SURVIVAL . . .

showed that in 28 potentially survivable accidents where fire was involved more than half the fatalities were due to post-crash fire. Of the 1,161 occupants involved, 488 were killed and 673 survived. The fatalities were broken down into three sections: 166 people died from impact forces; 28 drowned during an unsuccessful ditching; and 294 deaths were directly related to fires which broke out after impact.

A great deal of work is being done in the United States to produce fuels which will not spread when the tanks burst, and on the development of crash-resistant tanks. There are strong possibilities that a combination of these two approaches will considerably reduce the fire risk in aircraft accidents within the next five years.

"Solidified" fuel can be produced in gel or emulsion form. A gel is a liquid dissolved in a solid, while an emulsion is one liquid suspended in another. The US Army, which has been doing research on what it calls "safe" fuels for some years, has concentrated its attention firmly on emulsions because gels tend to become more viscous at low temperatures and to break down at high. Emulsions, they claim, are also easier to make and break and can be reconstituted if necessary.

While this work is going on in the US Army the FAA is evaluating gelled fuel so that its own tests, plus the Army work on emulsions, will give a good indication as to which type of modified fuel is better for civil applications. (The two specifications are not exactly alike because of different military requirements.)

At the moment it seems that an emulsified fuel will suit both military and civil needs. Tests have shown that emulsified fuels are much less readily ignitable and more easily extinguished, and that if a tank is ruptured in a crash the blobs of emulsion which spatter themselves around are less easily ignited and do not flow appreciably from their post-crash position.

Although it has been proved already that turbine engines will function adequately when using either emulsified or gelled fuel, work still has to be done on ascertaining the corrosive effects on ancillary fuel system equipment—such as pumps, filters and pipes—made of various materials.

It is ironic that much of the work in the last two years on "safe" fuels has resulted directly from the Vietnam war, where fatalities in the US Army from fires following helicopter crashes are said to outnumber fatalities in helicopter crashes resulting from enemy action. It's an ill wind . . . .

Other methods of reducing post-crash fires include the provision of literally crash-proof tanks, but this still leaves pumps, connections and the fuel lines themselves vulnerable. Another method is to inert the airspace above the fuel so that the constituency necessary for an explosive mixture cannot be achieved. It would seem that a combination of all the above methods would make the difference between life and death to at least 50 per cent of the prospective fatalities in a "survivable" accident.

If the fire hazard could be eradicated there would still remain many factors which affect survival. The first of these is the ability to reduce impact damage to occupants to an absolute minimum. This could be done, for instance, by providing shoulder and leg-restraining harnesses in addition to a lap strap, in the same way as military pilots are strapped to their ejection seats. It *could* be done, but it never will be, because passenger reaction and comfort must be taken into consideration. Some kind of emergency restraint system has to be used, although those suggested so far have proved impractical. Possible methods include the use of plastic bags which, mounted on the seat-backs, inflate (one would hope) either automatically at a pre-set level of forward g force or when actuated by the crew. The concept suffers from the twin facts that 100 per cent inflation reliability could not really be expected in operational use; and, of course, the bags would have to be deflated or punctured to allow the occupants to escape. Injuries to occupants from the impact would be very greatly reduced, but evacuation would undoubtedly be delayed.

There are still people—outside the aviation industry, of course—who believe that all aircraft seats should have some sort of ejection device fitted to them; but this would obviously be impracticable, because of the extra weight involved and because in any case untrained passengers would hardly be likely to be able to use an ejector seat and parachute effectively. More likely is the possibility that some of the nervous types would have second thoughts about flying at all, and eject on the take-off run. Another suggestion, made recently, was that the co-pilot's seat in all aircraft should be of the ejection type so that he could eject in an emergency in order to act as a human flight recorder. But this, too, is hardly practicable; provided enough information channels are used, the job is done much better by an efficient electronic device.

Nevertheless, the ejection seat, developed by a British company, Martin-Baker, has probably contributed more than anything else to survivability in military aircraft accidents. Developments in this field, going on all the time as military requirements become more and more stringent, have by no means been exhausted.

Probably the ultimate impact-reduction system which will evolve in passenger aircraft will involve not ejection seats but "de-lethalised" seats and restraint systems. These will be seats and lap-straps designed to reduce the effect of "flailing" limbs and trunks which inevitably occurs during a sudden deceleration. Seat-backs can be designed so that they do not split skulls which come into contact with them, and legs, too, can be cushioned. A good example of this kind of approach is found in the VC10 seat, which will be fitted as standard to all future BOAC aircraft.

Damage from loose articles lying around the passenger compartment will always be a risk, but with the trend towards stowing hand baggage in overhead cages rather than in racks at least one source of objectionable flying objects is eradicated.

Evacuation Because of the fire risk, evacuation as rapidly as possible is of absolute importance to survival. Fires have been known to consume a cabin within tens of seconds, either burning the occupants or asphyxiating them by consuming all the available oxygen. Minimum time required by the American

Survival starts before an incident happens. Here an FAA 707 is being used to check the efficiency of runway grooving as a means of reducing the aquaplaning danger