From: "Sandike, Steven Richard" <SSandik@entergy.com>
To: <tbrice@gw.dec.state.ny.us>, "Adler, Joseph J." <jadler@entergy.com>, "Quinn, Dennis M" <dquin91@entergy.com>, <dquinn@daq-inc.com>, "Hollenbeck, Peter" <pholl91@entergy.com>, "Hinrichs, Gary H" <ghinric@entergy.com>, "Mayer, Donald M" <dmayer1@entergy.com>, "Donahue, Patrick J" <PDonahu@entergy.com>, "Gray, Dara F" <DGray@entergy.com>, "Wilson, Daniel" <DWilson@entergy.com>
Date: 04/05/2007 1:41:35 PM
Subject: 2006 ground water dose assessment from IPEC

All,

To be sure you all have the latest data from which I am drafting the annual effluent report, I have attached some letters and other documents.

1) latest annual summary, describing source terms and flow rates used, broken down into 4 quarterly assessments and totalled.
<<2006GW-Rev1.pdf>>
Keep in mind, this is NOT going in to the Reg Guide 1.21 annual report until we complete a review of the source term selection process.
We still are working out a few unique questions, like, what to do when there are NO effected analyses in a quarter.

2) an independent assessment with an annual average source term selection - which was requested to "matching 2005's method"
<<chm-07-012.pdf>>
This was requested, I believe, because there was concern that the 2006 "method" was different than the 2005 method. To quell immediate concerns, I did what was requested and simply performed an annual assessment with average values, like I did in 2005, except that in 2005, we didn't even have "average" values, we had, in effect, Conservatively Guessed values.

The "methods" are essentially the same. I am bound by NUREG 0133, Reg Guide 1.109, and the ODCM to perform them the same way.
The differences are simply
1) source term selection - more data now, so a process of using the third quartile function of all available data was used. See below.
2) annual rainfall slightly lower in 2006 than in 2005
3) dose calcs broken down by quarter and summed.

Per discussions with the NRC, we thought it was more appropriate to perform quarterly assessments. This was because 10CFR50 requires compliance with quarterly integrated offsite dose evaluations.

B-1

We have a lot more source term info available in 2006, so it was of course, used. However, the "method" of determining offsite curies and dose did not change. It remains a function of annual average rainfall, converted to flow rates in areas and zones (by GZA modelling), and an application of source term. It is this application that probably initiated concern for a "different method". I hope this email will make it clear that A METHOD needed to be developed. There was no "method" in 2005 because there was little or no data.

Much of the source term in 2005 was conservatively assumed (some were deliberate "guesses"). In 2006, there was significantly more data available and the single biggest difference from 2005 to 2006 was the application of actual Strontium values at the river-front, rather than a conservative value found near the FSB in 2005. Furthermore, as stated above, this eval was performed on a quarterly basis. The selection process for the source term used in 2006 was, in fact, discussed with many of you, and is summarized below. We feel it is a sound conservative process, yet provides for improved and defendable accuracy over the 2005 report, as you might expect, as we learn more and more about our groundwater.

<<2740-GWdoses.pdf>> <<2005 and 2006 GW Dose Calcs.doc>>

I have about 50 pages of supplemental info including all dose calcs for each age group, area, and zone, as well as the rainfall, dilution, and flow rate determinations for 2006. Along with the source term compilations, we are making our final assessment on site, prior to submittal of the Reg Guide 1.21 annual effluent report. We may choose to slightly alter the source term selection prior to final publishing, but the memos above should be very close to what you will see in the Reg Guide 1.21 report.

We will certainly make sure you get a copy of the final report. When we are finished with decision making regarding some of the trickier issues of source term selection (what to do with no data, but a trend of either positive or negative results), I can send you the large pdf of "supplemental data" for the ground water assessment if you would like it, or anything else you would like to see.

Summarizing, the methods of offsite dose calcs from 2005 to 2006 are essentially the same. The slightly lower calculated dose in 2006 reflects an actual source term, instead of 2005's assumed. However, both these values are significantly below federal limits, and the total error involved in the integrated assessment is probably greater than the difference we currently see from 2005 to 2006. We aren't done, of course, and our data and reports will hopefully continue to be improved.

Steve Sandike
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Entergy

Indian Point NPP

Mar 28, 2007
IPEC-CHM-07-009 **Rev 1** *(Suspect vendor lab results excluded and new averages/3rd quartile source terms used)*

MEMORANDUM TO: D. WILSON - CHEMISTRY SUPERINTENDENT

FROM: S. SANDIKE – Sr. CHEMISTRY SPECIALIST

SUBJECT: ANNUAL SUMMARY OF GROUND WATER DOSE EVALUATION - 2006

Attached are quarterly breakdowns of effluent dose assessment from Storm and Groundwater for the year 2006. During the course of the year, members of the team determined that while an annual summary is required for the annual effluent report, doses should be determined quarterly, per age group, in a similar fashion to all other compliance mechanisms per 10CFR50, Appendix I.

The Adult age group remains the most limiting. The annual adult dose values for 2006 are as follows:

Parameter	2005 Eval	**2006 Eval**	Percent Limit- 2006
Total Body Dose	2.1E-3 mrem	**1.65E-3 mrem**	0.055%
Adult Bone Dose	9.7E-3 mrem	**6.43E-3 mrem**	0.064%

See the attached breakdown for quarterly data. The bases for parameters used in these calculations are described in 0-CY-2740, Liquid Radioactive Effluents, and summarized in the following sections.

Release Rate to River:

Flow rates from each area and zone are determined by applying annual average rainfall to conversion factors established by the team of site hydrologists per IPEC-CHM-06-012 in April 2006, as shown in the attached. Flow rates in gpm are then corrected for any remediation performed in that area/zone.

Dilution Flow:

Dilution flow has been established at 1.11E5 gpm for Areas 2, 3a, and 3b, as well as Zone B, per work performed by Entech Engineering and documented in IPEC-CHM-05-042, as these Areas/Zones go directly to the river. Zones C, D, and E use actual quarterly dilution flow on their way to the canal.

Source Terms:

Contamination levels for each area/zone are determined QUARTERLY, using a process of ranking ALL data in selected wells/drains in each area/zone, and using the 75% quartile value for the effected quarter's source term. This method is generally more conservative than using a simple mean. For those cases where there are sufficient negative analyses results to generate a ZERO for the 75% quartile value, the source term was determined from a MEAN value. This method ensures that a non-zero value is used when there are infrequent positive results in an area/zone. *Suspect vendor lab results were NOT included in the determination process.* The selection process is evident from spreadsheets stored with the supplemental information, maintained within the Chemistry Department.

Doses are less than 0.1% of the NRC effluents limits (3 millirem per year whole body and 10 millirem per year highest organ). Nonetheless, the effluent impact from groundwater will be included in the annual effluent report.

SS/ss

cc: D. Mayer J. Adler D. Gray R. Lavera D. Quinn T. Burns

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Indian Point NPP

Mar 9, 2007

IPEC-CHM–07-012

MEMO TO: D. WILSON - CHEMISTRY SUPERINTENDENT

FROM: S. SANDIKE – Sr. CHEMISTRY SPECIALIST

SUBJECT: 2006 GW DOSES USING 2005 SOURCE TERM SELECTION PROCESS

The Ground Water assessment of Mar 1, 2007, identified in IPEC-CHM-07-009 identified annual effluent doses from IPEC of approximately 60% those of 2005. The causes of this apparent reduction were a combination of minor changes in rainfall and dilution, with significant improvements in the number and quality of our source term analyses.

Methodology employed to determined the 2006 numbers did not change from that of 2005. However, since there was significantly more data was available for the 2006 assessment, and because discussions were held with the NRC over the year, dose calculations in 2006 were performed on a quarterly basis.

For the 2005 report, some source term values were conservatively estimated in excess of 100% of the limited analytical results we had accumulated by the time of the report (April 2006). Since that time, with ample data to support quality assessments per quarter, the guesswork was removed, as some wells were being sampled almost weekly. The volume of data available by March 2007 negates any need for overly conservative estimates of source term at the discharge points. Like any effluent calculation, actual data is used to generate an accurate report, and not a bounding calculation, as was somewhat required last year.

A system of selecting moderately conservative source terms was used for the 2006 assessment, nonetheless. As described in the earlier letter, this system involved application of the 75% quartile function to all analytical results in each area and zone, for each age group, over all four quarters. While the methodology for dose calculations did not change, it should be evident that, of course, the source term information must indeed change from year to year as we accumulate more data.

To demonstrate the effect of this process in comparison to simply using an annual average "best guess", as was required for the most part in the 2005 report, another calculation was completed and attached to this summary. This calculation uses annual average concentrations instead of the 75% quartile function, and indeed, the resulting doses are lower than the earlier report by the expected factor of approximately 1.5 (the ratio of 75% to 50%).

Returning to the question of 2006 doses being 60% those of 2005, the attached 2005 assessment shows that for the most part, very conservative values of Sr-90, particularly in Zones 2 and 3a, were updated in the 2006 report to actual values, in place of what was established very early in our ground water investigation as a VERY conservative guess at an annual average Sr-90 source term in these areas. The value used was 2 to 3 times higher than the values obtained over the course of the year, and since this area drives the majority of the dose calculation, it is reasonable to see the actual reported annual dose total for 2006 corrected by this fraction.

By April 2006, we had collected 4 sample results for Area 2, ranging from **18-26** pCi/L just before the annual assessment was published. Due to a desire to be conservative for the previous year (for which we literally had NO data), we chose to use **50** pCi/L in this area. This ultra-conservative assumption alone accounts for most of the difference in 2005 and 2006 dose assessment. The Sr-90 values collected over the year strongly suggested a value significantly lower than 50, and indeed, using the 75 percentile function discussed, Area 2 was assigned pCi/L of 21, 19, 9.4 and 16 for quarterly values in 2006. These more defendable values (averaging approximately 17 pCi/L for the year) comprise less than half the value applied in 2005 as a best estimate, in lieu of an absence of data.

Clearly, it is very unlikely that the effluent release rates changed from 2005 to 2006. The slightly different calculated annual dose in 2006 simply resulted in a more accurate assessment, from precisely the same dose calculational methodology employed in 2005. In reality, based on our current level of knowledge, it could be argued that 2005's data was over-reported. However, either of these assessments involves an error term that negates imagining that these annual summaries are different, at all.

Either selection process (for determining a source term) indicates that the annual doses remain at or below 0.01 mrem, **or less than 0.1%** of the respective limits.

SS/ss

cc: D. Mayer J. Adler D. Gray R. Lavera D. Quinn T. Burns

Total IPEC Summary for Ground Water releases in 2006 (H-3, Ni-63, Sr-90)

Based on average source term concentrations for the entire year

Sum of monitoring well calculations, IP2 and IP3, Areas 2, 3a, and 3b

Doses, in mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi/cc
H-3	0.00E+00	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	*1.63E+05*
Ni-63	2.65E-04	1.84E-05	8.92E-06	0.00E+00	0.00E+00	0.00E+00	3.84E-06	*1.35E+02*
Sr-90	3.82E-03	0.00E+00	9.36E-04	0.00E+00	0.00E+00	0.00E+00	1.10E-04	*1.52E+02*
Cs-137	1.14E-04	1.56E-04	1.02E-04	0.00E+00	5.29E-05	1.76E-05	3.01E-06	*5.43E+01*
totals	4.20E-03	1.76E-04	1.05E-03	1.82E-06	5.48E-05	1.94E-05	1.19E-04	***1.63E+05***

Storm Drain Water from Zone B, East/West Unit 2, near MH-2, going to river directly

Doses, in mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi/cc
H-3	0.00E+00	2.66E-09	2.66E-09	2.66E-09	2.66E-09	2.66E-09	2.66E-09	*2.37E+02*

Storm Drain Water from Zones C and D/E (Central U2 & U1/U3) to Discharge Canal

Doses, in mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi/cc
H-3	0.00E+00	1.44E-08	1.44E-08	1.44E-08	1.44E-08	1.44E-08	1.44E-08	*8.13E+04*

Totals:

Doses, in mrem

	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	uCi/cc
H-3 only	0.00E+00	1.84E-06	1.84E-06	1.84E-06	1.84E-06	1.84E-06	1.84E-06	*2.44E+05*
H-3, Ni-63, Sr-90, Cs-137	4.20E-03	1.76E-04	1.05E-03	1.84E-06	5.48E-05	1.94E-05	1.19E-04	*1.63E+05*
% Annual Limit	*0.042*	*0.002*	*0.035*	*0.000*	*0.001*	*0.000*	*0.001*	*Ann Avg Method*

	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI	
from Qrtly Breakdowns H-3, Ni-63, Sr-90, Cs-137	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	*from the sum of all quarterly assessments, which use the 3rd quartile function*
% Annual Limit	*0.059*	*0.002*	*0.051*	*0.000*	*0.001*	*0.000*	*0.002*	
3rd Quartile method / Annual avg method	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

This indicates that the 75 percentile method is indeed generating doses approx 1.5 times the average, which is exactly what 3rd quartile function should be doing.

Storm Drain Zone B (MH-2 East & West Unit 2) to the Hudson River directly, 2006

Release Rate 5.00E+07 ml/day or 1.32E+04 gpd or 9.18 gpm

Duration of Release, In days 365 Waste vol released = 4.82E+06 gal

Dilution flow 1.11E+05 gpm Dilution vol released = 5.83E+10 gal

Dil Factor 8.27E-05 *(dilution data per **IP-CHM-05-042** from Dr. John Hamawi)*

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	1.30E-08	1.00E-02	1.30E-06	1.08E-12	1.08E-10	2.37E+02
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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137		1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	1.30E-08	n/a	1.30E-06	1.08E-12	1.08E-10	2.37E+02

NUREG 0133 "Applicable Factor" for Near Field Dilution = 1.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LL
H-3	0.00E+00	2.66E-09	2.66E-09	2.66E-09	2.66E-09	2.66E-09	2.66E-09
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	0.00E+00	2.66E-09	2.66E-09	2.66E-09	2.66E-09	2.66E-09	2.66E-09

Central Unit 2 Storm Drain Releases of Tritium to the Hudson River via the Discharge Canal in 2005 (Zone C)

Release Rate 2.63E+07 ml/day or 6.95E+03 gpd or 4.83 gpm

Duration of Release, in days 365 Waste vol released = 2.54E+06 gal

Dilution flow 1.40E+06 gpm Dilution vol released = 7.38E+11 gal

Dil Factor 3.44E-06 *(dilution from actual 2006 data)*

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	5.80E-06	1.00E-02	5.80E-04	1.99E-11	1.99E-09	5.57E+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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137		1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	5.80E-06	n/a	5.80E-04	1.99E-11	1.99E-09	5.57E+04

NUREG 0133 "Applicable Factor" for Near Field Dilution = 5.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	9.85E-09	9.85E-09	9.85E-09	9.85E-09	9.85E-09	9.85E-09
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	0.00E+00	9.85E-09	9.85E-09	9.85E-09	9.85E-09	9.85E-09	9.85E-09

Storm Drain Releases of Tritium to the Hudson River via the Discharge Canal in 2005 from Units 1 and 3 (Zones D and E)

Release Rate 1.76E+08 ml/day or 4.64E+04 gpd or 32.22 gpm

Duration of Release, in days 365 Waste vol released = 1.69E+07 gal

Dilution flow 1.39E+06 gpm Dilution vol released = 7.31E+11 gal

Dil Factor 2.32E-05 *(dilution from actual 2006 data)*

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	4.00E-07	1.00E-02	4.00E-05	9.27E-12	9.27E-10	2.56E+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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137		1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	4.00E-07	n/a	4.00E-05	9.27E-12	9.27E-10	2.56E+04

NUREG 0133 "Applicable Factor" for Near Field Dilution = 5.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	4.58E-09	4.58E-09	4.58E-09	4.58E-09	4.58E-09	4.58E-09
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	0.00E+00	4.58E-09	4.58E-09	4.58E-09	4.58E-09	4.58E-09	4.58E-09

IP3 Tritium Released to Hudson River via Bedrock Pathway in 2006

(from the area near IP3 waterfront, as determined by samples from Monitoring Wells - Area 3b)

Release Rate 3.46E+07 ml/day or 9.14E+03 gpd or 6.35 gpm

Duration of Release, in days 365 Waste vol released = 3.34E+06 gal

Dilution flow 1.11E+05 gpm Dilution vol released = 5.83E+10 gal

Dil Factor 5.72E-05 *(dilution data per **IP-CHM-05-042** from Dr. John Hamawi)*

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	1.33E-07	1.00E-02	1.33E-05	7.61E-12	7.61E-10	1.68E+03
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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63		1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SR-90	1.75E-10	5.00E-06	3.50E-05	1.00E-14	2.00E-09	2.21E+00
SB-125		3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137		1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	1.33E-07	n/a	4.83E-05	7.62E-12	2.76E-09	1.68E+03

NUREG 0133 "Applicable Factor" for Near Field Dilution = 1.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.88E-08	1.88E-08	1.88E-08	1.88E-08	1.88E-08	1.88E-08
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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	5.54E-05	0.00E+00	1.36E-05	0.00E+00	0.00E+00	0.00E+00	1.60E-06
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	5.54E-05	1.88E-08	1.36E-05	1.88E-08	1.88E-08	1.88E-08	1.61E-06

IP1 Tritium Released to Hudson River via Bedrock Pathway in 2006

(from the area near IP1 waterfront, as determined by samples from Monitoring Wells - Area 3a)

Release Rate 2.65E+07 ml/day or 7.00E+03 gpd or 4.86 gpm

Duration of Release, In days 365 Waste vol released = 2.56E+06 gal

Dilution flow 1.11E+05 gpm Dilution vol released = 5.83E+10 gal

Dil Factor 4.38E-05 *(dilution data per **IP-CHM-05-042** from Dr. John Hamawi)*

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	6.10E-06	1.00E-02	6.10E-04	2.67E-10	2.67E-08	5.90E+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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	2.29E-09	1.00E-03	2.29E-06	1.00E-13	1.00E-10	2.22E+01
SR-90	1.03E-08	5.00E-06	2.06E-03	4.51E-13	9.03E-08	9.97E+01
SB-125		3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	5.09E-09	1.00E-05	5.09E-04	2.23E-13	2.23E-08	4.93E+01
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	6.12E-06	n/a	3.18E-03	2.68E-10	1.39E-07	5.92E+04

NUREG 0133 "Applicable Factor" for Near Field Dilution = 1.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	6.60E-07	6.60E-07	6.60E-07	6.60E-07	6.60E-07	6.60E-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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	4.37E-05	3.03E-06	1.47E-06	0.00E+00	0.00E+00	0.00E+00	6.32E-07
SR-90	2.50E-03	0.00E+00	6.13E-04	0.00E+00	0.00E+00	0.00E+00	7.20E-05
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	1.04E-04	1.42E-04	9.28E-05	0.00E+00	4.81E-05	1.60E-05	2.74E-06
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	2.65E-03	1.45E-04	7.08E-04	6.60E-07	4.87E-05	1.66E-05	7.60E-05

IP2 Activity Released to Hudson River via Bedrock Pathway, 2006

(from the area near IP2 transformer yard, as determined by samples from Monitoring Wells - Area 2)

Release Rate 1.50E+07 ml/day or 3.95E+03 gpd or 2.74 gpm

Duration of Release, in days 365 Waste vol released = 1.44E+06 gal

Dilution flow 1.11E+05 gpm Dilution vol released = 5.83E+10 gal

Dil Factor 2.47E-05 *(dilution data per **IP-CHM-05-042** from Dr. John Hamawi)*

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	1.87E-05	1.00E-02	1.87E-03	4.62E-10	4.62E-08	1.02E+05
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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	2.06E-08	1.00E-03	2.06E-05	5.09E-13	5.09E-10	1.12E+02
SR-90	9.23E-09	5.00E-06	1.85E-03	2.28E-13	4.56E-08	5.04E+01
SB-125		3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	9.17E-10	1.00E-05	9.17E-05	2.27E-14	2.27E-09	5.00E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	1.87E-05	n/a	3.83E-03	4.63E-10	9.46E-08	1.02E+05

in comparison to 2005, these values are the biggest reason for "dose reduction"

NUREG 0133 "Applicable Factor" for Near Field Dilution = 1.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06	1.14E-06
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	2.22E-04	1.54E-05	7.45E-06	0.00E+00	0.00E+00	0.00E+00	3.21E-06
SR-90	1.26E-03	0.00E+00	3.10E-04	0.00E+00	0.00E+00	0.00E+00	3.64E-05
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	1.05E-05	1.44E-05	9.43E-06	0.00E+00	4.88E-06	1.62E-06	2.78E-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	1.49E-03	3.09E-05	3.28E-04	1.14E-06	6.03E-06	2.77E-06	4.10E-05

But these values are determined from sample results - where 2005 data was purposefully estimated 2 to 3 times higher than the earliest sample results in Apr 2006.

Total IPEC Summary for Ground Water releases in 2005 (H-3, Ni-63, Sr-90)

Sum of two monitoring well calculations, IP2 and IP3, Areas 2 and 3

Doses, in mrem

ISOTOPE	BONE	LIVER	TOTBODY	THYROID	KIDNEY	LUNG	GI-LLI	adc
H-3	0.00E+00	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.52E-05	1.52E-05	*1.36E+06*
Ni-63	1.32E-03	9.17E-05	4.44E-05	0.00E+00	0.00E+00	0.00E+00	1.91E-05	*6.70E+02*
Sr-90	8.40E-03	0.00E+00	2.06E-03	0.00E+00	0.00E+00	0.00E+00	2.42E-04	*3.35E+02*
totals	9.72E-03	1.07E-04	2.12E-03	1.50E-05	1.50E-05	1.50E-05	2.76E-04	***1.36E+06***

Storm Drain Water from Zone B, East/West Unit 2, near MH-2, going to river directly

Doses, in mrem

ISOTOPE	BONE	LIVER	TOTBODY	THYROID	KIDNEY	LUNG	GI-LLI	adc
H-3	0.00E+00	1.63E-07	1.63E-07	1.63E-07	1.63E-07	1.63E-07	1.63E-07	*1.46E+04*

Storm Drain Water from Zones C and D/E (Central U2 & U1/U3) to Discharge Canal

Doses, in mrem

ISOTOPE	BONE	LIVER	TOTBODY	THYROID	KIDNEY	LUNG	GI-LLI	adc
H-3	0.00E+00	2.82E-08	2.82E-08	2.82E-08	2.82E-08	2.82E-08	2.82E-08	*1.58E+05*

Totals:

Doses, in mrem

	BONE	LIVER	TOTBODY	THYROID	KIDNEY	LUNG	GI-LLI	adc
H-3 only	0.00E+00	1.54E-05	1.54E-05	1.54E-05	1.54E-05	1.54E-05	1.54E-05	*1.53E+06*
H-3, Ni-63, Sr-90	9.72E-03	1.07E-04	2.12E-03	1.54E-05	1.54E-05	1.54E-05	2.76E-04	*5.06E+02*
% Annual Limit	*0.097*	*0.001*	*0.071*	*0.000*	*0.000*	*0.000*	*0.003*	

IP2 Activity Released to Hudson River via Bedrock Pathway, 2005

(from the area near IP2 transformer yard, as determined by samples from Monitoring Wells - Area 2)

Release Rate 1.84E+07 ml/day or 4.85E+03 gpd or 3.37 gpm

Duration of Release, in days 365 Waste vol released = 1.77E+06 gal

Dilution flow 1.11E+05 gpm Dilution vol released = 5.83E+10 gal

Dil Factor 3.03E-05 *(dilution data per **IP-CHM-05-042** from Dr. John Hamawi)*

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-04	1.00E-02	2.00E-02	6.07E-09	6.07E-07	1.34E+06
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		3.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	1.00E-07	1.00E-03	1.00E-04	3.03E-12	3.03E-09	6.70E+02
SR-90	5.00E-08	5.00E-06	1.00E-02	1.52E-12	3.03E-07	3.35E+02
SB-125		3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-134		9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137		1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57		6.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	2.00E-04	n/a	3.01E-02	6.07E-09	9.13E-07	1.34E+06

These values were not analyses results, but conservative Guesses

NUREG 0133 "Applicable Factor" for Near Field Dilution = 1.00E+00

Adult Total Body mrem

ISOTOPE	BONE	LIVER	TOT BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E+00	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05	1.50E-05
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NI-63	1.32E-03	9.17E-05	4.44E-05	0.00E+00	0.00E+00	0.00E+00	1.91E-05
SR-90	8.40E-03	0.00E+00	2.06E-03	0.00E+00	0.00E+00	0.00E+00	2.42E-04
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	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO-57	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTAL	9.72E-03	1.07E-04	2.12E-03	1.50E-05	1.50E-05	1.50E-05	2.76E-04

Excerpts from 0-CY-2470, Radioactive Liquid Effluents – for Ground Water dose assessment

Obtain average rainfall at IPEC over the period to be evaluated. This data is obtainable from the MET data or the Environmental group. Contact the site hydrologists to determine if there have been any updates to the model for determining flow rates from the Areas and Zones established in Reference 5.2.5.

Determine the flow rate to the river from each applicable pathway by multiplying the average rainfall (in feet per year or inches per month) by the associated conversion factor (CF), to obtain gpm. (Ref 5.2.5)

Areas and Zones as defined in Ref 5.2.5.	Area 2	Area 3a	Area 3b	Zone B	Zone C	Zone D/E
	Unit 2 Mon Wells	Unit 1 Mon Wells	Unit 3 Mon Wells	Unit 2 Strom Drains, E/W	Unit 2 Storm Drains, Center	Unit 1/Unit 3 Storm Drains
CF =	0.901	1.60	2.09	3.02	1.59	10.6

For example, with an average rainfall of 2.71 in/month, the ground water flow rate leaving Area 2 over the period in which the rainfall was measured would be: **2.71 * 0.901 = 2.44 gpm**

Subtract out any flow rate that is specifically removed from these Areas or Zones via remediation (which will be quantified separately).

For example, if a remediation system is pumping 5 gpm for 10 hours per day from Area 2 in the example above, the resulting flow rates would be 2.08 gpm for the remediation effort, and 0.36 gpm still going directly to the river from Area 2.

Assign a dilution flow to each Area and Zone per Ref 5.2.4. Typically, this dilution will be 1.11E5 gpm for Areas 2, 3a, and 3b, and Zone B as these Areas/Zones go directly to the river. Zones C,D, and E will use actual quarterly dilution flow.

Assign a NUREG 0133 "Applicable Factor" for Near Field Dilution. Like dilution flow, Areas 2, 3a, 3b, and Zone B will normally use a factor of 1.0, as these pathways go directly to the river. Zones C, D, and E will use the ODCM's factor of 5.0, as these go to the discharge canal.

Assign source term concentrations to each Area and Zone in the table below. Typically, a system of ranking all valid readings from all levels is used, such that the 75 percentile value is used for reporting. A more conservative value may be used per Chemistry Management . Data is available in WinCDMS or in the Ground Water Analyses database.

Area 2	Area 3a	Area 3b	Zone B	Zone C	Zone D/E
Unit 2 MW	Unit 1 MW	Unit 3 MW	Unit 2 SD, E/W	Unit 2, Center	U1/U3 SD
MW-36	(MW-58)	U3-1	MH-1 CB-19		MH-B7 CB-14
MW-37	MW-49	U3-2	MH-2 CB-23	MH-4	MH-B8 CB-15
MW-52	MW-50	U3-3	MH-12	MH4A	MH-C1 CB-33
MW-60	MW-59	U3-4D	MH-13	MH-5	MH-C2 CB-34
MW-61	MW-62	U3-4S	MH-14	MH-6	MH-D2
	MW-63	MW-48	MH-15		MH-E7

Perform individual dose calculations on each Area and Zone, using the above determined release rate, dilution flow, and source term. Either RETDAS, approved BASIC or Excel codes, or Ref 5.3.2 may be used to perform these ODCM dose calculations.

IF not already quantified, THEN perform similar quantification on any effluent as a direct result of remediation of ground water.

a) This quantification will generally involve specific source term determinations on the remediation flowpath, rather than a collection of ground water samples.

b) Discharge flow rate will be measured, and the routine site dilution and applicable near field dilution factors will be used, as this water will be directed to the discharge canal.

Combine the results for a site report of radioactive effluent from Storm & Ground water. This report is typically provided as an addendum to the Reg Guide 1.21 report and NOT added in to the other pathway's totals. Deliver any compiled information to Chem Management.

Methodology Used for Offsite Dose in 2005 and 2006 from Groundwater and Storm Water Pathways

The basic methodology for the dose assessments is based on an overall mass balance driven by precipitation. The total annual precipitation was used to determine how much water flowed through the storm water system and how much infiltrated into groundwater. The site was divided into several "Areas" of groundwater, and several "Zones" for storm water. For each area and for each zone, the amount of water flowing through was determined by the Entergy consultant for hydrology, GZA, and the amount of radioactivity in the groundwater or storm water was based on actual samples in each area. Therefore, the diluted concentration is determined by this simplified equation:

$$\text{Mass of water } \frac{\text{gallon/year} \times \text{uCi/cc}}{\text{(Dilution Factor)}} = \text{diluted concentration}$$

After the diluted concentration was determined, the normal Reg. Guide 1.109 type of methodology was used, including bioaccumulation factors, usage factors, etc.

The dilution factor was the normal discharge canal dilution for storm water that went to the discharge canal. For groundwater, and for storm water that went directly to the Hudson River, the non-discharge canal dilution factor developed by J. Hamawi was used. The difference in these dilution factors is about a factor of 40, where the discharge canal provides more dilution.

In 2005, only a limited number of monitoring wells and sample results were available, so very conservative values were selected in order to provide a "bounding calculation". The major contributor to the dose was Sr-90 in the Unit 2 groundwater, conservatively assumed to be 50 pCi/liter.

In 2006, there were no changes to the overall methodology; however, significantly more wells had been developed, and additional data was available. In addition, the decision was made to balance completeness and conservatism in the data selection by using all of the available data in each "area" or "zone" and use the 75th percentile value. In this way, the data from all applicable wells were used, including sample results for all elevations for wells near the effluent point to the river. In some cases, the 75th percentile value was less than the minimum detectable value, and in those cases, the mean value was used. The details of the methodology used in 2006 have been documented in Chemistry Procedure 0-CY-2470, Radioactive Liquid Effluents. While this same method was used in 2005, the procedure had not yet been written.

In summary, the same methodology was used for 2005 and 2006, but there was significantly more sample data available and utilized in 2006. This allowed the development of a more accurate, yet still conservative dose estimate.