3rd Nuclear Academics Discussion Meetings

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National Nuclear R&D Programs i n Republic of Korea

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Contents

- Nuclear R&D platform in ROK
- Introduction of organizations for nuclear R&D
- Current status of overall nuclear R&D
- The strengths and weaknesses of Korean nucle ar energy research
- Challenges and future issues in the field of nucl ear R&D
- A suggestion for further opportunities for cooper ation between UK and ROK

INTRODUCTION



1. Electricity Generation and Strategy



 Electricity generation cost per unit(KRW/kWh) is 39.1 for Nuclear, 100.9 for wind and 223.7 for oil



2. History of Nuclear Energy in Korea



Status and prospects of nuclear energy



Korean Nuclear Reactor Systems: Past & Future



NUCLEAR R&D PLATFORM IN ROK



1. Governmental Structure Related to Nuclear Energy





2. Special Organizations





3. National Research Foundation of Korea

Overall R&D Funding Budget





CURRENT STATUS OF OVE RALL NUCLEAR R&D



1. Comprehensive Nuclear Energy Promotion Plan (CNEPP)



VISION & Policy Goals of the 4th CNEPP



Priority Objectives by strategy



world

nced country

Priority Objectives by strategy



Priority Objectives by strategy



Investment Plan : \$1.9 billion

\$1.3 billion by MSIP and \$0.6 billion by MOTIE invested \rightarrow





3. FY 2014 Nuclear R&D Budget of MSIP (NRF)

Program	Fields to be awarded	Budget(M\$)
Nuclear Energy Technology Devel opment Program	uclear Energy Technology Devel opment Program e climate change, and improve national welfare	
Nuclear Energy Research Infrastructure Building Program	Supports the establishment of facilities and equipment for nuclear R&D an d its joint utilization, as well as systematically fostering core human resour ces in the field of nuclear energy	21.6
Radiation Technology Development Program	Designed to secure the public safety by gaining a foothold in creating valu e added technology, promoting health, and developing advanced non-dest ructive testing and nuclear activity detection technology using radiation tec hnology	44.5
International Cooperation for Nuclear Energy Development Program	Aimed at increasing international prestige by expanding nuclear energy te chnology overseas and participating in international activities	6.8
Other Activities	R&D Planning & Evaluation, SMART safety, Construction of research rea ctor, Heavy Ion Medical Accelerator Total	79.5 292.0



Nuclear Safety

- Severe accident evaluation and manage ment
- Comprehensive risk assessment
- Material and component safety enhancem ent
- Environmental radiation protection
 CANDU Reactor safety

Major Nuclear Safety Research Areas

Environmental **Risk Management Physical Integrity System Behavior** Protection a for yours for prove by produce pro ATLAS – T/H Develop of Adv. R A la press for pair 2; joins at The image cann be displayed. Radionuclide d Materials Degra isk Management Integral Effect ispersion/ Dos dation Assessm enough memor to open the image, or the image may have been corrupted Tools Tests for PW ent of e assess. NPP Comps Rs Environmental NDE Tech. & Co T/H Separate **Digital I&C PSA** Monitoring mputational Mat Effect Tests the image, or the image may have technology erial Sci. Advanced Mater Human Factor As Severe Acc. cannot be displayed. You ials Developmen Terrestrial Experiment & sessment Radioecology Analysis Integrity Monitori ng & Diagnostic Seismic Risk Ass The image cannot be displayed. Your computer may not have enough Adv Safety A Radiation S essment nalysis Metho Biology memory to open the image, or the image ds Corrosion & Wat DNA Integrated Risk/P mutation er Chemistry Op CANDU Safet erformance Mode timization y Technology



Future nuclear system

Design of prototype SFR system
 Nuclear hydrogen production system
 Basic technology for licensing of future re actor system

Nuclear fuel cycle

Proliferation resistant Pyroprocess technology
 HLW disposal
 D&D and site remediation
 Common nuclear fuel cycle technology



Radiation technology

- Fusion and combined radiation technolog
 y
- Medical and biological research using radi ation technology
- Radiation and RI utilizing technology

Radiation Technology & Its Applications

Radiation Fusion Technology



Radiation Fusion Technology

- Advanced materials for Industrial uses
- New crop resources & safe foods for food security
- □ Biotechnology for well-being
- Environment techniques for clean ecosystem

Targeted Radiation Therapy



Radiation Medical Technology

- Imaging techniques for intractable disease diagnosis
- Radio-pharmaceutical target therapy
- Radio-biological damage evaluation & control

High Resolution Radiation Detector



Radiation Instrument

- Diagnosis & measurement techniques for security
- Cutting-edge radiation detector for the high resolution
- Radiation generators of new concept for industrial application

Human resource and innovation

Global and high-level human resource training in nuclear field
 Innovative technology for leading

THE STRENGTHS AND WEAK NESSES OF KOREAN NUCLEA R ENERGY RESEARCH

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Stregths

International competitiveness of nuclear t echnology by export of research and com mercial reactors

- Consistent government policy for nuclear research and development
- Basic infra for nuclear and radiation resea rch and development

Weakness

- Shortage of fundamental technology for n uclear and radiation fields
- Graying of nuclear human resources and shortage of experts
- Need of funding and experience for large nuclear system development

Threats

Loss of nuclear safety credibility and acce ptance after Fukushima accident

- High-level radioactive waste management and aging of operating reactors
- Severe competition for international techn ology preoccupancy

CHALLENGES AND FUTURE IS SUES IN THE FIELD OF NUCLE AR R&D

Development of Advanced Nuclear System



Advanced Research Reactor



Innovative Nuclear Syste m



SFR-Pyroprocess System





Very High Temperature Reactor (VHTR)



Spent Fuel Management Policy - (253th AEC, Dec. 2004)

- Store spent fuel generated by 2016 at each reactor site
- Make final decision after formulating a wide national consensus and t echnical feasibility of various options



 Even though Korea has a "wait and see policy" for SF management, a few alternatives studies have been carried out over a long period.

R&D on Spent Fuel Management

Policy for SF Management "WAIT and SEE"



Pyroprocess Technology Development



PRIDE - PyRoprocessing Integrated inactive DEmonstration facility

- Purposes
 - To evaluate cold-run performance and scale-up issues for fullspectrum pyroprocess technology
- Main Features
 - Demonstration with depleted uranium or surrogate on engineering scale
 - Full remote operation and maintenance
 - Argon gas-filled hot cell with impurity level below 50ppm
 - Argon cell size: 40m(L) × 4.8m(W) × 6.4m(H)





Bird's-eye View of Argon Cell

PRIDE

KURT – KAERI Underground Research Tunnel

- A generic underground research laboratory
 - To develop and demonstrate repository disposal concepts and technologies needed for construction and closure of a repository
- On-going in-situ experiments
 - Site investigation techniques
 - Single hole heater test
 - Solute and colloid migration experiment

Host rock	• Granite	
Tunnel dimension	 Tunnel section : 6 m x 6 m Access tunnel : -10 %, 180 m Research modules : L 30 m / R 45 m 	
Overburden	rden • Maximum 90 m from the ground surf ace	



National Decommissioning Tech. Dev. Plan - AEC (Nov.2012)

 Complete D&D technology by 2021 to prepare decom. of Korean old NPPs and to enter the global market

□ Basic direction

① Develop key technology through investing \$140 M

- 21 key technologies including 8 world best technologies
- ② Construct D&D Infrastructure
 - DIDF(D&D Integrated Demonstration Facility)(\$40B→ \$130B)
 - Train manpower by designating ARCNEX (Advanced Researc h Center of Nuclear Excellence)
- ③ Strengthen international cooperation
 - UK, France, Japan, IAEA, OECD/NEA, etc

D&D situation in ROK

- Environment change
 - Extension of OL of two old reactors are under discussion
 - Government had tried to extend
 - Before Fukushima, the opponents to extension were minor
 - Currently most Koreans do not want extension because of safety concerns of old reactors.
 - The lawmakers of anti-government parties are strongly opposing the nuclear and insist prompt decommissioning
- It is likely at least one reactor will be permanently shut down before 202
 0.
- Considering such circumstances, government announced the national D ecommissioning Technology Development Plan(NTDP) to prepare NPP decommissioning
- Deposit for NPP decommissioning was raised from \$322M to \$598M

Basic Direction 2A - DIDF

DIDF Construction Project

D&D Integrated Demonst

ration Facility



Basic Direction 2B - ARCNEX

ARCNEX: Advanced Research Center of Nuclear Excellence

- MSIP designated 5 Univs and KAERI as ARCNEXs for basic study of D&D technology and training D&D experts. (2012~2017)
- Research topics
 - 1. Kyungpook National University(Leading)
 - New complex materials for selective separation and adsorption
 - 2. Dongkuk University
 - 3D visualization technology of decommissioned radwastes
 - 3. KAERI
 - Treatment of HLW from decontamination using ionic liquids
 - 4. Chosun University
 - Enhancing public acceptance of disposal of D&D wastes
 - 5. Kyunghee University.
 - Decontamination using supercritical fluids
 - 6. Busan National University
 - Control of hydraulic manipulators and metal waste treatment

Basic Direction 3 - International Cooperation

Bilateral

- ♦ UK.
 - MSIP-DECC MOU (Nov. 2013)
 - KAERI-Manchester Univ. MOU (Apr. 2008): D&D Technology Informat ion exchange (4th, 2014)
- ♦ France
 - ROK-France STC(Specific Topic of Cooperation)
 - KAERI-CEA D&D Technology Inf. Exchange (since 2002, 13th 2014)
- ♦Japan
 - KAERI-JAEA D&D Technology Inf. Exchange (since 2002, 13th 2014)
- Multilateral
 - OECD/NEA CPD(Cooperative Program on Decommissioning), TAG(Tec hnology Advisory Group)
 - ◆ IAEA IDN(International Decommissioning Network (since 2007)

A SUGGESTION FOR FURTHER OPPOR TUNITIES FOR COOPERATION BETWE EN UK AND ROK

KAERI-NNL Collaboration

Advanced reactor technology
Advanced Fuels technology
Virtual engineering
Decommissioning
Waste Management



Korea-U.K. Workshop

R&D Areas	Candidate for Joint R&D	Application Area
Nuclear Decommissioning	• In situ remote characterization	Characterization of the reactor core
	Activity assessment	prior to decommissioning
	• Visualization of contaminated	
	areas	and
	• Sensing, 3D Visualization and	
	CAD, VR etc	Retrieval of contaminated material
	Radiation effects on robotics	from hazardous zones
	• Large volume throughput techniques	Radioactive material processing and treatment
	• Novel, cost effective methods for effluent treatment and clean up	
	• Novel, cost effective methods for	
	building treatment and clean up	
	• Novel, cost effective remediation methods for site clearance	
	No specifics defined	Long term site monitoring of decommissioned sites

Korea-U.K. Workshop

R&D Areas	Candidate for Joint R&D	Application Area
Nuclear Waste	• Novel methods for the processing of C14 contaminated graphite	Graphite waste-forms
Management •	• Understanding the evolution of graphite waste-forms	
	Novel Waste-form treatment processes	Waste processing
	Dealing with mixed waste-forms	
	Bioremediation of waste materials	
	• Innovative processing technologies, encapsulation and waste-form stabilization	
	Recycle vs direct disposal	
	Waste minimization	
	• Next generation, novel contaminated materials e.g. salt contaminated pyro reprocessing waste.	
	Evolution of encapsulated waste	Encapsulation
	Novel encapsulation / waste immobilization	
	• Interim storage solutions for VLLW, LLW and ILW from	Engineering barriers /
	decommissioning of plant superstructure.	storage site evolution
	• Evolution of spent fuel in storage.	
	Long term storage issues	
	Modeling overall repository evolution	
	Thermal hydrological mechanical chemical and biological modeling	