



# Status of the evolutions of the ISO standards

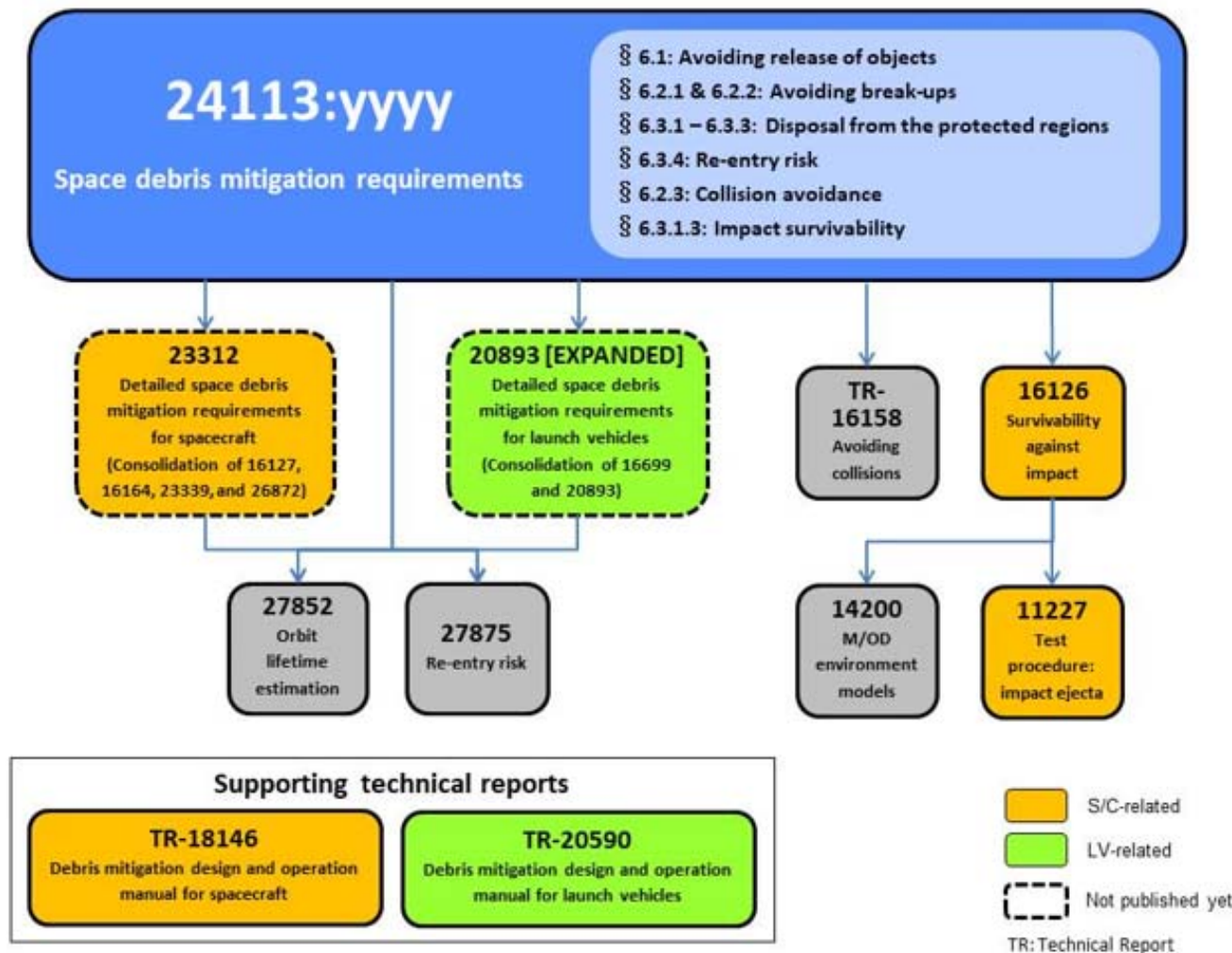
## 2018 Spring meeting report

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*Thanks to Hedley Stokes and Christophe Bonnal for the help*



# Structure of the ISO Space Debris Mitigation Work Items



# Published Work Items

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ISO Number	Title	Publication dates
11227	Test Procedure to Evaluate Spacecraft Material Ejecta upon Hypervelocity Impact	2012
14200	Process-based Implementation of Meteoroid and Debris Environment Models	2012
16126	Survivability of Unmanned Spacecraft against Space Debris and Meteoroid Impacts	2014
16127	Prevention of Break-up of Unmanned Spacecraft	2014
16158	TR: Avoiding Collisions with Orbiting Objects	2013
16164	Disposal of Satellites Operating in or Crossing Low Earth Orbit	2015
16699	Disposal of Orbital Launch Stages	2015
18146	TR: Space Debris Mitigation Design and Operation Guidelines for Spacecraft	2015
20590	TR: Debris Mitigation Design and Operation Manual for Launch Vehicle Orbital Stages	2017
23339	Estimating the Mass of Remaining Usable Propellant	2010
24113	Space Systems – Space Debris Mitigation Requirements	2010, 2011
26872	Disposal of Satellites Operating at Geosynchronous Altitude	2010
27852	Orbit Lifetime Estimation	2011, 2016
27875	Re-entry Risk Management for Unmanned Spacecraft and Launch Vehicle Orbital Stages	2010, <u>Amd 1</u> :2016

Revision to be planned every 5 years

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## Advancement of Registered Work items

### **Approval stage (Stage 50):**

ISO/FDIS 27875 Space systems — Re-entry risk management for unmanned spacecraft and launch vehicle orbital stages 50.00 WG 7

### **Enquiry stage (Stage 40):**

ISO/DIS 24113 Space systems — Space debris mitigation requirements 40.00 WG 7

### **Committee Stage (Stage 30):**

ISO/CD 20893 Space systems — Prevention of break-up of orbital launch stages 30.00 WG 7

### **Preparatory Stage (Stage 20):**

ISO/AWI 23312 Space systems — Detailed space debris mitigation requirements for spacecraft 20.00 WG 7

### **Standards under Review (Stage 90):**

ISO 11227:2012 Space systems — Test procedure to evaluate spacecraft material ejecta upon hypervelocity Impact 90.93 WG 7

## Last meeting in Spring

**Main goal :** Go through the CD/V comments on 24113 so that the document can be progressed to DIS as soon as possible

Thirteen votes were cast with only one disapproval vote (from Japan) for the CD version

Consensus on almost all topic, one remain not converged :

**6.3.1.2 1** The probability of successful disposal of a spacecraft or launch vehicle orbital stage shall be at least 0,90 through to the end of life.

➡ Project leader proposed to change the disposal probability requirement from 0.85 to 0.90 and proceed with this number in the DIS version of 24113.

Formal vote is due to end november

# ISO 24113 under revision

## Comments on the CD version have been received (13 pages)

- ↪ Have been addressed June 10-15, 2018 during ISO Spring Meeting 2018
  - Numerous points of terminology and definition
  - Significant modifications

### 6.1 Avoiding the intentional release of space debris into Earth orbit during normal operations

6.1.1 General 6.1.1.1 ~~Spacecraft and launch vehicle orbital stages shall be designed so as not to release space debris into Earth orbit during normal operations.~~

Is:

6.1.1.2 ~~Space debris released into Earth orbit as part of normal operations, other than as covered by 6.1.2, shall remain outside the GEO protected region, and its presence in the LEO protected region shall be limited to a maximum of 25 years after release.~~

Proposed:

6.1.1.1 Spacecraft shall be designed so as not to release space debris into Earth orbit during normal operations, other than space debris from pyrotechnics and solid rocket motors.

6.1.1.2 The total number of launch vehicle orbital stages and space debris objects left in Earth orbit by a launch vehicle during normal operations, other than space debris from pyrotechnics and solid rocket motors, shall be limited to one for the launch of a single spacecraft and two for the launch of multiple spacecraft.

6.1.1.3 Space debris left in Earth orbit by a launch vehicle after normal operations, other than space debris from pyrotechnics and solid rocket motors, shall satisfy the following conditions:

- a) remain outside the GEO protected region, and
- b) have an orbit lifetime of not more than 25 years if released into an orbit that lies within or crosses the LEO protected region.

## 6.1.2 Space debris from pyrotechnics and solid rocket motors

6.1.2.1 Pyrotechnic devices shall be designed so as to avoid the release into Earth orbit of products larger than 1 mm in their largest dimension.

**Is:**

6.1.2.2 Solid rocket motors shall be designed and operated so as to avoid releasing solid combustion products into the GEO protected region.

6.1.2.3 In the design and operation of solid rocket motors, methods to avoid the release of solid combustion products that might contaminate the LEO protected region shall be considered.



**Deleted**

**Proposed:**

6.1.2.1 Pyrotechnic devices shall be designed so as not to release space debris larger than 1 mm in their largest dimension into Earth orbit.

6.1.2.2 Solid rocket motors shall be designed and operated so as not to release space debris larger than 1 mm in their largest dimension into Earth orbit.



## 6.2.2 Accidental break-up caused by an on-board source of energy

**6.2.2.4** If for any reason a launch vehicle orbital stage cannot perform a controlled re-entry as planned then it shall be passivated, providing this can be done in a safe and controlled manner.

**6.2.2.5** The condition of a spacecraft shall be monitored periodically during its operation to detect any anomalies that could lead to an accidental break-up.

**6.2.2.6** During the operation of a spacecraft, if an anomaly is detected which could lead to an accidental break-up then a contingency plan shall be implemented to mitigate this risk.

**Proposed addition:**

## 6.2.3 Accidental break-up caused by a collision

**6.2.3.1** A spacecraft that will operate in the GEO protected region shall have a recurrent manoeuvre capability.

**6.2.3.2** A spacecraft that will operate in Earth orbit with a recurrent manoeuvre capability shall be designed and operated to actively manage collision risk until the end of life.

**6.2.3.3** For a spacecraft with the capability to actively manage collision risk, if the risk of collision with other space objects is assessed to be above the corresponding risk threshold set by an approving agent then collision avoidance manoeuvres shall be conducted to reduce the risk of collision below the threshold.

**Proposed addition:**



## 6.3 Disposal of a spacecraft or launch vehicle orbital stage after the end of mission so as to minimize interference with the protected regions

### 6.3.1 Probability of successful disposal

Is:

6.3.1.1 The probability of successful disposal of a spacecraft or launch vehicle orbital stage shall be at least 0,9 at the time disposal is executed.

6.3.1.2 The probability of successful disposal, as discussed in Annex A, shall be evaluated as conditional probability weighted on the mission success, i.e.  $P(D|M)$ .



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Proposed:

### 6.3.1 Provisions for successful disposal

6.3.1.1 The probability of successful disposal of a spacecraft shall be at least ~~0,95~~ through to the end of life.

6.3.1.2 The probability of successful disposal of a launch vehicle orbital stage shall be at least 0,90 through to the end of life.

6.3.1.3 During the design of a spacecraft for which a disposal manoeuvre has been planned, an assessment shall be made of the risk that a space debris or meteoroid impact will prevent the disposal.

6.3.1.4 Specific criteria for initiating the disposal of a spacecraft or launch vehicle orbital stage shall be developed, included in a disposal plan, evaluated during the mission and, if met, consequent actions executed.

NOTE It is possible for disposal criteria to be programmed into a spacecraft or launch vehicle orbital stage prior to the mission, and for consequent actions to be executed automatically when the programmed criteria have been met.

6.3.1.5 The condition of a spacecraft shall be monitored periodically during its operation to detect any anomalies that could affect its successful disposal.

6.3.1.6 During the operation of a spacecraft, if an anomaly is detected which could affect its successful disposal then a contingency plan shall be developed and implemented to mitigate this risk.

6.3.1.7 In case of mission extension, the capability of a spacecraft to perform successful disposal shall be reassessed considering the status of the spacecraft at the beginning of the mission extension.



Decision to keep 90% during ISO meeting in Helsinki

## 6.3.2 Disposal to minimize interference with the GEO protected region

**Is:**

**6.3.2.1** A spacecraft or launch vehicle orbital stage operating in the GEO protected region, with either a permanent or periodic presence, shall be manoeuvred in a controlled manner during the disposal phase to an orbit that lies entirely outside the GEO protected region.

**6.3.2.2** A spacecraft operating within the GEO protected region shall, after completion of its GEO disposal manoeuvres, have an orbital state that satisfies at least one of the following two conditions:

**Proposed:**

**6.3.2.1** A launch vehicle orbital stage shall be disposed of in such a way that long-term perturbation forces do not cause it to enter the GEO protected region within 100 years of its end of life.

**6.3.2.2** A spacecraft operating in the GEO protected region with a continuous presence shall be disposed of in such a way that its orbital state, after disposal manoeuvres, satisfies at least one of the following conditions:

**Proposed addition:**

**6.3.2.3** A spacecraft operating in the GEO protected region with a periodic presence shall be disposed of in such a way that long-term perturbation forces do not cause it to enter the GEO protected region within 100 years of its end of life.

## 6.3.3 LEO disposal manoeuvres

**Is:**

**6.3.3.1** A spacecraft or launch vehicle orbital stage operating in the LEO protected region, with either a permanent or periodic presence, shall limit its post-mission presence in the LEO protected region to a maximum of 25 years from the end of mission.

**Proposed:**

**6.3.3.1** The orbit lifetime of a spacecraft or launch vehicle orbital stage shall be less than 25 years starting from:

- a) the orbit injection epoch, if the spacecraft or launch vehicle orbital stage operates continuously or periodically in the LEO protected region and has no capability to perform collision avoidance manoeuvres, or
- b) the end of life epoch, if the spacecraft or launch vehicle orbital stage operates continuously or periodically in the LEO protected region and has the capability to perform collision avoidance manoeuvres, or
- c) the epoch of first intersection of the orbit with the LEO protected region within 100 years of the end of life, if the spacecraft or launch vehicle orbital stage operates continuously outside of the LEO protected region.

## 6.3.4 Re-entry

**Is:**

**6.3.4.1** For the re-entry of a spacecraft or launch vehicle orbital stage (or any part thereof), the maximum acceptable casualty risk shall be set in accordance with norms issued by approving agents.

**6.3.4.2** The re-entry of a spacecraft or launch vehicle orbital stage (or any part thereof) shall comply with the maximum acceptable casualty risk according to 6.3.4.1.

**Proposed:**

**6.3.4.1** Specific re-entry safety requirements imposed contractually, voluntarily or by national or international authorities shall be identified and applied.

**NOTE** Compliance with notification procedures defined by international civil aviation and maritime authorities is an important prerequisite for performing a controlled re-entry.

**6.3.4.2** The quantifiable risks associated with a re-entry shall be less than or equal to the corresponding risk thresholds set by approving agents.

**NOTE 1** There are several risks associated with a re-entry. Debris fragments that survive to reach the surface of the Earth represent an impact risk to people and property. Radioactive substances, toxic substances or any other hazardous materials that are released into the Earth's environment represent a pollution risk.

**NOTE 2** A number of existing guidelines and regulations use  $10^{-4}$  as the threshold for the re-entry casualty risk or the expected number of casualties, with the detailed method for risk assessment defined by the approving agent.