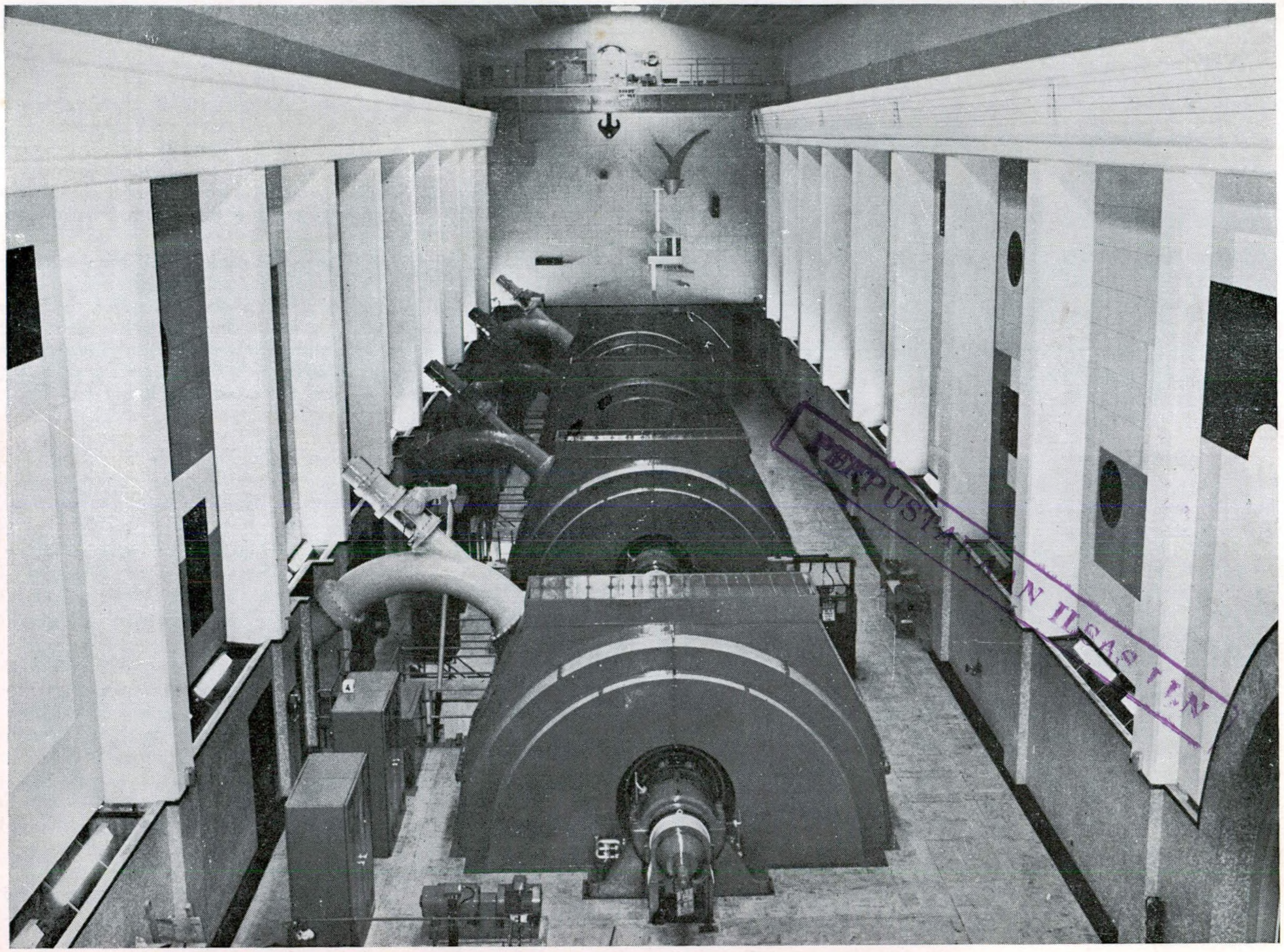
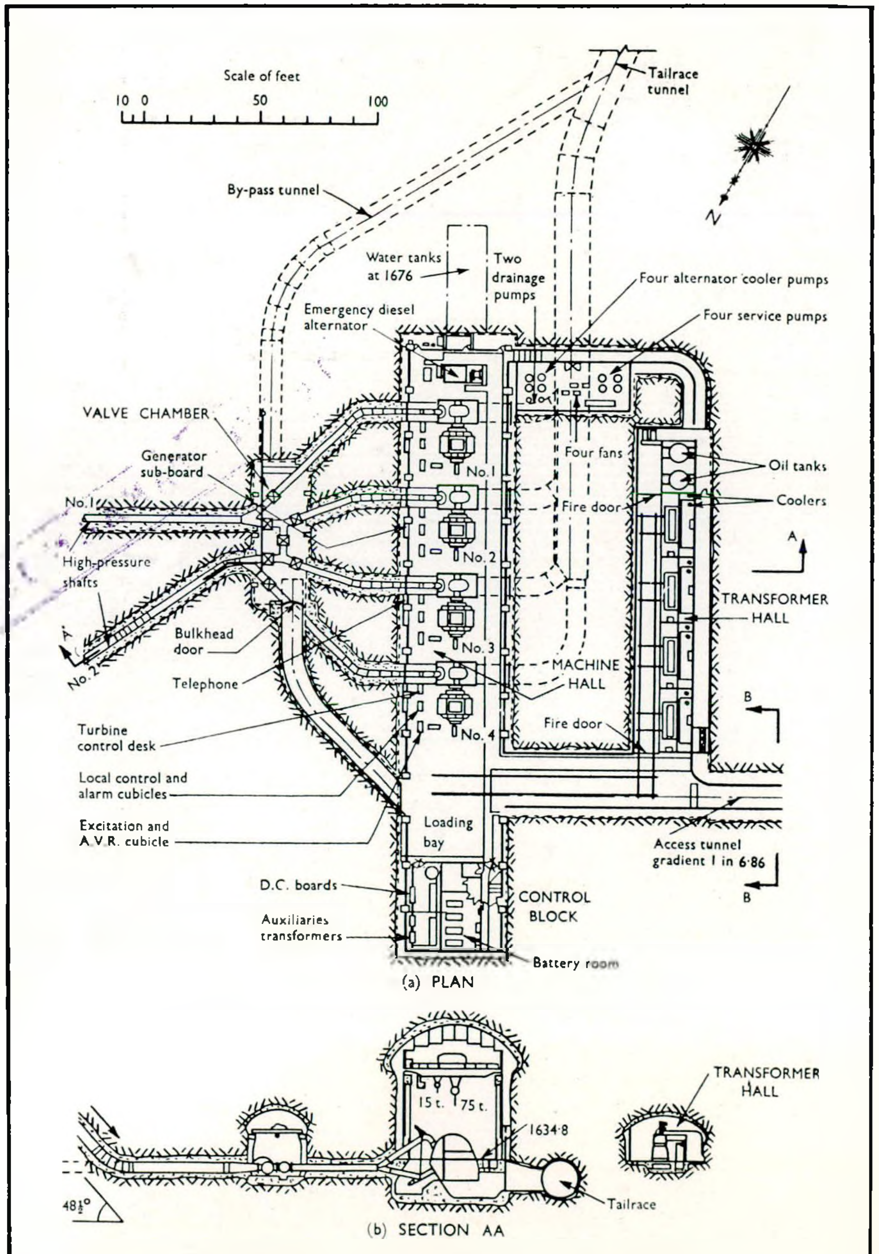
Lembaga Letrik Negara, Tanah Melayu



SULTAN YUSSUF POWER STATION



SULTAN YUSSUF POWER STATION

The Sultan Yussuf Power Station of the National Electricity Board is located in the State of Perak near the 19th milestone on the Tapah-Cameron Highlands road. The total installed capacity is 100,000 kW and the station generates some 320 million units in an average year. It operates as a peak load station and supplies power to the Board's consumers throughout the populated areas on the west coast or the States of Malaya.

The power station itself consists of three underground caverns which were hewn out of solid granite some 860 feet vertically below ground level. The roof arches of the three caverns were lined with concrete as a safeguard against possible opening of rock joints in the future. The walls of the caverns were left unlined. Access to the power station is provided by a half mile long tunnel which slopes downwards at a gradient of 1 in 7. The choice of site and the decision to locate it underground was arrived at after consideration of the facts that the turbines had to be set as near as possible to the maximum water level of the Jor reservoir of the Batang Padang Scheme; the station had to be within a predetermined distance of a practical site for a surge shaft; and the undesirability of erecting large-diameter surface pipelines on steep hillsides where the danger of landslides is always present.

The machine hall lies some 1,880 feet below the level of the Ringlet reservoir whence the water for the turbines enters the Bertam tunnel. This tunnel is 4¼ miles long; it is fully lined with concrete and has an equivalent diameter of 12 feet 9 inches. Located at the southern end of the tunnel is a surge shaft, 22 feet in diameter and 245 feet high, the purpose of which is to dampen surges which may occur as a consequence of the sudden acceptance or rejection of load on the machines in the Sultan Yussuf Power Station.

Two high pressure, steel lined shafts, each with an average diameter of 63 inches slope down at an angle of 48½ degrees to the horizontal from the surge shaft to the Sultan Yussuf Power Station. Each shaft has been designed to supply two turbines but valves have been provided in the upper and lower valve chambers to effect the isolation of either shaft for inspection, and allow three turbines to be supplied from the other shaft.

The machine hall is 270 feet long by 50 feet wide and is 60 feet high from the main floor level and contains an electrically operated 75/15 ton overhead travelling crane. Control of the four 25 MW sets in the station is carried out from the Control Room which overlooks the machine hall. Remote-control of the machines in the Habu and the future Woh and Odak stations is also effected from this Control Room. Forced ventilation, which is provided by fans in a pump and fan room in the underground station, has been designed to circulate a total quantity of 3 million cubic feet of air per hour. The air is routed down the access tunnel and is exhausted through the tailrace tunnel from the false ceiling in the machine hall. This false ceiling forms an upper ventilation duct below the concrete roof-arch and the design is aimed at acoustically reducing the high noise level commonly occurring in underground stations equipped with high head turbines with exposed casings.

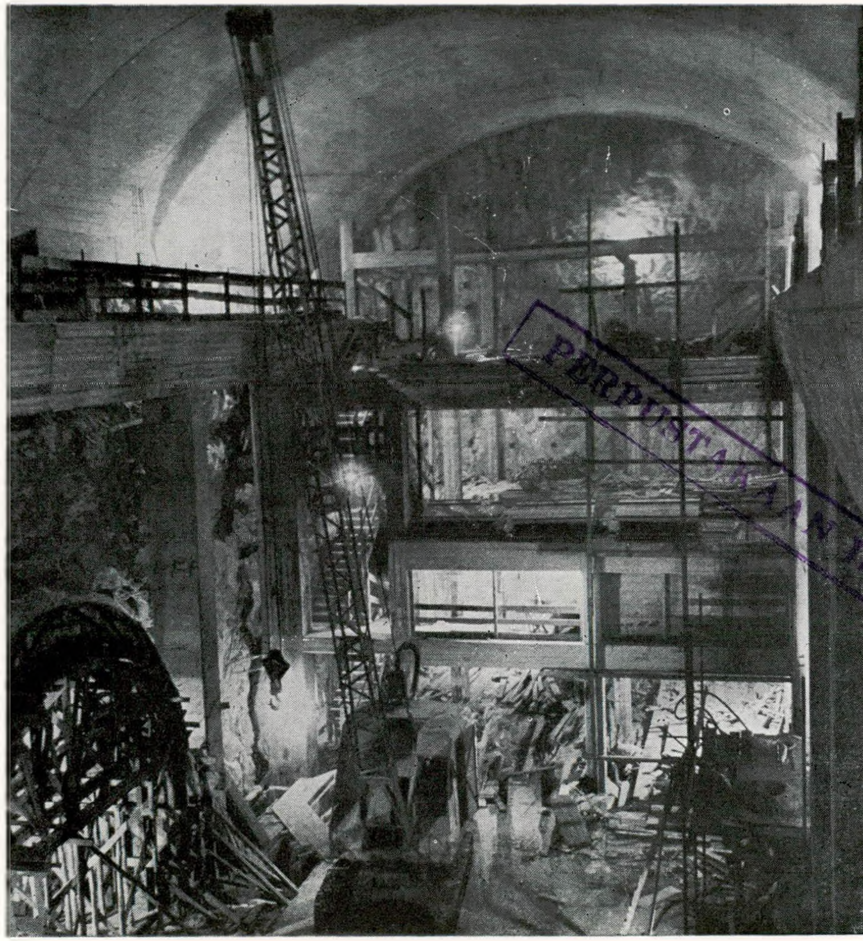
The four turbines in the machine hall are of the horizontal shaft, twin jet, Pelton type, each capable of developing 28,000 h.p. under the design head of 1,790 feet. The normal speed is 428 rev/min. The water, after expending its energy in the turbines, is led away through a tailrace tunnel, 16 feet 4 inches diameter and 1½ miles long, and discharges into the Batang Padang river where it is again impounded in the Jor reservoir for further use in the second phase of the Cameron Highlands Hydro-Electric Development.

The alternators are each rated at 25MW, 0.9 power factor and generate at 11,000 volts. Cooling of the alternators is by a closed recirculating air system, the air being cooled by water drawn from the tailrace. Station auxiliaries derive power through an 11,000 volt indoor switchboard located in the switchyard feeding into two 11,000/415 volt air cooled transformers in the station. Auxiliary supplies are further backed by an automatic starting 328 kW diesel generating set located in the machine hall. Each alternator has its associated transformer which steps up the generated voltage from 11,000 to 132,000 volts. These transformers, which are of the forced oil circulation, water-cooled type, are located in an underground transformer hall parallel with and connected to the machine hall.

Three-core 132,000 volt oil-filled cables, are run on a bench on one side of the access tunnel to connect each transformer to the surface 132,000 volt switchyard which is located near the portal. Control cables are run on a bench on the other side of the access tunnel. The swtichyard is of low level double bus-bar construction equipped with bulk-oil circuit breakers of 2,500 MVA symmetrical breaking capacity. A general services building incorporating workshops and storage facilities, 11,000 volt switchgear and transformers, relays, batteries, etc., is located at the switchyard. Nearby is the administrative block with offices for the Station Suprerintendent and his staff.

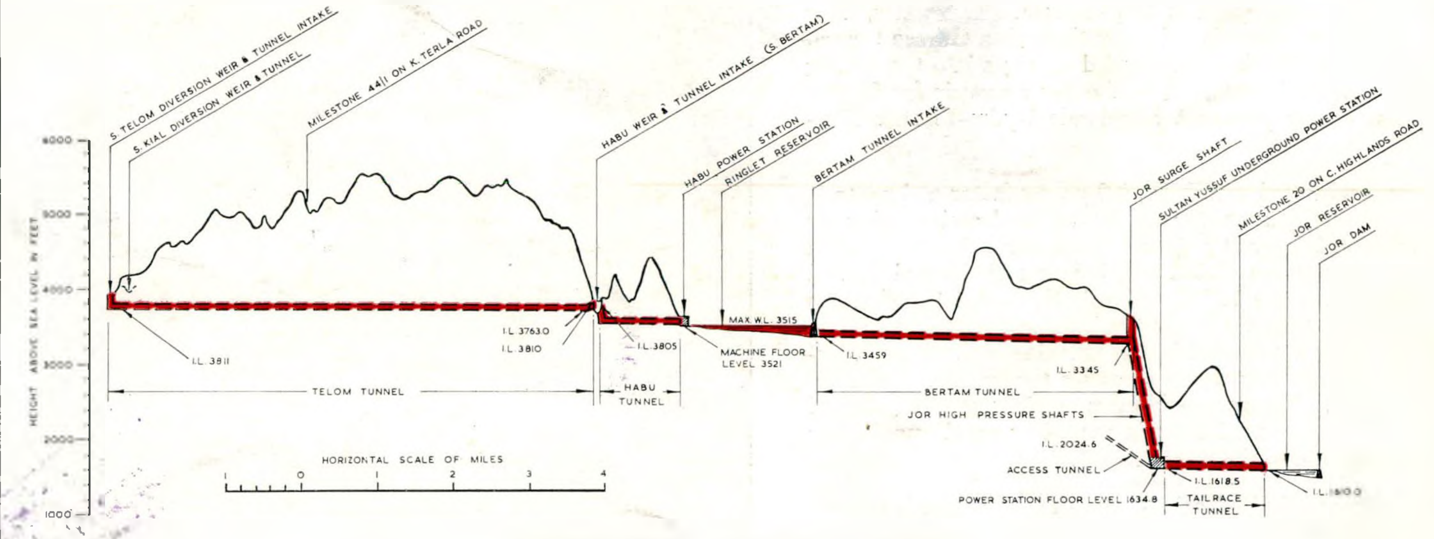
Special provision was made for the transport of exceptionally heavy loads to the power station at the time of construction. A special 110 ton railway wagon was purchased for conveying these loads from Port Swettenham to the railway station at Temoh, where a 70 ton gantry crane was erected on a new siding. A road transporter, consisting of two tractors and a trailer of 65 ton capacity mounted on 24 wheels then conveyed the heavy loads to the power station. The National Electricity Board also bore the cost of strengthening all the road bridges from the railhead to the site.

The Sultan Yussuf Power Station formed part of the Cameron Highlands Hydro-Electric Scheme which was financed by loans from the International Bank for Reconstruction and Development, the Commonwealth Development Finance Company Limited, and the Central Government. The total cost of the Cameron Highlands Scheme was $125 million. Site investigation and drilling took place at the height of the Emergency in the years 1954 to 1956. International tenders were called in 1958 and excavation of the underground power station commenced in September 1960. The first two 25 MW sets were commissioned in the early months of 1963 and the third and fourth sets were commissioned later the same year.

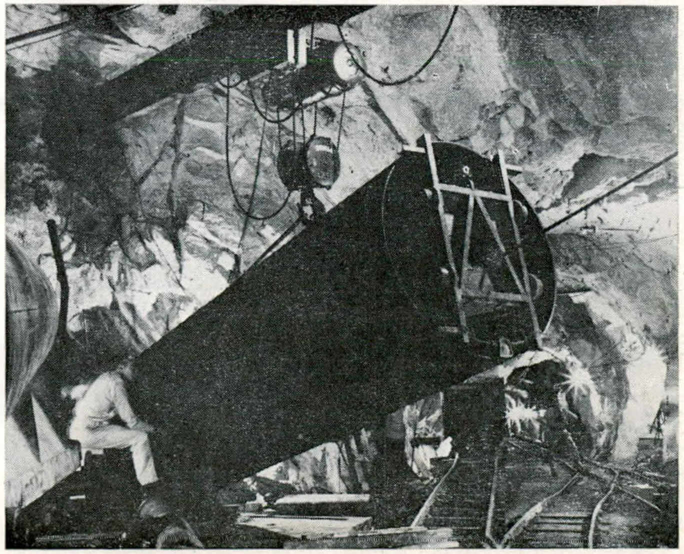


Control Block under construction

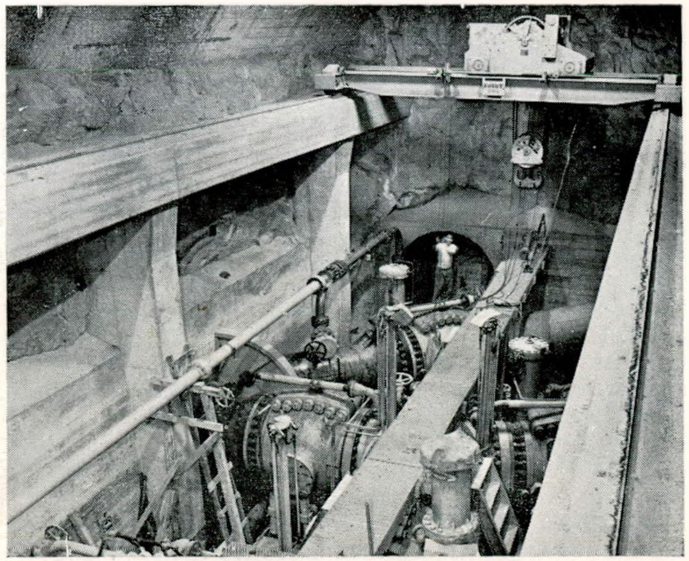
The Consulting Engineers to the National Electricity Board were Messrs. Preece, Cardew & Rider in association with Messrs. Binnie & Partners. The civil works were carried out by Joint Venture Cameron Highlands, an association of Hochtief A.G. and Philipp Holzmann A.G. Turbines, alternators, cranes and turbine inlet valves were supplied and erected by a Joint Venture of Le Material Electrique, Paris and Vevey Engineering Works, Switzerland. Switchgear was supplied and erected by the Associated Electrical Industries, London; transformers by Savigliano, Turin, Italy, and cables by the British Insulated Callenders Construction Co., Ltd., London. The Board's Project Engineer was Mr. J.H. Sumner, P.J.K., O.B.E., M.SC.(Tech), M.I.E.E.



LONGITUDINAL SECTION OF TUNNELS



Lowering steel linings down pressure shaft.



Erecting valves in lower valve chamber.