Debris Environment Overview

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Debris Approach

- **Debris is an environment generated by the shuttle as it flies and the shuttle must be engineered to successfully fly through that environment**
- **Our approach to the debris environment has four levels**
- **First - Eliminate sources of debris by design**
- **Second -Understand the transport mechanism for any remaining debris that is generated**
- **Third -Understand the impact tolerance for any debris that can be generated and can reach the shuttle**
- **Fourth – Contingency plans**

RTF actions map into our strategy

- **First - Eliminate sources of debris by design**
  - **ET Bipod redesign, ET TPS revalidation, SRB Bolt Catcher Redesign**
  - **Non destructive Evaluation (NDE) of TPS**
  - **Inflight video and photographic coverage**
- **Second - Understand the transport mechanism for any remaining debris that is generated**
  - **Tests of debris generation**
  - **Modeling of debris transport**
  - **Inflight video and photographic coverage**
- **Third - Understand the impact tolerance for any debris that can still be generated and can reach the shuttle**
  - **Coupon and full impact tests as well as analytical models**
  - **NDE of RCC to verify the effect of age on strength**
  - **TPS hardening**
- **Fourth, Contingency Plans**
  - **On orbit inspection and repair capability**
  - **Contingency Shuttle Crew Support (CSCS)**

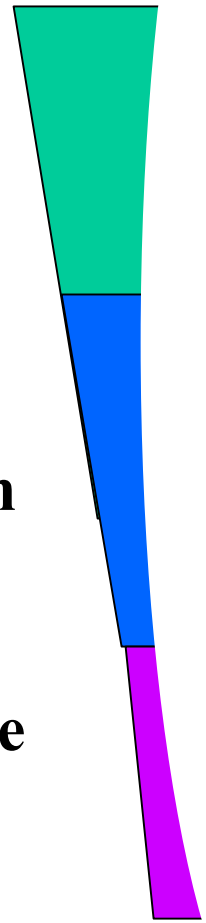
Debris Strategy

Eliminate Debris Generation

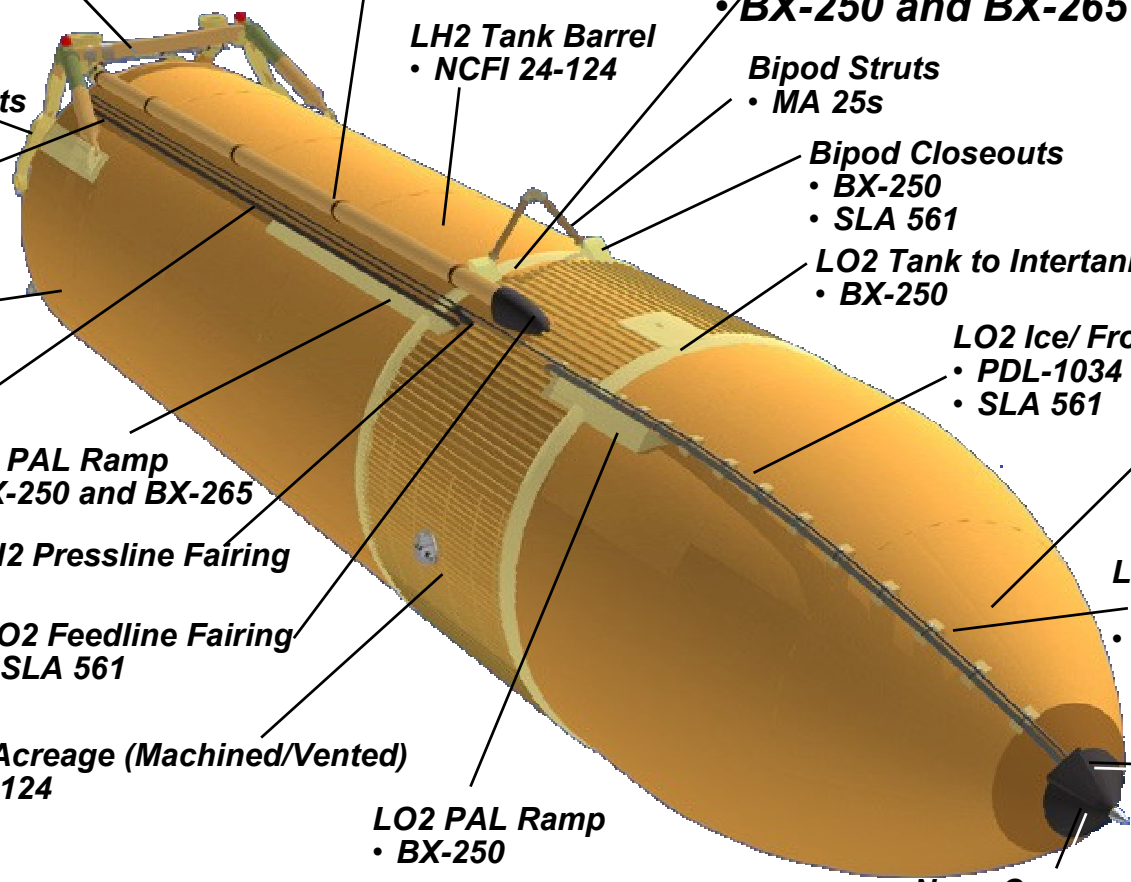
Eliminate Debris By Transport Mechanism

Eliminate Debris by Impact Tolerance

Contingency Plans



External Tank



LH2 Tank Dome
• NCFI 24-57
Apex Closeout
• BX-250
• SLA 561

LO2 Feedline
• BX-250 with PDL-1034 closeouts

LH2 Tank to Intertank Flange Closeout
• BX-250 and BX-265

Aft Interfaces / Cable Tray Covers/Fairings
• BX-250 with PDL closeouts
• SLA 561

LH2 Tank Barrel
• NCFI 24-124

Bipod Struts
• MA 25s

Bipod Closeouts
• BX-250
• SLA 561

Aft Struts
• BX-250 or BX-265

LO2 Tank to Intertank Flange Closeout
• BX-250

Third Hardpoint (planned for KSC)
• BX-265

LO2 Ice/ Frost Ramps
• PDL-1034
• SLA 561

LO2 Tank Ogive / Barrel
• NCFI 24-124

LH2 Ice/Frost Ramps
• PDL-1034

LH2 PAL Ramp
• BX-250 and BX-265

Composite GH2 Pressline Fairing

LO2 Cable Trays & Fairings
• SLA 561

LO2 Feedline Fairing
• SLA 561

Intertank Acreage (Machined/Vented)
• NCFI 24-124

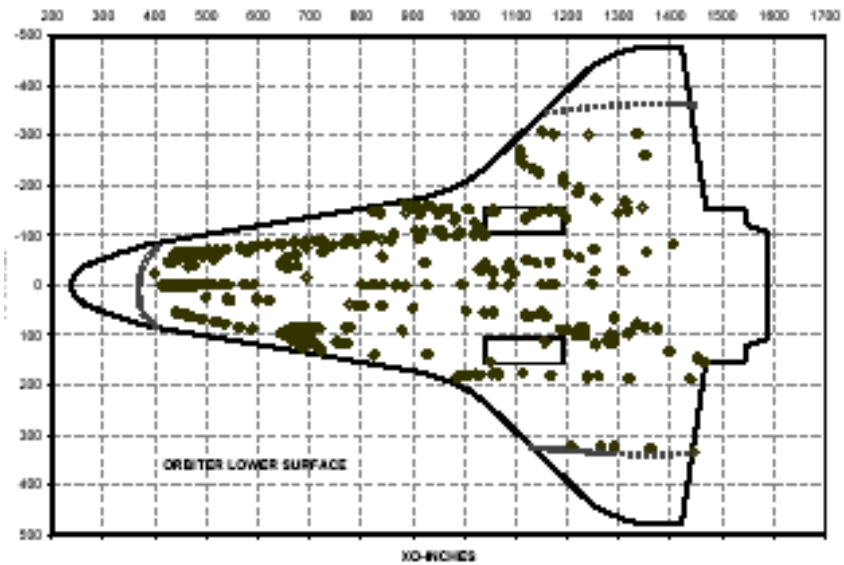
Nose Cone (internal)
• MA 25s
• PDL 1034

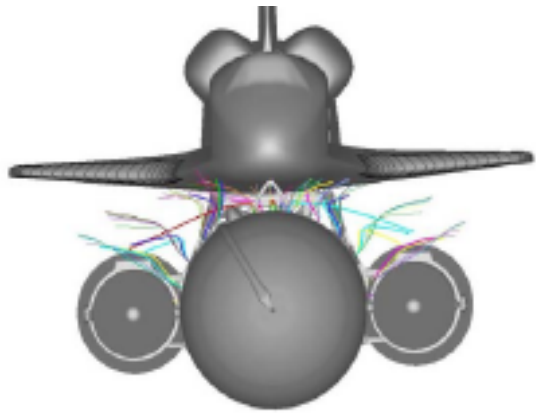
LO2 PAL Ramp
• BX-250

Nose Cone
• Graphite / Phenolic

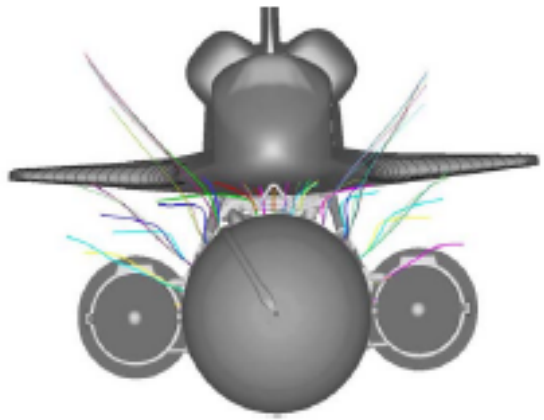
The application of TPS materials includes computer controlled automatic spray cells and manual application

Picture of ET Flange Foam Transport Cases

- 



60 ft/sec Initial Velocity



100 ft/sec Initial Velocity

Runs

Release locations: LH2 Flange (XT1120) at PHI angles 83.3, 75, 60, 45, 34.6, 10.5, 6, 0, -6, -10.5, -15, -30, -45, -60, -75, -83.7 and –89

Sizes: 1"x1"x1", 3"x2"x1", 3"x3"x2", 5"x5"x2", 10"x10"x2", 20"x10"x2", 20"x16"x2", and 25"x20"x2"

Initial Released Velocity: 0 to 100 ft/sec (5 ft/sec increment)

Impact Kinetic Energy

Weight (lbs)	Velocity (fps)	Energy (ft-lbf)
1.5	777	14,062
.2	777	1874
.1	1000	1552
.1	700	760
.02	1000	310

Purposes of Inflight Imagery

- **Verify Design Changes to Eliminate Debris**
- **Understand transport mechanisms of any remaining debris**
- **Observe integrated performance to find unknown phenomena**