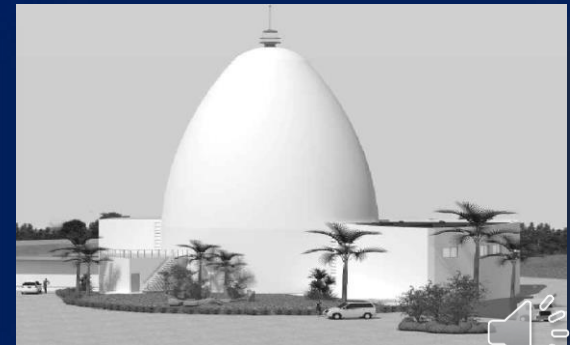


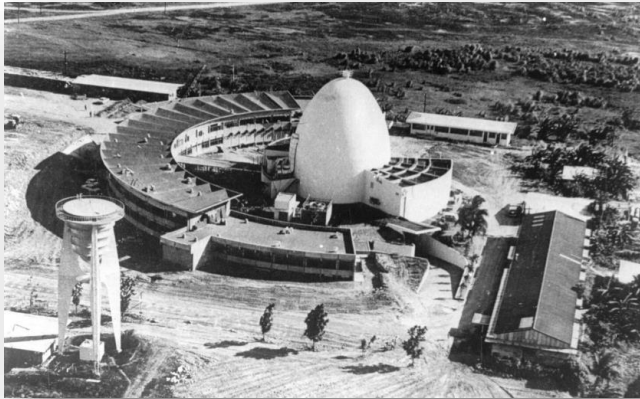
# Ageing Management Plan for PRR-1 SATER



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Nuclear Reactor Operations Section  
Department of Science and Technology  
Philippine Nuclear Research Institute



# Brief history of PRR-1



**1964** First operated at 1 MW

**1984** Upgraded to 3 MW TRIGA Reactor

**1988** Shutdown

**2005** Considered for decommissioning

**2014** Alternative endpoint considered

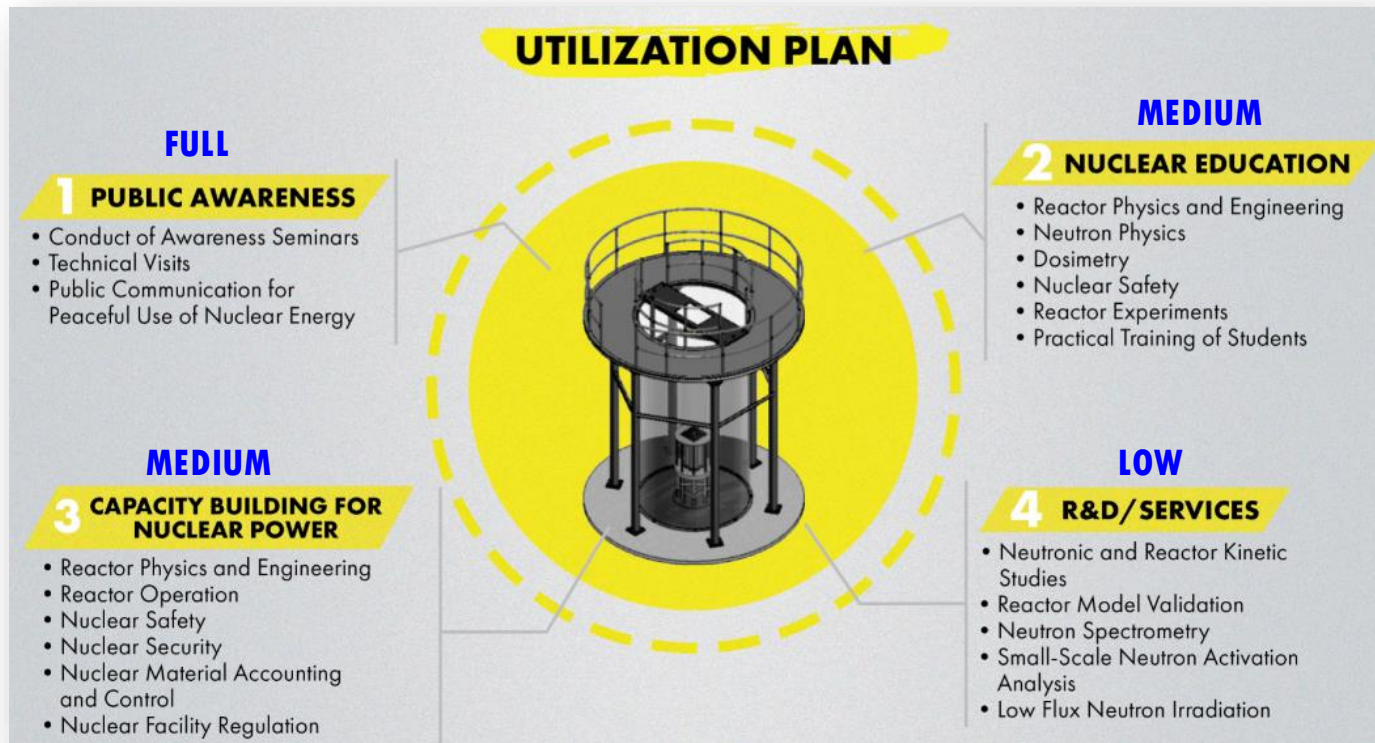
**2017** Start of establishment of PRR-1 SATER

**2022** Target start of PRR-1 SATER operation



# About PRR-1 SATER

Subcritical **A**ssembly for **T**raining, **E**ducation, and **R**esearch (**SATER**)

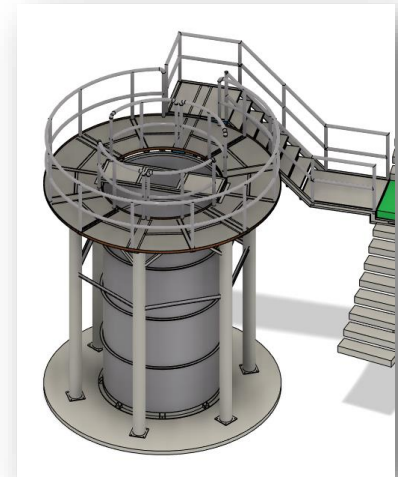


\*Full – full capability; Medium – some capability; Low – demonstration capability



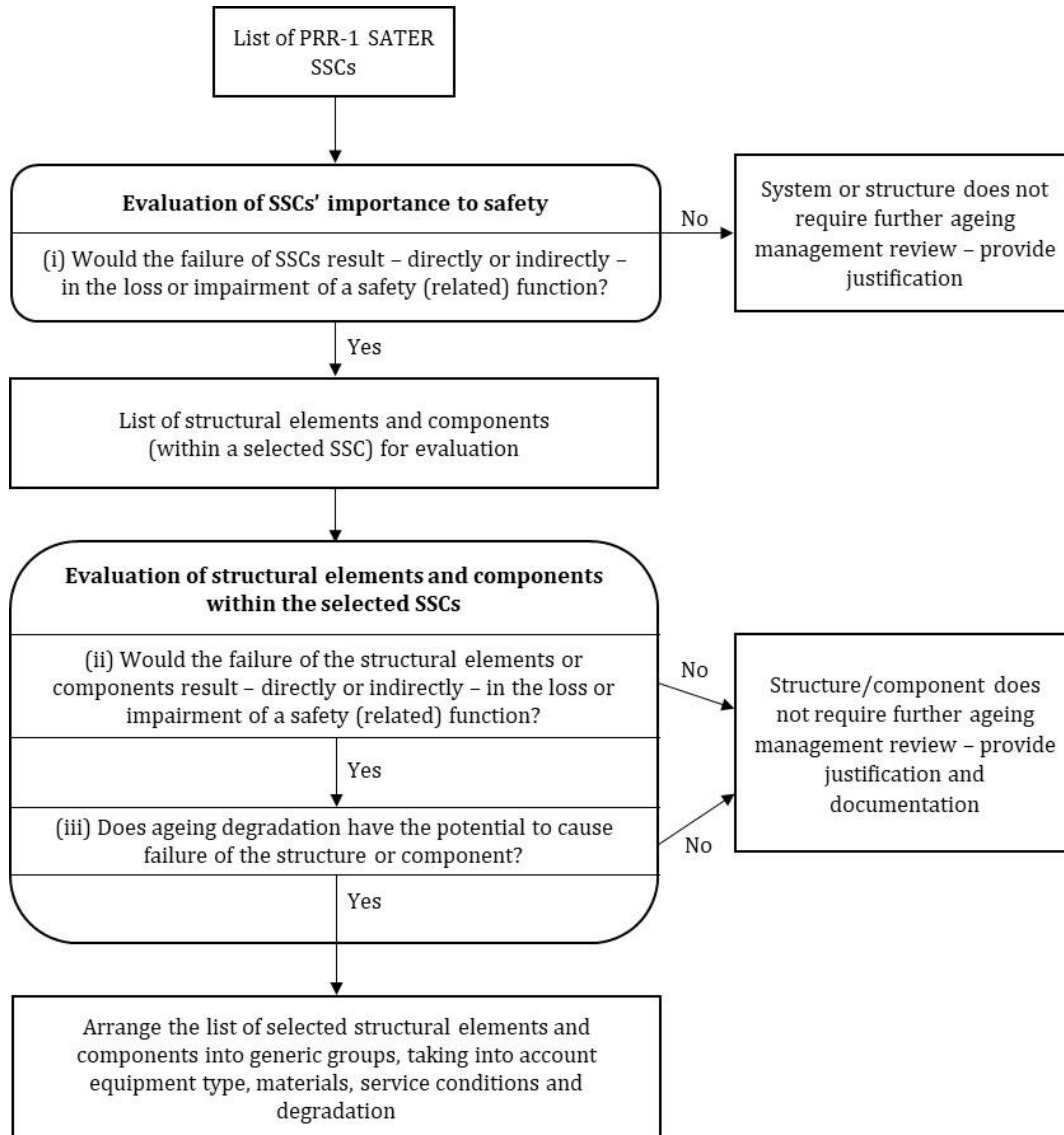
# About PRR-1 SATER

- ❑ PRR-1 is a **60-year-old** facility
- ❑ It will house the new **SATER** facility
- ❑ SSCs of PRR-1 SATER has a **wide range of age**
- ❑ Ageing will **virtually have no effect** on the safety-related functions of PRR-1 SATER
- ❑ An **Ageing Management Plan (AMP)** was developed as part of the license application for PRR-1 SATER
- ❑ The AMP for the facility **significantly graded**





# SSC screening for ageing management



Based on **IAEA SSG-10**:

1. SSCs are reviewed based on their importance or relation to safety
2. Specific elements of SSC important to safety are identified
3. SSC elements that are important to safety, which are susceptible to failure should be identified



# Application of SSC screening for PRR-1 SATER

- ❑ All SSCs of PRR-1 SATER has **non-nuclear safety (NNS)** functions
- ❑ Based on the screening process of IAEA SSG-10, none of the PRR-1 SATER SSCs require further ageing management review
- ❑ Nevertheless, a **graded evaluation** is applied based on the **non-nuclear safety-related functions** that should be fulfilled by the PRR-1 SATER SSCs:
  - (1) shielding against radiation; and
  - (2) uninterrupted monitoring of safety-related parameters.



# Application of SSC screening for PRR-1 SATER

## Guide for evaluating the PRR-1 SSCs (Adapted from Annex 1 of IAEA SSG-10)

Important to safety-related functions (SRF)?*	Ease of replacement	Ageing mechanisms
<b>Y: Yes</b>	A: Very difficult	1: Changes of properties due to neutron irradiation
<b>N: No</b>	B: Difficult technically or costly	2: Changes of properties due to temperature service conditions
<b>T: To some extent</b>	C: Normal D: Readily	3: Stress or creep 4: Motion, fatigue, or wear 5: Corrosion 6: Chemical processes 7: Erosion 8: Changes of technology 9: Changes of regulations 10: Obsolescence of documentation

\*Modified to be applicable for SATER by adding the descriptor, “related” to the (non-nuclear) safety-related function



# Application of SSC screening for PRR-1 SATER

## Criteria for PRR-1 SSC to qualify for the ageing management program

Important to SRF?	Ease of Replacement	Qualifies for Ageing Management?
Y	A or B or C or D	Yes
T	A or B	No
T	C or D	Yes
N	A or B or C or D	No





# Application of SSC screening for PRR-1 SATER

## PRR-1 SATER SSCs evaluation

SSC Items	Important to SRF?	Ease of Replacement	Ageing Mechanisms	Qualifies for Ageing Management?
Reactor building	T	A, B	3, 5, 9, 10	No
SATER tank	<b>Y</b>	<b>A, B</b>	<b>3, 5, 7, 9</b>	<b>Yes</b>
Reactor core (fuel rods)	<b>Y</b>	<b>A, B</b>	<b>5</b>	<b>Yes</b>
Core support structure	T	B	5	No
Reactor power control system (neutron source drive)	<b>Y</b>	<b>B</b>	<b>4, 5, 8</b>	<b>Yes</b>
Makeup water system	T	B	3, 6	No
Reactor monitoring system	<b>Y</b>	<b>B</b>	<b>5, 8</b>	<b>Yes</b>
Electrical power supply	T	B	8	No
Fuel handling system	T	B	8	No
Neutron source	<b>Y</b>	<b>B</b>	<b>4</b>	<b>Yes</b>
Irradiated fuel storage system	<b>Y</b>	<b>A, B</b>	<b>5</b>	<b>Yes</b>
Fresh fuel storage management system	N	B	5	No
Fire protection system	N	C	5, 8	No
Water purification system	T	B	4, 5	No
Radioactive waste management system	N	B	9, 10	No
Human-machine-interface (HMI)	T	B	8, 10	No



# AMP for selected PRR-1 SSCs

SSC Items	Minimization of ageing degradation	Detection and monitoring of ageing	Mitigation of ageing degradation
SATER tank	Water quality maintenance	NDT (Liquid Penetrant Testing) of tank every 15 years	Repair of degraded parts
Reactor core (fuel rods)	Water quality maintenance	Random visual inspection of fuel rods	Replace any degraded fuel rod with another fuel rod that satisfies the OLC
Neutron source drive	Annual preventive maintenance	Annual performance test	Replacement of degraded and/ or obsolete parts
Reactor monitoring system	Operation check	Annual testing and calibration of neutron monitor	Replacement of degraded and/ or obsolete parts
Neutron source	Water quality maintenance	Annual visual inspection of the neutron source	Replace with a new neutron source
Irradiated fuel storage management system	Water quality maintenance	Random visual inspection of fuel rods	



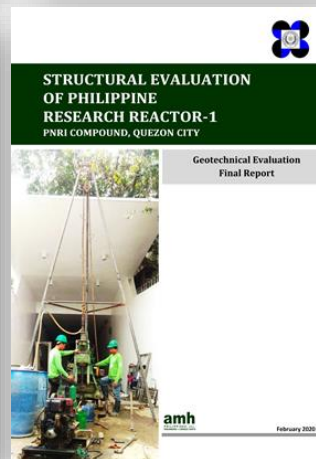
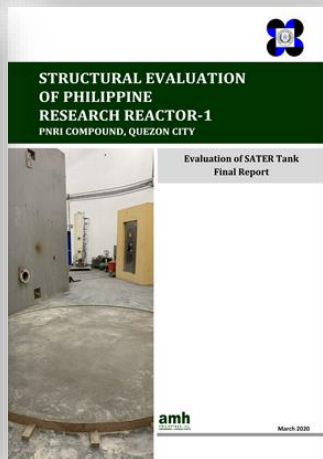
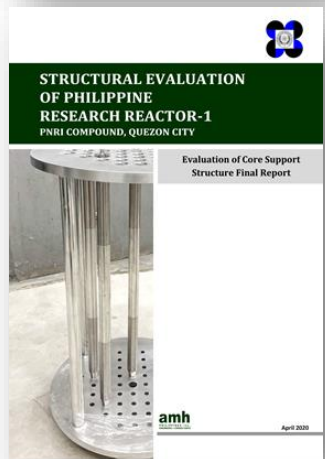
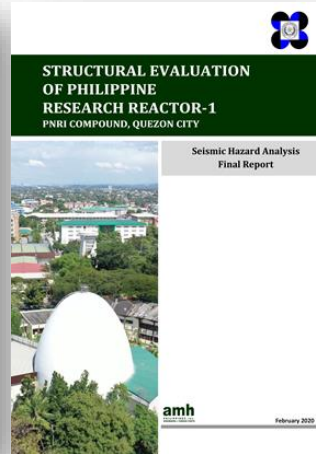
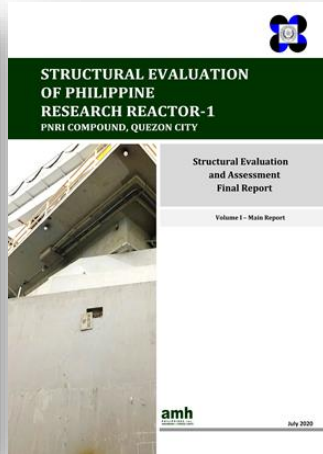
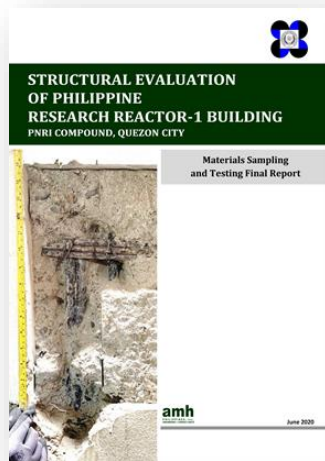
# Quality assurance and record keeping

- ❑ Continuous evaluation and improvement of the PRR-I AMP is ensured through the PNRI Quality Management System (QMS)
- ❑ All equipment and instruments of PRR-I are covered under the annual maintenance and calibration plans
- ❑ These plans are annually audited by internal and external auditors
- ❑ In addition to QMS documents, operators maintain control of documents that are relevant for the operation and maintenance of the PRR-I SATER



# Ageing management activities

## Evaluation of PRR-I structures (2020)



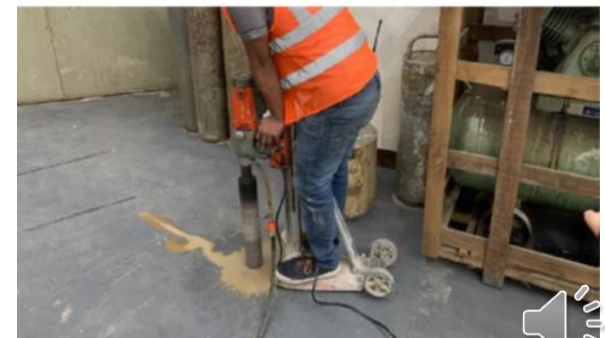
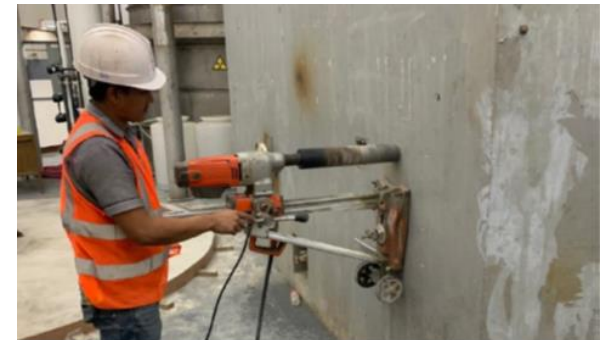
- Geotechnical Investigation
- Seismic hazard analysis
- Structural load analysis
- Materials sampling and testing
  1. Core compressive strength
  2. Rebound/Schmidt hammer
  3. Cement content analysis
  4. Chloride content determination
  5. Depth of carbonation
  6. Sulfate content determination
  7. Half-cell potential
  8. Ultrasonic pulse velocity

Reactor Dome  
Fuel Storage Tank  
Reactor Pool



# Ageing management activities

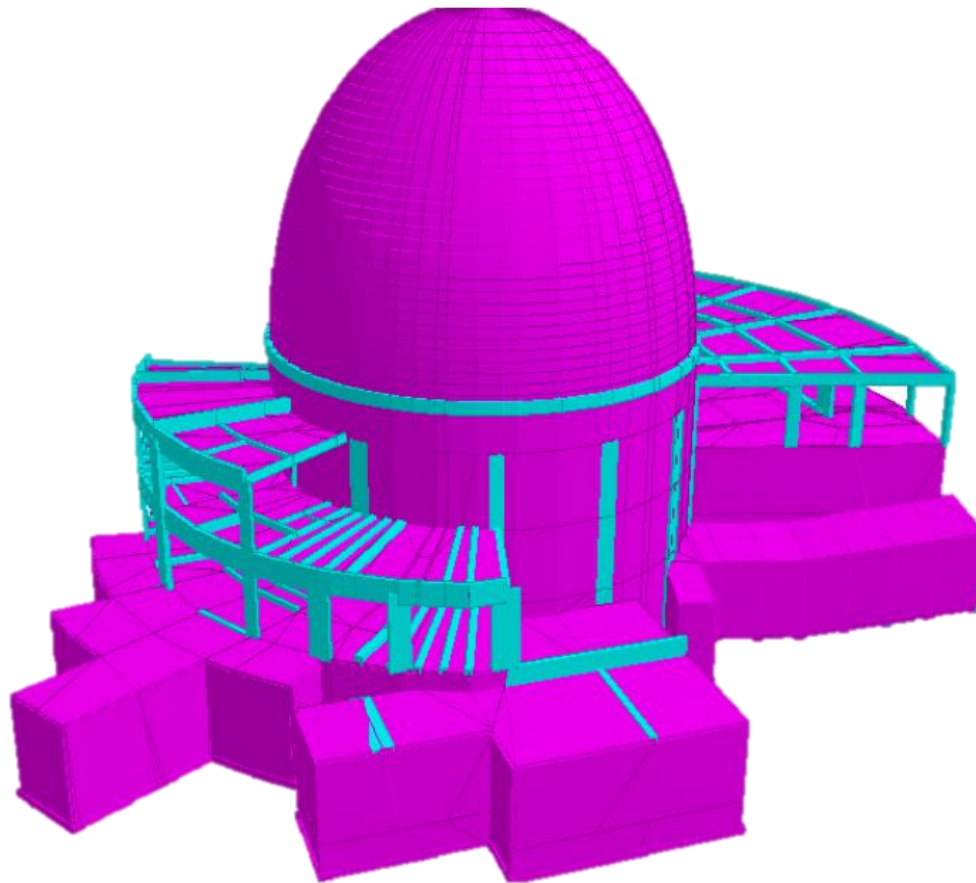
## Evaluation of PRR-I structures (2020)



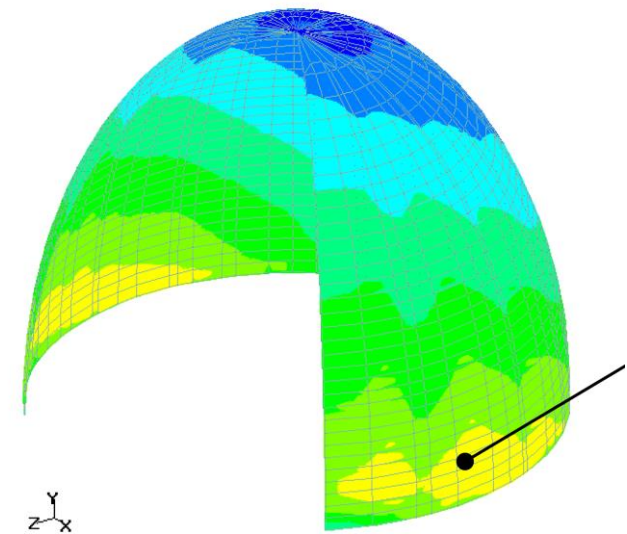
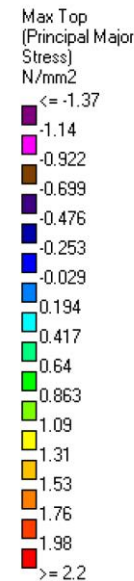


# Ageing management activities

## Evaluation of PRR-I structures (2020)



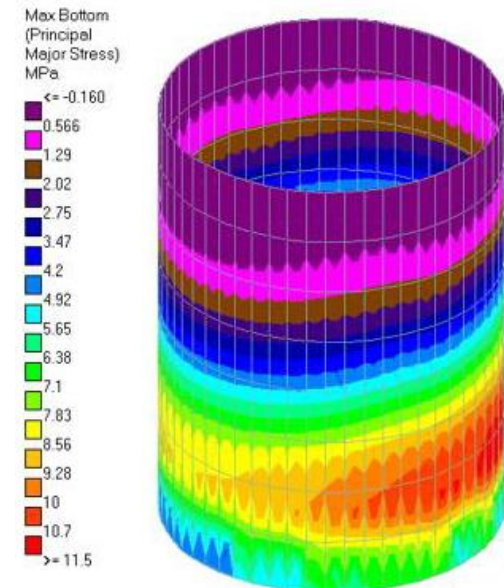
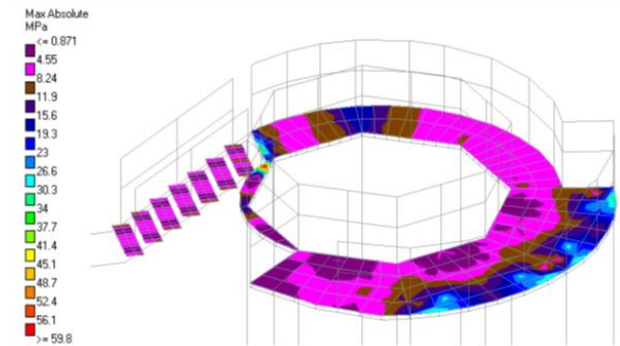
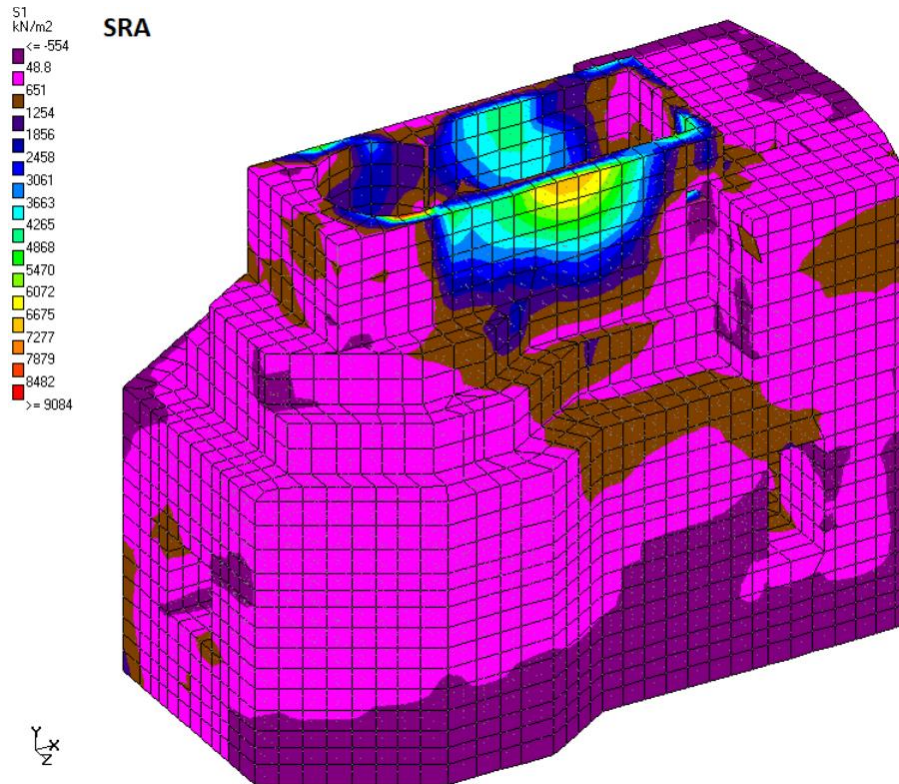
### Result of evaluation for Reactor Dome





# Ageing management activities

## Evaluation of PRR-I structures (2020)



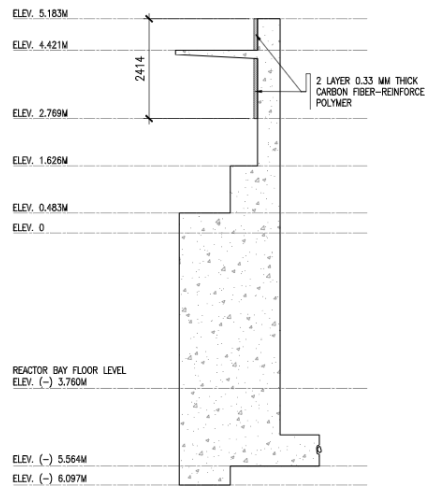
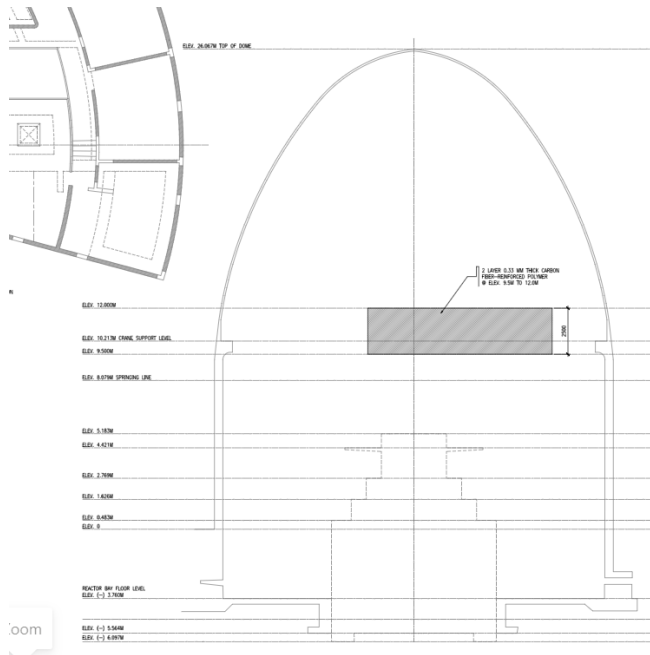
**Result of evaluation for former Reactor Pool and Fuel Storage Tank**



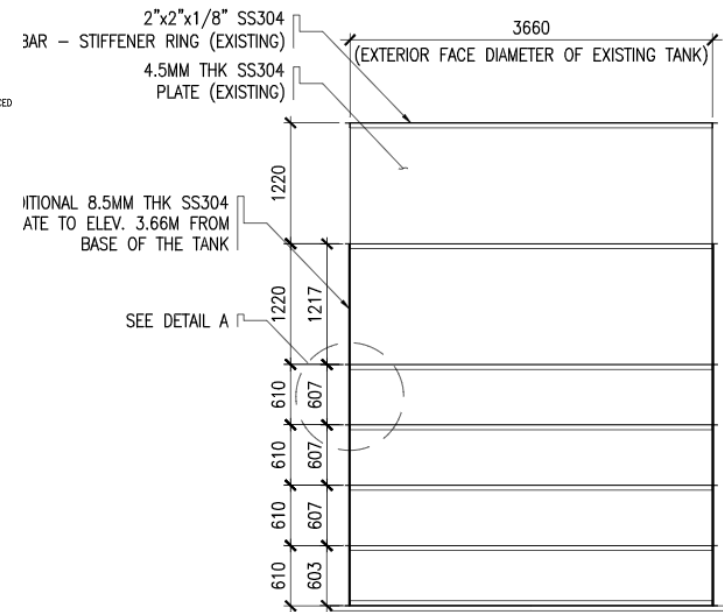
# Ageing management activities

## Retrofitting activities (2021)

Considering the seismic hazards and geotechnical data obtained from the evaluation, PRR-I structures were found to be suitable for operating SATER as a Hazard Category 4 facility. Nevertheless, recommended **retrofit measures** will be undertaken to meet the **life-safety performance objective** of the facility.



1B REACTOR POOL SECTION  
 S 23 SCALE : A1 1:80 MTS  
 A3 1:40 MTS



Installation of carbon fiber-reinforced polymer in vulnerable areas of the reactor dome and former reactor pool

Installation of additional SS layer at the bottom part of the fuel storage tank

# Summary

- ❑ PRR-I is a sixty-year-old facility, which will be reused for the operation of the new Subcritical Assembly for Training, Education, and Research (SATER).
- ❑ An ageing management plan (AMP) is developed to ensure that ageing effects are appropriately and commensurately addressed by the facility operators
- ❑ The operating conditions of PRR-I SATER indicate that ageing will virtually have no effect on the safety-related functions of the facility.
- ❑ The AMP developed for PRR-I SATER applies the recommendation of IAEA SSG-10 with significant grading considering the low hazard associated with the facility.
- ❑ Ageing management activities performed for the 60 year old structures of PRR-I were presented



# References

- [1] IAEA, “Ageing Management for Research Reactors,” *Specific Safety Guide No. SSG-10*, 2010.
- [2] IAEA, “SSR-3 Safety of Research Reactors,” *IAEA Safety Standard*, 2016.
- [3] PNRI NROS, “Final Safety Analysis Report of the PRR-1 Subcritical Assembly for Training, Education, and Research”, 2021.
- [4] AMH Philippines, Inc. “Structural Evaluation of Philippine Research Reactor-1 Building: Final Report”, 2020.

