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Protection against Hazards Arising from Benzene

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INTRODUCTION

The question of how to protect workers against the hazards arising from benzene and substances (notably solvents) containing it has already been raised on a number of occasions, for example at sessions of Industrial Committees (of the Chemical Industries Committee in particular), or at ILO tripartite technical meetings (for the printing and allied trades and for the leather and footwear industry). Some trade union federations (such as the International Graphical Federation and the Textiles, Clothing, Leather and Fur Workers’ Trade Unions International) have likewise passed resolutions on the matter.

The Governing Body of the International Labour Office, at its 164th Session (March 1966) decided to convene a meeting of experts to consider this question. Having considered the report on this meeting together with the recommendations made by the experts, it decided, at its 174th Session (March 1969) that the question should be included in the agenda of the 56th (1971) Session of the International Labour Conference with a view to its examination under the single-discussion procedure.

The procedure chosen by the Governing Body is laid down in article 38, paragraph 1, of the Standing Orders of the Conference, which runs as follows:

When a question is governed by the single-discussion procedure the International Labour Office shall communicate to the governments, so as to reach them not less than 12 months before the opening of the session of the Conference at which the question is to be discussed, a summary report upon the question containing a statement of the law and practice in the different countries and accompanied by a questionnaire drawn up with a view to the preparation of Conventions or Recommendations. This questionnaire shall request governments to give reasons for their replies. Such replies should reach the Office as soon as possible and not less than eight months before the opening of the session of the Conference at which the question is to be discussed.

This report has been drawn up in accordance with these provisions. A general introduction is followed by a review of law and practice in individual countries. The report also contains a questionnaire, prepared by the Office with a view to the preparation of a Convention and Recommendation.

In accordance with article 38 (1) of the Standing Orders, governments are requested to give reasons for their replies. In this connection it should be recalled that in deciding to put this matter on the agenda of the Conference, since it was to be examined under the single-discussion procedure, the Governing Body expressly observed that governments should, before communicating their replies to the Office, obtain the views of the employers’ and workers’ organisations concerned and take account of them so far as possible in their replies.

It has been found in the past that Members whose law and practice are in conformity with the essential provisions of an international instrument are sometimes
unable to ratify or accept that instrument formally by reason of comparatively minor divergences between its precise terms and national law or practice. These divergences may relate to the scope of the instrument: the scope of the relevant national legislation may not completely coincide with the instrument or may define differently the sector or sectors covered by it. Alternatively, they may relate to details of application of the basic principles. It is clearly desirable for difficulties of this nature to be taken into account at the time of the drafting of the instrument, with a view to determining whether it can be rendered sufficiently flexible to meet these difficulties without detriment to its substantive effect. A question has accordingly been included in the questionnaire inviting Members to indicate any particularities of national law and practice concerning the subject under discussion which in their view are liable to create difficulties in the implementation of international instruments as conceived in this report, and to make specific suggestions as to how these difficulties may be met.

On the basis of the replies received, the Office will draw up the final report, which in accordance with article 38 (2) of the Standing Orders should reach governments at least four months before the opening of the 56th Session. Governments are therefore requested to send their replies to the Office in Geneva as soon as possible, and in any event not later than 30 September 1970.
CHAPTER I

BACKGROUND

BENZENE: USE AND HAZARDS

Benzene (C₆H₆) is commonly used as a raw material in industry for chemical syntheses, and in many other industrial processes by virtue of its solvent properties.

As a raw material, benzene is used in the manufacture of phenol and cyclohexane and of chlorinated, nitrated and sulphonated derivatives, of great importance as industrial raw materials, of other homologues such as isopropylbenzene (used in the manufacture of phenol), vinylbenzene (used in the manufacture of polystyrene plastics), and maleic anhydride, together with a whole range of detergents. All these products occupy an important place in the chemical industry as starting points for the synthesis of plastics, pesticides, pharmaceuticals, of explosives and dyes, all of which are being produced on an ever-increasing scale.

Benzene and its homologues are excellent solvents of rubber, fatty substances, and many gums and resins both natural and synthetic, and some plastics. They are frequently used as solvents or as diluents in products designed to dry quickly (paint, varnish, lacquer, ink, gum, adhesive paste, and the like). Thus benzene and its homologues are much used in a great many technical processes, industrial operations, and artisanal activities.

Among industrial products, benzene is quite certainly one of the most dangerous. Because of its volatility it can penetrate into the organism via the lungs, and because it is a fat solvent it tends to penetrate the skin barrier.

Regarding the acute and sub-acute toxicity of benzene, it may cause nervous system effects (intoxication followed by narcosis) which are non-specific and characteristic of fat soluble volatile solvents in general, which have an affinity for nervous tissues. But the most serious danger from exposure to benzene lies in benzene’s more specific effects of long-term or chronic toxicity resulting from repeated absorption of small doses, as may occur in various circumstances of its use.

These chronic effects, which, it should be stressed, are insidious, are chiefly due to the action of benzene on the bone marrow. After a very long latent period, this often leads to serious (and sometimes irreversible) blood changes: anaemia, leucopenia, thrombocytopenia, and even the appearance of leukaemia in some individuals. This myelotoxic effect of benzene is one of the characteristics which distinguishes benzene from all other hydrocarbons, including its homologues used as industrial solvents. It is responsible, too, for a very serious occupational disease: benzene poisoning.
The use of benzene in the chemical industry has continued to increase, and accordingly how to protect the worker against the risks involved by exposure to it remains a difficult problem of occupational hygiene. Even though benzene as a solvent is at present not so widely used as other substances (especially its homologues), some petroleum spirits and proprietary preparations contain it in far from negligible quantities. This is a matter of particular importance in small factories and workshops where control and supervision are more difficult.

Such findings of an epidemiological character, and the recognition of benzene poisoning as an occupational disease, led to laboratory experiments which, together with clinical observations, have also confirmed the myelotoxic effect of benzene and have thus put the latter in a class different from that of its homologues. Awareness of the dangers has, moreover, led some countries to seek, by legislation, to reduce the use of benzene, either alone or mixed with hydrocarbons of the same or other series. Such legislation was also directed towards developing medical supervision and preventive measures on both technological and hygienic lines. At the international level, moreover, both the ILO and the Council of Europe have considered the question of how to protect the worker against the hazards involved.

**ACTION BY THE ILO**

As early as April 1948, on the occasion of the first session of the Chemical Industries Committee in Paris, the ILO submitted a paper on hygiene in the chemical industries. This dealt at length with the hazards involved in the use of benzene and urged that the possibility of finding a substitute should be looked into. It also recommended that a study be undertaken of protection against benzene vapours, of possible special labour regulations for certain categories of persons, and of the medical supervision of workers exposed to benzene.

The question of how to protect workers against the action of toxic substances, among them benzene, was again taken up at the Committee's fifth session (Geneva, February 1958) and sixth session (Geneva, May 1962); several delegates urged that measures should be taken, in particular, to replace such substances, wherever possible, by others less toxic.

A tripartite Technical Meeting for the Printing and Allied Trades, convened in Geneva in 1962, thoroughly reviewed the health and safety problems in the industry, with reference, *inter alia*, to benzene. It adopted conclusions concerning the protection of workers' health and expressed the wish that the use of benzene, either as a solvent or as a cleaning fluid, should be forbidden, and asked that the percentage of benzene in such products should be such as will not be harmful to the worker.

The Tripartite Technical Meeting for the Leather and Footwear Industry, meeting in Geneva in October 1969, also considered the risks to workers' health arising in this industry. In a resolution concerning protection against hazards arising from benzene and other chemical compounds, the Meeting noted with great satisfaction the decision taken by the Governing Body to include the question of protection against hazards arising from benzene to the 56th Session of the Conference.
At the practical level, the ILO has already tackled the problem in the Model Code of Safety Regulations for Industrial Establishments for the Guidance of Governments and Industry. This contains a special provision (Regulation 200) concerning benzene, which would prohibit the use of benzene as a solvent, unless arrangements have been made to use it in closed apparatus. Certain temporary exemptions are allowed, provided that sufficient ventilation is available to keep benzene vapours to a level not exceeding the maximum permissible concentration.

In May 1967 the Meeting of Experts convened by the Governing Body to examine the protection of workers exposed to benzene and other solvents containing benzene was held in Geneva. Having considered the various aspects of the toxicity of benzene, these experts came to the conclusion that in view of the hazards involved the ideal solution would be to forbid the use of benzene and of substances containing it, at any rate whenever other less poisonous products were available. If that were not the case, then use should be made only of such products as did not contain more than 1 per cent of benzene. The experts considered, too, the principles governing collective preventive measures, especially the supervision of the work environment, and urged that the benzene content of the working atmosphere should in no circumstances exceed 25 ppm (80 mg per cubic metre). To their report, they attached a list of substances which might suitably replace benzene in certain operations, and expressed the view that international standards, governing the protection of the worker against hazards arising from benzene, should be adopted.

RECOMMENDATION BY THE COUNCIL OF EUROPE (PARTIAL AGREEMENT)

The Sub-Committee for Occupational Hygiene and Safety of the Social Committee of the Council of Europe (Partial Agreement) considered the question of replacing benzene by other less dangerous substances in 1961, and a recommendation to this effect was in 1962 submitted to the countries which were parties to the Partial Agreement.

The matter was again considered by the same Sub-Committee in the light of the technical developments which had occurred since 1961. The Social Committee, and thereafter the Committee of Ministers of the Partial Agreement, adopted a new recommendation in 1966, and this was forwarded to the governments of the member countries. The recommendation is to the effect that benzene as a solvent or diluting agent, especially in certain liquids, pastes, paints, varnishes, adhesives, mastics and similar products, be progressively reduced and eventually eliminated altogether. It prohibits the use of solvents or diluents containing more than 5 per cent of benzene, unless in enclosed apparatus, and prescribes that containers holding substances with a higher benzene content must be labelled, and that approved methods of analysing the substances in question must be adopted. The recommendation specifies that after two years from the date of implementation of the recommendation countries must reduce the permissible level of benzene in these substances to 1 per cent.
CHAPTER II

LAW AND PRACTICE

Examination of the law and practice in the countries which have adopted standards to prevent the hazards arising from benzene, reveals that such standards are generally not confined to benzene alone, but cover the products and substances which contain it, together with certain of its homologues. Furthermore, although such standards are sometimes of a general kind, they usually apply to specific uses of benzene and to specific technical and medical preventive measures prescribed by law.

Solvents and diluents, and especially benzene, are used for so many industrial purposes and in so many branches of activity that the relevant legal provisions are, in most cases, dispersed among different laws. Thus, they may be found in legislation governing certain types of work (dangerous work), certain kinds of substance (toxic), or certain categories of worker (women and young workers), or governing certain kinds of protective action (medical or technical).

Since national legislation approaches the problem from so many angles, and since the branches of activity liable to be regulated are so multifarious, the most appropriate way of presenting this review of law and practice seemed to be to proceed by listing the fields in which provisions concerning prevention and protection have been adopted and are applicable. In general, it may be assumed that some of the measures taken by individual countries relate to technical aspects, while others are of a social nature. As dealt with in this report, technical prevention embraces such matters as the replacement of benzene by other products, the restriction of its use, its use in closed apparatus, the benzene content of solvents and other substances employed, the permissible concentration of benzene in the atmosphere of places of work, ventilation and other technical installations in places of work, personal protective equipment, labelling, and the special arrangements some countries make to keep the worker aware of the risks involved. The material grouped under the heading "medical protection" includes the restrictions on the employment of certain categories of person on work which would expose them to contact with benzene, the rules applicable to pre-employment, periodical and special medical examinations, the criteria to be observed in assessing physical fitness, and personal hygiene. It should be pointed out that mention is made only of provisions relating specifically to benzene. As already indicated, in many countries that are not included in this review similar provisions apply whenever substances harmful to health are used, the list of which is drawn up by the competent authorities or appears in regulations which the Office has been unable to consult.
Such a presentation would seem to enable the Conference to appreciate how the different national legislators have dealt with the problem in the different sectors involved. This being so, the Conference should be better placed to decide what ought to be done to render the worker’s protection even more complete and effective than it is already.

**TECHNICAL PREVENTION**

**Australia**

In Western Australia the Benzene Regulations, 1963, third schedule, lay down that a person shall not use any liquid containing more than one part per centum by weight of benzene for the purpose of spray painting except in accordance with the provisions of the Spray Painting Regulations, 1963. Article 3 of the Benzene Regulations specifies that where a liquid or other substance containing an excess of 5 per cent by weight of benzene is used in any process or occupation in any factory, a poster shall be displayed in a conspicuous position and in the vicinity of the process; a schedule to the Regulations states what information is to be given on the poster and which relates in particular to the hazards involved and the preventive measures to be taken. Moreover, the use of any liquid or other substance consisting of benzene or containing benzene in excess of 5 per cent by weight in any container holding more than six fluid ounces is not permitted unless that container has displayed on it the symbol adopted by the Chemical Industries Committee of the ILO, an indication of the amount of benzene present in the liquid or other substance, the word “Danger” in bold type, and an indication of the dangers involved in breathing benzene fumes. Provision is made for a special label for containers containing motor fuel with less than 20 per cent by weight of benzene. Another schedule sets out the method of analysis to be used in determining the benzene content of the substances in question.

**Belgium**

Article 394 of the Labour Code, amended by the Royal Order of 18 February 1960, restricts, and in some cases entirely forbids, the use of benzene, toluene and xylene. Thus, in all industries and all activities, apart from the supply of fuel for motorcars, the use of petroleum spirits to which benzene is added is prohibited. No metal or other object may be cleaned or scoured with benzene, toluene or xylene; with any product containing over 1 per cent of these substances; or with non-denatured petroleum spirits, the distillation of which commences below 150°C. Moreover, in all industries and activities, with the exception of the varnishing of mirrors in mirror shops, the use, for any operation whatever, of paints, varnishes or coatings containing benzene or benzols is prohibited. This prohibition also applies to diluents, thinners or scouring agents in paints, varnishes or coatings.

As regards certain work these regulations provide that in shops where waterproof clothing, shoes or slippers are manufactured or repaired, it is prohibited to use
in gluing operations any glues, cements or similar products containing over 1 per cent of benzene, toluene, xylene, or of their nitro or amino derivatives, such percentage being based on the entire amount of these substances.

In rotogravure printing shops, inks and their diluents, as well as the liquids utilised for the cleaning of inking rollers, cylinders, ink pots and all other objects soiled with ink shall not contain above 1 per cent of benzene, toluene, xylene, or of their nitro or amino derivatives.

Likewise, in mirror shops the varnishes used for the protection of the silvering of mirrors shall not contain above 1 per cent of such substances.

As regards marking and labelling, article 393 of the same Royal Decree lays down that containers containing toxic substances—these are listed in an annex, and comprise the pure and mixed benzenic hydrocarbons—must be marked. The name of the substances must be in a form, colour or aspect strongly contrasting with the background on which it is placed, so as to attract immediate attention. Certain exemptions, however, are provided for, notably in the case of substances delivered in bulk, and petrol and other petroleum spirits, exclusively destined for motor vehicles or heating.

**Bolivia**

Article 17 of the draft Occupational Safety and Health Regulations states that no process or material which liberates into the atmosphere of the workplace any harmful substance shall be used unless adequate preventive measures have been taken. It provides, moreover, that the maximum concentration in the environmental atmosphere shall be 100 ppm for benzene and 200 ppm for toluene.

**Brazil**

Article 1 of Ordinance No. 262 of 6 August 1962 lays down that industries which by their nature, conditions or work procedures expose the workers to harmful physical, chemical or biological agents likely to provoke diseases or intoxications listed in the text are considered as unhealthy. (Benzene, its homologues, and their nitro and amino derivatives, appear in a list annexed to Legislative Decree No. 293 of 28 February 1967.) Article 2 provides that in such cases the unhealthy conditions shall be eliminated by measures of collective or individual protection. Collective protection is defined as including replacement of the process, method, or harmful product; isolation of a phase or process capable of producing disease or poisoning; limitation of exposure time; elimination of the harmful substance by means of artificial ventilation; and modification of working methods. The measures of individual protection are set forth in detail in Decree No. 229 of 1967.

The following activities are considered as unhealthy for the purposes of these provisions: distillation of tar and coal; manufacture and use of benzene and its derivatives; manufacture and handling of toluene and xylene; gilding, bronzing and soldering with benzene; manufacture of leather articles, impermeabilisation products and impermeable tissues on the base of hydrocarbons; manufacture of linoleum, celluloid, varnishes, ebonite and gutta-percha articles and the like.
Bulgaria

The Ordinance of December 1950 on occupational safety and health lays down that concentrations of benzene in the atmosphere at places of work shall not exceed 100 mg/m³; this figure was reduced to 50 mg/m³ in 1964. Furthermore, the Ordinance of 25 March 1960 sets forth the instructions to be given to workers as regards occupational safety and health, so that they may be fully aware of the dangers inherent in the work they are doing, and of the precautions, technical and other, to be taken.

Canada

In the province of Ontario, section 1 of the regulations under section 55 of the Factory, Shop and Office Building Act of 1932, amended in 1937, lays down that where benzene is prepared for use or used in any industrial process, special precautions must be taken. Among other things packages or containers of substances containing benzene as an ingredient must be clearly labelled, and, when not in use, must be stored in a separate building or in premises sheltered from fire risk. An employer using such substances must, when required to do so by the Chief Inspector of Factories, post in a conspicuous place notices stressing the dangers presented by these substances and indicating the precautions necessary.

In the province of British Columbia, the Accident Prevention Regulations of 1 March 1966 specify that where workmen are exposed to paints, coating, thinners, solvents and similar materials containing harmful ingredients, the employer shall ensure that the harmful nature of the materials and the safe means of handling and using the materials are made known to them.

Chile

The 1953 Decree on the maximum permissible concentration of toxic substances in the atmosphere of workplaces lays down the following: for benzene—35 ppm; for toluene—200 ppm; and for xylene—200 ppm.

Costa Rica

Decree No. 1 of 2 January 1967, comprising the general occupational safety and health regulations, lays down (section 68) that dangerous substances must as far as possible be replaced by harmless or less harmful ones. It also describes the precautions to be taken in places of work to protect the workers’ health. Thus, the employer must, among other things, provide all equipment or individual protective equipment required, and ensure that his staff are aware of the risks and of the precautions to be taken.

Czechoslovakia

The Labour Health Regulations of 1958, amended by supplementary instructions in 1963, specify that in no place of work may the concentration of benzene in the atmosphere exceed 50 mg/m³.
Denmark

Act No. 226 of 11 June 1954 respecting the general protection of workers lays down (section 13.19) that toxic substances must be replaced by less dangerous ones whenever that can be done without undue inconvenience to the undertaking.

Finland

The list of permissible maximum concentrations of toxic substances in the atmosphere of places of work, approved by the Ministry of Social Affairs in 1962 under the Occupational Safety Act, 1958, lays down that the limit for benzene is 80 mg/m³ (25 ppm).

France

Decree No. 69-646 of 14 June 1969, which abrogates all previous provisions governing restrictions on the use of benzene, forbids the use of diluents or solvents containing more than 1 per cent (by volume) of benzene. It further decrees that no preparation (such as paints, varnishes, printing inks, glues, etc.) obtained from such liquids shall be employed. This prohibition, however, does not apply when the preparations or diluents in question are used in apparatus which is closed in normal operation, and in circumstances such that workers are not exposed to the danger of inhaling benzene fumes. The Regional Directors of Labour and Manpower are empowered under the Decree to grant exemptions in special circumstances, but must then specify what technical or personal precautions are to be taken.

The Order of 10 September 1947, prescribing the wording of the notice respecting the dangers of benzene poisoning, sets forth the precautions to be taken in undertakings where such a danger exists. A list of the jobs involved appears in section 1 of the Order of 25 March 1943. They include work in connection with the preparation, extraction, rectification and denaturation of benzols, and preparation of the derivatives thereof; degreasing, dry-cleaning and scouring; the preparation and handling of rubber solutions; the manufacture and use of varnishes, paints, enamels, putties, inks, etc.; other uses of benzols or products containing them; the preparation of fuels, and so on.

Precautions to be taken whenever it is not possible to use apparatus that is hermetically closed in normal working are prescribed particularly as regards the evacuation of fumes. Fumes are to be collected at the place of their formation on work-benches or around the benches in gluing operations; on machines when mechanical equipment is used to apply products containing benzols (rotary and flat-bed machines, folding tables in printing works, looms for the manufacture of waterproof fabrics, washing machines, and various appliances for dry-cleaning, etc.); and at the level of articles to be sprayed in the case of spray painting.

The order further provides that if the solvent evaporates over a large surface (clothing, dry-cleaning, rubber and other industries), additional exhaust nozzles may be installed near the workshop floor in view of the high density of the vapours. When
possible, a hood should be provided. Fumes will be captured *per descensum*, except in special circumstances or when the fumes are hot, in which case they may be captured *per ascensum*. The order makes it plain that the combined ventilation appliances (general appliances and local exhaust appliances), when working in the conditions specified by the manufacturer, should ensure that the benzol content of the atmosphere of the premises in question does not exceed 100 mg/m³. If it is not possible to employ collective means of protection the workers should be provided with personal protective equipment, including air-line respirators.

There are special provisions dealing with protection during the operations of cleaning, maintenance and repair of equipment that is usually closed, the drying of articles coated with glue, paint, etc., containing benzene, and the drawing-off of paint, solvents, etc., from barrels and drums. Vessels containing glue, and the ink containers in printing works, must be kept shut and any openings therein must be confined to special orifices designed to reduce exposure to benzene fumes to an absolute minimum.

The same 1947 Order describes the notice which is to be conspicuously displayed wherever the operations listed in the 1943 Order are proceeding. This notice provides information about the dangers involved, the medical ill-effects caused, and the precautions to be taken.

An Order of 10 October 1950 gives detailed instructions concerning the marking of receptacles containing benzene hydrocarbons or substances containing them. This order was amended by another Order of 18 December 1951. Three kinds of label are provided for, depending on the composition of the substances concerned.

A receptacle containing benzene, benzos, or any mixture of benzene hydrocarbons which begins to distil below 100°C, or products in which such hydrocarbons constitute more than 5 per cent by volume, must bear an orange-red label. In the middle of the label must appear the words "Caution: Toxic Vapours", and underneath, the technical and medical precautions to be taken, the name of the product, and the address of the seller.

A green label has to be affixed if the receptacle contains benzene hydrocarbons of which over 1 per cent of the volume distils below 130°C or over 10 per cent of the volume distils below 145°C, or products containing benzene hydrocarbons representing over 10 per cent by volume of the product. In such circumstances, the label shall bear the words "Harmful Vapours", and the other indications appearing on the orange-red label.

The label is yellow if the recipient contains benzene hydrocarbons of which less than 1 per cent by volume distils below 130°C, and less than 10 per cent by volume distils below 145°C, or products of which over 5 per cent by volume of the fraction distilling below 200°C is made up of benzene hydrocarbons. The label must indicate that the recipient contains benzene hydrocarbons authorised for use, together with the instructions appearing on the other labels.

The order specifies the size of these labels and the kind of characters to be used thereon. Green and yellow labels are not obligatory if the receptacle holds less than 1 litre. Various methods are used for analysis of benzene content, notably gas chromatography, as suggested by the French National Safety Institute.
Federal Republic of Germany

Specific provisions are to be found in the Accident Prevention Regulations of the Mutual Accident Insurance Associations, which have force of law.

Paragraph 2 of the 1952 Regulations for the textile industry prohibits the use of benzene for chemical (dry) cleaning.

Paragraph 27 (3) of the 1964 Regulations for the printing trades lays down that cleaning fluids (for rollers and cylinders) shall not contain more than 0.3 per cent by weight of benzene.

The 1965 Regulations of the Mutual Accident Insurance Associations for protection against dangerous chemicals provide that workers exposed to these products must be equipped with respiratory apparatus. Filter-respirators should only be used in closed workplaces where it can be safely assumed that the concentration of harmful gases and fumes in the environmental air does not exceed 2 per cent, or that the content of oxygen in it exceeds 15 per cent. In other cases, closed-circuit apparatus or air-line respirators must be used.

These same regulations also lay down figures for the maximum permissible concentration of benzene in the air. For benzene, the limit is 80 mg/m³, for toluene 750 mg/m³, and for xylene 870 mg/m³.

As regards labelling, the Solvents Ordinance of 1954 applying to all solvents considered harmful and to all products containing them (paints, varnishes, glues, etc.) lays down that all receptacles of over half a litre not intended for export must bear an orange label carrying a warning in black letters, if they contain products over 10 per cent of the weight of which is accounted for by solvents considered harmful. Benzene is reckoned at twice its weight, toluene and xylene at one-third of their weight. In practice, this means that any recipient containing 5 per cent by weight of benzene or 30 per cent of toluene or xylene has to be labelled.

The regulations of the Mutual Accident Insurance Associations and the Solvents Ordinance referred to above require moreover that a poster illustrating the precautions to be taken be prominently displayed wherever benzene hydrocarbons are used.

Hungary

The General Safety and Health Regulations for Unhealthy Occupations describe the technical precautions to be taken when there is a risk of exposure to benzene. In the chemical and printing industries, for instance, the regulations specify that there shall be prevention of spillage and formation of vapours; ventilation; local exhausts; for the rubber industry, benzene should be replaced by less toxic substances; in the manufacture of explosives, solvents, and so on, they provide that respirators shall be worn, especially by those cleaning vats, tanks, etc. There must also be medical supervision. The maximum permissible benzene content of the atmosphere is given as 20 mg/m³; for toluene and xylene, the figure is 50 mg/m³. There are special provisions concerning respirators and filters, protective equipment and working clothes, and the instruction to be given to workers.
Italy

Act No. 245 of 5 March 1963 concerning limitations on the use of benzene and its homologues in work operations lays down that the use of benzene shall be prohibited in the operations of painting, decoration, varnishing and coating in general, as well as in the removal of varnish and the cleaning of metal (article 4). Furthermore, the use of solvents containing benzene is forbidden (article 2) in dry-cleaning, degreasing and cleaning in general. Nor may benzene be used, in the printing trade, for purposes such as the cleaning of ink rollers, cylinders, ink pots, machine parts, or equipment in general (article 5).

Products containing glues, mastics, and cements, thinned by solvents containing benzene shall not be used in the manufacture or repair of raincoats, boots or shoes, nor may they be used in the waterproofing of fabric. Article 5 specifies that inks the diluent or dispersing substances of which contain benzene shall not be used. But according to article 6, the presence of benzene as an impurity only will be tolerated up to a maximum content of 2 per cent by weight of the solvent.

Decree No. 547 of 27 April 1955 (standards for the prevention of occupational accidents) applies as regards the obligation to display notices concerning the risks involved, the precautions to be taken, and the labelling of dangerous substances. Moreover, section 8 of Act No. 245, mentioned above, lays down that the manufacturers of solvents for industrial use and of products for use in the activities to which the Act relates must label any containers containing products comprising benzene, toluene or xylene; the label shall indicate the presence of these substances, their total percentage, and, separately, the percentage of benzene. This same obligation is imposed on anyone who, for commercial purposes, substitutes or in whatever way modifies the containers originally supplied by the manufacturers.

Furthermore, containers, whether for storage or direct use by the workers, containing solvents or products in which benzene is present in quantities exceeding 2 per cent by weight must be marked with the conventional sign betokening poison, i.e. the skull and crossbones. The same obligation applies to solvents containing more than 3 per cent by weight of toluene or xylene.

It is of interest to observe that article 10 of the Act specifically extends the application thereof to work given out to be done at home and involving all or part of the operations dealt with by the law.

Japan

Ordinance No. 24 of 13 October 1960 on the prevention of poisoning by organic solvents, deals in detail with the various aspects of technical prevention, notably ventilation, storage, the handling of empty containers, personal protection and the medical examination of workers exposed to, among other things, benzene. It contains provisions describing how the presence of solvents in the atmosphere is to be determined. The maximum permissible benzene concentration in the air, as laid down by the Japanese Occupational Medicine Association, is 25 ppm (80 mg/m³); for toluene, it is 100 ppm, and for xylene, 150 ppm.
**Malagasy Republic**

Order No. 987 of 20 May 1960 specified the special health and safety precautions to be taken in undertakings where the staff is exposed to benzene poisoning. Use must not be made of benzene or of any mixture of benzene hydrocarbons the distillation of which begins below 100°C, or of petroleum spirits or complex solvents containing more than 5 per cent of benzene hydrocarbons, as solvents, unless used in apparatus which is closed in normal operation. It prohibits, likewise, the use of rubber solutions in the manufacture of waterproof garments, in the manufacture or repair of boots and shoes, etc., when such liquids have been prepared with solvents extracted from crude benzols, and of which 1 per cent or more distils below 130°C or more than 10 per cent below 145°C, or when these preparations have been made with petroleum spirits containing more than 15 per cent of benzene hydrocarbons.

The order in question likewise prescribes the technical precautions to be taken in undertakings where workers are exposed to benzene poisoning. A list of the industrial operations which is very similar to that officially recognised in France (see above), to which these provisions apply is included. The technical precautions in question cover ventilation, elimination of vapours where they originate, breathing equipment and working clothes; special rules apply to certain jobs. The terms of the notice to be displayed in places of work to advise the workers concerning the risks involved, are also specified, and are in fact largely based on the French legislation. Recipients and containers for benzene hydrocarbons must be labelled, three different kinds of label being provided for. These provisions, too, are very similar to those obtaining in France.

**Mexico**

The Safety and Health Regulations of 26 January 1946 lay down general rules for the protection of workers against toxic substances. Such substances must be properly stored in sealed containers labelled with the name of the substance, marked "Poison" and bearing the skull and crossbones. Places of work must be properly ventilated; posters must be displayed to advise the staff on the risks they run and the precautions to be taken. Adequate protective equipment must be provided. An annex to the regulations lists the substances for the handling of which special medical supervision is required. Among these substances are benzene, toluene, xylene, and their derivatives.

**Morocco**

The Order of 25 August 1952 lists the jobs calling for special precautions against benzene poisoning. This list is similar to that in French legislation and includes in particular those jobs concerned with the extraction of benzols, the preparation and use of benzene homologues and derivatives, degreasing and scouring operations, the manufacture and use of varnishes and paints, and other jobs involving the use of products containing benzols.
Technical precautions to be observed during the performance of these jobs are indicated in the notice annexed to the Decree of 18 August 1952. They are similar to those obtaining in France (see above) and concern the evacuation of harmful fumes by means of suitable local exhaust appliances, the over-all ventilation and general layout of workplaces, the use wherever necessary of efficient personal protective equipment, and the suppression or control of pollution sources. The precautions prescribed must ensure that the concentration of benzene vapour in the air does not exceed 100 mg/m$^3$. The notice referred to must be displayed wherever the jobs listed in the Order of 25 August 1952 are carried out, and provides information about the dangers arising from benzene to which workers may be exposed and the personal precautions to be taken.

The Netherlands

Article 1 of the Decree of 19 November 1938 places in Class C workplaces where substances, vapours and gases are present which, due to their properties, can cause poisoning, such as benzene and its homologues. In such workplaces, the free air space should be at least 20 cubic metres per worker, of which at least 10 cubic metres should be above a height of 1.80 metres. The decree specifies what must be done to prevent noxious gas and vapours from escaping, and specifies that containers containing toxic substances must be labelled. The employer must provide suitable protective equipment, including respirators. Moreover, messrooms and washing facilities have to be provided in undertakings employing more than ten people.

Poland

The Safety and Hygiene Code of 1953 provides that, whenever technically possible, thinners used in inks for rotogravure printing, such as benzene, toluene or xylene, shall be replaced by less harmful substances.

For the rubber industry, the regulations provide, moreover, that whenever rubber solutions prepared with volatile, inflammable or harmful solvents are used, the work involving such solvents must be carried out in closed apparatus, and that places where solvent vapours may be given off must be provided with effective ventilating appliances which prevent the air of the workplaces from being polluted by these vapours.

An Order of 4 October 1950 sets forth the precautions to be taken in the transport, handling and storage of dangerous or toxic substances and provides that solvents containing benzene used in the printing industries may be transported only in hermetically sealed containers and must be stored in special premises in suitable closed containers bearing clear indications. In the chemical industry, the containers must be marked with the name of the substances they contain and bear the word “Toxic". Their issue for use must be closely supervised.

As regards atmospheric pollution, the above-mentioned 1953 Safety and Hygiene Code lays down that where rubber articles are being manufactured, the concentration of benzene in the air shall not exceed 100 mg/m$^3$. An Order of 15 December 1960, made by the Minister for the Chemical Industry, also provides that periodical analyses
of the air, to ascertain how much benzene it contains, shall be undertaken in accordance with Polish standards. These standards, made binding on all undertakings by an ordinance enacted by the State Planning Commission and dated 1 July 1967, lay down that the maximum permissible concentration of benzene in the atmosphere shall be 100 mg/m³.

In addition, all the regulations applicable to industries using benzene hydrocarbons provide that the relevant rules shall be conspicuously displayed in factories and shops, and that in general, workers shall be individually informed of the hazards involved and the precautions to be taken.

Spain

An Order of 14 September 1959 regulates the manufacture and use of solvents and other products containing benzene. Article 6 lays down that industries making and using solvents, glues, solutions, paints, varnishes, inks and other products containing benzene shall as far as possible replace benzene, benzol and, in general, products containing benzene by other, less toxic, substances. Containers must be labelled in accordance with an Order of 22 December 1953.

The instructions enacted on 1 March 1960 by virtue of the Order of 14 September 1959, specify that the maximum concentration of benzene fumes in the atmosphere of the workplace shall be fixed at 220 mg/m³. Where women workers are concerned, this concentration shall be 110 mg/m³. To ensure that these figures are not exceeded, open evaporation surfaces shall be reduced as far as possible; if necessary, the benzene fumes shall be drawn off locally, at their source, by down-draught ventilation by means of enclosures, canopies or fume cupboards, and in conjunction with a general ventilation of the premises. Upward ventilation is specially recommended when these benzene fumes are hot.

It is likewise specified that premises within which such substances are used shall be separated from other premises and not have any communication with them, or at least be provided with well-closing doors. Objects impregnated with these substances are to be dried in closed compartments or in premises separate from the place of work. Emptying and transferring operations are to be performed in separate premises, except when the quantities handled are very small, in which case all requisite precautions are to be taken to limit the escape of vapours. Rags soaked in benzene hydrocarbons shall be placed in closed receptacles immediately following their use and thereafter safely disposed of, outside.

Should a worker be called upon to enter premises where there are heavy concentrations of benzene vapours, he must be provided with a respirator, while suitable gloves must be worn in the handling of benzene or benzene-containing products.

Workers must be issued with special clothing, the daily cleaning and decontamination of which shall be at the charge of the undertaking, which must also provide washing facilities and showers, and dressing rooms fitted with separate cupboards for working and town clothing. Messrooms where the workers can eat must also be provided. Employers shall instruct their workers on the dangers of benzene and on the
importance of personal hygiene, and advise them on the precautions to be taken at work.

**Switzerland**

The Ordinance of 26 December 1960 on the technical prevention of occupational diseases caused by chemical substances, lays down (section 2) that the substances endangering health must be replaced, as far as technically and economically feasible, by other less harmful ones.

Section 3 of the same ordinance says that technical preventive measures, such as providing exhaust appliances, must be taken in order to contain and evacuate from work premises harmful gases, vapours and dusts containing substances mentioned in article 1 of the Ordinance of 6 April 1956 on occupational diseases (this list comprises benzene and its homologues); in particular, the maximum concentrations allowable on work premises, as established by the National Accident Insurance Office, should not be exceeded. For benzene, the maximum figure is given as 25 ppm \(80\, \text{mg/m}^3\).

In the canton of Geneva, the Code of 7 May 1963 on the Utilisation of Benzene, Benzols and Preparations Containing These Solvents lays down (article 1) that nobody may use such substances without a licence issued by the Department of Social Welfare and Public Health. Article 4 states that if such substances cannot be replaced, no licence will be issued unless everything possible has been done by the applicant to avoid the danger of poisoning. The licence will be refused if the substances in question can be replaced by other solvents. Furthermore, these substances cannot be obtained from shops except on production of the licence referred to (article 6), and any sales must be recorded by the seller in the special register for poisons.

**Turkey**

The Regulations of 12 August 1952 on dangerous and harmful substances in undertakings prohibits (article 314) the use as solvents of benzene, benzol, and all mixtures of benzene hydrocarbons, petroleum spirits whose point of distillation is below 200°C, as well as mixtures containing benzene hydrocarbons and whose point of distillation is below 100°C, and whose volume amounts to more than 5 per cent of the total. This prohibition, however, may be temporarily lifted if the solvents or solutions containing benzenic hydrocarbon are utilised in closed vessels throughout the operations, including centrifugation and drying, or if the Ministry of Labour has recognised that it is technically impossible to observe these provisions and a powerful ventilation system is available preventing the amount of benzene hydrocarbon in the air from exceeding the maxima set out in the annex to the regulations. A footnote to article 314 quotes the relevant provisions of Regulation 200 of the ILO Model Code for Industrial Establishments.

**USSR**

The 1957 Rules on working with mastics, paints, varnishes, glues and enamels in which benzene is used as a solvent or thinner lay down (article 1) that, whenever the
technology of the process so permits, benzene must be replaced by other, less toxic solvents. Article 2 forbids the use of benzene in rotogravure printing works, in the preparation of insulating materials in the production of electric appliances, in the preparation of synthetic leather, in the spray painting of cumbersome articles. Article 23 requires the complete exclusion of benzene from the primer and mastic and its replacement by other solvents in the manufacture of synthetic cloth.

The rules specify that in other processes, whenever the replacement of benzene by other solvents or thinners is entirely impossible for technological considerations, its content in the solvent shall not exceed 10 per cent, related to the liquid (volatile) parts of the varnish or glue. In particular cases, and with the consent of the health inspectorate, a temporary increase in the contents of benzene in varnishes or glues, but not exceeding 20 per cent, may be authorised; such temporary authorisation may not exceed six months.

There are detailed rules governing the precautions to be taken when such paints, varnishes and glues are being prepared and applied. Thus, the premises involved must be equipped with mechanical ventilation systems and local suction devices. Operations of other kinds may not be performed therein.

All operations using these varnishes, paints, glues, etc., are to be carried out either in fully enclosed exhaust hoods (exhaust cupboards), special rooms or on work tables provided with local exhausts.

In painting by immersion, precautions must be taken to ensure that there is no soiling of hands, while immersion baths must be equipped with local exhausts. Similarly, cleaning baths must have local exhausts to remove vapours from the entire surface of the liquid, while whenever possible, exhaust cupboards must be used.

Drying has to be done in specially equipped and ventilated drying chambers. The transfer, storage and distribution of toxic substances are subject to detailed rules. Similar provisions apply to spray-painting and to the manufacture of synthetic cloth.

The maximum permissible benzene concentration in the atmosphere of workplaces is 20 mg/m$^3$; for toluene the limit is 20 mg/m$^3$, and for xylene, 50 mg/m$^3$. Finally, the premises where such substances containing benzene are used to be provided with personal-service accommodation, including dressing rooms where working and town clothing may be kept separately, showers, and washing facilities. The workers must be supplied with special working clothes.

United Arab Republic

Order No. 50 of 12 February 1958 lays down that the employer shall take all necessary measures to ensure that the conditions obtaining in his workplaces adequately safeguard the health of the workers employed therein. When dangerous substances are used, they are to be kept in hermetically sealed containers, on which the contents, and, where appropriate, the method of use and the precautions to be taken against dangers shall be indicated (article 1, (e)). Article 2 specifies the technical action to be taken, such as the use of closed-system devices, the elimination of vapours by suitable ventilation, the use of separate premises, and, as a last resort, the wearing of special
clothing and the use of individual protective equipment. There is a table giving the maximum permissible concentrations of certain substances in the atmosphere. The figure for toluene is 100 ppm.

This same order (article 2 (f)) specifies that workers shall be instructed in the use of protective appliances and equipment.

**United Kingdom**

The Indiarubber Regulations of 31 March 1922 are applicable to all factories and workshops or parts thereof in which is carried on the manufacture of indiarubber or of articles or goods made wholly or partially of indiarubber. Paragraph 4 specifies that a fume process shall not be carried on in the open air nor in any room the floor of which is in any part below the level of the surrounding ground.

A “fume process” is defined as being “any process in which ... benzene (C₆H₆), whether pure or in the form of commercial benzol ... or any mixture containing any of such materials ... is given off”.

No fume process may be carried on without the use of an efficient exhaust draught effected by mechanical means and so contrived as to operate on the vapour given off as nearly as may be at its point of origin and to prevent it entering the air of any room in which persons work. Moreover, suitably placed inlets of sufficient area for the supply of fresh air to the room in which such processes are carried on must be provided. The regulations provide, however, that in a room where a standard of general ventilation of thirty changes of air per hour is maintained during working hours the above-mentioned exhaust draught shall not be required in the case of any fume process which is a fume process solely by reason of the use of benzene whether pure or in the form of commercial benzol.

Where a plenum system is used for the supply of fresh air to a room in which a fume process is carried on, the air supplied by such system shall not enter the room at a velocity which exceeds 350 feet per minute (100 metres approximately).

The regulations likewise specify that undertakings must provide a suitably equipped and maintained messroom for use by their employees.

In a memorandum issued in 1959 the Ministry of Labour described a colorimetric process for measuring the benzene contents of the atmosphere.

**United States**

On the federal level, the Walsh-Healey Act, applying to the undertakings directly run by the Federal Administration or under contract to it, contains general health and safety provisions, some of which deal specifically with exposure to toxic substances. The Act lays down that atmospheric pollution in places of work must not exceed the limits laid down by the American Conference of Governmental Industrial Hygienists, and that the employer must therefore make systematic checks on the air in places of work. The upper limit for benzene is 25 ppm. The employer must ensure that the requisite technical precautions are taken. He must supply his employees with the
necessary individual protective equipment and working garments, and instruct them as regards the risks they run and the precautions they should take.

Locally, the various states of the Union have their own legislation on such matters. This varies from one state to another, but the general principles involved are very similar. In Florida, for example, the 1957 Regulations (amended in 1960) for the control and prevention of occupational disease in industry lay down that as far as possible toxic substances shall be replaced by others, less dangerous. Closed-circuit systems are recommended as a way of eliminating poisonous fumes. Rules are given for the removal of fumes to reduce atmospheric pollution to acceptable levels, while standards to be met by general or local ventilation systems are described. The maximum permissible concentration of benzene in the air is given as 25 ppm; for toluene and xylene, this figure is 200 ppm. Should these figures be exceeded, the employer must provide appropriate respirators, while instructing his employees on how to use them and the limits on their use. If a worker comes into immediate contact with such substances, he must be provided with working clothes, gauntlets, aprons, and the like.

A point to be observed as regards the maximum permissible concentration of toxic substances in the atmosphere is that both federal regulations and state rules in practice abide by the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, already alluded to, which, for benzene, is 25 ppm. The same limit is prescribed by the United States Institute of Standards, another body dealing with such matters. In practice the tables produced and kept up to date by these two organisations, showing the maximum permissible concentrations of toxic substances in the atmosphere, are to a considerable extent adhered to in many countries. In the United States various means are used to ascertain how much benzene there is in the atmosphere, such as the micro-colorimetry method suggested by the Bureau of Mines, the Quick-Test Benzol Indication of the Mine Safety Appliances Co., and others.

There are general provisions which govern labelling. As far as benzene is concerned, reference may be made to the Benzol Labelling Act of 28 June 1933 of the state of Massachusetts, which states that any container containing benzene for use in an undertaking must be marked with the word "Benzol", followed by "Beware of Poisonous Fumes" or other prescribed words. In the case of products or substances containing benzene, the label must further specify whether such content is under 20 or over 15 per cent. Certain exceptions may be made for products to be used outside the state, for substances used only as motor fuel, and for substances which contain less than 1 per cent of benzene by weight.

**Uruguay**

The Decree of 14 September 1945 on benzene contains very detailed provisions governing its use and the various precautions—technical and medical—to be taken. The decree applies to establishments that manufacture, employ or handle benzene or its homologues and derivatives, and covers the following operations: the manufacture, extraction and refining of benzene; the use of benzene and its homologues
for the manufacture of benzene derivatives employed in the paints, perfumes, explosives and pharmaceutical industries; the use of benzene as a solvent for fats, rubber, resins, etc., especially in the extraction of oils and fats, the degreasing of bones, furs and fabrics, dyeing, etc.; the preparation of rubber solutions and the use of such solutions or of benzene in the manufacture and repair of tyres, air chambers, rubberised materials, clothing, footwear, headware, etc.; the manufacture and use of varnishes, paints, inks for colour printing, the impregnation of yarns and textiles, waterproofing, and so on.

Section 4 of the decree lays down that in workshops where waterproof clothes are manufactured or repaired, it is absolutely forbidden to use benzene for the preparation of glue, or to use glue containing the products mentioned.

These provisions do not, however, apply when the above substances are manufactured, employed or handled in closed apparatus preventing their escape into the workshop during the normal course of the work, or when they serve scientific purposes or, by virtue of the manufacturing process, are used in such small quantities that there is no fear of their having noxious effects on health.

Moreover, section 19 stipulates that the directors of industrial establishments in which benzene is employed shall conform to the instructions formulated by the officers of the Division of Hygiene of the Ministry of Public Health and of the National Institute of Labour and Associated Services, with a view to replacing benzene by other substances presenting a lesser degree of toxicity.

In all the establishments covered by the decree effective measures shall be taken for the aspiration of the toxic vapours arising from the manufacture, use or handling of the substances in question. To this effect, mechanical apparatus shall be installed to collect and lead away the toxic vapours. Moreover, in addition to installations for local collection, workshops shall have good general ventilation designed to remove rapidly from the air any vapours not collected at the source. Such ventilation systems shall be installed in accordance with the technical information of the competent department. The combination of local aspiration and additional ventilation should provide an atmosphere in which the benzene content is no more than 100 mg/m³, the content of the other substances employed being proportionate to their degree of toxicity.

All receptacles containing any of these substances which are not indispensable for the work in hand shall be kept hermetically sealed at a place outside the workshop. The storage rooms should also be provided with a natural system of effective and constant ventilation.

Section 27 of the decree provides that the director shall provide the following equipment for workers employed in occupations liable to produce benzene poisoning: working clothes which shall be washed at least once a week and which must be kept in perfect condition and frequently replaced; breathing masks for certain processes rendered particularly dangerous by the amount of gases or vapours given off by the substances employed; and barrier creams (mainly glycerine), the use of which shall be obligatory and with which each worker shall, above all, cover his face, neck and hands.
Dressing rooms and washrooms shall be installed outside the workshops, and provided with wash basins in sufficient number, with hot and cold water, ample supplies of soap, nail brushes and paper towels for the use of the staff. Hot and cold showers in sufficient quantity must also be installed. There shall, furthermore, be closets or cubicles provided with keys or padlocks, in which the street clothes of the workers can be kept separately from their working clothes.

As regards the employer's obligation to keep his staff informed, the decree lays down that he shall display in a conspicuous place in the workshop the decree itself, and works rules imposing the following obligations on the workers: to use working clothes and take all appropriate preventive measures; not to consume food or drink at the workplace; to wash with the greatest care before every meal; and to take a shower at least once a week. Workers must also be instructed in the dangers of benzene poisoning, and the precautions to be taken, by notices drafted in terms approved by the Division of Hygiene of the Department of Public Health.

**Medical Prevention**

**Austria**

Section 4 of the Benzene Ordinance of 28 March 1934 states that young persons who have not attained the age of 18 and women shall not be employed on the following processes using benzene, toluene and xylene or when these substances are given off during the process: the manufacture of chemical products; the manufacture of varnishes or pigments; in spray painting or spray varnishing; in the manufacture of rubber articles or adhesives and in the cementing of objects; the manufacture of waterproof materials; or the servicing and attendance of rotogravure printing machinery.

Certain derogations are permissible when adequate protection exists. Thus, women and young persons may be employed in painting and varnishing when the paints and varnishes used do not contain more than 10 per cent of benzene, 25 per cent of toluene, or 30 per cent of xylene and the work is done on tables or other supports which are fitted with efficient exhaust apparatus which, in so far as this is technically possible at the date in question, prevents the escape of vapours of these substances.

This same section lays down that neither women nor young male persons under the age of 18 may remain in places where their employment is prohibited or in places which are connected with such workplaces but are not separated therefrom by doors.

The Ordinance of 25 October 1954 to amend and supplement the list of undertakings and employments prohibited for young persons, annexed to the Act of 1 June 1948, gives the following list of tasks on which young people must not be employed: spray and dip painting and operations in connection therewith, although some exceptions are made concerning the employment of apprentices over 16 when the paints or varnishes used do not contain more than 10 per cent of benzene; work in printing establishments and type foundries, in connection with the operation and minding of
photogravure printing presses; work in connection with the manufacture and use of chemicals; work involving benzene, toluene or xylene, if it is impossible to prevent vapours or fumes produced by such substances from escaping in the workroom; work connected with the manufacture of paints and varnishes; operations connected with the manufacture of rubber goods in parts of undertakings in which rubber or similar substances are dissolved in benzene or toluene or such solutions are processed; operations connected with the manufacture and use of adhesives; operations connected with the manufacture of waterproof materials; and certain vulcanising operations.

As regards the medical supervision of workers, the Order of 28 March 1934 lays down (section 5) that the occupier of an undertaking shall not employ any persons on work involving benzol, toluol or xylol unless his physical fitness is certified by a medical practitioner. Section 6 lays down that in undertakings where benzene, toluene or xylene is used as the basic material or as a solvent or diluent in the manufacture of chemical products, varnishes or pigments or in the manufacture or use of rubber solutions for dipping, adhesives or similar products, and in intaglio printing where these substances are used as diluents for printing colours, the occupier of the undertaking shall be bound to cause the employees who are exposed to the effects of fumes or mists of the above-mentioned substances to undergo a medical examination every three months with a view to ascertaining the state of their health. The medical examination shall comprise in particular an examination of the condition of the blood. In other cases also the industrial authority may require the occupiers of undertakings where benzene, toluene or xylene are used to cause the employees who are exposed to the effects of fumes or mists of the said substances to undergo a medical examination, if there is a risk of injury to the health of these employees, in view of their physical condition. The condition of the blood has to be watched with especial vigilance.

Exceptions may be made when the substances concerned are used only in such quantities that in view of the protective devices available there is no risk of injury to the employees, or when the periodical medical examination shows after a period of two years that the health of the employees is not prejudicially affected. Section 9 specifies that the findings of the medical examination shall be kept in a special register.

Belgium

Article 3 of the Royal Order of 3 May 1925, dealing with the employment of protected persons, lays down that the employment or presence of children or young persons under 16 years in undertakings where rubber is treated with benzene or other organic solvents are prohibited.

The General Labour Code, as amended by the Royal Order of 15 April 1965, lays down (articles 124 and 128) that prior and periodical medical examinations shall be carried out in the case of persons exposed to occupational disease attributable to benzene, toluene, xylol, or to any solvent, spirit, products or substances containing them. All operations in any undertaking involving the manufacture, handling or use
of these substances are subject to this provision, together with all workers who may come into contact with the substances in question or may inhale the fumes thereof. The Code explains in detail how these medical examinations, including blood counts, are to be performed. The Code specifies that workers liable to inhale benzene fumes must be medically examined every three months, and other workers every six months. This latter category includes persons working in garages where motor vehicles are kept or repaired, and in petrol stations. The doctor making the examination may decide, if he deems it necessary, that other clinical and laboratory examinations shall be made, and may order more frequent medical examinations if the state of health of the workers concerned so requires (article 123).

**Brazil**

Legislative Decree No. 5452 of 1 May 1943 to approve the consolidation of labour laws lays down (sections 387 and 405) that neither women nor young persons under 18 shall be employed in premises or on tasks of a dangerous or unhealthy kind listed in an approved table. The Order of 16 September 1965 gives a list of such tasks, which include the manufacture and use of benzene, toluene and xylene.

Section 189 of the Legislative Decree of 1 May 1943 lays down that employees shall not be admitted to employment until they have undergone a medical examination, which shall be renewed periodically at least once a year if the employment is unhealthy or dangerous. Work subject to this regulation includes the manufacture and use of benzene or certain tasks involving the use of products and substances containing benzene.

**Bulgaria**

The Ordinance of 3 July 1959 to protect the work of women wage and salary earners lays down that women may not be employed on the particularly unhealthy jobs listed in the annex to the ordinance; these include the manufacture of benzene and of its amino and nitro compounds.

Ordinance No. A-87 of 7 September 1958 respecting the preliminary and periodical medical examination of wage and salary earners lays down that wage and salary earners entering employment for the first time, and those who have ceased work for more than six months, shall undergo a preliminary medical examination. Schedule 1 to the ordinance lists the chronic disorders which disqualify anybody from employment; in the case of employment involving the use of aromatic hydrocarbons (benzol, toluol, xylol and all solvents containing them) the workers must not suffer from disorders of the central nervous system, disorders of the blood or liver, nephritis, disorders of the sex organs or disturbances of the menstrual cycle. Schedule 2 lists processes and occupations in which workers are to undergo preliminary and periodical medical examinations, including the manufacture and use as solvents of benzol and toluol. In such circumstances, there is to be a medical examination every twelve months. Schedule 3 lists the special laboratory tests to be undertaken when a worker undergoes a periodical medical examination; for workers exposed to aromatic hydro-
carbons (including benzol and xylol) it gives a list of the blood examinations to be made.

**Canada**

In the province of Ontario the regulations under section 55 of the Factory, Shop and Office-Building Act, article 3 (d), lay down that the Chief Inspector of Factories may require, at specified intervals, physical examinations of workmen engaged in any industrial process using benzene. Similar provisions apply in Alberta. In Quebec workers exposed to benzene or its derivatives must have a full medical examination, including a blood count, at least once a year.

**El Salvador**

Article 89 of Decree No. 241 of 23 January 1963 lays down that the employment of women and young persons under 18 is prohibited in dangerous and unhealthy occupations. Article 91 specifies that unhealthy operations are those which, by their very nature, are likely to produce conditions affecting the health of the workers, as well as those which produce it by the nature of the substances used, transformed or given off or by the residues left by them whether solid, liquid or gaseous, and in particular: (a) those carrying the danger of poisoning due to the manipulation of toxic substances; and (b) any industrial operations which liberate harmful gases or vapours or noxious emanations.

**Finland**

The Order of 3 May 1961 on the medical examination of workers, as provided for in the Labour Code, lays down (sections 1 and 3, table 11) that any worker engaged in the preparation of benzene, or using benzene-containing glues in the footwear, rubber and plastics industries, or engaged in making and using nitric derivatives of benzene in the explosives and munitions industry, or using aromatic hydrocarbons in certain printing processes or in spray painting, must undergo a preliminary medical examination and thereafter be medically examined at regular intervals. Should the worker handle benzene or mixtures containing it, he has to undergo an examination of the blood at least once every four months, over and above the periodical examination. Section 3 specifies that the outcome of the examination shall be recorded in a special health book. The Labour Inspection Department may, if it deems fit, order that medical examinations shall be more or less frequent than the standard (section 6).

**France**

The Ordinance of 11 September 1947 governing the medical examination of workers exposed to benzene poisoning lays down that at the pre-employment examination the following should be considered unfit for work liable to cause benzol poisoning: girls under 18 years old, boys under 18 unless specially authorised by the doctor, pregnant women and nursing mothers, and all persons presenting specified medical contra-indications.
The amended Decree of 16 October 1939, concerning special health rules applicable to undertakings in which the workers are exposed to benzene poisoning, lays down (article 4) that before being assigned to any particular job, a worker must produce a certificate of physical fitness. This has to be renewed two months after assignment and thereafter at least. The list of jobs which entail this, as laid down every six months by the Order of 25 March 1943, includes the preparation, extraction, rectification and denaturation of benzo; the extraction of fatty substances; the degreasing of bones, skins, hides, fibres, textiles, clothes, dry cleaning, the degreasing of metallic pieces and all other objects soiled with fatty substances; the preparation of rubber solutions and their use; the manufacture and application of varnishes, paints, enamels, putties, inks, preservatives containing benzo, the manufacture of imitation leather, the sizing of rayon or other fibres; various uses of benzo as solvents for natural or synthetic resins; other uses of benzos or products containing them as a means for the extraction, impregnation, agglomeration or cleaning of other substances, as pickling agents, solvents or diluents; the use of benzos for dehydrating alcohols and other liquids or solids; and the use of benzos as denaturing agents; the preparation and handling of fuels containing benzene hydrocarbons.

For the purposes of this order, "benzol" means benzene hydrocarbons, pure or mixed, distilling below 200°C.

The Order of 11 September 1947 describes how the relevant medical examinations should be conducted and defines what "fitness" in this context means. It details, among other things, how examinations of blood content should be performed and the results interpreted. A worker displaying certain haematological modifications has to be kept under observation and subjected to special medical supervision.

In addition, the Decree of 14 June 1969, which forbids the use of benzene as a solvent, provides that in establishments where the Regional Director of Labour and Manpower gives special authorisation for the use of solvents or thinners containing more than 1 per cent of benzene there shall be a medical examination, including blood test, every three months.

Gabon

Decree 276/PR (5 December 1962), dealing with the employment of women, forbids (section 11) women to enter premises where benzene or nitrobenzene is being used, because of the noxious fumes which might be given off (table A).

Hungary

Order No. 4 (21 October 1966) forbids the employment of females on jobs involving the use of benzene and its derivatives.

Act No. 11 of 1967 (the Labour Code) lays down (article 52) that if the work involves a risk to health, the worker concerned must first be certified fit, in which event a periodical medical examination is prescribed. Decree No. 34 of 8 October 1967 (applying the Labour Code) lays down (article 79) that such medical examinations designed to prevent occurrence of the risks listed by the Ministry of Health
shall be obligatory. Instruction No. 13 of 1967 issued by the Ministry of Health, on the obligation to declare certain occupational diseases, includes poisoning by benzene or its homologues, by certain compounds of benzene and its homologues, or by their nitro- and amino-derivatives, in the list.

**Israel**

The Regulations of 15 January 1964 specify that young people under 18 may not be employed on work in which they would be exposed to the effects of toxic organic compounds such as benzol and other harmful hydrocarbons.

**Italy**

Decree No. 1720 of 7 August 1936, which approves the tables in which are set forth the occupations prohibited to women under 21 and children under 15, includes the cleaning of hides by the use of benzol. However, it authorises the employment of young persons of either sex in the preparation and use of substances dissolved in benzol, provided that the labour inspector is satisfied that all necessary precautions for the effective protection of health have been taken.

Presidential Decree No. 303 of 19 March 1956 (article 33) lays down that any worker exposed to the action of any of the toxic or harmful substances set forth in the table appended thereto must first be certified medically fit, and must thereafter pass a medical examination at stated intervals. Item No. 33 of the table (dealing with the risks attributable to benzene, toluene, xylene and their homologues) provides that any worker employed on the production of benzene hydrocarbons and their homologues must be examined every three months. This also applies in the case of any worker engaged in the redistillation of such substances, their use as raw materials in the chemical industry, their use in solvents and in rotogravure printing.

**Ivory Coast**

Decree No. 67-321 of 21 July 1967, which codifies the regulations governing occupational health and safety, sets forth (Part XVII) the special health and safety rules applicable in undertakings where the staff are exposed to benzene poisoning. It is, for example, forbidden to employ young persons under 18, and pregnant women or nursing mothers, on work involving exposure to this risk. There is a list of occupations which might cause benzene poisoning, which include: the preparation, extraction, rectification and denaturation of benzols; the extraction of fats and degreasing operations; dry cleaning; the degreasing of metal parts and of any other article soiled with fatty substances; the preparation, handling and use of rubber solutions; the preparation and application of varnishes, paints, enamels, putties, inks, and detergents containing benzols; the manufacture of imitation leather; the use of benzols as solvents of natural or synthetic resins; other uses of benzols or benzol-containing substances for extraction, impregnation, or cleaning purposes, or as solvents, diluents or scouring agents; and the preparation, transfer or handling of fuels containing benzene hydrocarbons.
The decree concerning the work of women and children provides, in article 3.D.310 and schedule B, that women shall not be employed on the application of rubber coatings in workplaces where benzene vapours are given off.

**Japan**

The Labour Code of 5 April 1947 forbids the employment of adolescents under 18 on any work involving the use of toxic or harmful substances (section 63). Ordinance No. 13 of 19 June 1954 relates to the application of this provision. Section 8 gives a list of the operations concerned; they include operations in the course of which noxious gases and fumes are liable to be given off, and work which might entail inflammation because of the handling of benzene.

The Ministry of Labour Ordinance No. 9 of 31 October 1947 on industrial safety and hygiene, amended on several occasions (the latest being in 1956), prescribes in article 48 the cases in which a medical examination is required. In paragraph (2) 1 this article provides that any worker employed in premises in which benzene fumes are generated shall be subject to a medical examination. Article 49 specifies that, in the case of such workers, a periodical physical examination shall be carried out at least twice a year, and shall include inspection of the teeth.

**Malagasy Republic**

Decree No. 62-152 of 28 March 1962 prohibits women, and children under 18, from working in or entering premises where benzene and its derivatives, or nitrobenzene or its derivatives, are being prepared.

Order No. 897 of 20 May 1960 deals with the special health and safety precautions to be taken in undertakings the staff of which are exposed to benzene poisoning; it provides for special medical supervision of such workers. These provisions, and the list of operations to which they apply, are similar to those contained in French legislation. They require a pre-employment medical examination, a check-up two months after assignment, and periodical examinations at intervals of not more than six months. How these examinations are to be conducted, and what criteria are to be used in assessing fitness, are described, and instructions are given about blood tests.

**Mexico**

Section 21 of the Regulations of 31 July 1934 respecting the employment of women and children in dangerous and unhealthy occupations lays down that children under the age of 16 years and women shall not be employed in the establishments, workshops and factories where operations involving benzene and its derivatives are carried on, and shall not even be admitted to such workplaces; this shall not, however, apply to women who as professional chemists or pharmacists are authorised to perform the work in question.

The Safety and Health Regulations of 26 January 1946 prescribe that the employers are obliged to have their workers undergo a pre-employment and periodical
medical examination. In industries where use is made of harmful substances, such re-examinations shall take place at the intervals specified in the regulations; for benzene, toluene and xylene the interval specified is one month.

Morocco

The Order of 28 August 1952, laying down guidelines for the medical examination of workers exposed to benzene poisoning, forbids the employment of boys (except with special permission) and girls under 18, or pregnant women and nursing mothers, and of workers presenting specified medical contra-indications, on work of this kind.

The Order of 18 August 1952 describes the special health precautions to be taken in undertakings where such a risk exists. A worker exposed to this risk must undergo a pre-employment medical examination, a re-examination two months after assignment, and a periodical check every six months. The blood tests accompanying the medical examinations are described. A special register, available on demand to the labour inspector and works council, must be maintained, containing particulars of any absence from work on the part of the workers in question, with the reasons given by them for their absence, together with the outcome of the medical examinations prescribed by the decree.

The Order of 25 August 1952 lists the industrial operations exposing workers to the effects of benzene hydrocarbon fumes and requiring the medical supervision prescribed by law. This list is similar to that in force in France.

The Order of 28 August 1952 lays down the recommendations concerning the medical examinations to be undertaken by virtue of the Order of 18 August 1952. These recommendations are similar to those laid down by French legislation.

Netherlands

The Labour Decree of 1920, amended by the Royal Decree of 12 July 1933, prohibits the employment of women or young persons in work where they might be exposed to the effects of benzene or its homologues, to an extent deemed noxious by the Senior Labour Inspector of the district (sections 33.12 and 34).

Poland

The Order of 28 February 1951 relating to work prohibited to women mentions, in connection with work in the chemical industry, any operation of manufacture or transformation and any activity in the course of which might be given off noxious organic compounds resulting from the distillation of tar and of cyclic hydrocarbons such as benzene, toluene and xylene, and their toxic derivatives, if the concentration of such substances in the atmosphere exceeds the maximum permissible figure. However, this prohibition does not apply to work done in laboratories or pharmacies, or in the therapeutic field. In addition, as regards printing and related activities, mention is made of heliogravure in premises where there are concentrations of fumes from toxic solvents such as benzene, toluene and xylene in excess of the authorised limits.
With regard to young people, the Decree of 26 September 1958 gives a list of forbidden tasks, including the making, processing or utilisation of noxious substances derived from the distillation of tars, and especially of cyclic hydrocarbons such as benzene, toluene and xylene. In the printing trades: all work in workshops where colours containing solvents such as benzene, toluene or xylene are made; all work in premises where such solvents are regenerated, and all photogravure work. In addition, the same decree prohibits the employment of young persons on brush or spray painting using harmful substances, on the preparation and utilisation of thinners, varnishes, paints and glues containing harmful substances, and the removal of these paints, etc., and on any work in premises where harmful chemicals are kept, and the grinding, mixing, sifting, weighing, dosage or packing of such substances.

An Order of 22 April 1968 by the Minister of Health and Social Welfare concerning the medical examination of workers lays down that any worker assigned to particularly arduous or unhealthy work must undergo a pre-employment medical examination and periodical check-ups, accompanied by appropriate special tests. Moreover, the regulations relating to certain activities provide for such examinations.

Thus, the Regulations of 22 November 1951 for the polygraphic industries specify, in section 165, that people employed in polygraphic industries on work entailing the use of substances harmful to health or on occupations giving off harmful vapours, gases or dusts, shall undergo a pre-employment and a periodical re-examination after every six months of work, or at shorter intervals if the physician deems it necessary.

The Regulations of 11 November 1953 for the rubber industries provide, in section 47, that workers liable to come into contact with harmful substances as for instance petrol, etc., shall undergo a medical examination at least once every six months.

The Regulations of 15 December 1960 for the chemical industries (synthetic polyamid fibres) provide, in section 57, that all workers must undergo a preliminary medical examination and that those employed in the chemical departments shall undergo periodical medical examinations, at least every six months.

Spain

The Order of 12 January 1963 on medical examinations (occupational diseases) lays down that women under 25, men under 20, pregnant women or nursing mothers, and persons suffering from disorders of the blood or certain syndromes, shall not be employed on work involving a risk of poisoning by benzene or its homologues.

Decree No. 792 of 13 April 1961 lays down (section 20) that every undertaking in which there are jobs where workers are exposed to the risk of contracting an occupational disease shall be obliged to provide for the preliminary medical examination of every worker about to be engaged, followed by such periodical, compulsory and free medical examinations as the Ministry shall order. The above-mentioned Order of 12 January 1963 states that workers exposed to benzene and its homologues
shall undergo a full examination plus a number of specified blood tests prior to engagement, and enumerates various syndromes, such as changes in the blood, diseases of the liver and gastro-intestinal tract, which debar a worker from employment; it also prescribes a medical check-up two months after the pre-employment examination. The outcome of such examinations has to be recorded on the worker's health card. The periodical examinations must take place every six months, and comprise the same blood tests. Should the examining practitioner deem it necessary, and in the circumstances provided for in the order, a worker may be classified as under observation and be made subject to medical examination at intervals not exceeding one month. Rules are given in connection with laboratory tests, notably blood tests, to be undertaken in such circumstances, and the medical criteria to be used when a final judgment of the worker's fitness or unfitness is to be taken are defined.

As regards special health precautions, the instructions enacted on 1 March 1960 state that a worker must not wash his hands in benzene or benzene hydrocarbons, nor may he eat in premises where benzene is used.

**USSR**

The prohibitions and restrictions applicable to women and young persons are set out in very detailed lists of specific occupations for each industry. The provisions apply to a particular stage or phase of production and in a few instances specifically refer to benzenic hydrocarbons.

For example, as far as women are concerned, the Order of 10 April 1932 gives a list of jobs on which females must not be employed which includes the manufacture of benzene and of its nitro and amino derivatives (in the chemical industry), and photogravure operations.

Order No. 629 of 29 August 1959 provides that young persons under 18, employed in the coke and allied chemical production industry, must not be assigned to the production of benzene in condensation and separation processes. In the chemical industry such young people must not be employed in any occupations which entail by law the extension of the annual leave period by twelve days at least. This provision covers the following occupations: painting and varnishing—the use of varnishes, paints containing benzene, toluene and xylene inside buildings; the preparation of paints, etc., containing benzene, toluene and xylene; the removal of paints by means of benzene, toluene and xylene; in the polygraphic industries—rotogravure: printers and helpers working with benzenic paints; in laboratories—those permanently engaged on analyses of the products of coal-tar distillation, aromatic hydrocarbons.

An order issued by the Ministry of Health of the USSR on 7 September 1957 deals with the pre-employment and periodical examination of workers employed in the occupations and activities set forth therein. Workers engaged in the production of benzene and toluene, those using benzene as a solvent, or engaged in the alkylation of benzene, and those using toluene and xylene as solvents, must undergo a medical
examination; those engaged in the distillation of coal-tar and redistribution of aromatic hydrocarbons must do so once every six months.

The same order contains instructions concerning the medical examinations. As regards workers exposed to aromatic hydrocarbons such as benzene, toluene, xylene, etc., it describes the blood tests to be undertaken and the contra-indications to admittance to employment in which workers are subject to periodical medical examinations.

United Arab Republic

Order No. 12 of 9 July 1959 respecting periodic medical examinations for workers exposed to occupational diseases deals, among other things, with poisoning caused by benzene or its amino and nitro derivatives. Section 3 prescribes that every worker recruited for a job in which he is liable to contract an occupational disease shall undergo a full preliminary medical examination. Section 1 specifies that workers exposed to poisoning by benzene and its compounds, homologues and derivatives, shall be medically examined every six months; and section 2 provides that, as far as these workers are concerned, the report shall indicate the state of the blood, nervous system and skin. The findings of a medical examination shall be treated as strictly confidential (section 8) and shall be entered on a personal record card (section 4). Furthermore, the medical practitioner responsible for periodic medical examinations may order any worker who is liable to contract an occupational disease to be medically examined at shorter intervals if the worker’s state of health so warrants (section 6).

United Kingdom

The Indiarubber Regulations of 31 March 1922, applicable to all factories and workshops in which indiarubber, or articles and goods wholly or partly made of indiarubber, are manufactured, lay down (section 2) that nobody under 18 shall be employed on a fume process, and that nobody under 16 shall be employed in premises where such a process is being carried on.

The expression “fume process” is defined as being “any process in which... benzene (C₆H₆), whether pure or in the form of commercial benzol... or any mixture containing any of such materials... is given off”.

Furthermore, the Regulations of 11 July 1922 concerning the manufacture of chemicals make it illegal to employ anybody under 18 in a nitro or amino process, such a process being taken to mean the manufacture of the nitro or amino derivatives of phenol or of benzene and its homologues, and the manufacture of explosives using any of these substances.

The Indiarubber Regulations of 1922 specify (section 12) that every person employed in any fume process shall be examined by a doctor once in every calendar month or at such other intervals as may be specified in writing by the Chief Inspector of Factories, on a date of which due notice shall be given to all concerned.
United States

In Pennsylvania the Regulations on Spray Coating and Regulations M-37 (employment of minors) prohibit the employment of young people under 18 on spray painting using substances which contain benzene.

For workers liable to inhale toxic solvents, especially benzene, the first-mentioned regulations require a pre-employment medical examination and check-ups at least once every six months. These examinations must comprise the blood tests prescribed. These regulations specify the medical contra-indications which preclude employment and the cases in which special medical supervision is compulsory.

Uruguay

The Decree of 14 September 1945 on benzene provides (section 8) that it is forbidden to employ pregnant women and minors under 14 years on work involving: the manufacture, extraction, and refining of benzene; the use of benzene and its homologues for the manufacture of the derivatives employed in the paints, perfumes, explosives and pharmaceutical industries; the use of benzene as a solvent for fats, rubber, resins, etc., especially in the extraction of oils and fats, the degreasing of bones, furs and fabrics, dyeing, etc.; the preparation of rubber solutions and their use, or the use of benzene, in the manufacture or repair of tyres, air tubes, rubberised materials, clothing, footwear, headwear, etc.; the manufacture and use of varnishes, paints, inks for colour printing, the waterproofing of textiles, and so on.

Section 9 of the decree lays down, moreover, that minors of under 18 years and women shall not be employed in the following occupations (when such occupations involve the use of benzene, its homologues, or substances containing them): the manufacture of chemicals if it is impossible to prevent the spread of fumes; the manufacture of varnishes and paints; the spraying of objects with paints and varnishes; the manufacture of rubber articles in the sections of the undertaking where rubber and similar substances are dissolved by means of benzene and toluene; the manufacture of glues and their use; the manufacture of waterproof materials; the maintenance and operation of machines for colour printing, when the printing inks are dissolved with benzene, toluene or xylene, or are diluted with these substances.

Section 12 of the same decree lays down that the owner of any establishment manufacturing, using or handling benzene, its homologues or derivatives must organise a medical service which is responsible for pre-employment and periodical medical examinations. Section 13 sets forth the physical disorders which constitute a bar to employment on such work. Section 14 requires a medical examination three months after employment begins, and subsequent examinations every six months thereafter, with especial attention being given to blood tests. Special provisions provide for exceptions, or for reinforcement of medical supervision, the issuing of certificates, and the recording of the outcome of examinations.

The decree lays down that workers shall use special barrier creams (particularly glycerine) during their work and shall wear the protective clothing provided by the
employer. They must not eat, drink or smoke in the workplace, and must take a shower once a week, or even more frequently, depending on the risk of contamination.

**Yugoslavia**

The Act of 12 December 1957 respecting employment relationships provides, in section 73, that women shall not be employed on or assigned to any jobs that are injurious to health. This prohibition also applies to young persons under 18 (section 82). In addition, no pregnant woman may be employed on work in which vapour, dust and harmful gases are given off (section 74).

The Decree of 4 April 1965 to promulgate a Basic Act respecting employment relationships lays down (section 27, (3)) that a community of workers shall make provision in its general administrative rules for the posts in which the work involves a major risk of accidents or illness. It shall ensure that workers assigned to such posts are given periodic medical examinations not less than once a year. Since poisoning by benzene or its homologues appears in the list of occupational diseases for which compensation is payable, it follows that such medical examinations have to be undergone by anybody assigned to a job involving exposure to such substances.

**Conclusions**

The foregoing review considers in detail the way in which a good number of countries endeavour, by legislative action, to protect the worker exposed to contact with benzene or with substances containing benzene and its homologues. It would seem that, as far as national legislations are concerned, there is a general awareness of the risks involved in exposure to these substances. Although the approach to this problem will, of course, vary from country to country, it is clear that very considerable efforts have been made to reduce these risks, and their consequences for health, to a minimum. In a number of respects, moreover, certain general trends as regards protection may be discerned, while there is also a certain degree of uniformity as regards several practical matters. It might be well, therefore, briefly to consider those aspects to which national legislation has mainly confined itself and to indicate how allowance might be made for them in the drafting of international standards.

It will be observed, first, that it is within the general framework of legislation governing toxic substances and dangerous work that special legislative provisions concerning benzene poisoning have, as a general rule, been adopted. Nevertheless, in a number of countries specific legislation has been enacted in connection with the industrial use of benzene, which seems to indicate a belief that technical and medical precautions of a special kind are required in order to protect the workers' health. This is, for example, the case of Western Australia, Austria, France (and of certain countries strongly influenced by France, such as Morocco and the Malagasy Republic) and Spain; it is true, also, of Italy, Switzerland (the canton of Geneva) and
Uruguay. The scope of the relevant legislation varies, of course, from country to country but, in general, the two main aspects dealt with relate to technical and to medical prevention.

**Technical prevention:** The provisions enacted may decree that benzene shall be replaced by some other product or that its use shall be limited. They may lay down that the benzene content of solvents, etc., employed in industry shall be limited, that closed apparatus be used or that action be taken to eliminate benzene vapours from workplaces. Figures are specified for the maximum permissible benzene concentrations in the atmosphere, and there are rules governing labels, individual protective equipment, and the instruction to be given to workers.

**Medical prevention:** This includes a prohibition or the employment of certain categories of worker on work which might expose them to benzene poisoning. There are provisions requiring pre-employment and periodical medical examinations. Criteria of physical fitness and rules for personal hygiene are laid down.

The points most frequently covered by national legislation are dealt with below.

**Prohibition on the Use of Benzene; Replacement by Some Other Product**

In several countries, there is legislation forbidding the use of benzene in a range of industrial operations. The list of operations affected by such prohibition varies from one country to another but the following are usually included: the preparation and use of paints, varnishes, colours, solvents and diluents; the preparation and use of products such as rubber solutions, glues, putties; the manufacture of rubber articles; the waterproofing of textiles; the manufacture and repair of waterproof garments and footwear; the extraction of fats, grease and oil and degreasing; the cleaning and scouring of metal; dry-cleaning; the preparation of printers’ inks and colours, especially for intaglio printing; the manufacture of imitation leather, artificial flowers, etc.

In practice, such prohibitions impose an obligation to seek substitute products. It should be pointed out, however, that some countries specify the replacement of benzene by another product, less dangerous or toxic, only when this is technically or practically possible.

Accordingly, the principle of the replacement of benzene—with, however, provision being made for a derogation—has been included in the questionnaire at the end of this report (question 6).

Similarly, the principle of the prohibition of the use of benzene in certain operations and in the preparation of certain products, as national legislation may specify, has also been retained (questions 7, 8, and 9).

**Restrictions on the Benzene Content of Solvents and Other Products**

In many countries, there is legislation laying down maximum permissible figures for the benzene content of industrial solvents, etc., in current use. Sometimes the content is defined in relation to the total weight of the mixture, sometimes in relation
to the total volume, and varies to some extent from one country to another. Apart
from some exceptional cases and special provisions, the following rates are in force
for benzene-containing products used in general or for specific purposes:

<table>
<thead>
<tr>
<th>Country</th>
<th>Maximum benzene content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia (Western)</td>
<td>5 per cent by weight</td>
</tr>
<tr>
<td>Austria</td>
<td>10 per cent by volume</td>
</tr>
<tr>
<td>Belgium</td>
<td>1 per cent by volume</td>
</tr>
<tr>
<td>France</td>
<td>1 per cent by volume</td>
</tr>
<tr>
<td>Germany (Federal Republic)</td>
<td>0.3 per cent by weight</td>
</tr>
<tr>
<td>Italy</td>
<td>2 per cent by weight</td>
</tr>
<tr>
<td>Malagasy Republic</td>
<td>5 per cent by volume</td>
</tr>
<tr>
<td>Morocco</td>
<td>5 per cent by volume</td>
</tr>
<tr>
<td>Turkey</td>
<td>5 per cent by volume</td>
</tr>
<tr>
<td>USSR</td>
<td>10 per cent by volume</td>
</tr>
</tbody>
</table>

The Council of Europe (Partial Agreement), in its recommendation on the use of
benzene (Strasbourg, 1966) has laid down a maximum of 5 per cent by volume, to
be reduced to 1 per cent two years after adoption of the recommendation by a member
country.

This principle, i.e. that there should be a limitation on the benzene content of
substances and products used, has been embodied in the questionnaire (see question 4)
in connection with the scope of the instruments envisaged.

Technical Prevention and Occupational Hygiene

National laws and regulations usually contain many provisions concerning
technical precautions against benzene poisoning. These provisions are sometimes of a
general nature; they may, for example, call for the use of closed apparatus and
fume-cupboards where possible, efficient ventilation and provision of individual
protective equipment. Sometimes they are more specific, and prescribe in greater
detail the type of local ventilation (they may, for example, prescribe down-draught
or updraught ventilation), and the capacity of the general ventilation system (volume
of air to be changed). They may prescribe that premises where the risk of benzene
poisoning exists must be kept separate, or specify precautions to be taken when
handling benzene or products containing benzene.

The questionnaire (questions 11 and 13 to 16) therefore covers these basic aspects
of technical prevention.

The maximum permissible concentration of benzene fumes in the atmosphere of
the workplace is sometimes laid down by law, although more often in semi-official
regulations. This is a matter of the greatest importance from the practical viewpoint
if effective action against benzene poisoning is to be taken. Yet the maxima are still
a matter of controversy; hence it might be useful to indicate the levels to be found in
the different legislations consulted. (The figures are sometimes given in ppm, some-
times in milligrams per cubic metre or milligrams per litre. To facilitate comparison,
the figures in the following table are in ppm, with the equivalents in milligrams per
cubic metre).

The research organisations which specialise in the question of the maximum
permissible concentrations of noxious fumes in workplaces have over the years, as a
Country | ppm | mg/m³
---|---|---
Bolivia | 100 | 320
Bulgaria | 17 | 50
Chile | 35 | 110
Czechoslovakia | 17 | 50
Finland | 25 | 80
France | 31 | 100
Germany (Federal Republic of) | 25 | 80
Hungary | 6 | 20
Japan | 25 | 80
Malagasy Republic | 31 | 100
Morocco | 31 | 100
Poland | 31 | 100
Rumania | 17 | 50
Spain: Men | 70 | 220
Women | 35 | 110
USSR | 6 | 20
United States ¹: Florida | 25 | 80
Georgia | 25 | 80
Maine | 35 | 110
Uruguay | 310 | 1000

¹ Under the Walsh-Healey Public Contracts Act, applicable to those who supply the federal Government, the figure for benzene is 25 ppm (80 mg/m³). This limit is also recognised by most states of the United States.

The result of reviewing these matters in the light of experience and more recent scientific data, displayed a definite tendency to reduce these figures.

This question of supervision of the degree of air pollution in the workplace is of fundamental importance, since such supervision is particularly helpful in assessing the risks involved. Moreover, it is by this means that the efficacy of the technical precautions taken can be measured. It has therefore been considered appropriate to include a question on this point. With a view, however, to enabling the application of such a provision to be limited to cases where the danger of pollution is particularly serious the question envisages the compulsory supervision of benzene-fume concentrations only when the substances used have a benzene content exceeding a certain figure to be specified by the competent authorities (question 12).

National legislation often includes special provisions concerning the sanitary facilities to be made available to workers exposed to the risk of benzene poisoning. Such facilities include, in particular, showers and wash-basins. Provisions concerning working clothes and the separate storage in dressing rooms of working and everyday clothes are also to be found. It is often forbidden to introduce foodstuffs into workplaces; in such cases provision is made for canteens, so that the worker can eat in wholesome surroundings, well removed from any possible contamination. All these points are covered in the questionnaire (questions 17 to 21).

**Labelling**

Some countries have adopted rules, sometimes detailed, concerning the labels to be affixed to receptacles containing benzene or benzene containing substances. Thus, it
may be compulsory to indicate the proportion of benzene in the substances concerned. Labelling is an important preventive measure in that it draws the attention of those concerned to the dangers involved; questions on this point have therefore been included in the questionnaire (questions 31 and 32).

**Medical Prevention**

Many countries have enacted detailed legislation concerning this important matter. In most cases, pre-employment medical examinations are compulsory for workers called upon to handle benzene or substances containing it; provision is also made for periodical medical examinations, accompanied by specified tests (blood tests, in particular).

Some countries specify that, after the pre-employment examination, a follow-up examination must be made of a worker’s health shortly after he has been assigned to work involving a risk of benzene poisoning (usually between one and three months thereafter).

To some extent, the intervals between successive medical examinations vary with the risk involved. The most common interval is between three and six months. Longer intervals are sometimes authorised when the worker is exposed to benzene homologues rather than to benzene itself. In some circumstances, after two or three years, if the examinations do not reveal any decline in a worker’s health, the competent authorities may lengthen the intervals between successive examinations, or grant derogations.

In some countries legislation is more rigorous and successive examinations follow at shorter intervals. In some countries the examining doctor may decide to place a worker under observation, in which case he is examined every month.

A number of texts provide detailed instructions concerning the way in which the medical examination is to be conducted and concerning the relevant laboratory tests. The blood tests to be undertaken are frequently described in some detail, and criteria of fitness are defined in relation to data concerning the composition of the blood, bleeding times, analyses of urine, haemoglobin rates, and so forth.

Medical contra-indications which prohibit a worker presenting them from being employed on work exposing him to the risk of benzene poisoning are specified and often include: any form of anaemia, leucopenia, thrombocytopenia, liver troubles, diatheses, organic troubles of the central nervous system, epilepsy, malfunctions of the endocrine glands or autonomous nervous system, neurasthenia or asthenia, mental troubles, low blood pressure, diseases of the kidney or of the sexual glands, anomalies in menstruation, intestinal dyspepsia, nutritional deficiencies, etc.

It should be noted that the legislation usually provides for the cost of such examinations to be borne by the employer.

The main aspects of medical prevention have been taken into account in the questionnaire (questions 23 to 27).

In a good many countries the employment of women or young persons under 18 years on industrial work involving a risk of benzene poisoning, or on certain specific tasks in which such a risk might arise is prohibited. These provisions, the
details of which vary from one country to another, are attributable to awareness of
the high degree of toxicity of benzene, whence the need to ensure that people predis­
posed to suffer from its effects are not exposed to risk.

While not contesting the validity of such an approach, the Office takes the view
that the provisions envisaged in the questionnaire would so reduce the risks that a
general ban on the employment of these two categories of workers would no longer be
essential. Since measures of this kind are based primarily on medical consider­
ations the Office deems it preferable to state the principle of special medical supervision of
women and young workers and to leave it to the responsible doctor to decide in
each case concerning fitness for employment (question 28). As, however, recent
research has shown that a pregnant woman or nursing mother is particularly
vulnerable to benzene, special provision for such persons has also been included
(question 29).

**Education**

In many countries the legislation stipulates that the workers must be kept in­
formed of the risks involved in exposure to benzene. In addition, some texts provide
that posters must be displayed, drawing attention to these risks and setting forth the
precautions to be taken; the actual wording to be used is sometimes specified.

If benzene poisoning is to be prevented, it is most important that the workers be
informed of the risks they may incur and be trained to take the requisite precautions.
These aspects of prevention have therefore also been covered in the questionnaire
(questions 34 and 35).
QUESTIONNAIRE

In accordance with article 38, paragraph 1, of the Standing Orders of the International Labour Conference, governments are requested to send their replies to the following questionnaire, giving their reasons for each reply, so as to reach the Office in Geneva by 30 September 1970 at the latest.

I. Form of the International Instruments

1. Should the International Labour Conference adopt international instruments concerning the protection of workers against hazards arising from benzene and from substances containing benzene?

2. If so, should these instruments take the form of a Convention supplemented by a Recommendation?

II. Scope

3. Should the instruments apply to all activities involving exposure of workers to benzene or to substances containing benzene?

4. (1) Should the instruments apply to substances containing benzene where the benzene content exceeds a level to be fixed by national laws or regulations?

   (2) Should the Recommendation set a level of 1 per cent in volume as the standard to be aimed at in this connection?

5. Have you any other suggestions regarding scope?

III. Restriction of the Use of Benzene

6. (1) Should the Convention provide that benzene or substances containing benzene should be replaced by harmless or less harmful substances whenever effective substitutes are available?

   (2) Should the Convention specify that paragraph (1) above is not applicable to—

   (a) the production of benzene;

   (b) the use of benzene in chemical synthesis?

   (3) Should the Convention provide further that the competent authority of a Member may permit temporary derogations from the obligation specified in paragraph (1) above, after consultation with the most representative organisations of employers and workers concerned, and that in such case the Member in question should, in its reports on the application of the Convention, indicate the progress being made towards the full application of that obligation?
7. (1) Should the Recommendation provide that the use of benzene or of substances containing benzene should be prohibited in certain work processes to be specified by national laws or regulations?

(2) If so, should the Recommendation provide that the work processes so specified should include the preparation of varnishes and paints, the manufacture of inks and colours for the printing industry, the manufacture and repair of waterproof clothing, the manufacture and repair of footwear, and the cleaning of metals?

8. Should the Recommendation provide that measures should be taken to prevent—
(a) the inclusion of benzene in certain industrial products (such as paints, varnishes, mastics, glues, adhesives, inks and various solutions), to be determined by national laws or regulations;
(b) the sale and export of such products if they nevertheless contain benzene?

9. Should the Recommendation provide that benzene should not be added as a solvent or thinner when the products dealt with in question 8 are used?

10. Have you any other suggestions concerning possible provisions on restriction of the use of benzene?

IV. Technical Measures for the Prevention of Hazards; Occupational Hygiene

11. Should the Convention provide that, where workers are exposed to benzene or to substances containing benzene, technical measures should be taken at the place of employment to ensure effective protection of the workers?

12. (1) Should the Convention provide that, where workers are exposed to benzene or to substances containing an amount of benzene in excess of a level to be fixed for this purpose by the competent authority, the employer should ensure that the concentration of benzene in the air of places of employment does not exceed the maximum permissible concentration, which should also be fixed by the competent authority?

(2) Should the Recommendation provide that the level of benzene and the maximum permissible concentration to be fixed in pursuance of the preceding paragraph should be progressively lowered?

13. Should the Recommendation provide that, in premises where benzene or substances containing benzene are manufactured, stocked or used, all appropriate measures should be taken to prevent the escape of benzene vapours into the air of places of employment?

14. Should the Recommendation provide that work processes involving the use of benzene or of substances containing benzene should as far as possible be carried out in enclosed apparatus.

15. Should the Recommendation provide that, where the work is not carried out in enclosed apparatus, places of employment in which benzene or substances containing benzene are used should be equipped with effective local exhaust systems, so as to
ensure the removal of benzene vapours to the extent necessary for the protection of the health of the workers?

16. Should the Recommendation provide that, where for special reasons workers are exposed to concentrations of benzene in the air of a workplace which exceed the maximum permissible concentration referred to in question 12 above, they should be provided with adequate means of personal protection against the risk of inhaling benzene vapours?

17. Should the Recommendation provide that every worker exposed to benzene or to substances containing benzene should wear appropriate work clothing?

18. Should the Recommendation provide that the use of benzene or of substances containing benzene by workers for cleaning their hands or their work clothes should be prohibited?

19. Should the Recommendation provide that food should not be introduced into or consumed on premises in which benzene or substances containing benzene are manufactured, stocked or used?

20. Should the Recommendation provide that, in undertakings in which benzene or substances containing benzene are manufactured or used, all appropriate measures should be taken by the employer to have available for workers—
(a) sufficient and suitable washing facilities, in suitable places and properly maintained;
(b) suitable accommodation for taking meals, unless appropriate arrangements exist for the workers to take their meals elsewhere;
(c) changing rooms or other suitable facilities, where work clothing can be stored separately from the ordinary clothes of the workers?

21. Should the Recommendation provide that the means of personal protection referred to in question 16 and the work clothing referred to in question 17 should be supplied, cleaned and regularly maintained by the employer?

22. Have you any other suggestions concerning possible provisions on technical measures for the prevention of risks and on occupational hygiene?

V. Medical Measures

23. Should the Convention provide that a thorough medical examination for fitness for employment, including a blood test, and periodic re-examinations at intervals fixed by national laws or regulations should be required for employment in any work involving exposure to benzene or to substances containing an amount of benzene in excess of levels which may be fixed for this purpose by the competent authority?

24. Should the Convention provide that the medical examination referred to in question 23—
(a) should be carried out under the responsibility and supervision of a qualified physician approved by the competent authority;
(b) should be certified in an appropriate manner?
25. Should the Convention provide that the medical examinations required thereunder should not involve the workers in any expense?

26. Should the Recommendation provide that—
   (a) a worker should not be assigned to work involving exposure to benzene or to substances containing benzene unless he has been found fit for the work in question by a thorough medical examination;
   (b) the continued assignment of a worker to such work should be subject to the repetition of medical examinations at intervals of not more than one year, to be fixed by the competent authority?

27. Should the Recommendation provide that the medical examinations should—
   (a) include a blood test, in a form specified by the competent authority;
   (b) be accompanied by appropriate advice on health care?

28. Should the Convention provide that there should be particular medical supervision of the fitness for employment of women workers and young workers?

29. Should the Recommendation provide that exposure of a woman worker to benzene or substances containing benzene during medically certified pregnancy and while she is nursing her child should be prohibited?

30. Have you any other suggestions concerning possible provisions on medical measures?

VI. Labelling

31. Should the Convention provide that any container holding benzene or substances containing benzene should have a label on which the word "Benzene" is clearly legible?

32. Should the Recommendation provide that such labels should, in addition, carry—
   (a) a clearly legible indication of the amount of benzene contained in the substance in question;
   (b) the symbol of danger prescribed by national laws or regulations?

33. Have you any other suggestions concerning possible provisions on labelling?

VII. Measures of Education

34. Should the Convention provide that each Member should take appropriate steps to ensure that any worker exposed to benzene or to substances containing benzene receives appropriate instructions on measures to safeguard health and prevent accidents?

35. Should the Recommendation provide that notices should be displayed in appropriate positions on premises in which benzene or substances containing benzene are used, which indicate—
   (a) the hazards;
   (b) the preventive measures to be taken;
   (c) the protective equipment to be used?
36. Have you any other suggestions concerning possible provisions on measures of education?

VIII. General Provisions

37. Should the instruments provide that each Member should, by laws or regulations or any other method consistent with national practice and conditions, take such steps as may be necessary to give effect to their provisions?

38. Should the instruments provide that each Member should, in accordance with national practice, specify the person or persons on whom the obligation of compliance with their provisions rests?

39. Should the instruments provide that each Member should undertake to provide appropriate inspection services for the purpose of supervising the application of their provisions, or to satisfy itself that appropriate inspection is carried out?

40. Should the Recommendation provide that the competent authority in each country should actively promote research into substances which could replace benzene?

41. Have you any other suggestions concerning possible general provisions?

42. (1) Are there any particularities of national law or practice which in your view are liable to create difficulties in the practical application of an international instrument as conceived in this report?

(2) If so, how would you suggest that these difficulties be met?

43. In the case of federal States, do you consider the subject-matter of the proposed Convention appropriate for federal action, or wholly or in part for action by the constituent units of the federation?