

Baggage Handler Exposure with the Increase in Use of Dry Ice Shipments

Presented to: International Systems Forum

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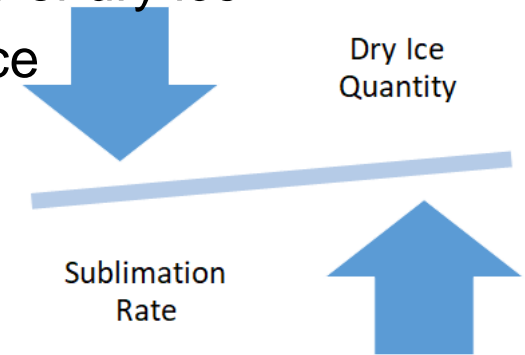
Date: April 21, 2021



**Federal Aviation
Administration**

COVID-19 Vaccine Transport

- Vaccine vials required to be maintained at -70°C or -94°F
- This requirement drives the use of dry ice far in excess of current guidelines
- Highly sophisticated packaging results in significant reduction of sublimation rate --> Greater permissible quantity of dry ice
- Exemptions provided to carry 15,000lbs of dry ice



Dry Ice Concerns on Aircraft

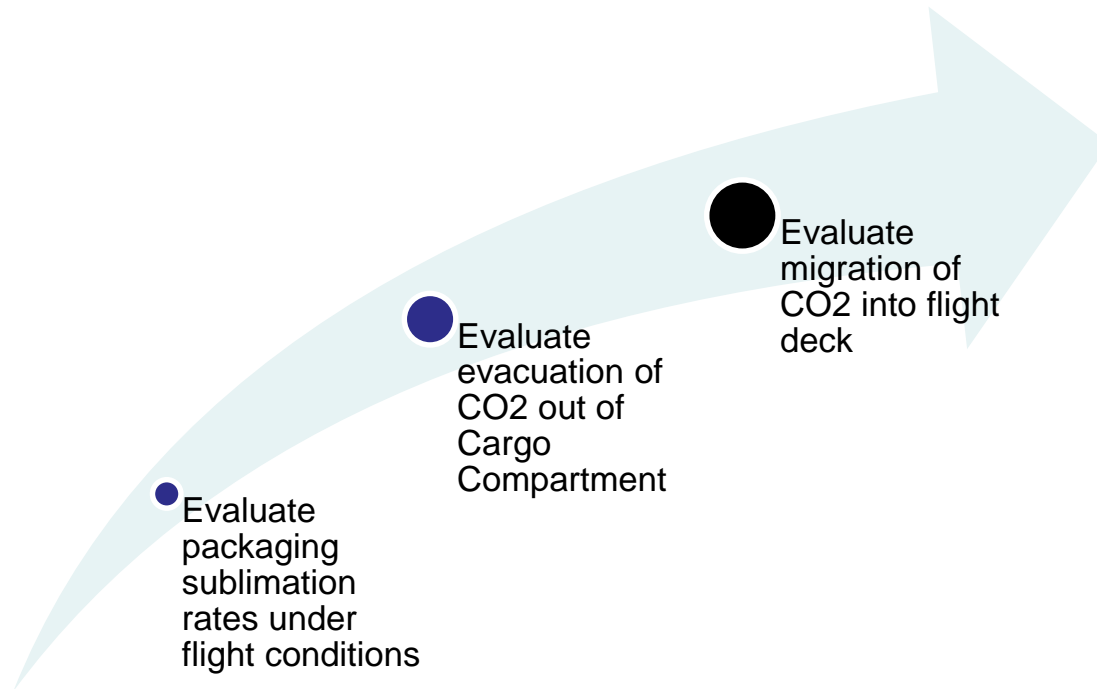
- Dry ice is solid form of CO₂ and sublimates to CO₂ gas
- As CO₂ gas accumulates there is risk to:
 - Baggage Handlers upon opening cargo door
 - Flight crew should CO₂ migrate to the flight deck
- Sublimation rates used in current guidance (AC 91-76A) are 1-2%/hour
- AC 91-76A provides a calculation to determine permissible amount of dry ice



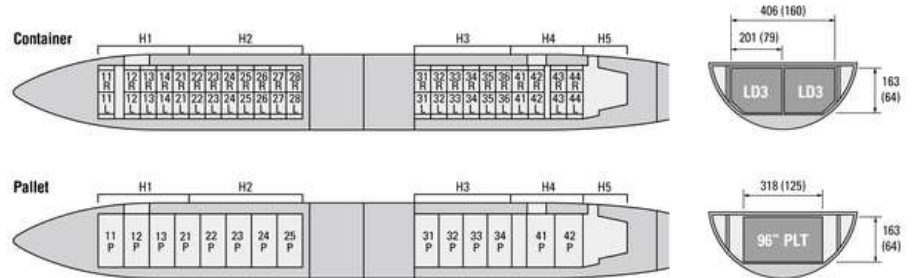
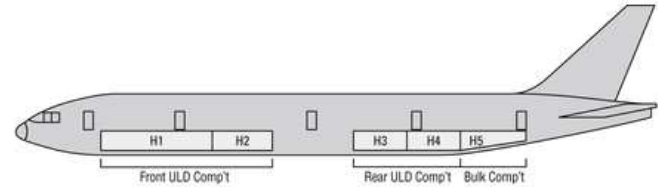
X = Dry ice loading in lb

$$X = \frac{(\text{CO}_2 \text{ concentration}) (\text{Aircraft Volume, ft}^3) (\text{Complete air exchanges per hour}^*)}{(\text{sublimation rate})}$$

FAA Dry Ice Experimental Approach



Vaccine Transport in a 777



Baggage Handler Exposure Locations

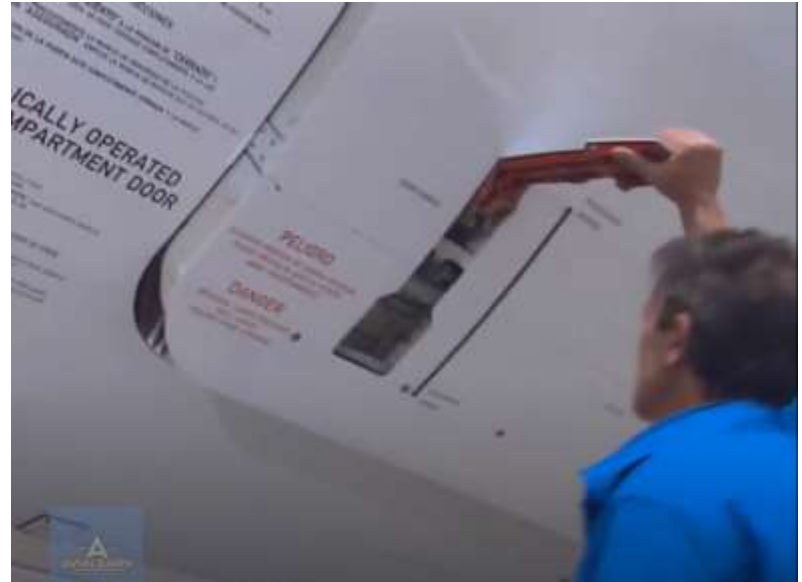
Handheld Forward Sampling

https://www.youtube.com/watch?v=JoY_1Byf0-E



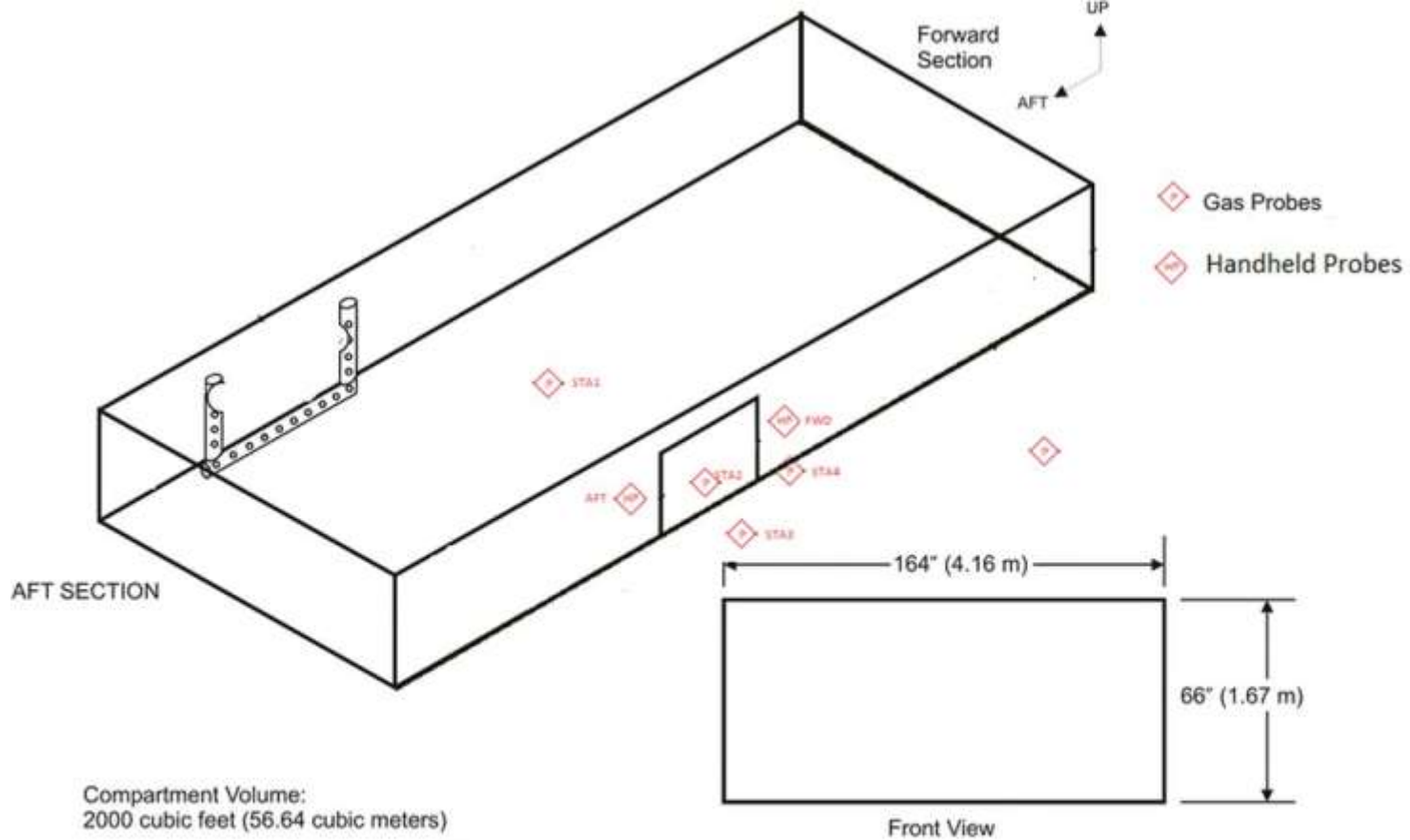
STA 2 Sampling

<https://www.youtube.com/watch?v=Er9uzx3ZVc4>



Test Setup



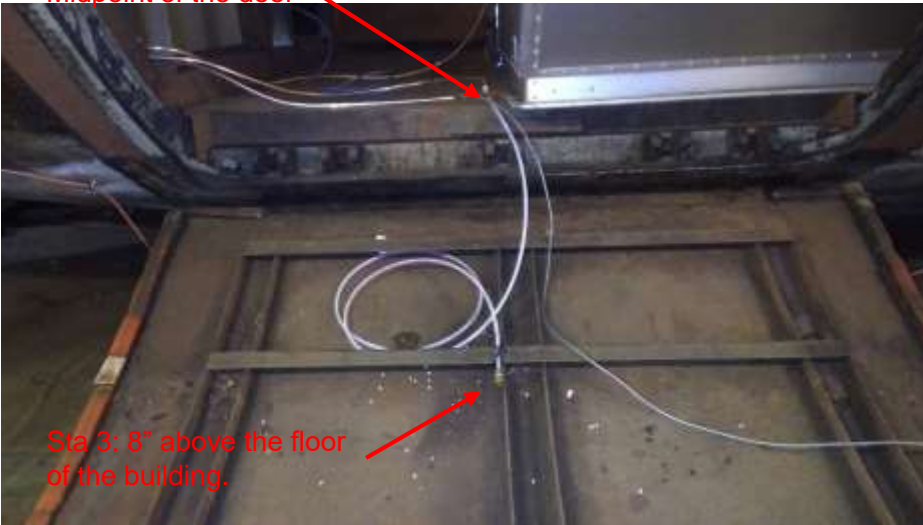


Compartment Volume:
2000 cubic feet (56.64 cubic meters)

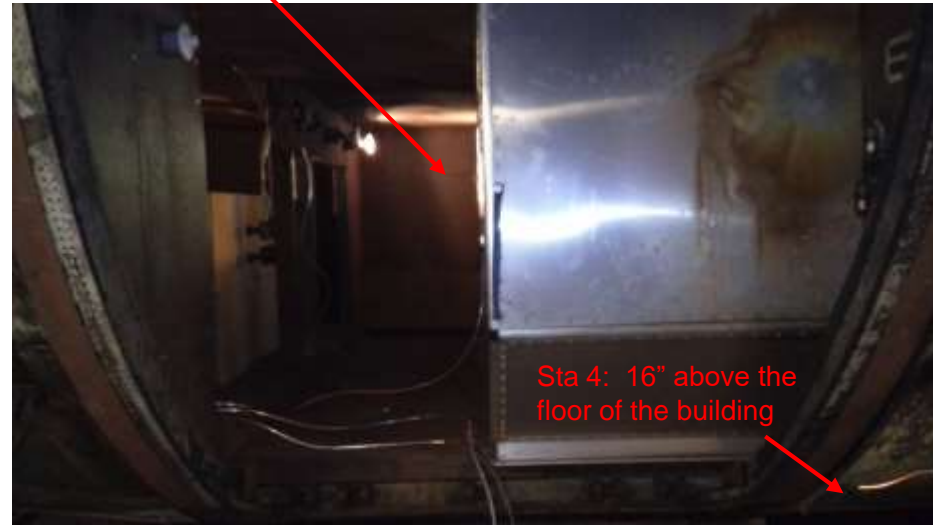
- STA1: 46.5" above cargo compartment floor
- STA2: At the cargo compartment floor, mid-point of doorway
- STA3: 8" below cargo compartment floor
- STA4: Exterior skin of the cargo compartment; 1 ft. forward of door
- HP FWD: 1 ft. forward of the door; 1ft. away from the door
- HP AFT: 1 ft. aft of the door, 1ft. away from the door

Gas Sampling Probe Locations

Sta 2: Floor of the
Cargo Compartment
Midpoint of the door



Sta 1: 46.5" above the
floor of the Cargo
Compartment.

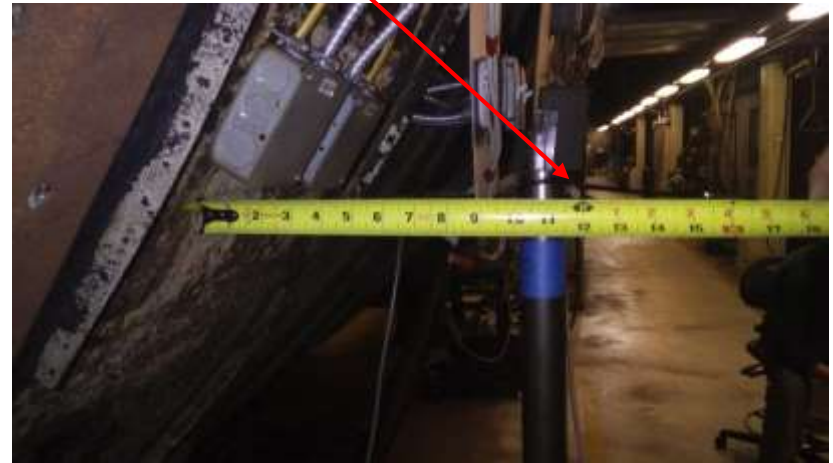


Portable Handheld Analyzers

1 ft. away from the plane
and 1 ft. aft of the door



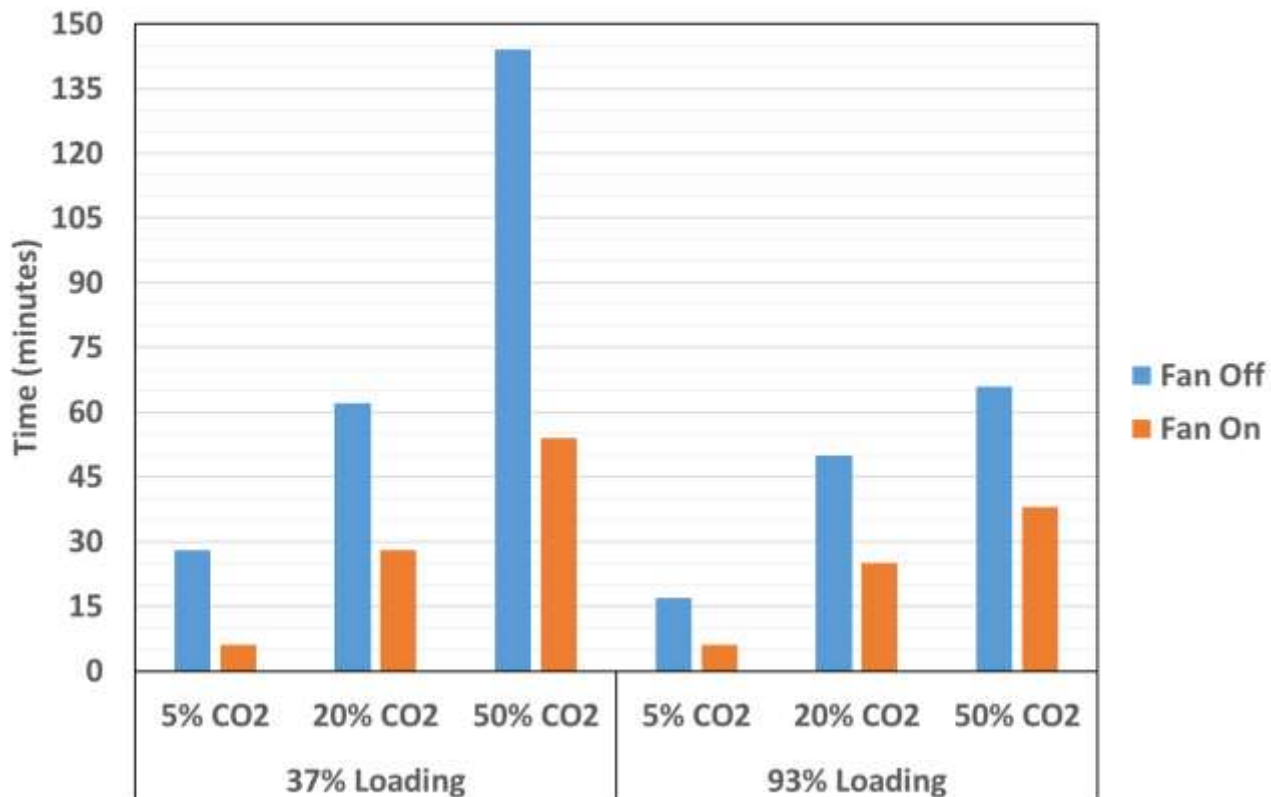
1 ft. away from the plane
and 1 ft. fwd of the door



Test Variables

- **Loading Percentage**
- **Quantity of Carbon di-Oxide**
- **Usage of Fan to expedite CO₂ evacuation**

Effects of Loading and Gas Generation on Evacuation Time from the Cargo Compartment



Results

- **As the quantity of carbon di-oxide increases the longer it takes to evacuate out of the cargo compartment.**
- **As the loading percentage increases the faster carbon di-oxide evacuates due to the lower free volume.**
- **Usage of a fan expedites the evacuation of carbon di-oxide.**

Recommendations

SAFO 20017

- Quoted sublimation rates outside those recommended in Advisory Circular (AC) 91-76A, Hazard Associated with Sublimation of Solid Carbon Dioxide (Dry Ice) Aboard Aircraft, are established under a specific set of conditions. If the operational conditions are not the same, the actual sublimation rate will be different.
- Decreased pressure, e.g., 8000-foot cabin altitude, will increase the sublimation rate.
- Reducing cabin pressure will draw CO₂ gas from a package(s), increasing the CO₂ concentration in the compartment. For this reason, existing smoke/fire/fume procedures should not be used unless they are modified to address this phenomenon.
- At the end of a flight, compartments containing dry ice will tend to have a high CO₂ concentration that can take several minutes to dissipate. When the cargo door is opened, the area immediately outside the door also experiences a high CO₂ concentration for several minutes.

Questions?



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