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"To the solid ground
Of Nature trusts the mind that builds for aye."—WORDSWORTH.

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Safety Work in Chemical Industries.

THE common impression that chemical industry is exceptionally dangerous is largely derived from such disasters as the serious explosion at the Royal Naval Cordite Factory, Holton Heath, on June 23, in which ten men were killed and three seriously injured. Like the Castleford disaster of last year, the explosion originated in the nitrating house, and indicates the devastating effects of chemical processes which are allowed to get out of control.

In spite of the poisonous and dangerous materials and the high temperatures and pressures which are frequently used, the accident rate in chemical industry compares very favourably with that of other industries, in a number of which both the frequency rate and the severity rate of accidents are considerably higher. This position is the result not only of experience but also of accurate and scientific control of the manufacturing processes. Chemical manufacturers are now well aware of the dangers connected with their industry, and take every possible step to reduce the number of accidents in chemical industry and develop adequate safety measures.

It is, indeed, significant that even in processes which to the ordinary person appear to involve the greatest risks, the accident rate, as a result of exceptionally strict control, is even lower than normal. The price of safety is unceasing vigilance, and the characteristic of chemical industry is not a high accident rate, but the appalling consequences which may attend the single slip or oversight on the part of the human element, which is responsible for 90 per cent of industrial accidents. The Castleford disaster may apparently be traced to the neglect to sample the waste acid storage tanks in the ordinary way, the Home Office inspectors observing that proper sampling might have led to detection of the presence of the nitro-compound in the acid mixer and allowed suitable precautions to be taken.

Even the strictest control may, however, at times be thwarted by some abnormal conditions, and if, as at Holton Heath, responsible officials such as the chemist in charge perish in the explosion, or, as at Chatterley, Stoke-on-Trent, on June 3, lose their lives in attempts at its control, it is difficult to detect the abnormal circumstances responsible and devise precautions to prevent its recurrence. This emphasises both the need for research into the causes of accidents and the importance of correlating, by publication, abstracting, and indexing, the information obtained by research or other means.

As noted in a recent article in NATURE (May 30, p. 805), to this formidable problem scientific workers have as yet given inadequate attention. Much valuable work has already been done, especially in chemical industry, which compares very favourably with other industries. In Germany, the work of the Berufsgenossenschaft der chemische Industrie is well known, and its publication in *Die chemische Industrie* of illustrated notes on accidents, safety precautions, and devices compiled by the technical inspectors receives a wide circulation. In Great Britain, the efforts of the Association of British Chemical Manufacturers, which in the last two years has undertaken the task of abstracting, indexing, and publishing safety information pertaining to chemical industry, are by no means so well known as they should be. The Association has published quarterly, since January 1930, a classified summary of safety information, derived not only from published literature but also from the records of the Association. The latter include information supplied privately by members of the Association, and this adds very considerably to their value. The wider the membership of the Association, and the more fully its members co-operate in this work by pooling their information on safety matters, the more effective and invaluable its Safety Summary will become.

In addition to the Safety Summary, the Association of British Chemical Manufacturers has for several years published what are termed "Safety Circulars". These are single sheets dealing with accidents which either present some unusual feature or indicate some useful precaution. The circular usually describes briefly the accident and its cause, and gives the views of the Works Technical Committee of the Association as to the precautions necessary to avoid repetition of the accident. Recent circulars have dealt with the escape of sulphuric acid in transfer by air pressure from a tank waggon to a raised storage tank, fires at a tar distillation plant and benzole plant, the bursting of a drum of phenol by compressed air, and fires at cellulose spraying plants. Such circulars are obviously of an interest which is not confined to chemical industry in the narrower sense. This is recognised by the Association, which holds the view that safety information, like medical science, should receive the widest possible publication. Accordingly, not only has a system of co-operation been arranged for the pooling of information with French and German colleagues, but also the benefits of its safety service are available to non-members on payment of a suitable fee.

A further feature of the safety work of the Association of British Chemical Manufacturers is the "Model Safety Rules for Chemical Works", of which Part 1 and a first section of Part 2 have already been issued to its members. These rules, as indicated by Mr. J. Davidson Pratt in his recent address on "The Cleaning and Repair of Plant and Vessels containing Dangerous Materials" at the Chemical Session in the National Safety First Week at Leeds, in some respects go beyond the Chemical Works Regulations issued by the Home Office. The addition to which Mr. Pratt particularly referred was intended to prevent misunderstanding where the full implications of the regulations regarding the thorough removal of dangerous material might conceivably be overlooked.

In his paper, Mr. Pratt outlines the main types of risk attached to the cleaning of containers and the chief precautions to be taken. While the details to be followed may vary widely with different materials and classes of vessel, certain general principles can be enunciated. For these the widest publicity is desirable, especially since volatile and dangerous solvents are now widely used in industries where the scientific knowledge and control is by no means so prominent as in chemical industry. In such industries the design of plant to facilitate safe cleaning may be completely overlooked and the question of responsibility assumes great importance.

Even in chemical industry the term 'responsible person' does not always receive an interpretation consistent with its use in the Chemical Works Regulations. Many serious accidents have occurred because the testing of stills or containers prior to repair work or entry by workmen has been entrusted to persons without adequate scientific knowledge. Under modern conditions, industrial safety requires the employment in industry generally of larger numbers of chemists and other responsible scientific workers. Under-staffing on the scientific side definitely increases the risks of operatives, and while it is probable that some delegation of responsibility is unavoidable under industrial conditions, the scientific and technical staff should be adequate to ensure thorough training of, and personal contact with, those to whom such responsibility is at any time delegated. It was a public-spirited policy which led the organisers of the British Association of Chemists to include in its programme the endeavour to secure legislation providing that certain prescribed operations should be under the direct control and supervision of a qualified chemist. While in practice such operations can frequently be carried out by well-trained assistants, their efficiency, especially from the safety point of view, depends upon uninterrupted personal contact with a responsible chemist upon whose experience and knowledge they can draw at once in emergency.

Radioactivity and the Atomic Nucleus.

Radiations from Radioactive Substances. By Sir Ernest Rutherford, Dr. James Chadwick, and Dr. C. D. Ellis. Pp. xii + 588. (Cambridge: At the University Press, 1930.) 25*s*. net.

THE appearance of a new book on radioactivity by Lord Rutherford and his associates is a noteworthy event in the world of physics. Rather than prepare a new edition of his standard treatise on "Radioactive Substances and their Radiations", the senior author has chosen to devote his present discussion primarily to the significant developments in radioactivity which have occurred since that treatise appeared. These developments deal primarily with the characteristics of the radiations from radioactive materials and the effects which they produce. In view of the present state of physics, and the fundamental questions associated with the outer part of the atom apparently well understood, and the atomic nucleus offering perhaps the most vital problem with which physics is now faced, we are fortunate to be presented with this clear and comprehensive account of the information regarding the nucleus which is afforded by studies in radioactivity. Nothing could be more timely.

One is impressed by the extent of the important information that has come from recent studies in radioactivity. Thus, among other things, discussions are found of the disintegration of atoms by alpha ray bombardment; the studies of nuclear charge and nuclear size by the scattering of alpha rays; the discovery of rare alpha, beta, and gamma particles of extraordinarily large energy, revealing hitherto unsuspected types of disintegration; the quantum mechanics theory which describes how radioactive disintegration is possible; magnetic beta ray spectra, and their associated gamma ray spectra, revealing nuclear energy levels and evidence that electrons as discrete entities may not exist within the nucleus; crystal measurements of gamma ray wave-lengths, and the precise confirmation of Einstein's photoelectric equation at very high frequencies; recent quantum theories of gamma ray scattering; experiments with cosmic rays and their significance regarding the origin of the rays. Many of these developments have resulted from the labours of the authors themselves, and none could be found better qualified to describe them.

Gradually our knowledge regarding the atomic nucleus becomes more precise. Experiments with scattered alpha rays have shown its minute size and its relative large mass. They have enabled us to measure its charge, and even to estimate the field of electric force in its neighbourhood. Further information on the latter point is given by the speed with which the alpha particles are ejected from the radioactive nucleus. Combining the evidence from these alpha ray experiments, it becomes evident that surrounding the nucleus there is a 'potential wall', which prevents alpha particles that are outside from entering the nucleus and those on the inside from escaping. We are thus afforded a basis for developing a quantum theory of radioactive disintegration according to which the probability of an alpha particle jumping this wall is greater if it has large energy, and a qualitative explanation of one of the fundamental laws of radioactivity is obtained. Studies of the sharpness of gamma ray lines suggest a nucleus in which planetary alpha particles correspond to the electrons of the outer atom; though how these particles are held together remains unknown. Similarly, the condition of the electrons in the nucleus remains unsolved. There is no gamma radiation that can be traced to these electrons, and when they appear as beta particles their energies are distributed over broad bands. Though much new light is shed by these studies in radioactivity, the nucleus of the atom,