Chapter 2 Strategic Priority Setting in Science and Technology

1 Promotion of Basic Research

Basic research, bringing human wisdom and serving as a source of knowledge, is an activity accumulated as a property shared by all mankind. It is realized in the steady, serious pursuit of truth and after much trial and error. The findings and inventions, which do not fall into the existing knowledge framework, will make leaps in knowledge. It is thus important to nurture innovative spirits among researchers. Basic research consists of two types: (1) academic research based on the free ideas of researchers, and (2) basic research that aims at future applications based on policies. It is necessary to understand the purpose of each of these types and should be widely, steadily, and continuously promoted.

To this end, we are promoting basic research at universities and other institutions by securing basic research funds such as government subsidies for national university corporations and financial aid to private educational institutions as well as through competitive funds, such as Grants-in-Aid for Scientific Research for (1) and JST Basic Research Programs for (2).

2 Priority Setting in Research and Development for Policy-oriented Subjects

It is essential to strategically prioritize research and development in response to policy challenges in addition to promoting basic research, which is "investment for tomorrow," in order to maximize the effects of governmental R&D expenditures under the Third Science and Technology Basic Plan. The four priority fields in the Second Basic Plan (Life sciences, Information and telecommunications, Environmental sciences, Nanotechnology/Materials) are made into four priority fields to be promoted in the Third Basic Plan, based on the level of contribution to the three ideas, strategic viability, the trends of S&T strategies in the world, and public expectations. Resources are allocated to these fields at a high priority. In addition to the above, the Third Basic Plan also deems the other four areas, including Energy, Monodzukuri technology, Social infrastructure, and Frontiers, as those in which R&D activities emphasize issues that are fundamental for the nation's existence and need to be addressed by the government (hereinafter "four fields to be promoted"), and resource allocation will be made in an appropriate manner. MEXT finalized the Sectoral Promotion Strategy (Decision by the Council for Science and Technology Policy on March 28, 2006) toward selection and concentration of investments as well as achievement of results during the period of the Basic Plan. In the Strategy, 237 tasks were chosen as important R&D tasks that should be worked on by the government. Research targets and achievement goals in particular are specified for each task. Finally, 62 Strategic Prioritized S&T were chosen as the subject of selective investments. At present, according to the Strategy, R&D projects are being promoted while ensuring thorough selection and concentration of the subjects, including the Strategic Prioritized S&T for selective investments in each of eight fields after a strict evaluation of R&D work on the Key Technologies of National Importance.

1 Life Sciences

The life sciences aim at elucidating the complex and elaborate mechanisms of biological phenomena produced by living things, and their results contribute greatly to the improvement of people's lives and to development of the national economy, through dramatic advances in medicine,

resolutions of food supply and environmental problems, and other areas.

In the Sectoral Promotion Strategy, for the field of life sciences, the following seven Strategic Prioritized S&T projects are listed as those requiring intense funding for the next five years. MEXT and other ministries promote research and development centered on these projects.

(1) Basic and generic research themes supporting life sciences research as a whole

1) Science and technology for reconstruction of complex systems of life

a) Promotion of genome-related research

Based on the completion of detailed sequencing of the human genome, MEXT started promotion of genome function analysis called Genome Network Project and other projects in FY 2004. This project aims to elucidate basic problems relating to life sciences, elucidate the mechanisms of disease development, and develop new treatment methods by clarifying the network that establishes vital activity mainly through comprehensive analysis of the interactions of biological molecules, etc. In addition, research has been steadily promoted in such fields as the analysis of protein structures and functions related to genome-based drug discoveries, etc., and the development of revolutionary medical technologies that make use of individual genome information.

The Ministry of Health, Labour and Welfare (MHLW) promotes R&D for the establishment of methods for the prevention, diagnosis and treatment of disease and the development of revolutionary new drugs by elucidating genes related to dementia, cancer, diabetes, high blood pressure, asthma, and other ailments of the elderly. Moreover, taking into consideration rapid advances in genomic sciences seen in recent years, research and development were carried out since FY 2002 into basic technologies (toxicogenomics) that allow rapid and effective prediction of the safety (toxicity, side effects, etc.) of compounds that are candidates for medical products.

The Ministry of Economy, Trade and Industry (METI) promotes R&D for developing tools (informatics and high-sensitivity quantitative analysis technologies) for analyzing functional RNA, as well as understanding its functions, by taking advantage of private-sector contribution through the New Energy and Industrial Technology Development Organization (NEDO).

b) Promotion of protein structural and functional analysis

Proteins are one of the basic molecules that constitute life, and an analysis of protein structure and function is essential for future industrial applications in the medical, pharmaceutical sciences, foods, environment, and other fields. While utilizing the results and organized infrastructure obtained through the Protein-3000 Project (National Project on Protein Structural and Functional Analyses), MEXT implemented the Targeted Proteins Research Program, which selects protein targets of crucial importance for academic research and industrial applications that present extreme difficult at the current technological level and executes the technological R&D required for analysis of the structures and functions since FY 2007.

c) Promotion of brain sciences research

Brain sciences is a field that is expected to lead to improvement in the quality of life, improvement in medical sciences, and the creation of new technologies and industries through the results of research. To this end, R&D projects that make maximum use of the capabilities of many universities and national research institutions, beyond the bounds of individual ministries and agencies, designated the subjects of understanding the brain, protecting the brain, creating the brain, and learning from the brain as the core fields.

MEXT promotes research at the RIKEN Brain Science Institution by utilizing the program Grants-in-Aid for Scientific Research for high-priority promotion of brain sciences research at universities. Furthermore, MEXT made an inquiry of the Council for Science and Technology in October 2007 concerning fundamental strategies and promotional measures for brain sciences research with a long-range outlook to strategically promote brain sciences research in Japan.

MHLW promotes research toward elucidation of the clinical state and development of treatment

methods of nervous and muscular diseases, such as Parkinson's disease, Alzheimer's disease, higher brain dysfunction, and mental diseases, including integration disorder syndrome, and depression.

d) Promotion of research in cell/biodynamics simulation

Since FY 2003, MEXT conducted the cell/biodynamics simulation project, with the aim to simulate the analysis of drug responsiveness and animal tests conducted by using living bodies and cells, based on life information technology and advanced imaging technology.

e) Promotion of immunity and allergy research

MEXT conducts basic research concerning immunity and allergies at the RIKEN Research Center for Allergy and Immunology. The Center and the Sagamihara National Hospital promote efficient research through collaboration between basics and clinical applications under the joint research agreement.

f) Promotion of analysis of the functions of carbohydrate chains

In regard to research on carbohydrate chains, which are believed to play important roles in a vast array of biological functions, MEXT used the Grants-in-Aid for Scientific Research and JST Basic Research Programs to promote carbohydrate chain research at universities. Furthermore, at the RIKEN Frontier Research System, researchers constructs cells and studies the membrane domains (Supra-Biomolecular System) made up of carbohydrate chain structures and fat molecules that support the cell functions in their research concerning functions whereby the body recognizes and communicates information.

METI develops methods and tools for analyzing the functions of carbohydrate chains and sugar proteins, utilization of such functions, and carries out R&D toward developing a mass-synthesis technology of carbohydrate chains by taking advantage of the private-sector contribution through NEDO.

(2) Challenges in the field of "better living"

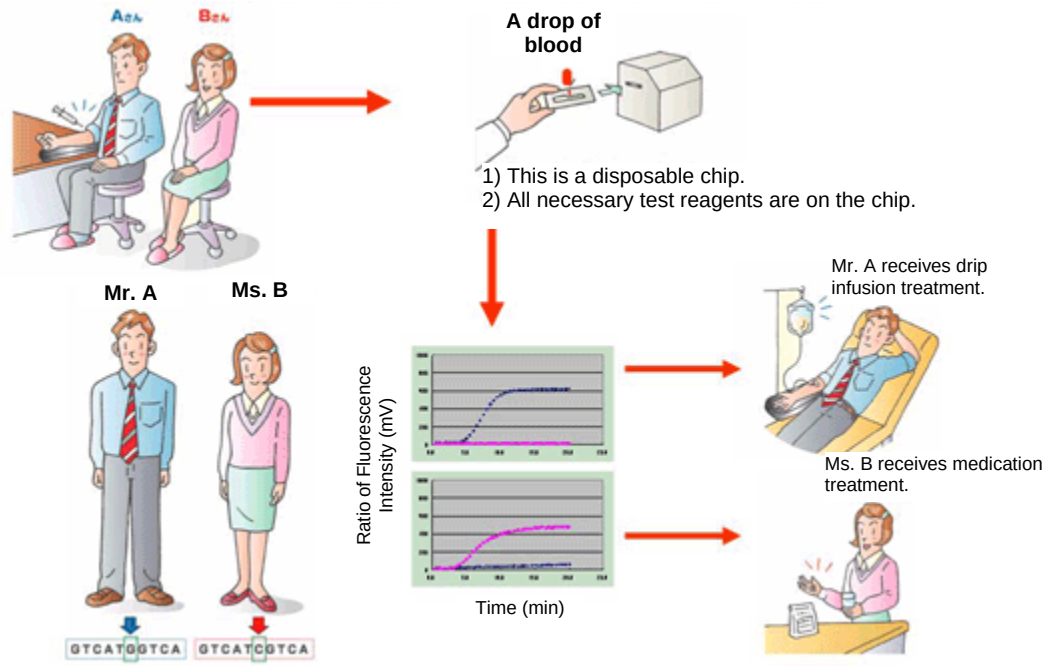
2) Translational research

a) Promoting establishment of bases for translational research

For the purpose of the steady application of the results of promising fundamental research in medical care for people, MEXT promotes a Coordination, Support and Training Program for Translational Research to support translational research for universities to develop results for promising fundamental research expected to be used for practical medical care. The program aims to formulate development strategies and establish bases in support of translational research to manufacture testing substances that satisfy the standards of the Pharmaceutical Affairs Act.

b) Promotion of genetic polymorphisms research

For the purpose of elucidating the causes of diseases and realizing effective personalized medicine, MEXT established Biobanks by collecting blood serum samples from patients suffering from targeted diseases and implements the project for realizing medical care according to individual genetic information, which aims to elucidate the relationship between SNPs and diseases by utilizing the samples collected. The RIKEN SNP Research Center promotes research on the elucidation of the causes of diseases, while ensuring cooperation with this project.



Flow of SNPs analysis system in medical activities
Full-automatic SNPs Analysis System (Joint development of Toppan Printing Co., Ltd., and Shimadzu Corporation). This system is capable of making SNP judgment within 45 minutes from a drop of blood (Source: RIKEN)

c) Promotion of research on the development, differentiation, and regenerative science

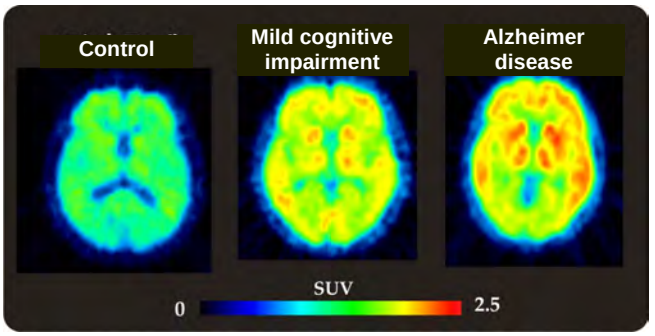
Research into development, differentiation, and regeneration in biological system aims to elucidate the mechanisms, etc. relating to the process in which one cell differentiates into various tissues or organs to form and maintain an individual. This serves as a basis for regenerative medicine, and the research of this field brings about rapid advances in stem cell research such as iPS cells and establishment of technology for producing Embryonic Stem (ES) cells in recent years.

MEXT conducts research at the RIKEN Center for Developmental Biology. Moreover, in FY 2003, the ministry launched the Project for Realization of Regenerative Medicine and promotes research towards developing a stem cell bank as research infrastructure in order to provide stem cells for researchers, and applies the results of basic research to clinical areas.

d) Promotion of molecular imaging research

Molecular imaging is a technique for visualizing quantities and functions of molecules in living organisms.

MEXT has been involved in the "Molecular Imaging Research Program", coordinating a central core for innovation in the drug discovery process with the Center for Drug Development Molecular Imaging (RIKEN), and for development of diagnostic technology with the Center for PET Diagnosis (National Institute of Radiological Sciences), carrying out revolutionary R&D to renovate drug discovery process and improve disease diagnosis at these centers, and promoting developing of human



Investigation photos regarding to what extent causative substances of Alzheimer disease are accumulated in the brain by using PET (a system to image molecules within the living body).
Much causative substance are accumulated in the portion in red color. Photo: RIKEN

resources and joint research projects.

MHLW promotes the development of medical devices toward noninvasive and minimally invasive treatment through applications of nanotechnology. The ministry also carries out research in innovative imaging diagnosis technology and devices for treatment of cancer and other diseases. Some research projects are supported through matching funds with NEDO.

METI implemented the Project for R&D on Molecule Imaging Equipment since FY 2005. It has been developing a molecular imaging device that can detect cellular function changes with high sensitivity, accuracy, and speed so that tumors can be discovered and the level of malignancy can be diagnosed at early stages.

e) R&D that promotes implementation of research results such as making the drug development process more efficient

METI carries out R&D for building the basic technology that will accelerate genome-based drug discovery for creating new medicines using genetic information. This involves technologies that elucidate disease mechanisms at the genetic level using human full-length cDNA, which is one of the fields where Japan is leading leader, technologies that create medicines based on disease mechanisms analyzed, technologies that efficiently create medicines based on membrane proteins' structure information that plays a crucial role in living organisms, and technology development toward the creation of research model cells for diseases based on human ES cells. Furthermore, METI also develops technologies to create new antibodies that can be used in antibody therapeutics and to efficiently purify the antibodies.

f) Development of new medical technologies and systems through cooperation among private-sector companies and clinical research institutions

METI implements organic cooperation among private-sector companies, such as venture firms and clinical institutions through NEDO to deliver research results in versatile technology fields to medical sites, thus trying to achieve rapid practical applications and dissemination of medical technologies by developing new medical technologies for achieving a reduction in the incidence by patients and persons involved in medical care.

3) Innovative cancer treatment technologies such as targeted treatment

Based on the Third Term Comprehensive 10-Year Strategy for Cancer Control (Decision by the Minister of MEXT and the Minister of MHLW in July 2003) or the Cancer-Fighting Basic Act (Enforcement in April 2007), some new understanding of the mechanism of cancer and new methods for prevention, diagnosis, and treatment for cancer, taking advantage of related research results are being elucidated.

MEXT has been carrying out the project Research Promotion for Innovative Therapies against Cancer as research that leads to clinical applications of outstanding results of basic research related to cancer-immunity treatment and molecular target treatment. The National Institute of Radiological Sciences (NIRS) promotes research in heavy-ion cancer therapy, which is expected to be a revolutionary treatment method for types of cancer that are otherwise difficult to treat. In addition, research and development are under way, led by NIRS, to reduce the size of heavy ion beam irradiation equipment for more popular use across the country. Based on the results of this research, Gunma University prepared a heavy-ion beam irradiation facility since FY 2006.

MHLW is involved in research on the mechanism of cancer and translational research that widely applies the research results; multicenter clinical trials for the purpose of establishing standard treatment procedures for cancer treatment; research on palliative care for maintaining and improving quality of life among cancer patients and their families; research on cancer epidemiology and dissemination of cancer information; and research concerning policy challenges such as building a system for promoting equalization of cancer medical services nationwide.

Since FY 2005, METI conducted the Project for R&D on a Next-generation DDS-type Malignant

Tumor Therapy System to develop molecular imaging devices that can detect cancer at a very early stage and to treat cancer cells with pinpoint accuracy.

4) S&T for overcoming emerging and reemerging infectious diseases

Currently, the society's fear of infectious diseases, such as new types of influenza whose existence was discovered anew or those that had been assumed to be overcome already, but are raging again (emerging and re-emerging infectious diseases), is increasing internationally. MEXT implements the Program of Founding Research Centers for Emerging and Reemerging Infectious Diseases to promote research on emerging and reemerging infectious diseases at research centers both in and out of the country in order to integrate the basic knowledge and develop human resources. MHLW sponsors research with an added emphasis on preventive and diagnostic technology for emerging and reemerging infectious diseases, animal-derived infectious diseases and other infectious diseases, on-site studies, and international measures for infectious diseases. The ministry also carries out broad and comprehensive studies on infectious diseases at the National Institute of Infectious Diseases (NIID).

(3) Challenges in the field of "better eating" and "better lifestyle"

5) S&T for the production and supply of safe foods which will improve our nation's international competitiveness

a) Research on microbial/plant and genome in food and environment fields

With advances in genome science, the analysis of the structures and functions of the plant genome is also progressing. By controlling the functions of plants based on these results, we anticipate being able to develop plants that will contribute to improved nutrition.

MEXT promotes research to improve plant productivity in terms of both quality and quantity, through the genome sequencing of Arabidopsis thaliana at the RIKEN Plant Science Center, and the level of research is on par with that of the US and Europe.

Ministry of Agriculture, Forestry and Fisheries (MAFF) promotes comprehensive genome research to secure three outlets: creation of new demand; renovation of food production technology; and the stabilization of international food demand and supply, while emphasizing the viewpoint that the results of genome research, including the complete decoding of the rice genome obtained in the past, will be returned to the public. More specifically, MAFF implements research focusing on the development of pigs with excellent properties of disease resistance or economic traits, or model pigs for medical research, and enhancement of production of useful substances by using a genetically engineered silkworm genome.

Furthermore, MAFF is working on the development of breed cultivation technology (genome breeding technology) to significantly shorten the breeding period to implement development of innovative breeds that may renovate food production technologies. For the stabilization of international food demand and supply, the ministry implements research on the elucidation of the molecular mechanism of resistance to environmental stress of plants and on the development of crops to avoid decreases in yields, even in faulty environments, by utilizing genes that are resistance to a broad range of environmental stresses including dryness, salt, and low temperatures.

Besides these projects, there is the continued promotion of development including production technologies of seeding for aquaculture that are difficult to artificially produce. Furthermore, in order to achieve a new target in the food self-sufficiency ratio, the ministry promotes the following projects: 1) development of domestic agricultural goods with unique characteristics in quality or processing compatibility for domestically produced agricultural goods for processing and industrial use where competition with imports is fierce; 2) development of breeding and growing technologies to innovatively improve the productivity or nutritious value of domestic feeds and technologies to produce stockbreeding goods, such as high-quality meats using domestic feeds; and 3) starting in FY 2007, the ministry worked on the development of low-cost cultivation techniques using IT, which will achieve dispersion of labor and drastic improvement in productivity, which are important problems

for scale expansion.

b) R&D concerning guarantee of safe foods/food products and consumer trust

With the outbreak of various incidents that threaten food safety and the enactment of the Basic Act on Nutritional Education [literal translation] (Act No. 63 of 2005), people are highly concerned with food or nutrition, and the guarantee of trusted and safe food products has become an important issue to be addressed. Under such circumstances, to expand and enhance food safety measures and to improve the technologies required to control food sanitation, MHLW promotes research on new factors that may cause damage, investigative research to formulate standards and criteria, and research and development for establishing an official method of examination with regard to additives, pollutants, chemical substances, residual pesticides, microorganisms, bovine spongiform encephalopathy (BSE), health products, and products derived from modern biotechnology and which reflects the achievements in risk control measures.

On the other hand, MAFF worked to develop basic technologies for the elucidation and diagnosis of the properties of prion proteins to control BSE to enhance the basic diagnostic and preventive technologies that will help eliminate fear and reduce the impact on the stockbreeding industry if and when such a disease ever breaks out, and to enhance the technologies to detect and reduce harmful microbes. Furthermore, the ministry is now working on the development projects and the technology to prevent tampering with food labels and methods of assessing the functionality of entire foods through nutrigenomics.

6) S&T for the utilization of biological functions for the production of materials and improvement of the environment

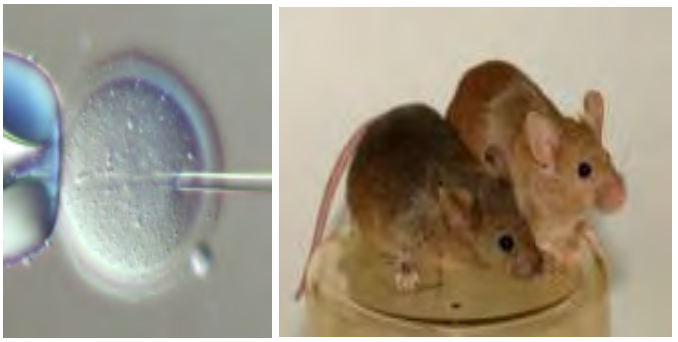
MAFF is involved in the development of technologies to reduce the use of chemical fertilizers and other agrichemicals by using organism functions and methods for assessing characteristics of soil organisms using eDNA (environmental DNA). METI develops technologies for producing substances with high add-on value, including highly functional proteins in closed systems; producing useful substances, such as industrial raw materials by utilizing plant functions and microbial functions in projects supported by NEDO; and highly efficient bioprocessing of industry drainage by controlling the microbial community.

(4) Challenges in developing institutional infrastructure

7) Development of life sciences infrastructure with the highest international standards

a) Preparation of bioresources

The field of bioresources is not limited to the mere preservation of genetic resources, but also plays an important role in exploring new areas of research. The national interest is served in the development, collection, storage, and provision of bioresources.



Mice (right) **that were born through micro-insemination using sperm from individual organisms refrigerated (-20 degrees) for 15 years**
Photo: RIKEN

In FY 2002, MEXT instituted the National BioResource Project for the purpose of establishing a system facilitating the systematic collection, storage, and provision of bioresources that are of particular strategic importance to the nation, such as experimental animals and plants (such as mouse clones), various cells, and genetic data from various life forms.

MAFF collects, preserves, and provides biogenetic resources related to the agriculture, forestry,

and fisheries industries through the Genebank Project, and the ministry also organizes, preserves, and provides rice genome resources.

Through the National Institute of Technology and Evaluation (NITE), which is a central agency for biogenetic resources (particularly of microbes) in Japan, METI not only does search, collection, and preservation of these biogenetic resources but organizes information concerning the resources (placing them systematically, information on base sequences, information concerning genes, etc.), provides services for R&D and commercialization. The ministry is also actively involved in coordinating biogenetic resources in Asia through various means such as signing a bilateral agreement with another Asian country based on the Convention on Biological Diversity (CBD) and founding a multi-national cooperative body (Asian Consortium) toward the preservation of microbe resources and their continuously maintained use. For unknown microbes such as those difficult to cultivate, through NEDO, the ministry develops technologies for collecting and preserving them; collects biogenetic resources and analyzes their functions for these microbes; and builds a biogenetic resources library based on genome information.

b) Promotion of bioinformatics

Recent advances in life sciences research have produced a massive amount of information like DNA base sequence data, 3D-structure data of proteins, and data concerning the emerging of genes. As a means to use databases containing these data effectively, it is critical to promote bioinformatics, a field created by fusing comprehensive database organization of life information together with life sciences and IT (information technology).

In FY 2006, MEXT began the Integrated Database Project to improve the usability of life sciences relational databases of Japan, encouraging the integration of its databases. The Institute for Bioinformatics Research and Development (BIRD) at the Japan Science and Technology Agency (JST) is actively engaged in the advancement, standardization, and expansion of databases, as well as in the development of genome analysis tools. The ministry also promotes the development of life sciences databases, including the DNA Data Bank of Japan, one of the three largest databases of its kind in the world, under the operation of the National Institute of Genetics (NIG).

MHLW collects and preserves human and animal-derived cultured cells and genes needed for use in research in medical and pharmaceutical fields. The ministry also collects and preserves medical plants and provides them for researchers, while breeding and supplying crab-eating macaques and other animals used for medical testing. Additionally, in FY 2007, the ministry implemented the "bio-resources research" to enhance bio-resources related to diseases.

In order to provide information on genomes and genes of agricultural and marine products, including rice, silkworms, and pigs, to researchers at universities and private-sector companies involved in the Agriculture, Forestry and Fisheries-related Genomic Information Integrated Database project, MAFF establishes a database that integrates the above-stated information (see Part 2, Chapter 3, Section 3, 2).

METI builds and renews useful and comprehensive databases of human genes, which includes the various annotations of gene function and relation with disease, and develops software for automatic, extraction and prediction corresponding to the internationally rapid increase of the information on human genes.

(Measures for appropriate ways to conduct animal experiments)

In June 2005, the Act on Welfare and Management of Animals was revised as a lawmaker-initiated legislation, and its Article 41 clarified the concept of 3R (Replacement, Reduction, Refinement) concerning animal experiments. The Act distinguishes experimental animals and animal experiments; for experimental animals, the Minister of the Environment is to determine the standards, which was disclosed as a public notice on April 28, 2006 as Standards Relating to the Care and Management of Laboratory Animals and Relief of Pain (Care and Management Standards). MEXT, MHLW, and MAFF established integrated basic policies for research institutions under their jurisdictions, promoting

appropriate ways to conduct animal experiments based on these guidelines.

(Efforts for bioethical issues)

Rapid development in the life sciences has raised expectations on innovation in medicine and other fields, but may also have brought about new bioethical problems with respect to human dignity and rights. In order to cope with these issues appropriately, CSTP's Expert Panel on Bioethics has been engaged in surveys and examinations of fundamental issues concerning bioethics, while MEXT, MHLW and other ministries are in charge of relevant laws and regulations, and guidelines and conducting other activities concerned.

Regarding human cloning technology, MEXT took measures prohibiting the production of human clone individuals under the Act on Regulation of Human Cloning Techniques (Act No. 146 of 2000) and prohibiting the creation and utilization of human somatic cell nuclear transfer embryo (SCNT) for the time being under the guidelines based on the Act.

In July 2004, CSTP issued the opinion on how to handle human fertilized embryos and human SCNT, entitled Basic Policy on the Handling of Human Embryos which is to regulate the creation and use of human fertilized embryos for research purposes and establish a framework to ensure the appropriateness of relevant research. In response, MEXT finalized the basic concept in February 2008 concerning the handling of cloned human embryos under the leadership of the Bioethics and Biosafety Commission of CST. Furthermore, regarding the handling of fertilized human embryos, MEXT and MHLW study the issue in close cooperation between the two ministries, such as holding joint committees. In addition, regarding human embryonic stem cells, MEXT implements investigations of research plans based on the guidelines formulated in FY 2001, and the ministry has confirmed compatibility with the guidelines of two establishment plans and 44 use plans (out of which five plans were concluded) (as of end of January 2008).

The Science Council of Japan (SCJ) established the Study Committee on Approaches to Assisted Reproduction Technologies [literal translation] on December 21, 2006, following requests from the Minister of Justice and the Minister of MHLW to have discussions from every viewpoint concerning issues related to the assisted reproduction technology, focusing on surrogate conception. SCJ implements studies on organizing of discussions in the past and approaches in the future concerning the assisted reproduction technologies in the Committee.

In the areas of human genome and gene sequencing research, epidemiological research, and clinical research, MEXT, MHLW and METI cooperate with each other for the promotion of that research based on the guidelines in order to ensure respect for human dignity and appropriate management of personal information.

(Efforts to ensure safety in life sciences)

Recombinant DNA technology is applied to a broad range of fields, from basic biological research to the production of pharmaceuticals and improvement of agricultural crops, however, it also has characteristics to add new properties to living organisms. For this reason, the appropriate use of living modified organisms has been ensued based on the Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Act No. 97 of 2003), which stipulates the measures necessary to prevent adverse effects on biodiversity due to the utilization of living modified organisms. Written warnings or briefing sessions have been conducted on some organizations that illegally utilized living modified organisms after the Act was enforced, with an aim to ensure thorough compliance with laws and regulations.

For clinical research aimed at the establishment of gene therapy, MEXT and MHLW are making efforts for the appropriate promotion of research based on the Guidelines for Gene Therapy Clinical Research, jointly formulated by the two ministries.

The major research issues in life sciences field in FY 2007 are shown in Table 2-2-1.

Table 2-2-1 Major Research Projects in Life Sciences (FY 2007)

Ministry	Research organization	Subject
Cabinet Office		• Research for evaluation technology of impacts on food and health
Ministry of Finance	National Research Institute of Brewing	• R&D work related to life science
Ministry of Education, Culture,Sports ,Science and Technology		• Target protein research program • Promotion of genome function analysis, etc. • Project for cell/living-body function simulation • Program for promotion of bridging research • Project for realization of medical care according to genetic information of individuals • Project for realization of regeneration medicine • Project for formation of emerging/reemerging infectious disease research centers • Molecular imaging research program • Promotion of research toward development of innovative cancer treatment method • Integrated database project • National BioResource Project
	RIKEN	• Project for comprehensive brain science research • Project for comprehensive genome science research • Project for plant science research • Project for comprehensive developmental and regenerative science research • Project for comprehensive allergy and immunology research • Project for genetic polymorphism research • Project for molecular imaging research • Bio-resource project
	Japan Science and Technology Agency	• Promotion of Bioinformatics Centers
	National Institute of Radiological Sciences	• Research for upgrading heavy ion cancer therapy • Study on molecular imaging
Ministry of Health, Labour and Welfare		• Study on child's specified chronic diseases • Medical expenses for patients having specified disease • Subsidy to Radiation Effects Research Foundation • Expenses for investigation commission of persons impaired by poison gas
Ministry of Agriculture, Forestry and Fisheries		• Breeding and integrated research toward enhancing consumption of domestic farm products in food service industry • Integrated research for developing Japanese-style forage feeding system to increase forage self-support ratio • Development of technology for reducing the impact on the environment using biofunction • Development of technologies for the suppression of Bovine Spongiform Encephalopathy (BSE), and diseases shared by humans and animals • Development of safe and secure manufacturing technologies for animal products • Development of the seed production technology in the Japanese eel and spiny lobster • Development of technology to analyze the characteristics of soil organisms by understanding of soil microflora • Comprehensive promotion of agricultural genome research • Assurance of Safe Use of Genetically Modified Organisms • Development of evaluation and management techniques for supplies of safe, reliable, and highly functional foods and agricultural goods • Development of new production systems utilizing IT, etc. which contribute to development of leaders • Creation of an integrated database of genome information on agricultural, forestry, and fisheries products • Research on the implementation and commercialization of agri-bio technology
	National Institute of Agrobiological Sciences	• Gene bank project

Ministry of Economy, Trade and Industry	METI, New Energy and Industrial Technology Development Organization	• Development of technologies to promote bridging of basic research to clinical research • Development of basic bio-technology to support faster creation of genome-based medicines • Development of fundamental technologies for analyzing protein structure toward acceleration of drug discovery • Development of technology for creating anti-body medicines with new functions • Development of technology to apply sugar-chain functions • Development of diagnostic technologies through fusion with biometric diagnosis toward realization of individualized medical practice • Functional RNA project • Genome information integrated project • R&D project for intelligent surgical instruments • Developing basic technology for high-quality manufacturing using plant functions • Development of sustainable manufacturing infrastructure utilizing microbial processes

2 Information and Communications

Information and communications technology are changing a wide range of socio-economic activities in a revolutionary way, not just in the industry but also in our daily lives, through means such as the implementation and widespread use of electronic government, working at home, remote medical practice, and distance education. This technology is becoming a critical foundation for the people to live in a safe and secure way. Further, mid- to long-range investment with emphases on those information and communications technologies in which Japan is leading internationally will lead to enhancement in S&T, academic research, and the industrial competitiveness of Japan.

The government's involvement in the general field of information and communications is spelled out in the New IT Reform Strategy (January 2006) and Priority Policy Program 2007 (July 2007) at the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters). The goal is to "realize ubiquitous and universal network society where everyone can enjoy the benefits of IT."

The Ministry of Internal Affairs and Communications (MIC) plans to promote R&D in an intensive and strategic manner, based on the UNS Strategic Programs (Telecommunications Council recommendation: July 2005), which specifies the directions of R&D to be emphatically promoted as well as the Sectoral Promotion strategy, and other guidelines.

Following the Strategy in the field of information and communications, MEXT promotes R&D to be implemented with emphasis based on the promotion guidelines for research and technology concerning information science and technology, which was finalized in July 2006. METI finalized on the other hand the innovation promotion measures to be implemented by METI with emphasis in the Industrial Structure Council in April 2007.

Below, major guidelines for each ministry and agency are summarized under the seven essential R&D issues in the Strategy.

(1) Network domain

In order to construct next-generation network technology which enables us to communicate a massive amount of information instantly and which anyone can use comfortably and conveniently, MIC carries out a variety of research projects including the following: basic technology R&D necessary for the construction of an all-packet-type, highly functional network; R&D to address the explosive increase in the Internet traffic and to strengthen the information-communication infrastructure; all-optical networks that can stably control, with extremely low power consumption, communication traffic which will have increased even more in 10 years; advanced technologies for sharing the use of radio waves through multiple radio systems; and R&D related to technologies that will make it easy to

construct wireless systems in unused frequency bands.

METI implements R&D of highly-efficient network device technologies where electronic and optical technologies are utilized.

(2) Ubiquitous network (RFID tag) domain

MIC, with the goal of achieving a ubiquitous network society in which access is available "anytime, anywhere, by anything and by anyone" is working on developing the technology which will, using many terminals (RFID tags, sensors, information household appliances, etc.), connect people to people, people to things, and things to things with information so that networks can be used conveniently and safely. For example, the project Research and Development of Ubiquitous Network, R&D are under way for necessary basic technologies such as Ultra-tiny Chip Networking, Ubiquitous Network Authentication and Agent Technology, and Ubiquitous Network Control and Management.

Observing the reality of the ubiquitous society, MEXT promotes R&D projects that will establish basic technologies necessary for us to use information with high add-on value safely and instantly through RFID tags.

METI promotes international standardization of related standards for RFID tags and has developed technology concerning price-reduction, called Hibiki Project (five yen per unit, assuming 100 million units produced monthly). Furthermore, to satisfy both of privacy protection of consumers and use in the secondary distribution, maintenance and recycling areas, the ministry developed technologies for RFID tags for which security functions are strengthened (Secure RFID Project) to promote the use of RFID tags in a growing number of industries.

The Ministry of Land, Infrastructure and Transport (MLIT), to promote the Free Mobility Project, promoted the formulation of public-private rules in data items and service provision required for route guidance intended for practical use, and the ministry implemented demonstration tests at eight locations in the country.

The Cabinet Office promotes collaboration with ministries and agencies according to the above-stated guidelines, focusing on the RFID tag technology as the Ubiquitous Networks of the Coordination Program of Science and Technology Projects. The Office also promotes, through the Science and Technology Promotion Adjustment Expenses, use in the medical field and the complementary challenge involving measurement and safety and security.

(3) Device/display domain

MEXT implements the development of an innovative spin device[fn.1] and basic technologies for large-capacity, high-speed storage required for realizing high-function and ultra low-power consumption computing. METI developed a variety of different technologies. In the semiconductor technology area, the ministry developed miniaturization technologies for a 45-nanometer or smaller technology node (processing/material technology, exposure system technology, design technology, and masking technology), technology for next-generation memory with a nonvolatile function, and application chip technology that will lead to reduced power consumption in information household appliances. In addition, the ministry sponsored the fundamental technology R&D for large-scale next-generation display panels with low power consumption.

(4) Security and software domain

MIC sponsored R&D of technology to prevent information leaks and the technologies for detecting, mitigating, and preventing BGP prefix hijacking. METI develops voice recognition technologies directly linked to consumer convenience under a project for the Development of Technologies to Use Information Household Appliance Sensors and Human Interface Devices [literal

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fn.1 A spin device utilizes the property of the electric charge of electrons and the property of spin (magnet property) that electrons have.

translation], establishes the environment where devices can be interfaced beyond different manufacturers, and then promotes the dissemination of achievements of the development. Furthermore, the ministry is working on the research and practice of software engineering to improve the reliability and productivity of information system software and promotes the development of highly reliable built-in software by utilizing these methods. The ministry also established the environment in which open-source software (OSS) can be used safely.

The both ministries carry out development and trial operation of a bot trapping / analyzing system. In addition, they carry out the development of technology for preventing damage caused by new types of threats to information security, and technology for minimizing the damage in the case where any has occurred. Further, they conduct research for ensuring information security, which is deeply involved with the people's lives and socioeconomic activities, and research on management techniques for developing an environment that enables people to use IT with a sense of security.

(5) Human interfaces and contents domain

MIC implements R&D technologies to support the production and distribution of next-generation image content under a content creation technologies and information utilizing technologies that enable us to share emotion with people all over the world. In FY 2007, the ministry demonstrated branch delivery of coded image streams to 1,000 assumed locations and real-time decoding of encrypted 4K images at the distribution destinations. Furthermore, toward realization of voice communication technology that overcomes language barriers, which is one of the Pioneering Projects for Accelerating Social Return, the ministry is working on R&D of voice translation technologies. The ministry also implements R&D of information analysis technologies (R&D of information believability validation technologies in telecommunications services [literal translation]) to provide reliable information and validate believability of information among various types of information available on networks.

MEXT implements development of super-giant database infrastructure software that enables management and utilization of super-giant data required for sensor network information analysis and distribution history management in an age where information is exploding.

METI implements the development of next-generation information search and analysis technologies for easy-to-use, accurate search and analysis of required information among large amounts of information that exist elsewhere other than on the Internet (Information Grand Voyage Project).

The Cabinet Office promotes a Coordination Program of Science and Technology Projects for the Very Large Information Integration and Application Platform in cooperation with MIC, MEXT and METI, and also promotes the development of technologies for content and knowledge processing in the next-generation information environment [literal translation] through the Special Coordination Funds for Promoting Science and Technology.

(6) Robot domain

MIC is involved in R&D toward creating robots that can provide services like life support and welfare/caretaking support; this is done by linking various types of robots with versatile sensors and devices via a network to further improve the single-function robot.

METI creates validating units for the purpose of developing safety technologies and ways to assure safety, as well as for developing technologies for implementation, to actually introduce and operate service robots such as cleaning robots and transporting robots. Furthermore, the ministry carries out development, with realistic uses in mind, in the fields of next-generation industrial robots, service robots, and special environmental work robots. Furthermore, the ministry develops intelligence technologies that perform different types of work without fail under the rapidly changing environment of production engineering and the living environment, and implements demonstration tests.

RIKEN implements the R&D of life support robots by establishing a cooperation center jointly with Tokai Rubber Industries, Ltd. Under the above-stated measures, the Cabinet Office promotes one

of the Coordination Program of Science and Technology Projects as the Establishment of Common Platform Technology for Next Generation Robots and conducts some projects, such as the structuring environmental information project funded by the Special Coordination Funds for Promoting Science and Technology as a complementary project.

(7) R&D platform domain

As a Key Technologies of National Importance (Strategic prioritized S&T: The world's highest level next-generation supercomputer), MEXT promotes the project Development and Use of an Advanced, High-Performance, General-Purpose Supercomputer so that Japan maintains world-leading positions in a wide range of areas such as science and technology, academic research, industry and medicine.

(8) Miscellaneous

As a strategic prioritized S&T, MEXT promotes programs such as the Leading IT Specialist Training Promotion Program, toward the formation of a central location where a graduate school can train human resources who will, as IT personnel with the highest standard in the world, address the changes in social circumstances with flexibility and foresight and play leading roles in companies and other organizations.

Main research topics in the field of information and communications in FY 2007 are shown in Table 2-2-2.

Table 2-2-2 Major Research Projects in Information and Communications (FY 2007)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications		• Research and development concerning next-generation backbones • Research and development on ultra functional network technologies utilizing nanotechnology • Research and development on element technology toward high-level uses of frequencies in mobile communication systems • Research and development on basic technologies toward promoting a transition of wireless systems to unused frequency bands • Research and development on ubiquitous sensor network technology • Research and development for Sophisticated Use of RFID • Research and development on Asia's ubiquitous platform technologies • Research and development on ubiquitous network technologies • Research and development on technologies for high-level usage of information household appliances • A trial to stop Cyber Attacks, such as spam, phishing • Research and development on detection, recovery, and prevention of path hijacking • Research and development of technologies for preventing information leaks • Research and development on the next-generation-type of image contents production and distribution support technology • Comprehensive research and development into network human interface technologies
	National Institute of Information and Communications Technology	• Research and development on basic technologies for next-generation networks • Research and development on photonic network technologies • Research and development of dynamic network technologies • Research and development concerning information believability validation technology in telecommunication services
Ministry of Education, Culture, Sports, Science and Technology		• Development and use of the next-generation supercomputer (development and use of the latest highly functional super computers) • Leading IT specialist training promotion program • Research and development of device/system core technology for high-function and ultra low power consumption computing • Development of ultra high-performance database core software based on the innovative execution principle • Development and dissemination of visualization technology of software development status • Research and development project of elemental technology for super computing of the future • Research and development project for innovative simulation software • Research and development project of fundamental technology for supporting a safe ubiquitous society
	RIKEN	• Study on biomimetics control
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization	• Development of technologies for robot-harvesting fruits and vegetables
Ministry of Economy, Trade and Industry		• (1) Actual implementation of industry-academia collaborative software engineering, listed under the coordination of industry-academia collaborative software engineering center • Task of supporting the creation of a service robot market • Developing technologies using information household appliance sensors and human interface devices • Secure platform project • Development of the next-generation information search and analysis technologies (Information Grand Voyage Project)
	New Energy and Industrial Technology	• MIRAI project • Development of an Extreme Ultraviolet (EUV) exposure system

	Development Organization	• Developing technologies for next-generation process-friendly designing • Semiconductor application chip project • Spintronics nonvolatile function technology project Spintronics nonvolatile function technology • Development of core technology for the next-generation, large-size, low-power consumption display • Development of the next-generation high-efficiency network device technology • Development of the next-generation robot intelligence technology • Project for development of the next-generation robot common infrastructure • Project for practical use of human support type of robots • Project to develop element technologies for strategic, cutting-edge robots
	Information Technology Promotion Agency	• Task of creating an early warning system for computer security • Taking security measures for corporate and private information • (2) central location for industry-academia collaborative software engineering, listed under the coordination of industry-academia collaborative software engineering center • Creating the basis of open-source software applications
Ministry of Land, Infrastructure and Transport		• Autonomous moving support project • Developing IT execution systems via robots, etc. • Study on unmanned work, inspection, and diagnosis by using subsea robots

3 Environment Field

The environment field is an essential area of science for preserving the natural environment, including ecological systems with diverse forms of life, for maintaining human health and preserving the living environment, and for maintaining the platforms for the future survival of mankind. The Third Science and Technology Basic Plan places priority on the environment. In the G8 Heiligendamm Summit in 2007, it was agreed to seriously study reductions in greenhouse gas emissions of at least by 50% throughout the world by 2050. Under the present situation that reduction in the greenhouse gas emission is one of the major agenda in the G8 Hokkaido Toyako Summit to be held in July 2008 and is a panhuman issue, Japan had divided the environmental fields into six research areas and is working on the measures detailed below:

(1) Research area related to climate change

(Observation of tropospherical changes due to small amount of greenhouse gas and other causes)

MEXT implements observational studies and technology development in order to establish a system to observe changes in atmospheric composition of minor components included in the atmosphere (nitrogen dioxide, ozone, etc.) and aerosol in the troposphere, about which there are uncertainties regarding environment preservation measures and climate

(Resolving the response process in continental areas and ocean that is related to climate change)

MEXT develops advanced observational equipment for carbon dioxide in the marine surface layer, ocean water and the atmosphere (low-priced unmanned observational equipment of small size and high durability, or simple and highly precise automatic measuring equipment that can be introduced in a large number of ships), in order to resolve the circulation mechanism of greenhouse effect substances including carbon dioxide in the ocean and other places, and make future predictions thereof. The ministry also verifies the precision of observational equipment and enhances the observation network.

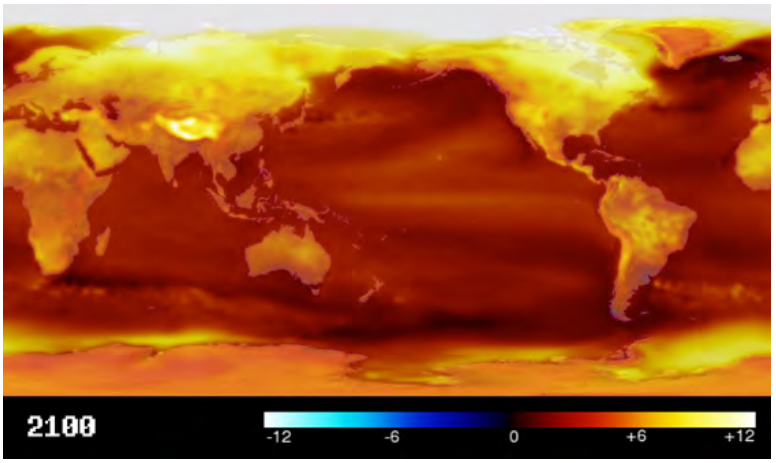
Japanese Antarctic Research Programs are centered at the National Institute of Polar Research, affiliated to the Headquarters for Japanese Antarctic Research Expedition (JARE) (Chairman: Minister of MEXT), and are operated in cooperation with relevant government agencies. In FY 2007, JARE 48 and 49 teams carried out routine observations of atmospheric phenomena, ozone, etc. around Showa Station, and also performed monitoring observations, etc., for the purpose of bringing to light environmental changes on a global scale. In particular, it executed research on the global environmental system in the aspect of cross-interactions in the space-atmosphere-ocean in the polar area.

MAFF has been working on the development of a carbon cycling model for forest and farmland that is conducive to the promotion of countermeasures against global warming.

(Climate change projection in the 21st century using climate model)

As a strategic prioritized S&T, MEXT promoted the implementation of global warming/climate change prediction experiments and the development of climate models by using the Earth Simulator, one of the world's most powerful supercomputers, possessed by Japan, under the Project for Sustainable Coexistence of Human, Nature and the Earth. Through this, development of unprecedented high-resolution models and the variations of models through experimental reproduction of climate were achieved. Also, various prediction experiments based on the greenhouse gas increase scenario by the Intergovernmental Panel on Climate Change (IPCC) were conducted, contributing in the preparation of the Fourth Assessment Report by IPCC, published in 2007, in terms of the prediction of changes in ocean circulation and precipitation phenomena (including seasonal rain fronts and typhoons) due to global warming. Starting in FY 2007, the ministry promoted research and development of climate change prediction in the Innovative Program of Climate Change Projection for the 21st Century for achievement of contributions to the fifth report. Furthermore, in order to adequately cope with issues such as climate change, water resource management, agriculture and other social problems that human society is currently facing, MEXT promotes the establishment of the Data Integration and Analysis System (DIAS), aimed to integrate and analyze various data obtained by satellite, numerical model and *in-situ* observations to create and provide useful information for policy makers and researchers.

In addition, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) promotes global environmental predictions and climate change predictions. As a strategic prioritized S&T, JAMSTEC implements basic studies for elucidation of the global environment fluctuation mechanism and realization of future predictions. Furthermore, the ministry promotes stable and efficient operation of the Earth Simulator by JAMSTEC. At the same time, it implements research and development for technology to improve the precision and speed of simulation using the Earth Simulator and technology to predict global environmental changes using the simulation, as a strategic prioritized S&T.



Global Warming Prediction in 2100
Photo: Center for Climate System Research, The University of Tokyo / National Institute for Environmental Studies / Frontier Research for Global Change, Japan Agency for Marine-Earth Science and Technology

(Monitoring of greenhouse gas and supracrustal environment using satellites)

Observation of greenhouse gas and supracrustal environment using satellites is being promoted as a strategic prioritized S&T. Because Earth observation by satellite is a highly effective means for observation that can collect various kinds of information extensively in a repeated and continuous manner, it is being promoted comprehensively under cooperation with related entities in and outside Japan, with the aim of solving environmental problems.

The Ministry of the Environment (ENV) is working jointly with the Japan Aerospace Exploration Agency (JAXA) and the National Institute for Environmental Studies (NIES) on the development of a greenhouse gas observation sensor to be installed on the Greenhouse Gases Observing Satellite (GOSAT), which is scheduled for launch in FY 2008. Furthermore, NIES promoted development of a system to process observational data of GOSAT (preparation of data processing/provision and validation of data quality).

JAXA continues to operate the Advanced Land Observing Satellite (ALOS) DAICHI, which was launched in January 2006 and implements demonstration tests for use concerning comprehension of vegetation and monitoring of forests in cooperation with related institutions. Furthermore, JAXA processes data acquired from the Precipitation Radar (PR) onboard NASA's Tropical Rainfall Measuring Mission (TRMM) satellite and the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) onboard Earth Observation Satellite (Aqua) and then provides data to researchers. Furthermore, JAXA implements research and development of the Global Change Observation Mission (GCOM), which observes the global environment with regard to climate change, hydrologic cycles, and vegetation.

(R&D and related measures for understanding phenomena on a global scale)

MIC implements development at the National Institute of Information and Communications Technology (NICT) of a differential absorption LIDAR (DIAL) for CO_2 remote sensing[fn.2] [fn.3]. Furthermore, the ministry implemented research and development on sensing network technology to

fn. 2 LIDAR (Light Detection and Ranging) is a system to measure the atmospheric status by transmitting laser beams into the atmosphere and observing scattering light from substances floating in the air.

fn. 3 Differential Absorption LIDAR (DIAL) measures the concentration of specified atmospheric components by simultaneously transmitting a light beam with a wavelength that is absorbed by specified atmospheric components and a light beam with a wavelength that is not absorbed and then comparing the intensity of the scattered light of the two beams.

resolve three-dimensional structures of the urban atmosphere, which also has a large impact on environmental changes in Asia and the entire world since FY 2006.

ENV promotes research studies conducive to preservation of the global environment, such as research on the destruction of the ozone layer and global warming, as well as observation necessary for countermeasures against global warming, from mid- and long-term perspectives.

(Earth Observation Technology Using Satellites)

NICT promotes the development of a Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) [fn.4] onboard the exposed facility of the Japanese Experiment Module (JEM: Japan Experiment Module, also known as Kibo) on the International Space Station. NICT also studies technology to enable the measurement of global environmental changes from space.

MAFF creates a database of imaging data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS), onboard NASA's global observing satellites Terra and Aqua, and makes it available on the Internet.

(2) Research area related to hydrological cycles and solute transport in watersheds

NICT developed a long range ocean radar, which realizes continuous long-term observation of the flow field of the Kuroshio Current, etc. at the shore and installed the radars at Ishigaki and Yonaguni Islands and observes the flow field of the Kuroshio Current south of the East China Sea.

MEXT establishes, in the Japan EOS Promotion Program, an oceanic research and observation network with international cooperation (including an moored buoy network) and a research and observation network using Doppler radars, as well as collecting observation data for atmospheric and oceanic fluctuation phenomena (including the Indian Ocean dipole mode phenomenon) and observational research in order to resolve the mechanism of the hydrological cycle and climate change in the Asian monsoon region. Furthermore, JAMSTEC establishes a global earth observation system to observe and collect data and information on water, thermal and material circulation with the regional and the global scale as a strategic prioritized S&T. JAMSTEC implements R&D to monitor changes in water circulation in global scale through in-situ observations and observations by utilizing satellites on atmosphere, oceans and land surfaces.

MEXT and the Ministry of Land, Infrastructure and Transport (MLIT) are working on establishment of integrated ocean observing system (ARGO Program), which deploys about 3,000 mid-depth floats to observe and report data on water temperatures and salinity by moving through the range from the sea surface to 2,000 meters deep throughout the world under the international cooperation to monitor the status of oceans around the world in real time. The number of the floats in service reached the target of 3,000 pieces in November 2007.

MLIT is working on the development of technologies, including land infrastructure technologies in accord with nature to implement development of reproduction and recovery technologies in the basin zone for comprehensive water circulation management, while taking the entire basin zone into consideration. The ministry is also working on research on elucidation of migratory mechanism of chemical substances in inner-bay deposition and comprehensive monitoring of the environment of inner bays, development of strategic stock management methods for housing and social capital, development of technology to reduce and recycle construction wastes, formation of waste flow systems to facilitate cyclical usage of resources, and research on collection of biomass energy from sewage sludge and animal manure.

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fn. 4 Superconducting Submillimeter Wave Limb Emission Sounder (SMILES) measures the amount of ozone by directing the antenna to the atmospheric limb and receiving submilimeter waves that are radiated by small amount of molecules in the air through the use of a high-sensitivity, low-noise receiver.

(3) Research area related to ecosystem management

ENV promotes research into the prediction of and countermeasures against the effects of a decrease in biodiversity. Furthermore, the ministry also promotes research in the fields including the field concerning preservation of sound ecological system and engagement with nature and the field concerning the maintenance and reproduction of a sound ecological system.

(4) Research area related to chemical risk and safety management

Chemical substances are used in various products, becoming more essential to people's lives. However, in order to sufficiently utilize their benefit, it is necessary to scientifically understand the risk and address it appropriately as well as to develop a society with a good sense of balancing risk and benefit. Survey, R&D as well as the formation of an intellectual foundation is currently being conducted mainly by relevant ministries for the development of risk evaluation/management methods for chemical substances, collection and provision of information on safety, as well as the development of testing/measurement methods necessary for them.

MAFF conducted elucidation of the dynamic state of the ecosystem in the area of agriculture, forestry and fisheries, development of evaluation methods for the impact on living organisms and ecosystems, and development of technology for dissolution and detoxification, for hazardous chemical substances.

METI promotes the establishment of methods and the development of an intellectual foundation in order to comprehensively manage risk evaluation for the entire life cycle of chemical substances under the Comprehensive Chemical Substance Assessment and Management Program, as well as the development of processes and methods that contribute to reducing the risk of hazardous chemical substances, and promotion of the establishment of an intellectual foundation. The ministry also promotes the development of technology related to the reduction and restraint of substances affecting the environment that is generated from industrial activities.

ENV promotes the R&D of methods for risk assessment test and measurement methods for chemical substances including the development of an intellectual foundation in order to contribute to countermeasures against environmental risks of chemical substances. ENV conducts surveys and research for related information and possible countermeasures on hazardous metal.

(5) Research area related 3R[fn.5] technologies

METI, while considering not only to R&D in the downstream sectors of recycling wastes, but to the 3Rs in the upstream sectors of expansion of product life and the design and manufacturing stages of energy-saving products, and implemented development projects for 3R-related technologies of rare metals and materials with innovative structures using high-tension steel that contribute to weight saving of construction components, both of which are indispensable for advanced manufacturing in the country

ENV promoted research that contributes to solving problems related to waste and building a recycle-based society. This research includes research for promoting the 3Rs, promoting the use of waste-derived biomass, social-scientific research for building a recycle-based society, research on waste control technology for safety and security including solution of asbestos problems, and research on a solution to drift wastes.

(6) Research area related to the biomass utilization technologies

As a strategic prioritized S&T, MEXT developed processing technology for detoxification disposal or recycling of wastes and biomass and implemented R&D on impact/safety assessment and social system design under a link-up between industry, academia, and government.

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fn. 5 Reduce, Reuse, Recycle

MAFF selectively implements the development of technologies related to methods to cultivate resource crops for the use of domestically produced biofuel and methods of low-cost cultivation of such crops, development of highly efficient biofuel production technologies, and the building of biomass-used models for comprehensively using biomass fuel and materials.

Since FY 2004, ENV started promoting the development of the practical use of basic global warming countermeasure technologies and prevention of global warming leading to commercialized products in a short period of time. Such projects include technology for comprehensive use of biomass, driving, and demonstration projects required for introduction of gasoline mixed with 10% bioethanol and technology for efficiently manufacturing hydrogen from wood biomass. Furthermore, the Cabinet Office, the Fire and Disaster Management Agency (FDMA), MAFF, METI, MLIT, and ENV implement demonstration projects where bioethanol is manufactured in Miyakojima, Okinawa, from sugarcane produced on the island where the residents actually use gasoline mixed with 3% ethanol.

(7) Other

ENV implements research on material cycling mechanisms and oceanic pollution caused by hazardous chemical substances in order to help preserve the global marine environment. SCJ established a committee on water, food, and sustainable society to study the issues from the viewpoint of building a society that will be sustainable into the future concerning the issues of water and foods, which are the foundation of mankind and have significant impacts on the global environment. Furthermore, the Council established an exploratory committee on global environmental issues caused by human activities, such as global warming, for cross-sectoral studies on subjects including scientific knowledge concerning climate change, impacts on ecologic system and socio-economic systems, and measures for mitigating climate change.

Major research subjects conducted during FY 2007 are as shown in Table 2-2-3.

Table 2-2-3 Major Research Projects in Environmental Sciences (FY 2007)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	Promotion of international information networks for conservation of the Earth's environment	• Research on measurement technology for global environmental changes • Research and development of technologies for the measurement of subtropical Earth environments • Research on global environment measurement and forecasting technology, using 3-D high-resolution imaging radar • Research on sensing network technology • Promotion of international information networks for conservation of the Earth's environment
	Fire and Disaster Management Agency	• Ensuring security corresponding to the utilization of new technology/materials
Ministry of Education, Culture, Sports, Science and Technology	Japan Agency for Marine-Earth Science and Technology, Japan Aerospace Exploration Agency, National Institute for Environmental Studies, universities, etc.	• Earth Observation and Ocean Exploration System • Research on global environment observation • Research on the prediction of global environmental changes • The Innovative Program of Climate Change Projection for the 21st Century • Plan for promoting the establishment of global observation system • Project for composite treatment and recycling of general/industrial waste and biomass
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization, National Institute for Agro-Environmental Sciences, Japan International Research Center for Agricultural Sciences, Forestry and Forest Products Research Institute, Fisheries Research Agency, etc.	• Development of biomass utilization technology for local revitalization • Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector • Development of comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystems • Assessment of the impact of global-scale change in water cycles on food production and alternative policy scenarios • Development of technology to predict/control population out break of marine life in relation to environmental change

Ministry of Economy, Trade and Industry		• R&D on architectural structure with new structural system using innovative structural materials • Project for development of alternate rare metal materials • Development of highly efficient recovery system of rare metals
	National Institute of Advanced Industrial Science and Technology	• Resolving the amount of the long-term absorption of carbon dioxide by the Pacific Ocean through data analysis of mid-deep seawater • Development of chemical substances and production technology using biomass as raw material • Preparation of detailed risk evaluation report of typical chemical substances
	New Energy and Industrial Technology Development Organization	• Regional biomass heat usage field test business • Development of methods for brief assessment of the hazardous property of oil refinery substances, etc. • Development of evaluation methods for the properties of nanoparticles • Development of risk trade-off analysis method aiming for optimum control of chemical substances • Development of hazard assessment by structure activity correlation method • Development of alternate technology for high-level lead soldering to promote the recycling of electric and electronic appliances
Ministry of Land, Infrastructure and Transport	Engineering Affairs Division	• Development of management technology for infrastructure and building stocks
	National Institute for Land and Infrastructure Management	• Research into supporting technology for energy conservation with better performance of existing residences • Wetland restoration project for urban area • Strategic planning and adaptive management on environment restoration in coastal zone • Research initiative with respect to achieving a more healthy water cycle in consort with regional activities
	Public Works Research Institute	• Development of recycling construction technology for building a material-cycle society • Development of the regional system for the cycling and usage of biomass, based on the joint biogas plant • Development of dam technology to preserve the natural environment • Development of technology to alleviate environmental risks in daily life • Development of technology to preserve/restore water ecosystems • Research on the intensive land use of coastal areas in cold regions • Development of designing technology for river basins and channels that coexists with the environment in the field of rivers in cold regions

	National Maritime Research Institute	• Research conducive to the prevention of marine pollution due to emission and effluence of oil and hazardous liquid from ships • Research conducive to the prevention of air pollution due to gas emission from ships
	Hydrographic and Oceanographic Department, Japan Coast Guard	• As part of activities of Hydrographic and Oceanographic department, geomorphological and geological surveys of sea bottoms for the detection of volcanic eruptions, and observations of water temperatures, ocean currents, waves, and other aspects of the Western Pacific ocean region
	Meteorological Research Institute, Meteorological Agency	• Comprehensive projection of climatic change around Japan due to global warming • Development and improvement of a materials circulation model and research on assessment of the effect on the global environment • Observational study of radiative process in the atmosphere
	Geographical Survey Institute	• Geodynamics by precise Earth measurement • Development of a correction model for seasonal variations observed in GPS coordinate time-series
	Port and Airport Research Institute	• Sea level rise monitoring by tidal level observation • Research on the changes in the characteristics of the emergence of tidal waves due to global warming • Research on geo-environment design technology for tidal mud flat regeneration • Study on elucidation, impact assessment and measures of migratory mechanism of harmful substances in coastal areas • Research on countermeasure technology against oil spill in coastal areas • Study on comprehensive environment monitoring and environment prediction models of inner bays
Ministry of the Environment	Global Environment Research Fund	• Study on detection of long-term changes in stratospheric processes and uncertainty assessment of prediction on ozone layer fluctuation factors • Multiphase and comprehensive assessment/prediction of mid- to long-term policy options toward society that exists from inducing global warming • Comprehensive research project on establishment of planning method • Comprehensive study on climate change scenario for supporting and disseminating policies related to global warming • Research on Sustainable Land Management in Atoll Island Countries • Study on feasibility of emission reduction estimation by avoiding forest reduction • Study on elucidation of transport/alteration of aerosol and precursor substances thereof from the Asian Continent • Study on vegetation in East Asia regarding risk assessment and impact prediction on agricultural products of ozone concentration rise • Study on the Ecological Deterioration of East Asian Marginal Seas due to the Anthropogenic Change in Effluent Nutrient Ratio • Comprehension of behaviors and early detection of settlement of marine organisms which make cross-border transfer through ballast water/adhesion on the body of large ships • Study on recovery of forest-soil cross-interaction systems and regeneration of tropical forest ecosystem • Study on impacts on life's diversity of alien species and impact mitigation thereof by taking a fragile oceanic island • Planning of sustainable spontaneous regeneration plans for release of Nipponia Nippon and social procedures thereof • Study on prevention of desertification and regeneration of ecosystem services in prairies of Northeast Asia • Proposal on package-type traffic measures based mainly on public traffic toward reduction in environmental burdens • Study on establishment of international agreement to deal with climate changes • Development of isotope/trace gas observation methods intended for assessment of separation of CO2 flux in ecosystems in continental areas • Study on fluctuation in iodine circulation in atmospheric air caused by artificial substances that give impacts to global warming

	Global Environment Research Coordination System	• Development of technologies for assessment of impacts caused by planting under CDM and prediction technologies thereof • Study on environmental impacts on oceanic material cycling by purposeful sequestration of CO2 in the ocean • Study on changes in emissive power of aerosol and elucidation of actual situation of the mechanism • Study on monitoring of impact detection of global warming by high-mountain ecosystems • Study on early detection and early prediction of global warming by utilizing Tibetan Plateau • Observation of greenhouse gas over Asia-Pacific region utilizing commercial aircraft • Long-term multi-component observation of small amount of greenhouse gases in the Asian and Oceanian regions
	Environmental Technology Development Fund	• Establishment of the common environment monitoring system and advanced database for ecosystems of forests, grass fields and lakes • Development of automatic enumeration system of asbestos in the air by using phase-contrast microscope • Research on environmental risk evaluation method for compound soil contamination caused by mineral oil and others • Research on the development of evaluation methods for the impact of chemical substances on the ecosystem based on genomics
	Environment Waste Management Research Grant	• Research on the technology system vision and diversion strategy in material-cycle society in the near future • Research on waste/resource management strategy through the establishment of material stock account system and application thereof • Development of material flow simulator for environmental load evaluation in concrete industry and the establishment of optimization supporting system • Analysis of generation characteristics of hazardous substances in the disposal and recycling process of waste containing plastics and the development of efficient countermeasure methods • Upgrade recycling of chlorine plastic products by substitutional dechlorination and the collection of valuable metal • Persistent chemical substances in household products and 3R scenario analysis • Lifecycle comparison methods of different scenarios including overseas recycling and application to discarded plastics • Analysis of resource cycling system for discarded electric and electronic devices and discarded plastics in Asian region • Study on safety/security measures at waste disposal/recycling facilities • Development of social/technological systems for environmental regeneration of inadequate permanent disposal systems • Study on incineration treatment of low-concentration PCB-contaminated materials • Establishment of test methods to validate detoxication of wastes containing asbestos through decomposition treatment • Research on the possibility of producing charcoal dust fuel from waste biomass and method to remove hazardous substances from it • Proposal of systems for recycling of coast driftwoods

	Technology Development Business for Global Warming Countermeasures	• Technology development for the practical use of biomass ethanol production process through enzyme method • Development of the production process of ethanol for fuel from molasses produced in Okinawa and demonstration experiment including E3 • Establishment of G hydrogen model society in Honjo and Waseda areas • Technology development and demonstration business for Academic City East Hiroshima Model related to the introduction of urban biomass energy technology • Practical use of on-site energy conversion system for urban organic waste by supercritical water • Development of woody biomass utilization technology aimed for CO2-free society and the establishment of Yakushima Model for renewable energy fusing system • Development of technology to produce woody biocoke by Pyrocoking technology and system to apply to SOFC power generation • Development of household and industrial charcoal dust combustion equipment for biomass charcoal dust network • Development of system for higher-yield production of bioethanol from plant-derived cellulose and low-cost production thereof • Development of technology concerning biofuel production through integrated/energy-saving enzyme method in southern part of Hyogo Prefecture • Development of technology on production of green methanol for carbon-free BDF and advanced utilization of the byproducts. • Project for technology development and demonstration for introduction of biomass-derived fuel for transportation • Development of technology concerning ultrasonic condensation for reduction in energy cost for bioethanol production • Development of technology concerning application to automotives and distribution of bioethanol-mixed automotive fuels for expanded demand in cold districts • Development of technology concerning bio-hydrogenation/gasification of waste foods • Project for promoting establishment of large-scale bioethanol production centers by using sweet corn for resource-oriented use • Project for demonstration of the global warming prevention initiative in urban renewal/industrial area of coastal areas by using technology for manufacturing high-efficiency, thermally-decomposable bio-oil
	Research Funding for the National Research Institute engaged in Environmental Pollution Research	• Production cost of observational research equipment equipped on satellites
	Survey and Research Funds for the National Organization for Pollution Prevention	• Research on comprehensive management methods conducive to unified preservation of ocean and land
	Environmental Management Bureau	• Investigative research on the biological effect of environment nanoparticles
	Environmental Health Department	• Research on the actual state of POPs contamination • Basic research for hazardous heavy metal countermeasure strategy • Provision of information on hazardous property classification, label investigation and label information of chemical substances

4 Nanotechnology and Materials

The nanotechnology and materials field contributes in the S&T progress and problem solving in fields such as life sciences, information and communications, environment. It forms important technology seeds that realize the development of industry, affluent lives for people and safe, assuring and comfortable society.

(1) Nanoelectronics area

MEXT promotes the development of logic devices that break the limitation of silicon devices, information memory with 100-fold memory density compared to conventional products, and element technologies for the next-generation electron microscopes. Furthermore, the ministry develops information communication materials utilizing nanotechnology at the National Institute for Materials Science (NIMS). METI develops nanoelectronics technology base on the operating principle of near-field optics to realize optical devices including low-loss and high-function polarization control components.

(2) Bionanotechnology and biomaterial area

MEXT establishes bases for bionanotechnology research open to the world and develops biomaterials for artificial bones and livers. Furthermore, NIMS develops biomaterials utilizing nanotechnology. MAFF is working on the development of processing and assessment technologies for developing new food materials by utilizing nanotechnologies. ENV implements the development of technology for the supersensitive and prompt detection of hazardous chemical substances by artificial tissue-nanodevice sensor complex.

(3) Materials area

As a strategic prioritized S&T, FDMA develops components to utilize nanotechnology materials for firefighting clothing. The Agency also implements research on the evaluation methods of the performance functions such as heat resistance.

MEXT promotes the Strategy for Rare Elements to develop innovative catalysts with structural design and control at the nano-scale and to develop technologies for scientifically elucidating roles of elements that determine the characteristics and functions of substances and materials for ensuring replacement and reduction in the use of rare elements. Furthermore, the ministry promotes R&D on the sophistication of environmental and energy materials, as well as R&D of materials with high reliability and safety at NIMS.

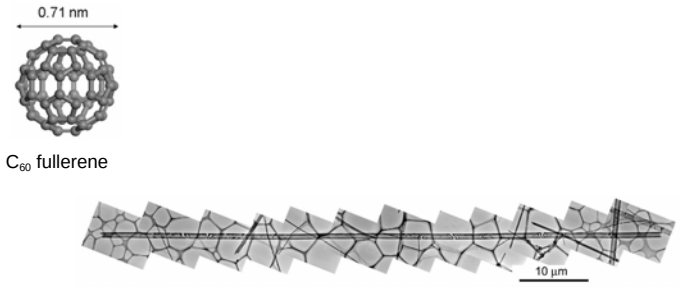
METI develops fundamental processing technologies related to welding and forging technologies for tissue control at the nano-scale to ensure further reliability, higher strength, and weight saving to take advantage of high-class steel products that are structure-controlled at the nano-levels.

ENV implements the development of environmental technologies that make use of the nanotechnology merits of miniaturization and improved function.

(4) Area of promotion basis for nanotechnology/material fields

MEXT promotes the Utilization of X-ray Free Electron Lasers, which enables instant measurement and analysis of ultra-fine structure to a substance to single-atom levels and ultra high-speed dynamic state and changes in chemical reactions. Furthermore, the ministry promotes commoditizing of state-of-the-art research facilities and equipment owned by research institutions, such as universities and independent administrative institutions, through the Open Advanced Facilities Initiative for Innovation (Nanotechnology Network) to promote fusion of fields, thus creating achievements that will lead to innovation.

In addition, the ministry



Transmission electron microscope image of C60 nanotube

Synthesis of fullerene nanotubes at a normal temperature became successful by using simple apparatuses. Fullerene nanotubes are expected for various applications as organic semiconductors, material for electrodes of various battery cells, material for catalysts, material for composite materials, etc.

Photo: National Institute for Materials Science

implements research and development based on mid- and long-range outlooks under the close cooperation of researchers, through the Virtual Laboratory in Nanotechnology Areas, in the JST Basic Research Programs.

METI promotes the project Research and Development of Nanodevices for Practical Utilization of Nanotechnology to strengthen the collaboration between upstream and downstream industries in order to improve technical capabilities and the international competitiveness of industries in Japan.

(5) Nanoscience/material science area

MEXT implements basic/fundamental research at RIKEN regarding control and creation of nano-level physicality and functions, technological renovation of electronic materials by using cross-correlation of electrons, and basic and fundamental research on nano-scale structure observation using light. Moreover, the ministry implements basic research over a wide range of fields at universities and independent administrative institutions.

Major research subjects conducted during FY 2007 for the nanotechnology/materials field are as shown in Table 2-2-4.

Table 2-2-4 Major Research Projects in Nanotechnology/Materials (FY 2007)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology, etc.	• Research and development of ultra functional network technologies utilizing nanotechnology • Research and development related to nano-ICT Ministry of Internal Affairs and Communications
	National Research Institute of Fire and Disaster	• Research on the development of material elements for firefighting clothing using nanotechnology and evaluation methods thereof
Ministry of Education, Culture, Sports, Science and Technology	Promotion of Novel Interdisciplinary Fields Based on Nanotechnology and Materials	• Strategy for Rare Elements • Development of processing device based on non-silicon device materials • Development of memory devices for ultrahigh density information • Founding biotechnology research centers • Development of environmental functional catalyst based on nanotechnology • Development of microstructure-controlled materials
	Research and Development Project for Economic Revitalization (Leading Project)	• Development of devices with new principles utilizing nanotechnology • Development of artificial organs utilizing nanotechnology • Development of ultrasensitive NMR (nuclear magnetic resonance apparatus) • Practical development of nano-measurement/processing technologies • Practical use of manufacturing technology for advanced semiconductors, including the development of extreme ultraviolet (EUV) light source • Next generation fuel cell project • Development of element technologies for the next-generation electron microscopes
		• Project for creation of innovations for advanced research facilities (Nanotechnology Network)
	National Institute for Material Science	• Development of common fundamental areas in the nanotechnology field • Creation and nanostructure control of nano-scale new materials • Development of information and communication materials utilizing nanotechnology • Development of biomaterials utilizing nanotechnology • R&D for improving environmental/energy materials • R&D on materials ensuring high reliability and safety
	RIKEN (The Institute of Physical and Chemical Research)	• Nano-scale science and technology, electron complex matter science research • Research on exotic particle beams, 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 • Extreme photonics research • Molecule ensemble research
	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
Ministry of Health, Labour and Welfare	Health and labour science research grants	• Research on advanced medical technology
	Health Policy Bureau	• Research on the application of nano-level imaging in medical area • Research on the development of microscopic medical equipment operational technology • Research on drug delivery system • Research on extra-early diagnostics of illness and medical treatment system
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization	• Development of technologies for nano-scale processing/evaluation of food materials

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		• Project for practical development of advanced analyzers (Development of core technologies for advanced components to create new industries) • Development of technologies for new nano-electronics semiconductor materials/new structures – In particular, nano-technologies for new materials and new structures • Project for development of alternate rare metal materials • Development of technologies for new nano-electronics semiconductor materials/new structures
	National Institute of Advanced Industrial Science and Technology	• Development of self-assembly technology • Development of strongly-correlated electron materials and devices • Survey on the social influence of nanotechnology
	New Energy and Industrial Technology Development Organization	• Research and development of infrastructure for innovatively higher strength/higher-function ferrous materials • Project for R&D on Next-generation DDS Therapy Systems for Deep Therapy • R&D of Molecule Imaging Equipment • R&D on the practical use of nanotechnology and advanced materials • Project on the development of carbon nanotube capacitor • Spintronics nonvolatile function technology project • Challenges to nanotechnologies achieved through fusion of different field and businesses • Development of technologies for new nano-electronics semiconductor materials/new structures – In particular, development of technologies for substrates/epitaxial growth of nitride-based chemical compounds s • Project for creation of photocatalyst industry for establishing recyclable society • Research and development of infrastructure for innovatively higher-strength/higher-function ferrous materials • Technology for highly-efficient manufacturing of three-dimensional optical device • Forged Magnesium Parts Technological Development Project (Development of Foundation Technology on Advanced Material for the Creation of New Industry) • Development for foundation technology on materials for textiles with new structure with advanced function expression (Development of Foundation Technology on Advanced Material for the Creation of New Industry) • Development of an evaluation basis for the development of next generation advanced material (Development of Foundation Technology on Advanced Material for the Creation of New Industry) • Technology development for ultra-flexible display material (Development of Foundation Technology on Advanced Material for the Creation of New Industry) • Technology development for low-loss optical materials with new functions (Development of Foundation Technology on Advanced Material for the Creation of New Industry • Technology for next-generation electro-optical materials and element synthesis (Development of core technologies for advanced components to create new industries) • Development of technologies for components using innovative micro reaction field (Development of core technologies for advanced components to create new industries) • Development of technologies for innovative components using high-function composite metallic glass
Ministry of the Environment		• Environmental technology development and promotion operations utilizing nanotechnology

5 Energy

Japan stipulated the Basic Energy Plan (Cabinet decision: March 2007) based on the Basic Act on Energy Policy (Act No. 71 of June 2002) and promotes measures concerning supply and demand of energy in a comprehensive and systematic manner on a long-term basis.

(1) Diversification of energy sources

(Promotion of the use of nuclear energy)

Nuclear energy is quasi-domestic energy that contributes to measures for preventing global warming since it does not discharge CO_2 in power-generating processes with excellent property in supply stability. Today, nuclear power generation accounts for approximately one-third of the total power generation in Japan, and it is planned that nuclear power will be promoted, while being positioned as the core power source in the future.

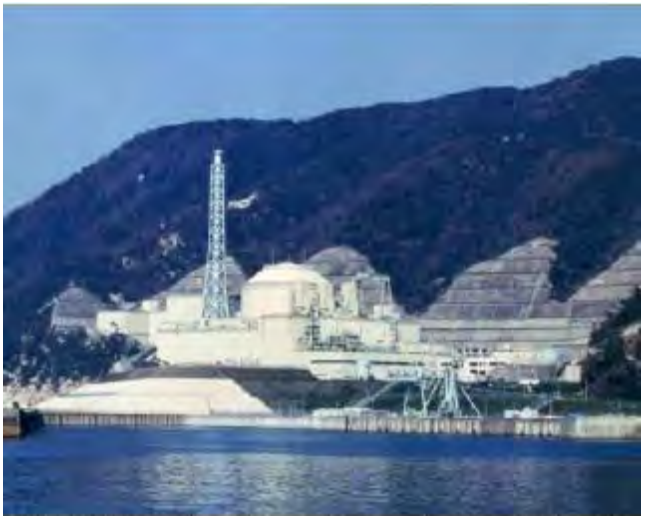
Research, development, and utilization of atomic energy in Japan have been conducted according to the Atomic Energy Basic Act (Enactment in December 1955), solely for peaceful purposes, based on the premise of ensuring safety, and the government has been steadily promoting the research, development and utilization of nuclear energy based on the Framework for Nuclear Energy Policy (October 2005) and the Basic Energy Plan.

1) Next-generation light water reactors (LWRs)

At present, as for LWRs which is the mainstream of nuclear reactors in Japan, it was decided that a domestic next-generation LWR should be developed with full cooperation of governmental and private sectors in preparation for the large-scale demand for replacement of the existing nuclear power plants (NPPs) in Japan, which is expected to begin in approximately 2030, and a feasibility study (FS) for the development was initiated in FY 2006.

2) Fast Breeder Reactor (FBR) cycle technology

The Fast Breeder Reactor (FBR) cycle technology was positioned as the strategic prioritized S&T and the Key Technologies of National Importance in the sectoral promotion strategy (March 2006) based on the Third Science and Technology Basic Plan. The government states that the FBR cycle technologies will be "promoted as one of the top-priority issues of the nation" in the Basic Energy Plan. Furthermore, METI's Advisory Committee on Energy and Natural Resources, finalized the Nuclear Energy National Plan (August 2006), MEXT's Council for Science and Technology (CST) finalized the Research and Development Policy on FBR Cycle Technology (October 2006), and the Atomic Energy Commission finalized the Basic Policy on Research and Development of FBR Cycle Technologies over the Next Decade (December 2006).



Prototype Fast Breeder Reactor Monju (Tsuruga City, Fukui Prefecture)
Photo: Japan Atomic Energy Agency

In these reports, a combination of sodium-cooled FBR, advanced aqueous reprocessing process and simplified palletizing fuel fabrication was selected as the most promising commercial system concept (main concept), and the FRB Cycle Commercialization R&D program, which aims to shift the FBR cycle to full-fledged demonstration and practical use phases will be implemented in the future. The reports also determined to promote research and development of element technologies based on the main concept, while utilizing international cooperation (Figures 2-2-5 and 2-2-6).

Figure 2-2-5 Technology Development Issues on Sodium-cooled Reactor

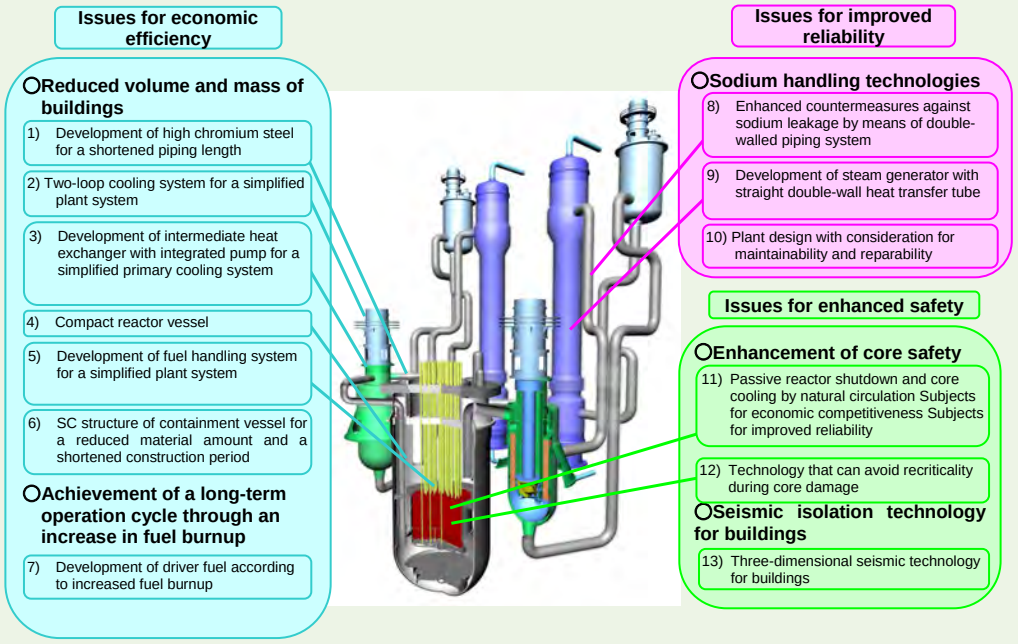
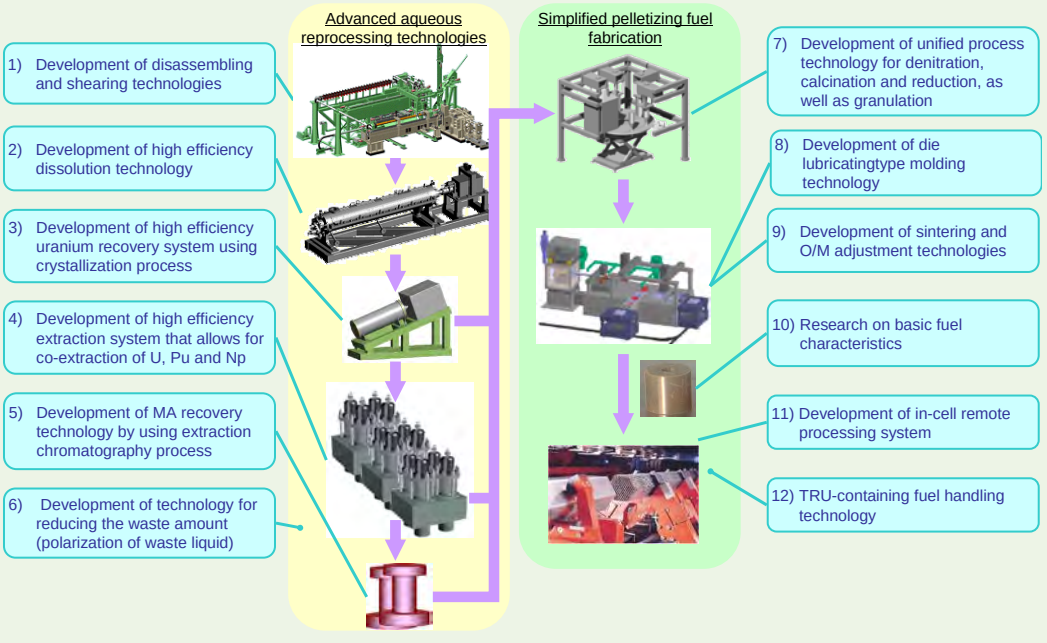


Figure 2-2-6 Technology Development Issues on Advanced Aqueous Reprocessing and Simplified Pelletizing Fuel Fabrication



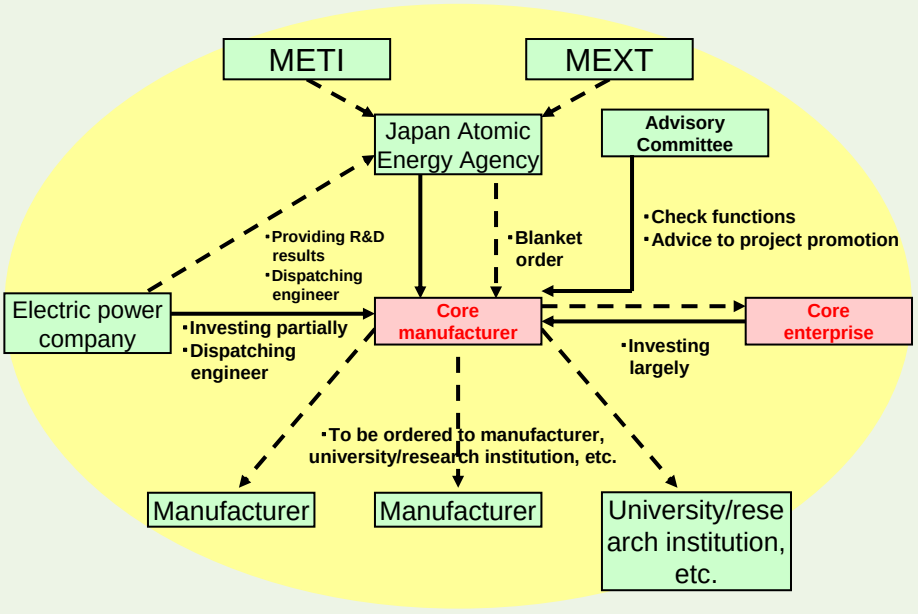
Concerning the prototype FBR Monju, in particular, the Basic Plan states that it should be positioned as the core research and development field of the FBR cycle technology, the operation will be resumed in FY 2008, and the expected purposes include demonstration of its reliability as an operational power plant and establishment of sodium handling technologies within the estimated period of about 10 years. Japan Atomic Energy Agency (JAEA) completed modification work in

August 2007 and is implementing their work, while placing the ultimate priority on the safety toward resumption of operation, including execution of tests to validate soundness of the entire plant.

At present, innovative technologies are scheduled for adoption in practical facilities and will be determined by FY 2010 at the latest. The research and development plan covering the processes up to practical use of the FBR cycle technology, which can achieve development goals concerning safety, economic efficiency, effective availableness of resources, reduction in environmental loads, and nuclear proliferation resistance, will be presented by 2015 at the latest after assessment by the government.

In addition, with the recognition that achieving a smooth transition to demonstration and commercialization from the R&D phases through cooperation of the R&D side and the introduction side is important for future practical use, five-way talks comprising METI, MEXT, electric power utilities, manufacturers, and JAEA started in July 2006 to implement the required studies. It decided on a policy to concentrate responsibility, authority, and engineering functions to one of the core manufacturers so the company can execute development of fast-breeder reactor efficiently under the defined responsibility system in December 2006 and selected the core company in April 2007 (Figure 2-2-7).

Figure 2-2-7 R&D Promotion System



3) Uranium enrichment and advanced fuel

Japan has to rely on imports for most of its energy resources. Japan 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.

In promoting plutonium utilization, Japan strives to ensure the transparency of plutonium use, not only from the viewpoint of rigorous management of nuclear, but in clear observation of the principle of never holding plutonium that is not required to implement current programs, so as to avoid arousing international concerns regarding the proliferation of nuclear weapons.

More specifically, related ministries and agencies report the management status of plutonium in Japan every year to the Nuclear Energy Council (September 18 in 2007), and to the International Atomic Energy Agency (IAEA) according to the Guidelines for the Management of Plutonium. Furthermore, electric power utilities announce their utilization plans in which the purpose of their plutonium use to be extracted in the appropriate year is stated, and the Nuclear Energy Council validates the purpose of use thus announced (The plutonium utilization plan for FY 2008 was

announced on March 7, 2008).

In order to stably secure requirements, from the viewpoint of assuring stable energy supply, for uranium resources and respective processes of nuclear fuel cycle that are required for light-water nuclear reactors in Japan, concerning the enriched uranium used as fuel in nuclear power generation, Japan promotes the development of domestic uranium enrichment projects, while endeavoring to maintain economic efficiency. At present, R&D of an advanced centrifugal machine having higher performance and excellent economic efficiency is in progress with close cooperation of governmental and private sectors, aiming for introduction in about 2010.

4) Spent fuel reprocessing technology

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 testing at the final stage (active testing) is in progress using the spent fuel aiming at the completion of construction in May 2008. Construction and operation of the Rokkasho reprocessing plant is aimed at steady establishment of the reprocessing technology on a commercial scale, as well as the evolution toward establishment of the nuclear fuel cycle.

Furthermore, at present, the Tokai Reprocessing Plant is reprocessing expended uranium fuel used in the Advanced Thermal Reactor Fugen. As a result, the expended fuel that were reprocessed so far reached 1,140 tons in total. Fugen, which had been undergoing independent development as a nuclear reactor featuring the ability to flexibly and efficiently utilize plutonium, recovered uranium and other fuels, terminated its operation in March 2003 with completion of a report summing up the project results at the end of September 2003. The facility is scheduled for reorganization into the Fugen Decommissioning Engineering Center in February 2008 to break up equipment, while executing investigations and research on safety demonstration; the project will be completed by 2028.

5) Geological disposal of the high-level dioactive waste

R&D of the geological disposal of high-level radioactive waste, which is a strategic prioritized S&T essential for Japan to establish a technology that supports the national safety regulation regime as well as to conduct the final disposal of high-level radioactive waste and other waste, and hence, needs steady promotion. R&D of this technology is being conducted in close cooperation with the relevant research institutions centered on JAEA. In addition, JAEA develops two underground research laboratory programs in Mizunami, Gifu Prefecture (crystalline rocks) and in Horonobe, Hokkaido Prefecture (sedimentary rocks).

6) Technologies for decommissioning of nuclear facilities and treatment/disposal of radioactive waste

It is important that decommissioning of nuclear facilities and treatment/disposal of radioactive waste should be conducted under the responsibility of nuclear facility establishers and radioactive waste generators in a planned and efficient manner. JAEA develops decommissioning engineering systems and radioactivity measurement/evaluation technologies. These are for the purpose of implementation of safe and rational decommissioning of nuclear facilities, treatment/disposal of radioactive waste, and reduction in the amount of radioactive waste as well as reusing the generated waste for resources.

7) Fusion energy

As for fusion energy, which is expected to be one of the future energy sources, JAEA, the National Institute for Fusion Science (NIFS), universities, and other organizations promote R&E through mutual cooperation, while efficiently utilizing international cooperation. In Japan, research and development have been promoted by using three types of reactors including a tokamak type[fn.6] (Critical plasma test

fn. 6 Tokamak type achieves nuclear fusion reaction in the processes to create twisted magnetic fields caused by those

equipment JT-60, JAEA); a helical type[fn.7] (large helical device LHD, NIFS); and a laser type[fn.8] (GEKKO XII, Institute of Laser Engineering at Osaka University), and the achievements are leading the world.

Critical plasma test equipment JT-60
Photo: Japan Atomic Energy Agency

Large Helical Device (LHD)
Photo: National Institute for Fusion Science

Implosion Laser "GEKKO XII" (Right) **and Heating Laser "LFEX"** (Left)
Photo: Osaka University

Furthermore, Japan takes an active role in participating in the ITER (International Thermonuclear Experiment Reactor) Project[fn.9], which aims for demonstrating S&T feasibility of fusion energy. Japan also implements the Agreement between the Government of Japan and the European Atomic Energy Community for the Joint Implementation of the Broader Approach Activities in the Field of Fusion Energy Research (hereinafter referred to as the "Broader Approach") as an advanced research and development project that complements and supports the ITER Project in Japan through Japan-Europe cooperation. The Broader Approach entered into force in June 2007, and the Agreement on the Establishment of the ITER International Fusion Energy Organization (hereinafter referred to as the "ITER Agreement") entered into force in October 2007 for full-scale activities.

Establishment of ITER Organization
(October 2007)
Photo: ITER Organization

Furthermore, as for the bilateral cooperation in the nuclear fusion field, Japan concluded the Agreement on Implementation of Cooperation for Nuclear Fusion Research with China in December 2007, following the US, Europe, and South Korea.

8) Basic and fundamental R&D for nuclear science

Basic and fundamental R&D for nuclear science is important to support utilization and development of nuclear energy, such as to maintain the technical basis concerning nuclear power utilization at a high level, as well as to create new knowledge and technologies. JAEA conducts basic and fundamental research projects concerning: nuclear and reactor engineering, fuel and material engineering, environmental and radiation engineering, advanced basic research, and advanced computational science and technologies.

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generated by coils and plasma current, thus confining heating plasma.

fn. 7 Helical type achieves nuclear fusion reaction in the processes to twist the coils themselves to create twisted magnetic fields, thus confining heating plasma

fn. 8 Laser type achieves nuclear fusion reaction in the processes to heat the nuclear fusion fuel having ultra high density that is imploded by irradiating laser beams with an ultra high intensity laser.

fn. 9 ITER Project is an international joint research and development project which intends to construct and operate a thermonuclear experiment reactor in France, under cooperation of 7 parties consisting of Japan, Europe, the US, Russian Federation, China, the Republic of Korea and India.

9) Nuclear non-proliferation

Japan concluded the full-scope safeguards agreements with IAEA in 1977 in responding to the ratification of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1975 and accepted the "safeguards" of IAEA, which is a measure for preventing nuclear materials from being diverted to nuclear weapons and established the domestic safeguards system based on related laws and regulations. Furthermore, Japan implemented physical protection (PP) to prevent theft of nuclear materials or attempts to sabotage nuclear facilities based on the international guidelines. In addition, Japan promotes the development of technologies that are required for implementing the above-stated measures.

Regarding the safeguards, after the conclusion of the Agreement, Japan received a conclusion from IAEA that there had been no diversion of the declared nuclear materials into nuclear weapons. Furthermore, in 1999, Japan concluded the additional act for enhancing the safeguards to positively deal with enhancement and promotion of streamlining of the IAEA safeguards. As a result, IAEA first concluded in 2004 that, concerning the status of Japan as of 2003, no undeclared nuclear materials exited and "all nuclear materials remained in peaceful activities" and the conclusion has been maintained ever since. Based on the conclusion, the Integrated Safeguards, which make the IAEA safeguards more efficient through reduction in the number of IAEA inspections have been implemented.

In addition, in order to implement effective and efficient safeguards for important facilities to be safeguarded, including the Rokkasho Reprocessing Plant which is in process of active tests and is scheduled to be completed in 2008, as well as the Rokkasho MOX fuel fabrication facility which is scheduled to start construction, the government is engaged in system development, including the establishment and advancement of safeguards measures. The government also organized an international training course for theimprovement of technologies for nuclear materials accounting.

JAEA performs the technology development for safeguards, development of technologies for facilitating more efficient, and effective nuclear material management, as well as the development of safeguards technology for a next-generation nuclear system.

In addition, Japan ratified the Comprehensive Nuclear-Test-Ban Treaty (CTBT) banning any nuclear explosion, and Japan makes every effort to improve international monitoring systems concerning radioactive nuclides.

10) Innovative nuclear energy system including high-temperature gas-cooled reactor

Effective use of nuclear fuel resources and a wide variety of uses of nuclear energy by promoting R&D of innovative nuclear energy systems are important to ensure the diversity and flexibility of energy supply. JAEA promotes performance evaluation of the high temperature gas-cooled reactor by means of the test operation of the High Temperature Engineering Test Reactor (HTTR) as well as the research and development of the IS process in which hydrogen is produced by pyrolysis of water, in order to establish high temperature gas-cooled reactor technology, which allows for various types of energy supply and heat utilization technologiessuch as hydrogen production. In FY 2007, JAEA achieved a continuous operation at the rated output of 30 MW (output coolant temperature of 850 degrees centigrade) for 30 days at the High Temperature Engineering Test Reactor (HTTR).

High Temperature Engineering Test Reactor (HTTR)
(Oarai R&D Center, Oarai-cho, Ibaraki Prefecture)
Photo: Japan Atomic Energy Agency

(Ensuring nuclear safety)

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 establish countermeasures in the case of an accident to ensure that damage to the lives and health of local residents, etc. can totally be eliminated.

As for research, development and utilization of nuclear energy in Japan, the government imposes stringent safety regulations on nuclear facilities in terms of design, construction and operation stages according to the Nuclear Reactor Regulation Act to levels that are not seen in any other industrial sectors in Japan. In addition, regarding radioactive isotopes and radiation generators used in the medical, agricultural, and industrial sectors, the government implements safety regulations based on the Act Concerning the Prevention from Radiation Hazards due to Radioisotopes and Others to prevent radiation hazards resulting from the use.

As for nuclear emergency countermeasures, efforts to expand and strengthen nuclear disaster measures are now being promoted based on the Act on Special Measures concerning Nuclear Emergency Preparedness, including dispatch of senior specialists for nuclear emergency preparedness, designation of Off-site Emergency Centers and implementation of emergency drills.

For surveys of environmental radiation, MEXT and other relevant ministries and agencies, prefectural governments and atomic energy utilities continue to conduct radiation surveys in areas surrounding nuclear facilities. In addition, they conduct surveys concerning environmental radioactivity levels in Japan, as well as radiation surveys of nuclear-powered military vessels when they enter ports in Japan. When the US nuclear-powered carriers return to the home port of Yokosuka scheduled in the summer of 2008, the parties concerned strengthen measures and systems concerning radiological investigation.

Furthermore, following the fact that three years passed since execution of the Prioritized Nuclear Safety Research Program formulated in July 2004, Nuclear Safety Commission of Japan conducted the interim assessment on the progress status and the utilization of achievements of the Program. JAEA now conducts necessary review of the Program based on the interim assessment.

Considering that electric power companies announced the hidden incidents from authorities with regard to the automatic shutdown of atomic power reactors at the beginning of 2007, MEXT issued a directive to JAEA and the universities to check for the existence of hidden incidents with regard to the automatic shutdown of atomic power reactors. As a result, MEXT confirmed that no hidden incidents required by law to be reported existed in any reactor (announced on April 27, 2007). Furthermore, considering it was confirmed in June 2007 that an incident concerning radioactive pollution in an uncontrolled area at JAEA was not reported, MEXT directed JAEA to investigate the incident. As a result, 46 inadequate incidents were confirmed, though no incident impaired safety or the soundness of facilities, and MEXT issued a strict caution to JAEA (announced on August 31, 2007).

Furthermore, considering the growing importance of preventing terrorist activities using nuclear or radioactive materials in recent years, the Criminal Radiation Emission Act was officially announced in May 2007 (enforced in September 2007) to secure precise execution of the International Convention for the Suppression of Acts of Nuclear Terrorism.

(Promotion of nuclear S&T, and development of infrastructure for the research, development and utilization of nuclear power)

1) Promotion of nuclear S&T

Nuclear S&T includes basic and fundamental research that explores the basic principles of nature and supports development in various S&T fields, including the life sciences and materials science, by means of development and utilization of quantum beam technology such as accelerators and high intensity lasers. With respect to the quantum beam technology, JAEA and the High Energy Accelerator Research Organization (KEK) jointly promote the Japan Proton Accelerator Research Complex (J-PARC Project), which aims at new developments over a wide range of research fields, including life

science, material science, nuclear physics and particle physics by generating and utilizing proton beams with the highest beam power in the world. The project is in progress towards the commissioning in FY 2008. In addition, RIKEN develops the RI Beam Factory (RIBF), an accelerator facility that generates beams of all types of radioactive isotopes (RI), from hydrogen to uranium, with the highest intensities in the world. RIKEN launched the operation of the RI beam generation system in FY 2006, and develops experimental installations to start full-scale experiments. Furthermore, national scientific research institutions under the control of each office and ministry promotes cutting-edge basic research in the three areas of fundamental technology, i.e. substances and materials, biological and environmental effects, and system. In addition, the Nuclear Energy Fundamentals Crossover Research is being conducted to promote research and development under active interaction among research institutions on various elements of technology development that are difficult to be promptly achieved by individual research institutions.

2) Dissemination of radiation utilization

Since radiation is used in a wide range of fields from basic and applied research to practical use in medicine, engineering, agriculture, etc. It is important to promote the dissemination of radiation utilization while conducting the research and development.

As for the state of radiation utilization in the respective fields, diagnostic technology using radioactive rays and treatment of cancer were partly put into practical use in the medical field. At present, R&D of cancer treatment by using protons, neutron rays, and heavy ion beams featuring higher quality of life (QOL) is being conducted. Treatment using particle beams has advantages that it gives less burdens to patients since surgery that accompanies anesthesia or incisions is not required. In particular, cancer treatment using heavy ion beams features higher convergence of radiation dosage, and it is a treatment method that can reduce affection to normal tissues since it can adjust the peak dose level to a cancer patient. For example, the National Institute of Radiological Sciences executed treatments exceeding 3,400 cases by August 2007. Gunma University started construction of a technology demonstration unit in FY 2006. Research is progressing into the diagnosis and treatment of cancer using proton beams at the University of Tsukuba's Proton Medical Research Center and other institutions.

In the agricultural sector, radiation is used for the improvement of crop varieties, the prevention of budding in potatoes, etc. In the industrial sector, radiation is used for non-destructive testing, for industrial measurements, and for quality improvements of polymer materials. In addition, development of environmental protection technologies using ion beams, gamma radiation and electron beams is in progress.

3) Disposal of radioactive waste

At present, radioactive waste that is generated from research institutes and medical facilities is not disposed of but stored by individual entities, however, it is an important subject to realize the disposal of this waste for the promotion of research, development and utilization of nuclear energy in the future.

To this end, aiming to achieve waste disposal at an early date, MEXT conducts studies to establish a system wherein JAEA, which generates the largest amount of research institute waste from its technical capabilities, will dispose of waste of its own and of other business operators as well.

4) Efforts for assuring trust and coexistence with communities

In order to promote smooth research, development, and utilization of nuclear energy, it is extremely important to obtain public confidence in nuclear power. For this purpose, nuclear power operators must build up a record of safe operations, and strive to win public understanding. To this end, activities to enhance the understanding by the public of nuclear energy are being implemented via two-way and transparent communication with the public through public hearings and public relations programs, as well as through the support of education programs at schools by sponsoring seminars for

school teaching personnel concerning nuclear energy and lending out simplified survey meters. Furthermore, to promote the coexistence of nuclear power research facilities and regions where such facilities are located, voluntarily executed programs in such regions are being supported by utilizing subsidies under the three basic acts related to power source siting and other measures.

5) International nuclear power cooperation

In the area of international nuclear cooperation, Japan implements active cooperation under the basic premises of ensuring peaceful use, securing nuclear non-proliferation, safety, and nuclear security.

For nuclear cooperation with Asian countries, the exchange of technology is being promoted through workshops under the framework of FNCA[fn.10] in which Japan plays a leading role. In the 8th FNCA Ministerial Level Meeting held in Japan in December 2007, the Joint Communiqué on the Peaceful Use of Nuclear Energy for Sustainable Development was released. Furthermore, cooperative research is being performed under the framework of RCA[fn.11], one of the IAEA activities. Furthermore, training projects for Asian countries are conducted to improve qualifications of nuclear-involved personnel.

As for R&D of the next-generation of nuclear energy system, Japan actively participates in GIF (Generation-IV International Forum)[fn.12] and plays a leading role in discussions on the sodium-cooled fast reactor.

In addition, Japan participated in GNEP (Global Nuclear Energy Partnership)[fn.13] proposed by the US and assumed the position of vice-chairman of the operation group, thus playing the central role in operations. In the 1st Ministerial Level Meeting in May 2007 (Japan, the US, France, China, and Russia), a joint communiqué concerning of the need to promote a nuclear fuel cycle that satisfies the nuclear non-proliferation requirements and cooperation in expansion of nuclear power generation was released. In the 2nd Meeting in September 2007, Operating Documents, which states broadening of partner countries participating in GNEP and the basic structure of GNEP, was formulated. Additional 11 countries joined the initial five countries to sign the Statement of Principles. Thereafter, five more countries signed the statement, and the number of partner countries reached 21 as of February 2008.

Moreover, Japan continues to provide multilateral support through extra-budgetary contribution funding to the IAEA and OECD Nuclear Energy Agency.

(Promotion of the use of renewable-energy)

Renewable-energy, including solar energy, biomass and waste energy, and wind energy, have problems, such as instability of power generation and higher cost, however, since they have advantages, including the potential contribution to addressing global warming and relatively limited resource constraint, it is necessary to actively promote technology development in order to solve the

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fn. 10 Forum for Nuclear Cooperation in Asia: A framework aiming that Asian countries promote peaceful and safe utilization of nuclear technologies, thereby promoting their social and economic growth. Ten countries participate in the Forum including Japan, Australia, Bangladesh, China, Indonesia, Korea, Malaysia, the Philippines, Thailand, and Vietnam.

fn. 11 Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology: A framework aiming for promotion and coordination of joint research, development, and training plans concerning nuclear science and technologies intended for developing countries in the Asia-Pacific region through mutual cooperation of the signatory countries and IAEA, as part of the IAEA activities. The signatory countries cover ten countries, including Japan, Australia Bangladesh, China, India, Indonesia, Korea, Malaysia, Mongolian People's Republic, Myanmar, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, and Vietnam.

fn. 12 Generation-IV International Forum: Cooperation that is based of the agreement for further promoting research and development of next-generation nuclear systems (the fourth generation) through international cooperation, with twelve participating countries, including Japan, Argentina, Brazil, Canada, China, France, Korea, Republic of South Africa, Switzerland, England, and the US as well as EURATOM.

fn. 13 Global Nuclear Energy Partnership: An initiative for developing and expanding nuclear power generation globally, while ensuring nonproliferation called for by the US. At present twenty-one partner countries participate in the initiative including Japan, the US, France, China, and Russia.

above problems, and thereby, to facilitate its introduction and dissemination.

1) Photovoltaic power generation

Photovoltaic power generation has been spreading as its price fell. Nevertheless, development of technologies that further lower costs is essential for the early establishment of a truly independent market. For this purpose, METI promotes the development of technologies that achieve lower costs and higher levels of efficiency, as well as the development of recycling and reuse technologies.

2) Biomass energy

Based on the Biomass Nippon Strategy (Cabinet decision: March 2006), MIC, MEXT, MAFF, METI, MLIT and ENV promote R&D into technologies for the efficient conversion of animal wastes, wood residues, organic sewage, food wastes, and other biomass sources into energy resources.

In particular, regarding biofuel, according to the progress schedule toward drastic expansion of domestic biofuel production formulated in the Biomass Nippon Comprehensive Strategy Promotion Council consisting of related ministries and agencies in February 2007 and reported to the Prime Minister, large-scale demonstration projects toward full-scale introduction of bio-ethanol were conducted in Hokkaido (2 locations) and Niigata prefectures. In addition, development of technologies to effectively produce ethanol from cellulose-based raw materials, such as rice straw and thinned wood, which will not compete with food supply, is being selectively promoted.

(Hydrogen energy/Fuel cells)

It is necessary to promote R&D of a fuel cell system that excels in environmental characteristics, allows for utilization of various energy resources, and has potential energy conservation effect in the civilian and transportation sectors, as well as R&D of production, storage and transportation technologies of hydrogen which is used as fuel of the fuel cell system.

In particular, since fuel cells, which directly generate electricity through a chemical reaction between hydrogen and oxygen, are very efficient and emit neither NOx nor SOx, they are expected to be key technology for energy and environmental fields. 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, MEXT promotes the development of innovative new components and materials that can improve fuel cell performance. METI promotes R&D of elemental technologies of the main unit of the fuel cells, R&D of peripheral technologies, including hydrogen energy utilization technologies, such as the production, transportation and storage of hydrogen fuels, and demonstration of large-scale fuel cell systems for household use, as well as experimental study on fuel-cell-powered vehicles and hydrogen supply system. MLIT conducts demonstration experiments on fuel cells for residential use.

In addition, FDMA makes efforts to enhance collection of information and security measures by paying attention to movement of dissemination of fuel cells.

(Promotion of development and utilization of fossil fuels)

1) Petroleum

In responding to requirements for dealing with heavier-gravity crude oil and lighter petroleum products, and to promote sophistication of oil factories, METI promotes projects for the development of innovative oil refining technologies and a technology to produce petrochemical feedstock of high value from heavy-gravity oils.

In addition, it becomes important to develop technologies that allows for promotion of energy conservation and resource saving by means of the advancement and improved efficiency of petroleum refineries as well as cooperation with various industries in petrochemical complexes. For this purpose, METI develops technologies, including promotion of process streamlining in oil factories, and effective utilization of by-products that are produced in petrochemical complexes.

2) Coal

Coal offers excellent supply stability compared to petroleum and other sources. But since coal emits the highest carbon dioxide of all fossil fuels, R&D is needed to reduce its burden on the environment. For this purpose, METI promotes the development of high efficiency 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). In addition, R&D of Carbon Dioxide Capture and Storage (CCS) technologies is being conducted from medium- and long-term viewpoints.

3) Natural gas, etc.

Because natural gas has lower carbon dioxide emission and less environmental burden than other fossil fuels, promotion of R&D into its utilization is therefore of importance. Consequently, METI promotes 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 gas use. The ministry also promotes the R&D 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.

(2) Promotion of countermeasures for energy conservation

From the viewpoint of preventing global warming, effectively utilization of limited energy resources, it is important to carry out R&D to improve efficiency in specific individual devices and element technologies and to promote R&D for improving energy supply and utilization efficiency of energy systems throughout social systems through the use of unused energy. It is also necessary to promote R&D from the viewpoint 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 various products.

For this purpose, METI established a strategy for the development of energy conservation technologies aiming, from discovery to commercialization of a new technology, and thereby to enhance the effectiveness of energy conservation technology development. The ministry promotes strategic research and development.

(3) Others

Issues concerning energy and environment are synthesizing issues that require research from aspects of both natural science and social science. In addition, in the Summit to be held at Hokkaido Toyako in July 2008, the environmental issue will be one of the key subjects. Toward the Summit, SCJ finalized the report *Lighting the Way: Toward a Sustainable Energy Future*, which was officially announced by the Inter Academy Council (IAC) in October 2007 to make concerted efforts for public relations. Table 2-2-8 shows major research topics in the energy sector (excluding nuclear power) implemented during FY 2007.

Table 2-2-8 Major Research Projects in Non-nuclear Energy (FY 2007)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	• Assurance of safety measures that respond to new technologies and new materials
Ministry of Education, Culture, Sports, Science and Technology	National universities and other institutions	• New energy and energy efficiency R&D • The Design a Sustainable Management and Recycling System for Biomass and General and Industrial Wastes • Development of fuel cells featuring higher performance and lower cost than conventional type
	National Institute for Materials Science	• Development of new heat-resistant materials that resist long-hour use at ultra high temperatures • Development of ultra-light and high-intensity structural materials featuring excellent workability that contribute to efficient use of energy
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Food Research Organization	• Development of biomass utilization technology for local revitalization
Ministry of Economy, Trade and Industry		• Experimental study on fuel cell systems • Development of solar photovoltaic technology for energy-saving and reduced environmental burden • Development of innovative technologies including those for petroleum refining that respond to heavier-gravity crude oil • Development of technologies that fuses advanced functions of petroleum refining within industrial complexes • Development of hydrogen energy technologies • Development of technologies related to GTL fuel and dimethyl ether fuel • Development of methane hydrate technologies • Research and development into clean coal technologies • Development of energy conservation technologies/energy-saving technologies －Research and development for CO2 heat pump water heater with higher efficiency and reduced size －Development of element technologies for practical use of high-efficiency gas turbine －Development of high-efficiency lighting equipment using organic electro-luminescence (organic EL) －Development of electric double-layer condenser using carbon nanotube －Study on carbon-fiber reinforced composite materials for weight saving of automotives －Development of core technology concerning next-generation low power consumption semiconductors －Development of core technologies of inverter by using high-performance power device (power element • Development of technology for distributed energy network systems • Development of technologies for sequestration and effective use of carbon dioxide
	Advanced Industrial Science and Technology	• Technologies for distributed energy network systems • Development of new fuel technologies including clean diesel engines • Development of technologies for manufacturing ethanol from wood-derived biomass
	New Energy and Industrial Technology	• Development of technologies of small-output fuel cells that could be compact mobile power sources

	Development Organization	• Development of technologies for new use pattern of fuel cells • Development of technologies for practical use of fuel cells (polymer electrolyte fuel cells) that use ion-exchange membrane as electrolyte • Maintenance project for building common infrastructure of hydrogen society • Development of technologies concerning hydrogen manufacturing through gasification of coal and coal • Basic research project for advanced hydrogen science • Research and development of new energy technologies • Development of technologies for practical use of next-generation battery systems • Development of technologies including stabilizing of electric power systems of wind-power generation • Large-scale demonstration concerning dissemination of mixed with 3% ethanol • Research and development of basic technologies for application of superconductivity • Strategic development of technology for streamlined energy use
	Japan Oil, Gas and Metals National Corporation	• Promotion of development and utilization of oil and natural gas
Ministry of Land, Infrastructure and Transport		• Development of high-efficiency fuel cell systems for collective housing
	Port and Airport Research Institute	• Research on understandings of coastal and offshore wind condition characteristics as well as utilization of wind energy

6 Monodzukuri Technology

The Monodzukuri (manufacturing) industry is the field with the highest international competitiveness among all industries, and is a lifeline for Japan. It also has a large ripple effect on other industries and serves as a driving force for economic growth. Under the Third Science and Technology Basic Plan, Monodzukuri technology is being promoted in order to clearly show the viewpoint that it strengths the ability of value-creating Monodzukuri, which aims for the development of S&T that raises the value of "things (*mono*)" by stepping out of the conventional development framework of manufacturing technology.

(1) Promotion of Monodzukuri technology with a common basis

As strategic prioritized S&T, MEXT promotes the development of the "only one, number one" measurement analysis technology and device that are able to respond to needs from the advanced researchers.

METI promotes the development of technology for manufacturing highly integrated complex MEMS, which features compact and high-precision and excellent energy saving characteristics in versatile sectors, including automobile, telecommunications, safety and security, environment, and healthcare. In addition, METI promotes the development of robot technologies that are utilized in the manufacturing sector. With these projects, METI supports creation of innovation in Monodzukuri.

(Support for the advancement of core manufacturing technology at SMEs)

The wellspring of international competitiveness of Japan's SMEs, whose excellent technologies play key roles in production, including casting, forging, and plating, lies in the point that they are working closely on details with downstream companies in the course of developing and manufacturing products and parts.

Those SMEs are, however, facing various difficulties, including greater risks caused by sophistication and specialization in their technologies. To this end, METI deployed supports to R&D concerning core manufacturing technologies and implemented promotion of information sharing between upstream and downstream industries as a means to establish the environment for solving the problems.

1) Support for R&D by manufacturing SMEs

Under the Act on Technology Advancement of SMEs (Act No. 33 of 2006), technologies related to welding and powder metallurgy were additionally designated as the Specific Core Manufacturing Technology, and the Guidelines for Advancement of Specific Core Manufacturing Technology [literal translation] in which directionality of technology development to be achieved for each technology was defined was formulated. In addition, the government also approved and supported plans of specific R&D prepared by SMEs based on the guidelines. Furthermore, efforts by SMEs to undertake innovative, highly-risk R&D, R&D to realize innovation in production processes were supported. Expenses for patent application of achievements obtained through the plans of specific R&D by SMEs were mitigated, low-interest financing by Japan Finance Corporation for Small and Medium Enterprise, and other projects were implemented.

2) Enhancement of the environment for advancement of core manufacturing technology

Support was provided for activities to create "opportunities of meeting" of SMEs and downstream companies, including allocation of personnel who coordinate and fine-tune cooperation between SMEs which play key roles in core technologies and industries, establishment of opportunities for information exchange between them.

In order to objectively establish the accuracy and reliability of processing and manufacturing performed by SMEs and to support the commercialization of products in the market, the infrastructure for providing measurement standards was enhanced by the establishment of an accuracy control system for SMEs by test institutions, developing human resources, and establishing facilities. Furthermore, very versatile software that digitizes, systemizes, and accumulates tacit knowledge, including design and processing know-how of experienced technicians owned by manufacturing SMEs, was developed. At the same time, in order for SME manufacturers without experience in designing software to create business software (production management, quality control, shipment management, etc.) and utilize accumulated know-how, etc., in their production activities, tools to support creation of such software were developed and provided to the SMEs. In this way, continuation of core technologies owned by SMEs was supported.

Serving as "shelters" for SMEs with problems involving intellectual property, societies of commerce and industry and chambers of commerce and industry across the country served as one-stop access points for advice and consultation. Seminars on prevailing corporate activities focused on intellectual property also were staged in various places around the country.

(2) Promotion of Monodzukuri technology with groundbreaking, dramatic development expected

METI implements the Project for Strategic Development of Advanced Robotics Elemental Technologies, which executes development of state-of-the-art technologies (for industrial, service and special environment use) toward realization of mission-oriented "real-type robot" within the scope of the Strategic Technology Roadmap. Such projects are expected to lead to innovative and dramatic development of manufacturing processes, thus making significant contributions to the enhancement of industrial and international competitiveness.

(3) Development, utilization of human resources and inheritance and deepening of skills among them

Monodzukuri is the field that can be referred to as the lifeline of our country, but shortage in the aspects of both quality and quantity of human resources who support manufacturing is assuming serious proportions. To solve this problem, MEXT is working on establishment of systems concerning development of human resources and other versatile creative measures, covering the elementary, lower secondary education, upper secondary education, and even lifelong learning stages.

In elementary, lower secondary education, education concerning Monodzukuri in related subjects

is provided from the elementary school stage based on the National Curriculum Standards. In particular, at specialized upper secondary schools, the Craftsman 21 project [literal translation], which develops specialist business workers suited for local characteristics is being conducted in cooperation with local industries. For upper secondary stages, under the project for supporting development of manufacturing engineers [literal translation], engineers involved in Monodzukuri with advanced knowledge and technologies for innovating manufacturing are being developed for universities, through development and implementation of educational programs that are prepared with organic combination of experiments/practical training and lectures which are achieved through cooperation among local communities and industries. In particular, colleges of technology aim to become an attractive option, by conveying their appeal to manufacturing through approaches such as Robot Contest. They also sponsor public lectures to provide manufacturing technologies to local communities.

In the area of lifelong learning, opportunities for career improvement are being amplified through the acceptance of working people at universities and other schools or public lectures. It is also intended to foster human resources for manufacturing by providing children opportunities to experience and learn manufacturing in each region, through approaches such as utilizing citizens' public halls and museums or opening classes in educational institutes to the public. Furthermore, this area also has an aspect to allow senior people to find worthwhile lives and enrich their life after retirement by passing knowledge and experiences of the baby-boom generation of people onto the next generation through measures for developing human resources for manufacturing.

JST supports engineers in acquiring extensive basic knowledge in S&T and knowledge of failure by providing Internet educational tools for self-learning that covers the respective areas of S&T and across different areas at http://weblearningplaza.jst.go.jp/, as well as the Failure Knowledge Database at http://shippai.jst.go.jp/ that includes failure cases in the S&T field together with lessons learned from failures.

The major research topics in FY 2007 for the manufacturing technology field are as shown on Table 2-2-9.

Table 2-2-9 Major Research Projects in Monodzukuri Technology (FY 2007)

Ministry	Research organization	Subject
Ministry of Education, Culture, Sports, Science and Technology	Japan Science and Technology Agency	• Project for the development of advanced measurement analysis technology and device
	RIKEN	• Research on the establishment of technology information integration system in advanced IT • Study on technologies for developing super analyzers
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization	• Highly Integrated, Complex MEMS Project • Research and development on ultra-flexible display members • Next-generation lightwave control material and technology on elements • Technology for highly efficient manufacturing of three-dimensional optical device

7 Social Infrastructure

Social infrastructure field is a basic field that supports people's lives. In order to achieve a prosperous, secure, safe society, R&D is being promoted so as to contribute to reducing the risks inherent in society and to improving public conveniences.

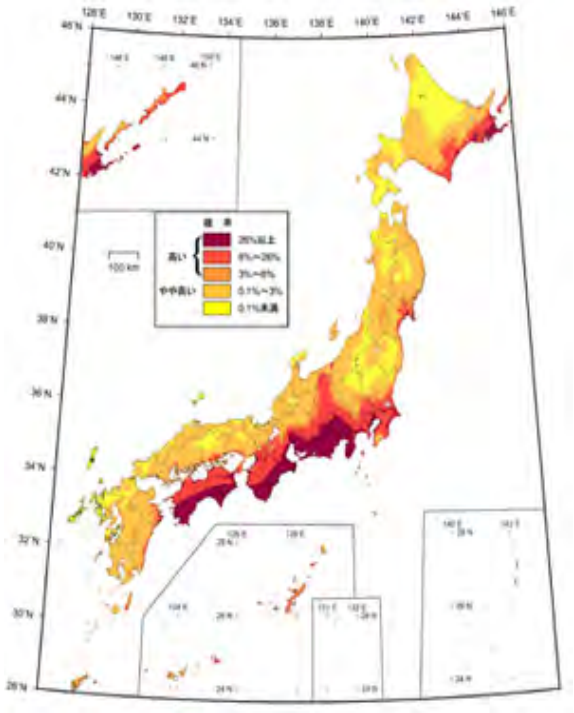
(Disaster prevention)

In Japan where natural disasters frequently occur, natural disaster accompanying enormous

damages, such as the Noto Peninsula Earthquake and the Niigata Chuetsu Offshore Earthquake both occurred in 2007. It is very important to continuously promote R&D of S&T on prevention of disaster, prevention of damage from spreading, recovery, and restoration to lessen damage caused by natural disasters.

Earthquake research in Japan is promoted with the collaboration and cooperation among related administrative agencies under policies for the promotion of earthquake research (April 1999) that are stipulated by the Headquarters for Earthquake Research Promotion (Director: Minister of MEXT; hereinafter referred to as the "Earthquake Headquarters") established under the Act on Special Measures concerning the Earthquake Disaster Prevention (Act No. 111 of 1995). In FY 2007, studies were made on the formulation of the New Comprehensive and Basic Policies (tentative title) as the policy for earthquake research for 10 years from FY 2009. It should be noted that the Earthquake Headquarters officially announced the revised edition of the National Seismic Hazard Maps for Japan, which generalized achievements of past earthquake research based on information including evaluation results of major fault zones in Japan in April 2007.

Regarding research on seismic/volcanic eruption prediction, related institutions including universities are promoting in an integrated and systematic manner, based on the New observation and research program for the earthquake prediction: The second 2004 fiscal year annual report recommended by CST, and the Seventh Volcanic Eruption Prediction Plan (both FY 2004 to 2008). In FY 2007, studies toward the recommendation Promotion of Observation and Research Program for Seismic and Volcanic Eruption Prediction [literal translation], which will be the five-year plan from FY 2009 were implemented.



Distribution map of probability of ground motions equal to or larger than seismic intensity 6 Lower, occurring within 30 years from the present
Source: Headquarters for Earthquake Research Promotion

Research and development in relation to disaster prevention S&T were promoted based on the Research and Development Policy on Disaster Reduction [literal translation] formulated in July 2006 by CST's Subdivision on R&D Planning and Evaluation.

Based on the policies of the Earthquake Headquarters, MEXT implements projects including selective survey and observation intended for earthquakes off Miyagi Prefecture and the fault zone on the Itoigawa-Shizuoka geotectonic line, technology development for laying a ocean-floor network system that is equipped with various observation devices, such as seismometers, water pressure gauges, and other instruments, on predicted seismogenic zones of the Tonankai Earthquake. In addition, starting in FY 2007, special project for earthquake disaster mitigation in urban areas is being implemented anew to promote research, which contributes to the elucidation of mechanisms that cause urban-area earthquakes beneath complicated plate structures. With these R&D projects, MEXT aims to clarify the earthquake mechanisms, improve earthquake prediction accuracy, and further reduce damages in the event of an earthquake. Furthermore, starting April 2007, MEXT held the meeting concerning support to disaster education, examined measures for continuously utilizing knowledge of disaster prevention S&T to disaster education, and officially announced the interim report in August 2007.

Furthermore, after the 2007 Noto Peninsula Earthquake and the 2007 Niigata Chuetsu Offshore Earthquake, MEXT conducted emergency surveys and research by using the Grants-in-Aid for

Scientific Research and the Science and Technology Promotion Adjustment Expenses, and acquired precious data concerning these earthquakes.

To acquire and accumulate date on breaking processes of structural steelwork and bridge structures, the National Research Institute for Earth Science and Disaster Prevention (NIED) implements R&D using experiments and research on earthquake resistance with a 3-D Full-Scale Earthquake Testing Facility (E-Defense) that contributes to reduction in seismic damage. In addition, NIED conducts research on the prediction of landslide disasters and wind and flood damage using MP Radar[fn.14], research on the practical use of a snow damage prediction system and disaster prevention measures based on the system, and research on volcanic eruption prevention and volcanic disaster prevention. Furthermore, in the area of international cooperation, Japan takes part in bilateral research on S&T for disaster prevention within the framework of S&T cooperation agreements with the US, Russia, Italy, and other nations, and the U.S.-Japan Cooperative Program in Natural Resources (UJNR).

Concerning technologies on observation and monitoring of natural disasters by satellites, JAXA operates the Advanced Land Observing Satellite Daichi (ALOS) launched in January 2006 with the purpose of mapping and disaster monitoring, conducting R&D of high-precision positioning, and experimental navigation and timing technology using a quasi-zenith satellite system. These technologies are developed and operated as technologies comprising the Key Technologies of National Importance, Earth Observation and Ocean Exploration System, aiming for domestic and international contribution by establishing a global observation and monitoring system using satellites, which is essential for the overall security of Japan.

FDMA promotes R&D on fire prevention, led by the National Research Institute of Fire and Disaster, concerning the assurance of safety of facilities handling hazardous materials in the event of earthquakes, technology to reduce damages of disaster, and research on technologies for disaster countermeasures.

MLIT selectively promotes R&D concerning comprehensive land use using land management technology from state-of-the-art technologies based on the Basic Plan for the Ministry of Land, Infrastructure and Transport Technology [literal translation] (adopted in November 2003 by MLIT), the Basic Plan for Research and Development in Information and Telecommunications [literal translation] (adopted in February 2000 by the Telecommunications Technology Council of the Ministry of Posts and Telecommunications). The Geographical Survey Institute (GSI) conducts continuous GPS observation by using Electronic Reference Stations[fn.15], observation of crustal deformation and plate motion by using state-of-the-art technologies, including a Very Long Baseline Interferometry (VLBI) and an interferometric SAR, and further analysis of the data obtained from the above-stated observations.

The Japan Meteorological Agency (JMA) establishes and operates observation facilities, while providing centralized information including observation data from relevant institutions. JMA also works together with NIED to conduct R&D toward further advancement of the emergency earthquake alert service which was started services to general public. The Japan Coast Guard (JCG) promotes seafloor geodetic observation, bathymetric survey and research on active faults. In addition, SCJ which is a representative institution of researcher communities implements prediction of disaster caused by climate changes and analysis on social mechanism of earthquake disasters. The Council submitted reports such as the one on paradigm conversion for building safe and secure society in May 2007.

(Antiterrorism and public safety measures)

In recent social conditions where international terrorism acts are aggravated, and deterioration of public safety is pointed out, to realize safe society with less crime is one of the most important and urgent needs of the general public. Therefore, it is quite important to further enhance approaches utilizing the most advanced S&T for antiterrorism and public safety measures.

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fn. 14 MP (Multi-Parameter) Radar: Weather radar that uses two types of horizontal and vertical polarized waves. It enables estimation of precipitation, discrimination of rain and snow, etc. thanks to its high accuracy and resolution.

fn. 15 As of the end of March 2008, 1,238 stations were established.

Regarding antiterrorism, to promptly detect hazardous and dangerous materials in advance, MEXT newly implemented the Project on Science and Technology for a Safe and Secure Society in FY 2007, in addition to the Science and Technology Promotion Adjustment Expenses, and conducts R&D based on the excellent technologies of our country of systems for detecting explosive materials, biological agents and chemical agents, and methods for treating dangerous materials in a safe manner.

Regarding crime-fighting measures, intensive promotion of the development of technologies and systems that can be used at the site of crime prevention, investigation support, and identification is required in order to realize a society with less crime using limited human resources. Therefore, the National Police Agency (NPA) implements the development of technologies to address crimes that fraudulently use the anonymity of the Internet, crime prevention and investigation support based on behavioral science, development of identification and testing methods using the latest information processing technologies, personal forensic examination by using three-dimensional facial imagery, DNA profiling, substance identification technology for identification of poisonous materials and trace evidence, and R&D of technologies to ensure children's safety at school and on route to and from school. In addition, JST's Research Institute of Science and Technology for Society (RISTEX) promotes R&D to secure children's safety.

(Transportation and transit systems)

There is an urgent need to restore the safety and reliability of the means of transportation, which are transportation devices necessary for everyday life of the general public. It is necessary to intensively promote the utilization of new technology to thoroughly prevent accidents and ensure safety by considering the expected demand increase in air transportation in the future as well as human factors such as operators at transportation facilities, and "finding," "decision" and "operation" of car drivers.

NPA and MLIT implement R&D in relation to a system to support safe driving through coordination with infrastructure, and information processing capacity relevant to safe driving. In addition, they are working with advanced R&D towards the realization of more safe and comfortable transportation and transit systems in the future.

MLIT provides subsidies to the Railway Technical Research Institute in order to promote R&D for the practical use of the superconducting magnetically-elevated train, which is targeted for high speed transportation in the future. In addition, the ministry promotes technology with high versatility for cross-sectional needs among deep subterranean utilization businesses, based on the "Vision of Research and Development Regarding the Deep Subterranean Utilization." [literal translation]

In addition, as for air transportation system, which is one critical social infrastructure for modern lifestyle, it is expected not only to support the maintenance and improvement of safety and environmental compatibility, but also to have ripple effects on a wide range of areas including information and telecommunication, nanotechnology and materials.

MEXT promotes R&D of technologies to prevent accidents and ensure the safety of transportation and new technologies for the domestic production of aircraft to deal with new demand, based on the Promotion Policy for Research and Development concerning Aerospace Science and Technology [literal translation] (July 2006) formulated by CST's Subdivision on R&D Planning and Evaluation. More specifically, toward domestic production of passenger aircraft which will be the first in 40 years since the production of YS-11, the ministry has achieved successful results in manufacturing of large structure model by using low-cost composites ahead of the world, elucidation of noise-generating mechanisms. Furthermore, following the Promotion of Research and Development of Technologies for Silent Supersonic Aircraft [literal translation] (July 2007) formulated also by the above-stated Subdivision, the ministry promotes R&D to acquire advantageous technologies that can lead the world. Furthermore, to deal with the increase in the number of flight operations, the ministry also works on R&D of the next-generation flight operation systems that will improve safety and efficiency.

METI promotes the R&D of environmentally-friendly, high-performance small aircraft as a project to develop technologies for domestically developed aircraft that meet new demand and implements

the development of element technologies, including aerodynamic design technologies, carbon fiber composite materials technologies, and flying and cockpit system technologies for improvement in fuel consumption by 20%, improvement in silence, and improvement in safety that will be utilized for development of high-performance jetliners through the industry-academia-government collaboration. Furthermore, in R&D projects of engines for environmentally friendly small passenger aircraft, the ministry implements the development of technologies for practical use of engines in small passenger aircraft in the 50-seat class in which the properties of energy efficiency and silence are dramatically improved. Furthermore, the ministry implements the creation and development of manufacturing and processing technologies for structural components for next-generation aircraft, thereby achieving energy saving and reduction in CO_2 emissions through drastic weight saving of aircraft. Based on the achievements obtained through such projects, the ministry promotes joint research between Japanese and French industries. In addition, the ministry implements surveys concerning technologies that are required for the development of an aircraft which can cruise at high speeds exceeding Mach 0.8 or 0.9 which is the cruising speed of ordinary aircraft with the cooperation of relevant institutions in cooperation with the Ministry for Ecology and Sustainable Planning and Development of France. Furthermore, the ministry also implements the development of fundamental technologies for advanced systems that contribute to improved safety and reduced operation costs of aircraft and surveys aiming for pursuing feasibility of the cargo aircraft-X (C-X), the rescue flying-boat (US-2) and other aircraft of the Ministry of Defense to private use.

The Electronic Navigation Research Institute selectively implements R&D on effective utilization of airspace and capacity expansion of flight routes, R&D on capacity expansion of congested airports, R&D of improved safety and efficiency achieved by preventive safety, and new technologies for ensuring security and smoothness of air traffic, and these research projects are expected to be important projects for developing future air transportation.

The major research topics in FY 2007 for infrastructure are shown on Table 2-2-10.

Table 2-2-10 Major Research Projects in Infrastructure (FY 2007)

Ministry	Research organization	Subject
National Police Agency	National Research Institute of Police Science	• Study concerning detection and identification methods of biological agents to cope with biological terrorism • Study on on-site treatment technologies of explosive substances • Research on the improvement of individual identification utilizing three-dimensional facial imaging • Development of methods for identification from biological samples through the single nucleotide polymorphisms (SNPs) analysis • Study on profiling of tablet-type narcotics • Research on speaker recognition techniques adequate for new speech communication methods • Study on case link analysis on enhancement of serial incidents and assumption of profile of criminal • Study on prevention of juveniles from crime and supports to victimized juveniles • Cognitive science study on information processing ability of drivers • Development of advanced traffic accident analysis technologies
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	• Considerations on safety measures related to a little longer-period ground motion at outdoor tanking stations • Expenses required for R&D system of fire safety and disaster preparedness technologies
	National Research Institute of Fire and Disaster	• Information system for supporting dramatic improvement in on-site fire-fighting/rescue activities and disaster prevention activities • Reduction in damage of dangerous facilities during large-scale earthquake • Perception of fire behaviors in buildings and facilities designed for various purposes

Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	• Special Project for Earthquake Disaster Mitigation in Urban Areas • Development of Dense Ocean-floor Network System for Earthquakes and Tsunamis • Promotion of seismic investigation and research (priority investigation and observation) • Promotion of centralization of observed data
	Office of Science and Technology Policy	• Safe and Secure Science and Technology Project
	Japan Science and Technology Agency	• Advanced integrated sensing technology
	RIKEN	• Development of a Supersensitive Poison Sensor Using a Nanostructure Film
	National Research Institute for Earth Science and Disaster Prevention	• Earthquake engineering research utilizing the Three-Dimensional Full Scale Earthquake Testing Facility (E-Defense) • Maintenance, Inspection, etc. of the three-dimensional full scale earthquake testing facility • Renewal of high-sensitivity seismograph stations
	Japan Agency for Marine-Earth Science and Technology	• Long-period monitoring system of drilling hole
	Japan Aerospace Exploration Agency	• Operation of the Advanced Land Observing Satellite "DAICHI" (ALOS) • High-precision positioning, navigation and timing experimental technology using a quasi-zenith satellite system • Study on the next disaster-monitoring satellite, etc. • Research and development of technologies for higher performance domestic passenger aircraft • Research and development of silent supersonic demonstrator air craft
	Special Coordination Funds for Promoting Science and Technology	• Underwater security sonar system • Development of integration system of detection and treatment of explosives for anti-terrorism act • Development of simultaneous on-site detection methods for chemical agents and biological toxins • Research and development of detection system for nuclear substance concealed in hand-carried baggage
Ministry of Health, Labour and Welfare	National Institute of Occupational Safety and Health	• Research on the improvement and practical use of risk management technology in accident-prone areas
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization	• Project on environmentally-compatible, high-performance small aircraft • R&D on an engine for environmentally-compatible small aircrafts

Ministry of Land, Infrastructure and Transport	Technology and Safety Division, Policy Bureau	• Development of emergency/alternative transportation support system • Research and development on next-generation inspection technologies to strengthen terrorism countermeasures for public transport • Development of technologies for prevention of accidents caused by human error
	Subsidy for the development of railway technologies	• Development of a superconducting magnetically levitated train
	Road Bureau	• Technologies for executing provision of information, reminder, warning, etc. of traffic events in the range that is not visible directly from drivers
	Ports and Harbours Bureau	• Damage reducing technologies, including enhancement of quake-resistant performance of structures for large-scale earthquakes • Prediction/simulation technologies of local phenomena caused by Tsunami • Technologies dealing with ultra external force generated by great earthquake • National land conservation and sediment budget • Development of drift sand balance control technologies • Evaluation/prediction technologies for inspection/diagnosis and soundness level of structures • Technology for reducing life cycle costs including social capital
	Civil Aviation Bureau	• Technologies for air traffic control/operation support by utilizing IT technologies
	National Institute for Land and Infrastructure Management	• Research on water management method utilizing precipitation prediction information • Research on the method for evaluating the level of social infrastructure development • Research on adequate management method of sewage pipes and drains • Research on procedure of cost reduction and safety operation for airports by preventive maintenance system
	Geographical Survey Institute	• Enhancement and improvement in prediction accuracy of crustal movement monitoring/modeling for reduction of damage caused by earthquake, volcanic eruption, etc.
	Public Works Research Institute	• Technologies for perception of planar analysis information of precipitation by utilizing satellite information, etc. • Technologies for reducing damages, including quake-resistant design of structures for large-scale earthquake • Development of construction systems using robots, etc. • Development of technologies for predicting the danger of landslide disaster caused by heavy rain and earthquake and alleviating damages thereof • Technology for the qualitative improvement of river levees for improving flood control safety • National land conservation and sediment budget • Enhancement of management of social capital, etc., and reduction in life cycle costs
	Building Research Institute	• Development of popular-type of quake-resistant refurbishment technologies • Development of reorganization of cities and buildings that deal with reduced population and aging society with a falling birthrate • Development of technologies for reproducing/utilizing existing stock • Development of technologies for accident risk assessment and improvement in safety and security in residences/buildings.
	Japan Meteorological Agency	• Earthquake observation network, earthquake and tsunami monitoring system, etc.

8 Frontier Science

Frontier science is an area to explore and probe the unknown in space and the oceans, and to promote R&D for the development and use as a new area for utilization. In the Third Science and

Technology Basic Plan, frontier science is positioned as an area where R&D should be promoted, focusing on R&D issues that must be addressed by the nation. This area aims to contribute to improvement in the safety and security of people's lives, the quality of people's lives, development of economic society, the overall security of Japan, and sustainable development of human beings, by using communication satellites and positioning, navigation and timing systems, earth observation and monitoring systems, and the oceans which have abundant resources.

(1) Space development and utilization

Space development and utilization expands universal knowledge regarding the origin of the universe and various phenomena on earth, and contributes largely in improving the quality of people's lives and development of industries. In addition, space technology is a strategic technology that is closely related to national security in a broad sense, and also it is a very important since it also relates to the international status of Japan.

Space development and utilization in Japan is strategically and selectively promoted, as lead by JAXA, based on the Basic Strategy of Japan for the Development and Use of Space (September 2004, CSTP) and the Long-Term Plan of Space Development (hereinafter referred to as the "Long-Term Plan") (February 2008, Prime Minister and Minster of MEXT), and Japan has continuously achieved significant advances as one of the leading countries of space technology in the world.

The future major satellite launching plans of Japan are as shown on Table 2-2-11.

Table 2-2-11 Japan's Major Satellites Launch Schedule

Satellite	Weight (kg)	Orbital altitude (km)	Launch vehicle	Launch date	Major objectives
Japanese Experiment Module KIBO of the International Space Station (JEM)	Approx. 26,800	Approx. 400	U.S. Space Shuttle	FY 2008 or later (Special storage room launched in FY 2007)	Expansion of Japan's space activities, promotion of leading science and technology development, and contribution to the advancement of international cooperation
Greenhouse gases Observing SATellite (GOSAT)	Approx. 1,750	Sun synchronous orbit Approx. 650	H-IIA	FY 2008	Continuous observation of greenhouse gases, to contribute to the elucidation and forecast of global warming, climate change, etc.
H-II Transfer Vehicle (HTV)	Maximum supply weight: Approx. 6,000	Approx. 350 ～460	H-IIB	FY 2009	To supply materials to the International Space Station by the Japanese transport system
Quasi-Zenith Satellite System (QZSS)	Approx. 1,800	Quasi-zenith orbit (Long radius of the orbit: Approx. 42,000)	H-IIA	FY 2009 (planned)	To demonstrate the fundamental technology of positioning, navigation and timing systems using satellites, which reinforces the global positioning system
Venus Climate Orbiter (PLANET-C)	Approx. 480	Orbit around Venus (Approx.300-80,000))	H-IIA	FY 2010	To explore Venusian atmosphere, and solve riddles in the basic principles of planetary weather and the evolution of atmosphere
Global Change Observation Mission-Water (GCOM-W)	Approx. 1,800	Sun synchronous orbit Approx. 700	H-IIA	FY 2011	To implement observation on a mass global scale that will be effective for ascertaining the global water circulation system
Radio-Astronomical Satellite (ASTRO-G)	Approx. 910	Highly elliptical orbit (Approx.100-20,000)	(Under review)	FY 2012	To describe the center of galaxies and areas appearing newborn stars with the highest resolution, and resolve the physical conditions
Global Precipitation Measurement/Dual-frequency Precipitation Radar (GPM/DPR)	Approx. 3,000	Approx. 400	H-IIA (Under review)	FY 2013	To develop the Dual-frequency Precipitation Radar (DPR) for monitoring 3-dimensional structure of rainfall, as part of international cooperation in the Global Precipitation Measurement (GPM) Program
Mercury Exploration Project (BepiColombo)	220 (MMO)	Elliptical polar orbit around Mercury (Approx. 400 ～12,000) (MMO)	Soyuz Fregat 2B	FY 2013	To observe the magnetic field, magnetosphere, the inside and the surface of mercury from many angles through international cooperation with the European Space Agency. Japan is in charge of the Mercury Magnetospheric Orbiter (MMO).

Note: The launch dates above are as of March 2008 and subject to change.

(Space transportation system technology)

In order to maintain Japan's overall security and autonomy in international society, it is important to have the ability to transport necessary satellites to a given place in space by the nation itself. Also, because space transportation system technology is an advanced system technology, the activities themselves for improving technical capabilities sophisticate the industry and develop the social economy. Therefore, "Space Transportation System" is selected as an essential R&D issue.

In particular, the development, manufacturing and launch of H-IIA launch vehicles, H-IIB launch vehicles (an upgraded version of the H-IIA launch vehicle), H-II transfer vehicles (HTV) and GX launch vehicles, implemented by JAXA, are positioned as one of the strategic prioritized S&T, named "highly reliable space transportation system. As for the H-IIA launch vehicle, which is Japan's central rocket that can launch a large-size satellite, transportation service for launching rockets by private sector was implemented starting in FY 2007. In FY 2007, the lunar explorer satellite KAGUYA (SELENE) was launched by using the 13th H-IIA and the Super High-speed Internet satellite KIZUNA (WINDS) by using the 14th H-IIA. As a result, the success launching rate of H-IIA rockets has achieved 90% or over, which far exceeds the world level in the initial operation phase. Also, in order to secure HTV, which should be involved in transportation of materials such as food, consumables, and experimental appliances to the International Space Station (ISS) and should constitute contribution means to Japan's ISS Project, as well as to secure measures of launching the HTV, Japan promotes the development aiming for launching of a technology-demonstration vehicle and test vehicle of H-IIB rocket, which has improved the launch capability of the H-IIA rocket and the capability to transport an eight-ton class satellite to the geostationary transfer orbit in FY 2009. Development, manufacturing, and launch of these H-IIA launch vehicles, H-IIB launch vehicles, and HTV are positioned as technologies configuring the Key Technologies of National Importance, the Space Transportation System Technology, which is being promoted under the national long-term strategy in the Third Basic Plan. Furthermore, as for the GX launch vehicles, which is developed through the initiative of the private sector in cooperation with the government and private sectors for the first time in Japan, METI implements R&D concerning avionics that the control the flight of rockets, and JAXA develops propulsion systems fueled by liquefied natural gas (LNG) that will become the second stage engine. At present, assessment is being implemented, considering the fact that there was a request by private sectors for strengthening roles of the government to play in GX rocket development, as well as assessments related to technical matters at JAXA. Under such circumstances, the government is going to promote the GX rocket development, including the LNG-fueled propulsion systems based on the outcome of such assessments.

(Telecommunication satellites systems, positioning, navigation and timing satellite system, satellite observation and monitoring system, and satellite sensor technology and fundamental technology of satellite)

Utilization of satellites for communications, broadcasting, and other purposes offer a broad range of benefits in terms of wide-area use, broadcast simultaneity, durability following disasters, etc. To this end, the telecommunication satellites systems, positioning, navigation and timing (PNT) satellite system, satellite observation and monitoring system, and satellite sensor technology and fundamental technology of satellites are selected as essential R&D issues.

Engineering Test Satellite-VIII KIKU No.8" (ETS-VIII), jointly developed by MEXT and MIC, to test and demonstrate large-scale satellite bus technologies for three-ton size satellites in stationary orbit, large deployable antenna technologies, mobile communication technologies of satellites and fundamental technologies related to satellite positioning systems utilizing high-accuracy clock standards, was launched in December 2006 and is now under operation. Both ministries jointly developed the Wideband Inter Networking engineering test and Demonstration Satellite KIZUNA (WINDS). The objective of WINDS is to develop and demonstrate satellite communication

technologies that enable ultrahigh-speedInternet/broadband data transmission and ultrahigh-speed networking technologies using satellite communication.

As for the PNT satellite system, under the cooperation of MIC, MEXT, METI and MLIT, R&D of a quasi-zenith satellite system that makes high-precision positioning, navigation and timing possible without being affected by mountain valleys or tall buildings are being implemented. Explanation of the satellite observation and monitoring system is included in Part 2, Chapter 2, Section 2, 3 (1) and 7.

As for the R&D regarding satellite sensor technology and fundamental technology of satellites, the Program to Improve Reliability (in relation to satellites) is selected as strategic prioritized S&T, and JAXA works to improve the reliability of satellite bus technology and components.

(Acquisition of technologies for Manned space activities based on the International Space Station project)

The International Space Station (ISS) project is an international cooperation project in which five pole countries of Japan, US, Europe, Canada, and Russia participate to jointly construct a space station in earth orbit. Japan participates in the project, aiming to accumulate technologies for manned space activities and acquisition of scientific knowledge through development and operation of the Japanese Experimental Module KIBO and an ISS fueling aircraft. As for KIBO, a special storage room was launched in March 2008, and the room was built on to ISS by Astronaut Doi and other crew members. In FY 2008, a special experiment room and an external platform for experiments will be launched to implement use of KIBO. Furthermore, as for the H-II Transfer Vehicle (HTV), which will play the role of material transportation to ISS, Japan develops it aiming for launch of a technical demonstration vehicle in FY 2009.

(Solar system exploration and space astronomical observation)

JAXA serves as the center of space science in Japan by launching science-mission satellites and conducting R&D with the participation of researchers from various universities or academic institutes nationwide, and has made world-class achievements.

Japan promotes the scientific satellite project as one of its essential R&D issues and succeeded in launching the lunar orbiting satellite KAGUYA (SELENE) and putting it in the lunar orbit in September 2007. The satellite KAGUYA implemented imaging of the earth-rise and the earth-set by using a hi-resolution camcorder for the first time in the world. Steady observation has been implemented since late in December 2007, and the observation is expected to bring significant achievements in the future. In addition, Japan continuously promotes the development projects such as: the 24th scientific satellite (Venus exploration project: PLANET-C), the 25th scientific satellite (radio astronomical satellite: ASTRO-G); and Bepi Colonbo (Mercury exploration project: an international cooperation project with ESA).

"Earth-Set" High-resolution photo-shot from the lunar explorer satellite Kaguya (SELENE)
Photo: Japan Aerospace Exploration Agency/Japan Broadcasting Corporation

(Promotion of international cooperation/collaboration)

In accordance with global-scale problems that gradually become serious such as environmental changes and large-scale natural disasters, the necessity of earth observation satellite technology and the importance of multinational cooperation and collaboration in space technology are growing than ever. Japan, through Asia-Pacific Regional Space Agency Forum (APRSAF), which serves as the host country, as well as other international conferences such as Committee on the Peaceful Uses of Outer Space (COPUOS) and Committee on Earth Observation Satellites (CEOS), aims for further promotion of international cooperation in the area of space science. Especially in Asia, Japan promotes the Disaster Management Support System in Sentinel-Asia project under cooperation of 51 institutions in 20 countries in the world and eight international organizations (as of January 2008) through APRSAF.

(2) Ocean Development

(Promotion of R&D in frontier (oceans) science

Because observation and exploration of the oceans, which account for 70% of the surface of the earth, contributes extensively in the society, from the clarification of global environment changes to disaster prevention/reduction and securing of resources, global efforts are being made in this area, mainly under the initiative of the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In particular, for Japan, a maritime state surrounded on all four sides by ocean and possessing the world's sixth largest exclusive economic zone (EEZ), the R&D in the field of oceans is an important task that may change the future of the country. From such viewpoint, in the Basic Concepts and Promotion Measures for Ocean Development from a Long-Term Viewpoint (CST recommendation, August 2002) it is stated that "for the development of ocean policies in the future, it is important to harmonize the three viewpoints, namely 'knowing the ocean (oceanic research/infrastructure development),' 'protecting the ocean (conservation of the ocean)' and 'using the ocean (usage of the ocean)' in a good balance, while showing strategic policies and promotional measures for the sustainable usage," and the Council promotes ocean policies based on this idea. Concerning the Basic Concepts and Promotion Measures, CST's Subdivision on Ocean Development finalized the follow-ups in December 2007. Furthermore, according to the Basic Act on Ocean Policy enforced in July 2007, the Headquarters for Ocean Policy, the general director of which is the Prime Minister, was established, and the Secretariat of headquarters was established in the Cabinet Secretariat to intensively and comprehensive promote policies concerning ocean. In the sectoral promotion strategy for the frontier (ocean) field in the Third Science and Technology Basic Plan, the Next-generation Ocean Exploration Technology which constitutes the Earth Observation and Ocean

Exploration System of the Key Technologies of National Importance, and the Offshore Platform Technology were chosen as strategic prioritized S&T. Furthermore, the important R&D issues in the following three domains were chosen.

(Deep sea and deep seabed exploration technology, technology to utilize living marine resources)

MEXT promotes the development of fundamental technology necessary for the observation/exploration of the oceans by JAMSTEC, and research on the oceans using such fundamental technology. For example, an deep-sea cruising vessel URASHIMA having the world record for the longest continuous autonomous cruise (317 km) succeeded in making precision bathymetric charts with the acoustic probing technology in the hydrothermal eruption area on Okinawa Trough. Furthermore, SHINKAI 6500, a manned research submersible with the world's top-level depth range (6,500 m in depth) is used for research on creatures in deep sea and extreme environmental conditions, and it achieved 1,000th underwater cruising in March 2007 after the first cruising in June 1990. Concerning the strategic prioritized S&T, since the Next-generation Ocean Exploration Technology was chosen as one of the technologies constituting the Earth Observation and Ocean Exploration System, MEXT promotes the R&D for this technology at JAMSTEC. The project for the development of deep sea riser drilling technology by using the deep sea drilling vessel CHIKYU, which has the most advanced drilling capabilities in the world and was started in FY 2006, allows drilling of the previously unreachable mantle as well as sampling useful microorganisms in the seismogenic zone. Furthermore, starting in FY 2007, MEXT implemented the projects for the development of technologies for a next-generation deep-sea cruising vessel and the development of technology for an unmanned research vehicle for deep ocean with high performance on a full-scale operation. These technologies enable surveys and observations in sea areas and marine phenomena where surveys are difficult with conventional means of ships, and also enable surveys and observations that require heavy work and precision work at deep-sea levels.

Manned research submersible SHINKAI 6500 with the world's top-level depth range (6,500 m in depth)
Photo: Japan Agency for Marine-Earth Science and Technology

(Oceanic environment observation/forecasting technology, ocean usage technology, oceanic environment conservation technology)

MEXT promotes observation prediction and simulation research on the global environment (observation of ocean, land and atmosphere and prediction/simulation of climate changes conducted around the world using observation facilities such as research vessels, buoys and terrestrial observation tools, aiming to clarify the global environmental changes including global warming) through JAMSTEC. For example, MEXT confirmed in August 2007 that the sea-ice area in the Arctic Ocean became smallest in recorded history and indicated that the area is decreasing at a speed far exceeding the prediction by IPCC. Furthermore, MEXT analyzed the data obtained through observation and research by utilizing the supercomputer Earth Simulator, which has world's highest level of performance, conducted modeling research for physical, chemical, and ecological programs of the global environment. Through such activities, MEXT conducted two-year continuous predictions of

the Indian Ocean Dipole mode phenomenon in October 2007 and succeeded in reproducing the phenomenon on a Madden-Julian oscillation model, thus contributing to improvement in prediction accuracy of phenomena that affects climate on a global scale.

METI continues to implement surveys for reserves of oil and other resources in cooperation with Japan Oil, Gas and Metals National Corporation.

MLIT is working jointly with the Port and Airport Research Institute to improve the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS).

JMA continuously implements surveys and research to improve monitoring and observation information of ocean phenomena and climate changes, including the observation of oceanic and maritime climatic phenomena and the clarification of the El Nino phenomenon.

JCG conducts R&D on oceanic surveying and observation technology as well as analysis technology.

The National Maritime Research Institute implements research on safety and environmental conservation in terms of ocean technology. In relation to the North East Asian Regional-Global Ocean Observing System (NEAR-GOOS) project, JMA and JCG operate a system for promoting the exchange of oceanic data for NEAR-GOOS area, furthering order to better promote oceanographic research.

(Research on clarifying the inner structure of the earth, undersea earthquakes and tsunami prevention technologies)

MEXT promotes research on the dynamics of the earth's interior, wherein surveys on crustal structure contributing in the dynamics analysis of ocean floor plates and survey on the delimitation of the continental shelf are implemented, using the remotely operated unmanned research vessel KAIKO 7000 and deep sea research vessels. For example, development of an earthquake and tsunami observation system to monitor the magnitude of earthquakes and tsunamis or crustal movement in real-time at the predicted source zone of the Tonankai and Nankai Earthquakes, which may cause extensive damage in our country is being implemented from FY 2006. In September 2007, as the first international operation of the deep sea drilling vessel CHIKYU, the launch of a drilling and research expedition was implemented at Kumano-nada offshore of the Kii Peninsula. Through this expedition, it is expected that the generating mechanism of massive ocean-trench earthquakes will be unraveled.

Furthermore, in order to promote surveys required for defining delimitation of the continental shelf of Japan, steady surveys are being conducted over the whole government under the overall coordination by the Headquarters for Ocean Policy, while ensuring cooperation among MOFA, MEXT, METI, MLIT, etc.

Major research areas in frontier science implemented in FY 2007 are as shown on Table2-2-12.

Table 2-2-12 Major Research Projects in Frontier Science (FY 2007)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	• Core technologies of satellite for disaster prevention measures and risk management
Ministry of Education, Culture, Sports, Science and Technology	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Technology for next generation ocean exploration system • Development of the world's best deep sea riser drilling technology by CHIKYU • Development of technology for next-generation deep-sea cruising vessel • Development of technology for unmanned research vehicle for deep ocean with high performance
	Japan Aerospace Exploration Agency	Highly reliable space transportation system technology • Development, manufacturing and launch of H-IIA launch vehicles • H-IIB launch vehicles • H-II transfer vehicles (HTV) • GX launch vehicles Technology to improve the reliability and functions of satellites • Program to Improve Reliability (in Relation to Satellites)
Ministry of Economy, Trade and Industry		• R&D in relation to the usage of slag • R&D on remote sensing technology
	National Institute of Advanced Industrial Science and Technology (AIST)	• Prediction of Earth and ocean environments based on geochemical and paleontological research of modern and past environments • Marine geological research and survey
	New Energy and Industrial Technology Development Organization (NEDO)	• Project on the Development of Fundamental Technology for the Next-generation Transportation System Designing (GX launch vehicle)
	Japan Oil, Gas and Metals National Corporation (JOGMEC)	• Methane hydrate technology development • Deep-sea mineral exploitation survey
Ministry of Land, Infrastructure and Transport	Maritime Bureau	• Research and development of offshore platform technologies • Development of natural gas hydrate (NGH) transportation vessel
	Hydrographic and Oceanographic Department, Japan Coast Guard	• IOC Sub-Commission for the Western Pacific Region (WESTPAC)
	Japan Meteorological Agency, Meteorological Research Institute	• Observational research on changes in ocean carbon cycle

[Interdisciplinary areas]

1 Key Technologies of National Importance

In order for Japan to achieve sustainable growth and lead the world in the rapidly changing conditions, such as the restricted supplies of resources and energy, global warming and frequent occurrence of natural disasters, it is important to establish a long-term national strategy, and carefully select and promote important technologies.

To this end, the government selected five Key Technologies of National Importance, namely space transportation system, earth observation and ocean exploration system, FBR cycle technologies, next-generation supercomputer and x-ray free electron laser upon the formulation of the Third Science and Technology Basic Plan. These Key Technologies of National Importance are intended for the improvement of overall national security and the achievement of the top world-level research function, and will be

continuously promoted with high priority.

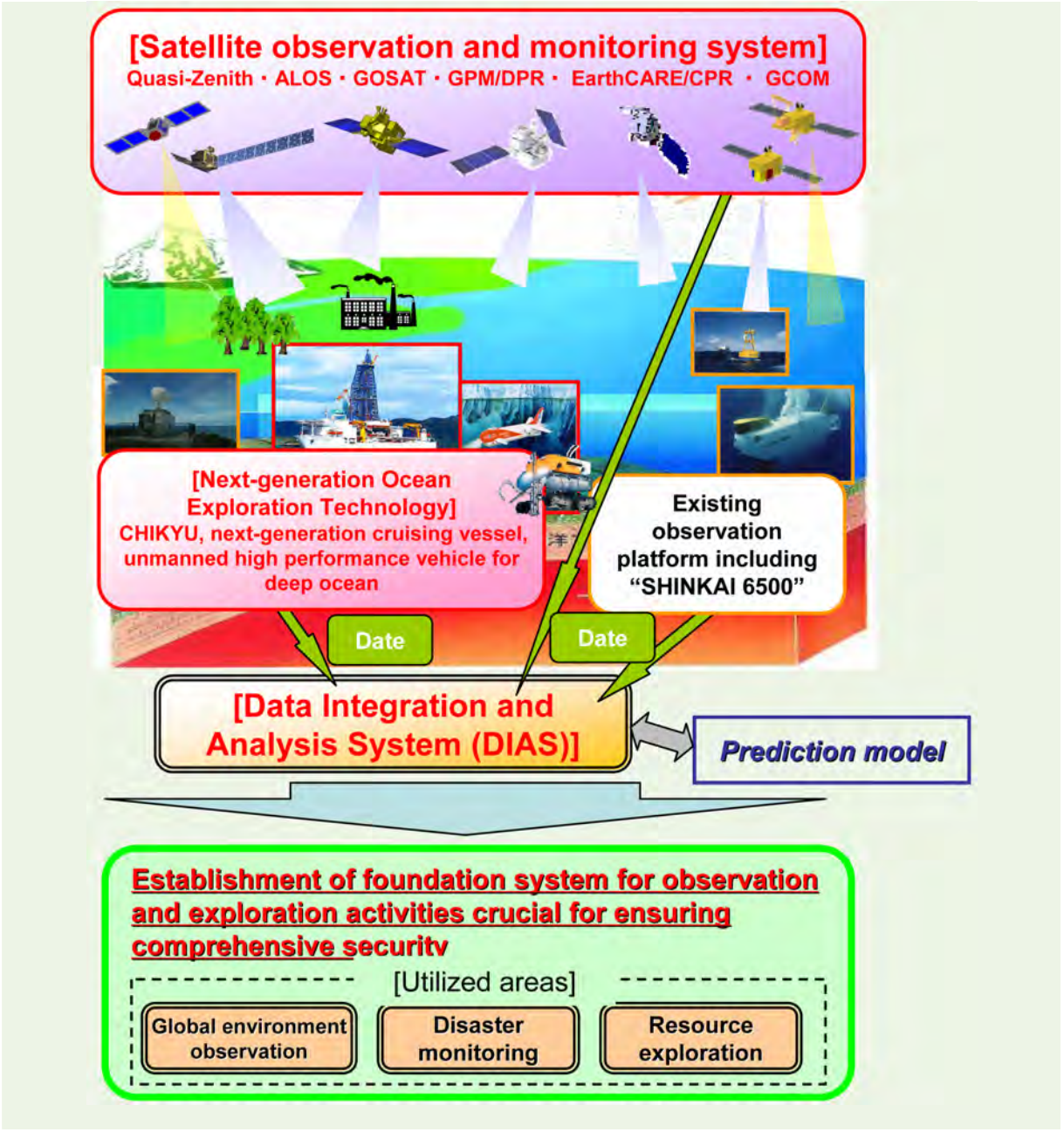
(1) Space transportation system technology

Refer to Part 2, Chapter 2, Section 2, 8 (1).

(2) Earth Observation and Ocean Exploration System

In order to predict changes in the global environment, it is necessary to prepare a global observation network and to manage and data derived from the network. In addition, detailed topographic survey and resource exploration in sea areas surrounding Japan are necessary from the viewpoint of overall national security. The earth observation and ocean exploration system aims to integrate, analyze, and provide data obtained from observation and exploration from the oceans and space to address the settlement of such issues and comprises three technologies: next-generation ocean exploration technology, satellite observation and monitoring system, and data integration and analysis system (DIAS). The promotional framework for the entire system was evaluated by CSTP in FY 2006, and social contributions in the areas of global environment observation, disaster monitoring and resource exploration are expected in the future (Figures 2-2-13).

Figure 2-2-13 Conceptual Diagram of the Earth Observation and Ocean Exploration System



(3) FBR cycle technologies

Refer to Part 2, Chapter 2, Section 2, 5 (1).

(4) Next-generation supercomputer

Next-Generation Supercomputer (Conceptual Image)
Source: RIKEN

Simulation using supercomputers is being firmly establishing its position as the method of S&T of modern days, together with theory and experiment. Because supercomputers enable a large-scale simulation at high speed, they are used for analysis of collisional damage of automobiles and forecast of the routes of typhoons or occurrence of concentrated heavy rain, etc. In order for Japan to maintain world-leading positions in a wide range of areas such as science and technology, academic research, industry, and medicine, MEXT started the project Development and Use of an Advanced, High-Performance, General-Purpose Supercomputer from FY 2006. Aiming to start operation in FY 2010 (and completion in 2012), the project is promoted by RIKEN under close industry academia-government collaboration.

In March 2007, MEXT decided the facility would be located in Kobe City (within the second phase) and determined the system configuration to be the complex general-purpose system comprising two arithmetic sections in September and started detailed design.

(5) X-ray free electron laser

X-ray free electron laser (XFEL) is a light having the combined features of laser and radiation light, and is a technology to allow analysis that is impossible with existing measures. Aiming for realization of a research facility with the world's best performance, which allows instant measurement and analysis of the ultrafine structure of a single atom, ultrafast behavior and alteration from chemical reactions, the technology was selected as a Key Technologies of National Importance and is currently being developed and improved. As a joint project with RIKEN and Japan Synchrotron Radiation Research Institute (JASRI), the system has been being developed as a facility attached to the synchrotron radiation facility SPring-8 since FY 2006 It is expected to bring breakthroughs in a broad range of science and technology fields, including biological science and nanoregion structural analysis such as the analysis of membrane protein that is difficult to crystallize, real-time observation of catalytic reactions and the generation of new functional materials, as well as to contribute in the generation of new knowledge through innovative utilization research.

Conceptual drawing of the X-ray Free Electron Laser (XFEL)
[The rectangular-shaped building at left is XFEL. The circular-shaped building is the Super Photon ring-8 GeV (SPring-8)]

Source: SPring-8 Joint Project for XFEL

2 Science and Technology for a Safe and Secure Society

The Third Science and Technology Basic Plan posts "The world's safest country: making Japan the world's safety country" as one of goals of the policy and promotes S&T approaches that contribute to building of safe and secure society in accordance with the strategies such as the sectoral promotion strategy, and science and technology promotion strategy contributing to safety [literal translation].

MEXT finalized the policy to promote research and development on science and technology for a safe and secure society in July 2006 and implements R&D according to the policy. Furthermore, starting in FY 2007, MEXT implements the project on science and technology for a safe and secure society, which aims to make contributions to national security and security of people's life by promoting R&D of important R&D issues including anti-terrorism measures and sharing of knowledge and technologies.

Concerning international cooperation, approaches are being promoted under the framework of bilateral science and technology cooperation agreements between Japan and the US, Japan and the UK, and Japan and France. In particular, with the US, cooperative activities are being implemented in a positive manner as the U.S.-Japan Framework Initiative for a Safe and Secure Society.

In addition, RISTEX promotes solution-providing R&D based on various on-site knowledge and experiences in the four areas of Protecting Children from Crime, Information Technology and Society, Brain-Science and Society, and Science Technology and Humanity, utilizing knowledge not only in the area of natural sciences, but humanities and social sciences, with the objective of providing specific solutions to various problems in society and contributing in social security.