

## THE ACCIDENT AT WINDSCALE ON OCTOBER 10, 1957

THE final report\* on the accident to No. 1 pile at Windscale on October 10, 1957, should be considered in relation to the previous reports<sup>1-3</sup>.

During a routine Wigner energy release, temperatures in the pile rose beyond safe limits, causing a fire which affected 150 channels and caused a certain amount of radioactivity, mainly iodine, to be released over an area of Cumberland. Following this incident, a committee of inquiry was set up under Sir William Penney, and reporting to the Prime Minister. A less technical version of its report has been released over an area of Cumberland. Following this incident, a committee of inquiry was set up under Sir William Penney, and reporting to the Prime Minister. A less technical version of its report has been published<sup>1</sup>. In the memorandum by the Prime Minister the immediate cause of the accident was given as "the application too soon and at too rapid a rate of a second nuclear heating to release the Wigner energy from the graphite . . .". The accident was considered as being due partly to inadequacies in the instrumentation and partly to faults of judgment by the operating staff, these faults of judgment being themselves attributed to weaknesses of organization.

Three committees were set up, each under the chairmanship of Sir Alexander Fleck, to advise on certain aspects of the incident. The committees on Organization and on Health and Safety reported in December 1957<sup>2</sup> and January 1958<sup>3</sup>, respectively. The report of the Technical Evaluation Committee, the subject of this article, was delayed due to the need to carry out a considerable amount of experimental and analytical work.

The Committee's terms of reference were: (1) to consider the new information available following the accident; (2) to consider the possible methods of carrying out the controlled release of Wigner energy; and (3) to advise the United Kingdom Atomic Energy Authority on the restarting of Windscale No. 2 pile.

The report begins by considering the phenomenon of energy storage in irradiated graphite—Wigner energy. This storage is due to defects in the crystal structure of the graphite following neutron bombardment. The energy is releasable, in varying extent and rate, by heating the graphite. The amount of energy stored decreases rapidly with an increase in the temperature at which irradiation takes place, that is, there is an annealing effect. This feature makes the effect particularly severe in low-temperature reactors such as BEPO and the Windscale piles, but very much less important in the Calder and sub-

sequent power-producing reactors. The Committee states that if the release of energy in No. 2 pile was attempted as previously, graphite temperatures in excess of 400° C. would almost certainly occur in considerable masses of graphite, and that temperatures in some pockets where previous releases had not been effective might reach 500° C.

The report next considers the implications of these transient high temperatures on the graphite, the fuel and the other materials in the reactor. A temperature limit of 400° C. is considered as reasonable for the graphite. Under these conditions the fuel element design is satisfactory. Having specified temperature limitations, the real problem is that of installing sufficient and effective instrumentation. A considerable increase in the number of graphite and fuel element thermocouples is required, and the fission product detection scanning gear needs improving.

A description of four methods of carrying out Wigner releases is then given. The first method, the one previously employed, uses nuclear heating to initiate the release of energy. The main difficulty is the non-uniformity in the spread of the release, leaving pockets unannealed. The Committee deprecates the application of a second nuclear heating to initiate the release of these pockets, as being certain to lead to excessive uranium temperatures, and recommends that no further releases by this method should be attempted. The second method was used with the BEPO reactor in March this year, but is not recommended for Windscale. The third method, a slow heating method, is also discarded, since it would cause excessive stresses in the concrete reactor structure. The fourth method combines the previous two. It is proposed that a partial anneal using a slow heating method should first be carried out, followed by a more rapid heating to a somewhat higher temperature. The heat would be supplied by heating the ingoing air. The necessary plant and instrumentation could be installed in 6-9 months, making the pile operational again in about a year.

No. 1 pile has added considerably to our knowledge of reactor technology and operation. It is hoped that No. 2 pile will be recommissioned, since the development of methods for altering the pattern of the instrumentation in a reactor after it has been in service will prove most useful as the nuclear power programme develops.

<sup>1</sup> Accident at Windscale No. 1 pile on 10th October, 1957. (Cmnd. 302.) (H.M. Stationery Office.) *Nature*, **180**, 1043 (1957).

<sup>2</sup> The organization of certain parts of the U.K.A.E.A. (Cmnd. 338.) (H.M. Stationery Office.) *Nature*, **181**, 439 (1958.)

<sup>3</sup> The organization for control of health and safety in the U.K.A.E.A. (Cmnd. 342.) (H.M. Stationery Office.) *Nature*, **181**, 1023 (1958.)

\* Atomic Energy Office. Final Report of the Committee appointed by the Prime Minister to make a technical evaluation of information relating to the design and operation of the Windscale piles, and to review the factors involved in the controlled release of Wigner energy. Pp. 20. (Cmnd. 471.) (London: H.M. Stationery Office, 1958.) 1s. net.

## EXCHANGE OF INFORMATION ON ATOMIC ENERGY

THE Agreement between the Governments of the United Kingdom and of the United States for Co-operation on the Uses of Atomic Energy for Mutual Defence Purposes described in the White Paper\* published on July 8 comprises twelve articles.

\* Agreement between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the United States of America for Co-operation on the Uses of Atomic Energy for Mutual Defence Purposes, Washington, July 3, 1958. Pp. 8. (Cmnd. 470.) (London: H.M. Stationery Office, 1958.) 6d. net.

The first is a general provision for the exchange of information and transfer of materials and equipment, unless such co-operation represents an unreasonable risk to the defence and security of the communicating or transferring party. Under the second article the two parties agree to communicate or exchange classified information jointly determined as necessary to the development of defence plans, the training of personnel in the use of or in defence

against nuclear weapons, the development of delivery systems for such weapons, and on research, development and design of military reactors, as well as other classified information required to improve the design, development and manufacture of nuclear weapons. The transfer of submarine nuclear propulsion plant and materials is covered specifically in the fourth article, while questions of responsibility, conditions and guarantees are dealt within the next three. Article VII restricts the communication of classified information or material transferred under the Agreement to third parties without prior authorization, and under Article VIII agreed classification policies are to be maintained and the present practice of consultation continued. The longest article (IX) is that dealing with patents, and includes provision for the issue of appropriate secrecy or prohibition orders. These clauses, however, make it possible for firms in one country to enter directly into relations with firms in the other on the sale of patents and licences, and should thus ease the exchange of information between the two countries where it had been hindered because information which was the property of individual British firms would, if exchanged, become the property of their American competitors.

As the Prime Minister explained in the House of Commons on July 8, the new Agreement, which supersedes that of June 1955, has been negotiated in consequence of the amendment of the United States Atomic Energy Act, 1954, so as to permit closer and more fruitful collaboration between Great Britain, the United States and other friendly countries. The Agreement was signed on July 3 but cannot become effective until it has lain before Congress for thirty

sitting days, and the Prime Minister preferred not to comment at that time on the practical results which might be expected when the Agreement comes into effect. We had been in close touch with the Commonwealth countries during the negotiations leading to the Agreement and co-operation with these countries was covered by Article VII. On July 15 Mr. Macmillan added that the United States Atomic Energy Act, as amended, still did not permit the transfer of complete nuclear weapons or manufactured nuclear components of such weapons, and the Agreement accordingly dealt rather with research and development than with the actual interchange of weapons. Replying to further questions in written answers on July 17, Mr. R. A. Butler said that no commitments or understandings were entered into which might have the effect of surrendering patent rights in the Calder Hall type of reactor. British interests were satisfactorily safeguarded by the clauses of the Agreement, and the Government saw no reason to expect that the undertakings to make available to the United States Atomic Energy Commission information about the Calder Hall design and the standard fuel elements used in the Calder Hall reactors would have any substantial effect on our export prospects. In the House of Lords on July 21, the Earl of Gosford said that this information related only to the Authority's own dual-purpose reactors and did not and would not include information developed from Calder Hall and included by industry in its latest nuclear power station designs. The Agreement was concerned exclusively with co-operation in the use of nuclear energy for defence and not with arrangements for co-operation on civil uses.

## COLONIAL DEVELOPMENT

THE schemes made under the Colonial Development and Welfare Acts in the period April 1, 1957–March 31, 1958, which are detailed in the latest return\*, bring the total commitments, from April 1, 1946, under the Acts to £194,259,668, of which £17,203,311 is for research schemes. The totals for the year in question are £17,480,563 for development and welfare and £1,123,850 for research schemes. Of this last, £351,709 is for agriculture, £158,830 for tsetse and trypanosomiasis, £106,207 for medicine, £101,108 for insecticides, £76,859 for fisheries, £72,622 for social science, £52,240 for products research, £23,546 for locust control, and £14,340 for economic research.

Of the actual research schemes, £135,730 is supplementary provision for the East African Trypanosomiasis Research Organization, 1957–60; £70,156 for the Colonial Pesticides Research Unit, Arusha, 1957–58; £66,858 for maintenance of the Colonial Road Research Section at the Road Research Laboratory, Harmondsworth; £65,000 for expansion of vaccine production and associated research in Nigeria; £51,675 for agricultural research in Swaziland; a further £49,300 for expansion of the Tropical Products Institute; £49,064 for the East African Scientific and Industrial Research Organization,

1957–60; a supplementary £43,056 for the Colonial Microbiological Research Institute, Trinidad; £37,785 for soil and land use surveys in British Guiana; £34,185 to establish a Veterinary Investigational Laboratory in Bechuanaland; £32,992 for the Nigerian Institute of Social and Economic Research; and £30,938 for the joint capital housing programme for the East African Agricultural and Forestry Research and Veterinary Research Organizations.

Other major research schemes include £23,546 for the Desert Locust Survey; a supplementary £30,800 to establish a Soils Laboratory in Sarawak; £23,023 for the study of soil fertility maintenance in high-rainfall areas in Nigeria; a further £22,084 for the Fisheries Development and Research Station, Sierra Leone; a further £20,100 for the West African Institute for Trypanosomiasis Research; £19,370 for control of malaria in a hyperendemic area of East Africa; and a supplementary £15,833 for sugar technology research at the College of Tropical Agriculture, Trinidad.

The development and welfare schemes follow the general pattern of recent years. A further grant of £644,000 goes to the Central Organization for Overseas Geodetic and Topographical Survey; Kenya receives £507,880 for the intensification of African agricultural development, with a further £508,120 for Agricultural Department expenditure in connexion with that intensification. Farm development in Jamaica receives a further £750,880, with £177,375

\* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the period from 1st April, 1957, to 31st March, 1958. Pp. 36. (House of Commons Paper No. 223.) (London: H.M. Stationery Office, 1958.) 2s. net.