About This Publication and the JAEA Organizational Outline

10



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

Highlight	Assistance in Environmental Restoration and Decommissioning	12
1-1	Degradation of Fuel Debris Under the Effect of Ionizing Radiation  - Formation of Solid Solution Improves Stability to Oxidative Degradation – Yuta Kumagai	14
1-2	Criticality Evaluation of Fuel Debris with Unclear Material Composition  – Development of a New Subcritical Depletion Code for Monitoring Noble Gases – Eka Sapta Riyana	15
1-3	Clarifying the Failure Mechanism of the Lower Part of the RPV  – Melting Test Assuming a Eutectic Reaction in the Complex Structure of a BWR – Takuya Yamashita	16
1-4	How to Effectively Remove lodate from Solutions?  - Coprecipitation of lodate with Barite (BaSO <sub>4</sub> ) Was Evaluated at a Molecular Level – Kohei Tokunaga	17
1-5	Characterization of Radioactive Waste for Safe Storage  – Effect on the Chemical Composition of Carbonate Slurry – Takuma Horita	18
1-6	Realization of γ-Ray Nuclide Analysis Under Severe Radiation Fields  – Development of a γ-Ray Spectrometry System Specific to High Dose Rates for Simple Nondestructive Assays – Masaaki Kaburagi	19
1-7	In-situ Monitoring System for Radioactive Aerosols  - Real-Time Monitoring of Alpha Aerosols to Improve Worker Safety - Youichi Tsubota	20
1-8	Simultaneous Measurement of the Energy Spectra of Alpha, Beta, and Gamma Rays  — Development of a Portable Continuous Air-Monitoring System for Detecting Alpha/Beta/Gamma Radioactive Material — Yuki Morishita	21
1-9	Novel Single-End Readout-Type Optical Fiber Radiation Sensor  – Highly Sensitive Position Detection by Photon Wavelength Analysis Using a New Spectroscopy System – Yuta Terasaka	22
1-10	Visualization of Radioactive Contamination at the Decommissioning Site on a Three-Dimensional Map  — Understanding Invisible Radioactive Contamination in a Virtual Space and Reducing Worker Exposure — Yuki Sato	23
1-11	Impact of Extreme Typhoons on Radiocesium Discharge  - Comparison of Effects of Two Typhoons-Etau in 2015 and Hagibis in 2019 - Takahiro Nakanishi	24
1-12	Approaching the Secrets of Long-Term Cesium Retention in Lichen  - Computational Chemistry Solves the Energetics of Complexation of Metabolites with Cesium –  Masahiko Machida	25

1-13	Rapid Analysis for Long Half-Life 99Tc  – ICP-MS Analysis with Solid-Phase Extraction and Gas-Phase Reaction – Makoto Matsueda	26
1-14	Selective Detection of Trace Sr Isotopes Using Lasers  - Simplified Pretreatment of Samples Containing Isobars and Stable Isotopes - Yoshihiro Iwata	27
1-15	Toward Confident Hot-Spot Visualization Using an Unmanned Helicopter  – Improvement of Detection Accuracy by Selecting Data on the Flight Conditions – Yoshiaki Shikaze	28
1-16	Research on the Decreasing Trend of Atmospheric Radiocesium Concentration After the Accident  – Assessing the Decrease Rate Based on Governmental Monitoring Results –  Tomohisa Abe	29
1-17	Why Does the Air Dose Rate in Urban Areas Decline Quickly?  – Reduction Effect Revealed by the Behavior of Radioactive Cesium – Kazuya Yoshimura	30

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

Highlight	Implementing Continuous Improvements in Safety and Emergency Preparedness	31
2-1	Understanding Reactor Risk Profiles Against External Events  – Probabilistic Assessment of Internal Flooding-Induced Risks by a Dynamic Approach – Kotaro Kubo	32
2-2	Understanding Containment Vessel Flow During Severe Accident  – Mass Transport Behavior Depending on the Relative Location of Outer Cooling and Initial Stratification – Satoshi Abe	33
2-3	Fuel Debris Form Prediction in a Severe Accident  – Measurements of Mass Fractions of Agglomerated Debris Settled on the Floor of a PCV – Yuzuru Iwasawa	34
2-4	Parameter Determination for Assessing the Sheltering Effectiveness in Japanese Houses  — Obtaining Data on Penetration Factor and Deposition Rate of Particulate and Elementary Iodine by Real House and Chamber Experiment — Jun Hirouchi	35
2-5	How Much Can Nuclear Piping Withstand Huge Earthquakes  – Development of Seismic Fragility Evaluation Method for Aged Piping –  Yoshihito Yamaguchi	36
2-6	A Path Toward Recycling and Landfill of Asbestos Waste Arising from Decommissioning  – Development of Evaluation Method for Exposure Dose by Cleared Asbestos Waste – Taro Shimada	37



### **Advanced Scientific Research**

Highlight	Fundamental Sciences to Realize the New Era of Nuclear Science and Technology	38
3-1	What is the Chemical Behavior of the Heaviest Element?  – A Small Breach of the Periodic Law Found in the Volatility of Element 105, Dubnium – Tetsuya K. Sato	39
3-2	Probing the Strong Interaction with Superconducting Detectors  – Drastic Precision Improvement in the X-Ray Spectroscopy of Kaonic Atoms – Tadashi Hashimoto	40
3-3	Slow Dynamics of Electrons in Uranium Compounds  – Approaching the Mystery of Superconductors Leading to Quantum Computers – Yo Tokunaga	41
3-4	Topology-Based Manipulation of Magnets in Spintronics  – New Principle for Power Saving in Magnetic Memories – Yasufumi Araki	42
3-5	Insight into Designing Highly Efficient <i>Ortho-Para</i> Hydrogen Conversion Catalysts  – Demonstration of Fast <i>Ortho-Para</i> Conversion of H₂ on a Stepped Surface –  Hirokazu Ueta	43
3-6	Unveiling the Retention Mechanisms of Uranium (VI) on Host Rocks  – Surface Sorption Process Related to Two Types of Sorption Species – Huiyang Mei	44
3-7	Towards Understanding the Coherent Properties of Bosons  – Determination of the Josephson Current in a Bose–Einstein Condensate – Shun Uchino	45



### **Nuclear Science and Engineering Research**

Highlight	Fundamental Technologies for Nuclear Energy Innovation	46
4-1	Development of a Low-Cost Transportable Device for Detecting Nuclear Materials  – Successful Experimental Demonstration of a New Nondestructive Method –  Masao Komeda	47
4-2	Connecting Nuclear Data with Transport Calculation  – Development of Nuclear Data Processing Code FRENDY Version 2 – Kenichi Tada	48
4-3	Unveiling the Mystery of the Radiation Damage that Does Not Follow the Conventional Theory  – Radiation Damage Mechanism in Ceramics Irradiated with Swift Heavy Ions –  Norito Ishikawa	49

ıl Areas	
stem – 5	0
rategies – 5	1
<b>System</b> 5:	2
5	3
t	trategies – 5 <b>System</b> 5

### **Neutron and Synchrotron Radiation Research**

Highlight	Contributions to Innovative Achievement in Science and Technology	54
5-1	Beam Measurement Using Light Produced by Beam-Gas Interaction  – Development of a Gas Sheet Beam Profile Monitor –  Ippei Yamada	55
5-2	Acceleration of Neutron Measurement by Deep Learning  — Over 10-Fold Acceleration of Neutron Reflectometry Measurement by an Accurate Noise Reduction Method — Hiroyuki Aoki	56
5-3	Wide Bandwidth Neutron-Spin Polarizer  – A Breakthrough in Neutron-Polarizing Supermirror with Very High Critical Momentum Transfer – Ryuji Maruyama	57
5-4	Discovery of Coupled Fluctuations with Protein Domain Structures and Active Sites  – Analysis of Protein Dynamics by Neutron Scattering and Molecular Simulation –  Hiroshi Nakagawa	58
5-5	Development of Nuclear Vitrification by Neutron Scattering  – Nanoscopic Structure of Borosilicate Glass with Additives – Ryuhei Motokawa	59
5-6	Fabrication of Environment-Friendly Piezoelectric Materials  – Local Structural Analysis of Bi <sub>0.5</sub> Na <sub>0.5</sub> TiO <sub>3</sub> in the High-Temperature Phase – Yasuhiro Yoneda	60
5-7	How Heavy Electrons are Formed in Eu-Based Compounds  — Direct Observation of the Band Structure of Eu 4f Orbitals, Which Have Magnetic and Localized Characteristics, by Synchrotron Radiation Experiments — Ikuto Kawasaki	61
	-	



### **HTGR Hydrogen and Heat Application Research**

Highlight	Research and Development on HTGH, Hydrogen Production, and Heat Application Technologies	62
6-1	New Seismic Classification of the HTTR  - Appropriate Seismic Classification Based on Technical Knowledge and Operation Experience –  Masato Ono	63
6-2	Challenge to Measure the Power Distribution in Very-High-Temperature Core Environments  — Development of a Power Distribution Measurement Method Using Neutrons Leaked from an HTGR Core — Yuji Fukaya	64
6-3	For Reducing the Cost of Construction of High-Temperature Gas-Cooled Reactors  – Development of Cesium Trap Material for Coated Fuel Particles –  Jun Aihara	65
6-4	Upgrading H₂ Production Efficiency in the IS Process  — Corrosion Stability Improvement of the H₂ Separation Membrane for HI Decomposition — Odtsetseg Myagmarjav	66
6-5	Achievement of Longer-Term H₂ Production in IS Process  — Introduction of a Novel Operating Procedure Using a Closed-Loop System — Nobuyuki Tanaka	67
6-6	Development of a Novel RPV Cooling System for HTGRs  — Comparison of the Structural Differences Between RPV Cooling Systems and Effects of External Parameters on RPV Cooling — Kuniyoshi Takamatsu	68
6-7	Toward More Accurate Core Analysis of High-Temperature Gas-Cooled Reactors  – Development of a Core Analysis Method with Specified Graphite Porosities – Shoichiro Okita	69



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

Highlight	Development of the Technology Base and Infrastructure Toward Improving the Fast Reactor Cycle	70
7-1	Fast Simulation Method for Chemically Reacting Flows  – Efficient Numerical Simulation for Developing New-Generation Nuclear Plants – Wataru Kosaka	71
7-2	Understanding Aerosol Behavior in Fast Reactor Accidents  – Test on Aerosol Transport Behavior Using the MET Facility – Ryota Umeda	72
7-3	Failure Prediction of Fast Reactor Components  - Cyclic Loading Test and Failure Prediction of Multiperforated Plates - Masanori Ando	73

7-4	Capturing the Oxygen Diffusion Phenomena in Nuclear Fuel  – Measurement and Evaluation of the Oxygen Self-Diffusion Coefficient of MOX Fuel –  Masashi Watanabe	74
7-5	Development of Fast Reactor Fuel for Reduction of Radioactive Waste  – Evaluation of Thermal Conductivity of High Am-Bearing Mixed Oxide Fuel on Stoichiometry – Keisuke Yokoyama	75
7-6	Evaluation of Experiments in the Prototype Fast Reactor Monju  – Solving Discrepancy Between Measurement and Calculation – Kazuya Ohgama	76
7-7	Toward Realization of Advanced MOX Fuels  – Measurement of Slight Variations in the Oxygen Content of Fuels – Shun Hirooka	77

## Research and Development on Fuel Reprocessing, Decommissioning, and Radioactive Waste Management

Highlight	Toward Decommissioning Nuclear Facilities and Managing Radioactive Waste	78
8-1	Toward the Design of the Disposal Facilities Considering the Environmental Standards  - Change in Uranium Concentration in Groundwater Depending on the Facility Layout and Structure - Rina Ogawa	80
8-2	Establishment of a Treatment Method for Nuclear Fuel Material for Safe Storage  – Stabilization Treatment of Nuclear Fuel Material Containing Organic Compounds – Kohei Tada	81
8-3	Toward Stabilization of Hazardous and Radio-Active Wastes  - Characterization of Lead Stabilized with Alkali-Activated Material – Junya Sato	82
8-4	Coating Removal Technique for Painted Steel Surface  – Performance Evaluation of Laser Cleaning – Ikumi Yamane	83
8-5	Decommissioning of a Facility with a History of Contamination Caused by a Fire Disaster in a Controlled Area  — Collective Dismantling of the Uranium Enrichment Laboratory Using a Large Isolation Tent —  Junya Kokusen	84
8-6	Dismantling a Tank Containing Liquid with α Nuclides  – Exposure Reduction Measures and Acquisition of Work Data for Future –  Yuta Yokozuka	85
8-7	New Method to Observe Fault Displacement Using a Conventional Device  – Significant Progress Toward Greatly Enhanced Underground Utilization –  Eiichi Ishii	86
8-8	Prediction of the Low-Permeability Domain in Soft Rock  – Estimation of the Effective Hydraulic Conductivity by Hydromechanical Simulation – Yusuke Ozaki	87

8-9	Discriminating Tephra with Similar Chemical Compositions  – Development of a Method for the in Situ Chemical Composition Analysis of Volcanic Glasses – Saya Kagami	88
8-10	Prediction of Radionuclide Migration by a Thermodynamic Sorption Model  – Assessing the Impact of the Transition of Repository Condition on Radionuclide Migration – Yuki Sugiura	89
8-11	Migration Behavior of Carbon-14 in Buffer Material  – Diffusion Experiments of Carboxylic Acid and Alcohol in Compacted Bentonite – Takamitsu Ishidera	90

### **Computational Science and E-Systems Research**

Highlight	Computational Science for Nuclear Research and Development	91
9-1	Deep-Learning Model for High-Resolution Steady Flow Prediction  – Convolutional Neural Networks for Multiresolution Steady Flow Prediction –  Yuichi Asahi	92
9-2	Acceleration of Multiscale Fluid Simulation on GPU Supercomputer  - Communication Reducing Method for Local Mesh Refinement – Yuta Hasegawa	93
9-3	Detecting the Quantum Fluctuation of Water  - High-Precision Calculations of Water Using the General-Purpose Molecular Simulation Code PIMD –  Motoyuki Shiga	94
9-4	Clarification of the Fundamental Properties of Radium  — Ab Initio Molecular Dynamics Simulations and Extended X-Ray Absorption Fine Structure Measurements Revealed the Hydration Structure of Barium — Akiko Yamaguchi	95

# **Development of Science & Technology for Nuclear Nonproliferation**

Highlight	Nonproliferation and Nuclear Security to Support the Peaceful Use of Nuclear Energy	96
10-1	Development of a Compact Nondestructive Analysis System for Measuring Nuclear Material  – Demonstration of Neutron Resonance Transmission Analysis System Using a Laser-Driven Neutron Source –  Kota Hironaka, Jaehong Lee	97