



Boeing recommends limiting the time animals are in cargo compartments prior to takeoff by coordinating closely with the ground crew.

FARE 2120

# Safe Transport of Live Animal Cargo

Transporting live animals requires special attention to the operation of the airplane's environmental control system (ECS). Optimal settings vary by animal species. By following recommended guidelines, operators can maximize animal cargo revenue and reduce unnecessary fuel burn.

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Airplane ECS control settings, animal physiology, airport and en route environments, and ground handling affect the safe transport of live animal cargo. To ensure the health of the live animals and maximize animal cargo revenue, proper ECS settings, animal handling (and packaging), and appropriate animal loading configuration should be used.

This article provides general information about safe transportation of live animal cargo and introduces cargo operators

to Boeing's live-animal cargo guidelines and service.

## THE FUNDAMENTALS OF SAFE LIVE ANIMAL TRANSPORT

The safe transportation of live animals as air cargo is based on controlling three environmental factors: temperature, relative humidity level, and cargo compartment carbon dioxide (CO<sub>2</sub>) concentration. Each type of animal has unique environmental

requirements for optimal health (see fig. 1). Failure to properly control these environmental factors may have an impact on animal welfare, comfort, and survivability, affecting animal cargo revenue.

The compartment temperature, CO<sub>2</sub> level, and humidity levels depend on the ambient temperature, animal type, the number of animals to be transported, airplane air-conditioning pack capability, and the ECS settings. Setting to the desired compartment temperature for the animal does not

**Figure 1: Recommended temperature, humidity, and CO<sub>2</sub> requirements for various animal species**

ANIMAL*	DESIRABLE TEMPERATURE RANGE	RECOMMENDED RELATIVE HUMIDITY (RH)	RECOMMENDED CO <sub>2</sub>
Beef cattle	40–80 deg F (4.4–26.6 deg C)	0–75% RH for swine/hog  0–80% RH for cattle/poultry	0–0.5% for 1-day-old chicks  0–3% for most other animals
Dairy cows, mature, dry	40–80 deg F (4.4–26.6 deg C)		
Dairy heifers, pregnant	40–75 deg F (4.4–23.8 deg C)		
Dairy calves	50–75 deg F (10–23.8 deg C)		
Hogs: Over 15 lb	50–75 deg F (10–23.8 deg C)		
Hogs: Pregnant gilts	50–70 deg F (10–21.1 deg C)		
Horses	40–80 deg F (4.4–26.6 deg C)		
Poultry: Over 10 days old	50–80 deg F (10–26.6 deg C)		
Poultry: 1-day-old (unfed)	90–100 deg F (carton) (32–37 deg C)		
Sheep	50–75 deg F (10–23.8 deg C)		

\*Recommended environmental control system (ECS) settings are determined based on the type of animals being transported.  
Source: American Society of Heating, Refrigerating and Air-Conditioning Engineers and Society of Automotive Engineers Aerospace Information Report 1600.

necessarily result in the temperature that is set from the flight deck. The animal heat load can result in higher compartment temperatures than that set from the flight deck. The humidity and CO<sub>2</sub> levels inside the compartment are not controllable by the ECS settings. The conditioned supply air from the air distribution nozzles, which are located in the ceiling or the sidewall (depending on aircraft design and model), contain some moisture and CO<sub>2</sub> prior to mixing with the air inside the compartment. The supply air properties combined with the animal heat load, CO<sub>2</sub>, and moisture

generation determine the overall compartment air properties (see fig. 2).

A preliminary animal carriage calculation (based on past in-service experience) should be performed to predict the compartment temperature, humidity, and CO<sub>2</sub> prior to animal shipment. If the compartment temperature, relative humidity, and CO<sub>2</sub> are beyond the recommended level for the specific animal after following the general guidance below, the number of animals to be transported should be reduced.

Animals can be transported in all airplane compartments. Depending on

the environmental control availability and flexibility of the ECS system, the number of animals in a load to be transported can vary. The right side of figure 3 shows the forward main deck, aft main deck, forward cargo compartment, aft cargo compartment, and the bulk cargo compartment. Some airplane models combine the aft and bulk cargo compartments into one temperature control (for example, the 777 freighter). Passenger airplanes have lower lobe compartments, which also may be used for animal transport.

## Figure 2: Supplied air and animal environmental factors schematic

This sectional view shows how the air supply mixes with the animal environmental factors.

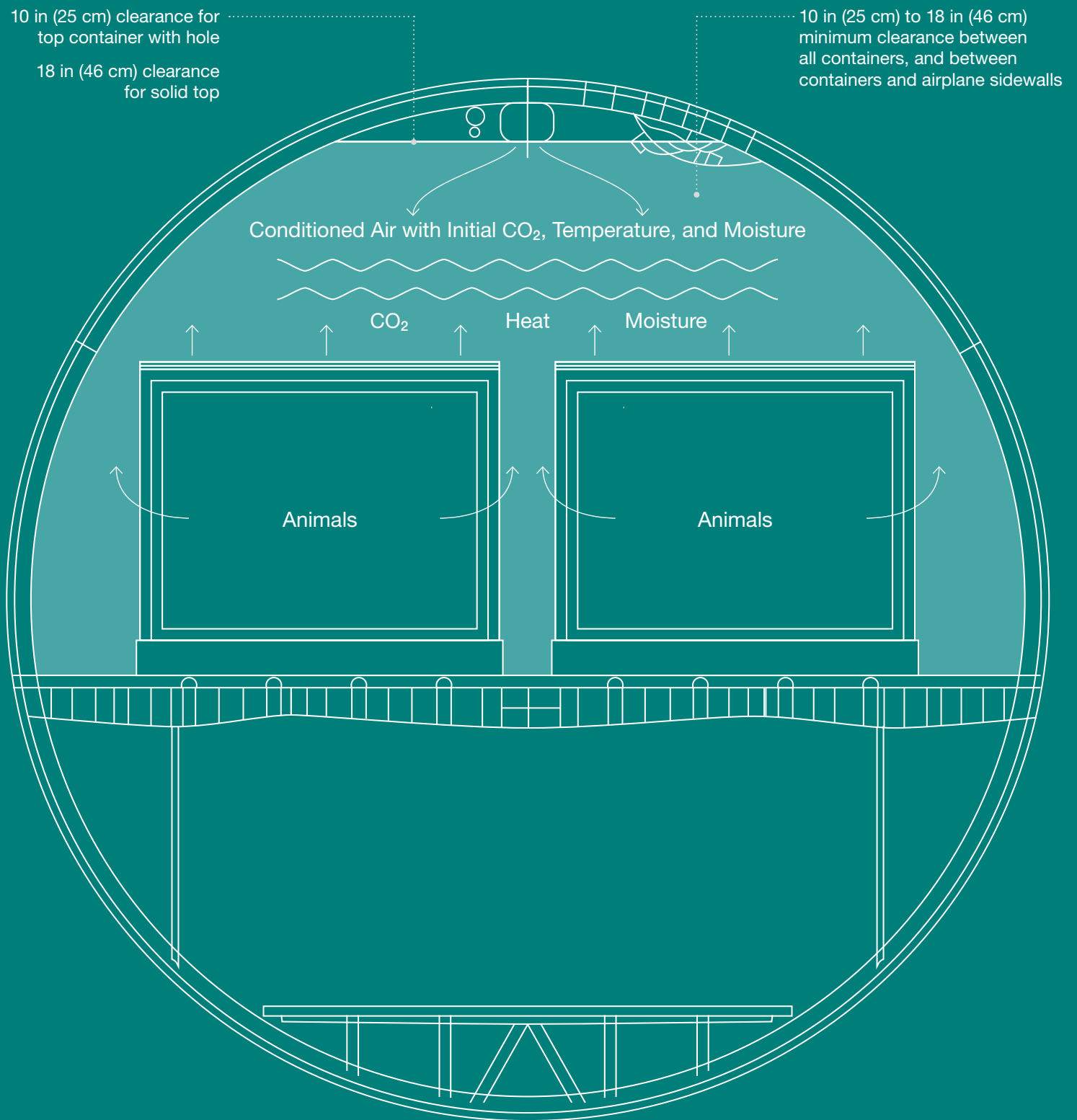


Figure 3: ECS flight deck panel and aircraft compartment identification (777F typical example)

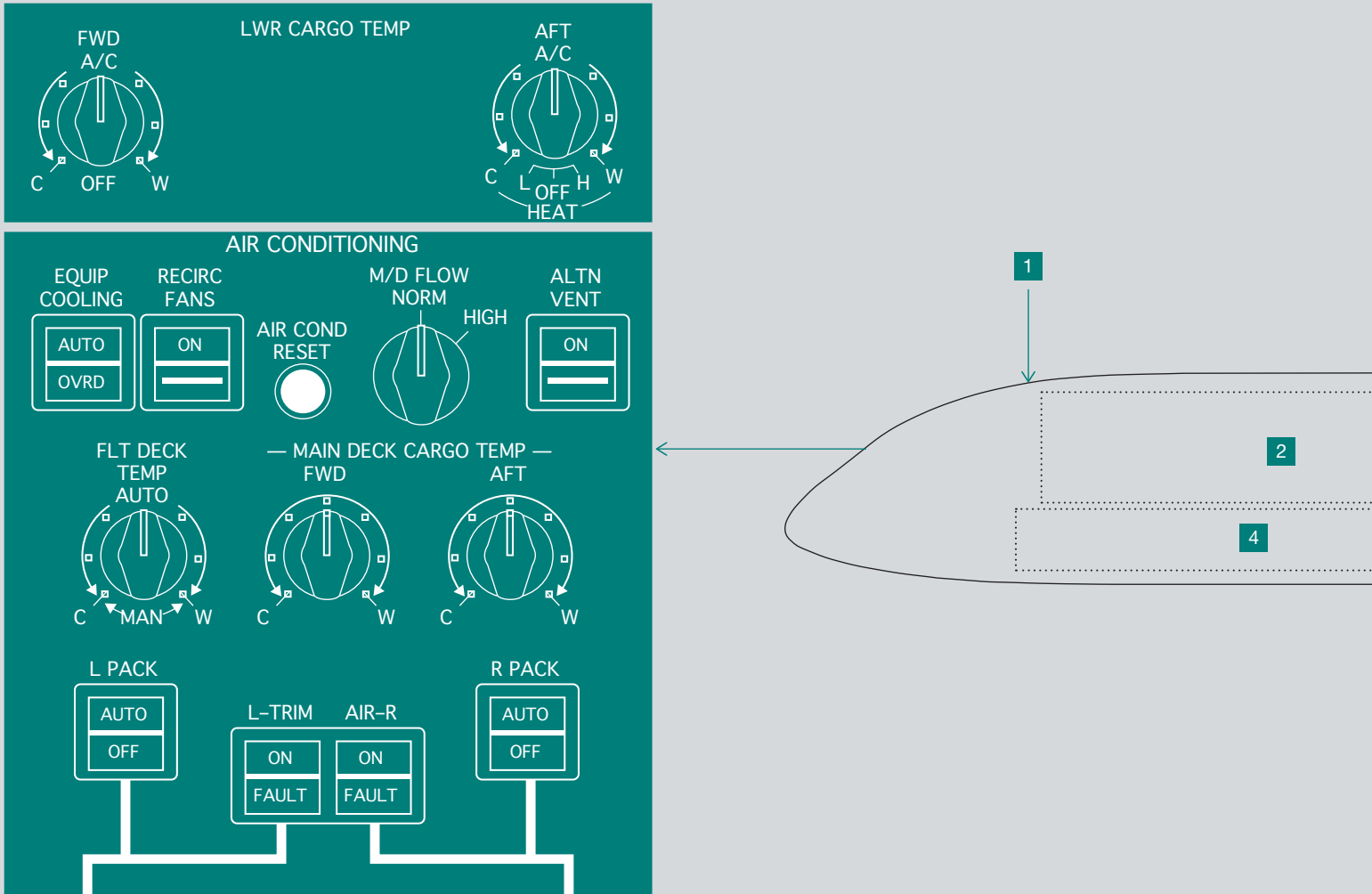


Figure 3 shows a typical 777F ECS control panel in the flight deck. For all freighters, the main deck compartments have the capability of temperature control (heating and cooling) for animal and temperature-sensitive cargo. Lower lobe compartments equipped with optional air-conditioning systems have temperature control for freighter and passenger airplanes. High and normal airflow options provide different supply airflow rates. A high airflow rate should be selected for high-density animal loads, thus increasing the animal transport capacity. A normal airflow option should be selected for low-density animal transport or other type of non-heat-generating cargo for fuel savings.

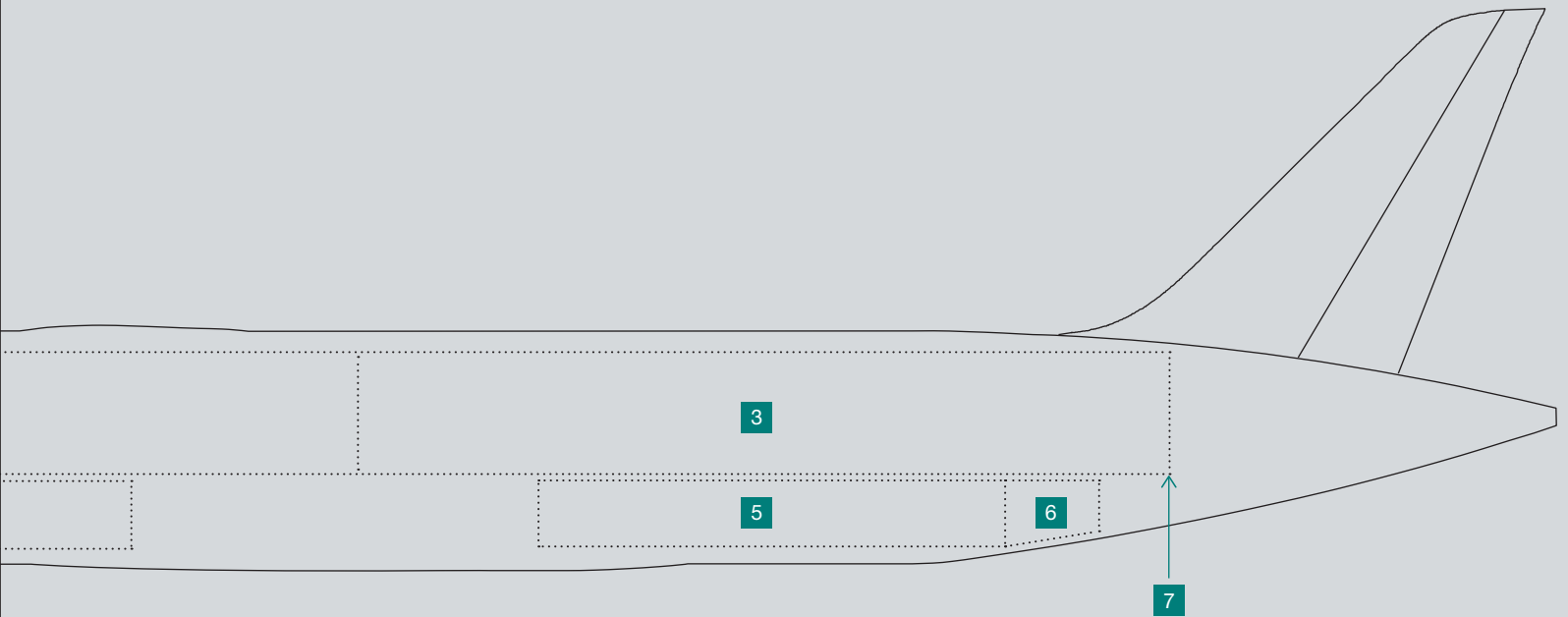
Lower lobe compartments in freighter or passenger model airplanes that only have cargo heat do not control temperature for cooling. Cargo heat only has the ability to control the compartment temperature to specific predefined temperatures (for example, keeping the compartment at 40 degrees F (4 degrees C) at a low setting and 65 degrees F (18 degrees C) at a high setting). These settings are when cargo heat is commanded on and the cargo heat is commanded off when the compartment temperature is 10 degrees F (-12 degrees C) above the setting. Cargo heat operates intermittently and does not have the ability to provide direct ventilation into the compartment. Some heated air may migrate into the compartment due

to the cargo floor design. Cargo heat selection is not recommended for animal transport; however, it is possible to transport a limited amount of live animal cargo with airplanes equipped only with cargo heat temperature control in the lower lobe compartment, depending on the operating conditions, the type of animal, and the duration of the trip.

**KEY FACTORS THAT INFLUENCE ANIMAL CARRIAGE**

A number of environmental factors influence the welfare of live animal cargo. In cases of extreme heat, many environmental factors

- 1 Rigid Cargo Barrier
- 2 Forward Main Deck Compartment
- 3 Aft Main Deck Compartment
- 4 Forward Lower Lobe Cargo Compartment
- 5 Aft Cargo Compartment
- 6 Bulk Cargo Compartment
- 7 End Wall



can be reduced or eliminated by loading live animal cargo at night.

- **Outside air temperature.** The higher the air temperature, the more time is required to cool the cargo compartment prior to loading animals.
- **Quantity, size, and type of animal cargo.** These factors affect the heat load, moisture, and CO<sub>2</sub> in the cargo compartment.
- **Airplane environmental systems' capability and configuration.** Auxiliary power unit (APU) and air-conditioning performance are affected by the ambient air temperature relative to ventilation capability. (APU gets higher efficiency for cooling the airplane when the ambient

temperature is cooler.) Some Boeing airplane models have lower lobe cargo compartment options, such as lower lobe air conditioning, that enhance live animal transportation. (Note: This lower lobe cargo compartment air conditioning may reduce main deck compartment cooling capacity.)

- **Airplane condition prior to loading animals.** Heat soak (caused by an airplane sitting on the ground in the sun in high outside temperatures with the air conditioning off) and preconditioning the cargo compartment both affect the amount of time required for the compartment to reach the desired temperature.

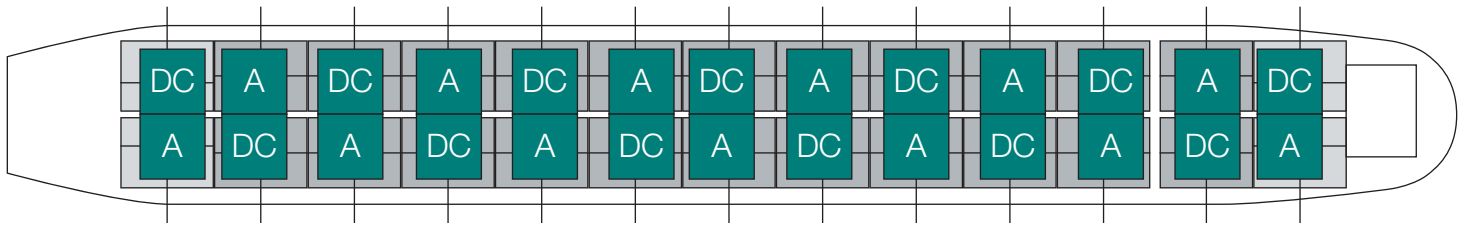
- **Time on ground with loaded cargo.** The longer the time that the airplane is on the ground with loaded live animal cargo, the longer the airplane will be required to cool the cargo compartment to a desired temperature.
- **Animal packaging and stocking densities.** The longer the time on the ground and the duration of flight, the lower the recommended density of animals in the cargo compartment.

#### PREPARING FOR ANIMAL TRANSPORT

Prior to loading live animals, prepare the airplane's air-conditioning system, keeping in mind the expected airport ambient conditions,

## Figure 4: Typical animal cargo loading

This represents a typical arrangement of animals (A) and dry cargo (DC) to improve ventilation and heat/moisture mitigation.



the animal's physiology, and the airplane's air-conditioning variable settings. Providing the greatest air ventilation flow throughout the pallets and containers by setting to the highest air-conditioning setting available helps ensure animal welfare for large loads.

Boeing recommends limiting the amount of time animals are in cargo compartments prior to takeoff by coordinating the airplane's departure closely with the ground crew. In addition, by briefing the flight crew about the animal cargo, operators can help ensure that ventilation in the cargo compartment is not cut off or reduced to save fuel.

These guidelines can help operators optimize animal welfare and maximize animal cargo revenue.

- Precondition the cargo compartment prior to loading the animals. If possible, use the airplane's ECS to achieve the ideal temperature for the type of animals being transported.
- Limit the time the airplane spends on the ground — including stopovers — while animal cargo is onboard.
- Load animals as close to the departure time as possible.
- Unload animals immediately upon arrival at the destination. Ensure that ground crew personnel are standing by and ready to unload animal cargo as soon as the airplane lands.
- Close cargo doors last before departure and open cargo doors first upon arrival. Adequate ventilation helps prevent unhealthy levels of CO<sub>2</sub> and humidity accumulating in the closed cargo compartment.

- Avoid holding animals in the airplane in the sun. Load at night if possible to avoid high temperatures and solar exposure.
- Do not transport animals and carbon dioxide (usually in dry ice form) in the same compartment.
- Avoid carriage of live animals with cargo with a lot of moisture on the container, such as rain, snow, or ice, or liquids inside the container.

### LOADING GUIDANCE

Boeing recommends these guidelines for the actual loading of animal cargo.

- Load animals so that there is space between the pallets to allow air to freely circulate among the live animals if space is available.
- Spread the loading of the animals evenly between the forward and aft of the airplane to reduce local moisture condensation inside the cargo compartment. In general, a weight and balance load sheet should be considered prior to loading animals (see fig. 4).
- Fewer animals should be placed in the furthest most forward and aft walls of the airplane due to the higher temperatures that are found there due to heat transfer through the forward and aft walls.
- Pallets or stalls must be designed to avoid breaking free during turbulence. Feet and hooves of heavy animals, such as horses and cattle, can puncture the airplane floor.

- Follow International Air Transport Association (IATA) Live Animals Regulations (LAR) Manual guidelines.

### ADDITIONAL GUIDANCE

If possible, provide additional cooling or ventilation to the airplane when it is on the ground. Portable air-conditioning units or fans can be used via the cargo door during refueling, loading, and unloading.

Operators may also consider adding additional fuel if still under the allowable takeoff weight to reduce the time required to refuel at stopovers en route to the cargo's final destination.

Animals should not be loaded until the airplane is ready to fly in all other respects.

### CONTAINER RECOMMENDATIONS

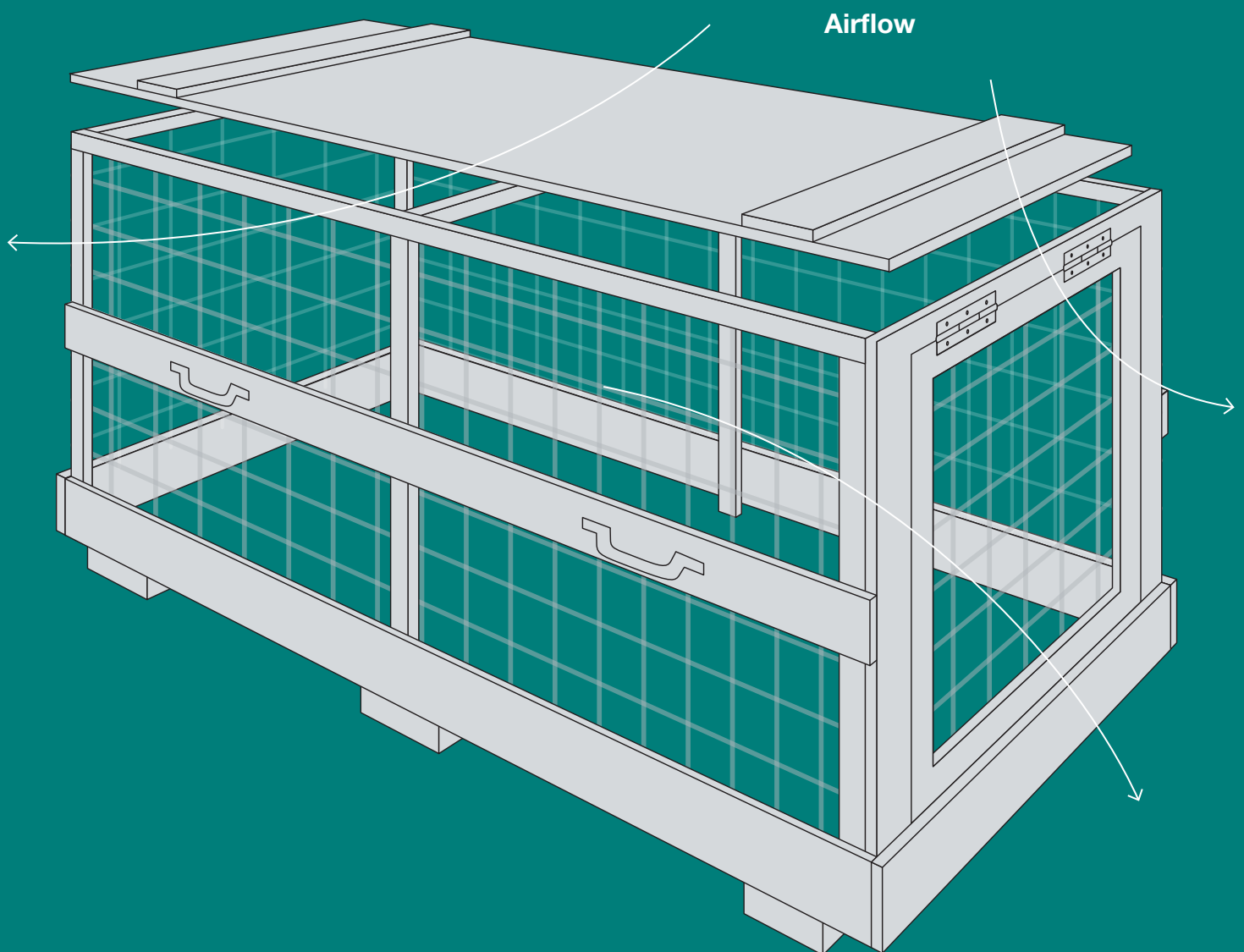
Follow IATA recommendations for containers for specific types of animal. In general, containers should be designed so that there are gaps or holes on the sides and on the top to allow air circulation throughout the containers (see fig. 5). Multi-tier containers should have gaps or holes between the top tier and the bottom tier to reduce CO<sub>2</sub> and local heat for animals in the lower container tier.

### MAXIMIZING VENTILATION AND REDUCING FUEL BURN

Flight crews should set the airplane's ECS for high flow to provide the most ventilation to the animals in the cargo compartment.

### Figure 5: Typical container/pallet ventilation paths

Adequate ventilation prevents unhealthy or stressful levels of CO<sub>2</sub> and humidity from building up in the cargo compartment. Have 10 in (25 cm) to 18 in (46 cm) spacing to the sidewall and space between crates to establish good compartment air circulation around the crates.





Boeing offers operators information about the transport of live animals, including detailed guidelines and methods to determine safe transport of live animal cargo in the cargo compartments of specific Boeing airplane models. The information can be accessed on the Web portal [MyBoeingFleet.com](http://MyBoeingFleet.com) or by contacting your Field Service representative.

If the lower compartment does not contain any animal or temperature-sensitive cargo, air conditioning to this area can be turned off to provide greater ventilation in the main deck compartment. This step will also help reduce fuel burn.

#### **MAIN DECK COMPARTMENT TEMPERATURE SELECTION**

Freighters typically have independent temperature controls for the forward and aft main deck cargo compartments. Boeing recommends that both the forward and aft compartments be set to the same temperature, using the

temperature range appropriate for the type of animals being transported.

#### **GETTING ADDITIONAL INFORMATION**

Boeing offers operators information about the transport of live animals, including detailed guidelines and methods to determine safe transport of live animal cargo in the cargo compartments of specific Boeing airplane models. The information can be accessed on the Web portal [MyBoeingFleet.com](http://MyBoeingFleet.com) or by contacting your Field Service representative.

In addition, IATA LAR provides a detailed classification of animal species, along with the container specifications required for

their transport. It also includes the most up-to-date airline and government requirements pertaining to the transport of live animals; information on handling, marking, and labeling; and the documentation that is necessary when transporting animals by air. The LAR is available from the IATA Web site at [www.iata.org](http://www.iata.org).

#### **SUMMARY**

Following the recommended guidelines can help operators ensure the welfare of live animal cargo. Operators can get detailed guidelines and recommendations from Boeing and IATA. 