



KR9800031

**Technology Development and Demonstration
for TRIGA Research Reactor Decontamination,
Decommissioning and Site Restoration**

Prepared for the 1st Workshop for Radioactive Waste
Treatment Technology in Korea
on the 28th October, 1997

by

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I. Introduction to Research Reactor Decommissioning Plan at KAERI

Triga Mark II

- 100kW constructed in 1962
- 250kW upgraded in 1969
- shut down on Dec. 30, 1995

decom. Option

conversion to a historical museum

Triga Mark III

- 2MW in 1972
- shut down on Dec. 30, 1995

decom. Option

completely dismantling

The removal and shifting of TM II spent fuels to TM III carried out in 1996.

Most of the decommissioning works are expected to be completed by 1999.

- **Technical Description of Triga Mark II & III**

	<i>TRIGA MARK-II</i>	<i>TRIGA MARK-III</i>
<i>First Criticality</i>	1962. 3.	1972. 5.
<i>Shutdown</i>	1995. 1.	1995. 12.
<i>Type</i>	Open pool, Fixed core	Open pool, Movable core
<i>Max. Power</i>	250 KW _{th}	2 MW _{th}
<i>Max. Th. Neutron (n/cm³·sec)</i>	1×10^{13}	6×10^{13}
<i>Coolant</i>	H ₂ O	H ₂ O
<i>Moderator</i>	H ₂ O	H ₂ O
<i>Reflector</i>	Graphite	H ₂ O
<i>Fuel</i>	UZrH	ErUZrH
<i>Total Operating Hours</i>	36,000	55,000
<i>Total Generating Power (MWh)</i>	3,700	69,000

• **Decommissioning Schedule for Triga Mark II & III**

Activity	1997	1998	1999	2000
Milestones	Start Eng. ▼	Submit DP ▼	Start D&D ▼	Site Release ▼
1. Project management	[Horizontal bar spanning from 1997 to 2000]			
2. D&D Engineering	[Horizontal bar spanning from mid-1997 to mid-1998]			
3. Environmental Assessment	[Horizontal bar spanning from early 1997 to early 1998]			
4. License	[Horizontal bar spanning from mid-1998 to mid-1999]			
5. Decontamination & Dismantling	[Horizontal bar spanning from early 1999 to early 2000]			
6. Radwaste Management	[Horizontal bar spanning from early 1999 to early 2000]			
7. Radiation Protection	[Horizontal bar spanning from mid-1998 to mid-1999]			
8. Technology Development and Demonstration	[Horizontal bar spanning from early 1997 to early 1998]			

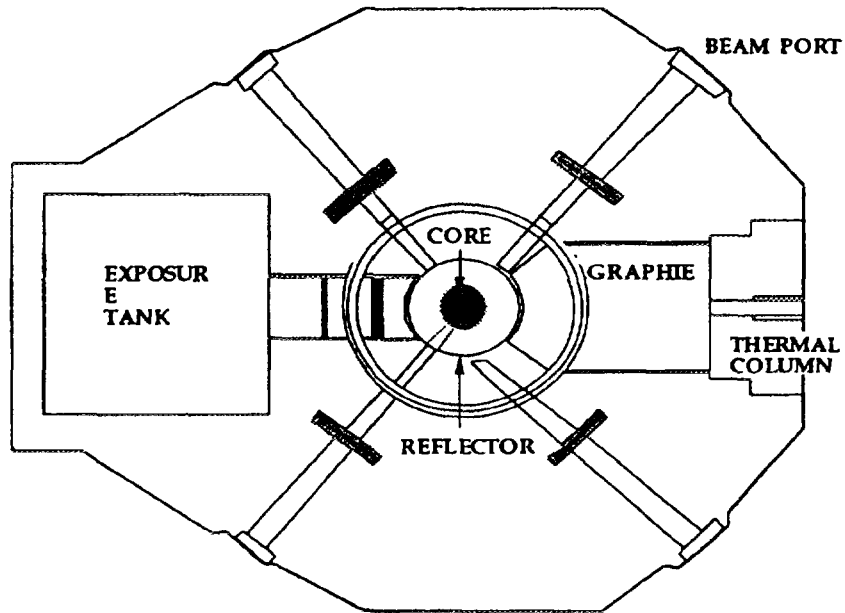
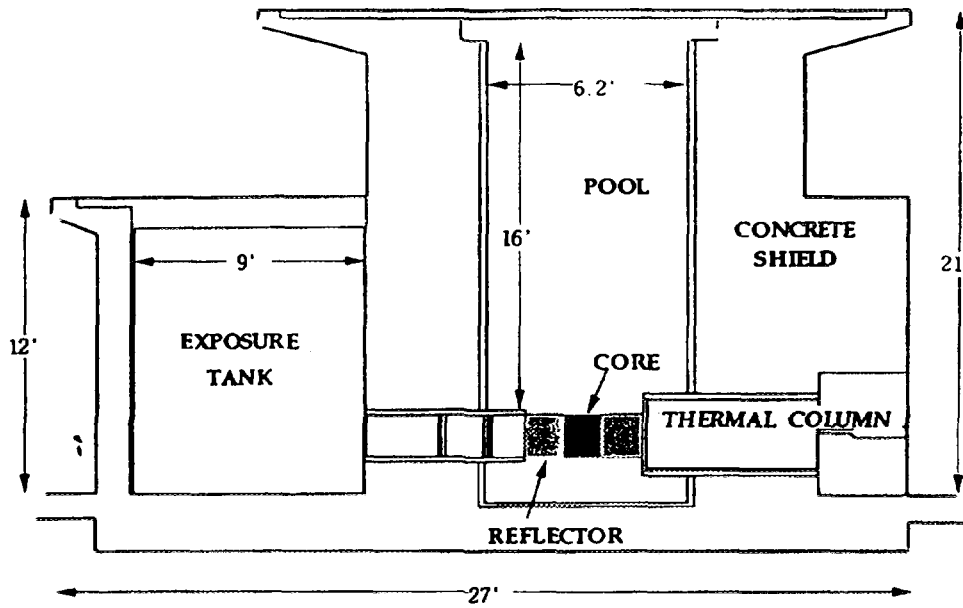


Figure. 1 TRIGA MARK-II 250KW

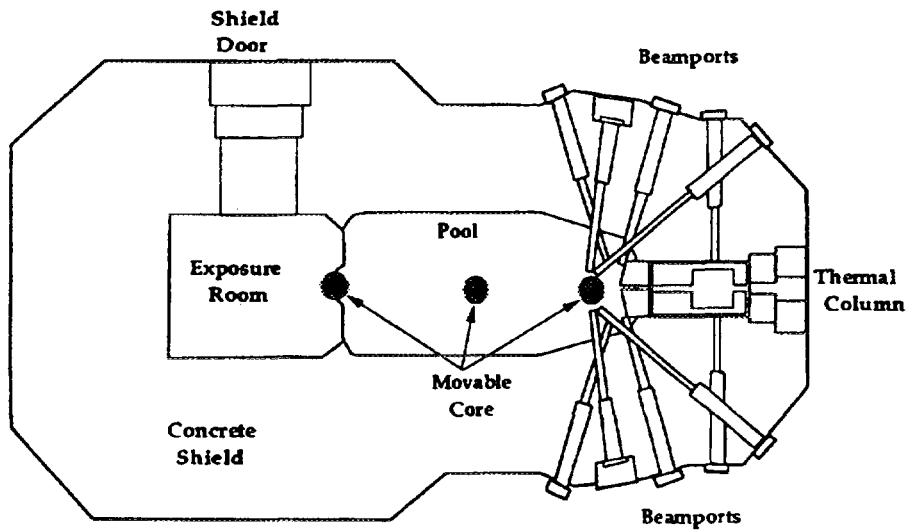
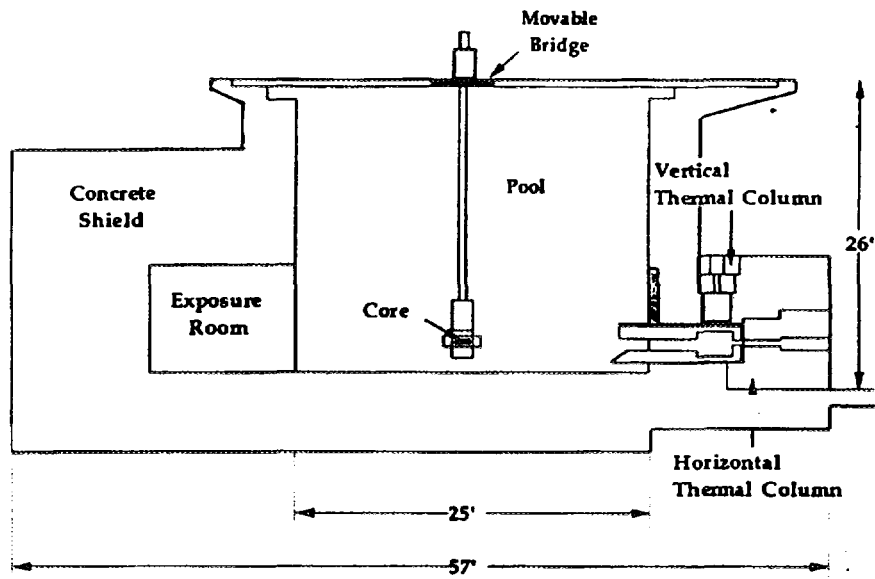


Figure.2 TRIGA MARK-III 2MW

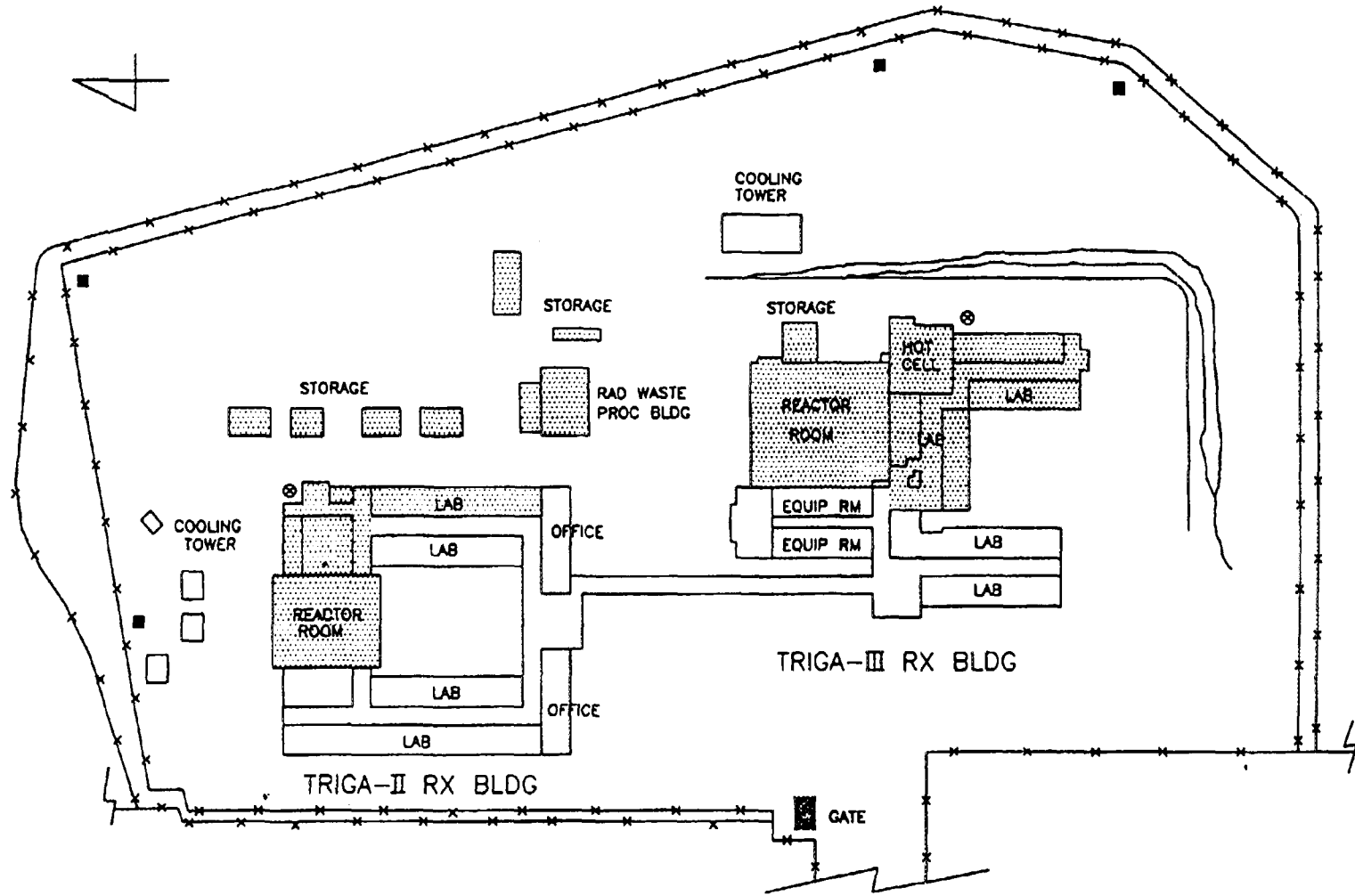


Figure.3 RESEARCH REACTOR SITE

II. Background of Technology Development & Demonstration

- 1) Decontamination, decommissioning, site restoration and waste treatment and reuse technologies has been developed at KAERI since the early of 1980s and TRIGA decommissioning is a good opportunity to test and demonstrate them.**

- 2) TRIGA decommissioning project is the last chance of large scale nuclear facility decommissioning to obtain the experiences and data bases before starting NPP decommissioning in Korea.**

- 3) Some of the following technologies are necessary to use for the TRIGA decommissioning:**
 - reactor coolant system decontamination for conversion of the TRIGA MARK II to a museum,**
 - incineration of combustible radwaste,**
 - metallic waste reuse,**
 - site evaluation and restoration,**
 - etc.**

III. Current Status of Technology Developments & Demonstrations

- System Decon. Technology for TRIGA Reactors**
- Concrete Decontamination and Dust Treatment Technologies**
- Wall ranging robot and Graphic Simulation of Dismantling Processes**
- Soil Decontamination and Restoration Technology for TRIGA Research Reactor Site**
- Recycling or Reuse Technologies for Radioactive Metallic Wastes**
- Incineration Technology Demonstration for Combustible Wastes**

System Decon. Technology for TRIGA Reactor

□ Goal

- Technology Development and Demonstration for the TRIGA MARK II Reactor coolant system Decontamination up to a level of release to a historical museum

□ Work scope

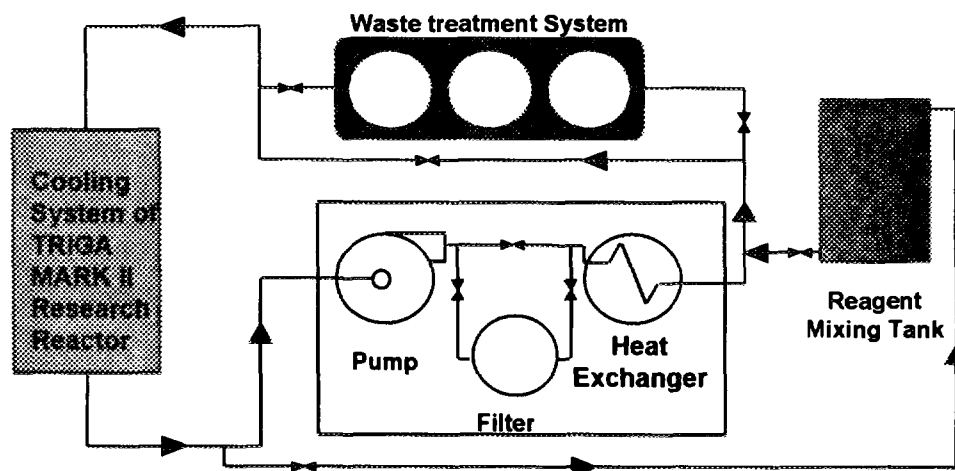
- Decontamination Process and Equipment Development
- Decontamination Technology Demonstration

□ Schedule

R&D Items	1997	1998	1999
□ Characterization of Contamination	[Bar spanning 1997 and 1998]		
□ Establishment of Decontamination Process	[Bar spanning 1997 and 1998]		
□ Design, Fabrication and Test Operation of Decontamination System	[Bar spanning 1998 and 1999]		
□ Demonstration of Decontamination Technology	[Bar in 1999]		

□ R&D Status

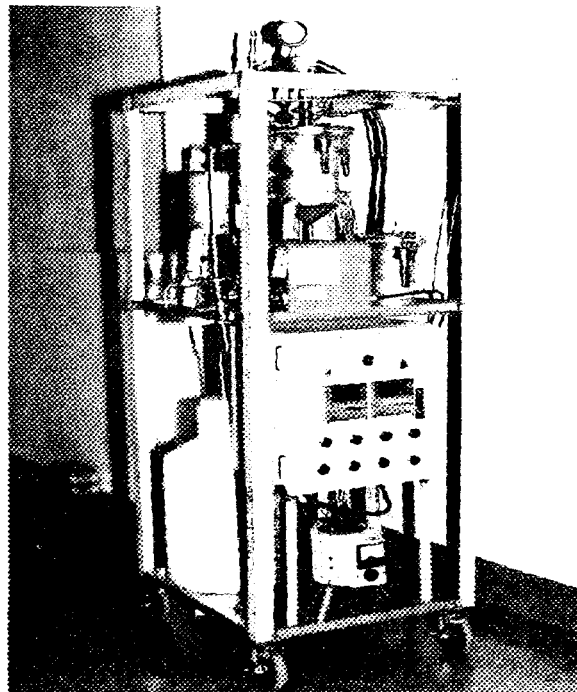
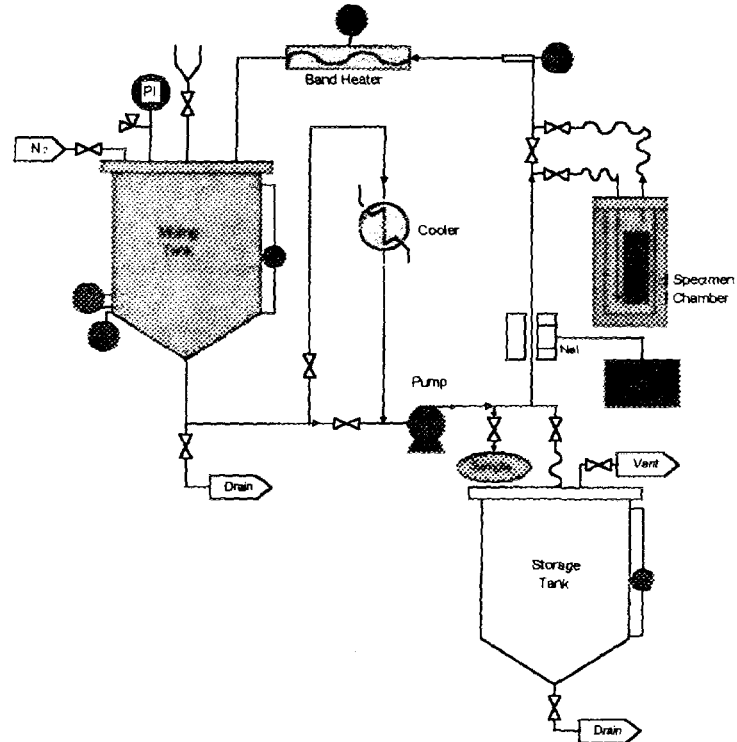
- Review of the documents for cooling system and contamination survey and characterization
- Basic decontamination reagent test



Decontamination Process for Cooling System of TRIGA MARK II Research Reactor

Experimental Apparatus of System Decontamination

Systematic Diagram



Photograph of
Experimental
Apparatus

Concrete Decontamination and Dust Treatment Technologies

Goal

- Development and demonstration of concrete decontamination and the resulted dust treatment technologies

Work scope

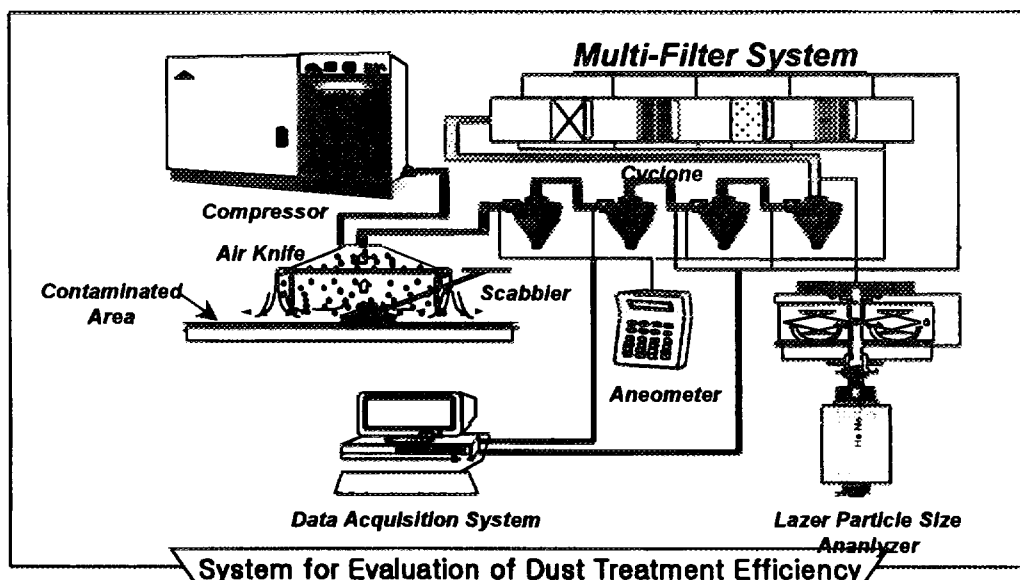
- characterization of concrete surface contamination and the level of cutting depth
- Process development and demonstration

Schedule

Items	'97	'98	'99
<input type="checkbox"/> Contamination Characterization	█	█	█
<input type="checkbox"/> Fabrication and test of lab scale concrete surface cutting equipment	█	█	█
<input type="checkbox"/> Development of dust treatment system	█	█	█
<input type="checkbox"/> Demonstration of the overall process system	█	█	█

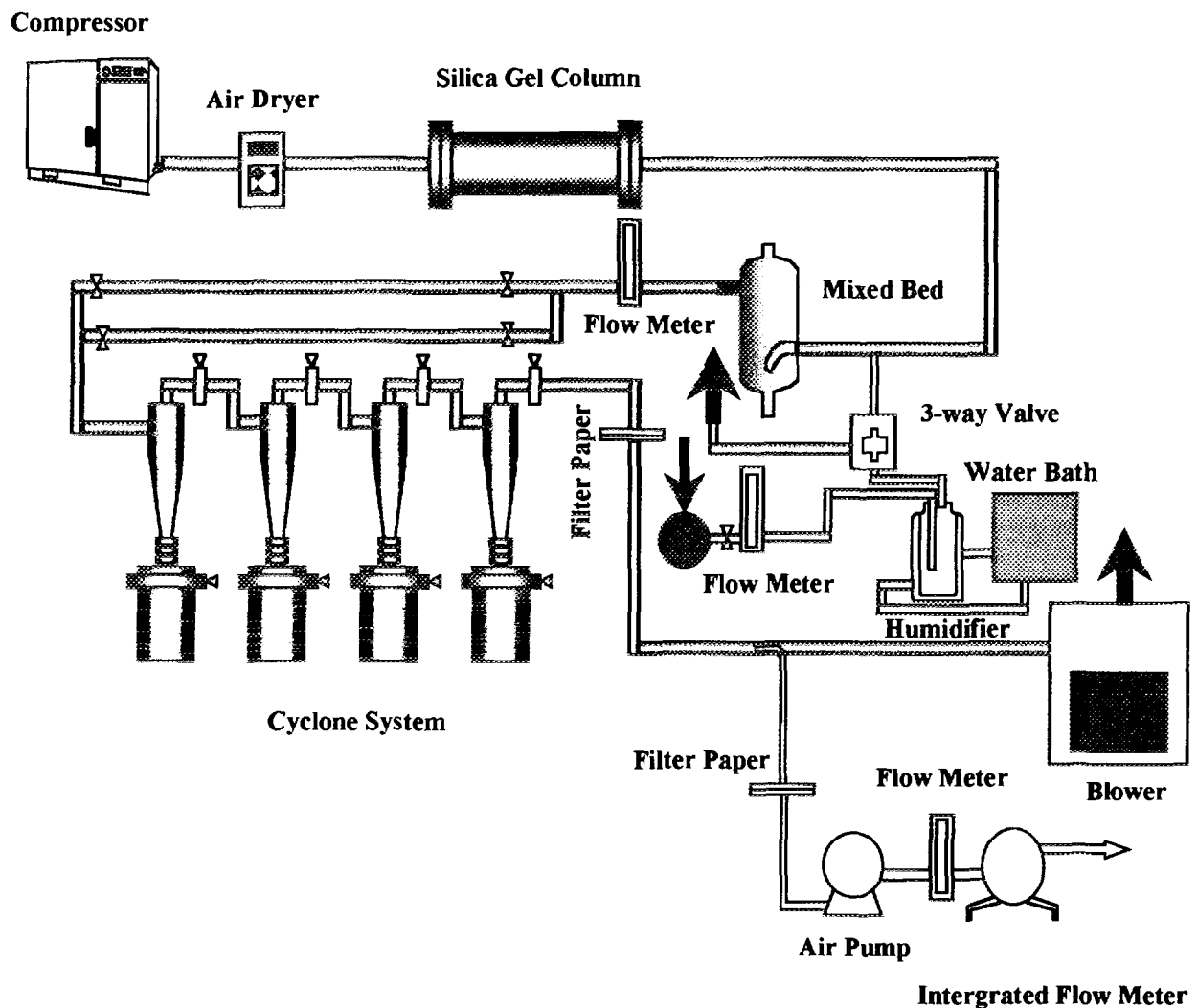
R&D Status

- Development of the dust treatment system from concrete cutting
- Fabrication and test of lab scale concrete surface cutting equipment



Development of Dust Removing Multicyclone for Concrete Decontamination

- System Components : Compressor, Dryer, Silica Gel Column, Mixed Bed, Multicyclone, Sampling Line, Blower
- Humidity Conditioning : Silica Gel Column, Humidifier
- Analysis : Filter Paper, Laser Particle Size Counter



Wall ranging robot and Graphic Simulation of Dismantling Processes

Goal

- Development and demonstration of graphic simulation technology and under-water wall ranging robot

Work scope

- Development of remote inspection and decontamination robot
 - under-water wall ranging robot with self coordinate identification
 - remote handling tools for inspection and decontamination
- Graphic simulation technology development for dismantling process

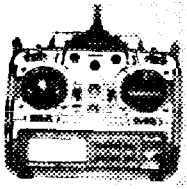
Schedule

Items	'97	'98	'99
<input type="checkbox"/> Development of wall ranging robot - robot development - demonstration in the TRIGA reactor pool	□	□	□
	□	□	□
<input type="checkbox"/> Graphic simulation of dismantling process - modeling of facility and equipment - dismantling process design and verification - application to TRIGA Decommissioning	□	□	□
	□	□	□

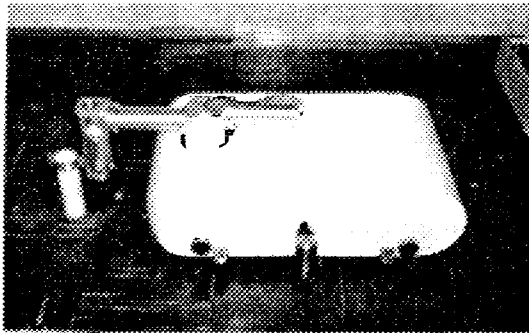
R&D Status

- Fabrication and performance test of remotely moving parts
- Graphic modeling of TRIGA reactor dismantling and its equipment
- Off-line computer simulation of dismantling processes

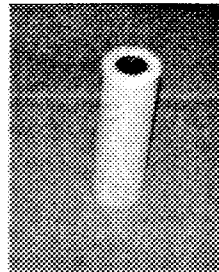
Wall Ranging Radiation Detection System



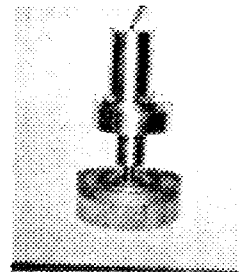
Remote controller



Experimental moving device

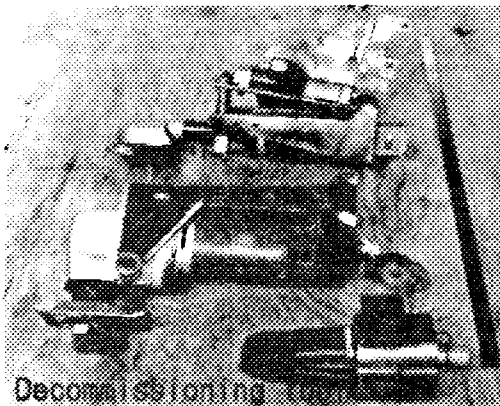


Radiation Detector

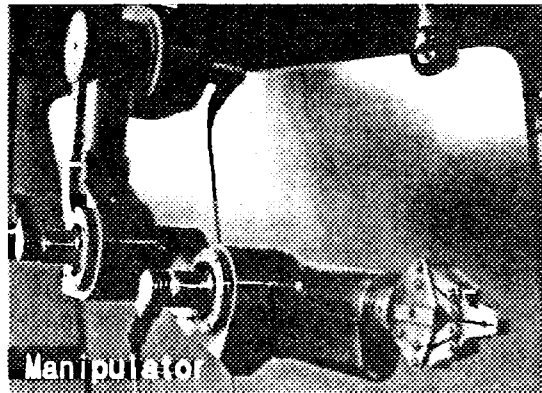


Decontamination Brush

Cutting/Decommissioning Device

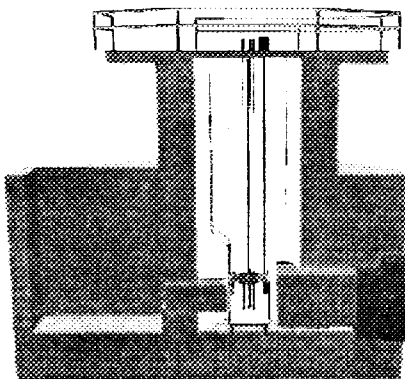


Decommissioning tool

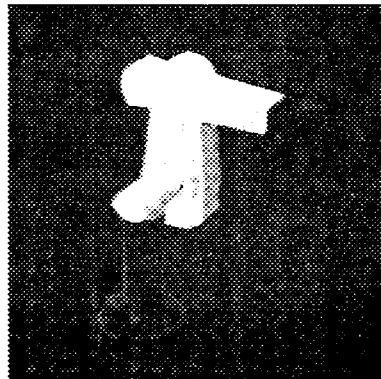


Manipulator

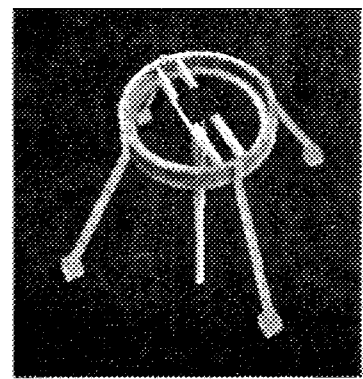
Graphical Computer Simulation of Decommissioning Process



Research Reactor

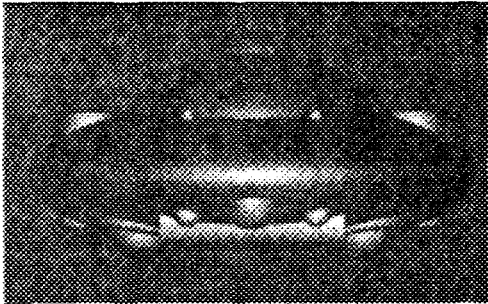
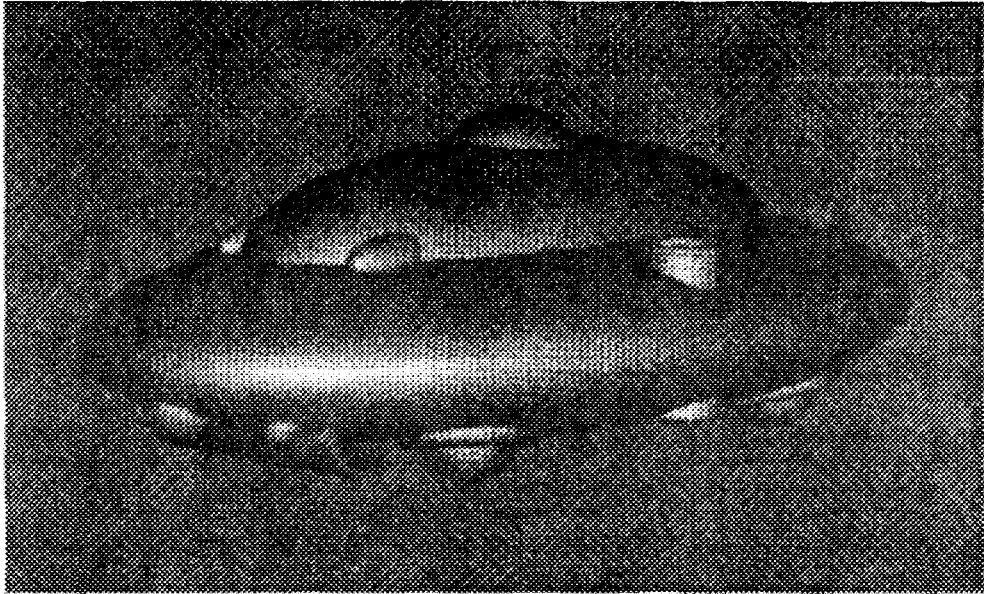


Manipulator

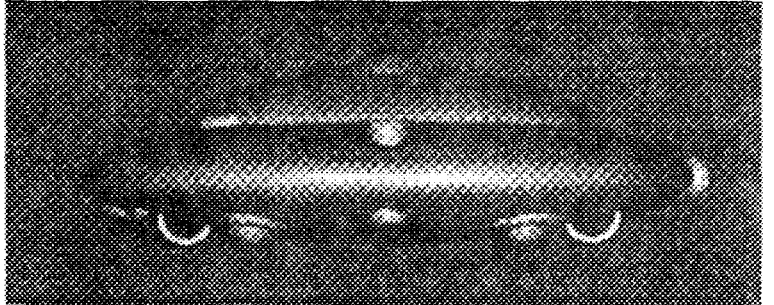


Transporter Bridge

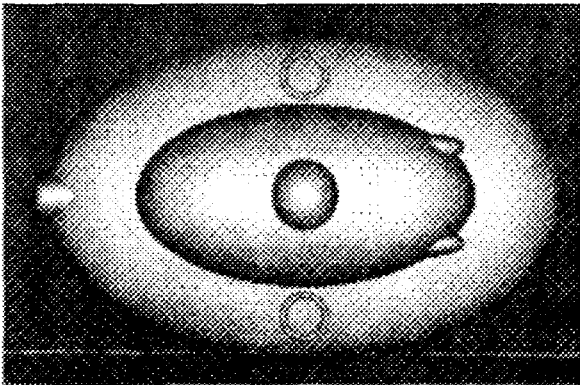
Development of Underwater Robot
for Wall Inspection of Reactor Pool



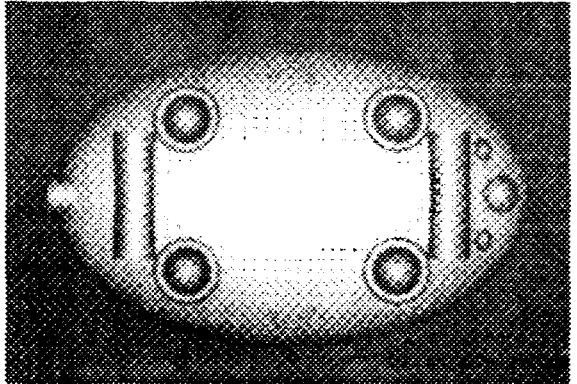
Front View



Side View

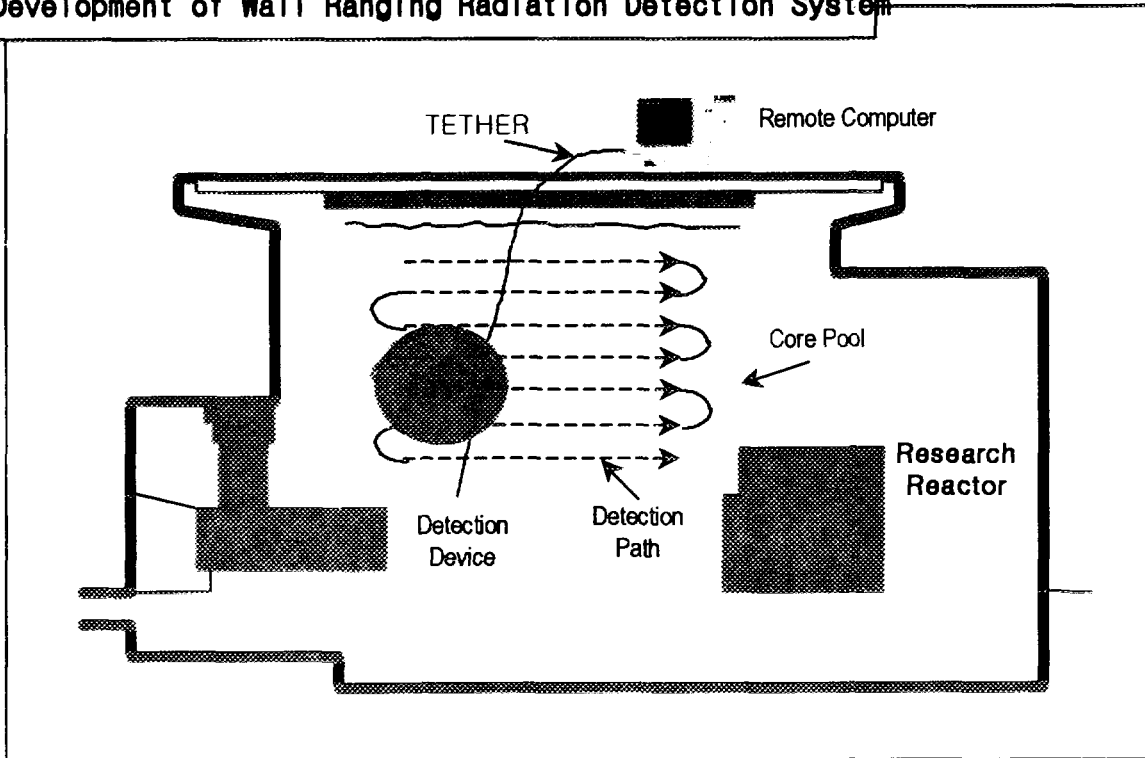


Top View

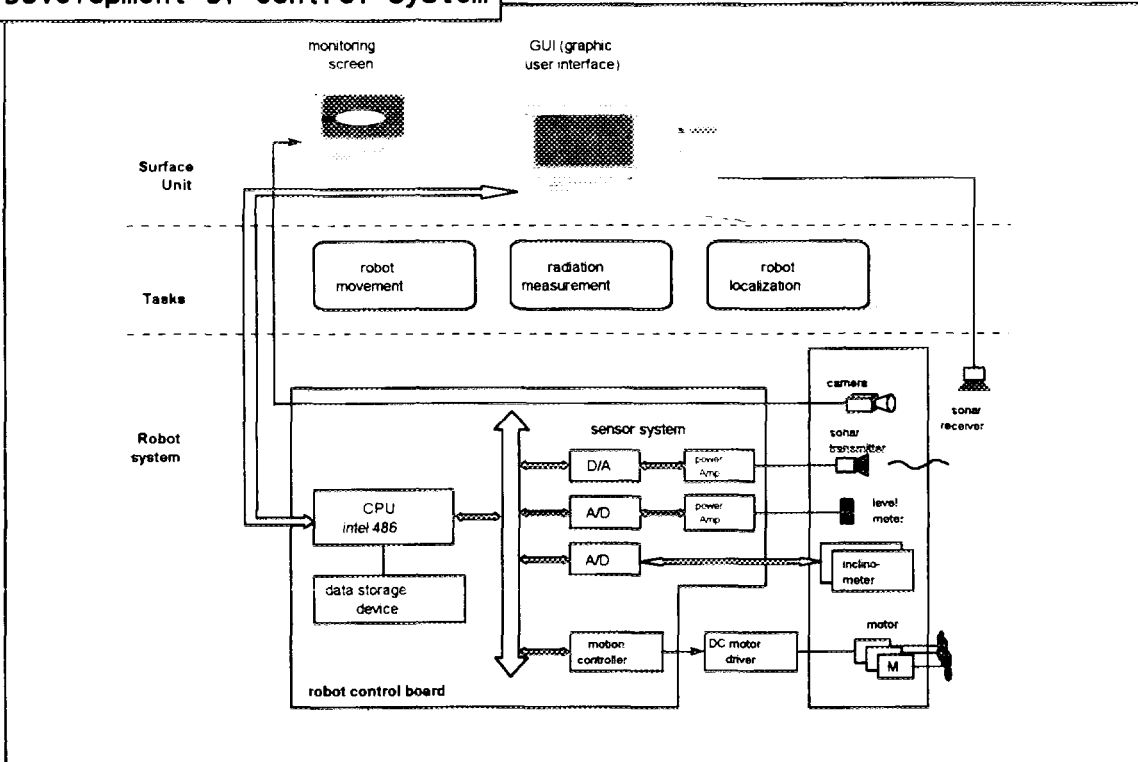


Bottom View

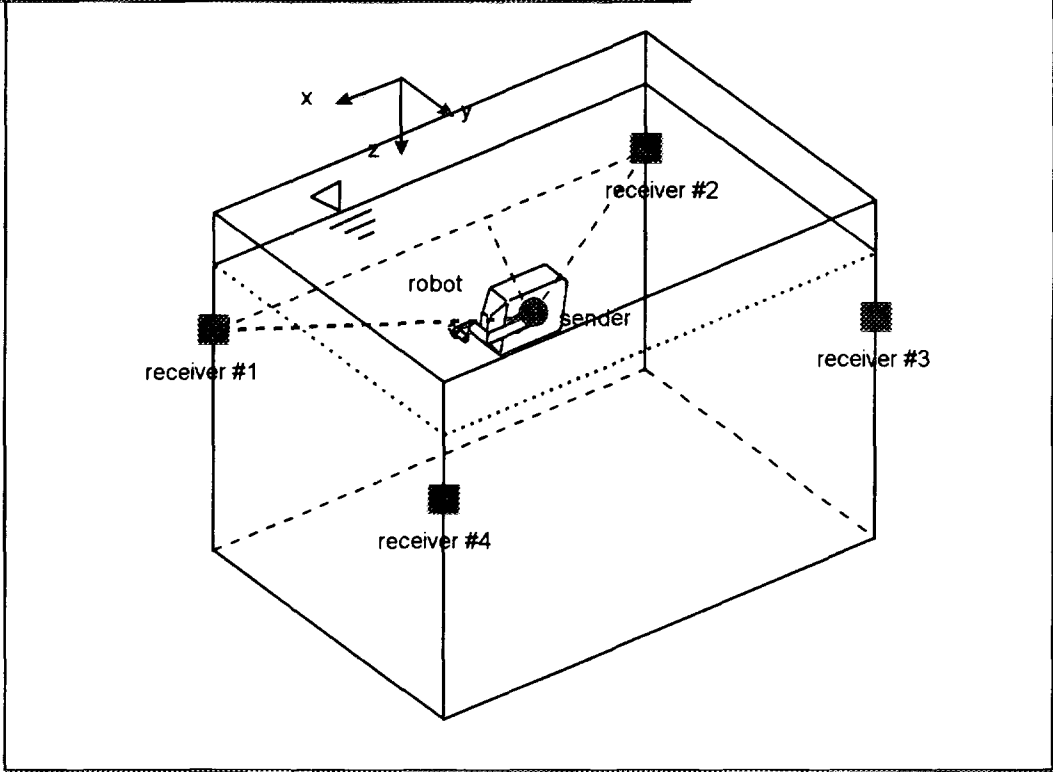
Development of Wall Ranging Radiation Detection System



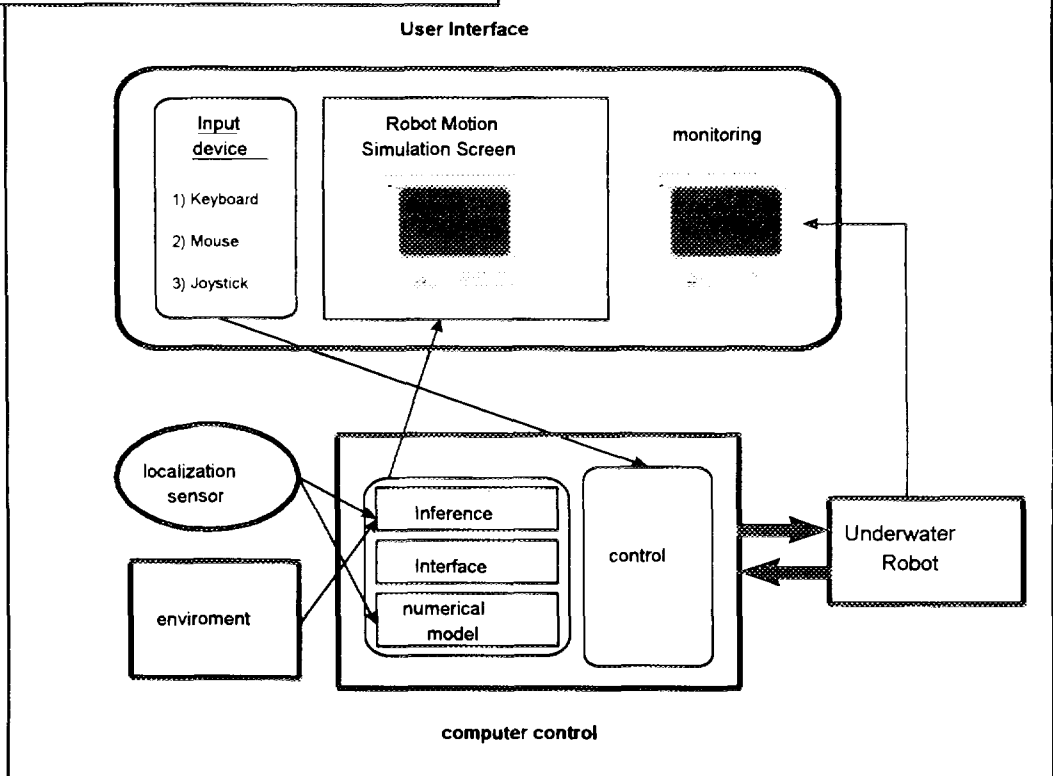
Development of Control System



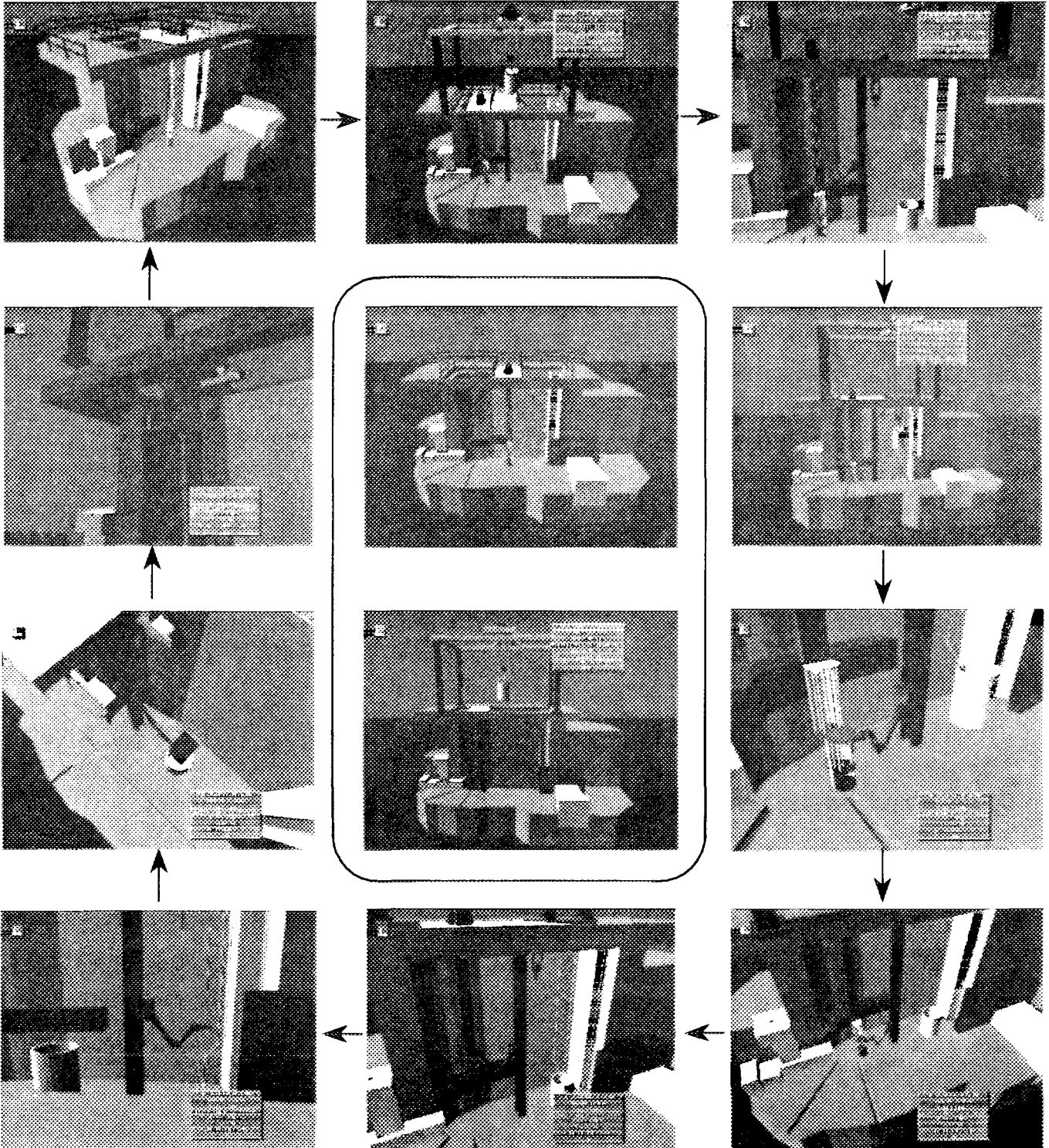
Position Recognition using Ultrasonic Sensor



User Interface of Moving Robot



Graphic Simulation of Research Reactor Dismantling Process



Soil Decontamination and Restoration Technology for TRIGA Research Reactor Site

- ❑ **Goal**
 - Demonstration of soil decontamination technology and development of evaluation techniques for environmental cleanup performance
- ❑ **Work scope**
 - Development and demonstration of soil decontamination technologies
 - Evaluation of underground migration of residual radionuclides focusing on the unsaturated zone behaviors

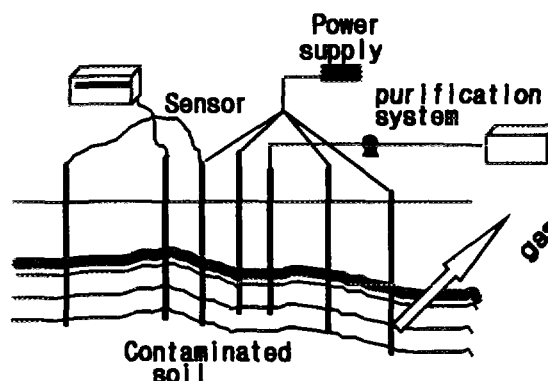
❑ **Schedule**

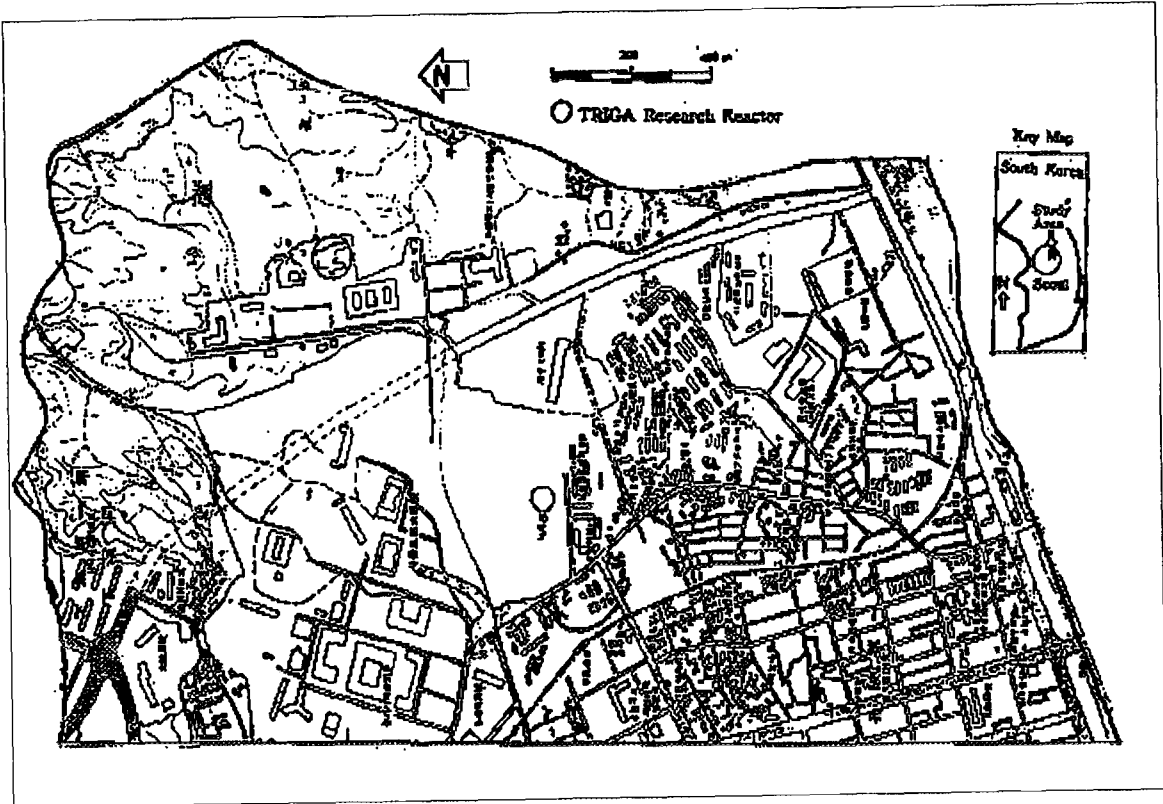
Items	'97	'98	'99
❑ Soil decontamination technology development			
- performance test of soil decon. equipment			
- demonstration of decontamination technology			
❑ Cleanup performance evaluation			
- modeling of radionuclide migration			
- site characterization			
- site cleanup performance evaluation			

❑ **R&D Status**

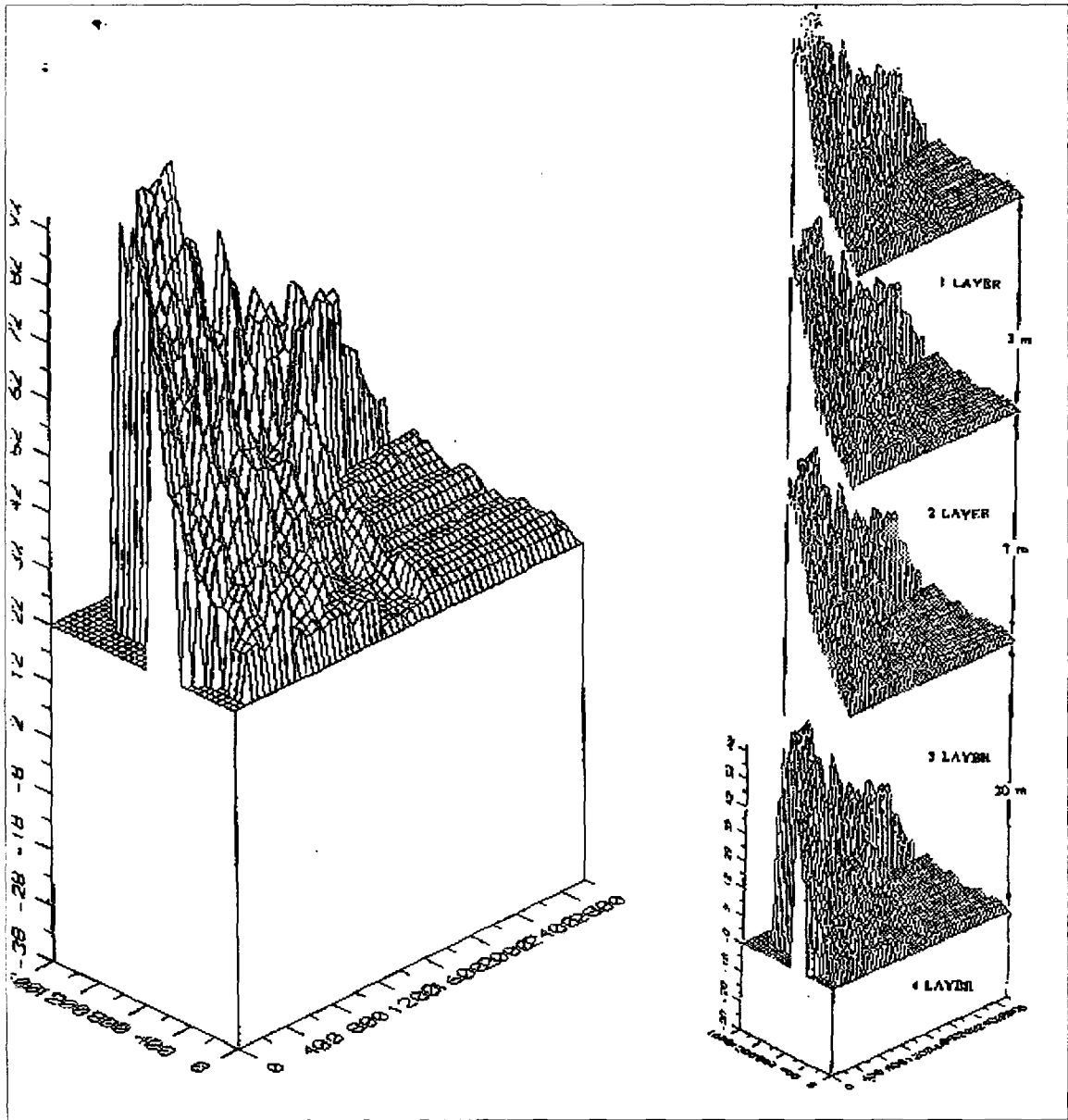
- Preliminary modeling of underground migration of Cs-137, Co-60, Sr-90 by using a MODFLOW computer code
- Soil washing test and lab scale electro-kinetic reclamation test

Concept of Electro-Reclamation

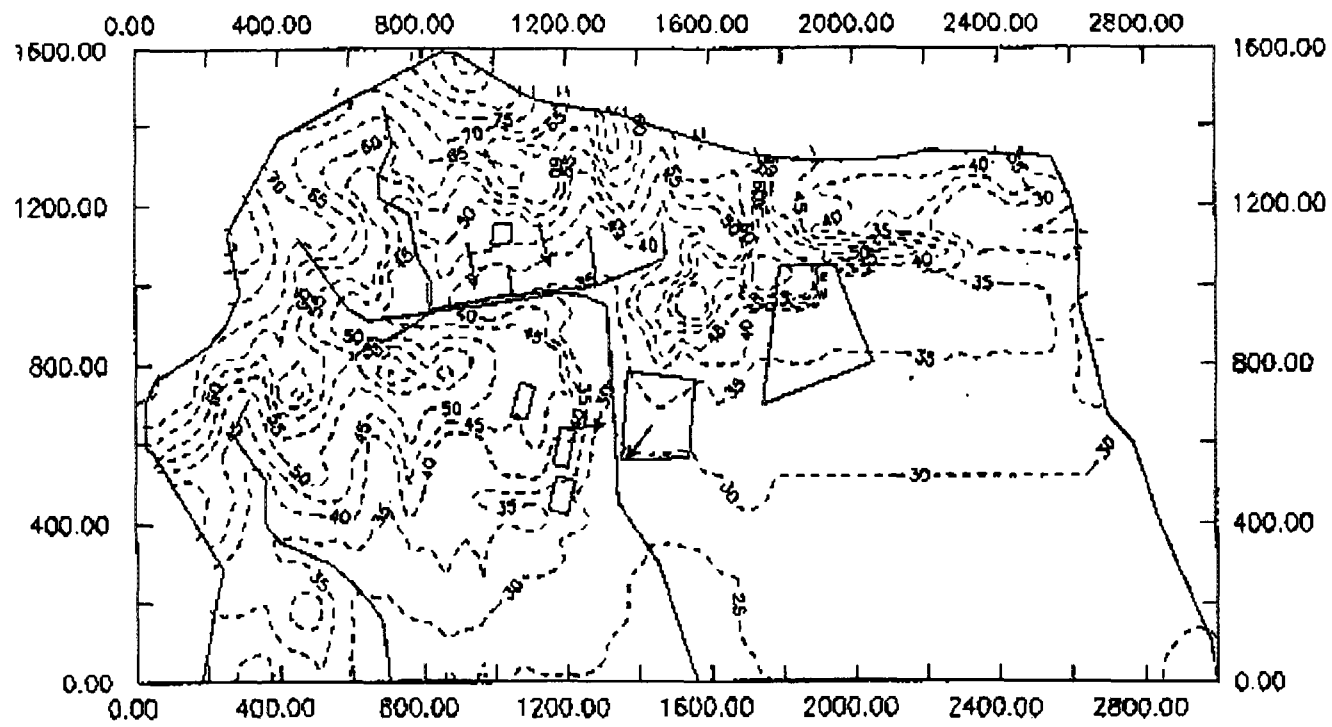




Location and topographical map of TRIGA area



Simulated result of Ground water table at 4 different layers of TRIGA Area by MODFLOW



--- Equipotential Line → Groundwater Flow Direction

Fig. 9 Groundwater flow modeling in 2 layer of study area

Recycling Technology for Radioactive Metal Wastes

Goal

- Development and demonstration of metallic waste recycling and reuse technology

Work scope

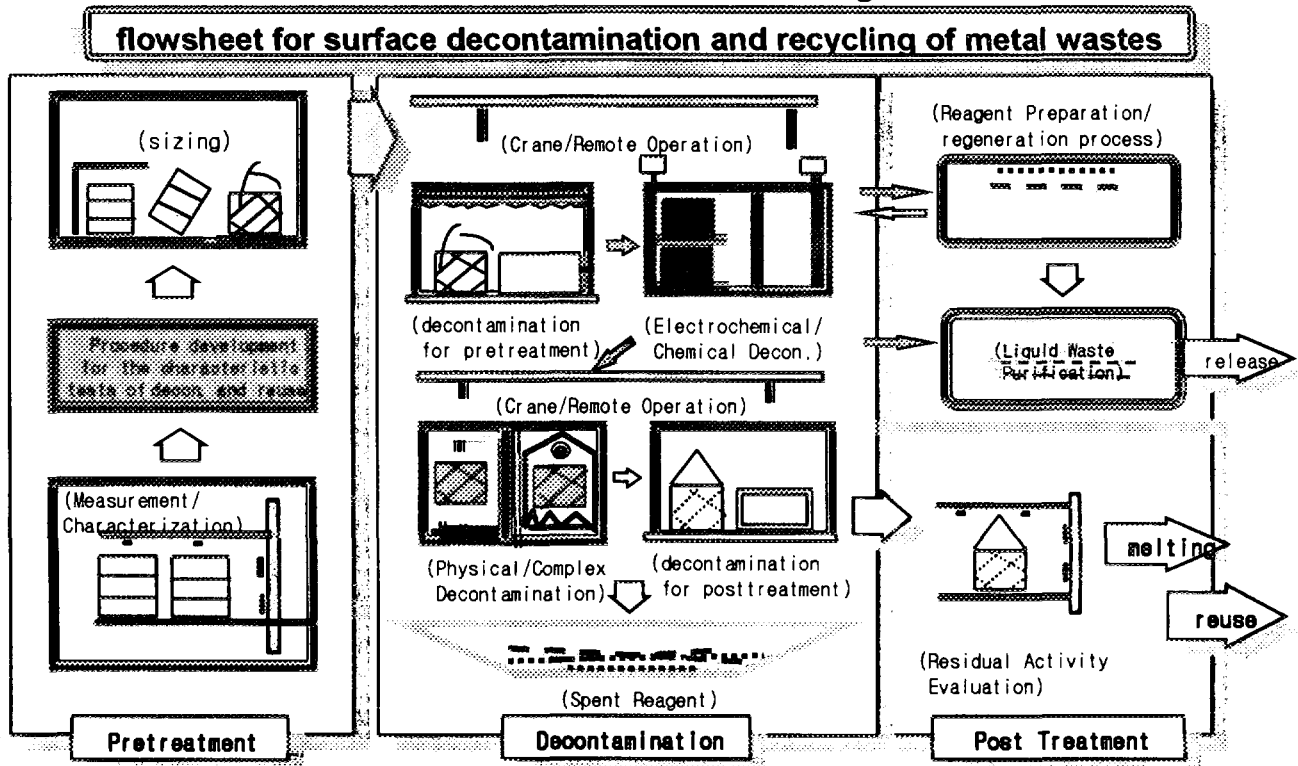
- Development and demonstration of decontamination, melting and the resulted waste treatment system
- Measurement and evaluation of residual radioactivity

Schedule

Items	'97	'98	'99
<input type="checkbox"/> Development of surface decontamination, melting and waste treatment system			
<input type="checkbox"/> Technology development for measurement and evaluation of residual radioactivity			

R&D Status

- Establishment of flow sheet for recycling of radioactive metallic wastes
- Electrochemical decontamination and waste regeneration test



Incineration Technology Demonstration for Combustible Wastes

Goal

- Incineration Technology Demonstration by using the Combustible Wastes from the TRIGA Research Reactor Decommissioning

Work scope

- Characterization of combustible wastes
- Evaluation of radionuclide partitioning and off-gas treatment system
- Incineration technology demonstration by using the existing pilot scale incinerator

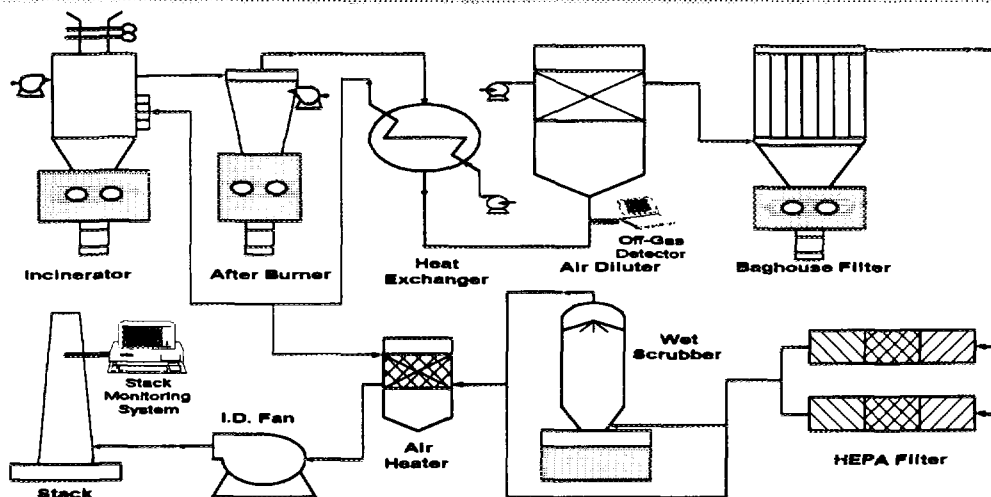
Schedule

Items	'97	'98	'99
<input type="checkbox"/> Characterization of combustible wastes	█		
<input type="checkbox"/> Radionuclides partitioning and off gas system		█	
<input type="checkbox"/> Incineration of combustible wastes from TRIGA			█

R&D Status

- Characterization of combustible wastes from TRIGA decommissioning
- Complementary work to obtain license for the operation of existing incineration facility
- Safety analysis in relation to the discharge criteria on the incinerators

Schematic Diagram of Combustible Waste Incineration Facility



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