Testing Capabilities at the National Transportation Research Center

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Abstract — The National Transportation Research Center (NTRC) is a joint venture of the U.S. Department of Energy (DOE), Oak Ridge National Laboratory (ORNL) and the University of Tennessee (UT). The NTRC has extensive capabilities to test full-scale and model packages that have been designed to the testing requirements of the Code of Federal Regulations, Title 10, Part 71.73. These are essentially the same tests that are specified in the International Atomic Energy Agency (IAEA) Safety Standard ST-1, *Regulations for the Safe Transport of Radioactive Material*, 1996 Edition. This report provides information about the facilities and capabilities of the Center.

INTRODUCTION

The National Transportation Research Center (NTRC) is a joint venture of the U.S. Department of Energy (DOE), Oak Ridge National Laboratory (ORNL) and the University of Tennessee (UT). The NTRC, established to be an independent, not-for–profit organization, will be completed and operational by October 2000. The 60,000 square foot facility contains offices for 150 staff personnel and a wide variety of laboratories that are dedicated to supporting the needs of private industry in all areas of transportation.

Figure 1. The National Transportation Research Center

TEST FACILITIES

One of the many focus areas of the NTRC complex is the Materials Packaging Laboratory (MPL). This facility can be used to test small packages to Type A package requirements. In

addition, outside package test facilities are available for use in order to test to Type B package requirements.

The ORNL Transportation Technologies Group (TTG) manages the MPL and operates all packaging test facilities. As a result, the TTG provides a one-stop shop for design, testing, and certification of a wide variety of packages needed for the shipment of radioactive materials. The TTG also provides the point of contact for integrating the capabilities of the entire Oak Ridge complex to the development of these packages.

Materials Packaging Laboratory

The MPL builds upon the extensive package design, evaluation and testing experience at ORNL carried out since the early 1960s. The MPL provides the capability to conduct a wide variety of performance tests that are capable of supporting the design and testing required for Type A packages. The general layout for the MPL is shown below.

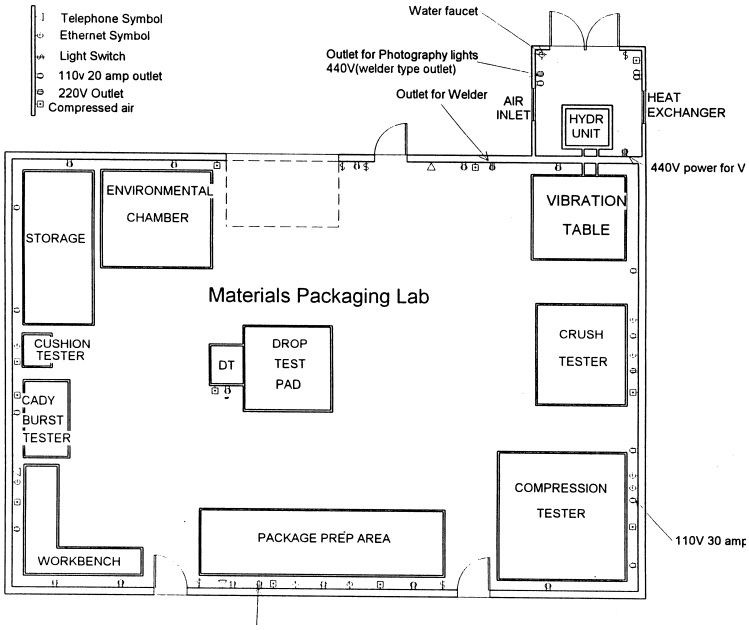

Figure 2. Layout of the Materials Packaging Laboratory.

<u>Available equipment</u>

- Vibration table, Lansmont
  10,000 lb. capacity

- Drop tester, Lansmont
  125 lb. capacity

- Cushioning tester, Lansmont
  5-ft drop height

- Compression tester, Lansmont
  30,000 lb. capacity
- Indoor drop test pad

The 2,400 square foot Laboratory has a 5-ton overhead bridge crane to aid in the movement of package specimens.

Outside Test Facilities

Test capabilities which are available outside the physical confines of the NTRC Laboratory include:

- 30 ft drop tests of packages weighing up to 10,000 lb onto a solid, unyielding surface;
- Puncture tests of packages weighing up to 10,000 lb and carried out at various orientations;
- Crush tests of packages dropping a 500 kg weight from 30 ft onto the package;
- Penetration tests and compression/stacking tests.

Figure 3. Drop testing packages—a 30 ft drop test.

Impact Pads

The NTRC has access to three drop pads. The impact pad located inside the MPL is constructed with a reinforced concrete reaction mass of 14 tons with a 5-ft square-impacting surface. The new outside impact pad at the NTRC has a reaction mass of approximately 100 tons with a steel-impacting surface that is 8 ft wide, 20 ft long and 4 in. thick. An older drop pad has a reaction mass of about 60 tons, but does rest on bedrock, increasing its effective mass. Its impacting surface is 5 ft wide and 17 ft long.

CAPABILITIES

Shock and Vibration Analysis

Packages are subjected to shock and vibration environments when exposed to normal conditions of transport as well as hypothetical accident conditions. Utilizing the vibration tester, the Materials Packaging Laboratory can subject packages weighing up to 10,000 lb to various vibration patterns to which they might be exposed during transport. The reaction of packages to such environments can be monitored by equipping them with accelerometers.

Dynamic Data Acquisition Capability

Data acquisition, as applied to drop testing of packages, consists of transducers sized for the expected shock and frequency range, signal conditioning electronics, and a recording and/or analyzing instrument. The type and range of the transducers, as well as the entire data acquisition system, are selected for the tests once the end use of the data is understood.

Data can be recorded digitally on a wide-band recording device that utilizes AIT digital tape or through-digital analyzers. Both devices are time coherent in their acquisition of signals and store the data in anti-aliases digital format.

This allows the data to be post processed at various filter ranges as required by the customer. Any section of the time domain signal can be post processed by filtering at various cutoff frequencies, plotted as magnitude versus frequency (FFT), sections magnified and analyzed, etc.

Data both raw and analyzed can be electronically transmitted to the customer in several formats. These include:

Hewlett Packard SDF format
MATLAB format
Intel x86 Binary
ASCII either comma, tab or space delineated format.
Excel format

The transducer signals are conditioned through computer-aided signal conditioners that do a startup calibration automatically. The recording and analysis instruments also do manual self-checks at each startup. Manual calibration of the entire system from transducer to recording device is accomplished with a field exciter that generates a known calibrated excitation signal which is measured by the system and whose calibration is traceable to an NIST (National Institute of Standards and Technology) value.

Metrication Laboratory

The Metrication Laboratory (ML) supplies trained and qualified personnel to carry out all dimensional and weight measurements that are required by sponsors to be accurate in accordance with the approved QA plan. The accuracy of all measuring equipment in the Lab is traceable to NIST standards.

Leak Test Equipment

Leak testing equipment is available through the Quality Engineering and Inspection (QE&I) Department, including pressure gauges, helium leak detectors, etc. The equipment is periodically calibrated, traceable to NIST standards. QE&I personnel are qualified to operate all leak test equipment.

Photometrics

Professional photographers are available for recording the testing activity and the results of the test. Photo coverage normally entails the use of real time video equipment, high-speed motion pictures (which are converted to VCR format for subsequent use) and still photography. All still shots employ digital cameras and the results are placed on a specially-identified temporary web site from which the photos can be downloaded on a PC.

Special Services

Not infrequently sponsors have requested unanticipated activities in connection with tests that have been carried out for them. For example, in several cases, when an impact limiter did not behave as expected, sponsors requested the limiter be sectioned so internal parts could be inspected and behavior of the limiter could be evaluated before testing continued. Frequently, the information would be needed within hours of the request and personnel at the Laboratory have always been able to provide these special services in the time frame required. Other unanticipated requests have involved millwrights and welders who are generally available on short notice.

ENGINEERING SERVICES

Many technical disciplines can be involved in creating a package for a specific purpose and to ensure that it can move safely throughout the shipping environment by whatever mode is chosen. These disciplines can include, for example, structures, heat transfer, criticality, shielding, containment, materials of construction, vibration, tiedowns (load securement), testing, and routing. Knowledge of standards as well as Federal Regulations that apply to shipping hazardous materials can also affect the package design in a number of ways. The TTG staff is experienced in, familiar with, and carries out, activities in all these areas.

In addition to carrying out various package design and testing-related tasks in-house, TTG offers consulting services for those organizations that simply need specific information on whether a particular package can meet current regulatory requirements. In addition, analytical studies can often be used to determine what tests are likely to produce the most damage and thus support testing plans.

Structural

Access to DYNA3D finite element structural code allows engineers to evaluate the affect of impact on packages and to estimate the corresponding degree of shock loading on package contents. The evaluation can also provide guidance on how the package might be tested; the evaluation can help pinpoint any potential structural weaknesses in the design.

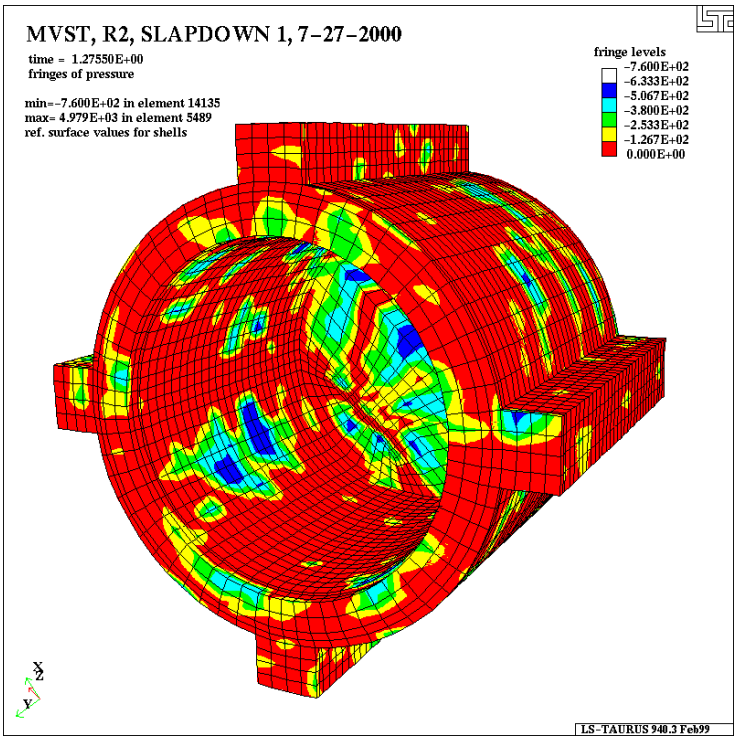

Figure 4. Analysis of a concrete shield dropped from a height of 1 m.

RECENT EXPERIENCE

In the past several years the TTG Group has tested a variety of packages, including scale models of large, spent fuel shipping casks, and full-size fresh fuel packages. Tests applied to the spent fuel cask models were to determine the adequacy of impact limiters designed to reduce shock loading on the cask in an accident. Tests applied to the fresh fuel packages were to determine the adequacy of internal structures used to protect the fresh fuel. Sponsors included:

Holtec International
Nuclear Assurance Corporation (NAC) International
Framatome-Cogema Fuels
ABB-Combustion Engineering

REFERENCES

LMER (Lockheed Martin Energy Research Corporation, Inc.). 1998. *The Radioactive Materials Packaging Handbook (Design, Operations, and Maintenance*), ORNL/M-5003, Oak Ridge, Tennessee.

AVAILABILITY OF SERVICES

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