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New

5th International Conference on Reliability Safety and Hazard – 2024 (ICRESH-2024), 21 – 24, Feb. 2024, Mumbai

Editor
Prabhakar V. Varde

SRESA Mission

We, at SRESA are at the advanced stages of publication of first SRESA standard on "Probabilistic Risk Assessment of Nuclear Plants".
It is encouraging to note that we received a positive response from AERB for publishing the SRESA's first standard through BIS. It is under consideration at BIS, as part of its review and approval procedure.
Let us hope that this standard will be published during early 2024.

From the President's Desk ....

ICRESH-2024 preparations are in advanced stages. The Preconference Tutorial is one of the major features of ICRESH events. Accordingly, Preconference tutorial have been scheduled on 21st February 2024.

Human factor is one of the important areas that needs special attention when we deal with risk and reliability aspects of engineering systems in general and safety critical systems in particular. Of course, it cannot be emphasised more that it is human creativity and innovative thinking and actions that leads advances in sciences in sciences and engineering, be conceptualization, design, operation and maintenance, regulation and ageing management. But the issue is in spite highest level of quality work the complex systems require further efforts for reducing error to avoid or eliminate undesirable consequences. The available literature shows in many industrial sectors shows the human contribution to accidents ranges from 50 – 80 %. Which means system should be more resilient to human errors.

It is heartening to note that ICRESH-2024 have excellent presentations sharing experiences on human factor and the role of Artificial Intelligence and Machine Learning (AI&ML) or to be more precise the Deep Learning (DL) in reducing the chances of human error. Further, the advanced research shows that the availability of engineering simulators or the data available from Digital Twins can provide valuable information towards understanding of human behaviour and associated factors.

- **Prabhakar V Varde**

In this issue ....

Safety Regulation of Nuclear Power Plants in India

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Abstract

Atomic Energy Regulatory Board (AERB), the national nuclear regulatory body of India was established in 1983, for the safety regulation of nuclear and radiation facilities. The mission of AERB is to ensure that the use of ionizing radiation and nuclear energy in India does not cause undue risk to the health of people and the environment. AERB is entrusted with the responsibility for regulation of safety in activities related to nuclear power generation, nuclear fuel cycle facilities, research in nuclear and radiation safety, industrial and medical uses of radiation. AERB develops safety codes, guides and standards for siting, design, construction, commissioning, operation and decommissioning of different types of nuclear & radiation facilities. AERB grants consents for different stages after safety review and assessment for establishment of nuclear and radiation facilities following a graded approach. To accomplish its mission, AERB carries out and promotes safety related research as part of its regulatory work and in support of its regulatory decisions. The regulatory process at AERB is continuously

evolving to cater to the new developments in reactor technology. In its journey of attaining maturity in safety regulation, AERB has traversed a long path from its evolution. This talk focuses on the evolution of safety regulation for nuclear power plants in India, approach adopted for regulatory decision-making and briefly describes the requirements and guidance related to Safety Assessment of NPPs.

Keywords: *consent; deterministic safety assessment; environmental safety; license for operation; nuclear safety; periodic safety review; probabilistic safety assessment; radiation safety; regulation*

1. Introduction

Nuclear energy - a clean energy source is an important element in India's energy mix for sustaining rapid economic growth. Presently, India has 22 operating reactors, with an installed capacity of 6780 MWe. Recently, India commissioned and commercialized an indigenously designed 700 MWe Pressurized Heavy Water Reactor (PHWR). Construction of seven indigenously designed 700 MWe PHWRs are in progress and a 500 MWe PFBR (Prototype Fast Breeder Reactor) is in an advanced stage of commissioning. The construction work of four 1000 MWe VVERs being set-up in technical cooperation with the Russian Federation is in progress at Kudankulam.

The nuclear power program in India is being followed with full regard to nuclear and radiation safety encompassing safety of plant personnel, public and the environment around the plants. The primary responsibility of ensuring safety of NPPs rests with the organization responsible for operation of NPPs. In India, these activities are carried out by the Nuclear Power Corporation of India Ltd (NPCIL) and the Bharatiya Nabhikiya Vidyut Nigam (BHAVINI). The task of laying down necessary safety requirements and their enforcement are entrusted to the Atomic Energy Regulatory Board (AERB).

2. Infrastructure for Nuclear and Radiological Safety

The Atomic Energy Act, 1962 and the rules framed thereunder provide the main legislative and regulatory framework pertaining to atomic energy in the country. The Act provides the Central Government with the powers to frame Rules and issue notifications to implement the provisions of the Act. The National Legislative requirement on nuclear and radiological safety for all activities related to atomic energy programme and the use of ionizing radiation in India is provided by Sections 16, 17 and 23 of the Atomic Energy Act, 1962. Also, exercising powers under section 30 of the Act, the Central Government has framed Rules to implement the provisions of the Act which are subordinate legislation for regulation. These cover radiological safety, management of radioactive wastes, administration of the Factories Act, 1948 and prescription of qualifications of persons employed in installations dealing with radioactive substances or use of any radiation generating plant, equipment or appliance.

Under the Atomic Energy Act, 1962, the Central Government promulgated the following Rules:

a) Atomic Energy (Radiation Protection) Rules, 2004, GSR 1691: These Rules give requirement of consent for carrying out any activities for nuclear fuel cycle facilities and use of radiation for the purpose of industry, research, medicine, etc.
b) Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987, GSR 125: These Rules establish the requirements for the disposal of radioactive waste in the country.
c) Atomic Energy (Working of Mines, Minerals and Handling of Prescribed Substances) Rules, 1984, GSR 781. These Rules regulate the activities pertaining to mining, milling, processing and/or handling of prescribed substance.
d) The Atomic Energy (Factories) Rules, 1996, GSR 253: The Central Government exercising the powers conferred by Factories Act, 1948, and Atomic Energy Act, 1962, had framed the Atomic Energy (Factories) Rules, 1996 to administer the requirement of Factories Act in the nuclear establishments to ensure industrial safety.

In addition to above, the safety requirements of other applicable legislations also need to be met for establishing and operating NPPs in India. The central or state agencies, as the case may be, have been identified to regulate the safety provisions of these acts and the applicants are required to obtain necessary clearances from these agencies.

Atomic Energy Regulatory Board (AERB) was established in 1983 under the provisions of the Atomic Energy Act, 1962 to carry out certain regulatory and safety functions envisaged under Sections 16, 17 and 23. AERB is the national regulatory body having powers to frame safety policies, lay down safety standards & requirements and powers to monitor & enforce provisions under the Act and Rules thereof, in nuclear and radiation installations and practices.

3. AERB

The mission of AERB is to ensure that the use of ionising radiation and nuclear energy in India does not cause unacceptable impact on the health of workers, members of the public and on the environment. AERB fulfills its mission by stipulating and enforcing requirements with respect to nuclear and radiological safety. In addition, AERB has also been given the mandate for overseeing industrial safety in all DAE units. This mandate is fulfilled by enforcing the Factories Rules.

The Board of AERB comprises of a Chairman and five members. While the Chairman and one of the members (Chairman of SARCOP is ex-officio

member) are full time employees of AERB, the other four are persons of repute from major national and academic institutions and serve on the Board as part time members. The Board reports to the Atomic Energy Commission (AEC).

AERB carries out its functions with the help of a secretariat consisting of Scientific/ Technical Divisions/Directorates at Headquarter located in Mumbai along with a Safety Research Institute (SRI) located at Kalpakkam. AERB has also established three Regional Regulatory Centers (Delhi, Chennai and Kolakata) for conduct of regulatory inspection of nuclear & radiation facilities in the respective region.

AERB is mandated to execute various functions, some of which are as given below.

a) Development of Safety Codes, Guides and Manuals for siting, design, construction, commissioning, operation and decommissioning for nuclear and radiation facilities,
b) Granting consents for siting, construction, commissioning, operation and decommissioning, after an appropriate safety review and assessment of nuclear and radiation facilities,
c) Ensuring compliance with the regulatory requirements prescribed by AERB during all stages of consenting,
d) Prescribing the acceptance limits of radiation exposure to occupational workers and members of public and acceptable limits of environmental releases of radioactive substances,
e) Reviewing the emergency preparedness plans for nuclear and radiation facilities and during transport of large radioactive sources, irradiated fuel and fissile material.

AERB has implemented integrated management system (IMS) which integrates all of its processes into one complete framework, enabling AERB to work as a unit with unified objectives. It provides provides a set of interrelated or interacting elements (systems) for establishing policies and strategies and thereby enabling the objectives to be achieved in an efficient and effective way.

The functions of AERB is executed through qualified work force and specialist Committees. Apex level Safety Committee includes Safety Review Committee for Operating Plants (SARCOP) and Safety Review Committee for Applications of Radiation (SARCAR). SARCOP is involved in safety surveillance and review of radiation safety in the operating units of DAE. SARCAR is involved in review of radiation safety in applications of radiation and use of radioactive sources in medical, industrial and research applications. In addition, there are advisory committees, viz. Advisory Committee on Nuclear and Radiological Safety (ACNRS) and Advisory Committee for Project Safety Review of Nuclear Power Plants (ACPSR-NPP). ACNRS provides advice to AERB on generic & specific safety issues concerning the safety of nuclear & radiation installations and on the process of revision of the existing and development of new safety regulatory documents. ACPSR-NPP carries out safety review of the NPPs under construction/commissioning and make recommendations to AERB regarding issuance of regulatory consents for different stages of the projects under construction.

4. Development of Safety Documents

AERB initiated development of safety documents soon after its formation in 1983 with the help of experts in relevant fields and considering international documents. While developing or revising AERB documents; review experience, feedback from nuclear and radiation facilities and new regulatory & technological developments are considered. The safety codes establish objectives and set minimum requirements that have to be fulfilled to provide adequate assurance for nuclear and radiation safety. The safety guides provide guidelines and indicate acceptable methods for implementing specific requirements prescribed in the codes. In addition, AERB also develops safety manuals that elaborate on specific aspects and contain detailed technical information and procedures in certain areas.

AERB maintains the following hierarchy for regulatory Documents in conformity with legal and regulatory instruments.

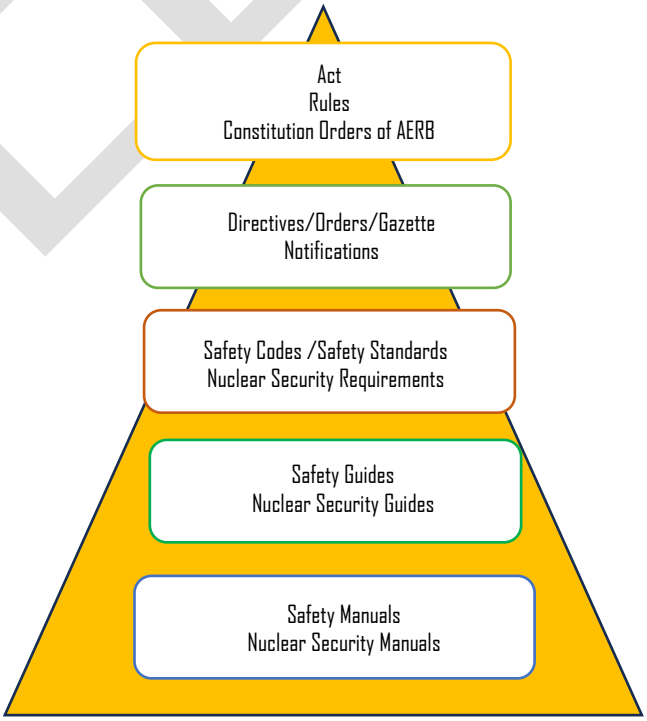

Fig. 1: Hierarchy of Regulatory Documents

AERB has set-up an elaborate mechanism for development of the regulatory documents. It involves (a) identifying the need for development of specific documents, (b) assigning priority and (c) the contents of the documents that are being developed. AERB has so far published more than

160 regulatory documents concerning different aspects of regulation and safety aspects of the facilities and activities that it regulates. AERB has published codes and guides covering aspects of siting, design, operation, radioactive waste management, quality assurance, radiation protection, emergency preparedness and regulation of NPPs and radiation facilities. All these safety documents are being extensively utilized in regulatory activities of nuclear and radiation facilities.

5. Safety Review and Licensing of Nuclear Power Plants

AERB has established multi-tier system of Safety Committees to support the safety assessment and consenting process being carried out by AERB, such as Safety Review Committee for Operating Plants, Advisory Committee for Project Safety Review, Project Design Safety Review Committee, Unit Safety Committee, Licensing Committee, Standing Committee, In-House Review Group etc. These committees comprise of experts in relevant areas from organisations within DAE and in many cases from reputed academic institutions and other governmental agencies. While the multi-tier system of committees provide support with respect to safety review and recommendation, the responsibility for ensuring that the regulatory decisions and enforcement are in line with the mission, policies and regulatory documents of AERB, lies with AERB.

AERB has established an elaborate system for in-depth safety review of Nuclear Power Plants. AERB gives 'Consents'/'Licence' for different stages such as Siting, Construction and Commissioning of NPP based on detailed safety review and assessments for ensuring compliance to the specified regulatory/safety requirements. The safety review process for different stages is briefly described below.

5.1 Siting

Safety review of the proposed site is carried out as per the requirements laid down in AERB's Code on "Siting of Nuclear Power Plants" (AERB/NF/SC/S Rev.I, 2014). The aspects considered in this phase include the geological, geotechnical, seismological, hydrological and meteorological characteristics of the site & surrounding region and also on-site demography, nearby industries, land & water use that is relevant to the safe design and operation of the plant etc. as per the norms specified in the code. Review by AERB also addresses aspects related to emergency preparedness in particular the suitability of the proposed site and the surrounding areas with regard to implementability of emergency response measures. A key requirement of AERB with respect to siting of the NPP is to maintain an 'exclusion zone' around the NPP inside which no residence or any other public activity is permitted. Besides, a 'sterilized zone' around the exclusion zone is also identified where only natural growth of population is permitted in order to ensure that the number of people to be managed in the event of an emergency is limited.

5.2 Construction

For the construction clearance of NPP, a detailed 'design safety review' of the plant design is carried out from Preliminary Safety Analysis Report (PSAR). PSAR provides general information on plant design, details of the design basis of the reactor & all its auxiliary systems, safety analysis for various operating states including normal operation, transients, upset plant conditions, design basis accidents and beyond design basis accidents. These analyses are based on a set of postulated initiating events both internal and external to the plant, as prescribed by the AERB's Code on Design of NPPs and associated Safety Guides. Quality Assurance (QA) aspects during design & construction as well as construction safety management aspects are reviewed in detail for compliance to the requirements specified in relevant AERB code/guides/standards to issue the construction clearance for the NPP.

AERB's issues 'consent for construction' of the NPP in three sub-stages, namely start of excavation, first pour of concrete of main plant buildings and erection of major equipment. Each of these sub-stages has specific pre-requisites in terms of submission of applications, information and their regulatory review. The regulatory review process of the project can be staggered and clearance for a particular sub-stage is given based on the completion of design safety review relevant to that sub-stage.

5.3 Commissioning

Commissioning is a stage at which the responsibility of the systems/plant is handed over from the construction organization to the commissioning/operating organization, requiring assurance of compliance of a number of aspects. The main aspects that are considered in review for commissioning clearances include completion of construction in accordance with the approved design and required quality; review of acceptability and resolution of any deviations from the approved design and their documentation; availability of commissioning plans, schedules and procedures; availability of adequate number of trained and qualified personnel; quality assurance plan for commissioning; framework for reporting, review and documentation of results of commissioning etc.

AERB issues 'commissioning clearances' in stages based on the construction clearances, satisfactory review of the results of commissioning of the preceding stages and resolution of any issues that are identified. The typical stages at which the commissioning clearances are considered for a PHWR based NPP are initial fuel loading; commissioning of coolant and moderator systems with light water; hot conditioning/passivation of Heat Transport system; charging heavy water into the system; first approach to criticality of the reactor; reactor physics

measurements/tests/calibration; Commissioning tests and monitoring of performance of plant systems at various steps of increasing reactor power levels up to rated capacity, to check the dynamics of plant systems and transient response. Commissioning clearances for the NPPs of other designs also follow a similar system of stage-wise reviews and clearances. Results of the commissioning tests and reviews are required to be incorporated in the PSAR of the plant to produce the Final Safety Analysis Report (FSAR) which forms the basis for the operating license of the NPP.

5.4 Operation

AERB issues 'license for regular operation' of the NPP, based on review of the NPP's performance at rated power within the commissioning consent for a given period. While applying for license for regular operation, the applicant has to submit the FSAR, reflecting the as built design approved by AERB, detailed performance reports, status of measures to resolve any pending issues. As per the present regulations, AERB issues the license for operation of the NPP for a maximum period of five years, beyond which the NPP has to seek a renewal of the license for operation as per the prescribed requirements.

The overriding consideration of the safety review/surveillance by AERB within the period of license for operation of the NPP is 'adherence to the approved Technical Specifications'. In case of any deviations or non-compliances, AERB may initiate appropriate enforcement actions, depending on the safety significance of the deviation. The enforcement measures resorted to by AERB for such cases can range from issuance of written directives for restoration of compliance to the requirement, restrictive measures including curtailment/suspension of operation to suspension/revocation of the operating license.

As a part of the licensing condition, Periodic Safety Review (PSR) of NPP is required to be carried out at specified intervals and review reports are to be submitted to AERB. PSR is a systematic safety assessment tool carried out at regular intervals and used in support of the decision making process for license renewal, where license has been granted for a limited period. Safety guide AERB/NPP/SG/O-12 (Rev.1) on 'Periodic Safety Review for Nuclear Power Plants' gives the guidance for carrying out a comprehensive PSR, once in ten years. The PSR covers fourteen 'safety factors', as identified in safety guide which address various aspects and management systems that governs the safety of the NPP such as actual condition of SSCs important to safety, deterministic safety analysis, probabilistic safety assessment, etc. PSR helps in identification & implementation of measures for upgrading safety of the NPP, address issues of ageing of components and keep it abreast of the changing safety practices & expectations. PSR is an important regulatory instrument for maintaining and improving high level of safety throughout the operating life cycle of the NPP.

Another important consideration in the safety review/surveillance by AERB is lessons learned from the experience elsewhere i.e. Operating Experience Feedback (OEF) utilized to effect improvements in the plant hardware and practices as relevant and appropriate for NPPs. AERB extensively uses the inputs from the Incident Reporting System (IRS) of the International Atomic Energy Agency for this purpose. A number of improvements have been incorporated in NPPs in the past, through the OEF route.

Licensing of plant personnel is another important aspect. The personnel in operational positions at NPPs should be formally licensed and qualified for various levels by AERB. The entire process is documented in two manuals, 'Licensing procedure for operating personnel' and 'QA manual for station licensing examination'. The competence requirement and the depth of knowledge and skills for each operational position are verified through a series of performance and knowledge checks prescribed in these manuals. Final verification is done through a written examination followed by certification by AERB Committee. The licenses are valid for a period of three years and have to be renewed thereafter according to the prescribed procedure.

5.5 Regulatory Inspections

Regulatory Inspection (RI) is carried out to ensure that the Nuclear/Radiation facility is in compliance with the regulatory requirements and licensing conditions. AERB conducts routine (safety & security) inspections periodically to cover all the activities of the licensee. These inspections are planned in advance and the schedule of inspections is intimated to the facility before inspection.

Apart from routine RIs, AERB also conducts special inspections to witness specific tests or activities at the facilities, and unannounced inspections to obtain firsthand and realistic information on the status of the facility and its compliance to safety requirements & relevant stipulations. AERB also deputes Site Observers at select nuclear facilities (co-located operating nuclear power plant(s) and plant(s) under construction) to observe activities of the facilities for regulatory compliance on a day-to-day basis.

In addition to detailed reviews during construction and commissioning, AERB carries out regulatory inspections of the projects to ensure that safety requirements in construction are appropriately followed and all pre-requisites are fulfilled before going to next stage in construction or commissioning. Observations from these inspections are appropriately considered for any enforcement measures and granting of the regulatory consents.

During operation stage, regulatory inspections are carried out to assess and verify compliance to the regulatory requirements. Besides the

routine regulatory inspections, AERB also conducts special regulatory inspections with specific objectives as deemed necessary. Inspections are taken up in case of significant events or after major modifications to the plant. The observations made during these inspections forms an important input to the safety review and enforcement measures of AERB.

6. Radiation Protection

Protecting radiation workers in NPPs and public from undue radiation exposures is one of the prime objectives of AERB. AERB is empowered to enforce provisions of Atomic Energy (Radiation Protection) Rules, 2004. Under this rule, AERB specifies safety directives, the dose limits for the radiation workers as well as for the member of public. AERB has prescribed a dose limit of 100 mSv over a period of five consecutive years and an annual limit of 30 mSv for radiation workers. AERB ensures that all the radiation protection measures are in place through its continuous safety monitoring process as well as periodic regulatory inspections. Environmental surveillance of all NPPs is done by the Environmental Survey Laboratories (ESL) established at the NPP sites. The radiological impact due to operation of these plants is assessed on a continuous basis by collection and analysis of samples of items of diet.

The aspects related to generation, management and environmental discharge of radioactive effluents from the NPP during the operational phase are regulated by AERB, in accordance with the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1971. In accordance with this, AERB has established limits on discharge of effluents through the gaseous and liquid routes. In addition, limits are also set for the solid wastes that can be stored at the on-site solid waste facilities. The impact of radioactivity discharges from the NPPs are monitored regularly by the ESLs and reported to AERB.

7. Safety Enhancements post Fukushima

Post Fukushima, safety re-assessment of all Indian NPPs was carried out by AERB and NPCIL to evaluate the capabilities of Indian NPPs to withstand currently defined levels of external events resulting from flood, tsunami, earthquake, etc. as well as Station Black Out (SBO). To enhance Emergency Preparedness and Response; Table Top Exercise (TT), Integrated Command Control and Response (ICCR) Exercise, Field Exercise and Demonstration (FED) are carried out at NPPs. AERB is progressively revising the identified documents as per its established process. AERB has issued the Safety Code on "Site Evaluation of Nuclear Facilities", "Design of Light Water Reactor based NPPs" and "Management of Nuclear and Radiological Emergencies" which are in line with the latest requirements specified in the IAEA documents.

8. R&D Support on Regulatory Issues and Safety Assessment

AERB has established SRI at Kalpakkam with the objective to build a unique research and knowledge base with a strong research capability in important safety related areas to supplement regulatory review and assessment activities of AERB. SRI conducts independent safety studies to supplement regulatory review and assessment activities such as Nuclear Safety Studies, Remote Sensing and GIS studies, Engineering safety studies, Environmental Safety and Fuel Chemistry Studies etc. The Nuclear Safety Analysis Division at Headquarter also conducts independent verification of safety analyses. It carries out safety review & assessment in areas of DSA, PSA, mechanical design and structural assessment, reactor physics & fuel safety assessment, shielding assessment, criticality safety assessment and technical support to NREMC during emergency.

Safety assessments are required for evaluating compliance with safety requirements for all facilities and activities and to determine the measures that need to be taken to ensure safety. Safety analysis of the Nuclear Power Plant (NPP) design, applying deterministic methods, establishes and confirms the design basis for the items important to safety and demonstrates that the overall plant design ensures radiation doses and releases are within the prescribed limits for operational states and acceptable limits for accident conditions. Based on this safety analysis, the robustness of the engineering design to withstand events, the effectiveness of the safety systems and safety related items or systems, and the basis for emergency preparedness can be established. Over the years, AERB established consideration of DSA and PSA in its Regulatory Decision Making. The risk informed decision-making process (sometimes referred to as an integrated decision-making process) includes the recognition of any mandatory requirements, the insights from the deterministic analysis, the insights from the probabilistic analysis and any other applicable insights.

AERB also sponsors research projects in universities on various issues to expand the regulatory research works and to support independent evaluation of safety. AERB funds for appropriate research projects to members of faculties of universities and other research organizations.

9. Public awareness

AERB considers all members of public should have access to objective and unbiased information on safety issues. AERB periodically issues press releases to keep the public informed about important regulatory and other related activities. The information on various activities of AERB is also made public through the periodic newsletters and annual reports. Apart from these, relevant information is also provided for queries raised in the Parliament of India and by general public either through direct interaction with senior officers of AERB or under the Right to Information Act.

10. International Co-operation

AERB has been actively involved with various international bodies for exchange of information and in co-operation in the field of regulation of nuclear activities for peaceful purposes. AERB experts have been actively participating in various activities of IAEA, OECD-NEA and have been contributing at various other international fora.

AERB is the national coordinator for IAEA-Convention on Nuclear Safety (CNS), IAEA–International Nuclear and Radiological Event Scale (INES), IAEA-Incident Reporting System (IRS) and Fuel Incident Notification and Analysis System (FINAS). AERB plays an active role in strengthening the global safety regime and towards this contributes in various meetings, peer review missions and development of safety standards of IAEA. It also utilizes experience gained through these safety-cooperation activities towards further augmenting safety regulatory system within India. AERB officials participate as member in the IAEA's Integrated Regulatory Review Service (IRRS) Missions to various countries.

AERB has been participating in Committee on Safety Standard (CSS) and IAEA Coordinated Research Programme (IAEA-CRP) and IAEA International Collaborative Standard Problems (IAEA-ICSP). AERB participates in annual meetings of CANDU Senior Regulators, organized by IAEA for exchange of information on issues specifically related to safety of PHWRs. AERB is one of the key contributors in CANDU Probabilistic Safety Assessment (PSA) Working Group established under by CANDU senior regulators forum.

India continued to participate in the activities of committees of NEA i.e. Committee on Safety of Nuclear Installations (CSNI) and Committee on Nuclear Regulatory Activities (CNRA) and their various working groups. AERB is also a member of VVER Regulators forum and regularly contributes to the activities of the Forum. AERB participates in the PSA Working Group, Reactor Physics Working Group of VVER Regulator's Forum.

11. International Peer Review of AERB

The Integrated Regulatory Review Service (IRRS) regulatory review process of IAEA provides a peer review of both regulatory technical and policy issues. The first IRRS Mission to India was conducted during March 16 – 27, 2015. The IRRS mission to India was limited in scope and covered only Nuclear Power Plants. The IRRS follow-up mission to India with extended scope was hosted during June 9-20, 2022. The 2015 mission covered regulatory activities in relation to Nuclear Power Plants, whereas the scope of the follow-up mission was extended to include the review of safety regulation of radiation sources facilities and activities. The IRRS Mission concluded that the AERB is an experienced, knowledgeable and dedicated regulatory authority for the protection of the public and environment.

12. Summary

The Atomic Energy Regulatory Board of India has completed journey of four decades and is an experienced, knowledgeable and dedicated regulatory body for the protection of the public and environment. The AERB has put in place a comprehensive system for design and operational safety review of nuclear power plants in the country. A number of safety documents have been developed to aid in such reviews. Feedback from operational experience and lessons learned from major incidents both within and outside the country, have been appropriately utilized for modifying designs and procedures for enhanced safety.

AERB is gearing itself to enhance its regulatory programme to face the current and future challenges in regulating radiation and nuclear safety, such as monitoring ageing and decommissioning, as well as providing oversight of the construction, commissioning and operation of new NPPs and RFs.

13. Brief Biodata of the Author

Shri S. B. Chafle is Executive Director of Atomic Energy Regulatory Board. Before joining AERB in 2017, he worked at the Bhabha Atomic Research Centre (BARC), Mumbai since 1988, where he was associated with Research Reactor Operation, Design of Process Systems of Research Reactors and Experimental Facilities of Research Reactors. Currently he is also Director, Nuclear Safety Analysis and Research Group, AERB; Ex-Officio Member of Board of AERB; Chairman, Safety Review Committee for Operating Plants (SARCOP); Chairman, Steering Committee for Co-ordination of Indian Participation in OECD/NEA activities; Member of BARC Safety Council (BSC) and Member of Crisis Management Group (CMG) of Department of Atomic Energy. He has B. Tech Degree in Chemical Engineering, Diploma in Financial Management (DFM) and Post Graduate Diploma in Software Technology (PGDST). He has wide-ranging experience and expertise in Process Design of Research Reactor systems and Reactor Safety Regulation.

Originally this article was authored by Shri S.B. Chafle for the ICRESH-2024 plenary sessions. Accordingly, it was initially scheduled to be published in Key Note Talk Volume of ICRESH-2024. However, due to unavoidable situation the article did not form part of Key Note Talk Volume of ICRESH-2024, therefore, it was thought appropriate to publish the article in this issue of SRESA Newsletter, after obtaining permission of the author.

Development of an Integrated Risk Assessment Approach for Structural Systems towards reaching De-Risking to Life and Property targets.

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1. Introduction

The structural systems are designed using available design codes, standards and specifications and constructed using best practices that include approved procedures, best practices and specifications, periodic / phased assessment and quality control procedures. Before, the occupancy pre-service inspections and audits are performed towards ensuring that design requirements are met and the structure is fit for occupation and intended services. During the service / occupancy periodic structural and fire audits are performed to qualify the structure for ensure fitness for service. This fitness for service or periodic qualification is also interpreted as an indicator for 'acceptable level of risk. However, the advanced technologies available for risk modelling, assessment and prediction can also be adopted for structural risk assessment, risk communication and finally development of a framework for risk management particularly for societal domain.

This article lays the first step in extending the available knowledge base in quality audits, advanced research and experience on risk modelling complex engineering systems to risk-assessment and management of structural systems where an improved and easily understandable risk metrics can be developed for used in public domain for structural systems in general and public housing domain.

2. Background

Concrete is the preferred choice of material for construction activities worldwide. In aged and existing structures, exposure to extreme environmental conditions, occurrence of external events, such as, flood, earthquake and accidental fire often result in widespread or local damages which can lead to collapse of such structures. With the need for design of concrete structures for longer service life, there has been a need to put scholarly efforts to assure the construction of more durable buildings which are resilient to local damages.

During last few decades, India's infrastructure industry witnessed significant increase in public investment and multifaceted expansion, leading to construction of new multistorey buildings and other industrial structures. Many buildings from this era and others have gradually lost strength due to various factors, such as, material degradation, structural deficiencies, unanticipated overloading, physical damage, etc. Use of such buildings could put the lives of occupants in jeopardy.

3. Traditional Approach to Risk Assessment and Management

The structural audit forms the cornerstone for qualification and basis for life assessment. Performing structural audit of existing buildings and timely implementation of repair/retrofitting works have to some extent led to increase in service life and safety of occupants of such buildings. For important infrastructure facilities as well as industrial structures, structural audit might be a periodic activity as stipulated by the prevailing regulatory standards. Structural audit of aged and existing structures requires a methodical and systematic approach involving multiple steps, such as, visual inspection to gather information about the causes of observed distress, condition assessment of in-situ concrete through non-destructive and partially-destructive tests on concrete (NDTs and PDTs), analyses and design checks for current postulated design basis loads to find locations of structural deficiency, and suggesting appropriate repair and/or retrofitting measures at the locations of structural deficiency. The NDTs and PDTs include Rebound Hammer Test, Ultra Sonic Pulse Velocity Test, Pull-out Core Test, Half Cell Potential Test, Carbonation Depth Test, and Chemical Analysis of Concrete for Chlorides, Sulphates, and pH. These tests effectively provide assessment of quality, carbonation condition, equivalent cube compressive strength, chemical contents, and pH of pore solution of in-situ concrete, as well as corrosion condition of reinforcing steel, in existing structures. Decisions regarding repair, strengthening, replacement and demolition of existing structures are normally governed by the performance of such structures to withstand the occurrence of extreme events, and/or unanticipated overload during their intended residual service life.

> India has rich heritage of ancient monuments that speaks for itself on art and science of structural systems. In fact, it can be argued that India has the oldest and advanced science and engineering of structurs and if it stood all strong all these more than 700 years then they are epitome of very high reliability and safety. So this is also the time to pay rich tribute to our Rishis and Sages for their knowledge of science and

4. Reliability-based Structural Health Assessment

The application of reliability-based methods for safety evaluation and damage assessment of aged and existing structures is becoming increasingly recognized, because these methods enable quantitative evaluation of structural safety. Reliability-based methods consider the stochastic nature of past and future loads due to operating conditions and environment, randomness in strength, and uncertainty in material changes due to ageing and possible degradation, and analytical/empirical models used to predict structural behaviour. These methods can be used to assess the extent of strength degradation over a period, residual life of the structures, implementation of inspection strategies to provide the needed

assurance of reliability, and the effectiveness of repair techniques in extending useable life and enhancing reliability.

5. Integrated Risk-based approach to Structural Health Assessment

In spite of the above systematic test and inspection as part of audit, during construction and design service period accidental collapse of the structure has been witnessed. Even the reliability-based approach appears to deals with the modelling of structural life assessment and leaves the scope of fatalities and financial consequences which should be the major concern for any structural assessment methodology. Finally, the methodology may not be effective in risk communication to the stakeholders.

The integrated risk-based approach is relatively a new approach [Varde, 2018]. One of the major features of the risk-based approach is, it integrates the deterministic and probabilistic framework towards reducing uncertainty in predicting remaining useful life (RUL) structures. The deterministic knowledge provides the information on major assumptions, design / data on structural configuration, design parameters, failure criteria at element / component, module and system level. During the service life the periodicity and results of tests & inspections and overall insights of qualification, also form part of integrated risk assessment framework. The structural failures can be classified into three major category a) early failures and b) service life failure and c) late or ageing relate collapses. Generally, early failure is attributed to inferior construction due to poor quality material, not following specifications and plans, compromised audit etc. Even sinking of structures due to inferior soil or strata conditions along with overreaching number of floors more than the approved plan and design specification can also lead to early failures. Further, the external events like fire, flood, or impact of external object can lead to collapses in all the three categories. Compromised safety culture that adversely impact surveillance and maintenance programme quality or periodicity have been found to result in service or useful life failure. The ageing related failure can be reduced by refurbishment or extended maintenance programmes. Additional prognostics and health management programmes help in reducing failures in all the three phases; however, it is more beneficial for ageing management or life extension program. In integrated risk-based engineering PHM has been considered as one of the most important tools, as the advanced intimation of incipient failures can be used to either eliminate or reduce the consequences of failure by implementing short-term or/and short-term management plans.

> The conventional approach for design of structural system is based on stipulated codes, guides and standards and a quality assurance programme along with other well proven best practices, along with periodic audits have served well towards ensuring stipulated life. However, the available literature shows, there are instances when structures collapse before reaching its design life or even prematurely, due to either use conditions, flood, fire, earthquake event, etc. This calls for developing living approaches for risk assessment and management such that advanced information is made available for appropriate action or mitigative plan can be initiated to wither eliminate or reduce the consequences of collapse or failure.

Proposed Risk-based Management Metrics

Numerical Estimate of Risk Potential (RP) / structure-yr	Colour Code	Significance	Periodicity of Risk Review (yrs)	Responsible agencies
RP = < $1.0*10^{-4}$	Green	Structure is SAFE and has resilience against external one-time event like earthquake, fire, flood. Should follow best practices for upkeep and maintenance.	15	Owner / House Society and Review Agency, including government agencies.
$1.0*10^{-4} \leq RP \leq 1.0*10^{-3}$	Yellow	Structure is SAFE. However, requires protection against external events like earthquake, fire, flood. Management & Mitigation measures against, fire are to be implemented. follow best practices for upkeep and maintenance	10	Owner / House Society and Review Agency, including government agencies.

$1.0*10^{-3}$ < RP ≥ $1.0*10^{-2}$	Amber	Structural repair and re-inforcement measures are must. Management & Mitigation measures against, fire are to be implemented / strengthened.	5.0	Owner / House Society and Review Agency, including government agencies.
$1.0*10^{-2}$ < RP ≥ $1.0*10^{-1}$	Red	Structure may not safe for habitants as significant degradation / issues have been recorded. Plan for demolition and disposal recommended.	1.0	Owner / House Society and Review Agency, including government agencies. Residents are supposed to play a significant role.

The probability risk assessment (PRA) approach provides a systematic and integrated framework for risk assessment. Generally, the quality of data in terms of accuracy and adequacy introduces relatively higher uncertainty in estimates for complex engineering systems. The same may not be true for civil structures as due to number, variety and complexity level of structures the data availability can be assumed to be an advantage factor. Further, civil infrastructures are more like passive systems which offer an inherent advantage. The availability of codes and standards in design, testing & services helps risk assessment procedure less complex compared to other engineering systems. These argument help reduce uncertainty in the final results. However, these factors need to be further researched. These benefits work for probabilistic and deterministic approach complement each other for providing an effective framework for risk assessment.

The PRA is increasingly be used for modelling, analysis, engineering management in decision making and development of applications. For example, the identification and prioritization of engineering program in general and risk-informed in-service inspection and maintenance management, etc which share similarity with structural systems. Further, the tradition approach to structural health assessment can be further improved and made effectively for addressing risk related issues management.

6. Risk Communication

The other major benefit of Integrated risk-based approach is that at lower level the risk potential of a structure is effectively communicated to the stakeholders using a rational based and quantified estimates of not only risk but also uncertainty associated with the estimation. These evaluations can be effectively used for identification and prioritization such that a management plan can be developed. This framework can also be used to effectiveness of the actions taken for example residual life estimations and further development of future surveillance schedules. After implementation of the schedule, it is also considered that each house / structure will have following metrics for risk communication.

The integrated risk-based protocol should envisage government approval for clearly indicating the Risk-potential of the structure / houses / buildings etc using the applicable colour code as shown in the colour metrics

Risk Potential Colour Code to indicate the level of Risk posed by a Structure

Imagin the colour code displayed prominently at the building at appropriate location might serve as an effective risk-communication in public domain and can save threat to life.

7. Conclusions

This objective of this paper / article has been to initiate the preliminary investigation regarding the applicability and feasibility of Integrated Risk-based approach to structural systems, particularly in the area of structural health assessment such that early detection of degradation or failure can be addressed as part of prognostics and health management program. Nevertheless, a broader consensus is required on the academic as well as domain specific level. For example, feasibility of applications on the buildings and houses can be a candidate area.

Dr. Kapilesh Bhargava, Scientific Officer 'H' is at Bhabha Atomic Research Centre (BARC), Mumbai, India Since August 1991 after successfully completing one year orientation course from 34th batch of BARC Training School, Mumbai, India.

Dr. Bhargava is known for his pioneering research in the field of time-dependent degradation and reliability assessment of corrosion-affected RC structures, estimation of blast induced ground vibration parameters, health assessment and probabilistic seismic margin assessment of existing civil structures of nuclear safety related facilities. Dr. Bhargava has published 181 papers in peer reviewed International / National Journals and International / National

Conferences and edited books. Dr. Bhargava has received many awards and recognitions at national and international forums, like Homi Bhabha Prize, JSPS Ronpaku Fellowship, Best Paper Awards, etc.
Dr. Bhargava is also Life Fellow / Life Member of many professional bodies like Institution of Engineers (India), Indian Geotechnical Society, Indian Concrete Institute, Indian Nuclear Society, Indian Society of Earthquake Technology, Indian Association of Structural Rehabilitation, and Society for Reliability and Safety.

Prof. Prabhakar V. Varde is a DAE - Raja Ramanna Fellow & Senior Professor at Homi Bhabha National Institute, BARC. During his service at BARC of 34 years, he contributed to research reactor programmes at BARC in operations, services, safety, projects, etc. He worked in many positions and rose through the ladder and retired as Associated Director Reactor Group at BARC, in July 2019. As for his academics and research interests, he is a mechanical engineer, and he completed his Ph.D. from IIT Bombay in 1996 in Reactor Safety. His areas of specialization are reliability engineering and nuclear plant operations safety by employing advanced tools like Artificial Intelligence, operations research, and risk-informed approaches. Dr. Varde did his post-doctoral fellowship at Korea Atomic Energy Research Institute (KAERI), South Korea in 2003. Further, since 2009 he has been serving as Visiting Professor / Faculty at Center Advanced Life Cycle Engineering, University of Maryland, USA.

He served as Chairman, Operations Safety Review Committee of Reactor Group at BARC, and Vice-Chair for Atomic Energy Regulatory Board (AERB) committee for 'PSA for DAE facilities. He developed reliability labs to facilitate advanced research in the areas that mainly include Probabilistic Risk Assessment, Physics-of-Failure modelling, Reliability Data Analysis, Life Testing, Prognostics and Health Management and human factor development. As a Professor of Practice at IIT Madras he was also involved in development of Centre of Excellence on *Safety Critical System Lab*. He has also served as expert / consultant at International Atomic Energy Agency, Vienna for over 15 years and Nuclear Energy Agency (WGRISK), Paris in PSA. Based on his R&D work he has over 255 international publications that also include over 18 edited / authored books His latest book "Risk-conscious Operations Management – An Integrated Paradigm for Safety Critical Systems" has been published by Springer – An international publisher on February 1, 2023. Keeping in view the national requirements in safety and reliability he founded a Society for Reliability and Safety (SRESA) in 2010 and presently he is serving as President SRESA and Lead Chief-Editor for SRESA's *International Journal of Life Cycle Reliability and Safety Engineering*.

Updated Brochure with including Galaxi of Keynote Speakers

5th Int. Conference on Reliability, Safety and Hazard

(ICRESH-2024),

21-24 February, 2024

Mumbai

(Brochure on next page)

Exhibition / Sponsorship

The conference will provide an opportunity to our commercial and industrial partners to showcase their products and services to support conference activities through sponsorships. Further details may be obtained from the Convenor / Secretary ICRESH-2024 or from the conference web-site.

Conference Deadlines

Abstract submission	**: June 15, 2023**
Abstract acceptance	**: June 30, 2023**
Full paper submission	**: Sep 15, 2023**
Acceptance intimation	**: Oct 10, 2023**
Final submission of paper	**: Oct 31, 2023**
Registration deadline	**: Dec 31, 2023**
ICRESH-2024	**: Feb 21-24, 2024**

About the Venue

The conference will be held at the DAE Convention Centre, Anushaktinagar, Mumbai. Mumbai is said to be the financial / business capital of India. The convention centre is located about 20 km from Mumbai International Airport and can be easily accessed by road. It is also easily accessible by road from the Railway stations (CSTM 19 km and Mumbai Central 22 km). The city of Mumbai has all types of hotel accommodation from budget hotels to five-star hotels.

DAE Convention Centre, Mumbai

The Conference will be held from Feb 22-24, 2024. A Pre-Conference Tutorial are arranged on Feb 21, 2024

Conference Chairman, ICRESH-2024

Prof. P. V. Varde, DAE-Raja Ramanna Fellow
Sr. Professor, HBNI & Former AD, Reactor Group,
Bhabha Atomic Research Centre, Mumbai

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5th ICRESH 2024

5th International Conference on Reliability, Safety and Hazard – 2024

(Advances in Risk & Reliability Modelling and Assessment)

February 21-24, 2024
Venue: DAE Convention Centre, Anushaktinagar, Mumbai, India

Organisers

Bhabha Atomic Research Centre, Mumbai
Society for Reliability and Safety, Mumbai

For further updates including registration details please visit conference website: https://www.sresa.org.in/ICRESH-2024.

About ICRESH

Over the last few years, extensive development work, in the area of Reliability Engineering in general and Probabilistic Risk Assessment in particular, has been performed as part of risk-informed applications. However, there is a need to take the level of knowledge to risk-based applications in support of asset management for complex systems like nuclear plants, space, aviation systems and process industries. The objective of this conference is to provide a forum for technical discussions on recent developments in the area of advances in risk and reliability modelling and assessment. The conference invites research and technical papers of high quality, bringing out the original contributions, for publication in the conference proceedings. As usual, it is proposed to publish a book containing the papers to be presented in the conference.

Bhabha Atomic Research Centre, Mumbai, along with the Society for Reliability & Safety are jointly organizing the Fifth International Conference on Reliability Safety and Hazard (ICRESH-2024) during 21-24 February 2024, at DAE Convention Centre, Mumbai. The earlier two conferences (ICRESH-2005 & 2010) were also held in Mumbai; the third conference was held at Lulea Technological University, Lulea, Sweden in year 2015 and in 2019 the fourth conference was held at IIT Madras, Chennai. These conferences were attended by Indian experts from many reputed labs and universities, around 20 delegates from several countries like USA, UK, Germany, Russia, Netherlands, South Korea, etc. also participated. Overall, about 130 papers, 30 invited talks and key note addresses marked the proceedings of the conference. One of the key parameters of the conference is that the book of conference proceedings was provided to participants in advance. In year 2010 it was jointly published with IEEE Reliability Society. Some of the selected papers are published in the International journal of Life Cycle Reliability Engineering, a reputed journal of SRESA and Springer.

ICRESH-2005, Mumbai

Conference Topics

ICRESH-2010, Mumbai

Reliability Prediction, Risk Based Design, Software reliability, PoF Models, Passive System Reliability, Investigation of Safety Critical Issues, Probabilistic Safety Assessment, Dynamic PRA, Risk-Informed Approach, Dynamic Models for Reliability Analysis, Stress Analysis in Support of Failure Prediction, Reliability Based Design and Evaluation, Reliability Centred Maintenance, Prognostics & Health Management, Precursor Event Analysis, Severe Accident Management, Heat Transfer and Thermal Management in Electronic System, Accelerated Life Testing, Remaining life Prediction in Support of Ageing Management, Fuzzy Reliability, Uncertainty & Sensitivity Modelling, Human Reliability Modelling, Human Factor Assessment, Failure Analysis Role of Advanced Methods in Human Factors, Artificial Intelligence Methods & Operational Reliability, Risk-informed Asset Management, Risk-based Applications, Risk-based Management Systems, Hazard Evaluation Methods, Hazard & Operability Study (HAZOPS).

Application Areas

Broad areas of the conference include but not limited to - Nuclear Power Plants & Research Reactors, Oil & gas, Chemical and Refineries, Railways, Space & Aviation Infrastructural, Software Systems, Health Care Systems, Transport and Monitoring Systems, Nuclear Facilities, structural Systems, Electronics & Communication Systems.

ICRESH-2015, Sweden

Authors interested in presenting papers based on original work of theoretical/ applied nature or case studies, are invited to submit an abstract not exceeding 400 words latest by **June 15, 2023**. The abstract should include key words / phrases and full e-mail address of the authors. Acceptance of the abstract will be notified by June 30, 2023. Soft copies of abstract and paper in MS word may be mailed to the Chairman, Technical Committee at e-mail address: icresh24@gmail.com The length of the paper should not exceed 6 pages. For detailed instructions regarding preparation of manuscript please visit conference web-site.

Conference Proceedings

Upon receiving notification about the acceptance of the abstracts, authors must submit complete manuscript of the full paper, by **September 15, 2023.** The conference proceedings will be published by a reputed publisher containing contributory papers. If possible full invited and key note talks will be included in the soft copy of conference proceedings. The soft copies of the conference proceedings will be made available to all contributors during the conference. In order to enable the technical committee to bring out the book of proceedings in time, it is essential that the complete manuscript of full-length papers is submitted by the due date positively. Papers received after this date may not be considered for print publication.

ICRESH-2019, IIT Madras

Galaxy of ICRESH-2024 Distinguished Plenary Keynote Speakers

Prof. Uday Kumar
Lulea University of Technology. Sweden

Prof. Michael Pecht,
CALCE University of Maryland, USA

Prof. Enrico Zio
Italy

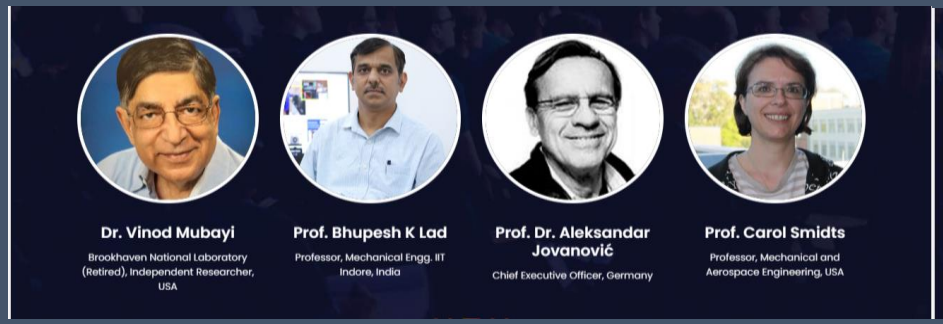
Prof. P. Dersin,
Lulea University of Technology. Sweden

Ms Janaki Devi Kompella
Managing Director of RELSAFE PRA Consulting, Thane

Prof. Gopinath Chattopadhyay
Federal University, Australia

Prof. P.K. Kapur
Amity University, Noida

Prof. J. Knezevic
MIRCE Akademy, Exeter, EX5 1JJ, UK



Dr. Vinod Mubayi
Brookhaven National Laboratory (Retired), Independent Researcher, USA

Prof. Bhupesh K Lad
Professor, Mechanical Engg. IIT Indore, India

Prof. Dr. Aleksandar Jovanović
Chief Executive Officer, Germany

Prof. Carol Smidts
Professor, Mechanical and Aerospace Engineering, USA

Prof. Anirudh Gautam
Research Designs & Standards Organisation (RDSO),Lucknow, India.

Prof. Pradip Kumar Ray
Emeritus Professor, Dept. of Industrial and Systems Engineering

Dr. Diego Galar
Operation and Maintenance Engineering at LTU, Luleå University of Technology.

Sameer Hajela
Executive Director (Reactor Safety & Analysis)

Shri S. B. Chafle
Executive Director, Atomic Energy Regulatory Board

Thank You ICRESH-2024 organizing Sub-committee Members and technical paper

Organizing a conference, that too an international event like ICRESH-2024 requires huge support from many unit heads, experts, well-wishers, logistic providers, coordinators etc without which the event organization a smooth manner is not possible. Broadly speaking the activities that directly require immense support for a conference can be divided into two major areas, organizational management and technical work. Typically organizing an international conference requires planning requires well over an year before the data of conference. Initial proposal, clearances, announcement, development of publicity material designating office bearers and the committees etc. Developing a funding model, venue, and call for abstract / papers follows. A systematic work of organizing committee and technical committee starts. Right from giving a call for paper till the material is given to the publisher involves many activities in between. This job rests with technical committee and reviewers. Please note the reviewers forms backbone to ensuring the technical quality of papers. In the same manner, apart from the organizing committee there are various sub-committees that support various activities of the conference and require minute planning, coordination and quality assurance. As "Atithi Devo Bhawah" is one of the core features of the ICRESH event.

Even though the Inaugural Program of the conference has a slot for thank giving but due to inherent limitation or constraint, viz. time limit, thanking individual supporters is not possible. SRESA has found a way to thank the technical reviewers and organizing sub-committee members through our SRESA Newsletter.

Dear friends SRESA is indebted to you for your whole hearted support and cooperation – a key to the success of the conference. The following pages provides the list of reviewers and organizing sub-committee members.

SRESA managing committee will also be happy to provide you with a Certificate – as a mark of our humble and token gesture for your support and cooperations.

President SRESA

ICRESH-2024 Organizing Sub-Committees

(Tutorial Parallel Sessions Management including multimedia, printing of tutorial notes, registration, refreshment, running tea and initial briefing, transport, logistics, welcome and honorarium lecturers / experts, including memento
and certificates for participants and faculty)

Souvenir / Abstract book

Dr. Hari Prasad, BARC	Convenor
Ms Vibha Hari, NPCIL	Member
Dr. Y. S. Rana, BARC	Member
Ms Saily Varde	Member

(Coordination and management of the abstract book work, that include technical program, messages, abstracts, advertisements, and other material as required and making the abstract book available at least 15 days before the ICRESH event to make it available for distribution and including it in conference kit).

Finance

Dr. Manoj Kumar, BARC	Convenor
Shri Mayank Agarwal, BARC	Treasurer (ICRESH-2024)
Ms Y. HemaSrita, Mah Uni.	Member

(Coordination and Management of funds, expenses and audit including maintaining SRESA support funds)

Publicity Resources, & Exhibition

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Shri Nishant Mishra, BARC	Member
Ms G. Samyukta, Mah-Uni.	Member
Ms M. Hanvitha, Mahi-Uni.	Member

(Conference and SRESA publicity material, Organization and Management of Exhibition, Inviting the Exhibits and advertisements for Abstract book. Etc).

Plenary Sessions

Dr Tej Singh, BARC, Mumbai	Convenor
Mr S.K. Sinha, BARC, Mumbai	Member
Dr. S. Muthukumar, DRDO	Member

(Coordination and management of plenary sessions that include, introduction of Chairman and Keynote Speakers, Honouring support and coordination for guests).

Stage management, inauguration and plenary & Valedictory

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Shri Sachin Kumar, BARC,	Member
Ms Rimpi Ganguli, NPCIL	Member
Shri Unmesh Chasker, BARC,	Member
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(Overall responsibility of stage management that also include coordination for stage setting, decoration, sitting arrangement of dignitaries, audio and multi-media)

Venue & Logistics

Dr. Kapilesh Bhargava, BARC	Convenor
Dr. Ranjan Kumar, BARC	Member
Ms Nidhi Pandey, BARC,	Member
Shri Unmesh Chaskar, BARC,	Member

(Management of Hall – A and Hall-B, Three Parallel Session halls, Exhibition Area, and Registration area, Security Aspects Management, Parking Zones and support services, like AC, Electricity back-ups. Coordination with other teams.)

Registration

Smt. Archana Sharma, BARC,	Convenor
Shri Aniruddha Ghosh, BARC,	Member
Dr. M.K. Vaishnavi, Anna Univ.	Member
Ms. Archana Yadav, Amity Uni.	Member
Ms. Ami Pandat	Member

(Registration desk management, Preparation of List of Invitees, Participation Certificates, Mementoes, Conference kit & coordination, etc)

Technical Sessions Management

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Ms Vibha Hari, NPCIL,	Co-Convenor
Dr. Santosh T.	Member
Dr. Manoj Kumar, BARC	Member
Dr. R.B. Solanki, AERB,	Member
Shri Vipul Garg	Member
Shri Arun Prashanth	Member

(Coordination and management of parallel sessions. Ensuring time and resource management. Coordination of Chairman's report on the session, grading for best paper's award, etc.)

Hospitality

Shri S.K. Sinha, BARC	Convenor
Shri P.K. Dubey, BARC	Member
Dr. Y. S. Rana, BARC,	Member
Shri Aniruddha Ghosh, BARC,	Member
Shri Nilesh Gohel, BARC	Member

(Core Responsibility: High Tea, Working Lunch, Banquette, Accommodations, Transport and logistics.)

Tutorials

Dr. Santosh Pradhan, AERB	Convenor
Shri Vipul Garg, BARC	Member
Shri Rajeev Nama, NPCIL,	Member
Shri Santosh T.	Member

SRESA Organizing Committee thank in all sincerity, the sub-committee members for offering their services to organizing activities of ICRESH-2024

SRESA Appreciate and Thank Technical Paper Reviewers for their contribution to ICRESH-2024 Proceeding

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SRESA ANNUAL AUDIT REPORT 2022 - 2023

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INDEPENDENT AUDITOR'S REPORT

To,
The Board of Trustees
Society for Reliability and Safety,
64 Vibha, R Paramhans Marg,
Opp. Cradinal Gracious High School,
Bandra East,
Mumbai – 400051.

Report on the Financial Statements
Opinion:
We have audited the financial statements of **Society for Reliability and Safety**, the Trust, which comprise the Balance Sheet as at March 31, 2023, and the Income & Expenditure Account for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements gives the relevant information and give a true and fair view in conformity with the accounting principles generally accepted in India:

a) In the case of the Balance Sheet, of the state of affairs of the Trust as at March 31, 2023; and

In the case of the Statement of Income and Expenditure Account of the **'Surplus'** of the trust for the year ended on that date;

Basis of Opinion:
We conducted our audit in accordance with the Standards on Auditing (SA's) issued by the Institute of Chartered Accountants of India. Our responsibilities under those Standards are further described in the auditor's responsibilities for the audit of the Financial Statements section of our report. We are independent of the trust in accordance with the code of ethics issued by the Institute of Chartered Accountants of India together with ethical requirements that are relevant to our audit of the financial statements under the provisions of the act and the rules thereunder, and we have fulfil our other ethical responsibilities in accordance with these requirements and the ICAI's code of ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion on the Financial Statements.

Management Responsibility or the Financial Statements:
The Board of Trustees are responsible for the matters with respect to the preparation of these financial statements that give a true and fair view of the financial position, and financial performance of the Trust in accordance with the accounting principles generally accepted in India, including the Accounting Standards prescribed by ICAI. This responsibility also includes the maintenance of adequate accounting records in accordance with the provision of the Act for safeguarding of the assets of the Trust and for preventing and detecting the frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial control, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditors Responsibility:

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing as applicable to the Trust. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal financial control relevant to the Trust's preparation of the financial statements that give true and fair view in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by Managing Committee, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the financial statements

Report on other Legal and Regulatory Requirements:

Further to our comments as mentioned above, we report as follows:

a) We have sought and obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit.
b) In our opinion proper books of account as required by law have been kept by the Trust so far as it appears from our examination of those books.
c) The Balance Sheet and the Statement of Income and Expenditure Account dealt with by this Report are in agreement with the books of account.

For M S V & Associates
Chartered Accountants
(Firm's Registration No. 130455W)

CA. Santosh Mane
Partner
M. No 125370
UDIN: 23125370BGRJGG5100

Place: Mumbai
Date: 30th September 2023

Report of an auditor relating to accounts audited Under sub-section (2) of section 33 & 34 and rule 19 of the Bombay Public Trust Act.

Registration No.: - **F-43051 (Mumbai)**
Name of the Public Trust: - **SOCIETY FOR RELIABILITY AND SAFETY**
For the year ending:- **31st March, 2023**

(a)	Whether accounts are maintained regularly and in accordance with the provision of the Act and the rules;	Yes
(b)	Whether receipt and disbursement are properly and correctly shown in the accounts;	Yes
(c)	Whether the cash balance and vouchers in the custody of the manager or records required by date of audit were in agreement with the accounts;	Yes
(d)	Whether all books, deeds, accounts, vouchers or other documents or records required by the auditor were produced before him;	Yes
(e)	Whether a register of movable and immovable properties is properly maintained, the changes therein are communicated from time to time to the regional office, and the defects and inaccuracies mentioned in the previous audit report have been duly compiled with;	N.A.
(f)	Whether the manager or trustee or any other person required by the auditor or appear before him did so and furnished the necessary information required by him;	Yes
(g)	Whether any property or funds of the Trust were applied for any object or purpose other than the object or purpose of the Trust;	N.A.
(h)	The amount of outstanding for more than one year and the amount written off, if any	Nil
(i)	Whether tenders were invited for repairs or construction involving expenditure exceeding Rs. 5000/-;	N.A.
(j)	Whether any money of the public trust has been invested contrary to the provisions of Section 35;	No
(k)	Alienations, if any, of the immovable property contrary to the provisions of Section 36 which have come to the notice of the auditor;	No
(l)	All cases of irregular, illegal or improper expenditure, or failure or omission to recover monies or other property belonging to the public trust or of loss or waste of money or other property thereof, and whether such expenditure, failure, omission, loss or waste was caused in consequence of breach of trust or misapplication or any other misconduct on the part of trustees or any other person while in the management of the trust;	No
(m)	Whether the budget has been filed in the from provided by rule 16A;	No
(n)	Whether the maximum and minimum number of the trustees is maintained;	Yes
(o)	Whether the meetings are held regularly as provided in such instrument;	No
(p)	Whether the minutes books of the proceedings of the meetings is maintained;	No
(q)	Whether any of the trustees has any interest in the investment of the trust;	No
(r)	Whether any of the trustees is a debtor or creditor of the trust;	No
(s)	Whether the irregularities pointed out by the auditors in the accounts of the previous year have been duly compiled with by the trustees during the period of audit;	Yes
(t)	Any special matter which the auditor may think fit or necessary to bring to the notice of the Deputy or Assistant Charity Commissioner.	Nil

For M S V & Associates
Chartered Accountants

CA. Santosh Mane
Partner
M. No. 125370
FRN-130455W
UDIN: 23125370BGRJGG5100

M S V & ASSOCIATES ★ MUMBAI FRN 130455W ★ Chartered Accountants

Place : Mumbai
Date : 30th September 2023

Interest on Sinking or Depreciation Fund -

The Bombay Public Trust Act, 1950
SCHEDULE - IXC
(Vide Rule 32)

Statement of income liable to contribution for the year ending **31st March, 2023**
Name of the Public Trust **SOCIETY FOR RELIABILITY AND SAFETY**
Registration No. **F-43051 (Mumbai)**

			Rs.	Rs.
I	**Income as shown in the Income and Expenditure Account (Schedule IX)**			1,79,950
II	**Items not chargeable to Contribution under Section 58 and Rules 32 :**			
	i)	Donations received from other Public Trust and Dharmadas	-	
	ii)	Grants received from Government and Local authorities	-	
	iii)	Interest on Sinking or Depreciation Fund	-	
	iv)	Amount spent for the purpose of secular education	-	
	v)	Amount spent for the purpose of medical relief	-	
	vi)	Amount spent for the purpose of veterinary treatment of animals	-	
	vii)	Expenditure incurred from donations for relief of distress caused by scarcity, drought, flood, fire or other natural calamity	-	
	viii)	Deductions out of income from lands used for agricultural purposes :-		
		a) Land Revenue and Local Funds Cess	-	
		b) Rent payable to superior landlord	-	
		c) Cost of production, if lands are cultivated by trust	-	
	ix)	Deductions out of income from lands used for non-agricultural purposes :-		
		(a) Assessment, cesses and other Government or Municipal Taxes	-	
		(b) Ground rent payable to the superior landlord	-	
		(c) Insurance premia	-	
		(d) Repairs at 10 per cent of gross rent of building	-	
		(e) Cost of collection at 4 per cent of gross rent of buildings let out	-	
	x)	Cost of collection of income or receipts for securities, stocks, etc. at 1 per cent of such income	-	
	xi)	Deductions on account of repairs in respect of buildings not rented and yielding no income, at 10 per cent of the estimated gross annual rent	-	
	xii)	Deduction on account of Miscellaneous Expenses	-	
		Gross Annual Income chargeable to contributions		**1,79,950/-**

Trust Address:
Society for Reliable and Safety
C/o Shri S J Raut
64 Vibha R Paramhans Marg,
Opp Cardinal Gracious High School, Bandra (East),
Mumbai – 400051.

For SOCIETY FOR RELIABILITY AND SAFETY

President **Secretary**

Treasurer

For M S V & Associates
Chartered Accountants

M S V & ASSOCIATES MUMBAI FRN 130455W Chartered Accountants

CA. Santosh Mane
Partner
M. No. 125370
FRN-130455W
UDIN: 23125370BGRJGG5100

Place :- Mumbai
Date:- 30th September 2023

The Bombay Public Trust Act, 1950

SCHEDULE - VIII

[Vide Rule 17(1)]

Regn No :- F-43051 (Mumbai)

Name of the Public Trust :- **SOCIETY FOR RELIABILITY AND SAFETY**

Balance Sheet As At :- **31st March, 2023**

FUNDS & LIABILITIES	AMOUNT (₹)	AMOUNT (₹)	ASSETS	AMOUNT (₹)	AMOUNT (₹)
Trust Fund			**Immovable Properties (At Cost)**		
Balance as per last Balance sheet	-		Balance as per Last Balance Sheet		
Adjustment during the year (give details)			Addition During the Year	-	
Add: Life Membership Fees	-	-	**Less : Sales during the year**	-	
	-		Depreciation up to date	-	-
			Fixed Assets		
Other Earmarked funds :-			(As per Annexure - A)		
Balance as per last Balance sheet		-	Balance as per Last Balance Sheet	-	
Depreciation Fund			Addition During the Year	-	
Sinking Fund			**Less : Sales during the year**	-	
Reserve Fund			Depreciation up to date	-	-
Any other Fund (Panipuravtha)					
			Investments		
			FD with State Bank of India	1,100,000.00	
Loans (Secured or Unsecured):-			Add: Accrued Interest on Fd	72,558.00	1,172,558.00
From Trustees	-				
From Others	-	-	**Loans (Secured Or unsecured): Good / doubtful**		
			Other loans	-	
			Tax Deducted at Source	6,157.00	6,157.00
Liabilities:-					
For Expenses			**Advances**		
- Income Tax Payable	43,920.00				
- Audit Fees Payable	20,650.00				
- Accounts Writing Charges Payable	6,000.00				
- Professional Fees Payable	11,800.00	82,370.00	**Sundry Debtors**		
Unidentified Receipt		2,115.00			
Balance C/fd		**84,485.00**	**Balance C/fd**		**1,178,715.00**

PV AM MK

M S V & ASSOCIATES ★ Chartered Accountants MUMBAI FRN 130

Balance B/d		84,485.00	**Balance B/d**		1,178,715.00
			Cash and Bank Balances :-		
			a) In Saving Account		
			- State Bank of India	429,004.65	
Income and Expenditure Account :-			**b) With the Trustee**	-	
Balance as per last Balance Sheet	1,417,479.65		**c) With the Manager**	-	
Add : Appropriation, if any	-		**d) Cash in Hand**	354.00	
Less : Surplus as per Income and Expenditure Account	106,109.00	1,523,588.65			429,358.65
Total		**1,608,073.65**	**Total**		**1,608,073.65**

As per our report of even date

For SOCIETY FOR RELIABILITY AND SAFETY

For M S V & Associates
Chartered Accountants

The above Balancesheet to the best of our knowledge and belief contains a true accounts of the Funds & Liablities and of the property Assets of the Trust

President **Secretary** **Treasurer**

CA. Santosh Mane
Partner
M. No. 125370
FRN: 130455W
AUDITOR
UDIN: 23125370BGRJGG5100

Place :- Mumbai
Date :- 30th September 2023

The Bombay Public Trust Act, 1950

SCHEDULE - IX

[Vide Rule 17(1)]

Regn No :- F-43051 (Mumbai)

Name of the Public Trust :- **SOCIETY FOR RELIABILITY AND SAFETY**

Income & Expenditure A/c. F.Y.Ended :- **31st March, 2023**

EXPENDITURE	AMOUNT (₹)	AMOUNT (₹)	INCOME	AMOUNT (₹)	AMOUNT (₹)
To Expenditure in respect of Properties			**By Rent**		
Rates, Taxes, Cesses			- Accrued	-	
Repairs & Maintenance	-		- Realised	-	-
Electricity Charges & License Fees	-				
Insurance	-				
Depreciation (by way of provision of adjustment)	-	-	**By Interest**		
			On Securities	-	
To Establishment Expenses			On Loans	-	
Website Expenses	7,268.00		On Fixed Deposit	61,559.00	61,559.00
Bank Charges	953.00				
Professional Fees	5,900.00		**By Donations in Cash or Kind**		-
Accounts Writing Expenses	3,000.00	17,121.00	**By Grants**		
To Remuneration to Trustees		-	**By Income From Other sources**		
			- Membership Fees		11,000.00
To Audit Fees		11,800.00	- Royalty for Journal Subscriptions		106,691.00
To Remuneration (in case of a math) to the -			- Registration Charges		700.00
head of the math, including his houshold - expenditure, if any		-			-
To Amount Written Off:					
a) Bad Debts	-				
b) Loans Scholarship	-				
c) Irrecoverable Rents	-				
d) Other Items	-	-			
To Miscellaneous Expenses					
Income Tax		44,920.00			
To Depreciation					
Balance C/fd		**73,841.00**	**Balance C/fd**		**179,950.00**

PV AM MK

M S V & ASSOCIATES Chartered Accountants MUMBAI FRN 130451

Balance B/d		**73,841.00**	**Balance B/d**		**179,950.00**
To Amount Transfer to Reserve or Specific Funds		-			-
To Expenditure on objectivs of the trust					
a) Reigious					
b) Educational					
c) Medical Relief	-				
d) Relief of Poverty	-				
e) Other Charitable Objects		-			
To Surplus carried over to Balance Sheet		**106,109.00**			-
Total		**179,950.00**	**Total**		**179,950.00**

As per our report of even date

For SOCIETY FOR RELIABILITY AND SAFETY

President **Secretary** **Treasurer**

For M S V & Associates
Chartered Accountants

M S V & ASSOCIATES ★ MUMBAI FRN 130455W ★ Chartered Accountants

CA. Santosh Mane
Partner
M. No. 125370
FRN: 130455W
AUDITOR
UDIN: 23125370BGRJGG5100

Place :- Mumbai
Date :- 30th September 2023

Society for Reliability & Safety (SRESA)

(REG. NO. : F-43051 (Mumbai))
SRESA COORDINATOR, SHRI S.J. RAUT, 64-VIBHA, R. PARAMHANS MARG
OPP. CARDINAL GRACIOUS HIGH SCHOOL; BANDRA(E) MUMBAI - 400051
Web Site: www.sresa.org.in (PHONE ; +91-9892464817)

MEMBERSHIP APPLICATION FORM. **MEMBERSHIP NO*.**

1.	Name of applicant		Affix your stamp / passport size photograph and send a soft copy by email
2.	Qualification		
3.	Affiliation		
4.	Position held		
5.	Specialization		
6.	Official address ☐ | Residential Address ☐ (Please tick the address to be used for official communication)		
7.	Brief Bio-data:		
8.	Cell phone number and email address	Email:	Cell No:
9.	Date of birt (DD/MM/YY)		
10	PAN Number (not applicable for student)		
11	Type of membership (Tick applicable category)	Petron (By Invitation) : Nil Honorary Member (By Invitation): Nil Life membership : Rs. 2,200/- Membership (annual) : Rs 1200/- Student membership : Rs 500/- (Please tick the applicable category)	☐ ☐ ☐ ☐ ☐
12	Payment mode: i) Cheque ☐ ii) Demand draft ☐ iii) On-line transfer: ☐ Cheque /DD/online transfer details :……..Date: ……. Amount: …… Name of the Bank:……Account number……ISFC code		
12	Signature of applicant:		

- Please send the scanned copy of the form duly signed by email to Secretary, SRESA along with a soft copy of the passport size photograph to secretary@sresa.org.in and a copy to treasurer@sresa.org.in
- SRESA account details are as follow: Money to be transferred in favour of '*Society for Reliability and Safety'*, SRESA Account number: 31110442604, Bank Name: State Bank of India, Branch: Anushaktinagar, Mumbai 400094. Branch Code 010124, IFS Code: SBIN0010124;.
- *will be allotted by SRESA Office.