DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 30

Mission Data Load
Validation Campaign Timeline & Requirement Overview

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Scope

This handbook provides Range Users with a clear guide to the Mission Data Load Validation process from the Safety Assessment Flight Termination System Engineering perspective. It serves to align SLD 30 engineers, support contractors, and Range Users by consolidating the Mission Data Load Validation timeline, subtest-specific tailoring language, and SLD 30 interpretations of key definitions into a single framework. It is important to note that while other deliverable reviewers (Safety Assessment Flight Analysis/Safety Assessment Risk Analysis) assess the same documentation, they may look for additional information not explicitly stated in this guide. If requiring a technical background on Mission Data Loads, please read *SEAE-FTS-002 Autonomous Flight Termination System Certification Roadmap* on the Flight Termination System Portal website.

Disclaimer: The safety requirements quoted in this document are sourced from the RCC 319-25 untailored edition; it is not program specific. This document is reference only and should serve as a notional guide to facilitate users' understanding of a Mission Data Load Validation Campaign.

Mission Data Load Validation Timeline

This page outlines a phased timeline for Mission Data Load validation, from initial criteria development through pre-launch testing. Governing safety requirements are indicated for each phase. Also outlined are which Range Safety departments the Range User will engage with in each phase.

Phase 1: Establish Termination Criteria

Mission Data Load's termination decision criteria is agreed upon between the Range User, Safety Assessment Flight Termination Engineering (SEAE), and Flight Analysis within Launch Safety (SELF).

Requirements:

- RCC 319-25 Section 3.29.7 (termination criteria)
- SSCMAN 91-710 Volume 2 for the Flight Data Package (provides vehicle performance)

Phase 2: Iterate and Approve Mission Data Load Software

The Mission Data Load is iterated between the Range User, Safety Assessment Flight Termination Engineering (SEAE), and Flight Analysis within Launch Safety (SELF) until Mission Data Load is finalized.

Requirements:

- RCC 319-25 Section 5.3.5.1 Box #3

Phase 3: Negotiate and Approve Test Procedures

Software in the Loop, Hardware in the Loop, and End to End tests are negotiated and approved between the Range User and Safety. The resulting procedures are admitted to Safety Assessment Flight Termination System Engineering/Safety Assessment Flight Analysis for appraisal.

Requirements:

- RCC 319-25 Section 5.3.5.1

Phase 4: Certify GSE and Test Equipment

The Ground Support Equipment, test equipment, and test procedures used during Hardware in the Loop, Software in the Loop, and End to End testing must be approved by the Range prior to implementation and use. Layout and designs are under configuration control and post Range approval. Deliverables for approval should include engineering drawings for Ground Support Equipment for repeatability.

Requirements:

- RCC 319-25 Section 6.1 ; 6.1.1 ; 6.1.3 ; 6.1.2 (d)(3)

Phase 5: Conduct Software in the Loop and Hardware in the Loop Validation

The approved MDL undergoes Software in the Loop and Hardware in the Loop validation.

Requirements:

- RCC 319-25 Section 5.3.5.1 Box #2 (SWIL)
- RCC 319-25 Section 5.3.5.1 Box #1 (HWIL)

Phase 6: Execute Final E2E System Verification

All flight units are installed in the rocket. Within 3 days prior to launch, the End to End test is run to ensure flight hardware and software respond correctly to the abbreviated number of test cases (a mix of nominal trajectories and scenarios).

Requirements:

- RCC 319-25 Section 5.3.5.2 (AFTS End to End Testing)

Software in the Loop Requirement Interpretation

1. Background and Purpose

Software-in-the-Loop testing occurs when the flight software is run through a desktop simulation. The primary purpose of this test is to build confidence that the Mission Data Load is accurate and reliable before it is inserted into the Automated Flight Termination Unit.

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2. Official Requirement (Untailored)

Source: RCC 319-25 Section 5.3.5.1 Box #2

“1. A Monte-Carlo or other statistical analysis shall be performed to ensure variations in tracking and vehicle performance do not result in failure to initiate a termination action or an inadvertent termination output.”

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3. Key Component Definitions

Not applicable.

Hardware in the Loop Requirement Interpretation

1. Background and Purpose

Hardware-in-the-loop tests consists of the flight software running on flight-like hardware. The purpose of this testing is twofold:

- To verify that the hardware design will react correctly to software commands.
- To check that an Automated Flight Termination System will utilize its mission rules correctly across a series of nominal trajectories and failure scenarios.

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2. Requirement (Untailored)

Source: RCC 319-25 Section 5.3.5.1 Box #1

"1. The MDL validation shall be conducted in a software-in-the-loop simulation and/or a hardware-in-the-loop test or end-to-end test. Cost and schedule risk can be reduced by conducting a software-in-the-loop simulation and/or a hardware-in-the-loop test prior to the end-to-end test. Flight-equivalent hardware can be used for hardware-in-the-loop tests. The final approved flight software shall be used for hardware-in-the-loop tests unless otherwise approved by Range Safety."

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3. Key Component Definitions

The following definitions apply to the execution of the Hardware in the Loop test:

- **Flight-Like Hardware:**
    - This is defined as an Engineering Development Unit (EDU) with the same design as a flight unit. Piece parts should be identical.
- **Flight Software:**
    - The final, approved flight software shall be used during the official HWIL test for record.
- **GSE & Test Equipment:**
    - A Critical Design Review (CDR) should be held prior to the MDL Validation campaign. Approval of the Ground Support Equipment (GSE) and all test equipment must occur prior to the campaign. The entire setup must be maintained under configuration control.

End to End Testing Requirement Interpretation

1. Background and Purpose

End to End testing is the final, comprehensive check of the entire Flight Termination System (FTS) after it is installed on the vehicle. Its purpose is to provide ultimate confidence that the fully integrated system will perform as expected during flight, validating the complete command chain from start to finish.

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2. Requirement (Untailored)

Based on RCC 319-25, the core requirements for the End to End test are:

- Scope: It must verify the entire FTS command path, from the command source to the final firing signal. This signal is captured by an oscilloscope, as the actual ordnance is not installed until after the End to End test. The pulse width and amplitude of the waveform is evaluated on the oscilloscope.
- Timing: It must be performed within three days of the flight.
- Power: The FTS must be powered by its internal flight batteries.
- Safety: The test uses ordnance simulators in place of live ordnance to safely confirm that the destruct signal and required energy are delivered.
- Re-Test: Any break in the system's integrity (e.g., disconnecting a connector) requires the affected part of the test to be performed again.

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3. Key Component Definitions

- Safe-and-Arm (S&A) Device: A critical safety switch that physically blocks the firing command until it is moved into the "arm" position.
- Ordnance Simulator: A non-explosive test device that electrically mimics the live ordnance, used to safely verify that the firing signal is correctly delivered.