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)
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 Component Overview

- Oxidizer Sump Tank
- Fuel Sump Tank
- Fuel Storage Tank
- Helium Tanks
- Quantity Gauging Sensors
SPS Propellant Pressurization and Flow
SPS Propellant Pressurization and Flow

- Oxidizer Sump Tank
- Oxidizer Storage Tank
- Fuel Storage Tank
- Fuel Sump Tank
- Helium Tank
- Helium Fill and Drain
- Oxidizer Fill and Drain
- Ox Fill Vent
- Bursts Diaphragm and Oxidizer Tank Relief Valve
- Heat Exchanger
- Propellant Utilization Valve
- Service Propulsion Engine

HELIUM REGULATOR PACKAGES
HELIUM ISOLATION VALVES
CHECK VALVES
HEAT EXCHANGERS
PROPELLANT UTILIZATION VALVE
SERVICE PROPULSION ENGINE
- Pressure fed engine
  - Hypergolic propellants
- Provided 91kN (20,500 lbs) of thrust
- Non-throttleable
- Restartable
- Gimbals for thrust vector control
CSM RCS Usage

SM RCS maintained attitude while firing the SPS

SM RCS provides translational acceleration for separation from the launch vehicle

SM RCS provided the Delta-V and control required for rendezvous and dock with the LM

SM RCS provided acceleration required for ullage maneuvers prior to SPS usage (midcourse corrections)
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

Coupled RCS control

Minimum impulse RCS control
- Two separate CM RCS systems
- Systems nominally worked together but either could maintain control

- Each system contained
  - One helium tank
  - One oxidizer, one fuel tank
  - Six thrusters
    - \( \sim 413 \text{ N} \) (93 lbs) of thrust each
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