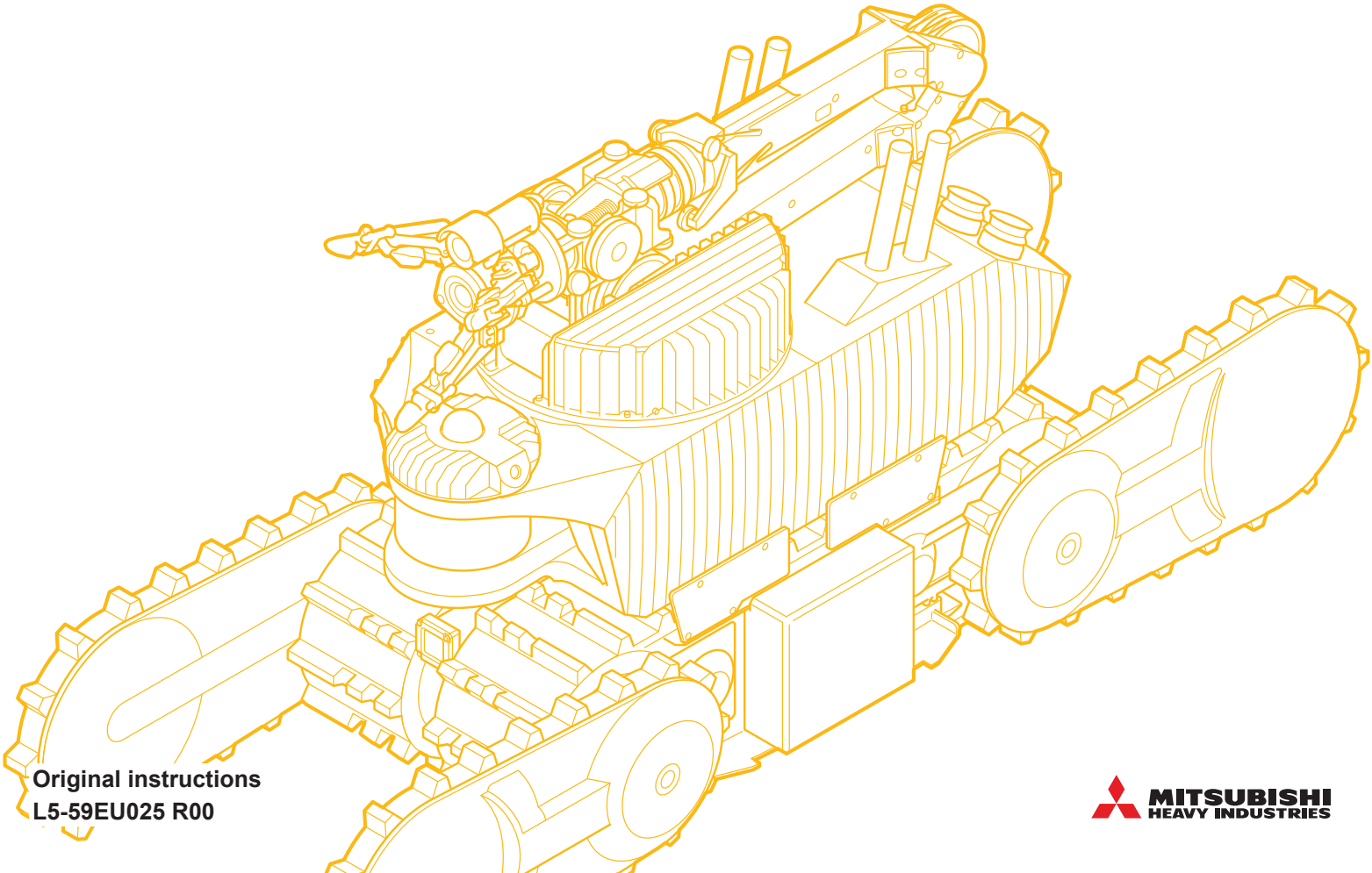
MOVE THE WORLD FORWARD

MITSUBISHI HEAVY INDUSTRIES GROUP

Robotic System for Autonomous Plant Inspection

EX ROVR

Maintenance Manual



Original instructions

L5-59EU025 R00

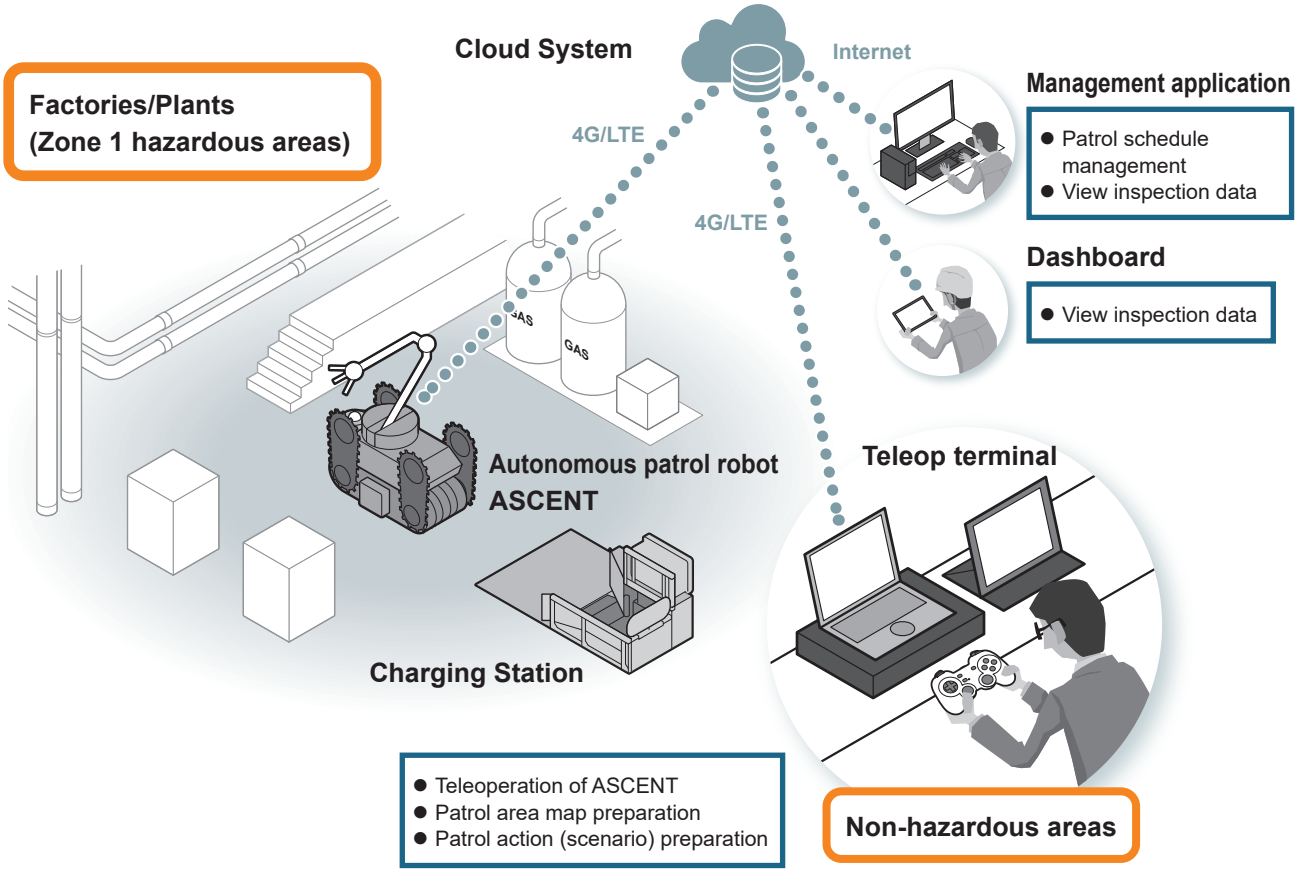
MITSUBISHI HEAVY INDUSTRIES

Contents

Chapter 1 EX ROVR Overview

1.1 Introducing EX ROVR

The EX ROVR Robotic System for Autonomous Plant Inspection is designed to monitor the interior of plants and factories where there is a risk of fire due to handling of flammable materials, such as in oil and gas plants. Inspections are performed by the ASCENT autonomous patrol robot, and the resulting data is stored in a cloud system for viewing.



EX ROVR is designed to comply with Japanese guidelines for explosion protection and ATEX/IECEx, the explosion protection certification widely adopted in Europe and other parts of the world.

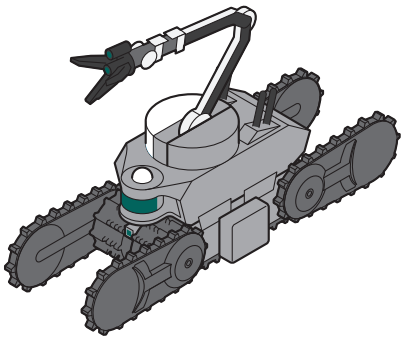
- The system can be used in Zone 1 and Zone 2 hazardous areas where there may be an atmosphere of explosive gas or vapor. It cannot be used in Zone 0 hazardous areas.
- It cannot be used in areas where there may be an explosive atmosphere of combustible or explosive dust (e.g., mines).
- It cannot be used in Group II C explosive gas atmospheres, except for hydrogen gas.
- In places where radiation levels are extremely high (e.g., disaster sites), there is a risk of malfunction or operational failure.
  Also, the system is not intended for use in the following locations.
- Public places where people gather, such as stores, lodging facilities, and parks
- Hospitals and other medical facilities
- Residences
- On board ships or aircraft

Reference: Classification of Hazardous Areas

Category	Description
Zone 0	Places of normal use where a hazardous atmosphere is continuously present, present for long periods of time, or frequently present. Applicable locations include places where flammable gases are constantly present, such as inside a flammable liquid container or above a flammable liquid surface.
Zone 1	Places where a hazardous atmosphere may occur under normal conditions of use. This indicates places where flammable gases are not constantly present, but are released under certain conditions. This includes places such as the openings of flammable liquid containers, where flammable gases are released only during inspection or other work.
Zone 2	Places where hazardous atmospheres are unlikely to be generated under normal conditions of use or, if generated, are present for only a short period of time, or where explosive atmospheres are only generated under abnormal conditions due to malfunction.

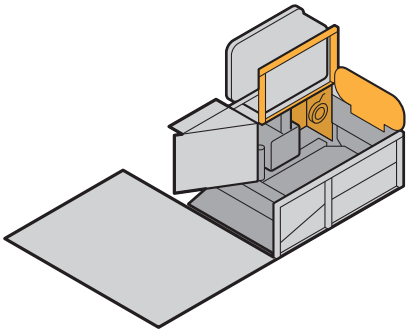
1.2 System Components and Their Functions

■ ASCENT patrol robot



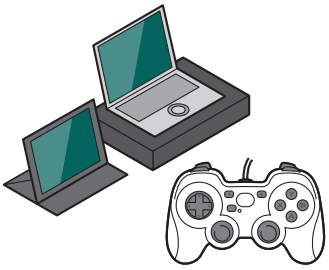
Robot that autonomously patrols inside a factory or plant to collect internal information. The system provides explosion-proof performance so that it cannot cause ignition in factories and plants where ignition is a hazard.

■ Charging Station



Purges, pressurizes and recharges ASCENT.
As with ASCENT, it provides explosion-proof performance, and can be installed together with ASCENT inside factories and plants.

■ Teleop terminal



Terminal used to operate ASCENT. Does not have explosion-proof construction, and should be used in a non-hazardous area separate from the hazardous area where the ASCENT and Charging Station are installed.
The terminal provides the following applications.
Teleop software: Used to operate ASCENT remotely.
Scenario Maker: Used to prepare scenarios that define patrol routes and inspection actions.

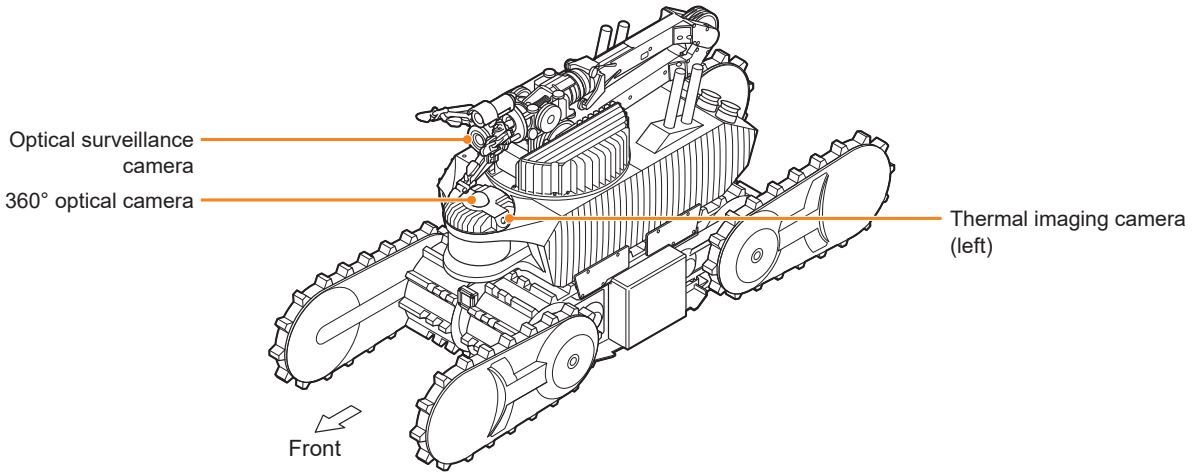
■ Web application

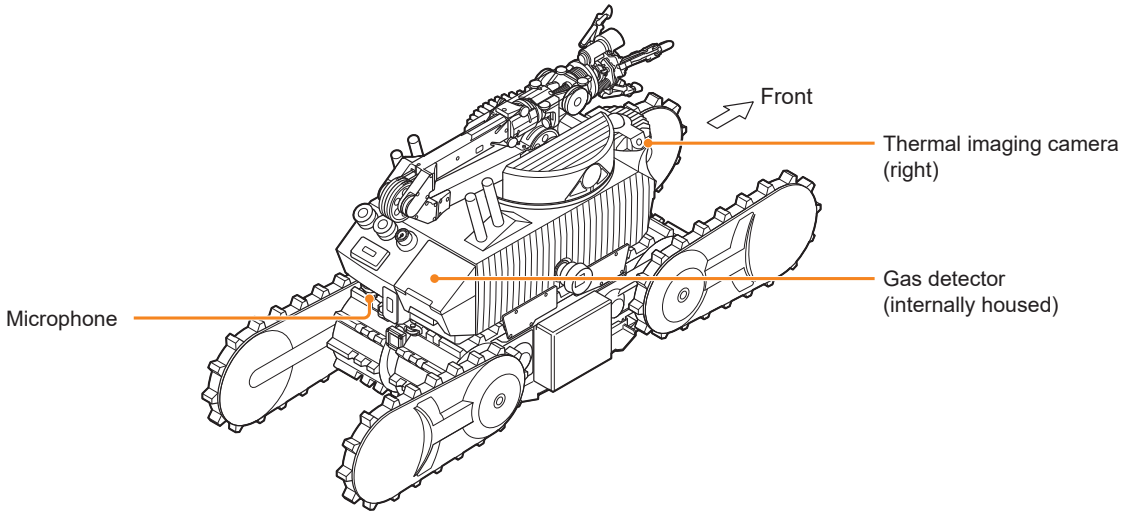
This application is used to access a cloud system from a web browser on a PC or tablet (not included with EX ROVR).
Management application: Allows system users to make ASCENT autonomous patrol schedules and view inspection data.
Dashboard: Used for checking the current position and status of ASCENT.

1.3 Inspection Targets

ASCENT is equipped with multiple optical and thermal imaging cameras, microphones, and gas detectors.
The following information can be obtained from each device

Target	Device	Information obtained
Instruments, etc.	Optical surveillance camera	Video (displays images captured by the camera during teleoperation) Still images (acquired manually or by scenario)
Entire area to be inspected (360°)	360° optical camera	Video (displays images captured by the camera during teleoperation) Still images (acquired manually or by scenario)
Any heat source	Thermal imaging camera	Video (displays images captured by the camera during teleoperation) Still images (acquired manually or by scenario)
Sounds	Microphone	Audio (acquired manually or by scenario)
Gases of the following types in the vicinity of ASCENT: Combustible gases (carbon monoxide), hydrogen sulfide, oxygen	Gas detector	Measured gas concentrations (always displayed on the teleop screen of the teleop terminal)





■ Notes on the on-board gas detection function

ASCENT detects four types of gases: oxygen (O_2), combustible gas (COMB), hydrogen sulfide (H_2S), and carbon monoxide (CO).

- Gas detection results do not guarantee safety within the patrol area.
- Gases other than those targeted and solvent vapor may also be detected, so please take the measurement environment into account.
- Avoid using the system in the vicinity of silicone sealants, etc., or in a silicone gas atmosphere, as this may impair the performance of the equipment.
- Detection of high concentrations of sulfur dioxide, chlorine, or other gases may shorten sensor life and increase errors.
- Prolonged detection of hydrogen sulfide may shorten sensor life or reduce sensitivity.
- In locations where variance from the standard atmospheric pressure is great (for example, at elevations greater than 1000 m above sea level), gas detector's oxygen sensor may become unable to display accurate values.
- Because it is calibrated with isobutane, there is reduced sensitivity with respect to other combustible gases.
- Since the gas detector automatically performs AIR adjustment (zero adjustment) upon ASCENT startup, the concentration displayed may be incorrect if ASCENT is started up in the presence of combustible gas.

1.4 ASCENT Driving Performance

Driving speed: Max. 1.2 km/h during horizontal travel
Driving time: 1 to 2 hours when fully charged (varies according to operation)
Time required for full charge: 2 hours

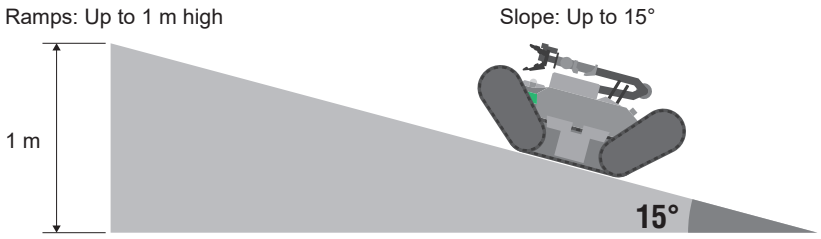
■ Driving performance on slopes, steps, stairs and ditches

⚠ WARNING

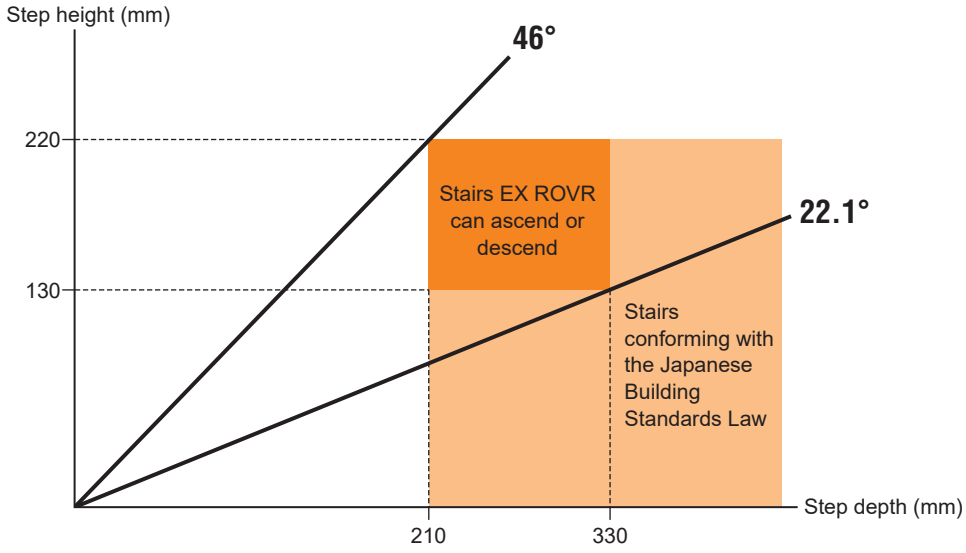
- **Do not drive on steps or slopes that exceed its performance limits.**
  Accident or damage may result due to tipping or slipping and falling.

		During autonomous patrol	During teleoperation
Slope		Depends on the nature of the inclination (such as the coefficient of friction)	
	Slope	See A on the next page	Inclination of 46° or less
	Bank	Water runoff slope or less (slope 1/50 to 1/100, or 0.57° to 1.15° in angular terms)	Slope for running without tipping over is 20° or less.
Stairs		Step height: 130 to 220 mm Step depth: 210 to 310 mm Step width: 900 mm or greater For slope, see B on the next page.	Step height: 130 to 220 mm Step depth: 210 to 310 mm Step width: 900 mm or greater Inclination of 46° or less
	Landing	Capable of navigating landings of the following shapes and dimensions. U-shaped: Minimum dimensions of 1800 mm (W) x 1000 mm (D) L-shaped: Minimum dimensions of 1000 mm (W) x 1000 mm (D) I-shaped: Minimum dimensions of 900 mm (W) x 900 mm (D)	
Difference in level		Height: 20 cm or less (must have a rectangular cross section)	Height: 40 cm or less (depending on form)
Ditches		Width: Within 15 cm	Width: Within 30 cm (depending on form)

A: Slope that can be navigated during automatic patrol



B: Inclination of stairway that can be navigated during automatic patrol

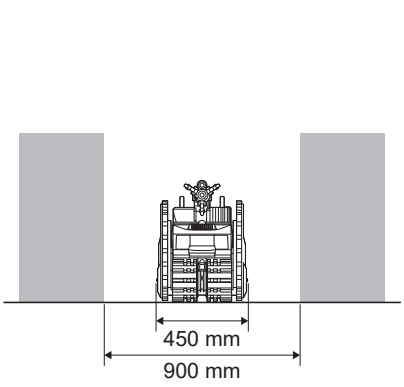


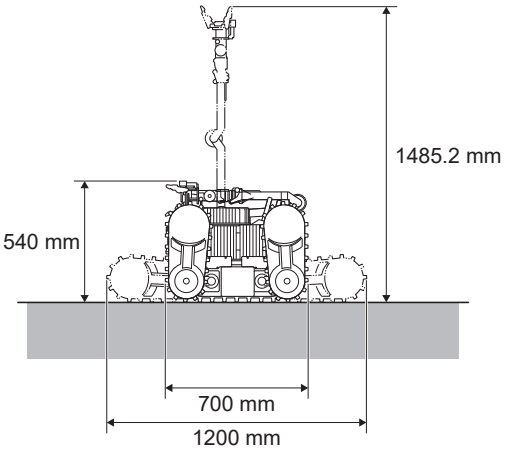
■ Places where driving is not possible

Driving is not possible on ice, sand, fine gravel (less than 5 mm in diameter).
In addition, puddles (2 cm or more deep), snow, weeds that were not present at time of map or route setting, and heavy rain or snowfall may make determinination of position difficult, although driving is possible.

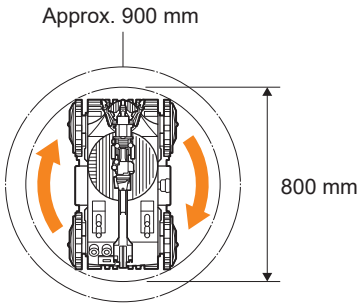
1.4.1 Driving route conditions

ASCENT cannot travel through aisles that are narrower than its own external dimensions. Allow enough space around ASCENT for a person to stand (approx. 900 mm).





When turning in an aisle, available area must exceed the total length of ASCENT. Allow approximately 900 mm of space as shown in the figure on the right.

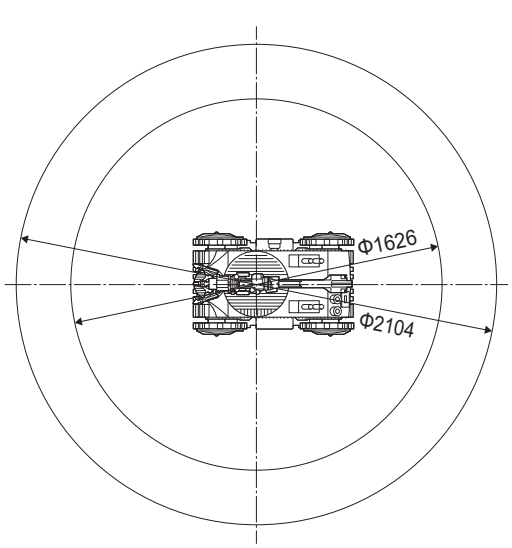


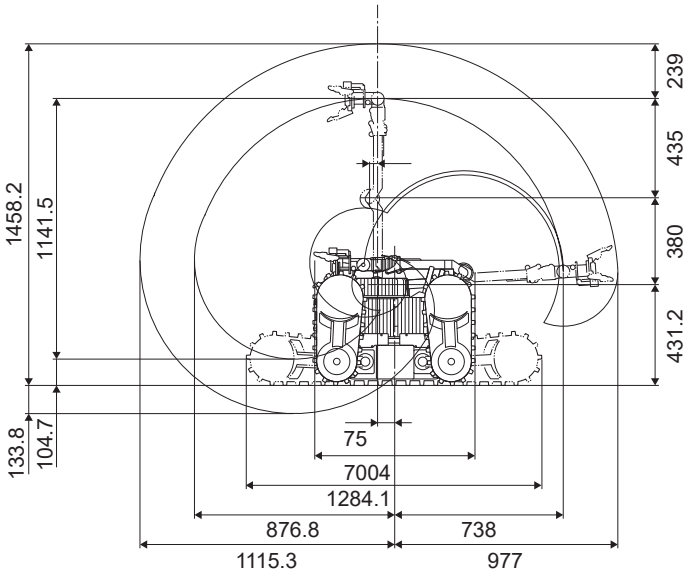
Also, be aware of the range of motion of the manipulator. When moving the manipulator, be careful not to hit nearby people or objects.

⚠ CAUTION

- **Do not move ASCENT with the manipulator extended.**
  There is a risk of causing injury to people or damage to objects by hitting them.
  Also, vibration may cause the manipulator to malfunction.

Unit: mm



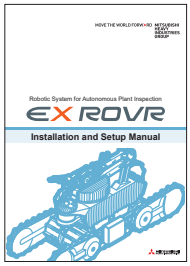


1.5 Introduction Sequence and Manual Composition

The EX ROVR introduction sequence is as follows. Refer to the appropriate manuals for tasks and operations required for introduction.

Charging Station Installation
- Transportation of the Charging Station to the installation place
- Make power and compressed air connections
- Adjust pressure

Preparing ASCENT
- Transportation of ASCENT to the Charging Station
- Purge, pressurize, and charge (putting ASCENT on standby)

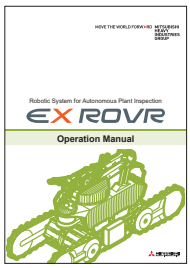


Refer to “Installation and Setup Manual”

Planning and maintenance
- Patrol route considerations
- Floor maintenance
- Stair/step measurement
- Installation of markers

Map creation
- Teleoperation of ASCENT to prepare a map
- Registration of inspection targets
- Registration of stairs and steps

Scenario creation
- Patrol route determination
- Determination of inspection target actions

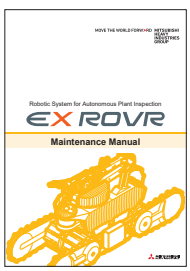


Refer to “Operation Manual”

Patrol schedule management
- Specification of scenario execution schedule

Verification of patrol results
- Patrol result verification from history

Care and maintenance
- Daily inspection
- Initial inspection
- Semi-annual inspection
- Bi-annual inspection



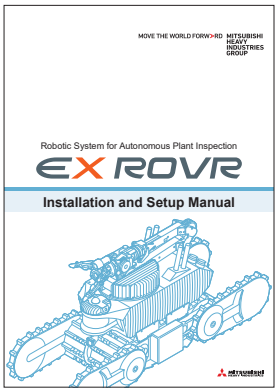
Refer to “Maintenance Manual” (This Manual)

1.5.1 Intended user

This product has been designed and developed for use by personnel who possess knowledge of explosion protection; that is, the knowledge required to work properly in Zone 1 hazardous areas. Work should be carried out under the supervision of a safety administrator with whom work details have been discussed in advance.

The individual operations and tasks described in the manuals for this product should be undertaken by the following users.

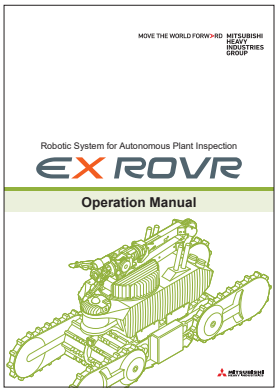
■ Installation and Setup Manual



- Electrical engineers or workers trained in safety who are familiar with the rules, regulations, and standards of the place of installation and IEC 60079-17*, if applicable.
- Workers who have knowledge of explosion protection and are qualified to work properly in Zone 1 hazardous areas.

* One of the standards set by the International Electrotechnical Commission, an international standardization organization that prepares international standards in the fields of electrical and electronic technology. Sets forth the requirements for maintenance and inspection of explosion-proof electrical equipment.

■ Operation Manual



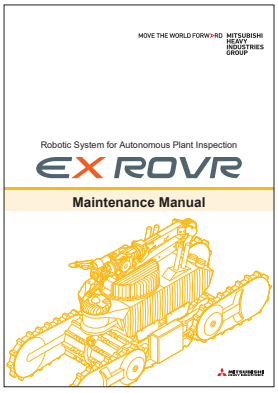
Users of ASCENT teleoperation and cloud systems:

- Workers who can perform basic computer operations.
- Workers who manage the company network.

On-site workers:

- Electrical engineers or safety-trained operators who are familiar with rules, regulations, and standards of the installation site and IEC 60079-17, if applicable.
- Workers who have knowledge of explosion protection and are qualified to work properly in Zone 1 hazardous areas.

■ Maintenance Manual



- Electrical engineers or safety-trained operators who are familiar with rules, regulations, and standards of the installation site and IEC 60079-17, if applicable.
- Workers who have knowledge of explosion protection and are qualified to work properly in Zone 1 hazardous areas.

MEMO

Chapter 2 Safety Precautions

The precautions presented here are intended to ensure safe and correct use of the equipment and to prevent injury to people and damage to property.
These precautions are marked “DANGER”, “WARNING”, “CAUTION”, or “NOTE”, and must be observed.

DANGER	Indicates a hazardous situation which, if handled improperly, presents immediate risk of death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if handled improperly, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if handled improperly, could result in injury.
NOTE	Indicates a situation which, if handled improperly, could result in equipment failure or property damage.

Icon examples

The following symbols are used to denote content that requires your attention (including warnings).

	Indicates cautionary information regarding safety.

The following symbols indicate prohibited actions.

	Indicates a prohibited action.
	Indicates that disassembly is prohibited.

The following symbol indicates a required action.

	Indicates a required action.

⚠ WARNING

The inspection environment's ambient temperature should be between 0 and 40°C.
Extremely high temperatures may cause the battery to overheat and malfunction. Furthermore, battery performance may deteriorate at temperatures below 0 °C.

Wear protective equipment when performing inspection work near ASCENT or Charging Station.
- Helmet
- Appropriate clothing that fits your body
- Safety shoes
- Non-slip gloves
- Protective goggles/glasses

Have at least two persons present when performing inspections with the power on.
If the machine operates unexpectedly, one's fingers could be caught or hit by moving parts, resulting in injury.
One person should always be available to make an immediate emergency stop.

If an abnormality is found, contact the manufacturer or your maintenance provider without attempting repairs yourself.
Failure to maintain safety may lead to accidents.

Use only replacement parts and accessories recommended by Mitsubishi Heavy Industries.
Using a non-recommended product may result in accidents or malfunctions.

Those who use a pacemaker or defibrillator should note the following.
- **Do not allow body parts containing implanted devices to come within 15 cm from the ASCENT radio module or teleop terminal.**
- **Keep body parts containing implanted devices at least 30 cm away from the contactless power reception unit while charging is in progress.**
- **Keep body parts containing implanted devices away from the magnet-operated power switch key.**

Radio waves and magnets may adversely affect the operation of electronic medical devices.

NOTE

When condensation may have occurred, wait for it to evaporate before performing regular inspections with power on.
Condensation may occur in locations that are subject to rapid changes in temperature, possibly causing ASCENT or its Charging Station to malfunction or run out of control. It can also cause gas detectors and cameras to malfunction.

■ Regarding ASCENT

⚠ WARNING

Do not disassemble ASCENT (except to remove the battery during disposal).
ASCENT has a pressurized explosion-proof structure. Disassembly or opening of covers may compromise the explosion-proof rating, resulting in ignition of flammable gases.
Before removing the battery or other parts for disposal, move ASCENT to a non-hazardous area.

Do not ride ASCENT.
There is a risk of injury from falling or getting your limbs trapped. It may also result in malfunctions.

Do not insert fingers or foreign objects (especially conductive foreign objects or flammable foreign objects such as oil) in the crevices of ASCENT (for example, at the base of manipulator).
Doing so may result in malfunction or fire.

If ASCENT enters an uncontrolled state (status LED flashes red) during inspection, immediately stop and recover it. (Except when checking the internal pressure interlock)
If the 3D-LiDAR malfunctions or a software error occurs, control over ASCENT may be lost, causing it to go astray.
If a software error is the cause, you may not be able to stop ASCENT from the teleop terminal. In this case, taking care with regard to safety, press the emergency stop button on ASCENT.

Do not perform the following operations in hazardous areas.
- **Do not power on ASCENT before purging (when internal pressure is not maintained).**
- **Do not turn on the power in maintenance mode.**
- **When ASCENT is stopped outside the Charging Station (e.g., by pressing the emergency stop button), do not power on ASCENT on the spot.**

Flammable gases may ignite.

⚠ CAUTION

Do not look directly at the laser beam emitted by the 3D-LiDAR and rear obstacle proximity sensor or magnify it by a lens or other means.
It may cause short-term visual impairment or afterimages.

NOTE

Avoid exposing the optical surveillance camera or the truck camera to direct sunlight for an extended period of time.
Such exposure may cause damage to the photoreceptors.

Keep electrical devices away from the area of ASCENT's antenna.
There is a risk of electromagnetic interference.

■ Regarding the Charging Station

⚠ WARNING

Do not disassemble the Charging Station (except to remove the auto oiler during disposal).
If disassembled, the explosion-proof rating may not be maintained, and flammable gases may ignite.

Make sure that the flanged flameproof joint plane surface between the Charging Station's control panel lid and the enclosure is not subjected to impact or insertion of foreign matter.
The contact area of the joint surface between the lid and the enclosure is an integral part that ensures the performance of the explosion-proof structure. If foreign matter gets inside or the joint surface is damaged or distorted, do not operate the system.

Do not apply excessive force to, pull or step on, or excessively bend the power cable.
Doing so may result in damage, heat generation, or fire.

When stepping inside the Charging Station, be careful of the rollers.
There is a risk of injury from falling.

■ About the teleop terminal

⚠ WARNING

Do not carry the teleop terminal into hazardous areas.
The teleop terminal is not explosion-proof. Carrying it into a hazardous area would present a risk of ignition of flammable gases.

Do not disassemble the teleop terminal (except to remove the battery during disposal).
Doing so may result in fire, electric shock, or malfunction.
The notebook computer cannot be removed from the case and used for other purposes.

Do not place containers of water or other liquids or metal objects on the teleop terminal.
If liquid or foreign matter gets inside, turn off the power and unplug the power plug from the outlet.

Do not expose the device to high temperature for a long period of time.
Prolonged exposure to extremely high temperature, such as near a fire or under the hot sun, may cause deformation, malfunction or deterioration of internal parts. Using it in that condition may result in fire or electric shock due to a short circuit or insulation failure.

Do not place the device in any location where there is a lot of water, moisture, steam, dust, or oily smoke.
Doing so may result in fire or electric shock.

NOTE

Keep electrical devices away from the area of the teleop terminal's antenna.
There is a risk of electromagnetic interference.

2.1 Before Doing Inspection Work

In accordance with the national industrial safety and health regulations of each country, the employer should give appropriate instructions and training to personnel (teleoperators and inspectors).
When an inspector has to work near ASCENT while it is being driven, establish and comply with work rules to avoid danger due to unexpected or erroneous operation. These work rules should include the following items:

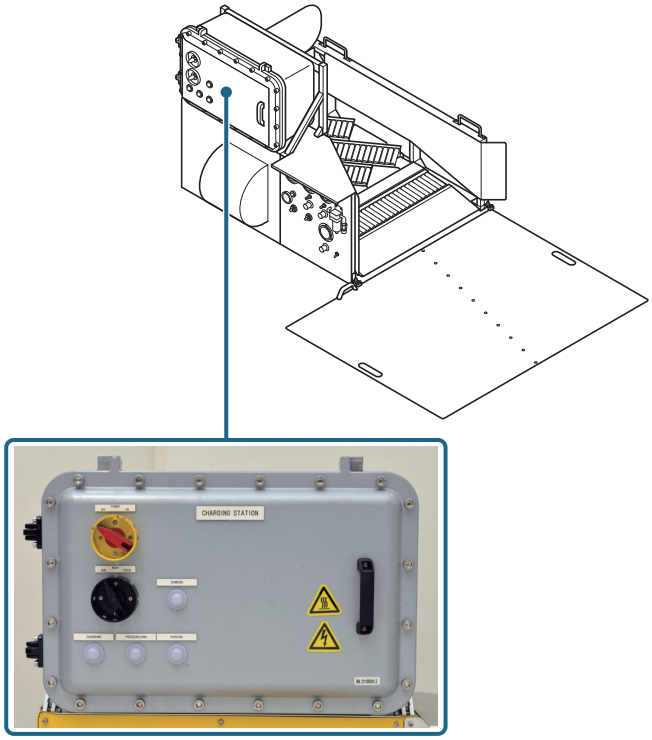
- ASCENT operation methods and procedures (e.g., identification of operators)
- Operating ASCENT and manipulator speed
- Method of signaling when work is performed by multiple workers
- Abnormality countermeasures
- ASCENT restarting measures after stopping due to an abnormality
- Measures to prevent danger due to erroneous operation
- Measures to enable the inspector or person monitoring the inspector to immediately stop ASCENT operation in the event of an abnormality

Take measures to prevent anyone other than the designated teleoperator from operating the teleop terminal while work is being performed, such as by displaying a message on the teleop terminal that work is in progress.

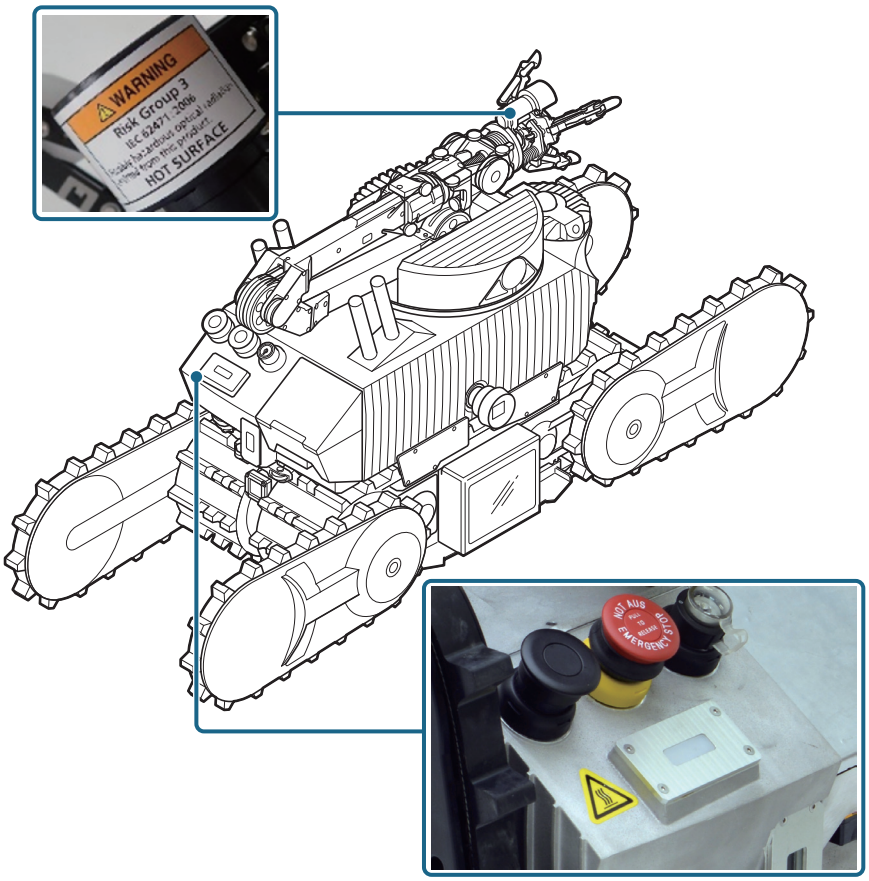
2.2 Warning Labels

Warning labels are attached to the following parts of the system to indicate hazards or warnings.

Charging Station



ASCENT

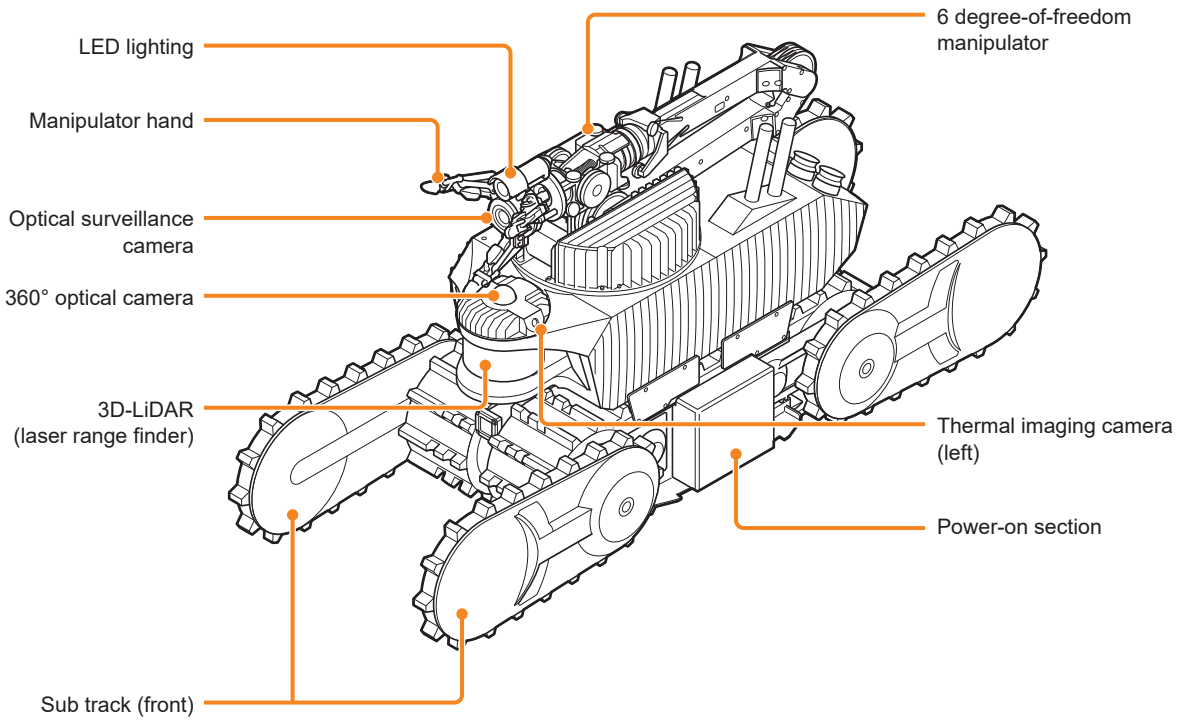


Warning labels	Description
	This symbol indicates that there is a heat danger due to high-temperature parts. Be sure to confirm that all parts are at a safe temperature.
	This symbol indicates electrical danger, such as risk of electrical shock or burns. The power supply must be disconnected.

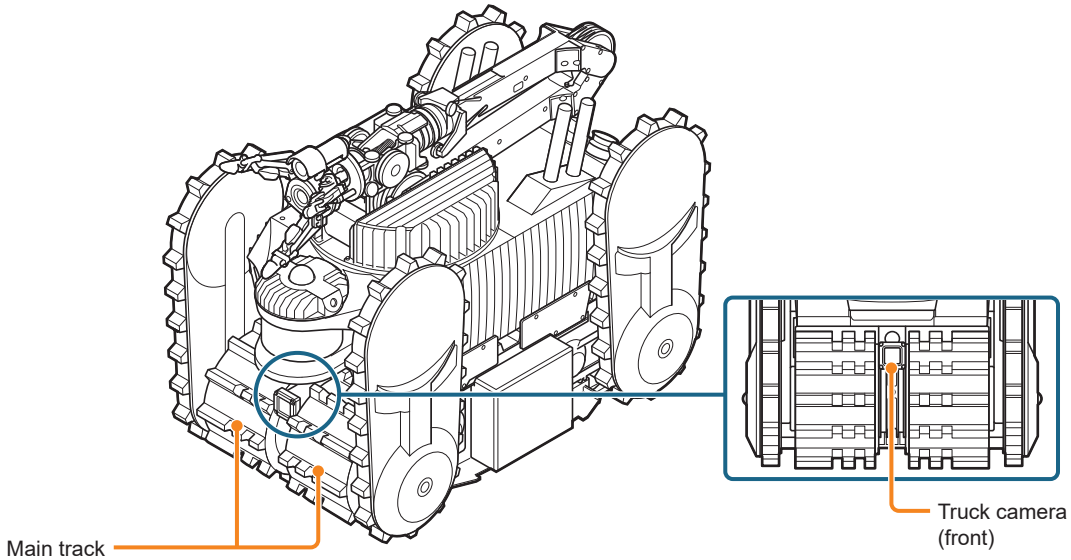
Chapter 3 Part Names and Functions

3.1 ASCENT

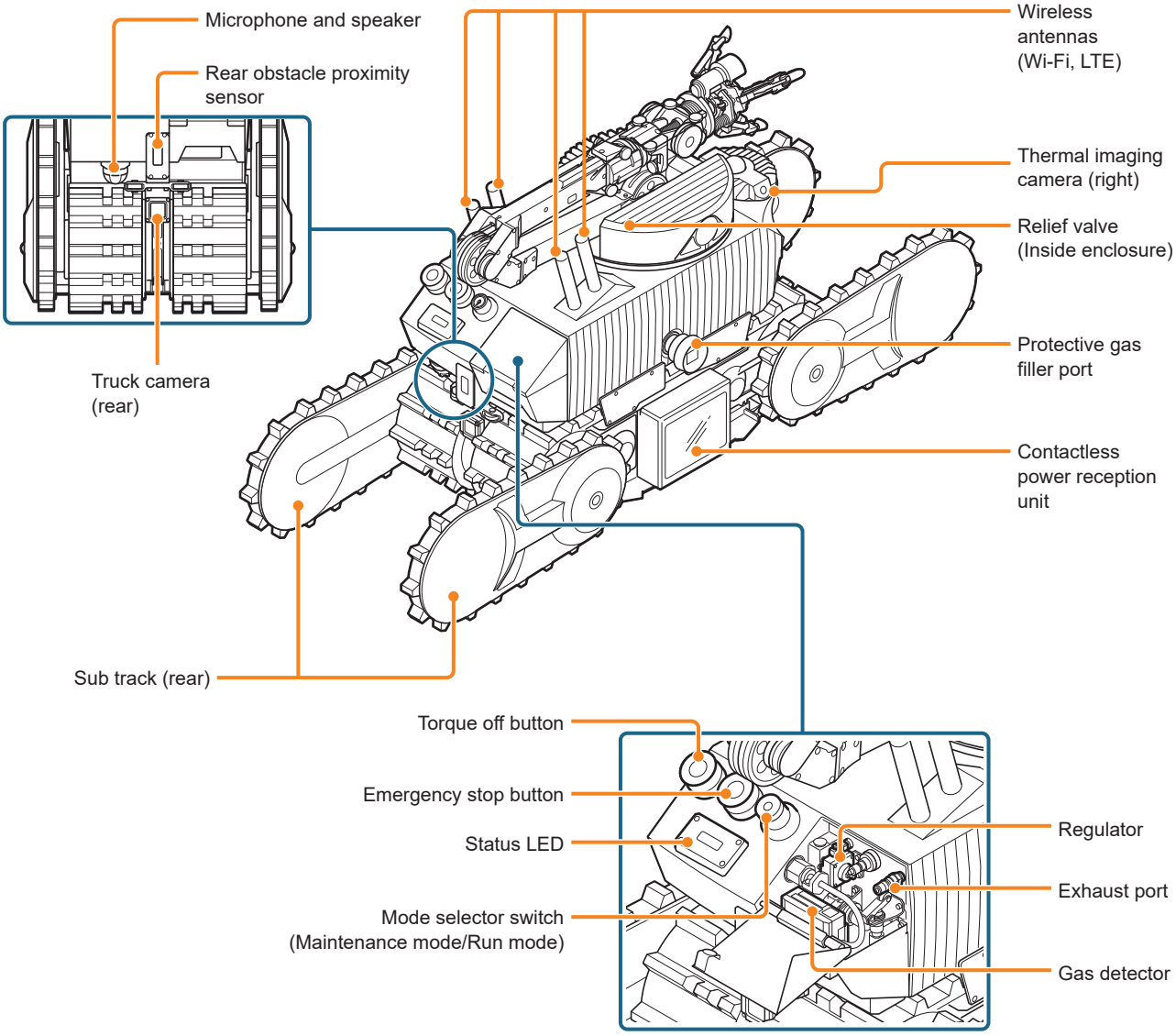
■ Top left front view (with sub track lowered)



■ Top left front view (with sub track raised)



■ Top right rear view

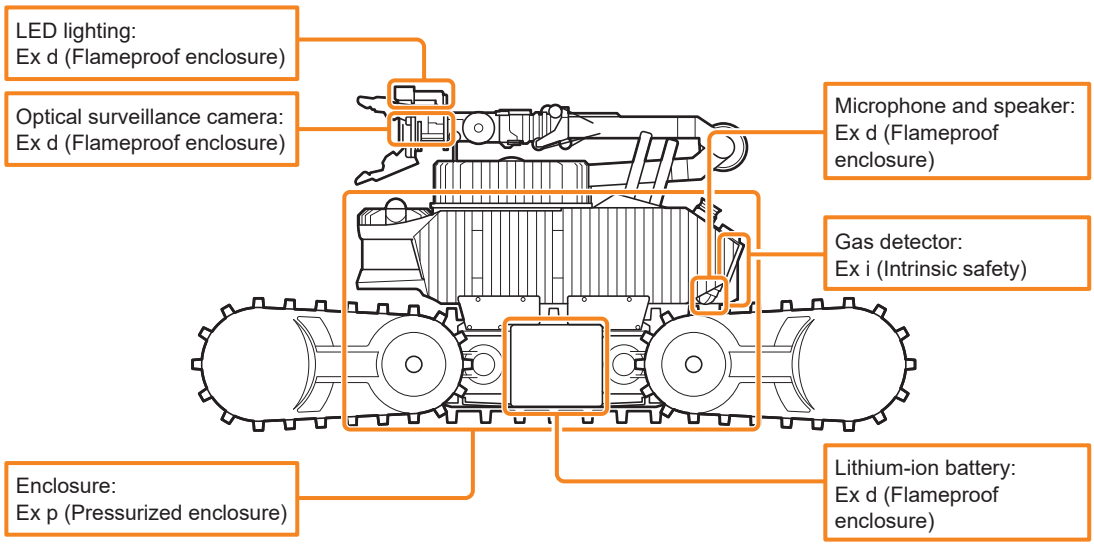


Status LED indications and their meanings

Status LED color	Status LED state	Description
Red	Lit	ASCENT powered on in one of the following states. • Standby mode • Self-check in progress • Preparing for power shut-down
	Flashing	An anomaly has occurred, and one of the following conditions is present. • Uncontrolled state (fatal anomaly) • Standby (not controlled)
Green	Flashing	Operating under control of teleop terminal.
Blue	Flashing	Scenario running.
Yellow	Flashing	Charging.
	Lit	Charging stopped (fully charged). Or, entering/exiting Charging Station.
Extinguished		ASCENT power is off.

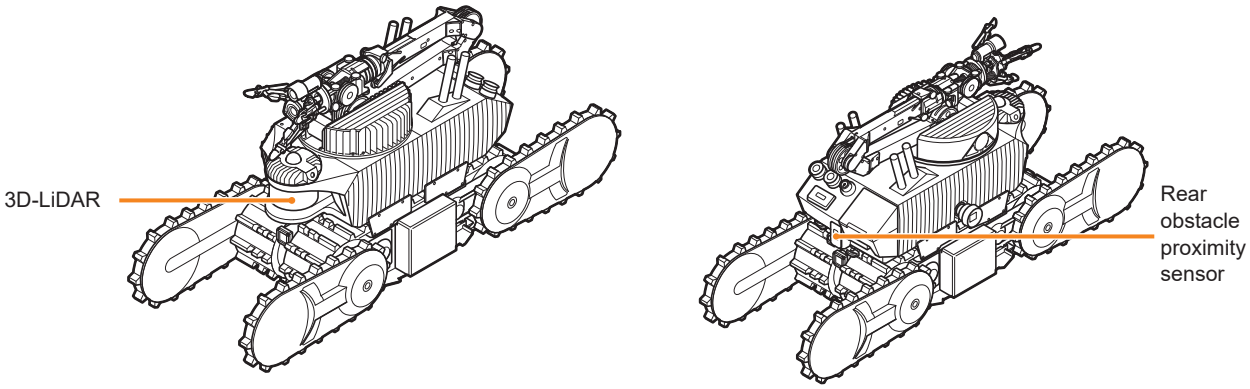
Explosion-proof structure of ASCENT

ASCENT has explosion-proof construction in its main body and individual parts. For details on explosion proofing, see “Installation and Setup Manual”.



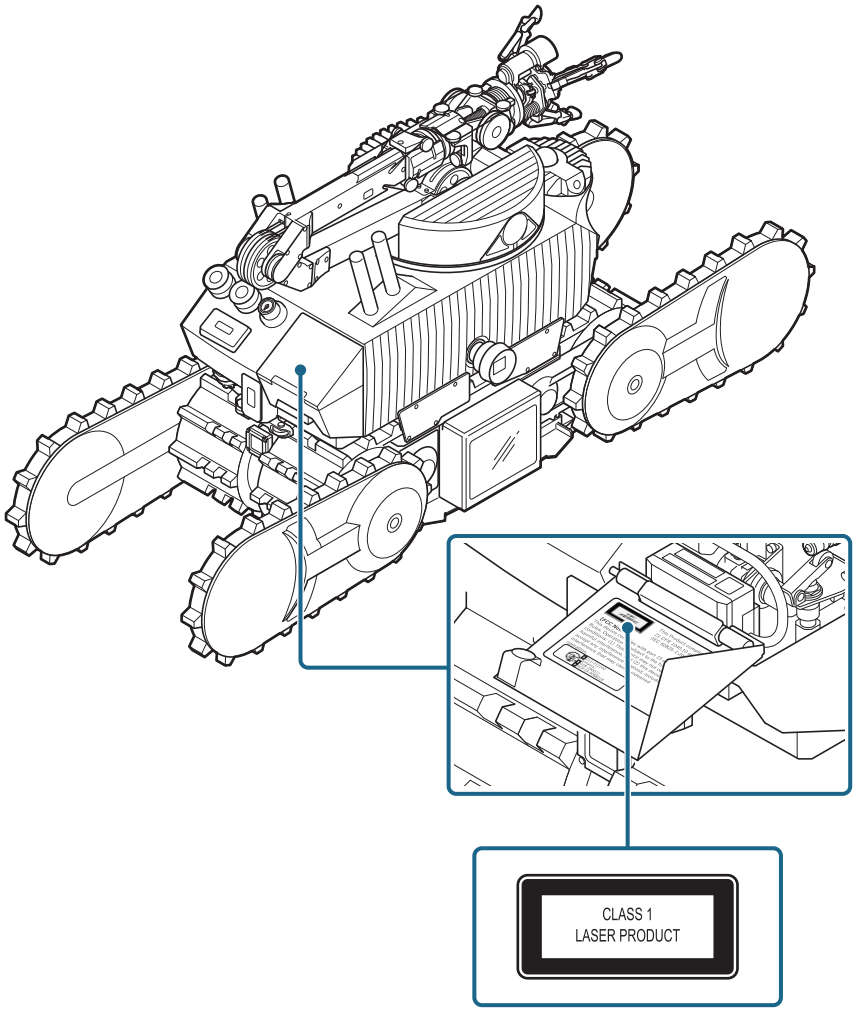
■ Information regarding ASCENT's Class 1 laser

Lasers are emitted from ASCENT's 3D-LiDAR and rear obstacle proximity sensor.



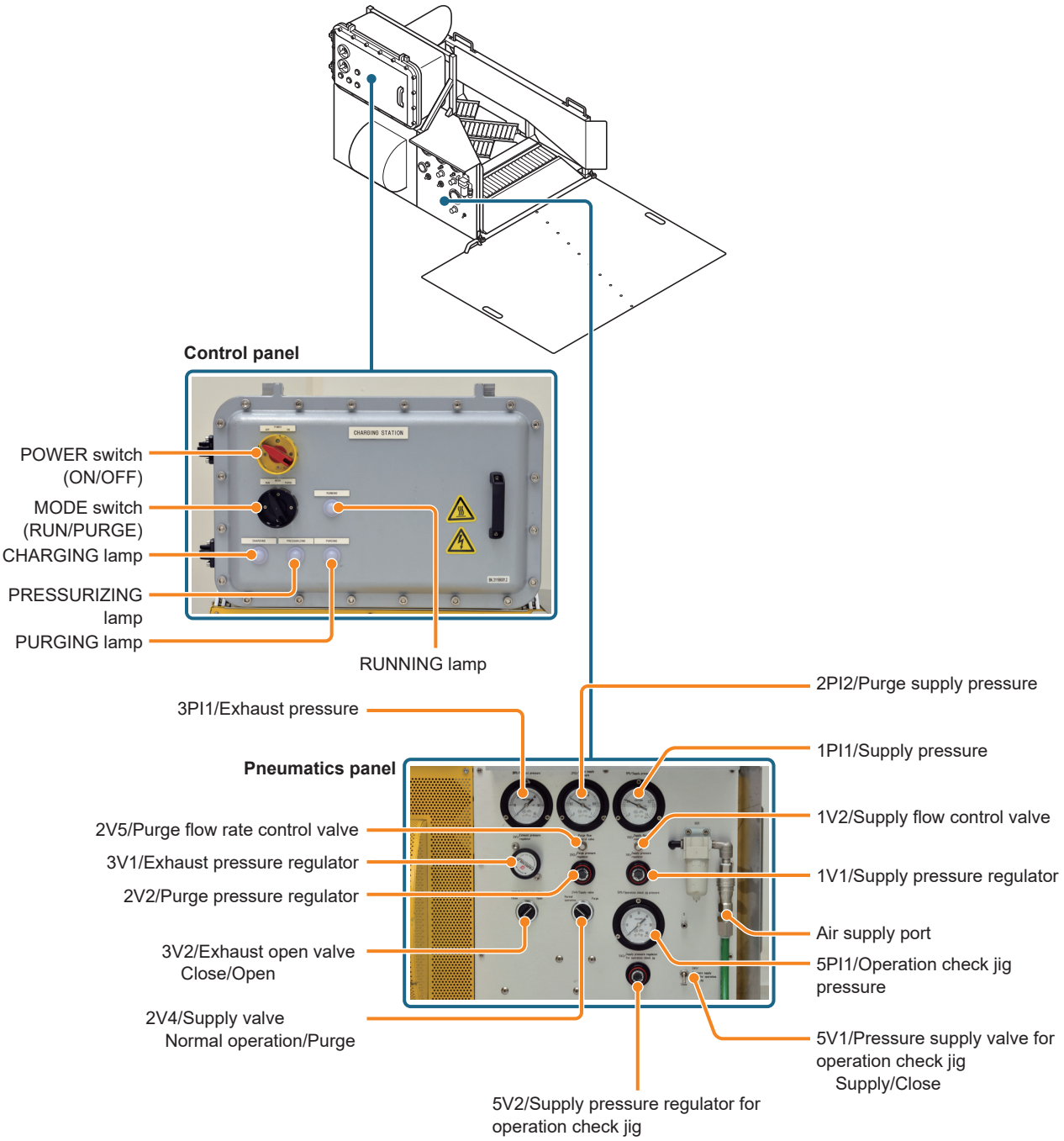
The laser complies with 21CFR1040.10 and 1040.11 and IEC 60825-1.
Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The label for the laser can be found on the nameplate affixed to the backside of the ASCENT rear cover.

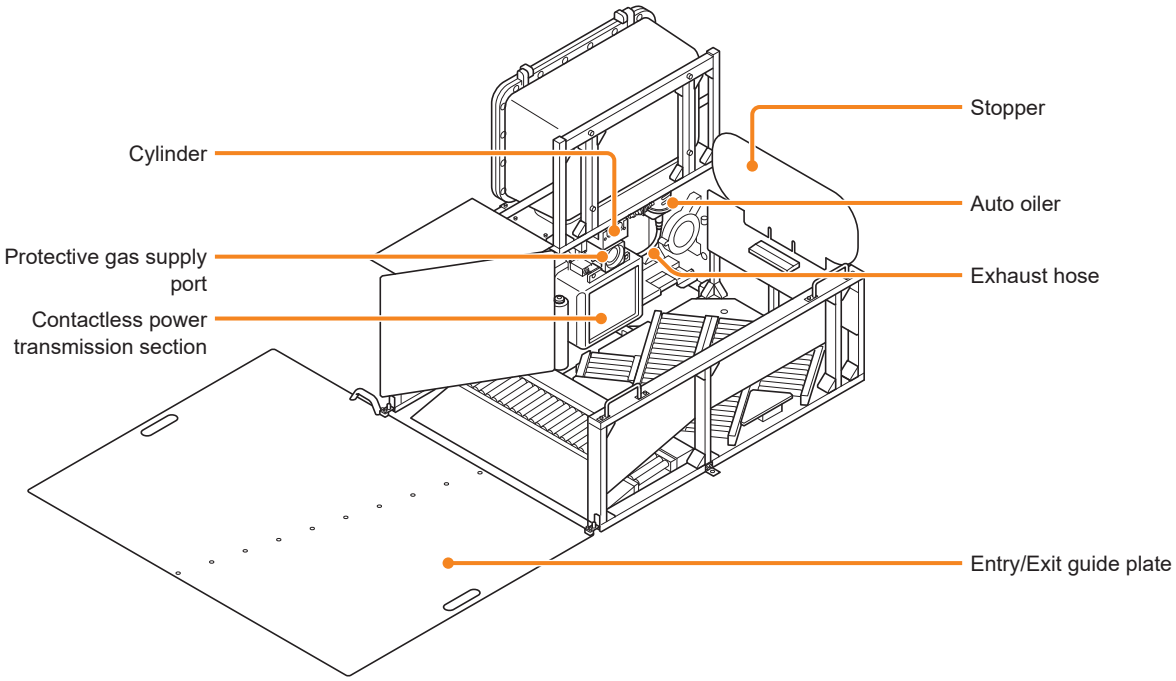


3.2 Charging Station

■ View from front upper right



■ View from front upper left

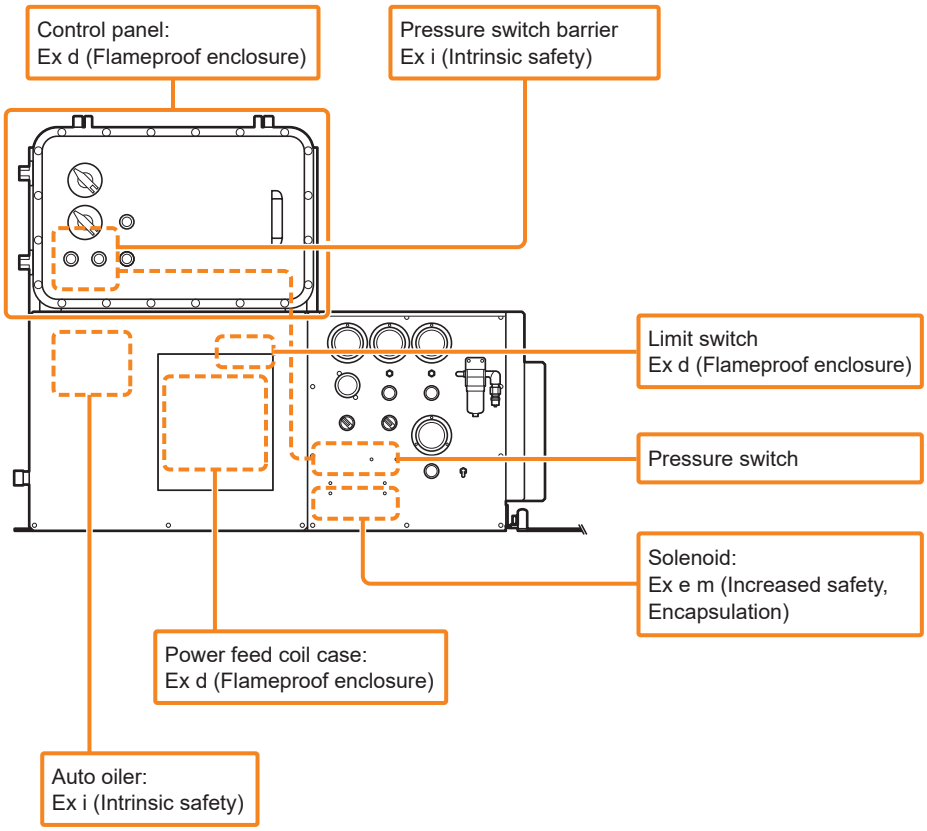


■ Lamp indications and their meanings

Lamp	State	Description
CHARGING lamp	Flashing (0.5 sec. lit, 0.5 sec. off)	Charging
	Lit	Charging completed
	Rapid flashing (0.2 sec. lit, 0.2 sec. off)	Charging error
PRESSURIZING lamp	Flashing (0.5 sec. lit, 0.5 sec. off)	Pressurizing
	Lit	Pressurization completed
	Rapid flashing (0.2 sec. lit, 0.2 sec. off)	Pressurization error
PURGING lamp	Flashing (0.5 sec. lit, 0.5 sec. off)	Purging in progress in purging mode
	Lit	Standby with purging completed
	Rapid flashing (0.2 sec. lit, 0.2 sec. off)	Standing by for purging initiation (error)
	Slow flashing (1 sec. lit, 1 sec. off)	Purging completed
RUNNING lamp	Lit	Normal
	Rapid flashing (0.2 sec. lit, 0.2 sec. off)	Cylinder positioning error

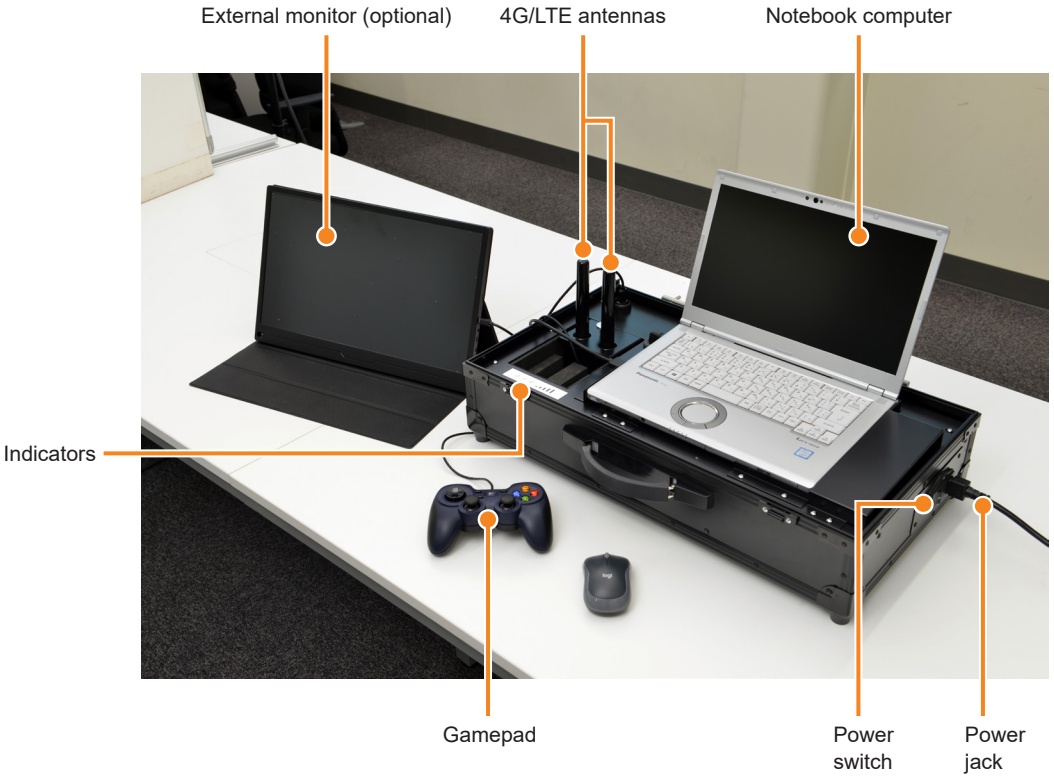
■ Explosion-proof structure of the Charging Station

The Charging Station has explosion-proof construction in its main body and individual parts. For details on explosion proofing, see “Installation and Setup Manual”.



3.3 Teleop Terminal

The teleop terminal is housed in a dedicated case.



■ Case

The pockets on the cover of the case can be used for storage of a mouse and cables.
Remove the cover from the case when using the teleop terminal. See “Operation Manual” for details.

External monitor (optional)

The following cables are provided when the optional external monitor is included at the time of purchase.

- HDMI cable: Connects to the notebook PC.
- USB cable: Used as a power cable for the external monitor.

Items contained in the case

The following items are contained in the case. These can all be used without removing them from the case.

- AC adapter for notebook computer
- LTE router
- AC adapter for LTE router

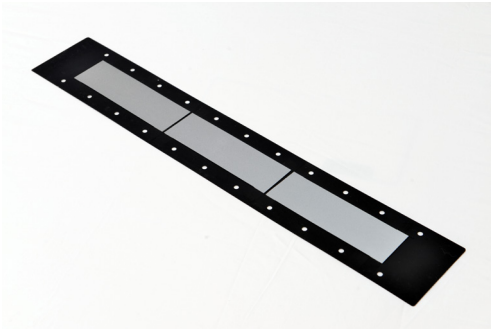
3.4 Bundled Accessories and Options

3.4.1 Bundled accessories

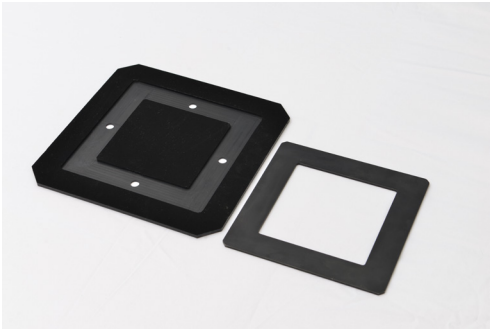
- Magnet-operated power switch key (1)

- Mode selector key (2)

- Positioning marker (10)



- Heat source teaching marker (1)

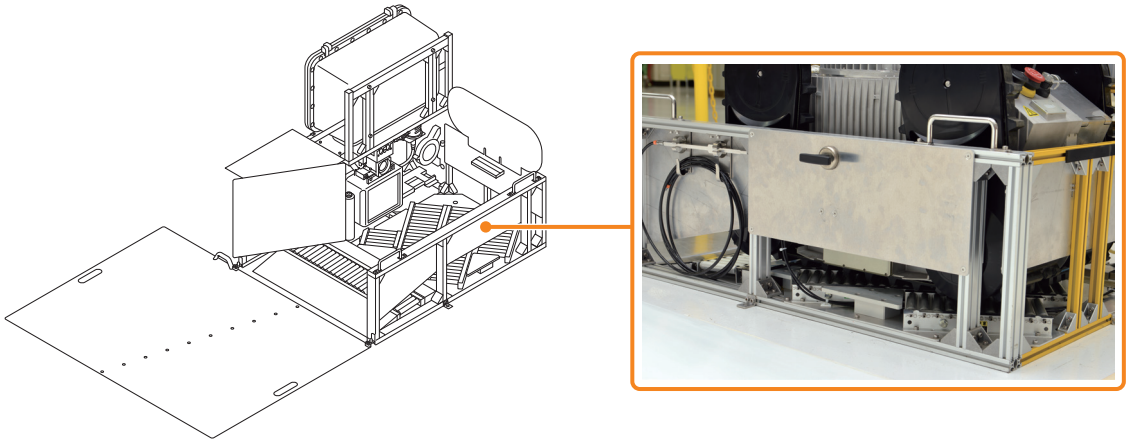


- Tool for checking internal pressure monitoring interlock (1)
- 2S-V socket (1)
- Installation and Setup Manual (1)
- Operation Manual (1)
- Maintenance Manual (This Manual) (1)

⚠ WARNING

- **Do not carry the magnet-operated power switch key or place it near electrical equipment.**
  Its magnetic field may cause malfunction or failure of electrical equipment. When not in use, be sure to return it to its stowage position.
- **The mode selector keys should be properly stored by the administrator so that they cannot be taken without permission.**
  Improper key management can result in unavailability of the keys at the time they are needed and may lead to accidents.

When not in use, the magnet-operated power switch key can be mounted on the side of the Charging Station in the position shown below.



3.4.2 Options

The following are available as options. Please contact your distributor for information on obtaining or installing these after purchase.

- Positioning marker
- Teleop terminal external monitor

3.4.3 Consumables

Please contact your distributor for information on obtaining or installing these.

Target	Consumables
Charging Station	Grease for auto oiler
	Element for air filter
ASCENT	Battery
	Filter for gas detector

MEMO

Chapter 4 Maintenance Overview

In order to maintain the performance of this product, maintenance is performed by means of periodic inspections at regular intervals. When the product is no longer needed, it must be disposed of by appropriate procedures.

4.1 Types of Periodic Inspections

Periodic inspections are required to ensure the safety of this product and to maintain its performance. The timing of periodic inspections is as follows for each type of inspection.

Inspection Type	Inspector	Timing	Note
Daily inspection	Customer	Recommended to be conducted every working day	Inspect ASCENTs, Charging Stations, and teleop terminals at their respective installation and usage locations. Perform inspections under normal operating (energized) conditions. For details of each inspection, see “Chapter 5 Inspection Items” (page 5-1).
Initial inspection	Customer	Within the first month	Inspect ASCENTs, Charging Stations, and teleop terminals at their respective installation and usage locations. If the unit is in continuous operation, shut down the power once and restart it for inspection. For details of each inspection, see “Chapter 5 Inspection Items” (page 5-1).
Ordinary inspection	Manufacturer or maintenance provider	Every six months after product introduction	Contact or request the distributor or maintenance provider to perform the inspection.
Detailed inspection	Manufacturer or maintenance provider	At either of the following times: • When the product is introduced, and when two years have passed since the last detailed inspection • When the product is introduced, and when the cumulative operating time since the last detailed inspection reaches 2000 hours.	

To ensure the safety and maintain the performance of this product, both ordinary and detailed inspections by a specialist are required. Both of these require specialized skills and special equipment, so be sure to contact or request to your distributor or maintenance provider.

4.2 When Disposing of the Product

Before disposal by a decommissioning agent, it must be prepared for disposal by the proper procedures, such as by removing some parts. See “Chapter 7 Disposal” (page 7-1) for details.

Chapter 5 Inspection Items

The following items are inspected during the daily and initial inspections. If the details of the inspection procedure are described in a “Check method”, perform the inspection according to the referenced procedure.

ASCENT

Check Item		Note
Exterior	Are there any scratches, cracks, dents, stains, or abrasion marks?	Check visually. For part locations, see “Chapter 3 Part Names and Functions” (page 3-1).
	Are any fastening bolts and washers loose, missing or significantly corroded?	
	Are the switches or antennas wobbly or deformed?	
	Are any tracks dirty, dusty or muddy?	Check visually. See “6.1.2 Track checks” (page 6-3).
	Are there any cracks in the track belts, significant grouser wear, or damage to the frame?	
	Are any bolts on the back of the sub tracks loose?	
	Check for frayed manipulator cables, dirt, dust, and entangled thread debris.	Check visually. See “6.1.3 Manipulator checks” (page 6-4).
	Check the manipulator cables for abrasion, wire breakage, kinking, deformation, corrosion, or looseness.	
	Is any manipulator bearing cracked or pulley bent?	
	Is any manipulator hand control cable broken or twisted?	
	Are there any scratches or cracks on the exposed cables of the visible surveillance camera, LED lighting, or gas detector?	Check visually. See “6.1.4 Exposed control cable check” (page 6-6).
	Are there any stains or scratches on the camera lenses, LED lighting, 3D-LiDAR, or the glass of the contactless power reception unit?	Check visually. For part locations, see “Chapter 3 Part Names and Functions” (page 3-1). Checking can be performed using a self-diagnosis scenario.(page 6-11)
	Is there any condensation or traces of it inside the camera lenses, LED lighting, or 3D-LiDAR?	Check visually. For part locations, see “Chapter 3 Part Names and Functions” (page 3-1).
	Is the Status LED cracked or dirty?	Check visually. For part locations, see “Chapter 3 Part Names and Functions” (page 3-1).

Check Item		Note
Performance	Does the battery life seem shorter?	See “6.2.1 Battery check” (page 6-8).
	Are camera images out of focus, too dark or too bright, or out of position?	See “6.2.2 Camera check” (page 6-9). Checking can be performed using a self-diagnosis scenario.(page 6-11)
	Is the temperature recorded in the images taken by the thermal imaging cameras the same as the temperature of the subject?	See “6.2.3 Thermal imaging camera check” (page 6-10). Checking can be performed using a self-diagnosis scenario.(page 6-11)
	Is there any abnormal vibration or heat generation?	See “6.2.5 Checking operation, vibration, abnormal noise, and heat generation while driving” (page 6-14).
	Did ASCENT deviate from the patrol route while moving?	
	Is the manipulator returning to its home position?	
	Do camera shooting results vary significantly?	
	Is there any abnormal noise?	
	Does the internal pressure drop interlock (power off) trip during operation?	
Explosion proofing	Does the internal pressure drop interlock work properly?	See “6.2.6 Internal pressure interlock check” (page 6-15).
Operation	**Initial inspection only:** Do the Torque Off and Emergency Stop buttons work?	Check behavior when the button is pressed.

Charging Station

Check Item		Note
Exterior	Are there any scratches, cracks, dents, stains, or abrasion marks?	Check visually. For part locations, see “Chapter 3 Part Names and Functions” (page 3-1). Check the rollers when ASCENT has exited.
	Are any fastening bolts and washers loose, missing or significantly corroded?	
	Are the rollers free of dirt, dust, rubbish, or entangled with thread waste? Do they rotate smoothly?	
Wiring	Are there any scratches or cracks on the exposed power cable?	Check visually.
	Are there any scratches or cracks in the air hose? Is air leaking from the source or the middle of the hose?	
Cylinder	Is the operating speed of the cylinder varying or cogging (the cylinder does not extend or contract smoothly)?	See “6.3.1 Cylinder operation” (page 6-21).
	Are the protective gas supply port and the contactless power transmission unit properly connected to ASCENT (not misaligned)?	
	Are there any cracks or breaks in the protective gas supply port O-ring? Is it moist with grease, not dripping, and is there any foreign matter?	See “6.3.2 Grease condition of the protective gas supply port O-ring” (page 6-22).
Operation	Is ASCENT tilted when docked?	Visually confirm immediately after ASCENT docks.
	Is the humidity and purity of the air sent from the Charging Station to ASCENT appropriate?	See “6.3.3 Purging operation check” (page 6-23).
	Initial inspection only: Is purging executing normally?	

Teleop terminal

Check Item		Note
Cable	Are there any scratches or cracks?	Check visually.
Gamepad	Do the buttons work properly?	Diagnose with checking software. See “6.4 Gamepad Button Check” (page 6-24).

If inspection reveals any abnormality, consult your distributor or maintenance provider.

Chapter 6 Inspection Procedure

Inspection work may be performed in hazardous areas.
Make sure that the explosion proofing of ASCENT and the Charging Station is being maintained before starting work.

⚠ WARNING

- **If inspection work is performed when explosion proofing has not been maintained, flammable gas may ignite.**

Inspection work requires one person (teleoperator) to teleoperate ASCENT and another (inspector) to inspect on site.

⚠ WARNING

- **Maintain communications when the inspector approaches ASCENT so that the teleoperator does not move ASCENT unexpectedly.**
  The inspector could collide with ASCENT when it has moved unexpectedly, or one's finger may get caught in the moving parts, resulting in injury.
- **Avoid teleoperation where radio connections are difficult or unstable.**
  ASCENT may behave unexpectedly or be unable to stop by teleoperation.
- **Avoid teleoperation when visibility is poor.**
  There is risk of collision or slipping.
  If visibility is poor due to insufficient light, such as in the rain, turn on surrounding lights so that the surroundings are clearly visible before teleoperating.

6.1 ASCENT's Moving Parts Checks

6.1.1 Operation when checking moving parts

Since each part of ASCENT cannot be checked while it is in the Charging Station, follow the procedure below to move it out of the Charging Station. For details on teleoperation, see "Operation Manual".

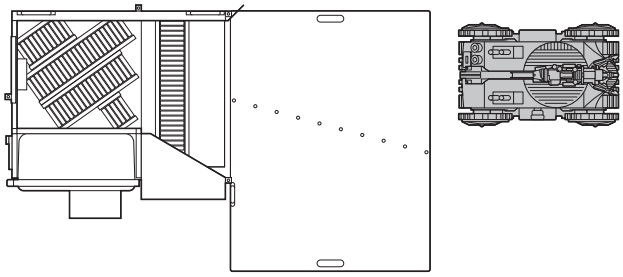
⚠ WARNING

- **Check the safety of the surroundings before starting work.**
  Collisions with other workers or work vehicles can result in personal injury or damage to the product.

1 **Start the teleop terminal and Scenario Maker.**

2 **Move ASCENT out of the Charging Station.**
Open the [Routine Operation] tab on the teleop screen, select [Exit Charging Station] in the [Routine Operation] panel, and then click [Execute] to move ASCENT out of the Charging Station. Proceed with the next step without moving ASCENT while it is undocked.

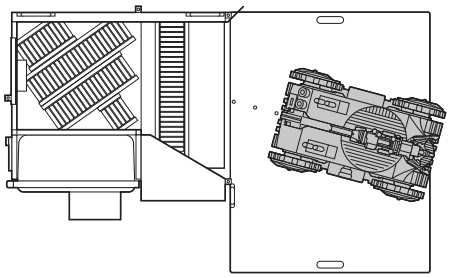
3 **Move ASCENT forward to where it is completely off of the entry/exit guide plate.**



4 **Check the inspection points.**

5 **After checking, dock ASCENT in the Charging Station.**

① Move ASCENT over the dotted line on the entry/exit guide plate.

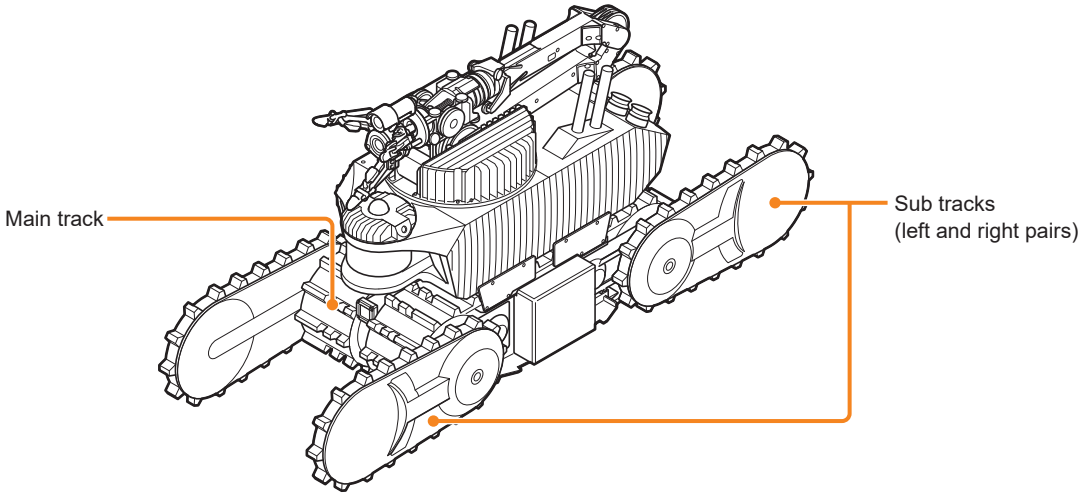


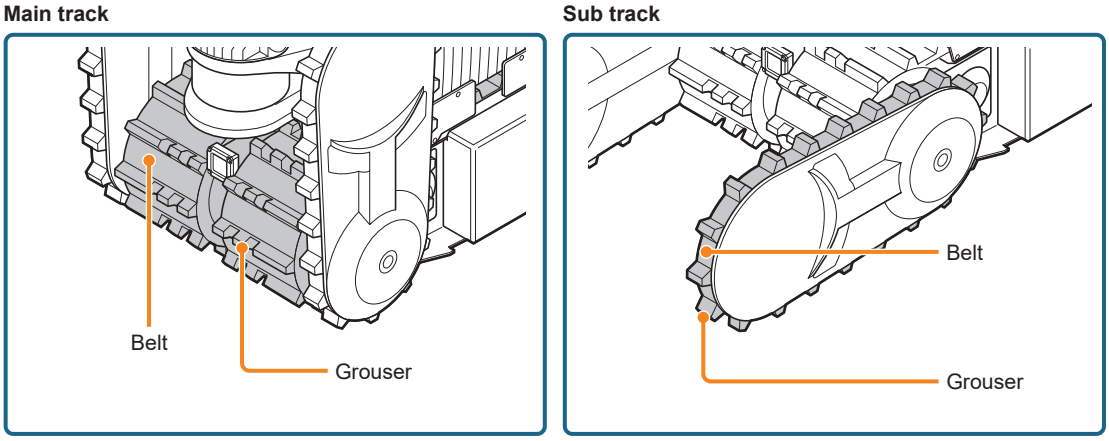
② On the [Routine Operation] panel, select [Enter Charging Station] and click [Execute] to dock ASCENT in the Charging Station.

NOTE

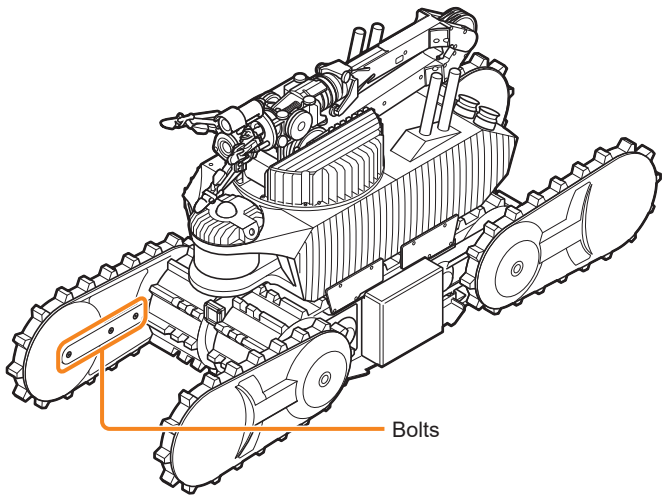
- **Enter along the dotted line of the guide plate.**
  If the entry angle is incorrect, ASCENT may crash into the Charging Station.

6.1.2 Track checks





- Are any tracks dirty, dusty or muddy?
  If the tracks are dirty, dusty or muddy, use a soft cloth moistened with water and well wrung out to remove the dirt. If greasy, use a neutral detergent instead of plain water.
- Are any of ASCENT's main or sub track belts cracked?
- Are the grousers (the protrusions on the main and sub tracks) significantly worn?
- Are the main and sub track covers damaged?
- Is there any rattling in the sub tracks?
  Check that the bolts that secure the sub tracks from the back side are not loose.



6.1.3 Manipulator checks

■ Manipulator attitude changes

Teleoperate ASCENT to change the attitude of the manipulator by the following procedure. Perform up to step 3 in “6.1.1 Operation when checking moving parts” (page 6-2) to undock ASCENT from the Charging Station, then do the following.

1 Open the [Manip.] tab on the teleop screen, and click [Attitude Change] > [Confirm] on the [ManiInfo] panel.

2 The [Attitude Change] screen appears. Select [Attitude 1], and click [Confirm].

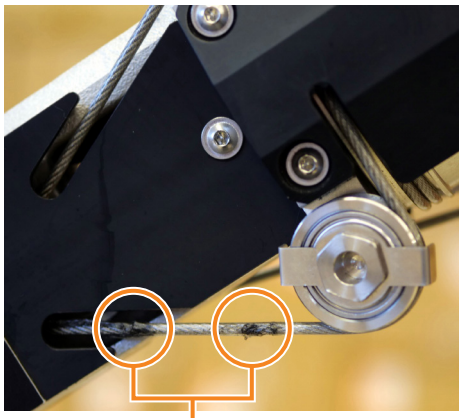
3 Check the manipulator.

4 After checking, select [Stowed Attitude] on the Attitude Change screen, click [Confirm] to stow the manipulator in its home position, and click [Back] to close the Attitude Change screen.

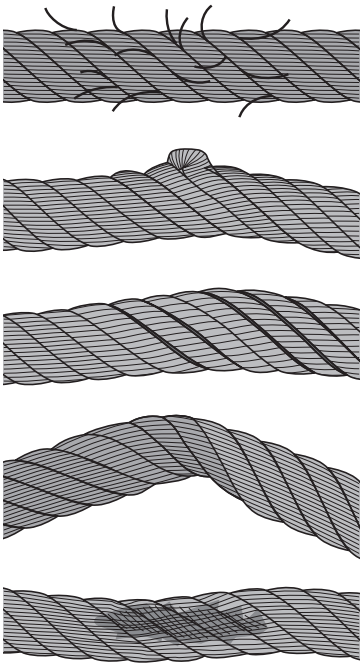
■ Check Items

Cables run from the base to the tip of the manipulator. Visually trace the cables exposed in the gaps and joints from the base of the manipulator to check the condition of the cables and pulleys.

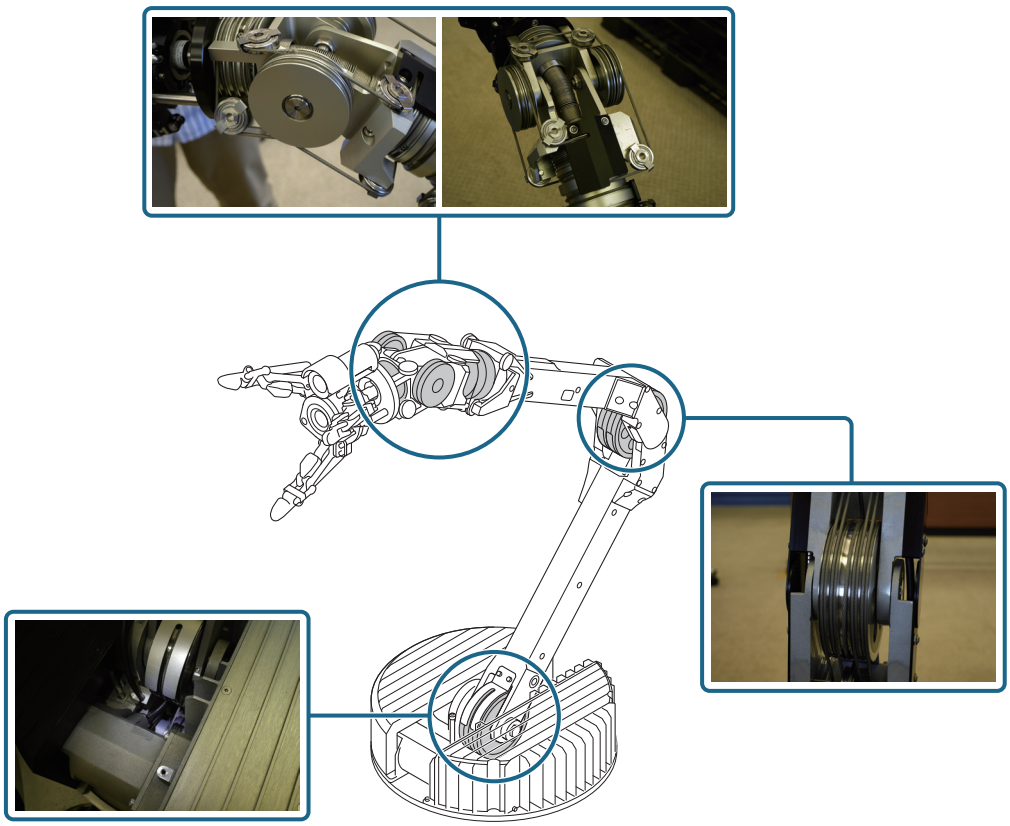
- Check for abrasion, fraying, kinking, deformation, corrosion, or looseness of the cables.
  Check that the cable sheath is not torn and that the wires inside are not exposed.



Minor cable damage



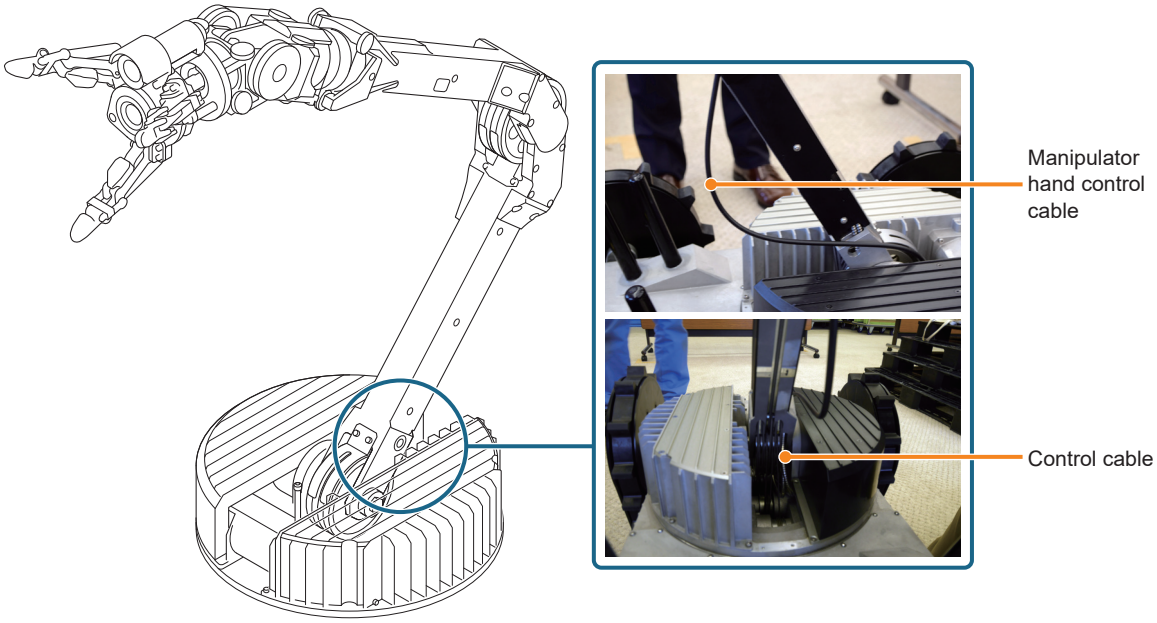
- Check the pulleys for deformation. Check that the pulleys turn smoothly during operation when the manipulator attitude is changed.



6.1.4 Exposed control cable check

■ Check the control cable for the optical surveillance camera and LED lighting

The control cables for the optical surveillance camera and LED lighting at the tip of the manipulator are in a single aluminum-sheathed control cable routed from ASCENT's body along the manipulator arm. Check this control cable for damage such as cuts or breaks.
Also check that the manipulator hand control cable is not broken or twisted.

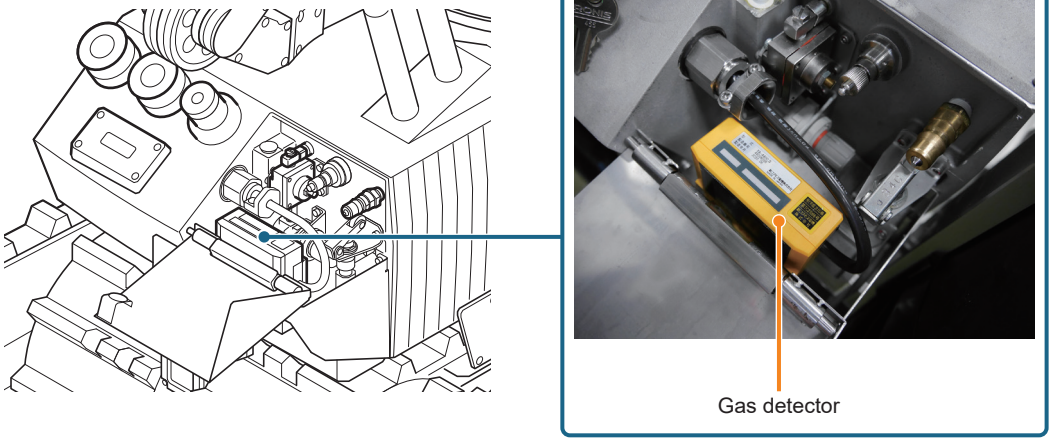


⚠ WARNING

- **Do not insert fingers or foreign objects (especially conductive objects or combustible substances such as oil) into the gap at the base of the manipulator.**
  It may cause injury, malfunction or fire.

■ Gas detector cable check

Open the lid on the back of ASCENT and check whether the gas detector cable is loose or unplugged.

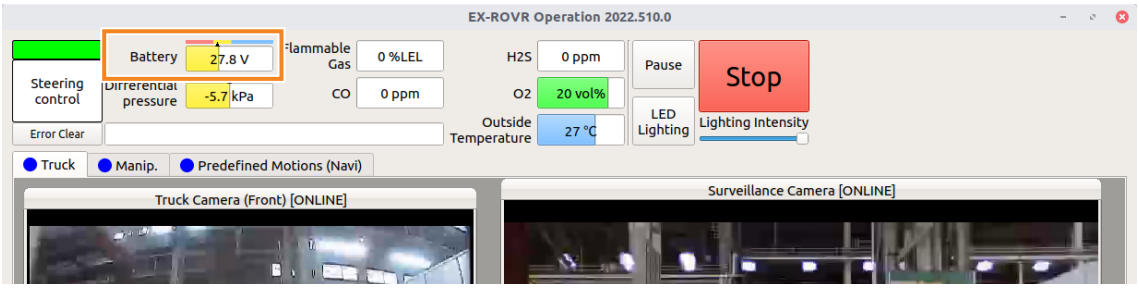


6.2 ASCENT Performance Checks

These checks ensure that ASCENT works and runs without any problems.
Examine the results of automatic patrols according to the self-diagnostic scenarios registered as standard in the cloud. Self-diagnostic scenarios are scheduled and executed in the same way as normal scenarios.

6.2.1 Battery check

Determine whether the battery life seems to be shorter than it was when first used.
ASCENT's remaining battery charge level is displayed on the teleop terminal's screen. Determine if the remaining capacity is decreasing faster than before.

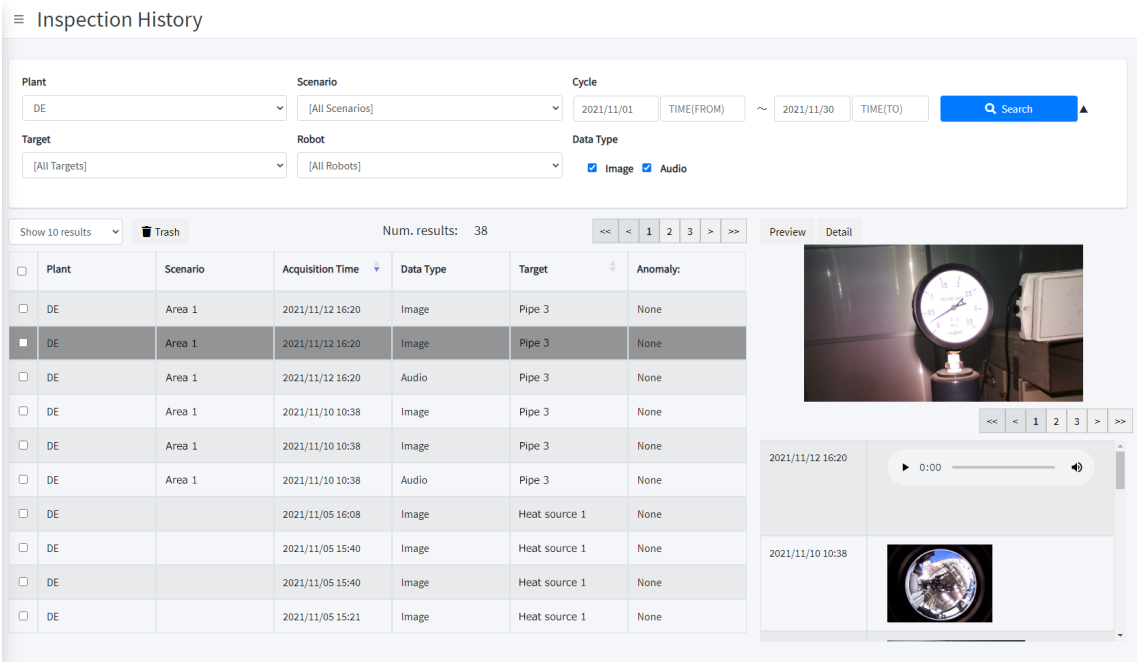


⚠ WARNING

- **If the battery does not recover its function, such as with extremely short usage time after recharging, ask your supplier to replace it.**
  The battery is a consumable item. Continued use of a deteriorated battery may cause overheating, ignition, explosion, or liquid leakage.
- **Contact your supplier to replace the battery when required.**
  Replacing the battery by yourself or using anything other than the designated battery may result in malfunction or accident.

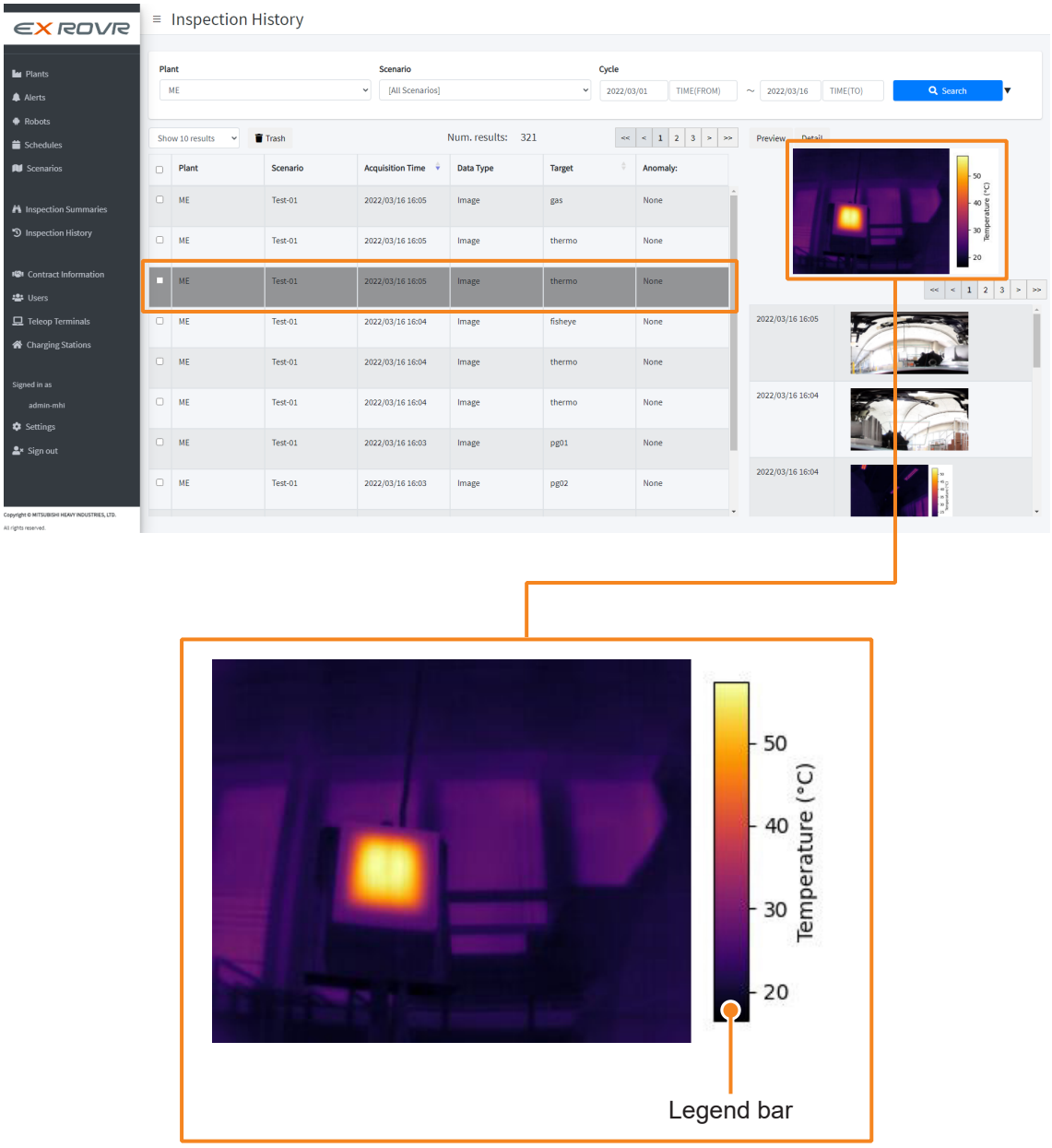
6.2.2 Camera check

Check that the images taken by the cameras are not out of focus, too dark or too bright, or significantly out of position.
Create a scenario to shoot with the cameras, then run an automatic patrol, and check the shot images.
The screen appears as follows when viewing scenario inspection history in the cloud. Here you can check the shot images.



6.2.3 Thermal imaging camera check

Check that the temperature recorded in the images taken by the thermal imaging cameras is the same as the actual temperature of the subject.
Create a scenario for shooting with the thermal imaging cameras, run an automatic patrol, and check the shot images. The temperature of each part shown in an image taken by a thermal imaging camera is determined by looking at the legend bar.



6.2.4 Checking by self-diagnosis scenario

By executing an automatic inspection scenario prepared in advance, you can check whether the cameras, microphone, and speaker are operating normally, and whether ASCENT and the Charging Station are functioning normally.
When a self-diagnosis scenario is executed, ASCENT performs the self-diagnosis operation from the entry/exit guide plate after exiting the Charging Station until it automatically re-enters and docks.
The following actions are registered as targets in the self-diagnosis scenarios, to be checked respectively.

Target name	Operation	Contents
Self diagnostic 1	Take a picture of the 3D-LiDAR using the optical surveillance camera with the LED lighting turned on.	Does it appear normal in the optical surveillance camera image? Is the 3D-LiDAR dirty? Is the image dark (is the LED lighting working properly)?
Self diagnostic 2	Take a picture of the protective gas filler port using the optical surveillance camera with the LED lighting turned on.	Does it appear normal in the optical surveillance camera image? Is the protective gas filler port dirty? Is the image dark (is the LED lighting working properly)?
Self diagnostic 3	Take a picture of the contactless power reception unit using the optical surveillance camera with the LED lighting turned on.	Does it appear normal in the optical surveillance camera image? Is the contactless power reception unit dirty? Is the image dark (is the LED lighting working properly)?
Self diagnostic 4	Take a picture of the rear obstacle proximity sensor using the optical surveillance camera with the LED lighting turned on.	Does it appear normal in the optical surveillance camera image? Is the rear obstacle proximity sensor dirty? Is the image dark (is the LED lighting working properly)?
Self diagnostic 5	Take a picture of the area around the Charging Station stopper using the optical surveillance camera with the LED lighting turned on.	Does it appear normal in the optical surveillance camera image? Is the stopper dirty? Is the stopper installed properly? Is the image dark (is the LED lighting working properly)?
Self diagnostic 6	Take a picture of the Charging Station rollers using the optical surveillance camera with the LED lighting turned on.	Does it appear normal in the optical surveillance camera image? Are the rollers dirty or is there any foreign matter caught in them? Is the image dark (is the LED lighting working properly)?
Self diagnostic 7	Capture an image with the 360° optical camera.	Does it appear normal in the 360° optical camera image?
Self diagnostic 8	Capture images with the 360° optical camera and the right thermal imaging camera.	Is image capture normal with the 360° optical camera? Is image capture normal with the thermal imaging camera? Is the temperature of the heat source detected normally?

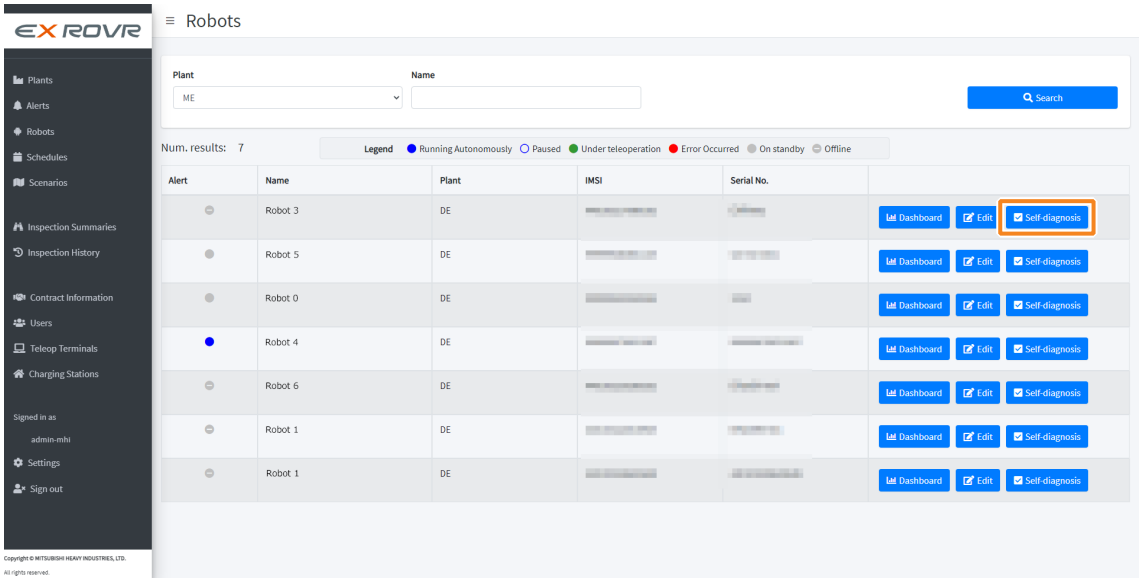
Target name	Operation	Contents
Self diagnostic 9	Capture images with the 360° optical camera and the left thermal imaging camera.	Is image capture normal with the 360° optical camera? Is image capture normal with the thermal imaging camera? Is the temperature of the heat source detected normally?
Self diagnostic 10	Play the audio through the speaker and record with the microphone at the same time.	Does the speaker play sound normally? Does the microphone record normally?
Self diagnostic 11	Create a map with 3D-LiDAR.	Does the 3D-LiDAR create maps normally?
(No target)	Change the angle of the sub track.	Does the gyro sensor work properly? Are the front sub tracks misaligned (is ASCENT in the correct position when raised by the sub tracks)?

Self-diagnosis scenario execution

Self-diagnosis scenarios are pre-registered in the cloud. Register them in the schedule to be executed at any time of day. Self-diagnosis scenarios take about 5 minutes to run. Schedule to run at a time different from the normal automatic patrol scenario. For schedule registration, see “Operation Manual”. Although a self-diagnosis scenario can be loaded into Scenario Maker and executed, in this case, inspection results will not be registered in the inspection history of the cloud.

Self-diagnosis scenario check

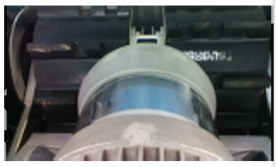
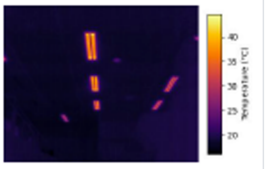
When a self-diagnosis scenario is executed according to a specified schedule, the results are registered in the cloud.
Open the [Robots] screen in the cloud and click [Self-diagnosis] to display the inspection history of self-diagnosis scenarios, where you can select a previously executed self-diagnosis scenario to check its results. By checking the results and captured images of a self-diagnosis scenario, you can confirm that ASCENT performed normally and the condition of each imaged part (cleanness, etc.).



Examples of self-diagnosis scenario results

ground-level

Plant	DE	**Start**	2022/05/31 18:50
Schedule	Self-diagnosis	**Completed**	2022/05/31 19:10
Scenario	Self-diagnosis scenario	**Inspection Duration (min)**	20
Robot	Robot 2	**Num. Anomaly**	8/ 9

Image / Audio		Target	
	Self-diagnosis 1	2022/05/31 19:00	2found
	Self-diagnosis 1	2022/05/31 19:00	2found
	Self-diagnosis 7	2022/05/31 19:00	2found
	Self-diagnosis 8	2022/05/31 19:04	2found
	Self-diagnosis 8	2022/05/31 19:08	2found

6.2.5 Checking operation, vibration, abnormal noise, and heat generation while driving

DANGER

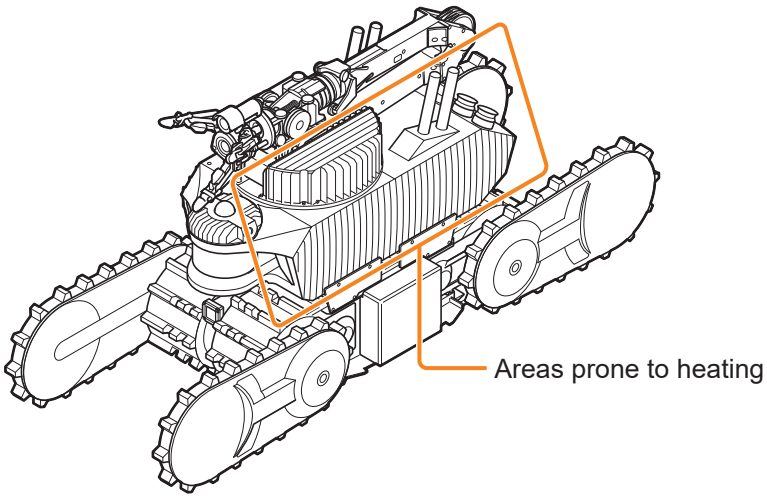
- **When ASCENT is traversing stairs, stay away from the bottom of the stairs.**
  If ASCENT slips and hits you, there is a danger of serious injury, such as broken bones.

WARNING

- **At least two people should accompany ASCENT.**
  If the machine operates unexpectedly, one's fingers could be caught or hit by moving parts, resulting in injury.
  One person should always be available to make an immediate emergency stop.

Inspectors accompany ASCENT during normal driving to check the following.

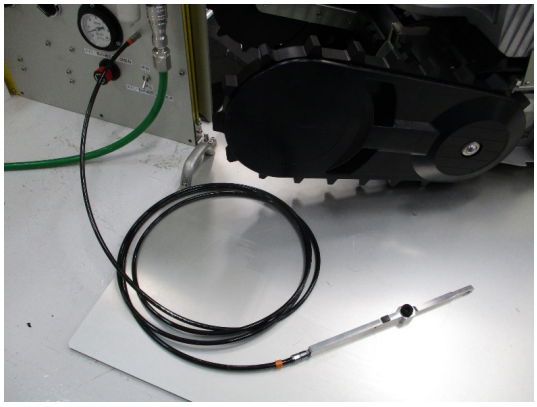
- Does it deviate from the patrol route or vibrate abnormally while moving?
- Does the manipulator return to its home position after executing a scenario?
- Do camera shooting results vary significantly?
- Is there any abnormal noise?
- Does the internal pressure drop interlock (power off) trip during operation?
- Is there any abnormal heating?
  As designed, the left-side housing of ASCENT tends to heat up. Check if the heating in this area is abnormally high.

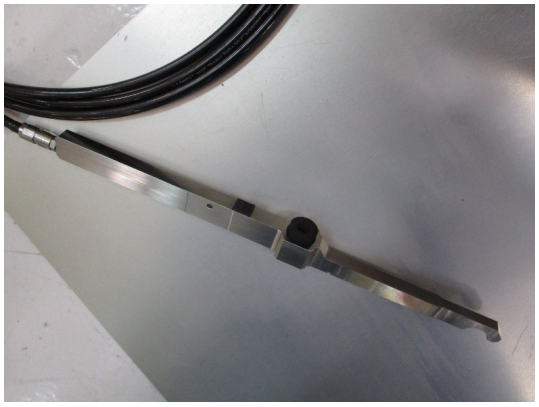


6.2.6 Internal pressure interlock check

ASCENT is equipped with an interlock mechanism that automatically cuts power off when the internal pressure of the main unit drops to the point where the explosion-proof performance cannot be maintained. This mechanism automatically cuts power off when the internal pressure of ASCENT's explosion-proof container drops below 3 kPa while driving. Check the differential pressure sensors for proper operation of the interlock mechanism.
Two differential pressure sensors are mounted on ASCENT. Use the supplied interlock check jig to check the differential pressure sensors mounted on each side.

Interlock check jig





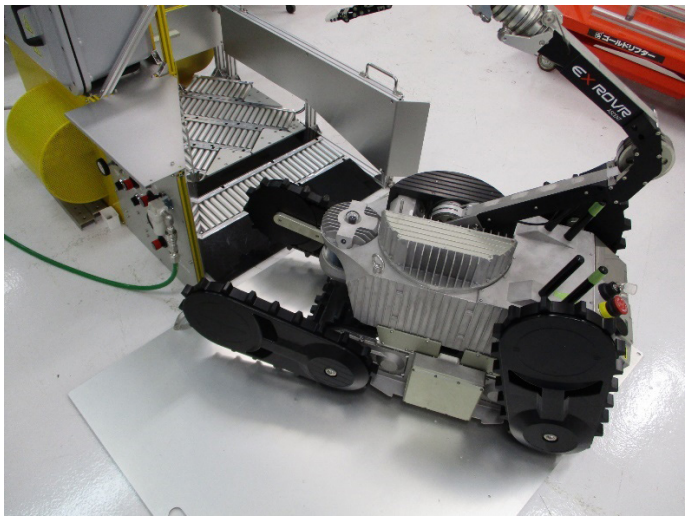
⚠ WARNING

- **Check the safety of the surroundings before starting work.**
  Collisions with other workers or work vehicles can result in personal injury or damage to the product.

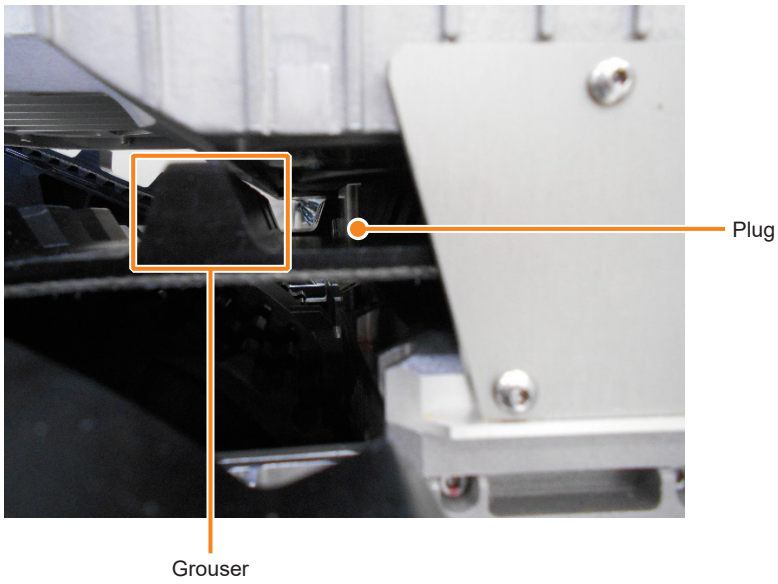
1 **With ASCENT turned on, press the torque off button.**
The status LED flashes red

2 **Push ASCENT by hand to move it alongside the Charging Station.**

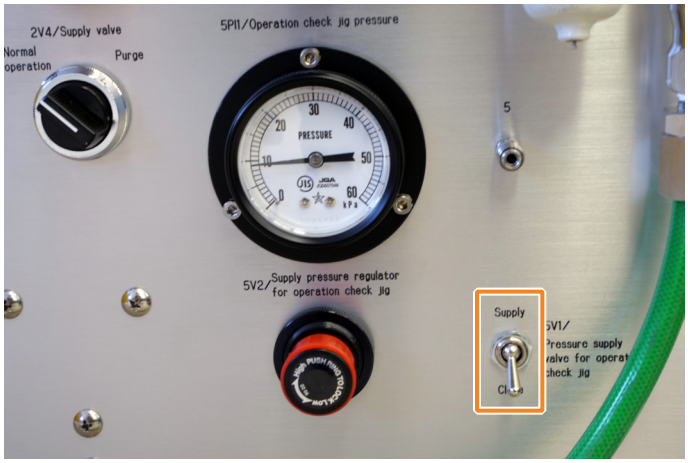
3 **Move ASCENT's front sub tracks by hand so they are almost horizontal.**



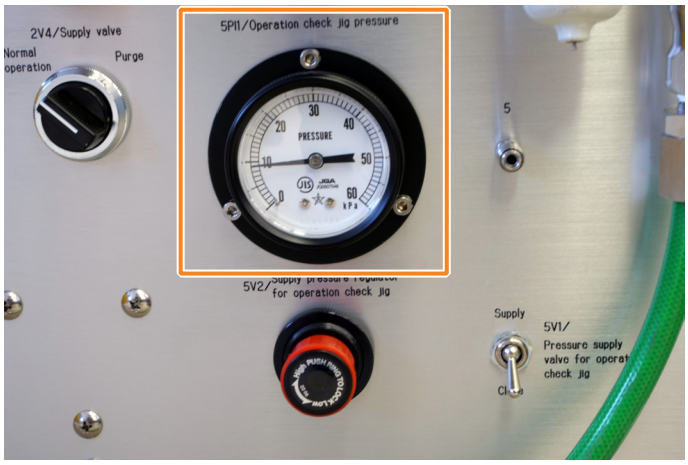
4 **Adjust the main track so that, when viewing ASCENT from the side, you can see the plug for attaching the interlock check jig through the gap between grousers.**



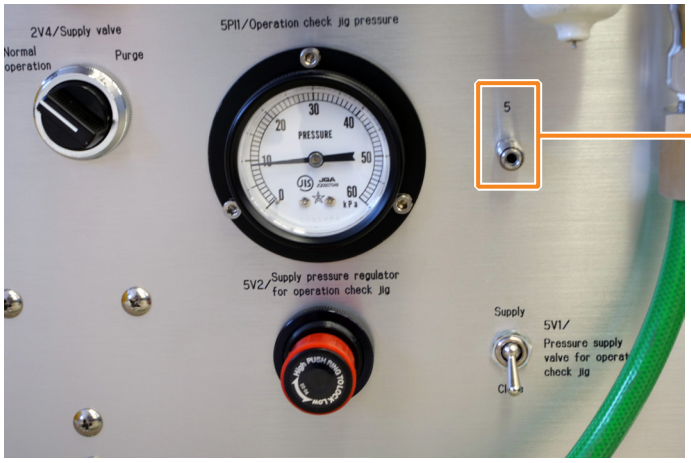
5 **On the Pneumatics panel, ensure that the "5V1/Pressure supply valve for operation check jig" switch is in the "Close" position.**



6 **Adjust the "5V2/Supply pressure regulator for operation check jig" so that the "5PI1/ Operation check jig pressure" is approximately 8 kPa.**



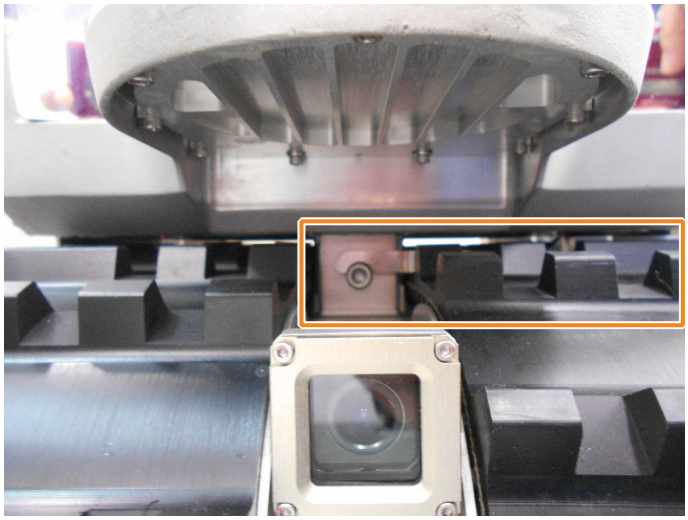
7 **Connect the hose of the interlock check jig to the pressure supply port for differential pressure sensor operation.**



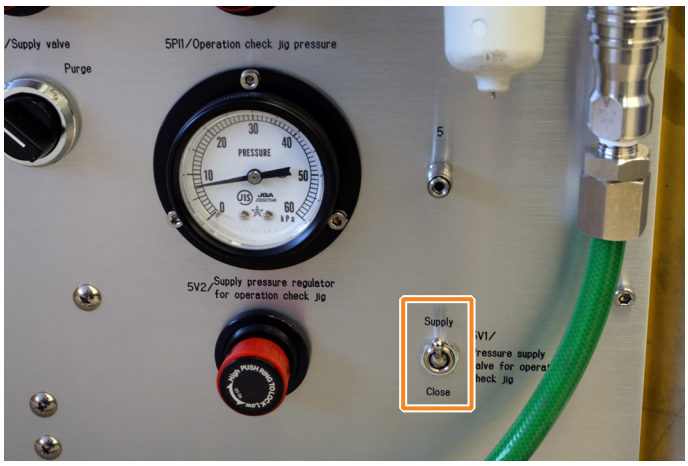
Connect the interlock check jig hose

8 **Insert the interlock check jig between and parallel to the main track grousers.**

9 **Hook the concave tip of the interlock check jig onto the plug.**



10 **Set the “5V1/Pressure supply valve for operation check jig” switch to “Supply”.**



Air is discharged from the interlock check jig outlet, and the “5PI1/Operation check jig pressure” reading drops.

11 With the concave tip of the interlock check jig hooked on the plug, gently lift the jig (until the rubber sheet touches the housing) and press the air outlet into ASCENT.

The “5PI1/Operation check jig pressure” should rise to about 8 kPa as ASCENT’s power shuts off.

12 Move ASCENT into the Charging Station, purge it, and turn it on again.

When docking (transporting) ASCENT, take care to observe the following.

- Check that no flammable gas is present.
- Only transport ASCENT with the power off.
- As much as possible, avoid carrying ASCENT when flammable gas is present. If absolutely necessary to transport ASCENT in the presence of flammable gas, observe the following precautions and use four persons according to the procedure shown in “Installation and Setup Manual” (page 6-3), and carry it carefully.
  - Check that the power is off.
  - Do not turn the tracks or manually change the angle of the sub tracks.

⚠ WARNING

- **Do not rotate the tracks or change the angle of the sub tracks.**
  There is a risk of generating electricity within ASCENT that could ignite flammable gas.

13 Repeat steps 2 to 11 to check the interlock operation of the differential pressure sensor on the opposite side.

14 After checking the differential pressure sensor on the opposite side, return ASCENT to the Charging Station, purge it, and turn it on again.

If the pressure does not rise

- Air could be leaking in the middle of the system.
  With the “5V1/Pressure supply valve for operation check jig” switch set to “Supply”, place a finger over jig’s air outlet to close it and check whether the pressure rises.
- The concave tip of the jig is not hooked on the plug, and the sponge washer at the air outlet is not in flush contact with ASCENT’s differential pressure sensor.
  Make sure that the concave tip is hooked on the plug, and that the jig is straightly aligned.

If ASCENT does not turn off

- The jig’s air outlet and the differential pressure sensor may be misaligned.
  Check that the jig is inserted parallel to the main track grousers.
- ASCENT’s internal pressure may be too high.
  Slowly turn the “5V2/Supply pressure regulator for operation check jig” to increase the pressure (maximum 20 kPa).

If ASCENT does not turn off after doing the above, it may be defective. Press the emergency stop button to discontinue operation, and contact your supplier or maintenance provider.

6.3 Charging Station Cylinder Check

⚠ WARNING

- **Keep fingers away from the vicinity of the cylinder.**
  If fingers are trapped, there is a risk of fracture or other serious injury.

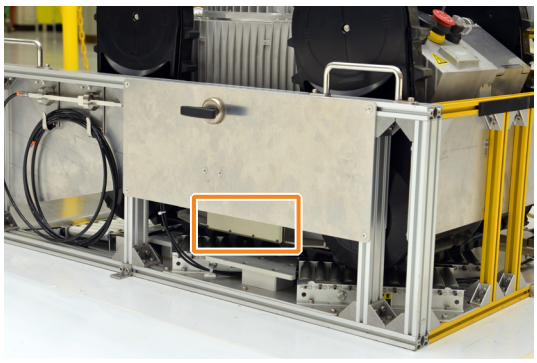
6.3.1 Cylinder operation

Check whether the cylinder moves without varying or cogging (does it extend and retract smoothly?), Also, since the protective gas supply port and the contactless power transmission unit can move left and right, ensure that they connect to ASCENT near the center of the range of movement.

Cylinder (when stowed in the Charging Station)

Cylinder (when connected to ASCENT)

Also check the movement of the power guard linked to the cylinder.



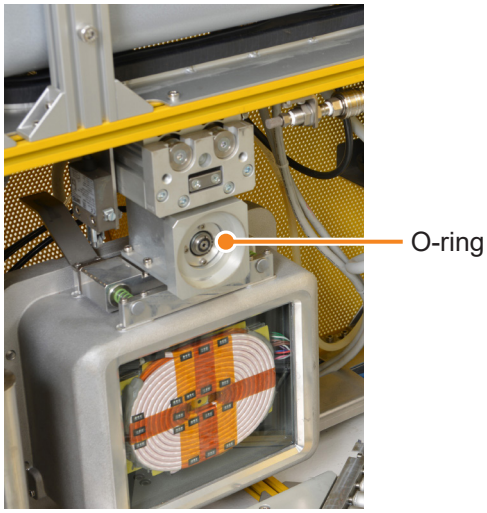
The cylinder is adjusted to expand and retract in 3 seconds. In other words, it should take about 3 seconds from the retracted state to the most extended state and from the extended state to the stowed position. Check whether the cylinder movement takes much more or less than 3 seconds.
Depending on the position of the sub tracks when ASCENT is docked, the extended cylinder may collide and fail to connect properly. The sub tracks must be at an angle between 100° and 105°.

Cylinder extension and retraction operation

When the MODE switch on the control panel is set to “PURGE”, the Charging Station cylinder should be extended. This operation should work even when ASCENT is not in the Charging Station.
To return the cylinder to its original position, set the MODE switch on the control panel to “RUN”.

6.3.2 Grease condition of the protective gas supply port O-ring

Check the protective gas supply port O-ring as shown in the figure below for cracks or breaks. Also check that it is moist with grease, not dripping, and free of any foreign matter. If there is too much grease on the O-ring, wipe off the excess grease with a dry cloth.



⚠ WARNING

- **If you need to replenish the grease or adjust the supply, contact your supplier.**
  If you replenish or adjust the grease yourself and accidentally charge the surface of the housing with static electricity, flammable gas may ignite.

6.3.3 Purging operation check

By purging ASCENT while docked in the Charging Station, you can check whether the Charging Station's cylinder, installed internal pressure supply device, and the explosion-proofing equipment (limit switch, solenoid valve, and pressure switch) operate correctly. It is not necessary to check the purging operation in daily inspections, **but be sure to check it during the initial inspection.**

Press ASCENT's emergency stop button to shut off the power, and carry it to the Charging Station for purging. It is easy to proceed with the inspection work by performing the purge operation check in the inspection at "6.2.6 Internal pressure interlock check" (page 6-15).

For details on the purging procedure, see the "Installation and Setup Manual".

■ Check Items

- Is the humidity and cleanliness of the air sent from the Charging Station to ASCENT appropriate?
  Humidity/moisture class: 3 (pressure dew point ≤ –20˚C)
  Solid particle: Class 2 or better recommended
- Does purging complete normally (not stop in the middle)?
- Is the operating pressure normal?
  Check the following instruments to see if the pressure is correct while purging.

Instrument to Check (Pneumatics panel)	Proper Value
1PI1/Supply pressure	0.4 MPa
2PI2/Purge supply pressure	Before purging: 0.28 MPa Purging: Approx, 0.26 MPa
3PI1/Exhaust pressure	Before connecting the exhaust hose: 0 kPa After connecting the exhaust hose to ASCENT When the internal pressure of ASCENT is 0 kPa: 0 kPa When the internal pressure of ASCENT is not 0 kPa: 5 kPa (when power is turned off while the internal pressure of ASCENT is maintained, such as when checking the internal pressure interlock). Before purging: 0 kPa Purging: Approx. 8 kPa

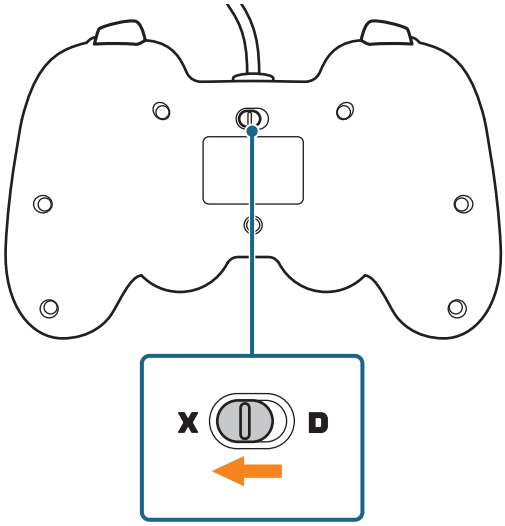
- Are the Charging Station's protective gas supply port and the contactless power transmission unit properly connected to ASCENT?
  During purging, check that the Charging Station cylinder is extended and that the protective gas supply port and the contactless power transmission unit are properly connected to ASCENT (not misaligned).

6.4 Gamepad Button Check

Use the check tool installed on the teleop terminal to check whether the gamepad buttons, D-pad keys, and joysticks work properly.

■ Precautions when checking the gamepad

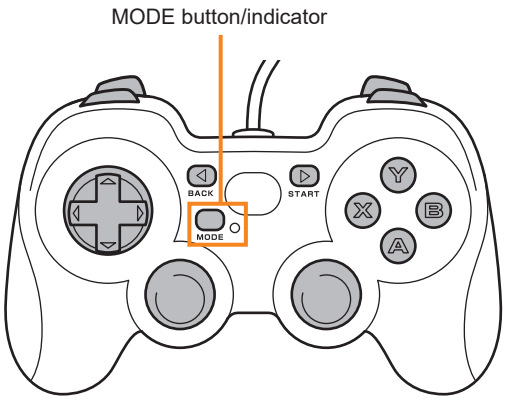
Ensure that the changeover switch on the back of the gamepad is set to the X side.
If it is on the D side, switch it to the X side. Always use with the changeover switch on the X side.



⚠ WARNING

- **When the switch is set to the D side, the behavior differs from that described in the instruction manual.**

Do not press the MODE button on the gamepad during inspection or operation.
When you press the MODE button, the indicator lights up. Press the MODE button again to turn it off.



⚠ WARNING

- **If you operate while the indicator is lit, the behavior differs from that described in the instruction manual.**

■ Check method

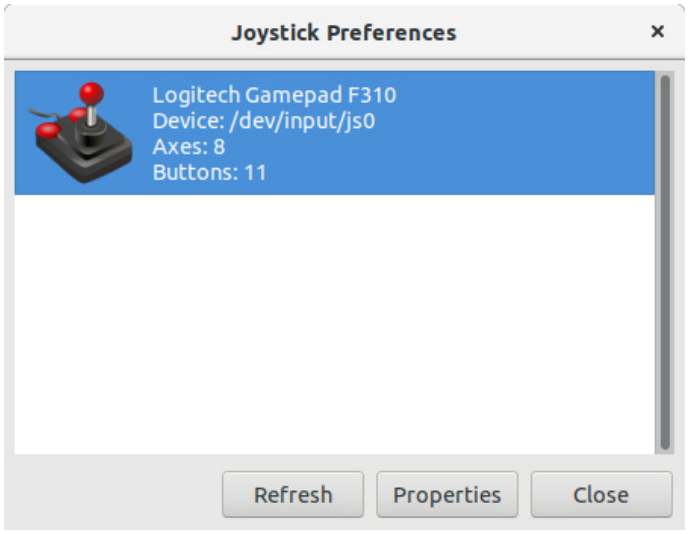
1 **If Scenario Maker and the teleop screen are running on the teleop terminal, close both.**

⚠ WARNING

- **Note that if you start the check tool while Scenario Maker and the teleop terminal are running, ASCENT will be teleoperated by the gamepad buttons, D-pad keys, and joystick in the following steps.**

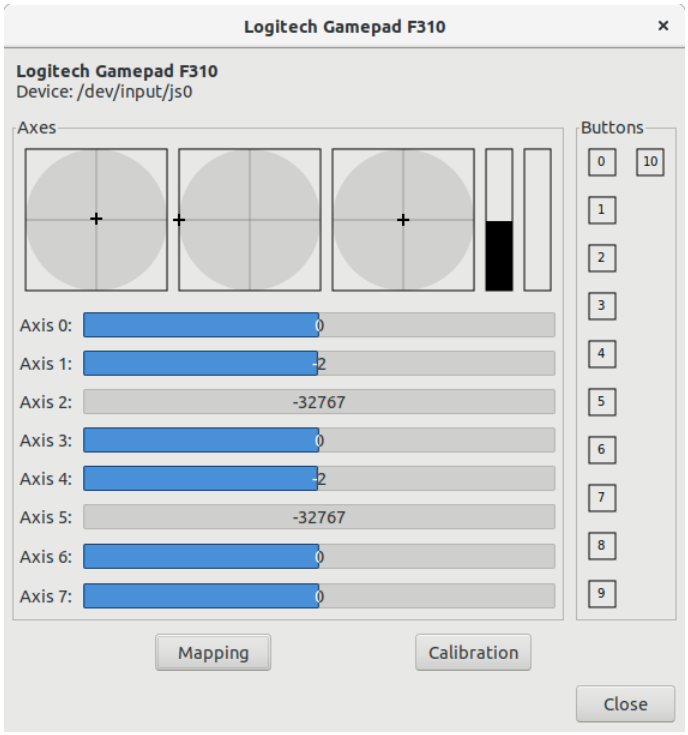
2 **Click the icon (jstest-gtk) on the desktop of the teleop terminal.**

The [Joystick Preferences] screen appears.



3 **Click [Properties].**

A screen that detects and displays the inputs from the gamepad is displayed.



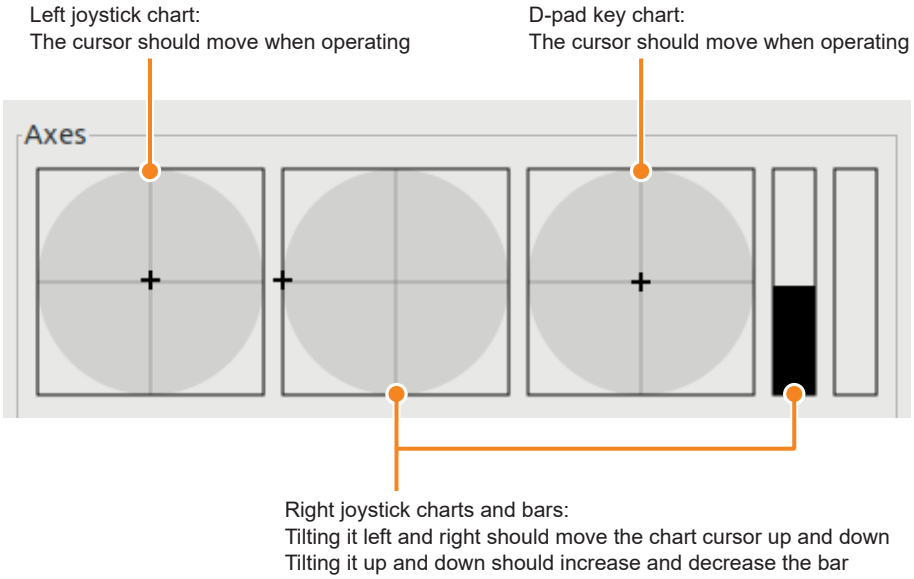
4 Press each button on the gamepad and check whether the display of the corresponding item on the screen changes.

Depending on operation of the buttons, joysticks, and D-pad keys, the display of [Axis 0] to [Axis 7] in [Axes] and [0] to [10] in [Buttons] changes as follows.

Gamepad parts		Corresponding item	Display result during operation
Right joystick	Up	Axis 4	Decrease value (bar decreases to the left)
	Down	Axis 4	Increase value (bar increases to the right)
	Right	Axis 3	Increase value (bar increases to the right)
	Left	Axis 3	Decrease value (bar decreases to the left)
Left joystick	Up	Axis 1	Decrease value (bar decreases to the left)
	Down	Axis 1	Increase value (bar increases to the right)
	Right	Axis 0	Increase value (bar increases to the right)
	Left	Axis 0	Decrease value (bar decreases to the left)
A Button		0	Reversed display
B Button		1	Reversed display
X Button		2	Reversed display
Y Button		3	Reversed display
Help button		8	Reversed display
R2 Button		5	Reversed display
R1 Button		Axis 5	Increase value (bar increases to the right)
L2 Button		4	Reversed display
L1 Button		Axis 2	Increase value (bar increases to the right)
D-pad keys	Up	Axis 7	Decrease value (bar decreases to the left)
	Down	Axis 7	Increase value (bar increases to the right)
	Right	Axis 6	Increase value (bar increases to the right)
	Left	Axis 6	Decrease value (bar decreases to the left)

For items that correspond with an [Axis], check that the display returns to the center when you release your finger from the button, joystick, or D-pad key.

You can also check if the left and right joysticks and the D-pad keys are working properly in the charts under [Axes].



5 After checking, click [Close] to close all screens.

If something goes wrong, discontinue use and contact your distributor or maintenance provider to replace the gamepad.

Chapter 7 Disposal

Properly dispose of the product in accordance with local regulations when no longer used.

■ Parts to be removed for disposal

When disposing of the product, remove the following parts for sorting.

Target	Parts to remove
ASCENT	Battery, gas detector
Charging Station	Auto oiler
Teleop terminal	Battery

Follow the steps below to remove each part.

⚠ WARNING

- **To remove a part, first move the product to a non-hazardous area.**
  Doing this work in a hazardous area could present a risk of ignition of flammable gases.

About product and battery disposal in Europe

The symbol at the left is displayed on products based on the WEEE Directive (2012/19/EU).
This symbol indicates that used products should not be disposed of with general waste.
Dispose of used products separately for recycling in accordance with local regulations.
Proper disposal can save valuable resources and prevent adverse effects on the environment and human health.

The symbol at the left is displayed on products based on the Battery Directive (2006/66/EC).
This symbol indicates that used batteries should not be disposed of with general waste.
Dispose of used batteries separately for recycling in accordance with local regulations.
Proper disposal can save valuable resources and prevent adverse effects on the environment and human health.

■ SIM treatment for communication

ASCENT and teleop terminals have built-in SIM cards for communication. The SIM cards must be disabled for disposal. See “7.4 Built-in SIM Disabling” (page 7-12) for details.

7.1 Battery Removal

⚠ WARNING

Do not remove the battery except when disposing of ASCENT.
Removing the battery in the presence of flammable gases may result in ignition. Further, improper battery installation may result in loss of explosion proofing.
When disposing of it, move ASCENT to a non-hazardous area before removing the battery.

Do not disassemble the removed battery or subject it to sharp impact.
It may cause battery leakage, explosion, ignition, equipment failure, or fire.

If the liquid inside the battery gets into your eyes, immediately rinse with water and see a doctor.
It may cause blindness.

Do not leave the battery in a hot place, near a fire, or put it in a fire.
There is a risk of explosion.

Do not leave the battery in a cold place (-20°C or below).
It may cause liquid leakage or explosion.

Avoid spillage of the liquid.
It may cause overheating, rupture or fire.

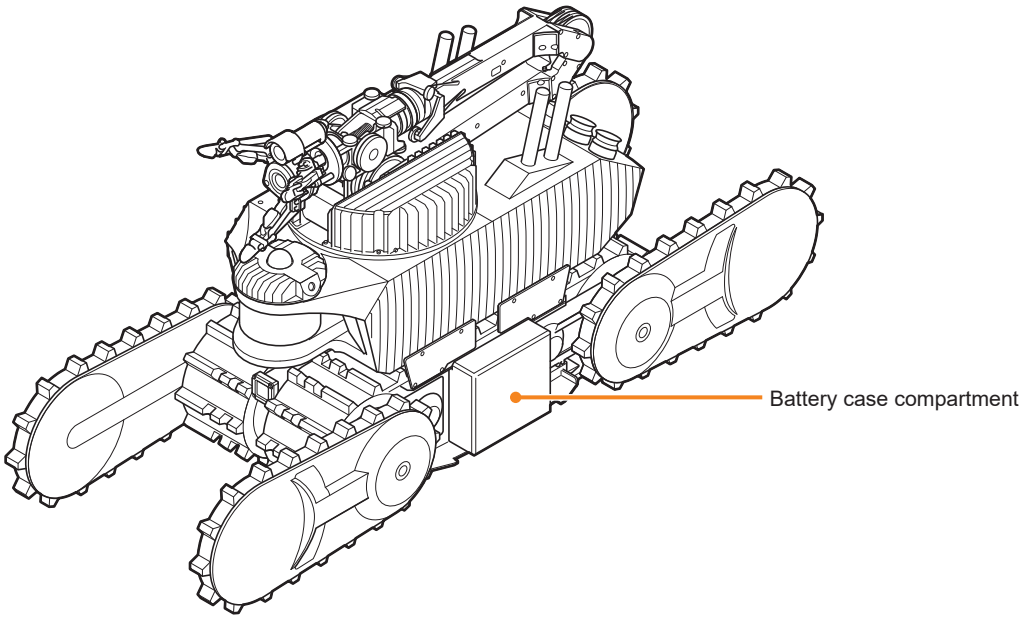
⚠ CAUTION

If the liquid from inside the battery gets on your skin or clothing, immediately rinse it with water.
It may cause skin injuries.

Do not allow metal objects to contact the terminals.
There is a risk of electric shock.

7.1.1 ASCENT battery removal

ASCENT's battery is housed in a battery case attached to the main body. Remove the battery case from ASCENT.



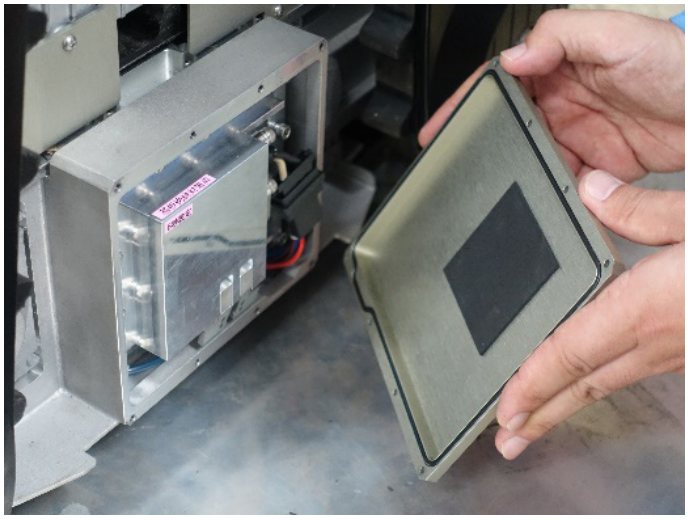
1 **Move ASCENT to a non-hazardous area, and press the emergency stop button on the back of ASCENT to ensure that it is powered down.**

2 **Loosen the M3 hex socket-head cap screws in the battery lid.**

⚠ CAUTION

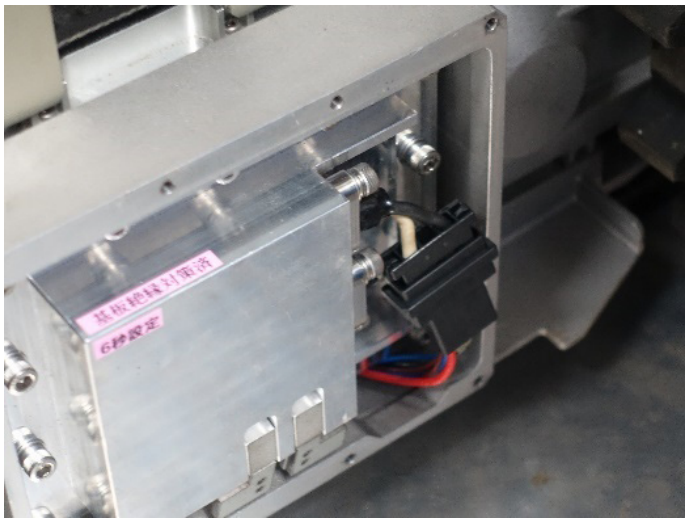
- **Do not loosen all of the screws at once.**
  Loosening all screws before the internal pressure is reduced may cause the lid to fly off and cause injury.

3 **Remove the lid.**

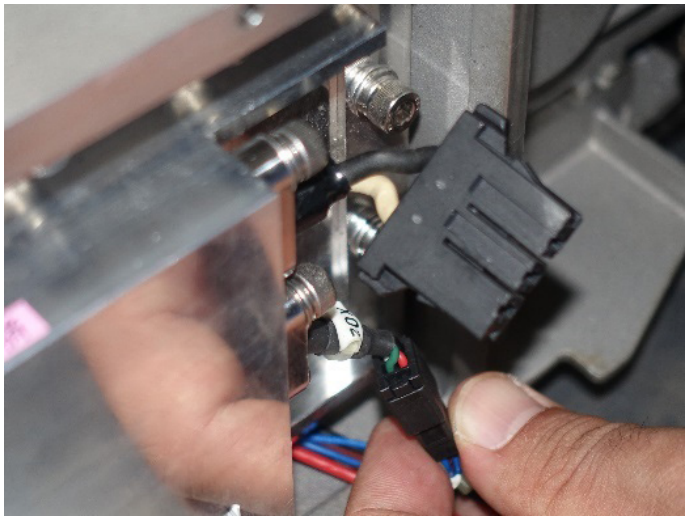


4 **Disconnect the two connectors between the battery and ASCENT's main unit.**

First, disconnect the large connector while pressing the tabs on both sides of the connector.



Next disconnect the smaller connector while pressing the tab on one side.



5 **Pull the battery case straight out horizontally, being careful not to pinch the cables or fingers.**

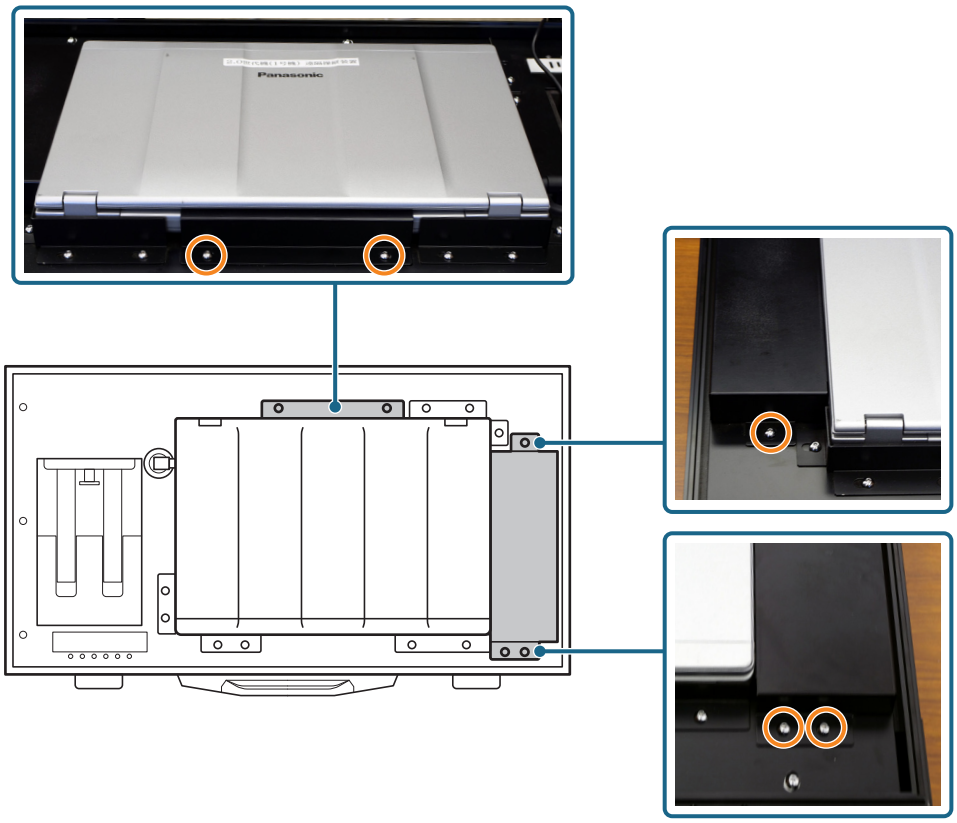
6 **Dispose of the removed battery case properly according to local regulations.**

7.1.2 Teleop terminal battery removal

1 **Disconnect the power cable from the teleop terminal.**

2 **Place the teleop terminal on a stable surface, and remove the case lid.**

3 **Remove the screws in the brackets that secure the notebook PC, then remove the brackets.**
Remove the brackets (two places) shown in gray below.
Bracket on the right side of the notebook PC: Remove the two screws from the front and one from the back.
Bracket on the back of the notebook PC: Remove the two screws.



4 **Unplug the USB and LAN cables from the notebook PC.**

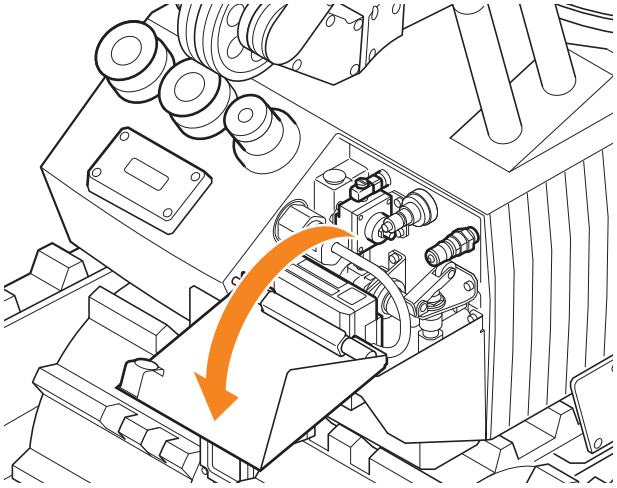
5 **Remove the notebook PC from the case.**

6 **Remove the battery from the notebook PC and dispose of it according to local regulations.**

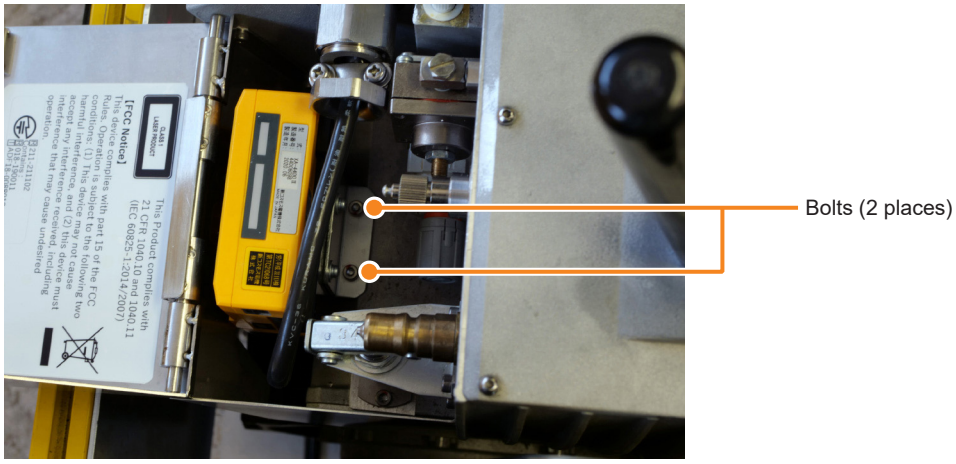
7.2 Gas Detector Removal

Follow the procedure below to remove the gas detector attached to the rear of the ASCENT.

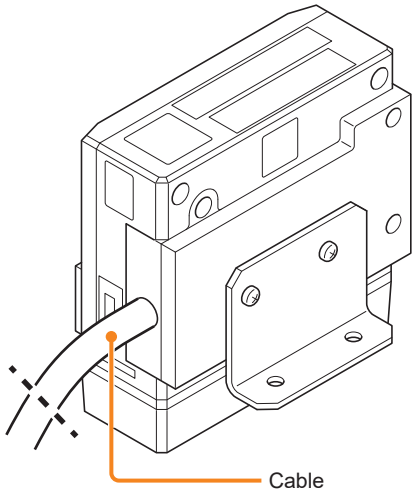
1 **Move ASCENT to a non-hazardous area and open the rear lid.**



2 **Remove the two bolts that secure the L-bracket inside ASCENT.**



3 **Remove the gas detector with the L-bracket, and cut the cable connecting the gas detector to the unit using wire cutters.**



4 **Do not dispose of the removed gas detector as is, but contact your supplier to request disposal.**

7.3 Auto Oiler Removal

Remove the auto oiler from inside the Charging Station.
Read the Grease Safety Data Sheet and work accordingly.

⚠ WARNING

- **Do not remove the auto oiler except when disposing of the Charging Station.**
  If static electricity has accumulated on the surface of the grease container when removing it from inside the housing, flammable gas may ignite.
  When disposing of it, move the Charging Station to a non-hazardous area before removing the auto oiler.

⚠ CAUTION

- **Wear protective equipment to prevent direct contact with the grease or contact with the eyes.**
  - **Oil-resistant protective gloves**
  - **Ordinary glasses with side plates or protective goggles**
  - **Work clothes and safety shoes that fit your body**

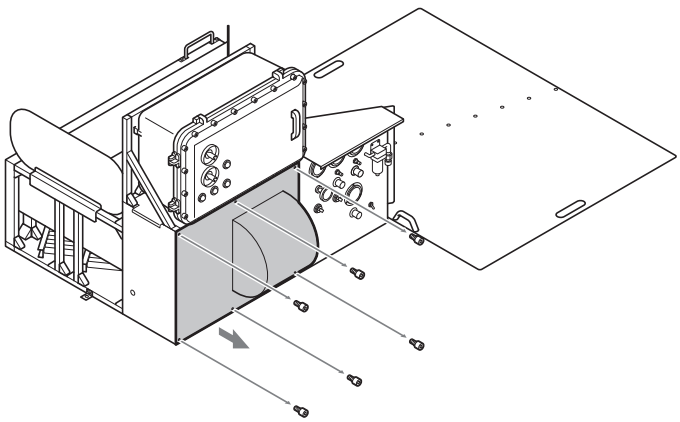
  If grease gets on your skin or into your eyes, take appropriate action according to the first aid instructions in the Safety Data Sheet.

1 **Shut off the Charging Station's power and air supplies, and disconnect the power cable and compressed air hose.**

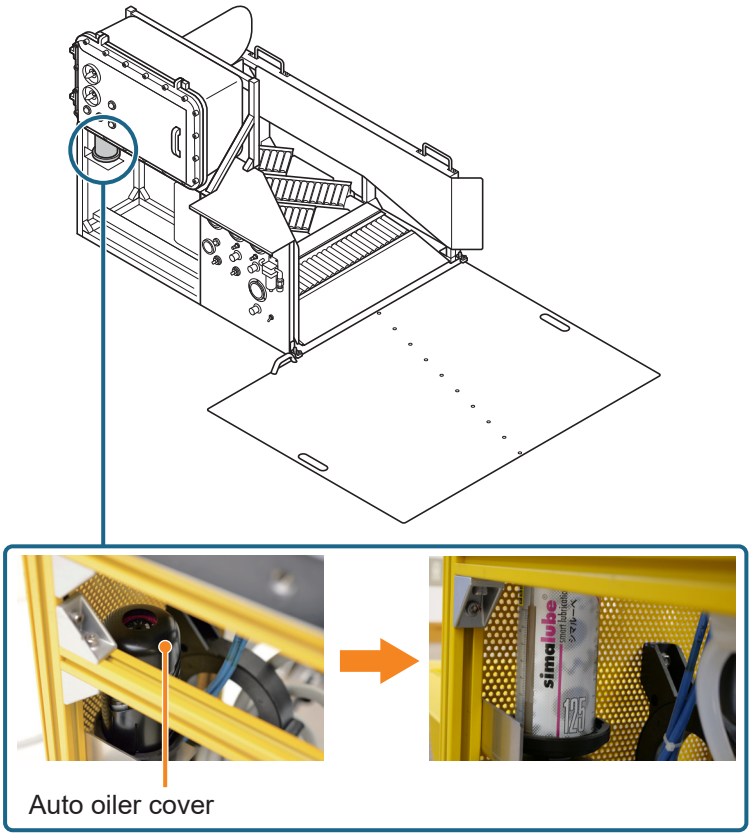
2 **Switch the "2V4/Supply valve" (supply pressure switching valve) to "Purge" to release the residual pressure.**

3 **Transport it to a non-hazardous area. (For the transportation method, follow the instructions in "5.2.1 Transporting the Charging Station" of "Installation and Setup Manual".)**

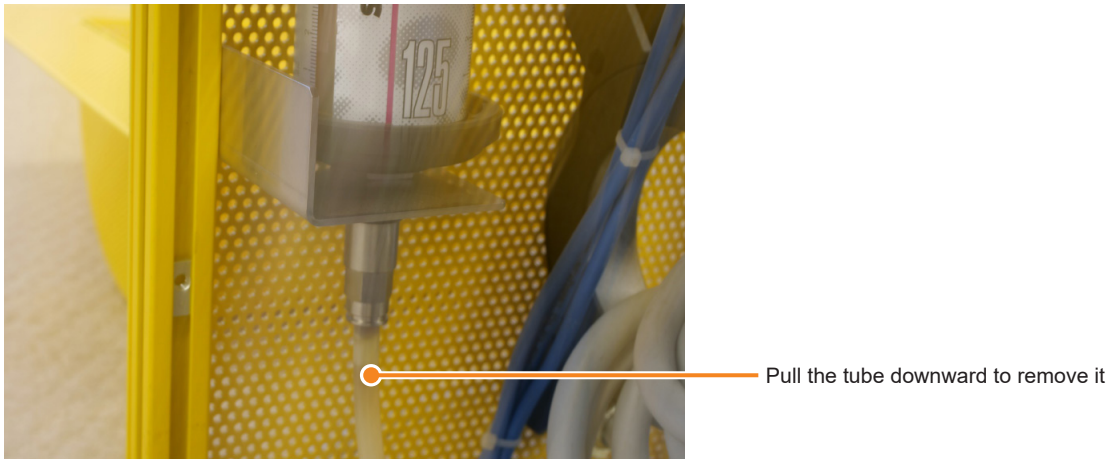
4 **Remove the punched metal plate from the side.**



5 **Remove the auto oiler cover.**

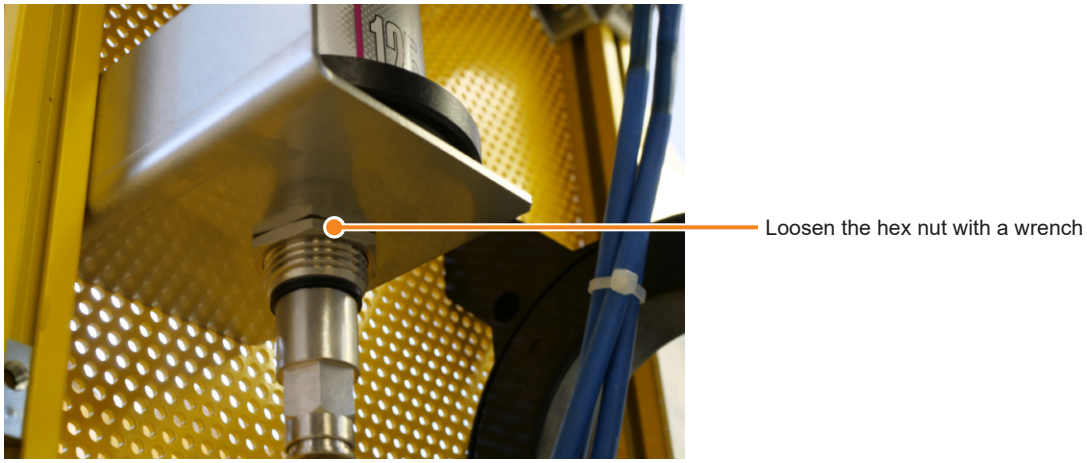


6 **Remove the tube connected to the bottom of the auto oiler.**



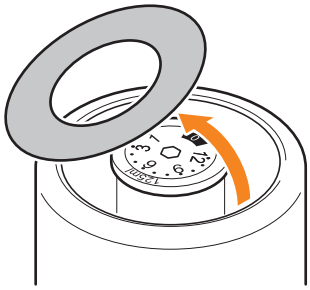
7 **Remove the auto oiler from the Charging Station.**

Use a wrench to loosen the hex nut that secures the bottom of the auto oiler, and then remove the auto oiler from the Charging Station.

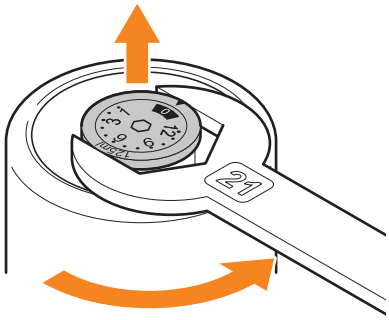


8 **Remove the washer on the grease container.**

The washer is affixed with adhesive tape and can be easily removed.



9 **Remove the gas generator using a 21 mm wrench.**



⚠ WARNING

- **Do not remove the gas generator near an open flame.**
  Removing the gas generator releases a small amount of H_2 gas, which could ignite if released near a flame.

10 **Dispose of the removed gas generator as a battery.**

The gas generator is an integrated battery unit that cannot be disassembled. Dispose of the entire gas generator as a battery.

11 **Properly dispose of containers and grease according to respective local regulations.**

7.4 Built-in SIM Disabling

ASCENT and teleop terminals have built-in SIM cards for LTE communication. When disposing of these products, have the built-in SIMs disabled.
Contact your distributor to request disabling the built-in SIMs.

Appendix A Inspection Checklist

ASCENT

Inspection Type | □ Daily Inspection | □ Initial Inspection

Check Item			Visual Check
Exterior	Are there any scratches, cracks, dents, stains, or abrasion marks?		Good - Bad
	Are any fastening bolts and washers loose, missing or significantly corroded?		Good - Bad
	Are the switches or antennas wobbly or deformed?		Good - Bad
	Are any tracks dirty, dusty or muddy?		Good - Bad
	Are there any cracks in the track belts, significant grouser wear, or damage to the frame?		Good - Bad
	Are any bolts on the back of the sub tracks loose?		Good - Bad
	Check for frayed manipulator cables, dirt, dust, and entangled thread debris.		Good - Bad
	Check the manipulator cables for abrasion, wire breakage, kinking, deformation, corrosion, or looseness.		Good - Bad
	Is any manipulator bearing cracked or pulley bent?		Good - Bad
	Is any manipulator hand control cable broken or twisted?		Good - Bad
	Are there any scratches or cracks on the exposed cables of the visible surveillance camera, LED lighting, or gas detector?		Good - Bad
	Are there any stains or scratches on the camera lenses, LED lighting, 3D-LiDAR, or the glass of the contactless power reception unit?		Good - Bad
	Is there any condensation or traces of it inside the camera lenses, LED lighting, or 3D-LiDAR?		Good - Bad
	Is the Status LED cracked or dirty?		Good - Bad
Performance	Does the battery life seem shorter?		Good - Bad
	Are camera images out of focus, too dark or too bright, or out of position?		Good - Bad
	Is the temperature recorded in the images taken by the thermal imaging cameras the same as the temperature of the subject?		Good - Bad
	Is there any abnormal vibration or heat generation?		Good - Bad
	Did ASCENT deviate from the patrol route while moving?		Good - Bad
	Is the manipulator returning to its home position?		Good - Bad
	Do camera shooting results vary significantly?		Good - Bad
	Is there any abnormal noise?		Good - Bad
	Does the internal pressure drop interlock (power off) trip during operation?		Good - Bad
Explosion Proofing	Does the internal pressure drop interlock work properly?	Check the differential pressure sensor (right)	Good - Bad
		Check the differential pressure sensor (left)	Good - Bad
Operation	**Initial inspection only:** Does the Torque Off button function normally?		Good - Bad
	Initial inspection only: Does the Emergency Stop button function normally?		Good - Bad

Inspector record column	
Inspection date	/ / (Year/Month/Day)

Charging Station

Inspection Type ☐ Daily Inspection ☐ Initial Inspection

Check Item		Visual Check
Exterior	Are there any scratches, cracks, dents, stains, or abrasion marks?	Good - Bad
	Are any fastening bolts and washers loose, missing or significantly corroded?	Good - Bad
	Are the rollers free of dirt, dust, rubbish, or entangled with thread waste? Do they rotate smoothly?	Good - Bad
Wiring	Are there any scratches or cracks on the exposed power cable?	Good - Bad
	Are there any scratches or cracks in the air hose? Is air leaking from the source or the middle of the hose?	Good - Bad
Cylinder	Is the operating speed of the cylinder varying or cogging (the cylinder does not extend or contract smoothly)?	Good - Bad
	Are the protective gas supply port and the contactless power transmission unit properly connected to ASCENT (not misaligned)?	Good - Bad
	Are there any cracks or breaks in the protective gas supply port O-ring? Is it moist with grease, not dripping, and is there any foreign matter?	Good - Bad
Operation	Is ASCENT tilted when docked?	Good - Bad
	Is the humidity and purity of the air sent from the Charging Station to ASCENT appropriate?	Good - Bad
	Initial inspection only: Is purging executing normally?	Good - Bad

Inspector record column	
Inspection date	/ / (Year/Month/Day)

Teleop Terminal

Inspection Type	□ Daily Inspection	□ Initial Inspection

Check Item		Visual Check
Cable	Are there any scratches or cracks?	Good - Bad
Gamepad	Do the buttons work properly?	Good - Bad

Inspector record column	
Inspection date	/ / (Year/Month/Day)

MEMO

L5-59EU025 R00

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