Five-Segment RSRB Feasibility Status

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Five Segment Booster (FSB) Objective

- Provide low cost, low risk approach to increase reliability and safety of Shuttle system
**STS Booster Upgrade Requirements**

- Safety/Reliability Improvement
  - FSB reliability > RSRB reliability
  - Enhance abort modes

- Increased System Capability
  - Performance improvement to ISS
  - Provide increased payload capability to other orbits

- Reduce Costs
  - Decrease operations costs

- Low Development Risk
Potential STS Upgrades

5 Segment RSRB - Phase A Study

- New Parachutes
- New Fwd Skirt
- New Fwd Attach
- Add Center Segment
- New Nozzle

4 Segment RSRB

5 Segment RSRB

416 in.

96 in.

1800 in.
5 Segment RSRB Design Summary

4-SEGMENT

- Same frustum & BSMs
- New forward skirt (-26")
- New medium wt parachutes

5-SEGMENT

- New attach case segments
- Increased segment length (26")
- Grain/inhibitor modification
- Reduced bore diameter (4")
- Reduced burn rate
- Insulation modification
- System tunnel modification

- Added center segment
- Insulation modification
- Reduced burn rate
- Modified inhibitor height
- Reduced bore diameter (4") w/lead-in chamfers

- Standard weight stiffeners
- Added stiffener ring
- New nozzle
- Increase nozzle length
- Insulation modification
- Reduced burn rate
Potential STS Upgrades

5 Segment RSRB - Phase A Study

STS Enhancements/5-Seg RSRBs

Modified inhibitor

13 fins
Reduced bore

Factory Joints
ET/SRB Separation Plane
Forward SRB Thrust Post
Field Joint

Field Joint
New Cylinder Segments

Field Joint
Field Joint
Field Joint
Field Joint

ET Attach Ring
Field Joint

Nozzle Exit Plane
(aft 9”)

Reduced bore diameter
Modified inhibitor

57.62-in. Dia
Ae/At = 7.01

152.6 in Dia
Same Attach Location

Changes noted in italic
5-SEGMENT BOOSTER DESIGN INCREASES RELIABILITY

4-Segment Booster

Improved TVP Gas Generator

Improved Nozzle

Improved Nozzle Flow Joint Design

Improved Nozzle Lines

New Forward Skirt

Improved Forward Skirt

Improved Forward Skin Bonding

New Forward Attachment on Case

5-Segment Booster
FSB Capability Improvement

FSB Design Features
- Add center segment
- Increase forward segment 26 in.
- Decrease propellant bore diameter 4 in.
- Increase nozzle length (~9 in) and exit diameter (3 in)
- Larger diameter medium wt. Parachutes
- Shorter Lt. Wt. forward skirt

Performance Constraints
- Maximum Dynamic Pressure 730psf
- Maximum Acceleration during SRB 2.7 g

Equivalent ISS Payload Capability - 60,500 lbm
- Orbiter ISS Payload increased to 40,000 lbm
- Improved abort mode capability
ENHANCED ABORT MODES
(SINGLE SSME OUT)
40-KLB PAYLOAD TO ISS ORBIT

ISS TITLES

ISS TRL

ISS ALT

ISS RM

Time (sec)

100  200  300  400  500
ET Impacts

- No change to aft interface

- Increased loads on forward interface
  - Maximum acceleration increased from 2.4 to 2.7 g
  - Pre-Phase A data indicates minimal structural impact
    - 2.7 g maximum acceleration will be confirmed in this study

- Protuberance and thermal environments remain to be defined and assessed
  - Stagnation heat load ~50% greater than current
  - Additional TPS will be required

Load increases are manageable with minimal weight penalty
Launch Site Assessment

FACILITY MODIFICATIONS

VAB
- MODIFICATION OF SRB ACCESS PLATFORMS
- ADDITION OF SRB ACCESS PLATFORMS

PADs
- MODIFICATION OF GOX VENT ARM
- MODIFICATION OF SRB FWD ACCESS PLATFORMS
- POTENTIAL MODIFICATION OF H2 VENT UMBILICAL

MLPs
- MODIFICATION OF SRB T-0 UMBILICAL
- POTENTIAL MODIFICATION OF SRB HOLD POSTS

HANGER AF
- ADDITIONAL SRB RAIL DOLLIES
- MODIFICATION OF SRB RETRIEVAL OPERATIONS (DIVER OPERATIONS)

LCC
- UPDATE LPS SOFTWARE
Conclusion

- FSB will be safer and more reliable than current RSRB
- Increased capability from FSB enables improved flight safety during boost phase
  - Reduced risk for SSME-out abort modes
  - Increased performance will enable Orbiter upgrades for increased crew survivability and still meet ISS commitments
- Improved performance increases payload capability to ISS and other orbits
- FSB offers low cost, low risk approach to gain safety and performance enhancements
5 Segment RSRB - Phase A Study

Forward Attach
FSB Grain Design
RSRM Nozzle

$A_e/A_t = 7.72$

FSB Nozzle

$A_e/A_t = 7.01$
FSB Forward Skirt

- Skeletal structure with internal stiffening ring/avionics interface
- Longitudinal beams oriented to each parachute riser fitting
- Length reduction =/> 26 inches
- Skin panels optimized for weight
- Weldment assembly
- Fwd and Aft ICD's unchanged
- Material: AL2219