United Services Section

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Some Aspects of Aviation Medicine in Regard to Radiological Hazards

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Group Captain Denis Wilson:

In dealing with this question I shall confine my remarks to those radiation hazards that may be encountered during peace. It will be realized, of course, that some of the points which may appear to be omitted or passed over are treated in this way for security reasons.

When I first started to be involved in this type of work five years ago the subject was almost a closed book on this side of the Atlantic and it seemed possible that radiation hazards to aircraft crews might be a real danger in the future even in peacetime. It was thought that these hazards might come from

(*a*) The ionization effect of cosmic radiation on high-flying aircraft.

(*b*) Inhalation and ingestion hazard on high-flying passenger aircraft following a series of atomic bomb tests a long way away.

(*c*) Hazards both of primary radiation and inhalation and ingestion for military aircraft sampling during these tests.

(*a*) The hazard due to cosmic radiation has been the subject of much research and if many of the major problems of the origin of the cosmic rays and their actual components are still unsolved those of the radiation hazards are less uncertain.

Cosmic radiation can be recognized at earth level and even considerably below the earth's surface. It is increased in intensity by a factor of about 15 at 75,000 feet in northern latitudes and more in the polar areas and then, probably as a result of a combination of the geomagnetic field and the earth's shadow, decreases to about 150,000 feet when it is again increased until at 8,000 miles it is presumed to reach its maximum. At this maximum, ionization dosage will be substantially greater in the denser materials such as aircraft or rocket ships and that includes the occupants inside. This is due to the transition effect.

So that we now know that unless an aircraft is going to spend many days at over 75,000 feet and beyond there is no perceptible radiation hazard to the crew. As this, at present, is confined to legendary characters like Jet Morgan of B.B.C. fame and his colleagues in papers like the *Eagle* we can dismiss it as a present danger.

(*b*) In the second case it was felt that high-flying transatlantic aircraft might by a combination

of circumstances fly for many hours in a layer containing comparatively fresh fission products from a series of bomb tests. It is known that bombs of the same approximate energy let off in the same area and under similar meteorological conditions will send their clouds to approximately the same height and whilst a proportion of these clouds fall out, the particle sizes are often so small that they remain in the sky for many days. It is theoretically possible that an aircraft flying on a standard course at an altitude around 45,000 feet for some hours might pick up and push into its pressurized cabin (and its passengers) measurable amounts of fission products. The medico-legal implications of a jet airliner full of rich and influential business men getting in such a position are full of intriguing possibilities! To date, however, we have not had any transatlantic passenger aircraft capable of flying at these altitudes and the problem has not arisen, but with the advent of the Comet III and the arrival of new nuclear weapons of fantastic power on the testing grounds the problem is not so very academic. The answer, of course, is simple, since cabin air can be filtered easily and effectively with little penalty in either weight or bulk. To date, however, no passenger aircraft carries these filters.

(*c*) Thirdly, it was felt that aircraft closely concerned with tests for scientific or military reasons were bound to get a fairly high degree of irradiation. The only information we could find was some calculations that were a little alarming to say the least, but since the scientist who produced these was "out of reach" we could not discuss them further with him, but had to do some thinking on our own. It was felt that there were reasonable grounds for disregarding the original alarmist calculations and since the Royal Air Force urgently wanted information on this as well as on aircraft contamination and decontamination we looked forward to the first British tests to supply the opportunity for getting details. Unfortunately, as you know, these were held at Montebello under conditions which could not be felt to give the R.A.F. any likelihood of getting reliable information and it was not until the Second Tests—October 1953—that we were given an opportunity of flying participation. We asked therefore for permission to carry out a detailed early study of just these points in relation to the Burst with a typical modern aircraft. The Air Staff were extremely co-operative and in early July 1953 we found ourselves the proud possessors of a brand new Canberra B2 with a really beautiful high speed finish on her to minimize the residual contamination hazard and to facilitate the decontamination procedures.

We removed the bomb sight and computers and installed special measuring and recording equipment which covered all rates of radiation that we might reasonably be expected to encounter from 0–10,000 r per hour. This consisted of two low-reading dose rate meters and two high-reading ones, all giving visual readings, the two higher rate ones also feeding on to spark-gap recorders so that we should have a graph of the levels throughout against a time scale and the known entry speed of the Canberra. As, however, the calculations that gave us these rates might be in error and as these rates were recognized to be dangerously high we had to devise a technique that would enable us to check the ionization peak before doing the complete cloud survey. We aimed to hit the cloud when the radiation had fallen to 5,000 r per hour or about 1·5 r per second—so we planned a tangential run on the cloud, enough to immerse the aircraft for about 2 seconds, when the exact rates could be seen and our calculations checked before the full run.

Film badges and electroscopes were carried by the crew to check the total integrated dosage as it was known that additional radiation would be received on the return journey from the outside contamination on the aircraft and from the collecting filters. A film camera was also used.

I will now let Wing Commander Geoffrey Dhenin describe the rest of the trip. Wing Commander Dhenin is Deputy Principal Medical Officer (Flying) of Bomber Command and the pilot of W.H.738—but before I finish I think I should say that the trip was a complete success and all data needed were obtained.

Wing Commander G. H. Dhenin:

Operation Hot-box

Bernard Shaw, once asked by a reporter what he thought of the feat of Amy Johnson in flying to Australia, replied that all the credit should be given to the aeroplane and that he could see little merit on her part since all she did was cling to the machine. In the operation which Group Captain Wilson is describing to-day my part was mainly that of limpet. The real work was done by the Group Captain, who originated the project and was a tower of strength, and by my navigator Wing Commander E. W. Anderson who had not merely to cling but to be intelligent about which way we were going or where we had just been, no mean task at 500 m.p.h.

The aeroplane, a new Canberra, W.H.738, was carefully prepared for the trip and its task. Various modifications were made to the fuel tanks, the navigation and radio equipment—these to simplify the task of flying a round trip of 20,000 miles, much of it over water. As to the task at

Woomera we tried to make a realistic estimate of the possible dangers we might encounter in the cloud and to do what we could to prepare for them. These risks were as follows:

(1) The risk of hitting something solid in the cloud.
(2) The risk of flameout due to the dust.
(3) The risk of losing our airspeed indicator—again due to dust.
(4) The risk of inhaling or swallowing radioactive dust.
(5) The risk from external radiation.

The first risk we did not think very likely; but a high speed aircraft can be severely damaged by quite small objects, hailstones, for example. We had ejection seats to help us abandon ship if necessary and we saw to it that the seats were serviceable and that we were all familiar with the drills.

The second was also not very likely; but we had a special high energy system fitted to give us the best chance of relighting if the fires went out. If this proved impossible a good belly landing should present no difficulties in the open country where the explosion took place; and we later arranged for a R.A.A.F. Lincoln, piloted by a personal friend of mine, to stand by 50 miles away to locate us and drop supplies if we should crash.

The third risk was, I thought, quite a likely one; and though there should not be too much difficulty in landing without a knowledge of one's airspeed, a mistake can be very expensive. So we arranged for a R.A.A.F. aircraft to be airborne over Woomera for our return so that we could go in together in formation and he could call out to me the airspeed.

The fourth risk we countered by sealing the cabin—cutting off the pressurization air from the engines and sealing all possible leaks by fabric, dope and selotape. Though the cabin environment was scarcely enhanced by this treatment, we were, of course, using oxygen and preferred the discomforts of low pressure and no ventilation to the hazards of cabin contamination.

The fifth risk we could do little about except to calculate what radiation dose we could accept, and arrange to enter the cloud at a time appropriate to the dose.

With these arrangements settled we could prepare a plan for the operation itself. Here I will confine myself purely to the two factors which most affected the safety of the aircraft. The first of these was runway conditions. A strip had been prepared at X 200 and we were intended to operate from there. When we saw it, I felt that the loose surface might easily damage the aircraft and prejudice the success of the operation. Loose stones could be thrown up by the nose-wheel and engulfed by the engines with the most unpleasant results. We therefore decided to operate from Woomera, 300 miles away, not a great distance for an aircraft which can cruise at about 500 m.p.h.

Most important of all was the timing of the explosion. Since we wanted to be in a position to enter the cloud early we must not be too far away. On the other hand we must not risk exposing the aircraft to the actual explosion, nor must we be looking directly at it when it occurred. Apart from the normal danger of looking at atomic explosions, a blind pilot cannot regain control of an aircraft—and a Canberra once out of control hits the ground very fast indeed. We therefore planned our position in space very carefully; exactly three minutes before the explosion we should be ten miles from the site at a height of 30,000 feet on a course of 300° which would take us towards a dried-up salt lake with the melodious name Lake Meramangye. We should then—at this precise minute—start to descend at a fixed rate to bring us to the height at which we intended to meet the cloud. At H −1 minute we were to get a check call from the airstrip at the explosion site (DUCK) and at H −10 seconds we should begin an accurate turn (3°/sec.) towards the explosion. We should thus be turning towards the bomb but not far enough round the turn to see the flash directly. By the time we wanted to enter we should be at the right height, the right speed and very near the cloud.

This was the plan and we made numerous rehearsals, not only of the operation but of the details—starting up filter motors, ejection drills; getting out of the aircraft without picking up contamination, dropping the wing-tip filter and many other details. Finally after a long wait and many disappointments, we took off as dawn was breaking and set course for Emu. We reached it in a little over 40 minutes at 30,000 feet, but were dismayed to find that Lake Meramangye was no longer visible, partly because it was not a very clear morning and partly because some recent heavy rain had changed its appearance. We did our orbiting, therefore, using radio-compass bearings, and all went according to plan. We received the count-down properly and were partly round our turn, descending, when the flash came. I saw it only as a reflection from the cockpit canopy but it was quite bright enough. We completed the turn and started the run-up. As we levelled out I noticed that I was over-breathing hard. It occurred to me that of the two explanations for this—the high carbon-dioxide content in the cabin or fright—the latter was the more likely.

The first run was no more than a "sniff" as we called it—we just immersed our wings for a couple of seconds so that the Group Captain could tell us whether we could reasonably go through the middle. As I turned he made his calculations and decided that we could. I therefore headed the

aircraft straight at the centre and got ready for a rough ride. The cloud as we drew nearer, looked distinctly nasty. In colour it was a dark red-brown, very solid but boiling as it were. I turned on all the cockpit lighting, for it was certain that I should not be able to see my instruments without lights. As we entered, it was indeed dark but not as turbulent as I expected; until just before we emerged the forces on the elevators increased to such an extent that I thought I might lose control. Then, as the cloud gave us the parting kick, the light began to appear as at the end of a railway tunnel. We emerged, having hit nothing solid nor lost our engines or instruments. The rest was easy—a run through the base and the top, a quick beat-up of the scientists below, then back to Woomera to drop our wing-tip filter and leave the aircraft.

It was not yet 8 a.m. when we joined the circuit at Woomera where the Australian Canberra was airborne waiting for us. We had no need of his services, so we bade him good morning and went in to land. After landing we taxied to a dropping zone, established previously, to drop our wing-tip filter. This filter, now containing much highly radio-active material, lay in a wing-tip tank, secured to the wing by explosive bolts. When the wing was over the dropping zone, I jettisoned the tank which dropped cleanly on the sand; but it bounced, and being caught by the very strong wind began to roll towards the aircraft. There was nothing one could do but wait and hope that it would not damage any part of the machine. By good fortune it rolled under the nose, just clearing the nose wheel and was soon stopped by Dr. F. Morgan, the radio-chemist, who courageously turned the tank into wind and got some ropes on it to pull it back to the dropping zone where it was to lie and cool down for a week.

Meanwhile we taxied the aircraft to the area where we planned to decontaminate it, got out and cleaned ourselves in the coldest shower in the Southern hemisphere—an open shower fed by ice-cold water from a water cart while the wind blew at 30 m.p.h. and the sun was not yet up. Then we went to breakfast.

To return to what Bernard Shaw told the reporter, the aircraft cannot be praised too highly.

Despite the long distance it had covered, the penetration of an atomic cloud, the sundry disagreeable decontamination measures and what my pilot friends are pleased to call the supreme handicap of having a doctor to drive it, W.H.738 nevertheless broke the new record between Ceylon and Karachi on the way home.