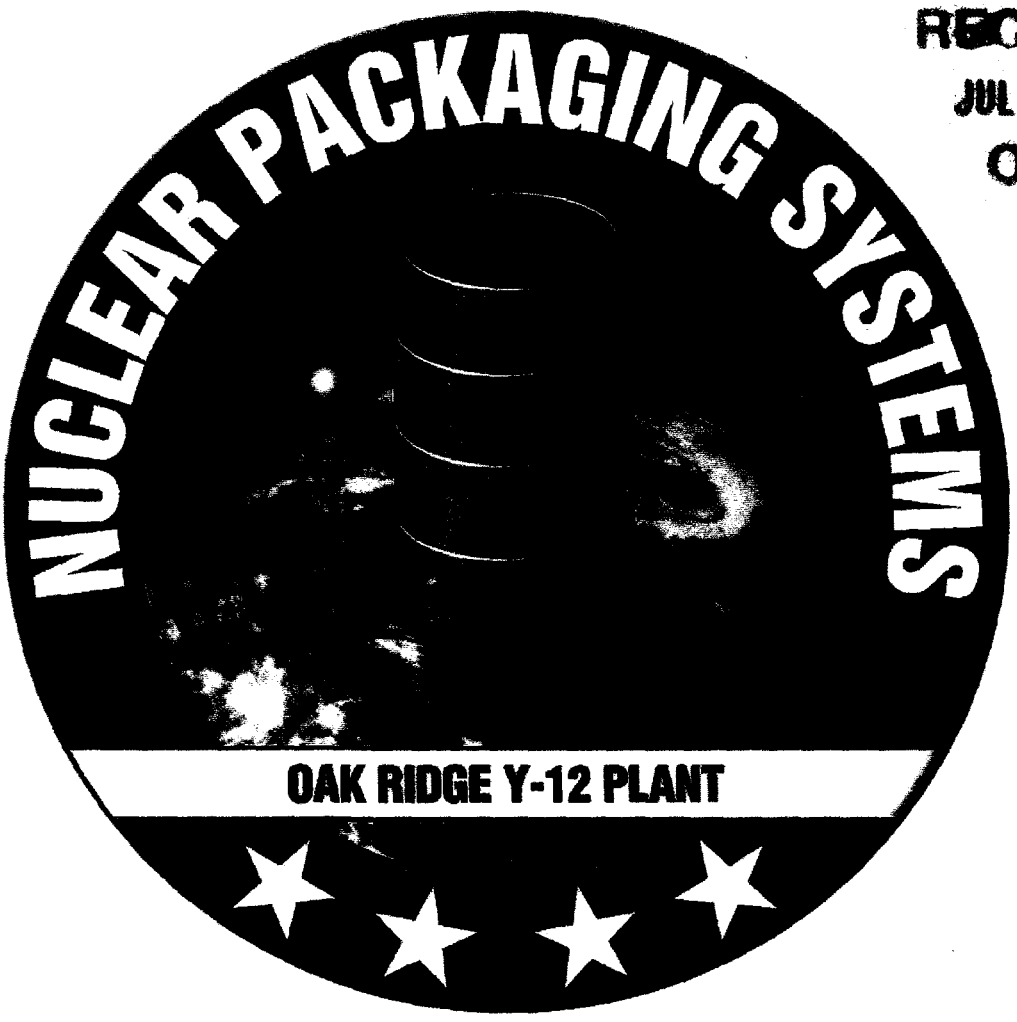
Y-12 Defense Programs

Nuclear Packaging Systems Testing Capabilities



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Y/LF-493/R1

Y-12 Defense Programs

Nuclear Packaging Systems Department

June 1995

Prepared by the
Oak Ridge Y-12 Plant
P. O. Box 2009, Oak Ridge, Tennessee 37831-8169
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MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

CONTENTS

OVERVIEW

The Nuclear Packaging Systems (NPS) Department can manage/accomplish any packaging task. The NPS organization is responsible for managing the design, testing, certification, procurement, operation, refurbishment, maintenance, and disposal of packaging used to transport radioactive materials, other hazardous materials, and general cargoes on public roads and within the Oak Ridge Y-12 Plant. Additionally, the NPS Department has developed a Quality Assurance plan for all packaging, design and procurement of nonweapon shipping containers for radioactive materials, and design and procurement of performance-oriented packaging for hazardous materials. Further, the NPS Department is responsible for preparation and submittal of Safety Analysis Reports for Packaging (SARP). The NPS Department coordinates shipping container procurement and safety certification activities that have lead-times of up to two years. A Packaging Testing Capabilities Table at the Oak Ridge complex is included as Table 1.

HISTORY

The Y-12 Plant NPS Department was formed in February 1988 to address concerns resulting from a U.S. Government Accounting Office audit of DOE-Oak Ridge and DOE-Albuquerque (DOE-AL) field offices concerning packaging certification and quality assurance practices. At present, the Y-12 Plant NPS Department program has responsibility for ensuring that all packaging used by the Y-12 Plant, whether for radioactive materials, hazardous materials, or general purpose cargoes, satisfies applicable quality, safety, and regulatory requirements. The life-cycle packaging process of testing container designs, preparing SARPs, and obtaining DOE Off-site Transportation Certificates is designed to ensure public safety.

Table 1. NPS Testing Capabilities at Oak Ridge, Tennessee

CAPABILITY	Y-12	ORNL	K-25	REMARKS
1. DEDICATED PACKAGING ORGANIZATION	X			Y-12 NPS has 10 Program Personnel and 42 technical- matrixed personnel (Appendix A)
2. PACKAGING QUALITY ASSURANCE PLAN (QAP)	X			Package QAP Table of Contents at Appendix B
3. PREPARATION OF SAFETY ANALYSIS REPORT FOR PACKAGING (SARP)	X			Have prepared 25 SARPs. Typical SARP Table of Contents at Appendix C
4. ENGINEERING SUPPORT				
A. Design	X			Six (6) new containers approved
B. Test plans	X			Have prepared 24 Test Plans; Typical Test Plan, Table of Contents (Appendix D)
C. Conduct of tests	X	X		
D. Testing Organization	X	X		
5. DROP TEST EXPERIENCE				
A. 1975-1985		X		
B. 1988-1995	X	X		Y-12 NPS prime user since 1988–1995
6. FACILITIES				Refer to Appendix E
A. Drop Test		X		
B. Thermal	X			
(1) Electric	X			
(2) Gas	X			
6. FACILITIES (Cont.)				
C. Immersion	X			
D. Sub-zero		X		

Table 1. (Cont.)

CAPABILITY	Y-12	ORNL	K-25	REMARKS
7. TECHNICAL EVALUATION				
A. Structural Evaluation	X	X		
B. Thermal Evaluation	X	X		
C. Containment Evaluation	X			
D. Shielding Evaluation	X	X		
E. Criticality Evaluation	X	X		
8. PERSONNEL QUALIFICATIONS, EXPERIENCE & CERTIFICATION				
A. Testing Supervision	X	X		
B. Support Staff	X	X		
C. Instrumentation	X	X		
D. Measurements	X	X		
E. X-rays	X	X		
F. Photometrics	X	X		
9. SUPPORT				Refer to Appendix F
A. Photometrics	X	X		
B. Data Acquisition	X	X		
C. Radiography	X	X		
D. Liquid Penetrant	X	X		
E. Leak Testing	X	X		
F. Mechanical Measures	X	X		

HIGHLIGHTS

1. *NPS Organization*: 52 Employees (10–Program, 42–Matrix/Support). Refer to Appendix A.

2. *DOE Award of Excellence*: The NPS Department was awarded the 1993 DOE Award of Excellence.

3. *Quality Assurance*: A Packaging Quality Assurance Plan has been developed and implemented. This plan has been recognized by DOE-AL as the best in the DOE Weapons Complex. The primary Quality Assurance requirements for the packaging program are the 18 elements of ASME NQA-1. The QAP Table of Contents is included as Appendix B.

4. *New Containers*: Designed, tested, certified, manufactured, procured, and introduced 21 different fissile contents for a family of six shipping containers since the NPS Department was formed in 1988. These containers were designed for maximum utility.

5. *Safety Analysis Reports for Packaging (SARPs)*: Prepared 25 SARPs in six years. A typical SARP Table of Contents is included as Appendix C.

6. *NPS Expertise*: The NPS Department has support for: (1) structural evaluation, (2) thermal evaluation, (3) containment evaluation, (4) shielding evaluation, and (5) criticality evaluation. Essential disciplines are matrixed to the projects as their services are required. These individuals are located throughout Martin Marietta Energy Systems, Inc. (Energy Systems) at the Y-12 Plant, Oak Ridge National Laboratory (ORNL), and the K-25 Site or they are qualified subcontractors.

NPS Program Management

The Y-12 Plant has a proven management system that provides control over cost, schedule, and product quality. The Y-12 Plant NPS program is responsible for all aspects of the life cycle elements for containers. These elements include design, certification, SARP preparation, procurement management, operation, acceptance testing, inspection, refurbishment, maintenance, and disposal. This responsibility is specifically associated with Type B fissile material "drum type" packaging.

Energy Systems Central Engineering performs several packaging activities including engineering design, performance of safety analyses, and preparation of safety analysis reports. The Y-12 Plant Nuclear Criticality Safety Department of the Health, Safety, Environment, and Accountability Division performs the vital function of conducting criticality safety analyses of packages for use with fissile material. In addition, the Energy Systems fabrication organizations have the capabilities of manufacturing packaging components for test lots or small quantities that are not provided by outside vendors. Energy Systems has established procurement relationships with fabrication subcontractors, such as drum manufacturers, insulation fabricators, machine shops and assembly specialists who are qualified to national standards, are familiar with DOE requirements, and have approved quality programs.

NPS Quality Assurance/Control Program

The Y-12 Plant NPS Quality Assurance and Quality Control (QA/QC) Plan and Procedures were developed and implemented to assure inclusion of quality in all aspects of the packaging planning, packaging preparation, and all steps of the packaging production leading to packaging certification. The Y-12 Plant NPS QA Plan and Procedures have been approved, and recognized by DOE, as the best in the Nuclear Weapons Complex. The QA/QC Plan and associated procedures have been utilized successfully for over four years at the Y-12 Plant in supporting drum-type container production. The primary QA/QC requirements for the NPS program are the eighteen elements of the ASME NQA-1 and QC-1 critieria.

NPS CONTAINER EXPERIENCE

The Y-12 Plant has successfully designed, tested, certified, manufactured, procured, and introduced 21 nuclear contents in 6 container programs (Type B) under the direction of DOE-AL certifying officials in the last five years. Four other container configurations have either completed the DOE-AL Nuclear Explosives Safety Division (NESD), Transportation Safety Review Board (TSRB) or were canceled. Energy Systems has designed, tested, certified, manufactured, procured, and implemented an additional nineteen nuclear container (Type B) designs through DOE-Headquarters (DOE-HQ) and the Nuclear Regulatory Commission (NRC). Energy Systems has conducted the NRC tests on eleven other packages designed to contain Highly Enriched Uranium (HEU), Pu, and fuel elements for DOE, Department of Defense (DOD), and civilian programs. The Y-12 Plant has also been certified to receive and use seven more DOE-AL containers which were designed and developed by other Nuclear Weapons Complex (NWC) members. Thus, the Energy Systems container experience, based on sixty-two packaging/contents, provides a broad-based capability.

ENGINEERING SUPPORT TO THE Y-12 PLANT NPS PROGRAM

Following a request from a DOE-operated facility, a team of engineers, representing a variety of technical disciplines, is formed to develop the shipping package and to prepare the SARP. Energy Systems Engineering Division supports the Y-12 Plant NPS program in the following areas: package design and analysis, developing the quality assurance criteria, fabrication and assembly of packaging components, compliance testing, and SARP preparation of shipping packages for off-site transportation of radioactive materials. Additional engineering tasks and a typical Test Plan Table of Contents are included in Appendix D.

PACKAGING TEST FACILITES

Drop Test Facilities

Drop and puncture testing has been carried out at ORNL since 1960, primarily in support of DOE packaging programs, as well as companies from the private sector. Type B packagings are the type most often tested, although Type A and explosive containers have also been subjected to tests at these facilities. The data and information generated in the tests have been instrumental in obtaining DOE, NRC, and Department of Transportation (DOT) approvals of the package designs. Since 1988, the Y-12 Plant NPS program has been the primary customer of this facility. Refer to Appendix E for capabilities of this ORNL-operated facility.

Thermal (Furnace) Facility

Nuclear Packaging Systems has access to two gas furnaces which have been fully characterized for performing hypothetical thermal accident testing. Each of these furnaces is capable of operating at up to 2100°F. These furnaces have been specially instrumented for performing such tests and have been used on several occasions for thermal testing. Automated loading machinery associated with each of these furnaces greatly simplifies the logistic of performing such tests. The furnaces are preheated prior to testing, and package support structures within the furnaces remain in the furnace before, during, and after testing.

Immersion Facility

The Y-12 Plant has an immersion facility for subjecting prototype packagings to regulatory testing requirements.

Temperature Conditioning Chambers

A need often develops to test packages at sub-zero temperatures. In order to reach -30°C (-20°F) under testing situations, ORNL has utilized a mobile refrigeration unit. Packages weighing up to 1364 kg (3000 lb) have been cooled in this manner prior to testing.

SUPPORT CAPABILITIES

Support capabilities within the Oak Ridge complex are sufficient to support testing of shipping containers. Specific support capabilities are photometrics, data acquisition and reduction system, radiography, liquid penetrant examination, leak test equipment, and mechanical measurement. Refer to Appendix F for technical data.

APPENDIX A

NPS ORGANIZATION MATRIX

oak ridge Y-12 plant

NUCLEAR PACKAGING SYSTEMS
E. Stumpfl

V. R. Williams

QUALITY LIAISON
G. W. Eckert

SPECIAL ASSIGNMENT ENGINEER
(Vacant)

CONTRACT SUPPORT
J. H. Doyle
J. K. O'Brien
S. E. Kincer
I. S. Worthington

MATERIAL CONTROL
J. E. Stokes
J. Grey

PACKAGING MANAGEMENT
S. E. McClanahan
H. E. Crowder
C. Heatherly
H. E. Turner
Engineer (Vacant)

TECHNICAL ADMINISTRATION
G. W. Stout
W. A. Shunk

BUSINESS MANAGEMENT
Vacant

TECHNICAL SUPPORT (1)

ENGINEERING DESIGN AND TEST
G. L. Bland
G. A. Byington
M. L. Goins
R. D. Harrell
R. O. Osborn
L. Roberson
H. W. Schrader
E. E. Zang

SAFETY ANALYSIS REPORTS – PACKAGING
S. D. Moses
J. C. Anderson
G. A. Aramayo
D. A. Dyslin
M. R. Feldman
J. E. Walls
R. W. Williams

PUBLICATIONS
W. G. McQuaig
N. J. Schulman

CRITICALITY SAFETY
K. J. Carroll
Y. Y. Chan
H. R. Dyer
E. P. Elliott
D. A. Tollefson

SHIELDING
S. N. Cramer

KEY
(1) As Needed

FUNCTIONAL SUPPORT

PRODUCTION COORDINATION ACTIVITIES

PRODUCTION PLANNING
D. E. Tracy

RESOURCE SCHEDULING
J. D. Plemmons

DESIGN & PRODUCTION SUPPORT
L. D. Snow

CENTER FOR CONTINUING EDUCATION
K. W. Porter

PROCUREMENT COORDINATION
N. E. Moore

OPERATIONAL AREAS

QUALITY SERVICES
R. J. Graham
S. L. Hunt
R. O. McCloskey

DISASSEMBLY & SPECIAL MATERIALS
K. L. Hall
M. D. Waldrop
C. E. Walker

U. ENRICHMENT
J. E. Vath

TRAFFIC MANAGEMENT
D. F. Francis

TRANSPORTATION SAFETY MANAGER
D. Cunningham

Y-GA 95-548R2

3/31/95

APPENDIX B

QUALITY ASSURANCE PLAN
AND
DEPARTMENT PROCEDURES

Packaging Systems Management

Quality Assurance Plan and Department Procedures

This Controlled Manual is the property of Martin Marietta Energy Systems. Please return the manual to the Manager, Packaging Systems Management, MS-8206, Building 9113, Martin Marietta Energy Systems, Inc., P.O. Box 2009, Oak Ridge, TN 37831, when no longer needed or requested.

Defense Programs Engineering Services
Y-12 Plant

MARTIN MARIETTA

Martin Marietta Energy Systems, Inc.

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Document number	Title	Revision date	Volume
DEPARTMENT PACKAGING PROCEDURES (CONTINUED)			
Y10-81-PP-015	*Trending and Quality Improvement*	10/29/93	I
Y10-81-PP-016	*Quality Assurance Records Replacement*	10/29/93	I
Y10-81-PP-017	*Records Management Repository*	10/29/93	I
Y10-81-PP-018	*Packaging Readiness Reviews*	Later	I
Y10-81-PP-019	*Surveillances*	Later	I
PLANT PROCEDURES - Uncontrolled Copies			
Y10-029	*Decommissioning of Packagings*	10/29/93	II
Y10-059	*Selection of Packaging*	11/02/93	II
Y10-068	*Periodic Testing of Reusable Packaging*	11/02/93	II
Y10-095	*Requirements for Category A and Category B Packaging Components*	10/29/93	II
Y10-096	*Requirements for Category C Packaging Components*	10/29/93	II
Y10-097	*Use of Type B Packaging*	10/29/93	II
Y10-098	*Use of Type A Packaging*	11/02/93	II
Y10-099	*Use of DOT Authorized Packaging*	11/02/93	II
REFERENCED PROCEDURES - Uncontrolled Copies			
EP-B-36	*Project Records*	05/20/92	II
ESS-QA-17.0	*Quality Assurance Records*	11/22/91	II
10-027	*Plant Training Program*	07/10/92	II
10-039	*Maintenance Recall Programs, A, B, and C*	09/01/89	II
Y10-135	*Command Media Development at the Y-12 Plant*	06/01/92	II
	Change Directive	04/28/93	II
	Change Directive	05/17/93	II

Document number	Title	Revision date	Volume
REFERENCED PROCEDURES (CONTINUED) - Uncontrolled Copies			
10-35-102	*Calibration and Maintenance Recall Programs*	06/03/88	II
Y60-121	*Calibration and Control of MT&E*	Later	II
Y60-122	*Laboratory Environments*	Later	II
Y60-123	*Out of Tolerance MT&E Report Evaluation*	Later	II
Y60-124	*Commercial Equipment Laboratories*	Later	II
Y60-028	*Y-12 Plant Self Assessment*	06/30/92	II
	Change Directive	10/01/92	II
60-051	*Instructions, Procedures, and Drawings*	03/31/89	II
	Change Directive	11/23/92	II
Y60-160Y	*Corrective Action System*	06/30/92	II
60-161	*Occurrence Reporting System*	05/24/91	II
	Change Directive	12/31/91	II
Y60-165	*Energy Systems Action Management Systems (ESAMS)*	06/30/92	II
Y60-181	*Technical Audit Program*	06/30/92	II
Y60-182	*Qualification, Certification, and Recertification of Audit Personnel*	06/30/92	II
Y60-183	*Surveillance*	06/30/92	II
60-191	*Software Quality Assurance*	03/31/92	II
Y70-108	*Outgoing Radioactive and Fissile Shipments*	12/31/92	II
Y70-913	*Off-Site Transportation Safety*	02/04/93	II
70-916	*On-Site Transportation Safety*	09/30/91	II
	Change Directive	02/24/93	II

APPENDIX C

SAFETY ANALYSIS REPORT FOR PACKAGING, OAK RIDGE Y-12 PLANT, MODEL DC-1 PACKAGE, WITH HEU OXIDE CONTENTS

SAFETY ANALYSIS REPORT FOR PACKAGING, OAK RIDGE Y-12 PLANT, MODEL DC-1 PACKAGE, WITH HEU OXIDE CONTENTS

Compiled by

Martin Marietta Energy Systems, Inc.
Packaging Systems Management

Prepared by the
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
managed by
Martin Marietta Energy Systems, Inc.
for the
U. S. Department of Energy
under contract DE-AC05-84OR21400

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FIGURES

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TABLES

TABLES (continued)

DEFINITIONS AND TERMS

actinide series	elements of atomic numbers 89 to 103
barn	unit for measuring reaction cross sections of elements (barn = 10^{-24} cm^2)
bremsstrahlung	the electromagnetic radiation (X rays) associated with the deceleration of charged particles
consignee	the person designated in the shipping papers to receive the shipment
consignor	the person executing the shipping papers, and named as such on the shipping documents
containment system	components of the packaging intended to retain the radioactive material during transport
cross section	a measure of the probability of interaction between a nucleus and an incident particle or photon
exclusive use	the sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with direction of the consignor or consignee
fissile material	any material consisting of or containing one or more fissile radionuclides (i.e., ^{233}U, ^{235}U)
frozen	to protect a particular version of a computer program from change
hydrogenous	material containing the element hydrogen
moderator	a material used to reduce the kinetic energy of neutrons by scattering collisions without appreciable neutron capture
package	the packaging together with its contents
packaging	the assembly of components necessary to ensure compliance with the packaging requirements
quality assurance	all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily and safely in service
safety analysis	a document that provides a comprehensive technical evaluation

report for packaging	and review of the design, testing, operational procedures, maintenance procedures, and quality assurance program to demonstrate compliance with Nuclear Regulatory Commission regulatory safety standards, or equivalent standards established by the Department of Energy for approving packagings and issuing certificates of compliance
streaming	an unrestricted path of photons and neutrons from a radioactive source
specific activity	the radioactivity of the radionuclide per unit mass of that nuclide
transport index	a dimensionless number (rounded up to the first decimal place) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation
transuranic elements	elements of atomic numbers about 92, all are radioactive and are products of artificial changes, members of the actinide group.

ABBREVIATIONS, ACRONYMS, INITIALISMS

α	coefficient of linear expansion
δ	linear expansion
ΔT	temperature differential
l	length
π	pi
ρ	density
σ	standard deviation
A	area
A	atomic weight
A	Durometer measured in Shore A
A_1	maximum activity of special form radioactive material permitted in a Type A package
A_2	maximum activity of radioactive material, other than special form, permitted in a Type A package
A_c	Actinium, atomic number 89
AEG	average energy group
ALARA	as low as reasonably achievable
^{242}Am	Americium isotope with atomic weight 242
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineering
ASTM	American Society for Testing and Materials
atm	atmosphere
at%	atom percent
Btu	British Thermal Unit
C	carbon
°C	degree Centigrade
CFR	Code of Federal Regulations
Ci	curies
cm	centimeter
cm^3	cubic centimeter
Cr	chromium
CRC	Chemical Rubber Company
CH_2	polyethylene
$C_3H_7NO_2$	carbamic acid-ethyl ester (Monothane)
$(CH_2)_2$	Polyethylene
$C_6H_{10}O_5$	cellulose
d	day
D	diameter
dia	diameter
DC	double containment
D.C.	District of Columbia
DOE	Department of Energy
DOT	Department of Transportation
DT	drum type
E	Young's modulus
eV	electron volts
°F	degree Fahrenheit

FAE	First article evaluation
Fe	iron
ft	foot
ft^3	cubic feet
g	acceleration of gravity
g	gram
gm	gram
gU	grams uranium
h	hour
hr	hour
H	hydrogen
HEU	highly enriched uranium
Hz	frequency, Hertz
H_2O	water
IAEA	International Atomic Energy Agency
IBM	International Business Machines
ID	inside diameter
in.	inch
IR	inside radius
J	Joule
k	spring rate
K	degree kelvin
k_{eff}	effective neutron multiplication factor
kg	kilogram
ksi	kips per square inch
lb	pound
LL	lower limit
m	meters
m^3	cubic meters
MeV	million electron volts
min	minutes
Mn	manganese
mrem	millirems
N	nitrogen
n	atom fractions
NA	not applicable
NC	National Coarse
Ni	nickel
NIOSH	National Institute for Occupational Safety and Health
NLF	neutron leakage fraction
NPT	American National Standard Taper Pipe Thread
NRC	Nuclear Regulatory Commission
O	oxygen
OD	outside diameter
OH	outside height
OR	outside radius
ORNL	Oak Ridge National Laboratory

OSHA	Occupational Safety and Health Act
^{208}Pb	lead isotope with atomic weight 208
%	percent
p	pressure
Pa	Protactinium, atomic number 91
PA	projected area
Pb	Lead, atomic number 82
pcf	pounds per cubic foot
PCV	primary containment vessel
PET	Product Engineering Transmittal
PICS	Part Information Control Summary
P_n	multiordered Legendre polynomial scattering treatment
Pn	Polonium, atomic number 84
ppb	parts per billion
PORTS	Portsmouth Gaseous Diffusion Plant
PSD	power spectral density
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch (absolute)
psig	pounds per square inch (gauge)
Q	decay heat
QA	quality assurance
QCPI	Quality Certification Procurement and Instruction
r	radius
R	degree Rankine
Ra	Radium, atomic number 88
rem	roentgen equivalent of man
RG	regulatory guide
RH	relative humidity
rms	root mean square
SARP	safety analysis report for packaging
SCALE	Standardized Computer Analysis for Licensing Evaluation
SCV	secondary containment vessel
sec	second
Sp act	specific activity (Ci/g)
sp gr	specific gravity
S	stress
SA	surface area
SR	Savannah River
SST	safe-secure trailer
t	thickness
T	temperature
Th	Thorium, atomic number 90
TI	transport index
TM	trademark

Type A	A quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for nromal form radioactive material
Type B	A quantity of radioactive material greater than a Type A quantity
^{232}U	uranium isotope with atomic weight 232
^{234}U	uranium isotope with atomic weight 234
^{235}U	uranium isotope with atomic weight 235
^{236}U	uranium isotope with atomic weight 236
^{238}U	uranium isotope with atomic weight 238
U	Uranium, atomic number 92
UL	upper limit
U.S.	United States
UNC	Unified National Coarse
U_3O_8	triuranium octaoxide
UO_3	uranium trioxide or uranyl oxide
V	volume
VF_p	volume fraction of polyethylene
VF_w	volume fraction of water
W	watts
wt%	weight percent
y	year

APPENDIX D

Engineering Support to the Shipping Package Program

ENGINEERING SUPPORT TO THE SHIPPING PACKAGE PROGRAM

Following a request from a DOE-operated facility, a team of engineers, representing a variety of technical disciplines, is formed to develop the shipping package and to prepare the SARP. Martin Marietta Energy Systems Engineering Division supports this effort in the following areas: package design and analysis, developing the quality assurance criteria, fabrication and assembly of packaging components, compliance testing, and document preparation of shipping packages for off-site transportation of radioactive materials.

Package Design and Analysis

The design process is initiated by the development of a Systems Requirement Document (SRD) issued by the Product Definition Engineer (PDE). A Responsible Engineering Designer (RED) is selected to: first, review and comment the SRD; second, to prepare the design criteria based on the SRD; third, prepare detailed design drawing, specifications, data sheets, and supporting calculations and analyses. At the disposal of the RED is a variety of technical experts skilled at performing structural, dynamic impact, thermal, shielding, and criticality analyses to the requirements stipulated in Title 49, Code of Federal Regulations (CFR), Section 173.7(d), and Title 10, CFR, Section 71. The RED coordinates independent design verification and resolves issues and fulfills actions identified in the design review process.

Quality Assurance Criteria

A graded quality method is employed to determine the level of quality assurance invoked on each package component. The RED is responsible for the following items: first, conducting an assessment to identify each packaging component, identify codes, standards, tests and inspections processes; second, supporting the systematic quality grouping of packaging components based on malfunction and failure analysis; finally, ensuring that the design requirements are appropriate and meet this graded quality assurance criteria.

Fabrication and Assembly

The Engineering Division supports the fabrication and assembly phase of prototype hardware used in the compliance and design verification testing. The RED is responsible for resolving any drawing requirement interpretation problems, reviewing design change requests, non-conformance reports, and reviewing requests for deviations from drawing requirements submitted by the PDE.

Prototype Testing

The RED and a designated Test Engineer (TE) work together to develop the test plan, test procedures, and data sheets required for physical testing. The TE oversees the assembly, instrumentation, testing, data recording and authentication of the physical test forms. Working with the RED, the TE is responsible for submitting the test report to the PDE for review and approval. A typical test plan Table of Contents is attached.

SARP Preparation

A SARP must be developed and submitted to the appropriate DOE agencies for review and approval. MMES engineers prepare sections pertaining to the structural, thermal, containment, shielding, and criticality aspects of the shipping package ensuring the protection of the public and worker safety and health, and the environment.

TEST REPORT
OF THE DT-23 SHIPPING PACKAGE

Prepared for the
Y-12 Plant Program Management
Packaging Group

by
Engineering Division
Y-12 Machine Design
Oak Ridge, Tennessee 37831-8202
managed by

MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U. S. DEPARTMENT OF ENERGY
under contract DE-AC05-840R21400

APPROVALS

Name	Organization
	Program Management
	Mechanical Engineering
	Mechanical Engineering
	Mechanical Engineering
	Project Engineering

CONTENTS

FIGURES

APPENDIX E

PACKAGING TEST FACILITIES

PACKAGING TEST FACILITIES
Located at the
Oak Ridge Complex

Drop and puncture testing has been carried out at the Oak Ridge National Laboratory (ORNL) since 1960, primarily in support of DOE packaging programs, as well as companies from the private sector. Type B packagings are the type most often tested. However, Type A and explosives containers have been tested at the facilities also. The data and information generated in the tests have been instrumental in obtaining Department of Energy (DOE), Nuclear Regulatory Commission (NRC), and Department of Transportation (DOT) approvals of the package designs. A summary of the drop and puncture capabilities is given below.

Drop Test Facilities (located at ORNL)

Impact (Target) Pads

Two drop test facilities have been used to test packages. The smaller is the Small Test Facility (STF) that uses a concrete pad and has an impact surface of armor plate. This facility was modified in 1990 to provide a larger impacting surface than was available with the original pad.

The concrete and steel in the original pad weighs approximately 40 tons. Its top surface is approximately 3.4 m (10 ft by 11 ft) and has an 2.4 m (8 ft) square armor plate surface imbedded in it. Recently several 15-cm (6 in.)-thick pieces of armor plate were added which effectively cover the entire pad and overhang about 0.6 m (2 ft) in one direction. The additional armor plate is welded to the original plate and adds approximately 20 tons of weight, bringing the total weight of the pad to approximately 60 tons. However, it has a significantly larger effective mass, because the bulk of the pad rests on a 1-m (3-ft)-diameter concrete column that was sunk into bedrock approximately 3 m (10 ft) below grade.

Punch

For the punch testing, both facilities use steel punches designed to the specifications given in the regulations and built at ORNL. Each punch is properly sized to the scale of the package being tested, welded to a steel plate which is, in turn, welded to the steel impact surface for that test.

Lifting Surface

The lifting structure at the Tower Shielding Facility (TSF) consists of four towers - each 96 m (315 ft) high - and set in a rectangular array 30 m by 60 m (100 ft by 200 ft). Each of the towers is guyed with two pairs of 2-in. cables. The hoisting of heavy test pieces is accomplished with a cabling system connected to the top of each tower. The towers currently provide the lifting capability of approximately 50 tons (110,000 lb) and, with some modification, this value could be doubled. Packagings weighing 23 tons (50,000 lb) have been dropped at the TSF in the past.

Release System

Two different pieces of equipment are used at ORNL to release packaging, depending upon their weight. The first can be operated remotely or directly by actuating a small, pressurized cylinder that is, in turn, connected to a hook that can release the package. This system works well with packages weighing less than 3.6 tons (8,000 lb) because it imparts no torque to the test piece once the release is made. For larger packages, up to 25 tons, the

larger release mechanism is actuated by an explosive device. Both mechanisms have positive safety release features that must be deactivated before the package can be released.

Nuclear Packaging Systems has access to two gas furnaces which have been fully characterized for performing hypothetical thermal accident testing. Each of these furnaces is capable of operating at up to 2100°F. These furnaces have been specially instrumented for performing such tests and have been used on several occasions for thermal testing. Automated loading machinery associated with each of these furnaces greatly simplifies the logistics of performing such tests. The furnaces are preheated prior to testing, and package support structures within the furnaces remain in the furnace before, during, and after testing.

Immersion Facility (located at the Y-12 Plant)

An immersion facility for testing packages is available at the Oak Ridge Y-12 Plant.

Temperature Condition Chambers (located at ORNL)

A need often develops to test packages at sub-zero temperatures. In order to reach -30°C (-20°F) for the testing configuration, ORNL has utilized a mobile refrigeration unit. Packages weighing up to 1,364 kg (3,000 lb) have been cooled in this manner prior to testing.

APPENDIX F

SUPPORT CAPABILITIES LOCATED AT OAK RIDGE COMPLEX

SUPPORT CAPABILITIES
located at the
Oak Ridge Complex

Photometrics

The photographic laboratories at both the Y-12 Plant and the Oak Ridge National Laboratory (ORNL) support drop testing activities. Y-12 Plant Photography provides the capability of taking both high-speed and normal-speed motion pictures. Drop tests are typically photographed at 24 and/or 500 frames, although a wide range of speeds is available. If necessary, overnight developing of the motion pictures can be obtained to permit a detailed examination of a first test prior to making a second drop the next day. All tests are videotaped. This information can be combined with the high- and normal-speed film images that have been transferred to a video format, making it easy to produce a high-quality documentary video quickly to describe the tests and results. The timing reference for the drop test is supplied by a constant speed clock (1800 RPM) which is placed in the cameras field of view during the drop and whose image is captured in each frame. Stadia (grid) boards are available for use as a background should that be needed.

Data Acquisition and Reduction System

Qualified personnel are available to determine the instrumentation requirements of a drop test, instrument the test piece, use the multiple-channel high-speed data acquisition system, filter and perform analog-to-digital conversion operations on the data, and provide the customer with the require information. A variety of modern test instrumentation is available. Typical equipment used for drop tests include:

1. Magnetic Tape Recorders (IRIG FM)
   (Honeywell Model 101 or Kyowa Dengo RTP-652A);

2. High-Speed Digital Waveform Recorder
   (AstroMed MT-9500 or Gould DASA-9000);

3. Spectrum/Signal Analyzers
   (HP 35660A or Tek 2630);

4. Signal Conditioners/Amplifies for piezo-electric
   or piezo-resistive accelerometers and strain gages.

All test instrumentation is calibrated and can be certified to NIST-traceable secondary standards by ORNL when required by the Customer. Test data are generally recorded on magnetic tape for subsequent analysis. A waveform recorder is used for real-time recording in parallel with the tape recorder for a quick examination of information from a specific transducer. A portable spectrum analyzer is available also for a rapid analysis of the frequency spectrum produced in the impact during the test.

A wide variety of post-test analysis methods are available. The data can be digitized in formats compatible with MS-DOS, VAX-VMS, UNIX, or VME-OS9 operating systems. Software for user-defined or standardized signal conditioning is available; the processed and raw data can be plotted, analyzed and/or delivered in any of the above formats on a convenient media for the customer.

Currently, data can be acquired in analog format with 28 channels on time-coherent data or in digital format with 60 channels of time-coherent data at a real-time rate of 12.6 Khz per channel. Additional digital channels can be obtained, given advance notice.

ORNL maintains x-ray equipment that is available for use in the packaging program. Test pieces weighing up to 1.36 tons (3,000 lb) have been x-rayed. Penetrameters are available if needed. Darkroom facilities are available. All x-rays are processed at ORNL. Each x-ray is marked on its image to identify it, and the image can be keyed to a sketch if necessary. All film work is dirt and oil free. Each radiograph is stored in its own envelope and labeled. Records of how the x-rays were made, the geometry of the procedure, film type, etc., are recorded in log books.

Liquid Penetrant Examination

Procedures for carrying out liquid penetrant examination and the equipment are available at both the Y-12 Plant and ORNL if needed.

Leak Test Equipment

Leak testing equipment is available at both the Y-12 Plant and ORNL, including pressure gages, temperature measuring instruments, helium leak detectors, etc. This equipment is periodically calibrated, traceable to NIST standards. It is available to the Drop Test program, along with personnel qualified to operate it.

Mechanical Measurement

External and internal measurements on any package may be made at the Y-12 Plant or ORNL. Measurements are traceable back to NIST standards.

OAK RIDGE NATIONAL LABORATORY
PERSONNEL QUALIFICATION, EXPERIENCE, AND CERTIFICATION FOR PACKAGE TESTING

Testing Supervision

All package testing at ORNL is assigned a Test Supervisor whose primary responsibilities are to interact with the customer and determine what testing support is needed, to review the customer's test descriptions, produce a testing budget, and to support the customer with advice related to testing, as requested. Once the Test Supervisor determines what is required, he will interact with other support groups at the Laboratory to obtain commitments for particular support personnel and equipment and produce an ORNL Test Plan. The Test Supervisor will support the transfer of funds to ORNL and be responsible for expenditures in accordance with the approve planning budget. The Test Supervisor will also be responsible for reporting the results in a final document as required by the customer.

Support Staff

The Plant and Equipment (P&E) Division of ORNL supplies the riggers who handle the physical aspects of drop testing. The riggers are indoctrinated before each test to acquaint them with the objectives of the test and what is expected of them. All are qualified to operate the equipment they are sent to operate (e.g., fork lifts, cranes, etc.). The paperwork describing their qualifications is kept in files by the P&E Division, which employs them. Riggers must meet the requirements set forth in P&E Procedure M-3.20, General rigging requirements, which specify their minimum safety regulations and requirements for personnel and equipment.

Instrumentation

Personnel who support the drop tests are staff members of the ORNL Metrology Laboratory and the Vibration Analysis Group. These organizations have had extensive experience in the measurement and analysis of vibration and shock data, and with the calibration and use of precision instruments. Engineering staff personnel all have graduate-level training in analytical and signal processing methods. Metrologists and instrument technicians have documented training and experience in all phases of the work, including installation of accelerometers and strain gages.

Metrication Laboratory

The Metrication Laboratory supplies qualified personnel to carry out all dimensional and weight measurements that are required by the test plan. The personnel and the equipment that are to be used to measure the test pieces must be qualified to written P&E Division procedures. Typically, these procedures include Procedures F-1.5, Dimensional Inspector Training; F-14.2, Calibrating Outside Micrometers; F-14.3, Calibrating Dial Indicators; F-14.4, calibrating Vernier calipers; F-14.5, gage Block Calibration; F-14.8, Calibrating Mass Standards; and F-14.9, Calibrating Scales and Balances.

Radiometrics

The Quality Engineering and Inspection Department of ORNL is responsible for supplying x-ray services. All personnel and the equipment they use are qualified to standard Quality Engineering Procedures which include Procedure Numbers NDE 10, Rev. 3, Certification of Nondestructive Examination Personnel; NDE 11, Rev. $, Training Program for Nondestructive Testing Personnel NDE 41, Rev. 5, Radiographic Examination of Welds; and NDE 42, Rev. 2, Radiography Documentation.

Photometrics

ORNL and the Y-12 Plant employ professional photographers who provide the expertise needed to photographically record a wide variety of research and production activities. Many have won photographic awards for their work.

In recent years, the testing of the DT-series of packages for the Y-12 Plant has been a key factor in obtaining DOE approvals for the package configurations tested and, in fact, has speeded up the approval process. In addition, Westinghouse has recently received its NRC Certificate of Compliance for the fresh fuel package tested at ORNL at the end of 1990. These tests met all necessary QA requirements established by NRC and DOE.

Leak Testing

All leak testing will be carried out by personnel from the Quality Engineering and Inspection Department. These people are trained and certified in accordance with procedures NDE 10, Rev. 3 and NDE 11, Rev. 4.

TEST PLANS AND PROCEDURES

Frequently, two types of test plans are developed and used for each drop series. The first is most often generated by the customer, which describes in general terms the tests to be completed, the conditions required, and the data to be taken. Often this test plan will include data sheets that are to be used to collect the data.

The second plan is generated by the Test Supervisor and is focused on the details and safety of the testing. It includes a brief introduction and a purpose for the tests. The test piece(s) are then described. If the packages are prepared in some way before they are received by ORNL to test, that preparation will be described, or referred to if it was described in the customers' test plan. The tests themselves are also summarized. If ORNL is to be responsible for supplying any equipment (e.g., accelerometers, strain gages, etc.) or collecting specific data during the tests, that is also noted. (Frequently the customer wishes to collect specific data and retains responsibility for those collection activities.)

The balance of the plan identifies which parts of the QA Plan for Drop Testing are applicable to that particular test series, and safety-related activities that are to be carried out, such as the indoctrination meeting held with the riggers, use of hard hats, and control of visitors. The plan also employs a check list to determine that specific actions have taken place before the drop test proceeds. This list can be administered by the Test Supervisor and/or the QA representative.

The test plan is generally approved by the Test Supervisor, Test Director, Test Sponsors, and by the Office of Industrial Safety. A QA representative usually witnesses the test series to ensure that the QA test plan is properly applied. The QA representative may also stop the test if necessary at any point if proper procedures are not followed.