
**Space systems — Safety
requirements —**

**Part 3:
Flight safety systems**

*Systèmes spatiaux — Exigences de sécurité —
Partie 3: Systèmes de sauvegarde en vol*





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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

This second edition cancels and replaces the first edition (ISO 14620-3:2005), which has been technically revised. The main changes compared with the previous edition are as follows:

- the text has been updated to be consistent with ISO 14620-1 and ISO 14620-2.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Space launch activities can present hazards to people and damage to property and the environment. International space treaties adopted by the United Nations impose legal liabilities on countries involved in launching space vehicles to provide compensation for certain injuries and damages incurred as the result of such launches.

This document affects the safety of exposed people, property and environment, as well as countries and organizations conducting commercial or civil launch activities.

Space systems — Safety requirements —

Part 3: Flight safety systems

1 Scope

This document sets out the minimum requirements for flight safety systems (FSSs), including flight termination systems (FTSs, externally controlled systems or on-board automatic systems), tracking systems, and telemetry data transmitting systems (TDTs) for commercial or non-commercial launch activities of orbital or suborbital, unmanned space vehicles. The intent is to minimize the risk of injury or damage to persons, property or the environment resulting from the launching of space vehicles.

This document can be applied by any country, by any international organization, whether intergovernmental or not, and by any agency or operator undertaking the launching of space vehicles.

This document is intended to be applied by any person, organization, entity, operator or launch authority participating in commercial or non-commercial launch activities of orbital, or suborbital, unmanned space vehicles unless more restrictive requirements are imposed by the launch site country.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10795, *Space systems — Programme management and quality — Vocabulary*

ISO 14620-1, *Space systems — Safety requirements — Part 1: System safety*

ISO 14620-2, *Space systems — Safety requirements — Part 2: Launch site operations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10795, ISO 14620-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

flight safety system

combination of flight-, ground- or space-based hardware and software designed, installed and/or operated specifically for providing flight safety

Note 1 to entry: This combination of equipment, facilities, procedures and personnel required to monitor operations provides protection to personnel and property both foreign and domestic from any damage that can be caused by a non-nominal flight.

Note 2 to entry: The flight safety system may include *flight termination systems* (3.2), *telemetry data transmitting systems* (3.6) and *range tracking systems* (3.4).

5.2 All spent stages shall incorporate tracking devices or establish means of tracking that enable real-time monitoring of vehicle position and velocity, except when pre-flight analysis establishes that the stage separation activity will not result in an unknown or hazardous impact area or dispersion.

5.3 All launch vehicles shall incorporate TDTs for monitoring vehicle performance data and the FTS and tracking system status that are capable of functioning throughout the launch phase until the end of range safety responsibility.

5.4 Any launch vehicle having a stage, motor or component capable of violating the defined safety envelope shall be equipped with an FTS that interrupts the flight of the vehicle if it diverts from its predicted flight trajectory and has sufficient energy to become a threat to public safety.

5.5 All the FTSs, telemetry and tracking systems of launch vehicles shall be compatible with applicable spaceport and/or range ground equipment.

5.6 The inability to accurately ascertain the vehicle's position shall be a criterion for stopping the launch countdown.

5.7 If the ability to accurately determine the location of the vehicle is lost after launch, this normally requires initiation of FTS action, unless otherwise specified in the mission rules or range safety operational procedures.

5.8 For launch vehicles and payloads containing radioactive materials, proof of compliance with all appropriate regulations governing radioactive materials shall be provided.

6 Flight termination system requirements

6.1 General

6.1.1 Any launch vehicle where a malfunction of the vehicle or any stage, motor, payload or component can generate an unacceptable hazard to public safety shall contain FTSs.

6.1.2 All launch vehicle stages capable of violating the defined flight safety envelope shall contain FTSs.

6.1.3 The FTS flight equipment reliability shall be not less than 0,999 or shall conform to quantitative flight safety requirements as required in ISO 14620-2, if the latter requirements are more stringent. This reliability should be established by analysis of all components and supporting test data. The reliability of FTS ground equipment (including the radio-frequency propagation path as far as the launch vehicle) shall be compatible with the reliability requirements of the flight hardware.

6.1.4 The FTS, including monitoring and checkout circuits, shall be designed to eliminate the possibility of an SFP inhibiting the function of the system or causing an undesired output of the system. This requirement shall be verified by performing an SFP analysis.

6.1.5 The FTS shall make non-propulsive all propulsive systems of the vehicle.

6.1.6 The liquid propellant system shall meet the following requirements:

- a) The FTS of a liquid propellant launch vehicle shall provide engine shutdown and inhibition of further engine start. This can be the result of the destruction of each stage.
- b) A rapid burning or explosion caused by the destruct capability of toxic propellants shall be initiated to consume as much propellant as possible before impact.

6.1.7 The solid propellant system shall meet the following requirements:

- a) The FTS destruct charges of a solid propellant vehicle shall be designed to destroy the pressure integrity of the motor and ignite any non-burning propellant.
- b) The destruct action shall cause a condition of zero thrust, zero lift and zero yaw; if not, any residual thrust shall cause a tumbling action such that no significant lateral or longitudinal deviation of the impact point can result.

6.1.8 The FTS shall be designed such that termination action of one stage will not sever or inhibit functioning of FTS circuitry or ordnance on other stages.

6.1.9 The FTS shall be designed to function properly in the environment (shockwave, heatwave, etc.) resulting from the vehicle break-up.

6.1.10 FTS components shall be independent of any other system on the vehicle or payload to the extent that normal or abnormal functioning of the other vehicle components does not inhibit or activate the FTS components.

6.1.11 FTS components shall be isolated from other vehicle components to the extent that normal or abnormal functioning of the other vehicle components does not inhibit or activate the FTS components.

6.1.12 FTS active components, electrical cables, batteries, ordnance lines and destruct charges shall be redundant unless otherwise approved by the launch site country.

6.1.13 Redundant ordnance components, signal cables and electrical power cables shall be physically separated from each other by the maximum distance possible and mounted in different orientations, or on different axes where technically feasible.

6.1.14 FTS electrical and ordnance components shall have their operating and storage life specified.

6.1.15 The launch vehicle operator shall verify the FTS has sufficient service life for the specified mission prior to launch.

6.1.16 For externally controlled FTSS, antenna, receivers and decoders shall be compatible with the used GSE (gain, coverage, operating frequencies, bandwidth and insertion loss).

6.1.17 For externally controlled FTSS, all equipment shall be designed or chosen to ensure a radio-frequency propagation path from the command transmitter/antenna system to the launch vehicle antenna.

6.1.18 For externally controlled FTSS, the response time of each equipment from the receipt of signal shall be enough short to be capable to maintain safety envelop.

6.1.19 For externally controlled FTSS, the FTS antenna system shall cover more than 95 % of the radiation sphere.

6.1.20 The FTS shall conform to the qualitative safety principles described in ISO 14620-2 and be subjected to a safety analysis as described in ISO 14620-1.

6.2 Flight termination system safe and arm devices

6.2.1 For launch vehicles in which propulsive ignition occurs before first motion, the FTS S&A devices shall be armed prior to arming launch vehicle and payload ignition circuits.

6.2.2 For launch vehicles in which propulsive ignition occurs after first motion (e.g. submarine launched ballistic missile, dropped from carrier-aircraft launch vehicle), the FTS S&A devices shall contain an ignition interlock that shall be designed such that ignition cannot occur unless the FTS arming devices are in the armed position.

6.2.3 FTS S&A devices shall have enough fault tolerant capability to meet safety requirements.

6.2.4 All the possibilities to perform each function of the FTS S&A devices (safing, arming) shall be tested after installation, but prior to launch.

6.2.5 FTS S&A devices shall be designed to interrupt the direct path of the initiating energy of the FTS.

6.2.6 FTS S&A devices shall incorporate a device providing a remotely controlled means of interrupting the direct path of the initiating energy of the FTS.

6.2.7 Redundant means shall be provided to remotely safe FTSs (inhibits).

6.3 Flight termination system ordnance

6.3.1 FTS ordnance shall be safe for any ground operation.

6.3.2 The FTS destruct ordnance train, including all ordnance components and appropriate interfaces or air gaps, shall be designed to initiate with the energy level provided from the arming or initiating device, to propagate through the ordnance train to the destruct charges and to render the propulsion system non-propulsive.

6.3.3 FTS ordnance items and other items that are conductive and interface with FTS ordnance shall be kept at the same voltage potential through grounding.

6.3.4 FTS ordnance components shall have a service life equal to or greater than that of the vehicle if the components are installed on the stage at the time of stage manufacture.

6.3.5 FTS ordnance component service life shall be dated from the time of component acceptance.

6.4 Ground support equipment

6.4.1 GSE shall provide verifiable safety inhibits.

6.4.2 GSE inhibits and inhibit controls shall be independent and shall not share the same failure modes.

6.4.3 All GSE and flight ordnance shall be safe for any ground operation.

6.4.4 System failures that can lead to catastrophic events shall be dual fault tolerant (three inhibits).

6.4.5 From prelaunch through lift-off, a means of continuously monitoring the status of the FTS shall be provided in order to verify the armed status of each FTS S&A device, the health and status of the FTS and other associated components (command receiver/decoders, firing units, batteries, etc.), proper functioning of the destruct simulator, power transfer switch status, hold fire control switch (stop launch sequencer), and status of the range command transmitter carrier (on/off).

6.4.6 It is presupposed that GSE used for checkout of the airborne range safety equipment is calibrated on a periodic basis in accordance with the flight safety rules of the launch site.

6.4.7 For externally controlled FTSs, the FSS shall be designed to interrupt the flight of a launch vehicle in the launch phase:

- a) if the vehicle deviates from its predicted flight trajectory and it can become a threat to public safety; or
- b) if the ability to accurately determine the location of the vehicle is lost, unless otherwise specified in the mission rules or range safety operational procedures.

6.4.8 All GSE that is a part of the FSS shall be maintained in a configuration control system.

7 Range tracking system requirements

7.1 Description

The RTS is an integral part of the FSS which assists flight safety operators in analysing flight data and protecting the public from errant vehicle flights.

7.2 Requirements

7.2.1 All launch vehicles and suborbital vehicles shall have an approved means of tracking the vehicle's trajectory throughout the launch phase and mission.

The RTS may use various ground-based or vehicle-incorporated tracking modes to provide accurate tracking information.

7.2.2 The RTS shall provide real-time data from which position, direction and velocity can be determined.

7.2.3 The RTS shall be designed to operate under the worst predicted flight environment.

7.2.4 The RTS shall be protected from internal and external interference, such as electromagnetic energy, which can inhibit the operation of the system.

NOTE This protection can be achieved by physical or electrical protection systems or procedures.

7.2.5 The RTS shall provide real-time indications of position and velocity of the launch vehicle.

7.2.6 All RTS electrical flight components shall have their operating and storage life specified.

7.2.7 Electrical components used in any RTS mission shall not exceed their specified storage life.

7.2.8 Space-based translators or receivers, such as GNSS, shall be independent of any on-board guidance system.

7.2.9 The RTS transponder system reliability shall be not less than 0,995 or shall conform to quantitative flight safety requirements as required in ISO 14620-2, if the latter requirements are more stringent. This reliability should be established by analysis of all components and supporting test data.

7.2.10 The RTS space-based systems (such as GNSS) reliability shall be not less than 0,999 or shall conform to quantitative flight safety requirements as required in ISO 14620-2, if the latter requirements are more stringent. This reliability should be established by analysis of all components and supporting test data.

7.2.11 The RTS ground equipment reliability shall be compatible with the reliability requirements of the flight hardware.

7.2.12 The RTS shall be tested, verified and certified by the director of range safety as capable of performing throughout the designated mission.

8 Telemetry data transmitting system requirements

8.1 Description

The TDTS is an integral part of the FSS which assists flight safety operators in analysing flight data and protecting the public from errant vehicle flights.

8.2 Requirements

8.2.1 All launch vehicles shall have a TDTS to provide vehicle performance data to flight safety operators, except when pre-flight analysis establishes that the flight of the vehicle will not result in an unknown or hazardous impact area or dispersion.

8.2.2 The TDTS shall provide uninterrupted data from lift-off through orbital insertion, mission completion, or until range responsibility for safety has been fulfilled and terminated.

8.2.3 The TDTS shall acquire, store, process and provide data in real time throughout the launch phase.

8.2.4 Telemetry data shall include data relevant to position and tracking, FTS status, RTS status, vehicle performance, and engine and control information.

8.2.5 The TDTS shall provide real-time indications of malfunctions of the FSS.

8.2.6 Sufficient TDTS data shall be obtained to determine the adequacy of the FSS throughout flight and to support pre-flight and post-flight analyses.

8.2.7 The airborne telemetry system shall be compatible with the ground-based telemetry stations.

8.2.8 The TDTS shall be designed to operate under the worst predicted environments.

8.2.9 The TDTS shall be protected from internal and external interference, such as electromagnetic energy, which can inhibit the operation of the system.

8.2.10 All TDTS electrical flight components shall have their operating and storage life specified.

8.2.11 The use of TDTS electrical components in any mission shall not exceed the specified storage life.

8.2.12 The TDTS reliability shall be not less than 0,995 or shall conform to quantitative flight safety requirements as required in ISO 14620-2, if the latter requirements are more stringent. This reliability should be established by analysis of all components and supporting test data. The TDTS ground equipment reliability shall be compatible with the reliability requirements of the flight hardware.

8.2.13 The TDTS shall be tested, verified and certified by the director of range safety as capable of performing throughout the designated mission, for compliance with resistance to environmental factors.

