

MIT Lecture

OMS/RCS

APU/HYDRAULICS

OMS/RCS

- Break into 2 sessions
 - OMS RCS first session / APU Hydraulics second
- Talk for about 30 minutes with 30 minutes for questions.
- Ask questions anytime. No lecture– I will throw a few things out and we will talk about them.
- Cover APU/ Hydraulics the same way.
- Cover the start of the Space Shuttle Program
 - `Max Appointed Jim Chamberlain To head Study Group.
 - I sent the best Engineer I had.
 - He balked
 - Quickly run through Many configurations
- Understand the impact of requirements very clearly
 - Fail OP fail safe good buzz word but can make a system less safe.
 - I can make a case that a 2 engine aircraft is safer then a 4 engine aircraft because of the way requirements are written.

- Original requirements
 - Low cost of operations
 - Oxygen/Hydrogen
 - Oxygen/ Methane
 - Oxygen/Alcohol

- Requirements changed to Low development costs
 - OMS went to Bipropellant
 - MMH/N₂O₄
 - Lot of experience-Apollo Agena
 - Performance—Long steady state burns
 - RCS went to Monopropellant hydrazine
 - Too Heavy—Weight in Back
 - Changed to Bi Propellant MMH/N₂O₄

- Development Program

- Remember

- It is not natural for Earth bound humans to think in terms of no gravity
 - It is not natural for earth bound humans to think in terms of the absence of pressure.

- There is no substitute for a good test program

- No vibration test

- Had good structural programs

- » Helium bottle fell out during Vibration test.

- Differences between OMS and RCS
 - OMS has few starts
 - Performance is critical
 - RCS thousands of starts
 - Very short (millisecond burns) to steady state burns of 500 or more seconds
 - Must operate over a wide range of mixture ratios and inlet pressures.
 - Dribble volume—effect of refrigeration—Helium saturation.
 - Effects of no gravity on Expulsion.
- Questions:

APU/Hydraulics

- Will cover both Subsystems together because they are so closely related.
- Like OMS/RCS went through many iterations
 - Fail op-fail op-fail safe VS fail safe
 - Big mistake to call APU Auxiliary Power unit
 - Should have been called PPU—Primary power unit.
 - Low Operational costs VS low development costs.
 - Power Requirements
 - Aero and Control people Want instant response.
 - Weight carried in someone else's budget.
 - Dual Tandem actuators
 - 4 VS 3 Systems
 - Hydraulics VS Electromechanical

- Power Source
 - Electric VS Turbine
- Turbine Development
 - Hydrogen/Oxygen
 - MMH/N₂O₄
 - Hydrazine
 - Pressure modulated VS Pulse Modulated
 - Absent of gravity on Gearbox development
 - Used gears to pump oil to sump
 - Absent of air and gravity on gas Generator development.
 - Heat soaked to valve in vacuum.
 - Added water spray for several flights
- Hydraulics
 - Hydraulics mostly off the shelf.
 - Added bellows and pressure source to Hydraulic reservoir
 - Added Water boiler to cool Hydraulic fluid.
 - First concept was to run the hydraulic fluid through a bucket of water.
- Importance of good test program and to think in terms of no gravity and no pressure.
- Questions.