Japanese Aerospace Literature
This month: *Spacecraft/Satellite Design*

N92-33856 JEM development status and plan for JEM crew training. KAZUHIKO YONEYAMA, *Space Station Program Dept. Science and Technology Agency,* The 14th Space Station Utilization Workshop in Japan pp. 31–47 (See N92-33854 24-12).

The outline, the operation plan, and the development schedule of JEM (Japanese Experiment Module) are described. The status of JEM crew training is also outlined. The following topics are addressed: conceptual drawings of the JEM; characteristics of JEM; structure of JEM pressurized module; equipment layout on exposed facilities; fundamental issues for space station operation; conceptual drawings of JEM operation system; major JEM development and operation schedule; description of Japanese space station crew; the process from space station crew selection to their getting aboard the station; selection criteria of JEM crew; Japanese astronaut education and training schedule; details of JEM crew training; and participation in Mission Specialist (MS) training. (Author (NASDA))

N92-33797 Study on miniaturization of satellites (Eisei kogata ka no kentou). HIROAKI OBARA, KATSUTOSHI OOMURA, OSAMU SAITOU, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 21 pp. (See N92-33753 24-91)

Problems in designing miniaturized satellite systems consisting of miniaturized constituent elements and missions suitable to miniaturized satellites, and subjects of technical development available for miniaturization are examined and reviewed. Results of reviews on satellite miniaturization of the following subsystems are outlined: (1) communication and data processing subsystem; (2) electric power supply; (3) sensors (optical and inertial sensors, and GPS (Global Positioning System) receivers) and actuators (wheels, RCSs (Reaction Control Subsystem)); and (4) structure and thermal control subsystem. Problems in designing the system are: (1) introduction of commercialized goods technology; (2) anti-space environment measures; (3) user friendly operation system; and (4) disposal of used satellites. Miniaturized satellite utilization missions considered are: (1) technology development mission (scientific and engineering experiments); (2) communication and positioning mission; (3) observation mission; and (4) planet exploration mission. (Author (NASDA))

N92-33796 Feasibility of microminiature satellites (Chou kogata eisei no kanou sei ni tsuite). RYOUICHI IMAI, *Launch Vehicle and Satellite System Lab., Future Space Activities,* Lunar Base Workshop 1991, 20 pp. (See N92-33753 24-91)

A conceptual study is conducted on technical problems and system design techniques to accomplish higher performance microminiature satellites by smaller systems. Applications of microminiature satellite technology to practical satellite mission are mentioned. Concepts of microminiature satellites, measures to miniaturize satellites, and microminiaturization technologies for communication and data processing, electric solar power paddle, attitude and orbit control, structure, thermal control, propulsion, and instrumentation systems are outlined. Examples of miniaturizing satellite missions such as planet exploration, low-altitude communication networks, space positioning system, low-altitude earth observation mission, clustered satellites, tethered satellites, and timely observation are described. Satellite miniaturizing technology can also be used to launch systems by lasers, and superconductive linear catapults (space escalator). It is pointed out that keys to promote satellite miniaturization are electronics, precision machining, raw material, electric power source technologies, and system design technology to integrate those technologies. (Author (NASDA))

N92-33792 Review on transportation systems for manned lunar missions (Yuujin tsuki misshon ni kansuru yusou shisutemu no kentou). TAKAHIRO ITOU, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 14 pp. (See N92-33753 24-91).

A transportation system from earth revolving orbits to the lunar surface, to be used in the manned lunar surface sites phase, in which three astronauts stay at the site during day time only, is reviewed. The review examines the system functional balance between composing elements and selection of the overall manned lunar transportation system and on subsystems such as manned transportation module, lunar landing vehicle, and lunar transportation vehicle. The following topics are covered: (1) representative example of earth-moon transportation profiles and required speed increments; (2) overall lunar transportation system structures; (3) functional balance between subsystems; (4) outline characteristics of manned transportation module; and (5) conceptual drawings and outline characteristics of lunar landing and take-off, and lunar transport vehicles. (Author (NASDA))

A92-35609 Outline of the exposed facility structures of the Japanese Experiment Module (JEM). KAZUHIKO KAMESAKI, M. TAKAI, KENJI SAKANO, TAKANE WATANABE, T. SAKADA, T. OJIMA, A. KITAMURA, and EIJI KINOUCHI, *Proceedings of the 7th Space Station Conference,* Tokyo, Japan, Apr. 16, 17, 1991, (A92-35601 14-12). Tokyo, Japan Society for Aeronautical and Space Sciences, 1991, pp. 13, 14.

The design of the exposed facility (EF) of the Japanese Experiment Module (JEM) is presented. The development of the engineering model and flight model are discussed.

N92-33793 Review on operation concepts and separation simulation of M-5 rocket vehicle air-launch program (M-5 roketto kuuchuu hassha keikaku no unyou kousou oyobi ridatsu shimyureshon no kentou). TADASHI ISHIKAWA, HIDEHIRO HIROSE, YASUHIRO TANI, and YOUSUKE NAGAO, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 17 pp. (See N92-33753 24-91).

This report reviews the methods to load and separate the M-5 air-launched rocket vehicle from the mother plane. Comparison of the features, merits, demerits, and separation profiles of the M-5 air-launched rocket vehicle with those of the U.S. air-launched rocket vehicle 'Pegasus' are made. The feasibility of separation from the mother plane is verified by simulation. (Author (NASDA))

N92-33791 Conceptual study on vertically launched fly-back boosters (Suichoku uchiage houshiki furai bakku busuta no gainen kentou). KOUICHI YONEMOTO and TAKASHI MUGITANI, *Aerospace Group, NASDA, Future Space Activities,* Lunar Base Workshop 1991 23 pp. (See N92-33753 24-91).

A conceptual study is conducted of fly-back boosters as the proposed candidates for future transportation systems which can be realized in the near future. System design requirements such as policy and scope of design study are reviewed. Conceptual design of the body such as the design flow and design conditions, optimization of performance sharing between fly-back boosters and upper-stage rockets, body configurations, weight estimates and weight balance of the body, trade-off of candidate optimized configurations, and flight profiles is conducted. Baselines and candidates of configuration, required performance, weights of engines for cruising, and dimensions of the body are presented. Results of body weight analyses, and flight profiles are also presented. (Author (NASDA))

N92-33790 Fly-back boosters (Furai bakku busuta). TAKASHI MAKINO and SEIJI MATSUDA, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 13 pp. (See N92-33753 24-91)

The first system review on rocket systems composed of fly-back booster and expendable upper-stage rockets which are capable of launching a payload of 30 tons into low earth orbit is conducted. Three types of winged reusable fly-back booster systems are reviewed on the following premises: (1) payload launch capability of 30 tons; (2) start of operation in the years 2000 to 2010; (3) two-staged vertically launched vehicles; and (4) the core will be a LH2/LOX two-stage launch vehicle with LE-7A rocket engines. 2nd-stage fundamental features, booster stage aerodynamic design, aerodynamic performance estimates, booster stage sizing, orbit analysis, and system trade-off of the fly-back boosters are reviewed. Fly-back booster launch vehicle flight sequence, 2nd-stage features, configuration and characteristics of three types of rocket system, and fly-back booster orbit condition histories are outlined. (Author (NASDA))

N92-33789 Conceptual study on orbit transfer vehicle launched by H-2 launch vehicles (H-2 roketto you kidou kan yusou ki no gainen sekkei). KOUHEI KATOU, MASAYA YAMAMOTO, TAKESHI KAWAZOE, KAZUHISA KANEKO, and TOSHIYUKI TANAKA, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 17 pp. (See N92-33753 24-91).

A conceptual study of the Orbit Transfer Vehicle (OTV) is conducted on the overall systems and propulsion systems. The premises for the study are: (1) OTV is mounted on the 2nd-stage of an H-2 launch vehicle and injected into Low Earth Orbit (LEO); and (2) OTV can be used for multiple missions such as lunar and planet exploration and geostationary missions. The results of orbit calculation for several missions are shown, and the system features, mass and power balance, and system structure of the OTV are presented. The results of reviews on the transportation capability, types of engine (specific impulse, thrust, and engine cycles), and performance and characteristics of main propulsion system are outlined. Main technical problems to be solved for realizing the propulsion system are: (1) high performance turbopump and heat exchanger development for LOX/LH2 expander cycle engine; and (2) engine low expansion section and deployment mechanism. (Author (NASDA))

N92-33782 Review on habitability at manned lunar surface sites (Yuujin getsumen kyoten ni okeru kyojuusei no kentou). KOUICHI FURUKAWA, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 15 pp. (See N92-33753 24-91)

A review is conducted on the habitability of a module to accommodate the short-time (ten sunlit days, maximum 15 days) stay of three crews at manned lunar surface sites to be used for various experiments and observations. Prerequisites for review are: (1) constructed in around 2010; (2) stay time is ten sunlit days and 15 days at the maximum; (3) constructed at the east side of equator facing at the earth; (4) lunar landing weight per one flight is within ten tons; (5) operation for three years twice per year; (6) consumed materials (water, oxygen, foods, etc.) are expendable; and (7) every crew is given one room. Pressurized module, sizings (constraints by launch vehicles dimensions, ceiling height for expected body statures of white race and the floor spaces and volumes of rooms of the pressurized module), layout, weights and electric power of room spaces of the living module are outlined. Configurations of overall lunar surface sites and living modules are conceptually displayed in drawings. (Author (NASDA))

N92-33787 Future transportation systems (Shourai gata yusou kei ni tsuite). TAKAO ETOU, *Future Space Activities,* Lunar Base Workshop 1991 12 pp. (See N92-33753 24-91).

A study was made of fly-back boosters as one future space transportation system. After presenting premises for review such as launch date, launch site, system configurations, numbers of reuse, and system structure, the following topics were discussed: speed increments, specific impulse, structural efficiency, sizing, performance balance optimization, and configurations. Comparison of various Japanese launch vehicles, relationship between lifted weight and payload weight, between propellant weight and tank length, performance balance optimization, and candidate configurations are presented with tables and charts. Separation speed of the booster is a problem peculiar to the fly-back booster. Reentry conditions and landing place are determined by the separation speed. (Author (NASDA))

N92-33777 Procedures for initial setting up manned lunar surface sites (Yuujin getsumen kyoten no shoki tachiage tejun ni tsuite). KATSUTOSHI OOMURA, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 13 pp. (See N92-33753 24-91).

Ideas to solve technical problems in constructing manned lunar surface sites such as energy supply, cartography of an accurate lunar surface map, connecting techniques of lunar modules, problem of life support, and standardization of OTV (Orbit Transfer Vehicle) and lunar landing modules are described. As a countermeasure for energy supply and lunar map cartography, the initial installation of large scale energy module and lunar roving vehicle ('lunar bulldozer') on the site are proposed respectively. For connecting lunar modules, the technology seems to be available to make a moving attachment to the lunar modules. For the life support problem, it seems to be useful to apply life support system and environmental control techniques for closed environment on the earth. (Author (NASDA))

N92-33773 Conceptual design of lunar landing module (Getsumen chakuriku ki no gainen sekkei). TAKESHI KAWAZOE, TOSHIYUKI TANAKA, KOUHEI KATOU, KAZUHISA KANEKO, and MASAYA YAMAMOTO, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 23 pp. (See N92-33753 24-91)

Analyses on mission operations and systems for lunar landing modules are conducted. The results of the review are presented. The main subjects of the review are as follows: (1) mission operation analyses (orbits); (2) attitudes; (3) methods of detecting the barrier at landing; (4) stability at landing; (5) system configurations, weight, and power balances; (6) main propulsion system thrust and speed increments; (7) weight and electric power analyses; (8) thermal analyses; (9) communication circuits; (10) payload interfaces; (11) on-ground systems; (12) assembly methods; and (13) subsystems. Sequences up to landing on the moon are introduced as follows: (1) launch to lunar transfer orbit; (2) mid-course maneuver; (3) entry into lunar gravity range; (4) deceleration before entering lunar rotating orbit; (5) getting on the lunar rotating orbit; (6) descending maneuvering to land on the moon; (7) getting on the lunar descending orbit; (8) throttling to hovering thrust; (9) hovering at an altitude of 100 km; and (10) stopping the engine to land on the moon at an altitude of several meters. (Author (NASDA))

N92-33772 Review on unmanned lunar landing modules lifted off by H-2 launch vehicles (H-2 ni yoru mujin getsumen chakuriku ki no kentou). SHUNICHIROU NAKAI, TETSUYA NAKAMURA, YUKIHITO KITAZAWA, and KAZUYUKI HIGASHINO, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 19 pp. (See N92-33753 24-91).

A review is conducted on unmanned lunar landing modules lifted off by H-2 launch vehicles to accomplish various missions on the lunar surface as the lead to manned lunar exploration. Results of mission trade-offs are presented, based on the assumption of conducting at least each one mission with and without roving vehicles, and one sample return mission, if possible. Detailed mission trade-offs for environment, geology, underground structure, and ground characteristic survey missions are presented, and an unmanned lunar landing module mission structure is exemplified. Operation plans up to arrival at the moon and after the arrival are introduced. Results of system reviews on operation plans, system structures, system function distributions, and subsystem reviews on propulsion, structures, thermal control, electric power, navigation, and guidance subsystems are presented. Reviews on configurations and development plans are also presented. (Author (NASDA))

N92-33755 Element technologies for manned service platforms (Yuujin sabisu purattofomu no youso gijutsu). MITSURU KOJIMA, HIROAKI OBARA, and KATSUTOSHI OOMURA, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 22 pp. (See N92-33753 24-91).

The space station, in low earth orbit (LEO), is preeminent in its ability to function as the nucleus of a space-based infrastructure. The space station program is being promoted as a development center, and Japan is participating in the program by developing the Japanese Experiment Module (JEM). Due to limitations inherent in the space station's design, it is necessary to develop Japan's original manned platform. Problems are to be expected in the development of basic technologies for the Manned Service Platform (MSPF). Four of these basic technologies are investigated. The areas are as follows: (1) structure and mechanism technology; (2) attitude and orbit control technology; (3) automation and autonomy technology; and (4) manned support technology. (Author (NASDA))

N92-33779 Construction of manned lunar surface sites (Yuujin getsumen kyoten no kouchiku). YOSHINORI YUZAWA, MICHIHIKO HORIE, TETSUYA NAKAMURA, RAITA AMAGATA, and TETSUYA HONDA, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 21 pp. (See N92-33753 24-91).

A review is conducted on manned lunar surface sites to be constructed in around 2010 to conduct various experiments and observations on the lunar surface in a short time prior to developing permanent lunar bases. Methods of construction and operation of manned lunar surface sites are established, taking requirements from the mission parts and shipping mean constraints. Review results of mission requirements and operation profiles are presented. Experiment subjects, structures and outlines of subsystems, weight balance, electric power balance and functional block diagram of the manned lunar surface sites are presented. Conceptual drawings of air-lock and roving vehicle, operation profiles and conceptual drawing of lunar surface sites are shown. (Author (NASDA))

N92-33769 Review on unmanned lunar exploration mission (Mujin tsuki tansa misshon no kentou). YUTAKA KANEKO, *Future Space Activities,* Lunar Base Workshop 1991 26 pp. (See N92-33753 24-91).

Advance survey by unmanned exploration using robots is mandatory for the future manned lunar surface activities to be accomplished more safely and at a lower cost. Reviews are conducted on the following spacecraft to implement such unmanned mission by the Launch Vehicle and Satellite System Laboratory in Tsukuba Space Center: (1) moon revolving observation satellites; (2) lunar roving vehicles; (3) lunar hoppers; (4) a sample retrieval system; (5) a lunar landing module; and (6) lunar data relay satellites. Spacecraft involved in unmanned lunar exploration missions are outlined. Major characteristics and system structure of the lunar landing module are presented. The major feature, weight and electric power balances of the lunar roving vehicles, system configuration, structure, weight, electric power balances, flight paths, and major characteristics of lunar hoppers are also presented. System structure and weight estimates are indicated. (Author (NASDA))

N92-33766 Mars scientific exploration roving vehicles and drilling equipment (Kasei idou kagaku tansa sha to kussaku souchi). KENJI SAITOU, MASAKI KOJIMA, SHUUZOU KINKORI, MANJISUZUKI, NOBUKI KAWASHIMA, and ICHIROU NAKATANI, *NASDA, Future Space Activities,* Lunar Base Workshop 1991 22 pp. (See N92-33753 24-91).

Running gears for the Mars scientific exploration roving vehicles and the drilling equipment for the vehicles used to conduct underground exploration are studied. Review results on moving, driving, and running system for the vehicle are presented. For the driving system, comparison between conventional wheel system and crawler system are shown in a comprehensive table, and measures for failures are suggested. As for the development of the drilling equipment, the following items are presented: (1) methods of underground exploration; (2) methods of drilling (core boring and auger boring); (3) specifications for and the results of trial production of the experimental boring machine; (4) results of experimental boring machine operation on a simulated Mars surface; and (5) excavating capability of the experimental boring machine. (Author (NASDA))

N92-33765 Fundamental research on Mars exploration using scientific exploration roving vehicles (Idou kagaku tansa sha o mochiita Kasei tansa no kiso kenkyuu). NOBUKI KAWASHIMA, ICHIROU NAKATANI, JUNICHIROU KAWAGUCHI, KOUICHIROU KOYAMA, NORIMI HASEGAWA, SHUUZOU KINKORI, MANJI SUZUKI, MASAKI KOJIMA, KENJI SAITOU, TSUGUO ADACHI et al., *NASDA, Future Space Activities,* Lunar Base Workshop 1991 10 pp. (See N92-33753 24-91).

The following fundamental items concerning Mars scientific exploration roving vehicles are reviewed: (1) special technical aspects; (2) review subjects; (3) purpose of the exploration; (4) methods of underground exploration; (5) other possible methods of scientific exploration; and (6) roving vehicle configuration. Communication between roving vehicles and the Earth, and the stringent environments on Mars are addressed. The driving system, roving distance, and the automatic driving system of the rovers are also presented. Focus is on the underground survey of Mars to check the existence of water or organic substance. The exploration methods covered are as follows: (1) analysis of samples excavated by mechanical drilling; and (2) electromagnetic measurement or sounding using artificial or natural earthquakes in order to explore deeper underground areas where samples can not be obtained by mechanical drilling. (Author (NASDA))

A92-56004 High-speed aerodynamic design of space vehicle and required hypersonic wind tunnel facilities. S. NOMURA, K. HOZUMI, S. SAKAKIBARA, and K. SOGA, *Proceedings of the 29th Aircraft Symposium,* Gifu, Japan, Oct. 7–9, 1991, (A92-56001 24-01). Tokyo, Japan Society for Aeronautical and Space Sciences, 1991, pp. 16–19.

Considerations and problems associated with the aerodynamic design of space vehicles at hypersonic speeds are presented, as well as the aerodynamic design logic and optimization techniques to develop and refine the configurations in a traditional phased approach based on the programmatic design of space vehicles. Current methodology for the determination of aerodynamic characteristics for designing space vehicles is also considered. In particular, the role of new NAL M10 hypersonic wind tunnel and the NAL gun tunnel and the interrelationship of the tunnels and CFD methods in an actual aerodynamic design and analysis is discussed. (Author)