APPENDIX 7A

Calculations Involving Irrigation

Dose from Ingestion of Milk from Cows Grazing on Land which has been Irrigated with Contaminated Water

Adopt NUREG 1.109 approach.

Problem is addressed in three stages.

Stage 1: Concentration of radioactive material in vegetation (C_{iv})

The expression used to derive C_{iv} is eq. A-8 on p. 1.109 - 15. Two components contribute to the total activity concentration.

Component 1 given in the first term of the bracketed expression refers to direct foliar deposition. This term is neglected as this is specifically excluded from the brief.

Component 2 refers to the uptake of radioactivity into vegetation from soil and can reflect long term deposition due to operation of a facility.

The modified expression taken from eq. A-8 for use in the project will therefore be:

$$C_{iv} = C_{iw} \cdot I \cdot \left[\frac{f_i \cdot B_{iv} \cdot \left(1 - \exp(-l_i \cdot t_b)\right)}{r \cdot l_i} \right] \cdot \exp(-l_i \cdot t_h)$$

where

C_{iw} - Bq·l^{-1} of nuclide *i* in water used for irrigation
I - L·m^{-2}·h average irrigation rate during growing season
f_i - fraction of year which crops are irrigated
B_{iv} - soil to vegetable radionuclide concentration factor
ρ - effective surface density of soil kg·m^{-2}
λ_i - radiological decay constant
t_b - period of time for which soil is exposed to contaminated water
t_h - hold-up time between harvest and consumption

In the current case, t_b will be assumed to be one year and t_h will be zero, and so $exp(-\lambda_i \cdot t_h)$ will therefore tend to one.

<u>Stage 2:</u> Concentration of radionuclides in milk

The radionuclide concentration in an animal product such as meat or milk is dependent on the amount of contaminated feed or forage eaten by the animal and its intake of contaminated water.

In the current case, the intake of contaminated water is neglected.

The radionuclide concentration C_{im} in milk is given by eq. A-11 of NUREG 1.109 on p. 1.109 - 16.

$$C_{im} = F_{im} \times C_{iv} \times Q_v$$

where

F_{im} - stable element transfer coefficient relating daily intake rate by an animal to concentration in milk, day·L^{-1}.

Q_v - Consumption rate of contaminated vegetable matter, kg·day^{-1}.

<u>Stage 3:</u> Dose to man from ingestion of contaminated milk

The dose D_i, is simply the product of the radionuclide concentration in milk C_{im}, the annual intake of milk Q_m, and the ingestion dose coefficient for the particular nuclide:

$$D_i = C_{im} \times Q_m \times DCF_i$$

thus

$$D_i = C_{iw} \cdot I \cdot \left[\frac{f_i \cdot B_{iv}\left(1 - \exp(-\lambda_i \cdot t_b)\right)}{\rho \cdot \lambda_i} \right] \cdot F_{im} \cdot Q_v \cdot Q_m \cdot DCF_i$$

Note: the above equations can be adapted to provide concentrations of radionuclides in various crop types using the appropriate transfer values. Dose to the consumer may then be calculated in a manner similar to the above example but using the appropriate consumption factors for the various crop types.