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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: LITHIUM BATTERIES USED IN EMERGENCY LOCATOR TRANSMITTERS

1. PURPOSE. This advisory circular warns of potential hazards associated with accidental release of sulfur-dioxide (SO_2) gas from lithium-sulfur batteries used in some emergency locator transmitters (ELTs). In addition, it sets forth the proper procedures that should be followed in the event such an incident is experienced.

2. BACKGROUND. There have been rare incidents aboard aircraft, and in storage areas, in which quantities of sulfur-dioxide have been released from lithium-sulfur (Li/SO_2) batteries. Although the data available to date is incomplete, it warrants concern of the potential hazards associated with the accidental release of sulfur-dioxide from Li/SO_2 batteries in passenger compartments of aircraft.

3. DISCUSSION.

   a. General.

      (1) Lithium batteries, currently used in some ELTs, have highly desirable characteristics such as energy density, low temperature performance, and long storage life capabilities.

      (2) Lithium batteries incorporate a safety release which can vent and suddenly release sulfur-dioxide (SO_2) in an airplane cabin. The safety release is necessary to prevent explosion if the cell is exposed to heat, but the effect of gas release can vary from minor irritation to incapacitation. Venting may occur due to either internal or external electrical short circuits.

      (3) The venting mechanism of an Li/SO_2 cell is a necessary safety device intended to relieve internal pressures preventing cell explosion. At room temperatures the internal pressure of a typical Li/SO_2 cell is about four atmospheres. Should the cell be heated from an external source, or internally by the

drain of heavy currents as would be the case in the event of a short circuit, the pressure will rise causing the cell to vent before explosive pressures are reached. Without venting, pressures can continue to build until the cell walls rupture.

(4) Typically, 20 grams of SO_2 are used in the manufacture of a standard "D" cell. If a new "D" size cell vents, approximately 10 grams of SO_2 will be released into the atmosphere.

(5) According to the Public Health Service Center for Disease Control, National Institute for Occupational Safety and Health, five parts per million of SO_2 is the permissible industrial exposure level, or 13 mg/meter^3. It is suggested that concentrations of 100 to 500 times the permissible level can lead to incapacitation.

(6) In many small airplanes, the cabin volume is approximately two cubic meters. The venting of a single "D" size cell can release 10 grams of SO_2 into this area. With no ventilation, this would produce a concentration of 5000 mg/meter^3, about 385 times the permissible level, which could lead to incapacitation. If an external short circuit occurred in an ELT, and no fuse is provided in the circuitry, the excessive current will be the same in each series-connected cell, and more than one of the cells might vent, increasing the hazard.

(7) A Li/SO_2 cell venting at the rate of six grams in ten minutes and releasing SO_2 into a two-cubic-meter cabin, even with normal cabin ventilation, may peak out at about 175 mg/meter^3, an irritating level that is not likely to lead to incapacitation. If the venting time were less than ten minutes, the hazard would be greater.

(8) All Li/SO_2 cells manufactured since 1973, for ELT use, contain the safety venting mechanism. Some earlier manufactured cells do not have this feature and should be removed.

b. Control Concepts.

(1) Some manufacturers of ELTs have developed systems to control the release of SO_2 in the event of battery venting. Two such concepts are:

(a) Encapsulating the batteries in an elastomeric potting compound which does not prevent venting, but does reduce the rate of release into the atmosphere.

(b) Isolation of the batteries in a tight compartment containing calcium oxide to absorb the SO_2 leaking or venting from the cells.

c. Precautions.

(1) The presence of SO_2 in the cabin area of an airplane can be easily detected. It is a heavy and colorless gas with an odor similar to burning sulfur or rotten eggs. It becomes pungent as concentrations increase and irritates the eyes, causing watering.

(2) At the first indication of SO_2, the cabin area should be ventilated as soon as possible and to the maximum extent possible. If oxygen equipment is available, breathing 100 percent oxygen will help, as will use of effective and well-fitted smoke goggles. If SO_2 gas is detected, the airplane should be landed as soon as practical. Passengers should leave the aircraft and the ELT should be removed for repair.

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