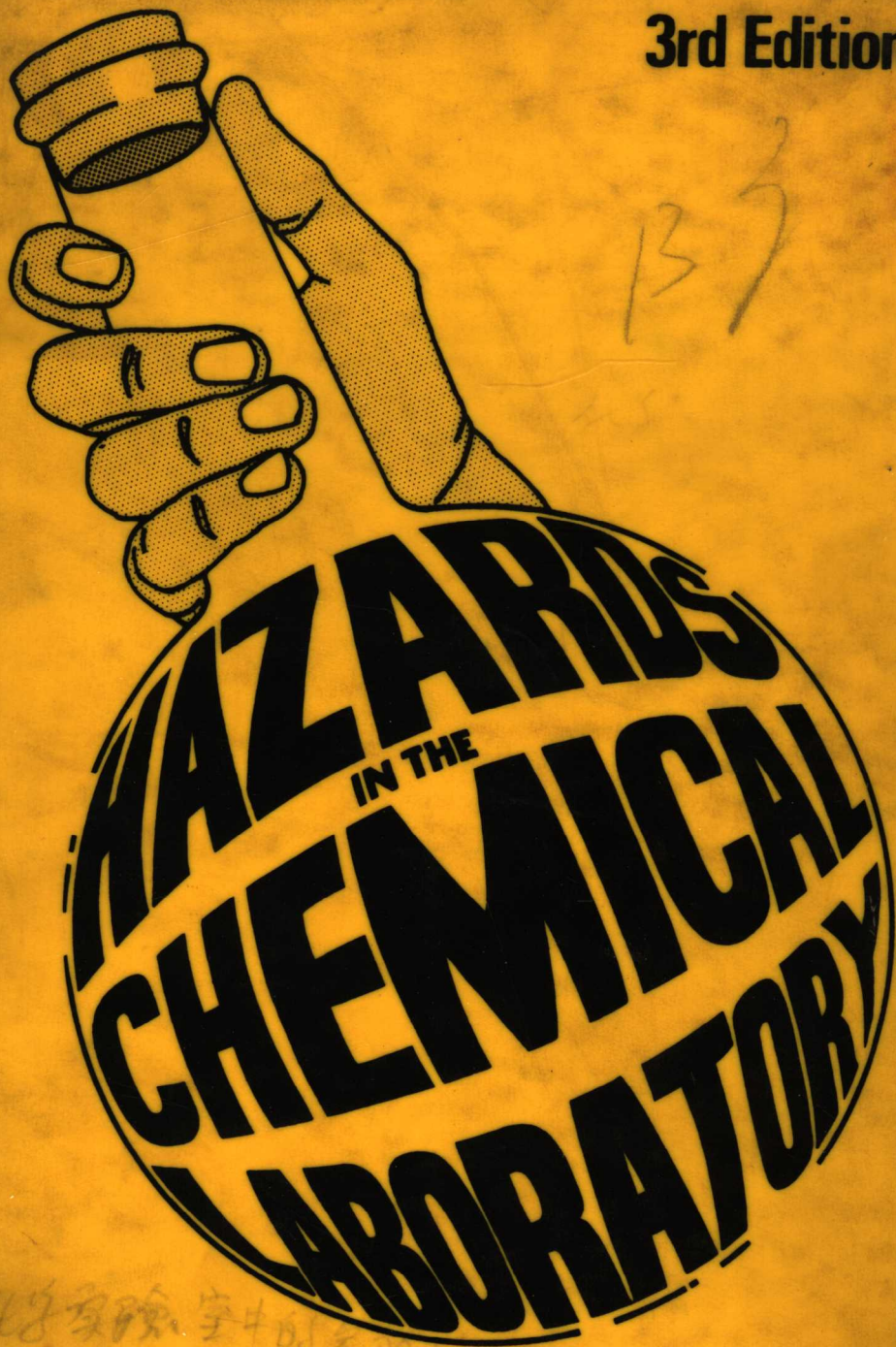


3rd Edition

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Edited by L. Bretherick

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Preface to the Third Edition

The rapid pace of events in safety matters in a laboratory context has led to the need to prepare a considerably revised third edition to reflect the many changes occurring in the four years since Dr Muir prepared the second edition in September 1976. As an example of this pace of events, the *Toxic substances list* (13 000 compounds in 1974) is now the *Registry of toxic effects of chemical substances* with data on some 34 000 compounds in the 1978 edition.

It has been a stimulating challenge to follow in the prestigious footsteps of my editorial predecessor, but Dr Muir has provided guidance, encouragement and assistance at all stages of this endeavour to ease my burden. I have also been fortunate in being able to rely on several of the previous team of authors to update their chapters to match current conditions in their specialised fields, but some changes have inevitably become necessary.

Mr Luxon, as well as revising his Introduction which gives an overview of the laboratory safety scene, has also provided in Chapter 2 an outline of the main features and implications for laboratories of the Health and Safety at Work *etc* Act 1974.

Chapter 3 has been completely recast to reflect modern laboratory practice and equipment, and is retitled 'Safety planning and management' to emphasise the inseparability of safety from good management. In Chapter 4, 'Fire protection', the decease of Mr G. C. Ackroyd left a gap which has been ably filled by Mr L. A. Warwicker, also of the Fire Offices' Committee, who, with Mr M. Sheldon of the Fire Protection Association, has thoroughly revised this chapter and the bibliography.

Some detail of the comprehensive toxicity and carcinogenicity testing now required for commercial chemicals, and comments on the predictive value of such testing have been added by Dr Magos during his revision of Chapter 6, 'Chemical hazards and toxicology'. The following Chapter 7 has been considerably revised by Dr Gilks, and 'Health care and first aid' now deals with mutagens and carcinogens and provides sources of information on toxicity and medical emergencies, both in the UK and in Europe. Appropriate references have been added to both these chapters.

The core of this book, Chapter 8, ('Yellow pages'), has been carefully revised in several respects, to reflect the steadily increasing body of knowledge on hazardous properties of chemicals used or likely to be used in laboratories. The main changes have been threefold. The existing substance monographs and entries have been revised to include 1980 TLVs, new reactive hazards and the modified Council of Europe label warning phrases which may soon be adopted into UK legislation. Several monographs have been added covering a selection of solvents and research reagents which it is now known show unusual or unusually hazardous properties. As in Chapter 7, the emotive subject of the carcinogenicity of chemicals has been faced squarely as a particular toxic effect, and all recognised (*ie* proven) and suspect human carcinogenic substances are now incorporated into Chapter 8, together with a selection of the more potent experimental animal carcinogens. To assist in the general recognition of potential carcinogens, a brief chemical classification of all these types has been attempted and references to more detailed sources are given.

The assistance with information from BDH Chemicals, previously enjoyed by Dr Muir, has been extended to me and this coupled with the assistance from former colleagues at May & Baker and from other professional contacts in the laboratory chemical supply industry ensures a good balance in the selection of materials now covered in this Chapter.

At the original editorial meeting at which this new edition was planned, the decision was taken not to include the previous chapter on 'Safety in hospital biochemical laboratories'. It was felt that this

specific aspect of infectious biological hazards was sufficiently important, both technically and legally, to merit much fuller treatment than was appropriate in a subsidiary chapter in a volume devoted to chemical and toxic hazards. Hospital biochemical laboratories, where both biological and chemical hazards are interfaced, need detailed and comprehensive professional guidance for both facets.

Dr Osborn has had the unenviable task of updating his well-established final Chapter 9, 'Precautions against radiations', at a time when major changes in this area are still impending prior to incorporation of the European directive and other proposals into UK legislation.

Finally, it is a pleasure to record the great encouragement, assistance and support from the editorial staff of our new Royal Society of Chemistry, notably from Dr Ivor A. Williams and Philip Connolly, who was responsible for all that was involved in converting a less than perfect manuscript into the volume now before you.

L. BREThERICK

July 1980

Preface to the Second Edition

Much has happened in the five years since the first edition was published to justify further changes in the scope and emphasis of *Hazards in the chemical laboratory*.

In the United Kingdom, the Health and Safety at Work *etc* Act 1974 has set new standards of safety and responsibility for the country which will soon permeate every practical activity in industry, teaching and research. In tune with this movement towards greater concern for good practice and the well-being of oneself and one's fellow worker, has been the publication by the Royal Institute of Chemistry of a *Code of practice for chemical laboratories* (London: RIC, 1976). This advises all who are involved in chemical laboratory work as to the current professional view of what constitutes good practice, at the same time leaving the responsible managers to devise and supervise the operation of their own laboratory rules and regulations in a manner that recognises the desirability and right of everyone in a laboratory team to play their part in promoting its smooth running.

The monumental, 10-year labour-of-concern, *Handbook of reactive chemical hazards* by Mr Bretherick, has had a major impact upon the

laboratory scene. This is a unique publication of world-wide importance which tackles, in much greater depth than has been attempted hitherto, the very difficult job of gathering together the scattered information about the instability and dangerous reactivity of chemicals, both commonplace and in the 'research' category, that can catch the laboratory chemist or research worker unawares. Today's research chemical quite often becomes tomorrow's routine laboratory reagent and this handbook should do much to reduce accidents caused by violent reactions and explosions.

As Mr Luxon stresses in his 'Introduction', there is public as well as professional concern about the emergence of hazards arising from the unforeseen toxic properties of a number of chemicals that have been in regular use in industry, and sometimes in domestic life, for many years. As a sign of this anxiety, and the enactment of the Occupational Safety and Health Act of 1970, the US Department of Health, Education, and Welfare published the *Toxic substances list* in 1971; this now appears annually and the 1974 edition featured 13 000 different chemicals.

We are very fortunate to have Dr Magos joining our authors to present the current findings of that difficult but rapidly growing science, toxicology, in relation to chemicals. His chapter, 'Chemical hazards and toxicology', follows a similarly authoritative presentation by Mr Bretherick of 'Reactive chemical hazards'. These two new chapters require and deserve very careful study by those likely to be working with the types of materials described by their authors.

At a less mentally exacting, but equally important, level are the two other new chapters on the Health and Safety at Work *etc* Act 1974 by Mr Corbett, and on Medical services and first aid by Dr Gilks. Mr Corbett spells out clearly how the new Act affects the chemist and it is worth noting that a useful new book *A guide to laboratory law*, which outlines the contents of the numerous earlier items of legislation that affect laboratory practice and now operating under the wing of the new Act, was published earlier this year. Dr Gilks outlines the role of the Employment Medical Advisory Service, which is also covered by the Act and stresses the importance of properly trained first aiders who are members of laboratory staffs.

The team that wrote the first edition is still with us, but these authors too have shown their awareness that we are in a period of reconsideration of old attitudes and practices, and have brought their contributions up to date and in line with the spirit of the legislative changes that are in progress.

It has been a great personal help and satisfaction to have Mr Bretherick's ready cooperation with fundamental changes in the book's largest section, Chapter 8 now renamed 'Hazardous chemicals'.

The possibility of providing our readers with immediate references to a great many (but by no means all) of the entries in *Handbook of reactive chemical hazards* has greatly increased the scope of our book, particularly to those engaged in research who would like to go back to the accounts of original incidents. Apart from the new exclusively 'Brethrick' references, Chapter 8 now includes new monographs dealing with chemicals that have found their way more generally into chemical laboratories.

We have to thank old friends again for helping us to get up to date. In particular, BDH Chemicals Ltd records have again been valuable and we are indebted to Mrs E. M. Stubbings and Mr E. R. Sheppard of that company for their assistance in obtaining information. We are also grateful to Mr J. P. Moore of Shell Chemicals UK Ltd, and Mr J. A. A. Forbes of St Peter's Hospital, Chertsey, for valuable comments on parts of the text. An editor is a particular burden to the 'regulars' who tidy up behind him and in this category he places Miss Lynette K. Hamblin of the Chemical Society who 'translated' him and his fellow authors to the printers with great tact and efficiency; his sincere thanks to her must be recorded and to other members of the Society staff who have worked on the book with us.

G. D. MUIR
September 1976

Preface to the First Edition

The present volume is a successor to the Royal Institute of Chemistry's *Laboratory Handbook of toxic agents*, first published in 1960, and issued in a revised edition in 1966. Before the second edition went out of print, the future of the publication was considered by both the Institute's Publications Committee, and by the previous editor, Professor C. H. Gray, and myself. It was generally felt that, rather than merely revise the existing material, it would be preferable to alter the underlying philosophy of the book by changing its scope from toxic hazards to a consideration of all hazards likely to be encountered in the chemical laboratory

The general format remains the same, with the major part of the book (printed on tinted paper) being an alphabetical guide to hazardous chemicals and measures to be taken in the event of accidents in their use. However, whereas previous editions have included details of measures to be taken against the toxic hazards of such chemicals, the present edition also includes methods for spillage disposal and extinguishing of fires where appropriate. Once more, an alphabetical

listing is adopted to enable the use of the book as a speedy reference in the case of emergency.

Much assistance was required in preparing this chapter, now extended to over 430 hazardous chemicals, and the preceding one on first aid. I must record my special thanks to my colleague Mr W. G. Moss for his collaboration when we prepared these chapters for the first edition of the earlier book, and to BDH Chemicals Ltd for permission to use their extensive records on the hazards, handling and disposal of chemicals; also to my colleague Dr P. Mostyn Williams who has added considerably to the earlier medical advice of Dr W. B. Rhodes.

Dr D. P. Duffield and Dr K. P. Whitehead of Imperial Chemical Industries Ltd have also provided important medical advice on up-to-date first aid practice, particularly on the treatment of cyanide and phenol poisoning. The chemical world must always be grateful for the pioneer efforts of ICI in encouraging chemical factory and laboratory safety and we would record again our thanks to Dr A. J. Amor and Dr A. Lloyd Potter for their interest in the first book and to pay special tribute to the work of Dr L. J. Burrage who has contributed so much to promote laboratory safety in this country.

Many other firms have given us the benefit of special knowledge of certain of their products and we are also grateful to James North & Sons Ltd for permission to reproduce their chart advising on the types of glove to be used when handling different classes of chemicals.

Despite extensive practical experience of chemical hazards, the writers of a book such as this lean heavily on the authors of major works on industrial toxicology. Not many may have had the privilege of knowing the charm and intelligence of that great lady, Dr Ethel Browning, who guided the Institute and some of the authors when the first book was conceived and drafted, and wrote two renowned works upon which we have drawn extensively, *Toxicity and metabolism of industrial solvents* and *Toxicity of industrial metals*, as well as editing the important series of monographs on toxic agents in which they appeared. Her death last year ended a long life of devoted service to industrial safety.

The valuable publications of the Chemical Industries Association—*Marking containers of hazardous chemicals* and *Exposure to gases and vapours*—have been referred to frequently and we would like to thank the Association for the privilege of perusing the text of the latter at the proofing stage. The *Laboratory waste disposal manual* published by the Association's counterpart in the US, the Manufacturing Chemists' Association, was also consulted extensively in preparing chapter 6, as were the following works:

Dangerous properties of industrial materials by N. Irving Sax

Extra pharmacopoeia (Martindale) edited by R. G. Todd

Industrial hygiene and toxicology edited by Frank A. Patty

Industrial toxicology by L. S. Fairhall

Poisoning by drugs and chemicals by P. Cooper

Poisons by Brookes and Jacobs

Toxicology of drugs and chemicals by W. B. Deichmann and H. W. Gerarde.

Other acknowledgements appear in chapter 5.

Of the remainder of the book, new chapters have been provided by Mr Ackroyd, Dr Taylor and Mr Sheldon on fire protection and by Mr Neill and Dr Russell Daggart on the particular hazards facing chemical workers in hospital biochemistry laboratories. In addition, Mr Luxon, of the Department of Employment, has contributed an entirely new introduction to replace the one by the late Sir Roy Cameron which appeared in the earlier editions. Mr Beard and Dr Osborn have thoroughly revised chapters 2 and 7 respectively. To all these authors, I am extremely grateful for the time they have spent on and interest shown in this project.

Dr Farago and his staff in the Editorial Office of the Institute have my sincerest thanks for their painstaking help and I am particularly indebted to Dr Martin Sherwood for his close collaboration in co-ordinating our efforts, sharing in our proof reading, and carrying out all the necessary negotiations with the printers. With my co-authors he has made the task of editing not only light, but both stimulating and enjoyable.

Finally, I should like to pay tribute to the immense amount of work which Professor Gray put into the planning and production of both editions of the *Laboratory handbook of toxic agents*. Although pressure of work prevented Professor Gray from taking a full part in the editing of this volume, I have had the benefit of his wise advice throughout its preparation. Without this and the substantial contribution he made to the earlier book, it is unlikely that this volume would have been possible.

G. D. MUIR
April 1971

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Chapter 1

Introduction

Since the publication of the second edition, there has been continuing public concern and debate on all matters relating to safety and health and in particular on the provisions in The Health and Safety at Work *etc* Act 1974 which provides a new approach and legal framework in respect of the control of such hazards.

As indicated in Chapter 2, the general purpose of this Act is to provide for one comprehensive and integrated system of law dealing with the health and safety of all persons engaged in work activities and the health and safety of others who may be affected by such activities. It is important that everyone concerned with work in the laboratory is aware of and accepts his legal responsibilities. Until specific subordinate legislation is enacted, guidance as to what may be required in laboratories may be drawn from existing parallel legislation in other areas such as factories, and from codes of practice such as that on the use of ionising radiation. More general guidance and the reasoning underlying such guidance is contained in this handbook.

Particular attention should be paid to systems of work and to the clear delegation of specific responsibilities to those organising units of

laboratory activity. A further important aspect of the legislation lies in the requirements in respect of consultation and this places a particular responsibility on chemists who are best able to advise the layman on the hazardous nature and properties of chemical substances, and the precautions necessary to ensure their safe use. It is, therefore, important that everyone concerned makes an evaluation of all aspects of health and safety and puts in train any necessary steps to ensure that his house is in order.

Regrettably, perhaps, in the past chemists, who habitually handle dangerous substances, have been inclined to disregard the hazards associated with their use particularly if such hazards are of a long-term nature. Every human being, and a chemist is no exception, tends towards the view that although an accident may happen to another, it will never happen to him personally because he is too wise and knowledgeable. Experience shows that nothing can be further from the truth. During work in the laboratory, many persons have suffered injury to their health which because of the insidious symptoms, may never have been associated with their work activity. It is only when permanent injury has occurred that many persons come to realise that the observance of even elementary precautions could have prevented such injury or, in extreme cases, premature death.

It is against this background that one should look at this edition of the handbook. The contributors have attempted to indicate and discuss the dangers likely to arise in the laboratory and have offered practical advice on their avoidance. The work will, I believe, also prove most useful in devising precautionary techniques in respect of the many reagents and substances which, for reasons of space, have not been included in this work.

At the same time this manual has become a much more useful and complete work not only for chemists in the laboratory but also for all those who handle hazardous substances on a small scale *eg* in industry. Additionally, the work will be useful in schools and higher education establishments where training in the correct use and handling of the substances should be considered an integral part of the curriculum of students in science subjects, and where the Health and Safety at Work *etc* Act has extended specific obligations in respect of safety and health matters.

The control of hazards of the laboratory is well known: the enforcement of safe work systems; the need for mechanical safety involving the guarding of dangerous parts of machines, even if driven by only fractional horse power motors, so that injury from contact with moving or trapping parts is prevented; the need to provide safe means of access to every place where anyone is at work even if the work is only

undertaken on rare occasions; the need for good housekeeping to minimise the possibility of accidents occurring through persons striking or being struck by objects; the need for care in handling glassware; the need to protect electrical conductors and to provide or use low voltage supplies or adequate earthing; and, of course, the matters with which this handbook is intimately concerned—the prevention of injury from fire, explosion or from exposure to hazardous substances.

Identification

Perhaps the most important single step we can take in securing the safe handling of chemicals is to ensure that a proper system of labelling is used that will identify the substance, indicate the hazards involved, and set out the simple precautionary measures to be followed. There has, of recent years, been considerable international discussion concerning labelling systems and the Council of Europe has published proposals concerning the labelling of pure chemical substances. This system is described in the so-called 'Yellow book', *Dangerous chemical substances and proposals concerning their labelling*, which can be purchased from HMSO. The EEC has embodied these general proposals in specific directives on pure substances and solvents. Other directives dealing with formulated products are in the course of preparation. The Health and Safety Executive has recently consulted interested parties on the formulation of legislation to give effect to these proposals. Chapter 8 follows these proposals both in respect of substances covered by the directives and similarly in respect of other chemicals. Failure to give some such simple warning of hazards is inexcusable, particularly in the laboratory where many chemicals may at some time be handled by inexperienced and unskilled persons who are not members of the lab staff *eg* cleaners and maintenance workers. Accordingly all chemicals should be labelled following the general guidelines used in these systems and set out elsewhere in this work.

Management's task

Safety and health is the responsibility of management and must be set out in a policy statement. Not only must the manager and all members of the staff know the hazards involved, but they must all be clearly seen to be directly interested and involved in the promotion of a safe and healthy environment. Strict procedures should be written into analytical and other methods. Where such methods do not exist, the work should be immediately supervised by a responsible person who is aware of the dangers and precautions to be followed both during normal