Paper No. 6561

The selection and investigation of potential nuclear power station sites in Suffolk†

by

Kenneth Michael Gammon, B.Sc., A.M.I.C.E.

and

Gordon Frederic Pedgrift, B.Sc.(Eng.), A.M.I.C.E.

Discussion

Mr F. H. E. Myers (Plant Testing Specialist, Headquarters, Central Electricity Generating Board) wrote that one outstanding item in site investigation appeared to be a careful assessment of the construction of an adequate cooling-water system. The cost and extent of such works was of prime importance because this largely governed the location of a suitable site.

84. The choice of site was, of course, dependent to a large extent on the type of nuclear reactor to be used. For example, the carbon-dioxide-cooled, graphite-moderated reactor of the present phase of development would weigh about 50,000 tons, whereas a boiling water or pressurized reactor would weigh one tenth this amount, and steam-cooled, heavy water marine reactors would probably weigh less still.

85. As it appeared that during the next 15 years or so, it would be necessary to find about 40 to 45 sites in Britain, each to carry generating plant of between 1,000 and 1,500 MW output, the problem of deciding on suitable locations must become increasingly difficult. One could imagine what the difficulty would be during the remainder of this century if the demand for power did not show signs of saturation.

86. Most of the sites would be for conventional fossil-fuel fired plant, and if advanced gas-cooled reactors and high-temperature gas-cooled reactors were satisfactory, sites near the sea would need to be found for these. This might be dependent to some extent on the success or failure of closed-circuit cooling of water now being tried out at Rugeley Power Station. Even if this were successful, enormous cooling towers would be needed for inland sites.

87. The position was still problematical, and it would seem worth while to give some detailed consideration to the use of the boiling water reactor or the marine types now being developed in large unit sizes. Those who were abreast of developments would know that a 54-MW output plant for marine application was described in "Nuclear Engineering", June, 1961. The weight, including plant items, would probably be of the order of 3,000 tons, so that for a 500-MW station the plant would weigh about 30,000 tons which was less than half the weight of one of the reactors at Sizewell.

88. For land-based stations, the civil works were very extensive and costly, particularly when floating caissons had to be used for the head works of the cooling-water intake. If the boiling water type or marine type reactors were considered, the complete generating station could be built on a floating pontoon of cellular reinforced concrete, and a very preliminary estimate of a suitable structure to carry up to 90,000 tons would indicate a cost for this of about £1,000,000 including anchorage in say 50 feet of tidal water. The tanker anchorage at Das Island in the Persian Gulf illustrated what could be done.

† Proc. Instn civ. Engrs, vol. 21 (Jan. 1962) pp. 139–160.

89. If the designs for the boiling water or marine type reactors could be standardized, as well as the layout of plant, it would be economically worth while to treat the third phase of nuclear power generation as being located on pontoons which could be assembled near a manufacturer's works, floated at sea, located off shore and then anchored in a manner similar to a "Mulberry Harbour" operation.

90. In this way the U.K. could cope with an ever-growing demand for electrical energy, without the ever-extending formalities about land and access, and thus provide an economic solution to the problem of future sources of electric power.

Mr E. Usher (Principal Assistant Engineer, Station Planning and Development; Central Electricity Generating Board) submitted some observations on the background of this work and asked for the Authors' views on the extent of the investigation necessary to ensure adequate data for the design and location of cooling-water-intake and -outfall works on exposed coasts.

92. The electricity industry undertook the implementation of the Government's nuclear power programme at quite short notice at the beginning of 1955. Some of the site requirements differed radically from those of conventional power stations and, during the early stages of the problem, the requirements were subject to change with increasing knowledge of the extent to which the early civil nuclear stations would differ from the military Calder Hall plant in output capacity, physical features and constructional requirements.

93. The first two groups of sites, on the sheltered Blackwater/Crouch and Severn estuaries, were examined as a matter of urgency, and selections were made and applications for statutory consent lodged before the end of the year. The stations which followed, of nearly double the output capacity and with greatly increased cooling-water requirements, tended to require more extensive and specialized investigations for which time was made by an early start, relative to the desired year of commissioning of plant.

94. Open coast sites, such as Sizewell, exposed to the full force of gales, with waves having a fetch extending many miles, posed new problems in the siting and design of cooling-water-intake and -outfall works because the power station, costing possibly £60 million, was entirely dependent for safe and continuous operation on an uninterrupted supply of cooling water. In their Paper the Authors briefly mentioned changes in sea-bed level and that the location of the works minimized recirculation. Experience showed that in some areas over short periods, large variations in levels might take place, often in the opposite sense to the long-term trend. Could the Authors give their opinion on the best way to safeguard against such unpredictable changes within the littoral drift zone in the design or location of the structure, and the period over which local observations should be taken?

95. In zones of bed-level fluctuations, there was a risk of "blanketing" the intake and outfall works during periods when the station was not in operation. What provisions would the Authors propose to make against this contingency? The Paper mentioned the protection provided by the Sizewell bank but it did not cover the magnitude of the waves for which the works were designed. Could the Authors state the magnitude of the waves for which the works were designed and how they would determine the wave magnitude and frequency on any future open coast investigations for which they would be responsible?

The Authors in reply thanked Mr Myers and Mr Usher for their comments. To Mr Myers they answered that in practice the weight of the reactor was not a critical factor in site selection, it was only one factor amongst the several mentioned in the Paper. It also appeared that immediate trends in reactor design gave rise to ground loads of the order of 2–3 ton/sq. ft, which was within the range of other industrial structures.

97. While an easing of the siting problems might be obtained by locating new types of nuclear stations on offshore pontoons the economics of this were doubtful and the operational problems and costs would be so great, that only in the most exceptional

circumstances could the Authors foresee any such station being practicable. There would also be the problem of possible effects of such a station on other interests.

98. In reply to Mr Usher the Authors considered that for work of this nature too much preliminary information could not be obtained. So far nuclear stations had been sited in areas hitherto relatively undeveloped, where long-term information either did not exist or only at such a small scale or taken at such irregular and infrequent intervals as to make comparisons with present surveys difficult. For example, while it was relatively easy to determine the level of the highest high water in a locality it was far from easy to determine the level of the lowest low water. Consequently the extent of the information gained was mostly governed by the time available for investigation. But however much information was obtained, a number of engineering decisions remained to be taken and in the end a considerable amount of judgement used in designing the works in a robust and simple manner. For the design and location of headworks, investigations should cover local and mass movements of water, littoral drift and sea-bed changes and wave characteristics. In addition biological and other physical data would be necessary.

99. In reply to § 94 the Authors believed that it was unlikely that any constructions on or around an intake or outfall works would prevent movements of the sea bed, the solution must lie in siting the works in an area estimated, from the records available, to be least likely to have bed disturbance. It was the Authors' opinion that the presence of a headworks structure would probably tend to depress the sea bed locally.

100. At Sizewell, quarterly sea-bed surveys along section lines about 1,000 feet apart over an area some 7,000 × 2,500 feet had been taken since 1958. These records were relatively easy to obtain using a launch and echo-sounder and would continue until 1965 to give data on natural changes, also to indicate any local changes due to the headworks themselves.

101. "Blanketing" of the headworks might occur during the infrequent periods of total station shutdown when the offshore works would be out of use. The headworks design should allow for sealing the ends of the intake and outfall shafts at such times. High-pressure water jets could be used to displace material accreted.

102. The estimate of wave height likely to cross the Sizewell Bank had given rise to some controversy since the development of suitable continuous wave recorders to supplement the visual assessment of wave heights had only become available in recent years, and interpretation of the information gained was open to some judgement. A wave recorder was now installed at Sizewell. The accepted design allowed for a headworks sited at a bed level of −20′ O.D. and it had been assumed that 18-ft high waves could break at this point with a +8′ O.D. high tide level. For future open coast investigations, consideration would be given to the installation of a wave recorder to supplement wave records obtained from light vessels.

103. Future open coast site investigations would benefit from information gained about the dissipation of heated water from new power stations on coasts or estuaries.