Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

# AEROSPACE RECOMMENDED PRACTICE

ARP 1523

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Revised

## INSULATED AIR CARGO CONTAINER



### 1. INTRODUCTION

1.1 This Aerospace Recommended Practice (ARP) outlines supplementary requirements for air cargo insulated containers as is intended to be used in conjunction with Society of Automotive Engineers (SAE), International Air Transport Association (IATA) and International Organization for Standardization (ISO) specifications listed below relating to air cargo containers:

SAE AS 832 (as revised)
IATA 50/3 to 50/8 inclusive
ISO 1496, Part VII

1.2 Nothing stated in this ARP shall in any way cancel or reduce the status of the above-mentioned SAE/IATA/ISO air cargo containers.

1.3 This ARP refers to the thermal efficiency of all insulated air cargo containers irrespective of their size and designation. This ARP does not provide detail regarding refrigerated nor heated containers and/or the methods and equipment employed to achieve those objectives; such as cryogenic, gaseous or liquid fluids; or mechanical compressors.

1.4 In preparing this ARP, for compatability and guidance purposes, the requirements of the following specifications have been taken into consideration, where applicable to air mode:

ANSI MH 5.1.1 (1974)
ISO 1496, Part II

### 2. PURPOSE

2.1 The purpose of this ARP is to establish minimum operational requirements that will ensure that perishable cargoes in insulated standard airborne containers can be kept in prime condition during the ground handling and air transportation cycle within a maximum timespan of 36 hours.

### 3. SCOPE

3.1 Perishable cargoes, e.g., dairy produce, fruit, vegetables, flowers, frozen foods, meat, fish, etc., require maintenance of specific temperature ranges during air related door-to-door transportation.

3.2 The overall temperature range for perishable commodities may be established anywhere between 68° F (20° C) and -13° F (-25° C) with allowable fluctuations of ± 1° C during the transport cycle.

3.3 During this period of door-to-door transportation, the container will be subjected to external ambient temperatures with extremes from 113° F (45° C) to -58° F (-50° C) and relative humidity up to 100%.







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3.3.1 For design purposes, this ARP considers the container must perform its protective function within an exterior temperature variation ( $\Delta$ T) of 95° F (35° C).

4. DESIGN CONSIDERATIONS

4.1 The container design shall incorporate careful consideration of the contribution of conduction, convection, radiation and air leakage to the unit's overall thermal efficiency. At the same time, optimum balance between insulation, structure, cost and weight must be a constant design goal.

4.2 Although no specific test is specified in Section 7 for thermal radiation, it is expected that consideration will be given to commonly encountered environments wherein radiant energy exchange can be minimized.

4.3 The container shall be free of sharp corners and/or crevices which might collect dirt, spillage or odors. No pockets shall exist in the cargo loading space that cannot be reached by conventional cleaning methods.

4.4 Construction shall collect spillage during the transport cycle but allow water run-off during flushing and/or washing. Adequate provision shall be made to ensure that cleaning water can satisfactorily drain from the inside of the container.

4.5 Materials used on container structure, interior surfaces and insulation shall neither absorb moisture nor odors and shall not be functionally affected by daily washing.

4.5.1 Method of washing shall include flushing using a pressure hose at 100 psig (689 kPa), 158° F (70° C) temperature and strong detergents.

4.5.2 Container when "washed" shall not require the use of odor neutralizing chemicals.

4.5.3 Container shall withstand freezing temperatures while wet immediately following washing. All valves, seals, doors and controls shall remain operative.

5. PRESSURIZATION

5.1 Containers will be closed at differing terminal altitudes. The critical condition will be that at sea level. Operationally the container could be subjected to either internal positive or negative pressure. Careful attention to the design of equalization devices (if any) and all seals is important in the control of air leakage heat transfer.

5.2 Pressure Equalization:

Further to 5.1 above, where the design of door seals is NOT adequate to relieve pressure, then a pressure equalization device should be installed for two-way equalization. This pressure relief device should be set to operate at 0.5 to 1.0 psig (3450 Pa to 6890 Pa) pressure differentials.

6. TESTS - AIRTIGHTNESS

6.1 On completion of the structural tests specified in the relevant SAE/IATA/ISO specifications, the container shall be tested for leakage rate.

6.2 The temperature inside and outside the container shall be stabilized within 5.4° F (3° C) of each other and shall both be within the range of 59° F - 77° F (15° C - 25° C). The container shall be empty and in its normal operational condition with the access doors closed in the normal manner. Any drain openings shall be closed.

6.3 Air shall be introduced through an accurate metering device and a suitable manometer shall be connected to the container by a leak-proof connection. The manometer shall not be part of the air supply system. The flow-measuring device shall be accurate to ±3% of the measured flow rate, and the manometer on the container shall be accurate to ±5%.

6.4 Air shall be admitted to the container to raise its internal pressure to .036 ± .0015 psig (1 ± .042 inch water) (250 ± 10 Pa [25 ± 1 mm water]) and the air supply regulated to maintain this pressure.

6.4.1 The air leakage rate, expressed in standard atmospheric conditions, should be no more than the values given in Table I (see Appendix A), i.e., 40% of the internal volume per hour. If the measured air leakage is equal to or less than the values given in Table I, the heat transfer results determined in the thermal test shall be reported without correction for air leakage.

6.4.2 If the measured air leakage exceeds these values but is no more than the values given in Table II (see Appendix A), then the measured U values in the thermal test shall be increased by the amounts given in Table III (see Appendix A).

6.5 The air pressure shall be increased to between 0.5 - 1.0 psig (3450 Pa - 6890 Pa) internal pressure. The pressure relief device, or door seal expulsion, must operate within the positive differential range of 0.5 - 1.0 psig (3450 Pa - 6890 Pa).

6.6 Upon completion of the above tests, there shall be no permanent deformation and the container must be fully operational. Closures, seals and pressure equalization device shall be intact and functional.

7. THERMAL TEST

7.1 This test is performed to establish the overall heat transfer rate, or K factor, of the container. The container must be tested in the exact configuration intended for use. Any options or component configuration alternatives must be tested in a seperate test and appropriately specified, when applicable, in the container performance data on the placard described in Section 8.

7.1.1 The heat leakage shall be expressed by the total heat transfer rate ($U_\theta$), which is defined by the formula

$$U_\theta = \frac{Q}{\theta_e - \theta_i}$$

The coefficient of heat transfer (K) is such that

$K = U_\theta/S$, expressed in watts per square metre per degree Celsius;

where

$U_\theta$ is the total heat transfer rate, expressed in watts per degree Celsius (see Note *);

Q is the power dissipated or absorbed by the operation of internal heaters and fans or internal cooling units, in watts;

$\theta_e$ is the average outside temperature which shall be the arithmetic mean of the temperatures recorded at the end of each test interval and measured 4 in. (100 mm) from the walls, at least at the 12 points shown in Appendix B;

7.1.1 continued..

$\theta_i$ is the average inside temperature, which shall be the arithmetic mean of the temperatures recorded at the end of each test interval and measured 4 in. (100 mm) from the walls at least at the 12 points shown in Appendix B;

$\theta$ is the mean wall temperature, by convention,

$$\theta = \frac{\theta_e + \theta_i}{2}$$

S is the mean surface area of the container in square metres, which is the geometric mean of the inside surface area S, and the outside surface area $S_e$; by convention,

$$S = \sqrt{S_i \times S_e}$$

If areas are corrugated, the projected area shall be used.

* NOTE: 1 W/°C = 0.556W/°F = 0.860 kcal/(h.°C) = 1.895Btu/(h.°F)

7.2 The test shall be performed under steady state conditions using the internal heating method. All measuring systems shall be selected and calibrated to result in the following root mean square average accuracies:

| | |
|---|---|
| Temperatures | ± 0.9°F (± 0.5°C) |
| Power | ± 2% of the quantity measured |

7.3 The interior air temperature shall be measured 4 in. (100 mm) from the walls at least at the following 12 points (see Appendix B):

(a) The eight interior corners of the container
(b) The centers of the side walls, floor and ceiling

7.3.1 The exterior air temperature shall be measured 4 in. (100 mm) from the walls at least at the following 12 points (see Appendix B):

(a) The eight exterior corners of the container
(b) The centers of the side walls, underside and roof

7.4 Test data for determining the heat leakage of the container must be taken after an appropriate soak period for the continuous period of not less than 8 hr during which the following conditions must be satisfied:

7.4.1 The test shall be performed with a mean wall temperature chosen between 50°F - 113°F (10°C - 45°C) and a temperature difference between inside and outside not less than 50°F (10°C).

(NB: It should be noted that a standard mean wall temperature of 50°F (10°C) should be used for rating thermal containers because it allows a better determination of all factors involved in the in-service conditions at which the containers will be operated, and facilitates comparison of different containers by owners and users. It also eliminates misunderstanding in applying the overall heat transfer rate values for different mean wall temperatures. Appropriate correction factors may be employed for the specific insulation material being used.)

7.4.2 Maximum difference between the warmest and coldest inside points at any one time: 5.4° F (3° C).

7.4.3 Maximum difference between the warmest and coldest outside points at any one time: 5.4° F (3° C).

7.4.4 Maximum percentage between the lowest and the highest power dissipation (BTU/hr.) (watts) values is not to exceed 3% of the lowest figure.

7.4.5 All readings shall be recorded at not more than 30-minute intervals.

7.4.6 All temperature measuring instruments placed inside and outside the container shall be so designed as to render the effect of radiation negligible.

7.5 Calculate $U_\theta$, the overall heat transfer rate, and $\theta$, the mean wall temperature as follows:

$$U_\theta = \frac{Q}{\theta_e - \theta_i} \quad \text{and} \quad \theta = \frac{\theta_e + \theta_i}{2} \quad \text{where:}$$

Q: Power dissipated by the operation of internal heaters (BTU/hr) (watts) for the test period.

$\theta_e$: Average exterior air temperature ° F (° C), (during the test as calculated from at least 17 sets of readings)

$\theta_i$: Average interior air temperature ° F (° C), (during the test as calculated from at least 17 sets of readings).

8. MARKINGS

8.1 The markings required for handling as specified in the applicable document(s) listed in 1.1 shall apply.

8.1.1 The overall heat transfer rate $U_\theta$ expressed in (BTU/hr. /° F (watts /° C).

8.1.2 The applicable mean wall temperature $\theta$.

8.2 The placard shall be 2.5 x 5 in. (60 x 125 mm) permanently affixed to the container, and contain black Gothic bold lettering of 0.4 in. (10 mm) high in the following format:

| |
|---|
| Heat transfer rate_____BTU/hr/° F _____watts/° C |
| Mean Wall temperature_____° F _ _____° C |

8.3 A sample perishable commodity capability should be indicated for guidance to the user. Suitable wording such as that following should be marked:

| |
|---|
| If commodity temperature to be maintained is 32° F (0° C), temperature within the container can be expected to vary ± __X__ ° F within __X__ hours of transport at the indicated mean wall temperature (ambient). |



PREPARED BY

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GROUND EQUIPMENT AND SYSTEMS