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# Esrange FTS Range Approval Process

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*Change record*

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## ACRONYMS

| | |
|---|---|
| ADS | Automatic destruct system |
| AFTS | Automatic flight termination system |
| ATP | Acceptance test procedure |
| CDR | Critical design review |
| COTS | Commercial off-the-shelf |
| DoD | Department of Defense |
| DOT | Department of Transportation |
| ELS | Equivalent level of safety |
| ESA | European Space Agency |
| ESB | Esrange Safety Board |
| ESC | Esrange Space Center |
| ESM | Esrange Safety Manual |
| FTS | Flight termination system |
| FTSR | Flight termination system report |
| LID | Laser initiated detonator |
| LOT | Lot acceptance test |
| MPE | Maximum predicted environment |
| PDR | Preliminary design review |
| RCC | Range Commanders Council |
| RF | Radio frequency |
| RSO | Esrange Range Safety Office |
| SRR | System requirements review |
| TIM | Technical interchange meeting |
| UN | United Nations |

# 1 INTRODUCTION

All flight termination systems (FTS) used in Esrange Space Center shall go through the Esrange FTS range approval process. The purpose of the Esrange FTS range safety process is to ensure that the flight termination systems meet the requirements stated in RCC 319-14 standard for design, performance, testing, analysis, and documentation. The Esrange FTS range approval process follows the guidelines stated in RCC 319-14 with minor changes.

This document is a supplement to Esrange Safety Manual (ESM).

## 1.1 References

ESM. (2019). Esrange Safety Manual (Version 8.1, Issued 29th of May 2019). Document no. SCIENCE-60-4208.

RCC 319-14. (2014). Flight Termination Systems Commonality Standard. New Mexico: Secretariat, Range Commanders Council, US Army White Sands Missile Range.

# 2 FTS RANGE APPROVAL PROCESS

This section gives an overview of the Esrange FTS range approval process. A step-by-step process is presented in Table 1.

The FTS range approval process begins usually when a flight safety analysis done by Esrange Range Safety Office states that an FTS system is required in order to reduce the risk levels of a specific mission (step 1). Either the mission does not meet the risk criteria stated in the Esrange Safety Manual (ESM) or the vehicle is not considered inherently safe.

The process starts with the identification of program requirements (step 2). This is done together with the Esrange Range Safety Office and the Range User. Usually, an initial technical interchange meeting is required, where the project shall describe, in detail, the type of testing planned at Esrange, the vehicle configuration, and proposed FTS component and system level design.

After identifying the program requirements, the Esrange Range Safety Office will begin tailoring the RCC 319-14 requirements and the needed documentation (step 3). A tailored set of documents will be generated and denoted as RCC 319 [T-program name]. This document is a living document and will contain tailored performance requirements for the system, tailored test requirements, tailored analysis requirements, and tailored documentation requirements.

Next the Range User shall review the tailored RCC 319 document and develop any waiver requests if the system cannot fulfill the tailored requirements (step 4). The waiver request should be a written request with supporting data. The Esrange Safety Board will either approve or withhold the waiver requests. Any granted waivers will be updated to the tailored RCC document.

After this the Range User shall begin the design of the FTS to the tailored requirements (step 5). Design reviews (system requirements review, preliminary design review, critical design review) shall be held as the design process proceeds.

The Esrange Range Safety Office has the authority to review and approve all the designs. After the critical design review, the Range User may start to acquire or develop the FTS components.

All FTS components shall be tested, and each test shall follow a written procedure that specifies the test parameters, the pass/fail criteria, and the testing sequence (step 6). The Range User is responsible for the component-level testing. The Esrange Range Safety Office shall review and approve all test plans and procedures before testing. The Esrange Range Safety Office has also the right to witness any test done to the components. The Range User is responsible for informing the Esrange Range Safety Office 30 days prior to any scheduled testing, for the Esrange Range Safety Office to send a presentative to witness the test on site. The Range User shall provide a written report demonstrating compliance to all component performance and environmental requirements. With COTS products that comply the RCC requirements, no additional component-level testing is required, but the Range User shall provide the test documentation to the Esrange Range Safety Office when asked.

In addition to the component-level and subsystem/system-level testing, the Range User is responsible for conducting a series of system analyses (step 7). The analyses results will be compiled to a Flight Termination System Report (FTSR) and submitted to the Esrange Range Safety Office for review in order to get the final approval for the system. The FTSR shall be submitted to the Esrange Range Safety Office no later than four months prior to the first scheduled flight. Note! The FTSR is the medium through which the FTS approval is obtained from the range.

After receiving the FTSR, the Esrange Range Safety Office will review the documentation and give the final approval for the system (step 8). The final approval will be sent as a formal letter to the Range User.

After the component-level testing the FTS subsystems and system will be assembled and pre-flight tested (step 9). Usually, the components are shipped to Esrange before the subsystem/system assembly, and both the Range User and the Esrange Range Safety Office are responsible for conducting the tests. The testing will include pre-flight component tests, pre-launch subsystem and system level tests, and electromagnetic compatibility tests. The Range User is responsible for providing all test equipment needed for pre-flight testing that are not available at the Esrange Space Center.

After the launch (step 10), a post-flight mission analysis will be done together with the Esrange Range Safety Office and the Range User (step 11). The telemetry data will be validated and any failure or anomaly reported. In case of a mission failure, the Esrange Range Safety Office will conduct a failure investigation.

An approximate timeline of the FTS range approval process is presented in Table 2.

*Table 1. FTS Range Approval Process Steps.*

| Step | Action | Responsible |
|---|---|---|
| 1 | FTS is needed to reduce the mission risk<br>• Flight safety analysis done by RSO shows that the mission does not meet the risk criteria in ESM chapter 6.2, or<br>• The vehicle is not considered inherently safe | RSO |
| 2 | Identification of program requirements<br>• An initial technical interchange meeting is required, where the project shall describe, in detail, the type of testing planned at each range, the vehicle configuration(s), and proposed FTS component and system design | RSO/ Range user |
| 3 | Tailoring of RCC 319-14 and required documentation<br>• RCC 319 [T-program name]<br>• Tailored performance requirements<br>• Tailored test requirements<br>• Tailored analysis requirements<br>• Tailored documentation requirements | RSO |
| 4 | Review of tailored RCC 319 and development of possible waiver requests<br>• A written waiver request with supporting data<br>• All waivers are approved by Esrange Safety Board<br>• Update of tailored RCC with granted waivers (RSO) | Range user |
| 5 | Design of the FTS to the tailored requirements and design reviews<br>• System requirements review shall provide a program's system requirements<br>• Preliminary design review (PDR) shall provide detailed subsystem and component design. New components shall have an individual PDR.<br>• Critical design review shall provide the final subsystem and component design and test requirements. Design shall be placed under configuration control after CDR. New components shall have an individual CDR.<br>• RSO has the authority to review and approve all designs | Range user |
| 6 | Testing of FTS components | Range user |

| | | |
|---|---|---|
| | • All FTS components shall be tested<br>• Each test shall follow a written procedure that specifies the test parameters, pass/fail criteria, and a testing sequence<br>• RSO shall review and approve all test plans and procedures<br>• RSO has the right to witness any test<br>• Range user shall provide a written report demonstrating compliance to all component performance and environmental requirements | |
| 7 | Flight termination system analyses and submission of Flight Termination System Report (FTSR)<br>• The initial FTSR should be provided at least 45 days before the start of the PDR<br>• The updated FTSR should be submitted at least 45 days before the start of the CDR<br>• The final FTSR must be submitted to the RSO for review and approval no later than four months prior to the first scheduled flight | Range user |
| 8 | Review of FTSR and final approval<br>• Final approval of the FTS system is done by Esrange Safety Board and transmitted by a formal letter to the Range user | RSO |
| 9 | Pre-flight testing of FTS subsystem/system at launch site<br>• Pre-flight component tests (certification tests)<br>• Pre-launch subsystem and system level tests<br>• Electromagnetic compatibility tests<br>• Range user shall provide all test equipment needed for pre-flight component testing that are not available at ESC | RSO/Range user |
| 10 | Launch campaign | RSO/Range user |
| 11 | Post-flight mission analysis<br>• Post-flight telemetry validation<br>• In-flight failures and anomalies reported<br>• In case of a mission failure, RSO will conduct a failure investigation | Range user/RSO |

*Table 2. FTS range approval process timeline.*

| Time | Event |
|---|---|
| T0 – 18 months | Technical interchange meeting<br>Tailoring of the RCC 319 requirements starts |
| T0 – 17 months | First version of the RCC 319 [T-program name] delivered to the customer<br>Review of the RCC 319 [T-program name] and creation of any waiver requests starts |
| T0 – 16 months | Design of the FTS starts |
| T0 – 13 months | System Requirements Review (SRR) |
| | First version of the FTSR delivered to RSO 45 days prior to PDR |
| T0 – 10 months | Preliminary Design Review (PDR) |
| | Updated version of FTSR delivered to RSO 45 days prior to CDR |
| T0 – 7 months | Critical Design Review (CDR)<br>Tailoring of the RCC 319 [T-program name] ends<br>Design of the FTS completed |
| T0 – 7 months | Component/subsystem/system level tests start |
| T0 – 4 months | Component/subsystem/system level tests completed<br>Final version of the FTSR delivered to the RSO |
| T0 – 1 month | FTS components shipped to Esrange |
| T0 – 1 month | Pre-flight component tests, pre-launch subsystem/system level tests, and range and vehicle compatibility tests start |
| T0 | Launch |
| T0 + 1 months | Post-flight mission analysis report delivered to the RSO |

# 3 TAILORING PROCESS

A tailored version of RCC 319-14 is developed by the RSO for a specific program with the participation of the Range User. To tailor the document, the following steps are taken:

(1) Requirements that do not have any relation to the affected system are deleted. Major paragraph numbers and titles of deleted requirements are retained followed by an annotation of Not Applicable, N/A, or other such notation.
(2) New requirements are developed or existing requirements are rewritten for any new technologies or unique applications.
(3) Any specific solution that will be used to satisfy any performance requirement will be documented in a text box.
(4) New designs or tests for specific components can only begin after applicable tailoring for that item has been completed.

The tailored version of the document shall be denoted as *RCC 319 [T-program name]* or other such designation as required by the range policy and place under configuration control. The tailored document is a living document and may change as the program matures.

# 4 WAIVER PROCESS

Waivers document noncompliance with one or more performance requirements that will result in a significant increase in risk to mission personnel or public safety. The equivalent level of safety (ELS) certifications document noncompliance with one or more performance requirement that's an insignificant increase in risk to mission personnel and public safety. Waivers and ELS certifications may have either limited or lifetime effectiveness.

a. Limited effectiveness. Time-limited waivers are set for a limited period of time or a limited number of flights/launches. The time constraint is normally determined as a function of cost, impact on schedule, and the minimum time needed to satisfactorily modify or replace the noncompliant item.
b. Lifetime effectiveness. Lifetime waivers are undesirable and shall be limited to those situations where it is practically impossible to meet the requirement. These waivers shall be reviewed for each flight/launch to ensure that rationale for their acceptance remains valid.

The range user shall submit adequate justification for waivers and ELS certifications from these requirements to the range All waivers and ELS certifications shall be approved by the ESB.

Supporting data for a waiver or ELS certifications request must include:

- A statement of the technical or other requirements that make the waiver or ELS certification necessary
- A discussion of the effect on FTS performance functions if the waiver or ELS certification is granted
- A discussion of the effect on the program if the waiver or ELS certification is not granted
- A detailed description of the proposed flight tests or operations
- A detailed description of rationale for acceptance and any mitigating factors
- A get-well plan to meet the requirements in question by the time the approved waiver/ ELS effectiveness expires.

The request for waiver -form is presented in Table 3.

*Table 3. Request for waiver scope and content.*

| ID | Data | Description |
|---|---|---|
| 1 | Organization | Name of the organization requesting the waiver |
| 2 | Number | Unique identification and register number |
| 3 | Issue | Issue status of the request for waiver |
| 4 | Date | Issue date for the request of waiver |
| 5 | Project | Project or campaign under which the waiver is supplied |
| 6 | Item designation | Identification of the nonconforming item per name and number, according to its configuration item data list |
| 7 | Affected item(s) | Identification of the item(s) (number and name) affected by the waiver |
| 8 | Effectivity | Model or serial number (or batch/lot number) of the nonconforming item(s) |
| 9 | Affected requirement | Identification of the RCC 319-14 requirement to which the item does not conform |
| 10 | Short description | Title or short description of the request for waiver (consistent with the title of the related nonconformance report) |
| 11 | Detailed description | Description of the nonconformity, supported by sketches and attachments as appropriate |
| 12 | Reason for request | Reason why the proposed nonconformity can be accepted (rationale) |
| 13 | Adverse effects | Item characteristics affected by the nonconformity |
| 14 | Limitation of use | Regarding the intended use |
| 15 | Classification | Major or minor as per the classification criteria |
| 16 | Approval | Decision, name, date and signature of Esrange Safety Board |

# 5 COMPONENT TEST PROCESS

A component shall satisfy each test or analysis required by an applicable table of RCC 319-14 to demonstrate that the component satisfies all its performance requirements when subjected to non-operating and operating environments. The Esrange Range Safety Office shall identify any additional test or analysis requirements in conjunction with the Range User for any new technology or any unique application of an existing technology.

Each test shall follow a written procedure that specifies the test parameters, including pass/fail criteria, and a testing sequence that satisfies the requirements of RCC 319-14.

For any component that is used for more than one flight, the test procedure shall provide for component reuse qualification, refurbishment, and acceptance.

The Esrange Range Safety Office shall review and approve all plans and procedures. The Range User shall not deviate from or change an approved procedure unless specifically approved by the RSO. This includes software for automated checkout, test equipment, pass/fail criteria, etc.

1. The Range User shall notify the RSO 30 days before the start of testing, at which time the RSO will determine if a representative will be sent to witness the test. The RSO shall have the right to witness any test.
2. Testing shall not begin until the test plan and/or procedure has been approved by the RSO.
3. Components whose test data reflect the unit is out-of-family when compared to other units shall be considered out of specifications.
4. Plans and procedures shall be submitted for review and approval 45 days prior to the start of the procedure.

The Range User shall provide a written report demonstrating compliance to all component performance and environmental requirements.

Each of the following constitutes a condition that requires resolution with the Range Safety Office approval.

- Any test that does not satisfy a performance specification or pass/fail criteria.
- Any failure to accomplish a range safety test objective.
- Any test result that indicates an out-of-family condition when compared to other tests, even if it satisfies other test criteria.
- Any unexpected change in the performance occurring at any time during testing.
- Examination showing any defect that could adversely affect the performance.
- Any discontinuity, dropout, or change in amplitude in a measured performance parameter.
- Any inadvertent output.

- Any sign that a part is stressed beyond its design limit, such as a cracked circuit board, bent clamps, worn part, or loose connector or screw, even if the component passes the final functional test.

In the event of a test failure or anomaly, the test item, procedures, and equipment shall undergo a written failure analysis. The failure analysis shall identify the cause and the mechanism of the failure and shall isolate the failure to the smallest replaceable item or items and ensure that there are no generic design, workmanship, or process problems with other flight components of similar configuration.

- In the event of a test anomaly, the test configuration shall be frozen until the RSO presentative can be contacted. The range shall have the right to participate in any failure analysis and corrective action. Invasive troubleshooting or corrective action shall not begin without an RSO approval.
- The failure or anomaly shall be reported verbally or electronically to the RSO representative within one day. Data shall be provided in a timely manner that allows the RSO enough time to review documentation that supports program schedule.
- A detailed description with any supporting data shall be provided in writing within two weeks of the date the failure was noted.
- A formal report containing a description of the failure, an analysis of the failure, and planned corrective actions shall be submitted to the RSO within 30 days of the failure.
- Flight approval will not be granted until the RSO approves the failure analysis and corrective action.

As a minimum the formal report shall

1. Describe all component test results and test conditions
2. Describe any analysis performed instead of testing
3. Identify, by serial number or other identification, each test result that applies to each system or component
4. Describe any family performance data to be used for comparison to any subsequent test of a component or system
5. Describe all performance parameter measurements made during component testing for comparison to each previous and subsequent test to identify any performance variations that may indicate potential workmanship or other defect that could lead to a failure of the component during flight
6. Identify any test failure or anomaly, including any variation from an established performance baseline, with a description of the failure or anomaly, each corrective action taken, and all results of additional tests.

# 6 SUBSYSTEM/SYSTEM TEST PROCESS

A component shall undergo one or more pre-flight tests at the launch site to detect any change in performance due to any shipping, storage, or other environments that may have affected performance after the component passed the acceptance tests.

Each test shall measure performance parameters of the component and compare the measurements to the acceptance test performance baseline to identify any performance variations (including any out-of-family results) that may indicate potential defects that could result in an in-flight failure.

Component certification testing

1. Component certification tests are conducted on FTS components to certify them for flight before installation in a higher assembly or vehicle
2. Tests are usually performed in a laboratory-type environment and include electrical and functional tests.
3. These tests may be required to be conducted at ambient and workmanship high and low temperatures.
4. Certification tests are designed to detect changes in performance since the manufacturer acceptance test or the last range certification test was carried out.
5. Tests shall be performed as close to launch day as possible. Certification time limits shall depend on the type of component and the overall vehicle configuration.
6. Certification test data shall correlate with the ATP baseline data and any previous certification test data. Differences in test results that may indicate a degradation in performance may result in rejection of the particular component for FTS purposes.

It is important to note that an FTS shall undergo pre-flight subsystem and system-level testing after the components are installed on a vehicle.

Data obtained from this test shall be compared to data from the pre-flight component tests and acceptance tests to demonstrate that there are no discrepancies indicating a flight reliability concern.

# 7 FLIGHT TERMINATION SYSTEM REPORT (FTSR)

In addition to component, subsystem and system-level testing, the FTS shall undergo a series of system analyses.

A summary of all analyses shall be included in the FTSR. Detailed analyses shall be submitted separately.

The different system analyses are listed in Table 4, see RCC 319-14 for details.

*Table 4. System analyses.*

| No | Analysis |
|---|---|
| 1 | System reliability<br>The FTS shall undergo an analysis that demonstrates the predicted reliability of the system. The predicted design reliability shall be a minimum of 0.999 at the 95 % confidence level. |
| 2 | Single-point failure<br>The FTS shall undergo an analysis that demonstrates that the system satisfies the fault tolerance requirement. Each analysis shall<br>a) follow a standard industry methodology such as a fault tree analysis or a failure modes, effects, and criticality analysis (FMECA)<br>b) identify all possible failure modes and undesired events, their probability of occurrence, and their effects on system performance<br>c) identify single-point failure modes<br>d) identify functions, including redundancy, that are not or cannot be tested<br>e) account for any potential system failures due to hardware, software, test equipment, or procedural or human errors<br>f) account for any single-point failure on another system that could disable an FTS. |
| 3 | Fratricide<br>The FTS shall undergo an analysis that demonstrates that the flight termination of any stage at any time during flight does not severe interconnecting FTS circuitry or ordnance to other stages until flight termination on all the other stages has been initiated. |
| 4 | Bent pin<br>Each FTS component shall undergo an analysis that demonstrates that any single short circuit occurring as a result of a bent electrical connection pin does not result in inadvertent system activation or inhibiting the proper operation of the system. |
| 5 | Radio frequency link<br>The RF link analyses shall be performed to demonstrate |

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|---|---|
| | 1. a 12-dB margin over 95 % of the antenna radiation pattern using a nominal trajectory<br>2. a 12-dB margin using actual antenna patterns for a nominal trajectory. When demonstrating the 12-dB margin, each lick analysis shall account for the following nominal system performance and attenuation factors:<br>a) path losses due to plume or flame attenuation<br>b) free space loss throughout the vehicle trajectory<br>c) ground system and airborne system RF characteristics<br>d) polarization losses. |
| 6 | Sneak circuit<br>With all components functioning nominally, the analysis shall demonstrate that there are no latent paths that could cause an undesired event or inhibited functions. |
| 7 | Software and hardware<br>Any computing system, software, or firmware that performs a software safety critical function shall undergo the analysis needed to ensure that the software/firmware has been verified and validated by an independent department, see Appendix A of RCC 319-14. |
| 8 | Battery Capacity<br>An analysis shall be performed to demonstrate that each FTS battery meets the performance requirements of RCC 319-14 Chapter 3. |
| 9 | Component maximum predicted environment (MPE)<br>An analysis shall be performed to determine FTS component MPE such as shock, thermal, and vibration. The assumptions, derivation technique, supporting data, and final environment shall be submitted to Range Safety for review and approval. |
| 10 | Failure analysis*<br>Any failure/anomaly occurring in an FTS or any identical component shall be submitted to Range Safety for review and approval. A summary of all failure analyses during qualification testing shall be included in the FTSR with all detailed reports submitted separately. |
| 11 | Qualification-by-similarity analysis*<br>A qualification-by-similarity analysis shall be submitted to Range Safety for review and approval. A summary of all qualification-by-similarity analyses shall be included in the FTSR with all detailed reports submitted separately. |
| 12 | Vehicle power analysis*<br>If vehicle-generated power is used to supply any part of the FTS, a vehicle power analysis shall be performed. |

| | |
|---|---|
| 13 | Radio frequency radiation analysis<br>An RF radiation analysis shall demonstrate that the system and components satisfy all performance requirements when subjected to emitting sources on the vehicle and from surrounding environments. A summary of the radiation analysis shall be included with the detailed report submitted separately. |
| 14 | Flight termination system breakup analysis<br>A breakup analysis shall be performed to determine the design and location of the FTS components and subsystems to ensure that the FTS functions reliably during a vehicle failure. |
| 15 | Tip-off analysis*<br>A tip-off analysis of standoff-autodestruct systems crossing staging or breakup interfaces shall demonstrate that destruct charge will hit the target before the stages become misaligned. A summary of the tip-off analysis shall be included with the detailed report submitted separately. |
| 16 | Automatic destruct system (ADS) timing analysis*<br>The ADS timing analysis shall calculate the worst-case time between ADS triggering and final destruct action. The analysis shall demonstrate that the FTS will function prior to becoming disabled by vehicle breakup. A summary of the ADS timing analysis shall be included in the FTSR with the detailed report submitted separately. |
| 17 | Ordnance initiator simulator analysis*<br>The analysis shall demonstrate that the simulator input current, impedance, voltage, optical power, or energy simulates the flight ordnance characteristics. A summary of the analysis shall be included in the FTSR with the detailed report submitted separately. |
| 18 | In-flight flight termination system analysis<br>A post-flight analysis shall be performed to demonstrate that the FTS met all applicable performance requirements during flight. An analysis shall be provided for review and approval for any in-flight anomaly or when termination action is taken. Range Safety representatives shall participate in the investigation and be given enough notice to support all activities. |
| 19 | Flight termination system laser-initiated detonator (LID) heat dissipation analysis*<br>An analysis shall be performed to demonstrate that the LIDs dissipate heat faster than single-failure conditions can input into the device without initiating or dudding. |

* system dependent analysis

## 7.1 Flight Termination System Report Format

Any report format provided by the range user is acceptable provided that all required data is included. Data submittals that cannot be included in the FTSR because of their size or configuration shall be referenced in the applicable section and submitted as attachments. The data package shall contain the following information:

1. **Table of Contents and Glossary**
2. **Introduction**
3. **Flight Termination System General System Description**
    a. **Vehicle Description.** A brief and general description of the vehicle.
    b. **Flight Termination System Description.** A brief and general description of the FTS, including block diagram showing the location of all FTS components on the vehicle and the interfaces with other systems.
    c. **Flight Termination System Cable Diagram.** A cable diagram of the FTS from the antennas to the termination device.
    d. **Overall Flight Termination System Schematic.** A complete line schematic of the entire FTS from antenna to the termination device, including TM pick-off points and ground (umbilical) interfaces.
4. **Flight Termination System Detailed Component and System Descriptions**
    a. A complete and detailed description of the FTS operation, including all possible scenarios and a discussion of how FTS components function at the system and piece-part level.
    b. A complete and detailed description of each FTS component and how it functions, including specifications and schematics, mechanical and piece-part specifications, and operating parameters.
    c. Detailed schematics and drawings to include the following:
        i. The complete FTS, showing: component values such as resistance, capacitance, and wattage; tolerance, shields, grounds, connectors, and pin numbers; and TM pick-off points.
        ii. All vehicle components and elements that interface with or share common use with the FTS.
        iii. An accounting of all pin assignments.
    d. Drawings showing the location of all FTS system and subsystem components on the vehicle that include the following descriptions.
        i. Component location, mounting (attach points), orientation, and cable routing.
        ii. Electrical connectors, connections, and the electrical isolation of the FTS.
        iii. An illustrated parts breakdown of all mechanically operated FTS components.
5. **Flight Termination System Analysis Results.** A summary of the applicable results of the analyses required in Chapter 7 in RCC 319-14 shall be included. The detailed analyses shall be submitted separately.
6. **Flight Termination System Ordnance Classification.** The classifications for each ordnance device shall be in accordance with the DOT, DoD, UN, or ESA regulations. Supporting documentation shall be included in this section.
7. **Flight Termination System Development, Qualification, Acceptance, Age Surveillance, and Reuse Test Plans, Procedures, and Reports**
    a. A list of test plans, procedures, and reports by title, number, and revision date.

   b. The maximum predicted flight loads for all anticipated environmental forces such as shock, vibration, and thermal for each FTS component, subsystem, and system.
   c. A matrix of the actual qualification and acceptance test levels used for each component, subsystem, and system in each test versus the predicted flight levels for each environment. The test tolerance allowed for each operational qualification test shall be included.
   d. A clear identification of those components qualified by similarity analysis or a combination of analysis and test.
   e. A summary of each applicable test report. The actual test report shall be submitted as a stand-alone document.

8. **Software and Firmware Independent Verifications and Validations.** A summary of software and firmware IV&V shall be included.
9. **Flight Termination System Modifications.** All modifications to an approved FTS, its associated equipment, component identification, test procedures, or any changes affecting the configuration and integrity of the FTS shall be included.
10. **Flight Termination System Ground Support and Monitoring Equipment.** The ground support and monitoring equipment section shall include a complete description of the ground test equipment used to check out the FTS. This section shall also include specifications, system schematics, and component schematics for program-unique test equipment for the following:
    a. Ordnance initiator simulator
    b. The RF ground support system
    c. The RF repeater system
    d. Safety console layout, display arrangement, and function of each monitor
    e. Safety console terminations including the following:
        i. Schematics of all FTS monitor circuits from the FTS component pick-off points to the console termination
        ii. Calibration data for all monitor circuit terminations provided to the console
    f. Any other ground support and monitoring equipment as required by Range Safety.
11. **Flight Termination System Installation and Checkout**
    a. A list of procedures for checkout, calibration, and installation of all components, systems, and subsystems of the FTS and its associated ground checkout equipment, including launch-day countdown.
    b. A summary of each task, objective, test configuration, test equipment, and a time sequence flow chart.
12. **Exception to Requirements.** The section shall include all waivers and conditionally compliant requirements.
13. **Changes to the Flight Termination System Report.** The change section shall include a summary of all changes to the last version of the FTSR. All changes shall be highlighted using change bars or similar means of identification.
14. **Telemetry Measurement.** This section provides a list of all FTS TM measurements. This section includes the following minimum information for each measurement:
    a. Description of each parameter
    b. A TM measurement identifier
    c. Sample rate
    d. Minimum and full-scale level
    e. Resolution

f. Engineering units and scaling factors
g. Analog or digital

15. **Flight Termination System Report Appendixes.** All FTS development, qualification, and age surveillance test reports shall be included as stand-alone appendixes.