

Chairman's Message

I welcome you to the 2014 SQUG Newsletter! Over the past two and a half decades, SQUG has played an important role in achieving progress on seismic safety of nuclear plants; it continues to do so with investigations, research and training for both - our domestic and international members.

Earthquakes occur with regular frequency, and one of SQUG's missions is to investigate those that are significant so that success and/or failure data on equipment and structures can be collected and evaluated. Although earthquakes in 2014 did not require detailed review, data from previous significant earthquakes (Kashiwazaki-Kariwa, Baja CA) continues to be evaluated and processed in the database. One significant seismic event in the US with its epicenter 11 miles southwest of the North Anna Nuclear Power Station (owned/operated by Dominion) occurred on August 23, 2011, when a M5.8 earthquake struck Central Virginia. The earthquake exceeded the plant's design basis spectra, although its energy content was small. There was no damage to safety systems and only minor damage to a few non-safety systems. The intense post-earthquake inspections, functional and surveillance tests before restart, and the recently completed long-term actions provided an invaluable experience and learning opportunity not just to my colleagues and me at Dominion, but also to the entire nuclear industry. For example, recent NRC and industry guidance on plant's post-earthquake responses have incorporated the lessons learned. A variety of initiatives are in progress in the US and worldwide to maintain and enhance the seismic safety of Nuclear Power Plants. The disastrous consequences of M9 Tohoku earthquake in Japan on March 11, 2011 have led to new "beyond design basis" initiatives in the US, in particular the implementation of US NRC's Fukushima Near-Term Task Force (NTTF) Recommendations 2.1 and 2.3. To address "beyond design bases external hazards", mitigating strategies have been developed. These strategies include purchase of portable backup equipment by each site and the establishment of national response centers in Memphis and Phoenix.

Estimates of seismic hazard at a site are bound to improve with time as the probabilistic seismic hazard analysis methods and models are refined, and new research continues. We need to be cognizant of the value of ongoing efforts such as seismic probabilistic risk assessments that many US plants are in the process of conducting for Fukushima NTTF 2.1. These efforts will provide opportunities for engineers to learn state-of-the-art methods, put them into practice, improve them, and prepare for new challenges. In all this, nuclear safety must be paramount in our everyday work.

This newsletter provides a brief update on the SQUG activities, and other issues of interest in nuclear power seismic design and on the ongoing "beyond design basis" efforts.

Divakar Bhargava

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SQUG Chairman

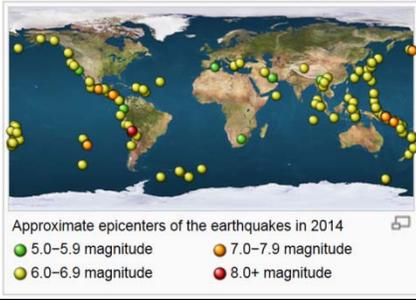
P.S.: On a personal note, I will relinquish my assignment as Chairman of the SQUG Steering Committee effective January 1, 2015. It has been an honor and a privilege to serve in the Steering Committee for the past 13 years and as its Chair for the past 5 years. Mr. Russell Childs from Duke Energy has graciously accepted to be the new Chair of the Steering Committee. Congratulations Russell! Other recent changes in the Steering Committee are noted within this newsletter. I will keenly follow the progress SQUG makes each year and I extend my best wishes to the SQUG Steering Committee and to all the SQUG members.

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Recent Earthquakes

 SQUG performed a review of major earthquakes in 2014 to assess whether any damage / failures occurred that might change the criteria for implementing earthquake experience. There have been 10 earthquakes in 2014 with a magnitude of 7 or greater. The largest of these was an 8.2 Magnitude earthquake in Chile.



Map of 2014 Earthquakes (Wikip.)

The Napa earthquake in California was significant, but did not have much data for SQUG.



B.R. Cohn Winery in Napa

Major earthquakes in 2014 have not exhibited the kinds of ground motion response or damage to engineered facilities to warrant further SQUG involvement.

Ongoing Earthquake Investigations and eSQUG

SQUG completed the inclusion of the Hawaii earthquake data into the eSQUG database in 2014. SQUG continues to process the experience data collected from the July 2007 Niigata NCO earthquake near the Kashiwazaki-Kariwa (KK) nuclear plant in Japan and the 2010 Baja California earthquake, and expects to finalize updating the eSQUG database with this data in 2015.



Kashiwazaki Kariwa Nuclear Plant

SQUG Current and Future Research

SQUG has been actively pursuing new ideas to furthering research in the equipment seismic qualification area, even beyond the traditional experience based methods. The SQUG Steering Group periodically reviews the need for new research and allocates funds as needed. If you have a new idea on a research topic that SQUG should pursue, please contact a Steering Group member. Discussed below are some of the current initiatives.

Seismic – Fire/Flood Guidance

To address the issues related to the conduct of a PRA incorporating seismically induced internal fire or internal flood, SQUG has recently documented a potential approach and prepared a phase 1 draft report. This was at the request of our international members, but the approach should be helpful to all SQUG members. The report discusses each step in the performance of such a PRA, what information would be needed to accomplish each step, and what gaps need to be filled. The phase 1 report will be published in early 2015.

Fragilities from Experience Data

The goal of this task is to assess the potential to demonstrate higher capacities for use in fragility assessments, based on experience data. These fragilities may be used for functional failure modes; anchorage failures must be addressed separately. The task considered two approaches - Bayesian and Frequentist and is being completed in stages. Increased capacities have been shown for four example classes - Fans, MCCs Battery Chargers and Inverters, and Horizontal Pumps. EPRI report 30020002933 "Assessment of the Use of Experience Data to Develop Seismic Fragilities" has been published.

Raising the Bounding Spectrum

A draft white paper has been developed to look at the feasibility of raising the Bounding Spectrum. This entails removing existing conservatism and incorporating shake-table test data. Possible sources of conservatism are structural amplification effects. Possible un-conservative effects include foundation size effects (spatial incoherence) and embedment effects. The white paper concludes that it is currently not practical to raise the Bounding Spectrum. However, the current research indicates that there is margin beyond the Bounding Spectrum. The SQUG web site will soon have the white paper posted.

Seismic Training Programs

Training is one of the key activities that SQUG conducts every year. Several SQUG sponsored training sessions, including three webinars, took place in 2014 and a variety of training initiatives are planned in 2015. In addition, there are EPRI-sponsored seismic training

programs outside of SQUG. The details are provided below.

SQUG Walkdown Training:

SQUG is in process of upgrading and improving the walkdown training course in six phases. Five phases are complete and the last phase (#4 below) is expected to finish in 2015. These phases are:

1. Improve Student Workbook
2. Upgrade Capacity vs. Demand Module
3. Revise Class Schedule
4. Improve Electrical Equipment Class Description (underway)
5. Consolidate Previous Changes
6. Transfer Administration to EPRI

About 45 students were trained in the two walkdown courses given in May and August of 2014. SQUG plans to give two one-week training classes in 2015. Look for the dates!

SQUG Web-based training:

In a survey we conducted in 2010-11, members expressed substantial interest in Web-based training. SQUG has given several web based training sessions in the last three years. In 2014, SQUG gave three webinars: Piping, HVAC / Ducts, and Cranes – all with the use of experience data. In addition, others are in preparation. In the December 2014 meeting, members agreed that in 2015, SQUG should give webinars and prepare white papers on the following topics:

- Earthquakes in the past year
- How to use the earthquake experience date (eSQUG)
- U.S. Post Fukushima Efforts
- Cabinet Frequency Estimation

Dates for these webinars will be announced as the year progresses.

SQUG Relay Evaluation Training

SQUG plans to give a two-day training course on relay evaluation in the second quarter of 2015. This

training course was offered for the USI A-46 effort in the 1990s but has not been given lately. SQUG is updating the course during the 1st quarter of 2015 to incorporate new information and to better match the current industry needs. The course is timely and can be of help with risk-based assessments being done for the Fukushima initiatives, and with potential operability issues for relay chatter. The course should be beneficial to civil / seismic engineers as well as to electrical engineers (for circuit analysis). Look for the dates!

Equipment Seismic Qualification

EPRI offers a “Fundamentals of Equipment Seismic Qualification” Training course periodically. The next course will be from Tuesday, May 12, 2015 to Thursday, May 14, 2015 at EPRI’s Charlotte Office. If interested, please contact Mr. Ken Huffman at 704-340-8738 or at khuffman@epri.com.

Risk-informed / SPRA Training

EPRI typically gives two identical one-week courses on seismic PRA each year. These consist of 1 day on hazard, ½ day on systems, ½ day on quantification and 2.5 days on fragility and margin issues. The classes are limited to about 20 persons. If you have an interest in attending this course in 2015, please contact Dr. Robert Kassawara at (650) 855-2302 or at rkassawa@epri.com

Post Earthquake Actions - EPRI Guidance and ANS Standard

In 2012, EPRI developed and published a technical update (EPRI 3002000720) to NP-6695, which provides guidance for a plant’s response to an earthquake. The primary motivation was the lessons from the Mineral VA earthquake of 2011. This guidance has an action

level matrix for combinations of damage levels and earthquake levels. It addresses earthquakes < OBE, >OBE but < SSE, and >SSE. An EPRI technical group is also working to update the ANS-2.23 Standard on the same subject. Recently, ANS comments were successfully resolved and revision of the standard is in progress.

Cast-in-place Anchor Capacities

The Current ACI 349 requirements result in reductions in capacity of cast-in-place anchors when compared to the previous versions of the code. The new criteria are recommended to be the basis for deriving HCLPF capacities for cast-in-place anchors. The current method is based on a 35° prism, which reduces capacities as the embedment increases. EPRI plans to assess whether the current ACI 349 criterion is conservative via research of the available test data and via peer review in 2015.

SQRSTS Update

The EPRI-SQRSTS (Seismic Qualification Reporting and Testing Standardization) program, which started in the early 1990’s, is one of EPRI’s longest running supplemental programs. The program, which conducts shake-table testing of equipment for its members, continues to generate significant interest and is of great value to utilities as evidenced by its large membership. Currently, just about all domestic utilities participate in the program and there is a growing contingent of international members. SQRSTS has recently invested significant time and resources to update its database of tested equipment (<http://sqrsts.epri.com/>) to reflect recent testing. In addition to adding value to program

participants, the SQRSTS database will also be used to support upcoming SQRSTS research initiatives – including revision of the EPRI G-STERI Report (Generic Seismic Technical Evaluation of Replacement Items) and the development of seismic fragilities from SQRSTS test data. If you are interested in learning more about SQRSTS, please contact Joe Vasquez, the Utility Chair, at 804-273-2454 or Ken Huffman, the EPRI Program Manager, at 704-340-8738.

International Support and Meetings

In 2013, SQUG held meetings with European members in Lyon, France and Glasgow, UK. These meetings provided an excellent forum to discuss experience-based and other seismic issues. Follow up actions included a request to conduct a webinar and prepare a white paper on US post-Fukushima effort. A webinar is planned in the first quarter of 2015.

SQUG is considering organizing meetings in Europe in 2015 to support our international members. If such meetings are held, the discussions will be based on the needs of the international members and would include topics such as application of the GIP and database, ongoing and proposed U.S. and European research programs, Fukushima and North Anna related initiatives in the US, training, and improved communication. The Steering Group considers ideas discussed at the meeting for future research, as applicable. If you are interested in hosting such a meeting, please contact Dr. Kassawara.

Fukushima Near-Term Task Force Recommendations

NRC's Near-Term Task Force (NTTF) Recommendation 2 related to seismic assessments has three parts. Part 2.2 is long-term review of seismic hazard; to be addressed later. NRC requested information from utilities on Parts 2.1 and 2.3 in their March 12, 2012 letter. The requests and status are as follows.

2.1 NRC requested licensees to reevaluate their site-specific seismic hazard using current NRC requirements and guidance to develop a ground motion response spectrum (GMRS). In 2013, EPRI developed two guidance documents – one called the Screening, Prioritization and Implementation Details or SPID – EPRI 1025287 and the other called the Augmented Approach – EPRI 3002000704. NRC endorsed both of them.

CEUS plants submitted their hazard curves, GMRS and planned actions to NRC in March 2014. NRC held several public meetings with licensees and prioritized plants for risk evaluation in three groups. Each group has a different date for completing risk evaluations. Some plants screened out and will not have to perform a risk analysis.

A lot of work continues to be performed for NTTF 2.1 Seismic 50.54(f) responses. CEUS plants that are required to perform the Expedited Seismic Evaluation Process (ESEP) will be submitting their reports to NRC by the end of 2014. A few plants were granted extensions because they were not screened-in to perform the ESEP until mid-2014 or later.

The NRC issued a letter to CEUS plants on December 10, 2014 providing a status of the

GMRS reviews. For the large majority of plants the NRC concluded that the utility submitted "Hazard is suitable for risk evaluation development." The letter also identified a small number of plants where the NRC needs additional information and has issued RAIs.

A small number of plants have completed Peer Reviews of their new SPRAs and are working to resolve Peer Review Findings and Observations. A number of additional plants are in various stages of SPRA development.

Work has also started to define closure strategies for NTTF 2.1 including considerations for SPRAs, ESEPs, High Frequency evaluations, and Spent Fuel Pool evaluations.

2.3 NRC requested licensees to perform seismic walkdowns to identify and address degraded, nonconforming or unanalyzed conditions relative to their current licensing bases. EPRI developed an approach for walkdowns and evaluations of a selected subset of equipment (EPRI Report 1025286). NRC endorsed the report on May 31, 2012. EPRI provided a series of regional training sessions between June and September 2012 and the evaluations started in July 2012. Plants sent their submittals to the NRC by the due date of November 30, 2012. The walkdown of items requiring drywell / containment entries or plant outage was deferred until later; however, most plants have completed that effort. The overall conclusion was that apart from the need to re-focus attention on seismic "house-keeping" procedure adherence, the NTTF 2.3 seismic

walkdown effort confirmed plants' compliance with their seismic licensing bases.

Seismic Source and Ground Motion Models Update

The Central and Eastern U.S. (CEUS) seismic source characterization model for nuclear facilities was completed and released in January 2012. The model used the SSHAC Level 3 assessment process development. It replaces the old EPRI/LLNL source characterization models. This model, together with the 2013 update of the EPRI-04/06 ground-motion prediction (or attenuation) equations (GMPEs) and site soil characteristics, was used by EPRI and others to perform probabilistic seismic hazard analyses (PSHA) for operating plants in the CEUS. The PSHAs provided site-specific hazard curves, uniform hazard response spectra (UHS) for several annual frequencies of exceedance, and Ground Motion Response Spectrum (GMRS) at the control point. Licensees submitted these curves to the NRC in March 2014 for the resolution of Fukushima NTF recommendation 2.1.

A completely updated ground motion model for CEUS, called Next Generation Attenuation - East or NGA-East, sponsored by the NRC and others, is currently being developed. The GMPEs from this effort are expected by mid-2015, but with NRC reviews and final report, we expect the model to be ready for production in early 2016.

High Frequency Tests and Guidance

Seismic testing of components for high frequencies has been completed and EPRI Report 3002002997 was issued summarizing the results. Overall, the test results were very positive

with most components passing the high frequency (20-40 Hz) random multi-frequency input testing at the shake table acceleration limits, and all components showing high frequency capacities equal to or greater than lower frequency (4-16 Hz) capacities.

EPRI is drafting guidance to perform evaluations at plants that screen-in for the High Frequency Confirmation evaluations. Guidance is also being developed for considering the high frequency motions in fragility calculations for plants performing SPRAs. Meetings to discuss the guidance with the NRC will begin in January 2015.

SQUG Web-Site Postings

The following links can be used to obtain useful SQUG information that has been added to the SQUG web site since the last Newsletter was published.

- Revised content posted to the SQUG web site are found on the following "What's New!" web page:
http://squgweb.mpr.com/private/01.3-What_Is_New.htm
- SQUG Calendar of Events including those scheduled for 2015:
<http://squgweb.mpr.com/08.0-Calendar.htm>
- SQUG Member Representatives and their contact information:
http://squgweb.mpr.com/private/07.3.2-Members_Company.htm
- Minutes from Recent SQUG Member Meetings Dec. 2012 and Dec. 2013:
<http://squgweb.mpr.com/private/16.2-Corresp2/files/130318.pdf>
<http://squgweb.mpr.com/private/16.2-Corresp2/files/140407.pdf>

- Video of SQUG Webinar Presentation on Seismic Verification of Piping and Tubing:
http://squgweb.mpr.com/private/22.2.2-Private_Videos/22.2.4-Piping_Video/22.2.4-Piping_Video.html
- Videos of SQUG Walkdown Course Introductory Material (to view prior to taking course)
http://squgweb.mpr.com/07.4.3-Training_Excerpts.htm
- Portable Equipment Seismic Verification Guidelines
<http://squgweb.mpr.com/private/19.7-Portable.htm>
- NARE Example for Trailer-Mounted Diesel Generator
http://squgweb.mpr.com/private/13.5-Examples/14-trailer_EDG.pdf

SQUG Membership and Steering Group Update

Currently, SQUG has fifteen US members including Los Alamos National Laboratory and fifteen international members. Recent changes include the Exelon - Constellation merger and the EdF - British Energy merger. SQUG has decided to accept non USI A-46 utilities to join SQUG, albeit with reduced dues, as of 2015. Members can request assistance with broader seismic technical issues such as equipment seismic qualification and risk/safety efforts, outside of the experience-based methods, and with training needs.

There have been several changes in the SQUG Steering Group as well, since the publication of the last newsletter. To represent our international members, Mr. Hugo Jadot of EdF has now been a Steering Group member for the past two years. He continues to facilitate the needed interactions between the US and the European

December 2014

SQUG members. Other recent Steering Group members are Ms. Melanie Brown of Southern Nuclear, who has agreed to serve as the Vice-Chair of the Steering Group (Congratulations Melanie!), and Mr. Daniel (Joe) Vasquez of Dominion. All the new Steering Group members bring a lot of expertise and experience to SQUG. The Steering Group members, as of January 1, 2015, are listed below. If you have a membership or technical inquiry, or would like to share your ideas or comments, please feel free to contact any Steering Group member.

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In Closing

We hope that this newsletter will help keep you up to date on our SQUG activities and other current significant seismic issues of interest in the nuclear power industry. We appreciate the contributions made to this newsletter by Messrs. Greg Hardy, John Richards, Paul Amico, Richard Starck, Joe Vasquez and others. If you have comments in any area or contributions for the next newsletter, please let us know. Finally, we wish you a joyful holiday season and a productive 2015.



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Abbreviations used in this edition:
ANS - American Nuclear Society
CEUS – Central and Eastern United States
EdF – Electricite de France
EPRI – Electric Power Research Institute
GMPE – Ground Motion Prediction Equation
G-STERI – Generic Seismic Technical Evaluation of Replacement Items
NARE – New and Replacement Equipment
NGA - Next Generation Attenuation
NRC - Nuclear Regulatory Commission
NTTF – Near-Term Task Force
OBE – Operating Basis Earthquake
SQURTS – Seismic Qualification Testing and Reporting Standardization
SSE – Safe Shutdown Earthquake
PRA – Probabilistic Risk Assessment
SQUG – Seismic Qualification Utility Group