附件一：**Characterization of Radioactive Inventory**

Characterization of Radioactivity Inventory

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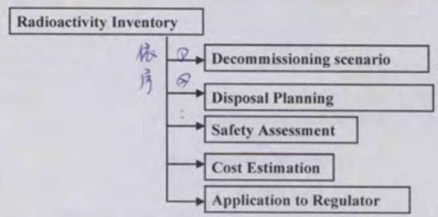
Confidentiality Note

1. Outline of Plant Characterization <Plant Characterization Objectives>

Accurate radioactivity inventory is crucial for specification of the decommissioning plan.



Plant Characterization

Radioactivity Inventory Evaluation

Evaluation for Neutron Activated Materials

- In & Near Reactor
  - RPV Inside (Core Internals)
  - PCV Inside (PCV Internals)
  - PCV & BSW Concrete
- SFP
- MS-Line, Vent Tube

Evaluation for Contaminated materials

- Fixed Contamination (Internal surface of PLR, CUW, MS, etc)
- Loose Contamination (Wall, Ceilings & Ventilation Sys) (External surface of Pipes, Equipments, etc)
- Secondary Wastes

Amount Estimation of Waste Materials

- Amount of materials made of metal
  - -Core Internals
  - -Pipes, Equipments
- Amount of Concrete structure
  - Buildings
- Amount of Secondary Waste

Radioactivity Inventory Data-Base system

2. Evaluation for Neutron activated Materials

- Neutron flux Measurement
- Neutron flux distribution calculation
  2 dimensional & 3dimensional calculation
- Radioactivity distribution calculation
- NR boundary estimation

2. Evaluation for Neutron activated Materials

Radioactivity distribution are
calculated using "calculation code"
and
***verified with measured values*.**

Calculations

- Neutron flux distribution calculation
- Radio-activation calculation

Measurements

- Material Sampling
- Radio-nuclide concentration analysis

Verification

Radioactivity distribution ⟺ Radioactivity at sampling points

2. Evaluation for Neutron activated Materials

Radioactivity distribution is
"calculated using calculation code".

Calculations

Neutron flux distribution calculation

Calculation code

DORT:Sn method
MCNP-5:Monte Carlo method
⇒Neutron flux distribution

-Storing neutron flux distribution

Radio-activation calculation

ORIGEN-S/SCALE5(Scale6.1)
⇒Radio-activation distribution
→calculating radio-nuclide concentration at all mesh points

2. Evaluation for Neutron activated Materials

Radioactivity distribution is also measured with concrete core sampling.

Measurements

material sampling

↓

Radio-nuclide concentration analysis

① Neutron flux measurement using activation foils

② Measurement of radioactivity distribution along the direction of the depth in concrete wall.

Analyzing radioactivity concentration of nuclides with chemical process

Radioactivity Evaluation

Reliability of calculated radioactivity is verified using measured radioactivity.

Verification

Radioactivity distribution ⟺ **Radioactivity at sampling points**

We will judge calculation radioactivity distribution "*Reliable*", if C/M (comparison between Calculated value and Measured value) is *less than one order magnitude*.

↓

Assessing the radioactivity distribution, we draw "radioactive-waste level classification lines".

↓

Referencing the line, we estimate amount of level-classified radioactive-waste using 3D-CAD system.

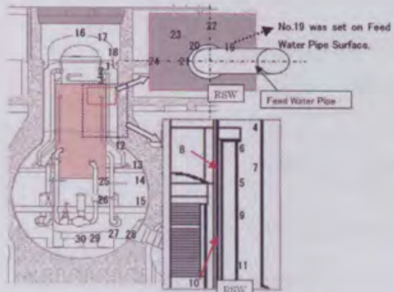
Neutron flux Measurement

- **Using activation foils at 30 locations in the PCV to measure neutron flux, where the characteristics of neutron transport phenomena can be observed.**
- **3 kinds of activation foils:**
  - **-Gold (Au)**
  - **-Au covered by cadmium (Cd) (Au+Cd) : to measure epi-thermal neutron flux**
  - **-Nickel (Ni): to measure fast neutron flux**

***Cd is an absorber to thermal neutron. So we can compute thermal neutron flux from the difference between radioactivity of Au and radioactivity of (Au+Cd).**

Neutron measurement inside the PCV

Location of activation foils



Neutron measurement inside the PCV

Around Feed-water pipe

RSW Out side

Photo. of Activation foil setting

Neutron measurement inside the PCV

- Activation foil: Au、Au+Cd Ni

Neutron flux are calculated using following equation

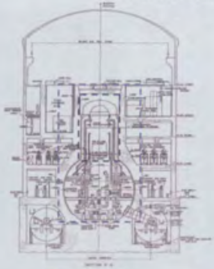
$$\phi = \frac{R_0 M}{m \cdot a \cdot A \cdot \sigma \cdot (1-e^{-\lambda T}) \cdot e^{-\lambda t}}$$

Φ : Neutron flux (cm-1・S-1)
R_0 : Radioactivity(Bq)
M : Atomic mass (g/mol)
a : isotope abundance
A:Avogadro No. (#/mol)
σ : Activation X-sec. (barn)
λ : Decay const. (S^{-1})
T : Irradiation time (S)
t : Cooling time (S)

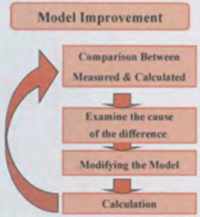
	Au	Ni
Atomic Mass M(g/mol)	198	58
Decay Const. λ (s-1)	2.96×10^{-6}	1.13×10^{-7}
Isotope abundance a	1.0	0.678
Activation X-sec σ(barn)	98.8	0.45

Neutron flux distribution calculation

Calculation range of 2D & 3D calculation



: 2-D Calculation
: 3-D Calculation



Survey the best combination of mesh interval width and numbers of directional quadrature

3-Dimensional Calculation

＜Purpose of 3-Dimensional Calculation＞

- 3-Dimensional (3-D) Sn calculation was performed in order to obtain

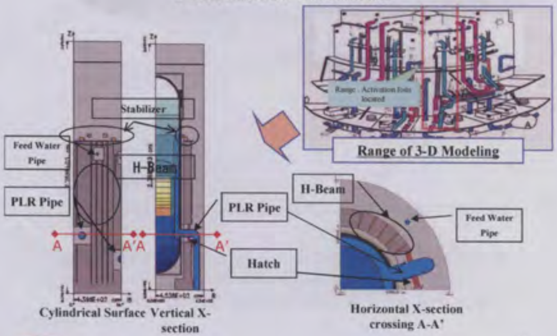
"Better understanding of neutron transport phenomena"

The Calculation Conditions for 3-D Calculation

Item	Condition
Code	TORT (DOORS3.2a)
Geometry	R－θ－Z
No. of Zone	704
No. of Mesh Intervals	
Radial	267
Azimuthal	178
Axial	730
Order of scattering Expansion	P5

Item	Condition
No. of Directions	S8
Boundary Condition	
Left	Reflected
Right	Void
Left	Reflected
Right	Reflected
Top	Void
Bottom	Void
Flux Convergence Criterion	0.001

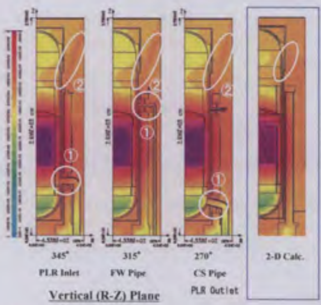
3-Dimensional Calculation



Cylindrical Surface Vertical X-section

Horizontal X-section crossing A-A'

3-Dimensional Calculation(Result)



<Example:Vertical (R-Z) Plane>

① Neutron leakage through a hatch was observed. But because water in the pipe shields neutron flux, the pipe that pierces the hatch reduces amount of neutron leakage.

② Neutron streamed through the gap of RPV and RSW. A stabilizer reduced amount of upward streaming neutron. Relatively high neutron flux occurred with the streaming was distributed in the narrow range.

2-Dimensional Calculation

<Purpose of 2 dimensional calculation>

To perform reliable 2 dimensional neutron distribution calculation
⇒It need considering the characteristic of neutron transport phenomenon inside the PCV.

<Our goal >

Average ratio of measured fluxes to calculated fluxes are

"Less than one order magnitude".

Table-2 The Calculation Conditions for 2-D Calculation

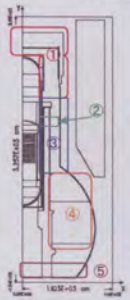
Item	Condition
Code	DORT (DOORS3.2a)
Geometry	R-Z
No. of Zone	68
No. of Mesh Intervals	
Radial	235 378 1104
Axial	656 1085 3242
Order of scattering Expansion	P5

Item	Condition
No. of Directions	S4 S6 S8 S10 S12 S16
Boundary Condition	
Left	Reflected
Right	Void
Top	Void
Bottom	Void
Flux Convergence Criterion	0.001

Comparison Between Calculation & Measurement

(C/M:Calculated value/Measured value)

The average ratio of the measurement to calculation



		C/M
①	PCV Upper Part	4.1
②	Round Feed Water Pipe	2.1
③	PCV Center Part	7.5
④	PCV Lower Part	5.6
⑤	PCV Floor	34.7

The average ratio of the measurement to calculation were calculated in each area.

Range of 2-D calculation was divided into 5 areas considering the characteristic of neutron distribution.

Summary of Neutron flux distribution calculation

<3-Dimensional Calculation>

- Characteristic neutron transport phenomena were understood in observing 3 dimensional flux distribution.
- 2 dimensional calculation model had been a good approximation of 3 dimensional model was confirmed.

<2-Dimensional Calculation>

- Reliable calculated neutron distribution was obtained after several modifications considering the transport phenomena inside the PCV of TS-1.
- Characteristics of neutron transport phenomena inside the PCV of TS-1 had been able to understand.

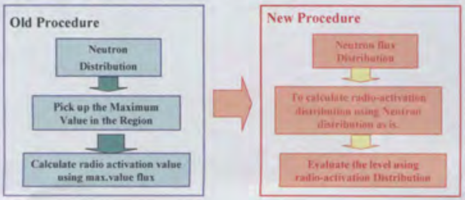
high ratio ↑ for small neutron flux.

Radioactivity Distribution Calculation

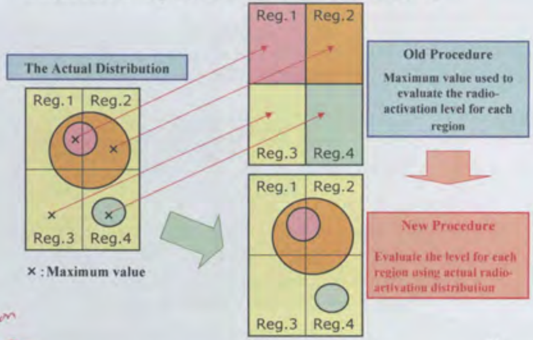
- To Improve the Procedure of Activation Calculation

⇒To calculate Activation distribution *using Neutron distribution as is.*

Improvement of Radioactivity Distribution Calculation Procedure



Radioactivity Distribution Calculation



Flux level Approximation method

<Derivation of the approximate equation>

The equation of nuclide formation, destruction and decay can be written the equation of relation between isotope formation rate and thermal neutron flux

[illegible]

$$C = CF \times (\phi_{th} / \phi_{base})^{n}$$

C:radioactivity concentration(Bq/g)

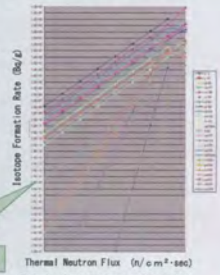
CF:conversion factor of flux ratio to radioactivity concentration(Bq/g)

ϕ th:thermal neutron flux (1/sec/cm2)

ϕ _base:reference thermal neutron flux

n: order of fitting equation, n=1 or 2

linear or parabola fitting method



Relation between isotope formation rate and thermal neutron flux

Applying "The method" to decommissioning planning

"The method" reduced computing time substantially. and performed the computation of a various condition.

- Materials to be evaluated: SUS304, SUS316, carbon steel, concrete
- Nuclides to be evaluated: 178 nuclides (their half-life are more than 1 month)
- Evaluation period: shut down, every 1 year from first year to 40th year, 50th year 100th year 300th year 1×10^3 1×10^4 1×10^5 1×10^6

Using "the method", we became able to draw "space and time dependent radioactivity distribution contour map"

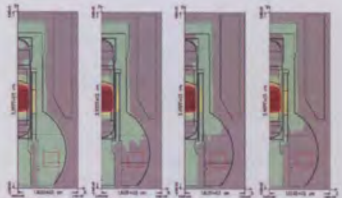
Applying "The method" to decommissioning planning

Example, utilizing time dependent radio-waste classification contour maps for dismantling planning

-Area, colored green, shows L3 level

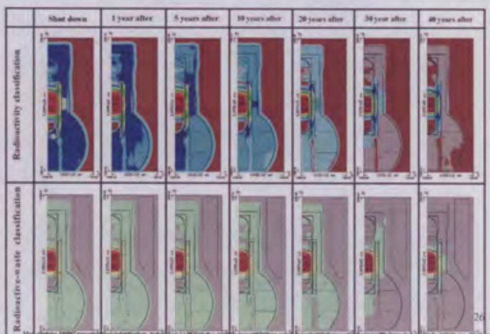
-Area, colored gray, shows CL level.

⇒Area, surrounded by red dotted line, in which PLR-pump is being installed will be CL level 24 years after.



Applying "The method" to decommissioning planning

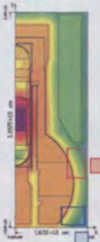
Example:Radioactivity and radioactive-waste classification contour maps



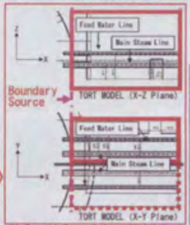
-To Estimate Boundary of Radioactive/Non-Radioactive material

◇ Materials, which is irradiated by neutron less than 6.25 μ Sv/h, can be treated as "Non Radioactive Material(NR)", According to a Report by the regulatory body .

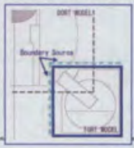
3D Neutron Flux Distribution Calculation



2D Neutron Flux Distribution



MS-Tunnel Room Calcu. Model



S/C Calcu. Model

Calculation Conditions for TORT

Item	Condition	
Code	TORT(DOOR3.2a)	
Cross Section Library	MATX-J33(175 Grp.)	
Geometry	X-Y-Z	
Order of Scattering Expansion	P5	
Numbers of Directions	S8	
Numbers of Mesh Intervals	MS-Tunnel Room	S/C
X	58	194
Y	98	34
Z	105	213
Boundary Condition	MS-Tunnel Room	S/C
Left	Boundary Source	
Right	Void	
Inside	Reflected	Void
Outside	Void	
Top	Void	Boundary Source
Bottom	Void	

Effective Dose Distribution Calculation

(Neutron Flux- Effective Dose Conversion Coefficient)

$$[E/\Phi]_{neutron} = \exp\left\{ \sum_{m=0}^{5} M_n^m \times (\ln E_n)^m \right\} \qquad [(\mu Svh^{-1})/(cm^{-2}s^{-1})]$$

E : $EffectiveDose(\mu Svh^{-1})$

Φ : $NeutronFlux(cm^{-2}s^{-1})$

E_n : $NeutronEnergy(MeV)$

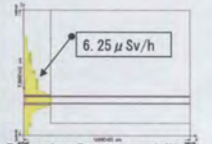
M_n^m : $Fittingprameter$

E-Min. (MeV)	E-Max. (MeV)	M_n^0	M_n^1	M_n^2	M_n^3	M_n^4	M_n^5
1.0E-9	2.0E-5	3.4631E+1	1.2821E+1	1.6924E+0	1.0754E-1	3.2721E-3	3.8259E-5
2.0E-5	1.0E-2	5.8748E+0	4.7905E+0	1.0317E+0	1.1090E-1	5.9680E-3	1.2843E-4
1.0E-2	5.0E+1	7.3159E-3	5.2212E-1	-1.0121E-1	-1.3526E-2	2.2409E-3	2.3975E-4
5.0E+1	5.0E+3	-1.0979E+1	1.0915E+1	-3.8755E+0	6.2884E-1	-4.5683E-2	1.1789E-3

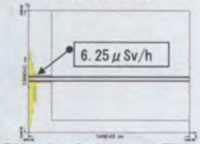
Ref. :AESJ-SC-R002:2010

Comparison Between Calculation & Measurement in MS-Tunnel Room - NR Boundary -

Pos. #	Foil Type	Mesured Activity		Calculated Activity	
		Isotope	Activity (Mesured) (Bq)	Activity (Calc.) (Bq)	C/E
1	Au	^{198}Au	4.06E+00	4.43E+00	1.09
	Ni	^{58}Co	ND	2.50E-04	-
2	Au	^{198}Au	2.38E+00	7.02E+00	2.96
	Ni	^{58}Co	ND	4.34E-04	-
3	Au	^{198}Au	1.42E+00	5.85E+00	4.11
	Ni	^{58}Co	ND	5.47E-04	-
4	Au	^{198}Au	2.33E+00	9.00E+00	3.86
	Ni	^{58}Co	ND	8.40E-04	-
5	Au	^{198}Au	2.26E+00	1.55E+00	0.69
	Ni	^{58}Co	ND	1.04E-04	-
6	Au	^{198}Au	2.28E+00	8.66E-01	0.38
	Ni	^{58}Co	ND	3.66E-05	-
7	Au	^{198}Au	2.11E+00	1.23E+00	0.58
	Ni	^{58}Co	ND	9.14E-05	-
8	Au	^{198}Au	1.77E+00	1.22E+00	0.69
	Ni	^{58}Co	ND	9.18E-05	-
9	Au	^{198}Au	6.50E-01	1.23E+00	1.90
	Ni	^{58}Co	ND	8.96E-05	-



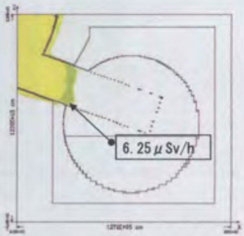
Effective Dose around MS-Line



Effective Dose around FW-Line

Comparison Between Calculation & Measurement of S/C - NR Boundary-

Pos. #	Foil Type	Mesured Activity		Calculated Activity	
		Isotope	Activity (Mesured) (Bq)	Activity (Calc.) (Bq)	C/E
11	Au	^{198}Au	2.54E+00	1.36E+02	53.68
	Ni	^{58}Co	ND	2.58E-03	-
12	Au	^{198}Au	5.27E+00	1.95E+02	37.07
	Ni	^{58}Co	ND	1.43E-02	-
13	Au	^{198}Au	1.20E+02	2.35E+03	19.54
	Ni	^{58}Co	ND	4.70E-01	-
14	Au	^{198}Au	2.51E-01	5.01E+00	20.00
	Ni	^{58}Co	ND	4.95E-05	-
15	Au	^{198}Au	5.43E-01	4.91E+00	9.03
	Ni	^{58}Co	ND	4.48E-05	-



Effective Dose around S/C

3. Evaluation for Contaminated Materials

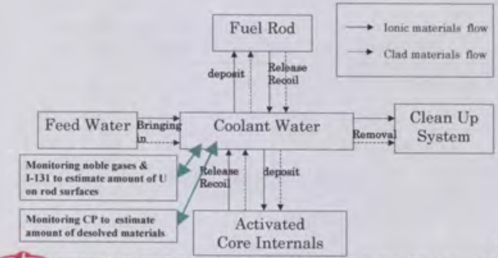
Contaminated Materials

Fixed Contamination
- Contamination deposited on internal surfaces of pipes, other equipments due to the transport of activated corrosion and erosion products or fission products and actinides.
  - Internal surface of PLR, CUW, MS, etc

Loose Contamination
- Contamination results from
  - ・Leakages in the primary circuit,
  - ・Processing and storage of radioactive effluents and wastes,
  - ・Maintenance and Repair activities,
  - ・Fuel discharging operations
  - ・Working incidents
- Airborne contamination
  - ・On walls, On ceilings
  - ・In the ventilation system.

Pseudo-concentration balance model

Concentration of CP, FP are balanced in "Reactor System"



3. Evaluation for Contaminated Materials

Radio-nuclide concentration of contaminated materials are

calculated using "pseudo-concentration balance model with monitoring date from coolant water chemical control process "

and

verified with coolant water radio-chemical analysis, with material sampling on internal surface and/or on external surface

Mechanisms of Pseudo-concentration balance model

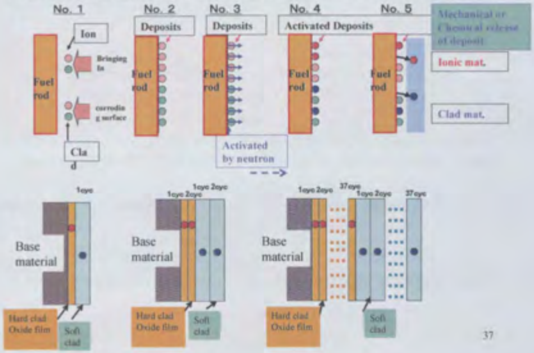
(1) Release of corrosion products from corroding surfaces
(2) Recoils from corroding surfaces or deposits
(3) Mechanical or chemical release of deposits
(4) Ionic and isotopic exchange from corrosion films and deposits
(5)Radio-nuclides are treated as "Soluble(ionic)" or "Insoluble(cladding)"

$$V\frac{dA_i^*}{dt}=\xi_i^*\Gamma_i-\delta^*A_i^*V+\sum_k(\xi_p^*\Gamma_{ik}^*-\delta_{pk}^*A_i^*S_k+Y_{ik}^*S_k)+h\Gamma_i^+-(\beta+g+\lambda_i)A_i^*V$$ ・・・ Concentration of radio-nuclide in coolant water

$$\frac{d\Gamma_i}{dt}=\sum_n(\delta^*A_i^*V+k_iM_i-\xi_i^*\Gamma_i)$$ ・・・ Amount of deposits on fuel rod surface

$$\frac{d\Gamma_{ik}^*}{dt}=\delta_{pk}^*A_i^*-(\xi_p^*+\lambda_i)\Gamma_{ik}^*$$ ・・・・・ Amount of deposits on internal surface

Image of Pseudo-concentration balance model



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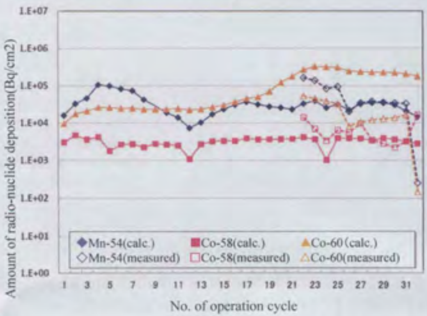
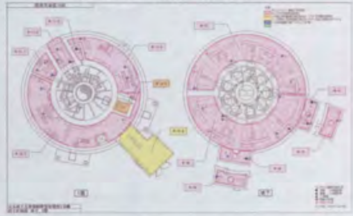
Calculation results of radio-nuclide deposition on PLR internal surface (Fixed contamination)



Contamination maps on reactor building (Loose contamination)



- Surface contamination in reactor building is limited to areas where radioactive liquids and aerosols have been released
- Calculation result is applied to evaluation for the concentration of each radio-nuclide referencing measured radioactivity of Cs-137 and Co-60, these are the commonest radio-nuclide and easy to measure.

4. Amount Estimation of Waste Materials

Amount of Waste materials

- Amount of Metals
- Amount of Concrete
- Amount of Secondary waste

To estimate amount of waste materials reliably, the following information is necessary:

-Review of historical information of the plant
>The construction record (construction drawings, design drawings)
>Maintenance and/or repair record

>Detail decommissioning plan

Amount estimation of Metals

- Core internals
  Estimate the amount referencing the design drawings
- Pipes other equipment
  >Estimate the amount referencing the design drawings
  > In situ investigation
  >Estimation with 3D-CAD using information from design drawings

Sample figure of 3D-CAD drawings

Amount estimation of Concrete

- Estimate the amount of concrete with 3D-CAD referencing the construction record and the design drawings

Boundary location data → 3D-CAD → **Amount of concrete, these are the radioactivity level classified**

Input design drawing of building and boundary location data to 3D-CAD

Referencing the radioactivity level map to grasp the location of the radioactivity level classified boundary.

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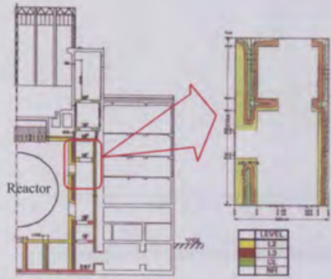
Radioactive-waste Level Classifications Map of Reactor Building Concrete Wall



"Map" was drew assessing calculated radioactivity distribution

↓

Radioactive-waste level classification lines were plotted referencing MAP and painting each areas in different colors

↓

Input the line location to 3D-CAD and estimate amount of level-classified radioactive-waste

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Sample of evaluation results of contaminated materials(Table of waste materials)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L2	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L2	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L2	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CL	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	L3	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CL	[illegible]
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	合 計		[illegible]				

May contain JAPC's proprietary information. Subject to JAPC's prior written consent before using for other purposes than originally intended or disclosing to any third party.

5.Radioactivity Inventory Data-Base System

<Objective of Radioactivity Inventory Data-Base System>

- the DB-system store the whole information about radioactivity inventory, these are necessary to plan the rational decommissioning plan.

① Store the whole information about the decommissioning plant

② Store the information about neutron activated materials and contaminated materials and treat them together or each by each

③ Store the radionuclide concentration information (78components,178nuclides)

④ Store and control the time dependent radioactivity distribution data

⑤ System installs "Decontamination simulation tool"

Stored Information of the DB-System

The DB-System stores following two type information

(1) Results of amount estimation of waste materials
ID No, Name, Location (Building, Floor#, Area), Weight, Volume & Capacity, Surface area (internal, external) , Kind of materials

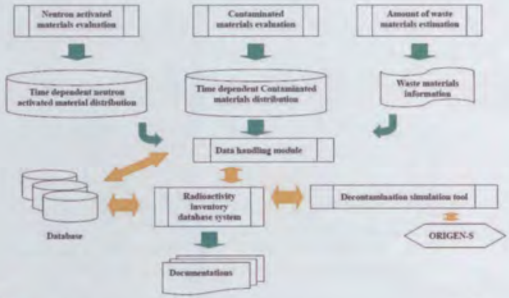
(2) Results of the evaluation of neutron activated materials and contaminated materials

→ Store the information about neutron activated materials and contaminated materials and treat them together or each by each

→ Store and control the time dependent radioactivity distribution data

→ Store and control the Statistical radioactivity data

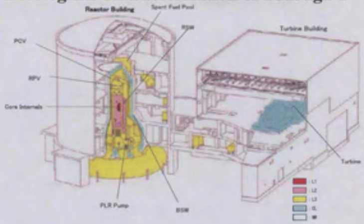
System Structure of DB-System



Screen Sample of the DB-System

Thank you for your attention

Radiological Characterization of Tsuruga-1



Classification of Radio-activity Level

附件二：**A Study on Cost Estimation Methodology for Decommissioning NPPs**

November 12, 2013

A Study on Cost Estimation Methodology for Decommissioning NPPs

Satoshi Yanagihara
Research Institute of Nuclear Engineering
University of Fukui

Contents

- Decommissioning Cost Estimation in Japan
- JPDR Decommissioning project
- Development of computer systems for evaluation of decommissioning project parameters
- Data analysis for project parameter estimation

Introduction

- Decommissioning cost was evaluated by the utility group in Japan; it was then approved by the government for establishment of decommissioning funding system.
- The Japan Power Demonstration Reactor (JPDR) was the first nuclear power plant which generate electricity by nuclear energy and being dismantled as a demonstration decommissioning project in Japan.
- Research and development was one to the subjects to be done in parallel with actual dismantling activities for future decommissioning of commercial nuclear power plants.
- Computer system and the related database were developed for evaluation of decommissioning cost and the other project parameters such as worker dose and waste arising for future decommissioning of commercial nuclear power plants.

Decommissioning Cost Estimation in Japan

Regulation

- Cost estimation is required for approval of decommissioning plan

Funding

- Decommissioning cost was studied for establishment of decommissioning fund; based on the study, the cost is included in electricity fee.

Cost estimation methodology

- Standard decommissioning process of NPP in Japan
- Estimation of waste arising from decommissioning NPP
- Study on work breakdown structure
- Estimated cost is reviewed every year in consideration of technology development and economical situation, etc.

Standard Decommissioning Process of NPP in Japan

- Premise for cost estimation of decommissioning and waste management
- Selection of rational decommissioning process and terms of safe enclosure on the basis of expected cost, worker dose and waste generation
- The strategy `safe enclosure and dismantlement` considered from the viewpoints of worker dose and waste generation.

Phase	Activities
Facility Operation	● Final shutdown for decommissioning ● Removal of spent nuclear fuels
D&D activities	● System decontamination ● Safe enclosure (5 – 10 years) ● Dismantlement
Release of site by completing the D&D activities	● Radioactive waste treatment and disposal ● Usage of the site for a new plant or other objectives

Major Dismantling Process and Work Activities

Radiological survey

Dismantlement of component and facilities in reactor bld.

- Dism. reactor internals（remote, underwater cutting）
- Dism. reactor pressure vessel（remote, underwater cutting）
- Dism. components in reactor enclosure
- Dism. thermal shielding (remote operation)
- Dism. radiological activated components in reactor enclosure (remote operation)
- Dism. Bio-shield activated (remote operation)
- Demolition of reactor enclosure
- Dism. Residual equipment（ventilation, crane, etc）

In parallel:

- Dism other equipments

Dismantlement of component and facilities in turbine bld.

- Dism. equipments (both radioactive and non-radioactive; main generator, turbine, condenser, etc.)
- Dism. Residual equipments in buildings（ventilation, crane, etc.)

Dismantlement of component and facilities in other blds.

- Dism. equipments (both radioactive and non-radioactive)
- Dism. residual equipments in the buildings（ventilation, hoists ,etc.)

Radiological surveys of residual facilities

- Demolition of reactor building
- Demolition of turbine building
- Demolition of the other buildings and facilities

Premise for Cost Estimation of Decommissioning NPP

- Application of standard decommissioning process
  → system decontamination /safe enclosure/dismantlement
- Waste management
  → disposal option depending on their radioactivity levels

●Relatively high level radioactive waste (sub-surface 50 – 100 m in depth)
→Radioactivity concentration is higher than those of implicated for the low level radioactive waste disposal center which is in operation.

●Relatively low level radioactive waste (concrete pit type)
→ Radioactivity concentration is higher than one tenth of regulation for near surface trench disposal option.

●Extremely low level radioactive waste (trench type)
→ Radioactivity concentration is higher than those of clearance levels proposed by nuclear safety commission(1999).

●Less than clearance level
→Radioactivity concentration is less than those of clearance levels propose by nuclear safety commission(1999).

Decommissioning Cost Estimation（1100MWe Class NPP)

The funding system has been established for decommissioning of NPPs. To prepare the system, decommissioning cost was estimated for 1100MWe class NPPs(BWR, PWR) follows:

Decommissioning Cost of NPP

BWR : 65.9 billion Japanese yens
- Dismantlement : 49.8 billion Japanese yen
- Waste Disposal : 16.1 billion Japanese yen

PWR : 59.7 billion Japanese yen
- Dismantlement : 42.9 billion Japanese yen
- Waste Disposal : 16.8 billion Japanese yen

(as of 2007 year price)

Radioactive Waste Disposal Costs

Items	BWR	PWR
Process (Treatment)	3.5	2.3
Inspection	0.4	0.3
Transportation (on site)	0.1	0.1
Transportation (out site)	5.8	5.3
Disposal	8.9	11.7
Total	18.7	19.7

Unit: billion Japanese yen

Transportation and disposal Costs

Category	BWR		PWR	
	Transportation	Disposal	Transportation	Disposal
Relatively high level :	0.7	1.5	1.8	3.9
Relatively low level :	1.5	4.5	2.2	6.7
Extremely low level :	3.6	2.9	1.4	1.1

Transportation: out-site transportation

Estimation of Waste Arising from Dismantling NPP

(1100MWe Class)

Categorization	BWR	PWR
Relatively high level radioactive waste (Intermediate level)	0.1 (100 m^3 ;0.1%)	0.2 (260 m^3;0.1%)
Relatively low level radioactive waste（Low level）：	2 (1600m^3 ;1%)	3 (2400 m^3;1%)
Extremely low level radioactive waste (Extremely low)：	10 (7,200m^3 ;2%)	3 (2800m^3;1%)
Less than clearance level：	530 (98%)	490 (99%)
Total：	550	500

(unit: thousand ton)

The volume was estimated as conditioned wastes for final disposal.

JPDR Decommissioning Program
- The first experience of dismantling reactor facility -

Plant Characteristics

- Reactor type & power : BWR, 45/90 MWt
- Facility operation period : 1963-1976
- Total output power : 21,500 MWD

Objectives

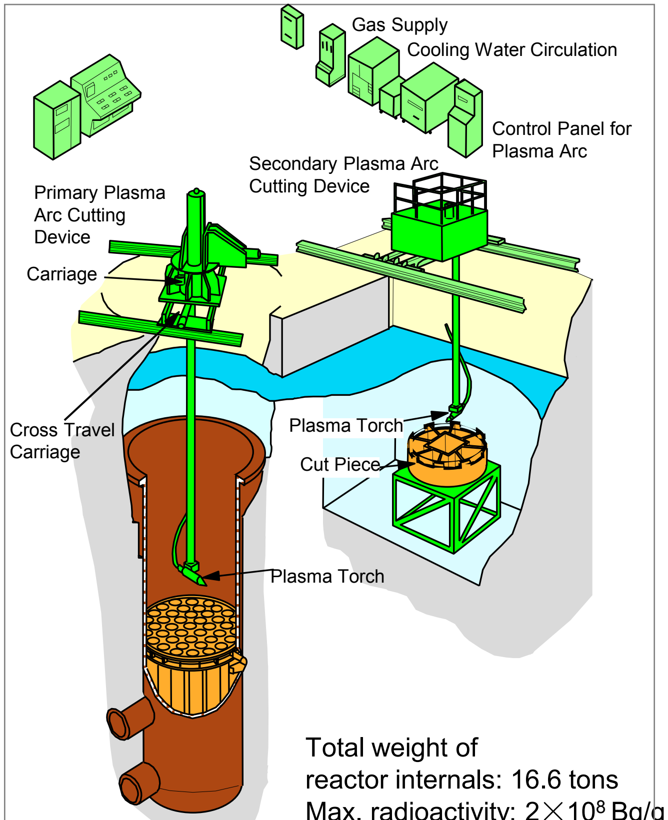
- to gain actual experience of nuclear power plant dismantling
- to verify the developed techniques in actual dismantling activities
- to collect data on JPDR dismantling activities

Dismantling Project Overview

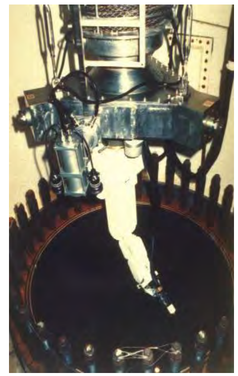
- Project period : Dec. 1986 - Mar. 1996
- Project cost : 23 billion yens (including R&D)
- Waste arising : 3,770 tons (Radioactive)
- Worker dose : 306 person-mSv

Decommissioning Database (1)

Plasma arc cutting is a thermal cutting method in which arc and plasma gas heat are produced by electrical current between arc node and object to be cut. By-product treatment is necessary for worker safety and proper waste management.



Mast Type Plasma Arc Cutting System



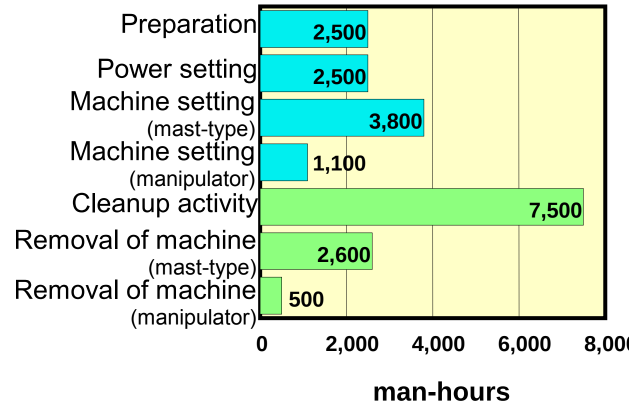
Slave arm (manipulator)

Mast-type remote handling machine

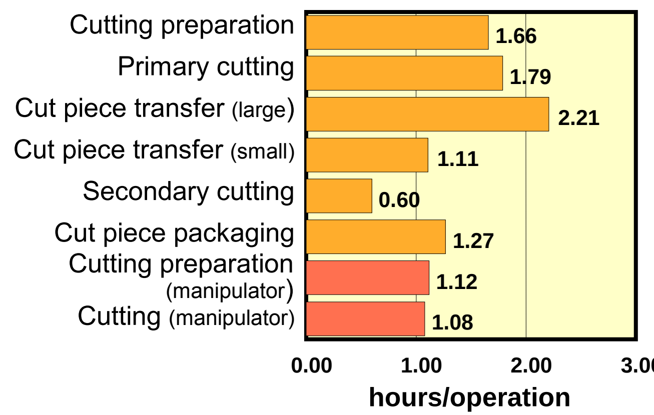
Cutting Capability (stainless steel)

- Max thickness 230mm, Cutting speed 50mm/min (in air)
- Max thickness 130mm, Cutting speed 75mm/min (underwate

Manpower Need



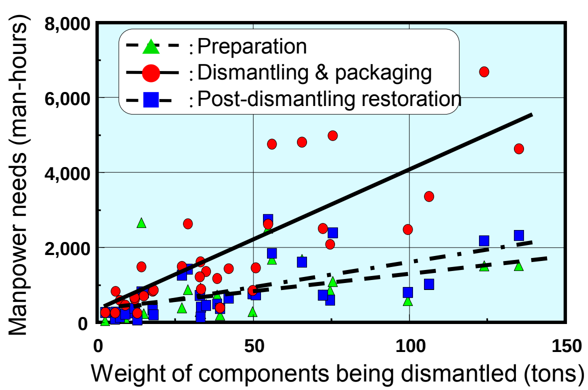
Unit Productivity Factors



Decommissioning Database (2)

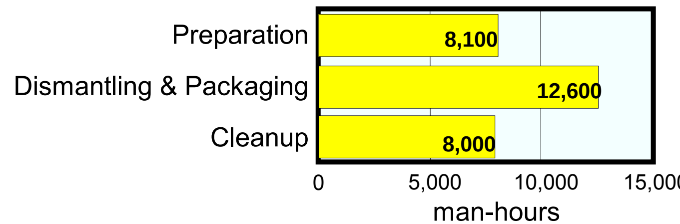
General facility components such as pumps, tanks and piping which have a small contamination, are dismantled by workers using conventional tools. These facility components are first removal from the original place by rough cutting. The cut pieces were transferred to conditional work place, where the pieces are further cut to be small segments for packaging. Mainly 200l drums are used for temporally storage together with $1m^3$ and $3m^3$ steel box additionally. The tools such as band saw, saver, high speed cutting, gas cutter, air plasma arc are applied in these dismantling work. Local ventilation systems and contamination control envelopes are used for preventing from being spread of contamination.

Cutting of pipe by rotary band saw

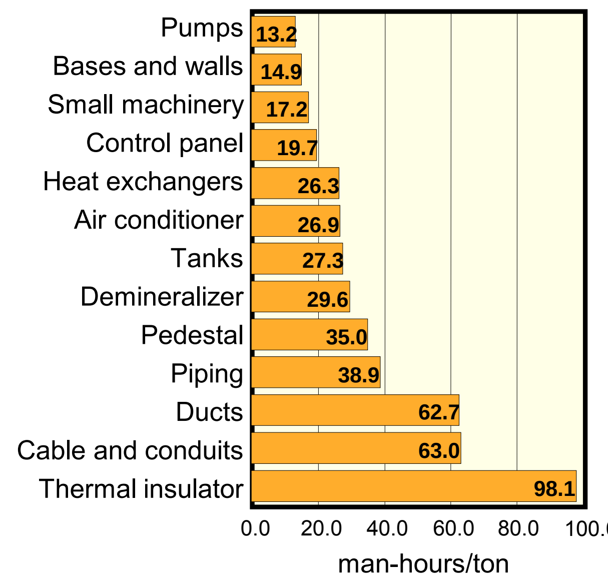


Relationship between manpower expenditure and weight of dismantled components

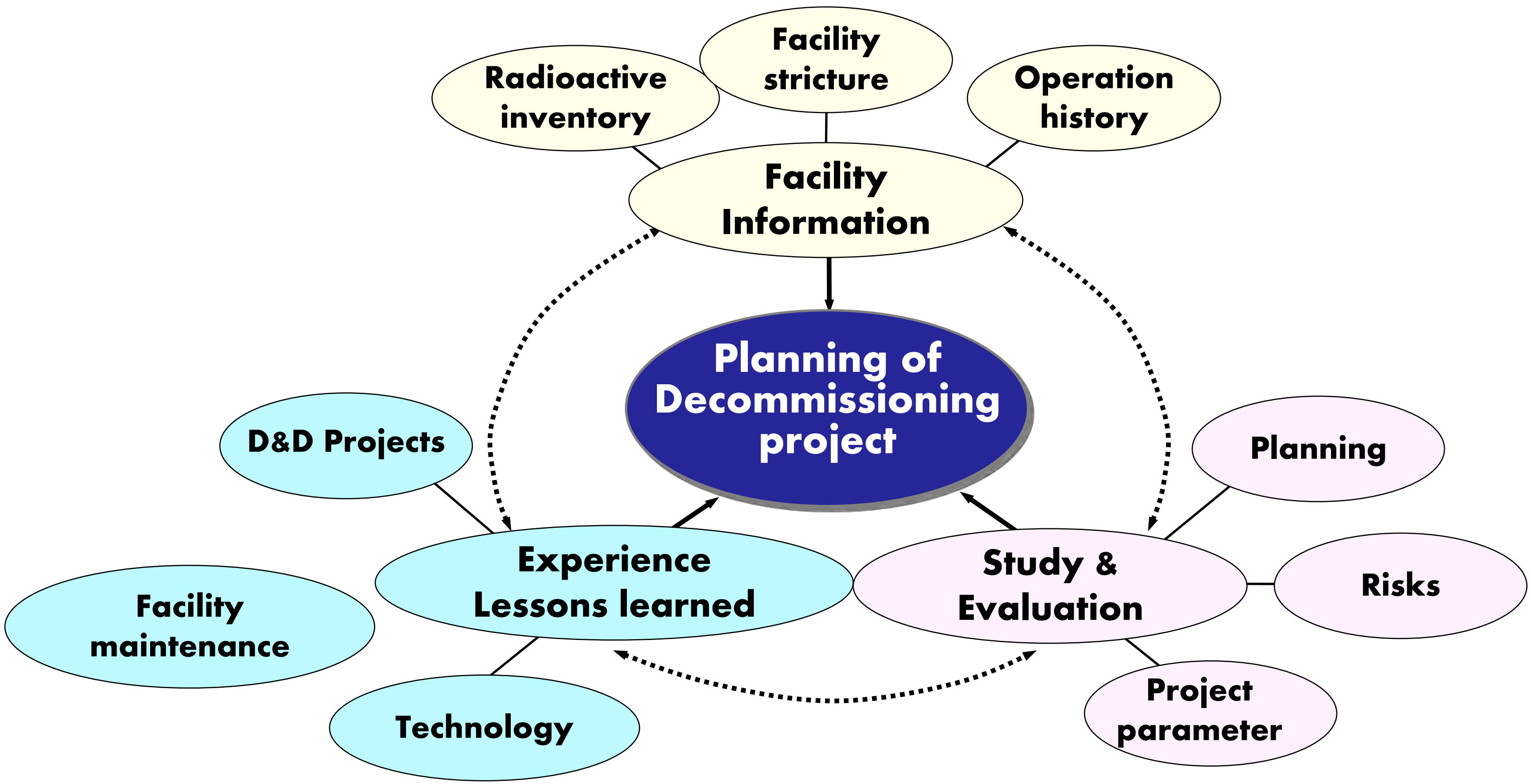
- **Manpower Need in dismantling facility components in Reactor, Turbine, Dump-condensor, Rad-waste Bldgs.**



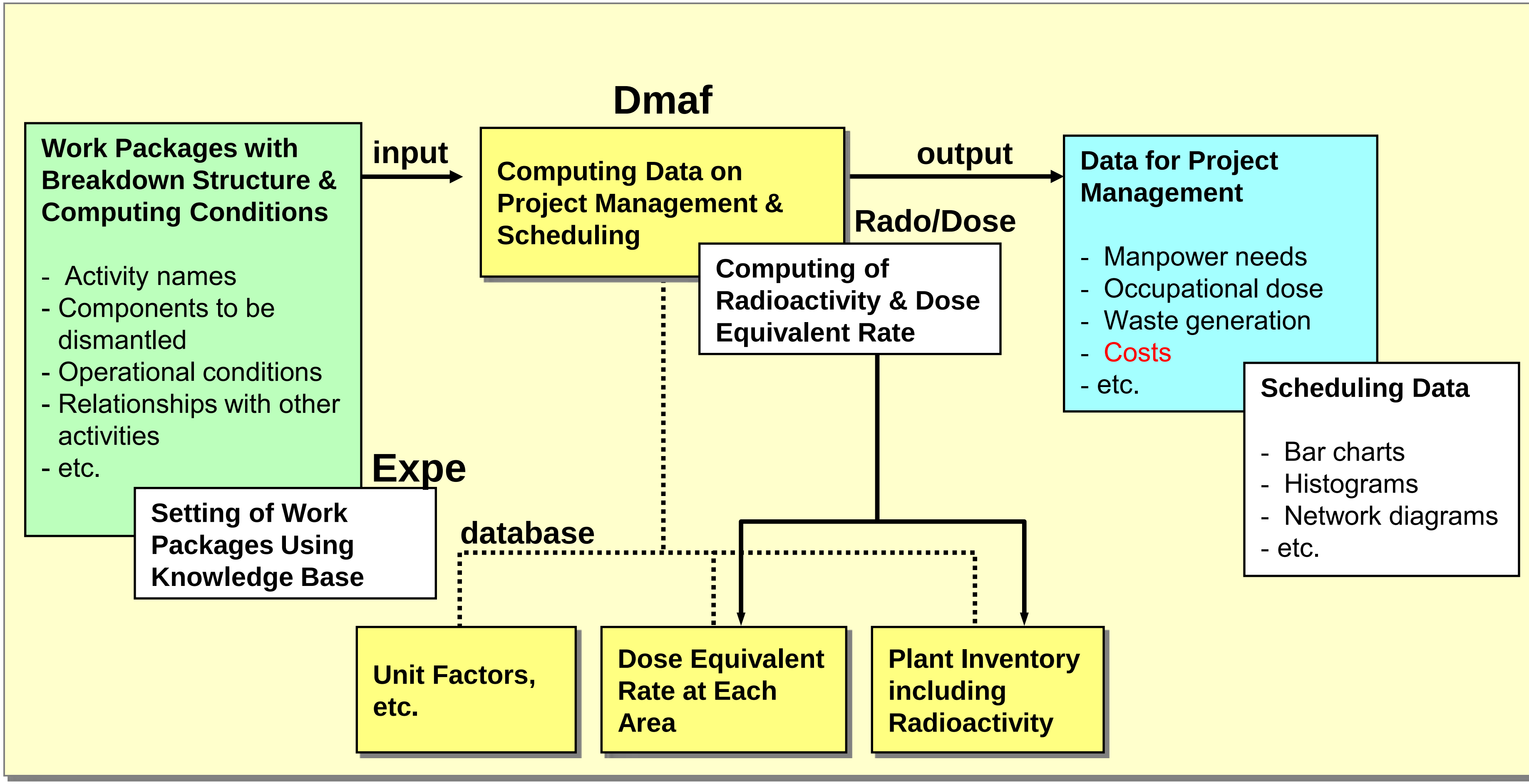
- **Unit Productivity Factors**



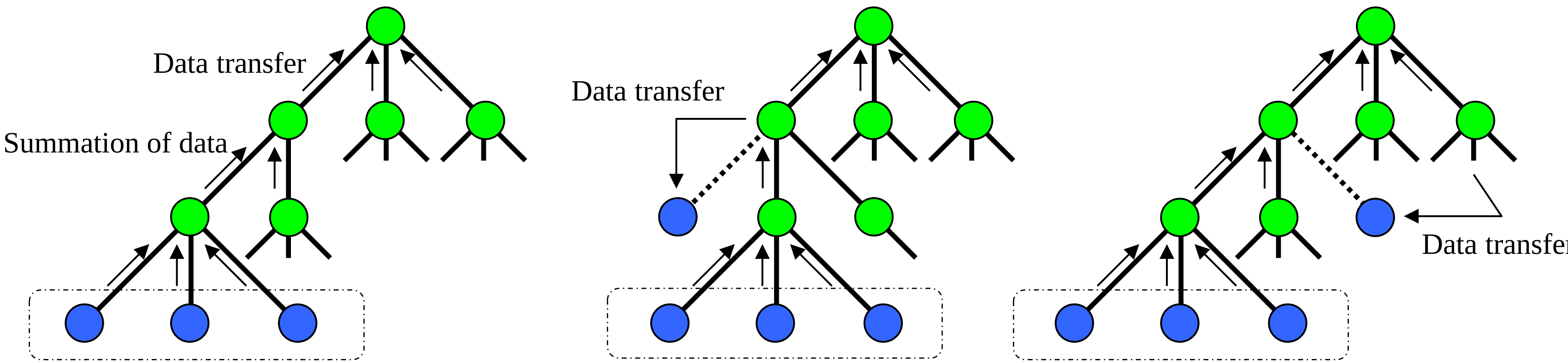
Development of Computer Systems for Planning and Management of Nuclear Decommissioning



Concept of COSMARD Calculations



Algorism of Evaluating Decommissioning Project Parameters



Setting work activities with simple calculation models

Step1
Calculated results were summed along with the work breakdown structure

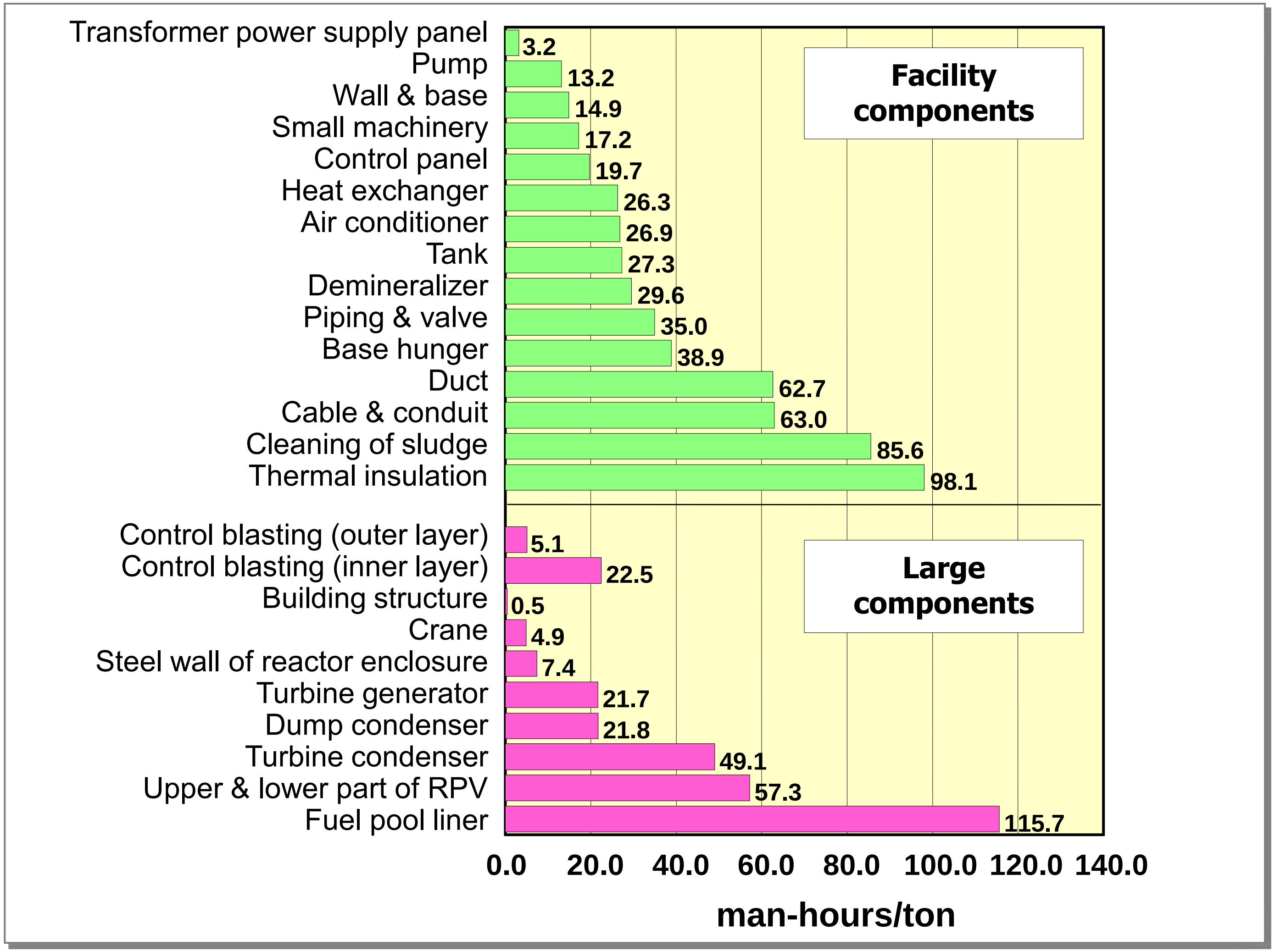
Step 2
After the summation of the results(Step1), the data are transferred from parent to other new activities

Step 3
After the summation of the results(Step1), the data are transferred to the other activities belonging to the family.

Unit Activities

Activities

Unit Productivity Factors of Hands-on Dismantling Activities



Cost Estimation Methodology
-Categorization of cost items-

Decommissioning cost is estimated in terms of cost categories considering their characteristics. There are basically three types of cost categories:

- activity-dependent cost,
- period-dependent cost, and
- Collateral and special item costs.

Activity-dependent cost:

Those costs associated with performing hands-on decommissioning activities. Examples of such activities include decontamination, removal of equipment, and waste packaging, shipping, and burial. These activities lend themselves to the use of unit cost and work productivity factors(or work difficulty factors) applied to the plant and structure inventories to develop the decommissioning cost and schedule.

Categories for Cost Estimation

Period-dependent cost:

Those costs include activities associated with the project duration: engineering, project management, dismantling management, licensing, health and safety, security, energy, and quality assurance. These are primarily management staffing level costs, developed by estimating the manpower loading and associated overhead costs based on the scope of work to be accomplished during individual phases within each period of the project.

Collateral and special item costs:

Those are costs for special items, such as construction or dismantling equipment, site preparation, insurance, property taxes, health physics supplies, processing liquid waste, and independent verification surveys. Such items do not fall in either of the other categories.

Standard Cost Items(I)

The working group of OECD/NEA studied first the decommissioning cost. Cost items(213) are identified in hierarchy form.

Level 1

- Pre-decommissioning actions
- Facility shutdown activities
- Procurement of general equipment and material
- Dismantling activities
- Waste processing, storage and disposal
- Site security, surveillance and maintenance
- Site restoration, cleanup and landscaping
- Project management, engineering and site support
- Research and development
- Fuel and nuclear material
- Other costs

Cost Groups include the followings:

- Labor costs
- Capital, equipment and material costs
- Expenses
- Contingency

Standard Cost Items(II)

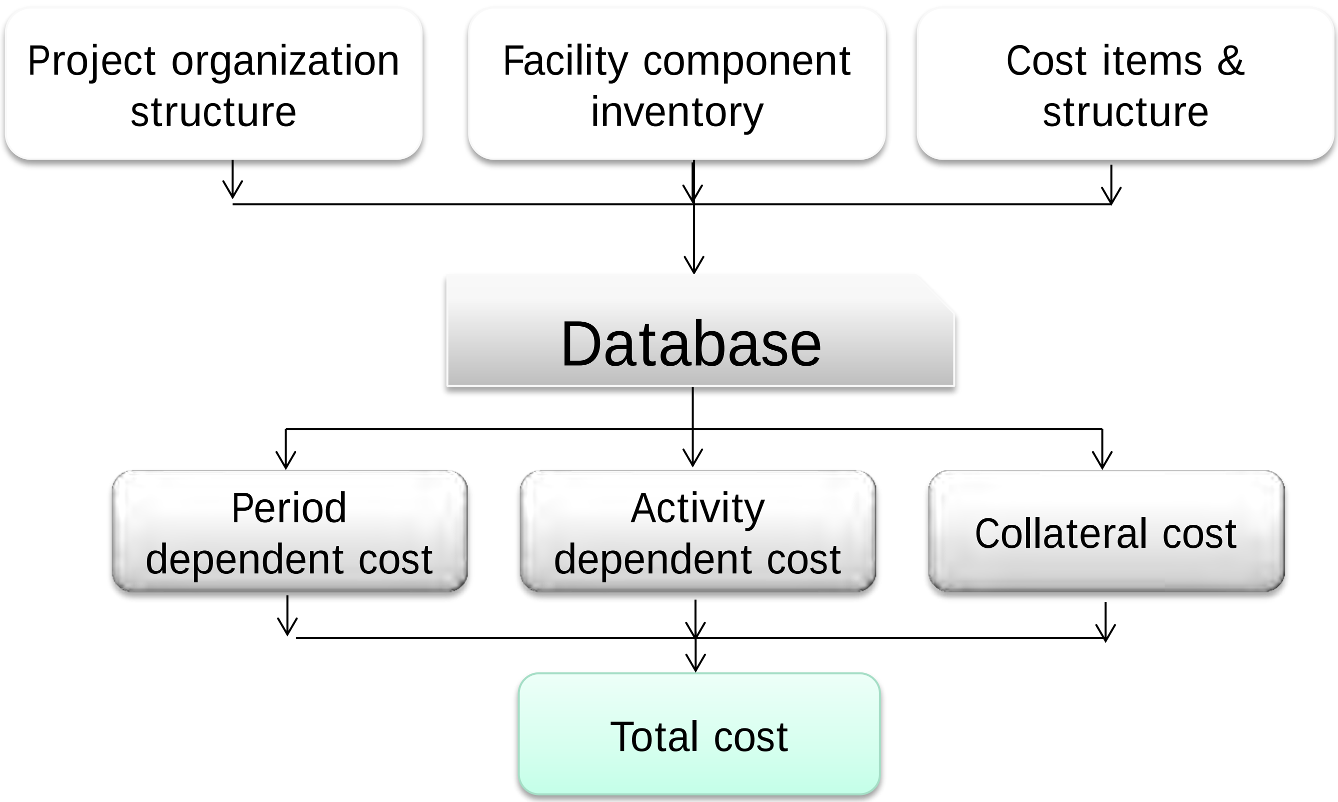
Level 2 Dismantling activities

- Decontamination of areas and equipment in all buildings to facilitate dismantling
- Drainage of spent-fuel pool and decontamination of linings
- Preparation for dormancy
- Dismantling and transfer of contaminated equipment and material to containment structure for long-term storage
- Sampling for radiological inventory characterization in the installation after zoning
- Site reconfiguration, isolating and securing structures
- Facility (controlled area) hardening, isolation or entombment
- Radiological inventory categorization for decommissioning and decontamination
- Preparation of temporary waste storage area
- Removal of fuel-handling equipment
- Design, procurement and testing of special tooling/equipment for remote dismantling

Construction of work breakdown structure by using command type input description

AAA	**：Activity(Work) name**
JNUM=jjj	**：Comments (Japanese)**
ENAM=ccc	**：Comments (English)**
METH=mmm	**：Selection of Technology**
TARG=ttt	**：Selection of components to be dismantled**
PERM=ppp	**：Setting of Parameters**
SUBF=sss	**：Setting of lower activities**
PATM=xxx	**：Setting of breakdown pattern**
#comment	**：Comments**

Calculation Flow for Cost Estimation
-Case Study : JPDR Decommissioning Project-



Input Data for JPDR Decommissioning Project Cost Estimation

```
JPDR費用
SUBF=廃止措置の前処置                      /PARM=期間=3      ;_#01
      施設停止作業                        /PARM=期間=1.5    ;_#02
      安全貯蔵の準備                      /PARM=期間=2.5    ;_#03
      管理区域の解体作業                  /PARM=期間=10     ;_#04
      廃棄物の処理・貯蔵・処分            /PARM=期間=10     ;_#05
      サイトの基盤と運転                  /PARM=期間=10     ;_#06
      従来型解体・取壊・サイト修復        /PARM=期間=2      ;_#07
      プロジェクト管理・設計・支援        /PARM=期間=10     ;_#08
      研究開発                            /PARM=期間=5      ;_#09
      燃料と核物質                        /PARM=期間=2      ;_#10
     その他の費用                         /PARM=期間=15       #11
```

```
#01
廃止措置の前処置                     #  準備期間 :3年
 SUBF=廃止措置計画の作成;              _#01.0100
     政策の研究;                       _#01.0200
     許認可;                           _#01.0200
     計画と認可のための放射能評価;     _#01.0300
     有害物質の調査と分析;             _#01.0400
     主契約者の選択                     #01.0500
```

Cost item structure

OutPut Data

Unit：MYen

CNT	ACT.NAME	全費用	期間依存費用	作業依存費用	付随型費用
1	JPDR費用	2.40E+04	8.13E+03	3.87E+03	1.06E+04
2	廃止措置の前処置	3.85E+02	3.70E+02	0.00E+00	0.00E+00
3	施設停止作業	3.70E+02	3.70E+02	0.00E+00	0.00E+00
4	安全貯蔵の準備	8.30E+02	1.98E+02	0.00E+00	6.32E+02
5	管理区域の解体作業	8.46E+03	2.49E+03	3.69E+03	1.88E+03
6	廃棄物の処理・貯蔵・処分	3.29E+03	9.77E+02	0.00E+00	2.31E+03
7	サイトの基盤と運転	2.32E+03	1.78E+03	0.00E+00	4.00E+01
8	従来型解体・取壊・サイト修復	2.44E+02	1.32E+02	1.12E+02	0.00E+00
9	プロジェクト管理・設計・支援	6.77E+02	3.17E+02	0.00E+00	0.00E+00
10	研究開発	4.85E+03	1.16E+03	0.00E+00	3.58E+03
11	燃料と核物質	2.37E+03	2.11E+02	0.00E+00	2.16E+03
12	その他の費用	1.84E+02	1.19E+02	6.50E+01	0.00E+00

Summary

- Decommissioning cost of nuclear power plants has been evaluated for establishment of funding mechanism based on the standard procedure of dismantling NPPs.
- The methodology and computer systems were developed in the JPDR decommissioning project; the unit activity factors developed in the project were applied for evaluation of the cost.
- The study is underway to evaluate optimum decommissioning scenarios by using the unit activity factors and computer code in University of Fukui.

附件三：**Key issues of decommissioning**

ANDES The association for nuclear decommissioning study

Tadamichi Satoh secretary-general , ANDES

Nov.12 2013 @Tokyo
Taiwan/Japan Technical Meeting on Decommissioning of NPP

Key issues of decommissioning

1. Decision-making of facility closure taking many factors into account
2. Decommissioning Scenario/Timing of eventual decommissioning activities
3. Availability of SF Storage and waste disposal route
4. Securing the funds for decommissioning cost

Key issues of decommissioning

7. Combination of High-tech and Proven-tech by Field-oriented approach
8. International harmonization(Scenario, Clearance level, Site release criteria)
9. Human Resource Development for Decommissioning

Key issues of decommissioning

5. Differences from operating phase to decommissioning phase
   - Organization & staffing
     <Combination of Plant-knowledge, DD- expertise and Project management >
   - Regulation
   - Mind setting & Incentive
6. Relationship with local community
   - Employment, local taxes, subsidy
   - Public acceptance/Information & communication

Possible Reason for Plant Closure

- **Mission Complete:**
  Research & demonstration facilities
- **Economic factors:**
  '60s small capacity facilities
- **Technical issues:**
  Heavy burden for modification
- **Serious accident:**
  TMI, Chernobyl ,Fukushima
- **Political considerations:**
  Plants of Italy, Germany and Sweden etc.

附件四：**Overview of Hamaoka NPPs**

Chubu Electric Power

Welcome to Hamaoka NPS

November 13, 2013

Chubu Electric Power Co.,Inc.

中部電力

ようこそ浜岡原子力発電所へ

Table of Contents

- Overview of Hamaoka NPS
- Earthquake countermeasures at Hamaoka NPS
- Tsunami countermeasures at Hamaoka NPS
- Implementation of Additional Safety Measures for Hamaoka Nuclear Power Station Units 3 and 4 in accordance with New Regulatory Requirements

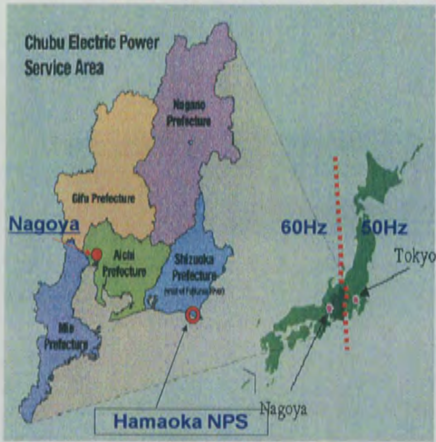
目次

- 浜岡原子力発電所の概要
- 地震対策
- 津波対策
- 浜岡3，4号機における新規制基準への対応

Overview of Hamaoka NPS

浜岡原子力発電所の概要

Outline of Chubu Electric Power Co.



- Service Area: 39,000 km^2
 =10.5% of the Japanese territory
- Population of Electric Service Area: 16 million
 =12.5% of Japan's total population)
- Generating Capacity: 34.03 GW(as of Mar. `13)
- Electric Energy Sales Volume : 126.6 TWh as of F.Y. 2012;Apr.'12- Mar.'13
- Number of employees : 17,345 as of Mar. `13

会社概要

- 供給区域
 : 39,000 km^2
 （全国の10.5%）
- 供給区域の人工
 : 約1,600万人
 （全国の12.5%）
- 発電設備
 : 34.03 GW(平成25年3月現在)
- 販売電力量
 : 126.6 TWh
 （平成24年度実績）
- 従業員数
 : 17,345人(平成25年3月現在)

Location of the Hamaoka Nuclear Power Statio

<Population>

- 4 local cities: Approx. 250k people
- 5 ex-towns (area inside the red line): Approx. 100k people

The safety agreement signed with the Shizuoka prefecture and 4 local cities.

浜岡原子力発電所の立地状況

周辺4市の人口：約25万人
旧5町の人口：約10万人

●静岡県および、御前崎市を始め、牧之原市・掛川市・菊川市と安全協定を結んでいます。

Overview of facilities at Hamaoka NPS

CHUBU Electric Power

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
Reactor type	BWR-4		BWR-5		ABWR
Thermal power (MWt)	1,593	2,436	3,293	3,293	3,926
Type of Primary Containment Vessel	Mark-1		Mark-1 modified		RCCV
Generating output (MWe)	(540)	(840)	1,100	1,137	1,380
Total power output (MWe)			3,617		
Construction commencement	March 1971	March 1974	November 1987	February 1989	March 1999
Operation commencement	March 1976	November 1978	August 1987	September 1993	January 2005
Current status	Decommissioning (Operation terminated on January 30, 2009		In outage (since November 29, 2010)	In outage* (since January 25, 2012)	In outage* (since March 22, 2012)
			Safety improvement measures being implemented		

*At the request of the Japanese government, all Units at the Hamaoka NPS halted operation as of May 2011. (Unit-4: May 13, 2011 Unit-5: May 14, 2011)

浜岡原子力発電所　設備概要

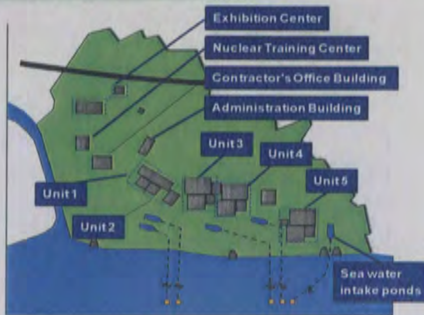
CHUBU Electric Power

	1号機	2号機	3号機	4号機	5号機
原子炉型式	BWR-4		BWR-5		ABWR
熱出力 (MWt)	1593	2436	3293	3293	3926
格納容器	Mark-1		Mark-1 改良型		RCCV
電気出力 (MWe)	(540)	(840)	1100	1137	1380
総電気出力 (MWe)			3617		
着　工	昭和４６年 （１９７１） ３月	昭和４９年 （１９７４） ３月	昭和５７年 （１９８２） １１月	平成元年 （１９８９） ２月	平成１１年 （１９９９） ３月
運転開始	昭和５１年 （１９７６） ３月	昭和５３年 （１９７８） １１月	昭和６２年 （１９８７） ８月	平成５年 （１９９３） ９月	平成１７年 （２００５） １月
現在の状況	廃止措置中 (H21.1.30運転終了)		定期検査中 (H22.11.29~)	定期検査中※ (H24.1.25~)	定期検査中※ (H24.3.22~)
			＜安　全　向　上　対　策　実　施　中＞		

※内閣総理大臣要請を受けて停止（4号機:H23．5．13　5号機:H23．5．14）

Layout of Hamaoka NPS

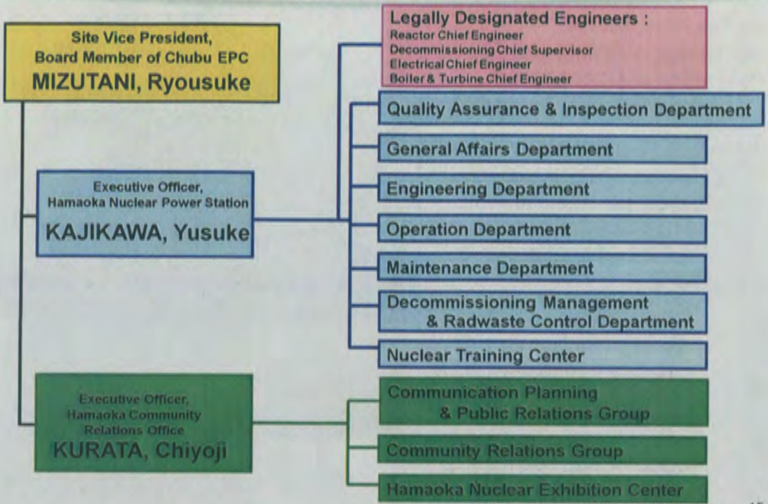
- Site Area: 1.6 km^2
- Number of Employees: 796
- Number of Contractor Personnel: 2,666 as of Oct 1 `13
- Unique Features
  - ➢ Hamaoka NPS is the only nuclear power station with no dedicated port access on the front side of the site in Japan.
    - *Large components are unloaded at Omaezaki Port, approx. 10km from the power station, and transported to the power station by tracks.*
  - ➢ Seawater for cooling systems is taken from intake towers, located 600 meters offshore.



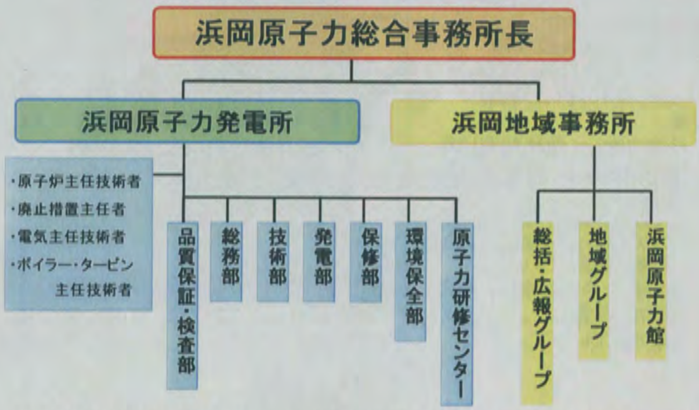
浜岡原子力発電所 敷地および配置

- 敷地面積: 1.6 km^2
- 中部電力従業員数: 796 → 不含外包人员
- 協力会社従業員数: 2,666
  (平成25年10月1日時点)
- 特徴
  - ➢ 日本で唯一、敷地前面に専用の港をもたない原子力発電所です。
    - *大型機器等は、発電所から約10km離れた御前崎港との間を陸上輸送しています。*
  - ➢ 蒸気を冷やす海水は、沖合600mに設置した、取水塔から取水しています。

Organization Chart of Hamaoka



浜岡原子力発電所　組織図



・1号機建設時の昭和46年から役員が常駐
・昭和56年に総合事務所長を配置

・平成24年7月1日より、原子力安全技術研究所（本店技術開発本部所属）を発電所構内に設置

Effort to improve safety of Hamaoka NPS

◆Responses to New Safety Regulations

- New safety regulations were introduced in July 2013.
- We have previously voluntarily introduced countermeasures for tsunami and severe accidents, but the new regulatory requirements have stipulated essential requirements that demand the consideration of further countermeasures and concrete responses. We have therefore proceeded with studies of these necessary responses.
- We have decided to implement additional measures in Units 3 and 4 in order to enhance functions including the ability to inject water into the reactors and to guarantee a power supply as measures to respond to earthquakes, tornados, fires, and severe accidents in September 2013.
- Studies of additional measures for Unit No. 5 are proceeding.

◆Earthquake Countermeasures

- We have voluntarily adopted a target earthquake resistance level of about 1,000 gals.
- We have conducted an evaluation of effects on the equipment and facilities essential for maintaining safety in Units 2-5 of Hamaoka Nuclear Power Station in their current state of shutdown based on this Cabinet Office model, and have verified that seismic safety will be maintained.
- We have decided on construction plans for earthquake countermeasures to be introduced to Hamaoka Units 3 and 4 based on Cabinet Office model in September 2013.

◆Tsunami Countermeasures

- In the wake of Fukushima Daiichi Accident, We have announced Tsunami countermeasures in July 2012 and enhancement such as raising of Tsunami Protection Wall in December 2012.

◆Accident Management Measures

- We have decided on implementing Accident Management Measures in December 2012. We are now installing several equipment such as filter vent system.

浜岡原子力発電所の安全性向上に向けた取り組み

◆新規制基準への対応

●新規制基準が平成25年7月に施行されました。
●当社は、これまで自主的に津波対策や重大事故(※1)対策に取り組んできていますが、新規制基準にできる限り速やかに適合することを目指し、必要な対応について順次検討を進めてまいりました。
● 3,4号機について、地震対策のほか、竜巻対策、火災対策および重大事故への対応としての注水機能強化、電源機能強化などの追加対策を平成25年9月にとりまとめました。
●5号機については、引き続き検討を進めます。

※1 重大事故:炉心の著しい損傷、使用済燃料プールに貯蔵する燃料の著しい損傷
シビアアクシデント:新規制基準では重大事故とされています。

◆地震対策

●目標地震動を1,000ガルとした耐震性の余裕を高める工事を自主的に実施しています。
●内閣府の「南海トラフの巨大地震モデル検討会」の検討結果を踏まえた地震動による発電所の耐震性を評価し、現状の停止状態において耐震安全性が確保されていることを確認しました。
●その後、新規制基準および内閣府の検討状況を踏まえて、具体的な工事対象施設や設計の検討を進め、3,4号機について工事計画を平成25年9月に取りまとめました。

◆津波対策

●福島第一原子力発電所事故の事象を踏まえ、平成23年7月に津波対策を公表しました。平成24年12月には防波壁の嵩上げ等の津波対策の強化の実施を決定し、順次津波対策工事を進めています。

◆重大事故対策

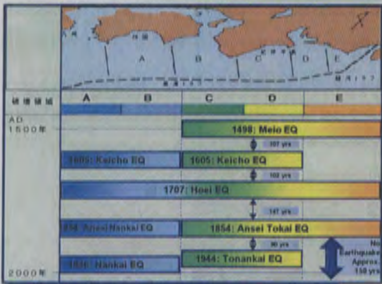
●平成24年12月に重大事故対策の実施を決定しました。現在、フィルタベント設備設置等の対策工事に着手しています。

Earthquake Countermeasures at Hamaoka NPS

地震対策

Situation of Earthquake in West Part of Japan

中部電力



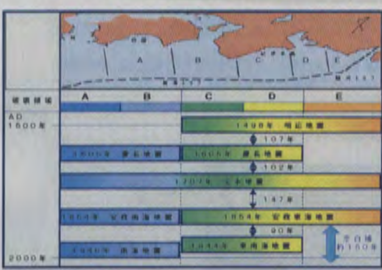
- At the Hamaoka NPS, we have been considering not only a possible Tokai earthquake as in the past, but also a magnitude 8.7 triple-interlocked earthquake that includes a Tokai earthquake as well as Tonankai and Nankai earthquakes to the west.
- The triple-interlocked Tokai/Tonankai/Nankai earthquake that we envision at the Hamaoka NPS would have maximum tremor strength of 800 gals in the bedrock.

Fukushima Daiichi NPS anticipated a potential earthquake centered off of Fukushima.Research shows that the devastating earthquake had a combined source area covering an extremely wide area from the coast of Sanriku to the coast of Ibaraki.

100~150年 周期 大地震

Situation of Earthquake in West Part of Japan

中部電力

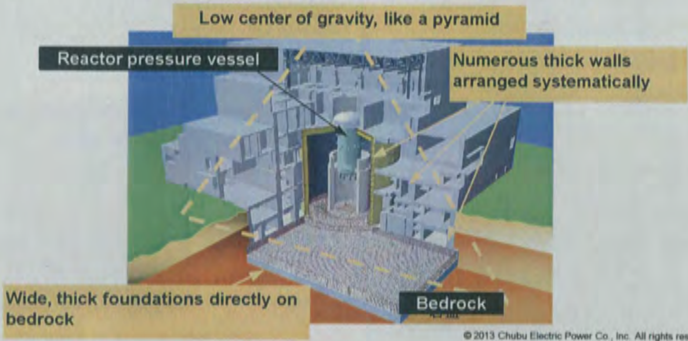


●浜岡原子力発電所は、想定東海地震はもとより、東海・東南海・南海地震の3連動によるマグニチュード8.7の地震も考慮しています。
●3連動地震による揺れとして、浜岡原子力発電所の岩盤上で最大で800ガルを考慮しています。

福島第一原子力発電所では、想定地震として福島の遠方を震源とする地震を考慮していました。
調査の結果、東北地方太平洋沖地震では、三陸海岸から茨城海岸を含む広大な範囲が連動し、破壊的な地震となったことが分かっています。

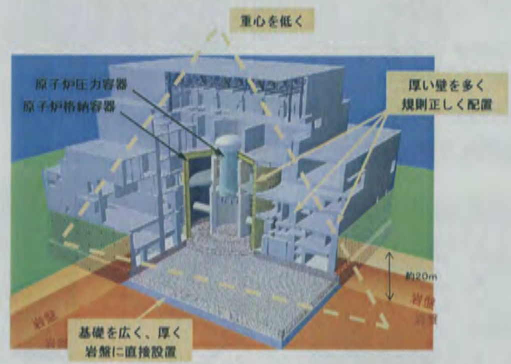
Seismic designs in Hamaoka NPS

- Reactor buildings are built to remain strong in earthquakes, with thick, wide foundations, numerous thick walls arranged systematically and a low center of gravity.
- Reactor buildings were built directly on solid bedrock by excavating down to a depth of approximately 20 m. It is known that tremors on hard bedrock are only about a third to half as strong as those at the surface.



浜岡原子力発電所の耐震上の配慮

・「基礎の面積を広く、厚く」「厚い壁を多く、規則正しく配置」「重心を下げる」など、地震の揺れに対し強い構造にしています。
・地面を20m程度掘り下げて、かたい岩盤に直接設置しています。一般的に、かたい岩盤での揺れは、表層地盤に比べ、2分の1から3分の1程度になるといわれています。



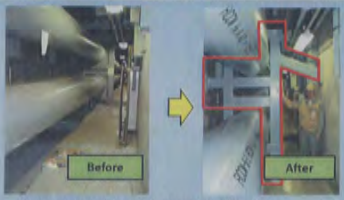
原子炉建屋のイメージ図

Examples of modifications for seismic margin enhancement

- For everyone's peace of mind, we have voluntarily adopted a target earthquake resistance level of about 1,000 gals.
- Specifically, these projects have modified or installed additional supports at approximately 5,000 points (including pipes and conduits inside reactor buildings), and surrounded exhaust stacks with supporting towers. These countermeasure projects were completed in March 2008.

Contents
Improvement of the ground around pipes and ducts
Stack modification
Piping and Electric circuit support modification
Refueling machine railway guide modification
Reactor building overhead crane support modification
Oil tank modification
Improvement of the ground behind the mound wall for intake pump room

Stack modification



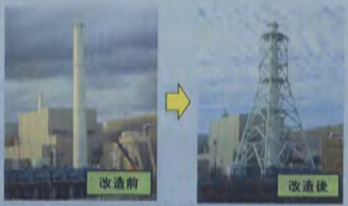
Piping and Electric circuit support modification

Because Reactor Vessel, Primary Containment Vessel, etc. have sufficient seismic margin, they are not necessary for the modification.

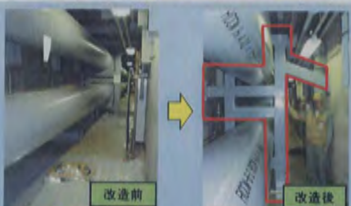
耐震裕度向上工事について

- 地域の皆様により安心して頂けるよう、耐震性を自主的に約1,000ガルまで向上させました。
- 主な追加工事は約5,000箇所にも上る配管サポート・電線管の補強、排気筒のサポートで、2008年3月に工事を完成させました。

耐震裕度向上工事の項目
配管ダクト周辺地盤改良工事
排気筒改造工事
配管・電路類サポート改造工事
燃料取替レールガイド改造工事
原子炉建屋天井クレーン支持部材改造工事
油タンク建替・改造工事
取水槽ポンプ室土留壁背後地盤改良工事



排気筒改造工事



配管・電路類サポート改造工事（合計約5, 000箇所）

原子炉の安全上重要な原子炉圧力容器、格納容器などは耐震性に十分な余裕があり、本工事は必要のないことを確認しています。

Tsunami Countermeasures at Hamaoka NPS

津波対策

Comprehensive Countermeasures for Tsunami

中部電力

Flooding Prevention Measures 1

Prevent tsunami from flooding the station site

Flooding Prevention Measures 2

Prevent flooding inside reactor buildings even if there is flooding on the station site

Enhanced Emergency Measures

Ensuring the cooling function will work even if there is a situation like that at Fukushima Daiichi, since there will be multiple alternative means of cooling the reactor.

Comprehensive Countermeasures for Tsunami

中部電力

浸水防止対策1

敷地内への浸水防止

浸水防止対策2

敷地内浸水時の建屋内への浸水防止

水密門

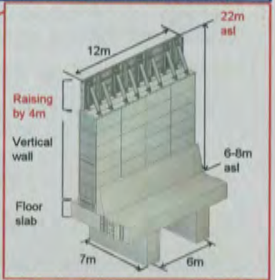
緊急時対策の強化

電源・注水・除熱の各機能に対し、多重化・多様化の観点から代替手段を講じることにより、福島第一原子力発電所と同様の事態に陥った場合においても、冷却機能を確保する。

Flooding Prevention Measures 1

Tsunami protection wall

- Tsunami protection wall: Approx. 1.6 km along the front of the station site.
- Tsunami protection wall will rise 22 m asl. This height was chosen based on a Nankai Trough Mega-quake.
- In contrast to a conventional sea wall or breakwater, the new tsunami protection wall combines reinforced concrete foundations embedded into the bedrock with an L-shaped wall consisting of structural steel and steel-framed reinforced concrete for high resistance to earthquakes and tsunami.



- The east and west sides of the power station will be protected from tsunami flooding by "cement-mixed soil embankments."
- These will rise from current 20 meters asl to 24 meters asl.

●Owing to Tsunami protection wall and embankment, flooding of Niino river will not affect on the plant site.
(embankment altitude of the site is more than 20m while the flood level is evaluated about 5m)

Installation of the wall with the height of 18m has been completed.
The height of this standard section of the Tsunami protection wall is to be raised to 22m asl.

浸水防止対策1

防波壁

- 発電所敷地前面に沿い、約1.6kmに亘る防波壁を設置しました。
- 南海トラフ巨大地震の試算に基づき、今後海抜22mまで嵩上げします。
- 一般的な堤防とは違い、この防波壁は鉄筋コンクリートの基礎を岩盤に埋め、鋼板と鉄筋コンクリートで構成した上部のL字構造と組み合わせることにより、高い耐震性と耐津波性を実現しました。

- 発電所の西側および東側は、セメントを混合した盛土によって津波浸水から保護します。
- 盛土高さは現状の20mから24mまで嵩上げします。

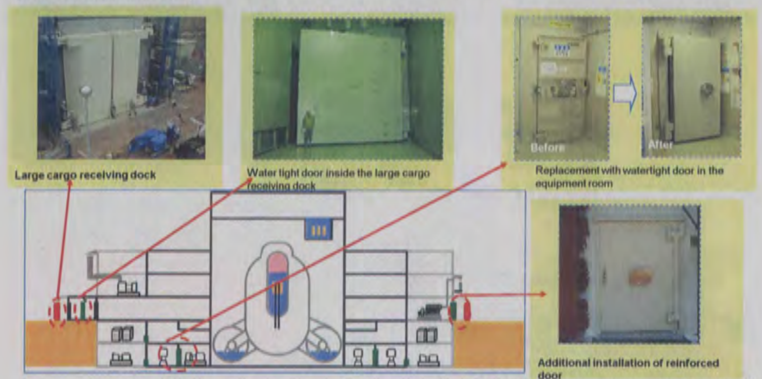
●盛土により、新野川の洪水からも保護されます。(盛土高さは海抜20m以上であるのに対し、洪水高さの評価値は5m程度です)

現在、海抜18m高さの壁部の据付が完了しました。
今後、海抜22mまで嵩上げします。

Flood Prevention Measures 2

Prevention of Flooding in Building

- Even if a tsunami overtops the tsunami protection wall or there is flooding on the station site for any other reason, these measures will protect safety-related equipment, such as emergency diesel generators located in reactor buildings.
- We are enhancing the pressure resistance and waterproofing of such points as the external wall doors of reactor buildings. External wall doors are being doubled: the inner door is watertight, and the tsunami protection door is built to resist wave impact. The tsunami protection door of the large cargo receiving dock is a double door that opens from the center. This allows it to be opened and closed more rapidly.



浸水防止対策2

建屋内浸水防止

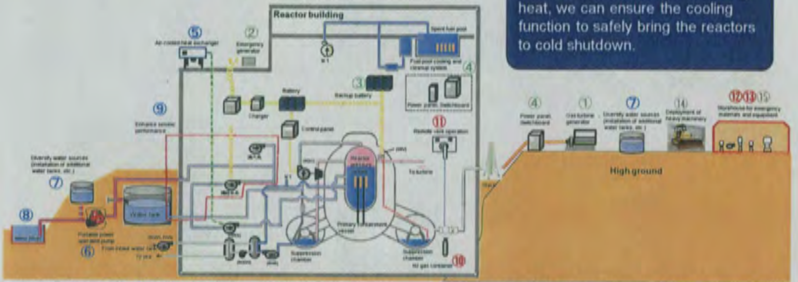
- 津波が防波壁を越波した場合等、敷地内が浸水した場合においても、非常用ディーゼル発電機をはじめとした重要機器を守ります。
- 例として、原子炉建屋外部扉等の扉の信頼性向上を実施しています。外部扉に関して言えば2重化し、外側には耐波圧扉を、内側には防水扉を設けることで耐津波性を確保しています。大物搬入口についても同様に2重化すると共に、観音開きとすることで開閉時間を短縮しています。

Enhancement of Power supply

(1) Power supply

①Install gas turbine generator on high ground & underground fuel tank
②Install emergency generators on reactor building rooftops
③Increase the capacity of batteries <so they can supply power for 24 hours>, & add spare batteries
④Install power panel and switchboard on upper floors or heights

Even if there is a situation like Fukushima Daiichi, where all AC power supply and reactor cooling function using seawater were lost, with multiple alternative means such as having multiple and diverse means of supplying electric power and injecting water; and having diverse means of removing heat, we can ensure the cooling function to safely bring the reactors to cold shutdown.

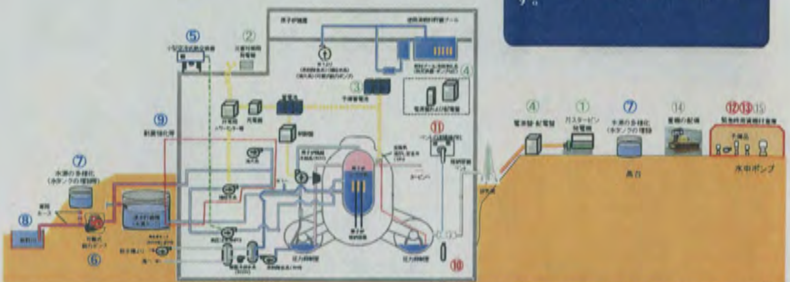


Ensuring the cooling function (underline stands for completed)

電源の強化

（1）電源設備対策
① ガスタービン発電機の高台設置
② 災害対策用発電機の建屋屋上への設置
③ 予備蓄電池の確保
④ 電源盤および配電盤の上層階または 高台への設置

仮に、福島第一原子力発電所のように交流電源や海水による冷却機能を喪失した場合においても、電源・注水・除熱の各機能に対し、多重化・多様化の観点から代替手段を講じることにより、原子炉を安全に冷温停止に導くための 機能を確保します。



Enhancement of Water Injection system

中部電力

(2) Water injection

⑤Secure alternative component cooling to operate HP coolant infection (air-cooled heat exchanger), etc.

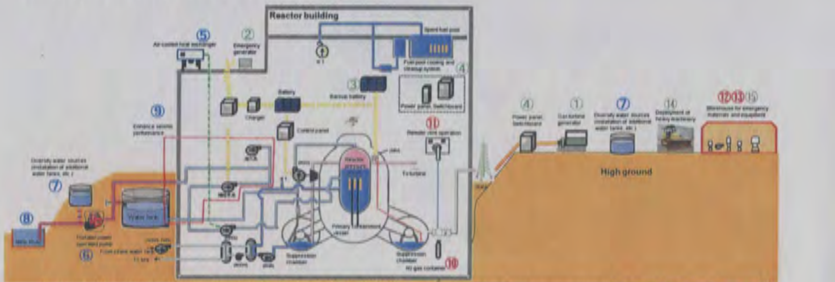
⑥Secure emergency portable high-capacity water supply pumps and portable power pumps

⑦Diversify water sources (installation of underground water tanks on high ground of 30 meters asl)

⑧Diversify intake water sources (water intake from the Niino River)

⑨Enhance seismic performance of makeup water system, etc. and switchboard on upper floors or heights

Ensure pumps and water are available and usable so that water can be injected into the reactor



Ensuring the cooling function (underline stands for completed)

注水機能の強化

中部電力

⑤ 高圧注水系を運転可能とするための
機器冷却の代替確保（空冷式熱交換器設置）
【電源はガスタービン発電機より供給】

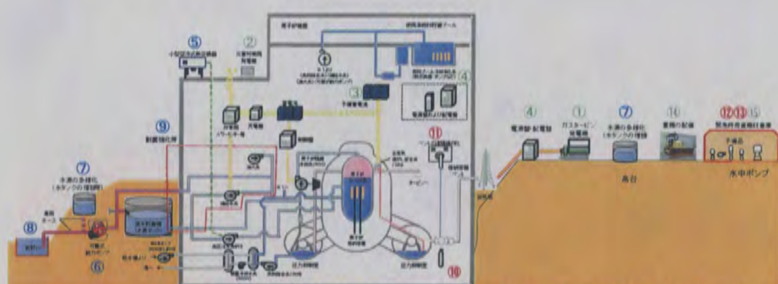
⑥ 可搬式動力ポンプによる水源の確保

⑦ 水源の多様化（水タンクの増設等）

⑧ 取水源の多様化（新野川からの取水）

⑨ 補給水系等の耐震強化、注水配管の追加設置

注水機能を確保するため、ポンプや水源を確保します。



Enhancement of heat removal system

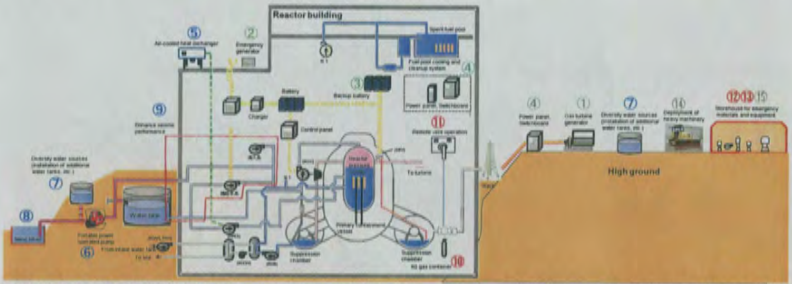
中部電力

(3) Heat removal

⑩Install N2 gas container for operation of containment vent valve
⑪Remote operation of PCV vent from a main control room
⑫Secure backup pumps (RCWS, RCCW, RHR) and motors
⑬Secure underwater pump (alternative to RCWS pump)

(4) Other

⑭Prepare heavy equipment such as bulldozer
⑮Install storehouse for emergency materials and equipment on high ground



Ensuring the cooling function (underline stands for completed)

除熱機能の強化

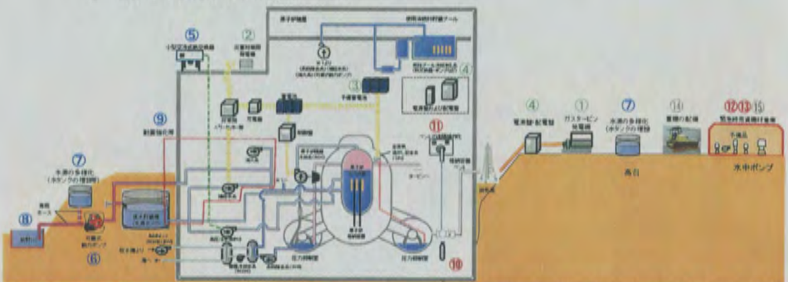
中部電力

除熱設備対策

⑩ 格納容器ベント弁操作用の窒素ボンベの設置
⑪ 格納容器ベントの遠隔操作化
⑫ 原子炉機器冷却海水系（RCWS）、原子炉機器冷却水系（RCCW）、余熱除去系（RHR）ポンプおよび電動機の予備品確保
⑬ 水中ポンプの確保（RCWSポンプの代替）

その他

⑭ ブルドーザー等の重機の配備
⑮ 緊急時用資機材倉庫の高台設置



Others

Measures for Early Recovery of Offsite Power

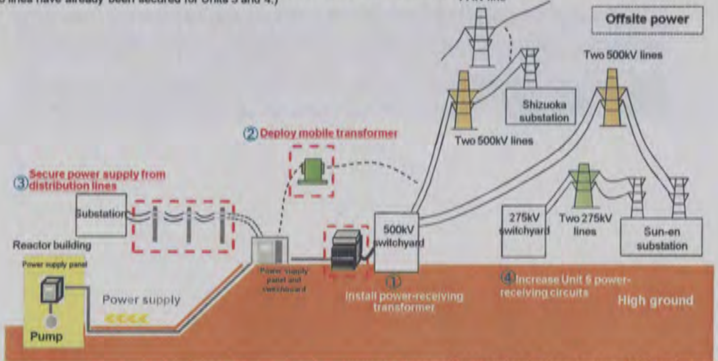
中部電力

① Installation of a power-receiving transformer on high ground level(500kV/6.9kV)
A power-receiving transformer was installed to supply a large amount of electricity required for long-term core cooling in case of inundation of the outdoor transformers due to tsunami, etc.

② Deployment of movable transformer on high ground level(77kV/6.9kV)
A mobile transformer was deployed in order to use 500kV transmission lines and receive 77kV.

③ Reinforcement of the power-receiving routes from the distribution lines
Distribution lines were installed to supply power from the off-site general high-voltage distribution lines to the emergency buses.

④ Increase of Unit 5 power-receiving circuits (from 4 to 6 circuits)
The circuits were increased in order to receive power from two 275kV lines in addition to four 500kV lines.
(6 lines have already been secured for Units 3 and 4.)



その他

外部電源の早期復旧対策

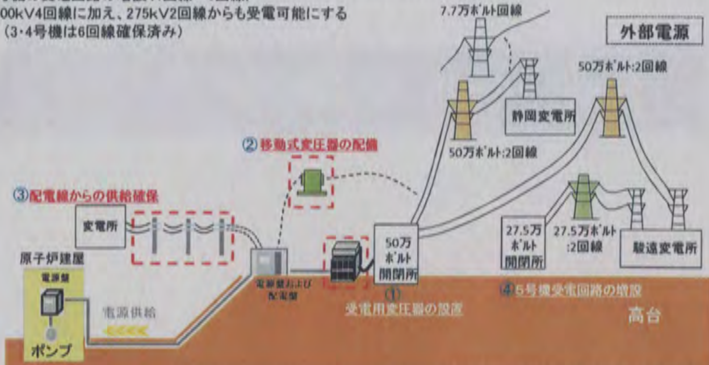
中部電力

①受電用変圧器の高台への設置（500kV／6.9kV）
屋外変圧器の津波等による浸水等に備え、長期炉心冷却に必要な大容量の電力を供給する受電用変圧器を設置

②移動式変圧器の高台への配備（77kV／6.9kV）
500kVの送電線を使用し、77kVを受電するために移動式変圧器を配備

③配電線からの受電ルート強化
発電所構外の一般高圧配電線から非常用母線へ電源を供給するための配電線を敷設

④5号機の受電回路の増設（4回線→6回線）
500kV4回線に加え、275kV2回線からも受電可能にする
（3･4号機は6回線確保済み）



Implementation of Additional Safety Measures for Hamaoka Nuclear Power Station Units 3 and 4 in accordance with New Regulatory Requirements

浜岡3，4号機における新規制基準への対応

Additional Safety Measures

[Previous Regulatory Requirements]

Seismic/tsunami resistance
Consideration of natural phenomena
Fire protection
Reliability of power supply
Function of other Structure, System, and Components (SSCs)

Accident management measures (Autonomous Chubu Electric Power measures)

* In the wake of the accident at Fukushima Daiichi Nuclear Power Station, existing design basis have been newly introduced and reinforced, and new standards (severe accident standards) have been added to respond to severe accidents exceeding the design basis.

Based on these essential requirements, Chubu Electric Power will implement the additional measures shown in the chart at the right.

[New Regulatory Requirements] **[Additional Measures to be Implemented 1-15]**

Design basis

[New Regulatory Requirements]	[Additional Measures to be Implemented 1-15]
Seismic/tsunami resistance	(1) Earthquake countermeasure Tsunami resistance measures
Consideration of natural phenomena (Specification of volcanic eruptions, tornados, and forest fires)	(2) Tornado resistance measures
Fire protection	(3) Fire resistance measures
Consideration of internal flooding	(4) Flooding resistance measures
Function of other SSCs*1	(5) Enhancement of reliability of static equipment (15) Other measures

Severe accident standards

[New Regulatory Requirements]	[Additional Measures to be Implemented 1-15]	
Measures to prevent core damage (postulate multiple failures)	(7) Reinforced water injection functions (8) Reinforced depressurization functions (9) Reinforced guarantee of power supply (10) Measures to respond to hydrogen inside filter vent equipment	(1)Earthquake countermeasure (6)Tsunami resistance measures (12) Reinforced of instrument functions (13) Reinforced of functions of emergency response center (14) Ensuring storage area& access routs
Measures to prevent containment vessel failure		
Measures to suppress radioactive materials dispersion	(11) Measures to control spread of radioactive substance outside facility	
Response to intentional aircraft crashes (specialized safety facility,* etc.)	→ Response is deferred for a five-year period following the formulation of the new regulatory requirements; we will proceed with studies in the future.	

新規制基準を踏まえた追加対策項目

【従来の規制基準】

耐震・耐津波性能
自然現象に対する考慮
火災に対する考慮
電源の信頼性
その他の設備の性能

アクシデントマネジメント策（当社の自主対策）

福島第一原子力発電所の事故を受け、従前の設計基準要求が強化されるとともに、設計基準を超えた事象に対する重大事故基準要求が新たに追加されました。

これらの要求事項を基に、中部電力では右に示す追加対策を実施することとしました。

【設計基準】

【新規制基準】	【実施予定の追加対策（1－15）】
耐震・耐津波性能	(1) 地震対策 津波対策
自然現象に対する考慮（火山・竜巻・森林火災を明記）	(2) 竜巻対策
火災に対する考慮	(3) 火災対策
内部溢水に対する考慮	(4) 溢水対策
その他の設備の性能	(5) 静的機器の信頼性強化 (15) その他対策

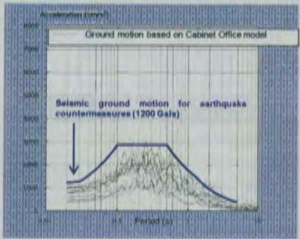
【重大事故基準】

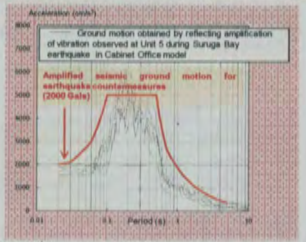
【新規制基準】	【実施予定の追加対策（1－15）】	
炉心損傷防止（複数の機器の故障を想定）	(7) 注水機能の強化 (8) 減圧機能の強化 (9) 電源の強化 (10) フィルターベント設備の水素対策	(1)地震対策 (6)津波対策 (12)計装機器の強化 (13)緊急時対策所機能の強化 (14)保管場所・アクセスルートの確保
格納容器損傷防止		
放射性物質の拡散抑制対策	(11) 建屋外部の放射性物質抑制策	
意図的な航空機衝突対応（特定重大事故等対処施設等）	→ 緊急時制御室などの特定重大事故等対処施設については、新規制基準施行後5年間について適用が猶予されており、今後検討してまいります。	

(1) Earthquake Countermeasure

Setting seismic ground motion for earthquake countermeasures

- We set the seismic ground motion for earthquake countermeasures based on the source fault model generating strong ground motion formulated by the Cabinet Office's Committee for Modeling a Nankai Trough Megaquake (termed the "Cabinet Office model" below).
- Specifically, based on the ground motion produced by the Cabinet Office model (a maximum figure of around 1,000 gals), we set a figure of 1,200 gals, exceeding the response spectra of the Cabinet Office figure, as our seismic ground motion for earthquake countermeasures. Similarly, based on the ground motion obtained by reflecting the amplification of vibration observed at Unit 5 during the Suruga Bay earthquake in the Cabinet Office model (a maximum figure of around 1,900 gals), we set a figure of 2,000 gals as our amplified seismic ground motion for earthquake countermeasures.



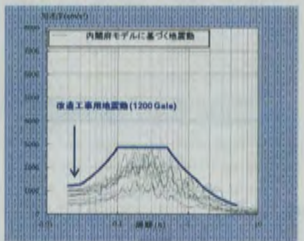


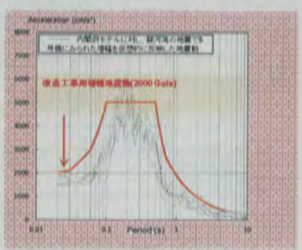
Response spectra

(1) 地震対策

改造工事用地震動の策定

・内閣府の「南海トラフの巨大地震モデル検討会」が想定した強震断層モデル（以下、内閣府モデル）を基に、改造工事用地震動を策定しました。
・内閣府モデルに基づく地震動は最大1,000ガル程度であり、そのスペクトル応答を超える地震動として「改造工事用地震動（1,200ガル）」を設定しました。
・また、5号機周辺においては、内閣府モデルに対し駿河湾の地震で5号機にみられた増幅を仮想的に反映した地震動（最大1,900ガル程度）を基に「改造工事用増幅地震動（2,000ガル）」を設定しました。





Response spectra

(1) Earthquake Countermeasure
Work to be performed

- We used the seismic ground motion for earthquake countermeasures (1,200 gals) to evaluate the requirement for conducting work on structures important to earthquake-resistant design.
- As a result of these considerations, we have decided to perform work including work to reinforce supports for pipes and electric circuits. In addition, taking into consideration records from seismic observation points within the grounds of the station, we have decided to perform work to reinforce facilities including the tsunami protection wall at Unit 5 and the Unit 4 water intake pond based on the amplified seismic ground motion for earthquake countermeasures (2,000 gals).
- We have verified that there is no necessity for the implementation of earthquake countermeasures in relation to main structures including the reactor buildings, the pressure vessels, and the containment vessels.

Nature of work to be performed	
Unit 3	Work to reinforce support for pipes and electric circuits
Unit 4	Work to reinforce support for pipes and electric circuits Work to reinforce ground around water intake pond
Shared facilities/area	Work to reinforce ground around tsunami protection wall Work to reinforce slopes within the station site

In future, we will move ahead with examination of concrete work plan for Unit 5.

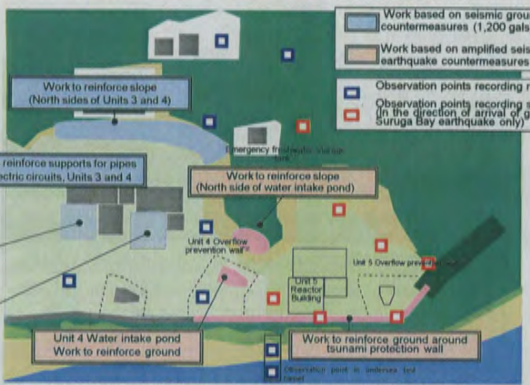
(1) 地震対策
地震対策工事の実施について

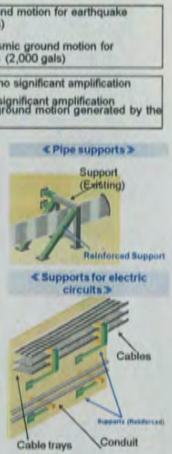
・耐震設計上重要な施設等(※)を対象に改造工事用地震動（1,200ガル）に対して工事の要否を検討しました。
・その結果、配管・電路類サポート等について工事を実施することとしました。また、敷地内の地震観測点の観測結果を踏まえ、5号機周辺の防波壁や4号機取水槽等については、改造工事用増幅地震動（2,000ガル）を用いて工事を実施することとしました。
・なお、原子炉建屋、圧力容器、格納容器などの主要施設については、改造工事が必要ないことを確認しています。

実施工事内容	
3号機	配管・電線管のサポート強化
4号機	配管・電線管のサポート強化 取水槽の地盤強化
共用施設	防波壁周辺の地盤強化 敷地内斜面の強化

5号機の工事内容については、今後、検討を進めてまいります。

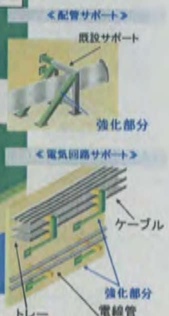
(1) Earthquake Countermeasure
Concrete details of the construction work





*We will ensure earthquake resistance up to 2,000 gals, the amplified seismic ground motion figure for earthquake countermeasures, in the overflow prevention walls and emergency freshwater storage tanks at Units 4 and 5.

(1) 地震対策
地震対策の具体例



※　4,5号機溢水防止壁および緊急時淡水貯槽については「改造工事用増幅地震動(2000ガル)」に対する耐震性を確保します。

(2) Tornado Resistance Measures

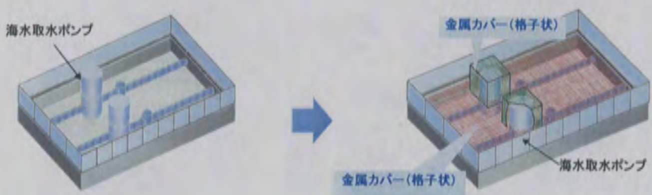
Outdoor seawater pumps and the pipes close to the pumps are designed with consideration of historically occurring strong winds/tyhoon. In order to ensure that functions essential to safety are maintained even in the event that a tornado strikes, we will take further measures to protect the facilities against impact by objects that might be caught up in a tornado

(2)竜巻対策

●竜巻対策

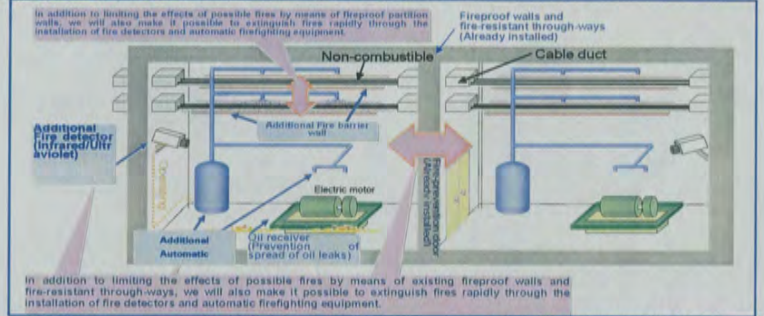
◆竜巻襲来時においても安全上重要な機能を損なわないように、屋外に設置されている海水取水ポンプおよび同ポンプ周辺の配管に対して、これまでの風（台風）を考慮した設計に加え、竜巻による飛来物の防護対策等を実施します。

【施工例】



(3) Fire Resistance Measures

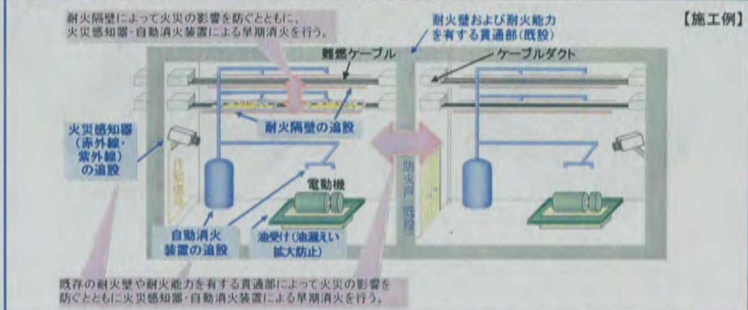
In order to ensure the maintenance of functions essential to safety, station facilities are designed to be protected against fire, for example through the use of fire barrier walls, fire-prevention doors, fire prevention dampers and other measures to partition areas, in addition to the use of non-combustible cables. These measures ensure the safety of the reactor facilities.
As further fire prevention and response measures, we will be installing additional fire detectors and firefighting equipment, implementing measures to prevent the spread of oil leaks from equipment containing oil, and installing additional fire-proof walls, among other equipment-based measures, in order to prevent the occurrence of fires and to increase our ability to detect and extinguish fires rapidly and to mitigate their effect in the event that they do occur.



(3) 火災対策

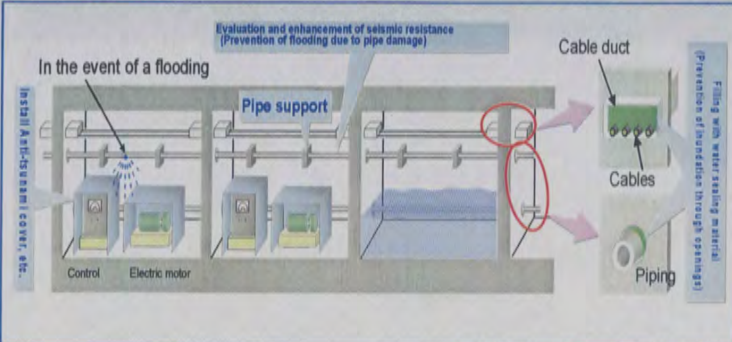
●火災対策

◆従来から、安全上重要な機能を損なわないように、耐火壁、防火戸、防火ダンパ等による区分分離および難燃ケーブルの使用等による火災防護設計をおこない、原子炉施設の安全性の確保を図ってきました。
　今回、さらなる火災対策として、油内包機器からの漏えい拡大防止、火災感知器・自動消火装置の追設、耐火隔壁の追設等の設備対策をおこない、火災の発生防止、火災の早期感知と消火、および影響軽減機能を強化します。



(4) Flooding Resistance Measure

Facility design incorporates measures such as the positioning of vital equipment inside rooms protected by watertight doors in order to ensure that functions essential to safety are maintained even in the event of flooding due to damage to pipes, etc. In addition to adopting measures to prevent the infiltration of water into equipment through open sections, we will install waterproof covers, etc. We will also be implementing measures to prevent water containing radioactive materials from flowing outside buildings.

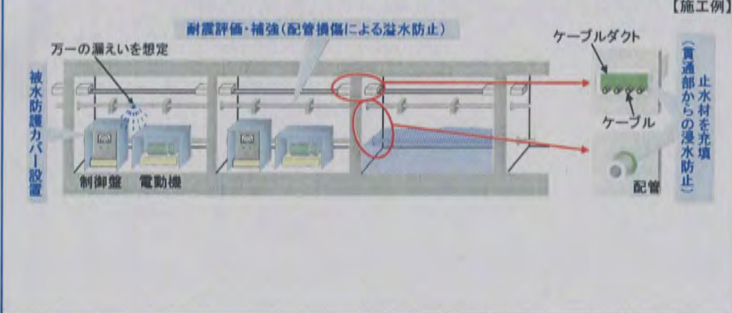


(4) 溢水対策

●溢水対策

◆配管の損傷等により溢水が発生した場合でも、安全上重要な機能を損なわないように、水密扉等で区画された室内に機器を設置する等の設計をしていますが、貫通部からの浸水防止対策の追加、被水防護カバーの設置等を実施します。また、放射性物質を含む溢水の建屋外への流出を防止する対策を実施します。

【施工例】



(5) Enhancement of Reliability of Static Equipment -Ensuring Availability of Back-up Filters

中部電力

We are seeking to further enhance the reliability of this equipment by enabling rapid responses in the event that a malfunction does occur.
We are therefore ensuring the availability of back-ups for the filter units in the stand-by gas treatment system (Unit 4) and the Main Control Room air-conditioning and ventilation system, which are essential to the maintenance of safety.

(5)静的機器の信頼性強化 予備フィルタの確保

中部電力

●静的機器の信頼性強化(予備フィルタの確保)

◆安全上重要な機器である非常用ガス処理系(4号機)および中央制御室換気空調系のフィルタユニットについて予備フィルタを確保し、万一、故障した場合でも迅速な対応ができるようにします。

(6) Tsunami Resistance Measures

We have already introduced measures to prevent flooding within the station site such as the installation of a tsunami protection wall, and measures to prevent inundation of buildings up to a height of T.P.+15m. In order to increase safety and to prevent severe accidents or other major events, as part of our additional measures we will further enhance measures to prevent inundation of buildings, for example by introducing equipment to automatically close openings in buildings up to the height of the intermediate roofs of the reactor buildings (about T.P.+20m).

Flap gate：Equipment to automatically close openings in buildings

(6)津波対策

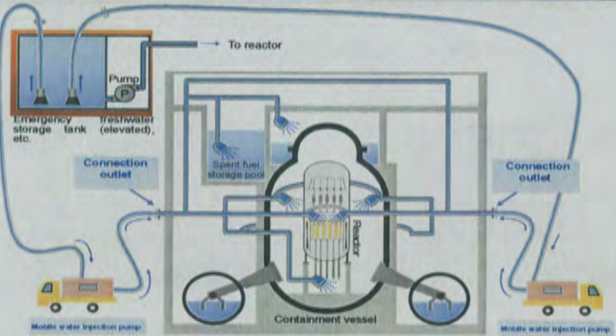
●津波対策

◆これまで、防波壁の設置等の敷地内浸水防止対策、高さT.P.+15mまでの建屋内浸水防止対策等を実施しています。今回、重大事故等の発生をより確実に防止するため、原子炉建屋中間屋上の高さ(T.P.+20m程度)までの建屋開口部に自動閉止装置を設置するなど建屋内浸水防止対策を強化します。

建屋開口部自動閉止装置のイメージ

(7) Enhanced Water Injection Performance

The facility is provided with multiple alternative water injection methods, including air-cooled heat exchangers to ensure that the high-pressure water injection system can be operated if the cooling functions of the reactors, containment vessels, and spent fuel storage pools are lost in the event of a severe accident or other major event. Seeking to further increase our ability to inject water into the reactors via movable equipment, as part of our additional measures we will be positioning additional mobile water injection pumps at each unit, and taking other measures including dispersed positioning of equipment, etc. the pump connection outlets outside the buildings and the water injection pipes inside the buildings.

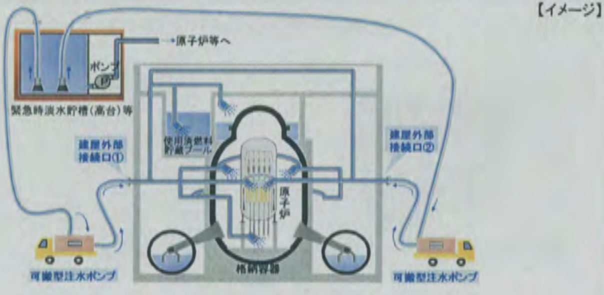


(7) 注水機能の強化

●注水機能強化

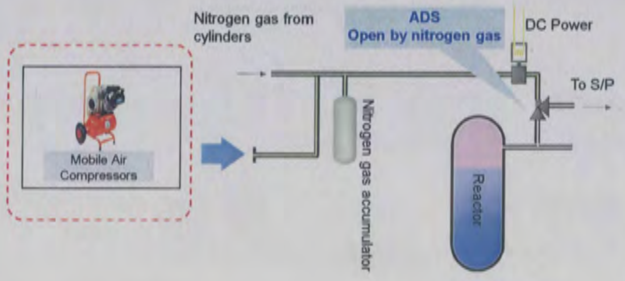
◆原子炉や格納容器、使用済燃料貯蔵プールの冷却機能が喪失した場合においても、高圧注水系を運転可能とするための空冷式熱交換器の設置など複数の代替注水手段を確保する対策を講じていますが、さらに、可搬設備による注水機能の強化を図るため、各号機に可搬型注水ポンプを追加配備するとともに、そのポンプを接続する建屋外部接続口の分散配置等の対策を実施します。

【イメージ】



(8) Enhanced Depressurization Performance

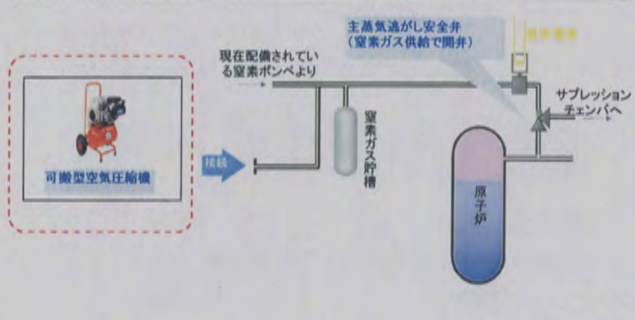
Reactor pressure vessels are depressurized by supplying nitrogen gas to the main steam safety relief valve and releasing valves. To provide a backup to the nitrogen cylinders, we will position additional mobile air compressors at each unit.



(8) 減圧機能の強化

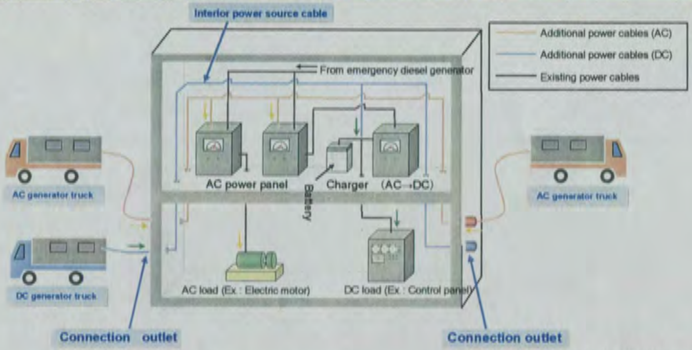
●減圧機能強化

◆原子炉圧力容器の減圧は、主蒸気逃がし安全弁に窒素ガスを供給し、弁を作動させることでおこないますが、現在配備されている窒素ボンベのバックアップとして、現場への可搬型空気圧縮機等の追加配備等を実施します。



(9) Enhanced Guarantee of Power Supply

The facility is supplied with multiple alternative power sources such as gas turbine generators positioned on high ground in the event that all AC power is lost. In order to provide a further guarantee of the availability of power sources using mobile equipment, we will position two AC and one DC generator trucks at each unit, and we will take measure dispersed positioning of relevant equipment including external connection outlets to connect the trucks and power supply cables inside the buildings.

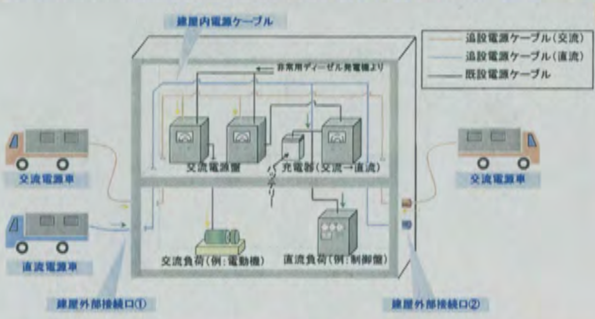


(9) 電源機能の強化

●電源機能強化

◆全交流電源が喪失した場合にも、高台に設置するガスタービン発電機など複数の代替電源供給手段を講じていますが、さらに、可搬設備による電源機能の強化を図るため、各号機に交流電源車および直流電源車を配備するとともに、その電源車を接続する建屋外部接続口の分散配置等を実施します。

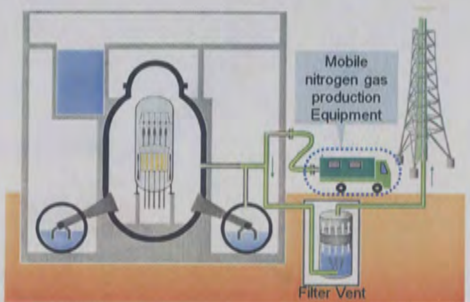
【イメージ】



(10) Venting of hydrogen by filter vent equipment

中部電力

Normally, the interior of the filter vent equipment is filled with nitrogen gas. We intend to make it possible by positioning of mobile nitrogen gas production equipment to refill the filter vent equipment with nitrogen gas after it has been used to discharge hydrogen gas produced in the containment vessel when the reactor core has been damaged.



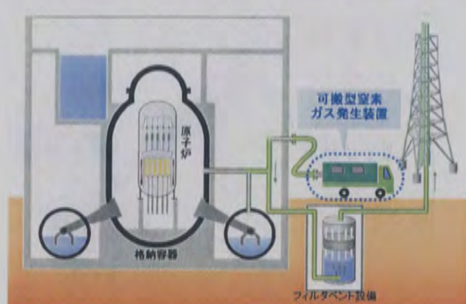
→ decrease to 0.1% dose

(10)フィルタベント設備の水素対策

中部電力

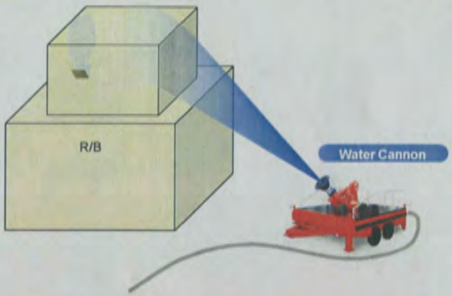
●フィルタベント設備の水素対策

◆通常時、フィルタベント設備内は窒素ガスで満たされていますが、炉心損傷時に発生した格納容器内の水素ガスをフィルタベント設備により排出した際、再度、同設備内を窒素ガスで満たすことができるように、可搬型窒素ガス発生装置等の配備等を実施します。



(11) Measures to Suppress Radioactive Materials Dispersion Outside the Facility

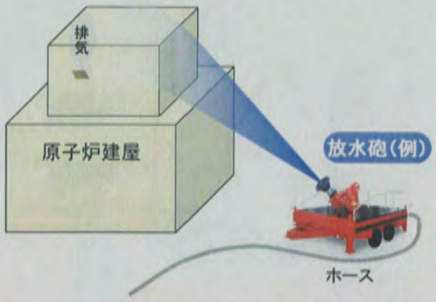
We will install water cannons and other equipment to control the spread of radioactive materials vented from the reactor buildings following a severe accident or other major event by spraying water on the buildings in order to cause the radioactive substances to fall to the ground.



(11)敷地外への放射性物質拡散抑制対策

●敷地外への放射性物質の拡散抑制対策

重大事故等が発生し、原子炉建屋ベント設備により排気する場合等においても、建屋に放水して放射性物質を地上に落とすための放水砲の配備等により、敷地外への拡散を抑制します。



(12)-(15) Others

中部電力

(12) Enhancement of performance of instruments

To ensure that it is possible to measure parameters that must be monitored following a severe accident or other major event, we already employ measures such as the use of separate dedicated power sources for critical instruments. We intend to implement further measures, including the use of metal-plated cables with high heat resistance for meters inside the containment vessels.

(13) Enhancement of functions of emergency response center

To ensure that essential personnel are able to spend long periods in the emergency response center even following a severe accident or other major event, we will take steps to increase radiation-shielding performance, for example by increasing the thickness of the walls of the center.

(14) Ensuring storage areas and access routes

We will ensure that the storage areas for movable equipment put in position as a measure to respond to severe accidents and other major events take natural phenomena such as earthquakes and tsunami into consideration. We will also ensure access routes.

(15) Others

We will install a seismic resistance data recording and storage system independently of the existing systems to make it possible to accurately record and store data concerning parameters that must be monitored even if an earthquake occurs. We will also implement measures including the installation of infrared cameras for monitoring outside buildings, to enable the personnel in the Main Control Room to remain aware of the external situation.

(12)-(15)その他

中部電力

計装機能強化

◆重大事故等が発生した場合においても、監視が必要なパラメータの計測が可能となるように、重要計器等への個別専用電源の配備等の対策を実施していますが、さらに、格納容器内の計器について耐熱性の高い金属被覆ケーブルへの交換等の対策を実施します。

緊急時対策所機能強化

◆重大事故等が発生した環境においても、緊急時対策所に、長期にわたって要員がとどまることができるよう、緊急時対策所の壁厚を増し、放射線の遮へい対策の強化等を実施します。

保管場所・アクセスルートの確保

◆重大事故等の対策として配備する可搬設備について、地震、津波等の自然現象等を考慮した保管場所を確保するとともに、アクセスルートを整備します。

その他の対策

◆地震発生時においても安全上重要な機能の状況把握に必要なパラメータが確実に記録・保存されるよう、耐震性を確保した記録・保存システムを既存のシステムから独立して設置します。また、屋外の状況を中央制御室で把握するための屋外監視用の赤外線カメラの設置等の対策を実施します。

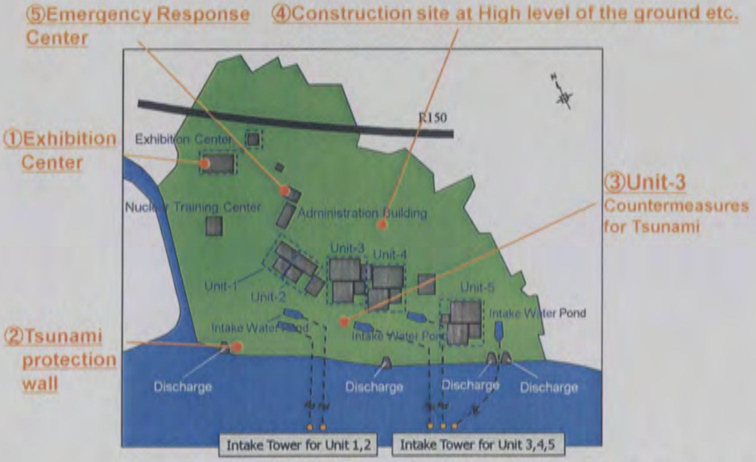
Schedule

13:00-14:00	Briefing of Unit-1,2 decommissioning
14:00-14:30	Briefing of Hamaoka NPS
14:30-15:00	Exhibition center
15:00-15:30	Construction site of Tsunami protection wall
15:30-16:00	Unit 3 - Countermeasures for Tsunami
16:00-16:20	Construction site at high level of the ground etc
16:20-16:40	Emergency Response Center
16:40-17:00	Questions and Answers

本日のスケジュール

13:00-14:00	廃止措置の概要説明
14:00-14:30	安全性向上対策の概要説明
14:30-15:00	原子力館 ご視察
15:00-15:30	防波壁設置工事 ご視察
15:30-16:00	3号機 津波対策工事 ご視察
16:00-16:20	高台工事現場 ご視察
16:20-16:40	緊急時対策所 ご視察
16:40-17:00	質疑応答

Inspection Site



本日のご視察場所

地震 → 津波 20min

→ 18 m accident
→ 22 m final

1400 億円