Summary Report

About Department/Center/School:

Reliability Engineering Centre, established in 1983, is the first and unique centre of excellence in India offering Masters' and research programs in Reliability Engineering. The conventional engineering branches mainly focus on design of systems for certain specific functional requirements. But in Reliability engineering, students are trained on how to design, predict, estimate, and demonstrate performance of a product throughout its mission life for failure free operation, which is also safe and easy to maintain deriving maximum benefits. In short, the Centre focuses on overall improvement in engineering skills of students by exposing them to theory and practices in Reliability engineering through its academic programs, involving students in research and consultancy projects for Industries and R & D organizations, (viz., BARC, DRDO, NPCIL, L&T, AERB, Vodaphone, Indian Army, ECIL, ISRO, Crompton & Greaves, Robert Bosch, GE, Covedien, TATA Motors, Secure Meters etc.), exposing students to life testing/ prediction/estimation/demonstration of engineering items, and encouraging for extracurricular activities.

1. Academic Programs (Range of Degrees and Disciplines):

a. M.Tech. Reliability Engineering
b. M.S. Reliability Engineering
c. Ph.D. Reliability Engineering

2. **Major 4-5 Thrust Areas of Research:**
Accelerated Life Testing, Condition Monitoring, Networks Reliability, Software Reliability,

3. Curriculum and Courses & Teaching Environment

Items	**Ratio/ Number**	**Items**	**Number/%**
Teacher-student Ratio	4/42	Average No. of students motivated (%) to opt of careers Eng/ Tech. Sectors UG/PG/PhD	NA/80/37
No. of Faculty members as on today	4	Average No. of students motivated (%) to opt of careers in Science sectors UG/PG/PhD	NA
Average No. of Tutorial Assistants	1	No. of teaching labs	2
No. of UG/DD students	NA	Average No. of students per experiments in core courses	3
No. of PG students/PhD students	29/13	No. of Students' workshops/``Tinkering'' Labs	NIL
Average no. of tutors with more than 100 students	NA	No. of new courses introduced	1
Average Students placements (%) (UG/DD/PG)	NA/NA/80	No. of New program introduced	NIL
No of major curriculum review in both UG & PG level	1	Undergraduate Vs PhD strength expressed as Percentage	NA
No of UG lab (teaching labs) developed/set-ups	NA	No of PG/research labs developed/new set up	2
No of E class rooms	NIL	No. of lab classes per week	2

Average No. of Course done per student for B. Tech/DD/M. Tech/Ph.D	NA/16/4.5	No. of core/elective/seminar/projects subjects taken for M.Tech respectively	7/6/2/2

4. Research and Development & its Environment

Items	**Number**	**Items**	**Number**	**Items**	**No.**
Total No. of Publications in Journals (2008-13)	59	Average no. of citation per paper	5.5	No of large interdisciplinary research projects	01
Total No. of Publications in Conference & Symposium	31	Average Journal publication per year	12	Number of Int. conf./workshops attended by students	24
Total No of Books & e-books published	2	h-Index of the department since 2008/overall h-index in Scopus		No. of PDF hired in the Institute	NIL
Total No of Edited Conference Proceedings/book chapters	2	Number of papers with citation more that the average no. of citation of the Journals	50	No. of international Students as PhDs/PDFs	NIL
Total No. of Technology Developed/transferred		No. of recognitions & Awards, fellows etc to faculty/students (provide break up if necessary)	10/3	No. of International visiting researchers /adjunct faculty stayed here for at least a week	02
Total No. of Patents Filed/Obtained	1	Average Retention(%) of Young faculty for at least 10 years	100	No. of short courses/workshops /conf. organized with international participations	NIL
Total No. of Copyright Filed/Obtained		No. of Sponsored research Project /fund(lakh) generated from non-internal source	4/84	Average No. of PhD granted per year	*02*
No. of Publications per Faculty/Masters/PhD students	15/2/4.5	No. of Consultancy /fund (lakh) generated from non-internal source	20/216	Average No. of PhD Granted per year per faculty	*0.5*
No. of Publications per Faculty/Masters/PhD students in Top Ten Journals as Identified by the department	14/1/4	No of Internal and external Collaborations research papers/research projects/PhD students	8/1/2	Patent granted per faculty	*0.25*

Average No. of Citation per faculty per year	15	No of M. Tech students motivated into pursuing PhD/PhD graduates motivated to pursue career in Academics(abroad or IIT etc)	12/9	Number of articles in collaborations with Ten countries*	NIL
Ranking of the department in terms of average citations per paper within the Institute	32	Ranking of the department in terms of total number of Journal publications within the Institute/publications per faculty	30/18	No of articles of the dept. contributing towards h-index of the Institute since 2008	*4*

5. External Stakeholder Engagement and others

Items	**Number**	**Amount Lakh**
No. of PhD/Master students' thesis funded by Industries	04/30	
Total number of Industry sponsored projects and its income (Lakh)	04	84
No. of Curriculum Development Initiative for Industries	02	
No of Technology transfer/adopted by Industry/Labs	NIL	
No. of Nationally relevant research projects	01	53
No of Policy inputs/consultancies provided	20	216
No. of Research grant and seed money from internal savings of the Institute per young faculty of the department and its total fund	2	10
No. of Community Relevant projects	NIL	

6. Vision for the Future (in brief):

(a) Departments/centers/schools should spell out its Mission and Vision Statements,

In line with the Mission and Vision 2020 of the Institute, we aspire to become the leader and first to be approached by Indian organizations for setting and achieving reliability, availability, maintainability and safety/security (RAMS) goal for engineering systems. We also aspire to be a truly interdisciplinary research centre.

(b) Plans for future to achieve the projected goals

We plan to achieve this by:

- Providing Training, consultancy and research support to various organizations.
- Achieving a close industry and institute collaborations through projects and courses.
- Applying research methods through development of 'easy to use' tools and systems for organizations as per their need.
- Educating and training to the management and engineers in organizations to bring awareness and knowledge about RAMS concepts to reduce the dependency of Indian organizations on foreign vendors and experts.
- Laboratory development
- Carrying out state-of-the-art research in area of RAMS.

- Become a multi-disciplinary centre in true sense through induction of faculties from most of the basic engineering disciplines and carrying out cross departmental research and training activities.

(c) Measures adopted towards above

- Contacted a number of organizations such as Defence Institute of Quality Assurance, Indian Railways, Larson and Tubro, etc. for organizing short/long courses on functional areas of reliability engineering.
- Development of a condition monitoring laboratory is in progress.
- One faculty member has joined the department with Information Technology background. We have now faculty members with Mechanical, Electrical, and Electronics basic degrees, making the centre interdisciplinary. We plan to take more faculty members from Mining, Civil, Chemical, Industrial Engineering backgrounds to make it more interdisciplinary Centre.
- Measures have been taken to induct students (both MTech. and PhD) from several engineering branches.

7. External peer review of the Dept./centre/schools (in brief):

(a) Date of the peer review: 11 April 2011

(b) Name of the Experts involved and their affiliations in short:

Dr. Ashok Despande(University of Pune), Dr. P.V. Varde (BARC, Mumbai), Dr. R.B. Misra (REC, IIT Kharagpur), Dr. S.K. Chaturvedi (REC, IIT Kharagpur), Dr. N.K. Goyal (REC, IIT Kharagpur), Dr. M.K. Tiwari (IE&M, IIT Kharagpur), Dr. K.K. Ray (Met Engg, IIT Kharagpur), Dr. N.K. Kishore (EE, IIT Kharagpur), Dr. U.C. Gupta (Maths, IIT Kharagpur), and Dr. V.N.A. Naikan (Head REC, IIT Kharagpur)

(c) Overall recommendations of the peer review committee: Strengths, weaknesses, suggestions and comments

The peer review committee meeting ended with following concluding remarks:

1. The committee found centre's progress satisfactory within the available resources in serving the field of reliability engineering and the post graduate program.
2. Proactive efforts need to be taken for faculty recruitment.
3. The Centre is not able to meet industry demands therefore its student and faculty strength need to be increased.
4. Due to faculty shortage, re-appointment of superannuating faculty should be explored.
5. Collaboration with other departments will be beneficial.

(d) Measures adopted/action taken at the department level to address the recommendations of the peer review report:

1. One faculty member is recruited to increase the faculty strength
2. Research scholars from other IITs whose PhD thesis are evaluated by our faculty members are encouraged to apply for faculty positions in the Centre
3. Process of recruitment of more faculty members is progressing
4. Regular seminar series by research scholars is implemented for improving the standard of research program and the communication skill of scholars

5. MTech students are encouraged to do their final year projects partly in industries. Several students have done their projects accordingly on industrial problems. This has also improved the industry-Institute interaction.
6. The centre has organized several short courses for industries, defence organizations and others.
7. The centre has collaborated with Mechanical engineering, Industrial engineering and physics department in the form of joint guidance of PhD students, keeping in line with the recommendation of the peer review committee.
8. The centre has collaborated with DRDO, ISRO, BARC, and Indian Army, BHEL, Indian Railways and others on nationally important projects.
9. One faculty member has visited University of Maryland for six months as visiting professor and to explore possible research/academic collaboration.

8. **Strengths, Weaknesses, Opportunities & Threats (SWOT) Analysis of the Department**

STRENGTHS	**OPPORTUNITIES**
• Strong M. Tech. and Ph.D. program with 100% employment in spite of being an interdisciplinary course. • Among the IITs it is the only established PG program in Reliability Engineering. • The program is financially sustainable considering centre's activities in Sponsored research, consultancy and short term courses with less number of faculty members.	• Possibility of dual degree course in reliability engineering. • Collaboration with other departments in the institute. • Collaboration with R&D organizations and institutes in the country. • Collaboration with international institutes.
WEAKNESSES • Shortage of faculty, which is main driving force, is restricting to meet market demands. • The location of centre in the campus puts it to disadvantages as infrastructure is not enough for further expansion of the centre. • Diversity in faculty specialization needs to be improved by adding faculty members from chemical, civil, material/metallurgy etc. background. Existing faculty are mainly from Electrical and Mechanical Sciences.	**THREATS** At present no threats are found considering recent growth of the department and rising demand of reliability engineering in industries.

9. Additional Information, if any

***Note: Ten countries: US, UK, Germany, Japan, Canada, France, Italy, Australia, Singapore, South Korea (optional :China may be replaced with anyone if department wants)**

Important Highlights

Overview/Importance of the Centre

Reliability Engineering Centre (REC), established in 1983, is the first, only and unique centre of excellence in India offering Masters' and research programs in Reliability Engineering. In the present scenario of global competition, Reliability Engineering plays a vital role in design, maintenance, safety/security and management of engineering systems. Reliability is considered one of the most important performance assessment index for most of the industrial products, processes and services.

Reliability Engineering focuses on systematic study and analysis of failures, and developing methods for eliminating them or at least minimizing their occurrence with minimum damage to system and environment. It is truly interdisciplinary in nature since failures are not limited to any particular types of engineering systems, processes and services. It is in effect a specialization sought by all engineering practitioners and researchers.

Reliability Engineering is an inter-disciplinary area and plays an important role at different stages of product life cycle starting from conceptual design, manufacturing, operation, maintenance, replacements to disposal. It systematically designs, studies failure process, finds out the root causes, suggests improvements and quantifies the product performance over a period of its mission time in contrast to the conventional engineering branches, which mainly focus on design of systems for certain specific functional requirements. But in Reliability engineering, students are trained on how to design, predict, estimate, and demonstrate performance of a product throughout its mission life for failure free operation, which is also safe and easy to maintain deriving maximum benefits.

Since its inception, the centre has been conducting academic programs in M. Tech., and Ph. D. apart from offering certain electives to all other branches of U. G. students of the Institute. Presently, REC has 4 faculty members, 17 M.Tech, and 15 Ph.D. students. About 50% of our students are sponsored by Defence establishments and other manufacturing industries. The centre has conferred Ph.D. degrees to 29 students, M.S. degrees to 2 student, and M.Tech. degrees to about 350 students. The alumni of the centre have contributed in several mission programmes of national importance and also in the growth of industry in India and abroad.

Vision and Mission of the Centre

The Reliability Engineering Centre embodies to act as a repository of knowledge and practices covering the broad domain of Reliability, Availability, Maintainability, Safety and Quality Engineering and to nurture the students through teaching, research and industrial partnership. Our focus is on the following.

- Achieve global excellence and create local impact in research and teaching in reliability and allied areas. Design and develop contemporary courses in line with the new developments in academics internationally as well as tailor-made for the companies to meet their emerging requirements.

- Enhance the analytical skill and problem solving ability of the students through innovative design and conduct of teaching, laboratory experiments, case studies, seminars and colloquium.
- Pursue research in the emerging fields of Reliability Engineering through enhancing core competence internally as well as through collaboration with internationally renowned academic institutions worldwide.
- Interact with industries through consultancy services for real life problem solving.

Details of Present Academic Programs and syllabus

Name of the Program	Duration (yrs)	Admission Process
M Tech	2	GATE, QIP, Industry sponsored
MS	2	Under Sponsored Project
PhD	3+	Institute Scholar, QIP, Industry Sponsored

Centre has been periodically reviewing its academic and research programmes. The centre has organized a peer review committee meeting on 11 April, 2011 to critically analyze the academic courses, research, laboratory, publication and other activities. The peer review committee consisting of Prof. Ashok Deshpande (University of Pune), Dr. P.V. Varde (BARC Mumbai), Prof. M.K. Tiwari (Department of Industrial Engineering & Management), Prof. N.K. Kishore (Department of Electrical Engineering), Professor K.K. Ray (Department of Metallurgical Engineering), Prof. U.C. Gupta (Department of Mathematics) and faculty members of the Centre brainstormed various issues and suggested recommendations for their implementation.

Possible Areas of Research

- Reliability Modeling of Engineering Systems
- Maintenance Engineering
- Network Reliability
- Reliability Engineering
- Maintenance Engineering & Management
- Probabilistic Risk/Safety Assessment
- Software Reliability
- Reliability Design
- Communication Reliability
- Electronic System Reliability
- Accelerated Life Testing
- Software Safety
- Reliability Testing Demonstration

Faculty Members of the Centre

#	Name	Designation	Area of Specialisation
1	Dr. V. N. A. Naikan	Professor	Reliability & Quality, Condition Monitoring, System Simulation
2	Dr. S. K. Chaturvedi	Associate Professor	System Reliability Modelling and Analysis, Reliability Data Analysis, Reliability Estimation, Maintenance Engineering
3	Dr. N. K. Goyal	Assistant Professor	System Reliability (Software, Network, Electronic), Probabilistic Risk/Safety Assessment, Life Testing
4	Dr. M. Sarma	Assistant Professor	Cloud Computing, Software Reliability

Research Activities of the Centre

Ongoing Sponsored Research & Consultancy Projects

- Rotating Machinery Fault Simulation Lab (MHRD)
- Design of Minimal Cost Backbone Network Layout for Given Capacity and Reliability Requirements (VEICET, IIT Kharagpur)
- Standardization of Virtual Keyboards in Indic Languages (DIT, MICT, Govt. of India)
- A New Framework for Testing Object-Oriented Programs (DST, New Delhi)
- Reliability Modeling & Prediction of Process Control System (DRDO Panagarh)
- RAMS for Garuda-III
- Reliability Prediction and Testing of Electrical Products (Crompton and Greaves, Mumbai)
- Reliability analysis of Permanent magnet machine set and its associated controller (BHEL)
- Hazard Identification and Risk Assessment of Industrial Activities (ITR)
- Reliability Assessment and Improvement (Secure Motor Ltd.)

Conferences (International/National organized), Short Term Training Programmes (in Last 5 Years), Publications (Papers in Journals and Conferences (in Last 5 Years) and Books/Book Chapters)

- Conferences organized: International conferences 3 and national conference 1
- Short Term Training Programmes organized: 23
- Publications
    - Journal Papers (National and International): 67
    - Conference Papers: 32
    - Books/Book Chapters: 8

Resources of the Centre

Laboratory Facilities

Environmental Lab: Various equipments used for testing reliability of components and devices for industry and defence applications are installed and operated as part of reliability demonstration tests. Major equipments that constitute the environmental lab are listed below:

- Dry Heat Chamber
- Humidity Chamber
- Salt Spray Chamber
- Cold Chamber
- Burn-in Chamber
- Thermal Shock Chamber
- FFT Analyzer
- Bump Test machine
- Endurance and Life test Machines
- Mechanical Fault Simulator Kit

Mechanical Fault Simulator Kit

Life Testing Lab

Thermal Shock Chamber

Endurance and Life test Machines

Dry Heat Chamber

Burn-in Chamber

Simulation Lab: The Simulation Lab is well equipped with the latest Configuration of Computers & other peripherals. The students are well exposed to various software as a part of curriculum and research activities.

ALTA BlockSim FMEA Accelerator CASRE

RELEX MATLAB Risk Spectrum Minitab

Simulation Lab

Library

The centre has a functional library in which several books on reliability engineering, quality engineering and allied subjects are available. The library has also collection of M. Tech, M.S., and Ph. D theses of all the past students. Library is open to members of the faculty, students of the centre and to the students/researchers from other departments/institutions with a prior permission from the Head of Centre.

Placement Scenario of the Centre

All the past and present M. Tech., M. S. and Ph. D. students passing out from the centre are well placed in reputed organizations such as BARC, Bloom Energy, Crompton & Greaves, DRDO, Eaton, Entity Solutions, GE, GM, Goodrich, HCL, Honeywell, IBM, INFOSYS, ISRO, LM Wind

Power, Maruti Udhyog, NPCIL, SATYAM, TATA Steel, TCS, Time Tooth, WIPRO, and many more.

Future Directions

- Integrated Dual Degree Programme with B. Tech. (Hons.) in conventional branches of Engineering and M. Tech. in Reliability Engineering.
- Strengthening of the Post Graduate Program – explore the possibility of M. Tech. in Software Reliability.
- Post Doctoral Program to be strengthened.
- Strengthening the interaction between REC and Industry.
- Introducing new courses such as safety, engineering asset management.
- Develop engineering failure analysis lab.