OSIRIS-REx

ASTEROID SAMPLE RETURN MISSION

Security–Regolith Explorer Spectral Interpretation, Resource Identification, and Security–Regolith Explorer

https://www.nasa.gov/?search=OSIRIS-REx

UNIVERSITY OF ARIZONA NASA'S GODDARD SPACE FLIGHT CENTER LOCKHEED MARTIN

SMA
SAFETY & MISSION ASSURANCE

OSIRIS-REx Lessons Learned and Relearned

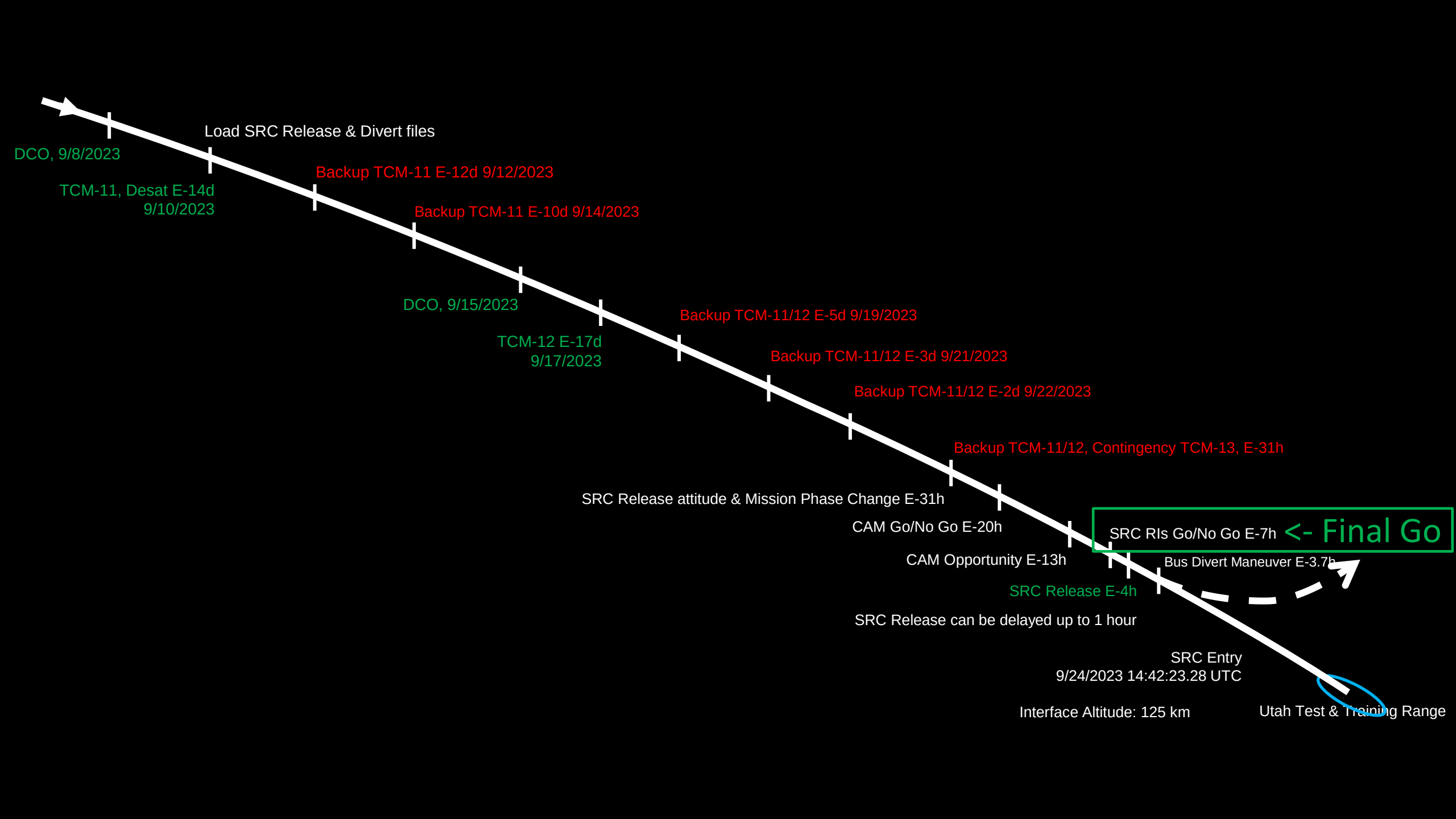
Ronald Perison
NASA/GSFC
ronald.e.perison@nasa.gov

SMA
SAFETY & MISSION ASSURANCE

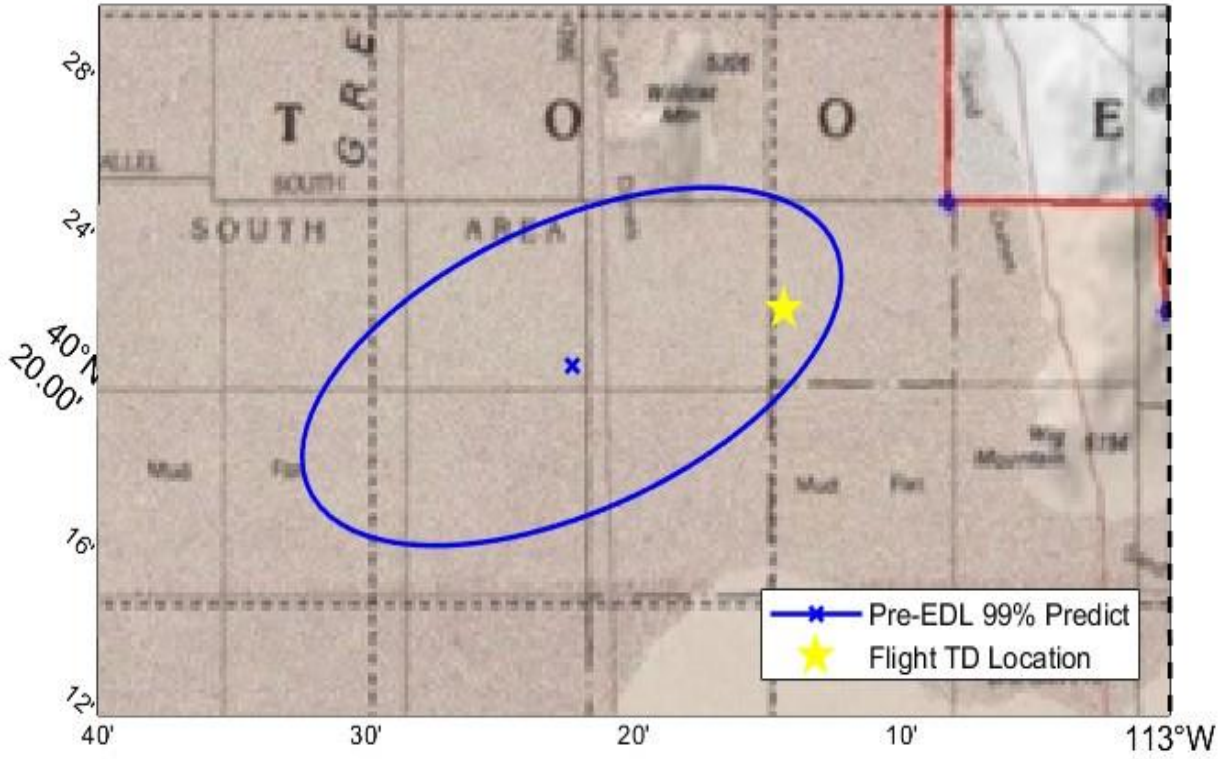
Overview

- This presentation focuses on the off-nominal parachute deployment of the OSIRIS-REx Sample Return Capsule (SRC) during earth entry on the final phase of flight
- The parachutes deployed later than planned although the actual landing and recovery were nominal
- The investigation by the joint NASA/Industry team discovered several Lessons Learned in the process of the Sample Return Capsule development effort, which largely treated this item through a Heritage “lens” since it was based on a previous NASA mission
- The evaluation of the returned flight hardware verified a miswiring of the harness sending signals from the electronics box to the parachutes which is consistent with video and timeline observed during decent and landing of the Sample Return Capsule

SMA
SAFETY & MISSION ASSURANCE


DCO, 9/8/2023
Load SRC Release & Divert files
TCM-11, Desat E-14d
9/10/2023
Backup TCM-11 E-12d 9/12/2023
Backup TCM-11 E-10d 9/14/2023
DCO, 9/15/2023
TCM-12 E-17d
9/17/2023
Backup TCM-11/12 E-5d 9/19/2023
Backup TCM-11/12 E-3d 9/21/2023
Backup TCM-11/12 E-2d 9/22/2023
Backup TCM-11/12, Contingency TCM-13, E-31h
SRC Release attitude & Mission Phase Change E-31h
CAM Go/No Go E-20h
SRC RIs Go/No Go E-7h <- Final Go
CAM Opportunity E-13h
Bus Divert Maneuver E-3.7h
SRC Release E-4h
SRC Release can be delayed up to 1 hour
SRC Entry
9/24/2023 14:42:23.28 UTC
Interface Altitude: 125 km
Utah Test & Training Range

Overview (continued)



SMA
SAFETY & MISSION ASSURANCE

SMA
SAFETY & MISSION ASSURANCE

Heritage vs New Design

- Spacecraft components, particularly the Sample Return Capsule, were reviewed and evaluated for heritage based on orbital environment and application
- The implementation of build, inspection, and test was not always consistent for heritage vs new design items by the joint NASA/Industry team

SMA
SAFETY & MISSION ASSURANCE

Heritage Reviews

- The team did not consistently apply the design review rigor otherwise used on new and highly modified designs
- Drawing configuration review on “build to print” components was inconsistent from a process standpoint

SMA
SAFETY & MISSION ASSURANCE

Lessons Learned – The Good

- The overall Mission Design utilized appropriate redundancy and resiliency in the spacecraft and instruments to successfully execute the mission
  - The main parachute had enough strength to withstand higher than expected loads during the late deployment during reentry
  - The sample collected from asteroid Bennu far exceeded the mass needed to achieve mission success
- The mission Team had excellent and timely communications between NASA, Industry, and Academia partners
- Proactive Risk Management practices helped resolve technical, safety and programmatic risks before they became big issues
- The earth reentry of the Sample Return Capsule executed flawlessly
- The spacecraft consumable resources (power, fuel) were conserved and enabled OSIRIS-REx to continue an extended mission called APEX

SMA
SAFETY & MISSION ASSURANCE

Lessons Learned (Relearned)

- The team did not apply sufficient rigor in some of the heritage elements
  - In some of the instructions and drawings, ambiguous language or/and drawing nomenclature introduced some uncertainty in intent or sequence of steps including interfaces and labeling on drawings
- Not rigorously adhering to “test as you fly” allowed an escape that may have flagged the parachute issue prior to flight

SMA
SAFETY & MISSION ASSURANCE

Lessons Learned (Relearned)

- The drawings were based on a 15-year-old design and some of the human expertise from that timeframe have retired
- Shortcomings in some configuration control of drawings have been identified. Thus, QA inspection of product to drawings that were not correct did not find the shortcomings

SMA
SAFETY & MISSION ASSURANCE

Conclusions

- Employing targeted, well thought out redundancy and resiliency in the mission design of the spacecraft, science instruments, and mission operations is a key factor in mission success
  - For example, the parachutes were single string, but the extra margin in them allowed them to handle the unexpected high loads from the late deployment
- Iterative Risk Management practices involving Management, Engineering and Safety and Mission Assurance needs to be proactive
- Rigorous review of heritage drawings and instructions are always needed to ensure proper configuration control is maintained
  - Drawing revisions and change notices always need to be verified
- “Test as you Fly” needs to be followed
- Sufficient budget and schedule, including reserves, for the mission allowed it to execute largely as planned with appropriate staffing

SMA
SAFETY & MISSION ASSURANCE