A Regulator's Perspective on Physical Testing for Type B Packages

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Abstract

The U.S. Nuclear Regulatory Commission has a great deal of experience certifying Type B transport packages as complying with the regulations in 10 CFR Part 71. With this experience base, supporting risk studies, and with an exceptional historical safety record for transport, we are very confident in both the current regulations and the methods we use to review and certify transportation packages. Nevertheless, we have a responsibility to remain vigilant and review our regulations and implementing practices with a view towards continuous improvement. NRC regulations permit certification through testing, analyses, comparison to similar approved designs, or combinations of these methods. Testing can be further broken into scale models, components, simple models, or full-scale models. NRC does not require full-scale testing for certification of any package; however, many applicants for package certification have conducted a physical testing program to demonstrate that the package design meets the hypothetical accident conditions. The plans for a repository at Yucca Mountain have raised significant interest in the United States of America in transportation of spent fuel, and created a broad stakeholder and public interest in transportation package testing. As an expected large increase in the number of spent fuel transports nears, this interest will likely grow. The technical and regulatory reasons for, or for not, performing tests need to be well understood and communicated to all stakeholders.

Speech

Introduction

Good Morning. Thank you for the opportunity to address this plenary session, and a special thanks to our conference hosts, for a very informative and interesting agenda and conference. This is my second PATRAM conference and I am markedly impressed with the outstanding papers and discussions. Of course the side discussions on the margins of the conference are also invaluable. Yesterday was extraordinary for many of us; marking the first time I, and I am sure many of you, have seen a full-scale regulatory drop test of a spent fuel cask. With that remarkable event, along with Friday=s additional test in mind, I thought a good use of my time would be to offer my views, as a regulator, on full-scale package testing. I am obliged to acknowledge that the views I am about to offer are my personal views and do not necessarily reflect the views of the U.S. Nuclear Regulatory Commission.

I have been the Director of NRC=s Spent Fuel Project Office for over five years. There have been several interesting events during this time B most notable is NRC=s response to the tragic events of September 11. This response included a wide range of actions including increased security for storage and transportation of radioactive material. During the last few years, we have seen a significant growth in dry cask spent fuel storage in the U.S. We have also seen a marked increased interest in the plans for transportation of spent fuel to the proposed high-level waste repository at Yucca Mountain. The increased attention on the safety and security of spent fuel transportation within the United States is evident at both the national and local level, the interest is not limited to the local Nevada area. Consequently, our interactions with transportation stakeholders have increased markedly over the past few years.

In the U.S., the Nuclear Regulatory Commission Spent Fuel Project Office approves designs for Type B and fissile material transportation packages. For these designs, an applicant must show that they meet the performance requirements established in our transportation regulations,10 CFR Part 71. Our regulations, as well as most other countries= regulations, are generally compatible with IAEA Regulations for the Safe Transport of Radioactive Material, TS-R-1. The NRC staff has a great deal of experience reviewing package designs. We issue about 100 approvals a year. These approvals include new certificates, amendments to certificates, and renewals of certificates. We also have a long history of sponsoring transportation research projects that support our regulatory approaches and conclusions with a view to improving safety.

This experience base, along with supporting risk studies, and an exceptional historical safety record for transport, lends support to the adequacy of our current regulations and the methods we use to review and certify packages. This point is worth reiterating B we are very confident in the adequacy of the current transport regulations and the methods used to demonstrate compliance with the regulations. Nevertheless, the NRC and all other national transportation regulatory agencies have a responsibility to remain vigilant in identifying and addressing potential weaknesses in its regulations and implementing practices. We must maintain a strong commitment towards continuous improvement in all aspects of our transportation program. This is especially true in the U.S., as we prepare for an expected large increase in the number of spent fuel transports.

Regulatory Base and Testing

Let me say a few words about the NRC regulations and regulatory process as they relate to testing. NRC regulations permit certification through testing, analyses, comparison to similar previously approved designs, or combinations of these methods. The testing aspect of the certification requirements can be further evaluated and demonstrated by scale models, component, or full-scale testing. NRC does not require any particular method be used, including full-scale testing, for certification of a package. The burden of demonstrating that the package design meets the regulations lies with the applicant. The NRC technical staff independently reviews the applicant=s safety case. Our review of an application is focused on safety, as confirmed through the applicant=s demonstration. I will note that the package design performance standards cover a wide range of accident scenarios. We do not require or expect an

applicant to perform scientific research, testing, or design optimization/improvement outside the bounds of the regulations.
The decision on the method of demonstration is solely the applicant=s. For some packages and for various reasons, full-scale tests can be the most timely, practical, and economical means for an applicant to demonstrate compliance to the NRC. Typically, spent fuel casks have been evaluated through a combination of engineering analyses and scale or component testing, while many other packages, as I noted, are evaluated using a combination of full-scale testing and analyses.

We very much welcome the full-scale spent fuel cask tests this week. We have long believed that there would be a lot to learn from such tests, in terms of our analytical and modeling capabilities and treatment of scaling. From a regulator=s point of view, the full-scale test provides valuable insights that will help focus our review, in a risk-informed way, on those aspects of the design that contribute most to safety. As I noted, several spent fuel cask vendors have demonstrated to the NRC staff, a reasonable assurance of compliance with the regulations without a full-scale test, using combinations of modeling approaches, scale and component tests. However, that is not the same as saying that a full-scale test would not or does not add great value to the safety case. This is an important point to emphasize, a full scale test does add value to the safety case. In that regard, NRC has actively engaged with GNS on their testing program for the CONSTOR cask through several pre-licensing interactions to share information and learn and understand the purposes and pretest expectations for the tests. Such pre-licensing interactions between the regulator and applicant are key to an effective and efficient review process. We very much value and welcome the initiative by GNS and Mitsubishi to perform the full-scale spent fuel cask tests this week.

Each spent fuel shipping cask design NRC has approved has undergone some form of a scale model physical test program. Because of the relatively smaller size of, for example, a quarter scale model, drop tests can be conducted more easily for many drop orientations to meet the multiple test requirements. However, we all recognize that in some cases, certain parameters are not amenable to scaling laws. For example, leak rates, fire duration, fire intensity, fabrication techniques (such as the size of the heat affected zone near welds) and material properties (such as wood grain size in impact limiters) are parameters which can be difficult to properly scale. If these parameters are design drivers, a bounding analysis may not be pragmatic, and a scale test alone may not provide sufficient assurance that the design meets compliance requirements. In some cases, a full-scale compliance test might be the preferred choice. For spent fuel casks, resolution of these types of issues from a regulatory compliance point of view has not required full-scale testing. In general, based on historical industry design efforts and our own historical oversight activities, the current practice of scale model drop tests and detailed finite element, numerical analysis provide reasonable assurance that spent fuel casks can safely be transported.

There are as well, many cases where applicants have decided that full-scale testing was preferred and has proved beneficial. For example, the TRUPAC-II package is a large (10-ton) package designed for transport of transuranic waste materials. The NRC first certified the TRUPAC-II design in August 1989, and the Certificate has been amended several times since then. The

package performance was demonstrated by a rigorous full-scale test program, which included the regulatory accident test sequence. Similar to our interactions with GNS in their package testing and pre-test evaluations, the NRC staff had significant interactions with the applicant for the TRUPAC II transportation package. Partly in light of the TRUPAC II=s unique design features including the use of certain type seals, the applicant was successful in obtaining certification by using a full-scale test program supplemented by analyses, rather than a very complicated modeling and analytical program. In the U.S., the TRUPAC-II certification testing program and the public outreach associated with it has been often cited as a very successful model for simultaneously demonstrating regulatory compliance and gaining greater public understanding. A large fleet of TRUPAC-II packages is now being used for transuranic waste shipments to the Waste Isolation Pilot Plant in New Mexico.

Types of Full-scale Testing

I will now discuss the rising level of public interest within the United States in performing full-scale spent fuel cask tests. This discussion will set the stage for my introducing or describing the types of physical testing programs, and the considerations for performing full-scale testing of spent fuel transportation casks.

Activities associated with the proposed high-level waste repository at Yucca Mountain, Nevada, have and will continue to raise significant interest from the public and interested stakeholders with respect to the transportation of spent fuel. The NRC plans to perform a study, we refer to as the Package Performance Study, which will include a full-scale test of a spent fuel transportation rail cask. NRC staff has conducted numerous open public meetings soliciting input on what type of tests should be performed. The meetings attracted a wide range of interested stakeholders including representatives of national, state, and local government, as well as several interest groups. The NRC staff developed options for testing which considered the public concerns, and we have proposed a framework for a full scale test which is currently before the Commission for consideration. Bret Tegeler from NRC=s Office of Nuclear Regulatory Research will speak to you tomorrow on the specifics of the NRC Package Performance Study. As a decision on the construction and operation of the proposed Yucca Mountain high-level waste repository draws near, I clearly expect an increasing public interest in transport package testing. Interest in full-scale package testing has also been reflected in comments and recommendations by state and national elected officials= remarks on spent fuel transportation.

From a technical standpoint, I believe that we clearly can make the case that the casks are designed to meet adverse and significant accident conditions, based on a successful demonstration that the cask meets the regulations= hypothetical accident condition tests. However, from a communications and outreach perspective, the case is not always convincing. I=ll add that we, the transportation experts, have not traditionally done a good job of communicating how the regulatory tests translate to real world accidents in terms that people can understand. To a concerned citizen, a 30 foot (or 9 meter) drop test which results in a 30-mile-per-hour (or a 50 km-per-hour) impact does not seem severe or reflective of reality, as vehicles routinely travel at twice or in some cases even triple that speed. Further, many people do not

understand the scientific meaning of an unyielding surface used in the drop test. In addition, although many people might agree that the casks are relatively straightforward engineered structures and are analyzable with engineering principles of physics and scaling, taking a common-sense approach, one might say why not test at full-scale just to be sure the design is safe.

The public comments we have received on the Package Performance Study on physical testing lead me to summarize the potential reasons for and types of full-scale physical testing programs, and who might best perform the tests. In our outreach meetings and interactions on the Package Performance Study, we have noticed that there is a communications gap and perhaps a misunderstanding, with respect to the types and goals of full-scale tests.

In general, physical testing programs can be categorized by their objectives. Four categories or types of physical testing programs could include developmental tests, compliance tests, benchmarking tests, and research tests.

Developmental tests are typically and mainly used by designers, to support a preliminary trial design and to economize the design process. The tests provide physical interpretation of the prototype packages and aid the designer in interpreting the structural performance of the package. There may often be no regulatory role in these tests.

Compliance testing is, naturally, testing to demonstrate the design against the regulatory requirements. These tests are typically initiated by the applicant. If used in a public outreach effort, much care must be taken to explain how the regulatory tests will translate to real-world accidents. I will hasten to add that regulatory testing may not answer public questions if the questioner doubts the severity of the regulations and test conditions themselves.

Benchmark or model validation tests are mostly used by engineers to independently check analyses. Generally, and for efficiency and broad applicability, these tests can focus on eliminating errors that can affect the conclusions, rather than disclosing minor computational issues. When enhanced computer-aided design tools are used, an independent check through physical testing of a component or prototype is very powerful tool to support the safety case showing regulatory compliance.

Finally, the fourth type of test is a research test. I will mention two types of regulatory research tests sponsored by NRC which we refer to as confirmatory and developmental research. Confirmatory research, such as the NRC package performance study, can be used by regulators to confirm the adequacy of a regulatory approach or requirement. Developmental research, for example, could have the goal of changing regulations or developing a new approach. The type of tests performed in this case might exceed regulatory requirements in order to investigate safety margins. The results would presumably benefit regulators, cask designers and users, and advance the public understanding. This research would often be sponsored and conducted by the regulator or by a collaborative effort with industry or interested organizations.

As I mentioned, NRC initiated the Package Performance Study, which we consider to be a confirmatory research program, to study the response of spent nuclear fuel transportation casks to extreme accident conditions.

Conclusion

Let me conclude by again welcoming, from my perspective, the full-scale tests being performed this week. As we begin to examine and further understand the test data, I am sure we will gain information that will improve cask design techniques, transport safety and our broader understanding of the robustness of the spent fuel transportation casks. This will in turn contribute to maintaining the exceptional record of safety that the world-wide transportation industry has compiled B a safety record, by any measure, of which we all should be proud.

Thank you. I look forward to our continued dialogue and interactions today, during the rest of this conference, and in our continued transportation program interactions.