AIR SAFETY

IT is a maxim of aircraft design and operation that economics and safety are complementary factors, and that it is always possible to achieve a favourable financial return by ignoring safety considerations, whereas too great a concentration on safety tends to result in economic failure. It is in the achievement of a fine balance of the two factors that the skill and ability of the efficient designer and operator manifest themselves.

This maxim was, no doubt, very much in mind, although never stated, at the all-day discussion on air safety held by the Royal Aeronautical Society on March 5 at the Institution of Civil Engineers. Four papers were presented covering different aspects of the problem, but few significant advances of scientific interest were revealed.

The first paper, by Mr. J. D. North, was on "Some Aspects of the Relationship between Airworthiness and Safety". In this paper, Mr. North brought some of the concepts of philosophy and psychology to bear on the problem. Starting with the conception of 'net yield' (being the difference between 'gross' yield and a somewhat indeterminate quantity 'damage'), he analysed the factors involved in the various terms, the principal ones being the environment, the human factor and the type of aircraft. The method of analogy provided the main approach, and his analogy was that of a game having the nature of patience or solitaire, the object of the game being to move along a grid containing several hazards and to lose the minimum number of points, the optimum path representing the time–space motion which gave the minimum damage. Statistically there is no doubt some basis for such an analogy; but the discussion indicated a certain lack of appreciation of Mr. North's methods and objectives. Apart from criticism of the vagueness of the term 'damage'—which, when interpreted as loss in prestige as well as material loss, may well alter the framing of the initial concept—one of the chief objections to the analogy is that it is unnecessary to import into the science of aeronautics unfamiliar methods and notations which lead eventually to results derivable far more simply by the usual methods. Indeed, there was great doubt as to whether more than a tiny percentage of those present at the discussion understood Mr. North's paper.

The second paper, on "The Physiological Aspects of Air Safety", was read by Dr. K. G. Bergin. The advances in the field of aviation medicine at the present time are naturally associated with the advances of aviation generally. Particular points of interest are the effects of high accelerations and decelerations, high-altitude effects, low-temperature effects, effect of vibrations, and the toxic effects of fumes. All these are, however, problems which arise principally in military aircraft, and so it was a much more restricted field of rather less interest that was covered by Dr. Bergin, who dealt with questions occurring during normal civil operations.

Referring to the question of vision, Dr. Bergin stated that the average percentage decrease in range of night vision varies linearly with altitude, being 5 per cent at 4,000 ft. and 35 per cent at 16,000 ft. Other factors reducing night vision include glare, lack of oxygen, smoking, alcohol, inadequate vitamin A, and fatigue. Suitable precautions can always be taken to ensure that diminution in visual acuity is not dangerous, particularly since the effect is temporary. A more serious problem is the permanent and irreversible deterioration in hearing, known as aviation deafness, resulting from the constant bombardment of the ear by noise over a period of time. The trouble is progressive, starting with a reduction of auditory acuity over the high-frequency range and eventually including the low tones as well. Lack of oxygen is a great potential source of accidents, since it results in false impressions of the pilot's own capabilities, a diminution in skill, speed of reaction and accuracy of attention to detail. The vision is also affected, particularly the power of accurate focusing and optical convergence.

On the question of equilibrium, Dr. Bergin described three common disorders: the autokinetic illusion, the oculo-gyral illusion possibly complicated by autokinesis, and the oculo-gravic illusion. The first of these consists of the apparent movement of an object when viewed against a dark background in the absence of spatial localization. The condition is dangerous only if it occurs at a critical moment. The second illusion is due to conflicting impulses from the eye and the semi-circular canals in the part of the ear known as the labyrinth, which, following angular acceleration, results in the apparent movement of objects. The third illusion is due to conflicting impressions between the eye and the otolith organ, and, following accelerations, consists of an apparent displacement of an object in space. The effect of the illusions can be eliminated by blinking, by the use of flashing lights instead of steady lights, or by the use of a number of non-planar lights.

The elimination of fatigue of personnel is important in accident prevention, since fatigue can result in diminished nervous impulses, slowed reactions, impairment of judgment, vision and hearing. Dr. Bergin emphasized the necessity for proper rest for the pilot between flights, adequate diet, and good conditions inside the cockpit. The latter should include proper seating, good windshield design, correct positioning of the instruments and controls, and good insulation. By great care of the health of the crew the risk of accidents can be diminished, and thus the medical aspects of aviation are of fundamental importance.

The third paper, by Capt. J. W. G. James, was entitled "Air Safety from the Pilot's Point of View". His paper was, of necessity, more concerned with the human element than with a scientific approach. He dealt with most of the current difficulties encountered by pilots, in particular stressing the need for better control-cabin layout and good handling characteristics (involving light controls, rapid response, low safety speed, stability, and no change in longitudinal trim during flap and undercarriage movement). The importance of proper training for pilots in order to achieve a high standard of technique, particularly in instrument flying, cannot be overstressed, and Capt. James expressed very definite views on this point. He also advocated the use of a medical service for maintaining health—as distinct from its use as an examining body—which at the moment is the function of the Ministry's medical service. He was somewhat critical of the present conception of 'flying hours' as a criterion for pilots' efforts, and suggested that an 'hours on duty' restriction may eventually be introduced. He felt, however, that all restrictions of this type could be

more easily handled by the co-operative effort of the pilots and operators. On the question of operating technique, Capt. James laid down recommended procedures and suggested that the use of drill cards for checking their implementation is desirable. The procedures, although of interest and conducive to increased passenger comfort, would not seem to increase the inherent safety of operation. He deplored the lack of standardization of air traffic control systems—some five are in common use—and expressed the view that such variations tend to decrease safety owing to the excessive practice required to maintain efficiency. The subject of accident investigation—about which much was said in the later discussion—has always been of particular interest to pilots, and Capt. James stressed the importance of this, since only by adequate representation of pilots on investigating committees can the stigma of pilot's error be avoided. (A rather interesting point raised in the course of the discussion was that the term 'pilot's error' might well be replaced by 'designer's error', since the possibility of guarding against possible mistakes in operation can well be regarded as the designer's responsibility.)

The last paper, presented by Dr. G. E. Bell, was entitled "Operational Research into Air Traffic Control". This paper was concerned with experimental investigations (including time and motion studies of take-off and landing, studies of air/ground communications, and an analysis of the traffic and traffic pattern in south-eastern England) and with theoretical investigations into the problem of traffic congestion. The quantitative data on the distribution of delay times was extremely enlightening. In August 1948, at London Airport, about 40 per cent of the incoming aircraft were held for an average time of rather less than 10 min., the average holding-time for all aircraft being some 3½ min. At Northolt, where the loading is heavier, the corresponding figures are 65 per cent held for an average of 16½ min. with an overall average of 10½ min. Approach times vary between 6 and 15 minutes, whereas runways are occupied for between 8 and 9½ minutes for each landing. Thus landing delays are considerable, and the necessary stacking increases the risk of collisions. Dr. Bell presented an analysis of the traffic congestion problem on the assumption of a constant holding-time and based on considerations of statistical equilibrium. He showed that by a knowledge of the 'expectancy' ε, or average number of arrivals in the holding time T, and of the values of the arrival probabilities, the probable degrees of congestion can be estimated. Assuming the Poisson distribution of probabilities, the mean delay is given by

$$t = \tfrac{1}{2}\,\frac{\varepsilon}{1-\varepsilon}\,T.$$

The effect of deviations from stipulated fixed intervals of arrival was also considered, and it was found that the improvement of a scheduled arrival-rate over a random one is only marked when the standard deviation is small compared to the scheduled interval.

He concluded by pointing out that the capacity of an airport is seriously affected by the 'holding time'; thus at a factor of 0·8, a 10 per cent reduction in holding time increases the capacity and reduces the average delay for the same congestion by some 10 per cent. The most promising approach to reduced holding times is the greater use of radar control.

Much can be said of the value of the day's discussion, but undoubtedly the contribution to the subject of 'air safety' was very limited. Too many gaps were left to regard the meeting as satisfactory. The attitude of the designers and the official regulating body (the Air Registration Board) only slipped in during the general discussion following the papers, instead of being adequately covered by formal statements; and it is a great pity that too much time was spent by the principal speakers on matters outside the scope of the day's proceedings, and too little on the fundamental requirements for an improvement of 'air safety'.

HENRY ROBERTS

BRITISH HYDROMECHANICS RESEARCH ASSOCIATION

THE British Hydromechanics Research Association was officially incorporated on September 20, 1947, as a company limited by guarantee, and at the first annual general meeting held a month later Sir John Anderson was appointed president, and a council of ten elected. In the Association's first annual report, which has recently been issued, a review is given of the progress during the period October 1947–September 1948. Mr. L. E. Prosser was appointed director of research in April 1948, and a small staff was recruited later in the year. Thirty-one manufacturers of hydraulic and related machinery are members of the Association, and the associate members include twelve firms of consultants and twenty professors and academic workers. Although directly controlled by industry, the Association operates under the ægis of the Department of Scientific and Industrial Research, and it is hoped that, in the very near future, with adequate support forthcoming from industry, the Association will qualify for a Government grant.

The aim of the Association is to promote original research in hydraulics, and in the application of scientific principles to the manufacture and use of hydraulic machinery and equipment. In this connexion it acts as a liaison between industry and university and Government research laboratories. An efficient information service is being built up to collect and disseminate to the members technical information on hydromechanics and related topics. There is a need for an abstract service covering current publications on hydraulic science, and the *Bulletin* of the Association should prove very valuable in this respect. The first number of the *Bulletin* appeared at the end of 1948, and its contents include a selection of non-critical abstracts arranged in accordance with the universal decimal classification, Association news, and book reviews.

Six sectional research committees, dealing with fundamental fluid mechanics, measurement and laboratory technique, pumps and turbines, control and motion of fluids in pipes and valves, seals and joints, and reciprocating machinery, have been set up. The names of the members of these committees and the subjects under consideration are listed in the annual report. There is little doubt that the Association can become invaluable to the hydraulic industry of Great Britain, and, as Sir John Anderson points out in his foreword to the report, "the formation of this new Research Association is more significant than its present modest development would indicate, as it represents a further step towards a closer relationship between Government and technical interests of industry".