TEAMSTERS SAFETY & HEALTH FACTS

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Transportation Safety
Cryogens
Dry Ice (Carbon Dioxide, Solid)

Dry ice and other cryogens, such as liquid nitrogen (LN2), are often used in shipping to keep food, biological samples, and medical supplies like some vaccines cold for long periods of time during shipment. Employees working with these substances should be made aware of their hazards and how to protect themselves.

General precautions:

- Avoid eye or skin contact with dry ice and LN2.
- Never handle dry ice or LN2 with bare hands. Use loose-fitting cryogenic gloves, which can be readily removed if LN2 splashes into them or a piece of dry ice falls into them.
- Use appropriate eye protection.
- Do not use or store dry ice or LN2 in confined areas, walk-in refrigerators, environmental chambers, or rooms without ventilation. A leak in such an area could cause an oxygen-deficient atmosphere.
- Never store a cryogen in a sealed, airtight container; the pressure resulting from the production of gaseous carbon dioxide or nitrogen may lead to an explosion.
- Read the safety data sheet (SDS) for more information on specific cryogens.

What is dry ice?

- Dry ice is carbon dioxide (CO2) in solid form that looks very much like ice, but it is a cryogenic material. Carbon Dioxide is colorless, odorless, and non-flammable. It is a naturally occurring component of the atmosphere (0.04%). CO2 is much heavier than air and tends to accumulate near the ground. When dry ice melts, it does not pool on the ground or form a puddle; dry ice transitions from a solid to a gas (sublimates) as it warms, releasing carbon dioxide. Dry ice is about twice as heavy as regular ice made from water.

Is Carbon Dioxide (CO2) gas hazardous?

- Contact Hazard: At -109 °F (-79 °C), skin contact with dry ice can lead to severe frostbite; skin cells freeze and become damaged very quickly. **Never handle dry ice with bare hands.**
- Asphyxiation Hazard: Dry ice will sublimate (change from solid to gas) at any temperature above -109 °F. This releases potentially substantial volumes of CO2 (1-pound solid releases approx. 250 liters gas), which can displace oxygen quickly in the air around the dry ice, causing difficulty breathing, loss of consciousness, and death. This is especially of concern in non-ventilated or confined spaces. Increased levels of CO_2 cause drowsiness; higher concentrations increase both breathing rate and heart rate. Exposure to Carbon Dioxide gas above 8% in air can cause asphyxiation and death.
- Explosion Hazard: Due to the rapid emission of large volumes of CO2 gas, any dry ice that is stored in a closed container can pressurize the container. Given enough time at average room temperature, such a container may explode if the gas is not able to escape.

What are the symptoms of CO2 overexposure and health effects?

- 0.04% CO2 (400 ppm): typical outside air CO2 levels; no physiological symptoms.
- 0.5% CO2 (5,000 ppm): FAA regulatory limit for transport category aircraft (14 CFR 25.831) and Occupational Safety and Health Administration (OSHA) occupational exposure limit; subtle to no physiological symptoms.
- 1% CO2 (10,000 ppm): drowsiness.
- 2% CO2 (20,000 ppm): headache and difficulty breathing during exertion.
- 3% CO2 (30,000 ppm): mild sleepiness, reduced hearing, sweating, increased heart rate, difficulty breathing at rest.
- 5% CO2 (50,000 ppm): lethargy, dizziness, confusion, rapid breathing/shortness of breath (noticeable inability to breathe fast and deep enough).
- 8% CO2 (80,000 ppm): dimmed vision, muscle tremor/twitching, and unconsciousness.
- >10% CO2 (100,000 ppm): immediate unconsciousness, seizures, and death.

What should I do if exposure to dry ice occurs?

- Eye Contact: Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Get medical attention if irritation occurs.
- Inhalation: Remove the victim to fresh air and rest in a comfortable position for breathing. Get medical attention if symptoms occur.
- Skin Contact: Flush contaminated skin with plenty of water, remove any clothing that is not frozen to the skin. Do NOT rub frozen body parts because tissue damage may result. Obtain medical assistance as soon as possible. Place the affected part of the body in a warm water bath (not above 40°C). Never use dry heat.

Ingestion: Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If the material has been swallowed and the exposed person is conscious, provide small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

How do I properly store dry ice?

- Store dry ice in a container that allows for the release of gas, such as a vented cooler or Styrofoam cooler. DO NOT store dry ice in a tightly sealed container. As dry ice changes from its frozen state to a gaseous state, it may cause an airtight container to expand and potentially explode.
- Dry ice should be kept in a well-ventilated room. Carbon dioxide produced during sublimation (solid to gas) can replace oxygen in closed spaces, creating an oxygen-deficient environment. This can result in suffocation.

How do I handle dry ice spills or leaks?

- No action should be taken without suitable training. Do not put dry ice down a sink, drain, toilet, or into the trash. Dispose of dry ice in an open container in a well-ventilated room and allow to sublimate.
- If dry ice spills on counters, floors, or other surfaces, you must wear protective gloves before handling.

Does the US Department of transportation limit shipping quantities of dry ice?

- Yes, the quantity of dry ice shipped via air or rail is limited to 440lbs (200kg). There is no quantity limit for ground transportation.

Are there concerns in transporting dry ice via air?

- A potential risk associated with the sublimation of dry ice is that gaseous CO2 will replace oxygen in aircraft compartments and interfere with the breathing abilities of the occupants. High levels of CO2 gas in compartments can lead to unrecognized degradation of cognitive functioning and present an asphyxiation hazard to persons in that space (e.g., ground crew who handle the loading and unloading of cargo containers). The risk of hazardous conditions increases proportionately with the amount of the dry ice carried, the sublimation rate of that dry ice, and any ventilation degradation of the aircraft. Airline employees should see the Safety Alert for Operators (SAFO) bulletin SAFO 20017 dated 12/10/20 for more information and specific guidance. Alternatively, the FAA Air Transportation Division can be reached at 202-267-8166.

Has the FAA detailed any considerations for shipping large quantities of dry ice?

- Aircraft manufacturers should provide information on maximum recommended dry ice quantities that the aircraft ventilation can accommodate, depending on the sublimation rate.

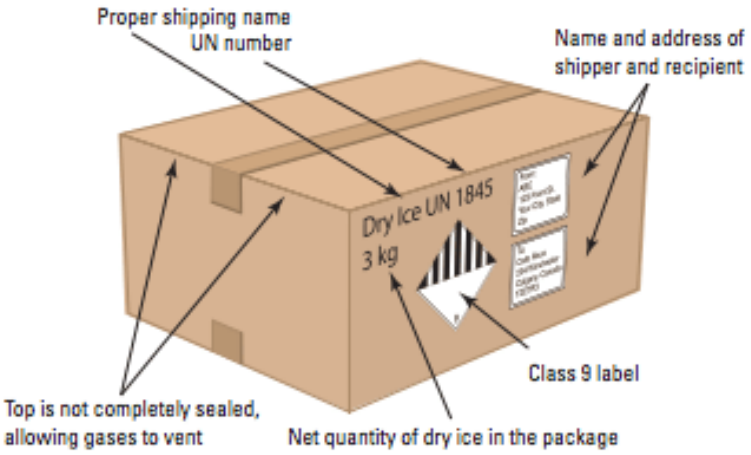
- An accurate determination of the dry ice sublimation rate is necessary to determine the correct quantity of dry ice that may be safely transported aboard an aircraft.
- As the dry ice sublimates, a loss of weight occurs, affecting the aircraft's center of gravity.
- Decreased pressure, e.g., 8000-foot 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.
- Dispatch with fully operational Environmental Control Systems, including all air conditioning packs and auxiliary power unit (APU), to enable effective ventilation for ground operations and inflight contingencies.
- CO2 sensors installed or carried in the aircraft or worn by the pilots and other crew members will assist the operator and crew in recognizing hazardous concentrations of CO2 and implementing effective risk controls.
- Pilot training on specific conditions and procedures can improve pilot decision-making in the event of a CO2 detector alert or other system abnormalities.
- Maximum ventilation, including during the ground de-icing and anti-icing process, will mitigate CO2 accumulation in the aircraft.
- 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.

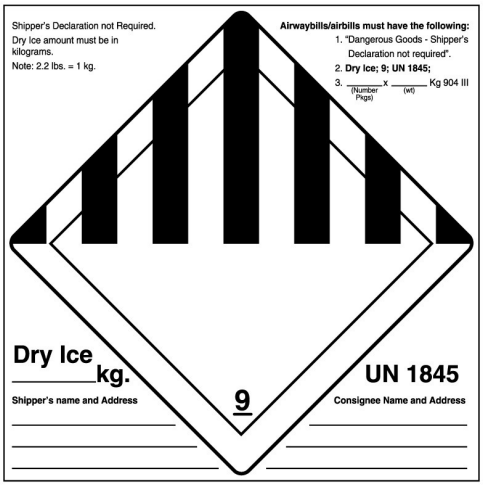
Is a label required to ship dry ice via ground transportation only?

- When non-hazardous material is packed on dry ice and is shipped via highway transport, a hazardous materials shipping paper (49 CFR 172 Subpart C) is not required, provided alternative documentation is supplied containing the following information:
  - Proper shipping name: Dry Ice, Class 9, UN number 1845
  - The number of packages
  - The net quantity, in kilograms, of dry ice in each package
- When hazardous material is packed on dry ice and shipped via highway transport, **DOT shipping papers should accompany** the shipment in accordance with DOT regulations 49 CFR 172 Subpart C.

Is a label required to ship dry ice via air, rail, or cargo vessel?

- For non-medical, non-hazardous shipments in the United States with 5.5 lbs. or less of dry ice, the carton must be marked with the words “Dry Ice” or “Carbon Dioxide, Solid,” along with a note of the contents and how many pounds or kilograms of dry ice are included.
- For non-hazardous shipments of more than 5.5 lbs. of dry ice, a Class 9 diamond hazard label and the markings "Dry Ice" or "Carbon Dioxide, Solid" and "UN1845 must be included on the outer carton.





Resources

1. Transportation of COVID-19 Vaccines Requiring Large Quantities of Dry Ice. SAFO 20017, 12/10/20. https://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/allsafos/media/2020/SAFO20017.pdf
2. CDC. Dry Ice for Healthcare Professionals. 1/7/21 https://www.cdc.gov/vaccines/covid-19/info-by-product/pfizer/downloads/dry-ice-safety-hcp.pdf
3. Carbon Dioxide, Safety Data Sheet. Airgas Updated 11/10/2018. https://www.airgas.com/msds/001091.pdf
4. OSHA Quick Facts, "Laboratory Safety: Cryogens and Dry Ice" Updated 10/2011. https://www.osha.gov/Publications/laboratory/OSHAquickfacts-lab-safety-cryogens-dryice.pdf
5. Harvard Dry Ice Shipping Information Guide. Rev 1. 12/2016 http://i-lab.harvard.edu/innolabs/wp-content/uploads/sites/5/2017/06/LL-Dry-Ice-Shipping-Information-Guide.pdf