



COMMONWEALTH OF AUSTRALIA.

PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS

R E P O R T

Relating to the Proposed

Erection of a

STEAM POWER STATION AT DARWIN

NORTHERN TERRITORY.

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STEAM POWER STATION, DARWIN, N.T.

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STEAM POWER STATION, DARWIN.

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The Parliamentary Standing Committee on Public Works, to which the House of Representatives referred for investigation and report the question of the erection of a Steam Power Station at Darwin, Northern Territory, has the honour to report as follows:-

S E C T I O N I - I N T R O D U C T I O N .

Historical.

1. The history of the generation of electric power in Darwin is an interesting subject, extending as it does over periods of transition and the exigencies of war. It appears that the first power supplied in the Northern Territory was from Holmes' Butchery, which supplied adjacent customers with lighting during restricted hours on the direct current system.
2. The original Darwin Town Council opened an unrestricted electricity supply in 1932 with a power house situated in Wood Street, near the present primary school. With the winding up of the Council, the plant was taken over by the Commonwealth. Darwin has been furnished by the Commonwealth ^{with} electric power generated by diesel sets, and for this there have already been three distinct power stations.
3. No.1 Power House was established in 1934 with a capacity of 120 kilowatts, and was located in the heart of the town. No.2 station was commenced during 1940, and it was on the then town outskirts, adjacent to the railway workshops. It had an initial capacity of 500 kilowatts. No.3 station was built in 1944, under wartime conditions,

and carried two sets with a total capacity of 1,000 kilowatts, the sets being second-hand ones taken over under national emergency powers. This third station was authorized by the Army, and the main reason for it at that time was for dispersion.

4. In 1946 Station No.1 was closed down, while, in 1951, it was decided to centralise power generation in No.2 Station, so the plant from No.3 Station was transferred and partly disposed of.

5. As power demand has extended, the No.2 Station has grown from its initial 500 kilowatts, until the present time, when a final machine being installed will increase the capacity to 6,760 kilowatts. It could be extended to a limited extent further, but it has reached the economical limit for diesel sets, and the time has come for a decision to be made concerning the best and most economical method to adopt for electric power generation in Darwin in the years to come.

S E C T I O N I I - THE PRESENT PROPOSAL.

The Departmental Selection.

6. After studying all the available alternatives in provision of electric power for Darwin, the Department of Works has submitted the following proposal as the most suitable, in consideration of the factors involved, and particularly the economics of the question.

7. First Stage - The first stage of the new power station would provide for meeting requirements up to 1971, and would comprise two 7,500 kilowatt turbo-alternators, two oil-fired boilers of 80,000 lb/hour capacity each, generating 450 p.s.i. 800F, and associated equipment. This steam station, of 15,000 kilowatts installed capacity, is estimated to cost £1,850,000, and it is proposed to install it on the seafront, adjacent to Stokes Hill, and to the north of the new Wharf.

8. Second Stage - The installation of a second stage, consisting of one or two 15,000 kilowatt turbo-alternators and associated plant, would depend on the growth of load, which is at present estimated at 10 $\frac{3}{4}$ % compound over the period to 1971. The additional capacity to be installed would be subject to a review at a

later date, together with the economics of continuing the use of the existing diesel station for standby purposes.

9. Alternate methods - The proposal to install a steam power station at this stage would include provision for the use of coal or nuclear energy in future stages, should either of these become more economical than oil fuel.

S E C T I O N I I I . - T H E C O M M I T T E E ' S I N V E S T I G A T I O N S

General.

10. The Committee studied the proposal, and took evidence from the officials of the Department of Works responsible for preparation of the submission. While in Melbourne an inspection was made of the power station at Spencer Street, where officials of the Melbourne City Council and the State Electricity Commission explained the working of the equipment, and gave most valuable information regarding the types of generating apparatus proposed for the Darwin station.

11. In Darwin the Committee inspected the existing power station, and paid particular attention to the proposed site for the new station, as well as the several alternative sites discussed at length during the inquiry. Evidence was taken from the Administrator of the Northern Territory and local officials conversant with the aspects of the inquiry being studied there by the Committee. Independent evidence was also obtained from other persons interested in the question of provision of electric power in the Darwin area, including the Mayor, and the Naval Officer in Charge at Darwin.

12. The question of the site for the power station assumed considerable importance, from the point of view of risk in the event of war, and some trenchant criticism was levelled at the proposal from this aspect. Evidence was therefore sought from Defence Department officials to enable the Committee to weigh the essential factors in this matter.

13. Plans of the site and alternative locations, diagrams of the proposed installations, and various graphs and statistics were studied by the Committee in the course of the inquiry.

Need for the New Station.

14. The existing power station - The existing station contains 8 Diesel generating sets, comprising 2 sets about seventeen years old, three sets seven years old, two installed last year, and one at present being installed, giving a total installed capacity of 6760 kilowatts. It is only practicable to install one more set in the existing building, and this would have a capacity of 1380 kilowatts, making the fully developed station of an installed capacity of 8140 kilowatts, or a firm capacity of 6760 kilowatts. This capacity will be fully needed by 1963, so that it follows that supply to all consumers cannot be assured beyond that date without an additional station.
15. Maximum load forecast - A study of the maximum load on the Darwin system in the past shows that, over the past 10 years the maximum demand has been increasing at an average rate of $10\frac{1}{2}\%$ compound per annum, and during July 1957 reached 3,700 kilowatts. The actual rate of increase over the past 3 years has been much greater (approximately $16\frac{1}{2}\%$ compound) but the likely duration of the present rate is unpredictable, and the more conservative rate of $10\frac{1}{2}\%$ compound has been used as the basis for forecasting future loads. This basis has also been adopted as it conforms closely to the general rate of increase in maximum demand for electrical power throughout Australia.
16. Growth of population - The maximum load estimate for the future, being on the conservative side, will have made allowance for normal growth under Australian conditions, but, as the recent statistics show, there is unusual development in Darwin, and it is possible that this might continue. The Committee took evidence from several witnesses who are best in a position to judge the trends of expansion, and several factors indicate that steps should be taken to provide for any unusual expansion over the years, beyond the average.
17. The Administrator voiced the feeling that Darwin will tend increasingly to grow as a commercial centre. This is foreshadowed by the building programmes that have been taking place in private business premises, and by the investment of banks in permanent premises.

18. All the experimental work on rice has been most encouraging, and certain minor industries for supply to the local market are developing, while it is pointed out that, for every ton of ore exported there has to be a related import of services and goods.

19. On the other hand, there was a note of caution in the evidence submitted by the Mayor of Darwin. He expressed the opinion that the increase of 100% in Darwin's population in the last 10 years constituted a boom which culminated about 18 months ago, and that there should be a more steady progress in the future, as there are no immediate factors apparent which might result in an unusual influx of population.

20. Additional facilities - Inquiry was made into the possibility of increase in future demand, caused by the more extensive use of modern electrical facilities and equipment. The introduction of household electrical aids would be within the normal estimate of demand, but, if a general policy were adopted to install air-conditioning in many homes, there would no doubt be a considerable rise in the maximum load.

21. The information received by the Committee shows that air conditioning is to be used more extensively in Government buildings, and in some of the hotel services in course of construction, but some considerable doubt exists regarding the general use of air-conditioning in private homes. While the opinion is widely held that air-conditioning in homes would be a very acceptable comfort and convenience, the cost of maintaining and running the apparatus would be heavy if large areas of the houses were treated. The use of a single unit in one room, for comfort under specially trying conditions, was cited as a more acceptable possibility in some of the homes, and this is being considered by an inter-departmental committee at present. The evidence in this regard therefore confirms the general basis adopted.

22. Depreciation of equipment. - It was pointed out, of course, that the equipment at the power stations in the past has been installed as the demand increased, and some of the engines have been in operation for many years. Two of the original engines are now in service in Alice

Springs. The engines now in use were installed in 1941, 1942, 1951, and 1956, and some of the Diesel engines will have reached the end of their economic life as base load sets by 1966. It is proposed, however, to use them as standby sets, so that their useful life will be considerably extended.

23. Increasing necessity. - It is therefore shown that, while the present power station is adequate for present conditions, there will be an urgent necessity for additions by the time the first stage proposed can be installed. It was stated that, if there were to be a delay in this project for 5 years, Darwin would be in a precarious position for power. The Committee is therefore satisfied that the need for the proposed power station has been adequately sustained.

Alternative Methods.

24. All feasible methods of extending generating capacity have been fully investigated and assessed on the basis of capital cost and total cost per kilowatt hour generated, the latter including interest on capital, depreciation, fuel, operation and maintenance. These costs have been based on supplying power for the period 1963 to 1971. The following alternatives were analysed:-

25. Continued use of Diesel Engines. - Whilst it is technically possible to prolong the useful life of the existing station for a few years, by progressively replacing the smaller sets by larger ones, the cost is found to be incommensurate with the additional capacity gained thereby.

26. Gas Turbines. - A gas turbine is a prime mover which burns fuel under high pressure and uses the gases to drive a wheel - the turbine. This turbine is then coupled to the alternator generating the electricity. kerosene or Diesel oil fuel is used. The only advantage that this system has is that there is less vibration in its rotary equipment than in a Diesel engine, and maintenance costs would be somewhat lower. The use of relatively expensive Diesel fuel, as well as higher capital cost, make generation by gas turbines, therefore, undesirable.

27. Free-Piston Gasifiers. - The free-piston gasifier has only recently become commercially available, and operating experience is very limited. This equipment consists of a horizontal cylinder containing two opposed pistons so arranged that the products of combustion, together with high pressure air, are discharged into a conventional gas turbine. Maintenance costs are said to be somewhat lower than for Diesels, but, because of their limited output, an unduly large number of units would be needed. The installed cost and cost per unit generated would both be higher than for Diesels, and there would be no compensating advantages with further growth of load.

28. Hydro-electric Power. - There is some hydro-electric potential at Adelaide River and Katherine River, but the distance of approximately 240 miles from Darwin would make power transmission uneconomical for this scheme, not only now, but also in the foreseeable future.

29. Nuclear Power. - For Darwin conditions nuclear power plant at present available would be higher in installed cost, and in cost per unit generated, than any other of the conventional thermal plants. No nuclear fuel in a state where it can be used is available in this country, so that nuclear fuel would have to be imported, and a specially trained operating staff would be essential. The use of nuclear power in Darwin is therefore unattractive at the present time. The Committee took considerable interest in the possibility of this alternative method of generating power, owing to the rapidly increasing knowledge being obtained in this field. It is a fascinating subject, and a great deal of study is being carried out all over the world. It is stated that large units are being operated economically, but it is not yet possible to provide small units which are economically attractive. Close study has already been made with the object of using this method of generation in other parts of Australia, for example at Mt. Isa, but it is agreed that it is uneconomical at this stage.

30. The opinion was expressed that, as development of atomic fuel production overseas has resulted in tremendous reduction in costs, it might well be expected that atomic power might be economic in about

10 years, even in Darwin. The use of nuclear power, from the point of view of costs as well as several other problems involved, is therefore unattractive at present, but provision should be made for the future use of this method of power generation, in case it should develop into an economical proposition.

31. Coal-fired Steam Plant. - As coal, which is used in the majority of the world's power stations, is not available in Darwin at a competitive price, heavy oil would have to be used instead.

32. Oil-fired Steam Plant. - A new steam station, with the existing Diesel station retained for standby purposes during annual overhaul, is the most economical and attractive method of meeting Darwin's power requirements from 1963 onwards. Heavy oil would be used, and storage space for it is available in the Navy tanks at Stokes Hill. A further advantage is the presence of the Navy installation for pumping the oil from the visiting tankers into the storage tanks. This equipment would be available and would facilitate the operation of this method.

33. Comparison of costs. - Carefully prepared graphs were submitted for the Committee's information in connection with the present cost of generating Darwin's power, together with estimates of cost in consideration of the calculated load in future years.

34. It is estimated that in 1963 the total cost per unit generated will be about 2 $\frac{1}{2}$ d per unit, gradually reducing to 1.57d in 1971. This is on an assumed load factor of 59%, the load factor being defined as the number of units generated, over the peak demand, multiplied by the number of hours in the year, 8,760.

35. Having come to the conclusion that the various alternatives to a steam station were all inadvisable at the present time, a more detailed investigation was made regarding the costs associated with the production of electricity by a steam station, compared with a Diesel station. It is shown that production by Diesel is slightly more economical for the first two years of the comparison, from 1963 to 1965. By 1965 it should cost just as much to generate power if you produce it by steam, as if it is produced by Diesel. From then on, however, the steam station is progressively more economical.

36. The Committee is satisfied that the proposal has been thoroughly investigated, including production by nuclear power and other methods. It is therefore recommended that the oil-fired steam station proposed, with appropriate use of the old equipment, is the most suitable at the present juncture, and should be erected.

Future Provision.

37. In the foregoing survey of the alternatives it has been indicated that development of various methods is proceeding, and it is quite possible that the economics of the whole matter could be altered very considerably within the next 10 years. It was shown that it is essential to proceed with the first stage of a new station at once, so that the new apparatus would be ready for use by the critical period in 1955. There is thus no opportunity to delay the provision of extra capacity for say 10 years. The proposal, however, covers the practical provision of the first stage with the equipment shown to be most economical under present conditions, but, in addition it will be possible to erect this station in such a way that future developments can be used. At the later stages it will be possible to include generation by nuclear power, hydro-electric power, or even coal, if any of these alternatives advances to the point of being most economical.

The Committee considers that this is a very wise precaution, under the present changing conditions, and recommends that it be adopted.

The Site.

38. It was necessary to give a great deal of consideration to the question of the site for the new station. This was mainly due to the fact that it is proposed to locate the new station on the waterfront at Stokes Hill, a position adjacent to the wharves, and near the oil storage tanks of the Navy. At the outset the factors involved were weighed by the Departmental officers in their search for the most suitable site, and the resultant submission to the Committee of the Stokes Hill site was made with the full recognition of the likely risks involved in war time, and the proximity to the town of Darwin itself.

39. A number of possible sites were considered, and the Committee was informed of the advantages and disadvantages of them all, while

visits of inspection were made to most of them during the visit to Darwin. In every case the capital cost of establishing the new station on a particular site had to be considered along with the many other factors involved.

40. Because of the need for ample supplies of cooling water, a site on the sea front is essential for the steam power station. Further, as fuel supplies will come in by sea, it should be in close proximity to a suitable wharf. The site selected at Stokes Hill meets all the requirements, and has an area of approximately 3.5 acres. It will require the relocation of an existing gravel road 75 feet seawards on reclaimed ground. It will then allow for extensions to generating plant, in stages, up to a total capacity of approximately 100,000 kilowatts, which should meet Darwin's requirements up to about 1987. Additional land could be made available by reclaiming a further area to seaward of the site.

41. The site selected is on land occupied by the Navy and owned by the Commonwealth Railways, both of whom have signified their concurrence in the proposal.

42. During the inquiry some very trenchant criticism was levelled at the proposal to locate the new station on the Stokes Hill site. It was considered that the proximity of the site to the town would increase the risk of damage in time of war, and would make the town a more attractive target.

43. The Committee gave thorough consideration to this aspect of the question, and, to ensure a completely balanced judgment on the matter, sought expert technical evidence on this point. Confidential evidence, in camera, was taken, and the official view of the Department of Defence was given to the Committee. In general terms this view confirmed that, even apart from financial considerations, the advantages of dispersal, gained by placing the new station at a site about 30 miles away, would be small, either in the case of attack by nuclear or conventional weapons. As a result there is no Defence objection to siting the proposed station at the Stokes Hill site.

44. After weighing all the points involved, including the technical

advice from the Defence Department, the Committee is satisfied that the proposed site at Stokes Hill is the most suitable for the purpose.

Other Considerations.

45. A number of other points emerged during the inquiry to engage the Committee's consideration. Questions regarding the use of the already severely limited waterfront in this area for the purpose of a power station; problems likely to arise from marine growth in the cooling system through the use of the sea water; and the relatively unimportant matter of the architecture of the building to house the equipment, were included in the evidence. The evidence contains ample reference to them for detailed study of the whole matter, but it is not necessary to include special reference to them in this Report.

46. Smoke Nuisance. - A question which did give rise to a certain amount of misgiving was the possibility of nuisance from smoke, owing to the situation of the power station near the town. Evidence was sought regarding the prevailing winds and the measures which could be taken to mitigate the smoke nuisance. There is no doubt that the prevailing winds will carry the smoke over the town on a considerable number of occasions during the year, but the Departmental officials assured the Committee that it is possible, in these days, to install preventive measures against this trouble.

47. The oil fuel to be used will not cause so much smoke as coal fuel, but most oil fuels contain sulphur. It was contended that the amount of sulphur is not very great, and dispersion of the gases from the furnaces could be effected by adjustment of the height of the stack to ensure that the discharged gases do not fall on to the town. Being well aware that, in spite of modern equipment, considerable nuisance is still being experienced in some of the larger cities in Australia, the members of the Committee are anxious that all possible steps should be taken to protect the residents in this locality.

48. It is admitted that, even with oil fuel, poor regulation of the equipment can result in considerable smoke nuisance, and successful operation depends upon the staff in charge of the work. It is therefore recommended that close attention should be paid to the

possibility of smoke nuisance; that adequate modern preventive equipment be installed; and that steps be taken to ensure that proper supervision is maintained over the handling of the equipment during operation.

Cost.

49. The estimated cost of the 15,000 kilowatt steam power station, based on current price levels, is £1,650,000. This estimate includes the cost of the site works, power station building, oil-fired outdoor boilers, generating plant and auxiliaries, sea-water cooling system for steam condensers, and all electrical equipment, including new switchyard, inter-connection with the existing Diesel station and normal contingencies.

50. In addition provision is made for special contingency items for Diesel plant, of £110,000; oil storage, £70,000; and aesthetic treatment, £20,000. This brings the total estimate for the new station to £1,850,000.

51. To minimise the cost of power station buildings, the modern trend of placing boilers outdoors is to be adopted. Generating sets, auxiliaries, electrical equipment, and all plant which must be protected from the weather will be housed in a steel framed building with light weight cladding, designed to permit the maximum of natural ventilation, and with provision for future extensions.

Methods and Time for Construction.

52. Method of carrying out the Work. - It is proposed to let a single contract for the detailed design and construction of the complete power station. Because of local conditions, site preparation and minor civil works may have to be done by Departmental plant and day labour. The Committee was informed that, owing to the standardised and technical nature of the equipment required, and the fact that tenders will be called from firms overseas, it has been found in other parts of Australia that the most economical method is to let a single contract.

53. Time for Construction. - It is estimated that specifications can be completed, tenders called and analysed, and contract let by June, 1959. If these dates are met, it is expected that the first 7,500 kilowatt set can be in operation not later than January, 1963,

and the whole station, including the second set, some months later. This is the equipment which is planned to cater for demands up to about 1971.

54. The second stage, to provide for the period to about 1987, would have to be planned in the light of developments in the intervening years, and could be included on this site. It is not desirable to plan beyond this period, but, if really abnormal expansion of Darwin occurred, the town would be spread out to such an extent that another station elsewhere would be warranted.

SECTION IV - THE COMMITTEE'S CONCLUSIONS

Summary of Recommendations.

55. The following is a list of the Committee's conclusions, in summary form only, arrived at after study of the proposal, evidence, plans, and the problems involved. The full recommendations are contained in the body of the Report, and may be referred to in the paragraphs quoted at the close of each of the following recommendations:-
1. The Committee is satisfied that the basis adopted in estimating the future load is reasonable, and that the need for the proposed power station has been adequately sustained. (Paragraph 36 and 50)
 2. Study of the alternative methods (including nuclear power) shows that the oilfired steam station proposed, with appropriate use of the old equipment, is the most suitable at the present juncture and should be erected at a cost of £1,850,000. (Paragraph 36 & 50)
 3. Provision for use of alternative methods in the later stages is a wise precaution, and should be adopted. (Paragraph 37)
 4. After weighing all the points involved, including the technical advice from the Department of Defence, the Committee is satisfied that the proposed site at Stokes Hill is the most suitable for the purpose. (Paragraph 44.)
 5. Close attention should be paid to the possibility of smoke nuisance, and steps should be taken to ensure that adequate modern preventive equipment is installed, with proper supervision of staff handling the apparatus during operation. (Paragraph 48.)

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17th April, 1958.