

found in institutions engaged in unclassified research, cannot be used for the production of atomic weapons or for the generation of power. In addition to information on uranium, details of the properties of plutonium-239 and xenon have also been released.

The following is a summary of the information made available.

*Thermal-neutron effects for uranium.* Thermal-neutron cross-sections for uranium (in barns for neutrons moving at 2,200 m./sec.) are as follows:

	Uranium-235	Uranium-238	Natural uranium
Fission	549	0	3.92
Capture	101	2.80	3.5
Scattering	8.2	8.2	8.2

For uranium-235 the number of neutrons per thermal-neutron fission is given by

$$\nu = 2.5 \pm 0.1.$$

*Fast-fission effect.* Typical values of the fast-fission contribution to the reactivity of research reactors are as follows: in a reactor of the 'CP-2' or 'GLEEP' type, 2.9 per cent; in a reactor of the 'CP-3' or 'ZEEP' type, 3.1 per cent. The following are average values of nuclear constants for natural uranium bombarded by neutrons above the uranium-238 fission threshold in a heterogeneous uranium reactor: fission cross-section, 0.29 barns; radiative capture cross-section, 0.04 barns; number of neutrons emitted per fission, 2.55; total cross-section, 4.3 barns; inelastic scattering cross-section, 2.47 barns; elastic scattering cross-section, 1.5 barns.

*Resonance absorption integral.* An approximate empirical formula for the effective value of the resonance absorption integral in a uranium lump at room temperature is given by

$$\int \sigma_c(E) dE/E = A[1 + \mu(S/M)],$$

where the integral is taken over the resonance energy band (see below),  $S$  is the lump surface area in  $\text{cm}^2$  and  $M$  is the mass of the lump in gm. The constants  $A$  and  $\mu$  depend on the total scattering cross-sections associated with each uranium atom. They are, therefore, different for uranium metal or oxide lumps. In fact,  $A$  is proportional to the 0.415 power of the scattering cross-section associated with each uranium atom up to the scattering cross-section of 1,000 barns. For uranium metal,  $A = 9.25$  barns and  $\mu = 2.67 \text{ gm./cm}^2$ . For  $\text{U}_3\text{O}_8$ ,  $\mu = 1.67 \text{ gm./cm}^2$ . The limiting value of the integral at great dilution is 240 barns. The approximate temperature dependence of the integral given above is

$$\int \sigma_c(E) dE/E = A[1 + \alpha T + \mu(S/M)],$$

where  $\alpha \sim 10^{-4}$  per  $^\circ\text{C}$ ., the temperature  $T$  is in  $^\circ\text{C}$ ., and  $A$  and  $\mu$  are as previously. The logarithmic width of the resonance energy band,  $\log_e(E_0/E_1)$ , is about 5.6 for uranium metal and 7.3 for  $\text{U}_3\text{O}_8$  or  $\text{UO}_2$ . The inverse diffusion length  $K_0$  for resonance neutrons in uranium metal of density  $\rho \text{ gm./cm}^3$  is  $K_0 = 0.022 \rho \text{ cm}^{-1}$ .

*Plutonium and xenon cross-sections.* The average values for the fission and capture cross-sections of plutonium-239 for an approximately Maxwellian neutron spectrum with a most probable neutron velocity of 2,200 m./sec. are 664 barns and 361 barns, respectively. The number of neutrons per thermal-neutron fission of plutonium-239 is  $3.0 \pm 0.1$ . The thermal-neutron absorption cross-section of xenon is  $3.5 \times 10^6$  barns.

## HUMAN RELATIONS IN INDUSTRY

ONE of the most important conferences yet called to discuss human relations in industry was held in London during March 18-20. It was sponsored by the Ministry of Labour and National Service, and was concerned not so much with the value of subjects like incentives, selection, training and joint consultation but rather with the means by which interest in these subjects could be stimulated, knowledge of them extended and practice of them improved. Papers dealing with various human problems in industry were circulated in advance, and these were discussed in detail during the conference. Members of the conference were also provided with a paper setting out points of view on human relations in industry which had been drawn from the reports of the Anglo-American Productivity Council teams, as well as a paper describing some of the projects sponsored by the Schuster Panel on the human factors affecting productivity; these two papers were used by members as supporting material in their discussions.

The discussions were reported under four main headings: these included factors affecting the opportunity to work; factors affecting the capacity of workers; factors affecting waste of man-power; and factors affecting the will to work.

Among the factors affecting the opportunity to work, the employment of older workers was considered to be a matter of urgent national significance. It was agreed that older persons willing and able to work should not be denied this opportunity on grounds of age alone. The test should be ability to do the job and not date of birth, although no compulsion should be applied to workers to go on working if they wish to retire. It was agreed that there is a widespread desire on the part of many workers themselves to continue work past their present retiring age and that economic and social considerations make this essential.

Accepting the findings of the Nuffield Research Unit, which has shown that ability changes with age, the conference decided that employers should aim at transferring older manual workers to more suitable work at any age where their age becomes a handicap to their continuation in their former job. This transfer process would affect only a small proportion of all manual workers and would vary in different industries; consideration should be given, where possible, to making the change in middle life to jobs which could be carried on in old age.

The importance of a lead from the Government and local authorities as employers was stressed by the conference, and steps already taken in the Civil Service to remove age barriers were favourably received.

In the case of professional, technical, managerial, clerical and administrative grades, it is questionable whether persons should remain in positions of responsibility when they have passed the stage when they are fully effective. A change of attitude is necessary in order to provide for "demotion without disgrace".

The difficulties arising from pension schemes were discussed, and the conference recommended that the Ministry of Labour and National Service should invite its newly appointed Advisory Committee on the Employment of Older Workers to conduct an investigation into the effects of pension schemes on

mobility and the possibility of greater interchange of pension rights.

Discussing the employment of women with domestic commitments, the conference considered that the regular employment of women with children of school age should not be pressed; but where they volunteer for employment it is desirable that work should be arranged at times which do not interfere too much with their domestic responsibilities. It was also agreed that the time has come when research should be undertaken into the social consequences of the employment of women with children of school age.

On the subject of the employment of the disabled, the conference recommended that inquiries should be made into the possibility of extending the provision of home work for disabled persons under fair conditions of labour which should be subject to adequate supervision. In order to assist in the placing of disabled persons, as much information as possible, medical and industrial, should be given to a prospective employer in respect of each person submitted for employment. While a general increase in the statutory quota of disabled persons to be engaged by certain employers might be justified at some future date, the present procedure whereby disablement resettlement officers make intensive efforts to place individual disabled persons offers the best prospects of success.

The conference endorsed the policy of the Committee on the Relationship between Employment in the Services and Civilian Life, and considered that ex-regular servicemen could make an important contribution to man-power requirements if they were given the opportunity to make full use of their qualifications despite their late entry to civilian employment.

Industrial training was considered as one of the main factors affecting the capacity of workers. There was general agreement that there should be increased flexibility in the ages of entry to apprenticeship. On the suggestion that the age might be lowered, the view generally supported was that systematic training from the earliest days is the most effective method of adjustment from school to work. The first period of apprenticeship training might profitably be general in character so that the new recruit can gain some information about different crafts and eventually pursue the one most suitable to his abilities. On the subject of raising the age of entry, it was generally recognized that the post-war changes in the educational system made a fixed age of entry undesirable. Experience of National Service recruits showed that many young men who are suitable for apprenticeships have gone into unskilled jobs when leaving school, and it was agreed that it should be made possible for men of this kind to become skilled craftsmen.

In present circumstances there are strong reasons for reducing the common five-year period of apprenticeship training; but it is essential that any reduction should not result in a decline in the quality of skill. There was agreement that training a worker for more than one craft or more than one semi-skilled occupation is, in general, desirable; but the feasibility depends on the circumstances of each particular industry. In certain circumstances it would be useful to train operatives for more than one semi-skilled occupation; but sometimes it is more valuable to provide opportunities for retraining as occasion demanded.

It was emphasized that courses of induction training could play an important part in assisting young persons to adapt themselves from school to industry, and that the supervisor should play an essential part in induction. Induction should not be left entirely to the supervisor, however, as the new worker should be introduced not only to his own department but also to the firm as a whole.

The conference agreed that there is room for great improvement in methods of training semi-skilled operatives, but that the experienced worker is not always the most effective instructor. Evidence was given that systematic training methods can greatly reduce the period of training. Pooling of information among firms on methods of training was recommended.

Training for supervision was discussed, and the following conclusions were reached: there are certain basic principles of supervision, common to all industries, that can be taught; there is, at the same time, a need for practical supervisory training courses related to the particular circumstances of a firm, and carried out within the firm, as well as a need for a central establishment to instigate and carry out research and to pool ideas and experiences in the supervisory training field. A large part of supervisory training is concerned with the provision of technical and other related knowledge, but it should not be divorced from the provision of the necessary practical skills; the status and authority of the foreman must be such as to encourage men to seek promotion to supervisory ranks; the provision of supervisory training creates a special problem for the smaller firms but can only be solved by their own joint efforts, or by drawing on the services of voluntary organizations which provide suitable courses or by the training of selected managers and supervisors to perform a part-time training function within the firms; short courses should be organized for the middle ranks of management, intermediate between training courses for foremen and those provided for higher management.

In discussing personnel selection, the conference examined the ways in which the introduction of more careful interviewing and/or tests contribute to the efficiency and stability of the labour force. It was reported that there is ample statistical evidence of the value of scientific selection in both industry and the Services, and generally agreed that a wider dissemination of the information available is required so that these methods should not be rejected without full knowledge of their results, and without further trial. The use of group selection techniques in the appointment of managers and supervisors was also discussed and recommended for more general use.

To extend the knowledge and practice of modern selection methods in industry, it was agreed that the existing literature on selection is too technical to make much impression on industry and that something more readable should be prepared. A short and simple code of selection for the use of supervisors should be made available on the lines of the Ministry of Labour and National Service Training Within Industry scheme.

Firms too small to employ elaborate selection procedures might co-operate and set up joint committees for the selection of operatives or of apprentices on which employers and trade unions are represented; such committees could, where necessary, use the services of a trained psychologist.

The group of the conference particularly concerned with factors affecting wastage of man-power was circumscribed in that its discussions were limited to means of reducing the rate of accidents and the incidence of disease, and the sickness-rate caused by poor environment. The planning of factories and the training of young and older workers were discussed, while the group also considered that there is a great deal of valuable material within the Factory Department of the Ministry of Labour and National Service and that steps should be taken to ensure wider circulation of this material in such a form that it could reach and be understood by all grades in industry. A 'digest' of the annual report of the Chief Factory Inspector would assist executives who are overburdened with reading matter.

The conference also examined the factors affecting the will to work and concluded that experience has undoubtedly proved the desirability of expanding joint consultation in the broad sense of the term, that is, including formal and informal consultation between management and workers, and consultation between all levels of management. The machinery of consultation appears to be of less importance than the attitude of mind of all concerned. Machinery must not be imposed, even benevolently, from outside but should arise out of consultation with all those affected at every level both of management (including supervision) and workpeople.

Management and trade unions have a responsibility to take all possible steps to make all concerned better able to take part in joint consultation. This could be done not only by the organization of formal courses at technical colleges but also by "learning by doing", for example, the establishment of junior consultative committees. More care should be taken to ensure that the conclusions and activities of joint committees are reported adequately to all levels of the undertaking. It is of particular importance to ensure that in the process of giving information to workpeople, junior management and foremen should not be by-passed.

A works committee should be given all the necessary information and in such detail as will enable it to deal with the problems it has to face. These usually only exclude subjects discussed by joint negotiating machinery, subjects which are confidential to the firm and might damage it if known to competitors, and problems concerned with individual cases except where the individual's permission is obtained.

An interesting discussion took place on a variety of problems concerned with incentives in industry, particularly with the adoption of systems of payment by results. Among the suggestions were the following: other incentives besides direct financial incentives are of great importance, particularly in small firms where it may not be possible to introduce elaborate systems of payment by results; such incentives include satisfaction with the job, pride in the firm and good relations with the worker's immediate colleagues.

A sense of security is of great importance, and without this sense the introduction of systems of payment by results is not likely to be of value. A sense of security includes not merely a sense of security in the job but also includes, where bonus systems are introduced, the need for the worker to understand the basis of the bonus system and be able to anticipate and measure the effect of his own efforts.

Where it is practicable to adopt systems of payment by results there are substantial advantages to be gained by their adoption; there is more scope for the adoption of such systems in manufacturing industries than in service industries, but there is some scope even in service industries. Such systems are satisfactory only if introduced with great care, and, at all stages, there should be adequate consultation between management and workers; before the scheme is adopted there should be complete agreement both on the principle and the details. It was also thought that there is scope for the continued dissemination of information about systems of payment by results by Government agencies, but without any pressure for the adoption of any particular type of scheme.

T. H. HAWKINS

## SCIENCE AND AGRICULTURE IN INDIA

FOR his presidential address to the thirty-ninth session of the Indian Science Congress, held in Calcutta in January, Dr. J. N. Mukherjee took as his subject "Science and our Problems, Science and the Yield per Acre". In the first part of his address, Dr. Mukherjee reviewed the position of science in India to-day, pointing out the necessity for increased industrial and agricultural production if the pressing economic and social problems of the country were to be solved. To this end, he said, one of the first essentials is the proper organization of scientific education and research. Both the State and industry have large-scale development programmes in hand, and the closest co-operation with the scientific community is needed if their planning is to be fully effective. He welcomed the fact that industries are already showing a growing interest in establishing research laboratories of their own.

Before bringing forward a number of practical suggestions as to how agricultural production might be increased, Dr. Mukherjee directed attention to some of the inherent difficulties with which India is confronted. About 80 per cent of the cropped area is dependent on rains, many of the holdings are too small to allow of the adoption of improved techniques, and the production of the important grain crops is largely the occupation of the poorest section of the community. Much, however, has already been done to raise output, and agricultural research has received a considerable impetus from the establishment of commodity committees and the rice and potato research institutes. More attention is still needed in other branches of agriculture such as soil survey, plant (and insect) physiology and ecology, agricultural economics and engineering.

Among special aspects that would seem to merit greater intensive investigation, Dr. Mukherjee mentioned the production of disease-resistant strains, the working-out of suitable crop rotations with special reference to the ley, and the introduction of new grasses and legumes. The establishment of a bureau of plant introduction has, in fact, already been suggested. Seed-growing, he said, should be developed as an industry under the management of a seed-growers' association, and methods for the control of pests and diseases, found successful in other countries, should be tested under conditions in India. Problems relating to water supply are naturally of fundamental