EFFICIENCY OF PERSONNEL IN THE SERVICES.¹
By Air-Commodore A. V. J. Richardson, O.B.E., M.B., B.Ch., D.P.H., K.H.S.,
Royal Air Force.

(1) INTRODUCTION.

It has been aptly stated that the fundamental function of a Medical Service is to provide a specialist contribution to the efficiency of the Force as a whole. I would suggest that the governing principle underlying this function is the prevention of undue loss of man-hours. As man-hours mean money, and their conservation and proper utilization spell economy and efficiency, each medical officer on being commissioned becomes, therefore, a custodian of the public purse, and of the efficiency of his Service.

Professionally the Medical Services are charged with the prevention of disease, and the care and treatment of sick and injured.

We are all familiar with the advances which have been made in preventive medicine, and with the benefits which have thereby accrued to the fighting forces—there can be no denying the high standard of medicine, surgery and other specialized branches of professional work in the Services; but must we not now ask ourselves, “Are the Medical Services doing all that is possible as regards the efficiency of the individual?” In fact, “What are we doing to assist in the solution of those problems which the employer of labour has to face everywhere?”

There seems perhaps a risk that we may lose sight of the relationship between our Services and civil life, and the fact that in these days of mechanization a Service is truly a cog in the industrial machine of the country. In this connexion do we not also tend to overlook that the great majority of our personnel return to industry in civil life on completion of their service?

Are there not lessons to be learnt in industry and applied in the Services? I feel there are, and I propose deliberately to raise a number of questions with intent to assist constructively in some of our Service problems, rather than merely to suggest criticism.

(2) THE NATURE OF THE PROBLEMS TO BE CONSIDERED.

Industry to-day is alive to the fact that the efficiency of an individual, irrespective of what his work may be, depends upon a variety of factors, included amongst which are physical fitness, working conditions, effects of surroundings (physical and psychological), and suitability for the particular

¹ President’s Address, October 14, 1935, based on the Proceedings of the Royal Society of Medicine, vol. xxix, p. 31 (United Services Section, p. 1), by permission of the Honorary Editors.
work. Moreover, it cannot be denied that occupational misfits result not only in economic waste of time, material and money, but also in discontented and unhappy individuals.

These problems concern employers of labour; do they not equally concern the Services, and indeed has not a Service a greater responsibility in that not only have the immediate requirements in the Service to be met, but also, in a more intimate sense, those of the individual, and in particular the matter of his absorption into civil life at a later date?

(3) What is Industry doing about these Problems?

A great deal of work has been done and is still in progress—mainly by two agencies in this country, the Industrial Research Board of the Medical Research Council, and the National Institute of Industrial Psychology—and research along the following lines has been already carried out:

(a) Personnel: Vocational guidance; selection and grading of individuals for particular trades; methods of training; accident proneness.

(b) Production: Economy of material, time and energy; economy of man-hours.

(c) Environment: Improvement of working conditions, e.g. lighting, heating, ventilation, &c.; improvement of methods and conditions of work to reduce fatigue, strain, boredom, with resultant spoiled work; elimination of noise; means of increasing interest and contentment of the individual, and so the avoidance of material loss and mental stress.

Doubtless, however, you are familiar with these investigations, and with the fact that the modern employer now realizes that the old method of trial and error is a thing of the past—that it is uneconomical to train a person for work for which he possesses no innate ability—and that aptitude for a particular type of work is a definite and measurable factor.

It seems evident therefore that, in these days of stringent competition, it is only by the application of these principles and the knowledge gained from such research as I have mentioned that a business concern can be maintained at its maximum efficiency.

(4) What are the Services doing about these Problems?

I should like to invite your consideration of such questions as the following:

Is there not scope for more work in the matter of the selection of personnel for specialized trades, or even for suitability for Service life generally. Are we, in fact, assisting sufficiently in the avoidance of the round peg occupying the square hole? What is being done to assist in training methods and in the selection of leaders? in the avoidance of wastage, such as material and instructors' time? in reducing the degree of impairment of performance resulting from fatigue? in the prevention of loss of time by illness and by cases which give difficulty from a disciplin-
Efficiency of Personnel in the Services

From any point of view—many of both these latter classes have to be discharged from the Service eventually.

It may be said that it is difficult to compare industry with the Services; that trades cannot be changed so easily in a Service, and that there are peculiar difficulties in investigating such problems as these in a Service. This may be so, but who would deny that the essential problems are the same, and that these very difficulties emphasize the necessity for the maximum of care both in the original selection and training of Service personnel and in the maintenance of their efficiency when trained.

I am well aware that work is being done by our Medical Services in certain directions, and though I have not time to refer to all of them now, I should like to bring to notice two investigations at present in progress, of which I have particular knowledge. I do so in the hope that the principles involved in them may prove of interest, and that they may bear a relationship to these sorts of problems in any particular branch of a Service.

The first of these investigations is into:

**Occupational Selection of Apprentices in the R.A.F.**—Twice a year a large number of boys between the ages of 15 and 17 enter the R.A.F. as Aircraft apprentices to undergo courses of training for two main groups of trades—Fitter-rigger and Wireless work. These boys, who eventually form the backbone of the skilled trades in the R.A.F., have a three years' training which is very thorough and which takes into consideration not only requirements of the Service, but those of civil life also. The cost of training each boy is around £200 a year.

On the conclusion of his training, a boy either passes out successfully in his skilled trade, or fails to do so—in the latter case he is remustered to an unskilled trade, such as is normally recruited direct from civil life. A percentage of the best boys are given cadetships and pass on to the R.A.F. Cadet College at Cranwell to become officers.

From these observations it will be appreciated that such matters as selection, training and output of aircraft apprentices have a bearing on Air Force finance and efficiency.

At Halton, late in 1931, attention was directed to the fact that there was a number of "backward boys" whose cases were referred for medical views, and from consideration of these to the fact that there were certain boys generally unsuited to Service life, and, in particular, ill adapted to their special trade, we were, in fact, confronted with the "misfit problem."

An investigation was therefore put in train which aimed at producing an assessment in each case under the following headings: (a) Suitability for Service life; (b) if so, for what trade most suited; (c) whether further particular observation is indicated, either physical or temperamental; (d) leadership qualities, suitability for promotion, for N.C.O. pilot, or a cadetship at the R.A.F. College at Cranwell.
A. V. J. Richardson

The method employed comprises an interview, a medical examination, and the application of special tests, both written and practical, and the data thus collected are entered on a card for each boy under such headings as: Physique, Temperament, Character, Intelligence, Mechanical Ability, Mechanical Aptitude.

This investigation, which is being carried out at Halton by Squadron Leader R. H. Stanbridge, is still in the experimental stage, but it is hoped that some assessment along these lines may assist in the solution of certain of the Halton problems.

The second investigation is into:—

Causation and Incidence of Fatigue in Aircraft Crews.—When we consider that the fundamental peculiarity of combatant service in the air lies not so much in the fact that the air is not the natural element of man, but rather in the fact that flying demands and encourages a degree of individualism unknown in any other branch of the Services, the matter of fatigue in aircraft crews becomes highly important. This is especially the case when we see that aircraft of to-day are tending more and more to strain the human element by the increase in their performance.

The type of fatigue I have in mind might be described as “the gradual exhaustion resulting from accumulative residua or uncancelled daily fatigue”—and it is not banished by alcohol or sleep. This condition naturally has a bearing on the continuance of air-efficiency; whilst there can be no doubt that there is a close connection between it and those deeper psychological problems which arise in flying personnel—problems, the significance and importance of which are doubly accentuated in war.

During the past two training years, therefore, an inquiry has been conducted into this very complex subject in the Air Defence of Great Britain Command. The inquiry has consisted of the use of certain of the usual medical tests, the exercise of special observation by the medical officers in charge of flying stations, and the application by them of certain comparatively simple tests designed to measure nervous fatigue.

Although analysis of the second year’s investigatory programme has not yet been completed, certain results of the first year’s work may be stated.

An opinion was formulated that the factors entering into diminished performance of aircraft crews, whilst varying according to the type of aircraft flown, could be conveniently arranged in three groups, on a basis of the means appropriate to their mitigation.

It will be obvious, however, that a hard and fast line cannot be drawn between these groups.

(a) Physical.

This group may be held to include mechanical factors which make a machine tiring to fly, and comprises mainly those producing bodily inconvenience arising out of peculiarities in aircraft design, for example:—
Discomfort and Uncomfortable Seating.—These two factors taken together are probably the greatest causes of fatigue in this group, and amongst the many factors to be included here are the following: "Cramped cockpit," "restriction in space," "bad lay-out of cockpit," "backache from sitting for long periods without movement," "cramped position," "badly padded seats," "shape of back of seat," "position of pilot from a navigational point of view," "position of seat in relation to controls," and "lack of support in the small of the back."

Heavy Controls.—As a tiring factor this ranks next. That the rudder bar is the worst offender would appear from extracts such as the following: "Heavy lateral controls," "strain in leg from rudder bar," "rudder pressure," "heavy rudder control," "bad action of rudder control forcing the pilot to push downwards with his knee rather than forwards in a horizontal position from the buttock."

Noise.—Noise ranks as an important factor, and, as would be expected, most highly in multiple-engined aircraft, and also with senior and older officers, for younger pilots tend to ignore noise until otherwise tired. It may here be mentioned that the origin of aircraft noise is mainly threefold—engine clatter, propeller tip vibration, and engine exhaust.

This first group attracts attention to the necessity in aircraft design for continuing to eliminate such mechanical factors as may be capable of producing diminished performance in crews; this is a matter in which medical advice should prove useful.

(b) Physiological.

This group includes those factors which cause interference with certain bodily functions such, for example, as cold and oxygen want; the latter may be caused directly by the effect of altitude alone or indirectly by the absorption of carbon monoxide.

(c) Psychological.

Mainly those resulting in the continuance of mental stress, such as "flying in unstable machine," "prolonged concentration during formation flying," "cloud flying," etc. The degree of mental fatigue in this connexion probably bears a definite relationship to the amount of concentration required during flight.

On the second and third groups, which are peculiarly medical interests, much has already been done, and much still remains to be done, but I would like here to refer to the relationship between fatigue and "indirect oxygen want" such as is caused by carbon monoxide absorption from engine exhaust fumes. This matter came up for consideration this year, having been raised during last year's work by Flight Lieutenant A. T. G. Thomas, one of our auxiliary air force medical officers, who was interested in the toxic effects of carbon monoxide.

It was accordingly decided to commence by estimating spectroscopically
the carbon monoxide concentration in the blood of aircraft crews under certain conditions of flight and in different aircraft, attention being particularly directed to stub exhaust aircraft. These estimations have this year been carried out by Wing Commander G. S. Marshall, the R.A.F. Consultant in Applied Physiology, and by Squadron Leader J. MacC. Kilpatrick, on his staff, and the results to date may be summarized in the following tables:

(1) **AIRCRAFT IN FLIGHT.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Duration of flight</th>
<th>Average height (feet)</th>
<th>Type of exhaust</th>
<th>CO per cent in blood before flight</th>
<th>CO per cent in blood after flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4.35</td>
<td>2 hours</td>
<td>1,000</td>
<td>Stub</td>
<td>4 per cent</td>
<td>7 per cent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long (open end)</td>
<td>7 per cent</td>
<td>7 per cent</td>
</tr>
</tbody>
</table>

(2) **AIRCRAFT "RUNNING UP" ON THE GROUND.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Duration</th>
<th>Type of aircraft</th>
<th>CO per cent in blood before flight</th>
<th>CO per cent in blood after flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5.35</td>
<td>20 mins. at 800 revs.</td>
<td>H— (stub exhaust)</td>
<td>1·5 per cent</td>
<td>6 per cent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F— (stub exhaust)</td>
<td>1·5 per cent</td>
<td>4 per cent</td>
</tr>
</tbody>
</table>

(3) **AIRCRAFT (ENCLOSED COCKPIT).**

<table>
<thead>
<tr>
<th>Date</th>
<th>Duration of flight</th>
<th>Average height (feet)</th>
<th>CO per cent Pilot before flight</th>
<th>CO per cent Pilot after flight</th>
<th>CO per cent Observer before flight</th>
<th>CO per cent Observer after flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6.35</td>
<td>2 hours</td>
<td>10,000</td>
<td>4 per cent</td>
<td>3·5 per cent</td>
<td>6 per cent</td>
<td>11 per cent</td>
</tr>
<tr>
<td>12.7.35</td>
<td>2 hours</td>
<td>8,000</td>
<td>2·5 per cent</td>
<td>1 per cent</td>
<td>5 per cent</td>
<td>12 per cent</td>
</tr>
</tbody>
</table>

On 7.6.35, heat in observer's cockpit only was "on" for half an hour.
On 12.7.35, heat in both cockpits was "off."

These results may be summarized as follows:

1. **H— Aircraft in Flight.**—A small increase in the carbon monoxide concentration was found in the blood of pilots of **H**—fitted with stub exhausts, whilst no increase in carbon monoxide was found in the blood of pilots of **H**—fitted with long exhausts (open end) flying under identical conditions.

2. **H**—and **F**— **Aircraft (both Stub Exhaust) when "Running up" on the Ground.**—A small increase in the concentration of carbon monoxide was found in the blood of two subjects, each of whom sat in the cockpit of one of these aircraft while the engines were "run up" on the ground for twenty minutes. More carbon monoxide was absorbed by the subject in the **H**—than by the subject in the **F**—.

3. **W— Aircraft (Enclosed Cockpit) in Flight.**—No increase in carbon monoxide was found in the blood of the pilot in this aircraft, but
Efficiency of Personnel in the Services

A marked rise in carbon monoxide concentration was found in the blood of the observer.

It may be said, therefore, that whilst the concentrations of carbon monoxide were not sufficient of themselves to produce symptoms in the "H—" and "F—," it is possible that a chronic concentration of these strengths, combined with other factors such as I have mentioned, might increase fatigue.

I would quote as an example of this possibility the case of an officer employed in a meteorological flight, whose duties included daily climbs to altitudes of 18,000 to 20,000 feet and for periods up to a fortnight, when other members were on leave, two such climbs daily. When he started this work he could get up to 24,000 feet without oxygen, but in course of time he noticed that he had to commence taking oxygen at 8,000 feet on a morning flight and if employed on an afternoon flight on the same day he had to commence oxygen at 3,000 to 4,000 feet, moreover if he did two such climbs daily for several days in succession he had to commence taking oxygen almost as soon as he left the ground. Otherwise he noticed no difference in his physical condition, and stated that after a month's leave his oxygen altitude went back practically to what it was when he started this work. The aircraft flown was supplied with a static radial engine fitted with an exhaust pipe terminating in an open end just in rear of the pilot's seat. Blood examinations showed a 6 per cent carbon monoxide concentration one hour after flight, and a reduction in hæmoglobin content (85 per cent).

It seems evident, therefore, that efficiency was interfered with in this case, which also leads to confirmation of the view of Surgeon Captain F. Dudley that carbon monoxide concentrations in the blood tend to be evanescent subject to ample oxygen being available and also that more attention should be paid to examinations of hæmoglobin content.

In the "W—," however, with its enclosed cockpit and central heating system, the concentration in the case of the observer approached the level of toxicity. This led to investigation by the engineering staff, who considered that it would be necessary to effect alterations in the design of the cockpit heating system.

Conclusion.

In the three Services we have expensive instruments, weapons and material on which much scientific investigation and research are constantly in progress to select and maintain these at the highest possible standard consistent with considerations of policy and economy.

The three Medical Services have the duty of maintaining at the highest level the health of those who work with these things. We believe we are doing our best to perform this duty.

The question which I want to leave with this meeting, however, is a broader one, and is this: "Are we as Medical Services giving all the lead we could to the executive in the matter of scientific selection, training and utilization of personnel and in the maintenance of their efficiency?"