Form 17 (Re: Article 20, paragraph (1))

Application for License Relating to Control of Spacecraft

April 1, 2018

To: Prime Minister

(Postal code) 100-0013
Address: XXX, Kasumigaseki, Chiyoda-ku, Tokyo
Name (Seal)
(Company name, in cases of a corporation)
XXXX K.K. (Seal)
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The applicant hereby submits an application for license relating to the control of a spacecraft pursuant to the provisions of Article 20, paragraph (2) of the Act on Launching of Spacecraft, etc. and Control of Spacecraft.

Name of spacecraft:	CAO spacecraft
Location of spacecraft control facility:	(i) XX, Yakumo-cho, Hokkaido (ii) XX, Nagoya-shi, Aichi
Orbit of spacecraft	Sun-synchronous sub-recurrent orbit Semi-major axis: XX km Eccentricity: XX Inclination: XX° Right ascension of the ascending node: XX° Argument of perigee: XX°
Purpose and method of using the spacecraft	Purpose: Business activity (geospatial information) Method: Provision of data (sale of data)
Configuration of spacecraft (Attachment 1)	As indicated in Attachment 1

The applicant needs not prepare an application for a spacecraft control facility outside Japan. Prepare Attachment 2 if any facility is applicable.

For the specific figures of these items, an applicant is permitted to state the figures allowing some realistic margin.

Content of termination measures specified by Article 22, item (iv) of the Act:	(a) □ (b) □ (c) □ (d) ☑ Natural decay (Other termination measures) as a termination measure is to be implemented.	
Control plan (Attachment 2)	To be indicated in Attachment 2	
Name and address of the representative in case of death	Name: Hanako Naikaku Address: XXXX, Sapporo-shi, Hokkaido	
Name of officers or employees in charge of business of control of spacecraft, etc.	Officer: XXXX (President, Satellite Control Center) Employee: XXXX (Person responsible for operation)	
Whether the applicant falls under any of the disqualification grounds under Article 21 of the Act		Applicable □ Non-applicable ☑

Note 1: The size of the paper must be Japan Industrial Standards (JIS) A4.

2: An applicant may affix a signature instead of affixing the applicant's name and seal. In this case, the applicant must personally affix the signature.

3: Attach the documents set forth in the items of Article 20, paragraph (2), items (ii) and (iii) of the Regulation for Enforcement of the Act on Launching of Spacecraft, etc. and Control of Spacecraft.

(Attachment 1-1)

Configuration of spacecraft

Dimension (mm)	(in operation) 630mm±5%×830mm±5%×1760mm±5%	
Total mass (kg)	50 - 70kg	
Design life	3 - 5 years	
Power system	Shunt control + Unregulated bus	
Attitude control method:	Three-axes attitude control system	
Configuration of propulsion Applicable ☑ Non-applicable □	One-liquid blowdown, 3N thruster × 4	
Type of propellant	Hydrazine	
Mass of propellant (kg)	3 - 5kg	
Main structural materials	AL-1/8-5056	
Main devices installed	Synthetic aperture radar antenna, data transmission antenna	

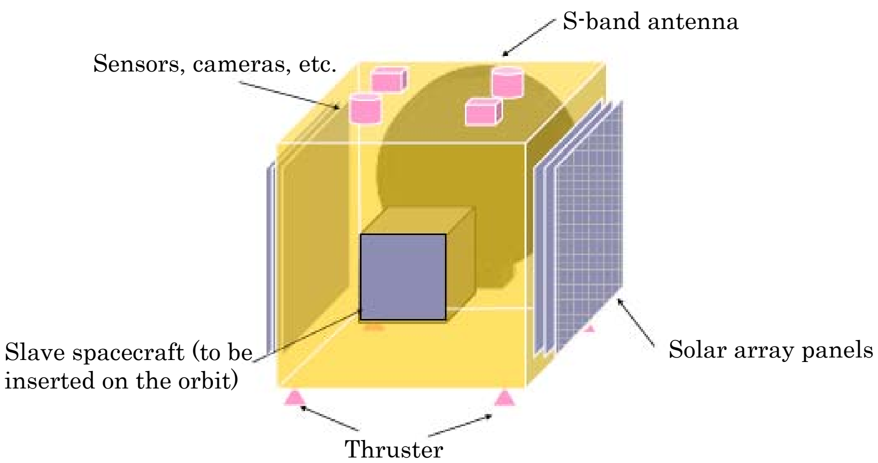
In the case of two-liquid system, describe information on the respective propellants.

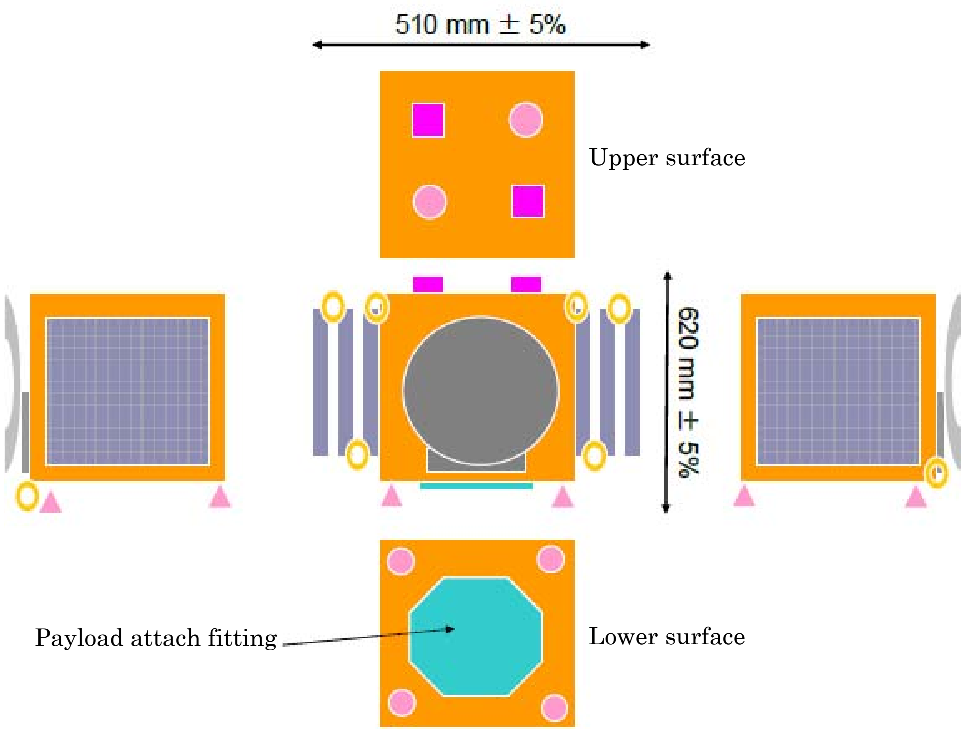
X: The following is the example for a 50cm class small satellite. An applicant is required to make a distinction from a "document certifying that the configuration of the spacecraft satisfies the launch vehicle safety standard provided in Article 22 of the Regulation" as necessary.

(Attachment 1-2)

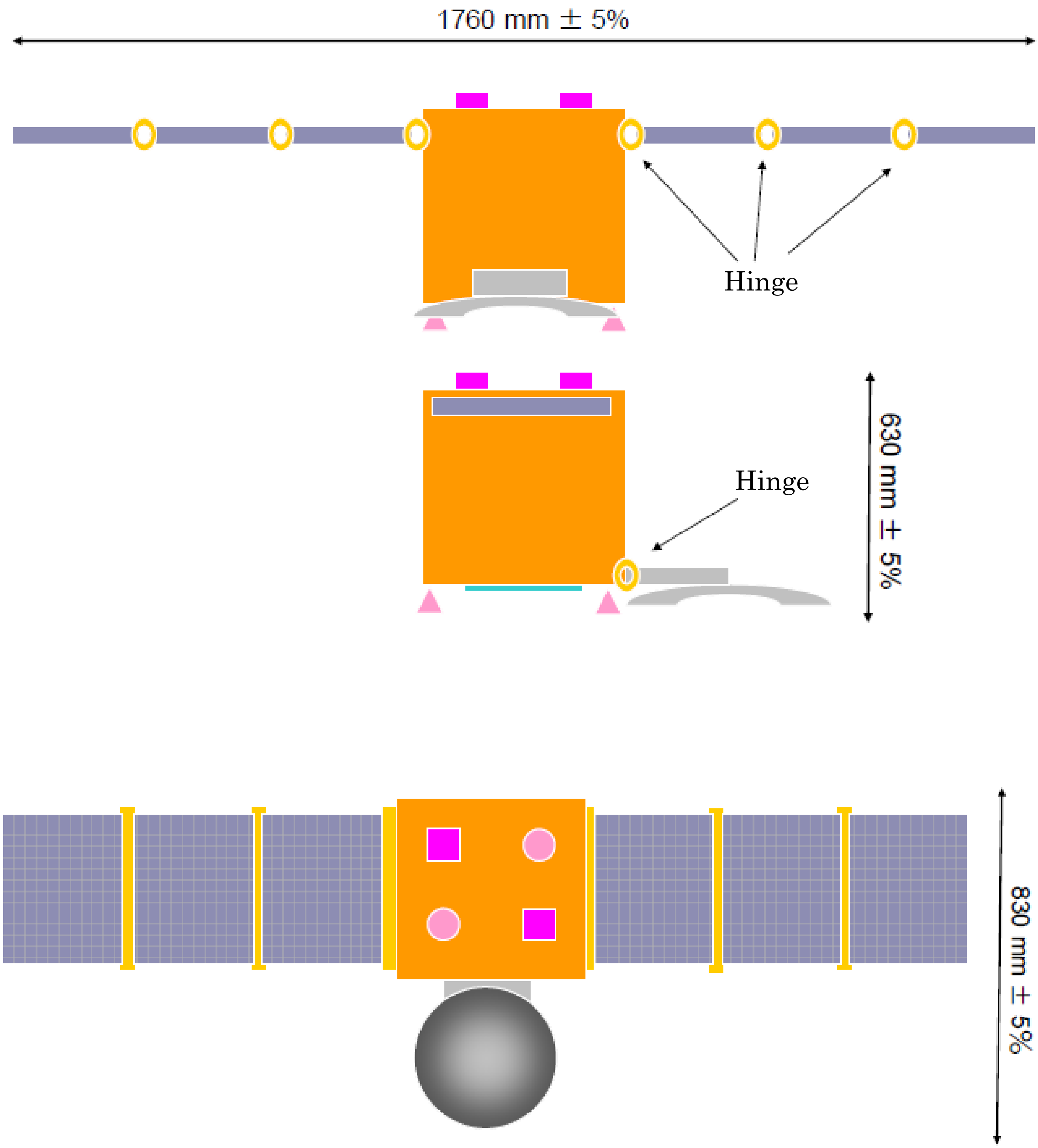
○Overview of Spacecraft

Include the overview at launching phase and operation phase.





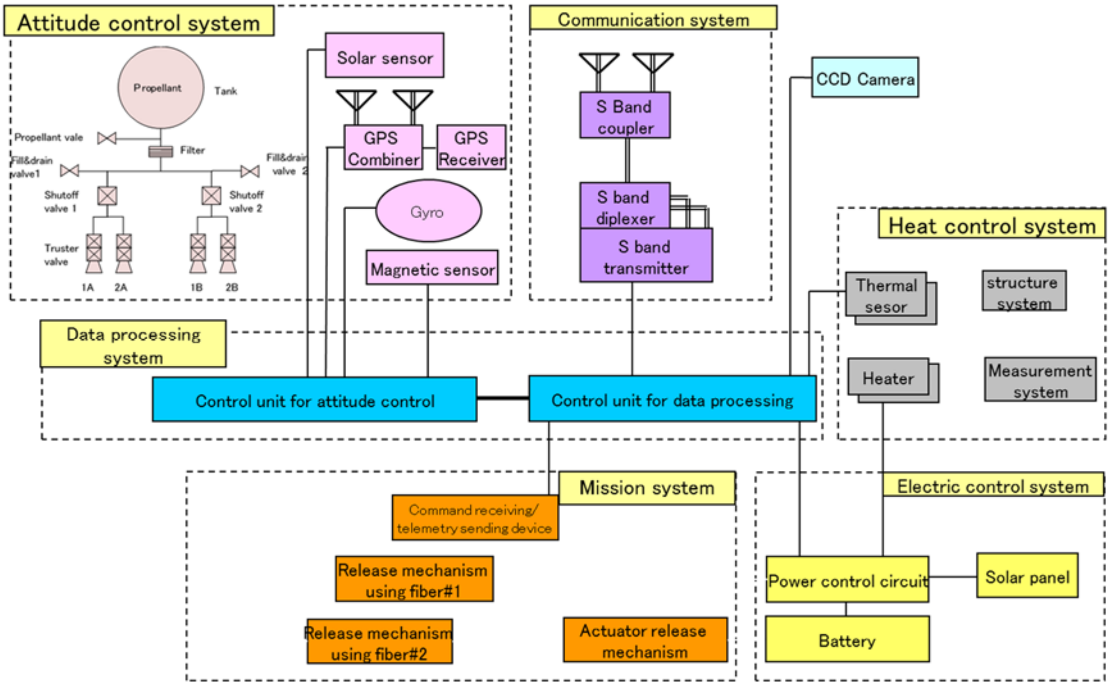
Overview at the time of launching spacecraft



Overview of spacecraft in operation

○Spacecraft system diagram

Indicate a spacecraft system diagram using a block diagram, etc.
The diagram is to be shown in a way to enable the identification of onboard components/equipment including a communication system, attitude control system, power system and mission system as well as their interfaces.



Spacecraft system diagram

(Attachment 1-3)

○Mechanism for the prevention of unintended release of objects

Enter information according to 6.2.1 of the Guidelines on Permission Related to Control of Spacecraft.
An assessment based either an analysis or testing is acceptable.

1. Evaluate whether the components, etc. of the spacecraft will not easily come off or scatter based on a structural analysis or environmental test. The following is a summary of the evaluations (for details, see the XX-XXXX structural analysis report and the XX-XXXX test results report.)

1.1 Results of structural analysis

(1) Mathematical model of structure

An analysis of the model designed using 3-D CAD software XXX was implemented by a finite element method software XXX. Figure 1.1-1 shows the analytical model.

Figure 1.1-1: Mathematical model of structure

(2) Materials used

Table 1.1-1 shows the specifications of parts and materials of the spacecraft.

Table 1.1-1: Main specification of members

Parts	Materials	Thickness	Allowable stress	Source:
X Panel	A7075-T7	XX mm	Yield stress=×× N/mm^2 Ultimate stress = ○○ N/mm^2	XX Material property database
Y Panel	5052-H34	XX mm	Yield stress=△△ N/mm^2 Ultimate stress= □□ N/mm^2	XX material science
SAP	CF honeycomb	XX mm	Yield stress=△△ N/mm^2 Ultimate stress= □□ N/mm^2	XX Vendor information
⋮	⋮	⋮	⋮	⋮

(3) Load condition

The conditions of acceleration provided in the interface control document of the XX launch vehicle are applied. In addition, load conditions, including an estimate of the maximum on-orbit load, are calculated. Table 1.1-2 shows the load conditions applied.

Table 1.1-2 Quasi-static load conditions (Unit: [G])

case	X	Y	Z
1	- ○.○	0	××.××
2	- ○.○	0	- ××.××
3	- ○.○	△△.△	0
4	- ○.○	- △△.△	0
⋮	⋮	⋮	⋮

(4) Safety factor (FS), margin of safety (MS)

The safety factors provided in the XX structural design standard (yield: FSy=1.25, ultimate: FSu=1.5) was applied.

The following definition provided in the XX structural design standard is adopted as MS.

$$\text{Margin of safety for yield loads: MSy} = \frac{\text{Yield stress of materials}}{\text{Stress generated from restricted loading} \times FSy} - 1$$

$$\text{Margin of safety for ultimate loads: MSu} = \frac{\text{Ultimate stress of materials}}{\text{Stress generated from restricted loading} \times FSu} - 1$$

(5) Validity of mathematical model of structure (results of correlation)

The mathematical model of structure was verified by comparing the natural frequency calculated using the mathematical model of the structure with the result of modal survey. Table 1.1-3 shows the comparison between the results of analysis of the natural frequency and the results of the vibration test. As the difference of the results of analysis and test does not exceed X% in terms of natural frequency, the mathematical model of the structure is considered to be valid.

Table 1.1-3 Comparison of natural frequency analysis results and modal survey

Mode No.	Analysis result [Hz]	Modal survey results [Hz]	Difference between model/test [%]
1	○○.○○	△△.△	X.XX
2	○○.○○	△△.△	X.XX
3	○○.○○	△△.△	X.XX
⋮	⋮	⋮	⋮

(6) Evaluation of stiffness

A natural frequency analysis was implemented using the mathematical model of the structure. As a result, it was confirmed that the natural frequency required under the XX interface control document (Longitudinal direction: not less than __ Hz; lateral direction: not less than ___ Hz) is satisfied. The results of analysis of natural frequency is shown in Table 1.1-4, and the major modes are shown in Figure 1.1-2.

Table 1.1-4 Results of analysis of natural frequency

Mode No.	Natural frequency [Hz]	Effective mass proportion [%]						Note
		X	Y	Z	R1	R2	R3	
1	○○.○○	XX.XX	0.XX	0.XX	0.XX	0.XX	0.XX	X1
2	○○.○○	0.XX	XX.XX	0.XX	0.XX	0.XX	0.XX	Y1
3	○○.○○	0.XX	0.XX	0.XX	0.XX	0.XX	0.XX	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Figure 1.1-2: Major modes

(7) Evaluation of strength

All the MSs were confirmed to be positive by evaluating strength using the mathematical model for the structure. The interface with the XXX launch vehicle is assumed to be fully rigid connection. The results of analysis for the yield stress and ultimate stress against the maximum stress generated at each part are shown in Table 1.1-5. Major contour of the generated stress is shown in Figure 1.1-3.

Table 1.1-5 Evaluation of Strength of Yield Stress

Parts	Load case	Maximum stress [MPa]	Allowable yield stress [MPa]	MSy	Allowable ultimate stress [MPa]	MSu
X Panel	11	○○	××	△.△△	□□	○.○○
Y Panel	15	○○	××	△.△△	□□	○.○○
SAP	8	○○	××	△.△△	□□	○.○○
⋮	⋮	⋮	⋮	⋮	⋮	⋮

Figure 1.1-3 X Panel case11 Contour of generated stress

1.2 Results of environmental test

(1) Test configuration

A test piece was set on a jig with sufficient stiffness to make various experiments. The test configuration is shown in Figure 1.2-1.

Figure 1.2-1: XX test configuration

(2) Date and place of test

Date: MM, DD, YYYY XX University, Structural Experiment Laboratory, vibration test device and impact test device

(3) Load level

Tests were implemented under the test conditions defined in the interface control document of XX launch vehicle.

(4) Measurement

Accelerometers were attached on several representative points of attachment of onboard instruments and structure panels to be evaluated. The points where the accelerometers were attached are shown in Figure 1.2-2.

Figure 1.2-2 Measurement points of acceleration

(5) Summary of result

The test piece was not broken or damaged and no anomaly event occurred during the test.

The response acceleration is shown in Figure 1.2-3, and the response level at each measurement point did not exceed the allowable level.

Figure 1.2-3: Test data

2. The following shows that measures to prevent release of equipment upon the operation of separation and deployment system of the spacecraft are taken. (see "XXXX Critical Design Report of deployment system" for the details"

2.1 Summary of design

This spacecraft is equipped with S-band antenna and solar array panels. In the following, overview of design to prevent generation of debris in relation to each deployment system is described.

(1) S-band antenna

Retention release mechanism is applied for antenna using fiber. Upon deployment of antenna, the fiber is blowout to release the retainer. It is covered so that the fragments of the cut fiber would not become debris by being released from the spacecraft. The overview is shown in Figure 2.1-1.

Figure 2.1-1 Overview of the cover for protection of dispersion of fiber

(2) Solar array panels

Retention release mechanism using pyrotechnic devices is applied to solar array panels. Upon antenna deployment, the bolts are cut using pyrotechnic devices so that the retainer is released. It has a mechanism (bolt catcher) so that the fragments of the cut bolts would not become debris by being released from the spacecraft. The overview of the cover is shown in Figure 2.1-2.

Figure 2.1-2 Overview of the cover for protection of dispersion of bolts

2.2 Evaluation of load upon deployment of deploying mechanisms

It has been verified that antennas, hinges and structure of solar array panels would not break out due to loads on orbit by both analysis and deployment test. The summary of structural analysis is described in 1.1 results of analysis for structure

(see "XX analysis report for structure" for more details).
The summary of deployment test of antenna and solar array panels are described in the following (see "XX analysis report for structure" for more details).

(1) Test configuration
A test piece was set on a jig with sufficient stiffness to make various experiments. The test configuration is shown in Figure 2.2-1.

Figure 2.2-1 Configuration of deployment test

(2) Date and place of test
YYYY year MM month DD day Structure test building of ○○ University

(3) Measurement
Accelerometers were attached on several representative points of attachment of onboard instruments and structure panels to be evaluated. The points where the accelerometers were attached are shown in Figure 2.2-2.

Figure 2.2-2 Measurement points of acceleration

(4) Summary of result

The test piece was not broken or damaged and no anomaly event occurred during the test.

No excessive local vibration response was detected in the measured data of accelerometer. The test data is shown in Figure 2.2-3.

Figure 2.2-3: Test data

3. Evaluation of combustion products

The pyrotechnic devices used for this spacecraft will not generate combustion product with a maximum dimension of 1mm or larger based on the record used for spacecraft (Type XXX). The shape and specification of the pyrotechnic device is shown in Figure 3-1 and Table 3-1.

Figure 3-1: Outer shape of pyrotechnic devices

Table 3-1: Specification of pyrotechnic devices

Type number	XXX
Mass	○○ g
Minimum current for ignition	△△ A
⋮	⋮

○Mechanism for separation or docking, if applicable

※ Clearly indicate the mechanism for the prevention of constraints on the control of other spacecraft.

Enter information according to 6.2.2 of the Guidelines on Permission Related to Control of Spacecraft.

This spacecraft will separate a slave spacecraft on orbit and the slave spacecraft will take pictures of the master spacecraft to monitor the status of operation of the master spacecraft. An overview of the separation system of the slave spacecraft and its operation, and summary of evaluation on constraints on the control of other spacecraft are shown in the following.

1. Outline

The slave spacecraft follows the master spacecraft keeping a distance of XXkm from the master spacecraft. The slave spacecraft is planned to take pictures of the master spacecraft using an onboard camera. The mechanism of separation of the slave spacecraft is briefly described in 1.1 and the overview of the operation plan is described in 1.2.

1.1 Slave spacecraft separation system

The configuration of the master spacecraft loading the slave spacecraft is shown in Figure 1.1-1. Major specifications of the slave spacecraft are shown in Table 1.1-1, and the configuration of the slave spacecraft after separation is shown in Figure 1.1-2.

The slave spacecraft is not equipped with a propulsion system. Its attitude is controlled by XX.

Figure 1.1-1 Overview of the configuration of the slave spacecraft onboard the master spacecraft

Table 1.1-1: Major specification of slave spacecraft

Dimension (mm)	○○ mm × ○○ mm
Mass (kg)	○○ kg
Battery	Lithium ion secondary cell (2S1P) (XX Manufacturing Company, XX-XXXX)
Attitude control method:	○○
Propulsion system	N/A
Main structural materials	AL-1/8-5056
Main devices installed	Camera, communication devices

Figure 1.1-2 Overview of the slave spacecraft after separation

The separation procedure of the slave spacecraft and an overview of the separation system are described in the following and in Figure 1.1-3, respectively.

(1) The master spacecraft receives a command for separation from the ground station.

(2) The door of the master spacecraft for ejection of the slave spacecraft opens.

・・・

Figure 1.1-3: Overview of slave spacecraft separation system

1.2 Operation of the slave spacecraft

The operation concept of the slave spacecraft is described in this section. The relative position of the slave spacecraft to the master spacecraft on orbit is shown in Figure 1.2-1.

Figure 1.2-1: Relative position of master spacecraft/slave spacecraft

(1) Separation of the slave spacecraft

The slave spacecraft is ejected to the same orbit as the master spacecraft by spring force of △N by operating the separation system described in 1.1 so that the slave spacecraft follows after the master spacecraft.

(2) Operation

The slave spacecraft follows after the master spacecraft keeping a distance of ○km and takes pictures of the master spacecraft. The power for the camera is triggered to turn on by receiving the separation signal ....

(3) Termination of operation

The altitude of the orbit of the slave spacecraft will decrease and its re-entry will begin earlier than the master spacecraft. As for the evaluation concerning re-entry, see the related sections of the following document.

(Attachment 1-4) For spacecraft for re-entry, into the Earth, a mechanism for the ensuring of public safety

(Attachment 2) See control plan 6 "Termination measures of spacecraft"

The application of the slave spacecraft is also submitted separately.

2. Assessment of impact on the control of other spacecraft

Because the slave spacecraft is injected into the same orbit as that of the master spacecraft and is operated at a close position to the master spacecraft, the impact on other spacecraft by the slave spacecraft is considered to be of the same level as that on the master spacecraft. Hence the procedure of injecting the slave spacecraft into the expected orbit is important so as to not place any restriction on the control of other spacecraft.

The procedure of ejecting the slave spacecraft is described in the following (1).

As for the prevention of contamination of space caused by break-up of the slave spacecraft, see the relating sections of the following.

(Attachment 1-3) Countermeasures for the prevention of unintended release of objects

(Attachment 1-4) Countermeasures to prevent break-up

(1) Countermeasures to inject the slave spacecraft into the expected orbit

The causes of a slave spacecraft not being injected into the expected orbit upon the ejection of the slave spacecraft were identified using the method of FTA (Fault Tree Analysis) and the countermeasures for each cause identified were studied. They are summarized in Table 2-1. (See "XXXXXX ○○○○" for details)

Table 2-1 Countermeasures for injecting the slave spacecraft into the expected orbit

Causes	Countermeasure
Physical interference with the door for ejection	The door is nominally set as open. The opening angle should be wide enough with a margin for tolerance of direction of the slave spacecraft to be ejected.
Excessive spring force for ejection	・・・
Errors in attitude of the master spacecraft	・・・
・・・	・・・

(Attachment 1-4)

○Countermeasures to prevent break-up

Enter information according to 6.2.3 of the Guidelines on Permission Related to Control of Spacecraft.

1. The following shows that a spacecraft has a function of transmitting telemetry data on the position, attitude and status of the spacecraft to a ground station for control of the spacecraft and that a spacecraft can measure parameters necessary for detecting precautions which may lead to break-up.

This spacecraft has a propulsion system and batteries which may be a cause of break-up due to pressure system. The spacecraft is monitored by measuring the status of the spacecraft using such sensors shown in Table 1-1.

Table 1-1: Sensors and monitoring items

System	Sensors	Monitoring items
Attitude control	sun sensor, GPS, gyroscope, magnetometric sensor	attitude and position
Propulsion system	tank pressure sensor, thermometer	tank pressure, tank temperature
Power system	Voltage sensor, current sensor, thermometer	voltages of batteries, currents of batteries

The telemetry data shown in Table 1-1 can be transmitted to the ground control facility via S-band antenna. The block diagram of the communication system that shows the relation of each sensor and antennas is shown in Figure 1-1.

Figure 1-1: Block diagram of communication system

2. The following describes how the configuration of the spacecraft is such that it will not be a cause of break-up.

The propulsion system is constituted with commercial products that comply with the High Pressure Gas Safety Act. It was confirmed that the maximum expected operation pressure (MEOP) in launch environment and orbit operation does not exceed the maximum tolerable pressure (rating) of each component. Specification of each component and MEOP are shown in Table 2.1-1 (See "XXX Critical Design Report on Pressure" for detail calculation of MEOP).

Table 2.1-1: Specification of pressure system components

Components	Manufacturer	Type number	Maximum tolerable pressure (rating) [MPa]	MEOP [MPa]
Tank	XX Manufacturing Company	XX-XXXX	○○.○	△△.△
Shut off valve	□□ valve	XX-XXXX	○○.○	△△.△
Plumbing	XX Manufacturing Company	XX-XXXX	○○.○	△△.△
⋮	⋮	⋮	⋮	⋮

Also it was confirmed that the results of pressure tests and airtight tests after the system integration do not show any problem. (See "XXXX Report on pressure system tests" for details of the tests".

2.2 Battery

Lithium ion battery cells manufactured by XX are used in XX parallel x serial. Specifications of the battery cells are shown in Table 2.2-1.

Table 2.2-1: Specification of battery cell

Type of battery	Lithium ion
Manufacturer, type number	Manufacturing company XX-XXXX
Rated voltage	XX V
Rated capacity	XX mAh
Size	○○ mm × ○○ mm
Weight	△△ g

It was confirmed that the battery is designed so as not to breakup according to the following check items.

(1) Prevention of internal short circuit

No internal short in battery cells was detected by comparing charge discharge characteristics before and after environment tests. The results of comparison in measurements of charge discharge characteristics are shown in Figure 2.2-1.

Figure 2.2-1 Comparison of charge discharge characteristic curve

(2) Prevention of break-up caused by external short circuit

In order to prevent break-up caused by an external short circuit, batteries with PTC

(positive temperature coefficient: device with positive temperature characteristic) were selected. Overview of PTC in a battery cell is shown in Figure 2.2-2. An overcurrent protection circuit was also equipped downstream of the battery. The overcurrent protection circuit monitors the current and shuts it down before it exceeds the maximum rating current (XX A) of the battery cell.
The configuration of the overcurrent protection circuit is shown in Figure 2.2-3.

Figure 2.2-2 Overview of PTC in a battery

Figure 2.2-3 Circuit diagram of battery

(3) Overcharge

An overcharge protection circuit was equipped in between the battery and solar cells in order to protect overcharge from the solar cells. The overcharge protection circuit monitors the voltage and shuts the circuit down before it exceeds the maximum

rating voltage XXV of the battery.
The configuration of the overcharge protection circuit is shown in Figure 2.2-3.

3. The following indicates that the spacecraft has a configuration to remove all remaining energy or ensure safety in the cases of anomalies.

3.1 Propulsion system
The configuration of the propulsion system is shown in Figure 3.1-1. In case of detection of anomaly in a monitoring item of the propulsion system, the shut-off valve shown in the figure is opened to vent residual propellant by activating the thruster valve (propellant emission).

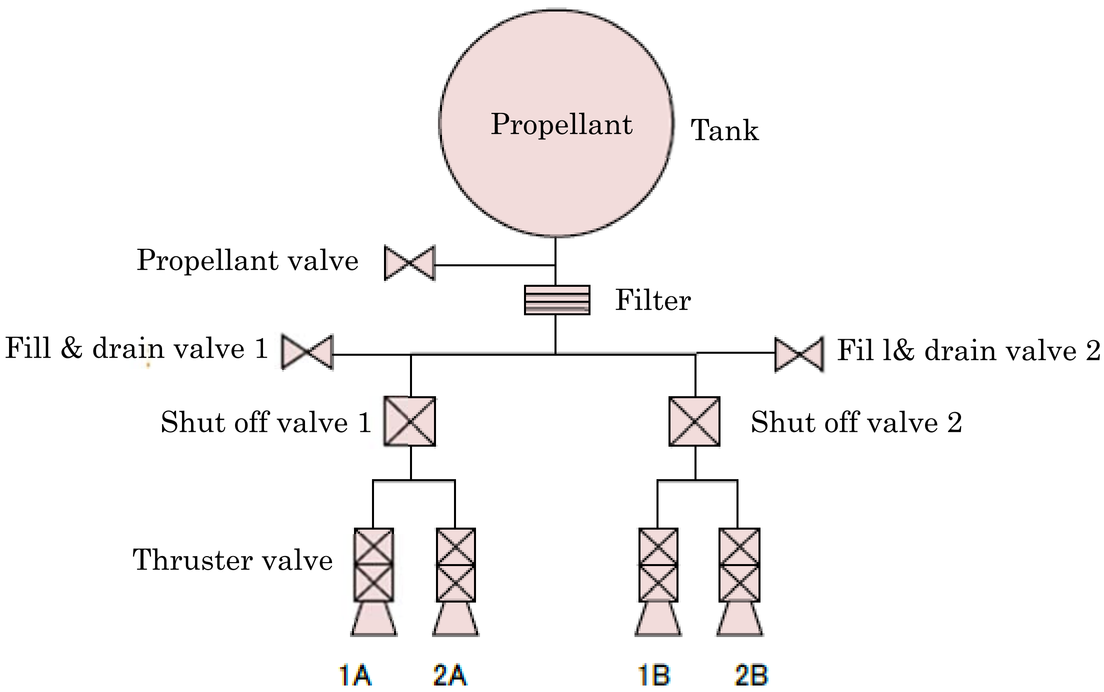


Figure 3.1-1: Configuration drawing of propulsion system

3.2 Battery
As for the prevention of increase of internal pressure due to battery anomaly, the following functions are implemented.

(1) Isolation function of charging circuit
In order to prevent an increase of internal pressure when an anomaly in a battery is detected, FET (Field-Effect Transistor) switches are equipped between solar cells

and the battery so that the solar cells are isolated from the battery. The power from the solar cells is isolated by switching off the FET in response to a command from the ground station. The circuit diagram of the isolation of the charging circuit is shown in Figure 3.2-1.

Figure 3.2-1 Circuit diagram of the function of isolation of charging circuit

(2) Safety valve

The battery cell including a safety valve to prevent the increase of internal pressure of the battery cell during an anomaly is selected. The internal pressure can be relieved by the safety valve even when the internal pressure of the cell increases. An overview of the safety valve of the battery cell is shown in Figure 3.2-2.

Figure 3.2-2 Overview of safety valve of the battery cell

○For spacecraft for reentry into the Earth atmosphere, countermeasures to ensure public safety

Enter information according to 6.2.4 of the Guidelines on Permission Related to Control of Spacecraft.

1. Outline

Survivability of the spacecraft and its components upon natural decay of the spacecraft is confirmed and expected casualties are evaluated to confirm public safety. A summary of each evaluation is described in the following. (See "XXX Report on the safety analysis upon re-entry" for details).

2. Conclusion

The results of the study show that the expected casualties upon the re-entry of this spacecraft are as follows, which satisfies the international criteria indicated in the guideline.

- Expected casualties: ●●.●$\times 10^{-\triangle}$ (<< 1×10^{-4})
  (Casualty area: △△.△△ (m^2))

3. Environment of the analysis and its condition

3.1 Tools used

○○tool Ver. △.△

Manual: 「○○○○○○○○」

3.2 Condition of analysis

(1) Assumption of orbit

- Inclination: XX°
- Initial condition of latitude and longitude of the spacecraft: ○°、○°
- Initial altitude of the orbit: ○○km

(2) Conditions of the analysis

Table 3.2-1 Conditions of analysis

Assumption of falling condition	random tumbling
Analysis method of heating and melting	mass concentration method
Oxidization heat of formation	○○%
・・・	・・・

(3) Data used

Table 3.2-2 Data used

Atmosphere data	US standard 1976
Fragment data	See Table 3.2-3.
Material data	See Table 3.2-4.
Population data	GPW (Gridded Population of the World) version-○
・・・	・・・

Table 3.2-3: Fragment data

Item	Shape	Dimension (mm)	Mass (kg)	Quantity	Major materials	Location
Structure	box	○×○×○	△	×	AL2014	outer shell
Battery	cylinder	Φ○×○	△	×	Nickel	inside Box
・・・	・・・	・・・	・・・	・・・	・・・	・・・

Table 3.2-4 Material property (summary)

Item	Specific heat	Thermal conductivity	Density	Emissivity	Latent heat	Oxidization heat of formation
AL2014	○.○	△.△	×.×	◎.◎	●.●	▲.▲
Nickel	○.○	△.△	×.×	◎.◎	●.●	▲.▲
・・・	・・・	・・・	・・・	・・・	・・・	・・・

(4) Approach on the break-up altitude

Based on literature XX, the break-up altitude is set as XX km.

The survivability of the spacecraft at an altitude lower than the XX km is analyzed assuming the condition in which the spacecraft is divided into each component shown in Table 3.2-3.

4. Results of analysis

4.1 Determination of the break-up point

The tool was used for analysis of the spacecraft configuration shown in Table 3.2-3 assuming the condition for analysis shown in Table 3.2-1 that starts from the initial condition described in 3.2(1). The property of the orbit at the break-up altitude XX km according to the calculation is shown in the following.

Table 4.1-1 Property of the orbit at the break-up altitude

Altitude (km)	○○.○
Inclination (°)	○○.○
Latitude and longitude (°)	latitude○○.○, longitude △△.△
Relative velocity (km/sec)	○○.○
Longitudinal angle (°)	○○.○

4.2 Reentry Survivability analysis

The tool was used for analysis of each component shown in Table 3.2-3 assuming the condition for analysis shown in Table 3.2-1 that starts from the break-up altitude shown in Table 4.1-1. The fragments survived are shown in the following.

Table 4.2-1: Survived fragments

Item	Casualty area (m^2/fragment)	Quantity	Total Casualty area (m^2)	Impacting kinetic energy (J)
Battery	○○.○	△	××.×	◎◎
・・・	・・・	・・	・・・	・・・

Total casualty area: ●●.● (m^2)

4.3 Expected casualties

The expected time of re-entry of this spacecraft is from XXX to XXX.

The expected casualties concerning the survived fragments shown in Table 4.2-1 is calculated. The results are shown in the following.

Table 4.3-1: Survived fragments

Expected time of falling	Expected casualties (person)
○○○○ year	●●.●
△△△△ year	▲▲.▲
・・・	・・・

(Attachment 1-5)

- ○ As for spacecraft, etc. containing substances derived from another celestial body that are to be retrieved by guiding them to fall onto the Earth, countermeasures to prevent the environment of the Earth from deterioration.

Enter information according to 6.2.5 of the Guidelines on Permission Related to Control of Spacecraft.

This item is not applied as this spacecraft is an earth orbiting spacecraft.

- ○ As for the spacecraft, etc. that are to be injected into orbits of a celestial body other than Earth or those to be caused to fall onto such celestial body, countermeasures to prevent such celestial body from harmful contamination.

Enter information according to 6.2.6 of the Guidelines on Permission Related to Control of Spacecraft.

This item is not applied as this spacecraft is an earth orbiting satellite.

(Attachment 2)

Control plan

Enter information according to 6.3 of the Guidelines on Permission Related to Control of Spacecraft.

1. Brief description of spacecraft control facility

For the operation of the spacecraft, two or more ground stations, in addition to the place of operation specified in the written application, are to be used. Spacecraft control facilities located in Japan are specified in Table 1-1, and other radio equipment in Table 1-2. The major place of operation is Hokkaido Station, and major ground station is XXXX.

Table 1-1: Brief description of spacecraft control facility

#	Category	Name of facility	State	Place
1	Place of operation	Hokkaido Station	Japan	_____ City, Hokkaido
2	Place of operation	Nagoya Station	Japan	______ City, Aichi
3	Ground station	×××	Japan	_____ City, _____ Prefecture

Table 1-2: Brief description of other radio equipment

#	Category	Name of facility	State	Place
1	Place of operation	□□□	U.S.	_______ State, _______ City
2	Ground station	○○○	South pole	○○°○○'○○"S, ○○°○○'○○"E
3	Ground station	△△△	Norway	XXXX Prefecture

2. Method of control of spacecraft

Main configuration of ground station XXX is shown in Figure 2-1.

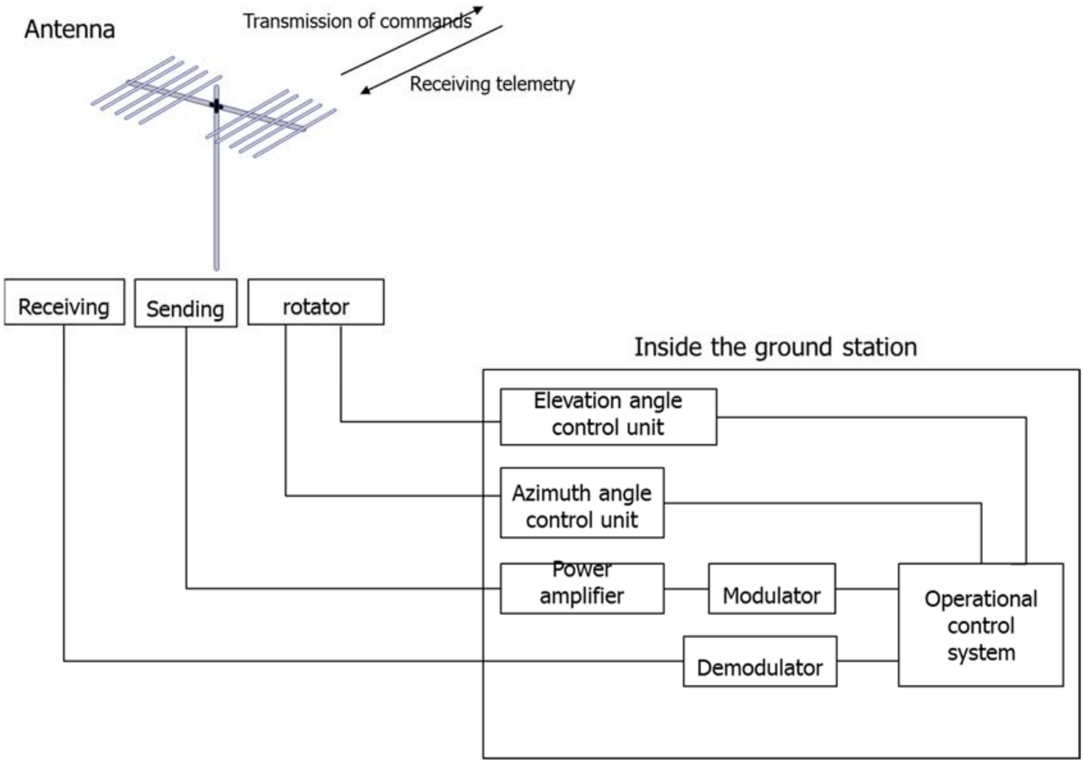


Figure 2-1: Configuration of ground station

This spacecraft separates a slave spacecraft and conducts the Earth observation mission on the orbit. An overview of the control of the spacecraft is shown in Table 2-1.

Table 2-1 Outline of control of spacecraft

Operational phase	Details of operation
Phase A (For X months)	<u>Initial operation</u> ・Check out of spacecraft bus system ・Evaluation of performance of orbit determination system, attitude determination system, and attitude control system ・Check out of the ground station
Phase B (After XX months)	<u>Ejection of slave spacecraft</u> ・The slave spacecraft is injected into the expected orbit with the expected attitude by maneuvering the attitude of the master spacecraft. ・Send commands for ejecting slave spacecraft ・Confirm that the separation is executed as expected via telemetries sent from the separated slave spacecraft and the master spacecraft.
Phase D (XX months and thereafter)	<u>Normal operation phase</u> ・The spacecraft take images for earth observation according to the commands sent from the ground station and transmits the data to the ground station.

3. Prevention of interference with the control of other spacecraft upon separation and docking

The spacecraft separates a slave spacecraft as specified in Attachment 1-3. The orbital life of the slave spacecraft, the assessment of the surrounding orbital environment and procedures to avoid critical effect on the control of other spacecraft are described in "XXXXXX Procedures for Separating Slave Spacecraft."

4. Prevention of break-up upon the occurrence of anomalies

The following is the method of implementation of measures to prevent the break-up of spacecraft in the case of detecting any anomaly in the position, attitude and condition of the spacecraft (for the details of procedures, see "XX-XXXX Procedures for Response to Contingency").

(1) Measures related to residual liquid propellants and residual high-pressure fluid

(i) Execute the procedure described in (ii) if the monitoring parameters relating to the propulsion system show abnormal values compared with thresholds (deviate from normal values) and the risk of break-up increases without any prospect of recovery. The monitoring parameters and their thresholds relating to the propulsion system are shown in Table 4-1.

Table 4-1 Monitoring parameters and thresholds for propulsion system

System	Monitoring parameters	Threshold
Propulsion system	Tank pressure Ptnk	Ptnk < XX MPa
	Tank temperature Ttnk	○○℃< Ttnk < △△℃

(ii) Residual propellant is vented by transmitting the following commands to open shut-off valves and activate thruster valves (thruster firing).

・Sending command to open shut-off valves

・Sending command for thruster firing

(iii) Confirm that the tank pressure Ptnk and tank temperature Ttnk recover to normal values.

(2) Measures related to battery

(i) Execute the procedure described in (ii) if the monitoring parameters relating to power system show abnormal values comparing with thresholds (deviate from normal values) and the risk of break-up increases without any prospect of recovery. The monitoring parameters and their thresholds relating to the power system are shown in Table 4-2.

Table 4-2 Monitoring parameters and thresholds for power system

System	Monitoring parameters	Threshold
Power system	Battery voltage Vbat	Vbat < XX V
	Battery current Ibat	Ibat < ○○ A
	Battery temperature Tbat	□□℃ < Tbat < △△℃

(ii) The solar cells must be isolated from the batteries by transmitting the following commands. The batteries must be discharged completely by operating loads only by batteries.

・Sending commands to open the switch for isolating charging circuit

5. Prevention of collision with other spacecraft, etc.

Because this spacecraft is not capable of transferring to another orbit, maneuvering to avoid collision cannot be executed, however, the projection area of the spacecraft is 0.XX m^2 and the probability of collision with another spacecraft, etc. is very small.

6. Termination measures for spacecraft

The spacecraft is to re-enter onto the earth by natural decay due to atmospheric drag.

The orbital life after the termination of operation considering atmospheric drag was analyzed using orbital life calculation software. The conditions input into the analysis are as follows.

【Condition for analysis】

Semi-major axis: XX km

Eccentricity: XX

Inclination: XX°

Right ascension of the ascending node: XX°

Argument of perigee: ○○°

Date of termination of operation: MM, DD, 20YY

Area-to-Mass: ○.○○○ m^2/kg

Average area: ○.○○○m^2

Mass: XX kg

The results of analysis using orbital life calculation software are shown in Figure 6-1. The results of analysis show that the orbital life is XX, and it was confirmed that the spacecraft will re-enter by natural decay within 25 years.

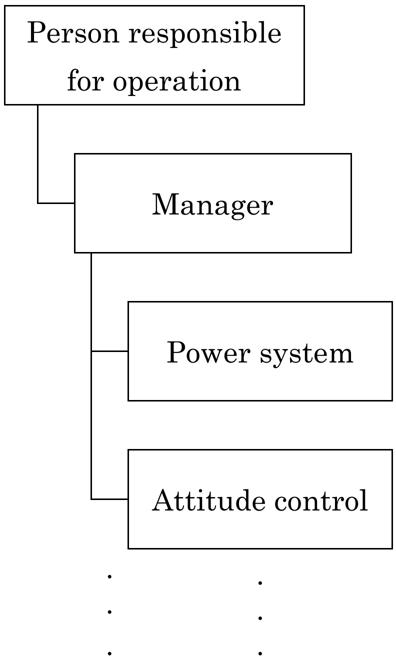
Figure 6-1 Result of analysis of orbital lifetime

7. Establishment of organizational structure for the implementation of the control of spacecraft

(1) Organization for management and duties

Persons in charge of respective duties as well as the roles and responsibilities are shown in the management structure tree in Figure 7-1.

<Duties and responsibilities>



Person responsible for operation: General supervision of the business related to the operation, control of spacecraft

Manager: Assistant to person responsible for operation, the general supervision while in operation

Power system: Control of a power system of spacecraft

Attitude control: Control an attitude control system of spacecraft

Figure 7-1: Tree of structure of organization for control of spacecraft

Training will be given to staff members of each system, so as to ensure that staff members acquire appropriate competence. The following is the brief description of a training plan for staff members of each system (for details, see "XX-XXX Training Plan").

- Confirmation of procedures
- Training related to nominal operations
- Training related to response to major contingencies

(2) Response to contingency

Figure 7-2 shows the reporting structure and route in cases where any contingent situation is discovered. Figure 7-3 shows the flowchart of response for contingent situations.

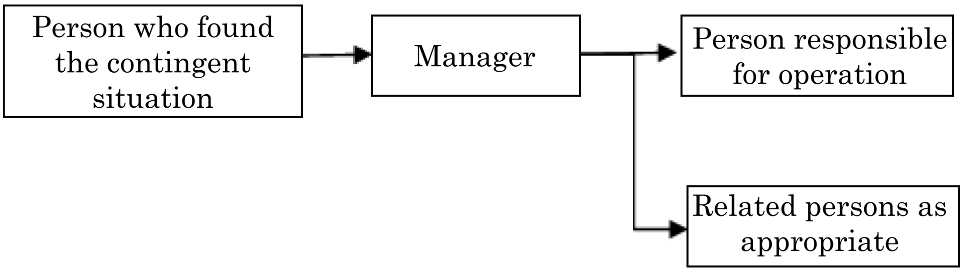


Figure 7-2 Reporting route in case of contingency

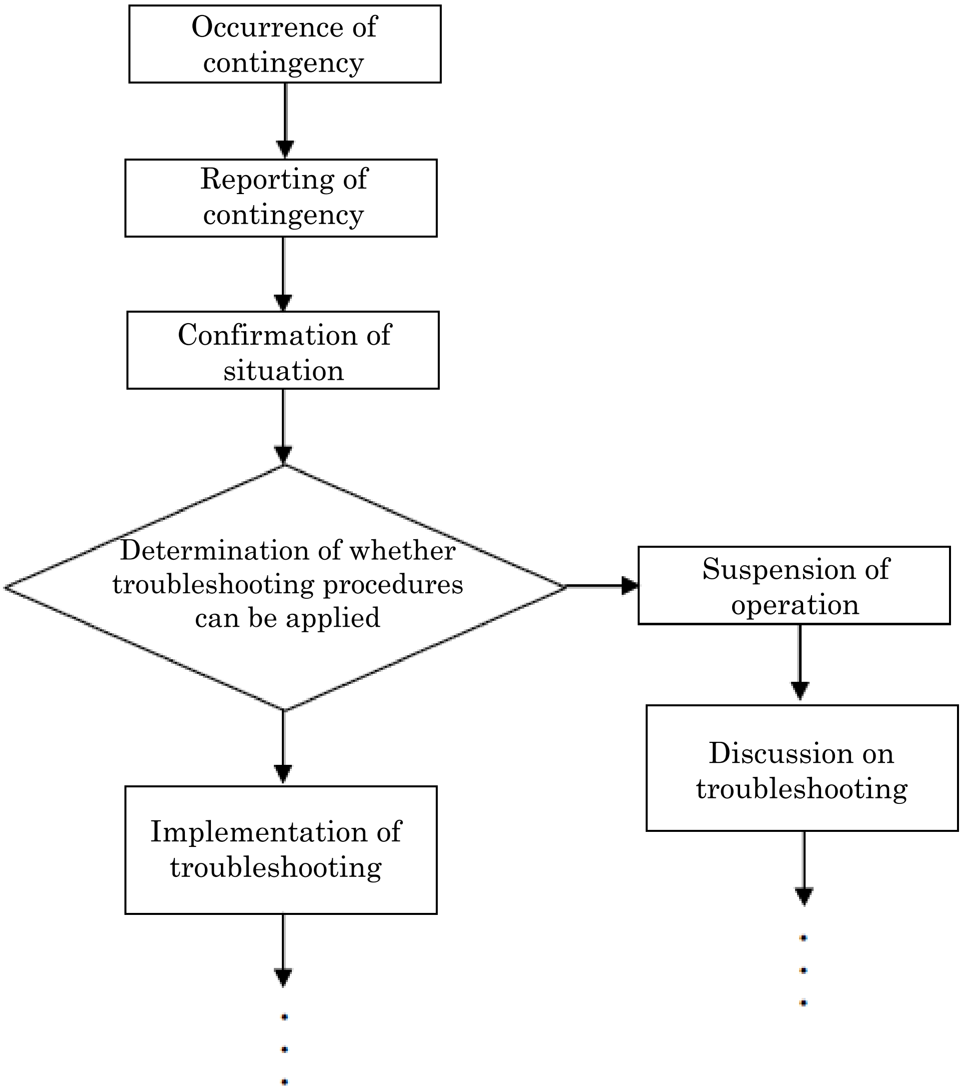


Figure 7-3 Flowchart for responding to contingent situations

After the initial response, study the causes according to the allocation of roles and responsibilities as well as organizational structures shown in Figure 7-4 so as to determine the permanent measures to address the problem.

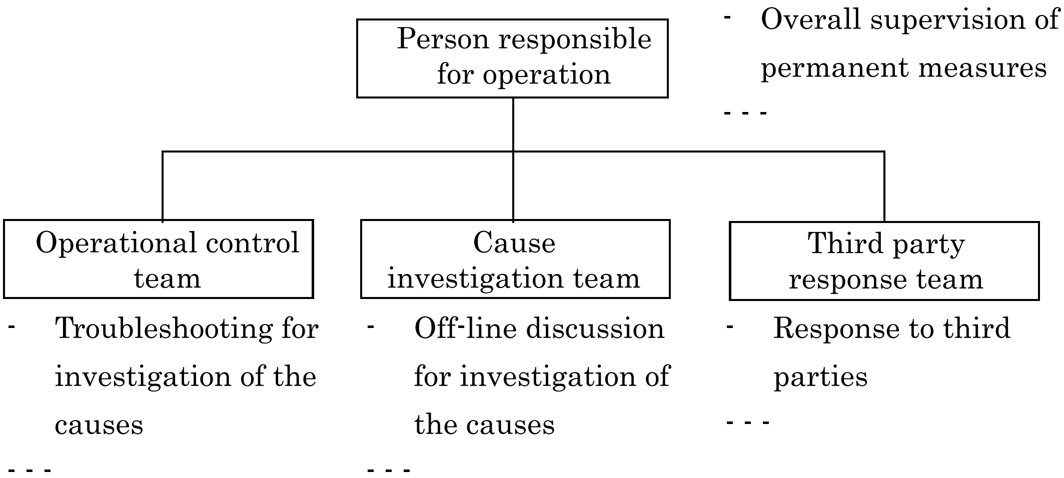


Figure 7-4: Tree of structure of organization for investigation and response related to causes of anomalies

(3) Security measures

The following is the overview of the security measures implemented at the spacecraft control facility.

Figure 7-5 shows the organizational structure for information security structure for the control of spacecraft.

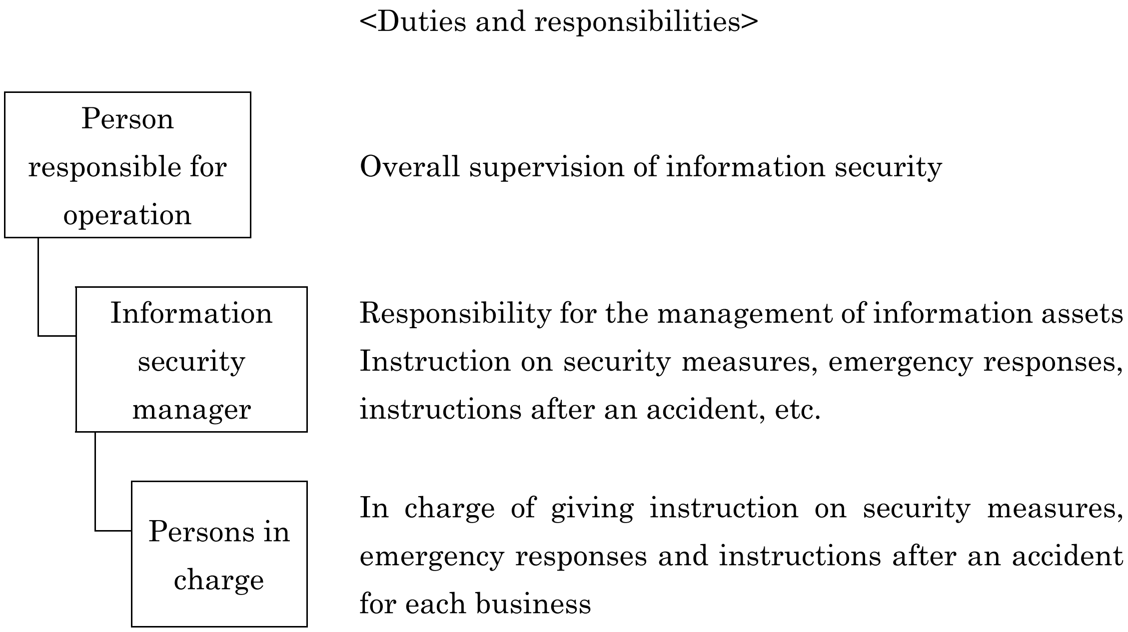


Figure 7-5 Organizational structure for Information security

The following is an overview of the security measures implemented at the spacecraft control facility (for details, see the XX-XXXX Regulations on Information Security related to Control of Spacecraft).

- Measures against malware

  Use anti-virus software XXX and use computers while paying attention to the following:
  - Keep the virus pattern file updated.
  - Use the latest anti-virus software as practicable as possible.
  - Keep the automatic real-time scan function activated.

- Measures against information leakage

  Ensure that the following measures are implemented as measures against information leakage from the workplace and systems.
  - Use a security system allowing access to the spacecraft control facility by only authorized persons.
  - Communications are to be encrypted using XXX.
  - Ensure that data, etc. will not be brought out of the spacecraft control facility to the possible extent. If necessary, manage the recording medium by keeping a management record.
  - Comply with a clear desk policy and clear screen policy (e.g. log off the system while not in use, lock the screen)