Three Research Objectives

1. Cost reduction and ensuring reliability
2. Creation of integrated energy service
3. Harmonization of energy and environment

Organization of the Central Research Institute of Electric Power Industry

[Head Office]
- General Affairs Group
- Management Planning Group
- R&D Planning Group
- Public Communications Group

[Central CS Promotion Office]
- CS Planning Division
- CS Promotion Division

[Research Laboratories and Centers]
- Socio-Economic Research Center
- Human Factors Research Center
- System Engineering Research Laboratory
- Nuclear Technology Research Laboratory
- Nuclear Information Center
- Low Dose Radiation Research Center
- Civil Engineering Research Laboratory
- Nuclear Fuel Cycle Backend Research Center
- Environmental Science Research Laboratory
- Solution Center for Environmental Issues
- Electric Power Engineering Research Laboratory
- High Power Testing Laboratory
- Shiobara Testing Yard
- Energy Engineering Research Laboratory
- Materials Science Research Laboratory
- Akagi Testing Center
- Komae Operation & Service Center
- Abiko Operation & Service Center
- Yokosuka Operation & Service Center
- Administrative Operations Center

Research Projects Implemented in Fiscal 2004

Total: 925 projects
- In-House Research: 371 projects
  (Promotive Subjects: 17 Subjects)
  (Base Research Subjects: 58 Subjects)
- Researches Commissioned by Electric Utilities and National Government: 554 projects

Staff Strength in Fiscal 2004

Total (not including executives) 802
- Research Staff 675
- Administrative Staff 127

Fiscal 2004 Expenditures

Total Expenditure 35.08 billion yen
- In-House Research and Research Commissioned by the Electric Utilities
  - Research Expenditure 15.98 billion yen
  - Equipment Expenditure 4.90 billion yen
  - Personnel & Overall Expenditure 7.32 billion yen
- Research Commissioned by National Government 6.88 billion yen

2004 Framework for Research Subjects

1. Socio-economy
   - Support for management strategies
   - Clarification of management environments

2. Environment
   - Environmental risk assessments
   - Measures to regional environmental problems
   - Coexistence with the environment

3. Energy Services for Customer
   - Energy conservation and comfortable environment design
   - Application of energy storage technologies

4. Power Delivery
   - Cost reduction and ensuring reliability of power delivering
   - Harmonization of power delivery systems and society
   - Development of new technology of transmission facilities

5. Nuclear
   - Improvement of economics and reliability of LWR power Generation
   - Fast breeder reactor
   - Concept of advanced reactors

6. Fossil Fuel Power Generation
   - Diversification and clean utilization of fossil fuels
   - Improving the efficiency of thermal power generation

7. New Energy
   - Utilization of natural and unutilized energy
   - Utilization of hydrogen energy

8. Information and Communication
   - Utilization of communication networks
   - Utilization of information technology

9. Construction and Preservation of Electric Facilities
   - Measures against natural disasters
   - Rationalization of construction and maintenance of electric facilities

10. Advanced Basic Technologies
    - Computer science
    - Bio-science
    - Material science
    - Nanotechnology
    - High temperature super conductivity
    - Earth science
    - Laser and plasma science

Promotive Subjects for Three Research Objectives and Base Research Subjects in Ten Fields
In the energy market which has begun the path to free competition due to the progress of deregulation, not only electric utilities but also those engaged in self-generation, wholesale of electricity and PPS are now required to conduct their business activities while harmonising economic viability and a stable supply with global environmental issues.

The Central Research Institute of Electric Power Industry (CRIEPI) has long understood these issues as a trilemma and has been acting as a general research organization engaged in all energy-related fields. Since FY 2004, the research structure has been reorganized based on specialist fields to prioritise the research themes and to consolidate the basic research.

Meanwhile, conscious efforts are being made to enhance CS activities, including merchandise development and entrusted research work as well as the consultation function in response to the actual demands with a view to positively contributing to society and solving environmental problems. Through these activities, the CRIEPI aims at establishing itself as “a reliable research institute” for electric utilities as well as electrical manufacturers, other industries, the government and society at large.

The Annual Research Report 2005 outlines the results of the principal research conducted in FY 2004. We would be extremely pleased if this publication further enhances the understanding of the CRIEPI’s activities on the part of its researchers and most grateful for their valuable opinions.
Principal Research Results

In fiscal 2004, the CRIEPI conducted a total of 925 research projects, focusing on the achievement of three goals, i.e. “cost reduction and ensuring reliability”, “creation of integrated energy services” and “harmonization of energy and environment”. Of these 925 projects, the results of 59 projects are compiled in this Annual Report 2005. We believe that these projects particularly contribute to solving a number of technological and economic problems faced by electric utilities. They were selected according to the following criteria and are presented here as our principal research results.

- Projects with a particularly high value in terms of innovation, creativity, scientific and technical achievements, economic efficiency and practicality
- Projects which are timely in view of the current socioeconomic and energy situations
- Projects which demonstrate the CRIEPI's abilities, such as our general R & D capability and expertise in basic as well as exploratory research

We will be greatly honoured if the reader finds the research results introduced in the Report useful to facilitate the further advancement of knowledge and technology.

Shirabe Akita, Chairman
Annual Research Report 2005 Editing Committee
On the Publication of the Annual Research Report 2005

Principal Research Results

Contents

I. Principal Research Results

Promotive Subjects

A. Cost reduction and ensuring reliability

[Diagnosis and life evaluation of power delivery apparatus]
(1) Reduction of Video Data Obtained from Aerial Inspection of Wire ........................................ 2
(2) Lifetime Evaluation for Distribution Transformers with Over Loaded Condition ........................................ 4
(3) Diagnosis of Water Tree Deterioration for Service Aged XLPE Cables
   -Study on Detection Technique of Very Small Signals for On-line Monitoring- ........................................ 6

[Maintenance and management of light water reactors]
(4) Evaluation of Fracture Toughness for Japanese Reactor Pressure Vessel Steel using Master Curve Method ........................................ 8

[Non-destructive methods for assessing power generation components and steel structures]
(5) Development of Crack Propagation Remaining Life Assessment Procedure and Analysis System ........................................ 10
(6) Development of Analytical Life Evaluation Method for 1300˚C Class Gas Turbine Blades ........................................ 12
(7) Development of Multifunctional Ultrasonic Inspection System and Numerical Modeling of
   Wave Propagation for Detection and Sizing of Flaws in Field Pipes with High Accuracy and Efficiency ........................................ 14

[Maintenance technology of electric facilities based on risk management approach]
(8) Development of Methods to Estimate the Seismic Source Model for Prediction of
   Broadband Strong Ground Motions ........................................ 16

B. Creation of integrated energy service

[Comprehensive evaluation for diffusion effects of distributed power generation]
(9) Development of a GIS-based Air Quality Modeling System
   -A Software Tool for Predicting Air Pollution Levels in Urban Areas- ........................................ 18

[Design of demand area network]
(10) Demonstration Test of Fast Separation and Islanding Prevention Methods on Fault Section in ADAPS ........................................ 20
(11) Development of Pilot Demand Supply Interface (DSIF)
   -Verification of System Function in Anonymous Demand Area Power System- ........................................ 22

[Development of SiC power diodes]
(12) Fabrication of High Performance 4kV SiC Schottky Barrier Diode ........................................ 24

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(13) International Climate Regime after Kyoto Protocol
   -Scenario for Future Framework Centering around Technology Development and Diffusion- ........................................ 26
[Development of prediction method and countermeasure against global warming]

(14) Multi-century Global Warming Projections under CO₂ Stabilization and Overshoot Scenarios

(15) Evaluation of CO₂ Uptake Amount by a Deciduous Forest by Advanced Flux Measurement Technique

(16) Estimation of CO₂ Sequestration Rate by Mangrove Ecosystem

(17) Effect of in-situ Iron Fertilization on Phytoplankton Growth and Biological Carbon Fixation in the Ocean

[Development of metallic fuel and pyro-process fuel cycle]

(18) Development of New Pyro-processing to Recover Purified UO₂


[Assessment of biological effects of low-level radiation]

(20) Acquisition of Radioresistance in Mice Induced by Low Dose-rate Long Term Gamma Irradiation

- Enhancement of Hematopoiesis and Reduction of DNA Damage -

[Development of storage technology for spent nuclear fuel]

(21) Development of Evaluation Method of Salt-induced Deterioration of Reinforced Concrete Casks under High Temperature

(22) Heat Removal Verification Tests Using Concrete Casks

[Development of technology for radioactive waste disposal]

(23) Development of Controlled Drilling Technology for Efficient Geological, Hydrological and Mechanical Surveys

[Effective utilization of biomass energy]

(24) Development of Performance Evaluation Techniques for Biomass Gasification Power Generation System

Base Research Subjects

1. Socio-economy

[Support for management strategies]

(25) Residential Customers’ Choice and Customer Equity of Electric Power Suppliers in Japan, the UK and the US

[Clarification of socioeconomic trends]

(26) Development and Practical Applications of the Safety Ensuring System

- Proposal of a Monitoring Method for the Safety Level of an Organization -

(27) Outlook for the Japanese Economy and Energy up to the Year 2030

(28) Institutional Fragility of Japanese Nuclear Legislations and Some Amendment Proposals for Their Improvement

2. Environment

[Measures to regional environmental problems]

(29) Intercomparison Study of Transboundary Air Pollution Models for East Asia (MICS-Asia)


(31) Evaluation of Biological Effects of Intermediate Frequency Magnetic Fields
3. Energy services for customer

[Energy conservation and comfortable environment design]
(32) Performance Test of Non-Intrusive Electric Appliances Load Monitoring System
   Using Harmonic Pattern Recognition ................................................................. 64

4. Power Delivery

[Cost reduction and ensuring reliability of power delivering]
(33) Scheme of Power System Stability Enhancement using Margin to Apparatus Limitation
   - Verification of Power System Stability Improvement using Higher Voltage Control on
     IEEJ WEST 30-machine System Model- ............................................................ 66
(34) Comparative Evaluations of Various Transmission Line Congestion Elimination Techniques
   for Bilateral Transaction
   - Development of an Evaluation Model from the Viewpoints of Fairness and Economic Efficiency- 68

[Harmonization of power delivery apparatus systems and society]
(35) Study on Lightning Damage Mechanism of Wind Power Generators ....................................... 70
(36) Simple Evaluation Method for Human Exposure to Non-uniform Magnetic Fields ......................... 72

[Development of new technology of transmission facilities]
(37) Development of a High-Tc Superconducting Power Cable with Long Length
   - Large Scale Verification Tests- ................................................................. 74

5. Nuclear

[Improvement of economics and reliability of LWR power generation]
(38) Development of Computational Flow Dynamics Code “MATIS-SC” for
   Steam Flow Calculation including Non-equilibrium Condensation ............................... 76
(39) Development of Versatile Methods to Estimate Kinetic Parameters for Various Kinds of Reactor .......... 78

[Concept of advanced reactors]
(40) Establishment of the Small Reactor Concept and Development of Related Innovative Technology .......... 80
(41) Transient Analyses of the Prototype Fast Breeder Reactor “MONJU” Performed
   by the Plant Dynamics Analysis Code CERES ...................................................... 82

[Nuclear fuel cycle]
(42) Development of Inspection System for Clearance Level (CLALIS) and
   Proposal of Reasonable Methods to Judge Satisfaction of Clearance ............................ 84
(43) Development of Evaluation Method for Chemical Alteration of Cementitious Materials
   in a TRU Waste Disposal Facility
   - A Coupling Transport and Chemical Equilibrium Calculation Code to Predict the Alteration Behaviour
   of the Fractured Cementitious Materials- ....................................................... 86

6. Fossil Fuel Power Generation

[Diversification and clean utilization of fossil fuels]
(44) Development of a Supporting System for an Optimum Coal Gasifier Operation ............................ 88

[Improving the efficiency of thermal power generation]
(45) Evaluation of Longer Life for MCFC Using Single-cells .................................................. 90

7. New Energy

8. Information and Communication

[Utilization of communication networks]
(47) Development of Reliable Communication Architecture Suited to Power System Control in the Liberalized Electric Power Industry

9. Construction and Preservation of Electric Facilities

[Measures against natural disasters]
(48) Development of a Method to Estimate Airflow within a Storm

[Rationalization of construction and maintenance of electric facilities]
(49) Probabilistic Considerations on Safety Factors for Seismic Stability of Foundation Grounds and Surrounding Slopes in Nuclear Power Sites
(50) Identification of Damping Factor of Foundation Ground of Nuclear Power Plants Based on Earthquake Observation Records
(51) Practical Seismic Safety Estimation Method of Reinforced Concrete Underground Structures Subjected to Strong Earthquake Motion

10. Advanced Basic Technologies

[Computer science]
(52) Numerical Simulation on Damping Characteristics of Lead Devices
(53) Precise Program Development of 3-dimension Analysis That Can Calculate Local Weather such as Down Winds

[Bio-science]
(54) Development of Nitrogen-Removal Bioreactor -Practical Application to Thermal Power Plants and Various Uses-
(55) High Density Cultivation of Cr(VI) Reducing Bacteria using Electrochemical Accumulation
(56) Development of Immunochromatography for Low-Level Cadmium Rapid Test -Application for Rice-

[Earth science]
(57) Influence of Plate Subduction and Trench Type Great Earthquakes on Crustal Deformation -Examination by Crustal Deformation Simulation-

[Nano-technology]
(58) Thin-Film Growth of Oxides Including Alkaline Metal by Pure Ozone

[Laser and plasma science]
(59) Development of a Simple Method for Visualization of High-Speed Phenomena

II. Research Activities in Fiscal 2004
1. Method of Conducting Research
2. Principal New Equipments
I. Principal Research Results

This Annual Report introduces the principal results of 59 projects conducted in fiscal 2004 in the following fields.

Promotive Subjects

A  Cost reduction and ensuring reliability
B  Creation of integrated energy service
C  Harmonization of energy and environment

Base Research Subjects

1  Socio-economy
2  Environment
3  Energy Services for Customer
4  Power Delivery
5  Nuclear
6  Fossil Fuel Power Generation
7  New Energy
8  Information and Communication
9  Construction and Preservation of Electric Facilities
10 Advanced Basic Technologies

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Note: The positions of the researchers listed in the principal research results are as of the end of September, 2005.