

Reliability and Safety Analysis Report (RSAR)

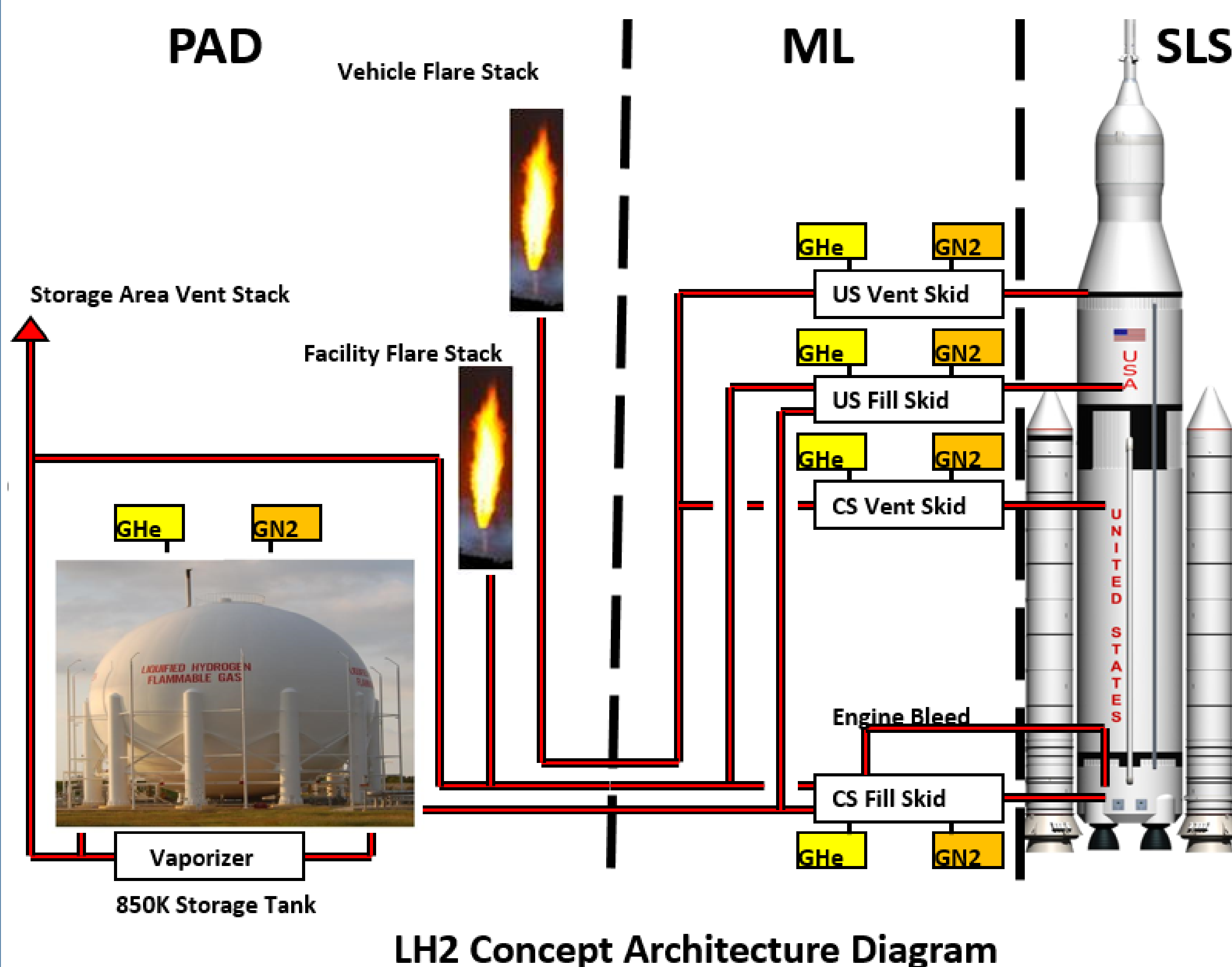
- Risk-based analysis process used for reviewing system design functions that could contribute hazards to personnel, flight hardware, facilities , and GSE.
- This analysis provides evidence of hazard mitigation at each design milestone during the development effort.
- The RSAR determines if the level of system hardware/software design complexity requires an additional, Failure Modes and Effects Analysis (FMEA).¹

RSAR for the LH2 Subsystem

The Space Launch System (SLS) has two liquid cryogenic stages, Core Stage (CS) and Upper Stage (UP). The CS and the US require Liquid Hydrogen (LH2) and Liquid Oxygen (LO2) to generate ascent thrust. Exploration Ground Systems (EGS) will provide an integrated LH2 Subsystem to service the SLS.²

RSAR Contents

1. Hazards/Risk to Safety of Personnel.
2. Hazards/ Risks to Safety of Flight Hardware, Facilities, GSE, and Environment.
3. Hazards/ Risks Associated with Safety System Functions.
4. Heritage equipment.
5. Critical Items.



- Over 70 Documents were utilized to find and mitigate possible hazard scenarios. Ex: LH2 Standards, Software, Purge, Valve Actuation, Power, Schematics and Heritage Components.

Hazard Analysis

- EGS is responsible for identifying all hazards associated with flight and ground system during ground processing.
- Hazards may manifest themselves in developments, manufacturing/ construction, testing, transporting, maintenance, and other ground processing and operation activities.
- The hazard analysis initiates from the formation and design concept phase and matures throughout the program life cycle, including verification of hazard controls being in-place prior to the commencement of ground operations.¹

Hazard Report for AA-2 Batteries

The Multipurpose Crew Vehicle (MPCV) program will conduct the Ascent Abort 2 (AA-2) flight test to demonstrate that Launch Abort System (LAS) can execute an ascent abort under high dynamic pressure conditions.

Hazard Report Contents

1. Hazardous Condition Description.
2. Acceptance Rationale.
3. Likelihood Justification.
4. Causes of Hazard.
5. Controls and verifications.



- Currently finding controls and verifications that will help mitigate the hazardous condition and causes.

Work Authorization Document (WAD)

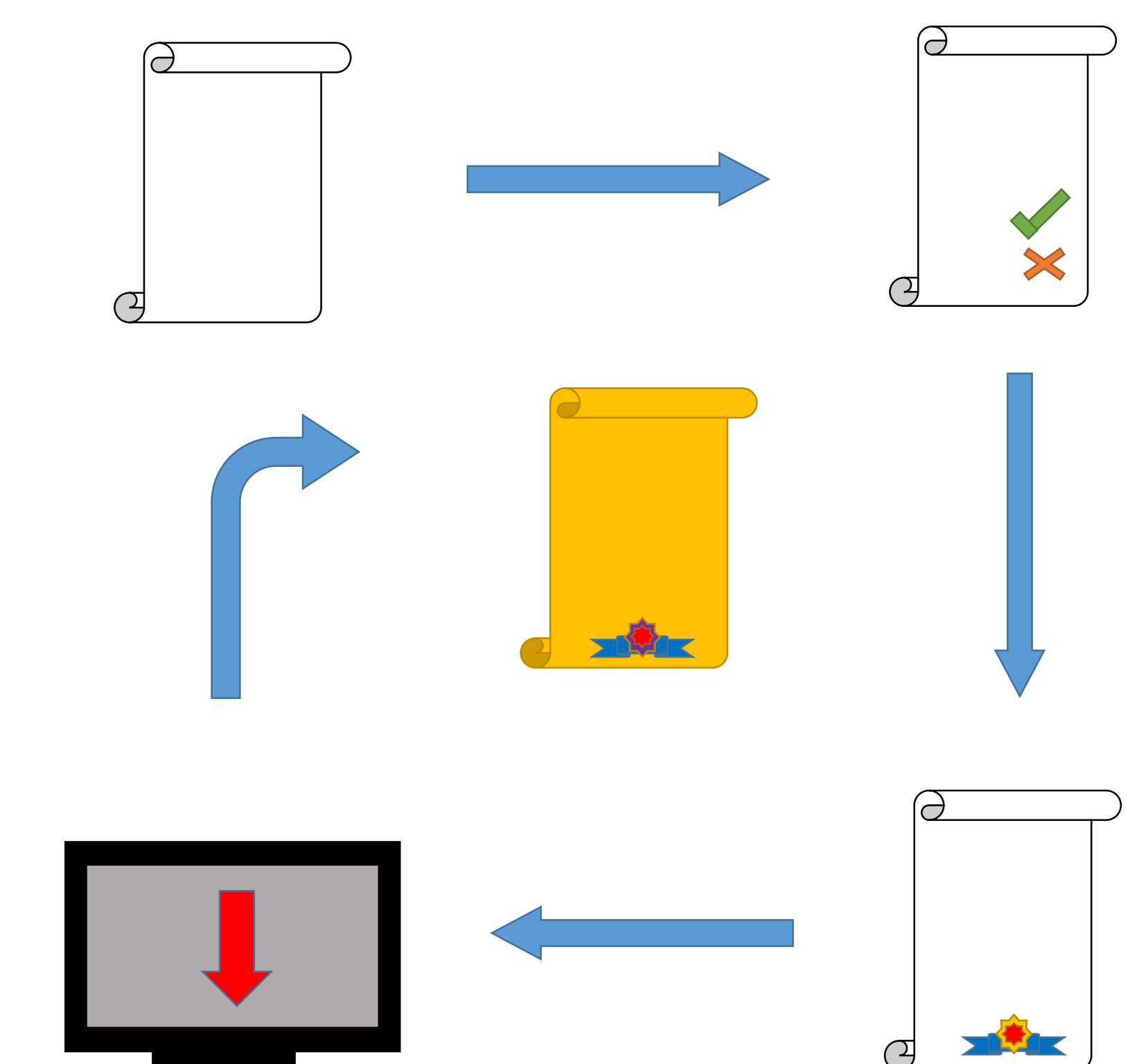
- Verifies technical compliance with Program requirements, drawings, and specifications.
- Makes the work instructions clear to ensure that the document's intent can be met.
- Provides traceability to the person(s) performing the work.
- Provides a complete and accurate history of the work performed.
- Is important that every WAD work step contains sufficient detail and appropriate verification buy-points for a list of authorized personnel traceability.

WAD Administration

The WAD Administration will help keep a constant communication between WAD authors and safety experts to ensure all possible hazards are listed and taken in consideration when personnel are performing the task.

WAD Review Process

1. Receive notification "document ready for review" from the contractor.
2. Assign documents to the appropriate safety staff.
3. Format/compile safety staff comments.
4. Send feedback to contractor.
5. Comment discussion/ closure meeting is performed.
6. Create database entries to record safety revisions for Certification of Flight Readiness (CoFR).



- **References:**¹Ingratta, James. *GSDO Program Safety and Mission Assurance Plan*. NASA Kennedy Space Center, June 1, 2018.² Lobbmeyer, D. *Concept of Operations SLS LH2 System*. NASA Kennedy Space Center, July 15, 2016.