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Esrange FTS Range Approval Process

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Change record

Version	Date	Changed paragraphs	Remarks	Author
1.0	2020-03-17		First version	PIVA
2.0	2022-06-22	All sections	Major document update	PIVA

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
DVT	Design Verification Test
ELS	Equivalent level of safety
ESA	European Space Agency
ESB	Esrange Safety Board
ESC	Esrange Space Center
ESM	Esrange Safety Manual
ESS	Environmental Stress Screening
FTS	Flight termination system
FTSR	Flight termination system report
IAW	In accordance with
LID	Laser initiated detonator
LAT	Lot acceptance test
MPE	Maximum predicted environment
PDR	Preliminary design review
QBS	Qualification by Similarity
QTP	Qualification Test Procedure
RCC	Range Commanders Council
RF	Radio frequency
RSO	Range Safety Office
RVM	Requirements Verification Matrix
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 system meets the requirements stated in RCC 319 standard for design, performance, testing, analysis, and documentation. The Esrange FTS range approval process follows the guidelines stated in RCC 319 with minor changes.

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

1.1 References

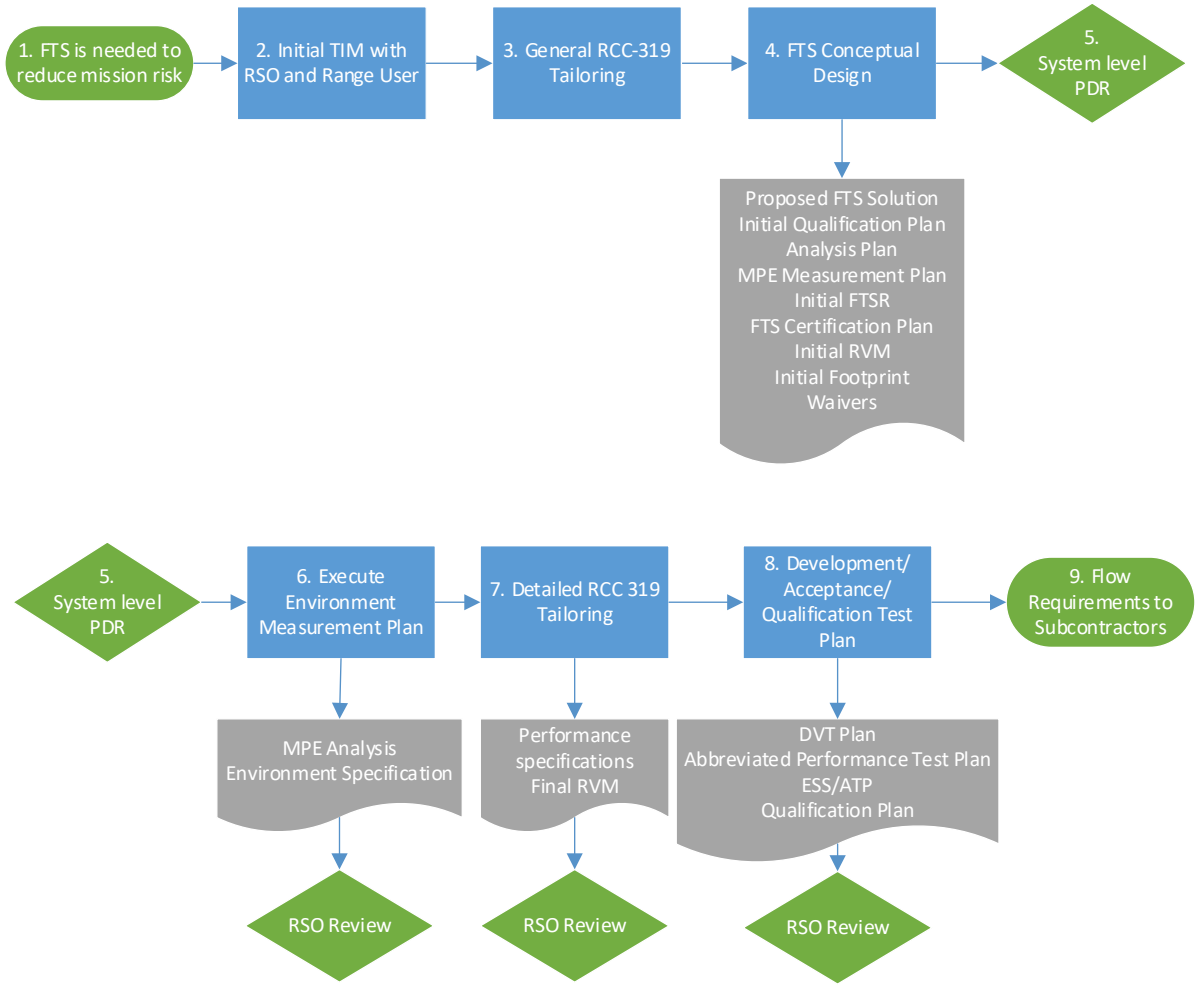
ESM. (2020). Esrange Safety Manual (Version 9.0, Issued 12th of June 2020). Document no. SCIENCE-60-4208.

RCC 319. (2019). 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 flowcharts pages 5 and 6 and described in Table 1.

An approximate timeline of the FTS range approval process is presented in Table 2. The actual timeline will be range user and flight termination system specific.



Esrange FTS Range Approval Process

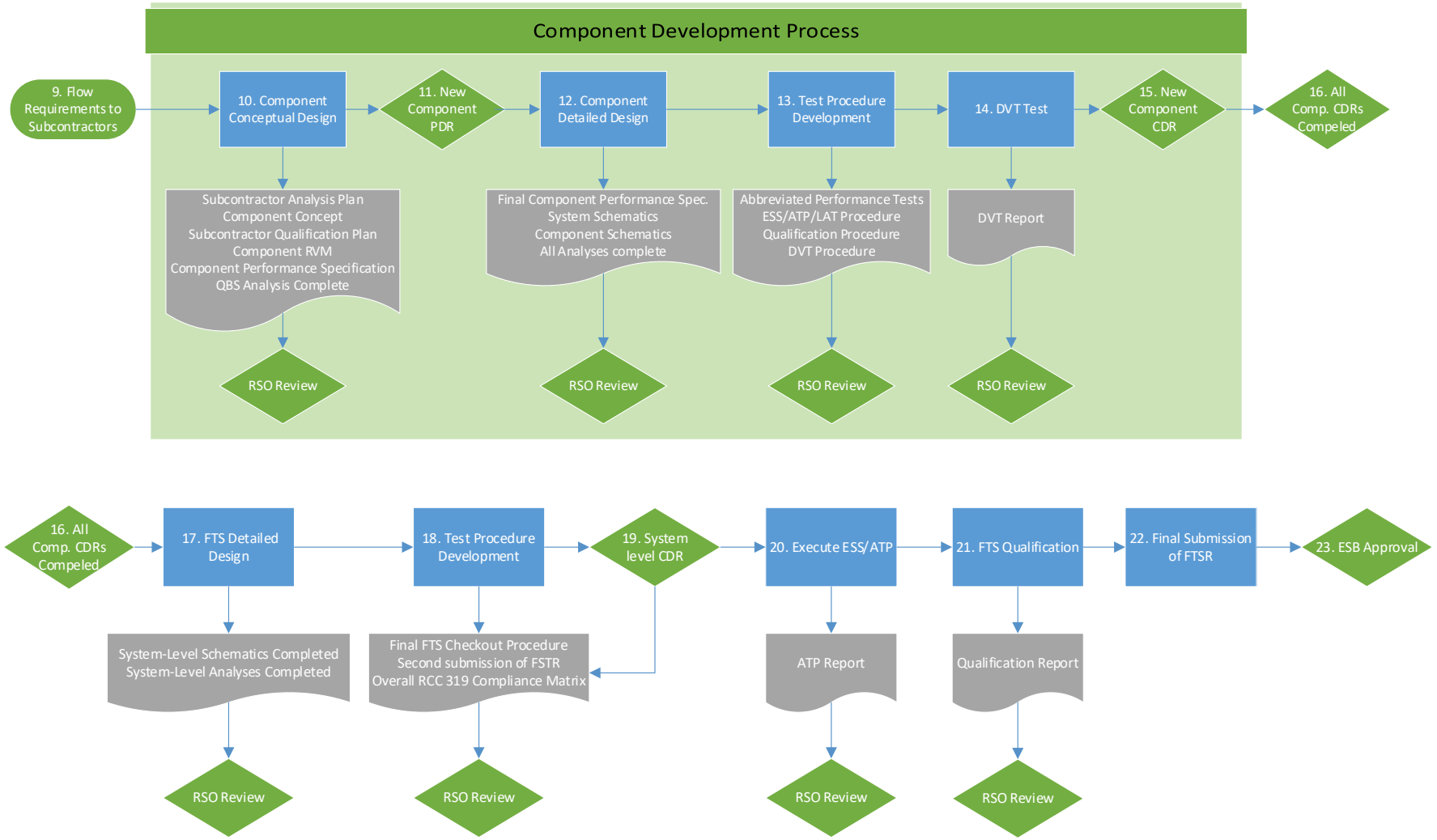


Table 1. FTS Range Approval Process Steps.

Step	Action	Owner
1	**FTS is needed to reduce the mission risk** An FTS is needed if the flight safety analysis done by SSC shows that the mission does not meet the risk criteria in ESM chapter 6.2., or the vehicle is not considered inherently safe.	RSO
2	**Initial TIM with RSO and Range User** An initial technical interchange meeting (TIM) shall be arranged, where the range user shall describe, in detail, the type of mission, the launch vehicle configuration, and the proposed FTS component and system design.	RSO/ Range User
3	**General RCC 319 Tailoring** After the TIM, the Range Safety Office can start the general tailoring of the RCC 319. General tailoring means tailoring of the whole standard, but the requirements will not be gone through line-by-line with the Range User. The tailored set of requirements will be denoted as RCC 319 [T-program name] and will contain: • Tailored performance requirements • Tailored test requirements • Tailored analysis requirements • Tailored documentation requirements	RSO
4	**FTS Conceptual Design** After receiving the tailored set of requirements, the Range User can start the conceptual design of the FTS. During the FTS conceptual design phase, the range user is expected to produce the following documentation that will be reviewed in the system-level preliminary design review: • Proposed FTS Solution • Initial Qualification Plan • Analysis Plan • Maximum Predicted Environment (MPE) Measurement Plan • Initial Flight Termination System Report (FTSR) • FTS Certification Plan • Initial Requirements Verification Matrix (RVM) • Initial Footprint • Waivers The range user or their prime contractor shall propose an FTS solution with all required components. New components that will require an individual PDR and CDR shall be identified.	Range User

	The Initial Qualification Plan lists all the qualification requirements (environments, number of samples, and test sequence) for each FTS component using the applicable qualification table in RCC 319 for each component. The qualification plan defines the expected method for meeting qualification, such as qualification by test, analysis, similarity, or demonstration. The Analysis Plan describes how all the analyses required in the tailored RCC 319 will be accomplished. Some analysis is done by the range user or their prime contractor at the system level. Other analysis is done by component manufacturers at the component level. The Maximum Predicted Environment (MPE) for each FTS component must be defined. This requires measuring the environment for each platform, station, and vehicle configuration. The range user or their prime contractor writes an MPE measurement plan defining how all the environments will be measured, including the placement of measuring devices. The Flight Termination System Report (FTSR) is an extensive report that contains a detailed description of the FTS, tailoring summary, system analysis results, design data, reliability data, component design data, ground support system data, test data, and FTS TM data. The FTSR is the medium through which the approval is obtained from the range. At the first FTSR submittal, the range user or the prime contractor will not be able to complete all required FTSR sections, but the initial submission should contain placeholders for all required content that will be populated with future updates. The FTSR is due no later than 45 days prior to the system PDR. The FTS Certification Plan lists the proposed means of accomplishing a complete FTS field certification prior to a mission. The Initial Requirements Verification Matrix (RVM) is a collection of all RCC 319 requirements. For each requirement, the initial RVM should indicate how (test, demonstration, analysis), which document/procedure (development testing, acceptance testing, qualification testing, analysis, etc.), and at which level (component, system) the requirement will be verified. The initial RVM should clearly indicate which RCC 319 requirements will require limited or lifetime waivers. Justification for each waiver is required. Justification and submission of a waiver does not guarantee RSO approval of the waiver. Determining if a proposed FTS solution is sufficient requires preliminary footprint analysis giving sufficient confidence an FTS concept is sufficient to keep a test item within the boundaries of the test range.	
5	**System Level PDR** The system level PDR will review the documentation produced during the FTS conceptual design and evaluate the maturity of the design to proceed to new component development process.	Range User/ RSO

6	**Execute Environment Measurement Plan** During this step, the approved MPE measurement plan is executed by the Range User and two documents are produced: • Maximum Predicted Environment (MPE) analysis • Environment specification The Maximum Predicted Environment (MPE) analysis analyses and explains the reasoning behind the environmental measurements results. The environment specification defines the non-operating and operating environments for each FTS component with temperature extremes, rates of change, levels and durations and clearly states the levels and durations used for acceptance and qualification tests. RSO shall review and approve the documentation.	Range User
7	**Detailed RCC 319 Tailoring** The detailed RCC 319 tailoring is done by the RSO and the Range User after completing the system PDR. Detailed RCC 319 tailoring means a line-by-line review of RCC 319. After performing the detailed RCC 319 tailoring the Range User shall produce performance specifications for the system and the components as well as the final RVM. The RSO shall review and approve the documentation.	RSO/ Range User
8	**Development/ Acceptance/ Qualification Plan** After finalizing the system and component-level specifications and verification matrix, the Range User shall establish the plans for development, acceptance, and qualification tests. The following documentation shall be produced: • Design Verification Test (DVT) Plan • Abbreviated Performance Test Plan • Environmental Stress Screening (ESS)/Acceptance Test Procedure (ATP) • Final Qualification Plan Development tests validate hardware design concepts and assist in the evolution of designs from the conceptual to the operational phase. The objective of these tests is to identify hardware problems early in their design evolution, so any required actions can be taken before beginning formal qualification testing and production hardware fabrication. The DVT Plan defines the test method required to demonstrate the design meets the requirements. Abbreviated performance verification tests are performed when there is insufficient time or access to a component during testing to perform all required performance tests. If the component is manufactured by the Range User or their prime contractor, the procedure to verify the performance of component shall be delivered at this stage.	Range User

	Environmental Stress Screening (ESS) is a process in which environmental stimuli, such as rapid thermal cycling and random vibration, are applied to electronic items in order to precipitate latent defects to early failure. ESS/ATP will contain the test plan and procedures for meeting the environmental stress screening and acceptance test requirements. The final qualification plan includes previous RSO comments and the results from the environmental specification to define qualification environments, levels, durations, and sequences of testing for each component and assembly. Final determination of what will be qualified by test, analysis, or similarity is made based on the results of the environmental specification. RSO shall review and approve the documentation.	
9	**Flow Requirements to Subcontractors** If the FTS component is manufactured by a subcontractor, the Range User shall provide the component level requirements to the subcontractor.	Range User
10	**Component Conceptual Design** The component conceptual design concerns any new components developed by the range user, their prime contractor, or their subcontractor. During this phase, the following documents shall be produced: • Subcontractor Analysis Plan • Component Concept • Subcontractor Qualification Plan • Component RVM • Component Performance Specification • Qualification-By-Similarity (QBS) Analysis Complete For items manufactured by the Range User or their prime contractor, a component-specific analysis plan may be required, or the analysis plan delivered prior to the system PDR may be sufficient. Items manufactured by a subcontractor should have their own analysis plans to verify the manufacturer fully understands the analysis requirements. At the component PDR, the design and operational concepts proposed for the component are presented, reviewed, and approved prior to beginning engineering fabrication. If the component is being developed by the Range User or their prime contractor, the system-level qualification plan is sufficient to meet this item. If the component is being developed by a subcontractor, a subcontractor-developed qualification plan detailing what environments will be tested, qualified by analysis, and/or qualified by similarity must be provided prior to the PDR for the new component. Subcontractors may have access to historical data unavailable to the range user or their prime contractor, allowing some qualification tests to be completed by analysis or similarity rather than through test.	Range User

	Historical test plans, reports, and test data must be deliverable to the government to leverage previous qualification testing. Each component manufacturer must provide an RVM to show how all the component requirements flowed from the range user or their prime contractor (including RCC 319 requirements) will be met. Suggested tailoring and waivers to RCC 319 requirements must be identified for review/approval by the range. The RVM includes which document will be used for verification, such as the DVT procedure, acceptance procedure, qualification procedure, or analysis. The component RVM provides a handy checklist for ensuring DVT, acceptance, qualification, and performance test procedures meet all contract requirements. If QBS is used for an environment, a QBS analysis detailing how the environment is qualified by similarity based on historical test data must be delivered for review prior to the component's PDR. The QBS analysis must include the test data from legacy testing. If historical data are not available for RSO review, the environment cannot be qualified by similarity. Analysis used to translate and/or compare the levels and durations must be clearly explained. The RSO shall review these documents before the component-level PDR.	
11	**New Component PDR** The new component PDR will review the documentation produced during the component conceptual design and assess the maturity of the design to proceed to the detailed design.	Range User/ RSO
12	**Component Detailed Design** The component detailed design concerns any new components developed by the range user, their prime contractor, or their subcontractor. The following documentation shall be produced: • Final Component Performance Specification • System Schematics • Component Schematics • All Analyses complete A final version of the component performance specification is needed prior to submitting component schematics, analysis, abbreviated performance test, ESS/ATP/LAT procedures, and qualification procedures to the range for review because those documents must verify proper performance of the component, which cannot be done until the performance requirements are finalized. A complete line schematic of the entire FTS from antenna to the termination device is due prior to the system-level CDR. The range user shall provide component schematics containing detailed drawings, schematics, and wiring diagrams of the FTS as a system. Analysis is preferred over testing when it is faster, cheaper, and fully capable of verifying the requirements. Analysis loses these advantages when completed after CDR. If an analysis finds a problem	Range User

	with the design of a system or component, any qualification testing completed on the defective design must be repeated, incurring significant schedule delays and cost overruns. Therefore, before CDR can approve the design for fabrication, all analysis must indicate the design meets all requirements. Analysis includes everything defined in the component analysis plan delivered prior to the component PDR. The RSO shall review these documents before the component-level CDR.	
13	**New Component CDR** The new component CDR will review the documents produced during the component detailed design phase and assess the majority of the design to proceed into FTS detailed design.	Range User/ RSO
14	**Test Procedure Development** • Abbreviated Performance Tests • ESS/ATP/LAT/QTP • DVT Procedure The component manufacturer shall define abbreviated performance test that will be performed during acceptance and qualification tests to ensure the component is operating correctly without inadvertent, abnormal, or missing output. The component manufacturer shall establish procedures for component environmental stress screening, acceptance testing, lot acceptance testing, and qualification testing. The component manufacturer must develop a DVT procedure to be approved by the RSO to verify the proposed design meets critical requirements prior to significant investment of resources. Prior developing the DVT procedure, all schematics should be approved.	Range User
15	**DVT Test** The RSO approved DVT test plan is executed. A report of DVT test results shall be written and approved by RSO. The DVT test report becomes an appendix of the overall FTSR delivered by the range user or their prime contractor.	Range User
16	**All Component CDRs Completed** All new component CDRs shall be completed before the range user can proceed to FTS detailed design.	RSO/ Range User
17	**FTS Detailed Design** The FTS detailed design can begin after all component CDRs have been completed. During this phase the range user shall finalize the FTS system-level design and produce the following documentation: • Final System-Level Schematics • System-Level Analyses Completed	Range User

	To prevent duplication of review, the system schematic and system analysis should be delivered together. An overall FTS schematic must be provided per Section 8.5. A complete line schematic of the entire FTS from antenna to the termination device is due prior to the system-level CDR. The system-level schematic must include TM pick-off points and ground (umbilical) interfaces. All analysis defined in the system analysis plan shall be completed at this time. Analysis reports completed at the system level are formally delivered as attachments to the system qualification report. The RSO shall review the documentation.	
18	**Test Procedure Development** • Final FTS Checkout Procedure • Second submission of FSTR • Overall RCC 319 Compliance Matrix The final submission of the FTS checkout procedure is delivered after the system-level schematics and analysis are completed. The system schematic is required prior to the checkout procedure to verify that the pass/fail criteria (voltage, resistance, current) are appropriate. The second submission of the FTSR is submitted at least 45 days prior to the system CDR. The second submission of the FTSR will include updates to all appendixes completed to date for the system and each component (i.e., all completed analysis, qualification plans, qualification procedures, DVT plans, procedures, reports, ESS/ATP/LAT procedures, etc.). An overall RCC 319 compliance matrix showing how each RCC 319 requirement is verified is required prior to CDR entry and must be approved prior to CDR exit. The RSO shall review the documentation.	Range User
19	**System Level CDR** The system level CDR will review the documentation produced during the FTS detailed design phase and assess system maturity for fabrication and testing.	Range User/ RSO
20	**Execute ESS/ATP** During the ESS/ATP phase all of the components and subassemblies will go through the acceptance tests. The approved ESS/ATP must be completed on delivered flight units. The acceptance test report with all attached test records must be written IAW RCC 319 Section 4.9 to demonstrate compliance to the flight unit's performance and environmental requirements as defined in the ATP. All ESS/ATPs must be completed on all qualification units prior to beginning qualification testing. Completing ESS and ATP prior to qualification also verifies adequacy of the ESS/ATP procedures. All failures during ESS and ATP must be investigated to find root causes.	Range User

	Corrective action to prevent recurrence must be implement before testing can resume. The RSO shall review and approve the acceptance test reports.	
21	**FTS Qualification** During the FTS qualification phase some of the components and subassemblies will go through the qualification tests. RSO is not required to witness all qualification testing, but notifications must be sent with proper notice (at least two weeks) to allow RSO to witness all portions of qualification testing. Any failure during qualification of an FTS component or assembly will halt qualification of the component or assembly until RSO is notified, the failure is investigated, the root cause is identified, corrective actions are mitigated, and a decision is made on the appropriate place to resume qualification testing (regression testing may be required). The qualification report with all attached test records must be written IAW RCC 319 Section 4.9 and approved by RSO prior to the final submittal of the FTSR. For requirements traceability, the qualification report must refer to all reports used to satisfy qualification requirements through analysis. The RSO shall review and approve the qualification report.	Range User
22	**Final Submission of FTSR** The final submission of the FTSR is due no later than six months before the first scheduled flight. The final submission provides the final remaining missing appendixes and clearly indicates which platforms and stations the FTS is qualified to support. It also includes all environmental limits, such as temperature limits, captive carriage duration, door-open exposure time (if applicable), the maximum number of FTS checkouts, the maximum free-flight time, and restricted flight maneuvers (if applicable). A reference in the FTSR to the environmental specification for detailed explanation of the limits is needed but not solely sufficient. The FTSR should also include the limits as a single reference for understanding the qualified FTS environments. Under no circumstances will an FTS mission be approved without the final FTSR being provided to the RSO for review and approval.	Range user
23	**ESB Approval** After receiving the FTSR, the RSO shall do the final review of the documentation and give the final approval for the system. The RSO shall then present the FTSR to the Esrange Safety Board, who will give the approval to the range user to use the FTS for a certain mission. The ESB approval shall be sent as a formal letter to the range user.	RSO

Table 2. FTS range approval process timeline.

Time	Event
L – 24 months	Technical interchange meeting with RSO and Range User
L – 23 months	First version of the tailored RCC 319 delivered to the Range User (1 month)
L – 23 months	Conceptual design of the FTS starts (3 months)
L – 20 months	System level PDR
L – 20 months	Environment measurement plan execution, detailed RCC-319 tailoring, test procedure development (2 months)
L – 18 months	Component development process starts (3 months)
L – 15 months	All component CDRs completed Detailed design of the FTS starts (3 months)
L – 12 months	System level CDR
L – 12 months	Component tests start (acceptance and qualification) (6 months)
L – 6 months	All component test completed Final version of the FTSR delivered to the RSO (6 months prior)
L – 5 months	Esrange Safety Board approval
L – 1 month	FTS components shipped to Esrange
L – 1 month	Pre-flight component tests, pre-launch subsystem/system level tests, and range and vehicle compatibility tests start
L – 0	Launch

3 TAILORING PROCESS

A tailored version of RCC 319 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 will result 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 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 to demonstrate that the component satisfies all its performance requirements when subjected to non-operating and operating environments. The Esrange RSO 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.

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 RSO 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 FTS ANALYSIS

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 for details.

Table 4. System analyses.

No	Analysis
1	System reliability 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 The FTS shall undergo an analysis that demonstrates that the system satisfies the fault tolerance requirement. Each analysis shall follow a standard industry methodology such as a fault tree analysis or a failure modes, effects, and criticality analysis (FMECA).
3	Fratricide 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 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 (RF) link The RF link analyses shall be performed to demonstrate 1. a 12-dB margin over 95 % of the antenna radiation pattern using a nominal trajectory 2. a 12-dB margin using actual antenna patterns for a nominal trajectory. When demonstrating the 12-dB margin, each link analysis shall account for the following nominal system performance and attenuation factors: a) path losses due to plume or flame attenuation b) free space loss throughout the vehicle trajectory c) ground system and airborne system RF characteristics

	d) polarization losses.
6	Sneak circuit With all components functioning nominally, the analysis shall demonstrate that there are no latent paths that could cause an undesired event or inhibited function.
7	Software and firmware Any computing system, software, or firmware that performs a software safety critical function shall undergo the analysis needed to ensure reliable operation IAW the requirement in Appendix A of RCC 319.
8	Battery Capacity An analysis shall be performed to demonstrate that each FTS battery meets the performance requirements of RCC 319 Chapter 3.
9	Component maximum predicted environment (MPE) 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 RSO for review and approval.
10	Failure analysis* Any failure/anomaly occurring in an FTS or any identical component shall be submitted to RSO 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* A qualification-by-similarity analysis shall be submitted to RSO 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* 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 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

	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* 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* 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* 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 FTS analysis 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* An analysis shall be performed to demonstrate that the LIDs dissipate heat faster than single-failure conditions can input into the device without initiating.

* system dependent analysis

7 FLIGHT TERMINATION SYSTEM REPORT (FTSR)

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. **FTS 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. **FTS Cable Diagram.** A cable diagram of the FTS from the antennas to the termination device.
    d. **Overall FTS 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. **FTS 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. **FTS 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. **FTS 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. **FTS 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. **FTS 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. **FTS 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 RSO.
11. **FTS 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 FTSR.** 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. **FTSR Appendixes.** All FTS development, qualification, and age surveillance test reports shall be included as stand-alone appendixes.