

CHAPTER

1

SAFETY SURVEILLANCE OF NUCLEAR FACILITIES



1.1 SAFETY REVIEW MECHANISM OF NUCLEAR FACILITIES

Nuclear facilities in India are sited, designed, constructed, commissioned, operated and decommissioned in accordance with strict quality and safety standards. The primary responsibility for the safety of the facility lies with the licensee. These licensees have a system of independent review and scrutiny of safety as an integral part of the management control. Atomic Energy Regulatory Board (AERB), the regulatory body of India, oversees the safety and has been mandated to frame safety policies, lay down safety standards and requirements. AERB has power to monitor and enforce safety and

regulatory provisions of the Atomic Energy Act, 1962 and the rules thereunder, in nuclear and radiation installations and practices. AERB has established a regulatory framework, which involves stipulating the safety requirements, issuance of regulatory consents after safety review, verification of compliance through safety reviews and inspections during various stages viz. siting, construction, commissioning, operation etc.

All nuclear facilities undergo an elaborate and in-depth safety review during various stages. The objective of safety review and assessment at various consenting stages is illustrated below:

Siting		to ensure that the chosen site meets Site Evaluation Criteria and is suitable for the proposed type and capacity of plant from environmental considerations
Construction		to ensure that the proposed plant design meet regulatory requirements, and the proposed construction meets quality requirements
Commissioning		to ensure that the commissioning programme and procedures meet regulatory requirements; performance of the plant is as per design intent; results of commissioning tests confirm adequacy of the plant design for operation; and safety analysis for as-built facility has been carried out
Operation		to ensure that plant operational limits & conditions meet regulatory requirements; adequate level of safety is maintained by proper operational & maintenance procedures & administrative control; organisational structure, training & qualification of operating personnel meet the requirements and conditions for renewal of consent as prescribed by AERB

Safety reviews related to the consenting decisions and safety monitoring during various stages are carried out through multi-tier safety committees. The committees include experts in relevant fields including process design, control and instrumentation, thermal hydraulics, structural analysis, reactor physics, seismology, probabilistic safety analysis etc., relevant to nuclear and radiation safety. The higher level committees include experts from academia, national R&D institutes and the Government bodies. The multi-tiered system of safety review follows the principle of “management by exception”, following graded approach and is based on principles, requirements and criteria specified by AERB in its regulatory documents.

In this approach, the issues of greater significance are given due consideration at higher-level committees for their satisfactory resolution. Recommendations of these committees concerning various safety issues and consents are further considered by AERB for arriving at regulatory decisions. This arrangement ensures comprehensiveness of the reviews and effective compliance with the specified requirements. Additionally, AERB carries out periodic regulatory inspections to check conformance with regulatory requirements and consenting conditions.

The licence for operation of the facilities is given after ensuring its satisfactory construction and commissioning as per the approved design, complying with the quality requirements and the specified safety/regulatory requirements. The licence for operation is given with a specified validity period. Renewal of licence for operation is considered based on separate application along with a comprehensive safety review as per the laid down requirements and process.

In the case of operating nuclear power plants (NPP), there is requirement for carrying out a comprehensive periodic safety review (PSR) once in ten years, as per the laid down

requirements. The PSR involves a thorough assessment of the safety of the plant in comparison with the current safety requirements and practices, covering a number of identified safety factors. The PSR facilitates a cumulative assessment of plant ageing, modifications, safety performance, advances in science and technology and feedback of operating experience. The PSR provides opportunities for identifying and implementing safety upgrades/enhancements in the plants as well as the regulatory programmes, as necessary. This regulatory approach ensures that the safety levels of the plants are maintained and enhanced to remain comparable with the contemporary safety standards /practices throughout the operating life of the plant.

Review of Security Aspects

AERB has also been entrusted with the responsibility of review and assessment of nuclear security aspects (having impact on safety) for different types of nuclear facilities in India. AERB has issued various regulatory documents specifying nuclear security requirements in this regard. Depending on the project stage, security aspects are reviewed against relevant regulatory requirements. Multi-tier approach is adopted for review of security aspects also.

The safety status of the nuclear facilities, significant events and enforcement actions during the year 2020 are covered in the following sections.

1.2 NUCLEAR FACILITIES UNDER CONSTRUCTION

AERB has established an elaborate system for in-depth safety review of Nuclear Power Projects (NPP) and Fuel Cycle Facilities (FCF) that are under construction.

During the year 2020, the status of various nuclear power projects and fuel cycle facilities under siting, construction and commissioning are being reviewed by AERB are presented in Table 1.1 and Table 1.2 respectively.

Table 1.1: Status of various Nuclear Power Projects

Project Stage	Project	District / State	Utility/ Licensee/ Applicant	Type	Review Status
Construction	Kudankulam Nuclear Power Project (KKNPP)-3&4 Kudankulam	Tirunelveli/ Tamil Nadu	Nuclear Power Corporation of India Limited (NPCIL)	1000 MWe VVER (light water reactor) each, of Russian Design	Clearance for First Pour of Concrete (FPC) granted in June 2017.
	KKNPP-5&6, Kudankulam	Tirunelveli/ Tamil Nadu	NPCIL	1000 MWe VVER (light water reactor) each, of Russian Design	Clearance for site excavation (first stage of construction consent) was issued in November 2018.
	Gorakhpur Haryana Anu Vidyut Pariyojana (GHAVP)-1&2, Gorakhpur	Fatehabad/ Haryana	NPCIL	700 MWe PHWR each, of indigenously design	Clearance for First Pour of Concrete was granted on November 18, 2020.
	Rajasthan Atomic Power Project (RAPP)-7&8, Rawatbhata	Chittorgarh/ Rajasthan	NPCIL	700 MWe PHWR each, of indigenously design	Clearance for Major Equipment Erection (last stage of construction consent) was issued in March 2015.
	Kaiga NPP- 5&6	Karwar / Karnataka	NPCIL	700 MWe PHWR each, of indigenously design	Clearance for Siting was issued on November 18, 2020.
Commissioning	PFBR, Kalpakkam	Kancheepuram/ Tamil Nadu	Bhartiya Nabhikiya Vidyut Nigam (BHAVINI)	500 MWe prototype Fast Breeder reactor of indigenous design	Clearance for receipt, handling and storage of 42 number of fresh fuel subassemblies at fuel building was issued in June 2019.
	KAPP-3&4, Kakrapar	Tapi/ Gujarat	NPCIL	700 MWe PHWR each, of indigenous design	Clearance for Phase-C commissioning was issued on November 2, 2020 for KAPP Unit#3.

Table 1.2: Status of various Fuel Cycle Facilities (under Siting, Construction and Commissioning)

Stage	Project	District / State	Utility/ Licensee/ Applicant	Project Details	Remarks
Siting	Away from Reactor (AFR) spent fuel storage facility for KKNPP-1&2 and KKNPP-3&4	Tirunelveli/ Tamil Nadu	NPCIL	Away from Reactor spent fuel storage facility for storing spent nuclear fuel of KKNPP-1&2 and KKNPP-3&4	Review of Siting application is under progress.
Construction	Fast Reactor Fuel Reprocessing Facility (FRFCF), Kalpakkam	Kancheepuram/ Tamil Nadu	Indira Gandhi Centre for Atomic Research (IGCAR)	Integrated facility for recycling spent fuel from PFBR. The project includes fuel fabrication & assembly, reprocessing and waste management facilities	Permission for resumption of construction activities involving earthmoving was given on November 8, 2018.
	PHWR Fuel Fabrication Facility and Zircaloy Fabrication Facility, Rawatbhata	Chittorgarh/ Rajasthan	Nuclear Fuel Complex (NFC), Kota	Fabrication facility for PHWR fuel and Zircaloy components	Construction consent granted in February 2018.
Construction & Commissioning	Demonstration Fast Reactor Fuel Reprocessing Plant (DFRP), Kalpakkam	Kancheepuram / Tamil Nadu	IGCAR	Reprocessing facility for spent fuel from Fast Breeder Test Reactor (FBTR)	Clearance for Acid-TBP run (Inactive run) for PPF, DFRP issued on March 12, 2019 & cold commissioning is in progress.

The information on the meetings of the important safety review committees for facilities undergoing reviews related to siting/ construction/ commissioning is given in Table 1.3.

Important outcome of the safety review and assessments related to nuclear power projects and fuel cycle facilities are given in subsequent paragraphs.

Table 1.3: Safety Review Committee Meetings of the Nuclear Power Projects & Fuel Cycle Facilities (under Construction)

Project Safety Committee	Abbreviation	Number of Meetings
Advisory Committee for Project Safety Review	ACPSR-NPPs (for PHWR, PFBR & LWR)	3
Project Design Safety Committee-Light Water Reactor	PDSC-LWR	2
Project Design Safety Committee-Pressurized Heavy Water Reactor	PDSC-PHWR	13
Civil Engineering Safety Committee	CESC	8
Site Evaluation Committee	SEC	6
Committee for Reviewing Security Aspects	CSRA	5
Total		37

Apart from these meeting, many In-house Group meetings organized for safety review

1.2.1 NPPs UNDER CONSTRUCTION: REVIEW STATUS

Safety review activities related to the Nuclear Power Projects (refer Table 1.1) continued during the year.

Due to COVID-19 pandemic situation, utility submissions were communicated to reviewers (Committee Members as well as AERB Officers) through e-mail and review observations were sought. Online meetings were conducted through video-conferencing to deliberate and finalise the safety review observations. In view of the situation arising from the COVID-19 pandemic, Nuclear Facilities under construction/ commissioning were requested to provide the status of preservation aspects of Structures, Systems and Components (SSC), Industrial and Fire Safety (I&FS) etc. Reports submitted by sites were noted for measures instituted for preservation, protection of SSCs, other equipment and Industrial and Fire Safety aspects.

A1. Light Water Reactor based NPPs

(i) Kudankulam Nuclear Power Project-3&4 (KKNPP-3&4)

KKNPP Unit-3&4 plant design is a repeat design of KKNPP Unit-1&2, which was extensively reviewed in AERB. Review process for Unit-3&4 is optimized to review of design differences impacting safety and compliance to AERB requirements. AERB gave clearance for First Pour of Concrete (FPC) on June 23, 2017 with certain stipulations. Presently, civil construction work is in progress at KKNPP-3&4. NPCIL has submitted Application for Erection of Major Equipment (EME) in August 2020. The application was conditionally admitted, pending submission of supporting documents.

Submissions related to Core Catcher were earlier reviewed and permission was given for erection of Core Catcher. Erection activity of Core Catcher which has been completed along with its support structures. Construction activities remained in progress for other safety related buildings. For safety systems building (UKA), construction activities are completed till - 4.25 m elevation (EL) and building was released for mechanical works. The support truss for Reactor pressure vessel was shifted to site and its pre-assembly was taken up. Also analyses for design check locations for essential loads pump house (UQC) were considered acceptable and communicated to NPCIL in May 2020.

Review of revised (Rev.1) Preliminary Safety Analysis Report (PSAR) w.r.t. Reactor Coolant System, Engineered Safety Features, Radioactive Waste Management System and Radiation Protection was completed. Whereas review of revised PSAR (Rev.1) on Electrical Systems, Control & Instrumentation, Auxiliary Systems etc., was nearing completion. In addition, review of PSAR (R-0) on Accident Analyses, Conduct of Operation, Initial Test Program etc., was in progress.

Reports on geological mapping, confirmatory geotechnical investigations, design and analysis for essential loads pump house (UQC) building structure were satisfactorily reviewed by AERB, and NPCIL was permitted to take up the construction of UQC.

AERB carried out review of design adequacy checks for critical locations of civil structures following AERB safety standards, and of concrete mix designs for normal and heavy concrete.



Under construction Main
Pump-house



Under Construction
Intake Tunnels



Liner Erection Works
in Reactor Building of KKNPP-4

(ii) Kudankulam Nuclear Power Project-5&6 (KKNPP-5&6)

AERB gave clearance for Excavation on November 14, 2018 with certain stipulations. Excavation of main plant area of KKNPP-5&6 was completed in March 2020. Review of analysis reports for safety related buildings viz. Reactor Building (UJA), Reactor Auxiliary Building (UKC), Diesel Generator Building (UKD), Safety related pump house (UQC) and Safety related tunnels (UKZ) was completed. Based on satisfactory review, AERB issued clearance on May 20, 2020 for taking up construction of essential loads pump house (UQC) structure up to +7.5 m EL. Subsequently, activities pertaining to construction of essential loads pump house (UQC) were in progress.

KKNPP-5&6 submitted application for First Pour of Concrete (FPC) along with PSAR. Review of these submissions are in progress with major focus on design differences w.r.t. KKNPP-3&4, impact due to implementation of new fuel (TVS-2M) and changes in design standards.

A.2 Fast Breeder Reactor

(i) Prototype Fast Breeder Reactor (PFBR)

AERB accorded permission for commissioning of Secondary Sodium Pumps in both the loops in Steam Generator (SG) Building-1&2 during December 2017. AERB gave clearance for receipt, handling and storage of 42 fresh fuel sub-assemblies (FSA) in the Fuel Storage Building (FSB) of PFBR on June 28, 2019. The FSAs were subsequently received and safely stored in the storage facility. AERB is monitoring the aspects related to safe storage of these FSAs at PFBR.

Main Vessel was cooled down and both loops of Secondary Sodium Main Circuits (SSMC) were in drained state. Sodium in Safety Grade Decay Heat Removal (SGDHR) storage tanks was in molten state at ~200°C, whereas sodium in all tanks (except SGDHR storage tanks) was in frozen condition. Their argon cover gas pressure were maintained and monitored from main control room (MCR) and through field rounds.

Towards rectification of Large Rotatable Plug (LRP) bearing, works related to inspection of load and spacer balls, greasing, placing of balls on bottom race and top race activities were completed as per the procedure. Further testing activities and inspection of back-up seal in LRP were in progress.

In-house review & assessment of commissioning procedures and reports pertaining to SGDHR purification circuits, commissioning of SGDHR loops, central sub-assembly temperature monitoring system, reactor inlet temperature monitoring system, Real Time Computer (RTC) based core temperature monitoring system, procedure for reactor containment building isolation systems, documents pertaining to transient temperature evolution in hot pool and operating personnel authorization were completed. These were further reviewed in the Specialists Group on Commissioning (SG-Comm).

Licensing programme for operation and fuel handing personnel for PFBR and licensing programme & Senior management certification document were reviewed and review observations were communicated to BHAVINI for their response.



Prototype Fast Breeder Reactor

A.3 Pressurized Heavy Water Reactor (PHWR)

(i) KAPP-3&4 and RAPP-7&8

Safety Review of KAPP-3

Safety review of various submissions for the twin units of 700 MWe PHWRs at Kakrapar, Gujarat (KAPP-3&4) and Rawatbhata, Rajasthan (RAPP-7&8) was in progress. Review Groups in AERB (i.e. In-House Working Groups, Task Force, PDSC) are progressively reviewing relevant submissions on Safety analyses, and reports like Stress analysis, Environmental Qualification (EQ), Independent Verification and Validation (IV&V), Commissioning Procedures, Technical Specifications for Operation, KAPP-3 applications for various stages of commissioning & related submissions including Commissioning reports. Majority of the safety review for KAPP-3&4 was conducted by AERB in-house review groups.

After completion of Primary Heat Transport (PHT) System, Hot Conditioning and Light Water Commissioning (LWC) of KAPP-3, and satisfactory safety review of NPCIL application, test results and associated submissions, AERB issued permission for draining of light water from PHT system on December 16, 2019 and draining of light water from Moderator system on January 13, 2020.

Subsequently, NPCIL application seeking clearance for 'Initial Fuel Loading' (IFL), part boroated heavy water (65 Te) addition to storage, cooling and moderator systems for flushing and addition of Heavy Water to PHT into the reactor of KAPP-3 was reviewed and Clearance for the IFL part of the application was issued on February 28, 2020. Clearance for addition of 65Te Heavy water to Moderator systems and addition of Heavy water to PHT systems of KAPP-3 was granted on March 18, 2020 with a regulatory hold point (RHP) for addition of Heavy water to PHT. After review of NPCIL submissions towards clearing regulatory hold point, permission for Heavy water addition to PHT system was granted on April 06, 2020. KAPP-3 was also granted Licence under the Factories Act, 1948.

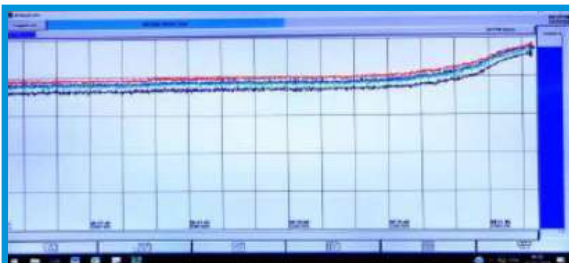
NPCIL application seeking Authorization of KAPP-3 for Bulk addition of heavy water to moderator system with minimum specified boron level in heavy water to prevent reactor criticality, First Approach to Criticality (FAC), Low Power Reactor Physics Tests & Experiments was reviewed and after approval by the Board of AERB, permission for bulk addition of Heavy water to Moderator System of KAPP-3 was granted on July 07, 2020. Subsequently, permission for FAC and low power reactor physics experiments was granted on July 17, 2020. KAPP-3 achieved Criticality on July 22, 2020.



KAPP-3&4 Main Plant Area



AERB Board Meeting for FAC Clearance of KAPP-3



Chairman, AEC, CMD, NPCIL and Director, BARC along with NPCIL Officers; remotely monitoring First Approach to Criticality at KAPP-3

AERB reviewed application seeking Authorization for Phase-C commissioning of KAPP-3 (i.e. Raising reactor power in stages) and issued permission on November 02, 2020 with regulatory hold points. After review of NPCIL submissions towards clearing regulatory hold-point, permission for Phase C-1 (RHP): Raising Nuclear Steam by increasing Reactor Power up to 50% FP of K A P P - 3 was granted on November 12, 2020.

AERB Site Observer Teams (SOT) are deputed at Kakrapar and Rajasthan Site for physical verification of compliances and to witness various

After completion of secondary side related Phase-C commissioning activities, reactor power was raised up to 18%FP and identified tests were completed. Preparatory activities for Turbine-Generator synchronisation to grid are in progress at KAPP-3.

Progress of KAPP-4 and RAPP-7&8:

Erection of equipment/components and pre-commissioning activities were under progress at KAPP-4.

RAPP-7: Concreting of OC dome has been completed. Hydro test and flushing of the individual circuits of PHT system was in progress. Erection of PHT piping and equipment viz. feeders, steam generators, PDHRS tanks, pressuriser has been completed. Installation of Poison Injection Unit (PIU) tube assemblies, reactivity devices (AR, CR & SR) guide tube assemblies were in progress.

RAPP-8: IC dome structure has been placed on Reactor Building. Installation of calandria tube, work of coolant channel assemblies up to installation of bellows has been completed. Construction of other safety related and non-safety related structures and installation of tanks, piping, pumps, heat exchangers and cable laying work were in progress.

(ii) GHAVP-1&2

Subsequent to grant of excavation consent by AERB, NPCIL commenced the excavation activities for main plant buildings of GHAVP-1&2. Ground improvement by replacing soil by compacted soil-cement has been undertaken to address the potential liquefaction concerns. Excavation and ground improvement works at the site have been completed.

Considering the characteristics of founding strata viz-a-viz configuration and layout of structures, combined pile-raft type of foundation (CPRF) system is proposed for certain safety related structures and raft foundation is proposed for others. Preliminary analysis and design of safety related structures considering the inputs of geotechnical investigations have been

reviewed by AERB.

Towards the next phase of construction, i.e. First Pour of Concrete (FPC), AERB carried out in-depth safety review through its multi-tier safety review mechanism to verify conformance with the requirements specified in relevant Safety Codes. The safety review focused on civil engineering aspects and changes in design / layout of GHAVP-1&2 w.r.t. nuclear & radiological safety aspects as compared to KAPP-3&4.

On November 13, 2020, the Board, after examining all the safety reviews, accorded approval for issuance of consent for 'First Pour of Concrete (FPC)' for twin units of GHAVP-1&2. The consent for FPC was issued on November 18, 2020.



GHAVP-1&2 Site ready for First Pour of Concrete after Excavation

Highlights of Safety Review of PHWRs under Construction

Main aspects of KAPP-3&4, RAPP-7&8 and GHAVP-1&2 safety review included review of revised PSARs, Commissioning Procedures, Commissioning Reports, Technical Specifications for Operation, KAPP-3 Primary Containment (PC) Integrated Leak Rate Test (ILRT) and Structural Integrity Test (SIT) Reports, Independent Verification & Validation (IV&V) of Computer Based Systems (CBS), Environmental Qualification Reports, Basis of Acceptance of identified equipment etc.

(a) Commissioning of KAPP-3

During commissioning activities, the progressive submission pertaining to commissioning procedures and reports of KAPP-

3 for IFL, addition of Heavy water to PHT and moderator, First Approach to Criticality (FAC) were reviewed. Subsequently, reports of Low Power Physics Experiments and Tests conducted at KAPP-3 after FAC were also reviewed. Detailed review of commissioning results of Post-Fukushima enhancements like Fire water hook-ups, Air cooled DG, Containment Filtered Venting System (CFVS), Passive Catalytic Recombiners (PCR) and First-of-a-kind (FOAK) systems like Passive Decay Heat Removal System (PDHRS), Containment Spray System (CSS), Regional Over-power Protection (ROPP) system was carried out.

AERB conducted special regulatory inspection w.r.t. commissioning of KAPP-3 during the Initial Fuel Loading (IFL). The FAC process at KAPP-3 was closely monitored through live streaming by AERB officers (during

July 18 to 22, 2020) for necessary checks as per the issued procedure for FAC and stipulations of the FAC permission. Detailed work activity plan for FAC of KAPP-3 was used to keep a track during the FAC process.

Regulatory oversight is ensured through AERB Site Observer Teams (SOT) and submission of commissioning stage specific checklist/reports by site to AERB. Special Remote Regulatory inspection of KAPP-3 was also conducted by AERB to check the preparedness of Site for Phase-C commissioning.

(b) Repeat ILRT and Displacement Measurements of KAPP-3

Earlier, full pressure Structural Integrity Test (SIT) and Integrate Leak Rate Test (ILRT) of the containment of KAPP-3 was conducted as part of pre-commissioning activities. ILRT was repeated to check the efficacy of repair and reduction in leakage rate within designer's expectation. Based on AERB recommendations, displacements of containment structures were measured at earlier identified locations during repeat ILRT. Significant reduction in leakage rate was observed in repeat ILRT compared to earlier test and structural safety was assessed considering measured displacement responses of containment structure. Repeat ILRT was remotely monitored by AERB through video conferencing.

(c) Reactor Physics Design and Commissioning Review of 700 MWe PHWR

The design of 700 MWe PHWRs employs a few first-of-a-kind (FOAK) systems and features and the related design aspects have undergone detailed safety review. The design employs limited coolant boiling at the fuel channel exits along with higher flux flattening within the core. The review was focused on the issues related to Regional Overpower Protection Systems (ROPS-1 and ROPS-2), validation of Flux Mapping Systems (FMS) capabilities to cater to the steady-state operation as well as dynamic scenario and affirming the availability of safety margins during various accidents. The safety review further focused on resolution of issues related to safe operation of fuel bundles within the stipulated bundle powers, conservative management of uncertainties associated with core follow-up tools and estimation of reactor power after the onset of partial boiling within the core. The safety review of reactor physics aspects

associated various commissioning procedures facilitated the granting of AERB clearances on IFL, FAC and Phase-C Physics experiments of KAPP-3.

(d) Technical Specifications for Operation of KAPP-3&4

Technical Specifications for Operation of KAPP-3&4 were reviewed and approved for reactor power upto 70%FP. Review was focussed on FOAK systems and specific features of 700 MWe PHWRs. Surveillance for monitoring of Safety limits, Limiting Safety systems settings and Limiting conditions for Operation were ensured. Appropriate clauses were introduced for addressing availability, surveillance and Allowed Outage Time (AOT) of equipment for following Accident Management Guidelines (AMG).

(e) Erection of IC Dome Liner of RAPP-8

AERB reviewed pre-requisite activities required to be completed before dome liner erection of RAPP-8. Entire erection activity was witnessed, monitored and respective compliances were checked by Site Observer Team of AERB.

(f) Combined Piled Raft Foundation at GHAVP-1&2

Utility adopted Combined Piled Raft Foundation (CPRF) for Nuclear Building (NB), where loads from superstructure is transferred to foundation soil media through combined/interactive actions of soil, pile and raft. This kind of foundation is complex and no International Standards/Codes are available except certain guidelines published by International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). Computational analyses of this structure include comprehensive modelling of entire soil media, individual pile and details of superstructure including raft. Interactions of pile and soil were calibrated through in-situ pile tests. Numerical model is exhaustive to capture all the intra-interaction responses of these components to estimate total as well as differential settlements. Dynamic analysis of CPRF was carried out using ACS SASSI (first time in Indian nuclear power plant), an advanced exclusive software to capture kinematic interaction between structure and founding semi-infinite soil media based on seismic wave propagation.

(g) Review of Additional Pile Tests in GHAVP-1&2

Initial pile tests in nuclear building of GHAVP-1&2 showed less skin friction between pile and surrounding alluvial soil. Additional pile tests were conducted to ascertain and get more insight on pile responses in load transfer mechanism. These tests were remotely witnessed by AERB through video conferencing.

(h) Design Safety Review for GHAVP-1&2

PSARs of GHAVP-1&2 as required for FPC, have been reviewed with a focus on design/layout differences in GHAVP w.r.t. KAPP-3&4 and site-specific changes. Analysis and design of SSCs considering in-situ pile test results and confirmatory geotechnical test data were reviewed by AERB.

(iii) Siting of KAIGA-5&6

NPCIL submitted an application to set up twin units (KAIGA-5&6) of 700 MWe Pressurized Heavy Water Reactor (PHWR) at the existing site of Kaiga, where four 220 MWe PHWRs (KGS-1&2 and 3&4) are already in operation.

The proposed NPPs at Kaiga-5&6 are similar to the standard 700 MWe PHWR project at GHAVP-1&2, except for certain site-specific changes. Hence, review was focused on review feedback, exception (if any), lessons learnt, differences / changes and site-specific aspects, as applicable to siting. All the phenomena/ criteria that could result in rejection of the site were reviewed in detail. Site-specific natural and human-induced events were reviewed with respect to their impact on the plant engineerability.

Based on multi-tier safety review by AERB and recommendations, the Board noted that the site in general satisfies the requirements of AERB Code on Site Evaluation for Nuclear Facilities. After examining the outcome of all safety reviews, the Board accorded approval for issuance of Siting Consent to Kaiga-5&6. The Siting Consent was issued on November 18, 2020.

NPCIL has also submitted the application for Excavation Consent for Kaiga-5&6 which is under review.

1.2.2 FCFs UNDER CONSTRUCTION: REVIEW STATUS

Safety review activities related to the fuel cycle facilities (refer Table 1.2) continued during the year.

B.1 Demonstration Fast Reactor Fuel Processing Plant (DFRP)

DFRP is being set up at Kalpakkam for reprocessing of spent fuel from Fast Breeder Test Reactor (FBTR) on regular basis and demonstration of reprocessing process of the PFBR spent fuel. Fabrication and erection work was in progress for head-end facility. In Process Plant Facility, Clearance for Acid-TBP run was issued to DFRP on March 12, 2019. Commissioning activities w.r.t. Acid-TBP runs such as acid rinsing of transfer air lift; functional testing of vacuum transfers from process cells to Uranium Reconversion (URC) Lab; Regular surveillance and functionality check of precipitator, pumps, blenders, furnaces; routine calibration of analytical instruments and radiometric counting system; surveillance of laboratory systems and analysis of various samples generated during commissioning has been completed.

Installation of alarm annunciators in Pu



Titanium Dissolver



Control Room

reconversion lab, I&C for electrode boiler, RTD and Pressure transmitter for leak testing of Containment box and troubleshooting of interlocks associated with steam jet transfers and vacuum killing system was in progress. Pre-Commissioning test reports were reviewed. Emergency Preparedness & Response manual of DFRP was reviewed and approved.

B.2 Fast Reactor Fuel Cycle Facility (FRFCF)

FRFCF is an integrated facility being set up at Kalpakkam. The facility will be used for recycling the spent fuel from PFBR, including fuel fabrication and assembly, reprocessing and waste management. AERB had issued consent for construction of this facility in the year 2013 and subsequently granted extension of Consent for Construction of FRFCF during December 2016. Presently, civil construction as well as soil back-filling works in Waste Management Plant (WMP), Core Sub-assembly Plant (CSP), Fuel Fabrication Plant (FFP) and Reprocessed Uranium Plant (RUP) areas were in progress. AERB has been following up the safety aspects related to construction activities.

B.3 Nuclear Fuel Complex, Kota (NFC-K)

Two facilities namely, 500 Tons per Annum (TPA) PHWR Fuel Fabrication Facility (PFFF) and 165 TPA Zircaloy Fabrication Facility (ZFF) are being setup at Nuclear Fuel Complex (NFC), Kota. In first phase, two modules each of 250 TPA PHWR Fuel Fabrication Facility and 65 TPA Zircaloy Fabrication Facility will be set up and 100 TPA ZFF will be added in second phase in near future.

AERB issued siting consent for NFC-K on May 28, 2014. Construction of non-plant buildings, facility boundary wall and watch towers was in progress. Construction consent to NFC-Kota was granted on February 05, 2018 with certain stipulations. Compliance to these stipulations is being verified through Regulatory Inspections. Currently, civil and structural works for Plant and Non-Plant Buildings are being carried out in NFC-Kota.

B.4 Safety Review of Away From Reactor Spent Fuel Storage Facility

NPCIL is setting up Away From Reactor (AFR) facilities for storage of spent fuel from operating reactors. The facilities are initially planned for KKNPP and RR sites. The progress of

safety review is as follows:

- ❖ Review of Site Evaluation Report (SER) and other associated submissions for KKNPP-1&2 are under detailed review.
- ❖ During safety review and grant of Siting consent for KKNPP-3 to 6, proposed AFR was not included in the scope. Review of NPCIL submissions for Siting Application and Site Evaluation report of AFR-KKNPP-3&4 were in progress.
- ❖ NPCIL submitted Site Evaluation Report and PSAR on AFR facility for RAPS site requesting for pre-consenting review by AERB, prior to Siting stage. Adequacy review of the submitted documents was under progress.

1.3 OPERATING NUCLEAR POWER PLANTS AND RESEARCH REACTORS

1.3.1 Operational Safety Review

AERB carries out safety review and surveillance of operating NPPs & Research Reactors following multi-tier review process. Exhaustive review takes place during review of application for renewal of licence for operation and resolution of other safety issues that would emanate during plant operation. Currently there are 22 operating NPPs in the country. The details of these NPPs indicating their capacity, commencement of operation and validity of current operating licence is given in Table 1.4.

1.3.2 Consents/Clearances/Permissions Issued

AERB renews licence for operation of NPPs under the Atomic Energy Act, 1962 (and rules framed thereunder), the Factories Act, 1948 (and rules framed thereunder) and authorization for safe disposal / transfer of radioactive waste under GSR-125 for next 5 years based on satisfactory safety review. During the year, a number of applications from the utilities were reviewed and licences for operations / clearances / permissions were issued. Important among these are as follows:

- (i) Renewal of licence for operation of RAPS-5&6 and authorization for radioactive waste disposal/transfer up to March 31, 2025.
- (ii) Renewal of licence for operation of MAPS-1&2 and authorization for radioactive waste disposal/transfer up to December 31, 2025.

Table 1.4: List of Operating NPPs

NPP	Site/District/ State	Unit	Type	Gross Cap. (MWe)	Commence ment of Operation	Validity of Licence
Tarapur Atomic Power Station	Tarapur / Palghar / Maharashtra	TAPS-1	BWR	160	Oct.-1969	March 2021
		TAPS-2		160		
		TAPS-3	PHWR	540	Aug.- 2006	August 2021
		TAPS-4		540	Sept.-2005	
Rajasthan Atomic Power Station	Rawatbhata / Chithaurgarh / Rajasthan	RAPS-1 [#]	PHWR	100	Dec.-1973	August 2024
		RAPS-2		200	Apr.-1981	
		RAPS-3		220	Jun.-2000	October 2022
		RAPS-4		220	Dec.-2000	
		RAPS-5		220	Feb.-2010	March 2025
		RAPS-6		220	Mar.-2010	
Kakrapar Atomic Power Station	Kakrapar / Tapi / Gujarat	KAPS-1	PHWR	220	May-1993	July 2024
		KAPS-2		220	Sept.-1995	
Madras Atomic Power Station	Kalpakkam/ Kancheepuram / Tamil Nadu	MAPS-1	PHWR	220	Jan.-1984	December 2025
		MAPS-2		220	Mar.-1986	
Narora Atomic Power Station	Narora / Bulandshahar / Uttar Pradesh	NAPS-1	PHWR	220	Jan.-1991	June 2023
		NAPS-2		220	Jul.-1992	
Kaiga Generating Station	Kaiga / North Uttar Kannada / Karnataka	KGS-1	PHWR	220	Nov.-2000	May 2022
		KGS-2		220	Mar.-2000	
		KGS-3		220	May-2007	April 2023
		KGS-4		220	Jan.-2011	
Kudankulam Nuclear Power Plant	Kudankulam / Tirunelveli / Tamil Nadu	KKNPP-1	PWR	1000	Dec.-2014	July 2021
		KKNPP-2		1000	Dec.-2017	

[#] Unit under shutdown since 2004 and the reactor core is defueled

- (iii) Renewal of licence for operation of KKNPP-1&2 and authorization for radioactive waste disposal/transfer up to July 31, 2021.
- (iv) Renewal of licence for operation of KAMINI, IGCAR under the Atomic Energy Act, 1962 (and rules framed thereunder) up to June 30, 2025.
- KKNPP-1&2 were operational. RAPS-1 is under shutdown since October 2004. MAPS-1 is shutdown since January 30, 2018 due to leak from pressure tubes. TAPS-1 & TAPS-2 are under shutdown since January 08, 2020 and July 13, 2020 respectively due to observed degradation in primary system piping weld joints during in-service inspection.

1.3.3 Safety Review of Operating Nuclear Facilities and Research Reactors

During this year, TAPS-3&4, RAPS-2 to 6, KGS-1 to 4, MAPS-2, NAPS-1&2, KAPS-1&2, and

Number of meetings conducted by various Safety Committees / Standing Committees / Expert Groups during the year is given in Table 1.5.

Table 1.5: Meetings of Safety Committees

Name of the Committee / Expert Group	No. of Meetings
Safety Review Committee for Operating Plants (SARCOP)	17
LWR Safety Committee (TAPS-1&2 & KK-1&2)	6
PHWR Safety Committee -1 (RAPS-1&2, MAPS-1&2, NAPS & KAPS-1&2)	7
PHWR Safety Committee -2 (KGS-1&2, KGS-3&4, RAPS-3&4 & RAPS-5&6)	6
PHWR Safety Committee -3 (TAPS-3&4)	6
IGCAR Safety Committee (FBTR, CORAL, KAMINI, IFSB, RML & RCL)	1
Standing Committee on Reactor Physics (SC-RP)	6
Standing Committee on Control, Instrumentation& Computer Based Systems (SCCI & CS)	4
Expert Group on Coolant Channels (EGCC)	6
Total	59

Regulatory Oversight for Safety of Operating NPPs during COVID-19

In view of COVID-19 pandemic, countrywide lockdown was implemented from March 23, 2020 till May 31, 2020. Nuclear Power Plants (NPPs) remained operational with essential manpower during the lockdown period. Reserve manpower was maintained for exigencies. Subsequently, restrictions were lifted in phases in accordance with the Government of India guidelines and manpower strength at NPPs was increased accordingly, following these guidelines. Subsequently, the full strength of manpower resumed functioning from office at NPPs. NPPs have implemented various measures to prevent the spread of COVID-19 viz. Social distancing, restrictions on conduct of physical meetings, frequent workplace sanitization, establishing COVID-19 isolation wards at Site hospitals, awareness campaigns for workforce etc. Based on AERB Directive, NPPs compared the measures adopted by them with 'Action Plans adopted by worldwide NPPs to manage risks related to COVID-19' received from IAEA. The measures implemented by Indian operating NPPs were observed to be in line with worldwide NPPs.

As on December 2020, no limitation has been faced by any NPP in maintaining the required manpower for safe operation. Technical specification requirements for availability of

minimum required operating manpower have been adhered to. In view of countrywide lockdown due to COVID-19 pandemic, AERB advised NPCIL to revisit the Emergency Preparedness & Response (EPR) plans of each site & keep themselves prepared for any eventualities and to maintain liaising with District Authorities. Accordingly, emergency response arrangements at NPPs were reviewed and ensured to be adequate. In view of restrictions for carrying out full-fledged emergency exercises due to pandemic, NPPs carried out Table Top exercises on emergency preparedness & response to assess the preparedness of responders (further details are provided in chapter 5 of this report).

AERB exercised its regulatory oversight through reviews of periodic reports on safety status of NPPs, event reports, licence applications etc., and safety appraisal through SOTs deputed at NPP sites, review of self-assessment checklists and remote regulatory inspection. AERB officers carried out these activities by interacting NPPs through tele-conferencing and video conferencing. Communication was maintained with NPP authorities to obtain safety status of NPPs on routine basis. There was no disruption in regulatory oversight of AERB due to COVID-19 pandemic.

As per the AERB directions, NPPs are periodically reporting on the number of COVID-19 cases at the sites.

(i) Rajasthan Atomic Power Station (RAPS)-5&6

Licences for operation of RAPS-5&6 and authorization for radioactive waste disposal/transfer were valid up to March 31, 2020. RAPS-5&6 underwent Periodic Safety Review (PSR) as a pre-requisite for renewal of its operating licence beyond March 2020, under the Atomic Energy Act, 1962. Station had also submitted applications for renewal of licence for operation under the Factories Act, 1948 and authorization for radioactive waste disposal/transfer under CSR-125. Based on the outcome of PSR, AERB renewed licences for operation of RAPS-5&6 and authorization for safe disposal/ transfer of radioactive waste for next 5 years i.e. up to March 31, 2025.

These applications were reviewed by AERB following multi-tier review process. Review assessment indicated that the performance of RAPS-5&6 with respect to nuclear, radiological and industrial safety had been satisfactory. The results of In-Service Inspections (ISI) were found to be satisfactory and plant is capable for safe operation for next five years. Radioactive effluent discharges remained well below the limits specified in technical specifications for operation. Effective dose to a member of public residing at exclusion zone was well within the limit prescribed by AERB (Refer chapter 4 of this report). Station possesses technical & administrative capability for safe operation of the plant. Station has a well-established program for utilization of operating experience and had implemented a number of safety modifications.

Station had implemented all short & medium term safety upgrades identified based on review of Fukushima NPP accident. Long term post Fukushima safety upgrades (such as establishment of OESC, provision for management of hydrogen, etc.) are expected to be completed by December 2022.

(ii) Madras Atomic Power Station (MAPS)-1&2

Licences for operation of MAPS-1&2 and authorization for radioactive waste disposal/transfer were valid till December 31, 2020. Station had submitted application for renewal of these licences/authorization to AERB. Based on the assessment of the application, AERB

renewed licences for operation of MAPS-1&2 and authorization for safe disposal/ transfer of radioactive waste for next 5 years i.e. up to December 31, 2025.

These applications were reviewed by AERB following multi-tier review process. Review assessment indicated that the performance of MAPS with respect to nuclear, radiological and industrial safety had been satisfactory before and after the EMCCR campaign. MAPS-1 is under shutdown since January 30, 2018 due to leak from two coolant channels (O-09 & Q-09). These channels were cut & removed from reactor core and sent to BARC for Post Irradiation Examination (PIE). PIE reports of these tubes were reviewed by AERB.

NPCIL had also carried out the volumetric inspection of the several pressure tubes in MAPS-1. Inspection has shown indications in outer diameter (OD) of many inspected pressure tubes. AERB has recommended to establish the root cause for pressure tube and end shield leak/degradation, and fitness for service assessment of coolant channels & end shield before restart of MAPS-1. NPCIL is in process of establishing the root cause of observed leak/degradation in pressure tubes and rectification of leak from End shield (North). The results of other In-Service Inspections (ISI) were found to be satisfactory.

Radioactive effluent discharges remained well below the limits specified in technical specification. Effective dose to a member of public residing at exclusion zone was well within the limit prescribed by AERB. Station has a well-established program for utilization of operating experience and had implemented a number of safety modifications based on this programme.

Station had implemented all short & medium-term safety upgrades identified based on review of Fukushima NPP accident and committed to implement the Long-term post Fukushima safety upgrades (such as establishment of OESC, implementation of DSS) in a time bound manner. AERB has also stipulated that any change in the status of MAPS-1 should be subjected to detailed safety review by AERB following the Long-Term Operation (LTO) methodology prescribed in IAEA safety standards.

(iii) Kudankulam Nuclear Power Plant (KKNPP)-1&2

Licences for operation of KKNPP-1&2 and authorization for radioactive waste disposal/transfer were valid up to July 31, 2020. As per regulatory requirement, station has submitted application for renewal of licence for operation under the Atomic Energy Act, 1962 along with Periodic Safety Review (PSR) report. Station has also submitted application for renewal of licence for operation under the Factories Act, 1948 and authorization for radioactive waste disposal/transfer under GSR-125.

These applications were being reviewed in AERB following multi-tier review process. Preliminary review carried out by AERB had indicated that the performance of the KKNPP-1&2 w.r.t. nuclear, radiological and industrial safety has been satisfactory during the reporting period. Based on preliminary review, AERB extended the licence for operation of KKNPP-1&2 and authorization for radioactive waste disposal/transfer for limited duration i.e. up to July 31, 2021.

(iv) KAMINI, IGCAR

The licence for operation of KAMINI research reactor at IGCAR was valid up to June 30, 2020. IGCAR submitted application for renewal of licence for operation under the Atomic Energy Act, 1962, which was reviewed in AERB.

Review assessment indicated that the performance of KAMINI w.r.t. nuclear, radiological and industrial safety had been satisfactory. Radioactive effluent discharges remained well within the limits specified in technical specification. There was no major operational or safety related issue with any of the facility system. Radiation dose received by the plant personnel during the reporting period was insignificant. The planned modifications and safety upgrades were carried out to address the operational problems, to overcome the obsolescence and improve the plant performance.

KAMINI had implemented all the short, medium & long term safety upgrades identified based on review of Fukushima NPP accident. The review had also indicated that KAMINI management is sensitive to safety related issues and a safety management system is in place for taking prompt & effective measures to resolve

any safety related issues. The reviews have brought out that the plant SSCs are capable of safe operation for a further period of 5 years without any undue risk to plant, personnel, public and environment. Based on above, AERB renewed the licence for operation of KAMINI under the Atomic Energy Act, 1962 for next 5 years i.e. up to June 30, 2025.

(v) Tarapur Atomic Power Station (TAPS)-1&2

TAPS-1 is under shutdown for 25th refuelling outage since January 08, 2020. During scheduled In-Service Inspection, a seepage indication was observed from one of the weld joints of reactor recirculation loop-A. Metallography of this weld had indicated sensitized structure. The root cause of the leak has been attributed to Inter Granular Stress Corrosion Cracking (IGSCC). Subsequently, station had developed the ultrasonic technique for detection of IGSCC type of cracks. With newly developed techniques, few more weld joints of TAPS-1 as well as TAPS-2 reactor recirculation loop (shut down in July 2020) were inspected. IGSCC types of cracks have been observed in all the inspected weld joints. Presently, station is in process of developing reliable ultrasonic technique for sizing & characterization of IGSCC cracks.

The issue of TAPS-1&2 was reviewed in AERB and it was noted that the degradation observed in weld joints of TAPS-1&2 reactors appears to be generic in nature and need to be resolved before restart of both units. After detailed review, AERB stipulated that restart of TAPS-1&2 would be subject to satisfactory resolution of the observed degradation in weld joints.

(vi) Safety Review of Nuclear Facilities pertaining to Civil Engineering Aspects

Review of following aspects for Operating NPP were completed:

- (a) Condition assessment of buildings / structures of RAPS - 7&8 towards collecting baseline data for lifetime health monitoring.
- (b) District Disaster Management Plans (DDMP)-Off-Site Emergency Management for Nuclear Power Plants located in India.
- (c) Technical Specifications deviation condonation request (TSDCR) on unavailability of one safety train of

Essential loads sea water cooling system of KKNPP-1&2.

- (d) Proposal on modification of power supply and control scheme of passive heat removal system (PHRS) dampers electromagnets of KKNPP-1&2.
- (e) Review of NAPS proposal for postponement of inspection requirements of Non-Nuclear Pressure Vessels (NNPVs) to BSD-2020 or December 31, 2020 was carried out.

Review of following aspects of nuclear facilities were completed:

- (a) Ageing management for buildings / structures at UCIL, Jaduguda and Turamdih.
- (b) Design Basis Flood Level of Solvent Extraction Plant, Tuticorin.
- (c) ISI and QA manuals for setting up of New Extrusion and Fuel Tube Facility-Hot Working (NEFT-HW) at NFC-Hyderabad.
- (d) Seismic re-evaluation and NDT reports of central control room building of HWP-Manuguru.
- (e) Height raising of Stage-1 tailings dam at UCIL, Jaduguda.

1.3.4 Safety Assessment of Operating NPPs in the wake of Fukushima Accident

Safety assessments carried out post Fukushima NPP accident had indicated that Indian NPPs have inherent strength in dealing with external hazards. However, certain safety enhancements were identified for strengthening the defences against rare external events exceeding the design bases and enhancing severe accident mitigation capabilities. These actions were classified as short, medium and long-term measures/safety upgrades. Implementations of short and medium term safety measures/upgrades have been already completed.

The long-term enhancements identified were:

- (a) enhancing severe accident management programme
- (b) strengthening hydrogen management provisions

- (c) provision of containment filtered venting, and
- (d) creation of on-site emergency support center.

These required research & development efforts, analysis, detailed engineering and testing/qualification. The severe accident management guidelines (SAMG) for different NPP designs (PHWR, BWR & PWR) were developed based on technical bases, reviewed & accepted by AERB and are now in place at all NPPs. The activities related to R&D, engineering, testing & qualification related to the rest of the long-term enhancements have been completed and their on-site implementation is now in progress. The present status of long-term safety upgrades/measures is as described below:

(a) Strengthening Hydrogen Management Provisions

The hydrogen management scheme in Indian PHWRs includes provision of suitable number of Passive Catalytic Recombiner Devices (PCRD) along with provisions for homogenizing the containment atmosphere and maintenance of the inert steam atmosphere. Installation of PCRDs along with the associated instrumentation and equipment of Post-Accident Hydrogen Management System (PAHMS) is in progress in the operating NPPs. PCRDs have been installed in KGS-1 to 4, NAPS-1&2, RAPS-4, RAPS-6 & TAPS-3. Installation of PCRDs was partially completed in RAPS-2, MAPS-1&2, KAPS-1&2, RAPS-3, RAPS-5 and TAPS-4.

(b) Provision of Containment Filtered Venting System (CFVS)

Technology development of CFVS has been completed and detailed engineering of the system has been finalized after analysis and testing. CFVS has been installed in TAPS-1&2 (BWR). Installation of CFVS was in progress at MAPS, TAPS-3&4 and KAPS-1&2.

(c) Creation of On-Site Emergency Support Centre (OESC) at NPP

On-site Emergency Support Centre building is proposed at all the NPP sites based on the safety review undertaken after Fukushima accident. AERB has framed requirements and guidelines for establishing On-Site Emergency Support Centres at all NPPs, which take into account the NPPs at the given site and the



PCRDs installed at TAPS-3&4



PCRDs installed at RAPS-3&4

accident scenarios. Activities such as safety review of submissions related to Geotechnical Investigation Reports for OESC building at GHAVP, RAPS, MAPS and TAPS site, finalization of beyond desing basis event (BDBE) spectra & related analysis, award of tender for construction

of building/construction of OESC etc. are at different stages of completion. Analysis & Design reports of OESC building at MAPS and KAPS were completed. After regulatory approvals, construction of the OESCs at two sites (Tarapur, Maharashtra and Kakrapar, Gujarat) is in progress.



CFVS Construction at MAPS-1&2



Construction of OESC at Kakrapar, Gujarat site

1.3.5 Licensing of Operating Staff

Operating personnel of NPPs responsible for control room operation namely Shift Charge Engineer (SCE), Assistant Shift Charge Engineer (ASCE) and Control Engineer (CE) are required to go through a rigorous licensing/relicensing process. This includes clearing checklists, written

exams, walkthrough and finally qualification interviews. A candidate after successfully completing the pre-requisites of licensing procedure, appears before the licensing committee constituted by AERB for qualification interview. This committee has member(s) from AERB. On satisfactory performance, the candidate is licensed/re-licensed for the given position.

During the year, total 16 meetings were held for licensing/re-licensing of operating personnel responsible for control room operations at various operating NPPs. Total 131 candidates were licensed /re-licensed. In addition to above 8 personnel for FBTR operation (Senior Shift Engineers (#4), Senior and Junior fuel handling Engineer (#2), Control Room Assistants/Field Supervisors (#2)) were also licensed/relicensed. Details are given in Table 1.6.

1.3.6 Authorization for Safe Disposal/Transfer of Radioactive Waste

At present, the renewal of authorization for Safe Disposal / Transfer of Radioactive Wastes for DAE Facilities (under GSR-125) is integrated with the renewal of Licence for Operation under AE(RP)R-2004. A list of DAE facilities for which authorization for safe disposal/transfer of radioactive waste were granted in the year 2020 are indicated in Table 1.7.

Table 1.6: Licensing of Operating Staff

Plants	No. of Persons Licensed					Licensing Committee Meetings
	SCE	ASCE	ASCE (F)	CE	CE (F)	
TAPS - 1&2	5	1	-	2	-	1
TAPS - 3&4	5	6	-	14	2	2
RAPS - 1&2	-	3	1	-	1	1
RAPS - 3&4	-	1	-	5	-	2
RAPS - 5&6	1	3	-	3	-	1
MAPS - 1&2	2	2	-	4	-	1
NAPS - 1&2	7	1	4	9	6	2
KAPS - 1&2	-	2	1	2	3	1
KGS - 1&2	3	6	1	5	-	2
KGS - 3&4	3	6	2	8	1	3
Total	26	31	9	52	13	16

Table 1.7: List of Facilities Authorised for Safe Disposal / Transfer of Radioactive Waste

S. No.	Name of DAE Organisation	No. of Facilities
1	Uranium Corporation of India Limited (UCIL)	3
2	Indian Rare Earth Limited (IREL)	1
3	Nuclear Fuel Complex (NFC)	-
4	Nuclear Power Corporation of India Limited (NPCIL)	3
5	IGCAR + SRI (AERB)	-
6	Board of Radiation & Isotope Technology (BRIT)*	-
7	Technology Demonstration Plant (HWB)	-
	Total Number of Authorisations	7

*LBL, JONAKI, BRIT is exempted from waste authorisation

1.4 NUCLEAR FUEL CYCLE AND OTHER RELATED INDUSTRIAL FACILITIES

1.4.1 Operational Safety Review

The nuclear fuel cycle facilities and other related industrial facilities under the regulatory control of AERB are mines and ore processing

plants of Uranium Corporation of India Ltd. (UCIL), mineral separation plants and chemical processing plants of Indian Rare Earths Limited (IREL), Nuclear Fuel Complex (NFC), Zirconium Complex (ZC), Heavy Water Plants (HWP), Atomic Minerals Directorate for Exploration and Research (AMD) and some of the facilities of Indira Gandhi Centre for Atomic Research

(IGCAR). In addition to this, Beach Sand Minerals (BSM) and other facilities handling Naturally Occurring Radioactive Materials (NORM) are

also regulated by AERB with respect to radiological safety aspects. The status of Nuclear Fuel Cycle and other Industrial Facilities is presented in Table 1.8.

Table 1.8: Status of Nuclear Fuel Cycle Facilities and other Industrial Facilities

Type of Facility	Name	Functional Status	District/ State	Scope of the Facility	Validity of Current Licence
Facilities operated by UCIL					
Mines	Narwapahar	In operation	Singhbhum (E) / Jharkhand	Underground uranium mine	March 31, 2023
	Turamdih	In operation	Singhbhum (E) / Jharkhand	Underground uranium mine	December 31, 2023
	Bagjata	In operation	Singhbhum (E) / Jharkhand	Underground uranium mine	*June 30, 2025
	Mohuldin	In operation	Singhbhum (E) / Jharkhand	Underground uranium mine	October 31, 2024
	Jaduguda	Shutdown	Singhbhum (E) / Jharkhand	Underground uranium mine	January 31, 2023
	Bhatin	Shutdown	Singhbhum (E) / Jharkhand	Underground uranium mine	April 30, 2023
	Tummalapalle	In operation	Y.S.R. Kadapa/ Andhara Pradesh	Underground uranium mine	February 28, 2023
	Banduhurang	In operation	Singhbhum (E) / Jharkhand	Opencast uranium mine	June 30, 2021
Ore Processing (Mills)	Jaduguda	In operation	Singhbhum (E) / Jharkhand	Uranium Ore Processing	*December 31, 2025
	Turamdih	In operation	Singhbhum (E) / Jharkhand	Uranium Ore Processing	February 28, 2021
	Tummalapalle	Under Trial Operation	Y.S.R. Kadapa/ Andhara Pradesh	Uranium Ore Processing	June 30, 2021
Facilities operated by IREL					
Mines	Chavara	In operation	Kollam / Kerala	Mineral Separation	August 31, 2024
	Manavalakurichi	In operation	Kanyakumari/ Tamil Nadu	Mineral Separation	August 31, 2024
	OSCOM Chatrapur	In operation	Ganjam /Odisha	Mineral Separation	August 31, 2024
Ore Processing Facilities	OSCOM Chatrapur	In operation	Ganjam /Odisha	Rare earth processing	*April 30, 2021
Others	Udyogamandal	In operation	Emakulum/ Kerala	Rare earths compounds and Uranium production	November 30, 2023
Facilities operated by NFC					
Nuclear Fuel Fabrication Facilities	NFC Hyderabad	In Operation	Hyderabad/ Telangana	Fuel Fabrication	August 31, 2022
	Zirconium Complex, Pazhayakayal	In Operation	Tuticorin / Tamil Nadu	Reactor Grade Zirconium Sponge production	June 30, 2021

Facilities operated by HWB					
Heavy Water Plants	HWP-Kota, Rawatbhata	In Operation	Chittorgarh/ Rajasthan	Heavy Water production	*December 31, 2025
	HWP-Manuguru	In Operation	Khammam/ Telangana	Heavy Water production Other diversified activities viz. production of enriched boric acid, elemental boron, boron carbide pellets and O ⁻¹⁸ enriched water	*June 30, 2025
	HWP-Baroda	Heavy water production suspended In Operation (Solvent and K & Na metal plant)	Baroda / Gujarat	Tributyl Phosphate (TBP), Potassium & Sodium metal production	May 31, 2021
	HWP-Hazira	In Operation	Hazira / Surat / Gujarat	Heavy Water production	July 31, 2023
	HWP-Thal	In Operation	Raigad/ Maharashtra	Heavy Water production	December 31, 2024
	HWP-Tuticorin	Heavy water production suspended In operation (Diversified activities like solvent production plant)	Tuticorin/ Tamil Nadu	Production of solvents: TiAP, DHOA, D2EHPA -II	July 31, 2023
	HWP-Talcher	Heavy water production suspended In operation (Diversified activities like solvent production plant)	Angul / Odisha	Production of solvents: TBP, ¹⁰ B enriched Boron D2EHPA, TOPO, TAPO, DNPPA and other product viz. ¹⁰ B enriched Boron, Boric Acid	*August 31, 2025
	TDP -Chembur	Main Plant operation is Shut down (Some systems are being operated in closed loop for developmental activities)	Mumbai/ Maharashtra	Crude Sodium Di -Uranate	October 31, 2021

* Renewed Licence for operation during the year 2020

1.4.2 Consent/Clearances/Permission Issued

AERB continued its regulatory supervision of fuel cycle facilities. During the year, applications from the following DAE units were reviewed and licences were renewed/issued/extended under the Factories Act, 1948 /the Atomic Energy Act, 1962 (and rules framed thereunder). The licences are valid for a period of maximum five years.

- (i) Licence for operation of Bagjata mine was renewed up to June 30, 2025.
- (ii) Extension of licence for operation of Rare Earths Extraction Plant (REEP) at IREL (India) Ltd., OSCOM and authorization for radioactive waste disposal/transfer, up to March 31, 2025.
- (iii) Consent for Trial Operation of Tummalapalle Mill was extended up to June 30, 2021.
- (iv) Licence for operation of Jaduguda mill was renewed up to December 31, 2025.
- (v) Licence for operation of HWP- Manuguru was renewed up to June 30, 2025.
- (vi) Licence for operation of HWP- Talcher was renewed up to August 31, 2025.
- (vii) Licence for operation of HWP- Kota was renewed up to December 31, 2025.
- (viii) Consent for Siting of Solvent Extraction Plant (SXP) at HWP-Tuticorin was issued with validity up to September 30, 2025.
- (ix) Consent for Siting & Construction of Solvent Production Plant (SPP) at HWP-Tuticorin was extended up to December 31, 2021.
- (x) Consent for Siting & Construction for setting up the 24kA Prototype Sodium Cell at HWP, Baroda.
- (xi) Approval for Setting up New Extrusion and Fuel Tube Facility-Hot Working at NFC, Hyderabad

1.4.3 Safety Review of Fuel Cycle Facilities

Number of meetings conducted by various

safety committees for fuel cycle facilities and other industrial facilities during the year are given in Table 1.9

The highlights of Safety Review of the operating Fuel Cycle and other Industrial Facilities are given below:

(i) Uranium Corporation of India Limited (UCIL)

During the year, the uranium mines at Narwapahar, Turamdih, Bagjata, Mohuldih, Banduhurang and Tummalapalle were under operation except during the nation-wide lockdown period due to Covid-19 pandemic. UCIL mine at Jaduguda and Bhatin are presently under shutdown. However, all other essential activities (like dewatering, ventilation etc.) to ensure safety of the mine are being continued. The mills at Jaduguda and Turamdih were under normal operation except during the nation-wide lockdown period. Tummalapalle mill is in trial operation.

(a) Renewal of Licence for Operation of Bagjata Mine

The licence for operation of Bagjata mine issued under the Atomic Energy Act, 1962 (and rules framed thereunder) was valid up to June 30, 2020. UCIL renewal application was reviewed in AERB following multi-tier review process. Safety review indicated that during the licence period, the operational & radiological status of these facilities was satisfactory. The average individual doses of the mine workers were well within the regulatory limit. Solid, liquid and gaseous wastes disposed/transferred from the facility were within AERB authorized limits. Based on the satisfactory safety review, AERB renewed the licence for operation for Bagjata mine for next five years i.e. up to June 30, 2025.

(b) Consent for Trial Operation of Tummalapalle Mill

The Consent for Trial Operation of Tummalapalle mill was valid till June 30, 2020. UCIL submitted application for regular operation of Tummalapalle mill, which was reviewed in AERB following multi-tier review process. Safety review indicated that UCIL had complied with most of the recommendations made by AERB and has initiated actions for resolution of the pending recommendations. In view of the above, AERB extended the validity of the existing consent for

Table 1.9 : Meeting of Safety Review Committee of Fuel Cycle Facilities

Name of the Committee	No. of Meetings
NFSC-1 (erstwhile, UCIL-AMD Safety Committee and BSM-NORM Safety Committee)	3
NFSC-2 (erstwhile, NFC Safety Committee)	1
NFSC-3 (erstwhile, HWP Safety Committee and ECIL Safety Committee)	4
Industrial and Fire Safety Committee (I & FSC)	1
Occupational Health Safety Committee (OHSC)	2
Total	11

trial operation and authorization for disposal/ transfer of radioactive waste under the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987) of Tummalapalle mill for one year i.e. up to June 30, 2021 to enable UCIL to resolve the pending issues satisfactorily.

(c) Renewal of Licence of Jaduguda Mill

The licence for operation of Jaduguda Mill issued under the Atomic Energy Act, 1962 (and rules framed thereunder) and the authorization for disposal/ transfer of radioactive waste under the Atomic Energy (Safe Disposal of Radioactive Waste) Rules, 1987 were valid till December 31, 2020. UCIL application for renewal of the licence was reviewed in AERB following multi-tier review process. During review, it was noted that tests / surveillance of SSCs were carried out periodically and results were found to be satisfactory. The average occupational doses to the mill workers & radioactive waste discharged/ transferred from mill were well within the AERB authorized limits. Based on satisfactory safety review, AERB renewed the licence for operation and authorization for disposal/ transfer of radioactive waste of Jaduguda mill for next five years i.e. till December 31, 2025.

(ii) Indian Rare Earths Limited (IREL)

Rare Earth Division (RED) at IREL Udyogamandal and Mineral Separation Plants (MSP) of IREL at Chavara, Manavalakurichi and Chatrapur operated safely during the year. Monazite up-gradation plants at IREL Orissa Sand Complex (OSCOM), Manavalakurichi and Chavara were operational. Operations of all these facilities were suspended during the period of nation-wide lockdown due to COVID-19 pandemic. However, all essential and emergency services continued during this period.

(a) Extension of Licence for operation of Rare Earths Extraction Plant, IREL (India) Ltd., OSCOM

The licence for operation of Rare Earth Extraction Plant (REEP) [earlier named as Monazite Processing Plant (MoPP)] of IREL (India) Ltd., OSCOM, Orissa were valid till April 30, 2020. The application for renewal of licence submitted by IREL was reviewed in AERB following multi-tier review process. Safety review indicated IREL had complied with most of the recommendations made by AERB and has initiated actions for resolution of the pending recommendations. In view of above, AERB extended the validity of existing licence for operation and authorization for disposal/ transfer radioactive waste for one year i.e. up to April 30, 2021.

(iii) Nuclear Fuel Complex (NFC) & Zirconium Complex (ZC)

All the plants of NFC, Hyderabad and ZC, Pazhayakayal operated safely during the year. However, operation of all these facilities were suspended during the period of nation-wide lockdown due to COVID-19 pandemic.

(a) Approval for Setting up New Extrusion and Fuel Tube Facility at NFC, Hyderabad

NFC, Hyderabad had submitted a proposal for setting up New Extrusion and Fuel Tube Facility-Hot Working (NEFTF-HW) in order to increase the extrusion capacity from existing 14,000 to 27,000 extrusions per year to meet the requirements. During review, it was noted that NFC has suitably addressed the safety aspects related to building design and layout of the facility. NFC has further committed to comply with the equipment safety requirements during the equipment erection. Based on the safety review AERB accorded the permission for setting up NEFTF-HW at NFC, Hyderabad.

(iv) Heavy Water Plants (HWP)

Heavy water plants at Kota, Manuguru, Hazira and Thal were operational. Heavy water production at HWPs-Baroda and Talcher were suspended due to unavailability of feed synthesis gas from fertilizer plant. Heavy water production facility at HWP-Tuticorin has been declared as 'CLOSED'. Diversified activities at HWP-Baroda, Talcher and Tuticorin were operational. Technology Demonstration Plant

(TDP), Chembur is under shutdown due to non-availability of feed phosphoric acid from fertilizer plant. However, trial operation for developmental activities were carried out. During the year following licence applications were reviewed:

(a) Renewal of licence for operation of HWP-Talcher

The Licence for operation of HWP-Talcher issued under the Atomic Energy Factories Act, 1948 was valid till August 31, 2020. HWP-Talcher application for renewal of licence was reviewed by AERB following multi-tier review process. Safety review indicated that the performance of HWP-Talcher w.r.t. operation and safety has been satisfactory and there were no major operational or safety related issue with any of the facility system. Based on safety review, AERB renewed the licence for operation of HWP-Talcher under the Factories Act, 1948 up to August 31, 2025.

(b) Renewal of Licence for operation of HWP-Manuguru

The Licence for operation of HWP-Manuguru (HWP-M) issued under the Atomic Energy Factories Act, 1948 was valid till June 30, 2020. HWP-Manuguru application for renewal of licence was reviewed in AERB following multi-tier review process. Safety review indicated that the performance of HWP-M w.r.t. operation and safety has been satisfactory during the review period. HWP-M had carried out several modification to address the operational problems, to overcome the obsolescence and improve the plant performance. HWP-M has satisfactorily addressed the recommendations made during safety review and inspections of AERB. Effluents discharges from the plant were well within the prescribed limits. On-site and off-site emergency preparedness plans are available and emergency exercises are being periodically conducted. Based on safety review, AERB renewed the licence for operation of HWP-Manuguru under the Factories Act, 1948 up to June 30, 2025.

AERB also granted permission for installation & operation of O-18 unit located in the premises of the HWP-Manuguru.

(c) Renewal of Licence for Operation of HWP-Kota

Licence for operation of HWP-Kota issued

under the Factories Act, 1948 was valid till December 31, 2020. HWP-Kota application for renewal of the licence was reviewed in AERB following multi-tier review process. Safety review indicated that there was no major operational or safety related issue at HWP-K. The planned modifications and safety upgrades were carried out based on operating experience. Based on safety review, AERB renewed the licence for operation of HWP-Kota for a period of five years i.e. up to December 31, 2025.

(d) Consent for Siting of Solvent Extraction Plant at HWP-Tuticorin

HWP-Tuticorin submitted an application for Siting consent of setting up Solvent Extraction Plant (SXP) for extraction of Uranium from Phosphoric Acid. Based on safety review, AERB granted the consent for Siting for setting up SXP at HWP-Tuticorin under the Atomic Energy Act, 1962 (and rules framed thereunder) with validity up to September 30, 2025.

(e) Extension of Consent for Siting and Construction of Solvent Production Plant at HWP-Tuticorin

The existing consent for Siting & Construction of Solvent Production Plant (SPP) at HWP-Tuticorin was valid up to December 2020. HWP-Tuticorin had submitted a request for extension of validity of the existing consent by one year. During review, it was noted that planned construction activities got postponed due to delay in obtaining required clearance from Tamilnadu Pollution Control Board and difficulties in foundation work of SPP buildings because of elevated ground water table at the site. Further, due to COVID-19 pandemic, the material supply and erection activities were affected. Based on safety review, AERB approved the extension of validity of existing consent for Siting & Construction of SPP up to December 2021.

(f) Consent for Siting and Construction for setting up the 24kA Prototype Sodium Cell at HWP, Baroda

HWB has taken up the production of nuclear grade sodium to cater to the requirements of the future Fast Breeder Reactors (FBR) in India. In this regard, HWB proposed to set up 24kA prototype sodium cell at HWP-Baroda. The prototype 24kA sodium cell will be operated for around 1 to 3 years for data generation and validation of the

process. Subsequently, industrial scale facility for sodium metal production will be constructed.

Accordingly, HWP-Baroda submitted an application for Siting & Construction of 24 kA Sodium cell along with supporting documents like Site Evaluation Report (SER), Safety Report, Construction Schedule, Job Hazard Analysis (JHA) report and QA Manual for construction. The application was reviewed in AERB following multi-tier review process. Based on safety review, AERB accorded the consent for 'Siting and Construction' for setting up the 24kA Prototype Sodium Cell at Heavy Water Plant, Baroda.

(v) Atomic Minerals Directorate for Exploration and Research (AMD)

Exploration work at various sites of AMD in northern, southern, eastern, western, central and south-central region was in progress. No regulatory inspection of AMD facilities was carried out during the year.

(vi) Beach Sand Minerals (BSM) & Naturally Occurring Radioactive Materials (NORM) Facilities

Periodic radiological reports submitted by the facilities were reviewed by AERB. No abnormality was observed during review.

1.4.4 Licensing of Plant Personnel in FCF

Operating personnel of Fuel Cycle Facilities are required to go through a rigorous Licensing process. This includes clearing checklists, written exams, walkthrough and finally qualification interviews. A candidate after successfully completing the pre-requisites of licensing procedure, appears before the licensing committee for qualification interview. This committee has member(s) from AERB. On satisfactory performance, the candidate is authorization/re-authorization for the given position.

During the year total 4 meetings were held for authorization/re-authorization of operating personnel from HWPs & ZC, and total of 42 candidates were authorized/re-authorized, as detailed below:

- (i) Licensing committee of Heavy Water Plants met on 3 occasions and 37 operation personnel (Shift In-charge, Field Engineer and Control Panel Operator) were

authorized/ re-authorized.

- (ii) Licensing committee of Zirconium Complex met once and 5 operation personnel (Shift In-charge) were authorized/ re-authorized.

1.5 OVERALL SAFETY PERFORMANCE OF NUCLEAR FACILITIES

1.5.1 Safety Performance of Nuclear Facilities in Construction Stage

(a) KKNPP-3 to 6

Construction activities are in progress at KKNPP-3 to 6 site. There was one fatal accident in the sea front and one fatality following an accident of serious nature at pump house area of KKNPP-3&4. AERB reviewed these accidents and measures to prevent recurrences of such incidents in future were recommended and conveyed to the site for compliance. Further details are given under section 1.8.2.

(b) PFBR

Pre-commissioning/commissioning activities at PFBR are in progress. There was no major reportable incident at PFBR calling for enforcement actions during the period.

(c) KAPP-3&4, RAPP-7&8 and GHAVP-1&2

Construction activities are in progress at KAPP-3&4, RAPP7&8 and GHAVP-1&2 sites. There was one reportable injury, one accident of serious nature in RAPP-7&8 during erection/construction related activities. AERB reviewed these incidents and measures to prevent recurrences of such incidents in future were recommended and conveyed to the site for compliance.

(d) Kaiga-5&6

There was no major reportable incident calling for enforcement action at Kaiga-5&6.

(e) DFRP and FRFCF

There was no major reportable incident calling for enforcement action during commissioning activities at DFRP and construction at FRFCF.

(f) NFC-Kota

Construction of the plant buildings is under

progress at NFC-Kota Site. There was no major reportable incident at NFC-K calling for enforcement action during the period.

1.5.2 Safety Performance of Nuclear Facilities in Operation

The operational performance and significant events were reviewed and the required modifications were implemented. During the year, RAPS-2 to 6, KGS-1 to 4, MAPS-2, NAPS-1&2, KAPS-1&2, TAPS-3&4 and KKNPP-1&2 were operational. RAPS-1 is under shutdown since October 2004. MAPS-1 is shutdown since January 2018 due to leak from pressure tubes. TAPS-1 and TAPS-2 are under shutdown since January and July 2020 respectively due to observed degradation in primary system piping weld joints during in-service inspection.

In the year 2020, there were total 34 significant events in NPPs. All the 34 significant events were reviewed in detail in AERB to see the adequacy of investigations, corrective actions, lessons learnt and the need for further regulatory actions. Details of the significant events are given in section 1.8.1.

All fuel cycle facilities operated safety during the period.

1.6 R&D UNITS AND OTHER FACILITIES IN CONSTRUCTION AND OPERATION

Safety review of Variable Energy Cyclotron Centre (VECC), Raja Ramanna Centre for Advanced Technology (RRCAT), Indira Gandhi Centre for Atomic Research (IGCAR), Electronics Corporation of India Limited (ECIL) and Board of Radiation & Isotope Technology (BRIT) was done apart from the Fuel Cycle Facilities. The status of R&D units and other facilities is presented in Table 1.10.

1.6.1 Variable Energy Cyclotron Centre (VECC)

The Room Temperature Cyclotron (K-130) was under operation delivering alpha and proton beams of various energies and intensities. Commissioning of Super-conducting cyclotron and Radioactive Ion Beam facility is in progress. The Stage-1 commissioning consent was issued to medical cyclotron facility, which will be used, for commercial production of isotopes for Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) as well as high end technological research. During

the year, following proposal was reviewed by AERB.

Stage-1 Commissioning of Medical Cyclotron, VECC, Kolkata

AERB granted consent for Stage-1 Commissioning of Medical Cyclotron and its associated beamlines till July 30, 2020. VECC submitted application for extension of the said consent. Based on safety review AERB extended the consent for Stage-1 Commissioning of Medical Cyclotron and its associated beamlines till December 31, 2020

1.6.2 Raja Ramanna Centre for Advanced Technology (RRCAT)

INDUS-1 Synchrotron Radiation Source (SRS) was under operation with beam energy of 450 MeV and beam current of 100 mA delivering synchrotron radiation through fourteen beamlines. INDUS-2, which is a synchrotron-cum-electron storage ring, was under operation at 2.5 GeV (max) beam energy and beam current of 200 mA (max). Twelve beamlines of INDUS-2 have already been authorised by AERB for carrying out experiments. In addition to these, major accelerators, other accelerators and Laser Facilities/Projects at RRCAT are being periodically reviewed. During the year, following proposals/issues related to RRCAT were reviewed by AERB.

(a) Authorization to Operate INDUS-2 Beamlines

RRCAT application for authorization to operate two more beamlines BL-3 and BL-18 of INDUS-2, Synchrotron Radiation Source was reviewed by AERB and authorization was granted on June 25, 2020, valid till March 31, 2021.

(b) Commissioning Consent for Stage-2 of TWINDUS LINAC-3

RRCAT is in process of developing RF based Linear Accelerator. After completion of Stage-1 of Electron Accelerator (10 MeV beam energy with 5 kW beam power), RRCAT applied for Stage-2 Commissioning consent for TWINDUS LINAC-3 at 10 MeV beam energy with 10 kW beam power (there is increase in beam power from earlier 5 kW). Based on safety review AERB granted commissioning consent for Stage-2 commissioning on July 30, 2020, valid till July 30, 2022.

Table 1.10: Status of R&D and other Facilities

Type of Facility	Name	Functional Status	Scope of the Facility	Validity of Current Licence
Facilities operated by VECC, Kolkata, West Bengal				
Particle Accelerator Research Facility (PARF)	Room Temperature Cyclotron (K-130)	In operation	Heavy ion acceleration	August 31, 2022
	Super Conducting Cyclotron (K-500)	Commissioning	Heavy ion acceleration	August 31, 2022
	Medical Cyclotron Project	Stage-1 Commissioning	Cyclotron machine along with 3 beam lines for production of radio-pharmaceuticals and 2 beamlines for research purpose	December 31, 2020
Facilities operated by RRCAT, Indore, Madhya Pradesh				
LASER	150 TW Ti: Sapphire Laser System	In operation	90 TW (for regular) and 150 TW (trial) (25 femto-second)	June 30, 2021
PARF	TWINDUS LINAC-1 Agricultural Radiation Processing Facility (ARPF)	In operation	Electron Acceleration, 10 MeV, 5 kW Technology Demonstration for Food Irradiation	*January 11, 2024
	TWINDUS LINAC-2	In operation	Electron Acceleration, 10 MeV, 5 kW	*January 11, 2024
	TWINDUS LINAC-3	Commissioning	Electron Acceleration, 10 MeV, 10 kW	*July 30, 2022
	INDUS-1	In operation	450 MeV, 100 mA Electron Storage Ring	September 30, 2023
	INDUS-2	In operation	2.5 GeV, 200 mA Synchrotron Radiation Source (SRS)	March 31, 2021
Accelerator	Electron LINAC	In operation	10 MeV, 10 kW	June 30, 2021
LASER	1 PW Laser System	Construction Completed	1 PW (femto second)	-----
Superconducting RF Cavity	Horizontal Test Stand for Superconducting RF (SCRF) Cavities	Commissioning and Operation	SCRF Cavity at 650 MHz	June 20, 2022
Facilities operated by IGCAR, Kalpakkam, Tamil Nadu				
Accelerator	1.7 MV Tandatron Accelerator	In operation	1.7 MV	August 31, 2021
	150 kV Accelerator	In operation	150 kV	August 31, 2021
Facilities operated by ECIL				
Electronic Component Development	ECIL, Hyderabad	In operation	Production of Instrumentation, Control & Communication systems and other electronic components	*June 30, 2025
	ECIL, Tirupati	In operation	Production of Nuclear, Industrial Instrumentation systems, EVM & VVPAT power packs etc.	October 31, 2021
Facilities operated by BRIT				
Board of Radiation and Isotope Technology	BRIT, Vashi, Navi Mumbai	In operation	Production of radioisotopes for radiation facilities, radio-pharmaceuticals mainly for Nuclear Medicine application, radiation processing etc.	January 31, 2024
	BRIT-RAPPCOF, Kota	In operation	Production of radioisotopes mainly for Radiation Processing plants	January 31, 2024

* Renewal of Validity of Licence during the year

1.6.3 Electronics Corporation of India Limited (ECIL)

ECIL facilities at Hyderabad and Tirupati operated safely during the year. However, operations of all these facilities were suspended during the period of nation-wide lockdown due to COVID-19 pandemic.

(a) Renewal of licence for operation of ECIL, Hyderabad

The Licence for operation of ECIL, Hyderabad issued under the Factories Act, 1948 was valid up to June 30, 2020. The facility submitted an application for renewal of licence for operation, which was reviewed in AERB following multi-tier review process. It was noted that safety performance of ECIL has been satisfactory during licensing period. Based on the safety review, AERB renewed the licence for operation of ECIL under the Factories Act, 1948 (and rules framed thereunder) for next five years i.e. up to June 30, 2025.

1.6.4 Board of Radiation & Isotope Technology (BRIT)

BRIT facilities at Navi Mumbai; RAPPCOF, Kota and its Regional Centres at various locations in the country are involved in production of radio-isotopes used in radiation facilities as well as radio-pharmaceuticals used mainly in nuclear medicine application. All the facilities operated safely during the year

1.7 INDUSTRIAL SAFETY OF NUCLEAR FACILITIES

Industrial Safety Awards and Fire Safety Awards are given by AERB to promote Industrial Safety and Fire Safety in DAE Units under its purview. AERB had evaluated the data related to industrial & fire safety performance of DAE units for the year 2019. Based on the same, awards for year 2019 have been finalized.

These awards were declared on March 4, 2021 during the celebration of 'National Safety Day' through virtual programme organized by AERB.

1.7.1 Industrial Safety Awards

AERB presents Industrial Safety Awards every year to the DAE units which achieve highest performances in Industrial Safety. These awards are given based on the relevant inputs/data received from each unit and its assessment with the set parameters that include longest accident free period, implementation of safety management system, injury statistics, dangerous occurrence, type of plant and operation, safety training imparted to personnel and efforts made by the plant towards improving safety.

For Industrial Safety award DAE units are categorized based on nature of plant operation as Production Units-I and II, R&D and other Low Risk Units, and Construction Units category. The winners of the AERB Industrial Safety Awards-2019 in various categories are as follows.



Release of Booklet on 'Occupational Injury and Fire Statistics of DAE Units -2019' by Dignitaries

Category	Name of the Winner Unit
Production Units - I (NPPs & HWP)	Rajasthan Atomic Power Station (RAPS)-3&4
Production Units -II (Others)	Zirconium Complex, Pazhayakayal
R&D and other Low Risk Units	Heavy Water Plant (HWP) - Tuticorin
Construction Units	Kakrapar Atomic Power Project (KAPP)-3&4

1.7.2 FIRE SAFETY AWARDS

Fire Safety award was instituted by AERB to ensure that maximum efforts are made by the DAE units to prevent occurrences of fire incident and ensure that appropriate management system is in place to prevent fire in these units. The award is given based on the marks computed through

review and assessment of inputs/data on management system, efforts for improvement, training and fire incident statistics. DAE units are categorised as Category-I and Category-II units based on fire potential. Following units were the winners of the AERB Fire Safety Awards-2019 in these categories.

Category	Name of the Winner Unit
Category-I (High Fire Risk Units)	Kakrapar Atomic Power Station (KAPS)-1&2
Category-II (Low Fire Risk Units)	Kakrapar Atomic Power Station (KAPS)-3&4

1.8 SIGNIFICANT EVENTS

AERB requires NPPs to report certain events that occur in the plant which have or may have impact on operational safety. Under the reporting system established by AERB, the events reportable to AERB are divided into two categories, termed as,

- (a) Events
- (b) Significant Events

This categorization of events is done based on their safety significance and importance to operational safety experience feedback. Based on the established reporting criteria, Event Reports (ER) and Significant Event Reports (SER) are submitted to AERB. The SERs received from the operating NPPs are rated on the International Nuclear and Radiological Event Scale (INES) of International Atomic Energy Agency (IAEA). The INES rates events at seven levels (1 to 7) depending on their safety significance as shown in figure 1.1 below.

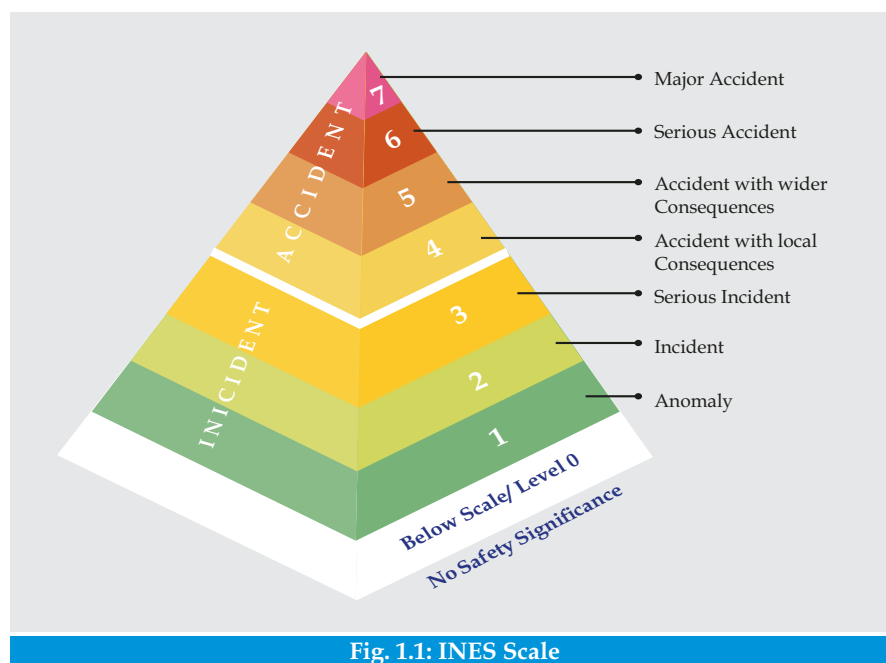


Fig. 1.1: INES Scale

Events rated at level 4 and above are termed as 'Accidents'. The accidents at Chernobyl NPP in former USSR (now in Ukraine) in April 1986 and Fukushima NPPs in Japan in March 2011 were rated at level 7 on INES. Events rated at levels 1, 2 and 3 are called 'Incidents'. The level 0 or below scale means events that have no nuclear and radiological safety significance.

1.8.1 Significant Events and INES rating w.r.t. NPPs

All the significant events reported were reviewed in detail by AERB and measures to prevent recurrence of such events were recommended.

(i) Significant Events in NPP under Construction/Commissioning

During 2020, one significant event was reported from KAPP-3 during Phase-B commissioning of KAPP-3. The significant event was rated at Level-0 on INES of IAEA.

❖ Reactor Manual Shutdown due to internal seal leak in Primary Circulating Pump-2 at KAPP-3

KAPP-3 reactor was critical and Reactor power was 0.1% FP and stable. PHT temperature was 258.6°C with all four PCPs running. Inadvertent intermittent actuation of PCP-2 back up seal while PCP-2 was running led to higher vibration and failure of mechanical seal leading to PCP internal leak and minor external leak. Significant event report was reviewed in detail by AERB and corrective measures to prevent recurrence of such event was recommended.

Direct cause for the SER is attributed to PCP vibration and mechanical seal leak. Root cause of SER is attributed to un-envisaged design aspect.

(ii) Significant Events in Operating NPPs

During the year 2020, a total of 34 significant events were reported from operating NPPs. Out of these, 25 significant events were rated at level 0 on INES and three events (one each at NAPS-1, TAPS-1 and TAPS-2) were rated at level 1 on INES. 4 significant events (one at MAPS-2 and three at KKNPP-1&2) were assigned provisional rating of level 0 since these are still under investigation.

The number of SERs in operating NPPs along with their ratings on INES are given in Table-1.11.

Two significant events, one each at RAPS-5&6 and KKNPP-1&2 were not rated on INES as these were related to industrial safety and had no relevance to nuclear and radiological safety.

Table 1.11: INES Rating of Significant Events in NPPs Reported during Calendar Year (2020)

NPPs	INES Rating of Events	
	INES-0	INES-1
TAPS - 1&2	0	2
TAPS - 3&4	2	0
RAPS - 1&2	1	0
RAPS - 3&4	1	0
RAPS - 5&6	3	0
MAPS - 1&2	4*	0
NAPS - 1&2	1	1
KAPS -1&2	4	0
KGS - 1&2	3	0
KGS - 3&4	1	0
KKNPP - 1&2	9*	0
Total	29	3

* One event at MAPS-2 and three events at KKNPP-1&2 were assigned provisional rating of level 0 as these events are still under investigation.

For the purpose of analysis, the events reported during year 2020 were also categorized as per the IAEA-IRS coding system. The classification of systems failed/affected during the significant events is given in Figure-1.2. The classification of direct causes and root causes of the significant events are given in Figure-1.3 & 1.4 respectively.

❖ Significant Events Rated at Level-1 on INES

- (i) On January 8, 2020, TAPS-1 was shut down for refueling. During the refueling outage, as per scheduled In-Service Inspection (ISI) program, inspection of weld joints of reactor coolant system piping was carried out. Liquid Penetration Test (LPT) revealed a defect /seepage in a circumferential weld joint (J-16) in the recirculation loop A piping of main reactor coolant system. Subsequently, the weld joint was examined by ultrasonic method and this revealed a circumferential crack in Heat Affected Zone (HAZ) of the weld joint. The detailed investigations revealed that the crack had occurred due to Inter-Granular Stress Corrosion Cracking (IGSCC). The previous inspections of the affected weld joint was

last carried out in 1998 & 2004 and the results were satisfactory. Following this observation, inspections were carried out in similar piping of TAPS-1&2 which revealed more similar cracks in weld joints. Presently both units are under shutdown. Station is planning replacement of reactor recirculation piping in both units to address the IGSCC issue. The event has been provisionally rated at level-1.

- (ii) On January 17, 2020, an event of localized hydrogen combustion occurred in stack basement area of TAPS-1&2. The event occurred due to leak of hydrogen rich gas in the stack basement from the off-gas line. The cause of leak is attributed to corrosion in off-gas line. Following the event, corrective actions like replacement of corroded piping, introduction of In-service Inspection program for off-gas line, health assessment of stack structure, incorporation of H₂ leak detectors in the affected area and improvements in area ventilation to prevent build-up of combustible mixture, etc. were taken.

- (iii) On April 12, 2020, an event of loss of off-site power had occurred at NAPS-1. In response to the event all three DGs started. However, one DG was slow to start and the other DG tripped due to earth fault in the bus. Later, the fault in the bus was rectified and power supply was restored. During the event core cooling was ensured through redundant equipment/DG available in other emergency bus.

1.8.2 Significant Events related to Industrial Safety

Significant events reported to AERB were reviewed in detail and measures to prevent the recurrence of such incidences were recommended. The analyses and recommendations of the accidents were forwarded to all units of DAE for information and lessons to be learnt from these incidents. A brief description of events, associated review and recommendations/ directives of AERB is given below.

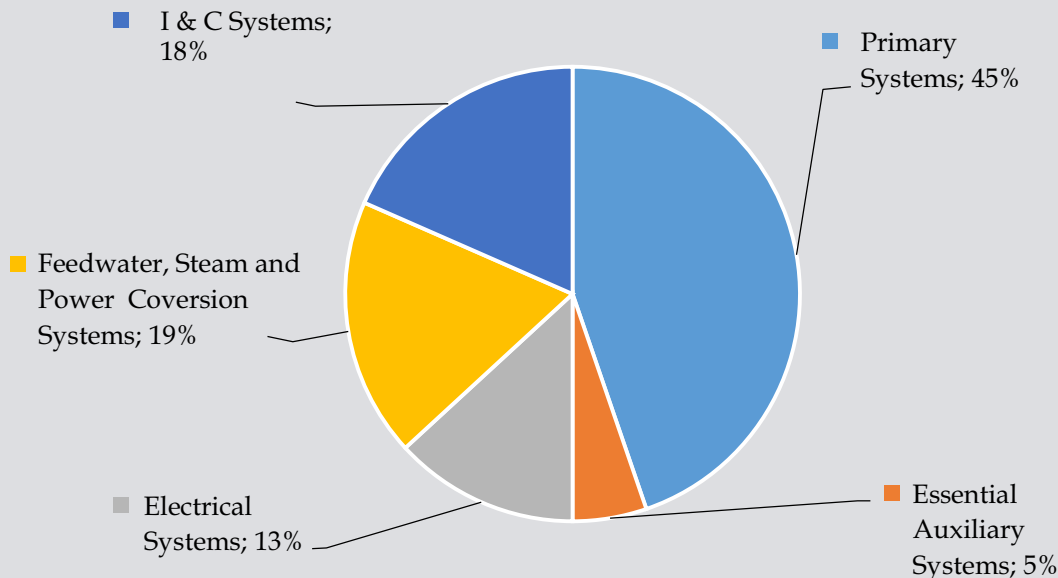


Fig.1.2: Classification of Failed/Affected System of SERs

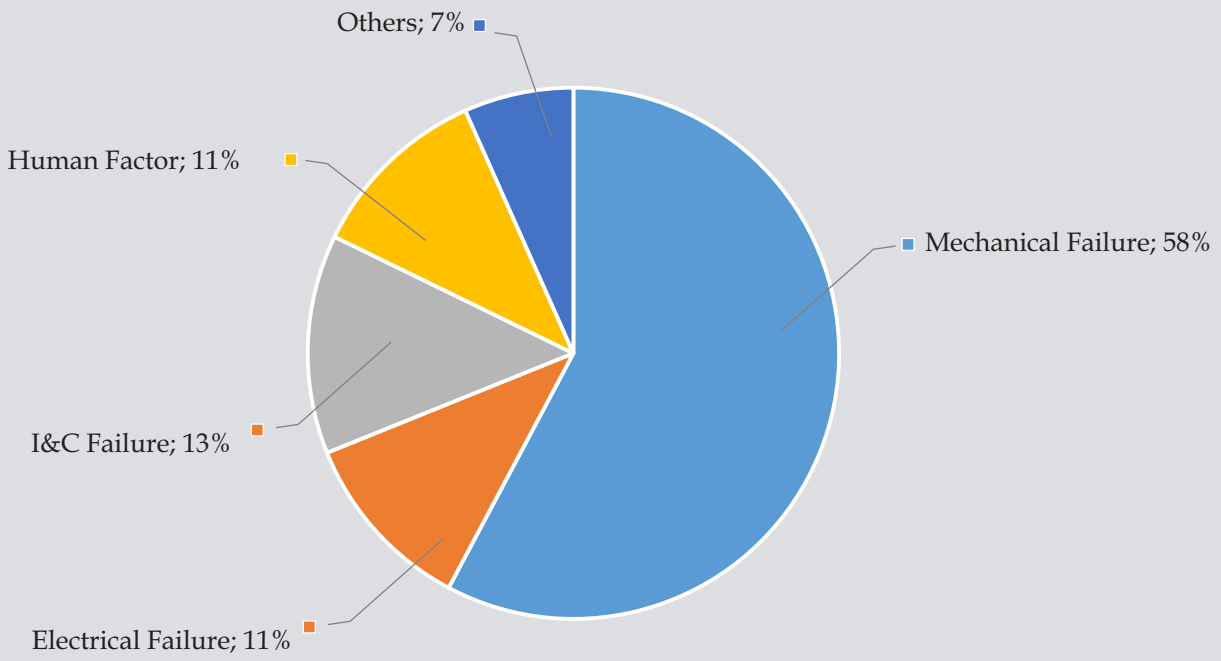


Fig. 1.3: Classification of Direct Causes of SERs

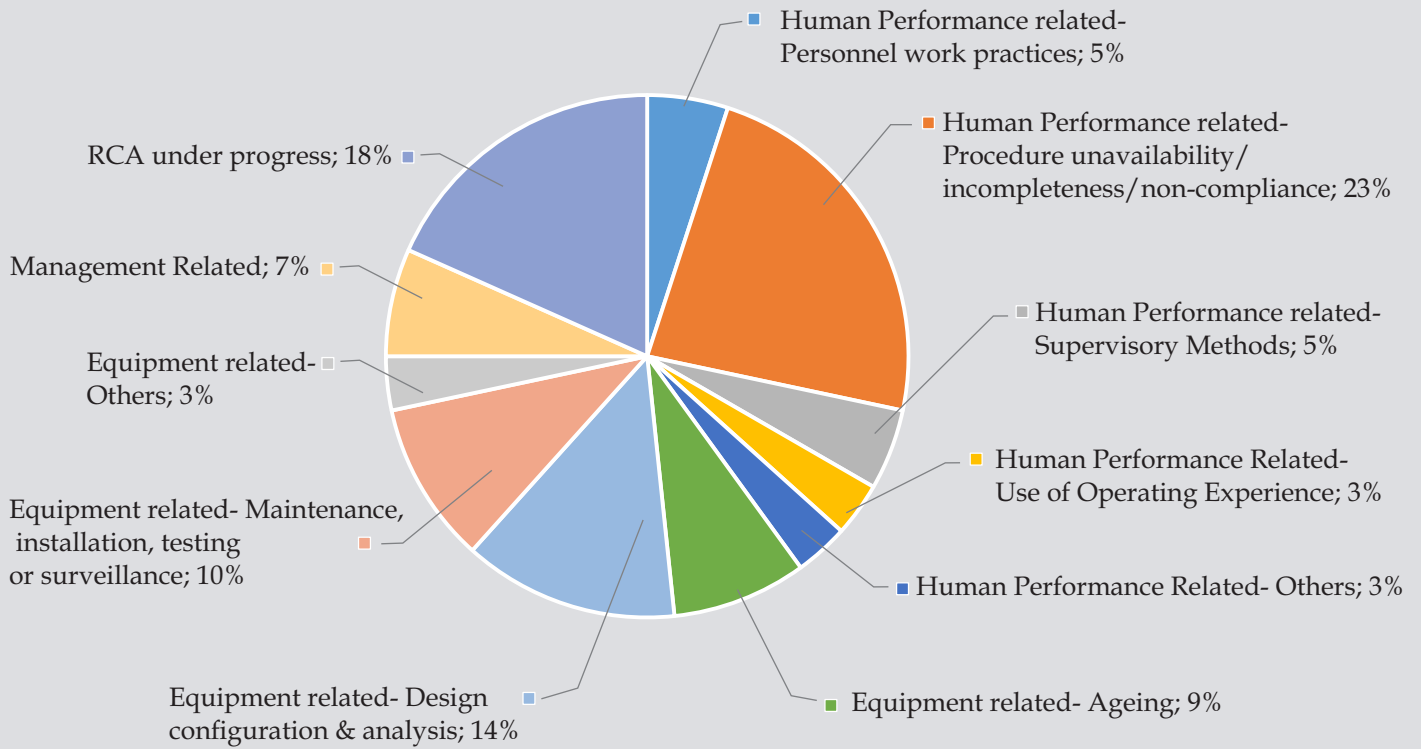


Fig. 1.4: Classification of Root Causes of SERs

(a) Kudankulam Nuclear Power Project (KKNPP-3&4)

On July 27, 2020, a survey boat with 10 personnel was returning back to KKNPP-3&4 site after inspecting a split barge anchored in the sea. While moving towards the temporary jetty of KKNPP-3&4, due to heavy swells, the survey boat tilted towards one side and two personnel (one of them was victim) fell overboard. While one of the two persons swam safely to the training bund structure, the victim was brought to the training bund with the help of lifebuoy by rescuer. The victim was unconscious. After the first-aider checked him, he was taken to hospital in Radhapuram where he was declared brought dead.

In view of travel restrictions due to COVID-19 pandemic, information from site itself was sought for conducting a detailed investigation by AERB. All construction activities (land and sea based) of the permanent dyke and flow training dyke was suspended by NPCIL. AERB recommended Site that activities should be restarted only after detailed and satisfactory review. The Site Investigation Report and the Accident Assessment Report were reviewed by AERB Standing Committee on Industrial & Fire Safety (SC-I&FS). Based on the improvements in

the safety management systems implemented by site, AERB granted permission to restart land-based construction activities at the breakwater dyke & flow training dyke on September 8, 2020.

(b) Kudankulam Nuclear Power Project (KKNPP-3 to 6)

On October 5, 2020, during removal of shuttering boards provided for wall concreting of 40 UQU (Discharge channel pump house), shuttering boards of 30m length got detached from the wall and tilted towards the victim. The victim was hit by the board at right side of the cheek and received cut injury. After first-aid, he was sent to Government Medical College Hospital, Nagercoil for further diagnosis and treatment. A fracture was diagnosed in his neck bone. On October 25, 2020 the victim succumbed to his injuries at the hospital.

The related submissions made by Site are being reviewed in AERB in-house. Meanwhile, in view of the increase in the occupational health safety related incidents leading to a fatality (including incident at KKNPP-3&4 on July 27, 2020) and few reportable injuries at KKNPP-3&4 project site, a letter on 'Enhancement of Safety Supervision at KKNPP-3 to 6 Site' was sent to Site for response. Site's responses on this are under review.