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Vapor-Phase Transport of ^{3}H Near a Nuclear Power Plant

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The tertiary cooling system of nuclear power plants typically contains elevated levels of ^{3}H which are often disposed of into nearby rivers. One reactor in the USA utilizes a cooling canal system (CCS) in which heat is dissipated in open canals (approximately 250 Km total length) with the water returned to the reactor in a closed loop system. The CCS also contains dissolved nutrients and concerns have been raised regarding the seepage of CCS water into surrounding low-nutrient surface waters. The occurrence of ^{3}H above "background" in surrounding surface waters has caused concerns with the assumption that ^{3}H transport from the CCS occurs only as seepage in the liquid phase and hence is a good tracer for nutrients. To evaluate vapor-phase transport, a network of evaporation pans and rain collectors was established at various distances from the CCS. The evaporation pans were filled with low ^{3}H water and ^{3}H values were monitored through time. A mass balance model was developed to account for vapor exchange, direct precipitation, and isotopic fractionation in the evaporation pans. The model predicts that pan water and atmospheric vapor equilibrate in about 20 days. Equilibrated ^{3}H values in the evaporation pans were about 500 TU 3 m from the CCS and decreased exponentially to about 9 TU 4.8 Km away. ^{3}H in rain also decreased exponentially with distance from the CCS but at values that were 2 to 3 times lower than the evaporation pans. A mass balance model was developed to evaluate the steady-state transport of vapor-phase transport into nearby surface waters as a function of the vapor exchange rate and water residence time. Results show that vapor-phase transport alone can produce significant ^{3}H values above background and this complicates the use of ^{3}H as a tracer of dissolved nutrients hypothesized to be seeping from the CCS into surrounding surface waters.