Space Launch System Thermal Control Presentation

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José Román,
NASA/Marshall Space Flight Center

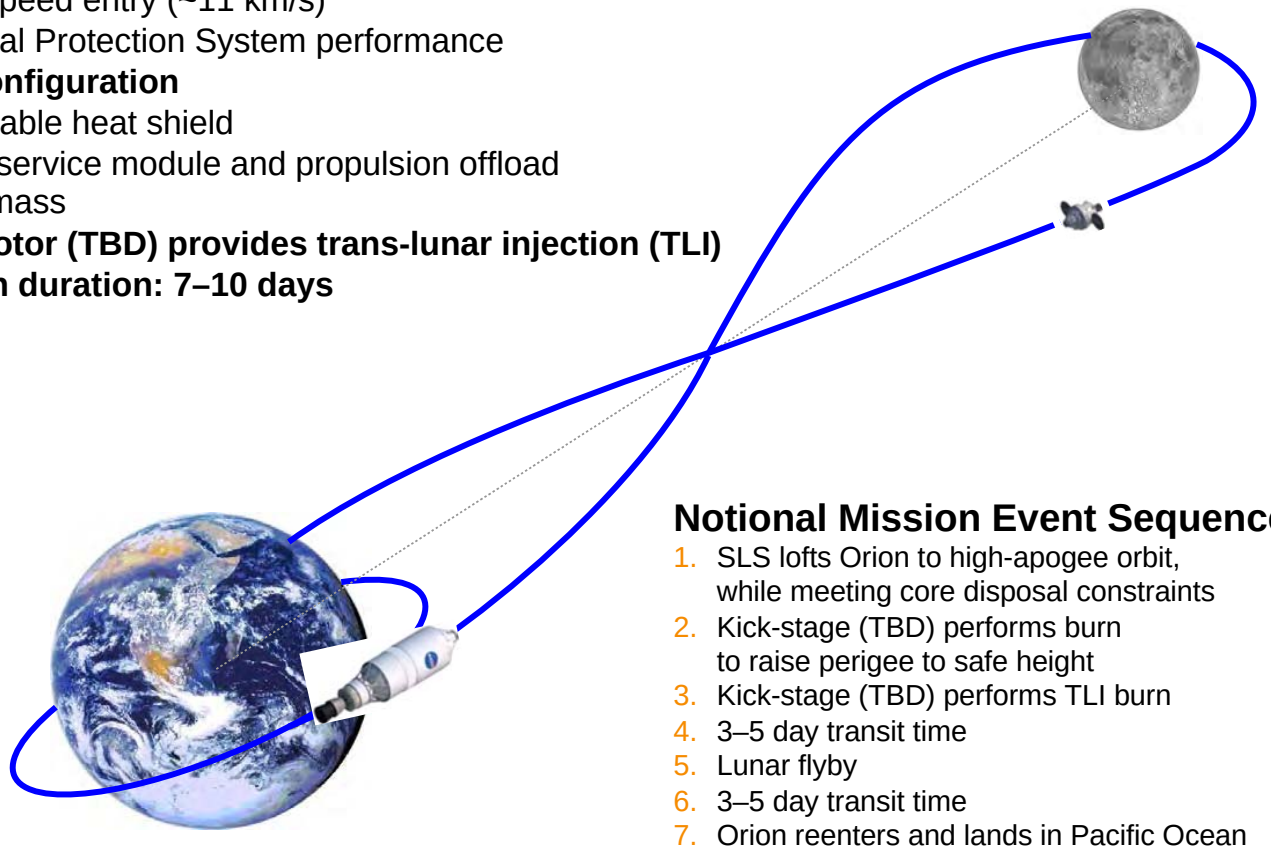
SLS Driving Objectives

- **Safe: Human-Rated**
- **Affordable**
  - Constrained budget environment
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Competitive opportunities for affordability on-ramps
- **Initial capability: 70 metric tons (t), 2017–2021**
  - Serves as primary transportation for Orion and exploration missions
  - Provides back-up capability for crew/cargo to ISS
- **Evolved capability: 130 t, post–2021**
  - Offers large volume for science missions and payloads
  - Modular and flexible, right-sized for mission requirements

SLS First Flight in 2017

Notional Mission for Orion First Flight in 2017: Uncrewed Beyond-Earth Orbit (BEO) Demonstration

- **Top-Level Objectives**
  - Demonstrate spacecraft systems performance to verify for safe crewed flight
    - High-speed entry (~11 km/s)
    - Thermal Protection System performance
- **Orion BEO configuration**
  - Lunar-capable heat shield
  - Two-tank service module and propulsion offload for lower mass
- **Kick-stage motor (TBD) provides trans-lunar injection (TLI)**
- **Orion mission duration: 7–10 days**

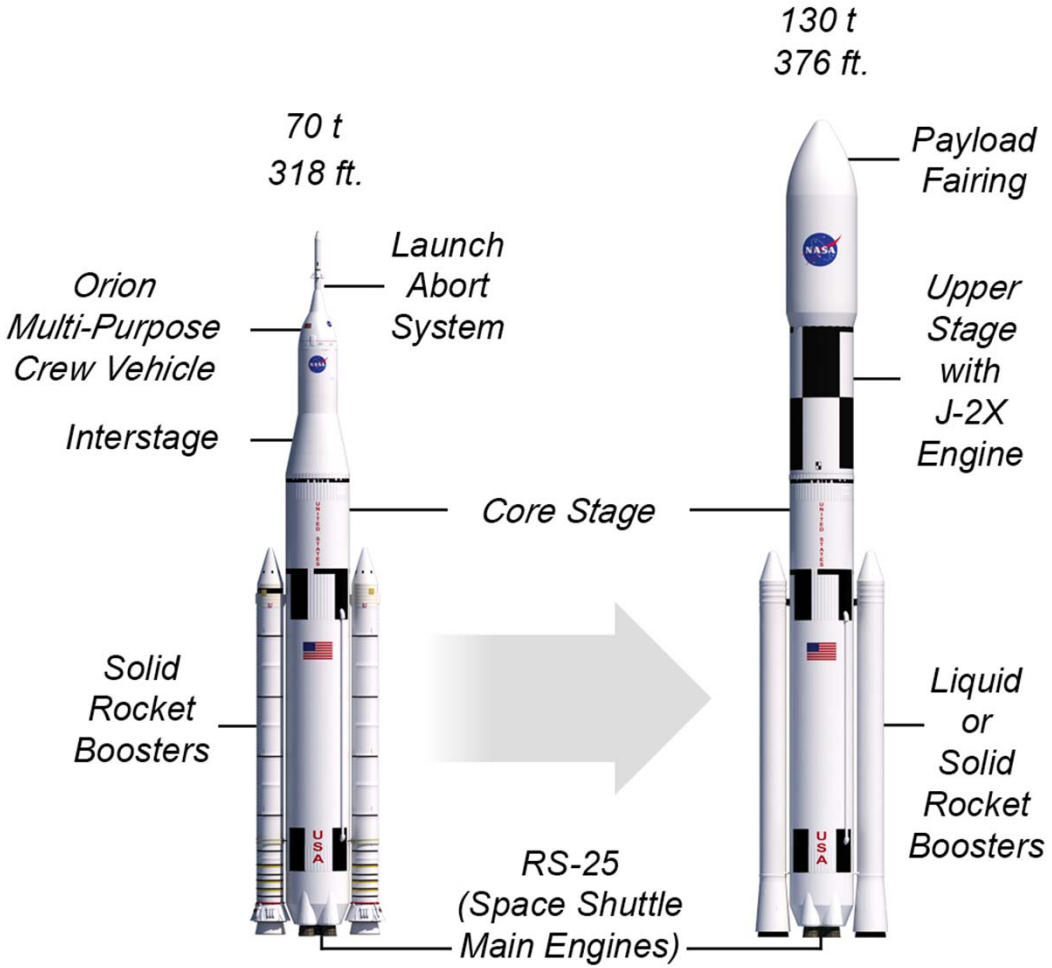


Notional Mission Event Sequence

1. SLS lofts Orion to high-apogee orbit, while meeting core disposal constraints
2. Kick-stage (TBD) performs burn to raise perigee to safe height
3. Kick-stage (TBD) performs TLI burn
4. 3–5 day transit time
5. Lunar flyby
6. 3–5 day transit time
7. Orion reenters and lands in Pacific Ocean

SLS FACT sheet

- **Two Configurations**
  - Initial Lift Capability 70 metric tons (t)
  - Evolved Lift Capability 130 t
- **Utilized existing liquid engines**
- **Booster based on STS SRB and Ares First Stage**
- **Initial Flight 2017**
- **Crew and Cargo configurations**
- **More info at *www.nasa.gov/sls***



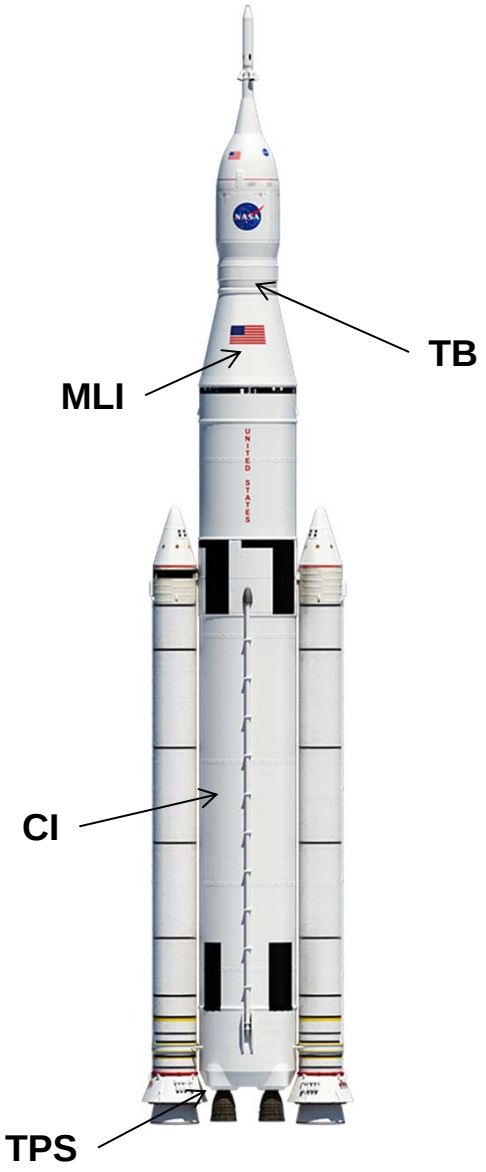
SLS Thermal Control

Passive Systems

- Thermal Protection Systems (TPS)
  - Base heating and aero heating protection
- Cryogenic Insulation (CI)
  - Reduce Cryogenic tanks boil off
- Multi Layer Insulations (MLI)
  - In orbit thermal control
- Thermal Barrier (TB)
  - Separate compartment thermal environments

Active Systems

- Purge gas convection
  - During ground phases only
  - Thermal control of components
  - Control compartments thermal environment



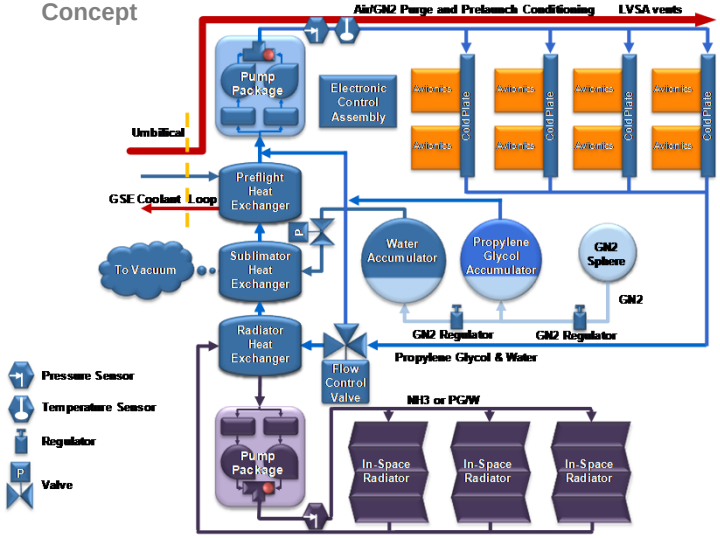
Special studies:
Cryogenic Propulsion Stage

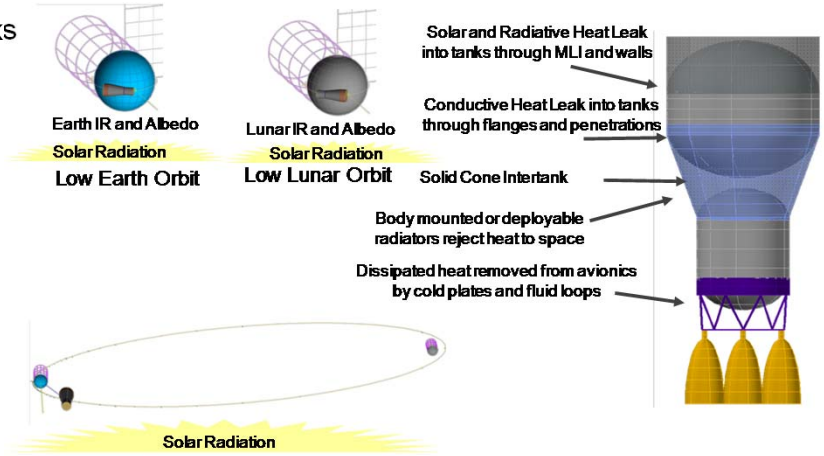
- **Deliverables:**
  - Vehicle System Level Thermal Analysis and Design
  - Avionics Thermal Control Subsystem (TCS)
  - RCS & Helium Tanks Thermal Conditioning Subsystem
  - Inputs to Cryogenic Fluid Management (Orbital Environments)

- **Functional:**
  - Provide thermal conditioning for avionics components
    Active TCS is required for long, in-space duration.
  - Maintain RCS propellant & MPS pressurant
    within acceptable temperature range.
  - Minimize heat leak into propellant tanks.

- **Possible Trades:**
  - Ascent aero-shield for MLI
  - Active vs. advanced passive for avionics thermal control
  - Vehicle attitudes for favorable orbital environments
  - Material and Design trades to reduce conduction to propellant tanks

Active Avionics Thermal Control Subsystem (TCS) Concept





Ground, Ascent and Earth-Moon L2 mission phases not shown

Advance Concepts
Improve Components Thermal Control

- **Heat exchanger capability for cooling.**
  - **Heat exchangers could possibly be placed “inline” with purge system for use as heat pipe condensers.**
  - **Use of heat pipes to improve avionics components heat extraction**