poor output and high labour wastage; there is also boredom and discontent. Whether a person is bored or interested in his work depends upon whether he is properly suited to that work; some people are suited by supervisory jobs, and others are most happy when doing apparently dull, routine, mechanical jobs. To be properly suited all individuals should be helped to find the right job when they leave school and, later, in any change they make; and, when labour is short, it is most important to use the labour force to the best advantage. It was Sir Walter Raleigh who said, "The nightingale did not win a prize in the poultry show"; a real attempt must be made to match the person to the job and the job to the person. Boredom or interest will also depend upon the extent to which the individual participates in the affairs of the firm; this may be encouraged by formal and informal joint consultation. Interest also depends upon the social environment and, for many people in industry, what matters most is neither the job nor the pay but the people they are working with; workers' solidarity is one of the strongest motives in industry.

Probably, however, the greatest effect upon motivation depends upon whether an individual feels he is being fairly treated; pay is always thought of in relation to other individuals. Another factor affecting motivation for or against work is whether individuals are repressed or encouraged; pride in the job is an important incentive. Training is also important since the individual feels that opportunities for training may lead to promotion.

After discussing motivating forces in general, Mr. E. W. Hughes advocated the use of intelligent rather than sentimental control of the prime urges to action. Among the more permanent incentives he regarded the need to satisfy self-expression through some activity as one of the most important, especially if the effort is recognized by the group in terms accepted by the group. Mr. Hughes has had special experience in the mining industry, and here, although many motivation problems are similar to those of other industries, the industry still has a long leeway to make up in certain conditions of work. But the effort is being made, and the National Coal Board is making a genuine and not unsuccessful attempt to remove factors which cause accidents, the stigma which goes with dirty faces and dirty clothes, and other deterrents. At Keresley Colliery, near Coventry, for example, the surface lay-out is such that, but for the pit-head gear, the colliery could be mistaken for a light engineering factory. In South Wales the casualties caused by dust resulted in a drift from the industry. The dust problem has been energetically tackled, and miners are returning to the industry.

Among the reasons why people enter the coal-mining industry is security of tenure. This is particularly true of young men and, for them, various apprenticeship and training schemes have been devised. Good wages have not the incentive value usually described, as is shown by the reduction of the mining labour force despite considerable increases in pay. Mr. Hughes also expressed the need for an extended system of joint consultation at horizontal levels in the mining industry.

In his address on organization and the person Mr. R. W. Latham suggested that joint consultation is not consultative procedure but an attitude of mind. Nor is it new despite the official introduction of joint consultation to industry by Sir Stafford Cripps in 1942; some small firms in Britain had established machinery for joint consultation in the eighteenth century. Mr. Latham also pleaded for the use of *ad hoc* committees in those departments of a factory which have particular problems. But he could not agree with other speakers who believed that, apart from wages negotiations, confidential matters to the firm and about individuals, nothing should be barred from discussion at works councils. According to Latham, most workers do not understand balance sheets or market research, and he advocated the education of industrial employees as one of the most urgent needs of to-day; this should be undertaken by the trade unions themselves. The majority of workers do want to participate in the activities of their firm, but, despite the clamour of a small minority, they do not want control.

In the ensuing discussion probably the most interesting point which arose concerned the profit motive and the social purpose of industry. This was summarized by one speaker as consisting of three main factors: first, it is generally accepted that private industry cannot be allowed to follow its own way without an ethical code; secondly, bureaucratic control is bad for industry because it is so negative; thirdly, there is a considerable and justifiable demand for participation in the control of industry and responsibility for running it by all who are engaged in it.

T. H. Hawkins

INDUSTRIAL RADIOLOGY GROUP OF THE INSTITUTE OF PHYSICS

SUMMER MEETING

THE summer meeting of the Industrial Radiology Group of the Institute of Physics was held at the Institute's House, 47 Belgrave Square, London, S.W.1, during July 23–25. A programme of lectures, covering a wide field of interest to the industrial radiologist, was arranged. One of the most interesting was that by Mr. L. van Ouwerkerk (Röntgen Technische Dienst, Holland), with the title "Xeroradiography", which it was explained is a dry method without the use of photographic films and is at present in the laboratory stage.

Mr. van Ouwerkerk stressed that his was largely a report of what had been done in the United States on this subject. Starting with a description of the application of xerography to photography, he described how a layer of photo-conducting insulating material, deposited on a metal plate, is charged and then exposed to light, with the resultant leaking away of the charge in proportion to the light falling on any spot. This latent image is developed by dusting with a fine powder which adheres only where the plate is charged. Prints can be made by transferring and fixing the powder image to paper. In elaborating these points Mr. van Ouwerkerk described in detail the requirements of the photo-sensitive plate as regards electrical conductivity and how it is charged under corona discharge, as well as the action of incident light in discharging it. He said that the latent image can be retained on the plate for several days, and described how it is developed by a powder mixture consisting of a fine resinous powder and a granular carrier of relatively large particle size, which serves to generate a charge on the smaller powder particles.

This powder image can be transferred to paper, plastic, material, etc., charged with the opposite sign and placed in contact with it, and is then fixed by fusing the resinous powder.

In considering the application of the method to radiography, Mr. van Ouwerkerk said that the inherent unsharpness due to grain size is better than for photographic film. Finer powders are used for development than in the case of xerography. One interesting point is that a crack in the object being radiographed gives an enhanced effect due to the localized charge there. The method has been successful with energies between 5 kV. and 10 MeV., exposure times required being somewhat less than for X-ray films. Good definition is obtained. In concluding, Mr. van Ouwerkerk said that the obvious advantages of the method make it merit our attention in the future.

In opening the discussion on Mr. van Ouwerkerk's paper, Mr. D. T. O'Connor related his own experiences with xeroradiography. The materials are inexpensive, the main difficulty being the selenium-coated plate, produced by the vacuum coating technique. For charging the plate almost any material is suitable, such as powdered charcoal, the cloud method being the simplest process. In this the powder is blown through a tube by means of compressed air into a box containing the plate. Mr. O'Connor spoke of the high cost of X-ray films for radiography and of their possible scarcity. Mr. van Ouwerkerk said that some loss of sensitivity is unavoidable in making permanent records by fusion of the sprayed powder; but it should be possible to compensate for this to some extent by increasing the contrast in copying. The only limitation in the size of the plate is in obtaining a uniform coating of selenium. Metal intensifying screens must, of course, not be in metallic contact with the plate, but this does not appear to cause loss of definition. He agreed that atmospheric humidity may cause some loss of charge of the plate.

One morning session was devoted to a symposium on "Penetrameters", and in introducing this Mr. J. C. Rockley (Aeronautical Inspection Directorate, Harefield) stated that a wider use of these is desirable; but that guidance is needed in their correct use, since the results obtained from different types do not always agree. He said that the function of the penetrameter is that of quality control, and in his opinion the step type gives a good idea of sensitivity and contrast, while the wire or ball type gives an idea of definition. He concluded with some remarks on deciding the position of the penetrameter on the specimen.

The principal speaker in the symposium, Mr. B. Schuil (Röntgen Technische Dienst) started by criticizing the name 'penetrameter', since the device neither measures nor expresses any quality in accepted units. penetration cannot, he claimed, be measured by expressing it as thickness-sensitivity, that is, the percentage of the wall thickness indicated by the last visible step or wire, since this depends on both geometry and exposure technique. A true penetrameter should compare the intensity of radiation after passing the object with that of the primary beam. In asking why we use penetrameters, Mr. Schuil said that their use means getting the best penetrameter image as regards contrast and definition. He gave as an example a case in which, by using salt screens instead of lead screens, a higher sensitivity was obtained due to greater contrast, in spite of the poorer quality image. But an optimum penetrameter image does not, he maintained, guarantee a sound object; many other factors influence the detection of flaws. Again, with very hard radiation, the absolute flaw sensitivity increases, and it is not possible to express it as a percentage of the plate thickness; rather, a certain minimum thickness can be revealed. Regarding different types of penetrameter, Mr. Schuil said that there is no ideal form, but he prefers, in general, those using wires to those using step-wedges or test plates, such as are recommended by the boiler code of the American Society of Mechanical Engineers. He concluded with some remarks on the practical use of penetrameters and the ideal penetrameter.

In opening the discussion on penetrameters, the chairman, Mr. C. Croxson (Armament Research Establishment, Woolwich), pointed out the advantages of having separate checks for definition and contrast, as embodied, for example, in the Ministry of Supply penetrameter. As a check on definition he suggested (*a*) fine wires of material similar to that of the specimen for use with small thicknesses, and (*b*) drilled holes in a plate, of similar material to that of the specimen, about 0·02 in. in diameter and of minimum depth to give just perceptible images; the latter for use with thick specimens. Mr. O'Connor said that a test object of comparatively large area is needed to assess contrast, and one of small area to assess definition. He expressed no particular preference for the step wedge type over the strip type used by the American Army Ordnance. Dr. A. Nemet pointed out the interrelation of contrast and definition; and while Mr. Croxson agreed, he said that nevertheless a more sensitive penetrameter can be made by having separate checks for the two, as he had suggested. Mr. E. Owen (Hadfields, Ltd.) said that he has found that the ball type of penetrameter has the poorest sensitivity. Other points made were the desirability of an identification mark as an integral part of a penetrameter; the necessity for a robust inexpensive construction; and the desirability of flexibility for penetrameters to be used on curved surfaces. The comments appeared on the whole to favour the wire type of penetrameter, but it was evident that it is as yet premature to consider the standardization of any particular types.

At further sessions Mr. D. Bromley (Admiralty Materials Laboratory, Poole) spoke on "An Analysis of the Quality of Radiographs", Mr. J. Rhodes (Royal Ordnance Factory, Woolwich) on "Gamma-ray Stereography", and Mr. H. Vinter (Denmark) on "The Correlation of Radiographic Results with Weld Strength". A comprehensive paper describing non-destructive testing in Germany was read for Prof. R. Berthold (formerly of the Reichsröntgenstelle, Berlin) in his absence, and Mr. E. van Someren (Murex Welding Processes, Ltd.) gave a paper entitled "Short Range Radiography". The meeting concluded with a symposium on "The Site Radiography of Pipe Welds", at which Mr. F. H. Gottfeld (Solus Schall, Ltd.) and Mr. R. V. Walker (Ministry of Supply) were the principal speakers.

An exhibition of apparatus of interest to the industrial radiologist, arranged by Mr. J. C. Rockley, was held concurrently with the summer meeting and comprised six sections. The first illustrated radioactive materials in industrial radiography and showed, as an example, the construction of a radiographic source containing radon and the extraction of the necessary radon. Further exhibits showed containers for gamma-ray sources and devices for handling them, a total of nine exhibits. Six of these were available

commercially, and the remainder had been designed by individual radiologists to meet their own needs. Protection was covered in this section by a selection of portable monitors, dosemeters and film badges suitable for workers with gamma-rays. Further exhibits showed the lay-out of X-ray laboratories by means of a model and photographs, as well as samples of many of the protective materials on the market. A section of outstanding interest showed by means of specimens the development of X-ray tubes from 1896 to the present day, mostly loaned by Messrs. Newton Victor, Ltd. In a section devoted to special applications of X- and gamma-rays, interesting examples were those on the use of X-rays in micro-radiography by the Bristol Aeroplane Co., Ltd., the autoradiography of radium and radon containers as a check on the correct distribution of the radioactive material by the Radiochemical Centre, Amersham, and electron radiographs of bank-notes taken by the Atomic Energy Research Establishment, Harwell, from the scattered electrons using an iridium-192 source. The section on stereoradiography, arranged by Ilford, Ltd., showed some striking applications of stereo work in radiography, together with examples of the apparatus required for this work. The section on radiographs covered a wide field in which twelve firms exhibited. Johnson Matthey and Co., Ltd., showed radiographs of brazed fittings, and Kodak, Ltd., had an instructive exhibit showing how gratuitous markings on the film due to various external causes can mislead the radiographer. Exhibits by the Aeronautical Inspection Directorate and the Atomic Energy Research Establishment showed the wide range of problems ranging from plywoods to wire-wound resistors that had been dealt with by these establishments. A final section showed a working model of a beta-ray thickness gauge.

B. N. Clack

EFFECT OF COLD ON MICRO-ORGANISMS

THE autumn meeting of the Society for Applied Bacteriology was held in the lecture hall of the London Medical Society on October 23, when a symposium was held on the subject of "The Effect of Cold on Micro-Organisms". There were about 120 members and visitors present.

Dr. A. T. R. Mattick (National Institute for Research in Dairying) opened the symposium by a short historical survey of the subject. He described how the lethal effect of freezing on bacterial cells, originally thought to be due to the crushing mechanism of ice crystals, has now given way to the concept of protein denaturation and precipitation. This is due to the classical work of Haines in 1937, who found that freezing at temperatures between −5° and −70° C. had no effect on the mortality of *Pseudomonas* species of bacteria, but that temperature is significant for survival on storage. Between −1° and −20° C., greater death-rates were found at the higher temperature, the critical maximum being −2° C. Extending these observations further, Weiser and Osterud in 1945 emphasized the difference between immediate death caused by the action of freezing, which is independent of temperature, and storage death, which is dependent on temperature and time. Storage death-rates are lower at temperatures below −30° C. than at temperatures above this value, such that at −195° C. no deaths appear to take place.

The limiting temperature below which all organisms cease to grow is about −8° C., although many bacteria will remain viable for long periods below this temperature. For example, *Streptococcus fæcalis* has been found viable in cheese after seven years at −15° C., and coliforms and *Pseudomonas* species have been found in butter. The metabolism of many bacteria is affected by reduced temperatures, the effect being largely that of change from saccharolytic to proteolytic and lipolytic action.

Dr. J. G. Davis (United Dairies, London), discussing the effect of cold in relation to dairying, said that the changes in metabolism which many bacteria undergo at reduced temperatures often give rise to pigment formation; for example, *Pseudomonas* can readily produce colour in milk and has been known to impart a blue-black pigment to butter. Probably more significant is the bitter, or sometimes 'oxidized' or 'oily, taste acquired by milk due to the lipolytic activities of micro-organisms. Plate counts on such milk samples may not be significantly affected; but the methylene blue test shows a marked decline. It is doubtful whether any cryophilic organisms can survive pasteurization, but obviously any which might escape such treatment will be liable to exert an adverse effect on the milk.

Ice cream of good quality can be stored satisfactorily at −10° C., at which temperature the bacterial count tends to fall; and, contrary to early opinion, cheese can be ripened at low temperatures and gives a better product free from bitter taste.

Dr. M. Ingram (Low Temperature Research Station, Cambridge), dealing with cold in relation to the microbiology of foods, said that all spoilage is due in the first place to the activities of micro-organisms. Freezing, however, is not always possible with many foodstuffs—for example, fruit and meat—and chilling only can be employed. The Q_{10} value of 2, which usually obtains in chemical reactions, is subject to much variation in bacteriology and depends very much on the species of micro-organisms being considered. It is, in fact, much higher than 2 at lower temperatures; hence a difference of only 1 or 2° C. at these levels may have a considerable effect on rate of spoilage. With all tissue material, especially the living tissues of fruit, a balance has to be sought between tissue damage or death and bacterial rot.

In general, pathogenic organisms cease to grow below about 5° C., *Bact. coli* at −5° C., and *Achromobacter* and *Pseudomonas* species at −3° C. Staphylococci and spore-forming bacteria do not suffer a high mortality on freezing, but most other types do. Mortality and storage death-rates are reduced by such substances as sugars and glycerol, and osmotic pressure plays a considerable part.

Enzyme action is not stopped by cold at anything like the same rate as bacterial growth; hence much lower temperatures are necessary for the preservation of some foods such as peas, herring and bacon.

Mr. H. Proom (Wellcome Physiological Research Laboratories, Beckenham) described some problems associated with freeze-drying. Freeze-drying for biological purposes was first described in 1909 by Shackle. Later, in 1933, Flosdorf and Mudd used a manifold process, and afterwards sublimation and spin-freezing methods were developed.

The effect of freeze-drying on the viability of bacteria varies with the species and the medium employed; but the importance of the process is in