(2) Research into Building a Sound Material-Cycle Society

In order to secure sustainable growth of Japan's economy and society in the future, it is absolutely essential to carry out research and development for creating a sound material-cycle society that promotes the 3Rs through effective utilization of resources and restriction of the generation of wastes, etc.

Efforts for the utilization of biomass will be improved in accordance with the Biomass Nippon General Strategy (decided by the Cabinet in December 2002).

The Ministry of Education, Culture, Sports, Science and Technology is currently engaged in the "The Project to Design a Sustainable Management and Recycling System for Biomass, General and Industrial Wastes," a tie-up between industry, academia, and government for the promotion of the detoxification disposal or recycling of wastes, and also for research and development into the impact and safety assessments and design of social systems, to encourage the commercialization and dissemination of recycling.

The Ministry of Economy, Trade and Industry is working on automobile recycling measures, measures for articles difficult to recycle, and development of technologies for construction materials recycling measures, and is also implementing practical application support projects to disseminate these technologies and develop an intellectual basis for surveys concerning dissemination of recycle technologies and recycled products.

The Ministry of Agriculture, Forestry and Fisheries is promoting the development of recycling and utilization technologies for biomass, the development of system technologies for the efficient recycling and utilization of local biomass resources, and the development of new energy production technologies that utilize organic resources in place of fossil fuels. In addition, the ministry started development of technologies to reduce production costs for biomass plastic in Fiscal 2004. Furthermore, the ministry is engaged in the development of technologies for the sorting and transport of recycled foodstuffs, an area that has long been a bottleneck, preventing the promotion of foodstuff recycling, as well as the development of reproduction and conversion technologies, and of constituent and quality evaluation technologies, needed for the promotion of advanced uses.

The Ministry of Land, Infrastructure and Transport is promoting the development of new geo-materials made from various wastes, and research into the applications of these to port and harbor facilities, the development of methods for strategic stock management of housing and social infrastructure capital, the development of technologies for the restricting and recycling of wastes generated during construction projects, the formation of logistic systems that promote the utilization of recycled resources, and research into the recovery of biomass from sewer sludge, livestock manure, etc.

The Ministry of the Environment is carrying out the research and development of processing technologies for the detoxification of toxic chemical substances generated in the course of waste processing, of technologies for the safe recycling of plastics, etc., and technologies for the proper management of final disposal sites, research into elucidation of the mechanisms for the generation of micro-pollutants at waste disposal facilities, etc. and control of their emissions, as well as research on the control of risks attendant with micro-pollutants. In addition, the ministry is promoting research for the establishment of a sound material-cycle society, including assessment of social systems to promote formation of a sound material-cycle society, ideal cost burden, studies on promotion methods, and research into recycling and reduction in waste generation.

The Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications is implementing research and study on safety measures for fire prevention in relation to the utilization of biomass energy.

The major research subjects conducted during Fiscal 2005 are as shown in Table 3-2-4.

Table 3-2-4 Major research subjects for building a recycling-oriented society (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	・Development of an integrated urban liquid and solid waste treatment system incorporating technologies for transforming kitchen garbage to biodegradable plastics
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Bio-oriented Research Organization, Private sector, universities, etc.	・Development of new technology for the treatment and local recycling of biomass ・Development of technology for assessments of and countermeasures for effects on agriculture, forestry, and fisheries by global warming ・Development of technology for reducing the production cost of biomass plastics
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization, Private sector, universities, etc.	・Development of fundamental technologies for manufacturing environmentally harmonious hyperfine steel particles ・Development of technologies for the detoxification and materials recycling of aluminum impurities ・Development of recycling technology for iron and plastic compounds, using an electric furnace technology ・Development of maintenance technology for extending the life of structures ・Support of 3R for practical uses (Request for Proposal)
	National Institute of Advanced Industrial Science and Technology	・Development of reduction technology for the final disposal amount in urban areas ・Development of chemical products and production technology from biomass ・Research on evaluation design for environment-conscious local measures ・Development of production technology for biomass liquid fuel
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's Secretariat	・Development of housing and urban infrastructure management technology for sustainable society and safe environment ・Development of management technology for infrastructure and building stocks ・Development of evaluation method and technical measures of environmental impact throughout a building's life cycle
	National Institute for Land and Infrastructure Management	・Research recycling systems for construction waste reduction
	Public Works Research Institute	・Research into social infrastructure development using new materials, unutilized materials, and recycled materials ・Research into technology for effective utilization of plant waste materials as green materials ・Study on technology for the exploitation of resources and the recycling of organic waste materials utilizing sewage sludge ・Study on a method for efficient use focused on inorganic characteristics of sewage sludge ash
	Building Research Institute	・Research and development into the effective utilization of existing buildings ・Quality management of structural recycled coarse aggregate from river sands and gravel as the original material, and study on blend and quality evaluation of concrete using the recycled coarse aggregate ・Development of production technology for reprocessed shaft materials from wooden buildings and evaluation technology for performance
	National Maritime Research Institute	・Research on application of environmental label to ships using method of life-cycle-assessment (LCA) ・Development of systems to evaluate and rate ship's life cycle value (LCV)
	Port and Airport Research Institute	・Research into recycling technology in coastal areas ・Research into life cycle management (LCM) of facilities for harbors, airports, etc.
	Civil Engineering Research Institute of Hokkaido	・Experimental study on developing a regional system of biogas-derived hydrogen energy supply, including the technology for such a system
Ministry of the Environment	National Institute for Environmental Studies	・Evaluation of policies for the promotion of resource recycling from the lifestyle perspective ・Research into methods for the analysis of recycling systems' local adaptability
	Grant-in-Aid for Scientific Research of waste disposal, etc.	・Study on construction of systems for optimal resource recycling in the region

(3) Research Related to Building a Society that Co-Exists with Nature, Research Related to the Comprehensive Management of Chemical Substances, and Research Related to Other Sectors

●Research and development related to biological diversity

With the extinction of wildlife species proceeding at a speed never seen before, the "Convention on Biological Diversity," which is aimed at conserving the diversity of living things on Earth and their habitats and conducting sustainable use of biological resources, and the National Strategy of Japan on Biological Diversity, which is based on the said convention, call for the promotion of basic surveys for the purpose of scientific and objective data collection and facilitation regarding the current state of the natural environment and how it is evolving over time, the expansion of ecological and taxonomic knowledge of living things, and basic research for the purpose of elucidating the structure and maintenance mechanisms of ecosystems.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) is participating in the Global Biodiversity Information Facility (GBIF), which is an international scientific cooperation project. The aim of this project is to distribute biodiversity data scattered in countries and utilize it worldwide via the Internet. MEXT is now advancing the creation of a biodiversity online database in Japan as part of the project.

The Ministry of Agriculture, Forestry and Fisheries is promoting research into the development of biofunction-based technologies for reducing the burden on the environment, the analyses of the mechanisms that enable plants to resist environmental stress, and research and development of technologies that encourage human coexistence with wild animals and birds, while reducing their damage to agriculture and forestry.

The Ministry of the Environment is promoting research into the prediction of and countermeasures against the effects of a decrease in biodiversity, by using the Global Environment Research Fund.

●Research and development related to antipollution measures

In the area of pollution prevention, the government is promoting the priority of research and development that utilizes pollution prevention testing and research funding. In recent years, in order to contribute to measures for mitigating environmental risks posed by chemical substances such as dioxins and endocrine disrupters, the relevant ministries and agencies are currently actively engaged in surveys, research and development, and establishment of an intellectual basis, including the development of methods for testing and measuring these substances and the collection and provision of information on chemical substances.

In the Ministry of Education, Culture, Sports, Science and Technology, the Japan Science and Technology Agency is promoting research and development into endocrine disruptors in its Basic Research Programs.

●Other

The Ministry of Internal Affairs and Communications is promoting research into an international information network technology for the protection of the global environment, to facilitate the effective distribution of global environmental data.

The Ministry of Agriculture, Forestry and Fisheries is promoting research into assessment methods based on environmental accounting systems, in order to enable the comprehensive evaluation of agriculture's diverse functions, and of the positive and negative influence on the environment, and is also engaged in the development of nature-friendly control technologies for the hydrological cycle, and for agricultural, forestry, and fishery ecologies in drainage basins, to encourage agriculture, forestry, and fisheries industries that co-exist with nature.

The Ministry of Land, Infrastructure and Transport is promoting the development of drainage basin restoration and recovery technologies that take the entire drainage basin into account for comprehensive hydrologic cycle management, as well as the development of land and infrastructure technologies offering co-existence with nature.

The Ministry of the Environment is promoting research into the design and presentation of scenarios for coexistence with nature in major cities and drainage basins, in relation to the "topic of technologies for the rejuvenation of drainage basins and major cities that are co-existent with nature" funded by the Environmental Technology Development

Fund.

Incidentally, major research subjects conducted during Fiscal 2005 are as shown in Table 3-2-5.

Table 3-2-5 Major research subjects for research related to building a society that co-exists with nature, research related to the comprehensive management of chemical substances, and research related to other sectors (FY 2005)

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Japan Atomic Energy Research Institute	Development of flue-gas radiation treatment
Ministry of Health, Labor and Welfare	Health and Labor Sciences Research Grants	Research into the safety and health effects, etc., of dioxins and other microscopic chemical substances, and of microorganisms
	Research Project on Health Science	Research on water purification/pipeline technology that contributes to the formation of a circulation system of safe water
	Research Fee for Water Supply Facility Improvement Project	Consideration of projects and measures that contribute to the conservation of water supply sources
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agrobiological Sciences, National Institute for Agro-Environmental Sciences, National Institute for Rural Engineering, Forestry and Forest Products Research Institute, and others	Development of comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystem Development of technologies for the management of agricultural and forest ecologies to reduce damage to agriculture and forestry by wild animals and birds Development of symbiotic management technology of water circulation/agricultural, forestry and fisheries ecosystem in the basin zone
	Project for the Development of the Agriculture, Forestry, and Fisheries Industry, Foodstuffs Industry, and Other Advanced Industrial Technologies	Development of technology for recycling-based use of marine resources using advanced technology Development of low-cost basic technologies for the production of organic fertilizers, etc.
Ministry of Economy, Trade and Industry		Environmental technology development Development of technology for CO2 fixation and effective utilization Development of environmentally friendly processing technology Development of materials that put low stress on the environment Development of environmentally friendly recycling technology
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's Secretariat	Development of thermal environment evaluation and countermeasure technologies for urban space
	National Institute for Land and Infrastructure Management	Study on risk evaluation of chemical substances in water environment Wetland restoration project for urban area Proper reuse of treated wastewater Research on the influence of soil and groundwater contamination on the watersheds Strategic planning and adaptive management on environment restoration in coastal zone
	Geographical Survey Institute	Geoecological research and survey using airborne LIDAR data - Case study in Shirakami Mountains
	Public Works Research Institute	Research on evaluating water quality risks Research on techniques for conserving the ground environment Research on comprehensive hydrologic models for rivers Research on techniques for controlling water quality and soil at dam reservoirs and in the downstream sections of rivers Research on techniques for controlling water quality and soil at dam reservoirs and downstream sections of rivers Research on techniques for treating bottom sediment in enclosed water areas Research on evaluating heat island phenomena reduction alternatives

Ministry or agency	Research institute or program	Subject
Ministry of Land, Infrastructure and Transport	Building Research Institute	Improvement on quantification of the intensity of pollutant emission and air ventilation methods for indoor air Research on aquatic conservation technology through high-grade combined treatment of existing individual sewage treatment tanks Development of symbiosis technology between humans, cities, and nature
	National Maritime Research Institute	Research on systems to injection carbon dioxide on sea for carbon dioxide sequestration in deep waters Research on technologies for reducing environment adverse effects from ships Japan-France joint research on detection of oil spills, etc. using fluorescence radar Research on technologies to observe marine pollutants in heavy weather Research on risk assessment method for elucidating environmental adverse effects from ship's anti-fouling substances
	Port and Airport Research Institute	Research on the assessment of the effect of toxic chemical substances in the coastal area and measures to mitigate those effects Research on oil-spill cleanup technology for the coastal area Comprehensive environmental monitoring of the Tokyo Bay and research on the environmental forecasting model
Ministry of the Environment	Global Environment Research Fund	Research into the selection of coral reef biodiversity preservation districts The study for methods and measures of invasive alien species risk assessment
	Environmental Technology Development Fund	Research into the restoration of hydro and material cycles that co-exist with nature in cities and drainage basins, and the development of ecology evaluation standards Research into the development of methods for diagnosing the degradation of multidimensional functions in natural drainage basin environments, and of integrated modeling for the effective evaluation of the soundness of restoration policies
	Research Funding for the National Research Institute engaged in Environmental Pollution Research	Theoretical research for appropriate lake utilization that takes the mutual interactions of life-forms into account, toward integrated protection of lakes
	Survey and Research Funds for the National Organization for Pollution Prevention	Research into elucidation of changes and behavior in the natural environments of world natural heritage districts
	National Institute for Environmental Studies	Research into the evaluation of technologies for natural restorations of marshland ecologies Assessment of the possibility of recovering the marshy ecosystem by the re-routing of rivers flowing into the Kushiro Wetlands Assessment of the lake environment based on organic linkage and preparation of a scenario for improvement

3.2.2.4 Nanotechnology and Materials

Nanotechnology and materials are key technologies for rapid developments over a wide range of scientific and technological areas. Nanotechnology is expected to become a major support element of all science and technology fields in the 21st century, and to lead to a new industrial revolution in the 21st century.

(1) Materials Fields

Based on the "Basic Strategy for Promotion of the Nanotechnology and Materials Sectors in the Ministry of Education, Culture, Sports, Science and Technology (interim report)" prepared by the Council for Science and Technology (Subdivision on Research and Development Planning and Evaluation)" in June 2002, the Ministry of Education, Culture, Sports, Science and Technology generally and widely promotes basic and fundamental R&D for materials science and technology, including "structural materials for the 21st century" and "superconducting materials." Research into materials science and technology is also being promoted through the administration of the "Special Coordination Funds for Promoting Science and Technology," and other similar programs including "Creative Research for Evaluation Science and Technology Program of the Japan Science and Technology Corporation (JST)", and the Frontier Research System, at RIKEN. The ministry is also encouraging the development of creative and advanced materials research at universities and independent administrative entities, as well as providing the "Grant-in-Aid for Scientific Research Program" for basic research into materials science and technology, in order to promote creative science research at universities and in others, so that they can serve as sources of free imagination and research inspiration for researchers.

The Ministry of Agriculture, Forestry and Fisheries is using "Insect Technology Research for Utilization of the Greatest Unused Resources of the 21st Century" to engage in research and development for the wider utilization of biomaterials such as fibroin, a silk protein, as a new material with active anti-thrombosis properties, or the development of materials utilizing the compound capabilities of the bone constituents of silk to form artificial bone or artificial ligaments.

The Ministry of Economy, Trade and Industry is promoting the Program to Create an Innovative Components Industry to strengthen the international industrial competitiveness of Japan while sufficiently using the functions and characteristics of substances to establish a high-value added material industry that creates new markets and employment. In Fiscal 2005, the ministry implemented the Project for Developing Manufacturing Process Technology for Advanced Titanium Alloy, which aims to develop innovative technology for manufacturing processes in which material creation technology and processing technology are integrated, the Production, Analysis and Measurement System for Microchemical Technology Project, which aims to speed up the process from the research and development stage to the production stage, and the Next-Generation Semiconductor Nanomaterials Advanced Evaluation Project, which aims to achieve efficient searching for the optimum combination of multiple materials.

(2) Nanotechnology

The Ministry of Internal Affairs and Communications is engaged in the research and development of optical functional devices and information memory elements, etc., as basic research on information communications. In addition, under the "Strategic Information and Communications R&D Promotion Programme," the ministry started the Research and Development on Ultrahigh-Functional Network Technology Utilizing Nanotechnology in Fiscal 2003 as well as promoting research and development on new information and communications functions and device technologies. Moreover, the National Institute of Information and Communications Technology is promoting Research and Development of New Functions and Extreme Technologies, and thereby implementing basic research into ultra-compact, ultra-high speed, and ultra-low power consumption information and communications devices, including the development of optical devices for the high-speed control and processing of large-capacity signals.The Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications is promoting development of methods of assessing corrosion and deterioration for dangerous facilities, and preparing the necessary databases for creating an environment for developing and introducing methods of assessing corrosion and deterioration for dangerous facili-

ties.

The Ministry of Education, Culture, Sports, Science and Technology has established research centers and a research system of the industry-academi a-government cooperation in order to promote research and development of novel interdisciplinary fields based on nanotechnology and materials expected for technical innovation. In addition, the ministry is promoting, in its R&D projects (Leading Project) for economic revitalization, the "development of artificial organs and artificial sense organs using nanotechnology," the "development of nano measurement and processing technology," etc., through cooperation between industry and academia in sectors where the life sciences, information and communications, environment, and energy sectors merge together, and in technologies in which they share common foundations. In addition, the "Nanotechnology Comprehensive Support Project" provides broad, cross-cutting and integrated support that goes beyond the bounds of existing research institutions and sectors, such as fostering human resources through seminars and international exchanges of young researchers, offering opportunities for the utilization of large and special facilities and equipment to outside researchers, collecting and publishing relevant information, and convening symposiums.

In addition, the Japan Science and Technology Agency implement the research and development of "virtual laboratories by nanotechnology field" from mid- and long-term viewpoints, in close cooperation with researchers by nanotechnology field" utilizing the Basic Research Programs.

The National Institute for Materials Science is engaged in the development of new materials for nano-devices, research into nano-scale materials for energy and environmental applications, and other nano-materials research. RIKEN is engaged in basic research, which will form the foundation of nano-science technology for future generations. This includes the measurement and control of nano-level properties and functions, simple quantum manipulation toward the development of new information processing devices, and space-time function materials for manufacturing auto-changing, auto-reacting materials, and materials that can change over time. Moreover, many universities and colleges and independent administrative institutions are engaged in basic research spanning a wide range of fields. Furthermore, various research funding support programs, including the ministry's Special Coordination Funds for Promoting Science and Technology, and the "Grant-in-Aid for Scientific Research Program," are being used for nano-technology research themes.

The Ministry of Agriculture, Forestry and Fisheries is utilizing information about biological functions obtained at the molecular and cellular level, and cooperation from industry, academia and government, as well as from different technology fields, to promote the development of revolutionary new functional materials through the use of nano-level structural controls, the development of technologies for the utilization of innovative biological functions, and the construction of a micro-bioreactor..

The Ministry of Economy, Trade and Industry is also promoting the "Nanotechnology Materials Program" to establish the technological foundation that contributes to the sustainable economic development as a source of industrial competitiveness of Japan, through intensive development of "nanotechnology" that may bring about innovative development in the broad areas of industrial technologies, as a source of Japan's industrial competitiveness. In Fiscal 2005, the ministry conducted the "research and development on nano-tech/advanced materials for practical use" to promote research and development conducted through cooperation with users by using innovative nanotechnology, for the purpose of developing devices for new materials that enable the creation of new industries, such as information appliances and fuel cells.

The Ministry of the Environment is implementing the development of environmental technologies that make use of the nanotechnology merits of miniaturization and improved function. In Fiscal 2005, the ministry started the development for thermoresponsive hydrophobic chromatography to reduce organic solvent waste.

The major research topics in the nanotechnology and materials science and technology sector con-ducted during Fiscal 2005 are shown in Table 3-2-6.

Table 3-2-6 Major research subjects in the nanotechnology and materials sectors (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology, etc.	・Research and development of ultra functional network utilizing nanotechnology ・Research and development on new functions and ultimate technologies
	Fire and Disaster Management Agency	・Development of methods of assessing corrosion and deterioration of dangerous facilities
Ministry of Education, Culture, Sports, Science and Technology	Special coordination funds for promoting science and technology	・Combinatorial computative chemistry for the revitalization of Japan ・Kyoto University personnel development unit for computative materials researchers ・Development of new crystal material for the terahertz range ・Use of nano-boundary control for the manufacture of magnetic recording materials ・Development of next-generation display media using self-organization of molecules ・Research and development into generation of high-polymer particles using micro-chemical reactors ・SNDM strong dielectric probe memory ・Development of SiO_2 glass-metal slope function material as a light source ・Comprehensive research on nano devices for elucidation of the structures and functions of chromosomes ・Establishment of appraisal method of materials/tissues in tissue engineering ・Standardization of lithium-ion cells for storing electrical power ・Research study on promotion of the social receptivity of nanotechnology ・Formulation and fostering of human resources of human environment medical engineering through collaboration of medical science, dentistry, and engineering ・Nanomedicine fusion education unit ・Creation of glass photonic element with innovative functions ・Research on high-reliable boundary surface for ferroelectric memory ・Development of nano micell type siRNA delivery system ・Development strategy of an observation robot system for the Asian hydrosphere ・Supercritical hybrid QD imaging and treatment ・Development of original hole detection system and ultrasensitive biosensor using magnetic nanobeads
	National Institute for Materials Science	・Development of novel materials for nano-devices ・Nanosynthesis and nanostructural materials for energy and environmental applications ・R&D of new superconducting materials ・High Temperature Materials 21 ・Project for the promotion of biological materials ・Ultra-Steel Products for New High Safety Infrastructures ・Combinatorial Materials Exploration and Technology (COMET) ・Development of virtual experimental platform for material design using computational science and technology ・Development of a carrier material for an innovative nano drug delivery system (DDS)
	RIKEN (The Institute of Physical and Chemical Research)	・Nano-scale science and technology ・Study on the genesis of matter ・Advanced technology research (physical science research) ・Material science research (Quantum Materials Research) ・Spatio-Temporal Function Materials Research ・Single Quantum Dynamics Research ・Research on exotic particle beams ・Electron complex matter science research ・Extreme photonics research ・Development of high-sensitive poison gas detector using nanotechnology processed thin film
	Japan Science and Technology Agency	・Creation of ultra-fast, ultra-power-saving high-performance nanodevice systems, creation of bio-elements and systems utilizing medical-oriented chemical and biological molecules, and other projects for the promotion of strategic creative research ・Project for the promotion of nano-space, spin superstructures, and other creative science and technology
	New Century Priority Research Creation Plan (RR2002)	・Nanotechnology　Researchers Network Center
	Research and Development Project for Economic Revitalization (Leading Project)	・Development of measurement, analysis, and evaluation equipment leading to next-generation science and technology ・Development of artificial organs and artificial senses using nanotechnology ・Development of devices operating on new principles based on nanotechnology ・Commercialization of extreme ultraviolet (EUV) light source technology and other advanced semiconductor manufacturing technologies ・Next-generation fuel cell project

Ministry or agency	Research institute or program	Subject
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agrobiological Sciences	・"Insect technology project" in order to utilize the most untouched natural resources of the 21st century
	National Food Research Institute	・Development of nanotechnology and materials technology for the innovative utilization of biological functions
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's secretariat	・Development of performance assessment method of novel structure buildings using innovative structural material such as high-tension steel, etc.
	Policy Bureau	・Research on the reduction of the effects on the environment in the transportation field utilizing nanotechnology
Ministry of Economy, Trade and Industry		・R&D of nanometry technology ・Precise macromolecule technology ・Nanometal technology ・Nano coating technology project ・Nano processing technology using a next generation quantum beam ・Development of low-temperature forming/integration technology of nano level electroceramics material ・Technology for creating a standard substance used for assessment of 3D nanometer ・Forming/processing technology of metallic glass ・Development project of semiconductor for efficient UV light-emitting device ・Development of ultra-pure metallic material for power-generating plants ・Development of ceramic reactors ・Creation/processing technical development project of high-tech titanium alloy ・R&D project of putting nanotechnology/tip material into practical use
Ministry of the Environment		・Environmental technology development and promotion operations utilizing nanotechnology

3.2.2.5 Energy

The "Basic Energy Plan" (by the Cabinet in October 2003) based on the Basic Law on Energy Policy (enacted in June 2002) revealed the energy R&D policies meriting priority promotion for the long-term comprehensive, planned promotion of policies related to energy supply and demand. The Plan states that intensive effort should be made by the government to ensure a stable energy supply and to resolve environmental problems based on important political significance.

(1) Research, Development, and Utilization of Nuclear Energy

Research, development and utilization of nuclear energy in Japan have been carried out strictly for peaceful purposes, in accordance with the Atomic Energy Basic Law. The Atomic Energy Commission formulated the "Framework for Nuclear Energy Policy (hereinafter referred to as "the Framework")" on October 11, 2005, and the Cabinet decided to respect the Framework on October 14 as a basic principle for nuclear energy policy and to promote research, development and utilization of nuclear science and engineering. In accordance with this decision, the government is steadily promoting research, development and utilization of nuclear energy.

Today, nuclear power generation plays an important role in energy supply as a major source of energy accounting for more than one-third of electric power supplies and also as an energy source that contributes to mitigating global warming. Moreover, accelerators and other achievements in atomic energy science and technology continue to provide new knowledge in basic science sectors, and offer essential research tools for the life science and nanotechnology and materials sectors. In addition, the use of radiation has spread to a wide range of sectors, including medicine, agriculture, manufacturing, and environmental protection. Thus, nuclear energy has greatly contributed to assuring stability in the nation's energy supplies and improving the lives of the people.

Meanwhile, in regards to the atomic energy R&D structure in Japan, the "Reorganization and Rationalization Plan of Public Corporations," adopted by the Cabinet in December 2001, called for abolition of the Japan Atomic Energy Research Institute and the Japan Nuclear Cycle Development Institute, and for their merger through the establishment of a new incorporated administrative agency for the comprehensive implementation of atomic energy research

and development. In response to these, the Law for the Japan Nuclear Energy Research and Development Organization was enacted at the 161st extraordinary Diet session, and the ministry is currently engaged in promoting operations toward the establishment of the new entity in October 2005. In October 2005, the Japan Atomic Energy Agency (JAEA) was established.

●Ensuring safety, and emergency preparedness

Safety is the indispensable prerequisite for the research, development, and utilization of nuclear energy. Enforcement of stringent regulations and safety management, and execution of safety research, are essential to ensuring safety. Moreover, in recognition of the impossibility of eliminating the occurrence of accidents to 0%, there is also a need to prepare countermeasures in the case of an accident to ensure that damage to the lives and health of local residents, etc., is held to the absolute minimum.

Because of these viewpoints, the government imposes stringent safety regulations on nuclear facilities in the design, construction, and operation stages of nuclear energy research, development and utilization, to a degree unseen in any other industrial sector in Japan. In addition to regulations, the government also has adopted various kinds of measures to ensure safety, such as environmental radiation monitoring and emergency preparedness.

Regarding the ensuring of safety at nuclear facilities, the Ministry of Economy, Trade and Industry and other related administrative organizations submitted a bill to the 162nd session of the Diet to amend the Law for Regulation of Nuclear Source Materials, Nuclear Fuel Materials, and Reactors, with the aim to strengthen the system to protect nuclear materials, introduce the clearance system[12] and enhance the regulation system concerning the dismantling and abolition of nuclear facilities. The bill was passed and approved in May 2005, and the amended law was enforced on December 1, 2005.

Regarding nuclear emergency countermeasures, efforts to expand and strengthen nuclear disaster measures are now being promoted based on the Special Law of Emergency Preparedness for Nuclear Disaster established in 1999, including the dispatch of the Senior Specialists for Nuclear Emergency Preparedness, designation of base facilities for emergency measures in urgent situations (off-site centers), etc., preparation of radiation measurement equipment and other necessary materials and equipment, preparation of disaster prevention plans for nuclear energy companies and implementation of emergency drills.

For surveys of environmental radiation, the Ministry of Education, Culture, Sports, Science and Technology and other relevant ministries and agencies, prefectural governments, and atomic energy enterprises continue to conduct radiation surveys in areas surrounding nuclear energy facilities. In addition, surveys of environmental radioactivity level in Japan are conducted, as well as radiation surveys of nuclear-powered military vessels when they enter port.

Enterprises engaged in handling radioactive materials reacted to the simultaneous multiple terrorist attacks that occurred in the United States in September 2001 by strengthening their controls of radioactive materials and reviewing their emergency communication procedures.

To introduce the international standard value (lower limit of the subject of regulations) set by the Interntional Atomic Energy Agency (IAEA) and streamline the regulations of radioactive isotopes along with their introduction, the Law for the Prevention of Radiation Sickness Caused by Radioactive Isotopes,[13] amended in 2004, was enforced in June 2005.

[12] Clearance: Excluding radioactive materials, of which radiation level is sufficiently small compared to the radiation levels in the natural world and of which effect on human health is negligible, from the subject of regulations of radiation protection as “those which do not require treatment as radioactive materials”

[13] The following amendments were made through amendments to the Law for the Prevention of Radiation Sickness Caused by Radioactive Isotopes in 2004:
(1) creation of a system of design certification by the equipment manufacturer
(2) rationalization of sales and leasing services from a license system to a notification system
(3) creation of a regular confirmation system to improve the safety of establishments
(4) creation of a regular training system to improve the ability of radiation protection supervisors
(5) preparation of provisions concerning disposal of waste by burial.

Also, in ensuring nuclear safety, it is important to promote safety research because serves as a technical basis for safety regulations, etc. To this end, the Nuclear Safety Commission is coordinating the "Five-Year Safety Research Program (Fiscal 2001 to Fiscal 2005)" and the "Priority Safety Research Program," thereby promoting safety research on a well-planned basis. Specifically, the following safety research projects were conducted for each sector at research institutes.

In the area of safety research related to nuclear facilities, JAEA and other organizations conducted research on a variety of issues such as: improvement of probabilistic safety assessment methods; safety evaluation on high burn-up of fuel for light water reactors, soundness evaluation on highly aged equipment and structures; safety of criticality and confinement at nuclear fuel facilities; evaluation on accident prevention, mitigation, and evaluations in Fast Breeder Reactors (FBRs).

For safety research related to environmental radiation, the National Institute of Radiological Sciences and other organizations conducted safety research on the dose evaluation of radiation exposure, as well as basic safety research into radiation effects.

Concerning safety research for radioactive waste management, safety research including near surface disposal and geological disposal, as well as clearance level verification technology, was conducted by JAEA and other organizations.

●Efforts for assuring trust and coexistence with communities

In order to promote the smooth research, development, and utilization of nuclear energy, it is extremely important to obtain public confidence in the government and nuclear power operators. For this purpose, nuclear power operators must build up a record of safe operations, and strive to obtain public understanding. To this end, public hearings and public relations programs are being promoted to ensure two-way communication and transparency, as well as activities to further their understanding, such as support for education about nuclear energy or lending out simplified radiation detectors.

Furthermore, to promote coexistence between nuclear power research facilities and regions where there nuclear facilities located, the Power Source Grant program, of which use was expanded to non-construction projects, is being utilized in response to the needs of the regional communities.

●Nuclear power generation and the nuclear fuel cycle

1) Nuclear power generation

With nuclear power generation being an important energy source for ensuring stable energy supplies in Japan, and also a superior energy source in terms of protection of the global environment, since it emits no carbon dioxide or nitrogen oxides in the course of power generation, its research, development, and utilization is being steadily promoted, predicated on the assurance of safety and on peaceful utilization.

For the light water reactors that are the main form of nuclear reactor currently in use in Japan, the government, electrical power companies, manufacturers of atomic power equipment, etc., have been cooperating to improve working efficiency, and reduce employee exposure to radiation on the premise of securing the safety of light water reactors by Japan's own technologies. In view of operational experiences to date, the parties have striven to make the lightwater reactor technology more economical, while maintaining high levels of reliability and safety.

2) Research and development of the nuclear fuel cycle

Japan, which must rely on imports for the vast majority of its energy resources, is steadily promoting efforts to establish the fuel cycle through effective utilization of the recovered plutonium, etc., from the reprocessing of spent nuclear fuel, in order to secure long-term energy supply stability in view of the future energy supply and demand in the world, and to reduce the load on the environment. It is important, therefore, to continue to promote research and development on the nuclear fuel cycle, and to steadily develop the Rokkasho Reprocessing Plant, the plutonium utilization program in light water reactors, and the interim storage of spent fuel.

In promoting plutonium utilization, Japan strives to ensure the transparency of plutonium use by disclosure of information regarding plutonium inventories, not only from the viewpoint of rigorous management of nuclear materials, but also in clear observation of the principle of never holding excess plutonium that is not required to implement current

programs, so as to avoid arousing international concerns regarding the proliferation of nuclear weapons. Specifically, Japan adopted international plutonium guidelines for improving the transparency of its plutonium use, and annually announces its plutonium management state through the International Atomic Energy Agency (IAEA).

Concerning the enriched uranium used as fuel in nuclear power generation, Japan is promoting the development of domestic uranium enrichment projects to secure independence over the entire nuclear fuel cycle, and endeavoring to maintain economy.

While some reprocessing of spent fuel from nuclear power plants is conducted at JAEA's Tokai Reprocessing Plant, most is consigned by contract to reprocessing by British Nuclear Fuel Limited (BNFL) and COGEMA, the French nuclear fuel company.

In view of the principle that spent fuel should be reprocessed domestically in Japan, construction is underway on a private-sector reprocessing facility (with an annual reprocessing capacity of 800 tons) in Rokkasho-mura, Aomori Prefecture, and a series of tests are currently underway toward a planned date of operation commencement of August 2007. The aim is the firm establishment of reprocessing technology on a commercial scale through the successful construction and operation of a private-sector reprocessing plant, toward the eventual establishment of the nuclear fuel cycle.

In this regard, the Tokai Reprocessing Plant, which had been reprocessing spent uranium fuel used in light water reactors under contracts with electrical power companies, completed this work in March 2006. As a result, about 1,100 tons were reprocessed in total.

Intermediate fuel storage is important as a means to provide flexibility for the whole nuclear fuel cycle because the time period until the fuel is reprocessed can be adjusted through the storage. A law concerning intermediate storage was enacted in 1999, and utility companies are preparing for the facilities to be commissioned by 2010. The "Fugen" advanced thermal reactor, which was undergoing independent development as a nuclear reactor with the ability to flexibly and efficiently utilize plutonium, recovered uranium, and other fuel, terminated its operations in March 2003, and the project ends as of 30 September 2003 with the completion of a report summing up the project results. The research and development necessary for decommissioning is now in progress.

3) Radioactive waste management

One of the most important issues from the viewpoint of executing coherent policies for the promotion of nuclear power utilization, and of obtaining the people's understanding and trust, is the management of the disposal of radioactive waste, and the decommissioning of nuclear facilities. Since radioactive waste varies in radioactivity and the types of radioactive materials contained in it, radioactive waste is now classified not by its sources, but by its disposal methods, and specific measures are taken.

JAEA, acting as the core institution working in close cooperation with the National Institute of Advanced Industrial Science and Technology, and university-affiliated research institutions, is now engaged in research and development on the disposal of high-level radioactive waste. In addition, JAEA is developing two underground research laboratory programs in Mizunami, Gifu Prefecture (crystalline rocks) and in Horonobe, Hokkaido Prefecture (sedimentary rocks) as key facilities for promoting its research and development.

Under the Law on Permanent Disposal of Special Radioactive Waste, enacted in May 2000, the Nuclear Waste Management Organization of Japan was established as a waste disposal contractor in October of that year. In December 2002, as part of the process for selecting a disposal site, the organization invited municipalities from throughout Japan to consider volunteering as candidates for exploring the feasibility of it constructing disposal facilities in their area.

Low-level radioactive waste generated at nuclear power plants has been disposed of at the Japan Nuclear Fuel, Ltd.'s Low-Level Radioactive Waste Disposal Center in Rokkashomura, Aomori Prefecture since December 1992, with about 36,400000－liter drums of waste already having been transferred to the center as of the end of January 2006.

The Ministry of Economy, Trade, and Industry established the Nuclear Energy Division under the Electricity Business Subcommittee of the Comprehensive Investigation Committee on Resources and Energy in July 2005, and has been considering the preferable method of disposal of radioactive wastes (TRU wastes) including transuranic nuclide.

The Ministry of Education, Culture, Sports, Science and Technology, in November 2005, established the Working Group on Radioisotope and Research Institute Wastes under the Panel for R&D on Nuclear Energy at the Research Planning/Evaluation Committee of the Council for Science and Technology, and has been considering specific candidates for disposal contractors.

With respect to regulation-related laws and ordinances, the "Law Concerning Prevention from Radiation Hazards due to Radioisotopes, etc." was amended to add an article about near surface disposal of solidified radioisotope wastes in June 2004. In May 2005, the Law for Regulation of Nuclear Source Materials, Nuclear Fuel Materials, and Reactors was also amended to reinforce provisions concerning the introduction of the clearance system and the dismantling and abolition of nuclear facilities. In addition, ministerial ordinances related to the Law were amended, and the Law Concerning Prevention from Radiation Hazards due to Radioisotopes, etc., amended in June 2005, was enforced.

JAEA has continuously researched and developed decommissioning technologies of nuclear fuel cycle facilities including the "Fugen" reactor.

●Research and development of fast breeder reactors and related nuclear fuel cycle technology

FBRs and related nuclear fuel cycle technology can greatly boost the efficiency of uranium resource utilization. When this technology is put to practical use, it will become possible to continue using nuclear energy for several hundred years even if we only depend on the uranium resources known today to be technologically and economically utilizable. The use of FBR cycle technology could further reduce the environmental burden by minimizing longlived radioactivity in high-level radioactive wastes. In terms of preparation for assurance of an effective future energy option, development effort in this area is plainly important.

The "Monju" prototype fast breeder reactor uses technology based on MOX fuel and sodium cooling, the most advanced of the FBR cycle technologies, and it is the only fast breeder reactor plant with power generating capabilities in Japan. "Monju" is positioned in the Nuclear Energy Policy Outline as the core for Japan's research and development into fast breeder reactor cycle technology

"Monju" ceased operations following a sodium leak accident in December 1995. In response to this situation, JAEA decided to implement plant modifications to increase safety toward resuming operations and obtained government approval. In February 2005, the agency obtained approval for the commencement of the plant modifications from Fukui Prefectural government and Tsuruga City municipal government, and has been implementing plant modifications since September 2005.

However, regarding an administrative suit initiated by the local residents to cancel the construction license of "Monju," the Supreme Court of Japan dismissed the high court decision and ruled in favor of the government through the dismissal of the appeal of the plaintiffs in May, 2005.

In addition, since July 1999, JAEA has been collaborating with electric power companies to conduct a "Feasibility Study on Commercialized Fast Reactor Cycle Systems," to propose, by around 2015, appropriate concepts for FBR cycle technology to be commercialized in the future and develop research and development plans toward its realization. In Phase II (Fiscal 2001 to Fiscal 2005), the agency was engaged in research and development in order to improve safety and economic efficiency, to reduce the burden on the environment, and to clarify the commercialization candidates for fast breeder reactor cycles in consideration of nuclear nonproliferation. The agency announced the final results of Phase II at the end of Fiscal 2005.

●Promotion of nuclear fusion research and development

Promotion of nuclear fusion research and the development of nuclear fusion are important because they expand available energy options for the future and increase the feasibility of fusion energy. In Japan, fusion research and development is promoted by JAEA, the National Institute for Fusion Science, and universities and colleges through mutual cooperation. In addition, bilateral and multilateral international cooperation is being actively promoted.

JAEA has been promoting R&D on a tokamak-type reactor[14] toward the realization of a practical reactor. In particular, JT-60 as large tokamak device has achieved significant results, which led the physicccs R&D toward the implementation of ITER[15], and demonstrated the feasibility of a steady-state fusion reactor. Further research is being

promoted to achieve the long pulse operation of high pressure plasma through the improvement of plasma confinement performance.

The National Institute for Fusion Science constructed the large helical device[16] (LHD) that is based on a unique idea originating in Japan and is the largest helical device in the world. Its research into new plasma regions leads the world. In addition, the Institute of Laser Engineering at Osaka University, other universities and in-dependent administrative institutions, etc., are engaged in basic research into various magnetic confinement and inertial confinement methods, and in research into essential technologies related to reactor engineering The ITER project is an international cooperation project that aims to demonstrate the scientific and technological feasibility of nuclear fusion energy with the participation of Japan, China, the EU, South Korea, Russia, the United Sates and India. Japan promotes this project actively. After the ITER ministerial meeting, held in Moscow in June 2005, it was decided that the ITER site would be in Cadarache. The Director-General Nominee of the prospective ITER International Organization was appointed in November of the same year. In addition, inter-governmental talks for the establishment of the ITER International Organization were concluded at the vice-ministerial-level meeting held in Tokyo in April 2006, thus remarkable progress is being made toward the realization of the project.

When the construction site for the ITER facility was decided, it was also decided that the Broader Approach, a complementary R&D project to be conducted in parallel with the ITER project under the cooperation between EU and Japan, would be implemented and Japan would assume an important role along with EU, the host of the ITER project.

●Promotion of nuclear science and technology

Nuclear science and technology mainly contributes to two sides. One side is the application to basic and fundamental research using "quantum beam technology[17]" which is innovated by the technologies of accelerators and high intensity lasers. Quantum beam technology supports research on the basic principles of nature and gives new valuable knowledge and results in life science and material fields. The other side is research and development for offering options of stable energy supply in the future addressing needs of the economy, society, and consumers by the development of nuclear fusion and innovative nuclear reactors.

With respect to the quantum beam technology, JAEA and the High Energy Accelerator Research Organization (KEK) have been jointly promoting the High Intensity Proton Accelerator Project (J-PARC[18] project), which aims at new developments over a wide range of research fields, including life science, material science, nuclear physics and elementary particle physics by generating and utilizing proton beams with the highest beam power in the world. The project was evaluated in August 2000 by the Advisory Committee on Evaluation of the High Intensity Proton Accelerator Project, which had been established under the Atomic Energy Commission and the Science Council's Accelerator Science Subcommittee. In view of the evaluation results, the construction of accelerators laid down in the plan commenced in fiscal 2001 and the project is in progress towards the commissioning in fiscal 2008.

[14] The Tokamak-type reactor is a machine confining plasmas by producing a donut-shaped magnetic field. It has a circular magnetic field produced by external coils and confines plasmas in a stable manner by creating a spiral magnetic field with the toroidal electric current. Research institutions around the world have constructed and studied this type of plasma experimental device for its excellent confinement performance.
[15] "ITER" means "(long) way" in Latin.
[16] Helical devices are different from tokamak devices which pass electric current through plasmas. They confine plasmas with a donut-shaped spiral magnetic field produced by external coils.
[17] "Quantum Beam Technology" means the technology which consists of generating and controlling electromagnetic waves such as high-strength and high-quality photons, and synchrotron radiation, and particle beams such as neutron radiation, electron beams, and ion beams, etc. using accelerators, high power laser devices, facilities and high flux research reactors for research purposes.
[18] J-PARC:Japan Proton Accelerator Research Complex

RIBF is the accelerator facility for generating beams of all types of radioactive isotopes (RI), from hydrogen to uranium, with the highest intensities in the world. To launch some experiments of the RI Beam Factory (RIBF) during fiscal 2006, RIKEN (The Institute of Physical and Chemical Research) is currently engaged in construction and development.

Moreover, basic research in nuclear science and technology creates the seeds that lead to diversification in nuclear power usage and future technological innovation, and contributes to research projects in the field of nuclear energy and the development of other science and technology sectors.

JAEA is making efforts to conduct fundamental research for the renewed development of nuclear energy, with advanced basic research into the science in radiation fields being conducted at the Advanced Science Research Center, the development of the X-ray laser and other advanced laser scientific research being conducted at the Kansai Research Establishment (in Kansai Science City,) and synchrotron radiation scientific research using a large synchrotron radiation facility (SPring-8) in Harima Science Park City, Hyogo Prefecture. Furthermore, national scientific research institutions under the control of each office and ministry are promoting cutting-edge basic research in the four areas of fundamental technology, i.e. substances and materials, biological and environmental effects, computation technologies, and disaster prevention and safety. In addition, the Nuclear Energy Fundamentals Crossover Research[19] is being conducted by organically combining the capabilities of incorporated administrative agencies, universities, national experimental research institutions and other research institutions through their active cooperation in research.

The outlook for the 21st century is for innovative new reactors with excellent economy and safety that are suited for thermal utilization and other diversified energy supplies, and to the spread of nuclear reactor use, as well as for the advent of innovative nuclear fuel cycle systems that can alleviate the problem of how to dispose of spent fuel and radioactive wastes and also improve the nonproliferation situation.

Beginning in Fiscal 2002, the Ministry of Education, Culture, Sports, Science and Technology has entertained various new ideas, using links between industry, academia, and government to perform research and development into public canvassing methods for selection between proposals related to innovative nuclear power technologies. Since Fiscal 2005, the ministry has been carrying out the R&D Project for the Nuclear Energy System Design using the competitive funding system.

Since Fiscal 2000, the Ministry of Economy, Trade, and Industry has been conducting research and development for innovative, creative, and practical nuclear power technologies by inviting proposals, to ensure that there will be a variety of choices regarding future nuclear power generation and the nuclear fuel cycle.

JAEA has been conducting a rise to power test for the High Temperature Engineering Test Reactor (HTTR) to establish a high-temperature, gas-cooled reactor technology that explores the possibilities for diversification of energy supplies, such as high-temperature thermal supplies, and to promote research and development in hydrogen production and other heat utilization. In April 2004, JAERI succeeded in removing high-temperature gases of 950 , which marked the highest temperature of an outlet of a nuclear reactor in the world.

●Promotion of radiation utilization

One use for nuclear energy is the application of radiation in a wide range of sectors from basic research to utilization in medicine, engineering, agriculture, and other sectors; promotion of research and development toward the widespread use of radiation is also important.

As for the state of radiation utilization, the medical sciences already make wide use of diagnostic technology employing X-ray Computerized Tomography (CT) and X-ray or gamma ray radio-therapy for the treatment of cancer, while research is being conducted on the use of protons and heavy ion beams, etc., for the treatment of cancer. In particular, the National Institute of Radiological Sciences (NIRS) is engaged in research on cancer therapy using heavy ion beams, which was approved as highly-advanced medical treatment by the Ministry of Health, Labour and Welfare in Fiscal 2003 with high expectations for its clinical effectiveness

[19] The Nuclear Energy Fundamentals Crossover Research is positioned as comprehensive experimental research on nuclear energy and consists of a variety of technical elements for which individual research institutions, by themselves, have a difficulty in making achievements promptly.

against cancer.

In addition, the institute is promoting research to downsize equipment in accordance with the Third Comprehensive Ten-Year Strategy against Cancer. In universities, as well, such as at the Tsukuba University's Proton Medical Research Center, research is progressing into the diagnosis and treatment of cancer using proton beams. In the agricultural sector, radiation is used for the improvement of crop varieties, the eradication of vermin without recourse to agricultural chemicals, the prevention of budding in potatoes, etc. In the industrial sector, radiation is used for non-destructive testing of industrial products, for industrial measurements, and for quality improvements of rubber, plastics, and other polymer materials. In the research area, research using ion beams and gamma radiation is being conducted at JAEA for the creation of new functional materials and biotechnology useful for preserving resources or cleaning up the environment, and using electron beams in environmental protection technologies for the elimination of toxic substances from smoke emissions.

●Nuclear non-proliferation policies and international nuclear energy cooperation

To smoothly carry on with nuclear energy research, development, and utilization requires that Japan clearly explain to international society its stance underlying nuclear power policies, and to obtain their understanding and trust. In addition, in order to resolve international concerns related to nuclear energy, such as the issues of nuclear safety and disposal of radioactive wastes, it is important that Japan actively make use of its technology and experience in cooperation with international society, so as to obtain the understanding and trust of the international community.

1) Nuclear non-proliferation policies

In order to ensure smooth implementation of the peaceful use of nuclear energy, the maintenance of the international nuclear nonproliferation regime, along with safety assurances, is extremely important. Several international frameworks, including the Treaty on the Nonproliferation of Nuclear Weapons (NPT), the comprehensive safeguards by the International Atomic Energy Agency (IAEA) based on the NPT, and the Comprehensive Nuclear Test Ban Treaty (CTBT), have been established. In addition to these frameworks, Japan reinforces the international nuclear nonproliferation regime with its technologies and skilled personnel in relation to the peaceful utilization of nuclear energy.

Japan is promoting the development and utilization of nuclear energy strictly for peaceful purposes, as stipulated in the Atomic Energy Basic Law. For many years, Japan has accepted "safeguards" to ensure the peaceful use of nuclear materials, based on the Safeguards Agreement with the IAEA, and implemented "physical protection" to prevent theft of nuclear materials or attempts to sabotage nuclear facilities. Japan is also promoting the necessary technology development for the implementation of the above measures. In 2004, the IAEA concluded that there was no indication of the diversion of nuclear materials placed under safeguards and no indication of undeclared nuclear materials or activities for Japan as a whole. Since then, the Integrated Safeguards, which are efficient safeguards that enable a reduction in the number of inspections, have been implemented.

In order to implement effective, efficient safeguards toward the commercial operation of the Rokkasho Reprocessing Plant, an important facility to be safeguarded, the government is engaged in system development, including the establishment of safeguards, measures, and the foundation of the Rokkasho Safeguards Analytical Laboratory and the Rokkasho Safeguards Center. The government also organized an international training course for the improvement of technologies for nuclear materials accounting.

In addition to responsibilities imposed under the NPT, it is important for Japan to ensure transparency by employing rational and consistent plans, while adhering strictly to the principle of non-possession of surplus plutonium. Therefore, in line with international plutonium guidelines designed to boost transparency of the nuclear fuel cycle program, Japan discloses through the IAEA the conditions of its plutonium management, and independently discloses more detailed data, to ensure that transparency is maintained at as high a level as possible. Furthermore, Japan actively promotes the development of technologies related to non-proliferation policy, and undertakes research and development activities with full consideration of nuclear non-proliferation in fields such as advanced recycling technologies.

Additionally, Japan in July 1997 swiftly ratified the CTBT banning all nuclear weapon test explosions and all other nuclear explosions, a historic step towards a world that is free of nuclear weapons, and is now engaged in development of an international monitoring system toward the treaty's eventual enforcement.

2) International nuclear power cooperation

In the area of international nuclear cooperation, it is important to promote international cooperation activities for common issues or R&Ds, such as those for the research, development and utilization of nuclear non-proliferation, as well as to respond positively to the expectations of developing nations.

Japan participates in the Generation IV International Forum (GIF), members of which are the United States, France, and eight other countries and one institution. In February 2005, the governments of five countries, the United States, France, the United Kingdom, Canada and Japan, concluded a framework agreement related to the development of next-generation nuclear energy technology (as of December 2005, the number of countries participating in the agreement was seven due to the addition of Switzerland and Korea.)

For nuclear cooperation with Asian countries, exchanges of information, opinions, and technology are being promoted under the framework of the Forum for Nuclear Cooperation in Asia (FNCA) for the peaceful utilization of nuclear energy, in such areas as research reactors and the medical utilization of radiation. The sixth FNCA Ministerial Level Meeting was held in Tokyo in December 2005, at which time opinions were exchanged between member nation ministers in charge of nuclear energy on such issues as human resource development, science & technology and nuclear energy.

Japan also participates in the Regional Cooperative Agreement for Research, Development & Training Related to Nuclear Science and Technology (RCA), a grouping since 1978 of IAEA member countries in the Asia-Pacific region hosting study seminars and other events in the industrial, medical, and radiation protection fields, as well as making technology transfers through the dispatch of Japanese experts, providing equipment and materials, offering funding and personnel assistance, and contributing to the social and economic development of developing nations.

For cooperation in nuclear energy with the countries of the former Soviet Union and of Central and Eastern Europe, Japan offers research cooperation for the decommissioning of nuclear facilities, bilateral cooperation for quality improvement of plant operators through training projects, and provision of multilateral support through extra-budgetary contribution funding to the IAEA. In addition, regarding the management and disposal of Russia's surplus weapons-grade plutonium, Japan is determined to utilize its technologies for the peaceful use of nuclear energy developed over many years in Japan to cooperate in the disposition program of Russia's surplus weapon-grade plutonium, as part of its contribution to nuclear disarmament and nonproliferation, in close cooperation with the principal countries of the United States and Russia, and with other involved countries. In particular, JAEA is engaged in research cooperation with Russia's Institute of Physical Energy Research and other institutes, such as the Research Institute for Atomic Reactors and the Institute of Physics and Power Engineering. The agency also started flame tests on 21 fuel assemblies to verify the reliability of the method for producing vibropack fuel and its applicability to fast reactors since fiscal 2004.

Finally, for nuclear cooperation with Europe countries and the United States, Japan exchanges experts and information regarding the peaceful use of nuclear energy, and the receipt and supply of nuclear materials and related services. Specifically, this includes research cooperation by JAEA with the U.S. Department of Energy (DOE) and the French Atomic Energy Commission (CEA), research cooperation between RIKEN and the U.S. -based Brookhaven National Laboratory, and also with Britain's Rutherford Appleton Laboratory.

(2) New Energy Research and Development

While new sources of energy can contribute to addressing global warming, and to stable energy supplies, it also faces problems of economy, such as lower energy conversion efficiency and higher electricity generating costs than those of fossil fuels. Research and development into fuel cells, photovoltaic cells, biomass energy, and other forms of new energy need to be aggressively promoted, in order to address these problems and promote the introduction and broader diffusion of these tech-

nologies.

●Fuel cells and hydrogen energy utilization

Because fuel cells, which generate electricity through a chemical reaction between hydrogen and oxygen, are very efficient and do not emit NOx or SOx, they are expected to be a key energy and environmental technology. While the development of fuel cell vehicles and stationary fuel cell systems is well-advanced, there still remain some hurdles to be addressed, such as durability and performance in order to make them commercially feasible. For this reason, the Ministry of Education, Culture, Sports, Science and Technology is promoting the development of innovative new components and materials that can improve fuel cell performance. The Ministry of Economy, Trade and Industry developed a basic, fundamental R&D system on polymer electrolyte fuel cells and established mass production technology for fixed fuel cells. The ministry is also promoting research and development in the demonstration of fuel cell vehicle and hydrogen supply facility areas. The Ministry of Land, Infrastructure and Transport is also conducting experiments on prototype fuel cells for residential use.

●Photovoltaic power generation

Photovoltaic power generation has been spreading as its price has fallen. Nevertheless, development of technologies that further lower costs is essential for the establishment of a truly independent market. For this purpose, the Ministry of Economy, Trade and Industry is promoting the development of technologies that achieve lower costs and higher levels of efficiency, as well as the development of recycling and reuse technologies.

●Biomass energy

Based on the Biomass Nippon Strategy (ratified by the Cabinet in December 2002), the Cabinet Office, the Ministry of Internal Affairs and Communications, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, and Transport, and the Ministry of the Environment are promoting research and development into technologies for the efficient conversion of animal wastes, wood residues, organic sewage, food wastes, and other unusable biomass sources into universally acceptable fuel forms, such as methane and other gaseous fuels (gasification), or methanol and other liquid fuels (liquefaction), and into technologies for these fuels' efficient utilization.

(3) Clean fossil fuel energy R&D

From the perspective of global warming prevention, the promotion of research and development into cleaner and more efficient fossil fuel utilization technologies is a necessity.

●Petroleum

In order to make efforts to further reduce carbon dioxide, nitrogen oxide, and other substances that are generated due to the production and use of petroleum and have an impact on the environment, the Ministry of Economy, Trade and Industry is promoting research and development into the more advanced, effective manufacturing processes of petroleum products and the higher quality of fuel for cleaner auto emissions.

●Coal

Coal offers excellent supply stability compared to petroleum and other sources. But since coal emits the highest carbon dioxide of all fossil fuels, research and development is needed to reduce its burden on the environment.

For this purpose, the Ministry of Economy, Trade and Industry is promoting the development of highefficiency power generation technologies and other clean coal technologies, such as the high-efficiency power generation technologies by the Integrated coal Gasification Combined Cycle (IGCC) and the Integrated coal Gasification Fuel cell Combined Cycle (IGFC).

●Natural gas, etc.

Because natural gas has lower carbon dioxide emission than other fossil fuels, the promotion of research and development into its utilization is therefore of importance in order to reduce the environmental burden.

Consequently, the Ministry of Economy, Trade and Industry is promoting research into technologies for the manufacture and utilization of liquid fuels (GTL, or Gas-to-Liquid) and dimethyl ethyl (DME), obtained by converting natural gas into liquid fuel, which should lead to the expansion of

natural gasuse. The ministry is also promoting the research and development of new exploitation technologies for the utilization of methane hydrates, believed to be available as an energy source in relatively large quantities from the seas around Japan.

(4) Energy Conservation and Energy Efficiency R&D

From the viewpoint of preventing global warming and effectively utilizing limited energy resources, it is important to carry out research and development not only to improve efficiency in specific individual devices, but also to improve the energy supply and utilization efficiency of all energy systems in society, for example by the introduction and use of distributed systems, and the utilization of unused energy. It is also necessary to promote research and development from a point of view of reducing all energy (life cycle energy) that is directly or indirectly consumed in the process of the production, use, re-use, and disposal of products.

To this end, the Ministry of Economy, Trade and Industry is strategically promoting research and development of the hydrate slurry air conditioning system[20] to overcome problems on the demand side in the process from the identification of seed technologies to the practical application thereof with the aim of increasing the effectiveness of development of energy-saving technologies.

In addition, the Ministry of Education, Culture, Sports, Science and Technology is promoting research and development into ultra-heat resistant materials for more efficient gas turbines, etc.

Table 3-2-7 shows a summary of the major research topics in the energy sector (excluding nuclear power) implemented during Fiscal 2005.

[20] Hydrate slurry air conditioning system: A system in which a multiphase media of hydrate and water solution is used as a heat carrier to conduct cold latent heat carrying in high density thereby reducing the carrying power required.

Table 3-2-7 Major research subjects in the non-nuclear energy sector (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	Consideration of necessary safety measures for installing an outlet within a gas station that supplies fuel cell vehicles with hydrogen
Ministry of Education, Cuture, Sports, Science and Technology	National universities and other institutions	New energy and energy efficiency R&D The Project to Design a Sustainable Management and Recycling System for Biomass and General and Industrial Wastes Next-generation fuel cell project
	National Institute for Materials Science	New century heat-resistant materials project Research into the development of highly efficient advanced structural materials with superior processability
Ministry of Agriculture, Forestry and Fisheries	National Institute for Agro-Environmental Sciences, etc.	Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector Development of new technology for the treatment and recycling of biomass
Ministry of Economy, Trade and Industry		Photovoltaic power generating technology Development of technologies for the stabilization of wind power generating systems Biomass energy technologies Hydrogen energy technologies Fuel cell technologies GTL and DME-related technologies Development of methane hydrate technologies Research and development into clean coal technologies Development of entrained bed coal gasification power plants Development of energy conservation technologies - SiC and other power electronics -Technologies for the analysis of the optimum utilization of energy between multiple industrial users (pinch technology) -Development of high-efficiency white light-emitting diodes (LEDs) -Research and development into high-efficiency organic EL technology ・Development of technology for distributed energy network systems ・Development of technology for performing the comprehensive evaluation of energy systems
Ministry of Land, Infrastructure and Transport		Promotion of technology development for the introduction of fuel cells and other new energy sources into residences Development of a new energy system to reduce CO_2 emissions, as well as the development of optimization technologies to adapt the system to houses and buildings R&D on the evaluation of positive effects on the urban environment from adding greenery to building sites
Ministry of the Environment	National Institute for Environmental Studies	Development of technologies for the manufacture of hydrogen from bioresources and biowaste, etc. Development of technologies for the manufacture of hydrogen using offshore wind power generation
		Global Environment Research Fund - Study on development and spread of household energy saving technologies and lifestyle Development of technologies to prevent global warming -Development of energy-saving technologies for practical use -Development of practical-use technologies to introduce renewable energy -Environmental Model Project for Urban Redevelopment

3.2.2.6 Manufacturing Technology

Manufacturing technology is the source of Japan's economic power and can even be called its lifeline, standing at the highest levels in the world. These technologies will continuously need to be advanced further, and the development of innovative technologies will be important. Based on this recognition, the Science and Technology Basic Plan positioned manufacturing technology as one of the eight areas meriting special priority.

To actively promote the fundamental technologies for manufacturing that support the growth of the manufacturing industry, the Manufacturing Fundamental Technology Promotion Basic Plan was adopted in September 2000, based on the Basic Law to Promote Fundamental Technologies for Manufacturing (1999 Law No.2), and comprehensive and planned implementation of measures for promoting such technologies is now in progress (see Section 3.3.6.6).

The Ministry of Education, Culture, Sports, Science and Technology is engaged in the development of next-generation fundamental technologies. For example, RIKEN is promoting the development of an "Integrated Volume-CAD System Using Advanced IT", based on technologies for utilizing the new concept of "volume data[21]", for the purpose of integrating geometric modeling, simulation, testing, manufacturing and other kinds of information technologies in production engineering, and is also engaged in the development of an advanced measurement technology that utilizes a multidimensional quantum detector, toward the goal of establishing a cutting-edge measurement technology based on new detection technologies.

The Ministry of Economy, Trade and Industry is promoting various projects, including the "MEMS Project," which aims to strengthen international competitiveness in key devices in the information and communications sector and other sectors by establishing manufacturing technology for MEMS ((Micro Electro Mechanical System)), the "Project for a Computer Aided Engineering System for MEMS," the "Advanced Machining System Development Project," which aims to develop advanced machine tools through improvement of production efficiency, accuracy and energy efficiency, the "Development of Eco-Management Production System Technology," which contributes to the improvement of production efficiency and energy efficiency in the manufacturing industry, the "Digital archive of human body properties," which promotes the development and designing of products through accumulation of data concerning the measure and shape of the human body and development of an automatic measuring system, and the "Knowledge support system for field operators at oil refinery," in which support system using ergonomic techniques is developed to conduct the maintenance and checkup of oil refineries during operation efficiently and with high reliability.

The Ministry of Agriculture, Forestry and Fisheries was engaged in the establishment of local brand food products through industry-academia-government cooperation and the development of technologies for the export of food, in order to strengthen competitiveness in the food industry. The ministry was also engaged in the development of technologies that ensure safe and trusted foods in response to consumer demand and the development of functional foods to improve peoples' health, as well as the development of functionality evaluation technology.

3.2.2.7 Infrastructure

Infrastructure is a basic sector that supports people's lives. In order to achieve a prosperous, secure, safe, and comfortable society, research and development is promoted to reduce the risks inherent in society, and to improve the people's conveniences so they can achieve a quality life.

[21] Volume data–digital data describing a material body which maintains geometry, internal structure and distributed physical properties, all in a unifiedform

(1) Science and Technology for Disaster Prevention

In order to mitigate the potential damage from natural disasters, it is important to be able to fully utilize scientific and technical knowledge to prevent disasters before they happen, limit the spread of damage when disasters actually occur, and recover from disasters. The major scientific and technological research issues on disaster prevention at each ministry and agency are shown in Table 3-2-8. The contents of the research are wide-ranging. In particular, the Ministry of Education, Culture, Sports, Science and Technology is conducting the "Special Project for Earthquake Disaster Mitigation In Urban Areas" that focuses on earthquake disasters. With the completion of construction of a three-dimensional full-scale earthquake testing facility (called "E-Defense") in March 2005, the National Research Institute for Earth Science and Disaster Prevention (NIED) has been performing full-scale experiments to improve earthquake protection since Fiscal 2005. In addition, universities and research institutions are conducting research into the prevention or mitigation of damage from various types of natural disasters other than earthquakes. With respect to snow damage caused by heavy snowfall in the 2005-2006 winter, relevant ministries and agencies, cooperating with research institutions and universities, implemented research and studies including emergency survey research using Special Coordination Funds for Promoting Science and Technology (SCF).

In the area of international cooperation, Japan is taking part in bilateral research on science and technology for disaster prevention within the framework of science and technology cooperation agreements with the United States, Russia, Italy, and others, and the "U.S.-Japan Cooperative Program in Natural Resources" (UJNR). In addition, in the Hyogo Framework for Action 2005-2015 formulated at the U.N. World Conference on Disaster Reduction held in January 2005, Japan was requested to provide support for the improvement of capacity for risk assessment, monitoring and early warning systems.

Table 3-2-8 Major research subjects in (natural) disaster prevention science and technology (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communication	National Research Institute for Fire and Disaster	•Survey on the methods of predicting the risk of a second failure at the site of a slope failure
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	•Special Project for Earthquake Disaster Mitigation In Urban Areas (including research to improve earthquake protection by using the E-Defense)
	National universities	•Basic research on natural disasters
	National Research Institute for Earth Science and Disaster Prevention	•Research on seismic activity in the Kanto and Tokai regions •Research on volcanic eruption prediction •Research to predict the occurrence of snow and ice related natural disasters •Research on countermeasures against heavy rains, strong winds, and landslides
Ministry of Land, Infrastructure and Transport	Engineering Affairs Division, Minister's Secretariat	•Development of technologies for prompt disaster prevention and alleviation measures utilizing disaster information and consideration of promotion policy
	National Institute for Land and Infrastructure Management	•Study for performance-based design of seawalls for controlled waste disposal taking into account large-scale earthquake motion •Study for mitigation of disaster caused by large-scale earthquakes and tsunamis •Study on earthquake disaster prevention measures utilizing seismic risk assessment technology
	Public Works Research Institute	•Research on economical seismic retrofit technologies for civil infrastructures •Research on enhancing techniques for mitigating damage caused by slope collapse and fluidization
	Building Research Institute	•Reearch on the management and enhancement of strong earthquake observation networks for buildings, and research on technologies to use the networks •Development of structural performance evaluation technology for building foundations •Simulation model for urban fire disasters using fire wind tunnel experiments and CFD •Research on the structural safety of roofing damaged due to strong winds
	Meteorological Research Institute, Japan Meteorological Agency	•Study on evaluation methods for volcanic activity •Improvement of the non-hydrostatic model (NHM) and data assimilation techniques •Study of process of structural change of typhoons passed by surrounding Japan and specific cases of high winds, heavy rains, and storm surges caused by the typhoons
	Geographical Survey Institute	•Study on the characteristics of crustal deformation around the Tonankai and Nankai Regions •Study for optimizing numerical crustal deformation models relating to seismic and volcanic •Research on the characteristics of crustal movements in trench-centered earthquake areas around the Japan Trench and Chishima Trench •Research on the optimization of monitoring networks for volcanic deformations
	Port and Airport Research Institute	•Development of performance design methods as a countermeasure against long-period waves •Research on the ocean wave prediction method using wave observation data •Research on technologies to prevent tsunamis caused by ocean trench earthquakes

(2) Earthquake Surveys and Research

Under the Special Measure Law on Earthquake Disaster Prevention, established after the occurrence of the Great Hanshin-Awaji Earthquake in 1995, the Headquarters for Earthquake Research Promotion (Chairman: Minister of Education, Culture, Sports, Science and Technology) were established to clarify the system of responsibility for earthquake surveys and research that should impinge directly on administrative policies and to promote comprehensive earthquake prevention measures throughout Japan. A Policy Committee and an Earthquake Research Committee was also established under the Headquarters for Earthquake Research Promotion, and based on "The Promotion of Earthquake Research–a basic comprehensive policy for the promotion of earthquake observation, measurement, surveys and research," adopted in April 1999, the Headquarters for Earthquake Research Promotion serves as the point of contact and cooperation between relevant ministries and agencies for the promotion of earthquake surveys and research (Figure 3-2-9).

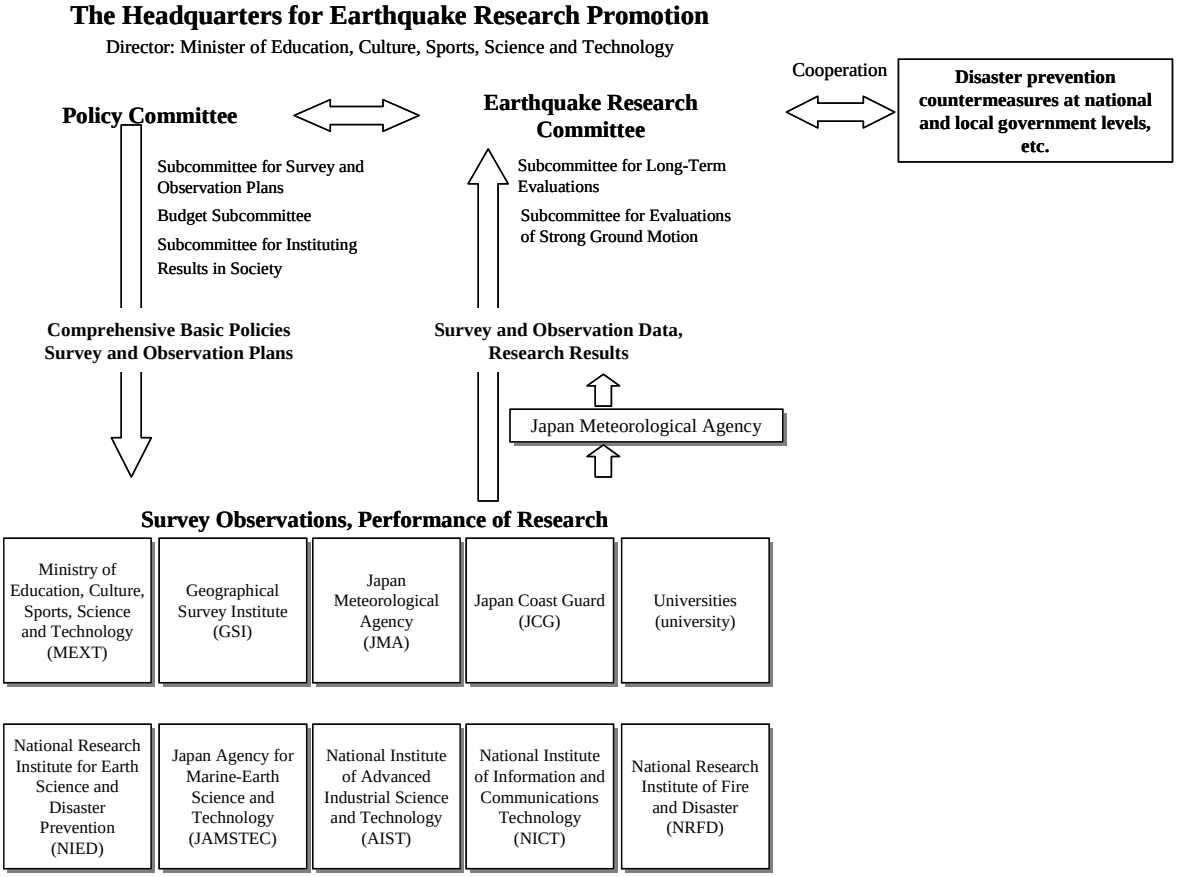

Figure 3-2-9 The structure of the headquarters for earthquake research promotion

The Headquarters for Earthquake Research Promotion, putting together the matters examined at the Policy Committee, formulated the "Focused Research and Observation Program in the Future" in August 2005. This stipulates the methods and targets for focused research and observation, as well as additional and complementary research on active faults.

The Earthquake Research Committee holds monthly meetings and extraordinary meetings. The extraordinary meetings are held when relatively large-scale earthquakes occur. At monthly meetings, the committee made comprehensive evaluations of earthquake activities in Japan by collecting information and results of analysis related to them and publishes them immediately to ensure their use in disaster prevention activities. In addition, extraordinary meetings were held to analyze the occurrence of an earthquake with an epicenter in the sea near Miyagi Prefecture on August 16, 2005, in order to prepare evaluations.

On the other hand, the Earthquake Research Committee performs a series of long-term evaluations of the probabilities of future large earthquake occurrence (site, scale (magnitude), and occurrence probability) as well as strong ground motion estimations, and published the results for 98 major active fault zones throughout the country and subducion-zone earthquakes in 7 sea areas around Japan. In March 2005, the committee published the "General Seismic Hazard Maps" based on these results (Figure 3-2-10).

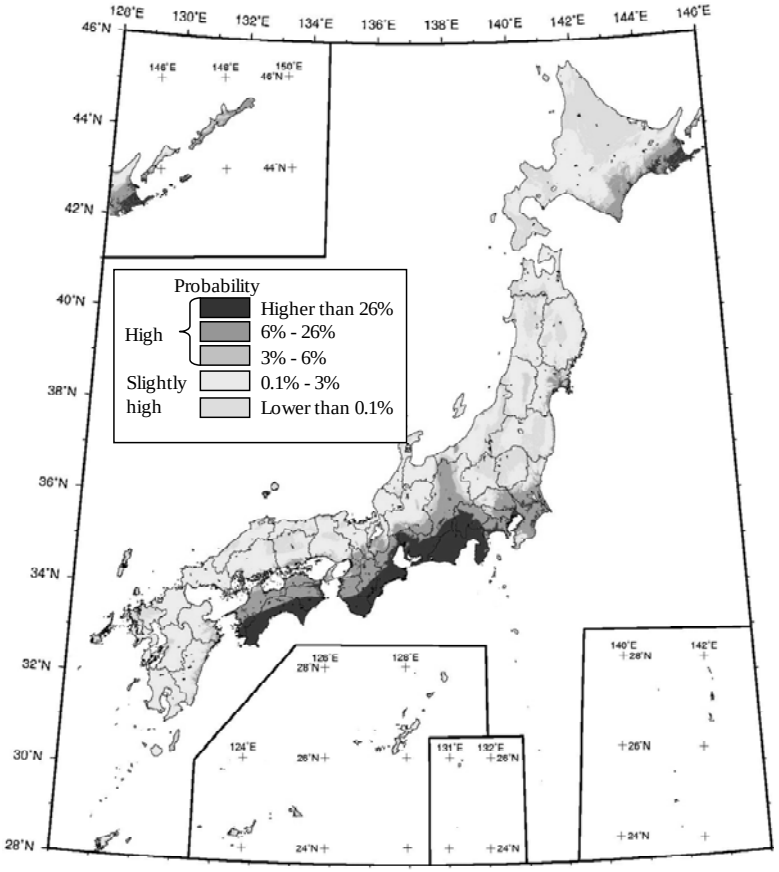

Figure 3-2-10 Probability Seismic Hazard Map (Distribution map of probabilities of having an intensity of 6 Lower or greater* quakes in the next 30 years)

Note: 1. Regarding figures for the classifications of the "high" possibility having an intensity Lower or greater quake in the next 30 years, it is shown that 26% will experience an earthquake about each 100 years on average, 6% about each 500 years, and 3% about each 1,000 years, respectively.
2. Base date: January 1, 2005

The major measures related to earthquake research and surveys of related ministries and agencies are as shown in Table 3-2-11.

Based on the policies laid down by the Headquarters for Earthquake Research Promotion, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) promotes additional or complementary research on active faults, and focused research and observation into ocean trench earthquakes in the Tonankai and Nankai earthquake zones, etc. and the Itoi River-Shizuoka fault line. In addition, as part of the "Special Project for Earthquake Disaster Mitigation in Urban Areas", it also promotes the research and survey into the crustal structure in major metropolitan areas. The National Research Institute for Earth Science and Disaster Prevention (NIED), acting in accordance with the "Fundamental Seismic Survey and Observation Plan," is promoting the development and operation of high sensitivity seismic observation stations and of broadband seismograph network, and is also engaged in collecting data from earthquake observation networks, and in processing and disseminating that data. The institute is also engaged in research into methods for the preparation of general seismic hazard maps. In addition, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) is promoting the development of a comprehensive real time deep sea-floor observation network system. The Advanced Industrial Science and Technology (AIST) promotes research into the mechanism and prediction of occurrence of earthquakes caused by active faults. The Geographical Survey Institute (GSI) operates 1,231 (as of March 2006) continuous GPS stations throughout the nation as well as Very Long Baseline Interferometry (VLBI) and other advanced survey technologies, to make observations and analysis of crustal deformation and plate motion. The Japan Meteorological Agency (JMA) establishes and operates observation facilities, while providing earthquake information with centralized observation data including other relevant institutes. The agency is also working together with NIED to conduct research and development towards practical application of the emergency earthquake information reports (EEIR), which aim to provide information including the hypocenter and magnitude of an earthquake before the strong motion occurs in order to mitigate the earthquake's damage. The Japan Coast Guard promotes seafloor geodetic observation, bathymetric survey and the research for the evaluation of earthquake activities. National universities conduct basic research into earthquakes.

The national research for earthquake and volcanic eruption prediction is comprehensively promoted according to the plan based on "The Second New Program of Research and Observation for Earthquake Prediction" adopted in July 2003 by the Council for Science and Technology as a five-year promotion plan (2004-2008) and "the Seventh Program for Prediction of Volcanic Eruptions," with universities, the National Research Institute for Earth Science and Disaster Prevention, the Japan Meteorological Agency, and other institutions proceeding in the spirit of cooperation while utilizing their particular functions and capabilities.

Table 3-2-11 Measures for earthquake surveys and research (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	•Development of a rational method to satisfy technical standards adopted by dangerous facilities with respect to "earthquake movements that last a rather long period"
	National Research Institute of Fire and Disaster	•Research into the creation and systematization of disaster prevention information at the time of an earthquake •Resaerch on the prevention of oil storage tank fires and the ensuring of safety of structures in the event of earthquakes
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	•Promotion of prioritized surveys and observation •Regional characterization of the crust in metropolitan areas under the Special Project for Earthquake Disaster Mitigation in Urban Areas •Surveys and research into Tonankai and Nankai earthquakes •Project for the realization of an advanced instantaneous quake information transmission network
	National universities	•Promotion of research and observation of the processes in the earth's crust leading to earthquakes
	National Research Institute for Earth Science and Disaster Prevention	•Research on the operation of earthquake observation networks and the mechanism of the occurrence of earthquakes •Research into methods for the preparation of general seismic hazard maps
	Japan Agency for Marine-Earth Science and	•Development and preparation of a comprehensive sea bottom network monitoring system
Ministry of Economy, Trade and Industry	National Institute of Advanced Industrial Science and Technology	•Research into the use of active faults and old earthquakes for quake occurrence •Research on the diversity of ocean trench earthquakes and the improvement in earthquake prediction capabilities •Research on the improvement of earthquake damage assessment based on information regarding active faults and geological conditions
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	•Observations for the elucidation of crustal activities leading up to earthquake •Observations for precise monitoring of crustal activities •Promotion of marine geodesy
	Japan Meteorological Agency	•Earthquake monitoring networks, and earthquake and tsunami monitoring systems •Monitoring system for the Tokai region, etc. •Collection (unification) of data from relevant agencies
	Meteorological Research Institute, Japan Meteorological Agency	•Improvement in the prediction accuracy for the Tokai earthquake and research of the preparation process of the To-nankai and the Nankai Earthquakes •Research into advanced use of seismic and crustal movement observation data
	Geographical Survey Institute	•Japanese archipelago precise geodetic network survey •Strengthening of crustal movement observation •VLBI (Very Long Baseline Interferometry) survey •Gravity survey and geomagnetic survey

(3) Aviation Science and Technology

R&D in aviation science and technology is knowledge-intensive and makes use of advanced technologies. As a result, it not only brings about the development of air transport, but also spills over into many other sectors.

In Japan, technology has accumulated through the independent development of the YS-11 commercial transport aircraft and other projects, international joint development of the Boeing 787 and other aircraft, and international joint development of the V2500 jet engine for commercial aircraft. The nation's technology is steadily increasing its role in the world's aviation industry. In particular, Japan's application of composite materials and other advanced materials in its structural design and

manufacturing technologies is recognized as top-class around the world.

To actively promote the development of aircraft and their engines, it is necessary to even further improve the technological levels. In the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology decided the "Policy to Promote Research and Development on Science and Technology for aeronautics" in Fiscal 2003, thereby indicating desirable ways of research and development. In addition, in the Ministry of Economy, Trade and Industry, Aircraft and Space Industry Committee's Aircraft Subcommittee under the Industrial Structure Council is holding discussions on the possibility of joint international development of domestic aviation aircraft and engines, and on other directions in aircraft industry policy.

In response to the above-mentioned promotion policy, the Ministry of Education, Culture, Sports, Science and Technology is intensively promoting R&D that can contribute to the development of a domestic aircraft and domestic jet engine, and R&D into transportation safety and environmental protection under the leadership of the Japan Aerospace Exploration Agency. Elsewhere, the agency is promoting research into numerical simulations and basic technologies for assessment of advanced composite materials. The agency also develops wind tunnels, engine testing facilities, and other large-scale testing and research facilities, encouraging their joint use by other institutions, to play a leading role in improving the level of aviation science and technology in Japan.

The Ministry of Economy, Trade and Industry is promoting research and development for low-cost small domestic aircraft with a limited burden on the environment and environmentally-friendly high-performance small aircraft that demonstrate the entire integration technology[22] for domestic engines, as well as research and development of engines for environmentally-friendly small aircraft. In addition, the ministry is promoting the development of civil aircraft using technologies for supersonic aircraft and the Defense Agency's aircraft, and the development of technologies for manufacturing and processing next-generation structural parts and materials, which realize reduced cost and increased reliability of composite materials for aircrafts and magnesium alloy parts and materials, as well as the development of next-generation technologies related to additional accessories and functions, such as incorporating maneuvering and air conditioning into electrical operation.

The Electronic Navigation Research Institute under the Ministry of Land, Infrastructure and Transport has been conducting research in the field of communications, navigation, monitoring and air traffic control to develop technologies for securing and facilitating air traffic safety. This research is expected to be important for the further advancement of air transportation.

(4) Development of Other Social Infrastructure

Society as a whole is becoming increasingly complex, with advancing urbanization and the general improvement of society through the development of transport, shipping, and communications systems, etc. On the other hand, however, rural communities face problems of population outflow and aging, reduced vitality in industry and society, a decline in public transport and shipping functions, and a general multifaceted decline in such important functions as land conservation, water source cultivation, and conservation of the natural environment. Moreover, in order to achieve a higher quality for people's lives, where leisure and prosperity can be experienced, the development of the socio-economic infrastructure has come to be demanded.

In this sector, a number of documents have established priorities for the promotion of research and development, including the "Basic Plan for the Ministry of Land, Infrastructure and Transport Technology," adopted in November 2003 by the Ministry of Land, Infrastructure, and Transport, the "Basic Plan for Research and Development in Information and Telecommunications," adopted in February 2000 by the Ministry of Posts and Telecommunications' Council for Telecommunications Technology (Ministry of Internal Affairs and Communications), and the "Items Related to Pollution Prevention that Require Experimental Research Priority," adopted in April 2003 by the Ministry of the Environment.

[22] verall integration technology: technology for producing entire completed airframe

Specifically, the Ministry of Land, Infrastructure and Transport and other ministries and agencies are promoting comprehensive land use through the development of advanced national land use management technology, and research and development into disaster prevention evaluations and countermeasure technologies in city renewal projects, and into other local disaster prevention activities. The ministry is also promoting research and development into technologies for a superconducting magnetically levitated train, and of other advanced transport and shipping systems.

The Ministry of Internal Affairs and Communications and other ministries and agencies are promoting research and development into ultra-high speed network technologies, advanced information resource transmission and accumulation technologies, and other advanced information and communication systems, as well as research and development for fire fighting and disaster prevention, including research on technologies for alleviating damage by disaster and disaster response technologies.

In addition, the Ministry of Agriculture, Forestry and Fisheries is engaged in the development of technologies for the restoration and improvement of agriculture, forestry, and fisheries ecologies, and of methods for managing drainage basin environments.

The Ministry of Economy, Trade and Industry promotes research and development of “human lifestyle engineering for quality life” for the development of universal design products and systems.

The Ministry of Land, Infrastructure and Transport offers subsidies and other support for the Railway Technical Research Institute to promote research and development toward the practical realization of a superconducting magnetically levitated train, for the objective of high-speed transport in the future. In addition, based on the “Development Vision for Technologies Related to Deep Underground Use,” the ministry is promoting the development of technologies with broad general applications for projects that require traversal of the deep underground.

The major research topics in Fiscal 2005 for socioeconomic infrastructure, safety assurance, etc., are as shown in Tables 3-2-12 and 3-2-13.

Table 3-2-12 Major research subjects in the improvement of the socioeconomic foundation area (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	•Research into basic information and communication technologies
Ministry of Education, Culture, Sports, Science and Technology	Japan Aerospace Exploration Agency	•Technologies for higher performance domestic passenger aircraft •Research into aviation safety and environment protection technologies
Ministry of Agriculture, Forestry and Fisheries	National Institute for Rural Engineering	•Development of eco-friendly management technology for water and agro-forested-aqua-ecosystems in watershed and estuary areas
Ministry of Economy, Trade and Industry		•Supersonic transport propulsion system •Behavior-based human environment creation technology
Ministry of Land, Infrastructure, and Transport	Engineering Affairs Division, Minister's Secretariat	•Development of technologies enabling a reasonable level of revitalization and utilization of aged buildings in view of their historical and cultural value •Development of techniques for revitalizing and reorganizing suburban residential districts in view of Japan's expected population decline •Research on the methods for evaluating the level of social infrastructure development •Development of technologies to manage social infrastructures
	Subsidy for the development of railway technologies	•Development of a superconducting magnetically levitated train
	Grants-in-aid for advanced research on ship technology funding	•Development of non-ballast water ships •Development of natural gas hydrate (NGH) carriers
	National Institute for Land and Infrastructure Management	•Research for the International Harmonization of Building Codes and Standards •Research on desirable environment in urban area for urbanized society •Development of effective evaluation and management methods for cost reduction of public works •Development of technologies enabling a reasonable level of revitalization and utilization of aged buildings in view of their historical and cultural value •Development of techniques for revitalizing and reorganizing suburban residential districts in view of Japan's expected population decline •Research on the method for evaluating the level of social infrastruture development •Research on procedure of cost reduction and safety operation for airports by preventive maintenance system •Study on efficient use of coastal areas for maritime transport by utilizing AIS
	Geographical Survey Institute	•Research on the advanced utilization of time-series geographic information on national
	Public Works Research Institute	•Research on improving the durability of structures and evaluating their performance •Research on evaluating the soundness of infrastructure stock and its remedial •Research on the efficient construction and redevelopment of dams considering the surrounding environment •Research on reducing the construction costs of super-long highway structures
	National Maritime Research	•Research on advanced logistic simulation
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	•Comprehensive research on waste disposal and the recycling of wastes •Comprehensive research on advanced treatments for effluents

Table 3-2-13 Major research subjects in the safety area (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	•Practical application of information support systems for the firefighting activities in difficult locations such as underground spaces •Research and development of robots for fire and disaster prevention
	National Research Institute of Fire and Disaster	•Advancement of firefighting, emergency services and rescue techniques •Safety measures for those who need help during disasters, such as elderly people •Safety evaluation for hazardous materials and facilities handling hazardous materials
Ministry of Health, Labour and Welfare	National Institute of Industrial Safety	•Clarification of destabilizing factors in the course of building bridges and the development of safe construction technologies •Research on basic safety technology for work systems based on human-machine •Research on the prevention of explosions and fire disaster in the process of industrial recycling •Research on the prevention of explosions and fires occurring due to static electricity generated from the spraying of liquid
Ministry of Agriculture, Forestry and Fisheries	Fisheries Research Agency	•Development of a method of assessing the safety of fishing vessel structures in consideration of human influence
Ministry of Economy, Trade and Industry		•Development of technologies for the safe management of liquefied petroleum gas supplies
Ministry of Land, Infrastructure and Transport	Policy Bureau	•Research and development on next-generation inspection technologies to strengthen terrorism countermeasures for public transport
	National Maritime Research Institute National Institute For Sea Training Marine Technical College	•Research on Formal Safety Assessment (FSA) method for developing safety standards - method of assessing the fire risk of passenger ships •Research on human errors in accidents at sea •Basic research on the cutting of mooring ropes at the fair leader •Detection of leakage and abnormality in machines, equipment and plants
	National Institute for Land and Infrastructure Management	•Study of road environments to help prevent human error

3.2.2.8 Frontier Science

(1) Space Development and Utilization

Space development and utilization not only brings about the “accumulation of intellectual property common to all humankind” through acquisition of commonly applicable knowledge regarding the origin of the universe and various phenomena occurring on Earth, but also contributes to development of critical and strategic national technologies, which serve as a basis for sustainable development of the nation, thereby contributing to national security in a broad sense. It is extremely important because the expanded use of space contributes to the “expansion of the socioeconomic infrastructure” through global environment observing and disaster monitoring, weather forecasting, and satellite-based communications and broadcasting activities, and to “pioneering advanced technologies” that may result in the creation of new technologies in various fields and of new industries with much additional value, so-called “spining-off”.

Since the successful launch of Japan’s first satellite “Ohsumi” in 1970, Japan had launched 113 satellites as of the end of March 2006. Table 3-2-14 shows the major satellites planned and/or prepared for future launch by Japan and their objectives.

The Council for Science and Technology Policy issued in September 2004 the “Basic Strategies for Space Development and Utilization in Japan.” This describes action plans for all space development and utilization in Japan.

The Ministry of Education, Culture, Sports, Science and Technology directed the Japan Aerospace Exploration Agency (JAXA) to promote research and development in a strategic and concentrated way in accordance with the “Long-Term Plan for Space Activities” in September 2003, based upon discussion in the Space Activities Commission. JAXA, learning from troubles in the past, has been making efforts to establish reliability, and succeeded in the No. 7 H-IIA launching in February 2005, and has continued to make successes in the

following five rockets launches by the end of March 2006, that is, three H-IIA launches and two M-V launches.

Furthermore, in accordance with the basic principles of overall space development and utilization in Japan, the Space Activities Commission holds discussions on the long-term plan for space development and examines safety in rocket launches. The commission also conducts investigation into the causes of accidents or malfunctions.

Table 3-2-14 Satellites and payloads planned to be launched

Satellite/payload	Weight (kg)	Orbital altitude (km)	Launch vehicle	Launch date (fiscal year)	Major objectives
JEM Japanese Experiment Module	Approx. 26,800	Approx. 400	U.S. Space Shuttle	2007	Expansion of Japan's space activities, promotion of leading science and technology development, and contribution to the advancement of international cooperation
WINDS Wideband Internetworking engineering test and Demonstration Satellite	Approx. 2,700	Geostationary orbit	H-IIA	2007	Development, etc., of ultra-fast high-capacity satellite communications technologies and other world-leading technologies, and experiments/ demonstrations thereof
SELENE SELenological and Engineering Explorer	Approx. 2,900	Orbit around the moon (Approx. 100)	H-IIA	2007	To research the origin and evolution of the Moon, collect data for a Moon-use feasibility survey, etc.
SOLAR-B 22nd scientific satellite	Approx. 900	Sun synchronous orbit (Approx. 600)	M-V	2006	Detailed observation of the structure and motion of micromagnetic fields on the solar surface, to elucidate the components of solar magnetism and the source of solar activity
GOSAT Greenhouse gas Observing Satellite	Approx. 1,500	Sun synchronous orbit Approx. 650	H-IIA	2008	Continuous observation of physical Earth quantities, to contribute to the elucidation and forecast of global warming, climate change, changes in the ozone layer, etc.
GPM/DPR Global Precipitation Measurement/Dual-frequency Precipitation Radar	Approx. 3,000	Approx. 400	H-IIA	2010	To develop the Dual-frequency Precipitation Radar (DPR) for monitoring precipitation, as part of international cooperation in the Global Precipitation Measurement Program (GPM)
HTV H-II Transfer Vehicle	Maximum supply weight: Approx. 6,000	(Approx. 350-460)	H-IIA	2008	To use a Japanese transport system that can contribute a fair share of material supplies to the Space Station
PLANET-C 24th scientific satellite	Approx. 480	Orbit around Venus (Approx. 300-80,000)	M-V	2010	To explore Venus' atmosphere, and solve riddles in the basic principles of planetary weather and the evolution of atmospheres
LUNAR-A 17th scientific satellite	Approx. 540	Orbit around the moon (Approx. 200)	M-V	To be determined	Elucidation of crustal structure and thermal structure of the moon
Bepi –Colombo Mercury Exploration Project	Approx. 200 (MMO)	Elliptical polar orbit around Mercury (Approx. 00-12,000) (MMO)	Soyuz Fregat 2B	2012	To observe the magnetic field, magnetosphere, the inside and surface of Mercury from many directions through international cooperation with the ESA (European Space Agency). Japan is in charge of the Mercury Magnetospheric Orbiter (MMO).

Note: The launch dates above are as of March 2006 and could be changed in the future.

●Earth Observation and Earth Science

This is described in 3.2.2.3.

●Space Science and Lunar Exploration

JAXA plays the core role in the field of space science in Japan, launching science-mission satellites with the participation of researchers from various universities or academic institutes nationwide.

"Hayabusa" the 20th Science-mission Satellite (MUSES-C) was launched in May 2003 for the purpose of performing an engineering test for a mission to take rock samples from an asteroid and bring them back to Earth. The microwave discharge ion engine mounted on "Hayabusa" marked a total operating time of 26,000 hours, and "Hayabusa" arrived at the asteroid "Itokawa" in September 2005. "Hayabusa" observed the vicinity of the asteroid after the arrival, and left the area in November. "Hayabusa" is the first satellite in the world that succeeded in landing on and taking off from an asteroid, and is now making preparations for its return to Earth.

Launches scheduled for Fiscal Year 2005 include "Suzaku" the 23rd Science-mission Satellite (ASTRO-E II) for the observation of X-rays emitted from active galactic cores and galactic clusters, aimed at investigating the structure and evolution of the universe, and "Akari" the 21st Science-mission Satellite (ASTRO-F) that is aimed at clarifying the process of formation and evolution of galaxies, stars and planets through infrared observation.

There are other projects now in development, such as the 22nd Science-mission Satellite (SOLAR-B), which is aiming to investigate the origins of the solar atmosphere and the causes of solar activity, and the Moon orbiter SELENE to gather data for investigation on the origins and evolution of the moon and to clarify the feasibility of the lunar resources utilization.

●Communications, Broadcasting, and Positioning

Utilization of satellites for communications, broadcasting, and other purposes offers a broad range of benefits in terms of wide-area use, broadcast simultaneity, durability following disasters, etc. In Japan, the private sector has already been deeply involved in satellites for communications and broadcasting, such as for satellite broadcasting. To further promote these private-sector efforts, the government is promoting development in advanced and underlying technologies where the risks are too big for the private sector, and the development of pioneering technology for the future utilization of space.

Furthermore, in order to ensure autonomous technologies in space development and utilization and to contribute to technological innovation, the government is engaged in the R&D and testing of new space technologies as well as underlying technologies to promote space development and utilization.

1) Engineering Test Satellite VIII (ETS-VIII)

JAXA, cooperating with the Ministry of Internal Affairs and Communications, is developing the Engineering Test Satellite Ⅷ (ETS-Ⅷ) with a targeted Fiscal Year 2006 launch. The purpose is to develop and demonstrate large-scale satellite bus technologies, large-scale deployable antenna technologies, mobile multimedia satellite broadcast system technologies, and fundamental technologies related to satellite positioning systems utilizing high-accuracy clock standards.

2) Wideband InterNetworking engineering test and Demonstration Satellite (WINDS)

JAXA, cooperating with the Ministry of Internal Affairs and Communications, is developing the Wideband InterNetworking engineering test and Demonstration Satellite (WINDS) with a targeted Fiscal Year 2007 launch. The purpose is to establish a satellite-based communications technology that enables ultra-high speed Internet and large-volume data communications, and to demonstrate ultra-high speed networking technology using satellite communications.

3) Quasi-Zenith Satellite System

The quasi-zenith satellite system will consist of multiple satellites placed in quasi-zenith orbits to ensure that one or more satellites are always visible at the zenith in the skies over Japan, and are expected to achieve virtually 100% land coverage without being affected by narrow mountain valleys or tall buildings. On March 31, 2006, the Cabinet decided the basic principles for the future at the meeting of the Council for Promotion of GPS and GIS. Based on the principles, the Ministry of Intnal

Affairs and Communications, the Ministry of Education, Culture, Sports, Science, and Technology, the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure and Transport plan to conduct, in cooperation with the private sectors, research into the quasi-zenith satellite system with a targeted Fiscal Year 2009 launch, in order to provide such high-accuracy positioning services.

●Manned Space Technology

The International Space Station (ISS) program is an international cooperative project being carried out jointly by five countries and regions, namely Japan, the United States, Europe, Canada and Russia, to construct the space stations in low Earth orbit. Japan is carrying out the development of the Japanese Experiment Module (JEM; also known as "Kibo") and the H-II Transfer Vehicle (HTV), as its contributions to the ISS.

In July 2005, astronaut Soichi Noguchi participated in the Space Shuttle Discovery's flight, and accomplished the important mission including three extra-vehicular activities.

In September 2005, the United States notified the results of its ISS program review to the international partners. In consequence of discussion, it was confirmed that the Japanese module "Kibo" will be delivered to the ISS by space shuttle flights as previously planned. On the other hand, it has been decided that "Centrifuge," a biology research laboratory developed by Japan for the United States to offset the Space Shuttle launch services for "Kibo," was canceled for it's flight.

1) Kibo

The development of "Kibo," the Japanese first manned space experiment module, is almost finished, and functional tests and maintenance are being conducted as preparation for its operation.

2) HTV

To support the ISS operation, it is necessary for Japan to transport various cargos to the ISS. In addition, severe safety, rendezvous technology and orbital transfer technology are required for approaching and berthing to the ISS as a manned facility. In order to acquire these technologies and to deliver necessary supplies in the future, Japan is developing the HTV unmanned transfer vehicle and will demonstrate its flight.

●Promotion of Space Environment Utilization

It is expected to promote research and development that contributes to society through the various kinds of experiments and observation, by utilizing the unique conditions of the space environment such as microgravity and a high vacuum.

As for preparation for utilization of "Kibo," JAXA is conducting microgravity experiments at a microgravity experiment facility (drop tower) and by aircraft (parabolic flights), and experiments of the High-quality Protein Crystallization, by using the ISS's Russian service module, as well as the Three-Dimensional Photonic Crystallization. To promote diversification for the ISS utilization, JAXA also provides space education events such as communication between high school students on the ground and ISS crew, and contests for the aircraft-based microgravity experiments conducted by university students.

The Ministry of Economy, Trade and Industry (METI) developed a next-generation Unmanned Space Experiment Recovery System (USERS) to promote the utilization of the space environment. It was launched in September 2002 and the part of the space vehicle containing the results of the test experiments was successfully returned to Earth and retrieved on May 30, 2003. Analysis of the samples obtained in a large-scale superconducting materials crystallization growth test using a microgravity space environment is now in progress. In addition, to encourage the broad use of Japan's well-developed industrial technology in commercial satellite production processes, and to rationalize their design, procurement, and manufacture, etc., the Space Environment Reliability Verification Integrated System (SERVIS) satellite program was used to develop guidelines and the necessary intellectual infrastructure for the transfer of industrial technologies to space-related devices and the use of databases of private-sector components for space-related devices, and the satellite was launched in October 2003. The private-sector components worked well in the tests, and various data is being obtained in accordance with the plan.

●Space Infrastructure

For autonomy of national space development in

the international community, it is important for Japan to acquire the capability for transporting necessary materials and equipments to a specific location in space whenever needed. For this purpose, Japan is engaged in the research and development of space transportation systems. Japan is also developing an advanced inter-satellite communication technology that targets the acquisition of space network operations technology.

1) H-IIA Rockets

For the launch of large-scale satellites, etc., JAXA has developed a two-stage rocket with liquid oxygen/liquid hydrogen-fueled engines for both the first and second stages (H-IIA) (Table 3-2-15) and employs it to launch large-scale satellites. H-IIA rockets are positioned as Japan's key rocket and are planned to be used appropriately through steady implementation of technology upgrades and improvements to reliability. Moreover the H-IIA standard type is to be transferred to the private sector to ensure the improvement in product quality through shared manufacturing liability.

The development of H-IIB rockets (capacity-enhanced H-II A) is being promoted jointly by the public and private sectors to ensure the launch capability of the H-II Transfer Vehicle (HTV) and to enhance international competitiveness. In September 2005, JAXA and Mitsubishi Heavy Industries, Ltd. concluded a basic agreement on the development of H-II B rockets, to stipulate a framework for joint development between the public and private sectors. In Fiscal Year 2005, the Advanced Land Observing Satellite (ALOS), also known as "Daichi", and the Multifunctional Transport Satellite 2 (MTSAT-2),also known as "Himawari-7", operated by the Ministry of Land Infrastructure and Transport and the Japan Meteorological Agency, were launched and successfully entered their planned orbits.

Table 3-2-15 Main specification of vehicles used to launch satellites

Launch vehicle type	Stages	Overall length (m)	Diameter (m)	Gross weight (tons)	Propellant
M-V	3	Approx. 30	2.5	Approx. 139	Solid for all stages
H-IIA (standard)	2	Approx. 53	4.0	Approx. 285	1st and 2nd stages, liquid hydrogen/oxygen; SRB-A, solid

2) M-V Series Rockets

JAXA launches science-mission satellites usually by using the M-V rockets that use solid propellant for all stages. In Fiscal Year 2005, JAXA launched the X-ray Astronomy Satellite "Suzaku" (ASTRO-E II) using M-V rocket No. 6 and the Infrared Astronomy Satellite "Akari" (ASTRO-F) using M-V rocket No. 8. These satellites successfully entered their planned orbits.

3) GX Rocket

The GX rocket is a rocket designed to launch small- or medium-size satellites, which has been developed under private initiative. Public-private sector joint research and development is now progressing toward the first launch in Fiscal Year 2008. JAXA will conduct a flight test of the LNG-fueled propulsion system in a GX rocket.

4) Optical Inter-orbit Communications Engineering Test Satellite (OICETS) "Kirari"

In August 2005, the Optical Inter-orbit Communications Engineering Test Satellite (OICETS) "Kirari," designed to conduct orbital experiments on basic technologies needed for communications in inter-satellite communication systems was launched using a Dnepr rocket designed in Russia and Ukraine. With this launch, JAXA was the first in the world to succeed in a bi-directional optical link, which is a feat achieved through communications with the Advanced Relay and Technology Mission Satellite (ARTEMIS) of the ESA, and demonstrated optical inter-orbital communications technologies in space. In March 2006, JAXA also achieved the world's first success in non-military laser-optical communications, accomplished by communications with the optical ground-based station (Koganei City, Tokyo) of the National Institute of Information and Communications Technology.

5) Data Relay Test Satellite (DRTS) "Kodama"

JAXA is advancing preparation for an inter-satellite communications demonstration between the Advanced Land Observing Satellite (ALOS) "Daichi", which was launched in January 2006 and the Data Relay Test Satellite (DRTS) “Kodama”.

●Fundamental and Advanced Research on Satellite and Launch Vehicle Technology

JAXA and research institutes of related ministries and agencies conduct fundamental research on launch vehicle and satellite technology. They also work in a number of advanced research areas, including an unmanned winged reusable space vehicle and a space plane.

●Promotion of International Cooperation in Space

In recent years, the need for international cooperation including with Asian countries in space activities has expanded, because satellite-based Earth observation contributes to solve global issues, such as environmental problems, disasters, which are getting much more serious, and space activities have become international activities with the globalization in society and the economy. Therefore, the need for Japanese contribution in space activities such as mitigating disaster damage utilizing satellites has become greater ever than ever before.

Japan promotes multilateral cooperation through the activities in the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), in which nations discuss the international order on exploration and utilization of space, and on the promotion of international cooperation, the Asia Pacific Regional Space Agency Forum (APRSAF) hosted by Japan, a place for discussing concrete international cooperative projects in the Asia Pacific region for the development of space technology and applications for the future, and the Committee on Earth Observation Satellites (CEOS), a place for coordinating technical matters and information exchange. Particularly in Asia, Japan promotes multilateral cooperation with space agencies and disaster management organizations for establishing ”the Disaster management support system in the Asia Pacific region,” a network system for sharing disaster information.

Japan participates in the International Space Station (ISS) program as the largest international cooperation project in space development, and is developing the Japanese Experiment Module (JEM: ”Kibo”) and the H-II transfer vehicle (HTV). Japan has close cooperation with all participating partners for the construction and utilization of the ISS.

As bilateral cooperation, Japan promotes cooperation in space activities with the USA concerning “Cross-Waiver of Liability for Cooperation in the Exploration and Use of Space for Peaceful Purposes.” With European countries, Japan maintains close cooperation, through annual administrative Japan-ESA meetings, etc**.** Moreover, with Russia, Japan promotes cooperative relations through a periodic Japan-Russia joint Committee on Cooperation in Outer Space**.**

(2) Ocean Development

The development and use of the ocean, which contains an abundance of resources, including biological and mineral resources, as well as vast space, is an important issue for a country as physically small and confined by the sea as Japan. Furthermore, because the ocean plays an important role in global environmental changes, and the movements of oceanic plates are believed to be a major factor of earthquakes and volcanism, elucidation of their mechanisms is urgent. In the light of these conditions, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the Intergovernmental Oceanographic Commission (IOC) called for the implementation in the early 1990s of the Global Ocean Observing System (GOOS), which aims to build a system for the conduct of comprehensive observations and research of ocean phenomena on a worldwide scale. The GOOS project is now being promoted in co-operation with the World Meteorological Organization (WMO).

This plan was also incorporated into the Agenda 21 that was adopted by the United Nations Conference on Environment and Development (UNCED), also called the Earth Summit. Based on these international efforts, it is crucial for Japan to promote ocean research related to global environmental issues, and to promote other research and development into ocean sciences and technologies. Furthermore, in order to shed some light on ocean phenomena occurring on a global scale, the relevant ministries and agencies have joined with universi-

ties, etc., to actively participate in international ocean research programs such as
GOOS. Also, Japan has taken a leading role in co-operation with China, South Korea, and Russia to promote the North East Asian Regional-Global Ocean Observing System (NEAR-GOOS) as a regional pilot project for GOOS.

Japan's ocean development adheres closely to the report of the Council for Science and Technology, and research and development is being promoted with the co-operation of relevant ministries and agencies according to their various situations. In "Basic Concepts and Promotion Measures for Ocean Development from the Long-Term Viewpoint (report)," subdivision responded in August 2002 to an inquiry by the Minister of Education, Culture, Sports, Science and Technology, by noting that "it is important to carefully balance knowing, protecting, and using the ocean for the policies for future ocean development when presenting strategic policies and promotion policies toward realization of sustainable utilization."

Moreover, the Inter-Ministerial council was established to promote and coordinate surveys for the establishment of the outer limits of the Japanese continental shelf. The council recognizes that it is important for the government to firmly implement these surveys.

At the Ministry of Internal Affairs and Communication, the National Institute of Information and Communications Technology conducts research into high-resolution three-dimensional microwave radar and shortwave ocean radar to facilitate the establishment of methods for the measurement of marine oil pollution, currents, and waves, etc., and the prediction of changes in the global environment, and implements joint observation in cooperation with universities and other research institutes.

At the Ministry of Education, Culture, Sports, Science, and Technology, research Institutions including the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) are promoting advanced and basic research and development into ocean sciences and technologies. These institutions cooperate with related ministries and agencies, universities, etc., to promote comprehensive projects.

The Japan Agency for Marine-Earth Science and Technology conducted marine observation using Triton buoys[23], Argo floats[24], and an oceanographic research vessel "MIRAI" with the aim of investigating the interactions between the atmosphere and the ocean, such as El-Nino events, as well as the effects they have on global climate change. In addition, the deep sea research vessel "KAIREI" was used for ocean surveys for research into the dynamics of oceanic plates. In addition, the agency conducted geological, biological, and geochemical studies at sea on board the "YOKOSUKA," the support mother vessel for a manned research submersible "SHINKAI 6500." For the deep-sea Earth drilling project[25], construction of the "CHIKYU" deep sea drilling vessel, which had started in Fiscal 1999, was completed in July 2005, and a test voyage carried out. Furthermore, the Project for Research on Marine and Extremophiles Biology promoted research for the elucidation of the physiological adaptability of deep-sea organisms existing in extreme environments.

In addition, Ocean Research Institute, University of Tokyo, is at the center of continuing ocean-related scientific research, including basic research related to GOOS for the purpose of building a comprehensive observation system for the elucidation and forecast of changes in the ocean environment, and for its preservation, participation in joint surveys of the Western Pacific region, and research into ocean flux[26], which can contribute to the elucidation of physical cycles in the ocean. In addition, other national universities are engaged in research into marine ecosystems and conducting observations of changes in the atmosphere and oceans.

[23] The Triton buoy is an oceanographic observation buoy that is deployed mainly in the tropical regions to automatically monitor and report wind, atmospheric temperature, humidity, precipitation, solar radiation, seawater temperature, salinity, and tides.
[24] The Argo float is a float that automatically rises and sinks between the water's surface and a depth of about 2,000 meters in order to monitor and report water temperature and salinity.
[25] The deep-sea Earth drilling project aims to promote R&D to bring to light global environmental changes, the earth's interior structure, and deep-subsurface ecology by providing the Integrated Ocean Drilling Program (IODP) with the "CHIKYU" deep sea drilling vessel which was developed to reach the earth's as-yet-unexplored mantle.
[26] The Research into ocean flux aims to elucidate the circulation velocity of various matter within the ocean interior or crossing between the ocean and other reservoirs (atmosphere, solid earth, etc.), as well as the factors determining the velocity. The flux refers to the rate of flow of materials per unit area.

The Ministry of Agriculture, Forestry and Fisheries elucidated ocean surface layer ecologies to facilitate the rational utilization and management of organic marine resources, and also elucidated the structure of deep sea ecologies and the relationship between mechanisms of change, and changes in surface layer ecologies.

The Ministry of Economy, Trade and Industry continues to implement surveys for reserves of oil and other resources, prediction of effects on the marine environment and surveys of the ocean bottom in cooperation with Japan Oil, Gas and Metals National Corporation, the National Institute of Advanced Industrial Science and Technology and other organizations.

The Ministry of Land, Infrastructure and Transport promoted research and development on next-generation coastal ships (Super Eco-Ship), and expanded the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS) in cooperation with the Port and Airport Research Institute. The Japan Coast Guard is engaged in research into upgrading water channel measurement and marine condition monitoring technologies, and into the development of seabed monitoring technologies and upgrading of the accuracy of current flow forecasting. The Japan Meteorological Agency continues to conduct investigation and research on the ocean, such as the oceanographic and marine meteorological observations and elucidation of El Nino phenomena, in order to improve the information about monitoring and forecasting of marine phenomena and climate change. Moreover, the National Maritime Research Institute is carrying out research into safety and environmental protection in the field of maritimetechnology. In relation to the NEAR-GOOS project, the Japan Meteorological Agency and the Japan Coast Guard operate a system for promoting the exchange of oceanic data for NEAR-GOOS area, in order to better promote oceanographic research. In addition, the Geographical Survey Institute conducts basic research of coastal sea areas for the purpose of providing the basic information needed for the formulation of comprehensive development, utilization, and protection plans for coastal sea areas.

At the Ministry of the Environment, the Global Environment Research Fund is being used to conduct research into cross-border air pollution including acid deposition, and marine pollution, including pollution from chemical substances on global-scale.

Table 3-2-16 summarizes the main research subjects undertaken in the ocean sciences and technology sector by various ministries and agencies in Fiscal 2005.

Table 3-2-16 Major research areas in marine science and technology (FY2005)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	•Research into global environment measurement and forecasting technology, using 3-D high-resolution imaging radar •Research and development of ocean radar
Ministry of Education, Culture, Sports, Science and Technology	Japan Agency for Marine-Earth Science and Technology	•Development of marine research technology •Research and development of deep-sea research •Promotion of ocean drilling in the 21st Century •Frontier research •Research and development of ocean utilization and marine ecosystems •Research and development of ocean observation
	National universities and other institutions	•Integrated Ocean Drilling Program (IODP) •Cooperative study of the Western Pacific (WESTPAC) •Global Ocean Observing System (GOOS)
Ministry of Agriculture, Forestry and Fisheries	Fisheries Research Agency	•R&D into fisheries resources •Development of techniques for stock enhancement •Development of techniques for advanced use of fishing grounds •Research into the improvement and development of fishing grounds •Observations of oceanographic environments related to fisheries •Technological development of fishing gear and methods •Measures for marine environmental conservation •Research of marine space use •Technological development of marine resources use
	Marino Forum 21	•Development of artificial fishing ground technology, using deep ocean water •Development and practical application of new technologies for protecting against red tide
Ministry of Economy, Trade and Industry	Japan Oil, Gas and Metals National Corporation	•Research and development of deep-sea mineral resources
	National Institute of Advanced Industrial Science and Technology	•Prediction of Earth and ocean environments based on geochemical and palaeontological research of modern and past environments
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	•IOC Sub-Commission for the Western Pacific Region (WESTPAC)
	Meteorological Research Institute, Japan Meteorological Agency	•Observational research on variability of carbon cycle in the ocean
	Geographical Survey Institute	•Basic research of coastal sea areas
	National Maritime Research Institute	•Research on practical technologies and international standard on mega-float •Research and development on key technologies for Super Eco-ship to innovate domestic transport system and coastal ships
	Port and Airport Research Institute	•Research into the physical environment of sand beaches •Elucidation of the mechanisms for wave liquefaction and deformation of the ground, and research into countermeasure and utilization technologies •Research into coastal seawater flows, and seabed environments •Research into work and monitoring by underwater vehicles
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	•Research into application of mitigation technologies to the Seto Inland Sea for creating an appropriate environment
	National Institute for Environment Studies	•Research into coastal environment management •Research into a mechanism of maintaining high-level nutrient salt concentration in the Ariake Sea: For appropriate shallow water management
	Global Environment Research Fund	•Research into the elucidation of the ocean's absorption of carbon dioxide from human sources in the Pacific region •Studies on environdynamics and forecast of global-scale marine pollution with hazardous chemicals •Studies of the impact of marine organisms introduced by the ballast waters and ships' hulls on coastal ecosystems and the management of ballast waters
	Global Environment Research Coodination System	•Study on the increase of sea-surface temperature in Asian monsoon regions based on coral skeletal climatology •Evaluation of the effects of the oceanic segregation of carbon dioxide on the oceanic material cycling process