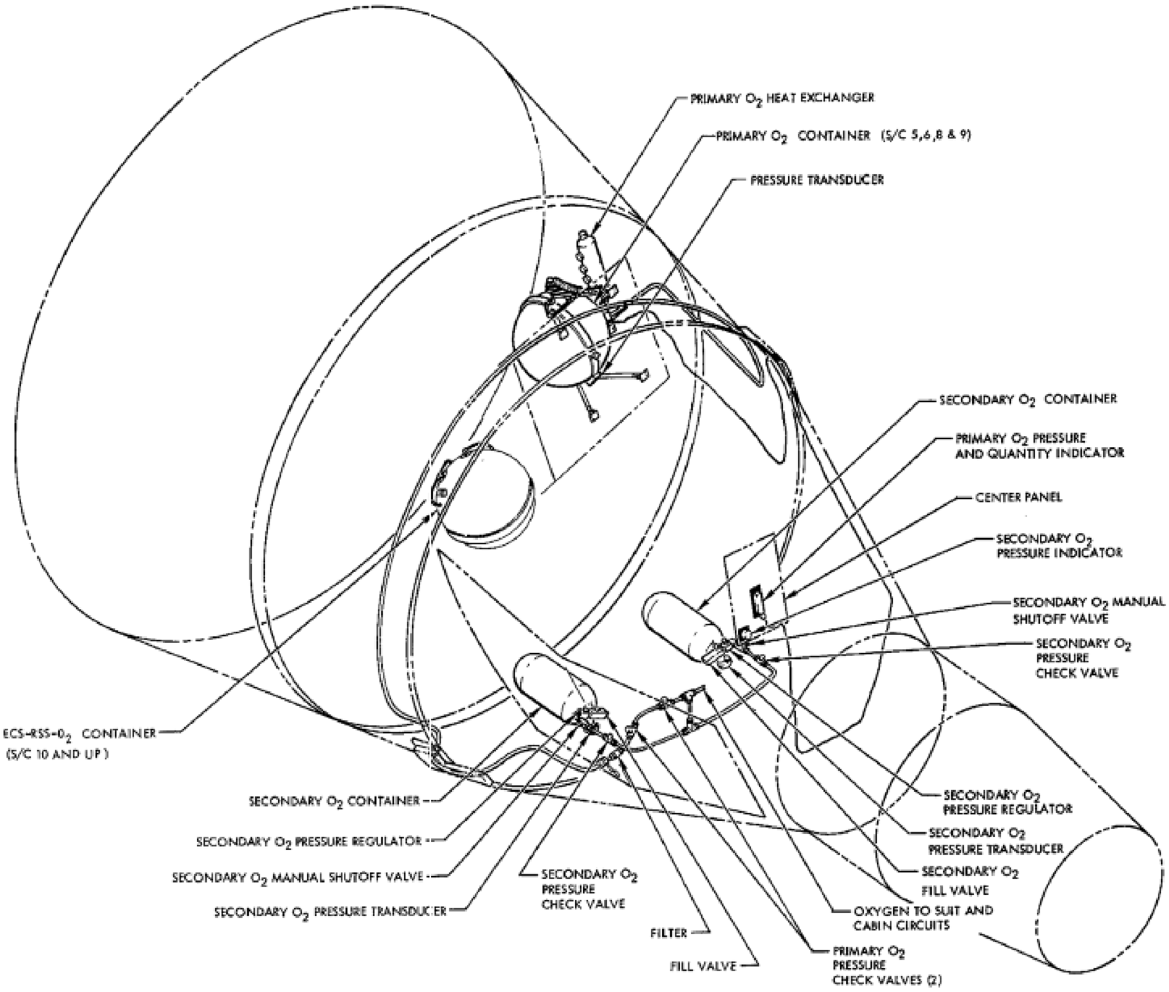


Figure 4.2.2 – Oxygen system, from SEDR 300 manual

PRIMARY OXYGEN

The primary system supplies oxygen to the environmental control system from the adapter. Once the adapter is separated, oxygen is retrieved from the secondary oxygen system.

The oxygen is stored in a supercritical form in a cryogenic spherical container, filled with liquid oxygen.

An electrical heater is used to build pressure to the critical point of 736 psia where it becomes a dense supercritical fluid. This fluid is then warmed, regulated, and filtered before it is released into the cabin loop or the suit loop.

The primary oxygen acts as a common tank that supplies oxygen for both the Environmental Control System, and to the Reactant Supply System for use by the Electrical Power System.

SECONDARY OXYGEN

The secondary oxygen system is stored in two cylinder-tanks located the re-entry module, and assumes the duties of the primary oxygen system when needed. It starts operating when the pressure in the primary system falls below 75 psi, or at retrograde when the primary oxygen tank is jettisoned with the Adapter.

3. CABIN LOOP

The cabin is a pressurized compartment, and oxygen is used to maintain a pressure of 5.1 psia by the cabin pressure regulator. The suit loop is providing the oxygen for the cabin for effective use of the oxygen available.

4. SUIT LOOP

Each astronaut has a pressurized suit, each operating independently from each other. Oxygen is circulated through these loops, and carbon dioxide and odors are removed. The gases are cooled in a head exchanger by the coolant loop to a temperature below dew point. The water that is condensing in the heat exchanger is dumped overboard, or routed to the water evaporator.

This system has two modes, one for normal operation, and another high-rate mode that shuts off the recirculation system and dumps the oxygen directly into the suits.

5. WATER MANAGEMENT LOOP

The water management system is used to store water in two tanks located the Adapter, collect and route unwanted water to the evaporators, or dump it overboard. The water comes from the electrical power system as the fuel cells generate water as a bi-product.

6. OVERVIEW OF THE ECS PANELS

The ECS controls are in the top-center of the main panel and consists of gauges, switches and pull handles.

Figure 4.6.1 – The Main ECS Panel

The main ECS panel has switches to control the SUIT FANs, the coolant pumps, the radiator flow, evaporators, high-rate oxygen flow, as well as the current readings of the cabin and suit temperature, cabin pressure, carbon dioxide amount in the suit, secondary oxygen status, warning lights, and cryogenic substance readout along with the heater controls. Note that the CRYO gauge has three modes, OFF, Oxygen and Hydrogen. The coolant pumps, evaporators and radiators are also controlled here.

The upper ECS Panel is located just above the main ECS panel and contains pull handles to activate various systems. Figure 4.6.2 shows this.

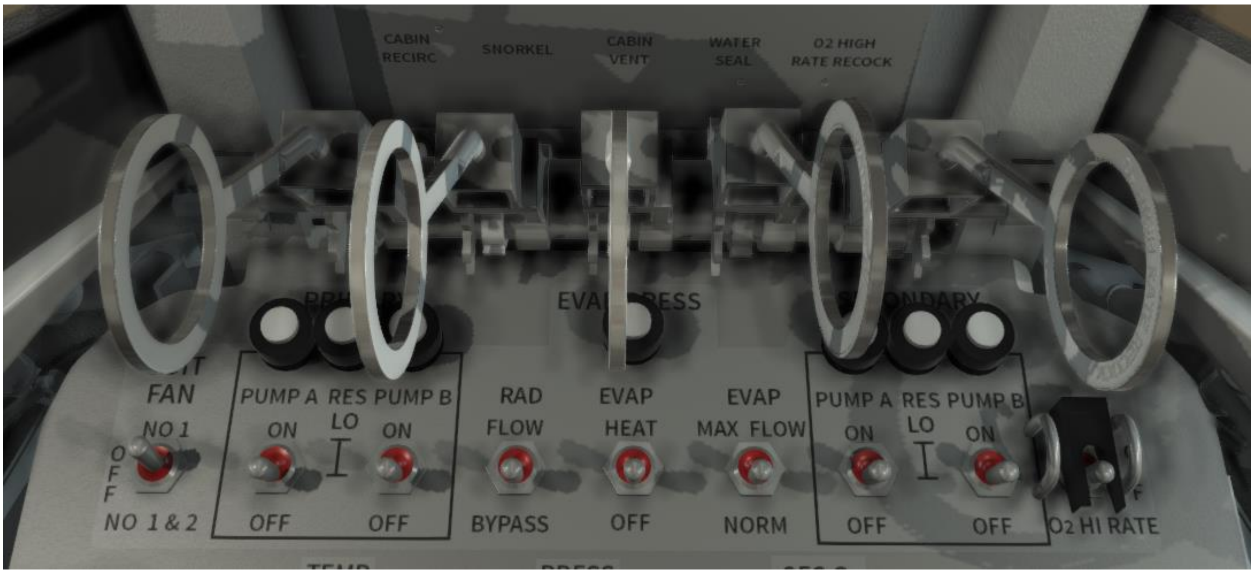


Figure 4.6.2 – Upper ECS control panel

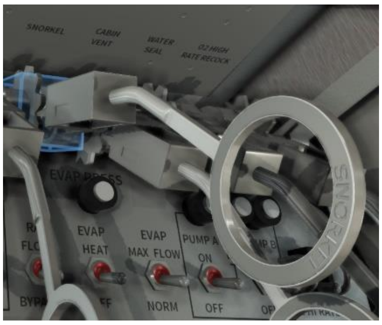
The upper panel has five handles to control the cabin recirculation fans, opening the Snorkel during reentry, venting the cabin, sealing the cabin from water during splashdown, and the O2 high rate recook mode needed to re-enable high-rate oxygen flow.

7. CONTROLS

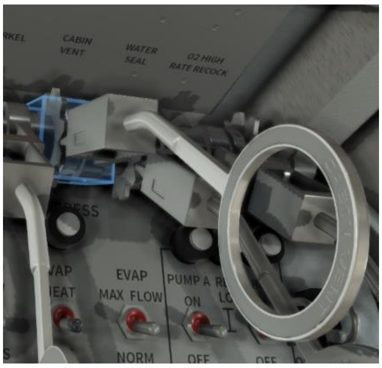
As noted in 4.6, there are many controls for operating the ECS. This section describes each of them, and how you use them.

UPPER PANEL

The CABIN AIRE RECIRC pull handle controls the recirculation valve that permits entry of cabin air into the suit circuit for removal of odors and carbon dioxide. It renovates the cabin air without having to perform a cabin decompression. It also removed carbon dioxide pockets in the cabin as the air is circulated in the cabin.

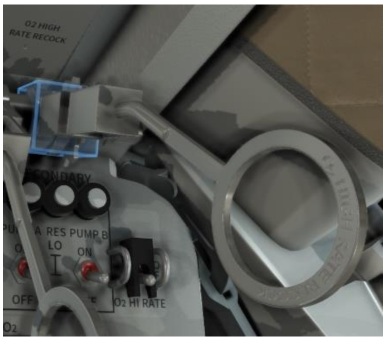


The SNORKEL handles the cabin air inlet that controls the entry of air and ventilation during landing and postlanding.



Opens the cabin outflow valve used to decompress the cabin in cases of emergency, and ventilation during landing.

The Water Seal makes the capsule watertight during landing by closing the relief valves.



The O2 HIGH RATE RECOCK handles manually returns the oxygen high-rate valve to the closed position, restoring normal oxygen flow rate and reestablishes the capability of starting a high-rate oxygen flow again.

INDICATORS

Several indicators are available to read the status of the ECS systems.

The first indicator is the cabin temperature and suit temperature. This dual indicator provides monitoring of the temperatures in both the suit circuits, and the cabin circuit in Fahrenheit.

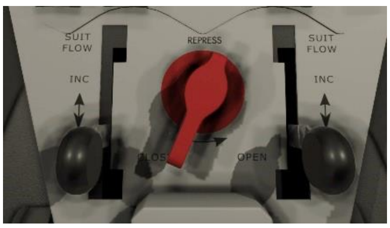
The CABIN and P CO2 PRESS indicator is also a dual indicator to monitor the cabin atmospheric pressure (pounds per square inch), and the amount of CO2 in the suit inlet (millimeters of mercury).

The Secondary O2 indicator is for monitoring the pressure in the two individual oxygen containers in the secondary oxygen subsystem.

The CRYO indicator is for monitoring the quantity and pressure of the cryogenic substances. Red markings locate the range where thermal pressurization may be discontinued by de-energizing the heaters. A switch below the indicator is used to select if the indicators should be OFF, read from the OXYGEN subsystem, or from the HYDROGEN subsystem.

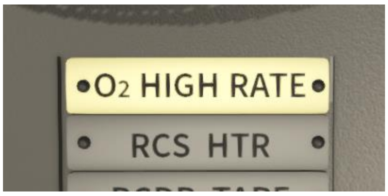
LOWER PANEL

The SUIT FAN is always placed to NO 1 & 2 but can be controlled in cases of emergencies and failures. You can also place this switch in No. 1 and No. 2 and use the circuit breakers to control the fans.

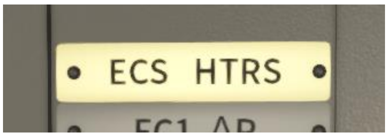


The suit flow is controlled using the controls on the lower center pedestal panel between the seats. A cabin repressurize knob is used to repressurize the cabin after being depressurized.

An O2 HI RATE switch is used to enable the high-rate oxygen flow manually. Normal operation is reestablished by placing this back of OFF and activating the O2 HIGH RATE RECOCK handle.



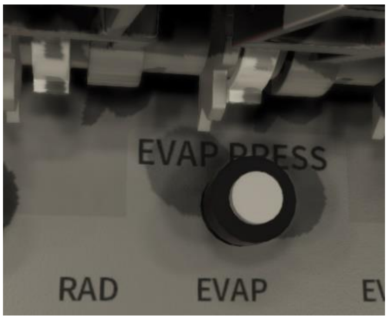
The O2 HIGH RATE telelight illuminates when the high oxygen rate valve is open.



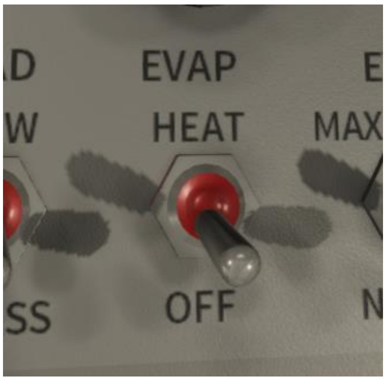
Illuminated if the ECS Heaters is manually activated.

The CRYO HEATER switches is used to energize or de-energize the heaters in the primary oxygen tanks, or the hydrogen tanks. AUTO will energize and de-energize the heaters automatically. Manual mode is controlled by placing the switch in OFF and ON position.

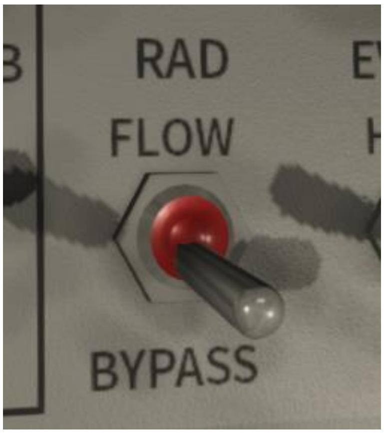
Each coolant loop has two pumps to push the coolant through the independent loop. During mission, both pumps in both circuits should be set to ON.
A light indicator for each of the 4 pumps are illuminated when operating.
If the coolant reservoir is low, the RES LO indicator is illuminated.



The EVAP PRESS light illuminates when the pressure in the evaporator is above 4.0 psig, before being released. It is off when below.



The EVAP heater switch is used to energize the evaporator heater, and is used to heat the water in the evaporator before dumping.



The Radiator flow switch is positioned in the FLOW position during orbital flight. This allows the coolant to pass through the radiators and radiate heat into space. These radiators are hot during ascent and initial orbit, so this switch will need to be in the BYPASS position. Ground can let you know the temperature using radio communication.

8. SYSTEM OPERTAION

The ECS is semi-automatic, and is operated using the controls in section 4.8.

PRE-LAUNCH

During pre-launch, the primary and secondary shutoff valves are opened, and a satisfying suit flow is adjusted using the controls. The Fans are positioned to the No.1 and No.2 position. The cabin is purged with pure oxygen, and the recirculation valve is opened. All 4 coolant pumps are activated. The coolant flow is set to bypass the radiators.

LAUNCH

The cabin relief valve is opened to let the pressure bleed to 5.5 psi, and the cabin air recirculation valve is still open. If failure is detected, the circuit will revert to high rate of operation.

The ground cooling heat exchanger does no longer exist. The constant generation of heat in the internal components is transferred to the coolant. The heat exchanger transfers this heat to water that is vented overboard in the form of steam.

ORBIT

Cabin pressure is maintained at 5.1 psia automatically. The cabin air recirculation valve is open to remove CO2 pockets in the cabin. High Rate O2 can be activated and deactivated manually, or automatically during emergencies.

During orbit, the radiators are used to aid in the cooling. The coolant system is in operation until Adapter separation where the pumps are jettisoned. Both loops active, with both pumps on.

It takes about 30 minutes to the radiators are cool enough to let the coolant flow through them.

RE-ENTRY

When the Adapter is separated, the primary oxygen system is disconnected and removed, and automatically activates the secondary oxygen supply with the valves open. Before adapter separation, the high-rate valves are opened to cool down as much as possible. A snorkel is used to open the cabin inlet to let outside air in and pressurize the cabin.

9. COOLANT FLOW

Pumps are pushing the coolant through the coolant loops using two pumps per loop. The schematics of this loop can be seen in Fig 4.9.1 and Fig 4.9.2. When a pump is activated, it takes the coolant from the reservoir, circulates it through the loop, and returns it to an external reservoir for rebalancing, cleaning, and cooling.

The coolant is passing through the Radiators seen in Fig 4.9.3, lowering the temperature of the coolant by radiating it to space.

Coldplates are used to absorb heat generated by the components, thus heating the coldplates rather than the component itself, and the coolant is flowing through the coldplats and cools them down.

Heat exchangers are used to transfer heat. The water evaporator transfers heat to water, to cool the coolant.

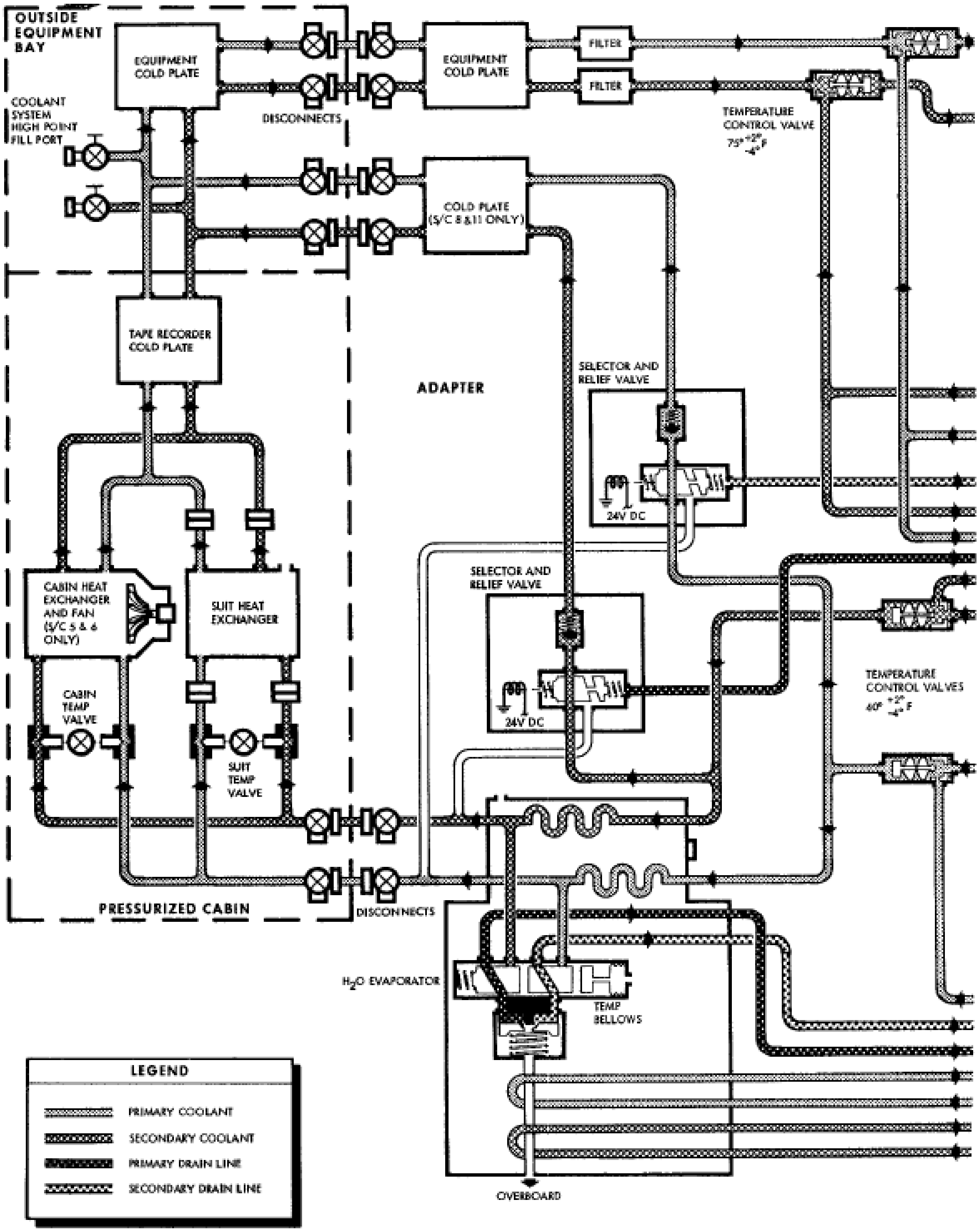


Figure 4.9.1 – Coolant Flow, Sheet 1 of 2. From SEDR 300 manual.

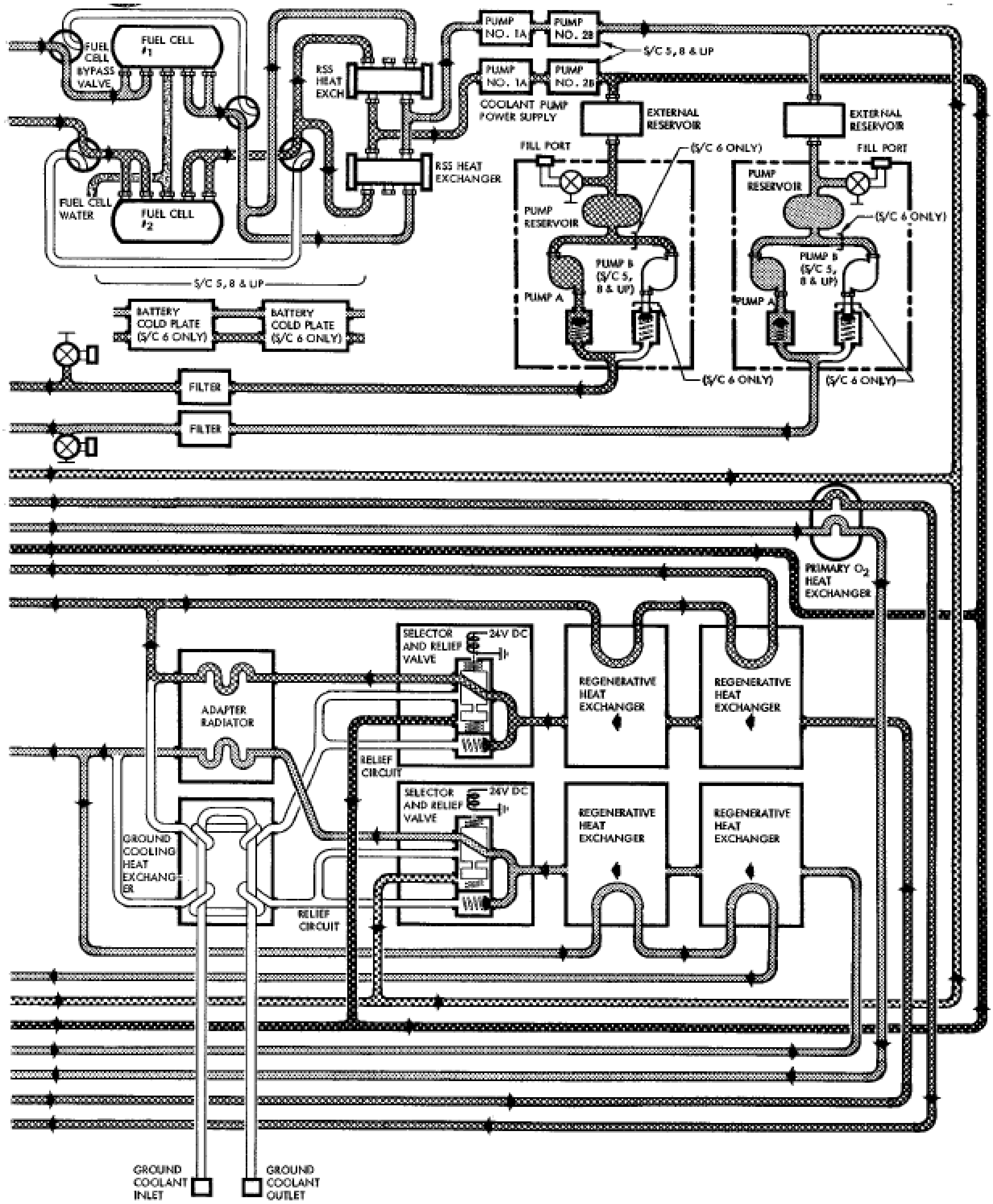


Figure 4.9.2 – Coolant Flow, Sheet 2 of 2. From SEDR 300 manual.

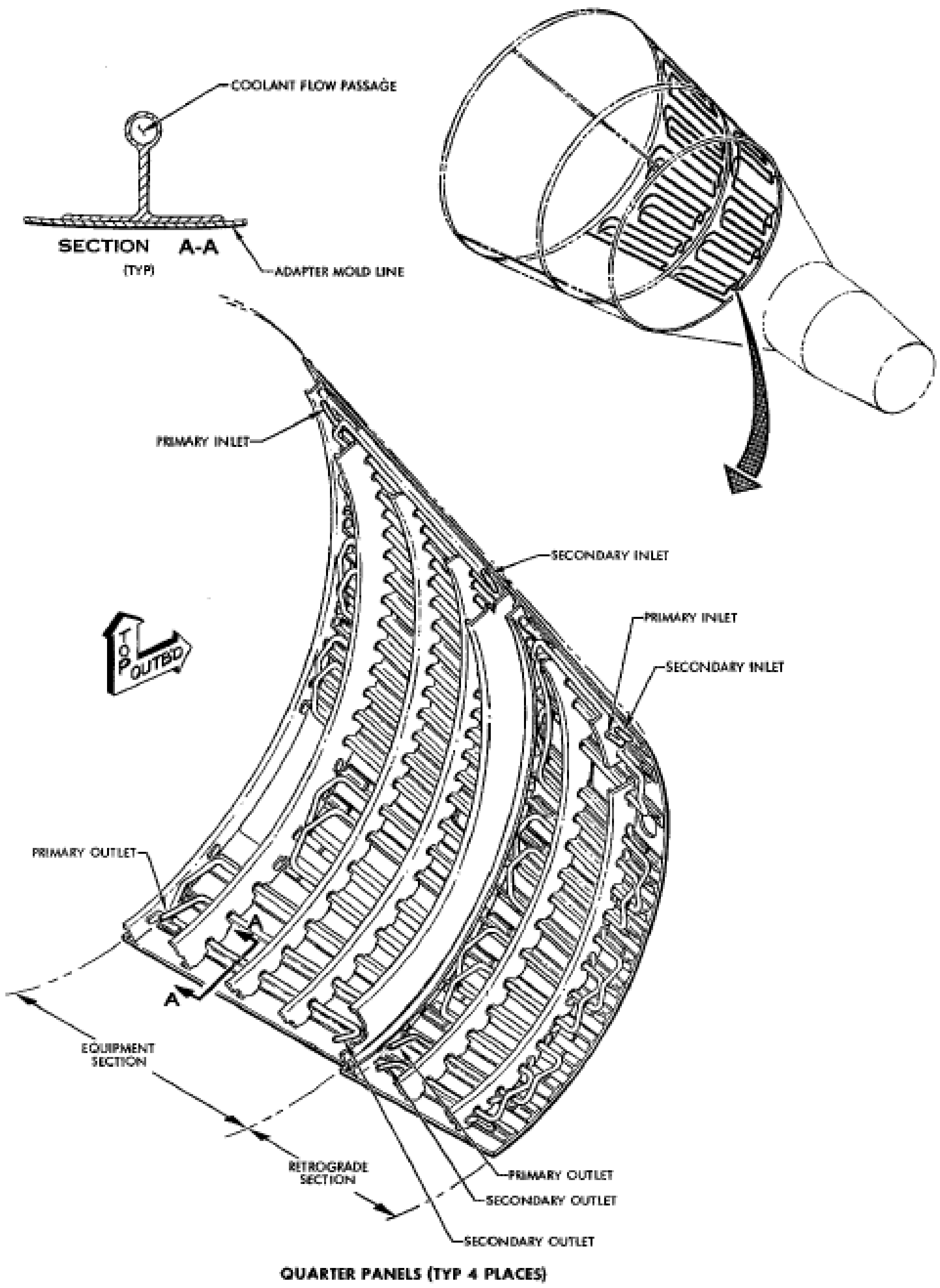
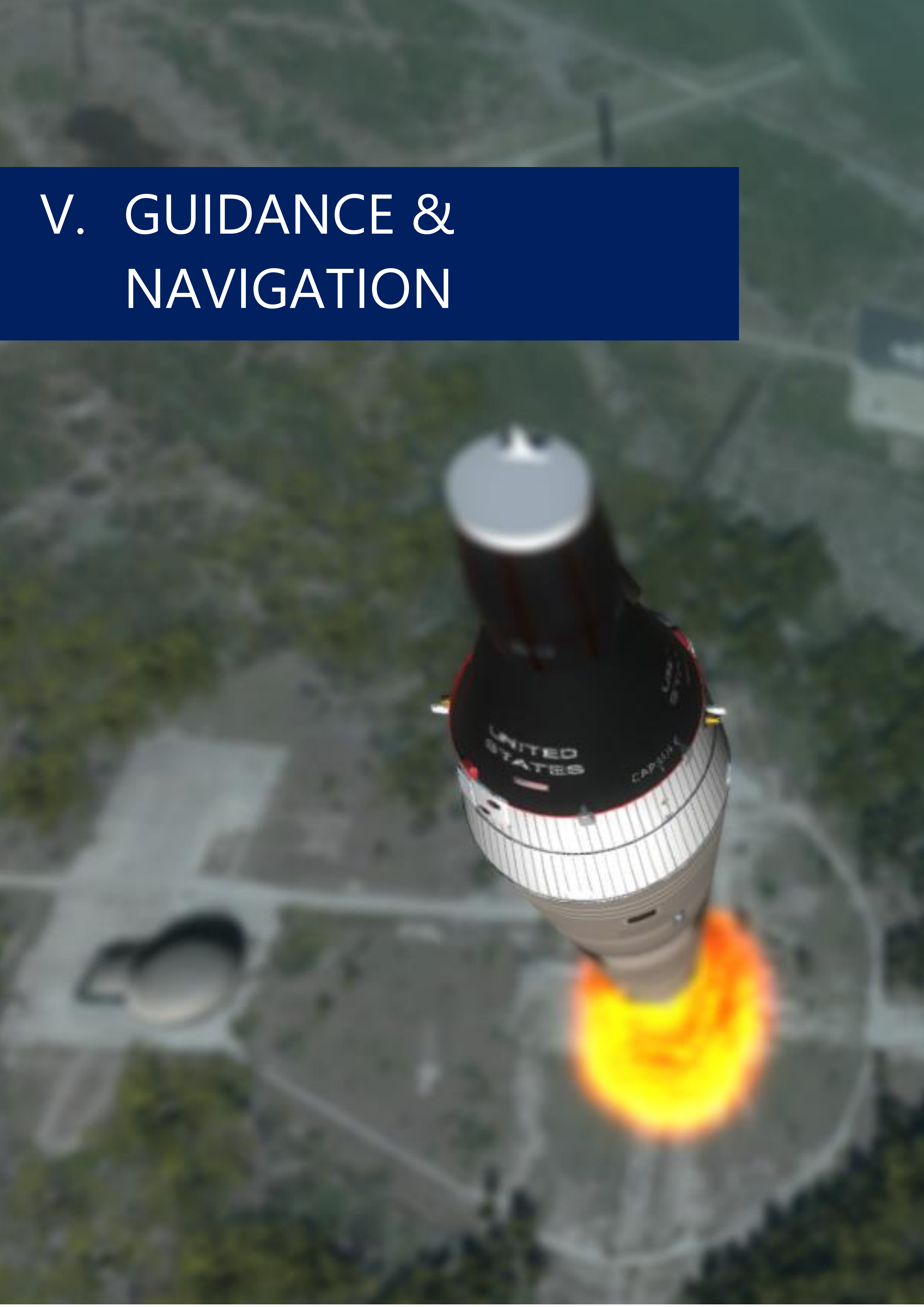


Figure 4.9.3 – Radiators, from SEDR 300 manual

V. GUIDANCE & NAVIGATION



V. GUIDANCE & NAVIGATION

1. GENERAL

The Guidance and Control System is a set of complex systems that enables the spacecraft to maneuver in space, control its attitude relative to Earth and perform a safe re-entry.

The spacecraft can be controlled about the pitch, roll and yaw axes, and can translate along the longitudinal, vertical, and lateral spacecraft axes. Automatic or manual control can be selected for attitude, while translation is manual only.

The Guidance and Control system is made up of seven individual systems:

1) Attitude Control and Maneuvering Electronics (ACME)

2) Inertial Guidance System (IGS)

3) Horizon Sensors

4) Rendezvous Radar System

5) Command Link

6) Time Reference System (TRS) / Electronic Timer

7) Propulsion System

The ACME converts input signal to thruster firing commands for the Propulsion System. Depending on the selected mode, input is received from hand control, IGS or the horizon scanners.

The IGS provides inertial attitude and acceleration information, guidance computation and displays.

The Horizon Scanners provides the Earth local vertical reference during orbit. The scanners are covered during ascent. Once fairings are jettisoned, the sensors are exposed to space and will spend 2 minutes to calibrate and start detecting the horizon. Keep this in mind, and wait for this before doing any attitude or translational maneuvers. The GYROs are usually not correct right after the ascent, so the scanners are used to automatically correct the errors.

The rendezvous radar is used to calculate the range to a rendezvous target, and attitude error information. The target range indicator on the commanders' panel provides range information, range-rate information, and can provide attitude direction on the Flight Director and Attitude indicator.

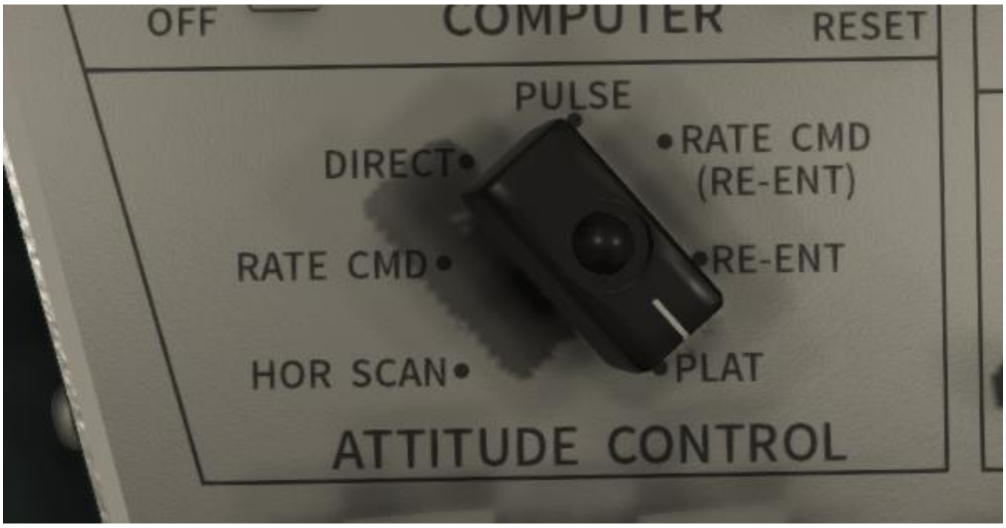
The command link can send messages to the target to enable, disable and control systems on the target vehicle. It is using an encoder below the pilots' panel to send messages.

The Time Reference System (TRS) provides a time base for all the guidance and control functions. Various timers and clocks are used to display the content. The Electronic Timer is the base for all timing related systems like the sequencer.

2. ACME

The ACME provides automatic or manual attitude control. It accepts signals from the hand controller, horizon sensors, the stable platform, and the computer. In the end, the ACME ensures the correct thrusters are fired based on what mode the spacecraft is configured to.

Seven modes are selectable on the center pedestal panel.



These modes are:
1) Horizon Scan
2) Rate Command
3) Direct
4) Pulse
5) Re-entry rate command
6) Re-entry
7) Platform

An ACME subsystem called ACE (Attitude Control Electronics) is used to process input signals and route them to either the OAME or RCS system. Rate gyro inputs to ACE (attitude signal processing) are used to dampen the spacecrafts attitude rates.

OAME is the thruster system used for attitude and translational changes during orbit. RCS (Re-entry Control System) is used during re-entry. The Platform, Horizon Scan and Re-entry modes are automatic, while rate command, direct, pulse and re-entry rate command are manual.

Each of the modes are provided as input to ACE for signal processing, and ACE decides what thrusters to fire.

2.1. OAME

The Orbital Attitude and Maneuvering Electronics has thrusters used to modify attitude in roll, pitch, and yaw, as well as translation using 16 different thrusters, 8 for attitude, and another 8 for translation. This is called the OAMS (Orbital Attitude and Maneuvering System) and is controlled by ACE or Direct Mode. When Direct Mode is selected, the stick input for manual attitude control is directly sent to the thrusters, by-passing the signal processing in ACE.

2.2. RCS

The Re-entry Control System is used during reentry when the OAME is jettisoned with the adapter. It consists of 16 thrusters for reliability. Two identical thruster rings are used, with 8 thrusters each. Both rings are typically used, but ring A or ring B can be used independently. Each system got its own fuel tank.

The RCS has a Direct mode, meaning it can manually fire the thrusters, while by-passing the ACE. The hand controller movements are directly passed to the RCS.

2.3. ATTITUDE MODE OPERATION

These are the modes that can be selected by the astronaut:

1) Direct (M1)
Thruster firing commands are applied directly to the OAME or RCS attitude solenoid valves using the attitude hand controller. A deflection of 2.5 degrees of the stick in the rotation direction is needed to apply thrust. Thrust is constant so it does not matter how far you push the stick.

2) Pulse (M2)
The input signal is processed by ACE, resulting in a 20ms long thrust pulse to either OAME or RCS. Each time you deflect the stick 2.5 degrees, a 20ms pulse in that direction is generated. This mode is normally used, and is good for fine control of movement.

3) Rate Command (M3)
The attitude rate is based in manual stick input, and is proportional to the displacement of the stick. The further you push the stick, the more thrust will be applied through the solenoid valves.

4) Horizon Scan (M4)
Pitch and Roll is processed by ACE to hold and orient the spacecraft based on the horizon scanner sensor. Yaw is controlled as pulse.

5) Re-entry (M5)
Spacecraft is automatically controlled during reentry. Roll rate is based on output from the digital computer based on where the spaceship is planned to land. Angular rate dampening is enabled.

6) Re-entry/Rate command (M5d)
Identical to the Re-entry mode, but the roll rate is manually controlled. Computer provides roll rate commands to the FDAI, and the pilot can follow this guidance manually.

7) Platform
Spacecraft attitude is maintained automatically by the inertial platform. The primary purpose of this mode is to automatically hold an inertial spacecraft attitude, or for maintaining spacecraft attitude during fine alignment of the platform.

3. INERTIAL GUIDANCE SYSTEM

The Inertial Guidance System (IGS) is a system containing an Inertial Measurement Unit, an Auxiliary Computer Power Unit, an On-Board Computer, and an Auxiliary Tape Memory.

3.1. INERTIAL MEASUREMENT UNIT

The Inertial Measurement Unit (IMU) provides inertial attitude and acceleration information, used for automatic control, computations, and visual display. Acceleration measurement is used for insertion, rendezvous, and retrograde computation and display. A mode selector controls the IMU.

The Inertial Measurement Platform Electronics is used to control the gyros based on attitude changes and can be turned on or off using the selector on the center pedestal panel. It has the following modes:

1) OFF - Turns off the platform

2) CAGE - Used for IMU warmup and to align the platform gimbals with the spacecraft body axes.

3) SEF - Small End Forward, will align the platform to small end forward attitude. This will align the gimbals with the Earth Local vertical. Basically, the astronauts can look forward in the prograde direction.

4) ORB RATE - Maintains attitude reference during spacecraft maneuvers. It is inertially free except for the pitch gyro, which is torqued to maintain a horizontal attitude with respect to Earth.

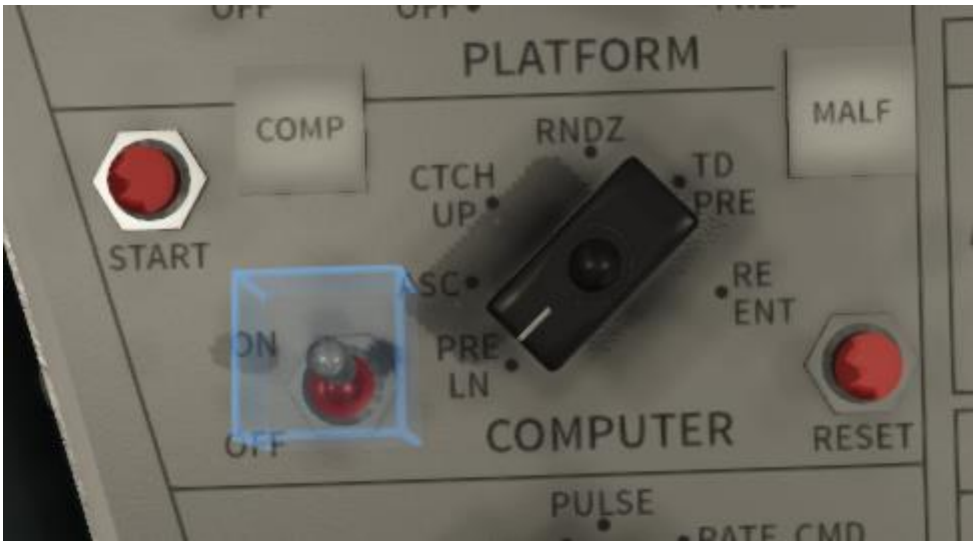
5) BEF - Blunt End Forward, SEF reversed. You are looking in the retrograde direction.

6) CAGE - same as previous cage mode, but for blunt end forward.

7) FREE - Completely inertial.

3.2. AUXILIARY COMPUTER POWER UNIT

The Auxiliary Computer Power Unit (ACPU) protects the computer from bus voltage variations. It can provide temporary computer power if the bus voltage drops momentarily. If the bus voltage remains depressed, the computer is automatically turned off. The ACPU is turned on with the computer power switch.



3.3. ON-BOARD COMPUTER

The On-Board Computer (OBC) stores data and is used as aid for guidance and control. Computations are utilized for insertion, rendezvous, and re-entry guidance.

It is controlled with a mode selector that loads the module the crew wants to run from the AUX Tape Unit. A START button executes the selected mode, RESET resets it after a mode has executed or from a malfunction when the MALF light illuminates. A Manual Data Insertion

Unit (MDIU) allows the crew to communicate with the computer where parameters can be written into the memory, read from the memory, or cleared.

An Incremental Velocity Indicator (IVI) displays the velocity change computation made by the computer.

3.4. INCREMENTAL VELOCITY INDICATOR

The IVI displays output from the computer and gives the direction of velocity change needed. The IVIs will show the change you need to make during the next burn to achieve a desired orbit. It will also show AUX TAPE position during manual tape operation, or the delta speeds needed for rendezvous. When you perform the velocity change, the IVIs will count down or up based on the direction. In most cases, you want to zero the IVIs using velocity changes (delta-V).

3.5. IMU OPERATION

PRE-LAUNCH

This phase is utilized to warm-up, check-out, program and align IGS equipment. Mission parameters are fed into the computer, and the pitch and yaw gimbals are aligned with the local vertical, and roll is aligned with launch azimuth. This is done automatically during the PRE-LN module. This will take about 60 seconds and can be seen on the FDAI as they roll towards the planned azimuth.

LAUNCH

At lift-off to insertion, the guidance functions are performed by the booster guidance system. If this should fail, the IGS guidance takes over as a backup using the computer. At SSEC, the IGS takes over from the booster guidance system.

At insertion, the computer calculates the difference to target orbit and displays this on the IVI's. At this point, the crew will accelerate using the OAMS thrusters to insertion velocity.

ORBIT

The IGS can be turned off if not being used for a long period of time. If turned off, it needs to be warmed up in CAGE mode one hour before critical alignment. The computer must be turned on in the PRE LN mode, and allowed 20 seconds of self-checks.

Three IGS modes can be used during ORBIT:

1) **Check-Out and Alignment**
   After insertion, the spacecraft is maneuvered to small end forward and the platform is aligned with the horizon sensors. The horizon sensors are used to align pitch and roll gimbals with the platform, and yaw is aligned through gyro compassing using the roll gyro. The platform will be maintained by the horizon sensors in both BEF and SEF modes.

   When performing maneuvers, the ORB RATE mode is used, an inertially free mode, except for pitch which is torqued at 4 degrees per minute based on orbit. This can drift it out of alignment. Setting it back to BEF or SEG will align it to the horizon again using the horizon scanners

2) Rendezvous
   The radar is providing information about the target to the computer. Platform is

aligned with BEF or SEF prior to the maneuvers. The computer is set to rendezvous and the radar is turned on to connect with the target. The computer controls the FDI pointers to align the spacecraft with the target, and the IVIs provide range difference relative to the target for use as a guide while translating.

3) **Preparation for Retrograde and Re-entry**
The IMU are monitoring while the retrograde rockets are firing, and applied to the computer for re-entry calculations. The FDI are biased in pitch with 16 degrees for correct re-entry attitude.

RE-ENTRY
After the retrograde rockets has fired, a 180-degree roll maneuver is initiated, and pitch is set so Earth is visible in the upper window so it can be used as a visual reference. The computer commands a re-entry attitude at 400.000 ft. and the spacecraft is controlled to null the needles on the FDI. Bank angle is displayed on the roll needle indicator, and needs to be nulled. This lasts until re-entry is complete and landing starts.

3.6. CONTROLS AND INDICATORS

The Attitude Indicator is the main indicator for attitude. It has an attitude indicator ball to show attitude relative to the platform, needles to point towards attitude change directions, and a set of controls to select data source and mode. Figure 5.3.6.1 shows the schematics for the FDAI.

The REF selector is used to select what reference the FDAI will use. This can either be the RADAR, PLATFORM, or the COMPUTER. The MODE switch is used to select if the pointers should display rate indication, pointer direction, or a mix of both.

The sphere will always be slaved to the inertial platform gimbals and indicates platform attitude. A scale selector is used for the needle sensitivity and can be either set to HI or LO mode.

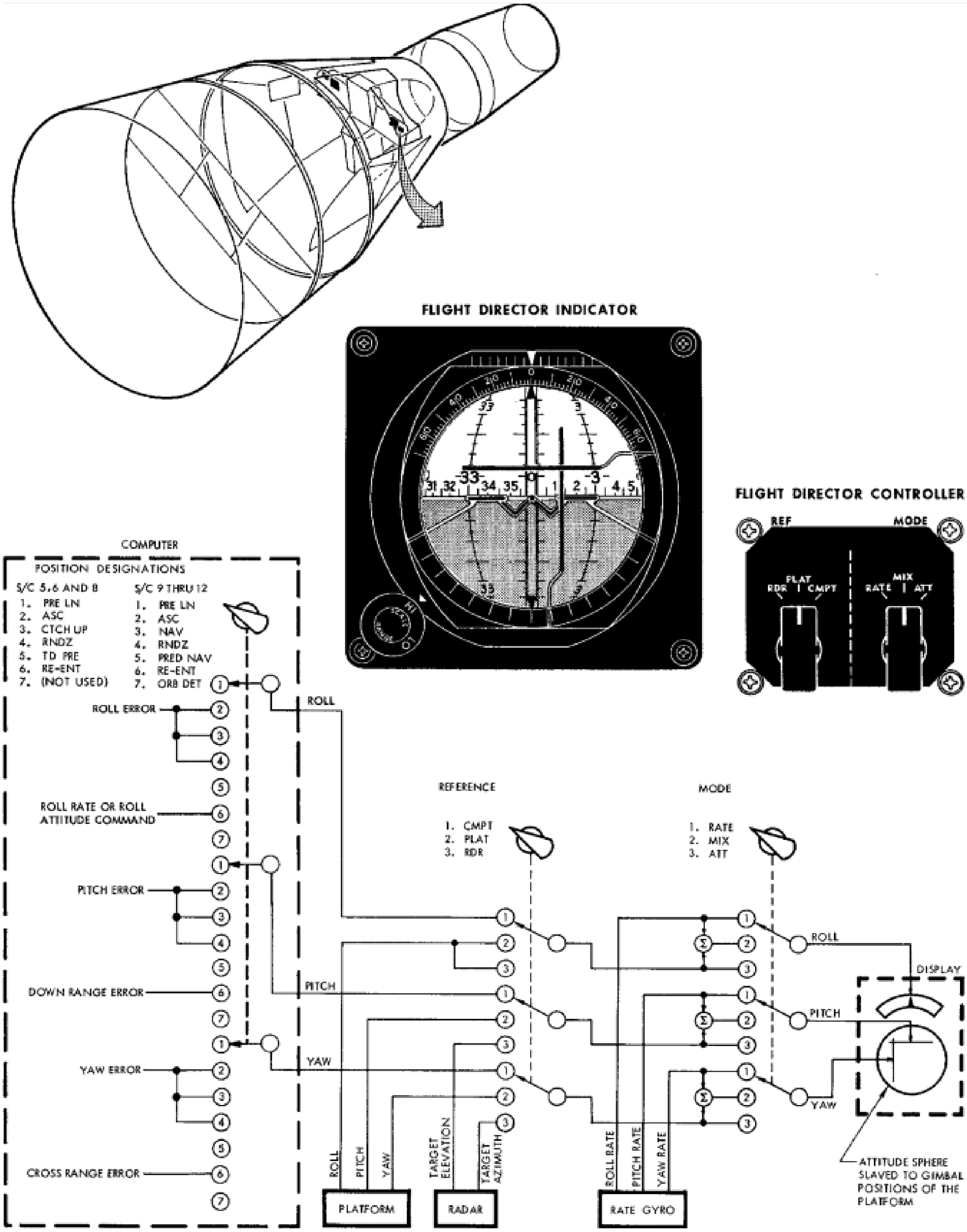


Figure 5.3.6.1 – FDAI schematics, from SEDR 300 manual

The FDI ball indicates attitude

And the mode selector selects the source and mode.

There are two independent FDAIs, one for the commander, and one for the pilot.

Other controls are the Manual Data Insertion Unit (MDIU), the IVI's and the Computer Controls which are discussed more in the next chapter.

The IMU controls and indicators are located on the center pedestal and contains the PLATFORM mode selector, an ACC light, an ATT light, and a RESET switch. The ACC light indicates if there is a malfunction in the accelerometer, the ATT indicates if a malfunction has occurred in the attitude gyros. The reset switch will fix minor malfunctions.

4. HORIZON SENSOR SYSTEM

The Horizon Sensor System is used to establish a spacecraft attitude reference to Earth local vertical, and provides the difference between the spacecraft and this reference.

This signal can be used to align the spacecraft and the inertial platform to the Earth local vertical. These sensors are covered by a cover that is jettisoned on orbit insertion.

Two scanners are available, one primary and one secondary. Only one scanner can work on the same time.

Figure 5.4.1 shows the horizon scanner system.

The Scanner Heater switch is energized, and the scanner is set to primary during pre-launch. When the JETT FAIRINGS switch is triggered, the scanners start to detect the Earth. The initial acquisition time is 120 seconds.

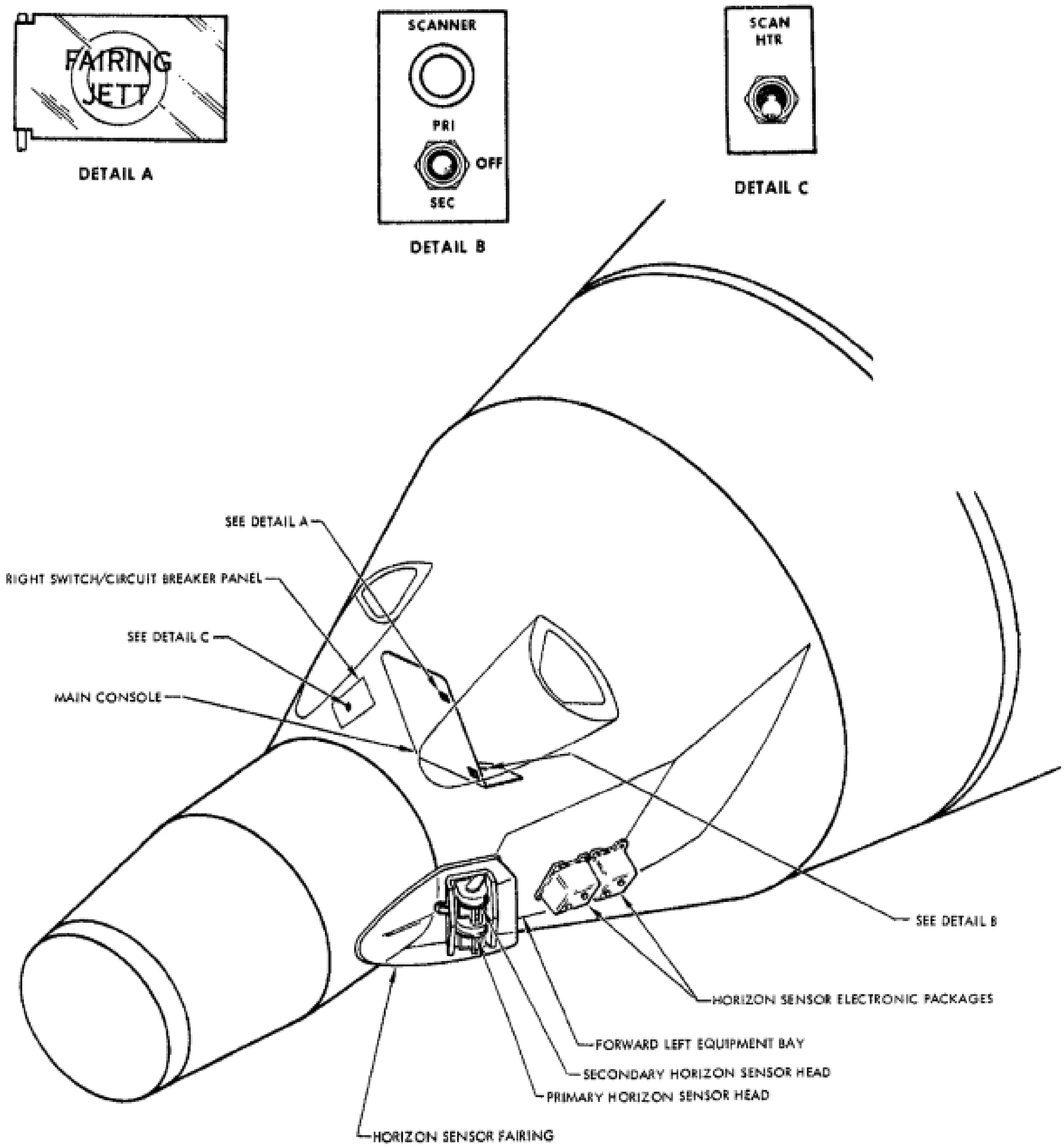
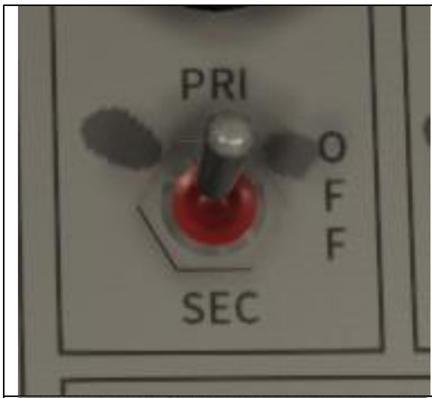
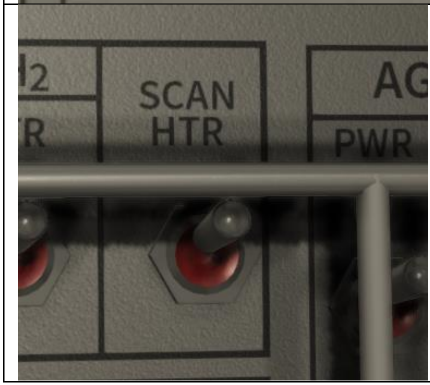


Figure 5.4.1 – Horizon Sensor System, from SEDR 300

	A scanner light illuminates if the system is unable to detect the Earth horizon.

	The scanner is controlled by the Scanner switch.
	The SCAN HTR controls the scanner heater.

5. RENDEZVOUS RADAR SYSTEM

The rendezvous radar system is used during rendezvous with a target vehicle. The radar is located in the rendezvous and recovery section, and a transponder is located in the target vehicle, used to establish a connection between the two.

This connection provides the spacecraft with range data, relative velocity and poisiton, and angular relationship between the two spacecrafts.

The radar is also used for communicating messages using the command link and encoder. The lock-on can happen when the range is about 180 nautical miles.

The computer uses this data to compute the differences in positon and velocity, as well as the attitude for aligning with the target.

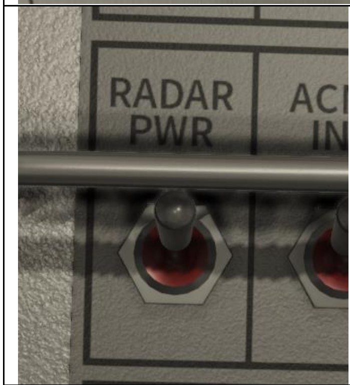
With the computer in the Rendezvous module, the IVI's will show the difference in velocity/position relative to the target, and the FDI with reference set to computer will align the needles with the target attitude.

If the FDAI ref is set to Radar, the needles will point towards the signal source, thus pointing directly towards the target.

Figure 5.5.1 shows this system.

The Radar is not active during launch, and is protected under a cap cover on top of the R&R section. JETT FAIRING will expose the radar.

The radar is placed into standby mode by closing the RADAR PWR circuit breaker, and the RADAR switch to STBY.

	Radar controls the radar power. STBY will energize the radar, and will warm up the system. The system needs 60 seconds of warmup to function properly. ON will turn the radar on and will try to connect with the target vehicle.
	The Radar Pwr switch controls the radar power ciecuit breaker.
	The LOCK ON light illuminates when the radar is locked on the target vehicles transponder.

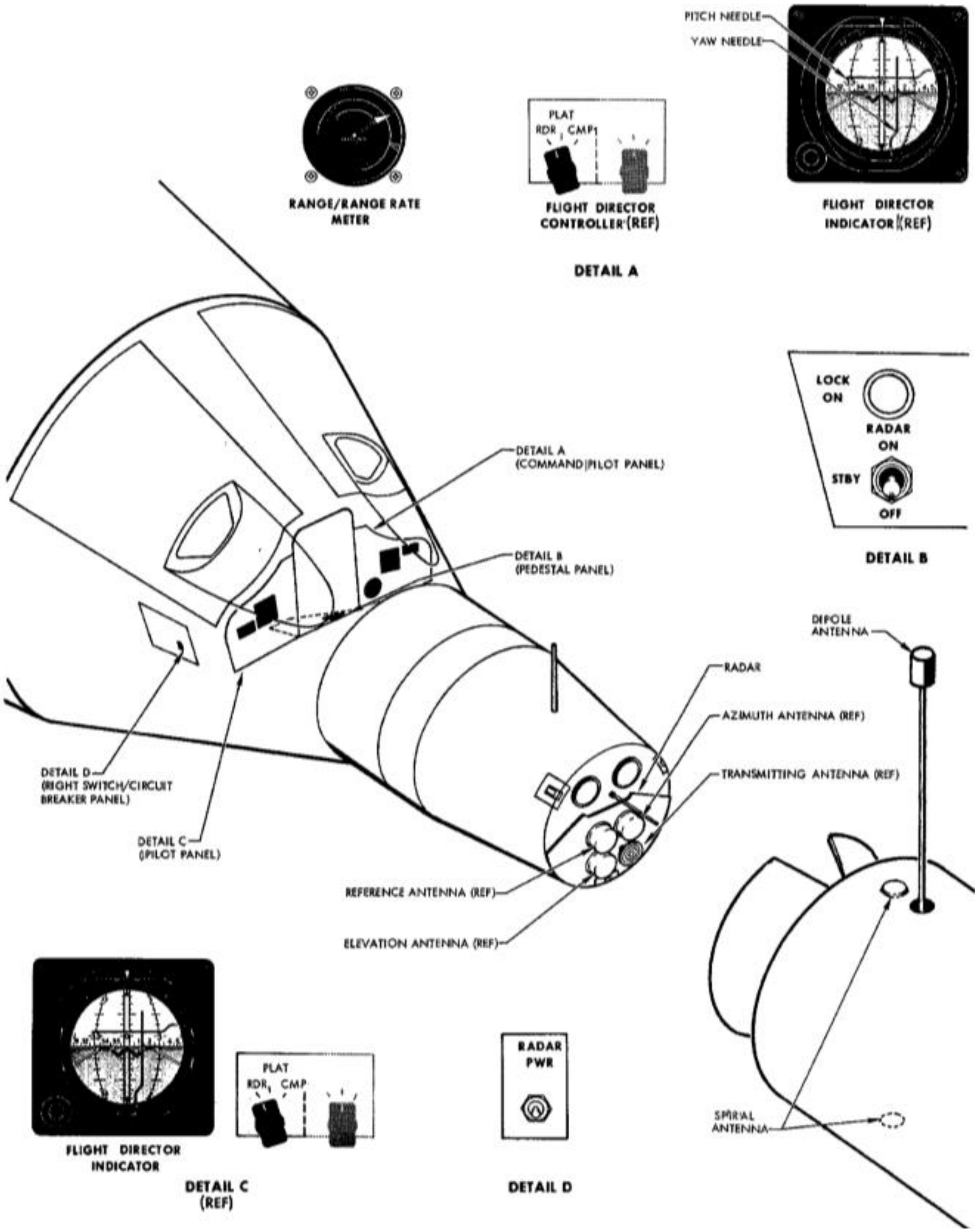


Figure 5.5.1 – Rendezvous Radar System, from SEDR 300

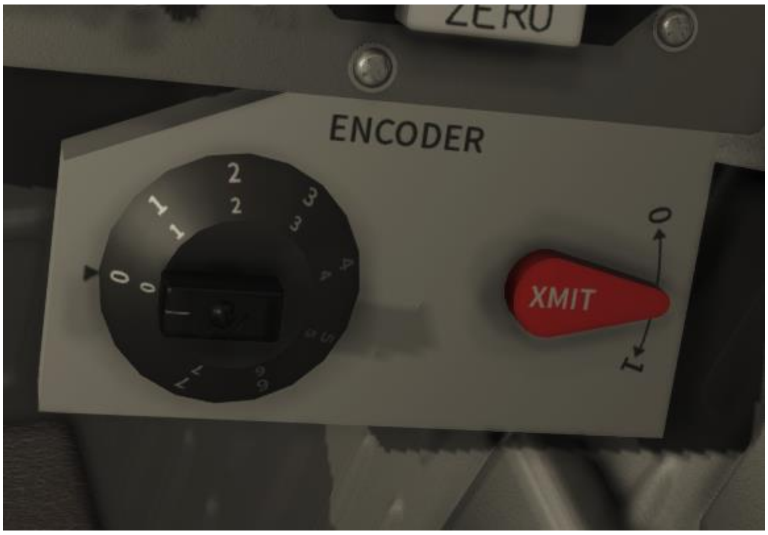
The Radar Range indicator displays the range to the target vehicle if in range.

6. COMMAND LINK SYSTEM AND THE ENCODER

The command link system is used to control and communicate with the target vehicle. It can be used to turn the acquisition and approach lights on or off, moving it, and enabling or disabling various systems.

The command link is using the radar to send the messages, and an Encoder is used to select what messages to send. The crew can send messages if the radar is locked on to the target.

The Encoder contains two numbered wheels, and one binary switch to transmit messages.



Each message consists of three digits. The first digit is controlled by the outer wheel and can be anything between 0 and 7. The second digit is controlled by the middle wheel and can have a number between 0 and 7.

The last switch is used to set the last digit to either 0 or 1, and transmits the message. The switch is automatically returned to the middle when the message is sent.

The encoder circuit breaker must be set to ON to enable the Encoder.

ENCODER/AGENA COMMANDS

1. LIGHTS

    250-1 ACQ LTS OFF-ON

    140-1 APPROACH LTS OFF-ON

    201 STATUS DISPLAY BRIGHT

    211 STATUS DISPLAY DIM

    200 STATUS DISPLAY OFF

2. BCNS & ANTENNA

    070-1 L-BAND OFF-ON

    230 VHF-DISABLES GROUND

    231 UHF-ENABLES GROUND

    260 DIPOLE SELECT

    270 SPIRAL SELECT

    151 BOOM EXTEND

3. CONTROL

060 RESETS 3 HOUR TIMER

220 UNRIGIDIZE

221 RIGIDIZE

340 V/M INTERROGATE(CLEARS)

520-1 V/M DISABLE/ENABLE

400-1 ACS OFF/ON

300-1 HORIZ SENS OFF/ON

341 GYROCOMPASS ON

350-1 GEO RATE OFF/ON

4. DATA RECORD SEQ

041 RECORD ON

030 RECORD/TM OFF

021 TM ON (OVER STA.)

5. PERFORM A PPS BURN

571 HYD GAIN DK

450 D/B NARROW

ARM STOP SW - ARM

521 VM ON

501 PPS ON (IGNITE!)

-- BURN --

-- VM CUTOFF --

500 PPS OFF

451 D/B WIDE

ARM STOP SW - STOP

520 VM DISABLE

6. ATTITUDE CONTROL

A. BEF

361 GEO RATE - NORMAL

310 ROLL H/S - YAW

321 H/S PHASE - IN

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

B. SEF

360 GEO RATE - REVERSE

310 ROLL H/S - YAW

320 H/S PHASE - OUT

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

WHEN TURN COMPLETE

350 GEO RATE - OFF

7. TIME REFERENCE SYSTEM

The Time Reference System (TRF) controls all the timing functions aboard the spacecraft. The systems main timing devices are an electronic timer, mission elapsed time digital clock, an event timer, an Accutron clock, a mechanical clock, and a correlation buffer.

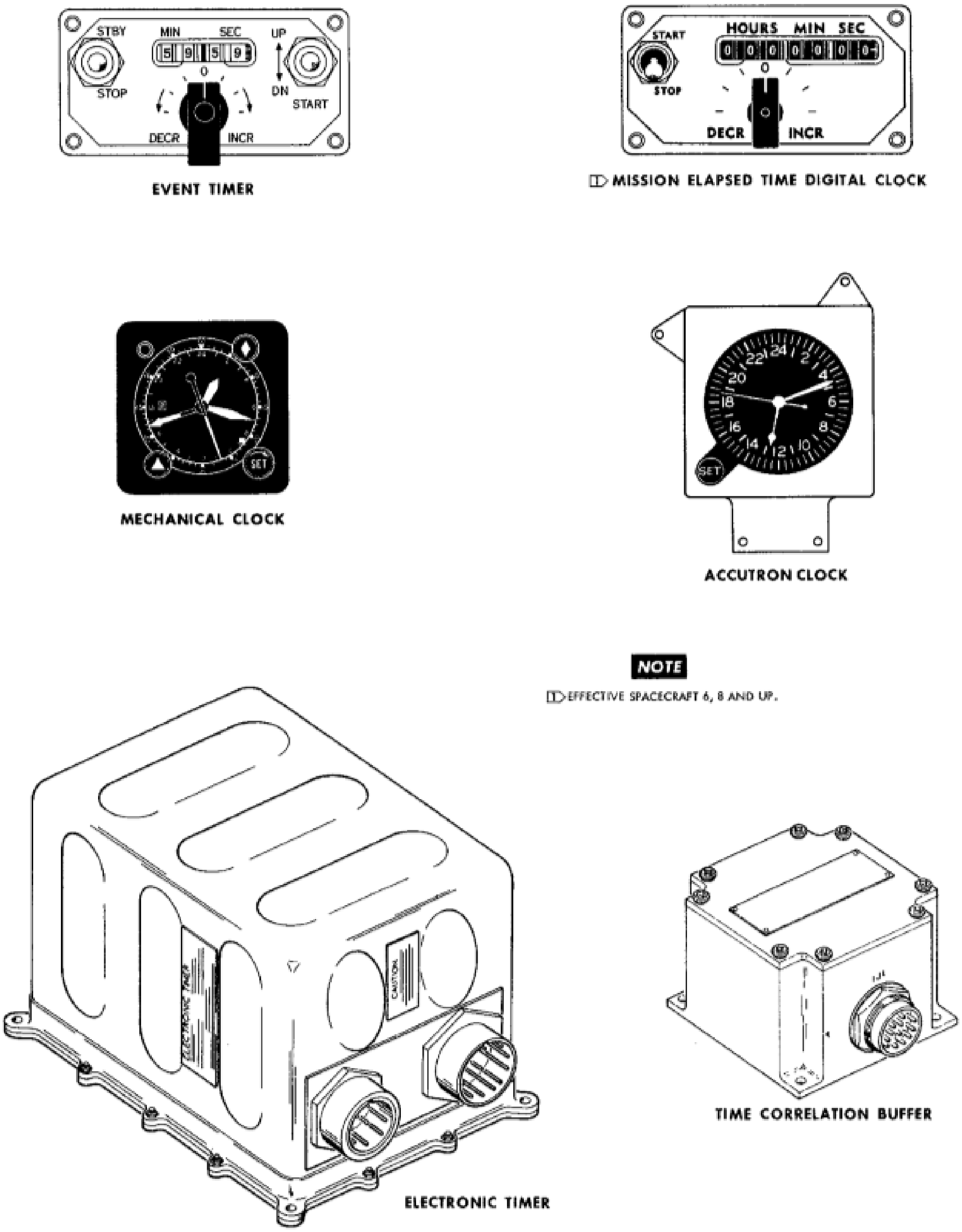


Figure 5.7.1 – TRS, from SEDR 300 manual

The electronic timer provides a countdown of Time-To-Go (TTG) to retrograde (Tr) and Time-To-Go to equipment reset (Tx), time correlation for the PCM data system for instrumentation and bio-med tape recorders, and a record of the Elapsed Time (ET) from lift-off. Figure 5.7.1 shows this.

The mission elapsed time digital clock shows the elapsed time since lift-off. It is usually left alone during the mission but can be adjusted, started and stopped.

The event timer is used for timing short-term activities and is operated by the crew. This starts counting at launch but can be modified at any time. The function switch in STBY activates the clock, and stops it in STOP.

With the function switch in STBY, the UP/STOP/DN three position switch controls the clock. UP will count up, middle will pause, and DN will count down.

The selector will adjust the timer. Move it to one of the INCR or DECR tick marks and leave it there until you are satisfied. The ticks (from center/0) will adjust 1 second, 10 seconds and 1 minute.

The Accutron clock shows GMT for the command pilot and is powered by internal battery.

The mechanical clock provides the pilot with an indication of GMT and the calendar date. In addition, it has a stopwatch capability used as a backup to the event timer.

8. PROPULSION SYSTEMS

The propulsion system provides attitude and maneuvering control. Two main systems exist, the OAMS and the RCS.

We touched these earlier, but to recap, the OAMS is used between insertion and retrograde, and RCS is used during re-entry. The respond from electrical commands from the ACME.

8.1 OAMS

The OAMS is used to fire single or multiple thrusters to rotate or translate the spacecraft.

The schematic can be seen in figure 5.8.1.

The OAMS can rotate the spacecraft in the roll, pitch and yaw axes, and translational control in six axes: forward, backwards, right, left, up, down.

The OAMS is the only system onboard that can translate the spacecraft.

The propellant consists of nitrogen tetroxide as the oxidizer and monomethyl hydrazine as the fuel.

The fuel is stored in three tanks for maximum operation time, and the oxidizer is stored in two tanks. Helium is used to pressurize the system and a reserve fuel tank is automatically available.

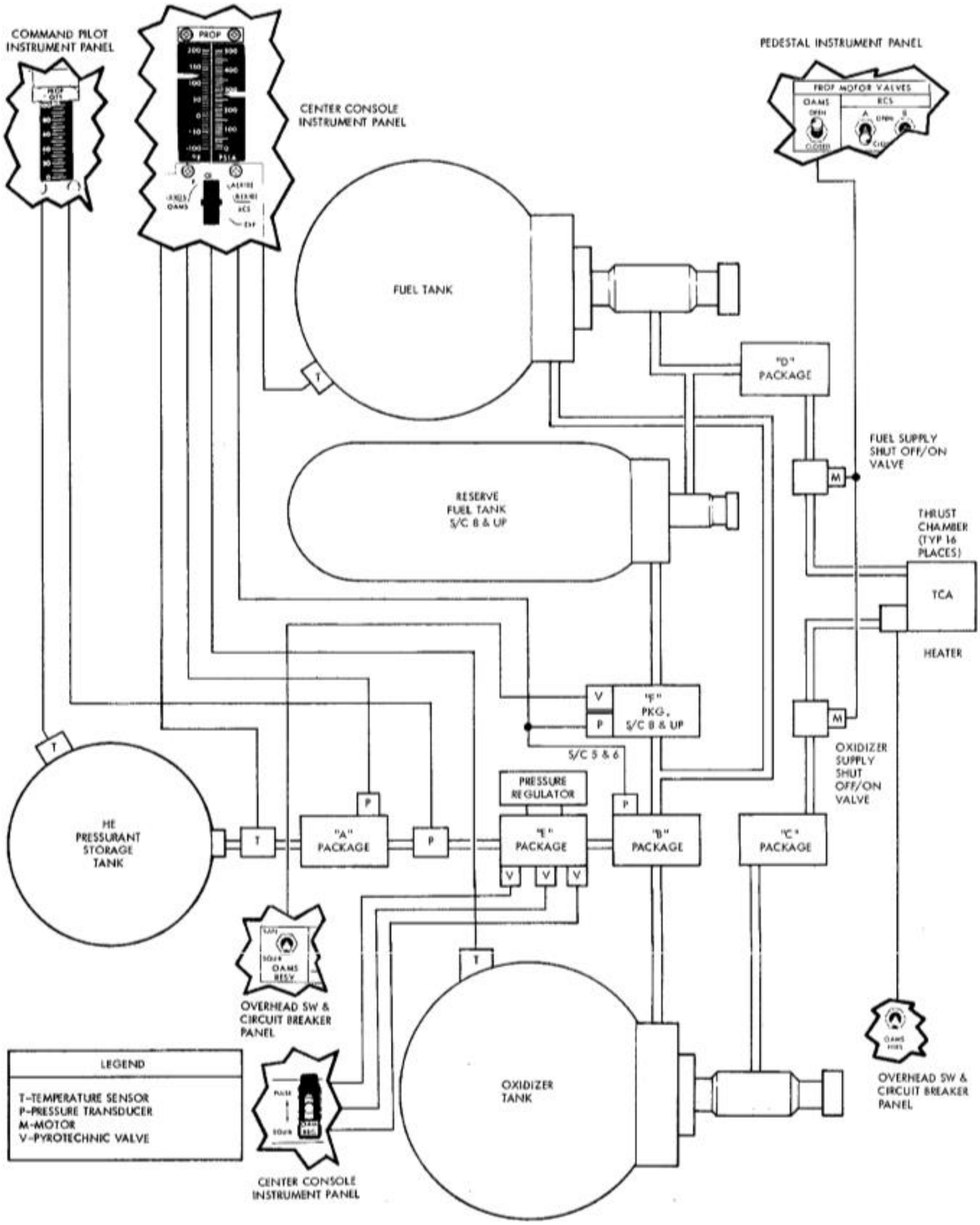
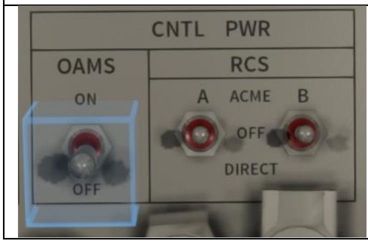


Figure 5.8.1 – The OAMS Schematics, from SEDR 300

The system is enabled by the OAMS control panel, both switches must be positioned to the UP position.

	Opens the OAMS propellant valves, providing the thrusters with propellant, a combination of fuel and oxidizer.
	The OAMS CNTL PWR powers the control lines for the OAMS thrusters.

A propellant indicator can be used to see the available propellant, and a selector is used to cycle between the tanks.

With the selector in OAMS, the PROP indicator shows temperature on the propellant, and the pressure in the tank.

Another indicator on the commander panel shows the propellant quantity left.

8.2. RE-ENTRY CONTROL SYSTEM

The RCS system is used after the Adapter has been separated. It can only control the attitude, not maneuver the spacecraft by translational control.

The RCS consists of two identical systems for redundancy, RING A and RING B. They can be used at the same time.

The propellant quantity can be monitored using the same indicators as the OAMS, but with the control selector set to either of the RCS RINGs.

The system works in the same way as the OAMS internally, with fuel tanks and oxidizer mixed to fire the thrusters.

A schematic can be seen in figure 5.8.2

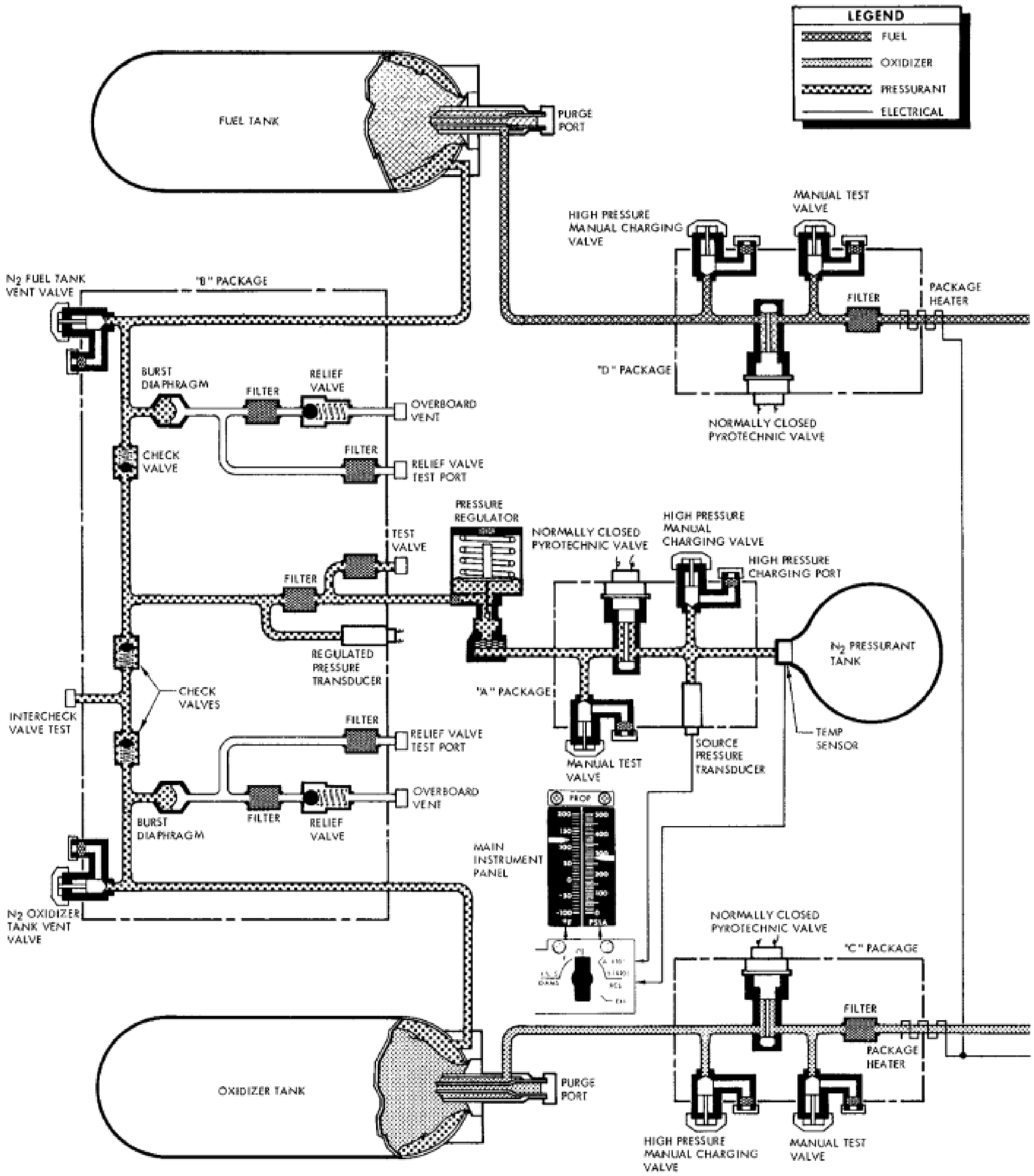
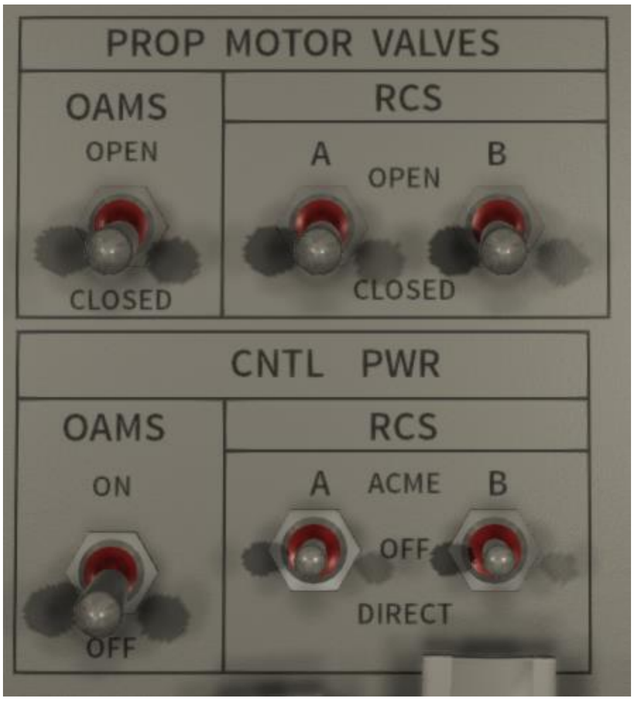
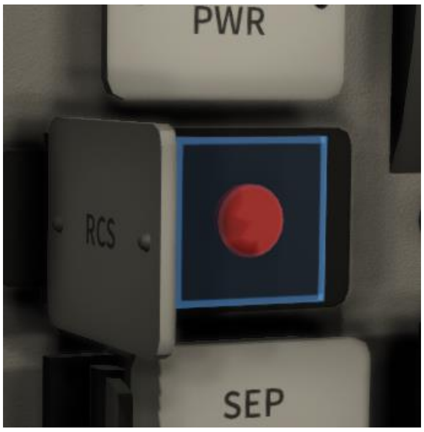


Figure 5.8.2 – RCS Schematic. Right lines go to the selected RINGs and fires the thrusters. From SEDR 300 manual.

It is enabled using the RCS switches next to the OAMS switches.



The RCS system is only activated when the RCS switch-indicator has been activated.



Doing this will disable the OAMS system for the rest of the mission.

VI. ON-BOARD COMPUTER

VI. ON-BOARD COMPUTER

1. GENERAL

The computer is a binary, fixed point, stored-program, general-purpose computer for use throughout the mission. Using inputs from the spacecraft systems as parameters to the stored programs, it can perform the required computations for launch and ascent, orbit insertion, rendezvous, and docking, retrograde, re-entry and landing. It can also be used as the backup for guidance during ascent.

It interfaces with the vast majority of the spacecrafts major components including the Inertial Platform and the spacecraft power system, the Time Reference System and the Digital Command System (used by ground to set parameters), the Attitude Display as a reference source, the Attitude Control and Maneuvering Electronics system for thruster control, the Titan Autopilot for guidance backup, the Auxiliary Tape Memory for module storage, the Incremental Velocity Indicators for delta-v and delta position indications, and the Manual Data Insertion Unit.

The OBC is used throughout the mission. An auxiliary Tape Memory system can load various modules from a tape into the computer memory. Typically, each phase of the mission has a dedicated module.

There are four switches used to control the computer:

	The ON/OFF Switch on the computer panel turns the computer ON or OFF. This also turns the computer power unit on that protects the computer from bus undervolt changes. When turned on, the computer runs through a set of checks lasting 20 seconds. The Computer Display Unity

	shows this. Do not use the computer during its startup routine. When the MDIU stops rolling its digits, the startup routine is complete.
	A seven-position mode switch is used to load modules from the AUX Tape Memory. The PRE LN and ASC modules are pre-loaded and does not require any loading time while the rest requires 10 minutes of loading.
	START will start the computer when the module is loaded, and the computer power is on. The COMP light will illuminate green when the computer is calculating and running a module.
	The RESET button will reset the computer after running a routine, or if a malfunction exists. The MALF light will illuminate if the computer has malfunctioned. If the MALF light glows even after pressing RESET, you might have to turn off the computer power and back on. If this does not work, there is a serious issue, and you have to stop using the computer.

The computer receives power from the Inertial Guidance Power Supply.

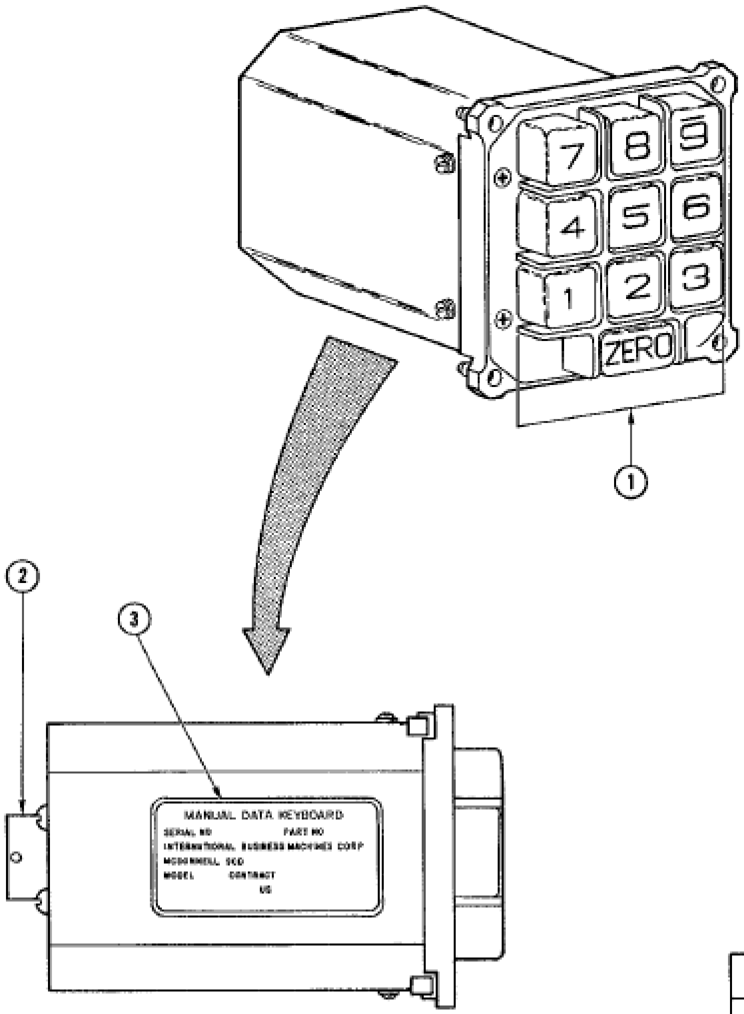
2. MANUAL DATA INSERTION UNIT

The Manual Data Insertion Unit (MDIU) contains a ten-digit keyboard and a seven-digit register with controls. It is used to insert data into the computer memory, or read data.

The first two keys that are pressed address the memory and the last five digits are the number to be inserted. Of reading from the memory, only the two first digits are needed.

If the first numerical digit (digit number three) is 9, it means that the value is negative. This can also be used when inserting values. 9 represents the minus symbol.

The keyboard can be seen in Figure 6.2.1



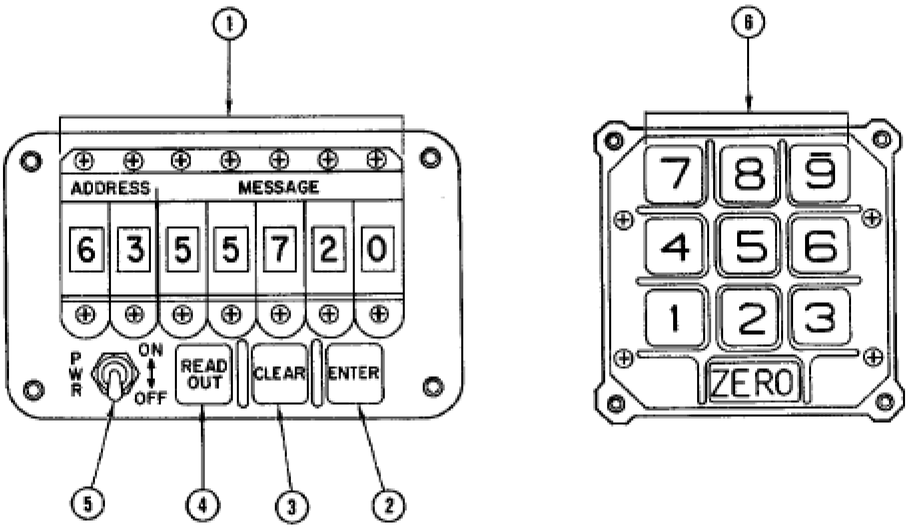
LEGEND	
ITEM	NOMENCLATURE
1	DATA INSERT PUSH-BUTTON SWITCHES
2	CONNECTOR J1
3	IDENTIFICATION PLATE

Figure 6.2.1 – The Keyboard, from SEDR 300 manual

The Keyboard can be interacted with using the mouse. Each button will change the current digit being modified. If you need to start from the beginning, press CLEAR and the first digit is the target digit for modification. For each keypress, the next digit will be changed.

The first two digits represents the ADDRESS and the last five digits represents the MESSAGE. The READ OUT button will fetch the message in the set address and display it in the message fiels. The ENTER button will enter an input MESSAGE to the selected ADDRESS, and CLEAR will reset the display and keyboard, but not touch any data.

The Display can be seen in Figure 6.2.2



LEGEND		
ITEM	NOMENCLATURE	PURPOSE
1	ADDRESS AND MESSAGE DISPLAY DEVICES	DISPLAY ADDRESS AND MESSAGE SENT TO COMPUTER DURING ENTER OPERATION; DISPLAY ADDRESS SENT TO, AND MESSAGE RECEIVED FROM, COMPUTER DURING READOUT OPERATION.
2	ENTER PUSH-BUTTON SWITCH	PROVIDES MEANS FOR CAUSING MESSAGE SENT TO COMPUTER DURING ENTER OPERATION TO BE STORED IN MEMORY.
3	CLEAR PUSH-BUTTON SWITCH	PROVIDES MEANS FOR CAUSING ADDRESS AND MESSAGE SET UP BY MDK TO BE CLEARED OR CANCELED.
4	READ OUT PUSH-BUTTON SWITCH	PROVIDES MEANS FOR CAUSING MESSAGE TO BE READ OUT OF COMPUTER AND DISPLAYED BY MESSAGE DISPLAY DEVICES.
5	PWR (POWER) TOGGLE SWITCH	PROVIDES MEANS FOR CONTROLLING APPLICATION OF POWER TO MDK AND MDR.
6	DATA INSERT PUSH-BUTTON SWITCHES	PROVIDE MEANS FOR CAUSING ADDRESS AND MESSAGE TO BE SENT TO COMPUTER AND TO BE DISPLAYED BY ADDRESS AND MESSAGE DISPLAY DEVICES.

Figure 6.2.2 – Display Unity, from SEDR 300 manual

Figure 6.2.3 shows how this looks in-game, with the controls used to operate it.

Figure 6.2.3

3. INCREMENTAL VELOCITY INDICATOR

The Incremental Velocity Indicator (IVI) provides velocity/position deltas required for attaining/correcting a set orbit, insertion, rendezvous, re-entry, or by the AUX Tape Unity. The computer controls the IVI's. The three digits on the IVI's represents the differences relative to the spacecraft body axes, thus the longitudinal axis (forward/aft), the lateral axis (left/right) and the vertical (up/down) axis.

These indicate the amount of change needed on each axis to reach a target calculated by the computer.

Figure 6.3.1 shows the IVI schematic.

LEGEND	
ITEM	NOMENCLATURE
1	FWD (FORWARD) DIRECTION INDICATION LAMP
2	FORWARD-AFT DISPLAY DEVICE
3	L (LEFT) DIRECTION INDICATION LAMP
4	LEFT-RIGHT DISPLAY DEVICE
5	R (RIGHT) DIRECTION INDICATION LAMP
6	UP-DOWN DISPLAY DEVICE
7	UP DIRECTION INDICATION LAMP
8	DN (DOWN) DIRECTION INDICATION LAMP
9	DN-UP ROTARY SWITCH
10	L-R ROTARY SWITCH
11	AFT-FWD ROTARY SWITCH
12	AFT DIRECTION INDICATION LAMP
13	IDENTIFICATION PLATE
14	CONNECTOR J1

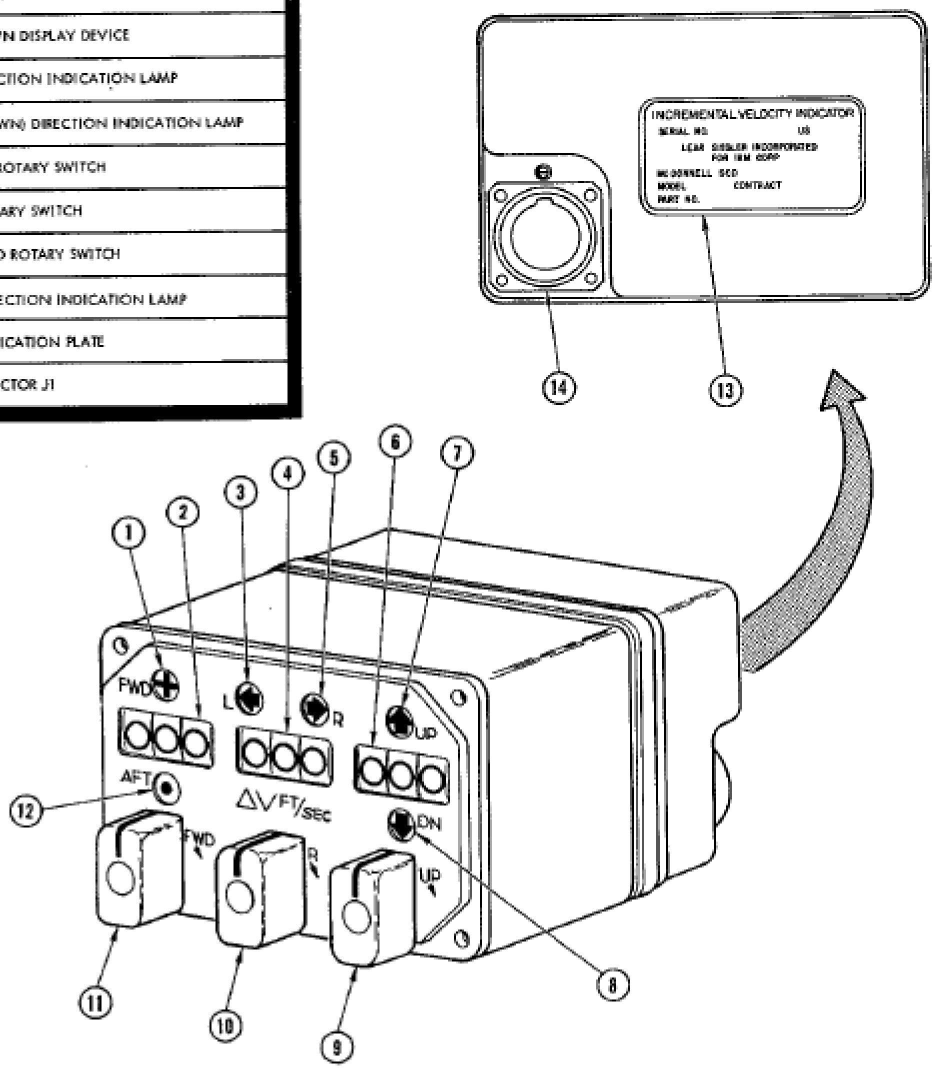
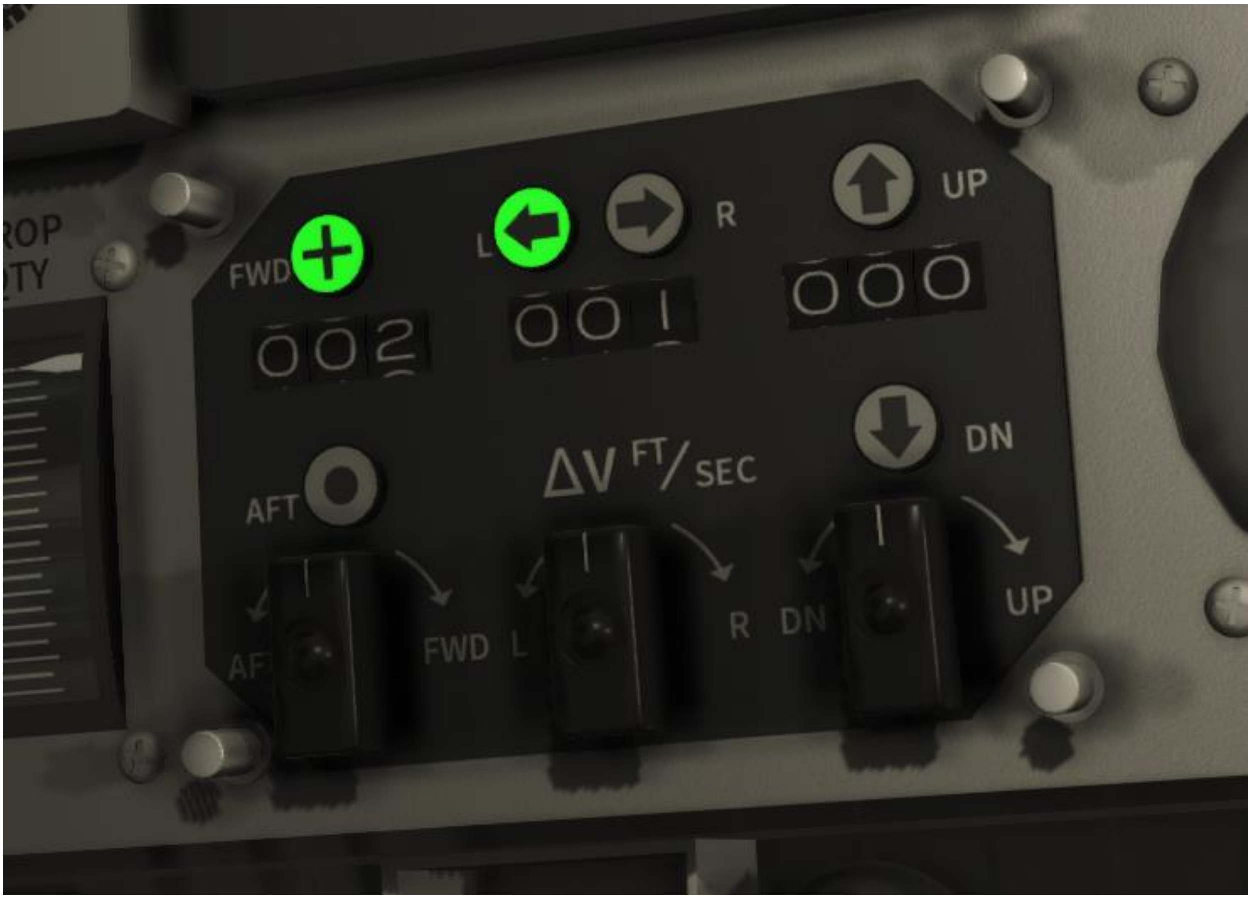


Figure 6.3.1 – IVI schematic, from SEDR 300



4. AUXILIARY TAPE UNIT

A module typically takes 10 minutes to load from the tape. Loading from the tape can be done automatically (normal) or manually. When manual mode is selected, the IVIs will display the position the tape is on, and wind/rewind can be used to move to the right location on the tape. Once the location of the desired module is found (each module got a start and end location on the tape), the module can be loaded into memory. The computer mode needs to be set to the right module.

Once the module is loaded in memory, the AUX TAPE Running light indicator goes from GREEN to UNLIT, and the computer module can be started by pressing START on the computer.

5. COMPUTER MODULES/PROGRAMS

5.0. LOADING AND THE PRE-LAUNCH MODULE

The pre-launch module will verify that the memory of the OBC is functional, and that the signals are working. Pay attention to the display to see the status. The number rolls will cycle as the memory tests are being done. Once the OBC is up-and-running, press START to start the program. When the program runs, the computer aligns everything needed for the ascent (you can see that the FDAIs will roll to the predefined data). You should allow the OBC to run for about 30 seconds.

The pre-launch module can then be used to configure the ascent data. The target Ap and Pe can be set, and the inclination. An inclination is met by rolling the rocket some degrees after ignition. Slight plane changes are also done during the final phases of the insertion.

If you do not roll correctly, some inclinations cannot be met.

You can configure the roll program by inserting the roll angle into Memory slot #11. The value requires two decimals, so if you wish to roll 72 degrees, you need to insert 7200, the command will be 1107200 INSERT. The FDAI will roll and align to the new setting. The target inclination must also be set using slot #10, and is like slot #11.

The OBC can automatically calculate the needed roll by inserting the target inclination into Memory slot #09. This will automatically update #10 and #11. For example, 0903250 ENTER will set the target roll to reach an insertion inclination of 32.5 degrees.

5.1. THE ASCENT MODULE

Guides the rocket to a predefined orbit. The orbit can be defined by inserting the desired Perigee into Memory slot #56 (#$56) and Apogee into #$57. This should have been pre-loaded by the crew before mission starts so you will not have to insert these manually.

Mission Control can update these through DCS during ascent if these needs to be modified but this usually will not happen unless there are some calculation issues.

Once the SPCFT has been separated, the IVIs will display adjustments that needs to be done to correct the target Apogee. Enable OAMS and zero out the IVIs to correct Apogee.

The IVI AFT/FWD, IVI L/R and IVI UP/DN will be stored in #$25, #$26 and #$27. The ASCENT program will write into this memory location during operation.

The ASCENT module provides pointing commands for alignment of the spacecraft to apply the velocity corrections.

5.2 THE CATCH-UP MODULE

This is also called the NAV module, and is used to finalize initial orbit, reach a specified orbit to either to experiment or catch-up with a target. All delta-V maneuvers are performed in the CATCH-UP module.

Note: This module requires all parameters to be inserted correctly before pressing START, or else a MALF light will illuminated.

In this mode, the pilot or ground will update orbit changes and when to initiate the burn. When the time of ignition is met, the commander will zero the IVIs.

The IVIs can be zeroed in any attitude and will always reflect the direction of the burn in ft/s relative to the current spacecraft attitude. If you are facing prograde and the planned burn is in prograde direction, the +FWD light would illuminate. If you would be facing retrograde, the oAFT light would be illuminated. If you would be facing towards Earth with your head in the prograde direction, most of data burn data would show in the UP direction etc.

This means that a burn can be performed in any attitude, as long as you zero the IVIs as fast as possible at the time of ignition.

PERFORMING A CATCH-UP BURN

Requesting burns can be done using the MISSION TOOLs.

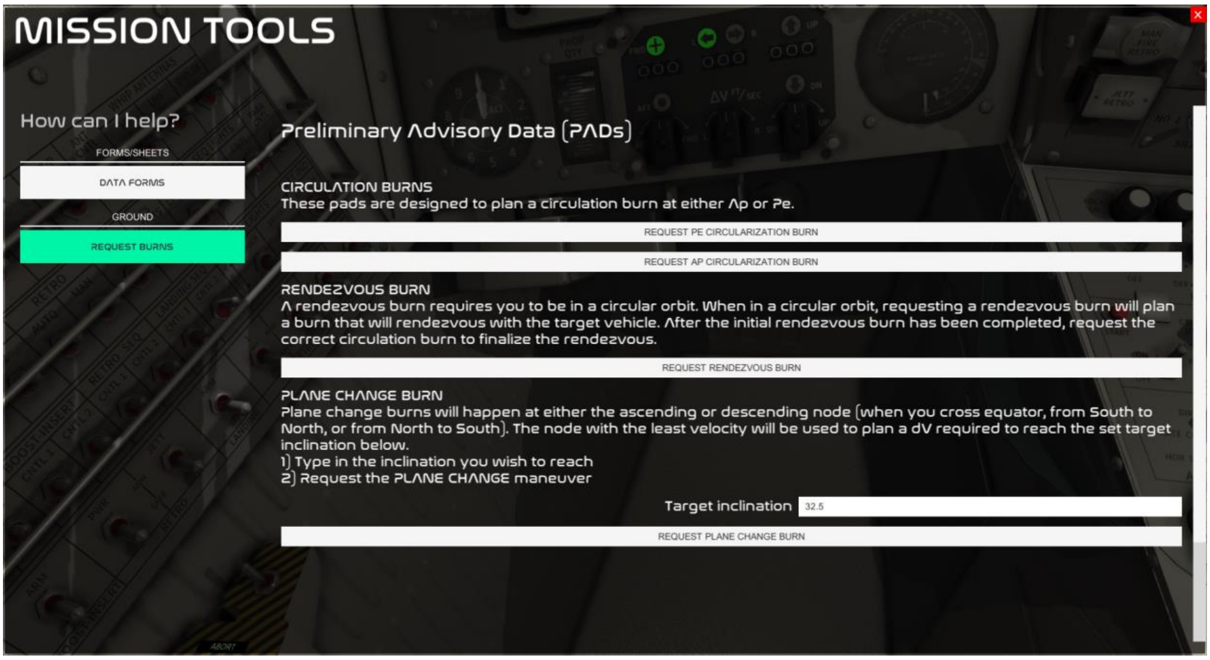
Note: Shortcuts to circulate at Ap, Pe and rendezvous burns are visible next to the MISSION TOOLs button.

The MISSION TOOLs will show you the available options:

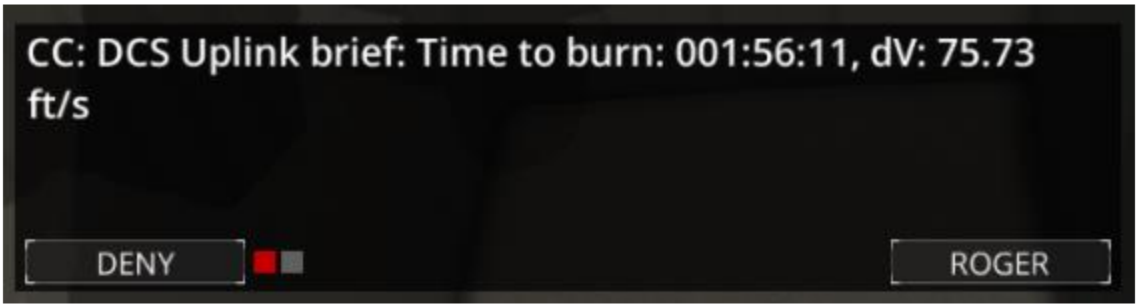
- Circularization at Ap or Pe
- Rendezvous burn

- Plane change burn

The procedure of executing the burn itself is the same no matter what type of burn you request.



Requesting a burn will uplink the burn to the OBC. In this case the requested burn is a circularization burn at AP. Ground will give a summary of the burn along with the PAD:

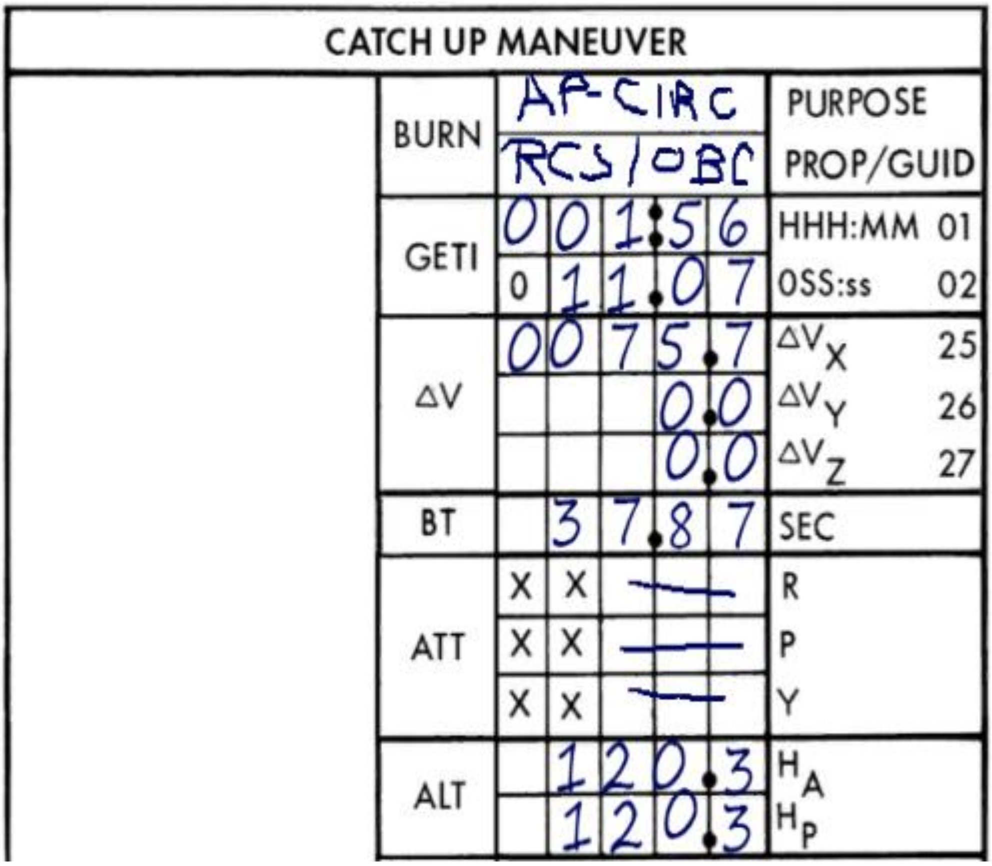


The PAD stands for Preliminary Advisory Data and contains all the details required by the burn.

Hint: You can use a built-in PAD system accessible from the MISSION TOOLs menu if you do not have the PAD on an external tabled or in printed form. To do this, you can open the CATCH-UP PAD sheet and fill out the PAD data by using the PAD drawing tools. See section 7.

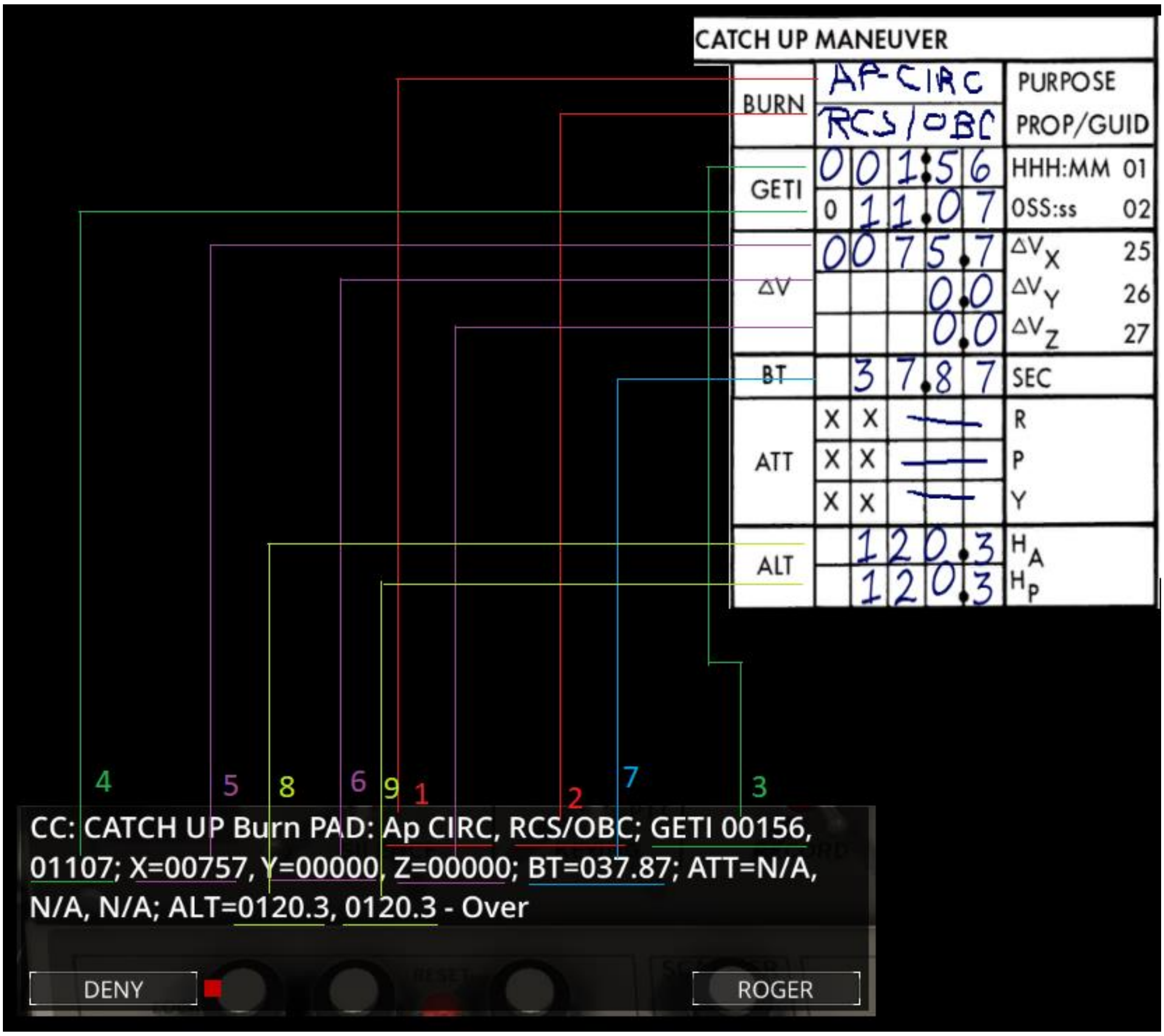
USING THE BUILT-IN PAD SYSTEM in this chapter for a primer on how to use the built-in PAD system.

Following the PAD message you received, fill in row by row in each section.



CATCH UP MANEUVER			
	BURN	AP-CIRC	PURPOSE
		RCS/OBC	PROP/GUID
	GETI	001:56	HHH:MM 01
		011.07	0SS:ss 02
	ΔV	0075.7	ΔV_X 25
		0.0	ΔV_Y 26
		0.0	ΔV_Z 27
	BT	378.7	SEC
	ATT	X X ——	R
		X X ——	P
		X X ——	Y
	ALT	120.3	H_A
		120.3	H_P

The first data point goes into the first row (BURN PURPOSE), the 2nd into BURN PROP/GUID, and each datapoint sequentially follows in the correct order.



By filling in the data in sequence you can see how the data maps directly with the form.

The form contains the time of ignition (GETI) in HHH:MM:SS:ss, the delta-V in ft/s for at Local Vertical where +X is the forward direction, the Burn Time (BT), burn attitude (all N/A) and the predicted orbit in nmi altitude at Apogee and Perigee if the burn is executed correctly.

Some of the rows in the PAD has a number on the right side of it. GETI/HHH:MM is 01, while 0SS:ss is 02. Delta-V X is 25, Y is 26 and Z is 27.

These numbers correspond to where in the OBC memory the data should be inserted into, or verified with.

To correctly set up the OBC for this burn, use the MDIU to insert the data into the computer. Each row in the PAD has 5 digits, with leading zeros to make it easy to plot this into the computer.

To set GETI, insert the following data into the computer:

0100156 E (ENTER)
0201107 E

To set Delta-V, insert the following data into the computer:

2500757 E
2600000 E
2700000 E

When the data is inserted into the computer, all parameters required to execute a burn has been set. Pressing START will make the computer calculate the burn and display the burn direction on the IVIs. The IVIs will show what direction to execute the burn in relative to the spacecrafts local body axis. If you rotate the craft, these values will change.

The IVIs will also display a set of numbers. This is the burn vector:

Since the Time of Ignition is set using Mission Time/GETI, the time to go (TTG) in minutes and seconds can be read using core #83 after pressing START with a valid burn.

To see the time to burn (countdown) in minutes and seconds, insert the following data into the computer:

83 READ OUT

Address 83 contains a snapshot of the time to ignition. The format is MMMSS where the first 3 digits of the MESSAGE is the minutes and the last two is seconds. In this case, its 018 minutes and 58 seconds left to the burn when READ OUT was pressed. Pressing it again will update the display with the new data.

It is common to prepare the EVENT TIMER with a countdown of 10 minutes. Once core #83 shows 01000 (10:00 minutes), start the event timer.

With the event timer counting down, you can prepare for the burn. The burn is easiest to execute if most data exists in one IVI channel such as +FWD. If the burn is prograde, set the platform to SEF so the craft manuevers towards the prograde direction. As the craft maneuvers towards this attitude, and the time to ignition gets closer and closer to zero, most of the delta-V visible on the IVIs will channel through this one section.

If the spacecraft would be facing retrograde instead (so in the opposite direction of the burn), 75 would be showing in the AFT direction (you need to burn aft to perform a prograde burn, since you are facing retrograde).

When the event timer or core #83 shows 00:00, execute the burn. With most data in one IVI axis, you should mostly need to just translate in one direction.

Note: The entire burn is executed manually using the translation stick.

5.3. THE RENDEZVOUS MODULE

This module helps you get close to the Target Vehicle.

The FDIs will give pointing commands to point the spaceship towards the target.

The IVIs will show you the relative distance left between your docking port and the Target Vehicle docking port.

You can use the RADAR guidance to point the spaceship towards the Target. The FDAIs will guide you to this attitude. Using the computer in this module, the FDAI will point you to the same alignment as the target vehicle. When you are close to docking, ensure this is zero in Pitch, Yaw and Roll for simpler maneuvering, this means you are in the same reference plane as the Target Vehicle.

5.4. THE REENTRY MODULE

This module will make the FDI provide pointing commands to reach BEF attitude. During the retrograde burn, the IVIs will show you the delta-V of the retrograde burn updated in real-time. Once you are getting into reentry, the ROLL indicator of the FDI will indicate where you need to roll in order to reach target position. Constant attitude of 0 degrees will make you fly forward longer, generating a little bit lift. By doing this, you can alter the position of where you will land.

Banking will make you turn slightly to alter the landing location left or right.

Rolling fully 360 degrees will make you follow current attained trajectory without any alterations.

The IVIs will display the distance left to the planned splashdown location. By using manual roll commands, the craft is maneuvered through the atmosphere so that it gets as close as possible to the planned landing location.

6. MEMORY MAP

#$08: Ascent guidance: Yaw guidance (0 off, 1 on)

#$09: Insert target inclination into 09 to let the OBC calculate launch Azimuth, and automatically update Core 10 and 11 (see below). If this is set to 03250, it will set the target azimuth to 32.5 degrees and the roll program angle to reach this inclination. Perturbations will occur, and must be corrected by the yaw guidance logic and/or on insertion if possible.

#$10: Ascent guidance: Set target inclination (if not using #$09)

#$11: Roll Program: delta roll (if not using #$09)

#$12: Separation Velocity

#$19: Time to Retrograde (sec)

#$25: IVI dV x

#$26: IVI dV y

#$27: IVI dV z

#$32: Current Orbit Plane Azimuth (Inclination)

#$33: Target Orbit Plane Azimuth (Inclination)

#$40: Current Pitch

#$41: Current Yaw

#$42: Current Roll

#$56: Set target orbit perigee

#$57: Set target orbit apogee

#$72: Time to next apogee or perigee, whichever comes first (sec)

#$73: Time to Ap (sec)

#$74: Time to Pe (sec)

#$75: Orbit Period

#$76: Seconds since Pe

#$80: Perigee of Target Vehicle

#$81: Apogee of Target Vehicle

#$82: Inclination of Target Vehicle,

#$83: Time to Burn (sec) to reach Target Vehicle

#$98: Current Apogee

#$99: Current Perigee

7. USING THE BUILT-IN PAD SYSTEM

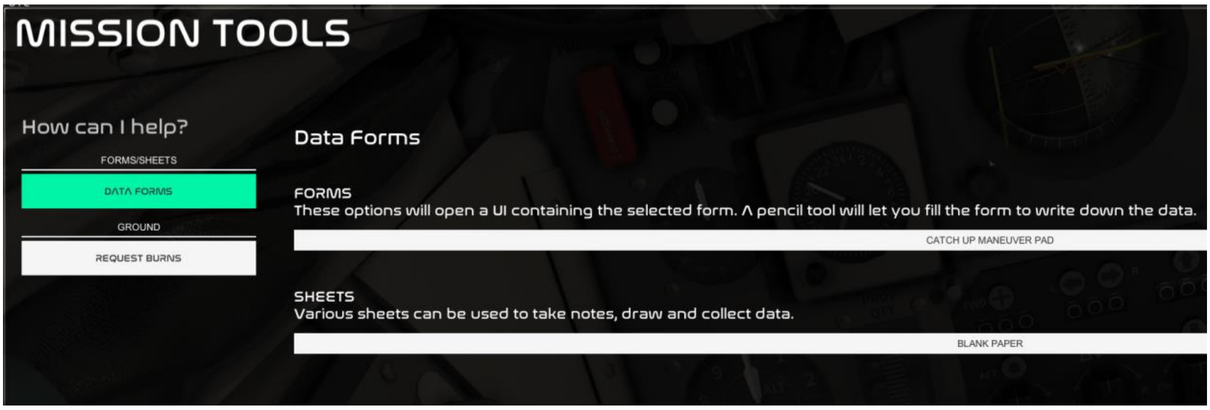
The Project Gemini for Reentry module will introduce you to PADs. PADs were forms the astronauts carried on-board to prepare for procedures, burns and other maneuvers. Ground would relay information related to a burn to the crew, and the crew would type this data into the correct form.

The form could then be used to insert the required data into the computer, or verify other important datapoints and calculation results.

As mentioned, Gemini will only be an introduction to PADs, meaning the PAD is quite simple with only a few datapoints. Once you start working with Project Apollo for Reentry, more complex PADs will be used throughout the mission.

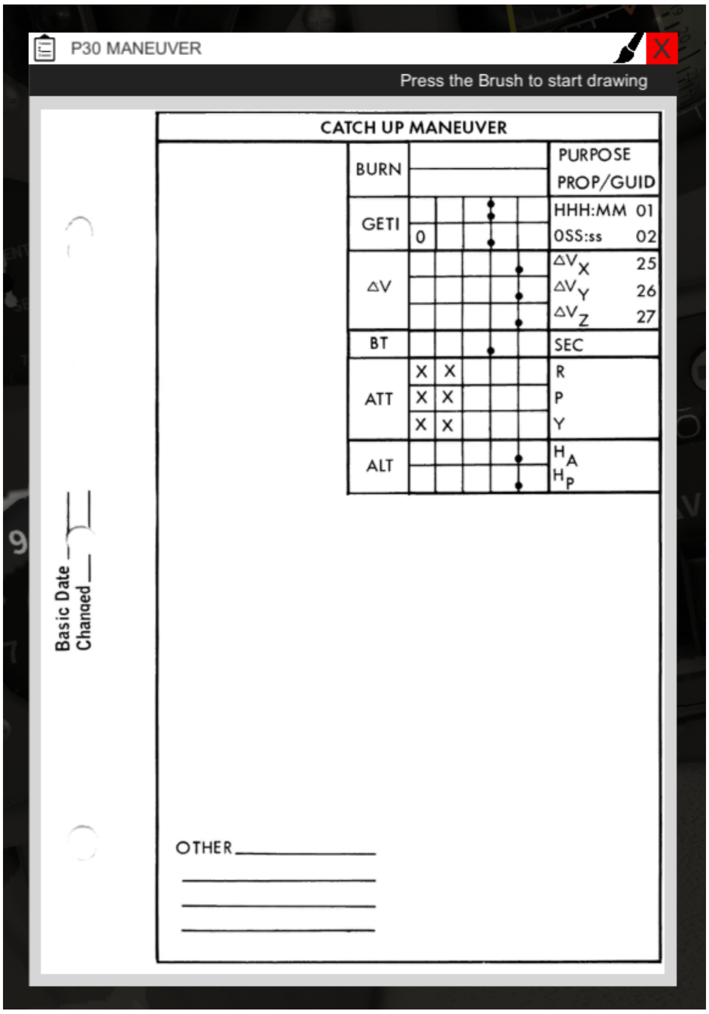
The built-in PAD system will give you access to these PADs if you do not have them externally (recommended) on a tablet or printed.

To open a PAD, use the MISSION TOOLs menu and select the DATA FORMS tab:



From here you can open various forms that can be filled out. Gemini only has one PAD so far, and a blank sheet of paper for drawing and writing down things if needed.

Once a form is opened, it will be visible in-game. A hotkey can be bound to toggle each type of PAD/form/sheet from INPUT settings.

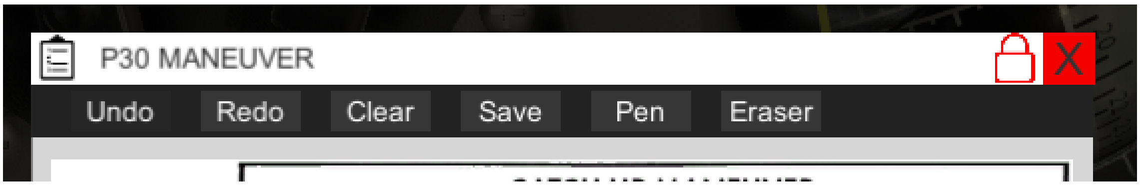


You can place the mouse cursor on the top handle bar (where the form Title is) and drag the form around.

If you place the mouse cursor on the corners of the form you can rescale the window. This is not possible to do if you are in drawing mode.

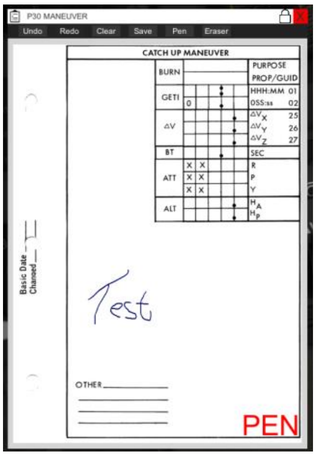
To enter drawing mode, press the BRUSH icon:

It will change into a lock meaning that the size and shape of the form is locked.



A toolbar appears with UNDO, REDO, CLEAR, SAVE, PEN and ERASER.

Left clicking on the form will draw onto it.



A pen and eraser tool can be selected from a toolbar.

Using the scroll wheel on the mouse, you can quickly cycle between the PEN and the ERASER tools, as well as stamps for each numeric digit you need, a plus symbol, and a minus symbol. The red text in the lower right corner will show you what tool you selected. It will be visible each time you move the mouse cursor into the form, or when you change the tool.

Stamps can be used to avoid having to draw numbers onto the screen.

VII. SEQUENCE SYSTEM

VII. SEQUENCE SYSTEM

1. GENERAL

The Sequencer will control the mission phase. During ascent, it will control staging/separation and jettison. Light switches in the main center panel can be opened and pressed to initiate the stage the Sequencer want you to initiate, or if you need to override the sequencer.

When a Switch Light illuminates Amber when an action is expected to happen. Pressing a switch will make the sequencer proceed and execute the action. But be very cautious about this, as they are not reversible. These switches can for example cut the electric lines between the capsule and the adapter, separate them and so on.

The sequencer is semi-automatic, meaning that the Sequencer will not automatically separate the spacecraft from the LV, the Adapter, the Retro section etc., this is done manually by the astronaut by pressing the light switch that glows.

Two timers are used by the sequencer. It's the time from booster engine ignition, and the time to retrograde.

During ascent, the spacecraft is controlled by the Radio Guidance System (RGS) and the Digital Command System (DCS), where the Gemini crew is monitoring the systems. As a backup, the Inertial Guidance System (IGS) and the On-Board Computer (OBC) can control the ascent.

When the ascent phase is over, the crew performs the required actions to separate the spacecraft from the launch vehicle, and the final delta thrust needed to attain orbit.

At this point, the sequencer is in standby mode, counting down to Time to Retrograde (Tr). 256 seconds before retrograde (Tr-256), the sequencer starts preparing for retrograde by illuminating light indicators on the control panel. The crew follows the instructions by the sequencers. At Tr-30, meaning 30 seconds before retrograde, the sequencer illuminates more lights to instruct the crew to separate the adapter and arm the automatic retrograde system.

If set up correctly, retrograde happens automatically. The crew ensures the correct orientation is maintained prior to this as firing the retrogrades in the wrong direction can be catastrophic. A manual ignite of the retro fire signal is given by the crew one second after the automatic fire signal is given for redundancy.

During descent, the sequencers provide ques for when the crew should deploy the parachutes. At splashdown, the chutes are jettisoned, and all systems are shut down.

The sequence diagram in figure 7.2.0.1 shows this.

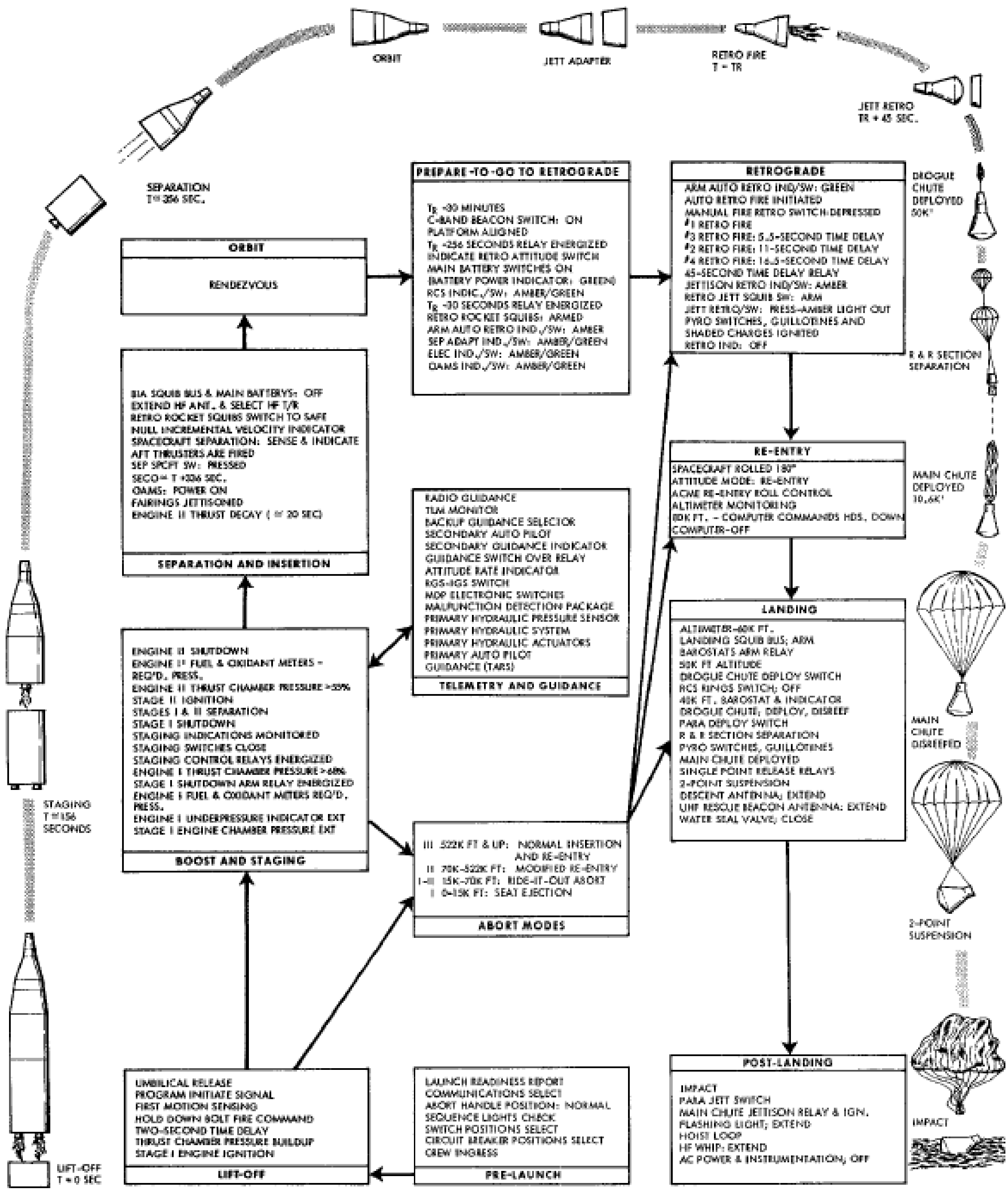


Figure 7.2.0.1 – Sequencer diagram, from SEDR 300 manual.

2. SYSTEM OPERATION

The sequencer can be divided into 8 stages:

1) Pre-launch
2) Lift-off
3) Boost and staging

4) Separation and insertion
5) Prepare-to-go to retrograde
6) Retrograde
7) Re-entry
8) Abort

2.1 PRE-LAUNCH

The command and pilot enter the cabin, and hatches are locked in place. The crew ensures all switches are in the correct initial position and system/engine lights are extinguished.

Most of the pre-launch configuration has already taken place when you enter the simulation, but it is always good practice to ensure the correct stats is set. Using the checklist system, or the checklists chapter in this manual, you can follow the steps needed in-game.

1: Altimeter is set (reading zero)
2: Ensure IVIs are zeroed
3: The sequence indicators are extinguished
4: The two ABORT, ATT RATE, SEC GUIDANCE, ENGINE I and ENGINE II lights are extinguished
5: Top three rows of circuit breakers on the left switch/circuit breaker panels are closed (up)
6: BOOST-INSERT and RETRO ROCKET SQUIB switches is set to ARM
7: RETRO and LANDING switches is set to SAFE
8: Tests the nine sequence lights using the SEQ LIGHTS TEST switch.
9: Starts the computer, takes 20 seconds.
10: The four MAIN BATTERIES switches and the three SQUIB BATTERIES switches is set to ON
11: The ECS and COOLANT systems are set
12: The rest of the systems are set as needed
13: A radio check is performed

When everything is set, the crew reports that they are ready using the radio. The launch will happen when the crew has reported that they are ready, and the countdown has reached zero. Ignition happens a few seconds before, and release of bolts that keep the rocket to the tower are released when thrust has built up.

2.2 LIFT-OFF

When the countdown reaches zero, the blockhouse signals the ignition. At this point the first stage engines begin their thrust chamber buildup. This can take anything from between one second to 4 seconds per engine. The ENGINE I indicators illuminate red when this happens. When the pressure exceeds 77% of rated pressure, a two-second time delay is initiated in the blockhouse. If everything is GO, the hold-down-bolt fire command is given, and the launch vehicle is committed to flight.

When motion is detected, the time since booster ignition starts, and the computer automatically starts. The time-to-retrograde timer starts counting down.

2.3 BOOST AND STAGING

The Titan II rocket starts to climb, and is controlled automatically. The crew monitors all vital indicators to ensure a safe lift-off. Abort must be executed if the ABORT light, any of the ENGINE I indicators, or the ATT RATE indicator illuminate after liftoff.

The ENGINE II illuminate amber, meaning it is ready for automatic ignition.

The STAGE I FUEL and OXIDIZER needles are continuously reducing, indicating the time left to separation.

The LONGITUDAL ACCELEROMETER must continuously increase according to flight plan.

The ALTITUDE must show a steady climb below 100.000 ft.

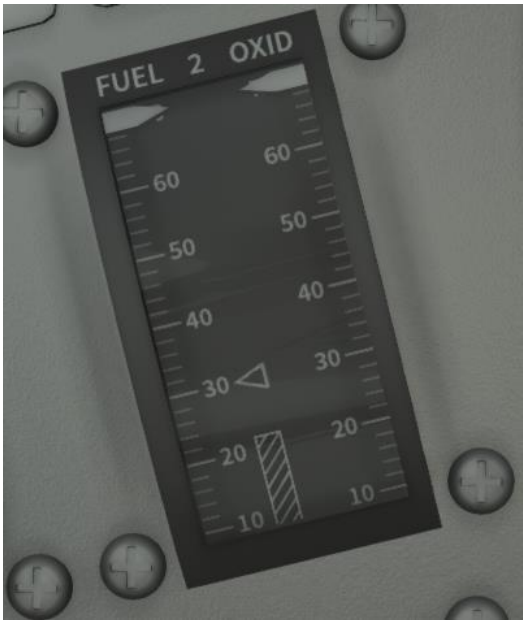
The long needle shows the height by x1000, and the short needle shows the height by x10000. If the short needle is at 5 and the long is at 6, it means that the altitude is 56000 ft.

At T+145 seconds, the acceleration should have reached about 6g's, and the first engine shutdown is energized. A few seconds later, the thrust chamber pressure drops to less than 68 percent, illuminating the red ENGINE I indicators. This is normal.

At this point, the booster engines are shut off, and the g's rapidly drop to 1.5g's and separation occurs. Both STAGE I of the LV and the LV Adapter that holds STAGE I and STAGE II together is separated, and the STAGE II engine immediately ignites. The ENGINE I lights extinguish. The ENGINE II light is extinguished when pressure is built up to 55 percent and the LONGITUDAL ACCELEROMETER begins to climb again.

During STAGE II, the ENGINE II under-pressure indicators, the Attitude Overrate (ATT RATE) indicator, and the two ABORT lights must remain extinguished.

The STAGE II FUEL and OXIDIZER needles will continuously reduce.



2.4 SEPERATION AND INSERTION

At T+330 seconds, the acceleration has climbed to almost 7g's, and the spacecraft will almost have reached orbital velocity and attitude. A few seconds later, the blockhouse computer transmits the SSECO (Second Stage Engine Cut Off) signal via a DCS message and the Stage II Engine is cut off.

The g's will rapidly fall, and the on-board computer will begin to compute the delta-V required for insertion. The orbit for each launch will differ from the target, and the initial orbit is used to tune the orbit to match the target. The ON-BOARD COMPUTER chapter went through how to do this.

At this point, the crew presses the JETT FAIRING button to jettison the sensor covers that protected the sensors during launch. These sensors are the horizon detection sensors, as well as the antenna and rendezvous radar. The horizon scanners will spend 120 seconds on warming up, powering up and detecting the initial horizon. The attitude indicator will at this point jump to the right attitude, but before this it will show an error so don't follow the attitude indicator until the scanners are working.

When scanner warning light illuminates when the horizon is not detected.

20 seconds later when the thrust has decayed, the sequencer illuminates the SEP SPCFT switch-indicator, and the crew presses the button. This will energize the squib bus No. 1 is applied through the BOOST-INSERT CONT circuit breaker, and separate the spacecraft from the launch vehicle.

If the separation is successful, the SEP SPCFT illuminates green. If separation happened, but this is not illuminating, a quick thrust of the OAMS system is needed to move the spaceship away from the LV.

The IVI's will now show the distance left to target orbit for Apogee. The AFT thrusters are fired until the IVI's are nulled.

The post-insertion checklist is executed:

1: RETRO ROCKET SQUIBs are set to SAFE
2: BOOST-INSERT squib is set to SAFE
3: MAIN BATTERIES 1,2,3,4 is no longer needed as the fuel cells are producing enough power and are turned OFF.

The complete checklist is found in-game.

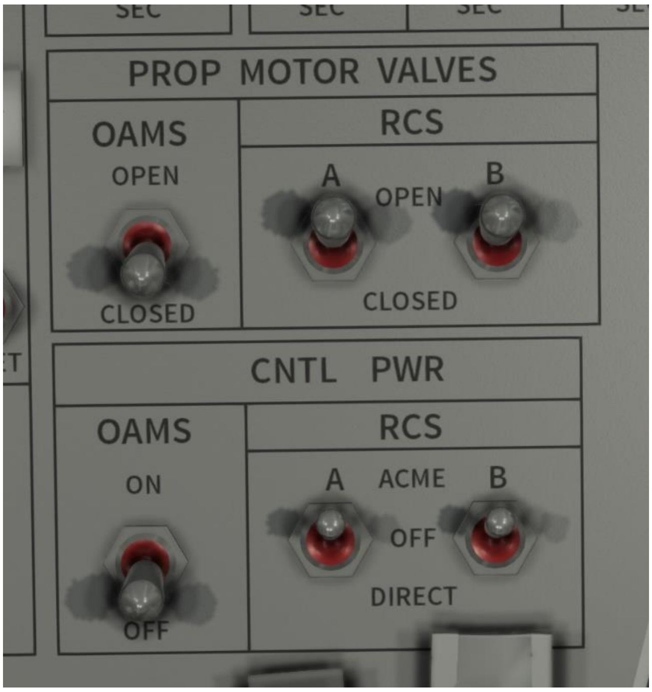
2.5 PREPARE-TO-GO TO RETROGRADE

30 minutes before retrofire, the platform is aligned and the spacecraft is maneuvered to blunt-end-forward (BEF).

At T-256, the sequencer illuminates the required crew actions. Batteries must be set to ON since the Fuel Cells are located in the Adapter that will be separated, the Re-entry Control System (RCS) illuminate amber, and the IND RETRO ATT illuminate amber.

The Battery indicator illuminate green when the batteries are on, and the indicate retro attitude light illuminate green when pressed. This places the FDI needles and the inertial platform to BEF mode.

The RCS turns to green when pressed and energized. This enables the RCS rings A and B. The RCS RING A and RCS RING B switches are set to ACME, and the attitude controllers are used to test the RCS system.



The OAMS must remain off as the system is jettisoned with the adapter section.

O2 HIGH RATE is initiated and systems are set to cool down the cabin.

At Tr-30 seconds, the SEP OAMS LINE, SEP ELEC, SEP ADPT, and ARM AUTO RETRO indicators turn amber. The crew follows the instructions of the sequencer and depress the SEP OAMS LINE switch-indicator. This closes the OAMS propellant lines and disables the OAMS system. This turns the SEP OAMS LINE light to green.

Then the SEP ELEC switch-indicator button is pressed, and the electrical system lines are cut, and power can no longer be received from the fuel cells. The indicator turns green.

Then the SEP ADAPT switch-indicator is pressed and the Adapter is separated from the spacecraft, and the indicator turns green when cleared from the Adapter.

Lastly, the crew presses the ARM AUTO RETRO switch-indicator button that arms the AUTO RETRO system. The 4 RETRO ROCKET SQUIBs are now set to ARM again.

2.6 RETROGRADE

When ready, and the Tr reaches zero, the retrograde rockets will fire one by one with a 5 second delay between them. For redundancy, the crew also manually initiates the retro fire signal.

When the RETROS has fired, the JETT RETRO SQUIB ARM switch is set to ARM, and the JETT RETRO lamp will illuminate amber at about 45 seconds later. When the crew notices this, it is pressed, and the retro engine section is separated from the spacecraft.

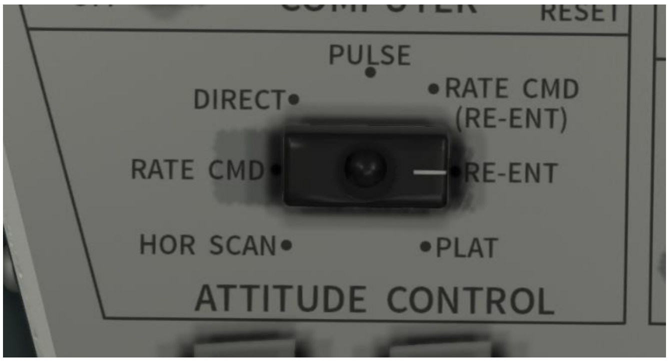
This will also jettison the index bar and scanners.

The spacecraft is now ready for re-entry.

2.7 RE-ENTRY

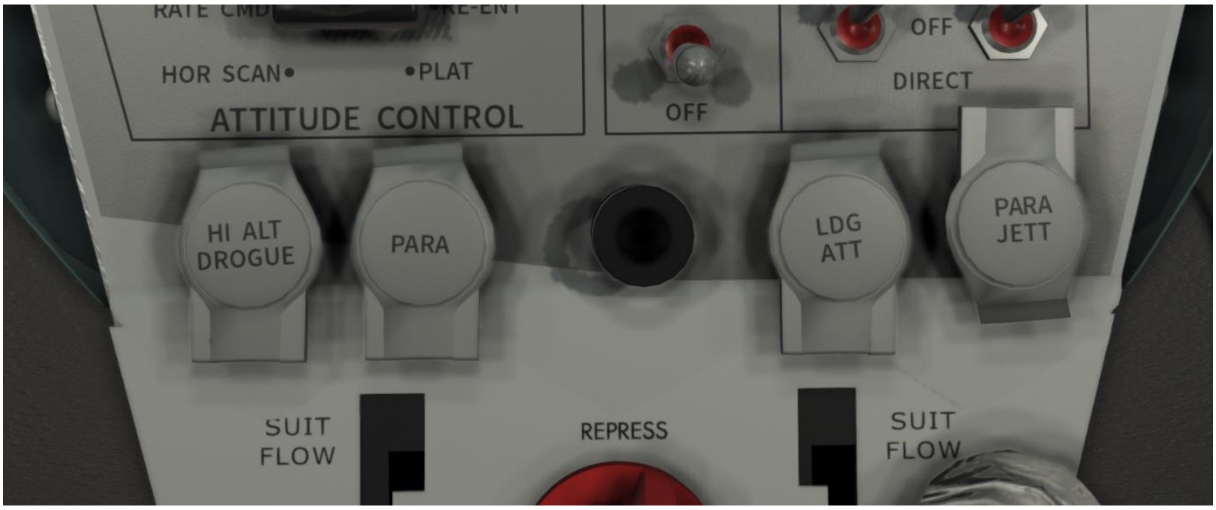
The RETRO PWR and RETRO JETT squibs are set to SAFE, and the orientation is rolled 180 degrees so the horizon is visible in the upper part of the window. The attitude control is set to RATE CMD (RE-ENT). The roll FDI pointer will start to move, and the crew will have to follow this to orient the spacecraft correctly while the computer calculates the point of splashdown.

Then the computer is ready, the mode is set to RE-ENT. The computer controls the roll attitude automatically.



After re-entry, the sequencer illuminates when the drogue and main parachutes are to be deployed.

These are deployed using the parachute and landing control buttons.



The drogue is released at around 40k ft., the main parachute at 10.6k ft., the landing attitude before splashdown, and the parachute jettison after splashdown. All of these triggers must be executed at the correct time by the crew.

VIII. ELECTRICAL POWER SYSTEM

VIII. ELECTRICAL POWER SYSTEM

1. GENERAL

The spacecraft is powered by two systems. The primary power source is from **two Fuel Cells** that generate power from Hydrogen and Oxygen, and the secondary system is powered by **four silver-zinc batteries**.

The Fuel Cells are located in the Equipment Section. It is using a system called RSS (Reactant Supply System) as provisions of Cryogenic oxygen and hydrogen to generate electrical power and water. The amount of reactant used is dependent on the power load. The more systems in use, the more reactants it will consume. Each Fuel Cell has three stacks producing power. The fuel cells are located in the Adapter module.

The two Fuel Cells are capable of running all the spacecraft systems, but a set of batteries are available in the Reentry module. These are used once the Adapter section has been jettisoned for reentry, or in case of fuel cell failures. There are 4 main silver-zinc batteries available.

These two systems are powering the Main DC Bus, thus most of the systems in use. For pyrotechnical systems, another bus named the Common Control Bus is being used. This is an isolated environment used during staging and in some systems during orbit. This bus is being powered by **three silver-zinc batteries** called the Squib Batteries. These batteries are typically ON during the entire mission.

Using switches and fuses, you can control what systems are being operational. It is important to turn off systems that is not needed to conserve reactants and batteries. You can check the status of batteries and Fuel Cells using the voltmeter and the ammeters, and the Cryogenic meter to read available reactants. Volts is the power strength available while amps are the power flow/how much power is being consumed from the power source.

The RSS (Reactant Supply System) needs to be purged and heated at intervals to ensure correct operation, prevent malfunctions, and keep the system pressurized.

1.1. SQUIBS

During boost/insert, a set of squibs are being used for staging during the ascent phases. This needs the Common Control Bus powered, and the boost-insert squibs armed. During landing, the landing squibs needs to be armed, and during retrograde, the retro rocket squibs need to be armed.

This is because of safety. You don't want to accidentally separate your retrograde module, adapter or deploy the chutes in space. This can happen if the systems are armed, and other system malfunctions triggers the squibs.

Squib control is very important. It is a simple task, but it is easy to forget to arm or disarm them. Use and follow the available checklists to make sure you do this correctly.

2. OPERATION

The Fuel Cells are located in the Adapter section, along with the Reactant Supply System, and the main batteries and squib batteries are located in the re-entry module. Figure 5.2.1 shows the overview.

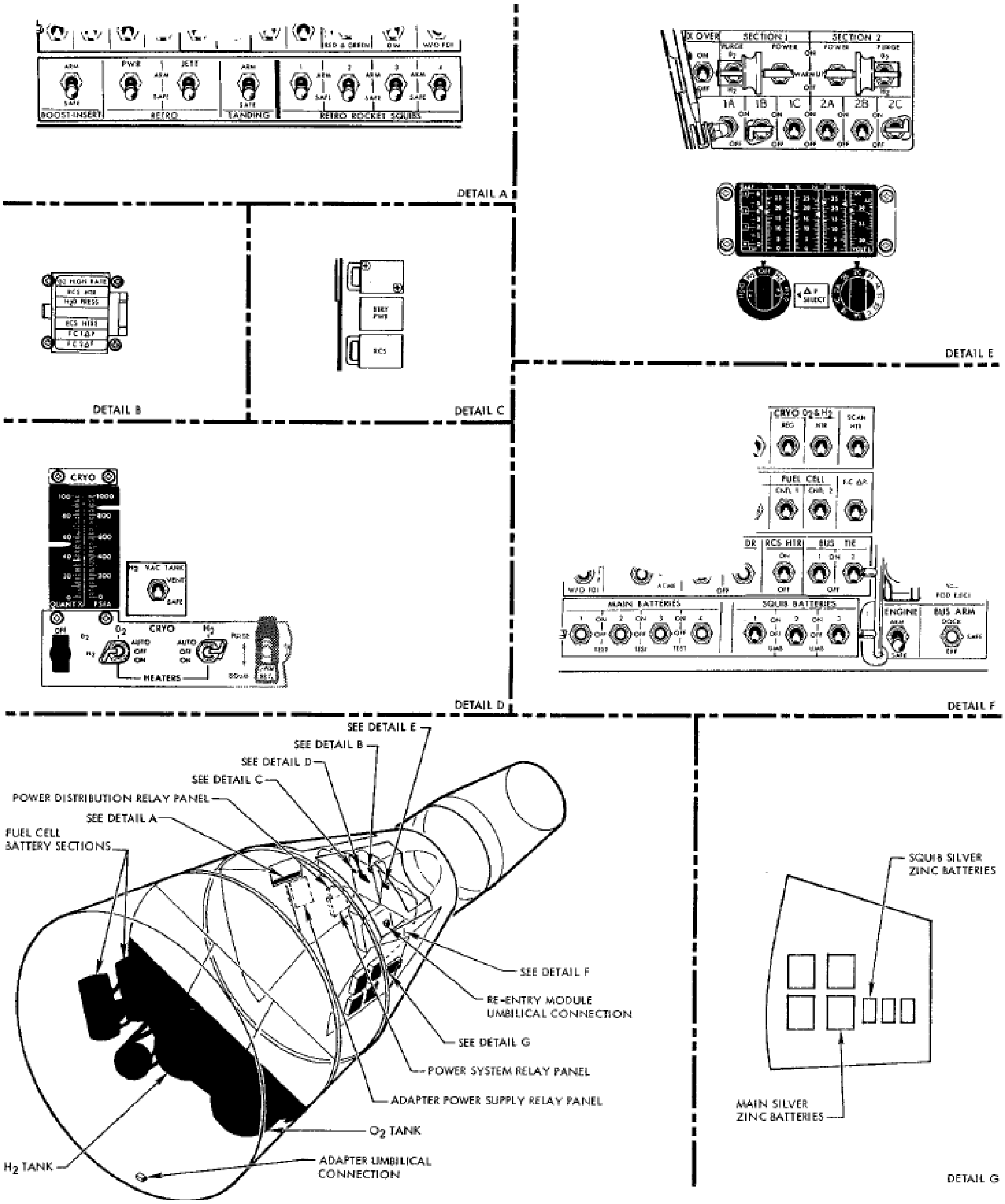
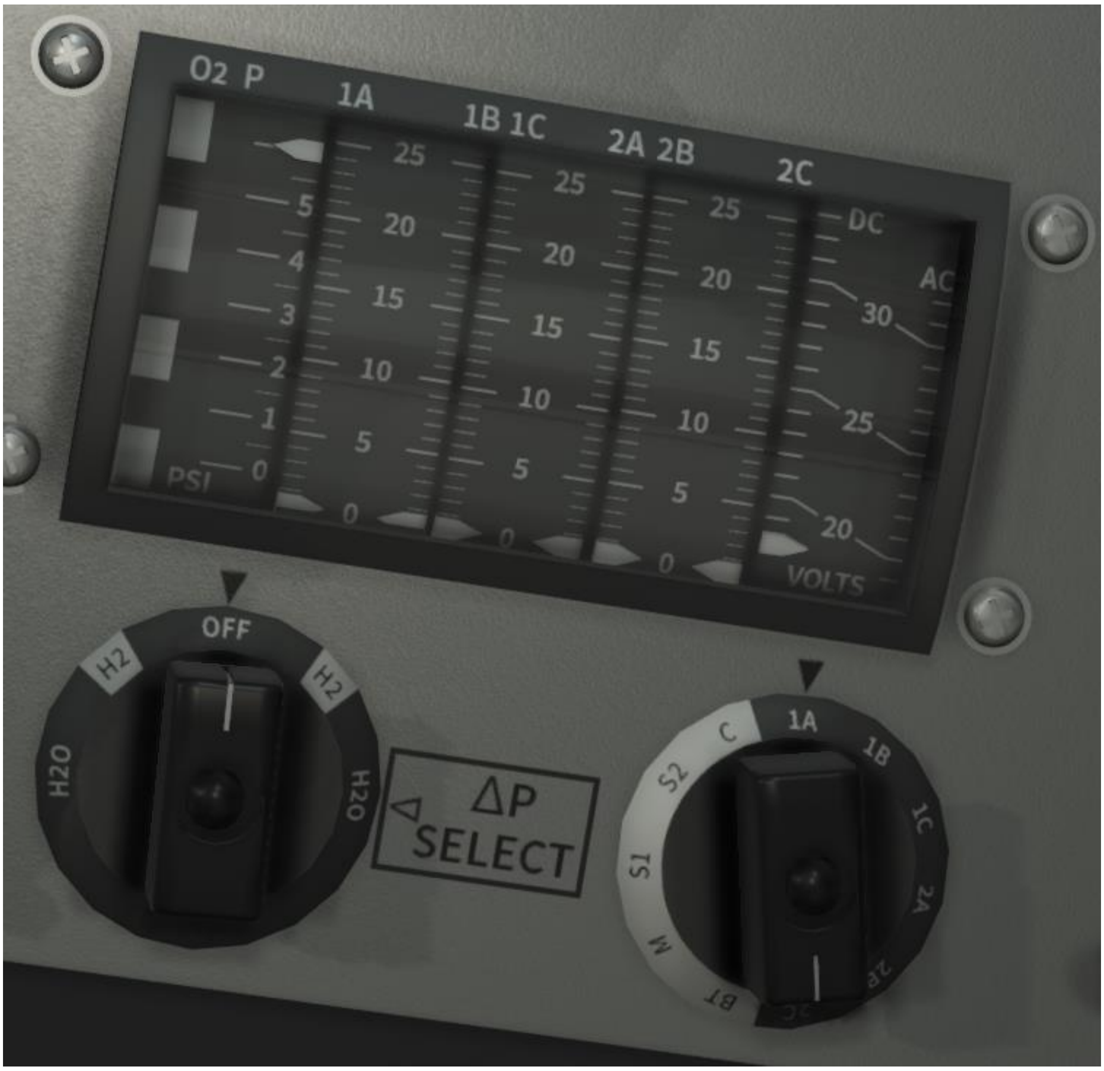


Figure 5.2.1 – Electrical Overview, from SEDR 300

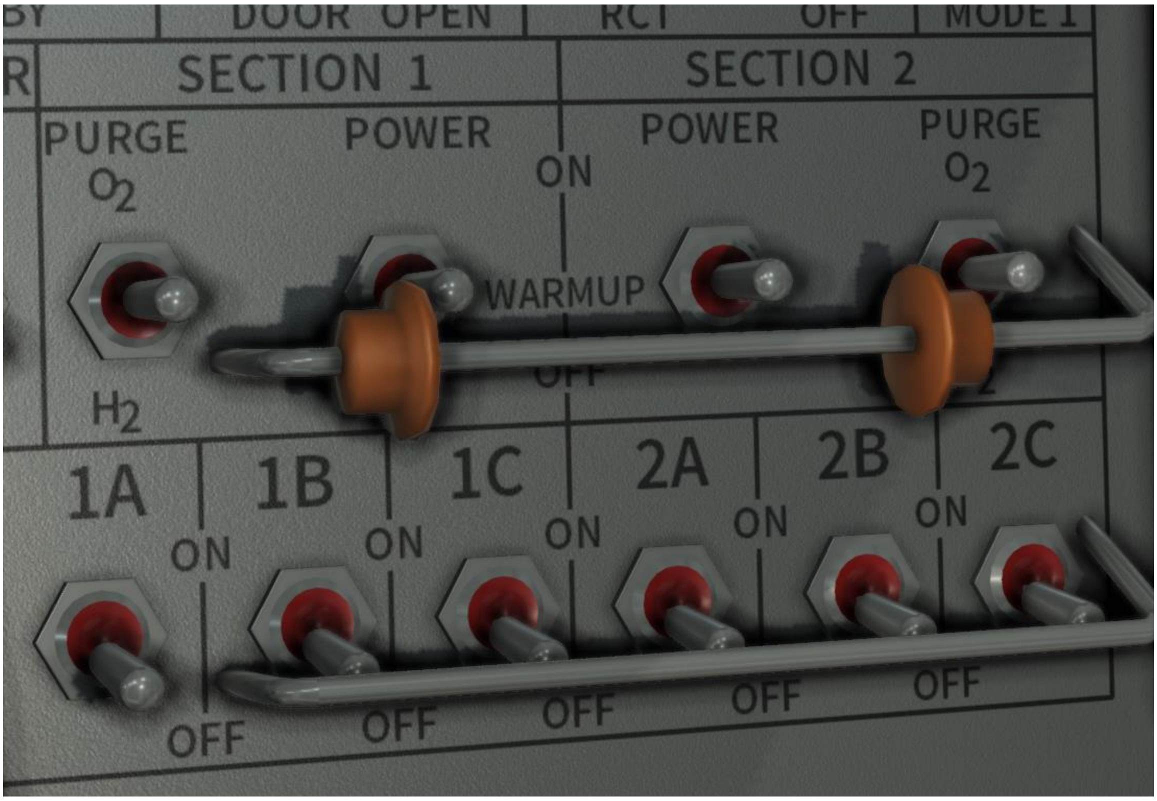
The two fuel cells and the four main batteries is powering the Main DC bus. The squib batteries power the Common Control bus, and the OAMS squib bus who distributes power to the Boost-Insert-Abort, retrograde, landing and Agena squib buses. These buses have their own arming switches needed during ascent, boost, retrograde and landing.

A power system monitor contains a delta pressure indicator, three dual-vertical-readout ammeters, and an AC/DC voltmeter to check the power system status. Two selectors are used to select what power system component to monitor.



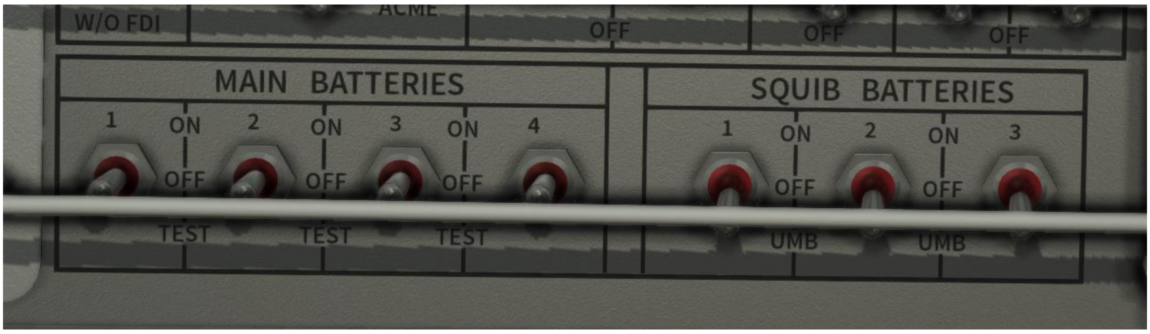
Each fuel cell contains 3 power stacks, each capable of generating power. For each fuel cell, three switches control the stack power, and one switch control the fuel cell power. The stacks in Fuel Cell 1 are named 1A, 1B and 1C and the stacks in Fuel Cell 2 are named 2A, 2B, and 2C.

The Fuel Cells are controlled on the Pilots Panel.

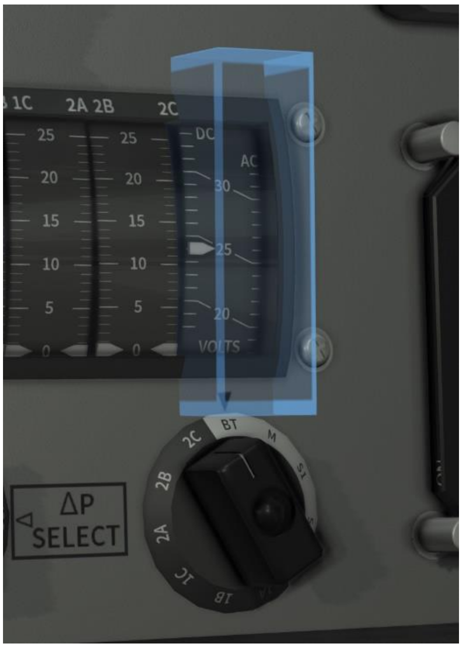


The Fuel Cells are generating electrical power by the ionization of Oxygen and Hydrogen. The Reactant Substance System controls this and can be monitored on the Main Center panel on the CRYO indicator.

The Main Batteries and the Squib batteries are operated from the Pilots circuit breaker panel.



Each battery has a test switch used to check the voltage. Using the electrical system monitor selector in BT position, and the battery you want to test in TEST, the voltmeter will show the battery voltage.

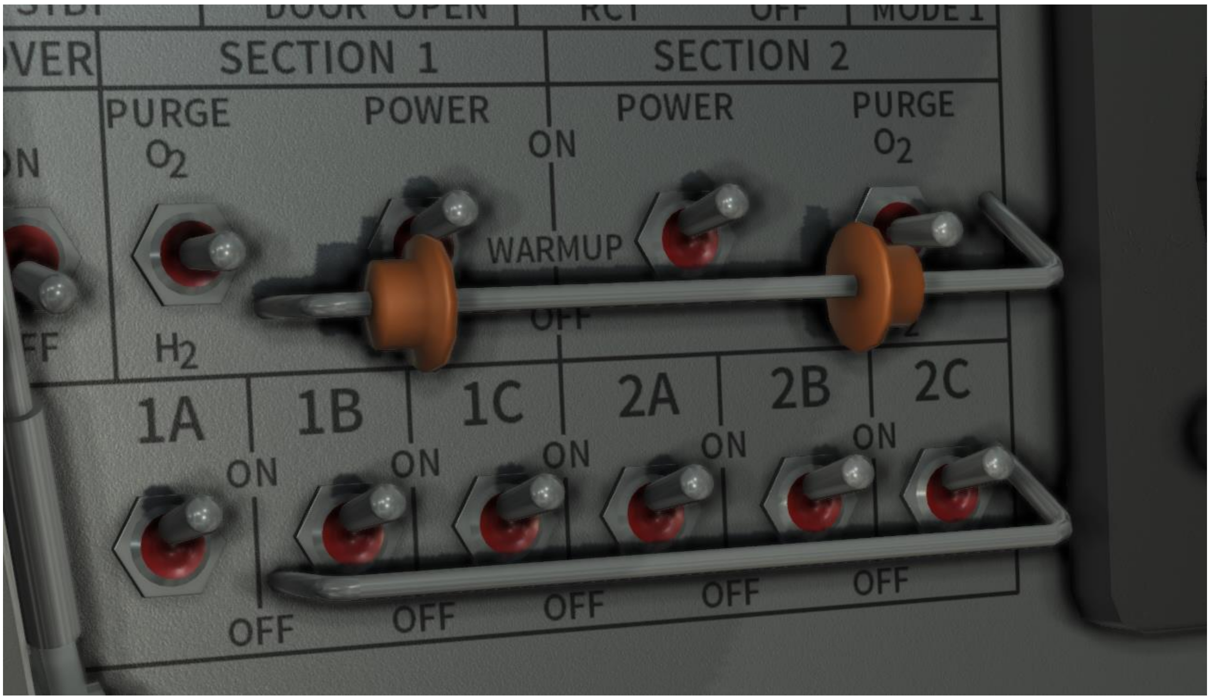


Each of the Squib batteries are initially connected to the umbilical tower by having the squib switches set to UMB. When the crew enters the cockpit, these are set to ON and will remain ON for the rest of the mission.

2.1. LAUNCH

Before launch, all the MAIN BATTERIES, SQUIB BATTERIS, FUEL CELL SECTION POWER and FUEL CELL STACK switches are set to the ON position.

All the electrical power sources are utilized during the ascent for redundancy. These are connected in parallel to the Main DC bus.



The Boost-Insert-Abort bus is armed and connected to the Common Control Bus for use during ascent.

The four RETRO ROCKET SQUIBS are set to ARM.

2.2. ORBIT

After orbit insertion, the MAIN BATTERIES switches are placed to the OFF position as the main power source during orbital flight are the Fuel Cells. The SQUIB BATTERIES remain ON for the rest of the mission.

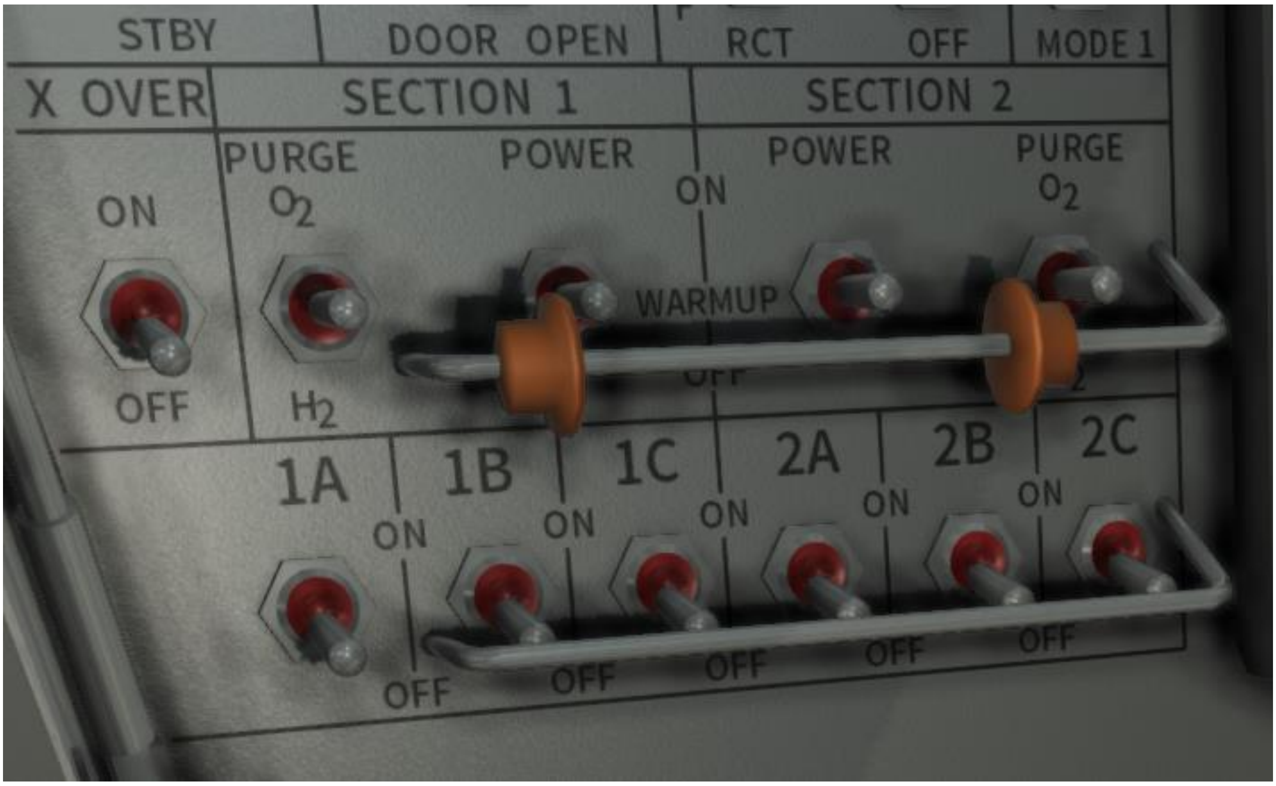
The RETRO ROCKET SQUIBS are set to SAFE.

The H2 VAC TANK switch is used to vent the area between the inner and outer wall of the RSS H2 tank to space when in the OPEN position. It is important to keep this in CLOSED when not performing a venting operation.

The BUS TIE switch is usually set to OFF during the entire mission, but if a failure occurs, the BUS TIE can be used to tie the main bus to the common control and OAMS squib bus. This is in the event the SQUIB BATTERIES fail to power the Common Control Bus.

As the Fuel Cells are operating, they must be purged periodically. This will remove a small percentage of the reactant gases so that impurities contained in the feed gases don't restrict reactant flow to the cells, and to remove any accumulation of product water in the gas lines.

The fuel cells are manually purged using the O2 an H2 PURGE switches. A more effective purge can be done using the X-OVER switch, this will increase the flow of gases to the fuel cell sections, but also use more gas when purging.



2.3. RE-ENTRY

Before retrograde (Tr-256) the crew will arm the retrograde squib buses by setting the RETRO PWR switch to ARM and each ROCKET SQUIB to ARM.

The MAIN BATTERIES are set to ON again as the Fuel Cells power source are about to be jettisoned with the Adapter. This will ensure continuity of the Main DC Bus when the Fuel Cells are disconnected. The Fuel Cell Stacks and Power switches are all set to OFF.

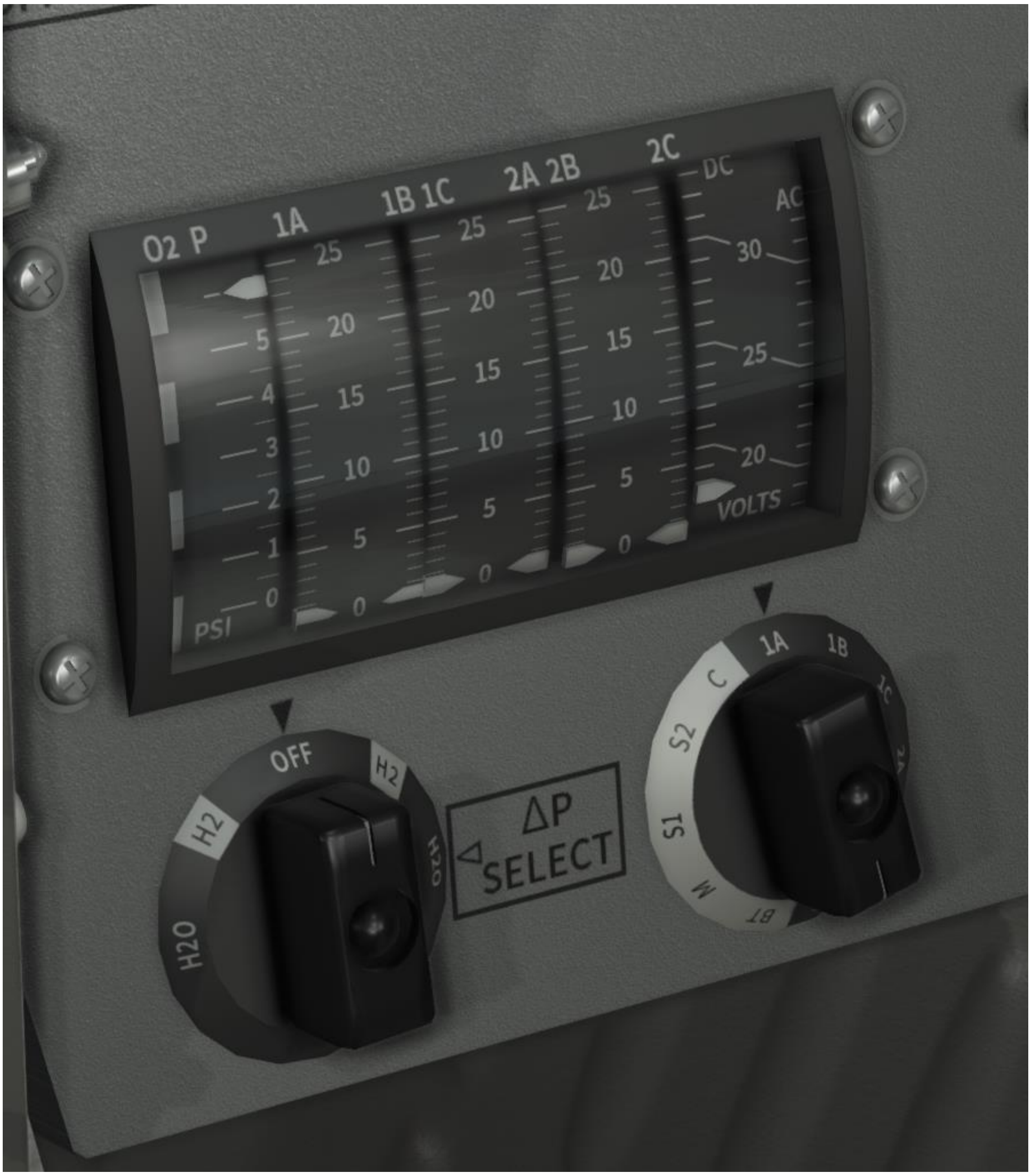
After RETRO FIRE the RETRO JETT switch is set to ARM, which arms JETT RETRO light-switch needed to jettison the retro engines. This should always be set to SAFE unless you are about to jettison it. Once separated, the crew will disarm the retrograde squib buses by setting the RETRO PWR switch, RETRO JETT switch and the RETRO ROCKE SQUIBS to SAFE.

The LANDING squibs are set to ARM to arm the electronics required for the LANDING sequence.

After landing, the landing squib is set to SAFE, the SQUIB BATTERIES 2 and 3 is set to OFF. All unnecessary electrical equipment will be deactivated to conserve the remaining battery for recovery operations. SQUIB BATTERIES switch 1 and the MAIN BATTERIS switches will remain ON.

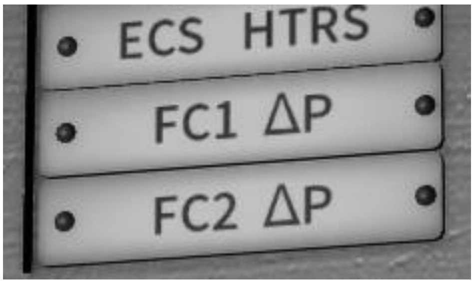
2.4. MONITORING

The ammeters can monitor the individual fuel cell stack currents (1A through 2C), and the voltmeter can be used to display fuel cell stack voltage, common control bus voltage, OAMS squib 1 and 2 voltage, Inertial Guidance System (IGS) inverter output voltage, main bus voltage and the battery tests. This is selected using the selector knob.



The delta pressure indicator displays O2 versus H2, and O2 versus H2O differential pressure in the fuel cell battery sections. If the differential pressure reaches the limit, the fuel cell battery performance needs to be evaluated. If a malfunction exists, that stack needs to be shut down.

The out of tolerance delta pressure indicators is will illuminate if these limits has been reached for FC1 and FC2.



The reactants in the Reactant Supply System (RSS) are displayed in the CRYO meter using the selector knob.

The BTRY PWR sequence light is illuminated at Tr-256 to remind that the batteries need to be turned on and amber. When connected, it will turn green.

3. FUEL CELLS

The Fuel Cell battery system has two Fuel Cells, each with 3 stacks in them. Each stack can be individually activated, and only one needs to be active to produce power.

Each stack contains 32 fuel cells, by which is producing electrical energy and water from a controlled oxidation of hydrogen.

A fuel cell can be seen in 8.3.1.

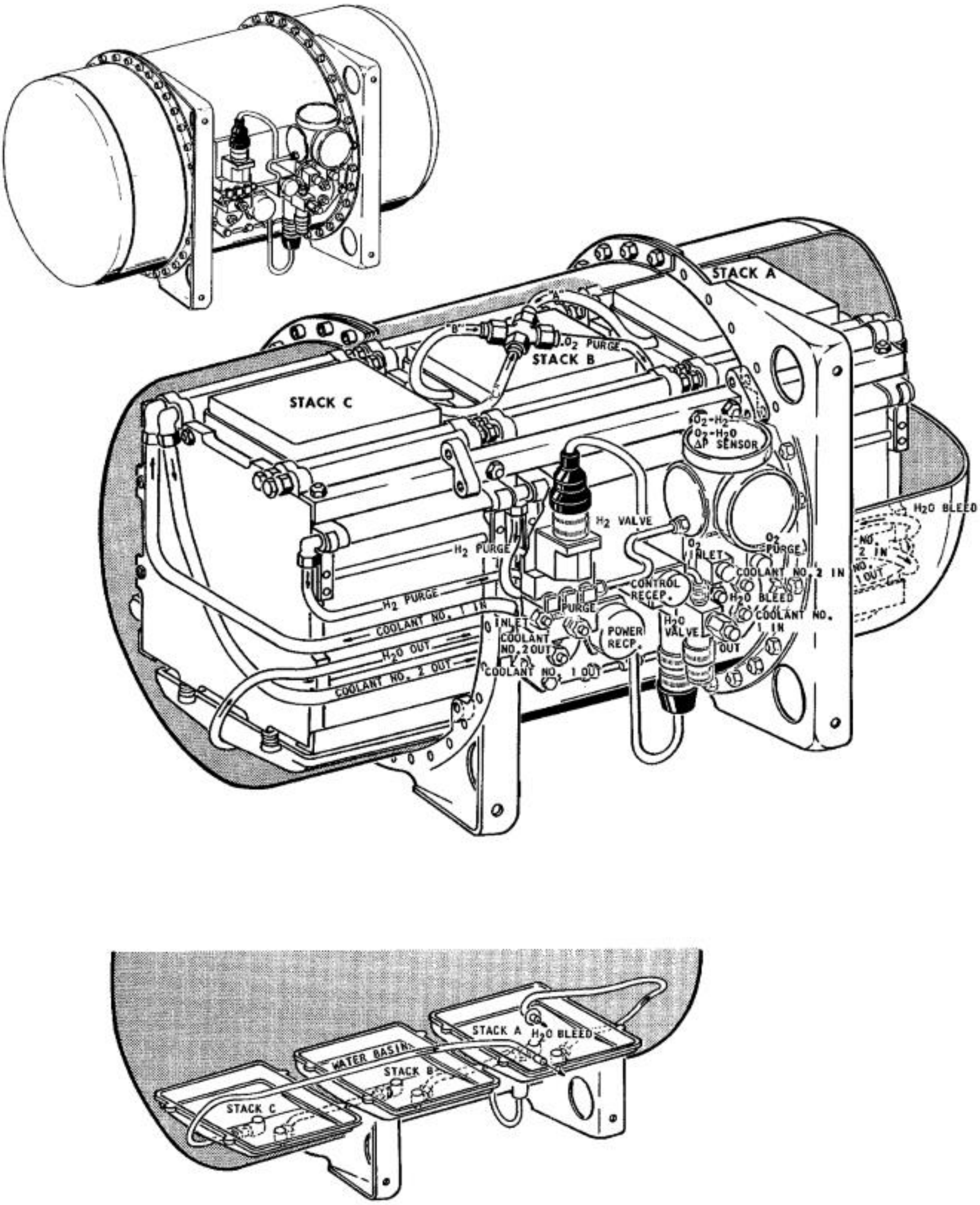


Figure 8.3.1. Fuel Cell Section, from SEDR 300

4. REACTANT SUPPLY SYSTEM

The Reactant Supply System (RSS) is a subsystem for the fuel cells, and it provides the fuel cells with cryogenic hydrogen and oxygen that is converted to gas before reaching them.

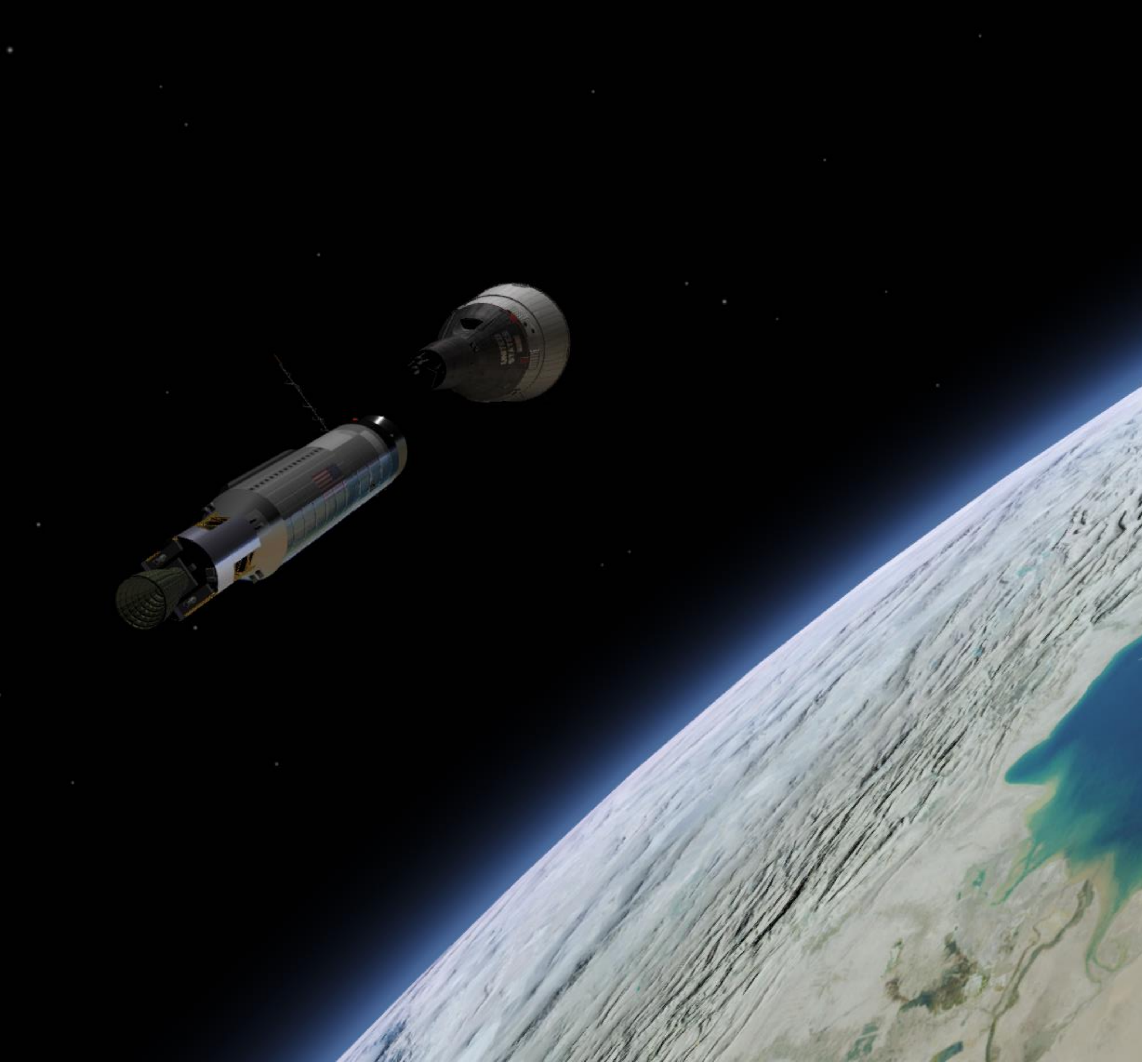
It also supplies oxygen to the ECS.

Two thermally insulated tanks are used to store hydrogen and oxygen.

A crossover valve provides the capability of supplying hydrogen and oxygen through dual pressure regulators to increase flow rate for more effective purging. It is controlled by the X-OVER switch.

Heat exchangers are used for cooling the coolant, and heating the reactant to a gaseous form.

IX. RENDEZVOUS & DOCKING



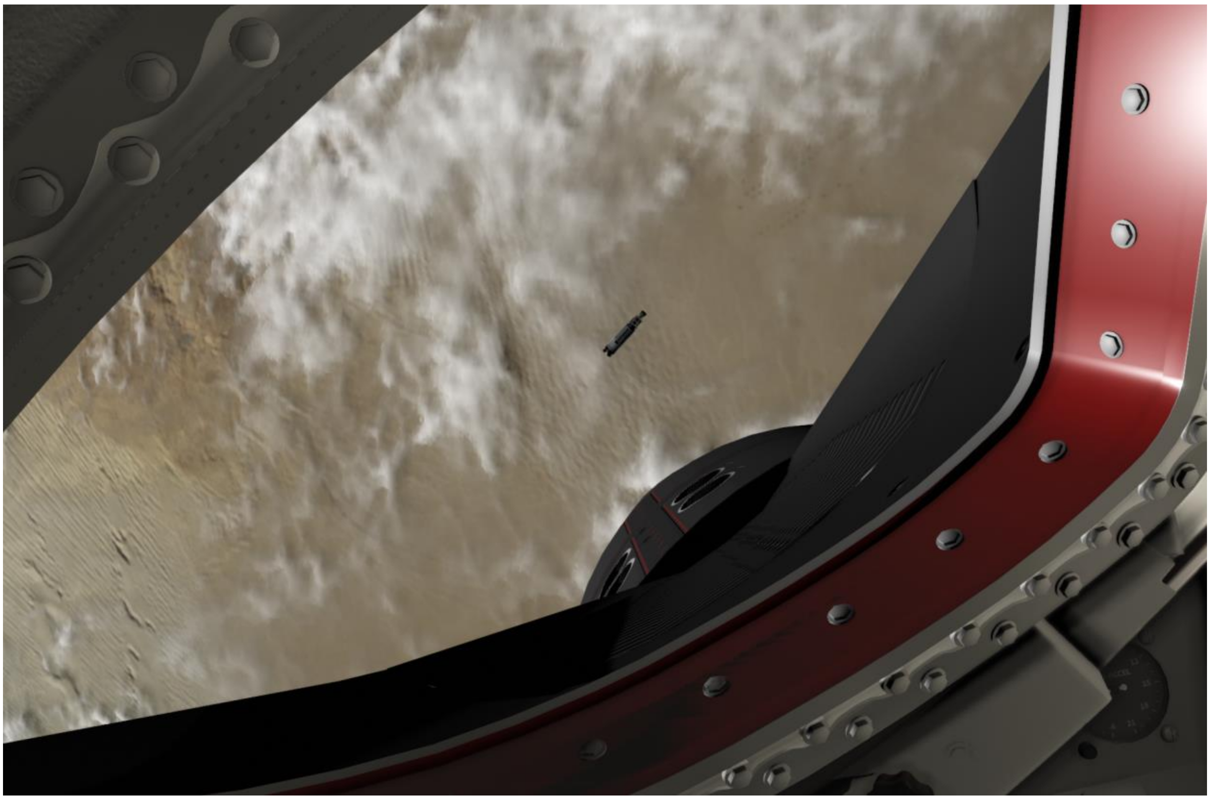
IX. RENDEZVOUS & DOCKING

1. GENERAL

The Gemini spacecraft is capable of docking with another target vehicle such as "Agena" as long as the vehicle has a Target Docking Adapter (TDA).

The spacecraft is using the computer to calculate docking parameters, and the translational and attitude control to move it towards the target vehicle.

When the nose of the Gemini spacecraft enters the docking probe, the spacecraft will dock with the target vehicle. The R&R (Rendezvous & Recovery) section is used to dock with a Target Docking Adapter (TDA) located on the other vehicle.



1.1. RENDEZVOUS & RECOVERY SECTION

The R&R section contains everything that is needed to dock with a target vehicles Target Docking Adapter (TDA). An index bar can be extended to help with alignment, mooring latches are used to attach when entering the TDA port. Other components can be seen in Figure 9.1.1.1.

The fairing is jettisoned at spacecraft separation from the launch vehicle, exposing the R&R sensors and equipment. The index bar is located so it will fit in the TDA docking port and is used as a guidance during final approach.

The index bar cannot be extended before the fairing is jettisoned. The index bar is discarded before entry.

The Rendezvous Radar is located in the front of the R&R section, and is used to control the target vehicle before docking using the encoder. The encoder is used after docking too, but the signals are sent through an umbilical connection instead. This connection provides a direct hardline control of the target vehicle.

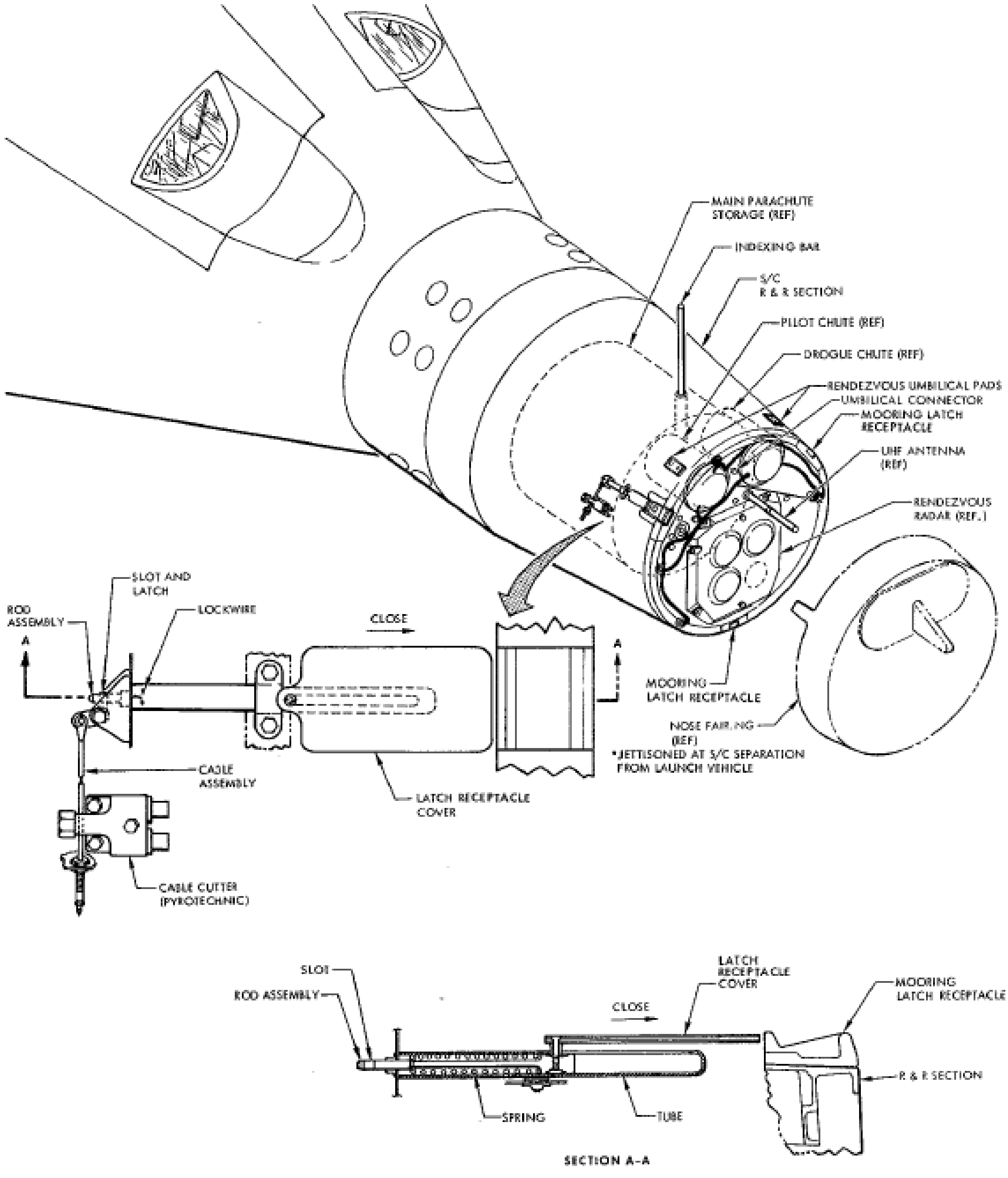


Figure 9.1.1.1 – R&R section, from SEDR 300 manual

1.2. APPROACH AND MOORING SEQUENCE

The crew can start tracking, and control, the target vehicle at approximately 100 nautical miles away. The Command Link System is used to un-rigidize the TDA so it's ready to accept docking. The acquisition lights are also turned on to make it easier to see. A flashing red light will appear on the target vehicle. The spacecraft should be aligned with the target vehicle as soon as possible to match the axes for 1:1 relationship with body axes deltas.

When aligned with the target vehicle, and ready to start the final docking maneuvers, the approach lights are turned on, as well as the status display lights.

The index bar is extended, and the docking alignment and maneuvering is aligned with the target vehicle.

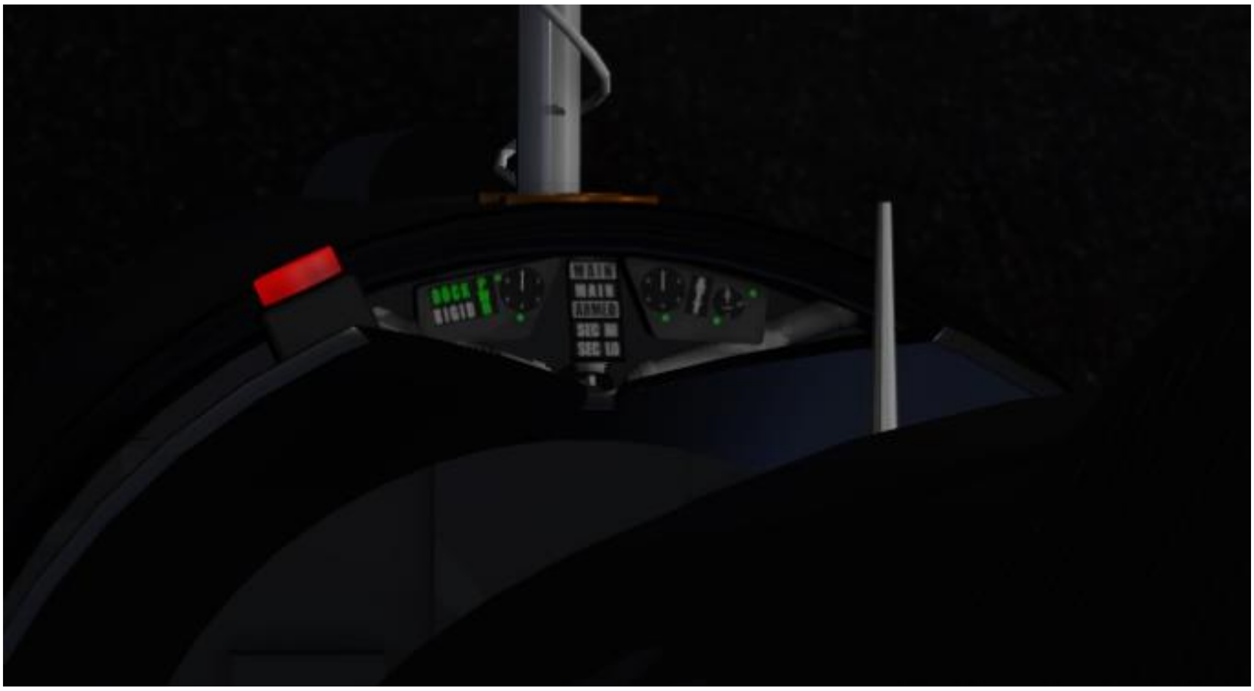
The switch to extend the index bar is on the right/pilot circuit breaker panel. Set this to Index Extend until bar is extended, then back to OFF.
The bar cannot be retracted again, and is automatically jettisoned during re-entry.

When getting close, the docking lights are turned on.

The exterior light switch is set to DOCK to turn the docking lights on. This is a spotlight on top of the spacecraft.

Alignment and translation adjustments are constantly being made during final approach.

The mooring sequence starts when the spacecraft enters the docking cone. The index bar fits in the cone, and the spacecraft will dock and latch. With the TDA in an un-rigidized state (DOCK is illuminated on the panel), it will rigidize, and the latches will attach.



The RIGID light illuminates when rigid.

The sequence can be seen in figure 9.1.2.1.

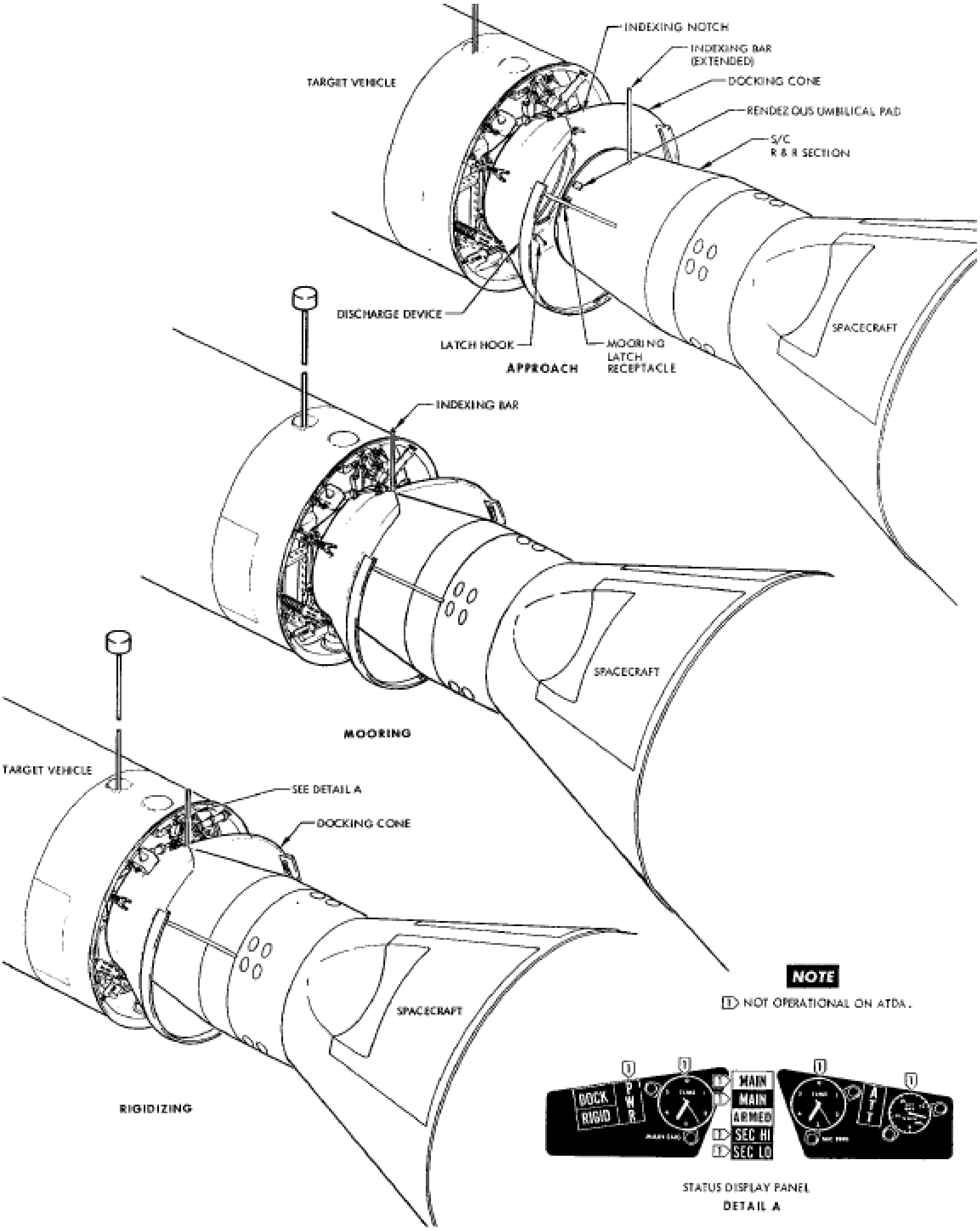


Figure 9.1.2.1 – Docking sequence, from SEDR 300

The crew can send the unrigidize command using the Encoder, or use the undock switch on the control panel. Another switch exists, EMER REL, and will cut the latches and release from the TDA. This is to be used in emergencies only, as it disables to possibility to re-dock again.

The EMER REL is a covered button and will undock from a TDA. This will disable the docking mechanism so use it only during an emergency.

When the unrigidize command is sent, the OAMS is used to back away from the target vehicle. This has to be done within 30 seconds before the docking mechanism is ready for the next docking. If the spacecraft is still in there, it will re-dock at this point.

The rigidize system can be activated through a switch on the panel as well by using the RIGID-OFF-STOP switch.

This switch can also be used to control the TDA, as a backup. Stop will stop the power from the rigid mooring device.

The UNDOCK switch can be used to undock from the TDA instead of using the Command Link System (primary) as a backup.

1.3. DOCKED

While docked and rigid, the acquisition lights and approach lights are turned off. The ENGINE switch can be used to ARM the engine on the target vehicle, so it can be used for orbital maneuvering.

1.4. SEPERATION

Using the switches described earlier, the undocking can initiate. This will separate the spacecraft from the target vehicle. The crew has 30 seconds to back away from the TDA before it will return to a ready-to-dock state.

2. TARGET DOCKING ADAPTER

The TDA is the adapter that makes docking possible. A docking cone is used to drive the spacecraft to the correct position, using an index bar on the spacecraft. Electromechanical devices in the spacecraft and the TDA rigidize the docking cone as soon as the mooring operation is done.

The approach lights are mounted on the docking adapter and positioned so they illuminate the nose during final approach.

The acquisition lights are used for visual guidance and tracking of the target vehicle within 20 nautical miles. They are red and are flashing.

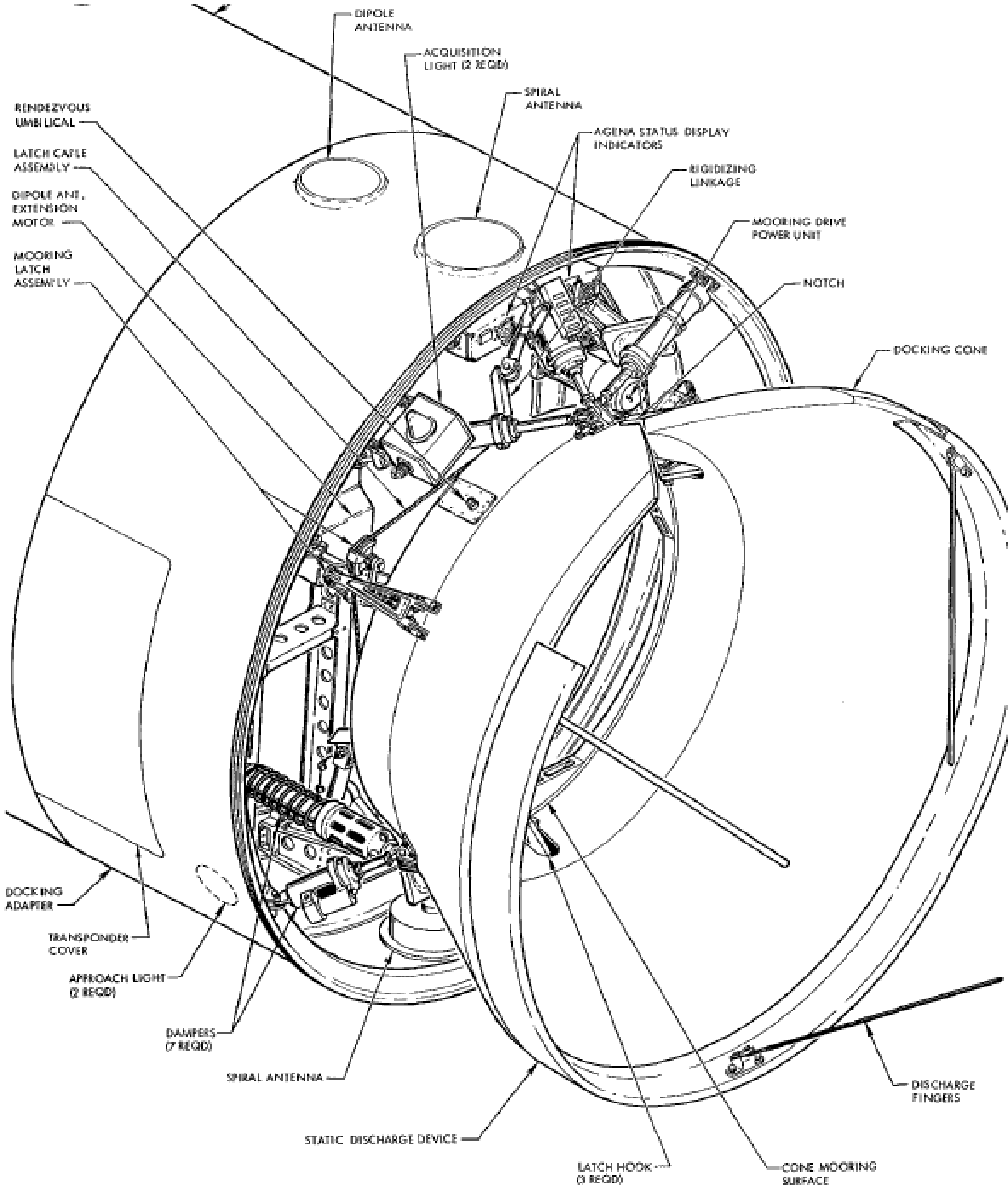


Figure 9.2.1 – TDA, from SEDR 300

A display panel is used to see the status of the TDA, figure 9.2.2 shows this.

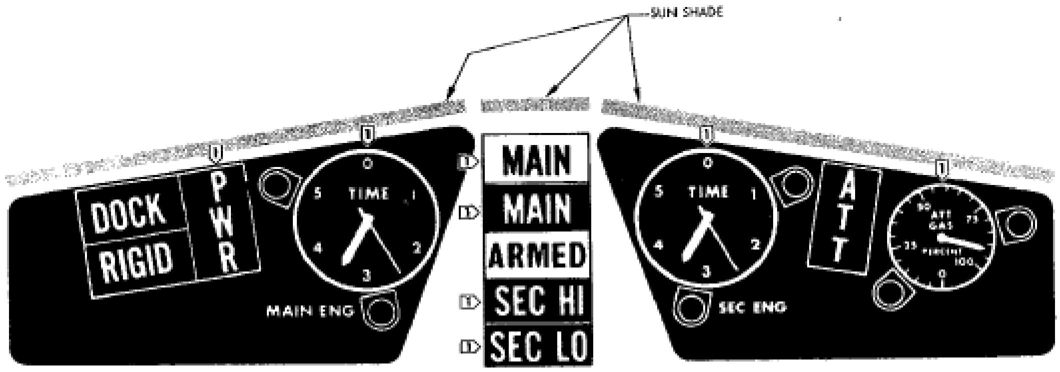


Figure 9.2.2 – TDA Panel, from SEDR 300

The DOCK light is illuminated(green) when the cone is unrigidized and hooks are reset and ready for a new docking.

The RIGID light illuminates(green) when the code is rigidized, usually means that it does not accept docking, or that the spacecraft is docked and rigid.

The PWR light(green) indicates that the target vehicle is powered.

The MAIN light illuminates red when there are factors that are outside of their limit range in terms of the main engine.

The MAIN light illuminates green when the values are within limit range.

The ARMED light illuminates amber when the MAIN engines can be fired.

The SEC HI illuminates green when there is a lot of propellant left.

The SEC LO illuminates green when there is a good amount of propellant left.

The ATT light illuminates green when the Agena attitude control system is active.

The MAIN TIME clock indicates time left of propellant on the MAIN engine.

The SEC TIME clock indicates time left in the SECONDARY engine.

The ATT GAS indicates total pressure remaining.

3. AGENA PRIMARY PROPULSION SYSTEM

The Primary Propulsion System (PPS) can be used as a powerful engine while being docked with Agena.

The PPS engine is a Bell XLR 81, and can burn for a total of 265 seconds, producing 71kN of thrust.

The time left of the PPS in seconds can be seen on the Agena Main Panel as seen above. To enable the engine, you need to first be docked with Agena.

When docked, follow the procedure below:

1) Send the following commands to Agena

571 HYD GAIN DK

450 D/B NARROW

2) Set the ARM STOP sw to ARM, this will arm the PPS

ARM STOP SW-ARM

3) With the PPS armed, send command 521 to enable the motor.

521 VM ON

4) To ignite the motor, send command 501
NOTE: This will fire the engine in the direction of Agena, so be sure to maneuver to the correct attitude first!

501 PPS ON (IGNITE!)

-- BURN –

5) The engine is now burning. It is a good idea to set up the IVIs and use the computer to see how much is left of your burn, using the normal procedures for this.

6) To stop the engine, send command 500 (just flip the encoder switch to 0 unless you have changed the 500-1 command. You can also use the ARM STOP sw by setting it to STOP.

-- VM CUTOFF --

500 PPS OFF

451 D/B WIDE

ARM STOP SW-STOP

520 VM DISABLE

4. AGENA ATTITUDE CONTROL

You can control the attitude of Agena to make docking easier. This can be done by the procedures below:

A. BEF

361 GEO RATE - NORMAL

310 ROLL H/S - YAW

321 H/S PHASE - IN

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

B. SEF

360 GEO RATE - REVERSE

310 ROLL H/S - YAW

320 H/S PHASE - OUT

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

WHEN TURN COMPLETE

350 GEO RATE – OFF

5. AGENA COMMANDS

The following is a list of commands you can use with Agena. Some of them are partially implemented or not yet implemented.

All commands are in three digits. The first two digits can be between 0 and 9, while the last digit can be either 0 or 1. If a command has the following syntax: XX0-1, it means that if the last digit is 0, the first description is used, if the last digit is 1, the last is used. For example, 250-1 means that 250 will turn OFF the ACQ lights, while 251 will turn them ON.

1. LIGHTS

250-1 ACQ LTS OFF-ON

140-1 APPROACH LTS OFF-ON

201 STATUS DISPLAY BRIGHT

211 STATUS DISPLAY DIM

200 STATUS DISPLAY OFF

2. BCNS & ANTENNA

070-1 L-BAND OFF-ON

230 VHF-DISABLES GROUND

231 UHF-ENABLES GROUND

260 DIPOLE SELECT

270 SPIRAL SELECT

151 BOOM EXTEND

3. CONTROL

060 RESETS 3 HOUR TIMER

220 UNRIGIDIZE

221 RIGIDIZE

340 V/M INTERROGATE(CLEARS)

520-1 V/M DISABLE/ENABLE

400-1 ACS OFF/ON

300-1 HORIZ SENS OFF/ON

341 GYROCOMASS ON

350-1 GEO RATE OFF/ON

4. DATA RECORD SEQ.

041 RECORD ON

030 RECORD/TM OFF

021 TM ON (OVER STA.)

5. PERFORM A PPS BURN

571 HYD GAIN DK

450 D/B NARROW

ARM STOP SW-ARM

521 VM ON

501 PPS ON (IGNITE!)

-- BURN --

-- VM CUTOFF --

500 PPS OFF

451 D/B WIDE

ARM STOP SW-STOP

520 VM DISABLE

6. ATTITUDE CONTROL

A. BEF

361 GEO RATE - NORMAL

310 ROLL H/S - YAW

321 H/S PHASE - IN

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

B. SEF

360 GEO RATE - REVERSE

310 ROLL H/S - YAW

320 H/S PHASE - OUT

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

WHEN TURN COMPLETE

350 GEO RATE - OFF

X. RETROGRADE SYSTEM

X. RETROGRADE

Retrograde is performed by 4 retrograde rockets in the retrograde section.

The retrograde phase begins about 5 minutes before retrofire, at a time point named Tr-256, meaning 256 seconds before.

The sequencer chapter explains the steps in detail.

XI. LANDING SYSTEM

XI. LANDING SYSTEM

The landing system provides parachutes for a safe landing and splashdown in the ocean, and a controlled re-entry.

1. RE-ENTRY

The re-entry computer module will guide the capsule through re-entry. After retrograde, the spacecraft is oriented to a re-entry attitude (0 degree pitch, 180 degree roll, 0 degree yaw).

For manual control, the RE-ENT RATE CMD is selected, or for automatic control, the RE-ENT mode is used (primary but not yet implemented). The computer will start the re-entry program at around 400.000 ft. The FDI is reference to the computer for both automatic and manual control.

ONLY the roll is controlled during re-entry, and the reason for this is that the roll is controlling the lift direction, and can be used to slightly alter the splashdown location and control the g-forces.

See figure 11.1.1 for roll attitude effect.

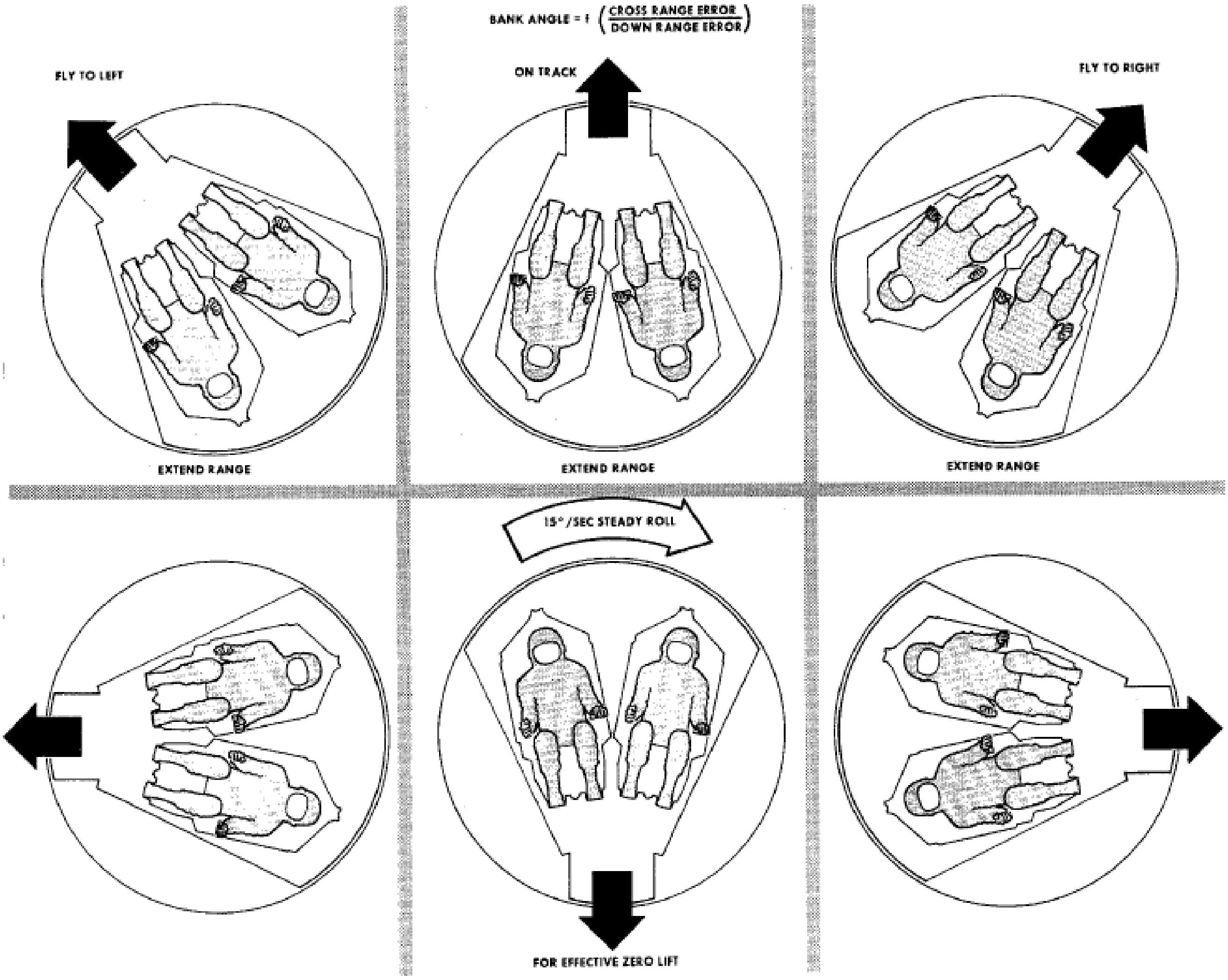
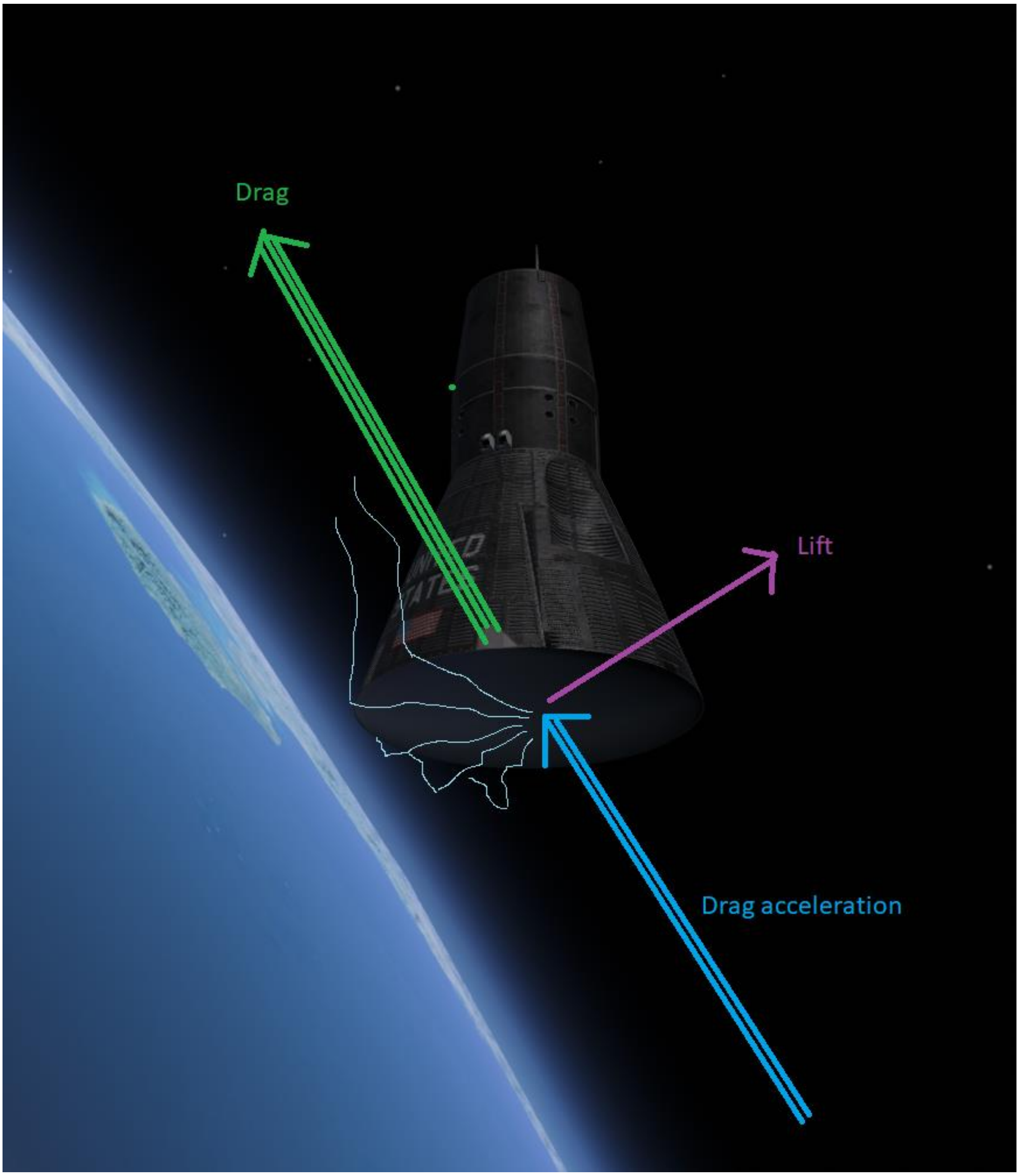


Figure 11.1.1 – Re-entry control, from SEDR 300 manual

As the spacecraft crosses the Entry Interface altitude, the upper part of the denser atmosphere, drag acceleration will start to decelerate the capsule.

Since the capsules center of gravity is slightly offset, the drag will tilt the spacecraft relative to the drag direction and the roll. Drag will push the capsule to this “trim attitude” automatically so there is no need to adjust the attitude.

This will generate a lift vector that can be used to control the rate of descent.



The IVIs will show the distance left to the planned landing location in nautical miles.

The g-force gauge is used to see your current g-force. This is a factor of how fast you fly through the air density. The lower the altitude, the higher the density.

You can use roll to fly "up" to less denser parts of the atmosphere, reducing g-forces but also how fast you bleed of velocity, or "down" into the denser part of the atmosphere, increasing g-loads and how fast you decelerate.

The longer you spend in the less dense part of the atmosphere, the further you will fly before landing. You can use this to distribute the energy during entry. If you have a long way to travel until planned splashdown location, maneuver so that you spend more time in the less dense areas. If you have a short flight, dive into the atmosphere while carefully maneuvering to avoid excessive g-loads.

2. LANDING

Three parachutes are used to land the spacecraft. These will retard the velocity after an altitude of around 50.000 ft.

The three parachutes are: 1) A drogue chute for initial attitude and retard. 2) A pilot and main chute for slowing down to a safe descent rate.

The LANDING switch arms the common control bus for landing and postlanding. This applies power to the two barometric pressure switches for illuminating 10.6K and 40K warning lights.

LANDING squib is used to arm the landing and postlanding common control buses and squibs.

At around 50.000 ft. the HI-ALT DROGUE is manually activated.

The HI-ALT DROGUE button deploys the drogue chute.

At 10,600 ft. the PARA switch is activated, deploying the pilot parachute. This parachute will remove the R&R section and deploy the main parachute.

The PARA button deploys the pilot chute. This drags the R&R section away, as well as deploying the main chute.

Figure 11.2.1 shows the landing sequence.

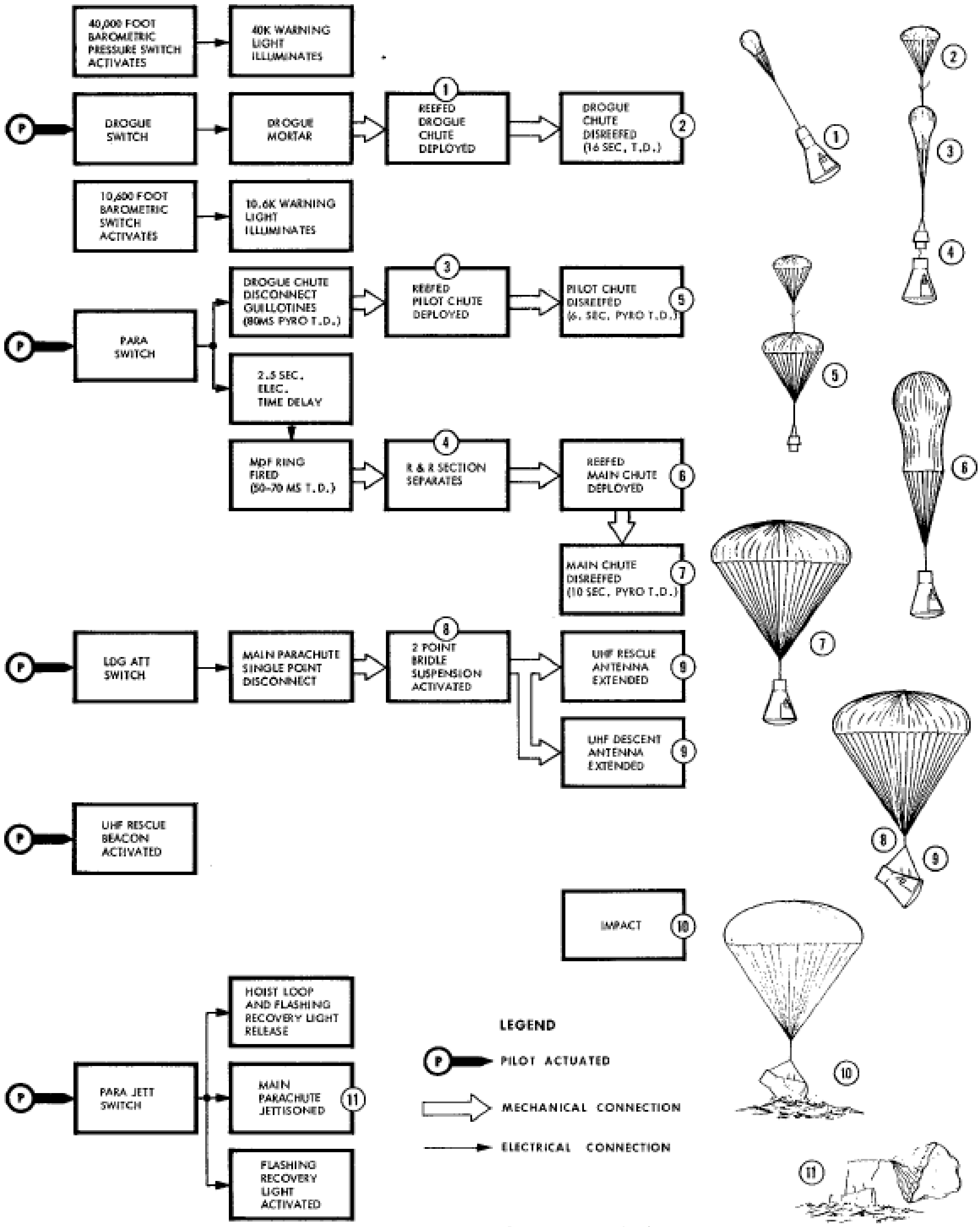


Figure 11.2.1 – Landing sequence, from SEDR 300

Before splashdown, the LDG ATT button is pressed to let the main chute automatically set the attitude of the capsule to an attitude more suited for splashdown. This is using two lines, connected to each side of the spacecraft to let it fall sideways.

The PARA JETT is pressed to release the main parachute after splashdown.

LDG ATT puts the spacecraft in splashdown attitude using the main chute lines.

PARA JETT jettisons the main chute from the spacecraft.

When you splash down, the mission will be complete, and you will be floating in the ocean. You can still operate the spacecraft. Press ESC to end the Simulation Session.

XII. COMMUNICATION

XII. COMMUNICATION

1. GENERAL

The communication system contains all the equipment for being able to communicate between the spaceship and ground. It provides radar tracking of the spacecraft, two-way voice communication between ground and the spacecraft, between the crew, telemetry and instrumentation, and post landing recovery communication.

Figure 12.1.1 shows the communication equipment on-board.

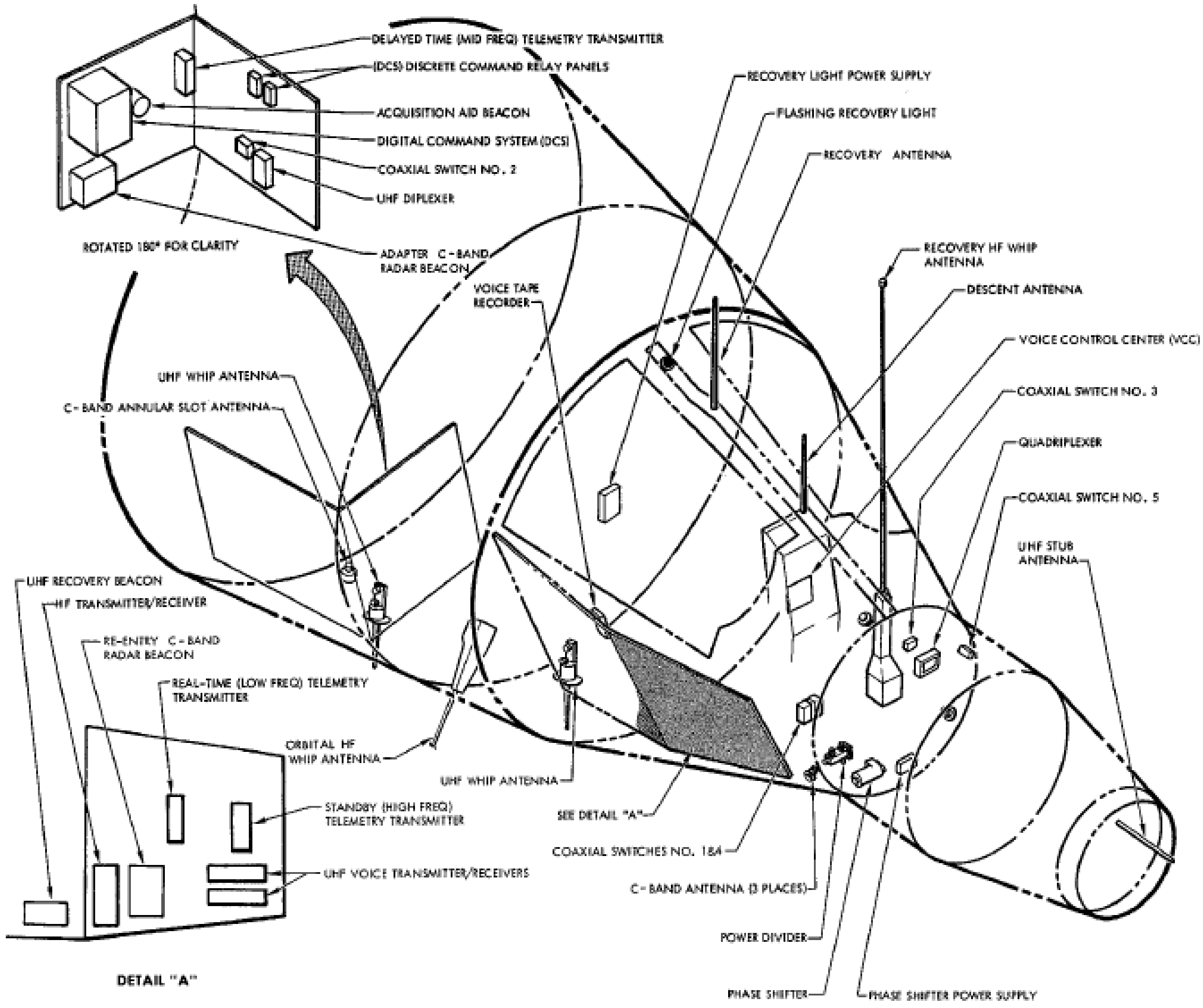


Figure 12.1.1 – Communication Equipment, from SEDR 300

It has eight antennas for the various communication components:
1) UHF recovery

2) UHF stub
3) UHF descent
4) 2x UHF whips
5) 2x HF whips
6) C-band

Four beacons are used to track and locate the spaceship during the mission.

Figure 12.1.2 and 12.1.3 shows the antenna usage throughout the mission.

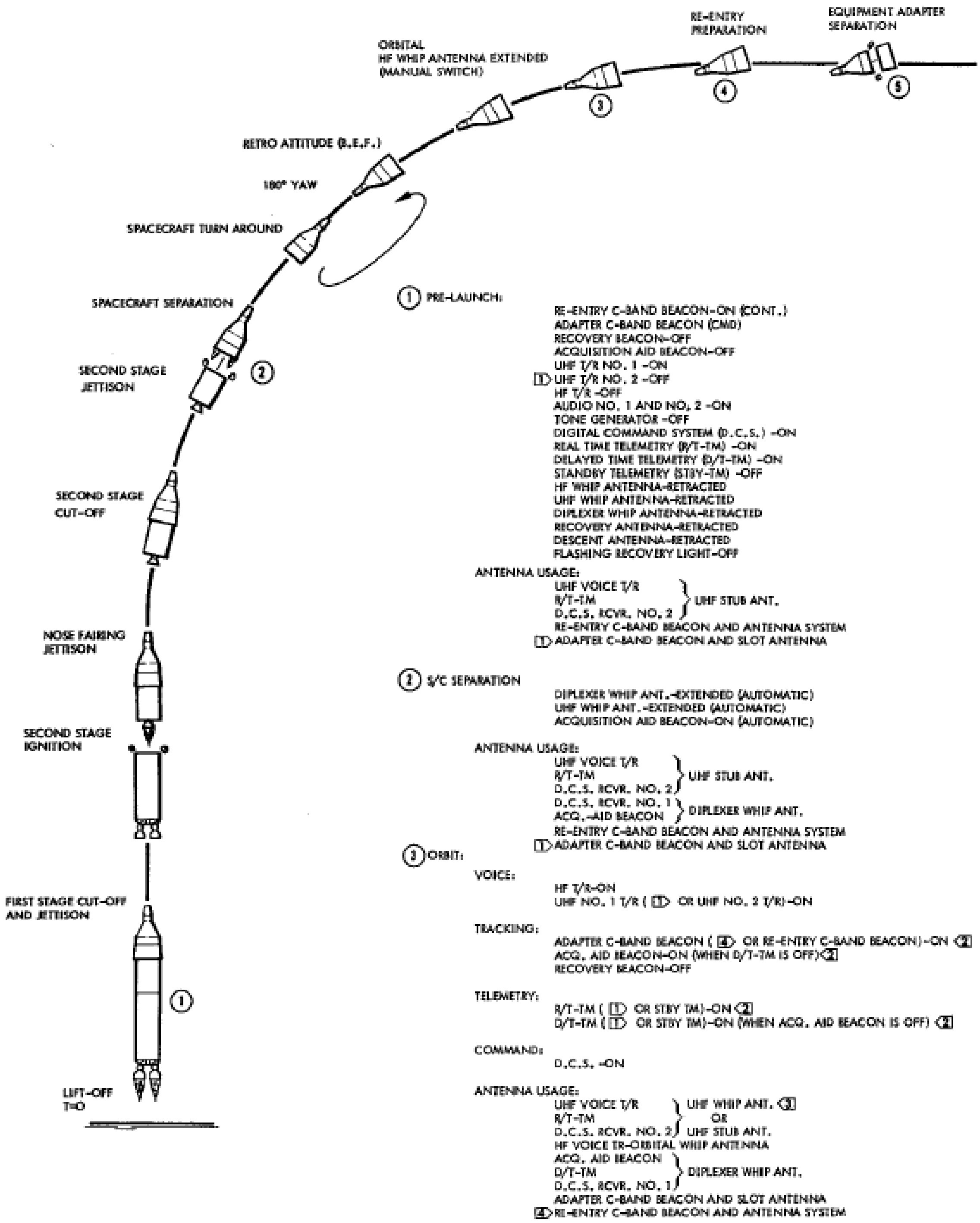


Figure 12.1.2 – Ascent to insertion communication sequence, from SEDR 300

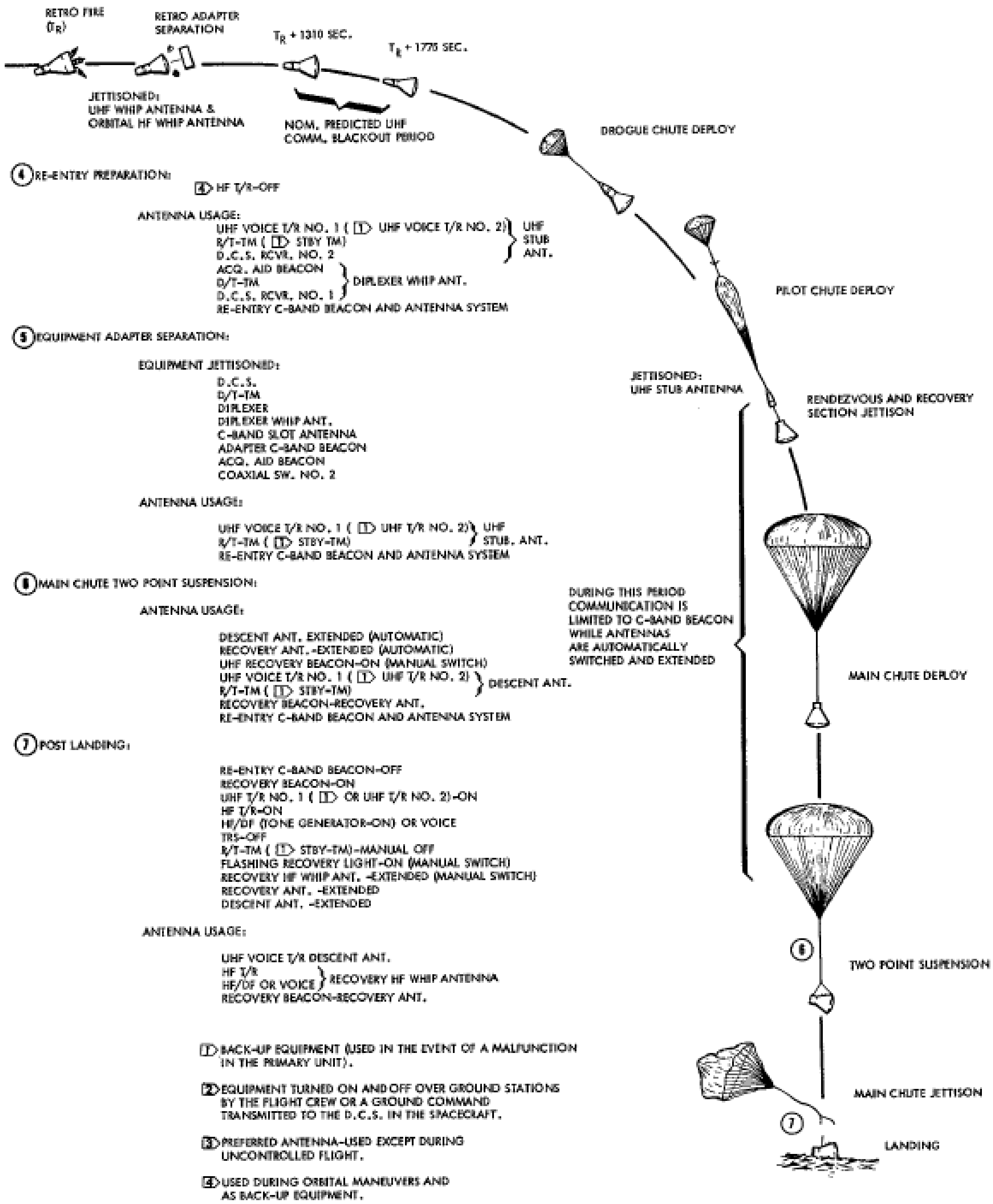


Figure 12.1.3 – Retro to landing communication sequence, from SEDR 300

Voice communication is maintained by either the HF transmitters/receivers, or the UHF transmitters/receivers.

The communication system is controlled by the lower center panel.

At insertion, the HF whip antenna should be extended by setting HF ANT to EXT, while the LANDING squib is set to SAFE.

Extending takes one minute. After extending, the HF ANT switch is placed to OFF.

The S-BAND and C-BAND switches should be in the CMD position as ground and external control is the primary control.

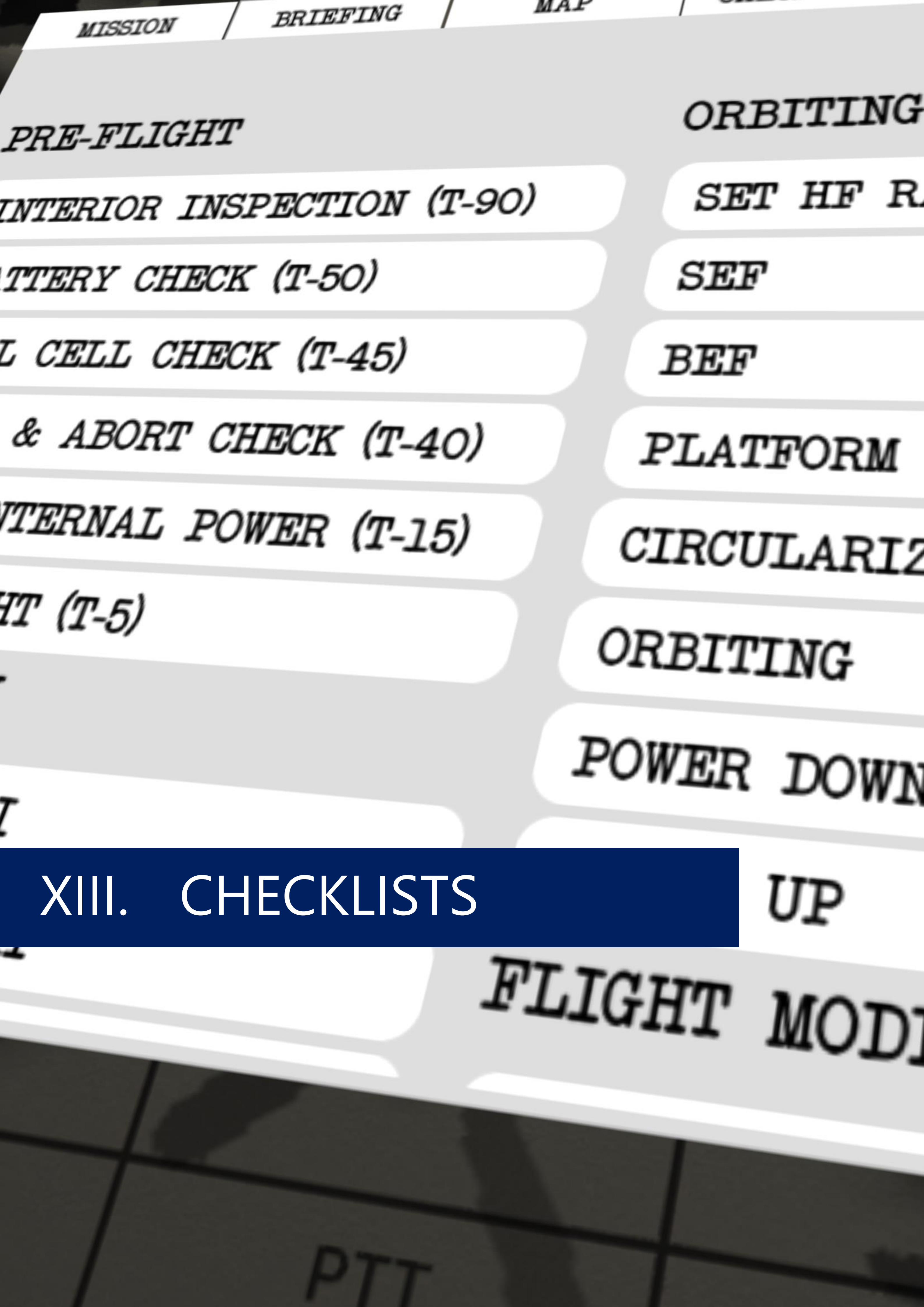
HF is controlled by positioning the HF select switch to RNTY and MODE switch 1 or 2 to HF position. UHF is the primary channel during orbit, but HF is needed after re-entry.

The preferred UHF antenna is on the ADAPTER during Orbit. The reentry antenna is used for re-entry.

Prior to adapter equipment section separation, the re-entry antennas are selected by placing T/M CONTROL to R/T & ACQ, the ANT SEL to RNTY. The HF is retracted, this can take over a minute.

During re-entry, a blackout occurs during atmospheric re-entry caused by an ionization shield around the spacecraft due to extremely high temperatures.

XIII. CHECKLISTS

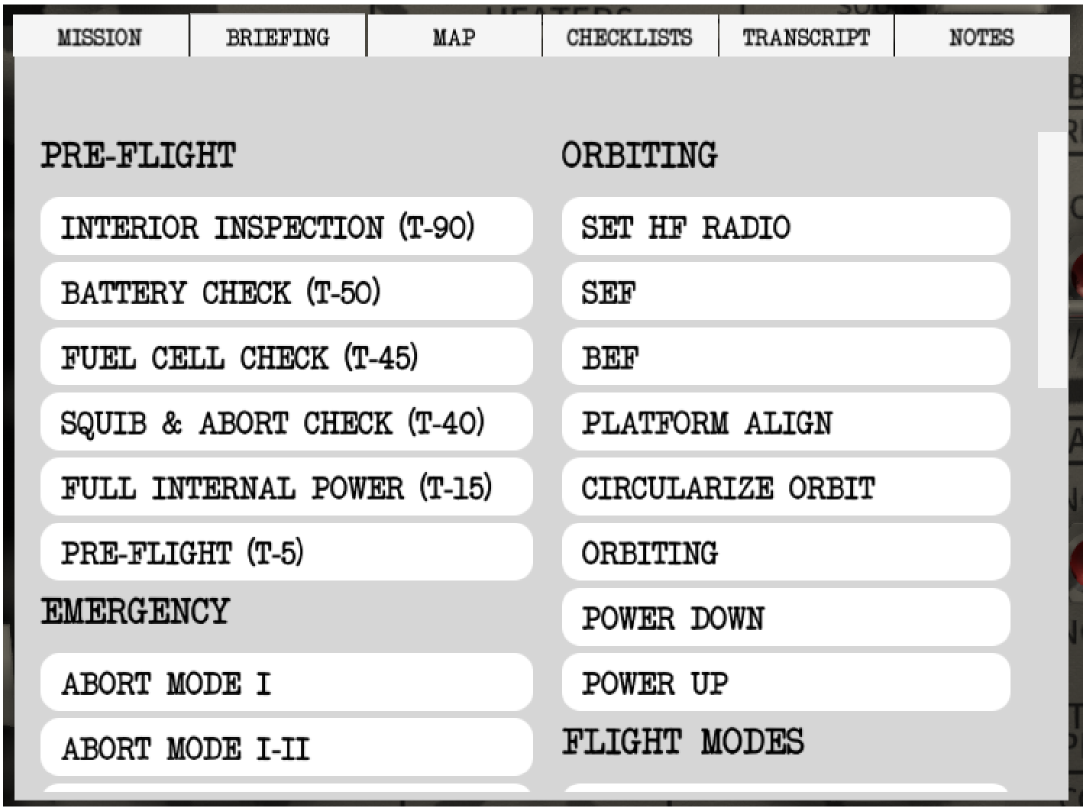


XIII. CHECKLISTS

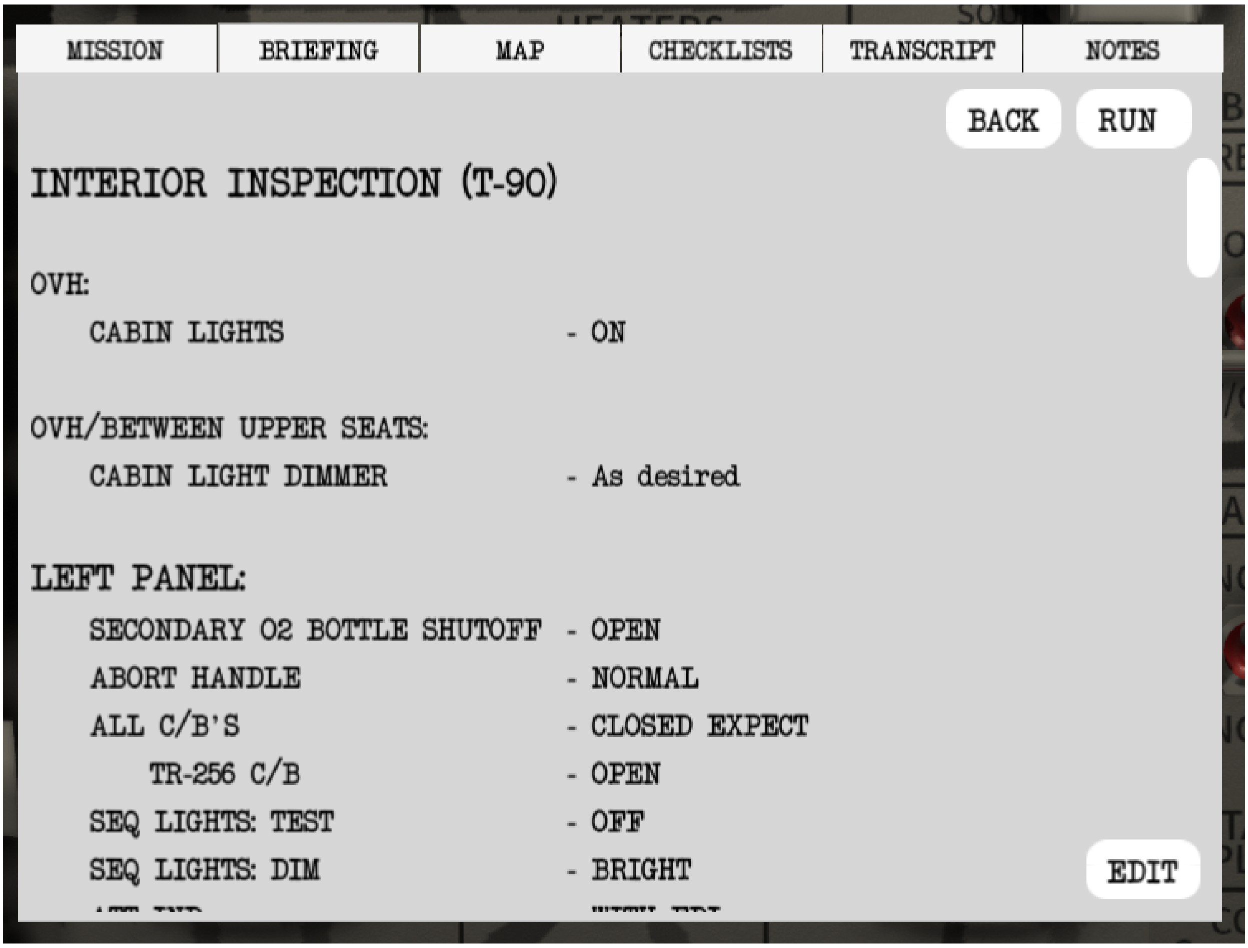
1. GENERAL

The checklists are available from the in-game Mission Pad menu. The in-game menu version is always up to date, so if you notice any difference between this and what you see in-game, the in-game instructions are to be followed.

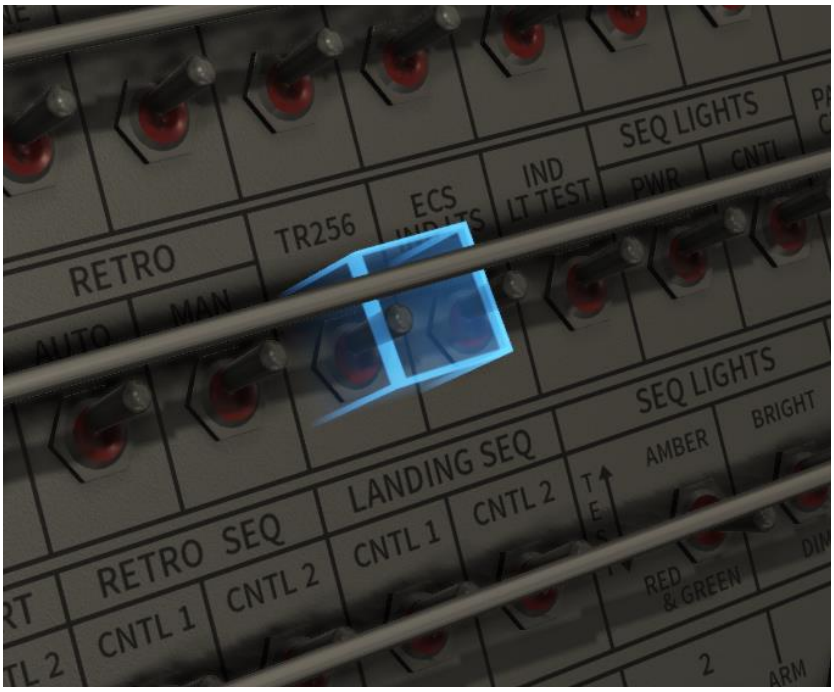
You can always export all the checklists form the game to a text file using the following console command from a Gemini mission: "cl -export"
This will export the checklists into "C:\Users\<your user>\AppData\LocalLow\Wilhelmsen Studios\ReEntry\Export\ChecklistsAsFile\Gemini.txt"



The following checklists can be accessed using the checklist menu. Click on the checklist you want to access, and it will take you to it. Two buttons are available on the selected checklist view, BACK and RUN. Back will take you to the checklist menu, and RUN will run the checklist with a highlighter to show where to click on most of the instructions, with exception of the optional steps or side-steps.



The highlighter will mark the switch that is in the wrong position.



The checklist guide will help you through the checklist.

The green bar will highlight the current step. Set the switch to the correct position and it will automatically proceed to the next item when/if a step is complete.

If the green bar is flashing, it means that a manual step is required. In this case, you will need to press the checkmark when you have performed the requested action to proceed.

Clear All will stop the currently executing checklist.

2. CHECKLISTS

PREFLIGHT CHECKLIST

PRE-FLIGHT

INTERIOR INSPECTION (T-90)

OVH:

CABIN LIGHTS	- ON

OVH/BETWEEN UPPER SEATS:

CABIN LIGHT DIMMER	- As desired

LEFT PANEL:

SECONDARY O2 BOTTLE SHUTOFF	- OPEN
ABORT HANDLE	- NORMAL
ALL C/B'S	- CLOSED EXPECT
TR-256 C/B	- OPEN
SEQ LIGHTS: TEST	- OFF
SEQ LIGHTS: DIM	- BRIGHT
ATT IND	- WITH FDI
BOOST-INSERT	- SAFE
RETRO: PWR	- SAFE
RETRO: JETT	- SAFE
RETRO ROCKET SQUIBS (4)	- SAFE

CP PANEL:

FDR	- COMP
FDM	- RATE

FDI SCALE RANGE	- LO
EVENT TIMER	- STBY (will start on liftoff)
EVENT TIMER	- ZEROED
EVENT TIMER MODE	- A

OVERHEAD PANEL:

ALL C/B'S	- CLOSED EXPECT:
OAMS HTRS C/B	- OPEN
H20 HTRS C/B'S	- OPEN
T/M AC	- ON
DC-DC CONV	- PRI
CTR LIGHTS	- AS NEEDED
ACME BIAS PWR	- PRI
ROLL JETS	- YAW
OAMS RESV	- SAFE
ATTITUDE DRIVERS	- PRI
ACME LOGIC SWITCHES (3)	- PRI

CENTER PANEL:

CABIN AIR RECIRC HANDLE	- UP (OPEN)
INLET SNORKLE HANDLE	- UP (CLOSED)
CABIN VENT HANDLE	- UP (CLOSED)
WATER SEAL HANDLE	- UP (OPEN)
O2 HIGH RATE RECOCK HANDLE	- UP
SUIT FAN	- OFF
PRIMARY PUMP A	- OFF
PRIMARY PUMP B	- OFF
RAD	- BYPASS
EVAP HEAT	- OFF

EVAP FLOW	- MAX FLOW
SECONDARY PUMP A	- OFF
SECONDARY PUMP B	- OFF

MISSION TIMER: START

Note: This will automatically make the timer count up on liftoff

H2 VAC TANK	- CLOSED
TDA RIGID CONTROL	- OFF
TDA UNDOCK CONTROL	- OFF
CRYO HEATERS (O2 & H2)	- OFF
CRYO INSTRUMENT	- OFF
PROP INSTRUMENT	- OFF
UHF T/R	- NO 1
HF T/R	- OFF
SILENCE	- OFF
KEYING	- CONT INT/PTT
RECORD	- CONT
BEACON CONTROL: RESC	- OFF
BEACON CONTROL: S-BAND	- CMD
BEACON CONTROL: C-BAND	- CONT
TM CONTROL: CALIB	- NO 1
TM CONTROL: SBY TM	- R/T
TM CONTROL: T/M	- R/T & ACQ
TAPE PLYBK	- CMD
ANT SEL	- RNTY
HF ANT POSITION CONTROL	- OFF
NO. 1 AUDIO SWITCH	- UHF

PEDESTAL:

RADAR	- OFF
PLATFORM	- FREE
SCANNER	- OFF
RATE GYROS (3)	- PRI
COMPUTER	- OFF
COMPUTER MODE	- PRE-LN
ATTITUDE CONTROL	- PLAT
OAMS PROP MOTOR VALVES	- CLOSED
PROP MOTOR VALVES: RCS A & B	- CLOSED
OAMS CNTL PWR	- CLOSED
CNTL PWR: RCS A & B	- CLOSED
REPRESS KNOB	- CLOSED

PILOT PANEL:

AUX TAPE	- ON/RESET
MODE	- AUTO
X OVER	- OFF
FC SECTION 1:	
FC PURGE	- OFF (center)
POWER	- OFF
FC SECTION 2:	
POWER	- OFF
FC PURGE	- OFF (center)
FUEL CELL 1A, 1B, 1C, 2A, 2B, 2C - OFF	
MDIU	- OFF
dP SELECT	- OFF
VOLTMETER	- C
FDI SCALE RANGE	- LOW

FDR	- COMP
FDM	- ATT

RIGHT PANEL:

ALL C/B'S	- CLOSED
ATT IND	- WITH FDI
AC POWER	- IGS
BIO MED RCDR	- 1 & 2 - CONT
RCS HTR	- OFF
BUS TIE: 1 & 2	- OFF
MAIN BATTERIES (4)	- OFF
SQUIB BATTERIES (3)	- UMB
AGENA CONTROL: BUS ARM	- SAFE
SECONDARY OXYGEN SHUTOFF	- OPEN

FC SECTION 1/2:

POWER	- WARMUP

BATTERY CHECK (T-50)

1. Battery 1, 2, 3, 4	- OFF
2. Battery 1	- TEST
3. Voltmeter	- BT
4. Verify volts > 24v.	
5. Battery 1	- OFF
6. Battery 2	- TEST
7. Verify volts > 24v.	

8. Battery 2 - OFF
9. Battery 3 - TEST
10. Verify volts > 24v.
11. Battery 3 - OFF
12. Battery 4 - TEST
13. Verify volts > 24v.
14. Battery 4 - OFF
15. Voltmeter - C

FUEL CELL CHECK (T-45)

1. Fuel Cell 1A - ON
2. Fuel Cell 1B - ON
3. Fuel Cell 1C - ON
4. Fuel Cell 2A - ON
5. Fuel Cell 2B - ON
6. Fuel Cell 2C - ON
7. Voltmeter - 1A
8. Verify volts > 24v.
9. Voltmeter - 1B
10. Verify volts > 24v.
11. Voltmeter - 1C
12. Verify volts > 24v.
13. Voltmeter - 2A
14. Verify volts > 24v.
15. Voltmeter - 2B
16. Verify volts > 24v.
17. Voltmeter - 2C
18. Verify volts > 24v.

19. Fuel Cell 1A	- OFF
20. Fuel Cell 1B	- OFF
21. Fuel Cell 1C	- OFF
22. Fuel Cell 2A	- OFF
23. Fuel Cell 2B	- OFF
24. Fuel Cell 2C	- OFF
25. Voltmeter	- C

SQUIB BATTERY & ABORT CAPABILITY CHECK (T-40)

1. Squib Battery (3)	- OFF
2. Voltmeter selector	- S1
3. Verify voltmeter indicates 0 volts	
3. Squib Battery 1	- UMB
5. Squib Battery 2	- UMB
5. Squib Battery 3	- UMB
6. Verify volts > 24v.	
9. Squib Battery 1	- OFF
10. Squib Battery 2	- OFF
3. Verify voltmeter indicates 0 volts	
12. Voltmeter selector	- S2
3. Verify voltmeter indicates 0 volts	
13. Squib Battery 1	- UMB
15. Squib Battery 2	- UMB
16. Verify volts > 24v.	
22. Verify all squib batteries	- UMB
23. Voltmeter selector	- C
24. Verify volts > 24v.	
25. Verify Abort Lights (2)	- Extinguished

26. Request Abort & Squib Check from Blockhouse
27. After 5 seconds: Squibs are checked
28. If squibs OK: Verify Abort lights Illuminated
29. After 15 seconds: Test results are returned
30. If success: Proceed
31. If failed: Repeat

FULL INTERNAL POWER (T-15)

1. Main Battery 1	- ON
2. Main Battery 2	- ON
3. Main Battery 3	- ON
4. Main Battery 4	- ON
5. Squib Battery 1	- ON
6. Squib Battery 2	- ON
7. Squib Battery 3	- ON
8. Fuel Cell 1A	- ON
9. Fuel Cell 1B	- ON
10. Fuel Cell 1C	- ON
11. Fuel Cell 2A	- ON
12. Fuel Cell 2B	- ON
13. Fuel Cell 2C	- ON
14. Fuel Cell Section 1	- ON
15. Fuel Cell Section 2	- ON
16. Request Switch to Internal Power	

PRE-FLIGHT (T-5)

1. Main Batteries 1, 2, 3, 4	- VERIFY/SET ON
2. Squib Batteries 1, 2, 3	- VERIFY/SET ON
3. Fuel Cell Stack 1A to 2C	- VERIFY/SET ON
4. Fuel Cell Section 1 Power	- VERIFY/SET ON
5. Fuel Cell Section 2 Power	- VERIFY/SET ON
6. Computer Power	- ON
7. MDIU Power	- ON
8. AUX Tape Power	- ON
9. Boost-Insert Squib	- ARM
10. Retro Squibs 1, 2, 3, 4	- ARM
11. Primary Coolant Pump A	- ON
12. Primary Coolant Pump B	- OFF
13. Secondary Coolant Pump A	- ON
14. Secondary Coolant Pump B	- OFF
15. Radiator	- BYPASS
16. Suit Fans	- NO. 1 and NO. 2
17. PLATFORM	- FREE
18. SCANNER	- PRI
19. Wait for Computer pre-check completion	
20. Ejection seat D-Ring	- Mount (TOOL: TOGGLE D-RING)

OBC INIT AND ALIGNMENT

1. COMPUTER	- PUSH START
2. Wait for the FDAI to align with predefined roll target (30 seconds)	
3. Computer	- ASC
4. ATTITUDE CONTROL	- RATE CMD
5. OAMS PROP MOTOR VALVE	- OPEN
6. RCS A & B PROP MOTOR VALVES	- OPEN

7. OAMS CNTL PWR - OFF

8. RCS A & B CNTL PWR - OFF

9. MDU - 72: _ _ _ _ _

10. RADIO CHECK

EMERGENCY

ABORT MODE I

(PRE-LAUNCH & LAUNCH TO 75,000 FEET)

ABORT INDICATOR: RED

1.0 SECONDS: PULL D-RING ON EJECTION SEAT

1.5 SECONDS: HATCH OPEN

2.0 SECOND DELAY: SEATS EJECTED

SEAT SUSTAINER FIRED FOR 2.25 SECONDS

3.0 SECONDS: SEAT-MAN SEPARATION

5.0 SECONDS: MAIN CHUTE OPENS

ABORT MODE I-II

(15,000 FEET TO 75,000 FEET)

BOOST INDICATORS MONITORED

ABORT LIGHT MONITORED

ABORT INDICATOR: RED

ANALYZE SITUATION AND DECIDE:

1) EJECT (ABORT MODE I)

2) RIDE-IT-OUT (ABORT MODE I-II)

RETRO ROCKET SQUIB SWITCHES: ARMED (PRE-LAUNCH)

ABORT CONTROL HANDLE: SHUTDOWN

WAIT 5 SECONDS FOR THRSUT DECAY

ABORT CONTROL HANDLE: ABORT

SEPARATION FROM LAUNCH VEHICLE

RETRO ROCKET SALVO FIRED

IF ABORT ALTITUDE < 25,000 FEET

TIME DELAY 7 SECONDS

IF ABORT ALTITUDE < 75,000 FEET

TIME DELAY 45 SECONDS

WAIT FOR TIME DELAY

JETTISON RETRO ADAPTER

MANEUVER S/C TO RE-ENTRY ATTITUDE

INITIATE NORMAL RE-ENTRY

DEPOLY DROGUE AT 40K FT.

DEPLOY MAIN/EMERGENCY CHUTE AT 10,6K FT.

INITIATE NORMAL LANDING & RECOVERY

ABORT MODE II

(75,000 FEET TO 522,000 FEET)

BOOST INDICATORS MONITORED

ABORT LIGHT MONITORED

ABORT INDICATOR: RED

ANALYZE SITUATION AND DECIDE:

ABORT OR NOT

ABORT CONTROL HANDLE: - SHUTDOWN

WAIT 15 SECONDS FOR THRUST DECAY

Retro Squibs 1, 2, 3, 4 - Verify ARM

ABORT CONTROL HANDLE:	- ABORT
SEPARATION FROM LAUNCH VEHICLE	
CNTL PWR RCS A, B	- ACME

Manuever to Reentry Attitude

RETRO PWR	- ARM
MAN FIRE RETRO	- PUSH

TIME DELAY 45 SECONDS

RETRO JETT	- ARM
JETT RETRO	- PUSH

MANEUVER S/C TO BEF ATTITUDE

INITIATE NORMAL RE-ENTRY

Start LANDING Checklist

ABORT MODE III

(ABOVE 522,000 FEET)

BOOST INDICATORS MONITORED

ABORT LIGHT MONITORED

ABORT INDICATOR: RED

ANALYZE SITUATION AND DECIDE:

ABORT OR NOT

ABORT CONTROL HANDLE	- SHUTDOWN

OAMS CNTL PWR SW	- ON
OAMS PROP MOTOR VALVES	- OPEN
JETT FAIRING	- PUSH
SEP SPCFT	- PUSH
SEP SPCF INDICATOR	- GREEN

MANEUVER S/C AWAY FROM LV

MANEUVER S/C TO RETROGRADE ATTITUDE

COMPLETE CHECKLIST: TR-256

COMPLETE CHECKLIST: TR-1 Min

MANUAL RETRO FIRE

COMPLETE CHECKLIST: POST RETRO JETTISON

NORMAL RE-ENTRY & LANDING INITIATED

ABORT CONTROL HANDLE:	- SHUTDOWN
WAIT 5 SECONDS FOR THRUST DECAY	
Retro Squibs 1, 2, 3, 4	- Verify ARM

ABORT CONTROL HANDLE:	- ABORT
SEPARATION FROM LAUNCH VEHICLE	
CNTL PWR RCS A, B	- ACME

Maneuver to Reentry Attitude

RETRO PWR	- ARM

MAN FIRE RETRO - PUSH

TIME DELAY 45 SECONDS

RETRO JETT - ARM

JETT RETRO - PUSH

MANEUVER S/C TO BEF ATTITUDE

INITIATE NORMAL RE-ENTRY

Start LANDING Checklist

ASCENT

ASCENT CHECKLIST

Verify platform alignment: FDAI should indicate roll offset for trajectory azimuth

T -10 seconds:

Computer Mode - ASC and not running

Ignition

Monitor ENGINE I (2) lt:

RED on pressure buildup

OFF on nominal thrust

Monitor ENGINE II lt:

AMBER: ready

Liftoff:

Monitor computer start & clocks are running

Monitor FUEL 1 OXID

Monitor ALTITIDE

Abort Mode I: < 15,000 FEET

Abort Mode I-II: 15,000 TO 75,000 FEET

Abort Mode II: 75,000 TO 522,000 FEET

Abort Mode III: ABOVE 522,000 FEET

At 75,000 FEET:

D-Ring	- STOW (Use C)

When FUEL 1 OXID depleted, staging.:

Monitor ENGINE II lt:

RED on pressure buildup

OFF on nominal thrust

Monitor FUEL 2 OXID

<size=22>SSECO and Insertion:</size>

SPCT SEP Lt	- LUMINATED
SPCT SEP	- PUSH
JETT FAIRING	- PUSH
OAMS	- ENABLE
IVIs	- "Zero"

May need to Zero IVI at Pe.

Note: It might not be possible to fully zero the IVIs. Do as best as you can, but don't force it.

INSERTION

1. BOOSTER-INSERT	- SAFE
2. RETROROCKET SQUIBS (4)	- SAFE
3. SEQ LIGHTS TEST	- RED & GREEN/AMBER

4. LEFT SEC O2 BOTTLE SHUTOFF - CLOSED
5. ATT IND LIGHTS C/B - CLOSED
6. CTR LIGHTS - AS REQUIRED
7. OAMS HTRS C/B - CLOSED
8. H2O HTRS C/B'S - CLOSED
9. ACME BIAS PWR - PRI
10. ROLL JETS - YAW
11. ATTITUDE DRIVERS - PRI
12. SUIT FAN - NO. 1 & 2
13. PRIMARY PUMP A - ON
14. SECONDARY PUMP A - ON
15. ANT SEL - ADPT
16. CRY QTY - OFF
17. RECORD - OFF
18. MAIN BATTERIES (4) - OFF
19. SQUIB BATTERIES (4) - OFF
20. AC POWER - IGS
21. RIGHT SEC O2 BOTTLE SHUTOFF - CLOSED
22. VOLTMETER - C
23. OAMS CNTL PWR - OFF
24. OAMS PROP MOTOR VALVES - CLOSED
25. RCS PROP MOTOR VALVES - CLOSED
26. RADIATOR - BYPASS
27. COMPUTER - CTCH UP

AT T+30 MINS:

REQUEST RADIATOR TEMP CHECK

FOLLOW INSTRUCTIONS FOR RADIATOR BY-PASS OR FLOW

ENTRY

PRE RETRO

CP CHECKLIST

1. SEQ LIGHTS	- BRIGHT
2. SEQ LIGHTS TEST	- AMBER/RED & GREEN
3. LEFT PANEL C/B'S	- CLOSED
4. TR-256 C/B'S	- CLOSED
5. ATT IND	- WITH FDI'S
6. OAMS CNTL POWER	- ON
7. PLATFORM	- BEF
8. ATTITUDE CONTROL	- PLAT
9. EVENT TIMER	- STBY
10. SET EVENT TIMER TO 20:00	
11. LEFT SEC O2 BOTTLE	- OPEN

PILOT CHECKLIST

1. OVERHEAD PANEL C/B'S (ALL)	- CLOSED, EXCEPT:
OAMS HTR C/B	- OPEN
H2O HTR C/B	- OPEN
2. CTR LIGHT	- AS NEEDED
3. SUIT FAN	- NO. 1 & NO. 2
4. KEYING	- CONT INTER - PTT
5. C - RNTY	- CONT
6. T/M	- R/T AND ACQ.
7. ANT SEL	- RNTY
8. VOLTMETER	- BT
9. MAIN BATTERIES (4)	- TEST/OFF

10. VOLTMETER - C
11. ATT IND - WITH FDI
12. RIGHT PANEL C/B'S (ALL) - CLOSED, EXCEPT:
    CALIB C/B - OPEN
    AGENA PWR C/B - OPEN
    AGENA CNTL C/B - OPEN
13. EXT LTS - OFF
14. ENGINE - STOP
15. RT SEC O2 BOTTLE - OPEN

AT TR -20 MINS (CORE 19 01200):

1. START EVENT TIMER COUNTING DOWN
2. COMPUTER - RNTY

ONCE COMPUTER LOADED:

1. START COMP - PUSH

256 SEC TO RETRO

EVENT TIMER READS 4:16 MIN

1. SEQUENCE LIGHTS - AMBER
2. COMPUTER - RENTY
3. SQUIB BATTERIES (3) - ON
4. MAIN BATTERIES (4) - ON
5. RCS PROP MOTOR VALVES A & B - OPEN
6. PROP GAUGE - RCS A
7. RECORD - CONT
8. CYRO QTY - OFF
9. ANT SELECT - RNTY

10. CP FDR	- PLAT
11. CP FDM	- ATT
12. CP FDI SCALE RANGE	- HI
13. ATTITUDE CONTROL	- RATE CMD (RE-ENT)
14. RATE GYROS (3)	- PRI
15. OAMS CNTL POWER	- OFF
16. OAMS PROP MOTOR VALVES	- CLOSED
17. RCS A & B CNTL POWER	- ACME
18. IND RETRO ATT	- PUSH
19. RCS	- PUSH
20. RETRO PWR	- ARM
21. CONTROL S/C ATTITUDE TO & HOLD RETROATTITUDE (20 DEG PITCH DOWN)	
22. PILOT FDR	- PLAT
23. PILOT FDM	- ATT
24. PILOT FDI SCALE RANGE	- HI
25. HF T/R	- OFF
26. PRIMARY PUMPS	- OFF
27. SECONDARY PUMPS	- OFF
29. RAD	- BYPASS

1 MIN TO RETRO

AT TR -1 (MIN):

1. HOLD RETROATTITUDE (20 DEG PITCH DOWN)	
2. SEP OAMS LINE	- PUSH
3. SEP ELECT	- PUSH
4. SEP ADAPT	- PUSH

AT TR -30 SEC:

1. RETRO ROCKET SQUIBS	- ARM

AT TR -5 SEC:

1. ARM AUTO RETRO	- PRESS

WAIT FOR RETROS TO FIRE

1. EVENT TIMER SWITCH TO COUNTING UP

AT TR +1 SEC:

2. MAN FIRE RETRO	- PUSH

AT TR +30 SEC:

1. PLATFORM	- BEF

AT TR +45 SEC (RETRO JETT LIGHT	- AMBER):
1. RETRO JETT	- ARM
2. JETT RETRO	- PUSH

POST RETRO JETTISON

1. RETRO PWR	- SAFE
2. RETRO JETT	- SAFE
3. RETRO ROCKET SQUIBS (4)	- SAFE
4. CP FDR	- COMP
5. CP FDM	- ATT
6. CP FDI SCALE RANGE	- LO
7. RCS CNTL PWR B	- OFF
8. BOOST INSERT CNTL 1 & 2 C/B	- OPEN

9. RETRO SEQ CNTL 1 & 2 C/B	- OPEN
10. CRYO O2 & H2 HTR C/B	- OPEN
11. OAMS CNTL PROP C/B	- OPEN
12. FUEL CELL CNTL 1 & 2 C/B	- OPEN
13. TAPE RCDR CNTL C/B	- OPEN
14. SECT NO 1 & 2 PWR	- OFF
15. 1A, 1B, 1C, 2A, 2B, 2C	- OFF
16. PILOT FDR	- COMP
17. PILOT FDM	- ATT
18. LANDING SQUIB	- ARM

Record Retrofire dV vector from IVI's

ENTRY

NOTE: TR will vary depending on your entry angle.

AT TR +14:30

CONTROL S/C ATTITUDES TO:

0 DEG YAW

170 DEG ROLL

HORIZON AT TOP OF WINDOW

AT TR + 19:00 (400K FEET)

AFTER ROLL NEEDLE DEFLECTION:

CONTROL S/C ATT TO BACKUP BANK ANGLE & DAMP PITCH AND YAW RATES

ATTITUDE CONTROL - RATE CMD (RE-ENT)

LANDING

WHEN 40k ILLUMINATES

1. RCS A & B CNTL PWR - ACME
2. HI ALT DROGUE - PUSH
3. "D" RING - UNCOVER
4. RCS A & B PROP MOTOR VALVES - CLOSED
5. O2 HIGH RATE - ON (27K)

WHEN 10.6k ILLUMINATES

1. PARA - PUSH
2. LDG ATT - PUSH

AFTER MAIN DEPLOYS

1. ATT IND CNTL C/B'S - OPEN
2. RESC BEACON - W/O LT
3. ACME BIAS PWR - OFF
4. RCS HTRS - OFF
5. SCAN HTR C/B - OPEN
6. COMPUTER - PRE LN
7. COMPUTER PWR - OFF
8. PLATFORM - OFF
9. RATE GYROS (3) - OFF
10. AC POWER - OFF
11. RCS C/B'S - OPEN
12. RCS CNTL PWR - OFF
13. ACME CNTL NO. 1 C/B - OPEN
14. ACME CNTL NO. 2 C/B - OPEN

2K CHECKLIST

1. "D" RING	- COVER & SAFE

POSTLANDING CHECKLIST

1. PARA JETT	- PUSH
2. HF ANT	- EXT/OFF (30 SEC)
3. LANDING	- SAFE
4. HF T/R	- RNTY
5. NO. 2 AUDIO	- HF/DF
6 ALL RADIO SWITCHES	- OFF EXCEPT:
a. UHF	- NO. 1
b. NO. 1 AUDIO MODE SWITCH	- UHF

LEFT C/B PANEL CONFIGURED AS:

TOP ROW:	
ALL C/B'S	- OPEN EXPECT:
AUDIO & UHF T/R C/B	- CLOSED
UHF RELAY C/B	- CLOSED
TONE VOX C/B	- CLOSED
HF T/R C/B	- CLOSED
HF WHIP ANT C/B	- CLOSED
SECOND ROW -	
ALL C/B'S:	- OPEN EXPECT:
ELECT TIMER C/B	- CLOSED
IND LT TEST C/B	- CLOSED
SEQ LIGHTS CNTL C/B	- CLOSED
THIRD ROW	
ALL C/B'S	- OPEN

ALL SWITCHES	- OFF EXCEPT:

RIGHT SWITCH PANEL:

BIO MED RCDR 1 & 2	- CONT
MAIN BATTERIES (4)	- ON
SQUIB BATTERY NO. 3	- ON

OVERHEAD SWITCH PANEL:

DC-DC CONVERTER	- PRI

CENTER PANEL:

SUIT FAN	- NO 1 & 2
RESC BEACON CONTROL	- W/O LT
HF T/R SWITCH	- RNTY

CONFIGURE C/B'S AS FOLLOWS:

OVERHEAD PANEL:

1ST ROW: RCS A & RCS B C/B'S	- OPEN
2ND ROW: ATTITUDE THRUSTER C/B'S	- OPEN
3RD ROW: MANEUVER THRUSTER C/B'S	- OPEN
4TH ROW: ACME, OMS CNTL, RCS SQUIB C/B'S	- OPEN
5TH ROW: ALL C/B'S	- OPEN EXCEPT:

CABIN LTS C/B - CLOSED

6TH ROW: ALL C/B'S	- OPEN EXCEPT:
SUIT FANS 1 & 2 C/B	- CLOSED
7TH ROW: ALL C/B'S	- OPEN EXCEPT:

RESC BEACONS C/B, & DC - DC CONV C/B - CLOSED

RIGHT HAND PANEL:

TOP ROW: ALL C/B'S	- OPEN EXCEPT:
BIO MED INST C/B	- CLOSED
2ND ROW: ALL C/B'S	- OPEN EXCEPT:
TAPE RCDR PWR C/B	- CLOSED

CABIN VENT	- DWN (OPEN)
WATER SEAL	- DWN (CLOSED)
INLET SNORKEL	- DNW (OPEN)

10 MINUTES AFTER LANDING:

DC - DC CONVERTER	- OFF
DC - DC CONBERTER C/B	- OPEN
IND LT TEST C/B	- OPEN
SEQ LT CNTL C/B	- OPEN

NORMAL EGRESS:

HF WHIP ANT C/B	- CLOSED
ALL SWITCHES & C/B'S	- OFF EXCEPT:
RESCUE BEACON C/B	- CLOSED
RESC BEACON	- CONTROL W/O LT

ORBITING

SET HF RADIO

1. HF Antenna Control	- EXT
2. Radio Antenna Select	- RNTY
3. Radio Mode (A or B)	- HF

SEF

1. Platform	- SEF
2. Attitude	- PLAT
3. OAMS or RCS	- ENABLED

BEF

1. Platform - BEF
2. Attitude - PLAT
3. OAMS or RCS - ENABLED

PLATFORM ALIGN

1. Navigate to the attitude using window reference
2. Platform - CAGE
3. Attitude Control - PLAT
4. Gyros will align to body reference after 5 seconds
5. New 0,0,0 attitude will be current orientation

CIRCULARIZE ORBIT

Computer:

- Set OBC to CTCH UP and wait for it to load
- Radio: Request Circularize at AP/PE burn PAD from GROUND
- OBC:

    RESET - push

Burn PAD:

- Core 01+02: Time of Ignition (GET) in HHH:MM:SS.ss
- Core 25+26+27: Desired ΔV (LV at TIG)
- Verify Core 01: HHHMM (TIG#1)

    Hours (HHH) and Minutes (MM) to burn

- Verify Core 02: 0SSss (TIG#2)

    Seconds (SS) and Milliseconds (ss) to burn

- Verify Core 25=ΔX, 26=ΔY, 27=ΔZ

- OBC:

    START - push

    COMP lt - on

    ****

    * IF MALF lt - on: *

    * RESET - push *

    * Verify PAD data and TIG is in the future *

    ****

Countdown to ignition:

- Core 83: MMMSS (TTG)

  Time to go in Minutes (MMM) and Seconds (SS)

Set EVENT TIMER to 10:00, count down and standby.

When Core 83 (TTG) is 10:00 (minutes), start Event Timer.

The Hohmann Transfer:

IVI's will show burn vector in Local Body axis (closed loop)

At Apogee/TTG (#83) is zero:

- Burn so IVI's read zero

Ap Perigee/TTG (#83) is zero:

- Burn so IVI's read zero

- OBC:

    RESET - push

ORBITING

COMPUTER	- PRE LN
COMPUTER	- START
PLATFORM	- OFF
RADAR	- OFF
COOLANT PUMPS	- AS REQUIRED

REQUEST RADIATOR TEMP CHECK

FOLLOW INSTRUCTIONS FOR RADIATOR BY-PASS OR FLOW

POWER DOWN

1. RADAR	- OFF
2. PLATFORM	- OFF
3. RATE GYROS (3)	- OFF
4. AC POWER	- OFF
5. ACME BIAS PWR	- OFF
6. COOLANT PUMPS	- AS DESIRED
7. T/M	- CMD
8. MANEUVER THRUSTER C/B'S	- CLOSED

POWER UP

1. MANEUVER THRUSTER C/B'S	- OPEN
2. T/M	- R/T & ACQ
3. COOLANT PUMPS	- AS DESIRED
4. ACME BIAS PWR	- PRI
5. AC POWER	- ACME

6. RATE GYROS (3)	- ON
7. RADAR	- AS REQUIRED

Start PLATFORM ALIGN Checklist, if GYRO Drift Enabled

FLIGHT MODES

RATE COMMAND MODE

1. Attitude	- RATE CMD
2. Platform	- ORB RATE
3. OAMS Control Power	- ON
4. OAMS Prop Motor Valves	- OPEN

MANUAL PULSE MODE

1. Attitude	- PULSE
2. Platform	- ORB RATE (or any other)
3. OAMS Control Power	- ON
4. OAMS Prop Motor Valves	- OPEN

ENABLE OAMS

1. OAMS Control Power	- ON
2. OAMS Prop Motor Valves	- OPEN

Disable OAMS when not needed:

1. OAMS Control Power	- OFF
2. OAMS Prop Motor Valves	- CLOSED

ENABLE RCS

WARNING - ONCE RCS IS ENABLED, OAMS IS NOT OPERATIONAL

1. RCS - PUSH
2. RCS A CNTL PWR - ACME
3. RCS B CNTL PWR - ACME
4. RCS A Prop Motor Valves - OPEN
5. RCS B Prop Motor Valves - OPEN

R&D

PRE-RENDEZVOUS CHECKLIST

1. RADAR - STBY
2. Computer - CTCH UP
3. Circulize Orbit CHECKLIST - COMPLETED
4. REQUEST TARGET BURN
5. OBC: Set up burn PAD
    a. Set CORE 01 (TIG) to HHHMM
    b. Set CORE 02 (TIG) to 0SSss
    c. Set CORE 25 (ΔX) to XXXXX ft/s
    d. Set CORE 26 (ΔY) to XXXXX ft/s
    e. Set CORE 27 (ΔZ) to XXXXX ft/s
6. SET EVENT TIMER TO 10:00 & STBY
7. Computer - START

CORE 83 COUNTDOWN TO BURN

AT CORE (83 01000) MIN/SEC

1. START EVENT TIMER (COUNT DOWN)

AT CORE (83 00060) MIN/SEC

1. PLATFORM - SEF
2. ATTITUDE CONTROL - PLAT (or RATE CMD)
3. OAMS CNTL PWR - ON
4. OAMS PROP MOTOR VALVES - OPEN

AT BURN (83 00000):

1. IVI's - ZERO
2. OAMS PROP MOTOR VALVES - CLOSED
3. OAMS CNTL PWR - OFF
4. Computer - RESET

CORE 73 COUNTDOWN TO APOGEE

RENDEZVOUS BURN II

4. REQUEST CIRCULATE AT AP (or PE if lower)
5. OBC: Set up burn PAD
    a. Set CORE 01 (TIG) to HHHMM
    b. Set CORE 02 (TIG) to 0SSss
    c. Set CORE 25 (ΔX) to XXXXX ft/s
    d. Set CORE 26 (ΔY) to XXXXX ft/s
    e. Set CORE 27 (ΔZ) to XXXXX ft/s
6. SET EVENT TIMER TO 10:00 & STBY
7. Computer - START

CORE 83 COUNTDOWN TO BURN

AT CORE (83 01000) MIN/SEC

1. START EVENT TIMER (COUNT DOWN)

AT T -1:00 MIN (CORE 83 00060):

1. PLATFORM	- SEF
2. ATTITUDE CONTROL	- PLAT (or RATE CMD)
3. OAMS CNTL PWR	- ON
4. OAMS PROP MOTOR VALVES	- OPEN

AT EVENT TIMER 00:00

1. IVI's	- ZERO
2. OAMS PROP MOTOR VALVES	- CLOSED
3. OAMS CNTL PWR	- OFF
4. Computer	- RESET

AFTER RNDZ BURN CHECKLIST

1. COMPUTER	- RNDZ
2. Radar	- ON
3. Encoder	- ON
4. Encoder CMD	- 251, ACQ Lights ON
5. FDR	- RDR
6. FDM	- ATT
7. Aquire a visual of docking target	

ONCE COMPUTER READY:

1. Computer	- START
2. FDR	- COMP

Align with target using FDAI

Translate towards target so IVI's L/R and UP/DN shows ZERO

Move closer by reducing FWD/AFT IVI's towards ZERO.

If target vehicle is Agena or Augmented Target Docking Adapter (ATDA)

1. AGENA CONTROL: PWR - ON
2. AGENA CONTROL: SQUIB (2) - ON
3. AGENA CONTROL: CNTL - ON

DOCKING

PRE-DOCKING

1. Index Bar - EXTEND
2. Exterior Lights - DOCK
3. Encoder CMD - 250, ACQ Lights OFF
4. Encoder CMD - 141, Approach Lights ON
5. Encoder CMD - 201, Agenda display BRIGHT
6. If Agena is rigid, Encoder CMD: 220 - UnRigidize

Keep docking port centered, zero IVI's until docking complete.

Warning: Keep alignment with target, keep speed low.

POST-DOCKING

1. Encoder CMD: - 140, Approach Lights OFF
2. Exterior Lights - OFF

UNDOCKING

1. OAMS PWR - ON
2. OAMS Valve - OPEN
3. Encoder CMD: 220 - UNDOCK
4. Within 30 seconds, back away from target vehicle.

EMERGENCY RELEASE

1. EMER REL - PUSH

Note: Destroys the hooks on Gemini Spacecraft. Unable to dock after this.

EVA

PRE-EVA

ECS System:

PRI PUMP A	- ON
SEC PUMP A	- ON
CRY QTY GAGE	- OFF
O2 HTR	- AUTO
H2 HTR	- AUTO
SUIT FAM	- NO. 1 & NO. 2
CABIN AIR RECIRCU	- UP (OPEN)
INLET SNORKEL	- UP (CLOSED)
CABIN VENT	- UP (CLOSED)
WATER SEAL	- UP (OPEN)
O2 HIGH RATE RECOCK	- UP
LT SEC O2 BOTTLE	- CLOSED
RT SEC O2 BOTTLE	- OPEN

GNS SYSTEM:

AC POWER	- IGS
ACME BIAS PWR	- PRI
BOTH FDR	- PLAT
BOTH FDM	- RATE
BOTH ATT IND	- WITH FDI'S
OAMS CNTL	- ON

OAMS PROP MOTOR VALVE	- OPEN
PROP GAGE	- 0
RCS HTRS	- OFF
ATTITUDE CONTROL	- PULSE
RATE GYROS (3)	- PRI
RDR	- OFF
COMPUTER	- ON/NAV (CTCH UP)
PLATFORM	- ON

ELECTRICAL SYSTEM:

VOLTMETER	- M
ALL CABIN LTS	- RED OR OFF
ATT IND LT C/B	- CLOSED
ALL AGENA CONTROL C/B'S	- CLOSED

COMMUNICATIONS:

HF ANT	- RET/OFF (1 MIN)
NO. 1 & NO. 2 AUDIO	- UHF
UHF	- NO. 1
HF	- OFF
KEYING	- CONT INTER/PTT
ANT SEL	- ADAPT
T/M	- CMD
C-BAND BEACONS	- CMD

FINAL EVA PREPERATIONS:

SEC PUMP A	- OFF
SEC PUMP B	- ON
CRYO QTY GAGE	- O2

CABIN AIR RECIRCU	- DWN (CLOSED)
RCS HTR	- ON
EXT LTS	- DOCK
EVENT TIMER TO 00:00 AND STANDBY	
O2 PRESSURE	- MAX (800 PSI)
CABIN REPRESS	- CLOSED

S/C DEPRESSURIZATION AND EGRESS

RECORD	- CONT
CABIN AIR RECIRC	- DOWN (CLOSED)
OAMS Controller Power	- OFF
OAMS Prop Motor Valves	- CLOSED
CABIN VENT	- DOWN (OPEN)

Wait until the CABIN PRESSURE is zero:

CABIN VENT	- UP (CLOSED)

Open the HATCH using the [C] menu

ATTITUDE CONTROL	- PULSE
PLATFORM	- ORB RATE

When ready to exit the vehicle, press the EVA button in the [C] menu. To enter, press the ENTER button in the open hatch on the outside.

POST-EVA

Close the hatch using the [C] menu.

CABIN VENT	- UP (CLOSED)
LT/RT SEC O2 BOTTLES	- CLOSED
RAD	- BYPASS
REPRESS knob	- OPEN

Wait until the CABIN PRESSURE gauge reaches normal cabin conditions.

REPRESS knob	- CLOSED
RAD	- FLOW
RT SEC O2 BOTTLE	- OPEN
CABIN AIR RECIRC	- UP (OPEN)

POWER DOWN S/C, IF NESSESARY

AGENA

AGENA COMMANDS

1. LIGHTS

    250-1 ACQ LTS OFF-ON

    140-1 APPROACH LTS OFF-ON

    201 STATUS DISPLAY BRIGHT

    211 STATUS DISPLAY DIM

    200 STATUS DISPLAY OFF

2. BCNS & ANTENNA

    070-1 L-BAND OFF-ON

    230 VHF-DISABLES GROUND

    231 UHF-ENABLES GROUND

    260 DIPOLE SELECT

270 SPIRAL SELECT

151 BOOM EXTEND

3. CONTROL

060 RESETS 3 HOUR TIMER

220 UNRIGIDIZE

221 RIGIDIZE

340 V/M INTERROGATE(CLEARS)

520-1 V/M DISABLE/ENABLE

400-1 ACS OFF/ON

300-1 HORIZ SENS OFF/ON

341 GYROCOMPASS ON

350-1 GEO RATE OFF/ON

4. DATA RECORD SEQ

041 RECORD ON

030 RECORD/TM OFF

021 TM ON (OVER STA.)

5. PERFORM A PPS BURN

571 HYD GAIN DK

450 D/B NARROW

ARM STOP SW - ARM

521 VM ON

501 PPS ON (IGNITE!)

-- BURN --

-- VM CUTOFF --

500 PPS OFF

451 D/B WIDE

ARM STOP SW - STOP

520 VM DISABLE

6. ATTITUDE CONTROL

A. BEF

361 GEO RATE - NORMAL

310 ROLL H/S - YAW

321 H/S PHASE - IN

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

B. SEF

360 GEO RATE - REVERSE

310 ROLL H/S - YAW

320 H/S PHASE - OUT

IF REQ: 401 ACS - ON

IF REQ: 301 H/S - ON

351 GEO RATE - ON

341 GYROCOMPASSING - ON

WHEN TURN COMPLETE

350 GEO RATE - OFF

OBC

MEMORY CORE LIST

#$08: Ascent guidance: Yaw guidance (0 off, 1 on)

#$09: Ascent Azimuth. Will automatically calc roll program and sets #$10, #$11

#$10: Ascent guidance: Set target inclination (if not using #$09)

#$11: Roll Program: delta roll (if not using #$09)

#$12: Separation Velocity

#$19: Time to Retrograde (sec)

#$25: IVI dV z

#$26: IVI dV x

#$27: IVI dV y

#$32: Current Orbit Plane Azimuth (Inclination)

#$33: Target Orbit Plane Azimuth (Inclination)

#$40: Current Pitch

#$41: Current Yaw

#$42: Current Roll

#$56: Set target orbit perigee

#$57: Set target orbit apogee

#$72: Time to next apogee or perigee, whichever comes first (sec)

#$73: Time to Ap (sec)

#$74: Time to Pe (sec)

#$75: Orbit Period

#$76: Seconds since Pe

#$80: Perigee of Target Vehicle

#$81: Apogee of Target Vehicle

#$82: Inclination of Target Vehicle,

#$83: Time to Burn (sec) to reach Target Vehicle

#$84: Time to Burn to finalize Hohmann orbit after the 83 core burn

#$98: Current Apogee

#$99: Current Perigee