AEROSPACE RECOMMENDED PRACTICE

ARP8058

Issued 2014-06

Thermal Design and Performance of Airplane In-Flight Food Storage Carts

RATIONALE

The design of the in-flight food storage (galley) cart and its interface with the airplane galley cooling system are important for maintaining the thermal environment necessary for keeping food and beverages in a safe and high-quality condition. This document provides design guidance, performance criteria, and test methods to ensure that the galley cart exhibits the characteristics necessary to comply with this thermal requirement.

TABLE OF CONTENTS

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides design guidance and a method for testing thermal performance of airplane in-flight food storage carts. It is noted that thermal performance criteria is not part of AS8056.

1.1 Purpose

The objective of airplane galley refrigeration systems is to maintain food at temperatures at which harmful bacterial growth is minimized. National health safety regulations that once allowed food to be stored at 45 °F (7 °C) have been improved and now call for food storage at temperatures below 39.2 °F (4.0 °C) (Europe) and 41 °F (5 °C) (USA). Airplane in-flight food storage carts are a critical part of the overall galley refrigeration system; therefore, assuring that a cart's thermal characteristics support this goal is essential. The requirements prescribed herein are directed toward this goal.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP695 Galley System Design and Installation Criteria

AS8056 Minimum Design and Performance of Airplane Galley In-Flight Carts, Containers, and Associated Components

2.2 Definitions

CART: A movable enclosure on wheels designed for the purpose of transporting and storing various items used for cabin service activities. A Cart is typically pushed up and down the airplane passenger aisles during cabin service activities.

INTERFACE: The fit and functional relationships of the cart with the galley or other structure (e.g., ducts).

INTERFACE CONTROL DRAWING (ICD): An engineering drawing created for the purpose of communicating interface information.

TROLLEY: The word “trolley” is synonymous with “cart".

2.3 Mandating and Recommending Phrases

The word “shall” indicates a mandatory criterion.

The word “should” indicates a criterion for which an alternative, including noncompliance, may be applied if it is documented and justified.

3. GENERAL REQUIREMENTS

3.1 Cart Design

The temperature in a galley cart is typically maintained either by dry ice placed inside the cart or by chilled air circulating over and around or through the cart. Each approach imposes specific design and performance requirements for the cart.

3.1.1 Dry-Ice Carts

Cooling is provided by sublimation of dry ice in a separate dry ice container. The cart's dry ice container should be located at the top of the cart to achieve downward cold air flow. The ice container shall be made from an insulated material and tightly constructed/sealed such that cold air flows out its intended air delivery hole(s) only. The insulated material should be selected to have a low heat transfer rate (e.g., be non-metallic) as this reduces conduction through the container and increases natural convection (see Figure 1). Reducing conduction through the container reduces the potential for freezing food located nearby (upper food storage positions) and reduces cooling loss to unintended areas (e.g., loss to the ambient environment).

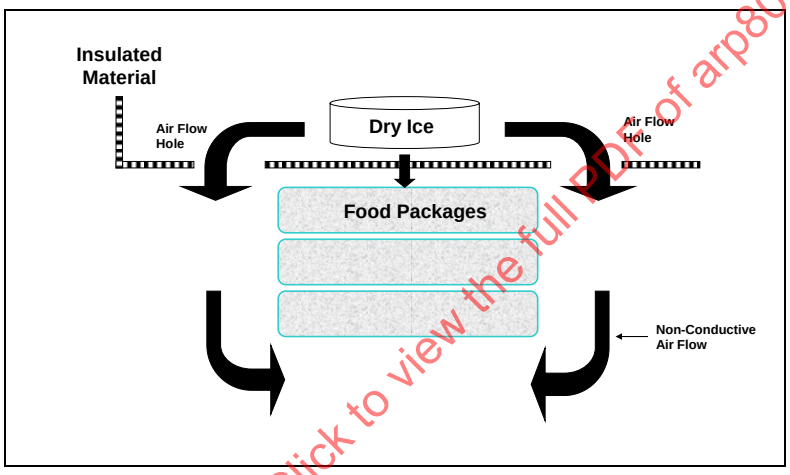

FIGURE 1 - DRY ICE COOLING FOR CARTS

3.1.2 Air-Through Carts

Cooling is provided by chilled air flowing into the cart. This cart has air inlet and outlet grills located in the back. Cold air from an external source flows through the inlet grill, comes in direct contact with the cart's contents and returns to the source through the outlet grill. Figure 2 illustrates an air chiller as the external source of cold air, which flows through galley ducting into the cart and then returns to the air chiller.

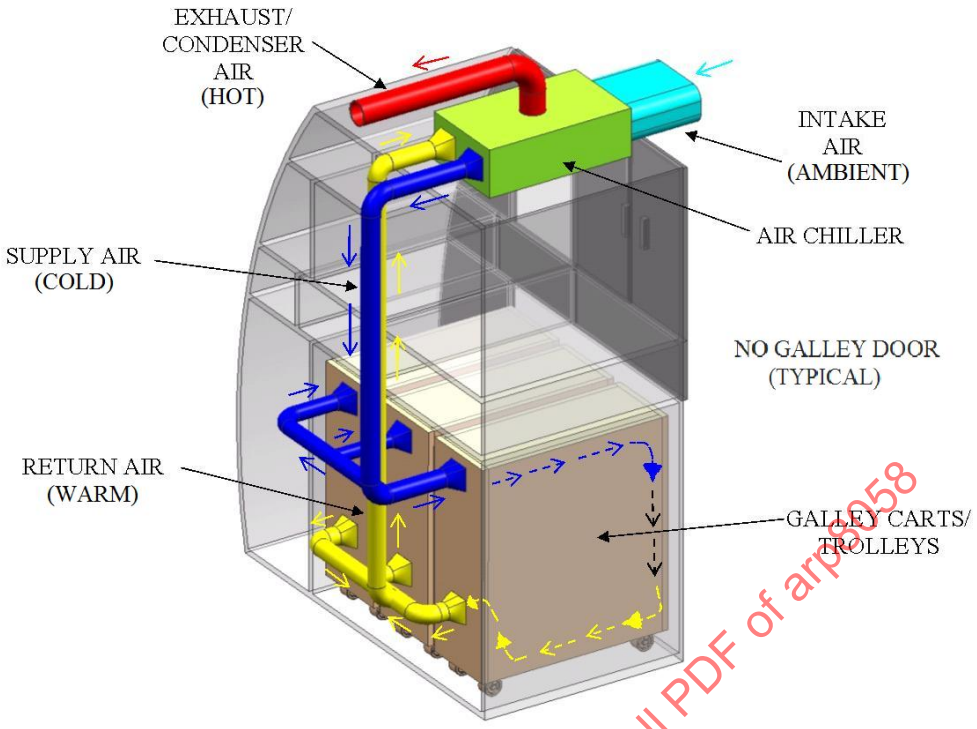

FIGURE 2 - AIR-THROUGH COOLING FOR CARTS

The back of the cart shall have one air inlet opening and one air outlet opening (see Figure 3). Service history has shown that a cart with openings dimensioned and positioned as described below can be successfully integrated into the refrigeration system:

a. The air inlet is 4.0 inches x 4.0 inches (H x W) (100 mm x 100 mm), with the center of the opening located 32 inches (812.8 mm) above and along the centerline of the cart bottom panel.

b. The air outlet is 4.0 inches x 4.0 inches (H x W) (100 mm x 100 mm), with the center of the opening located 10 inches (254 mm) above and along the centerline of the cart bottom panel

c. The inlet and outlet locations assume the cart bottom panel is approximately 4.0 inches (100 mm) above the airplane floor.

d. The air inlet and air outlet openings are covered with a grill (minimum 16 holes per inch).

e. The surface around the inlet and outlet openings is flat and smooth, extending at least 0.75 inches (19 mm) from the entire outer edge of the opening as shown in Figure 3.

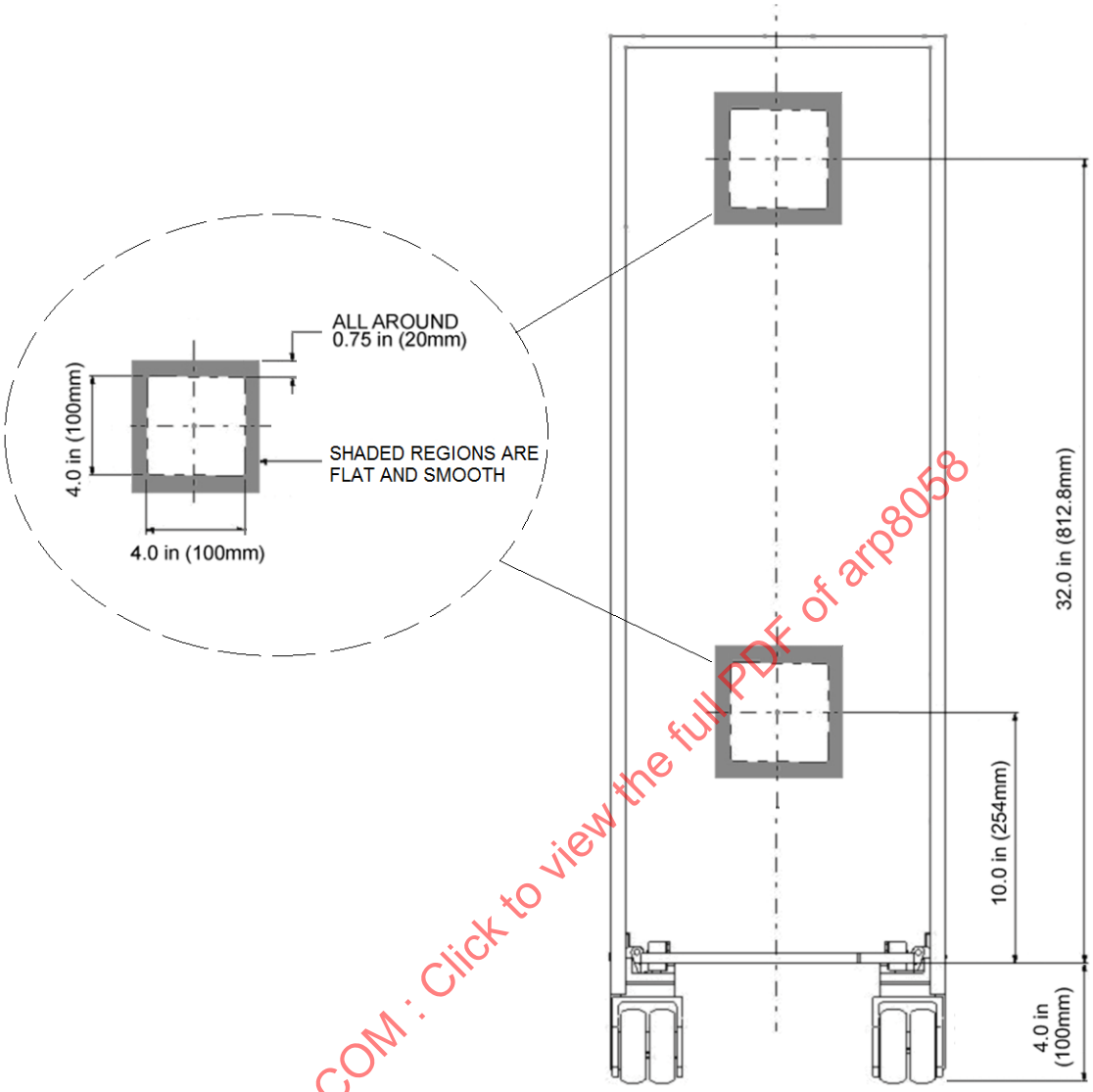

FIGURE 3 - THE REAR FACE OF THE AIR-THROUGH CARTS

3.1.3 Air-Over Carts

Cooling is provided by chilled air from an external source flowing around the outside of the cart, which is stowed in an enclosed compartment. Figure 4 illustrates an air chiller as the external source with cold air flowing through galley ducting into an enclosed galley compartment, circulating around the outside of the cart before returning to the air chiller.

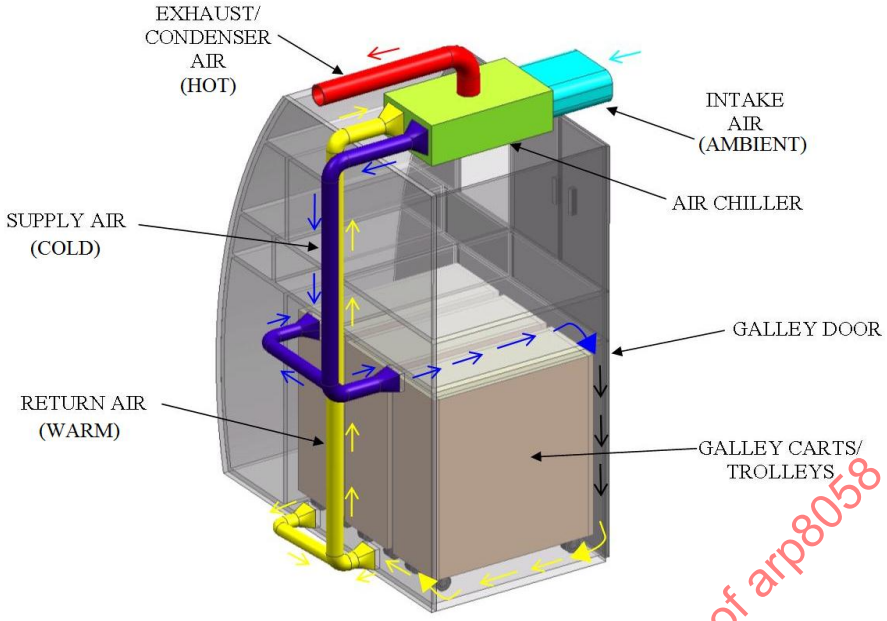

FIGURE 4 - AIR-OVER COOLING FOR CARTS

4. PERFORMANCE REQUIREMENTS

4.1 Thermal

The enclosure of the cart shall be designed to have a heat transfer coefficient (U-value) equal to or less than 0.005 BTU/hour-square inch-°F when tested per Section 5.

4.2 Leakage

All carts shall be designed and maintained to ensure doors and dry ice drawers seal tightly against their frames.

5. TESTING

5.1 Warm Air Test

The Warm Air Test shall be used to determine the Heat Transfer Coefficient (U-value). The U-value demonstrates the thermal characteristics (i.e., insulation and air leakage) of the cart.

5.1.1 Test Set-up

a. Set a fan on the interior floor of the cart as shown in Figure 5. The purpose of the fan is to provide a small amount of airflow so that a uniform temperature distribution is achieved inside the cart. The fan shall not generate more than 5% of the rated heat load in order to keep the heat load constant.

b. Place a known and constant heat load source (typically a 100 to 200 W incandescent light bulb) inside the cart.

c. Place at least three (3) temperature sensors inside the cart. These inside sensors are used to obtain the average inside temperature T_{IN}. The temperature sensors shall be located a minimum of 6 inches (152.4 mm) from the heat source and the fan and a minimum of 3 inches (76.2 mm) from cart interior surfaces to ensure accurate measurement of air temperature (see Figure 6).

d. Place at least two (2) temperature sensors outside the cart, at a minimum distance of 6 inches (152.4 mm) from its exterior surfaces. These outside sensors measure the ambient air temperature surrounding the cart and are used to obtain the average outside temperature T_{OUT} (see Figure 6).

e. For air-through carts, seal the air inlet and outlet openings.

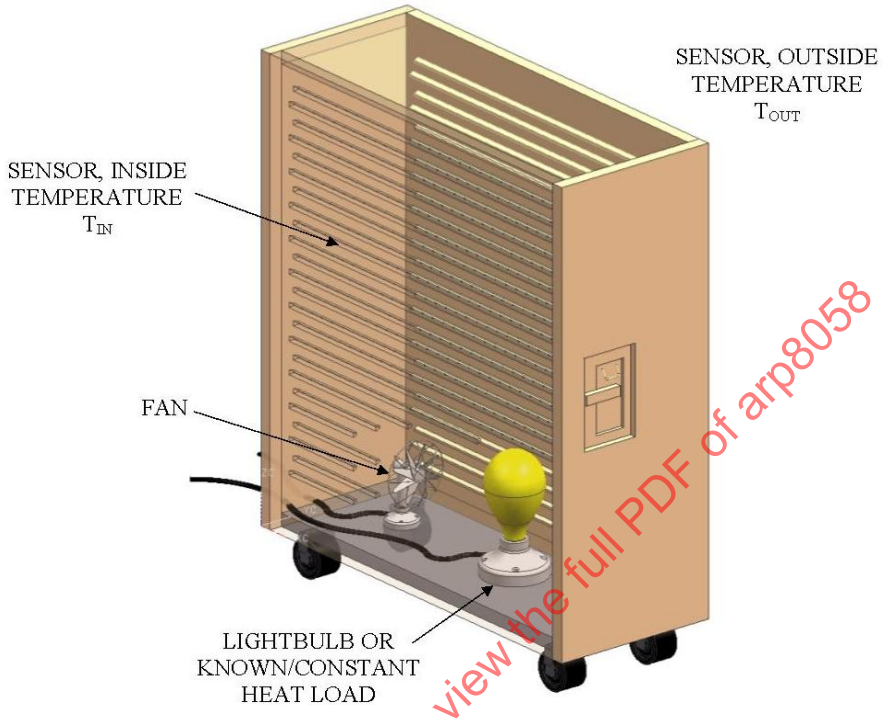

FIGURE 5 - WARM AIR TEST SETUP

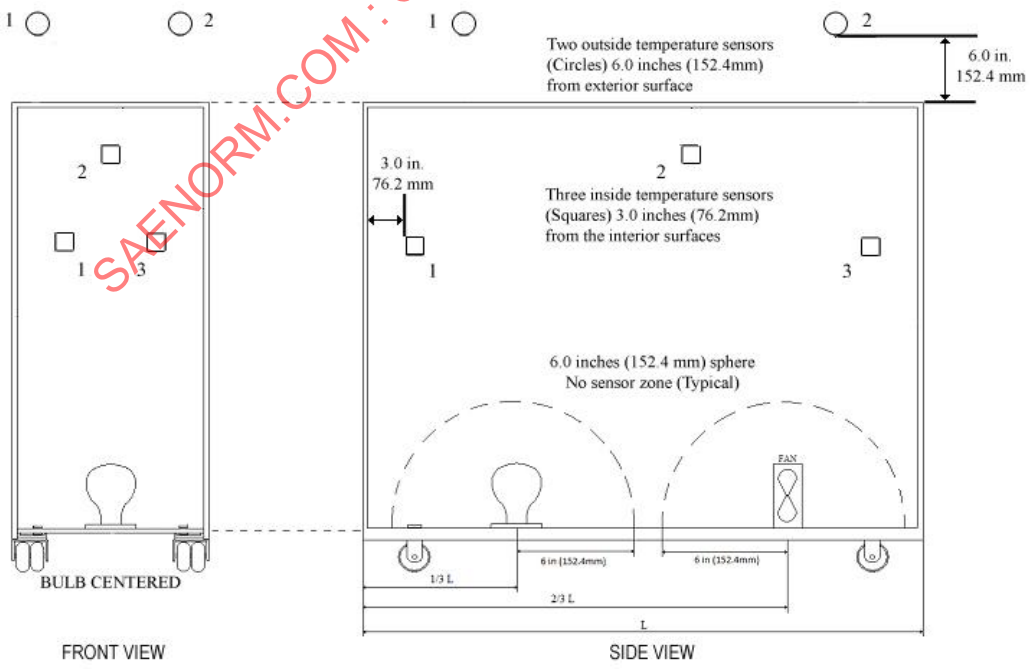

FIGURE 6 - TEMPERATURE SENSOR LOCATIONS