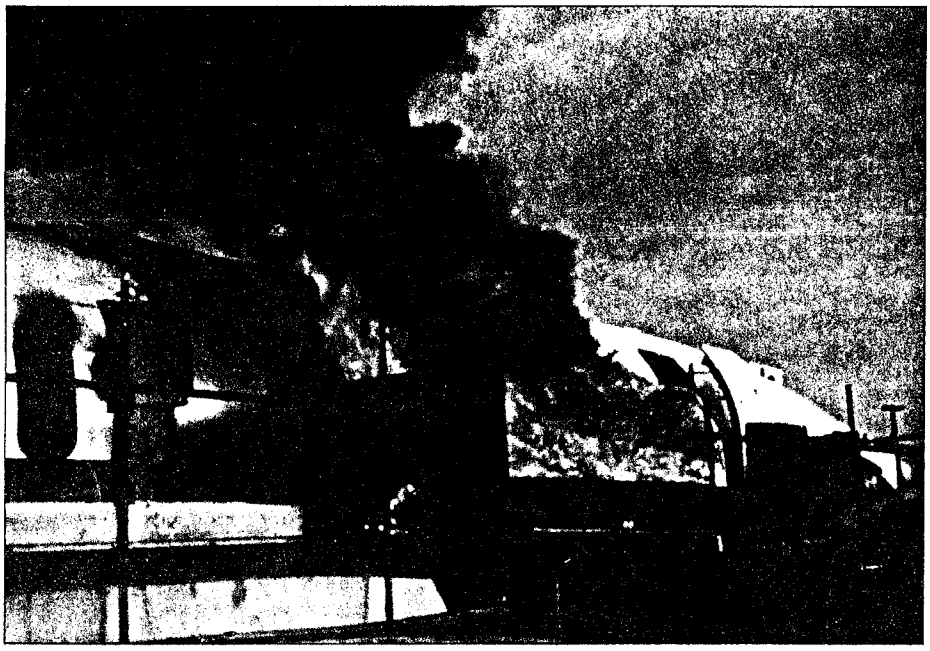
TECHNOLOGY

Safety

FOR CABIN-FIRE SURVIVAL



BY ARTHUR REED

LONDON—Signs are that the cabin water sprays for civilian transport aircraft will become mandatory, not just in Britain but throughout civil aviation.

Probably by the end of this year, the British Civil Aviation Authority (CAA) will produce a notice of proposed amendment (NPA), a draft outline of a change in regulations indicating the expected capability of cabin water spray systems, agreed to by the U.S. FAA, Transport Canada and the European JAA. A consultative process will follow, taking into account the views of the aviation industry. If these are strongly against, the proposal still could be dropped—but as of this writing, it seems very unlikely.

Around 12-18 months later, a rule will be introduced making it mandatory for a system to be built into all newly designed transport aircraft, accompanied by a further amendment covering all new aircraft in build, with a third phase covering retrofit of existing fleets. Rule making, including aircraft in build, could start to take effect from mid-1993.

This comes in the wake of a crash involving a Boeing 737-200 of British Airtours, the then-charter subsidiary of British Airways, on Aug. 22, 1985. at Manchester Airport. The aircraft was taking off with 130 passengers and six crew. As it accelerated along the runway, the left engine exploded and the head of a combustion chamber struck a fuel-tank-access panel in the lower surface of the wing, leaving a substantial hole.

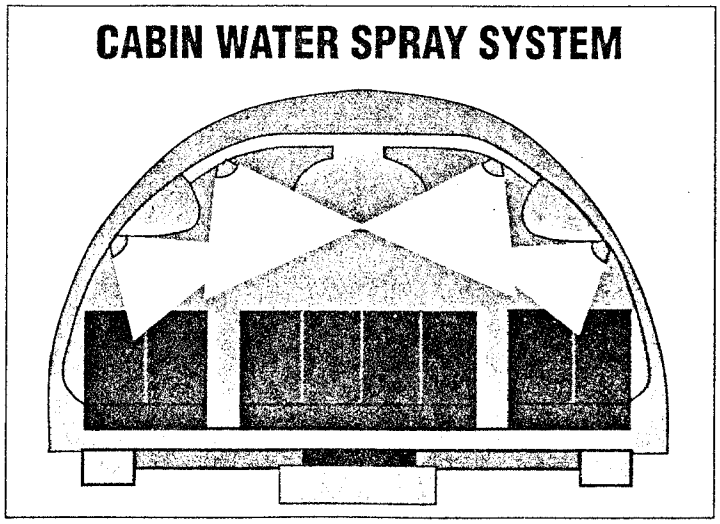
Fuel escaping through the hole reached the hot engine and a major fire developed, spreading under the rear fuselage and rapidly penetrating the cabin, which filled with dense black smoke. Fifty-five people died, 48 of them through inhalation of smoke and toxic gases.

A total of 31 safety recommendations were made by the Air Accidents Investigation Branch (AAIB) of the U.K. Department of Transport at the end of an exhaustive, 17-month inquiry that cost £200,000 ($336,000).

Many of these recommendations, including floor-level escape-path lighting, improved access to overwing exits and hardening of cabin interiors, were made mandatory by the CAA not long after the tragedy.

However, the AAIB tabled recommendations concerning cabin water sprays and smoke hoods. Six years after the accident, these two subjects continue to generate considerable debate and no little emotion within the British aviation industry. When finally they are resolved, the way in which it is done will affect the air-transport industry worldwide.

Recommendation 4.19 by the AAIB said: "Onboard water/spray mist fire extinguishing systems having the capability of operating from both on-board water and tender-fed water should be developed as a matter of urgency and introduced at the



Darchem Engineering diagram, left, shows how, in its SAVE system, water from under-floor tanks is fed under pressure to overhead pipes for spraying fire.

earliest opportunity on all commercial passenger-carrying aircraft."

Work on the sprays has been going on, however, and the CAA was approached shortly after the Manchester accident by the Safety (Aircraft and Vehicles) Equipment (SAVE) Co. with a proposal that such a system could improve survivability. Production engineered by Darchem Engineering, Ltd., the system feeds water under pressure from underfloor tanks to pipes running the length of the cabin. A network of titanium tubes runs behind the ceiling and fascia panels and nozzles at intervals along these tubes provide a fine spray of water droplets when the system is pressurized.

"This water mist," said Darchem, which has taken over SAVE, "cools the air inside the cabin; cools the passengers; suppresses the ignition of cabin furnishings, thus reducing the generation of smoke and fumes; absorbs toxic and irritant combustion gases in the atmosphere; washes smoke particles out of the atmosphere; inhibits flashover."

The claim of cooler cabin air certainly is borne out by a CAA video. Without water spray, the temperature inside the cabin was at 209°C after 2½ min. With spray, it was only 15°C after the same period.

In the Darchem system, pressure for the spray is provided by compressed nitrogen and the electric power for initiation from dedicated batteries. Research into aviation accidents shows that fuselages generally rupture into three large sections after a violent impact, the breaks occurring before and aft of the wing. Darchem has divided its system into three subsystems, independent of each other, including water supply and gas pressurization. Frangible joints in the supply pipes self-seal if the fuselage separates.

OTHER SYSTEMS

Three other U.K. companies, Kidde-Graviner, BP Ventures and AIM Aviation also are working on cabin-spray systems. Like Darchem's, Kidde-Graviner's system is divided into linked subsystems, each independently operable to protect a zone of an aircraft in case of a break-up following a crash. Water is pressurized by a pyrotechnic device to provide constant pressure operation and flows through lightweight piping to the spray nozzles, which are positioned along the cabin ceiling and walls, to deliver what the company claims is a precise distribution pattern.

David Wyatt of Kidde-Graviner told *ATW*: "Our conclusion so far is that the system will make the aircraft cabin more survivable, buying those extra few seconds and minutes to get people out."

According to Kidde-Graviner, a CAA study has indicated that 35, rather than 55, would have died as a result of the Manchester fire, had the aircraft been up to 1991 safety standards and that all would have survived if a water-spray system had been fitted. Worldwide, around 400 lives could have been saved by such systems over the last 25 years.

Live testing of spray systems has been going on in the U.K. at the CAA's Fire Service Training School at Teeside, using a Trident 2 fuselage, and at the Fire Research Station, with a 707 fuselage as the test piece. FAA has been conducting complementary trials on both narrow and

widebody fuselages at its Atlantic City fire-test hangar.

Said the CAA: "The results show very substantial increases in the time for which the cabin remained survivable under all but the most severe simulated wind conditions. The major part of the benefit was seen to be as a result of the wetting of the furnishings so that they are not so easily set on fire by the intense radiant heat. There is also a very rapid cooling of the smoke as it moves through the spray and washout of the soluble toxic gases."

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One drawback noted in both the CAA and FAA testing has been the effect of spray on visibility. The CAA noted: "In the absence of a spray, the natural buoyancy of smoke will result in a smoke layer at high level and clear air below. The effect of the spray is to bring the smoke down to all levels. The extent to which the smoke particles are washed out by the spray is insufficient to compensate for this effect."

Other worries are the possibility of inadvertent system discharge and its effect on electrical systems, particularly in fly-by-wire aircraft; the effect of wet floors on the speed of evacuation and the weight and cost of installation. About 15 gal. of water a minute are required for a 737-size system and the systems will be required to operate for 3 min., which has been shown to be the maximum time of arrival of fire services to an on-airport crash—each system would have external points into which the fire services could plug their hoses.

Ballpark system-weight figures, on the basis that a gallon of water weighs 8 lb., are 650 lb. for a narrowbody, and 1,100 lb. for a widebody that would carry around 100 gal. of water. With the industry estimating the average passenger and baggage weighs 170 lb., this would mean a loss of three fare-paying passengers per flight on a narrowbody and six on a widebody. Darchem puts the cost of a kit to fit the Boeing 757 at £100,000 ($168,000). Provisional figures from the CAA suggest a total first cost—production plus development—of £80,000 ($134,000) for a narrowbody and £110,000 ($184,000) for a widebody. Routine maintenance and annual inspection could cost £5,000 ($8,400) and £8,000 ($13,440) respectively.

Based on the British Airways average cost per kilogram weight increase per aircraft of £25 ($42), annual operating costs have been estimated at £7,500 ($12,600) for a narrowbody and £12,000 ($20,160) for a widebody.

A lot of the development work is being directed toward preventing spray systems from going off by accident. Final thinking on this is still in progress but it appears as if both automatic actuation—when sensors detect certain levels of heat and smoke—and the possibility of manual actuation from the cockpit and by cabin staff from the various zones in the cabin, are likely.

One danger that has been identified is that crew might commit the system and its 3 min. protection too early. It is likely that the systems will be made ready for action for takeoff and landing, the two segments of the flight when they are most likely to be needed, but protected against inadvertent operation during the cruise.

Some 150 delegates attended a 2-day conference on cabin water sprays organized by the CAA and chaired jointly by Dick Duffell, CAA's head of systems and equipment, and Denis Warren, head of the CAA's management services unit, at Gatwick airport last summer.

Represented were airlines, airframe and engine manufacturers, licensing authorities and equipment makers. Every aspect of the current debate was hashed out and attendees heard the "downside" from Boeing and Airbus, both of which have been looking at this aspect under CAA contracts. Delegates reported that the Airbus representative took a particularly gloomy view of the potential impact of cabin sprays on electronic and electrical systems.

As to smokehoods, the AAIB's Recommendation 4.24 was: "The CAA should urgently give consideration to the formulation of a requirement for the provision of smokehood/masks to afford passengers an effective level of protection during fires which produce a toxic environment within the aircraft cabin."

In response to the AAIB's prompting, the CAA published a draft smokehood specification in July, 1986. The spec was criticized for being too demanding but the CAA pointed out that it was finalized only after consultations with industry and with other aviation authorities.

Four different types of hoods were presented to the CAA—one manufacturer is believed to have spent around £1 million ($1.68 million) on research and development. None of them was con-

FAA-CAA SPRINKLER TESTING

The U.S. FAA has been working with the U.K. Civil Aviation Authority and Transport Canada on a cooperative test program for cabin sprinkler systems, according to Gus Sarkos, manager, fire safety branch at FAA's test facility in Atlantic City. The joint R&D program began testing in June, 1989.

Full-scale fire testing in the FAA's TC-10 test aircraft is under way consisting of setting the aircraft on fire "in different ways" to test the efficiency of systems against different types of aircraft. Initial testing in a narrowbody has just been completed, showing a 2-2½-min. improvement in survival time.

One of the key areas that FAA is working on is the development of a "full-scale, standard performance test" for water-spray systems, Sarkos said. "The idea is to try to optimize a standard test that will allow companies involved in developing the system to have a standard to work against."

Weight is a critical factor in the development of a standard criteria, he said. The systems being developed and tested carry a 4-lb. per-passenger weight penalty, "which is excessive." To be acceptable, this weight penalty will have to be reduced greatly "and is the area most being looked at," Sarkos said.

FAA wants to install a system in an actual aircraft next year, he said, with the final phase being research into "risk analysis" to determine the probability of certain kinds of fires and the probability of the system saving lives.

Sarkos said that Boeing is involved in the work over the practical concern of a sprinkler system going off in flight, with Boeing's test data expected to be completed by January.

Once the Boeing report is in, the FAA will be in a position to make a statement as to whether it considers a cabin sprinkler system to be viable, Sarkos said, "probably in June."

The FAA-CAA effort includes splitting work between the two, conducting independent work in different areas and sharing information.—**Douglas W. Helms.**

sidered adequate. The authority said it felt that some could "be positively dangerous," in some circumstances.

At the same time, the CAA was involved in a general review of regulatory policy on smokehoods with the U.S. FAA, the French Direction Generale de l'Aviation Civile and Transport Canada. All four authorities decided to reject the principle that the hoods should be required equipment on airliners. Twice before, FAA had considered the issue following air accidents involving fire.

The CAA's case against smokehoods continues to be that since it issued its specification, the other measures taken to improve cabin safety have reduced the hoods' potential to save lives. While an analysis of accidents since 1985 shows that one life a year worldwide might be saved by their use, the more likely outcome is that up to eight lives could be lost because of delays in evacuating the aircraft.

A major concern within the CAA continues to be the unpredictable response of untrained passengers to a strange piece of equipment in the traumatic conditions produced by an on-board fire, rather than any problems with the technical design of the equipment itself.

In taking its stance, the CAA flew in the face of the powerful Transport Committee of the House of Commons that early this year recommended mandatory and immediate installation of "the best smokehoods available." It also upset the Consumers' Association, whose assistant director, Derek Prentice, said: "None of us doubts the usefulness of sprinklers but they won't be universally installed for years. Meanwhile, travelers are being denied the possible benefits [that] smokehoods could undoubtedly bring. The CAA's evidence against them seems to be based more on conjecture and professional mistrust than on the views of the users. They have consulted with airlines, among others, but they admit that they have not consulted any users' representatives.

"Once again, the interests of professionals and airlines have been put before those of consumers."

Another continuing smokehood advocate is the independent Air Transport Users' Committee, whose chairman, John Cox, told *ATW*: "We started to ask questions about them very quickly after the Manchester disaster and we arranged tests on volunteers, including members of our committee. We are disappointed that the CAA appears to have closed the door on them. We are very much in favor of water sprays but we believe there should be a cocktail of measures—including both smokehoods and sprays—to make sure that passengers are better protected."

One of the volunteers who took part in the fire tests was John Parr, the committee's director general, who said: "There were six of us at the Offshore Oil Industry Fire Station, at Montrose, Scotland. The smokehoods were from the U.S., and were still in their boxes. They were not difficult to open or put on but the oxygen supply on the one I was given did not work immediately, so I took a replacement. In the fire environment, it was not uncomfortable, although we were aware of the heat. We were told that the atmosphere, which was one of totally impenetrable smoke, was such that we would have been dead within seconds without smokehoods."