Chair’s Note

Marc Bangart
Chair, Reliability Division of ASQ
marc@asqrd.org
Q1, 2016 Newsletter

Chair’s Message

As we approach the half-way point in 2016, the Reliability Division (RD) team has started strategic planning for 2017 and beyond. As part of our planning process it is critical to ensure we understand your needs, continue to focus on providing member value, and also find innovative ways to ensure our continued expansion. To this end the division is launching several initiatives. Our initiatives are broad and include development of online courses, ASQrd.org improvements and technical focus groups (to name a few). Our new search mechanism on ASQrd.org will go live shortly. The new search feature will allow easy searching of conference proceedings similar to online catalogs at university libraries. We are also in the process of launching several technical focus groups to include a focus on safety and security in complex systems. We would love to hear your input to our strategic plan. The division will send out an extensive survey later this year. Please watch your email and participate to ensure your voice is heard! Please email me (marc@asqrd.org) if you are interested in getting involved or have any comments. Thank you for your continued membership!
Division Budget Update

ASQ-RD Treasurer’s Financial Report for 1st Qtr 2016
James Breneman, 2016 ASQ-RD Treasurer (weibullman@gmail.com)

The division continued to have a strong balance sheet (Statement of Financial Position) with over $40,400 in its checking and ASQ Investment Program accounts. Investments in ASQ’s reserve fund program were over $89,700. There is also a $3,500 advance for ASTR '16 and $3,500 advance for RAMS’17 seed monies.

Membership revenue for the four months ended April 30, 2016 was 6,966.
Investment Income for the four months ended April 30, 2016 was $1,664.
Total division revenue from all sources for the four months ended April 30, 2016 was $9,330.

Expenses for the four months ended April 30, 2016 were $33,532.
The net deficit (net loss) for the four months ended April 30, 2016 was $24,201.

A cash breakdown of the Income and spending categories is on the next page.

The 2016 Budget is illustrated to the right:

1. Note that income from “Education/Courses” will be down from 2015.
2. Spending on on-line education in reliability will increase in 2015.
3. Travel will continue to be our largest expense.
4. Income from advertising is expected to increase the remainder of the year.

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ASQ-RD Income through April 30, 2016

INCOME $$
- Transfer from Savings 10,000.00 $
- 4000 Member Dues 6,966.00 $
- 4521 Education Courses 700.00 $
- 4990 Miscellaneous 7,153.80 $
TOTAL INCOME 24,819.80 $

EXPENSES $$
- 5100 Printing & Production 128.34 $
- 5400 Postage & Express 785.49 $
- 5500 Contract & Professional 7,306.01 $
- 5573 Advertising 1,381.13 $
- 5675 Rentals 1,161.26 $
- 5800 Meetings & Meals 10,222.53 $
- 5900 Travel 8,359.14 $
- 6100 Telephone & Website 150.00 $
- 6200 Joint Ventures-Partner Payments 7,330.40 $
TOTAL EXPENSES 36,824.30 $
Building on today’s technology innovations to meet the needs of the modern workplace, Relyence offers an all-new approach to quality and reliability analysis.

Check out our tools to see the Relyence difference. Our complete cloud solutions offer the unparalleled ease and security of the Microsoft Cloud. You simply log in with your web browser and get to work! Our on-premise solutions provide the same high-powered features and functions, with the ability to install locally if you choose.

With Relyence, you have any time, any place, any device flexibility. Built with the needs of today’s collaborative workplace in mind, Relyence allows you the freedom to work however you choose, with the workflow you see fit. PC, laptop, tablet, smartphone – Relyence is designed for today’s fast-paced, virtual workplace.

Take us for a free trial test run today! We’re convinced you’ll see the power awaiting you when you choose to join the Relyence revolution.

Check out our online trial today at www.relyence.com
There’s nothing to install. Just sign up and you’re in!
ReliaSoft Corporation is the global leader in reliability engineering software, training and services that combine the latest theoretical advances with essential tools for the practitioner in the field. We are dedicated to meeting the reliability, quality and maintenance planning needs of product manufacturers and equipment operators worldwide.

**SOFTWARE**

Acclaimed for their ease of use, analytical power and unparalleled technical support, ReliaSoft’s software facilitates a comprehensive set of reliability-related analysis techniques. The *Synthesis Platform*® facilitates intelligent integration between analysis tools.

- **Weibull++**
  - Life data analysis
- **ALTA**
  - Accelerated life testing data analysis
- **DOE++**
  - Experiment design and analysis
- **RGA**
  - Reliability growth analysis
- **BlockSim**
  - System analysis using block diagrams or fault trees
- **RENO**
  - Visual stochastic event simulation and risk analysis
- **iPredICT**
  - Standards based reliability prediction
- **XFMEA**
  - FMEA/FMECA and related analyses
- **RCM++**
  - Reliability centered maintenance analysis
- **RBI**
  - Risk based inspection analysis
- **MPC**
  - MSG-3 aircraft systems and powerplant analysis
- **XFRACAS**
  - Web-based FRCA/FRACAS and related activities
- **Orion eAPI**
  - Web-based asset performance management
- **Enterprise Portal**
  - Web-based Synthesis Portal

**EDUCATION**

ReliaSoft offers an extensive curriculum of reliability training courses that provide thorough coverage of the underlying principles and theory as well as the applicable software. The complete course list and calendar of upcoming public seminars are published on the web.

**CONSULTING**

ReliaSoft’s expert reliability consulting services team offers a uniquely powerful combination of industry insight, unparalleled subject mastery and, most important of all, direct access to all of ReliaSoft’s global resources, expertise and contacts.

Prenscia Access

Flexible access to engineering software for durability, reliability and maintenance

Prenscia Access is a unified, token-based licensing model that provides annual leased access to any combination of nCode and ReliaSoft desktop applications.

Upgrade your organization’s toolkit
Prenscia Access allows any number of users to run any configuration of applications — limited only by available tokens.

Unite your engineering processes
nCode software streamlines test and CAE durability processes, and ReliaSoft’s Synthesis Platform leverages data from all reliability activities.

Save money across the enterprise
Every engineer can utilize any or all nCode or ReliaSoft desktop applications at a fraction of the cost of individual licenses.

Keep every user’s software up-to-date
All version upgrades and new desktop application releases are included with the Prenscia Access license.
The 63rd Annual Reliability and Maintainability Symposium

The Annual Reliability and Maintainability Symposium (RAMS®) is a yearly gathering of the product assurance disciplines where training, tutorials, and the latest technical practices, procedures, and results are presented in easy-to-utilize forums and proceedings.

RAMS® consistently pushes the leading edge of our discipline and profession through published papers, informative tutorials, excellent networking and product demonstrations.

Coupled with our RAMS® Vendor trade show, RAMS® continues to be one of the most comprehensive gatherings of Product Assurance professionals available in today’s competitive business environment.

We focus on providing real-world value for commercial and government applications through succinct delivery of the latest techniques and business practices.

We understand what it takes to succeed in today’s market place, as our Symposium is organized and staffed by over 50 individuals, most volunteers, who are currently supporting these disciplines in some form or fashion.

Mission Statement

The Reliability and Maintainability Symposium (RAMS) attracts leading Reliability and Maintainability experts from across industry, academia, and the U.S. Government. The topics addressed are broad, including R&M requirements, mission critical design and acquisition areas aimed at policies, technologies, lessons learned, modeling, simulation and training.

RAMS helps government and industry leaders become better partners by bringing producers and consumers of reliable and maintainable products and services together to discuss and engage on a host of topics such as achieving affordable reliability and maintainability programs, controlling reliability test costs throughout the life-cycle, incentivizing industry in reliability and maintainability, improving reliability process efficiency and payback, and promoting more effective competition.

RAMS offers training tutorials and reliability certification exams for improving the acumen and enhancing the credentials of personnel at the symposium. Providing networking, education and training opportunities helps assure the readiness levels of all personnel so they are the most efficient in delivering and sustaining effective mission critical reliability and maintainability programs.

Join Us In Orlando!
Accelerated Life Test (ALT) — details

Day: Tuesday, September 27, 8:00am–5:00 pm

Objective

The successful student will understand how to use accelerated test principles that can improve hardware reliability for systems. Practical design techniques are encouraged with useful examples and case histories that supplement the theory. Design engineers and their managers who are responsible for design and development of long-lived systems. ALT can be a costly and time consuming activity, it is best to get it right the first time.

This seminar begins with basic theory and expands with the practical examples to cover a wide range of problems with setting-up and analyzing an ALT. ALT is actually a series of tests that can uncover failure modes and hidden flaws before a product is released. Learn easy and practical ways to approach a number of common reliability problems. This course is engineering oriented.
To find out more about any of these courses and to register for one or more, go to url:
http://www.asqrd.org/2016-courses/

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<th>Dates</th>
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<th>Courses</th>
<th>Instructor(s)</th>
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<td>August</td>
<td>Charlotte, NC</td>
<td>-CRE Preparation Course (two day)</td>
<td>Jim Breneman / Mohammad Pourgoil-Mohammad</td>
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<tr>
<td>September</td>
<td>Pensacola Beach, FL @ ASTR</td>
<td>-Accelerated Life Testing</td>
<td>Jim McLinn.</td>
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ASQ-Reliability Division wins Silver PAR Award for 2015

On behalf of the Performance Awards & Recognition (PAR) committee, we want to thank you for all of the hard work your leadership team provided to the division members this past year, as well as ASQ as a whole.

We are pleased to announce that the Reliability Division has received the Silver award recognition for 2015. This level was achieved by meeting the good standing requirements as well as meeting or exceeding the Member Leader Engagement and Retention & Growth metrics. Attached you will find artwork that can be used within your division to honor and promote your member unit’s PAR success in 2015.

Again, congratulations to everyone at the Reliability Division for your achievements. We are proud of your service to ASQ, and continue to look forward to what is ahead from your members.

With great thanks,
## Call for Instructors

The Division is looking to expand its cadre of Reliability and Maintainability instructors! If you are interested in teaching and reside in the USA or Europe please send your resume and course abstract to our education chair, Trevor Craney at trevor.craney@shell.com. Instructors may be required to provide a short sample course via WebEx.

### Call for Papers


Continuing in 2015-2016 & 2016-2017, the ASQ Reliability Division will administer a $1000 annual award for the best Reliability focused paper published in Quality Engineering. Published papers will be evaluated for the four issues on the July-June calendar.

Note – to be eligible for the award, at least one of the authors for a paper must be a member of the ASQ Reliability Division or hold a valid subscription to www.ASQRD.org when their paper is published.

For more information: Rong.Pan@asu.edu

To submit papers for publication: http://mc.manuscriptcentral.com/lqen
Upcoming Virtual Courses

Are you looking for available training opportunities that you can take advantage of without leaving your office? ASQ offers virtual courses to fit your training needs.

Virtual courses bring quality training solutions to your computer through valuable instructor-led classroom time. Allowing you to reap all the benefits of instructor led training and save on travel expenses and accommodations.

3 New Virtual Courses

Whether you’re new to quality and learning fundamental concepts or wanting to affect change in your organization, these three new fundamental courses will train you on how to begin your journey in quality. They will promote mastery of the fundamental concepts and practices of quality improvement.

Quality Concepts
July 27, 2016 / 08:00 am – 01:15 pm CST

Team Basics
July 28, 2016 / 08:00 am – 11:40 am CST

Continuous Improvement Techniques
August 2, 2016 / 08:00 am – 01:00 pm CST

Additional Virtual Courses

The Innovation Imperative
June 16, 2016 / 09:00 am – 05:00 pm CST

Failure Modes and Effects Analysis -- Process
July 12, 2016 / 08:00 am – 03:30 pm CST

Consultant's Boot Camp
July 14, 2016 / 09:00 am – 11:30 am CST

Lean for Service
July 19 – 20, 2016

Please register for ASQ TCC event June 2016 - Innovation Division on Jun 14, 2016 12:00 PM EDT at: https://attendee.gotowebinar.com/register/7489948348885512962

The ASQ Technical Communities Council is sponsoring this special one hour presentation that highlights the various divisions and their contribution to the global Quality community. This months featured division: Innovation Division

After registering, you will receive a confirmation email containing information about joining the webinar.
Have you noticed our “BLOG” area?

Go to ASQRD.ORG>HOME>Our Blog

Updated from all our Social Media sources on a daily basis… one-stop shopping for Reliability news!!
### English webinars:

1. **Test sampling and retesting for design changes**, June 2016, Andre Kleyner
2. **System Theoretic Process Analysis (STPA)**, July 2016, John Thomas
5. **Software FMEA**, October 2016, Ann Marie Neufe
6. **Weibull Analysis II**, November 2016, Jim Breneman
7. **Sample Size considerations in Statistical Experiments**, December 2016, Jorge Luis Romeu

*English series webinars always run at the same time on the same day; 2nd Thursday of the month at noon EDT

### Chinese Seminar:

1. **MULTI-OBJECTIVE AND MULTI-STAGE RELIABILITY GROWTH PLANNING IN EARLY PRODUCT DEVELOPMENT STAGE** (基于多目标多阶段的可靠性增长设计和优化建模), JUNE 12, 2016, 10AM BEIJING TIME.

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**ASQ- Reliability Division Webinar Series**

Reliability division offers free Webinars in English, Spanish, and Chinese featuring leading international practitioners, academicians, and consultants. Enhance your reliability knowledge. For more information, click here: [http://asqrd.org/webinars/](http://asqrd.org/webinars/)

The ASQ Reliability Division Webinar Series remains popular. Since the Webinar and Short Course programs were first offered in November 2010, the Reliability Division has provided 155 webinars providing nearly 13660 hours of professional development to its members at no cost. The most recent topics included webinars on:

- Finding Causes that Checklists Don't Find
- Effective Reliability Test Plan Development
- Empirical Limit Testing, The Benefits Of Discovery and Comparisons Instead of Assumptions and Predictions

In addition, to date we have provided Recertification Units RU’s to over 5835 individuals.

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**Webinar Outreach**

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<tr>
<td>David Auda</td>
<td>Kiruthika Sundarrajan</td>
</tr>
<tr>
<td><a href="mailto:davidauda@yahoo.com">davidauda@yahoo.com</a></td>
<td><a href="mailto:kiru31@yahoo.com">kiru31@yahoo.com</a></td>
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<th>Video Editor</th>
<th>Webinar Support</th>
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<td>Norma Antunano <a href="mailto:normaantu@aol.com">normaantu@aol.com</a></td>
<td>Mark Durivage <a href="mailto:mdurivage@hotmail.com">mdurivage@hotmail.com</a></td>
<td>Ward Baun <a href="mailto:wardbaun@gmail.com">wardbaun@gmail.com</a></td>
<td>Elaheh Rabiei <a href="mailto:elirab@umd.edu">elirab@umd.edu</a></td>
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For previously recorded webinars on topics relevant to reliability engineers delivered by subject matter experts. Visit: [http://www.asqrd.org/past-webinars](http://www.asqrd.org/past-webinars)
ASQ Learning Institute™ Spring Training

The ASQ Learning Institute™ provides you with career enhancing training to help you make an impact in your professional path and your organization. Take advantage of member pricing, and register for one of these upcoming courses. To register, click here or call 800-248-1946 and provide promo code MFGEM.

Onsite Training

Customize ASQ learning to meet your organization's unique needs and eliminate travel expenses with on-site training.

Courses

Certified Quality Engineer Certification Preparation
Failure Modes and Effects Analysis -- Design
Failure Modes and Effects Analysis -- Process
Lean Six Sigma Black Belt Training
Lean Six Sigma Green Belt Training
2014 Learning Institute Training Catalog

International Courses

See ASQ courses offered outside of the United States and Canada.

CRE Exam Information and Facts

Current CRE statistics:

The total number of CREs as of the March 2015 exam was 5,961. Local ASQ Sections and international organizations host exams all over the world. You will be asked to designate a preferred examination site on your application. If you are not a member of ASQ, please find the Section that is closest to your location. If you live in a country other than the United States, Canada or Mexico, international certification affiliates administer certification exams. Find an international certification exam location. ASQ will make every effort to accommodate your request. ASQ offers some translated certification exam locations.

The ASQ certification exam dates (by type of certification) is at:

http://prdweb.asq.org/certification/control/dates
ASQ-RD Membership is climbing!

While off to a rocky several years, ASQ-RD membership now seems to be on a upward slope; especially since late 2013.

Possible reasons are the ASQ-RD webinars, publications in Reliability, and Social media to better inform Reliability professionals of upcoming events, new techniques, ASQ-RD website for instant access to information and our instructor-led course offerings. Whatever may be the cause(s), we on the ASQ-RD leadership team will continue to look for better ways to inform, educate, and drive home the importance of Reliability as a vital feature

Tim Gaens, Membership Chair
The Regional Councilor effort continues to provide outreach at the local level and was an important part of the ASQ Reliability Division receiving a Silver Award from the ASQ Performance Awards & Recognition Committee in 2015. For 2016 year to date, Regional Councilors have been involved in 15 engagements. Keep up the great work!

You will notice on the following pages of our roster that some people on our Regional Councilor team have changed. We have some new volunteers join and some folks have moved on to serve the division in different ways or are no longer able to serve. We welcome our new Regional Councilors: Ha Dao in Region 9 and Rabia Muammar in Jordan.

We are recruiting for additional Regional Councilors and would welcome anyone in any location but we are specifically recruiting for locations where we do not have a Regional Councilor:
- International Locations
- Region 2 upstate New York and northern Pennsylvania
- Region 3 New York/New Jersey metro area and northern New Jersey
- Region 7 southern California, southern Nevada, Arizona
- Region 14B northern Texas, Oklahoma, Arkansas
- Region 15B eastern Louisiana, Mississippi, Alabama

We welcome Rabia Muammar who is our new Regional Councilor for Jordan.

Dan Burrows, Regional Councilor Coordinator (See next two pages for Regional Councilor details)

Juran & Deming —The Kings of Quality

Joseph Juran (1904-2008) and W. Edwards Deming (1900-93), the two most influential thinkers behind the total-quality movement, both launched their careers a few years apart at Western Electric, which used Statistical quality-control techniques pioneered at Bell Labs to build reliable telephones. And both gained acclaim while on loan to the government during World War II. The irony is, Japanese execs heeded the lessons of total quality ahead of American managers.

In 1969, JUSE asked Juran to lend his name to Japan's top quality award, a sort of super-Deming Prize for companies that maintain the highest quality for five years running. JUSE deemed Juran's vision of top-to-bottom quality management even more important than Deming's manufacturing insights. Juran demurred—a decision he later regretted. So what could have been the Juran Medal is instead called the Japan Quality Control Medal. There is a Joseph Juran Medal, though. It's awarded by the American Society for Quality. Juran personally presented the first one in 2001 to Robert W. Galvin, then head of Motorola Inc.'s executive committee.

Joseph Juran

W. Edwards Deming
## Regional Councilors

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<tr>
<th>ASQ Region</th>
<th>Regional Councilor</th>
</tr>
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<tr>
<td>1</td>
<td>Mohammad Pourgol-Mohammad <a href="mailto:mpourgol@gmail.com">mpourgol@gmail.com</a> Boston, MA</td>
</tr>
<tr>
<td>1</td>
<td>Hari Cheedella <a href="mailto:hari.pc@stanadyne.com">hari.pc@stanadyne.com</a> Windsor (Hartford), CT</td>
</tr>
<tr>
<td>2</td>
<td>OPEN (Upstate New York and Northern Pennsylvania)</td>
</tr>
<tr>
<td>3</td>
<td>OPEN (B9)</td>
</tr>
<tr>
<td>4 (Canada)</td>
<td>James Li <a href="mailto:james.li@rail.bombardier.com">james.li@rail.bombardier.com</a> Kingston, ON</td>
</tr>
<tr>
<td>5</td>
<td>Craig Hillman <a href="mailto:chillman@dfrsolutions.com">chillman@dfrsolutions.com</a> Washington, DC</td>
</tr>
<tr>
<td>6A</td>
<td>Colleen Ackermann <a href="mailto:cackermannaz@yahoo.com">cackermannaz@yahoo.com</a> Crescent Valley (North Central Nevada), NV</td>
</tr>
<tr>
<td>6A</td>
<td>Dock Brown <a href="mailto:dockbrownseattle@yahoo.com">dockbrownseattle@yahoo.com</a> Seattle, WA</td>
</tr>
<tr>
<td>6B</td>
<td>Syed Hussain <a href="mailto:bhassanpk@yahoo.com">bhassanpk@yahoo.com</a> San Francisco, CA</td>
</tr>
<tr>
<td>7</td>
<td>OPEN (B23)</td>
</tr>
<tr>
<td>8</td>
<td>Gary Josebeck <a href="mailto:garyjosebeck@gmail.com">garyjosebeck@gmail.com</a> (personal) <a href="mailto:gary.josebeck@owenscorning.com">gary.josebeck@owenscorning.com</a> (work) Granville (Columbus), OH</td>
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<tr>
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<th>Regional Councilor</th>
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<td>Ha Dao <a href="mailto:ha.dao@emerson.com">ha.dao@emerson.com</a> Dayton, OH</td>
</tr>
<tr>
<td>10</td>
<td>James McLeish <a href="mailto:jmcleish@dfrsolutions.com">jmcleish@dfrsolutions.com</a> Rochester Hills (Detroit), MI</td>
</tr>
<tr>
<td>11A</td>
<td>Ramesh Gulati <a href="mailto:ramesh.gulati@hotmail.com">ramesh.gulati@hotmail.com</a> Chattanooga, TN</td>
</tr>
<tr>
<td>11A</td>
<td>Sinan Meric <a href="mailto:sinan.meric@gmail.com">sinan.meric@gmail.com</a> Murfreesboro (Nashville), TN</td>
</tr>
<tr>
<td>11B</td>
<td>David Auda <a href="mailto:davidusaha@volvo.com">davidusaha@volvo.com</a> Greensboro NC</td>
</tr>
<tr>
<td>11B</td>
<td>JD Solomon Raleigh, NC <a href="mailto:jd.solomon@CH2M.com">jd.solomon@CH2M.com</a></td>
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<tr>
<td>12 &amp; Regional Councilor Coordinator</td>
<td>Dan Burrows <a href="mailto:dan@asqrd.org">dan@asqrd.org</a> Tinley Park (Chicago), IL</td>
</tr>
<tr>
<td>13</td>
<td>John Paschkewitz <a href="mailto:jjpengr@gmail.com">jjpengr@gmail.com</a> St. Louis, MO</td>
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<tr>
<td>14A</td>
<td>Norma Antunano <a href="mailto:normaantu@aol.com">normaantu@aol.com</a> Austin, TX</td>
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<tr>
<td>14A</td>
<td>Sidhartha Pingali <a href="mailto:pingalisidhartha@gmail.com">pingalisidhartha@gmail.com</a> Houston, TX</td>
</tr>
<tr>
<td>14B</td>
<td>OPEN (Northern Texas, Oklahoma, Arkansas)</td>
</tr>
<tr>
<td>15A</td>
<td>Tim Adams <a href="mailto:tim.adams@nasa.gov">tim.adams@nasa.gov</a> Melbourne (Kennedy Space Center), FL</td>
</tr>
<tr>
<td>15A</td>
<td>David Jennings <a href="mailto:david.jennings@orpaconsulting.com">david.jennings@orpaconsulting.com</a> Atlanta, GA</td>
</tr>
<tr>
<td>15B</td>
<td>OPEN (B2)</td>
</tr>
</tbody>
</table>
### Regional Councilors

<table>
<thead>
<tr>
<th>ASQ Region</th>
<th>Regional Councilor</th>
<th>ASQ Region</th>
<th>Regional Councilor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Leandro Daniel Torres&lt;br&gt;<a href="mailto:infotorresconsulting@gmail.com">infotorresconsulting@gmail.com</a></td>
<td>Honduras</td>
<td>Carlos Beza&lt;br&gt;<a href="mailto:carlosbeza@hotmail.com">carlosbeza@hotmail.com</a></td>
</tr>
<tr>
<td>China</td>
<td>Mingbin Chen&lt;br&gt;<a href="mailto:mingbin.a.chen@invista.com">mingbin.a.chen@invista.com</a></td>
<td>Italy</td>
<td>Alessio Griffoni&lt;br&gt;<a href="mailto:alessio.griffoni@gmail.com">alessio.griffoni@gmail.com</a></td>
</tr>
<tr>
<td>Greece</td>
<td>Spyros Vrachnas&lt;br&gt;<a href="mailto:svra52@gmail.com">svra52@gmail.com</a></td>
<td>Jordan</td>
<td>Rabia R. Muammar&lt;br&gt;<a href="mailto:r.muammar@outlook.com">r.muammar@outlook.com</a></td>
</tr>
</tbody>
</table>

![ASQ Division Map](image-url)
A Helpful Flowchart!!

ASQ RD members and subscribers:
Please contact us via www.asqrd.org

START HERE

Are you a member of ASQ?

- Yes
  - Are you a member of the Reliability Division?
    - Yes
      - Log into www.asqrd.org to access member benefits
    - No
      - Call ASQ customer care and add Division for $10 to member profile
- No
  - Did you subscribe to ASQRD.org for $20?
    - Yes
      - Log into www.asqrd.org to access member benefits
    - No
      - Purchase $20 subscription to www.asqrd.org
- No
  - Do you need certification exam discounts?
    - Yes
      - Join ASQ at www.asq.org and select Reliability Division during checkout
    - No
      - Log into www.asqrd.org to access member benefits
2016-2017 ASQ-RD Leadership Positions

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Past Chair
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Trevor.A.Craney@shell.com

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Nominating Chair
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ASQ-RD Mission

The mission of the Reliability Division is:
* Provide a global forum for networking among practitioners of reliability engineering, management and related topics,
* Facilitate growth and development of division members,
* Promote reliability engineering principles and serve as a technical resource on reliability engineering for ASQ, standards agencies, industry, government, academia and related disciplines.
* Sponsor, present and promote reliability, maintainability, and related training materials for courses, symposia, and conferences.
Wilks Tolerance Limit for Affordable Monte Carlo Based Uncertainty Propagation

Mohammad Pourgol-Mohammad, Ph.D, PE, CRE

As systems and their models become more complex and costly to run, the use of tolerance limit uncertainty characterization is gaining popularity. For example in very complex models containing several uncertain parameters (each represented by a probability distribution function), classical Bayes' and bootstrap Monte Carlo simulation may become impractical. Often in complex computer-based models of (5.1) in which calculation of values require significant amount of time and effort, the traditional Monte Carlo simulation is not possible. Wilks Tolerance limit is used in these cases

A tolerance interval is a random interval \((L, U)\) that contains with probability (or confidence) \(b\) at least a fraction \(g\) of the population under study. The probability and fraction \(b\) and \(g\) are analyst's selected criteria depending on the confidence desired. The pioneering work in this area is attributed to Wilks [1-2] and later to Wald [3-4]. Wilks Tolerance limit is an efficient and simple sampling method to reduce sample size from few thousands to around 100 or so. The number of sample size does not depend on the number of uncertain parameters in the model. There are two kinds of tolerance limits:

**Non-parametric tolerance limits:** Nothing is known about distribution of the random variable except that it is continuous

**Parametric tolerance limits:** The distribution function representing the random variable of interest is known and only some distribution parameters involved are unknown.

The problem in both cases is to calculate a tolerance range \((L, U)\) for a random variable \(X\) represented by the observed sample, \(x_1, x_2, \ldots, x_m\) and the corresponding size of the sample.

Consider \(g\) tolerance limits \(L\) and \(U\) for probability level \(\beta\) of a limited sample \(S_1\) of size \(N\), the probability \(\beta\) that at least \(\gamma\) proportion of the \(X\)'s in another indefinitely large sample \(S_2\) will lie between \(L\) and \(U\) is obtained from [1-5]

\[
p\left(\int_{L}^{U} f(x) \, dx \geq \gamma\right) = \beta
\]

(1)

where, \(f(x)\) is the probability density function of the random variable \(X\).

Let us consider a complex system represented by a model (e.g., a risk model). Such a model may describe relationship between the output variables (e.g., probability of failure or performance value of a system) as a function of some input (random) variables (e.g., geometry, material properties, etc.). Assume several parametric variables involve in the model. Further assume that the observed randomness of the output variables is the result of the randomness of input variables. If we take \(N\) samples of each input variable, then we obtain a sample of \(N\) output values \(\{y_1, y_2, \ldots, y_N\}\) for \(y = f(x)\). In using (1) for this problem, note that probability \(\beta\) bears the name confidence level. To be on the conservative side, one should also specify probability content \(\gamma\) in addition to the confidence level \(\beta\) as large as possible. It should be emphasized that \(\gamma\) is not a probability, although it is a non-negative real number of less than one [5]. Having fixed \(\beta\) and \(\gamma\), it becomes possible to determine the number of runs (samples of output) \(N\) required to remain consistent with the selected \(\beta\) and \(\gamma\) values.

Let \(y_1, y_2, \ldots, y_N\) be \(N\) independent output values of \(y\). Suppose that nothing is known about the pdf \(g(y)\) except that it is continuous. Arrange the values of \(y_1, y_2, \ldots, y_N\) in an increasing order and denote them by \(y(k)\), hence

\[
y(1) = \min_{1 \leq k \leq N} y_k, \quad y(N) = \max_{1 \leq k \leq N} y_k
\]

(2)

and by definition \(y(0) = -\infty\); while \(y(N+1) = +\infty\), it can be shown that for confidence level \(\beta\) [5] is obtained from

\[
\beta = \sum_{j=0}^{k-r-1} \binom{N}{j} \gamma^j (1-\gamma)^{N-j}, \quad 0 \leq r \leq k \leq N, \quad L = y(r), \quad U = y(s)
\]

(3)

From equation (3) sample sizes \(N\) can be estimated. For application of this approach consider two cases of the tolerance limits: one-sided and two-sided follow:
**One-sided Tolerance Limits:** This is the more common case, for example when measuring a model output value such as a temperature or shear stress at a point on the surface of a structure. We are interested in assuring that a small sample, of for example estimated temperatures, obtained from the model, and the corresponding upper sample tolerance limit \( T_U \) according to (3), contains with probability \( \beta \) (say 95%) at least the fraction \( \gamma \) of the temperatures in a fictitious sample containing infinite estimates of such temperatures. Table I shows values for sample size \( N \) based on values of \( \beta \) and \( \gamma \). For example, if \( \beta = 0.95; \gamma = 0.90; \) then \( N = 45 \) samples taken from the model (e.g., by standard Monte Carlo sampling) assures that the highest temperature \( T_H \) in this sample represent the 95% upper confidence limit below which 90% of the all possible temperatures lie.

**Table I** Minimum sample Size (One-Sided)

<table>
<thead>
<tr>
<th>( \beta \rightarrow )</th>
<th>0.90</th>
<th>0.95</th>
<th>0.99</th>
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</thead>
<tbody>
<tr>
<td>( \gamma )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.90</td>
<td>22</td>
<td>45</td>
<td>239</td>
</tr>
<tr>
<td>0.95</td>
<td>29</td>
<td>59</td>
<td>299</td>
</tr>
<tr>
<td>0.99</td>
<td>44</td>
<td>90</td>
<td>459</td>
</tr>
</tbody>
</table>

**Two-Sided Tolerance Limits:** We now consider the two-sided case, which is less common [6]. Table II shows the Wilks' sample size. With \( \gamma \) and \( \beta \) both equal to 95%, we will get \( N = 93 \) samples. For example, in the 93 samples taken from the model (e.g., by standard Monte Carlo sampling) we can say that limits \( (T_L, T_H) \) from this sample represent the 95% confidence interval within which 95% of the all possible temperatures lie.

**Table II** Minimum sample Size (Two-Sided)

<table>
<thead>
<tr>
<th>( \beta \rightarrow )</th>
<th>0.50</th>
<th>0.90</th>
<th>0.95</th>
<th>0.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>3</td>
<td>17</td>
<td>34</td>
<td>163</td>
</tr>
<tr>
<td>0.80</td>
<td>5</td>
<td>29</td>
<td>59</td>
<td>299</td>
</tr>
<tr>
<td>0.90</td>
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<td>38</td>
<td>77</td>
<td>388</td>
</tr>
<tr>
<td>0.95</td>
<td>8</td>
<td>46</td>
<td>93</td>
<td>473</td>
</tr>
<tr>
<td>0.99</td>
<td>11</td>
<td>64</td>
<td>130</td>
<td>663</td>
</tr>
</tbody>
</table>

Example 1:

A manufacturer of steel bars wants to order boxes for shipping their bars. They want to order appropriate length for the boxes, with 90% confident that at least 95% of the bars do not exceed the box's length. How many samples, \( N \), the manufacturer should select and which one should be used as the measure of the box length?

Solution:

From Table I, with \( \gamma = 95\% \) and \( \beta = 90\% \), the value for \( N \) is 29. The manufacturer should orders box's length as the \( x_{29} \) sampled bar (when samples are ordered).

To compare Wilks tolerance limit with Bayes' Monte Carlo consider a complex Mathematical-based routine [7] (called MD-Fracture) used to calculate the probability of a nuclear reactor pressure vessel fracture due to pressurized thermal shock. Certain transient scenarios can cause a rapid cooling inside the reactor vessel while it is pressurized.

Example 2:

A 2.828-inch surge line break in a certain design of nuclear reactors may lead to such a condition. Many input variables contribute to the amount of thermal stress and fracture toughness of the vessel. Some of them may involve uncertainties. The temperature, pressure and heat transfer coefficient are examples of such variables, represented by normal distributions. Also, flaw size, the distance from the flaw inner tip to the interface between base and clad of reactor vessel (\( C_{Dist} \)) and aspect ratio are unknown and can be represented by random variables with the distributions shown in the Table III.
To compare the results of vessel fracture due to this scenario using Wilks approach with $\gamma = 95\%$ and $\beta = 95\%$ with the results of the standard 1000 and 2000 trials standard Monte Carlo simulation, three Wilks' runs with 100 samples (assuming $\gamma = 95\%$ and $\beta = 95\%$ with two-sided case as shown in Table II) and two Monte Carlo runs with 1000 and 2000 are performed using the MD-Fracture Mathematical-based tool. Results show good agreement between Wilks tolerance limits and simple Monte Carlo sampling, as shown in Figure I.

### Table III  Distribution Characteristics of Some Input Parameters that Influence Pressurized Thermal Shock

<table>
<thead>
<tr>
<th>Flaw Characterizations</th>
<th>Input Distributions</th>
<th>Lower and Upper Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaw Size</td>
<td>Uniform</td>
<td>[0, 1.5] inch</td>
</tr>
<tr>
<td>C..Dist</td>
<td>Uniform</td>
<td>[0, 3] inch</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>Discrete</td>
<td>2, 6, 10</td>
</tr>
<tr>
<td>Temp., Pres., Heat Coe.</td>
<td>Normal</td>
<td>Oconee Case c4 0</td>
</tr>
</tbody>
</table>

![Figure I](image.png)

**Figure I** Comparison between Standard Monte Carlo Simulation and Wilks Tolerance Limit Method

References:


