Current Status of JMTR Refurbishment Project

M.Kaminaga, M. Niimi, N. Hori, K. Takahashi, M. Kannno, T. Nakagawa, Y. Nagao, M. Ishihara and H. Kawamura

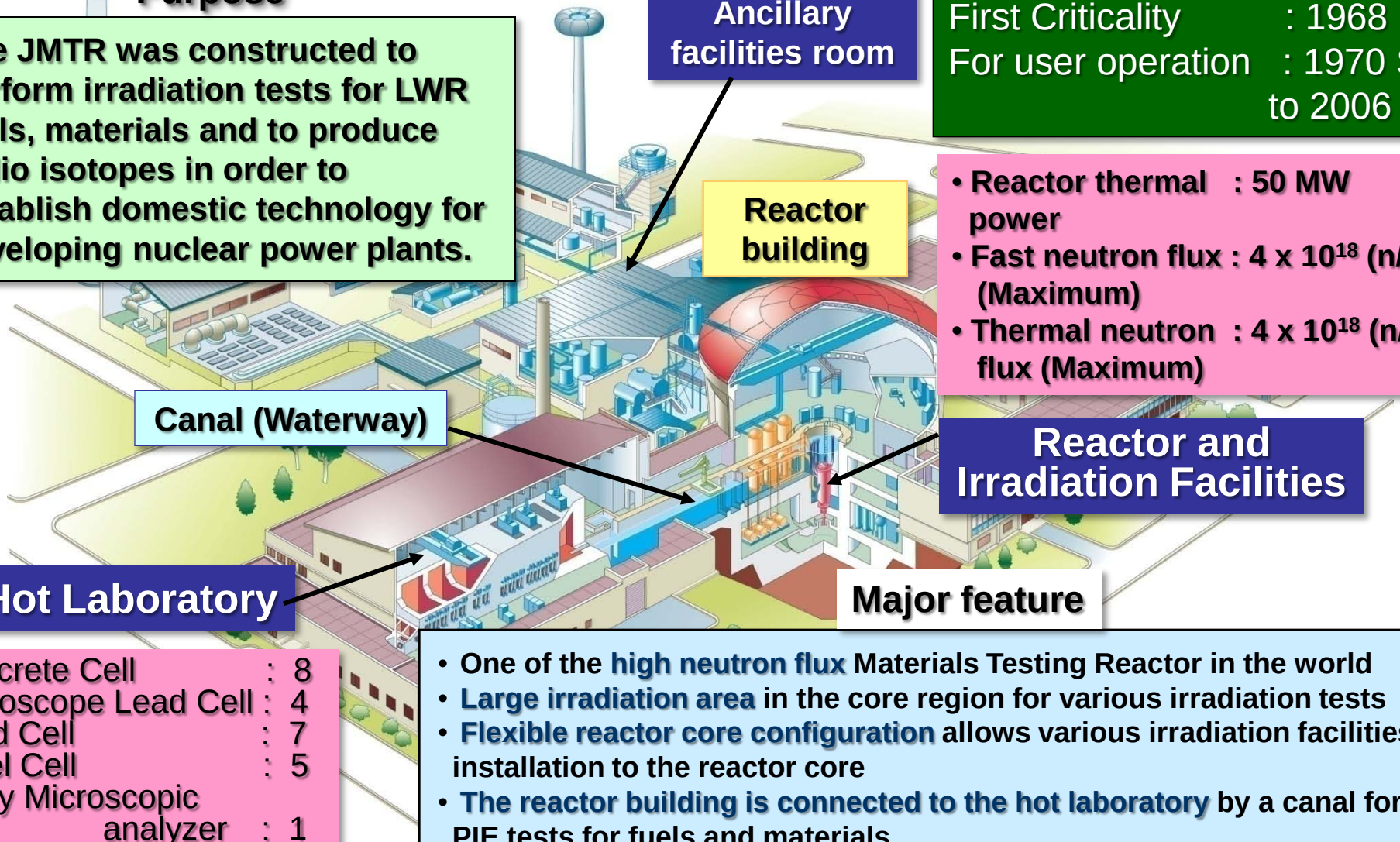
Neutron Irradiation and Testing Reactor Center,
Department of JMTR Operation,
Oarai Research and Development Center
Japan Atomic Energy Research Agency (JAEA)

1. Outline of JMTR

Purpose

The JMTR was constructed to perform irradiation tests for LWR fuels, materials and to produce radio isotopes in order to establish domestic technology for developing nuclear power plants.

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



- **Reactor thermal power : 50 MW**
- **Fast neutron flux : 4 x 10^{18} ($n/m^2/s$) (Maximum)**
- **Thermal neutron flux : 4 x 10^{18} ($n/m^2/s$) (Maximum)**

Concrete Cell	: 8
Microscope Lead Cell	: 4
Lead Cell	: 7
Steel Cell	: 5
X-ray Microscopic analyzer	: 1

Major feature

- **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 installation to the reactor core**
- **The reactor building is connected to the hot laboratory by a canal for PIE tests for fuels and materials.**

2. JMTR Refurbishment Project

JMTR operation was stopped after completion of the 165th cycle in August 2006, and repairing and replacement work for the re-operation from FY2011, was started in FY2007.

Aged-Investigation

- An investigation of aged components (aged-investigation) was performed in order to identify integrity of facilities and components to be used for re-operation of JMTR.

Replacement of rector related components

- Replacement is carried out within the range of licensing permission of the JMTR
- At present, boiler system, refrigerator for air conditioning system, power supply system, air supply and exhaust system for reactor building have been replaced.

Installation of new irradiation facilities

- Corresponding to the user's requests, new irradiation facilities, such as irradiation test facilities for materials/fuels, production facility for medical isotopes etc. will be planned to install.

3.(1) Components replacement policy

At the beginning of the project, integrity of the components was evaluated and concluded that the integrity of the components was maintained properly, based on the JMTR annual maintenance results obtained in February 2005. JMTR annual maintenance is still continued, therefore, the integrity of the components still maintained properly even for the components which are not replaced.

Selection of "Components to be continuously used" and "Components to be replaced"

JMTR utilization advisory committee suggested that "JMTR should be operated for more 20 years after refurbishment". Based on this suggestion, following items were considered for selection of "Components to be continuously used" and "Components to be replaced".

(1) Safety

➔ **Ageing of components, importance of safety feature, maintenance experience, etc.**

(2) Improvement of availability

➔ **Affordability of spare parts for maintenance**

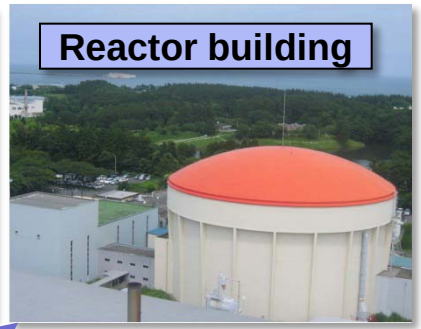
3.(2) Aged-investigation


Exhaust stack

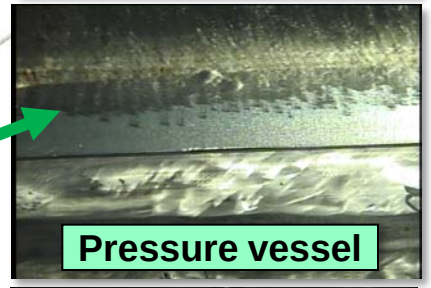

UCL elevated tank

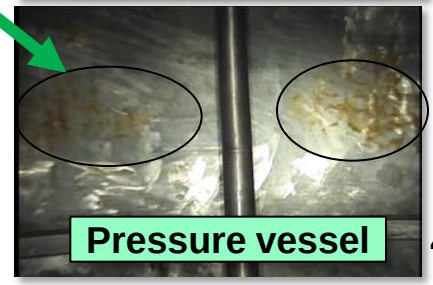

Secondary cooling tower


Diesel generator


Reactor building

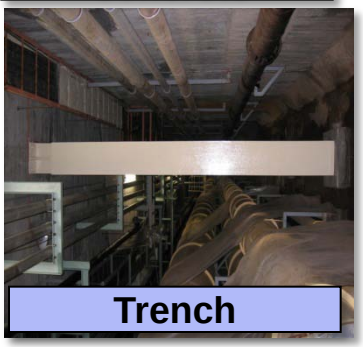

Main heat exchanger

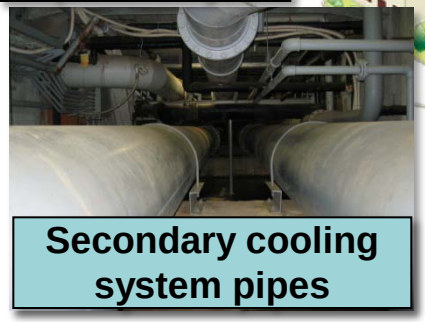

Pressure vessel

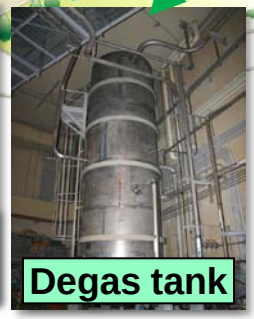

Pressure vessel

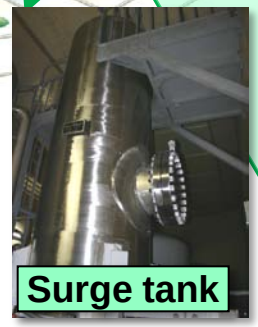

Filter bank concrete


Canal expansion joint


Trench


Secondary cooling system pipes


Degas tank


Surge tank

3.(3) Status of components replacement

UCL system circulation pumps (Replaced)

(Before)

(After)

High voltage transformer (Replaced)

(Before)

(After)

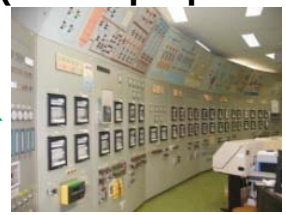
Power supply units (Replaced)

(Before)

(After)

Reactor operation console (Under preparation)

Process control system (Under preparation)



Neutron instruments (Under preparation)

Control rod drive mechanism (Under preparation)

Emergency exhaust blower (Replaced)

(After)

(Before)

Boiler (Replaced)

(Before)

(After)

Main primary pump motor (Under preparation)

Secondary cooling system

Power supply system

Reactor building air supply and exhaust system

Boiler units

Primary cooling system

Reactor and process control systems

3.(4) Components replacement schedule

Work schedule for the refurbishment

No.	Item	Yea	2007	2008	2009	2010	2011 Re-operation	Status at the end of August 2009
1	JMTR reactor core internals	Beryllium frame Gamma shielding plate						Under fabrication
2	Process and reactor control system	Process, neutron instruments, Safety protection system etc.						Under designning
3	Rector cooling systems	Primary cooling system, Secondary cooling system						Under designning
4	Radioactive waste disposal facility	Reactor room air feed and exhaust system, Drain system						Replacemet of "Reactor room air supply and exhaust system" has been completed.
5	Power supply	High votage power supply unit, Transformer, Cables						Replacemet has been completed.
6	Boiler, refregirator for air conditionning	Boiler, refrigirator for air conditioning system						Replacemet has been completed.
7	Purified water production system	Degassed demineralizer Regular demineralizer						Replacemet has been completed.

- **Replacement of the components is carried out on schedule based on the refurbishment work schedule.**
- **Components which are required to obtain “Approval of design and construction method”*, have been applied to the MEXT for approvals by March 2009.**

  * Primary cooling system, secondary cooling system, UCL system, Process and control system, Reactor room air supply and exhaust system, Beryllium frame, Gamma ray shielding plate

4. Installation of new irradiation facilities

New Irradiation Facilities

[New irradiation facilities will be installed by the external budget from the industrial users etc.]

Work schedule for the installation of new irradiation facilities

No.	Item \ Year	2006	2007	2008	2009*1	2010	2011 Re-operation	2012
1	Fuel Tests Irradiation facility of LWR fuels for ramp test	Conceptual design	Detail design	Designing, Fabrication, Installation				
2	Material Tests Irradiation facility for LWR core materials		Detail design	Designing, Fabrication, Installation		2 units		1 unit
3	New industrial use (1) ^{99}Mo production facility	Conceptual design, etc.				under planning		
4	New industrial use (2) Silicon semiconductor irradiation facility	Conceptual design, etc.				under consideration		
5	Fuel irradiation facility Irradiation facilities for LWR fuels	Conceptual design, etc.				under consideration		

*1 : In order to prepar necessary space for new material irradiation facilities installation, existing facilities are to be removed.

Post Irradiation Examination Faciliries

Corresponding to new irradiation facilities installed in the JMTR, necessary facilities for PIE are being installed in the hot laboratory.

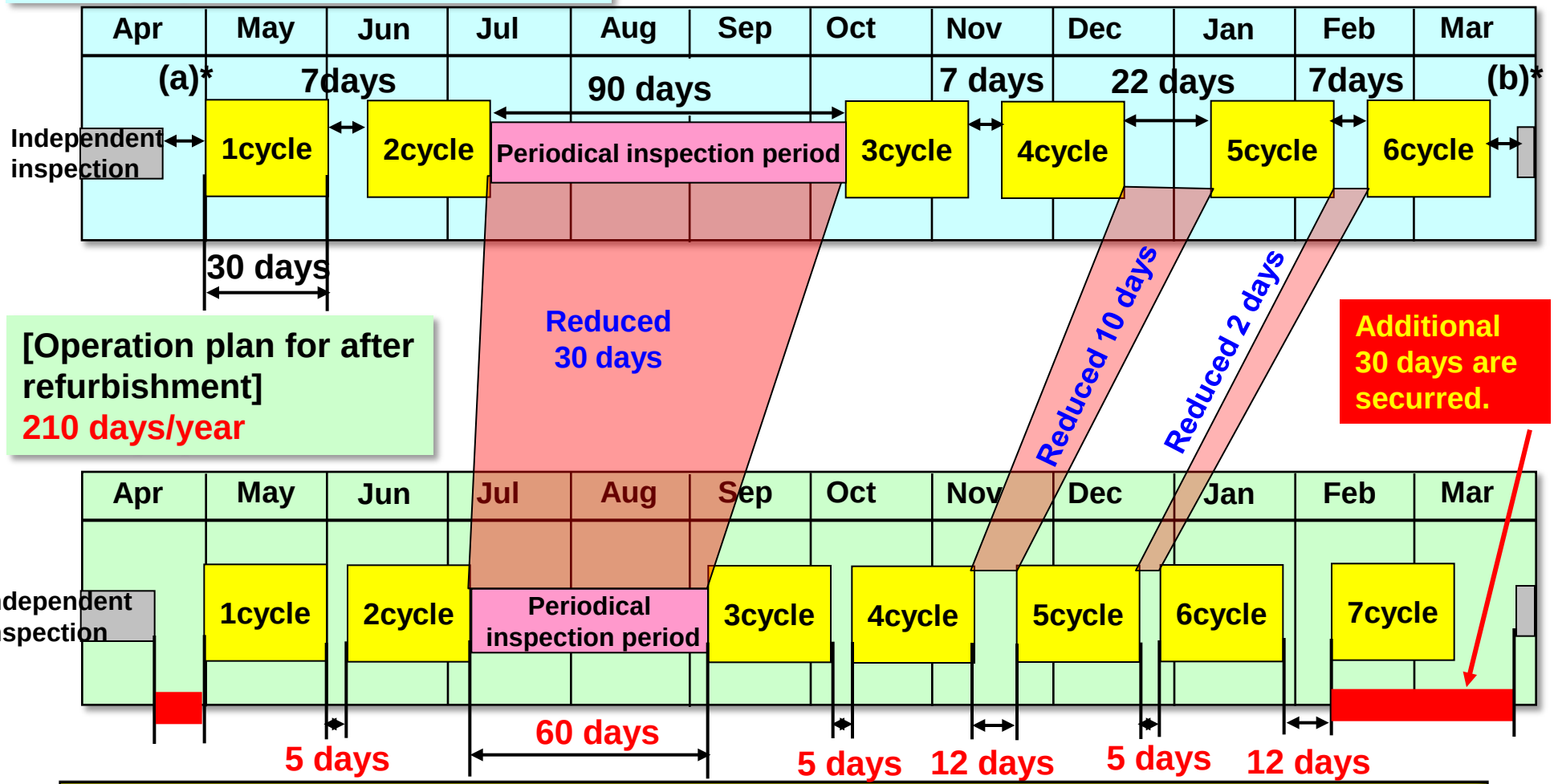
5. Role of new JMTR

Irradiation needs	Purpose
Lifetime extension of LWRs	• Aging management of LWRs for long term utilization • Development of LWR fuels and materials for aiming at the highest availability of LWRs.
Promotion of fundamental, and basic research	• Materials and components development for fusion reactor, such as ITER and demonstration fusion reactors. • Development of fuels and materials for high temperature gas cooled reactors (HTGR) which improves thermal stability. • Fundamental research for nuclear energy, such as the determination irradiation damage mechanism
Expansion of industrial use	• Production of silicon semiconductor with large diameter for industrial use, such as hybrid car. • Domestic production of ^{99}Mo for medical diagnosis medicine ^{99m}Tc
Human resource development for nuclear energy	• Education and training of nuclear scientists and engineers for the next generation nuclear energy development

6. Consideration for re-operation schedule

[Current typical operation schedul]
180 days/year

*: (a) + (b) = 22 days



[Operation plan for after refurbishment]
210 days/year

The JMTR will be operated safely and efficientry with increaseing availavility by the efforts of replace of components, increasing affordability, annual maintenance, etc.

8. Conclusion

- The JMTR refurbishment project is in progress according to its schedule aiming at re-operation of the reactor from FY2011.
- Replacement of components has been finished for the ancillary facilities, such as power supply, air conditioning system, UCL system, secondary cooling tower etc.
- Replacement of the reactor and process control system, beryllium reflector frame, motors of the main primary cooling pumps will be completed until FY2010.
- Annual operation schedule of the JMTR is under discussion in order to increase availability of the reactor.

Appendix

Appendix 1. Replacement of reactor components

Selection of components to be replaced

Criteria for selecting components to be replaced

1.Safety point of view
- (1) Aging of components
- (2) Importance of safety feature
- (3) Mantenance experience

2. Improvement of availability
- (4) Affordability of spare parts

Rep. : to be replaced
Cont. : to be continuously used

Facility, system	Components	Criteria				
		(1)	(2)	(3)	(4)	
Rector and process control system	Reactor control panel	O		O	O	Rep.
	Process control panel	O	O	O	O	Rep.
	Neutron instruments	O	O	O	O	Rep.
	CRDM	O	O	O	O	Rep.
Rector cooling system	Main pump motors	O	O	O	O	Rep.
	Main heat exchangers		O			Cont.
	UCL circulation pump	O	O		O	Rep.
	Secondary cooling system main pipes					Cont.
Radiological waste disposal system	Emergency blowers	O	O		O	Rep.
	Regular blowers					Cont.
Power supply system	Power supply units	O			O	Rep.
	High voltage transformer	O		O	O	Rep.
Other system	Water demineralizer	O			O	Rep.
	Boiler units	O			O	Rep.

Appendix 2. Aged-investigation of components to be used for re-operation

Investigation items for aged-investigation

1. Maintenance situation for aging such as corrosion, thinning, fatigue, irradiation effect
2. Possibility of appropriate status supervision after re-operation
3. Validity of current maintenance method

Investigated major components

Tanks in the primary cooling system

Inner wall surface was visually observed from the view points of corrosion, color change etc.

Main heat exchangers

Thinning of the heat exchanger tubes was measured by the eddy current testing. Visual observation was also carried out by using an endoscope.

Secondary cooling system pipes

Visual observation was carried out for the inner surface of the tubes which was covered with lining, from the view points of corrosion and thinning.

Secondary cooling tower

Main body and major parts were investigated visually from the view points of corrosion, rusting etc.

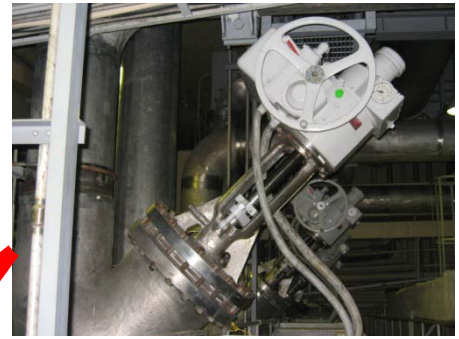
Power supply system

The insulation diagnosis examination of dynamo stator coil was carried out from the view point of reduction of insulation resistance.

Appendix 3. Replacement plan for the primary cooling system

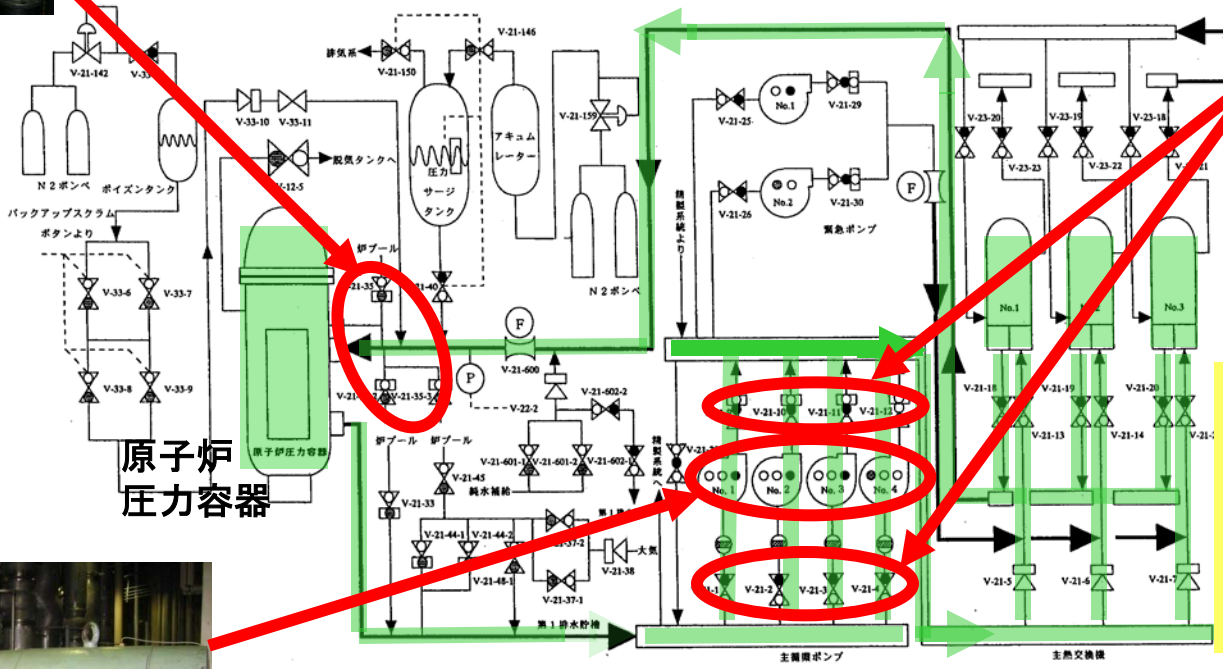
Rector pool connecting valve (Electromagnetic coil)

Electromagnetic coil is to be replaced with a new one which has same specification of existing one. ➔ Improvement of maintainability



Main pump outlet side Valve (Actuator)

Actuator is to be replaced with a new one which has same specification of existing one. ➔ Improvement of maintainability



Main pumps (Motors)

Pump motors are to be replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability

Special consideration is required for pump cast down characteristics.

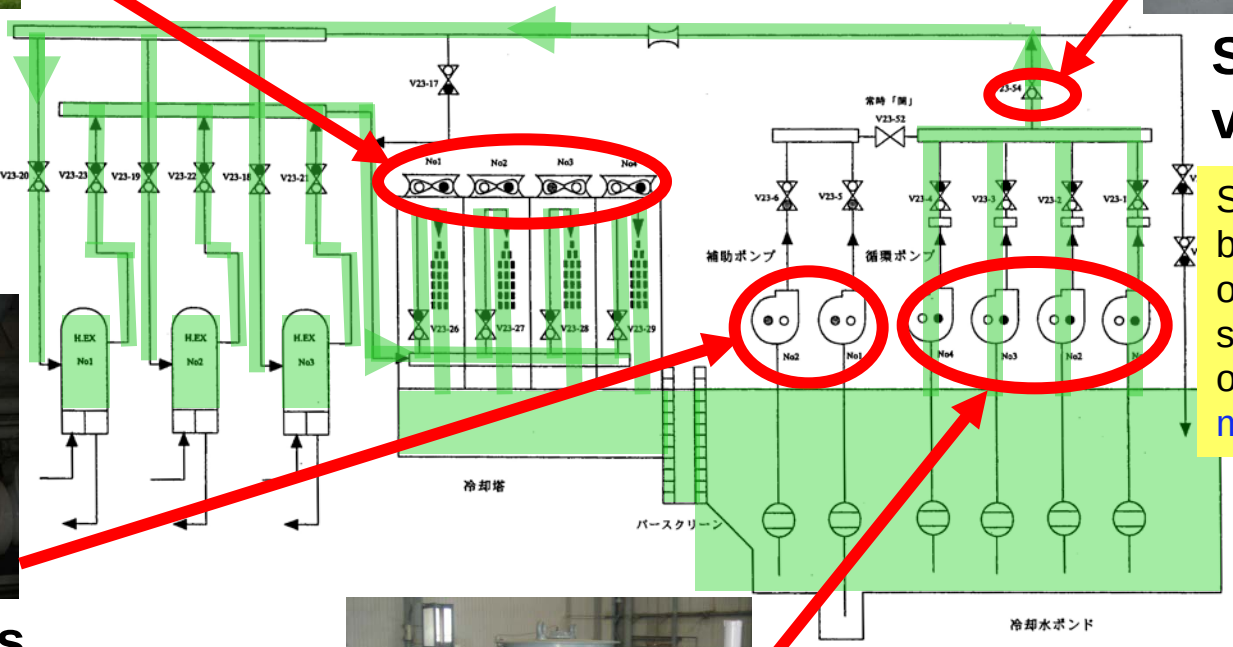
Appendix 4. Replacement plan for the secondary cooling system

Cooling tower fan (Motor and reduction gear)

Motors and reduction gears of the cooling tower fans have been replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability

Squeezing valve

Squeezing valve is to be replaced with a new one which has same specification of existing one. ➔ Improvement of maintainability



Auxiliary pumps

Auxiliary pumps have been replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability and maintainability

Circulation pumps

Circulation pumps have been replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability and maintainability

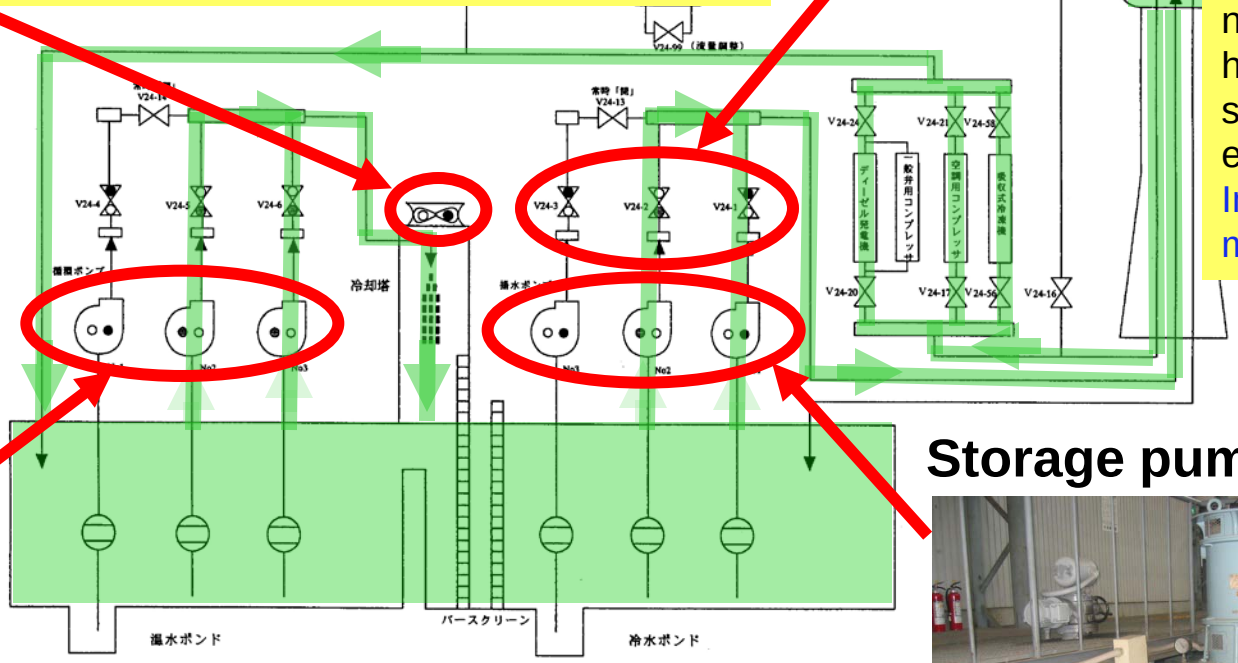
Appendix 5. Replacement plan for the UCL (Utility Cooling Loop) system

Cooling tower fan (Motor and reduction gear)

Motors and reduction gears of the cooling tower fans have been replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability

Storage pump outlet valves

Storage pump outlet valves have been replaced with new ones which have same specification of existing ones. ➔ Improvement of maintainability



Circulation pumps

Circulation pumps have been replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability and maintainability

Storage pumps

Storage pumps have been replaced with new ones which have same specification of existing ones. ➔ Improvement of reliability and maintainability

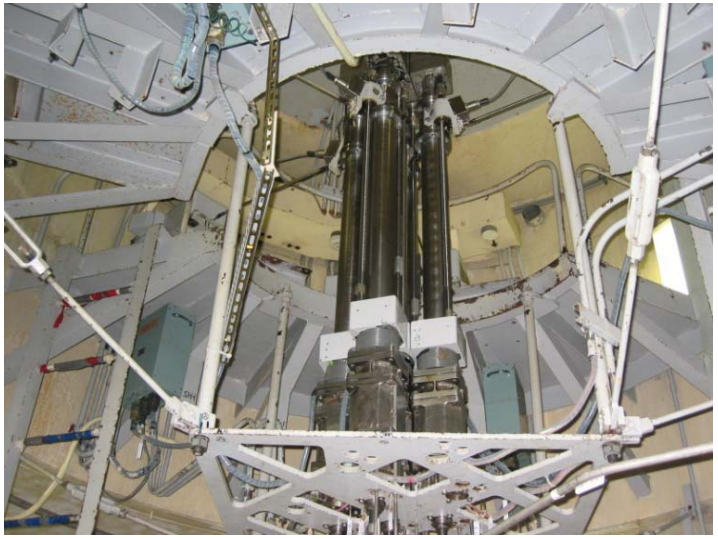
Appendix 6. Replacement plan for the reactor and process control systems

Reactor control panel

All of these systems are to be replaced.
➔ Improvement of maintainability, reliability

Neutron instruments

Process control system



Control rod drive mechanism (CRDM)