

**3rd WORKSHOP on
Regional Advisory Safety Committee for Research
Reactor in Asia and The Pacific (RASCAP)**

Serpong-Indonesia, 31 August – 4 September 2015

Current Status of The RSG-GAS Reactor Operation

Yusi Eko Yulianto



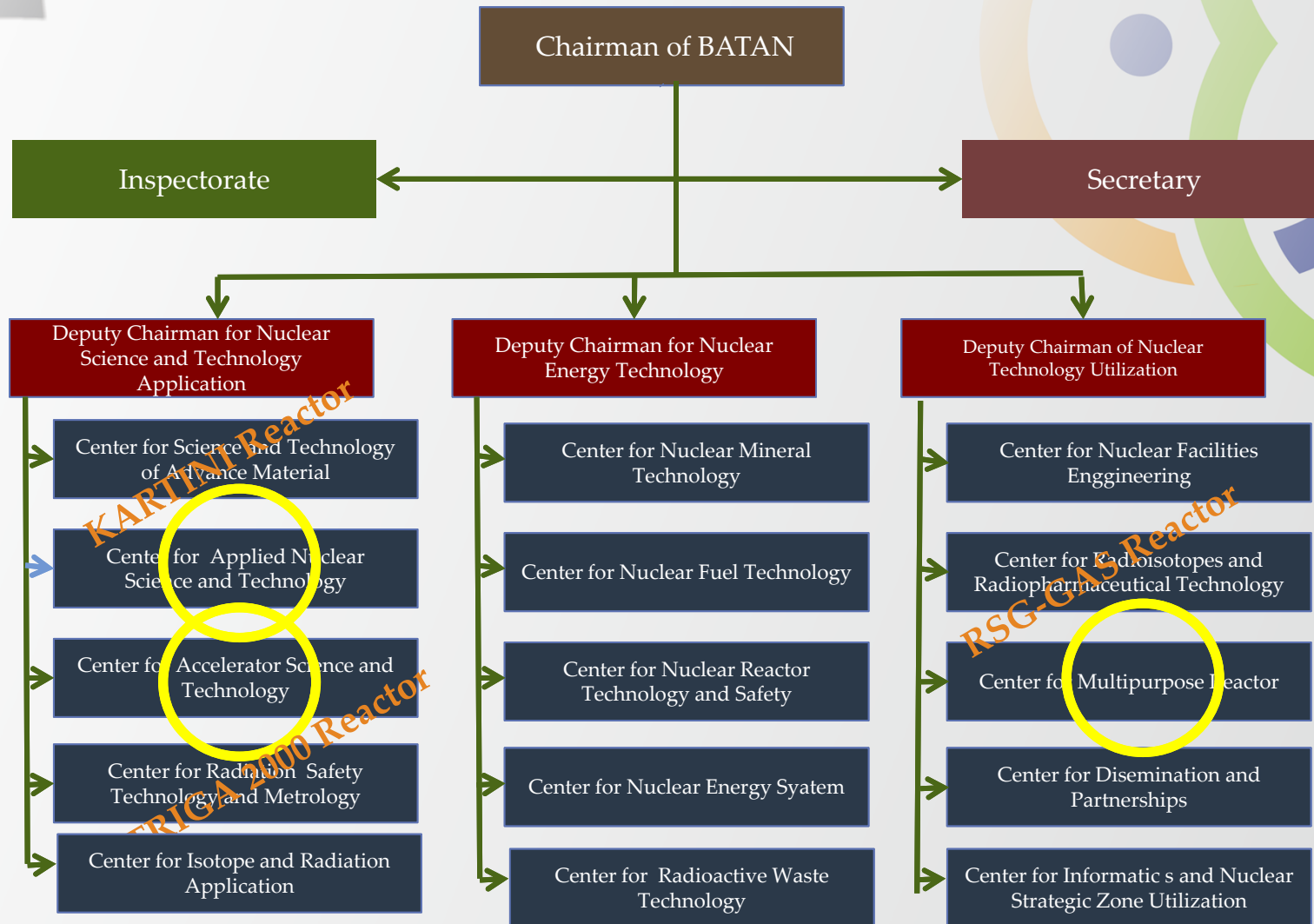
Introduction

- RSG-GAS reactor is one of three RRs operated by BATAN
- RSG-GAS reactor as a multipurpose reactor was designed and built by Interatom GmbH, Germany in 1982
- RSG-GAS reactor is utilized fulfilling the need of research and application on nuclear technology in Indonesia and regional
- Indonesia in cooperation with regional countries and International using the RSG-GAS reactor for workshop and other research purposes.
- BATAN is developing main service satisfaction for the user and stakeholder through the utilization of reactor operation

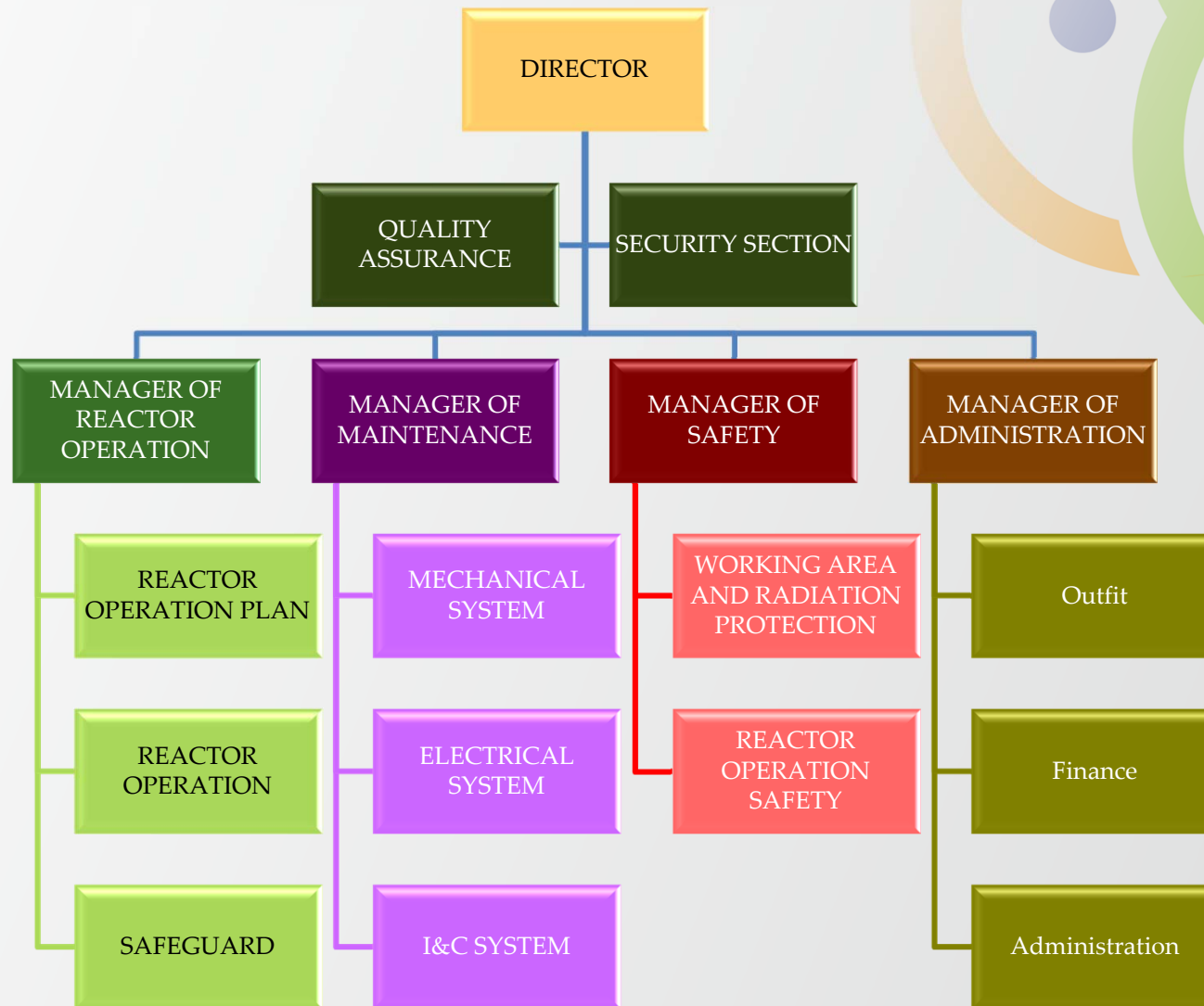
BATANs Research Reactor

	TRIGA 2000	KARTINI	RSG-GAS
Operator	PTNBR, Bandung	PTAPB, Yogyakarta	PRSG, Serpong
Power, kW	2000	100	30,000
Reactor Type	TRIGA MARK II	TRIGA MARK II	MPR
Operation	On: 2 Weeks Off: 2 Weeks	On: 5 days/week	On: 45 days/cycle 4 cycles/year
Utilization	RI, NAA, NR, NS	NAA, NR	RI, NAA, NR, NS, PRT, GC
Age, Years	52	37	29

ORGANIZATIONAL STRUCTURE OF BATAN



Organization Structure of Center for Multi Purpose Reactor (Reactor Management)



Complex of Nuclear Area Serpong

- Total extents of BATAN area in Serpong is ± 25 Ha
- Around 800 employees are working in BATAN-Serpong

Nuclear Waste Management

RSG-GAS Reactor

Center for Radioisotope Processing



Nuclear Fuel Element Factory

General Workshop

Management of BATAN-Area

Historical Moment of RSG-GAS Reactor



Location

Serpong, West. Of Java

Physical
Construction

1982

Commissioning

1985

First Criticality

1987

Silicide
Conversion

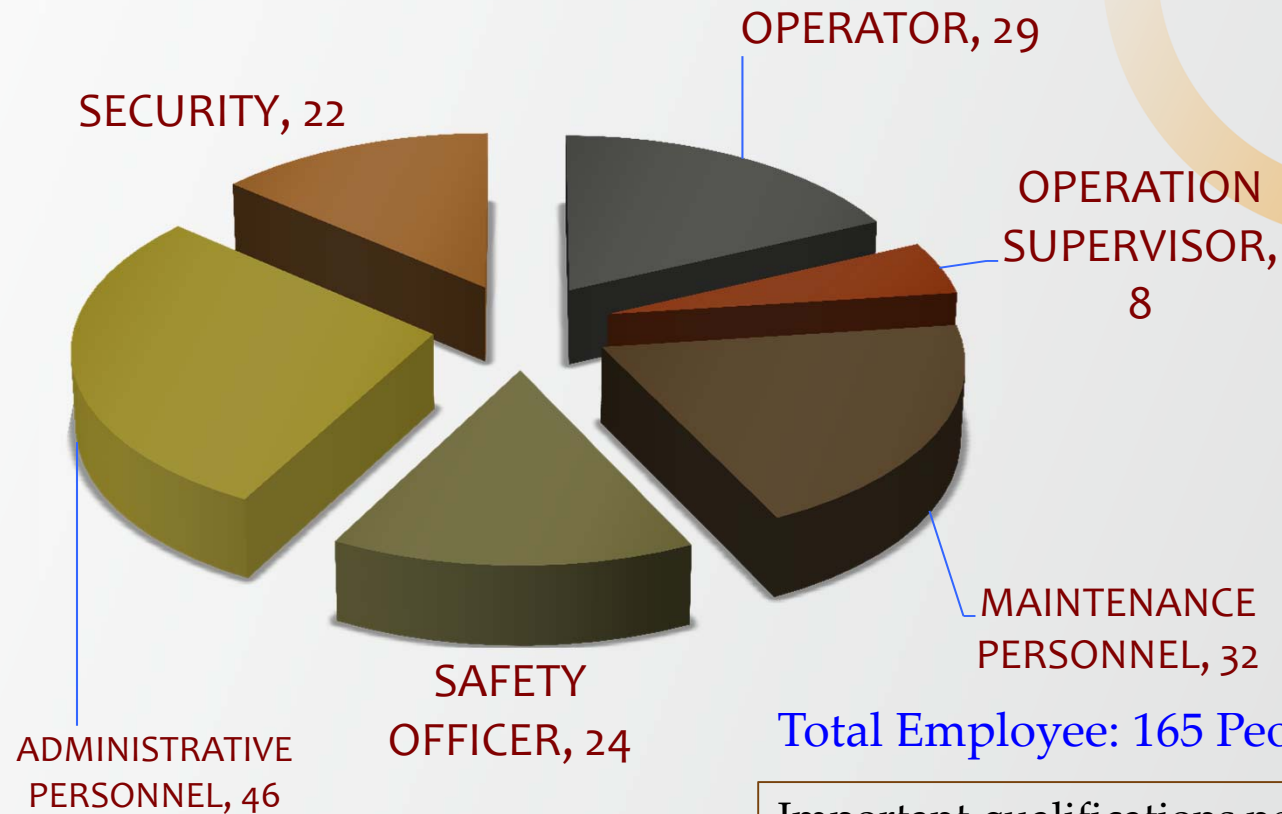
1995

Ageing Program

2000



Human Resources Composition

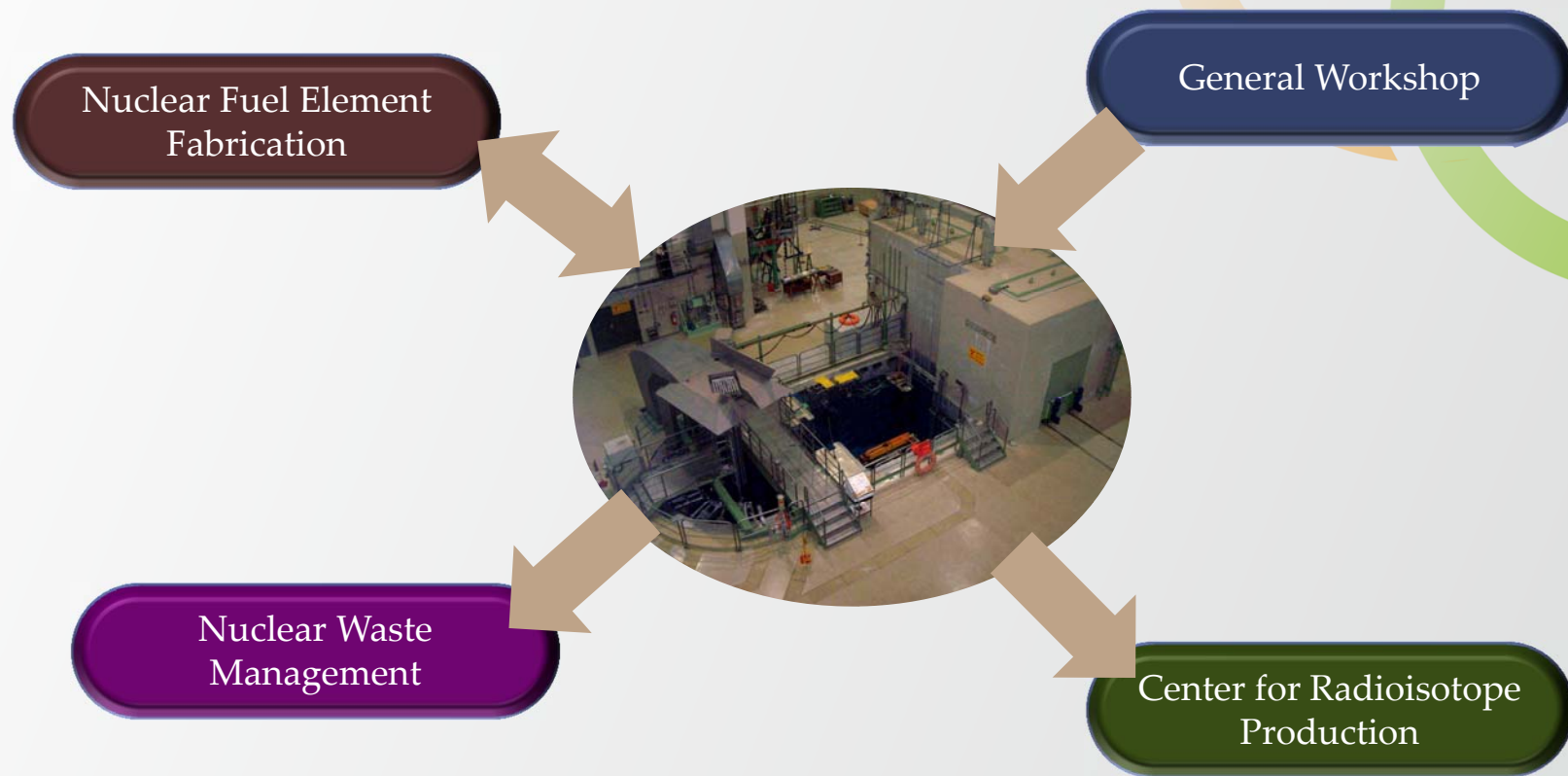


Total Employee: 165 Peoples

Important qualifications needed:

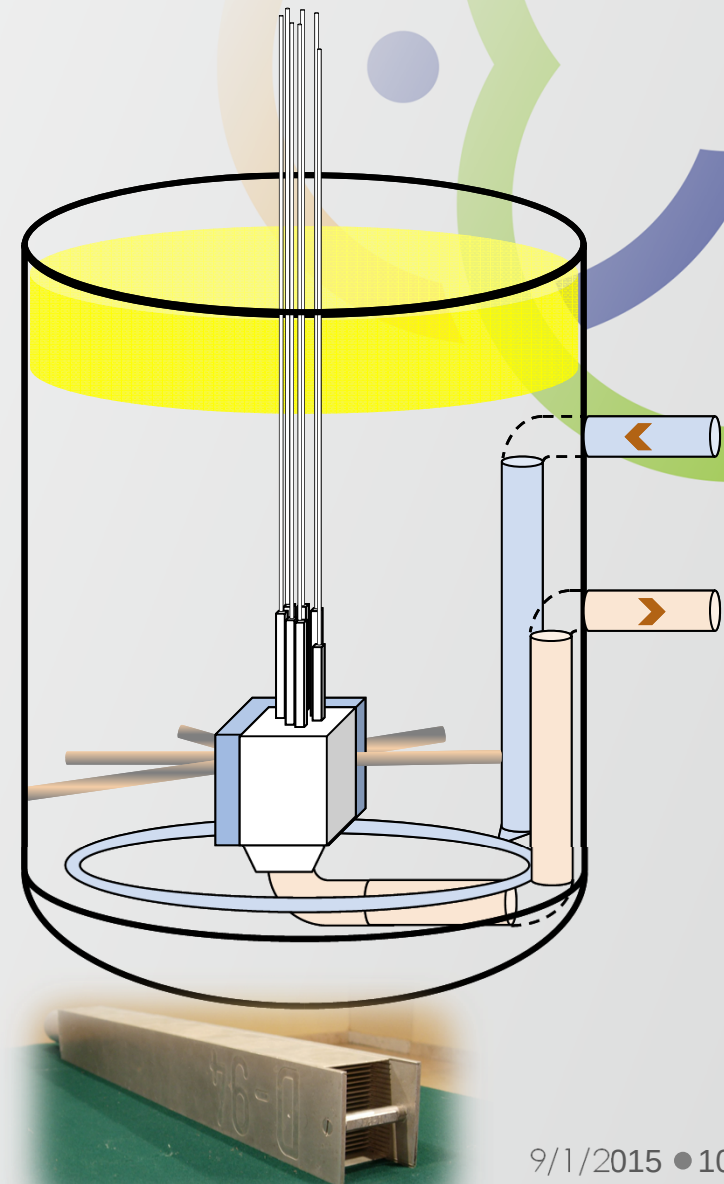
- Radiation Protection
- Operator
- Maintenance
- Safeguard
- Nuclear Security

The Infrastructures of RSG-GAS Reactor

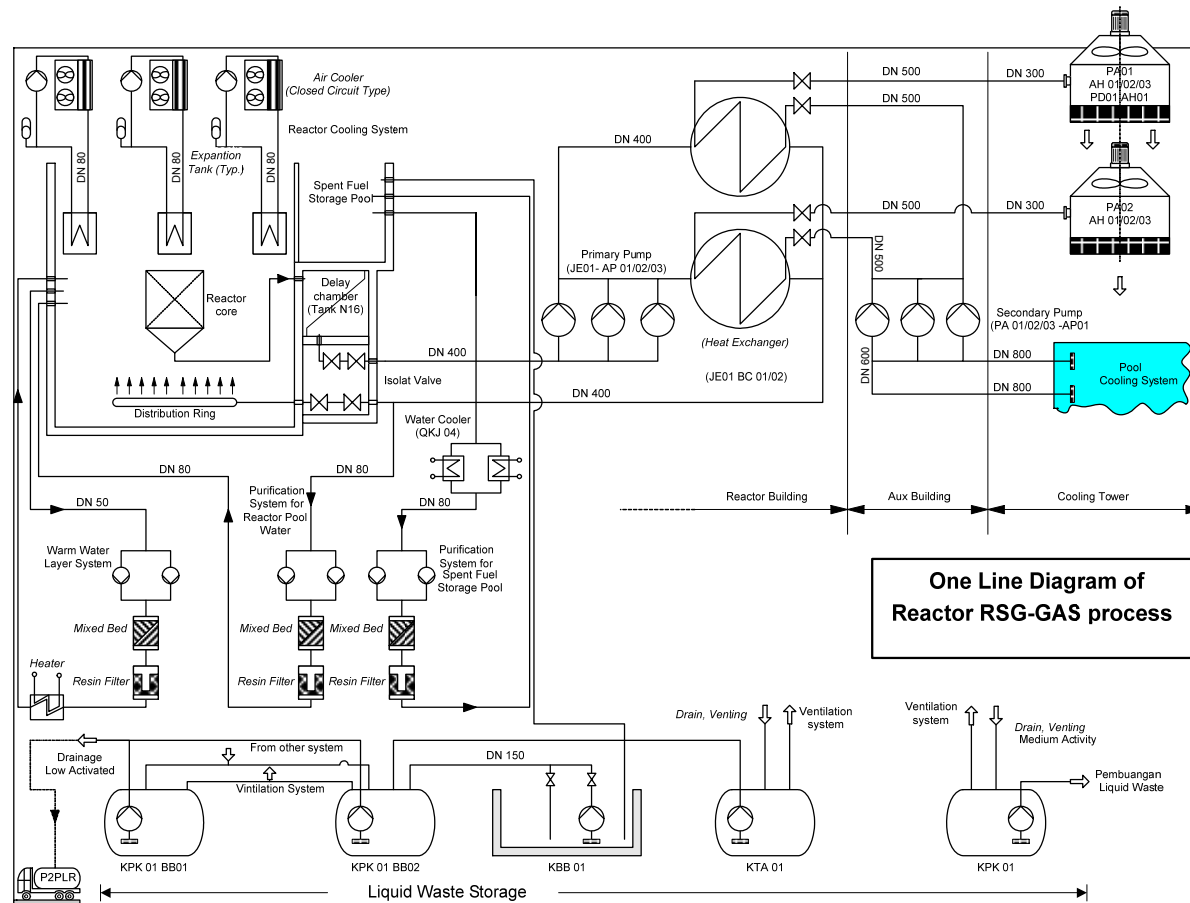


Reactor Specification

Power	30 MW
Neutron Flux	2.10^{14} n/cm ² .s
Cooling Material	Light Water
Fuel Type	MTR
Fuel Material	U ₃ Si ₂ Al
²³⁵ U Enrichment	19.75 %
²³⁵ U Density	2.96 gr/cm ³
Absorber	AgIn-Cd
Number of Control Rod	8
Reflector	Beryllium
Number of Neutron Beam	6
Radiation Protection Facility	Warm Water Layer



Reactor System

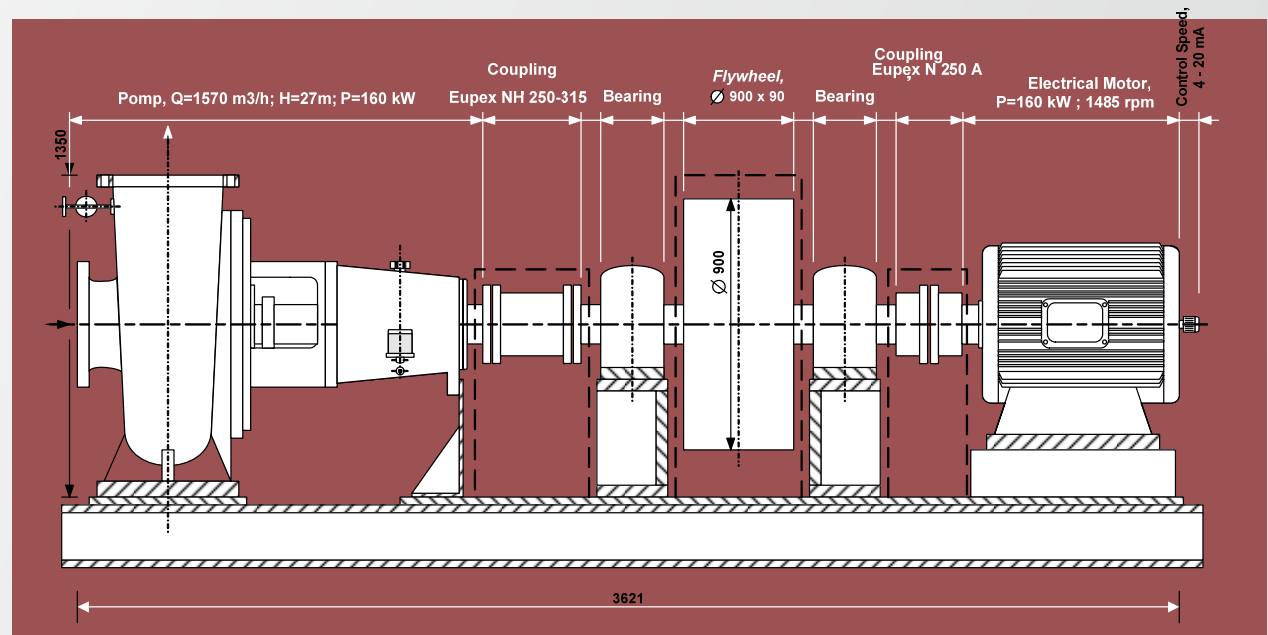


Primary Cooling System

Primary Cooling Pumps



Heat Exchanger



Secondary Cooling System



Cooling Tower



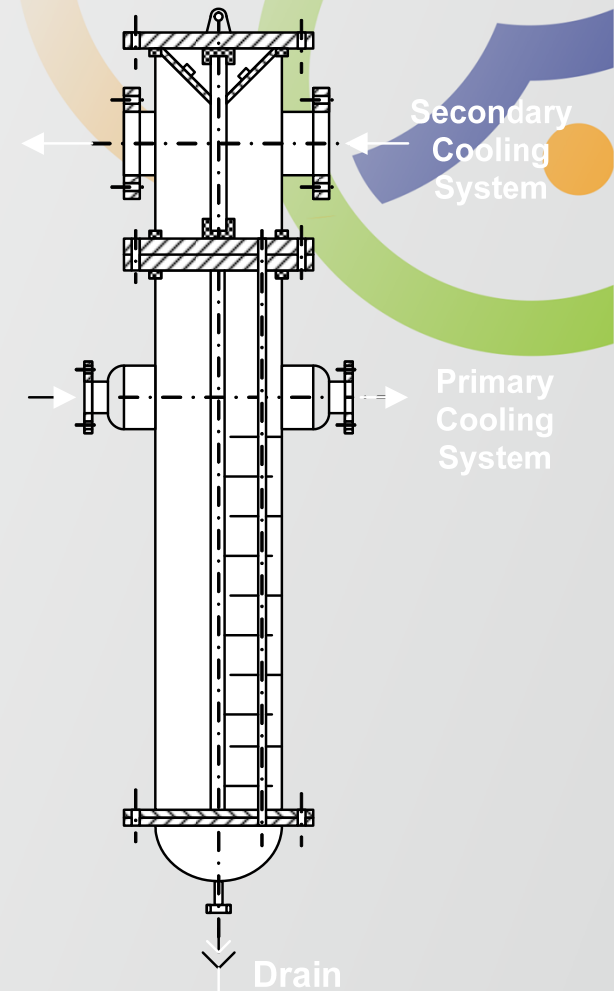
Secondary Cooling Pumps



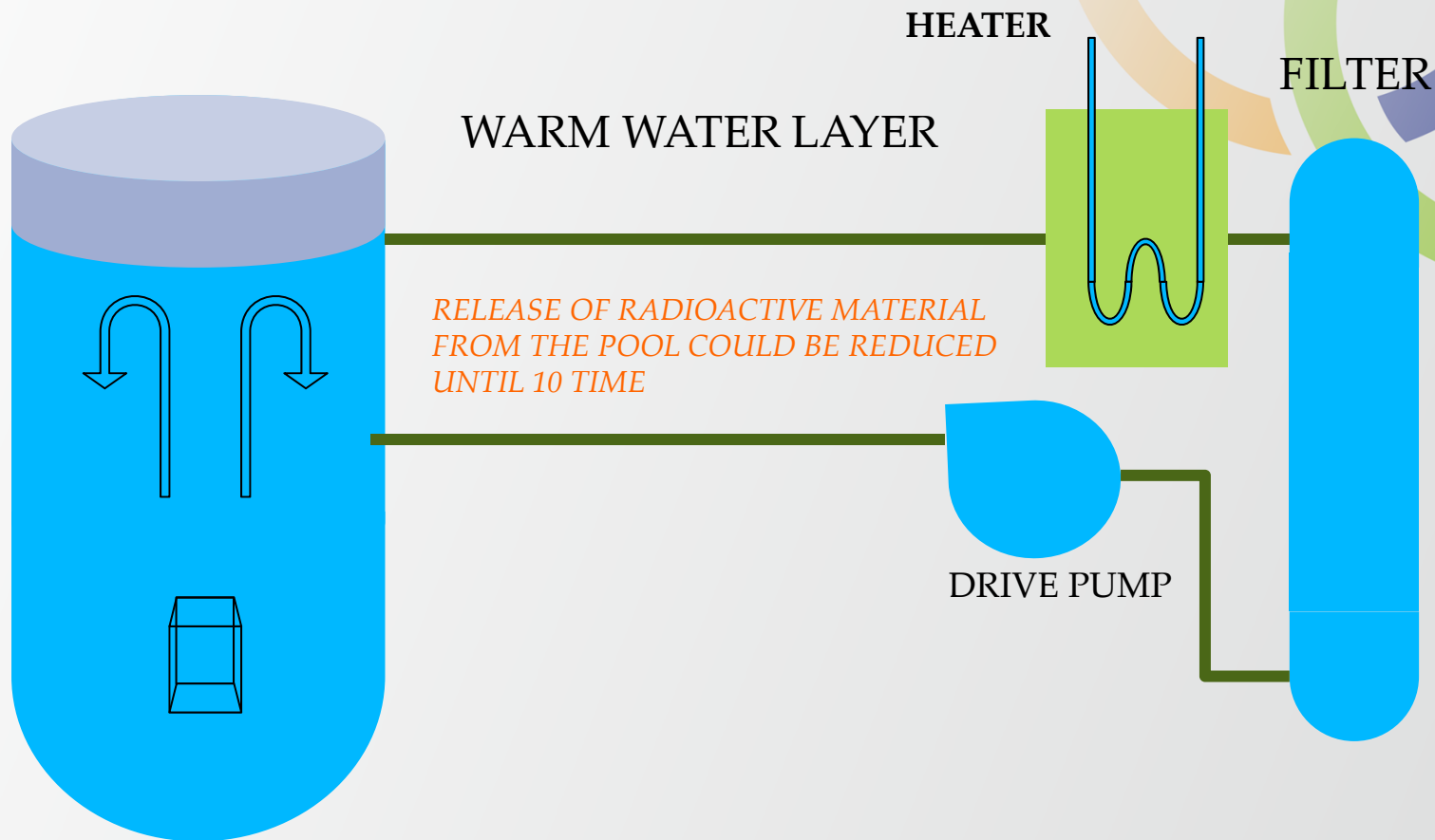
Secondary Piping System

Heat Exchanger

Type	<i>Shell and tube</i>
shell diameter	1300 mm / 51,181 inch
Tube diameter	22 mm ID, 23 mm OD, 0,917 ID, 0,906 OD
Amount of tube every phase	816 tubes
Tube length	7410 mm / 291,732 inch
Tube Lay out	<i>Square</i>
Contact area	780 m ² / 120900,242 inch ²
Flow rate in shell site	430 kg/sec
Flow rate in tube site	485 kg/sec = (1950-2000) m ³ /hr, 1067 lb/sec
Water cooling temperature	38°C

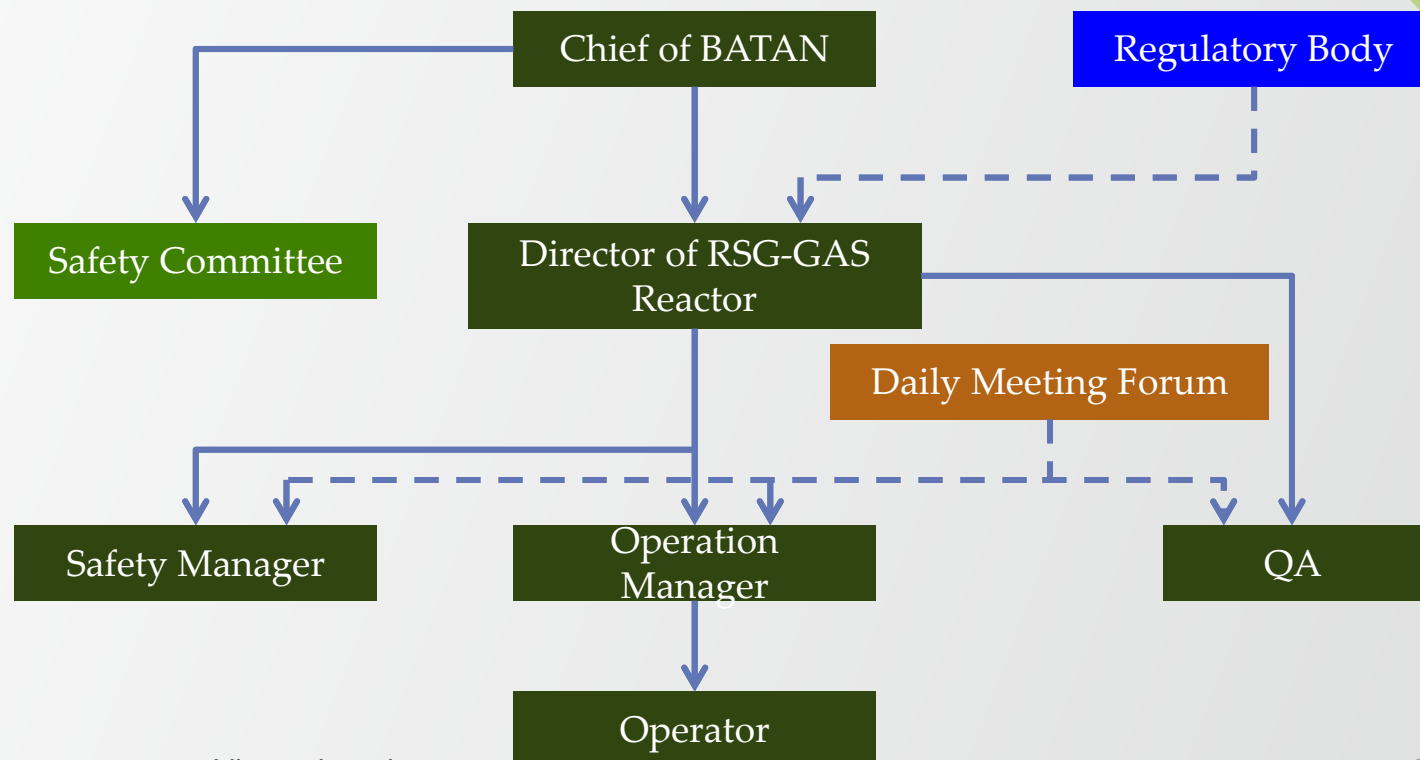


Warm Water Layer



Safety Management

- Is organizational activities to achieve the safe operational, utilization, maintenance, research and development of the research reactor under supporting of the establishment related parties/ Institutions such as regulatory body



Safety Requirement of Reactor Utilization

- Safety Analysis Report of irradiation facility
- Standard Operational Procedure of Facility
- Safety Analysis Report of irradiation target
- Standard Operational Procedure of material transport in facility

Operation Schedule 2015

SCHEDULE OF OPERATION AND MAINTENANCE OF RSG-GAS 2015 Rev. 1 (6 April 2015)

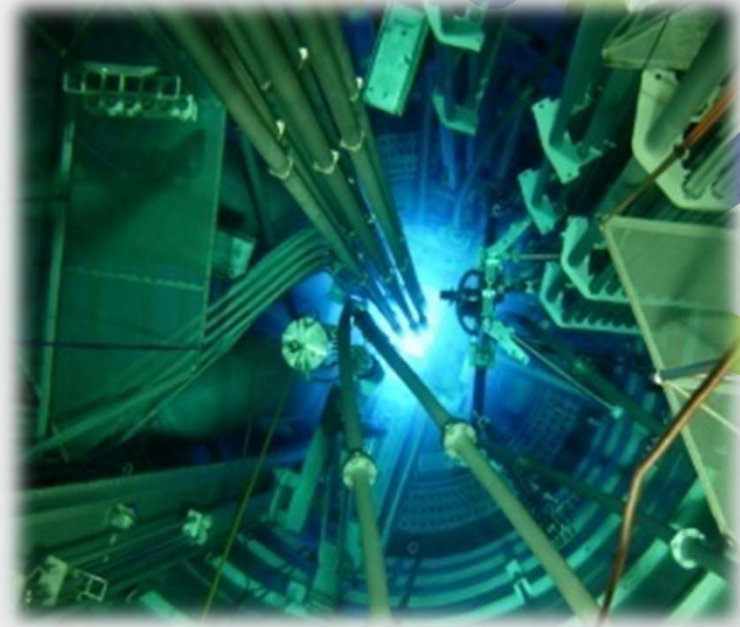
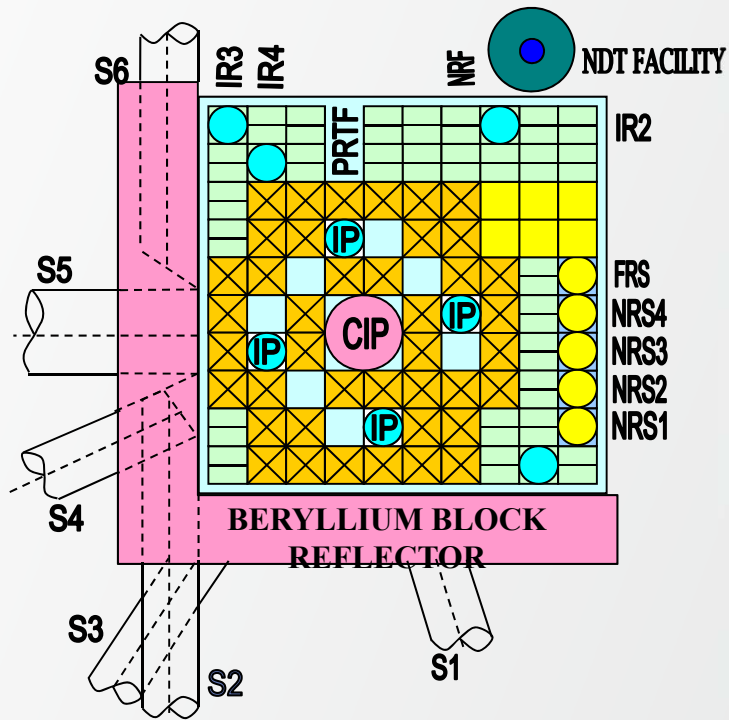
MONTH	DATE																															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
JANUARY	Maintenance (1-M), Refuelling (Core 87), Criticality, Rod & Power Callibration Rotate Of Beryllium Reflector Element																		Operation I (Core 87)			Stand By	Operation II (Core 87)									
FEBRUARY		Operation III (Core 87)					Stand By	Operation IV (Core 87)					Maintenance (1-M)							Operation V (Core 87)												
MARCH		Operation VI (Core 87)					Stand By	Operation VII (Core 87)					Stand By	Operation VIII (Core 87)					Maintenance (1-M & 3-M)							Opera-						
APRIL	tion IX (Core 87)		Stand By	Operation X (Core 87)					Stand By	Operatio (diklat)		Maintenance (1-M, 3-M & 6-M), Refuelling (Core 88) Criticality, Rod & Power Callibration Reactor Maintenance Technician & Supervisor and Reactor Operator & Supervisor Training																				
MAY	Maintenance (1-M, 3-M & 6-M), Refuelling (Core 88) Criticality, Rod & Power Callibration Reactor Maintenance Technician & Supervisor and Reactor Operator & Supervisor Training																		Operation I (Core 88)			Stand By	Operation II (Core 88)					Stand By				
JUNE	Operation III (Core 88)					Stand By	Operation IV (Core 88)					Maintenance (1-M & 3-M)							Operation V (Core 88)					Stand By								
JULY	Operation VI (Core 88)		Stand By	Operation VII (Core 88)					Maintenance (1-M), Eid Al-Fitr 1436 H																							
AUGUST		Operation VIII (Core 88)					Stand By	Operation IX (Core 88)					Stand By	Operation X (Core 88)					Maintenance (1-M), Refuelling (Core 89)													
SEPTEMBER	Maintenance (1-M), Refuelling (Core 89)												Operation I (Core 89)					Maintenance (1-M & 3-M), Eid Al-Adha 1436 H							Operation II (Core 89)							
OCTOBER		Stand By	Operation III (Core 89)					Stand By	Operation IV (Core 89)					Maintenance (1-M)							Operation V (Core 89)											
NOVEMBER		Operation VI (Core 89)					Stand By	Operation VII (Core 89)					Maintenance (1-M)							Operation VIII (Core 89)					Maintenance (3-M)							
DECEMBER	Maintenance (1-M&3-M)					Operation IX (Core 89)					Stand By	Operation X (Core 89)					Maintenance (6-M&1-Y), Refuelling (Core 90), Christmas, New Year															
Stand By Maintenance Operation Refuelling																																
Approved by Bambang Herutomo																																

Stand By
 Maintenance
 Operation
 Refuelling

Approved by Bambang Herutomo

Total Operation time in 2015: 152 days

Irradiation Position



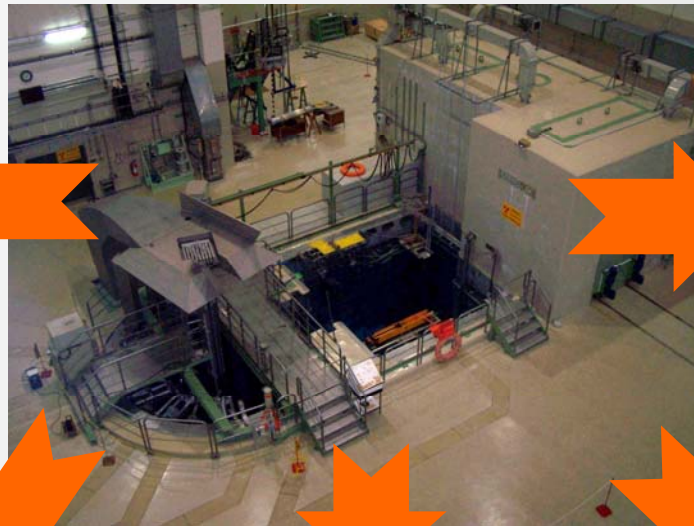
-  Fuel Assembly
-  Beryllium Reflection Element
- IR** = Irradiation Position (reflector)
- NRS** = Normal Rabbit System
- S** = Beam Tube
- NRF** = Neutron Radiography Facility (out of core)
- PRTF** = Power Ramp Test Facility

- CIP** = Central Irradiation Position
- IP** = Irradiation Position (core)
- FRS** = Fast Rabbit System

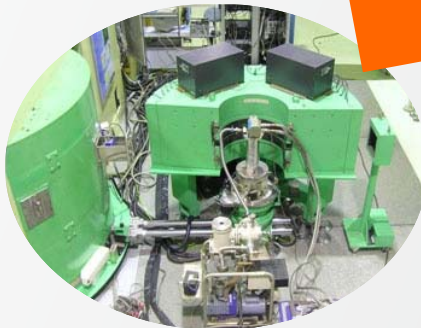
Utilizations of RSG-GAS Reactor



RI Production



Power Ramp Test



Neutron Spectrometer
and Diffractometer

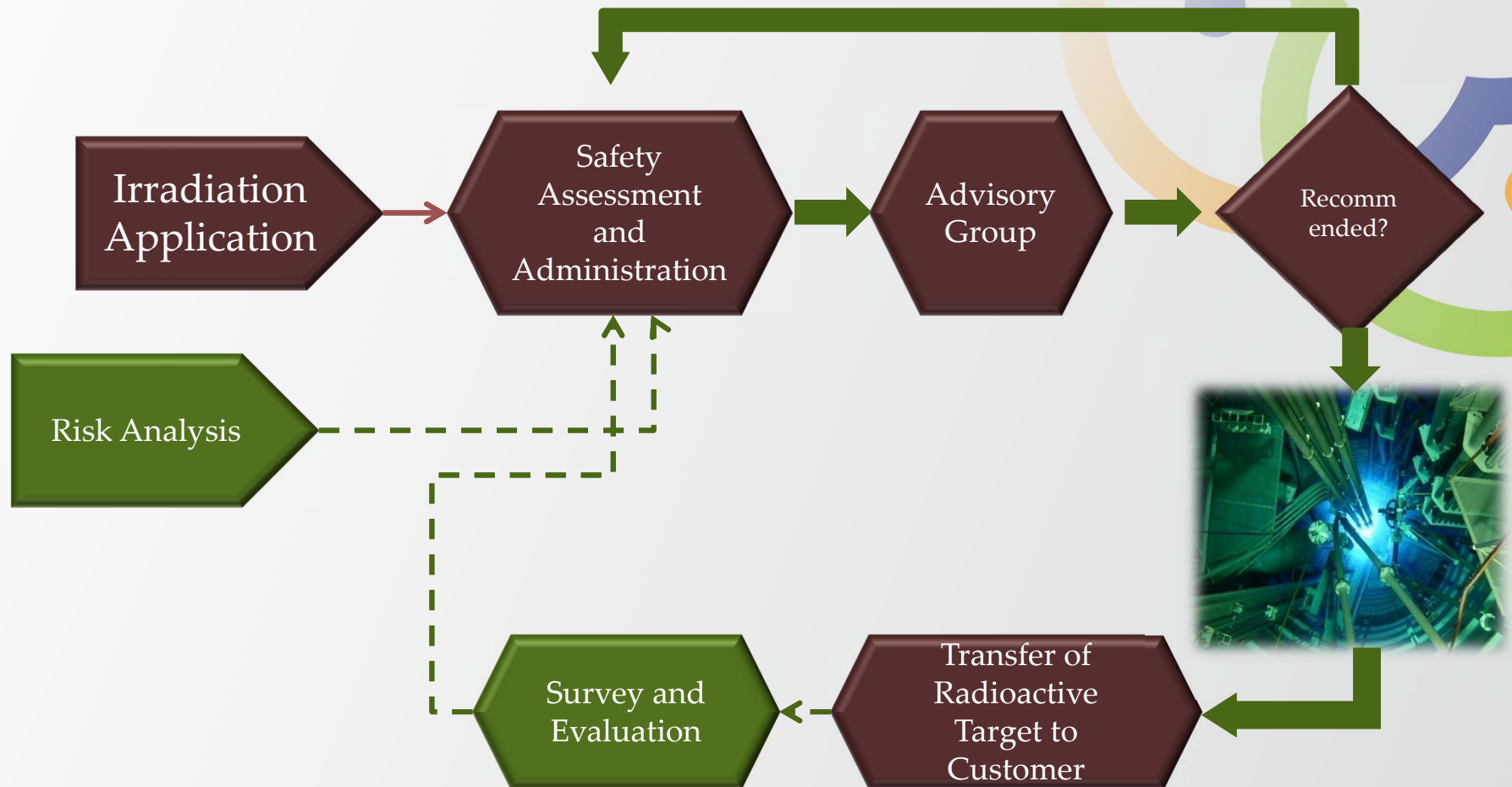


Neutron Activation
Analysis



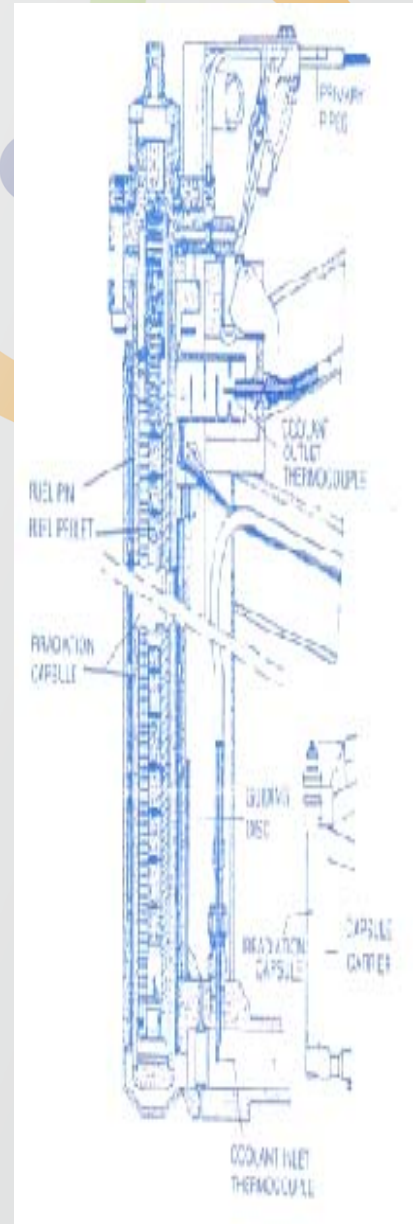
Neutron
Radiography

Irradiation Services

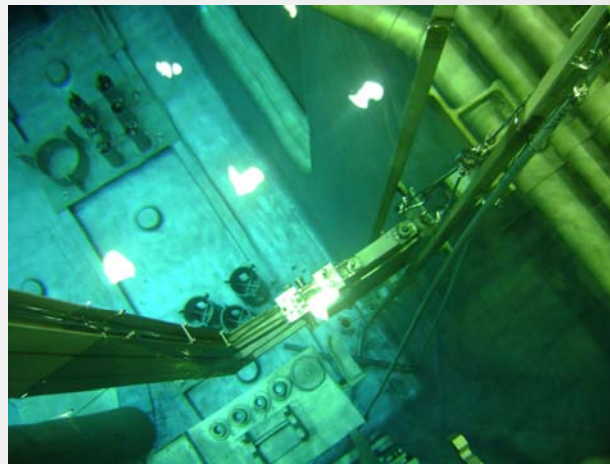
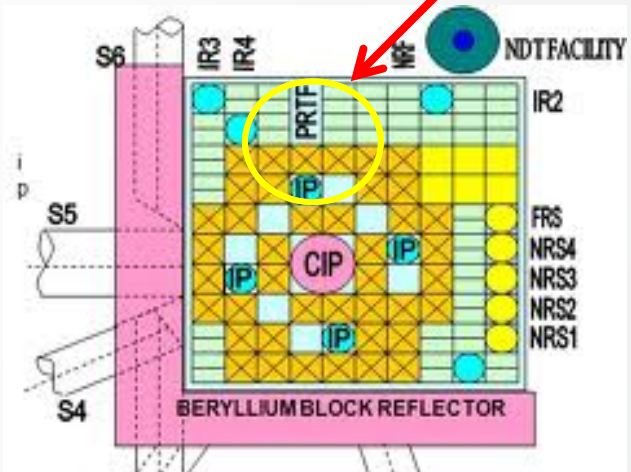


Power Ramp Test Facility

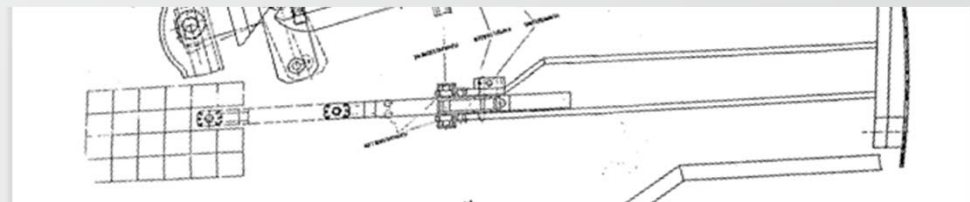
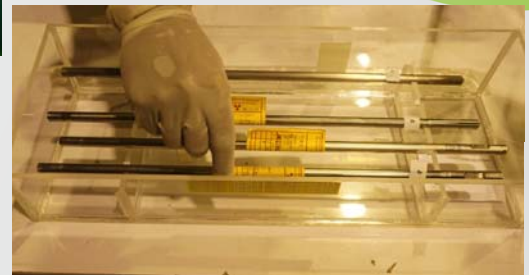
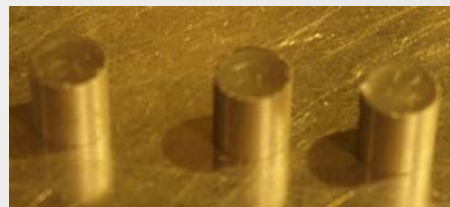
PRTF



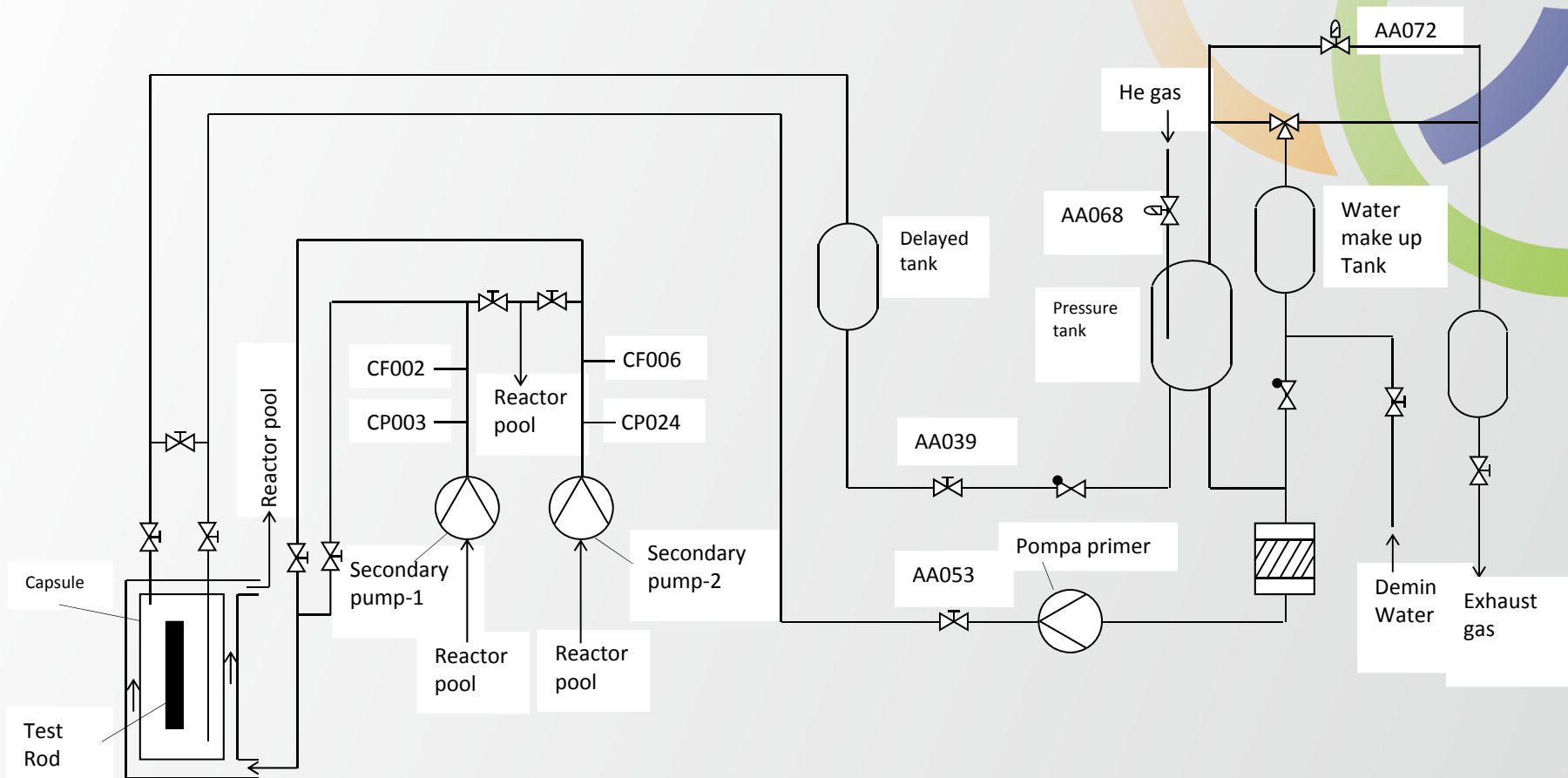
Location of Irradiation and Facility



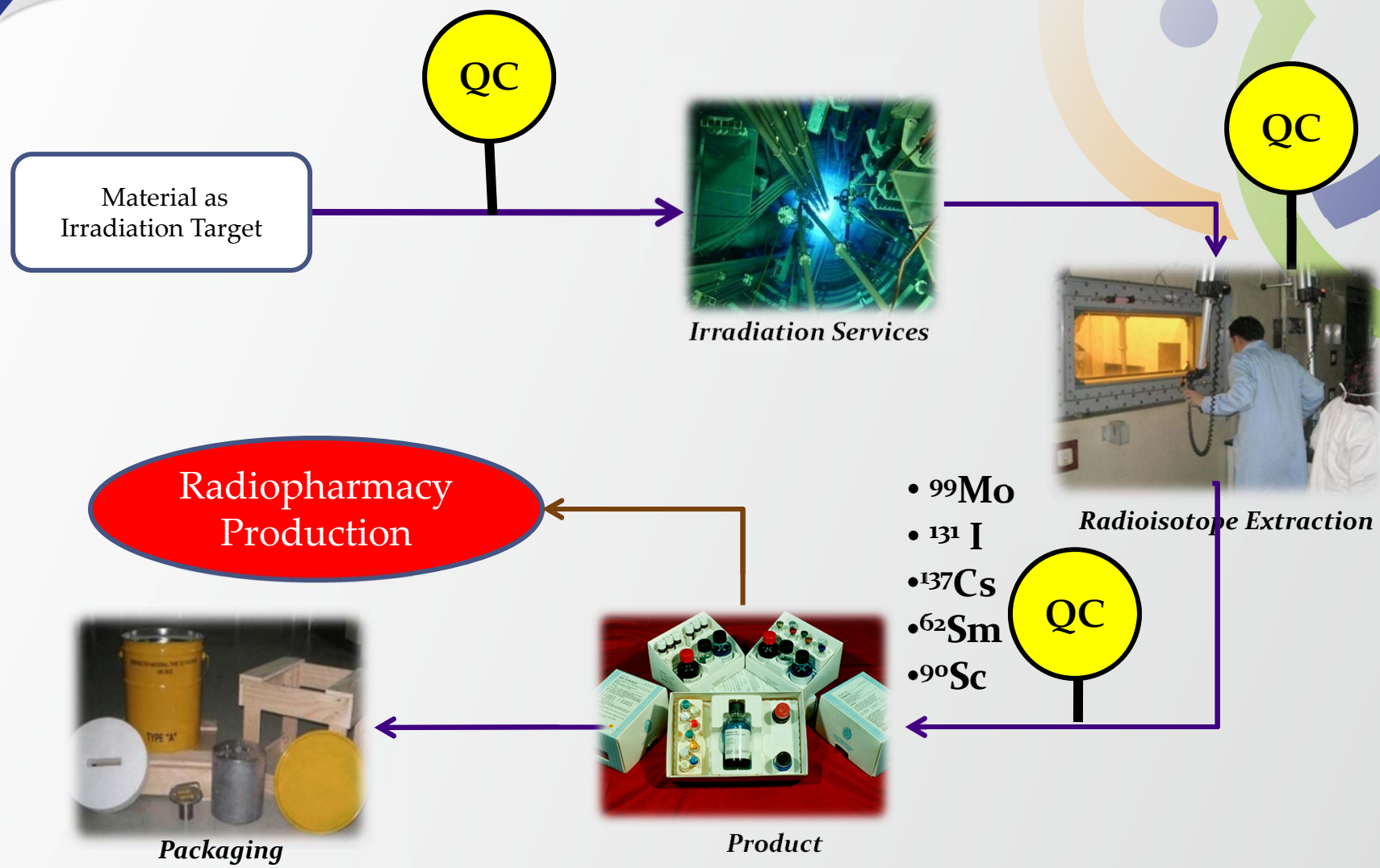
PARAMETER	LIMIT VALUE	SETTING VALUE	OLC
Minimum cooling flow	644 l/h (1 pump)	600 l/h (1 pump)	750 l/h (1 pump)
Max cooling flow	1000 l/h (1 pump)	900 l/h (1 pump)	750 l/h (1 pump)
ΔT Cooling (2 dari 3)	37 K	23 K	16 K
Max pressure of prim colling		162 bar	160 bar
Cooling Material Activity		2×10^4 cps	1000 cps



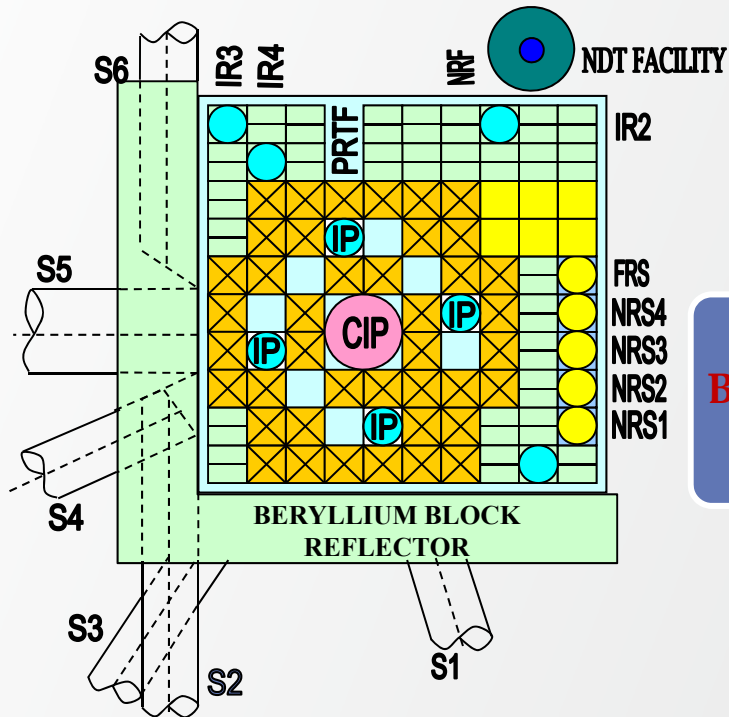
Installation of PRTF



Radioisotope Production



Neutron Spectrometer and Diffractometer



**Neutron
Beam Tubes :
6 Tubes**

**S1 : Iodine
Production**

S2 : RN1

S3 : unused

S4 : SN1

S5

S6: DN1

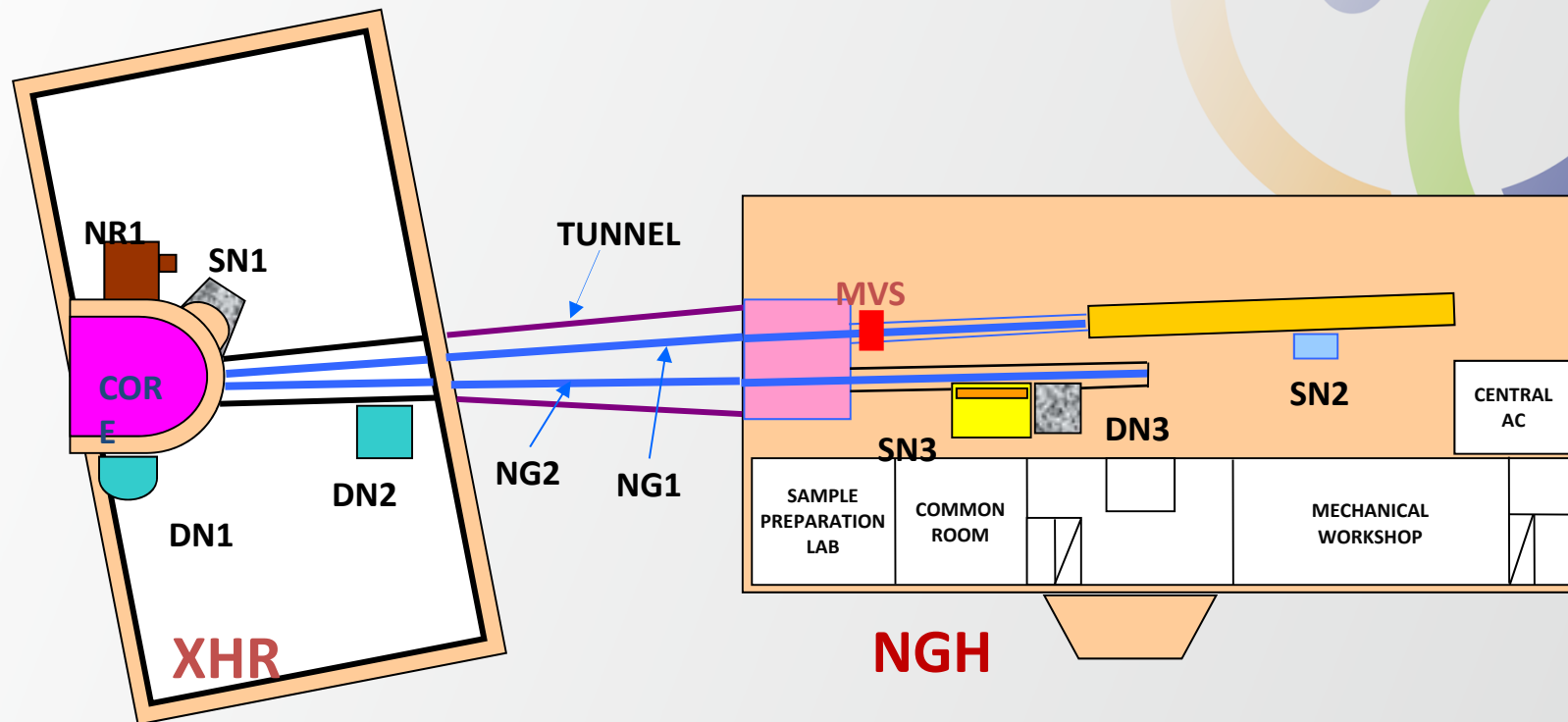
S5-NG1: SN2

S5-NG2-1:
DN2

S5-NG2-2 :
SN3

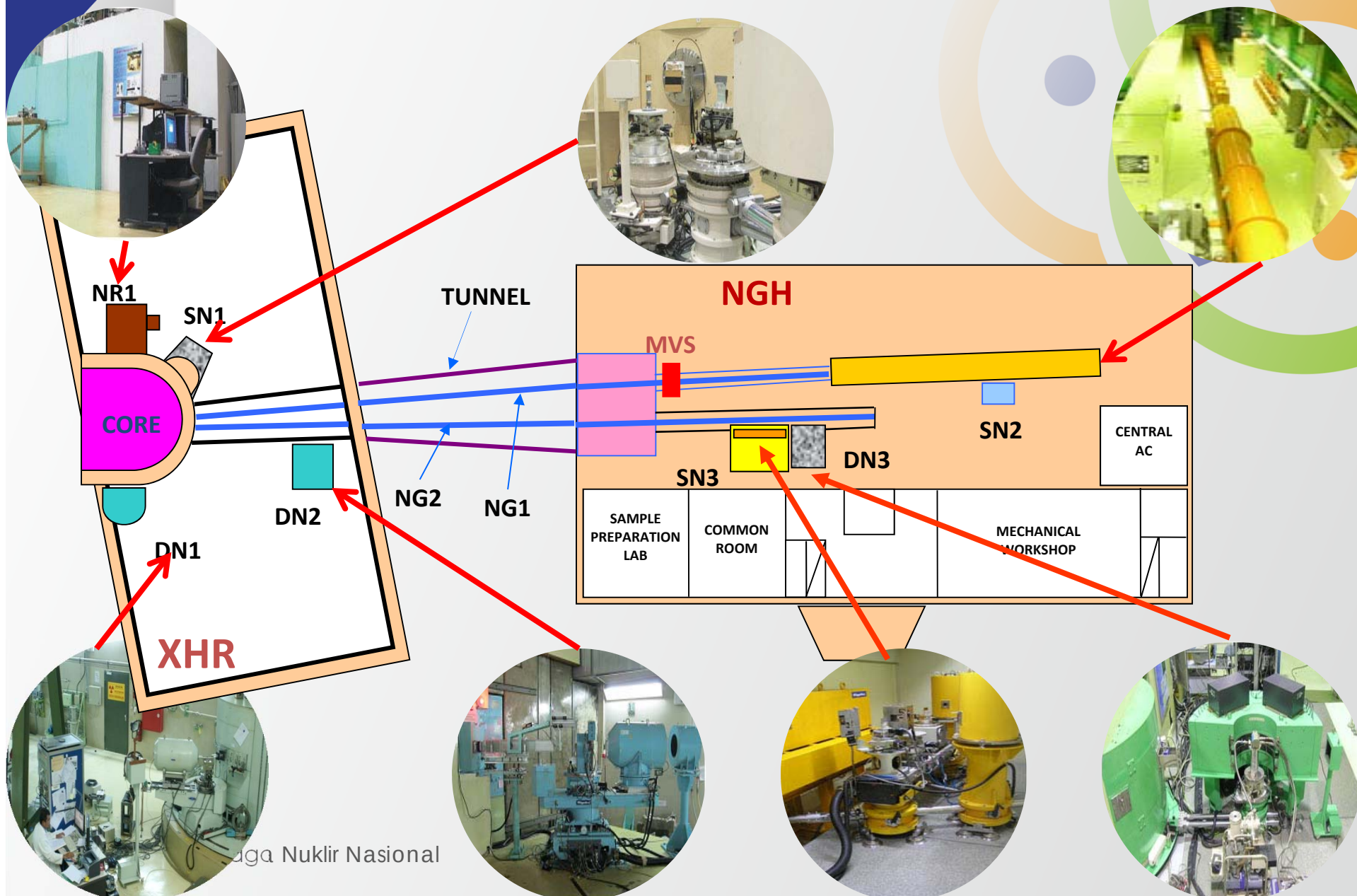
S5-NG2-3 :
DN3

Beam Channel Installation



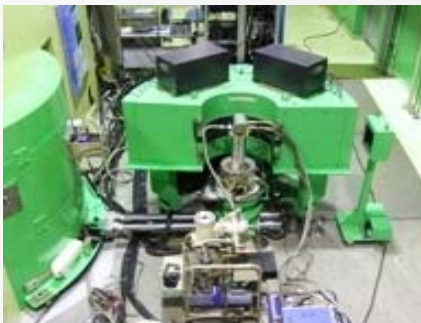
XHR	: eXperimental Hall of Reactor	DN1	: Neutron Diffractometer for Residual Stress Measurement
NGH	: Neutron Guide Hall	DN2	: Four-Circle Diffractometer/Texture Diffractometer
NG	: Neutron Guide	DN3	: High Resolution Powder Diffractometer
NG1	: First Neutron Guide	SN1	: Triple Axis Spectrometer
NG2	: Second Neutron Guide	SN2	: Small Angle Neutron Scattering Spectrometer
NR1	: Neutron Radiography Facility	SN3	: High Resolution Small Angle Neutron Scattering Spectrometer

Spectrometer and Diffractometer Facilities



Neutron Beam Tubes Instrument Capabilities

Material characterizations from atomic scale to macro scale



Crystal structure
(atomic scale: $\sim \text{\AA}$)



Molecular structure
(nano scale: $\sim \text{nm}$)



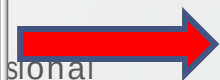
Molecular structure
(micro scale: $\sim \mu\text{m}$)



Defects
(macro scale: $\sim \text{mm}$)

→ Sizes

Neutron
Diffractometers



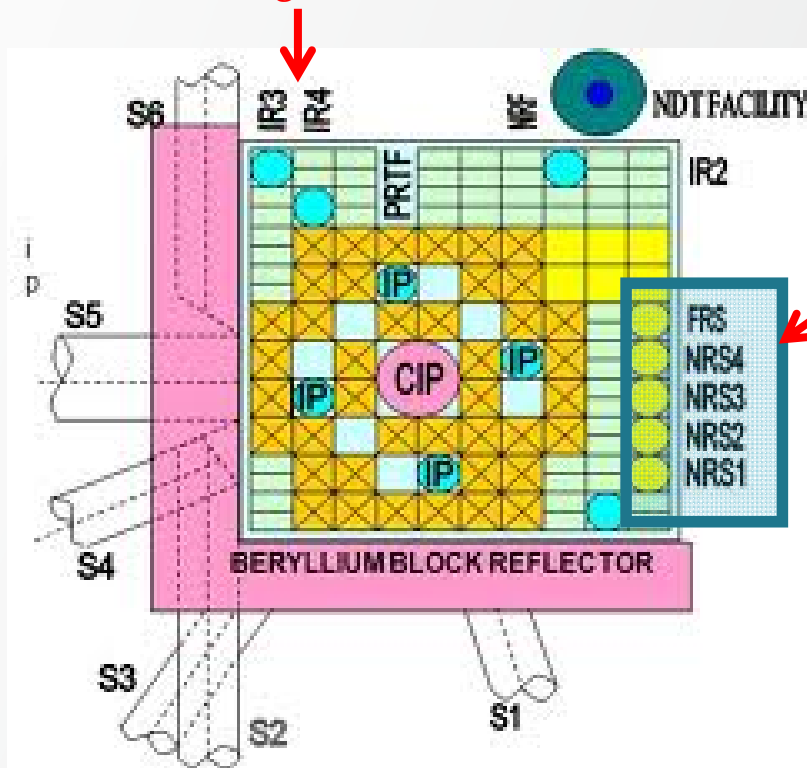
Neutron
Spectrometers



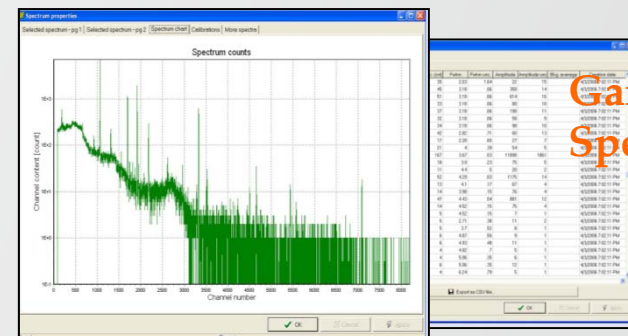
Neutron
Radiography

Neutron Activation Analysis

NAA:
Long & Medium Irradiation



NAA:
Short Irradiation



Gamma
Spectrometer

Irradiation Facilities:
1 CIP, 4 IP, 4 HRS and 1 PRS

Software: Genie 2000,
k0-DSM, ko-IAEA

Analysed samples:
Food, soil, biological stof, rock, blod and Seed

Neutron Radiography



Instrument Characteristics

Neutron source	: BEAM TUBE S2
Neutron flux at sample position	: 10^6 to 10^7 n/cm ² sec
Beam size at sample position	: 30 cm (dia)
Collimator L/D ratio	: 83
Cadmium ratio	: 6.4
Neutron/Gamma ratio	: $>10^5$ n/cm ² /mR
Radiography techniques	: Gd converter and X-ray film, Li ⁶ -ZnS scintillator screen, CCD based electronic imaging system.

Methods

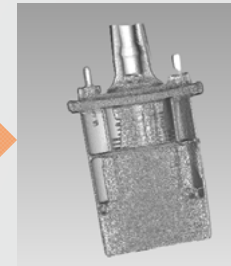
- Film method
- Real time method using CCD camera
- Neutron Tomography method

Utilization:

Materials inspections: industrial product, archaeological samples



Ignition coil

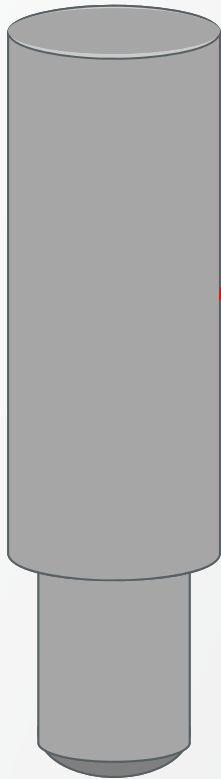


Archaeological object

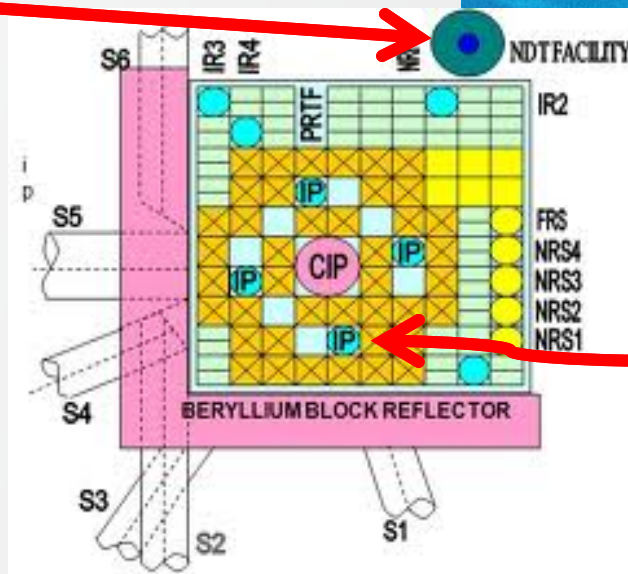


Gem Stone Coloration

1. Out Core Irradiation Facility



Produce:
17.5 kg-50
kg /month



2. In Core Irradiation Facility

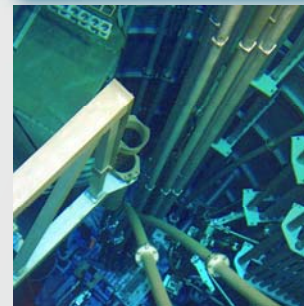
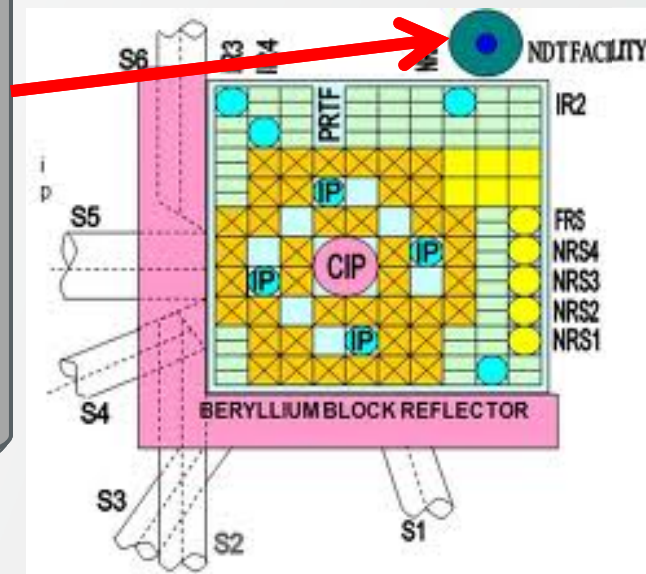
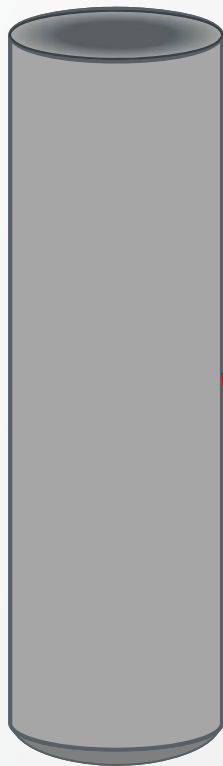
Training and Education

- Training for Operator and Maintenance Technicians
- Workshop on Ageing and Reactor Utilization
- Nuclear emergency preparedness drilling for local, district and national level.
- Dissemination of technology and nuclear energy to the public



Utilization Plan: Neutron Transmutation Doping

- Design and produce special container equipped with moderator and reflector
- Irradiating various dimensions of silicon ingots



Reactor Maintenance Program

Type of Maintenance	Checking	Testing	Repairing	Inspecting	Replacing
Mechanical	✓	✓	✓	✓	✓
Electrical	✓	✓	✓	✓	✓
I&C	✓	✓	✓	✓	✓
Water Chemistry	✓			✓	
Physical Protection	✓	✓	✓	✓	✓
Rad Protection	✓	✓	✓	✓	✓
Utilization Facilities	✓	✓	✓	✓	✓

Ageing Program

All Component

Component that
ageing
significantly

Age related
Components

Safety related
Components

Utilization
related
Components

INSPECTION EQUIPMENTS AND TECHNIQUES

Non Visual inspection equipment	Function
Radiography	To determine the condition of the inside components, using the technique of photography, with a light source is replaced with a beam of X-ray, gamma, or neutron
Ultrasonic Test	Knowing the thickness and defects in the bottom surface of the material with the principle of ultrasonic wave propagation
Eddy Current Test	Detect any cracks, defects in the bottom surface of the material with the principle of continuity of electric current flow
In-situ Hardness Test	Knowing the level of material toughness
Dye Penetrant Test	To find cracks, small holes (pin holes)
Helium Leak Test	Leakage test vessel. Tubes, pipes closed at both ends
Vacuum Test	Leakage test vessel. Tubes, pipes closed at both ends
Hydrostatic Test	Leakage test vessel or piping system

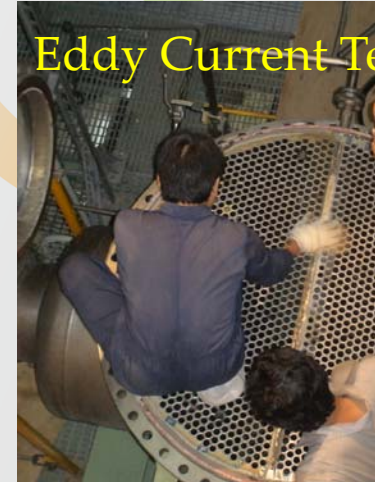
Practical Activities on Ageing

Visual Inspection



Pipe Replacement

Eddy Current Test



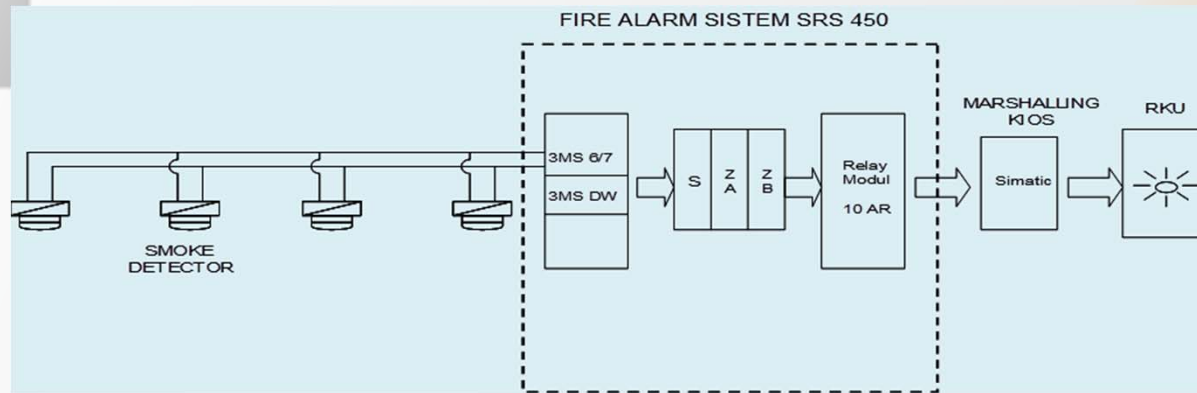
Infra Red Detection



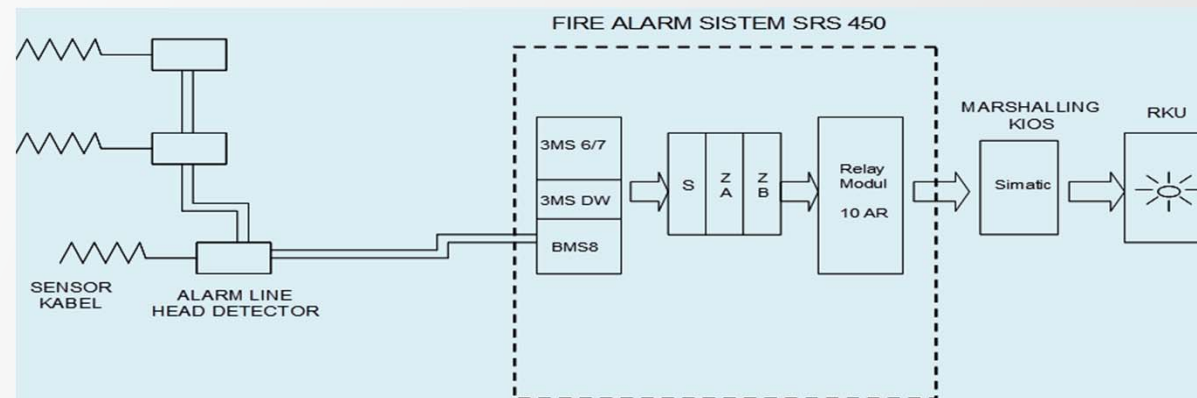
Ultrasonic Test



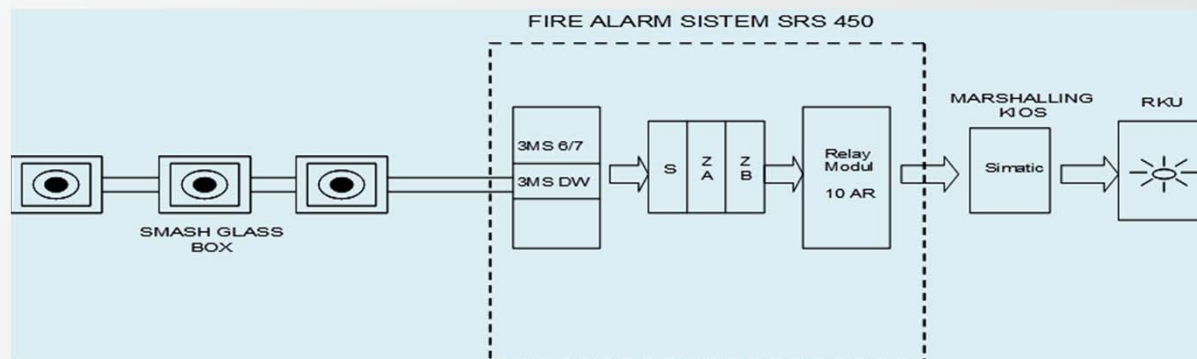
Fire Protection System



smoke detector



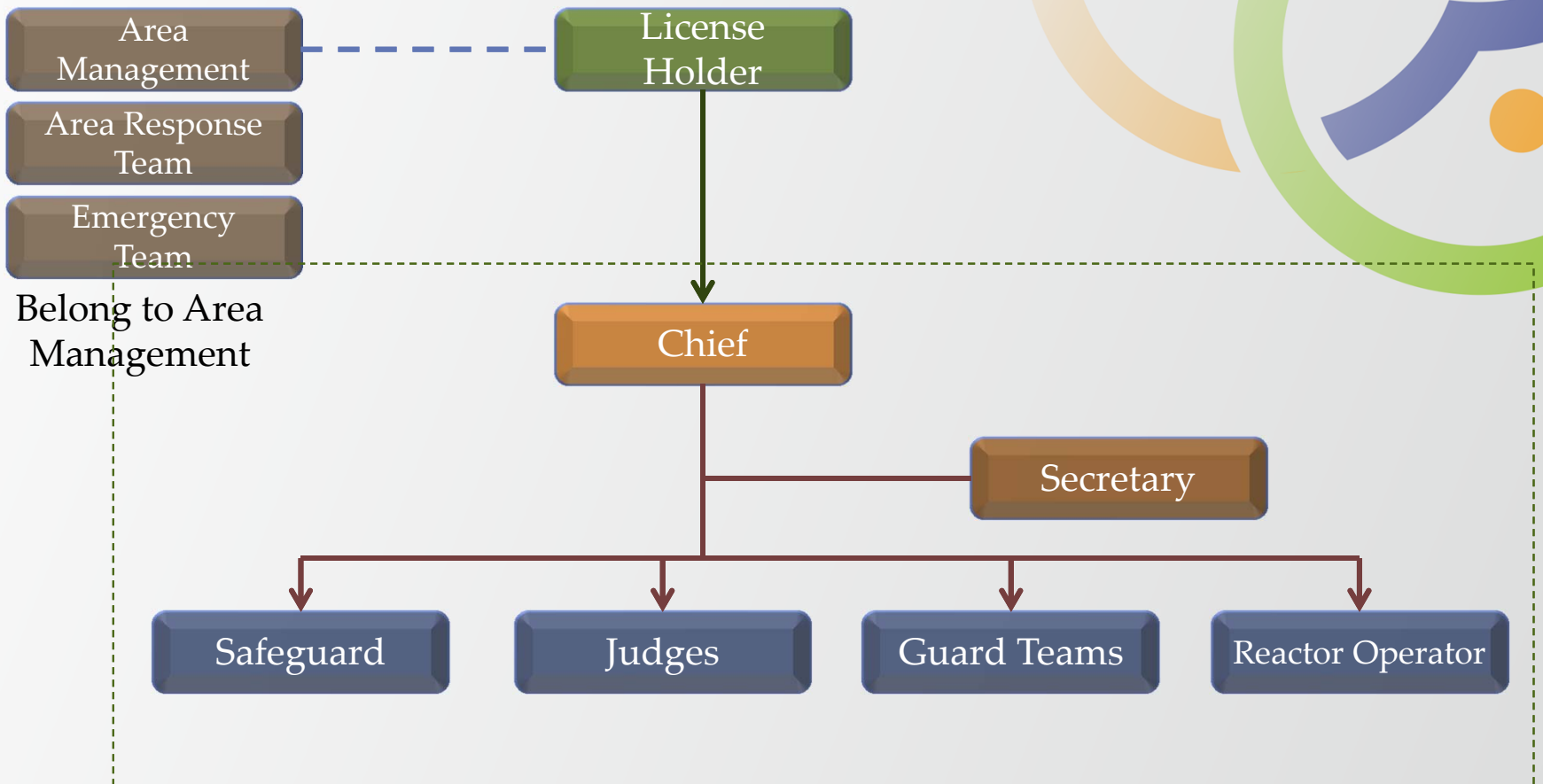
Line Alarm



smash glass box

Organization Structure of Physical Protection in RSG-GAS Reactor

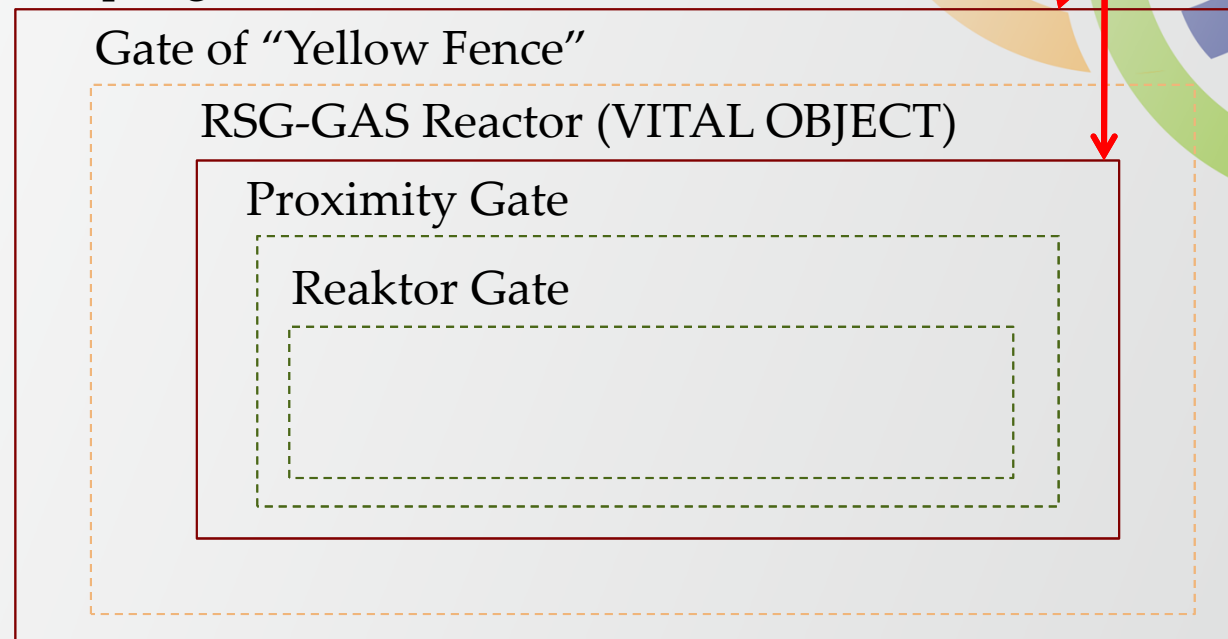
Based on BATAN Chief Decree No.1 Year 2009: #18



Physical Protection Design

Puspiptek Area (LIMITED AREA)

Serpong Nuclear Area (PROTECTION AREA)



Target of the Physical Protection



Reactor



Vital
Building



Uranium



Vital/Important
Research
Instrument

Conclusion

- RSG-GAS reactor is a multipurpose research reactor with multi utilization
- Operation of RSG-GAS is conducting safety and procedures to implement the law and other corresponding regulation.
- Management of RSG-GAS reactor plans to operate the RSG-GAS reactor for 152 days in 2015.
- Utilization of RSG-GAS reactor is going to develop the achievement for safety.



**FOR YOUR
ATTENTION**

THANK YOU

VERY

MUCH