

Post Fukushima Safety Assessment and Upgradation of RML Hot Cell Facility

A.Vijayaragavan, T. Johny and Divakar R.

Indira Gandhi Centre for Atomic Research,
Kalpakkam, TamilNadu, India.

Corresponding Author : A. Vijayaragavan <avr@igcar.gov.in>

1.0 Introduction

The $\alpha \beta \gamma$ hot cells of Radio Metallurgy Laboratory (RML) at IGCAR, India have been in operation since 1994. This facility co-located with the Fast Breeder Test Reactor (FBTR) caters to the post-irradiation examination of the fast reactor fuel and structural materials. The hot cells comprise of seven concrete shielded cells and two lead shielded cells. Kamini, a research reactor is located in the area below concrete hot cell no.3. Adjoining the hot cells in the hot laboratory building of RML, different service areas are provided such as operating area, isolation areas, warm work areas, highbay, trench, basement etc. catering to different operational requirements. The basement area houses the hot cell inert gas recirculation and purification system. The plan view of the various areas of the hot laboratory building shown in Fig. 1. Equipment for air supply/exhaust systems of the ventilated areas of hot laboratory are operating in a service building located on the eastern side of the hot laboratory building.

Subsequent to the accident at Fukushima NPPs, Japan in March 2011, a safety review was carried out to assess available capabilities and preparedness to deal with situations arising out of extreme natural events resulting from flood, tsunami, earthquake, etc. as well as the events of station black out. This paper briefly summarises the safety assessment and the upgradations carried out.

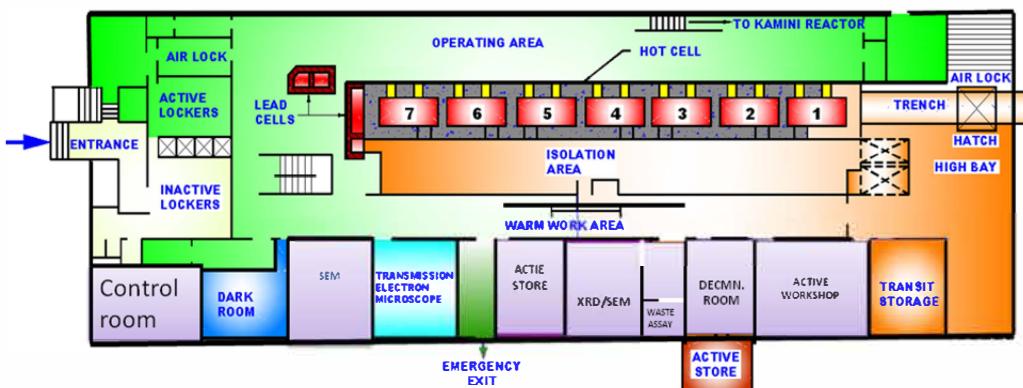


Figure 1. Plan view of hot laboratory building

2.0 Assessment of Flooding, station blackout and Mitigation measures

RML main building has a finished floor level of 11.5m (RL) and the original design basis flood level due to cyclonic condition was 8m (RL). However, a study conducted recently for Kalpakkam site has indicated that the flood level up to 12.01 m (RL) is possible under severe cyclonic conditions combined with heavy precipitation and high tide. Under these conditions, the flood level can reach 0.6m above the finished floor

level of RML which could lead to flooding of RML basement areas, Kamini reactor and could affect the power supply and ventilation systems. The hot cells at a higher elevation of 12.3 m(RL) precludes the possibility of water flooding inside and the alpha tight provision in the hot cells/glove boxes prevents water entry into the hot cells, even at higher flood levels. Similarly the hot cells ventilation ducts in the basement are leak tight and hence water is not expected to enter inside the ventilation pipelines. To prevent water ingress through various entry/exit locations into the hot laboratory building, suitable ramp of maximum height 600 mm (Fig 2) have been provided. In situations, where provision for ramp is practically not possible, the existing air lock door is modified to accommodate a flood gate of height 600 mm, which can be installed as and when required. All openings between the power cables in the trenches and the pipe/wall have been sealed.

Most of the hot cell equipment are connected with class IV power supply. Equipment like blowers of hot cell exhaust system, hot cell ventilation blowers, emergency lighting, etc are connected to the Class III emergency power supply from reactor (FBTR). In case of grid failure, two diesel generators (DG) of 180 kVA capacity each are available for connecting to the important systems to ensure the negative pressure of the hot cells. The flooding of the plant rooms (FFL: 11.8 RL) could lead to partial submergence of electrical panels, motors, blowers, compressors etc. In these areas, water level indicators are provided to annunciate alarm when water level reaches 11.3 m (RL) and facilitate manual tripping of the power supply. Retrofittings done at Lab area and phase I plant room area prevents water entry, if flood level is less than 12.01m. It also ensured that water won't enter the basement area. All the areas below ground level have been provided with dewatering pumps. Separate standalone emergency lights are provided at various locations to deal with complete blackout. Under such cases, a standalone DG set (7.5 kVA) installed in the first floor of service building with independent distribution lines caters to emergency lighting, communication and dewatering pumps.



Figure 2. Ramp provided at entry of building



Figure 3. Flood gate at entrance of operating area

A detailed study was conducted on all pipelines, tanks located below the finished floor level and in the basement area to assess the effect of buoyancy forces in case of water flooding. All the pipelines and tanks have been suitably anchored to the basement, wall and to the roof to ensure they do not detach and float. All gas cylinders are chained with the support structure.

A study conducted for Kalpakkam site indicates that the flood level due to Tsunami could reach 12.896 m (RL) on the sea side. However, RML is situated at a distance of 1 km from the sea. It may be noted that during 2004 Tsunami, there was no water ingress in RML complex. Even when flood level reaches 12.896m, water will not enter the hot cells due to its leak-tight construction from 0.8 m – 14.1m above FFL. Even in case of tsunami, KAMINI reactor and all basement areas won't get flooded, due to provision of special leak tight doors. Glove boxes are provided with bunker and locking arrangement at the glove and transfer ports to prevent water entry through these weak points. Glove boxes are anchored to prevent detachment and floating due to buoyancy force.

3.0 Seismic evaluation

The hot laboratory building built in the early 80's was designed for various live loads due to equipment installed as well as a horizontal seismic coefficient of 0.05g as per IS: 1893 and the vertical component assumed is 0.025 g. Efforts are being made for seismic re-evaluation of civil structures, equipment, pipe lines, ventilation duct and their supporting structures to determine the seismic margins available which can be withstood without compromising plant safety. Suitable upgradations and retrofitting to enhance the seismic capacity of safety related structure, system and components is proposed to be carried out.

4.0 Summary:

The revised design basis flooding will not affect the integrity of hot cells and the glove box in RML. Measures have been provided to prevent water entry to various radioactive areas of RML and Kamini. Hence flooding will not lead to radiological exposure of personnel and release of activity to the environment. Prolonged station black-out is not expected to lead to any unsafe conditions in the laboratory.

5.0 References

1. Regulatory practices for nuclear power plants in India, S.S. Bajaj, Sadhana, Vol. 38, Part 5, October 2013, pp. 1027–1050. Indian Academy of Sciences
2. Radiation Protection for Nuclear Fuel Cycle Facilities 2013, AERB Safety Code AERB/NF/SC/RP.