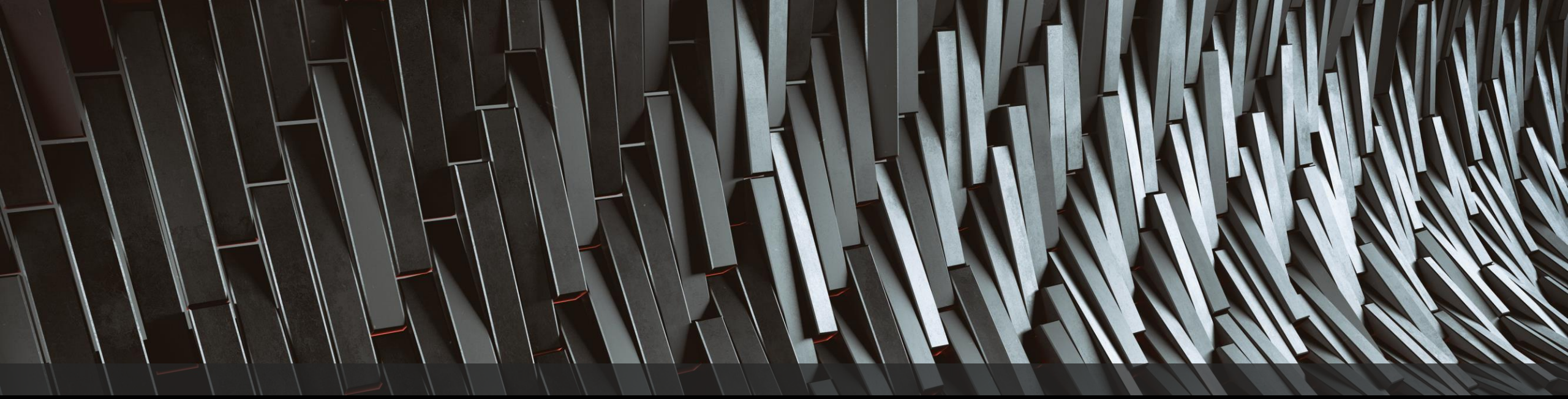
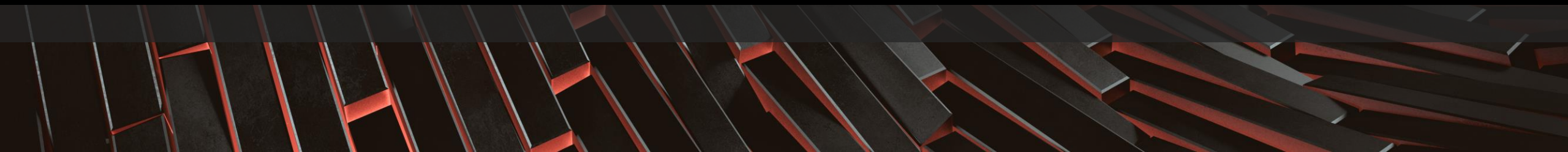


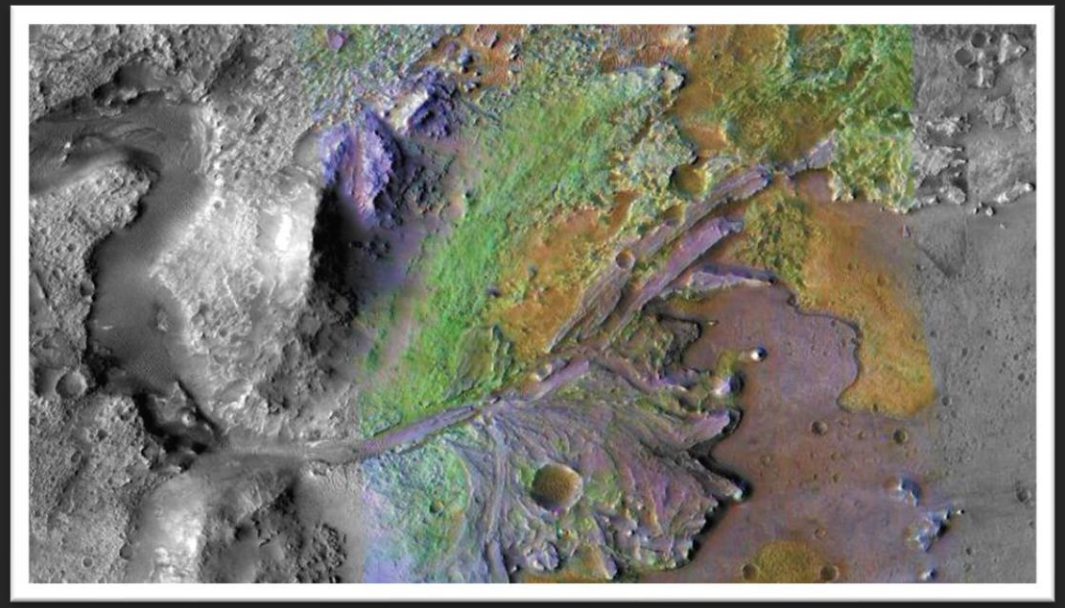
NASA's Approach to Qualifying Missions

Rachel J. McCauley



Overview

- Background
- Qualification Overview
- Approach to Qualification
- Real-world Examples
- Developing a Roadmap
- Nuclear applications
- Conclusions/Questions



Jezero Crater, Landing Site for the Mars Perseverance Rover

My Background

1. Undergrad is in Chemical Engineering with capstone in nuclear material processing. Started working at Y-12 for 3 years.

2. Asked to join a team to lead in systems engineering on new startup with Bechtel Corporation to build the next modern silo systems for GMD program. Started my masters in Aerospace Engineering.

3. Started working at NASA on new replacement to Shuttle, the Orion capsule and finished my masters in controllable solid propulsion aerospace systems.

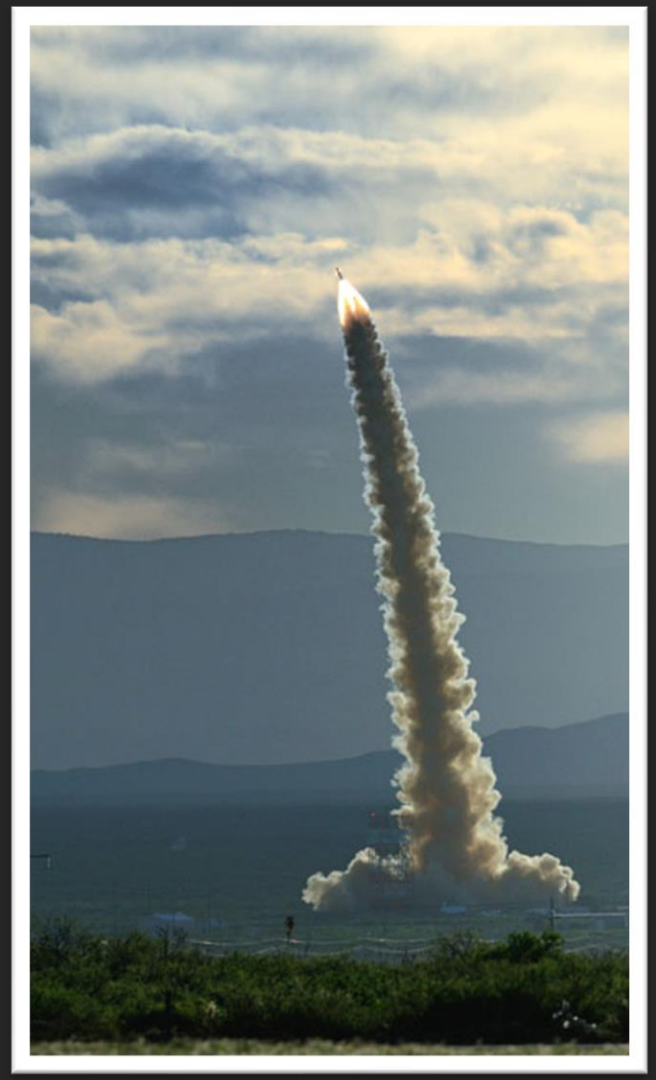
I have led systems through qualification on 4 NASA propulsion systems, 2 MDA sites, 4 system qualifications at Y-12.



1. Y-12 National Security Complex in Oak Ridge



2. Ground-based Missile Defense, Vandenberg Launch Complex



3. Orion Launch Abort System

Capabilities Integration

CAPABILITY | The ability to meet an exploration objective through Architecture, Engineering, Development, Technology, Operations or Research for a given set of constraints and level of risk.

Current Capabilities

Capabilities we have today, supporting or available for human or robotic missions….

THE DIFFERENCE IS THE **GAP**

Future Needed Capabilities

Anticipated future capabilities based on future mission architectures and agency strategic planning



GAP CLOSURE APPROACH

- Technology
- Development
- Engineering
- Scientific Research (Knowledge)
- Architecture Changes
- Operational Concepts
- Policy Decisions

TEST / Demo LOCATION

- Mars
- Lunar
- Gateway/Cislunar
- ISS/LEO
- Ground Activity

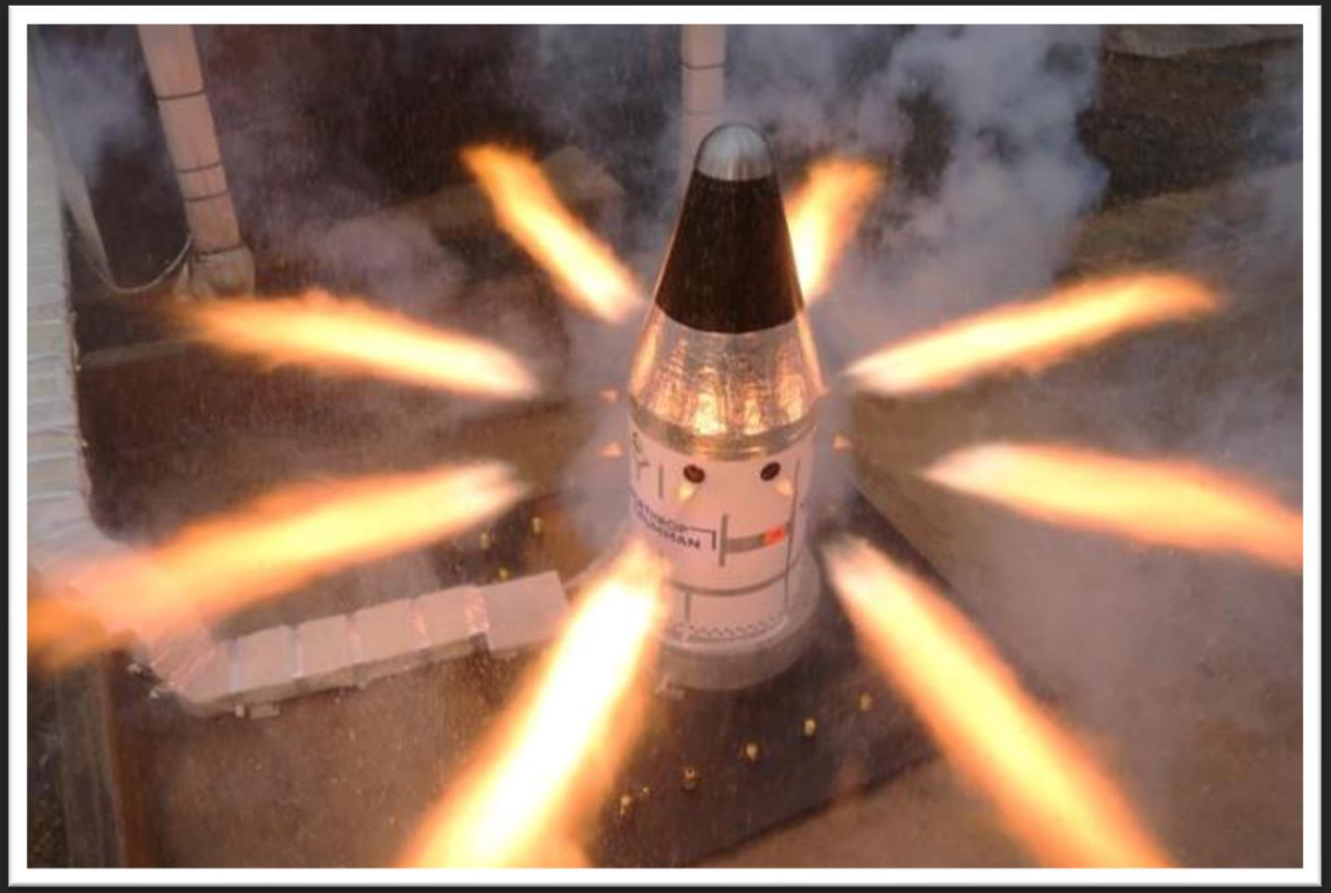
GAP CLOSURE MILESTONE

- In-Space Demo
- Ground Simulation
- Modeling and Analysis

OUTCOMES

- TRL Advancement
- Technology Infusion
- Updated Procedures
- Crew Health Countermeasures
- Updated Standards
- Enable Architecture

Qualification Overview



Qualification Test of Attitude Control Motor
for the Orion Launch Abort System

Qualification Purpose and Process in a Nutshell

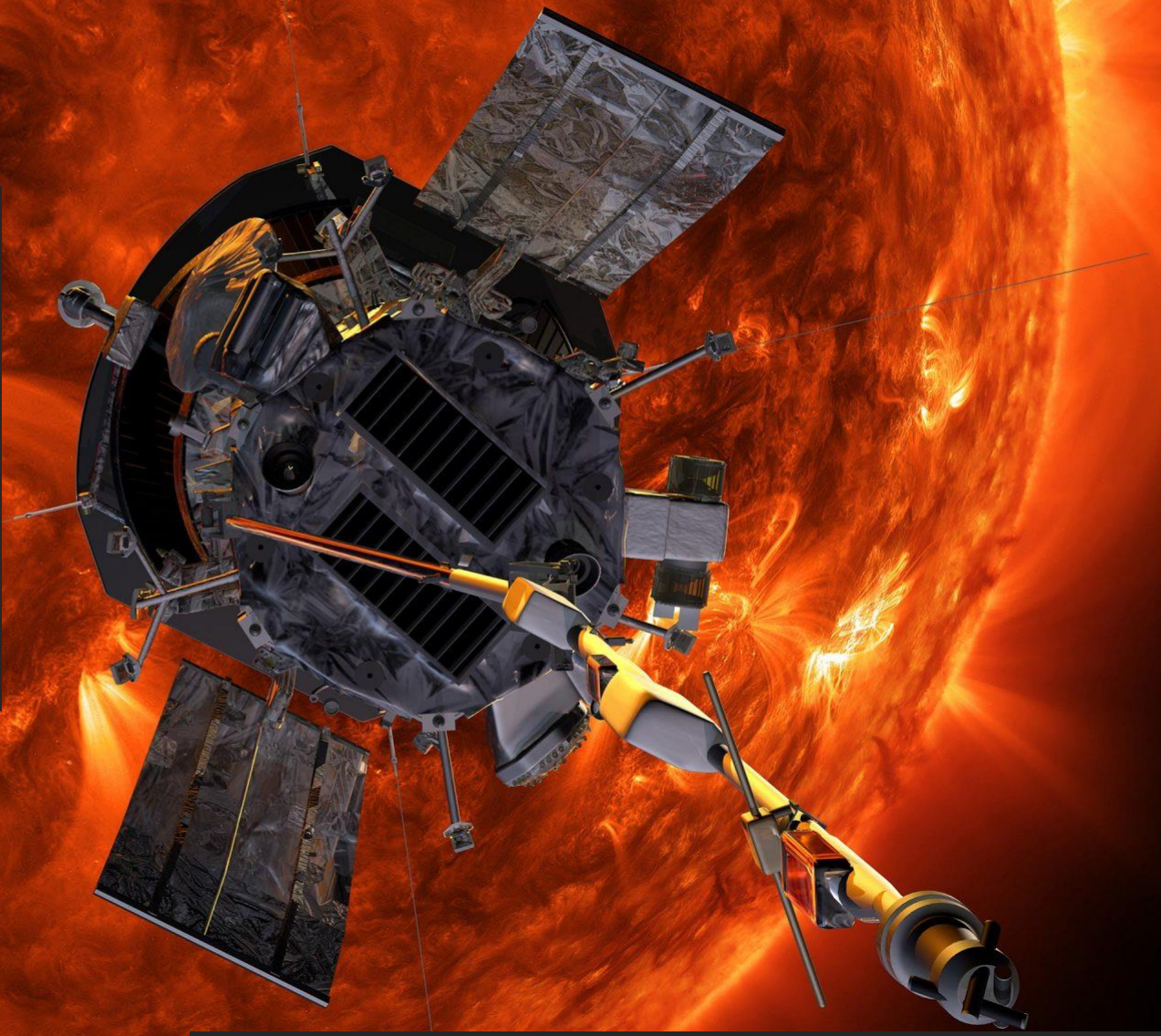
- Qualification is a process of activities that will ensure the flight unit design will meet functional and performance requirements in the anticipated environmental conditions
- Part of this is pushing the design to—and past—its limits to confirm the design will operate properly within expectations
- Qualification is performed only once regardless of how many flight units may be generated (if the design doesn't change).



Orion Abort Motor Qual Test 1

Tests to verify strength of the design

Approach to Qualification



Parker Solar Probe

Knowing the Process

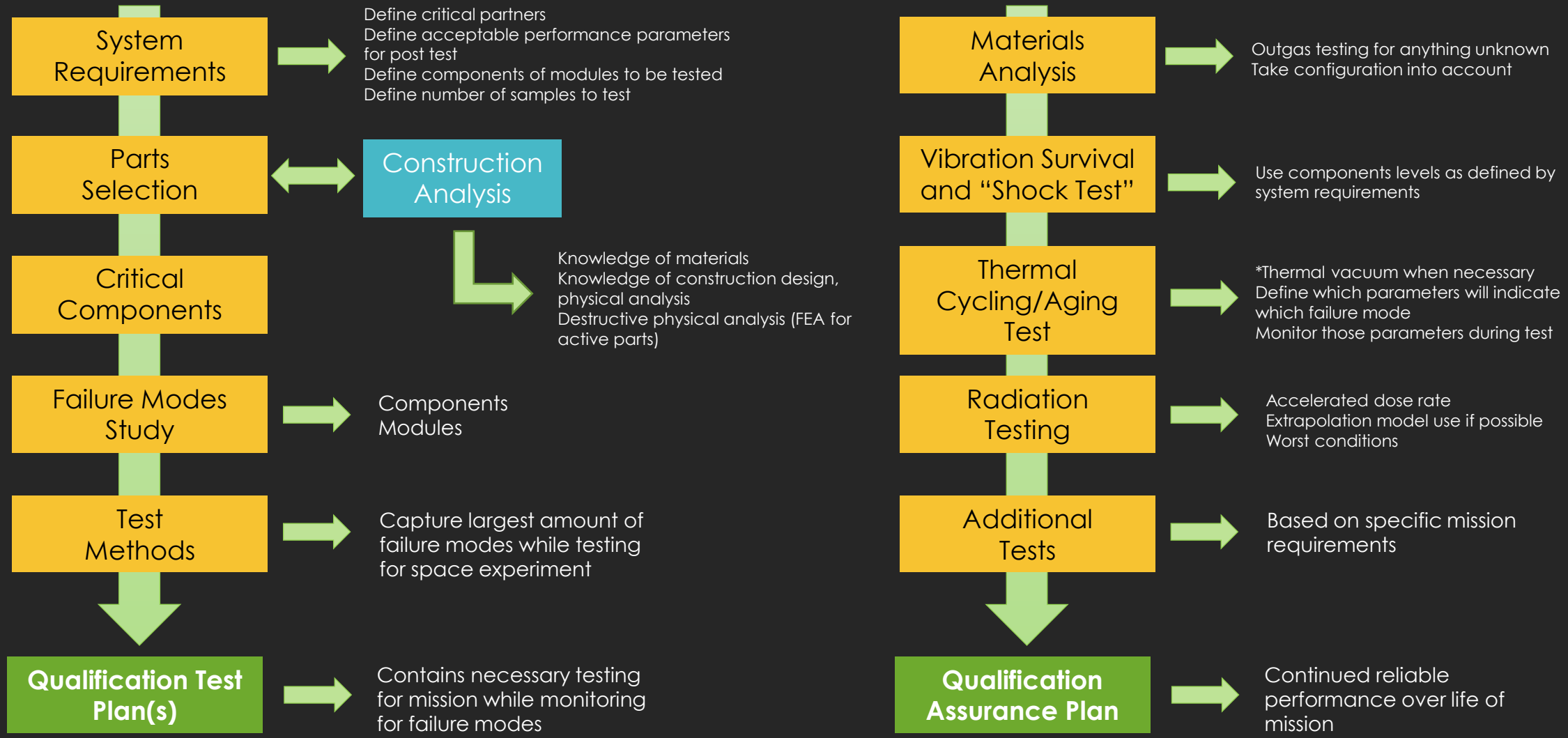
Department of Energy:

- **Quality Assurance Order, DOE O 414.1**
- **Environmental Management Quality Assurance Program, EM-QA-001**

NASA:

- **NASA Space Flight Program and Project Management Requirements, NPR7120**
- **NASA Systems Engineering Processes and Requirements, NPR7123**
  - Structural Design And Test Factors Of Safety For Spaceflight Hardware, NASA-STD-5001

Before beginning the qualification process, spend some time in prep work – know what your rules and processes are



Lessons Learned - Examples

- Process at Dept of Energy (Glovebox)
- Process at MDA (Silo)
- Process at NASA (Attitude control motor on Orion)

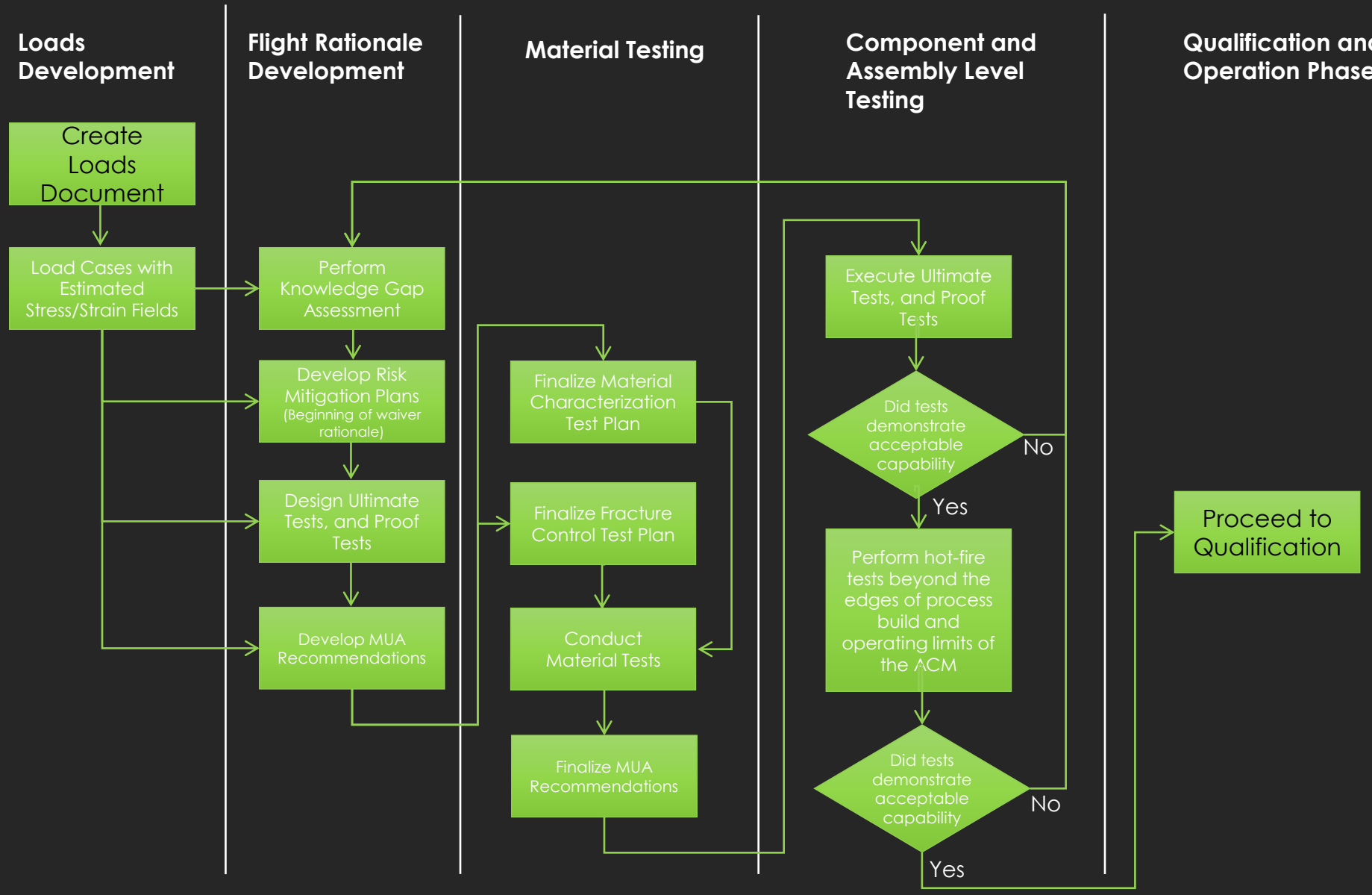


Y-12 National Security Complex in Oak Ridge

Take away:

- How YOU want to work through it
- Grow a community to bring through the process with YOU

Developing a Roadmap:



Nuclear Materials Applications

Lessons learned that apply to nuclear fuel qualifications?

1. Sub-scale tests and analysis may not be sufficient to evaluate material changes
2. In addition, fuel rods and integrated systems need to undergo service life evaluation
    1. Storage conditions may drive the frequency of testing and design requirements
3. Qualified fuel formulations may not behave as desired if subjected to modest modifications on new programs
    1. Perform an extensive material qualification to determine behavior rather than assume heritage remains valid for the modified formulation
        1. Changes in manufacturing can contribute differences
4. Never ignore low margin warnings in the development test phase as these are likely to pass into qualification design

Nuclear Materials Applications

Lessons learned that apply to inter-agency material partnerships?

a. Political – Understanding Driving Rules and Needs
b. Constant communication with stakeholders
c. Multi-agency – will need determination: you will be told “no” a lot, but no doesn’t always mean no
    i. Find out if it’s feasible, if it is, find your group to make it happen



Conclusions/Questions