Ageing Management Activities for Three Indonesian Research Reactor

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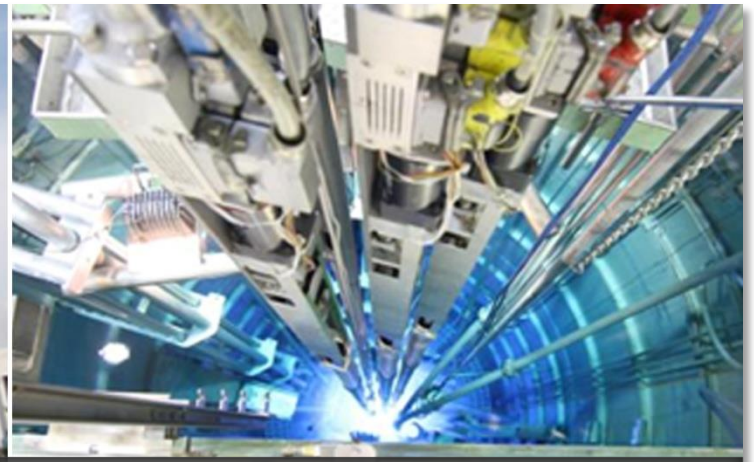
Research Reactor in Indonesia

TRIGA 2000 Reactor

- Located : Bandung
- Operational 1965, Power 250 kW
- Upgrades 250 kW to 1000 kW
- Upgrade 1000 kW to 2000 kW, in 2000
- Function : research and isotope production
- License : 2027

Kartini Reactor

- Located : Yogyakarta
- Operational 1979
- Power 100 kW
- Function : research and training for reactor operator
- License : 2029



RSG G.A Siwabessy

- Located : Serpong, Tangerang
- Operational 1987
- Power 30 MW
- Function : research, isotope production and material testing
- License : 2030

AMP at Indonesian RR's

- All indonesian RR's implemented AMP, IAEA standard SSG-10 and Bapeten regulation number 8, 2008;
- AMP is implemented by the establishment of AMP documents submitted to Bapeten as a license proposal;
- AMP document updated, important think on AMP program is determination critical SSC;
- Every 5 years operator shall submit AM report to Bapeten, PSR updated;

SSCs Screening at Bandung TRIGA 2000 facility

SSCs	Important to Safety (Y/N/M)	ease of replacement	Ageing mechanism
Category I			
Reactor tank	Y	A	1;2;3;4;5;6;7
Category II			
1. Reactor interior	Y	A;B	1;2;3;4;5;6;7
➢ Grid plate	Y	A;B	1;2;3;4;5;6;7
➢ Core platform	Y	A;B	1;2;3;4;5;6;7
➢ Safety plate	Y	A;B	1;2;3;4;5;6;7
➢ Fuel elements (SF, IFE, FFCR)	Y	A;B	1;2;3;4;5;6;7
➢ Core Reflector (graphite)	Y	A;B	1;2;3;4;5;6;7
2. Reactor structure	Y	A;B	1;2;3;4;5;6;7
➢ Biological shielding	Y	A;B	1;2;3;4;5;6;7
3. Cooling system	Y	B	2;3;4;5;6;7
4. Instrumentation & Control System	Y	B	1;2;8;9
5. Power Supply	Y	B	2;8;9
6. Ventilation system	Y	B	3;4;5;6;7
7. Irradiation facilities	N	B	1;2;3;5;6

SSCs Screening at Bandung TRIGA 2000 facility

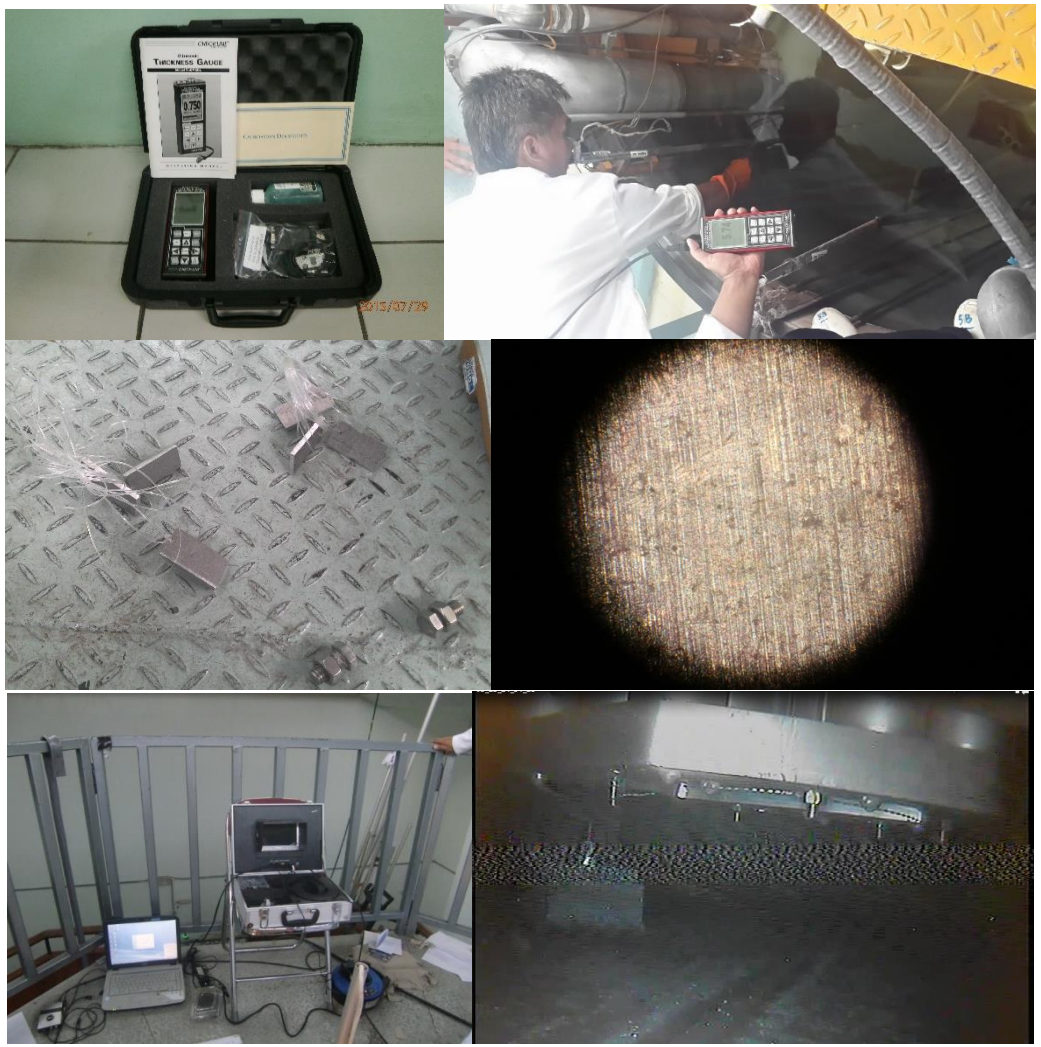
SSCs	Important to Safety (Y/N/M)	ease of replacement	Ageing mechanism
Category III			
1. Water purification system	N	B	2;3;4;5;6;7
2. Reactor demineralizer system	Y	B	2;3;4;5;6;7
3. N-16 Diffuser system	Y	B	1;2;3;4;5;6
Category IV			
Fuel storage system	N	B	1;3;5;6;7
Fuel handling system	N	B	1;5;6

Important to safety?	Ease of replacement	Ageing mechanisms
Y: Yes	A: Very difficult	1: Changes of properties due to neutron irradiation
N: No	B: Difficult technically or costly	2: Changes of properties due to temperature service conditions
M: Maybe, depending on specific reactor design and features; see also footnote 1 on page 1.	C: Normal	3: Stress or creep (due to pressure and temperature service conditions)
		4: Motion, fatigue or wear (resulting from cycling of temperature, flow and/or load, or flow induced vibrations)
	D: Readily	5: Corrosion
		6: Chemical processes
		7: Erosion
		8: Changes of technology
		9: Changes of regulations
		10: Obsolescence of documentation

- Based on this screening table the reactor tank is declared as the most critical SSCs
- A comprehensive treatment is implemented for reactor tank
- Reactor tank become the reference for ageing assessment for the lifetime of Bandung TRIGA 2000 facility

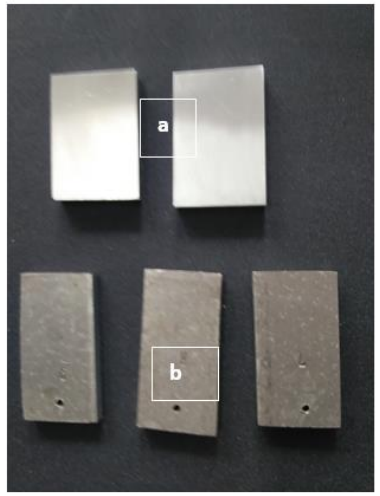
Surveillance Activity at Bandung TRIGA 2000 RR facility – Reactor tank

- Thickness measurement using Ultrasonic Thickness Gage
- Corrossion rate measurement using couponds
- Visual imaging using underwater camera



Surveillance Activity at Bandung TRIGA 2000 RR facility – Al Coupond

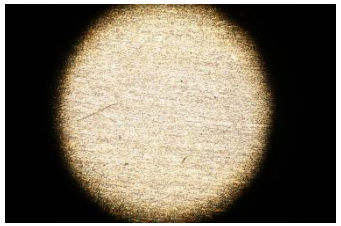
- 3 couponds from 3 different depth 2 m, 4 m, 6 m
- Macro imaging of samples before and after immersion is obtained using microscope

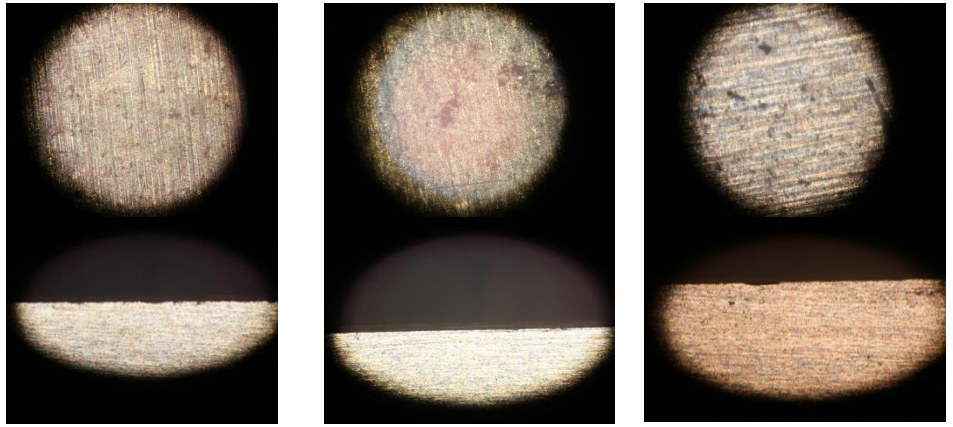


Sampel Al 6061
a) Before immersion & b) after immersion

After immersion at 2 m; 4 m; 6 m

Before immersion





Surface view

Cross section view

Surveillance Activity at Bandung TRIGA 2000 RR facility – Al Coupond

No. coupond	Initial mass (gr)	Final mass (gr)	Δ mass (gr)	Length (cm)	Wide (cm)	thickness (cm)	Surface area (cm^2)	CR mmpy
7 (2 m)	16.0745	15.9745	0.1000	4.83	2.607	0.4	31.13322	0.010205
8 (4 m)	16.725	16.6956	0.0294	5.053	2.63	0.4	32.72518	0.002854
9 (6 m)	16.5205	16.5121	0.0084	4.903	2.65	0.4	32.0283	0.000833

- Sampel at 2 m depth has the highest corrosion rate, 0.010205 mmpy
- At the shallow depth, the oxidation rate is higher because near the open air.
- At this highest corrosion rate, the Bandung TRIGA 2000 facility is still convenience in reference to 6 mm thick of Al-liner.

SSCs Screening at Kartini facility

SSCs	Important to Safety (Y/N/M)	ease of replacement	Ageing mechanism
Category I			
Reactor tank	Y	A	1;2;3;4;5;6;7
Category II			
1. Reactor interior	Y	A;B	1;2;3;4;5;6;7
➢ Grid plate	Y	A;B	1;2;3;4;5;6;7
➢ Core platform	Y	A;B	1;2;3;4;5;6;7
➢ Safety plate	Y	A;B	1;2;3;4;5;6;7
➢ Fuel elements (SF, IFE, CR)	Y	A;B	1;2;3;4;5;6;7
➢ Core Reflector (graphite)	Y	A;B	1;2;3;4;5;6;7
2. Reactor structure	Y	A;B	1;2;3;4;5;6;7
➢ Biological shielding	Y	A;B	1;2;3;4;5;6;7
3. Cooling system	Y	B	2;3;4;5;6;7
4. Instrumentation & Control System	Y	B	1;2;8;9
5. Power Supply	Y	B	2;8;9
6. Ventilation system	Y	B	3;4;5;6;7
7. Irradiation facilities	N	B	1;2;3;5;6

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Category IV			
Fuel storage system	N	B	1;3;5;6;7
Fuel handling system	N	B	1;5;6

Important to safety?	Ease of replacement	Ageing mechanisms
Y: Yes	A: Very difficult	1: Changes of properties due to neutron irradiation
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- Based on this screening table the reactor tank is declared as the most critical SSCs
- A comprehensive treatment is implemented for reactor tank
- Reactor tank become the reference for ageing assessment for the lifetime of Kartini facility

Surveillance Activity at Kartini RR – Tank Liner

- In order to assure and maintain the safety of the reactor, ageing management program (AMP) has been implemented through in service inspection (ISI) to the reactor tank liner by using a series of non destructive methods
- two swellings features seen on the bottom of the tank observed under thermalizing column
- it is probable that the seal on the cover plate in the bulk shielding facility (BSF) has deteriorated and allowed water to enter both the thermalizing column and the space between the aluminium reactor tank liner and the concrete.
- modification of BSF has been conducted to remove the condition that are causing swelling.

(a) (b)

Fig.1. Bulk Shielding facility (a) Before modification and (b) After modifiction

Ageing management at RSG-GAS – SSCs Screening

SSCs	Important to Safety (Y/N/M)	ease of replacement	Ageing mechanism
Primary cooling system	Y	B	3;4;5;7
Secondary coling system	N	B;C	4;5;6;7
Primary purification system	Y	B;C	3;4;5;6;7
Warm layer system	Y	B/C	2;4;6;7
Fuel storage pool purification system	Y	B/C	3;4;5;6;7
Resin flushing system	Y	B/C	3;4;5;6;7
Pool cooling system	Y	B;C	3;4;5;7
Low active waste water system	Y	C	3;4;5;6;7
High active waste water system	Y	C	3;4;5;6;7
Primary component drainage	Y	B/C	3;4;5;6;7
Floor drains	N	C	3;4;5
Pool drainage system	N	C	3;4;5
Non-active waste water system	N	C	3;4;5
Demineralized water plant	N	C	3;4;5;6

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		10: Obsolescence of documentation

SSCs	Important to Safety (Y/N/M)	ease of replacement	Ageing mechanism
Dosing system	N	C	3;4;6
Compressed air system	N	C	2;3;4;5;7
Mechanical cleaning system	N	C	4;5;6;7
Refueling & transportation system	Y	C	3
Erection equipment for reactor pool	N	B;C	3;4;8
Reactor system (liner & interior)	Y	A (Al-liner); B (pipes)	1;3;4;5;7;8
Experimentation system	Y	A (beam tubes) B (other)	1;2;3;4;5
Control & shutdown elements	Y	C	2;4;5
Cranes and hoist	N	C	3;5
Ventilation system	Y	B/C/D	3;4;5
Chilled water plant reactor building	Y	B/C/D	3;4;8
Diesel building ventilation system	Y	C	3;4
Auxiliary building ventilation system	Y	C	3;4
Electrical power supply	Y	B/C/D	4;5
Instrumentation & Control system	Y	B/C/D	2;4;5;8
Reactor core & accessories	Y	B;C	1;3;4;5;8

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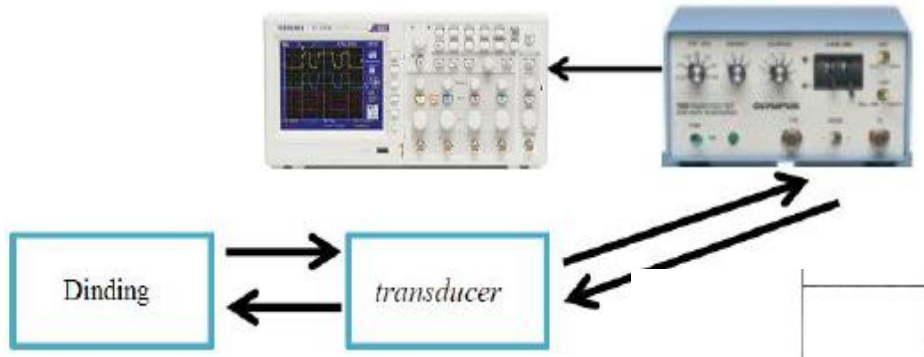
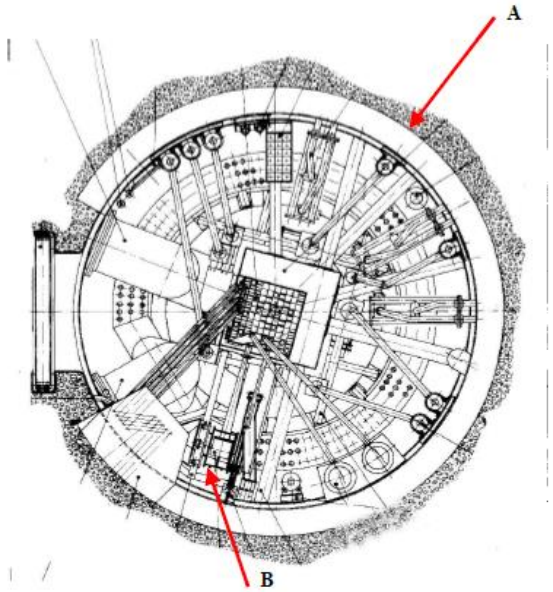
Surveillance Activity at RSG-GAS – Tank Liner

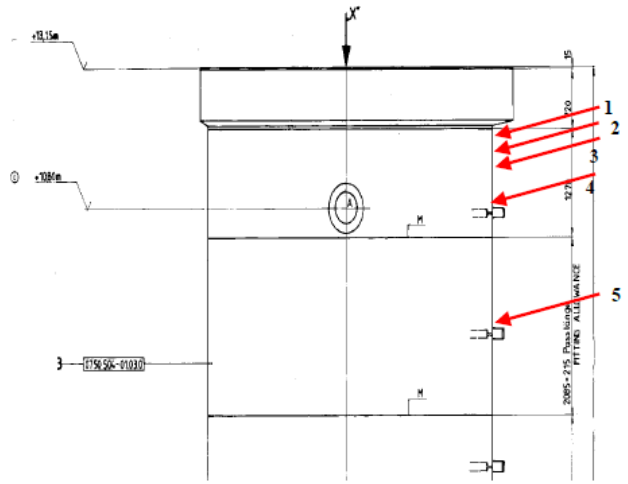
- using Ultrasonic thickness gage



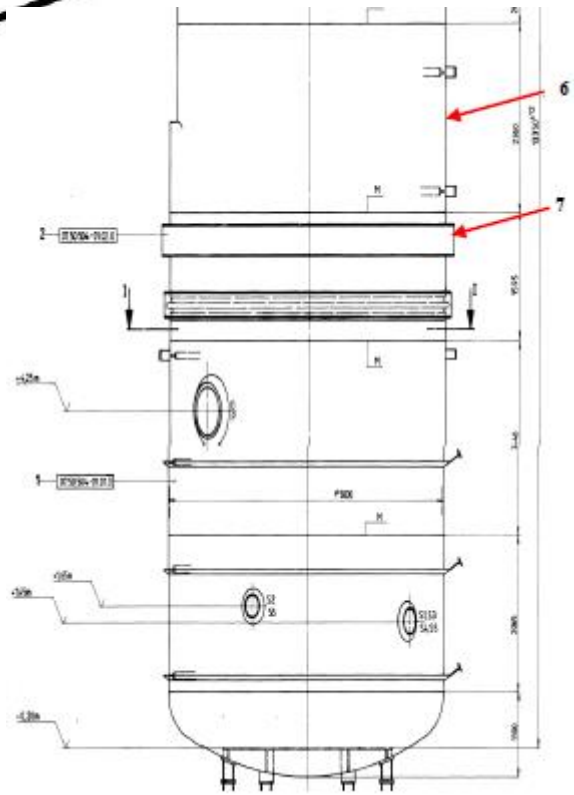
Measuring point



radially



Axially, upper segment



Axially, below segment

Future Action AMP

- tank linear measurement
- thermal imaging on reactor SSC
- in pile and out pile
- VIT of internal pool interior

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