JPRS-JST-89-027-II
13 DECEMBER 1989

FOREIGN
BROADCAST
INFORMATION
SERVICE

JPRS Report

Science & Technology

Japan

STA 1988 WHITE PAPER

PART II

JPRS-JST-89-027-II
13 DECEMBER 1989

SCIENCE & TECHNOLOGY
JAPAN

STA 1988 WHITE PAPER
PART II

43063815 Tokyo KAGAKU GIJUTSU HAKUSHO in Japanese 31 Jan 89 pp 1-499

[Selected portions of the 1988 STA Science and Technology White Paper]

CONTENTS

Chapter III. Government Policy

Part 1. Japan's Science and Technology Policy

The growth of science and technology is the foundation of the growth of the society and the economy, contributing to the invigoration of industrial activity and the elevation of living standards and welfare. Therefore, in recent years the importance of science and technology has risen on a worldwide basis. For Japan, in particular, which is poor in natural resources and will have to seek the foundation for its survival in its only resource--intelligent creativity, new developments in science and technology are urgently being awaited as opening the potential for the future, and consequently the stepped-up effort to promote science and technology is an extremely important policy matter.

From now on, it is important to generate innovative and creative technology that will contribute to the advancement and growth of mankind and, to that end, increased efforts will have to be made in basic research.

In recent years, Japan has begun to play an increasingly larger role in the international community and, in this respect, the importance attached to Japan's contributing to the world in the field of science and technology is also increasing. In view of this situation, and based on a report submitted by the Council for Science and Technology (CST), the supreme deliberative council on science and technology policy, at the 23 March 1986 Cabinet meeting the government adopted its "Outline of the Science and Technology Policy" (Outline), which presents the basics of the government's science and technology policy for the future. The Outline has as its main pillars the following three themes: 1) the promotion of creative science and technology focusing on enhanced basic research; 2) the development of science and technology with an emphasis on internationality; and 3) harmony between science and technology, and humans and society.

In line with this basic policy, the government has been promoting a comprehensive and flexible science and technology policy from a long-term perspective.

To be concrete, as for intensified basic research, creative and leading-edge academic studies in universities are being promoted by drawing on funds to subsidize science and technology research expenses; and by taking advantage of the "appropriations for coordinating the promotion of science and technology," basic research in the national research and testing institutes has been intensified, the "international frontier research system" at the Institute of Physical and Chemical Research is being promoted in an effort to ferret out new findings that may prove to be the keys to technical innovation in the 21st century, and the "creative science and technology promotion system" at the Research Development Corporation of Japan is also being promoted.

As for gearing the development of science and technology to increased internationality, the framework for science and technology cooperation agreements with foreign countries has been beefed up, thus aggressively promoting information exchanges, personnel exchanges and joint research projects.

Furthermore, in May 1986, the "Research Exchange Promotion Law" was legislated to remove the legislative bottlenecks to increased international cooperative research as well as to rebuild Japan's research structure in a way that would be open to the international community in terms of both research personnel and research information (employing foreign researchers in projects undertaken under the "Creative Science and Technology Promotion System," inviting foreign researchers to universities and national test and research institutes, and providing science and technology information to foreign countries).

1. Activity of Council for Science and Technology

The Council for Science and Technology was established in February 1959 within the Prime Minister's Office, based on the Law Pertaining to the establishment of the Council for Science and Technology, as an advisory organ to the prime minister in order to contribute to the comprehensive promotion of the government's science and technology policy. Since then, CST has deliberated on matters pertaining to the establishment of comprehensive and basic policy concerning science and technology as a whole, the establishment of comprehensive and long-term science and technology research goals, as well as methods of promoting the research projects that have been determined to be necessary and particularly important in achieving the above goals, and has presented the prime minister with reports containing the results of these deliberations, offering its opinions as needed. Major activities of CST in recent years are described below.

(1) CST report No 12, "The Outline of the Science and Technology Policy" submitted

As to the science and technology policy of Japan, in November 1984 CST formulated CST report No 11, "The Basic and Comprehensive Policy for the Promotion of Science and Technology From a Long-Term Perspective and for Coping With Changes in the Situation," outlining the basics of science and technology promotion measures to be adopted over the coming 10 years or so.

To realize the contents of report No 11, the government has been implementing various policy measures. The report by the Provisional Council for the Promotion of Administrative Reform dated 22 July 1985 and entitled "A Report on the Promotion of Administrative Reform" pointed out the need for adopting the Outline at a Cabinet meeting as the broad policy to be followed in promoting the growth of Japan's science and technology in the future. In response to the report, a Cabinet decision dated 23 September 1985, entitled "Concrete Policies for Promoting Administrative Reform for Now" was to adopt the Outline at a Cabinet meeting to be held within FY 1985.

Following the development mentioned above, CST was requested to formulate report No 12, "The Outline of the Science and Technology Policy." After taking into account the contents of report No 11, which defines the basics of the policy involving the promotion of science and technology for the coming 10 years or so and the subsequent changes in the situation surrounding science and technology, CST compiled the basics of the science and technology promotion policy, for which the government should make efforts to realize, and submitted the report to the prime minister on 3 December 1985.

In line with CST report No 12 and after making the required adjustments, the government adopted the Outline at a Cabinet meeting held on 28 March 1986.

The Outline contains the following:

a. Basic policy

"Science and technology rich in creativity" is the basis of science and technology promotion. At this time, full consideration should be paid to the "growth of science and technology in harmony with human beings and society" and the "development of science and technology with an emphasis on internationality."

b. Promotion of important policies

(a) Improving and reinforcing the system for policy promotion

A system for the promotion of R&D will be established in which the government, academics and industry will play their respective roles. Furthermore, from the perspective of invigorating the national experimental and research institutes, basic policy will be adopted, based on the results of CST deliberations, on the path that should be followed over the medium-to-long-term period.

(b) Improvement and enhancement of promotion conditions

Such policies as "increased investment for research and development," "recruitment and education of talented personnel," "strengthening of the foundation for the promotion of science and technology," and "expanded international exchange and cooperation" will be implemented comprehensively and flexibly.

c. Promotion of important R&D fields

In the important R&D fields, R&D will be promoted energetically and effectively, with priority placed on basic and trailblazing science and technology themes.

The prime minister shall draft, as needed, basic R&D programs for each of the fields in which R&D must be emphatically promoted.

(a) Promotion of basic and trailblazing science and technology themes that are expected to yield new developments

1) Science and technology related to matter and materials
2) Science and technology related to information and electronics
3) Life science
4) Software-related science and technology
5) Space science and technology
6) Ocean science and technology
7) Earth science and technology

(b) Promotion of science and technology themes needed for the invigoration of the economy

1) Development and management of natural resources
2) Development and utilization of energy sources
3) Upgrading of production technology and distribution systems
4) Recycling of resources and their utilization
5) Upgrading of services to society and living standards

(c) Promotion of science and technology for elevating the quality of society and living standards

1) Preservation or promotion of the health of the human body and mind
2) Formation of individualistic and cultural life
3) Formation of comfortable and safe society
4) Improvement of the human environment from a global perspective

(2) Submission of Report No 13 "On the Way the National Experimental and Research Institutes Should Be Conducted From a Medium-to-Long-Term Perspective"

After taking into account the contents of CST report No 11 and the report by the Provisional Council for the Promotion of Administrative Reform, the prime minister requested that the CST submit CST report No 13, "On the Way the National Experimental and Research Institutes Should Be Conducted From a Medium-to-Long-Term Perspective." The objective of the report was to explore, in view of the changing social and economic needs, how best the national experimental and research institutes could be tapped to expand, strengthen and invigorate R&D activity in basic and pioneering research themes thought to be difficult for the private sector to undertake on its own, from a medium-to-long-term perspective. Upon receiving the request, CST inaugurated the "Subcommittee on National Experimental and Research Institutes" within the general planning division, conducted deliberations, and submitted the report to the prime minister in August 1987.

After taking into account the changing situation surrounding the national experimental and research institutes and the problems they are facing, the report delineated the role of the national experimental and research institutes and the means for achieving it as follows:

1) As for the role of the national experimental and research institutes, the most important tasks are the promotion of basic and pioneering research aimed at new technological seeds and their globalization in order to contribute to the international community in the field of science and technology.

2) As for the policy that should be followed by the national experimental and research institutes, the following tasks were pointed out:

- The establishment of a research management system suited to basic and pioneering research, such as the creation of seeds, and promotion of cooperative research activity, breaking down the walls of individual research institutes or government ministries.

- Accurate and prompt, as needed, reviewing of the role and research structure of the national experimental and research institutes.

- Improvement of research management, such as giving increased decision-making power to the institute director, implementation of the evaluation of research results, promotion of research exchange, and personnel management according to individuals' life cycles.

- The emphatic and efficient promotion of measures to secure funds and personnel for research projects, the improvement or construction of research facilities and equipment, and the strengthening of research support capabilities, as well as the flexible operation of various conditions associated with research promotion.

(3) CST report No 14, "On the Basic R&D Program in the Field of Substances and Materials Science and Technology," submitted

In accordance with the recommendations in the "Outline of Science and Technology Policy," the prime minister asked CST to generate CST report No 14, "On the Basic R&D Program in the Field of Substances and Materials Science and Technology," in May 1986 to promote the R&D of substances and materials science and technology, emphasizing the R&D of basic and pioneering research themes, comprehensively and efficiently on a planned basis.

Upon receiving the request, CST established the "Substances and Materials Science and Technology Division," conducted deliberations and presented a report to the prime minister in August 1987.

In order to realize drastic advances in substances and materials science and technology, the basis for the progress of human society in the 21st century, the report points out the need for advancing the R&D particularly of basic and pioneering themes in the field, and lists the following as important R&D goals. They are: 1) quests for new phenomena and theoretical explanations of various phenomena; 2) the creation of innovative substances and materials; 3) the development of materials technology in accordance with the demand; and 4) the development of fundamental and common technologies. The report further shows the measures to be taken to achieve these goals.

(4) CST report No 15, "The Basic R&D Program in the Field of Information and Electronics Science and Technology"

The research and development of information and electronics science and technology has been playing a leading role in the information field, but also in other science and technology fields, giving rise to new technological innovations. The R&D achievements are expected to contribute to advances in the economy and society, as well as to improve the quality of life. CST report No 11 and the Outline have staked out the field as an area that should be targeted for emphatic R&D.

To that end, in order to formulate a basic program for the R&D of information and electronics science and technology, the prime minister asked CST to generate CST report No 15, "The Basic R&D Program in the Field of Information and Electronics Science and Technology," in August 1987.

CST has inaugurated the "Information and Electronics Science and Technology Division" in December 1987, and the division is deliberating on ways to answer the request.

(5) Report on inquiry No 16, "On the Basic Guideline for Improving the Foundation for the Promotion of Science and Technology"

CST report No 11 pointed out the need for strengthening and improving the foundation for the promotion of science and technology, and "On Concrete Measures for Administrative Reform for Now" (a Cabinet decision in September 1985) also says, "Improving the foundation for R&D that supports fundamental and creative research will be promoted by taking into account the opinion of CST, on a scheduled basis."

Furthermore, among the "promotion of key policy measures" contained in the Outline for which the government policy paper seeks the drafting of basic guidelines, the "improvement and strengthening of the conditions inducive to promotion" is cited, with one of the conditions being the "strengthening of the foundation for the promotion of science and technology."

In view of such a situation, in January 1988 the prime minister asked CST to formulate its report No 16 "On the Basic Guideline for Improving the Foundation for the Promotion of Science and Technology."

CST plans to study the basic guidelines for improving the foundation in its general planning division, with the cooperation of its life sciences division.

(6) Opinion on the Basic Policy for the Promotion of Science and Technology for Coping With Old Age Society; Opinion on the Basic Policy for the Promotion of Brain and Nerve System Science and Technology; Opinion on the Basic Policy for the Promotion of Immune System Science and Technology

With respect to the science and technology themes related to humans, such as the brain and nerve system science and technology, the immune system science and technology, and science and technology for coping with a society in which the elderly population is increasing, all of which are taken up in CST report No 11, CST conducted studies through its subcommittee established within the human system science and technology subdivision of the life sciences division to establish the basic policies for their comprehensive promotion. CST presented its "Opinion on the Basic Policy for the Promotion of Science and Technology for Coping with Old Age Society" to the prime minister in May 1986, and its "Opinion on the Basic Policy for the Promotion of Brain and Nerve System Science and Technology" and "Opinion on the Basic Policy for the Promotion of Immune System Science and Technology" in August 1987.

In light of the fact that in the development of science and technology in the future, the promotion of science and technology needed for the increased understanding of humans themselves is expected, in these Opinions the important R&D goals are sorted systematically and methods for their research are proposed.

As for important R&D goals in the coming 10 years or so, the science and technology for coping with an old age society has selected R&D targets from the following two areas: 1) research for maintaining the health of elderly people, and 2) comprehensive research to give support to the living and activities of the elderly.

As for the brain and nerve system science and technology, the following four tasks are taken up: 1) elucidation of brain and nerve functions; 2) elucidation of the causes for brain and neurological diseases, and development of their diagnosis and treatment methods; 3) using engineering to realize the mechanisms of the brain and nervous systems; and 4) development of the common foundation and support technology.

In the field of the immune system science and technology, the following four tasks are cited: 1) elucidation of the immune mechanism; 2) elucidation of the causes for immune system-related diseases, and development of methods for their prevention, diagnosis and treatment; 3) applications in fields other than medicine; and 4) development of the common foundation and support technology.

On the other hand, as for the measures for promoting R&D, all Opinions point out the need to strengthen the research structure, such as that of basic research, to strengthen the research support structure, such as ensuring the supply of experimental animals, for increased funding for research, for recruiting and training young researchers, and for promoting international cooperation.

(7) Main activities of the policy committee

The situations involving Japan are increasing in intensity both domestically and abroad. As a key to solving socioeconomic problems, the importance of science and technology has come to be increasingly recognized. As a reflection of such awareness among the people, the basic report submitted by the Provisional Commission for Administrative Survey in July 1987 called for the functional strengthening of the Council for Science and Technology (CST).

At the 33rd plenary session of the Diet (in March 1988), in order to facilitate the prompt and accurate processing of important policy matters at the CST forum and thus promote mobile and flexible implementation of science and technology policies the 12-member Policy Committee, including learned Diet members and learned personnel from various fields (the number was increased to 14 in May 1986), was inaugurated.

In order to realize the contents of the Outline of the Science and Technology Policy and CST report No 11, the Policy Committee carried out the following activities:

a. Basic survey for drafting science and technology policy

To gather data that would be of help in its deliberations and studies, the Policy Committee held hearings on the current state of the science and technology related policies involving pertinent government ministries and agencies, and exchanged opinions with industry and experts.

Furthermore, after taking into account the studies by the "Basic Survey Subcommittee," the Policy Committee held a science and technology forum in which front-line researchers from government, academia and industry participated to explore fields for interdisciplinary research that will be conducted using the Coordination Funds for Promoting Science and Technology, researched and surveyed the role of the national experiment and research institutes and directions of their capabilities that need to be strengthened, and surveyed and analyzed the concepts for international basic research programs, thus obtaining data that will serve as the basis for examining various policies and tasks.

b. Promotion and coordination of key research activities

In order to realize a balanced growth of science and technology as a whole, in April 1987 it was decided that the Coordination Funds for Promoting Science and Technology, a system instituted in FY 1986, would be used basically for strengthening the following activities in FY 1987:

1) To promote research in pioneering and basic science and technology fields, with emphasis placed on substances and materials science and technology, and life sciences.

2) To promote the R&D of themes of high national and social priority.

3) To aggressively promote international cooperative research.

4) To promote basic research at the national experimental and research institutes.

5) To examine the methods of promoting R&D, and to conduct the surveys and analyses required for selecting research tasks.

c. Processing of important policy measures

1) Determining important guidelines for science and technology promotion for FY 1988

After taking into account the basic policies presented in the Outline, in July 1987, the Policy Committee put together the "Important Guidelines for Science and Technology Promotion for FY 1988," which contains as the key elements for the promotion of science and technology for FY 1988 the following three points: 1) promotion of fundamental and basic science and technology, and bolstering the research staff with addition of creative people; 2) increased international exchange and cooperation; and 3) reinforcing the foundation for the promotion of science and technology and the promotion of research exchange, and requested the concerned circles to render their help in promoting the above measures.

2) Research evaluation

In order for R&D activities to be promoted effectively, it is important to evaluate individual research projects. Therefore, the Research Evaluation Subcommittee surveyed and examined research tasks undertaken using the Coordination Funds for Promoting Science and Technology for their results as well as for whether there existed the need to revise the research goals. Furthermore, in order to determine the appropriate manner of research evaluation according to the nature, progress and mode of the research involved, the Research Evaluation Guidance Drafting Committee was established within the above subcommittee. It came out with a report presenting basic ideas for research evaluation in May 1986, and with a report on the guidelines for research evaluation that September.

The Committee is studying the drafting of guidelines for evaluating large-scale R&D projects.

3) Harmony between science and technology and man and society

As for the harmony between science and technology on the one hand and humans and society on the other, a theme emphasized in CST report No 11, the "Conference on Life Sciences and Human Beings" was established in July 1985 under CST's Life Sciences Division for the purpose of conducting research on the effects the progress in life sciences has on humans and society and the resulting problems, and the Conference has been promoting deliberations by a staff of specialists from not only biology and medicine, but also liberal arts and social science. The Conference has published an interim report on the progress of the deliberations (December 1987).

4) Human frontier science program concept

With the cooperation of the concerned ministries and agencies, the Policy Committee has been studying the human frontier science program concept, a basic research theme focusing on elucidating the unique mechanisms of the human body to be undertaken as an international joint project. Japan proposed the concept, together with a presentation of the results of the research conducted so far, at the Venice Summit held in June 1987. The Japanese initiative was well received, and a phrase welcoming the presentation of a feasibility study on the concept's program was contained in the Economic Declaration. In response, the Feasibility Study Committee made up of noted Japanese and foreign scientists initiated the survey and examination of the program for its commercial contents and enforcement structure in November 1987, and the results were compiled in March 1988.

5) International problems conference

The importance of international relations surrounding science and technology has been increasing in recent years, partly as a result of the economic friction. Specifically, negotiations were held between Japan and the United States in connection with the science and technology cooperation agreement, and "the framework pertaining to the principles of international cooperation in science and technology" was discussed at OECD. In light of this situation, it is increasingly necessary for Japan to formulate a basic policy on how to cope with foreign countries in the field of science and technology.

In view of the situation, in November 1987 CST's Policy Committee initiated its International Problems Conference as a forum where members on the Policy Committee and learned personnel could discuss international problems, and studies of on-going international problems in the field of science and technology, mainly involving the advanced countries are being conducted.

6) Government, academia and industry cooperation conference

As one of the policies for promoting science and technology, increased cooperation among government, universities and industry has been encouraged from the system side, as illustrated by the enforcement of the Research Exchange Promotion Act (November 1986) and the "On the Basic Policy Pertaining to the Operation of Various Systems Designed for Increased Research Exchange Between the Government, Universities and Industry, and Foreign Countries" (adopted at a March 1987 Cabinet meeting). With the increasingly heightened consciousness of the importance of science and technology as its backdrop, a call is arising for the further increased cooperation among the government, academia and industry.

Therefore, the Government, Academia and Industry Cooperation Conference was initiated in February 1988, under the auspices of CST's Policy Committee, to discuss the significance of the government, universities and industry cooperating with each other and the future methods of such cooperation.

2. Science and Technology Administration System

(1) Planning and drafting of basic policies for science and technology and overall coordination

Science and technology policies in Japan are generally drafted and enforced by the relevant administrative organs having jurisdiction over the policy matters. However, when the need to adjust these discrete policies from an overall perspective arises, the prime minister is required to submit the problem to CST, an organ in the Prime Minister's Office, for deliberation.

The Science and Technology Agency has been conducting the overall coordination of science and technology matters in the relevant administrative organs, except those pertaining to cultural sciences and to university research.

Separate from these administrative organs, CST was established in 1959 as the supreme deliberative organ of Japan's science and technology policy and is comprised of the director-general of the Science and Technology Agency and other related ministries and learned personnel. CST deliberates matters related to the drafting of basic, yet comprehensive, policies pertaining to science and technology (excluding cultural sciences) as a whole, and establishes long-term and comprehensive research goals in science and technology, submitting the research results to the prime minister. Beginning with its first advisory report, CST report No 1--"Comprehensive and Basic Policies for the Promotion of Science and Technology for 10 Years From Now," submitted in 1960, CST has so far submitted the following advisory reports to the prime minister: "Basics of the Comprehensive Science and Technology Policies in the 1970s," a long-term and basic program covering all of science and technology (CST report No 5, 1971); "Basics of Comprehensive Science and Technology From a Long-Term Perspective" (CST report No 6, 1977); "Comprehensive and Basic Policies for the Promotion of Science and Technology From a Long-Term Perspective, To Cope With New Changes in the Situation" (CST report No 11, 1984); and "The Outline of Science and Technology Policy (CST report No 12, 1985).

In recent years, the importance of promoting comprehensive science and technology policies that are harmonious from the perspective of the nation as a whole is increasing. After taking into account the basic advisory report submitted by the Provisional Commission for Administrative Reform (July 1982), CST has strengthened its structure for coping with the major issues associated with science and technology promptly and accurately by inaugurating its Policy Committee.

The jobs of drafting development plans, for both the short- and long-term, for atomic power and space development belong to the Atomic Energy Commission and the Space Activities Commission, respectively, both of the Prime Minister's Office, while the Council for Ocean Development, another organ attached to the Prime Minister's Office, has the responsibility of preparing long-term plans for ocean development and submitting them to the prime minister. As seen above, plans are drafted for each of the important R&D fields. The role of the Science and Technology Agency is to provide the overall adjustment or coordination of these various R&D plans undertaken by various government organizations, except for the R&D activities undertaken at universities.

(2) R & D Promotion Systems

Figure 3-1-1 shows the organizational structure of the science and technology administration in Japan.

Part 2. Science and Technology Budget

The FY 1987 science and technology budget of Japan was ¥1,655 billion (estimated by the Science and Technology Agency. The following figures are also agency estimates, achieving a 3.5 percent increase over the previous year. The rate of increase, however, is lower than the 4.8 percent increase rate of FY 1986 over FY 1985. The General Account Budget for FY 1987 recorded a mere 0.02 percent increase over the preceding year, while the General Budget Expenditure, which is the General Account Budget minus the costs of government bonds and subsidies to local governments, registered a 0.00 percent reduction from the previous year. Consequently, it may be said that the increases in funding for science and technology are reflections of the government's efforts to bolster science and technology (Table 3-2-1).

Of the total science and technology budget, the expenditures for science and technology research appropriated in the budgetary accounts, the science and technology promotion fund and the energy development fund, totaled ¥569.9 billion in FY 1987, or an increase of 0.9 percent over the preceding year, with the sum accounting for 1.05 percent of that year's General Account Budget (Figure 3-2-2). Figure 3-2-3 shows changes in appropriations for individual accounts from year to year. Of all the accounts, the "subsidies, government investments and others" account that contains diverse expenditures, such as subsidies, consignment costs, investment money, the cost of burden-sharing, etc., accounts for 47.8 percent of the entire science and technology-related budget for FY 9187 as a result of the execution of large-scale projects, increased subsidies and consignments of research to semigovernmental corporations or private firms.

Table 3-2-4 shows appropriations for science and technology by government ministry or agency. Figure 3-2-5 gives itemized changes in appropriations, from the science and technology promotion fund and the energy development fund. Appropriations for the national testing and research institutes registered a 1.4 percent gain over the preceding year, reaching ¥165 billion, while the total of subsidies, government investments and others showed an increase of 0.7 percent, reaching ¥394.3 billion.

Funding for research and other appropriations contained in the science and technology promotion fund and the energy development fund achieved a gain of 4.9 percent over the previous year, reaching ¥1,085.1 billion, with the money mainly going to the costs of national universities.

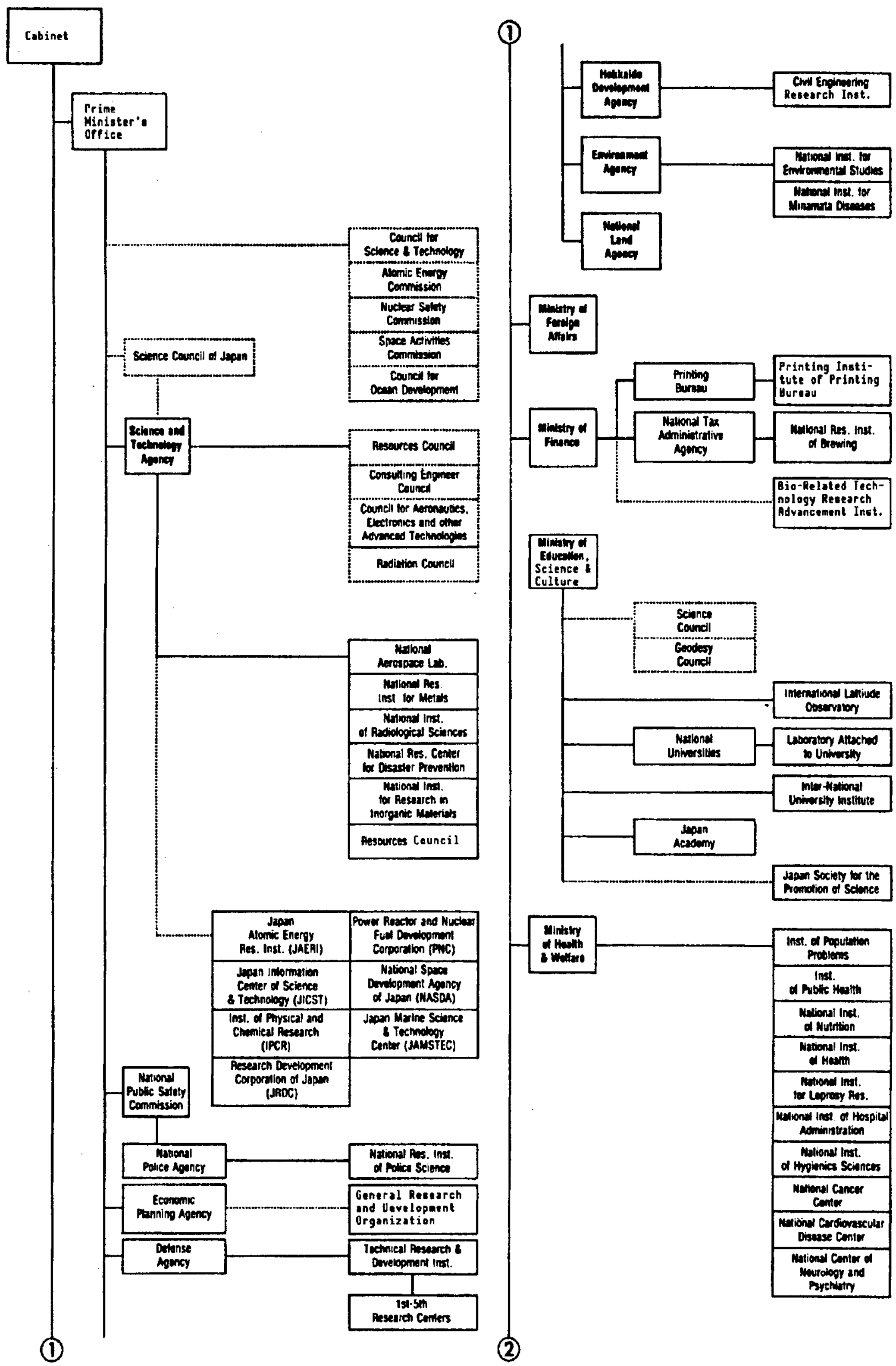


Figure 3-1-1. Organization Chart of Science and Technology Administration in Japan

[continued]

]Continuation of Figure 3-1-1]

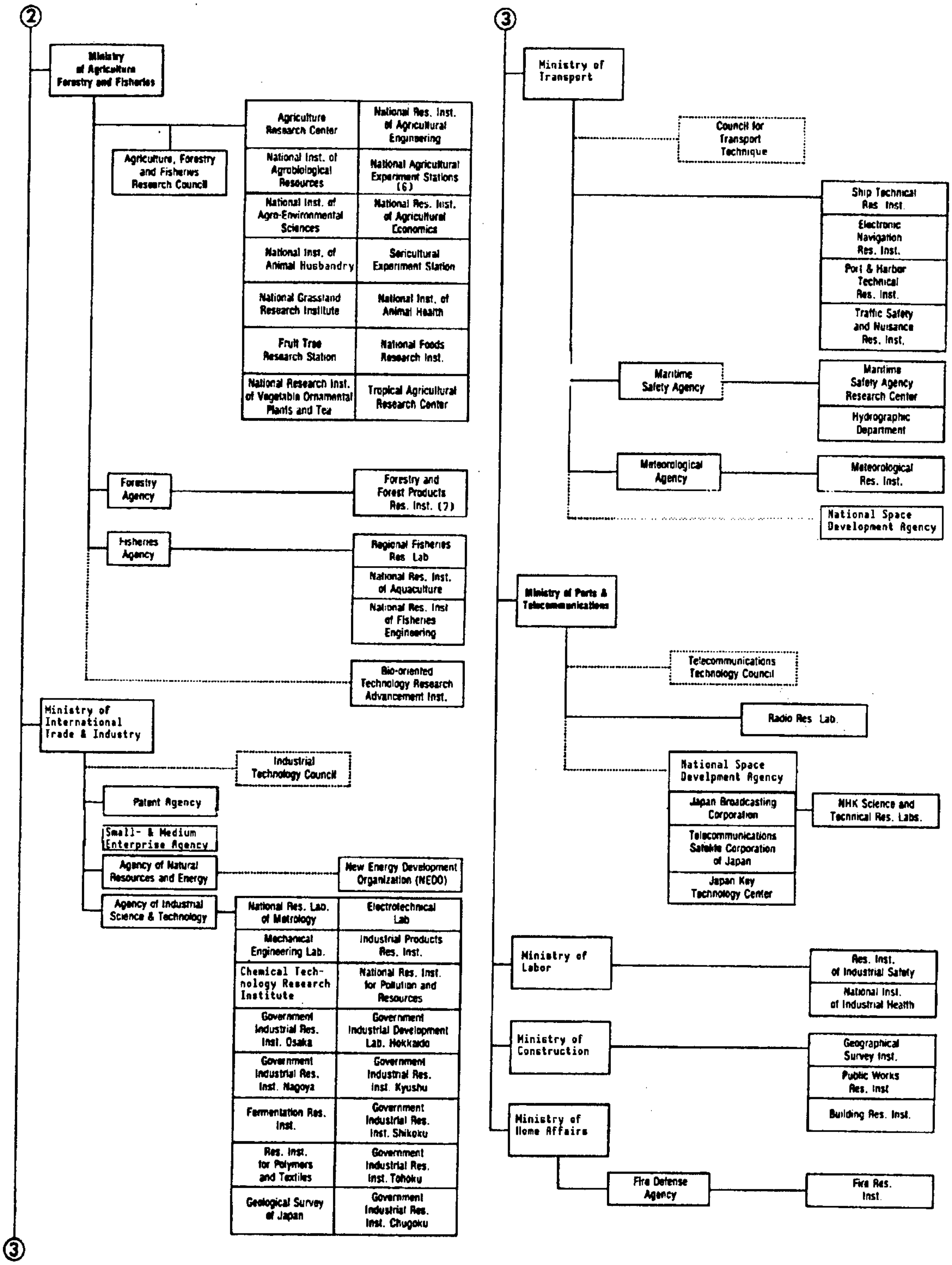


Table 3-2-1. Changes in Science and Technology (S&T) Budgets

(Unit: Y100 million)

Item \ FY		1983	1984	1985	1986	1987
S&T promotion fund	(A)	3,750	3,766	3,816	3,910	4,006
Increase over previous year	%	98.5	100.4	101.3	102.5	102.5
Research appropriations earmarked in S&T promotion fund and energy development fund	(B)	5,465	5,387	5,543	5,646	5,699
Increase over previous year	%	98.1	98.6	102.9	101.9	100.9
Research appropriations other than those earmarked in S&T promotion fund and energy development fund	(C)	9,097	9,389	9,710	10,343	10,851
Increase over previous year	%	102.1	103.2	103.4	106.5	104.9
S&T related budget (D) = (B) + (C)		14,562	14,776	15,253	15,990	16,550
Increase over previous year	%	100.6	101.5	103.2	104.8	103.5
General account	(E)	503,796	506,272	524,996	540,886	541,010
Increase over previous year	%	101.4	100.5	103.7	103.0	100.0
(B) / (E)	%	1.08	1.06	1.06	1.04	1.05
General budget spending	(F)	326,195	325,857	325,854	325,842	325,834
Increase over previous year	%	100.0	99.9	100.0	100.0	100.0

Notes: 1. The research appropriation included in "research appropriations in the energy development fund" and the "research appropriations other than those earmarked in the S&T promotion fund and the energy development fund" are estimates by the Science and Technology Agency.

2. The figures all represent the initial budgets for the fiscal year.

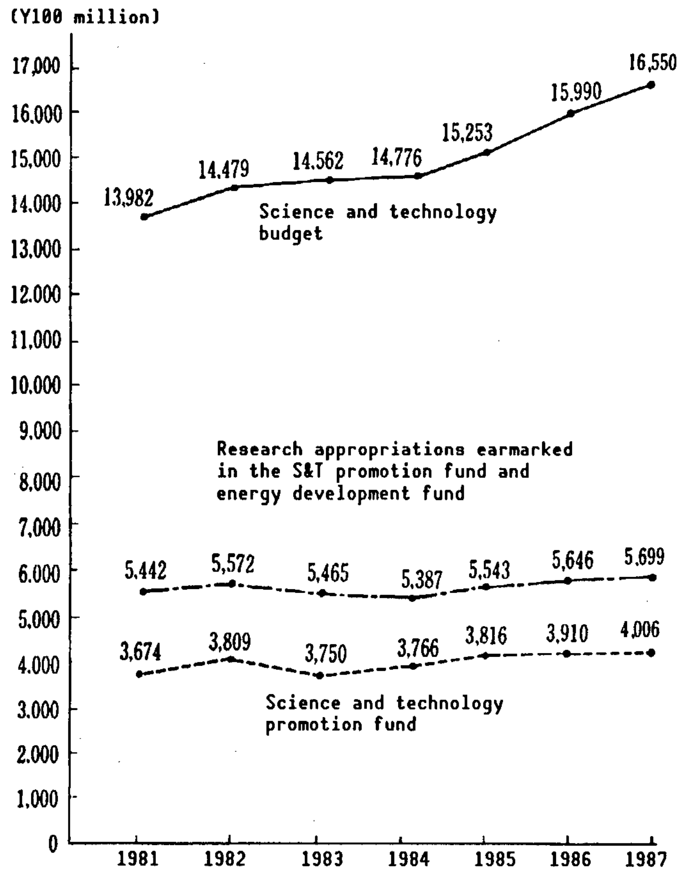


Figure 3-2-2. Changes in Science and Technology Budgets
Note: Figures represent the initial budget for the fiscal year.

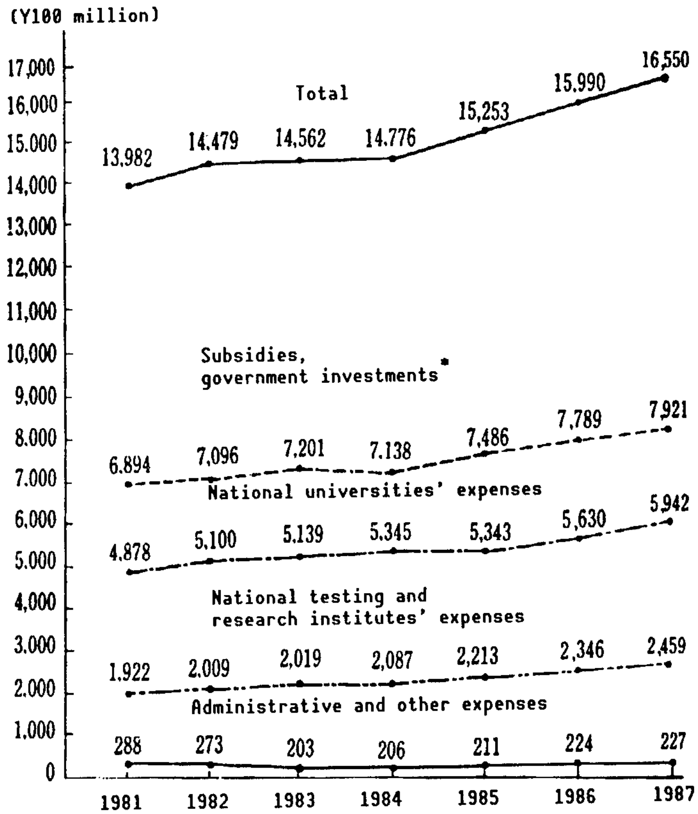


Figure 3-2-3. Changes in Science and Technology Budgets by Item
Note: * includes, in addition to subsidies, the costs of consignments, government investments, and burden-sharing costs.

Due to the differences in the financial systems of the various countries of the world, it is impossible to compare those countries directly with respect to the science and technology budget or its ratio of the country's entire budget, however, in Table 3-2-6, changes in the science and technology budgets for major countries of the world are given.

Table 3-2-4. Science and Technology Budgets for Ministries and Agencies

(Unit: Y1 million)

FY / Ministry or agency	1986 A	1986 B	1986 C	1986 B+C	1987 A	1987 B	1987 C	1987 B+C
Diet	517	517	—	517	524	524	—	524
Science Council of Japan	—	—	863	863	—	-	856	856
National Police Agency	899	899	—	899	925	925	—	925
Hokkaido Development Agency	142	142		142	143	143	—	143
Defense Agency	—	—	66,133	66,133	—	—	74,135	74,135
Economic Planning Agency	704	704	—	704	710	710		710
S&T Agency	154,277	321,985	98,357	420,342	160,765	324,731	100,501	425,232
Environment Agency	8,320	8,320	—	8,320	7,914	7,914	—	7,914
National Land Agency	210	210	—	210	160	160	—	160
Ministry of Justice	808	808	—	808	806	806		806
Ministry of Foreign Affairs	—	2,578	4,017	6,594	—	2,531	3,767	6,298
Ministry of Finance	329	329	610	938	335	335	674	1,009
Ministry of Education, Science and Culture	57,745	57,745	687,845	745,591	59,759	59,759	720,415	780,174
Ministry of Health and Welfare	28,015	28,015	8,106	36,121	29,886	29,886	9,875	39,761
Ministry of Agriculture, Forestry & Fisheries	60,733	60,733	5,744	66,477	61,098	61,098	5,651	66,748
MITI	56,427	59,832	157,725	217,557	54,527	57,297	164,112	221,409
Ministry of Transport	11,511	11,511	1,759	13,271	12,758	12,758	1,757	14,516
Ministry of Posts and Telecommunications	4,126	4,126	20,541	24,667	4,037	4,037	25,005	29,042
Ministry of Labor	599	599	2,371	2,970	601	601	3,034	3,635
Ministry of Construction	5,065	5,065	751	5,817	5,149	5,149	356	5,506
Ministry of Home Affairs	527	527	—	527	536	536	—	536
Total	390,954	564,644	1,034,324	1,598,969	400,634	569,901	1,085,139	1,655,040

Notes: 1. A represents the science and technology promotion fund.
2. B represents research appropriations earmarked in the science and technology promotion fund and the energy development fund.
3. C represents research appropriations other than "research appropriations earmarked in the science and technology promotion fund and the energy development fund."
4. Research appropriations in the energy development fund and C are estimates by the Science and Technology Agency.
5. The figures are the initial budgets for each of the fiscal years.
6. Additions of the figures in each column do not necessarily agree with the totals since the figures have been rounded to the nearest whole number.
7. The ¥4,300 million appropriated as the Japan Information Center of Science and Technology Expenses is contained in the Science and Technology Agency budget, the ¥1,000 million for the "capital investment and loan business" expenses for conducting testing and research of medical products and their technology, which is earmarked in the Adverse Drug Sufferings Relief and Research Promotion Fund is contained in the Ministry of Health and Welfare budget, and the Bio-Oriented Technology Research Advancement Institute expenses of ¥3,800 million are appropriated in the Ministry of Agriculture, Forestry and Fisheries budget.

[Notes continued]

[Continuation of Table 3-2-4 Notes]

Furthermore, ¥2.5 billion for expenses for the Japan Key Technology Center is earmarked in the budgets of both the Ministry of International Trade and the Ministry of Posts and Telecommunications. (However, this sum is counted only once to avoid redundancy in the total.)

8. The figures include appropriations for liberal arts research.

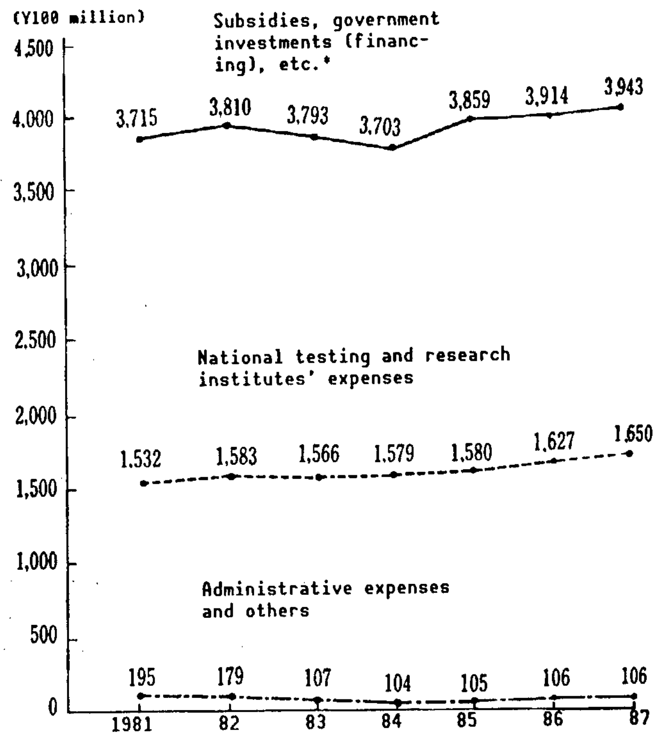


Figure 3-2-5. Changes in Research Budgets Earmarked in the Science and Technology Promotion Fund and the Energy Development Fund by Item

Note: In addition to subsidies, includes the cost of consignments, government investments (financing), and burden-sharing.

Table 3-2-6. Science and Technology Budgets of Major Countries

Country / FY	1983	1984	1985	1986	1987
(1) Japan (¥100 million)	14,562	14,776	15,253	15,990	16,550
Ratio of S&T budget to the total budget %	1.52	1.49	1.57	1.57	1.56
Note: The total budget includes both the General Account and Special Account Source: "Budget Book"					
(2) United States ($ million)	37,667	42,151	47,028	53,143	54,290
(¥ equivalents)	89,459	100,109	112,162	89,546	78,503
Ratio of S&T budget to the total budget %	4.7	4.9	5.1	5.4	5.4
Source: "Federal Government Budget Special Analysis"					
(3) West Germany (DM million)	11,381	11,680	12,701	12,826	13,814
(¥ equivalents)	10,587	9,748	10,292	9,954	11,116
Ratio of S&T budget to the total budget %	4.6	4.6	4.9	4.9	5.1
Note: West Germany contains only the federal budget, while the majority of expenses for research in universities, which are shouldered by the state governments, are not included. "Bundesbericht Forschung 1988." Source: "Bundesbericht Forschung 1988" "Finanzbericht"					
(4) France (million francs)	56,602	65,511	69,965	74,872	77,508
(¥ equivalents)	17,637	17,806	18,576	18,216	18,648
Ratio of S&T budget to the total budget %	6.4	6.8	7.1	7.3	7.0
Source: Attached papers to draft budget					
Great Britain (£ million)	3,923	4,262	4,520	4,562	4,749
(¥ equivalents)	14,135	13,529	13,976	11,277	11,256
Ratio of S&T budget to the total budget %	3.3	3.3	3.4	3.2	3.2
Source: "Annual Review of Government Funded R&D 1987" "The Government Expenditure Plans 1987-88 to 1989-90"					
(6) Soviet Union (100 million rubles)	125.4	130.2	134.5	142.4	--
(¥ equivalents)	36,689	36,364	41,656	35,080	--
Ratio of S&T budget to the total budget %	3.5	3.5	3.5	3.3	--

Source: Soviet National Economic Statistics Yearbook

Note: The accounting terms for both total budgets and science and technology budgets differ from country to country.

Part 3. Promotion of Research Activities in Government Institutions

The demands for science and technology R&D, beginning with enhanced basic research, from the economy and society are tending to increase, and hence the role of government institutions (national testing and research institutes, semigovernmental incorporated research institutes, universities) in research activities is increasing still further.

This chapter describes research activities being undertaken in the government institutions, with paragraphs devoted to each of the institutional categories --national testing and research institutes, semigovernmental incorporated research institutes, and universities. It also describes the progress of R&D in multidisciplinary fields such as nuclear power development, energy R&D other than nuclear power, space development, aeronautics technology R&D, ocean development, life sciences, materials science technology, disaster prevention science, earth science technology, soft sciences and comprehensive R&D.

1. Promotion of Research Activity in National Research Institutes

The National Experiment and Research Institutes are placed under the jurisdiction of various ministries and agencies, and they have been promoting research activities in their respective fields of research. The total FY 1987 costs for operating these institutes, including such expenditures as those for conducting tests and research, personnel costs, and overhead, was ¥245.9 billion, achieving an increase of 4.8 percent over the previous year. Table 3-3-1 break down the budget by ministry or agency. Figure 3-3-2 gives a breakdown of where the money earmarked in the science and technology promotion fund went. The total strength of personnel authorized at these institutes is 15,147 persons (of these, 9,820 are research personnel), a reduction of 90 persons from the previous year (a reduction of 20 in research positions).

(1) How national research institutes should be operated from a long-term perspective

By conducting research projects with varying contents covering a broad range of fields, the national experiment and research institutes have been meeting various administrative needs, thereby not only contributing to Japan's enhanced industrial foundation and the improved quality of living, but also playing a large role in the growth and progress of Japan's science and technology.

However, in recent years, the socioeconomic situation and the international environment and conditions surrounding Japan have changed greatly, as has the situation surrounding science and technology as evidenced by new science and technology developments. Consequently, the situations requiring scientific and technological approaches have been increasing in both number and diversity. In response to such changes, the national testing and research institutes are being asked to invigorate their activity and execute their role accurately. Their active participation is particularly demanded in the

Table 3-3-1. Appropriations for National Testing (Experiment) and Research Institutes

(Unit: Y100 million)

FY / Ministry or agency	1986 A	1986 B	1986 Total	1987 A	1987 B	1987 Total	Remarks
National Police Agency	899		899	925		925	National Research Institute of Police Science
Hokkaido Development Agency	142		142	143	—	143	Civil Engineering Experiment Station
Defense Agency	—	65,259	65,259	—	73,286	73,286	Technical R&D Institute
Economic Planning Agency	704	--	704	710	—	710	Economic Research Institute
Science and Technology Agency	26,899		26,899	28,403		28,403	Total of appropriations for nuclear research and experiments in national institutes
Environment Agency	7,318	—	7,318	6,963	—	6,963	Total of appropriations for pollution prevention research and experiments in National Institute for Environmental Studies, etc.
Ministry of Justice	808	—	808	806	—	806	Research and Training Institute of the Ministry of Justice
Ministry of Finance	329	610	938	335	674	1,009	National Research Institute of Brewing
Ministry of Education, Science and Culture	6,680	—	6,680	6,973	—	6,973	International Latitude Observatory, etc.
Ministry of Health and Welfare	9,858	3,646	13,504	9,867	4,470	14,337	National Institute of Health, etc.
Ministry of Agriculture, Forestry & Fisheries	56,013	—	56,013	56,339	—	56,339	Agricultural Research Center etc.
MITI	36,066	—	36,066	36,502	—	36,502	National Research Laboratory of Metrology, etc.)
Ministry of Transport	7,313	1,091	8,404	7,386	907	8,293	Ship Research Institute,etc.
Ministry of Posts and Telecommunications	4,126	—	4,126	4,037	—	4,037	Radio Research Laboratory
Ministry of Labor	599	582	1,181	601	1,241	1,842	Industrial Safety Institute, etc.
Ministry of Construction	4,435	686	5,122	4,497	291	4,787	Public Works Research Institute, etc.
Ministry of Home Affairs	527	—	527	536	—	536	Fire Defense Research Institute
Total (17 agencies)	162,717	71,874	234,590	165,024	80,868	245,892	

Notes: 1. Column A shows appropriations for research earmarked in the science and technology promotion fund and the energy development fund, and B contains research appropriations excluding those mentioned in A. Both show the amounts of initial budgets. Appropriations in the energy development fund and B are estimates by the Science and Technology Agency.

2. The numbers gained by adding figures in each of the columns do not agree with the totals because figures have been rounded to the nearest whole number.
3. To include liberal arts science institutions.
4. Radio Research Laboratory was reorganized into Communications Research Laboratory in April 1988.
5. Public Works Research Institute was reorganized into Development and Public Works Research Institute in April 1988.

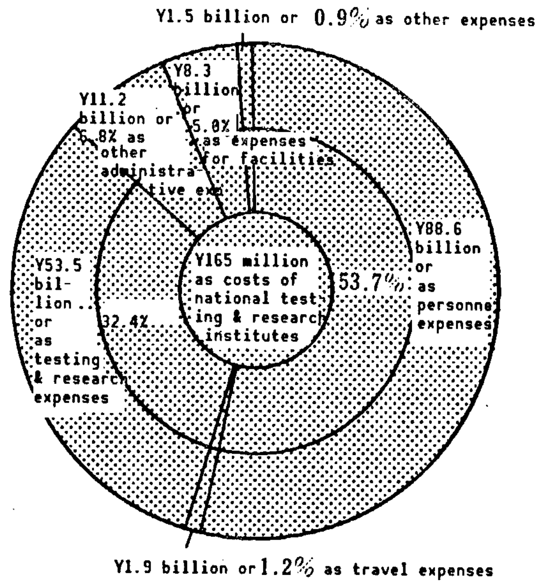


Figure 3-3-2. National Research Institutes' R&D Expenditure by Category (out of the fund for promotion of science and technology) (FY 1987)

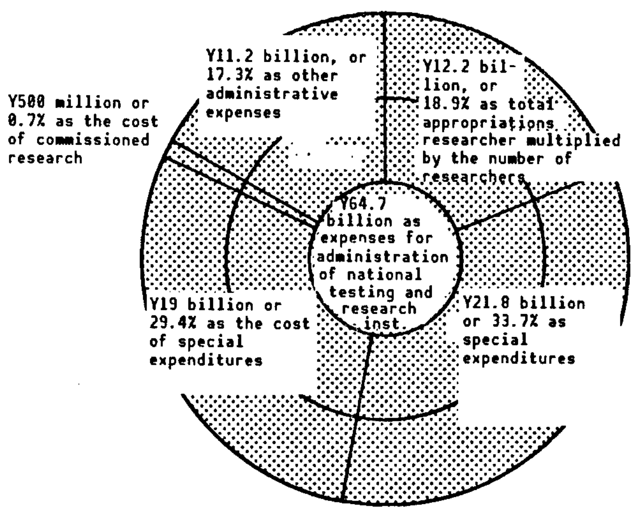


Figure 3-3-3. Funding for Administration of National Testing and Research Institutes by Budgetary Item (out of the fund for promotion of science and technology) (FY 1987)

effort to enhance creative R&D, a field that is especially important in promoting Japan's science and technology.

The Provisional Council for the Promotion of Administrative Reform report dated 22 July 1985, entitled "Report on How To Promote Administrative Reform," pointed out the need to invigorate the national testing and research institutes, asked the CST to survey and deliberate the course these institutions should take from a medium- to long-term perspective, and submit a report.

In response, in the Cabinet decision dated 24 September 1985 entitled "Concrete Policies for Promoting Administrative Reform for Now," the government decided to request that CST conduct a study on the issue, and the prime minister sent Request No 13, dated 3 December 1985, "On the Way the National Experiment and Research Institutes Should Be From a Medium- to Long-Term Perspective," to CST.

The CST continued deliberations through the forum of its Comprehensive Planning Division, and on 28 August 1987 sent a report to the prime minister.

Upon receiving the report, on 22 October 1987 the prime minister decided the basic course that the national testing and research institutes should take from a medium- to long-term perspective.

(2) Routine research

Routine research refers to ordinary research activities, principally in the relatively basic fields, that are conducted routinely and that provide the foundation for all kinds of research. Routine research is funded mainly by the "Agency budget calculated based on a fixed sum multiplied by the number of researchers" and the special budget, with the total of the two budgets in FY 1987 being ¥34 billion, accounting for 52.6 percent of the year's total appropriations for national testing (experiment) and research institutes of ¥64.7 billion (Figure 3-3-3).

The unit prices per worker are given in Table 3-3-4.

Table 3-3-4. Annual Changes in Unit Amount of Appropriations Per Research Worker

(Unit: ¥10,000)

Item	FY	1983	1984	1985	1986	1987
Experiment	I	144	144	144	144	144
	II	126	126	126	126	126
Nonexperiment	I	91	91	91	91	91
	II	82	82	82	82	82

Note: Experiment I includes research institutes that are mainly engaged in experiments in the field of science and engineering, while Experiment II consists of research institutes that mainly conduct biological and medical experiments.
Nonexperiment I includes the Economic Research Institute of the Economic Planning Agency, the Research and Training Institute of the Ministry of Justice, the Institution of Population Problems of the Ministry of Health and Welfare, and the National Research Institute of Agricultural Economics of the Ministry of Agriculture, Forestry and Fisheries. Nonexperiment II consists of the National Language Research

[continued]

[Continuation of Table 3-3-4 notes]

Institute and the National Institute for Educational Research, both of the Ministry of Education, Science and Culture, and the National Institute of Hospital Administration of the Ministry of Health and Welfare.

(3) Special research

Research activities contained in the special research category differ from those in the routine research category in that they need to be conducted in a priority basis to meet social and administrative requirements as planned within a certain fixed period of time.

The total of the ministry or agency appropriations for special research in FY 1987 (including the expenditures for facility improvements, in addition to the administrative costs) was ¥14.9 billion, a reduction of 6.6 percent from the previous year's level.

Special research tasks in FY 1987 numbered 490 themes, with their breakdown by ministry or agency given in Table 3-3-5.

Table 3-3-5. Number of Special Research Tasks and Budgetary Amounts by Agency

(Unit: ¥1 million)

FY	1984		1985		1986		1987	
Agency or ministry	Research tasks	Budget amount	Research task	Budget amount	Research task	Budget amount	Research task	Budget amount
National Police Agency	2	26	1	26	2	26	3	26
Science and Technology Agency	21	7,228	21	6,712	23	5,876	23	5,359
Environment Agency	12	628	12	583	12	537	12	469
Ministry of Justice	1	1	1	1	1	1	1	1
Ministry of Finance	1	35	1	35	2	35	1	35
Ministry of Education, Science and Culture	23	107	20	85	20	144	20	149
Ministry of Health & Welfare	9	50	9	51	9	49	8	48
Ministry of Agriculture, Forestry & Fisheries	28	601	28	600	29	600	28	600
Ministry of International Trade and Industry	130	2,568	129	2,568	132	2,568	136	2,568
Ministry of Transportation	17	372	16	915	15	699	15	461
Ministry of Posts and Telecommunications	10	1,089	10	889	12	769	10	677
Ministry of Labor	5	76	5	74	5	75	5	78
Ministry of Construction	4	15	6	32	4	27	4	26
Ministry of Home Affairs	3	45	4	45	9	123	8	123
Budget for R&D of environmental pollution control by national institutions (total appropriation of Environment Agency)	117	2,912	114	2,765	111	2,625	109	2,474
Budget for R&D of nuclear energy development of national institutions (total appropriation of Science and Technology Agency)	103	1,732	109	1,733	110	1,774	109	1,789
Total	486	17,485	486	17,114	496	15,928	490	14,883

[continued]

[Continuation of Table 3-3-5 notes]

Notes: 1. The figures contain appropriations earmarked in Special Accounts. They also contain appropriations for liberal arts science institutions.
2. The budgets include the maintenance fees of facilities and equipment in addition to R&D costs.
3. The figures for each fiscal year represent the original budgets.

(4) Improvement of research structure

If research institutes are going to increase their research efficiency in order to meet the requirements of the age, the key requirement is that they improve and strengthen their research structure.

In recent years, R&D themes in particular have been showing a tendency to increase in complexity and scale, and their execution must be conducted through the smooth cooperation of several research laboratories. Again, if only for the purpose of promoting the liaison and cooperation of various related institutions, research institutes are being asked to strengthen their planning and coordination capabilities.

In Table 3-3-6, cases of restructuring or improving the research structure that were undertaken in FY 1987 were given.

Table 3-3-6. Major Improvements, Such as of Research Structure, in Ministries and Agencies (FY 1987)

Science and Technology Agency	National Aerospace Laboratory	The name of the Calculation Center has been changed to the Mathematical Analysis Department.
	National Research Institute for Metals	The Structure Control Research Department has been relocated to the Tsukuba Branch Office.
	National Institute of Radiological Sciences	The Chemical Research Department was abolished, and the Department of Heavy Corpuscular Beams for medicine has been inaugurated. The Department of Pharmaceutical Research was abolished, and the Department of Chemistry and Pharmaceutical Research has been initiated.
Environment Agency	National Institute for Environmental Studies	The first through fifth groups in the General Analysis Department were abolished, and the Environmental Control Research Laboratory, the Area Planning Research Laboratory, the Resources Recycling Research Laboratory, the [continued]

[Continuation of Table 3-3-6]

		Environment and Economy Research Laboratory, and the General Evaluation Research Laboratory have been inaugurated. The Business Office of the Environmental Information Department has been elevated to the Information Control Section. The Chronic Effects Research Laboratory and the Acute Effects Research Laboratory of the Environmental Physiology Department have been reorganized into the Chronic Toxicity Research Laboratory and the Environmental Biochemistry Research Laboratory. The Human Behavior Research Laboratory of the Environmental Hygiene Department has been reorganized into the Laboratory for Research Into the Behavior of Mankind.
Ministry of Agriculture, Forestry and Fisheries	National Institute of Agricultural Science	The Beans Physiology and Behavior Laboratory has been reorganized into the Beans Breeding Laboratory.
	National Agricultural Experiment Station, Hokuriku	The Soil and Fertilizer Laboratory No 2 has been reorganized into the Quality Chemicals Laboratory
	National Agricultural Experiment Station, Shikoku	The Crops Laboratory No 2 has been reorganized into the Breeding Engineering Laboratory The Soil and Fertilizer Laboratory No 2 has been reorganized into the Commercial Utilization Laboratory
	National Agricultural Experiment Station, Kyushu	The Mulberry Plantation Laboratory has been reorganized into the Breeding Engineering Laboratory
	Tropical Agriculture Research Center	The Foundation Technology Laboratory has been established.
	Seikaiku Regional Fisheries Research Laboratory	The Shallow Sea Breeding Laboratory has been newly organized in the Shallow Sea Development Dept.
	National Research Institute of Aquaculture	The Immunity Laboratory of the Pathology Department has been organized
MITI	Mechanical Engineering Laboratory	The Traffic System Section of the Systems Department has been reorganized into the Knowledge mechanical Engineering Section

[continued]

[Continuation of Table 3-3-6]

	Government Industrial Research Institute, Nagoya	The Molten Body Engineering Section has been established within the Metals Department
	Electrotechnical Laboratory	The Excitation Process Technology Laboratory has been established within the Critical Technology Department
	Government Industrial Research Institute, Hokkaido	The Bio-Engineering Section has been established within the Applied Chemistry Department
	Government Industrial Research Institute, Chugoku	The Bio-Research Laboratory has been established within the Ocean Development Department
Ministry of Transportation	Meteorological Research Institute	The Aerological Physics Research Department has been reorganized into the Weather Research Dept. The Weather Satellite Research Department has been reorganized into the Weather Satellite/ Monitoring System Research Dept.
Ministry of Posts and Telecommunications	Radio Research Laboratories	The Consolidated Communications Network Laboratory was newly established within the Communications Department, and was then reorganized into the Communications Research Laboratory in April 1988.

2. Promotion of Research Activities in Semigovernmental Research Institutes

Research activities in semigovernmental research institutes have been conducted mainly with money from government investments and subsidies, as well as capital investments by the private sector, and these special corporations, along with the national research institutes, have been playing a large role in the government's research activities. Since they are able to gather a large pool of qualified personnel from both the government and the private sector, their management systems are flexible, and they are able to introduce private funds, these semigovernmental institutes are well suited to promoting goal-oriented R&D and, in these days, with R&D projects tending to become ever larger and more complex, requiring them to be tackled from a multisided approach, these semigovernmental institutes are expected to play a significant role.

Table 3-3-7 shows the trends in capital investments and subsidies provided by the government for these semigovernmental research institutes that were established to engage in R&D.

Table 3-3-7. Changes in Government Investments and Subsidy to Semigovernmental Research Organizations

(Unit: ¥1 million)

Item	FY	1983	1984	1985	1986	1987
Institute of Physical and Chemical Research	Investment	4,220	4,250	5,636	7,893	8,625
	Subsidy	5,231	5,333	5,460	5,900	6,067
Japan Atomic Energy Research Institute	Investment	65,374	64,287	79,069	79,273	76,470
	Subsidy	17,612	18,302	20,605	22,283	22,992
Japan Nuclear-Ship Development Agency	Investment	9,343	6,275			
	Subsidy	1,475	1,455	—	—	—
Power Reactor and Nuclear Fuel Development Corp.	Investment	105,461	107,957	117,178	120,163	117,938
	Subsidy	19,446	19,708	20,604	22,081	23,615
National Space Development Agency	Investment	78,687	76,784	80,941	82,215	83,846
	Subsidy	7,380	7,574	7,920	8,444	8,802
Japan Marine Science and Technology Center	Investment	3,972	3,919	5,541	5,174	6,218
	Subsidy	1,052	1,044	1,159	1,263	1,298
Bio-Oriented Technology Research Advancement Institute (formerly Agriculture Mechanization Research Institute)	Investment	80	80	75	75	75
	Subsidy	674	689	713	735	738

Notes: 1. The figures for the Power Reactor and Nuclear Fuel Development Corp. include appropriations earmarked in Special Accounts.
2. The figures for each fiscal year all indicate the initial budgets.
3. The Japan Nuclear-Ship Development Agency merged with the Japan Atomic Energy Research Institute as of 31 March 1985.
4. In addition to the investments and subsidy described above, the Bio-Oriented Technology Research Advancement Institute has capital investments and loans extended from the Industrial Investment Special Account.

In addition to these semigovernmental research organizations whose objective is to promote R&D, other special corporations whose main object is not R&D, including Nippon Hoso Kyokai (NHK), Japan Highway Public Corp. and Water Resources Development Corp., are also engaged in R&D in their respective fields of activity.

3. Promotion of Research Activity in Universities

Academic research that forms the basis of the promotion of science and technology has, as its basic objective, the creation of new knowledge or findings rich in creativity by drawing on the researchers' free ideas and high motivation for research. Universities, as the center of academic research, have as one of their basic roles the guaranteeing of Japan's academic foundation and its elevation to higher standards. Major features of the universities are that the growth of a broad range of learning, including liberal arts, social sciences and natural sciences is being aimed at there, that the respect for the independence of researchers is indispensable to the growth of research, and that research and education are being promoted synergetically.

It is difficult to strictly classify the Ministry of Education, Science and Culture appropriations, the sources of academic activities in both Japan's national and private universities, their attached laboratories, and the international university institutes, since education and research activity in universities are being promoted synergetically as inseparable entities. However, for the purpose of convenience, they can be broadly divided into funding for covering the ordinary and standard research costs and funding for supporting special research activities, the amounts of appropriations for which are determined by taking into account the research contents and their needs for funds, or those required by the special projects. Expenditures for improving or constructing research facilities and equipment also account for a large share of the ministry's budget.

The fund covering ordinary research expenditures is the budget used to establish the foundation on which the researchers can freely pursue their research. In the case of national universities, in addition to personnel expenses for the school personnel, it includes such appropriations as the amount of money allotted per school based on its number of teachers and the funds used to cover the expenses of teachers traveling for research purpose. To private universities, the ministry provides subsidies in the form of aid to defray their operating costs, which the universities use to partially fund their personnel expenses as well as their education and research activities.

The funding for special research activities constitutes various types of funding. One of them is the "Ministry of Education, Science and Culture Funding for Subsidizing Scientific Research," a system which has as its objective the intense promotion of unique academic research and which provides subsidies to research activities that will contribute to the progress of science in Japan. Under the scientific research subsidy system, of the research projects planned by investment researchers or groups of investment researchers themselves, those considered most important for the direction of scientific research in Japan are selected and provided with research funds, so that they will be able to realize advanced research results. This system has been playing an extremely important role in promoting first-line academic research by generating many innovative and creative new findings and by training many excellent groups of researchers.

In FY 1987, the research category "Priority Domain Research" was established to promote research in domains with strong academic and social requirements for research, and the "Overseas Academic Survey" was changed to its current name "Overseas Academic Research" to further promote international joint research. Furthermore, the following items have been strengthened. They include "General Research C" for promoting creative and pioneering basic research, "Encouraged Research (A)" for encouraging unique research by young researchers, "Experimental Research" for promoting experimental and applied research, and "Funding for Promoting the Disclosure of Research Achievements to the Public" for promoting the diffusion and disclosure of research results to the public (Table 3-3-8).

Table 3-3-8. FY 1987 Research Themes Targeted for Subsidies and Amounts of the Subsidies

(Unit: ¥1 million)

Research theme	Objective/contents of research	Budget
Funding for scientific research	To provide subsidies to cover the costs of research.	43,710
Specially promoted research	Of the research themes receiving high international evaluations, those considered to have the potential to generate exceptionally prime research results will be emphasized.	2,300
Special research	Research themes which are conducted over long periods in domains where the requirements for research are especially strong from an academic and social viewpoint. Research is being promoted in the cancer, nuclear fusion, natural disaster, and environmental science domains.	3,040
Priority domain research	Research themes which are conducted over fixed periods (3~6 years) positively and flexibly in domains where strong academic and social requirements exist. Research is being promoted in the matter (substances) and materials sciences, life sciences, and earth and space science areas.	4,620
Special research	Research themes which are conducted over a fixed period (3 years) in domains where strong academic and social requirements exist.	4,010
Comprehensive research	Research themes which are conducted jointly by researchers from various research organizations, by overcoming the walls separating those research organizations.	2,710
General research	Research themes which are conducted jointly or individually by a person or persons from the same research organization. (These are divided into the ranks of A, B and C by the amount of money.)	15,090

[continued]

[Continuation of Table 3-3-8]

Research theme	Objective/contents of research	Budget
	A--More than ¥10 million but less than ¥50 million. B--More than ¥3 million but less than ¥10 million. C--Less than ¥3 million.	
Experimental research	Experimental and application-specific research themes, which, if research progresses further on the strength of basic research achievements, have the potential of being translated into practical applications.	3,715
Encouraged research (A)	Research themes which are conducted individually by young researchers early in their careers in research institutions. (The research grant is less than ¥1.2 million)	4,410
Encouraged research (B)	Research themes which are conducted individually by kindergarten, elementary, junior or senior high school teachers, or by private citizens (The research grant is less than ¥300,000.	
Overseas academic research	Academic surveys, international joint research projects, and other necessary survey and research projects in foreign countries	1,825
Funding for promotion of special research	Providing subsidies to urgent and important research tasks.	1,900
Funding for promotion of research results disclosure to the public	To assist in the publication of research achievements and academic materials of high academic value.	1,030
Funding for encouraging special research	To promote research projects undertaken by private academic research institutions, which are unique and meet social requirements.	340
Total		45,080

Again, training young researchers rich in creativity is the most important task for strengthening and promoting the progress of academic research.

From this viewpoint, in 1985, the Ministry of Education, Culture and Science started a full-fledged fellowship system called the "Special Researcher System," a system that allows researchers to engage in their research freely and independently, as an enterprise to be managed by the Science Council of Japan. The program has since been expanded, and in FY 1987 the number of researchers receiving the fellowships reached 568.

Furthermore, in view of the fact that in recent years academic research activities in universities have been called upon to provide solutions to various industrial and social requirements, the Ministry of Education, Culture and Science has been implementing various measures so that the universities will be able to promptly and actively respond to the social requirements and cooperate by taking advantage of their specific features while retaining their independence. "Cooperative Research With the Private Sector," a system under which national universities accept researchers from private firms, and in which university researchers and private researchers jointly pursue a research task, was started in FY 1983. The system was welcomed with high expectations by researchers both within and outside of universities, and 396 joint research projects, mainly in the materials development, machine and instrument development, and biotechnology fields, were undertaken in FY 1987.

Again, in order to further promote the research cooperation between academia and industry, beginning with joint research projects, in FY 1987 the Ministry began preparations for the creation of a "Joint Research Center" of national universities (three universities). Other academe-industry cooperative enterprises to be enhanced include the promotion of consignment research in national universities and an acceptance of researchers on a commission, the promotion of joint research with researchers of private firms by taking advantage of the subsidy to scientific research (experimental research), and the establishment of a Comprehensive Research Liaison Council in the Japan Society for the Promotion of Science.

Furthermore, with international exchange and cooperation comprising the inherent demand of academic research, and in order for academic research to progress, it is necessary to elevate Japan's academic standards through international exchanges while, at the same time, contributing to the accumulation of mankind's intellectual assets by promoting international exchange and cooperation in academics. To that end, various projects, such as extending invitations to foreign researchers as a form of academic international exchange focusing on universities, dispatching Japanese researchers abroad, and participating in joint research projects with foreign countries have been promoted. Bilateral international cooperation projects based on agreements between specific countries and through multilateral or international organization exchanges and cooperation have also been actively promoted.

4. **Overall Promotion and Adjustment of Key Research Operations (Special Coordination Funds for Promoting Science and Technology)**

Since science and technology has gained in sophistication and complexity in recent years, it has become extremely important to promote and adjust R&D efforts from an overall perspective so that R&D activities will be promoted in a balanced way, while at the same time reinforcing the organic collaboration among government, academia, and industry. The demand is getting particularly strong for the Council for Science and Technology (CST) to be provided with reinforced capabilities to adjust R&D from an overall perspective. In view of this situation, in FY 1981 the Adjustment Fund for the Promotion of Special Research was abolished and, in its place, "The Special Coordination Fund for Promoting Science and Technology" was inaugurated as the budget for adjusting, from an overall perspective, the important research efforts that are needed for the development of science and technology, in line with the CST policy.

In connection with the operation of the Special Coordination Fund, CST adopted "The Basic Policy on Utilization of the Fund for Promoting Science and Technology" (adopted on 9 March 1981, and revised on 27 November 1984), and decided to use the money to promote the R&D activities which are especially required by Japan, keeping the following points in mind: 1) the promotion of leading-edge and basic research; 2) the promotion of R&D that requires the cooperative efforts of several research institutes; 3) the strengthening or organic collaboration among the government, academia and industry; 4) the promotion of international joint research; 5) flexible responses to emergency cases for which research must be commenced immediately; and 6) the implementation of research evaluations, and surveys and analyses of R&D.

On 22 May 1987 it was decided that research for FY 1987 would be promoted along the lines of the CST decision "On the Concrete Operation of the Adjustment Funding for the Promotion of Science and Technology for FY 1987," with special emphasis placed on science and technology in the field of substances and materials, as well as on life sciences. Six new research tasks and four survey tasks were undertaken, in addition to the tasks carried over from the previous fiscal year. Also, in a bid to effect a progressive response to an emergency that occurred during the fiscal year and to realize a flexible international response, an emergency research task was undertaken in the form of a survey of the magma chamber on Izu Oshima Volcano.

In light of the importance of the role that the government must play in basic research, in FY 1985 it was decided to promote a priority basic research program in the national testing and research institutes aimed at reinforcing basic research as the basis for the creation of innovative technological seeds.

In view of the importance of international exchange in promoting science and technology, in FY 1987 it was decided to start two programs--one, "The individual important international cooperative research program," which aims at promoting research of international joint research projects agreed upon at government-to-government levels in the national testing and research institutes, and the other, "the research on emergency projects commissioned program," which aims at letting the national testing and research institutes cope flexibly with the emergency needs for research with which they have been commissioned that arise during the fiscal year.

Outlines of the research tasks undertaken in FY 1987 using the Adjustment Funding for the Promotion of Science and Technology and their budgets are given in Table 3-3-9.

Table 3-3-9. Research Tasks Undertaken in FY 1987 Using the Special Coordination Funds for Promoting Science and Technology (Outlines) (Unit: ¥1 million)

Task	Outline	Budget
I. Promotion of basic and pioneering science and technology fields		
1. Fields where research will be promoted on a priority basis		
(1) Substances and materials related science and technology		
1) Research on development of reliability evaluation technology of structural materials	In order to establish reliability evaluation technology, focusing on forecasting the life and the remaining lifetime of structural metallic materials used in public structures, such as industrial plants and bridges, research will be conducted in the following areas: 1) establishment of high-temperature damage evaluation technology (demonstration tests in high-temperature environments); 2) establishment of environment strength evaluation technology (demonstration tests in corrosion-inducing environments); 3) establishment of monitoring technology (using AE and ultrasonic waves); and 4) establishment of data base utilization technology for lifetime and remaining lifetime forecasting.	102
2) Research on basic technology for creation of new materials based on hybrid structure design technology	Hybrid materials whose structures are controlled at the atomic or molecular level are drawing attention as new functional materials, so research will be conducted on the foundation technology necessary for the creation of hybrid materials, such as 1) metalinorganic, 2) inorganic-organic, and 3) metal-organic systems of materials.	234

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
3) Research on large-output and wave-variable lasers and laser processing technology	Research will be conducted on the development of large-output and wavelength-variable lasers that form the foundation of the laser processing technology that has been showing increasing potential in recent years as the processing technology for such applications as materials synthesis and microprocessing, and on the development of the synthesis and processing technologies of materials that take advantage of a laser's wave selectivity.	309
4) Research on the generation, measurement and utilization of ultrahigh temperature technology	In order to establish the basic technology necessary for the creation of new materials based on the synthesis of high-purity new substances by taking advantage of the high chemical reactivity inherent under ultrahigh temperatures (4,000~10,000°C), research will be conducted on 1) ultrahigh temperature generation and control technology (using the high frequency heat plasma method; 2) ultrahigh temperature measuring technology; and 3) ultrahigh temperature utilization technology.	172
5) Research on the analysis and evaluation technology of high-performance technical materials based on new beam technology	In order to facilitate the establishment of an analysis and evaluation technology based on a much more advanced beam technology, a technology that is required for the development of new high-performance functional materials, such as electronic and optical materials, and chemical functional materials, research will be conducted on 1) analysis and evaluation technology based on X-rays obtained from synchrotron orbital radiation (SOR); 2) analysis and evaluation technology utilizing high-intensity and low-velocity electron beams; and 3) analysis and evaluation technology based on submillimeter waves.	595

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
6) Research on basic technology for the creation of new functional materials through increased purification of rare metals	Rare metals are expected to express inherent specific properties, but the technology for their high-level purification has yet to be fully established. Therefore, research will be conducted on rare metals and their compounds with respect to 1) high purification technology; 2) ultra-trace amount analysis technology; and 3) the creation of new capabilities.	253
7) Research on basic technology for the development of functionally gradient materials for mitigating thermal stress	In order to establish the basic technology for the development of functionally gradient materials that are expected to find application as materials that can withstand ultrahigh temperatures in leading-edge science and technology fields, such as space, aircraft and nuclear fusion, research will be conducted on 1) the design technology of functionally gradient materials, 2) their structural control technology, and 3) technology for evaluating their specific properties.	257
(2) Life sciences 1) Research on the development of analysis and utilization technology of functions of biomembranes	In order to establish the technology that takes advantage of the capabilities of biomembranes to identify and/or select substances, research will be conducted for the development of 1) the technology for analyzing and/or constructing biomembranes, 2) the technology for controlling reactions between biomembranes and reactive substances, and 3) the utilization technology of biomembranes (biosensors, separation membranes).	187
2) Research on the development of analysis, modification and simulation technology of functional proteins	In order to facilitate new developments in the field of life sciences by establishing the technology that will make it possible to utilize the capabilities of functional proteins, such as enzymes and antibodies, more effectively, research will be conducted on the development of 1) the technology for analyzing the struc ture and functions of functional proteins (analysis and forecasting of three-dimensional structures), 2) the design	130

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
[continuation]	production technology of functional proteins technology required to evaluate their capabilities or provide them with new capabilities), and the simulation technology of proteins (man-made enzymes, etc.)	
3) Research on the development of routine and basic technology necessary for cancer research	In-line with the "Comprehensive 10-Year Strategy for Cancer Control" adopted at a meeting of the Council of Cabinet Ministers for Cancer Control and the "Report on Basic Policies for Promotion of Cancer Research" compiled by the CST, in order to establish the routine and basic technology necessary for the promotion of cancer research, efforts will be made to develop 1) gene analysis technology, 2) gene introduction and expression technology, 3) protein-related technology associated with cancer, and 4) sugar chain-related technology.	281
4) Research on the development of basic technology for the elucidation of brain functions	In order to explicate brain functions, a project that is expected to contribute greatly to a broad range of fields including information and electronics-related technology, efforts will be made for the development of 1) analyses by means of molecular and biological techniques (analyses of abnormal substances in the brain and genes, etc.), 2) analyses of brain functions by imaging (use of positron CT, NMR), and 3) modeling methods of brain functions (modeling of the functions governing voluntary motion and memory).	152
5) Research on the development of analysis and utilization technology of chromosomes	Regarding chromosomes, which hold the high-level key to the vital phenomena of higher animals and plants, in order to contribute to the speedy elucidation and treatment of genetic diseases and to the creation of new species by manipulating their functions, efforts will be made to develop 1) chromosome isolation and refining technology, 2) the technology to analyze the structure and functions of chromosomes, 3) the technology to introduce genes into chromosomes, and 4) the technology to introduce chromosomes into cells and make them express themselves.	149

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
6) Research on basic technology for the utilization of bio-energy conversion function	In order to further expand the scope of applications utilizing bio-energy conversion functions, including high efficiency and ultra-small size, etc., efforts will be made to develop 1) a high-efficiency optical information processing technology modeled on vision, 2) a highly efficient production and utilization technology of ATP (adenosine-triphosphate), and 3) bio-type energy conversion devices (modeling of the actuator mechanisms in the body).	255
7) Research on basic technology to elucidate immunoresponse mechanisms	In order to elucidate immunoresponse mechanisms (complex reactions among various kinds of immunity-related cells and control factors), which are vital to the understanding of the mechanisms involved in the onset of immune system-related diseases such as AIDS and adult T cell leukemia, as well as to explaining the high-level vital phenomena common to all life, efforts will be made toward the development of 1) the modification conversion technology of immunological receptors, 2) the cloning and breeding technology of immune cells, and analyzers of functions, and 3) the analysis of response mechanisms using immune system-related altering of animals.	422
2.		
1) Research on the development of new survey systems for use in waters within 200 nautical miles of Japan's shoreline	In order to augment and strengthen ocean surveys that must cover the broad area, in terms of both time and space, of 200 nautical miles from Japan's shoreline, as well as a broad variety of other objects, efforts will be made for the development of 1) leading-edge observation instruments, such as highly reliable sensors, 2) systems for obtaining ocean-related data, such as that involving ships and buoys, 3) high-precision survey technology of topographical features and geological formations of the seabed, and 4) technology to evaluate the reliability of the data thus obtained.	181

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
2) Research on knowledge based systems to lend support to the design of chemical substances	By establishing common models to lend support to the design of various substances based on the data processing technology currently being put to practical use, efforts will be made for the development of 1) the construction technology of knowledge base systems intended ultimately to help in the design of new chemical substances, 2) structure design knowledge base systems for aiding in the design of candidate structures, and 3) reaction design knowledge base systems for candidate structures.	335
3) Research on the development of technology for the effective utilization of deep-sea resources	From the viewpoint of high-level utilization of sea areas and of further promoting the development of biotechnology, efforts will be made for the establishment of technology to effectively utilize deep-sea resources that have heretofore been overlooked. To that effect, the following research themes will be undertaken: 1) technology for the effective utilization of water from the ocean depths with a view to ascertain different conditions involving the siting of facilities (on-sea and on-land facilities for utilizing water from the ocean), 2) research on undersea greening technology (creation of seaweed farms using artificial light), and 3) research on technology for probing and breeding deep-sea microorganisms.	347
II. Promotion of R&D projects meeting high-domestic and social demands		
1) Research on the development of R&D to cope with an aging society	To cope with the rapidly approaching aging of the society from the side of science and technology, research on the following themes will be undertaken: 1) technology probing causes of aging (factors controlling Alzheimer's disease, etc.) and 2) methods of health control for the elderly (technology to measure degrees of aging, remote medical systems, systems to prevent bed sores, etc.).	175

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
2) Research on earthquake tectonics in the active structural area of central Japan	Central Japan and its surrounding areas have been hit by frequent earthquake activity in recent years. Therefore, to elucidate the earthquake tectonics in those areas and thereby contribute to increased progress in earthquake forecasting research, research on earthquake tectonics will be undertaken in the following areas: 1) the eastern periphery of the Sea of Japan and the area around the Fossae magma, 2) the area where plates meet on the land, and 3) the area where three plates meet on the seabed.	126
3) Research for development of a system to forecast the probability of an earth or sand slide disaster	In order to develop an "earth and sand disaster and danger forecasting system" so that predictions can be made of areas likely to be hit by landslides in the wake of torrential rains, enabling alerts to be issued or instructions on evacuations or emergency activities to be given, efforts will be made for the development of 1) a method of inputting earth and sand disaster-related factors into the system used to forecast the probability of danger (the four factors currently include topography, geological features, flora and fauna, and soil conditions) and 2) a method of forecasting the probability of being hit by a landslide disaster.	77
4) Research on method to forecast inland earthquake on order of Magnitude 7	In order to promote the development of a technique to forecast earthquakes on the order of Magnitude 7 (M7), which is feared to wreak great damage but which is extremely difficult to forecast, the following projects will be undertaken in the test field in the western area of Sagami Trough: 1) precise survey of the crustal structure and survey of the history of crustal activities, 2) observation and study of crustal activities, and development of new observation and study methods, and 3) modeling of earthquake tectonics and research on the method of forecasting M7-class inland earthquakes.	249

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
III. Active promotion of international joint research		
1) International joint research on testing and evaluation technology of new materials	In the R&D of new materials, it is necessary to establish materials testing and evaluation techniques for common use internationally, so the following research projects will be undertaken jointly with European countries and the United States: 1) research on testing and evaluation techniques of important new materials (engineering ceramics, superconductive materials, etc.), and 2) research on common and fundamental testing and evaluation techniques (analysis of surface chemistry, abrasion tests, etc.)	166
2) Joint research with ASEAN countries on upgrading remote sensing technology and its application	In order to contribute to the effective utilization of the earth observation satellite and thereby to the formulation of rational land utilization programs in ASEAN countries by conducting joint research with those countries, research will focus on 1) upgrading the remote sensing technology (application of Japan's remote sensing technology to the other countries) and 2) elucidating environmental features of the tropical regions (grasping the forestry and agricultural environment characteristics).	122
3) Research on evaluation of ocean plate forming region (rift system) in South Pacific	Regarding the ocean plate forming region (rift system) in the South Pacific, the study of which is awaited from the perspectives of elucidating the plate tectonics and exploring mineral resources, such as hydrothermal deposits, 1) the plate forming process in the rift system and the surrounding environment will be elucidated, and 2) the plate forming mechanism will be researched.	250

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
4) International joint research on atmospheric, oceanic and weather changes in the Pacific	In order to understand the mechanisms of the world-scale weather changes and to improve the forecasting technology, the following projects will be undertaken in the Pacific Ocean that wields a great effect on weather changes: 1) observation, analysis and research of interactions between the atmosphere and the ocean, and of the atmospheric and oceanic changes, 2) research for the development of new observation technologies of elements causing atmospheric and oceanic changes, and 3) research for the development of models to simulate weather changes.	283
IV. Promotion of survey and analysis		
1) Surveys on directions of progress of leading-edge sciences and technologies and on prospects for growth of interdisciplinary research fields	In order to clarify the directions of R&D in the future, after taking into account the prospects for interdisciplinary research fields by promptly and accurately grasping the directions of leading-edge R&D projects, the following surveys will be undertaken: 1) directions of basic research aimed at innovational technologies, 2) prospects of interdisciplinary research fields involving information and electronics (exploration of where interdisciplinary research will be headed by holding discussions among researchers from different fields), and 3) the current status of soft science and technology 10^{-4} and its direction.	49
2) Survey of movements of personnel, investments and flow of information to facilitate smooth promotion of R&D activity	In order to obtain the basic data needed for beefing up and strengthening research personnel, investments and the flow of information, which support R&D activity, a survey will be undertaken to compare European and American statistics on R&D activities with those of Japan.	13

[continued]

[Continuation of Table 3-3-9]

Task	Outline	Budget
3) Analysis of current status, trends and potential of R&D through development of a comprehensive processing method of R&D-related information	In planning or drafting plans for science and technology policies, or in evaluating the progress of those plans, it is necessary to grasp the current status of R&D, its directions and its potential. Therefore, a data base will be prepared by gathering information on a large variety of R&D activities, and analysis programs will be developed. In addition, basic data on the movements of R&D will be prepared by using those programs.	38
4) Survey to help establish conditions for promoting pioneering and basic science and technology	In order to raise Japan's capability to create trailblazing technology seeds by promoting R&D in the pioneering and basic science and technology fields, 1) a survey will be undertaken to study the current status of the foundation for the promotion of science and technology, its problems, and science and technology trends abroad, and 2) a survey will be undertaken on the directions of improvements involving research management when promoting basic research.	38
5) Survey and study of feasibility of international basic research program concept	In order to conduct a survey and study of the feasibility of the "Human Frontier Science Program Concept," after taking into account the results of the survey undertaken in FY 1986, a project will be undertaken to survey and study the setup for the execution of the concept from an international viewpoint, its business contents and its key research fields. Furthermore, in order to provide the raw data for the survey and study, details of how related research projects abroad are being promoted and managed will be surveyed, and the opinions of foreign scientists regarding how to go ahead with the concept will be solicited.	151
6) Survey on generation, measurement and utilization technology of ultrahigh vacuum	Regarding the ultrahigh vacuum technology that is indispensable to the creation and evaluation of new materials, as well as to accelerator technology, surveys will be undertaken in three technology fields, i.e., 1) generation, 2) measuring and 3) utilization, in order to define the problems involved in these technologies and the directions of their R&D.	10

[continued]

[Continuation of Table 3-3-9]

7) Survey on development of generation engineering technology	Regarding the generation engineering technology that is expected to contribute to the growth of life sciences research in the future, surveys will be undertaken of 1) element technology and 2) application technology in order to define the problems occurring in these technologies and their direction of research promotion	11
8) Survey on how to upgrade "overcome-and utilize-snow" technology	In order to secure a comfortable and safe environment in snow-covered areas during the winter, the existing snow disposal technology will be examined from the perspectives of 1) upgrading the snow-handling technology and 2) snow-utilization technology, in order to define the problems inherent in the existing technologies as well as their R&D direction.	10
V. Emergency research and international cooperation with mobility		
1) Research on elucidation of chemical and physical, as well as biological, phenomena under micro gravity environment through international cooperation	Aiming for more detailed comprehension of basic physical, chemical and biological phenomena under microgravity environments, which is necessary for the full-fledged utilization of microgravity environments, research will be conducted, jointly with Europe and the United States on 1) elucidation of the physical phenomenon, 2) elucidation of the chemical phenomenon, and 3) elucidation of the biological phenomenon.	85
2) Emergency research on magma chamber in volcano on Izu Oshima Island	Regarding the magma chamber in Mt. Mihara on Izu Oshima Island, in order to obtain data necessary for predicting the volcano's activity in the future, such as grasping the magma chamber's activity, the positioning of the current eruption, and the magma chamber's position and the underground structure, the following activities will be undertaken: 1) probing deep, underground depths by triggering artificial earthquakes, 2) precise surveys of changes in the crust accompanying an eruption, and 3) surveys of effusive materials.	45

5. Promotion of Creative R&D

Until now, creative R&D has been promoted mainly in the universities, as well as national and public experiment and research institutions, but the following policy measures have been undertaken since FY 1986.

(1) International Frontier Research System

1) Background

Science and technology has shown remarkable progress and has contributed to the progress of society and the economy, but, in recent years, discoveries of important findings, the backbone of science and technology, have been stagnating and the progress of science and technology has hit a deadlock. If the advancement of science and technology is to be maintained into the future, discoveries of scientific findings at a more basic level, that will prove to be the sources of innovative technologies, are indispensable.

Until now, the social and economic growth in Japan has been built upon the introduction of achievements in basic research realized in Europe and the United States. However, since the international status of Japan has risen, it is about time that we evolve from the catch-up type of behavior and realize the duty to contribute to the world by playing a leading role in the discovery of new scientific findings.

Therefore, aiming for the aggressive discovery of new findings that will provide the bases for technical innovations in the 21st century, by promoting research through pooling the resources of researchers from various fields by overcoming the barriers separating the conventional research organizational setups under a research structure that is open to foreign researchers as well, in October 1986, the Science and Technology Agency established the International Frontier Research System within the Institute of Physical and Chemical Research.

2) An outline of the system

a. An outline of the organization

Although the International Frontier Research System is an internal organization of the Institute of Physical and Chemical Research, its management mode differs from the norm. It has two function fields, comprising seven research teams, under the system director (Figure 3-3-10).

b) Features

The International Frontier Research System has a management system that is fluid and is open to the world, and it has the following features: 1) a research system in which research capabilities from various fields are pooled; 2) a research system open to the world; 3) long-term research under a system where movements of the researchers are fluid; 4) active use of the talent of young researchers; 5) exploration of new findings backed up by experiments; and 6) an open and free research atmosphere inducive to unique and creative ideas.

The leaders of the chromosome, molecular element and biological element research teams are foreigners.

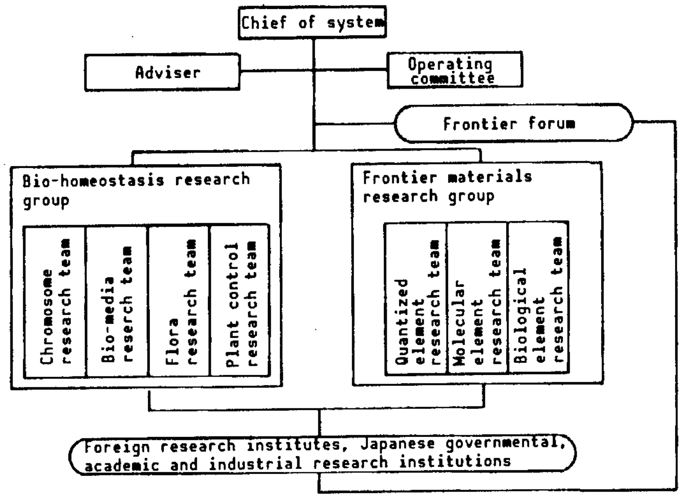


Figure 3-3-10. Organizational Chart of International Frontier Research System

c. **Research fields**

In order to discover new scientific findings, research in the International Frontier Research System is currently being conducted in the following two fields, and a budget of ¥1,535 million has been appropriated for FY 1987.

(i) Research on biohomeostasis focused on aging processes of animals and plants

In anticipation of the function's application to a broad range of fields, including the control of aging to cope with the coming elderly society in the 21st century, and the creation of plants capable of living under various environments, such as dry environments, etc., efforts will be made to explain the mechanism of homeostasis, a function inherent in animals and plants that enables them to control their physiological functions and generally maintain a balance by preventing those functions from going astray.

(ii) Research in the field of materials with new functions (frontier materials)

In anticipation of the creation of frontier materials (such as new functional elements) that will form the foundation for science and technology in a new age, efforts will be made to explain various phenomena brought about by biological molecules, such as cells and proteins, polymers, and substances such as metals in ultramicroscopic states, and combinations thereof.

(2) System for Promotion of Creative Science and Technology

1) Background

Since Japan has staked its future on science and technology, it is important that we amend our hitherto practice of relying on imported technology and try to discover, on our own, the seeds of science and technology that will blossom as innovative technologies in the future.

From this viewpoint, in FY 1981 the Science and Technology Agency established the "System for the Promotion of Creative Science and Technology," and designed the Research Development Corporation of Japan, an organization that has been acting as a liaison between researchers at the universities and national and public research institutions and industry, to mediate in the development of new technologies on a commissioned basis since it has demonstrated the capability to organize development projects for industrialization as well as a successful record in handling such projects as system promotion.

The greatest feature of this system is that, due to the recognition that experts' talents and the flexible management of the research system are indispensable for creative research activity, it is thoroughly organized, with "people" as its core (a fluid research system).

Entering the seventh year of its existence, the system has been progressing smoothly, already having created many noteworthy seeds.

2) Outline of the system

a. With the objective of extracting the expert ideas of foreign researchers as well as Japanese researchers in government, academia and industry and putting them to good use, the "System for the Promotion of Science and Technology" is organized along the line of a new "people-oriented structure" (a fluid research system), in which the researchers can devote themselves to creative research activity, taking no notice of their organizational (occupational) boundaries while enjoying the advantages of a life-long employment system, so that they will be able to create seeds for Japan's own innovative technologies (Figure 3-3-11).

b. Research is promoted under the following methods:

- A person who has excellent insights and leadership, as well as broad knowledge of the research task, is designated as the general manager. The general manager has a certain level of discretionary power over the research management, and the research is comprehensively promoted under him.

- Experts in the field of the research project to be undertaken are recruited from other countries as well as from government, academia and industry, and are organized into research groups. Existing private research laboratories will be used in conducting the research.

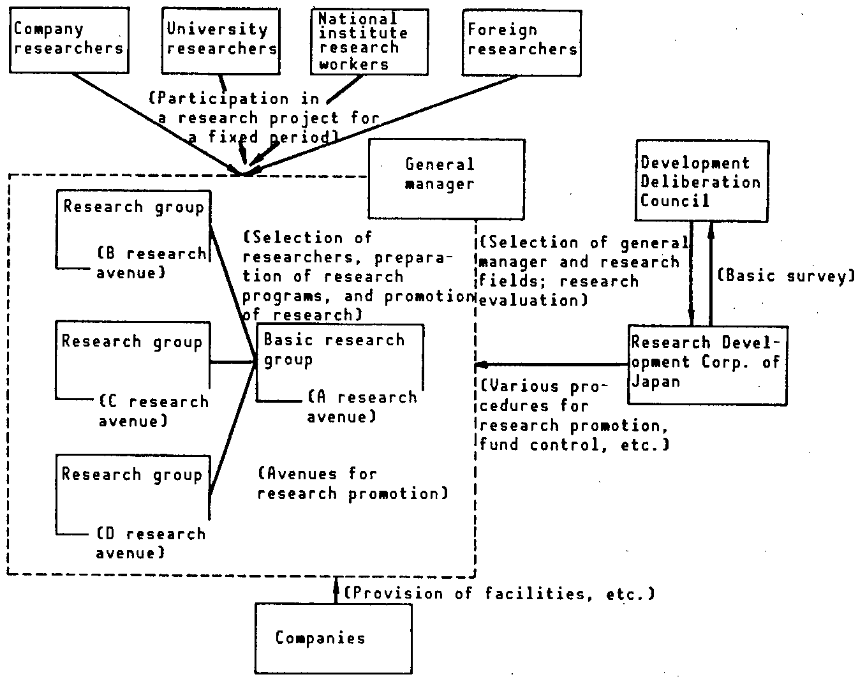


Figure 3-3-11. Outline of Exploratory Research for Advanced Technology

• As for the status of the researcher, the precondition is that he either retain his employment relationship with the research institute from which he hails or that he be free to return to his positions with his former employer. Upon successful coordination or negotiations with the employer organization, the researcher is hired on a contract basis for a fixed period of time (for example, 5 years) to participate in the research project. After the research has been completed and terminated, the research group is disbanded.

• The research project is promoted in a way so that the researchers' creativity will be put to the greatest use. If an unexpected finding or invention is discovered during the research term, the research management system is flexible enough to permit the research goal to be altered, such as aggressively going after the new development.

• Consideration is given so that there will be incentives for superior researchers from government, academia and industry, especially those from private industries, to take part in the system. The industrial rights obtained during the research will be jointly owned by the Research Development Corporation of Japan and the inventor, and they are transferable to the company or institution employing the inventor (from the inventory to his employer) after the research term has been completed.

3) Outlines of research projects

a. Four research projects were started in October 1981 (completed in September 1986), followed by one project each in October 1983 and October 1984, two projects in October 1985, and three projects each in October 1986 and October 1987. Outlines of each of these projects are shown in Table 3-3-12.

b. Each project is supported by 3~5 research groups, with a staff of about 20 researchers. The term of a research project, as a rule, is up to 5 years.

Table 3-3-12. Outlines of Research Projects Under Exploration Research for Advanced Technology (FY 1987)

Research project:	Mizuno Bioholonics Project
Research groups:	Basic Design; Control; Construction
Research locations:	Nissho Building (Tokyo); Teikyo University (Lake Sagami-ko); Nissho Building (Tokyo)
Sources of researchers:	Nippon Shoji Kaisha; Toyo Jozo Co.; Sanyo Electric Co.; University of Tokyo; Kyoto University; Saitama University; Hiroshima University; Teikyo University; Meiji College of Pharmacy; East Germany; Eisai Co.; Terumo Co.; Kanegafuchi Chemical Industry Co.; Kyowa Hakko Kogyo Co.; Hitachi Ltd.; Konica Corp. (formerly Konishiroku Photo Industry Co.); Sumitomo Seiyaku Co.; Mitsubishi Gas Chemical Co.; Fujitsu Ltd.; Tokyo Medical and Dental University; Chiba University; Kyushu University; Gakushuin University; Sweden
Outline:	By taking note of the collaborative relationship between the system as a whole and individual elements comprising the system in animal cells, tissues and organs, efforts will be made to create artificial elements (holons) that cooperate with one another, self-organizing models by the element array, and to study control methods. To take advantage of the self-organizing capabilities of animals in the manufacture of pharmaceuticals, their engineering applications will be probed.
Budget:	¥160 million

[continued]

[Continuation of Table 3-3-12]

Research project:	Hayaishi Biological Information Transmission Project
Research groups:	Transmission Structure (at Nippon Shinyaku Co. in Kyoto City); Transmission Behavior (at Nippon Shinyaku Co.)
Sources of researchers:	Kanagafuchi Chemical Industry Co.; Mitsubishi Petrochemical Co.; Ueno Pharmaceutical Co.; Shionogi U Co.; Nippon Shinyaku Co.; Eisai Co.; Kyowa Hakko Kogyo Co.; Fuji Pharmaceutical Co.; Kyoto University; Nagoya University; Osaka University; Nagoya City University; Toyama Medical and Pharmaceutical University; Osaka Bioresearch Institute; India; South Korea; Canada; France.
Outline:	By observing the chemical substances (information transmission substances) that play an important role in the transmission of information in the nervous system, studies will be conducted to probe their essence, as well as their mechanisms of information exchange. The research results will be used to explore these chemical substances' applicability to the field of medicine and diagnosis, such as in the manufacture of anesthetics that would only require an extremely small dose and would be free of side-effects.
Budget:	¥359 million
Research project:	Horikoshi Special Environment Microorganism Project
Research groups:	Basic Properties (at Institute of Physical and Chemical Research's Komagome and Wako Laboratories in Tokyo); Substrate Metabolism (at Institute of Physical and Chemical Research's Komagome and Wako Laboratories); Imparting of Resistance (at Hamamatsu Photonics in Hamamatsu City)
Sources of researchers:	Kumiai Chemical Industry Co.; Oji Paper Co.; Toray Industries; Meiji Pharmaceutical Co.; Mirinaga Milk Industry Co.; Q.P. Corp.; Godo Shusei Co.; Mitsubishi Electric Corp.; Idemitsu Kosak Co.; Suntory Limited; Zeria Shinyaku Co.; Fujisawa Pharmaceutical Co.; TGC Corp.; Japan Maize Products Co.; Marubishi Bioengineering Co.; Institute of Physical and Chemical Research (RIKEN); University of Tokyo; Tsukuba University; Tohoku University; Nihon University; the United States; Great Britain; West Germany; New Zealand; China; Canada [continued]

[Continuation of Table 3-3-12]

Outline:	The resistance mechanism of microorganisms that thrive on special environments, such as alkaline, acid or high-temperature environments, will be explained. Studies will be made of the possibilities of manufacturing new useful substances, such as new antibiotics, or of raising the efficiencies of the existing manufacturing processes of substances, by imparting the resistance associated with the above microorganisms to ordinary microorganisms.
Budget:	¥367 million
Research project:	Yoshida Nano-Mechanism Project
Research groups:	Basic Analysis (at Tsukuba Research Consortium in Tsukuba City); Measuring and Control (at Tsukuba Research Consortium); Processing (at the Oi plant of Nippon Kogaku K.K. in Tokyo)
Sources of researchers:	Akashi Seisaku-jo Co.; Nippon Steel Corp.; Nippon Kogaku K.K.; Intel; Yasukawa Electric Manufacturing Co.; Seiko Instruments Inc.; Japan Aviation Electronics Industry; Waseda University; Hiroshima University; Niotto Electric Industrial Co.
Outline:	By accounting for the physical actions and mechanical properties of substances in the nanometer region and by analyzing their new measuring and processing methods, studies will be made of their mechanical and structural element technologies.
Budget:	¥381 million
Research project:	Kuroda Solid Surface Project
Research groups:	Basic Properties (at Sukuba Research Consortium in Tsukuba City); Surface Reaction (at Tsukuba Research consortium); Functional Structure (at Toray Research in Otsu City)
Sources of researchers:	Nippon Steel Corp.; Rigaku Corp.; Sanyo Electric Co.; Toppan Printing Co.; Chemical Research Institute; Mitsubishi Metal Corp.; Kao Soap Co.; Mitsubishi Chemical Industries; Toray Research; Toray Industries; Hitachi Ltd.; Mitsui Toatsu Chemicals; University of Tokyo; Kyoto University; Hokkaido University; the United States; France; Canada; Taiwan

[continued]

[Continuation of Table 3-3-12]

Outline:	By taking advantage of scientific reactions that take place on the surfaces of solids, methods of modifying the surfaces of solids of known properties will be studied, and the structures, properties and reactivities of the modified solid surfaces will then be studied. By using the surface modifying methods thus obtained, methods of synthesizing new two-dimensional of three-dimensional designed substances will be probed.
Budget:	¥402 million
Research project:	Goto Flux Quantum Project
Research groups:	Basic Properties (at Hitachi Ltd. in Tokyo); Environmental Control (at Nippon Vacuum Technology Co. in Chigasaki City); Construction method (at Mitsui Shipbuilding and Engineering Co.'s Systems Technology Laboratory in Tokyo)
Sources of researchers:	Hitachi Ltd.; Albac Lion Co.; Mitsui Shipbuilding and Engineering Co.'s Systems Technology Laboratory; the Netherlands; Nippon Vacuum Technology Co.; University of Tokyo; Seiko Instruments Inc.
Outline:	By observing the fact that flux quantums operate at extremely high speeds, yet at low energy levels, the electric and magnetic phenomena accompanying the generation of propagation of flux quantums will be explained. Using the findings, efforts will be made to discover methods of controlling the flux quantums and to apply them to engineering fields, such as data processing and measuring.
Budget:	¥427 million
Research project:	Takaradani Ultraparticle Flexible Structure Project
Research groups:	Basic Analysis (at Stanley Electric Co. in Tsukuba City); Reconstruction (at Production and Development Science Laboratory Inc. in Kyoto); Functional Systems (at Stanley Electric Co.)
Sources of researchers:	Osaka University; Nagoya University; Toyada Laboratories; Yaskawa Electric Manufacturing Co., Ltd.; Nippon Mining Co., Ltd.; Matsushita Electric Industrial Co., Ltd.; Italy; Hungary

[continued]

[Continuation of Table 3-3-12]

Outline:	By observing the flexible structure of superparticles that control themselves when adapting to the environment, the working principles of the mechanisms of such phenomena as low-level energy conversion and the transport of specific substances will be probed in an effort to construct molecular systems with high-level functions, such as motion and memory.
Budget:	¥445 million
Research project:	Inaba Biological Photon Project
Research groups:	Measuring Technology (at Electromagnetic Research Institute in Sendai City); Biochemical Information (at Kojin-kai in Sendai City); Information Processing (at Electromagnetic Research Institute (DENJIKEN) and Kojin-kai)
Sources of researchers:	Tohoku University, the United States; Nippon Bunko Co.; Advan Test; Shimadzu Corp.; Olympia Co.; Nagoya University; Tokyo University of Agriculture and Technology; Hungary
Outline:	Efforts will be made to develop a method of measuring extremely weak light (biological photons) from the emission phenomena demonstrating a close relationship to the vital phenomena, and using the information thus obtained, the possibility of developing new measuring technology, targeted at organisms, will be explored.
Budget:	¥565 million
Research project:	Nishizawa Terahertz Project
Research groups:	Basic Analysis (at Semiconductor Research Institute in Sendai City); Element Design (at Semiconductor Research Institute in Sendai City); Circuit Construction (at Semiconductor Research Institute in Sendai City)
Sources of researchers:	Semiconductor Research Institute; Ube Industries; Kawatetsu Kogyo Co.; Hitachi Ltd.
Outline:	By observing the wavelength region that has not yet been able to be used for communications, the basic structure of elements operating in a broad spectrum of wavelengths, from millimeter waves to infrared

[continued]

[Continuation of Table 3-3-12]

	waves, will be explored for possible application to information engineering.
Budget:	¥99 million
Research project:	Furusawa Generation Gene Project
Research groups:	Gene Exploration (at Daiichi Seiyaku Co. in Tokyo); Gene Expression (at Tosoh Corp. in Ayase City); Gene Control (at Tosoh Corp. in Ayase City)
Sources of researchers:	Daiichi Seiyaku Co.; Koa Co.; Tosoh Corp.; South Korea; Utsunomiya University
Outline:	By observing the genes that are deeply involved in the process of life, the mechanisms of the fixation and expression of substances synthesized by these genes will be elucidated in order to probe their possible application to pharmaceuticals and agriculture.
Budget:	¥132 million
Research project:	Kokubu Chemical Organization Project
Research groups:	Organization Design (at Fukuoka Industrial Research Laboratory in Tsukushino City); Functional Organization (at Fukuoka Industrial Research Laboratory; Complex Organization (at Fukuoka Industrial Research Laboratory)
Sources of researchers:	Tokuyama Soda Co.; Dojin Laboratories; Mitsui Toatsu Chemicals; Mitsui Shipbuilding and Engineering; Asahi Chemical Industry Co.; Mitsubishi Chemical Industries; Tosoh Corp.; Ube Industries; Sogo Yakko Co.; University of Tokyo; Hisamitsu Pharmaceutical Co.; Kao Soap Co.; Asahi Glass Co.; Daikin Kogyo Co.
Outline:	By observing the self-organizing capabilities of synthesized molecules, the design of molecules that array and combine on their own and the methods for creating functional synthesized organizations using these molecules will be explored in an effort to explore the possibility of developing new functional materials.
Budget:	¥102 million

(3) Next-Generation Key Technology R&D System

1) Background

The technical levels of Japan have now attained the average levels of technology in the advanced industrial countries, and Japanese technologies in some fields, such as steel, automobiles and electric industries, are at the most advanced levels in the world. This has been realized by aggressively introducing technologies from the advanced countries in Europe and the United States after the war to fill the technical gaps and by reforming or improving the imported thermal conductivity. However, Japan is still lagging behind the advanced countries of Europe and the United States in terms of creative R&D, that is, the development of ingenious and innovative technologies.

In order for our resource-poor country to overcome its vulnerabilities, we will have to emphatically promote the R&D of the key technologies indispensable to the next-generation industries, such as aviation and space, information processing, new energy development and bio-industries, and will have to rapidly raise Japan's basic technology levels that are said to be behind those in the advanced countries in Europe and the United States. Because of their large ripple-effects, the development of such key technologies is strongly demanded from the viewpoint of the national economy. However, the development of a key technology not only requires a large sum of money and much time but also entails great risks. To promote the R&D of key technologies efficiently on a planned basis, in FY 1981 the Ministry of International Trade and Industry instituted the "Next-Generation Key Technology R&D System" to aggressively utilize the potential of the private sector.

Seven years into the program, almost all the themes are meeting their second-term R&D phase goals, generating steady achievements.

2) Outline of the system

Themes from the three fields of new materials, biotechnology and new functional devices that have theoretically or experimentally been found to have the potential for commercialization as innovative industrial technologies (two-leaf stage themes) have been selected, and R&D will be conducted until they reach the stage at which they show bright prospects of being translated into industrial technologies (sapling stage). Also, in order to promote R&D efficiently, a parallel development system will be adopted under which several R&D methods will be pursued simultaneously. In addition, the overall long-term R&D program (about 10 years) will be subdivided into approximately three stages, each lasting a few years, and the progress and results of the R&D accomplished during each stage will be evaluated against the initial goal, enabling the most appropriate development method to be determined during the development stage.

This system will be promoted under the tripartite cooperation of the government, academia and industry. From the viewpoint of tapping the potentials of industry, the actual R&D projects will be consigned to private firms, but the national experiment and research institutes will be called upon to contribute to R&D by drawing on their expertise and, depending on the contents of the research involved, universities will be asked to cooperate.

3) Outlines of R&D projects

Outlined in Table 3-3-13 are the 13 R&D themes being undertaken under the program and their budgets for FY 1987.

Table 3-3-13. Outlines of R&D Themes Under the Next-Generation Key Technology R&D System and Their Budgets for FY 1987

<u>New materials</u> (¥3,538 million)

1. Fine ceramics	•The goal is to develop structural materials featuring high reliability and high strength under high temperatures, high corrosion resistance and high precision and abrasion resistance, and to establish the technology for their application as the material used in ceramic turbines for coal gasification. •Incorporating such structural materials into heat engines, e.g., ceramic turbines for coal gasification, is expected to lead to substantial energy savings through reduced weight and increased thermal efficiency. These materials may also find their way into the leading edge industries, including nuclear power, aircraft design and space.
2. Materials for high-efficiency polymeric films for separation	•The goal is to develop high-efficiency liquid-separation films and gas-separation films that will make it possible to separate, condense and refine substances that either consume large amounts of energy or are very difficult to separate using the existing techniques. •Their application to various types of separation and refining processes will lead to great savings in energy consumption and to a pollution-free, clean chemical industry, complete with compact chemical plants, as well as to the recovery of hard-to-separate substances.
3. Conductive polymer materials	•The goal is to develop stable and easy-to-fabricate high conductivity (10^5S/cm (S: siemens=1/Ω) at room temperature), and to develop electrical and electronic materials exhibiting new functions not found in metals. •Using these materials as substitutes for copper and aluminum wire is expected to bring about such advantages as resource savings, compact cable support structures (indispensable for the development of resources on the seabed), and the development of organic ultrahigh conductivity materials.

[continued]

[Continuation of Table 3-3-13]

4.	High crystalline polymer materials	•The goal is to develop polymer materials featuring high crystallinity and with bending elasticity, the typical dynamic characteristic, of more than 100 GPa (10,000 kgf/mm^2). •The use of these materials as substitutes for aluminum or iron will lead to resource savings and to the realization of high-strength structural materials featuring high elasticity, electric insulation and machinability.
5.	High-performance crystal-controlled alloys	•By drawing on the element technologies needed to produce single-crystal alloys, the goal is to develop ultrahigh heat resistant alloys, heat resistant and tough alloys, and light weight and tough alloys. •The increased light weight, toughness and heat resistance of such alloys will be reflected in the greatly increased performance capabilities of machinery and equipment in such leading-edge technological fields as nuclear power, aircraft design and space, and new alternate energies, as well as in savings in energy consumption.
6.	Composite materials	•The goal is to develop resin-based composite materials (FRP) and metal-based composite materials (FRM) as light weight, high-strength and high-resistance structural materials. •When used as structural materials in aircraft and space equipment, these materials are expected to greatly increase the aircraft's and space equipment's performance capabilities. Furthermore, their use in transport systems, such as automobiles, will contribute to great reductions in energy consumption.
7.	Photoreactive materials	•By controlling the molecular structure or their state of assembly using light, the aim of the research is to develop photoactive materials applicable as mediums for ultrahigh density information recording. •These materials will accelerate the development of ultra-large capacity memory devices for ultra-large computers, and of ultra-small home or business disk drives. They are also expected to contribute to high-resolution display technology and high-speed optical computation and processing technology utilizing optical switches.

[continued]

[Continuation of Table 3-3-13]

Biotechnology (¥1,085 million)	
1. Bioreactor	•The goal is to develop bioreactors that will make it possible to effect great reductions in resource and energy consumption in some of the major reactions in the chemical industry that consume large amounts of energy (for example, oxidation reactions and synthesis reactions). •The use of these reactors in the reaction process in the chemical industry will provide hope for the debut of an energy-saving type of chemical industry that will operate at normal temperature and pressure, or for a pollution-free chemical industry.
2. Technology for large-quantity culture of cells	•The goal is to develop substitutes for bovine embryonic sera, indispensable in the culture of animal cells, and to develop the fundamental technology for the high-density culture of animal cells using these substitutes. •Fundamental technology, one of the basic ingredients of biotechnology, is expected to make it possible to supply large quantities of fine chemical products on a stable basis, a process that, until now, has eluded industrial production.
3. Recombinant DNA utilization technology	•The goal is to develop technology that will make it possible to create, by means of recombinant DNA techniques, new microorganisms capable of producing industrially useful substances using the host-vector systems authorized in the DNA experiment guidelines or newly-developed high-safety host-vector systems. •Considered to be among the basic ingredients in biotechnology, these technology-induced useful microorganisms are expected to contribute to the upgrading of the chemical and industrial process in the chemical industry and to savings in resources and energy.
New functional devices (¥1,404 million)	
1. Superlattice devices	•The goal is to develop superlattice functional devices fabricated by laminating ultrathin film crystals of different materials at precision on the atomic level and superstructure lattice devices having electrodes that control the movement of electrons inside semiconductor thin film crystals of less than several thousand A. •These devices, usually operating at normal temperatures, are expected to give rise to the [continued]

[Continuation of Table 3-3-13]

	following advantages: calculations at speeds surpassing the barriers of existing devices, and oscillations and amplifications at ultrahigh frequencies.
2. Three-dimensional circuit devices	•The goal is to develop, based on laminated structures, multifunctional integrated devices whose multiple functions, such as the signal conversion function and sensor function, are integrated into one structure, and high-density integrated devices in which the logic function, memory function and others are integrated in high density. •The larger capacities that surpass the limits of existing devices are expected to lead to smaller computers and the parallel high-speed processing of multiple signals. Imparting a device with multiple capabilities (measurement, calculation, memory, display, etc.) may make it possible for a single integrated circuit device to perform, for example, human visual information processing.
3. Biodevices	•The goal is to explain, by means of engineering, the excellent information processing functions inherent in animals, such as learning and memory, and realize new functional devices. To that end, the molecular organization technology that enables the plasticity, molecular recognition and self-organization capabilities inherent in living bodies to be realized will be developed. Biochips represent a challenge to the upper limits of integration available with the existing semiconductors, and they are expected to find applications in data processing equipment that will be able to solve efficiently those problems that existing computers find hard to handle.

6. Promotion of R&D Through Cooperation of Various Fields

In recent years, the social and economic requirements for science and technology have been diversifying and becoming complex. If science and technology is to contribute to solving such problems, it will be necessary to clarify the objective of the R&D project involved and to approach it comprehensively and systematically, employing the cooperation of people from various fields.

Such large-scale projects as nuclear power development, energy R&D other than nuclear power, space development, aircraft technology R&D, and ocean development, in particular, require large sums of money and large numbers of people, and they also require long development periods. Therefore, it is becoming necessary for such projects to be promoted through the close cooperation of academia and industry. Among other R&D activities that should be promoted through multidisciplinary cooperation are life sciences, materials science and technology, disaster-prevention science and technology, new science and technology fields such as earth science and technology and soft science, large-scale R&D, and R&D projects funded by the Coordination Funds for Promoting Science and Technology.

(1) Nuclear power development

Japan has been promoting the research, development and utilization of nuclear power, the core of oil alternative energies, in accordance with the Long-Term Nuclear Power Development and Utilization Plan (revised in June 1987) adopted by the Atomic Energy Commission (AEC), comprehensively and on a planned basis. The basic objectives of the development and utilization have been to establish nuclear power as the core energy, to foster creative science and technology, and to contribute to the international community.

The first prerequisite is promoting the research, development and utilization of nuclear power is the securing of safety, and this was again underscored by the April 1986 accident that occurred at the Chernobyl Nuclear Power Plant in the USSR. Taking the Soviet accident as a warning, the government should further strive to realize nuclear safety by drawing on lessons taught by the accidents and problems at home and abroad. To that end, the government has been aggressively implementing various measures to secure nuclear safety, beginning with the power promotion of research on nuclear safety, while, at the same time, strengthening disaster-preventive structures in preparation for an emergency.

As for nuclear power generation in Japan, 35 commercial reactors were in operation as of the end of March 1988, generating about 27.88 million kw of electricity, or accounting for approximately 17 percent of the total power generating capacity. In FY 1987, nuclear power output accounted for approximately 30 percent of the total electricity generated and, as such, nuclear power is an indispensable ingredient of Japan's power supply.

In order for nuclear power to be able to play a focal role as a stable energy source in the future, Japan will have to establish its own nuclear fuel cycle at the earliest date possible. Therefore, while striving to attain a steady supply of natural uranium from abroad and access to enrichment services rendered by foreign countries, Japan has been promoting various measures for the domestic enrichment of uranium, drawing on its previous R&D results, for the establishment of domestic reprocessing businesses, and for the disposal of radioactive waste. Furthermore, from the viewpoint of realizing the effective use of uranium resources, Japan has been promoting the R&D of advanced conversion reactors, fast breeder reactors, nuclear fusion that is said to be the ultimate energy source for mankind, high-temperature gas reactors, and nuclear ships.

Internationally, the tendencies are for stringent constraints to be imposed on the research, development and utilization of nuclear power from the perspective of intensifying nuclear nonproliferation. Standing on Japan's grounds that the research, development and utilization of nuclear power are strictly limited to peaceful purposes and that the peaceful utilization of nuclear power and nuclear nonproliferation are compatible, Japan will continue to promote cooperation with other advanced countries, and has also been aggressively promoting cooperation, as a nuclear advanced country, with developing countries (see Part 4 of Chapter 2 for international cooperation).

Table 3-3-14. List of Nuclear Power Related Budgets

(Unit: ¥1 million)

Item	FY 1986 budget	FY 1987 budget
(1) General account		
Investment and grants-in-aid to JAERI	101,556	99,462
Investment and grants-in-aid to PNC	65,925	64,289
Funds for National Institute of Radiological Sciences	6,463	7,085
Expenditures for research and experimental activities in national experimental and research institutions	1,774	1,789
Investment in Institute of Physical and Chemical Research	3,469	3,549
Expenditures for radioactivity survey and research	991	765
Expenditures for radioactive waste processing and disposal	138	138
Expenditures for commissioning of research projects for peaceful utilization of nuclear power	89	77
Expenditures for elevating quality of scientists and engineers	94	94
Funds for Atomic Energy Commission	144	144
Funds for Nuclear Safety Commission	243	295
General administrative funds for Atomic Energy Bureau	327	339
General administrative funds for Nuclear Safety Bureau	685	783
Funds for Radiation Commission	1	1
Total disbursements by Science and Technology Agency	181,899	178,811
Total administrative costs of ministries and agencies (other than STA)	4,023	4,496
Subtotal	185,922	183,308
(2) Special accounts for promoting development of electric power resources		
Electric power resource siting account	65,167	68,114
Electric power resource diversification account	106,238	108,800
Subtotal	171,407	176,914
Grand total	357,329	360,222

Table 3-3-14 shows nuclear power-related budgets for FY 1987, while Table 3-3-15 shows year-to-year changes in the nuclear power-related budgets for the major countries.

Table 3-3-15. Changes in Nuclear Power Related Budgets of Major Countries

Country	Unit	1984	1985	1986	1987
Japan	Y1 million	3,066	3,389	3,573	3,602
United States	Y1 million	7,797	8,073	5,845	4,827
	$1 million	3,283	3,385	3,469	3,338
Great Britain	Y1 million	733	1,203	1,021	984
	£1 million	227	389	413	415
France	Y1 million	1,914	1,909	1,852	—
	Million francs	7,043	7,189	7,611	
West Germany	Y1 million	1,832	1,701	1,443	1,319
	Million marks	2,195	2,099	1,859	1,639

Notes: The figures do not contain expenses for military utilization.
In the case of Japan, the figures contain appropriations in the Special Accounts for Promoting Development of Electric Power Resources (those for nuclear power).
The conversion rates into Japanese yen are based on attached material 33.

Sources: Japan (same as Table 3-2-12);
United States (combining DOE and NRC figure);
Great Britain (total expenditures from UKAEA--UKAEA annual report);
France (expenditures from CEA--CEA annual report);
West Germany (Federal Research and Technology Ministry budget)

1) Security of safety

In full awareness of the dangers of radiation, the development of the technology for nuclear utilization has been conducted, since its initial stages, by placing the highest priority on the securing of nuclear safety, supplemented by the implementation of sure measures for controlling radioactive materials, and, with respect to nuclear security, the nuclear power industry has been placed under as strict legal controls as have never been seen in any other industry.

To be concrete, the Law of Regulation of Source Materials, Fuel Materials and Nuclear Reactors specifies that, when designating a refining business enterprise, issuing a permit to start processing operations, issuing a permit to install a nuclear reactor, designating a reprocessing business enterprise, or issuing a permit to start a waste disposal business, the minister in charge is required to obtain the opinion of the Atomic Energy Commission and the Nuclear Safety Commission. Especially, with respect to nuclear safety, an issue of great concern to the people, the Nuclear Safety Commission is required to study and examine the results of safety reviews undertaken by various government agencies.

Furthermore, prior to initiating the examination and deliberation of the results of a safety review undertaken by the administrative agency concerned involving any nuclear facility, such as a commercial nuclear power reactor that is scheduled to be built, the Nuclear Safety Commission, under the Basic Program for Development of Electric Power Resources, holds an open hearing (primary hearing) before the project is adopted in an effort to obtain the opinions of the local populace regarding various problems associated with the project, such as its safety. Even after approval has been given for the construction of the facility, the concerned administrative agencies will implement safety controls and the Nuclear Safety Commission will examine the deliberate any items deemed necessary.

Once a nuclear reactor has been installed, the owner of the reactor and the local autonomous body concerned are required to undertake environmental radioactivity monitoring tests to confirm that the counts of radioactivity in the environment are well below the permissible exposure dosage set down by law, as well as to implement exposure control inside the facility. The government has been giving financial and technical assistance to the local autonomous bodies concerned.

Research on the safety of light water reactors and facilities has been undertaken mainly by the Japan Atomic Energy Research Institute (JAERI), and research is underway on reactor reactivity accidents and reactor coolant loss accidents. In FY 1987, while continuously conducting various tests using the Nuclear Safety Research Reactor (NSRR), experiments were also conducted using large nonstationary equipment under the ROSA-IV (Rig of Safety Assessment) program which simulates a loss of coolant accident caused by a small-aperture rupture in a pressurized water reactor.

Studies on the safety of advanced conversion reactors and facilities, high-speed breeder reactors and facilities, nuclear fuel facilities, the transport of nuclear fuels, and the processing and disposal of radioactive wastes have been undertaken mainly by the Power Reactor and Nuclear Fuel Development Corp. (PNC).

As for radioactive substances, such as iodine, discharged from nuclear power facilities into the environment, in order to reduce the amounts of their emissions, analyses of the behavior of fission products (FP), R&D of recovery techniques, and processing technology involving radioactive waste R&D have been undertaken.

As for public exposure to the radioactive substances discharged from nuclear facilities into the environment, efforts are being made to keep the exposure levels well below the recommendations of the International Committee for Radiation Protection (ICRP) and the levels stipulated in by law. The National Institute of Radiological Sciences has been conducting research on factors of great importance in estimating the influence of exposure to low dosage or low dosage rates of radiation on humans, with the studies focusing on the influence of a late-occurring radioactive disease on the patient's body, its influence on heredity, a damage evaluation of internal exposure while taking into account the specificities of the exposure forms, and an evaluation of exposure to environmental radiation.

As for disaster prevention measures in connection with nuclear power plants, etc., required actions are to be implemented in accordance with the disaster prevention program based on the Disaster Prevention Basic Law. Taking a lesson from the accident at the Three Mile Island Nuclear Power Plant in the United States, following on the heel of the Central Disaster Prevention Council decision of 1979, in June 1980 the Nuclear Safety Committee compiled the results of studies of technical and expert matters pertaining to disaster prevention in a report entitled "On Disaster Prevention Measures at Nuclear Power Plants and in Their Vicinities." In an effort to implement the results of these studies, the government has prepared various manuals, has provided the concerned local autonomous bodies with guidance and advice, and has given the financial disbursements necessary to enforce nuclear disaster preventive measures. The local autonomous bodies, on their part, have been strengthening nuclear disaster preventive measures, such as constructing public information networks for emergencies, constructing emergency medical facility, and holding lecture sessions.

The Nuclear Safety Commission also conducted an in-depth survey and study of the nuclear power plant accident that occurred in the Soviet Union in April 1986 and published a report in May 1987. After taking into account the specific features of nuclear power plants in Japan, the report concludes that, basically, there is no need to revise the existing systems or measures for nuclear disaster prevention, but due to the current accident, studies are being promoted to further strengthen the contents of the various disaster prevention measures and make them more practical.

2) Establishment of nuclear fuel cycle

If Japan's nuclear power generation is to be promoted smoothly in the future, the establishment of a nuclear fuel cycle aimed at the stable supply of nuclear fuel and the effective use of uranium resources is a policy matter of every increasing importance.

a. With respect to the securing of uranium resources, Japan has been relying on long-term purchase contracts while trying to diversify its supply sources, but, at the same time, Japan has been promoting its own prospecting activities and equity investments into mining development projects. In FY 1987, PNC conducted, on its own or in cooperation with organizations abroad, surveys and prospecting activities mainly in Australia, Canada and African countries. Private firms have also been promoting uranium prospecting and development activities abroad using "repayable-on-success" loans from the Metal Mining Agency of Japan.

b. Since the mainstay of nuclear power generation is light water reactors using enriched uranium as fuel, the securing of enriched uranium on a stable basis is also an important task.

Japan has concluded contracts with the United States and France for the provision of uranium enrichment services, enabling Japan to obtain sufficient amounts of enriched uranium required to keep its LWRs operating for now, but from the viewpoint of securing a stable supply of enriched uranium for the long term, the development of uranium enrichment technology based on a centrifugal separation method has been underway as a national project. While continuing to operate its pilot plant, PNC embarked on the construction of a prototype plant at Ningyo Toge in Okayama Prefecture in November 1985, with the plant entering partial operation in March 1988.

The construction of a commercial plant, on the other hand, is being prepared by Japan Nuclear Fuel Industries Co. at Rokkasho-mura, Aomori Prefecture, with its operation scheduled to start some time in 1991.

Furthermore, to raise the economy of uranium enrichment in the future, the development of new technology is being promoted. Regarding centrifugal separation technology, the development of a high-performance centrifuge incorporating new materials is underway to evaluate the feasibility of its practical application. Regarding laser uranium enrichment technology, the development of the atomic method is being promoted for a two-pronged approach, with a research association made up of private firms concentrating on development and the Institute of Physical and Chemical Research (RIKEN) engaged in long-term, basic R&D. As for the molecular method, PNC and RIKEN are advancing research to demonstrate its principle. With respect to the chemical method, the technique is undergoing testing by the private sector to ascertain its prospects for practical use.

c. Regarding spent nuclear fuel, the basic policy is to reprocess it and utilize the uranium and plutonium thus obtained to realize the effective utilization of uranium resources. Spent nuclear fuels are currently being reprocessed at PNC's Tokai Reprocessing Plant, while some are shipped to Great Britain and France for reprocessing on a contract basis.

The Tokai Reprocessing Plant processed about 51 tons of spent fuel in FY 1987, with the aggregate of spent nuclear fuels processed there as of the end of March 1988 reaching about 373 tons.

Regarding a privately-owned reprocessing plant, the Japan Nuclear Fuel Service Co. is preparing for the construction of a reprocessing plant in Rokkasho-mura, Aomori Prefecture, that would have an annual capacity of about 800 tons, aiming for its start of operations in the mid-1990s.

PNC is also advancing the R&D of methods for reprocessing spent nuclear fuel from fast reactors by drawing on its experience obtained from reprocessing at its Tokai plant.

d. In order to establish a nuclear fuel cycle, the establishment of a radioactive waste processing and disposal setup is an important task and, to that end, the following measures are being undertaken.

Efforts are being made to reduce the amounts of low-level radioactive wastes discharged from the nuclear power plants, etc. The wastes generated are disposed of after being treated for volume reductions and solidification. The basic disposal policy includes both land and ocean disposal.

As for land disposal, low-level radioactive wastes are laced inside drums and are solidified in cement before being buried in shallow geological formations. Japan Nuclear Fuel Industries Co. is currently promoting plans for the construction of a plant for the concentrated processing of low-level radioactive solid wastes in Rokkasho-mura, Aomori Prefecture, targeted to begin operations in 1991.

As for ocean disposal, the policy is to dispose of low-level radioactive wastes on deep seabeds, following the international standards. To that end, required surveys will be undertaken in the future, and efforts will be made to obtain the understanding of concerned people at home and abroad. Japan, however, will go ahead with ocean disposal prudently, rationalizing that the ocean disposal will not be carried out by ignoring the features of the countries involved.

High-level radioactive wastes, in the form of liquid wastes, are currently safely contained in tanks inside PNC's Tokai Reprocessing Plant.

The basic policy for the disposal of high-level radioactive wastes is to vitrify them into a stable form, keep them in storage for 30~50 years for curing, and then bury them in geological formations several hundred meters underground. The technological development related to vitrification, the storage of the solidified waste, and geological disposal is being undertaken principally by PNC, while the research devoted to safety measures are principally being promoted by JAERI. PNC is building a vitrification plant, scheduled for start-up some time around 1991. The institute is also promoting plans for the construction of a "Storage Engineering Center," which will be engaged in R&D to establish geological disposal technology, such as the execution of deep, underground tests, as well as in storing high-level radioactive wastes. Furthermore, the R&D aimed at establishing geological disposal technology will be undertaken systematically, with PNC as the core research promoter. The development of the technology to separate useful metals from high-level wastes and the "nuclear separation (group separation)/ quenching technology," which is a technology for transforming long-life nuclides into short-life nuclides or nonradioactive nuclides, is being promoted principally by JAERI and PNC.

3) An advanced type of reactor and plutonium utilization

In order to realize the effective utilization of uranium resources and thus heighten the supply stability of nuclear power generation, the goal of Japan's nuclear policy is to aim for the establishment of a plutonium utilization system that, from a long-term perspective, improves uranium utilization in LWRs in terms of safety and economy. That is, the plutonium obtained by reprocessing will basically be used in fast breeder reactors, which are overwhelmingly advantageous in terms of utilization efficiency of uranium resources, and the R&D of the FBR will be promoted on a steady basis.

As an interim measure before FBRs are put to practical use, the utilization of plutonium in LWRs and the advanced type of conversion reactors will be promoted in order to establish a broad technological base in plutonium utilization. The R&D of the fast breeder reactor technology for the MOX fuel needed for the aforementioned reactors is being promoted by PNC.

The FBR is epochal in that during the generation of electricity, it produces more nuclear fuel than it consumes. Consequently, by exploiting uranium resources, the technology will basically be able to solve the problem involving nuclear fuel, and FBRs are expected to become the mainstay of nuclear power generation in the future. The Japanese development of the FBR based on domestic technology has been underway since 1968 under the direction of the PNC.

In this regard, the experimental reactor "Joyo" completed its operation in December 1981 at a thermal output of 75,000 kw. In March 1983 the reactor was remodeled into a reactor core for irradiation use, with a thermal output of 100,000 kw. In August 1983, it entered rated operation, conducting irradiation tests of fuel and materials for FBRs.

Plans to construct the prototype reactor "Monju" (electrical output: about 280,000 kw) were adopted at a Cabinet meeting held in May 1982, and the Shiraki area in Tsuruga City, Fukui Prefecture, was selected as the site of the reactor with the consent of the Fukui Prefectural governor. On 27 May 1983, the prime minister approved the construction of the "Monju."

Prior to the approval, preliminary construction was started in January 1983, with construction of the reactor proper started in October 1985. Construction is now underway, aiming at the attainment of criticality in FY 1992.

As for the development of the demonstration reactor, the Long-Term Nuclear Power Development and Utilization Plan envisions development to start in the latter half of the 1990s, and stipulates that the work be promoted by close cooperation between the electric power companies, who are to play a leading role in the design, construction and operation of the reactor, and the PNC, who is expected to play an important role in the R&D of the reactor. Therefore, the Atomic Energy Commission inaugurated the FBR Development and Planning Special Committee, and the committee is studying measures for the long-term promotion of FBR development.

As for the advanced type of conversion reactor, the prototype reactor "Fugen" (deuterium reduction, boiling water light water cooling type, 165,000 kw in electric output) went into full-fledged operation in March 1979 and, on the whole, the reactor has been running smoothly. The reactor has also been providing an avenue for the R&D necessary for the design of a demonstration reactor, as well as for the accumulation and evaluation of operation experience and data.

As for the demonstration reactor (about 600,000 kw in electric output), the "Special Committee To Evaluate the Demonstration Reactor for an Advanced Type of Conversion Reactor" established within the Atomic Energy Commission began studying the technical and economic aspects of the conversion reactor in February 1980, and submitted a report detailing the significance of the advanced type of conversion reactor and the appropriateness of building the demonstration reactor to the Atomic Energy Commission. Upon receiving the report, the Atomic Energy Commission and the Federation of Electric Power Companies investigated who should construct and operate the demonstration reactor, and in August 1982 the Atomic Energy Commission adopted the basic policy that the demonstration reactor program should be promoted through government-private industry cooperation, with the Electric Power Development Co. serving as the entity responsible for the construction and operation of the reactor. The Electric Power Development Co. then conducted an environmental impact assessment survey in Oma Town, Aomori Prefecture, the scheduled site for the reactor, and in January 1984 embarked on the drafting of the basic design. After studying the results of the environmental assessment survey and the progress of the basic design work, in June 1985 the Electric Power Development Co. submitted a report to the concerned local authorities asking their cooperation in the project. The company plans to promote the construction of the demonstration reactor with the cooperation of PNC and the Federation of Electric Power Companies, aiming at an FY 1998 start-up.

4) High-temperature engineering testing and research

In order to study the approach to high-temperature engineering testing and research, the "Special Committee on the High-Temperature Gas Reactor R&D Program" was established within the Atomic Energy Commission in March 1986. The special committee conducted deliberations and studies, and put together an interim report in August of the same year, followed by a final report that December. The report states that, featuring excellent characteristics, such as supplying high-temperature heat, high inherent safety, and high fuel burn-up, the high-temperature gas reactor is expected to contribute to solving important tasks associated with nuclear power development, such as the need for increased economy and expanded scope of application, while securing its safety, and therefore, the technology's R&D has great significance. Furthermore, the use of a high-temperature gas reactor in the high-temperature region for such purposes as irradiation testing, especially in the materials system science and technology field, is expected to contribute to the creation of seeds for new technologies that might conceivably lead to technical innovations in the future. In light of the above advantages, the report proposes that it is necessary to establish the fundamental technology for a high-temperature gas reactor and upgrade it, as well as to promote pioneering basic research in high temperature engineering, and that the experimental reactor program that had been thought to be a step toward the commercialization of the rector should be reviewed with a view to upgrading the program so that an engineering test reactor provided with required functions, such as high temperature and substantial irradiation capabilities, can be constructed immediately. Drawing on its technology and expertise, JAERI plans to submit a request for approval of the construction of a high-temperature engineering test reactor in FY 1988, aiming at the start of construction in FY 1989.

5) Nuclear fusion

In nuclear fusion energy, the primary fuel source--deuterium--can be obtained from seawater and, therefore, when the technology has been put to practical use, it will guarantee rich supplies of energy.

For this reason, nuclear fusion energy is expected to provide an important energy source for mankind in the future, and the R&D of the technology is a matter of exigency for Japan, being poor in energy resources.

Nuclear fusion R&D has been promoted in line with the "Basic Program for Two-Step Nuclear Fusion R&D" of July 1975 and the "Long-Term Nuclear Power Development and Utilization Plant" of June 1987, both drafted by the Atomic Energy Commission.

In line with the basic program and the long-term plan, the emphasis in R&D has been placed in the attainment of the critical plasma condition. Focused on the development of the tokamak "Critical Plasma Test Equipment (JT-60)" (the goals are a plasma temperature of from several dozen million degrees to about 100 million degrees, and a power of plasma density and confinement time at 2~6 x 10^{10} sec/m^3), the following research projects have been undertaken: R&D of noncircular, cross sectional torus magnetic field equipment; R&D of high vector plasmas; R&D of nuclear fusion reactor core technology in relation to plasma diagnosis; and R&D of nuclear fusion reactor engineering technology. These R&D projects have been promoted by JAERI, as the major force, and by the Electrotechnical Laboratory and the National Research Institute for Metals. In September 1987, the JT-60 attained the target area of the energy-break-even plasma condition, thus demonstrating the possibility of building a nuclear fusion reactor.

In addition to the above research activities, universities are expected to conduct basic and creative research in such fields as confinement methods and reactor engineering technology. In line with the three research promotion measures--1) promotion of research into nuclear fuel; 2) promotion of research of methods other than the tokamak; and 3) promotion of research of reactor materials and related fields--research on plasma physics and related fields has been widely advanced at Nagoya University (tokamak and others), Kyoto University (heliotron), Osaka University (laser nuclear fusion), Tsukuba University (compound mirrors), and Kyushu University (high magnetic field tokamak). During FY 1988, the newly inaugurated "inaugural preparation office" is planning the creation of the "Nuclear Fusion Science Research Laboratory" (provisional name), a joint research facility for universities, and the construction of large helical equipment. Regarding international cooperation, such cooperative activities as the exchange of researchers, information exchange, and participation in joint R&D projects have been promoted through IAEA and OECD/IEA forums. Especially noteworthy is the fact that, under the auspices of the IAEA, joint activity for designing the international thermonuclear fusion experimental reactor (ITER), involving

Japan, EC, the United States and the Soviet Union, was started in April 1988, and Japan intends to participate aggressively in the program.

Based on the Japan-U.S. Agreement for Cooperation in R&D of Energies and Others concluded in May 1979, in August of the same year joint research was undertaken by Japan and the United States using the nuclear fusion experimental equipment "Doublet III" in the United States. Since then, the HFIR/ORR, FNS, TSTA and FFTF/MOTA joint research projects have been undertaken and, since 1983, exchanges of researchers, information exchanges and joint projects have been undertaken aggressively based on the "Agreements on Japan-U.S. Nuclear Fusion R&D Cooperation."

6) Nuclear ships

Regarding the R&D of nuclear ships, in order for Japan's nuclear ship technology, knowledge and experience to increase, the policy is to promote nuclear ship R&D gradually and steadily in accordance with the "Basic Plans for Research and Development of Nuclear Ships at the Japan Atomic Energy Research Institute," adopted in March 1985, and the activity for now will involve obtaining experimental data, as well as knowledge, regarding the sea using the nuclear ship "Mutsu" and putting the results thus obtained to practical use to conduct research on improving reactors for use in ships.

As for R&D using the nuclear ship "Mutsu," after going through such tests as the reactor output rise experiments and sea trials to confirm its performance, the ship will be put out to sea for trial cruises lasting about 1 year to study the effects of vibration, rolling or itching, or load changes of the sea on the reactor, and then the ship is to be decommissioned. In FY 1987, the construction of a new berth in the port of Sekinehama continued from the previous year.

In September 1982, after an overhaul including improvements in shielding and safety checks in Sasebo Port, the nuclear ship "Mutsu" was brought to Ominato Port in Mutsu City, Aomori Prefecture, and in January 1988 it was returned to Sekinehama Port where it is now anchored.

7) Utilization of radiation

Radiation has come to be used in a broad variety of fields, beginning with the basic science and covering medicine, agriculture and industry, and the number of business entities using radioactive isotopes or various radiation generating systems has been increasing annually in such fields as medicine, agriculture and industry. As of March 1988, the number of business activities that had been approved for the use of radiation or had filed a request for approval for the use of radiation in accordance with the provision of the Radiation Damage Prevention Law had reached 4,685.

The use of radiation in the medical field consists of two types: one is diagnosis using X-rays or radioactive isotopes, and the other is therapy using high-energy radiation generators (cyclotrons, linacs, etc.) or radiation irradiation equipment and instruments (Cobalt 60). Especially, in the treatment of malignant tumors (cancers), which are the major targets for radiation therapy, fast neutron or proton beams form the medical cyclotron at the National Institute of Radiological Sciences have been used for cancer treatment, and the procedure has been highly effective in the treatment of malignant melanomas. The construction of cancer treatment equipment using heavy particle beams, which result in a much higher remedial effect, has been underway at the above institute, aiming at clinical trials of the equipment in FY 1993. Research into cancer diagnosis and treatment using proton beams has been undertaken in universities, such as the research at the Particle Beam Medical Center of the University of Tsukuba.

In the field of diagnosis using radiation, diagnosis using positron emission nuclides (diagnosis by positron CT) has been drawing attention, and research has been underway on equipment development and image-processing techniques at the National Institute of Radiological Sciences, universities and national hospitals.

In industry, radiation has been used in a broad range of businesses in such applications as gauging, nondestructive testing, X-ray analyses, and activation analyses. In agriculture, radiation technology has seen widespread diffusal in such applications as improvement of crop species, use as a tracer in the study of the biological mechanisms of plants and marine animals, activation analysis and the elimination of insects and pests.

As for irradiation of food, in accordance with the Atomic Energy Commission's "Food Irradiation R&D Basic Program," R&D projects were completed on seven crops, including potatoes and tangerines, in March 1988 at the national research institutes and JAERI.

The irradiation of food has come to be increasingly practiced in foreign countries, and in Japan the efforts for the introduction of various systems aimed at diffusion of the technique will be promoted with the cooperation of concerned administrative organizations and with the understanding of the consumers.

As for the elimination of insects and pests, attempts have been made in Okinawa Prefecture and Amami Oshima Islands to exterminate "Urimi" flies by letting loose large numbers of infertile bugs that have been subjected to gamma ray irradiation.

In addition to the expanded use of radiation as mentioned above, the R&D of technologies for higher-level utilization of radiation, such as accelerator technology, beam control technology and generation technology of new radiation beams, has been drawing attention. Therefore, the following R&D activities have been underway: research on nuclear elementary particles using proton beams or emitted light (SOR) at the National laboratory for High Energy Physics of the Ministry of Education, Science and Culture; research on nuclear physics, materials and biology using heavy ions at the Institute of Physical and Chemical Research (RIKEN); research on high-level utilization of radiation aimed at the wide-scale application of heavy particle beams at JAERI; and research on techniques to generate small SOR and free electron lasers at the National Institute of Radiological Sciences. At the National Laboratory for High Energy Physics of the Ministry of Education, Science and Culture, efforts are being made to construct a light source to emit light of high luminance with short wavelengths, and the R&D of large-scale emitted light (SOR) facilities is being promoted with the cooperation of JAERI and RIKEN.

As the utilization of radiation has progressed, the demand for radioisotopes has been increasing yearly. Not relying on imports alone, JAERI, the National Institute of Radiological Sciences and private firms have also manufactured radioisotopes.

The JAERI manufacturing is focused on nuclides that are in strong demand and RI, the demand for which cannot be met with imports because of their short lifetimes, while the National Institute of Radiological Sciences is engaged in the R&D of manufacturing technology of short-life radioactive agents using a medical cyclotron.

Regarding the R&D of the techniques to utilize radiation, the Long-Term Nuclear Power Development and Utilization Plan adopted by the Atomic Energy Commission in June 1987 says, "The emphasis in R&D will be placed on the creation of sophisticated technologies, such as new beam generation and utilization technology and tracer technology, that will open new doors to nuclear power utilization and will contribute to a broad sector of science and technology."

(2) R&D of energy sources other than nuclear power

In order to secure a stable supply of energy, it is necessary to use a variety of energy resources, such as natural energies like coal in a new use mode, solar energy, and geothermal energy, in addition to the aforementioned nuclear power, while striving for the effective use of these energy resources.

In order to promote energy R&D comprehensively and efficiently, in August 1978 the government prepared the "Energy R&D Basic Plan," covering not only the aforementioned nuclear power, but also new energy technologies and effective utilization technologies of energies. The basic plan is subject to review as the R&D progresses.

Promising energy R&D fields in Japan other than nuclear power include fossil energy resources, natural energy resources, the effective utilization of energy resources, and environment protection and safety preservation in connection with the supply and utilization of energy resources. Described below are some of the major R&D projects from each of the above four categories that have been promoted as projects.

In the category of fossil energy resources, aiming for expanding the use of coal as a more flexible and cleaner energy resource, the following technical development activities have been underway: coal gasification (manufacture of hydrogen from coal, gasification combined cycle power generation) technology; technology to liquefy bituminous coal; and brown coal liquefaction technology.

In the fields of natural energy resources, R&D has been promoted on geothermal, solar, ocean, wind and biomass energy resources, aimed at increasing the supply of domestic energy resources.

The installed capacity of geothermal power-generating plants stood at about 220,000 kw as of December 1987, but in order to further expand the utilization of geothermal resources, efforts have been made to develop geothermal energy prospecting and exploration technology while, at the same time, conducting R&D of hydrothermal power generation technology and high-temperature dry rock power generation technology.

As for solar energy, the commercial solar heat air-conditioning and hot water supply system that employs solar heat as the heat source is in the stage of practical use. In addition, the R&D of industrial solar systems and solar light power-generating systems has been promoted. Regarding solar light power generation, R&D has been conducted in the manufacturing technology of solar cells, such as amorphous silicons, and various types of application systems have been developed.

With respect to ocean energy, R&D has been conducted on wave-power power generation using ship-like power-generating equipment and on power generation taking advantage of differences in ocean temperature.

As for wind-power energy, R&D has been conducted on the fundamental technologies for a one-megawatt-class wind-power power-generating system, as well as on methods for converting wind energy into heat for its utilization.

Regarding the research on methods of manufacturing liquid fuel from hydrogen system biomasses and on the technology that employs animals or photosynthesis function as the energy source, R&D has been promoted on using plants and bacteria to produce fuel alcohol as well as on the production of hydrogen by taking advantage of the photosynthesizing function and on organic system solar cells.

In the field of effective energy utilization, various R&D projects, covering a broad spectrum of society including industry, people's livelihood and transportation, have been making steady progress. They include: high-efficiency gas-turbine power generation aimed at a drastic increase in power generation efficiency; high-efficiency fuel cell power generation technology applicable to a broad scope of equipment, from a small dispersed type to a large-scale type of system; a new type of battery-power storage system for leveling fluctuations in electric power loads and a super heat-pump energy integration system; hydrogen energy technology that enables large quantities of hydrogen to be manufactured, transported and stored economically in order to contribute to diversifying the utilization modes of secondary energy; technology to realize energy-savings in consumer appliances, such as the general-purpose Stirling engine, in order to achieve savings in civiliansector energy consumption that is expected to increase in the future; technology to realize energy-savings in buildings; and technology to realize the effective utilization of natural energy resources in agriculture, forestry and fisheries industries.

(3) Space development

1) Regarding space development, many satellites have been developed and utilized in a broad range of fields, beginning with scientific observation, communications, broadcasting and weather observation, and extending to earth observations for resources prospecting and environmental protection, as well as navigation aids for shipping, and the results of such activities have come to play an important role in the everyday life of the people.

In the field of space environment utilization in which the R&D of new materials has been undertaken by taking advantage of the special space environment featuring microgravity and an ultrahigh vacuum, the Space Station Program, an international cooperative project involving Japan, the United States, Europe and Canada, has been promoted aggressively. The importance of space development will increase further in the future since the activity will open up a new frontier of activity for mankind.

2) Space development in Japan has been promoted by the National Space Development Agency (NASDA) and the Institute of Space and Astronautical Science (ISAS) of the Ministry of Education, Science and Culture, with the cooperation of concerned agencies, in line with the long-term guidelines contained in the "Outline of Space Development Policy" drafted by the Space Activities Commission in March 1978--since revised in February 1984--and the "Space Development Program" that the above commission adopts every fiscal year in accordance with the aforementioned guidelines.

Specifically, the development of satellites and rockets for scientific research in Japan has been undertaken by ISAS, while the development of commercial satellites and rockets has comprised NASDA's turf. Following the launching of test satellite "Osumi" in 1970, 38 satellites had been launched as of March 1988.

Records of development of satellites in Japan and future development plans are given in Table 3-3-16, while those for rockets are shown in Table 3-3-17.

Table 3-3-16. Records of Satellites Launched in Japan and Future Plans

(1) Satellites launched FY 1975 onward (as of March 1988)

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Scientific field					
Test satellite Tansei No 3	129	Elliptical 790/3,810	M-3H	19 Feb 77	To confirm the performance of launch rocket and to conduct experiments in satellite posture control
No 5 scientific satellite Kyokko	126	Elliptical 630/3,970	M-3H	4 Feb 78	To observe plasma density, temperature, electron energy distribution, and aurora particles
No 6 scientific satellite Jikiken	90	Oblong 227/30,051	M-3H	16 Sep 78	To observe electron density, particle beams, and plasma waves
No 4 scientific satellite Hakucho	96	Elliptical 550/580	M-3C	21 Feb 79	To observe X-ray stars, X-ray bursts, and supersoft X-ray nebulae
Test satellite Tarsei No 4	185	Elliptical 520/605	M-3S	17 Feb 80	To obtain the performance of the launch rocket and to conduct engineering tests and performance tests of the instruments, all necessary for the No 7 scientific satellite and those following
No 7 scientific satellite Hinotori	188	Circular 576/644	M-3S	21 Feb 81	To observe 2D images of solar hard X-ray flares, X-ray bursts, and solar particle beams
No 8 scientific satellite Terma	216	Elliptical 497/503	M-3S	20 Feb 83	To observe X-ray stars, X-ray Galaxy, and soft X-ray nebulae

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Space science experiments using particle beam accelerator (SEPAC)	--	--	Space shuttle (United States)	28 Nov 83 to 8 Dec 83	To elucidate the light emission mechanisms of auroras, the motions of charged particles in plasmas and excitation of electromagnetic waves
No 9 scientific satellite O-zora	207	Elliptical 327/537	M-3S	14 Feb 84	To conduct atmospheric studies in the stratosphere and the mesosphere, and to elucidate specific phenomena in the ionospheric plasmas
Test planet probe Sakigake	138	Orbit circling sun	M-3SII	8 Jan 85	To confirm performance of the M-3S II, and to achieve interplanetary orbits
No 10 scientific satellite Suisei	140	" " "	" "	19 Aug 85	To observe the inter planetary plasma on the inner side of the earth's orbit, and to observe and study the ultraviolet region of Halley's Comet
No 1 scientific satellite Ginga	420	Abridged 506/669	" "	5 Feb 87	To conduct detailed observations of the nuclear X-ray source in the active Galaxy and various celestial bodies emitting X-rays
<u>Practical-Use Field</u>					
Engineering test satellite I type Kiku (ETS)	82	Circular 980/1,100	N-1	9 Sep 75	To confirm the rocket launch technology, to obtain and increase satellite tracking and control technology, and to conduct tests in extending the antenna.

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Ionosphere observation satellite Ume	139	Circular 990/1,010	N-1	29 Feb 76	To observe the critical frequencies in the ionosphere and worldwide distribution of electric wave noise sources
ETS-II type Kiku No 2	130	Stationary L 130 deg E	N-1	23 Feb 77	To obtain the launch technology of stationary satellites and to learn the tracking and control technology of stationary satellites
Geostationary meteorological satellite Himawari	315	L 160 deg E	Delta rocket (United States)	14 Jul 77	Constant observation of weather from space and collection and distribution of weather data as part of the earth atmospheric development program (GARP)
Test medium-capacity stationary communication satellite Sakura	340	Stationary L 135 deg E	" "	15 Dec 77	To establish operation technology of communications systems using satellites
Ionosphere obser-servation satellite Ume No 2	141	Circular 980/1,220	N-1	16 Feb 78	Observation of world wide distribution of critical frequencies in the ionosphere to help in efficient operation of shortwave communications
Practical medium-capacity broadcast satellite Yuri	385	Stationary L 110 deg E	Delta rocket (United States)	8 Apr 78	To establish technology for operating broadcasting systems using satellites

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Test stationary communications satellite Ayame	130	Note	N-1	6 Feb 79	To establish technology for stationary satellite launch, tracking and control and to conduct communications experiments using millimeter waves
Test stationary communications satellite Ayame No 2	130	Note	N-1	22 Feb 80	To establish technology for stationary satellite launch, tracking and control, and to conduct communications experiments using millimeter waves
Engineering test satellite IV type Kiku No 3	638	Oblong 220/35,820	N-II	11 Feb 81	Confirmation of performance of N-II rocket and testing of on-board space instruments
Geostationary geological-satellite No 2 Himawari-2	296	Stationary L 120 deg E	N-II	11 Aug 81	Development of technology for weather satellites and improvement of the weather observation business
Engineering test satellite III type Kiku No 4	385	Circular 970/1,230	N-I	3 Sep 82	Upgrading of capabilities to develop technology commonly required for satellites consuming large amounts of electricity and mounting tests for space instruments

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Communications satellite 2-a Sakura 2-a	347	Stationary L 132 deg E	N-II	4 Feb 83	Development of communications satellite technology and response to communications demand
Communications satellite 2-b Sakura 2-b	347	Stationary L 136 deg E	N-II	6 Aug 83	Development of communications satellite technology and response to communications demand
Broadcasting satellite 2-a Yuri 2-a	356	Stationary L 110 deg E	N-II	23 Jan 84	Development of broad casting satellite technology and resolution of hard-to-receive TV broadcasting signals
Stationary weather satellite No 3 Himawari 3	303	Stationary L 140 deg E	N-II	3 Aug 84	Improvement of weather observation business and development of weather satellite technology
Broadcasting satellite 2-b Yuri 2-b	357	Stationary L 110 deg E	N-II	12 Feb 86	Development of broad casting satellite technology and resolution of hard-to receive TV broadcasting signals
Geodetic survey satellite (EGS) Ajisai	685	Circular 1,500	H-I	13 Aug 86	Readjustment of triangulation net for land survey in Japan, determination of positions of isolated islands, and establishment of the geodesic datum in Japan
Amateur satellite (JAS-1) Fuji	50	Circular 1,500	H-I	13 Aug 86	Worldwide-scale satellite communications using amateur radios

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Magnetic bearing flywheel experiment system (MABES)	295	Circular 1,500	H-I	13 Aug 86	Floating tests of a magnetic bearing flywheel under a non gravity environment
Marine observation satellite Momo-1	740	Sun synchronous quasi-recurrent orbit 909	N-II	19 Feb 87	Establishment of technology common to ocean observation earth observation satellites
Engineering test satellite V type Kiku-5	550	Stationary L 150 deg E	H-I	27 Aug 87	Confirmation of performance of H-I rocket (3-stage type) test unit; establishment of the fundamental technology for stationary 3-axis satellite bus; accumulation of proprietary technology necessary for development of next-generation practical use satellites; and experiments in mobile communications
Communications satellite 3-a Sakura 3-a	550	Stationary L 132 deg E	H-I	19 Feb 88	Continuous provision of communication services using communications satellite-2; coping with ever increasing and diversifying demand for communications, and development of communications satellite technology

Note) The experimental geostationary communications satellites failed to be lofted into stationary orbit.

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
(2) Satellites scheduled for launch (as of April 1988)					
Scientific field					
No 12 scientific satellite EXOS-D	About 300	Oblong 400/10,000	M-3S II	1988	Observation of accel eration mechanism of aurora particles and detailed observations of light emitting phenomena of auroras in the magnetosphere
No 13 scientific satellite MUSES-A	About 190	Moon synchronous 10,000~ 1.3 million	M-3S II	1989	Studies of required orbits for probing planets and of control technology; testing of moon swing-by technology
Space science experiment using particle accelerator (SEPAC)	--	--	Space shuttle (United States)	1990	Elucidation of light emitting mechanisms of auroras, of motions of charged particles in plasmas, and of excitation of electromagnetic waves
No 14 scientific satellite SOLAR-A	About 420	Circular 550	M-3S II	1991	Japan-U.S. cooperative observation to obtain high-precision images of solar flares during maximum activity period of next solar activity
Magnetosphere observation satellite GEOTAIL	--	Equator 50,000~ 1.6 million	Space shuttle (U.S.)	1992	Observation and study of structure and dynamics of large and magnetosphere's tail that exists on night side of the earth

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
No 15 scientific satellite ASTRO-D	About 430	Circular about 550	M-3S II	1992	Detailed observation of X-ray images and X-ray spectra of various celestial bodies in deepest parts of space
<u>Practical-Use Field</u>					
Communications satellite 3-b CS-3b	About 550	Stationary	H-I	1988	Continuous provision of communications services provided by CS-2, coping with the ever-increasing and diversifying demand for communications, and development of communications satellite technology
Geostationary weather satellite No 4 GMS-4	About 330	Stationary	H-I	1989	Improvement of weather observation business in Japan and development of weather satellite technology
Ocean observation satellite 1-b MOS-1b	About 740	Sun synchronous quasi-recurrent orbit Approx. 900	H-I	1969	Continuous observation of the ocean phenomenon provided by MOS-1, and and establishment of technology common to earth observation satellites
Broadcasting satellite 3 BS-3a BS-3b	About 550	Stationary	H-I	1990 (BS-3a) 1991 (BS-3b)	Continuous provision of broadcasting services provided by BS-2, coping with the ever-increasing and diversifying demand for communications, and development of communications satellite technology

[continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
Earth resource satellite 1 ERS-1	About 1,400	Sun synchronous quasi-recurrent orbit 570	H-I	1991	With its primary use involving prospecting for resources, the satellite will conduct national land surveys, and other surveys related to agriculture, forestry and fisheries, environmental protection, disaster prevention and coastal monitoring, while aiming for establishment of an active-type observation technology
Fast material processing test (FMPT)	--	--	Space shuttle (United States)	1991	Japanese scientists will board the space shuttle and test various materials in space
Engineering test satellite VI ETS-VI	About 2,000	Stationary	H-II	1992	Confirmation of performance of H-II rocket test unit, establishment of large-scale stationary 3-axis satellite bus technology needed for development of practical use satellites in 1990s, and development of technology for high-level satellite communications and its testing
Space experiment observation free flyer SFU	About 4,000	500	H-II	1992	Execution of various scientific research activities, including scientific and engineering experiments, [continued]

[Continuation of Table 3-3-16]

Satellite	Weight (kg)	Orbital altitude (km) and stationary position	Rocket used	Launch date	Major objectives
[continuation]					astronomical observations; securing of space experimental modules needed for development of various leading-edge industrial technologies; and upgrading of reliability of exposed portions of JEM and on-board experimental systems
Stationary weather satellite 5, GMS-5	Undecided	Stationary	H-II	1993	Upgrading of technology contributing to improvement of Japanese weather observation business and weather satellites
Space station attachment type experimental module JEM	Undecided	460	Space shuttle	1995	Execution of material experiments, life science experiments, science and earth observation, communications experiments

Note: The space experiment/observation free flyer SFU is associated with the scientific field but is contained in the practical-use field.

Table 3-3-17. Records of Development of Rockets in Japan and Future Plans

(1) Main specifications of rockets used for satellite launches from FY 1975 and later

Rocket type	Stage	Total length (m)	Diameter (m)	Total weight (tons)	Propellant	Satellite
M-3C rocket	3	20.2	1.41	41.6	All-stage solid	No 4 SS HAKUCHO
M-3H rocket	3	23.8	1.41	48.7	" " "	TS TANSEI-3 No 5 SS KYOKKO No 6 SS JIKIKEN
M-3S rocket	3	23.8	1.41	49.5	" " "	TS TANSEI-4 No 7 SS HINOTORI No 8 SS TENMA No 9 SS O-zora
M-3S II rocket	3	27.8	1.41	62.0	" " "	Test planet probe SAKIGAKE No 10 SS SUISEN No 11 SS GINGA
N-1 rocket	3	32.6	2.44	90.4	1st, 2nd stage liquid 3rd stage SOB solid	ETS I type KIKU IOS UME ETS II type KIKU-2 IOS UME-2 ESCS AYAME ESCS AYAME-2 ETS KIKU-4
N-II rocket	3	35.4	2.44	134.7	1st, 2nd stage liquid 3rd stage SOB solid	ETS VI type KIKU-3 GMS HIMAWARI-2 CS 2-a SAKURA-2a CS 2-b SAKURA-2b BS 2-a YURI-2a SWS HIMAWARI-3 BS 2-b YURI-2b
N-II rocket	2	35.4	2.44	133.4	" " "	Ocean observation satellite MOMO-1

[continued]

[Continuation of Table 3-3-17]

Rocket type	Stage	Total length (m)	Diameter (m)	Total weight (tons)	Propellant	Satellite
H-I rocket	2	40.3	2.49	138.7	" " " oxygen/liquid hydrogen, SOB solid	Geodetic survey satellite AJISAI, Amateur satellite FUJI, Magnetic bearing flywheel experiment system
H-I rocket	3	40.3	2.44	139.2	1st stage liquid, 2nd oxygen/liquid hydrogen, 3rd stage and SOB solid	ETS V type KIKU-5 CS SAKURA 3-a

Notes:
SS: Scientific satellite
TS: Test satellite
ETS: Engineering test satellite
IOS: Ionosphere observation satellite
ESCS: Experimentary geostationary communications satellite
GMS: Geostationary meteorological satellite
CS: Communications satellite
BS: Broadcasting satellite

(2) Main specifications of rockets being developed

Rocket type	Stage	Total length (m)	Diameter (m)	Total weight (tons)	Propellant	Planned launch year	Satellites to be launched in FY 1988 and thereafter
M-3S II rocket	3	27.8	1.41	62.0	All stages solid	1988 1989 1991 1992	SS-12 (EXOS-D) SS-13 (MUSES-A) SS-14 (SOLAR-A) SS-15 (ASTRO-D)
H-I rocket	3	40.3	2.44	139.2	1st,2nd stage liquid Oxygen/liquid hydrogen, 3rd SOB solid	1988 1989 1990-91 1991	CS-3b SWS-4 (GMS-4) BS-3a, BS-3b Earth resources satellite (ERS-1)
H-II rocket	2	About 49	About 4	About 259	1st,2nd stage liquid,	1991	Payload for performance survey (VEP)

[continued]

[Continuation of Table 3-3-17]

Rocket type	Stage	Total length (m)	Diameter (m)	Total weight (tons)	Propellant	Planned launch year	Satellites to be launched in FY 1988 ad thereafter
[continuation						1992	ETS-VI
						1992	Space experiment/ observation free flyer (SFU)
						1993	GMS-5

Activities in 1987 were as follows:

a. In the field of scientific research, the ninth scientific satellite "O-zora," launched in February 1984, observed X-ray stars. The test planet probe "Sakigakie" was launched in January 1985 to confirm the flight performance of the first unit of the M-3S II rocket series and to achieve an interplanetary orbit, as well as to obtain related technology, including that of posture control and long-distance communications. The 10th scientific satellite "Suisei," launched in August 1985, observed interplanetary plasmas, while the 11th scientific satellite "Ginga," launched in February 1987, conducted detailed observations of various X-ray celestial bodies.

Efforts were made to develop the 12th scientific satellite (EXOS-D) that is intended to observe in detail the acceleration mechanism of aurora particles in the geomagnetic sphere and the phenomenon of auroras' light emissions, of the 13th scientific satellite "MUSES-A" that is to be used to conduct studies on technologies needed for probing planets, such as detailed ranging of the orbit, control, and high-efficiency data transmission, and of the magnetosphere observation satellite "GEOTAIL" whose objective is to observe the structure and dynamics of the long and large magnetosphere tail that exists on the night side of the earth.

The development of the 14th scientific satellite "SOLAR-A," which is to be used in the joint Japanese-American high-precision solar flare image observation project that is to be undertaken when the sun enters its most active period the next time around, has been undertaken.

Furthermore, preparations have been made for a repeat trial of the space science experiment (SEPAC) using a particle accelerator whose objective is to elucidate the mechanism of the luminescence of auroras by means of electron beam radiation.

b. In the field of observation, meteorological observations were conducted using the geostationary meteorological satellite No 3, HIMAWARI-3, launched in August 1984.

The marine observation satellite No 1, MOMO-1, launched in February 1987, was used to observe ocean phenomena, focusing on the color of the sea and sea temperature, and studies were made of the successor to MOMO-1, the marine observation satellite 1-b (MOS-1b). Efforts were also made toward the development of the geostationary meteorological satellite No 4 (GMS-4) and the establishment of an active-type observation technique and, at the same time, the development of the earth resource satellite NO 1 (ERS-1 was promoted.

c. In the field of communications, the communications satellite 2-a (SAKURA 2-a), launched in February 1983, and the communications satellite 2-b (SAKURA 2-b), launched in August 1983, have been used for such purposes as communications for disaster relief, communications with isolated islands, and temporary communications. In February 1988, the communications satellite 3-2 (SAKURA 3-a) was launched.

The broadcasting satellite 2-a (YURI 2-a), launched in January 1984, and the broadcasting satellite 2-b (YURI 2-b), launched in February 1986, have been used to provide areas experiencing problems receiving NHK TV signals with programming and other services.

Furthermore, the development of the communications satellite 3-b (CS-3b) and broadcasting satellites (BS-3a and BS-3b) were promoted.

d. In the field of space experiments, in preparation for the first material processing test (FMPT), an experiment in which Japanese scientist-engineers will board the space shuttle and conduct material-related experiments by taking advantage of the space environment features, the training of the three payload specialists selected in August 1985 was conducted and the development of the experiment systems was continued.

e. As for the space station program, a program with particular significance in that it provides a new means for conducting manned space activity and that it contributes to the promotion of international cooperation, the growth of space technology, and the accelerated expansion of industrial activity in space, the required cooperation was extended through the decision to participate in the project with an experiment model (JEM).

Furthermore, the development of the space experiment and observation free flyer (SFU), a system to be used for such objectives as experiments for the development of leading-edge industrial technologies, scientific and engineering tests. astronomical observations and demonstration tests of JEM component models, was promoted.

f. In the field of common technology for satellites, aiming at verifying the performance of the H-I rocket (three-stage) test unit, at establishing the fundamental technology for the stationary three-axis satellite bus, and at conducting experiments involving mobile communications, the engineering test satellite V type (ETS-V) was launched in August 1987, and experiments are being conducted on satellite-based mobile communications.

Aiming at confirming the performance of the H-II rocket test unit and establishing large-scale stationary three-axis satellite bus technology, as well as at developing the technology for high-level satellite communications and testing the technology, development of the engineering test satellite VI type (ETS-VI) was promoted.

g. In the field of common technology for the transport system, the Institute of Space and Astronautical Science of the Ministry of Education, Science and Culture advanced the development of the M-3S II rocket that is to be used for the launching of the 12th scientific satellite (EXOS-D), the 13th scientific satellite (MUSES-A) and the 14th scientific satellite (SOLAR-A).

In order to be able to cope with the demand for satellite launches up to the latter half of the 1990s, as well as to accumulate the technology necessary for Japan's future space transportation system, in February 1987 the National Space Development Agency of Japan (NASDA) launched the three-stage test unit No 1 of the H-I rocket that has the capability of launching a geostationary satellite weighing about 550 kg using a liquid oxygen/liquid nitrogen propellant in its second stage, with the first H-I rocket (three-stage) used in the lift-off of the communications satellite 3-a (CS-3a) in February 1988. Development of the H-I rocket series was accelerated for their use in launching the communications satellite 3-c (CS-3b), broadcasting satellite No 3 (BS-3a and BS-3b), geostationary meteorological satellite No 4 (GMS-4) and the first earth resources satellite (ERS-1).

Furthermore, in order to be able to cope with the demand for satellite launches in the 1990s, drawing on the expertise obtained in the successful development of the H-I rocket, work was promoted on the development of the H-II rocket which, using liquid oxygen/liquid hydrogen engines in its first and second stages and supplemented with two solid booster rockets, will be able to lift geostationary satellites of about 2 tons.

f. Table 3-3-18 shows changes in Japan's space-related budgets.

Table 3-3-18. Changes in Space-Related Budgets

(Unit: ¥1 million)

Item \ FY	1983	1984	1985	1986	1987
National Police Agency	467	174	165	328	148
Science and Technology Agency	87,428	85,812	91,585	92,582	94,569
National Aerospace Laboratory	837	918	2,197	1,395	1,387
National Space Development Agency of Japan	86,067	84,358	88,861	90,659	92,648
Funding for fisheries problems around Tanegashima Island	407	407	400	400	400
Space Activities Committee	47	48	49	51	55
Funding for general administrative costs of space development	70	80	79	78	79
Institute of Space, Astronautical Science, Ministry of Education, Science and Culture	15,182	15,834	10,960	12,375	11,825
Ministry of International Trade and Industry	1,471	1,467	3,490	6,078	8,297
Ministry proper	1,382	1,363	1,366	1,629	4,772
Agency of Industrial Science and Technology	89	105	2,125	4,450	3,525
Ministry of Transportation	7,078	8,417	5,324	5,099	6,239
Electronic Navigation Research Institute	72	156	732	502	255
Maritime Safety Agency	88	115	127	141	357
Meteorological Agency	6,917	8,147	4,464	4,456	5,626
Ministry of Posts and Telecommunications	1,588	1,053	865	778	724
Ministry proper	666	8	9	9	8
Radio Research Laboratories	923	1,045	856	769	715
Ministry of Construction	2	2	2	2	2
Geographical Survey Institute	0	0	0	0	0
Fire Defense Agency of Ministry of Home Affairs	2	2	2	2	2
Totals	172	194	146	138	121
	113,389	112,953	112,537	117,380	121,924

Notes: 1. The figures are all initial budgets.
2. The Radio Research Laboratories was reorganized into the Communications General Laboratories.

(4) Aviation technology

Because of its knowledge-intensiveness and leading-edge technology characteristics, aviation technology will not only lead to the growth of air transportation, but will also have great ripple effects on other fields, such as the frontier and fundamental science and technology. Therefore, aviation technology is an indispensable foundation for Japanese technology if we are to be successful as a science and technology-oriented nation in the future.

1) Movements of aviation technology R&D in Japan

Thanks to the accumulation of technology obtained while independently developing several aircraft, including the civil transport aircraft YS-11, Japanese aircraft technology has recently advanced greatly, reaching a level that permits Japan to play a role on the international scene as evidenced by the Japanese participation in the design and manufacture of the Boeing 767 passenger jet, an undertaking that is being promoted as an international joint development project. In the development of commercial aircraft, the tendency is for international joint development projects to increasingly become the mainstay of the world. Japan is currently taking part in the international joint development of the commercial jetliner YXX, with a seating capacity of about 150, that is expected to find a large demand in the 1990s and thereafter, and the international joint development of the jet engine V2500 for commercial aircraft is being promoted by Japan, Great Britain, the United States, West Germany and Italy. If Japan is to participate aggressively and on an equal footing in the development and manufacture of international joint development projects that are expected in the future, it is urgently required that as high a level of Japanese technology necessary to be capable of contributing to international joint development projects be established. Toward that goal, various policies have been implemented along the line of advice or proposals by the Council for Aeronautics, Electronics and Other Advanced Technologies, aimed at promoting aircraft technology R&D. In August 1986, the council submitted a proposal (in reply to Inquiry No 8) entitled "The Key Tasks in the R&D of an Energy-Saving Type of Aircraft Technology and Concrete Measures for Achieving the Tasks," indicating the road toward innovative aircraft technology R&D of the 21st century.

The National Aerospace Laboratory of the Science and Technology Agency has been engaged in the R&D of the technologies necessary for Japan to utilize when developing aircraft in the future. The research and development of the short-distance takeoff and landing technology using the low-noise STOL experimental aircraft "Asuka," as well as of the fan-jet STOL aircraft aimed at demonstrating various new technologies, including noise reduction technology, etc., have been promoted emphatically as priority tasks. Furthermore, in FY 1987, the R&D for innovative aerospace technologies necessary for ultra-supersonic aircraft, space shuttles, and ultrahigh efficiency mass-transport aircraft was initiated. In addition, the National Aerospace Laboratory has been playing a leading role in the growth of aviation technology in Japan by conducting research into fundamental technology, such as numerical simulation by computer, and by building large testing and research facilities, such as various types of wind-tunnels, for joint use by concerned organizations.

At the Electronic Navigation Research Institute of the Ministry of Transportation, studies have been made of methods for elevating the safety of air traffic as part of the research on navigation and control technology, and these research activities are expected to play an important role in promoting the growth of air transport from now on. Furthermore, the Innovative Aircraft Technology Development Center of the Aerospace Industry

Association of Japan has been promoting survey research in connection with the development of innovative aircraft technology.

2) R&D of fan-jet STOL aircraft

The fan-jet STOL aircraft is one of the advanced types of aircraft expected to play a great role in future air transportation. Due to its advantages over the existing jetliners in terms of its short takeoff and landing (STOL) capability and lower ground noise, the STOL aircraft is well suited to Japan, having a high density of population in a small mass of national land.

From the viewpoint that Japan should play an active role in the R&D of technologies necessary for the development of such a STOL fan-jet aircraft, the Council for Aeronautics, Electronics and Other Advanced Technologies of the Science and Technology Agency put together a proposal entitled "On Concrete Measures for Promoting Development of a STOL Transport System Suited to Our Country," calling for the necessity of starting comprehensive R&D of the STOL technology, focusing on development of an experimental plane and its flight tests.

Upon receiving the proposal, in FY 1977 the National Aerospace Laboratory of the Science and Technology Agency began advancing "R&D of Fan-Jet STOL Aircraft," and, as part of the program, the development of the low-noise experimental STOL aircraft "Asuka" has been underway since FY 1979 as part of the tests to verify the feasibility of various technologies. With the domestically-developed jet transporter C-1 as its prototype, to which the required design alterations have been added and FJR710 engines, developed with assistance from the Aerospace Technology Research Institute of the Agency of Industrial Science and Technology have been mounted, Asuka is Japan's first semidomestically-developed large jet experimental aircraft. Measuring 29 meters in total length, 30.6 meters in width, and weighing 38.7 tons when fully loaded, Asuka can take off from or land at a runway less than 900 meters long. Another epochal feature of the aircraft is that the area subjected to aircraft noise can be reduced to from one-fifth to one-tenth that of the area that suffers from aircraft noise with the current generation of jets. In addition to the STOL and noise-abatement technology, Asuka features a variety of new technologies, such as computer-controlled flight technology, fly-by-wire technology, and composite materials technology, and the R&D of these technologies is being simultaneously promoted along with the development of Asuka.

Asuka successfully completed its maiden test flight in October 1985, and full-fledged flight tests began in FY 1986 to verify its various new technologies, such as the STOL technology and low-noise technology. It successfully handled short takeoffs and landings at the end of FY 1987.

(5) Ocean development

Oceans are not only rich sources of a rich variety of animals and minerals, but also harbor large amounts of energy and occupy large expanses of space. Hence, their development and utilization is an important task.

Regarding development of the oceans, the third meeting of the United Nations Conference on the Law of the Sea adopted a draft of the United Nations Convention on the Law of the Sea in April 1982 to establish a new order of the sea. At the final protocol and treaty-signing convention held in December the same year, as many as 119 countries signed the convention. Japan followed suit in February 1983.

Containing provisions involving such matters as the territorial waters extending 12 nautical miles, the passage and transit of international channels, exclusive 200-nautical mile economic waters, continental shelves, the development of deep-sea resources under the control of international organizations, the protection and preservation of the ocean environment, and the rights of the coastal nations to constrain or approve scientific surveys of the sea in the exclusive economic waters or on the continental shelves, the United Nations Convention on the Law of the Sea constitutes a comprehensive order of the sea.

The signing of the convention was terminated in December 1984, with 159 nations and territories having signed the treaty, while as of the end of March 1988 it had been ratified by 35 nations and Namibia. In response to the international movements toward the new order of the sea era, in July 1977 Japan put into force early the 12 nautical miles of territorial waters and 200 nautical miles of fishery area provisions, while in July 1982 it enacted a domestic law pertaining to the development of deep-sea mineral resources. While abiding by the United Nations Convention on the Law of the Sea, it is necessary to further enhance the effective utilization of rich resources, great amounts of energy, and large expanses of the oceans, while paying due attention to environmental protection, in order to improve the welfare of the people and the growth of society and economy.

1) Promotion of comprehensive ocean development

Under the recognition mentioned above, the government has been implementing various measures for ocean development. These measures have been implemented by the relevant ministries or agencies according to their administrative objectives, but the basic and comprehensive matters pertaining to ocean development need to be surveyed and deliberated at the forum of the Council for Ocean Development, an advisory organ to the prime minister.

In February 1978, recognizing the increasing need to freshly reexamine the long-term perspectives of ocean development for Japan and concrete measures to realize the perspectives in the wake of the new order of the sea era, Inquiry No 2, entitled "On the Basic Idea for Promotion of Ocean Development From a Long-Term Perspective and Measures for Ocean Development," was sent to the Council for Ocean Development. In August 1979, upon receiving the inquiry, the council submitted its first reply indicating the desirable shape of ocean development for society and the economy in the year 2000, which was followed in January 1980 by the council's presentation of its second reply, detailing the measures to be adopted to realize the concrete development goals contained in its first reply.

Furthermore, to cope with the changing international situation, such as the adoption of the United Nations Convention on the Law of the Sea, and to facilitate studies on measures to promote Japanese efforts toward ocean development, in 1982 the International Problems Division of the Council for Ocean Development began conducting surveys on the movements for ocean development in other countries and on the tasks for international cooperation in science and technology that Japan should undertake with foreign countries, and the results were compiled in a report in November 1984.

2) Promotion of development of ocean science and technology

In promoting ocean development, the R&D of basic and common ocean science and technology, such as ocean observation technology and diving operation technology, needs to be emphatically promoted while reinforcing the efforts to obtain further knowledge of the sea by conducting surveys and studies in such fields as the ocean phenomenon and weather, sea bottom geography and geological formation, seabed resources, and the productive power of marine fisheries resources. To that end, the "Ocean Science and Technology Development Promotion Liaison Council," made up of directors of the Secretariat from 14 relevant ministries and agencies, was established in 1969 to put together the "Ocean Science and Technology Development Promotion Programs" (from 1970 to 1978, "Development Plans of Science and Technology for Ocean Development").

Since 1984, the ocean development policies have been prepared by the "Liaison Council of Ocean Development-Related Ministries and Agencies" (established in 1980), and the liaison council has been putting together the "ocean development promotion program" that covers not merely ocean science and technology, but the broader area of the ocean development as a whole. The program has been revised every year, and the concerned ministries and agencies have been implementing their policies in accordance with the program.

Major marine science and technology development projects undertaken by the concerned government ministries and agencies during FY 1987 are as follows:

a. Development of marine biological resources

Marine biological resources are expected to play a big role in Japan's future food supply. In order to increase the utilization of marine biological resources by taking advantage of the basic productive power of the sea, efforts will have to be made in such fields as development of the technology for culturing resources, development of the technology for creating fishing grounds, and development of resources that have not been utilized until now.

Technical developments in these fields have been undertaken by the Regional Fisheries Research Laboratories, prefectural fisheries experiment stations, and the Fisheries Culture Center.

Regarding the resources culturing technology development, in FY 1987 efforts were made to develop techniques to produce species of red sea bream, yellowtail, flatfish and others in the field of fish culture, and subsidies were given to various prefectural government projects aimed at developing techniques to stock rivers with young fish.

The "comprehensive research" project (marine ranching program), a program aimed at the development of a system that will enable coastal fisheries resources to be turned into a sort of domesticated fish, was promoted and the development of necessary techniques was undertaken.

In the field of development of the technology to create fishing grounds, in connection with the projects for the construction and development of coastal fishing grounds, various surveys and studies were undertaken toward the goals of creating artificial fish habitats and fish farms, and of the comprehensive development of the sea. In the field of the development of resources that have not been used until now, developmental surveys were made of new fishing grounds by means of medium-depth traveling and round haul net fishing, of such resources that have yet to be utilized as "Arotsunasu" and pomfret, and of deep-sea regions by means of trawling. By taking advantage of the Coordination Funds for Promoting Science and Technology, a project entitled "Research for Development of the Technology for Effective Utilization of Deep Sea Resources" is underway.

b. Development of seawater and seabed resources

The seabed contains rich amounts of useful metal resources, such as oil, natural gas, manganese nodules, seabed hydrothermal deposits, and cobalt-rich crust deposits. Seawater also contains a variety of dissolved substances, and expectations are placed on their possible utilization. Furthermore, the value of seawater as a water resource is being reviewed with fresh interest. For Japan, poor in underground resources, tapping seawater and seabed resources for utilization is an important task.

The technical development activities in the field have been going on at the Agency of Industrial Science and Technology and the Metal Mining Agency of Japan.

Regarding the exploration of domestic oil and natural gas in the waters around Japan, in FY 1987 basic physical prospecting surveys were conducted in the Nishi Tsugaru-Niigata offshore area and the Akit-Aomori shallow water area, and basic drilling tests were undertaken in the waters off Kashiwazaki. R&D was also conducted for support systems for such operations as the maintenance, inspection and repair of undersea oil production systems. The development of deep sea mineral resources is regulated by the United Nations Convention on the Law of the Sea, and in December 1987, based on a supplementary resolution to the Convention, Japan registered a promising mining area of 75,000 km^2 in the water southeast of Hawaii for manganese module exploration, thus obtaining an exclusive activity right.

As for prospective activities for deep sea mineral resources, the resource survey ship "No 2 Hakurei-maru" conducted surveys to observe the distribution of manganese nodules in the sea area southeast of Hawaii and the distribution of hydrothermal deposits on the sea bottom in the East Pacific Oceanic Rise in the waters off Mexico. The ship also conducted surveys in the middle and western Pacific waters to survey the distribution of cobalt-rich crust deposits.

Efforts were made to develop the technologies to upgrade the activities for deep sea mineral resources prospecting and, at the same time, R&D was conducted on manganese nodule mining systems.

In the field of development of seawater resources, a large-scale experimental plant based on a reverse osmosis method was continuously operated to conduct experiments on energy-saving seawater desalination technology, and an experimental model plant for uranium recovery was also operated to realize uranium recovery technology from seawater.

c. Ocean energies

The sea contains various forms of energy, such as wave energy, ocean temperature difference energy, and current energy. Tapping these kinds of energy as reproducible energy sources is expected to greatly benefit Japan's energy supply in the future. Technical development efforts in this field have been promoted by the Japan Marine Science and Technology Center, the Agency of Industrial Science and Technology, and the Port and Harbor Research Institute.

As for the development of wave energy utilization technology, in FY 1987 the data gathered from the second-phase sea trials of the wave-power power-generating equipment "Kaimei" were analyzed to compare power generation systems as well as to study methods of increasing output, studies were made on the methods of designing economical air turbine-type wave-power power-generating equipment, and experiments were conducted in which a large scale model of a breakwater for wave-power power generation was battered by irregular waves to establish the wave-resistant design methods of such breakwaters. Regarding research on power-generating systems based on differences in ocean temperature, studies were made on the total system, an environmental assessment was taken, and the fundamental technologies and subsystems were developed.

d. Development of technology for utilization of ocean space

It is important that Japan, having been endowed with a small mass of national land, make effective use of ocean space as site for living, industrial production or storage.

Technical development in this field has been promoted by the Ministry of Transportation, the Ship Research Institute, the Port and Harbor Research Institute, port and harbor construction bureaus, the Public Works Research

Institute, the Building Research Institute, and the Regional Construction Bureau.

In FY 1987, as part of the ocean space utilization survey and research, surveys were made of coastal area utilization projects, port and harbor improvement projects, and coastal disaster-prevention projects.

Also, the following activities were undertaken: a survey on new methods of ocean space utilization; survey and research on the utilization of ocean space in connection with the development of resources and energies; a survey regarding the promotion of offshore man-made islands; a survey for the promotion of calm sea areas; development of the technology to create and preserve ocean utilization spaces; and a survey and study of the conditions for the comprehensive construction and development of coastal/offshore areas, with fishing as their core industry.

e. Development of technology for comprehensive utilization of sea areas

For the coastal areas of Japan, which feature diverse configurations and characteristics that should be utilized effectively, it is necessary to select some specific sea areas and try to utilize them fully after taking into account their specific features. In order for such a mode of utilization to be realized, the following three technological breakthroughs must be realized: 1) the technology that will enable the main utilization mode of the surface of the sea until now, i.e., fisheries, the coexist with the new modes of sea utilization; 2) the multipurpose technology that will enable multiple modes of utilization to be organically linked; and 3) the sea area control technology that will enable one to artificially alter the natural conditions of a sea area so that it will be amenable to efficient utilization.

Technical development efforts in this field have been undertaken by the Japan Marine Science and Technology Center, the Port and Harbor Research Institute and the Public Works Research Institute.

In FY 1987, surveys were conducted to determine that technical problems would exist if the comprehensive utilization of sea areas were to be achieved, and studies were made simultaneously on wave concentration and wave abatement technology, as well as electro-deposition technology using wave power.

f. Development of ocean environment preservation technology

Since Japan is an island country, the ocean environment has a great effect on the nation's economy and society. Therefore, surveys have been conducted to study the actual state of ocean pollution, and efforts have been made to study the actual state of ocean pollution, and efforts have been made to develop the technologies that will either prevent further deterioration of the marine environment or will improve it.

Surveys and studies in this field have been undertaken by the Environment Agency, the National Institute for Environmental Studies, the Port and Harbor

Research Institute, ports and harbors bureaus, the Maritime Safety Agency, the Meteorological Agency, and the Public Works Research Institute.

In FY 1987, as part of the fact-finding survey of ocean pollution, the actual state of pollution in Japan's coastal waters was surveyed to learn about the degree and mechanism of pollution, and a survey was undertaken to study the background pollution of the sea. Regarding efforts for the development of technologies that will prevent the further deterioration of the marine environment and instead will improve it, studies were made to improve the water quality of the Seto Inland Sea through controlling tidal currents in an experiment conducted using a water tank with the capability to change its "sea bottom" topography. Furthermore, with the twin objective of coping with the occurrence of red tides and the eutrophication of the sea and of systematically sorting out the techniques designed for functional recovery of the fishing grounds, while simultaneously developing new improvement techniques in a hurry, efforts were made to develop techniques to prevent damage from medium-layer proliferous broad-area red tides and tests were conducted. Furthermore, simulation models realizing the mechanisms of the contamination of water quality in closed waters were developed, and on-site experiments were undertaken to improve the quality of the seabed by covering it with sand.

g. Survey and research of the sea

If the development of the sea is to be promoted efficiently, a substantial intensification in the survey and research activity involving the sea is needed.

Survey and research activities in this field have mainly been promoted by the Maritime Safety Agency and the Meteorological Agency, but the Japan Marine Science and Technology Center, the Agency of Industrial Science and Technology, the Geographical Survey Institute and universities are also engaged in research in this field.

A project has been underway to prepare "basic drawings of the coastal waters" to facilitate the determination of the correct base lines and peripheral lines of Japan's territorial waters as well as to contribute to the development and utilization of these waters. In FY 1987, surveys were conducted in four sites, including Hatoma-jima Island, and topographical and structural drawings of the seabeds to a scale of 1:50,000 were drawn.

Furthermore, a survey project has been underway since FY 1983 to confirm the limits of the newly defined continental shelves of Japan under the United Nations Convention of the Law of the Sea.

For high-precision land surveying of Japan proper and its isolated islands, which form the bases in determining the boundaries of the sea areas over which Japan has a certain level of jurisdiction, laser ranging observations began in FY 1982 by means of the geodetic satellite "Radios," and observations have continued since 1986 using the domestically-developed geodetic satellite "Ajisai." Work has also been underway to come up with topographical and ground condition drawings, to a scale of 1:25,000, of the coastal water seabeds for use as the basic materials in drafting plans for the development, preservation and utilization of coastal waters. In FY 1987, surveys were conducted in the Bay of Tachibana, the Sea of Hiuchi, and the Bay of Hiroshima to study the topography and geological features of the sea bottoms there, and topographical and ground condition maps of the seabeds, to a scale of 1:25,000, were prepared.

Furthermore, in order to contribute to the development and utilization of the Black Current, Japan is participating in the joint Sino-Japanese survey of the Black Current area, a project aimed at the qualitative understanding of the mechanism of the current's changes, as well as the international joint survey aimed at elucidating the mechanisms of oceanic changes in the West Pacific, all part of the "West Pacific Joint Survey (WESTPAC)" that is an ocean survey project sponsored by the UNESCO Intergovernmental Committee (IOC).

In addition, Japan is participating in the "International Deep Sea Digging Program," a project aimed at elucidating the composition of the crust of the ocean bottom and the circumstances of the formation of the seabed by digging on the ocean floor using deep-sea excavation ships. Furthermore, by taking advantage of the Coordination Funds for Promoting Science and Technology, two research projects, "International Joint Research on Atmospheric and Oceanic Changes and Weather Changes in the Pacific" and "Research on the Elucidation of the Ocean Plate Area (lift system) in the South Pacific," were undertaken.

h. Development of common and basic science and technology

In promoting development of the sea, R&D needs to be made in such common and basic technologies as deep-sea exploration technology and diving technology in order to carry out undersea operations because the adverse conditions of the sea, such as high pressure, darkness and low temperatures, must be overcome. In this field of research, the Japan Marine Science and Technology Center is playing a leading role in the development of fundamental and pioneering technologies.

In the realm of deep-sea technology, research is being made for the development of deep-sea submersible survey systems. In FY 1987, successful deep-sea surveys were undertaken in the Sea of Japan, Suruga Bay, Sagami Bay and in the waters around the Izu Peninsula, Ogasawara Islands, and Okinawa and Amami Islands to study the marine biology and topographical and geographical features of seabeds, using the 2,000-meter-class research submersible "Shinkai 2000" and its support ship "Natsushima." Research was also conducted for the development of an unmanned research submersible with the capability to survey a broad area of the sea and to reach seamounts of gorges unaccessible to a manned submersible. The construction of a 6,000-meter-class research submersible capable of covering 96 percent of the waters extending 200 nautical miles off the shores of Japan was continued from the previous year, and work was also started on the construction of its support ship.

In the field of diving technology for undersea operations, with the objective of establishing saturation diving technology to perform operations at depths approaching 300 meters, an experiment was carried out to simulate diving to depths of 300 meters, and an actual experiment was conducted in the sea using an undersea work experiment ship.

Also, aimed at prompt and accurate ocean surveys, research was conducted toward the development of ocean monitoring systems and ocean remote-controlled probing technology.

Furthermore, the project "Research on the Development of New Survey Systems for Use in the 200-Nautical-Mile Waters Surrounding Japan" was promoted using money from the Coordination Funds for Promoting Science and Technology, and in the current second phase of the project, various systems for gathering data on the sea, such as high-reliability sensors for ocean monitoring and various types of buoys, all developed during the first phase, were used in sea trials.

i. International cooperation

With the April 1982 adoption of the United Nations Convention of the Law of the Sea that clearly stipulates the new order of the sea, ocean development is entering an era of international cooperation. With it, the R&D of ocean science and technology will come to be increasingly undertaken on an international framework. As a country surrounded by seas, Japan must be capable of coping with the new situation flexibly and powerfully.

From such a viewpoint, in FY 1987, based on bilateral agreements, Japan exchanged information and research data with France and West Germany and conducted a survey and research of the ocean plate formation area (lift system) in the Pacific Ocean in a joint project with France. As for multilateral international cooperation, Japan took part in the aforementioned WESTPAC and the international deep-sea digging program (ODP). Japan also exchanged information on the sea and data on ocean weather.

j. Ocean science and technology related budget

Table 3-3-19 shows the ocean Science and Technology Agency related budget of Japan.

Table 3-3-19. Summary of Science and Technology Related Budget

FY 1986 budget	FY 1987 budget	Increase or decrease over previous year. ( ) shows the increase rate

Science and Technology Agency

(bond) 13,300	(bond) 8,466	(bond) 4,834
14,110	10,681	Δ 3,429
		(Δ 24.3%)

Remarks:
Japan Marine Science and Technology Center (of the funding of 4,641 (3,336) for the R&D of a deep-sea research submersible, (bond) 7,135 and 3,156, and ((bond) 12,500 and 1,326) are appropriations for the construction of the 6,000-meter-class research submersible and its support ship; 1,368 (1,575) for R&D of diving and undersea work technology; 1,507 (1,526) for others); 112 (112) for R&D of the Black Current survey, development and utilization technology; 1,331 (6,129 for the development of ocean observation satellite No 1; of the funding for nuclear power development, 429 (472) for ocean-related research; 1,167 (834) for the Coordination Funds for Promoting Science and Technology; 79 (79) for the development of remote ocean surveying technology; 46 (47) for others.

Environment Agency

701	608	Δ 93
		(Δ 13.3%)

Remarks:
Expenditures for testing and research of pollution prevention at national institutions, 396 (436 (12 themes)); expenditures for measures to prevent water pollution, 142 (156); others, 70 (109).

National Land Agency

291	385	107
		(32.3%)

Remarks:
Expenditures for a survey to promote fisheries industry in Asami Oshima Islands and others, 20 (17); Coordination funds for promoting comprehensive national land development enterprises, 365 (274).

Ministry of Education, Science and Culture (Note 1)

599	492	Δ 93
		(Δ 17.9%)

Remarks:
International deep-sea digging program (ODP), 487 (593); West Pacific joint survey (WESTPAC), 5 (6).

[continued]

[Continuation of Table 3-3-19]

FY 1986 budget	FY 1987 budget	Increase of decrease over previous year. ( ) shows the increase rate

Ministry of Agriculture, Forestry and Fisheries

9,581	9,523	Δ 58 (Δ 0.6%)

Remarks:
Cultured fisheries technology development 1,724 (1,745); marine ranching program 410, (423); fishing ground creation technology development, 861 (861); ocean resources survey and development, 4,115 (4,109); new technology development, such as energy-saving in fisheries, 337 (304); development and testing of technologies for coping with red tides 234 (224); others 1,856 (1,915).

Ministry of International Trade and Industry

13,199	13,015	Δ 184 (Δ 1.4%)

Remarks:
Survey and development of mineral resources in deep sea bottoms, 1,172 (1,144); basic research into geological features of the sea bottom, 478 (484); survey and development of seawater desalination technology 88 (96); R&D of manganese nodule mining system, 819 (958); R&D of ocean energy, 98 (133); special research, 79 (80) (three themes); subsidies to the survey and verification of uranium recovery from seawater systems technology, 637 (1,140); basic survey for domestic oil and natural gas resources (sea areas), 5,125 (4,565); R&D of undersea oil production support system, 943 (1,037); basic geological survey for oil in the Antarctic, 684 (745); basic survey for development of coal resources, 1,365 (1,662); others, 1,527 (1,155).

Ministry of Transportation

11,129	8,464	Δ 2,665 (Δ 23.9%)

Remarks:
Expenditures necessary for waterway business operation, 2,186 (3,574); expenditures for ocean weather observation and others, 2,761 (3,838); special research, 462 (465) (12 themes); survey for disaster-prevention works in ports and harbors, and on shores, 170 (170); survey for port and harbor improvement projects, 2,657 (2,841); survey for the improvement of the Kansai International Airport, 104 (110); others, 124 (131).

[continued]

[Continuation of Table 3-3-19]

FY 1986 budget	FY 1987 budget	Increase or decrease over previous year. ( ) shows the increase rate
Ministry of Posts and Telecommunications		
325	393	Δ 68 (Δ 20.9%)

Remarks:
R&D of aviation and marine satellite technology, 389 (325).

FY 1986 budget	FY 1987 budget	Increase or decrease over previous year. ( ) shows the increase rate
Ministry of Construction		
469	520	Δ 51 (Δ 10.9%)

Remarks:
Preparation of basic maps of the coastal sea areas, 79 (84); surveying of data for ocean geodetic surveys, 29 (33); expenses for surveying coastal works, 188 (184); expenditures for surveying road works, 137 (127); comprehensive technology development projects, 65 (17); others, 17 (24).

FY 1986 budget	FY 1987 budget	Increase or decrease over previous year. ( ) shows the increase rate
Total		
(bond) 13,300	(bond) 8,466	(bond) 4,834
50,404	44,081	6,323 (Δ 12.5%)

(for reference)

FY 1986 budget	FY 1987 budget	Increase or decrease over previous year. ( ) shows the increase rate
Defense Agency (Note 2)		
(bond) 186	248	(bond) 62
571	554	Δ 17 (Δ 3.0%)

Remarks:
Expenditures for ocean observation-related business, 315 (325) (equipment for ocean observation, etc., 315 (325)); expenditures for diving medicine and experiment related activities, 239 (246).

Notes: 1. Of the appropriations for marine-related academic research activities at universities and research institutes, only part of them, such as expenditures for international joint research projects, are tallied.
2. The Defense Agency is not a constituent member of the Liaison Council of Ocean Development-Related Ministries and Agencies, however, the agency is listed here for reference.
3. In the expenditures for the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Construction, those for the Hokkaido Development Agency and the Okinawa Development Agency are included.

(6) Life sciences

The objective of life sciences is to elucidate the complex and precise mechanisms of vital phenomena of various forms of life and make the research results available when solving problems associated with human life in hygiene and medicine, environmental protection, agriculture, forestry and fisheries, and chemical industry. Therefore, this science is expected to harbor a large potential for technical growth.

1) Promotion of comprehensive life science

In Japan, with the Council for Science and Technology's advisory report No 5 "On the Basic Principles of Comprehensive Science and Technology Policy in the 1970s," submitted in April 1971, as a turning point, research on life sciences has come to be aggressively promoted as government policy. Later, in May 1972, the Council for Science and Technology established the Life Sciences Conference, which was restructured into the Life Sciences Division in July 1973, and this division has been functioning as the forum for deliberating the basic policy for promoting life science research. After conducting deliberations on life sciences with respect to long-term and comprehensive research objectives, measures to strengthen the research activities sufficiently to achieve the goals, etc., the Life Sciences Division put together an interim report in December 1974.

Based on the results of subsequent deliberations by the Life Sciences Division, the Council for Science and Technology reiterated the importance of promoting life science research in its sixth advisory report, "On the Basic Policies of Comprehensive Science and Technology Policy Based on a Long-Term Perspective," submitted in May 1977.

In August 1980, drawing on the results of the comprehensive studies undertaken by the Life Science Division to that point, the Council for Science and Technology initiated the "Opinion on Promotion of Life Sciences," which put forth the important research goals across the entire life sciences spectrum and the measures for promoting research to achieve those goals.

In its tenth advisory report entitled "On the Basic Plans for Promoting R&D of Pioneering and Fundamental Technologies in Life Science," submitted in April 1984, the Council for Science and Technology presented the basic R&D directions and measures to promote the research involving the so-called genetic information manipulation technology of life in order to realize efficient progress along a comprehensive and planned line (Table 3-2-20). The government officially adopted the contents of the advisory report as the prime minister's basic plans in August 1984 and, since then, efforts have been made for their comprehensive promotion.

The importance of life sciences as one of the basic and pioneering technological fields with a potential for new growth, as well as the need to promote emphatic research in the field, are clearly stated in the Council for Science and Technology's 11th advisory report, "On Comprehensive, Basic Policies for Promoting Science and Technology From a Long-Term Perspective

Table 3-3-20. Priority R&D Areas and Current Targets

System	Area	Current targets
Technologies for systematic use of genes, cells and proteins	Division and identification of genetic information substances	1. Development of technology for dividing and identifying genes 2. Development of technology for dividing and identifying chromosomes 3. Development of technology for dividing organelles 4. Development of screening technology of cells 5. Development of technology for dividing and identifying proteins
	Analysis of genetic information substances	1. Development of technology to analyze the structure of nucleic acids and proteins 2. Development of technology to analyze the function of nucleic acids and proteins 3. Development of technologies to analyze the structure and function chromosomes 4. Development of technologies to prepare gene maps and base array maps of chromosomes
	Preservation of genetic information substances and information	1. Establishment of technology to preserve the tissue, organs and the organisms themselves of genetic information substances, and establishment of their assaying, evaluation and utilization systems 2. Establishment of technology to analyze data on the tissue, organs and organisms themselves of genetic information substances and of their utilization systems
Technologies for functional design, modification and synthesis	Functional design	1. Development of technology for the design of genes and of that for the design of protein functions
	Modification and synthesis	1. Development of technology to modify and synthesize genes 2. Development of technology to modify chromosomes 3. Development of technology to modify and synthesize functional proteins

[continued]

[Continuation of Table 3-3-20]

System	Area	Current targets
Technologies on introduction of materials carrying genetic information and on expression of genetic information	Introduction of genetic information materials	1. Development of genetic splicing technology to extend to some specific portions, such as chromosomes and organelles 2. Development of technology to enable the introduction of high-level genetic information materials, RNA, and proteins into cells and tissues 3. Development of technology to delete some specific genetic information materials 4. Development of cell fusion technology 5. Development of new host-vector systems
	Expression of genetic information	1. Development of technology for efficient expression of genetic information 2. Development of technology for harmonious expression of genetic information
Common, fundamental technologies		1. Probing and development of new nucleic acid-related enzymes 2. Development of technologies for the production and utilization of monoclonal antibodies 3. Development of stock culture cell systems 4. Development of experimental animals of specific forms 5. Development of technology to create organisms 6. Development of new culture technology 7. Development of new isolation and refining technology 8. Development of new measuring and analysis technology 9. Development of safety evaluation technology

in Response to New Changes in the Situation" (November 1984), which set forth the basic directions of Japan's science and technology policy as a whole, and in the "Outlines of the Science and Technology Policy" (adopted at a Cabinet meeting in March 1986), which presented the basic Japanese policy for promoting science and technology.

2) Promotion of human systems science and technology

The need to promote the science and technology of human systems, a field of science aimed at elucidating the sophisticated and complex mechanisms of humans, such as the brain, the nervous system, the immune system, and aging, and to apply these findings to such diverse fields as medicine and engineering, has been pointed out in the Council for Science and Technology's 11th advisory report. In response, the Council for Science and Technology established within the Life Science Division the human systems science and technology subcommittee, and the subcommittee has conducted deliberations to establish the basic policies regarding the promotion of comprehensive research in each of the life science fields.

3) Promotion of cancer research

Cancer is the largest cause of death in Japan, accounting for about a quarter of all deaths. Making the situation worse is the fact that cancer-caused deaths are found most prominently among the population group ranging from the people who are in their prime and who shoulder the largest responsibility in terms of society and family to the aged. What all this amounts to is that the consequences of such deaths have a large social impact and that the misery of the bereaved families is unbearable. As a consequence, the fight against cancer is an urgent policy task that Japan should tackle with all its resources.

In view of the situation, in June 1983, the "Comprehensive 10-Year Strategy for Cancer Control" was adopted at a meeting of the Cabinet Ministerial Meeting on Cancer Control, and in July the Council for Science and Technology put together its report entitled "Opinion on Basic Policies for Promotion of Cancer Research." In line with this strategy and opinion, concrete measures for cancer control have been advanced by the concerned ministries and agencies and, since FY 1984, the Science and Technology Agency, the Ministry of Education, Science and Culture, and the Ministry of Health and Welfare, among others, have been intensifying their cancer research in compliance with the aforementioned 10-year strategy.

Thanks to these positive R&D efforts in the field of research on cancer behavior, in recent years research on the expression mechanisms of specific characteristics of cancer cells has advanced greatly on the genetic level as a result of the adoption of molecular biological techniques, such as recombinant DNA technology and methods of determining DNA base pair arrangements, and techniques of identifying elements specific to cancer cells by mean of monoclonal antibodies are unfolding. Therefore, the elucidation of cancer at the molecular level is making steady progress.

Advances in cancer diagnosis and treatment technology are making it possible to detect several types of cancer at an early stage of growth. The use of various therapeutic methods, including surgery, chemical therapy and radiation therapy, is making it possible for cancer to be controlled to a certain degree. Increased efforts for comprehensive research on cancer control are expected to lead to new breakthroughs.

4) Promotion of science and technology to cope with society with an increasingly aging population

Because of the declining birth rates and substantial increases in the average age, the elderly component of the Japanese population has been increasing at an unparalleled rate.

Due to this situation, the Council for Science and Technology's 11th advisory report pointed out that it is necessary to initiate research on aging in order to cope with the coming era of an aging population. Upon receiving the report, the Human Systems Science and Technology Subcommittee, established within the Council for Science and Technology's Life Science Division, began to draft basic policies for the promotion of science and technology dedicated to coping with a society inhabited by an increasingly aging population, and a report entitled "An Opinion on Basic Policies for Science and Technology for Coping With Long-Life Society" was submitted to the prime minister in May 1986. The contents of the opinion are reflected in the "Outlines of Policies for Coping With Long-Life Society" adopted at a Cabinet Ministerial Meeting held in June 1986, and R&D has been ongoing in the concerned ministries and agencies, including the Science and Technology Agency, the Ministry of Education, Science and Culture, and the Ministry of Health and Welfare.

5) Promotion of research on AIDS

In order to prevent the spread of AIDS, a grave disease affecting the immune system, in February 1987 the Cabinet Ministerial Meeting on AIDS Control drafted the "Outlines of Comprehensive Policies for AIDS control," pointing out the need to promote research on AIDS prevention, examination and treatment as well as of basic research, and R&D is being conducted in the Science and Technology Agency, the Ministry of Education, Science and Culture, and the Ministry of Health and Welfare.

6) Promotion of recombinant DNA

Research on recombinant DNA, a field of life sciences drawing especially great attention, is expected to contribute to the welfare of human beings in a broad range of fields, beginning with basic biological research on the structure and mechanisms of genes of organisms and extending to explanations of the causes of cancer and other diseases, the volume production of rare medical products such as insulin and human growth hormones, the development of useful microorganisms for the chemical and fermentation industries, and, furthermore, to applications research such as the breeding of agricultural products and domesticated animals.

In promoting research in this field, basic research is particularly important, and basic research activities are being continued at universities and experimental research laboratories of the concerned ministries and agencies.

In addition to the active R&D activities by the government as described above, the private sector, particularly the pharmaceuticals, foods, and chemicals industries, has been actively promoting recombinant DNA research recently.

However, DNA research needs to be promoted prudently since DNA manipulation imparts new properties to organisms. Therefore, in its sixth report entitled "On Basic Policies for the Promotion of Comprehensive Science and Technology Policy Based on a Long-Term Perspective" submitted in May 1977, the Council for Science and Technology pointed out the need to establish guidelines for safety in implementing recombinant DNA research. In November 1978, after hearing independent opinions of researchers in the field, the Science Council of the Ministry of Education, Science and Culture prepared draft guidelines for ascertaining safety in recombinant DNA experiments. Based on the draft guidelines, on 31 March 1979 the ministry released the guidelines to be followed so that research on recombinant DNA and similar techniques at the universities will progress steadily.

As for the guiding principle for the country as a whole that is to be observed at private sector research institutes as well as the national and public testing research laboratories, the Council for Science and Technology solicited opinions of the Science Council of Japan and other organizations and bodies and studied the procedures that should be followed at these institutions, including universities. Based on the study results, in August 1979 the Council for Science and Technology submitted its eighth advisory report entitled "On Basic Policies for the Promotion of Recombinant DNA Research," which introduced guidelines to be followed to secure safety when conducting recombinant DNA research within Japan. Upon receiving the report, the prime minister determined the guidelines for recombinant DNA experimentation.

The guidelines are basic rules to be observed initially when conducting DNA-related research, but, in order to ensure the smooth progress of recombinant DNA research, it is desired that the guidelines be revised as needed in a way that will reflect the increasing accumulation of new findings. Therefore, even after the guidelines were drafted, deliberations were going on within the Life Science Division of the Council for Science and Technology and, based on the results, as of the end of FY 1987, the guidelines had been subjected to revisions on eight occasions.

To make comprehensive use of the results of the aforementioned recombinant DNA research, Japan intends to review the guidelines as needed since changes in such factors as increased accumulation of scientific findings, research requirements, and social needs arise.

In light of the fact that products based on recombinant DNA technology are beginning to find practical use, the Ministry of Health and Welfare has come up with guidelines to be observed when manufacturing medical products, and the Ministry of International Trade and Industry has initiated guidelines for the manufacture of chemical products, to facilitate the application of recombinant DNA technology in these industries.

7) **Promotion of research and development**

While adhering to the basic policies proposed by the Council for Science and Technology, etc., the concerned ministries and agencies have been implementing various measures aimed at promoting life sciences.

Among the research projects being undertaken by the Science and Technology Agency and its associated research laboratories are, in addition to research on basic and pioneering life sciences, the life science research project and research on the safety evaluation of new recombinants at the Institute of Physical and Chemical Research (RIKEN); the commissioning of research projects for the commercialization of life science-related new technologies by taking advantage of the Creative Science and Technology Promotion System by the Research Development Corporation of Japan; research on the effect of radiation on organisms and research on the treatment of cancer using radiation at the National Institute of Radiological Sciences; and research on life sciences, such as the trial manufacture of medical RI at the Japan Atomic Energy Research Institute.

In the case of the Environment Agency, from the perspective of environmental preservation, the National Institute for Environmental Studies has been conducting studies, while other tests and studies aimed at pollution prevention have been undertaken by taking advantage of the "National Institutions Pollution Prevention Testing and Research Funds."

Aiming at academic development, and utilizing the "Funds for Assisting Scientific Research," the Ministry of Education, Science and Culture has been aggressively promoting research in the related fields, and numerous academic research projects are being undertaken every year.

As for the Ministry of Health and Welfare, life science-related research has mainly been continued in order to elevate the levels of health and medicine through research by the ministry's research institutions, including the National Institutes of Health and the National Cancer Center. The ministry has also been promoting various research projects studying the prevention, diagnosis and treatment of diseases by contracting out the projects or by providing subsidies to ongoing projects.

Intending to realize a drastic increase in productivity in the agriculture and forestry and foods industries, thereby securing a stable supply of food, the Ministry of Agriculture, Forestry and Fisheries has been intensifying it R&D efforts in pioneering and fundamental technology. At the same time, the ministry is promoting the development of leading-edge technologies, such as biotechnology, by taking advantage of the vitality of the private sector.

As for the Ministry of International Trade and Industry, technical development in life science-related fields is being promoted by various research institutes under the Agency of Industrial Science and Technology. The R&D activity for the comprehensive development of the bio-industry is being undertaken through the "Research and Development System of the

Fundamental Technology for the Next-Generation Industry," while the R&D activity aimed at promoting the development of equipment and systems for medicine and welfare using leading-edge technology is being promoted through the "Research and Development System of the Technology for Medical and Welfare Equipment and Systems."

Aiming at saving energy and lowering the costs of waste disposal, the Ministry of Construction is advancing the development of new waste water disposal systems based on biotechnology.

Table 3-2-21 lists research tasks in the field of life sciences that are being promoted by testing and research institutes under the various ministries and agencies.

Table 3-2-21. Life Science-Related Research Tasks Being Promoted by Research Institutes Under Certain Ministries and Agencies (Themes conducted during FY 1987)

Ministry or agency	Research institute	Research task
Science and Technology Agency	Coordination funds for promoting science and technology	•Research for development of fundamental technology to explain immune response mechanism •Research for development of common and fundamental technology to support cancer research •Research on fundamental technology involving utilization of biological energy conversion function •Research for development of technology to analyze and utilize biomembrane functions
	Institute of Physical and Chemical Research (RIKEN)	•Life science research project to study the composition of genes •Research on biohomeostasis under the international frontier research system •Promotion of recombinant DNA research •Gene bank enterprise
	Research Development Corporation of Japan	•Research on biophotons and development genes under the Creative Science and Technology Promotion System

[continued]

[Continuation of Table 3-3-21]

Ministry or agency	Research institute	Research task
		•Development of new technologies, such as human urine-derived leucocyte multiplication factor products, by contracting out research jobs
	National Institute of Radiological Sciences	•Survey and research on medical use of heavy particle beams
	Japan Atomic Energy Research Institute	•Technology for fixation of bioactivators
Environment Agency	National Institute for Environmental Studies	•Research relating to evaluation of the effect of harmful substances (pollutants) on aqueous biosystems •Research relating to plant development functioning as air and environmental indices by means of biotechnology •Research relating to explaining the chemical environment in leading-edge technology
Ministry of Finance	National Research Institute of Brewing	•Research relating to biotechnology and mechatronics to upgrade the manufacturing processes of alcoholic beverages and to develop new products
Ministry of Education, Science and Culture	Universities	(Funds for assisting scientific research) •Special cancer-related research •Multifarious and systematic probing of bioactive peptides and identifying their working mechanisms •Molecular and genetic development of cell replication •Response mechanism in hereditary control system
Ministry of Health and Welfare	Institute of Population Problems	•Research on regional differences in the composition of family members in a society inhabited by an aging population

[continued]

[Continuation of Table 3-3-21]

Ministry or agency	Research institute	Research task
	National Institute of Health	•Research on persistent virus infections using recombinant DNA technology •Research for pathological analyses of the growth cycle and process using primates and small experimental animals [continued]
	Institute of Public Health	•Research on allergy-caused respiratory disease from a public hygiene perspective
	National Institute of Nutrition	•Comprehensive research relating to establishment of a method to evaluate nutrition and physiology in preventive health care
	National Institute of Mental Health	•Systematic research relating to changes in the pathology of nervous disturbances and the standards for diagnosing such changes
	National Institute for Leprosy Research	•Research relating to the pathology of leprosy and its treatment using experimental animals
	National Institute of Hygienic Sciences	•R&D of methods to test quality of high molecular medical products produced by new technologies, including recombinant DNA •Research relating to in vivo activity of trace amounts of harmful elements contained in consumer products and their toxicity expression mechanisms

[continued]

[Continuation of Table 3-3-21]

Ministry or agency	Research institute	Research task
Ministry of Agriculture, Forestry and Fisheries	Agriculture, Animals and Resources Research Institute; Agriculture, Environment and Technology Research Institute; National Institute of Animal Industry; National Grassland Research Institute; Fruit Tree Research Institute; National Research Institute of Vegetable and Teas; Sericulture Experiment Station; National Institute of Animal Health; National Food Research Institute; National Forestry Industry Research Institute; Regional Fisheries Research Laboratory	•Comprehensive research relating to high-tech plant breeding •Elucidation of genetic expression mechanisms in agricultural animals •Elucidation of behavior of root sphere environment and development of control technology •Comprehensive research relating to development of technology for efficient utilization of animal resources •Improvement or construction of comprehensive control and utilization system for genetic resources of agriculture, forestry and marine animals, as well as for genetic and breeding information •Comprehensive research relating to development of systems for turning coastal fisheries resources into domesticated fish
Ministry of International Trade and Industry	Mechanical Engineering Laboratory	•Research relating to design and fabrication technology of advanced composite materials for medical use
	National Chemical Laboratory for Industry	•Research relating to production of lipid hybrids and their separation and condensation
	Government Industrial Research Institute, Osaka	•Research on bioelement detection system
	Government Industrial Research Institute, Nagoya	•Research on a composite bioceramic with high bioaffinity

[continued]

[Continuation of Table 3-3-21]

Ministry or agency	Research institute	Research task
	Fermentation Research Institute	•Research on substances controlling cellular functions •Research for development of biological functions by recombinant DNA and their utilization
	Research Institute for Polymers and Textiles	•Research for development of polymer materials with highly-selective catalytic functions •Research for development of polymer materials for separation of biological elements
	Electrotechnical Laboratory	•Research on bioinformation architecture •Research on multidimensional electronic measuring technology
	Industrial Products Research Institute	•Research for development of imaging and processing equipment of bioelectric potential distribution
Ministry of Construction	Public Works Research Institute; Building Research Institute	•Development of new waste water disposal system using biotechnology

9) Progress of life sciences and human dignity

While contributing significantly to the welfare of human beings, the remarkable progress in life sciences in recent years has come to give rise to problems that may affect humans' existence and dignity. In full recognition of the importance of these problems, Prime Minister Nakasone pointed out the problems inherent in recent advances in life sciences, beginning with recombinant DNA technology, at a special lecture he presented at Johns Hopkins University and at the summit held in Williamsburg, both in May 1983, and proposed a conference of international authorities not only knowledgeable in life sciences, but also with broad and deep wisdom and the capability to look into the future. The proposal received the approval of the leaders attending the summit.

In its wake, in March 1984 in the "Life Sciences and Humans Congress," sponsored by the Funds for International Exchange, was held in Hakone and was attended by 19 international authorities, including natural scientists, philosophers and religious scholars. The congress was the first international meeting dedicated to the discussion of life sciences, and themes for discussion included the present and future of life sciences, and significance of life sciences to society, the meaning of life sciences to the individual, and international cooperation from various viewpoints reflecting the diverse backgrounds of the participants. The congress was followed by a second, which convened in April 1985 in Rambouillet, France, at which discussions were held on discrete themes such as gene manipulation and artificial insemination.

In connection with the "Progress of Life Sciences and Their Harmony With Mankind and Society," a theme whose importance is pointed out in the Council for Science and Technology's 11th advisory report, studies have been underway by the Council on Life Sciences and mankind established within the Life Science Division of the Council for Science and Technology.

(7) Matter/materials related science and technology

New materials have had significant effects on society and the economy in the past. As can be seen in the discovery of new superconducting materials, the appearance of a new material has tended to lead to the exploration of new technologies, thus having a great impact not only on industry, but on society as well.

In recent years, in particular, the majority of R&D efforts involving the exploration of untrod areas in the leading-edge science and technology fields such as information, electronics, and life sciences have been seeking avenues for technical breakthroughs in new materials seeds. As such, in promoting innovative R&D and in realizing a science and technology-oriented nation, the importance of substance- and materials-related science and technology as the common and fundamental technology is increasing.

It is becoming increasingly important to research and develop new materials necessary for ongoing large-scale projects, such as ultrahigh-speed computers, nuclear fusion and space and ocean development, and materials suited to these projects are being sought.

In view of this situation, the creation of new materials is becoming an important task for Japan.

1) Promotion of comprehensive matter/materials-related science and technology

Regarding matter/materials-related science and technology, in acknowledgement of the above, various policy measures relating to matter/materials-related science and technology are being implemented in line with the opinions of the Council for Science and Technology and the Council for Aeronautics, Electronics and Other Advanced Technologies.

In its report (November 1984) submitted in a reply to Prime Minister's Inquiry No 11, entitled "On Comprehensive and Basic Policies Based on a Long-Term Perspective To Cope With New Changes in the Situation," the Council for

Science and Technology positioned matter/materials-related science and technology as a basic and pioneering science and technology demonstrating the potential for new growth and pointed out the necessity of strongly promoting R&D in that field.

Upon receiving Prime Minister's Inquiry No 14, entitled "On Basic Plans for 10^{-4} of Matter/Materials-Related Science and Technology" (May 1986), the council established the "Matter-Materials-Related Science and Technology Division." After studying R&D objectives in that field and measures for promoting the R&D, in August 1987, the Council for Science and Technology submitted its advisory report entitled "On Basic Plans for Research and Development of Matter/Materials Systems Science and Technology," which was officially adopted by the prime minister (in October 1987).

In August 1980, the Council for Aeronautics, Electronics and Other Advanced Technologies submitted its advisory report No 5 entitled "On How To Promote Comprehensive Research and Development of Critical Science and Technology and the Related Materials Science and Technology," which outlined the necessity of promoting comprehensive R&D in critical science and technology fields, such as ultrahigh pressure, ultralow temperature and ultrahigh temperature and the matter/materials systems science and technology related to them. With the increasing accumulation of data on materials and advances in data processing technology, the tendency toward trying to create new materials more efficiently by doing away with the conventional method based on trial-and-error experience had been rising in recent years. In view of this situation, in September 1984 the council submitted its seventh advisory report entitled "On How To Promote Research and Development for Creation of New Materials Based on Material Design Theory," introducing comprehensive approaches to the development of new materials based on materials designs.

In its advisory report No 9, "On Primary Tasks for Upgrading Measuring and Control Technologies Relating to New Materials Development and How To Promote Those Tasks," submitted in March 1986, the Council for Aeronautics, Electronics and Other Advanced Technologies presented methods by which the important fundamental technologies for new materials R&D, such as measuring technology and control technologies including critical technologies and beam technology could be promoted.

With the January 1986 discovery of a superconducting material by IBM Laboratories in Zurich, Switzerland, as a turning point, new superconducting oxides that demonstrate superconductivity at high temperatures have been discovered one after another, among them the new bismuth-based superconductor discovered by the National Research Institute of Metals of the Science and Technology Agency. Once put into practical use, these superconducting materials are expected to have a great impact on society and the economy, so their development is being viewed with great expectations worldwide. These oxide-based superconductors, however, are still in the materials stage, and much basic and fundamental R&D must be conducted, such as a theoretical explanation of their superconductivity, probing for new materials, and how they can be fabricated into new materials, before they can be used as practical materials. In light of the situation, the concerned government ministries and agencies discussed measures for strengthening R&D in the field of superconductivity, using the paper entitled "On Basic Measures for Promoting Superconductivity Research and Development," put together by the conference on superconductivity established within the Policy Committee of the Council for Science and Technology in November 1987, as the guide.

2) Promotion of matter/materials related science and technology

With needs that are broad in scope and wide in variety as its background, the R&D of matter/materials related science and technology is actively being promoted in various ministries and agencies.

The research in the Science and Technology Agency is focused on common and fundamental fields relating to all matter/materials-related science and technology, and efforts are being made for the R&D of metallic materials, such as superconducting materials, and materials for ultralow temperature equipment, as well as for the R&D of inorganic materials, such as bio/functional ceramics, at the National Research Institute of Metals, the National Institute for Research in Inorganic Materials, etc.

The Research Development Corporation of Japan is engaged in developing a manufacturing technology for fine powders of nonoxide-based ceramics and for white-conductive materials for composite materials, all based on contracting out actual jobs. The corporation is also promoting the R&D of "chemical organization" by taking advantage of the Creative Science and Technology Promotion System.

Among other R&D activities being promoted by the corporation by drawing on the Coordination Funds for Promoting Science and Technology are "Research Relating to the Fundamental Technology for Development of Functionally Gradient Materials To Be Used for Thermal Stress Mitigation," "Research Relating to the Fundamental Technology for Imparting New Functional Capabilities to Rare Metals Through High-Level Purification," "Research Relating to Development of Generation, Measuring and Utilization Technology of Ultrahigh Temperatures," and "Research Relating to Analysis and Evaluation Technology of High-Performance Functional Materials by New Beam Technology."

In addition to the above research institutes, the Institute of Physical and Chemical Research (RIKEN) and the Japan Atomic Energy Research Institute are also advancing research on matter and materials related science and technology.

As for the Ministry of Education, Science and Culture, basic research on matter/materials-related science and technology is being promoted generally through academic development at universities by drawing on the Funds for Assisting Scientific Research.

Among the special research projects being promoted using the Funds for Assisting Scientific Research are "Research on High-efficiency Photochemical Process," "Oxide High-Temperature Superconductors," "New Electronics Based on High-temperature Superconducting Materials," and "Functions and Physical Properties of Organic Metallic Compounds."

By taking advantage of the "Research and Development System of the Fundamental Technology for the Next-Generation Industry," the Ministry of International Trade and Industry is promoting the following R&D projects: "Fine Ceramics," "High-Efficiency Polymer Separation Film Materials," "Conductive Polymer Materials," "Composite Material" and "Photoreactive Materials." The Research Institute for Polymers and Textiles is engaged in research for the development of various polymer materials, while the Mechanical Engineering Laboratory, the National Chemical Laboratory for Industry and the Electrotechnical Laboratory are engaged in the development of materials appropriate for their respective research objectives (Table 3-3-22).

Table 3-3-22. Major R&D Tasks in the Field of Matter/Materials-Related Science and Technology Being Promoted by Research Institutes Under Ministries and Agencies

Ministry or agency	Research institute	R&D task
Science and Technology Agency	Coordination funds for promoting science and technology	•Research relating to analytical and evaluative technology of high-performance functional materials by new beam technology
	National Research Institute of Metals	•Research relating to the fundamental technology for development of functionally gradient materials to mitigate thermal stress •Research relating to fundamental technology for imparting new functional capabilities to rare metals through high-level purification •Research and development of cryogenic equipment materials •Research relating to development of lightweight, heat-resistant intermetallic composite materials •Research relating to development of intermetallic composite materials for use in high-performance light-emitting devices

[continued]

[Continuation of Table 3-3-22]

Ministry or agency	Research institute	R&D task
	National Institute for Research in Inorganic Materials	•Research on biofunctional ceramics •Research on fabricating diamond into semiconductors •R&D of ultrahigh abrasion-resistant materials
	Research Development Corporation of Japan	•Research on solid surfaces and chemical compositions through the Creative Science and Technology Promotion System
Ministry of Education, Science and Culture	Universities (funds for assisting scientific research)	•Research on high-efficiency photochemical process •High-temperature oxide superconductors •Functions and properties of organic metal compounds •New electronics based on high-temperature superconducting materials
Ministry of International Trade and Industry	Mechanical Engineering Laboratory	•Research on amorphous metal machining technology •Research on solid-phase junctioning of new materials
	National Chemical Laboratory for Industry	•Research on diamond solidification compacting by means of ultrahigh density energy
	Government Industrial Research Institute, Osaka	•Research on ion-conductive amorphous inorganic materials •Research on a refraction changing type of recording material
	Government Industrial Research Institute, Nagoya	•Research on photosensitive ceramic materials
	Research Institute for Polymers and Textiles	•Research on development of polymer materials for separation of bioelements •Research on development of physical property and shaping of high junction resin

[continued]

[Continuation of Table 3-3-22]

Ministry or agency	Research institute	R&D task
	Electrotechnical Laboratory	•Research on artificial functional grating •Research on creation of new surface layer materials using activated particles
Ministry of Transportation	Ship Research Institute	•Research on design of hybrid ocean structures
	Port and Harbor Research Institute	•Research on design of hybrid ocean structures
Ministry of Construction	Public Works Research Institute for Research and Development of Construction Technology	•Development of technology for research instituting durability of concrete •Research on engineering properties of geotextile-based new materials
Ministry of Health and Welfare	National Institute of Hygienic Sciences	•Research on polymer materials for medical use •Research on dental materials

(8) Information and electronics technology

1) Significance of promoting information and electronics technology

Since social and economic activities have become active and diversified, the quantities of information in every field of activity have increased and, accordingly, the needs for information are becoming sophisticated and diversified.

The importance of information and electronics technology as the fundamental technology for information processing and information transmission in telecommunication and broadcasting is increasing all the more. The technology is also coming to play an important role in elevating the livelihood of the people and in supporting socioeconomic growth through its applications in broad fields of activity, such as automatic control and measuring.

In its 11th advisory report, entitled "On Comprehensive and Basic Policies Based on a Long-Term Perspective To Cope With New Changes in the Situation," submitted in November 1984, the Council for Science and Technology positioned information and electronics technology as a basic and pioneering Science and Technology Agency field demonstrating a potential for new growth in consideration of its technological significance.

Upon the August 1987 receipt of the Prime Ministers Inquiry No 15, entitled "On Basic Policies for Research and Development of Information and Electronics Related Science and Technology," the Council for Science and Technology established the Information and Electronics Related Science and Technology Division, and the Prime Minister's Inquiry has been actively deliberated.

The Council for Aeronautics, Electronics and Other Advanced Technologies, an advisory body to the director-general of the Science and Technology Agency, has submitted reports in reply to Inquiry No 6 entitled "On Promotion of Comprehensive Research and Development of Information and Electronics Technology Relating to Systems That Will Supplement or Replace Human Intelligent Functions" and to Inquiry no 11 entitled "On Promotion of Comprehensive Research and Development Relating to Upgrading of Optical Science and Technology," showing approaches to the promotion of R&D in various information and electronics technology fields. The CST's response to the 11th Inquiry emphasizes the importance of optical science and technology, a comprehensive science and technology encompassing the generation of light, such as laser and synchrotron radiation light, as well as the control and application of light.

2) Discrete fields and their tasks

(i) Microelectronics

In microelectronics, which aims at higher device integration and sophistication, the R&D directions are twofold: one involves the search for the critical performance of a silicon-based ultrahigh performance LSI; and the other is a quest for the development of devices that surpass the limits of silicon, such as superlattice devices, by using compound semiconductors, Josephson devices, or new principles. Research is also being conducted in the high-density three-dimensional device that is expected not only to greatly expand the integration limits of two-dimensional devices, but also to display multifunctional capabilities, such as sensor capabilities.

Research and development is also being conducted on environment-resistant devices that will retain their high reliability even under rigorous conditions, such as in nuclear power plants and space and ocean environments, and research is also being conducted on molecular electronics capable of processing information at molecular levels.

Among the concrete R&D tasks are "research on diamond semiconductors" by the National Institute for Research in Inorganic Materials of the Science and Technology Agency, a "magnetic flux quantum information" project being undertaken by the Research Development Corporation of Japan under the Creative Science and Technology Promotion System, "research on molecular electronics" by the Electrotechnical Laboratory and others of the Agency of Industrial Science and Technology, and the "superlattice device" being undertaken under the Fundamental Technology R&D System for the Next-Generation Industry.

(ii) Optoelectronics

With the realization and room-temperature continuous oscillations using semiconductor lasers and of low-loss optical fibers, optoelectronics, a technology that uses optical signals in place of electric signals, is experiencing development, and new materials, elements and devices have been developed one after another. The scope of application has been expanding from optical communications to optical measuring and control to image information processing, and the optical industry is expected to achieve dramatic growth.

Therefore, aiming at the interconnection or integration of optical devices as well as at their high-performance capabilities, research efforts are being made to upgrade discrete devices, such as light-emitting and receiving elements, waveguides, optical switches, and modulators, as well as to realize optical logic devices and optical integrated circuits.

Among the R&D tasks undertaken during FY 1987 have been "research for development of intermetallic compound materials for high-performance light emitting devices" by the National Research Institute of Metals of the Science and Technology Agency, "sensing using optical waves" that was conducted as a special research project by drawing on the Funds for Assisting Scientific Research of the Ministry of Education, Science and Culture, "research on the basic technology for an optoelectronic computer" by the Electrotechnical Laboratory of the Ministry of International Trade and Industry, and the "research and development of frequency bands in the optical region" by the Radio Research Laboratories (reorganized in April 1988 as National Research Institute of Communications) of the Ministry of Posts and Telecommunications.

(iii) Bioelectronics

Bioelectronics, a field of technology that aims to realize excellent capabilities, such as the data processing capacity, through engineering by taking advantage of or imitating the sophisticated performances of organisms, is expected to contribute greatly to the information and electronics technology. Specifically, research on biosensors imitating the organisms' capabilities to identify specific particles, the ultrahigh level integration of bioelements, and pursuit of the feasibility of ultralow energy molecular circuits comprise the current research tasks. Research on intelligent machines incorporating high-level artificial intelligence simulating the brain's information processing system and research on new system principles, such as an architecture which, provided with the capability to self-organize the circuitry, is capable of compensating for partial damage and keeping the entire system in a state of high reliability, are drawing attention.

Among the bioelectronics-related research projects undertaken during FY 1987 are the "research and development of the fundamental technology for elucidation of brain function" that was conducted using the Coordination Funds for Promoting Science and Technology, "research on frontier materials" by the Institute of Physical and Chemical Research (RIKEN), and the "biodevices" carried out under the Fundamental Technology Research and Development System for the Next-Generation Industry.

(iv) Information processing related software technology

Research is being advanced to explain the highly sophisticated intelligence-related capabilities of humans, such as pattern recognition, learning, and inference and problem solving, and their realization by engineering means, by marshalling the results of research into the fundamental information technologies, such as mathematics and semiotics, as well as into such related fields as neurology, psychology and linguistics. Efforts are also being made for the R&D of various intelligent systems, such as expert systems, machine translation systems, and intelligent robot systems.

In connection with development of such artificial intelligence (AI) systems, research is being made into the new language best suited for AI system development, as well as into intelligence base system and inference system related software, and high-level operating system related software. Furthermore, R&D is being advanced into the technology that will enable various computer models to be interconnected for mutual operability, and thus a multi-media-compatible high-reliability dispersed database system would be established as the fundamental technology for the high-level information society.

Among the research projects in the field undertaken in FY 1987 were the "research for the development of the fundamental technology for elucidation of brain functions," conducted by taking advantage of the Coordination Funds for Promoting Science and Technology, "development of a practical-scale machine translation system" by the Japan Information Center of Science and Technology, "basic research for upgrading language information processing," undertaken as a special research project by drawing on the Funds for Assisting Scientific Research of the Ministry of Education, Science and Culture, "computer inter-operation data base system," promoted under the Ministry of International Trade and Industry's Large-Scale Industrial Technology Research and Development System, and the "fifth-generation computer research and development" by the Ministry of International Trade and Industry.

(v) Lasers

Research is being conducted for the development of new types of lasers, as well as for raising the performance of existing lasers, such as seeking larger output and higher efficiency. Research and development is also being conducted on the technology for tapping laser energy for practical use, on the technology that will give lasers a role in chemical reactions, and on the technology for the laser's use in analysis, measuring and control.

Among the research projects undertaken in FY 1987 were the "research on large-output and wavelength-variable lasers and laser processing technology," conducted using the Coordination Funds for Promoting Science and Technology, "research on new laser technology" by the Institute of Physical and Chemical

Research (RIKEN), and "research on the technology for controlling chemical reactions using lasers," by the National Chemical Laboratory for Industry of the Ministry of International Trade and Industry (Table 3-3-23).

Table 3-3-23. Major Research Tasks in Information and Electronics Technology Field Undertaken in FY 1987

Ministry or agency	Research institute	Research task
Science and Technology Agency	Coordination Funds for Promoting Science and Technology	•Research on large-output and wavelength-variable laser and laser processing technology •Research for development of fundamental technology for elucidation of brain functions •Research on knowledge base systems for assisting design of chemical substances
	National Research Institute of Metals	•Research for development of intermetallic composite materials for use in high-performance optical devices
	National Institute for Research in Inorganic Materials	•Research on diamond semiconductors
	Institute of Physical and Chemical Research	•Research on new laser technology •Research on intelligent machines with thinking capabilities •Research on frontier materials
	Research Development Corporation of Japan	•Magnetic flux quantum information
	Japan Information Center of Science and Technology	•Development of a practical-scale machine translation system
Ministry of Education, Science and Culture	Universities (funds for assisting scientific research)	•Basic research for upgrading language information processing •Sensing utilizing optical waves
Ministry of Agriculture, Forestry and Fisheries	Research undertaken outside the framework of ordinary research	•Development of information processing technology for strengthening agricultural production controlling system

[continued]

[Continuation of Table 3-3-23]

Ministry or agency	Research institute	Research task
Ministry of International Trade and Industry	R&D of Fundamental Technology for Next-Generation Industry	•Three-dimensional circuit devices •Superlattice devices •Biodevices
	Large-Scale Industrial Technology Research and Development	•High-speed calculating system for science and technology •Critical work robots •Data base system for inter-operation of computers
	Development of Computer Basic Technology	•R&D of the fifth-generation computer
	Mechanical Engineering Laboratory	•Development of hologram devices and research on their application
	Electrotechnical Laboratory	•Research on natural language conversation system •Research on information system architecture •Research on molecular electronics (a joint project with the National Chemical Laboratory for Industry and Research Institute for Polymers and Textiles)
	National Chemical Laboratory for Industry	•Research on the technology for controlling chemical reactions using lasers
Ministry of Transportation	Electronic Navigation Research Institute	•R&D of navigation aids and communications technology •Research on upgrading the capabilities of the aircraft collision prevention system
Ministry of Posts and Telecommunications	Radio Research Laboratories (reorganized into the National Research Institute of Communications in April 1988)	•Experiment and research on communications satellites •R&D of air and marine satellite technology •R&D of high-precision position-measuring technology using space radiowaves •R&D of frequency bands in optical region

(9) Disaster prevention and science and technology

1) Drafting of basic plan for research and development relating to disaster prevention

For Japan, whose natural environment is vulnerable to various types of disasters such as earthquakes, wind and flood damage, and damaging snowfalls, the promotion of disaster-prevention science and technology, a research field aimed at explaining the causes of disasters, preventing disasters from taking place, and reducing damage, is a highly important task.

Therefore, in July 1981, upon receiving an advisory report from the Council for Science and Technology, the government drafted its "Basic Plan for Research and Development Relating to Disaster Prevention," which presented the areas and goals of R&D that were to be conducted over a long period of time in order to combat disasters caused by natural phenomena, such as earthquakes, landslides, volcanic eruptions, heavy rains and heavy snows, as well as the secondary disasters accompanying such natural disasters.

In promoting R&D in these fields, various measures have been implemented to ensure the smooth progress of the R&D projects by establishing an integral cooperative relationship among government, academia and industry, by promoting basic research, and by building or refurbishing large-scale experimental facilities.

In November 1984, the Council for Science and Technology submitted an advisory report entitled "On Comprehensive and Basic Policies Based on the Long-Term Perspective To Cope With New Changes in the Situation." The report stated the necessity to upgrade the disaster prevention countermeasures and to promote comprehensive, systematic disaster prevention countermeasures in the future, and Japan's disaster prevention will be implemented in accordance with these basic policies.

2) Promotion of disaster prevention science and technology

a) Earthquake forecasting

Of all fields of disaster prevention science and technology that need to be promoted, earthquake prediction is a particularly urgent task for Japan, one of the world's major earthquake-ridden countries.

Earthquake forecasting, observation and research activities in Japan have been undertaken along the principles of the earthquake forecasting program proposed by the Geodesy Council of the Ministry of Education, Science and Culture and based on the "Basic Plans for Research and Development on Disaster Prevention," and have been promoted under liaison or cooperation between the governmental research institutes and national universities.

The results of such observation and research activities have been forwarded to the "Earthquake Prediction Liaison Council" for evaluation, study and overall judgment.

Furthermore, in response to the prediction that the Tokai area may be hit by a significant earthquake at any time, the Earthquake Prediction Promotion headquarters (chairman: director general of the Science and Technology Agency) was established within the Cabinet in October 1976. The headquarters, under a system incorporating the close liaison and cooperation of concerned organizations, has been promoting various measures aimed at intensifying the observation and research activities focused on the Tokai area, having central control of the observed data, and promoting a constant observation system and judgment structure.

With such activities as its background, and on the strength of society's strong demand for earthquake forecasting, the "Special Law for Coping With Large-Scale Earthquakes" was instituted in June 1978. In August 1979, based on the above special law, the Tokai area was designated as the "area requiring reinforced earthquake and disaster prevention countermeasures," and the "Judgment Council of the Targeted Area for Reinforced Earthquake and Disaster Prevention Countermeasures" was established within the Meteorological Agency.

In order for the fifth earthquake forecasting program, proposed by the Geodesy Council of the Ministry of Education, Science and Culture to progress smoothly, thus effectively implementing the Special Law for Coping With Large-Scale Earthquakes, the Earthquake Prediction Promotion Headquarters, in liaison with and the incorporating the cooperation of concerned organizations, has been promoting various measures aimed at furthering earthquake prediction, such as the expansion and improvement of observation and research activities.

Moreover, in line with the policy of the Council for Science and Technology, the "research on earthquake tectonics in central Japan with a seismically active structure" was continued in collaboration and with the cooperation of the related government organizations by drawing on the Coordination Funds for Promoting Science and Technology, and a new research theme "research relating to the prediction of inland earthquakes of a scale of magnitude 7" was undertaken.

b) Measures for earthquake disaster prevention

Regarding measures for earthquake disaster prevention, the following research activities were undertaken at the National Research Center for Disaster Prevention, the Port and Harbor Research Institute, the Public Works Research Institute, the Building Research Institute, and the Fire Research Institute: research on earthquake-proofness of buildings and civil engineering structures; tests using large-scale earthquake-proof testing facilities; research on earthquake-proofness of port and harbor structures; and research on how to counter fires resulting from a large earthquake. Regarding the observation of strong earthquakes, the concerned organizations exchanged their observation data and opinions at the forum of the "Liaison Council for the Promotion of Observation of Strong Earthquakes" established within the National Research Center for Disaster Prevention.

c) Volcanic eruption prediction

As for research on volcanic eruption prediction, in line with the third Volcanic Eruption Prediction Program proposed by the Geodesy Council of the Ministry of Education, Science and Culture in May 1983, the observation and research structures at the National Research Center for Disaster Prevention, the Geological Survey of Japan, the Maritime Safety Agency, the Meteorological Agency, the Geographical Survey Institute and national universities have been improved, and various observations and studies are being promoted. The results of these observations and studies have been forwarded to the "Volcanic Eruption Prediction Liaison Council" for assessment and study to reach an overall conclusion.

d) Measures for weather and water disaster prevention

Regarding measures for weather and water disaster prevention, the following research activities were undertaken at the National Research Center for Disaster Prevention, the Port and Harbor Research Institute, the Meteorological Research Institute, the Public Works Research Institute and the Building Research Institute: research on atmospheric air circulation, typhoons and heavy rains, and on explaining resultant weather phenomena such as disturbances; R&D of technologies to protect the people and their livelihoods from snow damage, such as techniques for removing snow from one's home and vicinity, techniques for removing snow from roofs, research on the cause of snowslides; research for the prevention of snow damage, such as an explanation of the cause of land snowstorms; and research on flood tides, waves, damage caused by river flooding, and wind-caused damage.

Regarding measures for the prevention of damage brought about by changes in the ground's surface, the National Research Center for Disaster Prevention and the Public Works Research Institute conducted studies on earth and sand disasters and tests using large-scale rainmaking experimental facilities.

Regarding research on measures for coping with fire and explosion disasters, research on how to cope with a large-scale fire in a big city and prevent explosions of powders, high-pressure gases and combustible gases was undertaken by the National Policy Agency, the National Chemical Laboratory for Industry, the National Research Institute for Pollution and Resources, the Building Research Institute, and the Fire Research Institute.

Table 3-3-24 gives the disaster prevention science and technology related budget, while Table 3-3-25 shows the budget related to earthquake prediction.

Table 3-3-24. Outlines of Disaster Prevention Science and Technology Related Budget (Unit: ¥1 million)

Ministry or agency	FY 1986 budget	FY 1987 budget	Research item
Hokkaido Development Agency	27	31	Studies on how to prevent river and sea disasters in Hokkaido and on how to prevent road-related disasters
Science and Technology Agency	2,559	2,576	Studies on crustal activities in the Kanto and Tokai areas (observations and studies of minor earthquakes using deep observation wells), studies on how to counter earthquake-caused disasters, and studies on techniques of snow damage prevention
Environment Agency	5	5	Survey of method for establishing target values to prevent soil subsidence
Ministry of Education, Science and Culture	3,419	3,352	Studies on natural disasters, basic research for earthquake prediction and volcanic eruption prediction, basic research on earthquake disasters
Ministry of Agriculture, Forestry and Fisheries	513	468	Studies on methods to prevent crop and forestry damage
Ministry of International Trade and Industry	1,101	1,075	Geological and geochemical research for earthquake prediction; research on safety technology for liquefied petroleum gas; research on safety technology involving mines
Ministry of Transportation	1,150	1,248	Survey of seabed topography and geological structure; research on weather, land and water phenomena; comprehensive research for practicalization of technique to predict a type of earthquake rising directly from beneath the ground's surface

[continued]

[Continuation of Table 3-3-24]

Ministry or agency	FY 1986 budget	FY 1987 budget	Research item
Ministry of Posts and Telecommunications	105	55	Research on geodetic survey for long-term earthquake prediction
Ministry of Labor	336	964	Research on technology for labor disaster prevention
Ministry of Construction	1,723	1,605	Survey of crustal changes by geodetic method; development of disaster information systems
Fire-Defense Agency	157	158	Research on measures to cope with large-scale earthquake and fire
Total budget	11,095	11,537	

Notes: 1. The above figures have been rounded; i.e., ¥500,000 and over is counted as a unit, while lesser amounts have been dropped.
2. The funding of ¥19.181 billion (¥17.820 billion for the previous year) for the Science and Technology Agency's "Research for securing of safety in nuclear power utilization" is not included.
3. The "Research on earthquake tectonics in central Japan with a seismically active structure" and the "Research for development of systems to assess the probability of earth and sand disasters occurring," both funded by the Coordination Funds for Promoting Science and Technology, are not included.

Source: Science and Technology Agency estimates.

Table 3-3-25. Outline of Earthquake Prediction Related Budget

(Unit: ¥1 million)

Ministry or agency Research institute	FY 1986 budget	FY 1987 budget	Research item
<u>Science and Technology Agency</u>			
Research and Development Bureau	5	5	•Promotion on earthquake prediction
National Research Center for Disaster Prevention	908	881	•Research on seismic activity in southern Tokyo •Research on crustal activity in the Kanto and Tokai regions •Research on earthquake occurrence mechanism

[continued]

[Continuation of Table 3-3-25]

Ministry or agency Research institute	FY 1986 budget	FY 1987 budget	Research item
			•Research on the technique for predicting a type of earthquake rising directly from beneath the surface of flat ground •Research on technique for predicting a sea-trench-type of large earthquake •Promotion of improvement of the research buildings for earthquake prediction •Improvement of facilities
Total budget	912	885	
Ministry of Education, Science and Culture			
Universities	1,690	1,693	•Promotion of comprehensive observation and research activity, and basic survey •Improvement of the observation network; strengthening comprehensive mobile observation equipment and equipment for comprehensive observation for crustal activity •Collection of various earthquake prediction data by using existing observation networks and their analysis and research
Total budget	1,690	1,693	
Ministry of International Trade and Industry			
Geological Survey of Japan of the Agency of Industrial Science and Technology	147	144	•Geological and geochemical research on earthquake prediction
Total budget	147	144	

[continued]

[Continuation of Table 3-3-25]

Ministry or agency Research institute	FY 1986 budget	FY 1987 budget	Research item
Ministry of Transportation			
Maritime Safety Agency	25	25	•Geodetic survey and tidal observation •Observation of geomagnetism and earth current
Meteorological Agency	856	947	•Improvement, maintenance and operation of constant monitoring system in the Tokai region •Improvement, maintenance and operation of small, medium and large earthquake observation networks •Improvement, maintenance and operation of a central monitoring system for earthquake activities,etc. •Intensification, maintenance and operation of geomagnetism and earth current observation •Improvement, maintenance and operation of tidal observation along the coastal area •Comprehensive research for practicalization of a technique to predict a type of earthquake arising directly from beneath the ground's surface
Total budget	881	972	
Ministry of Posts and Telecommunications			
Radio Research Laboratories	105	55	•R&D of high-precision measuring technology of space radio waves
Total budget	105	55	

[continued]

[Continuation of Table 3-3-25]

Ministry or agency Research institute	FY 1986 budget	FY 1987 budget	Research item
Ministry of Construction			
Geographical Survey Institute	1,604	1,572	•High-precision surveying of the geodesic networks of the Japanese archipelago •Observation of specified regions •Observation of the regions designated for enhanced observation •Astronomical survey, leveling and gravity survey
Total budget	1,604	1,572	
Grand total	5,339	5,320	

Notes: 1. In addition to the above earthquake prediction related activities, 1) the "Research on the earthquake tectonics in central Japan with a seismically active structure" and the "Research relating to prediction of inland earthquakes of a scale of Magnitude 7" were undertaken by taking advantage of the Coordination Funds for Promoting Science and Technology; 2) the Ministry of Education, Science and Culture appropriated ¥40 million (0) as the funding for "Joint Sino-Japanese Research on Earthquake Prediction; 3) the Geological Survey of Japan, of the Ministry of International Trade and Industry, appropriated ¥17 million (¥17 million) as the funding for "Earthquake Ground Water Telemeter Continuous Observation"; and 4) the Geological Survey Institute, of the Ministry of Construction, appropriated ¥19 million (0) as the funding for renewal of high-precision range-finding equipment.

2. The above figures are results of rounding; i.e., ¥5,000 and over is counted as a unit, while lesser amounts are dropped. Consequently, the totals of appropriations for various organizations in charge of research within each of the ministries and agencies do not necessarily agree with the end sums.

3. Radio Research Laboratories was reorganized into the National Research Institute for Communications in April 1988.

(10) Earth science technology

With the remarkable advances in stage-of-the-art technologies, such as remote sensing and research submersibles, in recent years, the amount of knowledge on the effects that large-scale atmospheric and oceanic alterations and human activities have on the environment has increased. These phenomena are also closely related to the social activities of human beings, and finding solutions to these phenomena is gathering an increasing social attention.

In this respect, promoting earth science and technology is expected to contribute the ability to cope with disaster prevention and environmental problems, as well as to predicting the future of the earth. In that the results obtained while promoting earth science and technology will be beneficial to the interests common to all human beings on this earth, this discipline is highly significant.

From the foregoing perspective, the Earth Science and Technology Division and established within the Council for Aeronautics, Electronics and Other Advanced Technologies, an advisory body to the director-general of the Science and Technology Agency, in March 1987, and the division has been deliberating on the comprehensive promotion of earth science and technology research.

Since the targets covered in earth science and technology are broad in terms of temporal and spacial expanse and are varied, they are well studied to international cooperation in research, and international joint research projects focusing on the United States and European countries have been planned or implemented. With Japan's recently attained international standing, it has become necessary for Japan to make positive contributions to the world community in the field of earth science and technology.

In line with the government's recognition described above, the related government ministries and agencies have been promoting R&D in their respective fields. Among the common technologies necessary for elucidating various earth-scale phenomena are weather satellites, marine observation satellites, earth observation data processing, and research submersibles, and the R&D of these technologies are being promoted by the National Space Development Agency, the Japan Marine Science and Technology Center, and the Meteorological Agency.

In grasping these phenomena, observations provide the basic data, so observations have been undertaken as routine business by the Maritime Safety Agency, the Meteorological Agency and other related ministries and agencies.

Descriptions of major R&D projects being undertaken by the government ministries and agencies follow.

1) Science and Technology Agency

By drawing on the Coordination Funds for Promoting Science and Technology, research involving the participation and cooperation of related organizations is being promoted on the earthquake tectonics in the area of central Japan that has a seismically active structure, and an international cooperative research project on atmospheric and oceanic alterations in the Pacific Ocean, along with weather changes, is underway.

The National Research Center for Disaster Prevention is engaged in research on themes necessary for earthquake prediction, such as elucidation of the plate structure.

2) Environment Agency

In addition to conducting research on such themes as changes in the amount of carbon-based trace elements that are contributing to the warming up of the earth and the Japanese archipelago-scale air pollution accompanied by a cloud physics process, the National Institute for Environmental Studies is promoting research on nonuniform optical reaction-induced conversion and decomposition of incurable chemical substances, as well as on the atmospheric-oceanic exchange of carbon dioxide.

3) Ministry of Education, Science and Culture

In addition to conducting academic studies as part of the international joint research programs involving the lithosphere exploration and development program (DELP), the international deep-sea digging program (ODP) and the weather change international joint research program (WCRP), universities are also engaged in other academic studies including earthquake and volcanic eruption prediction, atmospheric changes in the ultrahigh spheres, the physical mechanisms of weather changes, plate tectonics, and the movements and alterations of substances within the earth.

The National Institute for Polar Research is engaged in comprehensive research on the science involving the polar regions and observation of the polar regions.

4) Ministry of Agriculture, Forestry and Fisheries

The National Institute of Agricultural Environment and Sciences, the Forest and Forest Products Research Institute, and the Regional Fisheries Research Laboratory are engaged in the following activities: development of a technique to measure long-term changes in the environment and the national ecosystem, including the earth-wide environmental and ecological system, as well as of a technique to preserve and control the environment and the ecosystem, comprehensive research on technology to utilize natural energies efficiently, and development of technology to observe and evaluate agriculture, forestry and fisheries resources by means of remote sensing.

5) Ministry of International Trade and Industry

The Geological Survey of Japan is engaged in the following activities: geological and geochemical research on earthquake prediction, research on geology and subterranean structures of active volcanoes, research on the geological features of the seabeds of the continental shelves in the southwestern waters of Japan and other geological surveys involving the exploration of the earth and its resources.

6) Maritime Safety Agency

As part of its hydrographic concerns, the agency is engaged in the following activities: comprehensive seabed surveys in the jurisdictional waters, geodetic surveys of the oceans using geodetic satellites, surveys of the topography of the seabeds and subterranean structures for earthquake and volcanic eruption prediction, and surveys of the water temperature, currents and waves in the South Pacific regions. The Japan Ocean Data Center, established within the agency, has been collecting, controlling and providing marine data, including seabed topography, geological and geophysical data, and ocean currents and waves to the International Ocean Data Exchange System as the Japanese representative.

7) Meteorological Agency

The agency is engaged in the following weather-related activities:
1) research on radiation processes of clouds, research on atmospheric and oceanic changes using weather satellites, research to explain and predict the mechanisms of weather changes, such as oceanic and atmospheric general circulation models; 2) research on models used to predict the course of typhoons, research on basic and physical processes of various weather phenomena, such as dynamic and numerical studies of small- to medium-scale phenomena; 3) research on earthquakes and volcanic eruptions, such as the practicalization of a technique for predicting an earthquake occurring directly beneath the surface of the ground, and research on air, ground and water phenomena.

8) Ministry of Posts and Telecommunications

The Radio Research Laboratories (reorganized into the National Research Institute of Communications in April 1988) is engaged in the following activities: enhanced observations during Intermediate Atmospheric Sphere International Joint Observation Program (MAP), measurements of plate movements using a very long base radiowave interferometer (VLBI) for long-term earthquake prediction, and remote sensing of the earthly environment using radio waves and light.

9) Ministry of Construction

The Geographical Survey Institute is engaged in the following activities: observation and research of plate movements using VLBI as part of the DELP, joint research with ASEAN countries for upgrading remote sensing technology and its applications, and observation and research of crustal changes for earthquake prediction.

From the perspective of promoting earth science while taking into consideration the international situation, the Council for Aeronautics, Electronics and Other Advanced Technologies, an advisory body to the director-general of the Science and Technology Agency, will study the research tasks that need to be tackled.

10) Soft systems science and technology

1) In soft systems science and technology, the new analysis frames, methodologies and methods found in the rapidly advancing information science, system engineering and control engineering in recent years, as well as the

new theoretical models and findings developed various behavioral sciences and liberal and social sciences, are combined, forming a comprehensive science and technology which will be used to explain and solve various complex problems and to elucidate intelligence-related activities of human beings. Furthermore, this S&T field will include the development of theories, methods and means that will contribute to building production and social systems based on higher-level information processing technology involving such factors as situation and atmosphere or the software type capabilities of organisms, and their applications.

In Japan, necessity for promoting soft systems science and technology is emphasized in the Council for Science and Technology's April 1971 advisory report No 5, "On Basic Principles of Comprehensive Science and Technology Policy in the 1970s," the same council's May 1977 advisory report No 6 entitled "On Basic Principles of Comprehensive Science and Technology Policy Based on a Long-Term Perspective," the same council's November 1984 advisor report No 11 entitled "On Comprehensive and Basic Policies Based on a Long-Term Perspective To Cope With New Changes in the Situation," and in the Outlines of the Science and Technology Policy adopted at a Cabinet Ministerial Meeting held in March 1986.

In March 1974, the National Research and Development Organization (NIRA) was established through investments by the national government, local governments and the private sector, and the organization has been engaged in the comprehensive R&D of various problems facing modern society from an independent standpoint.

Based on its previous accumulation of research, in FY 1986 NIRA embarked on a comprehensive project aimed at elucidating Japan's tasks in the 1990s, from a fresh perspective, in preparation for the 21st century.

2) Since the relationships between science and technology and daily living have increased, when implementing the results of R&D in society it has become increasingly demanded that the requisite prior assessment statements and scientific findings needed for judgment be made available to the public.

From such a viewpoint, the government began conducting technology assessment related surveys in FY 1971 in an effort to develop the methodology of technology assessment and share the results with the private sector. As a result of such activities, technology assessment is beginning to take root.

Technology assessment per se is aimed at promoting the results of R&D so that they will take root in society, but in order for its original objective to be realized, various studies must be conducted, including studies of the public acceptance of the R&D results. For this reason, the public acceptance of new technology was taken up as an international cooperative theme by the "Working Committee on Technology, Growth and Employment" at the Versailles Summit held in June 1982 in France. Surveys and research were conducted with the cooperation of the concerned countries, and the final report was submitted at the Tokyo Summit in May 1986.

3) A general trend in science and technology in recent years has been to attach importance to the three themes of "promotion of science and technology rich in creativity," "promotion of science and technology harmonious with man and society," and "development with an emphasis on internationality."

From now on, the development of science and technology geared more toward intelligence, such as knowledge and information, than to the conventional hardware is desired.

In view of this background, the "Survey on the current state of research and development soft systems science and technology and its direction of development in the future" has been continued since FY 1987 in an effort to grasp the actual state of R&D of soft systems science and technology and its applications.

(12) Promotion of comprehensive research and development

Under the Comprehensive Research and Development System, of the R&D projects satisfying the requirements of society and the economy, those that are too large in scale and entail too great a risk in commercialization for the private sector to undertake on its own are promoted as joint research programs under the leadership of the government and with the cooperation of academia and industry.

Among the comprehensive R&D projects for FY 1987 are the R&D of comprehensive ocean science and technology (Science and Technology Agency), comprehensive R&D (Ministry of Agriculture, Forestry and Fisheries), extensive research outside of the framework (Ministry of Agriculture, Forestry and Fisheries), ordinary research to be conducted outside of the framework (Ministry of Agriculture, Forestry and Fisheries), R&D of substantial industrial technology (Ministry of International Trade and Industry (MITI)), R&D of new energy technology (MITI), R&D of energy-saving technology (MITI), R&D of the fundamental technology for the next-generation industry (MITI), R&D of transportation technology (Ministry of Transportation), and R&D of construction technology (Ministry of Construction), and their R&D themes and research objectives, as well as budgets and research periods, are given in attached material 30.

The following six themes were added to the list of projects to be undertaken under the Comprehensive Research and Development System beginning in FY 1987, "Development of high-quality and high-yield field crops for high-level utilization of paddy fields and development of technology for stable production at high levels" (comprehensive R&D), "Research for elucidation of arrangement of base pairs in plant DNA" and "Development of safety evaluation methods of recombinants in the open field environment" (R&D of biotechnology leading-edge technology), all undertaken by the Ministry of Agriculture, Forestry and Fisheries; and "Development of utilization technology of underground space," "Development of disaster information system" and "Development of technology for improving the living environment in a society with an aging population" (construction technology R&D), all undertaken by the Ministry of Construction.

Comprehensive research and development based on the cooperation of government, academia and industry is also being promoted by drawing on the Coordination Funds for Promoting Science and Technology (see Section 4 of this chapter).

7. Promotion of Local Science and Technology

As for science and technology research in the local areas, R&D has mainly been promoted by public R&D institutions, and local area promotion measures have been implemented to create technopolises, new media communities and teletopias. Recently, new developments have come to be seen, in addition to the conventional R&D activities, involving the promotion of local science and technology, as can be seen in the tightening of the Kansai cultural and academic research city concept into a concrete program and the demand for intensified regional R&D capabilities in accordance with the fourth Comprehensive National Development Plan. This section describes science and technology related conferences being held in the local areas and the movements of public research and development institutions.

(1) Conference for the promotion of local science and technology

As part of its policy to promote science and technology in local areas, since FY 1963 the Science and Technology Agency has held meetings called the "Conference for the Promotion of Local Science and Technology." The agency has divided Japan into eight blocs, and the Conference is held in each of the blocs. The Conference provides a forum where people from various walks of life, as well as people in the science and technology field, can get together. Efforts are made there for the government and the local community to exchange opinions and various problems relating to the promotion of science and technology in the area are discussed in order to foster the mood of cooperation between the science and technology institutions and other fields, beginning with industry and academia thus laying the groundwork for the promotion of science and technology in the area.

(2) Conference, etc., for promotion of science and technology in local areas

In order to promote the local science and technology and thus contribute to the causes of area activation and the enhanced welfare of the people in their respective areas, the local governments in Toyama, Hyogo and Shizuoka Prefectures have held council or conference meetings to discuss methods to promote science and technology on a local basis.

(3) Movements of local publicly-owned research institutions

Public research institutes (excluding national institutes) in the local areas are engaged in R&D activities appropriate for their respective areas, contributing to the area's progress. The following is a brief outline of public research institutes in the local areas, based on the "Science and Technology Research and Survey Report" by the Prime Minister's Office.

As of the end of FY 1986, 671 public research institutes (excluding national institutes), employing 15,294 researchers (3.1 percent of the total number of researchers in Japan), existed nationwide. These institutes spent ¥209.2 billion for R&D funding (2.3 percent of the total research expenses in Japan).

By prefecture, Hokkaido has the largest number of research institutes and the largest research funding, at 29 and ¥16.1 billion, respectively. Next comes Kanagawa Prefecture, having 24 research institutes. Tokyo expended the second largest sum of money for research, appropriating ¥12.3 billion.

While Hokkaido's testing and research institutes are mostly in the agriculture forestry and fisheries fields, research institutes in Tokyo and Kanagawa are mostly in the fields of industry and urban environment improvement. By number of researchers, Hokkaido comes first at 922, followed by Tokyo at 801.

Part 4. Promotion of Private Sector Research Activity

Further invigoration of industrial activity is needed to achieve the stable development of Japan's economy, and the role of private sector research activity in support of this invigoration is extremely important. From such a perspective, the government is working toward the improvement of environmental conditions that will allow the energy of the private sector to be displayed at its best. Moreover, the government plans to deal with the issue of the research and development fields that Japan should explore by positively using the outstanding technology and ability residing in the private sector as necessary, and by devising means to effectively proceed with research by bringing the private sector together with the academic community and strengthening cooperation between the two.

This chapter describes these promotion policies by dividing them into 1) promotion by means of grants and government investments, 2) new technology development consignment and services, and 3) promotion by the tax system and financing.

1. Promotion by Grants and Government Investments

Science and technology related subsidies, consignment costs, investments, and allotments (collectively called grants and government investments) were ¥792.1 billion in 1987, an increase of 1.7 percent over the previous year's ¥778.9 billion.

The breakdown by government office of these grants and government investments is shown in Table 3-4-1. Moreover, the important subsidies and consignment costs are shown in Tables 3-4-2 and 3-4-3.

When we look at subsidies, we find that 1) the Ministry of Education scientific research subsidy and private university ordinary expenses subsidy for the encouragement of academic research, 2) the Ministry of Health and Welfare scientific experiment and research expenses subsidy for the promotion

Table 3-4-1. Grants and Government Investments by Government Agency
(Unit: ¥1 million)

Government agency or ministry	FY 1986			FY 1987		
	A	B	Total	A	B	Total
Science and Technology Agency	294,333	89,843	384,176	295,568	91,536	387,103
Environment Agency	1,003	—	1,003	951	—	951
National Land Agency	210	—	210	160	—	160
Ministry of Foreign Affairs	2,578	4,017	6,594	2,531	3,767	6,298
Ministry of Education	47,944	124,807	172,750	49,833	126,172	176,005
Ministry of Health and Welfare	18,157	3,751	21,907	20,019	4,925	24,944
Ministry of Agric., Forestry, Fisheries	3,193	5,663	8,856	3,178	5,570	8,748
MITI	21,141	157,511	178,651	18,150	163,899	182,049
Ministry of Transportation	2,167	300	2,467	3,246	481	3,727
Ministry of Posts and Telecommunications	—	20,537	20,537	—	25,000	25,000
Ministry of Labor	—	1,605	1,605	—	1,502	1,502
Ministry of Construction	630	—	630	652	—	652
Total	391,354	387,534	778,887	394,288	397,853	792,141

Notes: 1. A is the science and technology promotion cost and the research and development costs within the energy measures costs. B is the research related costs other than A. Both are the initial budget portion. (Some include costs, other than grants, related to the specific government office.) The research-related costs within the energy measures costs, and B have been researched by the Science and Technology Agency.

2. This includes subsidies, investments, and consigned fees given to special corporations. For the activities of special corporations, see Section 3 of Chapter 3. Moreover, these include nuclear energy-related costs and space-related costs.

3. The ¥4.3 billion investment in the Japan Science and Technology Information Center, which is part of the Industrial Investments Special Account of the Ministry of Finance, is claimed by the Science and Technology Agency. Similarly, the ¥1 billion loan for operational expenses for experimental research involving medical technologies, which is part of the Research Promotion Fund for the Relief of Secondary Effects Damage Caused by Medicines, is claimed by the Ministry of Health and Welfare. The ¥3.8 billion of the Biological Special Industrial Technology Research Advancement Organization Fund is listed under the Ministry of Agriculture, Forestry and Fisheries. The ¥25 billion investment in the Japan Key Technology Center is counted by both the Ministry of International Trade and Industry and the Ministry of Posts and Telecommunications, respectively.

4. The cumulative figures in each column and the figures in the totals columns do not match because figures have been rounded off.

Table 3-4-2. Major Science and Technology Research-Related Subsidies
(Unit: ¥1 million)

Name (government agency)	Field (grantee)	Subsidy proportion	Budget amount FY 1986	Budget amount FY 1987
<u>Ministry of Education</u>				
Scientific research cost subsidy	Basic research in the social sciences and natural sciences and publication of research results (University and research organization researchers)	Fixed amount	43,500	45,080
Private sector academic research promotion subsidy	Research in the social and natural sciences (private sector academic research organizations)	Fixed amount	140	134
Private university research facilities preparation costs subsidy	Research facilities needed for academic research and information processing-related facilities (school charters establishing private universities)	Two-thirds (one-half with regard to information processing-related facilities)	1,555	1,477
Private university ordinary account subsidy	Private university operational expenses (school charters establishing private universities)	Fixed amount	115,213	115,516
Private school facilities improvement subsidy (private university, etc., research equipment and facilities improvements costs)	Private university research equipment (school charters establishing private universities)	One-half	4,140	5,120
Public medical school ordinary account subsidy	Ordinary account expenses of public medical schools, dental schools, nursing schools, and junior colleges (local public organizations)	Fixed	3,641	3,649

[continued]

[Continuation of Table 3-4-2]

Name (government agency)	Field (grantee)	Subsidy proportion	Budget amount FY 1986	Budget amount FY 1987
<u>Ministry of Health and Welfare</u>				
Health and welfare scientific research subsidy	Research on food hygiene and new pharmaceuticals development (local public organizations, individuals, private organizations, etc.)	Fixed amount	2,842	3,518
Scientific experimental research costs subsidy	Research on designated diseases and psychosomatic obstructions (local public organizations, individuals, etc.)	Fixed amount 10/10, 1/2	12,860	13,972
Cancer research grant	Cancer research (individual)	Fixed	1,600	1,600
<u>Ministry of Agriculture, Forestry and Fisheries</u>				
Ministry of Agriculture, Forestry and Fisheries experimental research subsidy	Agricultural and fisheries experimental research (local public organizations, private sector organizations, and individuals)	Fixed amount 9.5/10,1/2 *	1,941	1,936
Subsidies for expenses of enterprises promoting food industry technology	Development research work and commercialization tests of new food industry technologies (private organizations)	Fixed amount (9/10) 1/2	602	505
<u>Ministry of International Trade and Industry</u>				
Subsidies for costs of research and development of technologies to activate industries	Experimental research in the mining and manufacturing industries and experimental research on innovative technologies in the basic materials industry (private firms, individuals)	1/2,4.5/10	1,364	1,001
Technology improvement costs subsidy	Experimental research concerning development of new products and new technologies which small and medium-sized firms carry out (Small and medium-sized firms, small and medium-sized firm organizations)	2/3,6/10	1,397	2,002

[continued]

[Continuation of Table 3-4-2]

Name (government agency)	Field (grantee)	Subsidy proportion	Budget amount FY 1986	Budget amount FY 1987
New materials technology development subsidy	Development of technology to improve the durability and habitability of collective housing (private organizations, etc.)	1/2	--	87
Energy conservation technology R&D subsidy	R&D of energy conservation technology carried out by the private sector (private experimental researchers)	1/2,4.5/10	68	44
Technology development research subsidy	Experimental research to elevate the technology of small and medium-sized firms (local public organizations)	1/2, 1/4	356	356

Notes: 1. The * means that the proportionate amount was 10/10 for 1985.
2. The private university current accounts subsidy is only for current accounts related to medical and dental curricula and physical engineering courses.
3. The private school facilities improvement subsidy (private university research equipment and facilities improvement costs) is only for expenses related to research equipment of private universities (excludes specialized training schools).
4. Subsidies for the costs of enterprises promoting food industry technology are the costs for promoting the training of skilled food industry personnel, the costs for food industry technology information activities, and expenses excluding those facilitating exchanges and cooperation with overseas food industries.
5. Related agency costs have not been included.
6. This is the initial budget for each fiscal year.
7. The subsidy proportions of 6/10 for the technology improvement subsidy is prior to 1986.

Table 3-4-3. Major Science and Technology Research Consignment Costs
(Unit: ¥1 million)

System (government agency)	Field (grantee)	Budget amount FY 1986	FY 1987
Science and Technology Agency			
Peaceful uses of atomic energy research consignment costs	Research and development on the peaceful uses of atomic energy (private organizations, etc.)	89	77
Consignment costs for investigation and research into radioactive waste disposal measures	Establishment of radioactive waster disposal measures (private organizations)	131	131
Radioactive capacity measurement investigation consignment costs	R&D on radioactive capacity of the environment and the radioactive capacity of the environs of atomic energy facilities (local public organizations, private organizations, etc.)	517	273
Environment Agency			
R&D costs for pollution prevention	R&D for environmental protection policy (universities, local public organizations, private organizations, etc.)	577	542
Ministry of Health and Welfare			
Japan-U.S. medical cooperative research enterprise consignment costs	Japan-U.S. joint research on basic medicine (Japan-U.S. Medical Cooperative Research Society)	90	105
R&D consignment costs for pharmaceuticals	R&D on pharmaceuticals (local public organizations, private organizations, etc.)	180	239
Ministry of Agriculture, Forestry and Fisheries			
Designated research laboratories consignment costs	Designated research laboratories for plant breeding (local public organizations)	1,253	1,242
Biotechnology advanced technology seeds cultivation research consignment costs	Seed cultivation by advanced biotechnology related to agriculture, forestry and fisheries industries and the foods industry (universities, etc.)	100	100

[continued]

[Continuation of Table 3-4-3]

System (government agency)	Field (grantee)	Budget amount FY 1986	FY 1987
Ministry of International Trade and Industry			
Large industrial technology R&D consignment costs	R&D of large-scale industrial technology (private organizations)	3,736	3,043
New energy technology R&D consignment costs	R&D of new energy technology (private organizations, etc.)	296	245
Medical and welfare equipment technology R&D consignment costs	R&D involving medical and welfare equipment (private organizations)	613	586
R&D consignment costs for next-generation industrial base technology	R&D of the technology appropriate for the next-generation's industrial base (private organizations)	4,281	3,730
Consignment costs for development of electronic measuring device basic technology	R&D of the fifth generation computer	4,498	4,048
Consignment costs for new materials technology development	Development of technology for the improvement of the durability and habitability of collective housing	268	210
Ministry of Transportation			
Consignment costs for launching of geostationary meteorological satellites	Geostationary meteorological satellite launching operations (National Space Development Agency)	2,167	3,246

Notes: 1. Related agency costs are not included.
2. This is the initial budget amount for each fiscal year.

of medical science technology, and 3) the Ministry of International Trade and Industry (MITI) industrial activation technology research and development subsidy for the development of industrial technology are all large. Along with these, other subsidies are being put to use in accordance with their grant objectives and are contributing greatly to raising the level of Japanese technology. When we consider consignment costs, MITI's large-scale industrial technology research and development for the development of industrial technology is significant, and the accompanying consignment costs proceed by making use of the superior ability of the private sector in the research and development fields that must undertake, and contribute to the raising of the technological level of Japan.

2. Commissioned Development and Development Services for New Technology

The development of technology requires much time and money. Research and development can be advanced effectively by technology transfer, which raises the level of technology by means of creating a superior new technology through organically combining existing technologies and then applying this superior technology to different fields. The state of technology transfer was investigated and analyzed by the Scientific and Technical Council in "Opinion on the Promotion of Technology Transfer" (August 1980). This report contained the opinion that there was a need to carry out required improvements in the Research Development Corporation of Japan, which implements various technology transfers.

Generally speaking, the risk of failure always haunts personal efforts to develop technology. This risk is particularly great for high technology, and we are apt to be negative about applying the results of research to new commercial technologies. For this reason, the Research Development Corporation of Japan, in recognition of the great technological difficulties in commercializing the results of superior research, has founded a development consignment system, which aims for corporate involvement by consigning the development to corporations. Moreover, with development consignment, the results obtained will be carried out widely throughout the industrial community and, in this way, will be spread. Furthermore, the Research Development Corporation of Japan, by means of a new technology development services system, carries out technology transfer by taking as the research results of university and government laboratories as the transfer subject.

Moreover, the Research Development Corporation of Japan aims at strengthening technology transfer to meet real needs by widely investigating and collecting the needs of corporations and positively transferring new technologies to meet these needs. Along with this, it employs services from overseas by introducing from English language journals, technologies for which overseas services are possible.

Judging the development consignment and development services results up to the end of 1987, there were 217 cases (88 percent) of successful development consignment, 15 unsuccessful cases (6 percent), and 14 cases in abeyance (6 percent). Successes in 1987 included "diamond film low pressure vapor deposition technology," optical integrated circuit semiconductor lasers," and "hepatitis B vaccine manufacturing technology by means of recombinant DNA." In addition, the development of 12 new cases was begun, including "large-scale full color liquid crystal display manufacturing technology," "manufacturing technology for an optical metamer separation agent using polyamino acid," and an "automatic selection device for monoclonal antibody yielding cells."

On the other hand, in the case of development services, 400 services (involving 500 companies) have been established. In 1987, 49 services (involving 70 companies) were established, including "a high quality Langmuir Blodgett (LB) membrane manufacturing device," "automatic sewing machine rhythm control technology," and "vitronectine separation refinement technology."

The current status of the Research Development Corporation of Japan's development consignment and development services is shown in Table 3-4-4. In recent years, the demands for the development of advanced and basic technologies, such as new materials and biotechnology, and the development of public technologies in the areas of medicine and welfare have been increasing. Moreover, the university and national laboratories are producing many outstanding research results. This will mean that the demands on the role of the Research Development Corporation of Japan will be even greater in the future.

Table 3-4-4. State of Consigned Development and Development Services

Item	FY	1983	1984	1985	1986	1987
Consigned development	No of consigned items	15	18	15	15	12
	No of successful items	10	7	17	10	13
	No of successful or halted items	1	3	1	3	1
	Consignment contract amounts (Y1 million)	4,700	4,900	5,000	5,000	5,100
Development services	No of service tasks established	31	30	31	48	49
	No of service firms established	33	41	39	65	70

3. Promotion by the Tax System and Financing

For the purpose of facilitating Japan's research activity and raising the technologies level, the government has been devising taxation and financing measures for the research expenses handled by the private sector.

With regard to taxation measures to promote science and technology, special requisite measures have been devised through national and local taxes. The tax deduction system for increased experimental research costs, which was created in 1967, deducts 20 percent of the increase from the total tax when experimental research costs exceed the highest previous level. This plays a large role in private sector research activity based on independent and original efforts. Furthermore, in addition to the tax deduction for increased experimental research costs, the Basic Technology Research and Development Promotion Tax System has approved a tax deduction of 7 percent of the purchase price of assets used for basic technology development, and the Small and Medium-Sized Industrial Technology Base Strengthening Tax System allows a 6 percent tax deduction of experimental research costs annually accrued by small and medium-sized firms with the selection of the increased experimental research cost tax deduction. Incidentally, with regard to the creation of these systems, similar extraordinary measures have been created by local tax entities in determining the tax for the corporation portion of the corporation and for resident taxes.

Moreover, 1) a special deduction system for income related to overseas technology transactions, 2) the loss inclusion system for donations to special public interest corporations, and 3) an increase in the number of years for which assets used for research and development can be depreciated have all been enacted and have made large contributions to their respective fields. In addition to these, local tax measures have been devised, such as 1) the fixed asset tax on corporate assets used for research, as stated in Article 34 of the Civil Code, which aims at scientific research, 2) exemption from real estate income taxes; 3) an electricity and gas tax exception for the electricity and gas used in experiments by that corporation; 4) a reduction in the fixed asset tax for machines and devices used by the Mining

Table 3-4-5. Major Science and Technology Promotion-Related Tax Systems

Item	Purpose	Contents	Basis	Remarks
Tax deduction system for increased experimental research costs	Advancement of technological development	(1) When the expenses required for experimental research conducted by a corporation in the year applied (and calculated as a loss when calculating cash income) exceed the maximum amount of experimental research costs for each fiscal operating year from the standard fiscal year up to the operating fiscal year directly preceding the year applied, an amount corresponding to 20 percent of the excessive amount can be deducted from taxes. (However, this is limited to 10 percent of the total corporate tax.) (Applied fiscal year) The operating fiscal year beginning from 1 June 1967 to 31 March 1990.) (Standard fiscal year) Operating fiscal year directly preceding the operating fiscal year which includes 1 January 1967. (2) This is the same in the case of individuals.	Special Tax Measure Law Article 10, Paragraph 1 (Income Tax) Article 42, Section 4, Paragraph 1 (Corporate Tax)	First enacted 1967 up to 1989

[continued]

[Continuation of Table 3-4-5]

Item	Purpose	Contents	Basis	Remarks
Base Technology R&D Advancement Tax System	Advancement of technological development	(National tax) (1) A tax deduction of assets used for R&D of base technologies, such as new materials, advanced electronics technology, telecommunications technology, and space, is applied by deducting an amount corresponding to 7 percent of the acquisition price and adding that to the tax deducted in the existing tax deduction system for increased research costs. (However, this is limited to 15 percent of the corporate tax.) (2) This is the same in the case of individuals.	Special Tax Measures Law Article 10 Paragraph 2 (Corporate Tax)	Established 1985~1989
		(Local tax) (3) With regard to assets used for the R&D of base technologies, deduct an amount corresponding to 7 percent of the acquisition price from the standard of assessment of the corporate tax portion of the corporate resident tax. (However, this is limited to 15 percent of the corporate tax amount.)	Local Tax Law Appendix Article 8, Paragraph 1	Established 1985~1989
Small and Medium-sized Firm Technological Base Strengthening Tax System	Advancement of technological development	(National tax) (1) Deduct from taxes an amount corresponding to 6 percent of the research costs of small and medium-sized firms. (However, this is limited to 15 percent of the amount of the corporate tax.) Incidentally, the selection and application of this measure and the tax deduction of increased research costs is permitted.	Special Tax Measures Law Article 10, Paragraph 2 (Income Taxes) Article 42, Section 4, Paragraph 3 (Corporate Taxes)	Established 1985~1989

[continued]

[Continuation of Table 3-4-5]

Item	Purpose	Contents	Basis	Remarks
		(2) This is the same for individuals. (Local tax) (3) When choosing a tax deduction for an amount corresponding to 6 percent of (1), the 6 percent is deducted from the standard of assessment of the corporate tax portion of the Corporate Resident Tax. (However, this is limited to 15 percent of the Corporate Tax amount.)	Local Tax Law Appendix Article 8, Paragraph 2	Established 1985~ 1989
Special deduction of income related to overseas technology transactions	Advancement of technology transfer and Japan's technological develment along with multilateralization of foreign trade	(1) When, within the corporation's revenues, there is revenue from an overseas technology transaction, i) 25 percent of the revenue earned from the transfer or provision of industrial property (excluding the trademark authority) or expertise, or ii) 16 percent of the earnings from consulting activities are entered as losses when calculating total income earned. (However, this is limited to 40 percent of the income earned during that fiscal year.) (2) The same applies to individuals.	Special Tax Measures Law Article 21 (Income Taxes), Article 58 (Corporate Taxes)	Law established in 1964 up to 1989
Endowment deductions	Promotion of education and science and technology			
1. Endowments to corporation advancing specified public interests		(1) In the case of a corporation, these are permitted to be entered as losses in a separate category similar to the loss limitations of general contributions.	Corporate Tax Law Article 37, Paragraph 3	Established in 1961

[continued]

[Continuation of Table 3-4-5]

Item	Purpose	Contents	Basis	Remarks
		(2) In the case of an individual, the amount calculated according to the following is deducted from income as a specified grant. The incomel deduction amount = The amount of the specified grant (with a limit of 25 percent of income) minus ¥10,000.	Income Tax Law Article 78 Paragraphs 1 and 2	Established under the 1962 new tax deduction method. Revised under the 1967 income tax deduction method
2. Contributions to specified public trusts		Add contributions to certain of the specified public trusts subject to loss inclusion measures (in the case of corporate tax) or income tax deduction (in the individual tax) by including grants to corporations advancing specified public interests. *Corporations advancing specified public interests include corporations which claim research in science and technology as their chief aim, as well as certain specified public interest trusts whose objective is grants for research in science and technology.		Established in October 1987
3. Designated endowments		In the case of corporations, endowments serving to meet emergencies by disbursements for the promotion of education and science are entered as losses in their entirety. In the case of individuals, these are treated as specified endowments similar with (1).	Corporate Tax Law Article 37, Paragraph 3; Income Tax Law Article 78, Paragraphs 1 and 2	Established in 1960

[continued

[Continuation of Table 3-4-5]

Item	Purpose	Contents	Basis	Remarks
Loss accounting system of performance fees to the Power Reactor and Nuclear Fuel Development Corp.	Advancement of power reactor development	When the corporation pays a performance fee to fund the construction of a fast breeder nuclear reactor or an enriched uranium nuclear power plant to the Power Reactor and Nuclear Fuel Development Corp., an amount corresponding to this performance fee is entered as a loss when totaling the income earned for that fiscal year. (When the performance fee exceeds the investment in the enterprise during that fiscal year, the amount corresponding to that investment is subject.) (Applicable period) From 1 April 1959 to 31 March 1989.	Special Tax Measures Law Article 66.11	Established 1959 up to 1988
Exceptional measures regarding the acquisition of tangible assets for use in experimental research by the Mining and Manufacturing Technological Research Association	Advancement of technological development	(1) This is a special depreciation which the Mining and Manufacturing Technological Research Association levies on association members to acquire tangible assets for experimental research.	Special Tax Measures Law Article 18 (Income Tax) Article 52 (Corporate Tax)	Established in 1961 up to 1988
		(2) This is a compressed entry of up to ¥1 with regard to tangible assets for research acquired by the Mining and Manufacturing Technological Research Association through levies.	Special Tax Measures Law Article 66.10	Established in 1961 up to 1988

[continued]

[Continuation of Table 3-4-5]

Item	Purpose	Contents	Basis	Remarks
Tax exemption for research assets of academic research corporations	Promotion of science and technology	Corporations under Civil Law Article 34 and whose aim is academic research are tax exempt from real estate acquisition taxes, tangible assets taxes, special land possession taxes, and urban planning taxes on assets which are used directly in that research.	Land Tax Law Article 73.4, Article 348, Article 586, Article 702.2	Established in 1951 (Tangible Assets Tax) 1954 (Real Estate Acquisition Tax), 1956 (Urban Planning Tax), 1973 (Special Land Possession Tax)
Tax exemption from electricity and gas taxes for academic research organizations	Promotion of education and science and technology	Certain electricity and gas provided to schools and academic research organizations for direct use in education or academic research is exempt from the Electricity Tax and the Gas Tax.	Local Tax Law Article 489 and 489.2	Established in 1950
Tangible asset tax reduction measure for machines and equipment used in research by the Mining and Manufacturing Technological Research Association	Advancement of technological development	Of the machines and equipment receiving authorization under the stipulation of Mining and Manufacturing Industrial Technology Research Association Law Article 14, the standard of assessment of the tangible asset tax on those acquired new up to 1986 is valued at three-fourths of the price for as long as 3 years from the year in which the tax on the new tangible asset was levied.	Local Tax Law Article 15, Paragraph 28	Established in 1962 up to 1988

[continued]

[Continuation of Table 3-4-5]

Item	Purpose	Contents	Basis	Remarks
Creation of special deprecia- tion system for assets used in specified development research	Advancement of R&D investment	(1) With regard to assets used for specified develop- ment research of a certain size of i) machines and equipment and ii) buildings used for laboratories pro- duced, built, or acquired between 1 October 1987 and 30 September 1988 for cor- porations to offer for use in development research, the depreciation limits of the assets used in the laboratory involved can total an amount which adds the special depre- ciation limited amount to the ordinary depreciation amount for 1 year. (Twenty percent of the acquisition price with regard to i) and 10 percent of the acquisition price with regard to ii).) (2) The same applies to individuals.	Special Tax Measures Law Article 11.2 (Income Tax), Article 43.4 (Corporate Tax)	From 1 Oct 87 to the end of Sep 88
Exception from the standard of assess- ment for tangible assets tax connected with assets used for biotech- nology research	Reduction of burden connected with the prevention of public danger	(Local tax) Of the equipment and machines needed for genetic recombina- tion research, those needed to prevent danger to the public in accordance with "Guidelines for Recombinant DNA Experiments" are assessed at two-thirds the assessment standard of the tangible assets tax for as long as 3 years.	Local Tax Law Appendix Article 15, Paragraph 2	Estab- lished in 1986 (acqui- sition period is from 1985~ 1988)

and Manufacturing Technology Research Association; and 5) a reduction of the fixed asset tax for plants and equipment needed to conduct research into genetic recombinant technology and preventing risks to the public. The main science and technology promotion-related tax systems are shown in Table 3-4-5.

As for grants for financing, there is the Technology Promotion Financing System of the Japan Development Bank (the Industrial Technology Promotion Financing System and the Information Advancement Financing System). Low interest financing is carried out and contributes greatly to raising Japan's level of technology. The technology promotion financing system of the Japan Development Bank is intended to raise the level of Japan's production technology and to promote information in industry and society. The overall financing framework (record) for this in 1987 was ¥192 billion. Moreover, the Small and Medium-Sized Industry Finance Corp. established a new business and technology promotion loan system and is working to further raise the level of the technical capabilities of small and medium-sized firms and [to facilitate] the transfer of new technology into the private sector.

Furthermore, from the standpoint of nurturing small and medium-sized firms on a research and development model focused on ventures, the nonprofit Research and Development Company Growth Center (provides unsecured liability insurance for research and development expense loans to small and medium-sized businesses that cannot carry out R&D due to a lack of capital procurement capacity, even though they have the capacity to produce high technology.

Moreover, the New Technology Firm Insurance System for Small and Medium-Sized Firms, which was created in 1980, adds the insurance of the Small and Medium-Sized Firm Trust Insurance Corp. to the guarantee supplied by the Trust Guarantee Association when a small or medium-sized firm borrows funds from a financial agency to make it a new technology firm. (This system was widened and altered into the New Business Venture Development Insurance System and takes as its subject funds needed for R&D.)

Furthermore, the "Basic Technology Research Facilitation Law" was enacted in June 1985. This legislation takes as its objectives the facilitating of experimental research of basic technology carried out by the private sector and the raising of the level of private sector basic technology. (Note 1) (Mining, industrial, telecommunications, and broadcasting (including cable) technologies, and other technologies using frequencies in connection with telecommunications are under the jurisdiction of Ministry of International Trade and Industry or the Ministry of Posts and Telecommunications, and contribute a considerable extent to the strengthening of the national economic and national standard of living base. The preceding is also true for this paragraph.) It also enacts special measures to improve the research environment. These include the low cost use of state-owned research facilities and the flexible handling of state licenses related to international joint research. In addition, this law stipulates the creation of a basic technology research promotion center to carry out financial investments, with the aim of advancing research related to basic technology, to be carried out by the private sector using capital supplied by the Japan Development Bank and private sector funds. On the basis of this law, the specially authorized Basic Technology Research Advancement Center was established on 1 October 1985, and chose to make 15 investments (worth ¥1.04 billion in 1987) and 29 loans (worth ¥750 million in 1987) as its 1987 ventures.

Moreover, the "Biology Special Industrial Technology Research Advancement Organization Law" was enacted in May 1986. The objective of this law is to advance experimental research connected with biology-related industrial technology undertaken by the private sector. This law stipulates the creation of an organization which promotes biology-related special industrial technology research and provides investments for experimental research of biology-related special industrial technology carried out by the private sector. (Note 2) (This involves technologies (except those concerning basic technologies noted above) related to businesses which maintain, increase, or make use of biological functions as their business and which subsequently undertake to acquire and make use of the results of discoveries of biological functions. These firms fall under the jurisdiction of the government offices involved in these enterprises. It can be said that research is needed that is closely connected with the biological functions of a microorganism during its development or with the nature of the results of its discovery. These include: 1) Agriculture, forestry and fisheries; 2) food and beverage manufacturing industries and tobacco manufacturers; 3) in addition to those listed in (1) and (2) above those determined by law to be industries in which it is recognized as necessary and appropriate to take into consideration the nature of the technology related to the business enterprise and to work to improve that technology. The following refers to the same as does this paragraph.) The funds employed consist of loans from the Industrial Investment Special Account and Investments From the Private Sector. On the basis of this law, the specially authorized biology-related industrial technology research advancement organization was founded in October 1986, and it selected 10 investments (worth ¥800 million in 1987) and 55 loans (worth ¥2 billion in 1987) as its 1987 ventures.

Furthermore, the "Injury Relief Fund for the Secondary Effects of Medicines Law" was revised in May 1987, becoming the "Injury Relief and Research Promotion Fund for the Secondary Effects of Medicines Law." This law takes as its objective the promotion of experimental research into medical technology carried out by the private sector. (Note 3) (Technologies related to the production and sale of medicines (the term medicine is stipulated in Article 2, Paragraph 1 of the Medicines Law, and excludes those technologies to be used solely for animals) are under the jurisdiction of the Ministry of Health and Welfare. They contribute to guaranteeing and increasing the quality, efficacy, and safety, as well as to a considerable extent, to increasing Japan's health maintenance. In addition, medical supplies (medical supplies as stipulated in Article 2, Paragraph 4 of the Medical Law, and excluding those technologies to be used solely for animals), as well as the production and sale of items whose objective involves having an impact on the structure or functioning of the human body or use in the diagnosis, cure, or prevention of human illness, are under the jurisdiction of the Ministry of Health and Welfare. These technologies that will contribute to guaranteeing or raising the quality, efficacy, and safety of medicines, as well as contributing considerably to increased public health maintenance. The following refers to the same as does this paragraph.) It stipulates the creation of an injury relief and research promotion fund for the secondary effects of pharmaceuticals, which will invest in research involving medical technology carried out by the private sector. The funds to be used will be taken from the industrial investments special account as well as from the private sector. (This law reorganizes the former Injury Relief Fund for the Secondary Effects of Medicines.) On the basis of this law, the specially authorized "Injury Relief and Research Promotion Fund for the Secondary Effects of Medicines" was established in 1987. In 1987, it selected the investments (worth ¥100 million in 1987) and six other universities (worth ¥100 million in 1987) as ventures.

Part 5. Strengthening the Science and Technology Promotion Base

In order to proceed with smooth and effective research that meets the demands of the Japanese economy, a strengthening and perfecting of the science and technology promotion base is required.

For this purpose, the government is moving forward with all sorts of policies, including improvement of research organizations, improvement of the education and treatment of talented scientists and technicians, improvement of the science and technology information distribution system, construction of Tsukuba Science City, promotion of research exchanges, promotion of patents, promotion of standardization, and the spread of science and technology knowledge.

In this section, we provide an outline of the above policies. Incidentally, the general promotion of international cooperation is covered in Part 4 of Chapter 2, "The Trends of International Exchange."

1. Improvement of Training and Treatment of Scientists and Technicians

The progress and development of science and technology depends greatly on the ability, especially the creativity, of those conducting research and development. To encourage them, every effort must be made to increase the education, security and qualifications of talented scientists and technicians. For this purpose, the Science and Technology Agency has made every effort to nurture these individuals by long ago establishing an overseas student and domestic student trainee system, and by working to raise the qualifications of the researchers, along with enervating the national experimental laboratories. Moreover, the Ministry of Education has for some time been training superior researchers by expanding the higher education organizations, such as improving and broadening graduate schools. In addition, the Ministry of Education created a special researcher system in 1985 as a new undertaking of the Japan Science Promotion Society, and is working to train outstanding young researchers who are full of creativity.

The Science and Technology Agency, recognizing that it is equally vital to guarantee superior researchers in the national laboratories and that researchers be treated in a manner that enables them to devote themselves to research and fully exhibit their abilities, has collected the opinions of related government offices every year since 1961 and has made presentations to the National Personnel Authority about improving the treatment of government researchers. In 1987, the Science and Technology Agency expressed the desire to improve the salaries of the markedly young generation of researchers caught in the salary gap between the researcher wage scale and the teacher wage scale (1) (applied to national university professors). This is being improved by making them equivalent to the salaries of teachers at the compulsory education schools where special improvements are being carried out in connection with the Talent Resource Guarantee Law. In addition, the Science and Technology Agency presentation devises measures required to improve the treatment of employees working in Tsukuba Science City.

As a result, the average salary and improvement rate of second class researchers and educators (1) who graduated from college fewer than 10 years ago rose a mere 1.6 percent and 1.5 percent, respectively, but the researchers' [rate] rose above that of the educators (1).

2. Improvement of the Distribution System of Science and Technology Information

(1) Outline of the National Distribution System of Science and Technology Information (NIST)

1) Background of NIST

Since its founding, the Scientific and Technical Council, which sets forth the basis for science and technology policy in Japan, has regarded the problem of science and technology information distribution to be one of its major tasks. In October 1969, it recommended a "National Distribution System for Science and Technology Information (NIST)" in the "Basic Policy Concerning the Distribution of Science and Technology Information," which was the Prime Minister's Inquiry No. 4.

This recommendation pointed out that working to ease the distribution of science and technology information is important if science and technology activities are to advance effectively and that, to achieve this, national distribution must be reorganized by integrating the various information organs.

After the NIST concept was recommended, the Science and Technology Agency conducted a comprehensive functional analysis of National Distribution System for Science and Technology Information to contribute to its organizations. In February 1973, the Science and Technology Agency held a science and technology information conference to approach closer to the realization of the National Distribution System for Science and Technology Information and heard the opinions of this group. Then, in August 1984, with the cooperation of 16 related government offices, it put together the "Report on the Arrangement of a Nationwide Distribution System of Science and Technology Information."

Subsequently, in view of the remarkable changes in the circumstances surrounding science and technology information, such as the higher level of demands for information, the development of an information services industry overseas, and the progress of information processing technology, the Science and Technology Agency held conferences on advancing science and technology information activity beginning in May 1978, and listened to opinions regarding the future organization of the NIST. In December of that year, the Science and Technology Agency compiled a report, "The Goals and Policies of Science and Technology Information Activity." Furthermore, because of the remarkable progress in recent years in information processing and communications technology, the mode of distribution of science and technology information has changed, as has the significance of science and technology information, and the establish of a data base and distribution system has become an urgent topic. Moreover, along with expansion of the international distribution of information, science and technology information policy in Japan has had to emphasize an international focus For that purpose, the Science and Technology Agency Council's Policy Committee held Science and Technology Information Subcommittee sessions beginning October 1983, and studied the best ways to deal with science and technology policy at that time. In August 1984, the Science and Technology Agency compiled the report, "How To Respond to the Task Ahead of Us Involving the Distribution of Science and Technology Information."

2) Basic Concept and Framework Behind NIST

NIST takes the independent activities of many subsystems as its basis and responds to the diverse demands of its users by having the government coordinate for burden sharing and cooperation among them. The basic concept is as follows:

(a) Science and technology information activity should be established from a comprehensive and long-term perspective and advanced in a planned manner.

(b) The NIST program will be implemented from a national perspective through the close cooperation of the related agencies.

(c) It should develop activities closely adhering to the information needs of the users.

(d) Coordination between NIST and other information systems is a goal.

(e) Science and technology information distribution activity should advance based on the doctrine of international cooperation.

Its framework and the roles of the various organizations comprising it are shown in Tables 3-5-1 [not reproduced] and 3-5-2.

3) Policies for the arrangement of NIST

The aforementioned "Goals and Policies for Furthering Science and Technology Information Activity" raises the following seven items as major problems to be confronted.

(a) Database enlargement
(b) On-line services expansion

(c) Strengthening of primary information services and various guidance services
(d) Fostering of domestic organizations
(e) Advancement of international cooperation activity
(f) Facilitation of science and technology information activity
(g) Advancement of model activity in the Tsukuba region

Table 3-5-2. Role of NIST Member Organizations

NIST member organizations	Major roles
Central coordination organization	Integrated advancement of NIST structure, integrated coordination of other member organizations
Clearing organization	Collection, arrangement, processing, and provision of information sources and themes in progress
Comprehensive center	(1) Collection, arrangement, processing, and provision of common and basic bibliographical information (2) Backup experts center
Experts center	(1) Collection, arrangement, processing, and provision of information in expert fields (2) Expert analysis and evaluation of information
Data center	Collection, arrangement, analysis, evaluation and provision of numerical data
Regional services center	Information services for users in every region
Library and depository	Maintenance and provision of bibliographical data
Human talents fostering organization	Education and training of information experts
R&D organization	R&D of information processing technology

Incidentally, as far as a specific example of these policies is concerned, "research on a knowledge-based system to support chemical substance designs" is being implemented by means of science and technology promotion coordination expenses (1986-1988). This will be used in carrying out research involving the development of the technology to construct a knowledge-based system, the development of a structural design knowledge-based system to serve as a candidate structural design, and the development of a reaction design knowledge-based system involving candidate structural substances. All of these will contribute to the construction of a knowledge-based system to support a wide variety of research and development, such as new chemical substance designs.

In addition, the drafting of science and technology information distribution technology standards (SIST) has been going on since 1973 to standardize the documentation and the information processing technology in NIST.

(2) Science and technology information distribution-related budget

The 1987 budget amounts of the main policies involved in science and technology information activity are shown in Table 3-5-3. Among them are included hardware and software not generally restricted to science and technology information. Costs related to the development of communications technology are not included.

Table 3-5-3. Outline of FY 1987 Science and Technology Information Distribution-Related Budgets

(Unit: ¥1 million)

Name of government office	Breakdown contents	FY 1987 budget	Remarks
National Diet Library		1,105	Purchasing science and technology materials, mechanization of library operations, etc.
Science Council of Japan		2	Collection of observed data related to international cooperation involving observation of the middle atmosphere (MAP)
Science and Technology Agency	Science and technology promotion coordination fees	335	Research related to intelligence based systems to support chemical substance designs, comprehensive advancement of NIST, standardization of information, fact data base activity, etc.
	Japan Science and Technology Information Center	6,401	Enlargement of data base operations and on-line services, setting up of Tsukuba information facility, etc.
	Japan Atomic Energy Research Institute	371	International atomic energy information systems
	Power Reactor and Nuclear Fuels Development Corp.	221	Investigation of nuclear fuel resource information investigation of fast breeder reactor information
	Miscellaneous	1,553	Data sheet drafting (Metals Materials Technology Research Institute), etc.

[continued]

[Continuation of Table 3-5-3]

Name of government office	Breakdown contents	FY 1987 budget	Remarks
Environment Agency	National Pollution Research Institute	384	Environment information collection and processing, international environment information source
	National Minamata (mercury poisoning) Research Center	3	Reference system operation
Ministry of Education	Science Information Center	1,564	Data base formation, secondary information services, constructing large-scale scientific information network
	Organizing science information system	10,358	Preparing computer center, comprehensive information processing center, and information processing center, electronic computerization of university libraries, etc.
	Drafting and organizing secondary information	233	Data base drafting expenses, data base for scientific research subsidies and promotion costs for announcing the results of the research
	Publication of primary information	980	Costs of promoting public announcement of research results from scientific research subsidies (excluding the data base), research report publication costs
	Arrangement and provision of special materials and special data	617	Regional earthquake prediction and observation center, centers for analyzing such materials as space science, magnetism, and disaster science
	Information processing R&D	419	Integration and intelligent processing of multidimensional knowledge and information, research of high-level language information processing

[continued]

[Continuation of Table 3-5-3]

Name of government office	Breakdown contents	FY 1987 budget	Remarks
Ministry of Health and Welfare	Investigation of safety of pharmaceuticals	48	Collection of secondary effect information
	Medical information system development and dissemination	221	Consignment to the Medical Information System Development Center
	National Health Laboratory	13	Information activities management costs
Ministry of Agriculture, Forestry and Fisheries	Agriculture, Forestry and Fisheries Technology Office, Ministry of Agriculture, Forestry and Fisheries	422	Management of the Agriculture, Forestry and Fisheries Research Information Center, genetic resource information, grants to the Agriculture, Forestry and Fisheries Technology Information Association
Ministry of International Trade and Industry	Agency of Industrial Science and Technology	11	Development of ISONET on-line system
	Small and Medium-Sized Firms Agency	717	Information services for small and medium-sized firms and corporations
	Patent Office[2]	3,744	United States patent specifications and Japanese precis, comprehensive mechanization of the examination and determination process
Ministry of Transportation	Operation of the Japan Marine Data Center	133	Collection and provision of marine information and data
Ministry of Posts and Telecommunications	Radiowave Research Institute[3]	23	Operation of ionized layer data center, purchase of materials
Ministry of Labor	Harmful materials inspection measures	12	

[continued]

[Continuation of Table 3-5-3]

Name of government office	Breakdown contents	FY 1987 budget	Remarks
Ministry of Construction	Construction Research Institute	2	Image information systems facility costs
Total		29,902	

Notes: 1. In addition, the library purchases for the public schools and research institutes total ¥1.75 billion, of which most is for science and technology.

2. In addition, the patent announcement publication costs totaled ¥7.932 billion.

3. Reorganized as the Communications Research Institute in April 1988.

3. Promotion of Research Exchanges Among Industry, Universities and the Government

Research and development is getting more and more sophisticated and complex and is now expanding into frontier areas and interdisciplinary areas. To promote further creative research for advanced technology, it is essential that we actively encourage the establishment of structure which enables personnel and material exchanges beyond the bounds of the existing research organizations and make effective and efficient use of the limited research resources.

On the one hand, the research and development conducted by the government is restricted by the public employee system and the financial management system. The conditions have not been fully worked out in terms of promoting research exchanges with researchers from the private sector and from foreign countries. In order to improve the legal system's narrow path, the Research Exchange Promotion Law was implemented in November 1986, and the "Basic Policy on the Operation of Systems Connected With the Promotion of Research Exchanges Among Industry, Universities and the Government, as well as With Foreign Countries," to improve the narrow path from an operational standpoint, was passed by Cabinet council resolution in March 1987 (Table 3-5-4).

Table 3-5-4. Contents of the Research Exchange Promotion Law

Item	Legal system prior to the implementation of the Research Exchange Promotion Law	Special measures of the Research Exchange Promotion Law
(1) Employment of foreigners	In accordance with natural legal principles, Japan could only employ ordinary researchers who were used solely for experimental research.	Research department heads and research office heads can be hired (Article 3).
(2) Participation in research conference	Went on official business (TDY or foreign duty) or vacation	In addition, as a third means, the law opened the way for participation by being excused from the obligation of devotion to work (Article 4).
(3) Improvement of disadvantages found in pensions when leaving for the private sector	When taking temporary leave to conduct research at a school, research institute, hospital or other public facility (research leave), the research leave salary is one-half [the regular salary] for the period the worker is absent.	With regard to temporary leave to conduct national joint research or national consigned research, the salary can be paid in full (Article 5).
(4) Improvement of the treatment of patent rights for nationally entrusted research	The government acquires the patent right.	The government attempts to cede a portion of the patent right to the consignee who is liable for the funds invested (Article 6).
(5) Use of grants or fee reductions for patents related to international joint research	Charging low fees or providing grants for government patents was used many times when conducting international joint research. Consequently, the basis in law is necessary, but there was no fundamental ordinance, only ones for special cases.	The law opened the way for research to be carried out jointly with a foreign government, foreign joint organization, or an international organization (Article 7).

[continued]

[Continuation of Table 3-5-4]

Item	Legal system prior to the implementation of the Research Exchange Promotion Law	Special measures of the Research Exchange Promotion Law
(6) Abandonment of damage compensation claims related to international joint research	There are many cases in which the abandoning of damage compensation claims was sought when international joint research was being conducted. Consequently, a basis in law is necessary since there was no fundamental law and nothing could be done.	Same as above (Article 8).
(7) Use of low prices for experimental research facilities	There was the need for a basis in law to use government assets at low fees, but only special cases existed, with no fundamental law.	The law opened the way for researchers closely connected to the research of the government organization managing the research facility and who conduct particularly beneficial research in the research area concerned to provide the results of their research (Article 9).
(8) Items worth attention		When conducting international research exchanges by the special measures of this law, it was decided to give special attention to following the performance obligations set in the contract or other international agreement and to work for the maintenance of international peace and safety (Article 10).

In 1987, bearing this in mind, bureau directors of the related government offices held a Research Exchange Promotion Coordination Conference and devised such measures as the simplification of the part-time licensing procedures for public researchers by means of a partial revision of the ordinance concerning authorization of part-time work for public employees (Table 3-5-5).

Table 3-5-5. Record of Research Exchange Promotion Law Management

(1) Article 3-related (Number of foreign researchers employed as research officials)

3 persons (as of March 1988)

(2) Article 4-related (Total research officials participating in research conferences by being excused from work obligations)

	FY 1987
National research conference	1,677 people
Foreign research conference	546 people
Total	2,223 people

(3) Article 5-related (Number of research officials taking temporary leave for the private sector who are not forced to take disadvantageous absentee salaries)

	FY 1987
5 people	

4. Improvement of the Development-Preservation-Supply Function for Machines, Materials and Genetic Resources

In the Science and Technology Policy Principles adopted by the Cabinet Council on 28 March 1986, working to set up a science and technology promotion base for the development, preservation and supply of machines, materials and genetic resources, alongside the promotion of the distribution of science and technology information, was extolled. The various government offices have been moving forward with their respective required policies. Among these, if we look specifically at the fulfillment of the development, preservation and supply function for materials and resources used solely for biological-related research, we find that the Science and Technology Agency has been carrying out a variety of enterprises necessary for life sciences research at the Institute of Physical and Chemical Research (RIKEN). These include a gene bank enterprise to collect, preserve, and provide the cultures and genes of animals and plants needed for that research, the development of an experimental biology next-generation system, the development of laboratory animals, and an enterprise for the systematic preservation and division of microbes.

The Ministry of Education, as a part of the structure of a university research support system, is involved in the setting up of animal laboratory facilities, the development of new laboratory animals, and the systematic and genealogical collection, preservation and supply of plants, animals and microbes to be used in academic research

The Ministry of Health and Welfare, as part of its comprehensive 10-year anticancer strategy, is carrying out a research source bank enterprise for the collection, preservation and supply of cultures and genes originating from animals and of the personnel needed for cancer research, as well as a medical plant collection, preservation, and supply enterprise.

The Ministry of Agriculture, Forestry and Fisheries is moving ahead with a Ministry of Agriculture, Forestry and Fisheries gene bank enterprise that will ensure the genetic resources that will form the base of advanced biotechnology development. This enterprise will carry out the collection and preservation of genetic resources from agriculture, forestry and marine biology-across-the-board, such as plants, animals, microbes, trees and marine animals, as well as organizing a comprehensive management system to supply biological genetic resources and biological genetic resources information.

The Ministry of International Trade and Industry is conducting operations involving the consignment and allocation of microbes related to patents at its Patent Microbe Consignment Center. Along with dealing with the expansion of operations accompanying the progress of biotechnology, it is furthering the configuration and expansion of this center as well as carrying out research into animal and plant cell preservation technology.

5. Arrangement of Tsukuba Science City

Tsukuba Science City is a new city which, along with contributing to balancing development over the entire capital region, will form the junction of high-level research and education. Its construction is moving ahead as the national policy to respond to the demands of the era for scientific and academic research and high-level education.

Currently, 45 of the 46 national experimental research and educational organizations have virtually begun operations, with one educational organization (Tsukuba Technical Junior College) still under construction (Table 3-5-6).

Moreover, about 60 private sector research organizations have moved ahead and begun operations as of May 1987, with about 50 more certain to come forth in the future.

On the other hand, Ibaraki Prefecture, the Japan Development Bank, and private volunteer businesses obtained the support of various government offices and, in February 1988 established a Tsukuba Research Support Center which will make use of the research resources accumulated at Tsukuba Science City, creating a base for research exchanges and joint research.

In order for the experimental research and educational organizations at Tsukuba Science City to develop research activities under an integral cooperative atmosphere and increase the accumulated effect of Tsukuba Science City, the Science and Technology Agency, in cooperation with related government offices and research organizations, worked toward the study and

Table 3-5-6. Experimental Research and Education Organizations in Tsukuba Science City (at the end of 1987)

Organization name	Managing government agency	Space (area in approximate hectares)	Date transferred or established (year)
1. Education-related (8 organizations)		494	
Library Information University	Ministry of Education	11	54
Tsukuba University	" " "	246	48
Tsukuba Technical Junior College	" " "	8	62
High Energy Physics Laboratory	" " "	203	46
National education Assembly Hall Annex	" " "	7	49
National Science Museum, Tsukuba Experimental Botanical Garden	" " "	14	51
International Cooperation Corp., Tsukuba International Agricultural Training Center	Ministry of Foreign Affairs	2	54
International Cooperation Corp., Tsukuba International Agricultural Training Center	" " "	3	55
2. Construction-related (4 organizations)		191	
National Disaster Prevention Science and Technology Center	Science and Technology Agency	27	53
Land Research Institute	Ministry of Construction	126	53
Construction Research Institute	" " "	20	53
National Geography Academy	" " "	18	53
3. Physical Engineering-related (17 organizations)		304	
Metals Materials Technical Research Institute, Tsukuba Center	Science and Technology Agency	15	53
Inorganic Materials Research Institute	" " "	15	46
National Space Development Agency, Tsukuba Center	" " "	53	47
National Pollution Research Institute	Environment Agency	28	48
Agency of Industrial Science and Technology, General Affairs Office, Tsukuba Management Office	MITI		54

[continued]

[Continuation of Table 3-5-6]

Organization name	Managing government agency	Space (area in approximate hectares)	Date transferred or established (year)
Measurement Research Institute	MITI		54
Machine Technology " "	"		54
Chemical Technology " "	"		54
Microbe Industrial Technology Technology Research Institute	"	140	54
Fiber Polymer Materials " "	"		54
Geological Survey Institute	"		54
Electronics Technology " "	"		54
Manufacturing Science " "	"		54
Pollution Resources " "	"		54
Meteorological Research Institute	Ministry of Transportation		54
High Layer Meteorological Platform	" "	53	49
Meteorological Measurement Instrument Plant	" "		49
4. Biology-related (16 organizations)		440	
Institute of Physical and Chemical Research Life Sciences, Tsukuba Research Center	Science and Technology Agency	5	59
National Institute of Health, Tsukuba Center, for Primates Used in Experimental Research	Ministry of Health and Welfare	9	53
National Health Laboratory, Tsukuba Medicinal Plant Cultivation Laboratory	" "	5	54
Agricultural Research Center	Ministry of Agriculture, Forestry, and Fisheries		54
Agricultural Biological Resources Research Institute	" "		54
Agricultural Environmental	" "		54
Technology Research Institute	" "		51
Livestock Industry Experimental Station	" "		54
Fruit Tree Experimental Station	" "		52
Agricultural Land Experimental Station	" "		52
Silk Experiment Station	" "	421	54
Domestic Animals Health Experiment Station	" "		53

[continued]

[Continuation of Table 3-5-6]

Organization name	Managing government agency	Space (area in approximate hectares)	Date transferred or established (year)
Foods Research Institute	Ministry of Agriculture, Forestry and Fisheries		53
Tropical Agriculture Research Center	" "		52
Forestry Experiment Station	" "		53
Ministry of Agriculture, Forestry, and Fisheries, Technology Conference Office, Tsukuba Branch Office	" "		53
Seeds Management Center	" "		52
5. Joint Use-Related (1 organization)		2	
Research Exchange Center--Other Joint Use Facilities	Science and Technology Agency	2	52
Total (46 organizations)		1,431	

Note: The date of transfer or establishment is the year of amendment of the Establishment Law or of the completion of the facility.

advancement of the installation of facilities for joint use and the operation of the Tsukuba Science City Research Organizations Coordinating Council. The Research Organizations Coordinating Council consists of the heads of 63 organizations, including the private sector research organizations residing in Tsukuba Science City. The council has continued discussions by establishing committees of experts in separate fields to tackle the mutual use of library and research information, use of computers, exchange of researchers, environment and safety, publicity, international exchanges, Tsukuba moving fees, and facilities management. The council has made every effort to promote research exchange on the basis of these results.

Moreover, at the Research Exchange Center, which the Science and Technology Agency established as a joint use facility, the aim is to provide a forum for researchers to make research contacts and other forms of exchange and to provide smooth and swift science and technology information. The center also provides all sorts of conference rooms for international and other conferences, holds lectures, seminars, and foreign language training classes, assists research exchange sessions in every specialty, meets the needs of observers and sightseers, and operates a dormitory for foreign researchers.

6. Arrangement of Kansai Cultural Academic Research City

Since the mass of culture, academics, and research fostered in the Kinki region is growing, the construction of a creative cultural academic research junction directed toward the 21st century is the objective of the Kansai Cultural Academic Research City under construction in the Kyoto-Osaka-Nara hill region. On 27 May 1987, the "Kansai Cultural Academic Research City Construction Promotion Law" was enacted with the aim of promoting the drafting and implementation of a plan for the construction of this city. The law was implemented on 9 June.

Moreover, based on this law, the "Basic Policy on the Construction of the Kansai Cultural Academic Research City" was resolved by prime ministerial decree on 30 September 1987, and the "Plan for the Construction of the Kansai Cultural Academic Research City" of Kyoto Prefecture, Osaka Prefecture, and Nara Prefecture received the prime minister's authorization on 31 March 1988.

7. Promotion of Patent Administration

The number of Japanese industrial property applications reflects the increase in the level of technology and the flourishing ambition for technological development in Japan, and has shifted to the highest level yet witnessed in the world. This number is expected to continue to grow steadily in the future along with the development of technology. The time required for the examination of patents and new commercial ideas is becoming longer, not only because of the increase in the number of applications, but also due to such factors as the high quality and complexity of the technology and the expansion of the examination materials. Moreover, patent information is extremely valuable since firms are proceeding with patent controls and are moving ahead with technological development. However, because their quantity is expanding greatly along with the increase in the number of applications, appropriate access to the required information is becoming difficult in and of itself under the present system.

In order to resolve the above patent administration problem, since 1984 the Patent Agency has been moving ahead with a 10-year plan known as the Paperless Plan, which aims to build a comprehensive computerized system (a paperless system) to handle the overall patent administration (Table 3-5-7 [not reproduced]). Furthermore, the Patent Agency plans to strengthen the system to effectively use and provide patent information, which will be a result of the Paperless Plan.

On the other hand, the industrial property system has a strong international character and, along with the invigoration of competition in technology development and the expansion of commercial trade and technology trade on a worldwide scale, the need to strengthen international protection of industrial property and international coordination of the system is increasing.

In Japan, this movement toward internationalization is having a positive effect by strengthening the industrial property protection, a response to patent and trademark frictions through the promotion of international coordination and the promotion of international cooperation, and the strengthening of the system to handle international issues.

(1) Swift and precise granting of rights

1) Advancement of the Paperless Plan

Since 1984, the Patent Agency has been advancing through a 10-year plan, the Paperless Plan, by which it is working to comprehensively computerize patent administration in order to deal with the lengthening of the examination period caused by the increase in the number of applications. In 1987, which was the fourth year of the plan, the project, along with undertaking a detailed system design of the operation processing machine system and holding hearings on the tentative specifications for electronic applications standards, worked to complement the present international patent classification (IPC) and enlarge the F term method search field, which makes effective mechanized search possible. Moreover, along with advancing the collection of data for a comprehensive patent information data base, which will concentrate on public announcements of patents and new commercial ideas, the project is accumulating data for a conceptual mechanized search system and an examination decision search system.

2) Rationalization of applications and examination claims

Since 1976, the Patent Agency has taken as its chief aims working to convert applications from quantity to quality by perfecting patent management in corporations, making effective use of discoveries that result from technological development, and smoothly, swiftly and precisely granting patent rights. In doing so, it is carrying out an application rationalization policy.

To strengthen this rationalization, since 1985 the Patent Agency has taken the rate of public notices to be the key index of corporate patent management since these indicate the degree of rights effectively acquired. The top 100 firms, in terms of patent applications, have been offering guidance to make this rate above 60 percent. In 1987, an interim confirmation of the results of the guidance for 1985 and 1986 was carried out, and from the perspective of aiming to raise the public notice rate target further, 31 companies conducted a followup.

Nevertheless, because the surge of patent applications has caused the examination and processing period to lengthen to more than 5 years from the outset and, what is more, because of strong criticism from foreign countries regarding the slowness of the examination process, there is the need to drastically strengthen the rationalization measures. To achieve this, the Patent Agency has requested that beginning in 1988, the top 100 firms in terms of application design and implement a "Focused Examination Claim Plan," which will carefully select 80 percent of the new public notices or the matching examination claims.

(2) Appropriate response to internationalization of the industrial property system

1) Cooperation with international organizations

The Paris Treaty on the Protection of Industrial Property was established in 1883, and Japan joined this treaty in 1889. This treaty founded the principle of giving equity to foreigners in the protection of industrial property, and makes the contents of every country's legal system identical to a certain extent. The signatories of the Paris Treaty make up an alliance and, as of 1 January 1988, 97 countries are partners.

The industrial property system has a strong international character. In particular, the opportunities for the internationalization of the industrial property system have increased greatly along with the internationalization of economics and the internationalization of technological exchange. The study of this is moving forward, especially by the World Intellectual Property Organization (WIPO).

WIPO, along with reviewing the Paris Treaty, is studying the patent information problem, the developing countries industrial property development cooperation problem, the legal protection of the arrangement of integrated circuits problem, harmonization of patent laws involving the protection of discoveries, and the nontrademarked goods problem. Japan, as a WIPO member, is dealing with these issues on a positive basis.

In 1987, the expert committee on the harmonization of the articles in the Discovery Protection Law met (November 1987), and the Advisory Conference on Revising the Paris Treaty was also held (in May and September 1987).

Moreover, the Budapest Treaty on the International Approval of the Consignment of Microbes in Terms of Patent Procedures took effect in Japan in May 1981 when the Agency for Industrial Science and Technology Microbe Industrial Science and Technology Laboratory began operations as the international consignment authority. Moreover, the construction of a patent microbe consignment center was completed in March 1987, and every effort has been made since then for the expeditious use of the system, such as the October 1987 expansion of the scope of microbes consigned.

2) Advancement of international cooperation

i) Cooperation among advanced nations

The tripartite patent agencies of Japan, the United States, and Europe have, since 1983, held an annual tripartite patent agency summit conference to effectively resolve problems common to the three patent agencies. In addition, expert sessions are held.

The topics for study among the three agencies have mainly been the issue of patent information and the problem of the patent system and its operation. At the Fifth Tripartite Summit Conference, which was held in Munich in

January 1988, the problems involving electronic patent information and the harmonization of patent systems and operations were positively discussed, and concrete results emerged.

ii) Cooperation with the developing countries

The Patent Agency, in cooperation with the Joint International Cooperation Agency, has been accepting many students from China, the ASEAN countries, and other developing countries, and has been sending experts to South Korea and the ASEAN countries, and, along with this, since November 1986 has planned and moved forward with China on project-type technological cooperation involving a patent information search system development enterprise.

Moreover, Japan is cooperating with WIPO's technical assistance policy toward developing countries and, along with receiving students and sending experts, has been undertaking technical level searches on topics requested by the developing countries through WIPO. In 1987, WIPO created a trust fund for Japan's contributions and, through this, Japan has participated in detailed cooperation, meeting the needs of the developing countries.

3) Positive responses to patent friction

In recent years, international friction has emerged surrounding the industrial property rights accompanying the development of the internationalization of corporate activities. One factor behind this may be the lack of understanding on the part of foreign firms regarding another country's industrial property system and examination system. Since 1984, the Patent Agency has continued to work to dissolve this patent friction and held a summit meeting in November 1986 with corporate patent authorities from the United States in an effort to deepen the comprehension of Japan's industrial property system.

Another cause of patent friction is the slowness of the examination and decision process involving patents and new commercial ideas. As a means for dealing with this, the Patent Agency introduced a quick examination and hearing system in February 1986 and, along with processing implementation-related applications more rapidly, is working to shorten the required processing period by comprehensive measures centered around the Paperless Plan.

Furthermore, in order to carry out the harmonization of the industrial property system, the Patent Agency amended the Patent Law by introducing the multi-item system in line with the United States and Europe. This change was implemented in January 1988. (Note: With this system, a number of related discoveries can be included in one application and one discovery can be represented in many ways.)

4) Response to the GATT Uruguay Round

Cases have increased in which the incomplete organization or inappropriate system for operation of a country's intellectual property system has led to distortions or obstacles to international trade. With this as the background, the "trade-related aspect of intellectual property" was taken up as an item for negotiation at the Uruguay Round of the September 1986 cabinet ministers conference.

The eighth meeting of these negotiations was held in March 1988, and Japan, the United States, and the EC presented a list of trade issues related to intellectual property and proposals indicating their thinking on resolving these issues. The coordination of the opinions of all the countries, including a study of these proposals, is expected to be important in the future.

The Patent Agency has been responding positively through such actions as discussing the Patent Agency's basic response regarding intellectual property at the International Section of the Industrial Property Conference at the GATT negotiations.

(3) Advancement of industrial property information policy

Patent information is widely used by corporations as information on technology or on patent rights, or as information for grasping the technology and product development trends. However, due to the accumulated patent information accompanying the increase in the number of applications in recent years, precise access to the required patent information and its expeditious and effective use are becoming difficult.

In addition to this situation, we have reached the point where, along with the progress in the internationalization of the patent system, the use of foreign patent registers and the use overseas of Japan's patent register are increasing and in heavy demand.

However, on the international level, countries are adopting a common classification system (International Patent Classification), and Japan's Patent Agency has begun international cooperation in the area of information by carrying out an international exchange of information through tripartite cooperation with the United States Patent and Trademark Office and the European Patent Agency.

In this sort of environment, the Patent Agency has implemented the following policies:

(1) Provision of patent information through the Paperless Plan (In July 1987, it began on-line inspection of comprehensive data bases at Ministry of International Trade and Industry's Fukuoka Regional Office in addition to that at the Worldwide Industrial Property Materials Library and the Ministry of International Trade and Industry's Osaka Regional Patent Room);

(2) Enlargement of the Worldwide Industrial Property Materials Library Public Reading Room and regional reading rooms;

(3) Provision of patent information through the Japan Patent Information Organization, a nonprofit organization;

(4) Promotion of the exchange of electronic patent information among the patent agencies of Japan, the United States, and Europe;

(5) Study regarding the adoption of the fifth edition of the International Patent Classification.

8. Advancement of Standardization

Efforts toward standardization are moving forward, as indicated by the advancement of mutual understanding through the unification of terms, symbols, and test and evaluation methods, the unification and simplification of products to ensure technical uniformity and interchangeability, and the improvement of quality and performance of products by establishing rational standards, rationalizing the methods of use, and rationalizing production. Standards are being set to meeting these objectives. The standards are classified by the area where they are used, such as international standards regional standards by a group of countries such as the EC, national standards, group standards and company standards. As far as Japan's national standards are concerned, the Japan Industrial Standards have been set over a wide range of mining and manufactured products and, in addition to this, the Japan Agricultural Standards have been set for agricultural, forestry and fisheries products.

(1) Japan Industrial Standards

Japan's industrial standardization enterprise is based on the Japan Industrial Standards (JIS), which now amounts to about 8,200, and the JIS trademark system, which supports about 1,100 designated items and varieties. This has made a great contribution, and has the ultimate aim of rationalizing production, distribution, and consumption, as well as contributing to the development of industry, the promotion of trade, the raising of the quality of life, and the dissemination of science and technology.

Nevertheless, the circumstances surrounding the Japanese economy have been changing significantly in recent years, and include Japan's rise in international stature, the advance of a strong yen, etc. Moreover, new demands are emerging for industrial classification in the midst of an environment in which technological innovations, increased information, internationalization, and the diversification of the nation's needs are moving ahead rapidly.

In other words, when seen from the perspective of technological progress, we find remarkable developments in technological innovation, including the development of new materials such as fine ceramics and ferrous and organic, complex new raw materials, the rapid spread of information-related equipment, networking, the union of factory automation and mechatronics, and the progress in biotechnology, such as enzyme-use technology and recombinant DNA-use technology. The promotion of standardization is important as the support base of these technological developments.

On the international level, JIS is being asked to have more international rationality and compatibility than it did in the past, such as the opening overseas of the JIS trademark system and "the action program to improve market access."

Also, Japan is taking a larger and larger role in the international standardization activities, and as a good indication of that, Mr Isamu Yamashita (then vice-chairman of the Japan Federation of Economic Organizations) has assumed the chairmanship of the International Standardization Organization.

In the midst of this, the Agency of Industrial Science and Technology is promoting standardization administration along two basic lines: "the reaction to internationalization" and the reaction to new technology and higher information," which are based on the July 1985 "Recommendation on Drafting of a Long-Term Plan for Industrial Standardization" and the August 1986 "Industrial Standardization Advancement Long-Term Project by Sections."

In 1987, in order to aid in the steady implementation of the aforementioned long-term project and bearing in mind the increase in requests for standardization from every quarter, the Agency of Industrial Science and Technology implemented the following operation:

1) Enactment, etc., of Japan Industrial Standards

The Agency of Industrial Science and Technology focused on the enactment and amendment of the Japan Industrial Standards in the following fields, keeping in mind compatibility with international standards. (A total of 197 new standards were enacted, and 481 standards were amended.)

i) Standards needed to promote the development and dissemination of new technologies and information-related technologies;

ii) Standards needed to raise the national quality of life;

iii) Standards needed to improve the industrial base;

iv) Standards needed in order for resource and energy savings to advance.

Moreover, in order to collect the technical data needed for the writing of draft standards and the enactment of amendment of standards, the Agency of Industrial Science and Technology continued to conduct research on 20 items, including "Survey on the Standardization of Fine Ceramics" and "Research on the Standardization of Optical Electronics," in addition to taking up two new items, "Research on the Standardization of Bioprocesses" and "Research on the Standardization of Life Sciences Engineering."

The Japan Industrial Standards Committee incorporated its machine tools section into a newly-established factory automation section to advance standardization in the machine technology field in 1987.

2) JIS trademark system

The Japan Industrial Standards "mark" system is used by innumerable producers (processors) and users when designating or changing an item or items, and the designating has great merit. For example, along with giving emphasis to this mark with regard to household materials and home appliances, product designation has been canceled for items when the significance of the designation is weak. Moreover, in order to maintain the reliability of the Japan Industrial Standards mark, the quality control system must be strengthened, including the implementation of inspections by the privately authorized inspectors of Japan Industrial Standards mark authorized factories and by the attachment of an obligation to install a person responsible for quality control at such factories.

Moreover, in light of the simplification and greater fairness of transactions, which is a tenet of the action program, the Japan Industrial Standards mark system is under review with the aim of reducing the current items receiving the Japan Industrial Standards mark by about 10 percent.

3) International standardization

As for international standardization Japan participates in the International Standardization Organization and the International Electric Standards conference, and holds hearings on proposed international standards and activities as a governing member of these organizations.

Moreover, Japan is a member of the Pacific Asia Standardization Committee and the International Conference on Test and Inspection Organizations, is conducting a standardization exchange with South Korea, and is working to further international standardization.

4) Advancement of the standardization of information technology

The progress of information technology is outstanding, but in some areas, such as information processing machines, there is no interoperability. This has become a great social and economic problem. For this reason, on the basis of the second "Recommendation for the Advancement of the Standardization of Information Technology," which was sent from the Japanese Industrial Standards Committee to the Ministry of International Trade and Industry minister in March 1986, research into open systems interoperability, software, office automation machines, integrated circuit cards, etc., has been proceeding. Moreover, to promote the introduction of open systems interoperability, cooperation with the communications field has been moving ahead, participation in international conferences introducing open systems interoperability is being worked out. Incidentally, at the fourth International Conference on the Introduction of open systems interoperability which was held in Bonn, West Germany, in January 1987, it was decided that the next international conference would be held in February and March of 1989 in Tokyo.

In addition, assistance and cooperation is being carried out by private sector groups through the Japan-U.S. Information Technology Standardization Conference and the Asia Information Technology Standardization Forum.

(2) Japan agricultural and forestry standards

The agricultural and forestry products standards indication system consists of two key systems: the Japan Agricultural and Forestry Standards System, which is concerned with the standardization of agricultural and forestry products, and in connection with this the Quality Indication Standards System, which is working to widen the applicability of agricultural and forestry product descriptions. Whereas the Japan Agricultural Forestry Standards standardization system takes as its objectives the improvement of quality, the rationalization of production, the simplification and greater fairness of transactions, and the rationalization of use and consumption, the Quality Indication Standards System is intended to contribute solely to appropriate product selection by the consumer. In this way, it makes a large contribution to the improvement of the quality of food and the development of the agriculture, forestry and fisheries industries, as well as the food industry.

In recent years, the diversification of the quality of food has been moving forward as is apparent in the increase in health, safety, orientation toward natural things, orientation toward homemade items, and orientation toward high-priced items. In response to this, great changes are emerging in the development of new products in the agriculture, forestry and fisheries industry, as well as in the food industry. The agriculture and forestry products standards indication system must respond to these changes as well.

For that reason, improvements of standards are being carried out in response to the modification of taste, diversification, and packaging. Work is proceeding on improving the standards corresponding to the diversification of the raw materials for margarine, and the diversification and packaging of canned and bottled fruits, as well as the enactment of standards for pastries.

9. Science and Technology Dissemination and Education

To achieve the smooth promotion of science and technology, it is indispensable that the permeation of science and technology through widespread education, awards, and technological dissemination, as well as through seeking the understanding and cooperation of the nation, be promoted.

(1) Widespread education

Raising Japan's interest in science and technology and fostering the scientific minds of the youth so that they, as those responsible for the next generation, recognize the importance of science and technology is important for the promotion of science and technology. For that purpose, all sorts of activities were conducted in 1987, including the publication and distribution of educational journals about science and technology (Prometheus, "21st

Century Nuclear Energy Development and Use," etc.), the production and distribution of films on science and technology ("Volcanic Japan," "Toward a More Micro World") broadcasts of television productions ("Superconductor Story"), radio broadcasts, and the holding of seminars, such as "Science and Technology Seminar," "Nuclear Energy Administration Seminar," etc. Some events are conducted on a nationwide scale, such as periods in recognition of science and technology-related subjects, like "Science and Technology Week," which is coming up for the 28th time, and "Nuclear Energy Day," which is coming up for the 24th time. Moreover, in addition to the above, the Science and Technology Agency releases publicity stories and films in cooperation with the Prime Minister's Office, to television and radio, and publicity articles to newspapers and weekly journals.

Furthermore, the Science and Technology Agency holds regional science and technology promotion conferences in the areas of Hokuriku, Chugoku, and Saitama to study problems involving the regional promotion of science and technology.

In addition, the various government offices carry out widespread educational activities regarding science and technology in their respective fields.

(2) Awards

The fact that Japan honors persons who contribute to the progress of science and technology, the development of industry, and the increase of the nation's welfare through 1) the research, development, and fostering of superior science and technology, 2) widespread science and technology education, and 3) the advancement of science and technology promotion policies, can be considered to be an effective science and technology promotion measure. The Science and Technology Agency grants meritorious service awards to persons in science and technology-related fields who have recently achieved note-worthy success related to the promotion of Japanese science and technology (32 persons were honored in 1987). In addition, researchers (42 for 1987) are honored for meritorious research, workers (903 for 1987) are honored for their meritorious creative devices that have contributed to the improvement of science and technology in their jobs, schools (40 in 1987) are honored as meritorious creative educational institutions for their outstanding results in the fostering of creativity and ingenuity among their secondary school students, individual promoters of science and technology (59 in 1987) are honored as meritorious promoters of science and technology for their superior performance in contributing to the strengthening of the promotion of science and technology, and individuals and groups (17 persons and 3 firms in 1987) are honored as meritorious nuclear energy safety proponents for the superior results they have achieved by making every effort to ensure the safety of nuclear energy.

(3) Technology dissemination

A technical fellows system was established in 1957 with the goals of nurturing Japan's science and technology talents, using them effectively, and disseminating science and technology to small and medium-sized firms. This system is one wherein firms attempt to make the technical scholars comfortable and provide them with technical guidance by selecting highly capable people in science and technology applications and levying strict obligations on them.

The technical fellows contribute to disseminating and raising the level of Japan's science and technology through science and technology plans, research, designs, analysis, tests and evaluations, and by accepting the obligation of leadership in these aspects. Recently, they have been used for construction-related design supervision, pollution and safety measures required for technology in general, the development of systems technology and making technological inroads overseas. They are expected to be the bearers of technology transfer both within and outside of Japan, leading to future leaps forward in science and technology. Moreover, the number of persons designated as technical fellows has grown to 21,172 as of 31 March 1988.

The Technical Fellows Law, which is the basis of this system, was completely revised by the 98th session of the Diet in April 1983, with its chief goals being the creation of a new technical fellows candidate system to allow outstanding young talents to participate and the entrusting of the implementation of the tests and the registry to the private sector.

Upon receiving this amendment, the Science and Technology Agency, in February 1984, appointed the Japan Technical Fellows Society to be the designated testing organization and the designated registry organization. The first technical fellows test was conducted in 1984. As of 31 March 1988, there were 2,000 persons in the technical fellows candidates registry.

(4) Invention incentives

Japan, which lacks natural resources and energy, needs to produce outstanding discoveries by activating its intellectual resources in order to work toward the development of a stable economy and society in the future.

From this standpoint, as part of its discovery reward policy, the government selects and announces as "notable discoveries" those superior discoveries whose concepts are excellent and can be applied in the future. Along with disseminating the superior results of research and development, the government uses this to work toward the advancing the implementation of discoveries and, in that way, has contributed to raising the level of Japan's science and technology and to the development of society and the economy.

In 1987, the government selected 104 discoveries as "notable discoveries" and announced them publicly during Science and Technology Week.

In 1987 as well, the government continued its efforts of the previous year, and conducted surveys and research by consignment and how the creative forces of young people can be extended through creative activity.

10. The State of Activity of Science and Technology-Related Councils

(1) Japan Atomic Energy Commission

The Japan Atomic Energy Commission was established in January 1956, on the basis of the Atomic Energy Basic Law, with the objective of accomplishing, in a planned manner, Japan's policies regarding the uses of atomic energy research and development. In the more than 30 years since then, it has served the central function of making decisions regarding Japan's policies on the uses of atomic energy research and development.

The Japan Atomic Energy Commission has set down several long-term programs to serve as guidance for atomic energy research and development from the perspective that atomic energy research and development should advance on the basis of a long-term and comprehensive vision. Moreover, the authorities involved should, of course, express their clear vision on this subject throughout Japan and obtain and the understanding and cooperation of the nation in moving forward with this vision. The existing long-term plan was drafted in June 1987. This plan treats Japan's atomic energy research in terms of a 30-year period, examines the development route taken up to now, and keeps in mind the long-term perspective of the development of atomic energy policy as we approach the 21st century. Bearing all this in mind, the program makes clear the ways to advance the guidance principles and basic policies concerning the uses of Japan's atomic energy development up to the year 2000 so as to be appropriate for the environment of that new era.

Moreover, parallel with this, the government has been taking into consideration the changes in many concentrations, such as the changes in nuclear fuel use trends, and in March 1986 established the "High Temperature Gas Reactor Research and Development Program Experts Group" to conduct investigations and studies on the future high-temperature gas reactor research and development program. In May of the same year, the government established the "Fast Breeder Reactor Development Program Experts Group" to conduct investigations on the long-term plan for the development of the fast breeder reactor. Furthermore, bearing in mind the current situation concerning the uses of radiation, the Japan Atomic Energy Commission established the "Radiation Uses Expert Group" to carry out investigations of the best ways to conduct research and development to advance the uses of radiation in the future and to join the previously-established groups of experts in conducting dynamic investigations.

Within this group of experts, the "Enriched Uranium Conference" is investigating the conditions necessary for the development of new technology, such as new materials and a high performance centrifuge.

Moreover, the "High-Temperature Gas Reactor Research and Development Program Experts Group" compiled reports in August and December of 1986. These reports stated that the research and development of a high-temperature gas reactor which has superior characteristics, such as the capability of providing high-temperature, high inherent safety, and a high combustion point, is of great significance in increasing its economy and expanding the fields in which it can be used. In the future, the reports said, the base of this technology should be established and raised to a high level, and the construction of a high heat engineering test research reactor is appropriate.

Furthermore, in February 1987, the "Radiation Uses Expert Group" put together a report stating that the advancement of the commercialization of radiation uses, the advancement of research and development to provide higher radiation uses, and the advancement of international cooperation are important as future topics.

(2) Japan Atomic Energy Safety Commission

The Japan Atomic Energy Safety Commission was established in October 1978 as an advisory organ to the Prime Minister's Office to make plans, conduct investigations and to carry out decisions regarding items involving the guarantee of the safety of atomic energy. The major activities of 1987 were as follows:

1) Research related to the establishment of atomic energy facilities

The Japan Atomic Energy Safety Commission, in response to inquiries from the Administrative Management Agency, conducted a report of modified authorization of processing operations at Mitsubishi Nuclear Fuels Corp.'s Tokai Seisakusho. In addition, it carried out research on the results of safety research conducted by the Administrative Management Agency on the establishment and modification of conditions of different kinds of nuclear energy facilities.

2) Policies concerning a common sense of purpose within Japan

The Japan Atomic Energy Safety Commission, with the aim of conducting research concerning the establishment of nuclear reactors for use as commercial generators, has listened to the questions and opinions of local residents about the safety of the installation of these nuclear reactors and is conducting secondary public hearings in order to discuss this.

In 1987, after being presented with the written opinions of the local residents regarding the installation of a new No 4 reactor at the Chubu Electric Power, Hamaoka Nuclear Power Plant, the commission conducted an opinion hearing in the form of a meeting to hear these opinions directly from the local people themselves. The commission also held a public hearing with regard to the installation of a nuclear reactor at the Hokuriku Electric Power, Noto Nuclear Power Plant.

3) Drafting of safety investigation guidelines

The Japan Atomic Energy Safety Commission has conducted double checks of atomic power facilities on the basis of various guidelines, and very keenly improves these safety investigation guidelines.

The guidelines newly determined since 1987 are "Guidelines for Evaluating the Gravity Load Added to the Housing vessel Pressure Suppressor for a Boiling Water Reactor (BWR) MARKI-Type Reactor" in November 1987, "Basic Concept of Safety Examinations of Radioactive Waste Disposal Facilities." In March 1988, "Guidance for Evaluating Reactor Core Designs of Water Pressure Nuclear Reactors for Generating Electric Power" in April 1988, and "Concept of the Evaluation of the Safety of New Convertible Reactor Verification Reactors" in June 1988.

4) Miscellaneous

After the Chernobyl Nuclear Power Plant accident occurred in the Soviet Union, the Japan Atomic Energy Safety Commission established a Special Committee To Investigate the Soviet Nuclear Power Plant Accident in May 1986 and conducted an investigation of the causes of the accident and whether there were any aspects that could reflect on Japan's safety rules. In May 1987, following the Special Committees putting together of an accident investigation report, a related group of experts conducted a study of the items pointed out in the report from the perspective of generally increasing safety.

(3) Space Development Commission

The Space Development Commission was established in May 1968, on the basis of the Space Development Commission Establishment Law, to advance Japan's space development in a comprehensive and planned manner. The following were its main activities in 1987.

1) Revision of the principles of space development policy

The Space Development Commission established a Long-Term Policy Group in December 1987 to accurately respond to the changing circumstances inside and outside Japan concerning Japan's space development in recent years. This group then revised "Principles of Space Development Policy," which provides the long-term guidance for Japan's space development.

2) Space development program

The Space Development Commission, in accordance with the purpose of the "Principles of Space Development Policy," which were revised in February 1984, decided to revise the space development program annually by taking into consideration the current progress in research and development, societal needs, and the status of fiscal management. The following are the key points of the new projects in the "Space Development Program" adopted in March 1988.

i) To carry out the development of Scientific Satellite No 15 (ASTRO-D), with the aim of having it launched by the M-3 S II rocket in 1992.

ii) To carry out the development of the marine observation satellite No 1-b (MOS-1b), with the aim of having it launched by the H-I rocket in 1989.

iii) To carry out the development of Geostationary Meteorological Satellite No 5 (GMS-5), with the aim of having it launched by the H-II rocket in 1993.

iv) To carry out the required research and development of the Global Observation Platform Technical Satellite (ADEOS).

3) Group reports

i) The commission conducted an investigation of how Japan's space development ought to proceed from a long-term perspective, and published its report in May 1987.

ii) The commission conducted an investigation of safety measures connected with the launching of the H-I rocket (three stage) test vehicle, and published a report on its findings in June 1987.

iii) The commission conducted an investigation of why Japan's future response to the space station program should be, and published a report of its findings in July 1987.

iv) The commission conducted an investigation on safety policy connected with the launching of the H-I rocket (three-stage) No 1 vehicle and the Communications Satellite No 3-a (CS-3a), and published its report in October 1987.

v) The commission conducted an investigation of the results of the launching of Scientific Satellite No 11 (ASTRO-C) and marine observation satellite No 1 (MOS-1), and published its report in October 1987.

vi) The commission conducted an investigation of the results of the launching of the H-I rocket (three stage) test vehicle and the Technology Test Satellite (ETS-V), and published its report in February 1988.

vii) The commission conducted an investigation involving revising the "Principles of Space Development Policy" in order to clarify the basic direction and long-term promotion of Japan's future space development.

(4) Marine Development Council

The Marine Development Council, a reorganization of the Marine Science Technology Council, was established in the Prime Minister's Office in July 1971 for the purpose of investigating basic and comprehensive items concerning the development of the oceans. This was done in response to an inquiry by the prime minister.

In October 1973, this council presented a report entitled, "The Basic Concept and Policy of Japan's Marine Development Advancement." Moreover, in order to deal with subsequent changes in circumstances both within and outside of Japan, it conducted an investigation to grasp the current condition of marine development and to point out key issues. A group report on this subject was put together in December 1976 (by the Development Group and the Science and Technology Group). Subsequently, however, because the new marine order known as the 200 nautical mile era had to be adhered to, in February 1978 the council received Prime Minister's Inquiry No 2 entitled "Basic Concept and Promotion Policy of Marine Development From a Long-Term Outlook." The council established 11 groups, including the Long-Term Objectives Group, to investigate the basic concept of marine development and, in August 1979, published its first report, entitled "The Basic Concept of Marine Development From a Long-Term Outlook."

In the first report, the council portrayed society in the year 2000 by taking into account the trends of social and economic development, and indicated the desirable role for marine development in that society. Next, in order for that role to be realized, the report set forth the marine development objectives for 1990, which is the intermediate point in time between the current situation and the position anticipated in the year 2000.

Moreover, with regard to the promotion policy, the council established a working group to go over each of the 42 individual major issues identified in the first report and to determine how they can be resolved. Taking these conclusions into account, the council investigated the issue from a comprehensive perspective and, in January 1980, compiled a second report entitled "Basic Promotion Policy of Marine Development From a Long-Term Outlook." This report stated that the four measures below were fundamentally important.

1) Major expansion of the investigation of the oceans, particularly Japan's 200 nautical mile regime, and the establishment of a comprehensive investigation, observation and inspection system.

2) Comprehensive planning and controlled implementation of development uses and environmental safety of the oceans.

3) Positive promotion of Japan's response to, and international cooperation with, the new international marine order.

4) Establishment of a comprehensive marine development promotion system.

Furthermore, in order to deal with the changing international circumstances, beginning with the adoption of the United Nations Law of the Seas Treaty, and to contribute to the study of ways by which Japan's future marine development can be promoted, in 1982 the International Issues Group began to investigate the marine development trends overseas and the marine science and technology international cooperation tasks that Japan should support, putting together its report in November 1984.

(5) Technical Fellows Council

The Technical Fellows Council was established in August 1957, based on the Technical Fellows Law, for the purpose of conducting investigations into major items concerning technical fellows.

This council, bearing in mind the changes in science and technology and in Japan's economic and social circumstances since the enactment of the Technical Fellows Law (Law No 124 in 1957), conducted an investigation of amendments to the Technical Fellows Law and the uses of technical fellows. In June 1982, it published a report entitled, "Improvement of the Technical Fellows System," which advocated the establishment of a technical fellows candidate system and the transfer to the private sector of the examination and registry work. This report was presented to the Science and Technology Agency in July of that year.

Upon receipt of this report, the Technical Fellows Law was fully revised at the 98th Diet session (1983 Law No 25) and published on 27 April 1983. The implementation of this law, with the exception of one part, began on 1 April 1984.

Based on the amendment of the Technical Fellows Law, the new system, in addition to abolishing the preliminary examination and establishing the technical fellows candidate system, created an organization which the Science and Technology Agency director-general charged with the task of implementing examinations and registry.

Because of this, the qualifications of the technical fellows placed them into two categories: "technical fellows" and "candidate technical fellows." By the designation of the Science and Technology Agency director-general, these examination and registry operations were carried out by the Japan Technical Fellows Society beginning on 1 April 1984.

In 1987, after receiving the aforementioned report, "Improvement of the Technical Fellows System," along with the results of an investigation conducted regarding the implementation of exams, i.e., the Second Exam (the examination for technical fellows) and the First Exam (the examination for candidate technical fellows), the council conducted an investigation to revise the contents of the curriculum for the technical fellows examination (technology section, optional curricula, and the contents of optional curricula).

(6) Aviation and Electronics Technology Council

The Aviation and Electronics Technology Council was established in May 1978 to conduct surveys of comprehensive experimental research, requiring the cooperation of a number of sectors, covering aircraft technology, electronics technology and other scientific technologies.

Since its inauguration, this council has received inquiries from the Science and Technology Agency director-general and has published the following reports: Inquiry No 5, "Policy for Advancement of Comprehensive Research and Development Regarding Ultra Environmental Science and Technology and the Materials Science and Technology Related to This" (August 1980), Inquiry No 4, "Advancement of Comprehensive Research and Development of Laser Technology" (November 1980), Inquiry No 3, "Policies To Raise the Electronics

Technology Needed in the Advanced Technology Field" (March 1982), Inquiry No 2, "Research and Development Concept of Aviation Technology From a Long-Term Perspective" (September 1984), Inquiry No 7, "Advancement of Comprehensive Research and Development Regarding the Creation of New materials Based on Materials Design Theory" (September 1984), Inquiry No 6, "Advancement of Comprehensive Research and Development of Information and Electronics Technology Regarding Systems To Complement or Substitute for the Human Intelligence Function" (March 1985), Inquiry No 9, "Focal Issues for Raising the Measurement and Control Technologies Related to New Materials Research and Development and Measures for Their Advancement" (March 1986), Inquiry No 10, "Advancement of Comprehensive Research and Development Regarding the Development of Technology Using the Energy Conversion Function in Living Things" (March 1986), and Inquiry No 8, "Focal Issues in the Research and Development of Energy Saving Aviation Technology and Specific Ways To Advance Them" (August 1986).

Moreover, an investigation is still underway concerning Inquiry No 1, "Study of Plan To Implement Research and Development of the STOL Fan Jet" (December 1978), and a relevant interim report is to be published.

In 1987, a report was published (July 197) on Inquiry No 11, "Advancement of Comprehensive Research and Development of the Elevation of Optical Science Technology." This report, along with selecting important research and development topics by taking into account investigations of the current status, points at issue and technical issues of optical science technology, cited the measures needed to advance the organization and enlargement of the research and development base. Moreover, investigations and examinations continue regarding Inquiry No 12, "Ways To Advance Comprehensive Research and Development of Human Genetic Analysis," and investigations and examinations have begun (in March 1987) of Inquiry No 13, "Advancement of Comprehensive Research and Development Regarding the Creation of New Substances and Materials Which Have the Power To Respond Intelligently to and Manifest Functions in Response to Environmental Conditions," a new inquiry.

Furthermore, the Global Science and Technology Group (Founded in March 1987) is conducting investigations into the current handling of issues requiring comprehensive understanding from a global science and technology perspective, such as large-scale weather changes and the activity of the earth's crust. An interim report was compiled in July 1987.

(7) Resources Research Council

The Resources Research Council is an auxiliary organization of the Science and Technology Agency which was established within the Economic Stability Office in December 1947 (as the Resources Commission) with the objective of administratively and economically reflecting the high-level use and preservation of resources. With the inauguration of the Science and Technology Agency in May 1956, it became a subsidiary organization of the Science and Technology Agency.

During the 40 years since its inauguration, the Resources Research Council has conducted investigations of major items concerning the comprehensive use of resources. As of 1987, it had published one major report, 48 recommendations, 131 other reports, and 184 data publications. The results of the Resources Research Council's investigations have been used in the resources policy planning of related agencies. For example, railway electrification, the development and use of marine resources, the composition of Japan food ingredients, the configuration of a low heat distribution mechanism utilized in food preparation, and the uses of remote sensing are representative illustrations of results that have been obtained.

In 1987, while maintaining close contact with the Resources Research Office, investigations continued, and three reports were published. These were as follows:

1) "Survey on the Strengthening of Rainwater Accumulation and Filtration in Urban Areas" (Report No 106, 19 May 1987). This report confirms rainwater as being an important environmental resource in the urban environment. Urban area rainwater, which has been casually viewed as a resource up to now, is one which is quickly expelled from urban areas due to the paving of the earth's surface and, as a result, causes floods during torrential rains and consequently has a great impact on the urban environment, such as contributing to the lowering of the shallow subterranean water layer. The report reviews the current rainwater explosion system and discusses ways to safely and appropriately improve the urban environment to solve this problem.

2) "Summary on Plant Production by a Highly Environmentally Controlled System" (Report No 197, 22 July 1987). Plant production by highly environmentally controlled systems has the traits of accelerating the growth rate of the plants and avoiding the issue of topological conditions. Coupled with advances in biotechnology, this is expected to cause the production of a wide variety of plants to develop in the future. This report discusses the possibility of the future development of plant production by this highly environmentally controlled system and the research and development topics to make this a reality.

3) "Future Image of the Introduction of Home Electronics: A Research Report on the High-Level Use of Electronics Technology in the Household" (Report No 108, 8 December 1987). This report discusses the direction and points at issues concerning the introduction of home electronics, a scientific technology that can be realized at a level close to home, from the standpoint of working for the advancement of resource and energy conservation and for the realization of a civilized and full domestic life.

(8) Radiation Council

The Radiation Council was established in May 1956 on the basis of the "Law Concerning Technical Standards of Radiation Interference," and has, as its aim, the unity of technical standards concerning the prevention of radiation damage.

This council writes reports in response to inquiries from related administrative organizations. It also produces opinions as necessary. By 1987, it had written 80 reports and 9 recommendations and opinions.

Its major activities of 1987 were as follows:

1) On the basis of inquiries from the directors of related administrative agencies, in September and December of 1987 it conducted investigations of amendments to the technical standards of the ordinances under the jurisdiction of these agencies which accompanied the national laws based on the Recommendation of the International Radiation Protection Committee (IRPC) (Publication 26, 1977). These investigations were published as reports in December 1987 and February 1988.

Incidentally, the laws concerning this matter, which the Radiation Council was asked about, are shown in Table 3-5-8.

Table 3-5-8. Ordinances Related to Inquiries to the Radiation Council

Government office issuing the ordinance	Government ordinance	Local government ordinance	Proclamations	Remarks
Science and Technology Agency	2	15	10	Nuclear Reactor Regulatory Law Radiation Obstruction Prevention Law
Ministry of Health and Welfare		4	4	Medical law Pharmaceuticals Law Clinical Examination Technicians Law
Ministry of International Trade and Industry	1	5	5	Nuclear Reactor Regulatory Law Electricity Enterprise Law Mining Safety Law
Ministry of Transportation	1	11	4	Nuclear Reactor Regulatory Law Radiation Obstruction Prevention Law Road Transportation Law Road Transportation Vehicle Law Ship Safety Law Aviation Law Ship's Crew Law

[continued]

[Continuation of Table 3-5-8]

Government office issuing the ordinance	Government ordinance	Local government ordinance	Proclamations	Remarks
Ministry of Labor		1	1	Labor Health and Safety Law
National Personnel Authority		1		Government Employee Law
Totals	2	36	23	

Note: The total does not include redundancies caused by joint inquiries.

The council presented an opinion paper entitled "Doses of Radioactivity Beyond the Controlled Amounts in Shallow Earth Disposal of Radioactive Matter Waste," on 19 January 1988.

In addition to these Science and Technology Agency-related councils, councils related to other government offices conducted investigations and produced reports in science and technology in 1987. (For details see the data in appended data 30.)

Appended Data

Table of Contents

1. Changes in Research Expenses of Major Countries
(Japan)

Item / Year	Gross national product	National income	Research expenses	Defense research expenses	Government liability
	Y100 million	Y100 million	Y1 million	Y1 million	Y1 million
1965	336,023	263,804	425,833	4,077	131,149
66	395,089	310,917	488,659	4,984	156,546
67	462,394	369,114	606,296	6,660	183,370
68	547,605	428,291	767,834	8,642	216,390
69	649,201	514,224	933,228	9,319	245,191
70	751,520	610,297	1,195,328	11,065	301,413
71	828,063	659,105	1,345,919	12,305	369,025
72	965,391	779,369	1,586,708	14,096	432,068
73	1,166,792	958,369	1,980,896	15,575	522,684
74	1,381,558	1,124,716	2,421,367	16,156	641,077
75	1,522,094	1,239,907	2,621,827	16,949	720,755
76	1,711,525	1,403,972	2,941,373	18,825	800,386
77	1,900,348	1,557,032	3,233,543	21,826	886,115
78	2,087,809	1,717,785	3,569,953	24,272	999,502
79	2,254,526	1,822,069	4,063,627	27,649	1,113,822
80	2,451,627	1,993,352	4,683,768	29,599	1,209,557
81	2,596,688	2,081,566	5,363,986	32,573	1,340,320
82	2,723,829	2,168,591	5,881,539	36,487	1,388,812
83	2,840,583	2,281,188	6,503,737	39,452	1,440,717
84	3,030,160	2,398,107	7,176,511	44,607	1,494,546
85	3,212,903	2,543,949	8,116,399	58,677	1,573,953
86	3,345,694	2,644,507	8,414,993	66,133	1,651,680
87	3,511,879	2,740,767	—	74,135	—

Notes: 1. A is the research expense percentage of the gross national product.
B is the research expense percentage of the national income.
C is the research expense percentage of the government liability.
D is the government liability percentage excluding defense research expenses.
2. Research expenses and number of researchers are only those for the natural sciences.
3. The number of researchers is as of 1 April every year.
4. Defense research expenses are under the control of the Japan Defense Agency in terms of the nation's science and technology-related budget.
5. The population is determined by a nationwide survey as of 1 October and is an estimate.

Materials: 1. The gross national product and the national income come from the Economic Planning Agency's "National Economic Statistics Annual."
2. The research expenses, the government liability and the number of researchers come from the General Affairs Agency's Statistics Bureau, "Science and Technology Research Survey Report."
3. The population comes from the General Affairs Agency's Statistics Bureau, "National Census Survey Report" and "Population Estimate Material."

[Continuation of Table 1]

A	B	C	D	Number of researchers	Population
%	%	%	%	People	1 million people
1.27	1.61	30.8	30.1	117,596	98.275
1.24	1.57	32.0	31.3	128,928	99.036
1.31	1.64	30.2	29.5	138,689	100.196
1.40	1.79	28.2	27.4	157,612	101.331
1.44	1.81	26.3	25.5	157,057	102.536
1.59	1.96	45.2	24.5	172,002	103.720
1.63	2.04	27.4	26.7	194,347	105.145
1.64	2.04	27.2	26.6	198,084	107.595
1.70	2.07	26.4	25.8	226,604	109.104
1.75	2.15	26.5	26.0	238,179	110.573
1.72	2.11	27.5	27.0	255,202	111.940
1.72	2.10	27.2	26.7	260,250	113.094
1.70	2.08	27.4	26.9	271,956	114.165
1.71	2.08	28.0	27.5	273,102	115.190
1.80	2.23	27.4	26.9	281,920	116.155
1.91	2.35	25.8	25.4	302,585	117.060
2.07	2.58	25.0	24.5	317,487	117.884
2.16	2.71	23.6	23.1	329,728	118.693
2.29	2.85	22.2	21.7	342,237	119.483
2.37	2.99	20.0	20.3	370,045	120.235
2.53	3.19	19.4	18.8	381,282	121.049
2.52	3.18	19.6	19.0	405,554	121.672
—	—	—	—	418,337	122.264

2. Changes in Research Expenses by Sector of Performance in Major Countries

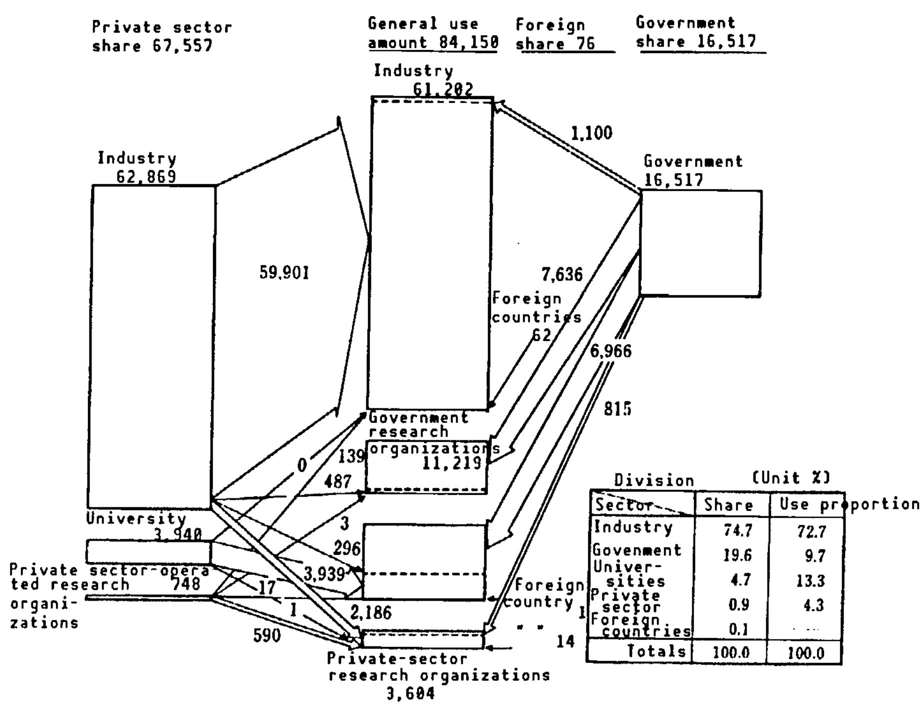
(1) Japan

Item / Year	Industry 100 million	Composition %	Government research organization 100 million	Composition %	Universities 100 million	Composition %	Privately operated research organizations 100 million	Composition %	Total 100 million	Composition %
1965	2,524	59.3	608	14.3	1,050	24.7	76	1.8	4,258	100
66	2,922	59.8	690	14.1	1,189	24.3	87	1.8	4,887	100
67	3,790	62.5	790	13.0	1,389	22.9	95	1.6	6,063	100
68	5,044	65.7	980	12.8	1,558	20.3	96	1.3	7,678	100
69	6,284	67.3	1,130	12.1	1,774	19.0	144	1.5	9,332	100
70	8,233	68.9	1,400	11.7	2,174	18.2	146	1.2	11,953	100
71	8,950	66.5	1,817	13.5	2,504	18.6	187	1.4	13,459	100
72	10,449	65.9	2,335	14.7	2,889	18.2	191	1.2	15,867	100
73	13,019	65.7	2,964	15.0	3,582	18.1	243	1.2	19,809	100
74	15,891	65.6	3,123	12.9	4,452	18.4	747	3.1	24,214	100
75	16,848	64.3	3,480	13.3	5,163	19.7	727	2.8	26,218	100
76	18,822	64.0	3,866	13.1	5,877	20.0	849	2.9	29,414	100
77	21,095	65.2	4,233	13.1	6,297	19.5	710	2.2	32,335	100
78	22,910	64.2	4,839	13.6	7,126	20.0	824	2.3	35,700	100
79	26,649	65.6	5,449	13.4	7,777	19.1	761	1.9	40,636	100
80	31,423	67.1	5,951	12.7	8,239	17.6	1,225	2.6	46,838	100
81	36,298	67.7	6,354	11.8	8,854	16.5	2,134	4.0	53,640	100
82	40,390	68.7	6,501	11.1	9,482	16.1	2,442	4.2	58,815	100
83	45,601	70.1	6,672	10.3	10,234	15.8	2,481	3.8	65,037	100
84	51,366	71.6	7,011	9.8	10,638	14.8	2,750	3.8	71,765	100
85	59,399	73.2	7,846	9.7	10,754	13.2	3,165	3.9	81,164	100
86	61,202	72.7	8,125	9.7	11,219	13.3	3,604	4.3	84,150	100

Note: Research expenses are only those for the natural sciences.
Source: General Affairs Agency's Statistics Bureau, "Science and Technology Research Investigative Report"

3. Flow of Research Costs in Major Countries

(1) Japan (FY 1986) (Unit: Y100 million)



Division / Sector	Share	Use proportion
Industry	74.7	72.7
Govenment	19.6	9.7
Universities	4.7	13.3
Private sector	0.9	4.3
Foreign countries	0.1	...
Totals	100.0	100.0

(Unit %)

[Notes to Figure 3]

Notes: 1. Research expenses are only those for natural sciences.

2. In the use of research expenses, there are two ways to account for the expenses: expenditures and expenses. Japan uses expenditures. Expenditures are the ordinary expenses required for research such as the personnel expenses, raw materials expenses, tangible fixed assets purchase expenses, and other ordinary expenses. Expenses are the amounts, within the expenditures, that take into account the depreciation cost of tangible fixed assets in place of the purchase price of tangible fixed assets.

3. The following concerns the scope of various organizational categories.

(1) The liability side

(i) Industry: Companies and special corporations that do not recognize research as their main business goal.

(ii) Government: Joint national and local organizations, state-run, publicly-run, and special corporation research organizations, national and public universities (including junior colleges, see the same below)

(iii) Universities: Private colleges (including junior colleges, see the same below)

(iv) Privately-operated research organizations: Privately-run research organizations for which operational profits are not the main objective.

(2) The users side

(i) Industry: Same as the liability side

(ii) Government research organizations: State-run, publicly-run, and special corporation research organizations

(iii) Universities: National, public and private universities

(iv) Privately-operated research organizations: Same as the liability side.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

4. Changes in Research Expense as Ratio by Character of Work in Major Countries

(1) Japan

(Unit: %)

Item / Year	Industry			Government research organizations			Universities			Private-operated research organizations			Overall		
	Basic research	Applied research	Develop. research	Basic research	Applied research	Develop research	Basic research	Applied research	Develop. research	Basic research	Applied research	Develop. research	Basic research	Applied research	Develop. research
1965	11.2	31.3	57.5	23.2	49.5	27.3	—	—	—	27.9	48.7	23.4	30.3	31.1	38.6
66	10.4	28.4	61.2	25.4	46.5	28.1	—	—	—	24.7	43.8	31.5	29.8	29.0	41.3
67	10.2	28.4	61.4	24.9	44.3	30.9	—	—	—	17.8	62.9	19.3	28.3	28.8	42.9
68	11.4	27.4	61.2	20.3	47.2	32.5	—	—	—	20.0	46.8	33.2	26.6	28.5	44.9
69	9.1	27.0	63.9	20.5	42.2	37.3	—	—	—	31.1	52.1	16.7	24.3	27.7	48.0
70	9.3	27.2	63.5	17.4	42.7	39.9	—	—	—	22.3	35.8	41.9	23.3	27.6	49.1
71	9.1	25.9	65.0	19.6	33.5	47.0	—	—	—	22.2	36.4	41.4	23.9	25.8	50.2
72	8.1	22.3	69.6	15.0	32.5	52.4	—	—	—	22.5	57.0	20.5	22.5	23.6	53.9
73	6.7	19.5	73.8	15.6	29.0	55.4	—	—	—	16.4	53.4	30.1	21.5	21.3	57.2
74	6.3	19.4	74.3	16.5	38.2	45.3	75.4	18.5	6.1	7.2	16.4	76.4	25.0	21.7	63.3
75	5.2	19.1	75.8	15.8	34.3	49.9	70.9	21.6	7.5	6.5	21.1	72.4	14.2	21.5	64.3
76	5.0	18.6	76.3	18.1	34.6	47.3	56.4	38.2	5.3	9.7	26.6	63.7	16.6	24.7	58.8
77	4.7	19.6	75.7	18.1	35.5	46.5	57.4	37.0	5.7	13.5	30.0	56.5	16.2	25.1	58.7
78	4.6	18.2	77.1	18.5	34.9	46.6	57.3	37.3	5.4	12.2	61.6	26.2	16.6	25.1	58.4
79	4.6	19.5	75.9	18.9	37.1	44.0	55.2	38.1	6.7	14.5	63.8	21.7	15.5	25.9	58.7
80	5.0	19.5	75.5	15.8	39.3	44.9	55.8	37.0	7.2	12.6	46.0	41.4	14.5	25.4	60.0
81	5.2	21.8	73.0	14.2	32.2	53.6	55.8	36.3	8.0	9.9	36.7	53.3	13.9	25.7	60.4
82	5.5	21.9	72.6	14.3	31.3	53.9	54.9	37.6	7.4	8.5	33.1	58.4	14.1	25.9	60.1
83	5.7	22.0	72.3	13.9	30.7	55.4	54.9	36.9	8.3	9.2	31.4	59.4	14.0	25.4	60.6
84	5.6	22.0	72.4	13.9	29.9	56.2	54.9	36.6	8.5	11.1	31.7	57.2	13.6	25.1	61.3
85	5.9	21.9	72.1	13.0	28.5	58.4	54.2	37.4	8.4	10.6	33.5	55.9	12.9	25.0	62.2
86	6.1	21.6	72.3	13.6	27.3	59.1	54.2	37.4	8.4	14.1	27.8	58.1	13.3	24.4	62.3

Notes: 1. Natural sciences only.
2. The composition of universities before 1973 has not been investigated, but the overall ratio by character to work has been calculated, with an estimated 80 percent for basic research and 20 percent for applied research.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

6. Changes in Total Research Expenses in Japan

(Unit: Y100 million)

FY	Total research costs (A)	Actual research costs	Gross national product (B)	National income (C)	Total research expenses in GNP A/B	Total research costs in national income A/C
					%	%
1965	4,258	14,100	336,023	263,804	1.27	1.61
1966	4,887	15,415	395,089	310,917	1.24	1.57
1967	6,063	18,262	462,394	369,114	1.31	1.64
1968	7,678	22,064	547,605	428,291	1.40	1.79
1969	9,332	25,020	649,201	514,224	1.44	1.81
1970	11,953	29,735	751,520	610,297	1.59	1.96
1971	13,459	31,669	828,063	659,105	1.63	2.04
1972	15,867	34,419	965,391	779,369	1.64	2.04
1973	19,809	35,756	1,166,792	958,396	1.70	2.07
1974	24,214	35,194	1,381,558	1,124,716	1.75	2.15
1975	26,218	35,478	1,522,094	1,239,907	1.72	2.11
1976	29,414	36,721	1,711,525	1,403,972	1.72	2.10
1977	32,335	38,449	1,900,348	1,557,032	1.70	2.08
1978	35,700	41,319	2,087,809	1,717,785	1.71	2.08
1979	40,636	43,695	2,254,526	1,822,069	1.80	2.23
1980	46,838	46,838	2,451,627	1,993,352	1.91	2.35
1981	53,640	51,826	2,596,688	2,081,556	2.07	2.58
1982	58,815	55,122	2,723,829	2,168,591	2.16	2.71
1983	65,037	60,053	2,840,583	2,281,188	2.29	2.85
1984	71,765	64,537	3,030,160	2,398,107	2.37	2.99
1985	81,164	71,954	3,212,903	2,543,949	2.53	3.19
1986	84,150	75,201	3,345,694	2,644,507	2.52	3.18

Notes: 1. Research expenses are those for internal use mainly involving natural science systematic research in the physical, engineering, industrial, agricultural and hygiene aspects of natural science research; organizations for humanities and the social sciences have been excluded.

2. The real research expenses are those expenses which make the total amount of research expenses (A) real by means of the research expense deflator, which is shown in Appended Data [not reproduced].

Sources: 1. For research expenses, General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

2. Gross national product and national income are found in the Economic Planning Agency's "National Economic Computation Annual"

7. Changes in Number of Organizations Conducting Research in Japan

(Unit: Item)

FY \ Item	Organization category	Companies, etc.		Research organizations			Universities
		Companies	Special corporations (a)	State-run Publicly-run	Special corpora-tions (b)	Private operations	
1965	10,758	9,452	14	643	6	196	447
1966	10,121	8,801	14	651	7	191	457
1967	11,290	9,939	14	659	9	189	480
1968	13,305	11,996	15	647	9	180	458
1969	12,594	11,270	16	639	9	180	480
1970	18,935	17,605	15	639	9	183	484
1971	15,753	14,382	15	662	9	196	489
1972	13,253	11,844	18	677	23	183	508
1973	11,614	10,170	20	693	21	179	531
1974	14,445	13,005	17	678	6	196	543
1975	14,552	13,075	15	669	6	209	578
1976	13,693	21,163	14	671	6	238	601
1977	17,289	15,767	13	683	6	216	604
1978	16,269	14,743	14	668	8	218	618
1979	19,618	18,044	14	681	7	239	633
1980	19,103	17,453	15	727	9	256	643
1981	18,026	16,334	14	736	9	285	648
1982	17,214	15,518	14	732	9	269	672
1983	19,367	17,631	15	739	9	295	678
1984	16,663	14,909	12	729	8	320	685
1985	16,263	14,478	12	705	8	365	695
1986	15,449	13,624	11	695	7	404	708

Notes: 1. Research organizations are those recognizing research related to natural science systems such as physics, engineering, agriculture and hygiene, as their main subject of research.

2. The companies that are subject to this investigation are those that had more than ¥1 million in capital in 1974, more than ¥3 million in capital from 1975 to 1978 and more than ¥5 million in capital since 1979.

3. Special corporations (a) have independent profitability. Special corporations (b) are not expected to have independent profitability.

4. The survey unit for the university is the department.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

8. Changes in Research Expenses by Source of Funds in Japan

(Unit: Y1 million)

FY \ Item	Total: Research costs (A)	Total	National and local public organizations: Share (B)	Share (A/B)	Private sector: Share (C)	Share (C/A)	Foreign countries: Share (D)	Share (D/A)
		%		%		%		%
1965	425,832	100	131,149	30.8	294,374	69.1	310	0.1
1966	488,660	100	156,546	32.0	331,758	67.9	356	0.1
1967	606,295	100	183,370	30.2	422,473	69.7	452	0.1
1968	767,834	100	216,390	28.2	550,874	71.7	571	0.1
1969	933,228	100	245,191	26.3	687,154	73.6	884	0.1
1970	1,195,328	100	301,413	25.2	893,485	74.7	428	0.0
1971	1,345,919	100	369,025	27.4	975,905	72.5	988	0.1
1972	1,586,708	100	432,068	27.2	1,153,560	72.7	1,081	0.1
1973	1,980,896	100	522,684	26.4	1,456,891	73.5	1,321	0.1
1974	2,421,367	100	641,077	26.5	1,778,834	73.5	1,456	0.1
1975	2,621,827	100	720,255	27.5	1,899,293	72.4	1,779	0.1
1976	2,941,373	100	800,386	27.2	2,183,368	72.7	2,619	0.1
1977	3,233,543	100	886,115	27.4	2,343,681	72.5	3,747	0.1
1978	3,569,953	100	999,502	28.0	2,567,390	71.9	3,061	0.1
1979	4,063,627	100	1,113,822	27.4	2,946,391	72.5	3,414	0.1
1980	4,683,768	100	1,209,567	25.8	3,469,557	74.1	4,655	0.1
1981	5,363,986	100	1,340,320	25.0	4,017,752	74.9	5,914	0.1
1982	5,881,539	100	1,388,812	23.6	4,486,044	76.3	6,682	0.1
1983	6,503,737	100	1,440,717	22.2	5,054,895	77.7	8,125	0.1
1984	7,176,511	100	1,494,546	20.8	5,674,783	79.1	7,182	0.1
1985	8,116,399	100	1,573,953	19.4	6,534,619	80.5	7,826	0.1
1986	8,414,993	100	1,651,680	19.6	6,755,682	80.3	7,631	0.1

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

9. Changes in Research Expenses by Sector in Japan

(Unit: ¥1 million)

Item / FY	Companies, etc.				Research organizations			
	Companies	Special corporations (a)	Total (A)	A/D	State-run	Publicly-run	Privately-run	Special corporations (b)
				%				
1965	239,616	12,743	252,359	59.3	30,042	24,019	7,643	6,722
1966	277,085	15,092	292,771	59.8	34,881	28,018	8,676	6,052
1967	362,316	16,654	378,970	62.5	37,010	32,498	9,483	9,470
1968	480,434	23,917	504,351	65.7	42,251	37,251	9,608	18,542
1969	600,581	27,771	628,352	67.3	44,956	42,625	14,383	25,463
1970	785,010	38,255	823,265	68.9	51,560	54,239	14,598	34,222
1971	845,790	49,230	895,020	66.5	58,035	63,920	18,721	59,790
1972	985,925	59,002	1,044,928	65.9	68,018	72,145	19,414	93,298
1973	1,238,444	63,483	1,301,927	65.7	82,266	90,645	24,320	123,509
1974	1,524,114	64,939	1,589,053	65.6	102,996	110,142	74,727	99,208
1975	1,616,211	68,726	1,684,847	64.3	177,596	111,460	72,684	118,959
1976	1,808,210	74,021	1,882,231	64.0	123,403	118,222	84,867	144,997
1977	2,019,851	89,649	2,109,500	65.2	140,618	132,141	71,013	150,573
1978	2,194,252	96,750	2,291,002	64.2	155,684	137,285	82,447	190,917
1979	2,559,917	104,995	2,664,913	65.6	177,704	150,877	76,119	216,331
1980	3,032,145	110,111	3,142,256	67.1	185,372	165,966	122,533	243,742
1981	3,517,034	112,759	3,629,793	67.7	191,956	177,702	213,934	265,783
1982	3,917,089	121,929	4,039,018	68.7	195,747	177,766	244,198	276,599
1983	4,435,361	124,766	4,560,127	70.1	200,863	178,222	248,087	288,082
1984	5,114,631	22,003	5,136,634	71.6	208,062	185,658	274,987	307,396
1985	5,913,942	26,005	5,939,947	73.2	227,454	193,052	316,461	364,704
1986	6,105,886	14,277	6,120,163	72.7	236,700	193,568	360,436	382,261

Notes: 1. Special corporations (a) have independent profitability, and special corporations (b) are not expected to be independently profitable.

2. The categorization of technology research associations was changed from a special corporation (b) to a privately-run research organization based on the Mining and Manufacturing Industries Technology Research Association Law of 1974.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

[continued]

[Continuation of Table 9]

(Unit: Y100 million

Total (B)	B/D	Universities: National universities	Public universities	Private universities	Total (C)	C/D	Overall total (D)	
	%					%		%
68,426	16.1	63,201	8,853	32,993	105,048	24.7	425,833	100
77,626	15.9	77,317	7,482	34,057	118,856	24.3	488,659	100
88,461	14.6	90,871	8,433	39,560	138,865	22.9	606,296	100
107,652	14.0	98,154	11,786	45,892	155,831	20.3	767,834	100
127,427	13.7	109,937	12,308	55,204	177,449	19.0	933,228	100
154,619	12.9	131,760	15,995	69,689	217,444	18.2	1,195,328	100
200,466	14.9	143,129	18,593	88,710	250,433	18.6	1,345,919	100
252,885	15.9	158,872	19,922	110,102	288,896	18.2	1,586,708	100
320,740	16.2	187,809	23,466	146,954	385,229	18.1	1,980,896	100
387,073	16.0	245,135	27,052	173,054	445,241	18.4	2,421,367	100
420,699	16.0	284,293	29,574	202,414	516,281	19.7	2,621,827	100
471,489	16.0	317,986	31,877	237,790	587,654	20.0	2,942,373	100
494,345	15.3	351,945	35,745	242,007	629,698	19.5	3,233,543	100
566,333	15.9	399,275	35,676	277,667	712,618	20.0	3,569,953	100
621,032	15.3	434,641	39,081	303,960	777,683	19.1	4,063,627	100
717,612	15.3	461,765	41,374	320,761	823,900	17.6	4,683,768	100
848,834	15.8	505,040	45,516	334,803	885,359	16.5	5,363,986	100
894,310	15.2	529,884	47,081	371,245	948,211	16.1	5,881,539	100
915,254	14.1	561,246	49,491	417,620	1,028,356	15.8	6,503,737	100
976,102	13.6	585,463	52,182	426,130	1,063,775	14.8	7,176,511	100
1,101,041	13.6	589,212	56,310	429,888	1,075,410	13.2	8,116,399	100
1,172,966	13.9	610,800	57,532	453,532	1,121,864	13.3	8,414,993	100

10. Changes in Research Expenses by Type of Cost in Japan

(Unit: percent)

	Fiscal year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Companies, etc.	Personnel costs	51.9	50.9	49.8	47.9	46.2	44.2	43.3	43.5	42.1	40.7	41.3
	Raw materials costs	17.5	18.2	19.0	19.0	18.7	19.9	19.8	19.6	20.5	20.5	20.5
	Tangible fixed asset purchase costs	11.6	12.1	12.5	13.7	15.1	16.0	15.9	15.4	15.5	16.5	15.7
	Expenses	19.0	18.8	18.8	19.4	20.1	19.9	20.9	21.4	22.0	22.4	22.5
	Total	100	100	100	100	100	100	100	100	100	100	100
Research organizations	Personnel costs	40.2	42.1	40.2	38.1	36.5	34.9	34.8	35.3	35.4	33.1	33.2
	Raw materials costs	8.1	6.8	7.0	6.0	11.1	12.6	13.3	12.6	13.6	14.6	17.4
	Tangible fixed asset purchase costs	29.2	27.4	29.8	28.7	30.4	29.9	28.0	25.8	27.2	29.2	26.9
	Expenses	22.5	23.7	23.1	27.2	21.9	22.6	23.9	26.3	23.9	23.0	22.4
	Total	100	100	100	100	100	100	100	100	100	100	100
Universities	Personnel costs	60.1	60.4	58.6	57.7	58.7	58.0	57.8	57.1	59.3	60.4	61.0
	Raw materials costs	8.5	7.4	8.1	7.9	7.6	8.9	9.2	8.4	8.8	8.7	8.7
	Tangible fixed asset purchase costs	18.6	18.6	19.9	20.5	20.0	19.2	18.9	19.4	18.0	16.0	16.0
	Expenses	12.8	13.6	13.5	13.9	13.7	13.9	14.0	15.2	14.0	14.9	14.3
	Total	100	100	100	100	100	100	100	100	100	100	100
Overall	Personnel costs	51.7	51.4	50.0	48.3	46.9	45.0	44.4	44.5	43.7	42.3	42.8
	Raw materials costs	14.2	14.3	14.9	14.9	15.5	16.9	17.1	16.9	17.8	18.1	18.5
	Tangible fixed asset purchase costs	15.8	15.7	16.7	17.3	18.3	18.8	18.2	17.5	17.5	18.1	17.3
	Expenses	18.3	18.5	18.4	19.5	19.2	19.3	20.3	21.1	21.0	21.5	21.4
	Total	100	100	100	100	100	100	100	100	100	100	100

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

11. Changes in Research Expenses by Character of Work in Japan

(Unit: Y1 million)

FY	Organization \ Item	Number of research organizations	Gross amount	%	Basic research	%	Applied research	%	Development research	%
1980	Total	17,775	4,538,392	100	659,774	14.5	1,153,393	25.4	2,725,225	60.0
	Industries	16,172	3,142,256	100	157,413	5.0	613,175	19.5	2,371,668	75.5
	Research organizations	960	682,133	100	103,852	15.2	276,243	40.5	302,037	44.3
	Universities	643	714,003	100	398,509	55.8	263,975	37.0	51,520	7.2
1981	Total	16,632	5,206,719	100	724,348	13.9	1,339,951	25.7	3,142,421	60.4
	Industries	14,994	3,629,793	100	189,297	5.2	791,340	21.8	2,649,157	73.0
	Research organizations	990	807,150	100	105,880	13.1	269,420	33.4	431,850	53.5
	Universities	648	769,776	100	429,171	55.8	279,191	36.3	61,414	8.0
1982	Total	15,941	5,795,049	100	815,713	14.1	1,498,871	25.9	3,480,465	60.1
	Industries	14,286	4,039,018	100	221,386	5.5	886,110	21.9	2,931,522	72.6
	Research organizations	983	876,161	100	110,952	12.7	281,718	32.2	483,491	55.2
	Universities	672	879,870	100	483,375	54.9	331,043	37.6	65,452	7.4
1983	Total	17,471	6,409,567	100	896,693	14.0	1,630,069	25.4	3,882,805	60.6
	Industries	15,775	4,560,127	100	259,849	5.7	1,001,164	22.0	3,299,115	72.3
	Research organizations	1,019	893,579	100	112,423	12.6	276,370	30.9	504,786	56.5
	Universities	677	955,861	100	524,421	54.9	352,535	36.9	78,904	8.3
1984	Total	15,926	7,080,943	100	959,941	13.6	1,780,808	25.1	4,340,194	61.3
	Industries	14,203	5,136,634	100	290,030	5.6	1,128,585	22.0	3,718,020	72.4
	Research organizations	1,042	951,167	100	124,464	13.1	289,185	30.4	537,518	56.5
	Universities	681	993,142	100	545,447	54.9	363,038	36.6	84,656	8.5
1985	Total	15,567	8,018,275	100	1,030,602	12.9	2,001,771	25.0	4,985,902	62.2
	Industries	13,811	5,939,947	100	351,657	5.9	1,303,180	21.9	4,285,110	72.1
	Research organizations	1,069	1,067,984	100	131,503	12.3	320,371	30.0	616,110	57.7
	Universities	687	1,010,344	100	547,442	54.2	378,220	37.4	84,682	8.4
1986	Total	14,878	8,318,712	100	1,102,843	13.3	2,030,831	24.4	5,185,038	62.3
	Industries	13,087	6,120,163	100	371,257	6.1	1,321,836	21.6	4,427,070	72.3
	Research organizations	1,092	1,137,460	100	156,903	13.8	312,100	27.4	668,457	58.8
	Universities	699	1,061,089	100	574,683	54.2	396,895	37.4	89,511	8.4

Note: This table categorizes the research expenses (see the note in appended data 6) by organizations related to the natural sciences of physics, engineering, agriculture and hygiene. Research expenses related to research of humanities and social sciences have been excluded.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

12. Changes in Research Expenses by Specified Objectives in Japan

(Unit: Y100 million)

Research field	1984				1985				1986			
	Companies, etc.	Research organizations	Universities	Total	Companies, etc.	Research organizations	Universities	Total	Companies, etc.	Research organizations	Universities	Total
Energy research	2,968	3,828	316	7,112	2,917	4,341	325	7,583	3,014	4,870	342	8,226
Petrochemical energy	576	219	16	812	576	244	17	836	636	250	16	903
Natural energy	238	83	49	371	243	84	47	374	203	79	49	331
Atomic energy	627	2,346	200	3,173	620	2,657	208	3,486	672	3,109	218	3,999
Energy conservation	1,396	1,064	44	2,503	1,361	1,243	48	2,653	1,401	1,326	50	2,778
Miscellaneous	132	115	6	253	116	112	6	234	102	106	8	216
Space development	193	825	194	1,213	303	1,071	146	1,520	428	1,000	159	1,587
Marine development	93	212	72	376	97	235	74	406	202	229	75	507
Information processing	3,436	336	109	3,882	4,015	351	127	4,494	4,444	313	171	4,928
Protection of the environment	1,012	284	99	1,395	1,084	304	111	1,499	1,074	328	114	1,516

Note: The companies subject to this investigation all have capital above ¥100 million.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report," however, the same organization's "Energy R&D Report" was also used with regard to energy research.

13. Changes in Life Sciences Research Expenses in Japan

(Unit: ¥100 million)

Research objective	1985								1986							
	Companies, etc.		Research organizations		Universities		Total		Companies, etc.		Research organizations		Universities		Total	
		Composition		Composition		Composition		Composition		Composition		Composition		Composition		Composition
		%		%		%		%		%		%		%		%
Health and pharmaceuticals R&D	338,412	79.0	47,249	42.8	239,223	71.1	624,884	71.4	333,074	76.4	47,359	38.6	250,328	71.4	630,761	69.3
Analysis of general life phenomena and biological functions	5,813	1.4	6,808	6.2	62,008	18.4	74,629	8.5	9,277	2.1	8,485	6.9	64,462	18.4	82,224	9.0
Food sources R&D	29,954	7.0	22,530	20.4	4,706	1.4	57,190	6.5	32,049	7.3	29,086	23.7	5,183	1.5	66,318	7.3
Environmental safety R&D	9,433	2.2	18,431	16.7	8,891	2.6	36,755	4.2	9,799	2.2	20,006	16.3	8,931	2.5	38,736	4.3
Mining, manufacturing of organisms and their functions R&D	31,490	7.3	4,390	4.0	2,423	0.7	38,303	4.4	36,663	8.4	5,147	4.2	2,473	0.7	44,283	4.9
Experimental biology R&D	8,490	2.0	2,737	2.5	10,946	3.3	22,173	2.5	9,935	2.3	2,913	2.4	9,798	2.8	22,646	2.5
Uses in energy development or organisms R&D	3,161	0.7	2,526	2.3	1,043	0.3	6,730	0.8	2,604	0.6	3,119	2.5	1,081	0.3	6,804	0.7
Other life sciences R&D	1,702	0.4	5,804	5.3	7,334	2.2	14,840	1.7	2,693	0.6	6,643	5.4	8,535	2.4	17,871	2.0
Total	428,454	100	110,475	100	336,574	100	875,503	100	436,093	100	122,758	100	350,792	100	909,643	100

Note: The companies, etc., subject to this table possess capital of more than ¥100 million.

Source: General Affairs Agency's Statistics Bureau, "Life Sciences R&D Report"

14. Changes in Research Expenses Per Researcher in Japan

(Unit: Y10,000)

FY	Companies, etc. (nominal)	Research organizations (nominal)	Universities (nominal)	Overall (nominal)	Overall (real)
1965	428	352	268	362	1,199
1966	447	389	272	379	1,196
1967	548	422	286	437	1,317
1968	618	497	287	487	1,400
1969	761	575	339	594	1,593
1970	875	681	394	695	1,729
1971	805	858	419	693	1,629
1972	927	1,019	477	801	1,738
1973	1,043	1,204	477	874	1,578
1974	1,216	1,368	562	1,017	1,478
1975	1,149	1,576	630	1,027	1,390
1976	1,296	1,746	668	1,130	1,411
1977	1,393	1,782	679	1,189	1,414
1978	1,491	2,031	779	1,307	1,513
1979	1,694	2,225	804	1,441	1,550
1980	1,814	2,506	818	1,548	1,548
1981	1,963	2,829	863	1,690	1,632
1982	2,093	2,737	911	1,784	1,672
1983	2,267	2,936	935	1,900	1,755
1984	2,294	3,052	932	1,939	1,744
1985	2,570	3,423	911	2,129	1,887
1986	2,431	3,614	925	2,075	1,854

Notes: 1. The research expenses per researcher are calculated by dividing the research expenses of the fiscal year concerned by the number of researchers on the first day (1 April) of the fiscal year concerned.

2. The deflator is in accordance with appended data 32 [not reproduced].

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

15. Changes in Number of Employees Involved in Research in Japan

Year	Research organizations	Research-related employees	%	Researchers	%	Research assistants	%	Technicians	%	Administrative and other related workers	%
1965	11,459	303,789	100	117,596	38.7	75,936	25.0	62,648	20.6	47,609	15.7
1966	10,758	323,009	100	128,928	39.9	82,915	25.7	60,156	18.6	51,010	15.8
1967	10,121	327,623	100	138,689	42.3	80,058	24.4	61,155	18.7	47,721	14.6
1968	11,290	356,275	100	157,612	44.2	83,188	23.3	68,153	19.1	47,322	13.3
1969	13,305	367,295	100	157,057	42.8	70,767	19.3	84,611	23.0	54,860	14.9
1970	12,594	392,236	100	172,002	43.9	75,363	19.2	88,282	22.5	56,589	14.4
1971	18,935	429,348	100	194,347	45.3	80,194	18.7	93,581	21.8	61,226	14.3
1972	15,753	426,935	100	198,084	46.4	82,308	19.3	86,149	20.2	60,394	14.1
1973	13,253	459,239	100	226,604	49.3	80,720	17.6	88,857	19.3	63,058	13.7
1974	11,614	468,060	100	238,179	50.9	79,400	17.0	87,516	18.7	62,965	13.5
1975	14,445	491,296	100	255,202	51.9	81,934	16.7	90,648	18.5	63,512	12.9
1976	14,552	487,999	100	260,250	53.3	79,245	16.2	89,089	18.3	59,415	12.2
1977	13,693	492,287	100	271,956	55.2	73,794	15.0	86,698	17.6	59,839	12.2
1978	17,289	486,776	100	273,102	56.1	72,479	14.9	83,321	17.1	57,874	11.9
1979	16,269	496,030	100	281,920	56.8	72,988	14.7	82,163	16.6	58,959	11.9
1980	19,618	521,119	100	302,585	58.1	73,918	14.2	85,882	16.5	58,734	11.3
1981	19,103	548,312	100	317,487	57.9	79,889	14.6	89,326	16.3	61,610	11.2
1982	18,026	567,235	100	329,728	58.1	83,592	14.7	90,072	15.9	63,843	11.3
1983	17,214	587,182	100	342,237	58.3	86,630	14.8	92,224	15.7	66,091	11.3
1984	19,367	627,814	100	370,045	58.9	92,826	14.8	96,109	15.3	68,834	11.0
1985	16,663	646,299	100	381,282	59.0	97,263	15.0	98,267	15.2	69,487	10.8
196	16,263	676,023	100	405,554	60.0	98,493	14.6	100,850	14.9	71,126	10.5
1987	15,449	691,822	100	418,337	60.5	99,569	14.4	101,492	14.7	72,424	10.5

Note: The figures for each year are as of 1 April.
Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

16. Changes in Number of Researchers by Sector in Japan

(Unit: People)

Item / Year	Companies, etc.				Research organizations			
	Companies	Special corporations (a)	Total	A/D %	State-run	Publicly-run	Privately-run	Special corporations (b)
1965	57,126	1,871	58,997	50.2	8,247	9,207	1,200	812
1966	63,638	1,719	65,357	50.7	8,471	9,487	1,284	704
1967	67,328	1,836	69,164	49.9	8,676	10,062	1,260	978
1968	79,642	2,022	81,664	51.8	8,642	10,537	1,433	1,056
1969	80,182	2,334	82,516	52.5	8,856	10,728	1,405	1,179
1970	91,516	2,544	94,060	54.7	8,826	11,149	1,465	1,262
1971	108,593	2,651	111,244	57.2	9,187	11,333	1,534	1,302
1972	100,017	2,746	112,763	56.9	9,231	12,284	1,734	1,569
1973	121,797	2,998	124,795	55.1	9,327	13,012	1,769	2,542
1974	127,536	3,154	130,690	54.9	9,206	13,848	1,824	3,412
1975	143,364	3,240	146,604	57.4	9,341	13,732	1,775	1,842
1976	142,554	2,662	145,216	55.8	9,341	13,698	2,048	1,923
1977	148,741	2,696	151,437	55.7	9,421	13,760	2,654	1,905
1978	150,924	2,782	153,706	56.3	9,712	13,857	2,342	1,977
1979	154,447	2,832	157,279	55.8	9,724	13,737	2,377	2,079
1980	170,279	2,965	173,244	57.3	9,895	13,988	2,512	2,246
1981	181,892	2,997	184,889	58.2	10,073	14,110	3,412	2,411
1982	189,952	2,990	192,942	58.2	10,067	14,257	5,901	2,449
1983	198,132	3,005	201,137	58.8	10,217	13,907	4,514	2,532
1984	220,835	3,047	223,882	60.5	10,179	13,958	5,376	2,467
1985	230,445	652	231,097	60.6	10,037	13,994	5,649	2,487
1986	251,138	633	251,771	62.1	10,169	13,843	5,902	2,545
1987	260,457	389	260,846	62.4	10,106	13,748	6,715	2,688

Notes: 1. The figures for each year are as of 1 April.
2. The distinction between special corporations (a) and (b) is the same as in appended data 9.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

[continued]

[Continuation of Table 16]

(Unit: People)

Total		Universities					Total (D)	
	B/D	State universities	Public universities	Private universities	Total	C/D		
	%					%		%
19,466	16.6	24,191	4,266	10,676	39,133	33.3	117,596	100
19,946	15.5	25,673	5,174	12,778	43,625	33.8	128,928	100
20,976	15.1	29,853	4,404	14,292	48,549	35.0	138,689	100
21,668	13.7	33,768	5,113	15,399	54,280	34.4	157,612	100
22,168	14.1	32,575	4,457	15,341	52,373	33.3	157,057	100
22,702	13.2	34,064	4,536	16,640	55,240	32.1	172,002	100
23,356	12.0	35,679	4,597	19,471	59,747	30.7	194,347	100
24,818	12.5	36,168	4,415	19,920	60,503	30.5	198,084	100
26,650	11.8	43,648	6,940	24,571	75,159	33.3	226,604	100
28,290	11.9	46,362	6,605	26,232	79,199	33.3	238,179	100
26,690	10.5	46,771	6,648	28,489	81,908	32.1	255,202	100
27,010	10.4	50,695	7,120	30,209	88,024	33.8	260,250	100
27,740	10.2	53,110	7,559	32,110	92,779	34.1	271,956	100
27,888	10.2	52,019	7,124	32,365	91,508	33.5	273,102	100
27,917	9.9	54,086	7,154	35,484	96,724	34.3	281,920	100
28,641	9.5	57,434	7,342	35,924	100,700	33.3	302,585	100
30,006	5.5	57,523	7,395	37,674	102,592	32.3	317,487	100
32,674	9.9	58,340	7,612	38,160	104,112	31.6	329,728	100
31,170	9.1	60,774	8,171	40,985	109,930	32.1	342,237	100
31,980	8.6	62,906	8,400	42,877	114,183	30.9	370,045	100
32,167	8.4	64,657	8,616	44,745	118,018	31.0	381,282	100
32,459	8.0	65,926	8,714	46,684	121,324	29.9	405,554	100
33,257	7.9	67,590	8,974	47,670	124,234	29.7	418,337	100

17. Changes in Number of Research Assistants, Etc., Per Researcher in Japan
(Unit: People)

Year	Companies, etc.	Research organizations	Universities	Overall
1965	2.12	1.42	0.85	1.58
1966	1.79	1.42	1.12	1.51
1967	1.70	1.43	0.85	1.36
1968	1.55	1.33	0.80	1.26
1969	1.74	1.32	0.71	1.34
1970	1.63	1.29	0.68	1.28
1971	1.51	1.24	0.63	1.21
1972	1.41	1.18	0.67	1.16
1973	1.31	1.24	0.48	1.03
1974	1.24	1.14	0.45	0.97
1975	1.15	1.19	0.43	0.93
1976	1.13	1.09	0.40	0.88
1977	1.03	1.03	0.38	0.81
1978	0.99	1.01	0.36	0.78
1979	0.96	1.02	0.36	0.76
1980	0.90	0.97	0.34	0.72
1981	0.89	1.05	0.34	0.73
1982	0.89	0.99	0.33	0.72
1983	0.87	1.06	0.33	0.72
1984	0.84	1.07	0.32	0.70
1985	0.84	1.07	0.31	0.70
1986	0.79	1.07	0.30	0.67
1987	0.77	1.09	0.28	0.65

Notes: 1. Research assistants, etc., per researcher is the total of technicians and administrative and other related persons, as well as research assistants per se.
2. The figures for each year are as of 1 April.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

18. Amount of Research Expenses and Number of Researchers by Industry in Japan

(1) Research costs per researcher

(FY 1986)

Industry	Companies, etc. conducting research	Research costs spent	Number of researchers	Research costs per researcher
		Y1 million		Y10,000
Overall industry	13,635	6,120,163	251,771	2,431
Agriculture, forestry, fisheries	60	4,343	197	2,205
Mining	31	21,657	698	3,103
Construction	1,346	121,103	5,752	2,105
Manufacturing	12,141	5,739,603	239,792	2,394
Food	1,376	147,175	8,116	1,813
Textiles	743	62,735	3,956	1,586
Pulp and paper	147	33,897	1,648	2,057
Publication and printing	25	16,437	805	2,042
Chemicals	1,717	983,585	42,523	2,313
Petroleum, coal products	87	68,588	1,914	3,583
Plastics	481	69,987	3,841	1,822
Rubber products	135	80,189	3,784	2,119
Ceramics	611	187,615	7,150	2,624
Steel	149	255,290	5,405	4,723
Nonferrous metals	429	110,228	3,514	3,137
Metal products	979	94,671	5,885	1,609
Machinery	1,817	379,095	21,313	1,779
Electric machinery	1,688	1,979,973	89,824	2,204
Shipping machinery	512	989,796	23,892	4,143
Precision machinery	632	199,185	11,545	1,725
Other industries	613	81,158	4,677	1,735
Transportation, communications, public service	57	233,457	5,332	4,378

Notes: Figures for number of companies, etc., conducting research and number of researchers are as of 1 April 1986.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

[continued]

[Continuation of Table 18]

(2) Number of researchers per 10,000 employees (FY 1987)

Industry	Companies, etc. conducting research	Percentage of number of researchers	Employees in companies conducting research	Number of researchers per 10,000 employees
		%		
Overall industry	260,846	100	6,119,386	426
Agriculture, forestry, fisheries	214	0.1	17,972	119
Mining	764	0.3	30,642	249
Construction	6,553	2.5	434,555	151
Manufacturing	248,449	95.2	4,955,419	501
Food	9,356	3.6	388,376	241
Textiles	3,391	1.3	182,503	186
Pulp and paper	1,785	0.7	89,265	200
Publication and printing	794	0.3	61,070	130
Chemicals	43,503	16.7	538,620	808
Petroleum, coal products	1,995	0.8	46,802	426
Plastics	3,651	1.4	94,179	388
Rubber products	4,017	1.5	97,326	413
Ceramics	7,077	2.7	211,132	335
Steel	5,503	2.1	280,050	197
Nonferrous metals	3,994	1.5	126,121	317
Metal products	6,392	2.5	211,141	303
Machinery	21,146	8.1	506,221	418
Electric machinery	94,067	36.1	1,133,870	830
Shipping machinery	25,148	9.6	638,243	394
Precision machinery	11,522	4.4	172,934	666
Other industries	5,108	2.0	177,566	288
Transportation, communications, public service	4,866	1.9	680,798	71

Note: Figures are as of 1 April 1987.
Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

19. Changes in Research Expenses as Percent of Net Sales by Industry in Japan

(Unit: %)

Industry \ FY	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Overall industry	1.39	1.42	1.48	1.57	1.49	1.48	1.62	1.78	1.97	1.99	2.31	2.57
Agriculture, forestry, fisheries	0.32	0.24	0.31	0.60	0.45	0.17	0.26	0.27	0.26	0.24	0.24	0.24
Mining	0.58	0.57	0.50	0.54	0.48	0.52	0.46	0.64	0.59	0.63	1.03	1.16
Construction	0.49	0.48	0.53	0.42	0.40	0.46	0.37	0.43	0.53	0.47	0.49	0.55
Manufacturing	1.61	1.64	1.70	1.82	1.71	1.73	1.91	2.15	2.31	2.34	2.69	3.03
Food	0.49	0.49	0.50	0.51	0.51	0.58	0.55	0.63	0.70	0.60	0.77	0.85
Textiles	0.71	0.66	0.56	0.77	0.82	0.77	1.09	1.13	0.90	1.16	1.18	1.23
Pulp and paper	0.49	0.47	0.46	0.49	0.42	0.41	0.43	0.52	0.63	0.66	0.71	0.80
Publication and printing	0.43	0.46	0.41	0.36	0.27	0.26	0.21	0.39	0.43	0.61	0.68	0.64
Chemicals	2.45	2.39	2.62	2.71	2.54	2.55	2.87	3.05	3.34	3.46	3.79	4.31
Synthetic chemicals and textiles industry	1.84	1.69	1.87	1.92	1.71	1.85	2.01	2.17	2.32	2.47	2.80	3.56
Oil fats and paints	2.40	2.40	2.71	2.73	2.17	2.48	2.56	2.66	2.83	3.09	3.14	3.42
Pharmaceuticals	4.91	5.05	4.84	5.00	5.53	5.45	5.85	5.56	6.59	6.49	7.04	6.89
Other chemical products	2.76	2.88	3.12	3.03	2.88	2.19	3.03	3.43	3.40	3.76	3.61	3.87
Petroleum and coal products	0.18	0.18	0.23	0.27	0.18	0.30	0.18	0.20	0.26	0.27	0.38	0.62
Plastics	—	—	—	—	—	—	...	—	—	1.94	1.75	2.09
Rubber products	2.20	2.25	1.96	2.60	2.44	2.10	2.33	2.47	2.40	2.62	2.86	2.92
Ceramics	1.25	1.40	1.22	1.29	1.27	1.30	1.39	1.64	1.82	1.96	2.61	2.87
Steel	1.05	1.02	1.11	1.08	1.04	1.14	1.30	1.50	1.60	1.52	1.94	2.54
Nonferrous metals	1.01	0.96	1.01	1.00	0.87	1.03	1.36	1.57	1.49	1.64	1.92	2.11
Metal products	1.10	1.00	1.18	1.08	1.28	1.15	1.22	1.43	1.31	1.46	1.59	1.61
Machinery	1.74	1.79	2.01	1.93	1.85	1.90	2.10	2.34	2.57	2.59	2.74	2.77
Electric machinery	3.75	3.66	3.61	3.74	3.55	3.71	4.06	4.52	4.70	4.55	5.10	5.50
Electric machine tools	3.29	3.49	3.49	3.59	3.19	3.35	3.80	4.17	4.40	4.45	4.82	5.23
Communications, electronics, electric measurement instru	4.17	3.80	3.71	3.89	3.91	3.94	4.21	4.72	4.85	4.60	5.25	5.63
Shipping machinery	1.95	2.08	2.27	2.44	2.37	2.34	2.62	2.69	2.66	2.76	2.90	3.21
Automobiles	1.77	2.20	2.32	2.60	2.51	2.38	2.82	3.02	2.89	2.90	2.96	3.20
Other transportation machinery	2.48	1.76	2.12	1.90	1.85	2.15	1.94	1.67	1.86	2.20	2.61	3.28
Precision machinery	2.74	2.37	2.91	3.15	2.96	3.02	3.47	3.97	4.02	4.08	4.49	4.59
Other industries	1.17	1.24	1.15	1.16	0.91	1.16	1.11	1.30	1.30	0.92	0.97	1.07
Transportation, communications, public service	0.27	0.27	0.33	0.35	0.40	0.32	0.39	0.32	0.36	0.84	0.98	0.96

Notes: 1. The figure is based on the sales divided by the research expenses spent within a company.

2. Only the numerical values for companies have been included: special corporations are not included.

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

20. Changes in Number of Research Organizations in Japan

By organ- FY / ization, dept.	1965	70	75	76	77	78	79	80	81	82	83	84	85	86
Total	845	831	884	915	905	894	927	992	1,030	1,010	1,043	1,057	1,078	1,106
State-run	83	88	84	83	85	83	87	89	90	95	97	95	95	94
Publicly-run	560	551	585	588	598	585	594	638	646	637	642	634	610	601
Privately-run	196	183	209	238	216	218	239	256	285	269	295	320	365	404
Special corporations	6	9	6	6	6	8	7	9	9	9	9	8	8	7
Physics	95	62	101	102	102	99	114	126	132	122	118	109	106	108
Engineering	230	234	259	276	270	263	282	298	319	309	330	352	377	404
Agriculture	408	409	416	418	418	416	418	450	463	462	471	472	466	464
Hygiene	107	110	108	119	115	116	113	118	116	117	124	124	129	130
Miscellaneous	5	16	—	—	—	—	—	—	—	—	—	—	—	—

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

21. Changes in Number of Universities in Japan

By organ- FY / ization, dept.	1965	70	75	76	77	78	79	80	81	82	83	84	85	86
Total	447	484	578	601	604	618	633	643	648	672	678	685	695	708
State university	264	267	318	334	339	349	359	365	369	381	382	385	386	391
Public "	40	38	39	40	41	42	44	45	46	49	50	50	53	53
Private "	143	179	221	227	224	227	230	233	233	242	246	250	256	264
Physics	64	70	80	81	85	85	86	84	87	89	90	92	94	97
Engineering	209	222	249	261	260	263	268	279	281	284	285	286	290	294
Agriculture	61	64	71	71	69	71	70	71	71	71	72	72	72	72
Hygiene	113	128	178	188	190	199	209	209	209	228	231	235	239	245

Note: Investigation unit in the case of universities is the department.
Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

22. Changes in Japan's Technological Balance of Payments by Industry

(1) Amount of technology exports

(Unit: Y1 million)

Industry \ FY	1976	77	78	79	80	81	82	83	84	85	86	Ratio (%)	Percentage of previous year	Amount of receipts/item (Y1 million)	Ratio of receipts to expenditures for R&D
Overall industry	83,404	93,325	122,049	133,145	159,612	175,106	184,921	240,887	277,512	234,220	224,078	100	0.96	41.0	% 5.1
Manufacturing	76,252	80,464	93,570	116,279	133,274	151,783	164,058	209,699	231,860	205,588	193,483	86.3	0.94	37.7	4.5
Food	1,902	2,193	1,737	1,862	2,169	3,689	4,720	3,640	6,820	6,139	4,945	2.2	0.81	46.7	9.4
Textiles	3,154	2,021	1,689	4,466	3,169	4,929	6,256	2,189	3,855	4,001	4,633	2.1	1.16	25.5	11.7
Chemicals	26,070	22,504	24,724	38,211	31,876	31,951	29,409	31,443	37,502	38,233	38,235	17.1	1.00	40.6	5.3
Ceramics	1,780	4,868	4,188	3,957	7,989	4,817	6,271	9,642	11,238	9,450	5,468	2.4	0.58	26.8	4.7
Steel	13,754	15,248	17,499	17,675	17,856	24,501	29,047	40,151	32,395	26,195	21,540	9.6	0.82	46.7	9.1
Nonferrous metals	5,607	1,984	567	2,544	3,663	2,037	3,034	2,349	1,924	1,947	3,586	1.6	1.84	22.1	4.3
Metal products	244	529	481	951	1,221	914	1,862	1,529	1,275	2,394	1,525	0.7	0.64	9.4	5.4
Machinery	2,346	4,276	3,770	6,160	9,621	5,336	5,249	10,717	11,396	11,714	6,806	3.0	0.58	16.2	3.4
Electric machinery	9,653	12,361	12,249	19,066	23,045	28,666	35,484	35,551	47,150	59,460	53,001	23.7	0.89	38.1	3.4
Shipping machinery	7,184	9,593	18,621	15,585	21,758	27,693	28,698	28,951	39,784	32,386	43,840	19.6	1.35	60.3	4.7
Precision machinery	376	567	1,111	843	873	2,900	2,418	4,037	1,802	1,725	1,850	0.8	1.07	21.0	1.5
Other manufacturing	4,181	4,319	6,934	4,954	10,033	14,331	11,611	39,500	36,721	11,946	8,055	3.6	0.67	25.4	3.9
Construction	6,516	12,287	27,909	16,358	25,399	22,326	19,145	29,955	44,638	26,530	20,835	9.3	0.79	72.3	38.5
Other nonmanufacturing industries	636	574	570	508	938	996	1,781	1,233	1,014	2,101	9,759	4.4	4.64	216.9	27.1

(2) Amount of technology imports

(Unit: Y1 million)

Industry \ FY	1977	78	79	80	81	82	83	84	85	86	Ratio (%)	Percentage of previous year	Amount of receipts per item (Y1 million)	Ratio of payments to expenses for R&D performance
Overall industry	190,066	192,058	240,984	239,529	259,632	282,613	279,280	281,447	293,173	260,577	100	0.89	34.8	% 5.8
Manufacturing	184,060	188,168	235,044	233,185	255,606	278,075	272,838	276,895	288,628	258,393	99.2	0.90	35.6	5.9
Food	6,616	10,865	8,584	9,642	10,609	11,286	8,690	9,480	10,422	10,793	4.1	1.04	124.1	23.0
Textiles	1,790	2,160	10,224	2,233	8,722	2,821	5,543	9,447	3,287	3,246	1.2	0.99	26.4	10.4
Chemicals	28,782	28,047	37,722	39,252	37,110	45,860	42,280	40,765	37,387	40,583	15.6	1.09	42.5	6.3
Ceramics	8,035	6,584	41,878	9,612	10,237	10,759	6,731	8,378	32,404	6,589	2.5	0.20	45.8	6.2
Steel	7,872	7,359	5,813	8,023	14,808	7,800	17,581	5,562	4,698	5,780	2.2	1.23	19.2	2.5
Nonferrous metals	3,505	3,464	4,371	3,690	3,623	3,396	3,651	5,100	5,078	4,158	1.6	0.82	22.7	5.0
Metal products	2,497	2,259	2,721	4,440	2,816	3,057	2,601	3,606	3,922	3,091	1.2	0.79	15.6	10.0
Machinery	25,433	22,126	31,214	30,209	30,810	27,405	28,493	23,905	24,483	25,413	9.8	1.04	23.9	10.9
Electric machinery	45,806	47,170	57,872	61,676	68,814	89,158	91,921	94,907	84,197	91,264	35.0	1.08	36.4	5.3
Shipping machinery	36,348	41,895	42,362	40,274	48,674	56,413	46,916	55,243	59,704	49,045	18.8	0.82	50.9	5.7
Precision machinery	3,204	4,060	4,576	2,948	3,769	3,515	4,405	4,386	5,059	4,154	1.6	0.82	17.5	2.9
Other manufacturing	14,174	12,178	14,708	21,185	15,613	16,606	14,027	16,116	17,987	14,275	5.5	0.79	28.6	6.1
Construction	4,955	3,099	4,890	2,707	2,918	2,298	4,397	2,294	3,476	1,755	0.7	0.50	8.4	2.7
Other nonmanufacturing industries	1,051	791	1,050	3,637	1,109	2,239	2,046	2,258	1,070	428	0.2	0.40	18.6	3.7

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

23. Number of Contracts Involving the Introduction of Foreign Technology Into Japan by Field

(Unit: Item)

Technology classification \ FY	1976	77	78	79	80	81	82	83	84	85	86
Chemicals	181	186	197	213	222	223	197	201	179	246	210
Petroleum and coal products	19	17	36	16	22	5	4	7	11	12	5
Steel and nonsteel metals	31	43	46	32	29	28	40	11	53	29	27
Metal products	55	70	43	31	38	49	62	70	52	56	39
Shipping machinery	110	98	131	136	126	78	91	70	87	113	82
General machine tools	469	406	509	447	494	450	442	406	371	355	329
Precision machinery	96	66	83	83	89	72	62	59	68	62	68
Electric machine tools	297	404	377	416	414	448	633	696	817	900	934
Construction methods	34	24	33	26	12	18	19	11	21	20	21
Food and tobacco	44	36	33	28	45	37	54	63	61	46	50
Textiles and textile products	266	259	309	285	295	324	318	309	300	262	257
Ceramics	31	29	41	36	33	43	40	34	46	51	42
Other products	224	261	267	338	300	273	248	247	268	256	269
Miscellaneous	36	15	34	29	23	28	19	28	44	28	28
Total	1,893	1,914	2,139	2,116	2,142	2,076	2,229	2,212	2,378	2,436	2,361

Source: Science and Technology Agency, "Foreign Technology Introduction Annual Report"

24. Changes in Japan's Technological Balance of Payments by Region and Country

(1) Technology export amount

(Unit: Y100 million)

Region or country \ FY	1977	78	79	80	81	82	83	84	85	86	Composition %	% of previous year
Asia (excluding West Asia	298.10	384.23	548.33	542.18	679.04	707.67	1,019.20	1,125.16	875.23	864.81	38.59	0.99
West Asia	68.86	125.83	99.36	244.13	101.57	56.97	173.00	307.83	141.13	104.85	4.68	0.74
North America	134.39	168.33	230.21	295.01	383.26	406.19	600.34	719.15	587.40	622.88	27.80	1.06
South America	79.31	94.92	75.92	108.42	117.70	108.03	100.68	36.54	87.40	51.61	2.30	0.59
Europe	246.79	187.03	221.97	290.46	321.49	389.63	370.63	407.07	454.61	435.98	19.46	0.96
Africa and Oceania	105.80	260.15	155.66	115.91	148.00	178.72	145.13	179.36	196.44	160.65	7.17	0.82
Total	933.25	1,220.49	1,331.54	1,596.12	1,751.06	1,849.21	2,408.87	2,775.12	2,342.20	2,240.78	100	0.96
South Korea	63	76	78	53	95	75	170	149	182	211	9.42	1.16
China	68	144	278	194	168	142	292	531	343	282	12.57	0.82
Taiwan	51	42	86	99	120	97	108	100	79	85	3.78	1.08
Indonesia	60	35	45	76	108	148	158	136	94	152	6.76	1.62
Thailand	28	25	37	42	50	56	61	83	62	54	2.43	0.87
Singapore	—	22	36	81	121	71	78	91	61	48	2.14	0.79
United States	90	131	192	221	326	356	536	659	518	577	25.75	1.11
Brazil	62	72	48	29	74	73	79	19	33	38	1.71	1.15
Great Britain	14	20	14	21	26	84	53	68	53	76	3.38	1.43
Italy	27	14	23	37	45	88	73	57	51	72	3.22	1.41
Soviet Union	51	43	52	48	24	20	19	11	24	5	0.21	0.21
West Germany	9	16	23	34	29	47	51	47	113	78	3.49	0.69
France	14	10	15	23	45	39	45	46	48	59	2.65	1.23
Australia	19	18	24	27	45	46	31	41	119	58	2.59	0.49

(2) Technology import amount

Region of country \ FY	1976	77	78	79	80	81	82	83	84	85	86	87	88
North America	1,175.48	1,210.87	1,252.43	1,560.73	1,568.62	1,739.01	1,885.61	1,940.00	1,939.89	2,102.79	1,745.51	66.99	0.83
Europe	594.30	679.98	664.32	809.63	821.27	844.25	926.62	844.99	866.98	815.67	851.37	32.67	1.04
Other	3.24	9.82	3.84	39.48	5.40	13.05	13.90	7.81	7.60	13.27	8.88	0.34	0.67
Total	1,773.02	1,900.66	1,920.58	2,409.84	2,395.29	2,596.32	2,826.13	2,792.80	2,814.47	2,931.73	2,605.77	100	0.89
United States	1,146	1,183	1,231	1,536	1,538	1,718	1,870	1,911	1,930	2,086	1,738	66.71	0.83
Great Britain	110	150	149	174	202	180	250	147	132	146	130	4.98	0.89
Italy	23	23	21	12	13	17	18	12	48	15	22	0.83	1.47
Netherlands	14	17	48	56	63	100	127	113	141	155	156	5.99	1.01
Switzerland	125	123	124	139	155	154	157	159	160	163	175	6.70	1.07
West Germany	195	222	206	219	205	189	178	196	178	176	207	7.93	1.18
France	73	74	64	138	111	103	109	114	104	68	73	2.79	1.07

Source: General Affairs Agency's Statistics Bureau, "Science and Technology R&D Report"

25. Changes in Technological Balance of Payments by Major Countries

(Unit: ¥100 million)

Country / Category / Year	Japan			United States			
	Exports	Imports	Revenue divided by expenditures	Exports	Imports	Revenue divided by expenditures	Exports
1970	197.0	1,479.0	0.133	8,347	806	10.36	978.0
1971	213.1	1,638.2	0.130	8,890	842	10.56	1,001.8
1972	212.2	1,655.5	0.128	8,399	891	9.42	1,026.3
1973	230.9	1,850.3	0.125	8,762	1,046	8.38	1,113.4
1974	324.2	2,152.8	0.151	11,161	1,011	11.00	1,357.5
1975	421.5	2,068.7	0.204	12,762	1,404	9.09	1,462.5
1976	519.1	2,372.8	0.219	12,911	1,430	9.03	1,782.5
1977	547.7	2,647.4	0.207	13,210	1,356	9.74	1,697.6
1978	591.2	2,459.6	0.240	12,382	1,410	8.78	1,565.1
1979	703.3	2,791.3	0.252	13,549	1,822	7.43	1,770.3
1980	802.5	3,010.6	0.267	16,062	1,644	9.77	2,162.8
1981	1,062.8	3,794.8	0.280	16,061	1,436	11.19	2,147.9
1982	1,392.5	4,369.2	0.319	12,893	1,539	8.38	2,187.0
1983	1,351.4	4,707.3	0.287	12,531	1,717	7.30	2,214.0
1984	1,650.6	5,400.8	0.306	13,371	2,271	5.89	2,049.8
1985	1,724.4	5,631.0	0.306	14,298	2,127	6.72	2,022.2
1986	1,526.6	5,454.3	0.280	12,321	1,751	7.04	1,651.3
1987	1,869.7	5,515.0	0.339	13,070	1,337	6.76	—

Notes: 1. The conversion to Japanese currency is in accordance with appended data 33 [not reproduced].
2. The Japanese numerical values have been tabulated chronologically.

Sources: Japan: Bank of Japan, "International Balance of Payments Statistics Monthly Report"
United States: Department of Commerce, "Survey of Current Business" "Business Monitor, MA4 Overseas Transactions" (Numerical values for 1970~1984), "British Business" 12 August 1988 (Numerical values for 1985~1986)
West Germany: Deutsche Bundesbank, "Monthly Report of the Deutsche Bundesbank"
France: Ministere de l'Economie, des Finance et du Budget, "Statistique & Etudes Financieres," "Les Balance des Paiements de la France"

[continued]

[Continuation of Table 25]

(Unit: Y100 million)

Great Britain		France			West Germany		
Imports	Revenue divided by expenditures	Exports	Imports	Revenue divided by expenditures	Exports	Imports	Revenue divided by expenditures
912.8	1.07	242.9	717.0	0.339	426.2	1,095.9	0.389
938.0	1.07	237.0	796.1	0.298	518.4	1,312.9	0.395
929.9	1.10	256.4	856.8	0.299	609.5	1,314.0	0.464
950.8	1.17	375.5	1,073.3	0.350	585.6	1,461.9	0.401
1,207.2	1.12	449.6	1,169.7	0.384	766.4	1,703.2	0.450
1,436.8	1.02	580.2	1,526.0	0.380	913.2	2,162.9	0.422
1,415.6	1.26	608.1	1,730.6	0.351	857.4	2,056.3	0.417
1,389.7	1.22	761.8	1,465.7	0.520	899.6	2,191.2	0.411
1,315.1	1.19	729.8	1,426.9	0.511	905.2	2,029.4	0.466
1,472.8	1.20	935.9	1,763.7	0.531	1,077.2	2,333.8	0.462
1,866.3	1.16	1,125.0	2,328.3	0.483	1,261.1	2,593.3	0.486
1,775.8	1.21	1,086.7	2,083.8	0.522	1,068.5	2,091.1	0.511
1,870.2	1.21	938.4	2,250.5	0.417	1,225.4	2,258.9	0.542
1,736.6	1.27	1,402.5	2,171.9	0.646	1,221.4	2,307.8	0.529
1,877.1	1.09	1,021.2	2,094.2	0.488	1,229.4	2,161.6	0.569
1,651.1	1.22	1,214.7	2,334.8	0.520	1,300.5	2,373.4	0.548
1,530.2	1.08	1,151.8	2,075.8	0.555	1,311.8	2,621.7	0.500
—	—	—	—	—	1,343.7	2,718.6	0.494

28. Changes of the Science and Technology-Related Budget by Item and Year

(Unit: ¥100 million)

Item		1982	1983	1984	1985	1986	1987
<u>Budget for National Research Organization</u>							
Budget for promotion of S&T	(A)	1,583	1,566	1,579	1,580	1,627	1,650
Budget for energy R&D	(B)	--	--	--	--	--	--
Budget for the promotion of S&T and energy R&D	(C)=(A)+(B)	1,583	1,566	1,579	1,580	1,627	1,650
Budget for other R&D of the promotion of S&T and energy R&D	(D)	426	453	508	634	719	809
Total	(C)+(D)	2,009	2,019	2,087	2,213	2,346	2,459
<u>Grant-in-Aid and Government Investments</u>							
Budget for promotion of S&T	(A)	2,047	2,077	2,083	2,131	2,177	2,250
Budget for energy R&D	(B)	1,764	1,715	1,620	1,727	1,737	1,693
Budget for the promotion of S&T and energy R&D	(C)=(A)+(B)	3,810	3,793	3,703	3,859	3,914	3,943
Budget for other R&D of the promotion of S&T and energy R&D	(D)	3,286	3,409	3,434	3,627	3,875	3,979
Total	(C)+(D)	7,096	7,201	7,138	7,486	7,789	7,921
<u>Administrative and Miscellaneous Expenditures</u>							
Budget for promotion of S&T	(A)	179	107	104	104	106	106
Budget for energy R&D	(B)	--	--	--	--	--	--
Budget for the promotion of S&T and energy R&D	(C)=(A)+(B)	179	107	104	104	106	106
Budget for other R&D of the promotion of S&T and energy R&D	(D)	95	97	102	107	118	121
Total	(C)+(D)	273	203	206	211	224	227
<u>National Universities' Expenses</u>							
Budget for other R&D of the promotion of S&T and energy R&D	(D)	5,100	5,139	5,345	5,343	5,630	5,942
<u>Composite Total</u>							
Budget for promotion of S&T	(A)	3,809	3,750	3,766	3,816	3,910	4,006
Budget for energy R&D	(B)	1,764	1,715	1,620	1,727	1,737	1,693
Budget for the promotion of S&T and energy R&D	(C)=(A)+(B)	5,572	5,465	5,387	5,543	5,646	5,699
Budget for other R&D of the promotion of S&T and energy R&D	(D)	8,907	9,097	9,389	9,710	10,343	10,292
Total	(C)+(D)	14,479	14,562	14,776	15,253	15,990	16,550

[continued]

[Continuation of Table 28]

Notes: 1. The figure for each fiscal year is the initial budget amount.
2. Included in each item are space-related expenditures and atomic energy-related expenditures.
3. (B) and (D) are from the report of the Science and Technology Agency.
4. The figures in each accumulated total column and the composite total column may not match because of rounding off.

29. Status of Special Funds for Promoting Science and Technology for 1987

I. Promotion of basic and advanced science and technology fields

1. Fields where promotion is focused

(1) Matter and material-related science and technology

Topic	Year	Implementing organization
(1) Research on the development of technology capable of verifiable evaluation of structural materials	1986-87 (2nd period)	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Transportation, universities, private sector
(2) Research concerning basic technologies in order to create new materials by hybridized structural design technology	1987-88 (2nd period)	Science and Technology Agency, Ministry of International Trade and Industry, universities, private sector
(3) Research on large power output and variable wave-length lasers and laser processing technology	1987-88 (2nd period)	Science and Technology Agency, Ministry of International Trade and Industry, universities, private sector
(4) Research on technology for the generation, measurement and application of ultrahigh temperature	1985-87 (1st period)	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Posts and Telecommunications, universities, private sector
(5) Research on technology to analyze and evaluate high performance function materials by new beam technology	1986-88 (1st period)	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Posts and Telecommunications, universities
(6) Research on basic technology to create new functions by high purification of rare metals	1987-89 (1st period)	Science and Technology Agency, Ministry of International Trade and Industry, universities, private sector

[continued]

[Continuation of Table 29]

Topic	Year	Implementing organization
(7) Research on basic technology for the development of functionally gradient materials to ease heat stress	1987-89 (1st period)	Science and Technology Agency Ministry of International Trade and Industry, Ministry of Posts and Telecommunications, universities, private sector

(2) Life Sciences

Topic	Year	Implementing organization
(1) Research on development of technology for the analysis and use of living membrane functions	1985-87 (2nd period)	National Police Agency, Ministry of Finance, Ministry of Health and Welfare, Ministry of Agriculture, Forestry and Fisheries, Ministry of International Trade and Industry, universities, private sector
(2) Research on development of technologies to analyze, modify and copy functional proteins	1986-88 (2nd period)	Ministry of Health and Welfare, Ministry of International Trade and Industry, universities, private sector
(3) Research on development of common technology to support cancer research	1987-89 (2nd period)	Science and Technology Agency, Ministry of Agriculture, Forest and Fisheries, private sector
(4) Research on development of basic technology for the purpose of understanding the functioning of the brain	1985-87 (1st period)	Ministry of International Trade and Industry, universities, private sector
(5) Research on development of technology to analyze and use the chromosome	1985-87 (1st period)	Science and Technology Agency, Ministry of Finance, Ministry of Health and Welfare, Ministry of Forestry and Fisheries, Ministry of International Trade and Industry, universities
(6) Research on development of basic technology to make use of the energy conversion function of living organisms	1986-88 (1st period)	Ministry of Agriculture, Forestry and Fisheries, Ministry of International Trade and Industry, universities, private sector

[continued]

[Continuation of Table 29]

Topic	Year	Implementing organization
(7) Research on development of basic technology in order to understand the immune response mechanism	1987-89 (1st period)	Science and Technology Agency, Ministry of Health and Welfare, Ministry of Agriculture, Forestry and Fisheries, universities, private sector

2.

Topic	Year	Implementing organization
(1) Research on development of new survey systems in the 200-nautical mile zone around Japan	1986-87 (2nd period)	Ministry of Agriculture, Forestry and Fisheries, Ministry of International Trade and Industry, Ministry of Transportation, universities
(2) Research on knowledge-based systems for supporting chemical substance designs	1986-88 (1st period)	Science and Technology Agency, Ministry of Health and Welfare, Ministry of Agriculture, Forestry and Fishery, Ministry of International Trade and Industry, universities, private sector
(3) Research on development of technology for the effective use of deep ocean resources	1986-88 (1st period)	Ministry of Health and Welfare, Ministry of Agriculture, Forestry and Fisheries, Ministry of International Trade and Industry, Ministry of Transportation, universities, private sector

II. Promotion of Research and Development Meeting Stepped-Up National and Social Needs

Topic	Year	Implementing organization
(1) Research on development of science and technology responding to an aging society	1986-87 (2nd period)	Science and Technology Agency, Ministry of Health and Welfare, Ministry of Agriculture, Forestry and Fishery, universities, private sector
(2) Research on earthquake tectonics of the Central Japan area with structures where people live and work	1985-87 (1st period)	Science and Technology Agency. Ministry of International Trade and Industry, Ministry of Transportation, Ministry of Construction, private sector

[continued]

[Continuation of Table 29]

Topic	Year	Implementing organization
(3) Research on development of a system to predict the degree of danger of a land-slide disaster	1985-88 (1st period	Science and Technology Agency, Ministry of Agriculture, Forestry and Fisheries, Ministry of International Trade and Industry, Ministry of Transportation, Ministry of Construction
(4) Research on the prediction of inland earthquakes measuring 7 on the Richter scale	1987-89 (1st period)	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Transportation, Ministry of Construction, private sector
III. Positive Promotion of International Joint Research		
(1) International joint research on new materials test and evaluation technology	1986-88 (1st period)	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Transportation, universities, private sector
(2) Joint research with ASEAN on the elevation and applications of remote sensing technology	1986-88 (1st period)	Science and Technology Agency, Environment Agency, Ministry of Agriculture, Forestry and Fisheries, Ministry of International Trade and Industry Ministry of Construction, private sector
(3) Research on the understanding of the oceanic plate formation zone (lift type) in the South Pacific	1987-89 (1st period)	Environment Agency, Ministry of International Trade and Industry, Ministry of Transportation, universities, private sector
(4) International joint research on the atmospheric and oceanic variations and climatic variations in the Pacific Ocean	1987-89 (1st period)	Science and Technology Agency, Environment Agency, Ministry of Agriculture, Forestry and Fisheries, Ministry of Transportation, Ministry of Posts and Telecommunications, universities

[continued]

[Continuation of Table 29]

IV. Promotion of Survey and Analysis

Topic	Year	Implementing organization
(1) Survey of the trend of evolution of advanced science and technology and the outlook for interdisciplinary research fields	1984-86	Science and Technology Agency, private sector
(2) Survey of the trends concerning the personnel talents, investments and information distribution that will contribute to the smooth advancement of R&D activity	1985-87	Private sector
(3) Analysis of the current state, trends and potential of R&D by the development of a comprehensive processing method of R&D-related information	1986-87	Private sector
(4) Survey into the improvement of conditions for the promotion of basic and advanced science and technology	1987	Ministry of International Trade and Industry, private sector
(5) Survey into the possibility of an international basic research program concept	1986-87	Private sector
(6) Survey into technology for generation, measurement and use of extremely high vacuums	1987	Private sector
(7) Survey into the development of generation engineering technology	1987	Private sector
(8) Survey into technology to overcome snow and make use of snow	1987	Private sector

[continued]

[Continuation of Table 29]

V. Urgent Research and Mobilized International Response

Topic	Year	Implementing organization
(1) Research by means of international cooperation on biology, physics and chemistry under a virtually weightless environment and analysis of life under that environment	1987-89 (1st period)	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Education, private sector
(2) Urgent research on the magma flow of the Izu Peninsula volcano	1987	Science and Technology Agency, Ministry of International Trade and Industry, Ministry of Transportation, Ministry of Construction

30. Comprehensive Research and Development Themes and Expenses by Government Agency

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Science and Technology Agency (Comprehensive marine science and technology research and development)				
R&D of deep sea diving survey vessels	To carry out precise diving surveys of major marine areas on the continental shelf and its slope by means of survey vessels that can dive to depths of 2,000 m. Moreover, to carry out development of a system of 6,000-m class diving survey vessels along with developing an unmanned exploration vessel intended to conduct surveys over a wide region.	3,336	4,641	1976~
R&D of diving operations technology	It is indispensable that humans carry out all sorts of activities underwater in order to advance marine development. Therefore, we need to develop mixed gas saturation diving technology and conduct real ocean experiments in order to be able to carry out diving operations to depths of 300 m safety, surely and effectively.	1,579	1,372	1976~
R&D on the use of the Japan Current	To conduct joint research with China on the Japan Current region, which has a close connection with the social and economic livelihood of Japan, and grasp its special value and development potential.	112	112	1977~
R&D of marine use technology	To carry out R&D of marine control technology, and R&D of marine energy use technology, as basic technology R&D with the common need to comprehensively develop and use the resources of the ocean, such as its space and energy.	100	84	1977~

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
R&D of marine observation technology	From the perspective of grasping the wide variety and volume of marine resources (mineral resources, fisheries resources, etc.), a system is needed to enable accurate and rapid survey and observation to be carried out, as well as the regular monitoring and observation of marine areas where the birth of new islands is possible and at focal points such as marine areas full of resources. Consequently, there is a need to develop a marine observation system that makes rapid, high density, high precision, and long-term, continuous observation possible, which was difficult through observation using survey ships in the past.	64	65	1977~
R&D of marine remote exploration technology	To conduct research into the fluctuation of ocean currents and estimates of marine productivity using satellite observation data, and to conduct comparative tests of satellite observation data and marine observation data in order to assist in the monitoring of the marine environment and the exploration of resources.	79	79	1976~
Ministry of Agriculture, Forestry and Fisheries		(comprehensive development research)		
Comprehensive development research on establishment of high-level cultivated farming technology which focuses on field rotation	The objective is to raise comprehensive food self-sufficiency from a long-term perspective by carrying out the development of a technology for producing cultivated field crops using a lower level of water than that used in rice fields, and to establish a technological base which can make use of water use reorganization measures.	312	--	1979~ 1986

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Development of of high-yield yield crops and establishment of cultivation technology	In connection with the further advancement of crop rotation and raising the grains' self-sufficiency rate, carrying out the development of the technology to allow for their stable cultivation and use	302	263	1982~1988
Comprehensive research of the safety function of national land resources and environment on which agriculture, forestry and fisheries-industries are sited, and advancing the maintenance of these resources and environment	To define these functions in order to maintain and cultivate the productivity of the agriculture, forestry and fisheries industries and to maintain the safety function of national land resources and environment, along with studying a scientific policy for the drafting of a comprehensive regional development program and a land use program.	150	94	1982~1987
Development of high quality and high quantity cultivated farmland crops and establishment of high grade, stable production technology for elevating the use of paddy fields	Carrying out the development of new crop varieties and cultivation technology in order to further raise the productivity of wheat, soybean, fodder and other cultivated harvest crops, as well as raising the quality and processing level.	--	328	1987~1996

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Ministry of Agriculture, Forestry and Fisheries (Large-scale separate research)				
Comprehensive research concerning technology for effective use of natural energy in agriculture, forestry, & fisheries industries	In order to deal with the food crisis and energy shortage that is expected to occur in the 21st century, research is to be undertaken to develop innovative technologies to cause a great leap upward in the substance fixing capacity of organisms, and to develop technology using natural energy as a substitute for petrochemical energy, as well as resource conservation and energy conservation technologies for agricultural production.	502	421	1978~1987
Comprehensive research of development of domestic fishing system for inshore fishery resources	One of the major current topics involves the substantial increasing of inshore fisheries resources in the waters of Japan by responding to the severe fishing environment of recent years, beginning with the 200-nautical mile issue. This will require the development of resource cultivation technology by stock management of fish sperm and environmental control to introduce medium and high-grade fish, which is dependent on the strengthening of resources.	423	410	1980~1988
Comprehensive research on the development of technology for the effective use of biological resources	To develop technology to convert living organisms, which can regenerate and have outstanding abilities to store natural energy into food, feed and energy, effectively and effortlessly, by using them in their entirely instead of only utilizing special parts.	441	444	1981~

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget	Research period (FY)
Ministry of Agriculture, Forestry and Fisheries (General separate research)				
Development of technology to predict migration of long distance migrant insects	To understand the generation conditions, migration factors, migration routes, and migration periods of long distance migrant insects, and to develop technology to predict the migration of these insects so that their early and effective elimination can be made possible.	93	72	1983~1987
Development of information processing technology to build agriculture production management systems	To develop methods for the accurate and rapid grasp of organism information and environmental information of crops and livestock and, based on these technologies, to develop organism and environmental diagnostic methods for crops and an information systems model to support cultivation and feed management.	131	151	1985~1989
Dynamic understanding of the root environment and development of a control system	To understand the mutual effects of crop roots, soil microorganisms, and the soil, along with working toward the development of a root environment control technology by using new procedures such as biotechnology and the functions of soil microorganisms	95	95	1986~1990
Ministry of Agriculture, Forestry and Fisheries (Biotechnology development research)				
Development of new biological resources by cellular fusion and nucleus transplants	To develop technologies by using cell fusion and cell nucleic transplantation to carry out the reproduction of superior strains of livestock, the mass production of useful substances such as monoclonal antibodies, and the production of new organisms and varieties which could not be realized by past hybridization and sudden transmutation methods.	112	0	1982~1986

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Understanding of the genetic generation mechanism in agricultural organisms	To carry out the structural analysis of useful genes by using, as subjects, microorganisms related to major livestock diseases, useful microorganisms whose use is anticipated by the food industry, and animals such as silkworms and mice, as well as to carry out the development of means to introduce genes into cells and an understanding of the mechanism for generating incorporated genes.	44	71	1984~1989
Development of technologies to make new use of microorganisms and enzymes in biomass conversion	In order to convert biomass resources into food, feed and energy, we need to search for and improve microorganisms and enzymes, establish technology to mass produce them effectively, and develop a bioreactor system that can consistently process them with high efficiency.	63	72	1982~1990
Biotechnology seeds cultivation research	To consign to the universities basic and interdisciplinary research involving seed cultivation through biotechnology in the agriculture, forestry and fisheries field.	100	100	1984~
Research concerning understanding of the chemical base arrangement of plant DNA	To use the rice plant to effectively understand the entire chemical base arrangement of DNA and to contribute to new variety breeding.	--	69	1987~1990

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget	Research period (FY)
Development of safety evaluation procedures of a recombinant in an environment outside [the laboratory]	To develop effective means of detecting recombinants and to study soil breeding organisms and animal breeding organisms with regard to means of evaluating the safety of recombinants.	--	22	1987~1989
Development of cultivation technology by gynogenesis of fishery product	To work for the establishment of gynogenesis as a breeding technology by understanding the conditions that make it safe and effective, and to develop genetically sound strains and methods for producing outstanding bodies by taking these findings into account.	27	20	1985~1989
Comprehensive research on biotechnology plant breeding	To make active use of biotechnologies, such as cellular manufacturing and recombinant DNA, and achieve breeding objectives, such as virus-resistant tomatoes, high protein rice, and crops whose synthesis capacity has surged.	445	449	1986~2000
Ministry of International Trade and Industry (Large-scale industrial technology research and development)				
Manufacturing methods of basic chemicals for which carbon monoxide is a raw material	In order to deal with the constraints in the supply of oil, there is a need to work for the drastic conversion of raw materials for the petrochemical industry by conducting R&D of new manufacturing methods of basic chemicals, such as ethyleneglycol, for which synthetic gas obtained from coal and natural gas (mixed gas consisting of carbon monoxide and hydrogen) is the raw material.	1,022	24	1980~

[continued

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget	Research period (FY)
System for mining manganese nodules	In order to mine, on a commercial scale, the manganese nodules lying on the ocean floor at depths of 4,000~6,000 m, there is a need to conduct R&D of a highly effective and reliable fluid dredge mining system.	958	819	1981~1991
High-speed computation system for science and technology purposes	To conduct R&D of a high-speed computation system that can process, in real time, science and technology computations that cannot be processed by current electronic computers, such as the processing of images sent from satellites and the simulation of a nuclear fusion reactor.	1,237*	887*	1981~1989
Automatic sewing machine	To meet the diversification of consumer needs in the apparel industry and conduct R&D of an automatic sewing system which will be able to automatically produce high added value merchandise in wide varieties and small volumes, from the preparatory process to the finishing stage.	1,341	1,301	1982~1990
Robots for critical works for	In order to develop high-level operating systems (limited robots critical work) capable of replacing humans in critical works, such as atomic energy and the oceans, there is a need to conduct R&D of essential technologies, such as movement technology, manipulation technology, and sensor technology, as well as to establish a total systems technology integrating these essential technologies.	368*	351*	1983~1990

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget	Research period (FY)
Observation system for resource exploration	To carry out the trial manufacturing and experiments involving synthetic aperture radars and optical sensors for use on satellites, as well as to conduct R&D of data processing and analytic technology related to this.	179*	182*	1984~1988
Comprehensive water regeneration system	By applying biotechnology and membrane separation technology, to conduct R&D of a comprehensive water regeneration system drastically different from that of the past.	320*	517*	1985~1990
Data base system using interdependently operating computers	As a basic arrangement of the advanced information society, there is a need to conduct R&D of technology that can interdependently employ scattered and different data bases and can deal with the multimedia of written language, sounds and images.	831	1,055	1985~1991
Super advanced processing system	In order to prepare an advanced industrial development base for use in airplane, space and electronics industries, R&D is being conducted of a system that will consistently carry out ultraprecision processing, ultramicroprocessing and ultrahigh-quality surface processing.	20	1,100*	1986~1993

[continued]

[Continuation of Table 30]

19861987 Research topic	Research Summary of research	budget (¥1 million)	budget	period (FY)
Ministry of International Trade and Industry (New energy technology R&D--the Sunshine Project)				
Solar energy	To establish and commercialize technologies involving new uses of solar energy, such as solar light and solar heat generator systems, solar heat regulators and hot water systems, etc.	549*	478*	1974~
Geothermal energy	To establish and commercialize geothermal energy exploration and exploitation technology, heated water generator technology, and environmentally safe multipurpose technology.	635	523	1974~
Coal energy	To establish high calorie gas manufacturing technology, gasified generator technology, and liquefied coal technology, and to develop manufacturing plant systems technology.	499*	420*	1974~
Hydrogen energy	To establish and commercialize hydrogen manufacturing technology, shipping and storage technology, application technology, and safety technology.	228	192	1974~
Comprehensive	To comprehensively grasp and arrange, as well as functionally and effectively promote, the development of new energy technology, such as the study of the impact that the development of the aforementioned four new energy sources will have on the environment and society, the effective deployment of energy systems, and the possibility of commercialization of sources of energy other than the above four, such as wind energy, ocean energy and oil shale	350*	290*	1974~

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Ministry of International Trade and Industry (Energy conservation technology development--the Moonlight Project)				
High efficiency gas turbines	To establish low pollutant, highly efficient gas turbines technology (integrated generator cycle with a heat efficiency of over 55 percent) by means of R&D of superhigh heat resistant materials and essential technologies.	53*	54*	1978~1987
New cell power storage system	To carry out R&D of a new large capacity battery cell technology and evaluation method to serve as a substantial energy conserver and oil substitute.	146*	77*	1980~1990
Fuel cell generator technology	To develop a fuel cell with high generator efficiency (40-50 percent) using natural gas, methanol, and coal gas as the fuels, and to establish a generator system with broad applications, from scattered generator plant use to use as a substitute for obsolete electric power plants.	129*	113*	1981~1990
All-purpose steering engine	To carry out R&D of the commercial technology for a steering engine suitable as a small power source, for a heat pump engine for use as a heat regulator, and for the systems employing these engines.	179*	60*	1982~1987
Super heat pump energy accumulation system	To carry out development of an energy accumulation technology with high heat storage efficiency and a broad range of operating temperatures by combining the multiple stages of the pressure heat pump and the chemical heat pump.	154*	141*	1984~1991

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget	Research period (FY)
Leading edge and basic energy saving technology	To carry out R&D aimed at the commercialization of superconduction electricity transmission technology, energy storage, new aluminum refining technology and heat-related energy conservation technology.	195	172	1976~

Ministry of International Trade and Industry (Next-generation industrial base technology R&D)

Fine ceramics	To work to overcome the difficulties of brittleness in processing and joining and to raise the reliability of ceramics by developing fine ceramics with the structural strengths of super heat resistance, rustproofing, high precision and sturdiness	104	11*	1981~ 1990
High efficiency polymer separated membrane material	To conduct R&D of membrane material which can fully separate and refine the components essential for mixed gases and mixed liquids.	539	417	1981~ 1990
Conductive polymer materials	To conduct the development of conductive polymer materials equal to metals without damaging the characteristics of the polymer through the synthesis of conductive elements.	366	328	1981~ 1990
Highly crystallized polymer materials	To carry out development of polymer materials having strength equal to that of metal without damaging the characteristics of the polymer by aiming for high crystallization.	291	260	1981~ 1990

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
High performance crystal control alloys	To carry out the development of heat resistant and tough alloys which will break through the barriers of past alloy performance through pure crystallization, miniaturizing crystals, and mixing sturdy particles.	590	522	1981~1988
Composite materials	To develop highly reliable structural materials, which are stronger than iron, lighter than aluminum, and have the strength and steel-like qualities that will meet a number of uses.	705	634	1981~1988
Bioreactor	Involving the major reactions of the chemical industry, to develop a bioreactor that will conserve energy, for use when large quantities of energy are consumed (oxide reactors, synthetic reactors, etc.)	425	373	1981~1990
Mass cellular cultivation technology	To carry out the development of an efficient animal cell cultivation technology that does not require a natural cultivation liquid (such as bovine fetal blood serum).	429	389	1981~1989
Technology using recombinant DNA	For resource conservation and energy conservation of chemical industry processes and oil extraction, which is a chemical industry raw material, to carry out the development of technology to create new microorganisms for use in chemical industry processes which are able to produce substances highly efficiently.	367	323	1981~1990
Super-lattice chips	To develop chips that utilize the new electric phenomena appearing within a structure which are controlled up to atomic level measurement by the precise growth of extremely weak crystal films.	524	442	1981~1990

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Three-dimensional circuit	By means of layered structures, to develop layered multifunctional integrated chips which integrate, to ultrahigh precision, the logic and memory functions.	959	814	1981~1990
Photo-sensitive material chips	To conduct the development of materials that can cause molecular structures or arrangements to physically and chemically transform by means of light, and to produce this alteration in a controlled mode.	110	177	1985~1992
Biochips	To realize high level and revolutionary processing functions, such pattern recognition and learning, new materials technology and new chip technology that will produce an understanding of the information processing function in living things and their imitation by engineering, as well as a biochemical reaction, must be developed.	60	147	1986~1995

Ministry of Transportation (Research and development of transportation technology)

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Comprehensive R&D of extraordinary sea disaster prevention	To undertake analysis of the essence of waves, the mechanism for generating extraordinary waves, and the impact that the force of waves has on ships, and to develop a ship operation technology that will enable a ship to navigate safely under extraordinary weather and ocean conditions.	82	--	1982~1986
R&D of a low cost subway system	In order to develop a low cost subway, a railroad system with lower construction costs will be developed by placing the vehicles on a low bed by using a linear motor running system and by reducing the tunnel cross section.	47	41	1985~1987

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget	Research period (FY)
R&D for offshore development of marine structures	To develop design and execution methods, as well as maintenance management methods, for floating- and fixed-type marine structures in deep-water offshore areas.	17	93	1986~1990
Ministry of Labor				
R&D of medical electronics machines for the aging	With the advent of a full-fledged aging society, there is the need to expand the scope of occupations for the elderly and to guarantee their safety at work. For this reason, there is a need to develop medical electronics machines for the aging.	183	299	1985~1989
Ministry of Construction (Research and development of construction technology)				
Development of comprehensive water lakes management technology of lakes and marshes	To carry out development of comprehensive water improvement technology and water management technology of and marshes by grasping the mechanism generating the inflow of polluted substances to lakes and marshes and that of the changes in their waters.	42	0	1982~1986
Development of fireproof designs for buildings	In order to establish effective fireproof measures for buildings, there is a need to conduct studies involving the prevention of the start and spread of fires, smoke control, evacuation, and fire resistance; to develop comprehensive fireproof designs; and to develop fire prevention diagnoses and improve technology for use in buildings already existing.	69	--	1982~1986

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Development of comprehensive technology for building cities with heavy snowfalls	In order to establish comprehensive snow-resistant cities, improvements and development are being studied, such as snow removal and snow melting technologies.	37	--	1982~1986
Development of high-level construction technology systems by use of electronics	In order to make use of electronics-related technologies in building operations, there is a need to develop construction technologies, such as automated operations technology and operations management technology using computers, as well as to develop means for evaluating the economy and safety brought about by their introduction.	90	90	1983~1987
Development of technology to increase the durability of concrete	To analyze the deterioration mechanism of concrete, deterioration diagnosis technology, technology to prevent deterioration and strengthen existing buildings, and the development of new materials and execution methods.	203	195	1985~1987
Development of new waste water disposal systems using biotechnology	To develop new waste water disposal systems by using biotechnology, such as the immobilized microorganisms, bioreactors, cellular fusion, and genetic recombinant technology.	130	155	1985~1987
Creation of space using oceans and the development of safety technology	Along with working for safety and erosion prevention of the shoreline, to develop economical marine structures to create multipurpose useful space along the shoreline and technology to take advantage of marine space.	17	65	1986~1990

[continued]

[Continuation of Table 30]

Research topic	Summary of research	1986 budget (¥1 million)	1987 budget (¥1 million)	Research period (FY)
Development of new wooden construction technology	To develop new wooden structures, outstanding in structural impact resistance, fireproofing and long-term durability, and to contribute to their dissemination.	29	71	1986~1990
Development of technology to make use of underground space	To conduct the development of construction technologies, such as earth survey technologies and underground excavation technologies, underground fire prevention technology, and underground environmental management technology, in order to achieve the safe use of underground space which is expected to be larger in size and deeper below the earth's surface.	--	21	1987~1991
Development of a disaster information system	To carry out development of an information processing system involving disaster information transmission technology, utilizing VTR cameras and satellite communications, to increase the efficiency of the rehabilitation of facilities that have encountered disasters and to prevent the spread of damage suffered during a disaster from affecting a wide area.	--	21	1987~1991
Development of technology to improve residential environment aging society	To develop technology to improve residential environment of the elderly, such as technology to make the lives and social activities of the elderly easier.	--	20	1987~

Notes: 1. The figure is the initial budget figure for each year.
2. * refers to a special account.
Source: Science and Technology Agency data.

31. Status of Activity of the Science and Technology-Related Councils in 1987

Government agency Council name	Date of inquiry	Date of report	Item name	Remarks
Ministry of International Trade and Industry				
Industrial Technology Council		24 Nov 87	Establishment of "Subcommittee on Structural Trends of Industrial Technology" (Technology Assessment Group)	
		17 Mar 88	Decision involving a Basic Program for R&D of Superconductor Electric Power Applications Technology (23rd Energy Conservation Technology Development Group)	
		30 Mar 88	Decision involving a Basic Program for R&D of Superconductor Materials and Superconductor Elements Establishment of the Planning Subcommittee (15th Next Generation Technology Development Group)	
Japan Standards Investigative Council		3 Jul 87	Establishment of Factory Automation Section	
Ministry of Transportation				
Transportation Technology Council	22 Jun 87	18 Sep 87	The Best Approach to Space Technology Development in the Ministry of Transportation (Inquiry No 14)	Interim report
Ministry of Posts and Telecommunications				
Electric Communications Technology Council	27 Sep 86	27 Apr 87	Technical Conditions for Automatic Identification Equipment for Radio Stations Established on Land (Inquiry No 29) The use of digital communications radio equipment as a technological	Partial report

[continued]

[Continuation of Table 31]

Government agency Council name	Date of inquiry	Date of report	Item name	Remarks
			condition for the automatic identification equipment of land-based mobile radio stations which use the above VHF frequency range, portable and mobile radio stations and simple radio stations.	
	24 Oct 86	27 Apr 87	Technical Conditions of a Simple Radiotelephone System for Small Boats in Harbor Areas (MARINET telephone) (Inquiry No 31)	
	23 Apr 85	25 May 87	Preferred Communications Methods To Ensure Efficient Electric Communications (Inquiry No 20) • Recommended communications methods for electronic mail communications.	Partial report
	23 Apr 85	28 Sep 87	Technical Conditions for Efficient Use of Relay Equipment of Communications Satellite No 3 and Standardization of Earth Stations (Advisory No 6)	
	27 Sep 86	28 Sep 87	Technical Conditions for Automatic Identification Equipment of Radio Stations Established on Land (Inquiry No 29)	
	27 Sep 86	28 Sep 87	Technical Conditions for Cable Television Broadcasting Facilities Accompanying Multichannel Growth (Inquiry No 30)	
	24 Jul 87	26 Oct 87	Technical Conditions for Radio Equipment of Radio Stations Carrying Simple Mobile Radiotelephone Communications (Inquiry No 34)	

[continued]

[Continuation of Table 31]

Government agency Council name	Date of inquiry	Date of report	Item name	Remarks
	24 Jul 87	25 Jan 88	Technical Conditions for Radio Equipment of Radio Stations Carrying Shore-line Radiotelephone Communications by New Means (Inquiry No 33)	
	26 Sep 85	25 Jan 88	Technical Conditions for Strong Signals on an FM Broadcasting Frequency (Inquiry No 25)	Partial report
	23 Apr 85	28 Mar 88	Technical Conditions for Use of the Data Channels of Satellite Broadcasts (Inquiry No 18)	
	22 Oct 87	28 Mar 88	Technical Conditions for Radio Equipment of Radio Stations Composed of Teleterminal Systems (Inquiry No 36)	

- END -

10

Foreign Broadcast Information Service (FBIS) and Joint Publications Research Service (JPRS) publications contain political, economic, military, and sociological news, commentary, and other information, as well as scientific and technical data and reports. All information has been obtained from foreign radio and television broadcasts, news agency transmissions, newspapers, books, and periodicals. Items generally are processed from the first or best available source; it should not be inferred that they have been disseminated only in the medium, in the language, or to the area indicated. Items from foreign language sources are translated; those from English-language sources are transcribed, with personal and place names rendered in accordance with FBIS transliteration style.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by FBIS/JPRS. Processing indicators such as [Text] or [Excerpts] in the first line of each item indicate how the information was processed from the original. Unfamiliar names rendered phonetically are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear from the original source but have been supplied as appropriate to the context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by the source. Passages in boldface or italics are as published.

SUBSCRIPTION/PROCUREMENT INFORMATION

The FBIS DAILY REPORT contains current news and information and is published Monday through Friday in eight volumes: China, East Europe, Soviet Union, East Asia, Near East & South Asia, Sub-Saharan Africa, Latin America, and West Europe. Supplements to the DAILY REPORTs may also be available periodically and will be distributed to regular DAILY REPORT subscribers. JPRS publications, which include approximately 50 regional, worldwide, and topical reports, generally contain less time-sensitive information and are published periodically.

Current DAILY REPORTs and JPRS publications are listed in *Government Reports Announcements* issued semimonthly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161 and the *Monthly Catalog of U.S. Government Publications* issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The public may subscribe to either hardcover or microfiche versions of the DAILY REPORTs and JPRS publications through NTIS at the above address or by calling (703) 487-4630. Subscription rates will be provided by NTIS upon request. Subscriptions are available outside the United States from NTIS or appointed foreign dealers. New subscribers should expect a 30-day delay in receipt of the first issue.

U.S. Government offices may obtain subscriptions to the DAILY REPORTs or JPRS publications (hardcover or microfiche) at no charge through their sponsoring organizations. For additional information or assistance, call FBIS, (202) 338-6735,or write to P.O. Box 2604, Washington, D.C. 20013. Department of Defense consumers are required to submit requests through appropriate command validation channels to DIA, RTS-2C, Washington, D.C. 20301. (Telephone: (202) 373-3771, Autovon: 243-3771.)

Back issues or single copies of the DAILY REPORTs and JPRS publications are not available. Both the DAILY REPORTs and the JPRS publications are on file for public reference at the Library of Congress and at many Federal Depository Libraries. Reference copies may also be seen at many public and university libraries throughout the United States.