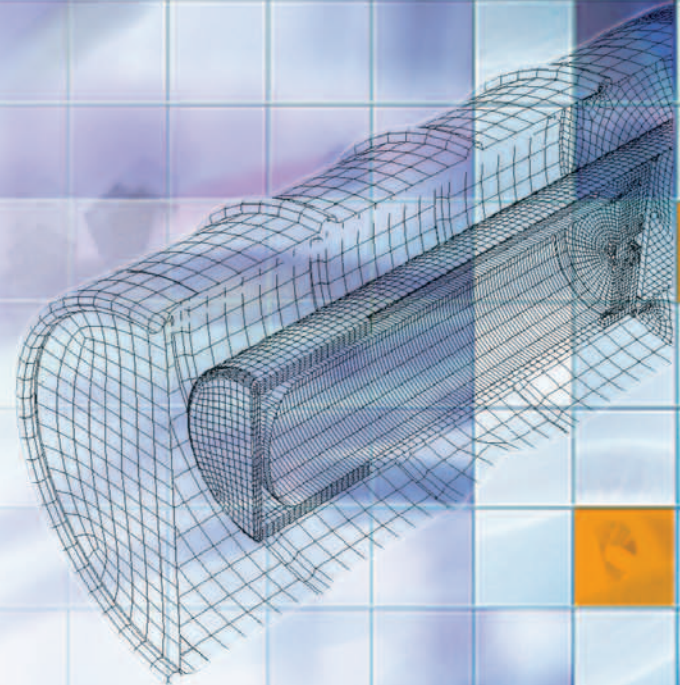


PACKAGING CERTIFICATION PROGRAM

SUCCESS STORIES, CHALLENGES, AND STRATEGIC DIRECTIONS



VISION

“The PCP is designed to meet the challenging requirements of packagings for storage, transportation, and disposal of radioactive and fissile materials across the DOE complex for the next decade and beyond. By employing the concept of virtual laboratories, we will continue to use our experience and expertise to improve the process of certification of radioactive material transportation packagings. We will also conduct packaging QA audits, testing, and field assessments to verify compliance and validate performance. In addition, we plan to engage in the life-cycle management of packaging by expanding into the certification of radioactive material packaging for long-term storage and disposal. We have also identified new activities that include the development of packaging storage standards and aging management programs, as well as the application of advanced technologies, such as radiofrequency identification.”

*Dae Y. Chung
Headquarters Certifying Official
Deputy Assistant Secretary
Office of Safety Management and Operations*

For more information, contact:

Dr. James M. Shuler
Manager, Packaging Certification Program
U.S. Department of Energy
EM-60, CLV-2047
1000 Independence Ave., SW
Washington, D.C. 20585
301-903-5513
301-903-9770 fax
James.Shuler@em.doe.gov

Top Aluminum
Bearing Plate

Top Aluminum Plate

SCV

PCV

Source

Aluminum
Honeycomb
Spacer

Aluminum
Honeycomb
Insert Absorber

34.0
34.0

1.41
1.80

30.5
29.8

28.9
28.4

27.2

25.19
24.69

25.3

180

175

2.94
3.21

2.34
2.46





ABOUT THE PROGRAM

The **Packaging Certification Program (PCP)** of the U.S. Department of Energy's (DOE's) Environmental Management (EM), Office of Safety Management and Operations (EM-60), ensures the safety of packagings for hazardous materials to support vital DOE missions across the Complex, as well as EM's risk reduction, cleanup, and closure activities.

The purpose of this essential DOE-wide asset is to protect the public, DOE employees and contractors, and the environment and property in a transportation incident and/or accident involving hazardous materials — including DOE radioactive materials.

PROGRAM SCOPE

The PCP, through its contractors (Argonne National Laboratory [ANL], Lawrence Livermore National Laboratory [LLNL], Oak Ridge National Laboratory [ORNL], Savannah River National Laboratory [SRNL], and Eagle Research Group), performs multiple functions to support packaging certification:

- Technical review of the Safety Analysis Report for Packaging (SARP),
- Development of guidance documents,
- Training,
- Packaging quality assurance (QA) audit and field assessment,
- Database and docket management, and
- Testing and methods development.

The PCP provides internal coordination within DOE for all matters pertaining to hazardous materials packaging certification and transportation safety per DOE Order 460.1B (Packaging and Transportation Safety). The PCP provides external coordination between DOE and other governmental, commercial, and international organizations regarding packaging certification and transportation safety, including participation in the development of packaging standards and transportation policy affecting packaging by national and international organizations.

The PCP also addresses the concerns of internal and external stakeholders in developing, coordinating, and implementing policies, standards, DOE Orders, and guidance related to aviation, maritime, rail, highway, pipeline, and hazardous materials safety per DOE Order 460.1B.



To effectively accomplish the mission of the PCP, program staff must possess multidisciplinary and highly technical capabilities (e.g., structural mechanics, radiation physics, nuclear engineering, fire dynamics expertise), along with adequate knowledge and understanding of the various safety standards and regulations.

MISSION

The mission of the PCP is to ensure the safety of packagings for hazardous and radioactive materials and support vital DOE missions across the Complex, as well as to support EM's risk reduction, cleanup, and site closure activities. The Deputy Assistant Secretary for the Office of Safety Management and Operations is the Headquarters Certifying Official (HCO) for DOE packaging certification, QA audits, and waste packaging operations.

ABOUT PACKAGING

Packaging refers to a container and all accompanying components or materials necessary to perform its containment

function. Packagings used by DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in Department of Transportation (DOT) hazardous materials regulations (Title 49 of the Code of Federal Regulations [CFR] Subchapter C).

For relatively low-level radioactive materials, DOT Specification Type A packagings are used. For fissile materials in Type A packagings, the pertinent regulations in Title 10 of the Code of Federal Regulations, Part 71 (10 CFR Part 71), must be satisfied. These packagings are designed to retain their contents under normal transportation conditions.

Shipments of high-level radioactive materials require the use of highly robust Type B packaging, which is designed and tested to prevent the release of contents under both normal conditions of transport and hypothetical accident conditions prescribed in 10 CFR Part 71.



GOALS AND STRATEGIES

The goals of the program are comprehensive, attainable, and rigorous:

GOAL 1: Ensure safety, health, and protection of the environment

STRATEGY: Achieve goal by enforcing safety standards and regulations

GOAL 2: Improve certification procedures and practices

STRATEGY: Achieve goal by continuing process improvements, training, communication, and lessons learned

GOAL 3: Verify compliance and performance

STRATEGY: Achieve goal by conducting QA audits and field assessments

The PCP has achieved these goals by implementing specific activities that address each goal. Continuing success in overcoming challenges depends on adequate resources and enhanced infrastructure.

STRATEGIC HIGHLIGHTS

Radioactive Material Packaging (RAMPAC)

RAMPAC is a DOE packaging asset that is used worldwide. It also provides information and protocols for the PCP. The RAMPAC website (www.rampac.com) is an all-in-one source for information on shipping containers for radioactive materials. The major areas of information available through RAMPAC are shown in the image to the right.

RAMPAC is a searchable database for many packagings and Certificates of Compliance (CoCs) issued by the Nuclear Regulatory Commission (NRC), DOE, and DOT. The database search can be

conducted on the basis of three criteria: (1) general information, such as CoC number, CoC type [e.g., AF, B(U)F-96]; model name/number; type of container (e.g., drum, cask); (2) contents (e.g., isotope, chemical form); and (3) packaging dimensions (e.g., length, width, gross weight, capacity). The result of a search is a list of all certificates for packagings in the database that have met the search criteria.

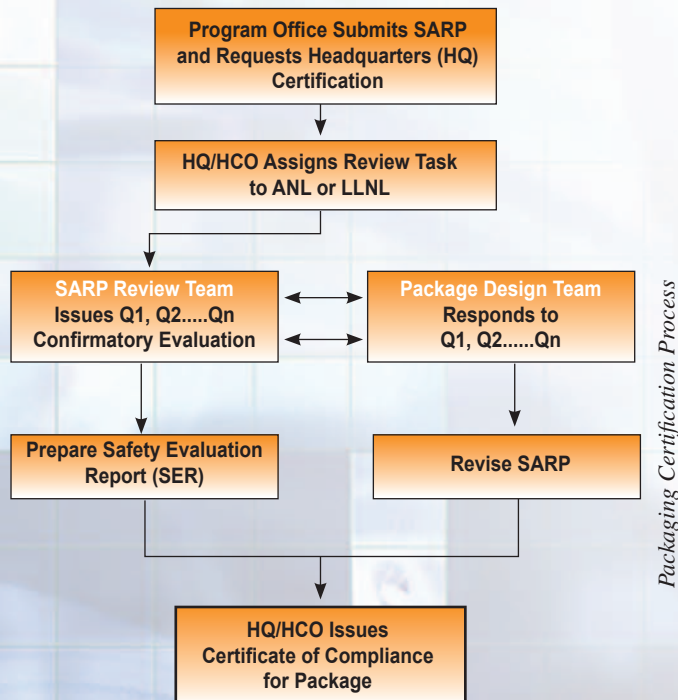


RAMPAC serves the needs of a variety of customers. RAMPAC provides information on certificate retrieval, news and newsletters, docket status and statistics, rules, regulations, and regulatory guidance and requirements for DOE Safety Analysis Reports for Packaging. RAMPAC also provides information on Safety Evaluation Reports (SERs), DOT Special Permits, non-certified packaging, and packaging decertification

checklists (i.e., cradle to grave) for radioactive material packaging. RAMPAC has been on-line since February 28, 1997. RAMPAC currently has over 900 registered users and numerous unregistered users.

Packaging Certification Process

PCP staffs continue to improve the packaging certification process by (1) providing updated training, interim guidance, and position papers and (2) improving communication with applicants for packaging in pre-application meetings, through lessons learned, and during an annual forum of technical program review, which is open to members of the DOE packaging community. The diagram below illustrates the PCP packaging certification process.



The SARP must demonstrate that the packaging meets all safety standards and requirements in the federal regulations. The length of the certification review to obtain a CoC depends on the quality of the SARP prepared by the Package Design Team and the team's responses to rounds of questions (e.g., Q1, Q2, ...Qn) issued by the SARP Review Team. The SARP reviewers also perform independent confirmatory evaluation and document their review determination in the SER, which provides the technical basis for the CoC. All SERs for the DOE CoCs are posted on www.rampac.com. Other important process-related information includes:

- Packaging Certification Process-improved Flowchart;
- Guidelines for Qualifications, Education, and Training of SARP Writing Team Members;
- DOE Packaging Review Guide (Rev. 2 and interim changes);
- SARP Submittal Guidelines;
- SARP Completeness Checklist; and
- Payment for DOE SARP Reviews.

Details on the above items are provided in www.rampac.com, under Requirements for DOE SARPs.

Training

Training is key to effective communication and achieving program goals. The PCP conducts five training courses and has made training part of the requirements for DOE SARPs. These courses are shown on page 5.

All of these courses are presented annually, sometimes more than once upon request, and the announcements and details of the courses can be found in www.rampac.com. The courses are open to the DOE packaging community and frequently draw participants from DOE, DOE contractors, NRC, industries,

COURSE TITLE (PRESENTER)	DURATION
Methods for Reviewing Safety Analysis Reports for Packagings and Performing Confirmatory Analysis (LLNL)	2 weeks
Quality Assurance for Radioactive Material Packaging (ANL)	3 days
Application of the ASME Code to Radioactive Material Transportation Packaging (ANL)	3 days
Management of SARP Preparation (SRNL)	3 days
Standardized Computer Analysis for Licensing Evaluation (SCALE) Code System (ORNL)	1–2 weeks

and foreign countries. The combined attendance of the five courses over the past 15 years is in the thousands; over 900 participated in the Quality Assurance and the American Society for Mechanical Engineers (ASME) Pressure Vessel and Piping Code courses at ANL alone. The PCP supports the development of new courses (e.g., welding of containment vessels) on the basis of training needs.



Participants in the ANL QA course 2006

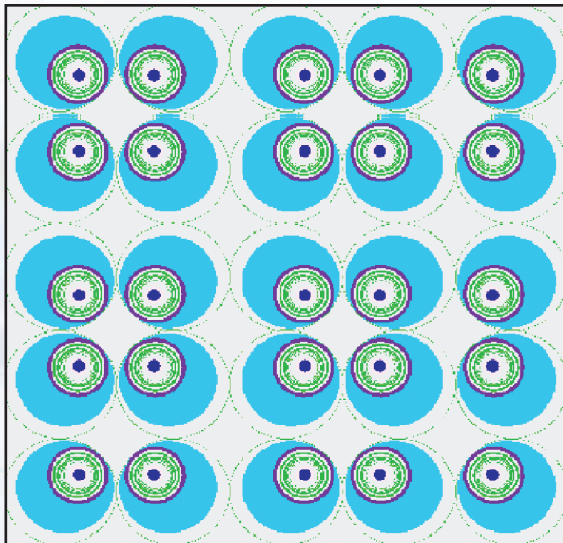
Packaging Quality Assurance (QA) Audit

A QA audit is a management evaluation tool. The conduct of a QA audit demonstrates implementation of a QA program. The results of the audit provide a status of compliance with the prescribed QA

program for the auditee’s management and the sponsor, such as DOE. In the case of Type B radioactive and fissile material transportation packaging, the licensee, certificate holder, or an applicant for a CoC must have a QA program in compliance with Subpart H, 10 CFR Part 71, Packaging and Transportation of Radioactive Material, and DOE Order 460.1B, Packaging and Transportation Safety.

In 2006, the PCP conducted a packaging QA audit of the Washington Savannah River Company (WSRC) to evaluate its implementation of the QA program requirements for Type B and fissile material transportation packagings in 10 CFR Part 71 and the DOE Order 460.1B. The Model 9975 transportation packaging was selected for the audit because it has successfully undergone design, procurement, fabrication, testing, and use. At the conclusion of the weeklong audit, the audit team determined that the WSRC has developed acceptable procedures that effectively implemented the QA requirements in the SARP and has a QA program for radioactive material transportation packaging in compliance with 10 CFR Part 71 and DOE O 460.1B. The QA audit report was issued by the Headquarters Certifying Official (HCO) in November 2006.

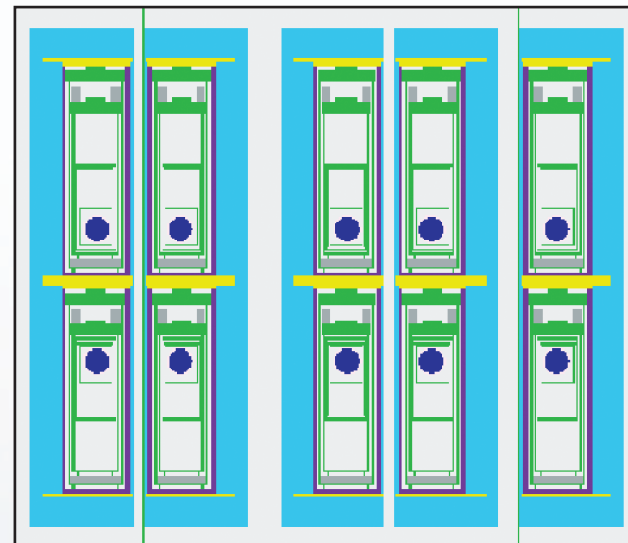
In 2007 and beyond, the PCP plans to conduct additional QA audits for DOE Type B and fissile radioactive materials packagings for the DOE CoC holders and users and eventually recommend approval by the HCO of the packagings only when the program complies with DOE O 460.1B and federal regulations.



Geometrical model used in the SCALE 4.4a/KENO V.a code criticality safety analysis of a finite array of 9975 packagings during Hypothetical Accident Conditions: plane view (left); cross-sectional view (right).

The Standardized Computer Analysis for Licensing Evaluation (SCALE) Code System

The PCP supports the development and maintenance of the SCALE Code system. ORNL developed and maintains the SCALE Code system under contract with NRC and DOE. The SCALE Code system is being used for analyses related to reactor physics, criticality safety, and radiation shielding and to perform spent fuel characterization for nuclear facilities and transportation/storage package design and certification. Details about the code are available at www.ornl.gov/sci/scale.



SUCCESS STORIES

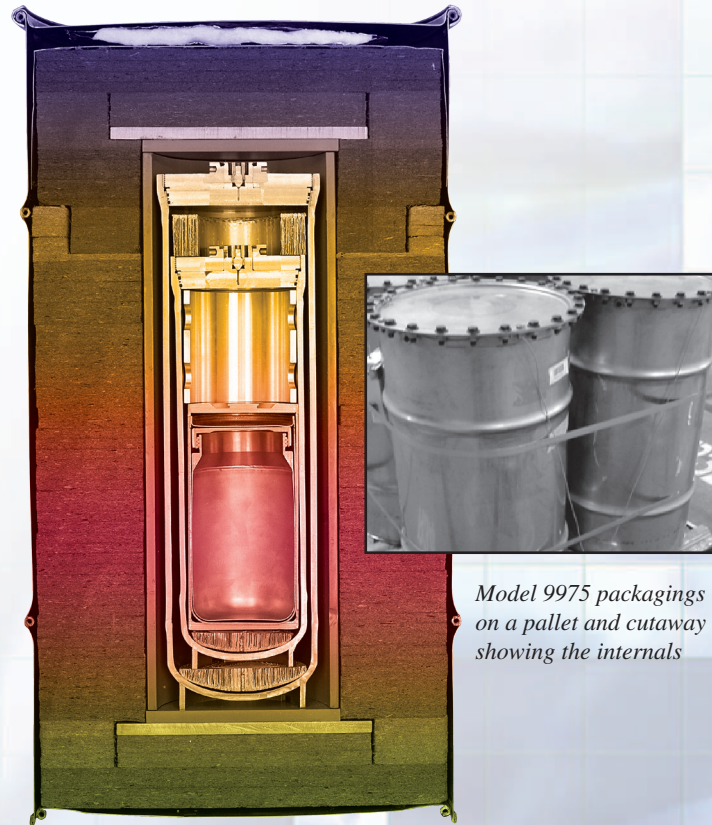
The PCP has played a critical role in many of DOE's success stories:

- At **Rocky Flats**, certification of the Model 9975 packaging for shipments of plutonium-bearing materials was essential for successful site closure.
- At **Fernald**, certification of the Steel Banded Wooden Shipping Container (SBWSC) for shipments of low-enrichment uranium materials was crucial in achieving site closure.
- **Tritium production in commercial reactors** is made possible with the certification of the NAC-LWT cask for shipments of the tritium-bearing Lead Test Assemblies.
- **Isotope production in accelerators and reactors** is greatly aided by the certification of the SAFESHIELD 2999A packaging for shipments of sources, targets, products, and wastes.
- **De-inventory of 227 low-enrichment UO_3 drums** at the Savannah River Site for shipment to the Nevada Test Site is made possible by the certification of drums as a Type A packaging in Type AF configuration.
- **The PCP has provided packaging support for international and domestic shipments** of plutonium from Russia, low-enrichment uranium from Iraq, and PuBe sources from Australia.

Success Story Highlight — Model 9975 Packaging

The Model 9975 was the primary radioactive material packaging used for the de-inventory of the Rocky Flats Site in Colorado and is

the primary packaging for the de-inventory of the Hanford site in Richland, Washington. The 9975 is the only packaging certified for the transportation of the 3013 cans containing stabilized plutonium metals and oxides. More than 4,000 Model 9975 packagings have been fabricated for use by the DOE Complex, and more than 1,000 additional fabrications are anticipated.



Model 9975 packagings on a pallet and cutaway showing the internals

Success Story Highlight — Steel Banded Wooden Shipping Container (SBWSC)

SBWSCs have been used to ship 34 types of payload from the Fernald Closure Project in Ohio, and the SARP has undergone 13 revisions. Other highlights include the following:

- Payloads are un-irradiated, low-enrichment (≤ 1.256 wt% U-235) uranium ingots, billets, derbies, sections, and scraps of various sizes and shapes.
- From April 2000 to March 2001, back-to-back certification reviews were conducted, covering approximately three payloads a month (including confirmatory analysis, SER, and revision of CoC).
- In FY2001, 86 shipments containing over 106 metric tons of uranium (MTU) were transferred to Portsmouth, OH, averaging nearly eight shipments per week. The remaining 274 MTU were transferred to Portsmouth by June 2002. Overall, the project was on schedule to complete disposition of all of the nuclear product material.



Hoisted NAC-LWT cask for the CLWR program

Success Story Highlight — NAC-LWT Cask

DOE is using the NAC International's Legal Weight Truck (NAC-LWT) cask for shipment of Tritium-Producing Burnable Absorber Rods (TPBARs) in Lead Test Assemblies (and as irradiated TPBAR sections in qualified canisters). Because of the concern about tritium permeation, the certification of the NAC-LWT cask required the use of tritium-tight seals for the closure of the cask. Certification of the NAC-LWT cask is essential to meeting the requirements of the Tritium Production in Commercial Light Water Reactor (CLWR) Program.

Success Story Highlight — SAFESHIELD 2999A Packaging

SAFESHIELD 2999A — a Type B transportation packaging certified by the PCP in October 2005 — supports the missions of DOE's Isotope Program. The program involves the production and sale of radioisotopes, by-products, surplus materials, and related isotope services for use in medicine, industry, and research. The low-melting-point, liquid-metal targets and the thermal insulating and shock absorbing foam represented a unique challenge for the certification review of the packaging.



SAFESHIELD 2999A packaging after drop test

THE CHALLENGE

DOE is at a critical juncture — the main challenge for the PCP is to maintain core competency while meeting the demands of an increasing workload and ensuring packaging safety. The growing complexity of packaging and transporting radioactive materials further challenges the PCP.

Meeting New Regulations

On October 1, 2008, all DOE and NRC Type B(), 6M, 6L, 20WC, 21WC, and other DOT specification packagings will no longer be allowed to be transported. EM-60 expects that many new replacement packagings will be submitted for certification so that they can be approved and built by October 1, 2008. At present, six DOE and 20 Type B() NRC packagings need to be replaced.

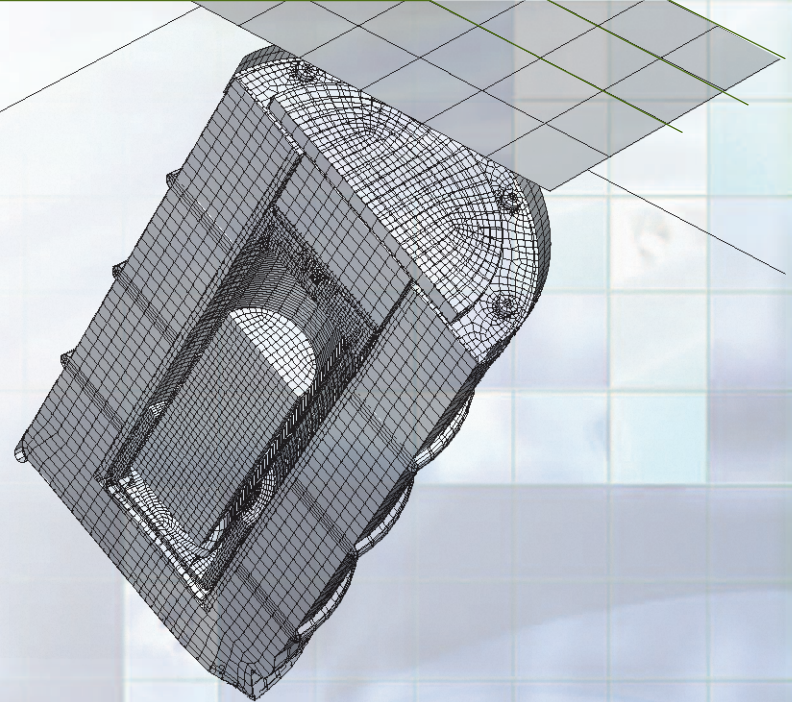
Increasing Workload

The accompanying table shows the recent PCP docket statistics (2003–2007). The increase in workload reflects EM’s risk reduction, cleanup, and site closure activities; the National Nuclear Security Administration’s (NNSA’s) de-inventory and consolidation; and the demands of other DOE programs (such as those related to isotopes and tritium production).

FISCAL YEAR

Category	2003	2004	2005	2006	2007*
Packaging dockets open at beginning of the year	9	9	13	16	14
New packaging dockets opened during the year	18	22	26	51	24
Packaging dockets closed during the year	18	18	23	53	24

* As of March 31, 2007



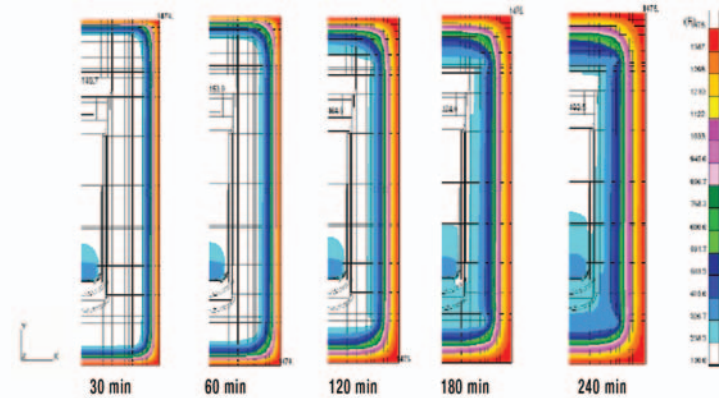
Primary Containment Vessel (bottom left)
for Model 9975 drum (top left)
and a finite-element mesh of drum (right)

Shipping “Cats and Dogs” Waste

EM continues to ship waste from various DOE sites, and the majority of shipments have been materials easy to package and ship in standard certified packagings. As the de-inventory process continues, shipments of miscellaneous DOE wastes (also known as “cats and dogs”) will require packaging modification and/or new packaging. Sophisticated analyses will be required to demonstrate packaging safety in certification review for these “cats and dogs” types of radioactive materials.

Addressing Attrition

Packaging certification is a mission-critical core competency of EM and DOE. Attrition of human capital will occur in the next 5–10 years. Maintaining core competency to meet the increasing workload and complexity is the challenge that the PCP must address to ensure packaging safety.



Calculated temperature distributions in a 9975 packaging during a 4-h, 1475°F (800°C) fire showing relatively low interior temperature due to packaging insulation protection



Participants in the LLNL course 2006

STRATEGIC DIRECTIONS

“Virtual Laboratories” for the PCP

The PCP is employing a “virtual laboratories” concept to manage the increased workloads and complexity. Applying this concept will expand the PCP’s mission into packaging certification for long-term storage and life-cycle management of hazardous and radioactive materials for DOE — for the next decade and beyond.



Participants in the ANL ASME course 2006

SARP review for regulatory compliance is highly technical and requires subject matter experts (SMEs) to evaluate issues in materials, structure, thermal, containment, shielding, criticality, operating procedures, maintenance and acceptance tests, and QA, subjects that often require years of learning, practice, and experience. (SARP review is not taught in universities.) Attrition of SMEs and SARP group leaders in recent years (and their anticipated retirement in the near future) is approaching a level that could severely jeopardize the chartered mission of the PCP.

Under the virtual laboratories concept, the PCP will draw, for each identified task, the talent and expertise that can be found in the United States — including resources in national laboratories, academia, and industries. Tasks could, for example, be SARP review, development of guidance and standards,

development of training courses, conduct of packaging QA audits, and field assessments. Initially, SMEs will be drawn from ANL, LLNL, and SRNL to form composite teams; later, SMEs could be drawn from other national laboratories, companies, and academia, with inevitable knowledge transfer and synergistic interactions. The PCP training courses, with participants shown in recent group photos, provide a pool of candidates for future SMEs.

The virtual laboratories will give the PCP the flexibility and agility to address the challenges and fulfill the needs of DOE while maintaining its core competence in an ever-changing environment.

Life Cycle Management (LCM) of Packaging

The objective of LCM is to ensure the following three primary safety functions of radioactive materials packaging:

- **Containment of radioactivity,**
- **Protection against radiation, and**
- **Maintenance of criticality safety for fissile material contents** throughout the entire life cycle of the packaging during storage, transportation, and disposal.

The PCP plans to engage in life-cycle management of Type B radioactive and fissile material transportation packagings that are also used for interim storage. As part of the LCM, staff will develop storage standards; examine the needs for considering the aging of contents; and evaluate interactions between contents and packaging and between packaging and environment, under normal conditions of storage and facility design-basis accidents.

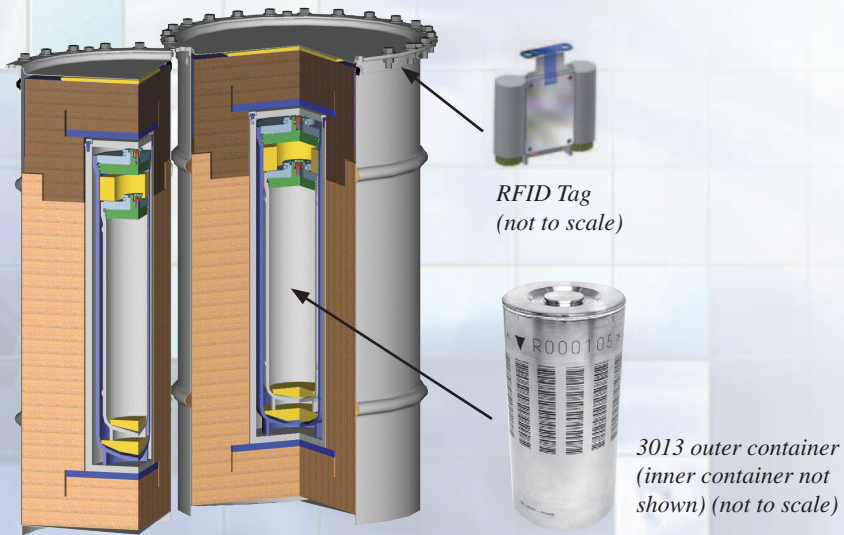
PCP staff will also develop programs for managing the degradation of materials and packaging components, which will include periodic inspection and monitoring and the application of advanced technology (such as radiofrequency identification [RFID]). The RFID technology appears particularly attractive for monitoring and tracking high-value assets and in nuclear materials management.

Packaging Certification for Storage

The PCP will develop protocols for the certification of packagings for the storage of radioactive materials. The protocols will leverage the vast experience gathered in the certification of packaging for the transportation of radioactive materials, as well as the knowledge gained in the LCM with respect to storage standards and aging management of packagings for radioactive materials. The protocols may consider a risk-informed, performance-based approach that is being pursued by other national and international regulating authorities, including the NRC.

Radiofrequency Identification (RFID) Technology

RFID technology is one of the most rapidly growing segments of today's automatic data collection industry. Examples of RFID applications are traffic toll collection, product labeling, and inventory control in the pharmaceutical and mass merchandizing industries. Advanced RFID tags are equipped with sensors for monitoring environmental conditions and other critical parameters, such as the status of seals and object movement.



Model 9975 cutaway showing a 3013 container and an RFID tag

RFID Tag
(not to scale)

3013 outer container
(inner container not shown) (not to scale)

Potential benefits of applying the multifunctional RFID tags in nuclear materials management are enhanced safety and security, reduced need for manned surveillance, real-time access of status and history data, and overall cost-effectiveness.

PCP staff is conducting a study of applying the RFID technology to the management of nuclear materials. Preliminary results are encouraging and provide the basis for the further development of RFID tags with modified form factors for field testing.

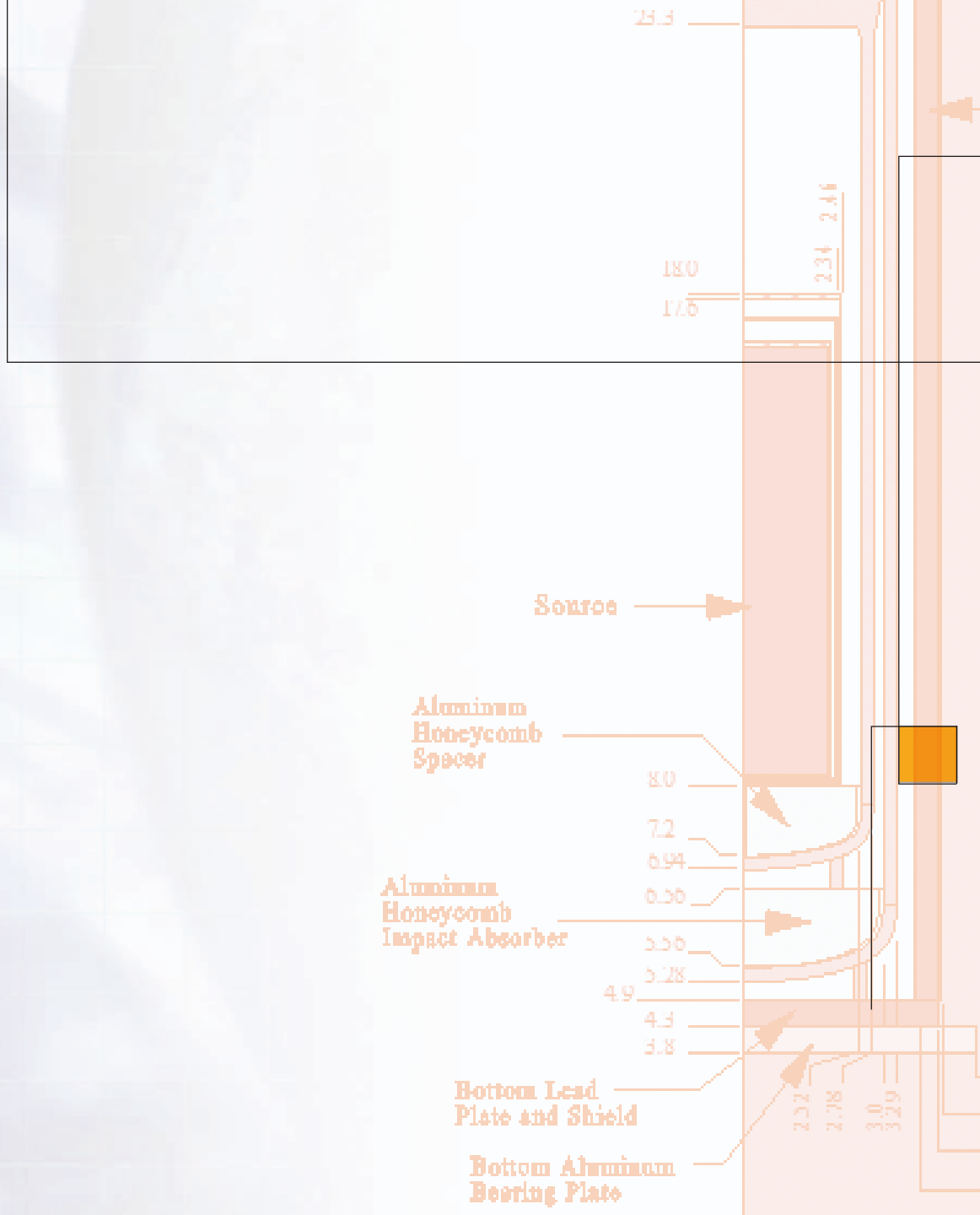
Model 9977/9978 — Post-Fire Test Evaluation



Digital radiograph showing silhouette of intact primary containment vessel (left), charred outer and intact inner polyurethane foam (center), and intact polyurethane foam (right)

Testing

PCP plans to reestablish a testing program that would address the needs for packaging various hazardous materials, as required by DOE Order 460.1B. In 1989, PCP staff established a testing program for DOT 7A Type A packaging, which was discontinued in 2002. Without an independent testing capability, DOE must rely solely on the testing results from suppliers of containers for packaging qualification — even though the consequences may be undesirable. The PCP is also engaged in a preliminary discussion with SRNL and the South Carolina State University (Orangeburg, SC) to form a partnership for developing the testing capability.





EM ***Environmental Management***

safety ❖ performance ❖ cleanup ❖ closure

DOE Packaging Certification Program