

# ISO 12807:2018 (E)

## Safe transport of radioactive materials — Leakage testing on packages

---

### Contents

	Foreword
	Introduction
1	Scope
2	Normative references
3	Terms and definitions
4	Symbols and units
5	Regulatory requirements
5.1	Relevant regulations
5.2	Regulatory containment requirements
6	Procedure for meeting the requirements of this document
6.1	General
6.2	Quality management system
6.3	Procedure
6.3.1	General
6.3.2	Determination of permissible activity release rates
6.3.3	Determination of standardized leakage rates
6.3.4	Determination of permissible test leakage rates for each verification stage
6.3.5	Selection of appropriate test methods
6.3.6	Performance of test and record of results
7	Determination of permissible activity release rates
7.1	Step 1: List the radioactive contents, Ai
7.2	Step 2: Determine the total releasable activity, RIT
7.3	Step 3: Determine the maximum permissible activity release rates, R
8	Determination of standardized leakage rates
8.1	General
8.2	Step 4: Determine the activity release rate due to permeation, RP
8.3	Step 5: Determine the maximum permissible activity release rate due to leakage, RG
8.4	Step 6: Determine the activity per unit volume of the containment system medium, C
8.5	Step 7: Determine the maximum permissible volumetric leakage rate of the medium, L
8.6	Step 8: Determine the maximum permissible equivalent capillary leak diameter, D
8.7	Step 9: Determine the permissible standardized leakage rate, QSLR
9	Containment-system verification requirements
9.1	Containment-system verification stages
9.1.1	General
9.1.2	Design verification
9.1.3	Fabrication verification
9.1.4	Preshipment verification
9.1.5	Periodic verification
9.1.6	Maintenance verification
9.2	Verification requirements
9.2.1	General
9.2.2	Step 10: Determine permissible test leakage rate for each verification stage, QTDA, QTDN, QTF, QTS, QTP and QTM
9.2.3	Step 11: Select appropriate test methods

**10 Leakage test procedure requirements**

- 10.1 General**
- 10.2 Step 12: Perform tests and record results**
- 10.3 Test sensitivity**
- 10.4 Test procedure requirements**
  - 10.4.1 General**
  - 10.4.2 Testing**

**Annex A (informative) Preferred leakage test methods**

- A.1 General**
- A.2 Comments and precautions**
  - A.2.1 Risks of explosion**
  - A.2.2 Tracer materials**
  - A.2.3 Leakage rates**
  - A.2.4 Avoid wetting the test item**
  - A.2.5 Partial pressure**
  - A.2.6 Vacuum conditions**
  - A.2.7 Performing leakage test**
- A.3 Quantitative methods**
  - A.3.1 Gas pressure drop**
    - A.3.1.1 Applicability of the method**
    - A.3.1.2 Leakage rate indication**
    - A.3.1.3 Test sensitivity**
    - A.3.1.4 Test method**
    - A.3.1.5 Advantages and disadvantages**
    - A.3.1.6 Hazards**
  - A.3.2 Gas pressure rise**
    - A.3.2.1 Applicability of the method**
    - A.3.2.2 Leakage rate indication**
    - A.3.2.3 Test sensitivity**
    - A.3.2.4 Test method**
    - A.3.2.5 Advantages and disadvantages**
    - A.3.2.6 Hazards**
  - A.3.3 Gas filled envelope (gas detector)**
    - A.3.3.1 Applicability of the method**
    - A.3.3.2 Leakage rate indication**
    - A.3.3.3 Test sensitivity**
    - A.3.3.4 Test method**
    - A.3.3.5 Advantages and disadvantages**
    - A.3.3.6 Hazards**
  - A.3.4 Evacuated envelope (gas detector)**
    - A.3.4.1 Applicability of the method**
    - A.3.4.2 Leakage rate indication**
    - A.3.4.3 Test sensitivity**
    - A.3.4.4 Test method**
    - A.3.4.5 Advantages and disadvantages**
    - A.3.4.6 Hazards**
  - A.3.5 Evacuated envelope with helium back pressurization**
    - A.3.5.1 Applicability of the method**
    - A.3.5.2 Leakage rate indication**
    - A.3.5.3 Test sensitivity**
    - A.3.5.4 Test method**
    - A.3.5.5 Advantages and disadvantages**
    - A.3.5.6 Hazards**
- A.4 Qualitative methods**
  - A.4.1 Gas bubble techniques**
    - A.4.1.1 Applicability of the method**
    - A.4.1.2 Leak indication**
    - A.4.1.3 Test sensitivity**
    - A.4.1.4 Test method**
      - A.4.1.4.1 Hot water bubble**
      - A.4.1.4.2 Vacuum bubble**
      - A.4.1.4.3 Pressurized cavity bubble method**

- A.4.1.5 Advantages and disadvantages
- A.4.1.6 Hazards
- A.4.2 Bubble test
  - A.4.2.1 Applicability of the method
  - A.4.2.2 Leak indication
  - A.4.2.3 Test sensitivity
  - A.4.2.4 Test method
  - A.4.2.5 Advantages and disadvantages
  - A.4.2.6 Hazards
- A.4.3 Tracer gas (sniffer technique)
  - A.4.3.1 Applicability of the method
  - A.4.3.2 Leak indication
  - A.4.3.3 Test sensitivity
  - A.4.3.4 Test method
  - A.4.3.5 Advantages and disadvantages
  - A.4.3.6 Hazards
- A.4.4 Tracer gas (spray method)
  - A.4.4.1 Applicability of the method
  - A.4.4.2 Leakage-rate indications
  - A.4.4.3 Test sensitivity
  - A.4.4.4 Test method
  - A.4.4.5 Advantages and disadvantages
  - A.4.4.6 Hazards

#### **Annex B (informative) Methods of calculation**

- B.1 General
- B.2 Gas leakage
- B.3 Correlation between gas leakage rates in different conditions
- B.4 Mixture of gases
- B.5 Correlation to standard conditions
- B.6 Liquid leakage
- B.7 Correlation between liquid-leakage rates at different conditions
- B.8 Correlation between gas and liquid leakage rates
- B.9 Aerosol leakage
- B.10 Correlation between gas and aerosol leakage rates
- B.11 Precautions in the use of correlations
- B.12 Surface tension
- B.13 Permeation
- B.14 Leakage test for pressure drop and pressure rise
- B.15 Correction for tracer-gas partial pressure
- B.16 Sensitivity of leakage test procedure

#### **Annex C (informative) Conversion tables**

#### **Annex D (informative) Worked examples**

- D.1 General
- D.2 Test leakage rates for dry spent fuel flask
  - D.2.1 General
  - D.2.2 Step 1
  - D.2.3 Step 2
  - D.2.4 Step 3
  - D.2.5 Steps 4 and 5
  - D.2.6 Step 6
  - D.2.7 Step 7
- D.3 Test leakage rates for wet spent fuel flask
  - D.3.1 General
  - D.3.2 Steps 1 and 6
  - D.3.3 Step 2
  - D.3.4 Step 3
  - D.3.5 Step 6
  - D.3.6 Step 7
  - D.3.7 Step 8
  - D.3.8 Step 9
  - D.3.9 Step 10

- D.4 Pressure rise test on closure fitted with double O-ring seals
  - D.4.1 General
  - D.4.2 Step 11
- D.5 Pressure drop test on closure fitted with double O-ring seals
  - D.5.1 General
  - D.5.2 Test data
  - D.5.3 Test results
  - D.5.4 Determination of leakage rate
  - D.5.5 Determination of standardized leakage rate
  - D.5.6 Effect of temperature change
- D.6 Comparison between pressure rise and pressure drop tests
- D.7 Determination of an unknown test volume for the pressure rise or pressure drop test
  - D.7.1 General
  - D.7.2 Procedure
- D.8 Gas permeation
  - D.8.1 General
  - D.8.2 Example 1: activity release by permeation (Krypton)
  - D.8.3 Example 2: Test gas permeation (helium)
- D.9 Aerosol leakage
  - D.9.1 Case No 1
  - D.9.2 Case No 2
- D.10 Correlation between gas and liquid leakage rates
  - D.10.1 General
  - D.10.2 Step 1
  - D.10.3 Step 2
  - D.10.4 Step 3
  - D.10.5 Step 6
  - D.10.6 Step 7
  - D.10.7 Step 8
  - D.10.8 Step 9
  - D.10.9 Step 10
- D.11 Correlation between leakage rates for different gases
  - D.11.1 General
  - D.11.2 Step 1
  - D.11.3 Step 2
  - D.11.4 Step 3
  - D.11.5 Steps 4 and 5
  - D.11.6 Step 6
  - D.11.7 Step 7
  - D.11.8 Step 8
  - D.11.9 Step 9
  - D.11.10 Step 10
- D.12 Sensitivity of gas bubble immersion test
- D.13 Containment for tritiated water
  - D.13.1 General
  - D.13.2 Step 1
  - D.13.3 Step 2
  - D.13.4 Step 3
  - D.13.5 Step 6
  - D.13.6 Step 7
  - D.13.7 Step 8
  - D.13.8 Step 9
  - D.13.9 Step 10
  - D.13.10 Step 11
  - D.13.11 Step 12
- D.14 Containment of liquids using double containment and taking radiolysis into account
  - D.14.1 General
  - D.14.2 Containment system
  - D.14.3 Retention of liquid containers
  - D.14.4 Determination of the rate of gas generation due to radiolysis
  - D.14.5 Determination of the pressure within the inner containment vessel
  - D.14.6 Determination of the leak diameter
  - D.14.7 Determination of the total liquid leakage in one year

- D.14.8 Determine the quantity of absorbent material required to retain liquids leaking from the inner container
- D.15 Containment of dry spent fuel flask with the sub-atmospheric pressure method
  - D.15.1 General
  - D.15.2 Calculation data
  - D.15.3 Evaluation of the partial pressure of the gas mixture subsequent to the rod failures
  - D.15.4 Evaluation of the internal flask pressure rise in one year due to the flask in-leakage
  - D.15.5 Evaluation of the global internal flask pressure rise in 1 year

**Annex E (informative) Rationale**

- E.1 General

**Page count: 85**