specifically to improve dissemination of data and to develop continuous operation data transmission systems.

Ferrybridge and After

On Monday, November 1, 1965, three of the eight cooling towers at the incomplete Ferrybridge C power station collapsed in a strong wind. Each was 375 ft. high, with a base diameter of 300 ft. and shells 5 in. thick, and they conformed to the familiar and attractive shape somewhat inadequately described as hyperboloidal. Nobody saw the first tower fall, but when the second and third fell there were a number of witnesses, who saw a succession of rippling and flexing movements of the tower wall, followed by the appearance of a hole and the collapse of the towers. Civil engineering failures on this scale are rare enough to cause a considerable stir, particularly as this type of tower is common in Britain. It is clearly necessary to determine why the towers fell, but a committee of inquiry was unable to supply an unambiguous answer. On June 12, the Institution of Civil Engineers held a one day symposium on the design of natural draught cooling towers—Ferrybridge and after.

Mr I. W. Hannah from the Central Electricity Generating Board gave a report of the failures. The chief mode of failure, the committee had decided, was vertical tensile failure. In strong winds the uplift of the structure exceeded the dead weight of the towers, imposing tensile instead of compressive forces on the structure. The possibility that forced vibrations had aggravated the weakness could neither be established nor ruled out. The wind speed taken into account in the design was a maximum value averaged over 1 min, but the report said that strong gusts were often of much shorter duration than that. At the symposium Mr C. W. Newberry of the Building Research Station suggested that gusts powerful enough to destroy the structure might last less than 3 sec. Mr H. C. Shellard of the Meteorological Office was optimistic that instruments capable of measuring such short gusts would soon be available.

One suggestion which gained currency after the collapse was that the array of towers—two rows with the towers in the second row coinciding with the gaps in the front row—had in some way created a "channelling effect" which increased the wind speed. Professor P. R. Owen of Imperial College dismissed this effect; before even reaching the front row of towers, he said, the wind had lost 30 per cent of its speed. The problem of the vibrations of the towers does not yet seem to be settled, and is accentuated by the unsteady and random nature of the wind loading on any structure. Professor A. H. Chilver of University College, London, discussed the appearance of vertical cracks and suggested that some form of circumferential prestressing might be needed to overcome the weakening effect of these cracks.

At Ferrybridge, a very conservative scheme of strengthening was undertaken, involving virtually new towers, 4 in. thick, built against the outer wall of the collapsed towers, with twice the original meridional reinforcement; the collapsed shells were rebuilt with 8 in. walls. There is as yet no general philosophy of failure to guide the CEGB in strengthening other towers, and as Mr W. A. Fitzherbert of CEGB said, "One can only hope for an adequate period without exceptional gales to allow the problems to be resolved". Meanwhile, a tower at West Burton power station has been fully instrumented with 72 external pressure gauges and 10 strain gauges embedded in the structure. These instruments are providing a flood of data which is difficult to analyse, but which may prove more reliable than wind tunnel studies. The flow around a cooling tower is dependent on Reynolds number; for the Ferrybridge disaster this was about $1{\cdot}3 \times 10^8$. Unfortunately there is no wind tunnel in Britain capable of reaching this Reynolds number for a scale model of the Ferrybridge array, which leads to uncertainty. A number of participants at the symposium were severely critical of this situation.

Spin-off for Sale

The attempt of the Ministry of Technology to persuade industry that there is money to be made from the discoveries of government laboratories seems to be meeting consumer resistance. Last week the ministry gave its support to a conference in Harrogate organized by the Institute of Physics and the Physical Society. The aim was to sell to industry the technology developed in government establishments, which last year cost about £260 million to run (excluding defence establishments). The government scientists were willing, even eager, to sell, but the men from industry were altogether more reluctant to buy. This was reflected in the disappointing attendance; there were 210 delegates, about 120 of them from industry and 65 from government establishments and research associations. Half the industrialists came from only 15 British companies, and three firms—ICI, AEI, and Rolls-Royce—supplied no fewer than 22 delegates between them. To some extent, the government scientists were preaching to the converted.

Preaching, in fact, is rather a poor description of the proceedings. Many of the papers were delivered in an offhand, throwaway style which made technology seem both unexciting and unprofitable. There were fortunately some exceptions to keep listeners awake. Mr D. W. Butcher of the Admiralty Materials Laboratory at Poole discussed how to reduce condenser sizes by the efficient condensation of steam. The addition of promoters which influence the interfacial tensions of vapour and liquid can cause the steam to condense in drops instead of a continuous film, greatly improving heat transfer. The difficulty is that the promoter effect is impermanent; if this snag could be overcome, great savings in the size of condensers could be made. Mr A. R. Moss of the Royal Armament Research and Development Establishment described arc plasma devices, and Mr R. A. Dugdale from AERE Harwell discussed another way of processing ceramics and metals, by glow discharge electron and ion beams. Mr S. W. Hollingum of RARDE gave the advantages of explosive forming of metals as high accuracy and low capital cost for prototype production. Although the deformation is carried out very quickly, the mechanical properties of the product are similar to those produced by more conventional means, although deformation may take place by twinning rather than slip. A final heat treatment is sometimes needed.

Mr D. S. Dean of the Rocket Propulsion Establishment at Aylesbury described the possible uses of