CC2e

Acceptable Human Decompression Levels

An effective method to extinguish spacecraft fires is to decompress the cabin to a vacuum. An investigation is underway to examine the possibility of donning an oxygen mask and to decompress the cabin to a physiologically acceptable level should a fire occur. It is the considered opinion of this Directorate that this level should not be lower than 3.0 psia.

The reason for recommending this value is that at ambient pressures lower than 2.72 psia, even 100 percent oxygen breathing is not sufficient to prevent hypoxia. Some increase in inspired pO_2 can be achieved by breathing oxygen at pressures higher than the sourrounding atmosphere; however, above 15 mm Hg pressure breathing becomes very fatiguing and can be continued for only a short period of time. The greatest limitation to pressure breathing is the effect on the cardiovascular system. Above 15 mm Hg, positive pressure breathing inhibits the return of venous blood to the heart and reduces the cardiac output. It is so difficult to pressure breathe at altitudes above 45,000 feet (20 to 30 mm Hg positive pressure) that, in the military, loss of cabin pressure at this altitude constitutes a serious emergency requiring immediate descent unless pressure suits are worn.

It appears extremely doubtful that should a fire occur in a spacecraft that the crewman would have time and be aware enough to put on an oxygen mask, decompress the cabin, and fight the fire all at the same time. The increased respiratory work required for pressure breathing would seriously limit any fire extinguishing or survival activity such as suit donning to permit complete depressurization of the cabin.

It is the opinion of this Directorate that no appreciable advantage can be gained by decompressing the cabin to levels which will just maintain consciousness of the crewmen. Past experience with ground-based simulator fires indicates that successful extinguishment was only achieved when the chambers were brought to near vacuum conditions.

Review of present Apollo spacecraft decompression capabilities reveals that it would require approximately 6 minutes to decompress the cabin to a vacuum. Under these constraints, a decompression even to a vacuum may only extinguish a fire in an already destroyed or inoperable spacecraft.

Comparison of Helium and Nitrogen
in Minimizing Decompression Sickness

A review of the pertinent literature describing decompression studies utilizing helium and nitrogen as diluent gases yields the following general conclusions:

a. Helium is equal to or worse than nitrogen as a diluent gas.

b. Bends occur sooner with helium.

c. A higher recompression pressure is needed for relief of bends when helium is used.

d. Intervening oxygen breathing prior to decompression from a mixed gas atmosphere was more effective in tests when nitrogen was the diluent.

References:

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3. "An Investigation of Decompression Hazards Following Equilibration in a Simulated Spacecraft Atmosphere of 50% O_2 - 50% He at 380 mm Hg," NAEC-ACEL-540, November 15, 1965.

4. "Comparison of Helium and Nitrogen in Production of Bends in Simulated Orbital Flight," Beard, S. E.; Allen, T. H.; McIver, R. G.; and Bancroft, R. W. Presented at the 37th Annual Scientific Meeting, Aerospace Medical Association, 1966, in Las Vegas, Nevada.