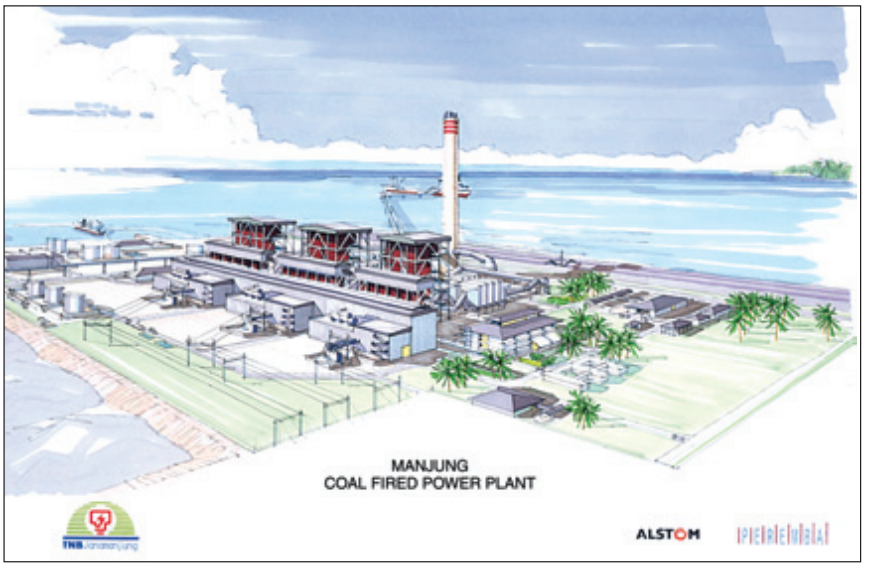

Artist's conception of Manjung ALSTOM

ENVIRONMENTAL CONSIDERATIONS FOR THE 3 × 700MW COAL-FIRED MANJUNG PROJECT

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TNB Janamanjung (TNBJ), a wholly-owned subsidiary of the national utility Tenaga Nasional Berhad (TNB) was created in 1996 by its parent company to develop a 2,100MW coal-fired power plant as a major contribution to the National Grid on an Independent Power Producer (IPP) basis.

The three units of 700MW capacity each were taken over by TNBJ in April, August and September 2003, respectively. This massive power station is located on the coast about 10 kilometres South of Lumut, a known tourist area with beaches and resorts at Pulau Pangkor and Pangkor Laut. What, then, were the main environmental factors in planning and building such a large coal-fired project in Malaysia?

Typical to large coal-fired power stations, the Manjung plant comprises conventional boilers, turbines and generator hall, control building, berthing facility/jetty, cooling water pump house, Flue Gas Desulphurisation (FGD) sea water washing facility, coal transportation system, a one million tonnes capacity coal yard, an ash disposal pond suitable for up to 25 years, an offshore Cooling Water (CW) intake and onshore discharge outlet, a 500-kV switchyard, two 500-kV transmission lines and associated civil structures.

ENVIRONMENTAL CONSIDERATIONS

To meet emissions guidelines published by the World Bank in 1996, the Environmental Impact Assessment (EIA) for Manjung indicated that ground level concentrations of SO_2 would be exceeded for coals containing more than some 0.3 to 0.4% sulphur. Therefore, it was decided to use an FGD system. A seawater washing system was found to be the most economic arrangement. Final optimisation of the FGD design led to a selection of a system which treats up to 65% of the flue gases.

LOCAL FLORA AND FAUNA

Being located in Malaysia, a host of exotic wildlife species live in the vicinity of the project:

- Approximately sixty species of fish were detected at sampling points offshore.
- Botanists determined that there are at least fifty species of plants on the mainland nearby, the most critical of which are a stand of mangroves along the shoreline and mangrove-related vegetation.
- Within a 3-km radius of the site on the mainland, there are over ten species of bats, one species of primate (the slow loris), three species of monkeys (long-tailed and pig-tailed macaques and the spectacled leaf monkey) and approximately twenty other mammals including the mouse deer and, occasionally seen swimming around the island, the small-clawed otter.
- Approximately sixty protected species of birds have been observed, including the crested serpent eagle and the large sea eagle.

The area, and Malaysia itself, is extremely rich and varied in wildlife of all kinds. Whilst several species of sea turtles are native to Malaysia, including

the green sea turtle and the rare and endangered leatherback, they nest largely on the East Coast and not in large numbers along the region immediately South of Lumut. Some miles North of Lumut, there is a turtle sanctuary along the sandy beaches. However, the area adjacent to the site itself has the character of being somewhat rocky in parts, is estuarial in character, being located not far from the mouth of the Perak River, and is not a turtle nesting location.

ENVIRONMENTAL CONSIDERATIONS

In general, the Manjung Project has been designed to World Bank emission standards – or better – and in strict compliance with Malaysian environmental laws and regulations, and is forecast to have minimal impact on the flora and fauna mentioned. As always with large power plant developments, environmental considerations are of paramount importance and the plant has been designed to minimise its effluent, noise levels and other impacts.

The Malaysian Department of the Environment (DoE) gave their approval for the Project on April 30, 1998, whilst the actual license to construct the plant was subsequently issued by the Ministry of Energy, Telecommunications and Multimedia the following June.

Ultimately, of course, the owner and developer of the Project, TNBJ, is responsible for ensuring that all of the applicable regulations of Malaysian environmental and other laws, as well as the additional stipulations of the EIA approval, are being implemented during all phases of the Manjung Project, including, later on, the operation of the plant throughout its life.

Completed project as seen from Ash Pond Area

PREPARATION OF THE MANJUNG PROJECT EIA

The Detailed Environmental Impact Assessment Study for Manjung was prepared by Tenaga Nasional Research & Development Sdn. Bhd. (TNRD), a subsidiary of TNB, but also an independent consulting entity in its own right. TNRD directed and co-ordinated the preparation of the EIA document, submitted it to the DoE and carried out discussions with the project representatives as required to obtain statutory approval.

Other participants in the various studies which provided both the raw data and analysis contained in the EIA were principally members of the faculty of the National University of Malaysia and the Institute of Medical Research, as well as independent consultants. Most of the baseline air quality, water quality and noise studies were carried out by professors and members of the faculty of the National University of Malaysia.

THE EIA AND MALAYSIAN STANDARDS AND REGULATIONS

The EIA for Manjung Project is a very detailed, comprehensive document. It has become a kind of benchmark for other EIAs for such projects in Malaysia.

Work by TNRD started in early April 1997 and the draft report was submitted to a DoE convened panel of internal and external specialists who, in August 1997, requested a number of changes to improve the quality and scope of the study. The draft EIA was revised and re-submitted in October 1997. Following a series of requests for further elaboration on portions of the EIA, approval of DoE was granted on April 30, 1998. The environmental parameters for the Manjung Project fulfil all of the Malaysian DoE requirements, including:

- Air emissions – flue gases: particulate matter, including PM_{10}, SO_2 and NO_2 as well as CO, for which the prime mitigating measures are Electrostatic Precipitators or ESPs installed in the flue gas system, operating at better than 99.6% efficiency, plus low-NO_x burners and a Flue Gas Desulphurisation (FGD) system using seawater washing and treating 65% of all flue gases downstream of the ESPs. World Health Organisation (WHO) standards for air quality are not to be exceeded for the Manjung Project.
- Cooling water system: a "once-through" circulating water system has been approved after taking into consideration that the project is located on a reclaimed island off the Northwest coast in the Malacca Straits. The main criterion for DoE is the Malaysian requirement that the cooling water temperature may not exceed 40°C (appropriate for tropical conditions) under any conditions. The plans for the final cooling water arrangement were optimised by the EPC Contractor and submitted to DoE and Perak State's Department of the Environment prior to construction. Based on the studies contained in the EIA, the impact on marine flora and fauna is predicted to be small and within acceptable limits for a tropical situation.
- Wastewater control and mitigation measures, including continuous and quarterly monitoring and reporting, fulfil all of the relevant Malaysian Environmental Regulations and Guidelines.

THE EXTENT TO WHICH THE MANJUNG PROJECT AND APPROVED EIA MEET WORLD BANK GUIDELINES

When the Manjung Project was initially set up by the parent organisation, TNB, as an IPP, it was intended to develop the project on a project-financed basis. To attract international investors, as well as IFIs and ECAs, it was decided, therefore, at an early stage to meet international criteria for environmental performance and quality.

The emissions criteria and air quality standards, in particular, due to global perceptions of pollution and emission of greenhouse gases, amongst others, were intended to meet relevant, prevailing World Health Organisation and World Bank Standards at the time.

Thus, it was decided by TNBJ early on to fulfil the known WHO/World Bank Standards for particulates and SO_2/NO_2, in particular, and therefore, low NO_x burners were specified, together with high-efficiency ESPs and, as previously noted, FGD plant and equipment using seawater washing.

Chimney emissions and ground level concentrations will not exceed the EIA stipulated levels of emissions at Manjung; see Table 1 for stack emissions and Table 2 for ground level measurements.

Table 2 demonstrates that both Malaysian Standards and World Bank Guidelines are also satisfied for ground-level concentrations.

The flue gases of greatest concern, SO_2 and NO_2, as well as particulates, are monitored continuously, both at the exit of the stack as well as at three permanent ground level monitoring stations, one on the island and the other two located close to where the maximum concentrations affecting the local population are expected to occur.

For cooling water, the once-through circulating water system has been optimised for intake and outlet locations for cost and performance in line with "Thermal Power-Guidelines for New Plants," which is part of the World Bank's *Pollution Prevention and Abatement Handbook*. Malaysian requirements opt not to identify a mixing zone requirement; instead, temperatures shall under no circumstances exceed 40°C, the condition imposed on all operating power stations in Malaysia as appropriate for tropical conditions, with minimum impact on marine flora and fauna. The final arrangement of the cooling water system, as required by the EIA, was submitted to the Malaysian Environmental Authorities for final approval after the EPC Contractor carried out his thermal plume modelling, and optimised his actual cooling water system, but prior to start of construction.

Manjung Project is designed to produce electricity at an attractive cost to consumers but with due regard to the environment in which it operates.

The newly completed Administration Building

TABLE 1: COMPARISON OF EMISSIONS STANDARDS AT THE STACK

Parameter	World Bank Recommended Guidelines	Malaysian Standards/ DoE	Allowed Values for Manjung Project (TNBJ)
NO_2 (mg/Nm^3)	650 (750 max.)	1700 (AW) 2000 (OI)	650
SO_2 (mg/Nm^3)	750 (2000 max.)	3500 200 (OI)	750
Particulates (mg/Nm^3)	50	n/a	50
PM_{10} (mg/Nm^3)	EIA should consider impact on Public Health	Must be adequately considered	Must be monitored and reported to DoE every 3 months

1. *AW applies to Acid Works; OI applies to Other Industries; therefore, in the absence of an appropriate Malaysian standard for these parameters, World Bank Guidelines have been followed for NO_2/NO_x and SO_2.*
2. *World Bank Guidelines are taken from the 1997 Handbook.*

TABLE 2. EMISSIONS STANDARDS FOR GROUND LEVEL CONCENTRATIONS

Composition	Averaging Time	World Bank GLC	Malaysian Standards (DoE)	Manjung Predicted GLC
Particulates ($\mu g/Nm^3$)	1 hour	–	n/a	44.2
	24 hour	230	260	109
	annual	80	90	32
SO_2 ($\mu g/Nm^3$)	1 hour	–	350	338
	24 hour	150	105	87
	annual	50	n/a	35
NO_2 ($\mu g/Nm^3$)	1 hour	–	320	300
	24 hour	150	n/a	75
	annual	100	n/a	31
PM_{10} ($\mu g/Nm^3$)	1 hour	–	n/a	n/a
	24 hour	150	150	133
	annual	50	50	50 or less

The motto of TNB Janamanjung is:

'Technology in Harmony with Nature.'

For the Manjung Project, a serious and conscientious effort has been made to realise this statement from the original design intent through to the present operational status, where by the plant is an important and effective contributor to the Malaysian grid.

This is an extract from a paper presented at Power-Gen Asia 2004, Bangkok.