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Current Status of JMTR

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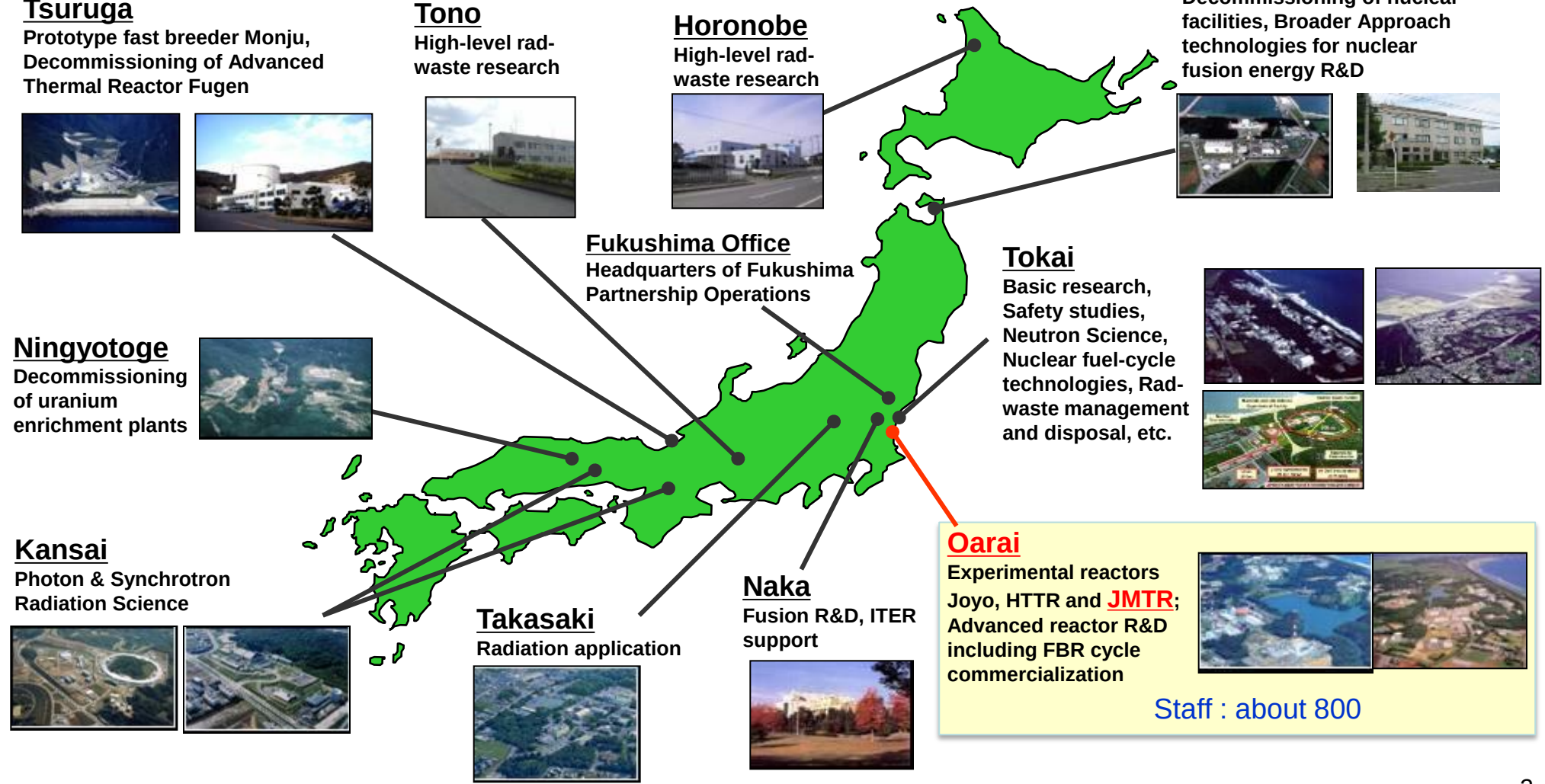
Neutron Irradiation and Testing Reactor Center
Oarai Research and Development Center
Sector of Nuclear Science Research
Japan Atomic Energy Agency (JAEA)

Contents

About Japan Atomic Energy Agency

- Largest organization for atomic energy research & development in Japan
- Staff : about 4,000



Tsuruga
Prototype fast breeder Monju, Decommissioning of Advanced Thermal Reactor Fugen

Tono
High-level rad-waste research

Horonobe
High-level rad-waste research

Aomori
Decommissioning of nuclear facilities, Broader Approach technologies for nuclear fusion energy R&D

Fukushima Office
Headquarters of Fukushima Partnership Operations

Tokai
Basic research, Safety studies, Neutron Science, Nuclear fuel-cycle technologies, Rad-waste management and disposal, etc.

Ningyotoge
Decommissioning of uranium enrichment plants

Kansai
Photon & Synchrotron Radiation Science

Takasaki
Radiation application

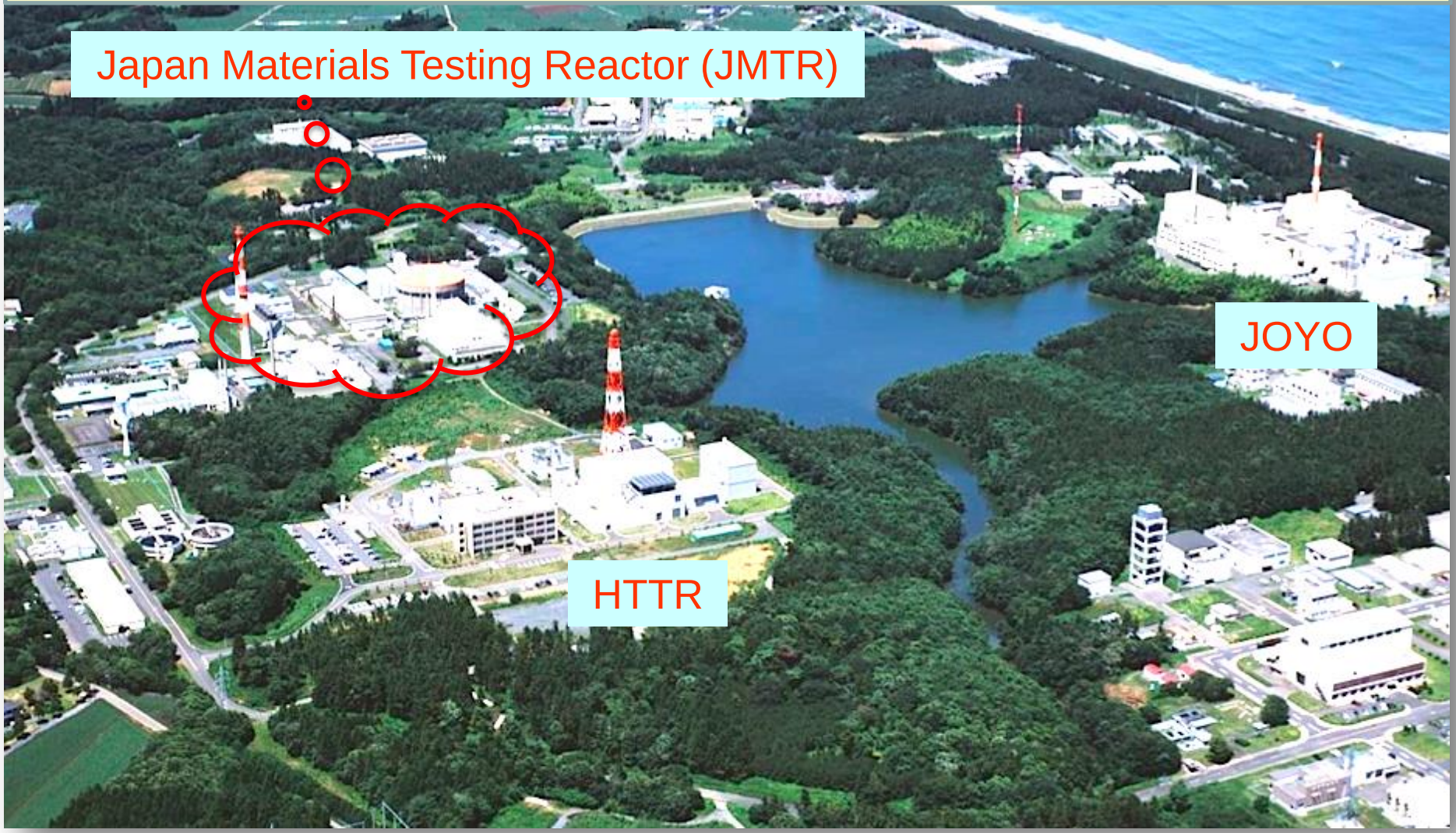
Naka
Fusion R&D, ITER support

Oarai
Experimental reactors Joyo, HTTR and JMTR; Advanced reactor R&D including FBR cycle commercialization

Staff : about 800

Aerial View of Oarai R&D Center

Three research reactors are located, and five hot laboratories are available for the post irradiation examinations of materials/fuels

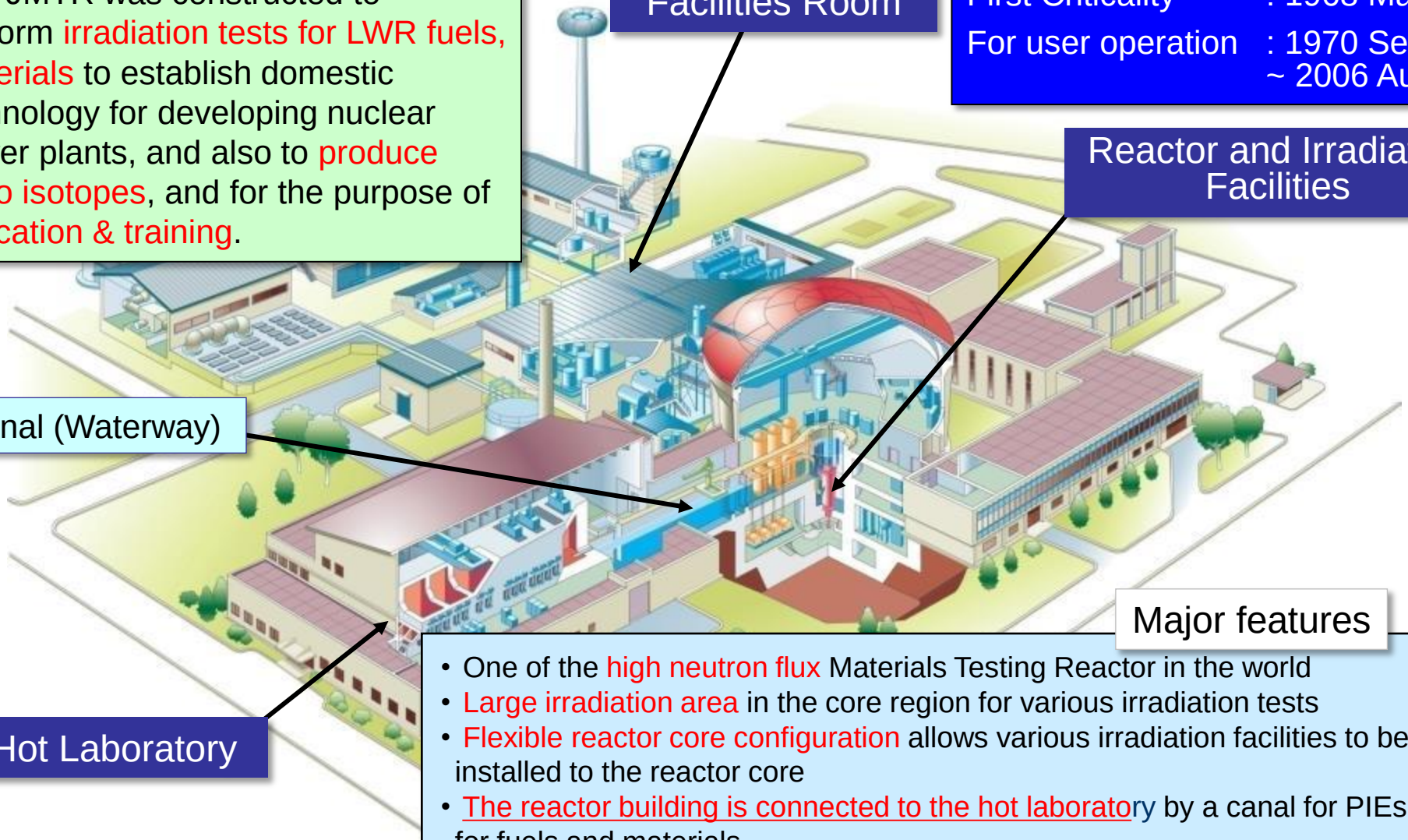


Outline of JMTR

Purpose

The JMTR was constructed to perform irradiation tests for LWR fuels, materials to establish domestic technology for developing nuclear power plants, and also to produce radio isotopes, and for the purpose of education & training.

Construction	: 1965 Apr.~
First Criticality	: 1968 Mar.
For user operation	: 1970 Sep. ~ 2006 Aug.



Major features

- One of the high neutron flux Materials Testing Reactor in the world
- Large irradiation area in the core region for various irradiation tests
- Flexible reactor core configuration allows various irradiation facilities to be installed to the reactor core
- The reactor building is connected to the hot laboratory by a canal for PIEs for fuels and materials.

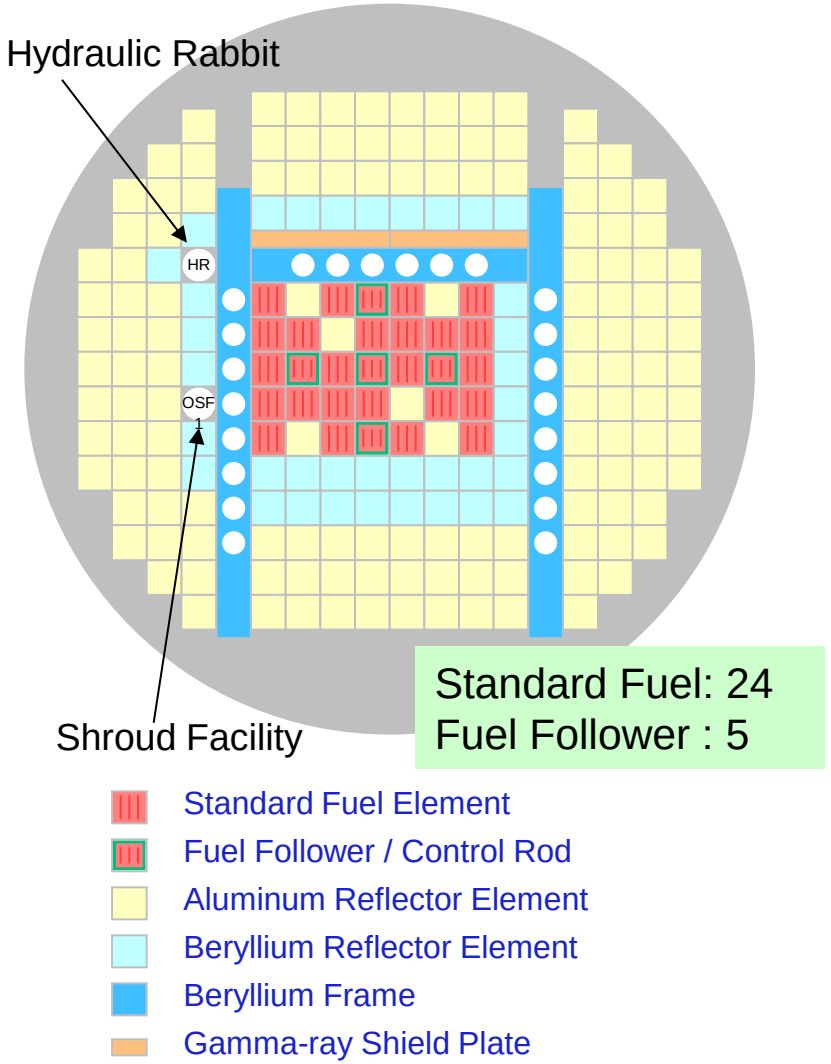
Performance of JMTR

Specifications of JMTR

Reactor Power	50 MWt
Fast Neutron Flux (Max)	4×10^{18} n/m^2·s
Thermal Neutron Flux (Max)	4×10^{18} n/m^2·s
Flow of Primary Coolant	6,000 m^3/h
Coolant Temperature	49° C / 56° C
Core Height	750 mm
Fuel	Plate type, 19.8% ^{235}U
Irradiation Capability (Max)	60 (20*) capsules
Fluence/y (Max)	3×10^{25} n/m^2
dpa/y of SUS(Max)	4 dpa
Diameter of Capsule	30 - 65mm
Temp. Control (Max)	2,000° C

* : capsule with in-situ measurement

Cross Section of the Core



Outline of the Hot Laboratory

PIE for fuels

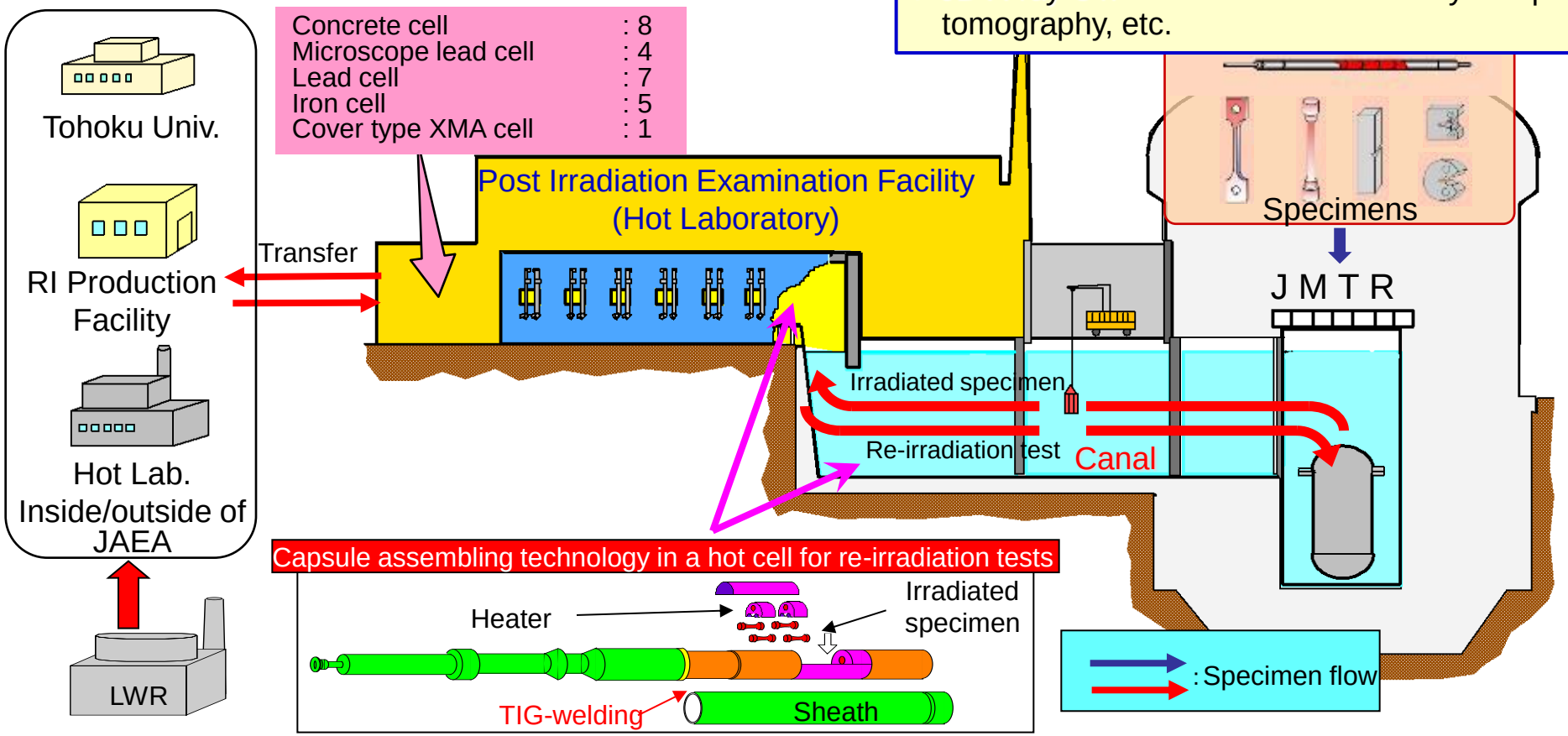
Eddy current test , X-ray micro analysis , Gamma scanning , Microstructure observation, Hardness test

PIE for materials

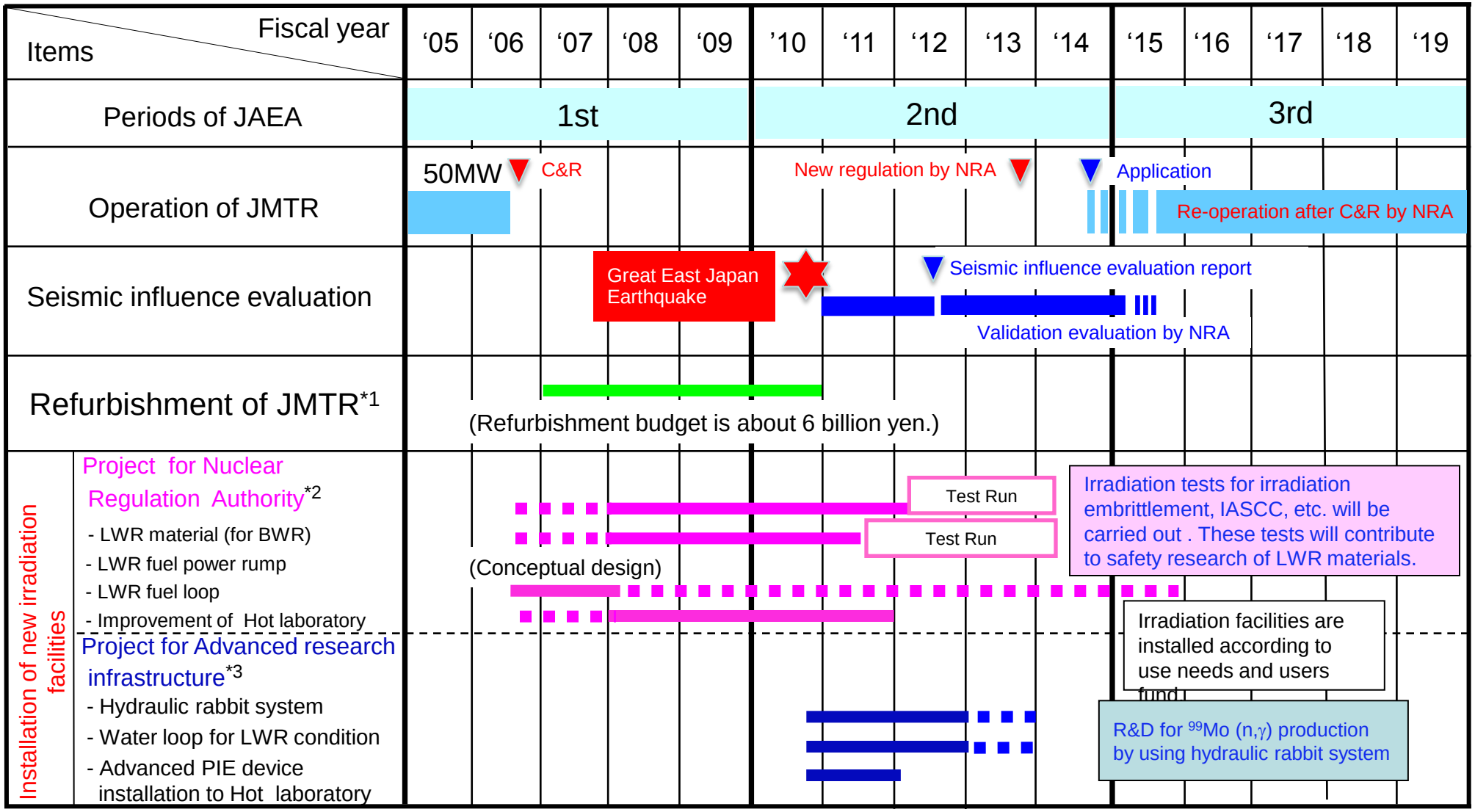
Crack propagation, Creep , Tensile, Fatigue, Fracture toughness, Charpy impact , Bulge (Small Punch)

Upgraded Equipment

- TEM: Transmission electron microscope
- FIB: Focused ion beam
- XPS: X-ray photoelectron spectroscopy
- Raman Spectroscopy
- EBSD-OIM: Electron backscatter diffraction orientation imaging microscopy
- 3D X-ray CT: three dimensional X-ray computed tomography, etc.



Re-operation Schedule



*1: Refurbishment works are carried out by government budget.
*2: IASCC, Irradiation embrittlement, Hafnium irradiation and fuel ramp tests are being prepared.
*3: Hydraulic rabbit system, Water loop for LWR condition and Advanced PIE device installation to hot laboratory are being prepared.

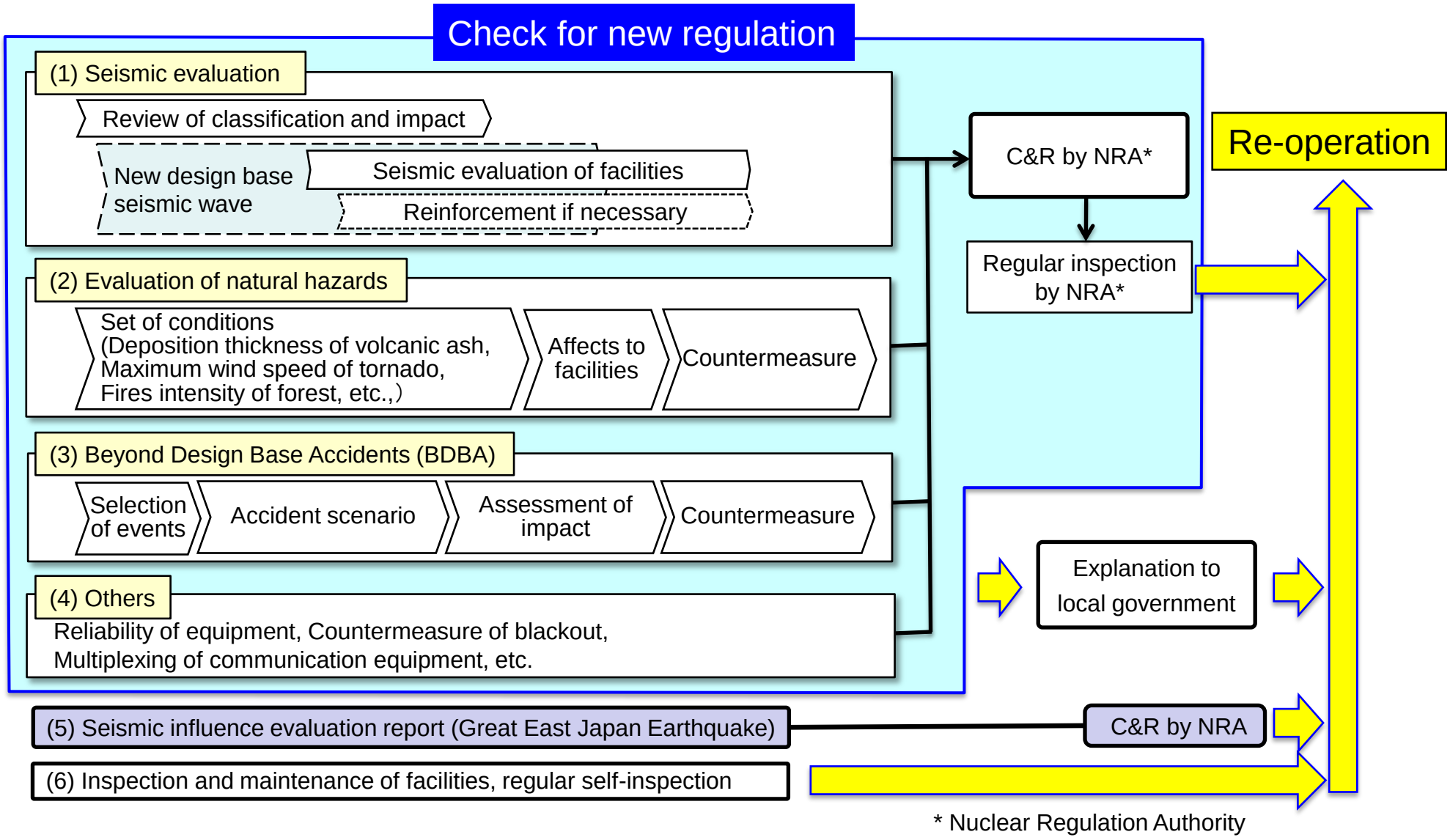
New regulatory requirements

New regulatory requirements (safety standard) for research and test reactors (Dec.18, 2013 by the NRA)

Major feature of the new regulatory requirements;

1) Accurate evaluation method on Earthquake and Tsunami,
   - •Define “Design Basis tsunami” that exceeds the largest in the historical records and require to take protective measures,
   - •More precise methods to define design basis seismic ground motion.
     => 3D observation of underground structure of the site,
2) Comprehensive consideration of natural hazards such as volcano, tornado and forest fire in addition to earthquake and tsunami, etc.,
3) Prevention of equipment and measures to protect fuel damage and to mitigate impact of the accidents (Beyond Design Base Accidents),
4) Provision of full evacuation of the site in the event that the influence of accident may expand outside of the facility.

Process toward Re-operation

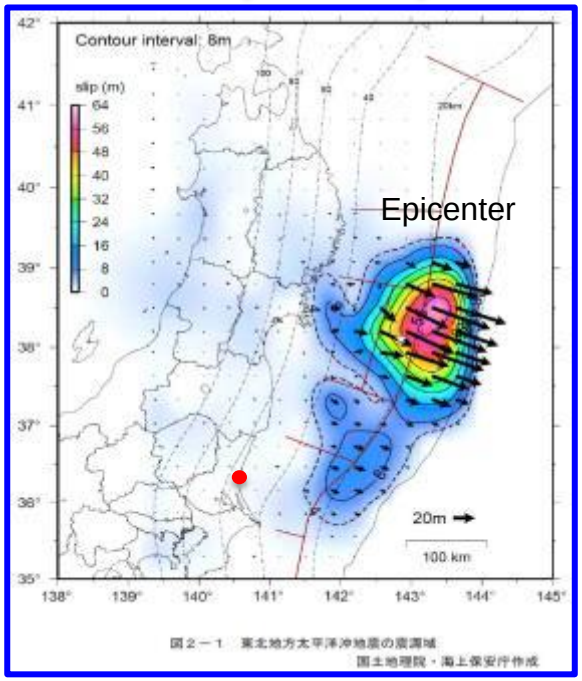


(1) Seismic evaluation

Facility	Design value*2	Measured value*3	New value*4
Building	0.3G	0.51G	about 0.8G
S class*1	0.6G	-	

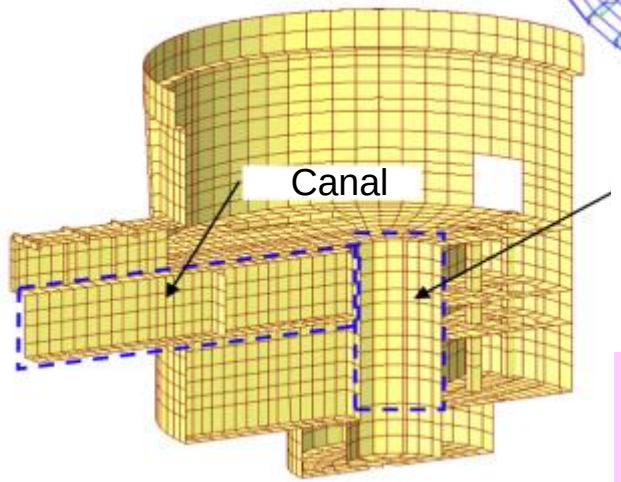
- ❖ Building ground pressure and soil stability are under evaluation,
- ❖ 3D calculations by basis earthquake ground motion are on going.

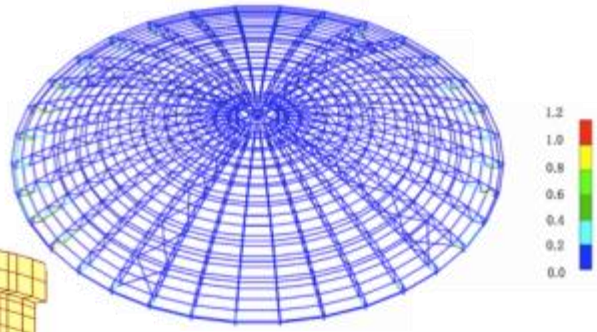
*1: Equipment to maintain fuel in water, etc.
*2: Design by static calculation
*3: Great East Japan Earthquake



http://www.jishin.go.jp/main/chousa/11nov_sanriku/f02-1.htm

Under discussion, from undersea faults and geological survey





Max Tsunami :
about +20m*
< JAEA-Oarai :
+35m

*: under discussion

(2) Evaluation of natural hazards

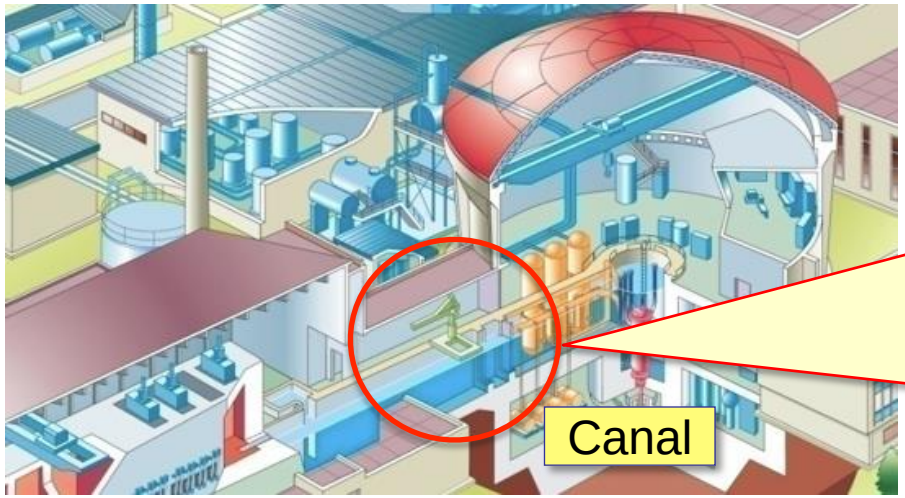
1) Deposition of volcanic ash
- -Evaluation of 11 volcanoes for 160km distance by geological survey,
- - Main ash source : Akagi Mountain. (about 130km, 45,000 years ago)

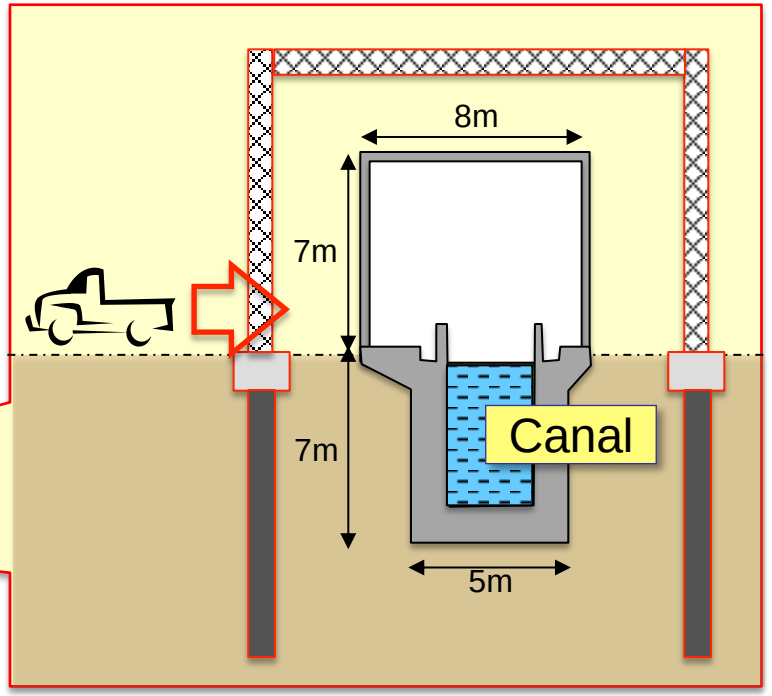
2) Fires
- -Forest,
- -Heavy oil tanks, (refueling)
- -Aircraft (B747, KC-767, F-15, etc.),

No affect to building (<200°C).

3) Tornado
- -Fujita scale (F3),
- -Maximum wind speed : 92m/s.

Under consideration:
"Protection of canal by wire-nets"





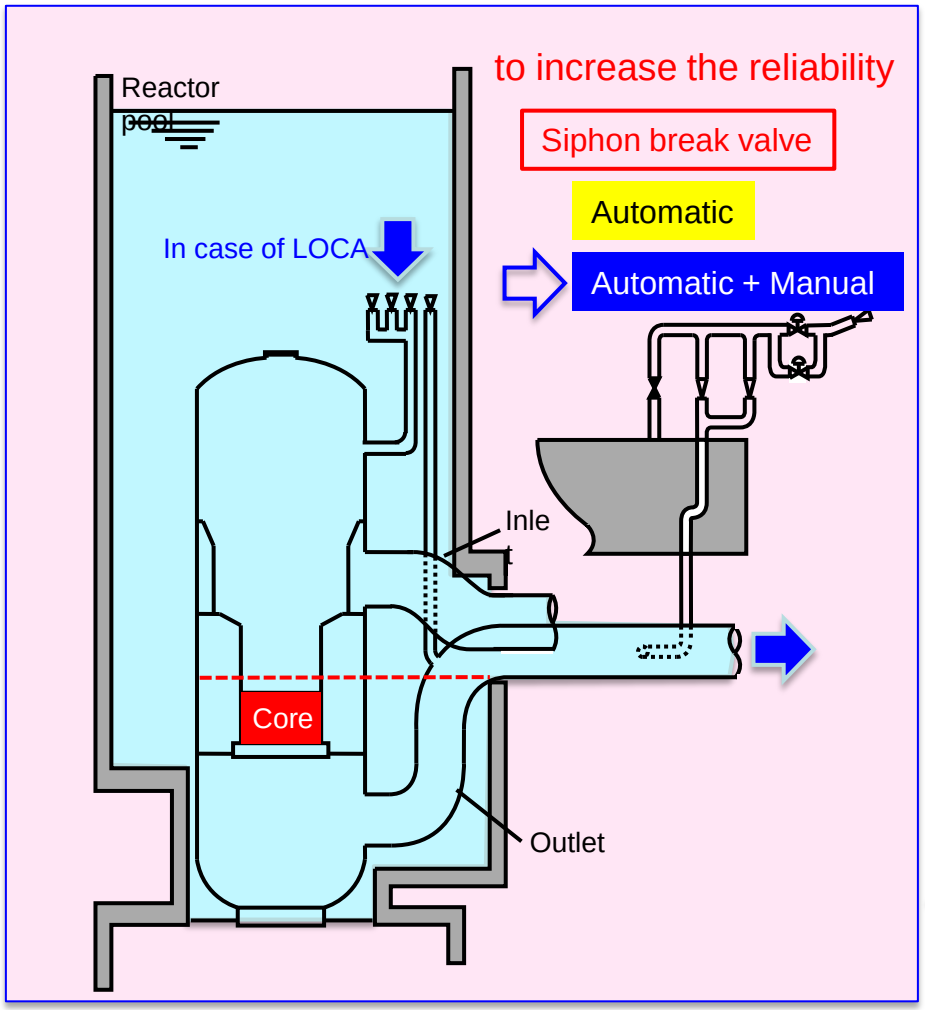
(3) Beyond Design Base Accidents

Examples of Beyond Design Base Accidents (BDBA)

Abnormal events	Loss of additional safety function
Uncontrolled control rods withdrawal at reactor start-up	Two control rods stuck
Reactivity insertion by failure of irradiation facility	
Loss of primary coolant	
Reactivity insertion by failure of irradiation facility	Main pumps stop by loss of commercial electric power supply
Loss of commercial electric power supply	Failure of emergency generator
Loss of primary coolant	Flow rate reduction of recirculation facility
Flow blockage of fuel coolant channel or Fuel handling accident	Failure of emergency exhaust system

- ❖ Under confirmation of time margin for BDBA countermeasure,
- ❖ Under preparation of manuals for BDBA countermeasure.

(4) Others



- Batteries, electric generate cars, etc., for blackout were prepared.

Under preparation items;

- Flame resisting of walls and cables under fire,
- Monitoring of irradiation facility's data in reactor control room,
- Radiation exposure evaluation using new population and weather data,
- Multiplexing of data transmission system for radiation monitoring posts,
- Addition of manual operation function for siphon break valves to maintain fuels in water.

Training Course for Foreign Young Researchers and Engineers

Purpose Contribution to nuclear HRD, expansion of the JMTR user and enhancement of international network

What is different from other training courses ?

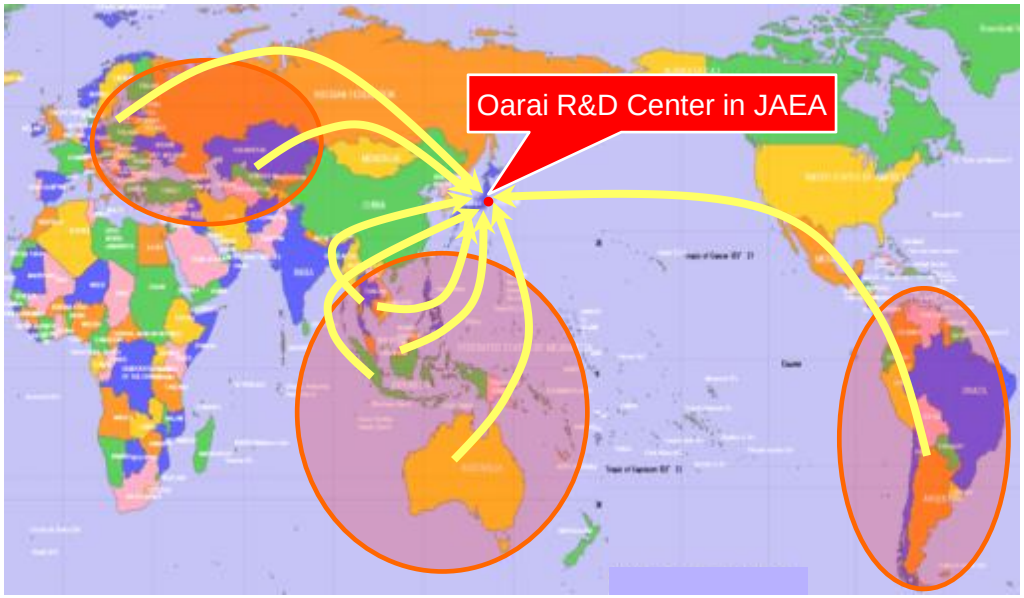
The training is based on actual works in the JMTR and the related facilities. Trainee can learn from basic science to actual application including the neutronic & thermal calculation for the irradiation test, the post irradiation examination, the reactor operation, etc.

Condition of invitation

1) About 20 young researchers & engineers
2) Supports from the JAEA
   JAEA's dormitory, round trip air-ticket, transportation from/to Narita Int. airport
3) Personal assignment arrangement with the JAEA

History of training course

2011, 10 trainees from 2 countries (2 weeks)
2012, 16 trainees from 5 countries (3 weeks)
2013, 18 trainees from 7 countries (3 weeks)
2014, 19 trainees form 7 countries (3 weeks)



Trainees in 2014

Number of trainees

Countries	2011	2012	2013	2014
Argentine			1	
Indonesia		3	2	3
Japan				1
Kazakhstan	5	5	4	4
Malaysia		3	3	3
Poland		2	2	2
Thailand	5	3	3	3
Vietnam			3	3
Total	**10**	**16**	**18**	**19**

Conclusion

- New regulatory requirements for the research and test reactors have identified on Dec.18, 2013 by the NRA (Nuclear Regulation Authority).
- Satisfaction of integrities for the updated earthquake forces, Tsunami are required.
- Consideration of natural phenomena, full evacuation, management for Beyond Design Base Accidents are required.
- Above analyses will intensively be performed timely, and an application to the NRA will be submitted in this year.
- As additional hardware, protection wire-nets of canal building from flying objects by the tornado, etc. are under consideration.
- After taking measures for safety requirements and the permission by the NRA, the renewed JMTR will be operated.
- As to other activities, the training for foreign young researchers and engineers was held, and 19 trainee attended in this course.