Degradation Monitoring of G.A. Siwabessy Research Reactor's Secondary Cooling Pipe

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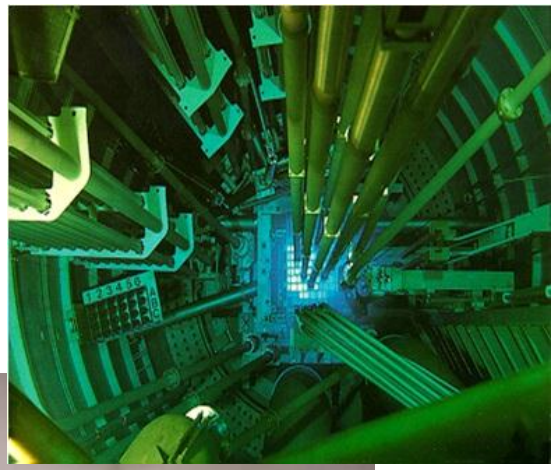
Introduction of G.A. Siwabessy Research Reactor

- One of three research reactor operated by BATAN
- Open pool type reactor
- 30 MW thermal power
- Multi purpose research reactor
  - Isotope Production
  - Material testing
  - Other Irradiation facility
- First criticallity was reached in 1987

Introduction of G.A. Siwabessy Research Reactor

- Flux neutron 10^{14} n/cm^2
- Fuel Element U_3Si_2Al
- Number of fuel elements : 40
- Number of control rod : 8
- Moderator : water
- Coolant : water



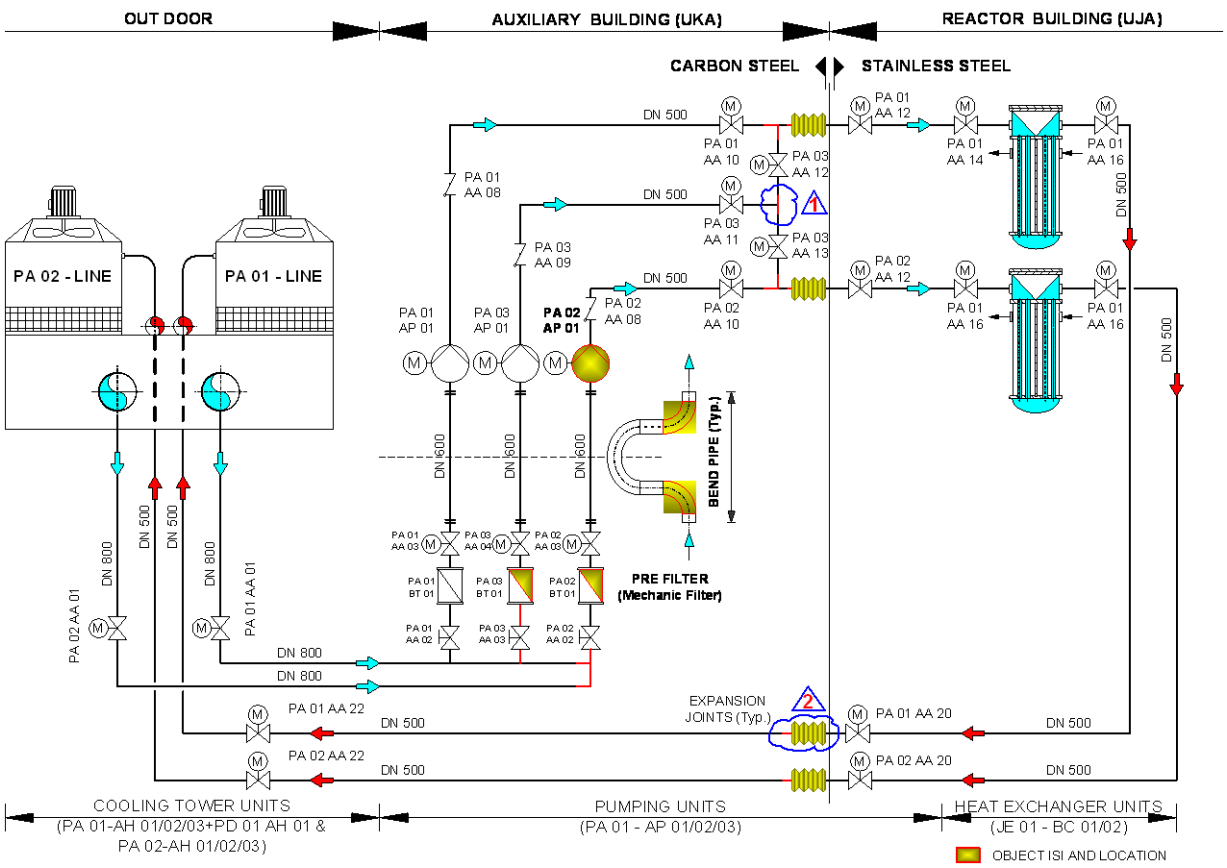
Ageing Management Programme for G.A Siwabessy Research Reactor

- Ageing Management wasn't considered in the initial operation
- After 16 years operation, many degradation phenomenons of SSC were observed, especially on seondary cooling system
- In 2003 AMP for research reactor was established (IAEA – EBP : NTC, Workshop, Experts mission)
- In-service inspections have been conducted to RR's SSC (mechanical components, electrical components, etc.)
- Many NDT methods have been applied to conduct ISI

Objectives of ISI

- To understand the degradation level of the secondary cooling system
- Mitigation/improvement/modification to minimize the degradation effects

Secondary Cooling System



Secondary Cooling System

Secondary Cooling system consists of many components, including

- Cooling tower
- Pumps
- Valves
- Piping system
- Mechanical Filter

Secondary Cooling System

Specifications of pipe in secondary cooling system

	Pipe #1	Pipe #2	Pipe #3
Material	R St. 37 .2	R St. 37 .2	Carbon steel
Standard	DIN 1626 Bl. 3	DIN 2673	ASTM A53-B
Diameter (mm)	813	610	510
Thickness (mm)	8	6,3	9

Secondary Cooling System

ISI methods applied to secondary cooling system

- Visual Inspection → Surface inspection
- Ultrasonic Flaw Detector → welded parts
- Ultrasonic thickness gauge → thickness measurement
- Ultrasonic thickness mapping → fine thickness mapping

Ultrasonic Flaw Detector

Ultrasonic Thickness Gauge

Ultrasonic Thickness Mapping

Ultrascan 5

Allow scanning up to 1mm in pitch.

Inspection History

- First inspection was performed in 2004
  - visual inspection
  - flaw detection
  - thickness measurement
- Second inspection was performed in 2007
  - thickness mapping
- Second inspection was performed in 2009
  - thickness measurement

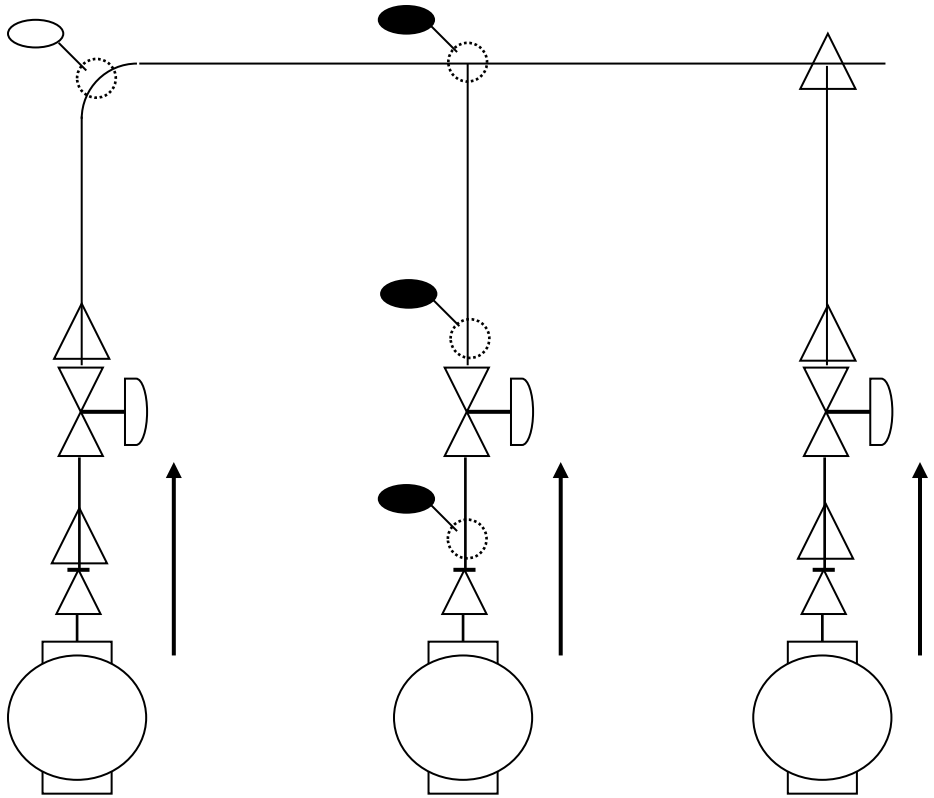
Inspection Methods

Visual Inspection

- Internal surface → using CCD Camera
- External surface → human eyes

Flaw Detection : According to ASME Section V

Ultrasonic Thickness Measurement

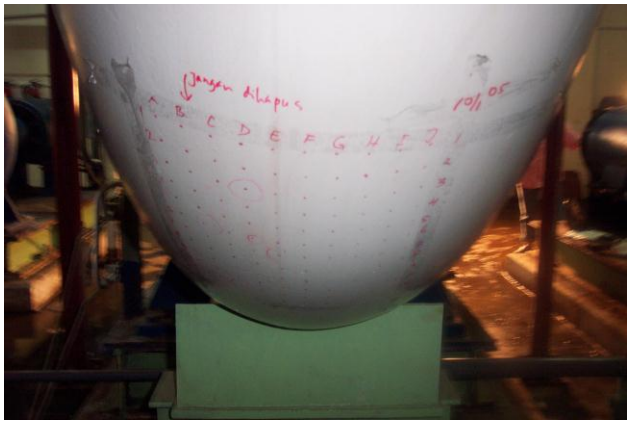


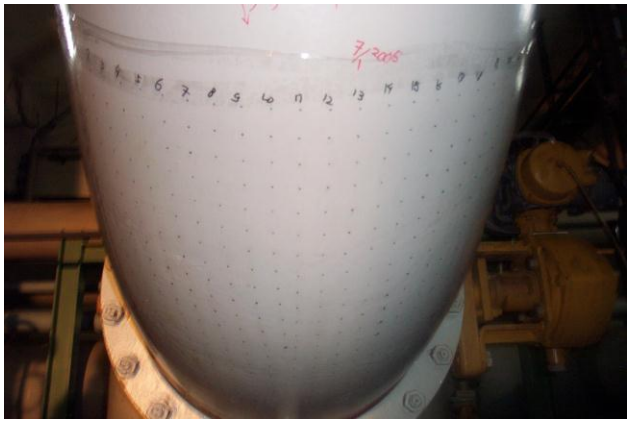
Inspected location

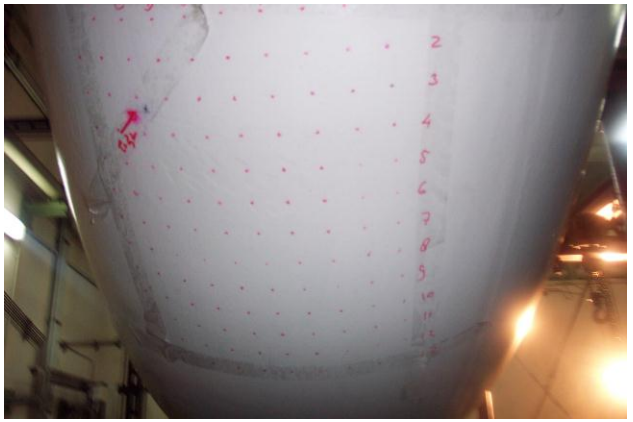
Inspected location (represenative)

Represented location

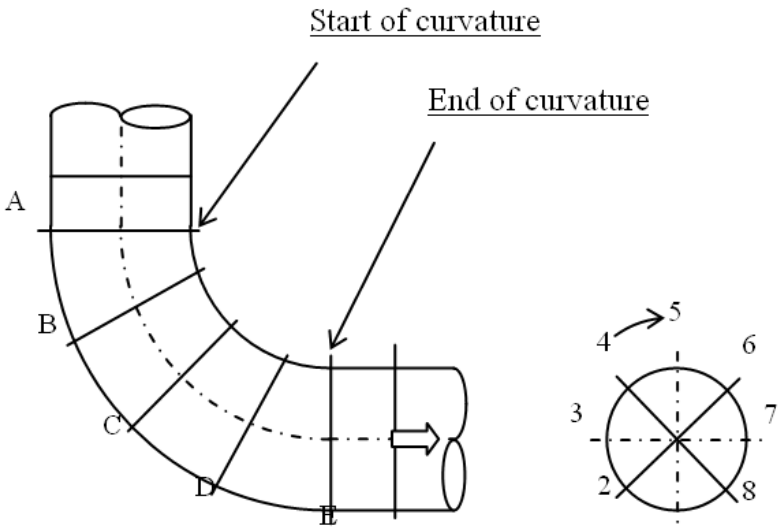
Ultrasonic Thickness Measurement (2004)

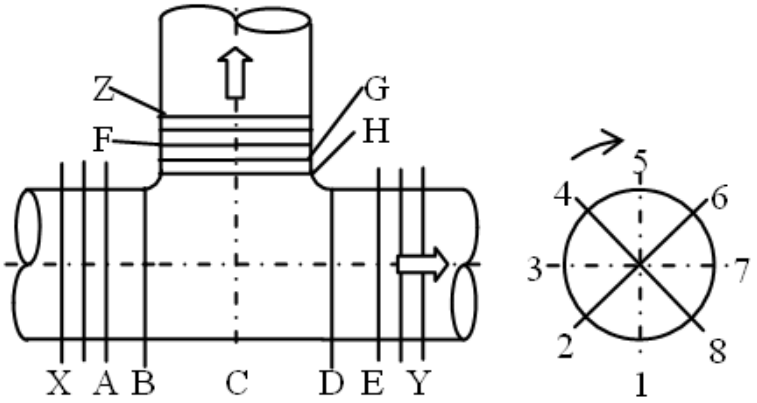






Ultrasonic Thickness Measurement (2009)

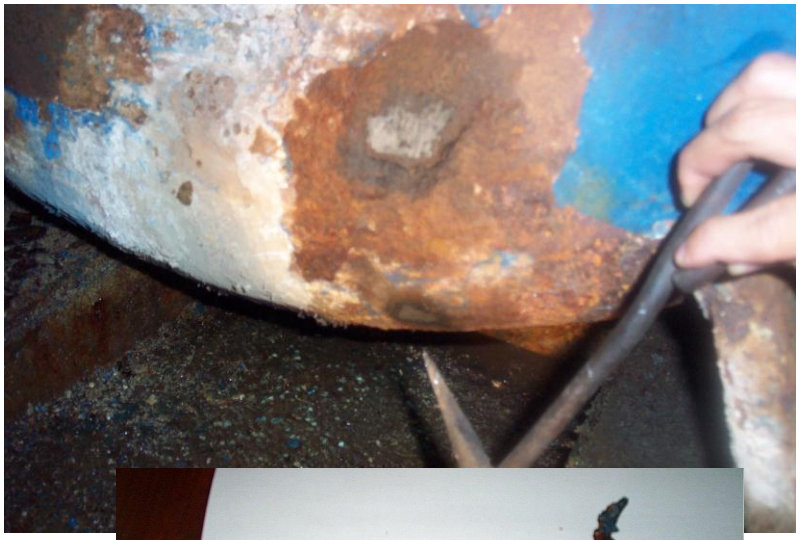


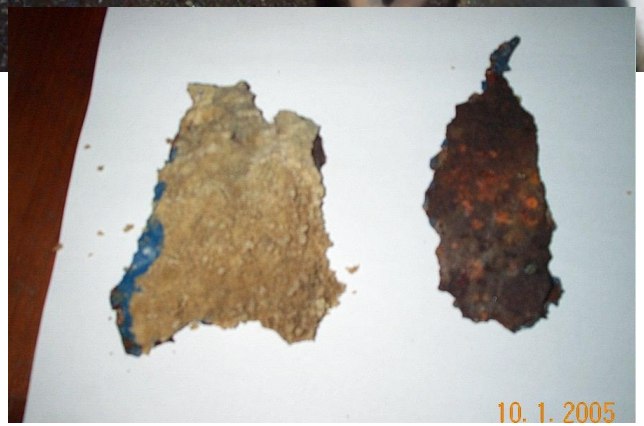


Inspection Results

Visual Inspection

Inspection Results



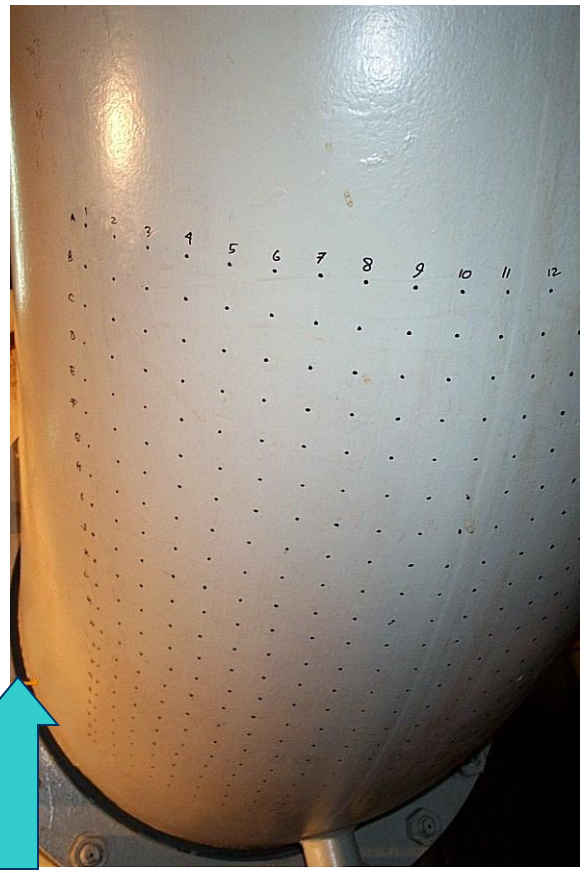


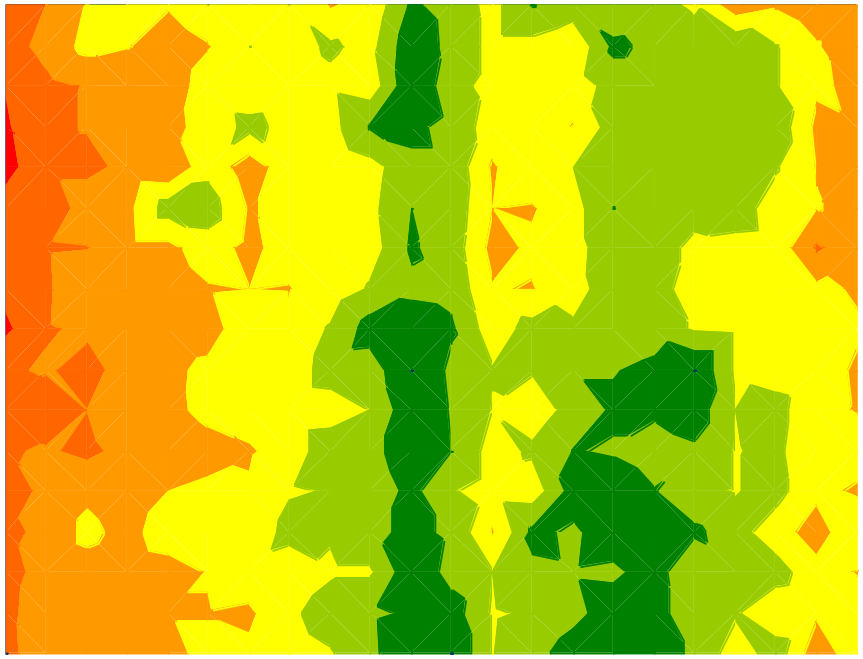
Inspection Results

Flaw detection : No significant indication observed

Thickness mapping : Indicated Pitting corrosion

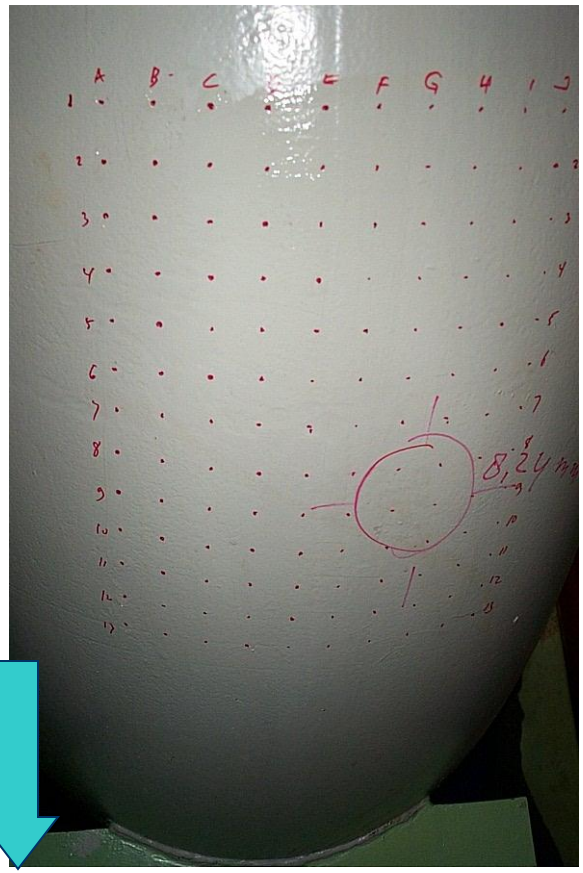
Inspection Results

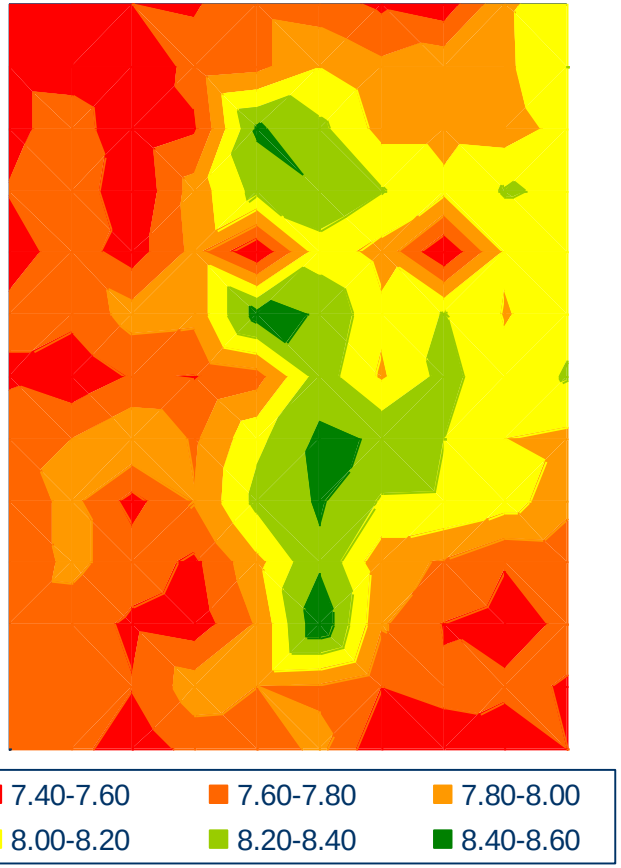




6.70-6.90 6.90-7.10 7.10-7.30 7.30-7.50 7.50-7.70 7.70-7.90

Inspection Results



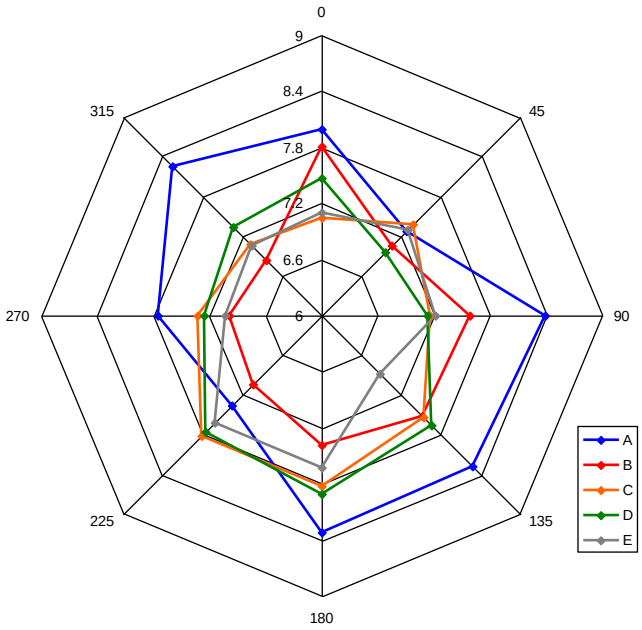


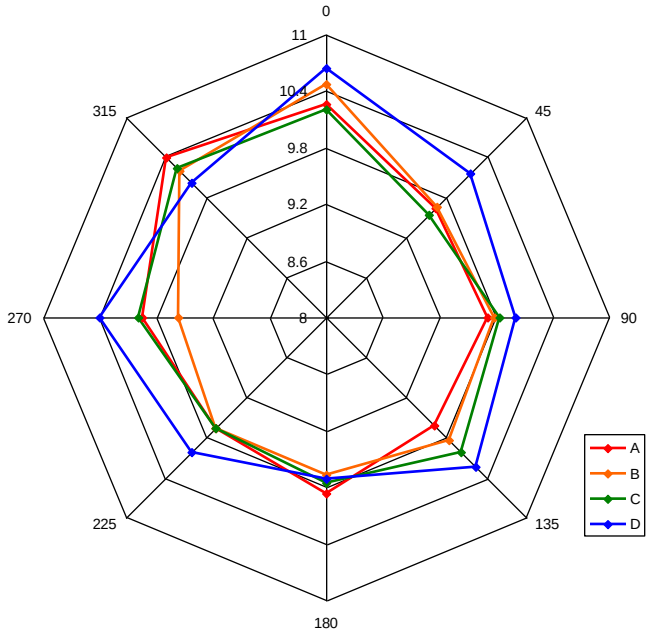
Consideration

Measurement results which larger than initial thickness are caused by

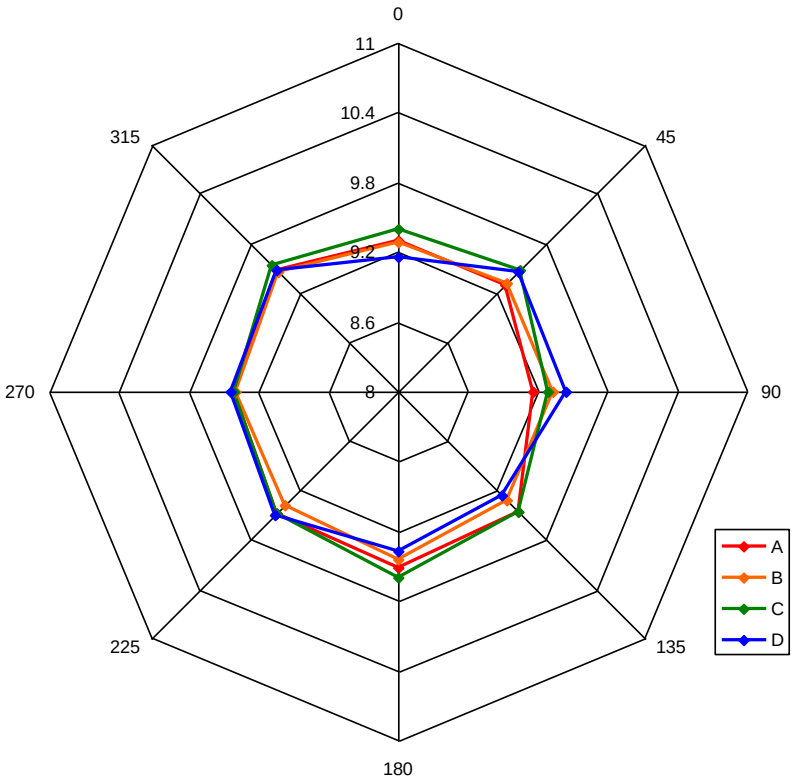
- Paint layer
- Corrosion (product)
- Sedimentation from cooling water (impurity of raw water, chemical agent)

Inspection Results





Inspection Results



Conclussion

- Degradation of pipe are due to homogenous and pitting corrosion rather than errosion-corrosion (flow accelerated corrosion)
- Improvement of water treatment are needed to suppress corrosion occurred in the internal surface

Next plan activity

- Core structure assessment
- Pool liner inspection
- Surveillance programme


Thank you for your attention