

MASS MINIATURE RADIOGRAPHY OF
CIVILIANS.



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MASS MINIATURE RADIOGRAPHY OF CIVILIANS

For the Detection of Pulmonary Tuberculosis

(Guide to Administration and Technique with a Mobile Apparatus using 35-mm.
Film : and Results of a Survey)

by

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PREFACE

In the autumn of 1941, at the request of the Ministry of Health, the Medical Research Council appointed their Committee on Tuberculosis in War-Time; and in October, 1942, this Committee issued a report (*M.R.C. Special Report Series No. 246*). One of the proposals made in the report was for the controlled use of mass radiography among the civilian population. This recommendation was accepted by the Government.

The first difficulty was the lack of suitable X-ray apparatus in this country. In order to ensure the availability of a standardised instrument of high quality, the Committee on Tuberculosis in War-Time had appointed a Technical Sub-Committee to make recommendations on the essentials of a suitable design; these were given in an appendix to the report mentioned. An excellent instrument was designed to a specification embodying these essential features, and approved by the Sub-Committee; and in the spring of 1943 the Ministry of Health and the Department of Health for Scotland announced that a limited number of mobile miniature radiography sets of this design were in the course of production at their request, and would be allocated in the first instance to selected local authorities in Great Britain.

The first set was purchased by the Medical Research Council themselves, who had received a recommendation from the Committee that a survey be conducted for research purposes on a few selected civilian population groups. Such a survey was a logical sequence to the Committee's report, and the team formed by the Council to carry it out included the secretary of the Committee and two members of the Technical Sub-Committee; these are also authors of the present report.

The objects of the investigation were three-fold: first, to discover the technical, administrative and social problems arising from civilian mass radiography, and to establish standard methods and procedures, in order to assist those responsible for the routine of the national scheme; second, to estimate the incidence of tuberculosis during war-time in various civilian groups, and to assist the authorities by estimating the demands likely to be made on the tuberculosis services as a result of mass radiography; third, possibly to throw light on the epidemiology of the disease. Thus, the purpose of the inquiry was as much guidance to others as the collection of statistical information. Indeed, many improvements were suggested by the experience gained, and these have already been incorporated in the manufacture of the X-ray apparatus, and in the training now being given to the teams that are to work under the local authorities in the national mass radiography scheme. Three of the authors of the present report have taken part in this training, which has been organised by Miss Clark on behalf of the Ministry of Health, and has already been completed for more than a dozen teams; and one of them (Dr. Kerley) has been appointed a Consultant Adviser on Mass Radiography to the Ministry.

The survey occupied the greater part of 1943; it covered approximately 23,000 persons from two factories, a large office group and a mental hospital, all of which were in Greater London. A description of the methods and results is given, together with suggestions for other workers in this field. The survey was purposely limited in size and scope, but, on the other hand, much time and care were spent on experiments in organisation, technique and interpretation, and the information has been exhaustively analysed.

The report is divided into two parts. Part I is a guide to the administration and technique of civilian mass radiography ; and Part II contains the statistical results of the 1943 survey by the Council's Unit, with discussion of associated problems.

It is recognised that the problems involved in mass radiography in civilian life differ to a large extent from those in the Services, where most of this type of work in Britain has so far been done. Hence the present report, by persons who have been closely associated with the development here of this diagnostic weapon, should be of considerable value in the early years of the civilian national scheme. It may also be useful in regard to similar schemes proposed in other countries, including liberated countries in Europe.

MEDICAL RESEARCH COUNCIL,
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15th September, 1944.

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MASS RADIOGRAPHY OF CIVILIANS

PART I

Guide to Administration and Technique of Civilian Mass Radiography

SECTION I

The Development of Mass Radiography

The detection of symptomless or latent pulmonary tuberculosis by mass radiography has been the subject of much careful investigation over the past twenty-five years. The results of chest surveys of apparently healthy groups, carried out in many countries, with full-size films, photographic paper or by screen examination (fluoroscopy), have clearly demonstrated the value of mass radiography, but all these methods have disadvantages which make their application on a large scale impracticable. The expense of full-size X-ray films is considerable, and the time required for processing and then interpreting them is too long; storage also presents a difficulty. Photographic paper is cheaper than film, but it has the same disadvantages of lengthy processing, slow interpretation and difficulty in storage, and the additional failings of poor detail and limited latitude for exposure. Large scale screen examination is cheap and easy to conduct, but fatiguing and dangerous for the operator; when carried out rapidly, it may result in minimal tuberculous lesions being overlooked; and no permanent record is provided.

It has long been obvious that all these disadvantages could be overcome by miniature photography of the chest image on the fluorescent screen, and, as far back as 1912, Caldwell not only predicted mass radiography on a national scale but described the technical developments necessary for its successful introduction. Approximately between 1925 and 1935 all the technical prerequisites for successful mass radiography were produced. Holland developed fine focus, rotating anode tubes, England contributed the highly luminescent Levy West screen, and Germany wide aperture lenses; while America, England and Germany all developed the necessary fine grain, fast film. It was left to de Abreu of Brazil to combine all these, and to employ mass radiography as we know it, on a large scale. He worked ceaselessly on the problem from 1924 onwards, and saw his labours justified in 1936. The pre-war literature of miniature radiography has been ably reviewed by Bentley and Leitner (1940).

Since the outbreak of war, miniature radiography has made great strides in its application to the examination of large groups of the apparently healthy, and its technique has been improved by intensive research, in which this country has had a full share. Both in the British Empire and in the U.S.A. the main field work has been government-sponsored—on Service personnel and war workers—but individual surveys have also been reported. In Britain, the Royal Navy and Royal Air Force led the way; because of shortage of medical personnel and the demands of the Services on X-ray manufacturers, it was not until 1943 that routine work on civilian groups was begun.

One of us has elsewhere outlined the origin of the British national civilian mass radiography scheme (Hart, 1944). The Committee on Tuberculosis in War-Time, set up by the Medical Research Council at the request of the Ministry of Health, reported in October, 1942 (*M.R.C. Special Report Series No. 246*). One of its proposals was for the routine use of mass radiography in civilians by means of the miniature method, which its Technical Sub-Committee had reported as having reached a suitable standard of radiographic technique and apparatus design. The Ministry of Health responded by

promptly implementing this recommendation, and in December, 1942, the Minister announced (Circular 2741) that mobile miniature radiography sets, in accordance with the specification approved by the Committee's experts, would be made available for the use of a limited number of local authorities, the limits being set by the restrictions of war conditions on production and staffing. These sets have been produced during 1943 and 1944 and, at the time of writing, 13 local authorities have commenced operations. Meanwhile, the team under the Medical Research Council, with which we have been concerned, has carried out field trials with one of these sets, and the experience gained has been drawn upon extensively in the present report.

American radiologists, accustomed to chest stereoscopy, were chary of any method which departed from the high technical standards to which they were accustomed; as a result, an apparatus which takes 5×4 -inch stereoscopic films was produced for their needs. The great disadvantage of this apparatus, however, is that it is static, and the interpretation of the films is a relatively slow process. After much research and careful consideration of all the problems involved, it was decided to use the 35-mm. fluorographic method, in preference to the 5×4 -inch method, for the British national scheme. The results to date have clearly justified the selection of this method, which in skilled hands is as accurate as the other, and has the added advantages of mobility of apparatus, larger numbers of examinations in a shorter time, and much more rapid processing and interpretation. Its accuracy has been demonstrated by a comparison of 35-mm. and 17×14 -inch radiographs taken in 2,000 subjects. (The results in the first 1,000 are given by Clark, Poulsson and Gage, 1941.)

SECTION 2

Equipment and Personnel for a Mass Radiography Unit

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A. *The X-ray Apparatus*

The following is a summary of the main features embodied in a mobile apparatus. This form of apparatus was used for the Medical Research Council survey, and is also being supplied for the national scheme to the local authorities through the Ministry of Health. We regard the majority of these features as essential in any similar type of apparatus. Some of the features are described in greater detail in subsequent sections of this report. *†

(i) *Power-unit.* The high tension power-unit, embracing four valve rectification, has an output of from 100 to 400 mA, with a maximum kilovoltage of 100 kVp and 91 kVp respectively. Provision is made also for screening at 3 mA at up to 85 kVp. When the electric mains supply is satisfactory, miniature radiographs are taken at 200 mA and large films at 300 mA. The exposure time for subjects of average chest thickness—8 to 10 inches—is then 0.1 sec. for miniature, and 0.05–0.07 sec. for large films. Unsatisfactory mains supply

* The manufacturer of the miniature radiography apparatus described throughout this report is Watson and Sons (Electro-Medical), Ltd. The apparatus was designed in accordance with a specification approved by the Technical Sub-Committee of the Committee on Tuberculosis in War-time.

† These notes should replace those in the Appendix of the Report of the Committee on Tuberculosis in War-time (1942).

(not met with on the M.R.C. survey) may necessitate exposures being made at 100 and 150 mA for miniature and large films, respectively, with appropriate increases in exposure time.

(ii) *X-ray Tube.* The rotating anode X-ray tube supplied with the apparatus has a dual focus. The focal-spot sizes are 1 mm. and 2 mm. square; for the higher milliamperages employed in mass radiography, it is necessary to use the broad focus. It is desirable to have a reserve tube. A multiple diaphragm fitted to the tube aperture serves to confine the X-ray beam to the area of the fluorescent screen at each of four distances—36, 48, 60 and 72 inches. The alignment between tube and screen is checked by means of an optical centring device.

(iii) *Fluorescent Screen and Grid.* Experience has shown that 16 × 16 inches is the optimum size for the fluorescent screen, the viewing side of which is covered by a sheet of protective lead glass. The yellow-green type of screen* used with the appropriate film forms the fastest combination as yet available. Important features of the radiographic grid are even spacing of the lead slats, and the highest possible radiographic translucency.

(iv) *The Camera.* The control of the electrically operated camera is linked with the X-ray exposure switch. The camera magazine is made to take 82 feet (25 metres) of 35-mm. film, which is removed in exposed lengths of from 5 to 25 feet; a cutter to divide the film is incorporated in the camera.

(v) *The Lens.* Experiments have been made with a number of different lenses, coated and uncoated, and it has been found that a new British-made lens of 2-inch focus and f/1.5 aperture, which is fluoride-coated, gives superb quality in the radiographs and is also faster than other lenses of this type tested.†

(vi) *Identification.* The identification system enables the number on the individual record card to be photographed on to the lower border of the miniature chest radiograph. The illumination of the card is controlled by the X-ray exposure switch. The mechanical position of the card is a factor in operating the electrical system; thus, the exposure cannot be made unless the card is placed correctly in the slot provided.

(vii) *Direct Radiographs.* High quality, full-size chest radiographs can be taken on this apparatus at distances up to 72 inches, although a 60-inch distance has been adopted for routine postero-anterior views.

(viii) *Screening.* Facilities for screen examinations are limited to positioning as a preliminary to taking a full-size radiograph.

(ix) *Adjustment for Height.* The use of a flexible cable system allows for a good range of subject heights, and only on rare occasions is it necessary for an examinee to stoop slightly to enable the whole of the chest to be included. Occasionally, an examinee is asked to stand on the higher portion of the camera-tunnel base in order to reach the screen, and persons under the height of 4 feet 8 inches stand on a low footstool.

(x) *Passage of Examinees.* It is unnecessary for examinees to pass through the apparatus between the tube and the camera tunnel, as was originally anticipated. They step in and out from one side only, passing by the apparatus, so that the operators, with their controls, work completely away from the side used by the examinees.

(xi) *Protection.* Protection from excessive radiation for the radiographers during routine operations is quite satisfactory. Metal protective screens, with lead glass viewing windows, are provided for the positioner and control table operators.

(xii) *Mobility.* The apparatus is mobile and can be dismantled or reassembled by two women in 12 minutes. Collection from the X-ray room and loading

* This is a Levy-West Mark 39 screen.

† This is a Cooke Anastigmat Lens, made by Taylor, Taylor and Hobson, Ltd.

into the van (or *vice versa*) takes approximately one hour. The carrying van should be fitted with tackle to raise and lower the three heavier parts of the apparatus.

(xiii) *Fitted Darkroom Van.* It is convenient for the carrying van to be fitted as a darkroom, thus rendering unnecessary a general purpose darkroom in the survey premises.

(xiv) *Generator.* The M.R.C. Unit has been fortunate in that suitable electric mains supplies have been available, but there is no doubt that a van fitted with a specially designed 20 kVA generator is desirable as an alternative to an unsatisfactory mains supply.*

Further details of this apparatus are provided by its manufacturer in booklet "Installation and Operating Instructions", and a general discussion of the principles involved in its use has been given by Minns (1943). It is imperative, however, for the radiographer to be able to deal with minor breakdowns; special instruction to this end will always be needed, and is at present included as part of the Ministry of Health's mass radiography training course.

A considerable number of improvements has been made in this apparatus as a result of our experience. These are incorporated in all new apparatus and, as far as practicable, will also be added to all apparatus already issued.

B. Accessory Equipment

A detailed list of accessories, with particular reference to the requirements for temporary premises, is given in Appendix 1.

C. Personnel

The following staff recommendations are for a Unit dealing with 1,500 subjects each week and including miniature, large film and medical examinations, as well as the completion of all appropriate clerical work—all staff, except the radiologist, being on a whole-time basis.† The functions of each member will be readily appreciated from the descriptions in the later sections.

- | | | |
|--|---|---|
| <ul style="list-style-type: none"> (i) Radiologist—1·3 half-day sessions each week. (ii) Medical Director. (iii) Unit Secretary. (iv) Radiographer-in-Charge (v) Senior Assistant Radiographer (vi) Photographer or Assistant Radiographer
(Darkroom Assistant) (vii) Marshal or Junior Radiographer (viii) Senior Clerk (ix)–(xi) 3 Assistant Clerks (xii) Doctor's Clerk. (xiii) Clerical Staff at Home Base. | } | <p>Permanent team of 8 dealing with actual radiographic examinations.</p> |
|--|---|---|

(i) *Radiologist.* The radiologist may report both on miniature and on large films, requiring three half-day sessions; or, if the medical director examines the miniature films, the radiologist should need one or two sessions a week for reporting on the large films. In any case, the radiologist and medical director will work closely together, and the latter should always be present for discussion during the reporting on the large films. Reporting sessions should be on specified days each week, so as to enable a programme for the Unit to be

* A number of vans equipped with generator, darkroom and lifting gear, is already under construction for the national scheme. See also footnote to p. 6.

† If the number is 1,000 subjects a week, the team can be reduced by two clerks; the Unit secretary and doctor's clerk should then be prepared to assist with the radiographic clerical work during rush periods.

booked some weeks ahead. A typical week's programme for the team might comprise 6 miniature, 2 large film and 3 reporting, half-day sessions.

(ii) *Medical Director*. The medical director has ultimate responsibility for the Unit as a whole. He takes part, with the Unit secretary, in the initial contact with factories or other establishments to be surveyed, particularly in giving expert medical information to management and workers. He may read both miniature and large radiographs, the latter with the radiologist, or, if the viewing of the miniature films is done by the radiologist, he should certainly participate with the latter in viewing the large films. Much of the medical director's time will be spent in interviewing and disposing of the abnormal cases—tuberculous and non-tuberculous—resulting from the surveys.

It will be wise for the medical director to serve whole-time. During the first few months, assisted by the special training provided by the Ministry of Health, and by participation in every process, he should be able to appreciate the many organising problems and technical difficulties that arise during a survey, and in this way he should be able to interpret any defects occurring in the radiographs.

He will obviously always work very closely with the Unit secretary and with the radiographer-in-charge (these three will be referred to as the principals of the Unit).*

(iii) *Unit Secretary*. The Unit secretary is responsible for all outside negotiations between the Unit and the establishment surveyed. The initial visit will be followed by the necessary mass radiography propaganda, and he or she will make the main arrangements for the survey. It is essential that the radiographer-in-charge should be called in to discuss, with the factory liaison officer and engineers, the lay-out of the X-ray suite, and other technical items such as electrical mains, water supply, etc.

The Unit secretary is responsible for contact between the Unit and the local authority public health department, for all records following a survey, and for the ordering of all materials and equipment according to medical and technical requirements. No doubt each Unit will have a records office at the home base, with permanent clerical staff who will work directly under the Unit secretary.

There should be a definite stage at which all data pass out of the hands of the radiographic team to the records office. Indeed, the work falls quite easily into four parts. The preparatory organisation is the joint responsibility of the three principals of the team. The radiographer-in-charge is then completely responsible for the production of radiographs, and for the organisation of the radiographic work, including the clerical side, while the examinees are passing through the department. When the full-size radiographs have been reported on, however, the records of abnormal subjects should be taken over by the medical director and be dealt with through his clerk, for the completion of medical interviews and disposal. The final records and analyses should then be the concern of the Unit secretary, in consultation with the medical director.

(iv) *Radiographer-in-Charge*. The radiographer-in-charge is responsible for the technical side of the work, and for the general supervision of the examinees passing through the X-ray department. He or she is directly responsible to the medical director. The radiographer-in-charge, with the great responsibility attached to this post, should not have to give her whole time to any particular part of the radiographic work. He or she should be free to act rather as a relief for every operation in turn, as becomes necessary, thus keeping in touch generally. There must be ample time to investigate any difficulties occurring in connection with the production and viewing of the miniature and large chest

* The development may be towards the home base of the Unit functioning as a chest centre for the observation cases, in which event it is not unlikely that a junior medical officer may also be required to be attached to the team. (See also footnotes to pp. 60 and 65)

radiographs, to keep a constant watch on the quality of the results, and to be free to answer any enquiries.

(v) *Senior Assistant Radiographer*. It is important to have a good senior assistant radiographer who is able to cope with the apparatus, and it is a good plan to give this assistant the general care of the X-ray plant.

(vi) *Photographer or Assistant Radiographer (Darkroom Assistant)*. This technician is responsible for the darkroom, but since the darkroom work on miniature film days does not exceed three hours, more than half her time can be spent acting as relief on the apparatus and in measuring chest thicknesses. It is therefore preferable to have a radiographer rather than a photographer. During the large film sessions, of course, the whole of the time of the darkroom assistant will be taken up in processing, and at all times the darkroom must take precedence as being the most important part of her work.

(vii) *Marshal*. In addition to controlling the flow of examinees, an important duty of the marshal is the measurement of chest thicknesses. As the latter requires accuracy, it would be as well to select someone who is technically minded. Such a person could also be taught the routine of the control table and of the darkroom. If the supply of personnel permits, it might even be advisable to appoint a junior radiographer, particularly if the darkroom assistant is a photographer (thus having three radiographers in the team). Such an arrangement would mean that fatigue could be avoided by interchanges of duty, and that, in the event of sickness, replacements of the technical personnel would be facilitated.

Both darkroom assistant and marshal should be able to relieve the clerks as necessary.

(viii)-(xi) *Four Clerks*. Seniority should be given to one of the four clerks, and it is helpful if she is also a stenographer. A second clerk should be able to relieve the marshal, and to assist with the changing of cassettes during large film sessions. The third and fourth clerks should be given responsibility for the two day-books and for checking the list of employees (nominal roll).

(xii) *Doctor's Clerk*. The functions of the doctor's clerk include writing the large film reports; keeping the large film recall book; arrangement of the appointments for medical interview; acting as receptionist at medical interviews; dealing generally with the correspondence of the medical director; and being responsible for the records of the "investigate" cases.

(xiii) *Clerical Staff at Home Base*. One or more clerks will be required to transfer information from the record cards to the Ministry of Health special statistical cards; to make the analyses and tabulations required by the medical director; and to keep in order the general files of films and record cards. They will work under the Unit secretary. Unless there is special clerical staff for this record work, the main team will be forced to interrupt the operational work periodically, as is already happening with certain teams.

While the individual duties are here defined, considerable mutual assistance is necessary; for instance, after the day's run all members of the Unit should be prepared, if necessary, to assist in completing the clerical work. Indeed, every effort should be made to develop the team spirit.

The arrangement of the X-ray suite is an important factor in the staffing problem*. In a well-planned department, the work of marshalling is negligible and can be dealt with by one person while measuring chests (with periodical relief). Less convenient planning may create the necessity for a full-time receptionist.

* The specially adapted carrying van of The Welsh National Memorial Association's Unit is arranged so that the X-ray examinations take place inside the van. The results of this arrangement—which may prove particularly suitable for small and scattered groups—will be awaited with interest.

SECTION 3

Approach to Civilian Groups—Propaganda and Preliminary Arrangements

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A. Preliminary Meetings and Publicity

Although the public has some knowledge of mass radiography, and is in favour of its introduction, intensive propaganda is required in individual groups that are to be surveyed; also, certain conditions have to be secured for the arrangements to run smoothly. We have learned much by experience and shall give what we now consider to be the desirable preliminary steps in arranging a particular survey, mentioning at the same time any important divergencies in our own procedure. As the Units working in the national scheme gain their own experience, they will develop and improve the procedure, which in any case will have to be adapted to local circumstances. In course of time, too, some of the propaganda may be unnecessary, as public knowledge and confidence in the method grow.

The following description applies to surveys carried out on the premises of the establishment investigated, but it can be adapted readily for cases where the apparatus is stationed at one site and subjects come to it from their places of work. The description applies to factories, and must be adjusted for office, school or other groups.

It is assumed that general publicity will have already been carried out in the area for which the mass radiography Unit is responsible. This may include preliminary discussions with, or announcements to, local organisations such as branches of employers' federations, trades unions, trades councils, the British Medical Association and the Association of Industrial Medical Officers. Medical Officers of Health and Tuberculosis Officers will presumably have been informed direct through the local authorities. A general conference in the area might include the above-mentioned, together with representatives of local factories and other interested bodies, while a discussion between the medical director and local tuberculosis officers and general practitioners might settle the smoothest procedure for disposal of abnormal cases.

The Unit will probably be faced with a long list of factories where there is the desire for a survey. The request may come from management, trade union or works medical officer. The most satisfactory is a joint request coming from management and workers, for this means that a welcome is assured.

At the factory selected, the first essential is to explain the scheme thoroughly to the representatives of management and workers, and to obtain their formal agreement.* The procedure suggested is as follows:—

(1) The management should be interviewed by the medical director of the Unit or by its secretary, and agreement obtained (a) that the scheme should be voluntary, but that the whole factory staff should be encouraged to volunteer, (b) that the results should be confidential between the team, the person concerned and any doctor who might be responsible for the care of the latter—therefore the results could not be communicated to the management or works

* Ministry of Health Memorandum 266/T (April, 1943), para. 12, states: "In regard to persons in employment it will be important that representatives of the Trades Unions and of the Employers should be consulted in advance as to the arrangements to be made locally".

medical officer without the consent of the person concerned,* and (c) that pay should be adjusted for time lost during the actual examination ;† in this regard, provided that the X-ray apparatus is to operate on the premises, assurance can be given that the effect of the time lost on industrial production is likely to be negligible—indeed in Survey 1‡ it was thought that the interest aroused by the scheme might even have increased the output.

The policy of the firm regarding re-employment of tuberculous persons after treatment should be explored at this meeting. Another essential is to secure that one person on the firm's staff will act as its organisational contact or liaison officer. His task will be to assist the Unit secretary and radiographer-in-charge in securing smooth running on the administrative and technical sides, and, in particular, to organise the collection of names of volunteers, and the arrangements for their attendance at suitable times. On the efficiency and interest of this person, and his influence with the workers, will largely depend the success of the scheme and the number of volunteers. As a rule this liaison officer should not be from the medical department—probably someone from the personnel or welfare staff may be the most suitable.

(2) A short meeting should be arranged between the Unit's representatives, including its medical director, and the shop stewards or shop stewards' committee (representing the workers in the factory), or the factory health and safety committee, joint production committee, works council or other joint management-labour committee; also, if possible, a similar meeting should be held with the supervisory staff's representatives. The object of these meetings is to explain the scheme and to answer queries, so that favourable propaganda may be carried back into the shops on the initiative of the employees themselves. Not only formal agreement but vigorous co-operation by the shop stewards should be aimed at. At the meeting the following points may be made :—

- (a) that the scheme is voluntary, free, and the results confidential (see above);
- (b) that a 100 per cent. response is desired; volunteers to include persons in good health as well as those having any symptoms, and to include also previously diagnosed tuberculous cases;
- (c) that the finding of a normal chest at the time of X-ray is not an absolute guarantee for the future, and that mass radiography will eventually have to be repeated regularly, in order to achieve its full value—even then, anyone who develops suspicious symptoms between routine X-ray examinations will be expected to report these promptly to his or her doctor;

* The Report of the Mass Radiology Sub-Committee of the Ministry of Health's Standing Advisory Committee on Tuberculosis (1943) states (para. 48): "It should be made clear, both to representatives of the employees and to the employers, that information obtained by the examination will be confidential. Generalised statistical information may be given to the employer or to the management of a factory if it is reasonably clear that it cannot be used to the prejudice of individual employees. If there is a works medical officer his co-operation in the examination should be secured but, if there is any suggestion from representatives of the employees that his participation in the examination of individuals would prejudice the confidential nature of the information obtained, it will be necessary to confine his part in the work to general matters and so avoid this risk. The welfare staff of a factory may, under similar conditions, give suitable help." Similarly, Ministry of Health Memo 266/T makes the following recommendation (paras. 17 and 23): "It should be clearly made known that the result of the examination will not be disclosed to anyone but the individual concerned without his permission." "No information about an individual's condition can therefore be given to the medical officer of the works at which he is employed, except with the worker's consent."

† Ministry of Health Memo 266/T, para. 17, recommends: "The Minister hopes that employers as a whole will encourage their employees to have the benefit of this examination by compensating them for time lost in attending for examination under the approved scheme."

‡ See p. 12, footnote.

- (d) that a proportion (about 5 per cent. in our experience) of those radiographed will be recalled to have a full-size film—over half of these will probably be found normal at this repeat-examination (the previous doubt having arisen from technical causes), but the remainder (say about 2 per cent. of the total examined) will be found to have X-ray appearances suspicious of abnormality, and will be asked to a private medical interview with the medical director of the team (or tuberculosis officer, etc., according to the Unit's arrangements);
- (e) that, finally, about 1 per cent. will be found to have tuberculous trouble requiring observation at work or treatment at sanatorium, and that the other 99 per cent. will have the satisfaction of knowing that their chests are satisfactory; the majority of the 1 per cent. will be able to continue work, and even those requiring active treatment should have better prospects of cure than persons whose disease is discovered in the ordinary way.

At this meeting, it will be advisable to emphasise that tuberculosis is not necessarily fatal, as is commonly thought; that it can be more easily cured if diagnosed early; that the cure may not necessarily involve leaving work; and that in the early, and sometimes even in the more advanced, stages symptoms may be slight or absent. At the same time, care must be taken lest the impression be left that an individual can afford to ignore symptoms developing after a normal radiograph, or that, in general, the dangers of tuberculosis can be lightly dismissed. The internal arrangements of the scheme in the factory (e.g. publicity, methods of collecting volunteers, recalling "suspects", provision of medical advice for those needing it, etc.) should be discussed. The financial position of persons advised to leave work is likely to be raised, and the national scheme of allowances introduced in 1943 (Ministry of Health Memo. 266/I) will have to be explained. The question of re-employment is also likely to be brought up, and it will be helpful if the management is able to state that suitable jobs will be provided if and when the worker is fit to return to industry.

In our experience, this meeting with the employees' representatives has been most valuable. We have been impressed by their sense of responsibility, and have found them eager to co-operate, and fully appreciative of the value of mass radiography both to individual sufferers and to the community. Without this co-operation of the shop stewards, the rank and file of the factory may feel that the scheme is being imposed on them "from above".

(3) Publicity should reach the individual employee mainly in two ways: (a) through his shop steward, who—or whose committee representative—will have already met the team; (b) through a leaflet, e.g. in his pay envelope. In addition, a canteen or similar mass meeting may be desired, while notices may be posted, and an announcement made on an internal broadcasting system. Photographs of previous surveys can be displayed, and an excellent 12-minute film is obtainable from the National Association for the Prevention of Tuberculosis, from which other publicity material can also be obtained. The works medical officer can be of valuable assistance in this publicity.

The leaflet should contain the more important of the points mentioned under (2). The following is an example of such a leaflet, for a survey where the X-ray apparatus is being operated on the premises:—

" To all Employees :

MASS RADIOGRAPHY (TUBERCULOSIS) SCHEME

As part of the national campaign against tuberculosis, Mass Radiography is being made available in this area, and this factory will shortly be visited by the . . . Unit, which will remain for . . . weeks.

After full discussion with the medical director of the Unit, the management and shop stewards' committee (or the joint works council, etc.) have welcomed this scheme wholeheartedly, and have resolved to do their utmost to make it a success.

The new apparatus used makes it possible to X-ray quickly large numbers of people for the early detection of tuberculosis. If tuberculosis can be discovered in its early stages, it is comparatively easy to cure; it may not even be necessary to leave work.

The examination will be free and voluntary. The results will be strictly confidential and will not be communicated to anyone else without your permission. Any communication will be to your private address.

Appointments will be made in every shop and department for those agreeing to take part, and it is hoped that there will be *as near a 100 per cent. response as possible*. Everyone is wanted, including any who may have been, or are, under medical care for tuberculosis or other chest or heart disease.

The taking of the X-ray picture is only a matter of seconds, and is like having an ordinary photograph taken. There will be no need to undress completely; a clean wrap will be provided for each woman. The X-ray apparatus will be inside the factory. Payment will be made for the time lost in working hours, but it is hoped that employees will do their best to see that the production programme does not suffer.

In some cases it will be necessary to recall persons for a second photograph, but such requests should not be viewed with alarm, since many of these re-takes are for technical reasons, such as an imperfect negative. Should medical attention be indicated, the doctor of the Unit will offer to see the individual privately, and give him advice as to any action that may be necessary to safeguard his health."

(4) A preliminary talk is advisable between the Unit's radiographer-in-charge, the medical director or Unit secretary, and the factory's liaison officer. The Unit's team can learn points of organisation about the factory, e.g. populations, shift rotas, departmental clock numbers; and the detailed procedure can be agreed. In particular, the collection of volunteers, and the arrangements for their attendance for X-ray, should be dealt with, and the provision of a nominal roll arranged. The accommodation for the medical interviews of abnormal cases by the medical director can also be decided. (More details are given on pp. 15-18 and 55.)

B. *The Role of the Works Medical Officer*

Under the present arrangements, the works medical officer, or the nurse if there is no doctor, can play a valuable part in disseminating publicity—not the least of which would be the offer to be the first volunteer. If possible, the works medical officer should be present at the preliminary meeting between the team's representatives and the management and shop stewards—presumably, where a factory health committee exists he will be a member of it. But while he will receive a statistical report of the findings, he cannot expect to know individual results without the permission of the examinee in each case, since this would constitute a breach of the confidential undertaking quoted on p. 7, and would be contrary to professional custom. Moreover, such action would be entirely inconsistent with the present voluntary basis of the national mass radiography scheme, and would probably endanger the latter by discouraging volunteers.

The necessity for the application of professional secrecy for this examination, carried out by a team unconnected with the factory, is generally appreciated by industrial medical officers, though it is natural that they should sometimes feel aggrieved at being excluded from seeing any but a statistical report from the medical director of the Unit. A works doctor will, in fact, know of the individual results in his factory in so far as the persons concerned inform him themselves, or give permission to their family doctor or tuberculosis officer to do so. Factors favouring the communication of this information will be a high degree of confidence of the employees in the works doctor, and a known generous policy on the part of the firm towards persons who contract tuberculosis—both during and after their treatment; factors operating against it will be the suspicion in employees' minds that the knowledge that they are suffering from tuberculosis, even in mild forms, may be used to their detriment.

In general, a keen medical department can do much for tuberculous employees, particularly for the returned "treatment" cases, for "good chronics", and, increasingly as mass radiography develops, for the sub-clinical cases requiring

observation only; rearrangement or changes of job, reduced overtime, half-time work, the creation of a special rehabilitation shop, etc., can be arranged by the medical department. Efforts in such directions, which are seen to be in the interests of the employees, will soon result in knowledge of the identity of most or all the tuberculous cases in the factory. Additional stimulus will be provided if the works medical officer informs the local tuberculosis officers of his willingness to collaborate in adjusting hours, etc., in the cases of workers at the factory under the tuberculosis officers' care—and this applies, of course, in cases quite apart from those discovered by mass radiography. Clearly, however, there may be always a small number of persons with tuberculous lesions who are unwilling for the works medical officer to know of their condition, and the wishes of these persons must be respected; even so, most of them will probably be willing to accept medical advice from a doctor or specialist unconnected with their place of work.

When discussing the confidential aspects of mass radiography surveys, the medical director of the team should point out that it is not his function, with a brief experience of a given case, to impart information to the works doctor even when the patient is quite willing; such a communication is best left to the doctor or specialist (e.g. tuberculosis officer) who will be responsible for the patient's future care.

The national mass radiography scheme has been conceived on a voluntary and confidential basis agreed with the Trades Union Congress, and on this basis the strictest professional secrecy regarding the results of the individual examinations made under the scheme in industry must be maintained. The view has been put to us, however, that a case could be made, in the interests of the community, for medical action to be made compulsory on the findings in individual instances—which is tantamount to changing the confidential nature of the scheme. In our opinion, at least four conditions would have to be fulfilled before such a change was justified: (1) entry to the scheme on the part of individuals to be compulsory instead of voluntary, and public opinion to be ready to accept this change; (2) enough apparatus and trained personnel to be available to cover the population, including re-takes at suitable intervals; (3) industrial medical officers to be financially independent of managements; and (4) facilities to have been provided for safe and reasonable employment in normal industry for those fit to work, even if the disease is in an infective stage. We believe that most, if not all, of these conditions are desirable in themselves, and we agree that an eventual change from the voluntary and confidential basis of mass radiography might also be desirable. But the time for such a change is not yet ripe, and the present arrangement must continue for some years, until the value of mass radiography has been fully demonstrated. Until then, there are many other developments that can be pursued, which will encourage persons to volunteer for the scheme and make those who are found to have tuberculosis ready to accept medical advice.

SECTION 4

Preliminary Technical Arrangements

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A. Premises

It is essential for the Unit to have a home base. This should be large enough to be used for surveys when required; it can serve also as a re-fitting centre between "outside" surveys, and to accommodate records and provide offices for the Unit's secretary and records staff. It is not unlikely in the future that facilities for simple laboratory tests will be provided at this home base.

The following comments deal chiefly with the conditions met with when the Unit is on tour—i.e. when the apparatus is placed on the premises of the establishment investigated—but the essential recommendations apply also to surveys at the home base.

Presuming that the Unit will be working to full capacity, the premises should be large enough to accommodate working arrangements for a team of eight, as well as for the medical director and his clerk. When an open floor space is available, it is divided into five rooms, comprising reception, undressing, office, X-ray and dressing rooms: the darkroom, doctor's room for projection and clinical examinations, and doctor's office may be established nearby.

The premises will vary, and sometimes a series of separate rooms will be provided. The arrangements met with in the four groups of the M.R.C. survey, and later in the two surveys undertaken in connection with the Ministry of Health training scheme, are described under Surveys 1-6 in Appendix 2.* In two of these surveys, the division of the large floor space was made by using wooden frames covered with hessian or "blackout" curtaining; in three surveys the existing dividing walls were suitable; and in one it was necessary for the Unit to provide partitions.

The situation of the X-ray room can be decided only when the position of the electrical mains supply is known. The floor where the apparatus is to stand must be reasonably level (see Survey 4).† If the water supply is not within easy reach of the X-ray room, it will be necessary to establish a "dry" darkroom conveniently near for changing cassettes, with the main "wet" darkroom for processing adjacent to the water supply.

When division of the floor space is necessary, communication should be arranged between the following: Unit entrance and reception room, reception room and both undressing room and office, office and X-ray room, X-ray room and dressing room, dressing room and exit. Thus, a one-way passage is established, and the amount of labour to control examinees passing through is minimised. Curtains or a door to close each room are an advantage, and there must be, of course, provision to darken the X-ray room for screening (fluoroscopy) and the doctor's room for viewing films, and also to make the darkroom itself completely light-tight.

For a Unit running at 1,500 miniatures a week, it is suggested that the minimum floor space for the various rooms should be as follows:—

<i>X-ray suite</i>		<i>Other rooms</i>	
Reception room ..	160 sq. ft.	Darkroom‡ ..	140 sq. ft.
Undressing room ..	150 " "	Doctor's room ..	140 " "
Office	160 " "	Doctor's office ..	120 " "
X-ray room ..	240 " "		
Dressing room ..	160 " "		

* Surveys 1, 2, 3 and 4 correspond respectively to Factory A, Office Group, Mental Hospital and Factory B, of the M.R.C. survey. Surveys 5 and 6 refer to a further large office group and another factory group, both examined in connection with the Ministry of Health training scheme.

† It is intended to fit floor rails and a means of levelling to all future apparatus, and, if possible, to existing apparatus. The focus-screen and focus-film distances will then be adjusted by a scale on the floor rails.

‡ Even where a van fitted as a darkroom is available (see p. 4), the space in the latter will be limited, and the facilities for placing the van may be unsatisfactory; it is therefore desirable, if at all practicable, to have additional darkroom accommodation on the premises.

In deciding on premises, the arrangements for unloading the apparatus and accessories from the delivery van, and the proximity to a convenient entrance gate, are important considerations. In Survey 1, the X-ray suite was very accessible and was on the same floor as a van-loading platform. In Survey 2, on the other hand, difficulty was experienced, owing to the rooms being two floors below street level.

The approach to the survey premises for the examinees should be clearly shown by directional notices. Both these and the instructional notices in the various rooms (see Appendix 3) can be fixed by the carpenters when the room divisions are being made.

The furnishing required is simple and can usually be borrowed. It might include two tables and several chairs in the reception room; benches or chairs all around the undressing room; four tables and eight chairs in the office, with a bench or additional long table for record files; one long and one small table in the X-ray room, for the clothes of the examinees and for the X-ray accessories; one high chair for the control table; and two further chairs. The dressing room can be furnished similarly to the undressing room, with the addition of a large mirror.

It is necessary to have a deep darkroom sink (see Appendix 1) to take the large tanks for processing up to 17 × 14-inch films, preferably with hot and cold water supply; a wet bench for the miniature films; a long dry bench for the loading and unloading of large film cassettes and for handling the miniature films; a bench for storing unexposed films and another for chemicals. Drying arrangements for the miniature films may consist of a small drying cabinet, or hot air blowers may be used in a dust-free room. For the large films, ample space is necessary for drying lines to take at least 100 films.

The doctor's consulting room requires the following: two or three tables, four chairs, clinical couch, blanket and pillow, dressing screen, viewing box, waste bucket, stationery, towels, and possibly a table lamp and a radiator; washing facilities should be at hand. The doctor's office should adjoin the consulting room.

A full list of the accessory general and darkroom equipment is given in Appendix 1. From this, a selection can be made for each survey, to be transported with the X-ray apparatus.

B. *Electric Supply*

(i) *Power Supply.* The X-ray apparatus should be placed as near as reasonably possible to the main electricity supply distribution point in the building, in order to avoid the use of any long additional cables.

Efficient operation of the apparatus depends upon its being connected to a supply network having a comparatively low resistance, and in Table I of the "Installation and Operating Instructions," provided by the manufacturer of the apparatus, the maximum resistance of the network for all possible voltages and supply conditions is given.

The supply into the X-ray room should terminate in a 50-amp. double-pole iron-clad switch of the 600-volt type, which the apparatus manufacturer suggests as capable of handling the maximum current taken by the apparatus, bearing in mind the fact that maximum loads are taken only for periods of 0.1 sec.

With a 50-cycle A.C. single-phase supply at about 230 volts, a supply line capable of delivering about 80 amps. to a normal commercial or industrial load will usually be suitable.

It is essential to make direct contact with the electrical engineer on the premises, and it is particularly important, when discussing the loading of the apparatus, to make it clear that the load is intermittent and for very short periods only—of the order of 0.1 sec. in each 30 secs. On the other hand,

every effort should be made to arrange with the engineer that the power is taken from a cable that does not carry heavy intermittent loads (e.g. lifts)—preferably it should be taken direct from the mains coming into the premises.

Until experience is gained by the Unit staff in dealing with the supply question, it is advisable to have the guidance of the apparatus maintenance engineers when approaching new establishments.

The standard apparatus as provided will operate on single-phase A.C. supplies between 140 and 260 volts, 50 cycles. When only a three-phase supply is available, or when the supply company will not permit connection with the existing single-phase supply, a three-phase to one-phase step-down transformer of a suitable type must be obtained (see Survey 2, Appendix 2). A standard transformer of this type is available, which will operate on any three-phase 50-cycle supply between 400 and 480 volts; it will deliver a single-phase output of 230–260 volts, depending on the incoming three-phase supply voltage.

It is sometimes possible to arrange for connection of the X-ray apparatus to one of the three-phase lines and to the neutral lead of a three-phase 4-wire supply. A connection of this kind may often be negotiated with the supply authorities, if the intermittent nature of the load is made known to them, and if they know that the apparatus will be operating in the particular establishment for a few weeks only (see Surveys 5 and 6, Appendix 2).

(ii) *Lighting and other Non-power Points.* Should artificial lighting be necessary, care should be taken to see that the clerks have suitable table lamps and that there is good lighting also for the X-ray apparatus and control table. In the darkroom, additional lighting points are required for two safelights, for the miniature film projector and the film drier, and for the developer immersion heater. In the doctor's room, lighting points should be available for the projector, the X-ray viewing box and the table lamp.

(iii) *Heating.* In winter, there should be adequate heating, particularly in the two changing rooms and in the doctor's room, as coldness is one of the chief complaints likely to be met with from the examinees. The temperature of the darkroom should be about 65° F. Fans should be provided in the main rooms of premises with very low ceilings.

C. Water Supply

This is a greater problem than was at first anticipated (see Appendix 2). The water must be free from foreign matter, and the use of a filter at the source may be necessary (see darkroom procedure, p. 47). It may not be possible to have running water in the darkroom. This means that all solutions will have to be prepared at the nearest water supply, which may be in another part of the building, and preferably where there is hot water available. It also means that both miniature and large films will have to be washed some distance away from the X-ray apparatus; and there may be some difficulty in obtaining the use of a sink large enough, and with taps high enough, to take the large film washing tank (see Appendix 1). If the water is very hard, it is advisable to rinse the washed films in a 1 per cent. solution of acetic acid. The maximum rate of flow likely to be required for washing films is about 50 gallons an hour, and any filter used should have this capacity.

D. Miscellaneous

It is advisable to secure both house and outside telephone facilities.

A small stamp showing the name of the factory will be required.

The daily cleaning of the rooms should be arranged, and provision made for the laundering of the chest covers worn by the women examinees, and of the white coats of the staff. A request should also be made for hand towels and soap. In badly ventilated premises a disinfectant spray is recommended.

If the premises are likely to be used for other purposes, e.g. air raid shelter or canteen, arrangements should be made to safeguard the X-ray plant. The camera should be removed each evening; both it and other essential parts of the apparatus, and the clerical records, may be conveniently locked in the darkroom.

The time schedule will, of course, have to take into consideration the time occupied by the members of the team in travelling. For the staff, arrangements should also be made for food, cloakroom accommodation, and—if there is to be nightwork—for resting. Entrance passes will be required for most factories.

In estimating the total period required for a survey, account should be taken of the fact that there will be a second chance for volunteers (see p. 17), and that, after the last miniature films have been taken, time must be allowed for reporting, and for recall for large films. The clinical interviews will continue after the apparatus has been removed.

E. *General Organisation*

The medical director or Unit secretary will have already arranged with the management for the appointment of a factory liaison officer (p. 8). It should be made clear that the latter's work will be considerable. Immediately after the preliminary meetings, the radiographer-in-charge, and the medical director or Unit secretary, should make contact with the factory liaison officer; and from thence onwards all arrangements should be made directly with him.

The items discussed with the liaison officer should include the numbers in the factory, and the provision of a list of employees (nominal roll); also the probable percentage expected to volunteer. The shift rotas and clock number systems should be inquired into, and a note made, or list obtained, of the principal occupations and grades of employees. Great variation may be met with in the shifts in a factory. In one survey, there were permanent day and night workers, three-shift workers rotating weekly, two-shift workers alternating weekly, and part-time workers both morning and afternoon. In planning the work of the Unit, the approximate numbers of workers involved in each type of shift should be determined. In order to cover all shifts, it may be necessary for the team to undertake several night sessions.

It is important to see that the factory liaison officer fully appreciates the routine of the survey. Unless this is understood, there are likely to be serious mistakes in the arrangements for sending examinees to the Unit. In any case, there should be a close co-operation throughout, and no unusual steps should be taken by the liaison officer without consulting one of the principals of the team.

It is essential for a definite programme for at least a week to be made in advance, deciding which sessions are to be used for miniatures, for large films, and for reporting and clerical work. For a Unit taking 1,500 miniatures, and completing all follow-up work in a five-day working week composed of ten half-day sessions, six of these can be miniature film sessions; this rate of 250 miniatures a session can, of course, only be reached after considerable practice and when the organisation for the supply of examinees is satisfactory. Allowing for at least 5 per cent. recalls, the six sessions' work will provide enough large film examinations (75 subjects) to occupy two sessions. The remaining two sessions will be required for reporting and general clerical work. This programme can be shown on a time sheet for the week ahead. Such a sheet shows times from, say, 9 a.m. to 5 p.m., divided into five-minute intervals; the periods of the day to be used for X-ray examination are indicated, after discussion between the principals of the team and the factory liaison officer; the latter will be given the sheet, so that he may arrange the group appointments, which he fills in day by day. (If there is a shortage in the chest covers available, the sessions for women must be booked with consideration of laundering arrangements.) A specimen week's time-sheet is given in Appendix 4.

Assuming there are two sessions a day, the exposure period will be 5-5½ hours, but there should be a short break for the team after 1½ hours, and no exposure period should exceed 2 hours without a break. A suitable schedule would provide for starting at 9.30 a.m., a 10-minute break at 11 a.m. (i.e. the last arrivals at 10.50 a.m.); work to continue again from 11.10 a.m. until 12.30 p.m., the exposure period thus ending at 12.40 p.m. After a lunch interval from 12.50 to 1.50 p.m., the examinees would start arriving again at 2 p.m. and would continue until 3.50 p.m., the day's taking of miniature films terminating at approximately 4 p.m., after a total exposure period of 5 hours (composed of 57 five-minute periods).

During the first few surveys by a newly constituted Unit, it is as well to limit the number of examinees to 5 or 6 every five minutes. With experience, however, it should be possible to increase to the rate of 8 to 10 in five minutes. When the X-ray suite is some distance from the examinees and transport is required, it is necessary to bring groups of 30 every fifteen or twenty minutes (a larger reception room may then be necessary).

With the above arrangement of a working day, and at the maximum rate of 10 every five minutes, 570 examinees would be booked for the day. In practice, however, there is usually a deficiency of at least 10 per cent. in the number of actual arrivals, and a day's work as outlined would not therefore greatly exceed 500 miniature examinations.

An interval of 10 minutes will be required when changing from one sex to the other, in the examinations, and it is preferable, therefore, so far as possible to keep to one sex for each period.

There will, of course, be a considerable amount of preparatory work and clearing up before and after each session. The radiographer-in-charge should be aware of each day's programme not later than the previous afternoon, by seeing how the liaison officer has filled in the time-sheet.

When a weekly night session is necessary, the team should have the morning free and the afternoon session should be later than usual (say, 3-6 p.m.); the night shift might be from 8.0 p.m. to midnight.

The taking of 1,500 miniature radiographs in one week should not imply that this average can be maintained throughout a survey, because of various interruptions and delays towards the end. Thus, for the examination of 6,000 persons, six weeks might be a reasonable time.

It is obvious that, with two teams working on shifts, the *apparatus* could function for 10 hours a day, X-raying 1,200 examinees. This would produce 6,000 miniatures in a 5-day week and require about 300 large film examinations—which would have to be done by a third team on another, simpler apparatus. Organisation on these lines would, however, offer little advantage, because it is difficult at present to provide even 500 examinees a day at one centre.

When the apparatus is newly installed, a test-run should be made on a small group, and it is essential to project this strip of film, so that any variation in the electric supply, or any defects in the apparatus arising from transport, can be known before making a large number of exposures. If all preliminary arrangements have been made, and if the apparatus is delivered in the morning, it should be possible to have this trial made on the same afternoon.

F. *The Collection of Volunteers, and Arrangements for Attendance*

Considerable variation in the percentages volunteering in different survey groups has occurred, both in our experience and in that of others. From the discussion in Section 3, it is apparent that many factors are involved, and one of the tasks of the various Units operating in the national scheme will be to work out efficient systems for obtaining the maximum number of volunteers, having regard to limitations of time and energy.

One of the most important factors in determining the proportion of volunteers is the method of collecting them. We have used and seen several methods, and are satisfied that the worst is to leave it to the individuals themselves to send in their names to their foremen or to a central office; this method will exclude the large group of apathetic people. The arrangement that we favour at present is as follows.

The factory's liaison officer (see above) visits the shops and departments in rotation, keeping in step with the demands of the Unit, so as to maintain an even flow. On these visits, he marks up his copy of the week's time sheet, allotting a number of the 5-minute periods to each department, and making appointments personally with each volunteer. This personal contact, which gives the opportunity for the individual doubts and suspicions of waverers to be removed, and their queries answered, by an enthusiast (for so the liaison officer should have been made by the Unit team), should be effective, providing that the ground has been adequately prepared. It is far less satisfactory to leave the distribution of appointments to the various shop foremen or supervisors. The liaison officer can usefully make a "second round" of the shops later, to pick up stragglers who have become converted during the period of the survey.

Firms have been willing to print a special attendance form for every employee. On these forms should be entered the name, clock number and shop or department (an "addressograph" system may be available), as well as the appointment time. These forms, together with blank envelopes (for the eventual result of the examination to be sent to the home), can be distributed to the volunteers in the shops by the liaison officer when making the appointments. The volunteers are asked to address the envelopes, and to bring them and the attendance forms to the X-ray examination. With this procedure, it will save the time of the Unit clerks if the form carries headings for some of the social particulars required for the national record card, e.g. age, address and home town, with the request that the individual fill them up before attending for X-ray; the Unit clerks will find transference of these particulars to the permanent cards easier than obtaining them by questioning. The back of the attendance form can carry any necessary further instructions and information, and can warn of further particulars that will be requested.

It is very desirable that the Unit staff, and the factory's liaison officer, should be able to see, as the survey progresses, how nearly the numbers radiographed approach the target—not only for the factory as a whole, but also for the different departments. Only in this way can the deficiencies be observed and those shops which require special attention in the "second round" be indicated. To secure this, a departmentalised list of employees (nominal roll) should be obtained from the management and kept in the X-ray department, names being ticked off by the Unit staff after the examinees have attended; when the survey is over, the average total figures of absence from work for the period will enable the factory-target figure to be adjusted.

If a nominal roll is not available, the attendance forms themselves can serve the same purpose (since they correspond to the entire personnel), if they are perforated and the counterfoils are retained by the liaison officer when appointments are accepted; the counterfoils are passed to the Unit before the attendance of the examinees concerned. In this way, persons who accept appointments but change their minds and do not attend will be known, since their counterfoils will remain without the corresponding forms.

Probably some better system of checking, at any desired moment in the survey, the numbers that have attended from any given shop or department against the target will be devised, but it is difficult to see how to avoid the routine labour of checking the names.

The factory liaison officer should be informed of the necessity for a test run before tackling the main group, and for this purpose he should be prepared to supply 10 or 20 volunteers.

The liaison officer should be warned that the apparatus, although very good, is by no means infallible, and that in the event of a breakdown he will be informed immediately, so that the flow of examinees may be stopped without delay. He will then be given the names and appointment times of the last group to have been examined satisfactorily, and the names of examinees who were exposed but whose chest films were unsatisfactory because of the breakdown. The latter, he will arrange to recall verbally for further miniatures to be taken. The liaison officer must also be warned of the possible necessity of recalling a group of examinees who had apparently passed through satisfactorily, because of the later detection of a mishap on the apparatus or in the darkroom.

SECTION 5

The Unit at Work

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A. *Moving In*

The accessory equipment will have been selected from stock according to the conditions of the particular survey, and an estimate made as to the quantity of films and chemicals required. Not all the items shown on the list of accessories (see Appendix 1) will be required for every survey. Nevertheless, since no reliance should be placed on obtaining any materials on site, the accessory equipment will necessarily be considerable. One of the team should be made responsible for checking the accessories in and out of the home base store.

For the M.R.C. survey, the manufacturer transported the complete equipment. The van was fitted with a winch and runway, so that there was no difficulty in raising and lowering the heavier parts of the apparatus into it. About one hour was required to move the apparatus out of or into the van and to or from the X-ray room, and a further hour for removal of the general accessories. In the absence of a fitted darkroom van (p. 4), the arrangements were very simple, a series of 18 carrying boxes having been made to contain all accessories ordinarily required (see Figs. 1-4, and Appendix 1). The addition of three table tops enabled the carrying boxes to be used as benches in the darkroom. The label of each box showed its contents.

It is presumed that, at the X-ray centre, all preparations to accommodate the Unit will have been completed in advance. On arriving at the premises, each member of the team should be responsible for a particular part of the equipment. The radiographers install the X-ray apparatus, the darkroom assistant fits up the darkroom, the clerks prepare the office, and the marshal the dressing rooms. Thus it should be possible to make a test-run a few hours after arrival, most of the time having been taken in the preparation of the darkroom. It is advisable to take enough made-up developer and fixer for several days' miniature work; one of the carrying boxes has divisions to contain six "Winchester" 80-oz. bottles (see Fig. 3).

B. General and X-ray Procedure

(i) *Alignment and Adjustment of Distance.* Before each session, and at other times as necessary, the alignment of the apparatus is carefully checked by bringing the camera-screen unit towards the transformer unit, so that the two pairs of white lines on the bases are exactly opposite. The camera-screen unit is then moved back to the required distance, which is read off by hooking to the tube holder the free end of the spring tape measure attached to the side of the frame of the fluorescent screen.* It is important to see that the correct aperture of the multiple diaphragm to the tube is in position, according to the distance used; the four apertures cover, in turn, 36, 48, 60 and 72 inches focus-screen distance.

The centring target is placed in position to mark the centre of the fluorescent screen, and the optical centring device is inserted into the tube diaphragm. After temporary release of the coupling between the tube and the camera-screen unit, the tube is raised in relation to the fluorescent screen, in accordance with the height scale on the base of the tube stand. From this position the tube is tilted downwards until, as seen through the optical centring device, the cross wires of the latter are over the screen target. This procedure not only ensures that the then horizontal ray from the tube is at a suitable level for correct centring to the subject (over the 4th-5th dorsal vertebrae), but that the beam of rays emerging through the diaphragm is confined to the area of the protective lead glass that covers the camera side of the fluorescent screen.† The centring device is then returned to the control table, where it must be replaced in order to allow electrical contact to be made, and the apparatus to function. Incidentally, the radiographic grid is in front of the screen and is therefore in contact with the examinee during exposure.

The tube focus selector switch is set to "broad" for both miniature and large film work, with these rare exceptions: (1) when the mains supply necessitates the use of a low output, making it advantageous to use the fine focus; (2) if the broad focus ceases to function.

(ii) *Miniature Radiography.* For miniature work, the focus-screen distance and multiple diaphragm are adjusted for 36 inches, and the switch on the side of the card illuminator is placed at "M.R." (miniature radiography). Should the M.R. switch be left in the normal position, as required for large films, the camera will function but the automatic safety devices will not be in circuit and there will be no indication of when the 82 feet of film have terminated, nor whether the film has been threaded correctly, nor whether the shutter has been left over the camera aperture. This means that when the film magazine is empty, or if the film has slipped out of the slot of the take-up spool, unless note is taken that the external disc on the spool is not rotating, a series of exposures may be made without fresh film being in the gate, and examinees will have to be recalled.

* In future apparatus, distance will be indicated on base rails. See footnote on p. 12.

† The *projection* of the lungs is the same as when the tube is off-centred to the 4th-5th dorsal vertebrae without tilting.

Lead figures showing the date and the name of the group surveyed (unless a very mixed group makes the recording of its name impracticable, when the X-ray centre should be shown) are attached by strapping at the top corners of the surface of the grid.* The protective screens are placed in front of the control table operator and conveniently for the positioner (see Appendix 2, Figs. 48-51). As a reminder of the preparatory procedures, a notice faces the control table operator, reading "CONE—SWITCH—DATE" (i.e. tube aperture—miniature radiography switch—lead figures on screen).

After seeing that the interior of the camera is quite clean (a small, fine-hair brush should be kept for this purpose), a spool of 82 feet of 35-mm. film is loaded into the magazine, which is placed in position at the base of the camera, leaving approximately 3 inches of film protruding; the spring indicator scale at the side of the magazine registers the length of film present (the camera will not operate when the magazine is empty). The empty take-up cassette is placed on the slide base, and pressed backwards in position to set the film cutter, a click indicating that the locking device has functioned. The manufacturer's batch number of the film in use is entered in the control table book.

To thread the camera, the end of the length of unexposed film (cut square) is evenly folded to a depth of $\frac{1}{8}$ inch. The tension control knob of the cassette is turned towards the operator, and the folded end of the film placed centrally in the slot in the spool; the knob is then released to give tension, thus holding the film in position over the sprockets (see Fig. 5). The lid to the cassette is replaced and locked in position, the back of the camera is closed securely and, by hand movement of the lever, the *first* frame is moved forward in the camera.

On the control table, the milliamperes are adjusted to 200; the mains voltage compensator is moved forwards or backwards one stud to energise the machine (the red pilot light indicates that the mains are "on"); and the input voltage is adjusted by stud control to give the correct reading on the pre-reading voltmeter—indicated by two limiting red lines. The exposure switch is now moved to the "prepare" position, and if a card has previously been placed in the slot, the rotor of the X-ray tube will be heard to function and the card illuminator will operate; if the card or its illumination is missing, or the threading of the camera is unsatisfactory, the rotor will not function. When the rotor operates correctly, the switch is released back from the "prepare" position and the small red pilot light flashes momentarily to show that the film has moved on in the camera (*second* frame) (see Figs. 6 and 38).

For a *routine* threading of the camera, the exposure switch is again moved to the "prepare" position and again released without making an X-ray exposure (*third* frame), so that the light-exposed strip of film is now in the take-up cassette, leaving "fresh," unexposed film in the gate, ready for the first miniature chest exposure to be made. (To economise in the use of the rotor, two or even three frames can be moved on by hand.)

For the *initial* threading on new premises, or for further periodic tests of the machine, the exposure switch action is completed for the second and third frames thus: From the "prepare" position, the switch is moved left to the "take" position and the green pilot light flashes momentarily to show that an X-ray exposure has been made; the switch is then released to return to the original position and the red pilot light is seen to glow, indicating that the film has moved on in the camera (this enables the mA seconds to be adjusted when necessary, to give the correct reading before the first examinee is radiographed, and to confirm that the apparatus is working satisfactorily).

* Fixtures are provided to hold the lead figures, but these are not generally used, because of the possibility of the lower metal border overshadowing the apices of the lungs. An improved arrangement, however, will be provided for future apparatus.

As explained previously, whenever the film should have moved on in the camera, the radiographer, in addition to noting the glow of the red light, should take the further precaution of seeing that the flat disc of the take-up spool of the camera has rotated; this indicates beyond doubt that the film has moved on by one frame in readiness for the next exposure.* If the red pilot light continues to glow, the film must be moved forward in the camera by hand manipulation, before another exposure is made.

Test exposures are made before starting a survey, and 10-20 volunteers are invited for this purpose. Two exposures are made for each subject, one following the standard exposure table, and the second at an increased kilovoltage, usually 4 kVp (two studs). From these exposures, any necessary modifications in the standard technique, to suit local conditions, can be decided. It is essential that the test strip should be projected, as it is impossible to estimate quality by direct vision, even with a lens. It is desirable for each Unit to have two such projectors and screens, one at the home base and the other for taking to outside work.

The preparations should now be complete for starting the actual survey. At the specified times and intervals, groups of examinees arrive with attendance forms and with self-addressed envelopes, and, on reaching the X-ray suite, they enter the reception room. Here they are instructed to pass into the undressing room, to undress to the waist (in the case of women, also to put on the special chest covers—see Figs. 7-10); they should then replace their coats or overalls and, carrying their belongings on the left arm, pass out of the undressing room to the marshal, for chest measurements to be taken.

The marshal asks them to slip the coat off the right shoulder, to place the right arm across the waist, and to relax and breathe normally. She then takes the measurement with the calipers (see Figs. 11-14) and enters it on the record card in the space between the serial number and the Unit code letters, using a soft pencil to give a *heavy* black mark which should record photographically.† For the women, the marshal should see that the upper level of the corset is not above the waist line and that necklaces are removed.

On receiving their cards from the marshal, the examinees pass into the office. They hand over record cards, addressed envelopes and attendance forms to the clerks; the latter, after entering necessary particulars on the cards (see p. 26), hand the cards back to the examinees, with instructions to pass on into the X-ray room in numerical order.

The X-ray apparatus is arranged so that the examinees enter the room from the tube side facing the screen (see Fig. 36). They are encouraged to be interested in what is happening to those in front of them, and so to appreciate what will be expected of them when they reach the apparatus.

When the first examinees arrive at the machine, the positioner makes certain from the control table record that the first card carries the next number in the sequence; the examinees are then asked to check that they are standing in numerical order, and a brief demonstration is given to this first group. Each examinee in turn removes his coat or overall, places his personal belongings on the table beside the X-ray machine, and hands his record card to the positioner. The latter calls out the last two digits of the serial number (the full number for the first examinee in a session), and also the thickness measurement—the control table operator is thus able to adjust the kilovolts and time according to the chest thickness, while positioning is in progress. The positioner then places the card in the slot, with the number-side downwards and facing the examinee, and

* Another method of checking that the film has moved on is under consideration by the manufacturer.

† Sometimes this space is not large enough, when the measurement will have to be recorded outside the photographed area. This point should be considered if new cards are designed.

presses the card well home (otherwise the machine will not function—see Fig. 15). The examinee steps on to the footplate of the apparatus, with feet symmetrical and well forward against the limiting border. Occasionally, it is necessary to remove hair pins or grips, where these are very low in the neck. After positioning is completed (see p. 37 and Figs. 17–19 for details); the positioner steps towards the protective screen, instructs the examinee to “take a deep breath in” and—after a brief interval—to “hold it”. By this time the positioner should be behind the screen and looking through the lead glass window (see Fig. 16).

At the moment when the positioner begins to say “take a deep breath in”, the control table operator moves the exposure switch into the “prepare” position; the sound made by the rotor indicates that apparatus conditions are satisfactory, and the light illuminates the number on the record card (at this stage the identification number is photographed on to the film). The operator watches the examinee and, when it is seen that the position is maintained and the stage of respiration suitable (*normal* full inspiration), the exposure switch is moved to the “expose” position, and the X-ray exposure made (as indicated by the glow of the green pilot light). The switch is released, and the radiographer observes the number of mA secs. registered. Meanwhile, the automatic movement of the film in the camera takes place (as shown by the flash of the red pilot light and the movement of the camera disc). To complete the operation, the control table operator ticks off the appropriate serial number in the control table book (see p. 29). The whole procedure of positioning and exposure takes approximately 30 seconds.

On being told that the examination is finished, the examinee steps off the machine and collects his or her belongings from the table, passes into the dressing room, dresses, and finally leaves the department by the exit door.

The positioner removes the card from the slot, and places it face upwards on the camera tunnel so that the previous number is visible for checking sequence.

The control table operator is in a position to note an incorrect position of the examinee or any movement, and to re-take if necessary. Unsatisfactory registering of the mA secs., showing an increase or decrease on the figure selected, would also indicate a re-take, possibly after adjusting the tube filament resistance. In such an event, a second tick is made in her book and appropriate comment made. On occasion, too, the subject does not keep the correct position during the “prepare” stage of the exposure switch, and if fresh instructions have to be given, the switch should be moved back to “normal” without exposure; since, however, the film will have moved on in the camera, a note of the “gap” (blank frame) must be made in the control table book, because it will be included in the total number of frames required on the length of film for development.

It should be noted that for subjects with chest measurements of 11 inches and over, it may be necessary to adjust the tube filament resistance to obtain the appropriate higher mA sec. reading.*

From time to time, it becomes necessary, for various reasons, to radiograph an examinee out of sequence number order. A gap of one blank frame should be made before such an exposure, in order to call attention to the irregularity during projection; a note is also made in the control table book (see p. 29).

As the work proceeds, the control table operator checks the number of exposures from her book (including intermediate blank frames but not those preceding and following a length of exposures). She marks them off in fives ((5), (10), (15), etc.) and, on reaching 50, she observes how many subjects have been examined. If this is also 50, she terminates the length; if less

* Tube filament resistance is referred to as “tube current control” in the manufacturer’s “Installation and Operating Instructions”.

(due to repeat exposures), and there is the probability that the 50 subjects will be reached within 60 exposures (the maximum that can be included on the length of film required for small tank development—see darkroom procedure, p. 45), she continues and terminates at 50 subjects.* To terminate the length, the film is moved forward four frames by hand manipulation so that the last chest exposure is in the light-tight cassette,† the lever is pressed down to cut the film, and the cassette is taken to the darkroom. Under conditions of complete darkness, the front is removed from the cassette, and the spool of exposed film is taken out, wrapped in black paper and placed in a tin, and the lid sealed with strapping. Everything should be prepared for this procedure in the darkroom—empty tin with lid beside it, black paper of suitable size, and a strip of strapping on the wall in front of the operator. A fresh spool is fitted into the empty cassette; the cassette is returned to the camera; and the film is threaded, as previously described. The whole process of removing and replacing the take-up cassette should take less than two minutes. A line is drawn across the control table book, and the word "cut" is entered. The renewal of the basic roll of film (82 feet) in the magazine takes about four minutes and is also recorded. It will be found that about 700 miniature radiographs are included on each 82 feet of film; during the process, the latter is cut into 14 lengths (50 subjects and 50-60 exposures in each complete length), for convenience of exposure and development (small tank method).‡

Each time the cassette is emptied, the chin rest and the surface of the chest stand coming into contact with the examinee should be cleaned with a cloth damped with a mild antiseptic (eventually paper rolls may be available); also the alignment of tube and screen is re-checked, the serial order of the waiting examinees checked, and all but the last of the exposed cards are handed to a clerk.

Until the team becomes experienced in the use of the apparatus, it is as well to process after each length of film has been exposed and, after processing, to examine the *wet* film for any gross defects, with closer examination on projection immediately the film is dry. Indeed, for the first month the finished results of each small group of examinees should be seen and attendances arranged accordingly. With experience, two lengths of exposed film can be developed at a time (p. 46).

Apart from this recording of the number and condition of exposures, etc., the control table book provides a daily log of the apparatus; any variations or troubles should be noted as they occur (see p. 29).

In due course, after the reports have been made on the projected chest radiographs, the examinee receives a letter either to the effect that the condition of the lungs is satisfactory or that a large film is required (see letters A and B, pp. 30 and 32). In the latter case, an appointment is usually given within a week of the taking of the miniature.

In the above procedure every effort is made to ensure correct identification of the subject with the film. For example, the subject passes directly from the clerks' tables to the X-ray machine, without any reason for the card to leave his hand. Loss of personal belongings is minimised by each examinee being

* It is convenient, for record purposes, to expose 50 subjects on each length of film, to read, for example, 5900, 5950, 6000, etc. The margin of ten exposures in each length enables small adjustments to be made from roll to roll.

† It is possible that future apparatus may incorporate a means of indicating that a pre-selected number of exposures has been made.

‡ An exposure counter inside the control table records the actual number of X-ray exposures; a reading should be made and noted before and after each survey, and the counter re-set before each survey. A similar counter on the tube registers the number of times the rotor functions, which slightly exceeds the X-ray exposures; this counter cannot be re-set and is a permanent record mainly of interest to the manufacturer.

made responsible for his own belongings—he carries these to the X-ray room and keeps them in sight during the whole period of the examination.

The arrangements suggested provide for a general undressing, and a general dressing room, and in our experience this has worked well (see Appendix 2, Survey 2). It should be possible, however, to give special consideration to individuals who are sensitive on account of scars, deformities, etc., by using a corner screen in one of the rooms and giving individual attention for the X-ray examination. Special requests of this kind have, however, averaged only 1 in every 8,000 examinations.

The average time taken for an examinee to pass through the X-ray department during miniature radiography should be 10-15 minutes.

Should there be a mishap on the apparatus or in the darkroom, affecting a number of examinees, the factory liaison officer should be contacted without delay and the mishap explained. He should be given a list of these examinees; with their clock numbers and shops, and be requested to make a special appeal for them to return (if possible, on the same day). The majority, if not all, will come back, particularly on being told that their previously booked cards will serve for the new examination. When they return it is usually impracticable to keep them in serial order, but the number order in which they are taken is entered in the control table book in preparation for projection. For those who do not return on the verbal appeal, action should be taken as indicated on p. 33.

General illustrations of the apparatus in use during a survey are given in Fig. 36, and typical strips of miniature radiographs are shown in Fig. 20.

(iii) *Large Film Examination.* In preparing for the taking of large films, the apparatus is again checked for alignment, the camera-screen unit is moved back to a distance of 60 inches, the tube is adjusted and the centring checked with the optical centring device, the tube diaphragm aperture is set to cover the screen at 60 inches distance, and the shutter over the camera aperture is closed and held in position by moving the camera slightly to the left. (A general illustration of the apparatus set for large film examination is given in Fig. 37; the camera tunnel is removed as for screening):

The switch on the card illuminator is set to normal radiography, the electric contact plug is removed from the camera, and thus the latter ceases to function. Except during screening, the camera and tunnel remain in position. Cassette holders are fitted in front of the screen, the large film exposure table is placed ready to be consulted, and the milliamperes are set to 300. The large film appointment book is placed on the table beside the apparatus. Keeping well in advance of arrivals, a clerk places the lead numbers (on strapping) on the appropriate cards, in order of appointment.*

On arrival at the department, and after undressing, the examinee has his appointment letter checked against the record card by the clerk-receptionist, who hands the prepared serial number to the radiographer. The examinee now passes into the X-ray room. The radiographer checks the name, serial number, chest thickness and the number of films required (as entered on the card)—she also carefully identifies the examinee with the name in the appointment book. As each cassette is placed in position, the serial number is strapped, with the appropriate code letters, on the right-hand corner of the cassette, and the name of the survey group or of the X-ray centre, and the date, are fixed on the upper left-hand corner (see p. 33). The positioning then continues, and one or more views are taken according to the instructions of the radiologist, given on the card. The same procedure with clothes and re-dressing is followed as for miniature radiography.

* An alternative method of numbering films is by contact-printing the serial numbers on the cards in the darkroom.

The exposed films are boxed in sequence order for later development, except in the case of special exposures, which are developed and examined before the individual leaves the department.

Within a week, and following the reporting on the large films, further letters are sent out to say either that the chest condition is satisfactory, or, in a small number of cases, to ask the examinee to attend for a brief clinical examination (see letters C and D, pp. 55 and 56). The procedure at this interview with the medical director is described in Section 7.

The large film examinations may require even more careful organisation than the taking of the miniatures, if the desired speed of, say, 3 films every 5 minutes is to be maintained. This applies particularly to film identification at the time of exposure, and to processing in restricted accommodation.

In mass radiography surveys, examinees should be treated as presumably normal subjects who have volunteered for an X-ray test. They do not expect to be found to be abnormal, and it is unwise to refer to them as "patients" or "cases," as may occur on attendance at a hospital.

On receiving a letter giving him an appointment for a large film to be taken, an examinee may be alarmed; he may telephone asking the reason for the recall. Enquiries of this kind should be treated with the greatest tact; no member of the team other than the medical director—or, in his absence, the radiographer-in-charge—should discuss the reasons for recall. It may be obvious from the comments on the record card that it is a true technical recall, in which event the individual can be assured that such is the case and may even be informed of the actual defect. When indications of possible normality are not so definite, the enquirer can be reassured by being told that the diagnosis is never given on the small miniature film (which is only one inch square); that any slight shadow is always investigated; and that it is quite likely that the large film will show a satisfactory chest condition, as occurs in the majority of people returning for large films. Occasionally, those who are recalled for cardiac abnormalities are alarmed lest they may have a pulmonary condition as well; a glance at the record card should enable the radiographer to reassure these examinees and discreetly to find out if they are aware of the cardiac condition.

C. *Details of Clerical Work*

(i) *Record Cards.* In the M.R.C. survey, one type of card was used for both the men and the women, and the number sequence was therefore continuous. In the national scheme, a two-card system operates, entailing a separate series of numbers for men and women. The numbers extend to seven digits, and commence with the figure 5 for women (e.g. 5008936) and with 0 for men (e.g. 0004729). The number is prefixed by the code letters allocated to the Unit and indicating the Local Authority (e.g. CMR). The cards are notched at the right upper corner so that an electrical contact is made when they are correctly in the slot—exposures without any recording of the serial number on the film are thus obviated.

Sufficient new cards should always be kept in stock (12,000 each for men and women is a reasonable batch), and it may be helpful to place a coloured card before the last 3,000 in each sequence, as an indication that the supply needs replenishing. The first number of a new batch should be checked against the last of the previous series. New cards should be examined to see that the serial number has been printed evenly in position; the number must be midway between the upper edge of the card and the black limiting line below if the whole of the number is to be reproduced photographically on the film. Assuming that the printing is satisfactory, the adjustable reflecting mirror in the camera should enable the whole number to be recorded. The cards should also be checked for loose cutting fragments, which, if detached in the recording slot on

the apparatus, may interfere with the electrical contact system so that the machine will cease to function.

The two-card system necessitates the use of separate day, and control table books for men and women.

NATIONAL RECORD CARD

(Size : 6×4 inches)

Front :—

DATE		MIL 5009301				
SURNAME (Block Letters)			PRESENT ADDRESS			
Christian Name(s)						
AGE	OCCUPATION		OCCUPATION CODE NUMBER	HOME TOWN OR DISTRICT <i>If other than place of examination</i>		
Date of Birth / /				<small>if this is not a County Borough state County</small>		
PARTICULARS OF FACTORY, SCHOOL OR OTHER ESTABLISHMENT			PREVIOUS M.R. EXAMINATION (if any)			
			At _____ Date (approx.) _____ IF A WOMAN WHO HAS SINCE MARRIED :— Maiden Name _____			
READING OF MINIATURE FILM			Classification of Diseases Number Ultimate Diagnosis (see over)	DISPOSAL		Card Completed <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div>
NORMAL	DIAGNOSIS FROM 35 mm. FILM	LARGE FILM REQUIRED		DOCTOR		
			HOSPITAL or SANATORIUM			
			DISPENSARY			
			NO ACTION			

Back :—

NAME & ADDRESS OF DOCTOR						
FULL SIZE FILM						
NO.	REPORT					
DATE						
TAKEN AT						
ULTIMATE DIAGNOSIS						
CLINICAL NOTES			YES		NO	
	F.H.					
	C.					
	P.I.					
	SPUTUM	NO SPUTUM PRESENT		SPUTUM PRESENT		
		Positive		Negative		

(ii) *General Procedure.* Before each session, the last previous number used is checked from the control table book, and the appropriate series of cards, according to the sex expected, is placed in a spare filing drawer kept for this purpose. The drawer is placed, with the chest-measuring calipers, on a table between the undressing room and the office. Whenever there is a change of staff during a session, the newcomer checks the number on the last card with the first of the new cards in the drawer. This covers the possibility that a small packet of blank cards may be placed in error in a white coat pocket or elsewhere. Should a card be missing from a sequence, a dummy should be inserted to show that the original is missing; an entry to this effect is also made in the day book against the number concerned, and the dummy card is retained in the file until the cards are eventually filed in alphabetic order.

When the blank card is handed to the examinee by the marshal, the chest thickness has already been entered by her in the space between the code letters and the serial number. The examinee, undressed to the waist and carrying the record card, attendance form and addressed envelope, passes—in serial number order—into the office.

The examinee sits at the clerk's table and hands card, form and envelope to the clerk. The available details are taken from the attendance form and envelope, and the other information required is obtained verbally: for some of the latter, the examinee may have been prepared by the instructions on the form (see p. 17). If the clerk, when copying information from the attendance form or envelope on to the record card, reads it aloud, the examinee can check the accuracy of the items. In entering the address, the name of the road should be written in block capitals.

The importance of accuracy and clarity, and the fact that the cards form the basis of the ultimate results, should be impressed on the clerks. Accuracy should never be sacrificed to speed. The maximum number of persons dealt with in an hour by each clerk should ordinarily not exceed 30-35.

On the women's cards, the prefix "Mrs." or "Miss" is added to the first names; no prefix is necessary for the men's cards. The age entry should be age-last-birthday. It is helpful to have a list of years of birth corresponding to different ages, as a check. The record of previous miniature radiography examinations will become increasingly important as the national scheme expands.

The occupation of the examinee is entered (later, the occupation code number is taken from the Classification of Occupations in Appendix IV of the "Advisory Report on the Working of a Mass Radiography Unit" which is supplied by the Ministry of Health to each Unit). If a list of the chief occupations in the particular establishment has been provided by the liaison officer, this should assist. The clock number or grade, and the department, shop or room number, may also be entered in the available space under the heading "Particulars of factory, school or other establishment"; whether the entire particulars of the group surveyed are entered at this point, or whether the main designation of the group (e.g. name of factory) is left for convenience to be stamped in batches, will depend on circumstances.

Other details of special interest to the particular inquiry may also be entered; for example, in Survey 6 the cards were marked "light" or "dark" according to whether the employees worked in light or darkness, while in the M.R.C. survey special note was made of any home contact with tuberculosis.

Shift rotation should be noted, so that recall appointments can be arranged accordingly. The entry should be made in an available space on the record card, but always in the same one, for convenience of checking. Abbreviations may be used to indicate the shifts for the present and the two following weeks. Thus PD/ = permanent days; PN/ = permanent nights; N/D/N = weekly

alternating nights and days; D/D/N = fortnightly alternations; A/N/M, M/A/N, etc. = three shift system changing weekly; PM/ = permanent part-time mornings; PA/ = permanent part-time afternoons. It is useful also to note any immediate holiday dates.

Voluntary information about previous illness may be entered (in telegraphic form) by the clerk, in the top space on the back of the card. Indeed, we would favour that every examinee should be asked specifically about "chest or heart disease" (including pulmonary tuberculosis) past or present; in this case, of course, the information on the card would become more confidential. The clerk's desks, therefore, should then be moved so that conversation cannot be overheard.

Finally, the serial number on the card is entered on the addressed envelope, and the card is returned to the examinee, with instructions to pass into the X-ray room, keeping in numerical order. Since the examinee is already undressed, the risk of the accidental exchange or misplacement of cards during this part of the procedure is minimised.

In the X-ray room, further voluntary information about lung trouble, etc., may be added to the card (at the top of the back) by the radiographer, who should similarly note any obvious physical abnormalities, e.g. wound scars. After exposure, the cards are placed in reverse order on the camera end of the tunnel, so that the last card is always visible to check the sequence. As each length of film is completed, all the cards but the last are taken back to the clerks, who stamp them with the date and with the name of the X-ray centre, the latter in the free space just below the notch in the card. In addition, the main designation of the group surveyed, if suitable for a stamp (i.e. if the group is sufficiently large and is not too mixed) should be stamped in the space headed at present "Particulars of factory, school or other establishment". (The local authority in charge of the Unit is already indicated by the printed code letters before the serial number).*

The cards are now ready for selected particulars to be entered in the day books, and for checking attendances on the nominal roll of employees. The clerks do as much of this work as possible in the intervals of booking-in.

It will be noted that a number of the above items are additional to those called for by the card of the national scheme as at present in use. These and other suggestions arising from experience are being submitted to the Ministry of Health for consideration should a revised design of card be envisaged.

After transferring particulars to the day books, the clerks place the record cards in a filing drawer in numerical order, ready for reporting.

As the day proceeds, the clerks also place the addressed envelopes in numerical order, checking to see that none is missing, and finally banding them together in bundles of 50 to await the sending out of letters after the miniature films have been reported on.

(iii) *Day Books.* No card system is safe from loss by removal of individual cards. For this reason, and because the cards will be finally filed in alphabetical order, day books should be kept, wherein essential particulars are entered in serial number order. Separate day books are kept for men and women. An

* The X-ray centre refers to where the apparatus operates (on the premises of the establishment examined; at a central site for a number of establishments; at the home base; etc.). The name and particulars of the group surveyed should adequately indicate the identity of the population group (e.g. Jenkins, Ltd., Lehill; National Fire Service, London Region)—whether these be stamped in batches or entered individually will depend on circumstances. Where the X-ray apparatus is operating on the premises of the establishment examined, name of survey group and X-ray centre will of course be the same.

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example of suitable entries is given below ; the last column could be omitted if desired :—

EXCERPT FROM A DAY BOOK (MALES)

Date..... Survey Group.....

Serial No.	Names.	Clock No. or Grade.	Shop or Dept.	Large Film Date.
0001639	Jones, J.	99	Z. 6	2.2.44
1640	Brown, G.	106	A. 5	
1641	Smith, B.	77	P. 4	
1642	Hartley, M.	2589	P. 4	2.2.44
1643	Longley, S.	1763	P. 4	

The name of the survey group is shown at the beginning of each survey unless several groups are included, when the name of the group will head its block of numbers ; or, if the groups are mixed, there will be an additional " survey group " column. The date is shown at the top of each page.

(iv) *Control Table Books.* These are kept by the radiographer and serve as a log of the apparatus. They record any variations in the exposure technique, fluctuations in the mains, and reasons for repeat exposures ; they draw attention to any irregularities in number sequence (serving as a check on the numerical arrangement of the cards for reporting). The control table books show when each insertion into the camera of a new roll of film takes place, and its batch number ; and, most important of all, they check the stage at which the exposures are to terminate for development (50 subjects), the exposures being numbered after every five. Another use of the control table books is in checking the techniques of the different staff (positioning, control table, measuring, and developing), by recording their initials over a test period. Finally, during projection, the books are used to record technical comments on positioning, exposure quality and processing ; this is of particular value during the initial work on the apparatus.

A whole line is given in the books to each serial number, and the numbers are in sequence on the left-hand side of the page. With two sets of cards, it is as well to have separate books for men and women ; foolscap size is preferable. The following shows semi-diagrammatically the type of entry, though actually the book will be in rough note form :—

EXCERPT FROM A CONTROL TABLE BOOK (MALES)

Date..... Survey Group.....

Serial No.	Total Exposures.	Second Exposure, with Reason.	Comments.	
			Following Exposure.	During Projection.
005946 ✓	(50)			
47 ✓		breathed ✓	FILM CUT	Good roll except last 6 exposures which s.o. show rotation (? tube out of alignment).
48 ✓				
49 ✓				
50 ✓	(55)			
51 ✓				<i>Test Roll</i> Meas. A.E. Pos. J.H. Con. C.F. Dev. S.M.
52 ✓	(5)	mA down ✓	Mains fluctuating badly, 11.30 a.m. to 12.30 p.m. (Nos. 5840 to 5956).	
53 ✓		movement ✓		s.u. Drying marks.
54 ✓				
55 ✓				
56 ✓				
57 ✓				
58 ✓	(10)			

Out of order →

(v) *Reporting on Miniature Films.* The rolls of miniature radiographs, marked to show the first and last numbers, are placed in sequence order in partitioned drawers, separate ones being used for men and women. The cards also are in numerical order in separate drawers, and both films and cards are handled direct from the drawers. Before the work commences, reference should be made to the control table book, to see if any exposures have been made out of sequence order; if this is so, the cards are adjusted accordingly, so that they are in the same order as the radiographs on the rolls of film.

An alternative arrangement, which meets the two-card system, is to attach the appropriate roll of films to the cards concerned, by a rubber band. When placed on a large tray, these packets are easily handled in the darkened projection room.

In preparing for projection, the clerk's table is placed behind the projector stand; this table carries a special shaded lamp which does not illuminate beyond the space required for the clerk's needs. The tray or drawers of cards and films are placed within reach of both projectionist and clerk.

One of the radiographers projects the films, while another checks off the control table book for any comments, and adds any observations on technique against the appropriate number or run of numbers.

After the film has been placed in the projector, the complete number of the first frame is called out by the projectionist, and this is carefully checked against the card. For each subsequent frame on the roll, only the last two digits need be called out, these again being checked against the cards. As the film is moved on from one frame to another, the radiologist passes the majority of the radiographs as "nil", and the clerk ticks the cards in the space under the heading "normal"; she also ticks in the heavily outlined square in the bottom right hand corner, indicating that the card is completed. Upon an abnormality being reported, the projectionist repeats the *full* number on the film and checks the number on the card with the clerk; the radiologist then states the number of large films and views to be taken, and the region concerned (e.g. left base, both apices, heart), for the guidance of the radiographer in taking the large films. These particulars can be entered under the heading "Diagnosis from 35-mm. film" and a tick made in the space under "Large film required". These "large film" cards are kept separate from the "normal" cards.

When each roll of film is completed, the "normal" cards are collected by one of the other clerks, so that the work of sending out appropriate "normal" letters (Letter A) may be begun. (A number of these letters will, in the meantime, have been stamped with the date.)

PRIVATE AND
CONFIDENTIAL

Letter A

.....MASS RADIOGRAPHY UNIT

(Address)

(Date)

Serial Number :

Dear M

The result of your miniature X-ray film is satisfactory as regards tuberculosis of the lungs, and we shall *not* require you for further examination. Thank you for your co-operation,

or

The miniature X-ray film taken of your chest shows *no* abnormality in the lungs requiring further investigation.

Yours very truly,

.....
Medical Director.

Before these letters are sent out, the cards are first examined to see that none but "normals" is included. Next, cards and addressed envelopes are checked as the serial numbers are entered on the letters, and the latter are enveloped. Two clerks should work together. Finally, the envelopes are closed and the letters despatched, either forthwith or at the same time as the letters giving appointments for large films. The "normal" cards are returned in serial order to the filing drawers.*

When the viewing of the miniature radiographs has been completed, the "large film" cards are dealt with as now to be described.

(vi) *Appointments for Large Films.* The appointment book for large films is kept by the radiographer-in-charge, who arranges the appointments in the order in which she wishes to deal with certain types of subjects, and according to sex, shifts, etc. Subjects for whom screening for position is required, e.g. those requiring oblique views, localised grid exposures, lordotic views, etc., are given appointments at the beginning or end of a session.

The serial numbers of recalled examinees in the large film appointment book will, of course, be usually out of sequence. The spacing of appointments will permit usually two or three films every five minutes, though more time will have to be allowed for the special examinations (say ten minutes for each such examinee).

The following headings are suggested as suitable for the appointment book:—

EXCERPT FROM A LARGE FILM APPOINTMENT BOOK (MALE AND FEMALE)†

Date..... Survey Group.....

Time.	Name.	Serial No.	Chest Thickness.	No. of Films.‡	Comments.
			<i>Inches.</i>		
9.30	Davies, C. (Mrs.) ..	5/6321	9	3	Heart.
9.40	Burns, F. (Miss) ..	5/6348	8	3	Lordotic.
9.50	Brownlow, J. ..	6224	10	2	Both apices.
9.55	Kendrick, M. ..	6250	8½	1	Technical.
10.0	Marsden, F. ..	6301	8½	2	L. apex.
10.0	Layton, S. ..	6296	9	1	L. base.

As the appointments are settled, the times and dates can be entered on the "large film" cards in the available space under "Diagnosis from 35-mm. film". The cards and appointment book are finally handed to the clerks, so that they may send out the letters. The same careful check is maintained

* It is recognised that the sending out of a letter to each person with a "normal" miniature radiograph, as well as to those recalled for large films, entails much labour and expense; and an alternative method is to place notices to state that unless a letter is received within, say, 1-2 weeks, the examinee can consider that the chest condition is satisfactory. We are, however, much in favour of sending individual letters, because there is no doubt that this completes the examination in a definite way that is appreciated by the examinees.

† The large film appointment book is kept near the telephone, as a number of appointments usually have to be altered.

‡ 1 = P.A.; 2 = P.A. and A.P.; 3 (heart cases) = P.A., and R. and L. oblique with barium swallow; 3 (lordotic) = P.A., P.A., with dorsi-flexion, and R. lateral.

when preparing these "large film" letters as with the "normal" letters. An example is given below :—

PRIVATE AND CONFIDENTIAL Letter B
MASS RADIOGRAPHY UNIT
 (Address)
 (Date)
 Serial Number :

Dear M.

We find it necessary to repeat your X-ray on a full-size film, and we hope you will attend again at the X-ray room on the date and at the time given below.

..... day
, 194
 morning/afternoon.

PLEASE BRING THIS LETTER WITH YOU.

Yours very truly,

.....
 Medical Director.

If you wish for a different appointment, please telephone the X-ray Unit (LEHill 4213).

The "large film" letters are posted so as to be received at the private address only a day or so before the appointment is due, in order to avoid unnecessary anxiety. As mentioned above, it may be preferable to post the "normal" and "large film" letters at the same time.

The "large film" cards are now handed to the doctor's clerk, who enters the particulars of each of these cards in the large film recall book, for which she is responsible.

(vii) *Large Film Recall Book.* The doctor's clerk enters the names of all persons requiring large films, in serial number order and in blocks of the same sex, using coloured pencils to distinguish the sexes. An example is given below :—

EXCERPT FROM LARGE FILM RECALL BOOK (MALES AND FEMALES)

No.	Large Film Taken.*	Name and Address.	Survey Group.	Clock No.	Particulars of Recall.†	Result of Large Film.*
5/6321	2.2.44	Davies, C. (Mrs.) 16, Green St., Townley.	Jenkins, Ltd., Lehill.	6899	(3) Heart	Investigate.
5/6348	2.2.44	Burns, F. (Miss) 4, Green St., Townley.	"	1077	(3) Lordotic	No action.
6224	2.2.44	Brownlow, J. 1, Mount Crescent, Highstead, Townley.	"	2107	(2) Both apices.	Investigate. (Priority)
6250	2.2.44	Kendrick, M. 34, Leaway Ave., Little Terpington, Nr. Townley.	"	2538	(1) Technical	No action.
6301	—	Marsden, F. 22, Peewit Cresct., Highstead, Townley.	"	6213	(2) Left apex	Investigate. (Based on miniature film).

* These columns will, of course, be filled in at a later stage.

† See previous table (p. 31), footnote †

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After entering the particulars, the doctor's clerk returns the "large film" cards to the radiographer-in-charge for the large film examinations. Her large film recall book should also be available during the large film sessions.

(viii) *Large Film Examination.* The cards are in appointment order, and the first six or so are prepared in advance; they are put separately on a table. The serial numbers, in half-inch lead figures, are placed on plaster strapping and laid on the cards; they will be collected by the radiographer and placed beside the Unit code letters in order to mark the film cassettes. The radiographer will already have lead letters on strapping, to show the date and the name of the survey group (unless a very mixed group makes the recording of this latter impracticable, when the X-ray centre should be shown).

As the examinees arrive, they are asked to undress, and each name and number is carefully checked, both by the clerk at the desk (who stamps the date in the space under "full-size film") and by the radiographer immediately before exposure. Future shifts (and, in the summer, immediate holiday dates) are noted by the clerk, in case a medical interview may be required.

If the examinee does not keep the appointment, and has not telephoned for an alteration, a special reminder letter may be sent, such as follows :-

PRIVATE AND CONFIDENTIAL
Letter B1
.....MASS RADIOGRAPHY UNIT
(Address)
(Date)
Serial No. :

Dear M

As you did not keep your appointment for a full-size film on.....and it is important in your own interest that this film be taken, I am giving you a further appointment as below :

.....day
....., 194
.....morning/afternoon.

PLEASE BRING THIS LETTER WITH YOU.

Yours very truly,

.....
Medical Director.

If there is no response to this proposal for a second appointment, a further special letter is sent, giving a third appointment; if there is still no response, the miniature radiograph is seen again by the radiologist and medical director, and the classification and disposal of the case decided on the basis of this miniature film. When such a film is technically useless for viewing, the examination is cancelled from the survey. When a decision can be reached, the subject is included in the appropriate category. If the latter indicates that a medical interview would be ordinarily desirable, the medical director may make a final attempt to persuade the examinee to come to see him, then proceeding according to individual circumstances. It sometimes happens that the examinee himself applies for the large film examination some months later.

As a variation of the above, the examinee will sometimes reply to the original large film appointment (Letter B) to the effect that he or she does not wish to continue the examination. In such cases the procedure will be similar.

As already mentioned (p. 24), a mishap on the apparatus or in the darkroom may require the recall of a number of examinees for miniature examination. While every effort is made to do this verbally, for various reasons a certain number will not respond; for these, it is as well to offer large film appointments,

using a special letter. If there is no response to this letter, the subject is cancelled from the records.

(ix) *Reporting on Large Films.* After the chest radiographs have been turned clockwise through a right angle from the viewing position, they are numbered with yellow pencil on the right-hand end of the upper long border, in order to identify the films without holding them up to the light; the corresponding record cards are attached with paper clips. The writing of the report on the card will be done by the doctor's clerk. The card is first handed to the radiologist for a brief scrutiny and then is passed back for the report, which the radiologist dictates after viewing the films. The report is written in ink or indelible pencil, under "Full-size film". In about half or so of the cases, the report will read "normal chest—no action", or just "nil". In the remainder, the radiological findings will be summarised, followed by the words "no action" or "investigate", the latter indicating an interview with the medical director.

After the reporting session, the cards are divided into two groups—"no action" (including "nil") and "investigate"; and letters C and D, respectively dismissing the examinee or summoning him to see the medical director, are sent out by the doctor's clerk. Examples of letters C and D are given in Section 7 (pp. 55, 56), where the procedure after the interpretation of the large films is fully described. Letter D should arrive at the examinee's home address within a day or so of the medical interview appointment.

The doctor's clerk now fills in the second and last columns of the large film recall book (see p. 32), which she keeps. She then returns the "no action" cards to the main files, and retains the "investigate" cards and corresponding films for the medical interviews. At the same time, she makes duplicate cards* corresponding to the "investigate" cards, to go in the main files so that the latter are complete for the general analysis.

The large films for the medical interviews are filed in separate envelopes for each case, but the "no action" films can be filed ten in each envelope.

(x) *Medical Interview.* Details of the procedure undertaken when the "investigate" cases, summoned by Letter D, are interviewed by the medical director, are given in Section 7. The suggested final tabulation of the results is also given in that section. The technique of the analyses is a matter for the clerks, and must now be summarised.

(xi) *Technique of Analyses.* It is advisable to complete the analysis of the record cards as soon as possible after each survey group has been examined, and before placing the cards in alphabetical order. As a preliminary step, a check should be made to see that the cards in the main files are in complete serial order, at the same time checking that the unnotched duplicate cards of the "investigate" examinees are in place, as these will be included in the counts.

For the national scheme, the Ministry of Health requires certain data for general statistical purposes; special statistical cards are supplied—one for every person radiographed—to which the necessary information has to be transferred from the individual record cards. This is presumably a task of the clerical staff working at the home base (see p. 6).† The statistical cards

* These may be obtained unnotched and without printed numbers, in which case they can be easily distinguished in the file; but if only notched cards can be obtained for duplicates, these should be inverted in the file, or plain cards should be used.

† The duplicate (unnotched) "investigate" cards in the main files will lack much of the information required for the statistical cards. To retain the confidential nature of the inquiry as far as possible, it is best for the top panel only to be filled in for each of such cards by the home base staff, and for these statistical cards then to be passed to the doctor's clerk; the latter will complete them from the original "investigate" cards when the required information is forthcoming, as a result of the primary interview with the medical director and the opinion of the tuberculosis officer, etc.

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will not be handled further locally but will be transmitted to the Ministry. The following is a facsimile of this statistical card:—

MASS RADIOGRAPHY STATISTICAL CARD

(Ministry of Health)

(Size : 5×3 in.)

MASS RADIOGRAPHY STATISTICAL CARD	DATE OF EXAMINATION		IDENTITY NUMBER		
	YEAR	MONTH			
	194 <input type="text"/>	NUMBER <input type="text"/>			
	SEX	MALE	FEMALE	AGE	OCCUPATION CODE NUMBER
	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	35mm. FILM	NORMAL	L. F.	CLASSIFICATION OF DISEASES NO.	
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>		
HISTORY	F. H.	C.	P. I.	SPUTUM	
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	NO SPUTUM PRESENT	
				SPUTUM PRESENT	
				Positive	
				Negative	
DISPOSAL	DR.	HOSP.	DISP.	N.A.	
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	

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The medical director will probably also require an "administrative" analysis for immediate local purposes; the final tabulation of such a "balance sheet" for a survey group is given on p. 62, and examples are shown in the tables of Section 11.

The figures required for Part 1 of the table on p. 62, i.e. for the "Analysis of Stages of Procedure", will be obtained in part from the factory management, etc.; and in part from the records of the Unit. Taking the various items in turn:—

- (a) Total employed in factory, etc., and
- (b) Total available during survey (taking account of absences); these will be obtained from the management, preferably separated by sex as well as showing both sexes together.
- (c) Total radiographed; this will be obtained by first noting from the two (male and female) day books the first and last serial numbers of the particular survey group under consideration; then taking out all the cards (male and female separately) appertaining to this survey, using the two limiting numbers as guide; and finally counting the total cards for each sex (excluding throw-outs) and giving the totals for the sexes separately as well as together.
- (d) Total passed on miniature film; this will be the total radiographed less the total recalled for full-size films, as recorded in the large film recall book (kept by the doctor's clerk); this latter figure will of course provide—
- (e) Total recalled for full-size film.
- (f) Total passed on large film (i.e. "no action"), and
- (g) Total recalled for medical interview (i.e. "investigate"); these will be obtained from the large film recall book, taking into consideration

the fact that a few of the persons who were recalled for large film, but did not attend, will have been assigned to the "no action" or "investigate" groups on the basis of their *miniature* films. The figures for group (*g*) should check with the total of the "investigate" cards, and the total of (*f*) *plus* (*g*) should, of course, equal (*e*).

The figures required for Part 2 of the table on p. 62, i.e. for the "Analysis of Results, on Initial Assessment", will be obtained as follows:—

The first item, total radiographed, will already have been obtained from Part 1, and will need to be subdivided by age as well as by sex. The age-groups suggested are 14, 15-19 (or 14-19), 20-24, 25-34, 35-44, 45-54, 55 and over (see e.g. Tables I and II, pp. 72-73 and 74).

The provision of the figures for the various disease categories requires the medical director or his clerk to subdivide the persons who have been seen at the medical interview, as represented by the original *notched* "investigate" cards. (These cards will have been in the keeping of the doctor's clerk since the reporting on the large films.) The cards corresponding to the subdivisions, i.e. categories (A) to (D) and sub-groups of (D), are now enumerated by the doctor's clerk. In addition, the cards in category (D) and its sub-groups, and possibly also those in (B) and (C), should be subdivided by sex and in age-groups, as for example in Table II, p. 74.

The last item, total recalled for medical interview, will be the total of categories (A) to (D); this figure should of course equal that for group (*g*) in Part I of the table.

In addition to the above "administrative" analysis, there may be other subdivisions of interest to the medical director, such as town of origin, factory department, occupation, etc.

Sorting, counting and checking of cards, and the tabulation of figures, do not come easily to everyone. Until confidence has been gained, it will be well for the Unit secretary and clerks to maintain close contact with the medical director concerning the technique of the analyses and the object of the various tabulations required. Counting should be done twice, for checking, and as each set of subdivisions is counted (it is well to keep the cards in piles of 10-50 while so doing), the aggregate figures should be checked against the total of the cards from which the subdivisions have been made.

After the analyses of the particular survey have been completed, the cards in the main files (male and female), including the unnotched duplicates of the "investigate" cases, are filed alphabetically. The actual "investigate" cards, corresponding to the persons who were recalled for the medical interview, are filed separately, in their disease categories; the file is kept by the doctor or his clerk.

SECTION 6

The Unit at Work—(continued)

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D. *Positioning**

(i) *Miniature Films.* Positioning for miniature chest radiographs is very exacting, because of the short focus-screen distance employed, although the inclination of the rays due to this short distance tends to aid the projection of the shadows of the scapulae outside the lung fields and to open up the apices. The arrangement of the apparatus enables the positioner to stand immediately behind the subject, to see that the chest is symmetrically in position.

The chin rest allows the subject to be centralised from side to side. In order to obtain a uniform level for the apices, and thus to ensure that both the pre-arranged tube centring level is correct and that the bases of the lungs are included—particularly in the long-chested subject, the upper level of the shoulders should be just below the lead markers on the radiographic grid (the examinee is in contact with the grid). This will mean that, for the subject with a long neck, the chin will be above the rest; while the subject with a short neck will not be able to reach it. It is not possible to mark the shoulder level on the grid surface, because, from behind the examinee, the direction of vision of the positioner varies according to his or her height, and also according to the height of the examinee. A suitable method is for the operator to place the record card in the slot, and then, while still at the side of the apparatus, to regulate the height of the camera tunnel with the left hand whilst placing the neck of the subject in position from behind with the right hand. The upper

* Reference may also be made to "Anatomical and Pathological Factors in Chest Radiography," by Kerley (1943).

level of the shoulders on the grid, and therefore on the screen, may thus be judged correctly.

The positioner moves behind the examinee, and the latter's hands, shoulders and arms, in this order, are placed in position. It may be necessary to ask the examinee to relax, so that the shoulders can be pressed forwards and downwards to make contact with the grid, whilst the hands are placed between waist level and buttocks, and the elbows are pressed against the frame of the stand. There can be no routine position for the hands and arms, which are placed to give the correct adjustment of the shoulders. The position of the hands will vary with the length of the arms and with the length of the chest. Thus the hands may be at waist level, well down over the buttocks, or, in certain types of subjects, the arms may be rotated medially and brought forward to the sides of the stand (see Figs. 17-19).

Occasionally, for a deformed chest, it is necessary to take also an antero-posterior view in anticipation that from the two views, P.A. and A.P., an opinion may be given.

When the examinee is asked to take a deep breath for the exposure to be made, note should be taken that the position has not changed when a satisfactory stage of respiration has been reached; where there is any doubt, a repeat exposure should be made immediately. It will be appreciated that a small rotation of the subject will show quite a marked deviation on the radiograph, because of the short distance employed. Any variation in the alignment between the X-ray tube and the screen and grid will likewise produce a considerable deviation.

(ii) *Large Films*

- (a) *Postero-Anterior*. Positioning is the same as for the miniatures, and while similar care is necessary at the greater distance of 60 inches, the smaller variations will not be quite so apparent on the large radiographs (see Fig. 21).
- (b) *Antero-Posterior*. The subject is turned to face the X-ray tube, and— if the lesion is apical—with slight flexion away from the cassette at the 6th or 7th dorsal region. The hands are placed behind the hips, with the shoulders and elbows brought well forward, and with the chin well out and level (an individual demonstration, facing the subject, is advisable). In this position, the apices are satisfactorily shown above the level of the inner parts of the clavicles (Fig. 22). The two projections, P.A. and A.P., often give just that difference in the view of an abnormality which is invaluable for radiological diagnosis (see p. 52). (While other views of the apices may be taken, these entail angulation of the tube, which is inconvenient on this apparatus when working at speed.)
- (c) *Lordotic Position*. This view is taken to establish the presence of a middle lobe collapse or interlobar pleurisy which, in the routine P.A. view, appears as an ill-defined opacity (see Fig. 23). The subject, who is placed with the hands holding on to the sides of the stand, is asked to practise bending slowly backwards and forwards from the waist, in preparation for similar instructions to be given during the fluorescent screen examination. On screening, it is possible to decide on the best position to show the sharp triangular shadow of the lesion (see Fig. 24). The actual degree of dorsi-flexion required will vary from subject to subject (see, for example, lateral view shown in Fig. 25). A right lateral view completes the examination (Fig. 25).

- (d) *Lateral View.* A right or left lateral view may be required. The selected side is placed against the cassette, and the arms are well folded over the head. The radiographer then stands in front of the tube and behind the subject, in turn, in order to make the necessary adjustments in position so as to obtain a true lateral view (see Fig. 26).

For upper, anterior lung lesions, the shoulders are pressed backwards and the hands clasped low over the buttocks; the chest and chin are thrust forwards, and the exposure is made on full inspiration, with the tube centred in front of the shoulders.

- (e) *Oblique Positions.* Oblique views are taken at a distance of 36 inches. The shorter distance is employed so as to make use of the oblique rays, in order to obtain separation of the heart and spine. It is necessary to screen for position. For the first (right anterior) oblique position, the subject is rotated under the screen until the space between the anterior borders of the bodies of the vertebrae and the posterior border of the heart is at its widest, or until the minimum overlap is obtained (see Fig. 28). In certain pathological cases where the enlarged left auricle overlaps the vertebral bodies, the correct angle is obtained by watching the barium-filled oesophagus and selecting the angle at which the oesophagus shows the maximum backward displacement from the spine (see below).

For the second (left anterior) oblique position, the subject is rotated until the aortic triangle is visible; the posterior border of the heart usually overshadows the vertebral bodies (see Fig. 29). In this view of the chest, the normal landmarks of the aortic triangle and window are often exaggerated in disease, and there is no difficulty in obtaining the correct angle on the screen.

For an upper lesion, the oblique view is taken with the arms lowered, the exact position being established by screening.

A barium swallow is given when it is necessary to outline the oesophagus in relation to the heart and great vessels. After the procedure has been explained, the examinee is given a small drink of water, followed by a *preliminary* drink of a mouthful of thick barium cream, which outlines the oesophagus for screening. With arms folded over his head, the examinee is placed in the approximate first oblique position; on screening, any necessary correction in the position is made, and the examinee is instructed to keep quite still. With the lights on again, the cassette is introduced and, on the left arm being released, the examinee is given another mouthful of barium, which he retains in his mouth until this arm is once more placed over his head. He is then told to "swallow" and after a few seconds, giving the barium time to outline the oesophagus, he is told to "stop breathing" and the X-ray exposure is made (see Fig. 30). For the second oblique position, which follows, the procedure is similar but the *preliminary* drink of barium is omitted (see Fig. 31). To complete the examination, a P.A. view is taken at 60 inches. Before leaving the X-ray department the examinee is offered a drink of water.

- (f) *Other Positions.* It may be necessary on occasion to take other views than true P.A., A.P., lateral or oblique. In these cases, there is some indication, with the request for large films, that a particular shadow is to be demonstrated. The actual position is then decided by screen

examination, with the subject rotated to give the best possible view of the abnormality concerned. It is helpful in these cases, if only a limited area is required, to use the small tube aperture intended for the greater distance. In making a special examination of the diaphragm in very broad subjects, the film should be placed transversely, following a screen examination to determine the position and extent of movement of the diaphragm. These comments apply also to special examinations requiring the penetration of an area of great opacity, when, in addition, a stationary grid may be employed at the nearer distances in order to give adequate contrast (see Figs. 32-33, and also Fig. 27).

E. Exposure Technique

In order to make for results of uniformly high quality, each part of the technical procedure—exposure and processing—has been standardised, both for miniature and large radiographs, from the experience gained by the M.R.C. Unit.

(i) *Chest Measurement.* Miniature radiography has passed beyond the stage of detecting only gross lesions. With good standardised technique, small and early lesions are clearly visible, and the importance of thickness measurement as the basis of a carefully standardised exposure table cannot be over-emphasised. Radiographers pride themselves on their ability to decide exposure technique by vision, and this is permissible for general radiography, and for taking large chest films which are developed individually. This guess-work method is unsatisfactory, however, for mass miniature radiography, where large numbers of subjects are dealt with rapidly, where the question of fatigue arises, and where periodic changes of operator involve variations in individual judgment. To these difficulties must be added the fact that only standard development is possible, because of the many chest exposures on the one length of film, which exclude the possibility of individual adjustment in development. No radiologist familiar with the difficulties of visualisation of small foci in miniature films would countenance the rough and ready procedure of visual judgment.*

An exposure table has been prepared on the basis of the thickness of the subject, as measured through the thickest part of the chest by a pair of flat-surfaced calipers (see Figs. 11-12). In taking a chest measurement, the marshal asks the examinee to relax and to place the right forearm across the waist; she holds the stationary arm of the caliper lightly in position against the back of the subject, while the adjustable arm is brought towards the anterior wall of the chest and moved gently in a vertical direction, just clearing the skin surface (see Figs. 13-14). The thickness measurement is read off on the scale at the base of the calipers. The *level* of the thickest part of the chest varies considerably, particularly as between men and women; for men, it is usually the upper, and for women, the lower part of the chest (through the breast). (This method differs from the common and unsatisfactory procedure of taking the thickness measurement with pelvimetry calipers in the midline at a certain fixed level, usually the axilla or the sternal angle.)

During the M.R.C. survey, the measurement was recorded to the nearest half inch *below* the scale reading (from 8 to just under $8\frac{1}{2}$ being recorded as 8, and from $8\frac{1}{2}$ to just under 9 as $8\frac{1}{2}$). Recently, however, the measurements have been recorded to the nearest half inch *above* or *below*, mid-points being assigned to the higher figure (from $7\frac{3}{4}$ to just below $8\frac{1}{4}$ being recorded as 8, and $8\frac{1}{4}$ to just under $8\frac{3}{4}$ as $8\frac{1}{2}$). This method has been found to be the more satisfactory; the exposure charts, of course, are unchanged.

* A photo-electric cell has been recently applied, in the U.S.A., to determine exposure automatically according to the type of subject (Morgan, 1943). Developments of this technique will be awaited with great interest.

Analysis of a series of subjects attending for mass radiography showed the average chest thickness measurement to lie between 8 and 10 inches for men and between $7\frac{1}{2}$ and $9\frac{1}{2}$ inches for women :—

FREQUENCY DISTRIBUTION OF CHEST THICKNESS IN
5,814 SUBJECTS

<i>Thickness in Inches.</i>	<i>Men.</i>	<i>Women.</i>	<i>Total.</i>
$6\frac{1}{2}$	—	9	9
7	9	98	107
$7\frac{1}{2}$	50	493	543
8	234	827	1,061
$8\frac{1}{2}$	460	800	1,260
9	729	544	1,273
$9\frac{1}{2}$	471	260	731
10	342	139	481
$10\frac{1}{2}$	144	62	206
11	49	35	84
$11\frac{1}{2}$	16	12	28
12	7	12	19
$12\frac{1}{2}$	2	4	6
13	2	1	3
$13\frac{1}{2}$	—	2	2
14	—	1	1
Total	2,515	3,299	5,814

For the purpose of the exposure tables (pp. 42, 43), the average is quoted as 8–10 inches, because over this range of thickness it is possible to maintain standard exposure time, increasing the kilo-voltage uniformly with increasing thickness of chest.

The question has been raised as to whether, within a given age-group, chest thicknesses are sufficiently similar for the kilovoltage to be within a very narrow range, thus giving a run of radiographs of similar quality. A tabulation of the frequency distribution of chest thicknesses according to age-group and sex showed, however, that the "scatter" within each age-group was much the same as that shown for the figures at all ages in the above table, although the *average* thickness increases, as one would expect, with advancing age.

The only adjustment conceded to type is for the elderly, thin person, where a reduction of 0.02 sec. in the exposure is made, and for very muscular groups (e.g. miners or seamen), when a small increase in time or kilovolts is made.

It will be appreciated that measurement of chest thickness forms a responsible part of the work of the Unit; with the general direction and instruction of the examinees on arrival, it is assigned to the marshal.

(ii) *Exposure Conditions for Miniature Radiography.* Between each pair of studs on the kilovoltage control, there is a difference of approximately 2 kVp. For measurements from 8 to 10in., the kilovoltage is increased by 2 kVp (1 stud) for each half inch and the exposure remains constant at 0.1 sec., 200 mA being used. This gives a range of kilovoltage from 78 to 86 kVp. Below 78 the contrast would be too great to show the periphery of the lungs satisfactorily, and for thicknesses less than 8 inches, therefore, the time is reduced by 0.01 sec. for each half inch in chest thickness, the kilovoltage remaining constant at 78 kVp. Conversely, above 86 kilovolts the chest radiographs tend to be lacking in contrast, and, for the very large subjects, a compromise is made therefore between increase in kilovolts and increase in time, up to 0.24 sec. at 90 kVp for $13\frac{1}{2}$ -inch thickness. The greatest thickness that we have encountered has been 16 inches.

EXPOSURE TABLE FOR MINIATURE RADIOGRAPHY (P.A. VIEWS)

The following exposure data apply to Ilford H.P.X. Film used with a Levy-West Yellow-Green Fluorescent Screen and the Stationary Radiographic Grid fitted to the apparatus; focus-screen distance 36 inches. The data assume also development in Ilford Blue Label Developer (ID.42) for 8 min. at 65° F. (18° C.). With different film, screen, grid or developer, the exposure table would require modification.

Chest Thickness in Inches.	kVp.	*(Stud).	† Time in Seconds at 200 mA.	mA Secs.	
6	78	(10)	0.06	12	
6½	78	(10)	0.07	14	
7	78	(10)	0.08	16	
7½	78	(10)	0.09	18	
8	78	(10)	0.1	20	} Exposures for average-sized subjects.
8½	80	(11)	0.1	20	
9	82	(12)	0.1	20	
9½	84	(13)	0.1	20	
10	86	(14)	0.1	20	
10½	86	(14)	0.12	24	
11	88	(15)	0.12	24	
11½	88	(15)	0.15	30	
12	88	(15)	0.17	34	
12½	88	(15)	0.2	40	
13	90	(16)	0.2	40	
13½	90	(16)	0.24	48	

When in doubt as to the adequacy of the tabled exposure—especially for large subjects, and during initial work, it is advisable for the operator to make two exposures, one according to the table and the other slightly different, note being made of the latter in the control table book.

A first class miniature chest radiograph should show the outline of the bony thorax and include the lungs satisfactorily from apices to diaphragm. Regional density variations in the lung fields, due to differing chest thickness, should be reduced to a minimum by using the appropriate kilovoltage from the above exposure table. Intimate contrast with exquisite detail should be such that the lung structure is shown well out to the periphery. Uniformity, which over a long series of radiographs is particularly important, should also be attained by the use of the table (see Fig. 20). Excessive contrast in the chest radiograph is to be avoided.

The latitude of exposure (30 per cent. \pm) allows for differences between the muscular and the non-muscular subject, particularly with this carefully prepared table, where the mid-point in density latitude is used. This can be proved by taking three radiographs (a), (b) and (c) of each of a series of subjects, varying either kilovoltage or time, as preferred; (a) is exposed according to the standard table, (b) is given increased exposure and (c) receives less exposure. For example, the changes in time could be of 0.02 sec., and those in kilovolts could be of 4 kVp (2 studs). Careful analysis of the results will show invariably that the radiographs taken according to the standard exposure table are to be preferred.

During projection of the miniature radiographs, particularly during the initial work by the Unit, a member of the technical staff should record comments in the control table book, e.g. "satisfactory" (s.), "slightly over exposed" (s.o.), "much over exposed" (m.o.), "too dense for interpretation"

* These stud values apply only to the standard apparatus supplied for the national scheme.

† At 100mA, the time in seconds should be doubled to give the same mA seconds.

(t.d.), and "slightly under exposed" (s.u.), "much under exposed" (m.u.), "too light for interpretation" (t.l.). Those films marked t.d. and t.l. will of course require repetition. Any other technical defects, including positioning and darkroom faults, should also be noted. After each series has been examined and commented on in this way, a general assessment can be made and causes of the chief faults identified and rectified.

Special care should be taken, when beginning a new survey, to see that the best results are being obtained. It may happen, owing to variation in the mains supply, that a general adjustment in the exposure table is required—when this is necessary, the same change should be made throughout the table of exposures for that survey. Instructions provided by the manufacturers give data which will enable the radiographer to re-calculate the exposure conditions for any given mains supply system.

(iii) *Exposure Conditions for Large Film Examination.* The large radiographs taken on this apparatus are of a very high standard, showing excellent detail and definition, with uniformity in density throughout the range of subjects (see Fig. 21).

(a) *Postero-Anterior Views.* Again the exposure technique is based on the chest thickness measurement (previously obtained), as shown in the following table:—

EXPOSURE TABLE FOR LARGE FILMS (P.A. VIEWS)

The following exposure data apply to Ilford Standard X-ray Film, used with Ilford Tungstate Intensifying Screens; Focus-film distance 60 inches. They also assume development in Ilford Blue Label Developer (ID.42) for 5 minutes at 65° F. (18° C.).* With different film, screen or developer, the exposure table would require modification.

Chest Thickness in Inches.	kVp.	†(Stud).	‡Time in Seconds at 300 mA.	mA Secs.	
6	54	(2)	0.05	15	
6½	56	(2)	0.05	15	
7	58	(3)	0.05	15	
7½	60.5	(4)	0.05	15	
8	62.5	(5)	0.05	15	} Exposures for average-sized subjects.
8½	65	(6)	0.05	15	
9	67	(7)	0.05	15	
9½	69.5	(8)	0.05	15	
10	71.5	(9)	0.05	15	
10½	71.5	(9)	0.07	21	
11	71.5	(9)	0.08	24	
11½	74	(10)	0.08	24	
12	76	(11)	0.08	24	
12½	78	(12)	0.08	24	
13	80.5	(13)	0.08	24	
13½	82.5	(14)	0.08	24	

Note.—When using a faster type of film, the exposure time may be reduced or there can be a compromise between reduction in time and in kilovoltage, according to the quality of chest radiograph preferred.

* During hot weather, developing conditions are modified according to the time-temperature chart shown in Appendix 6. In winter-time, in addition to heating the developer to 65° F., we have found it advisable to increase the exposure time by 20 to 40 per cent., according to the external temperature.

† These stud values apply only to the apparatus supplied for the national scheme.

‡ When working at a lower mA, the exposure time should be increased to give the same mA seconds.

(b) *Views other than Postero-Anterior.* Continuing to work on the basis of the thickness measurement, the kilovoltage and/or time for a particular thickness is increased beyond the exposure conditions required for the P.A. view at a distance of 60 inches. The following table will assist :—

LARGE FILM EXPOSURE TABLE FOR SPECIAL POSITIONS

Focus-Film Distance 60 inches

A.P. 4 kVp (2 studs) up on P.A. setting (Fig. 22).

Lat. 20 kVp (9 studs), and exposure time 0.03 sec., up on P.A. setting (Fig. 26).

Focus-Film Distance 72 inches

Heart (P.A.) 8 kVp (4 studs) up on normal P.A. setting at 60 inches.

(For focus-film distance of 60 inches, the increase is 2-4 kVp (1-2 studs), to obtain the necessarily greater density than for a radiograph of the lungs.)

Focus-Film Distance 48 inches

Lordotic 4 kVp (2 studs) up on P.A. setting at 60 inches (Fig. 24, see also Figs. 23 and 25).

Focus-Film Distance 36 inches

First oblique 6 kVp (3 studs) } up on P.A. setting at 60 inches (Figs.
Second oblique 8 kVp (4 studs) } 28-31).

Using Stationary Grid at 36 inches

P.A. 4 kVp (2 studs), and exposure time 0.03 sec., up on P.A. setting at 60 inches (Fig. 33).

Lat. 20 kVp (9 studs), and exposure time 0.03 sec., up on P.A. setting at 60 inches (Fig. 27).

Note.—Conditions with regard to materials and processing are the same as for the previous table.

(iv) *Screening (Fluoroscopy).* For screening operations, the lead to the film-numbering device is disconnected, and a "shorting" plug is attached to the lead. The camera and tunnel are removed from the screening stand, and their weight is replaced by sandbags placed on the frame of the screen.* The lead from the footswitch is plugged into the appropriate socket at the back of the control table, and the footswitch is placed in a convenient position for the operator. The screening resistance is adjusted to give up to 5 mA (usually 3 or 4 mA), as registered on the milliamperemeter.

When the radiographic exposure adjustments (time and kilovoltage), immediately following the screen examination, are within the values required for screening, i.e. 0.05 sec. or more and not more than 85 kVp, it is convenient to use these conditions for screening. On changing from footswitch to radiographic exposure switch, and *vice versa*, the appropriate mA values are obtained automatically, i.e. up to 5 mA for screening and 300 mA for large films. The rotor of the tube does not function during screening operations.

Screening is for positioning only, as the limited mobility of the tube, and the lack of smooth control of the tube diaphragm aperture, prevent diagnostic screening from being undertaken. Screening conditions are suitable, however, for oblique and lordotic positioning, for adjustment for special positioning, and for localising over small areas. (Eventually, a cassette tunnel will be available, which will simplify placing the cassette in position after screen-positioning has taken place.)

* A lead rubber apron is to be added to future apparatus, which, together with a cassette tunnel, will replace the sandbags as a counter-balance.

F. *Darkroom Procedure*

(i) *Processing Miniature Films.* Meticulous care must be taken in processing the miniature films; standardisation and cleanliness are of the utmost importance. There is no resemblance to the processing of full-sized X-ray films where only one examinee is concerned for each film or for several separate films and where visual inspection can be made during processing.

In miniature radiography, the decision between normal and abnormal rests upon one exposure. Early lung lesions may be small, and similar in density to the normal tissue; and viewing is of a projected enlarged image, upon which detail may be obscured by quite small abrasions or foreign particles. The type and size of the subject are the only variables permissible, and there is little latitude for development, which must be standardised. The high speed of the film, whether orthochromatic or panchromatic, makes complete darkness essential during handling. Any mishap in the darkroom may result in the inconvenience of the recall of a busy person, if it involves one frame; and up to 50 or more, if it involves a whole roll of exposed film.

The developing solution is prepared with great care, in accordance with the instructions given on the packet of chemicals recommended for the type of film in use. After mixing, the developer is filtered directly into storage containers such as "Winchester" 80-oz. bottles, and it is allowed to stand for 24-48 hours before being used. After standing, any sediment in the bottle should be left undisturbed. Similar care is taken with regard to the concentration and cleanliness of the fixing solution. This acid fixing solution should be of the *hardening* type, in order to prevent trouble caused by the undue swelling of the gelatin coating of the film. It is important that, in use, the temperature of the fixing solution should not be more than 5° higher or lower than that of the developer.

Two methods of development are employed at present* :—

- (a) using small tanks (daylight type) taking 70-inch lengths of film and up to 60 exposures (considered to be more precise for standard results)—see Fig. 3;
- (b) using frames taking up to 25-ft. lengths of film in standard X-ray developing tanks—see Fig. 39.

(a) *Small Tanks.* There are four parts to the daylight tank—the container, the spiral, the lid and the stirring rod. There are several types, the two in general use differing chiefly in size, one being made to take films of several widths and the other to take only the 35-mm. film. For both tanks, 16 oz. of developer are sufficient to cover the film, but since this quantity reaches the brim of the smaller tank, and it is essential for the film to be completely immersed, it is necessary to stand the tanks in a dish, to avoid spilling the contents on to the bench. Because of the active type of developer employed for this work, the films would show uneven development if the tank were filled with solution after the insertion of the film (as recommended with pictorial film, for which a slow acting developer is employed).

When these tanks are used for ordinary pictorial work, the solutions are changed without removing the lid; and one tank serves for the whole process which is carried out in the light after the lid has been placed on the tank containing the spiral and film. For miniature chest radiographs, on the other hand separate tanks are used for developing, rinsing, fixing and washing, the spiral holding the film being moved from tank to tank in complete darkness. The developing and fixing tanks, always used for the one purpose, are clearly marked, so that both containers and lids of the two tanks of solution are readily

* A complete unit has been proposed with ample capacity for processing both miniature and large films. It provides thermostatic and refrigerator control of temperature, and continuous agitation of the solutions, and it is suitable for both fixed and mobile darkroom (see Appendix 6).

distinguished by touch in the dark. Painted letters on the one tank, and strapping on the other, provide the necessary distinction. As the spirals must be perfectly dry for inserting the lengths of film, a ratio of two spirals to one tank is recommended (see Appendix 1), to give time for the spirals to dry when many films are developed on the one day.

Recommended development of H.P.X. film in Blue Label developer is 8 minutes at 65° F. It is very important to use the developer at the correct temperature. In *cold* weather, the temperature of the solution in the small tanks is maintained by placing them in a dish of hot water. Should there be difficulty in obtaining hot water, a small immersion heater may be used, but it may then be necessary to heat the solution in tall narrow containers. In *hot* weather, cooling by evaporation is achieved, by placing the base of the bottle of developer in cold water and draping a piece of wet muslin around the bottle from the neck downwards into the water. When convenient, bottles of developer, stood outside overnight against a north wall, will be found to be at a low temperature on the following morning. Another alternative is to place the tanks of developer in a deep dish containing cooling solution, made up of 1 lb. Ammonium Chloride and 1 lb. Sodium Carbonate mixed in 1 pint of water. The dish should be fitted with a cover which has two apertures for the developing tanks, to retain the somewhat obnoxious fumes of the cooling mixture and to prevent the films from being contaminated*. About ten minutes are required to cool the developer by 6-8° F., and the latter should be brought down to about 64° F. to allow for a slight rise during development.

It should be remembered that since everything concerned with development, including the films, will also be at a high temperature during hot weather, the blackening effect on the emulsion may be more than anticipated; hence it is wise to avoid processing during and for some time after the hottest part of the day, and thereafter to do so only with great caution, beginning with one length of film for immediate wet viewing, and subsequently modifying the development time if necessary.

Miniature films can be developed in a very small space, but the room must be completely light-tight, with adequate safeguard against the door being opened in error. With practice, two lengths of film can be developed simultaneously in two sets of tanks, but if there is likely to be any difference in the starting times, it is as well to use two timing clocks.

Having prepared the tanks in the correct order on the wet bench, and having placed the timing clock within easy reach, the operator turns to the dry bench on which stands the tin containing the exposed film and the spiral, and removes the spool of film from the tin.

Taking the spool in the right hand, the operator gently feeds the film into the spiral. When it is inclined to be stiff, it can be helped by easing the top and base of the spiral. Towards the end also, it is useful to ease the film forwards by pressure on the back surface with thumb and finger. The lead-in end on the camera, which is on the inside of the roll, is now on the outside of the spiral, and the end should be straightened to prevent scratching of the film below. If the film is too long, a measured 5 inches may be cut off, by using a piece of card, or by a groove of the correct length cut in the bench. Should there be another unexposed spool of film in the tin, the lid should be replaced, and fastened with the strapping, before the spiral is loaded.

The loaded spiral is placed in the developer, and the clock is set in motion, having been pre-set for 8 minutes. The spiral is raised and lowered to dispose of air bubbles, before the lid is fixed in position. The stirring rod is introduced, and is rotated clockwise (in direction of loading) every half-minute throughout

* It is essential to use fully hydrated salts. "Hypo" may be used in place of Sodium Carbonate, giving 20 per cent. less cooling, but dispensing with fumes and allowing use inside the darkroom.

development. This periodic agitation of the developer is very important for giving the maximum density, contrast and uniformity for the standard conditions employed. It is now safe to use a light until the 8 minutes have elapsed, when the room is darkened again for the spiral to be removed from the developer and placed in the rinse bath for 10 seconds, and thence into the fixer for 10 minutes. Finally, and in the light, the spiral is inserted into the washing tank, and placed under a cold water tap to which rubber tubing is attached. A piece of gauze, packed with cotton wool, is fixed by a rubber band to the end of the tubing to serve as a filter, and the latter is placed over the central aperture in the lid of the tank, from which the stirring rod has been removed (see Fig. 40). By fitting a T-shaped tube to the tap, and allowing the water to cascade, four lengths of film can be washed under the one tap. The water supply may be so unsatisfactory as to require filtration at the source, both for making up the solutions and for washing the films. The filter recommended in Appendix 2 can take 30-50 gallons an hour (see Fig. 41).

To accelerate drying, and to avoid drying marks, a wetting agent may be used. After washing for 20-30 minutes (not exceeding 30), the spiral is removed and placed for one minute in a tank containing the wetting agent, which should be used in the strength given in the instructions (this may vary from 1 in 500 to 1 in 1,000 parts of water). If the wetting agent is too strong, froth bubbles will form and show on the dried film. To obtain even immersion, the spiral should be rotated gently in a clockwise direction: too much agitation also will cause froth bubbles. On unwinding the film from the spiral, the moisture is removed from the back with a piece of damp, fine chamois leather, before being hung to dry in a dust-free atmosphere. Drying will take from 20 minutes in a heated drying cabinet to 2 hours on a bad drying day without air agitation or heat. A spool can be used to weight the centre of the 70-inch length, so as to reduce the drying space*. When the water is hard, the film should be rinsed in a 1 per cent. solution of acetic acid after washing, and before immersion in the wetting agent.

The manufacturers recommend that four full lengths of film be developed in each 16 oz. of developer, increasing development time by 1 minute for each length of film. In practice, however, we prefer to renew the developer after each two lengths of film without increasing developing time, and we find that uniformity of development is thus satisfactory. Whether two or four lengths of film have been developed in the one tank, the developer is by no means exhausted, and can be used further for developing the full-size radiographs, providing that there is not too long an interval.

The fixer is renewed after four lengths of film. The rinse water should be fresh for each length of film; and when running water is not available in the darkroom, a jug of water can be used for renewal, and a bucket for the used water. A tankful of wetting agent can be used for ten lengths of film†.

The two developing tanks are marked A and B, and the two fixing tanks C and D; and a wall chart is kept to show how many lengths of film have been passed through each solution. A similar record is kept for the tank containing the wetting agent (marked W) and may be included on the same chart (see Appendix 5, Chart 1).

When the films are dry, the backs are cleaned by wiping firmly with a chamois leather which has been *only slightly* moistened. The back of a very dirty film can be cleaned with a piece of cotton wool well moistened with carbon tetrachloride; because of rapid evaporation, the cleaning action must be done quickly and evenly, and without undue pressure, otherwise uneven markings

* A newly designed drying cabinet has separate compartments for both miniature and large films, and also can be transported in sections.

† When a wetting agent is added to the *developer*, even development is assured.

will show on the film. This preparation may also be used with great care for removing grease marks from the emulsion surface. Special precautions are necessary to keep the first and last chest radiographs in a length of film free from abrasions and foreign matter.

(b) *Frame Development.* The developing frame is rectangular in shape and fits into the 17 × 14-inch tanks used for developing the large films. The top and bottom of the frame are divided into sections to take the 35-mm. film, with a dental film clip at each upper corner. The frame rests on a cradle, on which it rotates while the film is wound into position (see Fig. 39). A special tank of developer is kept for developing the miniature films; and in preparing and using the solution, the same precautions are observed as for the small tank method.

Any length of film up to 25 feet (i.e. 200 chest radiographs) can be carried on a frame. Two developing frames can be placed side by side in the one tank, 400 chest radiographs being processed in approximately 30 minutes, excluding washing. From our experience, however, we prefer to limit the length of film to, say, 70 inches (60 exposures).

Again in complete darkness and with everything prepared beforehand, the exposed film is wound on to the developing frame. One end of the film is attached to the fixed dental clip, and the frame is slowly rotated in a clockwise direction on the cradle, while the film is guided between the divisions at the top and bottom of the frame. The end of the film is fixed to the second dental clip, which is attached to the frame by a stretched rubber band. This band enables the slack to be taken up as the film expands in the solution, and thus the film is always taut on the frame.

Development is for 8 minutes at 65° F., and the same rigid care must be taken in time and temperature. It is essential to see that the level of the developer is maintained above the upper level of the film on the frame, bearing in mind that there is a certain amount of loss due to the frame being removed and reversed from top to bottom during each minute of development. This periodic reversal is to prevent uneven development, resulting in "flow" marks due to the bromide sinking to the bottom of the tank. Fresh developer should be used for "topping up". Twelve 25-foot lengths of film may be processed before exhaustion of the developer is reached, development being prolonged by one minute for the second six lengths. The number of lengths of film that can be processed before exhaustion of the developer can be doubled if the development time is increased by one minute for each further additional six lengths.

The frame should be reversed twice in the rinse bath and once in the fixer, and washing should be for 30 minutes.

A 17 × 14-inch size tank of wetting agent can be used for sixty 25-foot lengths of film. After moisture has been removed from the back of the film with a chamois leather, the film may be wound on to a dry frame for placing in a drying cabinet.

It is hoped that, in the event of development with long lengths of film being preferred, continuous progress tanks will become available, in which the film is passed automatically from one solution to the next.

(ii) *Inspection and Filing of Miniature Films.* Each dried length of film is examined for mechanical abrasions, and for such gross technical defects as can be seen by direct viewing. The number at each end of the length is checked with the record in the control table book, and, after the ends have been trimmed to a suitable length—and the corners clipped for easy passage through the projector—the first and last numbers are written with white ink on the starting end of the film. Roughening of this part of the film surface simplifies marking.* In rolling the films, they should not be tightened by pulling on one end, or the

* When available, an electric pencil can be used for marking the films, the visibility of the "scored" figures being aided by writing over them with yellow pencil.

surfaces will be damaged by one coil rubbing against another (especially if there is grit on the surfaces); they should be loosely rolled, with the centre diameter not less than 3 cm. Rubber bands should not be used to confine the rolls, which should preferably be stored standing on one edge.

The rolls are filed in cabinets (separate for males and females), which may contain some 18,000 exposures. Four- or six-drawer cardboard cabinets, intended for storing stationery, can be adapted for this purpose. They can be obtained in quarto or foolscap size; the drawers are just deep enough to take a roll of film, and when divided by interlocking cross strips of cardboard or film celluloid, they form separate compartments (similar to egg boxes), to take either the short or the long rolls of film. A piece of washed-off film celluloid, attached by staples to the back of each drawer, provides a dust-proof transparent cover through which the numbers on the rolls of film are visible. The films are filed in sequence, and the first and last numbers in the drawer are written on the label on the front of the drawer (see Fig. 35; but note that an earlier form of labelling is depicted).*

Further information on the storage of miniature films may be found in the British Standards Institution leaflet 1153 (1944). No precise advice can, however, be given as yet on how long storage may be required.

Exact copies (negative transparency) of single miniature radiographs can be obtained by means of a simple reversal process, should these be needed for reference purposes.

(iii) *Processing Large Films.* Since radiographers will be familiar with this part of the work, it need be described only briefly. The accommodation at a temporary centre may not allow for the films to be processed as they are removed from the cassettes. They are usually placed, in the order of exposure, in a light-tight box for subsequent development, with the exception of any special films requiring inspection before the examinee leaves the department. It may be necessary to provide a mobile sink for the developing tanks (as shown in Fig. 47, p. 119).

Because, in general, development has to take place after the examinees have gone, correctly estimated exposure time and standard development (5 mins. at 65° F.) are as important as with miniature films. Moreover, for the large films, it is usually necessary during *hot* weather to allow for working at a higher temperature, by adjusting the developing time according to the time-temperature chart shown in Appendix 5, Chart 3. Because of the added temperature effect due to the warmer atmosphere and the warmer utensils, hangers and films, we have found it advisable to work at the minimum exposure time (see p. 43).

The developer is maintained at standard strength by using a replenisher, but it has been necessary to work out a special rate of replenishment, because the amount of unexposed film area present is larger in chest films than in general radiographic work. During a recent controlled test, 870 films (17 × 14-inch) were processed under standard conditions before the replenished developer was renewed, and the results were satisfactory. Commencing with a 3-gal. tank of fresh developer, and draining each film for 10 secs., 5 gal. of replenisher were added at the rate of 20 oz. for each 22 films. It is considered, however, that there is no advantage in replenishment beyond 540 chest films using 3 gal. of replenisher; this amount of replenisher agrees with the manufacturer's recommendation that the amount of replenisher used should not greatly exceed the original volume of developer. Careful note on a daily chart should be made of the number of films processed, and of the amount of replenisher used (see Appendix 5, Chart 2).†

* Specially designed cabinets will probably be available in due course.

† The replenisher tends to deteriorate on exposure to the air and should, therefore, be stored in, say, 40-oz. bottles. In the newly proposed unit, space is reserved for a tank of replenisher, which is kept at developer temperature, and it is suggested that a floating cork of balsa wood (boiled in paraffin wax) be used for this tank.

The fixing bath should be renewed after the processing of 150 (17 × 14-inch) films. When running water is not available in the darkroom, a "stop" bath of 2 per cent. acetic acid should be used for the rinse; "topping up" should be done with this acid solution, and the bath should be renewed after 100 films. The films should be washed for 30 minutes in running water. One of the difficulties of temporary accommodation is to find a large sink with taps high enough to take the washing tank; and this part of processing may well cause a bottle-neck, particularly when as many as 150 films are handled during a half-day session. It is advisable either to have two 10-gal. washing tanks, or one 10-gal. tank and one large galvanised iron tank, the latter to take 50 films.

Drying of the films may become a problem when the size of the premises is limited, and it is an advantage to use a "wetting" agent to accelerate this process. Drying time is then reduced by 25 per cent. Three hundred films may be passed through one 3-gal. tank of wetting agent before renewal.

The simplest way of dealing with the drying problem is to select a room, which may well be the general darkroom (Appendix 2, Survey 1) or a separate room (Survey 4). After swabbing the floor free of dust, lengths of thick cord, knotted at 6-inch intervals, are suspended from one side of the room to the other. The cords need not be taut, since the knots, one for each film, prevent the films from crowding together. Two hot-air blowers, placed on benches, enable both miniature and full-size films to be dried quickly and satisfactorily (see Fig. 42).

G. *Viewing and Interpretation of Miniature Radiographs*

The method of examining and interpreting 35-mm. film varies considerably, but it is probable that front projection, rather than either back projection or transillumination (direct magnification), will become universal. Back projection is too fatiguing for the viewing of large numbers of films, though it is convenient for an audience. Direct magnification is slow and fatiguing, and restricts the view to one individual.

The essentials for projection are good, even illumination; a flat field; a high degree of optical resolution; critical focussing; and a satisfactory screen which can be observed by several people at once. It is not suggested that more than one medical man should interpret the films at the same time, but it is essential that the technical members of the team should have facilities for viewing their results and discussing problems with the medical director.

At the present time, owing to the shortage of personnel, 1,000 examinations per week is about the average number passing through each Unit. Our own experiences with a full team have shown that 1,500 per week is relatively easy. With larger teams in the post-war period, 2,000 a week may well become routine. Speed of interpretation is therefore essential, as a long lag between the examinations and transmission of the results to the examinees is undesirable.

Speedy, accurate interpretation is dependant (1) on the interpreter's knowledge of chest radiography and chest disease, (2) on the quality of the films, and (3) on the routine of the projection.

(1) Is self evident; the medical directors selected are all individuals with previous knowledge of chest disease and chest radiology. Many are tuberculosis officers, and the Ministry's course has been designed to give them an increased knowledge of the technical factors necessary for first class chest radiography.

(2) If all the films are of similar quality and density, interpretation at speed is much facilitated. Accurate thickness measurements provide the basis for consistent results (see p. 40; but see also reference in footnote on that page to new photo-electric timer).

Experience has shown that a non-calcified tuberculous lesion which, in the full-size radiograph, is 1 cm. in size can be detected in a good miniature radiograph,

and that clusters of smaller nodules, 2 to 5 mm. in size on the large films, can also be detected. It follows that with a technique which reveals such lesions, grosser lesions will be obvious. A study of early "soft" lesions on miniature radiographs shows that the majority occur in the peripheral subclavicular areas of the upper lobes, and in the apices. These lesions are visible with the greatest clarity in a film which shows the rib borders clearly, but which does not show the bony structure of the outer end of the clavicle or of the head of the humerus. There is no doubt that this simple observation is the guide to the ideal miniature film. A latitude of plus or minus 2 kVp will not negative the diagnostic value of the film, but one of plus or minus 4 kVp certainly will, either by blacking out the peripheral areas so that the soft lesion is over-penetrated, or by concealing it by the soft tissues of the pectoral muscles.

If the film is of correct density, projection to approximately 5 × 5 inches will give the optimum image. If a larger image be used, the illumination will be too diffuse, the definition unsatisfactory, and the object will be too big to be visualised in a brief moment.

(3) The routine of projection is as follows: The operator stands behind the projector, while the interpreter sits about 18 inches from the screen. The clerk sits at a convenient place, with a masked lamp (see Fig. 34, and Fig. 45). The members of the technical team should be present, but there must be complete silence unless the interpreter interrupts the projection to discuss technical deviations.

The projector should be fitted with a first class lens, having good covering power, and a condenser system giving even illumination with a 100-watt lamp (see Fig. 43). The miniature film should be protected from overheating, and it should be possible to pass it through the gate without damaging the emulsion surface. The projector screen should be designed for easy renewal of the flat, matt white, viewing surface (see Fig. 44).

During projection, the film should be moved smoothly through the gate, from one frame to the next, so that the viewer begins to examine each radiograph as it moves into position. The projectionist calls out the serial number as the film comes to rest, so that the clerk can check the number on the record card (see p. 30). During projection, a member of the technical staff should make note of any technical observations in the control table book, at the same time giving any relevant technical details which may have been recorded when the film was exposed (see p. 29).

The interpreter begins slowly, as he not only has to adapt himself but must also give the projectionist time to adapt for reading out the numbers, and the clerk time to make the necessary entries on the cards. It is soon found that speed of interpretation increases rapidly over fifteen minutes, after which a maximum is reached. As the image moves into position, the eyes move up on the right-hand side and down on the left, and then quickly cover the picture as a whole. With good films, nothing at the bases will be overlooked, and the interpreter will almost automatically concentrate on the danger areas, i.e. the peripheral sub-clavicular areas and the apices. It is a useful check if occasionally two exposures are made of the same individual; if the interpreter is working at the correct speed, he automatically notices that the two successive films are of the one individual, and this is also a check on the projectionist who is reading out the numbers. As soon as the interpreter feels his eyes tiring, the session should be interrupted for 10-20 minutes.

Discussions on the probable diagnosis arise when other medical men are present. Such discussions are often futile and a waste of time, and we agree with Trail that interpretation of the *miniature* radiograph should be left to one individual.

During the M.R.C. survey, 70-inch strips showing 50 subjects have been used. Some workers may prefer to examine longer strips, but we have found the

interval involved in changing the 70-inch strips restful, while, nevertheless, an average speed of interpretation of 400 per hour has been reached.

It is obvious that the closer the detail of a miniature radiograph approximates to that of a full-size film, the more accurate is the interpretation. Indeed, because of the short distance at which miniature radiographs are taken, the apices tend to be shown more clearly in the miniature film. But this short distance carries the handicap that the anterior borders of the ribs, the soft tissues of the chest wall, and the root shadows tend to stand out with undue clarity at the expense of the smaller pulmonary vessels. With proper technique, this handicap has been considerably reduced, and the smaller peripheral vessels, with the exception of the fine apical branches, should be clearly visible when the film is projected.

At one period, we contemplated taking two miniatures, P.A. and A.P., of all individuals, and tests made on selected individuals with small posterior lesions showed the value of the method: It was found in practice, however, that the making and interpretation of two radiographs of each individual slowed down the work too much, and it was then decided to use this method for large films only. The results in suspect cases showed the value of this procedure, which may prove to be more useful than stereoscopy. An A.P. view gives a different view of the apices, and, since many tuberculous lesions are situated posteriorly, the A.P. view may show up such lesions with better definition. In a number of cases, the A.P. view showed a frank cavity which was invisible in the P.A. view. As an aid to the estimation of the extent and age of a tuberculous lesion, the combination of the P.A. and A.P. views is most valuable, and the taking of these is now our routine practice with large films (see Figs. 21-22).

H. Protection of Staff

Protection of personnel is of great importance, because of the large number of exposures made each day. In general, the "Recommendations of the British X-ray and Radium Protection Committee", 6th Revised Report, Feb., 1943, should be followed. In this publication the "tolerance dose" is given as follows:—

"The evidence at present available suggests that under satisfactory working conditions a person in normal health can tolerate with impunity exposure to X-rays and radium gamma rays to an extent of about one international roentgen (r) per week. On the basis of continuous irradiation during a working day of seven hours and a working week of five days, this figure corresponds approximately to a "toleration" dosage rate of 10^{-5} r per second (*0.2 r per day*). The protective values given in these recommendations are generally in harmony with the figure of one r per week under average conditions." (Italicised words our insertion.)

During each exposure, scattered radiation is produced, mostly from the body of the examinee. The amount of scatter, although comparatively small, is cumulative throughout the day, and would, if allowed to reach the operator, amount to quite an appreciable dose. Under the exposure conditions recommended for miniature radiography (p. 42), a total dose per day of 0.2 r would be reached after approximately 135 exposures, if the operator were at a distance of one metre from the subject and without the protective screen. With a standard protective screen in place, 5,000 exposures at the same distance would be needed to reach the tolerance dose in one day.

A small amount of scattered radiation arises from the edges of the tube diaphragm box, but it should be emphasised that the chief source of scatter is the examinee. Under reasonable working conditions, it is not usual to have the protective screen closer than about 6 feet from the centre of the examinee's body, and under these conditions the daily tolerance dose could only be reached by

the control table operator, behind the screen, after about 16,000 exposures in a day.

In the case of the Medical Research Council layout for Survey 1, dosage measurements carried out during the survey* showed that for the tolerance dose to be reached by the members of the team, it would have been necessary to make 10,000 exposures a day for the control table operator, and 20,000 a day for the positioner (both using protective screens); and 2,500 exposures a day for the nearest clerk, and 1,200 a day for the marshal (both working without protective screens).†

From the data quoted above, it will be seen that due precautions must be taken for all members of the team, particularly when the premises are small and the working distance from the apparatus is limited. It soon becomes a habit, however, to observe the protective measures and to use the screens; indeed, there is a rhythm about the positioner's movements which becomes an essential part of the work.

Two protective screens are supplied with the apparatus; in future apparatus, these will be widened a little, and the size of the lead glass window enlarged somewhat, in order to give better visibility for the operator. The present screens, when properly used, give adequate protection to the positioner and the control table operator (see Figs. 16 and 36). The safest position near to the apparatus, without the screens, is behind the camera—this is because the lead glass in front of the *fluorescent* screen (inside the camera tunnel) gives some protection.

The marshaller, who may be the most mobile member of the team, should avoid entering the X-ray room or moving within a 12-foot radius of the X-ray apparatus; but, as already mentioned, very little actual marshalling is required, and the department should be so arranged that the examinees follow through from one stage to the next, without the need for personal direction.

The position of the clerks should be arranged so that no skin surface is within 12 feet of the X-ray apparatus.

Once the working positions of the team, from the safety point of view, have been settled on a particular site, no alteration should be made, except on consultation with the medical director and radiographer-in-charge. As a check against possible carelessness, it is as well to make periodic tests, by each person wearing a dental film, placed on the side of the body towards the tube, during a week's work (see p. 121). After standard development, with the inclusion of a fresh film for comparison, overdosage will be apparent in the fogging of the film. If a particular film shows undue blackening, this should be confirmed, to exclude the possibility of accidental exposure; if necessary, a similar test should be made by arrangement with the National Physical Laboratory. Before the M.R.C. team commenced work, blood counts were taken and also X-ray films of the chest, and similar checks were made after six months.

In training new teams, dental film checks are made during the practical periods, so that from the beginning all members become accustomed to keeping their distance from the apparatus.

Every step should be taken to counteract any undue apprehension felt by the clerks and marshals, who probably hear of the possible dangers of receiving excessive X-radiation for the first time on joining the Unit. These fears should be readily allayed by a simple explanation, and by the means taken for protection—distance from the X-ray apparatus being the most important factor.

* Measurements made by Mr. A. J. Minns, Chief Engineer of Watson and Sons (Electro-Medical), Ltd., who was responsible for the design of the mass radiography apparatus used for the national scheme.

† As a result of this test, the work of the marshal was entirely re-arranged, to be as described in this report.

I. *Miscellaneous*

(i) *Chest Covers*. It became obvious in the initial stages of civilian mass radiography that it would be necessary to provide the women examinees with chest covers and, after trying out several patterns, a simple form was devised. This consists of an 18-inch square of material, with one corner removed to form the 6-inch neck line, and a 60-inch strap stitched along the neck line (centre of strap to centre of neck line). The ends of the strap are crossed, and are attached to adjacent corners of the square (Fig. 46). There are no loose ends to be torn off at the laundry. This form of chest cover fits every type of subject, and allows the straps to be knotted at the back to give a good fit for the smaller women. Photographs placed in the undressing room show how the chest cover is worn (see Figs. 7-10). We have used black-out material (Italian cloth), and have found that 85 yards of 54-inch material is sufficient for 350 chest covers, which, incidentally, have become known as "black-outs". The smooth finish of this material, and its dark colour, make it preferable to light cotton materials, which discolour with much laundering.

Although laundering and materials offer difficulties in war-time, it should be practicable for every examinee to have a freshly washed chest cover. If, however, laundering is not to hold up the examination, a minimum of 1,000 chest covers will be required, and preferably the number should be 2,000 (allowing for four working days).

Possibly the cloth covers will be replaced eventually by paper slips, thus dispensing with laundering.

(ii) *Visitors*. As civilian mass radiography will continue to be pioneer work for some time, it is as well to be prepared for visitors to the Unit. It is essential that the team should assist with this form of health education.

In each centre, there will be a desire for officials to visit the Unit, and there may be requests from groups of workpeople to have an opportunity of knowing a little more than can be shown during the passage through as examinees. So long as it does not mean sacrificing the efficiency of the Unit, every effort should be made to meet these requirements. Each Unit should have a programme in mind for such visits. Male visitors should be given appointments on men's days, and female visitors on women's days; if several are coming, they should be received together rather than wasting the time of the team by making several separate visits. The ordinary visitor will be quite satisfied with a brief explanation, but for one who is technically minded, a member of the technical staff should be available, and, of course, for medical visitors the medical director may like to be present.

SECTION 7

Procedure after Interpretation of Large Films

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A. *Primary Medical Interview*

After examination, by the radiologist and medical director of the Unit, of the radiographs of the persons recalled for full-size films (between 5 and 10 per

cent. of the total radiographed, falling to about 5 per cent. after experience has been gained), over half of these will probably be passed as indicating that no action is required; and the individuals will be so informed by letter to their private addresses. The following are two examples of such a letter :-

PRIVATE AND
CONFIDENTIAL

Letter C

.....MASS RADIOGRAPHY UNIT

(Address)

(Date)

Serial Number.....

Dear M

The result of your *large* X-ray film is satisfactory as regards tuberculosis of the lungs, and we shall *not* require you for further examination. Thank you for your co-operation.

or

The *large* X-ray film taken of your chest shows *no* abnormality in the lungs requiring further investigation.

Yours very truly,

.....
Medical Director.

The remainder of those recalled for full-size films (about 2 per cent. of the total radiographed, in our experience) will require further attention and medical advice. We shall describe one suggested procedure for interviewing and disposing of these "investigate" or "interview" cases in factories and office surveys; this can be readily adapted for other civilian groups. According to this procedure, the primary medical interview should be with the medical director, for otherwise it is difficult to see how he can keep the findings in general perspective; furthermore, the psychological difficulties which apparently healthy people may have in accepting further clinical investigation and possibly treatment can most easily be overcome by a doctor associated with the mass radiography survey that discovered the abnormalities. This is shown by our small percentage of defaults, while we have been informed that in certain civilian surveys, where this procedure has not been adopted, the wastage is greater.

Where the X-ray plant is inside the factory or other establishment investigated, the room in which the medical interview takes place will conveniently be also on the premises. Thus in Survey 1 (Factory A) the room was a small air-raid shelter, in Survey 4 (Factory B) it was a temporarily unused office, and for Survey 2 (Office Group) it was in a nearby civil service building. If practicable, the doctor's room should be away from the works medical department. The interviews are most conveniently spaced at intervals during working hours. The interview is unlikely to take less than 10-15 minutes, bearing in mind that these are not ordinary patients (in the M.R.C. survey, appointments were made half-hourly, to allow for the taking of laryngeal swabs for research purposes). The greatest privacy possible should be aimed at. Two adjoining rooms are desirable, one a consulting room for the actual interview, and the other to serve as a waiting room and office; the doctor's clerk will act as the receptionist. Where the X-ray plant is elsewhere than on the premises of employment, e.g. where a group of factories is being investigated, the doctor's rooms will presumably be in the same building as the apparatus; in other respects the procedure will be the same.

The letter giving the appointment for the medical interview should be sent to the private address of the individual. The following is an example of such a letter :—

PRIVATE AND CONFIDENTIAL Letter D
MASS RADIOGRAPHY UNIT
 (Address)
 (Date)
 Serial Number.....

Dear M

With regard to your X-ray film, I should be very grateful if you would allow me to give you a brief examination of the chest. Would you kindly, therefore, attend at..... on the date and time mentioned below and *ask to see me* (I shall keep you for fifteen minutes at the most).

.....day
 194
morning/afternoon.

PLEASE BRING THIS LETTER WITH YOU.

Yours very truly,

.....
 Medical Director.

If you prefer to come outside work hours, or cannot attend for any other reason, please send me a note (enclosing this letter) to this effect, and suggest alternative suitable dates and times. If you are under 16 years of age, one or both of your parents might like to attend the examination.

The primary medical interview between patient and medical director has the following objects :—

- (1) to keep a general view of the size and character of the social and medical problems arising from the survey, and of the types of case detected ;
- (2) to decide and arrange for the disposal of each case ;
- (3) to deal with the individual psychological difficulties resulting from discovery of latent pulmonary lesions and consequent need for further action ;
- (4) to obtain enough clinical and other data for use, in combination with the later reports from the tuberculosis officers and other physicians, to make a statistical analysis under suitable classification headings ;
- (5) to collect data for, and carry out, any special research or study.

It is suggested that the minimum requirements are a social and medical history,* physical examination where necessary, and a re-inspection of the X-ray films. The results (with the date) can be recorded in summary form under "Clinical Notes" on the national record card; alternatively, these clinical findings can be recorded in a special book, or on a separate sheet to which the card is permanently attached. Medical directors may find this alternative procedure preferable (as we have done), because the space available for "Clinical Notes" on the card is necessarily restricted. Separate recording permits greater detail, including the use of a stamped or printed chest diagram ; we have found it useful also to sketch the X-ray picture on a diagram which, likewise, can be stamped or printed in the book or on the sheet, as the case may be. If separate

* This might include particularly any history of tuberculosis or other illnesses, and note of any previous chest radiograph or attendance at a chest clinic ; present fitness and note of any symptoms (and whether the subject has attended his own doctor for these) ; family and contact history ; nature of work, hours and rota, travel time, family and domestic responsibilities, etc.

recording of the findings at the interview is adopted by the medical director, the section "Clinical Notes" on the card will be left blank (to avoid unnecessary duplication), but all the other entries (including "Diagnosis" and "Disposal" and the "F.H.", "C", "P.I." and "Sputum" panels) should in due course be filled in.

It is unlikely that elaborate examinations will be practicable as a routine at this short medical interview; arrangements for sputum examination will probably be left to the chest clinic. The chest clinic or dispensary area (if known), or name and address of the G.P., according to the intended disposal, should be entered in the top space on the back of the card.

The foregoing outlines one type of procedure for assessing cases that failed to pass their examination on the large film. An alternative is for the medical director to see *all* persons who have had full-size films (the appointments being held at the time of the taking of the large films, and being spaced at, say, five-minute intervals). Persons whose films have been passed as indicating no action will be merely so informed, while the abnormal cases will be dealt with as above. By this procedure, letters C and D are avoided, and the period of suspense for the individual shortened. On the other hand, there are the disadvantages that the medical director has to be present at each large film session, and he has to make a decision on the wet film without full discussion of the X-ray appearances with the radiologist; on the whole, we do not favour this method. Another alternative, which likewise we do not recommend, is for the cases to be disposed of without any interview with a medical man associated with the Unit.

The following discussion is based on the assumption that only persons who failed to pass on the large film examination are medically interviewed. Where the arrangement is that all those with large films are seen, our suggestions must be modified accordingly.

B. Classification and Disposal of Abnormal Cases

The national record cards (see p. 25) require certain entries giving the ultimate diagnosis of the diseases discovered, and their classification numbers (from the official list of diseases*); and showing the disposal of the abnormal cases.† The classification of disease distinguishes between active and inactive tuberculosis, but, as regards the degree of lung involvement, the classification goes no further than a division into unilateral (No. 22) and bilateral (No. 23), and this may need expansion.

We think that, in addition to these required entries, the medical director will find it valuable, for local use, to make a simple "administrative" analysis, which combines both disease and disposal. As will be seen, this will not interfere with the national statistics. At the time of the medical interview it is suggested that the cases be divided as follows:—

Category (A).—Persons with *non-tuberculous lesions* (e.g. heart abnormalities, bronchiectasis).‡ Some of these will be recommended to appropriate hospitals or clinics; others will be already under care; others can be dismissed, possibly with a letter to the general practitioner for his records.

* Given in Appendix III of the Advisory Report on the Working of a Mass Radiography Unit (Ministry of Health). This list has been recently amended slightly by the Ministry's Standing Advisory Committee on Tuberculosis, and re-issued as Supplement 3 to the Advisory Report.

† The "Disposal" panel on the national card reads "Doctor; Hospital or Sanatorium; Dispensary; No Action".

‡ The statistical value of the figures in this category will depend on the policy of the Unit. Thus, in the M.R.C. survey, persons selected for medical interview were mainly those with gross changes, those where benefit from diagnosis and treatment seemed likely, and the younger cardiac cases.

Category (B).—Persons *previously diagnosed at some time as having pulmonary tuberculosis*.* Most of these will be cured cases, or persons under observation at their chest clinics, and for these no new action on the part of the Unit is required. Some, however, may have lost touch and require their connection with the clinics to be re-established, e.g. because of a relapse. This latter group shows the value of including persons with previously diagnosed pulmonary tuberculosis in the mass radiography of a civilian group.

Category (C).—Persons with *newly-discovered tuberculous lung lesions requiring no special action* (e.g. old apparently healed lesions, negative clinically).† These persons can be dismissed forthwith, possibly with a letter of information for the G.P., for his records. This category will be added to later by some transfers from category (D) after the initial investigations by the tuberculosis officer of cases in that category.

Category (D).—Persons with *newly-discovered tuberculous lung lesions presumed to require medical action of some kind* (to be referred to as "significant" lesions). These persons should be recommended, for further investigation and advice, to the tuberculosis officer of the area in which they live (or to a private specialist)—either directly or through their general practitioners, according to individual circumstances. In our surveys, the majority were sent direct to their local chest clinics, and the G.P.'s received reports from the tuberculosis officers. We believe this to be much the most efficient method, and one that saves the G.P. trouble and unnecessary correspondence; if the dispensary service be regarded as part of the mass radiography scheme, and the T.O. sends a report to the G.P. on every case attending his clinic, then it seems quite reasonable. When recommending these patients to the tuberculosis officers, the medical director should send to the latter the radiograph, together with all relevant information and tentative suggestions as to action (possibly using a standard letter). (Unless duplicate films have been taken, this means that the Unit will have no permanent record, but transmission of the "base-line" radiograph to the patient's doctor seems essential, at least so long as many dispensaries lack an installation of their own and the taking of a further film entails delay and irritation for the patient.)‡

Having decided into which category, (A), (B), (C) or (D), the case falls, the medical director can enter this category next to or below the diagnosis on the back of the card, and at the same time tick the appropriate (immediate) "Disposal" § heading on the front. Cases in category (A) will require a tick

* To get, for statistical use, the total of previously diagnosed pulmonary tuberculosis in the group radiographed, it is necessary to add similar cases among persons recalled for full-size films but then passed as requiring no action (and no medical interview); even this total is somewhat artificial, since it excludes any persons with previously diagnosed disease who did not volunteer for mass radiography—a number which may not be known. Furthermore, any previous P.T. cases miniaturized but not recalled for large films would be excluded, though this number may be negligible. (If all persons having large films are medically interviewed, of course the above statement needs to be modified.)

† The figures in this category are of little statistical value, since they exclude all the persons whose full-size films, or even miniature films, showed apparently healed lesions passed as requiring no action, and who therefore were not summoned to the medical interview. (If all persons having large films are medically interviewed, the figures in this group will be larger, but they will still exclude lesions shown on miniature films but passed as not requiring large films.)

‡ See p. 60, footnote †.

§ We are regarding the "Disposal" section on the front of the national card as referring to immediate disposal *from the Unit*; we think it might be better subdivided into "Doctor", "T.O.", "Hospital", "No Action", and placed in the "Clinical Notes" section on the back. The need for an indication also of the initial disposal of tuberculous cases *from the T.O., etc.*—e.g. whether the latter places the case under "Treatment" or "Observation" or advises a "Single Re-check" or takes "No Action"—is recognised in the "administrative" classification proposed in the text; and it is suggested that these brief particulars be entered in available space on the back of the card when the T.O.s. report (see below) has been received.

against " Doctor ", " No Action " or possibly " Hospital "; those in category (B) may require " Dispensary " or " No Action "; (C) will merely need a tick against " No Action "; while (D) will require ticking of " Dispensary " or, less commonly, of " Doctor."

To make the classification of the " investigate " or " interview " cases complete, it is necessary to subdivide category (D). This is best done by the medical director, after obtaining a brief report of the initial investigations made by the tuberculosis officer in each case, and combining this with the radiological and clinical data derived by the mass radiography Unit. The tuberculosis officer's report may be obtained, with the least trouble to him, by means of a questionnaire (which might accompany or be part of the introductory letter from the medical director when recommending the patient, or be sent a month or so later). The following is the questionnaire used by us (slightly modified and condensed) :—

CONFIDENTIAL

Letter E

MASS RADIOGRAPHY UNIT

Chest Clinic.....
 Name of Patient.....
 Address..... Serial No.....

1. Did the patient come to see you ? YES/NO
2. Are the lesions tuberculous (apart from the question of activity) ? YES/NO
 If, not, what is the diagnosis ?
3. If tuberculous, which of the following decisions did you make after your INITIAL investigation ? (Changes of decision since initial investigation to be put under No. 7.)
 - (a) Requiring no further medical action—need not return to clinic.
 - (b) Requiring single re-check (after, say, 6 months) as precaution.
 - (c) Requiring dispensary observation for longer period, *while remaining at work* (state if hours or nature of work are being modified).
 - (d) Requiring sanatorium or equivalent treatment (include persons on waiting list or persons refusing recommendation).
 - (e) Requiring to leave work and remain at home, *without institutional treatment*.
4. If patient has gone to a sanatorium or institution, which is it ?
5. Has the patient any sputum ? YES/NO
 If YES, is it POSITIVE/NEGATIVE (give method).....)
6. Has patient qualified for financial allowances ? YES/NO
 If NO, give reason.....)
7. Any other remarks.....
 (T.O.'s signature).....
 (Date)

It may be desirable in this questionnaire to ask for the usual Ministry of Health classification of stages (A or B1, 2 or 3) or for a division into minimal, moderately advanced and far advanced, unless this has already been done on the basis of the data obtained by the Unit.

Having obtained the tuberculosis officers' reports, the medical director can complete the further differentiation of Category (D) and enter it on the back of the record card. This will involve the transfer into Category (C) of a few of the cases that the tuberculosis officers consider need no further action ; the bulk of the cases may conveniently be subdivided as follows :—

Category (D).—Persons with *newly-discovered tuberculous lung lesions* requiring medical action of some kind (i.e. " significant " lesions) ; these are subdivided into—

Category (Di).—*Requiring to leave work immediately for sanatorium or equivalent* (i.e. " treatment " cases), such cases including persons on waiting lists and persons refusing this recommendation, and

Category (Dii).—*Requiring out-patient medical observation, including periodic X-rays, while remaining at work* (i.e. " observation " cases). Most of these persons will be continuing full work, but for some of them restricted or modified conditions may be prescribed—such as reduced overtime, half-time work or lighter jobs ; as arrangements for modified work for the tuberculous



FIG. 1.—Selection of carrying cases to take Unit accessories (see p. 18).
FIG. 2.—Special case for large film developing tanks and hangers ; lid fitted to take more fragile accessories (see p. 18).

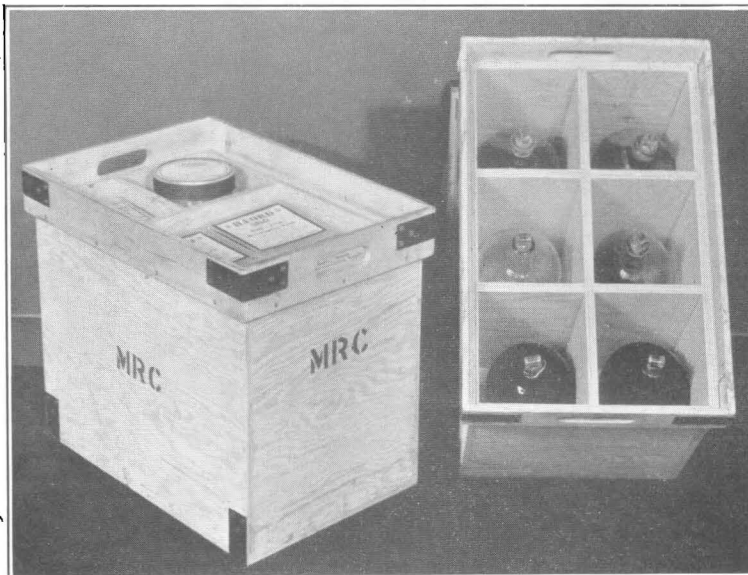


FIG. 3.—Four carrying cases form the legs of the darkroom bench (see p. 45).
FIG. 4.—Cases with divisions for bottles, etc. (see p. 19).

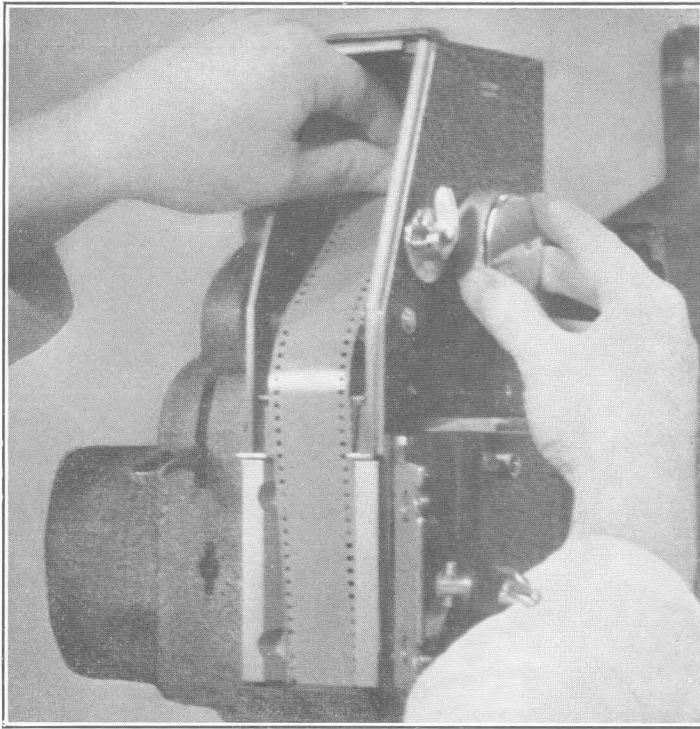
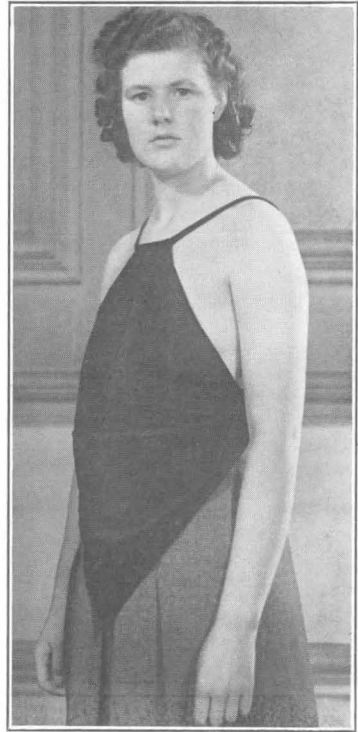
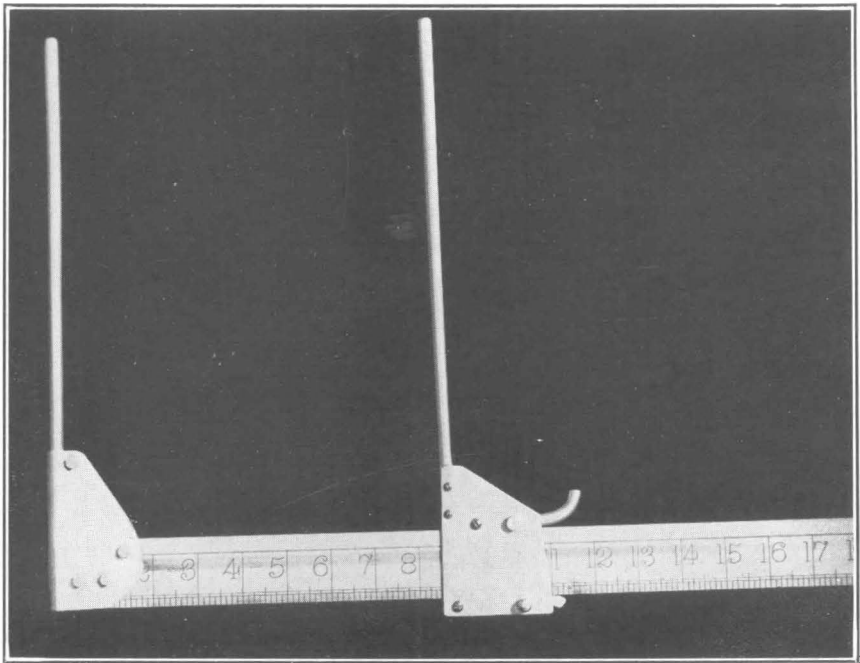
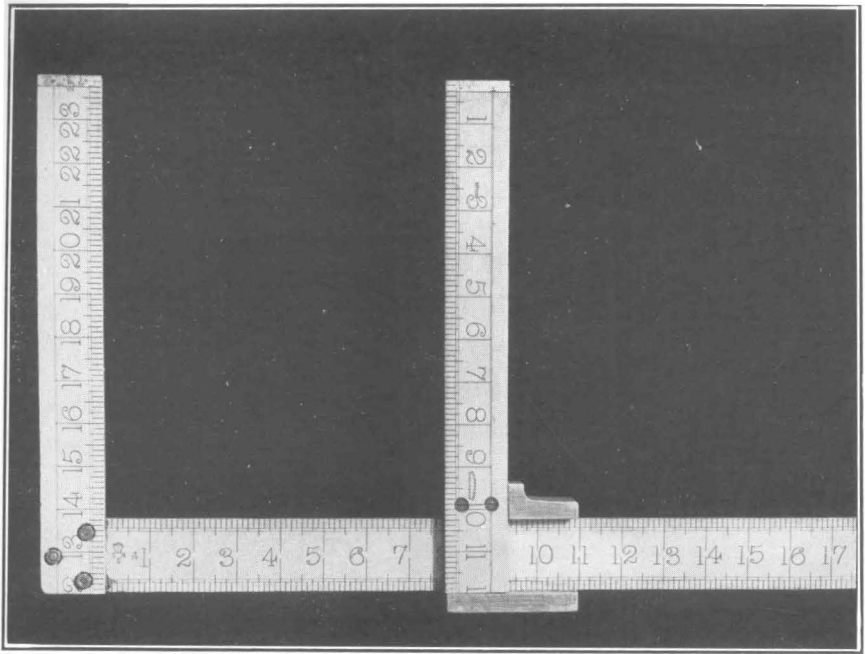


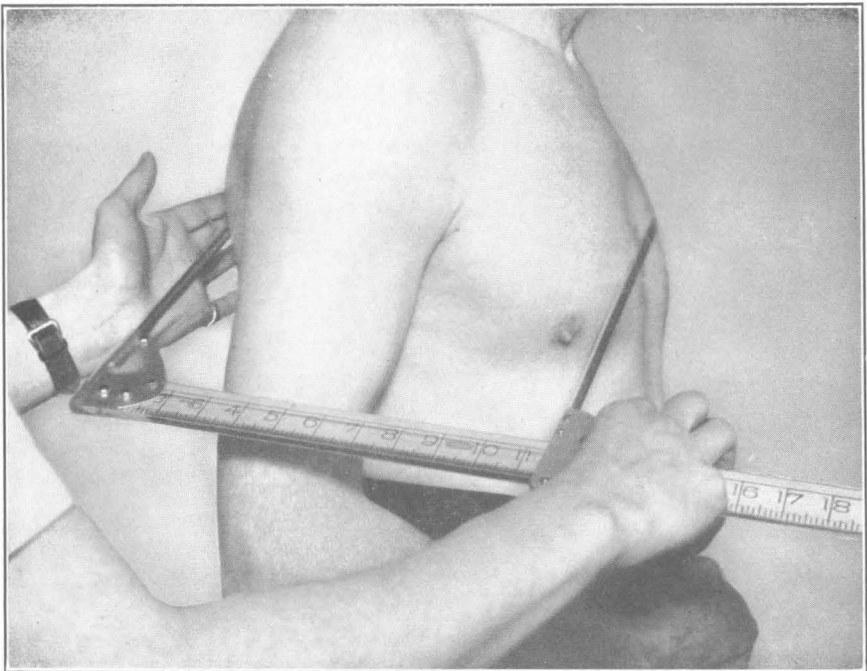
FIG. 5.—Threading the camera. Note tension control knob on right (see p. 20).
FIG. 6.—Adjusting exposure conditions according to chest thickness measurement, by reference to the exposure table (see p. 21).



FIGS. 7-10.—Four views showing the adaptability of the M.R.C. pattern chest covers. One size only is provided, and a single divided strap is knotted at the back for the smaller subjects (see p. 54; dimensions are shown in FIG. 46).



FIGS. 11-12.—Two types of caliper for measuring chest thickness (see p. 40).



Figs. 13-14.—Measurement is taken through the thickest part of the chest (see p. 40).

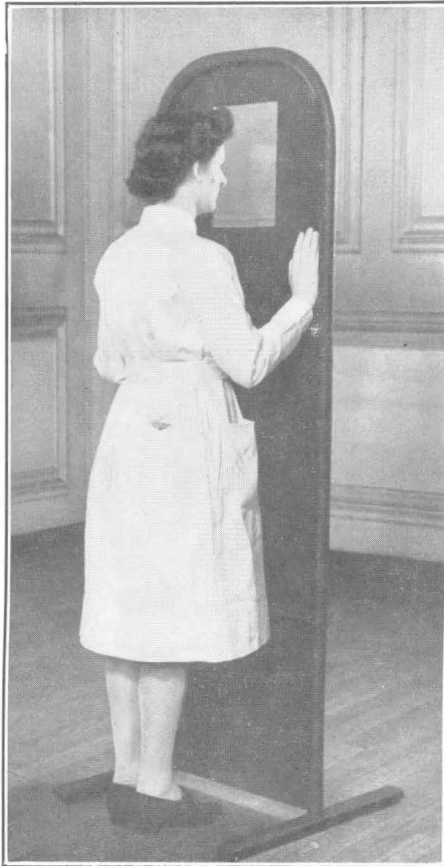
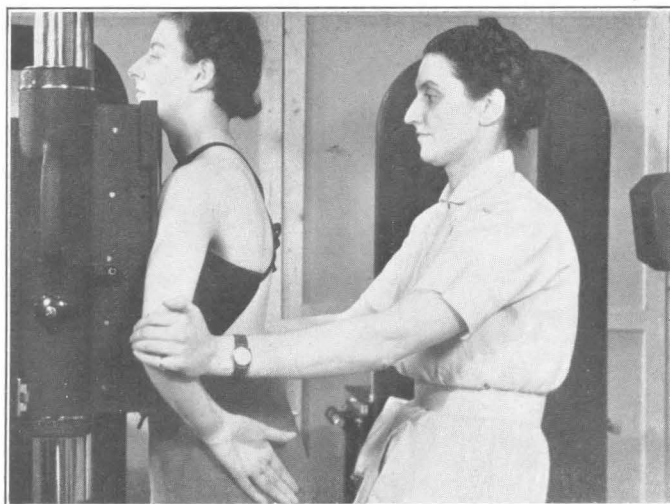
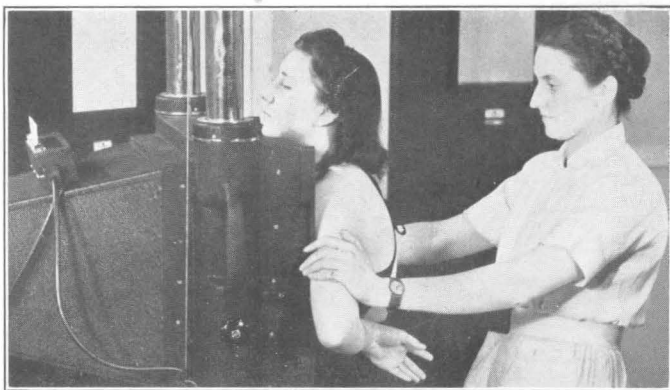


FIG. 15.—The record card is placed in the slot so that the number can be photographed on the film ; the card also serves to complete the electrical circuit, so that identification is ensured (see p. 21).

FIG. 16.—The operator stands behind protective screen during exposure. Note position of hands (see p. 53).



Three positions of arms for P.A. view (see p. 37) :—

FIG. 17.—A short-waisted, short-armed subject : hands at waist level.

FIG. 18.—A long-waisted, long-armed subject : hands well down over buttocks.

FIG. 19.—Alternative position for a stiff subject : arms rotated medially and brought forward to the sides of the stand.

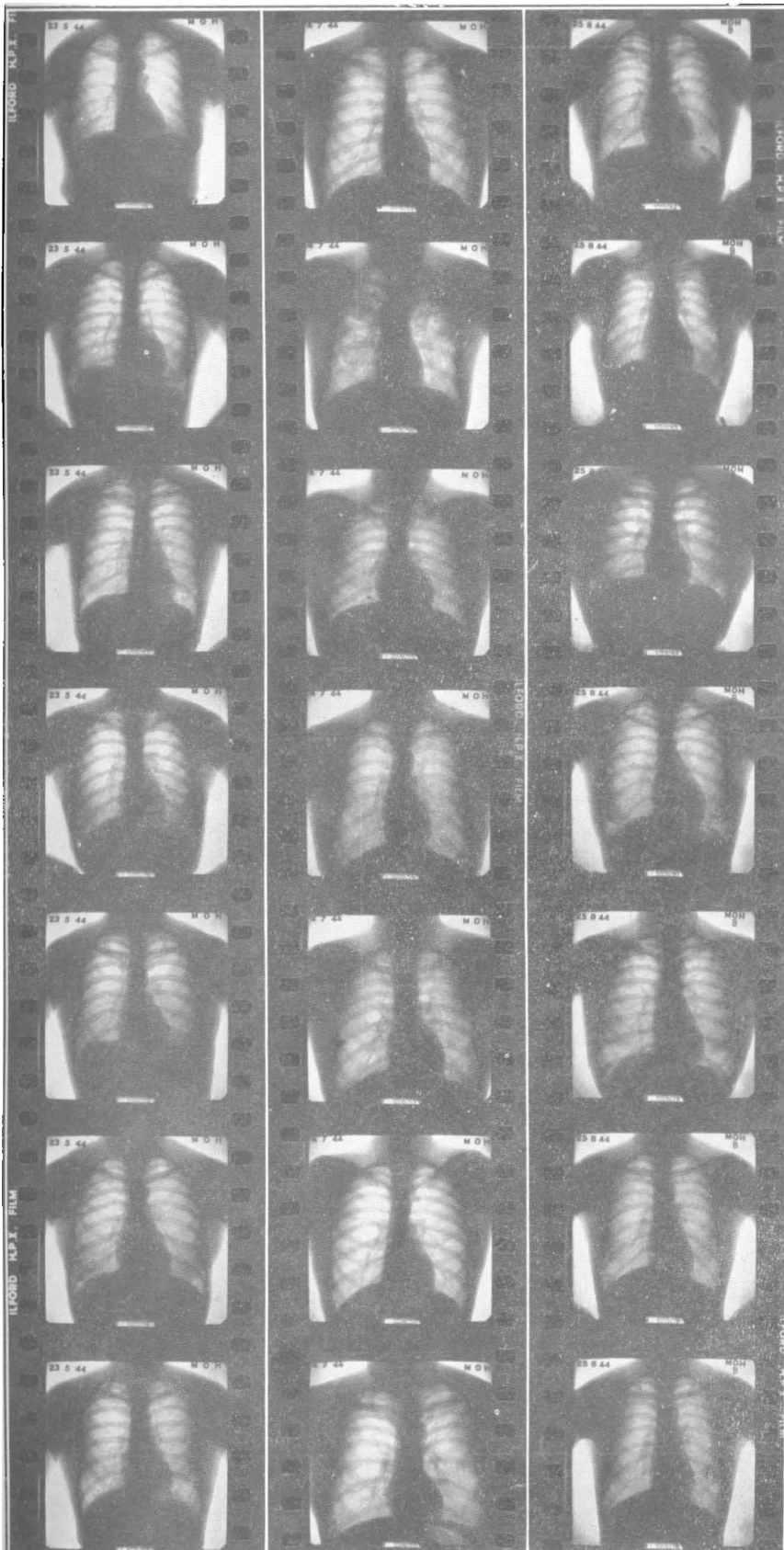
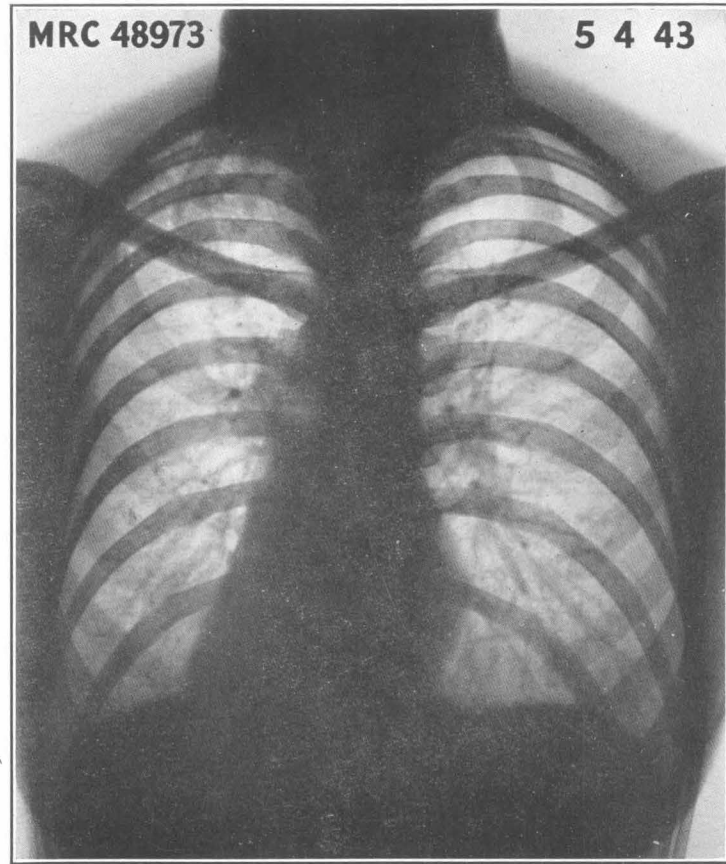
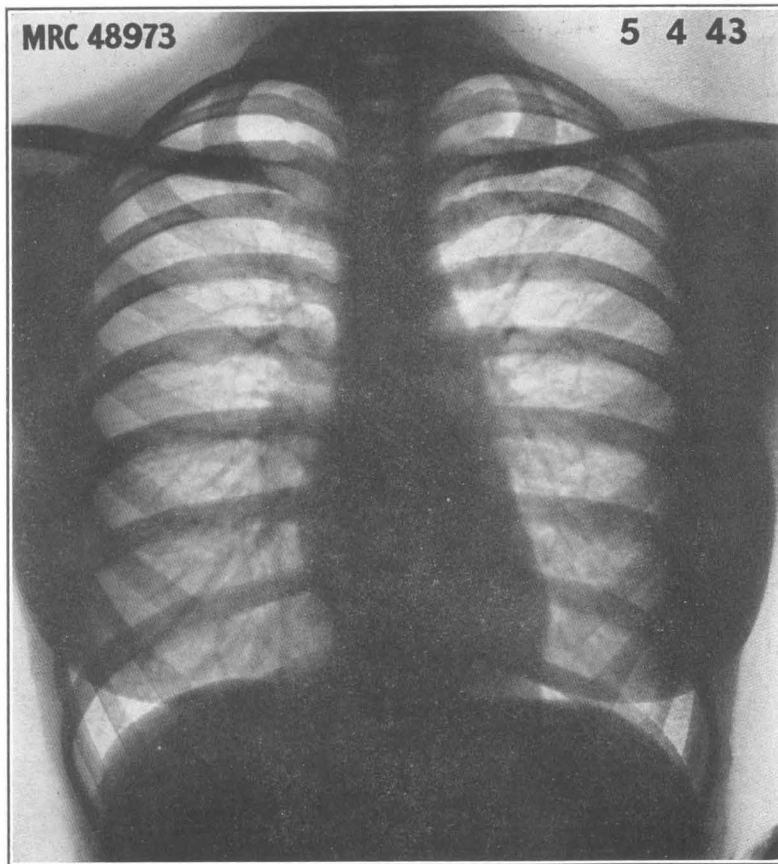
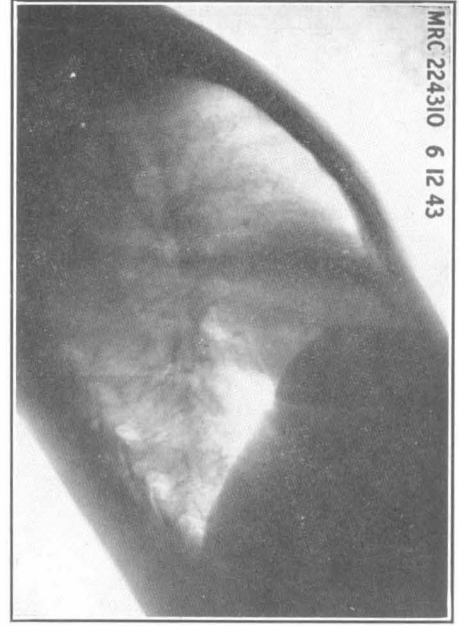
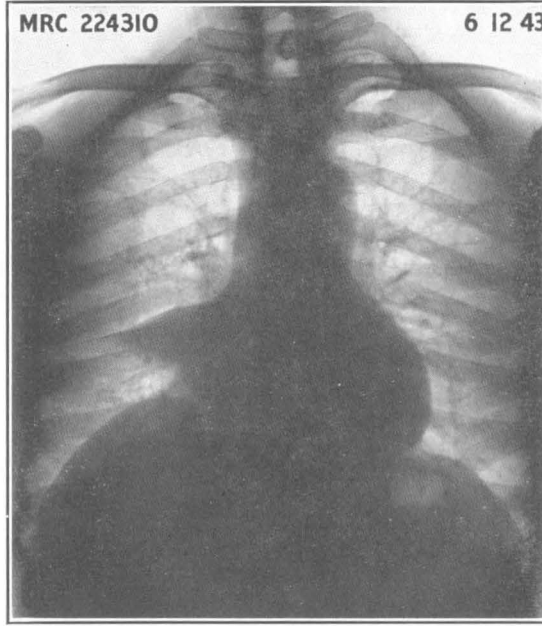
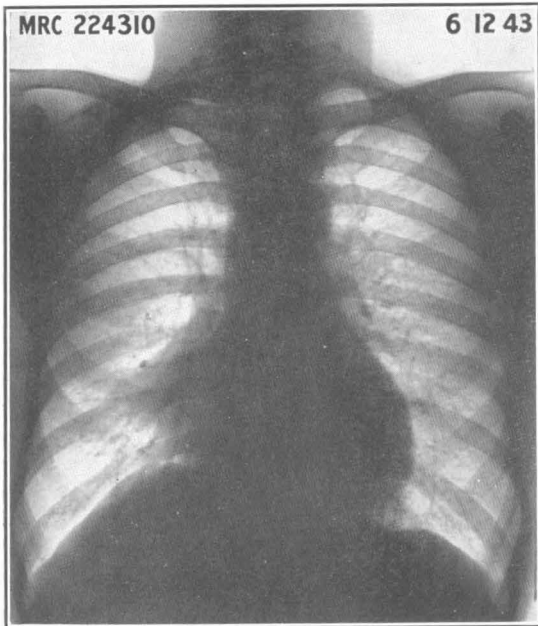


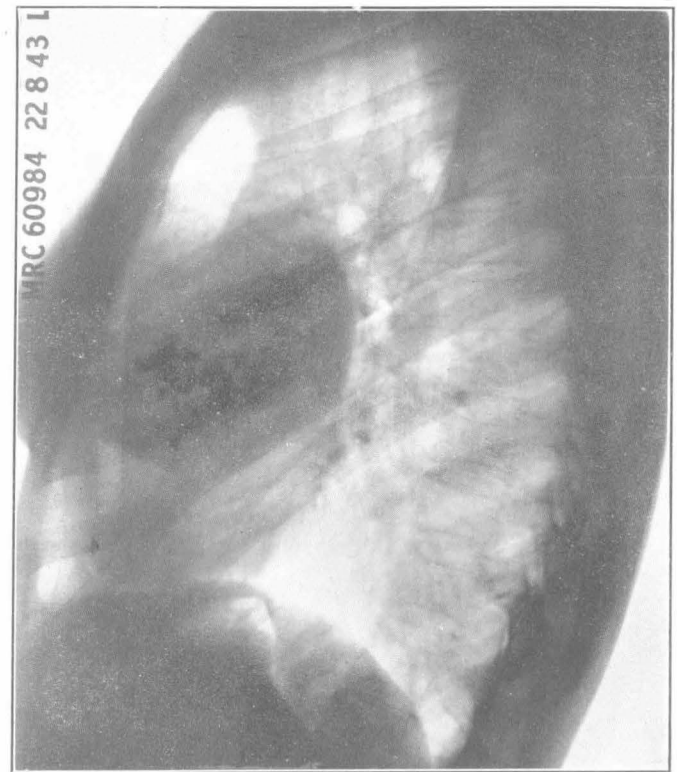
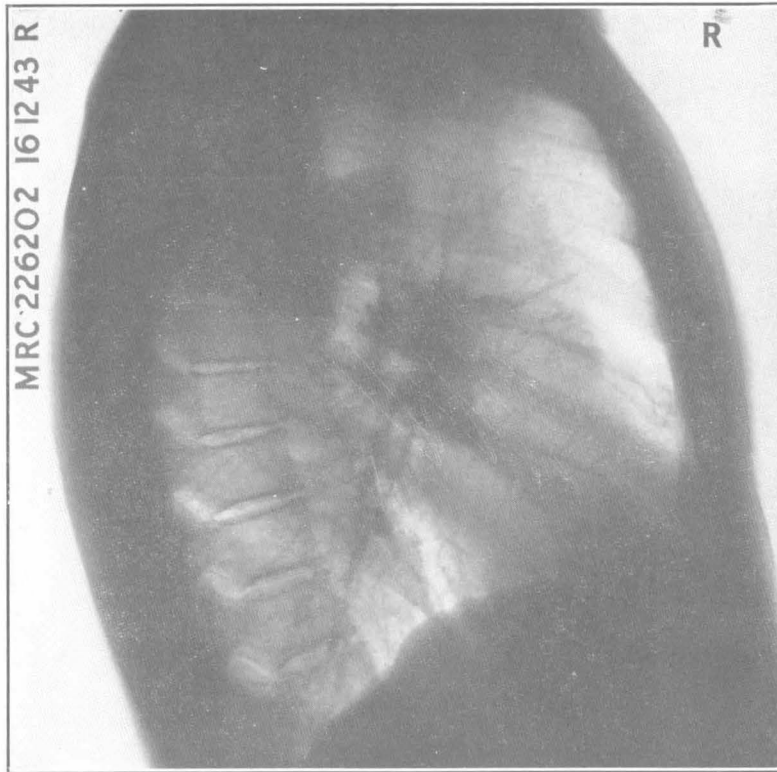
FIG. 20.—Strips of miniature radiographs (see p. 24)



Two views of the same subject (see p. 38) :—
FIG. 21.—P.A. view.
FIG. 22.—A.P. view.



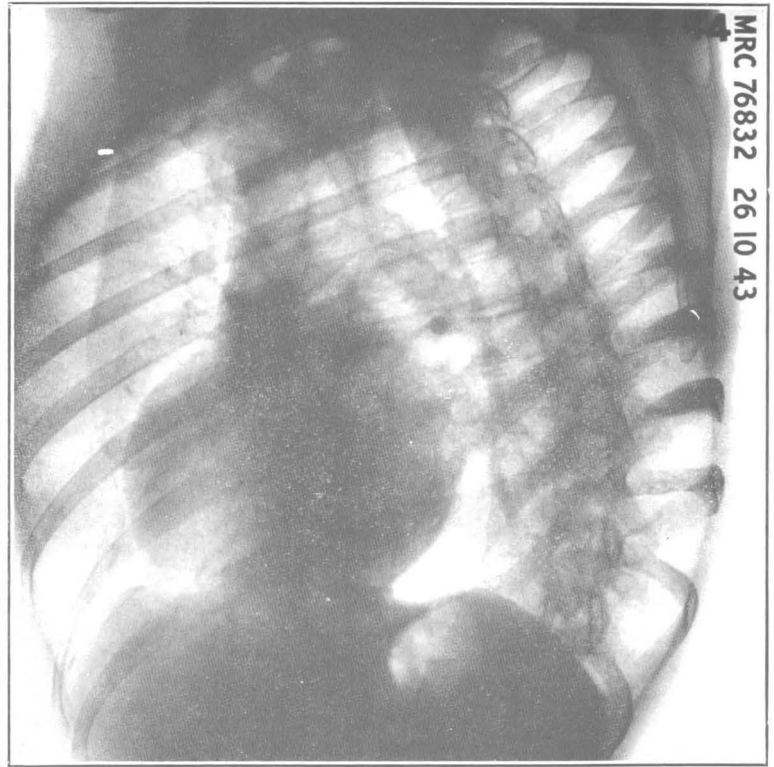
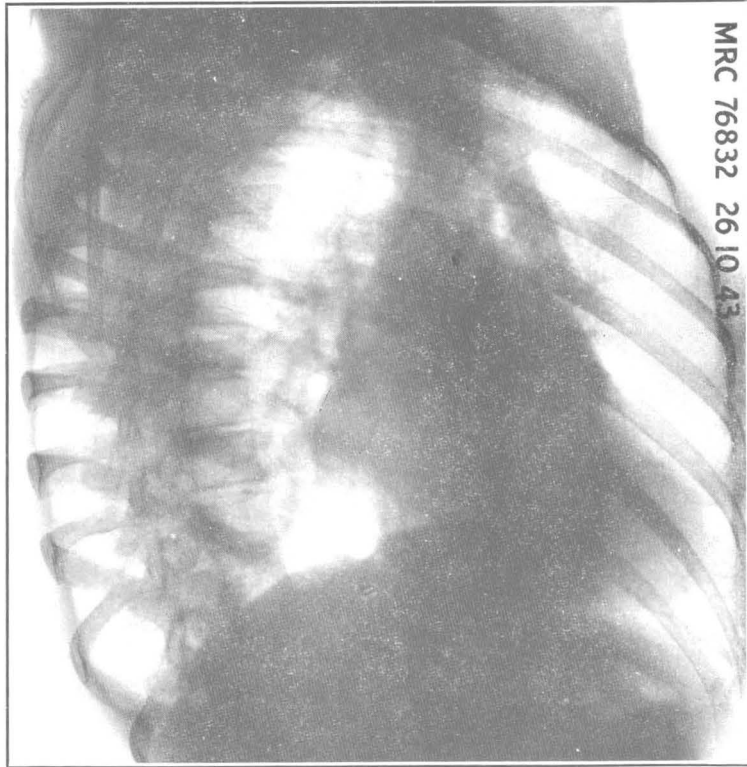
Three views of the same subject, showing middle lobe collapse (see p. 38) :—
FIG. 23.—Standard P.A. view.
FIG. 24.—Lordotic view.
FIG. 25.—Right lateral view.



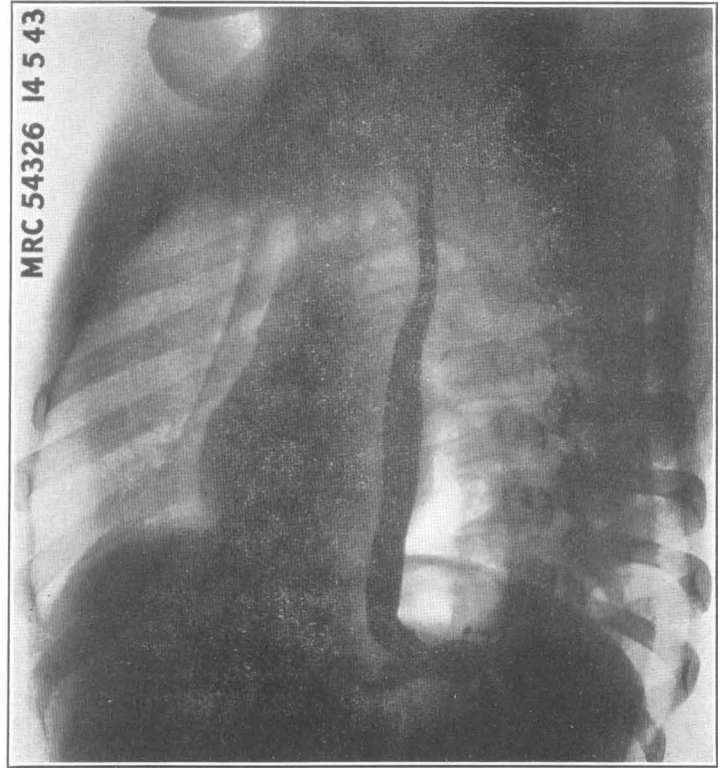
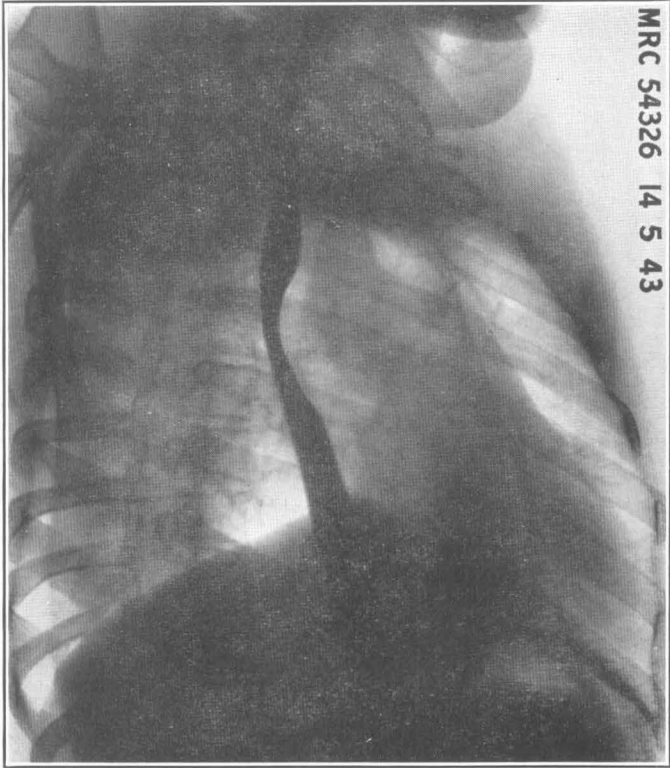
Lateral views (see p. 39) :—

FIG. 26.—A routine lateral view.

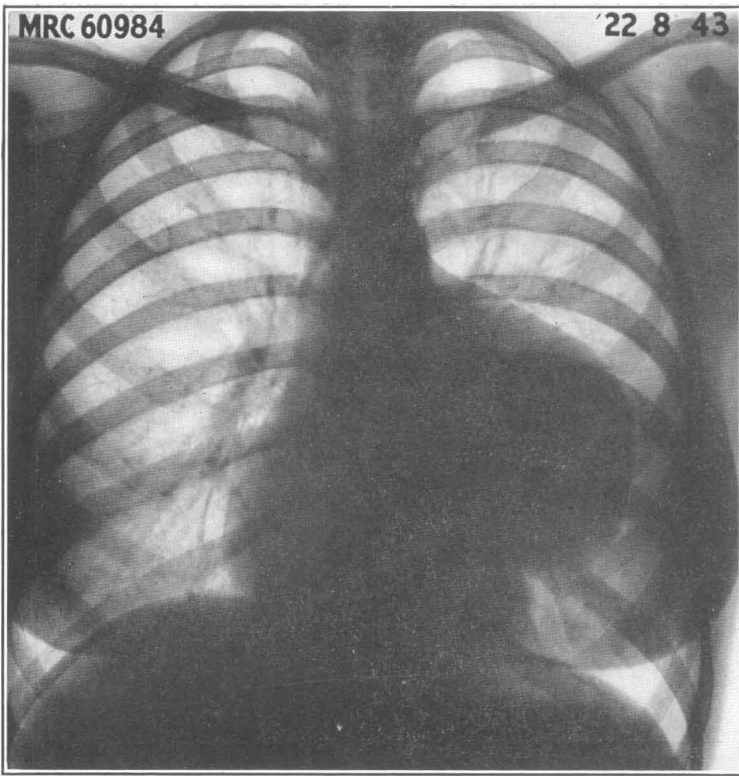
FIG. 27.—A lateral view taken with a stationary grid to show detail in dense abnormal shadow (see also FIGS. 32 and 33 from the same subject).



FIGS. 28 and 29.—First and second oblique views taken at a distance of 36 in., following screen examination for position (see p. 39).



FIGS. 30 and 31.—First and second oblique views taken with "barium swallow" (see p. 39).



The use of the radiographic grid in special conditions :—
FIG. 32.—Standard P.A. view in a case of dermoid cyst (see p. 40).
FIG. 33.—Selected area of same subject taken with a grid.

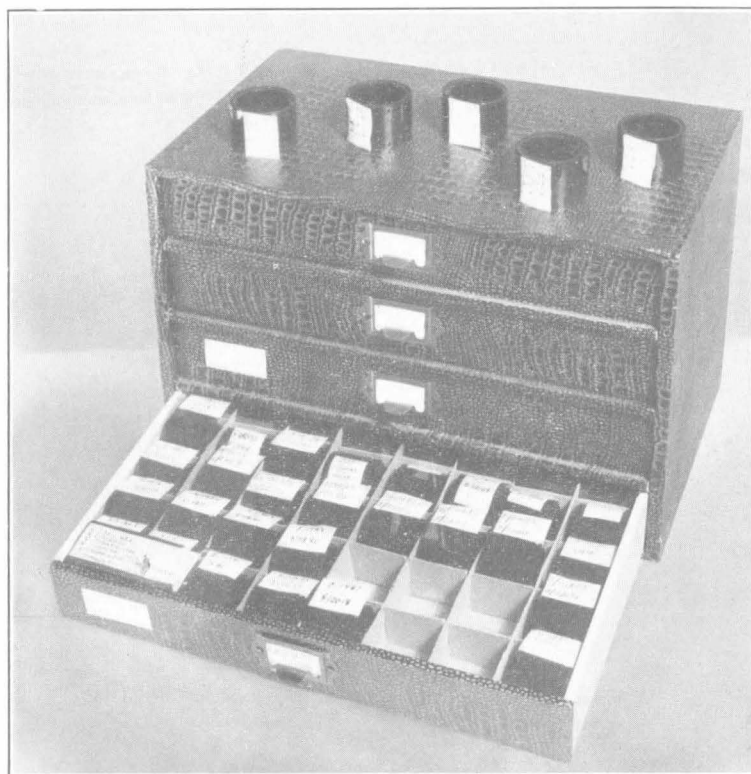
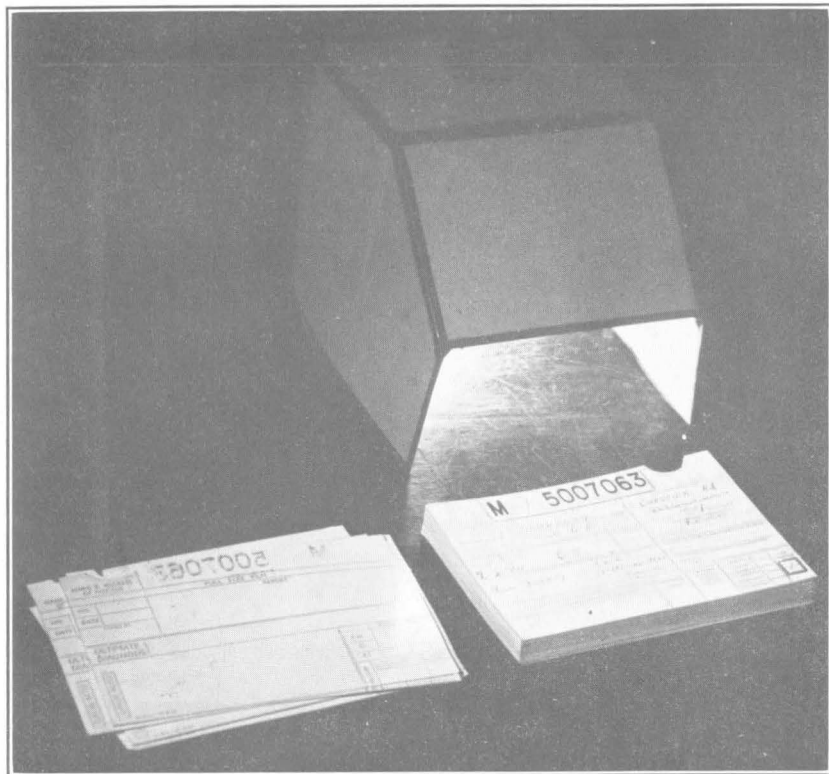


FIG. 34.—Shaded lamp for use of clerk during projection (see p. 30; and FIG. 45 for dimensions).
FIG. 35.—Filing cabinet for miniature films, with cardboard divisions (see p. 49).



FIG. 36—A survey in progress. (a) Positioner and control table operator stand behind protective screens (in this survey, the examinees approach the apparatus from their right); (b) Positioning (in this survey, examinees approach the apparatus from their left) (see p. 24).

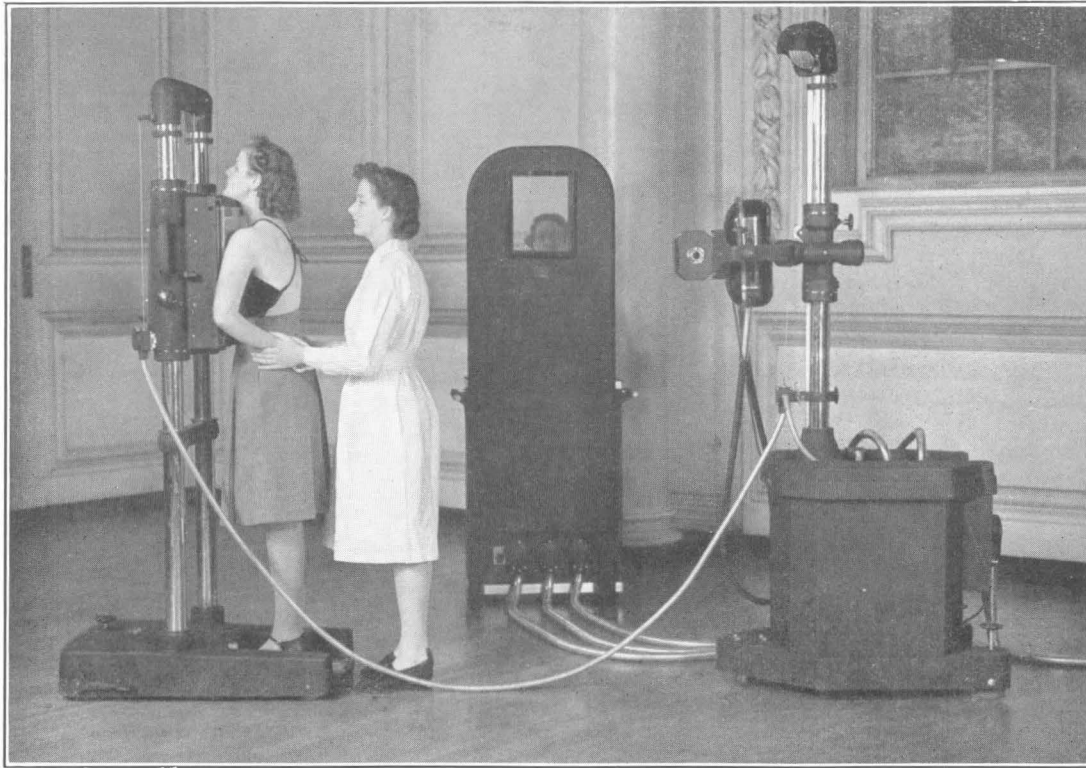
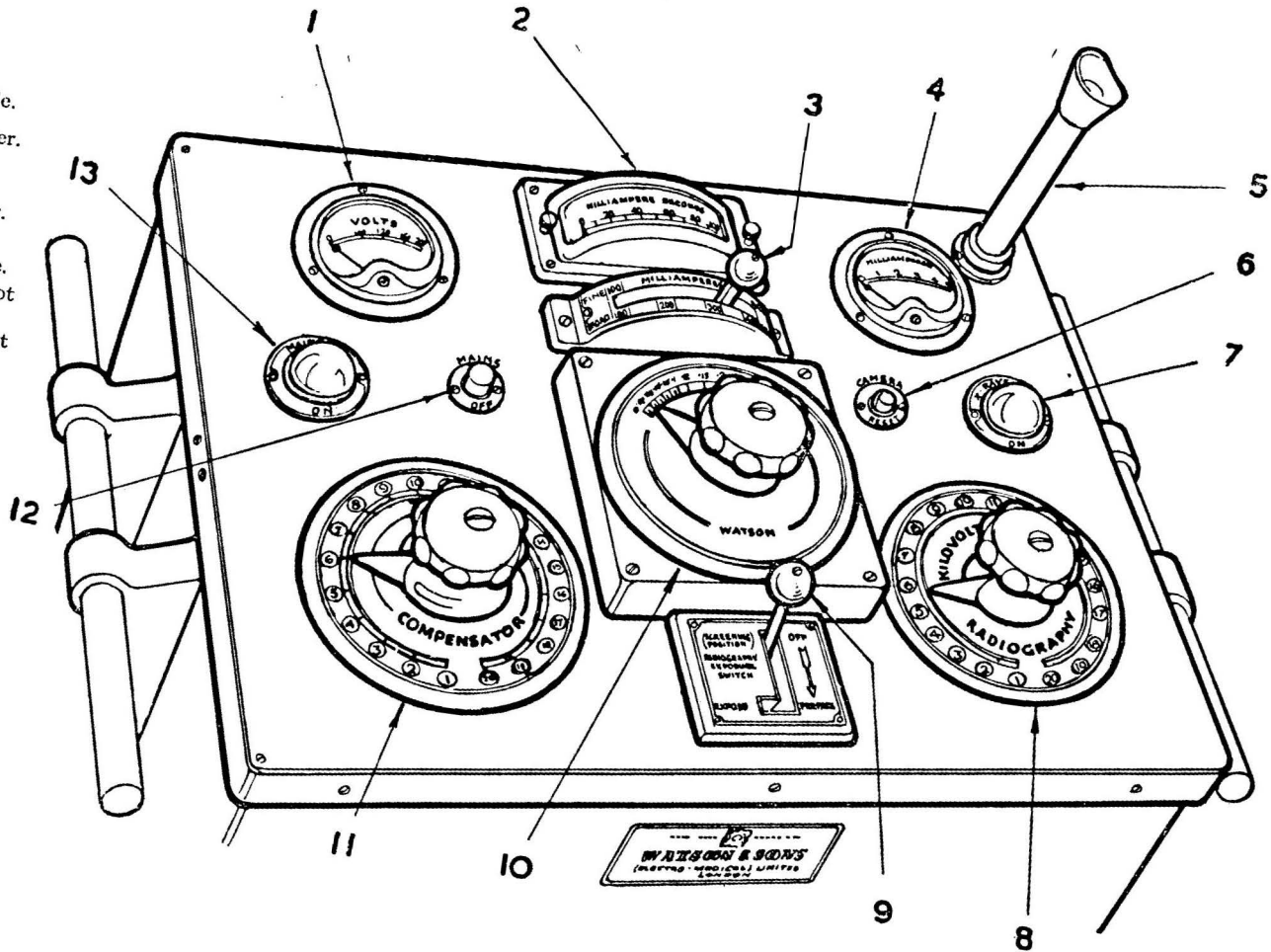


FIG. 37.—The apparatus set up for large film examinations ; distance increased to 60 in. (see p. 24).
The camera tunnel has been removed for screening.

Fig. 38.—Control Table.

1. Pre-reading Volt Meter.
2. Milliampere-Seconds Meter.
3. Milliamperage Selector.
4. Milliammeter.
5. Optical Centring Device.
6. "Camera Reset" Pilot Light (Red).
7. "X-Rays On" Pilot Light (Green).
8. Kilovoltage Control.
9. Exposure Switch.
10. Exposure Timer.
11. Mains Voltage Compensator Control and "Mains On" Switch.
12. "Mains Off" Press Button.
13. "Mains On" Pilot Light (Red).



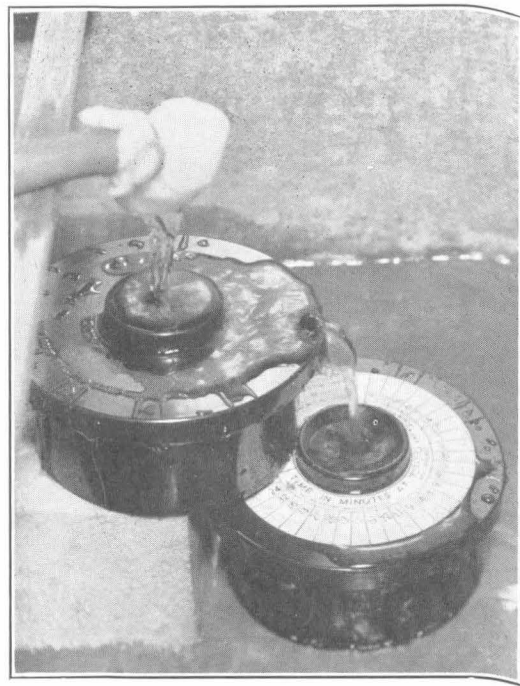
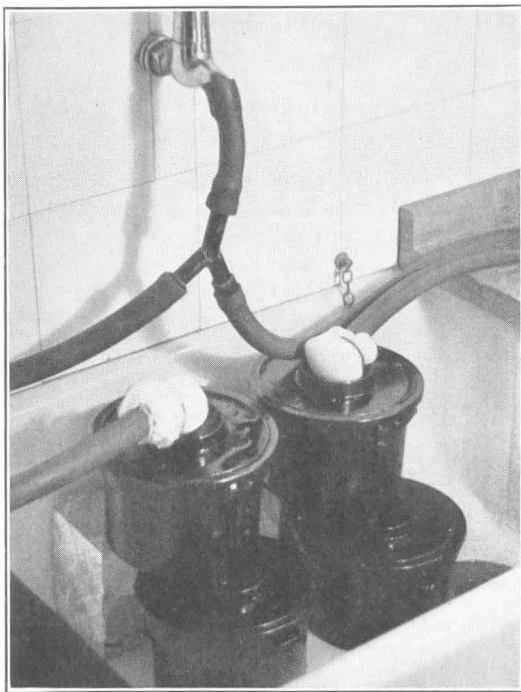
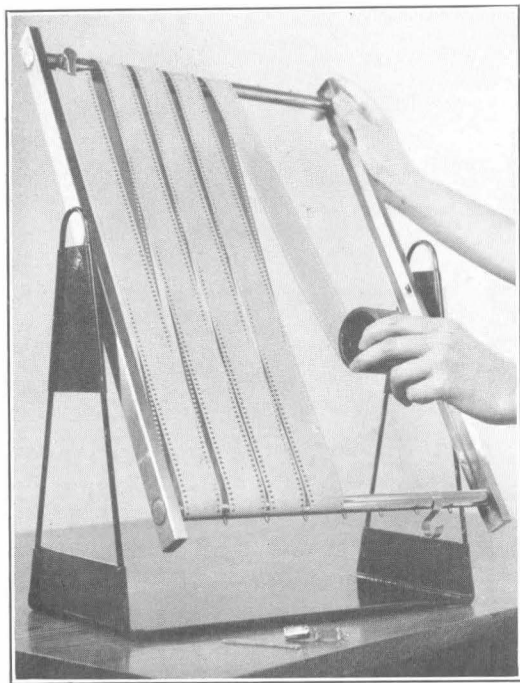


FIG. 39.—Developing frame to take long lengths of film (see p. 48).

FIG. 40 (a).—Miniature films being washed in daylight tanks. Note cotton wool and gauze filter attached to end of rubber tubing (see p. 47).

FIG. 40 (b).—As in FIG. 40 (a), showing cascade effect.

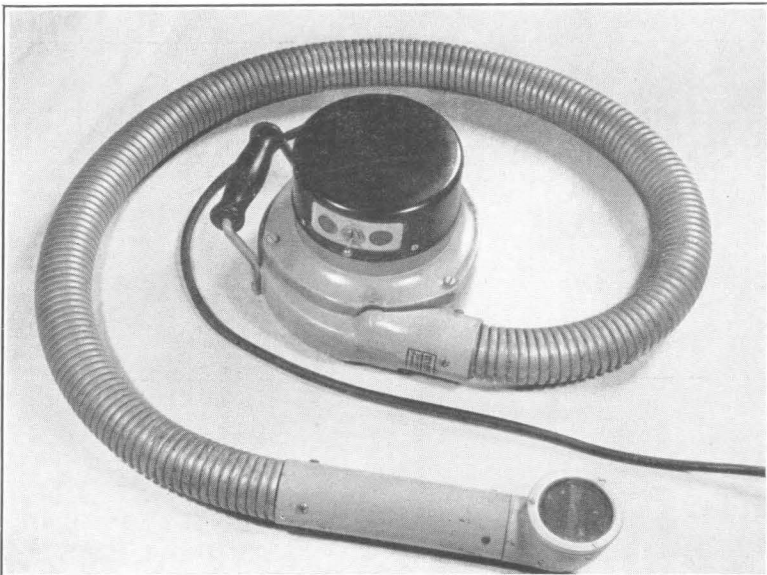


FIG. 41.—Filter on mobile stand, for use when local water supply is unsatisfactory (see p. 47).
FIG. 42.—Mobile hot-air blower for drying miniature and large films (see p. 47).

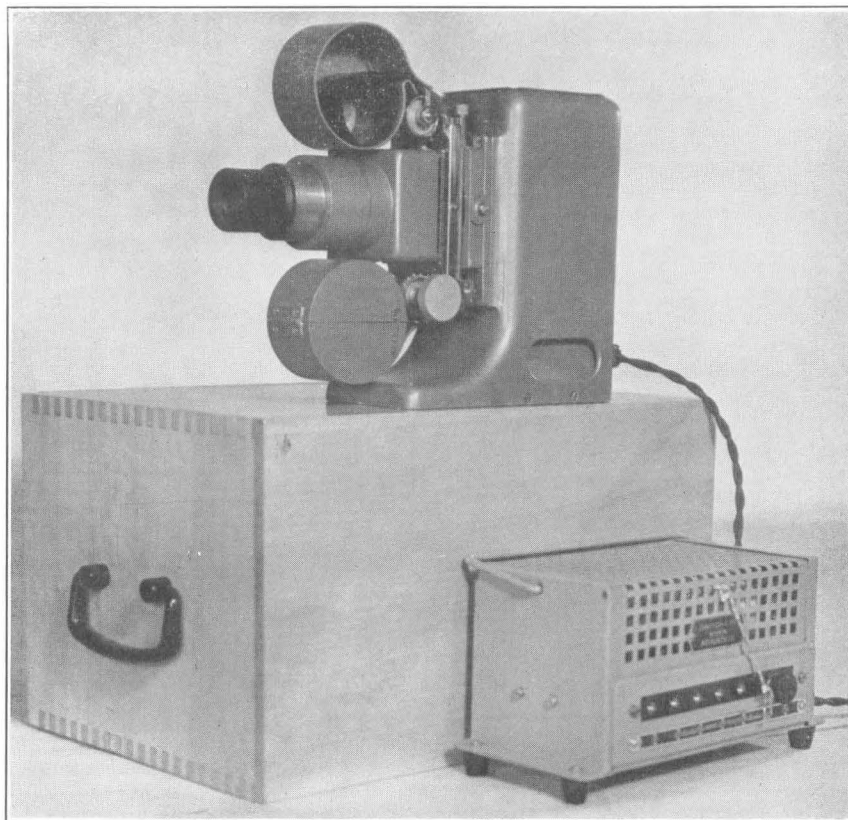
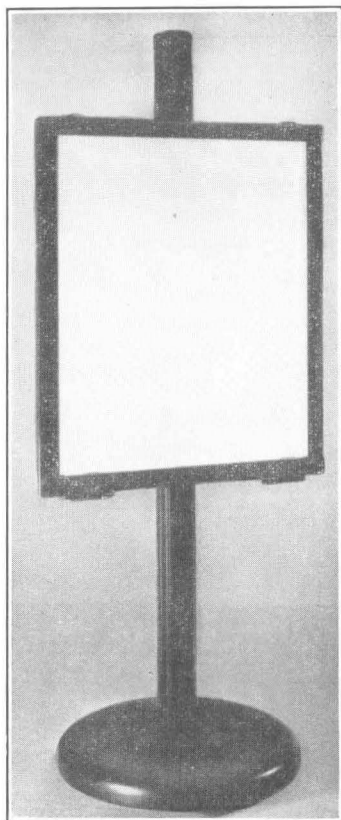


FIG. 43.—Projector for viewing miniature radiographs ; Ministry of Health standard type (see p. 51).
FIG. 44.—Projection screen ; height is adjustable and viewing surface can be replaced (see p. 51).

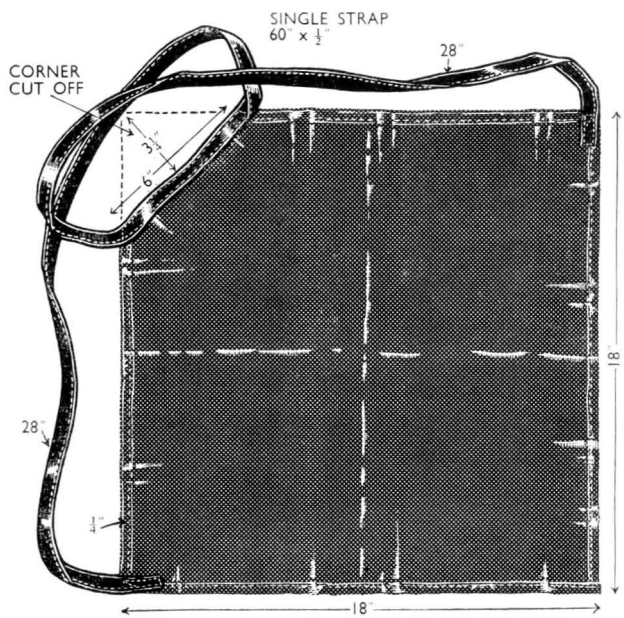
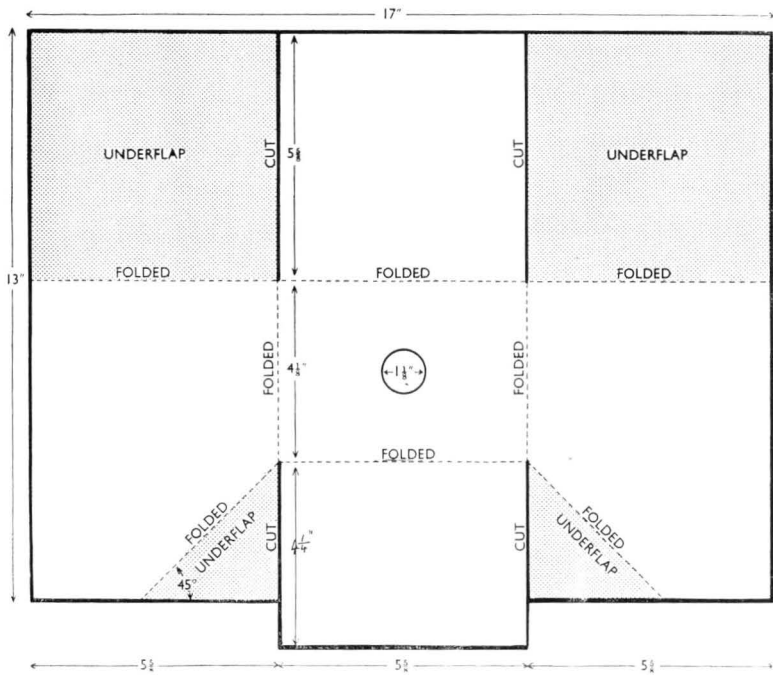


FIG. 45.—Dimensions of clerk's shaded lamp (see also FIG. 34).
 FIG. 46.—Diagram of chest cover (see also FIGS. 7-10).

in normal industry expand, it may be advisable, for classification purposes, to separate such cases from those observation cases that are on full work.

A sub-category of (Dii) is—

Category (Diii).—Observation cases thought to *require a single precautionary re-check* (after, say, 6 months).

There is also a possible category intermediate between (Di) and (Dii), i.e. cases requiring to leave work, but without institutional treatment; the numbers so far have been small. Alternatively, they might be included under (Di) or be kept separate.

The back of the card will now have category “(Di)”, “(Dii)”, etc. In addition, the tuberculosis officer's initial recommendation for disposal—“Treatment”, “Observation”, “Single Re-check”, “No Action”—can be entered in available space (see p. 58, last footnote).

The factors determining whether an individual case falls into category (C) or (D), or into which particular division of (D) it is placed, will include the appearance of the radiographic shadows, the sex and age of the patient, the medical and social history, the symptoms and signs if any, and the results of sputum or other ancillary examination. The radiographic appearance and the age are probably the strongest determinants. A knowledge of when the tuberculin test had become positive would be useful if available. It is to be hoped that, in the light of experience of mass radiography and progress of cases discovered, more accurate guidance will be available than present knowledge provides.*

The subdivision of the significant lesions into those needing treatment and those requiring observation is based, under the above procedure, upon the *initial* assessment by the tuberculosis officer and the Unit team. It is obvious that some of the persons recommended for observation will, after varying periods of attendance at the chest clinic, be discharged, while others may come to require sanatorium treatment. Since this re-distribution of the observation cases into other categories is a continuous process, it must not be allowed to confuse the classification; and it is for this reason that we are in favour of an initial basis for the primary classification, and suggest that the progress of the different “initial” groups be given in a *distinct* follow-up analysis and tabulation, made at stated different time intervals, and derived from later reports of the tuberculosis officers (see p. 63).††

The present “administrative” classification can be adopted without interfering with the entries at present required on the national record card. Indeed, if Letter E be used as a basis for obtaining the initial reports of the tuberculosis officers, and adequate information has been gathered at the primary medical interview on the Unit, the medical director will be enabled to fill in the data required under the national card's heading “Classification of Diseases Number” (provided that prolonged observation is not held to be necessary in order to make the diagnosis). He will also be able to fill in the entries “Sputum”;

* Some guidance on interpretation of lesions found in mass radiography is provided in Supplement 1 (1944) to the Advisory Report on the Working of a Mass Radiography Unit (Ministry of Health).

† Since the term “observation case” is used repeatedly in this report, we would stress that observation has the main object of supervising the patient's life and at the same time determining whether the tuberculous lesions are progressing, regressing, or static. The term is *not* used primarily in the sense of observation for diagnosis. Moreover, a number of undoubtedly “active” cases are included in our observation grouping.

‡ It may well eventuate that, where location and other circumstances permit, the short— or long-term—observation of subclinical cases in the (Dii) category in which the state of the lesion, or its activity, is in doubt will be done by the medical director himself in a special follow-up clinic (e.g. at the home base), the cases being transferred to the tuberculosis dispensaries if and when their course should indicate the taking of more active measures. One such clinic is already in operation. The data collected should assist in defining the prognosis and correct management of this important and difficult group of cases, which forms a substantial product of mass radiography.

MASS RADIOGRAPHY OF CIVILIANS

"F.H." (family history); "C" (contact); and "P.I." (past illnesses). * He will be able to enter any other particulars desired, e.g. whether the lesion is

A NATIONAL RECORD CARD COMPLETED

Front:—

DATE 3 MAR 1944		MIL 95014258		JENKINS LTD. LEHILL	
SURNAME (Block Letters) CARNEY			PRESENT ADDRESS 12, MAIN ST. TOWNLEY		
Christian Name(s) <i>Margaret M^{rs}</i>			HOME TOWN OR DISTRICT <i>Doverpool</i>		
AGE 43	OCCUPATION <i>Capstan lathe operator</i>		OCCUPATION CODE NUMBER 7	If this is not a County Borough state County	
Date of Birth 4/2/01	PARTICULARS OF FACTORY, SCHOOL OR OTHER ESTABLISHMENT JENKINS LTD. LEHILL <i>Machine Room A 62/4356 D/N/D</i>			PREVIOUS M.R. EXAMINATION (if any) At _____ Date (approx.) _____ IF A WOMAN WHO HAS SINCE MARRIED — Maiden Name _____	
NORMAL		DIAGNOSIS FROM 35 mm. FILM		LARGE FILM REQUIRED	Classification of Disease Number Ultimate Diagnosis (see over)
		<i>Left apex 8.3.44 PA/AP 9.40 am</i>		<input checked="" type="checkbox"/>	22
-READING OF MINIATURE FILM			DISPOSAL		Card Completed
			DOCTOR		<input checked="" type="checkbox"/>
			HOSPITAL or SANATORIUM		
			DISPENSARY <input checked="" type="checkbox"/>		
			NO ACTION		

Back:—

NAME & ADDRESS OF DOCTOR <i>D^r Smith, 12, Green St, Townley / Townley Chest Clinic</i>	
FULL SIZE FILM	
NO.	REPORT <i>Fibrosis and cavitation R. upper lobe</i>
DATE 8 MAR 1944	
TAKEN AT <i>Investigate</i>	
ULTIMATE DIAGNOSIS <i>Pulmonary Tb., left upper, active Category Di</i>	
CLINICAL NOTES <i>Daughter died P.T. 1942 Patient not examined then Pleurisy (dry) 12/43, one week Cough and sputum 6 mths. No other history. No physical signs On night work 2 yrs.</i>	F.H. <input checked="" type="checkbox"/>
	C <input checked="" type="checkbox"/>
	P.I. <input checked="" type="checkbox"/>
	SPUTUM NO SPUTUM PRESENT <input checked="" type="checkbox"/> SPUTUM PRESENT RESULT OF TEST Positive Negative
<i>Write Tub. Off. "Treatment"</i>	

* The national card carries the heading "P.I." for relevant past illnesses, but has no separate entry for known pulmonary tuberculosis, past or present. We think, indeed, that all persons when radiographed should be asked by the clerks if they have been, or are, under medical care for heart or chest disease (including tuberculosis), and the facts recorded in an available space on their cards.

minimal, whether clinically active, etc. (He will have already ticked the appropriate "Disposal"—i.e. immediate disposal from Unit—at the primary medical interview.)

It may be helpful to show a national card finally filled up for a case of newly-discovered pulmonary tuberculosis requiring treatment. In this instance, it has been assumed that there has been *no* separate recording of the data obtained at the medical interview, all the information having been entered, very briefly, under "Clinical Notes" (see above, p. 56).

In concluding this subsection, it may be useful to show how the "administrative balance-sheet" of the survey of a particular group, carried out according to the foregoing routine, might appear (for detailed technique of this analysis see p. 35):—

(Name of Group and Date of Survey)

1. Analysis of Stages of Procedure

(a) Total employed in factory, etc.*	[**]
(b) Total available during survey (taking account of absences).	[**]
(c) Total radiographed	[**]=[**] per cent. of (b)
(d) Total passed on miniature film	[**]
(e) Total recalled for full-size film†	[**]=[**] per cent. of (c)
(f) Total passed on large film (i.e. "no action")	[**]
(g) Total recalled for medical interview (i.e. "investigate").	[**]=[**] per cent. of (c)

2. Analysis of Results, on Initial Assessment‡

Total radiographed	[**]
Category (A) Non-tuberculous	[**]
(B) Previously diagnosed pulmonary tuberculosis §.	[**]
(C) Tb. lesions requiring no action	[**]
(D) Newly-discovered "significant" Tb. lesions.	[**]=[**] per cent. of total X-rayed.
(i) "Treatment" cases	[**]=[**] per cent. of total X-rayed.
(ii) Total "observation" cases	[**]=[**] per cent. of total X-rayed.
(iia) Single re-checks only	[**]
Total recalled for medical interview (A)-(D)	[**]

Note.—In Part 1, the totals for (c), and if practicable also those for (a) and (b), should be given for each sex separately, as well as for both sexes together. In Part 2, the total radiographed and the figures for category (D) and its sub-divisions, and also possibly the figures for (B) and (C), should be tabulated by sex and in suitable age-groups (see, for example, p. 36).

* Care should be taken that this figure includes the entire population under survey. Factory managements, when asked for the total employed, sometimes exclude managerial and supervisory staff, confining the figure to weekly wage earners, or they may exclude part-time workers, etc.

[**]=figures to be filled in (c.f. Table I, p. 72).

† A small number of group (e) will probably fail to attend for large film examination (on account of illness, refusal, etc.). The basis for recording these persons as "no action" or "investigate" (i.e. for medical interview) will have to be their miniature films; in the latter case, the miniature films will also have to be relied upon for classification into categories (A), (B), (C) and (D), and into the sub-categories of (D).

‡ For adaptation to survey of a mental hospital, see p. 85.

§ To get percentage based on total radiographed, add similar cases radiographed but not recalled for medical interview; to get incidence in whole group, add also, if known, similar cases among non-volunteers—a list of cases of pulmonary tuberculosis in the group, known to the works medical department, may assist.

The above "administrative" classification allows the demand upon institutional beds and upon the tuberculosis dispensary service, as well as the effect upon industry, to be easily gauged. This statistical information will be appreciated by the employers and trade unions involved.

As the classification has followed the lines of p. 59, persons advised to leave work but not sent to an institution have been included under (Di), and observation cases whose work is reduced in time or modified in nature are included under (Dii); both these sub-groups should, of course, be separated out if sufficient in number. Furthermore, sub-division of (D) cases will also be desirable according to the degree of involvement, e.g., minimal, unilateral, etc., and according to the clinical activity; otherwise, follow-ups will be incomplete (see below).

We would emphasise that the present classification takes no account of some of the entries on the national record card, which may provide the basis of various interesting analyses such as incidence of tuberculous and other lung disease, or heart disease, in relation to certain occupations or industries, or to types of factory or work place, place of birth, etc. Thus, it may be practicable to assess accurately the tuberculosis hazards in certain trades which have been believed to carry high risks, e.g. printing and shoe trades. Investigations will also be possible on the effects of various dusty occupations, and on the tuberculosis incidence in small factories.

C. *Communication of Findings*

While privacy should be aimed at in the arrangements for the primary medical interview, a limiting factor is that this must usually take place in working hours; so fellow-workers may be aware of the visit to the medical director.* But the actual results of the examination can and must be confidential between the individual patient and the Unit team. In cases of abnormality, the medical director will seek the patient's permission to send the data to the local tuberculosis officer or to his family doctor; in our experience, persistent objection is exceptional. As stated in Section 3, communications direct to the works medical officer or to the management, without the patient's permission, would constitute a breach of the confidential undertaking that has to be given in introducing the survey. Even if the patient is willing, responsibility for such communication is best left to his own family doctor or to the tuberculosis officer. After the patient has consulted one of the latter, the position is as with anyone spontaneously seeking advice. It is for these doctors, who will have the future care of the patient in their hands, rather than for the mass radiography team's medical director, who is associated with the patient only for a brief moment, to communicate with the works medical officer where it is in the patient's interest so to do, and then only, of course, with his permission. Any desirable rearrangements of work for "observation" cases can be achieved in this way.

Formal notification to the public health authority of cases with tuberculous lesions discovered by mass radiography is a somewhat controversial matter, which it is not proposed to discuss at this point. As with other communications, notification where required should usually be done by the patient's doctor or tuberculosis officer and *not* by the medical director of the team.

D. *Later Follow-up of Abnormal Cases*

In course of time, the tuberculosis officers will gather interesting data on the progress of patients brought to their notice through mass radiography. It

* In actual practice, the great majority of examinees have not appeared to mind their fellow-workers knowing of the visit; a minority have been able to conceal knowledge of the reason for their temporary absence from their shop, and a few have asked to come outside working hours.

will be useful for the medical directors of teams to collect this information, so that they may gain experience of the correct management of different types of case. In particular, a tabulation of the fate of the "observation" group is essential. Probably the easiest procedure is for the medical director to send out brief questionnaires at suitable intervals to the tuberculosis officers, and to note the results in a special "follow-up" entry to be added either to the record card or to the separate case sheet. With a knowledge of the initial degree of involvement of the lung, degree of activity, etc., interesting follow-up analyses will be practicable.*

Apart from ascertainment of the progress of the lesions, the medical officer will find it valuable to discover whether his cases qualify for financial allowances; whether they eventually return to work, and, if so, to what type of work. In this way, he will gain a much broader view of the results of the mass radiography scheme than by merely "sorting" the cases initially and then losing sight of them.

SECTION 8

The Chest Clinic and Mass Radiography

The tuberculosis officer learns of a newly detected case when the full-size film and notes are passed on to him from the Unit's medical director, either directly or through the family doctor, and an appointment for the patient to attend is arranged. Even in cases where observation is all that is likely to be required, it is better for the patient to see the tuberculosis officer with a minimum of delay. Most patients are anxious to have a definite opinion at the earliest possible date; and it is, as a rule, unsafe to give this, as the medical director may be tempted to do, without a full clinical investigation.

At the chest clinic, the first task is assessment of the case. A careful history is taken of present symptoms, of past illnesses and of any contact, familial or otherwise, with tuberculosis; an occupational history is also valuable. Physical examination, estimation of blood-sedimentation-rate and examination of any sputum should be performed as a routine. In the absence of sputum, culture of organisms obtained by laryngeal swab, as described in Section 15, has been found a helpful out-patient procedure.

It may be that this routine investigation still leaves doubt whether the lesions are active or inactive, and it may be judged unsafe to continue out-patient observation in the hope that serial X-ray examinations may decide this point. It can fairly be said, in this connection, that the decision may be as difficult as any in the whole field of clinical medicine. Recourse must then be had to an "assessment" bed† in a sanatorium or, preferably, a hospital (so that the tuberculosis stigma will not necessarily be incurred), where the resting temperature and pulse charts, blood picture and examination of gastric contents for tubercle bacilli, may aid in diagnosis.

The present shortage of institutional beds makes it specially desirable to reduce as far as possible the number of cases referred for "assessment". With increasing experience, it should be possible to class most cases after a single examination as for either "observation" or "treatment"‡. A report of the tuberculosis officer's opinion after his initial investigation should be sent to the general practitioner and—conveniently, on a questionnaire form such as that suggested on p. 59—to the Unit medical director, so as to complete his classification and entries for national statistics.

* See p. 60, footnote ‡.

† Perhaps a better term than "observation" bed, to avoid confusion with the out-patient "observation case", a term used frequently in this report.

‡ For definitions, see p. 59.

Under the heading of "treatment" are included those patients who obviously must go into hospital or sanatorium, and also those who are advised various degrees of rest in the country or at home. Patients excreting tubercle bacilli mostly require treatment. Even in the case of the elderly "T.B. carrier" with "benign" phthisis, notoriously unsuitable for sanatorium life, a short period in hospital will help to impress on the patient the importance and technique of hygienic precautions. It is recognised, however, that this may not always be practicable, with the present shortage of beds. Indeed, such shortage makes the border-line between "observation" cases left at work, and "treatment" cases temporarily withdrawn, to a certain extent artificial and movable.

"Observation" cases return to the chest clinic for re-assessment at intervals of between one and six months (most frequently three months), depending on the degree of danger attributed to the lesions. In cases where it is almost but not quite certain that the lesion is already healed, a single re-check after six months may suffice to satisfy the tuberculosis officer, and the patient can thereafter be discharged from observation. In the main group of cases, however, observation will be more prolonged, though we cannot, from our experience, offer any guidance as to its time-limit; it seems likely that the total duration will vary between six months and, say, two years, after which period all cases will either have shown evidence of activity and have required treatment, or will be discharged from supervision. Information of the type given by Brooks (1944 b), on the relapse rate of doubtfully inactive minimal cases among Naval personnel, should be of great value in this connection.*

Cases under observation need to be labelled as "pulmonary tuberculosis," and as such formally notified to the public health authorities, only if this disease is considered as definitely active: where a reasonable doubt exists and where the system of record-keeping at the clinic permits, the patient should be given the benefit of the doubt. He will usually appreciate being spared what is still often considered the stigma of notification, though he should understand the desirability of having his home-contacts examined just as if his case had been notified.

Refusal of co-operation raises a real difficulty. Persons who consent to mass radiography do not often refuse to discuss a positive result with a medical authority, but cases have occurred where a wilful break has occurred at all points of the chain between miniature films and chest clinic. Once a patient has reached the latter, any subsequent failure is likely to be the fault of the tuberculosis officer or his staff. Agreeable surroundings, prompt attention, a friendly atmosphere and an absence of stress on the word "tuberculosis" are helpful in promoting confidence, and the new patient should not be left alone with "old chronic attenders" in the waiting-room. The initial interview requires great tact on the part of the tuberculosis officer. His patient so far knows only that he has a "spot on the lung" (or some similar phrase, deliberately vague pending completion of the clinical picture). He must now be told, in suitable language, what exactly this chance radiological discovery means to him. The explanation should be frank and reasonably detailed. An intelligent patient will agree to go to a sanatorium all the more readily if he understands the necessity for rest or collapse therapy. An obstinate patient, who maintains that there cannot be much wrong with him because he feels so fit, will often be convinced by a demonstration of the shadows in his own X-ray film. It has been found that confidence established in this first interview promotes an enduring spirit of co-operation and, if for this reason alone, the tuberculosis officer should expend sufficient time and effort to ensure it.

* It is possible that the home base of the mass radiography Unit itself may become a follow-up clinic for patients not requiring institutional treatment (see p. 60, footnote †).

Failures will still occasionally occur, but they need not be absolute failures. A patient who refuses to go away for treatment, possibly for domestic or economic reasons of an almost insoluble nature, may yet be induced to attend the clinic periodically, and to take precautions regarding his infective sputum. It is better to retain his limited co-operation on such terms than to drive him away for ever by an ill-judged attempt at coercion.

The Government financial allowances (Ministry of Health Memo 266/T, 1943) encourage many patients to leave work for treatment who would otherwise be reluctant to do so, though some, who are earning good wages under war conditions, not unnaturally regard the allowances as inadequate. Few cases need to be classed as actually ineligible on medical grounds, since persons with the type of lesion detected by mass radiography mostly have some prospect of returning to part-time work, the minimum medical requirement. Eligibility applies to home or out-patient, as well as to institutional, treatment, and includes also observation periods when the diagnosis is in doubt. The continuation of the allowance is permitted, though on a reduced scale, during a period of post-sanatorium part-time work. The detailed financial assessment is usually undertaken by the almoner, welfare officer, or health visitor attached to the clinic.

The tuberculosis officer bears the responsibility also of advising on the type of work for which the patient is suited. This applies not only to the "treatment" case on return from the sanatorium, but also to some of the "observation" cases, which remain at work under supervision.

During the post-sanatorium rehabilitation period it is often useful to have a patient on part-time or modified work, and in some instances a change in the occupation may be desirable and practicable. When such changes are to be sought within the establishment in which the patient was formerly employed—be it factory, store, office or public service—the co-operation of the employer is best obtained directly by the tuberculosis officer or his nursing or social welfare staff. It is well for general contact to have already been established with the principal factories, etc., in the area, and a card-index of cases under the headings of such places of employment may be convenient. Contact with a factory on an individual case can best be made through the works medical officer, where one exists, or through the factory nurse or welfare officer, but in the absence of such agencies the manager himself must be approached. The tuberculosis officer will find that he is required to give a fairly precise account of the work for which the patient will be fit, and he will inevitably be asked for a prognosis; if he has visited the factory and understands something of workshop methods, he will be in a much better position to give useful advice. If post-institutional resettlement is to involve a change in employer (e.g. to obtain facilities for part-time work), or a change of occupation requiring re-training, the tuberculosis officer, through his almoner, can make contact with the Local Officer of the Ministry of Labour and National Service, in order to obtain facilities of the Interim Scheme for Training and Resettlement of Disabled Persons, and the services of the Local Disablement Rehabilitation Officer. Re-employment of post-sanatorium patients is, of course, easier when their disease is quiescent and non-infective, than when they are chronic and infective cases that are nevertheless fit for some or even full work; the whole problem will presumably be reduced by the introduction of rehabilitation workshops, etc., both inside and outside normal industrial units, when the Disabled Persons (Employment) Act, 1944, comes into full operation.

As regards conditions of employment for "observation" cases, the majority are likely to be suitable to remain on full work, but in some instances the tuberculosis officer may consider that shortening of hours, part-time work, or modification or change of occupation may also be desirable. Such various alterations in conditions of work may sometimes represent an alternative to

sanatorium treatment. Their effect upon the progress of lesions will have to be studied most carefully, and is one of the important questions for the future of mass radiography.

In carrying out re-arrangement of work, both for observation and for treatment cases, the confidential nature of the mass radiography scheme can be most easily maintained by obtaining the formal permission of the patient to communicate with the works doctor or other appropriate person, or by sending the communication through the patient himself; in many instances, the patient will have already made the initial approach to his executive. We think that the difficulties likely to arise from the necessarily confidential conditions of mass radiography have been exaggerated. In actual fact, persons who consent to the original X-ray examination rarely object to the findings being communicated in their own interest, provided that the relations existing within their industrial units are good.

PART II

Results of the Medical Research Council Survey, 1943

SECTION 9

Scope of Inquiry

As indicated in the preface to this report, a team was formed by the Medical Research Council early in 1943, to carry out a "pilot" mass radiography survey, using one of the transportable miniature radiography sets recently manufactured for the Ministry of Health. The apparatus was taken to each of the establishments investigated, and operated on the premises. The survey took place from March to December, 1943, and covered 23,042 persons, 9,377 being males and 13,665 being females; the examinations were entirely voluntary. The numbers examined in the different population groups, all of which were in Greater London, were as follows:—

	Total Radiographed.		
	Males.	Females.	Persons.
Factory Group A (March, 1943)	1,406	3,314	4,720
Factory Group B (Nov.-Dec., 1943)	3,439	2,218	5,657
* Office Group (May-July, 1943)	3,810	7,093	10,903
Mental Hospital (Oct., 1943) { Patients	642	922	1,564
	Staff	80	198
	9,377	13,665	23,042

Factory Group A.—Factory A is a light engineering plant in Middlesex employing over 5,000 persons. It is modern and compact, and is situated in a residential area mainly developed since the last war. The group radiographed represented 90† per cent. of the total employees available during the inquiry. The great majority of the employees lived in the locality.

Factory Group B.—The volunteers were drawn mainly from the heavy and light engineering sections of a very large factory in south-east London. This is an old-established factory, covering a wide area. Parts of the borough in which it is situated are old, but parts have been comparatively, recently developed, and the incidence of overcrowding given in the 1931 census was well below the average of the London boroughs. As judged by those with newly-discovered lesions, about half of the employees lived in the borough. The group radiographed represented 39 per cent. of the total available in the selected sections during the inquiry (the percentages of volunteers being 31 for males and 63 for females).

Office Group.—This group was composed of Civil Service personnel from more than 15 Government Departments in London. The volunteers numbered 62 per cent. of the total invited. It was estimated that about half lived outside the County of London, i.e. in the Home Counties.

Mental Hospital.—This 1,750-bed hospital is situated in south-west London, but draws its patients from the County of Middlesex. It is one of the few mental hospitals which has not had its accommodation reduced, or the number

* Factory Group A corresponds to Survey 1, Factory Group B to Survey 4, Office Group to Survey 2, and Mental Hospital to Survey 3 (see first footnote to p. 12).

† Throughout Part II, percentage figures are printed in italics.

of patients increased, as a result of the war. Nevertheless, the figures given below reveal that it has borne its share of the war-time increase of tuberculosis incidence and mortality that has occurred in the British mental hospitals as a whole.

The patients radiographed consisted of 89 per cent. of the total of in-patients (those excluded being bedridden and refractory cases). The staff examined represented 43 per cent. of the total resident and non-resident staff.

Tuberculosis (all forms) at the Mental Hospital surveyed, and at all County and Borough Mental Hospitals in England and Wales

Year.	Mental Hospital Surveyed.		All County and Borough Mental Hospitals.	
	New cases per 1,000.	Deaths per 1,000.	New cases per 1,000.	Deaths per 1,000.
1934-1938	8.3	5.2	6.4	4.5
1939	8.8	6.8	5.6	4.1
1940	14.0	10.4	6.4	5.7
1941	16.8	11.9	11.3	8.7
1942	15.0	10.0	10.8	9.0
1943	7.0*	5.0*	9.9	6.7

SECTION 10

Methods Used

The approach to the groups, and the administrative and technical routine, have been indicated in the general account given in Part I of this report, and they need not be particularised in detail; even in the mental hospital, our procedure was sufficiently similar to that already outlined not to require further-detailed description. Attention should, however, be drawn to certain points of procedure in our survey; other special features will be apparent when the individual results are considered.

The percentage of volunteers in Factory B was disappointing; it was much lower than that in Factory A. From the complex of factors that may have been responsible for this, we would select the following as being in our opinion the most relevant. In Factory A, very full discussion had taken place between the shop stewards and supervisory staff and the medical director of the Unit, while the factory medical department took full part in the publicity; the enthusiastic woman medical officer gave talks to groups of the workers; the factory's liaison officer (the sister of the medical department) carried out fully the functions enumerated on p. 8; she was familiar with the organisation in the shops, and personally visited the latter to collect volunteers and make appointments. Furthermore, at this factory a list of employees (nominal roll) was provided for the Unit for checking purposes. In Factory B, the preliminary discussions were less complete and covered fewer personnel, and publicity was less thorough. The organisational liaison was far less satisfactory, and the collection of volunteers was left to the initiative of individual employees, who were merely asked to give their names to their shop foremen; these names were then forwarded to a central office, and there was no personal contact between volunteers and the factory's liaison officer. No nominal roll was available for the use of the Unit, only the shop populations being provided. A severe epidemic of influenza was probably a contributory factor in reducing the numbers of

* The figures for 1943 do not include cases discovered by mass radiography; these will come in the 1944 returns.

volunteers, though allowance has been made for recorded absences during the survey. The approach of Christmas may also have been a factor.

In the Office Group, where the percentage of volunteers was moderate, we think that improvement in the method of collecting names would have made a difference. As in Factory B, the names had to be sent in by the individuals themselves; the contact with the liaison officer was indirect and her initiative was not fully used; a nominal roll was not used.

At the Mental Hospital, the percentage of volunteers among the staff was low, but no propaganda at all was carried out here. The impetus to volunteer was the staff's own prior knowledge and understanding of mass radiography, and the interest aroused by seeing it in action during the survey.

The above factors affecting the numbers of volunteers are mentioned without implication of blame; we were proceeding by trial and error, and expected to learn from experience. One further factor is the sex difference—in Factory B and the Office Group, the percentage of volunteers among females outstandingly exceeded that among males; in Factory A the difference was negligible, both percentages being very large. The lessons provided have been applied in the suggestions made in Part I for units working in the national scheme.

Our record card differed in some respects from the national card, which had not been prepared when we commenced operation, and certain additional entries were made, some for reasons special to this inquiry. For the factory groups, the entries included the following: X-ray centre, serial number, date of miniature, thickness of chest; surname, first name initials, Mrs. or Miss, address; sex, age last birthday; designation of group surveyed (e.g. name of factory), clock number, shop or department, shift and shift rotation; present and pre-war occupations, date of entry to factory, birthplace; previous history of tuberculosis, recent history of contact at home; reading of miniature film; report on large film if any; clinical notes and classification (these last were not used, as the medical data of the abnormal cases were kept separately with the cards attached). For the Office Group, the entries were appropriately modified, and the civil service grade was added. For the mental patients, the mental diagnosis was added and certain entries omitted.

The primary medical interview was confined to persons considered, on the basis of their large films, to require attention, i.e. the "investigate" cases; all other cases were recorded as "no action" and were dismissed by letter C. The interview was carried out by the medical director of the Unit, on the premises of the centre of examination. Subjects with tuberculous lesions which the medical director, as a result of the interview, considered as requiring further advice or action were recommended by him (with letter and radiograph) to their local tuberculosis officers either directly or, less frequently, through their family doctors; non-tuberculous subjects needing further attention were advised to consult their family doctors, to whom letters were sent similarly; tuberculous and non-tuberculous cases requiring no such action were dismissed verbally. Subsequent management of the "significant" tuberculous cases—"treatment" cases and "observation" cases—was thus usually in the hands of the tuberculosis officers.

In the mental hospital survey, the suspect patients were examined by the Unit's medical director in the wards, and action was decided in consultation with the medical superintendent of the hospital. The latter was responsible for their future care, and made any necessary formal notifications to the Public Health Authority. Disposal of tuberculous cases in the mental hospital was internal, i.e. "treatment" cases were transferred to verandah wards, while the "observation" cases remained in their own wards and were X-rayed periodically on the hospital's own plant.

The data obtained at the primary medical interview were fuller than the minimum suggested on p. 56; they were recorded on a separate sheet, to which

the record card was attached (a duplicate card being, of course, inserted in the card file). Arrangements were made for sputum tests (direct smear and culture) and for laryngeal swab culture, through the co-operation of the Central Emergency Public Health Laboratory, Oxford. Sedimentation rate and temperature range could not be investigated for the normal groups, but temperature charts and weight records were obtained for suspect cases among the mental patients.

Classification of cases discovered in the factory and office groups followed the recommendations given in Part I (see pp. 57-63). The reports from the various tuberculosis officers to whom the abnormal cases had been referred, giving their assessment of each case after *initial* investigation, were obtained (after a month or so) by means of the questionnaire described on p. 59. These reports, together with the radiological and clinical case data gathered by the Unit itself, were reviewed by two of us (B.C.T. and P.D'A.H.), and each case assigned to its classification group. Since films had been taken in duplicate, reference to the radiograph was possible at this stage. For the mental patients, the classification was suitably modified to be in accordance with the fact that the patients would remain inside the hospital; no tuberculosis officer's report was here involved and the initial assessment was made by ourselves.

Two gaps in our classification need to be mentioned: (a) A few of our cases were recommended to leave work but without institutional treatment—owing to their small number, we have, as suggested on p. 60, classified these as "treatment" cases (Di); again, the work of a small number of the observation cases was temporarily restricted by arrangement with the works medical officers but the number was insufficient to warrant separate categorisation—though, as this arrangement in suitable individual cases increases, they should probably be shown as a separate division of (Dii). (b) For purposes of simplification, we have shown no subdivision of the treatment and observation cases on the basis of degree of lung involvement or of clinical activity—though this will be desirable in routine mass radiography, particularly for follow-up studies.

SECTION II

Results for the Individual Groups

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The main results will first be given for each of the survey groups separately, and the results will be discussed as a whole in subsequent chapters.

A. *Factory Group A*

The analysis of the stages of procedure and of the results at this factory are given in Table I. (for explanation of terms, see Section 7). The inquiry was carried out in March, 1943. The total number radiographed was 4,720. The total available (allowing for absences) was 5,200, so that the percentage of volunteers was 90.*

Of the 4,720 persons examined, 250 (5.5 per cent.) were recalled for full-size films, and 115 of these (2.5 per cent. of the total radiographed) failed to pass the examination of large films (i.e. could *not* be regarded as requiring no medical action) and were asked to a medical interview with the medical director of the team. Finally, 66 persons (1.4 per cent. of the total radiographed) were classed

* See p. 68, footnote†.

as having newly-discovered tuberculous lung lesions requiring medical action of some kind (i.e. "significant" lesions).

In addition, there were 14 persons who had at some time previously been diagnosed as suffering from pulmonary tuberculosis; if to this number we add 6 similar cases in which large films were taken but the subjects were not medically interviewed, we obtain 20 cases, i.e. 0.4 per cent., out of the total radiographed; the inclusion of a further 2 cases not radiographed at all makes up a total of 22 cases of already known pulmonary tuberculosis, i.e. 0.4 per cent., out of the total *employed*.

The total incidence of cases of newly detected or previously known pulmonary tuberculosis in this population group is approximately $1.4 + 0.4 = 1.8$ per cent.

The non-tuberculous cases of this and the other groups will be discussed together in Section 14. Their number is of little statistical value, since only cases where it was thought that something could be done for the patient were recalled for the medical interview.

The 66 persons with newly-discovered, "significant" lesions were sub-divided as follows:—

Requiring to leave work immediately for sanatorium or equivalent (i.e. "treatment" cases)	15
(0.3 per cent. of total radiographed)	
Requiring medical observation while remaining at work (i.e. "observation" cases)	51
(1.1 per cent. of total radiographed)	

The 51 observation cases included 15 persons requiring a single precautionary re-check. The work of a small number of the observation cases was temporarily restricted, e.g. hours shortened, part-time, etc., by arrangement with the works medical officer.

Details by sex and age are given in Table II. It will be seen that the number of males examined was 1,406 and of females 3,314, of which 702 males and 2,269 females were in the age-group 14-34. The total incidence of newly-discovered significant cases was slightly greater among the males (1.6 per cent.) than among the females (1.3 per cent.) for all ages, but the reverse was the case when the age-group 14-34 was taken alone (1.4 per cent. and 1.6 per cent., respectively). For treatment cases taken alone, the incidence was approximately the same in both sexes (0.3 per cent. for males and females, all ages; 0.3 per cent. and 0.4 per cent. for males and females, respectively, aged 14-34). None of these sex differences is statistically significant (χ^2 test).

The treatment cases, expressed as a proportion of total significant cases, were 18 per cent. for males, 25 per cent. for females and 23 per cent. for both sexes together.

TABLE I
Factory Group A Examined by Mass Radiography, 1943

(i) Analysis of Stages of Procedure	
(a) Total employed in factory	5,500
(b) Total available during survey	5,200
(c) Total radiographed	4,720=90 per cent. of (b)
(d) Total passed on miniature film	4,470
(e) Total recalled for full-size film	250=5.5 per cent. of (c)
(f) Total passed on large film (i.e. "no action")	135
(g) Total recalled for medical interview (i.e. "investigate")	115*=2.5 per cent. of (c)

* Includes 1 person who refused a large film examination and was assessed on the miniature film; he refused also to attend the medical interview. He was classified eventually as an observation case on the basis of the miniature film.

MASS RADIOGRAPHY OF CIVILIANS.

(ii) *Analysis of Results, on Initial Assessment*

Total radiographed	4,720	
Category (A) Non-tuberculous	26*	
(B) Previously diagnosed pulm. tuberculosis.	14†	
(C) Tb. lesions requiring no action	9*	
(D) Newly-discovered "significant" Tb. lesions.	66=1.4 per cent. of total X-rayed.	
(i) "Treatment" cases	15=0.3 per cent. of total X-rayed.	
(ii) Total "observation" cases	51=1.1 per cent. of total X-rayed.	
(iia) Single re-check only	15	
Total recalled for medical interview	115	

* Figure refers only to those recalled for medical interview, and is therefore a minimum. It is of little statistical value.

† Add 6 cases radiographed on large films but then passed as requiring no new action and so not recalled for interview = 20 cases, in order to get the approximate percentage based on the total radiographed = 0.4 per cent. Add a further 2 cases not radiographed by us = 22 cases, in order to get percentage rated on whole employed group = 0.4 per cent. also.

TABLE II
Factory Group A
Newly-discovered Significant Tuberculous Lung Lesions

Ages.	Males.				Females.				Persons.			
	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.
14 to 19	173	1	—	1	398	2	6	8	571	3	6	9
20 to 24	112	—	2	2	809	2	6	8	921	2	8	10
25 to 34	417	1	6	7	1,062	6	14	20	1,479	7	20	27
35 to 44	423	1	4	5	783	1	7	8	1,206	2	11	13
45 to 54	194	1	4	5	238	—	—	—	432	1	4	5
55+	87	—	2	2	24	—	—	—	111	—	2	2
All Ages	1,406	4	18	22	3,314	11	33	44	4,720	15	51	66
Per Cent.	100	0.3	1.3	1.6	100	0.3	1.0	1.3	100	0.3	1.1	1.4
14 to 34	702	2	8	10	2,269	10	26	36	2,971	12	34	46
Per Cent.	100	0.3	1.1	1.4	100	0.4	1.2	1.6	100	0.4	1.1	1.5

* Including those requiring a single precautionary re-check. For all ages, these were : Males, 6 (0.4 per cent.) ; Females, 9 (0.3 per cent.) ; Persons, 15 (0.3 per cent.). For ages 14 to 34, they were : Males, 2 (0.3 per cent.) ; Females, 6 (0.3 per cent.) ; Persons, 8 (0.3 per cent.).

TABLE III

Factory Group A

(i) Results of Bacteriological Tests*

Case Category.	Newly-discovered Significant Tb. Lesions.		Previously Diagnosed Pulmonary Tuberculosis.	
	No.	Bact. Tests†	No.	Bact. Tests†
Treatment	15	8	..	..
Observation	51	—	..	..
Total	66	8	14	2

(ii) Bacteriologically-Positive Cases by Age and Sex

Age.	Bacteriological Tests Positive.					
	Newly-discovered Significant Tb. Lesions : Total Cases†			Previously Diagnosed Pulmonary Tuberculosis : Total Cases		
	Males.	Females.	Persons.	Males.	Females.	Persons.
14-34	2	3	5	1	—	1
35-44	1	1	2	—	—	—
45+	1	—	1	1	—	1
All ages	4	4	8	2	—	2

The bacteriological results are given in Table III. There were 8 T.B. positive cases amongst persons with newly-discovered lesions, all of these being "treatment" cases, and 5 of them being in the 14-34 age-group; 2 of the already-known pulmonary tuberculosis cases also were found to be bacteriologically positive. The problem of possible infectivity presented by these cases, as well as general aspects of the bacteriological examination in the inquiry, will be discussed later.

B. Factory Group B

The stages of the procedure at this factory are analysed, and the results given, in Table IV. The survey was made in November-December, 1943. The total of employees available in the selected sections of the factory (after approximate deductions for absences, the causes of which included notably the current severe influenza epidemic) was 14,479, and the total number radiographed was 5,657. This makes the percentage of volunteers 39, this percentage being divisible into 31 for the males and 63 for the females. Suggested reasons for the disappointingly small number of volunteers at this factory have been given (on p. 69); the major deficiency is clearly attributable to the males.

Of the 5,657 persons radiographed, 356 (6.3 per cent.) were recalled for full-size films, and 150 of these (2.7 per cent. of the total radiographed) were recalled for a medical interview on account of the appearances on the large

* The tests for tubercle bacilli included direct examination of film of sputum, culture of sputum, and culture of laryngeal swabs; but not every case investigated had both sputum and swab examinations. (See Section 15 for fuller details.)

† All of these were "treatment" cases.

film. The remainder of the "large-film-recalls" were passed as requiring no medical action. Finally, 71 persons (1.3 per cent. of the total radiographed) were classed as having newly-discovered tuberculous lung lesions requiring medical action of some kind (i.e. "significant" lesions).

In addition, there were 20 persons who had at some time been under medical care for pulmonary tuberculosis, but this figure is of little value for showing incidence, as there was an unknown number of similar cases not examined by us. Hence the total incidence of tuberculosis in this population group cannot be given.

The 71 persons with newly-discovered "significant" lesions were subdivided as follows:—

Requiring to leave work immediately for sanatorium or equivalent (i.e. "treatment" cases)	23
(0.4 per cent. of total radiographed)	
Requiring medical observation while remaining at work (i.e. "observation" cases)	48
(0.9 per cent. of total radiographed)	

The 48 observation cases included 15 persons requiring a single precautionary re-check. A few of the observation cases are having their work or working hours altered as a result of the survey.

Details by sex and age are set out in Table V. The number of males radiographed was 3,439, and of females 2,218; 1,450 of the males and 1,618 of the females were aged 14-34. The total incidence of newly-discovered significant cases was slightly lower among the males (1.2 per cent.) than among the females (1.4 per cent.), and this difference was increased for the age-group 14-34 taken alone (0.8 per cent. and 1.7 per cent., respectively). For treatment cases taken alone, the incidence was approximately the same for both sexes for all ages (0.4 per cent.), but was again lower in males than in females at ages 14-34 (0.2 per cent. and 0.6 per cent., respectively). Statistical assessment of these sex differences (χ^2 test) shows that the difference between males and females for total cases at ages 14-34 (0.8 per cent. and 1.7 per cent.) is probably significant; all the other differences are insignificant.

TABLE IV

Factory Group B Examined by Mass Radiography, 1943(i) *Analysis of Stages of Procedure*

(a) Total available during survey in selected sections of factory	14,479
(b) Total radiographed	5,657=39 per cent. of (a)
(c) Total passed on miniature film	5,301
(d) Total recalled for full-size film	356=6.3 per cent. of (b)
(e) Total passed on large film (i.e. "no action")	206
(f) Total recalled for medical interview (i.e. "investigate")	150*=2.7 per cent. of (b)

* Including a small number of persons who failed to attend for large film examination, and the desirability of whose recall for interview was decided on the miniature film. Five of these (4 of whom did not attend the medical interview either) were classified eventually, on the evidence available and without the assistance of large films, into 3 observation and 2 treatment cases of "significant" tuberculosis.

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(ii) *Analysis of Results, on Initial Assessment*

Total radiographed	5,657	
Category (A) Non-tuberculous	46*	
(B) Previously diagnosed pulmonary tuberculosis.	20†	
(C) Tb. lesions requiring no action	13*	
(D) Newly-discovered "significant" Tb. lesions.	71=1.3	per cent. of total X-rayed.
(i) "Treatment" cases	23=0.4	per cent. of total X-rayed.
(ii) Total "observation" cases	48=0.9	per cent. of total X-rayed.
(iia) Single re-check only	15	
Total recalled for medical interview	150	

* Figure refers only to those who were recalled for medical interview, and is therefore a minimum. It has little statistical value.

† Add 3 cases radiographed on large film but then passed as requiring no new action and so not recalled for interview = 23 cases, in order to get the approximate percentage based on the total radiographed = 0.4 per cent. Percentage based on whole employed group cannot be computed, as the number of persons previously diagnosed as tuberculous who did not volunteer was unknown.

TABLE V
 Factory Group B
 Newly-discovered Significant Tuberculous Lung Lesions

Ages.	Males.				Females.				Persons.			
	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.
14 to 19	368	2	1	3	315	4	2	6	683	6	3	9
20 to 24	265	1	3	4	676	4	8	12	941	5	11	16
25 to 34	817	—	4	4	627	1	8	9	1,444	1	12	13
35 to 44	979	6	4	10	399	—	2	2	1,378	6	6	12
45 to 54	659	5	9	14	177	—	1	1	836	5	10	15
55+	351	—	6	6	24	—	—	—	375	—	6	6
All Ages	3,439	14	27	41	2,218	9	21	30	5,657	23	48	71
Per Cent.	100	0.4	0.8	1.2	100	0.4	1.0	1.4	100	0.4	0.9	1.3
14 to 34	1,450	3	8	11	1,618	9	18	27	3,068	12	26	38
Per Cent.	100	0.2	0.6	0.8	100	0.6	1.1	1.7	100	0.4	0.8	1.2

* Including those requiring a single precautionary re-check. For all ages, these were: Males, 12 (0.3 per cent.); females, 3 (0.1 per cent.); persons, 15 (0.3 per cent.). For ages 14 to 34, they were: Males, 3 (0.2 per cent.); females, 3 (0.2 per cent.); persons, 6 (0.2 per cent.).

TABLE VI

Factory Group B

(i) Results of Bacteriological Tests*

Case Category.	Newly-discovered Significant Tb. Lesions.		Previously Diagnosed Pulmonary Tuberculosis.	
	No.	Bact. Tests +	No.	Bact. Tests +
Treatment	23	12	..	..
Observation	48	5	..	..
Total	71	17	20	4

(ii) Bacteriologically-Positive Cases by Sex and Age

Age.	Newly-discovered Significant Tb. Lesions : Total (and Treatment) Cases.			Previously Diagnosed Pulmonary Tuberculosis : Total Cases.		
	Males.	Females.	Persons.	Males.	Females.	Persons.
14-34	2 (2)	2 (2)	4 (4)	—	2	2
35-44	6 (5)	—	6 (5)	1	—	1
45+	7 (3)	—	7 (3)	1	—	1
All ages	15 (10)	2 (2)	17 (12)	2	2	4

The treatment cases, expressed as proportions of the total significant cases, were 34 per cent. for males, 29 per cent. for females and 32 per cent. for all persons.

Table VI shows the bacteriological results. There were 17 T.B. positive cases among persons with newly-discovered lesions, 12 of these being "treatment" cases, and 4 of them being in the 14-34 age-group; 4 of the already-known pulmonary tuberculosis cases also were found to be bacteriologically positive.

C. Office Group

The analysis of the stages of procedure, and of the results, in this group are shown in Table VII. The inquiry was carried out from May to July, 1943. The total number radiographed was 10,903. This total comprised volunteers from the London staffs of more than 15 Government Departments. The total invited was 17,706, so that the percentage of volunteers was 62.

It may be mentioned that of the 11 departments included with populations of 500 or more, 3 reached a proportion of volunteers of over 70 per cent.; these were the Air Ministry (typists) 95 per cent., the Ministry of Health 75 per cent. and the Treasury 73 per cent. Furthermore, taking 4 large Ministries with an aggregate population of over 10,000 in which the numbers invited were divisible by sex, the percentage of volunteers was 52 for males and 73 for females, making an average of 63 for all persons; the greater success with the women repeats the finding in Factory B.

* See footnote to Table III, p. 75.

Of the 10,903 examined by radiography, 551 (5.1 per cent.) were recalled for full-size films; and 229 of these (2.1 per cent. of the total radiographed) were asked to a medical interview, the remainder being dismissed as needing no medical action. Finally, 140 persons (1.3 per cent. of the total radiographed) were classed as having newly-discovered tuberculous lung lesions requiring medical action of some kind (i.e. "significant" lesions).

In addition, there were 26 persons who had at some time previously been diagnosed as suffering from pulmonary tuberculosis, but this figure is of little value, as there was at least an equal number of such persons not examined by us. Hence an attempt to measure the total incidence of tuberculosis in this population group on the basis of our data would have little meaning.

The 140 persons with newly-discovered, "significant" lesions were subdivided as follows:—

Requiring to leave work immediately for sanatorium or equivalent (i.e. "treatment" cases)	41
(0.4 per cent. of total radiographed)	
Requiring medical observation while remaining at work (i.e. "observation" cases)	99
(0.9 per cent. of total radiographed)	

The observation cases included 29 persons requiring a single precautionary re-check. A few of the observation cases are having their work restricted.

Details by sex and age are given in Table VIII. The number of males examined was 3,810 and of females 7,093, of which 545 males and 5,211 females were aged 14-34. The total incidence of newly-discovered significant cases was greater among the males (1.6 per cent.) than among the females (1.1 per cent.) for all ages, and there was a similar slight excess for males when the age-group 14-34 was taken alone (1.3 per cent. and 1.1 per cent., respectively). For treatment cases taken alone, the incidence was approximately the same in both sexes (0.4 per cent. for males and females, both at all ages and in age-group 14-34). Statistical assessment (χ^2 test) of these sex differences shows that the greater incidence of total cases among males over females at all ages is probably significant; all the other differences are insignificant.

TABLE VII

*Office Group Examined by Mass Radiography, 1943.**(i) Analysis of Stages of Procedure*

(a) Total invited in 15 Government Departments.	17,706
(b) Total radiographed	10,903=62 per cent. of (a)
(c) Total passed on miniature film	10,352
(d) Total recalled for full-size film	551=5.1 per cent. of (b)
(e) Total passed on large film (i.e. "no action")	322
(f) Total recalled for medical interview (i.e. "investigate").	229* =2.1 per cent. of (b)

* Including a small number of persons who did not attend for large film examination, and whose recall for interview was decided on the miniature film. One of these, who also failed to attend the medical interview, was classified eventually, on the basis of the miniature film alone, as an observation case.

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(ii) *Analysis of Results, on Initial Assessment*

Total radiographed	10,903	
Category (A)	Non-tuberculous	45*
(B)	Previously diagnosed pulm. tuberculosis.		22†
(C)	Tb. lesions requiring no action	.. .. .	22*
(D)	Newly-discovered "significant" Tb. lesions.		140 = 1.3 per cent. of total X-rayed.
(i)	"Treatment" cases	.. .. .	41 = 0.4 per cent. of total X-rayed.
(ii)	Total "observation" cases		99 = 0.9 per cent. of total X-rayed.
(iii)	Single re-check only		29
Total recalled for medical interview		.. .. .	<u>229</u>

* Figure refers only to those who were recalled for medical interview, and is therefore a minimum. It has little statistical value.

† Add 4 cases radiographed on large film but then passed as requiring no new action and so not recalled for interview = 26 cases, in order to get the approximate percentage based on the total radiographed = 0.2 per cent. Add also 27 known cases not radiographed by us = 53 cases, in order to get a rough percentage rated on the whole invited group = 0.3 per cent.; this incidence is a minimum figure, as there were almost certainly other previously diagnosed cases of which we had no knowledge.

TABLE VIII
Office Group
Newly-discovered Significant Tuberculous Lung Lesions

Ages.	Males.				Females.				Persons.			
	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.
14 to 19	78	—	1	1	704	4	2	6	782	4	3	7
20 to 24	66	—	—	—	2,345	10	19	29	2,411	10	19	29
25 to 34	401	2	4	6	2,162	9	14	23	2,563	11	18	29
35 to 44	948	—	18	18	1,149	4	10	14	2,097	4	28	32
45 to 54	1,445	7	19	26	597	—	5	5	2,042	7	24	31
55+	872	5	6	11	136	—	1	1	1,008	5	7	12
All Ages	3,810	14	48	62	7,093	27	51	78	10,903	41	99	140
Per Cent.	100	0.4	1.2	1.6	100	0.4	0.7	1.1	100	0.4	0.9	1.3
14 to 34	545	2	5	7	5,211	23	35	58	5,756	25	40	65
Per Cent.	100	0.4	0.9	1.3	100	0.4	0.7	1.1	100	0.4	0.7	1.1

* Including those requiring a single precautionary re-check. For all ages, these were: Males, 17 (0.4 per cent.); females, 12 (0.2 per cent.); persons, 29 (0.3 per cent.). For ages 14 to 34, they were: Males, 2 (0.4 per cent.); females, 3 (0.1 per cent.); persons, 5 (0.1 per cent.).

TABLE IX

Office Group

(i) Results of Bacteriological Tests*

Case Category.	Newly-discovered Significant Tb. Lesions.		Previously Diagnosed Pulmonary Tuberculosis.	
	No.	Bact. Tests +	No.	Bact. Tests +
Treatment	41	24	..	..
Observation	99	4	..	..
Total	140	28	22	3

(ii) Bacteriologically-Positive Cases by Sex and Age

Age.	Bacteriological Tests Positive.					
	Newly-discovered Significant Tb. Lesions : Total (and Treatment) Cases.			Previously Diagnosed Pulmonary Tuberculosis : Total Cases.		
	Males.	Females.	Persons.	Males.	Females.	Persons.
14-34	1 (1)	11 (11)	12 (12)	1	—	1
35-44	1 (—)	3 (3)	4 (3)	—	1	1
45+	11 (9)	1 (—)	12 (9)	1	—	1
Total	13 (10)	15 (14)	28 (24)	2	1	3

The treatment cases, expressed as proportions of total significant cases, were 23 per cent. for males, 35 per cent. for females and 29 per cent. for all persons.

The bacteriological results are shown in Table IX. There were 28 T.B. positive cases among persons with newly-discovered lesions, 24 of these being "treatment" cases, and 12 of them being in the 14-34 age-group; 3 of the already-known pulmonary tuberculosis cases also were bacteriologically positive.

D. Mental Hospital Patients

Some particulars of the Mental Hospital were briefly mentioned on p. 68. The patients live mainly in wards; a ward consists of a day room and one or more dormitories. An infirmary block is used for physically sick patients; almost all the already-known tuberculosis cases were in two verandah wards in this block. All patients with suspicious symptoms are X-rayed as a routine; X-raying of new entrants and staff has begun since our survey.

The stages of procedure and results are analysed in Table X. The survey was made in October, 1943. The total radiographed was 1,564 out of a patient population of 1,757, i.e. 89 per cent. The only exclusions were completely refractory patients or patients confined to bed.

Of the 1,564 radiographed, 168 (10.7 per cent.) were recalled for full-size films; and 90 of these (5.8 per cent. of the total radiographed) were medically examined, the remainder being passed as requiring no action. Finally,

54 patients (3.5 per cent. of the total radiographed) were classed as having newly-discovered tuberculous lung lesions requiring medical action of some kind (i.e. "significant" lesions); the criteria were as far as possible those used for the other groups.

In addition, 6 of the patients X-rayed by us had been previously diagnosed as having pulmonary tuberculosis, but these represented only the ambulatory cases of this category, and it is necessary to add the other 21 already-known cases which were not examined by us, making 27 in all, to obtain the incidence of known cases in the hospital (1.5 per cent.). It is important to note that all but two of these 27 already-known cases were in the infirmary wards, not in the general wards; this segregation is in contrast with the position of similar cases in the factory and office groups. Another difference, of course, is that in the Mental Hospital the known cases represent the production of manifest tuberculosis over a number of years, since the practice is to retain for treatment patients who develop this disease and not to transfer them to other hospitals.

The total incidence of newly detected or previously known pulmonary tuberculosis in the Mental Hospital was thus $3.5 + 1.5 = 5.0$ per cent.

The 54 patients with newly-discovered, "significant" lesions were subdivided as follows:—

Recommended for immediate segregation and bed rest in infirmary verandah ward (with collapse therapy, etc. if suitable)	20
(1.3 per cent. of total radiographed)	
Recommended for observation while remaining in own ward and continuing present mode of life (bed, up and about or work, as at present the case, but any contact with food supplies to be discontinued)	34
(2.2 per cent. of total radiographed)	

The observation cases included 8 patients recommended for a single precautionary re-check. The other 26 observation cases were recommended for periodic X-raying at varying intervals.

Details by sex and age are given in Table XI. The number of males examined was 642 and of females 922, of which 116 males and 88 females were aged 14-34. The total incidence of newly-discovered significant cases was greater among the males (4.5 per cent.) than among the females (2.7 per cent.) for all ages, and a similar excess was present for the age group 14-34 (6.0 per cent. and 3.4 per cent., respectively). For treatment cases taken alone, similar excesses were shown (all ages, males 1.9 per cent., females 0.9 per cent.; ages 14-34, males 2.6 per cent., females 1.1 per cent.). None of the above sex differences was, however, found to be statistically significant on the χ^2 test.

The treatment cases, expressed as proportions of the total significant cases, were 41 per cent. for males, 32 per cent. for females and 37 per cent. for all persons.

It is of interest that the apparently greater incidence in males than in females that was shown for the newly-discovered lesions is also evident for the cases already diagnosed, the incidences being males 2.4 per cent., females 0.9 per cent.; the difference between the sexes is probably significant in this case.

The bacteriological results are given in Table XII. The number of T.B. positive cases among patients with newly-discovered lesions was 14, 11 of these being "treatment" cases, and 5 of them being aged 14-34; 3 of the 6 already-known pulmonary tuberculosis cases X-rayed by us were also bacteriologically positive.

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TABLE X

Mental Hospital Patients Examined by Mass Radiography, 1943(i) *Analysis of Stages of Procedure*

(a) Total resident patient population	1,757*	
(b) Total radiographed	1,564†	= 89 per cent. of (a)
(c) Total passed on miniature film	1,396	
(d) Total recalled for full-size film	168	= 10.7 per cent. of (b)
(e) Total passed on large film (i.e. "no action")	78	
(f) Total medically examined (i.e. "investigate")	90	= 5.8 per cent. of (b)

(ii) *Analysis of Results, on Initial Assessment*

Total radiographed	1,564	
Category (A) Non-tuberculous or undiagnosed	26‡	
(B) Previously diagnosed pulm. tuberculosis.	6§	
(C) Tb. lesions requiring no action ..	4‡	
(D) Newly-discovered "significant" Tb. lesions.	54	= 3.5 per cent. of total X-rayed.
(i) "Treatment" cases, ..	20	= 1.3 per cent. of total X-rayed.
(ii) Total "observation" cases	34	= 2.2 per cent. of total X-rayed.
(iii) Single re-check only	8	
Total medically examined	90	

* Males 736, females 1,021.

† i.e. the whole population, less refractory and bed-confined patients.

‡ Figure refers only to those medically examined, and is therefore a minimum; it has little statistical value.

§ Add 21 similar cases not radiographed by us = 27 cases, in order to get percentage rated on the whole resident patient population = 1.5 per cent. (males 2.4 per cent., females 0.9 per cent.). These 27 cases include quiescent as well as active cases already known in the hospital; all but 2 of them were under treatment, segregated in verandah wards in the infirmary block.

TABLE XI
Mental Hospital Patients
Newly-discovered Significant Tuberculous Lung Lesions

Ages.	Males.				Females.				Persons.			
	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.	No. Examined.	Treatment Cases.	Observation Cases.*	Total Cases.
14 to 19	9	—	—	—	4	—	—	—	13	—	—	—
20 to 24	24	2	1	3	16	1	—	1	40	3	1	4
25 to 34	83	1	3	4	68	—	2	2	151	1	5	6
35 to 44	167	4	6	10	185	4	7	11	352	8	13	21
45 to 54	131	2	2	4	195	3	3	6	326	5	5	10
55+	228	3	5	8	454	—	5	5	682	3	10	13
All Ages*	642	12	17	29	922	8	17	25	1,564	20	34	54
Per Cent.	100	1.9	2.6	4.5	100	0.9	1.8	2.7	100	1.3	2.2	3.5
14 to 34	116	3	4	7	88	1	2	3	204	4	6	10
Per Cent.	100	2.6	3.4	6.0	100	1.1	2.3	3.4	100	2.0	2.9	4.9

* Including those requiring a single precautionary re-check. For all ages, these were; Males, 3 (0.5 per cent.); females, 5 (0.5 per cent.); persons, 8 (0.5 per cent.). For ages 14 to 34, the figure was nil.

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TABLE XII

Mental Hospital Patients(i) *Results of Bacteriological Tests**

Case Category.	Newly-discovered Significant Tb. Lesions.		Previously Diagnosed Pulmonary Tuberculosis.	
	No.	Bact. Tests +	No.	Bact. Tests +
Treatment	20	11	..	..
Observation	34	3	..	..
Total	54	14	6	3

(ii) *Bacteriologically-Positive Cases by Sex and Age*

Age.	Bacteriological Tests Positive.					
	Newly-discovered Significant Tb. Lesions : Total (and Treatment) Cases			Previously Diagnosed Pulmonary Tuberculosis : Total Cases		
	Males..	Females.	Persons.	Males.	Females.	Persons.
14-34	4 (3)	1 (1)	5 (4)	—	—	—
35-44	2 (2)	1 (1)	3 (3)	1	—	1
45+	5 (3)	1 (1)	6 (4)	2	—	2
All ages	11 (8)	3 (3)	14 (11)	3	—	3

E. *Mental Hospital Staff*

The results obtained in the survey of the staff of the Mental Hospital will be mentioned only briefly, as the group is so small. The numbers examined were 80 males and 118 females, the total of 198 representing but 43 per cent. of the total staff of 464 persons. This low percentage is largely accounted for by the absence of any active propaganda to obtain volunteers. No significant cases were found among the males; among the female staff, 4 persons were discovered with significant tuberculous lesions and 2 of these were recommended for sanatorium treatment; both these treatment cases were in the 35-44 age-group. These figures represent an incidence among the female staff of 3.4 per cent. significant cases, and 1.7 per cent. treatment cases.

SECTION 12

The Incidence of Tuberculosis as Revealed by Mass Radiography

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A. *The Normal Employed Groups; and Comparison with Previous Surveys*

In the two factory groups and the office group surveyed, the proportions of examinees recalled for full-size films were very similar, being 5.5 per cent., 6.3 per cent. and 5.1 per cent., respectively. The corresponding proportions

* See footnote to Table III p. 75.

recalled for medical interviews were also similar, being 2.5 per cent., 2.7 per cent. and 2.1 per cent.; these percentages of course included persons with non-tuberculous as well as persons with tuberculous lesions.

The total incidences of *newly-discovered* tuberculous lesions provide the main interest; for while the *previously diagnosed* cases identified in the course of the surveys have considerable medical and administrative importance (considered in a later section), their incidence is somewhat artificial—being dependent on the ease of obtaining employment, current labour demand, policy of the employer, etc.—and it has little statistical value.*

The incidences of newly-discovered, significant lesions in the three survey groups are summarised in Table XIII (data from Tables II, V, and VIII):

TABLE XIII

Incidence of Newly-discovered Significant Tuberculous Lung Lesions

	Males.			Females.			Persons.		
	Factory A.	Factory B.	Office Group.	Factory A.	Factory B.	Office Group.	Factory A.	Factory B.	Office Group.
<i>All Ages.</i>									
No. examined ..	1,406	3,439	3,810	3,314	2,218	7,093	4,720	5,657	10,903
Total cases (per cent.)	1.6	1.2	1.6	1.3	1.4	1.1	1.4	1.3	1.3
Treatment cases alone (per cent.) ..	0.3	0.4	0.4	0.3	0.4	0.4	0.3	0.4	0.4
<i>Ages 14-34.</i>									
No. examined ..	702	1,450	545	2,269	1,618	5,211	2,971	3,068	5,756
Total cases (per cent.)	1.4	0.8	1.3	1.6	1.7	1.1	1.5	1.2	1.1
Treatment cases alone (per cent.) ..	0.3	0.2	0.4	0.4	0.6	0.4	0.4	0.4	0.4

Table XIII shows that whether for males, females or persons, whether for total significant cases or for treatment cases alone, and whether for all ages or for ages 14-34 alone, the incidences are remarkably similar in the three population groups. If this similarity permits generalisation, one may estimate that in London employed groups in 1943, the total incidence of "significant" tuberculous lesions *newly discoverable* by mass radiography was between 1.0 and 1.5 per cent. Subdividing this figure: about 0.3-0.4 per cent. were persons requiring to leave work immediately for institutional treatment, while the remaining approximate 1.0 per cent. required out-patient observation, including periodic X-rays, while continuing at work; about one third of this observation group required only short-term observation (a single precautionary re-check) and about two thirds needed more prolonged and closer observation. On this basis, the total demands on the tuberculosis dispensary service would be for 10-15 persons out of every 1,000 examined; immediate demands on institutional accommodation would be made by 3 or 4 per 1,000; dispensary supervision without sanatorium treatment would be required by some 10 per 1,000. As regards industry, there would be an immediate temporary loss of 3 or 4 per 1,000; and adjustment of work would be desirable for some of these on return, as well as for some of the 10 per 1,000 who form the observation group and who do not leave their place of employment.

* In considering any incidences obtained after the war in relation to these present incidences, it should, of course, be borne in mind that the war-time population groups are relatively weak in certain male age-groups, owing to absences on military service.

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Table XIII also shows that there are slight sex differences in the incidences of total cases, both at all ages and at ages 14-34. In two of the three groups (Factory A and Office Group) the males have an excess at all ages, while in two of the three groups (Factories A and B) the females have an excess at ages 14-34. When the differences between males and females shown in Table XIII are examined by the χ^2 test, both the excess of total cases among males over females at all ages shown in the Office Group, and the excess of total cases among females over males at ages 14-34 shown in Factory B, are found to be probably significant; all other differences are insignificant. While, therefore, these figures show a tendency for the incidence of tuberculous lesions to be related to sex in a similar way to tuberculosis mortality, the evidence can be regarded as no more than suggestive.

The differences in incidence of tuberculous lesions according to age are summarised as follows:—

TABLE XIV
Age Distribution of Significant Tuberculous Lesions

Age.	Males.			Females.		
	Factory A.	Factory B.	Office Group.	Factory A.	Factory B.	Office Group.
<i>Incidence of Total Cases (per cent.).</i>						
14-34	1.4	0.8	1.3	1.6	1.7	1.1
35+	1.7	1.5	1.7	0.8	0.5	1.1
<i>Incidence of Treatment Cases (per cent.).</i>						
14-34	0.3	0.2	0.4	0.4	0.6	0.4
35+	0.3	0.6	0.4	0.1	0.0	0.2

It may be seen from Table XIV that there is a tendency for the incidence of total cases and of treatment cases to *increase* from young to older adult life in the males, and to *decrease* with age in the females. In other words, taking account of their respective contributions to the population at risk, females supply the majority of the significant tuberculous cases at the younger ages and males supply the majority at the older ages. These tendencies are consistent with the well-known influence of sex on tuberculosis mortality at different ages.

In comparing our incidence figures with those of previous mass radiography surveys, we shall consider mainly statistics showing the prevalence of "radiographic tuberculosis" in Great Britain among the adult population in war-time. These statistics divide themselves into those concerning persons employed in industry or civil life and those derived from Service personnel.*

* We have considered that the valuable statistics of mass radiography available from other countries, particularly from the U.S.A., both before and during the war, are less suitable for our present purpose, on account of differences in the populations and in the methods of interpretation and classification.

TABLE XV

Comparison of Present with Previous Mass Radiography Surveys of Adult Population Groups in Great Britain in War-time

(i) Particulars of Surveys

Reference.	Source.	Place.	Year.	Sex.	Age.	Number.	Method.*
1. Banszky (1942)	Entrants to 1 factory.	Surrey	1936-41.	M F	Various 14+	?	S
2. Hall (1942) ..	Employees of 2 factories.	Middlesex.	1940	M F	Various 14+	1,370	S
3. Stanford & Clark (1942).	Employees of 1 factory.	London	1941	M F	Various 14+	600	M R
4. Frank & Jacobs (1944).	Antenatal Clinic.	London	1943	F	Various adult.	1,125	S
5. Gilchrist, Graham & Davies (1942).	A.T.C. Candidates.	S. Wales	1941	M	15-18 mainly.	437	R
6. Propit Survey.†	Student Nurses.	London	1935-42	F	17-25 mainly.	2,570	R
7. Griffl (1944)†	Entrants to 1 factory.	Lancs.	1941-44	M F	Various 14+	3,000	M R
8. Brooks (1943, 1944a).	Naval Personnel.	U.K.	1940-43	M	Various 15+	368,000	M R
9. Trail (1942) ..	R.A.F. Personnel.	U.K.	1941-42	M	18-30 mainly.	30,000	M R
10. Clive (1943) ..	W.A.A.F. Personnel.	U.K.	1941-42	F	18-30 mainly.	30,000	M R
11. Present Survey	Employees of 2 factories and Civil Service Personnel.	London area.	1943	M F	Various 14+	21,000	M R

* Refers to primary examination: S = screening (fluoroscopy), M R = miniature radiography, R = full-size radiography. † Personal communication; provisional figures.

(ii) Results: Incidence (per cent.) of Newly-discovered Tuberculous Lesions

Reference.	Sex.	Active.	Inactive.	Doubtful.	Total.	"Treatment."*	"Observation."	Total "Significant."
1. Banszky ..	M	0.33	2.4	0.63	3.4	..	..	..
	F	0.63	3.0	0.53	4.2	..	..	..
	P	0.51	2.8	0.58	3.9	..	..	..
2. Hall ..	P	..	..	..	..	0.3	1.4	1.7
	P	..	..	..	..	0.2	1.2	1.4
3. Stanford and Clark.	F	..	..	..	..	0.5	1.0	1.5
4. Frank and Jacobs.	M	..	..	..	..	0.5	2.1	2.6
5. Gilchrist, Graham and Davies.	F	..	..	..	..	0.2	0.6	0.8
6. Propit Survey	P	..	..	..	..	0.7	0.1	0.8
7. Griffl ..	M	0.47	0.73†		1.20§	..	..	..
8. Brooks ..	M	0.22	0.36†	0.04	0.58	..	..	..
	F	0.34	0.45†	0.12	0.79	..	..	..
11. Present Survey||	M	..	..	..	..	0.4	1.1	1.5
	F	..	..	..	..	0.4	0.9	1.3
	P	..	..	..	..	0.4	0.9	1.3

* The terms "treatment", "observation" and "significant" are here used approximately in the same senses as for the present survey (see pp. 57-63).

† Apparently inactive on initial investigation (including 0.42 per cent. doubtfully inactive, for observation while working, and 0.28 per cent. with arrested lesions, for immediate return to general duties). ‡ Excludes calcified primary lesions and glands.

§ In his most recent analysis of 479,000 male naval personnel, Brooks (1944b) gives the figure for total adult-type pulmonary tuberculosis as 1.27 per cent.; he also gives a total of 0.9 per cent. for 23,000 members of the W.R.N.S.

|| Average of incidences in the three normal groups.

In Table XV the results of 10 surveys have been placed under one of two sets of headings for comparison, so far as possible, with those of the present survey. All the statistics refer to first examinations of the groups concerned, though in some of the surveys periodic re-examinations have followed or are intended to follow (e.g. Nos. 6, 7 and 8).

The method of classification adopted in the three small industrial inquiries made by Hall (screening) and by Stanford and Clark and Griffel (miniature radiography), in the survey of women attending an antenatal clinic by Frank and Jacobs (screening), in the investigation of Welsh boys by Gilchrist, Graham and Davies (full-size radiography), and in the Prophit survey on student nurses (full-size radiography), all allow them to be compared easily with the statistics of the present inquiry. It will be seen from the table that both for "treatment" and "observation" categories the results are fairly similar to ours. The comparatively low figures of the Prophit survey may well be due to the fact that the nurses had already passed through the "sieve" of the ordinary routine preliminary physical examination.

Banszky's industrial figures (screening), and the three sets of Service statistics (miniature radiography), are tabulated under the headings of "active," "inactive" and "doubtful"; this makes comparison with the present survey more difficult. We shall assume that the "active" groups can be compared with our "treatment" group; this is more likely to be so for the Navy figures, which are based upon assessment after initial investigation, than for the Air Force statistics, in which the "active" group appears to include a number of persons considered, after a period of observation, to require institutional treatment—in our classification, these persons would be retained in their initial, "observation" category. If the "active" cases are taken as roughly equivalent to the "treatment" groups, the incidences reported by Banszky, Brooks, Trail and Clive under this heading are of the same order of magnitude as those of the other inquiries tabulated, including our own.

When we come to the "inactive" and "doubtful" groups, we are on less firm ground, and it is not clear how far equation of these groups with our "observation" category is justified. Certainly, the "inactive" and "doubtful" groups together account for some, probably the majority, of the cases that we should have classed as "observation," but possibly they are wider than this; if so, differences in interpretation and range of inclusion of inactive lesions may come into play. Thus Banszky's large incidence of inactive cases apparently includes calcified primary lesions, while these are excluded from the Service figures. Our own procedure has been to ignore, for statistical purposes, cases with lesions considered on initial assessment as definitely inactive (including calcified primary lesions)*; since they require no action, they would be excluded from our observation group.

As regards the total new cases in the Service surveys, in spite of these possible discrepancies and overlapping in the sub-grouping, the evidence suggests that the total incidence of "positives" in the two sets of Air Force figures is genuinely lower than the civilian totals of significant lesions. This indeed is what might have been expected from the facts that these Service personnel are a selected population, and are the survivors of a previous medical examination. In the Navy, previous figures given by Brooks (1943), based on results from 1940 to 1942, also showed low totals; but since 1942 there has been, he states (1944 a), a rise, and the present tabulated totals are very similar to our total of "significant" tuberculosis.

As a commentary on future comparisons of mass radiography findings, we would suggest that a simple administrative classification—based on the action

* The list of diseases suggested for the national scheme includes calcified lesions. The percentage of these lesions detected by miniature radiography will always be considerably less than that by large-film surveys, because the former technique is designed to show non-calcified lesions. The adoption of this technique means that end-on vessels in the hila are of such considerable density that an accurate differentiation between them and calcified glands is not always possible.

taken with regard to the examinee (treatment, observation, etc.) after an initial assessment of his case, will facilitate comparison of results nationally and internationally. This can easily be additional to any classification based upon the findings as such (active, inactive, Ministry of Health group 1, 2, etc.). A disadvantage of our suggestion is that the dividing line between "observation" and "treatment" must be influenced to some extent by the availability of accommodation at the time in the particular country.

B. Mental Hospital Patients

The percentage of mental hospital patients recalled for full-size films was 10.7 and the percentage examined medically was 5.8. These percentages, which are about double the corresponding percentages for the normal groups, reflect both the difficulties of examination and the higher incidence of tuberculous lesions discovered.

The incidence of newly-discovered significant lesions in the Mental Patient Group (data from Table XI) may be compared with the average of the corresponding incidences for the three normal groups:—

TABLE XVI

Incidence of Newly-discovered Significant Tuberculous Lung Lesions.

	<i>Males.</i>		<i>Females.</i>		<i>Persons.</i>	
	<i>Mental Patients.</i>	<i>Average of Normal Groups.</i>	<i>Mental Patients.</i>	<i>Average of Normal Groups.</i>	<i>Mental Patients.</i>	<i>Average of Normal Groups.</i>
<i>All Ages.</i>						
No. examined ..	642	..	922	..	1,564	..
Total cases (per cent.)	4.5	1.5	2.7	1.3	3.5	1.3
Treatment cases alone (per cent.)	1.9	0.4	0.9	0.4	1.3	0.4
<i>Ages 14-34.</i>						
No. examined ..	116	..	88	..	204	..
Total cases (per cent.)	6.0	1.2	3.4	1.5	4.9	1.3
Treatment cases alone (per cent.)	2.6	0.3	1.1	0.5	2.0	0.4

From Table XVI it will be seen that the incidence of total significant cases and of treatment cases alone, both at all ages and ages 14-34, and both for males and for females, is greater in the mental patients than in the normal employed groups surveyed by us. For all ages and both sexes together, the ratio is about 3 to 1.

It is well known that the mental hospital population suffers an excessive incidence of tuberculosis as compared with the general population. In the years preceding the war, the death rate from tuberculosis (all forms) in the County and Borough Mental Hospitals of England and Wales as a whole was between 5 and 10 times that in the general population; in 1941 and 1942 the ratio had risen even higher, because the war-time increase in tuberculosis had been proportionately greater in the mental hospitals than in the general population. Whether the incidence of newly-discovered significant lesions, or that of lesions severe enough to require active treatment, be used as the measure of tuberculosis prevalence in our Mental Hospital Group, the ratio of 3 to 1 is lower than might have been expected from the differential mortality shown in mental hospitals as a whole; however, we have examined only one institution and that one has undoubtedly a high order of administrative efficiency.

Unlike the corresponding figures for the employed groups, the incidence figures for already-diagnosed pulmonary tuberculosis in the Mental Hospital are statistically valuable (males 2.4 per cent., females 0.9 per cent., persons 1.5 per cent.), since this represents the accumulation of cases manifested in the hospital in the past, less those patients who have died. To some degree, the incidence of such cases reflects the routine facilities for diagnosis—in this hospital an X-ray is taken of all patients showing suspicious symptoms, but some hospitals have not even an X-ray plant. On the other hand, since unfortunately we did not examine the majority of the previously-diagnosed cases in this hospital, we do not know how many were active and how many were arrested.

In order to obtain the total tuberculosis incidence in the Mental Hospital, the number of the already-diagnosed cases should probably be added to the number of significant cases discovered by mass radiography. These totals would be—males $4.5 + 2.4 = 6.9$ per cent., females $2.7 + 0.9 = 3.6$ per cent., persons $3.5 + 1.5 = 5.0$ per cent. We cannot compare them with any corresponding figure in the normal groups, as the incidences of previously-diagnosed cases in the latter have little meaning.

The finding of a greater incidence of newly-discovered and of previously-diagnosed cases among males than among females in this Mental Hospital Group has been pointed out (p. 84); and it was stated that the difference for the previously-diagnosed cases was probably significant. The difference between the sums of the previously-diagnosed and newly-discovered cases (i.e. 6.9 per cent. and 3.6 per cent.) is also significant on the χ^2 test. These findings are in agreement with the sex differences in the aggregate tuberculosis mortality of the British mental hospitals, where—at least, in recent years—the male rate has exceeded the female rate both at all ages and in the majority of the constituent age-groups. The greater incidence in males in the hospital surveyed may also be influenced by the fact that much of the male dormitory accommodation is older and less hygienic than the female quarters.

Comparison of the incidences of newly-discovered tuberculous lesions at ages over 35 with those at ages under 35 (not tabulated here) show a decrease with age both among males and females. A similar decline with increasing age in both sexes has been displayed in the statistics of mortality from tuberculosis in the whole mental hospital population in recent years; it contrasts with the differential behaviour of the two sexes in the normal adult population. Thus, both the incidences found in our Office and Factory Groups, and the mortality in the general population, show increases with age for males but decreases for females.

We have only one set of data derived by mass radiography from a British mental hospital with which to compare our results. This is a survey in 1943 of practically the whole of the 2,300 patients at Leavesden L.C.C. Mental Hospital, made by means of miniature radiography (Snell, MacMahon and Heaf, 1943). The hospital contains mainly mentally deficient cases, largely adults. The number of newly-discovered active cases was 36 (1.6 per cent.), and that of cases apparently inactive but requiring close observation was 50 (2.2 per cent.). The total incidence of tuberculosis (active, inactive, and cured), including 37 cases (1.6 per cent.) showing widespread calcification and 12 (0.5 per cent.) active, already-notified cases (contracted at Leavesden), was about 6 per cent., of which total, about 2 per cent. were active. Of these figures, we can compare the 1.6 per cent. new active cases with our 1.3 per cent. new treatment cases, the 2.2 per cent. observation cases with our 2.2 per cent. observation cases, and (but only approximately) the 6 per cent. total incidence of new *plus* already-known cases with our 5 per cent. similar incidence. These approximate comparisons show the results of the two surveys to be similar. (Since the figure of 2 per cent. total incidence of active cases is made up of some of the previously-

notified cases as well as the 1·6 per cent. new cases, and since we did not examine most of the already-diagnosed patients in our mental hospital survey, no further comparison can be made.)

Finally, as a rough generalisation, one might venture to estimate that the beds required to accommodate, segregate and treat tuberculous mental patients—including both those discovered by mass radiography and those already under treatment—would be about 3 per cent. of the total mental hospital bed capacity. This estimate is obtained from the L.C.C. figures and our own, by adding the new active or treatment cases to, say, one third of the observation cases (estimated number requiring treatment later), and to the estimated number of the already-known cases requiring continuation of the treatment being received.

SECTION 13

Previously Diagnosed Pulmonary Tuberculosis Encountered in Industrial Mass Radiography

Our policy in this survey was to ask for all persons who had been, or were at the time, under medical care for tuberculosis to volunteer with the others. At Factory A, almost all such employees were radiographed; at Factory B, the proportion included was unknown; in the Office Group, only about half volunteered but this was partly due to a misunderstanding. In the Mental Hospital, practically all the patients in this category were in the infirmary block, and only those who were ambulatory were included in the survey.

Taking the two factory groups and the office group together (21,000 persons), 56 persons with previously diagnosed pulmonary tuberculosis were called to the medical interview. In addition, 13 cases in this category were recorded, on the basis of their large films, as requiring no new action. Together, these two groups make an aggregate incidence of 0·3 per cent. of the total radiographed. This may be compared with the 1·3 per cent. incidence of newly-discovered significant tuberculosis.

Of the 56 cases interviewed by the medical director of the Unit, 14 were classed as definitely unsatisfactory from the standpoint of their medical or social condition; 30 were apparently cured, or were arrested or quiescent cases satisfactorily under dispensary observation; 12 could not be classified in either of these sub-groups.

The 14 unsatisfactory cases require closer analysis. They included relapses and chronic, still active, cases; 9 of them were found to be bacteriologically positive. Half of these persons had lost touch with their chest clinics, or had had no contact since leaving sanatorium. The majority were thought by us probably to require further sanatorium treatment or surgical interference. In some of the cases, the conditions of work seemed unsuitable, either because of the nature of their job or the hours of work, or because of the danger of their infecting others. Two examples may be given:—

Male aged 55. In sanatorium in 1925, and twice subsequently. Chronic active case with bilateral excavation; sputum infective. Has been employed as foreman 10 years; finds he is well able to do his job but is in contact with 200 operatives under his charge.

Male aged 28. In sanatorium 12 years previously. No contact with clinic since moving 3 years ago. Relapsed case; bilateral chronic disease with excavation; sputum infective. Has been working as moulder for 3 years—60 or more hours weekly; not in contact with many people. Worried and feels he is not holding his own.

These findings draw attention to the problem of already-diagnosed cases of pulmonary tuberculosis in industry, a problem which is apt to be overlooked when interest is centred on the disposal of cases newly-discovered by mass

radiography. The number of these persons is not inconsiderable—the present series represents an aggregate incidence of 0·3 per cent. of those radiographed alone—and there is no doubt that the number has markedly increased with the demand for labour since the war. The great majority are in satisfactory condition and able to do their jobs, though a number of these would probably benefit from some individual adjustments of hours or modifications of their work. For example, if the application of temporary part-time work to persons recently returned from a sanatorium became general, relapses might become less frequent. But the most serious problem lies with the known chronic, still active (and often potentially infective) case, where a person may constitute a danger to his fellow-workers, and where, although able and fit to do useful work and often carrying out a skilled job, he may be suffering from the long hours or unsuitable nature of his work. The problem cannot, however, be separated from that offered by those chronic active cases *newly revealed* by mass radiography surveys in industry, in which treatment is unlikely to produce arrest. This matter will be further discussed in Section 18 (b).

The incidence of known pulmonary tuberculous cases is likely to vary considerably from one industrial establishment to another, since it is dictated as much by the labour situation, and the policy of the firm in regard to taking back tuberculous employees after treatment, as by the rate of production of the disease. We have no other large civilian mass radiography surveys in Britain from which to draw material for comparison with ours, and the question hardly arises in Service surveys.

SECTION 14

Non-tuberculous Lesions Revealed by Mass Radiography

Our policy in this survey was to lay the main emphasis on tuberculosis, and our letters A and C to the patients who were passed as requiring no action, on the basis of their radiographs, conformed to this policy; many persons with non-tuberculous abnormalities were included under this heading. As stated on p. 57, footnote, we did, however, pick out and call to the medical interview persons whose radiographs indicated non-tuberculous changes for which it was thought some useful advice, or further investigation, care or treatment, might be given. Under the procedure of our survey we could not know until the medical interview, whether such a person was already aware that he had a non-tuberculous chest lesion, or whether we had discovered the condition; hence for a substantial number of those interviewed no fresh advice was, in fact, needed—on the other hand, objection was rarely taken to the interview.

It is best to consider the normal survey groups separately from the Mental Hospital Patients. Taking the Office and the two Factory Groups together, 117 non-tuberculous cases were interviewed by the medical director of the Unit. These are subdivided in Table XVII according to the lesions revealed:—

TABLE XVII
*Non-Tuberculous Lesions Revealed by Mass Radiography
(Factories A and B and Office Group)*

Cardio-vascular lesions	32	Atypical pneumonia	5
(rheumatic 16; others* 16)		Thoracic tumours	8†
Bronchiectasis, pulmonary fibrosis, pulmonary collapse	29	Enlarged hilar glands	4‡
Chronic bronchitis, asthma, emphysema	13	Others	26§
			117

* Including 1 coarctation of aorta, 1 aneurysm.

† 2 dermoids, 2 neurofibromata, 1 carcinoma, 1 rib tumour, 1 benign tumour, 1 of unknown aetiology.

‡ Including 2 ? sarcoidosis.

§ Including 2 pneumokoniosis, 2 congenital cystic disease, 1 achalasia of oesophagus, 1 spontaneous pneumothorax.

The Mental Hospital Patients included a remarkably large number of persons with cardiac enlargement, probably of hypertensive origin; these were mainly elderly persons, and they were not selected for medical examination. The group that was so examined comprised 26 patients, including 10 with bronchiectasis, pulmonary fibrosis or pulmonary collapse, and 5 with cardio-vascular lesions.

From this sample, as well as results of other authors, it is clear that mass radiography can filter out many non-tuberculous lesions for further investigation. The extent of its usefulness in this direction cannot be further discussed here.

SECTION 15

Bacteriological Investigation in Mass Radiography

The medical literature already contains a number of reports of bacteriological findings in mass miniature radiography surveys. In the Royal Navy series (see Table XV, p. 90), Brooks reports the identification of tubercle bacilli in 63 per cent. of men showing active tuberculous lung disease; this represents 25 per cent. of the total of adult-type pulmonary tuberculosis discovered, and 0.30 per cent. of the 368,000 men radiographed. The technique of the laboratory procedure is not described. For the Royal Air Force, Trail's data for males provide corresponding percentages for positive sputum in 26 per cent. of active cases, in 10 per cent. of the "total positive" and in 0.06 per cent. of the total 30,000 radiographed; while Clive's figures for females give percentages of 18 per cent., 8 per cent. and 0.06 per cent., respectively (see Table XV). In both these Air Force series, the method was to make direct examinations of films from three specimens of sputum.

More intensive laboratory examinations have been reported by Webster (1943) on recruits from the Australian military forces, and by Bigger (1943) on British Army personnel. In the Australian series, the tests included direct film examination, and the culture of sputum and of gastric contents. Out of 1,548 recruits (male and female) investigated for X-ray abnormalities suggestive of tuberculosis, tubercle bacilli were demonstrated in 24 per cent. Sub-dividing those investigated according to radiographical assessment, there were positives in 54 per cent. of 505 cases of active pulmonary tuberculosis; in 14 per cent. of 237 cases of pulmonary tuberculosis of doubtful activity; in 6 per cent. of 374 cases of old, healed or inactive tuberculosis; and in 9 per cent. of 224 doubtfully tuberculous cases. Of the total of 364 cases bacteriologically positive, direct sputum films accounted for only 65, sputum culture for 107, gastric films for 19 and gastric cultures for 173.

Bigger's series was composed of 20 suspects derived from 5,700 Army personnel examined radiographically. Patients were hospitalised for three or four weeks for investigation, and examinations made of sputum by film (both direct and after concentration) and by culture, and of fasting gastric juice by culture; several specimens were used for each of these tests. With this very thorough procedure, positive findings were obtained in all of 10 cases considered radiologically or clinically to have active disease, and in 3 other cases; this represents an incidence of 100 per cent. of active cases, 65 per cent. of the 20 suspects and 0.2 per cent. of the total radiographed. It was concluded, from these results, that culture both of sputum and of gastric juice was a valuable adjunct to the direct examination of films from sputum, but that sputum concentration was not superior to direct examination. The figures from more extensive miniature radiography surveys undertaken by the Army are not yet available.

In the present survey, we had facilities for the bacteriological examination of sputum and of laryngeal swabs from any of the persons who, by reason of

suspicious appearances shown on their full-size radiographs, had been selected to attend the interview with the medical director of the Unit ; hospitalisation was impracticable, and for this reason we did not consider it feasible to examine fasting gastric contents. The laboratory work was done at the Central Emergency Public Health Laboratory, Oxford, by Dr. A. Q. Wells and Dr. B. Moore.*

The arrangements for sputum investigation were made at the time of the medical interview ; as a rule, only one specimen was obtained. At the laboratory, the direct film was examined (without concentration) and, if typical acid-fast bacilli were demonstrated, the specimen was recorded as positive. In the absence of visible bacilli, the sputum was cultured on Jensen's modification of Loewenstein's medium and on Dorset's egg medium. All cultures showing colonies of acid-fast bacilli were tested for virulence, by inoculation of guinea-pigs ; if the culture was sterile, the sputum was classed as negative.

Laryngeal swabs were taken by the medical director of the Unit. The technique of Nassau (1941) was followed†. At Factory A, one swab was taken and was posted to Oxford where, after the acid-alkali treatment, it was cultured on the charcoal medium described by Nassau ; for the Office Group, two swabs were taken, one (the first or the second in strict alternation) being posted and the other seeded on to the medium on the spot by the medical director and the culture at once posted—the media were both charcoal ; at Factory B and at the Mental Hospital, two swabs were again taken but both were seeded on the spot, one (the first or second in alternation) on the charcoal medium and the other on Jensen's modification of Loewenstein's medium. All positive cultures were tested for virulence by animal inoculation.

In all, 318 of the 22,844 persons radiographed (Factories A and B, Office Group and Mental Patients, but excluding Mental Hospital Staff) were investigated bacteriologically at Oxford. These cases were selected by the medical director, on the basis of X-ray shadows or clinical findings suggestive of significant tuberculosis (as defined previously in this report), from the 584 persons recalled to the medical interview‡. They ranged from cases with gross and obviously active lesions, requiring immediate treatment, to those with smaller, possibly active, lesions considered to require only observation ; and from almost certainly tuberculous cases to those whose lesions were doubtfully tuberculous ; moreover, they included persons with previously diagnosed pulmonary tuberculosis as well as those with lesions discovered by the survey. In fact, almost all persons with shadows suggestive of significant tuberculosis, who were able to provide sputum, had the latter investigated, while laryngeal swabs were taken from the majority of persons with such shadows whether they had expectoration or not. It follows that many, though not all, of those investigated bacteriologically had both sputum and swabs examined.

Results of the investigation are given in Table XVIII :—

* This section has been written with the collaboration of Drs. Wells and Moore.

† A supply of swabs is previously prepared as follows : The last inch or so of a stout wire is spirally twisted, and cotton wool firmly wrapped around it ; the wire is then bent to an angle of about 30 degrees, just beyond the wool (an illustration is given in Nassau's paper) ; the wire is sterilised in a plugged test tube. Just before use, the swab is dipped in sterile distilled water. The patient sits in a chair, and the tongue is drawn forward by the operator by means of a piece of gauze. The operator then passes the swab over the back of the tongue down the larynx until the patient coughs (if no coughing reflex is obtained, the swab is probably in front of the epiglottis or in the upper oesophagus). After a label has been attached to the free end, the swab is placed in a grooved rack in an enamel tray (previously sterilised), which has a metal cover. For cultivation, the wire is straightened with forceps sterilised by flaming, and the swab placed for five minutes in a sterile test tube containing 10 per cent. sulphuric acid, after which it is transferred to a second sterile test tube containing 2 per cent. sodium hydroxide for a further five to eight minutes. The medium is then inoculated by smearing the rotated swab. The foregoing technique of taking the swab is very easy, and is surprisingly well tolerated even by mental patients. Possibly the procedure could be improved as regards effective contact with the laryngeal surface, e.g. by using a laryngeal mirror.

‡ The total of 584 included 143 cases classed as non-tuberculous, few of which were investigated bacteriologically.

TABLE XVIII

Analysis of 318 Cases Investigated Bacteriologically in Present Survey, Showing Relation of Results Obtained by Direct Sputum Film, Sputum Culture, and Laryngeal Swab

	Total Cases Investigated.	Total Cases Positive by any Method.*	Sputum Direct Film—										
			Sputum Direct Film+			Sputum Culture +			Sputum Culture —			No Sputum	
			Swab +	Swab —	No Swab.	Swab +	Swab —	No Swab.	Swab +	Swab —	No Swab.	Swab +	Swab —
Factory A	52	7	0	1	2	0	3	0	0	10	9	1	26
Factory B	88	21	5	7	0	2	2	2	1	21	18	2	28
Office Group	122	30	4	3	1	1	7	2	1	32	6	11	54
Total for Three Employed Groups	262	58	9	11	3	3	12	4	2	63	33	14	108
Mental Patients	56	15	1	0	0	0	1	0	2	20	2	11	19
Total of Survey	318	73	10	11	3	3	13	4	4	83	35	25	127

* These totals are slightly less than those in Tables III, VI and IX, as they exclude the few results obtained from outside laboratories.

It may be seen that of the total of 58 bacteriologically positive by any method in the *Three Employed Groups*, 23 gave positive direct films of sputum ; 35 were negative by direct film but yielded positive sputum or laryngeal swab cultures, i.e. these two methods together added about 150 per cent. to the results obtained by direct examination of the film from a single sputum specimen. Positive sputum cultures (with or without positive laryngeal swab cultures as well) accounted for 19 of these 35 cases, and positive laryngeal swab cultures, with sputum culture negative or no sputum available, accounted for 16. Taking the total of 15 positives from the *Mental Group*, only 1 gave a positive direct film from sputum, while no less than 14 were negative by this method but positive on culture of sputum or laryngeal swab ; 13 of these 14 were accounted for by laryngeal swab cultures, sputum culture being negative or no sputum being produced. From these results, it may be concluded that culture of sputum, and culture of laryngeal swabs, both add substantially to the positive total obtained by direct sputum tests alone.

Further information on the value of the laryngeal swab in the present inquiry can be obtained from this table. Considering all the cases in which both a sputum specimen and a laryngeal swab or swabs were examined from the same patient, we find that only 4 of the 87 in which the sputum was negative by direct film, and also by culture, yielded positive laryngeal swab cultures ; whereas as many as 24 of the 37 sputum-positive cases (film or culture) gave negative laryngeal swab cultures. This suggests that it is hardly worth taking a laryngeal swab if sputum is available. On the other hand, out of 152 cases where no sputum was provided, and in which laryngeal swabs were taken, 25 gave positive results, representing 34 per cent. of the 73 total positives of the survey. Hence laryngeal swabs seem particularly indicated where sputum is absent or unavailable. The success of this application is most evident for the *Mental Group* and for the *Office Group*. *Mental* patients are a notoriously difficult source of sputum for tests, because they tend to swallow it ; while it is stated by such authorities as Trail that women are less likely to produce sputum than men.

The present results of laryngeal swab cultures have been further arranged to compare : (a) first and second swabs from the same patients taken at the same time ; (b) swabs cultivated on the spot and those sent by post before cultivation—both taken from the same patients ; (c) swab cultures made on Jensen's modification of Loewenstein's medium, and cultures made on charcoal medium, both from the same patients. These comparisons of technique are shown in Table XIX :—

TABLE XIX

(a) Comparison of first and second laryngeal swabs from the same 235 persons (Factory B, Office Group and Mental Patients)

1st + 2nd -	1st - 2nd +	1st + 2nd +	1st - 2nd -	Total
14	16	11	194	235

Total positive 1st swab 25/235 = 10.6 per cent.

Total positive 2nd swab 27/235 = 11.5 per cent.

Difference = 0.9 per cent. ; S.E. of difference = 2.9.

Difference < 2 x S.E. of difference and is therefore insignificant.

The comparison indicates that the first of two swabs has no relative advantage or disadvantage over the second, taken on the same occasion.

(b) *Comparison of swabs cultivated on the spot and those sent by post before cultivation, both taken from the same 113 persons (Office Group)*

Total positive "spot" $16/113 = 14.2$ per cent.

Total positive "post" $7/113 = 6.2$ per cent.

Difference = 8.0 per cent.; S.E. of difference = 4.0 .

Difference = $2 \times$ S.E. of difference and is therefore probably significant.

Hence cultivation on the spot can be considered to be preferable to sending the swab through the post.

(c) *Comparison of swabs cultivated on Jensen's modification of Loewenstein's medium and on a charcoal medium, both swabs derived from the same 122 persons (Factory B and Mental Patients)*

Loewenstein + Charcoal -	Loewenstein - Charcoal +	Loewenstein + Charcoal +	Loewenstein - Charcoal -	Total
16	3	5	98	122

Total positive Loewenstein $21/122 = 17.2$ per cent.

Total positive charcoal $8/122 = 6.6$ per cent.

Difference = 10.6 per cent.; S.E. of difference = 4.2 .

Difference = $2\frac{1}{2} \times$ S.E. of difference and is therefore probably significant.

The conclusion is that the Loewenstein modification was more sensitive than the charcoal medium; it has the additional advantage of showing the colonies sooner and more easily than charcoal.

From consideration of the present and previous surveys, it is clear that some attempt at uniformity in bacteriological procedure associated with mass radiography is desirable; there is as yet, however, no agreement as to the best techniques, nor may such agreement be possible without further study and comparison. Provisionally, we would suggest the following as a working basis for investigating cases suspected from radiological or clinical evidence in such surveys:—

- (a) that it is unwise to rely upon a negative result from direct examination of the sputum film alone;
- (b) that culture of sputum should most certainly be done whenever the direct film is negative;
- (c) that laryngeal swabs should, if practicable, be taken in cases where sputum is absent or unavailable—they are thus particularly indicated in groups unlikely to provide sputum specimens easily, e.g. mental patients and possibly some groups of women;
- (d) that laryngeal swabs are probably not worth taking if a satisfactory sputum specimen is available, provided that cultures are done as a routine where direct films are negative;
- (e) that two laryngeal swabs should be taken, and that inoculation of the medium should be done on the spot—for this to be practicable, either the bacteriological laboratory must be near the tuberculosis clinic (for the acid-alkali treatment and cultivation would be wasteful of the time of the clinic personnel), or the patients must be able to attend the laboratory in order to have the swabs taken there;
- (f) on the value of the examination of fasting gastric contents we cannot speak from experience, though other investigators have had successful results (a disadvantage of gastric examination is that hospitalisation

is usually required—though Webster does this test on out-patients).*

We shall present the bacteriological results of this survey as incidences based on the types of case from which they were derived. This has been done (in Table XX) for the Three Employed Groups together, and for the Mental Patients:—

TABLE XX
Incidence of Bacteriologically Positive Cases† in Present Survey
(Data from Tables I-IX)

	Three Normal Employed Groups.			Mental Patients.		
	Total Number.	Bact. +		Total Number.	Bact. +	
		Number.	Per cent.		Number.	Per cent.
Total radiographed	21,280	62	0.29	1,564	17	1.1
Newly-discovered significant Tb. lesions						
(i) treatment cases	79	44	56	20	11	55
(ii) observation cases	198	9	5	34	3	9
Total	277	53	19	54	14	26
Previously diagnosed pulmonary tuberculosis	56	9	16	6	3	(50)

It may be seen from Table XX that positive findings (by any means) among the Employed Groups were obtained in 56 per cent. of treatment cases, in 19 per cent. of total newly-discovered significant tuberculosis and in 0.29 per cent. of the total radiographed; for the Mental Group, the corresponding proportions were 55 per cent., 26 per cent., and 1.1 per cent. We should mention the small but significant numbers of persons (see Table) who, in spite of their positive findings, were recommended by their doctors for observation (in the employed groups, while remaining at work).

Using Tables I-IX, the sex incidences of the bacteriologically-positive cases can be given. Thus for the Three Employed Groups, the 56 per cent. positives among treatment cases in Table XX can be subdivided into 75 per cent. for males and 43 per cent. for females; the 19 per cent. positives among all persons with newly-discovered significant lesions is made up of 26 per cent. for males and 14 per cent. for females; and the 0.29 per cent. positive among the total radiographed can be broken up into 0.44 per cent. for males and 0.19 per cent. for females. For the Mental Group, the 55 per cent. in Table XX can be subdivided into 67 per cent. for males and 33 per cent. for females; the 26 per cent. is made up of 33 per cent. for males and 12 per cent. for females; and the 1.1 per cent. can be broken up into 2.2 per cent. for males and 0.3 per cent. for females. Hence the incidence of bacteriologically positive findings is consistently higher among the males than among the females; part of this difference may be due to a greater difficulty in obtaining sputum specimens from women.

* Dr. A. G. Hounslow, Physician to Clare Hall Hospital (M.C.C.), gives us the following provisional figures for 99 cases examined culturally by both gastric lavage and laryngeal swab: positive both methods, 18; positive lavage, negative swab, 15; positive swab, negative lavage, 9; negative both methods, 57. Dr. Hounslow concludes that both tests are desirable for accurate work.

† Positive by any method used, i.e. sputum direct film, sputum culture or laryngeal swab culture. The figures for positives exceed slightly those in the previous tables of the present section, since they include a few results from outside laboratories.

Finally, the present incidences in the employed groups may be compared, in Table XXI, with those of the previous surveys mentioned on p. 96, all of which are based on Service personnel:—

TABLE XXI
Comparison of Incidences of Bacteriologically Positive Cases in the Present Survey with those in Previous Surveys

Per Cent. Bacteriologically Positive of :	Author.					Present Survey.
	Brooks.	Trail.	Clive.	Webster.	Bigger.	
Active or "treatment" cases	63	26	18	54	100	56
Total Tb. cases	25	10	8	(24)	65	19
Total radiographed	0.30	0.06	0.06	?	0.2	0.29

The comparisons can be only rough, on account of differences not only in sex-composition but also in the techniques used. It may be seen that the present incidences are similar to those found in the Services by Brooks and Webster, higher than the figures of Trail and Clive, and lower than those in Bigger's small series.

SECTION 16

Symptoms of Mass Radiography Patients, and their bearing on the Value of this Method

Of the 79 "treatment" cases derived from the Three Employed Groups investigated in the present survey, 29 denied any recent symptoms referable to their pulmonary condition. The symptoms admitted in reply to close questioning by the remaining 49* fell within the following categories:—

Respiratory alone (cough with or without sputum, breathlessness, chest pain)	31
Toxaemic alone (lassitude, wasting, amenorrhoea)	3
Respiratory and toxaemic combined	12
Other (haemoptysis, laryngitis)	3

In many of these cases the symptoms were slight in degree, and only 17 of the 49 had consulted medical opinion for such symptoms within the previous six months. In these 17 cases, no diagnosis of tuberculosis had been made, though in 4 of them the private doctor had obtained a specialist opinion. (In 1 further case—not included in this group—a doctor had been consulted within ten days of the mass radiographic examination, i.e. too recently for effective action to have been taken, and in 1 case no information regarding relations with the private doctor was available.) So in only 17 of the total 79 cases did the family doctor have any opportunity of diagnosing tuberculosis, and in the 4 of these where a second opinion had been sought the effort proved abortive.

It may be of interest to give the corresponding figures restricted to the young adult age-group. Out of the total of 30 "treatment" cases aged 14–24, 17 denied any recent symptoms. Those with symptoms thus numbered 13; of this sub-group only 6 had consulted medical opinion for such symptoms recently, and in these the diagnosis had not been made at the consultation.

It has been stated (Toussaint, 1943) that mass radiography of the apparently normal civilian population is a less economical way of case-finding than the *immediate* X-ray examination of general practitioners' patients displaying any of the classical symptoms of phthisis, even in minor form. In a scheme recently set up in Southwark and Bermondsey, by which doctors can have any of their patients with such symptoms easily and rapidly X-rayed, and which has been accompanied by an explanatory booklet to the local practitioners,

* One patient failed to report for the interview with the medical director of the Unit and must therefore be omitted from this analysis.

Toussaint and Pritchard (1944) have detected 3.2 per cent. of active tuberculosis in 2,500 persons X-rayed during 12 months—much of it in an earlier stage than, for instance, the 15 per cent. yield from cases referred by local practitioners under ordinary conditions to the Ealing Chest Clinic operated by one of us. Without disparaging its undoubted merits, such a scheme would clearly have been capable of detecting only 17 of our total 79 "treatment" cases discovered by mass radiography, namely, those in which the persons had symptoms and had also consulted their doctors on account of those symptoms. It is the much larger group without symptoms, or whose symptoms have not brought them to the doctor—but who yet have significant tuberculosis—that mass radiography is designed to reveal; the value of their discovery, from the standpoint of infectivity alone, is shown by the facts that 9 of the present 29 cases without admitted symptoms were bacteriologically positive (7 by laryngeal swabs) and at least 4 others showed cavitation radiographically, while 22 of 32 who had symptoms but had not consulted their doctors were positive and 3 or more others showed evidence of cavitation.

The theoretical basis of Toussaint's thesis is that, in his view, respiratory tuberculosis is a much more acute disease than is generally believed, particularly in adolescents and young adults; "the type of pulmonary tuberculosis which so commonly gives rise to a fatal issue in a short period of time (and which incidentally is responsible for the bulk of admissions to tuberculosis institutions throughout the country) is a disease in which the onset is often sudden and is *not* without symptoms" (Toussaint, 1943). The implication is that even periodic mass radiography will miss many of such cases altogether, or will detect them in a relatively late stage; while many persons passed with normal films will develop serious pulmonary tuberculosis, possibly only a short time afterwards.

While adult tuberculosis is undoubtedly rapidly established in some cases, our findings do not support this as a generalisation. In fact, not many of our "treatment" cases seem to fall into this category. Thus of the 49 patients presenting symptoms, the duration of the latter was as follows:—

	<i>All Ages. 14-24</i>	
Less than 1 month	4	3
1 to 3 months	7	1
3 to 6 months	7	3
6 to 12 months	11	3
1 year or more	20	3
	—	—
	49	13

With regard to the stage of the disease on diagnosis, on reviewing all the treatment cases in the younger age-group (i.e. 30 aged 14-24), we found that the disease was unilateral in nearly two-thirds of these. This, it should be noted, was a result of a single first mass radiography survey on employed persons, whereas it has been generally found that after periodic mass radiography has been established in a stable group, the total rate of appearance of new lesions falls and the relative proportion of early cases rises (see Hart, 1937; Reid, 1940, 1941). Thus, according to Reid, the annual incidence of new cases of clinically significant tuberculosis in employees of the Metropolitan Life Insurance Co., New York, dropped from 0.4 per cent. in 1930 to 0.1 per cent. in 1939 (without any corresponding drop in the incidence among applicants for employment); and twice as many of the cases discovered during this 10-year period were in the minimal as in the advanced stage, in contrast to half as many before this control programme became effective. Nevertheless, as many as 40 per cent. of the 330 cases diagnosed during this decade were detected by radiographs taken in the medical department through a visit initiated by the employee himself on account of symptoms *between* annual routine examinations (though

the proportion found in the earlier stages of the disease was lower in such cases). The supplement to the present report is also of interest in this connection (p. 134).

To conclude, there appears to be a case, in addition to the institution of mass radiography of apparently normal groups of the civilian population (preferably at regular intervals), for the improved organisation of earlier X-ray of symptomatic cases. Indeed, the two services are complementary, for periodic mass radiography should invariably be combined with encouragement and provision of facilities for the immediate examination of any persons who develop symptoms between two routine radiographs. One type of case, however, that will be detected only by mass radiography—and this applies even to single surveys—is the person with unsuspected, possibly infective, chronic disease whose symptoms are insufficient to take him to a doctor.

SECTION 17

Contributions to the Epidemiology of Tuberculosis provided by Mass Radiography

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A. *Economic Factors in Tuberculosis*

The importance of the relationship between the social and economic level of a group and its tuberculosis incidence is generally accepted, but the index of tuberculosis used has necessarily been mainly the mortality rate. Morbidity figures, based on notifications, have been considered too unreliable. Mass radiography provides an opportunity of assessing morbidity more accurately, and of supplying some answer to the question: Does production of tuberculosis in its earlier or less obvious stages have a similar economic relationship to that of mortality from this disease?

The data from industrial surveys are unsatisfactory for this purpose, since the inverted economic pyramid is too narrow for the numbers in the higher grades to be adequate in any one establishment; furthermore, the occupations and working environments of the higher grades are likely to differ too greatly from those of the lower paid staff, to make comparisons of value. Our Office Group, comprising 11,000 personnel of Government Departments, lends itself more easily to such a comparison; the civil service system of grading assists in this, for we had noted the grades of all the volunteers in this group and were able to translate these into salary ranges through information provided by the various establishment officers.

The fact that a substantial proportion (38 per cent.) of those invited in the Office Group did not volunteer is a potential source of error; it does not seem likely, however—taking the various factors into consideration—that the non-volunteers contained a materially different proportion of unsuspected significant tuberculosis from that found among the persons radiographed. Another disadvantage of such an analysis—and one which it would have been quite impracticable to overcome—is that while we know the salary grade of each person at risk, we do not necessarily know the economic position of his or her family. Thus, the family of a junior clerical officer might be better off than that of a member of the senior grade; such inconsistencies might tend to make less evident any inherent relationship between economic conditions and tuberculosis. In spite of these possible disadvantages, an economic analysis of the data from the Office Group was considered worth while.

To see if there was any relation between incidence of newly-discovered tuberculous lesions and economic grade of staff, the latter was divided into four groups: A (£800 or over)—677 persons; B (£800-£350)—1,835 persons; C1 (under £350, office staff)—7,747 persons; C2 (under £350, manual workers)—644 persons; total 10,903 persons.

In Table XXII (i), the total number of cases of significant tuberculosis, and the number of "treatment" cases alone, are shown for each of the four groups. In Table XXII (ii), the incidences of tuberculosis are compared. This cannot be accurately done by using crude percentages, since the sex and age-composition of the different economic groups are dissimilar. The procedure has been, therefore, to compare the observed numbers tuberculous in each economic group with those expected had the particular group been subjected to the sex and age-rates exhibited by the whole population (i.e. all four groups together):—

TABLE XXII

The Incidence of Newly-discovered Significant Tuberculous Lesions in the Office Group, the latter being Subdivided according to Economic Grading

(i)

Economic Group.	Males..			Females.			Persons.		
	Total X-rayed	Total Cases.	Treatment Cases alone.	Total X-rayed	Total Cases.	Treatment Cases alone.	Total X-rayed	Total Cases.	Treatment Cases alone.
A (£800 and over—office staff) ..	647	4	—	30	—	—	677	4	—
B (£800-£350—office staff) ..	1,498	29	5	337	4	2	1,835	33	7
C1 (less than £350—office staff) ..	1,171	17	3	6,576	71	25	7,747	88	28
C2 (less than £350—manual workers)	494	12	6	150	3	—	644	15	6
Total ..	3,810	62	14	7,093	78	27	10,903	140	41

(ii)

Economic Group.	Persons.					
	Total Cases.			Treatment Cases Alone.		
	Observed.	Expected.*	P.†	Observed.	Expected.*	P.†
A	4	11.0	.02 (ps)	—	2.48	> .05 (ns)
B	33	28.9	> .05 (ns)	7	5.96	> .05 (ns)
C1	88	90.9	> .05 (ns)	28	30.13	> .05 (ns)
C2	15	9.2	.05 (ps)	6	2.43	.04 (ps)
Total ..	140	140.0	..	41	41.00	..

* Obtained by applying the percentages tuberculous in each sex and age-group (14-19, etc., from Table VIII) among the whole volunteer population (i.e. all four economic groups together) to the numbers X-rayed in the same sex and age-groups in the economic group under consideration.

† P = the probability of obtaining the observed number from a Poisson series with a mean equal to the expected number, i.e. is a measure of significance. If $P < .01$ the observed number is significantly different from the expected number; if $.05 > P > .01$ this difference is probably significant; if $P > .05$ the difference is regarded as insignificant statistically. These three alternatives are designated (s), (ps), and (ns).

When statistical tests are applied to these comparisons, the results can be expressed as follows: In group A, the highest economic grade, the total incidence of significant tuberculous lesions is lower than that among the whole volunteer population (taking sex and age into account) by an amount that is probably statistically significant; in groups B and C1, the total incidence of significant lesions does not differ statistically from that among the whole volunteer population; while in Group C2, composed of manual workers (cleaners, lift-men, canteen workers, messengers, etc.), both the total incidence of significant lesions and the incidence of "treatment" cases, taken alone, exceed the corresponding incidences among the whole volunteer population by amounts that are probably statistically significant.

The finding of some inverse relationship between incidence of tuberculosis and economic grading is strengthened by the similar inverse relationship with the severity of the lesions found. Thus, when the observed number of treatment cases in each economic group is expressed as a percentage of the corresponding observed total number of cases, the figures are: group A, 0; group B, 21 per cent.; group C1, 32 per cent.; group C2, 40 per cent.*

The present evidence, therefore, suggests that not only mortality from tuberculosis but also the production of this disease, as revealed by mass radiography, is subject to economic influences. On the other hand, there is probably a selective factor operating to draw people into certain of the manual occupations of the Civil Service, and we are therefore unable to assess the significance of this relationship further.

B. *The Factor of Home-contact*

At the time of taking the miniature radiograph, each volunteer in the Office and two Factory Groups surveyed was asked by the Unit clerical staff the question: "Have you had any contact with tuberculosis during the last few years at home or in lodgings?" and the answer "Yes" or "No" was noted on the individual's record card. While this provided only a rough assessment, it was thought that, in a total of 21,000 persons, the information might be of value. Altogether, 406 persons (135 males and 271 females) gave the answer "Yes"; 61 of the males and 190 of the females were aged 14-34.

In Table XXIII the total volunteers (both sexes together) are grouped under the following headings: persons with newly-discovered tuberculous lesions, total cases and treatment cases alone; persons with previously-diagnosed pulmonary tuberculosis; all other persons. For each group, the number with a recent positive home-contact history is given, both for all ages and for ages 14-34. The incidences of recent home-contact in the different groups are compared roughly by using observed percentage-incidences of those answering "Yes". They are compared more accurately by relating the observed number with positive contact history in each tuberculous group to the number expected if the persons in the particular group were subject to the age-rates (both sexes together) shown by the control group of "all other persons".

From Table XXIII, and judging first from the crude percentages, it may be seen that the incidences of positive history of recent home-contact are distinctly higher in the tuberculous groups than in the control group "all other persons"; the excess is greater among previously-diagnosed than among newly-discovered cases, and it is evident for ages 14-34 as well as for all ages. Judging from the observed and expected numbers (which allow the differing age-composition of the groups to be taken into account), the incidences of recent home-contact

* There might have been a tendency to place under observation (while remaining at work) persons in the higher income groups who, if less favourably situated, would have been recommended treatment; this would tend to favour the relationship found. In actual fact, however, in none of the "observation" cases in groups A and B was economic position the deciding factor in placing them in this category.

both among the persons with newly-discovered lesions and among those with previously diagnosed disease are higher than the incidence among all other persons by amounts which are statistically significant, or, in one instance (ages 14-34), probably significant.

TABLE XXIII

Incidence of History of Recent Home-contact among the Tuberculous Persons in the Three Normal Employed Groups Surveyed

Group.	No. X-rayed.	Contact History Positive.*			P.‡
		Per cent.† Observed.	No. Observed.	No.† Expected.	
<i>All Ages.</i>					
Newly-discovered significant Tb. lesions:					
Total cases	278	6.5	18	5.00	< .01 (s)
Treatment cases alone	80	7.5	6	1.47	< .01 (s)
Previously diagnosed pulm. tub.	69	11.6	8	1.23	< .01 (s)
All other persons	20,933	1.8	380	380.0	..
<i>Ages 14-34.</i>					
Newly-discovered significant Tb. lesions:					
Total cases	150	6.0	9	3.05	< .01 (s)
Treatment cases alone	50	8.0	4	1.02	.02 (ps)
Previously-diagnosed pulm. tub.	35	17.1	6	0.71	< .01 (s)
All other persons	11,610	2.0	236	236.0	..

* Persons who answered "Yes" to the question: "Have you had any contact with tuberculosis during the past few years at home or in lodgings?"

† Obtained by rating the numbers observed giving positive contact histories on the numbers X-rayed.

‡ Obtained by applying the percentages with positive home-contact history in the different age-groups (14-19, etc., both sexes together) among "All other persons" to the numbers X-rayed in the same age-groups in the particular tuberculous group under consideration.

§ For meaning of P and of the bracketed designations of significance, (s) and (ps), see footnote to Table XXII.

We may conclude, therefore, that previous contact with the disease in the home is probably an important factor in producing both manifest and "radiographical" tuberculosis in employed groups. It is likely, of course, that some of the cases under review have been sources and not recipients in the contact-relationship; while the extent of this cannot be assessed, the fact that an association of home-contact with tuberculosis is evident in younger adult life as well as at all ages among the population surveyed, makes it improbable that the above generalisation as to cause and effect is to be discounted.

C. Group-contact as a Factor

The influence of group-contact, as opposed to home-contact, upon the development of tuberculosis in a given population is, of course, of great importance. From our knowledge of the growing frequency of non-reactors to tuberculin in young adult life, and their susceptibility to tuberculosis when

brought into contact with the disease, we should expect group-contact to be a contributory factor; and direct evidence of this has been supplied by observations varying from those upon hospital nurses under the Prophit (Royal College of Physicians) Survey (Daniels, 1944) to those upon institutionalized mental defectives exposed to known active tuberculosis (Plunkett, Weber, Siegal and Donk, 1940). These are "dynamic" studies, accompanied by tuberculin tests and X-rays over a number of years. The "static" assessment of group-infection, using single mass radiography surveys, and without opportunities for tuberculin testing, is much less satisfactory; but, since many opportunities will be afforded in due course in this country, a trial has been made using our present very limited material. While the findings are not statistically significant, owing partly to the small numbers, they are sufficiently suggestive to be of interest and may serve as a guide to other clinical-statistical work of this kind.

No analysis of the effect of group-contact could be carried out for Factory B or the Office Group; in neither instance was the percentage of volunteers considered adequate, nor in Factory B had we details which would allow us to delineate workshop groupings with precision. On the other hand, the cases and ward populations in the mental hospital could be accurately located; while since Factory A was highly departmentalised and we had noted each individual's department on his record card, we could map out on the factory blue-prints the infective cases and the groups at risk, taking account of shifts; it should be noted, however, that the departments were not necessarily separated by walls, and, of course, there was mixing, e.g. in the canteen.

A mental hospital offers an opportunity for investigating the spread of infection in a closed community, though, properly speaking, the contact is intermediate between "group-" and "home-contact". For the Mental Hospital investigated, we have tabulated the figures in Table XXIV:—

TABLE XXIV

*Group-contact in a Mental Hospital: Incidence of Newly-discovered Tuberculosis in Wards containing Infective Cases, and no Infective Cases, respectively**

		Males.			Females.		
		Popula- tion.	Total Cases.	Treatment Cases alone.	Popula- tion.	Total Cases.	Treatment Cases alone.
"Infective wards"†	No. .. Per cent.	373 100	18 4.8	4 1.1	286 100	11 3.8	1 0.3
"Non-infective" wards‡	No. .. Per cent.	168 100	2 1.2	0 0	499 100	9 1.8	2 0.4
Infective sources§	No. ..	9	9	8	5	5	5
Total	No. ..	550	29	12	790	25	8

* Infirmary ward and admission wards excluded; this excludes all previously diagnosed cases.

† The 9 male wards and 5 female wards each of which contains one or more "infective sources".

‡ The 6 male and 12 female wards none of which contains an "infective source".

§ One case for each "infective" ward. Actually, 16 male and 5 female cases were considered as potential sources, 11 males and 3 females being bacteriologically positive and 5 males and 2 females being bacteriologically negative but showing definite cavities on the radiograph. A bacteriologically positive finding, or definite excavation without such a finding, forms the criterion of "infective source".

The population of the wards varied between 30 and 60 persons. They consisted of day rooms with attached dormitories, though not always did a patient sleep in the dormitory belonging to his ward. The male and female blocks were separated. The infirmary and also the admission wards, in which the population was unstable, were excluded from the present analysis, leaving for comparison 373 males and 286 females in "infective" wards, and 168 males and 499 females in "non-infective" wards. For the males, the percentage with newly-discovered significant tuberculosis was 4.8 in the "infective", as against 1.2 in the "non-infective" wards, while the corresponding incidences for "treatment" cases alone were 1.1 per cent. and *nil*. On the female side, the differences were less, the corresponding percentages being 3.8 as against 1.8 for total cases and 0.3 and 0.4 for treatment cases. None of these differences between "infective" and "non-infective" wards is statistically significant, even when the varying age-composition of the two sets of wards is taken into account (calculations not shown here). The tendencies are, however, worth noting, as suggesting an influence of contact in the wards with sources of infection on the production of fresh cases among mental patients. The tendency is more evident for the males than for the females, and in this connection it may be recalled that the main male quarters were less satisfactory than the female side in regard to ventilation and structure of building.

In Factory A also, a comparison was made between, on the one hand, the incidence of newly-discovered significant tuberculosis in the aggregate of departments each of which contained one or more potential sources of infection, and, on the other hand, the incidence in those departments in which there were no such cases. The criterion of infectiousness was the excretion of tubercle bacilli or the presence of definite excavation radiologically. The total percentage of cases (both sexes) was 1.7 in the 11 "infective" departments (929 persons) as against 1.1 in the 82 non-infective departments (3,780 persons), while for treatment cases alone the percentages were 0.5 and 0.1, respectively. At ages 14-34, the corresponding percentages were 2.2 and 1.3 for total cases and 0.9 and 0.2 for treatment cases, in infective and non-infective departments, respectively. While there is a consistent tendency for the incidences amongst the persons exposed to infective cases in the factory to be higher than those amongst persons free from such exposure, none of the above differences is statistically significant.

D. *Tuberculosis in relation to Type of Mental Disease and Length of Hospitalisation*

(i) *Relation to Type of Mental Illness.* A particular vulnerability to tuberculosis has been claimed for patients with schizophrenia and dementia praecox by a number of authors. Most of the evidence rests upon mortality statistics and autopsy findings, though we understand that some Scandinavian inquiries have been based upon differential incidence in living patients.

At least one large survey has been made by mass radiography (full-size films). This was carried out by Wicks (1940) on 13,000 patients in Ontario mental hospitals. But while he found that "patients with schizophrenia showed a slightly higher percentage of significant pulmonary tuberculous lesions than those with any other type of mental illness", this excess was based on crude total percentages and no account was taken of sex and age differences in the mental groups. Since the excess found was only slight, it is doubtful, therefore, whether these results can substantiate the claims for selective predisposition.

The material from the present limited survey was tested to see if there was any support for an association between schizophrenia and tuberculosis. (For this suggestion, we are indebted to Professor M. Greenwood and Dr. Aubrey

Lewis.) Considerable difficulty was encountered—and this would apply to most such surveys in this country—owing to the nomenclature commonly used here for mental disorders. As one psychiatrist comments: "This terminology conceals dementia praecox under such classifications as confusional insanity, stupor, dementia and delusional insanity (under which other forms of mental illness also can be classified)". The best we could do was, in co-operation with the Medical Superintendent, to group the patients under four headings, according to the diagnosis recorded on the Board of Control's classification. These groups were: A, Organic Reaction Types (including General Paralysis, Senile Dementia, etc.)—357 patients; B, Schizophrenic Reaction Types (including Dementia Praecox)—528 patients; C, Mental Defectives—221 patients; D, Affective Reaction Types (including Manic-Depressive Psychosis, etc.)—454 patients; total (excluding 4 patients classed as Psychoneuroses)—1,560 patients.

Tests were made to see whether the incidences of newly-discovered tuberculosis in any of the four groups of mental illness differed from that in the whole patient population. In order to take into account the age and sex differences in the make-up of the mental groups, the observed numbers tuberculous (total new cases and treatment cases alone) in each of them were compared with the corresponding numbers expected had the persons in that mental group been subject to the tuberculosis sex and age-rates shown by the whole population. The results are given in Table XXV:—

TABLE XXV

Incidence of Newly-discovered Significant Tuberculous Lesions in the Mental Hospital Patient Population, the latter being Subdivided according to Category of Mental Illness

Mental Group.	Total X-rayed.	Total Cases		Treatment Cases alone.	
		Observed.	Expected.*	Observed.	Expected.*
A (Organic Reaction Types)	357	11	10.0	3	3.4
B (Schizophrenic Reaction Types)	528	23	22.4	7	8.7
C (Mental Defectives)	221	11	9.0	6	3.5
D (Affective Reaction Types)	454	9	12.6	4	4.4
Total	1,560	54	54.0	20	20.0

* Obtained by applying the percentages tuberculous in each sex and age-group (14-19, etc., from Table XI) among the whole patient population (i.e. all four mental groups together) to the number X-rayed in the same sex and age-groups in the mental group under consideration.

Note.—None of the observed numbers of total or treatment cases differs significantly from the corresponding expected number; i.e. in all instances $P > .05$ (from Poisson series).

It is found that in none of the mental groups is the incidence of tuberculosis distinguishable statistically from that in the whole population at risk (taking sex and age into account). Indeed, the observed number tuberculous in the schizophrenic group about equals (total cases) or is slightly less than (treatment cases) the expected number. Only the mental defective group has a noticeably higher-than-average incidence, but this excess is insignificant by the tests used. It may be added that the severity of the lesions, as judged by the ratio of new treatment cases to total cases, is also no greater for the schizophrenic than for the other mental groups.

There is, therefore, in this small series no support for the view that schizophrenia carries a selective predisposition to tuberculosis. It may be noted that

at this mental hospital the clinical state of nutrition of the patients appears on the whole to be highly satisfactory, having regard to war difficulties; possibly, were this not the case, differences in tuberculosis rate between schizophrenia and other mental illness might be revealed.

(ii) *Relation to Length of Hospitalisation.* The above data were now re-arranged according to duration of stay in the mental hospital. The new grouping was: I (0-2 years)—339 patients; II (2-10 years)—567 patients; III (10 years and over)—658 patients; total 1564 patients. The incidences of tuberculosis were tabulated in a similar manner to those of the previous table; the method of calculating expected numbers was also similar:—

TABLE XXVI

Incidence of Newly-discovered Tuberculous Lesions in the Mental Hospital Patient Population, the latter being Subdivided according to Length of Stay in the Hospital

Length of Stay in Mental Hospital.	Total X-rayed	Total Cases			Treatment Cases Alone		
		Observed	Expected.*	P.†	Observed.	Expected.*	P.†
I (0-2 years) ..	339	4	12.2	< .01 (s)	2	4.6	> .05 (ns)
II (2-10 years) ..	567	25	21.0	> .05 (ns)	9	7.7	> .05 (ns)
III (10+ years) ..	658	25	20.8	> .05 (ns)	9	7.7	> .05 (ns)
Total	1,564	54	54.0	..	20	20.0	..

* Obtained similarly to expected figures in Table XXV (see its footnote).

† For meaning of P, and of bracketed designations of significance (s) and (ns), see footnote to Table XXII.

From Table XXVI it can be seen that the observed numbers tuberculous in the groups of persons who had been in-patients for 2-10 years or for 10 years or more were slightly greater than the numbers expected, using the whole patient population as standard, but the excess is statistically insignificant. On the other hand, the group of patients who had been in the hospital for less than two years had an incidence of tuberculosis only one-third to one-half of that expected; for total cases, the difference between observed and expected is significant.

The somewhat rapid increase in tuberculosis incidence as between short and prolonged hospitalisation suggests that the mental patients had not imported their tuberculosis but had contracted it within the hospital, presumably through contact with infective cases or through deterioration of resistance. This suggestion may be taken in relation to the analysis of the effect of group-contact in the production of new cases, in sub-section (C), above.

SECTION 18

Associated Problems of Mass Radiography

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Some of the problems arising from mass radiography have already been discussed in Part I of this report, e.g. the questions of secrecy and of public

health notification. There are certain problems, however, which merit special attention and on which, as a result of our experience, we feel we have some useful suggestions to offer.

A. *Financial Allowances*

In 1943, soon after this inquiry began, the Ministry of Health introduced a new scheme of financial allowances for certain categories of persons with tuberculosis; the scheme is administered by the local authorities, and the allowances are payable when the individual leaves work for treatment.

The scheme of allowances was designed to encourage sufferers from tuberculosis to give up remunerative work in order to submit to treatment. "A primary object . . . is to secure diagnosis and treatment at the earliest possible stage, with the twin objects of care of the individual and removal of sources of infection" (Memo. 266/T). It is essentially a war-time measure, having the interests of the national effort in mind, but the provisions of the prospective social insurance scheme will, of course, cover those suffering from tuberculosis.

Clearly, such a scheme is an important adjunct to mass radiography, and it is of interest to see how the 79 cases classed by us as requiring to leave work for institutional treatment—derived from the 21,000 persons examined in the office and factory groups—have fared from its administration. Accordingly, information was obtained early in 1944 from the tuberculosis almoners (welfare officers) of the different local authorities under whose jurisdiction these patients had come. The results are shown in Table XXVII:—

TABLE XXVII

The Eligibility for, and Payment of, Financial Allowances Under Memo 266/T in the 79 "Treatment" Cases from the Three Normal Employed Groups

Died before any action could be taken	1
	— 1
<i>Still Working :</i>	
Did not contact T.O.	3
Refused sanatorium treatment offered by T.O.	6
Not taken off work by T.O. (including chronic cases unlikely to derive permanent benefit from treatment)	11
	— 20
<i>Not Working :</i>	
Did not apply for the allowance	7
Preferred public assistance though eligible	2
	— 9
Ineligible because receiving pay from employer	11
Ineligible because married women	9
Ineligible because single and receiving N.H.I., while in sanatoria, but eligible after discharge pending return to work	13
	— 33
Receiving allowance in sanatoria or at home	16
	— 16
Total "Treatment" cases in Factories A and B and the Office Group	79

It may be seen that 1 person died before a decision could be reached, and that in 20 cases the scheme could not operate because the patients remained at work for one reason or another. This group includes, however, some persons, the chronic condition of whose disease appears to have been the chief reason for this decision (the financial allowances are at present confined to

persons with pulmonary tuberculosis who are considered to have prospects of being restored to normal working capacity).

In 9 cases the patient did not apply for the allowance. Some of these were persons on higher grades of salaries, others would have been eligible; in 2 instances the public assistance allowances were preferred, presumably because they were larger.

In 33 cases the patients were ineligible. Eleven of these were receiving pay from their employers and 9 were married women (the financial allowances scheme ordinarily excludes earning wives whose husbands are not dependent on them.) The remaining 13 cases in this ineligible group were those of unmarried persons who were in sanatoria; they were expected to receive the allowances when they left, if they did not go back to work immediately.

Finally, 16 out of the 79 subjects were receiving allowances at the time of the check-up, some being in sanatoria and others at home and not working.

It is difficult to comment on this small inquiry. Apart from any question of the adequacy of the allowances, the chief categories of workers likely to be discouraged from leaving remunerative work by ineligibility would appear to be chronic active cases, married women, and possibly certain unmarried persons. It is of interest that a recent joint report of the National Association for the Prevention of Tuberculosis and the Committee for the Study of Social Medicine (1944) recommends that the financial allowances should be made available for all notified cases of tuberculosis, and not be restricted to pulmonary tuberculosis where the patient has a prospect of returning to normal work. "This would be a distinct encouragement for chronic tuberculosis patients to accept regular treatment and care," it is stated; and we may add that it would also assist in the success of mass radiography.

B. *Re-employment of the Tuberculous after Treatment*

Restoration of working capacity of tuberculous persons is one of the ultimate objects of mass radiography. It may be helpful to note how those who were detected in our survey have fared. Attention will be confined to the "treatment" cases. Some of these did not, in fact, leave work for institutional treatment, and others, at the time of this follow-up, were still in sanatoria; we have, however, the work-situation of 35 people who had left work after diagnosis and had completed a course of sanatorium or equivalent treatment. The position of this small group in May, 1944, was as follows:—

At home, not yet working, but hoping to resume soon	..	..	9
Retired permanently	..	..	1
Resumed work	..	..	25
			—
			35
			—

Of the 25 who were back at work, all but 1 were with their original employers. Of these 24, 7 were working under similar conditions to those before leaving, 14 had shortened hours or changed rota (e.g. no overtime, no night work), and 3 were on part-time work.

These figures are small, but encouraging so far as they go. They suggest the willingness of the employers in question not only to take back former workers when fit, but also to give facilities for modified working conditions. One may assume that in the majority of the latter instances the modifications are temporary.

Since practically all of this particular little group are in their old employment, no use would have been made of the facilities offered under the Ministry of Labour's Interim Scheme for Training and Re-settlement of Disabled Persons; clearly this scheme, as well as the full Disabled Persons

(Employment) Act, 1944, when in operation, should ordinarily be of great value to cases after treatment.

In considering employment and re-employment of the tuberculous in industry, the Committee on Tuberculosis in War-time (1942) divided them roughly into the "convalescent" non-infective cases and the chronic active cases (*M.R.C. Special Report No. 246*, pp. 21-25). The former present the fewer difficulties: Since the object is arrest of the lesion and restoration of the patients to full capacity, and since they probably carry no danger to their fellows, they may require only temporary shortening of hours or other modification of work, or a temporary phase in a special "rehabilitation" shop, or, in some cases, retraining for new jobs.

With the chronic active and often potentially infective cases, the difficulties of resettlement in suitable work are more formidable. Their problem constitutes a social challenge, for these people, who are fairly numerous in industry, can do and are doing productive work but, when left to find their own level, may harm themselves and others. At present, all a tuberculosis officer can do (short of recommending unemployment and penury) is to give them a course of treatment—if a sanatorium will take them (and they may already have had one or more such courses)—and then return them to work, obtaining such individual modifications of their conditions as can be arranged without too severe a reduction in earnings. It is necessary to steer between ignoring the problem presented by these cases, as often happens at present, and persecuting them. Planned arrangements for provision of suitable work, and at the same time maintaining economic standards, have been recommended by the Committee on Tuberculosis in War-time. The recommendations include the institution of "rehabilitation" or "sheltered" workshops. Some of these, it is suggested, could be in the larger industrial establishments, and others, as separate units on a regional or local basis, could be fed by a number of larger or smaller establishments; suitable systems of payment are an essential concomitant, and the possibility of additional aid such as hostels or "night sanatoria" (on the Russian model) should be borne in mind. We may hope that the Disabled Persons (Employment) Act will provide these facilities as a national responsibility. Mass radiography can be the starting point in their planning.

C. *The Problem of the Non-co-operative Patient*

Our experience has been that once a person has agreed to volunteer for mass radiography, he will generally complete the examination as far as putting himself, if necessary, under medical care. The exceptions to this generalisation were comparatively few, as the following aggregated figures from the three normal groups show.

Out of 1,157 persons recalled for large films, 1,130 attended (in a few instances, the individual spontaneously visited a chest clinic in the interval, the films being available to us), and 494 were asked to the medical interview with the medical director of the Unit. None of the latter failed to attend, and none refused to allow the medical director to communicate the findings to the family doctor or tuberculosis officer, or to arrange for a consultation where necessary. However, 12 persons with significant tuberculous lesions did not carry through such arrangements to be placed under medical care—fortunately, all these were observation cases. It does not, of course, follow that everyone who did consult his doctor or tuberculosis officer was willing to take the advice offered, but this is not the responsibility of the mass radiography Unit, and it may apply equally to cases discovered in the ordinary way.

The other 27 of the 1,157 persons recalled for large films failed to attend. By no means all of these defaults were refusals: a number did not return because of having left the factory, or on account of sickness, transfer, etc.

The miniature films of these 27 subjects were closely scrutinised ; on the basis of this review, 20 were passed as requiring no action and 7 as essential for the medical director to interview. Of these 7 persons, 2 had left and could not be contacted, 1 was away from work owing to illness, and could not be reached, 2 declined to attend the interview and would not have any action taken, and 2 attended the interview but refused any further action. The 7 cases were classified eventually on the evidence available as having significant tuberculosis—2 in the treatment and 5 in the observation category. Hence 7 significant tuberculous cases—2 treatment and 5 observation—were not successfully transferred to medical care ; and in 4 of these cases, the failure was due to refusal to follow the advice of the medical director and to have the information conveyed to the doctor or specialist.

The sum total of the defaults in these two groups is $12 + 7 = 19$ cases of significant tuberculosis, composed of 2 treatment and 17 observation cases, not placed under medical care by the Unit. These figures must be related to the totals of 278 newly-discovered, significant tuberculous cases from the three surveys, made up of 79 persons classed as requiring treatment and 199 needing observation ; the proportions of failures to effect a transfer from the Unit to routine medical care are, thus, 7 per cent., 2·5 per cent. and 8·5 per cent., respectively, in the above three categories.

It is evident that failures to effect the initial contact between the patient and his doctor or tuberculosis officer, due to non-co-operation on the part of the patient, do occur but are relatively uncommon. While it should be the aim of a Unit to reduce these failures to the minimum, it would be lacking in perspective to concentrate on this problem of human behaviour. If, in a group, 10 persons are discovered to need treatment and 1 refuses advice, the group is at least 10 times better off than had there been no investigation. The small gap between the number of persons requiring treatment and the number agreeing to it is likely to be narrowed as mass radiography gains in popularity, and as soon as the economics and rehabilitation of tuberculous patients are placed on a firm basis.

D. *Control of Tuberculosis in Mental Hospitals*

In the Report of the Committee on Tuberculosis in War-time (pp. 27–28) attention was drawn to the tuberculosis problem in mental hospitals and mental deficiency institutions, and some suggestions were made towards reducing the magnitude of this problem. These measures included the periodical X-ray of residents using miniature or full-size radiographs, and the segregation of the active cases so discovered.

Our limited mass radiography survey reinforces this argument. The evidence suggesting that contact with infectious cases in the wards plays a part in the production of new cases—and the finding that tuberculosis incidence rises sharply after a prolonged stay, i.e. that the disease is not, in general, brought in by the patients—serve to emphasise the importance of case-finding ; while the frequent absence of complaints, and lack of production of sputum, among mental patients enhance the value of a diagnostic procedure which is not dictated by symptoms. As an adjunct to routine periodic mass radiography, it would be advisable to X-ray all new entrants, both of staff and patients, and also all patients who do have any suspicious symptoms. The former procedure has now been started at the mental hospital investigated by us ; the latter has been carried out for some years.

On the question of war-time feeding, overcrowding, etc., in relation to the increase of tuberculosis in mental hospitals, our survey provided no information—indeed, this particular hospital has not had its accommodation restricted, though difficulties in ventilation have been accentuated by black-out requirements there, as in other institutions. Deficiencies in ventilation would be

expected to aggravate any tendency for infection to spread through group-contact.

As we have pointed out earlier, persons who develop manifest pulmonary tuberculosis in mental hospitals are usually treated within their own institutions, often in special wards; the numbers of these patients will, of course, be temporarily swelled by the findings of mass radiography. Adequate segregation, however, may sometimes be difficult. Moreover, the experience of other workers indicates that persons with healed lesions may sometimes be kept under special care for tuberculosis unnecessarily long. Thus Snell, MacMahon and Heaf (1943) state that, out of 48 "already notified" cases in a London mental deficiency institution, 19 showed "either no evidence of pulmonary tuberculosis or minimal healed lesions only, and they could be reasonably removed from the tuberculosis wards". Again, Plunkett and Tiffany (1941) write: "experience at three (mental) institutions (in New York State) has revealed that as high as 50 per cent. of inmates isolated in these (tuberculosis) wards may not have clinically significant tuberculosis".

Unfortunately, in our own inquiry, we did not examine the majority of the already-diagnosed tuberculous cases, but clearly a mass radiography survey should always include a review of such cases. Where, as in the L.C.C. hospitals, there is a large aggregate of pulmonary tuberculosis cases in the service, it might be practicable to pool these in one hospital set aside for the purpose; actually, this suggestion was made by an Inspector of the Board of Control nearly twenty years ago (Evans, 1927). In budgeting for space, the possible saving by returning a proportion of healed cases to their ordinary wards should be borne in mind. If we estimate (p. 94) that roughly 3 tuberculosis beds will be required per 100 mental hospital beds already occupied, we should get, from the 30,000 beds of the L.C.C., about 1,000 patients for transfer to the reserved hospital.

We have been impressed by the value of the laryngeal swab for obtaining specimens in mental patients who cannot produce sputum in the ordinary way, and we feel that an extensive trial should be made of this method. If successful, it may well replace examinations of gastric contents in mental hospitals, on account both of efficacy and of ease of manipulation.

There is no attempt here to put forward any comprehensive tuberculosis control programme for mental hospitals, nor have we the authority to do so. The above unco-ordinated suggestions, arising directly from mass radiography surveys, may, however, be of some value. The problem of control in New York State Mental Hospitals has been examined from a similar angle by Plunkett and Tiffany, having in view miniature radiography as the method of case-finding, while the most exhaustive survey of tuberculosis by mass radiography of which we have knowledge (in this case by large films) has been presented by Wicks (1940), based upon 13,000 mental patients in Ontario. All interested in the tuberculosis problem in mental hospitals should read the latter paper, which sets out in detail the arrangements for prevention, early diagnosis and treatment in the mental hospitals of this province, as they have developed during the past decade.

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Appendix I

*Detailed List of Accessories for Mass Radiography, with particular reference to the requirements for Temporary Premises**

- 1 pair Chest Measurement Calipers (*not* pelvimetry type) (see Figs. 11–12).
 - 2 Miniature Film Projectors with 6 spare Lamps (100 or 115 watt) (see Fig. 43).
 - 2 Projector Screens and Supports (preferably designed for easy replacement of matt white projection surface) (see Fig. 44).
 - 2 Viewing Boxes, 17 × 14 in., with 4 spare 100 watt Lamps.
 - 12 Cassettes: 2 (12 × 10 in.), 6 (15 × 12 in.), and 4 (17 × 14 in.)—or 12 of one size.
 - 12 pairs Tungstate Intensifying Screens: e.g. 2 (12 × 10 in.), 6 (15 × 12 in.), and 4 (17 × 14 in.); mounted in the cassettes.
 - 1 sheet Lead, 30 in. × 30 in. × 3 mm., to protect loaded cassettes.
 - 12 sets Lead Figures $\frac{1}{2}$ in., "0–9".
 - 3 sets Alphabet $\frac{1}{2}$ in., "A–Z".
 - 6 each Letters "R" and "L", $\frac{1}{2}$ in.
 - 2 Electric Hot Air Blowers (Hoover) for drying films (to use in dust-free room and particularly for large films) (see Fig. 42). †
 - 1 set Processing Tanks, 17 × 14 in., with wooden base board, 3 gal.
 - 1 extra Washing Tank, 10 gal.; or special Galvanised Iron Tank to take 50 films.
 - 2 extra 3-gal. Tanks.
 - 1 extra Lid (for 3-gal. tank).
 - 1 Watertight Sink (in teak) on a Stand, to take 17 × 14-in. processing tanks (essential when large sink not available on temporary premises) (see Fig. 47).
- (The previous 5 items are intended for setting up a temporary darkroom in a factory, etc. For the home base use a Standard Processing-Unit.)

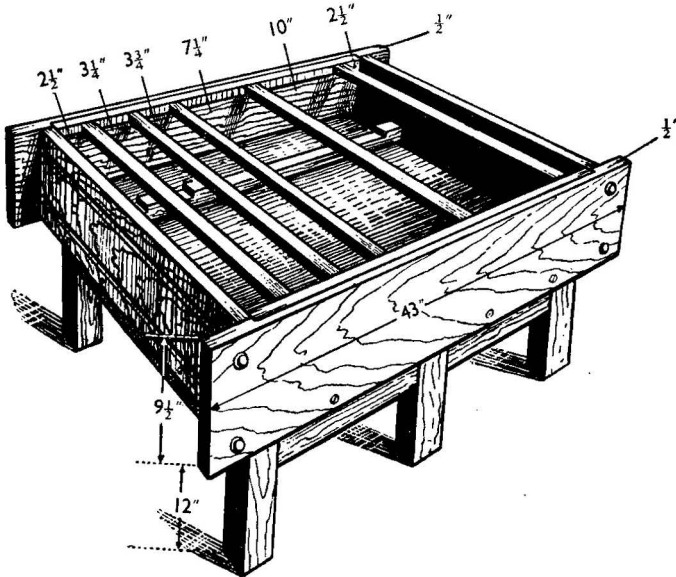


FIG. 47.—Dimensions of mobile teak sink.

- 2 Tank Syphons.
- 9 Daylight Tanks for 35-mm. film, with 6 spare Spirals (see Fig. 3).
- 2 large Frames and 1 Cradle, 17 × 14 in., for developing long lengths of miniature film (may be preferred to small Daylight Tanks) (see Fig. 39).

* The following accessories are additional to those at present supplied by the manufacturer with the apparatus for the National Scheme.

† A mobile drying cabinet will eventually replace the blowers.

- 1 Wet Film Carrier, 17 × 14 in. (takes all sizes).
 - 2 (10 × 8-in.) Processing Dishes.
 - 1 (18 × 16-in.) Processing Dish.
 - 2 Daylight Tank Thermometers.
 - 2 X-ray Tank Thermometers.
 - 1 Darkroom Film Container for unexposed films, to take 12 × 10 in., 15 × 12 in. or 17 × 14 in. films, according to film-size requirements.
 - 1 Light-tight Film Container for exposed films, to take 17 × 14-in. films.
 - 1 Bayonet-type Immersion Heater (600 watts) with spare Element.
 - 1 Timing Clock.
 - 2 X-ray Safelights.
 - 2 Darkroom Lamps; choose best type for this purpose (preferably safelight, opal viewing light and wander light in one for compactness); also 4 spare Bulbs of the wattage recommended with the lamps.
 - 11 doz. Hangers: 4 doz. 17 × 14 in.; 6 doz. 15 × 12 in.; 1 doz. 12 × 10 in. (or according to size of films used).
 - 12 doz. Film Clips (large, X-ray).
 - 3 doz. Dental Film Clips for miniature films.
 - 1 (15 × 12-in.) Radiographic Grid (for special conditions in large film examination requiring a grid).
 - 1 pair Dark Glasses.
 - 1 pair Lead Rubber Gloves.
 - 1 Lead Rubber Apron (to be attached to screen to replace the counterbalance provided by the camera tunnel).
(The previous 3 items are essential for screening for certain positions when taking large films, see footnote to p. 44.)
 - 3 empty 35-mm. Film Tins.
 - 2 Stirring Rods.
 - 2 (1-pint) Graduated Measures, enamelled steel.
 - 2 (2-gal.) Buckets for mixing solutions (with lip if possible; preferably stainless steel).
 - 2 (2-gal.) Jugs.
 - 8 "Winchester" 80-oz. Bottles for stock solutions.
 - 2 Funnels for bottling (6 in., unbreakable).
 - 1 fine Brush for camera.
 - 1 Screen-dusting Brush for cassettes.
 - 1 Tank-cleaning Brush.
 - 1 Darkroom Apron.
 - 1 Bucket and Mop for darkroom.
 - 1 Washleather (fine, for cleaning miniature films).
 - Rubber Tubing (2 yds.) for connection to water tap; with adjustable connections.
 - 1 T-shaped connection for water tap to take 2 pieces of rubber tubing.
 - 3 rolls Adhesive Tape 1 in. wide, linen backed, for X-ray room and darkroom.
 - 1 Filter for water to make up processing solutions and for washing films, particularly miniatures (very necessary when moving from centre to centre, as water supply not always satisfactory). (Metafilter DWF/C is suitable; capacity 30-50 gallons per hour, size 14 × 4 in., weight 5½ lb.; see Fig. 41.)
 - Supply of Powders for filter bed.
 - 1 Wooden Stand for filter (see Fig. 41).
 - 8 Pedestals for guide rope to restrict examinees to area and direction required (see Appendix 2, Figs. 48-51).
 - 1 Ironing Blanket and Cover
 - 1 Electric Iron
 - Soap and Soap Powder
 - 2 Blankets
 - 2 Pillows
 - 2 Kidney Dishes
 - 2 (8-in.) Enamel Bowls, etc.
 - 1 Waste Bucket
- } for laundering chest covers when no laundry available
or when too long delay. (Not required when using
paper chest covers.)
- } for Doctor's Room.
- 2 Electric Multiple Plug Boards, for darkroom and projection room (to save changing plugs on actual equipment and to reduce number of points required, particularly when moving from place to place). The plug-board is about 10 in. square and is fitted with two 5 amp. two-pin sockets, two 5 amp. three-pin sockets, one lamp-holder for bayonet fitting, two fuse holders, and one lead with a plug which can be interchanged as required to suit local conditions.
 - 6 Electric Radiators (usually necessary in winter-time).
 - 4 Table Lamps for clerks (very necessary, to provide concentrated lighting as general lighting often very poor).
 - 1 Reporting Lamp for clerks (see Figs. 34 and 45).
 - 1 Electric Fan (very necessary when working in room with low ceiling).
 - 1 Electric Marking Pencil.

- 1 card each 5 and 10 amp. Fuse Wire.
- 3 Screwdrivers : large, medium and small.
- 1 pair Pliers.
- 1 Oilcan.
- 2 Handlamps, A.R.P. pattern.
- 3 pairs Scissors for X-ray room, darkroom and office.
- 1 Hammer.
- 3 balls Thick Cord, for knotted lines in darkroom when drying large films.
- Rope, 50 yds., for guide ropes, to restrict examinees when passing from one part of examination to another.
- 1 box Tin-tacks.
- 1 box Small Nails.
- 2 Penknives.

Photographic Materials*

Films and Processing Solutions required for the examination of 10,000 subjects.

35-mm. Film for Miniature Radiographs

13 (82-ft.) Lengths on Spools with Keyed Cores.

Films for Large Radiographs (on the basis of 10 for every 100 Miniatures, i.e., 7 per cent. recalls plus additional films for special cases) :—

16 Boxes (72 in each) of X-ray Films, size 12 × 10 in., 15 × 12 in., and/or 17 × 14 in., as required.

Standard Dental Films, e.g., Ilford No. 4 (for protection tests to ensure that the staff is not receiving an overdose of X-radiation) :—

6 doz. (single).

Processing Materials

Developer (as recommended by manufacturers for the particular film used) :—

8 (2-gal.) Tins.

6 (1-gal.) Tins.

Replenisher, 11 (1-gal.) Tins.

Fixing Salts (acid, hardening) :—

12 (2-gal.) Tins.

9 (1-gal.) Tins.

Wetting Agent, 40 oz.

Chemicals for Cooling Solutions (for miniature films) :—

14 lb. Sodium Carbonate (fully hydrated).

14 lb. Ammonium Chloride (fully hydrated).

Cleaning material for miniature films :—

4 oz. Carbon Tetrachloride.

Linen

Staff Overalls.

Towels (for doctor's room and darkroom).

Dusters.

Cleaning Rubbers.

Floor Cloths.

1,000 Examinees' Chest Covers (at least). (85 yds. of 54-in. wide material makes approximately 350; M.R.C. pattern) or

30,000 Paper Chest Covers (new cover for each woman) for one year (see Figs 7-10, and Fig. 46).

Medical Supplies

First Aid Box, etc.

Card dealing with Treatment for Electric Shock, reprinted from "Electric Review".

Barium Cream for oesophageal meal (40 oz. is sufficient for one month).

6 half-pint Mugs for barium.

12 rolls Gauze

6 rolls Cotton Wool

} 3 months' supply { for medical purposes, and for filtering developing solution.

1 Spray for disinfectant (necessary when accommodation limited and many people passing through Unit).

Supply of Disinfectant.

Furniture

Partitions with detachable feet for easy storage :—

18 (4 × 7 ft.)

6 (2 × 7 ft.)

{ (The partitions are sufficient to divide one large room into six small rooms; they are made of "Essex Boarding" on wooden frames and can be hooked together or fastened at the corners with metal angle pieces).

3 Folding Tables (other tables and chairs, etc., usually available at centre, but all furniture would have to be supplied for home base).

* It is convenient to place orders for materials to cover 3-monthly periods.

Furniture—(contd.)

- 1 Base-board for chest stand (to enable subject to be rotated in position for lateral and oblique views). (This will not be required for future apparatus.)
- 1 High Chair for control table operator.
- 1 small "Hook-on" Shelf for attachment to control table (may be supplied with future apparatus).
- 1 large Mirror for dressing room (this is necessary for both men and women).

Carrying Cases for Accessory Equipment

Internal measurements of 19 open boxes, which are sufficient for the transport of all accessories, including darkroom equipment, for use with the mass radiography Unit when moving from place to place and when a fitted darkroom van is not available (see Figs. 1-4) :—

- 14 (19 in. L × 12 in. W × 15 in. D) with 3 in. quartering round upper edge to form rabbet. Hand-carrying slots in each end of box (in quartering). One box partitioned into six equal compartments of approximately 6 × 5½ in.; another divided to give three compartments, 12 × 11½ in., 6½ × 6½ in., and 6½ × 4½ in., respectively.
- 2 (22 in. L × 22 in. W × 25 in. D) without rabbets. Hand-carrying slots at top of each end. One box fitted with lid, the inside of which has suitable fittings for attaching immersion heater, one tank thermometer and two dish thermometers.
- 2 (30 in. L × 24 in. W × 15 in. D) with hand-carrying slots.
- 1 (24 in. L × 15 in. W × 24 in. D) with hand-carrying slots.
- 3 Bench Tops, 4 × 2 ft., to fit over the smaller boxes, so as to make tables (see Fig. 3).

Stationery

- Record Cards (a) Standard Serialised Record Cards supplied by the Ministry of Health (see p. 26).
- (b) Unnumbered and Ungrooved Cards, to be used as temporary "dummies" in place of standard record cards of abnormal cases whilst these cards are with the medical director for follow-up proceedings.

Day Books, male and female.

Large Film Appointment Book.

Large Film Recall Book.

Doctor's Case Sheets or Case Book.

Visitors' Book.

Desk Diary.

Control Table Book, foolscap size.

Note Pads (small).

Blotting Paper.

Indelible Pencils.

Coloured Pencils (Red and Blue, and Yellow X-ray).

Penholders, Nibs and Ink.

White Ink.

Erasers (Ink and Pencil).

Gum.

Rulers.

Clips (Paper and Bulldog).

Stapler and good supply of Staples.

Small Pins.

Rubber Bands.

Facsimile Letters (A) to (D) (see text).

Storage Envelopes, 17 × 14 in.

Postage Envelopes, 17 × 14 in. and 15 × 12 in.

Box Files for letters, etc.

Filing Cabinets or Drawers :—

- (a) two single drawers for unused record cards (male and female);
- (b) several cabinets for filing record cards;
- (c) one cabinet for cards awaiting completion;
- (d) cabinets for rolls of miniature radiographs (see Fig. 35).
- (e) cabinets for large X-ray films, 17 × 14 in.

6 Wastepaper Baskets.

String.

Pencil Sharpeners.

Propaganda and Instructional Photographs.

1 set of Directional Notices (see Appendix 3).

2 Tape Measures.

Chalk.

9 Filing Trays.
 Pencils.
 1 Portable Typewriter.
 Typewriter Carbons, Ribbons, Notepaper, Flimsy Paper, etc.
 1 Magnifying Glass for examining miniature films.
 1 Clock.
 Date Stamps and Pads.
 Name-of-Centre Stamp and Pad.

Appendix 2

Description of Surveys referred to in this Report

Survey 1. (Factory Group A*). The accommodation for this survey consisted of an air raid shelter's canteen, of dimensions 50 × 50 × 7 ft. Adjacent small air raid shelters were used for the doctor's room and for the darkroom. The main floor space was divided into five rooms, as shown on the plan diagram (Fig. 48). The dividing partitions were formed by wooden frames covered with old black-out curtains. The rooms led from one to the other, and had curtains across the openings, which could be looped aside as required. The curtain between the undressing room and the office was permanently in place, but a

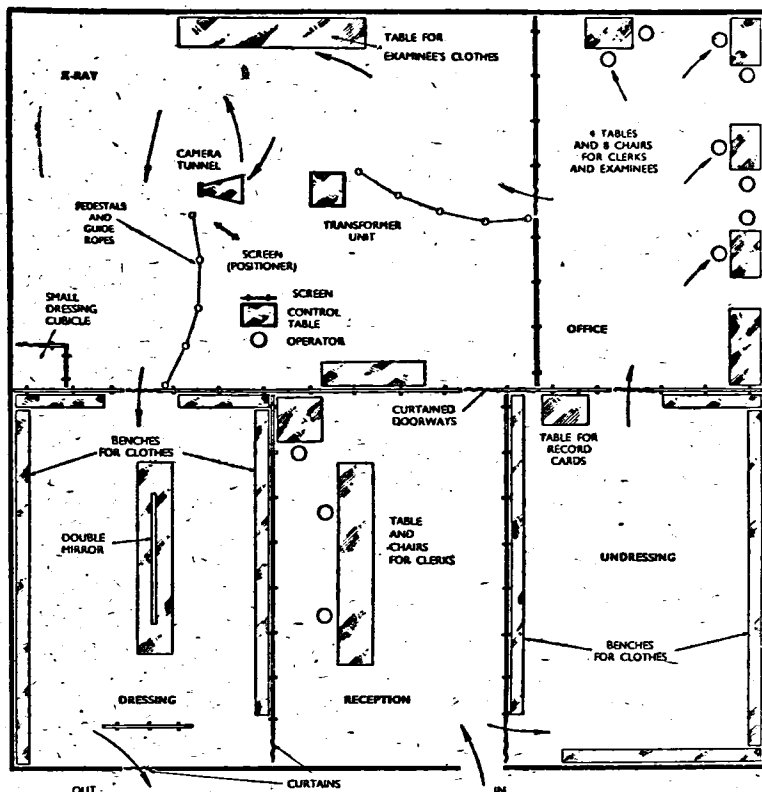


FIG. 48.—Plan of air raid shelter canteen (50 ft. square) adapted for X-ray examination rooms of Survey 1.

diamond-shaped aperture at eye level enabled the examinees to see when to enter the office as one of their number left the latter to pass into the X-ray room. The arrangement could have been improved, to enable the measuring to be done outside the undressing room, and a better plan for a similarly shaped space is shown in the lay-out for Survey 5.

The darkroom was conveniently arranged, although the water supply was some 20 ft. away in the canteen kitchen. The water required special filtering at first, owing to an oily

* See footnote to page 12.

scum, but it improved later. The large kitchen sink was very convenient for making up processing solutions and for washing the films. The difficulty in drying the large number of full-size chest films was overcome by using two hot air driers (Fig. 42); when the floor had been swabbed free of dust, the driers enabled both miniature and large films to be dried quickly and satisfactorily.

Night shift arrangements worked out very well. The two sessions began at 8 p.m. and went on until midnight. There was provision for a midnight meal, and for sleeping accommodation from 1 a.m. For the second night, only a skeleton team proved necessary.

The first week's work comprised 1,100 exposures and showed a very high standard of quality and uniformity; every exposure was acceptable to the radiologist. A careful analysis was made of the results, following which small adjustments were made in exposure technique; and during the second week of 1,400 exposures, again every chest radiograph was acceptable, though an analysis showed 0.5 per cent. to be slightly under-exposed and 1 per cent. slightly over-exposed. These results were considered satisfactory for an initial experience, working to an exposure table based on chest thickness. This survey, comprising 4,720 examinees, was completed in 4 weeks and 4 days (24 working days).

During this survey there were no major technical troubles, although two minor interruptions occurred; a fuse had to be renewed, and the removal of the control table covering proved to be a lengthy process.* Thirty minutes were lost, but although the examinees accumulated during that period, within half an hour the exposures had been speeded up sufficiently for the work to continue normally. The second breakdown was due to the main contact sticking. This occurred at night, and only fifteen minutes were lost.

Survey 2. (Office Group). A series of rooms provided the accommodation, two floors below ground level (Fig. 49). These rooms were quite convenient, but the lack of a complete one-way passage for the examinees entailed more congestion than in Survey 1.

For this survey, an additional room was subdivided by screens, to form cubicles, but most of the examinees preferred the general undressing room, and eventually the cubicles were dispensed with, to provide a second general undressing room.

The darkroom processing conditions were very unsatisfactory, although there was a dry darkroom near the X-ray room for the changing of cassettes. The miniature film darkroom, without water, was on the floor above, with washing arrangements two doors away. Large films had to be developed at the home base, two miles away.

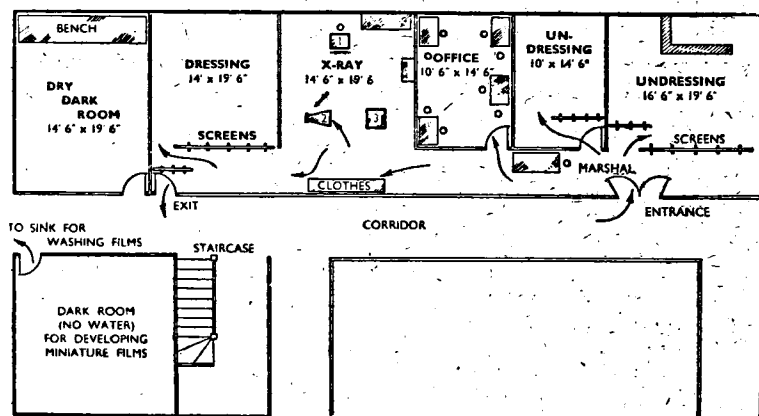


FIG. 49.—Plan of suite of rooms used for Survey 2.

The electric mains supply was three-phase, and the supply company insisted on the use of a 3-1 transformer. A technical breakdown during this survey was due to a loosening of one of the main fuses to the transformer, and it was some time before the trouble was identified. There were more technical troubles at this centre than anywhere else. For the first and only time, it was necessary to send a group of examinees away because of a complete breakdown. On the apparatus being overhauled, certain improvements appeared practicable, and these have since been incorporated into later sets. It was decided from this experience that periodical overhauls should be carried out on each set.

* In later apparatus the covering will be more easily removable.

On the operational side, small mistakes occurred, which, however, since they affected each member of the team in turn, served eventually to increase the general efficiency.

A heat wave occurred during this survey, and it was assumed in the darkroom that, as the temperature of the developer was too high, the usual time-temperature chart for *large films* applied; but on examination of the first lengths of developed film, it was obvious that this did not hold. Although, by reducing the projected screen image to a minimum, a reading was possible, the films were too dark. It was then made a rule that processing must be carried out always at the standard temperature of 65° F. (see p. 46).

This survey of 10,903 subjects was completed in 9 weeks (45 working days).

Survey 3. (Mental Hospital). Accommodation here was arranged in the general X-ray room, and existing electric mains were utilised. Although the "line resistance" was rather higher than is recommended (see the "Operational Instructions"), this did not affect the output of the apparatus (the same was the case in Survey 6 and has been the experience of others, showing that the apparatus has considerable latitude). An electric oven was in action each morning, but this also did not affect unduly the output of the apparatus.

The survey included both mental patients and hospital staff. For the mental patients, the organisation had to be completely different from that obtaining elsewhere. It was clear that there was no object in interviewing the patients. A separate room was therefore set aside for the clerks, and the case notes for a particular session were brought down during the previous session, so that the record cards could be ready. This took rather longer than was anticipated, and, after the first day, the four clerks were fully employed.

It was arranged that, for protection purposes, the hospital staff attending the patients should be changed periodically, as it was anticipated that many of the subjects would need to be held in position. A room was set apart for the patients to undress; and three or four nurses came during each half-day session, one to bring the patients from the wards, another to be in the dressing room, a third to collect the cards from the office to identify the patients, and a fourth to be in the X-ray room. Dental films were provided for both X-ray and nursing personnel, and a careful check made of exposure conditions.

It was soon found, however, that not more than 6 per cent of subjects needed to be held in position, and the assistant matron, who was present with the women patients throughout, soon learned to make use of the protective screens. It was agreed beforehand that it would be quite safe for each of the nursing staff to hold 50 subjects; but as the number needing to be held was so small, the assistant matron was able to continue in the X-ray room throughout the examination of the women. This was very satisfactory, as she knew every patient by name and was able to ensure correct identification of card with patient.

Conditions were not so satisfactory for the male patients. A large ward was used for undressing, and sometimes as many as 150 men were brought down before the session began; this meant that it was difficult to X-ray patients in the order in which they were booked, and the identification of card with patient also ran less smoothly.

Positioning difficulties and results were recorded in the control table book during projection, and an analysis of these records is shown below:—

	Per cent.
Bad position	16
Scapulae overshadowing lung peripheries	10
Taken on expiration	3
Moved	2
A.P. views necessary in place of P.A.	2
Kyphosis	0.5
Impossible to X-ray	1

The hours of work were restricted to the periods when both nurses and patients were available. The numbers were about 300 a day, and it took 2 weeks and 4 days (15 working days) to complete the examination of 1,564 patients and 198 staff.

Survey 4. (Factory Group B). For this survey, it was expected that the apparatus would have to be placed in three different centres within the factory, so as to be near the selected groups of workers. Eventually, however, only two centres were used. These were two, identical, A.R.P. First Aid Posts, which provided ample space (see Fig. 50). The dividing screens consisted of wooden frames 7 feet in height, covered with hessian. The electric mains supply of suitable output was brought in from another building.

There was a floor slope of 2½ degrees towards a central drain in each room; and although at first the apparatus appeared to be working satisfactorily, the tube and screen soon became increasingly difficult to raise and lower, and finally they were almost immovable. Furthermore, as the tube and screen were continually moving out of alignment, the radiographic results were very unsatisfactory. Unfortunately, it so happened that, for the first and only occasion, a very long run of miniatures—1,950 subjects in 4½ days—was completed without projection (our projector could not, for various reasons, be moved from the home base); owing to the difficulties due to the floor level, this run was very poor and resulted in a good many technical recalls. On consulting the factory engineer, it was agreed immediately to lay a concrete slab so as to obtain a level base, after which the results were

quite satisfactory. After three weeks' work the apparatus was moved to the second centre, where another level concrete base had been prepared.

These were the first premises in which there was running water in the darkroom. The sink, however, was not large enough to take the tanks for the 17×14 -inch films, and developing on a table, with the solutions on the films dripping on to the floor, was a messy process. It was very convenient having a "dry" darkroom near the apparatus, for changing the large film cassettes, and an additional large room where the lines for drying large films could remain fixed; this room had an inner cubicle, containing a sink large enough to take the large film washing tanks. The water supply was bad, and all lengths of miniature radiographs showed small particles embedded in the emulsion surface. A woman was provided at this centre to launder the chest covers, the Unit providing soap, electric iron, ironing blanket, etc.

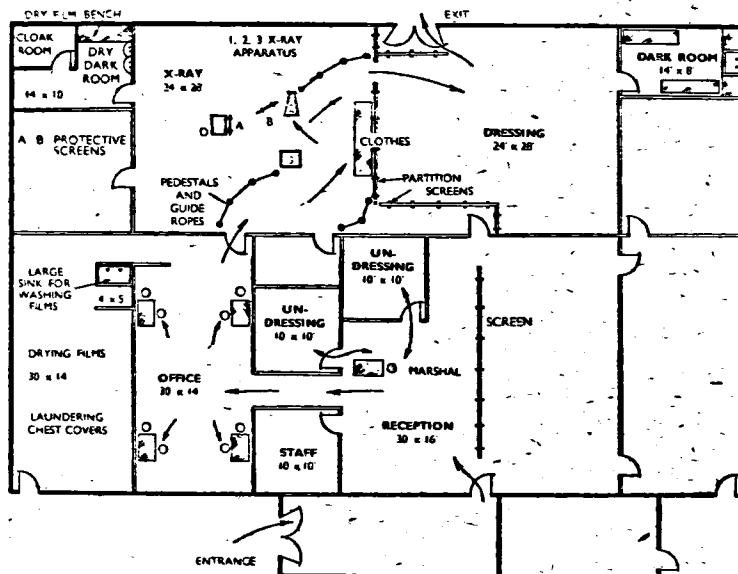


Fig. 50.—Plan of accommodation in A.R.P. First Aid Post and Gas Cleansing Station used for Survey 4.

There was considerable sickness among our staff during this survey, and a relief radiographer was necessary. Also, most of the team had to make long journeys, entailing four to six hours' travelling each day; in addition, a long walk was necessary from gate to X-ray centre, until a car was provided.

During the survey, some of the workers were brought to the centre in very large batches by internal coach transport. The satisfactory accommodation and adequate arrangement of the rooms, however, enabled the marshal to deal with these large numbers, measuring the chests and giving directions without undue difficulty.

Five weeks and 3 days (25 working days) were occupied in completing the examinations of 5,657 subjects at the two centres of this survey.

Survey 5. (Further Office Group). This survey is still in progress. The plan diagram (Fig. 51) shows the arrangement of the floor space, which is in a room comparable with that of Survey 1, except for its height. The similar floor space has been arranged to better advantage than in the earlier survey, so that the marshal can undertake both measuring and reception. A one-way passage for the examinees is maintained. Special partition screens, consisting of light wooden frames covered with grey Essex boarding, hook together to form the separate rooms (see Appendix 1). There is no covering to the doorways, but spare smaller screens can be moved across the openings as required. The work is in daylight, but the room can be darkened for X-ray screen-positioning (in all the other surveys, except Survey 3, artificial light had to be used throughout).

Since the small darkroom has no sink or water supply, a mobile teak sink has been made for the large film developing tanks, and has proved its value. This darkroom is used for all purposes except preparing of solutions and washing of films. It illustrates how even a very small space can be used for temporary darkroom work. The large films are dried towards the end of the day, on lines fastened across the dressing room.

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A small cloakroom, which serves the staff, is used also for washing the miniature films and for making up the developing solutions. The large films are washed in adjacent premises. (The main room used in this survey is shown in Figs. 5-19 and 36-37.)

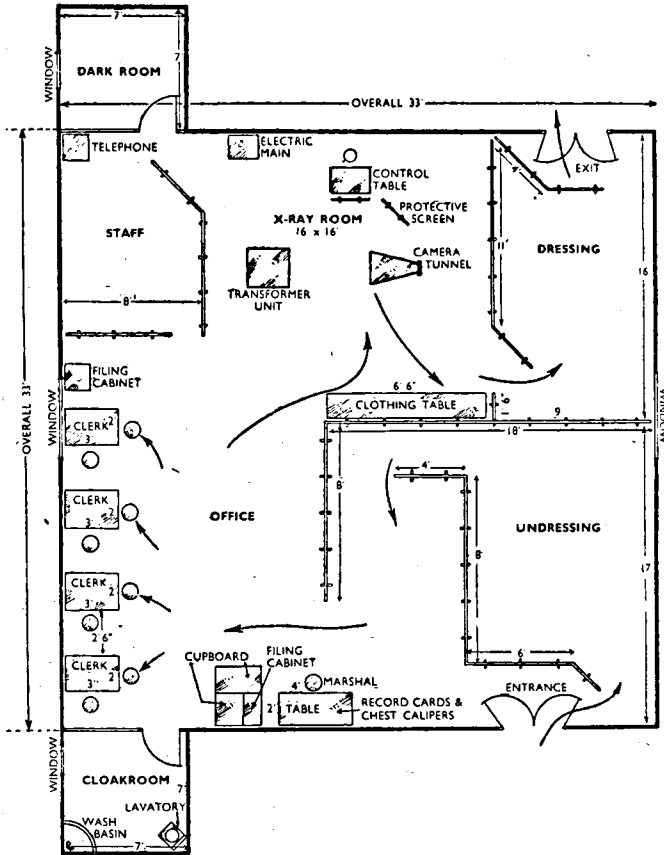


FIG. 51.—Plan of small conference room used for Survey 5.

It was necessary to bring in a new electric cable from the street, and at first the supply company insisted on the full three-phase supply being employed, by the introduction of a 3-1 transformer; but, in view of exposure conditions on the apparatus, the company eventually allowed the apparatus to be connected to one of the three-phase lines for a trial (see p. 14). As there have been no complaints of fluctuations by other users, the arrangement has been permitted to continue.

This survey, embracing the examination of large groups of office workers, is expected to last for a year in the first instance. It is not continuous, but it is being carried out during fortnightly periods at a rate of approximately 1,200 examinations a week. The routine has to be adjusted so as to take in the Ministry of Health's training scheme for mass radiography units.

Survey 6. (Further Factory Group). This factory provided 800 volunteers, and this was the first occasion on which the apparatus was taken to an establishment for so small a group.

A small First Aid Post was used for the survey. The apparatus was introduced on a Monday, and the miniature work was started on the Tuesday. It was completed on the Wednesday, including a late shift that night for the skeleton night shift. Reporting was on the Thursday, and the large films were taken on the following Monday. A few stragglers were dealt with on the next two days, and a small number of volunteers, who had been away ill, were X-rayed on the same apparatus subsequently at the Unit's home base.

The electric mains supply for these premises, and also the water supply, were satisfactory. A small dry darkroom near the X-ray room was used for the changing of cassettes, and the

main developing was done in a nearby fitted darkroom. Travelling for our staff was again excessive, and it was necessary to limit exposure work to from 10.30 a.m. to 4 p.m.

The examination of the 800 subjects (including large film and reporting sessions) was completed during 8 working days.

Appendix 3

Wording suitable for Directional Notices for use by a Mass Radiography Unit

ENTRANCE TO MASS RADIOGRAPHY UNIT (2, large)

WAY OUT ONLY. WAY OUT. X-RAY UNIT (2, large, of each)

ENTRANCE TO UNDRESSING ROOM

TO DRESSING ROOM

TO OFFICE. TO X-RAY ROOM

WOMEN—TAKE YOUR CLOTHES OFF TO THE WAIST, PUT ON A CHEST COVER

MEN AND WOMEN—PUT ON YOUR COATS OR OVERALLS, AND CARRY ALL YOUR CLOTHES WITH YOU ON YOUR LEFT ARMS

MEN—TAKE YOUR CLOTHES OFF TO THE WAIST AND PUT ON YOUR COATS

WOMEN—PLEASE REMOVE ALL NECK ORNAMENTS AND SEE THAT YOUR CORSETS ARE NOT ABOVE WAIST LEVEL

PLACE YOUR CLOTHES ON THIS TABLE AND GIVE YOUR CARD TO THE OPERATOR

DO NOT BEND YOUR CARD (2)

WHEN THE OPERATOR TELLS YOU, TAKE A DEEP BREATH IN AND HOLD IT (2)

IF YOU DO NOT HEAR FROM US WITHIN . . . DAYS, YOU WILL KNOW THAT YOUR CHEST PICTURE IS SATISFACTORY*

ABOUT FIVE OUT OF EVERY HUNDRED VOLUNTEERS WILL BE ASKED TO COME BACK FOR A FULL-SIZE FILM, BUT THIS DOES NOT NECESSARILY MEAN THAT THE CHEST IS OTHER THAN NORMAL (2)

AS YOU APPROACH THE X-RAY MACHINE, PLEASE SEE THAT YOU ARE IN NUMERICAL ORDER AS SHOWN ON YOUR X-RAY CARD (2)

THE RESULT OF THE X-RAY EXAMINATION WILL BE NOTIFIED TO YOU CONFIDENTIALLY (2)

8 Arrows to attach to notices.

Appendix 4

Weekly Time Sheet.

The time attendance sheet (a specimen of which is shown on p. 129) is provided for the factory liaison officer by the X-ray Unit. A rough copy is kept by the Unit's staff. The time sheet enables a record of the group-appointments to be available. The sheets can be printed in quantity, showing only the headings of the columns and the times at five-minute intervals, say, from 9 a.m. to 5 p.m.

The Unit's principals will decide which sessions are to be used for taking miniature and large films, and which are to be set aside for reporting. They will enter these on the time sheet. The actual times of attendance within the miniature sessions will be discussed with the factory liaison officer, after which the Unit's principals will enter these, and also meal-times and other breaks for the team, and periods before and after the actual exposure sessions. Thus, on referring to the specimen sheet, it will be seen that for Monday and Tuesday the following periods are excluded: 9-9.25 a.m., 10.45-11.5 a.m., 12.35-1.40 p.m., 3.5-3.20 p.m. and 4.10-5 p.m. It should be remembered in arranging these periods that each session continues for at least ten minutes after the arrival of the last examinees.

The time sheet is now passed to the factory liaison officer, with the following additional instructions: (1) that only the free five-minute periods are to be utilised; (2) that examinees should be booked at the rate of, say, 10 every five minutes (probably 6 to 8 for initial surveys), the sex to be indicated; (3) that when changing from one sex to another during

* Required only if individual letter A is not used (see p. 30, and p. 31, footnote).

MASS RADIOGRAPHY OF CIVILIANS

a session, there must be a break of ten minutes ; (4) that the appointments for large films, and the arrangements for reporting, will be made by the X-ray Unit staff.

From the specimen sheet, it will be seen that the days' totals are as follows : Monday 547, Tuesday 553 and Thursday 477, and the total for the week is 1,577. It will be seen that it is not always possible to make up the full 10 examinees for a session ; further, that there is a change from men to women on the Thursday morning.

Although these bookings give a satisfactory week's total, it should be remembered that the actual number examined is always somewhat smaller ; it is as well, therefore, to book 10 per cent. in excess of the numbers required.

Finally, the radiographer-in-charge should be able to consult the time sheet from day to day, noting essentials on her rough copy. (See also pp. 15 and 16.)

Weekly Time Sheet.

Survey Group..... Week Ending.....

TIME	MON.	TUES.	WED.	THURS.	FRI.	TIME	MON.	TUES.	WED.	THURS.	FRI.
9.0 ^{AM}						1.0 ^{PM}					
.5	/	/	/	/	/	.5	/	/	/	/	/
.10	/	/	/	/	/	.10	/	/	/	/	/
.15	/	/	/	/	/	.15	/	/	/	/	/
.20	/	/	/	/	/	.20	/	/	/	/	/
.25	/	/	/	/	/	.25	/	/	/	/	/
.30	Women	Women	↑	Men	↑	.30	/	/	/	/	/
.35	10	10		10		.35	/	/	/	/	/
.40	10	10		10		.40	Men	Women	↑	Men	↑
.45	10	10		/		.45	10	10		10	
.50	10	10		Women		.50	10	10		10	
.55	9	10		10		.55	10	10		10	
10.00	10	9		10		2.00	10	10		10	
.5	10	10		10		.5	10	10		10	
.10	10	10		10		.10	10	10		10	
.15	10	10		10		.15	10	8		10	
.20	10	10		10		.20	10	9		9	
.25	10	10		10		.25	10	8		9	
.30	10	10		10		.30	10	10		9	
.35	9	10		/		.35	10	10		9	
.40	9	10		/		.40	10	10		10	
.45	/	/	LARGE FILMS	/	LARGE FILMS	.45	10	10	REPORTING	10	
.50	/	/		/		.50	10	10		10	
.55	/	/		10		.55	10	10		10	
11.00	/	/		10		3.00	10	9		8	
.5		Men		10		.5	/	/	REPORTING	/	REPORTING
.10	10	10	LARGE FILMS	10	LARGE FILMS	.10	/	/		/	
.15	10	10		10		.15	/	/		/	
.20	10	10		10		.20	/	/		/	
.25	10	10		9		.25	10	10	REPORTING	10	REPORTING
.30	10	10		9		.30	10	10		10	
.35	10	10		9		.35	10	10		10	
.40	10	10		10		.40	10	10		10	
.45	10	10	LARGE FILMS	10	LARGE FILMS	.45	10	10		10	
.50	10	10		10		.50	9	10		10	
.55	8	10		10		.55	9	10		10	
12.00	8	10		10		4.00	8	10		10	
.5 ^{PM}	10	10		8		.5	8	10		10	
.10	10	10		8		.10	/	/		/	
.15	10	10		/		.15	/	/		/	
.20	10	10		/		.20	/	/		/	
.25	10	10		/		.25	/	/		/	
.30	10	10		/		.30	/	/		/	
.35	/	/		/		.35	/	/		/	
.40	/	/		/		.40	/	/		/	
.45	/	/		/		.45	/	/		/	
.50	/	/		/		.50	/	/		/	
.55	/	/		/		.55	/	/		/	
TOTAL	303	309		253			244	244		244	

Appendix 5
Darkroom Charts

Chart 1.—Processing Miniature Films

DEVELOPER		FIXER		WETTING BATH	
A (2)	B (2)	C (4)	D (4)	W (10)	
✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✓
A (2)	B (2)				
A (2)	B (2)	C (4)	D (4)		
A (2)	B (2)				
A (2)	B (2)	C (4)			

The above chart serves to record the number of 70-inch lengths of 35-mm. miniature chest film passed through the various processing solutions before renewal is necessary (daylight tank method).

16 oz. of solution are required for each tank. Two lengths of exposed film can be passed through each of the two tanks of developer (marked A and B); four lengths through each tank of fixer (marked C and D); and ten lengths through the wetting bath-tank (marked W).

Each square in the chart represents a length of film. As the lengths of film are passed from tank to tank, ticks are made in the appropriate spaces on the chart.

The processing times recommended are as follows (Ilford H.P.X. Film; Blue Label Developer):—

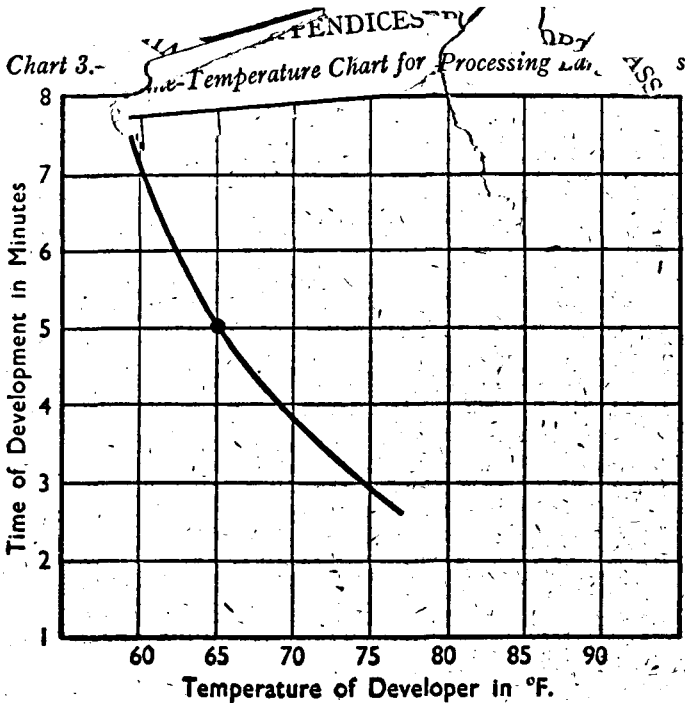
- Develop for 8 minutes at 65°;
- rinse for 10 seconds;
- fix for 10 minutes;
- place in wetting bath for 1 minute
- wash for 20–30 minutes.

(See also p. 46.)

Chart 2.—Processing Large (17×14-inch) Films.

Developer renewed after 550 films using 3 gallons of Replenisher. (Films drained for 10 secs. in Developer.)							Replenisher 20 ozs. added after 22 films.	Rinse (Acid) renewed after 100 films (when used).	Fixer renewed after 150 films.	Wetting Agent renewed after 300 films.	
FILMS DEVELOPED							TOTAL	OZ.			
4	4	4	4	4	4	22	20				
4	4	4	4	4	4	22	20				
4	4	4	4	4	4	22	20				
4	4	4	4	4	4	22	20				
4	4	4	4	4	4	22	20				
4	4	4	4	4	4	22	20	100			
				4	4	22	20	100			
					4	22	20	100			
					4	22	20	100			
4	4	4	4	4	4	22	20				
2	→										
2	4	4	4	4	2	22	20				
4	4	4	4	4	2	22	20				
4	4	4	4	4	2	22	20				
4	4	4	4	4	2	22	20				
4	4	4	2					100			
			2	4	2	22	20		150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	20	100	150	300	
4	4	4	4	4	2	22	3 gals.	100	150	300	
TOTAL FILMS 550							Replenisher	RENEW ALL SOLUTIONS			

The table shows the programme for the processing of 550 films with the necessary intermediate stages of replenishment of developer (22 films), renewal of acid rinse (100 films), renewal of fixer (150 films) and renewal of wetting agent (300 films). For convenience, the films are in units of 4, with a total of 22 in each completed line. When using the chart, the film figures are cancelled as the films are processed, so that the position can be seen at any moment. As each total for replenishment or renewal is reached, these totals are also cancelled. If the chart be covered with celluloid, the figures can be cancelled with grease-pencil on the celluloid. (See also p. 49).



Appendix 6

Suggested Requirements for a Mass Radiography Processing-Unit

Aspecially designed processing-unit for miniature and large films should be in two parts— (a) processing, and (b) washing.

(a) *Processing.* This part of the unit should have temperature controls (thermostat and refrigerator). Means of agitation of the developer should be provided both for miniature and for large films.

Miniature films. Each tank should take 6 ft. of 35-mm. film. Four sets of three tanks serve for developing, rinsing and fixing. There should be six spare spirals.

Large films. These tanks should take up to 17 × 14-inch films. For the developer, one large 6-gal. tank is required, provided with a shallow "divider" to accommodate 4 films on each side. One 3-gal. tank is used for replenisher and one of similar capacity for rinsing; and one 12-gal. tank, with shallow "divider", accommodates 8 films on each side for fixing.

(b) *Washing*

Miniature films. A perforated tray for the film spirals fits into the top of the large film tank. One small tank is required for the wetting agent.

Large films. Provision should be made for one 24-gal. tank, divided into two compartments to take 16 films in each; or, alternatively, two 12-gal. tanks may be used. One 3-gal. tank is required for the wetting agent.

It may be convenient to tabulate the number of tanks needed; the figures should be regarded as minimum requirements:—

Miniature films
14 tanks for 35-mm. film
6 additional spirals

Large films
One 6-gal. tank
Two 3-gal. tanks
One 12-gal. tank
One 24-gal. tank, or
two 12-gal. tanks.

In addition to the above, one master tank will be needed to supply a water jacket for the processing unit, so as to control temperature.

Two timing clocks, reading up to 10 mins., will also be needed.

All water should be passed through a filter.

For the above processing-unit, a drying cabinet is required which can accommodate at least fifty 17 × 14-in. films. It should have a separate compartment for miniature films, taking up to twelve 6-ft. lengths in one day (probably only six lengths will be drying at any one time). A bobbin could be used to suspend the films, in order to halve their length.

Deaths and New Cases of Tuberculosis in Great Britain, 1938-43*

Year.	ENGLAND AND WALES					
	Pulmonary.			Non-pulmonary.		
	Male.	Female.	Total.	Male.	Female.	Total.
	<i>Deaths.</i>					
1938	12,445	8,837	21,282	2,261	1,996	4,257
1939	12,702	8,840	21,542	2,229	1,852	4,081
1940	13,920	9,740	23,660	2,381	2,103	4,484
1941	13,985	9,648	23,633	2,653	2,384	5,037
1942	12,511	8,478	20,989	2,426	2,134	4,560
1943	13,064	8,276	21,340	2,218	2,092	4,310
	<i>Notifications.</i>					
1938	21,302	16,577	37,879	6,511	6,299	12,810
1939	19,695	15,235	34,930	5,660	5,616	11,276
1940	20,988	15,163	36,151	5,272	5,149	10,421
1941	23,147	16,352	39,499	5,819	5,646	11,465
1942	23,623	17,006	40,629	5,937	6,053	11,990
1943†	—	—	42,458	—	—	11,934

* House of Commons, Rep. Parliamentary Debates, June 15, 1944, cols. 2137-8.

† Provisional figures.

Year.	SCOTLAND					
	Pulmonary.			Non-pulmonary.		
	Male.	Female.	Total.	Male.	Female.	Total.
	<i>Deaths.</i>					
1938	1,396	1,185	2,581	435	416	851
1939	1,506	1,211	2,717	411	398	809
1940	1,669	1,368	3,037	486	480	966
1941	1,646	1,471	3,117	516	542	1,057
1942	1,561	1,482	3,043	473	482	955
1943	1,581	1,395	2,976	473	510	983
	<i>Notifications.</i>					
1938	2,603	2,190	4,793	1,369	1,403	2,772
1939	2,432	2,225	4,657	1,202	1,238	2,440
1940	2,720	2,492	5,212	1,240	1,270	2,510
1941	3,002	2,737	5,739	1,255	1,300	2,555
1942	3,272	2,952	6,224	1,342	1,482	2,824
1943	3,730	3,485	7,215	1,408	1,465	2,873

SUPPLEMENTARY REPORT

Re-Investigation of Factory Group A after One Year

By W. Pointon Dick, M.R.C.S., L.R.C.P., *Medical Director,*
Middlesex County Council Mass Radiography Unit

The Middlesex County Council was one of the first local authorities to begin routine mass radiography with its own team under the national scheme. After surveying a number of factories, it was decided to re-investigate, in April 1944, Factory A (which is in Middlesex) under similar conditions to those obtaining during the Medical Research Council survey made one year earlier. The films were examined by Dr. L. G. Blair, radiologist to the Unit, and the writer; and comparability of diagnosis and classification was attained through consultation between members of the M.C.C. and M.R.C. teams, and by interpretations of samples by both.

It may be recalled (p. 71) that the total population available (taking account of absences) at Factory A in March, 1943, was 5,200 of which 4,720 (90 per cent.) were radiographed. During the intervening twelve months the factory personnel had contracted by about 20 per cent. The dispersal of work to other producing units in the same organisation, the available population in April, 1944, was 4,240. Of these, about four-thirds had been there during the earlier survey and one-fifth had been taken on subsequently (to be referred to as "old" and "new" employees, respectively).

The total radiographed was 3,539, which was 83 per cent. of those available. This total may be divided into 2,912 "old" employees, X-rayed in the earlier survey (a volunteer percentage of approximately 90 per cent.); 148 old employees but not previously X-rayed; and 479 new employees, also of course not previously X-rayed (a volunteer percentage of 50 per cent.). The high percentage of the old employees who volunteered to be re-examined is very satisfactory, and stands in contrast with the comparatively low proportion of volunteers among the new employees.

The incidence of newly-discovered, significant tuberculous lesions in the different sub-groups in 1944 and, for comparison, the incidence in 1943 (taken from Table I, p. 72) are shown in Table (a).

TABLE (a)

MASS RADIOGRAPHY OF FACTORY GROUP A IN 1943 AND 1944

Group.	Number Radiographed.	Newly-discovered "Significant" Tb. Lesions.		
		"Treatment."	"Observation."	Total.
<i>March, 1943.</i>				
1. Total radiographed ..	4,720	15 (0.3)*	51 (1.1)	66 (1.4)
<i>April, 1944.</i>				
2. Old employees, X-rayed in 1943 ..	2,912	4 (0.1)	18 (0.6)	22†(0.7)
3. Old employees, not X-rayed in 1943 ..	148	0	0	0
4. New employees ..	479	3 (0.6)	5 (1.1)	8 (1.7)
5. Total radiographed ..	3,539	7 (0.2)	23 (0.7)	30 (0.8)

* Bracketed figures are percentages.

† In addition to these newly-discovered lesions in 22 persons negative in 1943, cases were identified of 29 persons whose disease was discovered in the 1943 survey (and who had remained at work under observation or had resumed work after treatment), and of 5 persons whose disease was known prior to the earlier examination.

The significant cases are subdivided into "treatment" (i.e. requiring leave work for sanatorium or home treatment) and "observation" (i.e. requiring out-patient supervision and serial film). These terms are thus used in the same sense as for the M.R.C. survey, and the findings are adequately comparable. Of the 18 "observation" cases derived from the old employees, X-rayed in 1943, 5 were put on reduced hours of work; there was also 1 such case among the new employees.

Table (a) provides some instructive comparisons. We see (row 2) that the incidence of new tuberculosis in 1944, among employees who in 1943 were radiologically negative, is 0.7 per cent., composed of 0.1 per cent. treatment and 0.6 per cent. observation cases. We can compare these figures with the tuberculosis incidence in the 1943 radiographed population (row 1), i.e. 1.4 per cent., composed of 0.3 per cent. treatment and 1.1 per cent. observation cases. (It is assumed that the changes in the factory personnel between 1943 and 1944, resulting in the loss of about 1,800 of the 1943 radiographed employees and their consequent exclusion from the 1944 survey, have not affected comparability.) The 1944 incidence is distinctly less than that of 1943. That this is probably due to the successful recognition of significant cases in the earlier survey and not to a fall of tuberculosis in the general population, is shown by the 1944 incidence among new employees who had been taken on subsequently to the 1943 survey and had therefore not been previously X-rayed (row 4); this incidence is similar to that in 1943. It should be added that 3 of the 4 treatment cases discovered in 1944 among persons found negative in 1943 were unilateral, and that all the 3 cases among the new employees were bilateral.

A supplementary figure of great importance is that for the number of persons who had developed and been diagnosed as suffering from active pulmonary tuberculosis between the March, 1943 and the April, 1944 examinations, having been passed as negative in the former survey. From the information received from the medical and personnel departments of Factory A, we identified 3 such persons, all of whom had left the factory for treatment; all were in the 20-24 age group. The first had a minimal lesion; she was treated at home and then changed to the occupation of post-woman. The second developed a pleural effusion in December, 1943, and was admitted to sanatorium. The third was diagnosed in March, 1944, as having bilateral pulmonary tuberculosis with cavitation and positive sputum, and she was admitted to hospital; she had had symptoms for four months.

The present findings thus illustrate the general experience that second and subsequent routine surveys of a group in periodic mass radiography produce fewer cases than the initial survey; the numbers are not large enough to indicate whether the proportion of favourable cases among those discovered also increases. At the same time, it is clear that propaganda among such a group is essential in order to persuade those who develop relevant symptoms in the interval between two routine examinations to be immediately X-rayed (see p. 104).

While it is reasonable to hope that eventually mass radiography will be repeated periodically, it would seem more economical, from the point of view of case-finding in the meantime, to employ the very limited number of apparatus for single surveys.

The writer wishes to express his thanks to the other members of the Middlesex County Council Mass Radiography Unit for their co-operation in the preparation of this report.