	About This Publication and the JAEA Organizational Outline	10
1	HTGR Hydrogen and Heat Application Research	
Highlight	Research and Development on HTGR, Hydrogen Production, and Heat Application Technologies	13
1-1	Development of a Neutron Detector with Improved Heat Resistance  - Consideration of the Thermal Cycle Load Specific to High Temperature Gas-Cooled Reactors - Takayuki Kozawa	14
1-2	Toward the Demonstration of H₂ Production Technology Using the HTGR  – Development of Safety Design Philosophy for HTTR Heat Application Test Facility –  Takeshi Aoki	15
1-3	Evaluation of the Fuel Integrity of High Temperature Gas-Cooled Reactor to Maximize the Performance  — Improvement of the Failure Assessment Method of Tristructural Isotropic Fuel Performance for High Temperature Gas-Cooled Reactor — Shoichiro Okita	16
1-4	Feasibility Study on Reprocessing Technology of HTGR Spent Fuel  – Improving the Economics of Reprocessing Based on the Existing PUREX Technology – Yuji Fukaya	17
1-5	Toward Stable Hydrogen Production by the IS Process  – Development of a Composition Control Method to Prevent Pipe Clogging by Iodine Precipitation – Yu Kamiji	18
1-6	Energy Saving for H <sub>2</sub> Production by the IS Process  – Membrane Development for HI Concentration to Suppress Swelling by Cross-Linking – Nobuyuki Tanaka	19
1-7	Enhancement of Corrosion Resistance of the Metallic Components Used in the IS Process  – Exploring a Coating Material That Can Withstand a Sulfuric Acid Boiling Environment –  Noriaki Hirota	20



## **Research and Development of Fast Reactors**

HIGHIGHT	Development of the Technology Base and R&D Infrastructure for Fast-Reactor Cycles	21
2-1	Measures Against Beyond Design-Basis Accidents to Effectively Reduce Accidents Possibly Involving Core Damage  - Probabilistic Risk Assessment Results for Fast Reactor Operational Conditions –  Hiroyuki Nishino	22
2-2	In-Vessel Retention of Molten Core Materials  - Visualization Experiment of Molten Core Materials Penetrating into Liquid Sodium - Kenichi Matsuba	23
2-3	Prediction of Whole-Plant Thermal-Hydraulic Performance in Sodium-Cooled Fast Reactors  – Coupling of One-Dimensional Plant Dynamics Analysis and Three-Dimensional Detailed Analysis Codes – Kazuo Yoshimura	24

2-4	Feasibility Study of Application of Dissimilar Welding Technology to Fast-Reactor Wrapper Tubes  – Applicability to Fast-Reactor Core Revealed by Microstructural Analysis –  Takashi Tanno	25
2-5	Toward an Efficient Shielding Design of Fast Reactors  – Evaluation of Sodium Radioactivity in the Primary System of the Prototype Fast Reactor Monju – Tetsuya Mouri	26

## **Advanced Scientific Research**

Highlight	Fundamental Sciences to Realize New Era of Nuclear Science and Technology	27
3-1	Establishment of a γ-Ray-Spectroscopy Technique to Study Actinide Nuclei  – Advancing Research on the Nuclear Structure of Superheavy Elements – Riccardo Orlandi	28
3-2	Uncovering the Origin of Short-Range Repulsive Nuclear Force Produced by Quarks – $\Sigma^+p$ Scattering Experiment at J-PARC – Takuya Nanamura	29
3-3	Successful Growth of High-Quality Uranium-Based Superconducting Crystals  - Contributing to the Elucidation of the Mechanism of Uranium-Based Superconductivity -  Hironori Sakai	30
3-4	Toward Highly Sensitive Detection of Sound Waves  - Sound Waves Drastically Alter Current-Voltage Characteristics - Michiyasu Mori	31
3-5	Why Can One Atomic Layer Graphene Separate Hydrogen and Deuterium?  – Toward the Mass Production of Deuterium Based on Quantum Tunneling – Satoshi Yasuda	32
3-6	Development of a New, Multilayered Electrode for Tunnel Magnetoresistance Devices with High-Performance and Functionality  — New Tunnel Magnetoresistance Devices for Advanced Industrial Applications — Kazuya Suzuki	33
3-7	Mysterious Energy Hidden in Thin Magnets  - Theory of Energy Generation in Extremely Small Systems - Kei Suzuki	34



## Nuclear Science and Engineering Research

Highlight	Fundamental Technologies for Nuclear Energy Innovation	35
4-1	Development of a Nondestructive Analysis System for Nuclear Material Measurement by Active Methods  - World's First System Capable of Conducting Three Nondestructive Measurements -  Harufumi Tsuchiya	36

4-2	Foundational Database for Diversifying Needs  – Development of the Latest Nuclear Data Library JENDL-5 – Osamu Iwamoto	37
4-3	Toward High Recovery Yields of Pyrochemical Reprocessing for Minor Actinide Transmutation Nitride Fuels  — Chlorination of Neptunium in Platinum Group Elements Compounds Without Using Corrosive Gases —  Hirokazu Hayashi	38
4-4	Development of a New Corrosion Inhibition Method Using Chelation Technique  – Crevice Corrosion Suppression by EDTA-Based Metal-Ion Introduction –  Takahito Aoyama	39
4-5	Computational Design of High-Strength Alloys  – Element Strategy Alloy-Design via Electronic Structure Calculations – Tomohito Tsuru	40
4-6	Mechanism of Actinide Transfer Between Water and Oil  — Studies of the Molecular Structure of Solvent Extraction Interfaces Using Vibrational Sum Frequency Generation Spectroscopy — Ryoji Kusaka	41
4-7	Development of a System for Whole-Body Dose Assessment in Carbon Ion Radiotherapy  – Use of Past Experience in Carbon Ion Radiotherapy to the Future of Radiotherapy –  Takuya Furuta	42
4-8	Measuring Neutrons Emitted in Spallation Reactions  - Toward Improving Prediction Accuracy Using Nuclear Reaction Models – Hiroki Iwamoto	43

## **Neutron and Synchrotron Radiation Research**

riigilligilt	Contributions to innovative Achievement in Science and Technology	44
5-1	Beam Loss Assessment of High-Intensity Negative Hydrogen Ion Beams  – Observation of Neutral Beams Generated by Residual Gas Electron Stripping – Jun Tamura	45
5-2	Inelastic Neutron Scattering Experiments Under the Highest Pressure in the World  – Observation of Hydrogen Vibrational Excitation of Metal Hydrides at 21 GPa – Takanori Hattori	46
5-3	Neutron Diffraction Experiments Under Pulsed High Magnetic Fields  – Development of a High-Field Pulsed Magnet System Exceeding 30 T –  Masao Watanabe	47
5-4	Neutron Scattering Measurements for Magnetic Moment in Comparison with Nuclear Spin Polarization  – A New Technique Useful in Study on Magnetism and Material –  Naoto Metoki	48
5-5	Visualizing Lithium-Ion Transfer in All-Solid-State Batteries  – Neutron Depth Profiling for the Operand Measurement of Li Ions – Takahito Osawa	49
5-6	Demonstration of Laser-Assisted Separation of Actinides  – Enhancing Selectivity in Solvent Extraction by Manipulating f Electrons with Light – Keiichi Yokoyama	50

5-7	Growth Process of Silicon Oxide Films Revealed Using High-Brightness Synchrotron Radiation  — Interfacial Defects and Carrier Trapping Dominate the World of Nanodevices — Yasutaka Tsuda	51
6	Computational Science and E-Systems Research	
Highlight	Computational Science for Nuclear Research and Development	52
6-1	Can Machine Learning Predict the Atomic Motion Inside Nuclear Fuel Materials?  – Toward the Application of Machine-Learning Molecular Dynamics to Nuclear Fuel Materials – Keita Kobayashi	53
6-2	Specificity of Liquid Metal Embrittlement  - Energy Criteria for Embrittlement: Atomistic Weak Interactions -  Masatake Yamaguchi	54
6-3	Understanding Hydrated Radium at the Molecular Level  - The Advent of Molecular-Level Research on Radium 125 Years After the Discovery of the Element – Akiko Yamaguchi	55
6-4	Exploring Large-Scale Simulations in Virtual Space  – Making Interactive Remote Virtual Reality Visualization Possible – Takuma Kawamura	56
6-5	New Data Conversion Method to Accelerate Nuclear Simulation  – Matrix Solvers with 16-Bit Operations Achieve Same Convergence as 64-Bit Operations – Takuya Ina	57
7	Development of Science & Technology for Nuclear Nonproliferation	
Highlight	Development of Technology and Human Capacity Building in the Fields of Nuclear Nonproliferation and Nuclear Security to Support the Peaceful Use of Nuclear Energy	58
7-1	Prevention of Acts of Nuclear/Radiation Terrorism at Large Public Events  – Development of Detection Equipment to Estimate the Direction of Incoming Neutrons – Takahashi Tohn	59

## Research and Development Related to the Accident at TEPCO's Fukushima Daiichi NPS

Highlight	R&D for decommissioning the FDNPS / R&D for environmental restoration	60
8-1	Lessons Learned from the Chornobyl Nuclear Power Plant  - What is the Condition Needed to Suppress Degradation of Fuel Debris? - Toru Kitagaki	<b>6</b> 2
8-2	Radiation Emitted from Fuel Debris  – Elucidation of the Characteristics of Bremsstrahlung X-Rays and Effects of the Dose Rate – Taichi Matsumura	<b>6</b> 3
8-3	Utilizing the Directivity of Cherenkov Radiation to Distinguish <sup>90</sup> Sr/ <sup>90</sup> Y and <sup>137</sup> Cs – Simultaneous Detection of the Source Positions of <sup>90</sup> Sr/ <sup>90</sup> Y and <sup>137</sup> Cs – Yuta Terasaka	<b>6</b> 4
8-4	Automatic Discrimination of Structure Category in the Workspace  - Development of a Structure Discrimination Method by Deep Learning Based on 3D Point Cloud - Takashi Imabuchi	<b>6</b> 5
8-5	Toward Predicting Cesium Distribution in FDNPS  - Improvement of the Analysis Code of Cesium Behavior in a Severe Accident – Shuhei Miwa	<b>6</b> 6
8-6	Toward Predicting the Properties of Cesium Remaining in FDNPS Reactor Buildings  – Clarification of Cesium Adsorption on Nonferrous Structural Materials –  Kunihisa Nakajima	<b>6</b> 7
8-7	Toward the Safe Storage and Management of Wastes Such as Fuel Debris  - Research and Development on Hydrogen Leakage/Diffusion Behavior Analysis – Atsuhiko Terada	<b>6</b> 8
8-8	Numerical Analysis of Hydrogen Combustion Behavior  – Effects of Temperature and Pressure on Flame Instability – Thwe Thwe Aung	<b>6</b> 9
8-9	Estimating Fuel Debris Temperature in FDNPS Unit 2 Under Air-Cooling Condition  – Numerical Simulation of Fuel Debris Heat Transfer – Susumu Yamashita	<b>0</b> 70
8-10	Effects of Forests on <sup>137</sup> Cs Behavior in River Catchment  – Development of a Watershed Model Combined with <sup>137</sup> Cs Migration in a Forest – Kazuyuki Sakuma	• 71
8-11	Future Behavior of Radiocesium on Land  - Prediction of Radiocesium Behavior on Land for 30 Years - Tsubasa Ikenoue	<b>•</b> 72
8-12	Remobilization Mechanism of Radiocesium from Bottom Sediments in Reservoir  – Vertical Distribution of <sup>137</sup> Cs in Sediment-Pore Water –  Hironori Funaki	<b>•</b> 73
8-13	Observation of Radiocesium Behavior in Estuaries  – Estimating the Origin of Particles Forming Turbid Layers near the Seabed – Toshiharu Misonou	• 74
8-14	Lichen as a Recorder of Radiocaesium  - Determining Radiocaesium Distributions in Biological Tissues by Combining Analytical Equipment - Terumi Dohi	<b>•</b> 75

8-15	Toward the Rapid Analysis of Plutonium Isotopes  – Analytical Technique Without Pretreatments – Makoto Matsueda	• 76
8-16	Reviews on Exposure Management for Residents After the Accident in Fukushima  – Toward the Lifting of Evacuation Orders for the Benefit of the Residents – Kazuya Yoshimura	• 77

### **Research and Development on Geological Disposal Technology**

Highlight	R&D to Improve the Reliability of Geological Disposal Technologies in Japan	78
9-1	Direct Observation of Fractures to Estimate Future Permeability  – Application of Fracture Visualization Technology by Resin Injection – Kazuhei Aoyagi	79
9-2	Deep Groundwater Physicochemical Components Affecting Actinide Migration  – Addition of Trace Elements to Groundwater in Granite and Mudstone –  Kazuya Miyakawa	80
9-3	Estimating the Erosion History Around the Depth of Geological Disposal  — Reconstructing Thermal History by Optically Stimulated Luminescence Thermochronometry of Borehole Cores — Manabu Ogata	81
9-4	Accelerator Mass Spectrometer: The Challenge of Ultra-Downsizing  – Filtering Atoms and Molecules Using Crystal Surfaces – Satoshi Jinno	82
9-5	Bentonite Swelling and Interlayer Cation Behavior  – Why the Expandability of Montmorillonite is Different Between K <sup>+</sup> and NH <sub>4</sub> <sup>+</sup> in Bentonite? – Ryohei Kawakita	83
9-6	Evaluation of Radionuclide Migration by a Diffusion Model  – Diffusion Test and Model Development for Compacted Ca-Bentonite –  Vuta Fukatsu	84

# **Steadily Promote Backend Measures with the Highest Priority on Safety**

Highlight	Decommissioning of Nuclear Facilities and Disposal of Radioactive Waste	85
10-1	Toward an Efficient Design for Disposal Facilities  – Evaluation of Skyshine Dose Generated from Disposal Facilities – Mizuki Nakamura	86
10-2	Toward the Practical Application of Flame-Retardant Waste Treatment Test Equipment  – Selection of Repair Materials for the Main Reactor Refractory –  Jun Kijima	87

10-3	Toward Using Geopolymer for the Treatment of Radioactive Wastes  – Investigation on the Possible Pathway of Zeolites Formation in the Geopolymer – Junya Sato	88
10-4	Toward the Safe and Long-Term Storage of Plutonium  – Aggregation of Plutonium and Shift to PVC-Free Storage – Shun Hirooka	89



## **Research on Nuclear Safety and Emergency Preparedness**

Highlight	Implementing Continuous Improvements in Safety and Emergency Preparedness	90
11-1	Toward Rapid Inspection for Evacuation Vehicle Contamination in a Nuclear Emergency  – Examination of the Performance of the Portal Monitor to Inspect Vehicles of Evacuees –  Hirokazu Hiraoka	91
11-2	Clarifying Damage Conditions of Structures Subjected to Projectile Impact  — Investigation of Damage Condition of Reinforced Concrete Panels Simulating Outer Walls of a Nuclear Building — Yukihiko Okuda	92
11-3	Toward Improving the Accuracy of the Structural Integrity Assessment Method for Reactor Pressure Vessels  – Effect of Stainless-Steel Overlay Cladding on Fracture Behavior of the Reactor Pressure Vessel –  Masaki Shimodaira	93
11-4	Toward More Rational Light Water Reactor Fuel Design and Safety Assessment  – Establishing a Model to Predict Irradiation Growth in Zirconium-Based Alloy Claddings – Kazuo Kakiuchi	94
11-5	Confinement of Radioactive Materials Within the Facility Under Fire Conditions  — Evaluation of the Properties of High-Efficiency Particulate Air Filters Clogged with Soot from Burned Gloveboxes — Shinsuke Tashiro	95
11-6	Accurate Estimation of the Three-Dimensional Distribution of Groundwater Contamination - Expectation for Contribution to Understand Underground Contamination for Decommissioning — Shizuka Takai	
11-7	Filtering Out Radioactive Materials from a Pool During Severe Accidents  – Evaluation of Two-Phase Flow Behavior During Pool Scrubbing by Computational Fluid Dynamics Simulation – Yuria Okagaki	97
11-8	Validation of the Latest Nuclear Data Library  – Postirradiation Experiment Analysis of Pressurized Water Reactor Fuels Using JENDL-5 – Tomoaki Watanabe	98