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# ***JPRS Report***

# **Science & Technology**

***Japan***

AIST

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SCIENCE & TECHNOLOGY

JAPAN

AIST

CONTENTS

|  |    |
|--|----|
| Outline.....   | 1  |
| Organization.....  | 3  |
| History.....   | 4  |
| FY 89 Budget and Personnel.....                            | 9  |
| Activities   |    |
| Basic Technologies for Future Industries.....              | 11 |
| The Large-Scale Project.....                               | 14 |
| The Sunshine Project.....                                  | 17 |
| The Moonlight Project.....                                 | 19 |
| Medical and Welfare Equipment Technology.....              | 22 |
| Regional Technology Development.....                       | 23 |
| The Human Frontier Science Program.....                    | 27 |
| Consolidating Research and Development Systems Relating to |    |
| Industrial Technology.....                                 | 31 |
| International Cooperation in Research & Development.....   | 33 |
| The Japan Key Technology Center.....                       | 43 |
| Technological Development in the Private Sector.....       | 44 |
| Industrial Standardization.....                            | 47 |
| Technology Research and Information.....                   | 49 |
| Diffusion of Accomplishments.....                          | 53 |

|   |    |
|---|----|
| Industrial Technology Council.....                          | 54 |
| Recent Trends Involving AIST.....                           | 55 |
| Laboratories and Institutes.....                            | 57 |
| R&D, Tsukuba Research Center.....                           | 58 |
| Introduction of Individual Laboratories and Institutes..... | 59 |

Agency of Industrial Science and Technology

43070727 Tokyo AIST in English 1989 pp 1-33

[Text] Outline of AIST

Progress in technological development has resulted in many striking achievements in the advanced fields of electronics, new materials and biotechnology. Developing such creative new technologies is essential for Japan, which has top-rated economic power and industrial technologies, to attain stable foundation toward further economical and social development. Equally important, it is an effective way for Japan to positively continue contributing to international society and play its role properly through technological development.

From this viewpoint, AIST will strongly promote the leading and basic research and development relating to new energy, energy-saving and anti-pollution and initiate R&D of global environment technologies to explicate the mechanism of these issues and work out the appropriate measures, in order to tackle the global environment issues such as green house effect and set up the Specific Research System a new for R&D. AIST has designed an integrated industrial technology policy for fiscal 1989 which places emphasis on the following programs.

Firstly, leading and basic research and development will be expanded on existing themes under a number of projects: the R&D Project on Basic Technologies for Future Industries, which devotes itself to the development of such frontier technologies as new materials and new function elements; the Large Scale Project (the National R&D Program), mobilizing technological activities of both government and private enterprises in important projects including effective utilization of marine biological resources to explore the new frontier of industries; and the R&D Project on Medical and Welfare Equipment Development, which aims at improving health and welfare through technological development. The development of energy-related technologies will be continued to carry out under the Sunshine and the Moonlight Projects, the former focusing on the utilization of solar energy, geothermal energy and so forth, and the latter on highly efficient energy conservation.

The Agency will do its part to vitalize Japan's regional economies through the R&D Projects on Important Regional Technologies.

Sixteen AIST laboratories and institutes will take the lead in related basic research and development, reinforcing the tie-ups among private industries, universities and government agencies to promote joint government-private sector research.

Secondly, AIST will execute various steps to strengthen international research collaboration, which include (1) R&D on specific themes to be shared by AIST and research institutes of advanced countries, (2) support to R&D by international joint research teams to elucidate physical functions, (3) invitation of foreign researchers to AIST laboratories and institutes and (4) cooperation of research and exchange of researchers through the International Research Collaboration Center to be located in NEDO newly from this fiscal year. In addition, AIST will make special efforts to promote the Human Frontier Science Program toward the forthcoming start of full scale business, explicating sophisticated biological functions and making a search for the possibility of application.

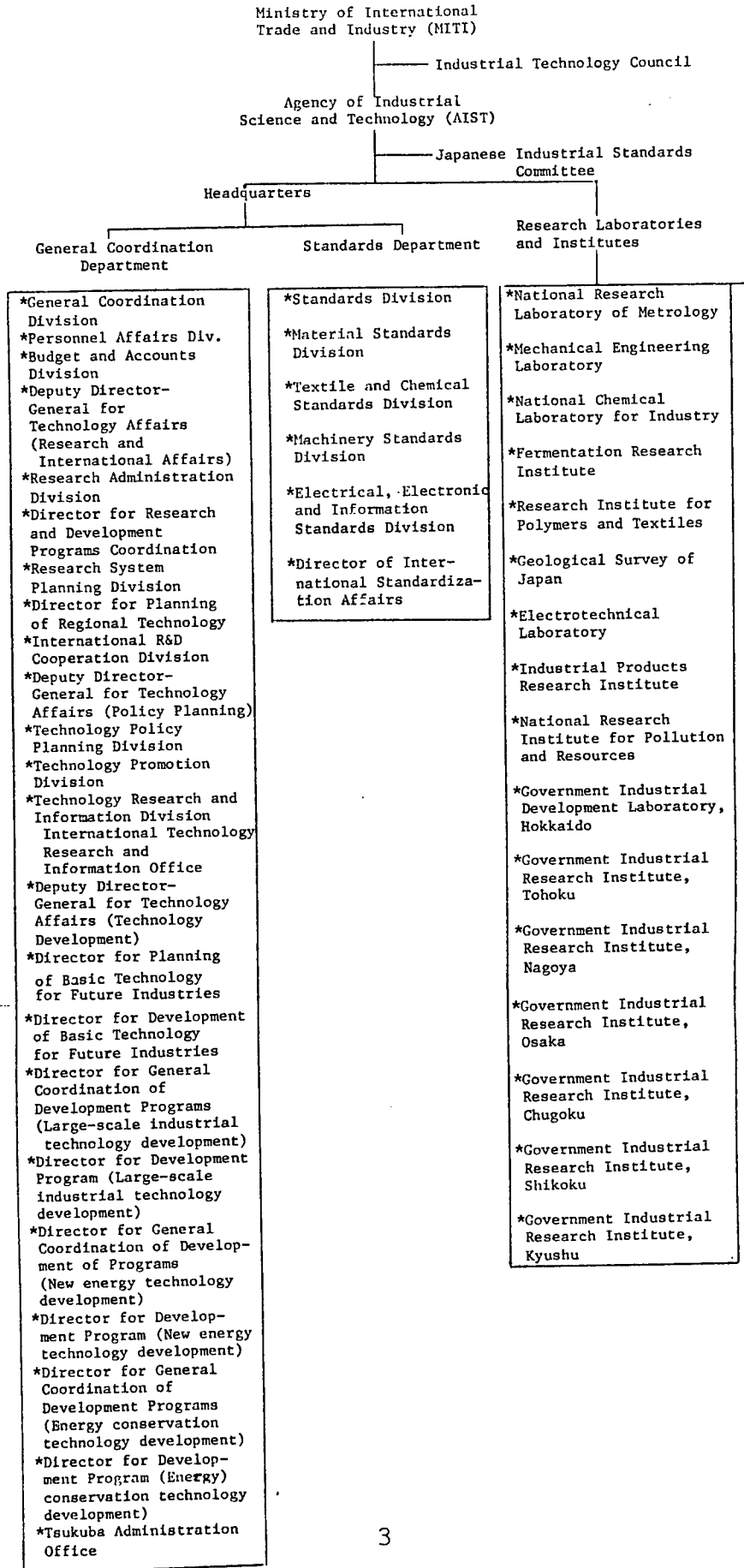
Thirdly, steps are also planned to create conditions to promote development of technology in the private sector. In addition to the investment and other programs offered by the Japan Key Technology Center, AIST suggests to make best use of various preferential taxation systems such as "special tax deductions for increased expenditure for experimental research" and "tax system for facilitation of research and development in fundamental technologies." On top of the AIST will carry out three existing projects and two new projects to prepare research foundation for promotion of advanced R&D.

Finally, the national industrial standardization (JIS) system has played an important role in the development of Japan's industries. Emphasis will be placed on participating in international standardization activities and in standardizing such new technological fields as information, new materials and biotechnology.

We will be happy if this booklet is of use in explaining the nature of the Agency of Industrial Science and Technology and in helping readers understand the policies it carries out.

[signed]  
Dr. Masaru Sugiura  
Director-General,  
Agency of Industrial Science and Technology

Organization of AIST



|   | 1945   | 1950  | 1960   |
|---|--|---|--|
| Category  |  | (1948) Established Agency of Industrial Science & Technology<br>(1949) Industrial Standardization Law<br>(1950) Established Industrial Technology Council (Prime Minister's Office)<br>(1951) Weight and Measures Law<br>(1952) Established AIST<br>(1952) Enterprise Rationalization Promotion Law | (1956) Established Science and Technology Agency<br>(1959) Established Science and Technology Council<br>(1961) Mining and Industrial Technology Research Organization Law |
| Laboratories and Institutes built before 1945                             |  |   |  |
| (1903) Central Inspection Institute of Weights and Measures               | (1913) Central Inspection Institute of Weights   | (1952) Central Inspection of Metrology  | (1961) National Research Laboratory of Metrology   |
| (1937) Government Mechanical Laboratory                                   |  |   |  |
| (1900) Industrial Laboratory  | (1918) Industrial Laboratory of Tokyo  |   |  |
| (1940) Chiba Alcohol Plant  | (1942) Alcohol Research Institute<br>(1943) Fermentation Research Institute  |   |  |
| (1918) Silk Laboratory  | (1937) Textile Research Institute  |   |  |
| (1882) Geological Survey of Japan   |  |   |  |
| (1981) Electric Laboratory  |  |   |  |
| (1928) Industrial Art Institute   |  | (1952) Industrial Arts Institute  |  |
| (1920) Fuel Research Institute  |  | (1952) Resources Research Institute   |  |
|   | (1949) Mining and Safety Research Institute  |   | (1960) Government Industrial Development Laboratory, Hokkaido  |
|   |  | (1952) Government Industrial Research Institute, Nagoya   |  |
| (1918) Industrial Laboratory of Osaka                                     |  | (1952) Government Industrial Research Institute, Osaka  |  |
|   |  |   | (1964)   |
| Promotion of R&D (Projects) through Government Private Sector Cooperation |  |   | (1964) The Expenses Commission System for R&D of Mining and Industrial Technology  |
| Promotion of Technological Development in the Private sector              | <ul style="list-style-type: none"> <li>Conditional Loans</li> <li>Tax System</li> <li>Financing</li> <li>Others</li> </ul> |   |  |
|   |  | (1951) Financing of Enterprises for New Technologies  |  |
|   |  |   | (1961) Promotion of  |

| 1970   | 1980   | 1985  | 1989 |
|--|--|---|------|
| (1970)Tsukuba Academic City Construction Law<br>(1973)Established Industrial Technology Council (MITI) |  | (1985)Act for the Facilitation of Research in Fundamental Technologies<br>Inauguration of the Japan Key Technology Center<br>(1986)Law for Facilitating Governmental Research Exchange<br>(1988)Law for Consolidating R&D Systems relating to Industrial Technology (Inauguration of New Energy and Industrial Technology Development Organization) |      |
|  | (Sep 1979-Mar 1980) Transfer of 9 Laboratories and Institutes from Tokyo Metropolitan Region to Tsukuba Center.          |   |      |
| (1971)Mechanical Engineering Laboratory  |  | (1979)National Chemical Laboratory for Industry   |      |
| (1969)Fermentation Research Institute  |  |   |      |
| (1969)Research Institute for Polymers and Textiles   |  |   |      |
| (1970)Electrotechnical Laboratory  |  |   |      |
| (1969)Industrial Products Research Institute   |  |   |      |
| (1970)National Research Institute for Pollution and Resources  |  |   |      |
| (1967)Government Industrial Research Institute, Tohoku   |  |   |      |
| (1971)Government Industrial Research Institute, Chugoku  |  |   |      |
| (1967)Government Industrial Research Institute, Shikoku  |  |   |      |
| Government Industrial Research Institute, Kyushu   |  |   |      |
| (1966)Large-Scale Project (The National R&D Program)   | (1974)The Sunshine Project (R&D on New Energy Technology)  | (1978)The Moonlight Project (R&D on Energy Conservation Technology)   |      |
|  | (1981)R&D Project of Basic Technologies for Future Industries  |   |      |
|  | (1976)R&D Project of Medical and Welfare Equipment Technology  |   |      |
|  | (1982)Regional Large-Scale Project (Specific Regional Technology Development System)                                     |   |      |
|  | (1985)Joint Government-Private Sector Research   |   |      |
|  | (1988)Grant for International Joint Research   |   |      |
|  | (1988)Consolidating for Research and Development System by New Energy and Industrial Technology Development Organization |   |      |
|  | (1980)Conditional Loans for Development of Practical Technologies Related to Oil-substitute Energy                       |   |      |
|  | (1981)Conditional Loans for Development of New & Practical Technology for Power Generation                               |   |      |
| (1967)Special Tax Deduction for Increases in Expenditure on Experimental Research                      |  | (1985)Tax System for R&D Facilitation in Fundamental Technologies   |      |
| (1968)Domestic Production Technology Promotion Capital Financing                                       |  | (1983)Financing for the Promotion of Industrial Technological Development<br>(1985)Financing for the Japan Key Technology Center  |      |
| Joint Research by Mining and Industrial Technological Research Associations                            |  | (1985)Activities of the Japan Key Technology Center (Mediation in Arranging Joint Research, Research Information Service)   |      |

FY1989 Appropriations Related to Industrial  
Technology in MITI

|  |                                       | (Unit: million yen)                   |  |   |
|--|---------------------------------------|---------------------------------------|--|---|
| Item   | Fiscal<br>1988<br>Appro-<br>priations | Fiscal<br>1989<br>Appro-<br>priations | Increase<br>over the<br>Previous<br>Year | Note  |
| Request for R&D-related appropriations   | 2,212                                 | 2,336                                 | 124                                      | Growth rate against previous year                             |
| General accounts   | 684                                   | 694                                   | 10                                       | 5.6%  |
| Special accounts   | 1,243                                 | 1,360                                 | 117                                      | 1.5   |
| Industrial investment accounts   | 285                                   | 282                                   | △3                                       | 9.4   |
|  |                                       |                                       |  | △1.1  |
| Major Projects   |                                       |                                       |  |   |
| (Positive contribution to international society)   |                                       |                                       |  |   |
| *Promotion of Human Frontier Science Program (HFSP)  | --                                    | 9                                     | 9  | International HFSP Organization (Tentative name for the fund) |
| *Promotion of International R&D Center   | --                                    | 3<br>(1)                              | 3<br>(1)                                 | To be located in NEDO.  |
| *Development of global environment technology  | --                                    | 1                                     | 1  | Specific R&D at national experimental research laboratories   |
| *R&D cooperation with developing countries   | 12                                    | 16                                    | 5  |   |
| *Support to international joint R&D  | 3                                     | 4                                     | 1  |   |
| [Further promotion of technological development projects]<br>(AIST-related)  |                                       |                                       |  |   |
| *Preparation project of research foundation by Integrated of New Energy & Industrial Technology Development Organization | 27<br>(25)                            | 22<br>(22)                            | △3<br>(△3)                               | Participation from industrial investment accounts             |

FY1989 Appropriations [continued]

\*R&D expenses of national experimental research institutes (Special R&D, Government-private sector joint R&D, important area technology R&D, operation expenses of laboratories, etc.)  
 \*R&D project on basic technologies for future industries

\*Large-scale project

\*Development of medical and welfare equipment

\*R&D on new energy technology

\*R&D on energy conservation technology

(Aerospace-related)  
 \*International joint research on aircrafts (YXX, V2500)  
 \*Unmanned space experiment system (Free flier)

(Data processing-related)  
 \*R&D for 5th generation computer

(Technological development relating to superconductivity)

Including development of global environment technology

|           |           |         |   |
|-----------|-----------|---------|---|
| 142       | 147       | 6       | Applied technologies for non-linear photonic materials, High-Performance materials for environments with extreme severe conditions and molecular assemblies for functional protein system |
| 64 (14)   | 68 (21)   | 5 (7)   | Underground space development technology, super/hyper-sonic transport propulsion system   |
| 136 (86)  | 139 (92)  | 3 (5)   | Laser osteotomy system, evacuation data system, three-dimensional tactile display   |
| 7         | 7         | △0      |   |
| 257 (241) | 271 (259) | 15 (19) |   |
| 97 (91)   | 103 (98)  | 6 (7)   |   |
| 44        | 42        | 2       |   |
| 39 (34)   | 45 (40)   | 6 (5)   |   |
| 57 (19)   | 65 (28)   | 8 (8)   |   |
| 34 (21)   | 44 (29)   | 10 (8)  | Moonlight, etc.   |

FY1989 Appropriations [continued]

[Others]

|   | --           | 1<br>(1)     | 1<br>(1) | 1<br>(1) | Development of new industrialized housings to realize the needs of those living |
|---|--------------|--------------|----------|----------|---|
| *Promotion of development for new industrialized housings |              |              |          |          |   |
| *R&D project of regional system technology                | 9            | 10           | 1        | 1        |   |
| *The Service of the Japan Key Technology Center           | 260<br>(260) | 260<br>(260) | 0<br>(0) | 0<br>(0) | Participation or financing from industrial investment accounts                  |
| *Promotion of standardization                             | 9<br>(1)     | 9<br>(2)     | 9<br>(0) | 9<br>(0) |   |

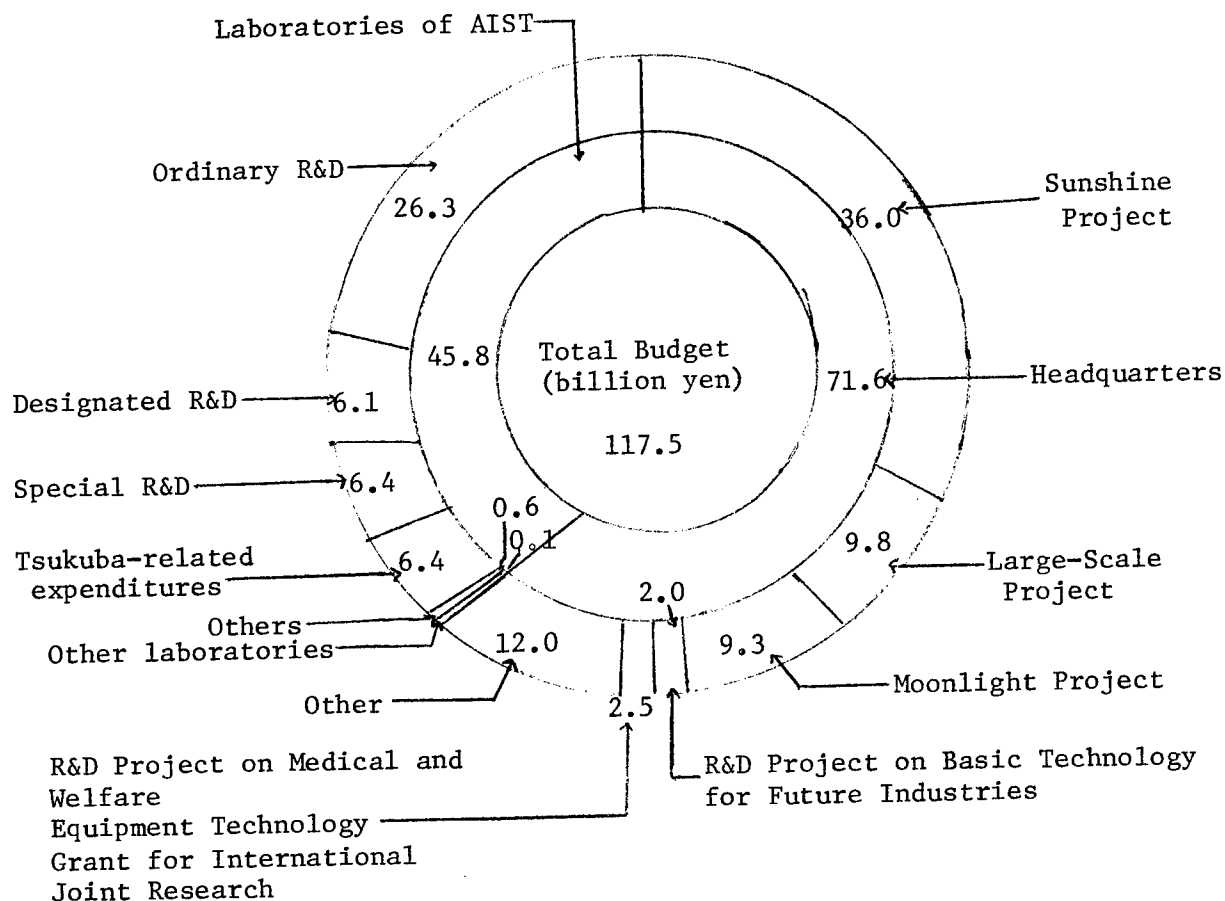
Note: Figures in ( ) belong to special accounts, which are part of the upper figures.

FY1989 Appropriations Related to Science and Technology in Japanese Government (Summary)

| Agency/Ministry                                     | General accounts | Growth rate against previous year (%) | Special accounts | Growth rate against previous year (%) | Total     | Growth rate against previous year (%) |
|---|------------------|---------------------------------------|------------------|---------------------------------------|-----------|---------------------------------------|
| Ministry of Education Science and Technology Agency | 196,805          | 2.9                                   | 657,517          | 5.7                                   | 854,322   | 5.1                                   |
| Ministry of International Trade and Industry        | 355,442          | 4.4                                   | 111,181          | 11.4                                  | 466,623   | 6.0                                   |
| Defense Agency                                      | 69,427           | 1.5                                   | 164,213          | 7.4                                   | 233,640   | 5.6                                   |
| Ministry of Agriculture, Forestry and Fishery       | 93,068           | 12.5                                  | --               | --                                    | 93,068    | 12.5                                  |
| Ministry of Health and Welfare                      | 64,279           | 9.0                                   | 3,400            | Δ5.6                                  | 67,679    | 1.6                                   |
| Ministry of Posts and Telecommunications            | 37,531           | 12.2                                  | 10,838           | 2.1                                   | 48,370    | 9.8                                   |
| Ministry of Transport                               | 4,447            | 3.8                                   | 26,000           | 0.0                                   | 30,447    | 0.5                                   |
| Environment Agency                                  | 15,387           | 12.2                                  | 913              | Δ0.3                                  | 16,300    | 11.4                                  |
| Ministry of Foreign Affairs                         | 7,882            | 1.7                                   | --               | --                                    | 7,882     | 1.7                                   |
| Others  | 6,408            | Δ0.1                                  | --               | --                                    | 6,408     | Δ0.1                                  |
|   | 11,406           | 2.3                                   | 4,683            | 25.0                                  | 16,089    | 8.0                                   |
| TOTAL   | 862,081          | 4.8                                   | 952,745          | 6.7                                   | 1,814,827 | 5.8                                   |

# FY1989 Budget and Personnel in AIST

## 1. Budget



Note: Ordinary R&D: Personnel expenditures and ordinary research expenditures of AIST laboratories.

Designated R&D: Research expenditures incurred by research laboratories through work connected with the Large-Scale Project, the Sunshine and Moonlight Projects, the R&D Project on Medical and Welfare Equipment Technology, the R&D Project on Basic Technologies for future Industries, and the Regional Large-Scale Project.

Special R&D: Expenditures incurred through Special Research, Expansion of Laboratory Facilities, Operation of Geological Research Vessel, Nuclear Research, R&D Promotion for Small Industries, Research Related to Prevention of Environmental Pollution.

Tsukuba-related expenditure: Expenditures in operating joint facilities at Tsukuba.

Budget for individual projects: The total budget for the Large-Scale Project, Sunshine and Moonlight Projects and R&D Project on Basic Technology for Future Industries, minus the budget for Designated R&D. (Designated R&D is also omitted from the Total Budget for AIST.)

2. Budget and Personnel for Government Laboratories

|   | <u>Budget</u><br>(million yen) | <u>Personnel</u> | <u>Researchers</u> | <u>Administrators</u> |
|---|--------------------------------|------------------|--------------------|-----------------------|
| Agency of Industrial Science and Technology<br>(Headquarters) | 71,636                         | 315              | 1                  | 314                   |
| National Research Laboratory of Metrology                     | 2,111                          | 220              | 129                | 91                    |
| Mechanical Engineering Laboratory                             | 3,181                          | 279              | 218                | 61                    |
| National Chemical Laboratory for Industry                     | 3,942                          | 356              | 280                | 76                    |
| Fermentation Research Institute                               | 1,100                          | 89               | 71                 | 18                    |
| Research Institute for Polymers and Textiles                  | 1,464                          | 126              | 103                | 23                    |
| Geological Survey of Japan                                    | 4,363                          | 360              | 240                | 120                   |
| Electrotechnical Laboratory                                   | 9,332                          | 690              | 557                | 133                   |
| Industrial Products Research Institute                        | 1,360                          | 126              | 102                | 24                    |
| National Research Institute for Pollution<br>and Resources    | 3,883                          | 324              | 248                | 76                    |
| Government Industrial Development<br>Laboratory, Hokkaido     | 1,176                          | 96               | 73                 | 23                    |
| Government Industrial Research Institute,<br>Tohoku           | 523                            | 54               | 39                 | 15                    |
| Government Industrial Research Institute,<br>Nagoya           | 2,539                          | 246              | 189                | 57                    |
| Government Industrial Research Institute,<br>Osaka            | 2,551                          | 221              | 170                | 51                    |
| Government Industrial Research Institute,<br>Chugoku          | 667                            | 52               | 40                 | 12                    |
| Government Industrial Research Institute,<br>Shikoku          | 486                            | 44               | 34                 | 10                    |
| Government Industrial Research Institute,<br>Kyushu           | 942                            | 91               | 71                 | 20                    |
| Common Expenditures   | 40,433                         | --               | --                 | --                    |
| Other Laboratories  | 5,469                          | --               | --                 | --                    |
| TOTAL   | 117,538                        | 3,689            | 2,565              | 1,124                 |

Activities of AIST

Research and Development Project on Basic Technologies for Future Industries

This project is aimed at the development of revolutionary basic technologies essential for establishing new industries.

The four fields covered are Superconductivity, new materials, biotechnology, and new electronics devices. The following 14 special categories, all of which have theoretically or experimentally shown potential for application in new industrial technologies, have been selected. Research and development in these categories are conducted until the materials involved are ready for practical application.

(Unit: million yen)

| Project Name  | Period (FY) | Budget for FY1989       | Outline of Project  | R&D Results   |
|---|-------------|-------------------------|---|---|
| (1) Superconductivity<br>1) Superconducting Materials & Devices | 1988-1997   | 1,872<br>[1,091<br>780] | Development of new superconducting materials, processing technologies for applying superconducting materials to electric power equipments, e.g. magnets and wires, and technologies for fabricating superconducting electronic devices. | An automatic fabrication system for searching superconducting material with high critical current density and high critical magnetic field was constructed, and superconducting thin films with good crystal-line properties were fabricated by sputtering, evaporation, and chemical vapor deposition methods. |
| (2) New Materials<br>1) High-Performance Ceramics               | 1981-1992   | 1,149<br>[10<br>1,138]  | Development of high-strength ceramics at elevated temperatures to be used as materials for gas turbine components.  | Si <sub>3</sub> N <sub>4</sub> and SiC ceramics which can stand high temperature were developed at materials for gas turbine components.  |
| 2) Synthetic Membranes for New Separation Technology            | 1981-1990   | 358                     | Development of synthetic membranes for new separation technology, to separate and refine freely mixed gases or liquid mixtures by utilizing differences in physical properties.   | Synthetic membranes which can efficiently separated ethanol/water mixed solutions, CO/N <sub>2</sub> mixed gases, and optical isomers of amino acid were developed.   |
| 3) Synthetic Metals   | 1981-1990   | 295                     | Development of synthetic metals and polymeric materials with electroconductive properties of metals.  | Layered synthetic graphite with the highest electroconductivity of 9x10 <sup>5</sup> S/cm was found. The first example of soluble conducting polymer was demonstrated by the introduction of a long alkyl chain on polythiophene rings.   |

|   |               |                       |   |   |
|---|---------------|-----------------------|---|---|
| 4)High-<br>Performance<br>Plastics                                  | 1981-<br>1990 | 235                   | Development of high-<br>performance plastics<br>and polymeric<br>materials with<br>mechanical properties<br>of metal.   | Polymers with high<br>flexural moduli, and<br>molding techniques for<br>obtaining high performance<br>liquid-crystalline<br>polymers and molecular<br>composites have been<br>developed.  |
| 5)High-<br>Performance<br>Materials<br>for Envi-<br>ronments        | 1989-<br>1996 | 301<br>[151]<br>[150] | Developments of<br>carbon/carbon<br>composites, inter-<br>metallic compounds,<br>and fiber reinforced<br>intermetallic compounds<br>which can be used to<br>develop a space plane<br>and SST/HST. | (Project launched in<br>FY1989)   |
| 6)Photo-<br>active<br>Materials                                     | 1985-<br>1993 | 318                   | Development of photo-<br>active materials, which<br>characteristically<br>exhibit a reversible<br>change in the structure<br>or arrangement of<br>molecules in response<br>to a light stimulus.   | Discovery of double-<br>layered LB films of<br>spiropyrans with the<br>ability of multiplex<br>recording, and photo-<br>active materials<br>memorized by photo-<br>chemical hole burning,<br>which is stable at liquid<br>nitrogen temperature. |
| 7)Non-linear<br>Photonics<br>Materials                              | 1989-<br>1998 | 151                   | Development of non-<br>linear photonics<br>materials which exhibit<br>high electric suscep-<br>tibilities and short<br>relation times for<br>application of optical<br>information systems.       | (Project launched in<br>FY1989)   |
| (3)Biotech-<br>nology<br>1)Large-<br>Scale Cell<br>Cultiva-<br>tion | 1981-<br>1989 | 360                   | Development of non-<br>serological culture<br>media and methods for<br>large-scale high-density<br>cultures of mammalian<br>cells for the efficient<br>production of bioactive<br>substances.     | Non-serological culture<br>media and culture<br>apparatus were developed.<br>Long-term culture<br>method for normal diploid<br>cells were established.<br>Production of useful<br>substances using the<br>new technique is now<br>underway.     |
| 2)Utiliza-<br>tion of<br>Recombi-<br>nant                           | 1981-<br>1990 | 306                   | Investigation into the<br>use of recombinant DNA<br>technology for the<br>development of new micro-<br>organisms for practical<br>use in industry.  | Noble host-vector systems<br>of thermophilic bacteria<br>were developed. Various<br>enzymes and bioactive<br>substances have been<br>efficiently produced by<br>the improvement of host-<br>vector systems of<br>industrial microorganisms.     |

|  |           |     |  |  |
|--|-----------|-----|--|--|
| 3)Molecular Assemblies for Functional Protein System | 1989-1998 | 151 | Development of molecular assemblies of functional proteins for reactors with sophisticated functions such as production and conversion of complexed biomaterials coupled with selective transport and recognition. | (Project launched in FY1989)   |
| (4)New Electron Devices                              | 1981-1990 | 342 | Development of superlattices electron devices with extremely fine structure tailored to atomic scale for utilizing new electronic effects.   | Multifunctional high speed devices which utilize resonant tunneling, high mobility, and ballistic of electrons in superlattices are realized by molecular beam epitaxy (MBE) and vital organic chemical beam deposition methods. |
| 1)Superlattices Devices                              |           |     |  |  |
| 2)Three-Dimensional ICs                              | 1981-1990 | 626 | Development of ICs characterized by a three-dimensional arrangement of active elements made of semiconductor layers.   | Prototype of 3D devices with optical detector, A/D logic and memory circuits are fabricated and superiority of 3D circuit are verified.  |
| 3)Bio-electronic Devices                             | 1986-1995 | 343 | Development of bio-electronic devices for future computer elements by understanding biological information systems and by using molecular-thin film technologies.  | A new optical method for detecting neural activities in the brain, and new techniques for fabricating well-organized molecular thin films have been developed.   |

Note: Upper columns in parentheses represent general accounts and lower ones special accounts. Those not in parentheses represent general accounts only.

Completed Research and Development Projects on Basic Technologies for Future Industries (Unit: million yen)

Fortified ICs for Extreme Conditions (1981-1985, 1,315)  
 Advanced Alloys with Controlled Crystalline (1981-1988, 3,903)  
 Advanced Composite Materials (1981-1988, 4,649)  
 Bioreactor (1981-1988, 2,978)

The National Research and Development Program

The Large-Scale Project

Under the National Research and Development Program (popularly known as the Large-Scale Project), AIST conducts R&D projects on technologies which are of particular importance and urgent need to the nation. Government funds are given by contract to participating private enterprises, which work closely with national laboratories and academic organizations.

A total of 25 projects have been undertaken since 1966. Sixteen of these have already been completed, with various technical results, including large-scale integrated circuits, high performance electric car battery technology and the practical use of desalination equipment. The results of such efforts are all available to the public, and have attracted worldwide attention. In 1989, AIST will continue to work on eight R&D projects currently in progress, and will also start two new projects: "Super/Hyper-Sonic Transport Propulsion System" and "Underground Space Development Technology."

(Unit: million yen)

| Project Name  | Period (FY) | Budget for FY1989             | Outline of Project   | R&D Results  |
|---|-------------|-------------------------------|--|--|
| Manganese Module Mining System                                    | 1981-1991   | 1,096                         | R&D on an efficient and reliable hydraulic mining system in which manganese nodules are collected by a towed vehicle for commercial-scale mining to help ensure a stable supply of nonferrous mineral resources. | The midterm assessment on detailed design and experiment development of fundamental components. Manufacturing of underwater pump, underwater cable, air compressor and collector.                            |
| High-Speed Computing System for Scientific and Technological Uses | 1981-1989   | 2,431<br>[ 341 ]<br>[ 2,090 ] | R&D on high-speed computing systems for scientific and technological applications; for areas which existing computers cannot handle with adequate speed.   | 3K-gate Josephson junction logic gate array, 4K-bit GaAs FET static RAM, 16K-bit HEMT static RAM.  |
| Automated Sewing System   | 1982-1990   | 978                           | R&D on an automated industrial sewing system, involving processes such as preparation, making-up and finishing, to cope with rapid changes in the domestic apparel market.                                       | Fundamental technologies essential to the automated sewing system were developed, and experimental machines were manufactured and operated. Software and hardware of the demonstration system were designed. |

|   |           |                               |   |  |
|---|-----------|-------------------------------|---|--|
| Advanced Robot Technology                         | 1983-1990 | 2,676<br>[ 269 ]<br>[ 2,407 ] | R&D on advanced robot technology for systems to support people working under difficult or dangerous conditions.   | Basic key technologies such as locomotion, manipulation, and sensor technologies have been developed for three types of robots--for nuclear power plants, for undersea, and for oil plant fire for oil refineries. Using these technologies, robots for feasibility study were designed. |
| New Water Treatment System                        | 1985-1990 | 2,528<br>[ 377 ]<br>[ 2,151 ] | R&D on a new wastewater treatment system using a high-concentration bioreactor and separation membrane, for water reuse and energy recovery (e.g. methane gas from anaerobic bioprocess).               | Bench-scale experiments made it possible to design a bioreactor-process for high-rate methane fermentation and a membrane-module with a persistent flux.   |
| Inter-operable Database System                    | 1985-1991 | 1,423<br>[ 861 ]<br>[ 562 ]   | R&D on technology for interoperable information systems with such features as distributed databases and multi media technology, to form an infrastructure for the "information-oriented society."       | Some of the Implementation Specifications required for the Infrastructure to assure the interoperability among networked heterogeneous computers have been developed in conformity with OSI.   |
| Advanced Material Processing and Machining System | 1986-1993 | 2,329<br>[ 362 ]<br>[ 1,967 ] | R&D on advanced surface processing using excimer laser beam and/or ion beam, and on ultra-precision mechanical processing, for advanced industries such as energy, precision machining and electronics. | Elementary techniques for the high power, high repetition ratio, long life excimer laser and the ultra fine ion beam and the deep ion injection were developed.  |
| Fine Chemicals from Marine Organisms              | 1988-1996 | 275                           | R&D on biotechnological production of fine chemicals such as pigments, dyestuffs, moisturizing materials, and coating materials for underwater structures.  | Preliminary investigations on useful materials from marine organisms and on utilization technology of biofunction.   |

|  |       |    |  |                                 |
|--|-------|----|--|---------------------------------|
| Super/<br>Hyper-Sonic<br>Transport<br>Propulsion<br>System | 1989- | 30 | R&D on a combined-<br>cycle engine which will<br>combine the "ramjet"<br>and "high performance<br>turbojet," and provide<br>high reliability<br>and efficiency at<br>both the subsonic and<br>the hyper-sonic level.   | (Project launched in<br>FY1989) |
| Underground<br>Space<br>Development<br>Technology          | 1989- | 30 | R&D on underground<br>space development<br>technology are as follows:<br>(1) geological survey and<br>evaluation technology<br>(2) dome construction<br>technology (3) environment<br>conditioning and hazard<br>prevention technology<br>(4) pilot dome construction. | (Project launched in<br>FY1989) |

Note: Upper columns in parentheses represent general accounts and lower ones special accounts. Those not in parentheses represent general accounts only.

Completed National Research and Development Projects (Unit: million yen)

1. Super High Performance Electronic Computer (1966-1981, 10,100)
2. Desulfurization Process (1966-1971, 2,700)
3. New Method of Producing Olefin (1967-1972, 1,200)
4. Remote-controlled Undersea Oil Drilling Rig (1970-1975, 4,500)
5. Sea-water Desalination and By-product Recovery (1969-1976, 6,700)
6. Electric Car (1971-1976, 5,700)
7. Comprehensive Automobile Control Technology (1973-1978, 7,300)
8. Pattern Information Processing System (1971-1980, 21,900)
9. Direct Steelmaking Process using High-temperature Reducing Gas (1973-1980, 13,700)
10. Olefin Production from Heavy Oil (1975-1981, 13,800)
11. Jet Aircraft Engines (1971-1981, 19,700)
12. Resource Recovery Technology (1973-1982, 12,600)
13. Flexible Manufacturing System Complex using Laser (1977-1984, 13,500)
14. Subsea Oil Production System (1978-1984, 18,200)
15. Optical Measurement and Control System (1979-1985, 15,700)
16. C<sub>1</sub> Chemical Technology (1980-1986, 10,500)
17. Observation System for Earth Resources Satellite-1 (1984-1988, 10,900)

## R&D on New Energy Technology

### The Sunshine Project

The Sunshine Project was started in July 1974 to secure a stable energy supply for Japan which has a vulnerable energy structure. High priorities are given to the development of the following four projects.

- (1) Coal Liquefaction and Gasification
- (2) Solar Photovoltaic Power Generation
- (3) Geothermal Energy Extraction
- (4) Hydrogen Energy Extraction

The Agency promoting the Sunshine Project is also active in international cooperation through IEA and other international organizations.

(Unit: million yen)

| Project Name         | Budget for FY1989             | Outline of Project  | R&D Results   |
|----------------------|-------------------------------|---|---|
| 1. Solar Energy      | 6,965<br>[ 207 ]<br>[ 6,758 ] | <ol style="list-style-type: none"> <li>(1) Research and development of high-performance and low-cost solar-photovoltaic-conversion technology which we hope will be widely used by early 21st century.</li> <li>(2) Development of the application of solar-thermal-application systems for industrial processes which require sophisticated thermal controls.</li> </ol> | <ul style="list-style-type: none"> <li>*The price of solar cell has been reduced from 20,000-30,000 yen/Wpeak to 900 yen/Wpeak.</li> <li>*The cost of solar-photovoltaic-conversion system has been reduced from 2,000 yen/kWh to 220-250 yen/kWh.</li> <li>*Technology of fixed-temperature-stock-room system (-5°C) driven by solar-thermal energy has been achieved.</li> </ul>  |
| 2. Geothermal Energy | 5,383<br>[ 305 ]<br>[ 5,078 ] | <ol style="list-style-type: none"> <li>(1) Nation-wide geothermal exploration survey assessing geothermal potential in Japan.</li> <li>(2) Research to confirm the effectiveness of exploration techniques for deep geothermal resources.</li> <li>(3) Development of binary cycle generation plant and hot dry rock generation system.</li> </ol>                        | <ul style="list-style-type: none"> <li>*Completion of geothermal potential map in Japan.</li> <li>*Geothermal potential assessment and development of optimum exploration methods for high potential areas.</li> <li>*Development of high precision Magneto-telluric method.</li> <li>*Design and test operation studies of Down Hole Pump for binary cycle power generation.</li> <li>*Production of geothermal reservoirs by fracturing techniques developed for hot dry rock power generation system.</li> </ul> |

|                              |                                 |  |   |
|------------------------------|---------------------------------|--|---|
| 3. Coal Energy               | 24,792<br>[ 307 ]<br>[ 24,486 ] | <p>(1) Coal Liquefaction Technology Development of original liquefaction processes for both bituminous and brown coal.</p> <p>(2) Coal-based Hydrogen Production Technology Development of mass-production technology for low-cost clean hydrogen energy.</p> <p>(3) Integrated Coal Gasification Combined Cycle Power Generation Technology (IGCC; Sponsored by ANRE) Development of the technology of IGCC which is more efficient and have less environmental impact than conventional coal-fired power generation.</p> | <p>(1)*Development of a new process, named NEDOL process, for liquefaction of bituminous coal by integrating the results of the three coal liquefaction methods.<br/>*Operation of 50 t/d pilot plant for liquefaction of brown coal.</p> <p>(2) Construction of 20 t/d pilot plant for coal-based hydrogen production.</p> <p>(3) Construction of 200 t/d IGCC pilot plant with entrained bed reactor.</p> |
| 4. Hydrogen Energy           | 121                             | <p>Development of technologies on hydrogen production, storage and transportation, and use and safety</p> <p>Development of technologies on producing highly efficiently, and on transportation and storage using metal hydrides</p> <p>Development of hydrogen batteries and hydrogen-fueled engines</p>  | <p>The pilot plant of alkaline-water electrolyzer with a 20N m<sup>3</sup>/h capacity was successfully operated for a long period at the highest efficiency in the world.</p>   |
| 5. Comprehensive Research    | 2,529<br>[ 170 ]<br>[ 2,359 ]   | <p>(1) Basic studies of other new energy technologies, such as wind energy, ocean energy, bio energy, but excluding four areas (solar, geothermal, coal and hydrogen) are proceeding.</p> <p>(2) Development of a high-efficiency membrane complex methane production unit.</p>  | <p>The pilot plant of 100 kW-class wind power generation system was successfully operated for a long period.</p>  |
| 6. International Cooperation | 62                              | <p>(1) International cooperation through IEA.</p> <p>(2) Bilateral cooperation with Australia, etc.</p>  |   |

Note: Upper columns in parentheses represent general accounts and lower ones special accounts. Those not in parentheses represent general accounts only.

## R&D on Energy Conservation Technology

### The Moonlight Project

Launched in 1978, the Moonlight Project is a comprehensive program of R&D for energy conservation under which work is carried out cooperatively by national laboratories, industries and universities.

(Unit: million yen)

| Project Name                                   | Period (FY) | Budget for FY1989          | Outline of Project  | R&D Results  |
|--|-------------|----------------------------|---|--|
| Advanced Battery Electric Power Storage System | 1980-1991   | 1,953<br>[ 38 ]<br>[1,915] | Development of an electric energy-storage system including high-efficiency, large scale advanced batteries.<br>The system is expected to have a load leveling function, allowing electric energy to be stored during off-peak hours and discharged during peak hours.       | Developed 4 type Advanced Batteries with capacity of 60kW, and with efficiencies of 77%.<br>Developed 1000kW class power storage, system using improved lead-acid batteries, and with efficiency of 70%.   |
| Fuel Cell Power Generation Technology          | 1981-1995   | 3,696<br>[ 78 ]<br>[3,618] | Development of design concepts for systems adaptable to both dispersed and centralized power stations, using fuel cell power generating devices whose potential efficiency can reach as much as 40 to 60%.<br>Natural gas, methanol and coal-derived gas are used as fuels. | [Phosphoric acid fuel cell]<br>Developed two 1000kW plants and two on-site 200kW systems which were [Molten carbonate fuel cell]<br>Developed 1kW and 10kW class cell stacks.<br>[Solid oxide fuel cell]<br>Developed 500W class cell stacks.<br>[Alkaline fuel cell]<br>Developed 1kW class cell stacks and tested more than 2000 hours continuously. |

|  |               |                            |   |   |
|--|---------------|----------------------------|---|---|
| Super<br>Heat<br>Pump<br>Energy<br>Accumulation  | 1984-<br>1991 | 1,791<br>[ 75 ]<br>[1,715] | Development of several new systems, each of which consists of a high-performance electric-driven heat pump system and a chemical heat storage system. These are expected to be used for air conditioning for large buildings, for district heating and cooling, or as process heat sources.<br>The systems are to be operated so as to store energy at night and to discharge the stored energy in the daytime in order to contribute to a leveling of electric power demand. | Applied for 38 patents as a result of studies on working fluids, materials, elemental apparatuses, systematization, etc.<br>Developed bench plant.  |
| Super-<br>conducting<br>Technology<br>for<br>Electric<br>Power<br>Accumulation<br>System | 1988-<br>1995 | 1,962<br>[ 93 ]<br>[1,869] | Development of a more efficient and stable electric power system using superconducting power apparatuses, among which generators are the closest target.<br>The system will assist in overcoming problems such as power loss and lack of suitable sites for transmission lines which occur as power stations become bigger and more remotely situated.  | Designed high stability and high current density type 10KA class NbTi conductors for field windings. Designed 70MW class model machine. Designed compressor unit of refrigeration system. |
| Ceramic<br>Gas<br>Turbine<br>Project   | 1988-<br>1996 | 707<br>[ 67 ]<br>[640]     | Development of ceramic gas turbines applicable to co-generation and electric power generation systems. These turbines, which use non-petroleum, fuels such as natural gas and methanol, offer thermal efficiency which may be increased to 42% by raising the turbine inlet temperature to 1350°C.  | (Project launched in FY1988)  |

|       |    |         |                                |
|-------|----|---------|--------------------------------|
| Other | -- | 630     | Leading and Basic Technology   |
|       |    | [ 270 ] | for Energy Conservation;       |
|       |    | [ 360 ] | International Cooperation      |
|       |    |         | in R&D; Technology Assessment  |
|       |    |         | on Energy Conservation;        |
|       |    |         | Conditional Loans for          |
|       |    |         | Energy Conservation Promotion; |
|       |    |         | Promotion of Energy            |
|       |    |         | Conservation through           |
|       |    |         | Standardization, etc.          |

Note: Upper columns in parentheses represent general accounts and lower ones special accounts. Those not in parentheses represent general accounts only.

Completed R&D Projects on Energy Conserving Technology (Unit: million yen)

1. Water Heat Utilization Technology System (1976-1981, 3,770)
2. Magneto-Hydro Dynamic (MID) Power Generation Technology (1976-1983, 4473)
3. Advanced Gas Turbine (1978-1987, 27,701)
4. Stirling Engine for Wide Use (1982-1987, 8,398)

R&D on Medical and Welfare Equipment Technology

Japan is putting much effort into raising the standard of its medical and welfare services, and there is an urgent need for more advanced equipment in this field. Often however, the development of technology for medical and welfare apparatus is hampered by large risks. Since 1976 fiscal year, AIST has addressed this problem by carrying out R&D aimed at the rapid development and marketing of reasonably priced, high-performance apparatus in this "high-risk" category. Research work is conducted at AIST's national research laboratories or on a consignment basis at the Technology Research Association of Medical and Welfare Apparatus (administered jointly by MITI and the Ministry of Health and Welfare).

By the end of fiscal 1988, R&D had been completed on 11 types of equipment for medical care and 12 for welfare use.

Ten of these are already in use.

In June 1986, the Cabinet decided on a general framework for measures to cope with Japan's aging society; development of equipment needed for an older society started in fiscal 1987, along with urgently needed equipment for cancer treatment. Development of four types of equipment for medical care and two for welfare continued into 1989 (fiscal year) from the previous year.

Development of laser osteotomy system, evacuation care system, and three-dimensional tactile display terminal for the visually handicapped started this year by the New Energy and Industrial Technology Development Organization.

(Unit: million yen)

| Project Name   | Period<br>(FY) | Budget<br>for<br>FY1989 | Outline of Project  |
|--|----------------|-------------------------|---|
| I. Medical equipment technology  |                |                         |   |
| 1. Hyperthermia system for cancer therapy                              | 1986-1989      | 76                      | Device capable of warning cancer tissues selectively at a certain temperature for treatment                       |
| 2. Automatic HLA typing system   | 1987-1990      | 97                      | Device to automatically classify leukocyte forms in treatment of leukemia   |
| 3. Laser angloplasty system  | 1988-1991      | 238                     | Device to remove thrombus into arteria with laser beam  |
| 4. Three dimensional imaging system for medical diagnosis              | 1988-1991      | 131                     | System providing three-dimensional imaging for medical diagnosis  |
| 5. Laser osteotomy system  | 1989-1992      | 8                       | System to perform osteotomy accurately with exima laser beam  |
| II. Welfare equipment technology                                       |                |                         |   |
| 1. System for processing prosthetic sockets                            | 1986-1989      | 37                      | Device to produce prosthetic sockets by determining the forms and properties of the cutting sections              |
| 2. Anti-decubitus mechanical mattress                                  | 1987-1990      | 42                      | A bed to provide prolonged prevention of decubitus ulcers for those who are the bed ridden and are unable to turn |
| 3. Evacuation care system  | 1989-1993      | 9                       | System to crash and remove formed stool of dyschesia with supersonic vibration                                    |
| 4. Three-dimensional tactile display terminal for visually handicapped | 1989-1992      | 16                      | System to form tactile solid body out of pin display of high density for visually handicapped                     |

Completed R&D on Medical and Welfare Equipment (Unit: million yen)

1. Medical equipment technology

- (1) Multichannel automated biochemical analyzer (1976-1978, 251)
- (2) Automated differential blood cell analyzer (1976-1978, 269)
- (3) Artificial heart for clinical use (1976-1979, 480)
- (4) Portable artificial kidney (1976-1980, 617)
- (5) Laser scalpel (1978-1981, 533)
- (6) Positron computer technology (1979-1982, 470)
- (7) Liver function support device (1979-1984, 653)
- (8) Diagnosis and therapy support system for neural disorders (1981-1986, 600)
- (9) Blood treatment system for immuno-related diseases (1983-1987, 362)
- (10) Photochemical reaction system for diagnosis and therapy of cancer (1984-1987, 306)
- (11) Immunological cancer diagnosis system (1985-1988, 306)

2. Welfare equipment technology

- (1) Modular-type motorized wheelchair (1976-1978, 226)
- (2) Braille duplicating system (1976-1978, 143)
- (3) Gait pattern analyzer for the handicapped (1976-1978, 161)
- (4) Multifunctional bed for the severely handicapped (1976-1978, 101)
- (5) Middle ear implant (1978-1982, 429)
- (6) Guidance device for the blind (1979-1983, 366)
- (7) Vocal and speech training device (1979-1983, 346)
- (8) Power driver artificial wheel leg (1980-1985, 427)
- (9) Chair capable of 3-dimensional movement (1981-1985, 297)
- (10) Book reader for the blind (1982-1988, 585)
- (11) Transfer supporting system for the handicapped (1983-1988, 522)
- (12) Automated body temperature adjuster (1984-1988, 272)

Measures for Regional Technology Development

1. Specific Regional Technology Development System  
(Regional Large-Scale Projects; see table below)

This system was inaugurated in 1982 to promote regional technological development, and executes 7 projects in 7 areas in 1989.

2. System of Advanced General Regional Technology Development

This system promotes joint research for development to introduce advanced technology into local areas.

### 3. Regional Technical Cooperation Promotion Projects

Major projects under this heading include:

- (1) Expansion of AIST's "Research Information Processing System (RIPS)" network to include regional research institutes, with the aim of closing "research information gaps" between different localities;
- (2) Preparation of a high technology application manual containing research information and know-how on advanced industrial technology, gathered by regional research institutes of AIST;
- (3) Promotion of joint research and cooperation with local societies, as well as dispatch of researchers for technical instruction, seminars for technical learning for local researchers, and technical symposiums.

(Unit: million yen)

| Project Name  | Period (FY) | Total Expenditure | Budget for FY1989 | Outline of Project  | R&D Results   |
|---|-------------|-------------------|-------------------|---|---|
| Advanced refining of rare metals (Tohoku region)  | 1985-1989   | 500               | 24                | Development of sophisticated techniques for the effective separation and refining of rare metal elements from resources such as ores and smelting residues, which are generally difficult to separate chemically or physically.   | Polymer resins which selectively adsorb metal ions were developed and their separation efficiency toward rare metal ions was investigated. Separation and concentration of gallium, indium and platinum group metals were carried out using newly developed polymer resins. |
| Intelligent snow removing technology for cold regions (Hokkaido region)                   | 1987-1991   | 500               | 30                | Development of an advanced snow remover equipped with newest sensing and automatic control systems to promote safety, increase efficiency and decrease operating loads.   | Fundamental experiment on the obstacle detector using ultrasonic and laser was carried out. Detecting method using infra-red camera was investigated. Automatic-control system of snow remover was analyzed. Field test of snow fall sensors was performed.                 |
| Visual recognition and identification for flexible manufacturing systems (Chugoku region) | 1987-1990   | 400               | 28                | Development of a system to promote the efficient production of mechanical and electrical components in small lots of way many varieties through visual recognition of the components' position, shape, and surface properties, and a database consisting of the knowledge of skilled workers. | A method for recognizing the position and shape of a part on production line has been developed and tested together with an image retrieval method enhanced by the know-how of skilled workers.   |

|   |           |     |    |  |  |
|---|-----------|-----|----|--|--|
| Synthetic technology of artificial clay for high performance ceramics (Chubu region)            | 1988-1992 | 600 | 35 | Development of economical synthetic technology of highly pure and plastic kaolinitic clay for plasticizer and raw material of high performance ceramics.   | Research of several starting materials and synthetic conditions in hydrothermal processes to increase the yield of kaolinite. Manufacture of test piece from the kaolinite by using slip casting method.   |
| R&D on reutilization system technology of composite materials (Shikoku region)                  | 1988-1992 | 350 | 28 | For manufacturing valuable products from large FRP wastes, i.e., fishery boats and bath tubs; this project is aimed at developing automatic cutting and crushing apparatuses for wastes and constructing new re-utilization system from the crushed and separated composite. | Concerning the technologies of breaking, crushing and classification, the response of vibration at cutting was measured, and a crushing test was carried out by a shredder-type crusher. Concerning the technology of re-utilization, the present condition of re-utilization of inorganic components was investigated and the fundamental researches on re-utilization of the composite materials were carried out. |
| Advanced utilization of lime and lime-based compounds for materials development (Kyushu region) | 1988-1992 | 500 | 33 | Development of technology for advanced utilization of lime and lime-based compounds such as calcium carbonate, calcium silicate hydrates, apatites etc. for pigment and filler for paper, substitute for asbestos, filter medium, adsorbent, fixed bed for bioreactor, etc.  | Synthesizing conditions for coarse and platy particles of basic calcium carbonate with high dispersion characteristics, and for the stoichiometric hydroxylapatite were clarified. Effective absorption of heavy metal ion on synthesized calcium silicate hydrate was recognized.   |
| Advanced surface modification in material processing (Kinki region)                             | 1989-1993 | 600 | 12 | Development of technology on advanced surface modification for materials such as metals, plastics and ceramics for mechanical, electrical, magnetical, and optical surface functions.  | (Project launched in FY1989)   |

## The Human Frontier Science Program

Since the Industrial Revolution, technology has long been recognized as a method of conquering, managing, and controlling nature. Technological developments have helped us to move into scientific domains of higher temperature, higher pressure, higher speed and greater magnitude. As a result, our knowledge base as well as the range of human activities have greatly expanded. In the meantime, a variety of serious problems have surfaced which include increases in resource and energy consumption and the heavier load imposed on the environment as well as more intense man-machine conflicts. In order to ensure humanity greater prosperity in the 21st century, it is necessary to create a new system of scientific technology which will foster harmonious relationships with society and nature.

Based on these observations, it is believed that basic research on the precise mechanisms of organisms has the potential to become a driving force in developing various research areas and could become a treasure chest of scientific and technological seeds as it is expected to exploit the frontier of scientific technology for the 21st century.

Living organisms possess superior functional characteristics which have become extremely sophisticated and precise over a billion years of biological evolution. In contrast, only several hundred years have passed since the Industrial Revolution. Today's most advanced scientific technology is no match for the superior mechanisms of living organisms. If these superior biological functions were to be clearly elucidated and properly utilized, it would help to develop a new system of scientific technology characterized by "anti-pollution" and "energy saving," thus bringing humans an unlimited number of benefits.

### 1. Human Frontier Science Program

The Human Frontier Science Program is an international joint project in which basic research to elucidate superior functions of living organisms will be conducted in an attempt to utilize its results for the benefit of all human beings. Voices which call for Japan to contribute more in the field of basic research are growing stronger. In response in the international area to this, the Japanese Government proposed the Program at the Venice Summit in 1987 in an effort to exploit the scientific frontier of the 21st century. After the proposal was adopted at the Venice Summit, a feasibility study was conducted by experts from the Summit member nations in 1987 and 1988. The feasibility study was successfully concluded and the statement concerning the HFSP has been adopted in the declaration of the Toronto Summit held in June this year.

In response to this statement, the Japanese Government will provide 2.384 billion yen as the operating funds for the organization in 1989 fiscal year.

The Intergovernmental meetings composed of delegates from the Economic Summit member countries and the Commission of the European Communities were held for the purpose of reviewing the framework of the Program, taking into account the progress of the Program. At the second meeting, the Chairman's Summary on the Implementation Scheme of the HFSP was adopted, including the location of the organization (Strasbourg, France).

The organization for the implementation of the HFSP will be established this fall in Strasbourg, France. The organization will undertake the activities, that are, research grants, fellowships, and workshops.

## 2. Research and Development Program for the Elucidation of Biological Functions (250 million yen)

While promoting the Human Frontier Science Program, in order to develop Japan's faculty for basic research the Research and Development Program for the Elucidation of Biological Functions has been created, research is currently in progress at research facilities of the Agency of Industrial Science and Technology in an attempt to elucidate biological functions under investigation.

Toronto Economic Summit - Economic Declaration (excerpts)

Other Issues - Human Frontier Science Program

We note the successful conclusion of Japan's feasibility study on the Human Frontier Science Program and are grateful for the opportunities our scientists were given to contribute to the study.

We look forward to the Japanese Government's proposal for the implementation of the program in the near future.

Specific Examples of Application of Biological Functions

Example 1: Reasoning capability of the brain and machine translation system

Illustration: I **saw** a girl **with** a telescope. [Bold printed in italics]

(1) Computers currently in use do not have inferring capabilities and will simply replace English with Japanese words based on the information already inputted (i.e., English-Japanese dictionary). In the case of the above illustration, several different ways of translation are possible. First, depending on the meaning of the preposition "with," the sentence can be interpreted in two different ways: (a) "I saw a girl holding a telescope," or (b) "I saw a girl by means of a telescope." It is also possible to translate the same sentence into (c) "I cut a girl with a telescope." (A scene from a magic show), if the meaning of "saw" is interpreted differently. Accurate translation will not [be] possible unless the meaning of the sentence is determined from context through reasoning processes.

(2) It would be possible to develop machine translation systems if the reasoning capability of the brain were elucidated through comprehensive research on patterns of electric pulse transmission in the brain (physiological aspect), logic of thinking (psychological aspect) and computer simulation (information technology).

Example 2: Mechanism of muscle movement and energy-saving power system

If the mechanism by which chemical energy of ATP (adenosine triphosphate) is converted directly to kinetic energy without once being converted to thermal energy, it is possible to develop new anti-pollution, energy-saving power systems with significantly higher thermal efficiency.

Outline of Chairman's Summary on the Implementation Scheme of the International Human Frontier Science Program

### Introduction

It is proposed to implement the HFSP under the following framework during the initial experimental phase ending at the end of the third fiscal year (i.e., 31 March, 1992).

It is also proposed that, in parallel with the implementation of the Program, during its initial phase intergovernmental meetings will be held, as appropriate, for the purpose of reviewing the framework of the Program, taking into account the progress of the Program. The implementing arrangements for the Program at the later stage will be decided before the end of the initial phase.

#### 1. Significance and Basic Principles

The HFSP aims to make a further contribution by promoting, through international cooperation, basic research focused on living organisms.

It is expected that the elucidation of such biological functions, through state-of-the-art science and technology, will contribute greatly to human-kind by stimulating significant intellectual challenges, by providing seeds for the future scientific and technological development.

#### Basic Principles

- \*The training and support of scientists early in their career
- \*Interdisciplinarity
- \*Harmony with existing or future programs carried out by each country
- \*Flexibility in the Program's operation
- \*Research results should be made as public as possible, etc.

## 2. Research Areas

- i) Basic research for the elucidation of brain functions
- ii) Basic research for the elucidation of biological functions through molecular level approaches

## 3. Participation in the Management and Support to the Program

The Management Supporting Parties will initially be the Economic Summit member countries and the European Communities.

After the actual activities are initiated, the Board of Trustees will decide as to the acceptance of those desiring to join the Management Supporting Parties.

The Japanese Government will provide about 2.4 billion yen as the operating funds for the organization in the first fiscal year 1989. Further contributions in funds for the HFSP are planned by the Japanese Government from FY1990 onward. The Japanese Government expects these Japanese contributions to provide a stable foundation of basic funding for the initial phase of the Program.

The Japanese Government considers that it will be necessary for Management Supporting Parties to offer financial contributions besides initial contributions in kind.

The selection of the way of financial contributions will be at the direction of each Management Supporting Parties on condition of the approval of the Board of Trustees.

## 4. Implementation Scheme

A non-profit organization will be established in Strasbourg to implement the HFSP.

The Board of Trustees is responsible for the overall policy concerning the conduct and operation of the Program.

The Council of Scientists deliberates and decides on scientific matters related to the operation of the Program.

Decisions are made by two-thirds majority vote in principle.

## 5. Specific Contents of the Program Activities

i) Research Grants ... Subsidy of research expenses given to international joint research teams

ii) Fellowships ... Subsidy of travel and living expenses given to researchers conducting research outside of their own country

iii) Workshops ... Subsidy given to research meetings in which information exchange and discussion on the most up-to-date research accomplishments

## Consolidating Research and Development Systems Relating to Industrial Technology

### 1. Outline of Policy

If Japan is to make a significant contribution to the development of the world community in the 21st century while also developing the infrastructure needed for its own long-term growth, it needs to promote research and development activities that serve as a foundation for industrial development and to actively participate in international exchanges of industrial technology.

For this purpose, the "Law for Consolidating Research and Development Systems Relating to Industrial Technology" was enacted in May 1988 to facilitate the establishment of a framework which ensures coordinated promotion of research and development in most advanced industrial technology areas, development of large-scale research and development facilities, and upgrading of international cooperation in research activities.

Under this new law, the New Energy Development Organization (NEDO) was reorganized on 1 October 1988 as the New Energy and Industrial Technology Development Organization and given responsibility for undertaking industrial technology (1) research and development projects, (2) research facility development projects, and (3) international joint research grant projects.

### 2. Outline of the Projects

#### (1) Research and Development Program

In October 1988, NEDO took over three areas of research and development, 1) The National Research and Development Program (Large-Scale Program), 2) the Research and Development Program on Basic Technologies for Future Industries, and 3) the Research and Development Program on Medical and Welfare Equipment Technology, in order to carry them out in closer cooperation with the government, academic sector, and private industry in Japan and overseas in a comprehensive and efficient manner.

In FY1989, NEDO undertakes new themes such as High Performance Materials for Severe Environments, Underground Space Development Technology.

#### (2) Research Facility Development Program

This program is designed to establish basic research facilities required for the promotion of international research and development on advanced industrial technology which should be undertaken but which cannot be established or owned by individual companies or organizations due to the extremely high costs involved. Such state-of-the-art facilities are established through joint investments made by NEDO, local governments and private industry, and are then made available to domestic and foreign researchers at moderate cost. In cases where it is particularly difficult to establish basic research facilities due to the high level of research and development required, NEDO will also undertake to develop the needed equipment and support systems.

In FY1989, NEDO continues three research facilities, Ion Engineering Center, Research Center for the Industrial Utilization of Marine Organisms and Japan Microgravity Center, and undertakes new two research facilities, Applied Laser Engineering Center and Advanced Material Research Center.

### (3) International Joint Research Grants Program

This program is designed to promote creative research and contribute to the advancement of international exchange in the field of industrial technology. Under this program, research grants are awarded to international joint research teams which fulfill the following conditions:

1. In principle, each team must be composed of four or more researchers
2. Each team must consist of researchers of two or more different nationalities
3. The research organizations where the researcher's major activities take place must be located in two or more countries.

In FY1989, NEDO provides new grants to four selected joint research teams in the field of material functions.

### (4) New Program in FY1989 - International Research Collaboration Center

The International Research Collaboration Center is designed to provide assistance and cooperation to other countries undertaking research and development related to industrial technology. The activities of the center can be divided into the following three areas.

#### 1. International Research Cooperation

NEDO undertakes various types of industrial technology research and development projects together with research institutes in other countries. In FY1989, NEDO begins projects with Mexico and China for collection of valuable elements from brine water, and a project with Canada for hydro-cracking of heavy oil and tar sands.

#### 2. International Research Fellowship

Under this program, NEDO invites about 10 researchers every year from industrialized countries to work at laboratories which belong to the Agency of Industrial Science and Technology (AIST). The length of invitation is for between six months and one year. NEDO bears expenses for air transportation to and from Japan as well as provide living allowances to those participating in the program. In addition, NEDO assists researchers with respect to their housing in Japan and provide consulting services regarding daily life activities. Such assistance and services are also extended to other foreign researchers working at AIST laboratories.

#### 3. Researcher Training

NEDO undertakes a project to train young researchers, both Japanese and foreign, on research practices at national laboratories in Japan.

## International Cooperation in Research and Development

International research and development cooperation advances Japan's own R&D while contributing to the formation of harmonious economic ties with other nations.

AIST is therefore an active research partner with developed and developing countries alike.

AIST conducts joint research programs in the area of advanced technology with developed countries and invites foreign researchers. Besides, under the Institutes of Transfer of Industrial Technology (ITIT), AIST conducts joint research and exchange of researchers with developing countries.

Further, NEDO will start to help foreign researchers work and live in Japan smoothly since this year.

### 1. Cooperation with Developed Countries

#### (1) Invitation of foreign researchers

① AIST has established on program in FY1988 to provide foreign researchers with an opportunity to conduct research for a certain period of time with researchers at the institutes of the Agency of Industrial Science and Technology (AIST) in order to advance scientific and technological knowledge in their respective fields and to promote creative research and development in the open environment of the institutes.

#### 1. Qualifications

Generally, a researcher under the age of 35, holding a doctorate in science or engineering.

#### 2. Number and period of invited researchers

Approximately 10 persons for a period of one year

#### 3. Host institutes

Sixteen research institutes belonging to AIST

#### 4. Compensation

Round trip airfare, living expenses, housing allowance, family allowance and relocation allowance

#### 5. Japanese language course

A Japanese language course is given as a general rule at the beginning of the researcher's stay.

Besides Foreign Researchers can be invited to AIST laboratories by

- ② AIST accepts researchers in EC countries through Japan-EC Industrial Cooperation Center
- ③ Foreign Researchers are invited by a charitable trust called the Japan Trust Fund which is administered by the Japan Key Technology Center.
- ④ AIST has made a memorandum of understanding with National Science Foundation to accept up to 30 U.S. researchers a year to AIST laboratories.

(2) Joint Research Project

① Specific International Joint Research Projects  
(Research conducted jointly by AIST research institutes and research institutions in advanced countries)

| Name of Project  | Japanese Research Institute                      | Counterpart Research Institute | Country | Duration (Fiscal year) |
|--|--|--------------------------------|---------|------------------------|
| Research for development of new doped-SiO <sub>2</sub> glasses   | Electrotechnical Laboratory                      | C.F.N. - Saclay                | France  | 1985-1989              |
| Research on highly sensitive detection using stabilized lasers   | National Research Laboratory of Metrology        | PTB                            | Germany | 1985-1989              |
| Research on heat-resistant carbon-ceramics composite materials   | Government Industrial Research Institute, Kyushu | DFVLR                          | Germany | 1986-1989              |
| Research on optical microgas-sensors   | Government Industrial Research Institute, Osaka  | UCL                            | Belgium | 1987-1990              |
| Research on precision evaluation of new superconductors and development of precision measurement devices               | Electrotechnical Laboratory                      | NIST                           | USA     | 1988-1992              |
| Research on the synthesis of fluorine-containing hetero-cyclic compounds and evaluation of their biological activities | Government Industrial Research Institute, Nagoya | NIH                            | USA     | 1989-1992              |

② Research Grants to International Joint Research Team

In order to develop the future industrial technology and to contribute to the improvement of both domestic and international cooperation on researches and studies, the system is to promote international joint research team carrying out original research related material fields. This program is administered by the New Energy and Industrial Technology Development Organization.

(3) Bilateral Cooperation

AIST cooperates with developed countries such as United States, United Kingdom, West Germany, France through science and technology cooperation agreements, industrial cooperation talks and so on concerning joint research, exchange of researchers, and information.

| Country | Frame Work   | Year of Initiation | Field of Cooperation (Mutually Selected Areas)  |
|---------|--|--------------------|---|
| U.S.A.  | U.S.-Japan Conference on Natural Resources (U.J.N.R.)  | 1964               | Fire Research and Safety, Marine Mining, Marine Instrumentation and Communications, Marine Geology, Others  |
| U.S.A.  | Agreement between the Government of Japan and the Government of the United States of America on Cooperation in Research and Development in Energy and Related Fields | 1979               | Fusion, Coal Energy, Solar Energy, High-energy Physics, Other energy and energy-related research and development areas, as may be mutually selected.  |
| U.S.A.  | Agreement between the Government of Japan and the Government of the United States of America on Cooperation in the field of Environmental Protection                 | 1975               | Stationary Source Pollution Control Technology, Management of Bottom Sediment Containing Toxic Substances, Air Pollution-Related Meteorology, Others  |
| U.S.A.  | Agreement between the Government of Japan and the Government of the United States of America on Cooperation in Research and Development in Science and Technology    | 1988               | Life sciences, including biotechnology; Information science and technology; Manufacturing technology; Automation and process control; Global geoscience and environment; Joint database development; and Advanced materials, including superconductors. |

|                |   |      |  |
|----------------|---|------|--|
| United Kingdom | MITI-DTI Talks.   | 1988 | Superconductivity, Marine Technology Biotechnology, Others   |
| France         | Agreement between the Government of Japan and the Government of the French Republic on Cooperation in the field of Science and Technology         | 1974 | Marine Science and Technology, Biological and Medical Science and Technology, New Energy Technology, Energy Conservation, Others   |
| West Germany   | Agreement between the Government of Japan and the Government of Federal Republic of Germany on Cooperation in the field of Science and Technology | 1974 | Marine Science and Technology, Biological and Medical Science and Technology, Environmental Protection Technology, New Energy Resources, Transport Technology, New Materials, Data Processing, Information and Documentation, Mechanical Engineering, Others |
| Australia      | Agreement between the Government of Japan and the Government of Australia on Cooperation in Research and Development in Science and Technology    | 1980 | Experimental Petrology, Lower Atmosphere Physics, Fluidized Bed Combustion Technology, Vision Technology for Robots, Others  |
| Australia      | Cooperation between Japan and Australia in Energy Research and Development and Related Areas  | 1978 | Coal Technology, Solar Energy Utilization, Energy Conservation, others   |
| Canada         | Agreement between the Government of Japan and the Government of Canada on Cooperation in Science and Technology                                   | 1986 | Environment Technology, Energy Technology, Space and Communications, Computers and Robotics, Others  |
| Sweden         | Japan (AIST) - Sweden (STU) Research and Development Cooperation  | 1981 | Medical and Welfare Technology, Biotechnology, Materials (Polymer and Composite, Ceramics, Lignin), Others   |
| Italy          | Agreement between the Government of Japan and the Government of Italy on Cooperation in Science and Technology                                    | 1988 | New Materials, Biotechnology, Volcanology and Seismology, Physics Environment, Artificial Intelligence Energy  |

(4) Multilateral Cooperation

① International Energy Agency (IEA) Energy R&D Projects

MITI participates in cooperative research and information exchange under the Committee of Research and Development of IEA.

| 1989.8.                |   |                                      |
|------------------------|---|--------------------------------------|
| <u>Working Parties</u> | <u>MITI's Joining Implementing Agreements</u> | <u>Start of MITI's Participation</u> |
| End Use Technology     | •Advanced Heat Pump                           | April, 1979                          |
|                        | •Alcohol and Alcohol Blends as Motor Fuels    | February, 1986                       |
|                        | •Energy Conservation in Combustion            | April, 1984                          |
|                        | •(Advanced Fuel Cells)                        | (Autumn, 1989)                       |
| Renewable Energy       | •Bioenergy                                    | May, 1987                            |
|                        | •Wind Energy Conversion Systems               | April, 1978                          |
|                        | •Solar Heating and Cooling Systems            | October, 1977                        |
|                        | •Production of Hydrogen from water            | October, 1977                        |
| Fossil Energy          | •Coal Technology Information Service          | March, 1977                          |
|                        | •Coal/Oil Mixtures                            | March, 1981                          |
|                        | •Enhanced Oil Recovery                        | May, 1979                            |
|                        | •Atmospheric Fluidized                        | February, 1980                       |
| Fusion Power           | •(Reversed Field Pinches)                     | (Autumn, 1989)                       |
|                        | •Energy Technology System Analysis            | September, 1981                      |
|                        | •Energy Technology Data Exchange              | January, 1987                        |

② International Cooperation Projects proposed by the Working Group on Technology, Growth and Employment (Summit).

These projects will be carried out on an independent basis, separated from the Summit framework.

| <u>Projects promoted by AIST</u>                               | <u>Participants (Observers)</u>                |
|--|--|
| Photovoltaic Solar Energy                                      | Italy, France, Germany, UK, EC, (U.S.)         |
| Advanced Robotics  | France, U.S., UK, Germany, Canada, Italy, (EC) |
| VAMAS (Versailles Project on Advanced Materials and Standards) | UK, U.S., Canada, EC, France, Germany, Italy   |

③ Organization of Economic Cooperation and Development

AIST takes part in the Committee of Science and Technology Policy of OECD. In 1990, Technology/Economy Program (TEP) Symposium will be held in Tokyo under the auspice of CSTP.

2. Cooperation with Developing Countries

(1) Institute of Transfer of Industrial Technology (ITIT project)

(1) Joint Research for New Technology

Fiscal year: April - 31 March

| Name of Research Project  | Japanese Research Institute                               | Counterpart Research Institute   | Country                    | Duration (Fiscal year) |
|---|---|--|----------------------------|------------------------|
| 1. Study on precision finishing technology for curved surface                                 | Mechanical Engineering Laboratory                         | Nanyang Technological Institute  | Singapore                  | 1985-1989              |
| 2. Research on coal properties and coal-forming depositional environment                      | Geological Survey of Japan                                | Wuhan College of Geology   | People's Republic of China | 1986-1989              |
| 3. Effective utilization of lignin from pulping waste liquor                                  | Industrial Products Research Institute                    | Thailand Institute of Scientific and Technological Research                    | Thailand                   | 1986-1990              |
| 4. Research on stress corrosion cracking of metals in the tropics                             | Government Industrial Research Institute, Chugoku (GIRIC) | Research and Development Centre for Metallurgy                                 | Indonesia                  | 1986-1989              |
| 5. Research on sensing technology for cutting process information                             | Mechanical Engineering Laboratory                         | Korea Institute of Machinery and Metals  | Korea                      | 1987-1991              |
| 6. Research on geology and mineral resources of the collision zone in Pakistan                | Geological Survey of Japan                                | Geological Survey of Pakistan Ministry of Petroleum and Natural Resources      | Pakistan                   | 1987-1990              |
| 7. Research on techniques for analysing geologic structure from Landsat TM data               | Geological Survey of Japan                                | Center for Remote Sensing in Geology Ministry of Geology and Mineral Resources | China                      | 1987-1989              |
| 8. Research and development of ceramic colour and colour glaze containing rare earth elements | Government Industrial Research Institute, Nagoya          | Xian Yang Research and Design Institute of Ceramics                            | China                      | 1987-1989              |

|   |   |   |             |           |
|---|---|---|-------------|-----------|
| 9. Research for industrialization of thermomechanical pulping of oil palm by-metals | Government Industrial Research Institute of Shikoku     | Palm Oil Research Institute of Malaysia   | Malaysia    | 1987-1990 |
| 10. Research on metallic materials using quantitative stereology                    | Government Industrial Research Institute, Kyushu        | National Industrial Research Institute  | Korea       | 1987-1989 |
| 11. Measurement of three-dimensional objects and non-destructive testing            | Mechanical Engineering Laboratory                       | Research and Development Centre for Calibration, Instrumentation, and Metrology | Indonesia   | 1988-1990 |
| 12. Hydrogenation of palm oil components  | National Chemical Laboratory for Industry               | Palm Oil Research Institute of Malaysia   | Malaysia    | 1988-1990 |
| 13. Research for enhancement of reference sections of sedimentary basins            | Geological Survey of Japan                              | Mines and Geosciences Bureau  | Philippines | 1988-1991 |
| 14. Separation and refining of rare metal ores from China                           | National Research Institute for Pollution and Resources | Guangzhou Research Institute of Nonferrous Metals                               | China       | 1988-1992 |
| 15. Research on new coal combination technology by fluidized bed                    | Government Industrial Development Laboratory, Hokkaido  | Institute of Coal Chemistry, Academia Sinica                                    | China       | 1988-1990 |
| 16. Study on the effective utilization of neglected hydrocarbons                    | National Chemical Laboratory for Industry               | Korea Advanced Institute of Science and Technology                              | Korea       | 1989-1991 |
| 17. Air pollution assessment at tropical area, India                                | National Research Institute for Pollution and Resources | Centre for Atmospheric Sciences, Indian Institute of Technology                 | India       | 1989-1991 |
| 18. Research on utilization of natural zeolite                                      | Government Industrial Research Institute, Tohoku        | Mineral Technology Development Center   | Indonesia   | 1989-1992 |

② Joint Research for Transfer of Technology

| Name of Research Project  | Japanese Research Institute                      | Counterpart Research Institute                                       | Country                  | Duration (Fiscal year) |
|---|--|--|--------------------------|------------------------|
| 1. Research on evaluation for standard of large force                     | National Research Laboratory of Metrology        | National Institute of Metrology                                      | China                    | 1987-1990              |
| 2. Research on radio frequency signal standards                           | Electrotechnical Laboratory                      | Thailand Institute of Scientific and Technological Research          | Thailand                 | 1987-1989              |
| 3. Research on the utility of clay in China                               | Government Industrial Research Institute, Nagoya | Xian Yang Research Institute of Non-Metal Minerals                   | China                    | 1987-1989              |
| 4. Research on reliability of volume measuring instruments in the tropics | National Research Laboratory of Metrology        | Directorate of Metrology Industrial Technology Development Institute | Indonesia<br>Philippines | 1988-1990              |

③ General Research

| Name of Research Project  | Japanese Research Institute            | Duration (Fiscal year) |
|---|--|------------------------|
| 1. Research on plasticization of tropical and subtropical plant materials | Industrial Products Research Institute | 1987-1990              |

④ Joint Research with Other Advanced Countries

| Name of Research Project   | Japanese Research Institute | Counterpart Institute in Advanced Country | Counterpart Institute in Developing Country | Duration (Fiscal year) |
|--|-----------------------------|---|---|------------------------|
| 1. Research for development on exploration techniques for rare mineral resources | Geological Survey of Japan  | United States Geological Survey, U.S.A.   | Mines and Geo-Science Bureau, Philippines   | 1987-1991              |

(2) Promotion Program of Research and Development Cooperation

| Name of Research Project   | Japanese Research Institute  | Counterpart Research Institute  | Country                         | Duration (Fiscal year) |
|--|--|---|---------------------------------|------------------------|
| Research and Development Project of Machine Trans-lation System with Japan's Neighboring Countries | Electrotechnical Laboratory<br>Center of the International Cooperation for Computer-relation | China Software Technique Corporation<br>National Electronics Thailand and Computer Technology Center                | China<br>Thailand               | 1987-1992              |
| International Research Cooperation on Recovery of Valuable Resources in Brine                      | Government Industrial Research Institute, Shikoku  | Language Research Division<br>Agency for the Assessment and Application of Technology<br>Comision de Fomento Minero | Malaysia<br>Indonesia<br>Mexico | 1989-1994              |
|  |  | The Institute of Saline   | China                           |                        |

### (3) Bilateral and Multilateral Cooperation

AIST promotes bilateral cooperation with China, Korea, etc. through science and technology agreements and multilateral cooperation with ASEAN countries.

#### 3. NEDO International Research Exchange Center

NEDO has established the International Research Exchange Center to conduct the following three programs:

- ① international joint research program
- ② international research exchange program to invite foreign researchers in the long-term and help them do research and live in Japan smoothly.
- ③ On the Research Training Program to re-educate researchers in and out of Japan.

#### The Japan Key Technology Center

The Japan Key Technology Center, established in response to a proposal by the private sector, conducts activities directed at the overall improvement of the environment for private research and development in fundamental technologies.

##### (a) Capital Investment

The Center provides capital investment for researches carried out by companies established for joint research purposes. ('89FY ¥20.2 billion)

##### (b) Loan Service

The Center provides conditional interest-free loans to aid in reducing R&D related risks and costs. ('89FY ¥6.4 billion)

##### (c) Mediation in Arranging Joint Research

Mediation is performed for private companies wishing to conduct joint research with national research institutions.

##### (d) Execution of Consigned Research

The Center brings together experts from government, industry, and academia to conduct research consigned to The Center by private companies.

##### (e) Japan Trust International Research Cooperation Service

The Center has established a charitable trust called the Japan Trust Fund. The operating profits from this fund will be used to invite foreign researchers in key technologies to Japan.

(f) Research Information Service

The Center collects and sorts a wide variety of important research literature which is kept on file at national research institutes and other organizations.

(g) Surveys Service

The Center conducts various kinds of surveys to aid private-sector research in key technologies.

Promotion of Technological Development in the Private Sector

To encourage R&D by the private sector, tax incentives are offered for technological development as well as financing for the development of industrial technology (through the Japan Development Bank) and conditional loans for R&D projects, and what operates a research association is operated for promoting mining and industrial technology.

1. Tax Incentives for Technological Development

(1) The following tax incentives have been instituted (effective until 31 March 1990) for facilitating research and development in fundamental technologies. These cover a 15 percent maximum deductible for corporate or income taxes or 10 percent in ① below.

① Tax Method for Deducting Additional Research Expenses

These are deductible from corporate or income taxes, and are equal to 20 percent of the excess of current qualified R&D expenditures over the highest amount of the previous R&D expenditure.

② Tax Incentives for Promoting R&D in Fundamental Technologies

Also deductible from corporate or income taxes is seven percent of the cost of acquiring facilities for conducting R&D in fundamental technologies. Categories of facilities are stipulated in the Ministry of Finance Notifications - No 47 dated 30 March 1985, No 60 dated 31 March 1986, No 126 dated 29 September 1987, No 52 dated 31 March 1988, and No 58 dated 31 March 1989.

③ Tax Incentives for Promoting R&D by small and medium enterprises

Six percent of the cost of R&D by small and medium enterprises during the business year, applied selectively with ① above are deductible from corporate or income taxes.

(2) Tax Incentives for Mining and Industrial Technological Research Associations

A. Special depreciation allowances are given to members of research associations for acquiring fixed assets used in experimental research in promoting mining and industrial technology.

B. Condense recording, of down to one yen, of charges imposed by cooperatives for the acquisition of fixed assets required for the study of mining and industrial technology.

C. Tax reductions are given on fixed assets used for research.

(3) Special depreciation allowances are permitted for assets used in subject research.

(4) Donations to Research Corporations, by special permissions, may be calculated as losses.

2. Promotion of International Joint Research

In order to develop future industrial technology and improve both domestic and grant is given to international joint research teams in material fields. This program is administered by the New Energy and Industrial Technology Development Organization.

3. Conditional Loans for R&D Projects

Other conditional loans are available for R&D development of energy-saving technology and alternative energy technologies for petroleum and new power generation techniques.

4. Financing for the Promotion of Industrial Technological Development (Development of new technology) (Japan Development Bank)

Funds are provided at attractive interest rates for the commercialization of important industrial technologies and the construction of special structures for advanced basic research which will make a significant contribution to the advancement of industrial technology and play a key role in upgrading the industrial structure.

5. Research Association System for the Development of Mining and Industrial Technology

This system, taking into account the efficiency and importance of joint research by enterprises, gives legal status to cooperative research organizations producing technology related to industry and mining. It was started in May 1961 and 52 associations are currently active.

Outline of Finance System for the Promotion of Industry and Technology; Budget for FY1989

|   |  |  |  |                                     |
|---|--|--|--|-------------------------------------|
|   |  |  | Development of new technology  |                                     |
|   | Improvement of research facilities   |  | Development for commercialization  | Commercialization of new technology |
| Construction costs eligible for financing | Cost entailed in acquiring special buildings and structures for basic and applied research | <ul style="list-style-type: none"> <li>• Construction of demonstration plants</li> <li>• Trial manufacture of machinery and equipment</li> </ul> | <ul style="list-style-type: none"> <li>• Production line construction</li> <li>• Development of heavy machinery</li> </ul> |                                     |
| Ratio of financing                        | Approximately 50% of construction costs of works eligible for financing                    |  |  |                                     |
| Financing period                          | 15 years or less (in principle)  |  |  |                                     |
| Redeemable period                         | Two to three years (in principle)  |  |  |                                     |
| Budget for FY1989                         | 750,000 (million yen)  |  |  |                                     |

## Industrial Standardization

### 1. Outline

Promoting industrial standardization is one of AIST's most important tasks. By law, deliberations on JIS (Japanese Industrial Standards) are the responsibility of an AIST subsidiary organization, JISC (the Japanese Industrial Standards Committee).

Industrial standardization has contributed to the building of Japan's industrial infrastructure and helped rationalize production in its industries. JIS operates through deliberations by some 8,800 experts from industry and academia, as well as consumers. As all JIS are voluntary standards, it is essential that they reflect the opinions of all concerned.

### 2. JIS and JIS Marking System

Like many other countries, the purpose of JIS is to promote (i) improved quality and rationalized production, (ii) smooth and fair trade, and (iii) rational consumption through appropriate and rational "standards." Some 8,000 JIS are established at the end of FY1988.

The JIS marking system is used to encourage standardization. Under the JIS Marking System, following government inspection regarding quality control and other factors, authorized manufacturers are permitted to attach the JIS mark to products which belong to categories designated by the relevant Minister(s) as worthy of the mark, thus helping users and consumers to judge the quality and performance of the product. So far, some 1,100 items bear the JIS mark, and some 16,000 permits, including 100 approvals for overseas factories, have been granted.

There are two possible ways of obtaining JIS marking approval for foreign factories: procedure A and B, as explained in the note below.

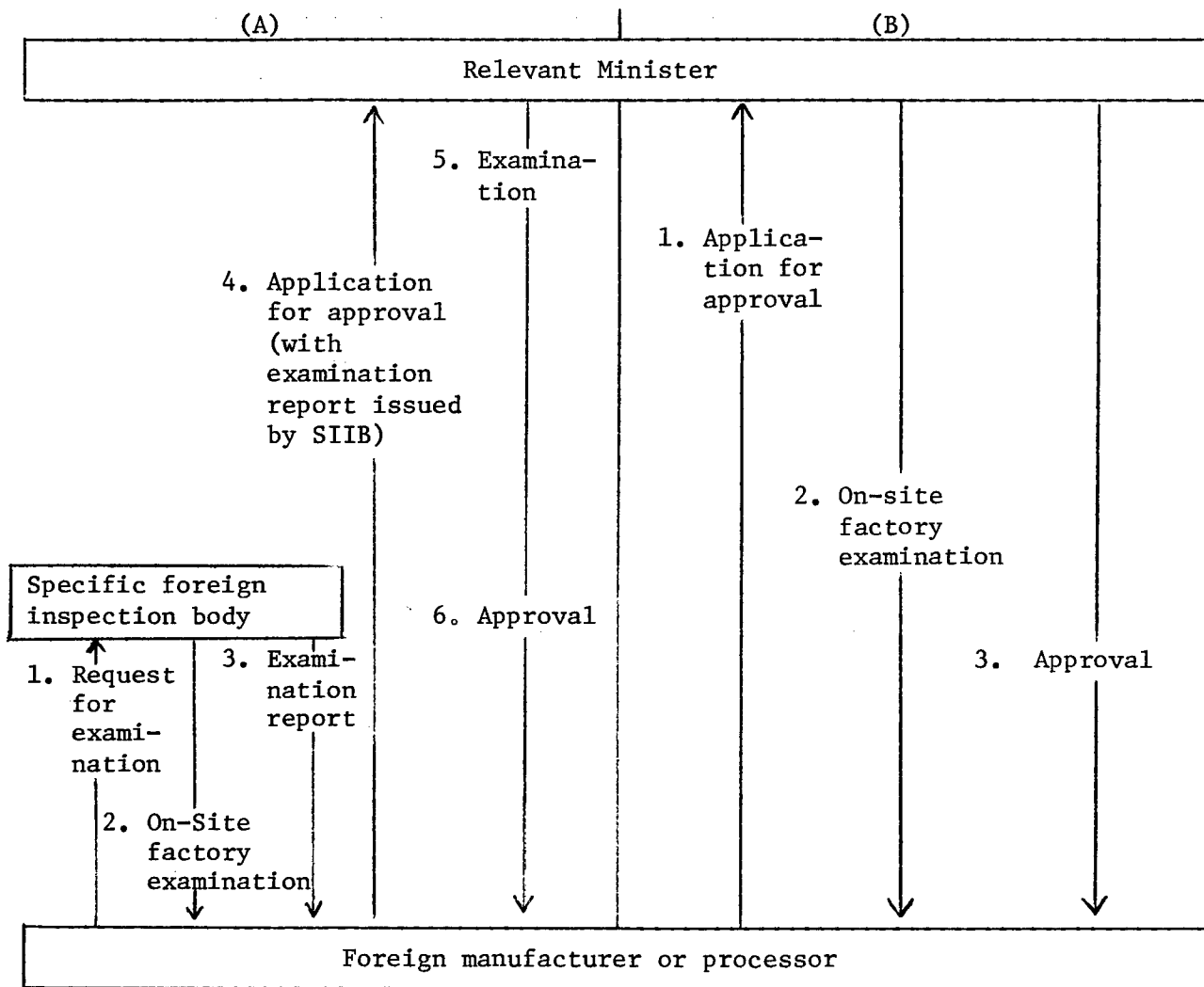
JIS Mark



Mark I

(Note) JIS Marking System for Foreign Products

A foreign factory seeking JIS marking approval may proceed according to scheme A or B.



3. International Standardization

(1) Participation in ISO and IEC

A large number of international standards have been established by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). Both organizations are involved in a wide range of activities. There were 7,107 ISO standards and 2,143 IEC standards at the end of 1988. The Japanese Industrial Standards Committee (JISC) is a member of ISO and IEC and has participated actively in ISO's work since 1952 and in IEC's since 1953. Whenever possible, JISC has

taken on important duties in the secretariats of the organizations' technical committees and sub-committees and has been active in promoting international cooperation and exchanges of technology and information.

At the 13th General Assembly of ISO was held in Tokyo in 1985, Mr Isamu Yamashita, vice-president of Keidanren, was elected the 14th ISO president. The first Japanese president of ISO, he served until 1988.

## (2) Technical Cooperation with Developing Countries

The Standards Department carries out technical cooperation in the field of Industrial Standardization and Quality Control. These cooperation are designed to help developing countries progress in industrial standardization and Quality Control in collaboration with the Japan International Cooperation Agency (JICA) and the Japanese Standards Association.

Three group training courses are conducted each year: a 3-month course on industrial standardization and quality control, a 2-month course on certification and inspection systems and a senior seminar on industrial standardization and quality control. Participants in these courses are officers in charge of standardization in government agencies or national standards bodies in developing countries.

Aside from holding training courses, the Standards Department sends experts and survey teams on Industrial standardization and quality control to developing countries upon request. And in order to transfer technology from Japan to a developing countries by means of training engineers and the governmental officials in charge of standardization and quality control in developing countries, a center for standardization is scheduled to be built, where Japanese experts will work for technical cooperation. The center will be a base to establish and promote standardization in the country. In 1989, five year cooperation plan isto start regarding to Industrial Standardization and Certification Test Center in Thailand.

## Technology Research and Information

### 1. Technological Surveys

In order for Japan to make sound economic progress and contribute to global welfare, it must deal successfully with a wide variety of issues, including trade friction, energy supply and employment. The creative and independent development of technology in a comprehensive and efficient manner will be indispensable to achieve these goals. In the planning and preparation of a reasonable and effective industrial technology policy, there is a need to come to grips with research and development both at home and abroad and to analyze industry and its problems while checking these findings against actual research and development in Japan.

To this end, AIST surveys trends in research and development, technology trade, and patents in Japan and overseas; the technology policies and development status of other countries, and more comprehensively, the important and urgent questions involved in the pursuit of creative and independent technological development.

In addition, technological assessments are carried out in order to study the various problems relating to technology and society and to propose appropriate counter measures.

#### (1) Domestic Surveys

AIST conducts a variety of surveys in Japan designed to gather information on trends in technological development and determine appropriate technological policies. These have included the "Survey of Conditions for Promotion of Technological Development" and "The Survey of Research Management Systems and Research Prospect Systems in Japan and Overseas, and Their Development."

#### Major Recent Themes

<Survey of Conditions for the Promotion of Technological Development>

\* Basic survey concerning development process of new technologies

<Survey of Research Management Systems and Research Prospect Systems in Japan and Overseas, and Their Development>

\* Survey for research forecast method by data retrieval

#### (2) Overseas Surveys

The Office of International Technology Research and Information was newly established in 1988 in order to expand and strengthen the functions of overseas surveys.

The office conducts collection and analyses of various overseas technological publications, reports and literatures as well as surveys and analyses of technological development and technological policies in advanced countries such as the United States and Europe in cooperation with JETRO and other organization.

These works are funded in part by the Special Coordination Fund for Promoting Science and Technology.

[Project of FY1988 funded by the Special Coordination Fund for Promoting Science and Technology]

\* Survey on the infrastructure for science and technology promotion in the United States and Europe

The Committee for Science and Technology Policy (CSTP) of the OECD conducts various Programmes including the exchange of experiences and information on science and technology policies of member countries in order [to] promote the international cooperation in the field of science and technology. AIST makes positive contribution to the activities of CSTP, participating in various conferences.

In May 1988, OECD started the 3-year Programme named TEP (Technology/Economy Programme) for the purpose of analyzing the inter relationship between science, technology, economy and society and also developing useful indices for the governments of member countries to plan, execute and evaluate the technology-related policy.

In this regard the Government of Japan will [host] an international conference for TEP in Tokyo in March 1990.

### (3) Technology Assessment

To make technology work for social progress while maintaining harmony between the natural environment and the economy, it is necessary to analyze and evaluate the potential effects of technology on our lives and to take appropriate measures to deal with them. In this way technological development will produce truly desirable results. AIST leads the way in conducting technology assessments of important and urgent technologies and tries to lay a foundation, through the development and propagation of TA methods, for its wide use in the public and private sectors.

#### Major Recent Themes (Themes for FY1988)

Basic survey of research and industrial promotion

#### 2. Propagation Activities

To enhance awareness of mining and manufacturing technologies and the industrial technology policies of AIST, the Agency publicizes its policies and the technological achievements made at its 16 research laboratories in its bulletin "ISAT (Industrial Science and Technology)." In addition, AIST issues "An Introduction to AIST," distributed domestically and overseas in both Japanese and English, in which on-going projects are described. AIST also publishes details of its work in the "AIST Annual Report." Newspapers, television, and radio are also used to report on the progress of AIST projects under way.

Points of "Trend and Themes of Industrial Technology" (Industrial Technology White Paper prepared in September 1988)

## 1. Current status of Japan's industrial technology

### (1) Technological level in the field of high-technology products

In these 5 years, the technological level was raised rapidly, and the survey has proved that approx. 90% of the 40 kinds high technology products reached the top level of the world or at least near its technological level, which include fine ceramics, semiconductor memory elements, household VTR, biotechnology products in use of micro-organisms, optical fiber and so forth.

### (2) Research level in the field of basic technology

Partly, some are found at the top level of the world, but relatively, most of such research still stays far behind. This is because the Government's R&D investment is rather limited and the attitude toward basic research is insufficient.

(Reference)

Government's sharing of R&D expenses:

|                 |                  |
|-----------------|------------------|
| Japan ... 19.4% | U.S.A. ... 46.8% |
|-----------------|------------------|

Ratio of Government's sharing of basic R&D expenses against GNP:

|                |                  |
|----------------|------------------|
| Japan ... 0.1% | U.S.A. ... 0.22% |
|----------------|------------------|

### (3) Status of international exchange of researchers

Exchange of researchers has been increasing year after year; acceptance of researchers is about 80% of sending of those. 3/4 of the latter are to advanced countries, while the former remostly from developing countries.

(Reference)

Researchers sent: 56,000 (those to advanced countries: 42,000)

Researchers accepted: 44,000 (those from developing countries: 37,000)

## 2. Future Themes

It is now the time of transit that Japan should actively tackle with fortifying basic and original research and making international contribution in the field of industrial technologies. Japan will be, therefore, required to positively challenge the basic and original R&D that may possibly lead to "technological innovation supporting the 21st century," and try to strengthen its international contribution through processes, outcomes and effects of such R&D.

## Diffusion of Technological Accomplishments

The Agency of Industrial Science and Technology registers as industrial properties both at home and abroad the technological developments of its 16 research laboratories and Several Projects under outside contact, and works to ensure their effective utilization and diffusion.

Patents and other industrial properties (collectively referred to as "patents")\* within the jurisdiction of AIST can be licensed to both domestic and foreign companies under certain conditions. They are (1) a license fee is paid, (2) the license is capable of using the patents and (3) the license is non-exclusive.

In October 1985, cabinet orders for budgets, settlement of accounts and accounting procedures were revised to permit the option of selling on a portion contract of the patents resulting from commissioned R&D to the commissioning party. This move was taken to encourage commissioned research by creating more of an incentive to take on commissioned work.

\* "patents" as used here refers to patents, utility models, designs and trademarks.

### 1. Patents Under AIST's Jurisdiction and their Licensing

The present status of patents under the jurisdiction of the Agency of Industrial Science and Technology as of 31 March 1989, is shown in the table below. The Agency is in charge of a total of some 18,300 patents, about 16,400 in Japan and about 1,900 abroad, which includes patents that are pending. Of the total, 762 patents are licensed to private and semi-private enterprises. The revenue from licensed patents totaled ¥324 million in fiscal year 1988.

#### Industrial Properties Under AIST's Jurisdiction (registered or pending as of 31 March 1989)

|                                       | Domestic <sup>1)</sup> | Foreign <sup>2)</sup> |
|---------------------------------------|------------------------|-----------------------|
| Laboratories                          | 9,544                  | 1,443                 |
| Commissioned research and development | 6,852                  | 462                   |
| Total                                 | 16,396                 | 1,905                 |

Note: 1) Total number of patents, utility models, designs and trademarks.  
2) Total number of cases.

## 2. System of Disseminating Technological Accomplishments

Permission to use patents under the jurisdiction of the Agency of Industrial Science and Technology, with the exception of some jointly owned patents, is granted to abroad segment of Japanese and foreign businesses by the Japan Industrial Technology Association (JITA).

JITA is a nonprofit foundation intended primarily to diffuse the technological achievements of the Agency of Industrial Science and Technology. The Association offers the services of engineering consultants, mediates in the conclusion and control of state-owned patents, gives briefings and publishes information on state-owned patents likely to be exercised in the near future, and otherwise works to publicize research results.

In a tie-up arrangement with the Research Development Corporation of Japan, JITA calls on it to promote application of unused state-owned patents.

In order to encourage the use in other countries of state-owned patents associated with high technology, JITA began in fiscal year 1983 to send high tech exchange missions overseas. AIST holds technological briefings for interested foreign companies and takes part in international exchanges of technology.

## Industrial Technology Council

### 1. Overview

The Industrial Technology Council (ITC) was established on 25 July 1973, as an affiliated institution of the Ministry of International Trade and Industry. ITC officials investigate and deliberate on important matters related to scientific technology in the mining and manufacturing industries in response to inquiries from the Minister of International Trade and Industry.

Conditions affecting Japanese technological development have changed in recent years. The time has come for Japan to develop original technologies in a way that can give full play to national ingenuity and creativity. Moreover, Japan is pinning high hopes on technological development as a means of enhancing the quality of national life, upgrading the domestic industrial structure and contributing to international society.

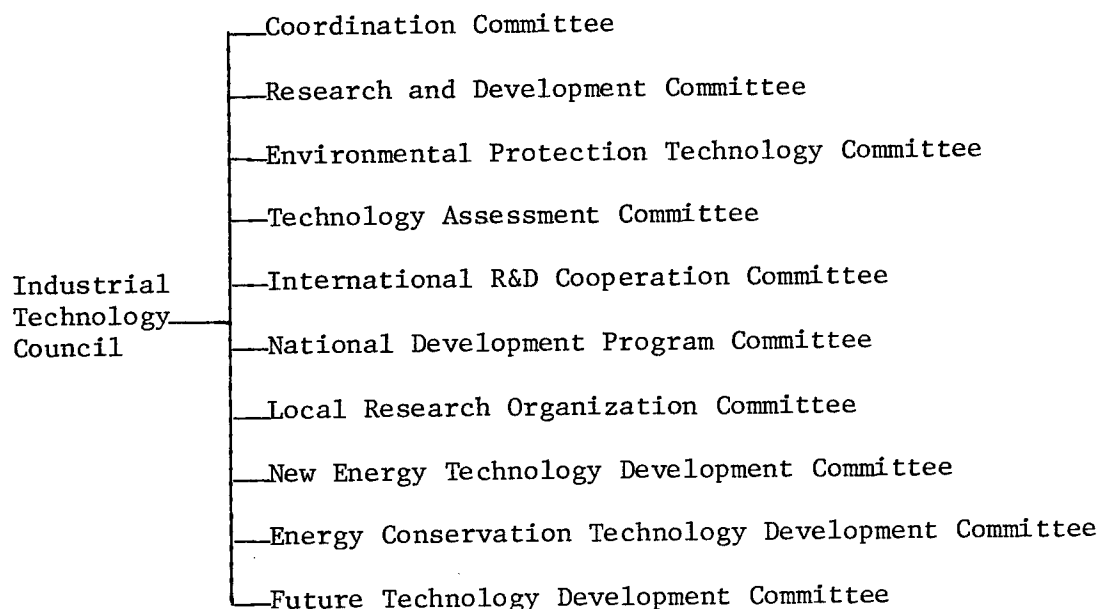
ITC is working on a broad range of issues related to technological development, which is sure to take on even more importance in the years to come.

### 2. Activities (Recommendations and Reports Since FY1982)

\* "New Evolution of the Sunshine Project" (Interim report of the New Energy Technology Development Committee, 23 August 1982)

- \* "Promotion of the Research and Development of Technology for Anti-cancer Equipment" (Interim report of the Medical Care and Welfare Subcommittee, Research and Development Committee, 6 October 1983)
- \* "R&D Policy" (Report of the Planning Subcommittee, Coordination Committee, 27 November 1984)
- \* "Future System of the Second Round" (Report of the Planning Subcommittee, Future Technology Development Committee, 24 June 1988)

Organization Chart of the Industrial Technology Council  
(as of 30 June 1989)



Recent Trends Involving AIST

Environment issues of global scale, which are recently represented by green house effect due to carbon dioxide and destruction of stratospheric ozone layer, may exert critical affect on industrial society and human life. In this sense, they are now arousing public interest remarkably.

Having great influence on the environment of global scale, Japan is expected to make utmost contribution with its outstanding technological development. In fiscal 1989, AIST established budgets for specific R&D on global environment and started to promote leading R&D for environmental issues of global scale at most appropriate AIST laboratories and institutes, which include mechanism explication of greenhouse effect and other environmental problems as well as synthesis of artifical light.

Concrete projects starting from FY1989 on solidification of carbon dioxide

Development of technology to solidify carbon dioxide with synthesis of artificial light (FY1989-FY1993)

(Purpose)

The project aims at developing the technologies to counter the measures for earth warming phenomenon caused by carbon dioxide by converting such carbon dioxide to other useful substances by means of sunshine light or other abundantly available energy and reducing it in the air.

(Laboratories and Institutes in charge)

\* National Research Institute for Pollution and Resources

Employing the available technology of solidifying or removing harmful components in the air, the Institute will develop technology to synthesize useful organic substances from carbon dioxide in use of photo- or heat-reacting catalyzers.

R&D on capability of seaweeds to solidify carbon dioxide (FY1989-FY1992)

(Purpose)

Among various photo synthesis in the sea water that may absorb considerable volume of carbon dioxide on the earth, seaweeds play the most important role. R&D is aimed at quantitatively explicating seaweeds' photo synthesis under classified conditions such as carbon dioxide concentration, kind of seaweeds, etc., finding natural corresponding capability against increase of carbon dioxide and working out the measures in use of the findings.

In this R&D, technological development is also to be made to determine the concentration of carbon dioxide in the sea water more simply and accurately with small volume of samples.

(Laboratories and Institutes in charge)

\* Fermentation Research Institute

Utilizing its own stocks of various seaweeds and findings of cultivation, the Institute will undertake R&D on photosynthesis activity of seaweed against increase of carbon dioxide.

\* National Research Laboratory of Metrology

Utilizing precise and accurate metrological technology, the Laboratory will develop the technology to measure seawater and so forth with small volume of samples.

R&D on capability of coral reef to solidify carbon dioxide (FY1989-FY1992)

(Purpose)

Solidification of carbon dioxide into calcium carbonate is considered important next to photo synthesis as solidification method of carbon dioxide in the natural world. This R&D intends to quantitatively explicate solidification of carbon dioxide by coral reefs through the survey of the carbon dioxide level in the past and formation of lime stone, and find the corresponding capability of the nature to the increase of carbon dioxide.

(Laboratories and Institutes in charge)

\* Geological Survey of Japan

Utilizing wide range of findings about lime stone and coral reef, it will carry out R&D on formation of lime stone and actual status of coral reef.

Buildup of technological model to minimize discharge of industrial carbon dioxide (FY1989-FY1992)

(Purpose)

The R&D aims at building up a certain engineering model that can fully evaluate the engineering technology of carbon dioxide discharge and, by means of it, clarify effectiveness of discharge minimizing technology and desirable setup of energy systems.

(Laboratories and Institutes in charge)

\* National Research Institute for Pollution and Resources, Electrotechnical Laboratory

They will build up the engineering model that can analyze the current status and make the forecast about demand and supply of various energy, relevant technological and economical activities of national level and acceptable volume of discharge in various environment, and indicatively handle characteristics and properties of energy application technology and environmental discharge control technology. By means of such achievement, they will make trade-off analysis of environmental discharge with technological economy and evaluation of feasible carbon dioxide discharge control technology. In addition, they will find the optimum state for trade-off and make clear the composition and technological properties of CO<sub>2</sub> low discharge energy system to realize such optimum state.

Laboratories and Institutes

Technology is a repository of great hope in today's world. At the research laboratories of AIST, work is carried on in developing the leading and basic technologies that will form the groundwork for future technological innovations.

## R & D

Research carried out at AIST laboratories and institutes includes the following characteristics.

- \* Research and development of leading technologies to form a base for future technological innovation.
- \* As national institutes, AIST facilities conduct research needed for the propagation of technical standards required for government administration, the establishment, maintenance and supply of standards, and the creation of sophisticated experimental methods.
- \* Research addressing social needs in earthquake prediction and environmental protection.
- \* Government support makes possible fundamental and comprehensive experimental research which would be beyond the resources of the private sector.

Research projects are classified into two broad categories: ordinary fundamental research, and special research. Research institutes under AIST have over 600 ordinary research themes and more than 100 special ones. These are further classified into 17 fields, such as electronics, earthquake prediction and biotechnology.

Six joint research programs are planned, mainly by several research laboratories in Tsukuba.

### The Tsukuba Research Center

In fiscal year 1980, nine research laboratories under AIST moved to Tsukuba Academic City to form the Research Center of the Agency of Industrial Science and Technology. Having previously been scattered over the Tokyo metropolitan area, consolidation of these nine institutions--National Research Laboratory of Metrology, Mechanical Engineering Laboratory, National Chemical Laboratory for Industry (formerly the Industrial Laboratory of Tokyo), Fermentation Research Institute, Research Institute for Polymers and Textiles, Geological Survey of Japan, Electro-technical Laboratory, Industrial Products Research Institute, and National Research Institute for Pollution and Resources, helped the Center forge closer relations among AIST institutions and supported the efficient development of advanced research activities.

#### 1. Project for Expanding Research and Information

To support research and development and permit more effective use of research and technological information and more advanced computerization and processing, AIST is developing system for promoting laboratory automation, constructing and expanding data bases on research and technology, and expanding networks, aided by the Research Information Processing System (RIPS), installed for joint use by AIST institutions at the time of their move to Tsukuba.

## 2. Project for Promoting Research Cooperation

AIST is taking a variety of steps to promote interaction between AIST institutes in Tsukuba, while stepping up private/public international technical exchanges and more effective use of research and technical information. This includes holding comprehensive symposiums and other forums at Tsukuba, accepting researchers from foreign countries and receiving technical trainees from local public entities and other organizations. These arrangements are aimed at strengthening research projects and encouraging studies in Japan.

## 3. Activities of RIPS (Research Information Processing System)

At the end of fiscal 1987, a large-scale, general-purpose computer system (FACOM M-780/20) and a super computer system (CRAY supercomputer XMP/216 and its IBM front-end processor 3090/18E) were installed as the third stage to meet increasing demands for high-speed calculations and large-scale memory capability. Furthermore, software for structural analysis, image processing, models of simulation and scientific calculations were installed in this system. In addition to the present one, a high-speed channel (EATHER-NET) enhanced the network among the laboratories. Now, RIPS is aimed at supporting the advanced, efficient research activities demanded by the AIST laboratories.

## Introduction of Individual Laboratories and Institutes

The National Research Laboratory of Metrology (NRLM) is the national institute for standards representing to length, time, mass temperature and related quantities in Japan, and takes the lead in unifying units and standards of various physical and engineering quantities for science and technology. The research work covers broad fields for the development and the improvement of standards. The NRLM is responsible for the setting of working standards and calibration of measuring instruments in compliance with the Measurement Law. The technical information services are also carried out. Another important responsibility is to promote international cooperation for metrological unification, in pursuance with the Metric Convention. The NRLM keeps close contact with the International Bureau of Weights and Measures, the International Bureau of Legal Metrology and the research institutes for standards in many countries. The major research projects of the institute are as follows:

1. Standards and Metrology (1) Basic standards of length, time, temperature and mass (2) Industrial standards of density, force, pressure, flow rate, vibration, shock acceleration, surface roughness, microparticles and viscosity.

2. Applied Precision Metrology (1) Precision measurement of laser frequency (2) Precision nonlinear spectroscopy (3) Precision long distance measurement (4) Nanometrology (5) High temperature thermophysical properties

(6) Thermal and mechanical properties of solids (7) Thermophysical properties of fluids (8) Precision dimensional metrology (9) Measurement system and evaluation (10) Reliability of measurement apparatus (11) Measurement for high temperature superconductivity.

National Research Laboratory of Metrology  
1-4, Umezono 1-chome, Tsukuba-shi, Ibaraki, 305  
Tsukuba Gakuen 0298 (54) 4118  
Senior Officer for Research Planning  
Total personnel: 219  
Total budget: 2,111 (million yen)

The Mechanical Engineering Laboratory (MEL) since its establishment in 1937 to encourage Japan's machinery industry has conducted R&D in key high-risk frontier technologies, and continues work on basic technologies in mechanical engineering. In expanding its activities, MEL's aim is to promote social development through the latest technology advances and systematization of mechanical science and technology. Based on national policy needs and the laboratory's own specialities, some of MEL's projects arranged according to their R&D fields are shown below:

1. Energy Technology (1) Wind power conversion system, (2) Super heat pump energy accumulation system, (3) Ceramic gas turbine, etc.
2. New Processing Technology (1) Ultra precision processing, (2) Processing of amorphous alloys, (3) Advanced processing and evaluation technology on long life components for atomic energy, etc.
3. New Material Technology (1) High performance materials for severe environment, (2) Application of damping alloys, (3) Solid state bonding of new materials, etc.
4. Mechanism (1) Locomotion technology in advanced robots, (2) Manipulation technology in advanced robots, (3) Diagnosis technique of power transmitting machine elements, etc.
5. Information Technology (1) Support system technology for advanced robots, (2) Optical information processing using innovative optical devices, (3) Computer aided analysis and design of jigs and fixtures for machining, (4) Prediction and prevention of traffic accidents, etc.
6. Control Technology (1) Intelligent control for machining, (2) Cybernetic machines (3) Design and control of machines in space, etc.
7. Bionics (1) The chemical messenger in brain, (2) Image reconstruction of optic tract structures, (3) Studies on motile molecular assemblies, etc.

Mechanical Engineering Laboratory  
2, Namiki 1-chome, Tsukuba-shi, Ibaraki, 305  
Tsukuba Gakuen 0298 (54) 2521  
Research Planning Office  
Total personnel: 279  
Total budget: 3,220 (million yen)

The National Chemical Laboratory for Industry (NCLI) was established in 1900 for promoting the chemical industry in Japan. The laboratory conducts numerous research projects in four areas: 1) development of new substances and highly functional materials; 2) bio- and biomimetic chemistry; 3) conversion and conservation technologies for energy and resources; and 4) standardization and safety technologies. Many strategies aiming first area are introduced in chemical reactions and processes for examples, ultra-high temperature plasma, ultra-high pressure, laser beams, computer-aided molecular design systems. For the elucidation and application of biological functions, the laboratory has developed technologies for genetic engineering, cell membranes, artificial and super enzymes, and artificial photosynthesis. In effective utilization of energy and natural resources, extensive studies are being made on catalysis technology, coal liquefaction, heat storage using chemical reactions, fuel cells, superconductors, membrane technology, and biomass utilization. Regarding the final area, intensive studies are also made on standardization of chemicals, as well as a means of controlling environmental pollution, eliminating industrial hazards, and preventing explosions of gases and explosives. The main research projects of the Institute are as follows:

- (1) Ultra-high temperature: generation, measurement and utilization,
- (2) Solid state polymerization under ultra-high pressure, (3) Laser regulated chemical reactions, (4) Development of organo-silicon compounds,
- (5) Research and development of superconducting materials and devices,
- (6) Research on the analytical and evaluational technology for high-quality functional materials by beam technology, (7) Advanced material processing and machining systems, (8) Synthetic membranes for new separation technology, (9) Research for morphogenesis and expression of genetic information, (10) Development of proteins with new function, (11) Liquefaction of coal: catalyst and analysis, (12) Super heat pump energy accumulation system, (13) Establishment of standards for metal and nonmetal ion reference solutions, (14) Prevention of gas explosions used in semiconductor industries.

National Chemical Laboratory for Industry  
1, Higashi 1-chome, Tsukuba-shi, Ibaraki, 305  
Tsukuba Gakuen 0298 (54) 4431  
Research Planning Office  
Total personnel: 355  
Total budget: 4,100 (million yen)

The Fermentation Research Institute (FRI) was established in 1940 with the objective of contributing to the development of industries involved with microorganisms. The Institute conducts a broad range of activities including the development of a variety of enzymes, techniques for biologically treating industrial waste water, and improved industrial processes related to microorganisms. Recent years have brought advances in such areas as recombinant DNA technology, bioreactors using immobilized enzymes and coenzymes, cell growth and gene expression control in cultured animal and plant cells, hydrogen producing microorganisms, the production of substances regulating cell function, the development of new enzymes and the

utilization of thus far unused resources. As the authorized depository for patent microorganisms in Japan, the Institute also handles the deposition and distribution of domestic and foreign strains of microorganisms.

Major research performed at the Institute centers on the areas below. Designated Research: Analysis of Regulatory Mechanisms of Cell Proliferation, Protein Molecular Assembly Technology, R&D on a New Water Treatment System, Fundamental Technology for Utilization of Marine Organisms, Basic Technology for Research and Utilization of Useful Biological Function, Research on Energy Conversion by Photosynthetic Microorganisms, Algal Potential for Carbon Dioxide Fixation, Molecular and Cellular Biological Study of Morphogenesis in vitro, Regulation of Plant Gene Expression, Molecular Mechanisms for Regulatory Protein Functions, Research on Photosynthetic Molecular Assembly, and Molecular Recognition and Response of Smooth Muscle Cells. Special Research: Carbohydrate Production from Phytomass, Application of Recombinant DNA Technology to Hydrocarbon Utilizing Soil Pseudomonads, Microbial Utilization of Hydrocarbons and Petrochemicals, Development of Plant Genetic Engineering, Production of Substances Regulating Cell Function, Construction of a Bioreactor, Efficient Treatment of Offensive Odors Using Microorganisms, and Flocculant Produced by Microorganisms. Special Coordination Funds for Promoting Science and Technology: Basic Investigation into Safety of Recombinant DNA Technology in Open System, Development of Useful Microbiological Resources and Prolonged Preservation, and Structural and Functional Elucidation of Regulatory Proteins of Cell Functions.

Fermentation Research Institute  
1-3, Higashi 1-chome, Tsukuba-shi, Ibaraki, 305  
Tsukuba Gakuen 0298 (54) 6023  
Technical Service Office  
Total personnel: 89  
Total budget: 1,105 (million yen)

The Research Institute for Polymers and Textiles was originally established in 1918 as the Silk Laboratory and in 1937 became the Textile Research Institute covering the entire area of textile technology. After the War, polymer science and technology was integrated into this research field, and the present name was adopted in 1969. The present organization was founded in 1988 comprised of four research departments, divided into 16 laboratories, plus an administrative department and a research planning office. In recent years, research activity has been focused on upgrading polymer materials, the synthesis of new functional polymers, bio-function utilizing technology and innovative technology for textile industries. And, future emphasis is to be placed on the development of functional materials based on molecular-level science. Main research items are as follows:

1. Synthesis and structuring of polymeric materials (1) Synthesis of ordered polymers (2) Organization of polymer surfaces (3) Synthesis of biologically functional polymers.
2. Functional Molecules (1) Photo-reactive polymers (2) Energy transforming polymers (3) Conductive polymers (4) Polymeric materials for specific separation.
3. Bio-functional materials (1) Structure analysis and molecular design of biopolymers (2) Biocompatible materials and pharmacologically active polymers (3) Biosensor and biodevice (4) Biomimetic materials.
4. Composite and high performance materials (1) Highly durable materials under extreme conditions (2) Light-weight strong polymeric materials (3) Polymer alloys.
5. Innovative systems and processing technology (1) Expert system for polymer design (2) Innovative processes with computer (3) Bioreactor.
6. Measurement and analysis of materials (1) Characterization and evaluation of polymers (2) Nondestructive evaluation techniques for polymeric materials (3) Weathering of polymeric materials.

Research Institute for Polymers and Textiles  
 1-4, Higashi 1-chome, Tsukuba-shi, Ibaraki, 305  
 Tsukuba Gakuen 0298 (54) 6229  
 Senior Officer for Research Planning  
 Total personnel: 125  
 Total budget: 1,539 (million yen)

Established in 1882, the Geological Survey of Japan is the only national research institute in the country concerned with the systematic investigation of geology and mineral resources. It is responsible for geological sheet mapping and for research on geology and various kinds of resources (metallic and non-metallic minerals, fuel, geothermal energy and groundwater) in the Japanese archipelago and adjoining offshore areas. Its work has contributed substantially to environmental conservation and to mitigating damage from geological hazards such as earthquakes, volcanic eruptions and landslides. The Survey also takes an active part in international research projects and technical cooperation efforts. Experts on geology and mineral resources are sent overseas and foreign trainees are admitted to training course in the Survey. In addition, the Survey provides technical guidance to other agencies, local governments and the general public. The results of its work are published in the form of various scales of geological and thematic maps, bulletins and special publications. Major research programs in each field are as follows:

1. Field of geothermal resources (1) Data analysis and evaluation of the confirmation study on the effectiveness of prospecting techniques for geothermal resources (2) Confirmation study of the effectiveness of prospecting techniques for deep geothermal resources (3) Basic study on nationwide and regional geothermal assessment, etc.

2. Field of utilization and development of resources (1) Study on metal concentration mechanism in the hydrothermal system (2) Marine geological study of the continental shelf along the eastern margin of the Japan Sea, etc.

3. Field of disaster prediction and pollution (1) The Geological study of earthquakes (2) Geological geochemical and geophysical study of active volcanos (3) Long range prediction model for changes in the shallow water environment to enable optimum industrial development use.

4. Field of geological study for atomic energy utilization (1) Geological study of deep underground disposal of high-levels of radioactive waste (2) Geochronological study on estimating fault activity, etc.

#### Geological Survey of Japan

1-3, Higashi 1-chome, Tsukuba-shi, Ibaraki, 305

Tsukuba Gakuen 0298 (54) 3575

Research Planning Office

Total personnel: 360

Total budget: 4,600 (million yen)

The Electrotechnical Laboratory (ETL) was founded in 1891 as a testing laboratory for electrical insulators under the Ministry of Communications. After several major organizational changes since then, including the separation of what was then called the Electrical Communication Laboratories, NTT, in 1948, the ETL now stands as the largest national research institute in Japan. For promoting future industrial science and technology, the ETL is responsible for conducting advanced research and development in electronics, standards and measurements, energy, and information and computer technologies. A list of ML ETL's notable achievements begins with the wireless telegraph, developed as early as 1896, and includes just, to name a few, Japan's first transistorized computer--the Mark IV (1959); the Kondo effect the way (1964), which later earned the London Award for Dr Kondo, ETL Fellow; the first genuinely data-driven computer SIGMA-1 (1987); the discovery of a new type of oxide superconductor and the development of 1 kbit Josephson RAM in 1988; and the record high-power excimer laser ASHURA (1989).

The ETL consists of 14 research divisions located in Tsukuba Science City and one research center in the Osaka area. Within 58 sections some 550 researchers, including approximately 250 Ph.D's are now actively working in the vast new frontiers of science and technology. The major research topics are: (1) Electronics fundamentals; physical studies on superconductivity, dynamics of elementary excitations, etc., development of new superconductors, opto-electronic materials, and amorphous semiconductors, VLSI technologies based on superlattice and three dimensional structures, advanced microfabrication technologies, supermolecular technology utilizing organic molecular assemblies, and biochemical and physiological studies on information processing in living organisms; (2) Standards and measurements; establishment and supply of national standards of electricity,

photometry, acoustics, and ionizing radiation and radioactivity, and advanced measurement techniques based on the uses of quantum effects and of sound and electromagnetic waves; (3) Energy-related technology; utilization of solar and other environmental energy sources, fuel cells and redox flow batteries, magnetically and inertially confined nuclear fusion, advanced laser technology, and superconductor application technologies; (4) Information and computer technology; cognitive science and its applications, artificial intelligence, pattern recognition, parallel processing computer architecture, software engineering, and intelligent robotics.

The ETL, keenly aware of the increasing importance of technical exchanges both with the private sector and academia, is also actively participating in a wide range of cooperative research efforts.

Electrotechnical Laboratory  
1-4, Umezono 1-chome, Tsukuba, Ibaraki, 305  
Tsukuba Gakuen 0298 (54) 5006  
Research Planning Office  
Total personnel: 690  
Total budget: 9,320 (million yen)

The Industrial Products Research Institute (IPRI), established in 1928, specializes in the field of improving the quality of life. Fundamental researches in this field are (1) biomimetic chemistry; (2) materials evaluation technology; (3) biometrics and sensor technology; (4) psychometrics and cognitive science. Those researches have been applied to development of materials and apparatuses for medical use, equipment related to human health and welfare, to design and evaluation of housing systems, and also to evaluation of consumer goods, by combining material and human engineering. Since we have various specialists in physics, chemistry, mechanical engineering, electrical engineering and electronics, information science, psychology, physiology, forestry, industrial design, and so on, IPRI is able to synthetically and systematically solve interdisciplinary problems, which might be difficult for an institute engaged in one specific field to solve. The current research topics are listed below.

1. Research related to materials and apparatuses for medical use, human health and welfare: (1) Biometric transduction of sensory information, (2) Fitness evaluation of above-knee sockets of artificial leg, (3) Three dimensional display for the blind, (4) Non-invasive measurement of functional decreases in humans, and etc.
2. Research related to housing systems: (1) Fundamental system technology for emergency in living space, (2) Psychological and physiological measurement of the influence of low frequency noise on the body, and etc.
3. Research related to consumer goods: (1) Measurement of human fuzzy information processing, (2) Research on the ergonomic design of visual display terminals, (3) Modelling of thinking process in conceptual design of products, and etc.

4. Special research projects: (1) Fundamental research on organic liquid and gas separation by membranes, (2) Research and development of advanced composite materials, (3) Development of sensing technique in automated sewing system, (4) Design of synthetic receptor molecules, and etc.

Industrial Products Research Institute  
1-4, Higashi 1-chome, Tsukuba-shi, Ibaraki, 305  
Tsukuba Gakuen 0298 (54) 6610  
Research Planning Officer  
Total personnel: 126  
Total budget: 1,391 (million yen)

The National Research Institute for Pollution and Resources, established in 1920, is concerned with a wide range of research fields related to exploitation, processing and utilization of mineral resources and natural energy resources, mining and industrial safety, and environmental protection. Research concentrating on safety maintenance in coal mines is also conducted at the Institute's Coal Mining Research Centers in Hokkaido and Kyushu (including the Usui Experimental coal mine). At the Institute extensive research efforts are focused on the following fields.

#### 1. Mineral Resource Development and Utilization

\* Exploitation and development of marine mineral resources off shore or in deep seabeds, such as manganese nodules, hydrothermal deposits and cobalt-rich manganese crusts.

\* Advanced construction technology for underground space utilization.

\* Production of new materials, such as functional silicon materials and ultrafine powder.

\* Processing and refining technology for low quality ore and unexploited resources, especially rare metals.

#### 2. Energy Development and Utilization

\* Comprehensive utilization technology for oil-alternative fuel resources such as coal, natural gas, oil sand, oil shale and biomass, including organic materials technology.

\* Advanced combustion technology utilizing various low-grade fuels and energy-saving technology.

\* Geothermal energy exploitation and heat extraction technology.

#### 3. Environmental Protection

\* Comprehensive industrial pollution control technology for elimination of emission, pollutants measurement and environmental assessment.

- \* Pollution control and measurement technology for newly developed chemicals.
- \* Advanced assessment technology for regional scales.
- \* Global environmental studies on climatic changes, acid rain formation and transformation of chemicals in the troposphere.

#### 4. Mining and Industrial Safety

- \* Coal mine safety technology, such as gas and coaldust explosions, mine-fire and gas outbursts to support the domestic coal mining industry.
- \* Safety assessment for utilization of underground space.
- \* Demolition of old constructions using explosives and its safety assessment.

National Research Institute for Pollution and Resources  
 16-3, Onogawa, Tsukuba-shi, Ibaraki, 305  
 Tsukuba Gakuen 0298 (54) 3026  
 Research Planning Office  
 Total personnel: 324  
 Total budget: 3,880 (million yen)

The Government Industrial Development Laboratory, Hokkaido (GIDLH) was established in 1960 an R&D institute for developing industries and mining in Hokkaido. GIDLH consists of three research departments. The Resources and Energy Engineering Department is engaged in a wide range of basic and applied researches in the field of energy and natural resources. The Applied Chemistry Department covers analytical chemistry, synthetic chemistry, and the chemistry field including life sciences. The Material Science and Technology Department is carrying out R&D in new and functional materials, the research on evaluation techniques for these materials and advanced utilization of these materials for cold regions.

In recent years, the GIDLH has been working on the following R&D projects:

1. Energy technology R&D: (1) Research in coal liquefaction and gasification, (2) Development of heat pump technology for cold regions.
2. Environmental protection R&D: (1) Development of materials for the removal of harmful discharge materials, (2) Evaluation of new snow tire having low dust pollution, (3) Utilization and processing of shredder dust from waste car treatment, (4) Development of combustion catalyst for reducing NOx.
3. New materials R&D: (1) Development of fine ceramics from silica found in rice husks, (2) Development of inorganic fibers and non-crystal materials with a high functional ability, (3) Development of a new preparation method for ultrafine particles.

4. Biomass and biotechnology R&D: (1) Synthesis of optically active substances by enzymatic reactions, (2) Construction of unique strains of yeast with hydroxylation ability on polyaromatic compounds by genetic engineering, (3) Advanced pyrolysis of biomass resources.

5. Regional technology R&D: (1) Intelligent snow removing technology for cold regions, (2) Development of sensing device for medical use for cold district.

6. International cooperation in R&D with developing countries: (1) New coal combustion technology with fluidized bed (China).

Governmental Industrial Development Laboratory, Hokkaido  
2-17, Tsukisamu-Higashi, Toyohira-ku, Sapporo-shi, Hokkaido, 004  
Sapporo 011 (851) 0151

Total personnel: 88

Total budget: 1,180 (million yen)

The Government Industrial Research Institute, Tohoku was established in 1967 as a research facility for developing mining and industrial technology for the Tohoku region. Initially, it conducted a major project on automatic processing for Kuroko ore which is abundant in the Tohoku district and its vicinity. Since then, it has made a names of research contributions ranging from utilization of regional resources to advanced technology areas, all stemming from the desire to develop industries in this region as well as share the responsibilities for national projects. In addition, since 1975, it has taken part in international joint research and development projects with various countries such as Thailand, Indonesia and China.

At the present time, research is focused on the following four fields:

1. Utilization of geothermal resources (1) Developing materials for geothermal power plants (2) Recovery of useful metals from geothermal hot water.

2. Utilization of regional resources (1) Developing advanced technology for the separation and refinement of rare metals (2) Research on separation and refining technique for biochemical materials from low utilized biomass (3) Technique for extracting lipids.

3. Development and evaluation of new materials (1) Research on energy-saving production for inorganic materials with high melting points (2) Research on development of nano-composites by intercalation (3) Research on evaluation of raw materials for fabrication by residual stress measurement (4) Research on a functionally gradient material by a self-propagating high temperature synthesis process.

4. International joint research (1) Research on separation and refining of rare metals produced in China (2) Research on utilization of natural zeolite.

Government Industrial Research Institute, Tohoku  
4-2-1, Nigatake, Miyagino-ku, Sendai-shi, Miyagi, 983  
Sendai 022 (237) 5211  
Total personnel: 54  
Total budget: 516 (million yen)

The Government Industrial Research Institute, Nagoya (GIRIN) was established in 1952 as a research center to contribute to the development of various industrial fields. It embraces six research departments, namely, Mechanical Engineering, Metallurgical Engineering, Chemistry, Radiation Research, Ceramic Science and Ceramic Technology, and has a staff of 246 and a budget of about 2.5 billion yen (as of fiscal year 1989).

Besides the main office and research laboratories in Nagoya, GIRIN has a branch concerned with traditional ceramic technology at Seto-city, which is well-known for being the longest producing of ceramic wares in Japan.

Since its establishment GIRIN has played an important role in developing industrial technology in such areas as machining, casting and foundry, synthesis of fluorine-containing organic compounds, application of radiation, development of new ceramics for industrial applications, and production technology of pottery and porcelain, and so on.

The institute is now conducting 42 research projects in conjunction with several national projects, such as the R&D Project on Basic Technologies for Future Industries, the Sunshine Project, the Moonlight Project, and so forth. The institute is also carrying out 51 basic research projects in fields under the following categories:

1. Advanced Ceramic Technology (1) Electronic Ceramics, (2) Engineering Ceramics, (3) Bioceramics, (4) Functional Composite Materials
2. Traditional Ceramic Technology
3. Utilization of Solar Energy
4. Energy Saving Technology
5. New Metals and Casting Technology
6. Global Environmental Protection Technology
7. Fluorine Chemistry
8. Radiation Physics and Chemistry
9. Biotechnology
10. Beam Technology

GIRIN has also been actively collaborating in international research projects, especially in the field of developing new materials.

Government Industrial Research Institute, Nagoya  
1-1, Hirate-cho, Kita-ku, Nagoya-shi, Aichi, 462  
Nagoya 052 (911) 2111  
Total personnel: 246  
Total budget: 2,544 (million yen)

The Government Industrial Research Institute, Osaka was established in 1918 as a comprehensive research institute to contribute mainly to the development of the chemical industry. The institute's objectives are to develop new materials and related measuring technologies. New materials have been developed in the fields of glass, ceramics, carbons, thin films, polymers and composite materials, and are being broadly applied in the optics, atomic energy, high temperature and electronics industries. Major research at the Institute is being corrected in the following:

1. New materials technology: creation of functional materials, fine ceramics, composite materials, biomimetic materials, search for material properties and new field of material measurement, creation of new resources, application of thus far unutilized resources.
2. Energy technology: hydrogen production technology, transportation and storage of hydrogen, utilization of hydrogen, advanced battery energy storage system, fuel cell power generation technology (molten carbonate fuel cell), technology for energy conservation.
3. Processing and systems technology: observation system for Earth Resources Satellite-1, advanced material processing and machining system, new water treatment system.
4. Anti-pollution technology: automation techniques for monitoring pollution in lakes, high performance materials for treatment of hazardous waste, composite materials preventing low-frequency sound. GIRIO also emphasizes various kinds of research like technology for peaceful use of atomic energy and medicine.

\* Main equipments: ion implantation machine, high resolution transmission electron microscope (analytical version), hot isostatic press, ESCA-Auger analyzer, picosecond laser, ion accelerator, high resolution NMR.

Government Industrial Research Institute, Osaka  
8-31, Midorigaoka 1-chome, Ikeda-shi, Osaka, 563  
Ikeda 0727 (51) 8351  
Total personnel: 221  
Total budget: 2,560 (million yen)

The Government Industrial Research Institute, Chugoku was established in 1971 to conduct pollution control studies in the Seto Inland Sea and engineering studies to develop new industrial technology in the Chugoku district. Since then, there have been many noteworthy achievements by the Institute results, including research on dissolution of polluted sediment in the Seto Inland Sea, development of a fresh surface characterizing microscope using exo-electron, and materials evaluation in severe environments.

Two research departments, the Marine Science and Technology Department and the Industrial System Department, are affiliated with the Institute. The first has four research divisions, and studies ocean engineering using

the largest hydraulic model of the Seto Inland Sea in the world, shown in the picture [picture omitted], as well as physical, chemical and biological oceanographies. The second has three research divisions, and studies machining technology, the surface science of new materials and computer science in factory automation.

The institute also conducts marine biology studies under a major national R&D program, a materials study of hydrogen energy and ocean thermal energy conversion (OTEC) under national R&D projects focusing on new energy, computer image processing studies for developing specific regional technology and international joint research with Indonesia in the area of corrosion.

Government Industrial Research Institute, Chugoku  
2-2, Hirosehiro 2-chome, Kure-shi, Hiroshima, 737-01  
Kure 0823 (72) 1111  
Total personnel: 52  
Total budget: 678 (million yen)

The Government Industrial Research Institute, Shikoku was established in 1967 as a R&D center for developing mining and industries in the Shikoku region, taking advantage of its mild climate and location near the sea and rich forest resources. Its R&D centers upon pulp and paper technology and in developing marine resources, it is primarily concerned with extraction and uses of minor elements dissolved in sea water, and underwater welding and cutting.

Balancing its regional and national interests, the institute has emphasized research in marine resources, functional resources and mechatronics. Furthermore, our institute is the leader in the Shikoku region for research and technologies.

1. The major research areas of the Institute are as follows:

(1) Manufacturing process of high-functional chemicals from sealife  
(2) Developing excellent absorbents for uranium and lithium (3) Developing functional sheets from acidic polysaccharides, the main constituents of seaweeds (4) Research on mooring lines for OTEC (Off-shore-Thermal-Energy-Conversion) system

2. Local Technologies

(1) R&D on re-utilization system technology of composite materials  
(2) Control of a flexible long arm and development of a small active mass damper (3) Swing and vibration control of a crane (4) Manufacturing of multicomposite fine particle by the laser spraying method (5) Utilizing chitinous polymer

### 3. International R&D cooperation projects and fundamental research

(1) Research on industrialization of thermomechanical pulping of oil palm by-products (2) International research cooperation on recovery of valuable braine sources (3) Molecular mechanism of interactive recognition between cell surface and polysaccharides (4) Manufacturing degradation-controlled sheet.

Government Industrial Research Institute, Shikoku  
3-3, Hananomiya-cho 2-chome, Takamatsu-shi, Kagawa, 760  
Takamatsu 0878 (67) 3511  
Total personnel: 44  
Total budget: 486 (million yen)

The Government Industrial Research Institute, Kyushu was established in 1964 to contribute to developing mining and industries in Kyushu.

The institute has conducted 17 special research and 35 general research projects in the following major fields:

1. Production and processing technologies for new materials (1) Study of ductile ceramics at high temperatures (2) Development of intelligent ceramic composite materials (3) Research on fabrication and thermal characterization of heat resistant carbon-ceramic composite materials (4) Machining technology in ceramics and cutting tool application (5) Development of ceramic cutting tools for steel (6) Development of high-performance engineering carbons (7) Development of advanced carbon/carbon composites with oxidation resistance (8) Technology for improving properties of materials by the powder forming method (9) Development of particle dispersed composite metals by high pressure solidification method (10) Research on metallic materials using quantitative stereology (11) Study of production of multifunctional microspheres (12) Study of spectroscopic characterization of ceramics

2. Advanced technology for utilizing natural resources (1) R&D utilizing lime and lime-based compounds in advanced materials (2) Processing and evaluation of inorganic polymer having layer structure (3) Production of porous ceramic materials from rice husks (4) Advanced utilization of volcanic glass (5) Production and utilization of molecular sieves from coal (6) Research on concentration a trace amount of gallium (7) Refining process of fine parts of weathered granite

3. Energy and pollution control technologies (1) Study of the behavior of coal and solvent mixtures in the initial stages of coal liquefaction (2) Hot-gas corrosion of ceramics for gas turbine blades (3) Development of new muffler adaptable with controlled resonators (4) Research on the advanced biological treatment of organic waste water (5) Liquefaction of coal and extraction of liquefied products under the condition of super-critical state

Government Industrial Research Institute, Kyushu  
Shuku-machi, Tosu-shi, Saga, 841  
Tosu 0942 (82) 5161  
Total personnel: 90  
Total budget: 946 (million yen) - END -

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