Conditions of Employment in Air Traffic Control Service

by

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THE rapid development of aviation has brought to the forefront the question of air traffic control among the problems of air navigation which require constant revision and improvement. The further expansion of civil aviation will depend greatly on the maintenance of safety in flying and since safety depends to an increasing degree on control from the ground, this implies the necessity of further developing an efficient air traffic control service.

The activities of the I.L.O. in the field of civil aviation have hitherto been mainly confined to matters concerning conditions of employment of flight personnel.[2] A brief survey of general conditions of employment of ground staff was, however, included in the I.L.O.'s report " Review of Conditions of Employment in Civil Aviation " [3] for the 1960 *Ad Hoc* Civil Aviation Meeting. That meeting adopted a resolution [4] inviting the Governing Body of the International Labour Office to instruct the Director-General to undertake a study of conditions of employment of ground personnel in air navigation services. It is in partial implementation of that resolution that the present preliminary study has been made. Its purpose is to review the occupational content of the air traffic controller's functions and to make a comparative analysis

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[1] The International Labour Office wishes to thank the International Transport Institute for making available the services of Professor Schenkman to carry out the study on which the present article is based, and for providing valuable background documentation.

[2] See Jacob Schenkman : " Conditions of Employment in International Civil Aviation ", in *International Labour Review*, Vol. LXIX, No. 3, Mar. 1954, p. 189.

[3] I.L.O. *Ad Hoc* Civil Aviation Meeting, Report I : *Review of Conditions of Employment in Civil Aviation* (Geneva, 1960), pp. 134 ff.

[4] Resolution (No. 6) concerning conditions of employment in air navigation services. I.L.O. : *Official Bulletin*, Vol. XLIII, 1960, No. 5, p. 387.

of various national practices with respect to certain aspects of the conditions of work of the staff concerned.

Development of Air Traffic Control Service

Importance of Air Traffic Control to Safety in Air Navigation

Aviation depends for its safety and regularity of operation on a great variety of elements. Accuracy in the design and construction of aircraft, navigational instruments and airborne safety equipment, as well as their proper maintenance; thorough training of and aircrews and ground personnel; efficient communication and provision of information, particularly in respect of the weather—all these are indispensable, but safety also requires that they be complemented by adequate provision of air traffic control service from the ground.

The important role that air traffic control service plays in the provision of safety in air navigation has long been recognised. Indeed, air traffic control was organised as soon as the flow of traffic, combined with the regular practice of instrument flying, made it necessary to establish special ground units for the regulation of flights in given portions of the airspace, with particular attention to maintaining appropriate separation amongst aircraft for the purpose of preventing collisions. Nevertheless, the constant and rapid increase in density and frequency of air traffic which has taken place throughout the world in recent years, coupled with the greatly increased speed, range and cruising altitudes of the advanced types of aircraft in use, has tended to strain the capacity of present-day air traffic control techniques to provide the requisite services, which comprise [1]:

(1) preventing collisions between aircraft;

(2) preventing collisions between aircraft on the manœuvring area and obstructions on that area;

(3) expediting and maintaining an orderly flow of air traffic;

(4) providing advice and information useful for the safe and efficient conduct of flights;

(5) notifying appropriate organisations regarding aircraft in need of search and rescue aid, and assisting such organisations as required,

to which technical developments in radar have added the task of vectoring aircraft along the desired paths, a circumstance under

[1] I.C.A.O.: *International Standards and Recommended Practices, Air Traffic Services. Annex 11 to the Convention on International Civil Aviation*, fourth edition (Montreal, May 1960), para. 2.2.

which the air traffic controller is taking over some of the responsibility respecting the navigation of the aircraft so far entrusted solely to pilots. Thus, in the final analysis safety in flying still depends primarily on the human elements in the air and ground services—particularly the pilot in the air and the air traffic controller on the ground—and the latter has become one of the key figures in aviation, whose responsibilities resemble those of the pilot and who is confronted with problems of safety on a daily routine basis compounded by the increase in the number and speed of aircraft.

Evolution of Air Traffic Control Organisation

Since the Second World War considerable attention has been given to the basic problems involved and to the improvement of techniques and methods and the organisation of adequate facilities.

Improvements in these services have, however, meant a heavier workload for the air traffic control units, and this has entailed an increase in staffs, expansion of facilities, wider use of radar and improved procedures and operational techniques.

Under the guidance of the International Civil Aviation Organisation (I.C.A.O.), a specialised agency within the United Nations family, the situation has been gradually improving. It is now through the application of the I.C.A.O.'s standard international Air Traffic Control Procedures, as implemented by the respective state aviation authorities, that these services are operated. An important landmark in the evolution of air traffic control was the adoption in 1950, by the I.C.A.O. Council, of Standards and Recommended Practices for Air Traffic Services, Annex 11 to the Convention on International Civil Aviation.[1] This Annex, together with Annex 2, concerning Rules of the Air [2], has provided a framework of essential rules within which detailed procedures have been developed, and has thus served as the basis of national practice in air traffic control and of the licensing of the operating personnel.

It has been the practice of governments that they alone should exercise control and provide air traffic services in the airspace over their territories. However, this policy has raised a number of serious problems, since it precludes in many instances the establishment of control areas on the basis of sound operational and technical considerations. " Insistence upon air traffic control space boundaries conforming with national boundaries in many cases results

[1] Air traffic control service ; flight information service and alerting service : see *International Standards and Recommended Practices, Air Traffic Services*, op. cit.

[2] I.C.A.O. : *International Standards, Rules of the Air. Annex 2 to the Convention on International Civil Aviation*, op. cit.

in the creating of units of airspace whose shape and size are technically and operationally unsuitable." [1]

In consequence, the I.C.A.O. Assembly in 1962 resolved unanimously that States should " as a matter of urgency review their air traffic services area boundaries on the basis of technical and operational considerations . . .".[2]

In fact, in recent years, although a number of States are still reluctant to delegate the provision of air traffic control service over their national territory to another State, there have been some instances of implementation of this practice in national functions in providing an air traffic control service. Examples of this are the Central American Air Navigation Facilities Corporation, established in 1960 by Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua ; the Agence pour la Sécurité de la Navigation aérienne en Afrique et à Madagascar (ASECNA) established in 1959 by the Convention of Saint-Louis du Sénégal for twelve French-speaking African Republics; and "Eurocontrol", which groups Belgium, France, the Federal Republic of Germany, Luxembourg and the United Kingdom under one agency for the provision of an air traffic control service. Moreover, instances exist where, by mutual consent, area control centres of a given country exercise control over the airspace of bordering countries, as for instance in the case of the Geneva area control centre, where Swiss personnel control traffic over parts of France and Italy.

These agencies and arrangements may pave the way for other States to consider the formation of similar international groupings. Such an evolution is the more desirable since the speed of modern aircraft has still more reduced the significance of national boundaries for air traffic.

Objectives of Air Traffic Control

Air traffic control is provided for the purpose of promoting the safe, orderly and expeditious flow of air traffic as detailed in the first three objectives enumerated above. Preventing collisions between aircraft is one of its major functions. This is being achieved for aircraft in flight and while landing and taking off by using the separation method of longitudinal, lateral or vertical spacing as prescribed by I.C.A.O. Annex 11. The air traffic control system also ensures avoidance of collision on the ground through the control of movement on the manœuvring areas of the aerodromes.

[1] I.C.A.O. Working Paper A.14-WP/1, P/1, 20.12.61, p. 9.

[2] Resolution A.14-24 in I.C.A.O. Doc. 8287, A.14-TE/35, *Report of the Technical Commission, Rome, 1962*, p. 20.

Although the prevention of collisions is the primary reason for air traffic control, it also fulfils other functions which are important in themselves since they involve economic and financial considerations. One of these—as already mentioned—is ensuring the expeditious flow of air traffic in order to prevent congestion and delays which would offset the advantages gained by the speed of modern aircraft.

Economic Aspects of Air Traffic Control Services

The efficiency and regularity of air traffic is vital to the whole economy of air operations. Every unnecessary minute of operating time resulting from delays in flight, or on departure or landing at airports, means wasted money. For example, one major scheduled airline has calculated that the economic losses ascribed to inefficient air traffic control in its 1961 operations amounted to a sum larger than the total profit earned in the same year.

In certain circumstances inadequacy of air traffic control service may entail limiting the number of aircraft admitted to a given airway at a given time in order to ensure safe separation of aircraft in flight. Such a restriction compounds traffic congestion, causes excessive delays, which interfere with operating schedules, and imposes considerable economic penalties on flight operations as a whole.

Economic penalties resulting from unsatisfactory air traffic control are particularly severe in the operation of jet aircraft. If, for instance, a jet has not been cleared fast enough by the air traffic control service to be able to reach its most economic operating altitude, the flight is handicapped by excessive fuel consumption. Also, because of the very heavy fuel consumption of jet planes during taxi-ing before take-off, instances have even occurred of jets having to return to the apron for refuelling before taking off after having been held too long on the ground owing to congestion of traffic. Careful planning is therefore essential in order to minimise take-off costs.

The operating characteristics and the relative operational inflexibility of jet aircraft have thus increased the importance of eliminating delays in the ascent and descent phases and reducing restrictions on " en route " altitudes. It has placed new emphasis on the need for progress in air traffic control.

There is, however, no standard by which the economic impact of air traffic control services on operational efficiency and regularity of traffic may be measured with accuracy, but there is ample evidence to the effect that many hours of flying time are saved yearly by the efforts of the air traffic controllers.

Types and Functions of Air Traffic Control Services

The basic functions performed by air traffic control services are local control (taxi-ing, landing and take-off), approach control (first stage of departure and final stage of approach) and area control (" en route " stage of flight) based on obtaining information concerning proposed and actual flight progress.

Air traffic control facilities include the following types of units :

(a) Aerodrome control towers, established for the purpose of providing air traffic control service to aerodrome traffic on runways, taxiways, and the whole manœuvring area of an aerodrome used for taking off, landing and terminal movements of aircraft.

(b) Approach control offices, set up to provide air traffic control service to flights which are arriving at or departing from one or more aerodromes in a given terminal control zone. However, the functions of approach control are often fulfilled by an aerodrome control tower or an area control centre, and thus separate approach control offices are seldom established.

(c) Area control centres, which provide air traffic control service to flights taking place principally in specified control areas during the " en route " phase of flight operations. The last of the air traffic control units to have been established, area control centres became necessary to provide continuity of control to aircraft while operating between aerodromes.

The major factors which must be taken into consideration in planning the establishment of the appropriate facilities are the volume and density of traffic, the types of flight operations and types of aircraft used, the meteorological conditions, and the geographical and topographical characteristics of the area served.

There exist no uniform requirements which could be universally applied for the purpose of determining which of the above-mentioned types of air traffic control facilities should be established, and the practice therefore must vary from case to case. Most frequently, however, it is the volume of traffic—with particular regard to the period of peak traffic density—and type of flight operations which are the major determining factors.

Financial Aspects of Air Traffic Control

An efficient air traffic control service requires relatively expensive modern equipment and highly qualified personnel.

Where traffic is dense enough to justify the cost of modern equipment such as radar, it becomes possible for the controller

to watch each aircraft's progress continuously instead of having only the pilot's intermittent reports of his whereabouts to guide him. Such equipment is, however, still very expensive.

Even in areas where it is recognised to be highly desirable, if not essential, from the viewpoint of safety, the considerable investment involved has prevented the installation of modern air traffic control equipment in many cases where adequate financial resources were not available. In the developing countries, where both financial means and technical " know-how " are lacking, the situation is particularly serious, since these countries are constantly faced with difficulties in the establishment of the services required. In many such regions substantial benefits could be derived from the establishment of fewer and larger air traffic control centres, including international centres, jointly operated and financed. In consequence the I.C.A.O. Assembly in 1962 declared, in the resolution already quoted, " that Contracting States should: . . . consider, as necessary, the desirability of establishing a joint air traffic services authority to serve air traffic services areas encompassing airspace over two or more States ".[1]

It should be remembered, nevertheless, that no matter how good the equipment is, the over-all efficiency of the system depends very much on the man who analyses the situation and makes the decisions. An attempt will be made in the following section to describe the profession of air traffic controller.

The Air Traffic Controller's Profession

There are not many industrial occupations in which a sense of responsibility for the lives of others is so necessary and, in effect, so highly developed as in the work of the air traffic controller.

The task of ensuring the safe, orderly and expeditious flow of air traffic carries heavy responsibility and requires at all times a cool head and an alert mind. This task can become very complicated and indeed, under certain conditions, the safety of aircrews and passengers is as much affected by the work of air traffic controllers as by the pilots themselves. In this respect, their profession is one which brings reward and job satisfaction in the knowledge that it is largely due to their skill and devotion that travel by air is still the safest means of transportation, at least on a mileage basis.

Duties

In summary, the air traffic controller is responsible for ensuring that aircraft under his control are fully protected against collisions,

[1] I.C.A.O. Doc. 8287, A.14-TE/35, op. cit., p. 21.

with the minimum of restrictions to their intentions. His duties cover an infinite number of unpredictable variables and combinations. In approach and area control, he is called upon to organise traffic in four dimensions. In aerodrome control he must synchronise the movement of aircraft into and out of the airport with the movement of those on the ground and of those circulating in the air over the aerodrome or in its vicinity, awaiting the opportunity to land. In doing so he is controlling a number of aircraft at the same time. In area control he must simultaneously check flights initially contacted that will soon be under his control, know the flight plans of aircraft approaching his area, and co-ordinate their patterns with other controllers as each flight passes from his control area to another one.

Air traffic controllers provide pilots with the latest information concerning weather conditions at destination aerodromes. They then give detailed instructions concerning flight approach to the aerodrome, which runway to use and when to land and take off. They operate airport lighting systems, traffic direction indicators and other visual means of traffic control. They keep records of all traffic movements and prepare the relevant reports. In receiving and transmitting information, the controllers use a variety of instruments including radio, trunk telephone, tele-typewriters, inter-phones and visual means of communication.

For his part, the radar controller acts on information derived from his own observations, in addition to that received from the pilot and from the assistant controller. The work of the radar controller must be of the highest accuracy, because of the reduced separation minima applied and the consequent need for precise navigation in the airspace which he controls.

The assistant controllers have as primary duties the collection, calculation and posting of flight information, the revising of this information as flights progress, the forwarding of flight information to adjacent centres, and assistance to controllers.

Preventing collisions between aircraft is, as we have seen, the principal purpose of air traffic control services. At the present time, when satisfactory collision prevention can only be achieved by means of traffic control from the ground, this is the most important duty of air traffic controllers.

Classification

Air traffic controllers are classified according to types of air traffic control facilities, types of equipment operated and functions. In practice, however, these criteria vary from case to case and are interrelated.

The first group, classified according to the types of facilities, includes aerodrome tower controllers, approach controllers and area controllers (also referred to as airway or station controllers).

Classification according to types of equipment operated or functions includes such categories as chief controllers or supervisors, radar controllers, duty controllers, procedural controllers, co-ordinators, assistant controllers or communicators.

Qualifications Required

Teamwork is essential in this trade. The efficiency of the services rendered by air traffic control units is the cumulative result of the proficiency with which individual controllers perform their duties. Great importance must in consequence be attached to methods of selection and training of candidates for the profession. Severe aptitude tests are widely employed as part of the selection procedure and in most countries there are clearly defined criteria (age, physical and psychological aptitude, educational level, experience) applying to candidates for training as air traffic controllers.

The I.C.A.O. has adopted standards and recommended practices for the licensing of aviation personnel, including air traffic controllers. According to standard 4.4 of Annex 1 to the Chicago Convention a contracting State shall require an applicant for an air traffic controller's licence to meet definite requirements in respect of age, knowledge, experience and medical fitness.[1]

The standards and more particularly the recommended practices allow for a certain margin of freedom in national legislation.

As regards age, national requirements vary between a lower limit of 16 and an upper limit of 36 years of age at the time of recruitment.

In the United Kingdom the Ministry of Aviation requires candidates to be at least 16 years of age when applying for the post of assistant controller, and at least 23 years of age but under 35 for the post of air traffic control officer. In the United States the minimum age requirement for air traffic controller specialists of stations is 18 years and for all other categories of controllers, 21 years. In the Netherlands the air traffic controller candidate has to be over 23 years and under 30 years, after completion of his training. In Australia the corresponding limits are 20½ years and 36 years ; in Malaya, 18 and 26. In Denmark and Switzerland air traffic control personnel is recruited for training from the age of 17 years.

[1] I.C.A.O. : *International Standards and Recommended Practices, Personnel Licensing. Annex 1 to the Convention on International Civil Aviation* (Montreal, November 1962).

Some of the I.C.A.O. and national requirements for the medical fitness of air traffic controllers (for example visual and auditory capacity) are the same as for professional pilots. Certain types of controllers must undergo annual medical examinations throughout their entire period of employment in order to confirm their physical fitness. As a rule failure to meet the medical requirements results in the suspension of privileges pertaining to the controller's rating. Controllers who fail to obtain the renewal of their medical certificate by reason of physical disability are, in the United States for instance, " subject to reassignment to a position not requiring such certificate if such position is available. . . . If no such position is available they will be subject to retirement for disability, if eligible, or separation from the service." [1]

Candidates have also to meet certain psychological requirements and to pass psycho-technical tests, including various aptitude tests.

Standards concerning special knowledge are often supplemented by requirements relating to general education. In Switzerland and the Netherlands for instance, the equivalent of matriculation with the sciences or pure or applied mathematics as major subjects, or an even higher standard, is required. As a consequence of I.C.A.O. rule 4.4.1.2.a, knowledge of the language (frequently foreign) nationally designated for use in air traffic control is an automatic condition.

Past experience in aviation, either in the air or on the ground, is an important criterion in the selection of candidates for air traffic control in a few countries, such as the United States, the United Kingdom and the Netherlands. Elsewhere, such experience is taken into account, but it is not required since very few candidates with such experience are available. It would, incidentally, be in the interests of the air traffic control service to create working conditions such as to attract candidates with an aviation background and this would also possibly assist in providing alternative employment for grounded flying personnel.

Training

The air traffic controller has a high professional standard, and the complexity of his job is reflected in the training which his work requires. In order to promote the uniform application of its standards and recommended practices and to provide interested States with guidance, the I.C.A.O. has published manuals for the training of controllers.

[1] Announcement No. 2.54-3 (59), the Board of U.S. Civil Service Examiners, August 24, 1959, p. 6.

Training curricula cover a wide range of technical subjects, such as air traffic control services, practices and procedures ; communications ; meteorology ; air navigation ; operating characteristics of aircraft and the Rules of the Air. In some countries the controller's training also includes familiarising flights and even flight training.

The basic technical objective of training is to ensure that the air traffic controllers have a thorough knowledge of standard procedures which must be adhered to generally, and to develop the judgment of the individual controller so that he can act independently of established procedures wherever such action is required in the interest of safety in air navigation. There is also an administrative objective, namely to ensure a constant supply of qualified controllers to fill vacancies occurring as a result of promotions, retirements and the expansion of air traffic control services.

Training is usually carried out in two ways—by courses of instruction at a centralised training establishment and by on-the-job training at an aerodrome or air traffic control centre similar to the one in which the controller is destined to work. It is an important part of the controller's training that he should gain experience in the actual working conditions of a control tower or centre. However, in 1961 the European Civil Aviation Conference stated that " to use only ' on-the-job ' training methods was undesirable. Furthermore, a system involving alternating periods of instruction and practical work was considered a necessity." [1] The importance of classroom training prior to on-the-job training is thus generally recognised ; but in some countries (Ireland or Sweden for example) the small number of controllers required makes the expense of regular classroom instruction difficult to justify for the aviation authorities. Moreover, certain countries (for instance Denmark) have indicated that the shortage of air traffic control personnel has given rise to some contraction of training.

Training for air traffic control is organised on a national scale in most of the I.C.A.O. member States. However, the I.C.A.O. training manuals mentioned above have tended to standardise national training curricula. Thus, among Western European countries there is at present no serious lack of uniformity in the training of air traffic controllers and radar controllers, in the sense that there are no major deviations in principle from the criteria suggested in the I.C.A.O. manuals.

In some of the developing countries the I.C.A.O. has been conducting extensive training programmes within the framework of

[1] I.C.A.O. Doc. 8185, E.C.A.C. (4/1). *Report of the Fourth Session of the European Civil Aviation Conference, Records of the Session,* Vol. 1 (Strasbourg, 1961), p. 45.

its technical assistance activities ; in these cases training methods and curricula are strictly patterned on the I.C.A.O.'s standards.

In many parts of the world the synthetic trainers for air traffic control developed by I.C.A.O. are being extensively used. In 1959 the I.C.A.O. produced an additional synthetic trainer for radar controllers ; radar controller training is usually undertaken by qualified air traffic control officers with some years of experience.

The practical training of air traffic controllers is, in fact, a continuous process and does not end when the air traffic controller's licence and rating are obtained. As new techniques and equipment are constantly being developed, controllers have to undergo various degrees of retraining or additional training on the job.

Moreover, measures to recruit and train additional controllers are by necessity actively pursued by national aviation authorities.

An interesting experiment in training has been undertaken by the Ministry of Aviation in the United Kingdom. In 1962 it instituted a new class, the Air Traffic Control Officer Cadets, within the Civil Air Traffic Control Organisation. Since the traditional sources of recruitment for air traffic control officers have to a great extent dried up, the Ministry is attempting, through this new venture, to attract young men and women, in particular the grammar-school graduates, into the air traffic control organisation. It offers them a four-year training course which includes flying instruction up to the standard required for a private pilot's licence. In the last five years the Ministry has doubled the number of control officers in its employment.

In the United States there were only 1,000 air traffic controllers (airport) in 1945 ; by mid-1961 the number had increased to 12,300, including 5,600 airport tower controllers and 6,700 air route traffic controllers.[1] In the same year the 16,500 air traffic control specialists formed 42 per cent. of the total work force of the Federal Aviation Agency [2] ; today air traffic controllers make up roughly half of all the personnel of this agency. Air traffic control is the biggest single service of the F.A.A. and the most important single function, in which 17,626 air traffic controllers were employed in July 1962.[3]

Licences and Ratings

Air traffic controllers' licences are issued by the appropriate state aviation authorities. The licence itself carries with it no special privileges. These are associated *only* with the specific

[1] Department of Labor : *Occupational Outlook Handbook, 1961* (Washington), p. 552.

[2] Federal Aviation Agency : *Third Annual Report, 1961* (Washington), p. 58.

[3] *Airlift* (Washington), July 1962, p. 21.

ratings that may be gained after the licence has been obtained. These ratings cover aerodrome control, approach control and area control. They are based on practical experience in the operation of an aerodrome tower or control centre, and they are valid exclusively for the particular air traffic control facility and specific locality for which they were issued.

In 1961 the I.C.A.O. introduced a new radar rating for air traffic controllers exercising specialised radar control functions. Many States now require licensed air traffic controllers to hold radar ratings for the operation of surveillance and precision radar equipment, in addition to the other ratings mentioned above. In some cases, as in Belgium, there is no separate radar rating, but experience in the use of radar equipment is included in the grant of the usual ratings in areas where radar is used. In other cases there is not one single radar rating, but separate ratings are issued for each of the three functions of radar control, namely : approach (precision) radar control, approach (surveillance) radar control and area (surveillance) radar control.[1] The grant of these ratings adds further responsibilities to the national aviation authorities concerned with air traffic control, but is considered essential in order to ensure the professional competence of personnel employed in these services.

Working Conditions in Air Traffic Control Service

General Situation

In recent years there have been clear indications of growing interest by all concerned in the working conditions of air traffic controllers, because of their direct relationship to the quality and efficiency of these services. Commenting on the resolution of the 1960 *Ad Hoc* Civil Aviation Meeting concerning conditions of employment in air navigation services[2] the President of the I.C.A.O. Council stressed that " unless satisfactory salaries and working conditions are given to personnel in charge of the technical ground services for air navigation the quality of these services is hampered ".[3]

An I.C.A.O. Special Implementation Panel under the chairmanship of the then President of the I.C.A.O. Council reported to the

[1] I.C.A.O. : *Amendment 155 to the International Standards and Recommended Practices, Personnel Licensing. Annex 1 to the Convention on International Civil Aviation* (Montreal, June 1962), p. 53.

[2] *Official Bulletin*, loc. cit.

[3] I.L.O. : *Minutes of the 149th Session of the Governing Body*, Appendix XI, p. 80.

Organisation its concern about the inadequate working conditions in air traffic control in many countries throughout the world.[1]

In 1962 the I.C.A.O. Assembly adopted the following resolution concerning conditions of employment for aviation ground personnel:

> It is apparent from studies made on implementation matters during recent years that conditions of employment in many States hardly correspond with the qualifications required and the responsibilities carried by aviation ground services technical personnel ; and,
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> Whereas this is a major cause of difficulty in recruiting suitably qualified personnel or retaining such personnel after completion of training . . .
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> The Assembly resolves to invite Contracting States to examine this matter and to ensure for the personnel in the aviation ground services conditions of employment commensurate with the qualifications required and the responsibilities carried by these personnel.[2]

The International Air Transport Association (I.A.T.A.), during its Technical Conference on 2 March 1960—

> . . . clearly indicated that the limitations in air traffic control services in certain areas are directly related to the lack of trained and experienced control personnel. . . . In order to ensure that suitably qualified personnel are engaged, particular attention must also be given to improving the position of Air Traffic Control and Communications personnel and ensuring that status, salary and working conditions provided are commensurate with their responsibilities. . . . It was further recognised that at the present time, it is a frequent occurrence for trained controllers to accept more remunerative positions immediately they become proficient in the initial practices of air traffic control. Additionally it was reported that the rate of loss of controllers to other interests is much greater than the rate of recruitment or replacement.[3]

In a communication to the I.L.O. at the beginning of 1963 the I.A.T.A. reiterated this view, stressing that the conditions of work and employment opportunities in air traffic control services should be such as to attract the right type of personnel into a career in civil aviation. The communication also stressed how essential it is for the governments of developing countries to recognise the importance of the air traffic controller. His training, qualifications and conditions of work should be commensurate with the important responsibilities that are assigned to him.

The International Federation of Airline Pilots' Associations, which speaks for the airline pilots, who are vitally interested in the efficiency of air traffic control, recently expressed the view that in

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[1] See, e.g., I.C.A.O. : *Implementation Panel Report*, Doc. 7759, PNL/3, para. 6.4, and idem : *Implementation Panel Report*, Doc. 7966, Part II, para. 20.1.5.

[2] Resolution A.14-12, in I.C.A.O. : *Report of the Executive Committee*, Doc. 8270, A.14-EX/31, Rome, 1962, p. 52.

[3] I.A.T.A.: *13th Technical Conference : Minutes, 2 March 1960*, Doc. GEN-1804.

some countries " there appears to be a good deal of deterioration in the way of employment of unqualified controllers ".

The President of the International Federation of Air Traffic Controllers' Associations, a technical and professional organisation, in a recent communication to the I.L.O., remarks that although the general pattern of air traffic control has become really international, it varies greatly in different parts of the world : " There are, of course, various reasons for this. Within the Federation there is general agreement on the thesis that the efficiency of an air traffic control system is directly related to the conditions of employment of A.T C. personnel. . . ."

Various national air traffic controllers' associations also criticise the prevailing conditions of employment. Dissatisfaction with these conditions is being strongly demonstrated on the national level, resulting in industrial friction which interferes with the normal provision of service. This situation has resulted in some cases in frequent strikes of controllers.

Methods of Determining Working Conditions

The provision of air traffic control is the responsibility of governments, and is carried out in nearly all countries as a public service, either by governmental aviation authorities directly or by authorised agencies having varying degrees of autonomy and acting on behalf of the authorities.

Throughout the world the majority of air traffic controllers are therefore government employees and have the status of civil servants. The terms of their employment and general conditions of work are similar to those in the civil service. In cases where air traffic controllers are not civil service personnel their conditions of work are nevertheless usually patterned after those of the civil service. Consequently the working conditions of controllers are as a rule determined by legislative procedures, and are laid down by laws, decrees, national regulations and administrative orders. Only in very rare cases are these established on the basis of collective agreements in the usual sense of the term.[1]

[1] Among exceptional cases where air traffic control is not directly carried out by government authorities are the following countries.

In Belgium controllers are employed by the airways authority (Régie des voies aériennes), which is an autonomous body distinct from the government aviation administration, responsible to the Belgian Government for the provision of air traffic control services.

In Peru controllers are employed by the Corporación Peruana de Aeropuertos y Aviación Comercial (CORPAC), which is a governmental corporation entrusted by the Peruvian Government with the provision of air traffic control services.

In Switzerland air traffic controllers are employed by the Radio-Suisse Corporation, which is entrusted with the provision of air traffic control by

On the other hand, the conditions in which air traffic controllers work, as will be seen below, do not fit into the conventional framework of civil service occupations. This has resulted in special terms of employment, owing mainly to the increasing scope of air traffic control and the resultant heavy workload.

As flight operations are carried on, at least for long-distance traffic, 24 hours a day, seven days a week and 365 days a year, at a density which may vary, but hardly ever falls to zero, air traffic control facilities must be operated on a continuous basis, the only exception being aerodromes of secondary importance. As a result controllers have also to work at night, during weekends and on official holidays.

As staff is not available in unlimited numbers and even is scarce in many countries, controllers may be called upon to work longer hours than other workers, in particular in advanced countries. The present tendency towards a reduction of weekly hours will in consequence be less felt in this trade and overtime may be more frequent. Moreover, the division of the 24 hours of service may entail long tours of duty, in particular in remote air traffic control facilities, when frequent changes of shifts would increase the inconvenience of long travelling times between workplace and home.

These facts may have adverse effects on both staff and public. Too long hours at all times of the day and night disrupt the social life of controllers, increase their fatigue and reduce their efficiency, thereby reducing also the safety of air navigation.

It is frequently asserted in controllers' circles that hours of work and schedules are too heavy. The information summarised hereafter may throw some light on the problem.

First of all it must be noted that there is no uniformity in this respect ; practice varies from country to country and between various aerodrome traffic towers or centres in the same country.

Data will be given hereafter under three headings : hours of work, overtime, and staffing and scheduling shifts.

Hours of Work

Although the great variety of conditions makes it difficult to generalise, on the whole hours of work appear to range between 40 and 48 a week.

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the Swiss Confederation and the Geneva and Zurich cantonal authorities. The conditions of work of the Swiss controllers are patterned in general after those of the postal, telegraph and telephone personnel with certain modifications due to the nature of work in air traffic control. (*Rapports de service des fonctionnaires de P.T.T.*, C.1, Berne, 1955, and *Durée de travail dans l'exploitation*, C.21, Berne, 1949.)

Italy is a unique case in Europe where controllers are employed by the Air Force, which is responsible for all air traffic control in the country, and their working conditions are determined by Air Force regulations.

In France controllers work, in different places, 40 hours, 42 hours, 42½ hours and 45 hours ; in Belgium 41½ hours, 42½ hours and 45 hours ; in the United Kingdom, 42 and 44 hours ; in the Senegal Republic, 40 and 42 hours.

In the United States and Australia controllers work 40 hours a week. They have a 42-hour week in Algeria, Denmark, India, Ireland, the Netherlands and Tunisia. The Indian Government indicates that, at stations where the air traffic control watch hours are not " continuous " and only one officer is available, he is expected to attend to all aircraft operations and this may well exceed 42 hours per week. The working week is 44 hours in Nigeria and Luxembourg ; 45 hours in Austria ; 45½ hours in Greece and 48 hours in the Congo (Brazzaville) and Malaya.

In some countries the working week is spread over five days, in others six. For instance, in the United States, controllers work a basic five-day week. In Belgium, the Netherlands, Denmark, the United Kingdom and Switzerland, the six-day working week is practised.

Normal hours of work are calculated as an average over the week, for instance seven per day in Denmark and eight in Nigeria and Switzerland.

Swiss controllers who, according to law, are supposed to work a 46-hour week, are in fact working six eight-hour days per week, amounting to 48 hours a week. In order to comply with the law of the country in practice the Swiss controller is compensated by a 20-minute credit per day ; when sufficient credits are accumulated, he is compensated by complete days off.

In general, daily hours of work range from seven in Denmark, or Ireland, to 12 hours in Austria, France or Malaya.

Controllers frequently consider that the hours of work should be substantially reduced.

The United States Air Traffic Control Association recommends that a daily six-hour tour of duty (30 hours a week), instead of the presently prevailing eight-hour day and 40-hour week, be established for air traffic control centres and radar facilities declared by the Federal Aviation Agency to be facilities of a complex high-density character. In support of this recommendation the Association points to the fact that the constant exposure of the controller to the conditions prevailing in complex high-density facilities has created a safety problem and that this fact is reflected in the critical physical and mental impact on the controller and the mounting tensions and pressures that have been building up in these facilities. The Federal Aviation Agency Administrator, in a recent report to the United States Congress, indicates that in the interests of maintaining the highest level of well-being and efficiency among controllers, he plans to establish a new work schedule for many controllers. This schedule would provide for a six-hour active working day plus two hours to be used as training and relief time at primary airports with a high density of traffic.

In Australia, too, the Civil Air Operations Officers' Association takes the view that the hours of duty of air traffic controllers engaged on regular rotating shift duty should not exceed 30 per week or an average of 30 hours per week over a cycle of shifts. A claim has been lodged accordingly with the Public Service Arbitrator.

In cases where controllers work 12 consecutive hours per day the reasons given most frequently are the shortage of qualified personnel and the absence of adequate transport facilities at suitable times. It is indicated that in some cases the time required for a one-way trip from home to work amounts to one or one-and-a-half hours.

Speaking for the pilots, the International Federation of Airline Pilots' Associations has also expressed the view that in a great many cases, and

especially in the developing countries, the controller is required to monitor too many frequencies and is kept at work for too long shifts.

Overtime

It has already been noted that overtime is in some cases required by the very nature of the service and that in many instances, at the present time, the shortage of controllers calls for considerable rostering of overtime shifts to provide the coverage necessary to ensure operations. Overtime means, however, that the off-duty hours of controllers are reduced, and their fatigue made more acute. It seems, therefore, logical that overtime, whatever its cause, should be kept to a minimum and resorted to only in exceptional cases, rather than become the general rule. One deterrent is supplied by the application of special rates for the compensation of overtime.

There is wide diversity between countries both as to the extent to which overtime is habitually worked and also as to the method of compensation for overtime, sometimes given in the form of compensatory time off.

No overtime rate is applicable, for instance, in Belgium, France, Algeria or the Congo Republic (Brazzaville).

In the Senegal Republic there is no overtime in principle, but the agency responsible (the ASECNA) provides for compensatory time off in lieu of payment. In Austria no overtime is normally worked, but a special financial allowance is permitted for instruction activities carried out during the controller's spare time.

Overtime is practised and paid on a limited scale in Denmark. In Switzerland, too, overtime is rare (the system of compensatory time off granted for hours worked weekly beyond the legal standard has been described in the preceding section).

In some countries a distinction is made according to grade with regard to the payment of overtime. In the United Kingdom, for instance, overtime is payable only to Air Traffic Control Assistants and not to Air Traffic Control Officers. A long-hours gratuity is payable to the latter if they work an average of five or six hours a week in excess of the conditioned hours.[1] This amounts to 8 per cent. and 10 per cent. respectively of the controller's salary. Overtime worked by Air Traffic Control Assistants is payable at the rate of time-and-a-quarter for work over 44 hours and up to 54 hours per week, time-and-a-half for work beyond 54 hours and up to 60 hours, and double time for work beyond 60 hours a week.

In India overtime payment is not made to Air Traffic Control Officers, but only to Aerodrome Operators at scheduled rates for duty performed in excess of 42 hours a week. Similarly in Nigeria there is overtime payment or time off in lieu of overtime for Air Traffic Control Assistants only and not for Air Traffic Control Officers. In Malaya only the lowest grade of Air Traffic Control Officers is entitled to overtime payments.

[1] Conditioned hours are the maximum hours of work required per week and the maximum number of hours which may be worked before overtime becomes payable.

In Australia payment for overtime is made at the rate of time-and-a-half. However, when on any day overtime work exceeds three hours, payment for all overtime after the first three hours is made at the rate of double time. Double rates, additional to normal salary, are also paid for overtime on Sundays and public holidays. No overtime is payable to certain categories of controllers in receipt of salaries in excess of a determined figure. For overtime performed on a Saturday in addition to ordinary duty on that day payment is made at the rate of double ordinary time.

In Greece overtime amounts to as much as 24 hours per month and is compensated by a portion of the monthly basic salary increased by 50 per cent.

In the United States controllers may work overtime in some instances ; for this they receive equivalent time off or additional pay. Eight hours' overtime is the maximum permitted for a given week.

Methods of Staffing and Scheduling Shifts

The appropriate staffing of air traffic control facilities in order that the staff may effectively discharge their responsibility for the safe, regular and expeditious control of air traffic has been under continuous review by the competent national authorities. As a result of the steady growth of air traffic, its increasing complexity and the improvement of air traffic control techniques and equipment, it has become necessary to revise the methods employed for the analysis of the workload to determine manpower requirements.

There is at present no standard staffing formula applicable to all these facilities. The practice followed in this respect varies from country to country and from facility to facility within the same country, depending on conditions of operation peculiar to each particular facility, which cannot be covered in practice by a general staffing standard. Local air traffic control units are therefore allowed to exercise great discretion in this respect.

Watch rotation for controllers has been a subject of concerted attention for some time, but difficulty is experienced in finding satisfactory solutions to the several problems inherent in the very nature of air traffic services. The main controlling elements in the determination of the watch rotation are the qualifications of personnel and the staffing requirements of the units.

A centre's control area is divided into a number of sectors, depending upon the amount of traffic normally handled by the centre. The number of controllers assigned to each sector may vary, for instance, from one to three or four, again depending on the amount of traffic. During slack periods the sector may be manned by one controller ; during busier hours the same sector will be manned by two or three controllers. One man will generally work on the radar, another on the radio, and the third will assist in other necessary details.

In many countries shifts are scheduled on the basis of monthly duty rosters. The weekly and daily shifts are in turn based on such rosters. There is, however, no uniformity in the details, and the methods in use vary greatly from country to country. Different shifts are applied at aerodromes with a low traffic density, where air traffic control is provided only during the day, and at major aerodromes where the service is maintained on a 24-hour basis. In some cases the single-shift method is used; in others the system of dual, triple or quadruple shifts per 24-hour period is practised. In some instances the same facilities may have different shifts for different teams and rotation is assured by interchanging of watch positions. In practically all cases watch systems are adapted to suit local requirements of a given facility. In the absence of prescribed rules, the rosters for controls are in many cases agreed to mutually by management and staff with a view to meeting operational requirements. The composition and size of different watches on different shifts are determined by the level of the workload foreseen.

The following examples of the practice followed in various countries with respect to shift work illustrate the degree of diversity. They are nearly all applicable to aerodromes and centres operated on a continuous 24-hour basis.

In Greece controllers work on four shifts: from 0700 to 1330 hours; from 1300 to 1830; from 1800 to 2330; and from 2300 to 0730 hours. The 30-minute overlap between shifts is allowed for briefing purposes and safe changeover of shifts.

In Denmark controllers work on four shifts. The morning shift from 0800 to 1500 hours; the day shift from 1130 to 1830; an afternoon shift from 1500 to 2200; and a night shift from 2145 to 0815 (of the next day). This last shift amounts to 10½ hours, the previous three being seven hours each. Fifteen minutes' overlapping between shifts is allowed.

In Ireland too the method of four shifts is used. Duty rosters here are in cycles, of either 12 or four days. The 12-day cycle is as follows: three days each from 1600 to 0015 hours; three days each from 0930 to 1615; one rest day; three days from 0000 to 0945 hours and two rest days. The four-day cycle consists of one day from 1400 to 2215, one day from 0800 to 1415, one day from 2200 to 0800 and one rest day.

In the United Kingdom controllers work on a four-shift system as follows: first day from 1245 to 2000 hours; second day from 0745 to 1300 hours and from 1945 to 2359 hours (same day); third day from 0001 to 0800 hours; fourth day off; fifth day repeats the sequence of the first day. This is the pattern followed by each individual controller on this four-shift system, so that no control officer has two days off in any week.

In Austria controllers work three shifts: from 0700 to 1900 hours; from 1900 to 2400; and from 0000 to 0700.

In Belgium controllers work three shifts. Two day-shifts from 0800 to 1500 and from 1500 to 2200 hours, each lasting for seven hours, and a night shift of ten hours, from 2200 to 0800 next day.

In Israel the three-shift method is applied. Shifts begin at 1400 up to 2130. The same shift continues the following day from 0800 to 1400, with a

break from 1400 until 2130, when the same shift begins its night duty at 2130 and ends at 0800 the following day. Thereafter the controllers working on this shift are free for 54 hours.

In Tunisia controllers work three shifts, from 0700 to 1300, from 1300 to 1900 and from 1900 to 0700 hours.

In Luxembourg the method of three shifts is also practised, on Mondays to Saturdays, from 0700 and 1400, from 1400 to 2100 and from 2100 to 0700 hours. On Sundays and official holidays only two shifts are worked, from 0700 to 1900 and from 1900 to 0700.

In Malaya, too, three shifts are worked, with an afternoon shift from 1300 to 1930, a morning shift (the next day) from 0730 to 1300, and on the same day a night shift from 1930 to 0730 hours the following day. The next day is a day off, followed by an afternoon shift the following day. Shifts are continuous without break for a meal or a rest.

In Nigeria the three shifts for controllers are from 0700 to 1300, from 1300 to 1900 and from 1900 to 0700. Controllers are expected to arrive at their place of work at least 15 minutes before the commencement of duty to enable them to check their equipment and to facilitate the proper handing over of watches.

In India three shifts are used. Normally watch hours are from 0700 to 1300 (six hours) ; from 1300 to 1900 (six hours) and from 1900 to 0700 (12 hours). There is no overlapping of shifts under this system but air traffic control officers are expected to report for duty sufficiently early and get complete briefing from the relief officer before taking over a watch.

In Switzerland shifts are rotated daily. Three basic shifts are worked, from 0600 to 1230, from 1230 to 2000 and from 2000 to 0600.

In France a three-shift method is used based on the following timetable : from 0745 to 2005 ; from 1945 to 0805; and from 1200 to 2330 hours. The first shift is worked by two teams of controllers, the second by one team and the third irregularly, depending on available personnel. Under this method the consecutive daily working time exceeds 12 hours in the first two shifts. Another method used provides for three shifts as follows : from 0600 to 1300 ; from 1300 to 2000; and from 2000 to 0600. Under this system controllers work seven or ten hours per shift.

In Australia staff is rostered, according to the service provided, for 24-hour or 16-hour coverage. The 24-hour coverage is in three shifts, from 0700 to 1500, from 1500 to 2300, and from 2300 to 0700 ; the 16-hour coverage is in two shifts, from 0700 to 1500 and from 1500 to 2300.

In Algeria and the Congo (Brazzaville) two shifts are the rule—in Algeria from 0700 to 1800 and from 1800 to 0700 ; in the Congo from 0500 to 1300 and from 1300 to 2100.

Conditions Related to Work at Night

By its very nature night work presents disadvantages. Sleep disturbance and irregular meals with their consequent health repercussions are among the major problems in this respect. Moreover, when controllers work on night shifts, their normal pattern of family and social life is disrupted.

Research carried out in various countries on the effects of night work and the degree of fatigue of controllers working on night shifts indicate that the most critical period occurs approximately between 0200 and 0500 hours.

Special compensation is often granted to controllers working on night shifts. The system varies in different places as does also the delimitation of the night period and the frequency of night shifts.

As regards national practices, in Switzerland night work is deemed to be from 2100 to 0600, in France from 2100 to 0500, in Denmark and the United States from 1800 to 0600, in Greece from 1800 to 0730, in Malaya from 1930 to 0730, in Australia from 1800 to 0630 and in Ireland from 0000 to 0945.

In Australia a controller who performs ordinary duty on a shift any part of which falls between the hours of 1800 and 0630 is paid an additional 10 per cent. of his salary for that shift. If a controller is required to work his ordinary hours continuously between the hours of 1800 and 0800 for a period exceeding four weeks he is paid an additional 25 per cent. of his salary for that shift.

In the United Kingdom an allowance is payable for the inconvenience and disturbance of working at night to those controller officers whose salary does not include an element to cover this contingency. At present there are three scales of allowances which are based on salary scale maxima. The amounts of the allowances vary from case to case. Casual night shift work attracts the same allowances as regular night shift work. In this respect there is no difference between applicability to Air Traffic Control Officers or Air Traffic Control Assistants.

In Greece night work is compensated by 50 per cent. of one-thirtieth of the monthly basic salary. Night work normally occurs every sixth or every fifth day.

In Ireland there is an additional payment in respect of attendance for duty at night which is made in the form of a small cash allowance.

In Denmark controllers receive extra pay for night work. This is also the case in Luxembourg, where a cash grant is provided for work at night.

In France a supplementary payment is made for night work. The number of nights worked per month is six or seven. In some places, at major facilities, a controller works at night only once in eight days instead of once in four.

In Switzerland controllers working at night have the following day off duty wherever possible.

In the United States the night differential is 10 per cent. of the normal rate of pay.

In Belgium night work occurs on an average once every five days, or once a week.

In Malaya work on night shift occurs once in four days in rotation.

Work on Weekends and Official Holidays

National practice with respect to work on weekends and official holidays, and to methods of compensation for and recuperation of such work, varies widely. The following examples of various national practices illustrate the situation:

In Australia work performed between midnight on Friday and midnight on Saturday, or on Sunday, is paid at time-and-a-half. In cases where a controller works on Sunday within a week in which he is rostered for duty on the other six days of the week, he is paid for Sunday duty at the rate of double time. A controller performing a full day's duty on a Sunday is,

wherever possible, granted a day off during the six days succeeding that Sunday, and in such cases the extra payment for Sunday work is one half day's pay. Holiday work in Australia is compensated by a day's leave in lieu of the holiday within one month after the holiday. Where this is not applicable, the controller is paid one day's pay at the ordinary rate instead.

In the United Kingdom the Ministry of Aviation Staff Regulations with respect to work on Sundays and holidays refer only to some grades of assistant controllers. They provide that " when exceptional attendance on a scheduled rest day is necessary, the Officer will be granted, whenever possible, time off in lieu, equivalent to the hours of attendance on the scheduled rest day, during the ensuing four weeks. When time off in lieu (either in part or in whole) cannot be granted within that time the uncompensated attendance will be paid for at time rate and a half ".

In the United Kingdom compensation for Sunday or rest day duty is not payable to Air Traffic Control Officers, but only to Air Traffic Control Assistants, and the above provisions are applicable only to the latter. Air Traffic Control Officers required to work on a public holiday or privileged holiday are allowed time off in lieu (a day or half a day as the case may be), normally within the next six months. Where it is not possible to grant time off in lieu, the hours of attendance may be regarded as Sunday duty for the purpose of calculation of overtime where applicable. The Institution of Professional Civil Servants indicates that in the United Kingdom there is no compensation for work on Sundays or public holidays for Control Officers.

In the Netherlands controllers working more than 26 Sundays in the course of a year are compensated by an extra yearly payment ; in Israel controllers are compensated by extra pay for duty at night, and on weekends and holidays ; in Denmark controllers who work on Sundays and official holidays receive extra pay. In Greece controllers working on Sundays and official holidays receive compensation for each shift worked, amounting to one twenty-fifth of the monthly basic salary plus 20 per cent.

In the Republic of Senegal there is an additional payment for normal hours worked at night but no other conditions applicable to work at night and on weekends and official holidays exist. The same situation prevails in the Republic of Congo (Brazzaville). In Nigeria Sunday work is compensated by overtime pay at time-and-a-half and double time on public holidays. There are no additional conditions attached to duties performed at night.

In the United States work on federal holidays is paid at double the normal rate.

In Switzerland Saturday is considered as a normal working day and only work on Sundays is subject to compensation. An additional half day off duty is granted to controllers for work on more than two consecutive Sundays or official holidays.

In Ireland no compensation is granted for work at weekends or on public holidays, but leave is allowed in lieu of any attendance on public holidays, such leave being calculated at the rate of one day for each public holiday worked.

In Malaya air traffic control staff in facilities with a 24-hour watch system have one weekend off every four weeks in rotation. No leave is granted on public holidays nor on any other day in lieu of these. Air traffic control staff rostered on day shifts only on six days in a week are entitled to one day off in lieu of Sunday (weekly day of rest) and days off in lieu of public holidays with no overtime.

In India and Luxembourg no special conditions are attached to work at night, weekends or holidays. In France and Austria controllers work

the same hours and times throughout the year without regard to weekends and official holidays, and holidays worked are not recoverable.

Breaks and Rest Periods

A much-discussed feature of the controller's work is the lack of scheduled rest periods, interruptions for meals and other relief breaks. In this respect also, practice varies greatly.

In some countries the weekly and daily hours of work are inclusive of meal breaks, e.g. in Ireland, where in the 42-hour week one hour of meal break per shift is included ; in others, e.g. the United Kingdom, the 44-hour week is exclusive of meal times. At certain stations, however, short rest breaks of 20 minutes in the morning and 25 minutes in the afternoon are allowed. At night, a two-hour rest is given to controllers at these stations. These arrangements are not general throughout the air traffic control system and apply only to certain areas in the United Kingdom.

In Switzerland controllers are entitled to a 30-minute break during an eight-hour tour of duty. In certain facilities a system of graded, payable breaks, included in the working hours, is applied. This provides for a 15-minute break for a tour of duty lasting from three-and-a-half to four-and-a-half hours, 30 minutes for one of five to six-and-a-half hours and 45 minutes for one from seven to eight hours.

In Austria controllers remain at their control position continuously for the duration of a 12-hour working shift, a break of 30 minutes for lunch being permitted.

In Tunisia controllers are entitled to a three-hour break during the night work which lasts from 1900 to 0700.

The United States Government, in a communication to the I.L.O. in 1960, indicated that " within recent years, controllers have been known to stay fixed to an operating position for the full time of an eight-hour duty without relief. Eating while actively working at control position has been a common practice for many years. Earlier, this was due to workload and the lack of properly qualified personnel ; today occasionally it is due to such conditions, but more often to the lack of ample time off duty, to the non-existence of lounge and eating areas or the inaccessibility of commercial eating facilities."

In Malaya controllers work without break for meal or rest during a whole day's or night's shift lasting for 12 consecutive hours. The Nigerian Government has indicated that " it is impossible, due to the staff situation at present, to arrange any break during a watch for the air traffic control officer ; however, it is hoped that, when the required establishment is obtained, watch supervisors will be available as reliefs during watches to allow each air traffic control officer a break ". The Australian Government has indicated that no provision is made for meal breaks in that country since meals are taken on duty during slack periods.

In the many countries where break and relief periods during the duty time are not officially provided at all, or are very brief, amounting in certain cases to 10 minutes, this shortcoming is being overcome through on-the-spot arrangements between the controllers themselves. Such practices are certainly far from satisfactory.

Regulations with respect to rest periods vary from country to country. In the Netherlands, for instance, a minimum of 10 hours' rest between shifts is required. In the United States the Federal Aviation Regulations provide that an airport tower controller " may not serve or be required to serve

(a) for more than 10 consecutive hours, or *(b)* for more than 10 hours during a period of 24 consecutive hours unless he has a rest period of at least 8 hours at or before the end of the 10 hours of duty ".

Environmental Factors of Air Traffic Control Facilities

General Observations

The environment in which air traffic controllers, whether at airport towers or at air traffic control centres, must perform their work frequently leaves room for considerable improvement. This remark is borne out by observations on the spot, field inquiries and replies to questionnaires from national and international sources. Although many factors contribute in varying degree to unfavourable comments from controllers, those cited most often include inadequate working space, poor arrangement of equipment, obsolete equipment, high noise levels, poor illumination and poor temperature and humidity control. The United States Air Traffic Control Association, for instance, points to the fact that " many facilities —overcrowded, poorly ventilated and inadequately lighted— continue to function with second-hand and make-shift tools ".[1]

An American air traffic controller describes environmental conditions in United States air traffic control facilities in the following terms :

> The tempo of I.F.R. traffic control today is an awesome thing to watch at any busy facility. The calm voice sounding out instructions, the quick jottings of numbers and altitudes, other voices talking constantly in the background, phones ringing, buzzers sounding, lights blinking—while two controllers vie for the attention of a third, who is seemingly engrossed in a radarscope and oblivious to anything else. All this is happening while someone is planning, watching, and directing airplanes about the sky. You can feel the tension and concentration, even though you have little or no understanding of how it is being done.[2]

The International Federation of Air Traffic Controllers' Associations in the recent communication to the I.L.O. quoted in the preceding section made the following general comment :

> The environmental factor will affect . . . efficiency on the job and consequently be of influence on the safety and regularity of air traffic. Although a lot of study has been made on these factors . . . the fact remains that, in Europe at least, most A.T.C. centres, approach control and radar units and control towers do not come up to the requirements. In general one finds high noise-levels, insufficient air conditioning and ventilation, inadequate facilities for rest, poor lighting, etc. One or two show sites in some countries which suffer less of these shortcomings cannot blur this general impression.

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[1] *Airlift* (Washington), Vol. 24, No. 5, Oct. 1960, p. 39.

[2] Charles A. Kite : " I.F.R. Controlmanship ", in *Journal of Air Traffic Control* (Washington), Oct. 1959.

Layout and Design of Air Traffic Control Facilities

In most cases the control tower unit is combined in one location with the approach control office, the latter facility being located on the lower level of the tower. Whenever the radar equipment used does not furnish a bright light display the approach control office has to be located in a darkened room. On the other hand area control centres are not necessarily located at aerodromes and in many instances are even situated in remote places.

In general, aerodrome control towers are so situated and designed as to enable controllers to have an unobstructed view of the runways, taxi-strips and manœuvring area, as well as of aircraft take-offs and landings and aircraft in flight in the immediate vicinity of the aerodrome. In order to achieve this throughout the year, many forms and shapes of control tower cabs have been tried. In practice, it has been found that a square-shaped room with splayed corners, and glazed all around is satisfactory.

Partly because of variation in ownership (local, municipal, state, federal) aerodromes are noteworthy for lack of consistency in design and absence of standardisation with respect to the location and lay-out of control towers. It frequently happens that practical and operational air traffic control requirements are overridden on aesthetic grounds.

The United States Air Traffic Control Association in a communication to the I.L.O. in 1963 indicated that: "Often new terminals are built, runways are improved and the control tower remains a dilapidated structure with poor visibility, poor heating and ventilation and completely unsatisfactory. Even the facilities at our largest and newest airports. . .are inadequate. . . ."

In the United States, in order to remedy this situation, the Federal Aviation Agency adopted towards the end of 1962 a new standard design for air traffic control towers. It will provide greater visibility from the tower cab, improved space for the use of radio and radar equipment and a better environment for personnel. The design takes into consideration the range of requirements from the smallest to the largest aerodrome in the country. At the same time the Agency expects to realise considerable savings when construction of towers of this type begins in 1963.

A review of complaints and proposals for remedy leads to the following remarks:

Space allocation in the control facilities is frequently inadequate, many centres being overcrowded. Controllers are often cramped together in close proximity.

The principle of working from a sitting position has been generally accepted, but there are still control towers where the

equipment requires the controller to work from a standing position, so as to be able to have an unobstructed view of the runways and airport operating area.

Although the particular nature of the controller's work often requires sitting for long periods, more particularly if he is tied down by a headset, in some facilities simple office chairs are used, in others, ordinary arm-chairs, and only in a very few instances are specially designed comfortable chairs provided.

Control desks often have insufficient working space for the controller's comfort, and make it impossible for a person with average reach to operate all his equipment satisfactorily from a sitting position.

The positioning of control panels and equipment is on the whole far from satisfactory. Various systems are being tried out and in some centres the radar controller and the operational controller's positions are now located side-by-side in order to facilitate co-ordination of operations.

In summary not enough attention is paid to human engineering when equipment is being positioned. In practice there is little consultation with the controllers themselves. Only in very few instances do they have a say in the matter and even then not a determining one. Controllers feel that their views should be taken into consideration even if only in the interests of the service.

The application of the principles of ergonomics [1] requires that the working area and equipment should be built around the operators rather than that the operators should be placed in a setting which makes no allowance for their requirements and capabilities. An analysis of these requirements would result in an improvement of the controller's work and the service rendered by an air traffic control facility. It should, in addition, eliminate expenses incurred in the redesigning or relocating of facilities or equipment after they have been put into operation. In many States existing air traffic control facilities are accordingly being re-examined at present by the competent authorities. Such efforts will certainly make it possible to eliminate some of the failures which in the past have been wrongly attributed to personal inefficiency of controllers.

Air Traffic Control Equipment

The rapid increase in air traffic and the acceleration of flights have demanded corresponding improvement in the controller's equipment. Today this includes radar, instruments for data gathering, data presentation, recording and communications,

[1] See " Ergonomics. The Scientific Approach to Making Work Human ", in *International Labour Review*, Vol. LXXXIII, No. 1, Jan. 1961, pp. 1-35.

sometimes electronic computers for handling and processing flight data, and other semi-automatic equipment of varying degrees of complexity.

Although all categories of equipment are essential to the controller's work, none is so important as adequate and reliable communications equipment for ground-to-air (controller-to-pilot) radio communications and centre-to-centre communications.

However, the basic equipment in control remains the control desk.

Similarly, although great progress has been made in the controller's tools and highly sophisticated equipment has been developed, the old simple and reliable flight progress boards are still used all over the world as the basic tool for keeping track of aircraft within the controller's sector. Judging by past experience, this will most probably remain so for some time to come. Flight progress strips are arranged under the appropriate fix designators chronologically or according to altitude levels or in separate groups according to arrivals and departures of aircraft. Each strip indicates aircraft identity, destination, altitude, route and other essential items.

Experienced controllers can, by a look at the flight progress board, instantly evaluate the traffic situation. As the boards tend to become larger in size, it is therefore most important that their size should not exceed the dimensions which a controller can normally take in visually from his working position without undue head or eye movements. Here, again, human limitations must be considered if errors are to be prevented.

The effective integration of the controller and his equipment is essential in the performance of control duties for safe operations. Equipment alone, even when the best, cannot give satisfactory service unless it is operated by competent personnel.

With respect to the equipment situation in general, it must be stressed that enormous differences exist in practice. There are only too many facilities where old and obsolete types of equipment are still being used, and in many countries locally designed, makeshift arrangements exist.

It is obvious that without the essential equipment controllers are forced to adopt such devices as increased separation standards. In doing so, they must inevitably restrict the availability of airspace, thus bringing on the attendant ills of delays, unavailability of preferred routes and flight levels, and so forth.

As a result of this situation controllers in many places experience the uncomfortable feeling of working with equipment which is many years behind that of the medium (namely air navigation) it is intended to serve.

Lighting and Visual Protection Devices

In the field of lighting and visual protection devices, there is also great variation in practice between the different countries and individual facilities. The persistent difficulty in this respect is that of providing adequate illumination for the incompatible visual tasks that the controller is faced with while performing, for instance, radar surveillance and reading data on a flight progress strip on his board. Often two or more controllers in adjacent work areas are performing visual control tasks that require different conditions for optimum viewing. This problem is not confined to the control towers but also arises in the control centres.

It must first be underlined that the need to operate radar in darkened rooms has in itself disturbing effects on the eyes and possibly the general health of controllers, but the tension and fatigue are further increased when the contradictory needs of the controllers in matters of lighting are not properly met.

This problem has been solved satisfactorily only in a few cases. Many countries realise the need to improve the situation and are carrying out substantial research in the field of illumination. In some instances special prototypes of lighting systems are at present undergoing intensive trials. The United States Government indicates that, in some of the new centres, specially designed variable-intensity lighting systems will be provided in the control rooms.

The United Kingdom Ministry of Aviation, in a communication to the I.L.O. in 1963, stated that—

> A very high over-all standard of lighting should be provided and reflections which may cause eye-strain and distraction should be reduced to a minimum. Areas of unduly high illumination and areas of shadow causing high visual contrast should be avoided. Lighting of flight progress boards in centres where pencil and small writing is to be observed should be in the order of 20 ft. candles. In operations rooms where radar displays are used it should be possible to reduce the light intensity to any required level, but it is necessary to ensure that the walkways between rows of working positions are clearly lit. . . . To avoid highlights which could cause eye-fatigue all metal surfaces and furniture, etc., are made as far as possible with non-reflective surface.

Controllers indicate that great contrasts in lighting intensity increase visual fatigue. Medical research carried out on eye-fatigue in various countries generally confirm that this is the case.[1] This problem is particularly serious in tropical countries where the vagaries of the climate necessitate the provision of visual protection devices. In some control towers, in locations where

[1] See I.L.O. : *Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry* (Geneva, 1949).

night flights do not take place, the tower glass is tinted to reduce glare. A major disadvantage of glass tinting is, of course, the reduction of the ability of controllers to observe aircraft at night and therefore it has been necessary at other centres to institute alternative means for reducing heat, glare and fading effects of direct sunlight.

A considerable number of problems in this field exist also in countries with a cold climate. In some towers windows are often blurred by rain or wet snow, thus obstructing the controller's vision and straining his eyes.

It will be seen from these short remarks that, on the whole, no standards exist regarding lighting and visual protection, with resulting difficulties for controllers.

Noise and Noise Abatement Devices

Noise is one of the critical problems in the working environment of the air traffic controller. In this respect, a distinction is to be made between the external noise generated by the aircraft engines and the internal noise within the air traffic control facilities.

A high level of noise interferes with speech communications. Occasionally, in many control towers, noise makes loud talking and even shouting necessary. This in turn tends to raise the noise level still higher. Under such circumstances noise not only impairs the controllers' efficiency but gives rise to working errors which may have dangerous consequences.

Although individual controllers react to noise in different ways, it is now well recognised that prolonged and constant exposure to noise levels of above 65 to 70 decibels will eventually prove annoying to the majority of controllers and increase their fatigue.

There are many ways of reducing and controlling noise at air traffic control facilities, and in some cases satisfactory results have been achieved. In most cases, however, the problem has not been solved and remains critical. For instance the Indian Government, in a communication to the I.L.O. in 1963, indicated that with regard to noise " no special devices are provided and the problem exists ". The Irish Air Traffic Controllers' Association also indicates that " noise level is very high and noise abatement devices non-existent ". In many other countries where such devices do exist they are not sufficient. One country with a tropical climate indicates that only one out of eight towers is soundproof. The United Kingdom Institution of Professional Civil Servants indicates that " the noise level is usually so high as to be a nuisance, and so far as the Institution is aware, insufficient efforts are made to control unnecessary noise ".

Measures taken in various countries for reducing noise or eliminating it vary greatly. In some of the new facilities the control room floor, ceiling and walls are treated with materials having a high noise-reduction factor. On the other hand, in many facilities there is no noise control applied to reflecting surfaces, pipes, overhead ventilation ducts, teleprinters, pneumatic transmission tubes or sliding stripholders on flight progress boards; single windows, which provide insufficient protection from outside noise, still prevail in control towers.

On the whole it is recognised that in order to achieve a better working environment further measures to reduce the noise levels in control rooms are required. The United Kingdom Ministry of Aviation, in a communication to the I.L.O. in 1963, indicated that " psychological and physical comfort of control staff is greatly improved and consequently efficiency enhanced if the noise level in operations rooms and at working positions is low ".

Air Conditioning, Ventilation, Heating

This problem is important not only because temperature and humidity can have adverse effects on the controllers, but also because they can interfere with optimum or accurate performance of the types of equipment which are sensitive to temperature changes. Many temperature problems result also from the generation of heat by the newer types of air traffic control equipment. Air conditioning is therefore often essential to provide the right operating conditions for complex equipment as well as the comfort of operating personnel. The United Kingdom Ministry of Aviation has stated that " air conditioning and ventilation is most important for the welfare of staff, particularly in operations rooms, where either double glazing or semi-darkness conditions have to be provided and natural ventilation is not possible ".

Some States make it their policy to air condition all control towers and centres, many others do not. In the many towers where air conditioning and ventilation are not provided control rooms can be aired only by opening the windows, but this in turn increases the noise levels. In many countries only new facilities are air conditioned. One country in a tropical climate area indicates that only one tower out of eight is air conditioned, the rest having ceiling fans.

According to the United Kingdom Institution of Professional Civil Servants, " almost without exception, air conditioning, ventilation arrangements are sub-standard; even in the new units difficulties are experienced. The Institution believes that major improvements are required."

Closely related to the air conditioning, ventilation and humidity control, is the problem of heating. Because of its large glazed area, the cooling and heating requirements of the control tower cab frequently differ from the conditions of other parts of the building, and for this reason special additional arrangements, specifically adapted to the control room, are required to heat or cool the cab.

Sanitation, Recreation and Rest Facilities

Adequate sanitary arrangements should be provided in control towers close to the visual control rooms. Some facilities have no wash-places or shower baths ; personal locker rooms are not always provided and in many towers clothes are hung in corners of the control rooms, or on the walls in the corridors and staircases.

The situation with respect to recreation and rest facilities is nearly everywhere unsatisfactory, and in many countries there are none at all. In other places the available facilities are seldom used because of the shortage of personnel, or because they are not suitable for rest purposes.

In view of the special conditions under which controllers work, and their working environment, improvements in this area are urgently needed everywhere in order to ensure satisfactory standards of welfare.

* * *

In conclusion, while it is difficult to assess in detail all the implications of unfavourable environmental factors for the efficiency and well-being of air traffic controllers, it is evident that an inadequate working environment does have an adverse effect on the controllers' work and the efficiency of the service, and greatly increases fatigue.

Impact of New Equipment on Conditions of Employment in Air Traffic Control

Equipment for air traffic control, in common with aviation generally, is developing continuously and rapidly and is becoming increasingly complex and technically more sophisticated. New equipment is, of course, required to enable controllers to cope with the greater amount and velocity of air traffic, and it is the recent high rates of traffic increases that have given an impetus to the development of improved equipment for supplementing the controller's efforts in handling the volume safely. It must be stressed, however, that the primary reason for introducing new equipment is not to facilitate the controller's work but to improve the accuracy

of air navigation and permit greater utilisation of the shrinking air space by applying reduced separation between aircraft. This development has, in fact, resulted in a more complex system of operation and has had both favourable and adverse effects on the controller's work and environment.

In particular, the more and more extensive use of radar and electronic equipment, coupled with the introduction of semi-automatic and automatic techniques, creates a number of special problems relating to conditions of employment in the service.

Radar

Radar, which was initially used as an adjunct to other control equipment, is now becoming more and more a primary and indispensable element in air traffic control. The radar controller has thus become the top operational officer. The use of radar has brought many advantages and improvements from the operational viewpoint. By making the position and movement of individual aircraft continuously visible on a screen, radar renders invaluable assistance in the safe control of landings and take-offs under all weather conditions. At the same time, by enabling a reduction of separation standards, it has increased the responsibilities of controllers in maintaining the safe movement of aircraft in ever-increasing traffic. Surveillance radar allows, for instance, for a reduction of the intervals between successive landings of aircraft regardless of visibility, thus reducing congestion in airports with a high density of traffic. This means, however, a faster pace of work for the controller and a reduction of the time at his disposal for the safe control of successive landings.

Moreover, the use of radar is now being extended to operations of longer range and broader scope, in order to provide a complete coverage of areas where traffic density along the airways is high and where the need for reduced separation standards exists. This increased use of secondary radar in conjunction with primary radar will affect the work of the controllers by increasing the proportion of working time spent at the radar screen—precisely that part of the control function which is recognised to be the most fatiguing.

In addition to this—and although bright light display equipment may overcome this problem—radar has brought with it some more explicit disadvantages which are inherent in the very nature of radar controllers' work. In particular, as we have seen in the previous section, the necessity of working in darkened rooms with artificial lighting may have disturbing effects, overstraining the visual capacity of controllers because of the constant need to focus their eyes on numerous faint targets on the radar screen. Instances

have occurred in some countries of controllers exposed to prolonged work in front of radar screens suffering serious eye-fatigue with symptoms of diminished visual capacity. For example the Danish Air Traffic Controllers' Association, in a communication to the I.L.O. in 1963, indicated that " one radar controller has been unable to pass the annual medical test due to indications of glaucoma, after having worked for two years as a radar controller ". This problem is causing much concern and is being intensively investigated in a number of States. Some countries are experimenting with different types of daylight scopes and closed circuit television screens designed to improve this situation.

In addition to the problem of lighting, the extensive use of radar has accentuated other problems such as that of ventilation and air conditioning as it is extremely desirable to overcome the excessive heat generated by this type of equipment.

In view of the greater strain of radar control, problems such as the shortening of uninterrupted working time, and the provision of adequate rest periods, relief breaks and rest facilities, have acquired special urgency. In Belgium, for example, as is indicated by the Belgian Guild of Air Traffic Controllers, no agent may serve a radar screen for more than two consecutive hours in approach control, although such a limitation has not been extended to other control operations. In many countries the normal period of duty at a radar position is indeed two hours, after which a controller switches over to another control post. There are, however, instances where controllers work at a radar screen for periods far exceeding two hours, and in some cases they spend an entire day's tour of duty in front of a radar screen without interruption. The shortage of qualified radar controllers is the reason given for such extreme practices. Considerable concern has been expressed that, with the extension of radar control, the practice of prolonged work at radar screens, which is now exceptional, will become the rule, with adverse effects on the health of controllers and consequently on standards of safety in air navigation.

The International Federation of Air Traffic Controllers' Associations has stated that " it may be taken for granted that working conditions in A.T.C. units at busy airports and at busy air traffic control centres are of equal physical impact and of equal nervous stress for all personnel, except that radar control work is particularly exhausting and tiring ".

A satisfactory solution of these problems would substantially improve the working environment of radar controllers and permit them to handle more traffic effectively with less fatigue and eye-strain. Appropriate measures for improvements in this field would therefore seem most essential.

The impact of new equipment on the recruitment and training of controllers varies from country to country at the present time. Some countries indicate that the introduction of radar and electronic equipment has made it necessary to raise the basic qualifications required, and thus rendered recruitment of new personnel more difficult. Others, where the standards laid down for procedural controllers were already high before the introduction of radar, have not experienced greater recruitment difficulties on that account. With respect to training, however, nearly all countries point out that the impact has been substantial and that more specialised training is now required. Training tends to be longer and of greater technical complexity with the development of new equipment. At the same time re-training of controllers is becoming necessary, either on the job or through specialised supplementary courses. The United Kingdom Ministry of Aviation has commented that " the quantity, complexity and diversity of aeronautical electronic equipment, together with more critical permitted working tolerances, are such that the amount of technical training needed on specific equipments is greater than a few years ago ".

The widespread use of radar requires the maximum possible degree of uniformity in its application if the best results are to be obtained. In order to ensure this the I.C.A.O. has recently introduced a new radar rating for controllers, which can only be gained by licensed controllers.[1] The I.C.A.O. emphasises the fact that radar control must be of high quality, and that " it is therefore essential for States to ensure that the radar training given A.T.C. personnel is of the highest standard ".[2]

The potential impact of the use of radar equipment on the professional status of the air traffic controller has been noted by the International Federation of Airline Pilots' Associations, which states that " there is little doubt that the controller will become more and more important as new technical equipment (e.g. radar) becomes more extensively used. . . . We see therefore a continued increase of responsibilities of the air traffic controller, possibly including some kind of ' parallel responsibility ' with the pilot for the navigation of the aircraft—a responsibility which is not yet allocated to him under the I.C.A.O. regulations. This flows, of course, mainly from the existence of radar." This has recently been confirmed by a meeting of the I.C.A.O. in May-June 1963, which, after reiterating the long-established principle that the

[1] *Amendment 155 to the International Standards and Recommended Practices, Personnel Licensing. Annex 1 to the Convention on International Civil Aviation* (Montreal, June 1962), p. 53.

[2] *I.C.A.O. Training Manual,* Doc. 7192-AN/857, Part 14 b) (Montreal, 1960), p. 1.

primary responsibility for the navigation of an aircraft in both the horizontal and the vertical planes rests with the pilot, " took note of the fact that when an aircraft is being vectored by radar, either by approach control or while en route, a pilot is often unable to determine his exact position and, consequently, his terrain clearance and it was agreed by the Meeting that under such a circumstance, the controller should be responsible for ensuring adequate terrain clearance ".

Automation in Air Traffic Control

There is a growing awareness of the fact that, if the density of air traffic and the speed of aircraft continue to increase at an accelerated pace, it will no longer be possible to ensure the safety and regularity of air traffic without the aid of some form of automatic equipment.[1] In certain areas the point has in fact already been reached where a further increase in manpower at air traffic control units is no longer a suitable means for coping with the greater demands placed on the service. Reducing the controller's workload, in addition to increasing the efficiency and the traffic handling capacity of the system, is therefore among the primary objects of introducing automation techniques into the air traffic control service. It is believed also that, in this way, safety in air navigation will be improved to a considerable extent.

In a number of States the development of equipment for the automatic processing of air traffic control data has been vigorously pursued in the last few years. Some countries have already gained experience with the practical application of electronic computers and associated equipment for the automatic printing of flight progress strips, electronic recording of flight plan data in a form in which it can be fed directly to computers, and electronic methods of transfer of control from one centre to another.

In view of the need to ensure compatibility of this equipment, the Air Navigation Commission of the International Civil Aviation Organisation decided, in June 1961, to establish an international panel of experts to prepare material and recommendations relative to the development and application of automation in air traffic control.[2] This I.C.A.O. Air Traffic Control Automation Panel, at its second meeting in October-November 1962 in Montreal, considered the high-speed electronic computer—

[1] See, e.g., *Annex 11 to the Convention on International Civil Aviation*, fourth edition, op. cit., p. 47.

[2] *I.C.A.O. Annual Report of the Council to the Assembly for 1961* (Rome, 1962), Doc. 8219, A. 14/4, pp. 43-44. The Air Traffic Control Automation Panel held its first meeting in Montreal in March 1962.

. . . an ideal tool for use in air traffic control. . . . The Panel reiterated the statement that automation of A.T.C. tasks can result in a significant improvement in the effectiveness of the human controller by relieving him of many functions which he now has to perform in the process of handling traffic, i.e. those associated with his tasks as a communicator, navigator, calculator, predictor of future events and performer of other duties which detract him from primary responsibility of controlling traffic.[1]

The Panel also expressed the view that the introduction of automatic data-processing techniques will require over-all standardisation to a much larger degree than heretofore.

In this connection the United States Federal Aviation Agency, in its second annual report for 1960, expressed the view that—

. . . present manual and limited computer systems of A.T.C. place a heavy burden on the controller, and in high traffic density areas of the close future will make such human control impracticable. To prevent severe air traffic bottlenecks with attendant reductions in traffic flow . . . automation is required to relieve the controller of his routine functions and to free him for the task for which the human is uniquely suitable, namely, exercising judgment. F.A.A. continued to assign top priority to the development of semi-automatic A.T.C. systems.

Although it is clear that, for control purposes in high traffic density areas, the widespread application of automatic processing and other techniques is essential in order to cope with the increasing congestion of aircraft flying at high speeds, the question arises how far automation should go. In this respect opinions vary greatly among the experts concerned. However, even the most ardent proponents of automation recognise that the most sophisticated systems require the attendance of controllers to resolve conflicts and make decisions. At its second meeting the I.C.A.O. Panel concluded that—

. . . in determining the requirements for automatic processes in A.T.C. it was considered that the following criteria could be used as guidance : a machine should be used *(a)* if a particular A.T.C. function cannot be carried out by a human operator, *(b)* if a machine can perform a particular A.T.C. function more economically than a human operator, and *(c)* if a machine can perform a particular A.T.C. function better (i.e. faster, more accurately and/or more reliably) than a human operator.[2]

Indeed some of the air traffic control functions, especially in congested terminal control areas [3], may well be a task beyond the competence and capabilities of the equipment manufacturer, designer, engineer, scientist and mathematician. It has been

[1] "Air Traffic Control Automation Panel", in *I.C.A.O. Bulletin* (Montreal), Vol. XVIII, No. 2, 1963, p. 30. The third meeting of this Panel will be held in October-November 1963.

[2] *I.C.A.O. Bulletin*, loc. cit., p. 31.

[3] A terminal control area is a portion of a control area normally situated at the confluence of airways in the vicinity of one or more major airports.

suggested that in an area such as western Europe, which is virtually a collection of adjoining and overlapping terminal areas, it may well be that the " computer " embedded by nature in the head of the controller will prove to be the most effective way of preventing collision in air navigation. It is obvious that " automation will undoubtedly remove from the controller much of the routine work, computers will alleviate the burden and strain of unrelenting vigilance on the human eye and brain, but even when flight itself is fully automatic the need for the human air traffic control officer will remain ".[1]

One of the crucial problems of automation, from the point of view of the controller's actual work, lies in the complex relationship between the human controller and the automatic equipment. It will be of the utmost importance to establish a sound balance between the tasks reserved for the controller and those performed by any machine. In its preliminary study entitled *The Technical, Economic and Social Consequences of the Introduction into Commercial Service of Supersonic Aircraft* the I.C.A.O. states that " the introduction of semi-automatic systems of air traffic control will inevitably lead to some change in the actual work done by the controllers. They will need to have a good grasp of the method of functioning of the equipment on which they rely as well as of the operational characteristics of the supersonic aeroplane." [2]

The International Federation of Air Traffic Controllers' Associations stresses that there is not yet sufficient evidence available concerning the impact of automation on the actual work of controllers. The Federation points out that—

> . . . so far the automation equipment in very few countries, such as the Netherlands, only relieves the controller from his clerical work in order to help him concentrate his undivided attention on his main function of controlling air traffic. Future developments will have to be closely investigated to ensure that the controller will retain his capacity of controlling air traffic during periods of technical failure of automatic equipment, although part of his control work will normally be executed by semi-automatic technical devices.

The Department of Civil Aviation of the Netherlands Government stresses that the automatic printing of flight progress strips has permitted savings of the controllers' precious time and therefore increased their working efficiency.

With the introduction of semi-automatic processes in air traffic control, training programmes have to be revised and recruitment methods will, in addition, need to be adjusted in order to ensure

[1] " The Air Traffic Control Officer in Britain ", in *I.T.F. Journal* (London), Jan. 1962, p. 15.

[2] I.C.A.O. Doc. 8087-C/925 (Montreal, August 1960), p. 86.

that personnel are of the required high standard. The future controller will be working on the very frontier of science in this particular field.

The United States Air Traffic Control Association, in a communication to the I.L.O. in 1963, indicates that "in those facilities having computers, there has been no noticeable decline in numbers of personnel". It seems unlikely, therefore, that in the foreseeable future automation will solve the problem of the shortage of controllers, as in the coming years the growth of traffic will presumably be substantially greater than the relief afforded to staff by new technical equipment and the demands on personnel may thus continue to increase.

Conclusions

From the foregoing analysis, a number of conclusions bearing on the working conditions of controllers seem warranted. The controllers' profession is a relatively new one, only just coming out of obscurity. It has not yet been studied or analysed to any great extent. The proper evaluation of the services this profession renders to safety in air navigation should, however, lead to undisputed recognition of its real importance.

An air traffic control service can only be as safe and efficient as the quality of its personnel and their working environment allow it to be. Through the efforts of the I.C.A.O., air traffic control procedures are being standardised throughout the world, but efficiency of service varies greatly, being largely influenced by the equipment used, environment and conditions of employment. Although, in recent years, and especially since the I.L.O. *Ad Hoc* Civil Aviation Meeting took place in 1960, the situation in this respect has gradually been improving, it is still far from being satisfactory everywhere. Additional effort is therefore needed, particularly in view of the fact that air traffic control services will, in many respects, have a determining influence on the extent to which civil aviation can expand.

In its turn the further expansion of aviation will place an increasing workload on controllers. They will be called upon to play an even more vital, if changing, role. Their profession will continue to grow in importance, while they will be challenged to adapt themselves to changing techniques and procedures. The wide use of new control equipment, especially radar and automatic equipment, will necessitate major changes in air traffic control practices and will affect nearly all aspects of the profession.

Among the major technical and operational developments that will undoubtedly have an impact on the work and workload of the

controller the following may be mentioned : steady traffic growth bringing additional aircraft into the controlled airspace ; increases in flying speeds ; the advent of supersonic aircraft ; the extension in scope and altitude of the controlled airspace ; progressive application of control to all users of the airspace ; more closely co-ordinated and even integration of civil and military air traffic control services, which is being intensively pursued by I.C.A.O. ; the equipment of all aircraft with radio sets ; installation of additional airborne navigational aids on board aircraft ; and finally the rapid growth of general aviation at an even greater rate than that of air carrier operations, the development of further inter-city and inter-terminal helicopter operations and of vertical and short take-off and landing aircraft.

At the present time there is an acute shortage of qualified controllers everywhere. In the developing countries this shortage is particularly serious. Where the level of general education would normally make it possible to find eligible trainees the basic reason for difficulties in recruitment lies very largely in the relatively unattractive conditions of employment which prevail almost everywhere in this profession. There is the greatest need to raise these conditions to correspond with the qualifications required of controllers and the responsibilities they shoulder.

Training will of necessity become more complicated in future as technical and operational changes are introduced, and the increased requirements of the profession will, in turn, give rise to a need for the application of higher standards in the selection and recruitment of controllers.

The international character of the profession is evident. It would therefore seem logical that the training of controllers, particularly radar controllers, should be further standardised internationally. Standardisation of training through international co-operation will, in fact, become increasingly essential with the introduction of automation into air traffic control. A heavy programme of training is required to meet the chronic shortage of personnel.

The hours of work of controllers should in many cases be reduced and, in order to avoid over-strain and to minimise fatigue, the hours of work at radar screens and on night shifts should be reviewed and suitably limited. In work of this type shifts of the order of 12 consecutive hours give cause for anxiety. The reorganisation of hours of work and shift schedules to allow for better rest breaks would also appear to be called for, especially in the form of minimum periods of rest before assuming duty. This will become even more urgent as the workload continues to increase in the future.

Although many improvements have been made in the working environment of controllers, there is still a great need for further progress in this respect in a great many places. Among the outstanding problems are the need for appropriate layout of facilities, equipment and tools, adequate noise control and the installation of appropriate lighting. There is a great field here for the application of ergonomics. The participation of the controllers themselves in the design and development of facilities and equipment would be most helpful and might, indeed, prove to be indispensable.

Automatic processes most recently introduced into certain phases of air traffic control operations would not appear to have any adverse effects on the conditions of employment of controllers. Automation tends to facilitate and supplement their work rather than to replace them. On the whole controllers have responded favourably to automation, and there is no evidence of the fears and resentment manifested by workers in industry with regard to the possible impact of automation and technological change on their employment. This may well be due to the fact that for the foreseeable future the need for both new, modern equipment and additional controllers will continue to exist and consequently the future employment outlook is favourable.

In view of the importance generally attached to air traffic control services, and considering the complexity of the many problems in this field and the urgency of their solution, it is to be hoped that action will be taken by the authorities in collaboration with representatives of the staff concerned to improve the general conditions of employment for air traffic controllers ; this would be another step towards the achievement of optimum conditions in air navigation and would contribute, through the improvement of safety, to the continued orderly growth of aviation.