

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Quantitative Risk and Reliability Techniques
ABS Consulting Training Course
Project No. 20.06002.01.338
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DATE/PLACE: March 12–16, 2007
Knoxville, Tennessee

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PERSONS PRESENT: John A. Farquharson, ABS Consulting (Instructor); Ted C. Lawson, Marathon Petroleum (Attendee); Ben Treadgold, Amerada Hess Corporation (Attendee).

BACKGROUND AND PURPOSE OF MEETING/TRIP: The purpose of the trip was to attend a training course offered by the Risk Consulting Division of ABS Consulting in Knoxville, Tennessee.

SUMMARY OF PERTINENT POINTS AND ACTIVITIES: This 5-day course titled “Quantitative Risk and Reliability Techniques” was divided into several sections related to various topics in risk assessment, including examples and workshops.

John A. Farquharson, a project manager in the Risk Consulting Division at ABS Consulting, was the instructor, and Myron L. Casada, a technical director within the same division, also provided a couple of brief presentations. The course was intended to provide a broad overview of general risk assessment techniques, including both quantitative and qualitative aspects. Major areas covered during the course included risk-informed decisionmaking issues, hazard identification techniques, component reliability analysis, failure data selection, human reliability analysis, and reliability quantification techniques such as event tree analysis, fault tree analysis, and layer of protection analysis.

The discussion on the risk-informed approach involved relevant topics such as selection of techniques for making risk-informed decisions, key factors to consider during the decisionmaking process, structure needed to improve the efficiency of the approach, and type of resources needed to support a risk-informed judgment. The hazard identification techniques presented were the commonly used checklist, failure modes and effects analysis, hazard and operability analysis, and what-if analysis. Characteristics, benefits, and practical limitations for each technique were discussed, and examples were developed during the class.

The background theory for various quantitative methods was briefly introduced, and numerical risk assessment examples were provided using fault trees and event trees. An overview of their implementation was demonstrated using the software Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE), developed by the Idaho National Laboratory

under sponsorship of the U.S. Nuclear Regulatory Commission (NRC). The Layer of Protection Analysis approach was presented as a standardized simplified risk-assessment tool with some limited consideration of quantitative aspects. It was indicated that the Layer of Protection Analysis can be useful to assess overall risk levels prior to implementing a more detailed quantitative reliability analysis, but that it is limited to a single cause-consequence pair for a scenario. The application of Event Tree Analysis and Fault Tree Analysis was also extended to consider dependent failure analysis and standby safety systems. The analysis of component failure data from multiple sources in published literature was also presented as an essential first step in reliability quantification techniques. The basics of Human Reliability Analysis were discussed in terms of human error characterization, simplified human behavior models, and various factors affecting human performance. Quantification techniques and human failure data for Human Reliability Analysis were briefly introduced and discussed through examples.

Other items of interest are noted next:

- Myron L. Casada introduced some more recent software tools developed for risk assessment applications. The PROFILER software was developed by ABS Consulting for the risk analysis of pipeline releases in the oil and gas industry. The THESIS Bow-Tie software uses the so-called bow-tie methodology to provide a risk management tool that overlooks hazards, safety barriers, and consequences in an integrated graphical interface. THESIS Bow-Tie was originally developed by Shell and subsequently transferred to ABS Consulting control. These two products provided examples of efficient tools that can be developed for risk assessment purposes, which may also be of interest for licensing review activities for nuclear applications.
- John A. Farquharson is currently involved in providing risk assessment analysis for the Department of Energy Y-12 National Security Complex in Oak Ridge, Tennessee. The complex specializes in several activities related to nuclear weapons. He discussed several items pertaining to risk assessment of nuclear facilities based on his expertise in nuclear engineering. On the last day of class, local news agencies reported that a small fire had occurred in one of the Y-12 facilities due to uranium chips that result from nuclear material handling operations. It was indicated that no injuries or contamination resulted from the incident. However, this type of incident indicates the need for efficient and thorough risk assessment analyses in order to ensure safety and mitigate consequences in the nuclear industry in general.
- The release of a preliminary report by the U.S. Chemical Safety and Hazard Identification Board on the 2005 accident in a British Petroleum refinery in Texas City, Texas, was mentioned. The report indicated that a sequence of component and human failures due to inadequate training led to catastrophic consequences that included 15 deaths and several injuries. This type of accident and the findings of the subsequent report seem to strongly support the need for techniques in risk assessment in certain industrial applications. These techniques are already common to many areas of interest to the nuclear arena, such as probabilistic risk assessment of nuclear power plants and preclosure safety analysis in high-level waste.

IMPRESSIONS/CONCLUSIONS: The course was very useful in terms of providing a broad overview of both qualitative and quantitative risk-assessment methods. ABS Consulting provides several other courses in the field of risk and reliability assessment, allowing for more in-depth training in several areas discussed in this class. The extensive notes, documents, references, and examples included in the course also provide a very good opportunity for further development of the ideas presented.

PROBLEMS ENCOUNTERED: None.

PENDING ACTIONS: None.

RECOMMENDATIONS: The techniques presented during the training course are directly relevant to the preclosure safety analysis activities currently being performed by NRC and CNWRA staff in connection with the potential high-level waste Geologic Repository Operations Area at Yucca Mountain, Nevada. Hence, it is highly recommended that staff involved in preclosure safety analysis activities attend this course, especially the new staff. Furthermore, the introductory nature of the course also makes it suitable to those interested in risk assessment in general.