(5) An antenna must radiate circularly polarized radio waves that are compatible with the flight termination system antennas on the launch vehicle; and

(6) Any steerable antenna must allow for control of the antenna manually at the antenna site or by remote slaving data from a launch vehicle tracking source. A steerable antenna's positioning lag, accuracy, and slew rates must allow for tracking a nominally performing launch vehicle within one half of the antenna's beam-width and for tracking a malfunctioning launch vehicle to satisfy paragraph (l)(2) of this section.

§ 417.305 Command control system testing.

(a) *General.* (1) A command control system, including its subsystems and components must undergo the acceptance testing of paragraph (b) of this section when new or modified. For each launch, a command control system must undergo the preflight testing of paragraph (c) of this section.

(2) Each acceptance and preflight test must follow a written test plan that specifies the procedures and test parameters for the test and the testing sequence. A test plan must include instructions on how to handle procedural deviations and how to react to test failures.

(3) If hardware or software is redesigned or replaced with a different hardware or software that is not identical to the original, the system must undergo all acceptance testing and analysis with the new hardware or software and all preflight testing for each launch with the new hardware or software.

(4) After a command control system passes all acceptance tests, if a component is replaced with an identical component, the system must undergo testing to ensure that the new component is installed properly and is operational.

(b) *Acceptance testing.* (1) All new or modified command control system hardware and software must undergo acceptance testing to verify that the system satisfies the requirements of § 417.303.

(2) Acceptance testing must include functional testing, system interface validation testing, and integrated system-wide validation testing.

(3) Each acceptance test must measure the performance parameters that demonstrate whether the requirements of § 417.303 are satisfied.

(4) Any computing system, software, or firmware that performs a software safety critical function must undergo validation testing and satisfy § 417.123. If command control system hardware interfaces with software, the interface must undergo validation testing.

(c) *Preflight testing*—(1) *General.* For each launch, a command control system must undergo preflight testing to verify that the system satisfies the requirements of § 417.303 for the launch.

(1) *General.* For each launch, a command control system must undergo preflight testing to verify that the system satisfies the requirements of § 417.303 for the launch.

(2) *Coordinated command control system and flight termination system testing.* For each launch, a command control system must undergo preflight testing during the preflight testing of the associated flight termination system under section E417.41 of appendix E of this part.

(3) *Command transmitter system carrier switching tests.* A command transmitter system must undergo a test of its carrier switching system no earlier than 24 hours before a scheduled flight. The test must satisfy all of the following:

(i) *Automatic carrier switching.* For any automatic carrier switching system, the test must verify that the switching algorithm selects and enables the proper transmitter site for each portion of the planned flight; and

(ii) *Manual carrier switching.* For any manual carrier switching, the test must verify that the flight safety system crew can select and enable each transmitter site planned to support the launch.

(4) *Independent radio frequency open loop verification tests.* A command control system must undergo an open loop end-to-end verification test for each launch as close to the planned flight as operationally feasible and after any modification to the system or break in the system configuration. The test must:

(i) Verify the performance of each element of the system from the flight safety system displays and controls to each command transmitter site;

(ii) Measure all system performance parameters received and transmitted using measuring equipment that does not physically interface with any elements of the operational command control system;

(iii) Verify the performance of each flight safety system display and control and remote command transmitter site combination by repeating all measurements for each combination, for all strings and all operational configurations of cross-strapped equipment; and

(iv) Verify that all critical command control system performance parameters satisfy all their performance specifications. These parameters must include:

(A) Transmitter power output;

(B) Center frequency stability;

(C) Tone deviation;

(D) Tone frequency;

(E) Message timing;

(F) Status of each communication circuit between the flight safety system display and controls and any supporting command transmitter sites;

(G) Status agreement between the flight safety system display and controls and each and any supporting command transmitter sites;

(H) Fail-over conditions;

(I) Tone balance; and

(J) Time delay from initiation of a command at each flight safety system control to transmitter output of the command signal.

(d) *Test reports.* If a Federal launch range oversees the safety of a launch, the range's requirements are consistent with this subpart, and the range provides and tests the command control system, a launch operator need only obtain the range's verification that the system satisfies all the test requirements. For any other case a launch operator must prepare or obtain one or more written reports that:

(1) Verify that the command control system satisfies all the test requirements;

(2) Describe all command control system test results and test conditions;

(3) Describe any analysis performed instead of testing;

(4) Identify by serial number or other identification each test result that applies to each system or component;

(5) Describe any test failure or anomaly, including any variation from an established performance baseline, each corrective action taken, and all results of any additional tests; and

(6) Identify any test failure trends.

§ 417.307 Support systems.

(a) *General.* (1) A flight safety system must include the systems required by this section to support the functions of the flight safety system crew, including making a flight termination decision.

(2) Each support system and each subsystem, component, and part that can affect the reliability of the support system must have written performance specifications that demonstrate, and contain the details of, how each satisfies the requirements of this section.

(3) For each launch, each support system must undergo testing to ensure it functions according to its performance specifications.

(b) *Launch vehicle tracking.* (1) A flight safety system must include a launch vehicle tracking system that provides launch vehicle position and status data to the flight safety crew from the first data loss flight time until the planned safe flight state for the launch.

(2) The tracking system must consist of at least two sources of launch vehicle position data. The data sources must be independent of one another, and at least one source must be independent of any vehicle guidance system.

(3) All ground tracking systems and components must be compatible with any tracking system components onboard the launch vehicle.

(4) If a tracking system uses radar as one of the independent tracking sources, the system must:

(i) Include a tracking beacon onboard the launch vehicle; or

(ii) If the system relies on skin tracking, it must maintain a tracking margin of no less than 6 dB above noise throughout the period of flight that

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