FY2014

Reports on Research Activities Settlement of Accounts

From April 1, 2014

To March 31, 2015

June 2015

Central Research Institute of Electric Power Industry

Contents

Reports on Research Activities

Overview of Research Report

In fiscal 2014, the electric power industry sought and began devising operating strategies for a new era, in light of progress with electricity system reform. At the same time, nuclear power plants did not resume operation, and the operating environment became increasingly harsh.

Although provisional reductions in benefit income, which accounts for most of our business revenue, remained in place, we streamlined operations and cut costs further so that we could focus our resources on projects with the greatest priority based on the needs of the electric utility industry. We gave the highest priority to the pursuit of projects that would enable the electric utility indudustry to fulfill the role expected of CRIEPI.

Accordingly, we produced highly effective results from research into medium- and long-term issues, as well as issues that are particularly urgent for the electric power industry, such as responding to screening to determine nuclear power plants' compliance with new regulatory standards, paving the way for the resumption of operations at nuclear power plants; the operation and preservation of thermal power plants, which are essential for the stable supply of electricity; and addressing the technical and institutional aspects involved in expanding the introduction of renewable energy.

We also established the Nuclear Risk Research Center (NRRC) and Research Team for Advanced Management of Power Supply and Demand as new frameworks enabling CRIEPI to exercise its comprehensive strengths and adequately supply research results in a timely manner. In addition, in order to fulfill our responsibilities as an industry research institute supporting the electric power industry with our technical strengths and problem-solving abilities, we devised research strategies for each field that address changes caused by electricity system reforms, and also systematized our foundational technologies.

In terms of organizational operations, we made steady progress in consolidating research bases in the Yokosuka area and Abiko area. As part of this effort, we designed reorganization of the administrative divisions to streamline and enhance the administration and management. Moreover, we proactively took measures to build a resilient business operation structure, reaching our goal for reductions in staff one year early.

As a result, we fulfilled our mission as a joint research organization for the electric power industry, made progress in establishing a business foundation for the future and devised research strategies, and strengthened our preparations for reforms.

I. Research Activities

1. Research Results

We pursued research as laid out in the research plans established based on the Portfolio of Research Subjects, which provided an overview of the entire electric power business and clarified the issues that CRIEPI should address. We produced and provided diverse research results that contribute to the electric power industry.

Specifically, we addressed assessments of the safety of nuclear power plants in the face of natural external events such as earthquakes, tsunami and tornadoes, as well as the screening to determine the compliance of nuclear power plants with new regulatory standards, which are crucial issues for the electric power industry, and also continued to exercise our comprehensive strengths and give the highest priority to natural disaster measures for electric power facilities. We also developed facility diagnosis and life assessment technology contributing to the rational maintenance and replacement of electric power generation facilities and transmission and distribution facilities, and made steady progress in developing technology enabling companies to adapt changes in the electricity network, such as the broader introduction of renewable energy and activation of the demand side.

Below, we describe the representative research results newly achieved in fiscal 2014 for each research pillar, which indicate the direction of our research in the medium term.

(1) Establishment of Optimal Risk Management

With the aim of mitigating and managing risks involved in the stable supply of electricity and improving the safety of nuclear power generation, we assessed the impact of natural phenomena and socio-economic changes on the electric power industry, and addressed issues so that we could propose countermeasures. The section below describes the primary outcomes.

- **Enhancement of tsunami fragility assessment on nuclear power plant facilities**

We continued to establish and sophisticate technology to assess the fragility of nuclear power facilities in the face of tsunami hydrodynamic force and collisions induced by tsunami debris based on the results of large-scale hydraulic tests utilizing a tsunami and flood channel.

- **Evaluations of risks to health from low-dose radiation**

We formulated a biological mechanism hypothesis that exposure to low-dose rate radiation would not have a cumulative effect, and confirmed the feasibility of this hypothesis using a numerical model.

- **Development of a high-resolution long-term meteorological and climate database**

We calculated the occurrence of meteorological phenomena over the past 57 years and used this to set up a database that could be utilized in evaluating weather damage to electric facilities and the evaluating the safety of nuclear power facilities.

- **Issues with electricity system reforms and response**

We clarified the risks that electric power companies could face as a result of electricity system reforms, and presented knowledge that would be useful in establishing a business environment in Japan.

(2) Improvement of Facility Operations and Maintenance Technologies

We carried out research and development raising efficiency and economic performance in the operation and conservation of electricity facilities and electric transmission and distribution facilities in order to technically support the stable supply of power, which in turn supports the lives of Japanese citizens and economic activity. The section below describes the key results.

- **Development of a life assessment method for welded parts of high chromium steel pipe**

We developed highly accurate evaluation methods for creep life for welded parts of high chromium steel pipe, which are often used in ultra-super-critical thermal power plants.

- **Development of technology for preventing sulfide corrosion on boiler tubes in thermal power plants**

We developed a sulfide corrosion resistant coating that reduces corrosion on thermal boiler water wall tubes in thermal power plants to 25% or less compared with an uncoated part and can be used at low cost and in a short time.

- **Development of technology to evaluate impact of thermal power plants on air quality**

We determined the extent of the impact of $PM_{2.5}$ generation sources in Japan and overseas measured in regions in Japan using the most up-to-date numerical analysis methods assessing $PM_{2.5}$ by generation source.

- **Synthesis system of numerical analysis for current and sediments in rivers and reservoirs**

We developed an integrated system for flood and sediment behavior projection to simultaneously project and analyze stream regime and sediment behavior during floods from the river’s upper reaches to the mouth of the river.

- **Proposal of abnormality diagnosis method for transformers**

We proposed decision criteria to be applied in emergency diagnosis, as well as diagnosis in routine inspections, as a method of diagnosing abnormalitites in oil-immersed power transformer winding.

(3) Development of a Supply/Demand Infrastructure for Next-generation Electric Power

We built up a next-generation technical foundation capable of greater efficiency in terms of both power supply and power use that would also ensure energy security. We also addressed issues involved in energy conservation and a shift to low carbon. The main results are described below.

- **Assessment of the impact of the large-scale introduction of renewable energy**

We systematically organized the basic impact that various conditions in the power system would have on system stability when renewable energy is introduced on a large scale, and assessed the economic impact of countermeasures.

- **Development of methods to estimate photovoltaic power generation output using sensors in distribution lines**

We developed a method of estimating power demand and photovoltaic power generation output in real time using periodic power flow information detected by a sensor installed in the distribution lines.

- **Development of manufacturing technique for high-quality SiC single-crystal films**

We developed a high-quality SiC single-crystal film capable of reducing power losses in power semiconductors used for power conversion, and verified this by manufacturing a single-crystal film with a practical-level bore.

Please refer to “Overview of Research Results” from page 43 for more details on research results.

2. Promoting research and strengthening the research foundation

(1) Clarify research strategies based on communication with power companies

- Taking into account the fact that the impact of electricity system reforms differ by the sectors of the electric industry, we clarified the role that CRIEPI should play in research and development in the electric power industry, as well as research strategies in the various corresponding research fields.

- We strengthened multi-layered communication with electric power companies, beginning with various research committees held by CRIEPI, gatherings for an exchange of opinions, and research exchange meetings. Through this means, we reflected frontline needs accurately and in a timely manner in the Portfolio of Research Subjects and research plans and their pursuit in accordance with this Portfolio.

(2) Further strengthen research structure

- We organized and systematized our foundational technology in an overhaul that would enable us to respond to changes in the electric power industry and society and also strengthen our competitiveness as a research institution.

- We thoroughly screened every part of our research activities and improved the efficiency of our research implementation so that we can continue to generate high-quality research results, even as research funding continues to be constrained.

- We carried out research evaluations by external experts in order to raise the quality of our research results and fulfill our responsibility to provide external accountability, and reflected these findings in our research activities. Moreover, we quantified the value of our research and endeavored to improve cost effectiveness by implementing research value assessments to calculate the estimated economic value of the research outcomes.

(3) Enhancing research capacity and problem-solving skills

- We established the Nuclear Risk Research Center (NRRC) as a base for research and development essential so that nuclear power companies can independently and sustainably improve safety. The Center’s director is global authority on Probabilistic Risk Assessment (PRA). In this way, we have built a system in which electric power companies and industry circles work together to carry out research and development and utilize the results. As a result, we have started setting up and refining PRA using an exsisting plant, as well as initiatives to expand these improvements in the use of PRA results among electric power companies.

- We formed the Special Research Team for Next-Generation Electricity Supply/Demand

Management to strengthen the system for promoting research involving overall optimization of energy supply/demand and new value creation for electricity, taking into account the mutual reliance and cohesiveness on the electricity distribution and demand side. We also accelerated the development of technology to stabilize the power distribution system enabling more sophisticated supply/demand management and an expanded introduction of renewable energy.

- In order to maintain and develop our research ability and problem-solving ability into the future, we introduced and updated large-scale research facilities and basic research facilities essential to resolving issues for the electric power industry after a careful selection process, as described below, while reducing costs.

  - Facility to test cooling limits of simulant fuel in light water reactors: Simulation of transient thermal flow in a nuclear reactor up until a severe accident, with the results utilized in verifying the effectiveness of safety measures

  - Addition of one-way vibration function to centrifugal table: Used in developing and examining new aseismic design methods that can be used in assessing collapse of slopes near nuclear power plants

  - Basic equipment for battery performance test and material investigation: Used in research assessing internal degradation, estimating life and evaluating materials for secondary batteries expected to be introduced as a means of stabilizing electricity systems

  - Updates to electricity system simulator: Updates to those electric generators simulating actual electricity systems and constituent devices such as electric power cables and others that have aged

- We trained personnel with impressive expertise and knowledge of the frontlines of electric .power companies through long-term dispatch of researchers to research institutions in Japan and overseas and to electric power companies in order to maintain and develop foundational research skills.

- We maintained and expanded networks with research institutes in Japan and overseas, such as the Electric Power Research Institute (EPRI), Electricite de France (EDF), Nuclear Damage Compensation and Decomissioning Facilitation Corporation (NDF) and the Marine Ecology Research Institute (MERI) in order to mutually complement scientific knowledge and contribute to the utilization of our results.

(4) Management and Utilization of Intellectual Property

- As well as carefully selecting, maintaining and utilizing intellectual property that can be

expected to contribute to society through the electric power industry, we made research reports widely available to the public through our download service. The number of research reports is shown in Table 1 on page 15, the number of papers reported is shown in Table 2, the number of applications and registrations of patent right, and the number of internally registered software are shown in Table 3 on page 16 and the number of licensed patents and licensed software applications are shown in Table 4.

- Through our participation in national and academic committees, we have contributed to the establishment of various standards and criteria related to energy and the environment, as well as technical guidelines. Our primary contributions to formulation of major codes, standards, and technical guidelines are shown in Table 5 on page 17.

(5) Promotion of Funded Research

- We proactively carried out funded research to meet the requests of the electric power industry, and promptly provided results that helped to solve issues on the frontlines. As requests from electric power companies have increased since the Great East Japan Earthquake, funding and manpower has been squeezed, so we have used our ingenuity in determining the content of our research and the process, and endeavored to carry out effective research.

- In our research funded by the national government, we carefully selected and implemented studies on research topics that are consistent with our research strategy in the various fields and that help to solve issues in the electric power industry or issues that lead to improvements and refinements in our research capacity. The main funded research projects commissioned by the national government are shown in Table 6 on page 18.

- We continued to carry out operations at the PD Center, which gives certification exams for experts on ultrasonic inspection working with nuclear power plant equipment, as well as operations at the High Power Testing Laboratory, which performs short-circuit tests on electric power equipment.

II. Administration

1. Curbing overall operating expenditures

- We reviewed all operations to offset higher material costs and the significant expansion in assets for which fixed asset taxes must be paid as a result of our shift to the status of a general incorporated foundation. We also suspended or postponed and streamlined operations based on priorities in order to curb operating expenditures across the board.

- With our commissions and procurement, we not only used specified competitive biddings to select contractors and revised specifications, but also canceled projects or moved them in-house based on a review of the need for each operation in order to cut costs on an ongoing basis.

- We reexamined the likelihood that we would use facilities in the future and continued to retire and sell facilities that we do not use in order to reduce future obligations such as maintenance costs and fixed asset taxes. We also clarified medium- and long-term plans for facility maintenance in order to identify rational expenditure timing and cut costs for the maintenance of facilities that we will continue to own.

- We continued with cuts to salaries at the same level as in fiscal 2013 in order to reduce overall personnel expenses.

2. Steady establishment of research bases

- We steadily moved ahead with efforts to consolidate research bases into two bases, one in the Yokosuka area as a base for research on energy industry technology and one in the Komae area as a research base for nature and the environment. This is intended to establish the research environment essential in maintaining and improving our research capacity while also reducing fixed management costs. This was funded with the income generated from the sale of some of the land in the Komae area in fiscal 2013 and represented an effective replacement of assets.

- In the Yokosuka area, we signed a contract for construction work with the aim of completing construction work on the New Research Building to hold the research divisions moved from the Komae area in fiscal 2016. We also moved ahead with construction blueprints and administrative procedures for the Materials Analysis Building. The research divisions that will use the completed laboratories began the move from the Komae area in advance.

- In order to reorganize administrative and management divisions in April 2015, we drew up measures to streamline operations and organizational and institutional designs that would make operations more sophisticated, strengthen research support systems and lead to human resource training and utilization, while also adjusting to fewer personnel. We also established a common

area in the Abiko facility using an existing building in order to adapt to the transfer of employees following the reorganization.

- In light of the impact that the establishment of these research bases will have on employees' lives, such as an increase in the number of employees commuting long distances, we took measures aimed at improving operational efficiency, such as allowing researchers to work at home.

3. Encouraging personnel's job performance and hiring diverse staff in line with research development

- Extensive support (personal support) of each individual employee is the most important part of our human resource management, and we took measures to raise motivation and utilize human resources.

- We established employee and hiring plans with a focus on utilizing the newly introduced "special limited-term research positions" and hiring researchers with sophisticated expertise and experience from among the diverse human resources in different fields and industries.

- Even as we are reducing administrative and management personnel, we devised proposals to reassign personnel to positions in which they can optimize their abilities, depending on each individual's suitability, in anticipation of the transfer and reorganization.

4. Effective dissemination of research results and research capacity to electric utility and public

- We held press conferences, issued press releases and ran feature articles in a timely manner in order to effectively highlight CRIEPI's original research capacity and significance to the electric power industry and the public. In order to contribute to publicity activities based on social conditions and needs of electric power companies, we carried out public hearings targeting electricity business companies and external experts and provided them with ongoing information.

- In May 2014, we held the Research Results Presentation 2014 and introduced research activities in a multi-faceted manner related to thermal power generation and environmental issues on the theme of "living with limited fuel resources and the environment." In addition, we publicized our research results in an easy-to-understand manner through publications such as CRIEPI TOPICS.

5. Sound and rigorous pursuit of business operations

- We continued our efforts to strengthen governance, steadily implemented risk management, and established and improved compliance awareness. Moreover, we endeavored to run autonomous

operations in a sound and rigorous manner, such as the appropriate and safe management of security exports.

- We continued to strengthen technical measures and educate executive officers to enhance information security.
- We augmented our business continuity plan (BCP) to prepare for large-scale natural disasters by strengthening our backup system for backbone operations.
- We completed our Plan on Expenditures for Public Benefit within the intended period in fiscal 2014 (the Cabinet Office will confirm completion around October 2015).
- Please refer to the next page regarding our system for ensuring that directors comply with laws and articles of incorporation and our system for ensuring appropriate operations.

Basic Principles on Internal Controls

CRIEPI has established the following basic principles for its internal control system in order to ensure that its operations are managed appropriately and efficiently.

(1) Management system for administration

- The Board of Directors will hold meetings regularly and will also hold special meetings as necessary, and will discuss and make decisions on important issues related to the performance of operations in accordance with laws and articles of incorporation as well as decisions by the Board of Councilors. In addition, Vice Presidents' job performance will be supervised.
- A committee concerned with management and research strategies and consisting of Vice Presidents and other the executives carrying out operations (below, "Management Committee") will be held regularly and important issues involved in conducting operations will be discussed with a flexible and multidisciplinary approach.
- The operations that executives are in charge of performing will be clarified and business will be conducted in an appropriate and prompt manner.
- Responsibilities and authority in exercising professional duties for Vice Presidents will be clarified in internal regulations, and efforts made to ensure that Vice President and employees perform their jobs appropriately and efficiently.
- Minutes for important committees such as the Board of Councilors, Board of Directors and Management Committee and other information related to Vice Presidents' execution of professional duties will be appropriately prepared, saved and managed in accordance with the articles of incorporation and internal regulations.
- An Internal Audit Division will be set up under the jurisdiction of the President and the job performance of each division will be regularly monitored in order to ensure that operations are conducted appropriately and efficiently.

(2) System for risk management

- A risk management system and internal regulations will be established.
- Risks related to business activities in carrying out professional duties will essentially be managed with a self- governing approach, based on laws and internal regulations.
- General risk management will be carried out by the Internal Audit Division in a centralized manner, with audits to ensure that important risks are appropriately managed without omission; the results will be reported to the President and Management Committee.
- Important risks that could potentially have a substantial effect on management will be discussed in the Management Committee and the necessary countermeasures will be discussed as required.
- In order to prepare for emergency disasters, internal regulations on the support organization and information system will be stipulated in internal regulations, and disaster prevention training will be carried out.

(3) Management system for compliance

- Action guidelines for compliance will be established and put into practice with the Vice Presidents taking the lead. In addition, employees will receive ongoing training on the prevention of improprieties via CRIEPI's website for internal users.
- A whistleblowing hotline will be permanently established with both internal and external access so that employees can discuss issues anonymously.
- The Internal Audit Division will audit employees' performance of professional duties in terms of compliance and report the results to the Management Committee. Executives will make the necessary improvements in light of the audit results.

(4) Audit system

- The General Auditor will audit Vice Presidents' and other the executives' performance of professional duties to ensure that they conform to the law and are appropriate by attending important meetings such as the Board of Directors meetings and perusing important documents. A full-time auditor will be appointed.
- The Internal Audit Division will provide staff to assist in the auditor's work. During the periods when the General Auditor's support staff are working exclusively with the General Auditor, they will not receive instructions or guidance from executives, and the General Auditor's wishes will be respected as regards transfers and evaluations.
- When Vice Presidents and/or employees discover anything that could significantly harm CRIEPI or detect acts that violate laws, articles of incorporation and other internal regulation, they should report directly to the President General Auditor and/or the Internal Audit Division.
- The Vice Presidents and employees will report to the auditor regarding the status of the execution of professional duties when requested to do so.

III. Workforce

CRIEPI aimed for a workforce of about 800 employees, and we maintained the current number of research staff, but gradually decreased the number of office staff by streamlining office work. We endeavored to curb the total workforce by being selective in accepting other staff, such as special visiting researchers. Moreover, we were steadily taking steps to reduce the workforce by suspending the employment of temporary contract employees, as well as considering rehiring measures based on the need for operations when rehiring employees who are retiring at the mandatory retirement age. As a result of these measures, we achieved total employee numbers of about 800, our target for the end of fiscal 2015, one year ahead of schedule (workforce at the end of the fiscal year numbered 835 in fiscal 2011, 825 in fiscal 2012 and 820 in fiscal 2013).

The workforce as of March 31, 2015 was as follows.

Item	Numbers	Percentage distribution (%)
1. Research	697* * Including 8 special limited-term research positions and 17 visiting researchers	87.6
(Breakdown according to field)		(100.0)
(1) Electrical Engineering	107	15.4
(2) Civil Engineering and Architecture	100	14.3
(3) Mechanical Engineering	90	12.9
(4) Chemistry	67	9.6
(5) Biology	53	7.6
(6) Nuclear Engineering	54	7.7
(7) Environmental Science	41	5.9
(8) Information and Communication	34	4.9
(9) Socio-economics	44	6.3
(10) Research Support and Management	107	15.4
2. Office work	99	12.4
Total	796	100

IV. Meetings Held

1. Board of Councilors

Date held	Agenda
May 27, 2014 (No.9)	1. Selection of council members
June 13, 2014 (No.10)	1. Approval of report on research activities in fiscal 2013 2. Approval of report on settlement of accounts in fiscal 2013 3. Fiscal 2013 Report on Implementation of the Public Interest Expenditure Plan
September 4, 2014 (No.11)	1. Selection of council members and board members
November 20, 2014 (No.12)	1. Selection of council members
March 20, 2015 (No.13)	1. Decision on decrease in ongoing donations in fiscal 2015 2. Approval of Research Plan in fiscal 2015 3. Approval of Statement of Budget in fiscal 2015

2. Board of Directors

Date held	Agenda
April 30, 2014 (No.10)	1. Selection of council members
May 29, 2014 (No.11)	1. Fiscal 2013 report on research activities 2. Fiscal 2013 report on settelemt of accounts 3. Fiscal 2013 Report on Implementation of the Public Interest Expenditure Plan 4. Report on performance of job functions by President, Executive Vice President, and Managing Directors 5. Decision to convene regular Board of Councilors
June 23, 2014 (No.12)	1. Dismissal of important employees
August 4, 2014 (No.13)	1. Selection of council members and board members
October 29, 2014 (No.14)	1. Selection of council members

March 12, 2015 (No.15)	1. Decrease in ongoing donations in fiscal 2015 2. Fiscal 2015 research plans 3. Fiscal 2015 statement of budge 4. Report on performance of job functions by President, Executive Vice President, and Managing Directors 5. Decision to convene regular Board of Councilors

Table 1: Number of Research Reports

	Research reports, etc.	Funded research reports	Total
Socioeconomics	23	1	24
Environment	27	20	47
Customer energy services	18	10	28
Power distribution	56	42	98
Nuclear power generation	74	41	115
Fossil fuel power generation	21	30	51
New energy	13	12	25
Information & communication	18	5	23
Construction and maintenance of electric power facilities	14	19	33
Advanced basic technologies	6	3	9
Total	270	183	453

(Number in fiscal year 2012)	270	166	436

Table 2: Number of Papers Reported

	Papers (Peer reviewed papers included above)
Socioeconomics	117 (23)
Environment	129 (31)
Customer services	94 (11)
Power distribution	232 (49)
Nuclear power generation	365 (112)
Fossil fuel power generation	106 (33)
Renewable energy power generation	54 (8)
Information & communication	48 (11)
Construction and maintenance of electric power facilities	129 (30)
Advanced basic technologies	129 (41)
Others	9 (1)
Total	1,412 (350)

(Number in fiscal year 2012)	1,409 (360)

Table 3: Number of Applications and Registrations of Patent Right, and Internally Registered Software

	Patent right		Software Registration
	Application	Registration	
Socioeconomics	1	0	2
Environment	7	19	9
Customer services	2	8	6
Power distribution	15	21	29
Nuclear power generation	13	12	8
Fossil fuel power generation	18	22	7
Renewable energy power generation	1	4	4
Information & communication	2	3	4
Construction and maintenance of electric power facilities	3	5	8
Advanced basic technologies	21	21	1
Others	1	0	0
Total	84	115	78
(Number in fiscal year 2012)	84	146	74

*Number of patents held as of end-fiscal 2014: 811

Table 4: Number of Licensed Patents and Licensed Software Applications

	Total	(Number in fiscal year 2013)
Number of licensed patents	52	19
Number of licensed software applications	440	312

Table 5: Contribution to Formulation of Major Codes, Standards, and Technical Guidelines

Field	Code, Standard, Technical Guideline, etc.	Organizations and Groups Concerned
Nuclear power	JSME S FA1-2014 Standards for Used Fuel Storage Facilities, Structural Standards for Metal Casks	Japan Society of Mechanical Engineers
Nuclear power	JSM-NRE-009 Guidelines for Setting Designed Tornado Wind Speed and Flying Object Speed in Tornado Impact Assessments for Light Water Nuclear Reactors	Japan Society of Maintenology
Thermal power	JEAC3705-2014 Regulations for Internal Combustion for Electric Power Generation	Japan Electric Association
Power distribution	JEAC9701-2012 Regulations for System Interconnections (2014 Supplement)	Japan Electric Association
Power distribution	JEAC5006-2014 Regulations for Batteries for Power Storage	Japan Electric Association
Power distribution	JEAG5002-2014 Guidelines for Fire Prevention Measures at Electric Power Substations	Japan Electric Association
Power distribution	JEM1498 Standard and Active Isolated Operation Detection Method for Single-Phase Power Conditioners for Use with Distributed Power Sources (frequency feedback method with step injection)	Japan Electrical Manufacturers' Association
Power distribution	JIS C 2143-1:2015 Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results (revised in March 2015) JIS C 2143-8:2015 Electrical insulation materials – Thermal endurance properties – Part 8: Instructions for calculating thermal endurance characteristics using simplified procedures (established in March 2015)	Institute of Electrical Engineers of Japan, Japanese Standards Association
Power distribution	IEC61786-2:2014 Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 2: Basic standard for measurements	International Electrotechnical Commission (IEC)

Table 6: Main funded research commissioned by government

Source of commission	Name	Field
Ministry of Economy, Trade and Industry		
	Survey of Geological Disposal of Technology (Development of Technology for Evaluation and Verification of Migration of Groundwater in Bedrock)	Nuclear power
	Initiative for Safety Measure Improvement and Technical Basis Development for Nuclear Power Plants (Improving Analytical Methods for Thermal Hydraulics Phenomenon in Fuel Exposure Process)	Nuclear power
	Initiative for Safety Measure Improvement and Technical Basis Development for Nuclear Power Plants (Establishment of Technical Foundation for Performance Evaluation of Filter Vents)	Nuclear power
	Project to Develop Technology Foundation to Advance Safety Measures for Nuclear Reactors for Power Generation (risk assessment for nuclear power generators, establishment of foundation for research)	Nuclear power
	Survey on Countermeasures for Global Warming (Survey on International Trends in Global Warming [United Nations Framework Convention on Climate Change, UNFCCC])	Environment
Secretariat of the Nuclear Regulation Authority		
	Outsourcing Expenses for Fire Prevention Measures for Nuclear Power Facilities (Tests to assess impact of sea water and boric acid injections)	Nuclear power
New Energy and Industrial Technology Development Organization		
	Technology development for SOFC commercialization promotion / Basic study on rapid evaluation method of SOFC durability	Thermal power
	Project on revolutionary coal gasification power generating plant with zero emissions; Basic research project on revolutionary gasification technology; Research on basic technology to develop high efficiency oxy-fuel IGCC	Thermal power
	Project for Research and Development on Response to Output Fluctuations in Power Systems: Wind Power Projections and More Sophisticated Controls / Simulation of Operation of Projection Technology System	Power distribution
	Project to Verify Development of Distributed Energy Next-Generation Power Network / Development of Shared Foundational Technology to Build Next-Generation Power Distribution System	Power distribution
	SIP (Strategic Innovation Creation Program) / Next-Generation Power Electronics / Development of Base-type Shared Foundational Technology related to SiC / Comprehensive Research and Development for SiC Next-Generation Power Electronics	Power distribution
National Institute of Advanced Industrial Science and Technology		
	Development of heating method for methane hydrate recovery using CO_2 /water emulsion	Thermal power
Japan Atomic Energy Agency		
	Development of Testing Equipment for Elementary Steps for Breakage and Melting of Fuel Rods and Control Rods	Nuclear power
International Research Institute for Nuclear Decommissioning		
	Property Evaluation of Melting and Solidification of Debris	Nuclear power
	Research on Evaluation Technology for Waste Inventory	Nuclear power
	Consideration of Residual Water Vaporization for Zeolite	Nuclear power

Note: The above independent administrative entity became a national research and development corporation on April 1, 2015.

Settlement of Accounts

Outline of Settlement of Accounts

Net property at the end of fiscal 2014 was 38,752 million yen, 2,360 million yen lower than the end of the previous fiscal year.

1. Balance Sheet

(1) Assets

The balance of assets at the end of the fiscal year was 55,866 million yen.

a. Current assets, including cash and deposits and accounts receivable, totaled 6,813 million yen.
b. Fixed assets amounted to 49,052 million yen.

- Special assets whose use has been designated totaled 13,322 million yen, including machine and equipment, tools and furniture, special assets for retirement lump sum grants benefits package allowance, special assets for reserves for acquisition of research facilities, and special assets for purpose of establishing research bases.
- Other fixed assets, including land, buildings, and machine and equipment, amounted to 35,730 million yen.

(2) Liabilities

The balance of liabilities at the end of the fiscal year was 17,114 million yen.

a. Current liabilities, such as accrued liabilities, totaled 6,952 million yen.
b. Fixed liabilities, such as accrued retirement benefits for employees, were 10,162 million yen.

(3) Net Assets

The balance of net assets at the end of the fiscal year was 38,752 million yen.

a. Designated net assets totaled 608 million yen.
b. General net assets amounted to 38,143 million yen.

2. Statement of Changes in General Net Assets

(1) Changes in general net assets

General net assets decreased by 2,219 million yen in this fiscal period.

a. Current revenue amounted to 27,817 million yen.

- Current benefit recieved from electric utility companies amounted to 23,565 million yen.
- Operating revenue stood at 3,934 million yen.

  Of this operating revenue, governmentally funded research operating revenue accounted for 2,595 million yen.

  Other operating revenue, including revenue from short-circuit tests and revenue from

joint research, totaled 1,339 million yen.

- Other revenue, such as interest recieved, amounted to 120 million yen.

b. Current expenditure amounted to 29,998 million yen.

- Project costs related to research totaled 28,190 million yen.
  Of these project costs, personnel expenditures such as salary and benefit and retirement benefit expenditures amounted to 8,994 million yen.
  Expenditures, including supplies expenses, expenses for commission and depreciation allowance, amounted to 19,195 million yen.
- Administrative expenses related to headquarters operations were 1,808 million yen.
  Of this, personnel expenditures such as board members' salary, salary and benefit and retirement benefit expenditure totaled 1,037 million yen. Expenditures, such as supplies expenses, totaled 770 million yen.

c. Non-recurring profit totaled 45 million yen, consisting of facility donated profit.

d. Non-recurring expenses totaled 83 million yen, consisting of losses on sale of fixed assets.

(2) Changes in designated net assets

Designated net assets decreased 140 million yen in this fiscal year.

a. Subsidies recieved, including revenue from the Ministry of the Economy, Trade and Industry, was 35 million yen.

b. Facility donated profit totaled 43 million yen, including donations from the Japan Society for the Promotion of Science.

c. Transfers to general net assets totaled 219 million yen due to depreciation allowance related to the designated net assets included in fixed assets.

(3) Net assets final balance

Net assets in this fiscal period fell a total of 2,360 million yen, which is the sum of fluctuations in general net assets and designated net assets. Accordingly, the balance of net assets at the end of the fiscal year was 38,752 million yen.

I. Financial Statements

Balance Sheet

As of March 31, 2015

Account	Current fiscal year	Previous fiscal year	Increase/ decrease
I. Assets section			
1. Current assets			
Cash and deposit	4,559,029,175	3,559,402,456	999,626,719
Securities	0	4,130,545	△ 4,130,545
Account receivable	2,093,724,144	1,380,919,284	712,804,860
Suspense payable	124,531,714	32,556,830	91,974,884
Advance payment	36,075,915	382,652,938	△ 346,577,023
Total current assets	6,813,360,948	5,359,662,053	1,453,698,895
2. Fixed assets			
(1) Special assets			
Buildings	199,044,490	237,679,539	△ 38,635,049
Ancillary buildings	90	1,310,928	△ 1,310,838
Structures	1,506,426	2,059,385	△ 552,959
Machine and equipment	450,562,924	604,502,982	△ 153,940,058
Tools and furniture	52,191,042	48,138,006	4,053,036
Lump-sum depreciable assets	1,276,709	1,170,833	105,876
Intangible fixed asset	8,325,379	9,854,811	△ 1,529,432
Special assets for retirement lump sum grants benefits package allowance	3,435,900,000	3,435,900,000	0
Specific assets for reserves for acquisition of research facilities	3,200,000,000	4,300,000,000	△ 1,100,000,000
Special assets for special project reserves	910,000,000	1,450,000,000	△ 540,000,000
Specific assets for purpose of setting up bases	5,063,494,033	5,997,134,033	△ 933,640,000
Total special assets	13,322,301,093	16,087,750,517	△ 2,765,449,424
(2) Other fixed assets			
Land	8,553,518,118	8,553,518,118	0
Buildings	10,458,325,295	10,935,609,058	△ 477,283,763
Ancillary buildings	3,337,553,859	3,337,535,463	18,396
Structure	1,301,936,553	1,270,091,960	31,844,593
Machine and equipment	7,920,162,857	8,228,664,436	△ 308,501,579
Tools and furniture	1,781,777,579	1,893,042,321	△ 111,264,742
Rolling stock and vehicles	35,055,189	50,266,593	△ 15,211,404
Lump-sum depreciable assets	59,008,061	43,887,715	15,120,346
Intangible fixed asset	710,378,781	632,801,125	77,577,656
Construction in process account	1,572,937,930	435,894,090	1,137,043,840
Total other fixed assets	35,730,654,222	35,381,310,879	349,343,343
Total fixed assets	49,052,955,315	51,469,061,396	△ 2,416,106,081
Total assets	55,866,316,263	56,828,723,449	△ 962,407,186
II. Liability section			
1. Current liability			
Accrued liability	6,603,858,643	5,002,766,734	1,601,091,909
Money entrusted	80,243,489	86,984,059	△ 6,740,570
Advance receipt	23,925,345	176,181,067	△ 152,255,722
Accrued bonus	244,000,000	253,000,000	△ 9,000,000
Total current liability	6,952,027,477	5,518,931,860	1,433,095,617
2. Fixed liabilities			
Allowance for retirement benefits for directors	527,000,000	440,000,000	87,000,000
Accrued retirement benefits for employees	9,635,000,000	9,757,000,000	△ 122,000,000
Total fixed liabilities	10,162,000,000	10,197,000,000	△ 35,000,000
Total liabilities	17,114,027,477	15,715,931,860	1,398,095,617

Account	Current fiscal year	Previous fiscal year	Increase/ decrease
III. Net assets section			
1. Designated net assets			
Special benefits	360,363,361	391,968,484	△ 31,605,123
Cash subsidy	152,692,612	233,626,138	△ 80,933,526
Cash contribution	95,324,897	123,630,812	△ 28,305,915
Total designated net assets	608,380,870	749,225,434	△ 140,844,564
(Including appropriation to special assets)	(608,380,870)	(749,225,434)	(△ 140,844,564)
2. General net assets	38,143,907,916	40,363,566,155	△ 2,219,658,239
(Including appropriation to special assets)	(9,278,020,223)	(11,902,625,083)	(△ 2,624,604,860)
Total net assets	38,752,288,786	41,112,791,589	△ 2,360,502,803
Total of liability and net assets	55,866,316,263	56,828,723,449	△ 962,407,186

Statement of Changes in General Net Assets

From April 1, 2014 to March 31, 2015

Account	Current fiscal year	Previous fiscal year	Increase/decrease
I. General net assets increase/decrease section			
1. Current increase/decrease section			
(1) Current revenue			
[1] Benefit received			
Current benefit received	23,565,000,000	23,565,000,000	0
[2] Operating revenue	(3,934,904,356)	(2,474,101,545)	(1,460,802,811)
Funded research operating revenue	2,595,035,679	2,024,089,394	570,946,285
Other operating revenue	1,339,868,677	450,012,151	889,856,526
[3] Other revenue	(120,747,952)	(126,043,356)	(△ 5,295,404)
Interest received	7,605,705	7,604,783	922
Facility usage fee received	78,020,293	80,880,097	△ 2,859,804
Miscellaneous revenue	35,121,954	37,558,476	△ 2,436,522
[4] Transfer from designated net assets	196,474,301	311,725,606	△ 115,251,305
Total current revenue	27,817,126,609	26,476,870,507	1,340,256,102
(2) Current expenditure			
[1] Project cost			
Personnel expenditure	(8,994,556,998)	(9,302,895,324)	(△ 308,338,326)
Salary and benefit	7,001,720,008	6,811,565,964	190,154,044
Retirement benefit expenditure	1,030,040,436	1,534,742,318	△ 504,701,882
Welfare expenditure	962,796,554	956,587,042	6,209,512
Expenditure	(19,195,543,266)	(17,254,719,198)	(1,940,824,068)
Supplies expenses	1,840,610,215	1,771,746,908	68,863,307
Printed material expenses	345,422,554	320,817,102	24,605,452
Fuel, light, and water expenses	942,168,597	881,012,127	61,156,470
Expenses for commission	6,593,060,516	5,353,779,137	1,239,281,379
Collaboration research contribution	799,176,286	677,418,837	121,757,449
Repair expenses	1,503,189,521	1,432,415,664	70,773,857
Rental rate	293,212,280	250,595,187	42,617,093
Tax and public charge	509,600,453	335,690,817	173,909,636
Travel and transport expenses	675,361,319	636,858,970	38,502,349
Communication and transportation expenses	75,685,649	91,915,907	△ 16,230,258
Other expenditure	557,618,728	781,067,328	△ 223,448,600
Depreciation allowance	5,060,437,148	4,721,401,214	339,035,934
Subtotal of project cost	28,190,100,264	26,557,614,522	1,632,485,742
[2] Administrative expenses			
Personnel expenditure	(1,037,382,202)	(1,076,034,436)	(△ 38,652,234)
Board members' salary	142,100,000	142,705,000	△ 605,000
Salary and benefit	580,315,089	581,649,898	△ 1,334,809
Retirement benefit expenditure	85,929,699	120,858,888	△ 34,929,189
Welfare expenditure	142,037,414	138,100,650	3,936,764
Allowance for retirement benefits for directors transfer	87,000,000	92,720,000	△ 5,720,000
Expenditure	(770,637,284)	(793,224,716)	(△ 22,587,432)
Supplies expenses	22,093,545	14,580,195	7,513,350
Printed material expenses	31,288,987	39,274,949	△ 7,985,962
Fuel, light, and water expenses	24,590,796	32,893,152	△ 8,302,356
Expenses for commission	120,876,881	123,918,659	△ 3,041,778
Repair expenses	9,093,823	15,633,696	△ 6,539,873
Rental rate	341,356,242	361,610,564	△ 20,254,322
Tax and public charge	47,465,917	32,689,103	14,776,814
Travel and transport expenses	20,173,619	24,883,175	△ 4,709,556

Account	Current fiscal year	Previous fiscal year	Increase/decrease
Communication and transportation expenses	7,800,548	8,069,111	△ 268,563
Other expenditure	100,774,824	100,225,129	549,695
Depreciation allowance	45,122,102	39,446,983	5,675,119
Subtotal of administrative expenses	1,808,019,486	1,869,259,152	△ 61,239,666
Total current expenditure	29,998,119,750	28,426,873,674	1,571,246,076
Current ordinary increase/decrease	△ 2,180,993,141	△ 1,950,003,167	△ 230,989,974
2. Non-recurring increase/decrease section			
(1) Non-recurring profit			
[1] Fixed asset donated profit			
Facility donated profit	21,706,204	6,436,400	15,269,804
[2] Gain from sale of fixed assets			
Gains on sale of facility and other	270,169	6,553,046,014	△ 6,552,775,845
[3] Transfer from designated net assets	23,241,748	0	23,241,748
Total non-recurring profit	45,218,121	6,559,482,414	△ 6,514,264,293
(2) Non-recurring expenses			
[1] Loss on sale of fixed assets			
Loss on sale of tools and furniture	83,721,772	189,746,896	△ 106,025,124
[2] Losses on sale of fixed assets			
Losses on sale of facilities and other	161,447	14,119	147,328
Total non-recurring expenses	83,883,219	189,761,015	△ 105,877,796
Current non-recurring increase/decrease	△ 38,665,098	6,369,721,399	△ 6,408,386,497
Current general net asset increase/decrease	△ 2,219,658,239	4,419,718,232	△ 6,639,376,471
General net asset beginning balance	40,363,566,155	35,943,847,923	4,419,718,232
General net asset final balance	38,143,907,916	40,363,566,155	△ 2,219,658,239
II. Designated net asset increase/decrease section			
[1] Cash subsidy received			
Subsidy received	35,621,840	95,658,920	△ 60,037,080
[2] Fixed asset donated profit			
Facility donated profit	43,249,645	61,500,458	△ 18,250,813
[3] Transfer to general net assets	219,716,049	311,725,606	△ 92,009,557
Current designated net assets increase/decrease	△ 140,844,564	△ 154,566,228	13,721,664
Designated net assets beginning balance	749,225,434	903,791,662	△ 154,566,228
Designated net assets final balance	608,380,870	749,225,434	△ 140,844,564
III. Net assets final balance	38,752,288,786	41,112,791,589	△ 2,360,502,803

Statement of Changes in General Net Assets (Breakdown)

From April 1, 2014 to March 31, 2015

Account	Project total	Corporate total	Total
	Ongoing projects (*)		
I. General net assets increase/decrease section			
1. Current increase/decrease section			
(1) Current revenue			
[1] Benefit received			
Current benefit received	0	23,565,000,000	23,565,000,000
[2] Operating revenue	(3,934,904,356)	(0)	(3,934,904,356)
Funded research operating revenue	2,595,035,679	0	2,595,035,679
Other operating revenue	1,339,868,677	0	1,339,868,677
[3] Other revenue	(102,985,316)	(17,762,636)	(120,747,952)
Interest received	0	7,605,705	7,605,705
Facility usage fee received	75,223,993	2,796,300	78,020,293
Miscellaneous revenue	27,761,323	7,360,631	35,121,954
[4] Transfer from designated net assets	196,474,301	0	196,474,301
Total current revenue	4,234,363,973	23,582,762,636	27,817,126,609
(2) Current expenditure			
[1] Project cost			
Personnel expenditure	(8,994,556,998)	(0)	(8,994,556,998)
Salary and benefit	7,001,720,008	0	7,001,720,008
Retirement benefit expenditure	1,030,040,436	0	1,030,040,436
Welfare expenditure	962,796,554	0	962,796,554
Expenditure	(19,195,543,266)	(0)	(19,195,543,266)
Supplies expenses	1,840,610,215	0	1,840,610,215
Printed material expenses	345,422,554	0	345,422,554
Fuel, light, and water expenses	942,168,597	0	942,168,597
Expenses for commission	6,593,060,516	0	6,593,060,516
Collaboration research contribution	799,176,286	0	799,176,286
Repair expenses	1,503,189,521	0	1,503,189,521
Rental rate	293,212,280	0	293,212,280
Tax and public charge	509,600,453	0	509,600,453
Travel and transport expenses	675,361,319	0	675,361,319
Communication and transportation expenses	75,685,649	0	75,685,649
Other expenditure	557,618,728	0	557,618,728
Depreciation allowance	5,060,437,148	0	5,060,437,148
Subtotal of project cost	28,190,100,264	0	28,190,100,264
[2] Administrative expenses			
Personnel expenditure	(0)	(1,037,382,202)	(1,037,382,202)
Board members' salary	0	142,100,000	142,100,000
Salary and benefit	0	580,315,089	580,315,089
Retirement benefit expenditure	0	85,929,699	85,929,699
Welfare expenditure	0	142,037,414	142,037,414
Allowance for retirement benefits for directors transfer	0	87,000,000	87,000,000
Expenditure	(0)	(770,637,284)	(770,637,284)
Supplies expenses	0	22,093,545	22,093,545
Printed material expenses	0	31,288,987	31,288,987
Fuel, light, and water expenses	0	24,590,796	24,590,796
Expenses for commission	0	120,876,881	120,876,881
Repair expenses	0	9,093,823	9,093,823
Rental rate	0	341,356,242	341,356,242

Account	Project total	Corporate total	Total
	Ongoing projects (*)		
Tax and public charge	0	47,465,917	47,465,917
Travel and transport expenses	0	20,173,619	20,173,619
Communication and transportation expenses	0	7,800,548	7,800,548
Other expenditure	0	100,774,824	100,774,824
Depreciation allowance	0	45,122,102	45,122,102
Subtotal of administrative expenses	0	1,808,019,486	1,808,019,486
Total current expenditure	28,190,100,264	1,808,019,486	29,998,119,750
Current ordinary increase/decrease	△ 23,955,736,291	21,774,743,150	△ 2,180,993,141
2. Non-recurring increase/decrease section			
(1) Non-recurring profit			
[1] Fixed asset donated profit			
Facility donated profit	21,706,204	0	21,706,204
[2] Gain from sale of fixed assets			
Gains on sale of facility and other	270,169	0	270,169
[3] Transfer from designated net assets	23,241,748	0	23,241,748
Total non-recurring profit	45,218,121	0	45,218,121
(2) Non-recurring expenses			
[1] Loss on sale of fixed assets			
Loss on sale of tools and furniture	81,657,793	2,063,979	83,721,772
[2] Losses on sale of fixed assets			
Losses on sale of facilities and other	161,447	0	161,447
Total non-recurring expenses	81,819,240	2,063,979	83,883,219
Current non-recurring increase/decrease	△ 36,601,119	△ 2,063,979	△ 38,665,098
Current general net asset increase/decrease	△ 23,992,337,410	21,772,679,171	△ 2,219,658,239
General net asset beginning balance			40,363,566,155
General net asset final balance			38,143,907,916
II. Designated net asset increase/decrease section			
[1] Cash subsidy received			
Subsidy received	35,621,840	0	35,621,840
[2] Fixed asset donated profit			
Facility donated profit	43,249,645	0	43,249,645
[3] Transfer to general net assets	219,716,049	0	219,716,049
Current designated net assets increase/decrease	△ 140,844,564	0	△ 140,844,564
Designated net assets beginning balance			749,225,434
Designated net assets final balance			608,380,870
III. Net assets final balance			38,752,288,786

(*) Content of ongoing projects: Research, surveys, and tests on electric power technology and the economy and general coordination of the aforementioned.

Notes for Financial Statements

1. Important accounting policy

CRIEPI adopted the Public-Service Corporation Accounting Standard (April 11, 2008, revised on October 16, 2009; Cabinet Office's Public Interest Corporation Commission).

(1) Assessment standard and assessment method of valuable stock certificates

The cost method by the moving- average method has been applied.

(2) Depreciation method of fixed assets

- For tangible fixed assets, building (excluding building attached structures) has been managed by the equal installment method, small fixtures have been by the three-year uniform extinguishment, and other tangible fixed assets including machine and equipment have been by the constant percentage method.
- Intangible fixed asset has been managed by the equal installment method.
- Lease assets from finance lease trade other than ownership transfer was calculated for the lease period of expiration year and based on the equal installment method with zero residue prices.

(3) Allowance allocating standard

Allowance for doubtful debts: To prepare for doubtful debts including account receivable and loan receivable, uncollectible amount is individually estimated to account for allowance.

Allowance for employees: To prepare for paymenets of employees allowance, estimated amount for this year is calculated to account for allowance.

Allowance for retirement benefits for directors: To prepare payment of vice presidents and general auditors special service bonus, estimation at the end of period is account for allowance based on the private regulation to pay allowance for retirement benefits for directors.

Allowance for retirement benefits for employees: To prepare for payment of retirement

allowance and annual pension, amount deducting the pension asset amount assessed from the present value method based on future estimated retirement benefit is account for allowance. And retirement benefits for counselors are accounted for the estimation at the end of period based on the related private regulation and expressed in the combined form.

(4) Account processing of consumption tax, etc.

Account processing of consumption tax, etc. is controlled by the before tax method.

2. Change in important account policy

There were no changes in important account policy.

3. Change in designated assets and balance

The change in designated assets and balance are as follows.

(Unit: yen)

Subject	Balance at the end of previous period	Current increased amount	Current decreased amount	Balance at the end of current period
Buildings	237,679,539	0	38,635,049	199,044,490
Ancillary buildings	1,310,928	0	1,310,838	90
Structures	2,059,385	0	552,959	1,506,426
Machine and equipment	604,502,982	3,100,000	157,040,058	450,562,924
Tools and furniture	48,138,006	36,000,638	31,947,602	52,191,042
Lump-sum depreciable assets	1,170,833	1,454,907	1,349,031	1,276,709
Intangible fixed assets	9,854,811	2,811,000	4,340,432	8,325,379
Special assets for retirement lump sum grants benefits package allowance	3,435,900,000	0	0	3,435,900,000
Specific assets for reserves for acquisition of research facilities	4,300,000,000	0	1,100,000,000	3,200,000,000
Special assets for special project reserves	1,450,000,000	0	540,000,000	910,000,000
Specific assets for purpose of setting up bases	5,997,134,033	0	933,640,000	5,063,494,033
Total	16,087,750,517	43,366,545	2,808,815,969	13,322,301,093

4. Breakdown of funding for fixed assets

The funding for fixed assets can be broken down as follows.

(Unit: yen)

Subject	Balance at the end of previous period	(Including appropriation from designated net asset)	(Including appropriation from general net asset)	(Including liability relating item)
Buildings	199,044,490	(199,044,490)	-	-
Ancillary buildings	90	(90)	-	-
Structures	1,506,426	(788,625)	(717,801)	-
Machine and equipment	450,562,924	(346,754,535)	(103,808,389)	-
Tools and furniture	52,191,042	(52,191,042)	-	-
Lump-sum depreciable assets	1,276,709	(1,276,709)	-	-
Intangible fixed assets	8,325,379	(8,325,379)	-	-
Special assets for retirement lump sum grants benefits package allowance	3,435,900,000	-	-	(3,435,900,000)
Specific assets for reserves for acquisition of research facilities	3,200,000,000	-	(3,200,000,000)	-
Special assets for special project reserves	910,000,000	-	(910,000,000)	-
Specific assets for purpose of setting up bases	5,063,494,033	-	(5,063,494,033)	-
Total	13,322,301,093	(608,380,870)	(9,278,020,223)	(3,435,900,000)

5. Assets offered as collateral

No asset offered as collateral is recorded.

6. Acquisition value, accumulated depreciation and balance at the end of current period for fixed assets

Acquisition value, accumulated depreciation and balance at the end of current period for fixed assets are as follows.

(Unit: yen)

Subject	Acquisition value	Accumulated depreciation	Balance at the end of current period
Special asset	(5,551,901,704)	(4,838,994,644)	(712,907,060)
Buildings	485,172,882	286,128,392	199,044,490
Ancillary buildings	60,246,000	60,245,910	90
Structures	28,268,470	26,762,044	1,506,426
Machine and equipment	4,842,579,324	4,392,016,400	450,562,924
Tools and furniture	118,722,555	66,531,513	52,191,042
Lump-sum depreciable assets	3,764,713	2,488,004	1,276,709
Intangible fixed asset	13,147,760	4,822,381	8,325,379
Other fixed asset	(107,692,948,023)	(82,088,749,849)	(25,604,198,174)
Buildings	20,677,999,735	10,219,674,440	10,458,325,295
Ancillary buildings	13,546,293,407	10,208,739,548	3,337,553,859
Structures	5,941,220,139	4,639,283,586	1,301,936,553
Machine and equipment	50,983,657,695	43,063,494,838	7,920,162,857
Tools and furniture	11,601,496,263	9,819,718,684	1,781,777,579
Rolling stock and vehicle	115,122,083	80,066,894	35,055,189
Lump-sum depreciable assets	152,793,980	93,785,919	59,008,061
Intangible fixed asset	4,674,364,721	3,963,985,940	710,378,781
Total	(113,244,849,727)	(86,927,744,493)	(26,317,105,234)

7. Claimable assets, balance of allowance for doubtful debts at the end of period, and balance of claimable assets at the end of period

Claimable assets, balance of allowance for doubtful debts at the end of period, and balance of claimable assets at the end of period are as follows.

(Unit: yen)

Subject	Claimable assets	Balance of allowance for doubtful debts at the end of period	Balance of claimable assets at the end of period
Account receivable	2,093,724,144	0	2,093,724,144
Housing loans and welfare loans among special assets of accrued retirement benefits	28,852,000	0	28,852,000
Total	2,122,576,144	0	2,122,576,144

8. Contingent liabilities such as guarantee liabilities

A guarantee liability to employees housing loans is 1,606,953,765 yen.

9. Breakdown of held-to-maturity bond certificates and book values, actual values and appraisal profit or loss

The breakdown of held-to-maturity bond certificates and book values, actual values and appraisal profit or loss is as shown below.

(Unit: Yen)

Type and issue name	Book value	Actual value	Appraisal profit/loss
No. 108 yield-bearing government bond (5yr)	320,289,600	320,448,000	158,400
Total	320,289,600	320,448,000	158,400

10. Breakdown of subsidies, etc. and delivers, current increase/decrease, and balance

Breakdown of subsidies, etc. and delivers, current increase/decrease, and balance are as follows.

(Unit:yen)

Name of subsidies	Deliverer	Balance at the end of period	Current increase	Current decrease	Balance at the end of period	Describing division in balance sheet
Subsidies						
• Subsidy for projects assessing impact on power systems of mass adoption of distributed generation	Ministry of Economy, Trade and Industry	135,362,135	0	48,324,257	87,037,878	Designated net assets
• Project to promote the introduction of solar power generation system at CRIEPI's laboratories in the Yokosuka area in fiscal 2008	New Energy and Industrial Technology Development Organization	9,752,187	0	1,238,527	8,513,660	Designated net assets
• Project to promote introduction regional new energy in fiscal 2009	New Energy Promotion Council	2,117,660	0	311,296	1,806,364	Designated net assets
• Applicability survey of manufacturing technology for fly ash concrete not using cement	Ministry of Economy, Trade and Industry	0	19,897,999	19,820,065	77,934	Designated net assets
• Research and development for Advanced Humid Air Turbine (AHAT) System	Ministry of Economy, Trade and Industry	0	1,400,000	1,400,000	0	-
Grants						
• R&D for SiC innovative power electronics to create a low-carbon society (super-thick membrane and multi-layer SiC epitaxial wafer technology)	Japan Society for the Promotion of Science	84,744,705	0	30,723,182	54,021,523	Designated net assets
• Review of measures for utilizations of micro hydro power generation in forestry areas	National Land Afforestation Promotion Organization	702,736	14,323,841	14,579,938	446,639	Designated net assets
• Fiscal 2010 grant for project to subsidize costs of development of dual analog/digital equipment to alleviate poor reception	Association for Promotion of Digital Broadcasting	946,715	0	158,101	788,614	Designated net assets
Total		233,626,138	35,621,840	116,555,366	152,692,612	

11. Breakdown of transfer from designated net assets to general net assets

Breakdown of transfer from designated net assets to general net assets is as follows.

(Unit: yen)

Content	Amount of money
Transfer to balance of current account	
Depreciation allowance related to designated net assets	155,008,461
Transfer by exception from specification as designated net asset	5,960,900
Transfer by implementing of project for which subsidy was received	35,504,940
Transfer to non-recurring revenue	
Transfer due to retirement of designated net assets	23,241,748
Total	219,716,049

12. Trading content to related parties

No trading to related parties is recorded.

13. Important subsequent event

No important subsequent event is recorded.

14. Notes on assets from projects implemented

The balance of assets from projects implemented are as follows.

(Unit: yen)

Subject	Book value at start of fiscal year	Book value at end of fiscal year
Special asset	(904,716,484)	(712,907,060)
Buildings	237,679,539	199,044,490
Ancillary buildings	1,310,928	90
Structures	2,059,385	1,506,426
Machine and equipment	604,502,982	450,562,924
Tools and furniture	48,138,006	52,191,042
Lump-sum depreciable assets	1,170,833	1,276,709
Intangible fixed asset	9,854,811	8,325,379
Other fixed asset	(34,303,619,241)	(33,570,161,137)
Land	8,243,518,118	8,243,518,118
Buildings	10,722,257,606	10,254,164,079
Ancillary buildings	3,310,360,101	3,318,119,013
Structures	1,268,774,869	1,300,971,767
Machine and equipment	8,220,580,234	7,914,672,741
Tools and furniture	1,848,576,275	1,740,788,545
Rolling stock and vehicles	19,873,527	34,068,131
Lump-sum depreciable assets	43,043,318	59,008,061
Intangible fixed asset	626,635,193	704,850,682
Total	(35,208,335,725)	(34,283,068,197)

15. Retirement benefit related

(1) Summary of employed retirement benefit

CRIEPI has established a defined-benefit pension system for its retirement pension program and retirement lump sum grants.

(2) Retirement benefit liability and its contents

(Unit: yen)

[1] Retirement benefit liability	△22,890,693,467
[2] Retirement pension asset	13,969,961,020
[3] Non-accumulated retirement benefit ([1]+[2])	△ 8,920,732,447
[4] Non-depreciated mathematical calculation difference	△ 335,857,208
[5] Unamortized past service liabilities	1,050,124,761
[6] Accrued retirement benefits for employees ([3]-[4]-[5])	△ 9,635,000,000

(3) Items for retirement benefit expense

(Unit: yen)

[1] Working expense	987,940,652
[2] Interest expense	226,676,929
[3] Expectable operation benefit	△133,855,325
[4] Mathematical calculation difference depreciation	560,270,259
[5] Unamortized past service liabilities	△525,062,380
[6] Retirement benefit expense ([1]+[2]+[3]+[4]+[5])	1,115,970,135

(4) Primary pension assets

The percentage of each main category making up total pension assets is as follows.

Bonds	51%
Stocks	10%
Cash and deposits	6%
Other	33%
Total	100%

Total pension assets include 17% in retirement benefit trusts established for the corporation pension plan.

(5) Items for calculation bases of retirement benefit liability

[1] Period allocation method of retirement benefit expectation: Period fixed amount standard based on the working period

[2] Discount rate: 1.0%

[3] Expectable operation benefit: 1.0%

[4] Processing year of difference on mathematical calculation: Five-year constant percentage method is applied for depreciation after next year of occurrence.

[5] Number of years over which past service costs are amortized: Past service costs are amortized using the straight-line depreciation method for a five-year period from the fiscal year in which they were incurred.

II. Supplementary Statement

1. Details on specific assets

(Unit: yen)

Type of asset	Book value at start of fiscal period	Increase in current fiscal period	Decrease in current fiscal period	Book value at end of fiscal period
Buildings	237,679,539	0	38,635,049	199,044,490
Ancillary buildings	1,310,928	0	1,310,838	90
Structures	2,059,385	0	552,959	1,506,426
Machines and equipment	604,502,982	3,100,000	157,040,058	450,562,924
Tools and furniture	48,138,006	36,000,638	31,947,602	52,191,042
Lump-sum depreciable assets	1,170,833	1,454,907	1,349,031	1,276,709
Intangible fixed assets	9,854,811	2,811,000	4,340,432	8,325,379
Special assets for retirement lump sum grants benefits package allowance	3,435,900,000	0	0	3,435,900,000
Specific assets for reserves for acquisition of research facilities	4,300,000,000	0	1,100,000,000	3,200,000,000
Special assets for special project reserves	1,450,000,000	0	540,000,000	910,000,000
Specific assets for purpose of setting up bases	5,997,134,033	0	933,640,000	5,063,494,033
Total special assets	16,087,750,517	43,366,545	2,808,815,969	13,322,301,093

Notes

1. The decrease in specific assets for reserves for acquisition of research facilities is due to the liquidation of specific assets for the acquisition of power plant thermal hydraulics laboratory, facilities to test the light water reactor's simulated fuel cooling limit and a power system simulator.
2. The decrease in specific assets for reserves for projects was due to the liquidation of specific assets for the purpose of carrying out joint research and moving research facilities to the Yokosuka area laboratories.
3. The decrease in specific assets for the purpose of setting up bases was due to the liquidation of specific assets for the purpose of acquiring new research laboratories in Yokosuka.

2. Breakdown of Allowances

(Unit: yen)

Category	Balance at start of fiscal period	Increase in current fiscal period	Decrease in current fiscal period		Balance at end of fiscal period
			Intended use	Other	
Allowance for employees	253,000,000	244,000,000	253,000,000	0	244,000,000
Allowance for retirement benefits for directors	440,000,000	87,000,000	0	0	527,000,000
Allowance for retirement benefits for employees	9,757,000,000	1,099,684,035	1,221,684,035	0	9,635,000,000

Audit Report by Third-Party Auditor

May 8, 2015

Central Research Institute of Electric Power Industry

President Masahiro Kakumu

Meisho auditors

Senior Partner
Managing Partner
Certified Public Accountant
YoshihiroWada

Managing Partner
Certified Public Accountant
Masayuki Tomikawa

We audited the financial statements of the Foundation of Central Research Institute of Electric Power Industry (hereinafter referred to as “CRIEPI”) in the fical 2014 business term from April 1, 2014 to March 31, 2015, including balance sheets, profit and loss statement (“Statement of Changes in General Net Assets” according to the stipulations of the Public Interest Corporation Authorization Guideline II-4), supplementary statements, notes on financial statements and the breakdown of the “Statement of Changes in General Net Assets” cash flow calculation sheet, notes on financial statements and list of assets (hereinafter, the subjects of our audit will be referred to as “financial statements”), in accordance with Clause 199 of the Act on General Incorporated Associations and General Incorporated Foundations and Paragraph 1, Section 2, Clause 124 of the same Act.

Management’s responsibility for financial statements

Management is responsible for the preparation and fair presentation of the consolidated financial statements in accordance with accounting principles generally accepted in Japan, and for such internal control as management determines is necessary to enable the preparation of consolidated financial statements that are free from material misstatements, whether due to fraud or error.

Auditor’s responsibility

Our responsibility is to express an opinion on the consolidated financial statements based on our audit as an independent auditor. We conducted our audit in accordance with auditing standards generally accepted in Japan. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the consolidated financial

statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the consolidated financial statements. The procedures selected depend on our judgment, including the assessment of the risks of material misstatement of the consolidated financial statements, whether due to fraud or error. In making those risk assessments, we consider internal control relevant to the entity's preparation and fair presentation of the consolidated financial statements in order to design audit procedures that are appropriate in the circumstances, while the objective of the financial statement audit is not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, the financial statements referred to above fairly present, in all material respects, the net change in assets and profit/loss (change in net assets) for the period for which the financial statements were prepared, in accordance with accounting principles generally accepted in Japan.

Interests

Our firm and its employees have no interest in CRIEPI which should be disclosed pursuant to the provisions of the Certified Public Accounts Law of Japan.

Audit Report

Audit Report

We audited management's execution of their professional duties and CRIEPI's financial assets and income and expenditures in the fiscal year from April 1, 2014 to March 31, 2015 and report the audit method and results as follows.

1. Audit method and description

In accordance with the audit standards and the fiscal 2014 audit plan, we sought to facilitate mutual understanding with directors, the Internal Auditing Department and other employees, gathered information and worked to improve the environment for conducting audits. In addition, we attended meetings of the Board of Directors and other important meetings, received reports from directors and other employees regarding the performance of their duties, and when deemed necessary, sought explanations, and perused important documents in surveying business and financial conditions.

We received reports on the establishment and administration of the system established to ensure appropriate and efficient business operations (internal control system) from directors and other employees, and sought explanations when deemed necessary.

Moreover, we examined whether the independent auditor was correctly performing the audit and also received reports from the independent auditor on the execution of these responsibilities and sought explanations when deemed necessary.

Based on the above methods, we examined the business reports and statements of revenue and expenditures (balance sheets and statement of changes in general net assets) and supplementary statements.

2. Results of audit

(1) Results of audit on directors' execution of duties and internal control system

a. We have determined that there were no serious occurrences of dishonest or false activity or violations of any laws or the Articles of Incorporation by any of the directors in carrying out their duties.

b. There are no points to note regarding the establishment and administration of the internal control system.

(2) Results of audit of business reports

a. We have determined that the business reports properly indicated the condition of

CRIEPI in accordance with laws and Articles of Incorporation.

b. We have nothing to point out as regards the descriptions in the business report of the internal control system.

(3) Results of audit of Financial Statements and Supplementary Statements

The method of audit employed by Meisho auditors and the results thereof are proper and the financial statements and supplementary statements properly presents CRIEPI's financial assets and income and expenditures in all important respects.

May 19, 2015

Central Research Institute of Electric Power Industry

General Auditor, Kouichi Nishi

General Auditor, Yoshihiro Naito

General Auditor, Koji Kaibe

Overview of Research Results

1. Priority subjects and priority subjects with limited terms

CRIEPI identified 35 priority subjects for its research, selected as those the technologies that will be most dispensable to the electric power industry at present and in the future, on which to focus its efforts and maintain, continue or expand.

We identified 10 priority subjects with limited terms from among these priority subjects as particularly urgent issues that must be resolved quickly through the Institute's collective strengths, and produced timely results. Priority subjects and priority subjects with limited terms that are highly inter-related will be grouped together in 11 subject groups as we endeavor to produce and disseminate effective results. The main research results for priority subjects and priority subjects with limited terms are outlined below for each pillar and research group.

(1) Establishment of Optimal Risk Management

Nuclear Power Plant Safety

- **Evaluation of LWR System Safety:** We developed a model to assess accident progress (accident sequence evaluation model) and a model to assess radioactive substance emissions when accidents occur (source term evaluation model) with a view to establishing a probabilistic risk assessment for incidents caused by earthquakes (earthquake PRA). Using these, we carried out a trial risk assessment of an actual plant and confirmed that we could effectively evaluate the plant's vulnerabilities and countermeasures.

- **Assessment of Natural Hazards to Nuclear Facilities:** We developed a method of estimating deep ground structures (several kilometers in depth) from the results of microtremor measurement with a view to predicting ground motion in aseismic design of facilities with a critical function at nuclear power plants. We also integrated a method of estimating volcanic smoke and ash fall with the Numerical Weather Forecasting and Analysis System (NuWFAS) in order to assess the impact of ash fall on power plants. This made it possible to estimate changes over time in the distribution of ash fall over a wide area.

- **Fragility Assessment of Nuclear Facilities against External Natural Phenomena:** We developed a non-linear numerical analysis method that can caluculate the timing of soil faillure and the amount of soil strain with a view to evaluating seismic stability of a foundation ground and surrounding slopes of a nuclear power plant when an earthquake occurs. We also verified the accuracy of the analysis method with numerical correlations on scaled model test results. In order to evaluate the tenacity of nuclear power facilities

in the face of a tsunami, we used evaluation experiments in tsunami and flood channel and developed a method of estimating tsunami shock wave pressure on structures from the front of the tsunami as it runs up onto the shore.

- **Development of Environmental Diffusion Evaluation Methods and Long-term Behavior of Radioactive Materials:** We developed a transfer model of radioactive materials to marine sediment and marine organisms, in addition to oceanic diffusion of released radioactive materials. We applied this model to actual oceanic waters and found that the reduction and delay in the concentration of radioactive materials in marine organisms on the sediment can be attributed largely to the movement via prey organisms on the sediment.

- **Establishment of Methodologies to Evaluate Fires in Nuclear Facilities:** We established construction methods for automatic foam extinguishing systems for fires in cable trays with a view to devising measures to mitigate the impact of fires in nuclear power plants, and confirmed its effectiveness through fire verification tests. We also carried out internal arc fire experiments on low-voltage power panels and clarified the conditions (arc energy thresholds) in which fires would develop after an arc is generated.

Radiation Risk

- **Quantitative Evaluation of Low-dose Radiation Risk and Reflection to Radiation Protection Systems:** We confirmed by radiation exposure experiments that there are discrepancies in behavior of tissue stem cells to maintain stem cell function between low and high dose-rate. This is aimed at clarifying the impact of radiation exposure on cancer risks. As a result, we forecasted that it would be possible to establish a mechanistic hypothesis that damaged stem cells are eliminated from the body through competition and thus the impact of exposure does not accumulate.

Nuclear Fuel Cycle and Backend Technologies

- **Systematization of Long-term Safety Evaluation for Radioactive Waste Disposal:** Damage to the engineered barrier material as a result of the hydrogen gas emitted from the waste through metallic corrosion is a concern in disposing of low-level radioactive waste, and in order to assess its long-term soundness, we carried out tests to clarify the mechanism by which gas moves within the bentonite materials used in the barrier. Based on this, we developed a method of evaluating gas movement.

- **Development of Long-term Storage/ Management Technologies for Spent Fuel:** We developed a device capable of automatically and simply measuring salt

concentration over a long continuous period, which is needed to assess stress corrosion cracking (SCC) in canisters. We confirmed that this can be used on the frontlines. Using a simulation testing device, we assessed the salt concentration on the surface of canisters in concrete casks, and clarified that the salt concentration adhering to the surface is sufficiently low compared to the SCC limit value even when the amount of salt in the atmosphere along the coast is substantial.

Natural Disaster Reduction on Transmission and Distribution Facilities

- **Development of Prediction Methods of Weather/Climate Affection to Electric Power Facilities:** We developed an evaluation method through numerical analysis of tornado missiles' speed and dispersal to devise methods for impact assessment and protection in the event that tornado missiles hit important facilities at a nuclear power plant. We also experimentally verified the collision energy absorption performance and penetration prevention performance of high-strength steel net, developed as a protection measure, by carrying out tests in which heavy bobs simulating missiles were dropped.

- **Demonstration of Preventive and Mitigating Measures against Snowstorm Damage to Transmission and Distribution Facilities:** We observed cases of the accretion of snow characterized by strong winds and moisture at full-scale test facilities for snow-storm damage (transmission lines in the Kushiro area). We analyzed these observational results and clarified conditions in which countermeasures would have the most effect and the impact of heat generation on transmission lines through power transmission currents.

- **Risk Management against Lightning:** There are concerns about malfunctions caused by electromagnetic noise caused by surges and other phenomena in general-purpose IP (Internet Protocol) equipment introduced to power stations and substations. Accordingly, we carried out experiments to reveal the impact of electromagnetic noise on the IP transmission of the equipment. Based on these results, we observed the threshold noise level to create communication errors and established methods to evaluate the appropriateness of introducing IP equipment to power stations and substations.

Energy and Environment Institutions

- **Well-functioning Electricity Market and Neutralization of Network:** Mechanisms of balancing supply/demand through a nationwide supply/demand balancing market in Germany following the high penetration of renewable energy and trends in the costs incurred to relieve congestion during actual operations demonstrate that the cost of ensuring reliability of a power transmission system had not declined when electric

power transmissions were unbundled. Moreover, we clarified the current problems with economic methods encouraging the new construction and expansion of nuclear power generators following deregulation in Europe and the points to note in the event that it is adopted in Japan.

- **Institutional Environments surrounding Nuclear Industry:** A national public survey on energy policy and nuclear power generation technology indicated that in order to raise understanding of electric power industry's activities and restore trust in them, interest in energy issues overall, such as securing stable resources, must be stimulated and the public must understand that the electric power industy shares the public's concerns over its impact on the environment and health for people in the future.

- **Climate Change Policy:** We found that since energy prices are high and energy efficiency levels are also extremely high in Japan, policies such as taxes and more severe regulations have little cost effectiveness, while voluntary initiatives in industry that are economically rational are effective in augmenting the government's policy methods.

- **Scientifically and Economically Rational Scenarios to Reduce CO_2 Emissions:** We surveyed the IPCC's new information on the climate impact, which is considered as basis for judgment about long-term targets for reducing CO_2 emissions, and explicated the concept of climate change risks and evaluation points. We clarified that the assessed risk levels for climate change depend on the scope of risks and associated socio-economic factors.

(2) Further Improvement of Facility Operations and Maintenance Technologies

Nuclear Power Plant Maintenance

- **Structural Integrity Evaluation of Reactor Pressure Vessels and Core Internals:** We carried out elevated temperature tensile tests at various temperatures on the materials used in penetrations existing at the bottom of research vessels, and developed a method to estimate the relationship between stress and strain in each material. This was part of our efforts to evaluate the soundness of reactor pressure vessels in the event of a severe accident.

- **Integrity Evaluation of LWR Components and Piping:** With a view to evaluating the structural integrity of equipments made of cast stainless steel used in main coolant systems in LWRs, we evaluated the change in the microstructure, the hardness and the fracturetoughness of materials that have suffered thermal aging heat treatment. We will develop prection method of reduction of fracture toughness due to thermal aging.

- **Integrity Evaluation of Cable Insulation used in Nuclear Power Plants:** In order to establish soundness evaluation methods for instrumentation and control cables at nuclear power plants, we evaluated the mechanical characteristics of the insulating materials in degraded cables removed from power plants, and demonstrated that degradation was less severe than predictions made using the conventional cable age-related degradation evaluation method.

- **Development of Nondestructive Inspection Techniques for LWR Components and Piping:** We developed phased-array ultrasonic testing methods able to measure crack length (radial dimension) with a high degree of accuracy with a view to evaluating the soundness of anchor bolts stabilizing pressure vessels. In addition, we developed a non-destructive inspection technique for measuring the depth and length of cracks by imaging the shape of the cracks formed in the dissimilar metal welds, such as reactor vessel outlet and inlet nozzle welds~~s~~.

Construction, Operation and Maintenance of Power Generation Facilities

- **Development of Life Assessment Technology for High Temperature Structural Components of High Chromium Steels:** We developed a life assessment method depending on the various shapes of the welded part and the repair welding for creep damage in the welded parts of high chromium steel pipes to maintain stable operations of ultra super critical thermal power plants. We examined the accuracy of this assessment method using full-scale pipes at a demonstration creep test facility.

- **Development of Comprehensive Atmospheric Assessment Method for Thermal Power Plants:** In order to assess the impact of thermal power plants on $PM_{2.5}$ observed in regions in Japan, we evaluated sources of $PM_{2.5}$ in Japan and overseas using numerical analysis methods that tag the substance causing $PM_{2.5}$ and track it. This showed that 47% of the derivations were overseas, and the impact of thermal power plants in Japan was 3%.

- **Development of Technologies for Increasing the Use of Coal Ash:** In order to establish the environment safety assessment of coal ash products used in ground materials, we developed a measuring equipment system for boron in coal ash, based on thermal neutron absorptiometry, and a rapid leaching test method for fluorine in coal ash using wet ball-milling.

- **Development of Technologies of Environmental Impact Assessment for Biodiversity Conservation:** In order to efficiently implement environmental assessments of wind-powered electricity, a new target of assessments, we developed a

method to reconstruct 3D positions of bird flight trajectories from video observation instead of the previous visual observation of bird flight trajectories. This made it possible to estimate the number of bird collisions with a high degree of accuracy.

- **Synthesis System of Numerical Analysis for Current and Sediments in Rivers and Reservoirs:** We added functions to predict the movement of sediment accumulated in reservoirs and changes in water quality to the existing system predicting rainfall intensity and discharge, and developed an integrated system for flood and sediment behavior projection that can predict the flow from a river's upper stream to the mouth of the stream and the behavior of sediment during floods. This is intended to encourage rational dam operations.

Operation and Maintenance of Transmission and Distribution Facilities

- **Maintenance and Management Technologies of Aged Transmission and Distribution Facilities:** We applied a technology to detect coil abnormalities using frequency response analysis (FRA) to the diagnosis of oil-immersed transformers in two situations as one solution to efficiently maintain transmission and distribution facilities. Based on the investigation dismantlement of transformers and the diagnostic results from FRA, we devised criteria to determine coil abnormalities that should be adopted in both emergency diagnoses, such as lightning surges, as well as detailed diagnoses carried out in routine inspections.

- **Development of Soundness Assessment Technologies of Aged Transmission Towers:** With the aim of devising a simplified assessment method for corrosion inside steel pipes, we applied new corrosion speed assessment methods utilizing several sensors to steel pipes exposed to the natural environment for about two and a half years, and confirmed that it was generally consistent with actual corrosion speed distribution. In addition, we confirmed that the guided wave measurement method used in cooling pipe inspections at power plants could detect thinning resulting from corrosion inside steel pipes, and theorized that this method could be applied to corroded parts of steel towers.

(3) Development of a Supply/Demand Infrastructure for Next-generation Electric Power

Next-generation Thermal Power Technologies

- **Improvement of Operation and Control Technologies to Diversify Fuel Types for Pulverized Coal Fired Power Plant:** We clarified the operating conditions for pulverizers that would enable a high coal blending rate for low HGI bituminous coal, which is hard to grind, with the aim of expanding the use of this more affordable type of coal at existing pulverized coal fired power plants. We also tested the corrosion

resistance effect of a sulfide corrosion resistant coating (already developed, CRIEPI COAT) in boiler water wall tubes. We confirmed that it could be used simply and at low cost. CRIEPI COAT reduced corrosion to 25% or less compared with an uncoated part.

- **Advancement of Utilization Technologies for Low Rank Energy Resources:** A biomass carbonization prome as a measure to expand the biomass co-firing rate in existing thermal power plants. We carried out carbonization tests on cedar chips and clarified the impact of operating conditions such as residence time and carbonization temperature on fuel properties of carbonizaed biomass. The results showed that by using the ratio of carbonizaed biomass production rate and raw biomass feed rate as operation indicators, carbonized biomass with consistent properties can be produced stably and in large quantities.

Next-generation Power Grid Technologies

- **Power System Security Assessment with High Penetration of Photovoltaics:** With the aim of improving the efficiency of operations of electric power systems when photovoltaic power is adopted on a large scale, we systematically addressed the impact of individual system conditions, such as the site at which photovoltaic power is adopted and operating conditions, on the system stability of the power system. Using these results, we confirmed that system conditions with a major impact on system stability can be easily ascertained even when multiple system conditions change through analysis utilizing system models at actual scale.

- **Development of Accurate Power Output Estimation and Forecast Techniques of Photovoltaic Power Generation:** In order to ascertain the photovoltaic power generation output in each region, which fluctuates depending on the weather, we developed a method to estimate in real time the amount of solar radiation needed to meet supply/demand in one-minute increments from weather satellite images recorded and delivered every 30 minutes. We also developed a method of estimating the incident solar radiation amount for the PV panel surface of PV array contributing to photovoltaic output in order to accurately estimate photovoltaic output.

- **Development of Next Generation Distribution Network Techniques:** In order to support prompt recovery after incidents at power distribution lines in which photovoltaics are interconnected in a large volume, we developed a method of estimating actual load and photovoltaic power generation output in real time based on power flow data from switches with sensors on power distribution lines. We confirmed that this method can be applied to capital plans for power distribution systems and operations during accidents by comparing photovoltaic power generation output

estimated from actual power distribution lines' power flow data and actual measured data.

- **Demonstration and Common Specification of Next-generation Communications Network Systems:** We evaluated transmission delay characteristics when IP based microwave radio link is used for transmission line protection, which has severe delay constraints to develop an IP network for highly reliable system protection and control. As a result, we demonstrated that an IP network for system protection and control could be built by incorporating time synchronization mechanisms in microwave radio equipment to compensate the influence of delays.

- **Assessment of the Value of Next-generation Demand Management:** With a view to forecasting future power demand, we gave questionnaires on an ongoing basis on power conservation over four years following the Great East Japan Earthquake and confirmed that awareness of power conservation and initiatives has gradually declined. At the same time, this demonstrated that there is a high possibility that, despite these conditions, gains in actual demand are being curbed in part because of cost-cutting awareness resulting from updates to more efficient equipment and higher electricity charges.

Energy Utilization Technologies

- **Development and Evaluation of Advanced Heat Pumps:** With the aim of promoting and spreading high-performance heat pumps for industrial users, we carried out tests to assess the performance of the SGH165 heat pump for industrial use, which produces 165℃ vapor. We also clarified the impact that operating conditions such as the temperature of heat source water at the entrance and vapor pressures have on the amount of vapor formed and energy consumption efficiency (system COP).

- **Establishment of Evaluation Technologies for High Performance Secondary Batteries:** In order to establish long-term operation method of battery energy storage systems, which are now testing on the several fields for stabilization of the power grid inter-connected with large amount of renewable energy power generation systems, we devised a method of analyzing the factors of a decline in the capacity of lithium ion batteries during the charge-discharge cycle tests. We also evaluated quantativelly effects of the increasing the internal registance on the degradation of the battery capacity.

2. Basic technology subjects

Basic technology subjects are those that we address with the aim of identifying and resolving issues faced by the electric power industry and strengthening our basic research skills, which are the source of our problem-solving, using our “pool of knowledge” consists of knowledge useful on the frontlines, personnel with advanced expertise, sophisticated research facilities and our overseas and domestic human network.

We designated 35 basic technology subjects in fiscal 2014 to capitalize on the strengths and specialized skills of eight laboratories with specific research fields. Our main results are outlined below.

Socio-economic Research Center:

- We examined the feasibility of devising a community-based strategy for electric power companies after full deregulation of retail sales, based on cases in the UK and elsewhere, and determined that not only is there a need to always provide new value meeting the needs of consumer and the community, but that various factors have an impact, such as the region’s culture and history, the extent of urbanization and the community’s vitality.

- In order to ascertain comprehensive costs of introducing renewable energy, we developed a method of establishing an electrical power source composition and plan to minimize the cost of power generation that takes into account adjustments for fluctuations to frequency and lower power generation efficiency for thermal power. This indicated that in the event that renewable energy is introduced on a large scale, the capacity of power generation facilities on the system-side can only be reduced slightly, and a reduction in the facility use rate of thermal power plants would increase the power generation unit cost.

System Engineering Research Laboratory:

- In order to evaluate the impact on supply/demand adjustments, such as inadequate capacity to adjust the frequency of power systems as a result of the large-scale introduction of renewable energy, we built a simple and multi-purpose analytical model with few setting parameters that can be used with electric generators of various specifications for thermal power generators, the primary regulated power source, and developed a simulation method that can simulate output fluctuations in electric generators relative to fluctuations in frequency.

- We developed a method of estimating the air temperature, air flow distribution and the power consumption based on catalog information for various room air conditioners to

achive both energy conservation and comfort. Using this method, we developed a tool to support the selection of a suitable type of air conditioner that can adapt to various lifestyles.

Nuclear Technology Research Laboratory:

- In order to evaluate the conditions of the reactor core under atmospheric pressure resulting from severe accidents, we carried out boilup experiments with a simulated fuel bundle. The quantified coolant boiling behavior revealed the core coolability under atmospheric pressure.

- In order to evaluate safety for storing radioactive waste material, we clarified the increase in internal pressure in storage containers resulting from water vapor from the zirconium molybdate adhering to waste material from the fuel cladding, and expanded the knowledge needed to assess the safety of storage vessels.

Civil Engineering Research Laboratory:

- In order to contribute to the evaluation of the activity of fault fracture zones in bedrock, we established a method of evaluating activity by specifying the most recent fault planes using helical X-ray CT scanners and others, and determining the breakage of minerals on the fault plane.

- In order to contribute to the development of a structural capacity assessment method for steel-reinforced concrete structures after an earthquake, we carried out load tests for steel-reinforced concrete parts, and clarified the relationship between the widening of cracks and a decline in bearing force. As a result, we developed a method of determining the damage level for parts from measurements of the widening resulting from cracks in the parts.

Environmental Science Research Laboratory:

- We developed a biological process for the treatment of selenium in desulfurization wastewater in coal-fired thermal power plants. The process using microorganisms lowers the treatment cost by reducing the amounts of chemicals and sludges, compared to the conventional chemical process.

- We developed a method for analyzing the coastal current pattern and its frequency with flow observation using ocean radars for the environmental impact assessment of coastal power plants construction. This method reduces the number of observation points with a conventional velocimeter, and is expected to cut down the period and cost of oceanic

observation.

Electric Power Engineering Research Laboratory:

- We carried out tests in which lightning impulse currents were applied to clarify the causes of smart meter malfunctions resulting from lightening and the conditions under which they occur in order to establish lightning protection for smart meters. Based on these results, we determined that the rate at which lightning malfunctions occur can be reduced by reinstalling lightning protection elements within the meter.

- We have developed generic simulation models of distributed energy resources and incorporated them into the electromagnetic transient analysis program XTAP developed at CRIEPI. These models are used for assessing, for instance, the contribution of a large-scale photovoltaic generation system (solar farm) to fault currents in a transmission system.

Energy Engineering Research Laboratory:

- In order to establish rational inspection methods for gas turbine rotor blade thermal barrier coating, we devised an efficient testing process for non-destructive inspections looking at several areas of damage and deterioration, such as coating thinning and delamination. This inspection process is based on priority rankings taking into account the impact on rotor blade durability and the reduction in time achieved by narrowing the targets in a simplified inspection.

- With the aim of developing quantitative evaluation methods through numerical analysis of thermal flow within the pulverized coal boiler, we endeavored to improve analysis accuracy and raise the sophistication of advance projections of combustion characteristics of unused coal by deciding on swirling air inflow conditions from the each burner for numerical analysis in a comparative inspection with onsite measurement data.

Materials Science Research Laboratory:

- We succeeded in verification tests for the manufacture of high-quality SiC single-crystal ultra-thick film six inches in radius that can be used with power semiconductors with voltage resistance over 13kV to develop low-loss power transformers using SiC power semiconductors.

- With the aim of reducing sulfurization in water wall tubes at coal-fired boilers, we clarified the effect of periodic gas composition fluctuations within the boiler on

sulfidation rate of water wall tube materials made of low-alloy steels, and also proposed a new non-destructive inspection method that can identify the areas where sulfidation has taken place quickly and at low cost to coal-fired boilers.