



Entergy

Indian Point NPP

Oct 21, 2005
IPEC-CHM-05-034

MEMORANDUM TO: D. LEACH – Unit 2 SFP Integrity Issue Team Leader

FROM: S. SANDIKE – Sr. CHEMISTRY SPECIALIST

SUBJECT: DERIVATION OF DILUTION FLOW AND DOSE CALCULATIONS

The key element in producing a valid bounding calculation for potential offsite dose from Spent Fuel Pool releases to the bedrock (bypassing the discharge canal) is the determination of a dilution factor into the Hudson directly. While it is very conservative to assume NO dilution from circulator or service water pumps, it is not appropriate to imagine there is no dilution from natural sources.

The terms used in the calculation for dilution factor are defined in NUREG 0133 (pages 15-16) and involve an understanding of not only the released fluid and receiving body of water, but also an “applicable factor” that includes consideration for mixing effects in the near field. For this calculation, which is clearly outside the ODCM, determination of the volume of the receiving body of water (the applicable portion of the Hudson) and the “applicable factor” need to be re-evaluated before routine Reg Guide 1.109 methodology for dose calculations may be applied.

Assuming (from reports by the site Hydrologist) that a good worst-case assumption of the transport of SFP water into the Hudson is under the canal, into the sediment, and upwards into the river, we can determine a “near field dilution factor”, per NUREG 0133 as follows:

$$Fl = \frac{\text{liquid waste flow}}{\text{discharge structure exit flow} * \text{applicable factor}}$$

This calculation requires knowledge of the exit flow of all fluids from the bedrock into the sediment and then diffused into the Hudson River. It also requires knowledge of the inputs to the “applicable factor”. Much of this information can be determined from an ODCM basis document: “Radio-ecological Studies of the Hudson River”, from NYU and Dr. Paul Linsalata (1987). In his report, the factor is identified as a ratio of concentrations effected by stream velocity and cross sectional area over a chosen distance. We may update this data specifically for releases under the canal and into the sediment as follows:

$$\text{Applicable Factor} = e^{-ux/D}$$

Where;

- u = velocity, approximated by modern flow rate over a chosen area
- x = the distance over which tidal flow is most apt to apply
- D = an averaged longitudinal diffusion coefficient for the local area of the river.

Using the assumptions for the original report, and historical stream flows from the effluent reports since 2000, the velocity can be represented by 22,864 cfs /140,000 ft² or 0.16 ft/sec. The distance over which the tides are likely to move remains the same, as does the diffusion coefficient (-22 miles and 4000 ft²) to provide a value of 104.

The determination of an actual dilution flow rate from natural sources is pending from the site hydrologists. Assuming only 0.01 percent of the average stream flows reported annually are discharged along the bedrock and into the Hudson under Indian Point, an early conservative assessment of this value would be 2.28 cfs or approximately 1,000 gpm. This, in concert with the applicable factor, provides a dilution factor of approximately 100,000 to 1 (approximately 3% of routine releases).

Release Rate ml/day or 2.64E+00 gpd or 0.001834728 gpm

Duration of Release, in days Waste vol released = 2.40E+02 gal

Dilution flow gpm Dilution vol released = 1.31E+08 gal

Dil Factor 1.83E-06

ISOTOPE	Activity Released uCi/ml	10CFR20 EC*10 conc limit	PRE DILUTION CONC/MPC	POST DILUTION uCi/ml	POST DILUTION CONC/MPC	MICRO- CURIES RELEASED
H-3	2.00E-02	1.00E-02	2.00E+00	3.67E-08	3.67E-06	1.82E+04
MN-54		3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55		1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-58		2.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	1.00E-07	3.00E-05	3.33E-03	1.83E-13	6.12E-09	9.10E-02
NI-63		1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90		5.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SB-125		3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134	8.00E-07	9.00E-06	8.89E-02	1.47E-12	1.63E-07	7.28E-01
CS-137	1.00E-05	1.00E-05	1.00E+00	1.83E-11	1.83E-06	9.10E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	2.00E-02	n/a	3.09E+00	3.67E-08	5.67E-06	1.82E+04

NUREG 0133 "Applicable Factor" for Near Field Dilution =

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	2.26E-07	2.26E-07	2.26E-07	2.26E-07	2.26E-07	2.26E-07
MN-54	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FE-55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-60	0.00E+00	5.93E-09	1.31E-08	0.00E+00	0.00E+00	0.00E+00	1.11E-07
NI-63	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SB-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134	1.33E-06	3.15E-06	2.58E-06	0.00E+00	1.02E-06	3.40E-07	5.51E-08
CS-137	2.12E-05	2.91E-05	1.90E-05	0.00E+00	9.86E-06	3.28E-06	5.61E-07
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	2.26E-05	3.24E-05	2.18E-05	2.26E-07	1.11E-05	3.84E-06	9.54E-07

The very preliminary calculation above indicates that the quarterly doses from the potential release of isotopes from the Unit 2 SFP (even when released with minimal dilution directly to the Hudson along the bedrock) result in less than 1% of our reported quarterly liquid effluent doses.

SS/ss

cc: W. Axelson D. Wilson R. Lavera D. Quinn NRC (info only)