SRESA Newsletter

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New

2nd International Conference on Reliability, Safety and Hazard—ICRESH-2010

From the President's Desk

Research and development work in the area of reliability and safety is actively being pursued in India and abroad. Many research organizations in India which include BARC, IITs, IISc, IGCAR, AERB-SRI, NPCIL, Centre For Reliability (Chennai), process industries and universities have been involved in developmental activities for enhancement of reliability and safety. There have been many research publications from India in this field on risk based application and reliability software which is a testimony to the ever increasing applications of this field in the last three decades. There have been many national and international conferences organized in this area of reliability and safety. The R&D work in the field of reliability supported industries at national and international level. There is a need of an umbrella organization which would facilitate the exchange of ideas, complement and supplement work performed in different areas and work for the growth of this field for providing right orientation to the reliability and safety. The Society for Reliability and Safety (SRESA) has been formed with these objectives. Most of the present members are from BARC, AERB, IGCAR and NPCIL. This is the first issue of newsletter of the society. There are three articles featured in the newsletter. These articles deal with upfront activities in the field of reliability and safety.

Dr. S. K. Gupta

Inside this issue:

SRESA and its objectives

A need was felt to create a forum to enable and encourage the exchange of ideas of professionals working in the field of safety and reliability. This led to the formation of this society. SRESA has been registered in November 2010. The objectives of the society are as follows :

a) To promote and develop the science of reliability and safety;
b) To encourage research in the area of reliability and safety engineering, technology & allied fields;
c) To hold meetings for presentation and discussion of scientific and technical issues related to safety and reliability.
d) To evolve a unified standard code of practice in safety and reliability engineering for assurance of quality based professional engineering services.
e) To publish journals, books, reports and other information, alone or in collaboration with other organizations, and to disseminate information, knowledge and practice of ensuring quality services in the field of Reliability and Safety
e) To organize reliability and safety engineering courses and/or services for any kind of energy systems like nuclear and thermal power plants, research reactors, other nuclear and radiation facilities, conventional process and chemical industries.
f) To encourage Scholarships, Grants and Awards useful in furthering the foregoing objectives.
g) To co-operate with government agencies, educational institutions and other organizations having similar objectives;
h) To cater to the need of ageing studies, life assessment and failure analysis in a scientific and technical manner.
i) To engage in other activities as may be appropriate for fulfillment of the objectives of the Society.

It is heartening to know that SRESA is involved in organizing the ICRESH 2010.

The Society is a non-profit non-trade union organization engaged in fulfillment of the objectives as stated above.

R & D Activities at Reactor Group

P. V. Varde, BARC

The R & D activities in respect of probabilistic safety assessment and reliability modeling has been in progress since over a decade in Reactor Group. However, keeping in view the future requirements apart from reliability modeling, like life prediction and root cause failure analysis of engineering components, a Life Cycle Reliability Engineering Laboratory in Dhruva complex has been set up and operational since over one and half year. The major R & D activities are a) Intelligent methods in support of diagnosis and optimization b) Development of risk based management system in support of operation and maintenance management of the plant, c) Reliability prediction using accelerated test methods, d) Development of Physics-of-failure methods in support of life and reliability prediction of electronic and mechanical components e) Probabilistic Safety Assessment for research and power reactors f) Development of risk based methodology for ISI and maintenance management g) Assessment of human factors based on simulation methods and O & M data. Many of the activities like PSA of CIRUS, DHRUVA and Risk based ISI has been supported by Reactor Safety Division, BARC.

Adequate facilities / software and expertise have been developed in the area of level-I PSA modeling, life and reliability prediction of engineering components and root cause analysis. To make the pace of above R & D programme more efficient and effective, some additional features are being incorporated into the lab which include a) installation of temperature and humidity accelerated test chamber b) General purpose FPGA simulation facility c) Scanning Electron Microscope d) Data acquisition and analysis system and other equipment required for electrical / electronic parameter monitoring.

The lab has completed safety re-assessment for a 30 year old Co-60 based irradiator facility as a part of regulatory regimenting requirement. This study provided important inputs for regulatory review and the plant received its first reauthorisation of license for three years. This study also formed the basis for getting quality accreditation for the plant from the European Union. Apart from this, the other major works of this lab include completion of Level-I PSA of the three research reactors at BARC, viz, Dhruva, Cirus and Apsara. Development of surveillance test interval (STI) optimization procedure using intelligent methods has been another significant feature. As a part of life prediction of electronic components a procedure has been developed for predicting life of control / power connectors. The salient feature of this work is taking the life testing methods one stage ahead to understand the root causes of degradation using microscopic examination and positron annihilation spectroscopy. Based in the above R & D work the lab has published over 80 papers in International Journals and conferences over a decade.

Future directions in R&D in Reliability and Safety

Gopika Vinod, Rohit Rastogi, Manoj Kumar, S.V. Shrikhande & V. V. S. Sanyasi Rao , BARC

As of today, Probabilistic Safety Assessment has reached a mature level, wherein it is actively supporting decision making for operations and regulatory actions in nuclear power industry. However, with the advent of new technology and increase in the complexity of systems handled, new challenges are emerging. Lot of research activity is being pursued by academia and R&D organizations for adapting the existing methods to these new technologies and also for developing new methods. The main thrust can be seen in addressing the system reliability analysis, which requires a comprehensive and integrated consideration of components, such as hardware, software, human and organization. This article looks into each of these components and directions in which research in heading to tailor to current needs.

Earlier reliability analyses, consider hardware devices to be in binary state (i.e. functional or faulty). Yet there are many components, for e.g. control valves, whose overall performance can settle on different levels, bring out the multi state concept. These calls for mechanistic modeling of components, which gives a new dimension for multiple states reliability analysis. Similar concern arises with reliability modeling of programmable electronic components such as FPGA, PLD, etc. Current trend is to employ Physics of Failure models in reliability estimation. Physics-of-Failure (PoF) in reliability concentrates on (i) addressing the root cause mechanisms and driving forces responsible for equipment failures (ii) modelling failure mechanisms and understanding the application environment so that failures that will occur within the required service life can be predicted and eliminated from the design.

Computer Based Systems (CBS) used for protection and control functions in nuclear and defense applications, need to be demonstrated to meet the target reliability and safety requirements. Markov models are extensively used to estimate Mean Time Between Failure (MTBF) for the system, which takes into account the number of channels in the system and repair policies. Markov models are developed to estimate various reliability metrics required for the system, address dangerous or spurious failures. These studies are essential to determine whether the CBS meet the target requirements, if not, the system needs to be redesigned or operating / repair policies need to be modified.

There is extensive discussion in the literature about the nature of software failure. Two interesting questions, from the beginning, have been: What is software failure and how these failures can be modeled probabilistically. Software faults remaining in the software after testing normally do not impair functioning of the software. A fault is revealed only when it is triggered by a specific input leading to a software failure. In this concept, a software failure is random due to the randomness of the associated triggering event.

When developing models and methods for the analysis of software failure behavior, two points of view can be considered – (i) a software-centric approach which looks for the definition of failure modes and the evaluation of their probabilities (ii) a system- centric viewpoint which is founded on the practical observation that most failures in software occur due to specification and requirement errors, looks into software development process. Extensive work has been car-

ried out on formal verification and validation techniques, which provides a qualitative indication of software quality. One of the approaches to the quantitative analysis of software failures is by fault injection methods which deliberately inject faults in the software and count the number of times that the software maintains its function in spite of the injected fault. Given the many processing paths of software and the corresponding potentially hidden failure modes, the method remains controversial and needs extensive runs for building high confidence in support of the results. Furthermore, case studies must be specifically tailored to test susceptibility to common mode failures and verify whether fault injection is an adequate method to address such problem. Recent direction is towards harnessing software quality metrics for predicting software reliability, in Bayesian belief networks along with expert judgment.

With respect to modeling human errors, the early methods of analyses, the so-called 'first generation' ones like the Technique for Human Error Rate Prediction, Accident Sequence Evaluation Program and Human Cognition Reliability, are built around the pivotal concept of human error: because of the inherent deficiencies of humans, they naturally fail to perform tasks just like mechanical, electrical, structural components do. The quantity Human Error Probability (HEP) can be defined with respect to a given task and appropriately modified in consideration of the environmental conditions under which it is performed. The factors representing the effects of the environment on the human performance of a task are called Performance Shaping Factors (PSFs). Later experimental results from extensive studies of human performance in accidents have shown that the importance of the contextual conditions in which the task is performed is greater than the characteristics of the task itself. This became the underlying principle 'second-generation' methods of HRA like the Cognitive Reliability and Error Analysis Method and A Technique for Human Error Analysis. Current R&D aims at augmenting first- and second-generation methods by the use of virtual environments for mimicking the performance of humans in actual scenarios. With the increase in computing power and advancements in "Virtual reality", simulation-based HRA methods are gaining importance, which can provide a dynamic model to reproduce human decisions and actions during the scenario development and uses the results of these experiments as basis for human performance estimation.

Structural reliability methods address the uncertainty in the design variables for systems, structures and equipment (SSE) in the framework of probabilistic methods. The uncertainty propagation from the design variables to the output variables help in quantifying the reliability of these SSE. This methodology not only gives a metric of safety but also helps in setting the benchmarks for safety analysis. This is frequently done in terms of reliability index. This method is very popular across industries like nuclear, offshore, aerospace, geotechnical and many more. Research is going on in applying this technology to different failure modes across different SSEs in these industries.

Research activities are on to replace the traditional working stress design based codes by limit state design codes. The working stress design codes suffered from the limitation of non-uniform design under different loading scenarios. The limit state design codes result in designs which are more consistent and have quantifiable margins to failures. The reliability based design optimization is being now adopted in industries which do not have a code of practice for design. Reliability based inspection schedules are increasingly being used in the industry. Efforts are being made to quantify the reliability of existing structures. This approach is helping in fitness for purpose assessment and for the residual life estimation of the structures. Efforts are on to validate the methodology adopted during structural reliability evaluation by performing extensive experiments.

In addition, the reliability analysis of the modern complex systems entails an integrated approach in which the hardware, software, organizational and human elements are treated in a combined frame which accounts for their dynamic interdependences in the complex related tasks of system production, maintenance and emergency management. To cope with such complexity, dynamic reliability methodologies are being advocated to provide a framework for simulating directly the response of a system to an initial perturbation, as the system hardware and software components and the operating crew interact with each other and with the environment. This can be achieved by embedding models of controlled process dynamics and human operator behavior within stochastic simulation engines reproducing the occurrence of failure and success transitions along the scenarios. These scenarios are automatically generated within the dynamic simulation, e.g. by means of the Discrete Dynamic Event Trees or MC simulation techniques.

The new challenges presented requires embracing multiple directions of battling the difficulties of practical application through theoretical advancements in system and uncertainty representation and modeling and through computational developments for quantification, the latter particularly sustained by the power of computer simulation. They offer immense scope for further R&D in system reli-

Combined 'Safety Margin ' for LBLOCA by Deterministic and Probabilistic Methodologies

Mahendra Prasad, AERB

In the context of technology neutral measures for reactor safety the quantification of safety measure, margin (SM), can be obtained based on a combination of deterministic and probabilistic methods. The deterministic analysis involves best estimate with uncertainty analysis in SM evaluation and use of LBLOCA event tree.

The study involved five input uncertain parameters namely nominal power, decay power, fuel clad gap conductivity, fuel thermal conductivity and discharge coefficient, selected based on literature review and engineering judgment. The nominal, minimum and maximum values of the parameters were obtained from available data sources. In the absence of concrete experimental data on such parameters, it was assumed that the parameters follow uniform probability distribution. These five parameters were sampled using Latin Hypercube Sampling (LHS) to obtain 25 input sets. An event tree for the LBLOCA initiating event has been used from a level-I probabilistic safety assessment (PSA) study of NPP. In the event tree four safety systems were modeled. The success and failure of these systems generated a number of accident sequences. The non-core damage (NCD) accident sequences were identified for the study. The accident sequences were analyzed using a thermal hydraulic code and peak clad temperature (PCT) values were obtained for the 25 input set for each sequence. A Kolmogrov – Smirnov goodness-of-fit test was carried out for each accident sequence PCTs which indicated that the PCT followed normal distribution.

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The mean and standard deviation of PCT for each NCD accident sequence were calculated. The safety margin in an NCD accident sequence was calculated as the ratio of the difference between the acceptance criteria for PCT and mean PCT, and the standard deviation of the respective sequence. The relative values of the safety margins in accident sequences indicated the importance of the safety systems. Since the safety margins for each sequence were positive, the overall combined safety margin for the case of LBLOCA was obtained as the weighted sum of the safety margins of the four sequences. The weights are the ratio of the NCD accident sequence frequency and the LBLOCA frequency.

Upcoming Conferences

International Congress On Productivity, Quality, Reliability, Optimization And Modelling
7 - 8 FEBRUARY, 2011, New Delhi, India
www.icpqrom2011.org

PSA 2011–International Topical Meeting on Probabilistic Safety Assessment and Analysis
13–17 March2011,WilmingtonNC,USA
Web site:www.psa2011.org

SMiRT 21
21st INTERNATIONAL CONFERENCE ON STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY,
NOVEMBER 6-11, 2011, NEW DELHI, INDIA
Conference email: smirt21@hbni.ac.in

Conference Webpage: www.hbni.ac.in/smirt21 (or) smirt21.hbni.ac.in

PSAM11 & ESREL2012
25-29, June 2012, Helinski, Finland

International Conference on Reliability, Safety and Hazard -2010

P. V. Varde, BARC

The Second International Conference on Reliability, Safety and Hazard 2010 (ICRESH-2010) is being organized by Bhabha Atomic Research Centre, Mumbai as the lead organizer from December 14-16, 2010 in Hotel Four Point by Sheraton, Vashi, Navi Mumbai. The Co-organizing partners for this conference are, Center for Advanced Life Cycle Engineering (CALCE), University of Maryland, USA; IEEE – Reliability Society, International Institute of Information Technology, Pune; and the newly launched Society for Reliability and Safety. As can be seen this partnership and overwhelming response that we received from not only India but also abroad made this conference a truly International event ready to offer the R&D experience of experts in the area of Reliability & Safety in general and "Risk -based Technology and Physics-of-Failure Methods", in particular.

We are happy to bring to your notice that Dr. S.K. Banerjee, Chairman, Atomic Energy Commission has given his consent for being the Chief Guest for the conference. Further it adds to our excitement when we inform you that Dr. R.K. Sinha, Director, BARC has also obliged us by giving his consent to deliver the presidential address of the conference. Prof. Michael G. Pecht, Director, Center for Advanced Life Cycle Engineering, University of Maryland, USA was kind enough to agree to our proposal to be the guest of honour for the conference inauguration programme. Later he will deliver the Conference Keynote address. Keeping in line with Indian Tradition of *"Atithi Devo Bhava"* (Our Guest is like a God), Shri V.K. Raina, Director, Reactor Group and Conference General Chairman will welcome the dignitaries and participants of the ICRESH-2010. Once the conference inaugural programme is over, be ready for the academically rich technical session comprising of 25 keynote addresses, same number of invited talks and over 100 contributed papers that will be presented during the period of these three days.

The eminent speakers to deliver the Keynote talk are : Prof. Michael Pecht Director, CALCE University of Maryland, USA; Shri S.S. Bajaj, Chairman, Atomic Energy Regulatory Board, India; Prof. Knezevic Director, MIRCE Academy, UK; Shri S.K. Jain, Chairman & Managing Director, Nuclear Power Corporation of India Limited, India; Prof. Vinod Mobayi, Senior Scientist, Brookhaven National Lab, USA; Prof. Joseph Mathew, CEO, CIEAM, Australia; Mr. G. P. Shrivastava, Director Electronics & Instrumentation Group, BARC; Prof. Jorge Baron, Argentina; Prof. Uday Kumar: Sweden; Prof. B. K. Dutta, Dean (Engg. Sciences), Homi Bhabha National Institute, India, BARC; Dr. Carol Smidts, Director, Center for Academic Excellence in Digital Control Systems and Safety The Ohio State University, USA; and many more dignitaries who will be illuminating the technical sessions with their rich R&D experience.

Overall 220 delegates, including 20 from over 10 countries are participating in the conference. Even though contributed papers and invited talks organized in three parallel sessions, form one of the major features of the conference. The panel sessions covering over 24 keynote addresses by renowned experts from India as well as abroad is an academic and R&D treat for the ICRESH participants. There are over 125 contributed papers to be presented in three parallel sessions for three days. This includes 25 invited talks to be delivered by the future leaders bringing out the R&D experience of experts on risk-based engineering, probabilistic safety assessment and physics-of failure methods.

We are happy to inform you that for ICRESH-2010 proceedings we have the copy right agreement with IEEE-Reliability Society. IEEE Reliability Society will have the publishing rights of the proceedings. However, a conference book will be printed and distributed to the participants along with the conference kit that will be made available on the first day of the conference from the registration desk.

The pre-conference tutorial scheduled on December 12 and 13, 2010 is one of the added features of the conference. The topics for the tutorials have been chosen in such a manner that the participants get deeper level of understanding on the theme of the conference – Risk-based Technology and Physics-of-Failure Methods. Dr. Mubayi, Senior Research Scientist, Brookhaven National Lab, USA and Dr. Diganta Das, Senior Scientist, Center for Life Cycle Engineering, University of Maryland, USA and Dr. VVS Sanyasi Rao, BARC, Mumbai will be giving the tutorial lectures. Dr. V. V. S. Sanysi Rao will cover the Level 1 Probabilistic Safety Assessment while Dr. V. Mubayi will address the participants about Level 2 and Level 3 PSA and associated regulatory issues. Dr. Diganta Das from CALCE will give tutorials on Physics-of-Failure Methods for Life and Reliability Prediction of electronic components. It is expected that over 50 participants from BARC, NPCIL, AERB and other industrial and academic institutions will be attending the two days tutorial at Training School Complex, Anushaktinagar, Mumbai.

The Conference Exhibition is also one of the exciting features of the conference. Here, our industrial partners and organizations will have an opportunity to showcase their product, services and expertise.

Taking feedback from the participants and ideas to consolidate the recommendations for future research and development work is a crucial element of the conference. A planery session will be conducted as part of the valedictory function of the conference. The valedictory function and SRESA Award Ceremony will be held on the last day, i.e. December 16, at 1600 hrs and this will mark the closing of the conference. The final recommendations of the conference will be communicated to the organizers and sponsors so that future trends for further research can be fine tuned keeping in view the reliability and safety requirements of complex engineering systems.

Input for articles in this news letter are compiled from various sources in Department of Atomic Energy, India.

Compiled by Mr. R. B. Solanki
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Society for Reliability & Safety

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Membership No. ☐
(To be allotted by society office)

Application for Membership of the Society

1.	Name of the Applicant		
2.	Affiliation		
3.	Position held		
4.	Qualification		
5.	Field of Specialization		
6.	Address:		
	Official:	Residential:	
7.	Telephone No. (With STD Code) / Mobile No.		
	Official:	Residential:	
8.	e-mail		
9.	Date of birth (DD/MM/ YY)		
10.	Type of membership applied for (Tick applicable category)	Annual Membership (Yearly Fee Rs.500/-) ☐ Life Member (Fee Rs.2000/-) ☐ Associate Member (Fee Rs.200/-) ☐ Corporate member (Fee Rs.50,000/-) ☐ Affiliate Member (Fee Rs.10,000/-) ☐ Emeritus Member & Patron* (Fee Nil) ☐ (Entry Fee Rs.200/- in addition to above membership Fee)	
11.	Payment Mode		
	Cheque: ☐ Cheque No. : Date:…… Amount:…… Name of the Bank :	Demand Draft: ☐ D D No: Date:…….. Amount:…….. Issuing Bank :……. …… ……	Direct Deposit/Net Banking: ☐ Date:…… Amount:…… Transaction Details:……. ……

Society Account Details: Money to be transferred in favour of 'Society for Reliability and Safety' SBI, BARC, Swift Code : SBININBB508, Account Number 31110442604
** Honorary Position given by Executive Committee's recommendation*

SIGNATURE OF APPLICANT: