Adventures in Package Testing

John McLamb, CHP, RRPT
Health Physicist
National Institute of Environmental Health Sciences
Does a 4G/CLASS 6.2 package meet the requirements to be used to ship radioactive materials under US DOT and IATA Regulations?
Case 1 Small activity

- P32 ≤ 0.0027 mCi
- I125 ≤ 0.027 mCi
- C14 ≤ 0.270 mCi
- S35 ≤ 2.7 mCi
- H3 ≤ 27 mCi
Exempt from Regulations!
Case 2 medium activity

- P³² > 0.0027-1.4 mCi
- I¹²⁵ > 0.027-8.1 mCi
- C¹⁴ > 0.270-8.1 mCi
- S³⁵ > 2.7-8.1 mCi
- H³ > 27-110 mCi
Excepted Package

► Must meet General Design Requirements

- DOT 49 CFR 173.410
- IATA 10.5.3
General Design Requirements (DOT)

- Package can be easily handled and properly secured during transport.

- Structural lifting attachments must have a safety factor of three. Failure of attachment must not compromise packaging.
General Design Requirements (DOT)

- Free from protruding features and easily decontaminated.
- Avoid pockets or crevices
General Design Requirements (DOT)

►► Added features will not reduce the safety of the package.

►► Capable of withstanding the affects of acceleration, vibration or vibration residence under normal conditions.
General Design Requirements (DOT)

- Physically and chemically compatible with contents.
- Valves protected against unauthorized operation.
General Design Requirements (DOT)

► For air transport:
  - Surface temp will not exceed 122°F
  - Containment unimpaired at temperatures ranging from -40°F to 131°F
  - Capable of withstanding pressure decrease of not less than 95kPa (13.8 lb/in²)
Case 3 higher activities

- $^{32}$P \( > 1.4 \text{ mCi} – 14 \text{ Ci} \)
- $^{125}$I \( > 8.1 \text{ mCi} – 81 \text{ Ci} \)
- $^{14}$C \( > 8.1 \text{ mCi} – 81 \text{ Ci} \)
- $^{35}$S \( > 8.1 \text{ mCi} – 81 \text{ Ci} \)
- $^3$H \( > 110 \text{ mCi} – 1100 \text{ Ci} \)
Type A package

In addition to the General Design Requirements must meet requirements of:

- DOT 49 CFR173.412
- IATA 10.6.2.1
Acceptable Evaluation Methods

Compliance with must be shown by:

- Performance of tests with prototypes or samples of the specimens
- Reference to a previous, satisfactory demonstration of compliance
- Performance of tests with models of appropriate scale
- Calculations or reasoned evaluation
Type A Package Design
Requirements

► The outside of the packaging incorporates a feature, such as a seal that is not readily breakable, and that, while intact, is evidence that the package has not been opened.

► The smallest external dimension of the package is not less than 10 cm.
Type A package

- Containment and shielding is maintained during transportation and storage in a temperature range of $-40 \, ^\circ C$ ($-40 \, ^\circ F$) to $70 \, ^\circ C$ ($158 \, ^\circ F$).

- The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport.
Type A package

- Account is taken of radiolytic decomposition and generation of gases.

- The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 psi).
Type A package

- Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.

- Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield.
Type A package

Failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions, must not impair the ability of the package to meet other requirements of this subpart.
Type A package

► Each packaging designed for liquids will—
  ▪ Be designed to provide for ullage
  ▪ Either—
    ► (i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents.
    ▪ (ii) Have a containment system composed of primary inner and secondary outer containment components
  ▪ Meet the conditions prescribed in 49CFR173.412(j) for tests performed under 49CFR173.466
Type A package

- Each package designed for gases will be able to prevent loss or dispersal of contents when subjected to the tests in §173.466.
Type A package

When evaluated against the performance requirements of this section and the tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent—

- (1) Loss or dispersal of the radioactive contents; and
- (2) A significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.
Performance Testing!
Type A Test Requirements

- Water Spray Test
- Free Drop Test
- Stacking Test
- Penetration Test
Water Spray Test

- Must precede each test.
- Simulate rain fall at 2 in. per hour applied to 4 sides of package.
- At least 1 hour duration.
- Allow for maximum soaking without appreciable drying.
Free Drop Test

► Must drop onto target so package suffers maximum damage.
► 4 separate samples each dropped on a different corner.
► Target must be flat horizontal rigid surface.
► Dropped from a height of 4 ft (30 ft for liquids and gases).
Stacking Test

► Subjected to compressive load for at least 24 hr.

► Load must be at least:
  - 5 times the mass of the package.
  - 1.9 psi multiplied by the vertical projected area of the package.
WARNING

DRY ICE MUST NOT BE PACKED INSIDE THIS COMBINATION PACKAGING

UN
4G/CLASS 6.2/04
GB/2450

Air Sea
ATLANTA
Penetration Test

- Specimen must be placed on a rigid flat horizontal surface.
- Bar of 1.25 in. in diameter with a hemispherical end and a mass of 13.2 lb.
- Must be dropped and directed to fall with its longitudinal axis vertical onto the center of the weakest part of the specimen.
- Dropped from 3.3 ft (5.5 ft for liquids or gases).
Conclusion

- A 4G/CLASS 6.2 package does meet the requirements to be used to ship radioactive materials under US DOT and IATA Regulations...as long as extra tests are performed and documentation of previous testing can be obtained for Type A quantities.