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SAFETY REVIEW OF BARC FACILITIES

Towards developing the various technologies for the envisaged nuclear power programme in the country, a number of facilities were established in Trombay in the early years. These included a thorium extraction plant, uranium fuel fabrication plant, heavy water production facility, research reactors, a fuel reprocessing plant, waste treatment facilities and a number of hot laboratories for radioisotope production, radiochemistry research and radiometallurgy studies. As mentioned earlier, the safety aspects of these facilities were looked after by Health Physics Division, BARC and Reactor Safety Committee in the early years and by DAE-SRC from 1972 onwards. After the formation of AERB in 1983, a number of safety committees were constituted for safety review of various BARC facilities under the jurisdiction of SARCOP. AERB was also associated with the licensing of plant personnel in all the critical installations. Subsequently, as per a decision of Government of India, the regulatory and safety review functions related to Bhabha Atomic Research Centre (BARC) were transferred from AERB to an internal safety committee structure of BARC in June 2000.

During the period 1983 to 2000, safety review of the following major BARC facilities was carried out by AERB.

Research Reactors

The first two research reactors in Trombay, Apsara and CIRUS, which were commissioned in 1956 and 1960 respectively did not have a structured safety review during the project phase. However for safety review of their operations Bhabha set up a formal reactor safety committee by an office order in 1962 with A.S. Rao as the Chairman and V. Surya Rao, V.N. Meckoni and A.K.Ganguly as members. Later when DAE Safety Review Committee (DAE-SRC) was constituted in 1972, it took over the responsibility for the safety review of all the

research reactors. This Committee formed a separate Unit Safety Committee for each category of plants.

Dhruva

During the seventies, a need was felt for a research reactor with higher neutron flux than CIRUS to meet the growing requirements for radioisotopes and also to provide scope for major science and engineering experiments related to the power programme. This led to the design, construction, commissioning and operation of a 100 MWt research reactor Dhruva. The construction of CIRUS and the experience gained in its operation and maintenance, coupled with the infrastructure built in the various research and development groups in BARC helped in designing and constructing Dhruva. DAE-SRC gave stage-wise clearance based on an in-depth review by the Dhruva Safety Committee (DSC) chaired by M.S.R.Sarma.

Ground breaking of Dhruva was done on May 17, 1974 and it attained first criticality on August 8, 1985. The design and engineering of this reactor had been a totally indigenous effort with several divisions of BARC participating in this task led by S.M. Sundaram, as Project Manager. For example, the Reactor Engineering Division of BARC did the design and the engineering of the pile block and the Reactor Control Division did the design and engineering of the reactor protection and regulating systems. The Design report of Dhruva was reviewed in depth by Dhruva Safety Committee (DSC) under DAE-SRC. Various Safety concerns were resolved by experimentation, tests, design modifications etc. Each and every clause of the technical specifications for operation was deliberated upon before approval of this document. DAE-SRC gave stage wise clearance for Fuel Loading, Heavy Water Addition, Initial Criticality and Power Operation.

While giving clearances for the first criticality, besides ensuring that all necessary systems were available for operation and their commissioning results were acceptable, DAE- SRC also stipulated that the first approach to criticality should be done in the presence

of designated senior experienced design group persons who were thoroughly familiar with the reactor systems.

During the review of the initial operation of the reactor, it was observed that due to excessive flow induced fuel vibrations, the fuel clad had abraded resulting in release of aluminium turbidity and uranium contamination in the heavy water coolant. DAE-SRC recommended that reactor operation be suspended till completion of clean-up of the system and incorporation of appropriate design modifications in the fuel to solve the problems.

Post-irradiation examination of the fuel showed excessive fretting wear of aluminum clad leading to exposure of the uranium metal. The analysis showed that the fuel clusters had been subjected to excessive vibration caused by the diametrical clearances between the fuel assembly and the guide tube, at the bottom where the coolant entered. It was also noticed that the natural frequency of the fuel assembly was close to the natural frequency of main coolant heat exchangers together with their support structure, causing resonant vibration of the fuel assemblies. All these deficiencies were rectified. Also the turbidity in the coolant was successfully removed by using a specially developed magnesium loaded ion exchange resin and a centrifuge system. DSC and DAE-SRC were monitoring the progress of the modifications made at various stages and after the problems were solved the reactor power was allowed to be raised in steps reaching the final design value of 100 MWt in January 1988.

CIRUS

After over thirty years of operation of the 40MWt research reactor CIRUS, detailed aeging studies of its systems, structures and components were performed and a refurbishing plan was submitted to BARC Reactor Safety Committee and SARCOP. The plan was reviewed in AERB which included the assessment of stored Wigner energy in the graphite reflector of the reactor, a thorough evaluation

of the major structures like the reactor containment, stack, ball tank, underground D.M. water storage tanks, sub soil piping etc apart from the in-core components like reactor vessel and endshields.

While the refurbishing work was in progress, the safety review of BARC facilities was transferred from AERB to an internal safety committee structure of BARC. As such AERB was not involved in clearance for restart of CIRUS. However, the reactor was successfully brought back in operation after this major refurbishing effort.

Reprocessing Plants

The first plutonium extraction plant was commissioned in Trombay in 1964. Based on the experience gained here, BARC constructed a power reactor fuel reprocessing plant (PREFRE) at Tarapur in mid seventies. Both these plants came under the review of SARCOP in 1987.

BARC sought the approval of AERB in 1994 for the construction of a power reactor fuel reprocessing plant at Kalpakkam (KARP) By the time the application was received in AERB, the construction of the plant was already in progress. An Advisory Committee for Project Safety Review (ACPSR) was constituted by AERB in 1994 with R. K. Garg, former, CMD, IREL as Chairman.

ACPSR noted that though the KARP design had been reviewed by an internal review Committee of Nuclear Recycle Group, BARC, it did not undergo a formal review by a Project Design Safety Committee (PDSC) of AERB. In the case of NPPs and research reactors, AERB has spelt out in its Safety Guide AERB/SG/G-1 all the requirements of AERB's consenting process, including guidelines on preparation of Preliminary Safety Analysis Reports, definition of various stages of authorization of plant construction and commissioning. In the absence such a regulatory document for fuel reprocessing plants, ACPSR had to evolve its own procedure for the consenting process.

In order to carry out a detailed safety analysis and review, ACPSR constituted thirteen specialist Working Groups to address various aspects of the plant like spent fuel handling and chopping, process instrumentation, conversion laboratory, electrical systems, mechanical systems, process equipment, piping, services and auxiliaries, civil engineering of critical structures, criticality safety, health physics, waste management, industrial safety and fire safety. The Advisory Committee also reviewed the safety of KARP under total power failure scenario, analysis of design basis accidents and hypothetical upper limit accidents, safety classification of the buildings based on radiological consequences, earthquake resistant design of safety related structures and the Technical Specifications for operation for KARP.

After the review by ACPSR, AERB issued the authorization for storage of MAPS spent fuel bundles in KARP fuel storage pool in May 1997, Cold Uranium Commissioning Runs in April 1998 and authorization for Hot Commissioning Runs in September 1998.

Advanced Fuel Fabrication Facility

BARC installed an Advanced Fuel Fabrication Facility (A3F) at Tarapur in 1989 for fabrication of mixed oxide (MOX) fuel sub-assemblies for Tarapur Atomic Power Station (TAPS). AERB constituted an ACPSR with K. Balaramamoorthy, the then Chief Executive, NFC to carry out the safety review of the project. ACPSR had several detailed discussions on the engineered safety features of the plant to ensure the containment of radioactivity during plutonium powder handling operations, criticality safety etc. Based on the recommendations of this Committee, AERB issued the authorization for regular operation of A3F in 1994.

Waste Management Facilities

In order to treat the radioactive waste arising from the operation

of the research reactors, reprocessing plant and other radioactive facilities in Trombay, BARC had established a few waste treatment plants. Similarly, Tarapur site also had waste treatment plants to take care of the wastes arising from operations of TAPS and PREFRE. All these plants came under the review of SARCOP from 1987 onwards. BARC in 1993 sought the approval for the construction of the following waste management projects

a) Solid waste Storage Surveillance Facility (SSSF)-Tarapur

b) Away From Reactor-Waste Management Facility at Tarapur

c) Waste Immobilisation Plant (WIP), Trombay

AERB constituted an ACPSR with M.K.T.Nair, Former Director, Nuclear Waste Management Group, BARC as Chairman. The Committee was assisted by six Specialist Working Groups, constituted for detailed review of the safety aspects of different systems/ areas, viz., civil engineering and structural safety, process safety and instrumentation, mechanical systems including remote handling and services, electrical systems, health physics and environmental safety, industrial and fire safety. Based on the review of this Committee, authorization was issued for storage of vitrified waste product canister overpacks in SSSF. The review process of these projects was handed over to BARC Safety Council in June 2000.

The rich experience gained by AERB staff through design and operational safety review of the various BARC facilities was extremely useful for their safety review work at the nuclear power plants and other nuclear fuel cycle facilities. It also helped in establishing a strong link between the staff of AERB and BARC that proved to be of great value as BARC is a strong multi-disciplinary organization with high level of expertise and it is the most important technical support organization of AERB.

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