Research and Development Support Achievements (As of July 2025)”

No.	Classification	Name	Summary of Operations	Equipment / Tools
1	Analysis	Development of an Environmental Variation Analysis Model for Closed Spaces Using the JEM(*1) Onboard ECLSS(*2) Equipment *1: Japanese Experiment Module in International Space Station *2: Environmental Control and Life Support System	(1) Developed an analysis model of time-based variations in carbon dioxide concentration, temperature, and humidity inside a closed environment equipped with the JEM air revitalization system during astronaut stays. (2) Conducted computer simulations using the developed model, based on astronauts' metabolic rates.	SICLE (SImulator for Closed Life and Ecology) This is software that we created.
2		Support for Nutrient Cycle Simulation of a Lunar Habitation Base	Modeled a lunar habitation base concept under study by a private company using SICLE and conducted simulations. Provided analysis of simulation results and make suggestions for improvement.	SICLE
3		Development of an ECLSS Equipment Control and Analysis System	Studied the integration of an ECLSS simulator and equipment control/analysis system based on SICLE technology into the operating system for space station development.	Programming Language: Python Development Environment: Eclipse, GitHub
4	Research and Development Support	Analysis Work and Technology Demonstration Support for ECLSS Research and Development for Future Exploration	(1) Ground test support for the research and development of an ECLSS in Gateway mission. ① Managed BBM experiments for the CO_2 removal system ② Improved efficiency of data processing for CO_2 removal system BBM experimental results (2) Provided analysis, design, drafting, and fabrication support for the research and development of an ECLSS in Gateway mission. (3) Provided technical support for the research and development of a pressurized lunar crewed rover ECLSS	CO_2 Removal System Note for (1)②: Language: Python
5		Support for Research and Development of ECLSS Equipment Element Technologies	・Evaluated the performance of water electrolysis cells under varying parameters, including electrical characteristics, gas separation performance, long-term operation changes, and gravity effects. ・Assessed water electrolysis and methanation (methane production) performance using integrated water electrolysis cells and Sabatier reactors, including operation tests on scale-up equipment, which is lab-scale. ・Conducted performance evaluation tests of -cells of water electrolysis/fuel cell (electrolysis tests, power generation tests, reversible operation tests). ・Performed power generation tests of cells of CO_2/H_2 fuel cell. ・Prepared test environments and procedure manuals and supported data analysis.	・Charge/discharge test equipment ・Impedance measurement equipment ・Gas Chromatograph (GC) ・Water supply system ・Electrolysis equipment ・Power supply and electronic load equipment ・Gas Chromatograph/Mass Spectrometer (GC/MS) ・Gas supply system
6		Support for Research on ECLSS Air Revitalization Technologies	Operations, Equipment Assembly, and Research Assistance for ECLSS Studies	・Various ECLSS devices ・Various analytical instruments (GC, GC/MS, etc.)

Research and Development Support Achievements (As of July 2025)”

No.	Classification	Name	Summary of Operations	Equipment / Tools
7	Research and Development Support	Support for Research and Development of ECLSS Hydrogen/Methane Production Technologies	・Developed, fabricated, operated, and analyzed test data for methanation/reaction equipment using the Sabatier reaction. ・Developed, post-processed, and conducted performance comparison tests of CO_2 adsorbents and dehumidifiers; developed, fabricated, operated, and analyzed test data for related equipment. ・Developed and fabricated air production equipment for testing CO_2 separation and collection systems. ・Developed gas–liquid separators for methanation equipment outlets. ・Fabricated and operated integrated systems combining methanation equipment (Sabatier reaction) and water electrolysis equipment. ・Developed and tested equipment for trace toxic gas adsorption and removal.	Equipment: ・Analytical instruments(FT-IR、GC)
8		Research on microalgae with a view toward future space applications	Biomass measurement of carrier-based culture (solid-surface culture)	Hyperspectral / Multispectral Camera
9		Support for Demonstration of Carbon Dioxide Recovery Systems	(1)Renovation work for outdoor/indoor boiler exhaust gas piping (2)Modification, design, and installation of CO_2 separation and collection systems (3)Development of condensate drain equipment (4)Operation of CO_2 separation and collection systems	Standard tools such as a screwdriver
10		Performance evaluation of lithium-ion secondary batteries	・Charge-discharge cycle testing, capacity measurement, DoD(*3) setting, and impedance measurement assuming LEO (Low Earth Orbit) *3: Depth Of Discharge ・Charge-discharge cycle testing under atmospheric and vacuum conditions assuming the space environment (long-term performance testing) ・Establishment of environmental conditions for performance evaluation testing and support for data analysis	・Charge-discharge equipment ・Vacuum chamber ・Constant-temperature bath / incubator ・Impedance measurement device
11		Research and development support for Mg (magnesium) metal batteries	①Fabrication and evaluation of Mg (magnesium) metal batteries ②Physical property evaluation	①Glove box, dry chamber, charge-discharge equipment, potentiostat, planetary ball mill, mixer, coating machine, press, ultrasonic welding machine, vacuum degassing sealer ②Various analytical instruments (SEM, ECCS, NMR, XRD, Raman spectrometer, Karl Fischer titrator, etc.)
12		Pipe assembly and testing support for the lunar exploration equipment grand model	Based on the design drawings, performed component selection, fabrication, and assembly for piping sections. Conducted leak tests using a vacuum pump.	-

Research and Development Support Achievements (As of July 2025)”

No.	Classification	Name	Summary of Operations	Equipment / Tools
13	Operation	"JEM Operations – Rack Officer / Operator"	As a member of the Flight Control Team, performed the following tasks: ・Prepared experiments conducted using equipment installed in the ISS Japanese Experiment Module 'Kibo' (including development of operation procedures, etc.) ・Monitoring and commanding experiment equipment from the ground to execute experiments ・Supported astronauts' activities/experiments from the ground.	-
14		JEM Operations – User Integration Tasks	User coordination for small-animal missions in the ISS Japanese Experiment Module 'Kibo', including: ・Converting researcher requirements into actual operation scenarios and scheduling. ・Creating requirement and constraint documents, as well as anomaly response tables, referenced during actual operations ・Coordinating requirements with NASA researchers and operation personnel	-
15		Satellite operations – tasks such as support for data analysis	・Operation of communication antennas ・Operations for low-Earth-orbit satellites (Commanding and satellite data downlink) ・Support for data analysis ・Troubleshooting and assistance with recovery operations	-
16		Performance assessment of satellite data"	Performed assessment of health and status (H&S) data, as well as experimental data obtained from low-Earth-orbit satellites, over short-term (1 month), medium-term (3 months), and long-term (6 months/1 year) periods. Reviewed the content of procedures planned for future operations.	-
17		Satellite launch and operation preparation	Preparation of procedures required for satellite launch and operations.	-
18	Survey	Investigation of LEO, lunar orbit (surface), and Mars exploration scenarios for ECLSS studies	Investigated and reviewed existing domestic and international optimization studies regarding routes, mission durations, ISRU scenarios, and system sizing for lunar and Mars exploration missions, using LEO and lunar orbit as intermediate points, and organized and summarized the findings.	-
19		Study on optimizing supply quantities (water, food, fuel) using the MIT SpaceNet	Using SpaceNet, a simulation software developed by the Massachusetts Institute of Technology (MIT), conducted route planning for lunar and Mars exploration. Calculated logistics mass (initial loading, ISRU(In-Situ Resource Utilization), and intermediate resupply) for water, food, and fuel, and examined scenarios that minimize mission duration, transit time, and supply requirements.	-
20		Investigation of research outcomes from closed-isolation experiments	With a view toward creating new space food-related businesses for space travel and future lunar and Mars stays, promoted co-creation activities in this field, identified technical research challenges assuming ultra-long-term stays, and investigated research outcomes from closed-isolation experiments.	-