FREQUENTLY ASKED QUESTIONS IN SAFETY ANALYSIS REPORTS FOR PACKAGING REVIEW

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ABSTRACT

A methodology has been developed to rank Frequently Asked Questions in Safety Analysis Reports for Packaging (SARP) review. The method has been applied to 39 SARPs reviewed by Argonne National Laboratory between 1986 and 2001. General Information (Chapter 1) and Structural Evaluation (Chapter 2) are the two topical areas where more problems were found in the SARPs, followed by Quality Assurance (Chapter 9), Containment (Chapter 4), and Operating Procedures (Chapter 7). These problem areas indicate where future training resources should be directed.

INTRODUCTION

The U.S. Department of Transportation (DOT) regulations in Title 49 of the Code of Federal Regulations, Part 173 (49 CFR 173.7d) authorize the U.S. Department of Energy (DOE) to certify its own packages for transportation of radioactive materials. The DOT regulations also require DOE to certify that the packages meet standards equivalent to those prescribed by the Nuclear Regulatory Commission (NRC) in Title 10 of the Code of Federal Regulations, Part 71 (10 CFR 71) for commercial shipment of radioactive materials. DOE Order 460.1A establishes the safety requirements for packaging and transportation of radioactive materials that are equivalent to the standards described in 10 CFR 71; the Implementation Guide for DOE Order 460.1A contains information on the administrative procedures for certifying and using radioactive material packaging by DOE. DOE Order 460.1 and its Implementation Guide thus provide the basis for DOE packaging certification. Exclusions from DOE Order 460.1A are DOE's Office of Defense Program for packagings of nuclear weapons and weapons components, Office of Naval Reactors Program for packagings used in nuclear-propulsion-related activities, and Office of Civilian Radioactive Waste Management, which is required by law to have its packagings reviewed and certified by NRC.

The DOE packaging certification program, established at DOE Headquarters in 1986 and supported by technical review groups at Argonne National Laboratory (ANL) and Lawrence Livermore National Laboratory (LLNL), have reviewed many SARPs submitted with applications for new certifications, certificate renewals, and amendments. Over the years, the technical reviewers have generated many hundreds of questions (or request for additional information/ clarification) covering all aspects of the design of packages and their safety compliance as demonstrated and documented in the SARPs either by tests or analyses or a combination of the two. The reviewers have observed that many of the same issues came up repeatedly for such items as contents definition, materials specification, drawing legibility, etc. A compilation and distribution of "Frequently Asked Questions" (FAQs) was considered to be an important vehicle for helping applicants avoid common problems in SARP preparation; the result would be a more efficient packaging review and certification process [1-3]. Use of the FAQs by the applicant, coupled with the guidance provided in the DOE Packaging Review Guide [4] and the various training

courses, should help avoid common omissions and shortcomings before the SARP is submitted for review.

METHODOLOGY

To compile the list of FAQs in SARP review, the input questions submitted by the ANL and LLNL technical review staffs were analyzed by following a criterion that defines a FAQ based on its "relative frequency of occurrence" in SARP reviews. The relative frequency can be determined by dividing the number of times a FAQ was asked by the total number of SARPs a reviewer had reviewed in the past. (Special consideration is necessary for FAQs in shielding and criticality, as explained later.) A tally of relative frequencies for the FAQs can thus be generated, and any ranking (e.g., the top 10 most frequently asked questions) or cutoff frequency (e.g., 50%) can serve as an objective criterion to generate either separate (i.e., ANL or LLNL) or combined (ANL and LLNL) lists of FAQs in SARP review. ANL and LLNL were to independently determine the frequency tally of their FAQs; this paper focuses mainly on the ANL results.

The early portion of the ANL analysis of FAQs was completed in 1996 by R. A. Alsup, who compared the FAQs with the Q0, Q1, Q2, and Qn questions that the ANL reviewers had asked in the 35 SARPs reviewed between 1986 and 1995 for various contents such as uranium hexafluoride, uranium tritide, uranium and plutonium metal and oxide, source capsules, spent fuel, transuranic waste, etc. Each FAQ that has been identified for a given SARP was counted only once, even though that FAQ may appear more than once in the exchange of questions (if unresolved) and responses between reviewers and applicants. A spreadsheet program was used to tabulate the data and evaluation results, which were subsequently verified by the ANL SARP reviewers who submitted the FAQs. The spreadsheet program was also used to generate a statistical compilation of SARP review questions by chapters in the 35 SARPs reviewed by ANL. The compilation combines the Q0, Q1, Q2, and Qn questions in each of the nine chapters in the SARPs for a total of 2,288 questions. Breakdowns of SARP review questions by chapters and contents are also provided for SARPs that, because of the nature of the contents for the packages, have no concerns in either shielding, criticality, or shielding and criticality. A breakdown of questions by Q-list issuance (i.e., Q0, Q1, Q2, etc.) is not given in this paper; it can be obtained with additional effort when it is necessary to investigate the reasons for fully versus partially resolved questions.

Between 1996 and 2001, ANL conducted major reviews for four additional SARPs for packages containing plutonium metals and oxides, highly enriched uranium metals and oxides, low-enrichment uranium metal ingots and scraps, and various target and special form materials. The 497 questions generated during the review of these SARPs were used to validate the earlier results on the nature of the FAQs and the statistics. Recent statistics of questions generated in the LLNL SARP review are also included for comparison.

RESULTS

The data and evaluation results of the FAQs were tabulated for the 35 SARPs reviewed by ANL between 1986 and 1995. In the spreadsheet, the SARPs are listed by abbreviated titles and docket numbers in chronological order starting from the SARPs (T-3, RH-72B, and ATR) that were under review at the time. The first column in the spreadsheet gives the two-digit "chapter.question" combination that uniquely identifies each FAQ submitted by the ANL SARP review staff. (The total

number of FAQs is 54; see www.et.anl.gov/sections/thm/research/faq.html for a complete list.) Each cell in the spreadsheet's 35 columns of SARPs contains one of the three possible types of entries: 1 for a match between a FAQ and a previously asked question for the SARP, blank for no match, or "--" for null. Null entries were made only for FAQs in shielding (Chapter 5), criticality (Chapter 6), or shielding and criticality (Chapters 5 and 6) for certain packages. For example, the ATR package has criticality concern, but no shielding concern, because the package contains fresh, unirradiated but highly enriched uranium metal fuel elements. Mount-TT, UC-609, and TT-6M, on the other hand, have neither shielding nor criticality concern because the contents for these packages are tritium. For these and other similar packages (10 of a total of 35), no questions need to be asked on shielding, criticality, or shielding and criticality because such concerns do not exist. Null entries are therefore necessary to exclude them from being used in the determination of relative frequencies of FAQs for Chapters 5 and 6.

Additional columns in the spreadsheet contain the evaluation results: The SUM column tabulates the number of times each FAQ has appeared in the total number of SARPs (35 or 25) reviewed and given in an adjacent column under Total # of Packages. The Percentage column gives the relative frequencies of the FAQs. The last three columns in the spreadsheet compare the relative frequencies of each FAQ to assumed cutoff frequencies of 50, 35, and 20%, respectively. The number of FAQs above a certain frequency, indicated by the sum of 1s in the entries for each of the last three columns, apparently increases with lowering of the cutoff frequency.

The evaluation results within the spreadsheet can be sorted easily, and certain FAQs, e.g., questions 2.8, 4.4, 5.4, 6.3, and 8.4, obviously appear less often than others. The top 10 most frequently asked questions by the ANL reviewers are (in descending order): questions 1.1, 1.2, 2.2, 2.4, 2.10, 9.1, 2.7, 3.1, 1.5, and 9.4, appearing in General Information (Chapter 1), Structural (Chapter 2), Thermal (Chapter 3), and Quality Assurance (Chapter 9) in the SARP.

STATISTICAL COMPILATION

Figure 1 shows the percentages of SARP review questions by chapters based on the data listed in the spreadsheet. Among the 35 SARPs reviewed by ANL between 1986-1995, more questions were asked in Structural (Chapter 2) than in any other chapter, followed by General Information (Chapter 1), Containment (Chapter 4), Operating Procedure (Chapter 7), Thermal (Chapter 3), and Quality Assurance (Chapter 9).

When the SARP review questions are grouped by chapter and content, the percentages of questions in Structural (Chapter 2) remain the highest (26.4, 25.7, 30.0, and 27.5%) of all chapters in the four subgroupings of SARPs containing both Chapters 5 and 6 (for fissile and radioactive materials), without Chapter 5 (for unirradiated fissile material), without Chapter 6 (for nonfissile radioactive material), and without 5 and 6 (for tritium-containing material). Compared to the percentages shown in Fig. 1, the area (or Chapter) that has the next-highest percentage of SARP review questions depends on the content of the package: for example, Containment (Chapter 4) has the second-highest percentage (20%) of SARP review questions for the five SARPs (ATR, PuO/AmO, HPG MOD 3, 5-Watt Radioisotope) without Shielding (Chapter 5) concern; Containment (Chapter 4) also has the second-highest percentage (14.2%) of questions for the five SARPs (Shippingport, ^{60}Co capsules, BUP-500 RTG, Krypton, BUSS) without Criticality (Chapter 6) concern; and Operating Procedures (Chapter 7) has the second-

highest percentage (14.8%) of questions for the five SARPs (Mound-TT, UC-609, TT-6M, AL-M1 Nuclear, DT-14A) without Shielding (Chapter 5) and Criticality (Chapter 6) concerns.

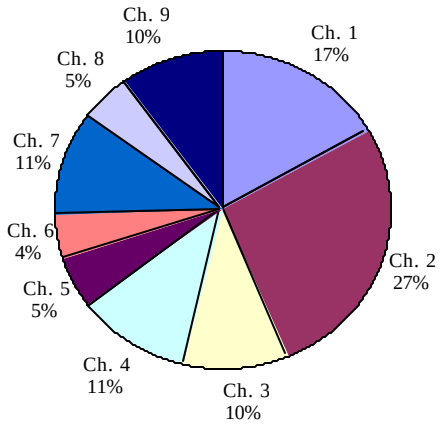

Figure 1. SARP Review Questions by Chapters (2,288 Questions in 35 SARPs)

Table 1 lists the percentages of questions generated in the reviews by Chapters (1 to 9) in the SARPs and by ANL between 1986 and 1995 and between 1996 and 2001, and by LLNL. The percentages of questions in each SARP chapter differ somewhat between ANL and LLNL, but Structural (Chapter 2) and General Information (Chapter 1) are consistently ranked the highest among all chapters for ANL and LLNL. The two sets of ANL data also reveal an increase (by a factor more than 2) of percentage of questions in Criticality (Chapter 6), due to a particular SARP for which the applicant has changed the package contents and design approach (from finite to infinite arrays) several times during the review.

Table 1. Percentages of review questions by SARP chapters and by ANL and LLNL

SARP	Ch. 1	Ch. 2	Ch. 3	Ch. 4	Ch. 5	Ch. 6	Ch. 7	Ch. 8	Ch. 9
ANL* (1986-1995)	16.7	26.8	10.3	10.9	5.2	4.4	10.7	4.9	9.9
ANL** (1996-2001')	17.1	23.1	5.0	9.7	4.2	10.3	12.3	8.0	10.3
LLNL	22.7	30.8	10.0	8.9	5.2	5.6	7.4	3.9	5.6

*2,288 review questions in 35 SARPs.
**497 review questions in 4 SARPs.

SUMMARY

A methodology has been developed to rank the FAQs in SARP reviews. The method has been applied to 35 SARPs reviewed by ANL between 1986 and 1995 and validated with the questions generated by

ANL for 4 additional SARPs reviewed between 1996 and 2001. For the 39 SARPs reviewed by ANL between 1986 and 2001, the top 10 most frequently asked questions, in descending order, are:

Ch. 1 Provide identification of all materials (e.g., steel, wood, foam, seals, vent plugs, etc.) in the packaging with complete, authoritative (ASTM, etc.) materials specifications.

Ch. 1 Provide a complete set of detailed, legible engineering drawings of the packaging. (As-built drawings should be provided if packaging fabrication deviates from design.)

Ch. 2 Provide quantitative design criteria for each structural component of the packaging, if analysis is used for packaging qualification. Provide numerical values of the allowable stress/deformation limits for structural materials based on authoritative sources (ASME, etc.).

Ch. 2 Provide mechanical properties of all materials of construction of the packaging for the range of normal and hypothetical accident conditions (e.g., temperature, strain rate, etc.) expected for the packaging. For impact-limiter materials of a given density, stress-strain data as a function of temperature and strain rate should be provided.

Ch. 2 Provide evidence that the worst conditions (temperature, orientation) for maximum damage to the packaging have been used in the 9-m drop and puncture tests. Show that the puncture test damage is treated subsequently to and cumulatively with the 9-m drop test.

Ch. 9 Identify all QA requirements for the use of the packaging. Use of the packaging includes operation, acceptance testing, maintenance, and repair throughout the life cycle of the packaging.

Ch. 2 Provide analyses of lifting and tiedown devices for the packaging as prescribed in 10 CFR 71. An account should be provided in the SARP for possible lifting and tiedown of the packaging by unintended means.

Ch. 3 Provide justification for assumptions, and input and relevant output data for the thermal analysis performed for the packaging. Show that the computer program used in the analysis is a validated code, and that the hypothetical accident thermal event modeled is for the worst-case conditions.

Ch. 1 Provide a document-controlled SARP.

Ch. 9 Remove site-specific procedures and shipping/facility requirements from Chapter 9 of the SARP. Packaging-specific requirements must be specified in the SARP. Quantitative pass/fail criteria must be specified so that the desired result will be accomplished no matter who is performing the work.

The majority of these 10 most frequently asked questions in SARP reviews appear in General Information (Chapter 1) and Structural (Chapter 2), which corroborate with the trend identified in the statistical compilation of SARP review questions by chapters, and nearly so by chapters and contents. Thermal (Chapter 3), Containment (Chapter 4), Operating Procedures (Chapter 7), and Quality

Assurance (Chapter 9) are other areas where more problems were found in SARP preparation, as indicated in the historical data. These problem areas also point to the need for continuing the following Training Courses sponsored by the DOE Package Approval and Safety Program:

- Methods for Reviewing Safety Analysis Reports for Packagings (General).
- Application of the ASME Code to Radioactive Material Packaging (Structural).
- Quality Assurance for Radioactive Material Packaging (General and QA).

Proactive measures should be taken to disseminate the FAQs in SARP reviews to potential applicants in the field. Direct mailing of FAQs as part of a preapplication package, handouts of FAQs for future participants in the above Training Courses, and posting of FAQs on the web are among the means by which common problems in SARP preparation might be avoided for a more efficient process of packaging certification. The list of the FAQs in SARP reviews by ANL can be found at www.et.anl.gov/sections/thm/research/faq.html

ACKNOWLEDGMENTS
Work supported by the U.S. Department of Energy, Office of Safety, Health and Security (EM-5), under Contract W-31-109-ENG-38. The encouragement by Michael Wangler, the DOE Headquarters Certifying Official and Director, Package Approval and Safety Program, is greatly appreciated.

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