European Joint Aviation Authority inevitably introduces further delay. As far back as 1976 the Snyder report concluded that state of the art technology was not being sufficiently applied to cabin safety,¹⁰ and reports since then have concurred.^{5,11} As a survivor of the Kegworth crash asked, why does it take so long to do so little?

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- 1 Taylor AF. Fire, fuel and survival: a study of transport aircraft accidents, 1955-74. In: Advisory Group for Aerospace Research and Development. *Aircraft Fire Safety*. Neuilly-sur-Seine, France: NATO-AGARD, 1976:25-1-12. (CP-166.)
- 2 Civil Aviation Authority. In: Transport Committee. *Aircraft cabin safety. Minutes of evidence Wednesday 24 January 1989*. London: HMSO, 1989: 111-6.
- 3 NLDB Study Group. *NLDB report on the M1 aircraft accident: Boeing 737-400 on 8 January 1989 near Kegworth, Leicestershire*. University of Nottingham: NLDB Crash Study, 1990.

- 4 Carter RDG. 737-400 at Kegworth, 8 January 1989—the AAIB investigation. In: Advisory Group for Aerospace Research and Development. *Aircraft accidents: trends in aerospace medical investigation techniques. Proceedings of the Aerospace Medical Panel symposium*. Neuilly-sur-Seine, France: NATO-AGARD (in press).
- 5 Transport Committee. *First report. Aircraft cabin safety. Report, minutes of proceedings and appendices*. London: HMSO, 1990.
- 6 Hill IR. Injury mechanisms analysis in aircraft accidents. In: Advisory Group for Aerospace Research and Development. *Models and analogues for the evaluation of human biodynamic response, performance and protection*. Neuilly-sur-Seine: NATO-AGARD, 1979: A12-1-10. (Conference proceedings No 253.)
- 7 Hardy RN. Infant and child restraint research. In: *Proceedings of the European cabin safety conference 1990*. London: Civil Aviation Authority, 1991: 132-48.
- 8 Transport Committee. *Second special report. Government observations on the first report of the committee, session 1990-91 (aircraft cabin safety)*. London: HMSO, 1991.
- 9 Muir H, Morrison C, Evans A. *Aircraft evacuations: preliminary investigation of the effect of non-toxic smoke and cabin configuration adjacent to the exit*. London: Civil Aviation Authority, 1990. (CAA paper 90013.)
- 10 Snyder RG. *Advanced techniques in crash impact protection and emergency egress from air transport aircraft*. Neuilly-sur-Seine, France: NATO-AGARD, 1976:138-43. (AG-221.)
- 11 Parliamentary Advisory Council for Transport Safety. In: Transport Committee. *First report. Aircraft cabin safety. Report, minutes of proceedings and appendices*. London: HMSO, 1990: 29-35.

Smoke hoods in aeroplanes

May reduce inhalational injury from smoke

Convincing regulatory authorities of the efficacy of preventive measures is difficult, particularly when it comes to transport: witness the strength of opposition to legislation for seat belts and drink-driving. Providing air passengers with protective breathing equipment is another case in point.

Ever since a Boeing 737 caught fire at Manchester airport in 1985 various groups have sought to persuade the world's licensing authorities that providing smoke hoods or masks would increase survival and decrease smoke inhalational injury to the survivors of aircraft fires. Britain's Civil Aviation Authority however, has rejected the suggestion, basing its decision on calculations that smoke hoods would kill eight people for every life that they saved. But this decision ignored the effects of inhalation of smoke on survivors—hardly surprising as the authority's tests used theatrical smoke, which is of necessity non-toxic.¹

Making simulated evacuations from aircraft more lifelike is not the answer: they already carry an appreciable risk of injury to participants. But serious doubt must exist over how far the results of simulations can be generalised to circumstances where other mechanical, thermal, and toxicological insults are operating. Restraint systems used are inadequate and rotation may be possible around the lap belt, resulting in head injuries and an increased reaction time. Real fires cause fear, and heat can quickly exhaust the most stoical person.

Anyone who has had a face full of smoke from a bonfire will readily attest to its noxious effects - the lachrymation and stinging of the eyes, the involuntary breathholding, and the coughing. Fire authorities and aircraft regulatory bodies recognise these and ensure that firemen and air crews are provided with protective breathing equipment.

Smoke is a complex mixture of toxic gases and particles, which changes as conditions within the fire change. It may contain hydrogen chloride and hydrogen fluoride, which are intense local irritants. Cyanide and carbon monoxide are asphyxiants, and intellectual function falls as the concentration of carboxyhaemoglobin rises. Benzene causes bradycardia; chlorine is selectively cardiotoxic. Some of the responses are contradictory: nasal inhalation of irritants inhibits respiratory movements while increasing concentrations of carbon dioxide stimulate respiration. The increased demands of exercise may increase passengers' oxygen requirements by as much as 50% in an environment that is becoming progressively short of it.

Particulate matter in smoke may include iron, magnesium, antimony, aluminium, lead, phosphorus, and nitrogen in addition to carbon.² Large particles may become lodged in the upper airways, and the smaller ones may reach the alveoli.^{2,3} Damage to or overloading of the normal defence mechanisms increases the chances of larger particles reaching the lower airways. Changing from nasal to oronasal breathing increases the rate of deposition. Adding particulate matter to toxic gases enhances their toxicity; removing particles from smoke reduces it.^{4,5}

Whereas soluble particles may dissolve, releasing their components, insoluble particles may remain in the lungs for a long time,⁶ predisposing to chronic lung disease. Reduced lung function and symptoms resembling those in industrial bronchitis have been found in firemen who have inhaled smoke.⁷ Little is known, however, about the long term effects of smoke inhalational injury, which is probably under-reported.⁸

What is known about the acute effects is that inhalation of smoke increases mortality from serious burns and, by incapacitating people, slows down the rate of escape from fires. The aisles and exits of aeroplanes are narrow, and it takes few bodies to block them. There is good evidence that some aircraft fires are survivable but that people have died and been injured because they could not escape in time.

The Civil Aviation Authority's decision to reject smoke hoods for passengers was announced in the same week as an international committee (including members of the authority) agreed a specification for protective breathing equipment for passengers. Manufacturers claim that by using experience gained in the Gulf war they could produce an effective device. It's time for the authority to think again.

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- 1 Civil Aviation Authority. *Improving passenger survivability in aircraft fires: a review*. London: Civil Aviation Authority, 1991. (CAP 586.)
- 2 Hill IR, Mitchelson BP. The investigation of particulate matter in the lungs of fatal smoke inhalation victims. *Agard* 1989;467:39.1-8.
- 3 Horowitz JH. Abnormalities caused by smoke inhalation. *J Trauma* 1979;19:915-6.
- 4 Boren HG, Lake S. Carbon as a carrier for irritant gases. *Arch Environ Health* 1964;8:119-24.
- 5 Birky HM. *Hazard characteristics of combustion products in fires*. Washington: NASA, 1977. (NBSIR-77; 1234 NASA—CR 135088.)
- 6 Snipes MB. Species comparisons for pulmonary retention of inhaled particles. In: McClellan RO, Henderson RF, eds. *Concepts in inhalation toxicology*. New York: Hemisphere, 1989:193-277.
- 7 Unger KM, Snow RM, Mestros JM, Miller WC. Smoke inhalation in firemen. *Thorax* 1980;35: 838-42.
- 8 Moylan JA, Chan CK. Inhalation injury an increasing problem. *Ann Surg* 1978;188:34-7.