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SRESA Newsletter

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New

21st International Conference on Structural Mechanics in Reactor Technology—SMiRT 21, 6-11, November 2011.

From the President's Desk

The Society for Reliability and Safety (SRESA) publishes newsletter periodically covering upfront areas in the field of reliability and safety. This provides the communication link which fulfills one of the objectives of SRESA— to facilitate sharing of ideas and experiences from the work being carried out in different organizations. Two issues of SRESA newsletter have already been published. This is the third issue. There are three articles featured in this issue. The first article presents the role of nuclear regulatory research, the second one discusses the aspects of time variant reliability analysis of components under stochastic loading and the third article emphasizes on reliability analysis of optocouplers using physics of failure approach. An article on Book review is also included in this issue, which provides an overview on the book titled 'Reliability Engineering and Risk Analysis - A Practical Guide'. The new section is introduced, the newly joined members of SRESA. Upcoming conferences are listed for information purpose.

Dr. S. K. Gupta

Inside this issue:

Role of Nuclear Regulatory Research

S. K. Pradhan and S.K. Gupta

Atomic Energy Regulatory Board, Mumbai, India

The success of Global Nuclear Safety Regime is built upon a foundation of research. A key element of this research is the nuclear safety research performed or sponsored by regulatory organizations. This regulatory research has contributed significantly to improved safety and has laid the foundation for activities such as risk-informed regulation, plant life extension, improved plant performance (e.g. power uprates) and new plant designs.

Research is needed by the regulator to provide independent judgment, to determine areas in which improvements might be necessary, to anticipate potential problems and in general to improve the effectiveness of the regulatory system and ensure that the regulatory requirements are adequate and practical. Regulatory research provides output to all the activities of regulatory bodies shown in Figure 1.

Regulatory research can be divided into two major categories. The first one is the, so called, confirmatory research, which has the purpose of ratifying a particular safety criterion, or a set of criteria, or in verifying that it is well founded the justification of a particular or generic request for regulatory approval presented by a given plant operator. The aim of confirmatory research conducted independently by the regulator is to increase confidence on the research previously done on the same subject. The second category of safety of new foreseeable nuclear-projects and at acquiring the necessary knowledge and experience on the potential new application to take the necessary regulatory options. The usefulness of anticipatory research may not become apparent for many years after the initiation of the research. One of the key challenges for regulators is to maintain the proper balance between confirmatory research and anticipatory research.

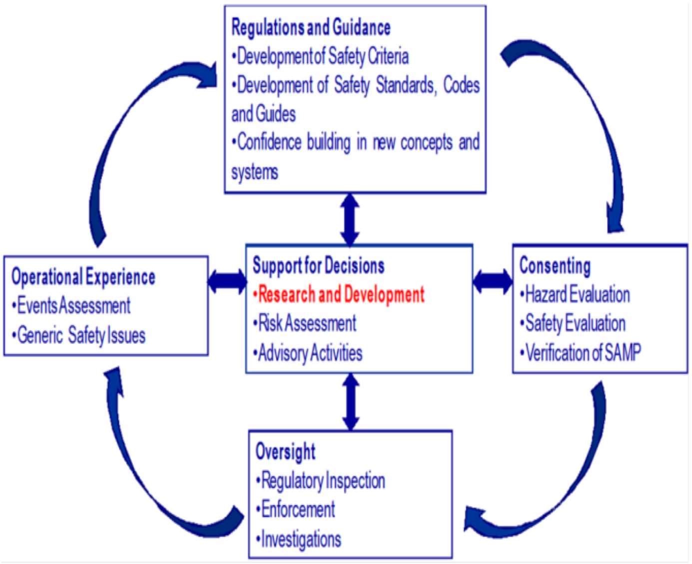

Fig. 1: Role of Regulatory Research in the Regulatory Process

When the regulatory body gets research initiated in-house, it is called direct mode of regulatory research. The regulatory body may get research initiated by its Technical Support Organizations (TSOs). This mode of regulatory research is called TSO mode. The TSO may be established solely for regulatory body or for both regulatory body and industry. In later case, care has to be taken to ensure the independence of regulatory body in defining the scope of regulatory research. The regulatory body may also get research initiated by sponsoring academic institutes, universities etc. Research can also be carried by regulator- industry co-operation or by co-operation of regulators, industries, universities either from one country or from different countries. Among all modes of regulatory research, the direct mode is the most efficient way of conducting regulatory research because it improves the technical competence of regulators considerably which in turn leads to high quality safety reviews and improved regulation in general. The regulatory research based on the time frame of carrying out research may be classified into short-term or long-term.

Among others, the funding for regulatory body should cover the costs of research and development, consultancy services and international co-operation. Where the regulatory body levies charges for licenses, a direct link between the funds generated and the regulatory body's budget should be avoided. Regulatory body shall have authority to decide the funding for research activities. Regulatory body should have authority to liaise with regulatory bodies of other countries and with international organizations to carry out research. It helps to leverage budgets and avoid duplication of programmes.

Due to the complex nature of nuclear regulatory system, it is very difficult to assess the effectiveness of nuclear regulatory research programme. Effectiveness of regulatory research can be inferred from the following factors such as number of generic issues identified, number of generic issues resolved, increase in technical competence level of regulators, the difference between the time taken to assess the adequacy of the design and operational aspects of reactor with and without regulatory research, the reduction in the cost of regulation and the increase in the transparency of regulatory decision making. Though it would be difficult to identify the amount of contribution of regulatory research to regulatory effectiveness, the usefulness of regulatory research can be easily inferred from the factors mentioned above.

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Mr. S. K. Pradhan is a Mechanical Engineer from CET Bhubaneswar (2002). He completed his M.S. in Nuclear and Quantum Engineering as part of KINS-KAIST Nuclear Safety Master Programme at KAIST, Daejeon, Republic of Korea (2011). He is from 46th batch of BARC Training School. He has been with AERB since 2003. He is associated with thermal hydraulics safety analysis, safety review of NPPs and regulatory document development.

Dr. S. K. Gupta is an Electrical Engineer from IIT Madras (1971). He completed his Ph.D. in Energy Systems Engineering at IIT Bombay. He is from 15th batch of BARC Training School. He has been with AERB since 2004. He is associated with thermal hydraulics safety analysis, safety review of NPPs and regulatory document development.

Time Variant Reliability Analysis of Components Under Stochastic Loading

M. Hari Prasad, BARC, Mumbai
A. Srividya and A. K. Verma, IIT, Bombay, Mumbai

In general, the loading or stresses on structures and also the material properties are not constant, but changes with time. In the standard structural reliability analysis only the random variables are used in the failure probability calculations. If the loading process is stochastic in nature one should use random processes instead of random variables. As a result the failure probability is no longer just a single number, but also a function of the time. Hence, just mentioning a value for the failure probability does not give any meaning without specifying the period of time for which it was derived. There are two classes of random processes one is stationary and another one is non stationary random processes. In stationary processes the statistical properties (mean, standard deviation etc.,) do not change with time. Whereas in the case of non stationary processes these properties changes with time. If the random process is stationary then the failure probability obtained at each and every point of time will also be a constant and it doesn't change with time. But, if one considers the cumulative effect then it is increasing function of time. In the case of non stationary processes the failure probability at each and every point of time changes.

There are different ways in which the loading [1] can take place and it can be either discrete or continuous in nature. And also, the loading can be time invariant or time variant. Hence, there are four categories with respect to sample space and time space. The following classification is usually made with respect to loading actions:

- Permanent loading (self weight, earth pressure etc.)
- Variable loading (live loads, wind, snow etc.)

Exceptional loadings (impact, fire, explosion, avalanches.etc.)

In the case of permanent loads there is of course no need for time dependent modelling. It can well be modelled by a set of deterministic and random variables. For variable and exceptional loadings one has to develop time dependent models [3]. The appropriate time variant models for action parameters may vary very much depending on the nature of the load. Some typical and useful process models are (refer Fig. 1)

a. Random sequence
b. Point pulse process with random intervals
c. Rectangular wave process with random intervals
d. Continuous and differentiable process

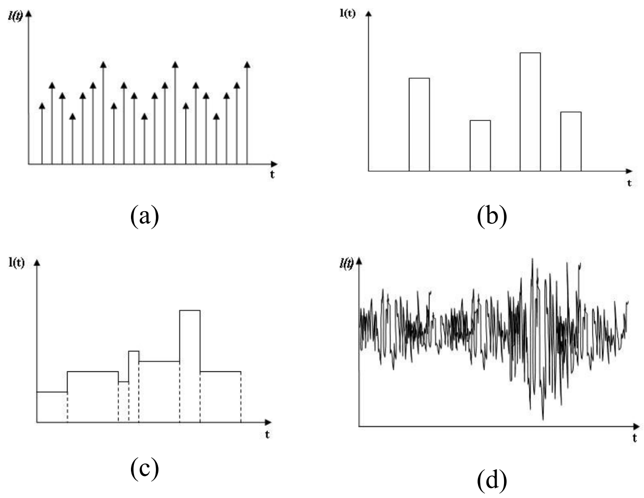

Fig. 1: Different types of loadings

In the continuous case (Fig. 2) if the loading process is considered as a stochastic process and if it satisfies the Ito stochastic differential equations given in the following equation, then one has to find the first time the random process crosses the moving barrier.

$$dX(t) = \mu dt + \sigma\, dW$$

where W is the standard Weiner process with zero mean and variance t while μ & σ are drift and diffusion terms, respectively.

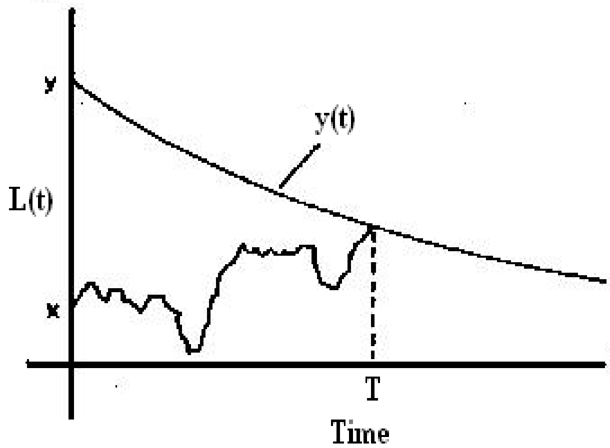

Fig. 2: The random process hits the moving barrier *Y(t)*, T is the first passage time

The first passage time [3]is also a random variable. If one knows the probability density function of the first passage time then the reliability function can be easily developed from the basic reliability concepts.

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Shri M. Hari Prasad joined Bhabha Atomic Research Centre in the year 2000 after completion of his M. Tech in Reliability Engineering from IIT-Bombay. He is now pursuing PhD in Reliability Engineering at IIT Bombay. He has 11 years of experience in the fields of System Reliability Analysis, Level 1 and Level 3 PSA analysis and Seismic PSA analysis. His areas of interest include dynamic reliability analysis, Structural Dynamics and Finite Element Analysis.

Reliability Analysis of Optocouplers using Physics of Failure Approach

Adithya Thaduri
Indian Institute of Technology Bombay, Mumbai

The reliability of electronic systems, used in nuclear power plants, is traditionally estimated with empirical databases such as MIL-HDBK-217, PRISM etc. These methods assign a constant failure rate to electronic devices, during their useful life. The constant failure rate assumption treats failures as random events. Currently, electronic reliability prediction is moving towards applying the physics of failure approach which considers information on process, technology, fabrication techniques, materials used, etc. This is essential in case of semiconductor technologies like CMOS where adequate data is not available for reliability prediction, but failure mechanisms are fairly well understood [1].

With this aim, as a first step, physics of failure approach was extended to optocouplers. Optocouplers are used at the isolation in circuitry for safety of signal conditioning unit from the measurement equipments. The main reason for application of optcouplers is its light as medium since it is resistant to input disturbances which provide safety to condition unit. It consists of LED at the input which converts the input signal to light and photo detector at the output which converts to this light signal to electrical signal. The device is properly isolated in order to reduce the noise in the light medium. Current Transfer Ratio (CTR), current transfer ratio, is the performance parameter of optocoupler, is the amount of output current derived from the amount of input current and normally expressed as a percent. Due to this degradation of CTR, the optocoupler fails to provide isolation and overall measurement system is turned off. Earlier studies present in literature indicated that degradation of optocoupler is due to mainly LED degradation.

Total electron flux emitted by LED degrades slightly over operating time of the device. At higher stress currents, change of light output increased over time. Main causes include reduction in emitter efficiency, decrease in transmission ratio, and reduction in responsiveness of photo detector or change in gain of amplifier which all are dependent on time. The critical cause is the result of electrical and thermal stressing of PN junction. Assuming degradation mechanism establishes a resistive shunt parallel to active PN Junction. At low values of input current, resistance path exhibits appreciable impact on the performance which offers low resistance. As current increases further, junction experiences low resistance which draws more current.

Important area of investigation is the light output test of LED, assembly area in die attach and wire bond. Temperature cycle is a more effective screen than stabilization bake. Temperature coefficient of expansion and low glass transition temperature of unfilled, clear plastics is much greater than that of the other components. To maintain reasonable device integrity requires temperature range of operation and stronger mechanical construction; some clear plastics build up mechanical stress on the encapsulated parts during curing. This stress has been likened to rapid, inconsistent degradation of IRED light output.

Although a filled plastic would stop these phenomena, the filler also spoils the light transmission properties of the plastic. The decrease in quantum efficiency of LEDs is the main reason for CTR degradation of optocouplers. Other less important causes of CTR degradation are a decrease in the transmission of the transparent epoxy, a change in sensitivity of the photodetector and a change in gain of the output amplifier. It is now known that the rate of CTR degradation is influenced by the materials and processing parameters used to manufacture the LED, and the junction temperature of the LED in addition to the current density through the LED.

Bajensco [2] and Lindquist [3] proposed model for CTR degradation from the stress parameters as input current and temperature. To define and quantify the accelerated testing stress parameters, two-stage Design Of Experiments (DOE) was carried out; one is for screening parameters and another is for implementation of these parameters. From the experimental analysis, it was found that increase in both input current and temperature degrade the performance of CTR. Stress levels for accelerated testing was done by DOE and experiment was carried out at several time intervals (See Figure 1). From the model defined, time to failure was calculated at user conditions at particular degradation rate [4]. Designer can choose the input parameters to fit for time to failure at particular degradation ratio. Response surface method was also studied to verify the model proposed.

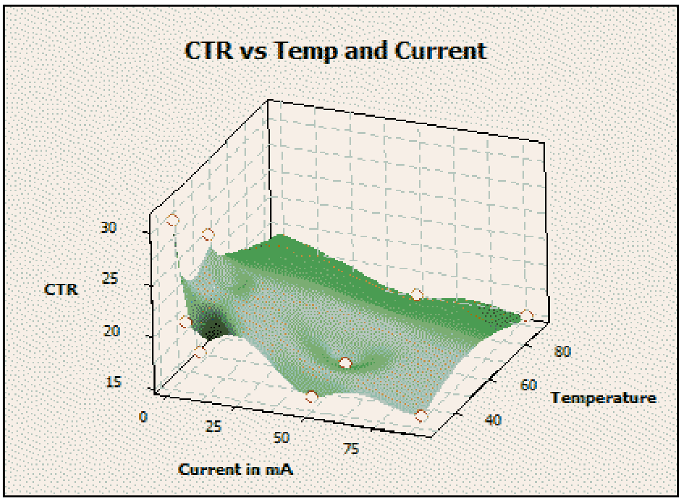

Fig. 1: Performance of CTR with current and temperature

The project, "Reliability Prediction of Electronic Components in the Context of Ensuring Nuclear Safety", under BRNS scheme is executed at IIT Bombay and describes common failure mechanisms- encountered in CMOS and BJT ICs and the efforts being taken to quantify these effects for devices such as optocoupler, CFD, instrumentation amplifier, inverter etc. Similar experiments will be extended to CMOS and BJT devices, by studying their failure mechanisms.

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Mr. Adithya Thaduri completed M.Tech in Reliability Engineering at IIT Bombay and B.Tech in Electronics and Instrumentation Engineering at Bapatla Engineering College. Currently he is Senior Research Fellow in Electrical Engineering Department at IIT Bombay. His areas of expertise include reliability engineering, failure analysis of semi conductor devices, digital VLSI design , simulation and fabrication of MEMS device, etc.

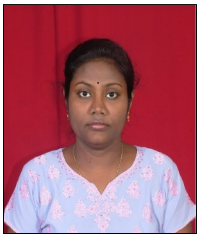
New Members

The society in its 7th meeting approved the following scientists / engineers as life members of SRESA. SRESA welcomes the new members and looks forward to their valuable contribution and support.

Shri. V. K. Patil joined BARC in the year 1992. His areas of expertise include software development using Pascal, Object Pascal, Borland Delphi, C, iFIX SCADA package, Computer hardware troubleshooting & maintenance. He has been involved in the development of Operator Information Display system software.

Dr. C. Senthil Kumar is a senior Scientific Officer at Safety Research Institute, Atomic Energy Regulatory Board, Kalpakkam. He has more than 20 years of research experience and is involved in reliability and probabilistic safety assessment (PSA) of nuclear power plants. Some of the areas of his interest include seismic safety assessment, passive system reliability, software reliability, real time systems.

Shri R. S. Rao joined Atomic Energy Regulatory Board in 2000 after completion of his M.Tech in Energy Systems Engineering from IIT-Bombay. He has been involved in the review of Level-1 and Level-2 PSAs. He has also been involved in the thermal hydraulics and severe accident review and analysis activities.



Smt. L. Srivani joined IGCAR, Kalpakkam in the year 1999 after completion of her B.Tech in Electronics and Communication Engineering. Her field of specialization includes digital hardware design and verification, Reliability and Level-1 PSA analysis and Synthetic benchmark circuits.

Book Review:

Name of the Book: Reliability Engineering and Risk Analysis—A Practical Guide
Authors: Mohammad Modarres, Mark Kaminskiy and Vasiliy Krivstov
Publisher: CRC Press, USA

This is the second edition of the book published in 2010. It provides a practical and comprehensive overview of reliability and risk analysis techniques. It is written keeping in mind students at undergraduate and graduate levels and practicing engineers. This edition has additional topics (compared to the earlier edition) covering probability plotting; maximum likelihood estimation of censored data; generalized renewal with applications; more detailed Bayesian estimation methods; estimation of probability bounds of availability of repairable units; models of physics of failure approach to life estimation; expanded discussion of uncertainty analysis. More emphasis is laid on introduction and explanation of practical methods and techniques used in reliability and risk studies, and discussions of their uses and limitations. The methods cover a wide range of topics used in reliability engineering and risk analysis activities.

This book introduces the concept of reliability and risk; presents the basic mathematics needed for reliability studies; discusses component reliability models, outlines the methods of data analysis; elaborates the methods for evaluation of reliability of systems and suggest methods for the assessment of availability and reliability of repairable systems. Special topics like physics-of-failure, human reliability, reliability centered maintenance, reliability growth models accelerated life testing, analysis of dependent failures, uncertainty analysis, use of expert opinion in estimating reliability parameters and probabilistic failure analysis are included. Finally, risk analysis with emphasis on quantitative risk assessment, probabilistic risk analysis and a case study are presented.

The authors are very highly qualified people in the area of nuclear and reliability engineering, statistical methods and reliability engineering. The presentation is very lucid and the concepts are illustrated with appropriate examples. For beginners, it is an excellent book. For reliability practitioners, it is a good reference.

Reviewer: Dr. V.V.S. Sanyasi Rao, BARC.

UPCOMING CONFERENCES

21st International Conference on Structural Mechanics in Reactor Technology (SMiRT 21)
Date: 6-11 November 2011;
Venue: India Habitat Centre, New Delhi

International Conference on Reliability, Safety and Security Engineeri (ICRSSE-2011)
Date: September 28-30, 2011;
Venue: Singapore **Website:** http://app.www.sg/

Industrial workshop on New Horizons in Nuclear Reactor Thernal Hydraulics & Safety
Date: 2-3, January 2012
Venue: Safety Research Institute, AERB, Kalpakkam, India

5th International Conference in Quality, Reliability and Information Technology
Date: 7-9 December 2011; **Venue**: Kathmandu, Nepal
Website: http://doee.ioe.edu.np/icqrit/

International Conference on Reliability and Structural Safety, ICRSS 2011;
Date: Dec 21-23, 2011, **Venue:** Phuket, Thailand
Website: http://www.waset.org/conferences/2011/phuket/icrss/

99th Session Indian Science Congress Association
Date: January 03-07, 2012, **Venue:** Bhubaneshwar
Website: http://www.sciencecongress.nic.in

International Symposium on Uncertainty & Safety Assessment and Management (ISEUSAM-2012)
Date: January 4-6, 2012 **Website:** http://www.becs.ac.in/

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Some of the Key Product details

Sr. No	Products/Company name	Application
1	Xilinx,Actel,Altera	FPGA Design, Simulation and Synthesis. VLSI Tools.
2	BDI 3000 Emulator Debugger from Abatron	Embedded Development Tools
3	OrCad/ PSPICE/ ALLEGRO from Cadence	PCB design, Layout and Simulation Tools
4	ETAP from OTI	ETAP a fully integrated Electrical Engineering software solutions including arc flash, load flow, short circuit, transient stability, relay coordination, cable ampacity, optimal power flow,
5	ANSYS	ANSYS MECHANICAL, STRUCTURAL, MULTIPHYSICS,EXPLICIT DYNAMICS, FATIGUE ANALYSIS
6	ZENI EDA	ASIC BACK-END Design Tool
7	Reliability from Reliasoft	Reliability Analysis Tool

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1	In House	PCB & FPGA design
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4	General Circuits LLC USA	ASIC Design, PCB Design ,Fabrication and ZENI EDA
5	NeST	Onsite and offshore software & Hardware Development Solution
6	Aayur Technologies, Bangalore	Integrated systems and solutions provider of Electro Mechanical Packaging for Electronics Display systems and Command Control Systems.

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Application for Membership of the Society

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