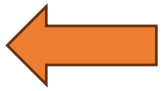
BIRDS seminar
-Simplified SAR process-

Japan Manned Space Systems corporation (JAMSS)
Safety & Mission Assurance Department
December, 2023

The simplified SAR process document

- JAXA has drafted the document for this process definition. The structure is as shown below.
  [Note] The document is described in Japanese.
- **Content**
  1. Introduction
  2. Scope (Design Constraints)
  3. Reference Document
  4. Process
  5. Safety Assessment Methodology
  Attachment A. Applicability Checklist
  Attachment B. Simplified SAR format



Today's topics

Scope (Design Constraints)

No.	Item	Design Constraints	Rationale
1	General	(1) Use “BIRDSBus” version 4 (FAB, OBC/EPS). (2) Compliant to JPAH Vol. 8. (3) Install two inhibits on battery hot line and one on RTN. (Note: This is satisfied if FAB is used without design change.) (4) Apply double insulation between battery and protection circuit (such as inhibits) (5) Solar cells Power generation due to the illumination in JEM does not exceed power to activate PIC.	(1) Users can apply the Baseline hazard control related to inhibits by using FAB, OBC/EPS. (2) To prevent Cubesats from affecting J-SSOD deployer system (3)(4)(5) To assure general design for evaluation of battery, inadvertent antenna deployment, RF radiation.

Scope (Design Constraints) (Cont.)

2	Identification of New Hazard	(1) Not install hazardous system related to hazard after Cubesat deployment (such as propulsion system, separation mechanism etc.). (2) Not conduct operations related to hazard after Cubesat deployment (such as laser irradiation). (3) New identified unique hazard report except for baselined BIRDS-5 Unique Hazard Reports shall be classified as FRC1.	(1)(2)(3) This simplified process is applied to Cubesats which can be approved by JAXA SRP (in other words, if NASA review is needed, this process CANNOT be applied).
3	STD-1* Flammability	(1) MIUL shall be approved by JAXA M&P expert.	(1) To assure that general verification is applied.
4	STD-2* Offgassing		
5	STD-3* Toxic	(1) Not installed chemical/biological materials whose THL=3 or 4.	(1) To assure that general Cubesat evaluation is applied.
6	STD-5* Sharp Edge	(1) Design so that there is no sharp edge, pinch points, and holes on +Z side (accessible by crew) leading injury and perform touch test to verify it.	(1) To assure that general verification is applied.
7	STD-10* Wire	(1) Apply 6 inches, DFMR or wire derating approaches.	(1) To assure that STD HR is applied.

Scope (Design Constraints) (Cont.)

8	STD-12* EMC	(1) Apply TIA 1416A. (2) Apply JDX-2020277 (EMC evaluation guideline for FET) to FET used for hazard controls	(1)(2) To assure that general verification is applied.
9	Structure	(1) Not installed shatterable materials except for camera lenses or solar cell covers which can be inspected visually after Cubesat random vibration test.	(1) To assure that general verification is applied.
10	Battery	(1) Use Ni-MH or Li-ion batteries listed in Common Battery HMST, whose energy is less than 80 Whr. (2) Install DC/DC converter (LTC3119) and diodes between solar cells and rechargable batteries. (Note: This is satisfied if FAB is used without design change.) (3) If battery heater is installed, provide three inhibits for power supply to it. (Note: This is satisfied if FAB is used without design change.)	(1) To assure that batteries are used within the scope of FRC1. (2)(3) To assure that general hazard control is applied regarding battery hazard.

Scope (Design Constraints) (Cont.)

11	Inadvertent Antenna Deployment	(1) Not install deployment mechanism except for metal convex antennas based on the design of BIRDS platform. (2) Hold antennas by wires and control according to JMX-2011303 (Cubesat Common SVP/FCP). (3) Evaluate ISS collision hazard caused by interference with J-SSOD/adjacent Cubesat due to inadvertent deployment of antennas immediately after Cubesat deployment.	(1) To prevent unique hazard causes due to complex deployment mechanism. (2) To assure that general hazard control and its verification is applied. (3) To assure that general assessment is performed.
12	RF Radiation	(1) Control inadvertent RF radiation by three inhibits if STD HR (OE 1298 JAXA3 version) cannot be applied (in other words, if Cubesat does not meet criteria of OE-14-002 and/or SSP50005).	(1) To assure general design for hazard control for RF radiation.
13	IVA Electrical Shock	(1) Prevent power supply to high voltage devices by three inhibits on FAB of BIRDSBus.	(1) To assure design to which the same hazard control and verification can be applied as the Baseline.

The simplified SAR format

- You can use the simplified SAR format if your Cubesat is compliant to the design constraints described in the above.
- By using it, you can perform hazard analysis based on BIRDS-5 baseline SAR.
- The format main structure is introduced in the following pages.
  [Note] That is just framework explanation.
  The final version of the format is under coordination in JAXA.

The simplified SAR format (Cont.)

1 Introduction

1.1 Purpose

SAR の目的を記載する。

The purpose of this Safety Assessment Report (SAR) is to verify identification and description of the hazards regarding XXX-Sat for Phase 0/I/II.

1.2 Scope

SAR の解析範囲を明確にするため、審査対象品目 及び 審査対象フェーズ（打上げ、軌道上運用、放出）を説明する。

The scope of this document is to show safety design and verification results of XXX-Sat from its launch to deployment from ISS.

1.3 Applicable Documents

システムに対して適用すべき文書を記載する。基本的に下記を適用する。

(1) JSX-TBDBIRDS バスを使用した小型衛星簡易 SAR プロセス
(2) 29_BIRDS5_SAR-03[BIRDS-5] Flight Safety Assessment Report for Phase III
(3) JX-ESPC-101132 JEM Payload Accommodation Handbook Vol.8 Small Satellite Deployment Interface Control Document

2 Safety Analysis Methodology

2.1 Methodology

安全解析手段等を示す。「小型衛星簡易 SAR」を適用することを記載する。

Safety analysis has been performed in accordance with SSP30599. In addition, the Cubesat uses BIRDSBus, which meets design constraints in Applicable Document (1). Therefore, the safety analysis has also been performed based on Applicable Document (1).

Compliance with ISS Jettison Policy are evaluated by J-SSOD system integrator in "Safety Assessment Report for series product."

2.2 Safety Requirements

適用した安全要求文書を記載する。基本的には下記を記載する。

(1) SSP51721 ISS Safety Requirement Document
(2) PPD1101 ISS Jettison Policy

These sections are the same as general SAR

3 System Description

3.1 Overview

対象アイテムとそのミッションシナリオ全般について記載する。

The XXX-Sat is 1U CubeSat whose dimension is 100 mm x 100 mm x 113.5 mm and weight is less than 1.33 kg. External views of XXX-Sat in its stowed configuration and deployment configuration are shown in Figure 3.1-1 and Figure 3.1-2, respectively.

The XXX-Sat performs the following missions:

- Communication by in-house radio device.

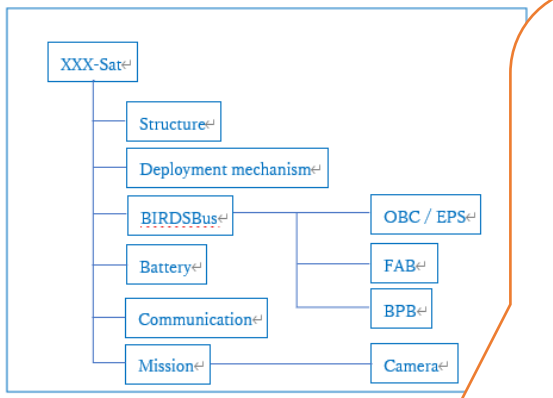


Figure 3.1-3 The system block diagram of XXX-S

3.2 Design Different from Baseline

ベースライン SAR に対する設計の差分の情報を記載する。

In this section, design difference of XXX-Sat from BIRDS-5 (PearAfricaSat-1 and ZIMSAT-1) in Applicable Document (2) is described.

3.2.1 Structure

System description section mainly describes design difference from the Baseline.
It can focus on mission-unique designs.

The simplified SAR format (Cont.)

5 Hazard Analysis Result

5.1 Hazard Identification and Assessment

3 項で示した差分に対して新規に識別されるハザード、および、ベースライン

のハザード解析との差分を記載する。

There is no new identified hazard. XXX-Sat has no high-voltage (>32 V) circuit, Electrical Shock (BIRDS5-UNQ-05) is not applicable to XXX-Sat hazard analysis. All the other hazards based on Applicable Document (2) are applicable to XXX-Sat.

The difference of assessment from HR in Applicable Document (2) is the followings:

- Add assessment in-house radio transmitter (445.0 MHz) in the verification of STD-12,
- No need for VHF band assessment in the verification of STD-12,
- No need for magnetic field assessment in the verification of STD-12.

The hazard controls and verification method in Applicable Document (2) can be applied to XXX-Sat, except for HR described in section 5.2. The verification result is shown in Appendix B-1 “Baseline Hazard Report Verification Matrix”.

5.2 Modification of Hazard Report

3 項で示した差分に対して修正が必要な HR を記載する。

The Battery Unique Hazard Report (BIRDS5-UNQ-02) needs to be modified because XXX-Sat has a battery heater and hazard control for the battery heater shall be added. Refer to Appendix B-2 “XXX-Sat-UNQ-01”.

Based on system description, hazard analysis is performed.
A new hazard may be identified and the Baseline HR can be modified.

Simplified SAR format (Cont.)

Verification matrix is attached.

This is based on BIRDS-5 Baseline HR.

Users can use it to show verification results if the same control and verification is applied

No.	Hazard Title	Verification No.	Verification Document	Status	
SHR-1	Flammable Material	V-1.1(a)	**MIUL** XXX-Sat-MIUL-01	Closed (January 1, 2000)	
SHR-2	Material Offgassing	V-2(a)	**MIUL** XXX-Sat-MIUL-01	Closed (January 1, 2000)	
SHR-3	Inadvertent Release of Battery Electrolyte	V-3(b)	**HMST** Appendix G Common Battery HMST	Closed (January 1, 2000)	
SHR-5	A Crew Exposure to Mechanical Hazards	V-5.1(a)	設計図面 XXX-Sat-AD-01	Closed (January 1, 2000)	
		V-5.1(b)	シャープエッジ検査記録 XXX-Sat-SEIR-01	To be closed at Phase III	
SHR-10	Injury/Damage as a Result of Improper Power Distribution Circuitry and Circuit Protection Devices	V-10.1(a)	**JAXA**チェックリストに従った評価 XXXSat-STD-Attachment-1	<For phase 0/I/II> Closed (January 1, 2000) <For phase III> To be closed at Phase III	

Re-verification is needed if the HR can be applied as is.

These indicate Baseline HR titles and Verification.

Simplified SAR format (Cont.)

If new hazards are identified and/or the Baseline HR is modified, UNQ HRs are attached in the same way as general SAR.

BIRDS5-UNQ-02	Battery Leakage / Rupture	1.1(1) 1.1(2) 1.1(3) 1.1(4) 1.2-1 1.2-2(1) 1.2-2(2) 1.3(1) 1.3(2) 1.4-1(1) 1.4-1(2) 1.4-1(3) 1.4-2(1) 1.4-2(2) 1.5	ベースライン適用時 ・バッテリ検証試験 ・絶縁検査 ・回路設計 ・保護装置機能試験 ・リーク電流解析 ・引渡し前充電量確認 N/A	N/A	The XXX-sat has battery heater. For thermal exceedance, the hazard control and verification is added. Refer to XXX-sat-UNQ-01.
BIRDS5-UNQ-03	Exposure of the ISS to Excessive Levels of EMI radiation and RF radiation	1.1	インヒビット機能試験 XXX-sat-IFTR-01	To be closed at Phase III	
BIRDS5-UNQ-04	Impact / Collision to ISS due to inappropriate CubeSat deployment from J-SSOD by inadvertently-deployment	1.1-1(1)	インヒビット機能試験 XXX-sat-IFTR-01	To be closed at Phase III	

Rationale for N/A etc.

The expected efficiency of the format

- If the format is used, we expect that the volume of SAR can be decreased compared with general SAR.

SAR content	General SAR (149 pages in the case of BIRDS-5)	Simplified SAR (Approximately 50 pages)
1. Introduction 2. Safety Analysis Methodolog	1 page / each	Same as left
3. System Description	14 pages	Approximately 5 - 10 pages (depends on Cubesat system)
4. Launch Configuration 5. Operation	1 page / each	Less than 1 page
6. Hazard Analysis Result	10 pages	1 or 2 pages (depends on Cubesat hazard)
Hazard Report	87 pages	Approximately 10 pages (depends on Cubesat hazard)
The other appendix etc.	34 pages	Same as left

Backup

About “BIRDSBus”

- The “BIRDSBus” is open platform for Cubesats developed and published by Kyushu Insutitute of Technology. The “BIRDSBus” is available for Cubesat Developers all over the world.
- Actually, many Cubesats deployed from J-SSOD have used the “BIRDSBus” and there will be multiple users in the future.
- See the following Web site for the details: https://birdsopensource.github.io/
- The developers can modify some design of the “BIRDSBus” for their use.