Appendix 5.1a
Derivation of Heat Re-circulation Factor

Appendix 5.1a Derivation of Heat Re-circulation Factor

It is assumed that all cooling water discharges have an excess temperature of 6°C with reference to the ambient water temperature. Theoretically, the potential short circuit problem of the recirculation of heated water to the cooling water intake should be taken into account by conducting a series of model runs. The first run should be simulated with an excess temperature of 6°C at the spent cooling water outfalls and the second run should be simulated with an excess temperature of 6°C plus the temperature elevation at the intakes predicted in the first-run. More simulations should be iterated with the temperature elevation at the intakes plus temperature at the outfall to reproduce the potential build-up of heat recirculation, until the results converge. Assuming that the temperature elevation at intake is proportional to that at cooling water discharge, the temperature elevation at intake can be derived as follows:

No. of model-run	Temperature of spent cooling water (°C)	Temperature elevation at intake (°C)
1	k	E
2	E+k	(E/k)x(k+E) = E[1+(E/k)]
3	E[1+(E/k)]	(E/k)xE[1+(E/k)] = E[1+(E/k)+(E/k)^2]
... ...	... ...	... ...
n	...	E[1+(E/k)+(E/k)^2+......+(E/k)$^{n-1}$]

Where:

Excess temperature of the cooling system = k (°C)

Mean temperature elevation at intake = E (°C)

The temperature elevation at intake for n-times simulation

$=E[1+(E/k)+(E/k)^2+......+(E/k)^{n-1}] = E[1-(E/k)^n]/[1-(E/k)]$

For (E/k)<1 and when n tends to infinity, temperature elevation at intake would become E[1/(1-E/k)].

Based on the above consideration, only one model simulation would be required and the resulted temperature elevation at intake can be factored up by [1/(1-E/k)] to account for the potential short circuit problem. Under the current EIA study, the maximum of the mean temperature elevations predicted amongst all the water intakes is conservatively used as the value of E for calculation of the recirculation factor [1/(1-E/k)].