



Human Development in Japan and Abroad Using Monju towards Next-Generation Age



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3. International Educational Training

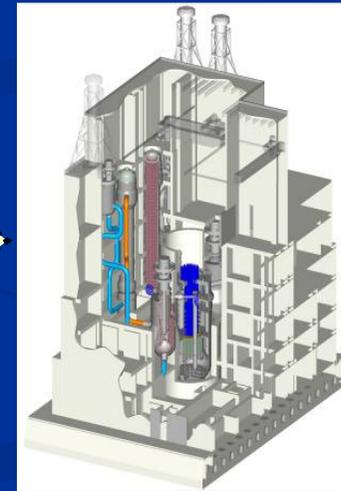
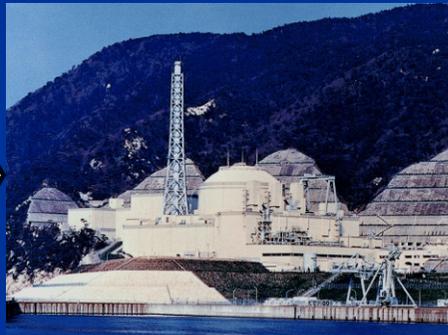
- International Sodium Handling Training Course*
- International Reactor Plant Safety Course for Asian Nations*

Conclusion

Introduction

Human Development towards the new FBR Age

- ◆ Aiming at starting commercial operation of a demonstration FBR around 2025 in the Fast Reactor Cycle Technology Development Project called the **FaCT Project**.
- ◆ Reflecting Monju Operation and Experiences to the FaCT Project.
- ◆ Human Development included Abroad via Various Kinds of Educational Trainings Using Monju by INITC



**FBR Cycle
Feasibility Study**

FaCT Project

**Demonstration
FBR**

2005

2015

≈2025



1. FBR Engineer Educational Training

- ◆ **Strengthening Sodium Handling Technical Training**
- ◆ **Upgrading FBR Operation Technical Training**
- ◆ **New Establishment of FBR Plant System Engineering Training**



Improvement of FBR Engineer Educational Training after Accident

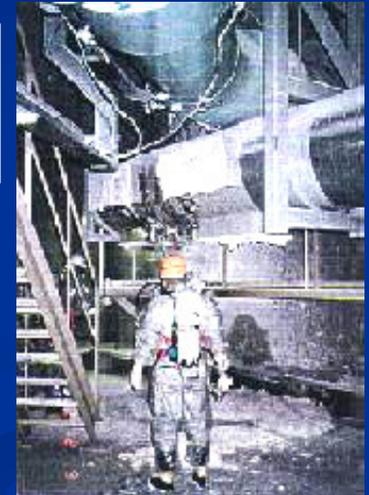
- ◆ Poor Education and Training before the accident
- ◆ Taking main **4 kinds of Remedies**

1. Establishment of Educational Training Framework which consists of 4 kinds of technical trainings

2. Strengthening Sodium Handling Technical Training by new construction of Fast Reactor Training Facility (FRTF) and new establishment of 7 kinds of handling training courses

3. Upgrading FBR Operation Technical Training by remodeling Monju Advanced Reactor Simulator (MARS) and improving training contents.

4. Establishment of FBR Plant System Engineering Training Courses which consists of fundamental and advanced courses





Establishment of Training Framework

- ◆ Training Framework which defines the Basic Policy of Educational Training
- ◆ Categorizing into the 4 kinds of Technical Trainings

Training Framework	Course Number	Target Point for Learning
Sodium Handling Technical Training	6 courses	Learning <u>various kinds of sodium handling technologies</u> including <u>knowledge regarding sodium</u>
Maintenance Technical Training	7 courses	Learning <u>four kinds of maintenance technologies peculiar to Monju</u> components and four types of conventional maintenance technologies
FBR Operation Technical Training	8 courses	Learning operation technologies for <u>normal and abnormal operation modes</u> by using a operation training simulator
FBR Plant System Engineering Training	5 courses	Learning <u>fundamental and advanced FBR plant engineering technologies</u> based on their carrier



Strengthening Sodium Handling Technical Training

New Construction of FRTF

- ◆ Before the accident, **No Training Facility**
- ◆ As the first remedy, the Fast Reactor Training Facility (**FRTF**) which consists of **Sodium Handling and Maintenance Training Facilities** was built newly beside Monju in May, 2000.



Monju

FRTF



Sodium Handling Training Facility

Maintenance Training Facility

<Overview of FRTF>



Technical Subjects which should be Learned

To systematically master sodium handling technology, the following items are listed up as the technical subjects which should be learned.

- ◆ Sodium General Knowledge
- ◆ Sodium Physical and Chemical Properties
- ◆ Sodium Loop Operation Techniques (Sodium Charge and Drain operations)
- ◆ Sodium Purification Control Technique
- ◆ Sodium Corrosion Mechanism
- ◆ Treatment Skill for Sodium Compounds
- ◆ Response and Treatment Skills against Sodium Piping Leak



Establishment of Sodium Handling Training Courses

- ◆ The Sodium Technical Subjects are categorized into **4 Groups**.
- ◆ Establishing **6 Training Courses** based on 4 groups.

Group Category	Training Courses	Remark
Sodium Properties	① Sodium Beginner Course	1 Day
	② Sodium Expert Course	2 Days
Sodium Loop Operation	③ Sodium Loop Operation Course (Charge, Drain and Purification Operations)	3 Days
Sodium Handling Skills Against Sodium Leak	④ Sodium Leak Response Course	2 Days
	⑤ Sodium Fire Fighting Course	1 Day
Sodium Handling Skills in Maintenance Work	⑥ Sodium Handling Internal License Course	1 Day

Sodium Properties

<Main Lecture>

- Basic Knowledge regarding Sodium
- Chemical and Physical Properties of Sodium
- Reasons of Using Sodium as a Coolant of FBR
- Sodium Corrosion & Sodium Purification Control

<Main Exercise>

- Observation of Small Scale Sodium Combustion
- Measurement of 6 kinds of Sodium Physical Properties
 - ✓ Density
 - ✓ Melting point
 - ✓ Kinetic Viscosity
 - ✓ Specific Heat
 - ✓ Thermal Conductivity
 - ✓ Surface Tension





Sodium Loop Operation

<Main Lecture Contents>

- Specification & Design Philosophy of Monju Cooling System
- Function & Characteristic of Monju Sodium Components
- Corrosion by Sodium and Impurities in Sodium
- Sodium Purification Control Operation



<Main Exercise Contents>

- Loop Preheating
- Charge and Drain Operations
- Purification Control Operation (Measurement of Sodium Impurities Concentration)





Sodium Handling Skills Against Sodium Leak

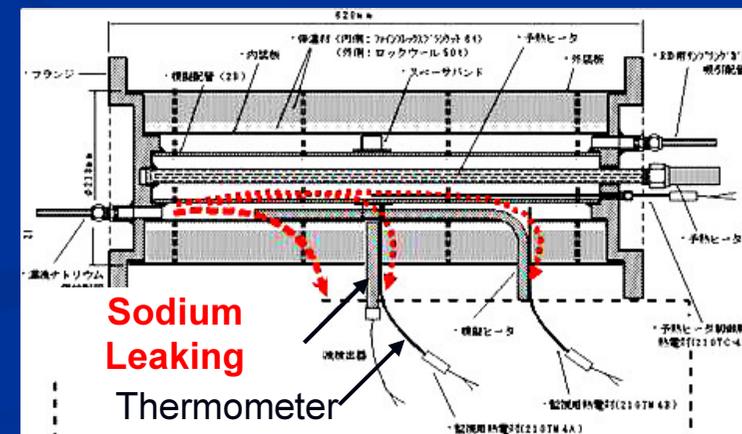
Distinctive Course for Strengthening Sodium Handling Technology
 ⇒ **Development of “Sodium Leak Response Course”**

- Starting as the **Only Training Course Available Worldwide** from June 2001.
- An **Imitation Leak Pipe** which has a space between inside-rod and outer insulator.
- The **Charged Sodium Leaks through the Gap** between insulator and sodium leak detectors, thermocouples and electrical heaters.



[Sodium Piping Leakage Condition]

- Leak Amount [2kg]
- Sodium Temperature [500°C]
- Leak Rate [100kg/h(Monju≈170kg/h)]



<Imitation Sodium Leak Pipe>

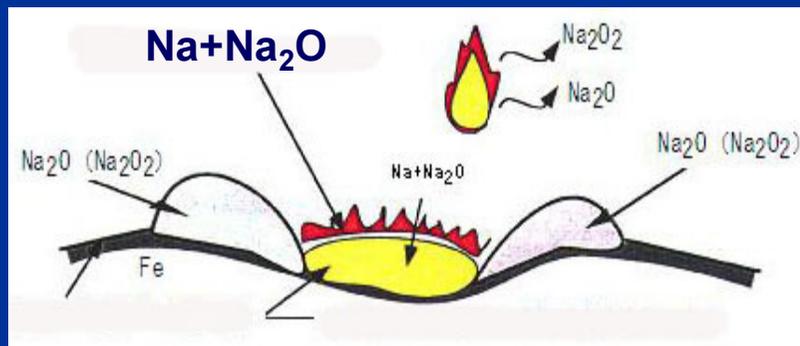
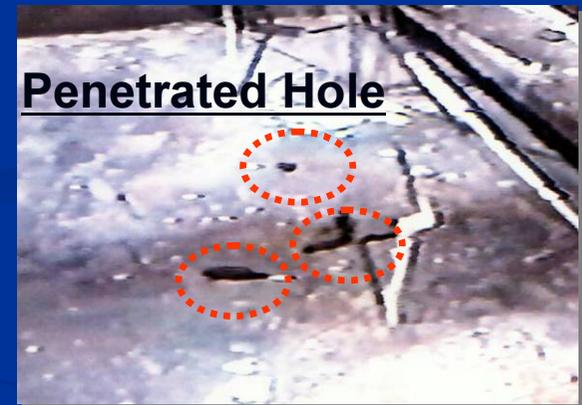


- ◆ This course is very Useful Training for the trainee who has Never Seen a Sodium Leak Scene.
- ◆ **Not Only Watching a Sodium Leak Scene** but also a **Dismantling Work** of the leaked pipe.
- ◆ Observing Residual Sodium Compounds in Insulator
- ◆ Experience of the Waste Processing Work

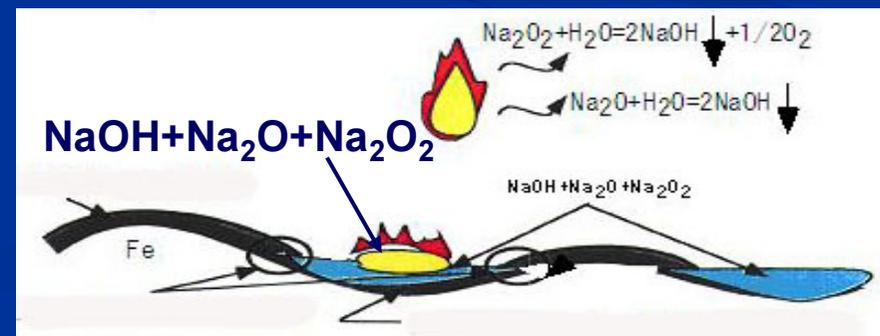


Other Distinct ⇒ Prevailing New Knowledge regarding Sodium Corrosion

- Reappearance Experiment Simulated the Monju Leak Accident in 1996
- Occurrence of an Unexpected Phenomenon in Design that Some Holes Penetrated the Liner Plate by the Leaked Sodium
- Two Types of Corrosion: Molten Salt Type Corrosion and Na-Fe Double Oxidization Type Corrosion
- Strong Corrosive Power of Molten Salt Type Corrosion occurring under Humid Environment due to the cause of Sodium Peroxide (Na_2O_2) which is a Strong Oxidizer
- Actual Corrosion Type occurred at the Monju Accident is Na-Fe Double Oxidization Type Corrosion which has not strong corrosive power.
- Humidity Plays a Key Role.



<Na-Fe Double Oxidization Type Corrosion>



<Molten Salt Type Corrosion>

Sodium Handling Internal License Course

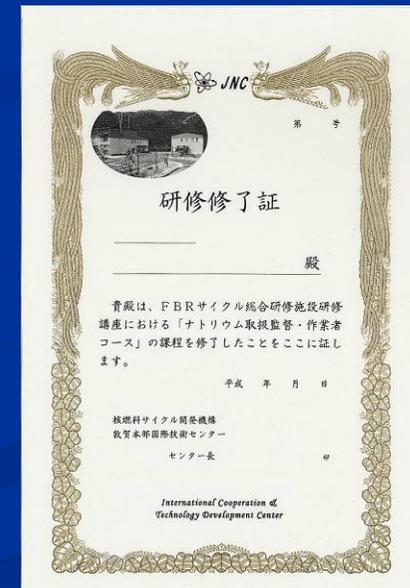
Before engaging sodium handling work at Monju, all workers have to attend the **Sodium Handling Internal License Course** and have to **Pass the Examination (>60 points)**. (680 persons / as of October, 2009)

<Main Lecture Contents>

- Feature & Chemical Property of Sodium Combustion
- Cleaning Treatment Method of Sodium Compounds
- Mechanism of Sodium Spontaneous Combustion
- Notes on Sodium Handling Working
- Examination for Completion

<Main Exercise Contents>

- Sodium Wiping Work
- Observation of Sodium-Water Chemical Reaction
- Observation of Sodium Spontaneous Combustion
- Treatment Work of Sodium Compounds



<Certificate of Completion>

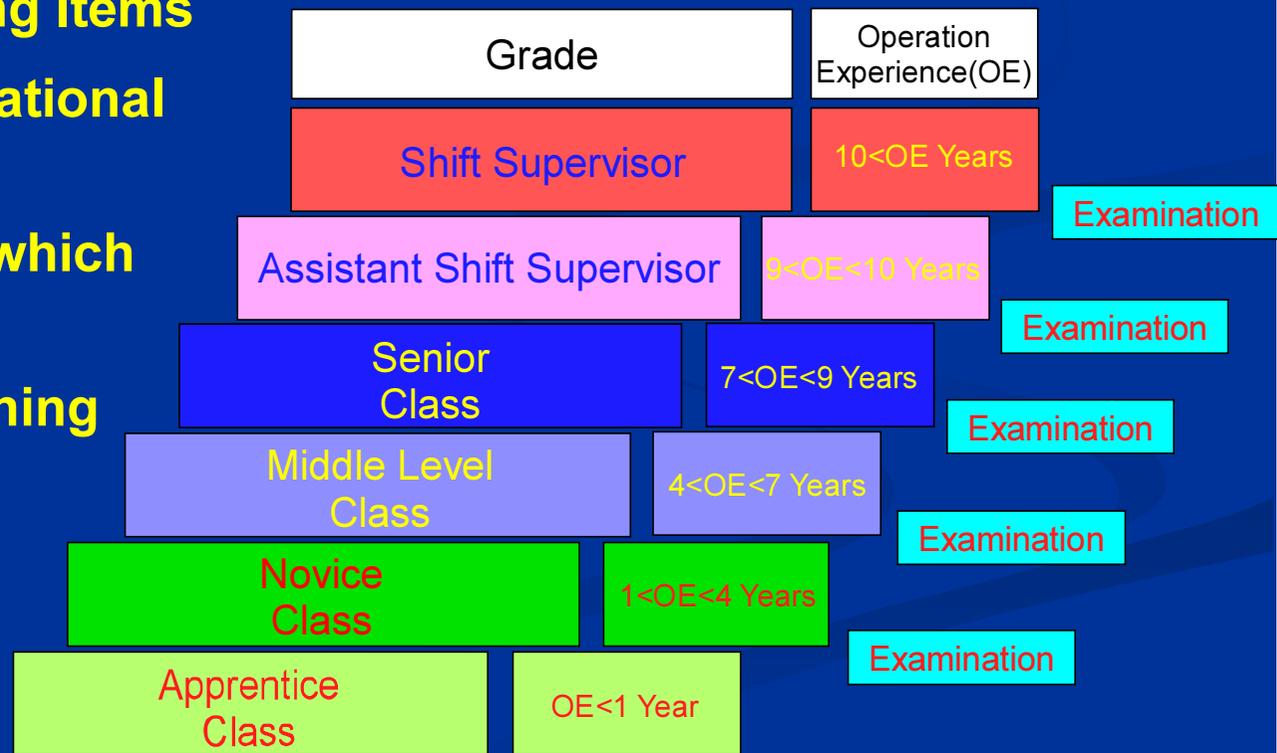


Upgrading FBR Operation Technical Training

Establishment of Educational Training Guidance

- ◆ Monju operators are classified into 6 grads.
- ◆ The Educational Training Guidance defined the following items was established after the Monju leak accident.

- Educational Training Items
- Frequency of Educational Training
- Training Contents which should be learned
- Preparation of Training Material

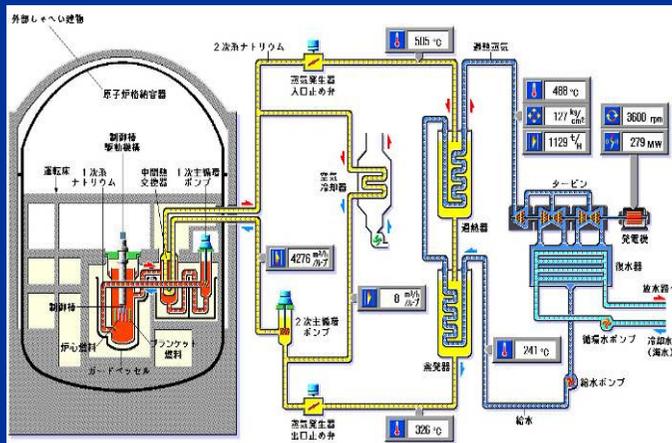


<Monju Operator Grades>



Training by Monju Advanced Reactor Simulator (MARS)

- ◆ Full Scope Type Simulator
- ◆ Offering Plant Behaviors under normal and abnormal with **Real Time**
- ◆ Enabling 73 Training Cases for Normal Mode Operation and 320 Cases for Off-Normal Mode Operation
- ◆ MARS Satisfies the Plant Simulation Accuracy Required by ANSI/ANS-3.5-1985 (Nuclear Power Plant Simulator).



<MARS Overview & System Scope>

For Upgrading FBR Operation Training

⇒ **Remodeling of MARS (Supplement of Synthetic Sodium Leak Monitoring System)**

- ◆ To **Discover** and to **Confirm** a Sodium Leak Accident **Quickly and Exactly**
- ◆ Link to MARS's Computer System
- ◆ Display **Automatically a Virtual Graphic** of **Small or Large Leaks Scale** calculated by MARS



Large Leak



Small Leak



No Leak



<Synthetic Sodium Leak Monitoring System>

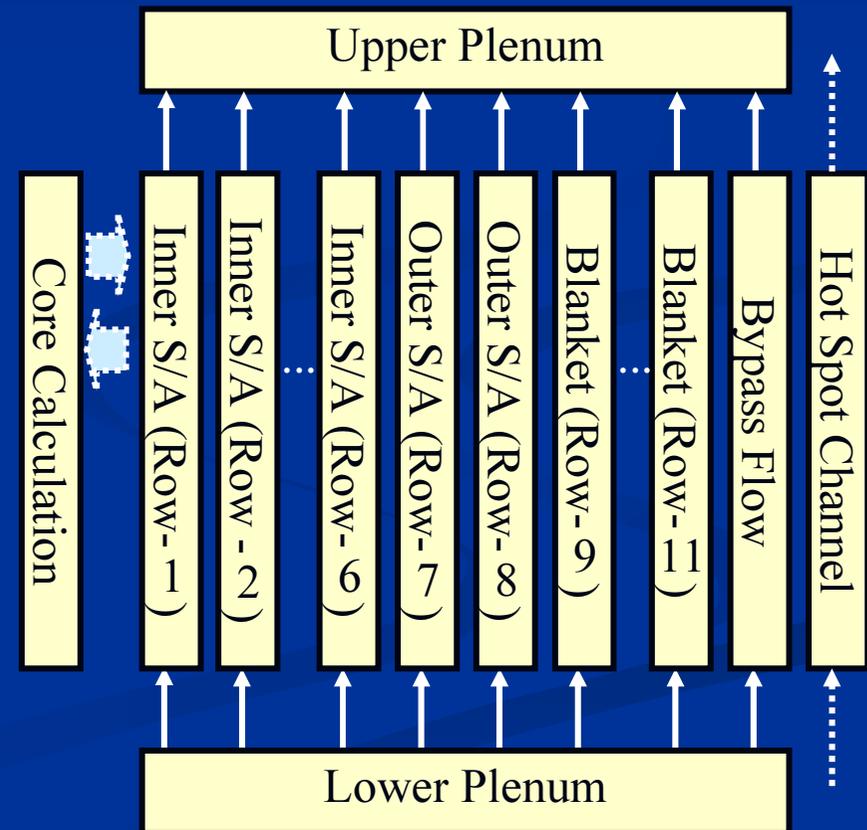


Other Remodeling ⇒ Improvement of Core Calculation Accuracy

For Future Sevier Accident Training (LOCA, LOHRS, etc.), **Indispensable Improving Core Dynamic Characteristic Analysis Accuracy**

Remodeling Contents

- ◆ **From a Single Channel to Multi Channel** which consists of 11 Representative Channels
- ◆ Concatenating Two Plenums and Each Channel with Momentum Equations and Friction Factors for Calculation of Pressure Drop at each S/A
- ◆ Reactor Power: One Point Reactor Kinetic Equation with 6 Groups of Delayed Neutron.



Other Remodeling ⇒ Improvement of Man-Machine Interface

◆ Man-machine interface between instructor console and each control panels including local panels have been improved, and consequently, operability of the instructor console has become very good.



<Malfunction Data Scene>



<Initial Condition Setting Data Scene>



<Console Panel>



<Analog Trend Data Scene>



For More Upgrading Operator Training (For Future)
⇒ Introduction of Systematic Approach Training (SAT)

■ Now Preparing introduction Systematic Approach Training (SAT)

■ Educational Evaluation System for Nuclear Power Plant Operators defined in the Japanese guidance named JEAG.

■ Expectable that Potential Issues Hidden in the Present Education System will be Revealed.

■ Grasping the Training Results Quantitatively.

Defining required training skill according to each class

Fix training items corresponding to each class

Implementing training

Confirmation of comprehension level by Test

Analyzing training & examination result data

Revealing any potential issues in training structure by administrators (instructors & section manager)

Report of training and examination results data to each operator

Taking remedies



Establishment of FBR Plant System Engineering Training

- For Improving Poor Education and Training before the Accident
- **One Basic Course** covers All FBR Fundamental Technologies via 12 Lectures
- **Four Advanced Courses divided into 4 Groups**
- Learning **Step by Step** based on their knowledge level

Categories	Training Courses	Remark
FBR Basic Course	Covers basic manifold FBR system engineering technologies via 12 lectures	lectures 3 Days
FBR Advanced Course- 1	Covers system design, safety design & assessment and plant application license	2 Days
FBR Advanced Course- 2	Covers core characteristic, core shielding & radiation source and fuel design, etc.	2 Days
FBR Advanced Course- 3	Covers core structure & material designs, fuel handling system and sodium components & feature	2 Days
FBR Advanced Course- 4	Covers plant operation experience, radiation control and radioactive waste treatment	2 Days



2. Student Educational Training

- 1. Tsuruga Summer Institute on Nuclear Energy**
- 2. Environmental Energy Education for under High School Students**

Tsuruga Summer Institute on Nuclear Energy

- ◆ Organizing: Sponsorship by 3 Institutes (Fukui University, Wakasawan Energy Research Center and JAEA) and as **One of Collaborative Activities** based on a **Technical Cooperation Agreement with CEA**, France.
- ◆ Target: **Graduate Students** mainly from a total of about **Ten Universities** in Kansai, Chubu, Hokuriku, Kanto areas including Fukui prefecture
- ◆ Training Duration and Capacity: 1 week / 40 students
- ◆ Contents: **4 Lectures, 3 Exercises, 5 Sight Tours, 5 Open Speeches, including English Debate and Monju Discussion**





Environmental Energy Education for under High School Students

- ◆ JAEA supports **Environmental Energy Education** for under high school students as one of collaborative activities for enhancing **Symbiotic between Local Community and Nuclear Energy including Monju.**
- ◆ Learning Items: Environment, Energy, Extensive Nuclear Science Field
- ◆ Participants: About **7,000 students from 2007 to as of Sep., 2009.**

Nuclear Lesson



Human Development in Nuclear Field (Employment)



Energy Environmental Education



Science Education Support



Science School



Various Kinds of Science Events





3. International Educational Training Program

- 1. International Sodium Handling Training Course**
- 2. International Reactor Plant Safety Course for Asian Nations**

International Sodium Handling Training Course

- ◆ Sponsor: Nuclear Research Exchanging Program sponsored by MEXT
- ◆ Past Participants: China Institute of Atomic Energy and Sandia National Laboratories of U.S.A.
- ◆ Training Duration and Capacity: **10 weeks / 5 trainees**
- ◆ Contents: **10 Lectures** & **12 Exercises** regarding such as sodium properties, sodium loop operation, sodium corrosion, sodium leak, compounds treatment, etc., in addition, FBR engineering technologies.





International Reactor Plant Safety Course for Asian Nations

- ◆ Sponsor: Nuclear Instructor Development Program sponsored by MEXT
- ◆ Participants: **8 Asian Countries** (China, Indonesia Thailand, Philippines, Malaysia, Bangladesh, Sri Lanka)
- ◆ Training Duration and Capacity: **4 weeks / 10 trainees x 2 times / year**
- ◆ Contents: **20 Lectures** covering nuclear safety design principal, safety measures, safety assessment, seismic design, quality assurance, , etc.; **4 Exercises; 10 Sight Tours, Discussion**





Open of CEA-JAEA Collaboration Website

CEA-JAEA Collaboration Website regarding education and training field will be opened newly today. The address is as follows:

<http://www.cea-jaea-collaboration.net/>

The screenshot shows a web browser window displaying the CEA-JAEA Collaboration Web-site. The browser's address bar shows the URL <http://www.cea-jaea-collaboration.net/>. The website has a green and blue header with the text "TRAINING AND EDUCATION" and the "JAEA" logo. Below the header, there is a navigation menu with links: *Common Contents*, *Home*, *Event & News*, *Archive*, *Sodium PocketBook*, *Literature*, *Training Facility*, and *Contact*. The main content area features a central banner with the text "CEA-JAEA Collaboration Web-Site" and a welcome message: "Very welcome to our CEA and JAEA collaboration site. This site is given on the various kinds of individual information concerning both institutes' activities on educational training relating to Fast Breeder Reactor (FBR) technology, such as: event & news; training facility; training courses; etc. Please contact us if you have any questions about our site contents. Thank you!". Below the banner are two images: one of the CEA facility and one of the JAEA facility. At the bottom, there are links for "French Version" and "English Version", and the text "DESTINATION MONJU". The footer contains the copyright notice: "Copyright(C) CEA and JAEA for each contents. All Right Reserved." The browser's status bar at the bottom shows "インターネット" and "100%".



Conclusion

- After Monju accident, the **FBR Engineer Educational Training** was drastically improved based on the teachings obtained from the accident.
 - Strengthening Sodium Handling Training**: 1) Construction of the FRTF; 2) Development of sodium leak response course which is the only training course available worldwide, 3) Prevailing new knowledge concerning sodium corrosion, etc.
 - Upgrading FBR Operation Training**: 1) Supplement of synthetic sodium leak monitoring system, 2) Improvement of reactor core calculation, etc.
- The **Student Educational Training** contributes to progress symbiotic between local community and nuclear energy including “Monju” from 2007, and about 7,000 students have jointed as of September, 2009.
- The **International Educational Training** provides two types of training courses were started from 2006: The **International Sodium Handling Course** by participation of China and U.S.A.; the **Reactor Plant Safety Course** by joint of 8 countries in Asia.
- The variety of those training activities mentioned above can be expected to contribute to the development of nuclear human resource in Japan and abroad towards the next-generation age.



Thank You for Your Attention!

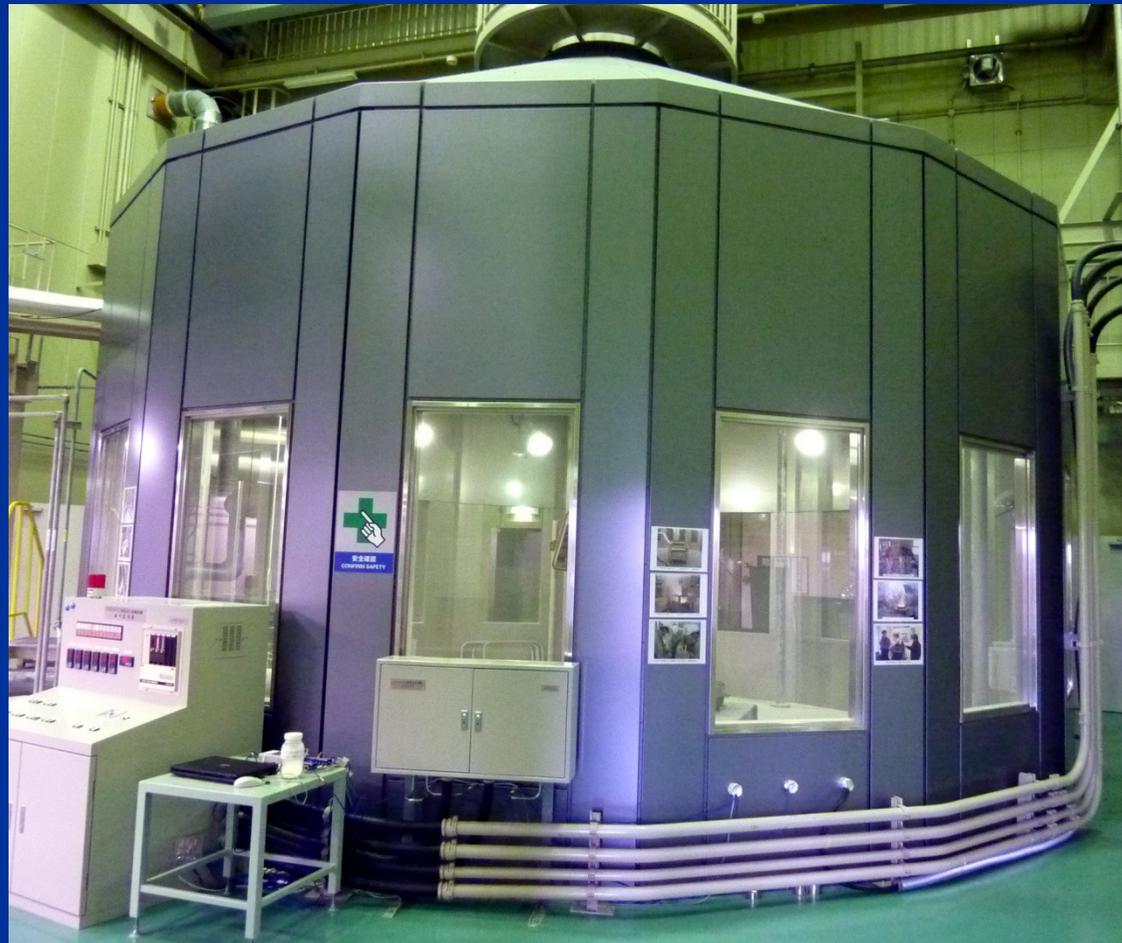


Appendix



Multiple Sodium Training Cell

Sodium Fire Fighting Training Course, Sodium Leak Response Training Course, Sodium Handling Internal License Course, etc., are held in this cell. The cell provides an **exhaust system which can trap sodium compounds of 95% more** by high performance HEPA filters.





Training Goal of Each FBR Engineer

Before establishing the **Educational Training Framework for FBR Engineer Educational Training**, the goal of each FBR engineer was defined as the following in order to perform its training effectively.

Target	Training Goal Point
Monju Operator	<ul style="list-style-type: none"> ● Operational Technology ● Sodium Handling Technologies including knowledge (sodium properties and features) ● FBR Basic Knowledge
Monju Maintenance Engineer	<ul style="list-style-type: none"> ● Maintenance Technologies peculiar to Monju and conventional technologies ● Sodium Handling Technologies ● FBR Basic Knowledge
FBR Engineer	<ul style="list-style-type: none"> ● FBR Plant System Engineering Technologies ● Sodium Knowledge