

Use Main Engine for OMS

Space Propulsion Technology  
Assessment Workshop

April 2001



# Current Baseline

## Use Main Engine for OMS

- Currently projected vehicles have separate OMS engine systems
  - Some consideration of using main engine propellants and main propellant tanks
    - With or without separate accumulators
  - Even in this case separate OMS engines, feed lines, valves, real estate to place the engines
- OMS thrust levels are so far below the main engine thrust levels that throttling the main engine is not reasonable
  - On the order of 0.25% to 2%
- However a LOX/hydrogen main engine with this level of thrust has long ago been designed, developed, and tested
- The J-2S incorporated a tank head low thrust mode of 1,000 to 5,000 lbf
  - Nominal engine thrust of 265,000 lbf
  - Method is independent of engine power cycle
  - Operable with either gas or liquid propellants
  - Four engines tested in this mode for a total of 6,915 seconds
  - Tested in vacuum at AEDC
- Weight - 32 lbm plus small added ox dome weight - about 50 lbm total



# Concept

## Use Main Engine for OMS

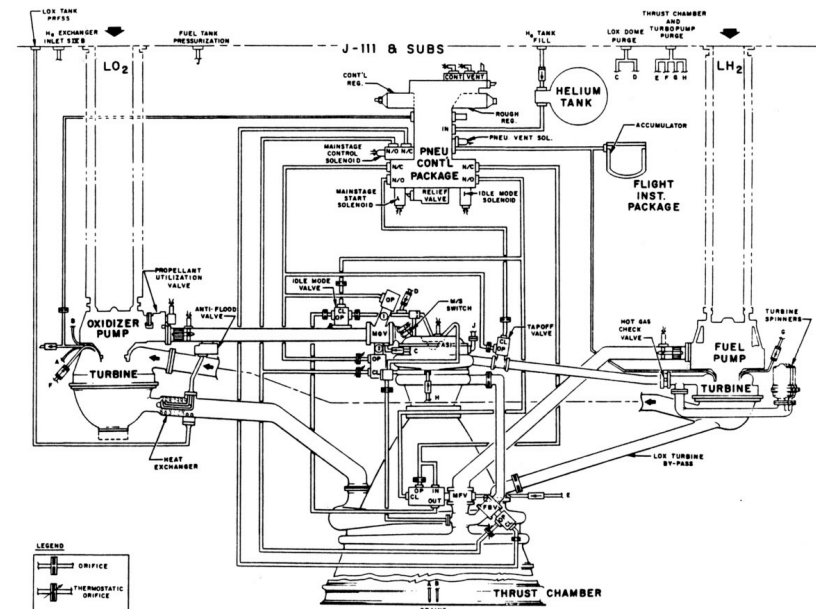
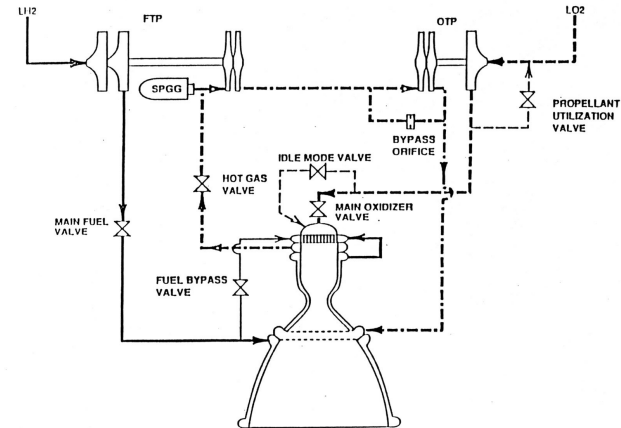
- Proven technology
  - J-2S
  - RL-10
- Simplest way to think of implementation is
  - Oversized augmented spark igniter
    - Capable of performing OMS function



# Potential Solutions

## Use Main Engine for OMS

- Idle mode is a pressure fed mode of any pump fed engine
- As implemented in the J-2S
  - Propellants are supplied through the vehicle primary feed system to the pump inlets
  - Initiated with either gaseous or liquid propellants
    - $\approx 32$  psi for the oxygen
  - Main fuel valve and the fuel bypass valve opened
  - Oxygen idle mode valve opened
  - Engine turbopumps do not operate
  - Made possible by adding an injector manifold which only passes oxidizer through the center rows of the injector to maintain a stable pressure drop in each element even at the very low propellant flows of idle mode

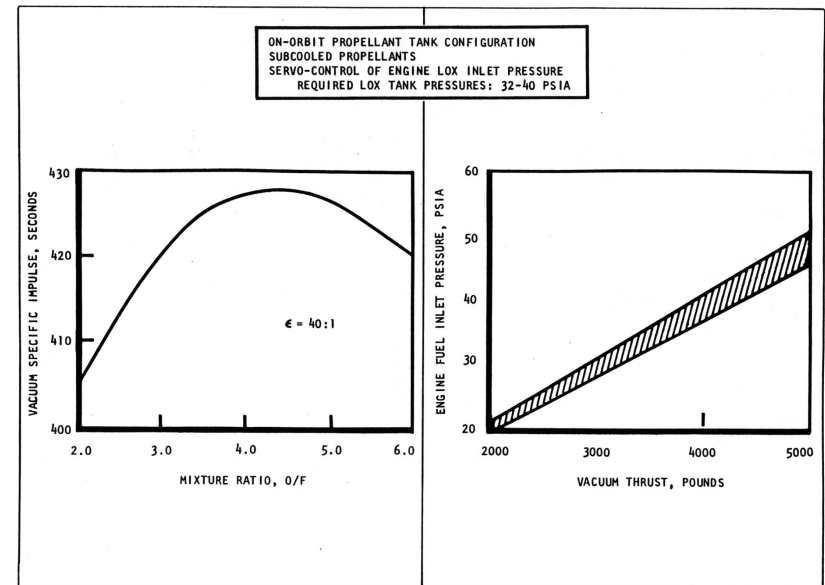




# Potential Solutions

## Use Main Engine for OMS

- As implemented in the J-2S (Cont'd)
  - Fuel bypass valve controls the pressure and thus the flowrate and thrust
    - Shown for 20 to 45 psi
    - Mixture ratio varies
- For other power cycle/engines
  - Exact plumbing connections would vary
  - Mixture ratio could be held constant
    - Thrust would be lower
    - Probably desirable
- Although propellant conditions, and thus mixture ratio, are unknown at start of thrust, they quickly become predictable as propellant settles
- Very simple system
  - About 50 lmb extra on 3,867 lbm engine





## Cost to Mature Technology

### Use Main Engine for OMS

- There is no cost to develop this capability to TRL 6
  - It has been tested in a full scale engine for significant time and in a vacuum
- However
  - There would be additional tests needed in a new implementation to characterize the low thrust operation and to test the new implementation in a vacuum
    - Cost added
      - About \$50M-\$80M mostly for testing
    - Cost saved
      - Entire cost of design, development, test, manufacture, and operation of an OMS system
      - Vehicle weight improvement
  - Schedule impact
    - Probably none for the cost shown due to parallel testing