Extra Slides
KAEC (Korea Atomic Energy Commission) authorized the R&D action plan for the SFR and Pyro-processing to provide a consistent direction to long-term R&D activities for spent fuel management in December, 2008.

The R&D action plan was revised in November 2011 in order to refine the plan and to consider the available budget for the R&D.
Sodium-cooled Fast Reactor Development

SFR provides a Technological Alternative for the Solution of Spent Fuel Management Problem

- By recycling spent fuel from LWRs, the amount of high-level radioactive waste, disposal space and management term can be reduced.

Objectives of a Prototype SFR Program

- Acquisition and demonstration of design, construction, and operation technologies
- Irradiation test of TRU fuels from spent LWR fuel

Milestones for a Prototype SFR Development

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Concept</td>
<td>2012</td>
</tr>
<tr>
<td>SAR</td>
<td>2017</td>
</tr>
<tr>
<td>Specific Design Approval</td>
<td>2020</td>
</tr>
<tr>
<td>Construction</td>
<td>2026</td>
</tr>
<tr>
<td>Prototype Plant (150MWe)</td>
<td>2028</td>
</tr>
</tbody>
</table>

Prototype SFR

Conceptual Design

System Performance Test & Specific Design

Detailed Design

Prototype Plant (150MWe)
Pyroprocessing Technology Development

Pyroprocessing technology aims to recover U and TRUs from spent fuel for SFR fuels.

- Make it difficult to recover only high-purity plutonium (proliferation resistance)
- Minimization of Deep Geological Repository Space and HLW amount (environmental friendliness)
- Production of nuclear fuel materials for Gen-IV reactors, SFRs (resource recycling)
- Creation of indigenous technology with comparative international superiority (technical self-reliance)

**Characteristics**

**Key Tech. Development**
- ‘97 ~ ‘11: Lab.-scale test
- ‘17 ~ ‘25: Scale-up & Design

**Engineering-scale Demo.**
- PRIDE, Active Test(DFDF/ACPF)
VHTR and Nuclear Hydrogen Development

Clean, Safe Energy with a Wide Range of Application

- Highest Level of Nuclear Safety
- Wide Temperature Range of Heat Energy
- High Efficiency
- Substitution of Fossil Fuels

Advantages of VHTR for hydrogen production
- High efficiency (~50%) using thermochemical water splitting
- No GHG emission compared to LNG steam-methane reforming
- A clean and efficient manner reducing fossil fuel dependence

Plan

- '06
- '12
- '16
- '26
- '30

Key Technology Development
- System Concept & Point Design
- System Design & Construction
- Demonstration & Operation

R & D
- Design and Analysis Code
- Helium Test Loop
- Material & Components
- TRISO Fuel
- Hydrogen Production Process
Small Reactors Development

SMART Partnership

Saudi Arabia and Korea signed MOU for SMART partnership (March 3, 2015)

SMART Power Co. (Joint Venture)

Prime vendor company for SMART construction abroad

- 330 MWt, SMR
- Integral type PWR
- Enhanced Safety with Passive systems
- Modularization for Field Installation and Maintenance
- Fully Digitized Control System

Innovative Concept

Proven Technologies

Comprehensive Technology Validation

Separate Effect Tests
Integral Effect Tests
Component Development

SMART (System-integrated Modular Advanced Reactor)
Research Reactor - HANARO

KRR-1 (1962)

KRR-2 (1972)

HANARO (1995)

TRIGA Mark-II
(Pool Type)
250 KW
Education & Training
RI Production
NAA

TRIGA Mark-III
(Pool Type)
2,000 KW
RI Production
NAA
Neutron Beam Experiments

CNL (2009)
(Open-Tank In-Pool Type)
30,000 KW
Cold Neutron Laboratory : 2009
Neutron Beam
Fuel/Material Irradiation
RI Production / NAA
NTD

JRTR

KJRR

GROWTH

FOUNDATION

CHALLENGE
<table>
<thead>
<tr>
<th>Neutron Science</th>
<th>Neutron Activation Analysis</th>
<th>Neutron Irradiation</th>
<th>RI R&amp;D</th>
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</thead>
<tbody>
<tr>
<td>Thermal Neutron Instruments (7) Cold Neutron Instruments (8)</td>
<td></td>
<td></td>
<td>31 Hot Cell in 4 Bank</td>
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<tr>
<td>Nano-Structure Study</td>
<td>Non-destructive Analysis (archeology, food, industrial materials etc.)</td>
<td>Vertical Irradiation Holes Capsule / NTD</td>
<td>Medical &amp; Industrial RI Production</td>
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<tr>
<td>Hydrogen Storage &amp; Fuel Cell</td>
<td>Depth profiling in thin film matter</td>
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<td>Radio-pharmaceuticals for Therapy (Lu-177)</td>
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<tr>
<td>Magnetic &amp; Crystal Structure</td>
<td>Thermal-Cold Neutron Combined Study</td>
<td>Neutron Transmutation Doping</td>
<td>Fission Mo-99 Production Process</td>
</tr>
<tr>
<td>Residual Stress Instrument</td>
<td>Short Distance Neutrino Detection</td>
<td>High-Tech Material Study</td>
<td>RTG for Space Exploration</td>
</tr>
</tbody>
</table>
Nuclear Safety R&D – Major Areas

**Physical Integrity**
- Materials Degradation Assessment of NPP Comp.
- Advanced Materials Develop.
- Integrity Monitoring & Diagnostics
- Corrosion & Water Chem. Optimization

**Reactor Cooling (Thermalhydraulics)**
- T/H Integral Effect Tests for Adv. PWRs (ATLAS, SMART-ITL)
- T/H Separate Effect Tests for Core, Systems & Components
- High-Resol. Experiment & Modeling
- Adv. Safety Analysis Technology
- Adv. Simul. of T/H Behavior & Multi-physics Behavior

**Severe Accident Management**
- Interaction & Cooling of Molten Corium
- Containment Integrity under Severe Accidents
- Minimization of Source Terms for Severe Accidents
- Severe Accident Analysis Codes

**Risk Management**
- Risk Assess. for External Hazards
- Risk Assess. for Multi-unit Sites
- Risk-Informed Accident Management & Emergency Responses
- PSA Software Development incl. Human & Digital I&C Reliability
- PSA Models for New Reactors (SFR, VHTR, SMART)

**Environmental Protection**
- Radionuclide Dispersion & Dose Assess.
- Environmental Monitoring Technology
- Terrestrial Radioecology
- Radiation Biology
Nuclear Safety R&D – Major Facilities

ATLAS

TH integral effect tests for accident conditions of APR1400, OPR1000 & APR+ at prototypic press & temp

*OECD/NEA/CSNI ISP-50
*OECD/NEA ATLAS Project

TROI

Steam explosion tests with prototypic reactor core materials of up to 30 kg

*OECD-SERENA Project

VESTA

Test of corium behavior in a reactor cavity for up to 300 kg of prototypic corium

* Fukushima Vessel Tests

Various Test Facilities for new design features of APR1400, APR+ & SMART
Radiation Technology

Radiation Application R&D

Basic & Fundamental Technology

Future Radiation Technology

Radiation Physical Chemistry

Radiation protection

New Technology of Accelerator Application

Radiation Technology

Radiation Detector Technology

Radiation Generator Technology

Advanced Industrial Material

Environmental Remediation Technology

Fusion Technology

Hydrogel for atopic dermatitis(Putto)
High-strength wind turbine blade
Construction of large-scale & multi-purpose demonstration center for electron beam processing

‘HemoHIM’ to enhance immunity & for chemotherapy supplement
Composition containing ‘Hesperidin’ to protect cells
Special purpose foods(space, patient) using radiation

Production of medical RI using 30MeV Cyclotron
Manufacturing Nano particle using electron beam
Security inspection technology using multi radiation sources

Mutant new type varieties of chrysanthemum, dwarf Hibiscus and kenaf
High functional new rice, soybean and blackberry variety (‘Maple’)

Industrial new material & Environment

Biotechnology & RI

Radiation Equipment

Radiation Breeding

Future Radiation Technology

Radiation Protection

Basic & Fundamental Technology

Radiation Physical Chemistry

Future Radiation Technology

Radiation protection

New Technology of Accelerator Application

Radiation Technology

Radiation Detector Technology

Radiation Generator Technology

Advanced Industrial Material

Environmental Remediation Technology

Fusion Technology

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Industrial new material & Environment

Biotechnology & RI

Radiation Equipment

Radiation Breeding
DD&R Technology Development

Decontamination, Decommissioning & Remediation

Nuclear facilities

Site reuse
Site remediation
DD&R Planning

Waste recycling
Decontamination
Dismantling
Disposal

Facility reuse
Refurbishment

- National DD&R Plan (Nov. 2012, AEC)
  - Complete DD&R technology development by 2016
  - To prepare decommissioning of old NPPs in Korea
- KAERI’s R&D Goal
  - Development of key DD&R technologies for NPP by 2016
  - Demonstration of Engineering Technology in DD&R system by 2021

DD&R tech. for research reactor and uranium conversion plant
key tech. of DD&R for NPP
Demonstration of DD&R technology for NPP
Commercialization of DD&R tech. for NPP

'98
'11
'16
'21
'30
Nuclear Fuels Development

LWR & SMR Fuel
- Accident Tolerant Fuel (ATF) Pellet
- Accident Tolerant Fuel (ATF) Cladding
- ATF Irradiation Test in the Halden Reactor
- SMART Fuel Assembly TH Test
- SMART Fuel Structural Integrity Test

Research Reactor Fuel
- Rod-type Fuel for HANARO
- Centrifugal Atomizer for Powder Production
- Atomized U$_3$Si Powder
- HANARO Fuel Manufacturing Facility
- HANARO Fuel Storage

Plate-type Fuel for Kijang reactor

SFR Fuel
- Metal Fuel Slug Fabrication
- Metal Fuel Cladding, Duct & Parts
- Metal Fuel Performance Evaluation
- TRISO-Coated Fuel
- X-ray Test

VHTR Fuel
- UO$_2$ Kernel fabrication
- UO$_2$ Kernel

U$_3$SiPowder

HANARO Fuel Manufacturing Facility

SMART Fuel Assembly TH Test

LTAs for ATR Irradiation Test
Materials Safety
- Structural Integrity Evaluation of RPV Materials
- Corrosion Evaluation of Nuclear Materials
- Non-Destructive Evaluation of Degradation
  - Modeling & Simulation of Material Damage
- Mitigation and Water Chemistry

Advanced Materials
- Development of ODS (ARROS)
- Development of Ceramics & Composites
- Development of Nano-Materials
- Development of Fusion Materials (ARAA)

PIE Technology
- Irradiated Materials
- Irradiated Fuel
- Research Reactor Materials & Fuel
- Development of Advanced PIE Technologies

Radwaste Tech.
- Treatment of Solid Radwaste
- Treatment of Liquid Radwaste
- Development of ITER Radwaste Treatment System

RPV: Reactor Pressure Vessel, ODS: Oxide Dispersion Strengthened Alloy