



Common Lunar Lander Propulsion System

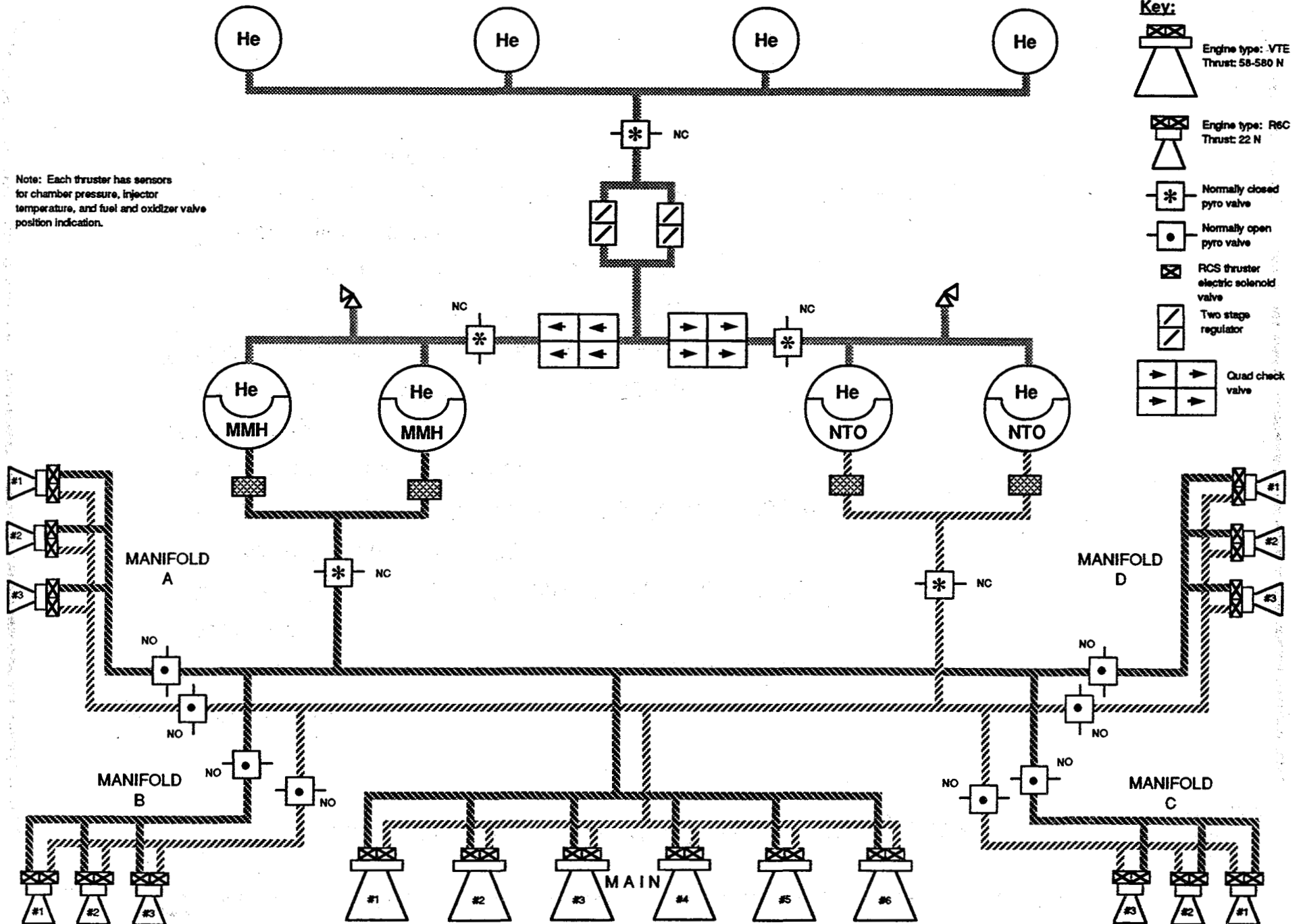
System Characteristics

- Two-stage pressure-fed storable bipropellant (MMH/NTO)
- Lander stage
 - Six main engines - TRW Variable Thrust Engines (VTE)
 - Originally baselined for OMV
 - 10:1 throttling capability from 58 - 580 N (13 - 130 lbf)
 - Throttling required for landing
- Transfer stage
 - Aerojet Transtar engine - 16731 N (3750 lbf)
- Twelve attitude control engines for each stage
 - Marquardt R6-C's (lander) and R-1E's (transfer)
 - 22 N (5 lbf) and 110 N (25 lbf) respectively
 - Extensive flight history
 - Arranged in quads: two 4-engine clusters and two 2-engine clusters
 - Provide 3-axis stabilization

COMMON LUNAR LANDER PROPULSION SYSTEM

9/12/61 RJS

Note: Each thruster has sensors for chamber pressure, injector temperature, and fuel and oxidizer valve position indication.





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Point Design Output

- Dry propulsion system mass breakdown:

	Lander Stage	Transfer Stage
- Fuel tanks	6.7 kg	38.6 kg
- Oxidizer tanks	6.7	41.0
- Pressurant tanks	11.3	72.7
- Engines (includes controllers)	58.8	93.4
- Lines/Valves/Thermal	8.4	30.1
- Mounting hardware	1.7	6.0
- Pressurant	2.2	4.5
- Residual fuel	3.3	32.2
- Residual oxidizer	<u>5.4</u>	<u>57.9</u>
Total dry system mass	104.5 kg	386.4 kg

- Wet propulsion system includes above plus usable propellant

- Usable fuel	161.2 kg	1574.9 kg
- Usable oxidizer	<u>264.4</u>	<u>2834.8</u>
Total usable propellant	425.6 kg	4409.7 kg
Total wet propulsion system mass	530.1 kg	4796.1 kg

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System Mission Requirements

- Provide propulsive maneuvers and attitude control from LEO through landing
 - TLI: 3200 m/sec
 - MCC's: 30 m/sec
 - LOI: 840 m/sec
 - D/O: 30 m/sec
 - TD&L: 1820 m/sec

Key Drivers to Subsystem Selection

- Multiple restart ==> liquid propellants
- Simplicity, orbital stay time, packaging ==> storable propellants
- Landing ==> throttling engines

System Readiness Level

- All elements are flight proven except:
 - VTE : Complete development program then proceed into qualification
 - Transtar: Flight weight engine developed, ready for qualification
 - Tanks: Custom sized for propellant/pressurant load, industry survey required