

SAFETY GUIDE 600—A GUIDE FOR THE TESTING OF SMALL FISSILE MATERIAL PACKAGES

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ABSTRACT

A revision of Safety Guide 600 (SG-600) entitled *Regulatory Compliance Testing of NNSA Type B Packages* was sponsored by the U.S. National Nuclear Security Administration (NNSA) Service Center, Package Certification Division (PCD). The NNSA has the authority to certify Type B packages containing materials of national security interest. SG-600 has been thoroughly revised and reissued. This paper reviews the revised Guide and its recommended approach to the testing process.

The revised SG-600 addresses the following primary subject areas of the package testing process (1) oversight authority, (2) applicable federal regulations, (3) quality assurance program, (4) test plan, (5) testing, and (6) test report in individual chapters. Since the relationships and interactions among these subject areas are of paramount importance to the testing process, they are presented both graphically and in text in the first chapter of SG-600.

BACKGROUND

The U.S. Department of Transportation (DOT) has overall responsibility for the packaging and transportation of hazardous material transported domestically in the United States, and internationally in and out of the United States. The DOT in Title 49 Code of Federal Regulations (CFR) 173.7 grants the U.S. Department of Energy (DOE) the authority to certify radioactive material shipping packages provided that the packages are evaluated against standards equivalent to those specified in 10 CFR 71.

Department of Energy Order 461.1A assigns the responsibility for approving and issuing offsite transportation certificates (OTCs) for packages containing materials of national security interest to the Director of the National Nuclear Security Administration (NNSA) Service Center (SC) in Albuquerque, New Mexico. An OTC is synonymous to a U.S. Nuclear Regulatory Commission (NRC) certificate of compliance. The NNSA SC's Packaging Certification Division (PCD) is responsible for reviewing applications and the supporting safety basis documents submitted in support of package certification requests. The principal safety basis document required to support NNSA certification requests is the safety analysis report for packaging (SARP). The SARP like the NRC required safety analysis report follows the content and format specified in NRC Regulatory Guide 7.9 plus additional NNSA specified requirements. Therefore, the SARP, and if applicable supporting documents, must demonstrate that the proposed package meets the criteria specified in 10 CFR 71. Sections 10 CFR 71.71 and 71.73 specify the tests, and test conditions which the proposed packages must be subjected to and 10 CFR 71 Subpart E specifies the criteria which these packages must meet when subjected to these tests. The PCD has created a series of documents titled Safety Guides, or SGs. A principal intent of these SGs is to ensure that all NNSA SARPs address all of the regulatory

required information, data, and analyses, including information on the tests and test results, needed to demonstrate whether the package meets or does not meet regulatory requirements. The primary goal of SG-600 is to document successful testing practices that have resulted in certified Type B packages and to make the information on these practices readily available to NNSA organizations and/or individuals who can benefit from its use.

PCD contracted with the Oak Ridge National Laboratory (ORNL) Transportation Technologies Group to revise the previous edition of SG-600. SG-600 Revision 2, issued in September 2007, describes the following primary subject areas of the package testing process: (1) oversight authority, (2) applicable federal regulations, (3) quality assurance program, (4) test plan, (5) testing, and (6) test report. There are individual chapters dedicated to each of these six subject areas of the testing process. In addition, the relationships and interactions among all of these subject areas are of paramount importance to the testing process. These relationships and interactions are discussed in the first chapter of the SG.

SG-600 INTRODUCTION

The first chapter of SG-600 Revision 2 provides an introduction that includes an overview, a discussion of the SG's intent and scope, and a discussion and definition of terms specific to the Guide.

The Overview section includes Figure 1 (included below), which graphically portrays the relationships between each of the primary subject areas covered in the remainder of the document. The figure illustrates the interaction among the competent authority (in this case, NNSA SC), the federal regulations (primarily 10 CFR 71, but also 49 CFR as well as DOE Order 461.1A), quality assurance (QA) programs for testing, the test plan, the actual performance of the tests, and the test report. The competent authority is responsible for ensuring that the applicants and associated organizations comply with the applicable federal regulations. In relation to testing of radioactive material packages this includes ensuring that a QA program for the test program under which the tests are conducted, the test plan, the test processes and procedures, and the test report all comply with the requirements specified in 10 CFR 71. The QA program under which testing is performed has a direct impact not only on the actual tests but also on the test plan and the test report. The test plan is a principal document for ensuring that the prescribed tests support the proposed package's certification and is therefore critical for ensuring that the tests are conducted as specified in the regulations and to the information documented in the test report. Figure 1 shows that the testing provides input to the test report in which the results of the testing process are published. Finally, Figure 1 shows how the test report completes the process loop by providing input to the competent authority through the safety basis submission and approval process.

The SG's Intent section explains that the SARP is the principal safety basis document supporting the application for an OTC, and that the SARP must provide descriptions of the testing processes, include information to demonstrate that the tests were performed as specified in the regulations and supporting DOE/NNSA documents, and include appropriate recording/documentation of the test results and the correct interpretations of the test results within the SARP both by direct discussion and by reference to the test report.

The scope of SG-600 is defined as covering all aspects of testing Type B packages used for the domestic transport of radioactive materials by land or sea. It does not cover packages that are designed to transport less than a Type B quantity of radioactive material, or packages proposed for the transport of either plutonium or other fissile materials by air. The SG's Scope section provides a brief description of the information contained in each of the subsequent six chapters.

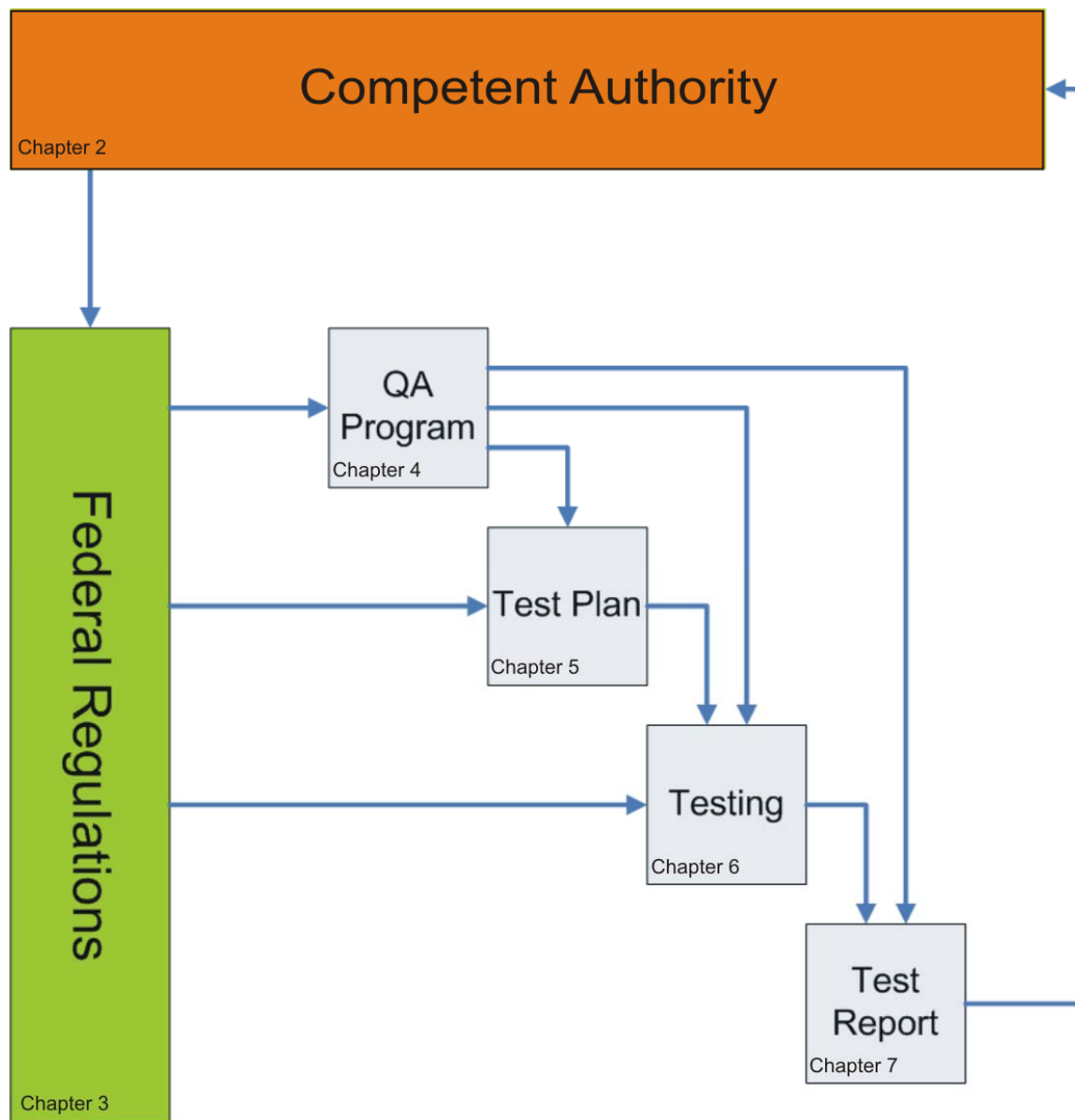


Figure 1. Overview of primary subject areas of Type B compliance testing (depicts relationships among primary subject areas/activities).

The Introduction chapter defines two terms that are used throughout the SG but are not found in related literature. These terms are *testing authority* and *design authority*. “Testing authority” is used in SG-600 to identify the individual, working group, or organization that is directly responsible for testing, including writing the test plan, performing all tests or subcontracting for such test to be performed, and documenting the testing process and associated test results in a test report. Similarly, “design authority” is used to identify the individual, group, or organization that is directly responsible for the design of a Type B package. The distinction between these two entities is important because 10 CFR 71 requires that there be a level of independence between those designing the package and those performing the tests.

COMPETENT AUTHORITY

This chapter provides brief descriptions of how the U.S. competent authorities for radioactive material packages, and NNSA in particular, carry out their responsibilities. This chapter also provides a brief discussion of the DOT and NRC authorities for Type B packages and a discussion of the DOE order that applies to NNSA Type B packages, and its impact on testing requirements. This information is included in the SG to help prospective testing authority staff better understand the basis for the tests specified by the regulations and the NNSA competent authority's expectations.

REGULATORY ANALYSIS AND INTERPRETATION

The information presented in this chapter is intended to help the prospective testing authorities understand the 10 CFR 71 requirements that must be met to conduct a successful package testing project. The information presented is also intended to help the prospective testing authority and other organizations with related functions (such as design authority and SARP preparing organization) understand the competent authority's need for specific information, as well as the nuances of the package testing process.

10 CFR 71 specifies three types of requirements relevant to the testing of Type B packages. These requirements are specified in Subparts E, F and H. The following is a synopsis of these Subparts and the requirements which they specify:

- Subpart E (10 CFR 71.41 through 10 CFR 71.65) *Package Approval Standards* specifies the standards to which a proposed Type B package must be evaluated when subjected to the effects of the tests specified in 10 CFR 71.71, 10 CFR 71.73 and 10 CFR 71.61.
- Subpart F (10 CFR 71.71 through 10 CFR 71.77) *Package, Special Form, and LSA-III Tests* specifies the normal conditions of transport, hypothetical accident conditions, accident conditions for air transport of plutonium, and qualification of special form and LSA-III materials tests.
- Subpart H (10 CFR 71.101 through 10 CFR 71.137) *Quality Assurance* specifies the quality assurance requirements applicable to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of components of packaging that are important to safety.

This chapter quotes each Subpart E and F section and provides a discussion as to how they relate (or do not relate) to package testing. A table lists each subsection and its title, indicates if the information contained in that subsection is applicable to the guide, and lists the guide section in which it is discussed. For 10 CFR 71 subsections that discuss testing requirements that are within the scope of this SG, this chapter contains an explanation of how the NNSA competent authority interprets the regulatory requirements contained in those subsections. It also contains a brief discussion of 10 CFR 71 Subpart H.

QUALITY ASSURANCE REQUIREMENTS FOR TESTING PROGRAMS

This chapter specifies that all testing processes must be performed under the auspices of a QA program. It also provides guidance on the type of QA program that must be in place before any of the Type B package testing processes may begin. The discussion centers on how the 18 points outlined in 10 CFR 71 Subpart H are to be implemented through an established QA program. The SG specifies that although the testing authority is not required to have a QA program which is fully compliant with 10 CFR 71 Subpart H, the testing authority must operate under a QA program which covers the 10 CFR 71 Subpart H requirements applicable to testing. The chapter provides a crosswalk between the 18 elements of a 10 CFR 71 Subpart H QA and the 10 elements of a 10 CFR 830.122 based QA program.

The chapter also discusses each of the eighteen 10 CFR 71 Subpart H elements and describes how each element affects the testing process. This information is provided to assist the user establish a QA program specifically tailored for Type B package testing.

PACKAGING TEST PLAN DEVELOPMENT

As stated in 10 CFR 71.111, *Instructions, Procedures, and Drawings*, all activities affecting quality must be performed based on documented instructions, procedures, or drawings, which must be followed. Package testing is such an activity, and the instructions, procedures and sometimes drawings that specify the testing process are typically contained in a test plan. Furthermore, 10 CFR 71.123 *Test Control* states that a test program must, “assure that all testing required to demonstrate that the packaging components will perform satisfactorily in service is identified and performed in accordance with written test procedures that incorporate the requirements of this part and the requirements and acceptance limits contained in the package approval.”

The SG notes that in addition to being required by 10 CFR 71, creating a comprehensive test plan before beginning the testing activities has other benefits. For example, it provides opportunities to:

- lay out the test sequence and ensure that all required test elements and all required test facilities, test personnel, and test and data recording equipment are identified and included;
- foster a clear understanding between the testing authority and the design authority as to what the testing will entail;
- enable the design authority to determine if the proposed testing meets regulatory requirements;
- compare the content weight, shipping (packing) configuration, center of gravity, etc. of the proposed package with those of the test units and to identify any differences, determine their significance, communicate them to the design agency/applicant, and make adjustments, if needed and possible;
- document many items that are pertinent to QA, such as equipment calibration information and procedural references; and
- develop, finalize, and document graphical illustrations of test orientations to ensure there is no miscommunication between the individuals who design the test processes and the individuals involved in performing the tests.

This chapter also describes a format for test plans that has been used to successfully meet the 10 CFR 71 requirements, and successfully guide many Type B package testing projects.

TESTING PROCEDURES AND METHODOLOGIES

This chapter describes all of the activities necessary to complete a successful testing program. The discussions cover test preparations, actual testing activities, and post-test activities that must be completed during a testing project.

The Test Preparations section contains subsections devoted to facilities and to pre-test preparations. The Facilities subsection contains details on the drop pad and thermal test facility requirements, and describes the infrastructure and the testing hardware typically required for performing a complete Type B package test sequence. The Pre-test Preparations subsection describes the processes of test unit receipt, test unit assembly, test unit conditioning, test unit measurements, and control of the testing area. Each of these processes is important to a successful testing program. Test unit receipt must include a process to demonstrate that the various package components being used are the correct components specified by the design

authority. Test unit assembly must be performed in consonance with how an actual package would be assembled for an actual shipment. Measurements of the test unit (e.g., dimensional, weight), as described in the test plan, must be performed and recorded for comparison with the same measurements taken of the post-test units. Finally, from the time the test unit components are received until all testing and post-test activities are complete, the testing area must be controlled to ensure that the conditions of the test units are affected only by the tests to which the test units are subjected.

The Testing section describes each of the normal conditions of transport (NCT) tests, including vibration, water spray, free drop, compression, and penetration; and the hypothetical accident conditions tests, including free drop, crush, puncture, thermal, immersion–fissile material (0.9 m), and immersion–all packages (15 m). In this section, ORNL’s 40-plus years of Type B package testing experience provides insight into how specific tests are typically performed and what pitfalls may await an inexperienced testing authority. It also provides detailed descriptions of how each of the regulatory specified tests can be successfully performed.

The Post-test Activities section describes the test unit disassembly and post-test leakage-rate process necessary to complete a successful testing project. The Test Unit Disassembly subsection provides a detailed discussion on this subject, and it includes a discussion on the data that should be gathered during this process. The Post-test Leakage-Rate Testing subsection includes a discussion on helium leakage-rate testing.

TEST REPORTING

The test report documents the tests performed, and the associated test results. Test information, data, and test results not contained in the test report cannot be used in the package certification application. Therefore, it is absolutely essential to ensure that the test report contains a comprehensive, thorough description of the tests performed and the results of those tests.

This chapter provides an outline for a test report that has been successfully used to document Type B package tests. The chapter details each of the test report sections used and suggests how various forms of data can be presented in a comprehensive test report.

APPENDICES

The SG includes two appendices. The first appendix includes a sample data sheet and a sample procedure checklist to convey the level of detail that should be included in these documents. The second appendix provides a sample test procedure for an NCT free drop test that includes the checklist and data sheet that could be used for this test.

CURRENT SG-600 STATUS

SG-600 revision 2 is publicly available through the internet at <http://otac.doeal.gov/SafetyGuidesRpt.aspx>.