

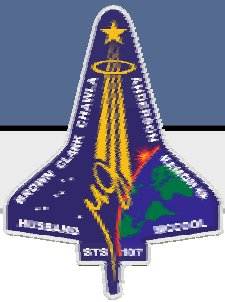
# Columbia Accident Investigation Board

*Unintended consequences ...*

- **Schedule Pressure**
  - 19 February 2004: Scheduled ISS “US Core Complete” date
  - Problems grounded entire shuttle fleet, eliminated most schedule margin, and changed launch dates of other missions
  - US Core Complete date remained unchanged
  - Over time, aberrant processes, reduced focus, other symptoms arose

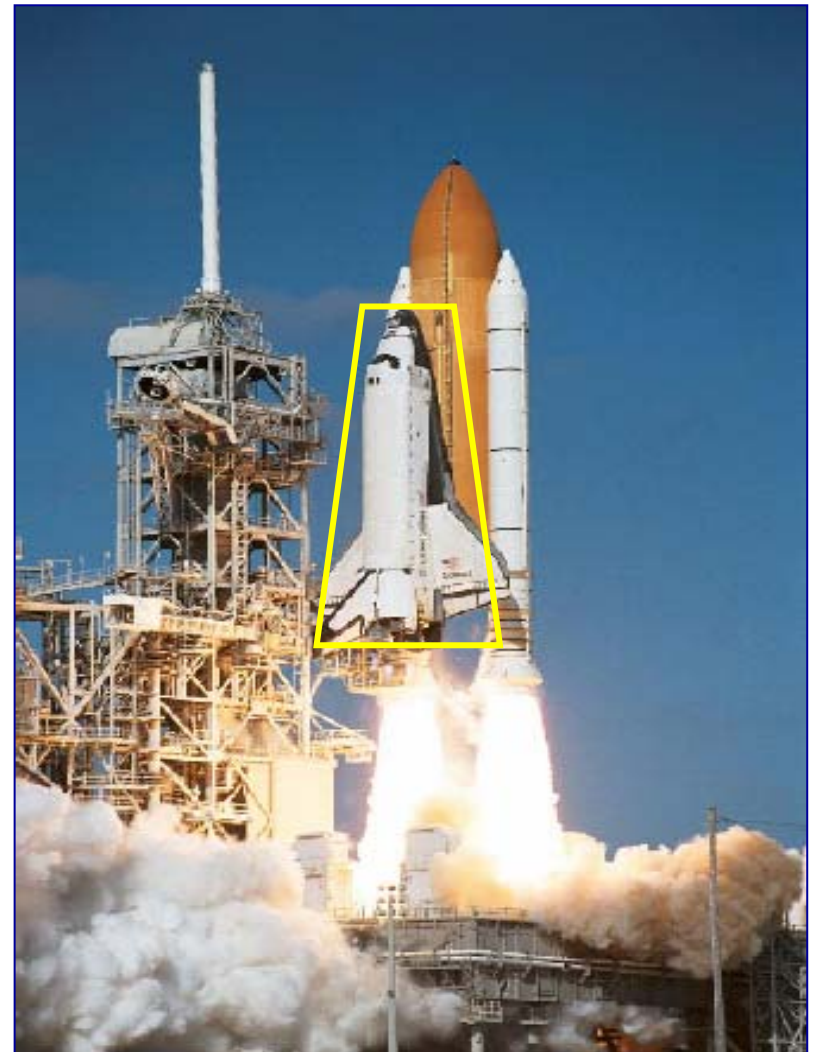


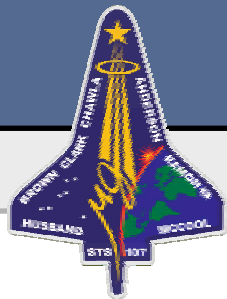
**NASA's  
“US Core Complete”  
Screensaver**



# Columbia Accident Investigation Board

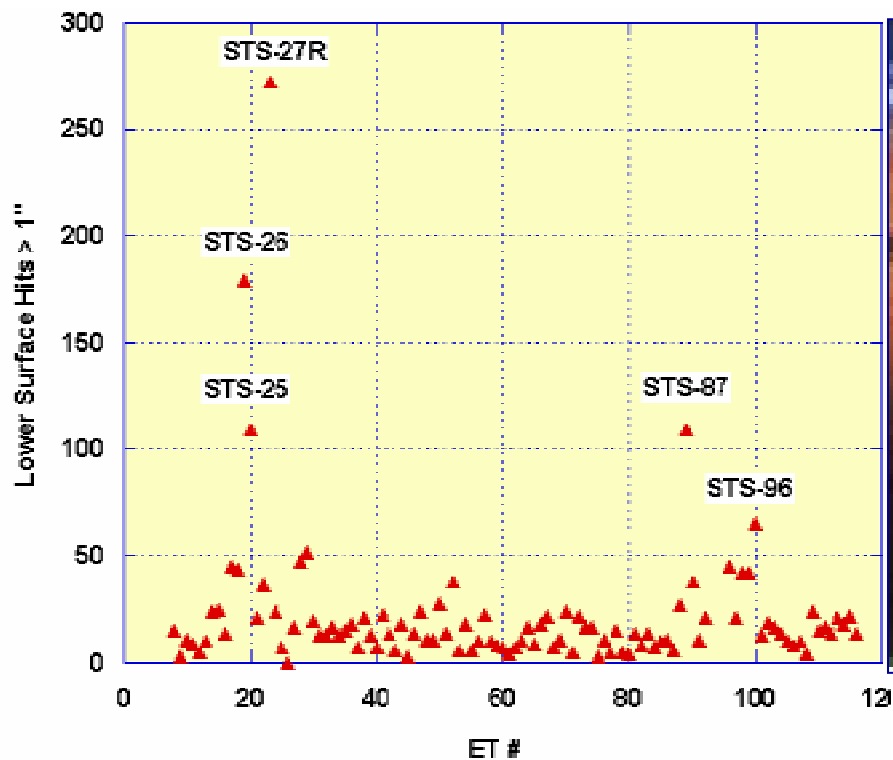
## *Acceptance of Foam Shedding*

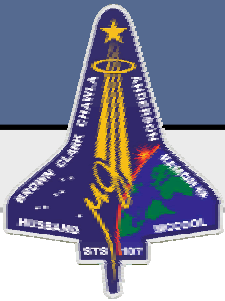




# Columbia Accident Investigation Board

## Lower Surface Hits > 1"

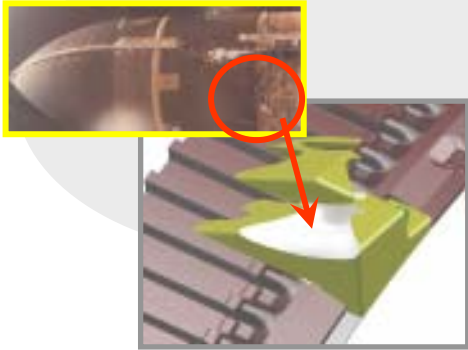




# Columbia Accident Investigation Board

## Previous Foam Loss Events

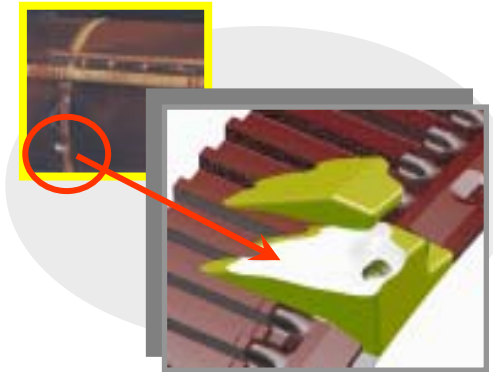
**STS-07:396 in<sup>3</sup>**  
*Challenger 6/18/83*



**STS-032: 258 in<sup>3</sup>**  
*Columbia 01/09/90*



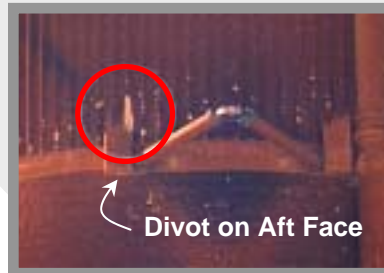
**STS-050:836 in<sup>3</sup>**  
*Columbia 06/25/92*



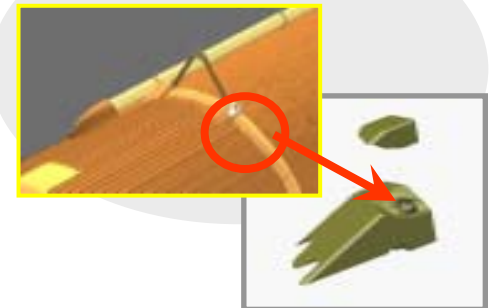
**STS-52\***  
*Columbia 10/22/92*



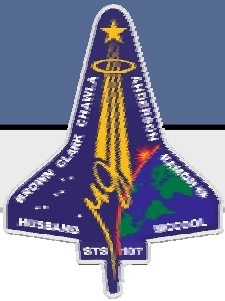
**STS-62\***  
*Columbia 3/04/94*



**STS-112: 307 in<sup>3</sup>**  
*Atlantis 10/07/02*




**\*Previously undetected until CAIB investigation**





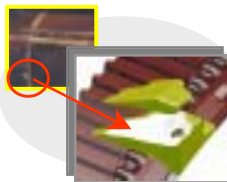
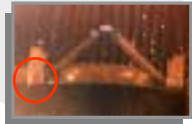
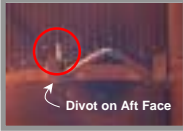
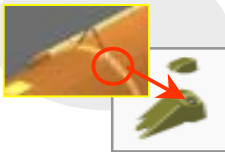
# Columbia Accident Investigation Board

## Previous Foam Loss Events



### Columbia Accident Investigation Board

Previous Foam Loss Events

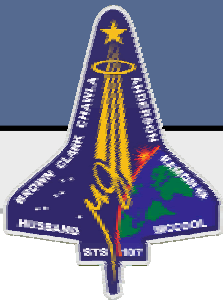
<p><b>STS-07: 396 in<sup>3</sup></b> Challenger 6/18/83</p> 	<p><b>STS-032: 258 in<sup>3</sup></b> Columbia 01/09/90</p> 	<p><b>STS-050: 836 in<sup>3</sup></b> Columbia 06/25/92</p> 
<p><b>STS-52*</b> Columbia 10/22/92</p> 	<p><b>STS-62*</b> Columbia 3/04/94</p> <p>Divot on Aft Face</p> 	<p><b>STS-112: 307 in<sup>3</sup></b> Atlantis 10/07/02</p> 

*\*Previously undetected until CAIB investigation*

5:112 = 1 in 23 ...

to 7:112 = 1 in 16 ...

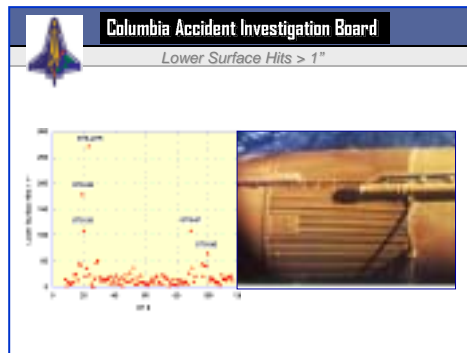
to 7:72 = 1 in 10



# Columbia Accident Investigation Board

## Decision Making at NASA

- History of Foam Anomalies
  - Original External Tank design: **Foam shedding damage not allowed**
  - Shedding causes not understood--or studied
  - Hazard analyses not changed over time—  
“No safety-of-flight concerns”
  - Foam shedding **became normal expectation**



**“The *unexpected* became the *expected* which became the *accepted* ...”**