Apollo Command & Service Module
Propulsion Systems Overview
Lesson Objectives

• Define the systems for CSM propulsion and control
• List the times during the mission at which each system was used
• Describe the basic components and operation of the
  - Service Propulsion system (SPS)
  - SM Reaction Control System (SM RCS)
  - CM Reaction Control System (CM RCS)
CSM Propulsion Systems
SPS Usage Throughout the Mission

Initial SPS Capability

SPS abort capability during post-atmospheric portion of the launch or after translunar injection

SPS provided injection into a lunar orbit

SPS Provided nominal midcourse corrections
SPS Usage Throughout the Mission

SPS provided nominal midcourse corrections on the return trajectory.

SPS used for injection from a lunar orbit to a transearth trajectory.
SPS Propellant Pressurization and Flow

- **Oxidizer Sump Tank**
- **Oxidizer Storage Tank**
- **Fuel Storage Tank**
- **Fuel Sump Tank**

**System Components**:
- **Heater Exchanger**
- **Oxidizer Fill and Drain**
- **Fuel Fill and Drain**
- **Helium Fill and Drain**
- **Burst Diaphragm and Oxidizer Tank Relief Valve**
- **Burst Diaphragm and Fuel Tank Relief Valve**
- **Check Valves**
- **Helium Regulator Packages**
- **Helium Isolation Valves**

**Connection Points**:
- **Propellant Utilization Valve**
- **Service Propulsion Engine**
SPS Propellant Gauging
• Pressure fed engine
  - Hypergolic propellants
• Provided 91kN (20,500 lbs) of thrust
• Non-throttleable
• Restartable
• Gimbals for thrust vector control
SPS Operation

Guidance and Navigation System

Crew (Manual)

Fire command

CM S ROTATIONS

T.V.

PITCH DOWN

+PITCH GIMBALLING DEFLECTION

+Y

+Z

-\(x\)

-\(y\)

+YAW GIMBALLING DEFLECTION

-\(x\)

-\(y\)

-\(z\)

T.V.

YAW LEFT
SM RCS provided translational acceleration for separation from the launch vehicle.

SM RCS maintained attitude while firing the SPS.

SM RCS provided the Delta-V and control required for ullage maneuvers prior to rendezvous and dock with the LM.

SM RCS provided the Delta-V and control required for the SPS usage (midcourse corrections).
CSM RCS Usage

CM RCS activated after CM separation from the LM

CM RCS provided maneuvers and controlled attitude during entry

CM RCS maintained control and damped rates in the event of a high altitude abort

SM RCS provided velocity changes up to 100 fps to bring the spacecraft to an earth return trajectory
• 4 separate reaction control system units

• Each contained:
  - Two oxidizer tanks
  - Two fuel tanks
  - One helium tank
  - 4 Thrusters

• Thrusters
  - Pressure fed
  - 445 N (100 lbs) of thrust each
SM RCS Propellant Pressurization and Distribution
• Four engines in each of the 4 reaction control units
  - Units used simultaneously
  - 3 units could control if one failed
• Engine fire commands generated from the Stabilization and Control System
• Backup manual option
- Each system contained
  - One helium tank
  - One oxidizer, one fuel tank
  - Six thrusters
    - \(~413 \text{ N (93 lbs)}\) of thrust each

- Two separate CM RCS systems
- Systems nominally worked together but either could maintain control
CM RCS Prop Flow and Distribution

- Two identical systems, A and B
- Similar components to SM RCS
- Interconnect capability between the two systems
• Define the systems for CSM Propulsion and control
• List the times during the mission at which each system was used
• Define the basic components and operation of the
  - SPS
  - SM RCS
  - CM RCS
• http://images.jsc.nasa.gov/lores/S66-10998.jpg
• http://www.hq.nasa.gov/office/pao/History/SP-350/profile.html