Attachment-1 Hazard report template (From payload/GSE arrival to the KSC to the moment the payload is handed over to the launch vehicle) Optional

Thereafter, typical hazard control and safety verification methods that have been proven in past safety reviews of payloads are described, since they are not generally applicable to hazards at the launch site, but may be applicable to hazard causes during the integration phase with the launch vehicle. Whether or not it corresponds to a hazard depends on the instructions from the launch vehicle.

The contents of HR-X.1 through X.4 can be cited in the format provided by the launch vehicle or otherwise used as appropriate.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No | Hazard | Cause | Hazard control | Safety verification method (baseline) | Status | Ph | Verification results | Document Name/number |
| HR-X.1  Apply    N/A | Crash of a launch vehicle due to inadvertent deployment of safety critical mechanisms (e.g. retention-release mechanisms) of payload  Case of pyrotechnic devices use | (1) Insufficient mechanical design of retention-release mechanism (rod, etc.) | (1-1) Ensuring soundness and strength of retention rods. | (1-1-1) Confirm the strength margin by analysis or other methods | OPEN | II |  | A summary of analysis results is attached |
| (1-1-2) Confirm soundness by testing or other methods | OPEN | III |  |  |
| (2) Inadvertent release due to false signals from the circuit | (2-1) 2FT design against inadvertent release (the design has a minimum of three independent inhibits to the energy source. At least two of the three inhibits are designed to be monitored.) | (2-1-1) Confirm 2FT design by drawings or other methods | OPEN | II |  | FT design schematics is attached |
| (2-1-2) Confirm that 2FT is valid by electrical performance tests or other methods | OPEN | III |  |  |
| (2-2) An electro-explosive device (EED) does not cause fire or malfunctions when 1 A DC and 1W DC are applied for five minutes. “No-fire” means that the ignition level is 0.1 % at 95 % of the confidence level determined by Bruceton test or equivalent statistic test methods. Or, use a NASA Standard Initiator or other standards-based initiator. | (2-2-1) Confirm purchase records or other methods | OPEN | II |  |  |
| (2-3) For the EED, shields are equipped with equal to or greater than 20 dB attenuation against the maximum no fire power of pyrotechnics. | (2-3-1) Confirm that there is a margin of at least 20 dB by analysis or other methods | OPEN | II |  | A summary of analysis results is attached |
| (2-4) No stray current before pyrotechnic devices connecting. | (2-4-1) Pyrotechnics firing circuits is checked for stray voltage prior to electrically connecting, and confirm that the result does not exceed 1/10 of the maximum no-fire current or 50 mA, whichever is lower. | OPEN | III |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No | Hazard | Cause | Hazard control | Safety verification method (baseline) | Status | Ph | Verification results | Document Name/number |
| HR-X.2  Apply    N/A | Crash of a launch vehicle due to inadvertent deployment of safety critical mechanisms (e.g. retention-release mechanisms) of payload  FT design approach for NEA | (1) Insufficient mechanical design of retention-release mechanism (NEA) | (1-1) 2 FT design against mechanism failure | (1-1-1) Confirm 2FT design by drawings or other methods | OPEN | II |  | FT design schematics are attached |
| (1-2-1) Confirm that 2FT is valid by functional testing or other methods | OPEN | III |  |  |
| (2) Inadvertent release due to false signals from the circuit | (2-1) 2FT design against inadvertent release | (2-1-1) Confirm 2FT design by drawings or other methods | OPEN | II |  | FT design schematics is attached |
| (2-1-2) Confirm that 2FT is valid by electrical performance tests or other methods | OPEN | III |  |  |

HR-X.2 comes from “CSA-113032 Mechanical Systems Safety for Payloads launched by JAXA (Interpretation of JMR-002)”

Mechanisms mean subsystems (e. g. latch mechanisms) that use frictional force, magnetic force, and elastic force by spring as retention force of safety critical configuration.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No | Hazard | Cause | Hazard control | Safety verification method (baseline) | Status | Ph | Verification results | Document Name/number |
| HR-X.3  Apply    N/A | Crash of a launch vehicle due to inadvertent deployment of safety critical mechanisms (e.g. retention-release mechanisms) of payload  Design for minimum risk approach 1 for NEA | (1) Insufficient mechanical design of retention-release mechanism (NEA) | (1-1) Securing retention force/torque margin greater than 1 | (1-1-1) Confirm that margins are sufficient by analysis, or other methods | OPEN | II |  | A summary of analysis results is attached |
| (1-1-2) Confirm that the mechanism is sound by mechanical environmental testing. | OPEN | III |  |  |
| (1-2) Adopting redundant springs where a spring function failure could result in a hazard (redundancy is not needed if the spring function failure does not result in a hazard) | (1-2-1) Confirm that the springs are in a redundant configuration by drawings or other methods | OPEN | II |  | FT design schematics is attached |
| (2) Inadvertent release due to false signals from the circuit | (2-1) 2FT design against inadvertent release | (2-1-1) Confirm 2FT design by drawings or other methods | OPEN | II |  | FT design schematics is attached |
| (2-1-2) Confirm that 2FT is valid by electrical performance tests or other methods | OPEN | III |  |  |

HR-X.3 comes from “CSA-113032 Mechanical Systems Safety for Payloads launched by JAXA (Interpretation of JMR-002)”

Prerequisite 1 for HR-X.3: Under the environment where such a mechanism needs to be in retention mode, load transfer within mechanism is designed to occur within the strength of its materials. (When factors that make verification difficult such as magnetic force is present, design for minimum risk cannot be applied.)

Prerequisite 2 for HR-X.3: Under the same environment, relative movement at a level where retention status of mechanism is deemed changed between components on load path of the mechanisms is designed not to occur. (When factors that require consideration such as jamming of mechanism part is present, design for minimum risk cannot be applied.)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| No | Hazard | Cause | Hazard control | Safety verification method (baseline) | Status | Ph | Verification results | Document Name/number |
| HR-X.4  Apply    N/A | Crash of a launch vehicle due to inadvertent deployment of safety critical mechanisms (e.g. retention-release mechanisms) of payload  Design for minimum risk approach 2 for non-metallic lock wire | (1) Design related to individual non-metallic locking wires and knots | (1-1) Confirm tensile strength | (1-1-1) Using elongation of wire as a parameter, confirm tensile strength of wire per elongation Note: If “aging treatment” (1-4) was implemented, test after such treatment. The wire used in tensile test is the same lot as flight items. And, when wires are exposed to external environment of payload, consider the thermal input after opening vehicle fairing. | OPEN | II |  |  |
| (1-2) Confirm creep deformation amount | (1-2-1) Check the creep deformation amount as creep displacement occurs at room temperature. Note: Comprehend the flight item status when applying tensile to the wire. The wire is the same lot as the flight items. For the duration of applying load, consider the period from installation to the payload to launch. | OPEN | II |  |  |
| (1-3) Confirm stretch of knot | (1-3-1) The knot is to simulate the flight configuration and confirm the stretch amount of the knot by testing. | OPEN | II |  |  |
| (1-4) Aging treatment (Stretch treatment) | (1-4-1) As tension and duration for elongate in advance can be determined, seek the relationships of deformation amount, applied tension, and duration of tension application by testing (1-1～1-3) | OPEN | II |  |  |
| (1-4-2) If aging treatment on the knot is necessary, attain the data equivalent to the knot. | OPEN | II |  |  |
| (1-4-3) Use wires that underwent aging treatment in advance in the payloads. | OPEN | III |  |  |
| (1-5) Confirm strength deterioration by compression in the radial direction of wire (swage part, knot, etc.) | (1-5-1) In the design of payload, confirm if there are any parts that get compressed in the radial direction of wire. And if there are applicable parts, simulate flight configuration, and confirm strength deterioration by compression by testing. | OPEN | II |  |  |
| (2) Insufficient mechanical design of retention-release mechanism | (2-1) Redundant design\* | (2-1-1) Confirm by drawings or other methods that the wires are in a redundant configuration. | OPEN | II |  | Schematic is attached |
| (2-2) Ensuring design tension margin | (2-2-1) Secure adequate margin to avoid lack of strength against maximum load. Present that one wire system is valid enough to show redundancy of the wire. Note: Seek maximum load on wire taking the maximum tension at the time of wire processing, vibration and shock during launch, manufacturing tolerance. And calculate the worst wire length and tension strength considering tension strength (1-1), creep deformation (1-2, 1-3), aging treatment (1-4), loosening of wire (2-4). | OPEN | II |  | A summary of analysis results is attached |
| (2-2-2) Confirm the lock by vibration test and visual inspection after the test. | OPEN | III |  |  |
| (2-3) Design with no sharp edges in the wire proximity area | (2-3-1) Confirm that equipment near the wire doesn’t have sharp edges by drawings or other methods | OPEN | II |  |  |
| (2-3-2) Confirm removal of sharp edges by visual or touch. | OPEN | III |  |  |
| (2-4) Design to prevent friction between wires and equipment | (2-4-1) Confirm that appropriate clearances are provided to prevent friction between wires and equipment during vibration and shock by drawings or other methods | OPEN | II |  |  |
| (2-4-2) Confirm that clearances are as shown in the drawings by measuring or visual inspection. | OPEN | III |  |  |
| (2-4-3) Confirm that the wire doesn’t have friction damage by vibration test, visual inspection or other methods. If visual inspection after installation of wire is difficult, confirm that there is no friction of wire based on results of spatial clearance inspection and EM vibration test or other methods. | OPEN | III |  |  |
| (2-5) Tension and wire length setting considering loosening | (2-5-1) Set the required tensile and length considering loosening of wire by time elapsed up to launch (payload separation) for tensile and deformation level as a setting of wire. | OPEN | II |  |  |
| (2-5-2) Check the wire visually or touching or by measuring the tensile. | OPEN | III |  |  |
| (2-6) Knotting wires using the proper knotting procedure | (2-6-1) Incorporate “how to knot” procedure confirmed in the test (1-3) in the payload design. | OPEN | II |  |  |
| (2-6-2) Confirm the knots are made according to the proper procedure by visual inspection. | OPEN | III |  |  |
| (2-7) Outfitting design with adjustable wire tension or displacement | (2-7-1) When installing wires to payload, ensure the design allows adjustment so that the wire will be of particular tension and length. | OPEN | II |  |  |
| (2-7-2) Confirm that specified tensile or length has been set by measurement. | OPEN | III |  |  |
| (2-8) Design to prevent scattering when cutting wire | (2-8-1) To prevent space debris scattering, confirm that the design is such that no separated material is generated when wires are cut by drawings or other methods | OPEN | II |  |  |
| (2-9) Design where shear forces are not applied | (2-9-1) Ensure that no shear force is applied to the wire. | OPEN | II |  |  |
| (3) Inadvertent release due to false signals from the circuit | (3-1) 2FT design against inadvertent release | (3-1-1) Confirm 2FT design by drawings or other methods | OPEN | II |  | FT design schematics is attached |
| (3-1-2) Confirm that 2FT is valid by electrical performance tests or other methods | OPEN | III |  |  |

From ”CSA-113030A Safety checklist for Non-metallic Lock-wire design of the small satellite”

\*For catastrophic hazards, it is usually necessary to adopt a 2FT design, but the hazard control in this hazard report is a design for minimum risk approach. For the design for minimum risk, redundancy is usually not necessary by designing with sufficient strength margin, but for non-metallic lockwires, redundant design (retention by two wires) is usually taken to cover their mechanical vulnerability.