

Proposed Change Level (1, 2, 3, 4): 3

Proposed Change: Replace 1N Thrusters with 5N Thrusters

Lead Engineer: Taylor

Subsystem: Thrusters

Reason for Change:

5N Thrusters would provide reduction in firing in-efficiency for maneuvers with little system impact.

Efficiency comes from:

1. Arc for apogee raise maneuvers can be reduced (by factor of 2.5). For a constant fire direction, unchanged by the probe position on the perigee arc, the offset from actual instantaneous burn is minimal. The 15% inefficiency, becomes 5%.
2. Number of perigee burn splits to accomplish apogee raise can be reduced (P1-2, P1-4 and P1-9 can now be 1-2 burns, not 2-4)
3. Side thrusting more efficient since same can be done with reduce pulse width (more details in minutes below)

Reference Documentation Summary

Themis Thruster Sizing 9_30_2003.ppt (Swales)

Fuel Slosh with Pulsing.xls (Pankow)

Themis Booms with Thrusting.xls (Pankow)

Bus PDR presentation: Themis_Thermal_PDR final.ppt (R. Zara/Swales)

THEMIS_maneuver calculator_RevB4.xls

Subsystem Impacted: (Bold indicates an impact)

ACS	C&DH	Mechanical	Propulsion	Booms	IDPU S/W
Battery	EGSE	MGSE	RF Comm	EFI	SST
Bus	Harness	Mission Ops	Solar Array	ESA	SCM
Avionics Unit	I&T	Power	Thermal	FGM	
BUS S/W	Launch Vehicle			IDPU	

Minutes Summary (Systems Engineering Meeting):

Replacing 1N thrusters with 5N thrusters have the following potential impacts:

1. Dynamic instabilities. Primary concerns are Fuel Slosh and Boom Wire "Wiggle". Initial analyses done by Swales and UCB (Pankow) showed no problems (see reference documentation).
2. Cost. 5N thrusters cost ~250K more than 1N thrusters. This has been written as an option to the RCS contract.
3. Magnetics. Valves are the same size, with same or similar valve, and should behave the same magnetically.

Recommendation is to replace all 1N thrusters (4 total) with 5N thrusters.

Additional trade: 2x5Nt (axials) + 2x1Nt (radials).

Benefits: Smaller radials are (1) more benign on boom dynamics from side-thrusting (2) More benign on boom heating

Drawbacks: Smaller radials are (1) less efficient than 5Nt because need longer pulse duration and longer arc to achieve same effect; (2) Longer arc (2-3 times) increases TX-ON time which has power and MOC issues (violates <30min contact); (3) Longer arc (2-3 times) has power problems because current design does not permit offset by more than 13deg from ecliptic normal for long times; and (4) Cost benefit is only 75K, not 250K/2. Loss of 55K from bulk-buy of 20thrusters and above.

Approval

PROPRIETARY

YES ☐ NO ☐

Project Manager

Date

Systems

Impacted Subsystem Lead

Distribution

- Subsystem trades (level 4) can be made within the resources of the subsystem. Systems Engineer insight and involvement.
- Trades that impact subsystem/system interfaces or resource allocations (level 3/level 2) require concurrence by the Configuration Control Board (CCB): Principal Investigator, Project Manager, Mission Systems Engineer (MSE), Probe Systems Engineer, Mission Operations Manager and affected Team Leads. GSFC Mission Manager insight.
- Trades that impact Level 1 *baseline* science/programmatic requirements must include approval by Principal Investigator and GSFC Mission Manager.
- Trades that impact Level 1 *minimum* science/programmatic requirements must include approval by NASA HQ.

Date