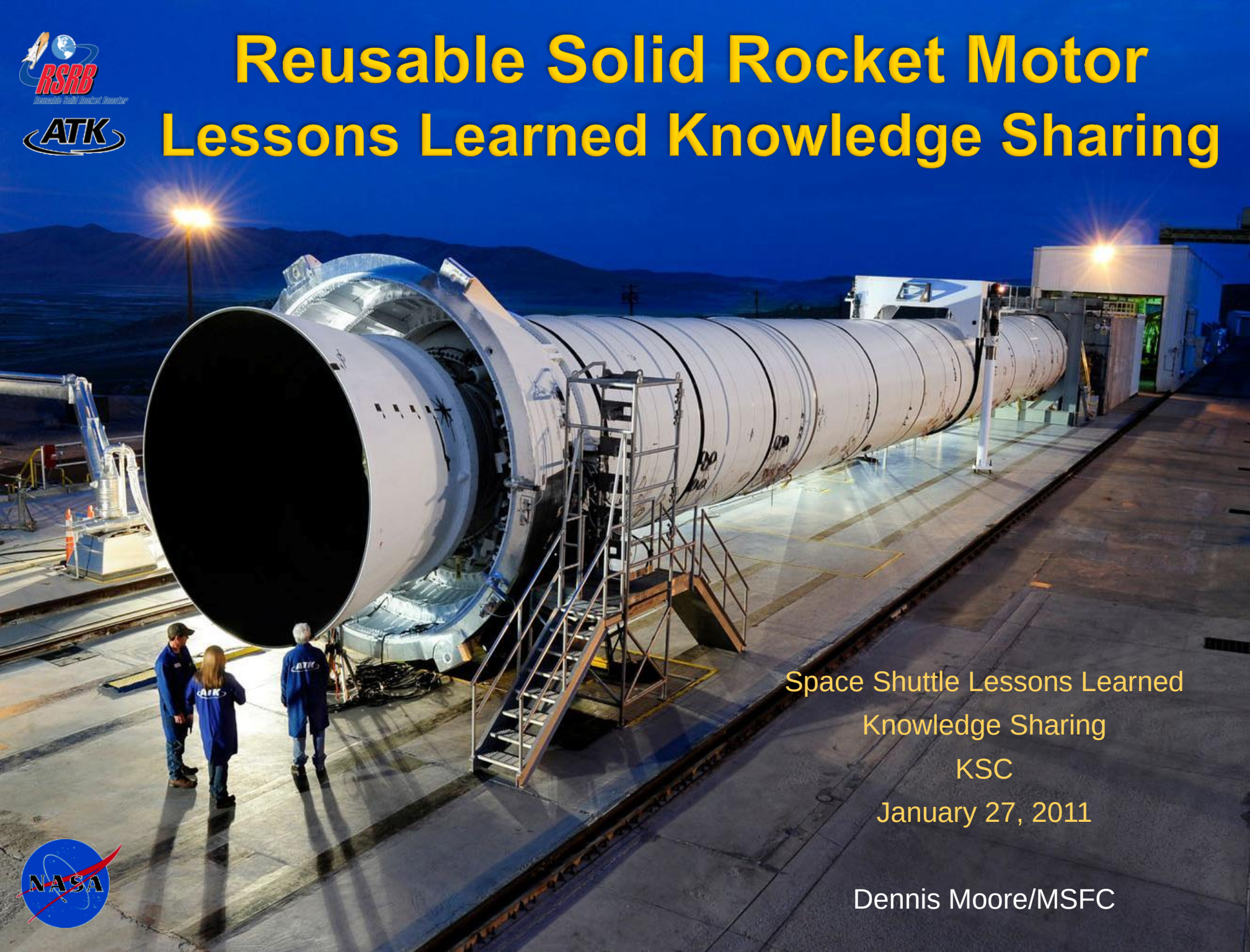
Reusable Solid Rocket Motor Lessons Learned Knowledge Sharing



Space Shuttle Lessons Learned
Knowledge Sharing
KSC
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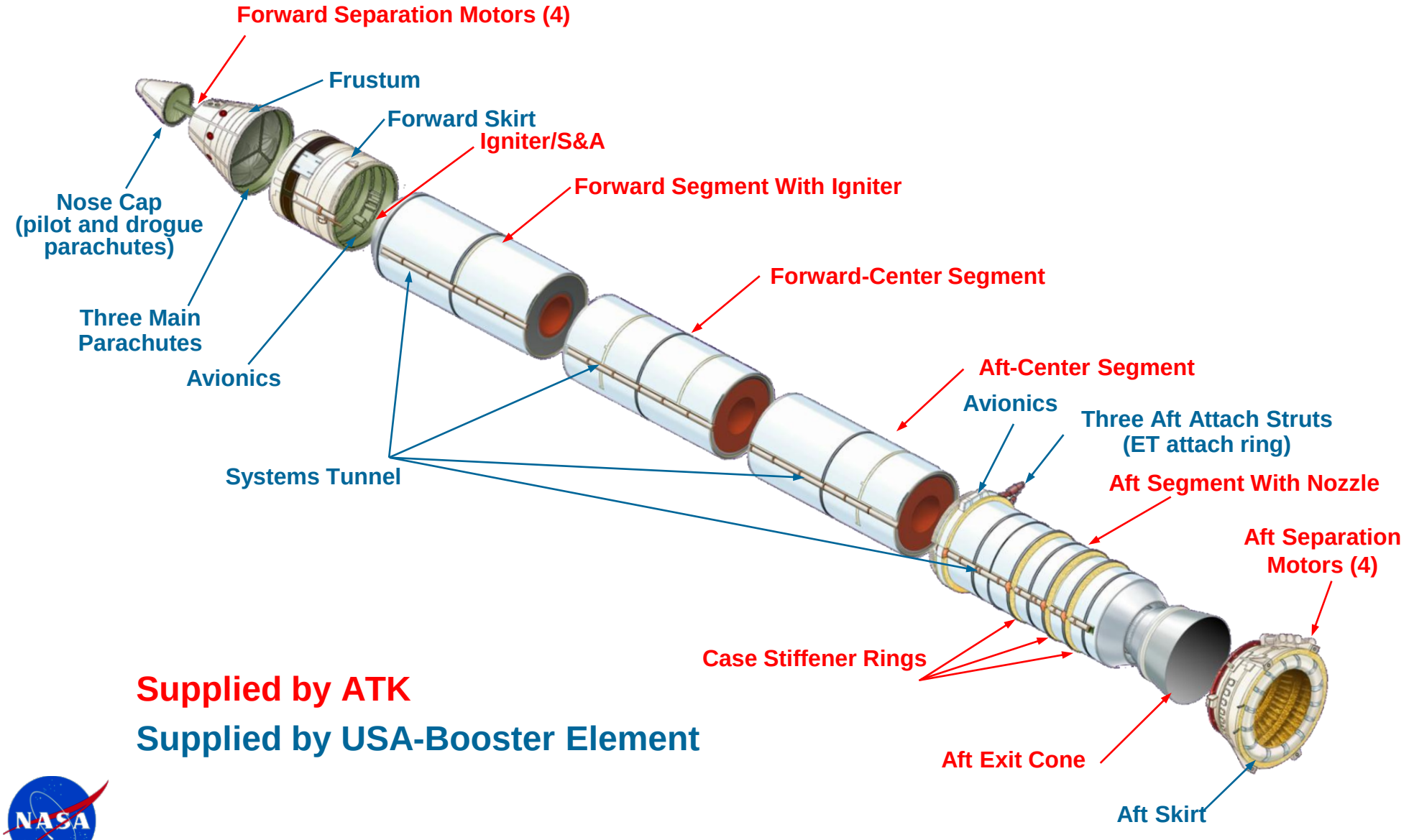
Dennis Moore/MSFC

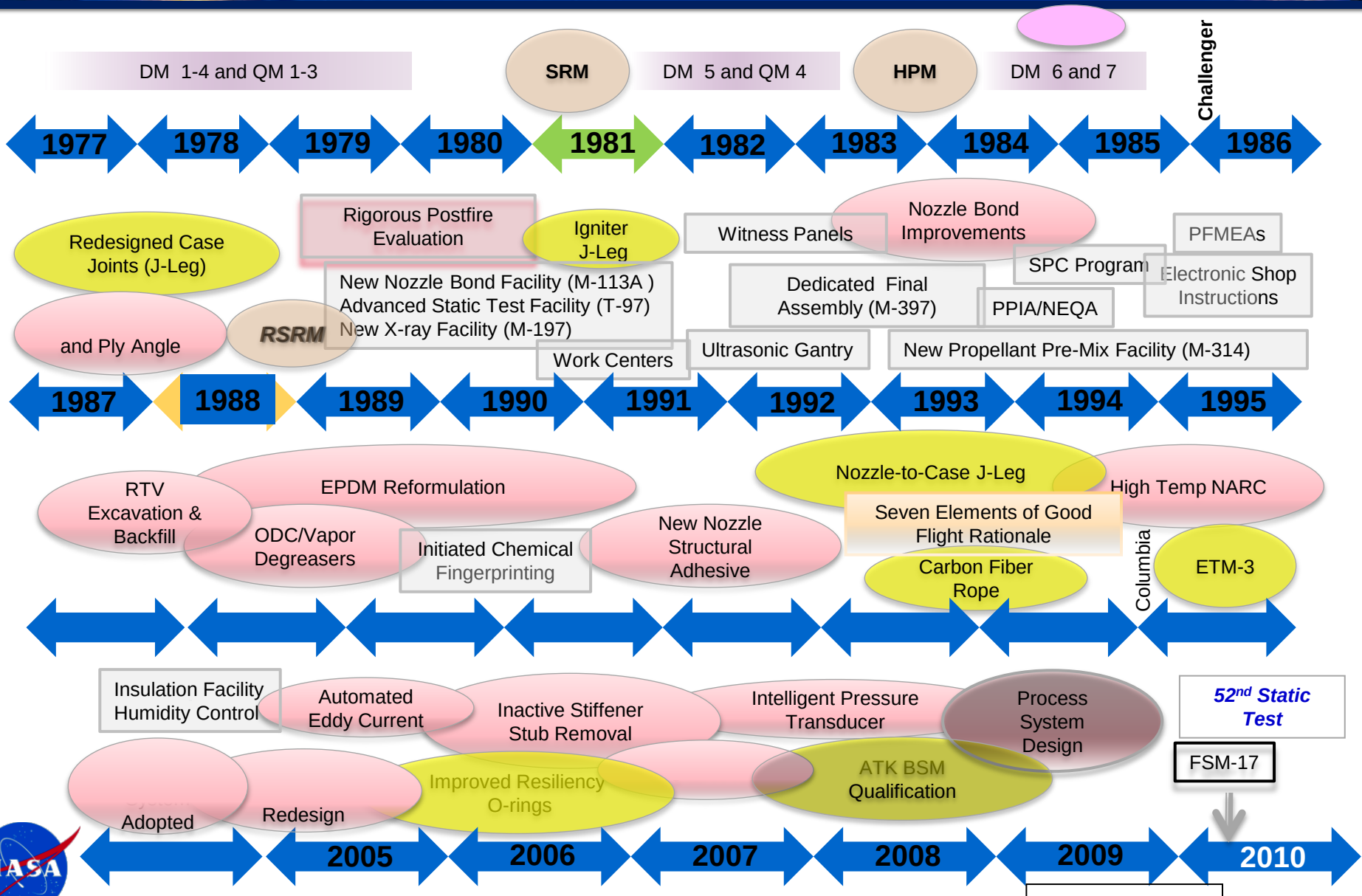
Booster/Motor



Supplied by ATK

Supplied by USA-Booster Element

SRM/RSRM Evolution



Static Test: Key to Our Success

- The RSRM is the highly reliable rocket motor it is today due to constant vigilance and focus on the necessary elements of RSRM flight safety
  - … these elements are key to the successful culmination of the Space Shuttle Program

RSRM Test Program

Subscale Solid Rocket Test Motor (SRTM)

5 Inch Propellant Center Perforated Subscale Testing

Subscale MNASA Motor

Flight Support Motor

Insulation Witness Panel Subscale Testing

Igniter Testing

Propellant Dog Bone Testing

RSRM Postflight

Launch

Retrieval

Open Assessment

BSM Assessment

RSRM

Postflight Assessment

Nozzle Assessment

Insulation & Case

Igniter Assessment

Field Joint Evaluation

Nozzle Internal Joints

Return to Utah

RSRM Postflight → RSRM Reliability

RSRM Postflight

- Postflight Team
  - ATK DEs, MEs & QEs (responsible for hardware)
  - MSFC Project/Engineering/S&MA
- Postflight Task
  - Thoroughly evaluate and document hardware condition
  - Identify, assess, and document reportable conditions and items of interest

Disciplined approach to evaluating hardware, dispositioning findings, and identifying IFAs
Postflight has led to significant Design Improvements
Approach is unique in SRM Industry

7- Elements Of Good Flight Rationale

- Solid technical understanding
  - Physics based or root cause understanding of issue, based on engineering data (perhaps using a fault tree)
- Condition relative to experience base
  - Experience base includes full-scale flight, ground test, or qualification level tests
- Bounding case established
  - Using physics based understanding, determine the bounding case (e.g., lower A-basis allowables, upper three sigma loads and environments, anchored with test data)
- Self limiting aspects
  - Physical reasons why it can't get any worse than the bounding case or show the part is fail-safe
- Margins understood
  - Adequate margins, ideally not substantially reduced from baseline
- Assessment based on data, testing and analysis
  - Final risk assessment based on test data and analysis, not gut feel or expert opinion
- Interactions with other elements/conditions addressed
  - Address interactions with other conditions (MRB, changes, technical issues), and vehicle elements

Implemented 2001

Some Thoughts On Minority Opinions

- Seek out minority opinions
  - Silence doesn't always mean agreement – a lot of thinkers support us
  - Don't allow any fence sitters
- Have a team of folks listen carefully – Hear Them Out
  - Pull in some help from expert(s)
  - Avoid arguing or making counterpoints until they've been heard out
  - Keep in mind they could be right
- Make a decision and tell them how you got there
- Be an advocate for the minority opinion
  - Encourage and offer to take it forward
  - Use the management chain
- Allow folks to change their minds
  - New data or new way of thinking

Summary

- RSRM is a highly reliable human-rated Solid Rocket Motor
  - Largest diameter SRM to achieve flight status
  - Only human-rated SRM
- RSRM reliability achieved by:
  - Applying special attention to Process Control, Testing, and Postflight
  - Communicating often
  - Identifying and addressing issues in a disciplined approach
  - Identifying and fully dispositioning “out-of-family” conditions
  - Addressing minority opinions
  - Learning our lessons

We are NASA/Contractor team working together with common goals