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 breakthroughs in research results of the highest standards in the world, and in 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. Under its prioritization policy, the government has selected four sectors requiring particular priority, including the life sciences, information and communications, the environment, and nanotechnology and materials.

3.2.2.1 Life Sciences

3.2.2.1.1 Promotion of Life Scinces

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.

3.2.2.1.1.1 Basic Policies for the Promotion of Life Sciences Research

In Japan, the life sciences are being promoted more aggressively than in past years. The "Basic Plan" has positioned the life sciences as one of its four priority sectors, and called for prioritized, strategic efforts in this sector.

As the Promotion Strategy for each Sector, the priority areas among the technologies to be developed for protecting the people's health have been selected as follows: (1) technologies that utilize genome-related technologies for the prevention and treatment of disease, in order to achieve a vital and long-lived society; (2) elucidation of life-protecting mechanisms in relation to infectious diseases, and environmental factors and technologies for the prevention and treatment of disease; and (3) promotion of basic technologies for mental health and for the brain, and technologies for the prevention and treatment of disease. In the area of the "development of technologies for competitiveness and sustainable growth," it listed: (4) technologies for materials production and environmental treatment that

utilize the functions of living things; and (5) food science technologies that contribute to better food supply security and to improved diet. In the area of "joint basic science," it listed: (6) development of technologies for emerging and interdisciplinary areas, and advanced analytical technologies; and (7) construction of systems for the promotion of research into the efficient return to society of the fruits of advanced research.

Based on this priorities list, the Council for Science and Technology in the Ministry of Education, Culture, Sports, Science and Technology drew up the "Policy for Promotion of Research and Development in the Life Sciences" in June 2002.

3.2.2.1.1.2 Efforts Toward Industrialization, Etc.

To strengthen efforts toward commercialization of the life sciences, in January 1999 the heads of five ministries and agencies drew up the "Basic Policy for the Creation of Biotechnology Industries." The five ministries and agencies followed up the Basic Policy in July of that same year with the adoption of the "Basic Strategy for the Creation of Bio-technology Industries."

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. On January 20, 2004, follow-ups were implemented for 200 detailed action plans, confirming that efforts have been making generally steady progress.

3.2.2.1.1.3 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. Japan's role was centered on sequencing human chromosomes 11 and 21, and included discoveries of genes related to specific diseases, and the results have been highly praised by the scientific community. Japan's contribution in terms of the number of base pairs sequenced ranked third (accounting for 6% of total base pairs), following the United States and the United Kingdom.The Ministry of Education, Culture, Sports, Science and Technology, having just shouldered a part of the international effort toward the completion of a detailed sequencing of the human genome, is now engaged in steady promotion of post-genome research 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, according to the report "On Promotion of a Post-Genome Strategy," prepared in December 2000 by the Committee on Policy Matters of the Council for Science and Technology's roundtable for the promotion of a post-genome strategy. In addition, the ministry is working through the Grants-in-Aid for Scientific Research, the Basic Research Programs, and other related programs to promote the priority of basic research in this sector at universities and colleges. In FY2003, Japanese researchers acting as part of an international team of researchers from countries all over the world successfully sequenced

in high accuracy the genome base pairs in chimpanzee chromosome 22, which corresponds to human chromosome 21. Researchers also successfully developed the world's first technology (DNA Book ™) enabling wide circulation of mouse full-length cDNA[2] clones in book form at low cost, as part of the ministry's efforts for the comprehensive promotion of analysis and integration of various genome information, and other aspects of genome sciences research.

Since FY2000, the Ministry of Health, Labour, and Welfare has been involved in the Millennium Project, using the elucidation of genes related to senility, cancer, diabetes, high blood pressure, asthma, and other ailments of the elderly, to promote R&D toward 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, targeted the rice plant, silkworm, and animals to isolate genes useful for improving agricultural production, such as a gene that confers resistance to rice blight, developed a DNA utilization technology, and implemented the MAFF gene bank project for the systematic collection, accumulation, and distribution of the DNA utilization results. In particular, the Rice Genome Project is important for laying the foundations for research into major grains and other crops, and has now been repositioned as part of the Millennium Project.

In particular, Japan has assumed a leading role in sequencing the full length of the rice genome. Although the project's international consortium consists of 10 countries and regions, Japan alone has accounted for about 60% of the total sequence. Under Japan's supervision, a precise sequence for the most important parts of the genome was completed in December 2002. In addition, the "Project for Development of a Complete Rice Plant cDNA Library" launched in FY1999 had collected information for about 32,000 different rice genes by FY2003. About 80% of the silkworm's total genome sequence was also analyzed and announced 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 structure led to the identification of about 30,000 genes comprising the complete human cDNA, and analysis of those genes is now in progress.

At the Ministry of the Environment, the independent National Institute for Environmental Research is researching the utilization of genome technology in research for the preservation of biological diversity, and also into the health effects of toxic chemical substances.

2 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 July 2003, a total of 796 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 work-prone Japanese, as well as for such illnesses as strokes, senility, and bone fractures that are a major source of demand for nursing assistance.

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 was started in FY2003 for the development of cellular and physiological function simulations for drug development using the vast amounts of data obtained in genome sequencing, as an R&D project for the purpose of economic revitalization

At the Ministry of Agriculture, Forestry, and

Fisheries, research into "development of the rice genome simulator" is going forward 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 the building of a comprehensive database, complete with independently obtained data, centering on human cDNA information and with 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. 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[3], 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 2004, the joint group had published SNP data for 200,000 locations, via the JSNP database[4]. Also, the "Project for Realization of Medicine in Response to Individual Genetic Information," an R&D project for the purpose of economic revitalization, 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 serum samples, etc., 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 senility, 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 Program" (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.
mechanisms of living organisms

(3) Promotion of Development, Differentiation, and Regeneration Science Research

Research into the generation, differentiation, and regenerative fields entails the elucidation and application of the basic mechanisms that give rise to advanced biological phenomena, such as the coding for the creation of individuals and the integral processes for biological functioning as individuals. In particular, rapid advances in stem cell and Embryonic Stem (ES) cell research in recent years is opening the way for broader applications such as the development of cell transplant technologies that do not cause graft rejections, and other regenerative medical techniques.

At the Ministry of Education, Culture, Sports, Science and Technology, the Center for Developmental Biology at RIKEN is operating as a part of the Millennium Project seeking the elucidation of the basic mechanisms for the generation, differentiation, and regeneration of living things to contribute to regenerative medicine. In addition, competitive funding projects such as the Basic Research Programs and Research for the Future Programs are being used to promote priority research in this field at universities and colleges. Moreover, in FY2003 the "Regenerative Medicine Realization Project" was launched as an R&D project for the purpose of economic revitalization.

Furthermore, to contribute to the realization of regenerative medicine, the Ministry of Health, La-

bour, and Welfare is using the Grant for Health Sciences as a part of the Millennium Project to promote research into the elucidation of mechanisms for the occurrence of five major diseases afflicting the elderly, including strokes, bedsores, and broken bones. In addition, national research institutions (such as the National Cancer Center and the National Center of Neurology and Psychiatry) are at the center of research into efforts to prevent graft rejections following organ transpnd fisheries products and plants, and to utilize the self-repair mechanisms of human cells to prevent other side effects.

In FY2002, the Ministry of Economy, Trade and Industry began promoting development of equipment in support of practical applications of regenerative medicine, with the development of technology and supporting equipment for artificial control and cultivation at the genetic level of human stem cell proliferation and differentiation processes by the New Energy and Industrial Technology Development Organization.

(4) Promotion of Plant Science Rsearch

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.

Japan took a leading role in the international consortium of 10 countries and regions to promote reading out the entire genome base sequence for rice. In December 2002, a precise sequence for the most important parts of the genome was successfully completed, and Prime Minister Koizumi announced to the world that the sequence analysis was complete. The data sequenced by the international consortium was made 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.

In the Ministry of Education, Culture, Sports, Science and Technology, the Plant Science Center at RIKEN is engaged, as part of the Millennium Project, in research into the relationship of advanced functions and genes in plants at the molecular, cell, individual, and group levels. In addition, the “Research for the Future Program” by the Japan Society for the Promotion of Science (JSPS) promotes plant gene research, as well as a broad range of other basic research at universities and colleges.

(5) Development 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 supply 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 supply of bioresources that are of particular strategic importance to the nation, such as test animals and plants (such as mouse clones), various kinds of stem cells, and genetic material 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. In April 2003, the National Institute of Agrobiological Sciences established the Rice Genome Resource Center to provide centralized high-precision management of samples and data, and to make them available to the private sector, as well as 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 to serve as Japan's core bioresource organization for microorganisms, etc. The Center engages in the search, isolation, collection, and identification of biological genetic resources, as well as their preservation. It also collects and sorts information related to bioresources (information regarding systematic identification in microbiology, base sequence information, and information about genes, etc.), and offers supplies of the actual bioresources. The Center has also implemented a project to create a gene resource library for unknown microorganisms to promote the industrial utilization of microorganisms. It is also acting in accordance with the Convention on Biological Diversity to ensure access to biological genetic 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, aromoting 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 Encephalopathy (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 foodstuffs 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 has conducted basic research into the application of biotechnology for the development of enhanced functional foods that assist in health promotion, and has continued surveys and research into the safety of genetically modified foods, etc.

(7) Promotion of Cancer-Related Research

Cancer accounts for about 30% of total deaths in Japan. Under the "Second Comprehensive Ten-Year Strategy against Cancer" (ratified at the Cabinet Conference for Cancer-Related Measures in June 1993), 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.

At the Ministry of Education, Culture, Sports, Science and Technology, 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.

Acting in response to "On the Future of Cancer Research," a report released in March 2003 by the "Expert's Committee on the State of Future Cancer Research," the Minister of Education, Culture, Sports, Science and Technology and the Minister of Health, Labour and Welfare agreed in July 2003 to adopt the "Third Comprehensive Ten-Year Strategy against Cancer," a new 10-year strategy that started in FY2004.

(8) Promotion of Research on Immunologic and Allergic Diseases

In the area of the promotion of research related to the immune system, allergies, and infectious diseases, there is a need to promote comprehensive research that links to clinical applications research for the creation of radical new treatment methods for hay fever, atopic dermatitis, rheumatoid arthritis, and other immunologic and allergic diseases, and the eradication of emerging and reemerging infectious diseases.

In this situation, at the Ministry of Education, Culture, Sports, Science and Technology, the Research Center for Allergy and Immunology at RIKEN is engaged in research on the basic and comprehensive elucidation of immune systems toward the development of effective counters to immunologic diseases. In addition, Grants-in-Aid for Scientific Research are being used for the prioritized promotion of basic research in this sector at universities and colleges, while the Special Coordination Fund for Promoting Science and Technology is being utilized by the relevant ministries and agencies in a dynamic coordinated response for research into Severe Acute Respiratory Syndrome

(SARS), highly pathogenic avian influenza (Bird Flu), and other potentially damaging infectious diseases.

In addition, the Ministry of Health, Labour and Welfare established a clinical research center at the National Sagamihara Hospital,[5] aimed at the elucidation of rheumatism, bronchial asthma, hay fever, atopic dermatitis, and other immunologic and allergic diseases, and the development of treatment methods. The center's research is currently concentrated on the clinical side.

(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 research 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 FY2003 are shown in Table 3-2-1, by ministry or agency.

5 National Sagamihara Hospital: with the conversion in April 2004 from national hospital to an incorporated administrative agency, the official name was changed to National Hospital Organization Sagamihara National Hospital.

Table 3-2-1 Major research subjects in life sciences (FY2003)

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	Strategic Information and Communications R&D Promotion Basic Research 21 for Breakthrough in Info-Communications Incorporated administrative agency: Communications Research Laboratory	· Research into elucidating and applying the info-communications functions of living organisms · 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
Ministry of Education, Culture, Sports, Science and Technology	Incorporated administrative agency: RIKEN (The Institute of Physical and Chemical Research)	· Promotion of bioresource projects · Promotion of comprehensive research into brain science · Promotion of comprehensive research into genome science · Promotion of plant science research · Promotion of comprehensive research into developmental and regenerative science · Promotion of varied genetic research · Promotion of immunological and allergy research
	Incorporated administrative agency: Japan Science and Technology Agency	· Promotion of bio-informatics · Promotion of research using competitive funding
	Incorporated administrative agency: National Institute of Radiological Sciences	· Promotion of heavy ion beams for clinical research
	Incorporated administrative agency: Japan Agency for Marine-Earth Science and Technology	· Promotion of Frontier Research System for Extremophiles, etc.
	Incorporated administrative agency: Japan Aerospace Exploration Agency	· Research into medical science, etc., related to space
	Universities and colleges	· Research into the overall promotion of cancer research · Basic research into carcinogenesis and the prevention of carcinogenesis · Research into the biological aspects of cancer · Diagnosis and treatment of cancer · Research into human cancers, and epidemiological research into host factors · Strategic and advanced research into cancer · Comprehensive genome research toward the elucidation of living systems · Genomic analysis of hereditary factors, and the elucidation of abnormal molecule conditions in · New developments in genomic biology toward the elucidation of cellular systems · New developments in genome informatics · Advanced research into brain science · Molecular foundations for the appearance of infection, and host response
	Special coordination funds for promoting science and technology	· Development and clinical application of new receptor specific drugs · Research into the molecular and nervous system mechanisms for fatigue and feelings of fatigue, and into their prevention · Clinical bio-informatics personnel development unit · Molecular analysis of the Immune System and Its manipulation of development, activation · Studies on the analysis and systemization of non-nutritive functional substances in foods · Genome epidemiological research of life-style related diseases in the town of Hisayama · Elucidation of the mechanisms for selective synapse strengthening, and elimination by gene
	HFSP (Human Frontier Science Program) (Note)	· International joint research for the elucidation of the complex mechanisms of living organisms
Ministry of Health, Labour and Welfare	Health and labour sciences research grants	· Comprehensive strategy for cancer control · Comprehensive research on aging and health · Research on the human genome, tissue engineering · Research on psychiatric and neurological diseases and mental health · Research on emerging and re-emerging infectious diseases · Research on HIV/AIDS · Research on sensory and communicative disorders · Research on specific diseases · Research on food and chemical safety · Research into the health sciences, focusing on drug innovation · Clinical research for evidence-based medicine · Research on allergic disease and immunology
	National Institute of Infectious Disease	· Research into gene recombinant vaccines, etc. · Research into the development of vectors related to gene treatment, safety evaluations, etc. · Research into AIDS, Hansen's disease, etc. · Research into methods for the diagnosis, prevention, and treatment of SARS and other infectious diseases
	National Institute of Health Sciences	· Research into standard test methods, quality evaluation methods, etc., for · Research into assuring the safety of food and chemical substances, etc.
	Incorporated administrative agency: National Institution of Industrial Health	· Development of mental and physical health indicators for work stress control · Ergonomic improvements of working conditions in the information technology era · Study on work environment management for irregular work using organic solvents

Ministry or Agency	Research institute or program	Subject
Ministry of Agriculture, Forestry and Fisheries	Incorporated administrative agencies: National Agriculture and Bio-oriented Research Organization, National Institute of Agrobiological Sciences, etc.	· Integrated research for providing fresh and delicious "Brand Nippon" agricultural-products · Development of technologies for the suppression of Bovine Spongiform Encephalopathy (BSE), and diseases shared by humans and animals
		· Development of a comprehensive management system of hazardous chemicals in agricultural, forestry and fisheries ecosystem · Elucidation of the entire rice genome DNA sequence · Isolation of useful genes in the rice genome, and elucidation of their functions · Development of DNA marker-aided selection technology for plants and animals · Development of a rice genome simulator · Research into animal genomes for the utilization of useful genes ・Insect Technology Research for Utilization of the Greatest Unused Resources of the 21st Century • Comprehensive research into food safety and functionality · Development of isolation and utilization technologies for useful genes obtained through animal genome analysis · Assurance of Safe Use of Genetically Modified Organisms · Development of stable production technology of cloned animals by somatic cell nuclear · Elucidation of animal (livestock, insect) behavioral mechanisms, and the development of control · Surveys and research into local agricultural methods using special resources · Expenses required for the promotion of research into the prevention of invasive insect · Elucidation of the effects of climate warming on crops and animal husbandry, and the development of technologies to control those effects · Evaluation of the effects of organic farming on the soil environment, and the certification of environmental conservation effects · Elucidation of the mechanism for outbreaks of mastitis, and the development of preventive · Elucidation of the properties of hoof-and-mouth disease and other malignant infectious diseases found overseas, and the development of advanced diagnostic technologies · Comprehensive research into the creation of new agriculture, forestry, and fisheries products by modifying morphological and physiological functions · Development of new weed control technologies that utilize plant metabolism genes · Establishment of useful substance production systems using plants, animals, and insects · Research into the development of next-generation plants applying gene recombinant · Development of livestock disease control technologies using recombinant cytokines · Gene bank project
	Private sector, universities, etc.	· Development of technologies for assuring food safety and security · Development of technologies for the promotion of "Brand Japan" processed food supplies · Development of efficient plant breeding and growing systems that utilize genetic · Development of new separation and extraction technologies in the food industry · Development of health-oriented food evaluation and production technologies using the life sciences · Development of next-generation fermentation technologies in the food industry · Development of fundamental technologies for the low-cost production of biologically based · Development of foundations for the commercialization of multi-function, energy-saving
Ministry of Economy, Trade and Industry	Incorporated administrative agency: National Institute of Advanced Industrial Science and Technology	· Development of basic technologies for production processes using biological functions ·Elucidation of useful protein functions, utilizing human genome information and its · Development of information technology required for DNA analysis, disease prevention, · Development of technologies for the synthesis and structural analysis of sugar chains that play important roles in protein stabilization, immune system reactions, and other metabolisms in the human body · Construction of a gene resource library for unknown micro-organisms based on genome information · Development of technologies for high-speed analysis of various types of trace constituents found in the body · Development of high-safety technologies for the differentiation and cultivation of a mass volume of artificial cells and tissues enabling regenerative medicine · Analysis of the three-dimensional structure of physiological macromolecules · Development of technologies for the analysis of intracellular network dynamism · Development of bioinformatics-related databases · Model analysis of gene diversity · Behavior-based human environment creation technology
	HFSP (Human Frontier Science Program) (Note)	· International joint research for the elucidation of the complex mechanisms of living organisms
Ministry of Land, Infrastructure and Transport	Hokkaido Development Program Fund	· Surveys for the promotion of structural reforms for local industry, utilizing sugar chain engineering
Ministry of the Environment	Incorporated administrative agency: National Institute for Environmental	· Studies on biomediation technologies for contaminated soil environments · Community change and ecosystem management of shallow, eutrophic lakes

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

3.2.2.1.2 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. On the other hand, because the possibility of new bioethical issues that might violate human rights and dignity has arisen, the Expert Panel on Bioethics, established under the Council for Science and Technology Policy (CSTP), is now engaged in surveys and examinations of basic policies and 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 studying their appropriateness.

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, based on the "Guidelines for Handling of a Specified Embryo[6] (FY2001 Ministry of Education, Culture, Sports, Science and Technology, Notification No.173)" contained in that law. Moreover, based on Paragraph 2 of the appendix to the law, the Expert Panel on Bioethics under the CSTP is discussing the treatment of human fertilized embryos and human somatic cell nuclear transfer embryos. After release of an interim report in December 2003, the panel held hearings open to the public, and then, commenced the final stages of preparing a final report.

In the meantime, Japan has been actively involved in the United Nations discussions on the formulation of an international convention against the reproductive cloning of human beings. However, the participating countries have not reached a conclusion due to their different positions over the creation and utilization of cloned human embryos for therapeutic and research purposes.

In the area of human Embryonic Stem (ES) cell[7] research, the Ministry of Education, Culture, Sports, Science and Technology has proceeded under the "Guidelines for Derivation and Utilization of Human Embryonic Stem Cells (FY2001 Ministry of Education, Culture, Sports, Science and Technology, Notification No.155)" to review the compliance of each derivation and utilization plan with the guidelines. By March 2004, one derivation plan and 13 utilization plans has been reviewed, and the first-ever derivation of human ES cells in Japan was reported in August 2003.

For clinical research, the Ministry of Health, Labour and Welfare adopted the "Ethical Guidelines for Clinical Research" (Ministry of Health, Labour and Welfare Notification No.255) in July 2003 to ensure suitable progress in this research.

Elsewhere, in the areas of human genome and gene sequencing research or epidemiological research[8], etc., suitable efforts from the perspective of bioethics are being promoted based on guidelines adopted by the relevant ministries and agencies.

At the United Nations Educational, Scientific and Cultural Organization (UNESCO), investigations were conducted toward the adoption of an "International Declaration on Human Genetic Data," based on the expanding range of fields in which human genome information is utilized, including non-medical fields, and the increasing amount of information about individuals that is being collected. Japan was also a participant in this effort, and the Declaration was adopted in October 2003.

6 A Specified Embryo: refers to nine types of embryos, including a human split embryo, a human embryonic clone embryo, a human somatic clone embryo, a human-human chimeric embryo, a human-animal amphimictic, a human-animal hybrid embryo, a human-animal chimeric embryo, an animal-human hybrid embryo, or an animal-human chimeric embryo.

7 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.

8 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

3.2.2.1.3 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. But because one of its characteristics is its application of new properties to living organisms, so that ensuring sufficient safety is required, guidelines for safe utilization of this technology have been in operation in the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Health, Labour and Welfare, the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of Economy, Trade and Industry.

Japan ratified the Cartagena Protocol on Biosafety[9] to the Convention on Biological Diversity to prevent adverse effects on biodiversity due to the utilization of living modified organisms, and then passed the Law Concerning the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms in June 2003, to ensure that the necessary legal measures are in place in Japan (Figure 3-2-2). In response, the Ministry of the Environment, the Ministry of Finance, the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Health, Labour and Welfare, the Ministry of Agriculture, Forestry and Fisheries, and the Ministry of Economy, Trade and Industry (the six ministries) made preparations to draw up the necessary ordinances. Japan ratified the Protocol in November 2003, and then promulgated the above law in February 2004 to officially bring the law into effect. The six ministries then proceeded to begin converting their programs for ensuring safety, which had been based on ministry guidelines, into programs based on law that ensure appropriate utilization of living modified organisms.

For clinical research aimed at the establishment of gene therapy,[10] the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare are promoting appropriate research that takes safety and ethics into consideration, based on guidelines jointly adopted by the two ministries.

9 The Cartagena Protocol on Biosafety to the Convention on Biological Diversity: adopted in January 2000 under the Convention on Biological Diversity, it went into effect in September 2003. The protocol is intended to ensure adequate protections regarding the movement across national borders of any living modified organisms that could have adverse effects on biological diversity, and standards for their safe use. (As of February 2004, a total of 86 nations and the EU had ratified the protocol

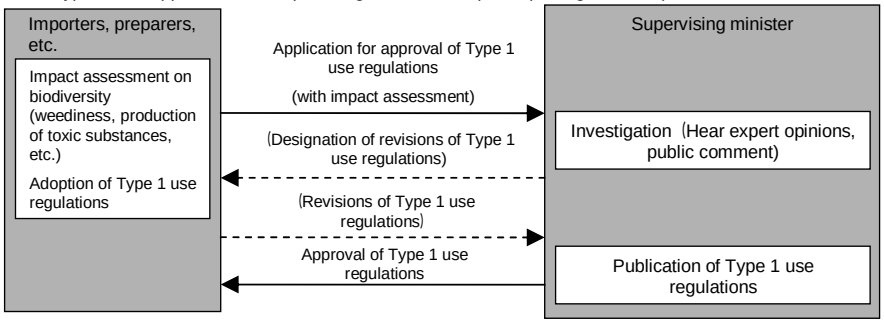
10 Gene therapy: a treatment method that involves the insertion of genes, or cells containing genes, into the bodies of patients for the purpose of treatment of disease. It is not an established method of treatment at present, but is practiced as one aspect of clinical research

Figure3-2-2 Summary of major measures in the Law Concerning the Conservation and Sustainable Use of Biological Diversity hrough Regulations on the Use of Living Modified Organisms

I. Type 1 Use measures (Usage without concern for nonproliferation: Outdoor use)

(1) Before use (before initial use)

● For Type 1 use, approval of the supervising minister is required (see figure below).



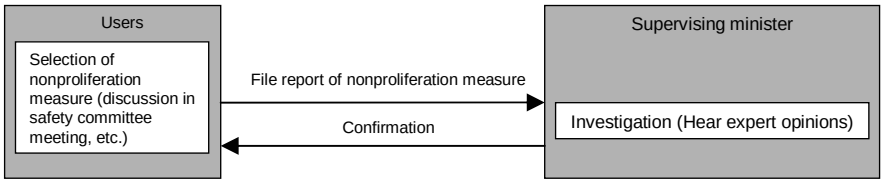
(2) During use

● Strictly observe the Type 1 use regulations, provide information to the national government (person gaining approval), and take measures when an accident occurs.

II. Type 2 use measures (Usage with nonproliferation measures: In-house use)

(1) Before use

●In cases in which nonproliferation measures are not regulated by laws or ordinances, seek confirmation from the supervising minister about nonproliferation measures taken (see figure below).



(2) During use

● Strictly observe laws and ordinances, confirm nonproliferation measures with supervising minister, and take measures when an accident occurs.

III. Lifeforms inspection (Inspection at the edge of the water for non-approved gene recombinant lifeforms)

● Notification required for importation of lifeforms designated by the supervising minister, and inspections may be required in response to orders by the supervising minister.

IV. Provision of information

● Provision of information is required for transfers.

V. Export measures

● For export, previous notification (only when intentionally releasing into the environment) and provision of information is required.

3.2.2.2 Information and Communictions

Promotion of research and development in the information and communications sector is important for the creation and expansion of such knowledge-intensive industries as the information and communications industry and the high-tech industry, as well as for reform of existing industries, such as new developments in the manufacturing industry, etc. Moreover, it brings great changes not just to industry, but also to a broad swath of social and economic activities that extend to the daily lives of the people, and is therefore an important foundation that enables people to live safely and with confidence.

3.2.2.2.1 Basic Policies for Promotion

Information and communications technology based on computers and networks is the principal intellectual and creative infrastructure that forms modern society, and is expected to be the driving force which brings great changes in society overall, from individual lives to social systems, and even the direction of science and technology.

The information and communications sector is positioned in the Basic Plan as meriting priority in distribution of research and development resources as a sector that is rapidly developing and directly linked to construction of the advanced information society, and to expansion of the information and communications industry and the high-tech industry. Moreover, the following items were shown to be areas of importance in sector promotion strategies:

1. Research and development toward ubiquitous usage of technology throughout society
2. Technologies that form the seeds of nextgeneration breakthroughs and new industries
3. Broadly based R&D infrastructure technologies (computerization of R&D) In the Ministry of Education, Culture, Sports, Science and Technology, the Subdivision on R&D Planning and Evaluation of the Council for Science and Technology Policy responded to this strategy in June 2002 by drawing up the “Policy for Promotion of Research and Development in Information Science and Technology.” The promotion policy noted that care needs to be taken to create research areas and build new research styles suited to the new era, and to ensure the training of researchers and technologists who can offer advanced diversity.The Council for Science and Technology Policy, taking note of the change that has taken place in the information and communications sector, from the development of a basic IT infrastructure to the effective utilization of IT, adopted “On Promotion of Information and Communications Research and Development” (May 2003) to call for the promotion of strategic R&D toward the promotion of IT systems use.

Furthermore, the Strategic Headquarters for Promotion of an Advanced Information and Telecommunications Network Society (IT Strategy Headquarters), established under the Basic Law on the Formation of an Advanced Information and Telecommunication Network Society (IT Basic Law), has aimed for the positioning of Japan as the world’s most advanced IT nation by 2005, adopting the “e-Japan Strategy” (January 2001 IT Strategy Headquarters), which placed emphasis on “developing the IT infrastructure,” and “e-Japan Strategy II” (July 2003 IT Strategy Headquarters), which placed emphasis on the effective utilization of IT toward the realization of a “society that is in good spirits overall and can live without concern, and a society capable of accepting new impressions and more convenient than ever.” The “e-Japan Strategy II” calls for the priority utilization of IT in medical, food, and other sectors, and as part of an effort to develop infrastructure for a new IT society, also calls for the “promotion of R&D that generates next-generation knowledge.” In this effort, Japan will need to further strengthen the long-developed technologies in which it already leads the world, and to strengthen and test its R&D in the increasingly important software technology, information security technology, and human interface (where

humans come into contact with machines) technology.

3.2.2.2.2 Major Research and Development Issues

3.2.2.2.2.1 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 hard-ware 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.).

For specific research and development topics, the Ministry of Internal Affairs and Communications is engaged in "R&D into ubiquitous network (an anything, anywhere network) technology," 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 engaged in "comprehensive software development for e-Society infrastructure," for the realization of software development that will be the key to the formation of the world's most advanced information and communications systems, and the construction of an IT society in which anyone can participate with confidence anywhere at any time, while 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.

3.2.2.2.2.2 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.

3.2.2.2.2.3 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 net-works, and virtual research institutes that allow joint research over long distances by linking research institutions with universities via high-speed net-works.

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 FY2002 are as shown in Table 3-2-3.

Table3-2-3 Major research subjects in the information and communications sector (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	·Research and development into ubiquitous network (anything, anywhere network) technology ·Promotion of transition to Internet IPv6 ·Research and development into Asian broadband satellite infrastructure technologies ·Comprehensive research and development into network human interfaces ·Research and development into time stamp platform technologies ·Construction of infrastructure for research into computer viruses, etc. ·Research and development into network architecture for the next-generation Internet ·Promotion of network security infrastructure technologies ·Comprehensive support for the development of electrical communication systems that form the foundation for the merger of communication and broadcasting services ·Research and development into quantum information communication technologies ·Comprehensive research and development of IPv6 for home electronic information devices, etc.
Ministry of Education, Culture, Sports, Science and Technology	Universities, Japan Science and Technology Agency, National Institute for Materials Science, Institute of Physical and Chemical Research (RIKEN), 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.	·National Research Grid Initiative (NAREGI) ·Comprehensive software development for e-Society infrastructure ·Priority research and development project for realization of the world's most advanced IT nation ·e-Science realization project ·Development of Super SINET, etc.
Ministry of Agriculture, Forestry and Fisheries	National Agriculture and Bio-oriented Research Organization, etc.	·Construction of an agricultural, forestry, and fisheries research information digital community, etc.
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization, Information Technology Promotion Agency, etc.	·Business grid computing project ·Development of an Extreme Ultraviolet (EUV) exposure system ·Semiconductor application chip project ·Cutting edge system LSI design project ·Digital information device interoperability infrastructure project ·Energy-saving next-generation PDP project ·Development of next-generation semiconductor materials and process technology (MIRAI project), etc.
Ministry of Land, Infrastructure and Transport		·Development of robotic and other IT implementation systems, etc.
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, Electronic Navigation Research Institute	·Quasi-zenithal satellite communications system program

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 technol-

ogy to resolve global environmental problems, and Japan is actively moving ahead in this area, through the research and development projects detailed below.

The Strategy for Promotion of the Environmental Sector selects five subjects as meriting particular priority in the environmental sector, including: (1) research into global warming; (2) research into waste-free and resource recycling technologies; (3) research into eco-harmonious river basin and urban area regeneration; (4) research into the comprehensive risk management of chemical substances; and (5) research into the global water cycle. The strategy also calls for the promotion of scenario-guided initiatives that set the route to a solution that achieves the common policy goals of the government as a whole.

Furthermore, the "Biomass Nippon General Strategy" (adopted by the Cabinet in December 2002) offers support for the utilization of existing composting and animal feed conversion technologies, and for the development and commercialization of technologies for the production and manufacture of value-added products from biomass, including waste products.

In addition, in the Ministry of Education, Culture, Sports, Science and Technology, the Committee on Global Environmental Science and Technology, acting under the auspices of the Council for Science and Technology's Subdivision on Research and Development Planning and Evaluation, in May 2003 revised "On Policy for Promotion of Research and Development Related to Global Environmental Science and Technology" (first issued in June 2002).

3.2.2.3.1 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. The World Summit on Sustainable Development (WSSD) was held in Johannesburg, South Africa in August and September 2002, at which time the "Plan of Implementation" document that serves as an action guideline for participating countries was adopted. At that same time, Japan announced the "Koizumi Initiative," detailing the specific actions Japan intends to take in regards to sustainable development, including the use of global monitoring and other science and technology.

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 Washington, D.C. in the following month of July with the participation of a total of 34 countries, including the G8 countries and China, and the European Commission, and of 23 international organizations, including UNESCO. At the summit, a declaration noting the need for a global Earth observation system of systems was adopted, which was followed up at the Second Earth Observation Summit, held in Tokyo in the spring of 2004, with the adoption of a framework for a 10-year implementation plan. The 10-year implementation plan is to be adopted at the Third Earth Observation Summit, to be held in Europe near the end of 2004. In regards to the Framework Convention on Climate Change, the Third Conference of Parties to the Convention (COP3), held in Kyoto in 1997, adopted the Kyoto Protocol, which incorporated commitments to reduce the amount of greenhouse gas emissions in advanced nations and other countries, followed in June 2002 by Japan's official ratification of the Kyoto Protocol. In December 2003, at COP9 held in Italy, discussions were conducted toward the adoption in the future of the proposal of Japan and so on for the Global Climate Observing System (GCOS) implementation plan.

3.2.2.3.1.1 R&D and Related Measures for Understanding Phenomena on a Global Scale

Phenomena such as global environment problems, which spread temporally and spatially, cannot be confined to a single country, but are cross-border

issues. Therefore, it is crucial to ensure global partnerships in the course of promoting research and development. It is also important that Japan plays an active role in the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), and other international research programs, and pursues joint researches with foreign research institutions.

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, at which discussions were conducted toward the building of a Global Earth Observation System of Systems (GEOSS), 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). In addition, the Intergovernmental Panel on Climate Change (IPCC), which provides scientific information regarding climate change, is currently engaged in preparing a Fourth Assessment Report (AR4) to be published in 2007. In this regard, the Ministry of Education, Culture, Sports, Science and Technology, in its "The Project for Sustainable Coexistence of Humans, Nature and the Earth," is engaged in the development of a high-precision global warming model that will contribute to AR4.

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" commenced operation in March 2002, and in November of that year won the "Gordon Bell Award," the most prestigious award in the high-performance computer technology sector, followed in June 2003 with the receipt of the "21st Century Achievement Award" in recognition for its many contributions to the information technology sector. Furthermore, to promote research and development using the "Earth Simulator," "The Project for Sustainable Coexistence of Humans, Nature and the Earth" was launched in FY2002. It consists of two operating missions, "The 'Japan Model' mission for the prediction of global warming" that aims for highly reliable estimation of warming trends, and the "Mission for prediction of hydrological cycle variation" for the purpose of forecasting the extent of water resources and water-based disasters in the future.

Simulation results using the "Earth Simulator"

The "21st Century Achievement Awards" ceremony

The Frontier Research System for Global Change (FRSGC), a joint project of the Japan Aerospace Exploration Agency (JAXA) and the Japan Marine Science and Technology Center (JAMSTEC), promotes six research programs, including climate variations research, hydrological cycle research, global warming research, atmospheric composition research, ecosystem change research, and integrated modeling. In addition, the "Frontier Observational Research System for Global Change (FORSGC)" performs basic observational research in two research programs, for observation of climate change, and observation of the hydrological cycle. Under these two projects, 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 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, which was begun during the International Geophysics Year of

1957, 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 FY2003, the 44th wintering expedition and the 45th 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.

3.2.2.3.1.2Earth Observation Tecnology 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 exposed 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.

At the Japan Aerospace Exploration Agency, data is being collected from a Precipitation Radar (PR) mounted on the Tropical Rainfall Measuring Mission (TRMM) satellite of the National Aeronautics and Space Administration (NASA), launched in November 1997 and from the Advanced Microwave Scanning Radiometer for EOS (AMSR-E), mounted on the NASA Earth Observing System (EOS) Aqua satellite launched in May 2002, and from the Advanced Earth Observing Satellite-II (ADEOS-II) "Midori II" launched in December 2002, until the cessation of operations in October 2003. In view of the importance of utilizing this data, the agency is promoting the development and operation of satellite data information systems that promote the use of satellite data in Earth observations, disaster monitoring, and resource management, etc., the mutual utilization of data, and research into data analysis and utilization, in close cooperation with related organizations. Furthermore, the agency uses a web page to publish satellite data, etc., to deepen peoples' understanding of the current state of the global environment. Moreover, the agency 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. Moreover, a vigorous investigation into the cause of the problem that aborted the operations of "Midori II" in October 2003 is in progress.

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 is promoting the development of the Multi-functional Transport Satellite (MTSAT) as a successor to the Geostationary Meteorological Satellite Himawari No.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 for research and development of the greenhouse gas monitoring sensor mounted on GOSAT.

As use of the data obtained in this way from satellites is important, 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, in close cooperation with related organizations. Furthermore, the agency uses a web page to publish satellite data, etc., to deepen peoples' understanding of the current state of the global environment

3.2.2.3.1.3 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 Marine Science and Technology Center is promoting R&D into ocean observation technologies, including demonstration tests of the TRITON buoy at mid- and high- latitudes, and research into the next-generation JAMSTEC-Compact Arctic Drifter (J-CAD) and other marine platforms capable of mounting automated organism and chemical constituent monitoring systems. Also, the oceanographic research vessel "MIRAI" was used to implement the BEAGLE2003 southern hemispheric navigation, during which high-precision measurement of the water temperature and of dissolved substances in the southern hemispheric ocean was performed to contribute to research into quantitative evaluations of the state of global warming, and projection of climate change.

The Ministry of Internal Affairs and Communications promoted the development of extended-range marine radar to be put into Ishigaki Island and Yonaguni Island, to perform long-term observation of the Kuroshio Current flowing northward through the East China Sea continuously.

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[11]) since FY2000. In this project, an array of 3,000 mid-depth floats are being deployed with international cooperation all around the world to measure temperature and salinity data to an ocean depth of 2,000m.

In addition, the Ministry of Economy, Trade and Industry is promoting research on the mechanism for CO2 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-PAP) promoted by the United Nations Environment Program (UNEP) in the Sea of Japan and the Yellow Sea.

11 ARGO: acronym for "Array for Real-time Geostrophic Oceanography." The acronym is intended to recall the name of the ship used by the Greek mythic hero Jason, and the connection with the Jason series of Earth observation satellites.

3.2.2.3.1.4Research and Development of Stratospheric Platforms

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

Major research subjects promoted in relevant ministries and agencies in the area of Earth science and technology are as shown in Table 3-2-4.

Table 3-2-4 Elucidation of various global-scale phenomena, and major research topics in the Earth sciences and technology sector (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Incorporated administrative agency: National Institute of Information and Communications Technology	· International joint research on advanced electromagnetic technology for the global environment · Research and development of technologies for the measurement of subtropical Earth environments · Research on global environment measurement and forecasting technology, using 3-D high-resolution imaging radar · Promotion of international information networks for conservation of the Earth's environment
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	· Aeolian dust experiment on climate impact · International research project on the interaction between the sub-vent biosphere and geo-environment · Unzen Volcano: International cooperative research with scientific drilling for understanding eruption mechanisms and magmatic activity
	Incorporated administrative agency: National Research Institute for Earth Science and Disaster Prevention	· Studies on mechanisms and impacts of climate change causing global warming · International geosphere-biosphere programme (IGBP)
	National Universities and Other Institutions	· Antarctic research · International cooperative research project on the arctic environment · Academic research into earthquake and volcanic eruption prediction systems
Ministry of Agriculture, Forestry and Fisheries	Incorporated administrative agency: National Institute for Agro-Environmental Sciences	· Assessment and mitigation techniques of global warming effects on the agriculture, forestry and fisheries sector
Ministry of Economy, Trade and Industry	Incorporated administrative agency: National Institute of Advanced Industrial Science and Technology	· Evaluation of the impact of carbon dioxide sequestration on the dynamics of global warming substances · Research into land-based monitoring of oceanic air mass regions · Evaluation of long-term carbon dioxide absorption, based on the analysis of intermediate- and deep-ocean water in the Pacific Ocean
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	· 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 · To collect, manage, archive and disseminate data and information concerning water temperature and the role of currents in ocean water circulation, and on materials involved in ocean floor contours, geology and earth-related physics
	Japan Meteorological Agency Meteorological Research Institute	· Development of High-Resolution Ocean General Circulation Model, and Elucidation on Mechanisms of the Formation, Maintenance, and Variation of Water Masses Based on the Model · Study of the prediction of regional climate changes over Japan due to global warming
	Geographical Survey Institute	· Study on geodynamics using precise Earth measurement technology · Plate motion and deformation in the East-Asia and Pacific region
	Incorporated administrative agency: Port and Airport Research Institute	· Use of tide-level observation to monitor rising sea levels
Ministry of the Environment	Global Environment Research Fund	· 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 · Research into the maintenance of sustainable national territories for island nations formed from coral atolls · Elucidation of the dynamics of global-scale ocean pollution caused by toxic substances, and research into their prediction · Research into gene migration due to the release of gene recombinant organisms, and evaluation of the impact on biological diversity · Integrated study for the terrestrial carbon management of Asia in the 21st century based on scientific advancements · Research on the explanation of long-term trends, and prediction of future changes in the ozone layer · Development of a monitoring system for the halocarbon inventory in East Asia · Studies on the effects of organic aerosols on regional and global climates · International co-operative survey to clarify Trans-boundary Air Pollution Across the Northern Hemisphere
	Global Environment Research Coodination System	· Research into the mechanisms for the carbon dioxide cycle in ocean surface layers, using radioactive nuclides as multi-tracers · Evaluation of the impact of carbon dioxide marine isolation on the ocean material cycling process

3.2.2.3.2 Research into Building a Recycling Society

In order to secure sustainable growth of Japan's economy and society in the future, R&D is needed to support the introduction of production systems that reduce to a minimum the input of resources and the emission of wastes, etc., and to create a recycling-based society that effectively utilizes resources and restricts the generation of wastes, etc., through the use of nature's own recycling functions and the other functions of biological resources.

As one of its R&D projects (Leading Project) for economic revitalization launched in FY2003, 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 actively engaged in the development of technologies for the recycling of containers and packaging, such as the liquefaction of waste plastics, and for the expansion of recycling capabilities, such as advanced technologies for recycling metal scrap, the development of technologies related to thermal recycling (use of energy from waste incineration), such as the expanded use of high-efficiency waste power generation and of wastes converted to solid fuel (RDF), the development of technologies for the use of ash from incinerated wastes of urban areas as cement materials, and the development of technology for the proper disposal and recycling of discarded consumer electronics and automobiles.

The Ministry of Agriculture, Forestry and Fisheries is promoting the development of innovative recycling and utilization technologies for farm animal wastes, 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. The ministry is also 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 geomaterials 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, etc.

The Ministry of the Environment is promoting the research and development of processing technologies for the detoxification of dioxins and other 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. Elsewhere, the ministry is engaged in research into elucidation of the mechanisms for the generation of micro-pollutants at waste disposal and recycling facilities, and into control of their emissions, as well as the long-term control of the risks attendant with micro-pollutants.

The major research topics currently being promoted by the relevant ministries and agencies are as shown in Table 3-2-5.

Table 3-2-5 Major research subjects for building a recycling-oriented society (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Education, Culture, Sports, Science and Technology	Special Coordination Funds for Promoting Science and Technology	· Development of an integrated urban liquid and solid waste treatment system incorporating technologies for transforming kitchen garbage to biodegradable plastics
Ministry of Agriculture, Forestry and Fisheries	Incorporated administrative agency: National Agriculture and Bio-oriented Research Organization Private sector, universities, etc.	· Development of new technology for the treatment and local recycling of biomass · Development of technologies for the construction of food resource recycling systems
Ministry of Economy, Trade and Industry		· Development of fundamental technologies for manufacturing environmentally harmonious hyperfine steel particles · Development of technologies for the detoxification and materials recycling of aluminum impurities · Development of technologies for the simultaneous separation and materials recycling of non-ferrous metals · Development of recycling technologies for building materials, glass, etc. · Development of technologies for resource-recycling-type housing · Support project for the commercialization of technologies promoting the recycling society · Development of recycling technology for iron and plastic compounds, using an electric furnace technology · Development of cement manufacturing technology utilizing recycled resources containing large amounts of chlorine · Development of safety technologies related to the recycling process for heat-insulating urethane · Development of technologies for the promotion of non-ferrous metal recycling · Development of technologies for the reutilization of parts for electronic and electrical machinery · Development of technologies for the simultaneous recovery of chlorine from waste plastics and alkalis from waste glass bottles · Development of technologies for life-cycle environmental impact assessments for products, etc. · Development of technologies for the design and manufacture of environmentally friendly plastics with low waste volumes
	Incorporated administrative agency: National Institute of Advanced Industrial Science and Technology	· Research on renewable plastic with free categorization · Research on a support system for green process manufacturing technology · Research on materials technology for easy dismantlement and simple recycling · Research on recycling technology with high efficiency for resources · Research on an evaluation method for recycling technology · Research on chemical recycling technology · Research on environmental technologies that effectively use biomass
Ministry of Land, Infrastructure and Transport	Minister's Secretariat, Technology Research Division	· Architecture for the formation of a recycling society and safe environment and development of technologies for urban infrastructure development · Development of technology for the control and management of social infrastructure stock
	National Institute for Land and Infrastructure Management	· Research into rational recycling technologies for construction waste
	Incorporated administrative agency: Public Works Research Institute	· Research into social infrastructure development using new materials, unutilized materials, and recycled materials
	Incorporated administrative agency: Building Research Institute	· Research and Development Project on Timber-based Hybrid Building Structures · Development of dissemination and support systems for housing with independent recycling of energy resources · Research and development into the effective utilization of existing buildings
	Incorporated administrative agency: National Maritime Research Institute	· Research into the application of LCA in shipping · Survey and research into the establishment of recycling and usage technologies to restrict the generation of waste FRP when ships are scrapped
	Incorporated administrative agency: Port and Airport Research Institute	· Research into the utilization of recycled materials in harbor work
Ministry of Land, Infrastructure and Transport	Independent administrative institution: Civil Engineering Research Institute of Hokkaido	· Environmentally friendly resource circulation project for cold,snowy region · Experimental study on developing a regional system of biogas-derived hydrogen energy supply, including the technology for such a system
Ministry of the Environment	National Institute for Environmental Studies	· Evaluation of policies for the promotion of resource recycling from the lifestyle perspective · Research into methods for the analysis of recycling systems' local adaptability

3.2.2.3.3 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

3.2.2.3.3.1 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" was adopted for the purpose of conserving the diversity of living things on Earth and their habitats, and conducting sustainable use of biological resources. Japan has responded with active measures, including the adoption of measures for the conservation of biological diversity and the assurance of sustainable use. Based on the Convention, the National Strategy of Japan on Biological Diversity, a systematic summary of Japan's basic policies and other measures, was revised upward on March 27, 2002 by the Council of Ministers for Global Environment Conservation. The strategy calls 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), thereby promoting an international scientific cooperation project. The aim of this project is to distribute biodiversity data and utilize it worldwide via the Internet. MEXT is now proceeding to make a biodiversity online database in Japan as a part of the project.

The Ministry of Agriculture, Forestry and Fisheries is promoting research into the development of technologies for the promotion of sustainable agriculture that reduce the burden on the environment, for analyses of the mechanisms that enable plants to resist environmental stress, and for 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.

3.2.2.3.3.2 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, research interests have turned particularly to finding countermeasures to environmental risks posed by chemical substances such as dioxins and endocrine disrupters. The relevant ministries and agencies are currently actively engaged in surveys and research and development toward the development of methods for testing and measuring these 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.

3.2.2.3.3.3 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 con-

trol 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 Japan Coast Guard is engaged in the development of a technology for the utilization of satellite data to enable continuous monitoring of red tide pollution, for the purpose of environmental monitoring in Tokyo Bay.

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.

The major research topics currently being promoted by the relevant ministries and agencies are as shown in Table 3-2-6.

Table 3-2-6 Major research subjects on global and natural environment conservation technologies (FY2003)

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
	Institute of Public Health	· Research into the conservation of waterways and water resources
	Funding for the environmental health maintenance research project	· Study for the drafting of guidelines on measures to combat global warming and other issues affecting waterworks
Ministry of Agriculture, Forestry and Fisheries	Incorporated administrative agency: 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 · Assessment and mitigation techniques of global warming effects on the agriculture, forestry, and fisheries sector · Integrated study on the development of natural cyclical functions through forest, agricultural and aquatic ecosystems · Development of technologies for the management of agricultural and forest ecologies to reduce damage to agriculture and forestry by wild animals and birds · Research into the development of innovative technologies for the promotion of sustainable agriculture · Development of eco-friendly management technology of water and agro-forested-aqua-ecosystem in watershed and estuary areas · Use of environmental accounting for comprehensive assessments of the multifunctionality of rural areas · MAFF gene bank project · Advanced evaluation of CO_2 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 environmentally moderate food manufacturing systems, such as for the improved efficiency of energy use, etc. · Development of advanced sewage treatment technologies, using ecosystem controls in the food industry · 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_2 fixation and effective utilization · Development of environmentally friendly processing technology · Development of materials that put low stress on the environment · Development of environmentally friendly recycling technology
Ministry of Land, Infrastructure and Transport	Hydrographic and Oceanographic Department, Japan Coast Guard	Environmental monitoring in Tokyo Bay
	Minister's Secretariat, Technology Research Division	· Development of countermeasure technologies to protect residential indoor air quality · Development of land and infrastructure management strategy for a harmonized society with nature
	National Institute for Land and Infrastructure Management	· Research into methods for the dissolution of endocrine disruptors using microorganism controls · Research into comprehensive water cycle models, and methods for water cycle · Research into environmental management technologies for enclosed bays · Research into chemical risk evaluations in riverine and other environments · Projects for the restoration of tidal flats in urban seaside areas
	Incorporated administrative agency: 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
	Incorporated administrative agency: 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 Institute	· 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 systems · Research into the reduction of compound pollution caused by ships' generation of toxic volatile gases
	Incorporated administrative agency: Port and Airport Research Institute	· Research into coastal and tideland ecological system response to changes in water bottom quality due to *meso kosumu* tests · Research into oil spill recovery systems · Research into environmental creation technologies for harbor waters · Survey of the uses of biological activity for the improvement of water environments
Ministry of the Environment	Global Environment Research Fund	· Research into the selection of coral reef biodiversity preservation districts · Research on the rehabilitation ~~of~~ the landscape level of degraded tropical forests
	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
	Incorporated administrative agency: National Institute for Environmental	·Research into the evaluation of technologies for natural restorations of marshland ecologies · Research into the elucidation of higher-order physiological memory functions for organic chemical substances, and the development of risk evaluation methods · Evaluation of the sources of the generation of organic fluorosis compounds and other POPs pollutants · Research into the development of basic technologies for the elucidation of pollutants and countermeasures

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. Now in the Basic Plan, nanotechnology and materials have located recognition as one of four areas, requiring the priority allocation of research and development resources. 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.

The "Promotion Strategies by Sector" set five areas for priority attention, including "nanodevices and materials for next-generation information and communications systems," "materials for environmental preservation and upgraded use of energy," "nanobiology that utilizes and controls ultra-small systems and materials for medical use and biological mechanisms," "measurement and evaluation, processing, numerical analysis and simulation, and other basic technologies and related sectors," and "substance and materials technologies that contribute to the realization of revolutionary material properties and functions." It also indicated the need for more active competition and a better environment that encourages competition at R&D sites, the promotion of integration between different sectors and between researchers, the establishment of system frameworks that facilitate the application of the fruits of research in industry, clarification of the responsibilities and roles of industry, academia and government, and further cooperation among these sectors, and the assurance and development of human resources.

3.2.2.4.1 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 order to promote materials technology, the Second Science and Technology Basic Plan calls for the government to place priority on the promotion of R&D in areas where a market mechanism alone cannot lead to strategic and effective results, such as in basic and advanced R&D, and in R&D for basic technologies that lead to industrialization.

For materials R&D, the Plan placed priority on the promotion of the following:

1. Clarification and control of structures and shapes at the atomic and molecular levels of materials that serve as the basis for information and communications, medicine, etc., as well as materials technology for the control of material surfaces and interfaces, etc.
2. High value-added energy and environmental materials technologies suitable for energy saving, recycling, and resource saving
3. Safe space-creating materials technologies for assurance of safe living spaces

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 the field of materials science and technology, the report positioned "materials for environmental protection," "materials for advanced use of energy," "materials for creation of safe space," "basic technologies such as evaluation and processing" and "discovery of materials creating new and advanced functions" as the prioritized areas in meeting the needs of society.

Specifically, 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 21st century" and "superconducting materials." Research into materials science and technology is also being promoted through the administration of the "Special Coordination Funds for Promoting Science

and Technology," and other similar programs including "Creative Research for Evaluation Science and Technology Program of the Japan Science and Technology Corporation" (JST), and the Frontier Research System, at RIKEN. The ministry is also encouraging the development of creative and advanced materials research at the Institute for Materials Research and the Institute of Multidisciplinary Research for Advanced Materials at Tohoku University, the Institute for Molecular Science at the Okazaki National Research Institutes, 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.

The Ministry of Agriculture, Forestry and Fisheries is using "Insect Technology Research for Utilization of the Greatest Unused Resources of the 21st Century" to engage in research and development for the wider utilization of biomaterials such as fibroin, a silk protein, as a new material with active antithrombosis 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 research and development on new materials processing technologies, such as the "Next-Generation Semiconductor Nanomaterials Advanced Evaluation Project," "Synergy Ceramics," and "Supermetals." In addition, the ministry promotes cutting-edge, fundamental R&D conducted by international joint research teams funded through the International Joint Research Grant Project (a NEDO grant), to improve the international level of materials science and technology standards.

The Ministry is conducting research and development on fundamental superconductor technologies with the cooperation of industry, academia, and government, primarily led by the New Energy and Industrial Technology Development Organization.

3.2.2.4.2 Nanotechnology

3.2.2.4.2.1 Major Policy Proposals for Nanotechnology

The Basic Plan notes that, while Japan is either equal to or leading the countries of Europe and the United States in its standards for nanotechnology research and development, the United States and other countries are making very rapid progress in this field.

The Plan also calls for balanced and prioritized promotion of nanotechnology for both basic and advanced R&D and for future industrialization, and notes the importance of building research networks that promote joint efforts and information exchanges between different research areas and researchers, and of developing personnel for new interdisciplinary areas.

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. The "Research Committee Regarding Application of Quantum Dynamic Effects to Information and Communications Technology, and Future Prospects (Chairman: University of Tokyo professor Hiroyuki Sakaki)" convened in February 2000 to study promotion policies for research topics and R&D needed for the creation of innovative quantum information and communications technologies in the 21st century. The committee issued a report in June 2000. In response, the Ministry of Internal Affairs and Communications began in FY2001 promoting the "research and development of quantum information and communications technologies," and is currently implementing research and development at communications and broadcasting institutions for quantum encoding technologies, showing the promise of practical utilization at relatively early dates. In May 2001, the ministry launched the Committee for Promotion of Quantum Information and Communications Research (Chairman: Reona Ezaki, president of Shibaura Institute of Technology), to perform comprehensive investigations of the current state of re-

search and development, and its direction and general strategies, etc. In addition, at the National Institute of Information and Communications Technology, the "Information and Communications Breakthrough Basic Research 21" program, and the "Strategic Information and Communications R&D Promotion Programme" (established in FY2002) are promoting "research into new functions and extreme technologies for information and communications devices," and are 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.

At the Ministry of Education, Culture, Sports, Science and Technology, the "Promotion Policies for R&D in Nanotechnology Materials," prepared in June 2002 by the Council for Science and Technology (Subdivision on Research Planning and Evaluation), pointed out the need for the development of a cross-cutting support system for nanotechnology that goes beyond the bounds of existing institutions or sectors to promote research into items with commercial or industrial potential, to promote seed research, and to foster human resources. In response to this report, the ministry included in its R&D projects (Leading Project) for economic revitalization launched in FY2003 the "development of measurement, analysis, and evaluation tools leading the way to next-generation science and technology," the "development of artificial organs and artificial sense organ using nanotechnology," the "development of devices based on new principles derived from nanotechnology," the "practical realization of advanced semiconductor technologies, including development of Extreme Ultraviolet (EUV) light sources," and the "next-generation fuel cell project," all launched 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.

As a continuing effort, 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 utilized its Basic Research Programs to implement the research and development of "virtual laboratories by nanotechnology field" from the mid- and long-term viewpoint, in close cooperation with researchers.

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

The Ministry of Agriculture, Forestry and Fisheries is utilizing information about biological functions obtained at the molecular and cellular level, and cooperation from industry, academia, and government, as well as from different technology fields,

to promote the development of revolutionary new functional materials through the use of nano-level structural controls, the development of technologies for the utilization of innovative biological functions, and the construction of a micro-bioreactor, while the ministry's National Foods Research Institute is promoting research into measurements in the nano-domain.

The Ministry of Economy, Trade and Industry is promoting the "Nanotechnology Materials Program" to establish the foundations of nanotechnology, which is expected to bring innovative

developments over a wide range of industrial sectors, including the use of nano-level controls to improve the functionality and characteristics of materials, boosts to energy savings, and reductions in the burden on the environment. Moreover, the "Nanocarbon Applied Product Creation Project" was launched in FY2003 for the early practical realization of products applying carbon nano-tubes. Furthermore, the ministry is promoting the Nanotechnology Business Creation Initiative (established October 2003), with participation by many corporations, for the objective of planting technology seeds in the nanotechnology sector that match market demand, and creating new businesses.

In FY2003, the Ministry of the Environment commenced the development of environmental technologies that make use of the nanotechnology merits of smaller size and improved function in regards to environmental monitoring, impact assessments on health and the ecology, and environmental pollution prevention measures.

The major research topics in the nanotechnology and materials science and technology sector conducted during FY2001 are shown in Table 3-2-7.

Table 3-2-7 Major research subjects in the nanotechnology and materials sectors (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Incorporated administrative agency: National Institute of Information and Communications Technology, etc.	· Research into new functions and extreme technologies for information and communications devices
Ministry of Education, Culture, Sports, Science and Technology	Special coordination funds for promoting science and technology	· Research into the development of nanohetero metallic materials by elucidating their nanostructure-property relationships · Research into the creation of new functional materials using ceramics integration technology · Research into active atom array networks for a new information processing platform · Practical development of opto-media crystals for information technology · Application of ultra-fine grained steel sheets for automobiles · Radiant-control directly excited microchip lasers · Development of a high-speed atomic force microscope for capturing nanometer-scale dynamic behavior of biological · Development of a new-type X-ray photoemission electron microscope · Development of continuous fiber reinforcements for pre-stressing and smart bonding technology · Creation of bio-conjugate photosensitive nanomaterial · Nano-spintronics design and manufacturing · Combinatorial computative chemistry for the revitalization of · Kyoto University personnel development unit for computative materials researchers · Development of new crystal material for the terahertz range · Use of nano-boundary control for the manufacture of magnetic recording materials · Development of next-generation display media using self-organization of molecules · Research and development into generation of high-polymer particles using micro-chemical reactors · SNDM strong dielectric probe memory · Development of SiO2 glass-metal slope function material as a light source · International exchanges of nanotechnology researchers
	Incorporated administrative agency: National Institute for Materials Science	· Development of novel materials for nano-devices · Nanosynthesis and nanostructural materials for energy and environmental applications · R&D of new superconducting materials · Reproduction of ultra-steel from steel scrap · Exploration and creation of catalysts for removing harmful chemical substances · High Temperature Materials 21 · Project for the promotion of biological materials · Ultra-Steel Products for New High Safety Infrastructures · Combinatorial Materials Exploration and Technology (COMET) · Development of virtual experimental platform for material design using computational science and technology
	Incorporated administrative agency: RIKEN (The Institute of Physical and Chemical Research)	· Nano-scale science and technology · Study of slow quantum beam · Study on the genesis of matter · Coherent science research (Phase II) · Advanced technology research (physical science research) · Materials Science research (quantum materials research) · Spatio-Temporal Function Materials Research · Single Quantum Dynamics Research
	Incorporated administrative agency: Japan Science and Technology Agency	· Creation of ultra-fast, ultra-power-saving high-performance nanodevice systems, creation of bio-elements and systems utilizing medical-oriented chemical and biological molecules, and other projects for the promotion of strategic creative research · Project for the promotion of nano-space, spin superstructures, and other creative science and technology · International joint research project into entropy control
	New Century Priority Research Creation Plan (RR2002)	· Nanotechnology Researchers Network Center
	Research and Development Project for Economic Revitalization (Leading Project)	· Development of measurement, analysis, and evaluation equipment leading to next-generation science and technology · Development of artificial organs and artificial senses using nanotechnology · Development of devices operating on new principles based on nanotechnology · Commercialization of extreme ultraviolet (EUV) light source technology and other advanced semiconductor manufacturing technologies · Next-generation fuel cell project
Ministry of Agriculture, Forestry and Fisheries	Special ccoordination funds for promoting science and technology	· Comprehensive research into nano-devices for the elucidation of chromosome structures and functions
	Incorporated administrative agency: National Institute of Agrobiological Sciences	· Studies for the utilization of insect properties
	Incorporated administrative agency: National Food Research Institute	· Development of nanotechnology and materials technology for the innovative utilization of biological functions
Ministry of Economy, Trade and Industry		· Carbon nanotube FED project · High-strength nanoglass display monitor project · High-function nanoglass device project · Full-color rewritable functional capsule paper project · Diamond ultimate function project · Next-generation semiconductor nanomaterial advanced evaluation project · Nanocarbon application product manufacturing project · Micro-analysis and production system project · Nano-biotechnology project
Ministry of the Environment		· Project for the promotion of environmental technology development using nanotechnology

3.2.2.5 Energy

For research and development in the energy sector, the "Strategy for Sector Promotion" detailed priority sectors, research and development targets, and promotion policies from the viewpoint of contributing to a reduction in reliance on fossil fuels, and toward the realization of an efficient, secure, and stable energy demand structure, as well as the goals of stable energy supplies, ensuring energy security, and the prevention of global warming. Furthermore, the "Energy Basic Plan," (by the Cabinet in October 2003) based on the Energy Policy Basic Law (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.

3.2.2.5.1 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 promotion 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.

Today, nuclear power generation is a major source of energy accounting for more than one-third of electric power supplies, and thus plays an important role in energy supply. 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 addition, 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 the Ministry of Education, Culture, Sports, Science and Technology, the Preparation Council for Merging Two Public Atomic Power Corporations studied the new incorporated administrative agency in terms of its basic philosophy, mission, operations, organization, and management methods, and then in September 2003 issued the "Report Regarding the Merger of Two Public Atomic Power Corporations." Based on this report, the ministry is currently engaged in promoting operations toward the establishment of the new entity sometime in FY2005.

3.2.2.5.1.1 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.

Furthermore, learning from the criticality accident that occurred at the J.C.O. uranium processing plant in September 1999, inspections related to complete observance of security regulations are now being strictly performed in accordance with the Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors,[12] which was revised in 1999. Moreover, in response to revelations beginning in August 2002 of problems related to deceptive accounting of self-inspection operations at nuclear power plants, nuclear operators were asked to perform comprehensive inspections, and the suitability of their inspection result reports were checked. In response, the Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, was revised again in FY2002 to make it possible to collect reports from maintenance and inspection providers at nuclear facilities as part of continuous efforts to further strengthen safety regulations.

In the area of nuclear emergency preparedness, 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 to nuclear accident sites, preparation of off-site centers and other disaster countermeasure sites, development of emergency plans and manuals, implementation of emergency drills, and rearing and training of personnel.

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.

The Radiation Safety Regulations Review Group studied basic ideas regarding the incorporation into domestic law of exemptions to the Basic Safety Standards (BSS) issued by the International Atomic Energy Agency (IAEA), and prepared an interim report in August 2003. Based on this report, the Ministry of Education, Culture, Sports, Science and Technology and other relevant government institutions are now studying specific legislative measures. In addition, the Radiation Council's General Administrative Group examined proposals for exempting natural radioactive materials from regulation, and presented a report in October 2003 entitled "Exemption of Regulations on Naturally Occurring Radioactive Materials."

Also, in ensuring nuclear safety, it is important always 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 FY2003, the safety research activities described below were implemented at research institutions, based on the Five-Year Safety Research Program, while at the same time the Nuclear Safety Commission presented an interim report detailing the degree of success in meeting the goals of each research topic.

12 The Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, was amended in 1999 to strengthen the safety regulations for transport control, as follows:

(1) Addition of the Facilities Periodical Inspection System for fuel fabricators

(2) Establishment of an inspection system for strict compliance with safety regulations that business operators and employees must follow

(3) Institution of nuclear safety inspectors

(4) Clarification of the obligation of business operators to provide safety education to employees

(5) Establishment of a system to accept proposals for the improvement of safety assurance from employees

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 regulatory exemption (clearance) verification technology, was conducted by JAERI and JNC.

In regards to the Five-Year Safety Research Program, and in view of the changes in the structures of the institutions engaged in safety research, the Nuclear Safety Commission is promoting studies into the adoption of a “Priority Safety Research Program” for research into safety issues in FY2005 and beyond.

3.2.2.5.1.2 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 or lending out simplified radiation detectors.

Furthermore, to promote coexistence between nuclear power research facilities and local candidate sites, the Power Source Grant program is being utilized to promote efforts in response to the needs of the local candidate sites.

In FY2003, grant funds were reviewed and merged to enhance local autonomy and creativity, and support policies for both hard and soft aspects were adopted.

3.2.2.5.1.3 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 develop Japan’s own technologies for enhancing the reliability of the lightwater reactor, improve working efficiency, and reduce employee exposure to radiation. In view of operational experiences to date, the parties have striven to make the lightwater reactor technology more economical, while maintaining high levels of reliability and safety.

(2) Research and Development of the Nuclear fuel Cycle

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

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

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

While some reprocessing of spent fuel from nuclear power plants is conducted at 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 July 2006. 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 re-processing of spent uranium fuel used in light water reactors, and about 1,000 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 2003.

Intermediate storage of spent fuel provides an adjustable time period until the fuel is reprocessed, and thus lends an element of flexibility to the nuclear fuel cycle as a whole. A law concerning intermediate storage was enacted in 1999, and private sector organizations are now making preparations for the commercial operation of storage facilities 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.

Based on the research and development results of the Japan Nuclear Cycle Development Institute, the Atomic Energy Commission's Special Committee on Nuclear Back End Countermeasures concluded in October 2000 that the technical feasibility of the geological disposal concept had been obtained, and the technical basis for the implementation of geological disposal provided. In response to these efforts, the Law for Final Disposal of Specified Radioactive Waste was passed in May 2000, followed in October of that year by the establishment of the Nuclear Waste Management Organization of Japan (NUMO). In December 2002, the organization announced the start of their open solicitation to invite municipalities to voluntarily participate in the selection of the preliminary investigation areas.

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 165,000 200—liter drums of waste already having been transferred to the center as of the end of March 2004. For other low-level radioactive waste, it is necessary to promote specific efforts toward the realization of disposal in the future. Regarding radioisotope and research institute wastes, burial disposal is scheduled to be implemented in response to the Atomic Energy Commission's summary report, prepared in May 1998, on "Basic Ideas for Treatment and Disposal of Radioisotope and Research Institute Wastes." Studies were conducted by the Japan Atomic Energy Research Institute, the Japan Nuclear Cycle Development Institute, and the Japan Radioisotope Association, the three main generators of this kind of waste.

In February 2002, the Ministry of Education, Culture, Sports, Science and Technology established the "Roundtable Discussion on Disposal Enterprises for Radioisotope and Research Institute Wastes," to promote studies into the conditions for developing waste disposal programs, toward the early implementation of waste disposal operations. Concerning the decommissioning of nuclear power facilities, an on-site dismantling test of the Japan Power Demonstration Reactor (JPDR) was successfully completed by the Japan Atomic Energy Research Institute in 1996, while the first decommissioning of a commercial reactor in Japan was commenced in December 2001 at the Japan Atomic Power Co., Ltd.'s Tokai Power Plant. At present, the Japan Atomic Energy Research Institute and the Japan Nuclear Cycle Development Institute have conducted surveys and technological development regarding the decommissioning of facilities related to the nuclear fuel cycle, including the above-mentioned "Fugen" reactor.

3.2.2.5.1.4 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.

Since fast breeder reactors have the advantage of generating more nuclear fuel than they consume, while generating electricity and greatly boosting the efficiency of uranium fuel utilization over light water reactors, their development has been steadily promoted through cooperation between the public and private sectors. The "Joyo" experimental fast reactor has been in operation since initial criticality in April 1977. The upgrade to the MK-III core, which brought faster high-neutron flux and expanded the irradiation field, was completed in November 2003, to ensure continued utilization as a high-performance, fast neutron irradiation reactor.

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 "Long-Term Program for Research, Development and Utilization of Nuclear Energy" as the core for Japan's research and development into fast breeder reactor cycle technology.

"Monju" has not operated since ceasing operations following a sodium leak accident in December 1995. In response to this situation, the Japan Nuclear Cycle Development Institute prepared a list of measures needed for the prevention of a reoccurrence of the accident, and in December 2002, the Nuclear and Industrial Safety Agency of the Ministry of Economy, Trade and Industry approved the commencement of plant modifications to reinforce countermeasures for a sodium leak accident. Later, on January 30, 2004, the application for detailed design and construction procedure for plant improvement in regards to the sodium leak countermeasure was approved. However, the Kanazawa branch of the Nagoya High Court issued a ruling in January 2003 in an administrative suit, which had been initiated by the local residents, to nullify the construction license of "Monju." In response, the government appealed the ruling up to the Supreme Court of Japan, on the grounds that the ruling went against previous decisions handed down by the Supreme Court, and constituted a gross misinterpretation of the Nuclear Reactor Regulation Law.

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.

3.2.2.5.1.5 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 "Long-Term Program for Nuclear Energy," which were adopted by the Atomic Energy Commission, in cooperation among JAERI, the National Institute for Fusion Science, and universities and colleges. In the future, prioritization efforts are to proceed 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.

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, an inter-university research institute, constructed a large helical device that is based on a unique idea originating in Japan. The facility is the largest helical device in the world, and its research into new plasma regions leads the world. In FY2003, the facility achieved a plasma ion temperature of 113 million degrees using argon gas (with an electron temperature of 52 million degrees and a density of 3.5 trillion particles/cc).

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. International cooperation on the bilateral and multilateral levels is also being actively promoted.

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, intergovernmental negotiations are underway among Japan, China, the EU, South Korea, Russia, and the United States concerning the drafting of a joint implementation agreement, selection of a construction site, and cost sharing. So far, negotiations have been held nine times. Two candidate sites have been proposed: Rokkasho-mura, Aomori prefecture (Japan); and Cadarache (France). 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. On this 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.

3.2.2.5.1.6 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. Based on the evaluation results, the construction on the High Intensity Proton Accelerator commenced in FY2001. In addition, the Assessment Operations Division of the High Intensity Proton Accelerator Project, a part of the Council for Science and Technology, issued an interim assessment in December 2003, in which it noted the continued significance, importance, and urgency of the project, and called for the commencement of construction of the Neutrino Facility in FY2004, so that Japan can continue to play a leading world role in the sector. 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.

The Ministry of Economics, Trade, and Industry, as well, was also continuing research and development in FY2003 into public canvassing methods for selection between proposals related to innovative, creative, and practical nuclear power technologies, 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. Furthermore, JAERI, RIKEN, universities, and national research institutes are broadly engaged in research and development in reactor and nuclear physics, and in fuels and materials, etc.

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 other 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. Fundamental research and development into the four fundamental technology areas of substances and materials, biological and environmental effects, computation technologies, and disaster prevention and safety, is now being pursued at JAERI, RIKEN, and other incorporated administrative agencies.

3.2.2.5.1.7 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 therapy using heavy ion beams, with high expectations for its clinical effectiveness against cancer. Clinical trials of the heavy ion therapy on actual patients commenced in June 1994, and excellent results have been obtained for certain types of cancer. As a result, heavy ion therapy was officially approved as an advanced medical treatment in October 2003. 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.

3.2.2.5.1.8 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 FY2003, Japan continued steady implementation of the IAEA Safeguard Agreement and of the Additional Protocol designed

to strengthen the safeguards' effectiveness, and also engaged in studies with the IAEA toward the application of safeguards (integrated safeguards) that achieve maximum effectiveness and efficiency. In addition, in preparation for the start of operations of the Rokkasho Reprocessing Plant, an important facility to be safeguarded, the government promoted development 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 explosions and all other nuclear explosions, a historic step towards a world that is free of nuclear weapons, and is now engaged in development of an international monitoring system toward the treaty's eventual enforcement.

(2) International Nuclear Power Cooperation

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

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.

Japan also participates in the Generation IV International Forum (GIF), related to Generation IV nuclear energy systems, a grouping of the United States, France, and eight other countries and one institution, for studies related to the development of next-generation nuclear energy technology.

3.2.2.5.1.9 Infrastructure for the Promotion of Nuclear Energy Use

An important issue for the promotion of the research, development, and utilization of nuclear energy while maintaining safety is the fostering and maintenance of superior human resources, and the maintenance and transmission of technology skills. As a result, the universities that handle the core function of human resource development need to be in contact with research and development institutions, private-sector enterprises, and other related institutions, while also maintaining an international perspective, in order to be able to foster diverse and capable human resources. In addition, government research institutions and private-sector enterprises need to create systems that will encourage mutual personnel and technology exchanges such as joint research activities and exchanges of personnel. It is important for Japan as a whole to strive to maintain, continue, and develop its personnel and technology capabilities. Moreover, the development of R&D activities that challenge the broad possibilities of nuclear power, and also offer dreams and hope to young people, is important for fostering personnel willing to test nuclear power.

The Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry are contributing to personnel development through the implementation of 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.

3.2.2.5.2 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.

3.2.2.5.2.1 Fuel Cells and Hydrogen Energy Utilization

Because fuel cells, which generate electricity through a chemical reaction between hydrogen and oxygen, are very efficient and do not emit NOx or SOx, they are expected to be a key energy and environmental technology. While the development of fuel cell vehicles and stationary fuel cell systems is well-advanced, there still remain some hurdles to be addressed, such as durability and performance in order to make them commercially feasible. For this reason, the Ministry of Education, Culture, Sports, Science and Technology is promoting the development of 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.

3.2.2.5.2.2 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.

3.2.2.5.2.3 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.

3.2.2.5.3 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.

3.2.2.5.3.1 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.

3.2.2.5.3.2 Coal

Coal offers excellent supply stability compared to petroleum and other sources. But since coal emits the highest carbon dioxide of all fossil fuels, 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 coal combustion technology, or the Integrated coal Gasification Combined Cycle (IGCC).

3.2.2.5.3.3 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.

3.2.2.5.4 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 promoting research and development into energy-saving technologies for the industrial, residential, and transport sectors, including elemental technologies that use superconductor technology, such as high-efficiency power storage devices, power generators, cables, and transformers, etc., cogeneration systems, and energy conservation technologies for manufacturing processes and plants.

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 3-2-8 shows a summary of the major research topics in the energy sector (excluding nuclear power) implemented during FY2003.

Table 3-2-8 Major research subjects in the non-nuclear energy sector (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Education, Cuture, Sports, Science and Technology	National universities and other institutions	· New energy and energy efficiency R&D · The Project to Design a Sustainable Management and Recycling System for Biomass and General and Industrial Wastes · Next-generation fuel cell project
	Incorporated administrative agency: 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	Incorporated administrative agencies: 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) - Clean-energy vehicle-related technologies - Superconducting power equipment technologies - Industrial co-generation - Next-generation chemical process technologies
Ministry of Land, Infrastructure and Transport	Independent administrative institution: Civil Engineering Research Institute of Hokkaido	· Experimental study on developing a regional system for biogas-derived hydrogen energy supply, including the technology for such a system · Promotion of technology development for the introduction of fuel cells and other new energy sources into residences
Ministry of the Environment	Incorporated administrative agency: 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 · Granted project of the development of bio-energy supply technologies using wastes generated from residences, etc.
	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. In the Promotion Strategies by Sector, the priority areas and items included "use manufacturing technology innovations to strengthen competitiveness," "pioneer new areas of manufacturing technology," and "determine technologies for minimizing environmental burdens," as well as measures for promoting the attainment of research and development goals, including to "develop human resources, and improve environments that encourage creativity," "accumulate knowledge fundamentals, technology, and know-how," "handle incentives for acquisition of intellectual property," "collaborate and allocate responsibilities among industry, academia, and government from the initial stages of research," "promote the development and standardization of intel-

lectual infrastructure," "support venture businesses and marketing of new products," and "specify tasks for management, business models, and science and technology policy."

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, Developing an Infrastructure for Manufacturing).

With the Science and Technology Basic Plan, Japan is actively promoting research and development into extreme-situation technologies with high added-value, technologies for reducing the burdens on the environment, technologies for assuring safety in the manufacturing workplace, and technologies for making things that are built based on IT and the principles of biology.

Specifically, 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 the "Otsu Localized Photon Project," which aims for the establishment of a new ultra-fine fabrication technology using optical near fields, and 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,[13]" 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 "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," to unite international joint research for the development of new production systems, the "Basic Software Development for Fundamental Robot Development," to promote the development of next-generation robots, and the "System Technology Project for Creation of a Human Behavior-Oriented Living Environment," which supports the measurement and cumulative understanding of human behavior, and applies the data to products made for the human behavior characteristics of specific individuals, all for the purpose of supporting and strengthening the international competitiveness of Japan's manufacturing industry toward the revitalization of Japan's economy.

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.

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

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.

In the Promotion Strategies by Sector, two priority areas are stipulated: "build safety," which includes such items as mechanisms for the generation of abnormal natural phenomena, immediate response systems for disasters (disaster prevention IT, emergency rescue systems, etc.), and measures to reduce massive disaster damage to densely populated urban areas; and "create foundations for renewing the beauty of Japan, and for a high-quality life," which includes such items as rebuilding beautiful living spaces in coexistence with nature and traffic systems in response to new flows of people and goods.

3.2.2.7.1 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. To this end, the research institutions in every ministry are implementing research and development in accordance with the "Basic Plan for Research and Development on Disaster Prevention" (established by the Prime Minister in 1981, and revised in 1993), and through the promotion of liaison adjustments and cooperation by the Inter-Ministerial Liaison Committee for Disaster Prevention Science and Technology.

In addition, the Committee on Research and Development under the Council for Science and Technology issued the "Research and Development Policy on Disaster Reduction" in March 2003, forecasting the state of disaster prevention technology in 10 years time, and showing the important research and development topics that the Ministry of Education, Culture, Sports, Science and Technology should promote over the next five years.

The major scientific and technological research issues on disaster prevention at each ministry and agency are shown in Table 3-2-9. 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 3-2-9 Major research subjects in (natural) disaster prevention science and technology (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communication	Incorporated administrative agency: National Research Institute for Fire and Disaster	・Development of a system to predict the risk and expansion of forest fires
Ministry of Education, Culture, Sports, Science and Technology	Research and Development Bureau	・Special project for earthquake disaster mitigation in urban areas
	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
	Incorporated administrative agency: National Research Institute for Earth Science and Disaster Prevention	・Development of a real-size, three-dimensional vibration destruction test simulation system
Ministry of Agriculture, Forestry and Fisheries	Incorporated administrative agency: National Institute for Rural Engineering	・Elucidation of mechanisms for pond disasters, etc., due to concentrated heavy rains, and the development of forecasting technologies
Ministry of Land, Infrastructure and Transport	Comprehensive Policy Bureau	・Development of an Urgent Transportation System
	National Institute for Land and Infrastructure Management	・Research into managed-waste protective levee performance designs that take major earthquake movements into account ・Development of technologies for the improvement of urban disaster prevention, based on analyses of the relationship between loss of human life during earthquakes and urban structures ・Research into the advancement of real-time disaster information technologies
	Incorporated administrative agency: 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
	Incorporated administrative agency: 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	・Study on an evaluation method for volcanic activity
	Geographical Survey Institute	・Landform change analysis on volcanic slopes ・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 ・Development of an analysis technique for SAR interferometry ・Preparation of GIS infrastructure information ・Study on the characteristics of crustal deformation around the Tonankai and Nankai Regions ・Study for optimizing numeral crustal deformation models relating to seismic and volcanic activities
	Incorporated administrative agency: 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).

At present, 16 APEC (Asia-Pacific Economic Cooperation forum) economies and one United Nations institution are jointly engaged in the SCF-funded "Development of Earthquake and Tsunami Disaster Mitigation Technologies and Their Integration for the Asia-Pacific Region," while UNESCO (United Nations Education, Science, and Culture Organization) and the Inter-national Union of Geological Sciences are engaged in an international cooperation project for "Cultural Assets and Forecasting of Landslide Disasters."

Building on the 1990s, which were declared the International Decade for Natural Disaster Reduction (IDNDR), in 2000 the United Nations declared the International Strategy for Disaster Reduction (ISDR), an initiative that is expected to play an active role in the field of disaster prevention science and technology

3.2.2.7.2 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.

The Headquarters for Earthquake Research Promotion has established a Policy Committee and an Earthquake Research Committee consisting of staff members from relevant ministries and agencies, and from academia. 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 3-2-10).

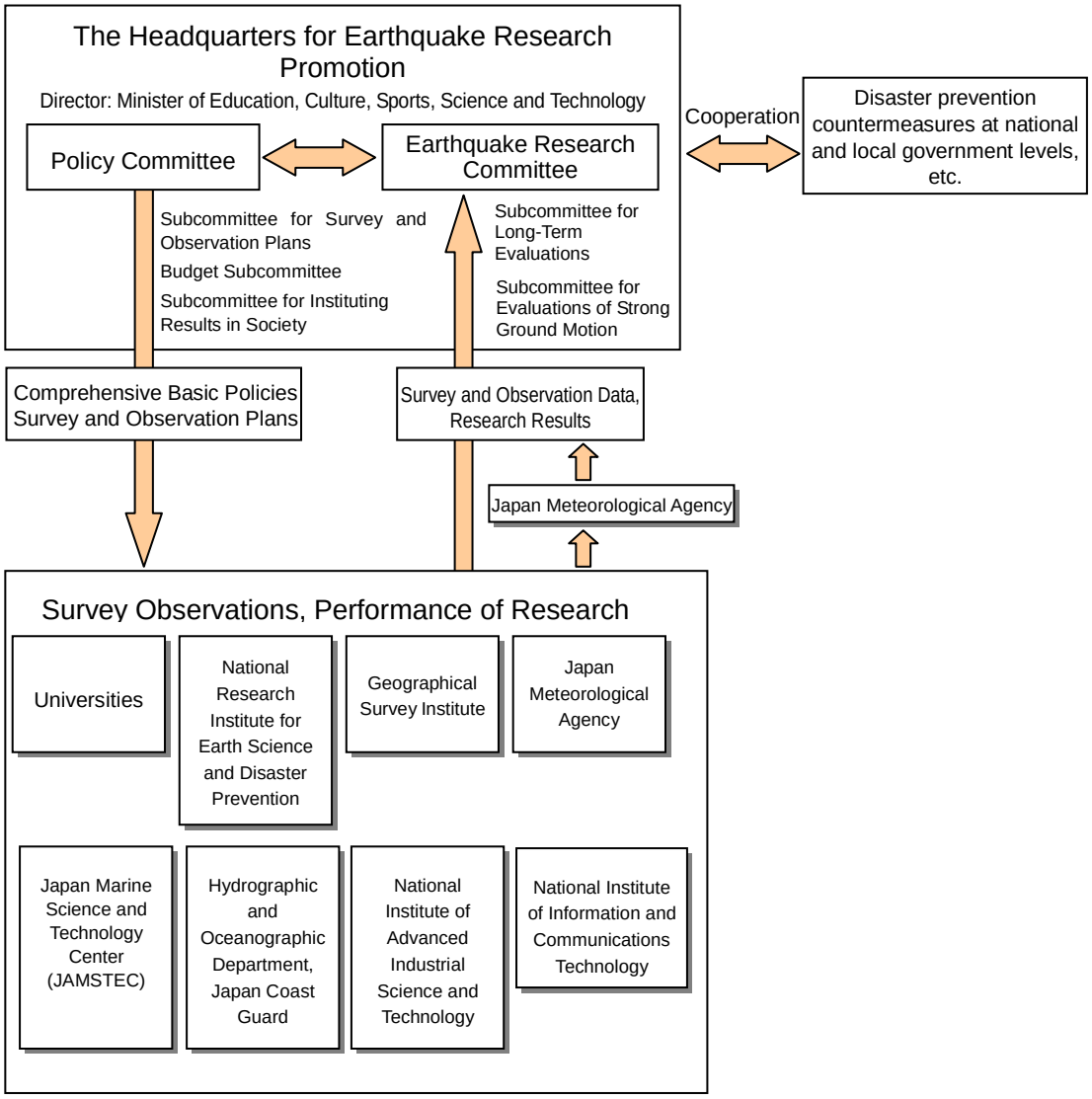


Figure 3-2-10 The structure of the headquarters for earthquake research promotion

The Policy Committee performs administrative adjustments of budgets related to earthquake surveys and research in the relevant ministries and agencies. In August 2003, the Headquarters adopted the "Estimate of Budget Requests Related to Earthquake Surveys and Research for FY2004," and called upon the Prime Minister and other relevant ministers to respect its content when drawing up the government budget.

In addition, the Survey and Observation Planning Subcommittee established under the Policy Committee issued the "Plan to Strengthen Surveys and Observation Targeting the Tonankai and Nankai Earthquake Regions (First-Stage Report)" in June 2003.

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 collects comprehensive evaluations of earthquake activities in Japan

and publishes them immediately to ensure their utility in disaster prevention activities. For example, extraordinary meetings were held following the occurrences of the Miyagi Prefecture Offshore Earthquake in May 2003, the North Miyagi Prefecture Earthquake of July 2003, and the Tokachi Offshore Earthquake of September 2003, and evaluations were prepared. In addition, the Earthquake Research Committee performs a series of long-term evaluations of the probabilities of earthquake occurrence in selected active fault areas. Of the 98 fault zones listed, the committee had already published evaluation results for 48 fault zones as of February 2004. The committee has also published evaluation results regarding marine trench earthquakes, including the Nankai Trench Earthquakes (the Tonankai and Nankai Earthquakes), and the earthquake extending from the Sanriku Offshore region to the Boso Offshore region (including the Miyagi Prefecture Offshore Earthquake) (Figure 3-2-11). Furthermore, a series of strong quake motion evaluations are being conducted for some active fault zones and marine trench earthquake zones where the probability of earthquake occurrences is considered particularly high.

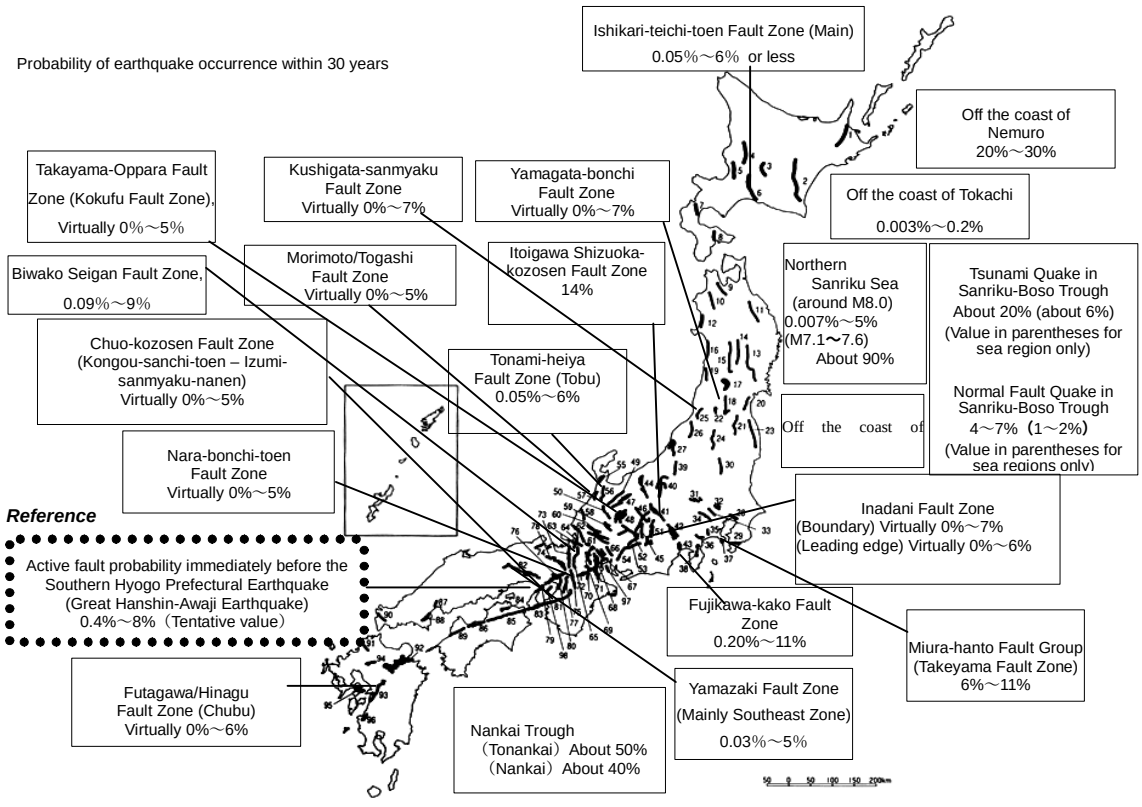


Figure 3-2-11 Fault zones and sea areas with announced evaluation resuts

Based on the above results, the Earthquake Research Committee is promoting the preparation of "General Seismic Hazard Maps," with the goal of covering the whole of Japan by the end of FY2004. As the first step in that process, in May 2002 the committee published a test map restricted to a region centering on Yamanashi Prefecture, followed in March 2003 with a test map limited to the Northern Japan region.

The major measures related to earthquake surveys and research in ministries and agencies are as shown in Table 3-2-12.

Table 3-2-12 Measures for earthquake surveys and research (FY2004)

Ministry or agency	Research institute or program	Subject
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
	Incorporated administrative agency: 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 maps
	Incorporated administrative agency: 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	Incorporated administrative agency: 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
	Japan Meteorological Agency	・Earthquake monitoring networks, and earthquake and tsunami monitoring systems
	Meteorological Research Institute	・Study to improve the accuracy of forecasting the Tokai earthquake by modeling its generation processes
	Geographical Survey Institute	・Japanese archipelago precise geodetic network surveying ・Strengthened observation of crustal deformation ・Very-long baseline surveying ・Gravity surveys and geomagnetic surveys

Based on the policies laid down by the Headquarters for Earthquake Research Promotion, the Ministry of Education, Culture, Sports, Science and Technology promotes surveys of active fault zones, and is also performing extended pilot survey evaluations and observations of regions where the

probability of earthquake occurrence is considered to be high. In addition, as part of the "Special Project for Earthquake Disaster Mitigation in Urban Areas," surveys and research into the crustal structure in major metropolitan areas are being conducted, as well as research into the improvement of prediction accuracy for the Tonankai and Nankai earthquake zones. The national universities are also promoting basic research into earthquake prediction. In addition, the National Research Institute for Earth Science and Disaster Prevention, 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 an earthquake observation network 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 Marine Science and Technology Center is promoting the development of a comprehensive real time deep sea-floor observation network system.

The National Institute of Advanced Industrial Science and Technology is promoting research into the evaluation of the potential of earthquake occurrences by surveying active fault zones, etc.

The Geographical Survey Institute promotes earthquake surveys and research through GPS continuous observation at about 1,224 stations around the nation (as of the end of March 2004), and also through the use of Very Long Baseline Interferometry (VLBI) and other advanced survey technologies to monitor crustal deformation and plate motion, and then analyzes the observation data. The Japan Meteorological Agency (JMA) produces a catalog of the locations and magnitudes of earthquakes based on the integrated analysis of waveform data of JMA and other relevant institutes, and promotes the development of new observation facilities and research for earthquake prediction. Furthermore, JMA plans to start official dissemination of Earthquake Early Warnings for disaster mitigation, which is aimed at providing information on the hypocenter and magnitude of an earthquake before the arrival of the shock of earthquakes, and is engaged in cooperative research with the National Research Institute for Earth Science and Disaster Prevention for upgrading this information.

The Japan Coast Guard's Hydrographic and Oceanographic Department promotes sea area measurement, as well as earthquake surveys and research in seabed terrain and active fault areas.

Japan's research into earthquake and volcanic eruption prediction is performed based on the "New Program of Research and Observation for Earthquake Prediction" adopted in August 1998 by the Geodesy Council (since FY2001 called the Subdivision on Geodesy and Geophysics under the Council for Science and Technology), and on the "The Sixth Program for the Prediction of Volcanic Eruptions" (both programs are five-year plans lasting from FY1999 to FY2003), 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 engaged in projects suited to their particular functions and capabilities. In July 2003, the Council for Science and Technology selected "The Second New Program of Research and Observation for Earthquake Prediction" and "The Seventh Program for Prediction of Volcanic Eruptions" as programs for promotion in the next five-year plan (FY2004 to FY2008), and presented the proposals to the Minister of Education, Culture, Sports, Science and Technology and other relevant ministers for approval.

3.2.2.7.3 Aviation Science and Technology

R&D in aviation science and technology is knowledge-intensive and makes use of advanced technologies. As a result, developments in this field are not limited to air transport, but can also spill

over into many other sectors, and the field can be expected to play an important role in Japan's future development as a nation of creative science and technology.

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 improve the technological level still more. To this end, at the Ministry of Education, Culture, Sports, Science and Technology, the Council for Science and Technology's Aeronautical Science and Technology Committee settled on the "Promotion Policy for Research and Development into Aerospace Science and Technology" in FY2003. In addition, at the Ministry of Economy, Trade and Industry, the Industrial Structure Council's Aircraft and Space Industry Committee's Aircraft Subcommittee is holding discussions on the possibility of joint international development of civil aviation aircraft and engines, and on other directions in aircraft industry policy.

The Japan Aerospace Exploration Agency is placing priority promotion, based on the above promotion policy, on R&D that can contribute to the development of a domestic aircraft and domestic jet engine, and on R&D into transportation safety and environmental protection.

Elsewhere, the agency is promoting research into aviation safety and environmentally compatible technologies, and into fundamental technologies for computer-based numerical simulations. 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 engaged in the research and development of "propulsion systems for environmentally suitable next-generation supersonic transporters" in response to the environmental needs of the next generation. Major aircraft engine manufacturers from Europe and the United States are also participating in this research and development. Elsewhere, the ministry is promoting the development of "technologies for manufacturing and processing of next-generation structural parts and materials" expected to be utilized in aircraft and other equipment, the development of design, manufacturing, and basic technologies related to "innovative lightweight structures," and the development of technologies related to engine structures and materials based on "MGC (Melt-Growth Composite) materials," as well as the development of technologies related to cockpit and piloting systems and other "advanced aircraft systems."

The Electronic Navigation Research Institute, an independent administrative institution for the Ministry of Land, Infrastructure and Transport, has been conducting research in the field of navigation and air traffic control systems to improve air traffic safety. This research is expected to be important for the further advancement of air transportation.

3.2.2.7.4 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.

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

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

The Ministry of Land, Infrastructure and Transport offers subsidies and other support for the Railway Technical Research Institute to promote research and development toward the practical realization of a superconducting magnetically levitated train, for the objective of high-speed transport in the future. In addition, 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 FY2003 for socio-economic infrastructure, safety assurance, etc., are as shown in Tables 3-2-13 and 3-2-14.

Table 3-2-13 Major research subjects in the improvement of the socioeconomic foundation area (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Incorporated administrative agency: National Institute of Information and Communications	· Research into basic information and communication technologies
Ministry of Education, Culture, Sports, Science and Technology	Incorporated administrative agency: Japan Aerospace Exploration Agency	· Technologies for higher performance domestic passenger aircraft · Research into aviation safety and environment protection technologies
Ministry of Agriculture, Forestry and Fisheries	Incorporated administrative agency: 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	Construction technology research and development	· Development of housing technology for a sustainable society and safe environment · Development of technology for urban infrastructure management
	Subsidy for the development of railway technologies	· Development of a superconducting magnetically levitated train
	Grants-in-aid for advanced research on ship technology funding	· Research and development into ultra-large floating ocean structures
	National Institute for Land and Infrastructure Management	· Research into the development of knowledge-sharing methods in construction projects · Research into measures for the effective utilization and activation of social infrastructure stock · Research for the International Harmonization of Building Codes and Standards · Research into the development of sand and dirt motion models for coherent sand flow systems · Research into airport pavement design and repair to accommodate ultra-large air-craft loads that take life-cycle costs into account
	Geographical Survey Institute	· Development of the technology to use precise three-dimensional spatial data for the regeneration of cities
	Incorporated administrative agency: 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 · Research on reducing the construction costs of super-long highway structures
	Incorporated administrative agency: Port and Airport Research Institute	· Research into improving the reliability of harbor structures through the development of high-quality monitoring systems using intelligent materials
	Incorporated administrative agency: National Maritime Research Institute	· 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 3-2-14 Major research subjects in the safety area (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Incorporated administrative agency: National Research Institute of Fire and Disaster	· Advancement of firefighting, emergency services and rescue techniques · Safety measures for those who need help during disasters, such as elderly people · Safety evaluation for hazardous materials and facilities handling hazardous materials
Ministry of Health, Labour and Welfare	Incorporated administrative agency: National Institute of Industrial Safety	· Research into the advancement of the safety technologies related to the development of comprehensive safety control measures for production and construction systems
Ministry of Agriculture, Forestry and Fisheries		· Research into the prevention of accidents involving capsizing fishing boats
Ministry of Economy, Trade and Industry		· Development of technologies for the safe management of liquefied petroleum gas supplies

3.2.2.8 Frontier Science

Frontier science is positioned in the Basic Plan as fundamental to the nation's existence, and an area in which it is essential for Japan to be involved. The Promotion Strategies by Sector stipulate the following areas and items as meriting priority:

1. Assurance of safety
   (1) Information-gathering technology using satellites (including transportation capability)
   (2) Advanced positioning and survey technology
2. Technology innovations aimed at pioneering world markets
   (1) Low-cost, reliable transportation technology
   (2) Next-generation satellite technology
   (3) Technology for the utilization of marine resources
3. International contributions to human intellectual creation, and assurance of international position
   (1) International projects that give people, and particularly the next generation, dreams, hope, and pride
   (2) Construction of a worldwide network for global environmental information

3.2.2.8.1 Space Development and Utilization

Space development and utilization is extremely important because it uses the acquisition of commonly applicable knowledge regarding the origin of the universe and various phenomena about the Earth to "accumulate intellectual properties common to all humankind," and also 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 successfully launched 103 satellites as of the end of-March 2004, ranking third in the number of satellites launched behind the United States and the former Soviet Union. Table 3-2-15 shows the major satellites planned for future launch by Japan and their objectives.

Table 3-2-15 Satellites and payloads planned to be launched

Satellite/payload	Weight (kg)	Orbit	Orbital altitude (km) / location	Launchvehicle	Launch date (fiscal year)	Major objectives
ALOS Advanced Land Observing Satellite	Approx. 4,000	Sun synchronous orbit	Approx. 690	H-IIA	2004	· To contribute to cartography, regional monitoring, disaster situation monitoring, resource exploration, etc.
LUNAR-A 17th scientific satellite	Approx. 540	Orbit around the moon	Approx. 200	M-V	2004	· Elucidation of crustal structure and thermal structure of the moon
ASTRO-E II 23rd scientific satellite	Approx. 1,700	Circular orbit	Approx. 550	M-V	2004	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	Geostationary orbit	-	H-IIA	2005	· To develop, test, and demonstrate large satellite bus and mobile satellite communications technologies, etc.
OICETS Optical Inter-orbit Communications Engineering Test Satellite	Approx. 570	Circular orbit	Approx. 600	—	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	2005 to 2007	· Expansion of Japan's space activities, promotion of leading science and technology development, and contribution to the advancement of international cooperation
WINDS Wideband InterNetworking Engineering Test and Demonstration Satellite	Approx. 2,700	Geostationary orbit	-	H-IIA	2006	· Development, etc., of ultra-fast high-capacity satellite communications technologies and other world-leading technologies
SELENE SELenological and Engineering Explorer	Approx. 2,900	Orbit around the moon	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	Sun synchronous orbit	Approx. 600	M-V	2006	· Detailed observation of the structure and motion of micromagnetic fields on the solar surface, to elucidate the components of solar magnetism and the source of solar activity
GOSAT Greenhouse Gas Observing Satellite	Approx. 1,500	-	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	2007	· 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	2007	· 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. 647	Orbit around Venus	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	Sun synchronous polar orbit	Approx. 750	M-V	No date	· To use infrared observations toward the elucidation of the formation and evolution of the Milky Way galaxy, stars, and planets

For an overall view of Japan's space development and utilization efforts, the Council for Science and Technology Policy in June 2002 issued its "Space Development and Utilization Policy," and various ministries and agencies are promoting space development and utilization efforts based on this report. Work on a follow-up to the report began in October 2003, in the Council for Science and Technology Policy's Expert Panel on Space Development and Utilization.

In October 2003, the Ministry of Education, Culture, Sports, Science and Technology merged the three space development organizations, the Institute of Space and Astronautical Science, the National Aerospace Laboratory of Japan, and the National Space Development Agency of Japan, into a central institution for national space development, and launched it as the Japan Aerospace Exploration Agency (JAXA). For such accidents as the failure of the H-IIA No. 6 launch vehicle, JAXA commenced a complete inspection of all rockets and

satellites, to promote space development through the improvement of reliability and the prevention of a reoccurrence of such failures.

With the "Space Development and Utilization Policy" in mind, the Space Activities Commission has been engaged in discussing a long-term program of space activities, and has performed safety checks for rocket launches, and investigations into failures.

3.2.2.8.1.1 Space Science and Luna 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.

For activities in recent years, the "Hayabusa" Scientific Satellite No.20 MUSES-C was launched in May 2003, and is currently on its way to a rendezvous with an asteroid in the summer of 2005, when it will perform an engineering test for a later planned mission to take rock samples from the asteroid and return them to Earth.

The "Nozomi" Scientific Satellite No.18 PLANET-B, launched in July 1998, had a serious problem in one section of its power system that controllers were unable to resolve, and a plan to put it into orbit around Mars in December 2003 had to be abandoned. The investigation into its causes and possible improvement measures is now in progress.

Launches scheduled for FY2004 include Scientific Satellite No.17 LUNAR-A, designed for the investigation of the lunar internal structure and thermal structure, and 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.

Other projects now in development include Scientific Satellite No.21 ASTRO-F for observation in the infrared spectrum to investigate the process of the formation and evolution of galaxies, stars, and planets, 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 the feasibility of the utilization of the Moon.

3.2.2.8.1.2 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 FY2006 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.

3.2.2.8.1.3 Promotion of Space Environment Utilization

The space environment offers unique characteristics for research, such as microgravity and high vacuum, that are difficult to obtain on Earth. Utilization of the space environment is expected to promote research, experiments, and observation across a broad range of fields, and to contribute to the development of society and the improvement of living conditions.

JAXA is proceeding with the development of the Japanese Experiment Module (JEM; also known as "Kibo") for the International Space Station, including a multi-user internal experiment facility (transported to the United States in FY2003) and test devices to be mounted on an exposed platform. The agency is implementing policies for the promotion of space environment utilization. A public announcement for ground-based research projects offering opportunities to researchers in a broad array of fields involved in preparation for the utilization of the space environment first began in FY1997, and that announcement is also being used as a basis for the promotion of international projects in test devices provided from various organizations for use in the International Space Station program.

Moreover, for early utilization of the space environment before launching "Kibo," JAXA is using the Russian Service Module and other platforms already operating at the International Space Station for medical experiments and public broadcasting tests using a high-definition camera, environmental durability tests for materials used in space, and the joint government-private sector "High-quality Crystalization Project on Protein Structure and Function Analyses for Practical Applications." Efforts to diversify utilization of "Kibo" are also in progress, to extend its use beyond scientific research to include activities in such sectors as education, culture and arts, and the humanities. The "Kibo Education Utilization Workshop" was held in August 2003 to focus on the use of "Kibo" for educational purposes. In July and November 2003, space education events involving interaction between children and the astronauts on the International Space Station were held.

In March 2003, the Space Activities Commission established the "Special Committee for Utilization of the International Space Station" for the purpose of studying prioritization of ISS use, and improving the efficiency of its operations and uses.

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 30, 2003. The private-sector components worked well in the tests, and various data is being obtained in accordance with the plan.

3.2.2.8.1.4 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)

Engineering Test Satellite VIII (ETS-VIII) is being developed toward aFY2005 launch for the purpose of developing large-scale geostationary 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, and for orbital demonstrations, in cooperation between JAXA and the Ministry of Internal Affairs and Communications (MIC).

(2) "Tsubasa" Mission Demonstration Test Satellite (MDS-1)

JAXA's "Tsubasa" Mission Demonstration Test Satellite (MDS-1), launched by the H-IIA No. 2 launch vehicle in February 2002, was intended to demonstrate the function of commercial parts in orbit, to verify the technology for shrinking the size of components, etc. (devices mounted on satellites), and to measure radiation and other space environment data. "Tsubasa" successfully completed operations in late-September 2003, obtaining in-orbit data as planned for private-sector components, as well as other data related to measurement of the space environment. The data will be used to boost the reliability of components and devices to be developed in the future.

3.2.2.8.1.5 Space Infrastructure

For autonomy of national space development, 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 expendable launch vehicles and reusable transport systems.

Japan is also developing an advanced inter-satellite communication technology, one of the most important requirements for supporting various activities in space, toward the acquisition of space network operations technology.

(1) M-V Series Rockets

For the launch of scientific payloads, the Institute of Space and Astronautical Science first developed the L (Lambda) series rockets and the M-3S2 and other M (Mu) series rockets, both of which used solid propellant for all stages, before moving on to development of the M-V rocket. The M-V rocket is capable of launching approximately 1.8 tons of payload into low orbit (Table 3-2-16), and launches No.1, No.3 and No. 5 were a success. Upon the foundation of JAXA, research and development of the M-V rocket was ended.

Table 3-2-16 Main specification of vehicles used to launch satellites

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

(2) H-IIA Rockets

For the launching of satellites into geostationary orbit, etc., JAXA developed the N series rocket and then the H series of launch vehicles, including the H-II launch vehicle, before moving on to the H-IIA launch vehicle. The H-IIA is a two-stage rocket that uses liquid oxygen/liquid hydrogen-fueled engines for both the first and second stages (Table 3-2-16), and is capable of lifting as much as four tons of payload into geostationary transfer orbit. The launch of the H-IIA No. 1 launch vehicle 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 when the solid rocket booster (SRB-A) failed to separate. An investigation into the causes of the accident is being implemented to prevent a reoccurrence, and to facilitate an early resumption of operations. Moreover the H-IIA standard type is to be transferred to the private sector in the years following FY2005, 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.

(3) GX Rocket

The GX rocket is Japan's first rocket being led by the private sector in cooperation with the government, is designed to launch small and medium-size satellites, and uses liquid natural gas (LNG) for its new propellant system. Joint public-private sector research and development is now in progress toward a first launch in FY2006.

(4) HOPE-X H-II

For the HOPE-X (H-II Orbiting Plane-Experimental), which is designed to establish the technological foundations for a reusable transport system, JAXA concluded that further studies are needed into the mode of a future reusable transport system. As a result, JAXA is conducting a review of the development results obtained to date, and is continuing to focus on R&D into elemental technologies and on the High Speed Flight Demonstration. The High Speed Flight Demonstration (Phase II) was conducted in July 2003 at the Esrange test site in northern Sweden, where flight data was successfully obtained in a flight test approaching the speed of sound. In this test, the prototype failed to land properly, and an investigation into the cause of the failure is now being performed.

(5) Optical Inter-orbit Communications Engineering Test Satellite (OICETS)

JAXA was forced to put off the launch date for the Optical Inter-orbit Communications Engineering Test Satellite (OICETS), which was to conduct orbital experiments on the elemental technologies needed for optical communications technologies in inter-satellite communication systems, because the

European Space Agency (ESA) made a failure on the launch of the Advanced Relay and Technology Mission (ARTEMIS) geostationary satellite, which was to be a part of the joint project. Investigation of counter-measures revealed a possible solution that will allow ARTEMIS to reach the requisite orbit and perform the experiments, with the result that preparations are now in progress toward a new launch date in FY2005.

(6) Data Relay Test Satellite (DRTS)

For the objective of performing data relay experiments between earth observing satellites and "Kibo" on the International Space Station in order to promote 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) on September 10, 2002 on top of the H-IIA No. 3 launch vehicle. In February 2003, DRTS successfully received wide-area Earth observation imaging data directly from the "Midori II" Advanced Earth Observing Satellite (ADEOS-II). Preparations were in progress for an inter-satellite communications test with the Advanced Land Observing Satellite (ALOS), scheduled to be launched in FY2004.

3.2.2.8.1.6 Fundamental and Avanced 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.

3.2.2.8.1.7 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 more globalized, the need for international cooperation in space activities is now greater than ever before. Consequently, Japan promotes cooperation with many countries, including the United States, European countries, Russia, Canada, and countries of the Asia-Pacific region in various fields.

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 (APRSAF) 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, by providing its own "Kibo." It is 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 under 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 space cooperation agreement between the Government of the Russian Federation and the Government of Japan has been extended.

3.2.2.8.2 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 cooperation 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 for Survey of the Continental Shelf" was established in June 2002 to promote surveys for the establishment of the outer limits of the Japanese continental shelf that can be of assistance to Japan's ocean development. 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 is conducting 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.

At the Ministry of Education, Culture, Sports, Science, and Technology, research Institutions including the Japan Marine Science and Technology Center (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 are ongoing observational research projects in the oceans using Triton buoys and other devices, and an intensive observation voyage in FY2003 around the southern hemisphere using state-of-the-art oceanographic devices on board MIRAI, one of JAMSTEC's oceanographic research vessels, with the aim of investigating the

interactions between the atmosphere and the ocean, such as El-Nino events, as well as the effects of them on global climate change. In addition, the "SHINKAI 6500" manned submersible and the "KAIREI" deep sea research vessel were used for ocean surveys for research into the dynamics of ocean plates, and into various forms of crustal movements occurring under the sea floor. 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 Frontier Research System for Extremophiles promoted research for the elucidation of the physiological adaptivity of deep-sea microorganisms existing in extreme environments.In addition, the University of Tokyo Ocean Research Institute 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.

At the Ministry of Economy, Trade and Industry, the Japan Oil, Gas, and Metal National Corporation (formed on February 29, 2004 from a merger and reorganization of the Metal Mining Agency of Japan and the Japan National Oil Corporation) and the National Institute of Advanced Industrial Science and Technology are at the center of continuing efforts at the development of ocean floor mineral resources and the prediction of environmental effects, and of geological surveys of the seabed.

The Ministry of Land, Infrastructure and Transport promoted research and development into next-generation 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 is continuing investigations and research toward the expansion of monitoring and forecast information for marine phenomena and climate change, including oceanographic and marine meteorological observations and elucidation of the El Niño phenomenon. 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 3-2-17 summarizes the main research subjects undertaken in the ocean sciences and technology sector by various ministries and agencies in FY2003.

Table 3-2-17 Major research subjects in marine science and technology (FY2003)

Ministry or agency	Research institute or program	Subject
Ministry of Internal Affairs and Communications	Incorporated administrative agency: National Institute of Information and Communications Technology	· Research into global environment measurement and forecasting technology, using 3-D high-resolution imaging radar
Ministry of Education, Culture, Sports, Science and Technology	Japan Marine Science and Technology Center	· Development of marine research technology · Research and development of deep-sea research · Promotion of ocean drilling in the 21st Century · Frontier research · Research and development of ocean utilization and marine ecosystems · Research and development of ocean observation
	National universities and other institutions	· Ocean Drilling Program (ODP) · Cooperative study of the Western Pacific (WESTPAC) · Global Ocean Observing System (GOOS)
Ministry of Agriculture, Forestry and Fisheries	Fisheries-related research institutes	· Development of techniques for stock enhancement · Development of techniques for advanced use of fishing grounds · Research into the improvement and development of fishing grounds · Observations of oceanographic environments related to fisheries · Technological development of fishing gear and methods · Measures for marine environmental conservation · Research of marine space use · Technological development of marine resources use
		· R&D into fisheries resources
	Marino Forum R&D into frontier technologies	· Development of artificial fishing ground technology, using deep ocean water · Development of technique for predicting phytoplankton blooms responsible for paralytic shellfish poisoning · Development of marine sensing technology for fisheries resource surveys
Ministry of Economy, Trade and Industry	Metal Mining Agency of Japan (On February 29, 2004, merged into Incorporated administrative agency: Japan Oil, Gas and Metals National Corporation)	· Research and development of deep-sea mineral resources
	Incorporated administrative agency: National Institute of Advanced Industrial Science and Technology	· Prediction of Earth and ocean environments based on geochemical and palaeontological research of modern and past environments
Ministry of Land, Infrastructure and Transport		· Surveys for the Promotion of the fisheries in the Amami Islands
	Hydrographic and Oceanographic Department, Japan Coast Guard	· IOC Sub-Commission for the Western Pacific (WESTPAC) Region
	Japan Meteorological Agency, Meteorological Research Institute	· Study of dynamical ocean weather prediction of the Western North Pacific · Development of an advanced ocean data assimilation system, and analysis from seasonal to interannual variations in the ocean
	Geographical Survey Institute	· Basic research of coastal sea areas
	Incorporated administrative agency: National Maritime Research Institute	· Research into technology for upgrading megafloats, and international · Research and development into next-generation domestic route shipping (Super Ecoship)
	Private Sector	· R&D into very large floating structures
	Incorporated administrative agency: Port and Airport Research Institute	· Research into the physical environment of sand beaches · Elucidation of the mechanisms for wave liquefaction and deformation of the ground, and research into countermeasure and utilization technologies · Research into coastal seawater flows, and seabed environments
Ministry of the Environment	Research Funding to the National Research Institute engaged in Environmental Pollution Research	· Research into application of mitigation technologies to the Seto Inland Sea for creating an appropriate environment
	Water Maintenance Bureau	· Research into red tide
	Incorporated administrative agency: National Institute for Environment Studies	· Research into a methodology for evaluating the impact of the environmental load from rivers on the marine ecosystems in the Bohai and East China Seas · Studies on movements of hazardous chemicals in East Asian sea regions · Research into the detection of ecological changes and land-based loading effects in Asian coastal seas
	Global Environment Research Fund	· Research into the elucidation of the ocean's absorption of carbon dioxide from human sources in the Pacific region ・Iron fertilization feasibility as an option for CO2 mitigation, and its effects on marine ecosystems · Research on the biogeochemical cycle in the East China Sea responding to the change in the environmental loading from land · Study on the marine environmental deterioration due to N and P loadings, and silica deficiency in the global aquatic system
	Global Environment Research Coodination System	· Research into material databases related to carbon dioxide in the ocean, for the elucidation of oceanic carbon dioxide absorption volumes · Study on the increase of sea-surface temperature in Asian monsoon regions based on coral skeletal climatology · Evaluation of the effects of the oceanic segregation of carbon dioxide on the oceanic material cycling process

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 an aspect 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. An interim report was prepared in September 2003, and the final report was completed at the end of April 2004. In addition, the "Japan-U.S. Workshop on Science and Technology for a Secure and Safe Society" was convened in February 2004 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 June 2003, the Committee on Cultural Resources was established under the Subdivision on Resources of the Council for Science and Technology to look at cultural resources from the perspective of science and technology, and to engage in surveys and discussions regarding the promotion of science and technology that support the preservation, application and creation of cultural resources. A report, "Promotion of Science and Technology Supporting the Preservation, Application and Creation of Cultural Resources," was issued by the division in February 2004.