

## **3.2 Priority Strategies for Science and Technology**

### **3.2.1 Promotion of Basic Research**

Basic research builds on the free thinking of researchers to discover new natural laws and principles, to build original theories, and to predict and discover unknown phenomena, thereby contributing to the expansion of humankind's intellectual assets and bringing about creation of research results of the world's highest standards and of innovative new technologies that support the economy. While the results of basic research do not always lead immediately to practical applications, they rather accumulate as the common property of all humankind, and should therefore be widely, steadily, and continuously promoted.

In promoting basic research, attention must be given to the fact that such research depends more on the capabilities of individuals than on those of groups. It is therefore necessary to support researchers so that they are able to carry out highly creative research based on their liberal and open ideas. There is also a need to promote cross-sectoral research whereby researchers from different areas of expertise step outside their respective areas for exchanges and, in the process, come up with new ideas. To this end, while keeping in mind global research trends and conditions in Japan, research is being actively promoted in areas that require organized and international promotion, and in areas that require large-scale facilities and equipment for expansion of the frontiers of knowledge.

In addition, universities and Inter-University Research Institutes, which play a core role in the academic research that contributes to the development of culture and the building of civilization, are comprehensively developing both research activities and education activities as integral parts of their entire systems.

### **3.2.2 Prioritization of Research and Development in Response to Issues Important to the State and Society**

Aggressive and strategic investment in priority sectors and promotion of research and development

are essential for ensuring sustained economic development through vitalization of the economy and industry, and for assuring people of safe, secure lives.

The following measures were taken in FY 2004 in line with the Priority Strategies stipulated in the Basic Plan and the "Promotion Strategy for Each Sector" (see Figure 3-1-4).

#### **3.2.2.1 Life Sciences**

##### **(1) Promotion of 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.

##### **(Efforts toward Industrialization, Etc)**

To strengthen efforts toward commercialization of the life sciences, the heads of five ministries and agencies (Director-General of the Science and Technology Agency, Minister of Education, Minister of Health and Welfare, Minister of Agriculture, Forestry and Fisheries, and Minister of International Trade and Industry [all of them are at that time]) drew up the "Basic Policy for the Creation of Biotechnology Industries (January 1999)" and the "Basic Strategy for the Creation of Bio-technology Industries (July 1999)." Based on this Strategy, the "Millennium Project" was implemented from FY2000 to FY2004 to promote revolutionary advances in personalized medicine for individual characteristics in response to the Aging Society, and to promote environments that offer prosperous and healthy eating habits and secure living. Moreover, an evaluation and support council consisting of third-party experts has provided annual evaluations of the state of the project.

Furthermore, the Prime Minister's Office established the BT (Biotechnology) Strategy Council in July 2002. This strategy council issued the "Strategies for Development of Biotechnology" in December 2002, detailing three strategies focused on 2010, including: (1) revamping research and development; (2) enhancing the process of industrialization; and (3) ensuring public understanding,

and specific action plans for achieving those strategies. Follow-ups were implemented for the status of implementation of the strategies in March 2005.

## **(Strategic Life Sciences Fields)**

### **(1) Genome-Related Research**

On April 14, 2003, the International Human Genome Sequencing Consortium, a grouping of six countries and 24 institutions from Japan, North America, Europe, and China engaged in sequencing the human genome containing all human genetic information, announced completion of detailed sequencing of the human genome.

Based on the result, the Ministry of Education, Culture, Sports, Science and Technology started the “Genome Network Project” 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 function of regulating gene expression and interactions of biological molecules, including proteins. In addition, post-genome 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. In addition, basic research in this sector at universities and colleges has been intensively promoted through the Grants-in-Aid for Scientific Research, the Research for the Future Programs and other related programs.

Since FY2000, the Ministry of Health, Labour, and Welfare has been involved in the Millennium Project, using the elucidation of genes related to dementia, cancer, diabetes, high blood pressure, asthma, and other ailments of the elderly, to promote R&D for the establishment of methods for the prevention and treatment of disease and the development of revolutionary new drugs. Moreover, as part of research for the promotion of incipient advanced medical technologies, especially those that build on the rapid advances in

genomic sciences seen in recent years, research and development commenced in FY2002 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 Agriculture, Forestry and Fisheries, in research performed mainly by the National Institute of Agrobiological Sciences, isolates genes from rice plants, silkworms, and animals to be used for improving agricultural production, develops DNA utilization technology, and systematically collects, accumulates and distributes the DNA utilization results. In the Rice Genome Project, Japan has assumed a leading role, particularly in sequencing the full length of the rice genome. Although the project’s international consortium consisted of 10 countries and regions, Japan played a central role, accounting for about 60% of the total sequence on its own. The sequencing of all 370 million base pairs that can be sequenced by existing technologies, including parts difficult to sequence, was completed in December 2004. Regarding genome sequencing of the silkworm, about 80% of the entire base sequence was sequenced and made public in February 2004.

Furthermore, the Ministry of Economy, Trade and Industry engaged in genome function research and technology development at the National Institute of Advanced Industrial Science and Technology, performed DNA analysis, etc., of industrially useful microorganisms at the National Institute of Technology and Evaluation, and worked through the New Energy and Industrial Technology Development Organization to utilize private-sector vitality to pursue technology development for the analysis of genetic information. In FY2001, analysis of the complete human cDNA<sup>2</sup> structure led to the identification of about 30,000 new human genes, and these genes are now distributed by the National Institute of Technology and Evaluation, with analysis of those genes now in progress.

<sup>2</sup> cDNA: abbreviation for “complementary DNA (or complementary deoxyribonucleic acid).” The term denotes DNA synthesized by using reverse transcriptase in a template for messenger RNA (m-RNA). cDNA consists only of the gene regions of the DNA, so that a complete cDNA encompasses all information about a single gene.

### **a) Promotion of protein structural and functional analyses**

Analysis of protein structure and molecular function is one of the most important fields in post-genome research, because the research results can link directly to applications in medicine or to uses in industry.

Toward the goal of developing genome-based drugs in Japan, the Ministry of Education, Culture, Sports, Science and Technology utilized such facilities as the world's largest NMR (Nuclear Magnetic Resonance) facility and SPring-8 (the Large-Scale Synchrotron Radiation Facility) to bring together researchers from industry, academia, and government into the "Protein 3000 Project," to elucidate the structures and functions of one-third (about 3,000) of the approximately 10,000 basic protein folds known to exist, and to transfer the research results, to include patenting the results to industry in FY2002. By October 2004, a total of 1,640 structures had been confirmed.

The Ministry of Health, Labour and Welfare is promoting research and development as part of its Medical Frontier Strategy into the elucidation of the functions and interactions of proteins affiliated with disease, in order to improve prevention and treatment performance for cancer and heart attacks, the two main causes of death for employment age Japanese, as well as for such illnesses as strokes, dementia, and bone fractures that are a major source of demand for nursing care.

The Ministry of Agriculture, Forestry and Fisheries has been promoting research into the comprehensive elucidation of rice proteins as one aspect of its research into the rice genome, while the genome analysis center of National Institute of Agrobiological Sciences is engaged in researching the expression of proteins from genes and prediction of their functions by comparing their three-dimensional structures with those of already known proteins.

The Ministry of Economy, Trade and Industry has brought researchers from industry, academia, and government to its Japan Biological Information Research Center to engage in "analysis of the three-dimensional structures in biological molecules," specifically, R&D into the structural analysis of membrane proteins believed to play particularly

important roles in the body, and into the "analysis of protein functions" for the analysis of newly discovered human genes using results obtained from analysis of the total human cDNA structure.

### **b) Promotion of bio-informatics**

Recent research into the genome sciences has made available vast volumes of genome-related information, necessitating the appearance of the new field of bio-informatics, an integration of the life sciences and IT (Information Technology) sectors, as a way to utilize this information.

In the Ministry of Education, Culture, Sports, Science and Technology, the Institute for Bio-informatics Research and Development (BIRD) at the Japan Science and Technology Agency is actively engaged in the upgrading, standardization, and expansion of databases required for the development of bio-informatics, as well as in the development of genome analysis tools with the cooperation of researchers in both the biology and information technology sectors. The ministry is also promoting the development of the DNA Data Bank of Japan (DDBJ), one of the three largest of its kind in the world, under the operation of the National Institute of Genetics, and other genome-related databases, and is using Grants-in-Aid for Scientific Research for the priority promotion of basic research in this sector at universities and colleges. Furthermore, the Special Coordination Fund for Promoting Science and Technology is being utilized to implement programs related to personnel development in the bioinformatics field, with funding targeted at universities and colleges. Also, a project has been implemented since FY2003 for the development of biosimulation for drug development using the vast amounts of data obtained in genome sequencing.

At the Ministry of Agriculture, Forestry and Fisheries, research into "development of the rice genome simulator" is progressing as part of research into the rice genome. The simulator is being developed as a virtual testing system that will collect base sequence data obtained from rice genome research and data from analyzing useful gene functions, and add in related information from conventional rice breeding and culturing research data, etc., to enable computer-based simulations of improvements to rice and other crop varieties.

In FY2000, the Ministry of Economy, Trade, and Industry commenced building a H-invitational database (comprehensive database), which includes independently obtained data and advanced search and analysis tools, to enable utilization in research and industrialization of the vast amounts of biotechnology-related data and achievements obtained from the Millennium Project. The database has been made public and renewed since FY2004. In addition, the ministry commenced the “Project for Analysis of the Gene Diversity Model” in FY2000 (based on the supplementary budget) to implement the development of software that will make it possible to conduct efficient searches for genes related to disease, based on micro-satellites, SNPs<sup>3</sup>, and other polymorphic gene information.

### c) Promotion of gene polymorphic research

Various ministries are engaged in the promotion of research and development for the elucidation of genes related to specific diseases, toward the goal of more effective medicine suited to specific individuals.

At the Ministry of Education, Culture, Sports, Science and Technology, for example, the SNPs Research Center at RIKEN is engaged in the search for genes related to specific diseases as part of Millennium Project activities, while the Institute of Medical Science, the University of Tokyo, and the Japan Science and Technology Agency are cooperating in the search for SNPs in healthy people. By March 2005, the joint group had published SNP data for 200,000 locations, via the JSNP database<sup>4</sup>. Also, the “Project for Realization of Medicine in Response to Individual Genetic Information” was launched in

FY2003 mainly at the Institute of Medical Science of the University of Tokyo, and with the cooperation of many other medical institutions, to perform collection of DNA/serum samples and clinical information, from targeted patients for the development of a bio-bank, and to engage in research for the elucidation of the relationship between SNPs and the effects and side-effects of drugs. Furthermore, the Ministry of Education, Culture, Sports, Science and Technology is using Grants-in-Aid for Scientific Research and similar programs for the priority promotion of basic research in this sector at universities and colleges.

In the Ministry of Economy, Trade and Industry, joint examination of the SNPs data by the Institute of Medical Science of the University of Tokyo and the Bio-Industrialization Consortium (JBiC), in the form of analysis of gene polymorph frequencies (allele frequency analysis), was completed in FY2002. Currently, data about SNP locations is being issued from both the JBiC bio-data base system and the JSNP database.

The Ministry of Health, Labour and Welfare is promoting searches for gene polymorphs for disease-related genes and drug-reactive genes related to dementia, cancer, diabetes, high blood pressure, asthma, and other ailments, all as part of the Millennium Project.

In FY2002, the Ministry of Agriculture, Forestry and Fisheries commenced the development of SNP markers in agricultural crops for the purpose of developing effective crop breeding and nurturing systems that make use of gene polymorphs.

3 SNPs: abbreviation for Single Nucleotide Polymorphisms. It refers both to the expression of base sequences on the genome that vary according to race or individual (such as the difference between a healthy individual and a sick person), and to the corresponding area on the genome.

4 JSNP database: a database set up for the Millennium Project, jointly promoted by the Human Genome Analysis Center at the University of Tokyo's Institute of Medical Science, and the Japan Science and Technology Agency, for SNPs scattered throughout the human genome's gene regions (<http://snp.ims.u-tokyo.ac.jp>)

## **(2) Promotion of Brain Sciences Research**

Brain science is expected to lead to results that improve the quality of life, as well as to improved medical science and to the creation of new technologies and industries. In this regard, the Council for Science and Technology's Life Sciences Division Committee of Brain Science issued a "Long-Term Strategy for Research and Development on the Brain" in May 1997, a long-term plan for the promotion of brain sciences research in Japan. The resulting efforts have greatly strengthened Japan's brain sciences research, which were divided broadly into the three fields of "understanding the brain," "protecting the brain," and "creating the brain," through research and development that makes maximum use of the many universities and national research institutions that extend beyond the bounds of individual ministries and agencies.

At the Ministry of Education, Culture, Sports, Science and Technology, "understanding the brain," "protecting the brain," "creating the brain," and "nurturing the brain" are being promoted as fields of research at the Brain Science Institute at RIKEN, through the utilization of competitive research funds by the Special Coordination Fund for Promoting Science and Technology, and by the Japan Science and Technology Agency, for the priority promotion of brain science research at universities and colleges. Brain research is also being performed at the Japan Science and Technology Agency for the purpose of contributing to education, etc.

Activities in other ministries and agencies include the Ministry of Health, Labour, and Welfare's efforts to promote research on the elucidation of mental and nervous system disorders such as Alzheimer's disease and Parkinson's disease, and on the development of methods of treatment, while the Ministry of Agriculture, Forestry, and Fisheries is engaged in research on brain and nervous system functions in animals, and the Ministry of Public Management, Home Affairs, Posts and Telecommunications is engaged in research into the elucidation and application of info-communication functions in living organisms.

Furthermore, the "Human Frontier Science Pro-

gram" (HFSP), which was first proposed by Japan at the Venice Summit of advanced nations in June 1987, operates based on the principles of "internationality," "interdisciplinarity," and "encouragement of young scientists," to provide subsidies within an international framework for research that contributes to the elucidation of brain functions and other complex.

## **(3) Promotion of Research on Development, Differentiation, and Regeneration 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, which is expected to lead to treatment for diseases that are now difficult to cure. The research of this field brings about rapid advances in stem cell research and establishment of technology for producing Embryonic Stem (ES) cells in recent years.

The Ministry of Education, Culture, Sports, Science and Technology is implementing Research for Future Programs and conducting research at the RIKEN Center for Developmental Biology, as well as promoting basic research at universities and colleges by Grant-in-Aid for Scientific Research, etc. Moreover, in FY2003, the ministry launched the "The Project for Realization of Regenerative Medicine" and has been promoting research towards developing a stem cell bank as a research infrastructure and applying the result of basic research to a clinical aspect.

Furthermore, to contribute to the realization of regenerative medicine, the Ministry of Health, Labour, and Welfare is promoting research focusing on clinical aspects in transplant and regenerative medicine as a part of the Millennium Project.

The Ministry of Economy, Trade and Industry is promoting development of equipment in support of practical applications of regenerative medicine.

## **(4) Promotion of Plant Science Research**

Advances in genome science have also led to progress in the analysis of plant genome structures

and functions. Control of plant functions based on these results is expected to lead to the development of plants that can contribute to improvements in eating habits, etc.

Rice genome research is important for laying the foundations for research into the major cereals and other crops. The Ministry of Agriculture, Forestry and Fisheries is currently promoting the Second Phase of the “Rice Genome Project,” which involves the reading of all DNA base sequences for the rice genome, and the elucidation and patenting of the functions of useful genes, which are efforts that have attracted worldwide acclaim.

For the entire genome base sequence for rice, sequencing data by the international consortium is open to the public on the website. The data sequenced by the international consortium is available on the Web, and is now being examined by researchers around the world as the optimum information resource (Golden Reference) for crop genome research.

The Ministry of Agriculture, Forestry and Fisheries commenced post-genome sequence research even as the base sequence readings were continuing. In FY2003, the ministry launched new research into the elucidation of gene functions, with emphasis on five particular characteristics (quality, photosynthesis capability, functional substance production, resistance to disease, and resistance to adverse environments) of importance to agriculture and other industries, and accelerated efforts to patent useful genes.

The Ministry of Education, Culture, Sports, Science and Technology is promoting the genome sequencing of rice and *Arabidopsis thaliana* etc., discovery of candidate useful genes, collection of complete cDNA and maintenance of variant resources at the RIKEN Plant Science Center, as part of the Millennium Project. Also in plant research, full-scale foundation for functional analysis, network analysis and metabolome analysis has been developed, and Japan has caught up with the United States and Europe in terms of research levels.

The Ministry of Economy, Trade and Industry is implementing analysis of routes and functions of substance production systems using plants and development of basic technologies including multigene transfer technology at the New Energy and Industrial Technology Development Organization.

## **(5) 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.

In FY2002, the Ministry of Education, Culture, Sports, Science and Technology 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), human cells, and genetic data from various life forms.

At the Ministry of Health, Labour, and Welfare, the National Institute of Health Sciences (responsible for cells) and the National Institute of Infectious Diseases (responsible for genes) joined to establish a Master Bank (in FY2001, these two institutions began setting up the Pharmaceuticals Basic Technology Research Facility toward an eventual merger) for the collection and preservation of human and animal-derived cultured cells and genes needed for use in research in medical and pharmaceutical fields. The supply of cultured cells and genes is made through the Japan Health Sciences Foundation to researchers and other personnel. The foundation has also commenced distribution of human tissue with careful consideration for bio-ethics issues. It also collects, stores, and supplies medicinal plants, and breeds and supplies kanikui-zaru monkeys and other animals used for medical testing.

In the Agriculture, Forestry, and Fisheries Ministry, the Gene Bank Project collects, classifies, and identifies all plants, animals, microorganisms, trees, marine life, and other bioresources utilized in the agricultural, forestry, and fisheries industries. The project also conducts evaluations of characteristics, and propagates and preserves specimens. It provides bioresources and information about those resources to the national research institutes, the independent administrative institutions, the private sector, universities, etc. The ministry also promotes maintenance of genome resources that are the results of rice genome research, as well as storage and provision to the private sector, universities and colleges.

In addition, the Ministry of Economy, Trade and Industry established the NITE Biological Resource

Center at the National Institute of Technology and Evaluation as Japan's core bioresource organization for microorganisms, etc. The Center engages in the search, isolation, collection, and identification of biogenetic resources, as well as their preservation. It also collects and sorts information related to bioresources (systematic identification, base sequence information, and information about genes, etc.). The Center has also implemented a project to create a gene resource library for unknown microorganisms. It is also implementing the development of a system for collecting and utilizing various microorganisms overseas, including conclusion of agreements with Asian countries and launch of an Asian consortium for utilization of microbial resources with ASEAN countries, etc. in accordance with the Convention on Biological Diversity to ensure access to biogenetic resources in Southeast Asia.

The Ministry of Environment instituted the "Environmental Sample Time Capsule Project" in FY2002 for the purpose of preserving the cells of wildlife threatened with extinction. In addition, the independent National Institute for Environmental Research is engaged in the collection, preservation and supply of algae, and in building an algae database.

## (6) Promotion of R&D in Food Sciences

Building a stable and sustainable production and distribution system for agricultural, forestry, promoting the development of functional foods that can contribute to improving the people's health are essential if Japan is to be able to maintain food security and to guarantee an abundant food supply.

For this purpose, the Ministry of Agriculture, Forestry and Fisheries continues to promote the quality of wheat, soybeans, and vegetables, to improve food self-sufficiency, and as a response to the recent sharp rise in imports of raw vegetables, to develop superior new crops resistant to diseases and pests and rich in nutrition and functional constituents, and new agricultural, distribution methods and processing technologies, as well as to develop cloning and other animal husbandry-related technologies. Moreover, to promote food safety and security, the ministry is upgrading technologies for the detection of toxic microorganisms, and developing technologies for DNA identification of species types. For control of Bovine Spongiform Encep-

halopathy (BSE), the ministry is engaged in the elucidation of the shape and characteristics of prion proteins, and in the development of diagnostic technologies. Moreover, the ministry is engaged in the development of basic technologies useful for the diagnosis and prevention of outbreaks within Japan of diseases shared by humans and animals, both to assuage the people's concerns, and to reduce the effects of such outbreaks on the livestock and poultry industries. In addition, the ministry is accelerating research into the elucidation of bio-regulatory functions through combinations of food-stuffs capable of contributing to the development of new functional foods, as well as supporting the development of technologies for the use of bio-markers (simple biological indices) in the scientific evaluation of food efficacy, and the development of production technologies for food that is efficacious at maintaining health. Furthermore, beginning in FY2004, the ministry is promoting the development of technologies that strengthen disease and pest defense functions already available in crops, or that share them between life forms, to reduce the agricultural burden on the environment.

The Ministry of Health, Labour and Welfare is continuously conducting surveys and research into the securing of food safety through the application of biotechnology.

## (7) Promotion of Cancer-Related Research

Since cancer accounts for about 30% of total deaths in Japan, the "Third Comprehensive Ten-Year Strategy for Cancer Control" (ratified by the Minister of Education, Culture, Sports, Science and Technology and the Minister of Health, Labour and Welfare in June 1993) was formulated as a new 10-year strategy that started in FY2004. Based on this strategy, researchers in Japan are promoting the elucidation of the essential elements of cancer, and of new prevention, diagnostic, and treatment methods that utilize these research results.

Under this 10-year strategy, since FY 2004, the Ministry of Education, Culture, Sports, Science and Technology has been promoting the "Cancer Translational Research Program" as bridging research to apply the excellent results of basic research relating to cancer immunotherapy and molecular-targeted therapy clinically. Furthermore, the National Institute of Radiological Sciences is acting under this 10-year

strategy to perform clinical trials of a heavy ion medical accelerator that is expected to become a revolutionary new treatment method for particularly difficult-to-treat cancers. In addition, Grant-in-Aid for Scientific Research promotes priority research at universities and colleges.

The Ministry of Health, Labour and Welfare, meanwhile, is engaged in the development of a helical CT that will be useful in the early detection of lung cancer, and in the development of safe cancer treatment methods using endoscopes that reduce the burden on the patient.

### **(8) Promotion of Research on Immunologic and Allergic Diseases**

It is necessary to comprehensively promote research in the area of the immune system, allergies, and infectious diseases with the aim of achieving eradication of hay fever, rheumatoid arthritis, and other immunologic and allergic diseases, which many people desire, and coping with infectious diseases, which are still a national health threat.

The Ministry of Education, Culture, Sports, Science and Technology engages in research for the basic and comprehensive elucidation of immune systems at the RIKEN Research Center for Allergy and Immunology. In addition, since FY 2004, the ministry has been promoting research and development that leads to the suppression of Severe Acute Respiratory Syndrome (SARS) and other infectious diseases by utilizing the Special Coordination Funds for Promoting Science and Technology. At the time of the Sumatra Earthquake in Indonesia and subsequent tsunami, the ministry conducted field surveys necessary to appropriately predict and respond to the proliferation of infectious diseases in the afflicted areas, as well as consideration of research contents and systems that are required in the future. Moreover, the ministry is intensively promoting basic research in this sector at universities and colleges by using Grant-in-Aid for Academic Research Program.

The Ministry of Health, Labour and Welfare is strengthening the national health risk management network and promoting research in the sectors of emerging and reemerging infectious diseases, measures against HIV/AIDS, measures against hepatitis, and immunologic and allergic diseases. The ministry is also conducting research on broad-ranging infectious diseases in a leading, unique and compre-

hensive manner at the National Institute of Infectious Diseases. In addition, the ministry established a clinical research center at the National Hospital Organization Sagamihara National Hospital, aiming at the elucidation of immunologic and allergic diseases, and the development of treatment methods. The center's research is currently concentrated on clinical aspects.

Incidentally, the RIKEN Research Center for Allergy and Immunology and the National Hospital Organization Sagamihara National Hospital has made a joint research agreement, and are promoting efficient research through collaboration between the basics and clinical applications.

The Ministry of Agriculture, Forestry and Fisheries is promoting comprehensive research on the control of Bovine Spongiform Encephalopathy (BSE), highly pathogenic avian influenza (Bird Flu) and other infectious diseases shared by humans and animals at the National Agriculture and Bio-oriented Research Organization.

### **(9) Promotion of Other Research and Development**

Because living things are generally efficient at energy conversion, consuming little energy for reactions at normal temperatures and pressures, the Ministry of Economy, Trade and Industry has promoted the "Program for Creation of Recycling-Type Industrial Systems Using Bio-Functions" to develop the basic technologies required for effective utilization of bio-functions based on genome information, and for their expanded use in industrial systems.

In regard to research on sugar chains, which are believed to play important roles in a vast array of biological functions, the Ministry of Education, Culture, Sports, Science and Technology is using the Grant-in-Aid for Scientific Research and Basic Research Programs to promote sugar chain research at universities and colleges. The Ministry of Economy, Trade and Industry is promoting research and development into automatic devices for synthesizing sugar chains as well as structure analysis devices, and of the analysis of functions for the general acquisition of genes related to sugar chain synthesis.

Utilizing and strengthening the excellent research capabilities of certain regions can be effective for promoting research and development in the life sciences sector. In this regard, the government's



Urban Renewal Office decided in August 2001, in “Urban Renewal Project No.2,” on the “formation of an international center for life sciences in the Osaka region.” This action was followed in July 2002, in “Urban Renewal Project No.4,” with the “formation of an international center for genome sciences in the Tokyo region.” In line with these decisions, the Ministry of Education, Culture, Sports, Science and Technology has expanded related facilities and equipment at universities and colleges, and promoted translational research that bridges the gaps between basic research and applied research

through cooperation between industry, academia, and government to form life science research sites and to build systems that link the re-search sites with each other. In addition, the Ministry of Health, Labour and Welfare is promoting the development of core research institutions in the Osaka region for infrastructure technology toward the development of revolutionary new pharmaceutical products, etc.

The major life science research projects implemented in FY2004 are shown in Table 3-2-1, by ministry or agency.

**Table 3-2-1 Major research subjects in life sciences (FY2004)**

Ministry or Agency	Research institute or program	Subject
National Police Agency	National Research Institute of Police Science	· Study into a new personal identification system using information obtained from biological samples
Ministry of Internal Affairs and Communications	Program for Promoting Strategic Information and Communications Research and Development	· Research into elucidating and applying the info-communications functions of living organisms
	National Institute of Information and Communications Technology	· Research into a communication-friendly society
Ministry of Finance	National Research Institute of Brewing	· Research, etc., into genetic analysis and the regulatory control of gene expression of filamentous fungi

### 3.2.2 Prioritization of Research and Development in Response to Issues Important to the State and Society

Ministry or Agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	RIKEN (The Institute of Physical and Chemical Research)	<ul style="list-style-type: none"> <li>· Promotion of bioresource projects</li> <li>· Promotion of comprehensive research into brain science</li> <li>· Promotion of comprehensive research into genome science</li> <li>· Promotion of plant science research</li> <li>· Promotion of comprehensive research into developmental and regenerative science</li> <li>· Promotion of varied genetic research</li> <li>· Promotion of immunological and allergy research</li> </ul>
	Japan Science and Technology Agency	<ul style="list-style-type: none"> <li>· Promotion of bio-informatics</li> <li>· Promotion of research using competitive funding</li> </ul>
	National Institute of Radiological Sciences	<ul style="list-style-type: none"> <li>· Promotion of research and development for upgrading heavy particle therapy of cancer</li> </ul>
	Japan Agency for Marine-Earth Science and Technology	<ul style="list-style-type: none"> <li>· Promotion of Frontier Research System for Extremophiles, etc.</li> </ul>
	Japan Aerospace Exploration Agency	<ul style="list-style-type: none"> <li>· Research into medical science, etc., related to space</li> </ul>
	Universities and colleges	<ul style="list-style-type: none"> <li>· Research into the overall promotion of cancer research</li> <li>· Basic research into carcinogenesis and the prevention of carcinogenesis</li> <li>· Research into the biological aspects of cancer</li> <li>· Diagnosis and treatment of cancer</li> <li>· Research into human cancers, and epidemiological research into host factors</li> <li>· Strategic and advanced research into cancer</li> <li>· Comprehensive genome research toward the elucidation of living systems</li> <li>· Genomic analysis of hereditary factors, and the elucidation of abnormal molecule conditions in human diseases</li> <li>· New developments in genomic biology toward the elucidation of cellular systems</li> <li>· New developments in genome informatics</li> <li>· Advanced research into brain science</li> <li>· Molecular foundations for the appearance of infection, and host response</li> </ul>
	Special coordination funds for promoting science and technology	<ul style="list-style-type: none"> <li>· Cooperative strategy for suppressing emerging and reemerging infectious diseases</li> <li>· Development of an automatic antibody selection system</li> <li>· Postgraduate education research unit for agricultural and life information science</li> <li>· Research supporter development system for animal experimental medicine</li> <li>· Promotion of rice genome annotation</li> </ul>
	HFSP (Human Frontier Science Program) (Note)	<ul style="list-style-type: none"> <li>· International joint research for the elucidation of the complex mechanisms of living organisms</li> </ul>
Ministry of Health, Labour and Welfare	Health and labour sciences research grants	<ul style="list-style-type: none"> <li>· Third comprehensive research on strategy against cancer</li> <li>· Comprehensive research on aging and health</li> <li>· Research on the human genome, tissue engineering</li> <li>· Research on psychiatric and neurological diseases and mental health</li> <li>· Research on emerging and re-emerging infectious diseases</li> <li>· Research on HIV/AIDS</li> <li>· Research on sensory and communicative disorders</li> <li>· Research for the eradication of intractable diseases</li> <li>· Research on food safety</li> <li>· Research on health sciences focusing on drug innovation</li> <li>· Research on allergic disease and immunology</li> <li>· Research on proteomics</li> <li>· Research on advanced medical technologies</li> <li>· Research on medical devices for analyzing, supporting and alternative</li> <li>· Translational research</li> </ul>
	National Institute of Infectious Disease	<ul style="list-style-type: none"> <li>· Research into gene recombinant vaccines, etc.</li> <li>· Research into the development of vectors related to gene treatment, safety evaluations, etc.</li> <li>· Research into AIDS, Hansen's disease, etc.</li> <li>· Research into methods for the diagnosis, prevention, and treatment of SARS and other infectious diseases</li> </ul>
	National Institute of Health Sciences	<ul style="list-style-type: none"> <li>· Research into standard test methods, quality evaluation methods, etc., for pharmaceuticals</li> <li>· Research into assuring the safety of food and chemical substances, etc.</li> </ul>
	National Institution of Industrial Health	<ul style="list-style-type: none"> <li>· Study on work environment management for irregular work using organic solvents</li> <li>· Comprehensive research on occupational stress of elderly workers</li> <li>· Research on genetic factors that determine sensitivity to adverse factors in the work environment</li> </ul>

### 3.2 Priority Strategies for Science and Technology

Ministry or Agency	Research institute or program	Subject
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Bio-oriented Research Organization, National Institute of Agrobiological Sciences, etc.	<ul style="list-style-type: none"> <li>· Integrated research for providing fresh and delicious "Brand Nippon" agricultural-products</li> <li>· Development of technology for reducing the impact on the environment using</li> <li>· Development of technologies for the suppression of Bovine Spongiform Encephalopathy (BSE), and diseases shared by humans and animals</li> <li>· Development of a comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystem</li> <li>· Elucidation of the entire rice genome DNA sequence</li> <li>· Isolation of useful genes in the rice genome, and elucidation of their functions</li> <li>· Development of DNA marker-aided selection technology for plants and animals</li> <li>· Development of a rice genome simulator</li> <li>· Research into animal genomes for the utilization of useful genes</li> <li>· Insect Technology Research for Utilization of the Greatest Unused Resources of the 21st Century</li> <li>· Comprehensive research into food safety and functionality</li> <li>· Development of isolation and utilization technologies for useful genes obtained through animal genome analysis</li> <li>· Assurance of Safe Use of Genetically Modified Organisms</li> <li>· Development of stable production technology of cloned animals by somatic cell nuclear transfer</li> <li>· Elucidation of animal (livestock, insect) behavioral mechanisms, and the development of control technologies</li> <li>· Surveys and research into local agricultural methods using special resources</li> <li>· Expenses required for the promotion of research into the prevention of invasive insect pests</li> <li>· Elucidation of the effects of climate warming on crops and animal husbandry, and the development of technologies to control those effects</li> <li>· Evaluation of the effects of organic farming on the soil environment, and the certification of environmental conservation effects</li> <li>· Elucidation of the mechanism for outbreaks of mastitis, and the development of preventive technologies</li> <li>· Comprehensive research into the creation of new agriculture, forestry, and fisheries products by modifying morphological and physiological functions</li> <li>· Comprehensive research into the creation of new agriculture, forestry, and fisheries products by modifying morphological and physiological functions</li> <li>· Development of new weed control technologies that utilize plant metabolism genes</li> <li>· Establishment of useful substance production systems using plants, animals, and insects</li> <li>· Gene bank project</li> </ul>
	Private sector, universities, etc.	<ul style="list-style-type: none"> <li>· Development of technologies for assuring food safety and security</li> <li>· Development of technologies for the promotion of "Brand Japan" processed food supplies</li> <li>· Development of efficient plant breeding and growing systems that utilize genetic information</li> <li>· Development of new separation and extraction technologies in the food industry</li> <li>· Development of health-oriented food evaluation and production technologies using the life sciences</li> <li>· Development of next-generation fermentation technologies in the food industry</li> </ul>

Ministry or Agency	Research institute or program	Subject
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization	<ul style="list-style-type: none"> <li>· Development of basic technologies for production processes using biological</li> <li>· Elucidation of useful protein functions, utilizing human genome information and its analysis tools</li> <li>· Development of information technology required for DNA analysis, disease prevention, etc.</li> <li>· Development of technologies for the synthesis and structural analysis of sugar chains</li> <li>· Construction of a gene resource library for unknown micro-organisms based on genome information</li> <li>· Development of tools for analysis of biomolecules through the use of nanotechnology</li> <li>· Development of high-safety technologies for the differentiation and cultivation of a mass volume of artificial cells and tissues enabling regenerative medicine</li> <li>· Analysis of the three-dimensional structures of physiological macromolecules of membrane proteins</li> <li>· Development of technologies for the analysis of intracellular network dynamism</li> <li>· Development of bioinformatics-related databases</li> <li>· Development of technology for model analysis of gene diversity</li> <li>· Behavior-based human environment creation technology</li> </ul>
	National Institute of Advanced Industrial Science and Technology	<ul style="list-style-type: none"> <li>· Construction of a neural network and development of new information processing technology based on its functions</li> <li>· Age dimension technology programs for healthcare</li> <li>· Elucidation of organism responses to stress and the identification and practical application of stress markers</li> </ul>
	HFSP (Human Frontier Science Program) (Note)	<ul style="list-style-type: none"> <li>· International joint research for the elucidation of the complex mechanisms of living organisms</li> </ul>
Ministry of the Environment	National Institute for Environmental Studies	<ul style="list-style-type: none"> <li>· Research into the elucidation of higher-order physiological memory functions for organic chemical substances, and the development of risk evaluation methods</li> <li>· Development of a method of assessing the influence of environmental pollutants on human and organisms using toxicogenomics</li> </ul>

Note: Funding provided by the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Economy, Trade and Industry.

## (2) Efforts for Bioethical Issues and Safety

### (Efforts for Bioethical Issues)

Rapid developments in the life sciences in recent years have given rise to expectations of revolutionary achievements in the fields of medicine and elsewhere.

Therefore, to cope with these issues appropriately, the Special Research Committee on Bioethics, established under the Council for Science and Technology Policy (CSTP), and Special Committee on Guidelines in the 21st Century for the Life Science and Bioethics, Science Council of Japan, are now engaged in surveys and examinations of specific important issues concerning bioethics, while the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Health, Labour and Welfare and other ministries are preparing the relevant laws, regulations, and guidelines and conducting other activities.

Regarding human cloning technology, the Ministry of Education, Culture, Sports, Science and Technology has taken measures prohibiting the production of human clone individuals under the Law Concerning Regulation Relating to Human Cloning Techniques and Other Similar Techniques (Year 2000, Law No.146) and prohibiting the creation and utilization of human clone embryos for the time being under the guidelines based on the said law.

The Expert Panel on Bioethics under the CSTP has discussed the handling of human fertilized embryos and human clone embryos since August 2001 according to the provisions of the said law. Consequently, in July 2004, the CSTP compiled a statement of opinions to related office and ministries concerning the “Basic Conceptual Approach Relating to Treatment of Human Embryos.” Regarding the creation and utilization of human clone embryos and human fertilized embryos, which are permitted in the statement with limitations, the Ministry of Education, Culture, Sports, Science and Technology

and the Ministry of Health, Labour and Welfare started consideration toward formulating guidelines for ensuring appropriate handling.

Furthermore, in the United Nations, considerations toward formulating a convention against the reproductive cloning of human beings started in 2001 have not reached an international consensus in terms of the utilization of human clone embryos for therapeutic and research purposes. A nonbinding declaration that prohibits such utilization was adopted by a vote in March 2005<sup>5</sup>.

In the area of human Embryonic Stem (ES)<sup>6</sup> cell research, the Ministry of Education, Culture, Sports, Science and Technology has carried out examination of research plans under the guidelines formulated in 2001 and has reviewed one derivation plan and 21 utilization plans so far.

Elsewhere, in the areas of human genome and gene sequencing research, epidemiological research<sup>7</sup> or clinical research, respect of human dignity and suitable management of personal information are required. Therefore, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Health, Labour and Welfare and other related ministries are cooperating for the appropriate promotion of research based on the guidelines<sup>8</sup>.

### **(Efforts to Ensure Safety in the 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, one of its characteristics is its application of new properties to living organisms. For this reason, the ensuring of appropriate use of living modified organisms, etc. has been aimed at based on the Law Concerning the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Year 2003, Law No. 97), which stipulate the measures necessary to prevent adverse effects on biodiversity due to the utilization

of living modified organisms.

For clinical research aimed at the establishment of gene therapy<sup>9</sup>, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare are making efforts for the appropriate promotion of research based on the Guidelines for Gene Therapy Clinical Research, and revised the guidelines based on the Law Concerning the Protection of Personal Information in December 2004.

### **3.2.2.2 Information and Communications**

Promotion of research and development in the information and communications sector not only brings about innovative results in many other areas of research and development but also contributes to the creation of new industries and development of existing industries. In addition, as can be seen from the dissemination of mobile phones and computers, information and communications technology has become essential for a wide variety of activities in our daily life, and is an important foundation that enables people to live safely, comfortably and with confidence.

### **(A Society Served by Ubiquitous Networks, and Building a High-Speed, Highly Reliable Information Communication System for the Creation of a World Market)**

Society demands that Japan swiftly return research results to society and to the economy by constructing a “high-speed, highly reliable information communication system” with unified hardware and software and strong cooperation among industry, academia, and government ahead of the rest of the world, centered around superior technologies (mobile, optical, device technologies, etc.)

5 Affirmative votes: 84 Dissenting votes: 34 (including Japan) Abstention: 37 Non-participation: 36

6 Human Embryonic Stem (ES) cells: these primordial cells have attracted high expectations for medical applications because of their capability of differentiating into all parts of the human body. At the same time, however, sacrificing human embryos would raise ethical concerns.

7 Epidemiological Research: scientific research that clarifies causes of a disease by investigating the frequency and geographical distribution of disease incidence and other factors related to human health

8 Ethical Guidelines for Human Genome and Gene Analysis, Ethical Guidelines for Epidemiological Research, and Ethical Guidelines for Clinical Research

9 Gene therapy: a treatment method that involves the insertion of genes, or cells containing genes, into the bodies of patients for the purpose of treatment of disease. It is not an established method of treatment at present, but is practiced as one aspect of clinical research

For specific research and development topics, the Ministry of Internal Affairs and Communications is engaged in “R&D on ubiquitous network technologies,” involving research and development into technologies for real-time verification from extremely large numbers of terminals, and into technologies for the control of network channels.

The Ministry of Education, Culture, Sports, Science and Technology is working on the “Establishment of software technology infrastructure to support electronic storage and utilization of intellectual assets,” in which research and development is conducted for electronic storage of intellectual assets in the cultural and arts sectors as well as for software technology necessary for utilizing digital contents in the educational sector.

The Ministry of Economy, Trade and Industry is engaged in the “business grid computing project,” which aims for the development of infrastructure software allowing multiple network-linked computers or memory devices to function as if they were a single computer, toward the realization of the goal of a highly reliable, safe-to-use social IT infrastructure.

### **(Information and Communication Technologies that Lead to Next-generation Breakthroughs and the Seeds of New Industries)**

Society demands the promotion of research and development into advanced information and communication technologies carried out in cooperation with interdisciplinary sectors, like next-generation human interface technologies, next-generation information and communication technologies that make use of quantum engineering and other new principles and technologies, such as space development (communications), nanotechnology, and bioinformatics.

A specific research and development topic in this area is the “Quasi-Zenith Satellite System Plan” being developed through the cooperation of the Ministry of Internal Affairs and Communications, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Economy, Trade and Industry, and the Ministry of Land, Infrastructure and Transport, that will be able to provide high-quality communications, broadcasting, and positioning services to virtually 100% of the country without being affected by narrow mountain valleys or tall buildings.

### **(Infrastructure Technologies for Research and Development)**

Society demands the development of science and technology databases, an area in which Japan lags behind Europe and North America, the development and equipment of technologies for supercomputer networks, and virtual research institutes that allow joint research over long distances by linking research institutions with universities via high-speed networks.

In the Ministry of Education, Culture, Sports, Science and Technology, specific research and development topics being carried out include the “National Research Grid Initiative (NAREGI),” which involves the development of infrastructure software of sufficient quality to become an international standard, for the purpose of constructing an ultra-high speed research grid computing environment capable of linking distributed high-performance computers into a high-speed network.

The main research topics in the information and communications sector during FY2004 are as shown in Table 3-2-2.

**Table3-2-2 Major research subjects in the information and communications sector (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	<ul style="list-style-type: none"> <li>·Research and development on ubiquitous network technologies</li> <li>·R&amp;D on Technologies for Sophisticated Use of RFID</li> <li>·Promotion of transition to Internet IPv6</li> <li>·Research and development into Asian broadband satellite infrastructure technologies</li> <li>·Comprehensive research and development into network human interface</li> <li>·R&amp;D on time-stamping platform technologies</li> <li>·Promotion of network security infrastructure technologies</li> <li>·Research and development relating to the technology for an advanced network certification infrastructure</li> <li>·Comprehensive support for the development of electrical communication systems that form the foundation for the merger of communication and broadcasting services</li> <li>·Research and development into quantum information communication technologies</li> <li>·Research and development of photonic network technologies</li> <li>·Comprehensive research and development of IPv6 for (digital) Information consumer electronics, etc.</li> </ul>
Ministry of Education, Culture, Sports, Science and Technology	Universities, Japan Science and Technology Agency, National Institute for Materials Science, RIKEN (the Institute of Physical and Chemical Research), Japan Atomic Energy Research Institute, Japan Aerospace Exploration Agency, National Research Institute for Earth Science and Disaster Prevention, Japan Agency for Marine-Earth Science and Technology, National Institute of Informatics, etc.	<ul style="list-style-type: none"> <li>·Establishment of software technology infrastructure to support electronic</li> <li>·National Research Grid Initiative (NAREGI)</li> <li>·Comprehensive software development for e-Society infrastructure</li> <li>·Priority research and development project for realization of the world's most advanced IT nation</li> <li>·e-Science realization project</li> <li>·Development of Super SINET, etc.</li> </ul>
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Bio-oriented Research Organization, etc.	<ul style="list-style-type: none"> <li>·Construction of an agricultural, forestry, and fisheries research information digital community, etc.</li> </ul>
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization, Information Technology Promotion Agency, etc.	<ul style="list-style-type: none"> <li>·Business grid computing project</li> <li>·Development of an Extreme Ultraviolet (EUV) exposure system</li> <li>·Semiconductor application chip project</li> <li>·Cutting edge system LSI design project</li> <li>·Digital information device interoperability infrastructure project</li> <li>·Energy-saving next-generation PDP project</li> <li>·Development of next-generation semiconductor materials and process technology (MIRAI project), etc.</li> </ul>
Ministry of Land, Infrastructure and	Engineering Affairs Division, Minister's Secretariat	<ul style="list-style-type: none"> <li>·Development of robotic and other IT implementation systems, etc.</li> </ul>
Ministry of Internal Affairs and Communications Ministry of Education, Culture, Sports, Science and Technology Ministry of Economy, Trade and Industry Ministry of Land, Infrastructure and Transport	National Institute of Information and Communications Technology, Japan Aerospace Exploration Agency,  New Energy and Industrial Development Organization	

### 3.2.2.3 Environment

The field of the environment is an essential area of science for the preservation of the natural environment, including ecological systems with their diverse forms of life, for the maintenance of human health and the preservation of the living environment, and for maintaining the foundations for the future survival of mankind. At present, there is an increasing need for efforts in science and technology to resolve global environmental problems, and Japan is actively moving ahead in this area, through the research and development projects detailed below.

#### (1) Research into Earth Observation and Change Forecasts, and Other Solutions for Global Environmental Problems

In recent years, global warming and other global-scale environmental issues have become imminent, and these issues urgently require international cooperation in their resolution.

In response to the “science and technology for sustainable development” action plan agreement reached in June 2003 at the G8 Evian Summit in France, the First Earth Observation Summit was held in the United States in July 2003. Following that, the Second Earth Observation Summit was held in Tokyo in April 2004, and a framework for a 10-year implementation plan for the establishment of Global Earth Observation System of Systems (GEOSS) was adopted with the participation of 43 countries. Based on those results, the 10-year implementation plan was adopted at the Third Earth Observation Summit in Belgium in February 2005.

In regards to global warming issues, the Kyoto Protocol, which incorporated commitments to reduce the amount of greenhouse gas emissions in advanced nations and other countries, went into effect in February 2005. In December 2004, the Tenth Conference of Parties to the Framework Convention on Climate Change (COP 10) was held in Argentina to give consideration to the steady introduction of the Implementation Plan for the Global Climate Observing System (GCOS).

#### (R&D and Related Measures for Understanding Phenomena on a Global Scale)

Since phenomena relating to global environment problems go beyond national borders, global cooperation is crucial in promoting research and development. Therefore, Japanese researchers are participants in the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), and other international research programs, continuing to advance joint research.

Promoting the international sharing of global observation information is important for the elucidation of various global-scale phenomena. Japan hosted the Second Earth Observation Summit in April 2004, and is an active participant in and contributor to the Committee on Earth Observation Satellites (CEOS) and the Integrated Global Observing Strategy Partnership (IGOS-P).

The Ministry of Education, Culture, Sports, Science and Technology is promoting research and development into the highly trustworthy projection of global change using the “Earth Simulator” system, one of the world’s fastest supercomputers. The “Earth Simulator” won the “Gordon Bell Award,” the most prestigious award in the high-performance computer technology sector, for three consecutive years from 2002 to 2004. As research and development using the “Earth Simulator,” the ministry implemented the Intergovernmental Panel on Climate Change (IPCC), which provides scientific information regarding climate change and the “Project for Sustainable Coexistence of Humans, Nature and the Earth,” which aims to achieve high-precision predictions of global warming that will contribute to the Fourth Assessment Report (AR4) and the forecast of water resources and water-based disasters in the future. In addition to contributing to the 10-year implementation plan prepared by the Earth Observation Summit, the ministry established the Earth Observation Promotion Committee under the Council for Science and Technology, in accordance with the Basic Strategy for Efforts Regarding Future Earth Observation (December 2004).

The Japan Agency for Marine-Earth Science and Technology is promoting research on global environment prediction, including climate variation research, hydrological cycle research, global warming research, atmospheric composition research, ecosystem change research, and integrated modeling. In addition, regarding research on global environment observation, the agency is promoting observation of climate change, observation of the hydrological



cycle, observation of global warming and observation of ocean general circulation. Moreover, research cooperation with the United States is carried out at the International Pacific Research Center (IPRC) located at the University of Hawaii, and the International Arctic Research Center (IARC) at the University of Alaska.

The Japan Science and Technology Agency's Basic Research Programs promote research and development related to the "Mechanism of Global Change" and "Hydrological System Modeling and Water Resources System."

The Ministry of Internal Affairs and Communications' National Institute of Information and Communications Technology (NICT) is currently engaged in international joint research with the United States, primarily with the University of Alaska, within the framework of the Japan-U.S. Science and Technology Cooperation Agreement, to promote comprehensive research into technologies for the observation and measurement of the arctic atmosphere.

Japan's Antarctic research program is centered in the National Institute of Polar Research, in cooperation with relevant governmental agencies. The Headquarters for the Japan Antarctic Research Expedition (JARE) has been established within the Ministry of Education, Culture, Sports, Science and Technology (MEXT), under the chairmanship of its Minister. In FY2004, the 45th wintering expedition and the 46th expedition carried out regular observations of ocean and atmospheric phenomena around Showa Station, and also performed monitoring observations, etc., for the purpose of elucidating environmental changes on a global scale.

### **(Earth Observation Technology Using Satellites)**

Satellite-based Earth observation is an extremely effective method for repeated and continuous acquisition of various information covering wide areas. Japan is currently engaged in comprehensive promotion of this activity toward the resolution of global environmental problems, in cooperation with related organizations in Japan and abroad.

The National Institute of Information and Communications Technology (NICT) is promoting the development of superconducting submillimeter wave rim radiation sounders mounted on the ex-

posed part of the station's Japanese Experiment Module (JEM; also known as "Kibo") on the International Space Station. NICT is also studying technology to enable the measurement of global environmental changes from space.

The Japan Aerospace Exploration Agency (JAXA) processes data collected from a Precipitation Radar (PR) mounted on the Tropical Rainfall Measuring Mission (TRMM) satellite of the National Aeronautics and Space Administration (NASA), the Advanced Microwave Scanning Radiometer for EOS (AMSR-E), mounted on the NASA Earth Observing System (EOS) Aqua satellite and other satellites, to provide data to researchers and users. To improve the precision of weather forecast, JAXA started using data obtained from AMSR-E in FY 2004. Moreover, JAXA is engaged in the development of the Advanced Land Observing Satellite (ALOS), in development research on the Greenhouse Gas Observing Satellite (GOSAT), and in research on the Global Precipitation Measurement/Dual-frequency Precipitation Radar (GPM/DPR), and is also proceeding in cooperation with the relevant organizations on these research efforts. Regarding the future plan of earth observation satellites, the Special Committee for Earth Observation in the Space Activities Commission is now carrying out deliberations.

The Ministry of Economy, Trade and Industry is currently engaged in joint operations with the Japan Aerospace Exploration Agency for the operation of the Advanced Spaceborne Thermal Emission and Reflectance (ASTER) radiometer, a resource exploration sensor mounted on the NASA global observation satellite (Terra), and for the development of the next-generation Phased Array Type L-Band Synthetic Aperture Radar (PALSAR), to be mounted on ALOS. It is also engaged in the development of the ground-based processing and analysis technologies required for the observation data obtained from the satellite sensors.

The Japan Meteorological Agency developed the Multi-functional Transport Satellite (MTSAT-1R) and launched it on February 26, 2005, as a follow-on satellite to the Geostationary Meteorological Satellite (GMS-5).

The Ministry of Agriculture, Forestry and Fisheries has created a database of imaging data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) mounted on the Terra and

Aqua NASA global observing satellites, and has made it available on the Internet.

The Ministry of the Environment is using valuable observation data on the ozone layer and other phenomena obtained from the Improved Limb Atmospheric Spectrometer-II (ILAS-II) mounted on “Midori II” to promote observation, monitoring, and research of the global environment, and is cooperating with the Japan Aerospace Exploration Agency and the National Institute for Environmental Studies for research and development of the greenhouse gas monitoring sensor mounted on GOSAT.

To promote the use of the data obtained in this way from satellites, the Japan Aerospace Exploration Agency’s Earth Observation Research and Application Center is promoting the development and operation of satellite data information systems that promote the use of satellite data in earth observations, disaster monitoring, resource management, etc., the mutual utilization of data, and research into data analysis and utilization. Furthermore, the agency uses a web page to publish satellite data, etc., to deepen peoples’ understanding of the current state of the global environment.

### **(Ocean Observation Technology)**

The oceans occupy about 70% of the Earth’s surface, and are strongly related to many global-scale phenomena on earth, so that the elucidation of the roles that they play is an important issue. To advance knowledge in this area, the Japan Agency for Marine-Earth Science and Technology promoted research and development into ocean observation technologies, including the next-generation JAMSTEC-Compact Arctic Drifter (J-CAD) and Argo float for establishing a global ocean intermediate water observation system.

The Ministry of Internal Affairs and Communications developed an extended-range marine radar, which realizes continuous long-term observation of

the flow field of the Kuroshio Current, etc. at the shore at the National Institute of Information and Communications Technology, and started observing the flow field of Kuroshio Current in the south of the East China Sea by installing the radars at Ishigaki Island and Yonaguni Island.

To observe the global ocean in real time, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Land, Infrastructure and Transport have been engaged in the development of an Advanced Ocean Observing System (Japan ARGO<sup>10</sup>) since FY2000. In this project, profiling floats are being deployed under international cooperation all around the world to measure temperature and salinity to an ocean depth of 2,000m.

In addition, the Ministry of Economy, Trade and Industry is promoting research on the mechanism for CO<sub>2</sub> circulation in the Pacific Ocean.

The Ministry of the Environment is promoting research into the utilization of satellite remote sensing technology, a special method for monitoring the ocean environment, as a part of the Northwest Pacific Regional Ocean Action Program (NOW-PA-P) promoted by the United Nations Environment Program (UNEP) in the Sea of Japan and part of the Yellow Sea.

### **(Research and Development of Stratospheric Platforms)**

The Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Internal Affairs and Communications have implemented research and development into stratospheric platforms, which are large unmanned airships positioned in the stratosphere and equipped with observation sensors and radio transmitters, etc., for use in Earth monitoring, telecommunications, broadcasting, etc.

<sup>10</sup> ARGO is named after the ship of the Greek mythic hero Jason, which is the name of the earth observation satellites series.

### (Technology Development to Restrain the Emission of Carbon Dioxide Accompanying Energy Use)

Carbon dioxide accompanying energy use accounts for about 90% of the total emission of greenhouse gases that cause global warming. Therefore, it is necessary to develop, practically apply, introduce and disseminate technologies for restraining

the emission of carbon dioxide.

In FY 2004 the Ministry of the Environment started promoting development for practical application of basic mitigation techniques and development of mitigation techniques that can be commercialized in a short period of time.

Incidentally, the major research subjects conducted during FY 2004 are as shown in Table 3-2-3.

**Table 3-2-3 Elucidation of various global-scale phenomena, and major research topics in the Earth sciences and technology sector (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	<ul style="list-style-type: none"> <li>· International joint research on advanced electromagnetic technology for the global environment</li> <li>· Research and development of technologies for the measurement of subtropical Earth environments</li> <li>· Research on global environment measurement and forecasting technology, using 3-D high-resolution imaging radar</li> <li>· Promotion of international information networks for conservation of the Earth's environment</li> </ul>
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	<ul style="list-style-type: none"> <li>· Aeolian dust experiment on climate impact</li> <li>· International research project on the interaction between the sub-vent biosphere and geo-environment</li> <li>· Unzen Volcano: International cooperative research with scientific drilling for understanding eruption mechanisms and magmatic activity</li> </ul>
	National Research Institute for Earth Science and Disaster Prevention	<ul style="list-style-type: none"> <li>· Study on extreme weather events and water-related disasters due to Climatic Change</li> <li>· Research on earthquake and volcanic eruptions</li> </ul>
	National Universities and Other Institutions	<ul style="list-style-type: none"> <li>· International cooperative research project on the arctic environment</li> <li>· Academic research into earthquake and volcanic eruption prediction</li> </ul>
Ministry of Agriculture, Forestry and Fisheries	National Institute for Agro-Environmental Sciences National Institute for Rural Engineering, National Institute for Agro-Environmental Sciences, Japan International Research Center for Agricultural Sciences, Forestry and Forest Products Research Institute	<ul style="list-style-type: none"> <li>· Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector</li> <li>· Assessment of the impact of global-scale change in water cycles on food production and alternative policy scenarios</li> </ul>
Ministry of Economy, Trade and Industry	National Institute of Advanced Industrial Science and Technology	<ul style="list-style-type: none"> <li>· Evaluation of the impact of carbon dioxide sequestration on the dynamics of global warming substances</li> <li>· Research into land-based monitoring of oceanic air mass regions</li> <li>· Evaluation of long-term carbon dioxide absorption, based on the analysis of intermediate- and deep-ocean water in the Pacific Ocean</li> </ul>

Ministry or agency	Research institute or program	Subject
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	<ul style="list-style-type: none"> <li>· As part of data and information for Hydrographic and Oceanographic activities, comprehensive ocean research in jurisdictional sea areas, ocean positioning using satellites, geological surveys of sea bottoms for the detection of volcanic eruptions, and surveys of water temperatures, ocean currents, waves, and other aspects of the Western Pacific ocean region</li> </ul>
	Japan Meteorological Agency Meteorological Research Institute	<ul style="list-style-type: none"> <li>· Study of the prediction of regional climate changes over Japan due to global warming</li> <li>· Development and improvement of a materials circulation model and research on assessment of the effect on the global environment</li> <li>· Observational research to enhance the radiative process</li> </ul>
	Geographical Survey Institute	<ul style="list-style-type: none"> <li>· Study on geodynamics using precise Earth measurement technology</li> <li>· Plate motion and deformation in the East-Asia and Pacific region</li> </ul>
	Port and Airport Research Institute	<ul style="list-style-type: none"> <li>· Use of tide-level observation to monitor rising sea levels</li> </ul>
Ministry of the Environment	Global Environment Research Fund	<ul style="list-style-type: none"> <li>· Development of greenhouse gas sink and source control technologies, through the utilization and preservation of land ecological systems mid- and long-term policies toward the stabilization of greenhouse gases in the atmosphere</li> <li>· Research into the maintenance of sustainable national territories for island nations formed from coral atolls</li> <li>· Elucidation of the dynamics of global-scale ocean pollution caused by toxic substances, and research into their prediction</li> <li>· Research into gene migration due to the release of gene recombinant organisms, and evaluation of the impact on biological diversity</li> <li>· Integrated study for the terrestrial carbon management of Asia in the 21st century based on scientific advancements</li> <li>· Research on the explanation of long-term trends, and prediction of future change ozone layer</li> <li>· Development of monitoring system for the halocarbon inventory in East</li> <li>· Studies on the effects of organic aerosols on regional and global climate</li> <li>· International co-operative survey to clarify Trans-boundary Air Pollution Across the Northern Hemisphere</li> </ul>
	Global Environment Research Coordination System	<ul style="list-style-type: none"> <li>· Research into the mechanisms for the carbon dioxide cycle in ocean surface layers, using radioactive nuclides as multi-tracers</li> <li>· Evaluation of the impact of carbon dioxide marine isolation on the ocean material cycling process</li> </ul>
	Technology Development Program for Mitigating Global Warming (competitive funding)	<ul style="list-style-type: none"> <li>· Development toward practical application of basic technology to restrain emission of carbon dioxide</li> </ul>
	Open-Type Project to Subsidize Development of Technologies Directly Connected to the Marketing of Competitive Global Warming Mitigation Measures	<ul style="list-style-type: none"> <li>· Development of technologies to restrain emission of carbon dioxide, which can be commercialized in a short period of time</li> </ul>

## **(2) Research into Building a Recycling Society**

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

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

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

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

The Ministry of Agriculture, Forestry and Fisheries is promoting the development of recycling and utilization technologies for biomass, the development of system technologies for the efficient recycling and utilization of local biomass resources, and the development of new energy production technologies that utilize organic resources in place of fossil fuels. In addition, the ministry started development of technologies to reduce production costs for biomass plastic in FY 2004. Furthermore, the ministry is engaged in the development of technologies for the sorting and transport of

recycled foodstuffs, an area that has long been a bottleneck, preventing the promotion of foodstuff recycling, as well as the development of reproduction and conversion technologies, and of constituent and quality evaluation technologies, needed for the promotion of advanced uses.

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

The Ministry of the Environment is carrying out the research and development of processing technologies for the detoxification of toxic chemical substances generated in the course of waste processing, of technologies for the safe recycling of plastics, etc., and technologies for the proper management of final disposal sites, research into elucidation of the mechanisms for the generation of micro-pollutants at waste disposal facilities, etc. and control of their emissions, as well as research on the control of risks attendant with micro-pollutants. In addition, the ministry is promoting research for the establishment of a recycling-based society, including analysis and assessment of social systems to promote formation of a recycling-based society and technologies for reducing the generation of waste at the production and consumption stages and for establishing a resource recycling system.

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

The major research subjects conducted during FY 2004 are as shown in Table 3-2-4.

**Table 3-2-4 Major research subjects for building a recycling-oriented society (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	<ul style="list-style-type: none"> <li>Development of an integrated urban liquid and solid waste treatment system incorporating technologies for transforming kitchen garbage to biodegradable plastics</li> </ul>
Ministry of Agriculture,	National Agriculture and Bio-oriented Research Organization, Private sector, universities, etc.	<ul style="list-style-type: none"> <li>Development of new technology for the treatment and local recycling of biomass</li> <li>Development of technology for assessments of and countermeasures for effects on agriculture, forestry, and fisheries by global warming</li> <li>Development of technology for reducing the production cost of biomass plastics</li> </ul>
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization, Private sector, universities, etc.	<ul style="list-style-type: none"> <li>Development of fundamental technologies for manufacturing environmentally harmonious hyperfine steel particles</li> <li>Development of technologies for the detoxification and materials recycling of aluminum impurities</li> <li>Development of recycling technologies for building materials, glass, etc.</li> <li>Development of technologies for resource-recycling-type housing</li> <li>Development of recycling technology for iron and plastic compounds, using an electric furnace technology</li> <li>Development of cement manufacturing technology utilizing recycled resources containing large amounts of chlorine</li> <li>Development of maintenance technology for extending the life of structures</li> <li>Support of 3R for practical uses (Request for Proposal)</li> </ul>
	National Institute of Advanced Industrial Science and Technology	<ul style="list-style-type: none"> <li>Research on renewable plastic with free categorization</li> <li>Research on a support system for green process manufacturing technology</li> <li>Research on materials technology for easy dismantlement and simple recycling</li> <li>Research on recycling technology with high efficiency for resources</li> <li>Research on an evaluation method for recycling technology</li> <li>Research on chemical recycling technology</li> <li>Research on environmental technologies that effectively use biomass</li> </ul>
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's Secretariat	<ul style="list-style-type: none"> <li>Development of housing and urban infrastructure management technology for sustainable society and safe environment</li> <li>Development of management technology for infrastructure and building stocks</li> <li>Development of evaluation method and technical measures of environmental impact throughout a building's life cycle</li> </ul>
	National Institute for Land and Infrastructure Management	<ul style="list-style-type: none"> <li>Research recycling systems for construction waste reduction</li> </ul>
	Public Works Research Institute	<ul style="list-style-type: none"> <li>Life cycle analysis on disposal and reuse of food wastes in sewerage systems</li> <li>Research into social infrastructure development using new materials, unutilized materials, and recycled materials</li> <li>Research into technology for effective utilization of plant waste materials as green materials</li> <li>Study on technology for the exploitation of resources and the recycling of organic waste materials utilizing sewage sludge</li> <li>Study on a method for efficient use focused on inorganic characteristics of sewage sludge ash</li> </ul>
	Building Research Institute	<ul style="list-style-type: none"> <li>Research and Development Project on Timber-based Hybrid Building Structures</li> <li>Development of dissemination and support systems for housing with independent recycling of energy resources</li> <li>Research and development into the effective utilization of existing buildings</li> </ul>
	National Maritime Research Institute	<ul style="list-style-type: none"> <li>Research into the application of environmental labels of ships by LCA</li> <li>Research into the recycling of ships</li> </ul>
	Port and Airport Research Institute	<ul style="list-style-type: none"> <li>Research into recycling technology in coastal areas</li> </ul>
	Civil Engineering Research Institute of Hokkaido	<ul style="list-style-type: none"> <li>Environmentally friendly resource circulation project for cold, snowy region</li> <li>Experimental study on developing a regional system of biogas-derived hydrogen energy supply, including the technology for such a system</li> </ul>
Ministry of the Environment	National Institute for Environmental Studies	<ul style="list-style-type: none"> <li>Evaluation of policies for the promotion of resource recycling from the lifestyle perspective</li> <li>Research into methods for the analysis of recycling systems' local adaptability</li> </ul>

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

#### **(Research and Development Related to Biological Diversity)**

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

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

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

The Ministry of the Environment is promoting research related to strategies for preservation of wild plants based on gene maps and individual base models.

#### **(Research and Development Related to Antipollution Measures)**

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

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

#### **(Other)**

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

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

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

The Ministry of the Environment uses the Global Environment Research Fund to promote research into forecasts of the effects of global warming, and

into their countermeasures. In addition, the Environmental Technology Development Fund is being used to support the topic of technologies for the rejuvenation of drainage basins and major cities that are co-existent with nature, to promote research into

the design and presentation of scenarios for coexistence with nature in major cities and drainage basins.

Incidentally, major research subjects conducted during FY 2004 are as shown in Table 3-2-5.

**Table 3-2-5 Major Research Subjects for Research Related to Building a Society that Co-Exists with Nature, Research Related to the Comprehensive Management of Chemical Substances, and Research Related to Other Sectors (FY 2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Japan Atomic Energy Research Institute	· Development of flue-gass radiation treatment
Ministry of Health, Labour and Welfare	Health and Labour Sciences Research Grants	· Research into the safety and health effects, etc., of dioxins and other microscopic chemical substances, and of microorganisms
	National Institute of Public Health	· Research into the conservation of drinking water sources
	Research funding for the project for the environmental sanitation	· Study for the produce of guidelines for waterworks to prevent global warming
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agrobiological Sciences, National Institute for Agro-Environmental Sciences, National Institute for Rural Engineering, Forestry and Forest Products Research Institute, and others	· Development of comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystem · Development of technologies for the management of agricultural and forest ecologies to reduce damage to agriculture and forestry by wild animals and birds · Development of eco-friendly management technology of water and agro-forested-aqua-ecosystem in watershed and estuary areas · MAFF gene bank project · Advanced evaluation of CO <sub>2</sub> balances in forests and oceans, etc.
	Project for the Development of the Agriculture, Forestry, and Fisheries Industry, Foodstuffs Industry, and Other Advanced Industrial Technologies	· Development of technology for recycling-based use of marine resources using advanced technology · Development of low-cost basic technologies for the production of organic fertilizers, etc.
Ministry of Economy, Trade and Industry		· Environmental technology development · Development of technology for CO <sub>2</sub> fixation and effective utilization · Development of environmentally friendly processing technology · Development of materials that put low stress on the environment · Development of environmentally friendly recycling technology



### 3.2 Priority Strategies for Science and Technology

Ministry or agency	Research institute or program	Subject
Ministry of Land, Infrastructure and Transport	Technology Research Division, Minister's Secretariat	· Development of thermal environment evaluation and countermeasure technologies for urban space
	National Institute for Land and Infrastructure Management	· Research into environmental management technologies for enclosed bays · Study on risk evaluation of chemical substances in water environment · Projects for the restoration of tidal flats in urban seaside areas · Proper reuse of treated wastewater · Research on the influence of soil and groundwater contamination on the watersheds
	Geographical Survey Institute	· Geoecological research and survey using airborne LIDAR data - Case study in Shirakami Mountains
	Public Works Research Institute	· Research on evaluating water quality risks · Research on techniques for conserving the ground environment · Research on comprehensive hydrologic models for rivers · Research on techniques for controlling water quality and soil at dam reservoirs and in the downstream sections of rivers · Research on techniques for controlling water quality and soil at dam reservoirs and downstream sections of rivers · Research on techniques for treating bottom sediment in enclosed water areas · Research on evaluating heat island phenomena reduction alternatives
	Building Research Institute	· Mechanisms for the emission of indoor pollutants from construction materials · Research into quantification of the effectiveness of heat island countermeasures
	National Maritime Research	· Actual sea area tests of deep-sea carbon dioxide reservoirs · Research into measures for the prevention of large-scale oil spills by tankers · Joint Japanese-French research into the prevention of marine pollution · Research into monitoring of environmental pollution when toxic liquid substances leak into the environment · Research into the development of technologies for real-time 3-dimensional measurement systems · Research into the reduction of compound pollution caused by ships' generation of toxic volatile gases
	Port and Airport Research Institute	· Research on the assessment of the effect of toxic chemical substances in the coastal area and measures to mitigate those effects · Research on oil-spill cleanup technology for the coastal area · Comprehensive environmental monitoring of the Tokyo Bay and research on the environmental forecasting model
Ministry of the Environment	Global Environment Research Fund	· Research into the selection of coral reef biodiversity preservation districts · Research on the rehabilitation the landscape level of degraded tropical forest
	Environmental Technology Development Fund	· Research into wildlife and plant preservation strategies based on gene maps and individual base models · Research into the restoration of hydro and material cycles that co-exist with nature in cities and drainage basins, and the development of ecology evaluation standards · Research into the development of methods for diagnosing the degradation of multidimensional functions in natural drainage basin environments, and of integrated modeling for the effective evaluation of the soundness of restoration policies
	Research Funding for the National Research Institute engaged in Environmental Pollution Research	· Theoretical research for appropriate lake utilization that takes the mutual interactions of life-forms into account, toward integrated protection of lakes
	Survey and Research Funds for the National Organization for Pollution Prevention	· Research into elucidation of changes and behavior in the natural environments of world natural heritage districts
	National Institute for Environmental Studies	· Research into the evaluation of technologies for natural restorations of marshland ecologies · Assessment of the possibility of recovering the marshy ecosystem by the re-routing of rivers flowing into the Kushiro Wetlands · Assessment of the lake environment based on organic linkage and preparation of a scenario for improvement

### 3.2.2.4 Nanotechnology and Materials

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

#### (1) Materials Fields

Japan has to date maintained a high standard of research and development in materials, and will need in the future to take the lead over the rest of the world in technological innovation.

In view of the wide-ranging and diverse demands for materials science and technology, relevant ministries and agencies are actively engaged in research and development in many different areas of materials science and technology.

At the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology (Subdivision on Research and Development Planning and Evaluation) prepared the “Basic Strategy for Promotion of the Nanotechnology and Materials Sectors in the Ministry of Education, Culture, Sports, Science and Technology (interim report)” in June 2002.

In response to this, the National Institute for Materials Science generally and widely promotes basic and fundamental R&D for materials science and technology, including “structural materials for the 21<sup>st</sup> century” and “superconducting materials.” Research into materials science and technology is also being promoted through the administration of the “Special Coordination Funds for Promoting Science and Technology,” and other similar programs including “Creative Research for Evaluation Science and Technology Program of the Japan Science and Technology Corporation (JST)”, and the Frontier Research System, at RIKEN. The ministry is also encouraging the development of creative and advanced materials research at the Institute for Materials Research and the Institute of Multidisciplinary Research for Advanced Materials at Tohoku University, the Institute for Molecular Science at the National Institutes of Natural Science, and the Institute for Chemical Research at Kyoto University, as well as using the “Grant-in-Aid for Scientific Research Program” for basic research into materials science and technology, in order to promote creative science research at universities and in others, so that they can serve as sources of free imagination and research inspiration for researchers.



Part of three-dimensional structures of proteins which were analyzed through joint research with the RIKEN Genomic Sciences Center

Source: RIKEN

The Ministry of Agriculture, Forestry and Fisheries is using “Insect Technology Research for Utilization of the Greatest Unused Resources of the 21<sup>st</sup> Century” to engage in research and development for the wider utilization of biomaterials such as fibroin, a silk protein, as a new material with active

anti-thrombosis properties, or the development of materials utilizing the compound capabilities of the bone constituents of silk to form artificial bone or artificial ligaments.

The Ministry of Economy, Trade and Industry is promoting the Program to Create an Innovative

Components Industry to strengthen the international industrial competitiveness of Japan while sufficiently using the functions and characteristics of substances to establish a high-value added material industry that creates new markets and employment. In FY 2004, the ministry has implemented the Integrated Development of Materials and Processing Technology for High Precision Components, which aims to develop innovative technology for manufacturing processes in which material creation technology and processing technology are integrated, the Production, Analysis and Measurement System for Microchemical Technology Project, which aims to speed up the process from the research and development stage to the production stage, and the Next-Generation Semiconductor Nanomaterials Advanced Evaluation Project, which aims to achieve efficient searching for the optimum combination of multiple materials.

## **(2) Nanotechnology**

### **(Major Policy Proposals for Nanotechnology)**

The Ministry of Internal Affairs and Communications is engaged in the research and development of optical functional devices and information memory elements, etc., as basic research on information communications. In addition, under the “Strategic Information and Communications R&D Promotion Programme,” the ministry started the Research and Development on Ultrahigh-Functional Network Technology Utilizing Nanotechnology in FY 2003 as well as promoting research and development on new information and communications functions and device technologies. Moreover, the National Institute of Information and Communications Technology is promoting Research and Development of New Functions and Extreme Technologies, and thereby implementing basic research into ultra-compact, ultra-high speed, and ultra-low power consumption information and communications devices, including the development of optical devices for the high-speed control and processing of large-capacity signals.

The Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications is promoting development of methods of assessing corrosion and deterioration for dangerous facilities, and preparing the necessary databases for creating an environment for developing and introducing

methods of assessing corrosion and deterioration for dangerous facilities.

At the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology (Subdivision on Research Planning and Evaluation) prepared the “Promotion Policies for R&D in Nanotechnology Materials” prepared in June 2002. In response to this report, the ministry is promoting, in its R&D projects (Leading Project) for economic revitalization, the “development of artificial organs and artificial sense organs using nanotechnology,” the “development of devices based on new principles derived from nanotechnology,” etc., through cooperation between industry and academia in sectors where the life sciences, information and communications, environment, and energy sectors merge together, and in technologies in which they share common foundations. In particular, under the “development of measurement, analysis, and evaluation tools leading the way to next-generation science and technology,” the ministry carried out newly-adopted subjects for the purpose of promoting development for practical application of nano-tech measurement and processing technologies. In addition, the “Nanotechnology Comprehensive Support Project” provides broad, cross-cutting and integrated support that goes beyond the bounds of existing research institutions and sectors, such as fostering human resources through seminars and international exchanges of young researchers, offering opportunities for the utilization of large and special facilities and equipment to outside researchers, collecting and publishing relevant information, and convening symposiums.

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

The National Institute for Materials Science is engaged in the development of new materials for nano-devices, research into nano-scale materials for energy and environmental applications, and other nano-materials research. RIKEN is engaged in basic research, which will form the foundation of nano-science technology for future generations. This includes the measurement and control of nano-level properties and functions, simple quan-

tum manipulation toward the development of new information processing devices, and space-time function materials for manufacturing auto-changing, auto-reacting materials, and materials that can change over time. Moreover, many universities and colleges, and independent administrative institutions are engaged in basic research spanning a wide range of fields. Furthermore, various research funding support programs, including the ministry's Special Coordination Funds for Promoting Science and Technology, and the "Grant-in-Aid for Scientific Research Program," are being used for nano-technology research themes.

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

The Ministry of Economy, Trade and Industry is intensively promoting development of "nanotechnology" that may bring about innovative development in the broad areas of industrial technologies.

The ministry is also promoting the "Nanotechnology Materials Program" to establish the technological foundation that contributes to the sustainable economic development as a source of industrial competitiveness of Japan, through systematization of results obtained and other knowledge. In FY 2004, the ministry implemented the development of nanomaterials with new functions to increase international competitiveness of the manufacturing industry, development of common technologies, including nano-processing and nanomeasurement such as MEMS<sup>11</sup> research and development for practical application using nanotechnology (Focus 21), such as the Carbon Nanotube FED<sup>12</sup> Project, and the standardization of nanomeasurement technology (intellectual basis).

The Ministry of the Environment is implementing the development of environmental technologies that make use of the nanotechnology merits of miniaturization and improved function. In FY 2004, the minister started the development of environmental measuring equipment using new carbon materials.

The major research topics in the nanotechnology and materials science and technology sector conducted during FY2004 are shown in Table 3-2-6.

11 MEMS : Micro-Electro-Mechanical System: Accumulation of machine elements, sensor, actuator and electronics on the silicon substrate by using micro molding techniques.

12 FED : Field Emission Display: Display unit based on the principle of having fluorescent materials emit light by emitting electrons from electron emitters on a flat surface and hitting the fluorescent materials with the electrons: Promoting research for achieving high-quality images and low power consumption by using carbon nanotube, a new material, for electron emitters.

**Table 3-2-6 Major research subjects in the nanotechnology and materials sectors (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology, etc.	<ul style="list-style-type: none"> <li>· Research and development of ultra functional network utilizing</li> <li>· Research and development on new functions and ultimate technologies</li> </ul>
	Fire and Disaster Management Agency	<ul style="list-style-type: none"> <li>· Development of methods of assessing corrosion and deterioration of dangerous facilities</li> </ul>
	Special coordination funds for promoting science and technology	<ul style="list-style-type: none"> <li>· Research into the development of nanohetero metallic materials by elucidating their nanostructure-property relationships</li> <li>· Research into the creation of new functional materials using ceramics integration technology</li> <li>· Research into active atom array networks for a new information processing platform</li> <li>· Practical development of opto-media crystals for information technology</li> <li>· Application of ultra-fine grained steel sheets for automobiles</li> <li>· Radiant-control directly excited microchip lasers</li> <li>· Development of a high-speed atomic force microscope for capturing nanometer-scale dynamic behavior of biological molecules</li> <li>· Development of a new-type X-ray photoemission electron microscope</li> <li>· Development of continuous fiber reinforcements for pre-stressing and smart bonding technology</li> <li>· Creation of bio-conjugate photosensitive nanomaterial</li> <li>· Nano-spintronics design and manufacturing</li> <li>· Combinatorial computative chemistry for the revitalization of Japan</li> <li>· Kyoto University personnel development unit for computative materials researchers</li> <li>· Development of new crystal material for the terahertz range</li> <li>· Use of nano-boundary control for the manufacture of magnetic recording materials</li> <li>· Development of next-generation display media using self-organization of molecules</li> <li>· Research and development into generation of high-polymer particles using micro-chemical reactors</li> <li>· SNDM strong dielectric probe memory</li> <li>· Development of SiO<sub>2</sub> glass-metal slope function material as a light source</li> <li>· International exchanges of nanotechnology researchers</li> <li>· Comprehensive research on nano devices for elucidation of the structures and functions of chromosomes</li> </ul>
	National Institute for Materials Science	<ul style="list-style-type: none"> <li>· Development of novel materials for nano-devices</li> <li>· Nanosynthesis and nanostructural materials for energy and environmental applications</li> <li>· R&amp;D of new superconducting materials</li> <li>· High Temperature Materials 21</li> <li>· Project for the promotion of biological materials</li> <li>· Ultra-Steel Products for New High Safety Infrastructures</li> <li>· Combinatorial Materials Exploration and Technology (COMET)</li> <li>· Development of virtual experimental platform for material design using computational science and technology</li> <li>· Development of a carrier material for an innovative nano drug delivery system (DDS)</li> </ul>
	RIKEN (The Institute of Physical and Chemical Research)	<ul style="list-style-type: none"> <li>· Nano-scale science and technology</li> <li>· Study on the genesis of matter</li> <li>· Coherent science research (Phase II)</li> <li>· Advanced technology research (physical science research)</li> <li>· Material science research (Quantum Materials Research )</li> <li>· Spatio-Temporal Function Materials Research</li> <li>· Single Quantum Dynamics Research</li> <li>· Research on exotic particle beams</li> </ul>

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Japan Science and Technology Agency	<ul style="list-style-type: none"> <li>· 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</li> <li>· Project for the promotion of nano-space, spin superstructures, and other creative science and technology</li> </ul>
	New Century Priority Research Creation Plan (RR2002)	<ul style="list-style-type: none"> <li>· Nanotechnology Researchers Network Center</li> </ul>
	Research and Development Project for Economic Revitalization (Leading Project)	<ul style="list-style-type: none"> <li>· Development of measurement, analysis, and evaluation equipment leading to next-generation science and technology</li> <li>· Development of artificial organs and artificial senses using nanotechnology</li> <li>· Development of devices operating on new principles based on nanotechnology</li> <li>· Commercialization of extreme ultraviolet (EUV) light source technology and other advanced semiconductor manufacturing technologies</li> <li>· Next-generation fuel cell project</li> </ul>
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agrobiological Sciences	<ul style="list-style-type: none"> <li>· Insect technology project</li> </ul>
	National Food Research Institute	<ul style="list-style-type: none"> <li>· Development of nanotechnology and materials technology for the innovative utilization of biological functions</li> </ul>
Ministry of Economy, Trade and Industry		<ul style="list-style-type: none"> <li>· Carbon nanotube FED project</li> <li>· High-strength nanoglass display monitor project</li> <li>· High-function nanoglass device project</li> <li>· Full-color rewritable functional capsule paper project</li> <li>· Diamond ultimate function project</li> <li>· Next-generation semiconductor nanomaterial advanced evaluation project</li> <li>· Nanocarbon application product manufacturing project</li> <li>· Micro-analysis and production system project</li> <li>· Project for the development of semiconductors for high-efficiency UV luminous elements</li> </ul>
Ministry of the Environment		<ul style="list-style-type: none"> <li>· Project for the promotion of environmental technology development using nanotechnology</li> </ul>

### 3.2.2.5 Energy

The “Basic Energy Plan” (by the Cabinet in October 2003) based on the Basic Law on Energy Policy (enacted in June 2002) revealed the energy R&D policies meriting priority promotion for the long-term comprehensive, planned promotion of policies related to energy supply and demand. In particular, it is necessary to promote research and development of energy that contributes to mitigating global warming, in line with the entry into force of the Kyoto Protocol.

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

Research, development, and utilization of nuclear energy in Japan have been carried out strictly for peaceful uses, in accordance with the Atomic Energy Basic Law. In regard to its basic and pro-

motion policies, the Atomic Energy Commission adopted the “Long-Term Program for Research, Development, and Utilization of Nuclear Energy” (hereafter called the “Atomic Energy Long-Term Plan”), and is steadily moving ahead under this plan. The Atomic Energy Commission has been holding the New Plan Formulation Council since June 2004 to formulate a new Atomic Energy Long-Term Plan. The Commission is conducting deliberations with the aim of formulating the plan by the end of 2005.

Today, nuclear power generation plays an important role in energy supply as a major source of energy accounting for more than one-third of electric power supplies and also as an energy source that contributes to mitigating global warming. Moreover, accelerators and other results of atomic energy science and technology continue to provide new knowledge in basic science sectors, and offer essential research tools for the life science and materials science and technology sectors. In addi-

tion, use of radiation has spread to a wide range of sectors, including medicine, agriculture, manufacturing, and environmental protection. Thus, nuclear energy has greatly contributed to assuring stability in the nation's energy supplies and improving the lives of the people.

Meanwhile, in regards to the atomic energy R&D structure in Japan, the "Reorganization and Rationalization Plan of Public Corporations," adopted by the Cabinet in December 2001, called for abolition of the Japan Atomic Energy Research Institute and the Japan Nuclear Cycle Development Institute, and for their merger through the establishment of a new incorporated administrative agency for the comprehensive implementation of atomic energy research and development. In response to these, the Law for the Japan Nuclear Energy Research and Development Organization was enacted at the 161st extraordinary Diet session, and the ministry is currently engaged in promoting operations toward the establishment of the new entity in October 2005.

### **(Ensuring Safety, and Emergency Preparedness)**

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

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

radiation monitoring and emergency preparedness.

Regarding ensuring safety of nuclear facilities, consideration has been given on the strengthening of a system to protect nuclear materials, introduction of the clearance system<sup>13</sup> and enhancement of the regulation system concerning the dismantlement and abolishment of nuclear facilities, from an expert viewpoint based on domestic and international trends. The Ministry of Economy, Trade and Industry gave considerations at the Nuclear Safety and Security Subcommittee of the Advisory Committee for Natural Resources and Energy. The following three reports were compiled in 2004: "Concerning the Strengthening of Measures to Protect Nuclear Materials at Nuclear Facilities," "Concerning the Establishment of a Clearance System at Nuclear Facilities," and "Concerning Regulations on the Abolishment of Nuclear Facilities." In addition, the Ministry of Education, Culture, Sports, Science and Technology gave consideration at the Study Meeting on Safety Regulations for Research Reactors and compiled a report titled "Concerning Desirable Safety Regulations for Nuclear Reactor Facilities for Experiment and Research" in January 2005. Based on these reports, the Ministry of Economy, Trade and Industry and other related administrative organizations gave consideration to establishment of specific laws and ordinances, and a bill was submitted to the 162nd session of the Diet.

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

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

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

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

To introduce the international standard value (lower limit of the subject of regulations) set by the International Atomic Energy Agency (IAEA) and streamline the regulations of radioactive isotopes along with their introduction, the Law for the Prevention of Radiation Sickness Caused by Radioactive Isotopes<sup>14</sup> was amended in 2004 so as to incorporate provisions for regular confirmation of methods of using radioactive isotopes, disposal of waste by burial and other matters.

Also, in ensuring nuclear safety, it is always important to reflect the latest scientific and technological knowledge in safety regulations. To this end, the Nuclear Safety Commission is coordinating the "Five-Year Safety Research Program (FY2001 to FY2005)."

In the area of safety research related to nuclear facilities, the Japan Atomic Energy Research Institute (JAERI) conducted evaluative and analytical research of light water reactors, regarding the high burn-up of fuel, advanced aging, severe accidents, and other accidents and incidents, and also conducted research into criticality safety at nuclear fuel facilities. In addition, the Japan Nuclear Cycle Development Institute (JNC) conducted safety research on accident prevention and mitigation, accident evaluations, severe accidents, etc.,

in Fast Breeder Reactors (FBRs), as well as safety research on the safety of criticality, shielding, confinement, etc., in nuclear fuel facilities. Other incorporated administrative agencies and other organizations also engaged in basic safety research.

For safety research related to environmental radiation, the National Institute of Radiological Sciences, working with JAERI, JNC, and other independent administrative agencies, conducted safety research on the dose evaluation of radiation exposure, as well as basic safety research into radiation effects.

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

In regards to the Five-Year Safety Research Program, in view of the changes in the structures of the institutions engaged in safety research, the Nuclear Safety Commission compiled in July 2004 the "Priority Safety Research Program" that presents research into safety issues to be conducted in FY2005 and beyond.

### **(Efforts by Nuclear Experts toward Assuring Trust and Coexistence with Communities)**

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

14 The following amendments were made through amendments to the Law for the Prevention of Radiation Sickness Caused by Radioactive Isotopes in 2004:

- (1) creation of a system of design certification by the equipment manufacturer
- (2) rationalization of sales and leasing services from a license system to a notification system
- (3) creation of a regular confirmation system to improve the safety of establishments
- (4) creation of a regular training system to improve the ability of radiation protection supervisors
- (5) preparation of provisions concerning disposal of waste by burial.



Furthermore, to promote coexistence between nuclear power research facilities and local candidate sites, the Power Source Grant program, of which use was expanded to non-construction projects, is being utilized in response to the needs of the local candidate sites.

## **(Nuclear Power Generation and the Nuclear Fuel Cycle)**

### **(1) Nuclear Power Generation**

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

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

### **(2) Research and Development of the Nuclear fuel Cycle**

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

In promoting plutonium utilization, Japan strives to ensure the transparency of plutonium use by disclosure of information regarding plutonium inventories, not only from the viewpoint of rigorous management of nuclear materials, but also in clear observation of the principle of never holding excess plutonium that is not required to implement current programs, so as to avoid arousing international concerns regarding the proliferation of nuclear weapons. Specifically, Japan adopted international plutonium guidelines for improving the transparency of its plutonium use, and annually announces its Plutonium management state through the International Atomic Energy Agency (IAEA).

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

While some reprocessing of spent fuel from nuclear power plants is conducted at the Japan Nuclear Cycle Development Institute's Tokai Reprocessing Plant, most is consigned by contract to reprocessing by British Nuclear Fuel Limited (BNFL) and COGEMA, the French nuclear fuel company. In view of the principle that spent fuel should be reprocessed domestically in Japan, construction is underway on a private-sector reprocessing facility (with an annual reprocessing capacity of 800 tons) in Rokkasho-mura, Aomori Prefecture, and a series of tests are currently underway toward a projected completion date of May 2007. The aim is the firm establishment of reprocessing technology on a commercial scale through the successful construction and operation of a private-sector reprocessing plant, toward the eventual establishment of the nuclear fuel cycle.

In this regard, the Tokai Reprocessing Plant has contracted with electrical power companies for the reprocessing of spent uranium fuel used in light water reactors, and about 1,060 tons has already been reprocessed. There are no plans to renew the contract when the period of the current contract is completed.

In addition, research and development of MOX fuel fabrication in Japan is now in progress at the

Japan Nuclear Cycle Development Institute, and about 170 tons of MOX had already been produced by the end of December 2004.

Intermediate fuel storage is important as a means to provide flexibility for the whole nuclear fuel cycle because the time period until the fuel is reprocessed can be adjusted through the storage. A law concerning intermediate storage was enacted in 1999, and utility companies are preparing for the facilities to be commissioned by 2010.

The “Fugen” advanced thermal reactor, which was undergoing independent development as a nuclear reactor with the ability to flexibly and efficiently utilize plutonium, recovered uranium, and other fuel, terminated its operations in March 2003, and the project ends as of 30 September 2003 with the completion of a report summing up the project results. The research and development necessary for decommissioning is now in progress.

### (3) Radioactive Waste Management

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

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

Low-level radioactive waste generated at nuclear power plants has been disposed of at the Japan Nuclear Fuel, Ltd.’s Low-Level Radioactive Waste

Disposal Center in Rokkashomura, Aomori Prefecture since December 1992, with about 170,000 -200 liter drums of waste already having been transferred to the center as of the end of January 2005.

The Ministry of education, culture, sports, science and technology started the “Roundtable discussion on disposal enterprises for radioisotope and research institute wastes” to consider the basic policies of disposal management on the primary contractor in February 2002 and published the final report in March 2004. Following the results, the Japan Atomic Energy Research Institute and the Japan Nuclear Fuel Development Institute have been progressing further study of disposal realization in cooperation with the Japan Radioisotope Association.

“The Law Concerning Prevention from Radiation Hazards due to Radioisotopes, etc.” was amended to add an article about near surface disposal of solidified radioisotope wastes in June 2004.

The Japan Atomic Energy Research Institute and the Japan Nuclear Fuel Development Institute have continuously researched and developed decommissioning technologies of nuclear fuel cycle facilities including the “Fugen” reactor.

### (Research and Development of Fast Breeder Reactors and Related Nuclear Fuel Cycle Technology)

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

The “Monju” prototype fast breeder reactor uses technology based on MOX fuel and sodium cooling, the most advanced of the FBR cycle technologies, and it is the only fast breeder reactor plant with power generating capabilities in Japan. “Monju” is positioned in the Atomic Energy Long-Term Plan as

the core for Japan's research and development into fast breeder reactor cycle technology

"Monju" ceased operations following a sodium leak accident in December 1995. In response to this situation, the Japan Nuclear Cycle Development Institute decided to implement plant modifications to reinforce countermeasures for a sodium leak accident to further increase safety toward resuming operations and obtained government approval. In February 2005, the institute obtained approval for the commencement of the plant modifications from Fukui Prefectural government and Tsuruga City municipal government, and then started preparation for the plant modifications.

However, regarding an administrative suit initiated by the local residents to nullify the construction license of "Monju," the government appealed the ruling up to the Supreme Court of Japan in response to the high court decision against the government in January 2003, and the appeal was accepted. In March 2005, oral proceedings were held at the Supreme Court.

In addition, since July 1999, the Japan Nuclear Cycle Development Institute has been collaborating with electric power companies to promote a "Feasibility Study on Commercialized Fast Reactor Cycle Systems," to propose appropriate concepts for FBR cycle technology to be commercialized in the future and develop research and development plans toward its realization, and is engaged in research and development to clarify the commercialization candidates that improve safety and economy, reduce the burden on the environment, and offer assurances for nuclear nonproliferation.

### **(Promotion of Nuclear Fusion Research and Development)**

Promotion of nuclear fusion research and the development of nuclear fusion are important because they expand available energy options for the future and increase the feasibility of fusion energy. In Japan, fusion research and development is promoted based on the "The Third Phase Basic Program for Fusion Research and Development" and the "Atomic Energy Long-Term Plan," which were adopted by the Atomic Energy Commission, by JAERI, the National Institute for Fusion Science, and universities and colleges through mutual cooperation, while aiming at prioritization based on "The Future of Nuclear Fusion Research in Japan,"

decided upon in January 2003 by the Science and Technology Council's Working Group on Nuclear Fusion Research. In addition, bilateral and multi-lateral international cooperation is being actively promoted.

JAERI is promoting R&D on a tokamak-type reactor toward the realization of a practical reactor. In particular, the large "JT-60" tokamak device has achieved significant results, which led the physics R&D toward the implementation of ITER, and demonstrated the feasibility of a steady-state nuclear fusion reactor. Further research is being promoted to achieve the long pulse operation of high pressure plasma through the improvement of plasma confinement performance.

The National Institute for Fusion Science constructed the large helical device (LHD) that is based on a unique idea originating in Japan and is the largest helical device in the world. Its research into new plasma regions leads the world. In December 2004, LHD achieved the world's largest input energy value into plasma, 1.3 billion joules.

In addition, the Institute of Laser Engineering at Osaka University, other universities and independent administrative institutions, etc., are engaged in basic research into various magnetic confinement and inertial confinement methods, and in research into essential technologies related to reactor engineering.

The ITER is an international cooperation project that aims for verification of the scientific and technological feasibility of nuclear fusion energy, and Japan promotes it actively. At the present time, six parties, specifically, Japan, China, the EU, South Korea, Russia, and the United States, participate in the project. In Japan, the Cabinet agreed on May 31, 2002 on a policy that Japan would propose Rokkasho-mura, Aomori prefecture as a candidate site with the aim of hosting ITER, based on the conclusion of the Council for Science and Technology Policy. In addition to Rokkasho-mura, Cadarache in France is proposed by the EU as a candidate site for the place to build an ITER. On the understanding of the above-mentioned policy, the Japanese government is making its best effort to host ITER in cooperation with local government authorities, industry and academia.

Based on the assumption that ITER is actually sited in Japan, the Ministry of Education, Culture, Sports, Science and Technology established the

ITER Safety Regulations Review Working Group to perform specific expert studies into safety regulations for ITER, and a “Report on ITER Safety Regulations,” was released in November 2003. The ministry is promoting operations for confirmation of the necessary safety measures and, based on the above report, is proceeding with further studies in preparation for the legal framework.

### **(Promotion of Nuclear Science and Technology)**

Nuclear science and technology uses the development and utilization of accelerators and high intense lasers to identify the ultimate components of matter and shed light on the laws of nature. The contribution of nuclear science and technology has two major aspects. The first is fundamental, theoretical research that supports science and technology development in the life sciences and materials-related scientific and technological sectors. The other is research and development that addresses the needs of the economy, society, and consumers by offering options for stable energy supplies in the future by means of nuclear fusion and innovative nuclear development. The promotion of nuclear science and technology requires the development of an environment conducive to creative research, and necessitates efficient and balanced development of the supporting fundamental, theoretical research.

Accelerator science is constantly affected by international competition, and its technology-intensive character means that post-proposal and evaluation results should be reflected without delay in the next steps of research. The Japan Atomic Energy Research Institute (JAERI) and the High Energy Accelerator Research Organization (KEK) are jointly promoting the High Intensity Proton Accelerator Project that aims at the construction of a proton accelerator with the highest beam power in the world, and new development over a wide range of research fields, including life science, materials science, nuclear physics and particle physics. The project was evaluated in August 2000 by the Advisory Committee on Evaluation of the High Intensity Proton Accelerator Project, which had been established under the Atomic Energy Commission (AEC) and the Science Council Accelerator Science Subcommittee. In addition, the Assessment Operations Division of the High Intensity Proton Accelerator Project, a part of the Council for

Science and Technology, conducted an interim assessment and started construction of a Neutrino Facility in FY 2004. In addition, RIKEN (The Institute of Physical and Chemical Research) is currently engaged in construction of the RI Beam Factory, an accelerator facility for generating beams of all types of radioactive isotopes (RI), from hydrogen to uranium, at the highest intensities in the world.

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

Beginning in FY2002, the Ministry of Education, Culture, Sports, Science and Technology has entertained various new ideas, using links between industry, academia, and government to perform research and development into public canvassing methods for selection between proposals related to innovative nuclear power technologies.

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

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

Basic research in nuclear science and technology nurtures the seeds that lead to the diversification of nuclear power usage and future technological revolutions, and contributes to project research in the field of nuclear energy and the development of oth-

er scientific and technological sectors. JAERI is making efforts to conduct fundamental research for the renewed development of nuclear energy, with advanced basic research into the science in radiation fields being conducted at the Advanced Science Research Center. On the other hand, the Kansai Research Establishment, which is in Kansai Science City, is engaged in the development of the X-ray laser, as well as other advanced laser science. In addition, JAERI and RIKEN commenced operation of a large synchrotron radiation facility (SPring-8) in October 1997, built in Harima Science Park City, for the purpose of promoting utilization and research by researchers from both Japan and abroad. Furthermore, national experimental research institutions under the control of each office and ministry are promoting leading-edge basic research in the four areas of fundamental technology, i.e. substances and materials, biological and environmental effects, computation technologies, and disaster prevention and safety. In addition, basic crossover research on nuclear energy is also being conducted by organically combining the potential capabilities of incorporated administrative agencies, universities, national experimental research institutions and other research institutions through their active cooperation in research.

### **(Promotion of Radiation Utilization)**

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

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

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

### **(Nuclear Non-Proliferation Policies and International Nuclear Energy Cooperation)**

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

#### **(1) Nuclear Non-Proliferation Policies**

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

addition to these frameworks, Japan reinforces the international nuclear nonproliferation regime with its technologies and skilled personnel in relation to the peaceful utilization of nuclear energy.

Japan is promoting the development and utilization of nuclear energy strictly for peaceful purposes, as stipulated in the Atomic Energy Basic Law. For many years, Japan has accepted “safeguards” to ensure the peaceful use of nuclear materials, based on the Safeguards Agreement with the IAEA, and implemented “physical protection” to prevent theft of nuclear materials or attempts to sabotage nuclear facilities. Japan is also promoting the necessary technology development for the implementation of the above measures. In FY 2004, the IAEA concluded that Japan shows no sign of diversion of nuclear materials under safeguards or of undeclared nuclear materials or nuclear activities. Through this, the Integrated Safeguards, which are efficient safeguards that enable a reduction in the number of inspections, were started.

In response to the start of uranium experiments at the Rokkasho Reprocessing Plant, an important facility to be safeguarded, the government started operation of the Rokkasho Safeguards Analytical Laboratory (on-site laboratory). The government also organized an international training course for the improvement of technologies for nuclear materials accounting.

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

Additionally, Japan in July 1997 swiftly ratified the CTBT banning all nuclear weapon test expl-

osions and all other nuclear explosions, a historic step towards a world that is free of nuclear weapons, and is now engaged in development of an international monitoring system toward the treaty’s eventual enforcement.

## **(2) International Nuclear Power Cooperation**

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

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

For nuclear cooperation with Asian countries, exchanges of information, opinions, and technology are being promoted under the framework of the Forum for Nuclear Cooperation in Asia (FNCA) for the peaceful utilization of nuclear power, in such areas as research reactors and the medical utilization of radiation. The Fourth FNCA Ministerial Level Meeting was held in Okinawa in December 2003, at which time opinions were exchanged between member nation ministers in charge of nuclear power on such issues as how to promote nuclear power cooperation, strategies for fostering human resources, sustainable development, and nuclear power energy.

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

contributing to the social and economic development of developing nations.

For cooperation in nuclear energy with the countries of the former Soviet Union and of Central and Eastern Europe, Japan offers research cooperation for the decommissioning of nuclear facilities, bilateral cooperation for quality improvement of plant operators through training projects, and provision of multilateral support through extra-budgetary contribution funding to the IAEA. In addition, regarding the management and disposal of Russia's surplus weapons-grade plutonium, Japan is determined to utilize its technologies for the peaceful use of nuclear energy developed over many years in Japan to cooperate in the disposition program of Russia's surplus weapon-grade plutonium, as part of its contribution to nuclear disarmament and nonproliferation, in close cooperation with the principal countries of the United States and Russia, and with other involved countries. In particular, the Japan Nuclear Cycle Development Institute (JNC) is engaged in research cooperation with Russia's Institute of Physical Energy Research and other institutes, such as the Research Institute for Atomic Reactors and the Institute of Physics and Power Engineering.

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

## **(2) New Energy Research and Development**

While new energy can contribute to addressing global warming, and to stable energy supplies, it also faces problems of economy, such as low energy densities and high electricity generating costs, and of stability, meaning that output can

fluctuate in accordance with the surrounding natural conditions. Research and development into fuel cells, photovoltaic cells, biomass energy, and other forms of new energy need to be aggressively promoted, in order to address these problems and promote the introduction and broader diffusion of these technologies.

### **(Fuel Cells and Hydrogen Energy Utilization)**

Because fuel cells, which generate electricity through a chemical reaction between hydrogen and oxygen, are very efficient and do not emit NO<sub>x</sub> or SO<sub>x</sub>, they are expected to be a key energy and environmental technology. While the development of fuel cell vehicles and stationary fuel cell systems is well-advanced, there still remain some hurdles to be addressed, such as durability and performance in order to make them commercially feasible. For this reason, the Ministry of Education, Culture, Sports, Science and Technology is promoting the development of new components and materials that can improve fuel cell performance. The Ministry of Economy, Trade and Industry is promoting research and development into fuel cell elements and hydrogen energy utilization technologies, including the manufacture, transport, and storage of hydrogen fuel, and the demonstration of fuel cell vehicle and hydrogen supply facilities. The Ministry of Land, Infrastructure and Transport is demonstrating prototype fuel cells for residential use.

### **(Photovoltaic Power Generation)**

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

### **(Biomass Energy)**

Based on the Biomass Nippon Strategy (ratified by the Cabinet in December 2002), the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, and Transport, and

the Ministry of the Environment are promoting research and development into technologies for the efficient conversion of animal wastes, wood residues, organic sewage, food wastes, and other unusable biomass sources into universally acceptable fuel forms, such as methane and other gaseous fuels (gasification), or methanol and other liquid fuels (liquefaction), and into technologies for these fuels' efficient utilization.

### **(3) Clean Fossil Fuel Energy R&D**

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

#### **(Petroleum)**

People are demanding further reductions in the environmental burden due to the use of petroleum products. In particular, the Ministry of Economy, Trade and Industry is promoting the development of technologies for cleaner, higher quality gasoline, diesel oil, and other motor fuels, toward further reductions in nitrogen oxides, particulates, and other automobile gas emissions.

#### **(Coal)**

Coal offers excellent supply stability compared to petroleum and other sources. But since coal emits the highest carbon dioxide of all fossil fuels, research and development is needed to reduce its burden on the environment. For this purpose, the Ministry of Economy, Trade and Industry is promoting the development of 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).

#### **(Natural Gas, etc.)**

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

environmental burden. Consequently, the Ministry of Economy, Trade and Industry is promoting research into technologies for the manufacture and utilization of liquid fuels (GTL, or Gas-to-Liquid) and dimethyl ethyl (DME), obtained by converting natural gas into liquid fuel, which should lead to the expansion of natural gas use. The ministry is also promoting the research and development of new exploitation technologies for the utilization of methane hydrates, believed to be available as an energy source in relatively large quantities from the seas around Japan.

### **(4) Energy Conservation and Energy Efficiency R&D**

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

To this end, the Ministry of Economy, Trade and Industry is strategically promoting research and development of the hydrate slurry air conditioning system<sup>15</sup> to overcome problems on the demand side in the process from the identification of seed technologies to the practical application thereof with the aim of increasing the effectiveness of development of energy-saving technologies.

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

Table 3-2-7 shows a summary of the major research topics in the energy sector (excluding nuclear power) implemented during FY2004.

<sup>15</sup> Hydrate slurry air conditioning system: A system in which a multiphase media of hydrate and water solution is used as a heat carrier to conduct cold latent heat carrying in high density thereby reducing the carrying power required.



**Table 3-2-7 Major research subjects in the non-nuclear energy sector (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	· Consideration of necessary safety measures for installing an outlet within a gas station that supplies fuel cell vehicles with hydrogen
Ministry of Education, Culture, Sports, Science and Technology	National universities and other institutions	· New energy and energy efficiency R&D · The Project to Design a Sustainable Management and Recycling System for Biomass and General and Industrial Wastes · Next-generation fuel cell project
	National Institute for Materials Science	· New century heat-resistant materials project · Research into the development of highly efficient advanced structural materials with superior processability
Ministry of Agriculture, Forestry and Fisheries	National Institute for Agro-Environmental Sciences, etc.	· Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector · Development of new technology for the treatment and recycling of biomass
Ministry of Economy, Trade and Industry		· Photovoltaic power generating technology · Development of technologies for the stabilization of wind power generating systems · Biomass energy technologies · Hydrogen energy technologies · Fuel cell technologies · GTL and DME-related technologies · Development of methane hydrate technologies · Research and development into clean coal technologies · Development of entrained bed coal gasification power plants · Development of energy conservation technologies - SiC and other power electronics - Technologies for the analysis of the optimum utilization of energy between multiple industrial users (pinch technology) - Development of high-efficiency white light-emitting diodes (LEDs) - Research and development into high-efficiency organic EL technology
	National Institute of Advanced Industrial Science and Technology	· Development of technology for distributed energy network systems · Development of technology for performing the comprehensive evaluation of energy systems
Ministry of Land, Infrastructure and Transport		· Promotion of technology development for the introduction of fuel cells and other new energy sources into residences
	Hokkaido Bureau	· Survey for supporting utilization of unused wood biomass energy and other energy sources
Ministry of the Environment	National Institute for Environmental Studies	· Development of technologies for the manufacture of hydrogen from bioresources and biowastes, etc. · Development of technologies for the manufacture of hydrogen using offshore wind power generation
	Global Environment Research Fund	· Total adaptation of advanced energy saving technologies to a CCRH research institute building

### 3.2.2.6 Manufacturing Technology

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

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

The Ministry of Education, Culture, Sports, Science and Technology is engaged in the development of next-generation fundamental technologies, such as, for example, the Japan Science and Technology Agency's R&D for an "evaluation system for ultra-precise semiconductors," which is aiming for the establishment of fundamental technologies for next-generation semiconductor manufacturing processes.

In addition, RIKEN is promoting the development of an "Integrated Volume-CAD System Using Advanced IT," based on technologies for utilizing the new concept of "volume data,"<sup>16</sup> for the purpose of integrating geometric modeling, simulation, testing, manufacturing and other kinds of information technologies in production engineering, and is also engaged in the development of an advanced measurement technology that utilizes a multidimensional quantum detector, toward the goal of establishing a cutting-edge measurement technology based on new detection technologies.

The Ministry of Economy, Trade and Industry is promoting various projects, including the "MEMS

Project," which aims to strengthen international competitiveness in key devices in the information and communications sector and other sectors by establishing manufacturing technology for MEMS (Micro Electro Mechanical System), the "Project for a Computer Aided Engineering System for MEMS," the "Digital Meister Project," which uses information technology to convert manufacturing workplace skills and know-how into software and databases, the "IMS International Joint Research Project," in which new production systems are developed through international joint research, the "Project for the Practical Application of Next-Generation Robots" to develop technologies for putting robots with high-level safety and flexible motion, which move near specific people, into practical application and to conduct demonstration tests thereof, the "Development of a Software Infrastructure for Robot Systems" for the purpose of promoting development of next-generation robots, the "Digital archive of human body properties," which promotes the development and designing of products through accumulation of data concerning the measure and shape of the human body and development of an automatic measuring system, and the "Knowledge support system for field operators at oil refinery," in which support system using ergonomic techniques is developed to conduct the maintenance and checkup of oil refineries during operation efficiently and with high reliability.

The Ministry of Agriculture, Forestry and Fisheries is engaged in the development of production technologies of new functional constituents, based on fermentation methods, and of technologies for improving the quality and capacity for production of fermented foods, to meet consumer demands for high-quality foods. The ministry is also engaged in the development of technologies that help to promote the utilization of Japan's own domestic agricultural produce, such as technologies for the improvement of processing rationality, as well as the development of new isolation and extraction technologies that can form the foundation for sustainable growth in the food industry.

<sup>16</sup> Volume data : digital data describing a material body which maintains geometry, internal structure and distributed physical properties, all in a unified form

### 3.2.2.7 Infrastructure

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

#### (1) Science and Technology for Disaster Prevention

Japan has experienced many natural disasters in its history, and has adopted many disaster prevention measures in response. In order to protect human life and property, and to mitigate the damage from natural disasters, it is important to make full utilization of scientific and technological knowledge in the course of preventing disasters before they happen, for limiting the spread of damage when disasters occur, and for recovery from disasters. The major scientific and technological research issues

on disaster prevention at each ministry and agency are shown in Table 3-2-8. The contents of the research are wide-ranging. In particular, earthquake disaster prevention research includes the "Special Project for Earthquake Disaster Mitigation In Urban Areas," with participants including disaster prevention research institutions from industry, academia, and government, and the development of a three-dimensional full-scale earthquake testing facility (called "E-Defense") by the National Research Institute for Earth Science and Disaster Prevention. In addition, the Earthquake Research Institute at the University of Tokyo, the Disaster Prevention Research Institute at Kyoto University, other university institutes throughout Japan, the National Institute for Land and Infrastructure Management, the National Institute for Rural Engineering, and others are engaged in research into the prevention or mitigation of damage from various types of natural disasters.

**Table 3-2-8 Major research subjects in (natural) disaster prevention science and technology (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and	National Research Institute for Fire and Disaster	· Survey on the methods of predicting the risk of a second failure at the site of a slope failure
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	· Development of a real-size, three-dimensional vibration destruction test simulation system
	National universities	· Basic research on natural disasters · Basic research into sand barriers, coastal disasters, and disaster prevention materials, and research into forecasting the advent of snow/ice-related disasters
	National Research Institute for Earth Science and Disaster Prevention	· Development of a real-size, three-dimensional vibration destruction test simulation system
Ministry of Land, Infrastructure and Transport	Engineering Affairs Division, Minister's Secretariat	· Development of technologies for prompt disaster prevention and alleviation measures utilizing disaster information and consideration of promotion policy
	Policy Bureau	· Development of an Emergency Transportation System in a Disaster Situation
	National Institute for Land and Infrastructure Management	· Research into managed-waste protective levee performance designs that take major earthquake movements into account · Study for mitigation of disaster caused by large-scale earthquakes and tsunamis · Study on earthquake disaster prevention measures utilizing seismic risk assessment technology
	Public Works Research Institute	· Research on economical seismic retrofit technologies for civil infrastructures · Research on enhancing techniques for mitigating damage caused by slope collapse and fluidization
	Building Research Institute	· Development of seismic safety design policies for RC buildings with soft-first stories · Development of firefighting performance evaluation methods in built-up areas
	Japan Meteorological Agency Meteorological Research Institute	· Study on an evaluation methods for volcanic activity · Development of nonhydrostatic model (NHM) and improvement of assimilation techniques · Research into technologies for diagnosing the risk of severe
	Geographical Survey Institute	· Study and development of a monitoring system for volcanic deformation detection · Study to improve the monitoring methods of the crustal deformation in the Tokai region · Study on the characteristics of crustal deformation around the Tonankai and Nankai Regions · Study for optimizing numerical crustal deformation models relating to seismic and volcanic activities
	Port and Airport Research Institute	· Research into the mechanism for the generation of long-cycle waves, and into countermeasures for long-cycle waves in ports and along coastlines · Research into the prevention of high tide and tsunami disasters related to global warming

In the area of international cooperation, Japan is taking part in bilateral research on science and technology for disaster prevention within the framework of science and technology cooperation agreements with the United States, Russia, Italy, and others, and the “U.S.-Japan Cooperative Program in Natural Resources” (UJNR). In addition, in the Hyogo Framework for Action 2005-2015 formulated at the U.N. World Conference on Disaster Reduction held in January 2004, Japan is required to provide support for the improvement of science and technology as well as capacity for risk assessment, monitoring and early warning.

## (2) Earthquake Surveys and Research

In light of the Great Hanshin-Awaji Earthquake Disaster that occurred in 1995, the Special Measure Law on Earthquake Disaster Prevention was passed for the purpose of promoting comprehensive

earthquake prevention measures all across Japan. The law stipulates the system of responsibility for earthquake surveys and research that impinge directly on administrative policies, and the Headquarters for Earthquake Research Promotion (Chairman: Minister of Education, Culture, Sports, Science and Technology) was established based on that law to facilitate these activities, a Policy Committee and an Earthquake Research Committee was also established under the Headquarters for Earthquake Research Promotion based on it. Based on “The Promotion of Earthquake Research – a basic comprehensive policy for the promotion of earthquake observation, measurement, surveys and research,” adopted in April 1999, the Headquarters for Earthquake Research Promotion serves as the point of contact and cooperation between relevant ministries and agencies for the promotion of earthquake surveys and research (Figure 3-2-9).

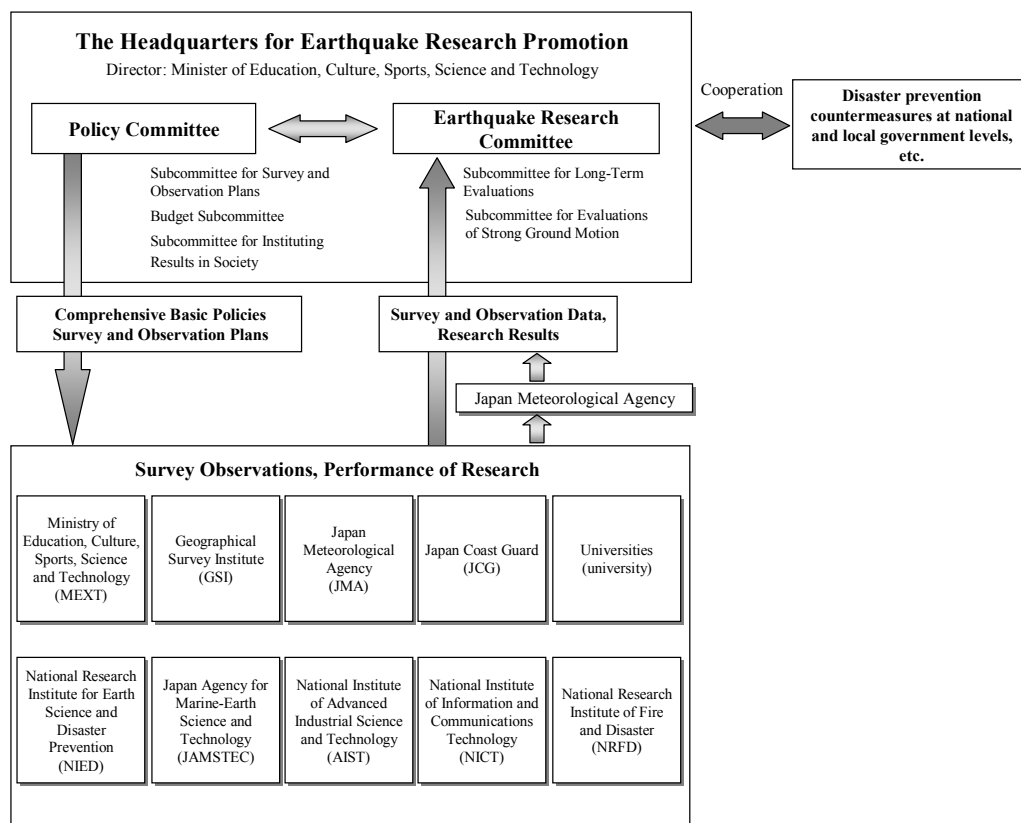


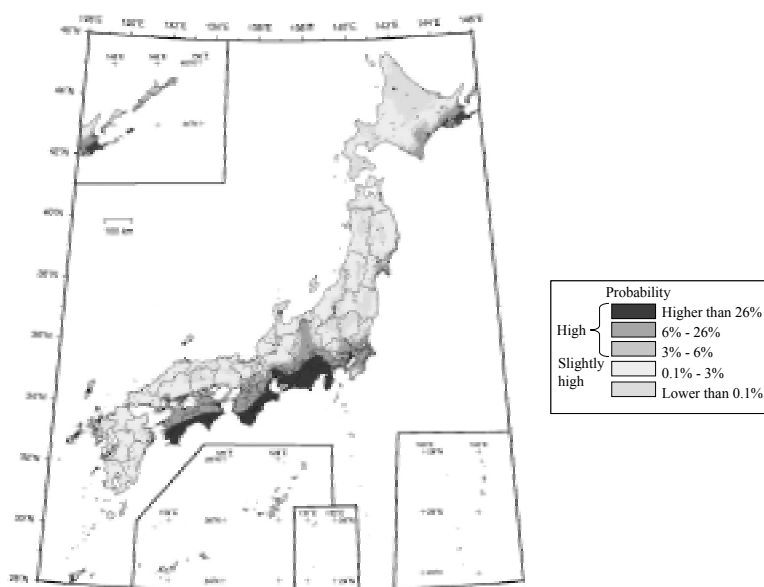
Figure 3-2-9 The structure of the headquarters for earthquake research promotion

The Policy Committee intended to perform administrative adjustments of budgets related to earthquake surveys and research in the relevant ministries and agencies. In August 2004, the Headquarters adopted the “Estimate of Budget Requests Related to Earthquake Surveys and Research for FY2005,” and called upon the Prime Minister and other relevant ministers to respect its content when drawing up the government budget.

The Earthquake Research Committee holds regular meetings on a monthly basis, and at other times when an earthquake does particular damage. At these meetings, the committee makes comprehensive evaluations of earthquake activities in Japan by collecting information and results of analysis related to them and publishes them immediately to ensure their utility in disaster prevention activities. In addition, extra meetings were held to evaluate the occurrences of the earthquakes at off-shore of the Kii Peninsula on September 5, 2004, the Niigata Chuetsu Earthquake on October 23, the earthquake

off-shore of Kushiro on November 29 and the earthquake off-shore west of Fukuoka Prefecture on March 20, 2005, to prepare evaluations.

On the other hand, the Earthquake Research Committee performs a series of long-term evaluations of the probabilities of future earthquake occurrence, and published the results for 98 major active fault zones (including 10 provisional evaluations) throughout the country and subduction-zone earthquakes at 7 sea areas around Japan. In addition for the purpose of enhancing the strong ground motion estimation method, the committee selected some fault zones and ocean trench earthquakes subject to long-term evaluations as model cases and predicted strong ground motions gave by these earthquakes by use of this method, and also published these evaluation results. At the end of FY 2004, the committee published the “General Seismic Hazard Maps” based on these results (Figure 3-2-10).



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

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

2. Base date: January 1, 2005

\* 6 Lower or greater: Japanese standard quake scale

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

Based on the policies laid down by the Headquarters for Earthquake Research Promotion, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) promotes research and surveys of active fault zones, and is also performing much more detail research and surveys at some regions where the probability of earthquake occurrence is high. In addition, as a part of the “Special Project for Earthquake Disaster Mitigation in Urban Areas”, it also promotes the research and survey into the crustal structure in major metropolitan areas, as well as research into the improvement of prediction accuracy for the Tonankai and Nankai earthquake zones and ocean trench earthquakes around the Japan Trench and Chishima Trench. On the other hand, the national universities are also promoting fundamental study for earthquake prediction. The National Research Institute for Earth Science and Disaster Prevention (NIED), acting in accordance with the “Fundamental Seismic Survey and Observation Plan,” is promoting the development of high sensitivity seismic observation stations and of wide-area earthquake observation facilities, and is also engaged in collecting data from earthquake observation networks now under development that will eventually cover the entire nation, and in processing and disseminating that data. The institute is also engaged in research into methods for the preparation of general seismic hazard maps. In addition, the Japan Agency for Marine-Earth Science and Technology is promoting the development of a comprehensive real time deep sea-floor observation network system. The Geographical Survey Institute operates 1,229 (as of March, 2005) continuous GPS stations throughout the nation as well as Very Long Baseline Interferometry (VLBI)

and other advanced survey technologies, to make observations and analysis of crustal deformation and plate motion, and hence promotes earthquake research. The Japan Meteorological Agency (JMA) analyzes seismic wave data including that of other relevant institutes, and promotes the development of observation facilities and research for earthquake prediction. Furthermore, JMA plans to disseminate Earthquake Early Warning, which provides information including the hypocenter and magnitude of an earthquake before the principal motion to mitigate the earthquake's damage, and is engaged in research for upgrading this information in cooperation with the National Research Institute for Earth Science and Disaster Prevention. The Japan Coast Guard promotes marine research on earthquakes such as seafloor geodetic observation, surveys of seafloor topography and active faults.

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

Incidentally, related ministries and agencies, research institutes, universities, etc. cooperatively conducted studies and research on the Niigata Earthquake in October 2004 and the Sumatra Earthquake and tsunami in Indonesia in December 2004, as an emergency research funded by the Special Coordination Funds for Promoting Science and Technology.

**Table 3-2-11 Measures for earthquake surveys and research (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and	National Research Institute of Fire and Disaster	· Research into the creation and systematization of disaster prevention information at the time of an earthquake
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	· Basic earthquake-related survey grants · Promotion of prioritized surveys and observation · Regional characterization of the crust in metropolitan areas under the Special Project for Earthquake Disaster Mitigation in Urban Areas · Surveys and research into Tonankai and Nankai earthquakes · Project for the realization of an advanced instantaneous quake information transmission network
	National universities	· Promotion of research and observation of the processes in the earth's crust leading to earthquakes · Operation of geophysical observation stations
	National Research Institute for Earth Science and Disaster Prevention	· Development of basic survey and monitoring facilities for earthquakes · Research into methods for the preparation of general seismic hazard
	Japan Agency for Marine-Earth Science and Technology	· Development and preparation of a comprehensive sea bottom network monitoring system
Ministry of Economy, Trade and Industry	National Institute of Advanced Industrial Science and Technology	· Research into the use of active faults and old earthquakes for quake occurrence forecasting
Ministry of Land, Infrastructure, and Transport	Japan Coast Guard	· Observations for the elucidation of activities in the Earth's crust leading up to an earthquake · Observations for precise monitoring activities in the Earth's crust · Promotion of marine geodetic sites
	National Institute for Land and Infrastructure Management	· Study for mitigation of disaster caused by large-scale earthquakes and tsunamis
	Japan Meteorological Agency	· Earthquake monitoring networks, and earthquake and tsunami monitoring systems
	Meteorological Research Institute	· Improvement of the accuracy of prediction of the Tokai Earthquake and research on preparatory process of the Tonankai and Nankai Earthquakes · Research into advanced use of seismic and crustal movement observation
	Geographical Survey Institute	· Japanese archipelago precise geodetic network survey · Strengthening of crustal movement observation · VLBI (Very Long Baseline Interferometry) survey · Gravity survey and geomagnetic survey

### (3) Aviation Science and Technology

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

In Japan, technology has accumulated through the independent development of the YS-11 commercial transport aircraft and other projects, international joint development of the Boeing 777 and other aircraft, and international joint development of the V2500 jet engine for commercial aircraft. The nation's technology is steadily increasing its

role in the world's aviation industry. In particular, Japan's application of composite materials and other advanced materials in its structural design and manufacturing technologies is recognized as top-class around the world.

To actively promote the development of aircraft and their engines, it is necessary to even further improve the technological levels. In the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology decided the "Promotion Policy for Research and Development into Aerospace Science and Technology" in FY2003, thereby indicating desirable ways of rese-



arch and development. In addition, in the Ministry of Economy, Trade and Industry, Aircraft and Space Industry Committee's Aircraft Subcommittee under the Industrial Structure Council is holding discussions on the possibility of joint international development of civil aviation aircraft and engines, and on other directions in aircraft industry policy.

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

The Ministry of Economy, Trade and Industry is promoting research and development for low-cost small aircrafts with little environmental burden and environment-adopted high-performance small aircraft that demonstrate the entire integration technology for engines, as well as research and development of engines for environment-adopted small aircrafts. In addition, the ministry is promoting the development of technologies for manufacturing and processing of next-generation structural parts and materials, which realize a reduction in the cost of and increasing reliability of composite materials for aircrafts and magnesium alloy parts and materials, and the development of technologies related to engine structures and materials based on "MGC (Melt-Growth Composite) materials," as well as the development of next-generation technologies related to accessories, such as incorporating maneuvering and air conditioning into electrical operation.

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

#### (4) Development of Other Social Infrastructure

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

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

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

The Ministry of Internal Affairs and Communications and other ministries and agencies are promoting research and development into ultra-high

speed network technologies, advanced information resource transmission and accumulation technologies, and other advanced information and communication systems, as well as research and development for fire fighting and disaster prevention, including research on technologies for alleviating damage by disaster and disaster response technologies.

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

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

The Ministry of Land, Infrastructure and Transport offers subsidies and other support for the Railway Technical Research Institute to promote re-

search and development toward the practical realization of a superconducting magnetically levitated train, for the objective of high-speed transport in the future. In addition, publication of the “Development Vision for Technologies Related to Deep Underground Use” has served to promote the development of technologies with broad general applications for projects that require traversal of the deep underground. Furthermore, guidelines for ensuring safety in public use of the deep underground, and guidelines for protection of the environment, were issued in February 2004, and technology research and development is now being promoted for utilization of the deep underground that takes safety and environment into consideration.

The major research topics in FY2004 for socioeconomic infrastructure, safety assurance, etc., are as shown in Tables 3-2-12 and 3-2-13.

**Table 3-2-12 Major research subjects in the improvement of the socioeconomic foundation area (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and	National Institute of Information and Communications Technology	· Research into basic information and communication technologies
Ministry of Education, Culture, Sports, Science and	Japan Aerospace Exploration Agency	· Technologies for higher performance domestic passenger aircraft · Research into aviation safety and environment protection technologies
Ministry of Agriculture, Forestry	National Institute for Rural Engineering	· Development of eco-friendly management technology for water and agro-forested-aqua-ecosystems in watershed and estuary areas
Ministry of Economy, Trade and Industry		· Supersonic transport propulsion system · Behavior-based human environment creation technology
Ministry of Land, Infrastructure, and Transport	Engineering Affairs Division, Minister's Secretariat	· Development of housing and urban infrastructure management technology for sustainable society and safe environment
	Subsidy for the development of railway technologies	· Development of a superconducting magnetically levitated train
	Grants-in-aid for advanced research on ship technology	· Research and development of environmentally-friendly ocean vessels (green ships)
	National Institute for Land and Infrastructure Management	· Research for the International Harmonization of Building Codes and Standards
		· Research into airport pavement design and repair to accommodate ultra-large air-craft loads that take life-cycle costs into account
		· Research on desirable environment in urban area for urbanized
		· Development of effective evaluation and management methods for cost reduction of public works
	Geographical Survey Institute	· Development of the technology to use precise three-dimensional spatial data for the regeneration of cities
	Public Works Research Institute	· Research on improving the durability of structures and evaluating their performance
		· Research on evaluating the soundness of infrastructure stock and its remedial techniques
		· Research on the efficient construction and redevelopment of dams considering the surrounding environment
		· Research on reducing the construction costs of super-long highway structures
	National Maritime Research	· Research into more advanced distribution simulations
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	· Comprehensive research on waste disposal and the recycling of wastes
		· Comprehensive research on advanced treatments for effluents

**Table 3-2-13 Major research subjects in the safety area (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Fire and Disaster Management Agency	<ul style="list-style-type: none"> <li>Survey and research on the desirable ways of comprehensive fire control safety measures for various subjects of fire control</li> <li>Survey and research on the desirable ways of fire control safety measures that correspond to the practical application of fuel cells</li> </ul>
	National Research Institute of Fire and Disaster	<ul style="list-style-type: none"> <li>Advancement of firefighting, emergency services and rescue techniques</li> <li>Safety measures for those who need help during disasters, such as elderly people</li> <li>Safety evaluation for hazardous materials and facilities handling hazardous materials</li> </ul>
Ministry of Health, Labour and Welfare	National Institute of Industrial Safety	<ul style="list-style-type: none"> <li>Research on prevention of human errors as causes of industrial accidents in the construction sector</li> <li>Research on basic safety technology for work systems based on human-machine collaboration</li> <li>Research on the prevention of explosions and fire disaster in the process of industrial recycling</li> <li>Development of a method of assessing the wind resistance of temporary structures</li> </ul>
Ministry of Agriculture, Forestry and Fisheries	Fisheries Research Agency	<ul style="list-style-type: none"> <li>Development of a method of assessing the safety of fishing vessel structures in consideration of human influence</li> </ul>
Ministry of Economy, Trade and Industry		<ul style="list-style-type: none"> <li>Development of technologies for the safe management of liquefied petroleum gas supplies</li> </ul>
Ministry of Land, Infrastructure and Transport	National Maritime Research Institute	<ul style="list-style-type: none"> <li>Research on FSA method to formulate safety standards –Development of a method of assessing the fire risk of passenger ships</li> </ul>
	National Institute For Sea Training	<ul style="list-style-type: none"> <li>Research on human errors in accidents at sea</li> </ul>
	Marine Technical College	<ul style="list-style-type: none"> <li>Basic research on the cutting of mooring ropes at the fair leader</li> <li>Detection of leakage and abnormality in machines, equipment and plants</li> </ul>

### 3.2.2.8 Frontier Science

#### (1) Space Development and Utilization

Space development and utilization not only brings about “accumulation of intellectual properties common to all humankind” through acquisition of commonly applicable knowledge regarding the origin of the universe and various phenomena occurring on earth, but also maintains critical national technologies, which serve as a basis of sustainable development of the country, through development of technologies necessary for space development and utilization, thereby contributing to national security in a broad sense. It is extremely important because the expanded use of space contributes to the “expansion of the socioeconomic infrastructure” through communications and broadcasting, weather forecasting, and global environment and disaster monitoring, and to “pioneering advanced technologies” that might result in the creation of

new technologies in various fields and of new industries with high added value.

Since the successful launch of Japan’s first “Ohsumi” satellite in 1970, Japan has launched 105 satellites as of the end of March 2005. Table 3-2-14 shows the major satellites planned for future launch by Japan and their objectives.

The Council for Science and Technology Policy decided in September 2004 the “Basic Strategies for Space Development and Utilization in Japan”, which indicates action plans of Japan’s space development and utilization.

The Ministry of Education, Culture, Sports, Science and Technology is promoting research and development in a strategic and concentrated way at the Japan Aerospace Exploration Agency (JAXA), in accordance with the Long-Term Program of Space Activities determined by the resolution of the Space Activities Commission in September 2003. In response to such accidents as the failure of the

H-IIA launch vehicle No. 6, JAXA conducted a complete inspection of all satellites and rockets to promote efforts to increase reliability of space technology in terms of both technology and the system. As a consequence, JAXA succeeded in launching H-IIA launch vehicle No. 7 mounting Multifunctional Transport Satellite No. 1 (Himawari No. 6) in February 2005.

The Space Activities Commission conducted an

investigation into the causes of failure of H-IIA launch vehicle NO. 6, Midori-II, Nozomi, etc., from technological aspects, conducted a survey and deliberation on future methods, a survey and deliberation on the review of the manufacturing system and responsibility for rockets among JAXA and manufacturers, and a survey and deliberation on the complete inspection of all satellites and rockets.

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

Satellite/payload	Weight (kg)	Orbital altitude (km) / location	Launch vehicle	Launch date (fiscal year)	Major objectives
ALOS Advanced Land Observing Satellite	Approx. 4,000	Approx. 690	H-IIA	2005	· To contribute to cartography, regional monitoring, disaster situation monitoring, resource exploration, etc.
ASTRO-E II 23rd scientific satellite	Approx. 1,700	Approx. 550	M-V	2005	· To observe X-rays from active galactic cores and galactic clusters, to elucidate the structure and evolution of space, etc.
ETS-VIII Engineering Test Satellite-VIII	Approx. 2,800	-	H-IIA	2006	· To develop, test, and demonstrate large satellite bus and mobile satellite communications technologies, etc.
OICETS Optical Inter-orbit Communications Engineering Test Satellite	Approx. 570	Approx. 600	Dnepr (Russia /Ukraine)	2005	· To conduct orbital tests of effective optical communications technologies in inter-satellite communications, and specifically of element technologies focusing on capture pursuit tracking
JEM Japanese Experiment Module	Approx. 26,800	Approx. 400	U.S. Space Shuttle	2007	· Expansion of Japan's space activities, promotion of leading science and technology development, and contribution to the advancement of international cooperation
WINDS Wideband InterNetworking engineering test and Demonstration Satellite	Approx. 2,700	-	H-IIA	2007	· Development, etc., of ultra-fast high-capacity satellite communications technologies and other world-leading technologies
SELENE SELEnological and Engineering Explorer	Approx. 2,900	Approx. 100	H-IIA	2006	· To research the origin and evolution of the Moon, collect data for a Moon-use feasibility survey, etc.
SOLAR-B 22nd scientific satellite	Approx. 900	Approx. 600	M-V	2006	· Detailed observation of the structure and motion of micromagnetic fields on the solar surface, to elucidate the components of solar magnetism and the source of solar activity
GOSAT Greenhouse gas Observing Satellite	Approx. 1,500	Approx. 650	H-IIA	2007	· Continuous observation of physical Earth quantities, to contribute to the elucidation and forecast of global warming, climate change, changes in the ozone layer, etc.
GPM/DPR Global Precipitation Measurement/Dual-frequency Precipitation Radar	Approx. 3,000	Approx. 400	H-IIA	2009	· To develop the Dual-frequency Precipitation Radar (DPR) for monitoring precipitation, as part of international cooperation in the Global Precipitation Measurement Program (GPM)
HTV H-II Transfer Vehicle	Maximum supply weight: Approx. 7,000	Approx. 350-460	H-IIA	2008	· To use a Japanese transport system that can contribute a fair share of material supplies to the Space Station
PLANET-C 24th scientific satellite	Approx. 480	Approx. 300-79,000	M-V	2008	· To explore Venus' atmosphere, and solve riddles in the basic principles of planetary weather and the evolution of atmospheres
ASTRO-F 21st scientific satellite	Approx. 960	Approx. 750	M-V	2005	· To use infrared observations toward the elucidation of the formation and evolution of the Milky Way galaxy, stars, and planets
LUNAR-A 17th scientific satellite	Approx. 540	Approx. 200	M-V	To be determined	· Elucidation of crustal structure and thermal structure of the moon
Bepi-Colombo Mercury Exploration Project	Approx. 200 (MMO)	Approx. 400-12,000 (MMO)	Soyuz Fregat 2B	2012	· To observe the magnetic field, magnetosphere, the inside and surface of Mercury from many directions through international cooperation with the ESA (European Space Agency). Japan is in charge of the Mercury Magnetospheric Orbiter (MMO)

### **(Earth Observation and Earth Science)**

This is described in 3.2.2.3.

### **(Space Science and Lunar Exploration)**

JAXA plays the core role in the field of space science in Japan, launching scientific satellites with the participation of researchers from universities and colleges nationwide.

The “Hayabusa” Scientific Satellite No.20 MUSES-C was launched in May 2003 for the purpose of performing an engineering test for a later planned mission to take rock samples from the asteroid and return them to Earth. The microwave discharge ion engine mounted on “Hayabusa” marked a total operating time of 20,000 hours in December 2004, and “Hayabusa” is traveling in orbit around the sun toward arriving at the asteroid in the summer of 2005.

Launches scheduled for FY2005 include Scientific Satellite No.23 ASTRO-E II for the observation of X-rays emitted from active galactic cores and galactic clusters to investigate the structure and evolution of the universe, and Scientific Satellite No. 21 ASTRO-F for the elucidation of the process of formation and evolution of galaxies, stars and planets through infrared observation.

Other projects now in development include Scientific Satellite No.22 SOLAR-B for detailed observation with a high degree of accuracy of the structure and motion of magnetic fields on the solar surface to investigate the origins of the solar atmosphere and the causes of solar activity, and the Moon orbiter SELENE to gather data to investigate the origins and evolution of the moon and to clarify feasibility of the utilization of the moon. Incidentally, for Scientific Satellite No. 17 LUNAR-A designated for the investigation of the lunar internal structure and thermal structure, the plan is under review through consideration of problems in the development of observational equipment to be mounted (penetrator).

### **(Communications, Broadcasting, and Positioning)**

Utilization of satellites for communications, broadcasting, and other purposes offers a broad range of benefits in terms of wide-area use, broadcast simultaneity, durability following disasters, etc. In Japan, the private sector is already deeply involved in satellites for the communications and broadcast

sector, such as for satellite broadcasting. To further promote these private-sector efforts, the government is promoting development in advanced and basic technologies where the risks are too great for the private sector, and the development of pioneering technology for the future utilization of space.

#### **(1) Wideband InterNetworking engineering test and Demonstration Satellite (WINDS)**

Development is in progress in cooperation with the Ministry of Internal Affairs and Communications on the Wideband InterNetworking engineering test and Demonstration Satellite (WINDS), toward a FY2007 launch. The objectives of this ultra-high speed Internet satellite are to establish a satellite-based communications technology that enables ultra-high speed Internet and large-volume data communications, to test ultra-high speed networking technology using satellite communications, and to implement new utilization tests through cooperation between Industry, academia, and government that will serve to stimulate new demand and to promote the IT revolution in Japan.

#### **(2) Quasi-Zenith Satellite System**

The quasi-zenith satellite system would consist of multiple satellites placed in quasi zenith orbits to ensure that more than one satellite is always visible at the zenith in the skies over Japan, to achieve virtually 100% land coverage for high-quality communications, broadcasting, and positioning services, without being affected by narrow mountain valleys or tall buildings. Research into the quasi-zenith satellite system is now being promoted between the government and the private sector toward a FY2008 launch.

#### **(Manned Space Technology)**

Japan has obtained various advanced technologies, including highly-advanced manned space technology, through participation in the International Space Station (ISS) Program, and is thereby aiming to accumulate basic technology necessary for Japan in the future. Japan is now carrying out the development of the Japanese Experiment Module (JEM; also known as “Kibo”) and H-II Transfer Vehicle (HTV).

## **(1) Kibo**

Japanese astronauts who engage in the assembling and operation of “Kibo” continue training in Japan and abroad. Mr. Soichi Noguchi, an astronaut who is conducting training at the National Aeronautics and Space Administration (NASA), will board the first flight after the accident of Space Shuttle Columbia.

## **(2) HTV**

Technology for rendezvous with a manned facility (ISS) requiring high-level safety and reliability and inter-orbit transportation technology can be established through development of an unmanned transfer vehicle HTV that replenishes ISS with supplies.

## **(Promotion of Space Environment Utilization)**

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

The Space Activities Commission compiled a report of the Utilization Subcommittee in June 2004 and recommended the review of the utilization plan to achieve the more efficient and effective operation and utilization of “Kibo.”

While advancing development of “Kibo,” JAXA is publicizing ground-based research projects offering research opportunities to researchers in a broad array of fields involved in preparation for the utilization of the space environment.

Moreover, until the commencement of operation of “Kibo” in orbit, JAXA implemented space experiments at ISS using Soyuz and scientific experiments through international cooperation. JAXA is also continuously conducting “High-quality Crystallization Project on Protein Structure and Function Analyses for Practical Applications” using a Russian Service Module at ISS based on government-private sector cooperation. To ensure that this kind of research is rationally conducted without trouble, JAXA also utilizes a zero-gravity experiment facility operated by the private sector (drop tower) and zero-gravity experiment (suborbital flight) by aircraft.

Efforts to diversify utilization of “Kibo” are also

in progress, to extend its use beyond scientific research to include activities in such sectors as industrial use, education, culture and arts, and the humanities. In the industrial use sector, a system to consistently deal with ground-based research, space experiment and commercialization was newly established through coordination between industry, academia and government and a research basis was established. In the education sector, activities were conducted such as the “Kibo Education Utilization Workshop,” space education events involving interaction between children and the astronauts on the International Space Station, and a contest for an aircraft-based zero-gravity experiment for university students.

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

## **(Fundamental Satellite Technology)**

JAXA and research institutes of related ministries and agencies are engaged in research, development and space demonstration of the new technologies and the fundamental technologies required for the support of space development and utilization activities, to ensure autonomy in space activities, and to contribute to technological innovations that spread beyond the space sector to other sectors.



### (1) Engineering Test Satellite VIII (ETS-VIII)

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

### (Space Infrastructure)

For autonomy of national space development in the international community, it is important for Japan to acquire a capability for deploying necessary materials and equipment at specific locations in space when they are needed. For this purpose, Japan is engaged in the research and development of space transport systems. Japan is also developing an advanced inter-satellite communication technology toward the acquisition of space network operations technology. Japan is also developing an advanced inter-satellite communication technology toward the acquisition of space network operations technology.

### (1) H-IIA Rockets

For the launching of large-scale satellites, etc., JAXA developed a two-stage rocket that uses liquid oxygen/liquid hydrogen-fueled engines for both the first and second stages (H-IIA) (Table 3-2-15) and

uses it to launch large-scale satellites. The launch of the H-IIA launch vehicle No. 1 in August 2001 was followed by four more successful launches that marked the transition to practical operations. However, the launch of the No. 6 vehicle carrying information gathering satellites in November 2003 ended in failure because the solid rocket booster (SRB-A) failed to separate. Thereafter, an investigation into the causes of the accident was conducted and measures were taken from both technical and institutional aspects, while a review that went back to the basics of design was also conducted. Since then, Multifunctional Transport Satellite No. 1 (Himawari No. 6) of the Japan Meteorological Agency and the Ministry of Land, Infrastructure and Transport was launched by H-IIA launch vehicle No. 7 on February 26, 2005 and was successfully placed in the predetermined orbit. In September 2004, the Council for Science and Technology Policy again positioned H-IIA rocket as the Japan's key rocket and determined to steadily advance technology upgrades and increase reliability. Moreover the H-IIA standard type is to be transferred to the private sector to ensure international competitiveness through the unification of manufacturing responsibility for the improvement of product quality. A basic contract for transfer was signed in February 2003 between JAXA and the private-sector entity, Mitsubishi Heavy Industries, and transfer to the private sector is steadily under way.

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

Launch vehicle type	Stages	Overall length (m)	Diameter (m)	Gross weight (tons)	Propellant
M-V	3	Approx.30	2.5	Approx. 139	Solid for all stages
H-IIA (standard)	2	Approx.53	4.0	Approx. 289	1st and 2nd stages, liquid hydrogen/oxygen; SRB-A, solid

### (2) M-V Series Rockets

JAXA developed the M-V rocket, which uses solid propellant for all stages, and launches scientific satellites.

### (3) GX Rocket

The GX rocket is a rocket designed to launch small and medium-size satellites, which has been developed by private initiative. Public-private sector joint research and development is now progre-

ssing toward the first launch in FY2006. JAXA will conduct a flight demonstration of the LNG-fueled natural propulsion system by using a GX rocket.

#### **(4) Optical Inter-orbit Communications Engineering Test Satellite (OICETS)**

JAXA is preparing to launch the Optical Inter-orbit Communications Engineering Test Satellite (OICETS), which is to conduct orbital experiments on the elemental technologies needed for optical communications technologies in inter-satellite communication systems, in FY 2005 by a Dnepr rocket of Russia/Ukraine.

#### **(5) Data Relay Test Satellite (DRTS)**

For the objective of performing data relay experiments using with earth observing satellites and “Kibo,” for the promotion of the development of data relay functions for the Communications and Broadcasting Engineering Test Satellite (COMETS) and to accumulate experience in more advanced inter-satellite communications technology, JAXA launched the “Kodama” Data Relay Test Satellite (DRTS), and is advancing preparation for an inter-satellite communications test with the Advanced Land Observing Satellite (ALOS), which is scheduled to be launched in FY2005.

#### **(Fundamental and Advanced Research on Satellite and Launch Vehicle Technology)**

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

#### **(Promotion of International Cooperation in Space)**

With the increasing importance of observations from space by Earth observation satellites as global problems such as earth environmental problems and disasters have become more serious in recent years, and with the increasing internationalization of space activities as the society and the economy have become increasingly globalized, the need for international cooperation in space activities is now greater

than ever before. In particular, Japan’s contribution in the space sector, including efforts to alleviate disaster using satellites, has become further necessary in response to serious damage to the surrounding area by the Sumatra Earthquake and Indian Ocean tsunami which occurred in December 2004. In February 2005, JAXA acceded to the “International Charter on Space and Major Disasters,” a framework for international cooperation aimed at contributing to the understanding of disasters and restoration following disasters, through provision of satellite data without charge at the time of large-scale disasters.

In the area of multilateral cooperation, Japan is actively engaged in the promotion of such cooperation through the activities in the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) which discusses the international order on exploration and utilization of space, and on the promotion of international cooperation, the Asia-Pacific Regional Space Agency Forum (APRSAPF) hosted by Japan, a place for exchanging opinions about the international cooperation in space development in the Asia-Pacific region, and the Committee on Earth Observation Satellites (CEOS), where technical coordination and information exchange on earth observation satellite systems is undertaken.

Japan is participating in the International Space Station (ISS) program, the largest international cooperation project in space development, through the provision of “Kibo,” HTV and a life science test facility (Centrifuge). This is being carried out in close cooperation with all participating nations in the construction and utilization of ISS.

In the area of bilateral cooperation, cooperative space activities between Japan and the United States are proceeding smoothly in light of the Agreement between the Government of Japan and the Government of the United States of America concerning Cross-Waiver of Liability for Cooperation in the Exploration and Use of Space for Peaceful Purposes. For cooperation with European countries, a close relationship with the European Space Agency (ESA) is maintained through annual administrative Japan-ESA meetings. Moreover, regarding cooperation with Russia, the Japan-Russia Joint Committee on Cooperation in Outer Space is held on a regular basis to promote a cooperative relationship.

## (2) Ocean Development

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

This plan was also incorporated into the Agenda 21 that was adopted by the United Nations Conference on Environment and Development (UNCED), also called the Earth Summit. Based on these international efforts, it is crucial for Japan to promote ocean research related to global environmental issues, and to promote other research and development into ocean sciences and technologies.

Furthermore, in order to shed some light on ocean phenomena occurring on a global scale, the relevant ministries and agencies have joined with universities, etc., to actively participate in international ocean research programs such as GOOS. Also, Japan has taken a leading role in cooperation with China, South Korea, and Russia to promote the North East Asian Regional-Global Ocean Observing System (NEAR-GOOS) as a regional pilot project for GOOS.

Japan's ocean development adheres closely to the report of the Council for Science and Technology Subdivision on Ocean Development, and research and development is being promoted with the co-operation of relevant ministries and agencies

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

Moreover, the Inter-Ministerial Liaison Committee (this committee was reorganized and expanded into the "Inter-Ministerial Liaison Committee for Survey of the Continental Shelf and Marine Resources" in August 2004) was established to promote surveys for the establishment of the outer limits of the Japanese continental shelf. The liaison committee recognizes the importance to the government as a whole of firmly implementing these surveys, and that maximizing the use of scientific knowledge is important for the performance of appropriate surveys and analyses.

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

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

Among these projects, the Japan Agency for Marine-Earth Science and Technology conducted marine observation using Triton buoys and an oceanographic research vessel "MIRAI" with the aim of investigating the interactions between the atmosphere and the ocean, such as El-Nino events, as well as the effects they have on global climate change. In addition, the deep sea research vessel "KAIREI" was used for ocean surveys for research

into the dynamics of ocean plates. In addition, the agency conducted geological, biological, and geo-chemical studies during a five-month research voyage “NIRAI-KANAI,” primarily extended around the southern-hemisphere Pacific Ocean on board “YOKOSUKA,” the support mother vessel for a manned research submersible “SHINKAI 6500.” For the deep-sea Earth drilling project, construction of the “CHIKYU” deep sea drilling vessel continues to progress since its commencement in FY1999.

Furthermore, the Project for Research on Marine and Extremobiosphere Biology promoted research for the elucidation of the physiological adaptivity of deep-sea organisms existing in extreme environments. In addition, Ocean Research Institute, University of Tokyo, is at the center of continuing ocean-related scientific research, including basic research related to GOOS for the purpose of building a comprehensive observation system for the elucidation and forecast of changes in the ocean environment, and for its preservation, participation in joint surveys of the Western Pacific region, and research into ocean flux, which can contribute to the elucidation of physical cycles in the ocean. In addition, national universities are engaged in research into marine biosystems and conducting observations of changes in the atmosphere and oceans.

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

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

The Ministry of Land, Infrastructure and Transport promoted research and development into next-g

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

At the Ministry of the Environment, the Global Environment Research Fund is being used to conduct research into the elucidation of the effects of pollution from the Changjiang River on marine ecosystem in the East China Sea, and on global-scale ocean pollution due to toxic substances.

Table 3-2-16 summarizes the main research subjects undertaken in the ocean sciences and technology sector by various ministries and agencies in FY2004.

**Table 3-2-16 Major research subjects in marine science and technology (FY2004)**

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	<ul style="list-style-type: none"> <li>Research into global environment measurement and forecasting technology, using 3-D high-resolution imaging radar</li> <li>Research and development of ocean radar</li> </ul>
Ministry of Education, Culture, Sports, Science and Technology	Japan Agency for Marine-Earth Science and Technology	<ul style="list-style-type: none"> <li>Development of marine research technology</li> <li>Research and development of deep-sea research</li> <li>Promotion of ocean drilling in the 21st Century</li> <li>Frontier research</li> <li>Research and development of ocean utilization and marine ecosystems</li> <li>Research and development of ocean observation</li> </ul>
	National universities and other institutions	<ul style="list-style-type: none"> <li>Integrated Ocean Drilling Program (IODP)</li> <li>Cooperative study of the Western Pacific (WESTPAC)</li> <li>Global Ocean Observing System (GOOS)</li> </ul>
Ministry of Agriculture, Forestry and Fisheries	Fisheries Research Agency	<ul style="list-style-type: none"> <li>R&amp;D into fisheries resources</li> <li>Development of techniques for stock enhancement</li> <li>Development of techniques for advanced use of fishing grounds</li> <li>Research into the improvement and development of fishing grounds</li> <li>Observations of oceanographic environments related to fisheries</li> <li>Technological development of fishing gear and methods</li> <li>Measures for marine environmental conservation</li> <li>Research of marine space use</li> <li>Technological development of marine resources use</li> </ul>
	Marino Forum 21	<ul style="list-style-type: none"> <li>Development of artificial fishing ground technology, using deep ocean water</li> <li>Development and practical application of new technologies for protecting against red tide</li> </ul>
Ministry of Economy, Trade and Industry	Japan Oil, Gas and Metals National Corporation	<ul style="list-style-type: none"> <li>Research and development of deep-sea mineral resources</li> </ul>
	National Institute of Advanced Industrial Science and Technology	<ul style="list-style-type: none"> <li>Prediction of Earth and ocean environments based on geochemical and palaeontological research of modern and past environments</li> </ul>
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	<ul style="list-style-type: none"> <li>IOC Sub-Commission for the Western Pacific Region (WESTPAC)</li> </ul>
	Japan Meteorological Agency, Meteorological Research Institute	<ul style="list-style-type: none"> <li>Observational research on variability of carbon cycle in the ocean</li> </ul>
	Geographical Survey Institute	<ul style="list-style-type: none"> <li>Basic research of coastal sea areas</li> </ul>
	National Maritime Research Institute	<ul style="list-style-type: none"> <li>Research into technology for upgrading megafoats, and international standardization</li> <li>Research and development into next-generation domestic route shipping (Super Ecoship)</li> </ul>
	Private Sector	<ul style="list-style-type: none"> <li>R&amp;D into very large floating structures</li> </ul>
	Port and Airport Research Institute	<ul style="list-style-type: none"> <li>Research into the physical environment of sand beaches</li> <li>Elucidation of the mechanisms for wave liquefaction and deformation of the ground, and research into countermeasure and utilization technologies</li> <li>Research into coastal seawater flows, and seabed environments</li> </ul>
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	<ul style="list-style-type: none"> <li>Research into application of mitigation technologies to the Seto Inland Sea for creating an appropriate environment</li> </ul>
	Water Environment Department	<ul style="list-style-type: none"> <li>Research into red tide</li> </ul>
	National Institute for Environment Studies	<ul style="list-style-type: none"> <li>Research into coastal environment management</li> <li>Research into a mechanism of maintaining high-level nutrient salt concentration in the Ariake Sea: For appropriate shallow water management</li> </ul>
	Global Environment Research Fund	<ul style="list-style-type: none"> <li>Research into the elucidation of the ocean's absorption of carbon dioxide from human sources in the Pacific region</li> <li>Iron fertilization feasibility as an option for CO<sub>2</sub> mitigation, and its effects on marine ecosystems</li> <li>Research on the biogeochemical cycle in the East China Sea responding to the change in the environmental loading from land</li> <li>Study on the marine environmental deterioration due to N and P loadings, and silica deficiency in the global aquatic system</li> </ul>
	Global Environment Research Coordination System	<ul style="list-style-type: none"> <li>Research into material databases related to carbon dioxide in the ocean, for the elucidation of oceanic carbon dioxide absorption volumes</li> <li>Study on the increase of sea-surface temperature in Asian monsoon regions based on coral skeletal climatology</li> <li>Evaluation of the effects of the oceanic segregation of carbon dioxide on the oceanic material cycling process</li> </ul>

### **3.2.2.9 Promotion of Science and Technology for Safety, Security, and Spiritual Enrichment**

Toward realization of the goal of “a nation securing safety and quality of life,” offered in the Basic Plan as a stance that Japan should be aiming for, the Ministry of Education, Culture, Sports, Science and Technology in April 2003 established the “Study Group on Science and Technology Policy for Building a Safe and Secure Society,” consisting of representatives from industry, academia, and government, to conduct studies into scientific and technological policies toward the realization of a society that can ensure safety and security. The study group compiled the final report in April 2004. In addition, the “2nd Japan-U.S.

Workshop on Science and Technology for a Secure and Safe Society” was convened in March 2005 to discuss how Japan and the United States can cooperate in the fields of science and technology in response to the various risks and threats that confront society, and is continuing a wide range of studies toward building a safe and secure society.

In addition, research and development utilizing competitive funding, such as the Special Coordination Funds for Promoting Science and Technology, the Project for Promotion of Strategic Creative Research (Japan Science and Technology Agency) and the Research Program on Development of Innovative Technology (Japan Science and Technology Agency), is conducted in order to promote scientific and technological activities that contribute to the creation of new culture.