INTERNATIONAL LABOUR OFFICE

IVth INTERNATIONAL CONFERENCE ON PNEUMOCONIOSES
(Bucharest, 27 September - 2 October 1971)

Working Group on the
International Classification of Radiographs
of Pneumoconioses ILO U/C Revision 1971

Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>INTERNATIONAL CLASSIFICATION OF RADIOPHGRAPHS OF PNEUMOCONIOSES</td>
<td>5</td>
</tr>
<tr>
<td>NOTES ON THE USE OF THE CLASSIFICATION</td>
<td>13</td>
</tr>
<tr>
<td>RADIOLOGICAL TECHNIQUE</td>
<td>23</td>
</tr>
<tr>
<td>APPENDIX I - ILO Meeting of Consultants on the International Classification of Radiographs of Pneumoconioses (Geneva, 15-20 December 1968) - List of Participants</td>
<td>27</td>
</tr>
<tr>
<td>APPENDIX II - Members of the Working Party under the Auspices of the Permanent Commission and International Association on Occupational Health's Sub-Committee on Asbestosis</td>
<td>29</td>
</tr>
<tr>
<td>APPENDIX III - Members of the Working Party of Experts Advising ILO and the UICC/Cincinnati Group</td>
<td>31</td>
</tr>
</tbody>
</table>
INTRODUCTION

At the end of 1958 a meeting of experts convened by the International Labour Office examined the question of the classification of radiographs of pneumoconioses with a view to arriving at an international agreement on this matter. They adopted the "international classification of persistent radiological opacities in the lung field provoked by the inhalation of mineral dusts" (Geneva classification, 1958). This classification was illustrated by a set of fourteen radiographs and has since been applied widely throughout the world. Over 900 sets of standard radiographs illustrating the international classification were sold in fifty-five countries.

After ten years the ILO carried out an inquiry among the users of the international classification in order to find out what difficulties if any were encountered in the application of the international classification. It appeared that symbols 2 and 3 were not easily identified and it was suggested to combine them in one symbol of "suspect cases"; the distinction between categories 2 and 3 did not appear sufficiently clear; the order of the symbols was questioned and certain films illustrating the classification were criticised. Requests for a "normal" film in the set of standards were also received.

A working group was set up to assist the Office in the revision of the international classification. It was composed of Dr. Gilson (United Kingdom), Dr. Jarry (France), Professor Vigliani (Italy), and Professor Worth (Federal Republic of Germany).

In order to finalise this preparatory work, done in consultation with the Commission of the European Communities (Coal and Steel Community), a meeting of consultants was convened in Geneva from 16 to 20 December 1968 (see list of participants in Appendix I).

The meeting took note of the considerable preparatory work already carried out by the ILO, the CECA and the Working Group, and defined the aim of its work as follows:

To revise, clarify, and bring up to date the 1958 ILO international classification of radiographs of pneumoconioses. To accomplish this it was decided to:

1 Dr. Jarry and Professor Worth are also members of the Working Group for Radiological Classification established by the Coal and Steel Community (CECA).
(1) provide an improved version of the 1958 ILO classification to be used primarily for clinical purposes, this to be designated as "short classification";

(2) provide an extended classification to be used for epidemiological and other studies of the pneumoconioses due to all mineral dusts, including, for example, asbestos and beryllium, this to be designated as "extended classification";

(3) provide clear instruction for the use of the classification.

This meeting led to the publication of Occupational Safety and Health pamphlet No. 22 by ILO in 1970, and to the distribution of sets of standard films of this revision illustrating the "short classification", but a full set of the standard films illustrating the "extended classification" was not available.

Subsequent to the meeting in 1968 in Geneva details of the UICC/Cincinnati classification were published in Chest (1970, 58, 57). As this classification was essentially an extension of the ILO 1958 scheme and provided a means of classifying films of all types of pneumoconiosis including asbestosis, it seemed highly desirable to achieve an effective synthesis between the ILO 1968 revision and the UICC/Cincinnati 1970 proposals.

This has now been achieved as a result of two international working parties. The first was held in Sardinia in September 1970 under the auspices of the Permanent Commission and International Association on Occupational Health's Subcommittee on Asbestosis (see Appendix II) and, second, a specially convened working party of experts advising ILO and the UICC/Cincinnati group (see Appendix III). This meeting was held at the Medical Research Council Pneumoconiosis Unit, Cardiff on 13-15 April 1971.

The Sardinia meeting reviewed the provisional set of standard films which had been collected and copied for use with the UICC/Cincinnati 1970 classification. A hundred sets of these provisional standards were subsequently distributed towards the end of 1970, principally in the USA and UK, for use pending the completion of further discussions aimed at bringing about full unification of the ILO and the UICC/Cincinnati schemes.

1 The "extended" classification was based on the UICC/Cincinnati classification, which embodied the 12-point scale elaboration of the 1958 ILO classification developed by the National Coal Board, United Kingdom.
Also during the period 1968-70, approximately 900 sets of the ILO 1968 revised classification were ordered by the ILO and dispatched to forty-nine countries.

The joint working party in Cardiff reviewed the considerable body of evidence accumulated since 1968 on the practicability, usefulness, and scientific validity of the UICC/Cincinnati classification. They recommended minor modifications to the classification in the light of this evidence. The meeting then considered the means of achieving full synthesis between the ILO 1968 proposals and the UICC/Cincinnati scheme as modified at the meeting.

The working party unanimously recommended this should be achieved by:

1. A short classification similar to ILO 1968 revision but with the following modifications:
   a. Category Z be omitted;
   b. Categories of small irregular opacities (types "s", "t", "u") of the UICC/Cincinnati scheme be introduced to supplement that used to classify small rounded opacities (types "p", "q" ("m"), "r" ("n").

2. A full classification similar to the ILO 1968 extended scheme but with small modifications as follows:
   a. A modification of the way pleural thickening was classified;
   b. Substituting a single set of additional symbols for the separate "obligatory" and "optional" groups recommended in the ILO 1968 revision.

3. A new set of standard films be collected and copies prepared, including as many of the ILO 1968 and UICC/Cincinnati 1970 provisional set as possible, but subject to requirement to reduce the total number of films to the smallest practical number which would demonstrate the standards required. It was anticipated that to achieve this might mean selection of some new films (but without important change of level) which could be used as standards for more than one feature. The use of photographic reduction of certain standards to make composite films (35 x 35 cm), illustrating several standards, was to be explored.

4. A recommendation was made that the distribution of the new unified classification to be known as the "ILO U/C classification of the radiographic appearances of pneumoconioses 1971" should be undertaken by the ILO if ratified at the Fourth International Conference on Pneumoconiosis to be held at Bucharest in September 1971. The ILO would be responsible for the distribution of the standard films and text.
INTERNATIONAL CLASSIFICATION OF
RADIOGRAPHS OF PNEUMOCONIOSES

Scope of the Classification

International classification of persistent radiological opacities in the lung fields provoked by the inhalation of mineral dusts, including coal and carbon.

Object of the Classification

The objects of the classification are to codify the radiological appearances of pneumoconioses in a simple reproducible manner. The classification does not define pathological entities, or take into account working capacity. The classification does not imply legal definitions of pneumoconiosis for compensation purposes, nor sets or implies a level at which compensation is payable. However, the scheme can be of value in reporting the types and extent of pneumoconiosis in those receiving compensation, and hence international comparability of pneumoconiosis statistics.

SHORT AND FULL CLASSIFICATIONS

These are complementary and fully compatible (see tables 1 and 2).

The short classification is intended for clinical and other uses to which the 1950, 1958, and 1968 (short) ILO classifications have been put. It is fuller than the previous ILO classifications in that it now covers appearances seen in asbestosis and certain other mineral pneumoconioses which were not completely covered by earlier ILO schemes.

The full classification is intended primarily for a complete and semi-quantitative description of the appearances where these are required of all the principal features, including those in the pleura. The classification is likely to be particularly useful for epidemiological studies where the radiographic appearance is to be related to other measurements such as changes in lung function or indices of dust exposure.

The short and full classifications are arranged so that it is possible to use any combination of either to suit particular needs. For example, in coalworkers' pneumoconiosis
where pleural changes are relatively uncommon but a full classification of rounded opacities may be needed, it is possible to use the full classification for the small opacities and the short classification for the pleural changes.

In the interests of international comparability and to assist in the interpretation of publications on pneumoconioses where this classification is used, it is desirable to specify whether the short or full classification was employed; also when using the full classification, whether all the symbols were used systematically or whether only a selection was recorded as present or absent in all films.

**SHORT CLASSIFICATION**

**Symbol 0**:

No radiographic evidence of pneumoconiosis but not necessarily a normal radiograph.

**Rounded Small Opacities**

In the 1958 classification there was an implied relationship between extent and profusion of small opacities (see previous definition of category 1). This has been a cause of ambiguity. In the revised (short) version only "profusion" is to be recorded.2

Small opacities are to be graded in three categories of increasing profusion. When the distribution of small opacities is markedly uneven, as for instance when large opacities, emphysema, or other diseases are also present, the film is classified on an over-all assessment.

- **Category 1.** Rounded small opacities are definitely present but are few in number. In this category rounded small opacities are commonly seen in the upper and middle zones of both lungs, but rarely are seen only in one lung.

- **Category 2.** Rounded small opacities are numerous in both lungs.

---

1 Profusion is defined as the number of opacities per unit area.

2 In the full classification provision is made for recording "profusion" (as in the short version) and "extent" by the number of zones in the lung affected, "upper", "middle", and "lower"; "right" and/or "left".
Category 3. Rounded small opacities are very numerous in both lungs. In this category the normal lung markings are usually obscured.

Types of Rounded Small Opacities

The symbols "p", "m", and "n" are retained. However, because of difficulty for English-speaking people in phonetically distinguishing the symbols "m" and "n", when desired the symbols "q" and "r" are used. Therefore, in the classification "m" and "n" are given in brackets opposite "q" and "r" respectively. This is done to ensure continuity of understanding and comparability in studies and publications in which the symbols "m" and "n" have been used.

The rounded small opacities are classified according to the greatest diameter of the predominant opacities and are denoted by the following symbols:

- p - rounded small opacities up to about 1.5 mm in diameter.
- q - rounded small opacities exceeding about 1.5 mm up to about 3 mm in diameter.
- r - rounded small opacities exceeding about 3 mm up to about 10 mm in diameter.

Irregular Small Opacities

The ILO 1968 revision omitted category "L" but retained "Z" - suspect pneumoconiosis. However, comparative reading trials of coalworkers' pneumoconiosis have shown that films so classified are likely to be at the lower end of several different features and could be better classified with the present full classification which provides a more refined system of notation.

Moreover, it was noted that films showing irregular opacities were generally classified under this heading, variously described as "linear", "honeycomb", "fibrosis", etc. and that there was no provision for grading these opacities. This is the reason why category Z was abandoned and replaced by the category of "small irregular opacities".

The irregular small opacities are graded in the same way as the rounded small opacities.
Category 1. Irregular small opacities definitely present but few in number. The normal lung markings are usually visible.

Category 2. Irregular small opacities numerous. The normal lung markings are usually partly obscured.

Category 3. Irregular small opacities very numerous. The normal lung markings are usually totally obscured.

These irregular small opacities tend to occur in the lower zones of the lungs, especially in asbestos-exposed workers, but may occur in any zone and also in other types of pneumoconiosis - for example, following exposure to diatomite. They are also seen in coalworkers and provide a means of classifying these features.

The variability of shape and width of these opacities makes it impracticable to provide even approximate quantitative sizing as is done with the rounded opacities (see above). Reliance has, therefore, to be placed on visual comparisons with the standard films illustrating the three types and categories of irregular small opacities.

Types of Irregular Small Opacities

The symbols "s", "t", and "u" are used to subdivide the films on the basis of the fineness of the predominant opacities.

s - fine irregular or linear opacities.

t - medium irregular opacities.

u - coarse (blotchy) irregular opacities.

Large Opacities

Category A. An opacity having the greatest diameter of between 1 and 5 cm, or several opacities each greater than 1 cm, the sum of whose greatest diameters does not exceed 5 cm.

Category B. One or more opacities, larger or more numerous than those in category A, whose combined area does not exceed one-third of the right lung field.

Category C. One or more large opacities, whose combined area exceeds one-third of the right lung field.

The background of rounded small opacities shall be specified if possible.
Recommended Additional Symbols

(See also notes on use of classification.)

ax cv ho px
bu di k rl
cb ef od tba
cn em pl tbu
cb es plc
cp hi pq

Miniature Films

When mini-films are used it is of the greatest importance that they be of good quality. The same criteria for classification are to be applied. However, it must be recognised that with these films there may be some reduction in accuracy particularly in the identification of early pneumoconiosis — for example, category 1. Mini-films are unsuitable for use with the full classification.

FULL CLASSIFICATION

This classification is designed to apply to the radiographic changes provoked in the chest by the inhalation of all types of mineral dusts including coal, carbon, asbestos and beryllium and to provide a means of recording more information about these radiographic changes than can be done in the short version.

This is based on the UICC/Cincinnati classification, which embodied the 12 point scale elaboration of the ILO classification, developed by the National Coal Board, United Kingdom, with some modifications.

Both the short and the full classifications are entirely compatible, as can be seen in table 1.

As compared with the short classification, the full classification presents the following features:
Small Opacities

(1) The use of a 12-point scale for classifying small opacities without the need to use extra number of standard films. The instructions are to classify the film in the usual way into one of the four categories 0 to 3, and if, during the process, a neighbouring category is considered as a serious alternative, record this after the formal category. Thus category 2/1 is a film which is category 2, but category 1 was seriously considered as an alternative. The film which is without doubt a category 2, i.e. a mid-category closely similar in profusion to the standard film, would be classified as 2/2. In films within category 0, a subdivision is also possible. Thus, category 0/1 is a film which is category 0, but category 1 was seriously considered. Category 0/0 is a normal film without small opacities. Occasionally films look exceptionally "normal", i.e. there is exceptional clarity of the normal architecture. Provision for these is made by the category 0/-.

(2) The recording of the "extent" by the number of zones in the lung which are affected. Each lung is divided into horizontal thirds: upper, middle and lower zones, which are numbered from 1 to 6 beginning with the right lung.

Large Opacities

(1) The addition of information about the sharpness of outline of the shadows which are divided into "ill" and "well" defined.

Pleural Thickening

(1) Recording of costophrenic angle obliteration.

(2) Recording of thickening of the pleura other than in the costophrenic angle by noting the site, and by grading the width and extent of the shadows.

Diaphragm

(1) The recording of the presence of an ill-defined outline if exceeding in extent that set by a lower limit standard film.
Cardiac Outline

(1) Recording the extent in four grades (0-3) of the loss of sharpness of outline of the cardiac border (shaggy heart).

Pleural Calcification

(1) Recording the site and extent in three grades on the basis of the cumulated length of the shadows.

Standard Films

To illustrate the classification, a set of standard films (listed below) is available from the ILO. To keep the total number of films to the minimum a number have been selected to show more than one standard. In addition, there are three composite films illustrating: (1) large opacities; (2) some of the grades of pleural thickening and calcification; and (3) examples of "eggshell" calcification of the hilar glands and a mesothelioma of the pleura associated with exposure to asbestos.

A majority of the films are taken with standard kV technique and without fixed grids. The reason for this is simply that the films selected come from large collections made in the course of surveys and routine examinations in the past when high kV facilities were not available. In the future it may be possible to collect suitable films for standards taken with alternative techniques as described in the section on "Radiological Technique".

<table>
<thead>
<tr>
<th>Film No.</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>09012</td>
<td>p 1/1</td>
</tr>
<tr>
<td>08928</td>
<td>p 2/2</td>
</tr>
<tr>
<td>316</td>
<td>p 3/3</td>
</tr>
<tr>
<td>09294</td>
<td>q 1/1</td>
</tr>
<tr>
<td>09051</td>
<td>q 2/2</td>
</tr>
<tr>
<td>899</td>
<td>q 3/3</td>
</tr>
<tr>
<td>10064</td>
<td>r 1/1</td>
</tr>
<tr>
<td>4326</td>
<td>r 2/2</td>
</tr>
<tr>
<td>06958</td>
<td>r 3/3</td>
</tr>
<tr>
<td>Film No.</td>
<td>Standard</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>3551</td>
<td>ε 1/1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>ε 2/2</td>
</tr>
<tr>
<td>112</td>
<td>ε 3/3</td>
</tr>
<tr>
<td>27368</td>
<td>t 1/1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>t 2/2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>t 3/3</td>
</tr>
<tr>
<td>44</td>
<td>u 1/1</td>
</tr>
<tr>
<td>45</td>
<td>u 2/2</td>
</tr>
<tr>
<td>1969</td>
<td>u 3/3</td>
</tr>
<tr>
<td>3802</td>
<td>Normal</td>
</tr>
<tr>
<td>003</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>004</td>
<td></td>
</tr>
<tr>
<td>pq</td>
<td></td>
</tr>
<tr>
<td>391</td>
<td>pleural thickening grade 1</td>
</tr>
<tr>
<td></td>
<td>(lower limit);</td>
</tr>
<tr>
<td>34055</td>
<td>wd A</td>
</tr>
<tr>
<td>0056</td>
<td>wd B</td>
</tr>
<tr>
<td>34069</td>
<td>wd C</td>
</tr>
<tr>
<td>5081</td>
<td>id B</td>
</tr>
<tr>
<td>278</td>
<td>ca (mesothelioma)</td>
</tr>
<tr>
<td>830</td>
<td>co (eggshell calcification)</td>
</tr>
</tbody>
</table>

(Tables I, II and III will be available at the meeting of the Working Group.)
NOTES ON THE USE OF THE CLASSIFICATIONS
(prepared with the assistance of Dr. J.C. Gilson)

Background

The chest radiograph remains the most specific means of diagnosis of pneumoconiosis. It is, therefore, desirable that there is an international system of classification of the radiographs of pneumoconiosis so that statistics of incidence of pneumoconiosis in different countries and industries can be compared and trends of improvement or deterioration detected. The ILO has for forty years taken a lead in assisting in the establishment of an international classification and improving it as new information becomes available.

The scheme recommended in 1950 introduced new principles which have been retained in subsequent revisions. First, the scheme should be descriptive of the radiographic appearances with the minimum of interpretation in terms of other disciplines, such as pathology or function. Second, the classification should accord with the natural history of the types of pneumoconiosis covered. Thirdly, the classification should be tested for observer variation before being recommended.

The revisions made since 1950 have preserved the continuity of the general scheme. Each revision has been built on the experience with the previous one. There has been a widening of the types of pneumoconiosis covered and also more features are covered in greater detail.

The review of the classification made by the ILO Committee of Experts in 1958 showed the basic importance of having a set of standard films to which users could refer in order to ensure uniformity in the application of the classification. Shortly thereafter acceptable copies of a standard set of original radiographs illustrating the 1958 classification were made available by the ILO and largely distributed.

In 1968, taking into account the experience gained in ten years of application of this classification, it was clear that the detail required for some epidemiological purposes where the radiographic appearances were to be related to indices of dust exposure, different aspects of pulmonary function, and other clinical features was more than many clinicians needed. A proposal was, therefore, made for both short and extended classifications (ILO 1968). However, the short and extended schemes in that revision were not fully compatible, but could be made so with small changes. The
1971 revision achieves this and incorporates small improvements in the light of experience with the UICC/Cincinnati scheme over four years.

The increasing interest in the ILO classifications for research and teaching purposes is seen by the numbers of sets of standard films distributed. Between 1950 and 1958 about 25 sets per annum; between 1958 and 1968 about 100 sets per annum; and between 1968 and 1970 about 350 sets per annum.


Category "L" (Linear Opacities)

The standard 1958 film was not though satisfactory by many users; also there was no grading of profusion or extent of these opacities.

The category was omitted from the 1963 revision, but provision was made to cover the features of asbestosis and some other types of pneumoconiosis in the 1968 extended scheme by a category of "irregular small opacities". However, no standard films of these were available for the 1968 extended scheme. The position is now unified. Three categories (1, 2, 3) of irregular small opacities have been introduced into the 1971 short scheme and standard films provided.

Category "Z" (Suspect Pneumoconiosis)

This was present in the 1958 scheme and retained in the 1968 short scheme, when it was thought to be of use to the clinician to describe films with indefinite features - round or linear opacities, pleural changes, enlarged hilar gland, etc. - which might suggest a diagnosis of pneumoconiosis. The limitation of the usefulness of this category was shown in comparative reading trials of coalworkers' pneumoconiosis, by workers in the USA and the UK (Ashford and Enterline, 1966). As a result it was not recommended for use by epidemiologists because films so classified are likely to be at the lower end of several different features and these are, therefore, better classified for each of the features separately. This is readily achieved in the full classification (1971) and can be done adequately on the short 1971 scheme now that the category of irregular small opacities is included.
Small Opacities (Rounded and Irregular)

The 1958 category 1 had been criticised as being too low by some users of the classification. The experts recognised there may be some conflict between the needs of the clinician who wants a category 1 film which was indisputably pneumoconiosis and those of the epidemiologist who would prefer a lower limit standard which would be on the borderline between categories 0 and 1 and would, therefore, be read as category 1 by only half the readers. A decision was taken to select for the 1968 standards a mid-category film which is slightly further up the scale than the 1958 standard (a precise comparison is not possible because the copies of the 1958 films were not as good as those for the 1968 standards). Categories 2 and 3 are retained at about their previous level and should be regarded as mid-category films.

The definitions of the types "p", "m", and "n" are retained with small alterations. First, a recognition of the uncertainty of the sizing (type) is made by the word "about" 1.5 and 3 mm, etc. Second "q" and "r" are suggested as alternatives to "m" and "n" because of the phonetic and written errors when using "m" and "n", but the definitions of "q" and "r" are identical to "m" and "n" respectively.

The classification and grading of features as diverse as those seen in the films of pneumoconiosis must inevitably involve a degree of oversimplification and formalisation of a pattern which may appear rather different to different observers. The rounded small opacities have long been recognised as a feature of certain pneumoconioses, especially silicosis and coalworkers' pneumoconiosis. The size of the opacities in fact varies quite widely in a single film and not all opacities are equally well rounded, but the use of the term "rounded" and an approximate size of the opacities by the symbols "p", "q" ("m"), and "r" ("n") are widely used. Much research has now established the relationships between the type and category of rounded opacities and mortality, morbidity, changes of lung function, and duration of exposure to dust, and dust content and composition in the lung.

Starting with this well-established ILO scheme, the UICC/Cincinnati classification 1970 recommended (Chest, 1970, 58, 57) the addition of a complementary category of "irregular" small opacities to describe those radiographs in which the rib spaces contained shadows which were small, but linear or curved, rather than round. The shadows so classified are not the normal vascular and bronchial markings which contribute to the normal architecture of the lung. They are shadows which are additional to or replacements of the normal pattern. On account of the variation in size and shape of these
irregular opacities they cannot be defined verbally as precisely as the rounded opacities. Inspection of the standard films of category 2 "rounded" and "irregular" opacities shows the marked difference of appearance. In deciding the category of irregular small opacities a decision has to be made on how much of the whole pattern is likely to be the normal lung architecture and how much the "abnormality" to be classified as irregular small opacities. A mental concept of the normal lung pattern is, therefore, necessary (a "normal" film is provided with the standard set). The features included in this group, "irregular small opacities", are those described in other classifications as "linear", "reticular", "honeycomb", "fibrosis", etc. The choice of the term "irregular small opacities" was to contrast them on the one hand with the "rounded opacities" in shape, and on the other hand with the "large opacities" for size.

The irregular small opacity group provides a means of classifying films seen in asbestos workers and in other types of pneumoconiosis where the opacities cannot well be described as "round". Films of this type are also seen in silicosis, mixed dust pneumoconiosis, occasionally in coalminers' pneumoconiosis, and diatomite pneumoconiosis, and other types. The relationship of the severity and extent of these linear shadows and dust exposure, lung function, and mortality is less well established than in the case of rounded opacities, and this was recognised at the time of the 1968 revision, but once a scheme of classification is available information will build up. Some has already been published on asbestos workers.

In the 1958 scheme both profusion (opacities per unit area) and extent (number of rib spaces affected) are used in the definitions of the categories of small opacities. This has been criticised because it makes difficult the classification of films with definite but very sparse small opacities in several rib spaces. The 1968 and 1971 schemes, therefore, define the categories on profusion only. It is not thought that this change of definition will materially alter the level of reading because many observers probably have been using a convention of this type and not sticking quite strictly to the 1958 definition of category 1. No provision is made for recording the extent of the rounded and irregular small opacities in the short classification, but this is done in the full 1968 and 1971 schemes.

Large Opacities

No changes are recommended here, with the exception of the small alteration of the words "longest diameter" to "greatest diameter". This was done to make it clear that the diameter does not have to be measured with any particular relation to the axes of the lung.
Symbols

These were introduced in the 1958 scheme to call attention to other features of the radiograph which might be relevant but were not in the main classification. At that time the experts said, "The classification would be incomplete without a mention of the complications of pneumoconiosis or the other abnormalities seen in the radiographs ... It was also difficult to fix the lower limits of the complications which did deserve mention. For these reasons it was decided that the use of additional symbols should remain optional, but was strongly recommended because, in particular, useful statistical comparisons could be made." Experience since 1958 has shown the value of the symbols. These were extended in number in the US Public Health Service modification of the 1958 ILO scheme. The 1968 revision recommended an obligatory and optional list, but the working group in 1971 preferred a single list with the recommendation that there should be a statement in all publications using this classification on which of the features recorded by symbols were systematically looked for and recorded.

THE EXTENDED 1968 AND FULL 1971 CLASSIFICATIONS

The way the full classification relates to the short version is seen in table 1.

The full classification provides the following extra information compared to the short scheme:

(1) A more detailed statement about the rounded and irregular small opacities. These are categorised on a 12-point instead of a 4-point scale. Also the extent is recorded by noting in which of six zones the opacities occur.

(2) The classification of pleural thickening on the chest wall by site, width, and extent. Also separation of filling of the costophrenic angle from pleural thickening elsewhere.

(3) Classification of pleural calcification by site and extent.

(4) Recording of the presence or absence and extent of changes in the outlines of the diaphragm and cardiac border when the normal sharp outlines become ill defined. The changes in the cardiac outline include the so-called "shaggy heart".
These more detailed features were introduced primarily to enable the ILO 1968 scheme to describe features seen in asbestosis, but the full scheme should not be regarded as useful only for this purpose. Many of the features classified in fact provides a comprehensive scheme for all types of pneumoconiosis. The full classification in fact provides a comprehensive scheme for all types of pneumoconiosis and, though it may appear complex at first sight, most of the features are those which will be noted during the scrutiny of any chest film, and the scheme merely provides (when used with a reading sheet such as in table 3) a convenient way of noting what is observed in a systematic way.

Rounded and Irregular Small Opacities

(See also short classification.)

1) Extent. The six zones of the lung are defined by horizontal lines at one- and two-thirds of the vertical distance from the apex of the lung to the dome of the diaphragm. The extent of the small opacities is recorded by the number of zones affected.

2) Twelve-point scale. To use the 12-point scale of rounded and irregular small opacities is a simple procedure. The instructions are "classify the film in the usual way into one of the four categories 0-3 by comparing with the standard film and, if during this process a neighbouring category is considered a serious alternative, record this after the formal category". Thus, if the film well matches the standard film (which are mid-categories), it will be read as 1/1, 2/2, 3/3. But if the film is decided to be a category 2 but category 1 was considered a serious alternative, the film is recorded as 2/1. There is now good evidence that this procedure does not alter the reading into the formal categories, but does provide more information and reduces the variation in readings between different observers. In practice, the 12-point scale takes no longer to record than the formal categories, and many readers find it easier, as an appropriate place for films on the borderline is provided. It has also been shown that for rounded and irregular opacities the extended scale can be used within category 0. The category 0/0 film is one with no opacities; 0/1 is a film which is less than category 1 but in which category 1 was considered a serious alternative. 0/- are the not very common films where there is exceptional clarity (but not exaggeration) of the normal lung architecture. Such films occur especially, though not exclusively,
The large opacities seen in pneumoconiosis vary in sharpness of outline. No provision is made for recording this in the 1953 scheme. The large opacities seen in asbestosis and in some other types of pneumoconiosis have much less well-defined edges than those which are characteristically seen in silicosis and coalworkers' pneumoconiosis. The extended classification makes provision for recording the outline of the shadow by the symbols "id" (ill defined), "wd" (well defined) after the category. It is possible that the sharpness of the outline may be related to the rate of progression of the shadows; further research on this is needed.

Pleural Thickening

Costophrenic angle. The costophrenic angle is a common site of pleural thickening and the least specifically related to pneumoconiosis. For this reason the full classification records filling of the costophrenic angle separately from pleural thickening in other sites. A lower limit standard film is provided but no upper limit, and the degree is not graded. If the thickening extends appreciably further up the chest wall, the film is then classified as costophrenic angle.
filling and pleural thickening. "Leafing" of the diaphragm should not be recorded as filling of the angle even though it leads to obscuration of the costophrenic angle.

Chest walls. Asbestos-exposed workers may develop highly characteristic though not entirely specific thickening along the chest wall. In addition, plaques fairly uniform in radiopacity with well-defined edges are occasionally present. They may occur on the chest wall where they may have a characteristic shape. (See composite standard film No. 1.) Pleural thickening in the 1968 extended scheme was categorised on the basis of extent and width combined. Experience showed this was not satisfactory. The 1971 scheme proposes a scheme where the maximum width of the shadow and the combined length of all the shadows are separately graded (table 2). As the small areas of pleural thickening are difficult to detect with certainty and may be confused with the "companion shadows" of the ribs, grade 1 pleural thickening is intentionally set at a fairly high level where there is an unmistakable shadow of pleural thickening. (In practice, it may be possible to detect with a fair degree of certainty changes less than grade 1.) The pleural changes associated with pneumoconiosis tend to be bilateral, hence provision is made in the extended scheme for recording whether they are on the right and/or left lung. When the diffuse pleural changes are widespread but not thick, the "ground-glass" appearance is produced.

Ill-defined Cardiac Outline

The shaggy appearance of the mediastinal shadow is highly characteristic of asbestosis when well marked. Less marked changes, affecting especially the left cardiac border, are also seen and may be the only abnormality detected in the films of some asbestos workers. A separate recording of this feature from pleural thickening is included in the full classification to cover the shaggy heart of asbestosis. The lower limit of grade 1 is set fairly high to exclude the not infrequent poor definition of the extreme tip of the left cardiac outline from other causes, such as cardiac fat pads.

Ill-defined Diaphragm

A lack of definition of the diaphragm is common from many causes, such as movement, single adhesions, scollopings, marked leafing, etc. For this reason the lower limit for recording an ill-defined diaphragm is one-third of one side.

Further research is needed to validate the usefulness of classifying separately the contours of the cardiac and diaphragm outlines in this way.
Pleural Calcification

There are three main causes of pleural calcification - post traumatic, old infections, and exposure to asbestos, tremolite, talc, and some other minerals. The mineral dusts tend to produce bilateral changes. The calcification varies from just detectable spicules a few millimetres long to large areas covering nearly the whole lung. The calcified plaques due to asbestos tend to lie along the ribs where they may be missed. They are often more clearly seen on the surface of the diaphragm and pericardium. The large plaques have "rolled" edges of greater radio-opacity and have been likened in appearance to holly leaves or candlewax.

Pleural calcification has been separated from pleural thickening and graded independently because the calcified and uncalcified pleural changes do not always run parallel and there is evidence that pleural calcification may be related to particular types of asbestos or associated minerals. Calcification is graded on the length of the greatest diameter of the shadows and by adding the diameters of the shadows as is done for "large opacities".

Calcification within the wall of the aorta should not be recorded in this classification.

GENERAL INSTRUCTIONS FOR THE USE OF THE CLASSIFICATION

There are no absolutely specific individual features of a film which are uniquely the result of dust exposure, but in deciding whether a film is to be classified within the scheme the following recommendations are made:

(1) decide if any of the changes seen in the pleura or the parenchyma are sufficiently characteristic of pneumoconiosis to be recorded in the classification. If so, proceed with the classification;

(2) if it is probable that all the changes seen are the result of some other aetiology, do not classify but record opinion using appropriate symbols and comments;

(3) if changes might be due to pneumoconiosis, record the features of the classification, but make a note that other aetiology is thought possible.
Viewing Screens

To apply the classification satisfactorily requires at least two viewing boxes with uniform illumination and well matched for colour and intensity.\(^1\) The standard film against which the comparison is being made is put up on one box, the film for classification on the other. In practice it is often more convenient to use a much larger screen so that four or five standard films most used can be displayed round the film for classification. The films should be viewed both from not more than about 30 cm in order to look for small opacities which may be 1 mm or less in diameter, as well as from at least twice this distance to obtain a general impression of the film and the degree in which the normal architecture is altered. The viewing of the films should proceed methodically and preferably in the order in which the features to be recorded are listed in the reading sheet, so that the final assessment includes all the features as well as the symbols. When the classifications are being used for epidemiological purposes on groups of films where the total abnormality rate may be about 30 per cent, it will be found practicable to classify 200-500 films a day using the full classification.

\(^1\) Viewing boxes should have a brightness of at least that obtainable with two 15 W fluorescent tubes. Variable illumination is not a necessity. Kodak cold light series 11 meets this requirement.
Essentials of Chest Radiography

The most desirable chest radiograph for the study of the pneumoconiosis or other pulmonary disease is one in which the lung is shown in greatest detail. While it is helpful to visualise the mediastinal structures as well, this is of secondary importance. Thus, a film in which the vertebral bodies are faintly visible through the heart shadow will ordinarily be adequate for the study of pulmonary detail.

The maximum information can be obtained from radiographs which have a broad range of contrast, i.e. a long grey scale. High contrast radiographs should be avoided.

Two types of technique for chest radiography are commonly employed. With a proper balancing of the exposure factors and careful attention to all detail, under ideal conditions good radiographs can be produced by either method. In one, the kilovoltage used ranges from 60 to 80 kV. In order to deliver sufficient radiation to produce a radiograph of adequate density, the exposure time must be relatively long, 0.05–0.08 s. In the other, the kilovoltage used ranges from 110 to 140 kV and the exposure time is comparatively short, 1/60–1/30 s (0.017–0.032 s). With this technique, a grid of air-gap is required to reduce secondary radiation.

There are several advantages to the high kilovoltage technique. First, the low kilovoltage technique does not permit the use of short exposure times, e.g. less than 1/30 s, except when using generators of considerably higher capacity than 300 mA or the patients are quite small. Secondly, with larger patients, or when using more than 75 kV, secondary radiation increases rapidly, decreasing radiographic detail. The reduction of radiographically effective radiation resulting from the interposition of a grid or air-gap between the patient and the film to eliminate this secondary radiation must be compensated for by either increasing the exposure time, which is already relatively long, or increasing the kilovoltage. Thirdly, the higher the kilovoltage employed, the smaller is the effect of

any drop in line voltage, poorly functioning phototimer, and
selection of wrong exposure factors by the technician. It is
for these reasons that the technique used should be a combina-
tion of as high a range of kilovolts and as low a range of
milliamperes-seconds as permitted by the available equipment.
This produces radiographs of maximum detail; variations in
density and contrast are minimised, so that the radiographs
are consistent in quality and the number of unsatisfactory
examinations is markedly reduced. The latter is probably
the outstanding feature of the high kilovoltage technique.
Moreover, the higher the kilovoltage, the smaller is the
radiation dose to the patient.

However, the high kilovoltage technique requires modern
and costly X-ray equipment and an adequate electrical supply,
which are not usually available in screening centres or in
field work. At present, low kilovoltage technique is commonly
used, and, when properly applied, provides suitable results for
detecting lung changes due to dust exposure.

Equipment

The installation and maintenance of the radiographic
equipment is of the greatest importance. The electric power
source should be independent of other users. It must be of
adequate capacity, for example, having a resistance of not more
than 0.1 Ω, and should be subject to no more than 5 per cent
fluctuation. The voltage drop between the main supply and the
X-ray unit when the unit is at its maximum output should not
exceed 10 per cent. The radiographic unit must be carefully
calibrated at the time of installation and should be recalbi-
rated periodically. Preventive maintenance at regular inter-
vals is strongly recommended.

The generator should have a minimum capacity of 300 mA at
125 kV. A generator with a capacity of 150 kV is strongly
recommended. The generator must be full-wave rectified. It
should be equipped with an accurate timer (± 1 per cent) capable
of minimum exposure of no more than 10 ms.

A rotating anode tube is essential. It should have as
small a focal spot as feasible for the anticipated load, but in
no instance should this exceed 2 mm in diameter.

The total filtration, added and inherent, of the primary
X-ray beam shall be the equivalent of 2 mm of aluminium.
The radiation shall be confined by means of a collimator to the portion of the subject to be examined. This will not only decrease radiation hazard, but also will improve detail by reducing scattered radiation. The collimator should have adjustable diaphragms, a light beam for centering, and be designed so that the projected field cannot exceed the size of the film. Evidence of collimation should be visible at the edges of the film as "cone cuts".

Medium speed (par speed) intensifying screens should be used. They provide the best compromise between sharp definition and short exposure. The cassettes in use should contain screens of the same speed. Both films and screens should be tested and matched for speed, and cassettes should be checked periodically for screen cleanliness, contact and defects.

The X-ray film should be of a general-purpose type and of medium sensitivity. High speed film is not recommended. To improve collimation, the film should be no larger than needed to cover both lungs, including the costophrenic angles.

When using kilovoltages of 80 and above, reduction of secondary radiation by a grid or other means is essential. A 10:1, 100-line per inch fixed grid or an air-gap of 8 inches with an 8 ft. focal-spot film distance may be used.

Automatic processing should be employed whenever possible. If only manual processing is available, a constant time-temperature technique must be followed meticulously. An improper exposure cannot be corrected by improper processing.

Further improvement in radiographic quality may be expected with the use of a three-phase generator or other means of increasing the effective photon energy, high-speed rotating anode tubes, smaller focal spots, finer grain film, etc.

**Technique**

Correct centering of the X-ray tube and careful positioning of the subject are of great importance for the proper visualization of anatomic structures and comparison of serial examinations. For the PA projection, the X-ray tube should be centred to the centre of the film and the X-ray beam directed horizontally. The shoulders should be positioned so that the scapulae are outside the lung fields. The exposure should be made at full inspiration and immediately after this has been reached, to avoid the valsalva effect. It is desirable, but not essential, that all the clothes above the waist be removed.
The focal spot-film distance should be fixed at 6 ft. (1.8 m.) and should not be less than 5 ft. (1.5 m.).

For the reasons given above, a variable high kilovoltage, constant milliampere-second technique is recommended. Exposure factors employed may vary somewhat with each generator and tube. The highest range of kilovoltage and shortest range of milliamperes-seconds obtainable should be used. For the average subject, with an AP chest diameter between 21 and 23 cm., the usual exposure factors will be 5 mAs at approximately 125 kV. The recommended exposure time is $\frac{1}{60}$ (0.017) s. It should not exceed $\frac{1}{30}$ (0.32) s. With larger diameters of the chest, additional exposure is obtained by increasing the kilovoltage. The milliampere-second product is increased only when the kilovoltage required to give a proper exposure exceeds the capability of the generator or X-ray tube. With focal spot-film distances of less than 6 ft. (1.8 m.) the technique should be adjusted by decreasing the milliampere-second product.

When using a low kilovoltage technique, the exposure factors for an average subject will be approximately 300 mA, 0.05 s (15 mAs) at 75 kV. For larger subjects, greater amounts of radiation are obtained by increasing either the milliampere-second product or the kilovoltage.

Phototimers are inaccurate with exposures of less than 0.03 s. and are not recommended with the high kilovoltage technique since films of variable density and contrast result. Phototiming can be very useful with exposures of longer duration.

---

1 Based on 60 Hz current. For 50 Hz current, exposure times are $\frac{1}{50}$ (0.02) and $\frac{1}{25}$ (0.04) s. respectively.
APPENDIX I

ILO Meeting of Consultants on the International Classification of Radiographs of Pneumoconioses
(Geneva, 15-20 December 1968)

List of Participants

Mr. W.G. Clarke, MFR, AMPS, 28 Southcourt Road, Penylan, Cardiff, CF3 7DB, United Kingdom.

Dr. J.C. Gilson, FRCP, Director, MRC Pneumoconiosis Unit, Llandough Hospital, Penarth, CF6 1XW, United Kingdom.

Dr. G. Guerra, Casilla 2114, La Paz, Bolivia.

Dr. Horai, MD, Professor, Second Department of Internal Medicine, Nara Medical University, Kashihara City, Nara Prefecture, Japan.

Dr. G. Jacobson, MD, Professor and Chairman, Department of Radiology, School of Medicine, University of Southern California, 1200 North State Street, Los Angeles 33, California, USA.

Dr. J.J. Jarry, médecin-chef, Charbonnages de France, 9 avenue Percier, Paris VIII, France.

Professor A.A. Letavet, Director, Institute of Occupational Health, Academy of Medical Sciences, Ul. Obuba 14, Moscow 0120, USSR.

Professor E.C. Vigliani, Director, Clinica del Lavoro, via San Barnaba 8, Milan, Italy.

Professor G. Worth, Chefarzt, Krankenhaus Benthanien, 413 Hoers, Federal Republic of Germany.

Representative of the Commission of the European Communities:

Dr. Hentz, Communauté du Charbon et de l'Acier, (CECA), Direction générale du travail, assainissement et reconversion, Luxembourg.
Secretariat:

Dr. L. Parmeggiani, Chief, Occupational Safety and Health Branch.

Dr. A. Annoni and Dr. N. Gavrilescu, Occupational Safety and Health Branch.

Professor A.A. Letavet could not attend. During the course of the meeting, Dr. J.J. Jarry had to leave and was replaced by Dr. C. Amoudru, médecin-chef, Houillères du Bassin du Nord et Pas-de-Calais (France).\(^1\)

The meeting appointed Dr. J.J. Jarry and Professor E.C. Vigliani, Chairman and Vice-Chairman respectively. Dr. G. Jacobson was appointed Rapporteur.

---

\(^1\) At present: médecin-chef, Charbonnages de France, Paris.
APPENDIX II

Members of the Working Party under the Auspices of the Permanent Commission and International Association on Occupational Health's Sub-Committee on Asbestosis

Professor B. Pernis (Chairman)  
Clinica del Lavoro "Luigi Devoto", Via S. Barnaba 8, Milano, Italy.

Dr. Premysl V. Pelnar (Secretary)  
Scientific Secretary, Institute of Occupational and Environmental Health, Suite 412, 5 Place Ville Marie, Montreal 113, Canada.

Dr. P. Cartier  
Theford Industrial Clinic, PO Box 247, Theford Mines, Que., Canada.

Dr. J. Champeix  
Faculté de Médecin de Clermont-Perrand, Bd. Winston-Churchill, Clermont-Perrand, France.

Dr. L.J. Cralley  
Associate Chief, Occupational Health Program, National Center for Urban and Industrial Health, 1014 Broadway, Cincinnati, Ohio 45202, USA.

Dr. B. Goldstein  
(representing Dr. I. Webster)  
Medical Research Council for South Africa, Pneumoconiosis Research Unit, PO Box 4788, Johannesburg, Republic of South Africa.

Dr. A. Grut  
H.M. Senior Medical Inspector of Labour, Direktoratet for Arbejdstilsynet, Baugårdsvej 73-75, Stengården (Hellerup), Denmark.

Dr. G. Wright  
Head, Medical Research Department, St. Luke's Hospital, 11311 Shaker Boulevard, Cleveland, Ohio 44104, USA.
The following experts were also invited and took part in the discussion:

<table>
<thead>
<tr>
<th>Expert</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. H. Bohlig</td>
<td>Federal Republic of Germany</td>
</tr>
<tr>
<td>Dr. Paccini</td>
<td>Italy</td>
</tr>
<tr>
<td>Dr. G. Jacobson</td>
<td>USA</td>
</tr>
<tr>
<td>Dr. J. Jarry</td>
<td>France</td>
</tr>
<tr>
<td>Prof. F. Lavenne</td>
<td>Belgium</td>
</tr>
<tr>
<td>Prof. E.C. Vigliani</td>
<td>Italy</td>
</tr>
<tr>
<td>Dr. L. Parmeggiani</td>
<td>International Labour Office</td>
</tr>
</tbody>
</table>
APPENDIX III

Members of the Working Party of Experts Advising ILO and the UICU/Cincinnati Group

Canada

+ Dr. P. Cartier
Thetford Industrial Clinic,
PO Box 247, Thetford Mines, Que.

+ Professor J.C. McDonald
Department of Epidemiology and Health, McGill University,
3775 University Street,
Montreal 2, PQ.

Europe

* Dr. C. Amoudru
Médecin-chef, Charbommages de France,
9 avenue Percier, Paris VIII, France.

+ Dr. A. Annoni
Occupational Safety and Health Branch, International Labour Office,
CH 1211 Genève 22, Switzerland.

* Professor P. Lavenne
Université Catholique de Louvain,
Cliniques Universitaires St. Pierre,
3000 Louvain, Brusselsestraat 69,
Belgium.

Dr. L. Parmeggiani
Chief, Occupational Safety and Health Branch, Conditions of Work and Life Department, International Labour Office, CH 1211 Genève 22, Switzerland.

* Professor G. Worth
Chefarzt, Krankenhaus Benthanien,
413 Hoers, Federal Republic of Germany.

Unable to attend

+ Dr. H. Fohlig
Chefarzt der Strahlenabteilung des Städtischen Krankenhaus Lüdenscheid,
588 Lüdenscheid, Federal Republic of Germany.

* Professor E.C. Vigliani
Clinica del Lavoro "Luigi Devoto",
Via S. Barnaba 8, Milano, Italy.
South Africa

Professor S.P. Oosthuizen (part-time) representing + Dr. G.K. Sluis-Cremer
Radiological Department, Pretoria Hospital, PO Box 437, Pretoria, Republic of South Africa.

USA

+ Dr. L.J. Bristol
Director, Silicosis Control Unit, Trudeau Institute Inc., Medical Research Laboratories, Algonquin Avenue, PO Box 59, Saranac Lake, NY 12983.

+* Dr. B. Felson
Professor and Director, Department of Radiology, University of Cincinnati College of Medicine, General Hospital, Cincinnati, Ohio 45229.

* Professor G. Jacobson
Chairman, Department of Radiology, University of Southern California, School of Medicine, 2025 Zonal Avenue, Los Angeles, California 90033.
USA (Contd.)

+ Dr. W.S. Lainhart
  Deputy Director, Division of Epidemiology and Special Services, Department of Health, Education, and Welfare, Public Health Service, 1014 Broadway, Cincinnati, Ohio 45202.

+ Dr. E.P. Pendergrass
  Emeritus Professor of Radiology, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, Pa. 19104.

Observers

Dr. William Cole

Mr. Earle F. Shoub
  Appalachian Laboratory for Occupational Respiratory Diseases, Bureau of Occupational Safety and Health, Public Health Service, Morgantown, West Virginia.

+ Members of the UICC/Cincinnati Working Group.

* Advisors to ILO.