Beaver Valley Power Station

Radiation Protection Technical Position/Evaluation/Calculation

Subject	No.	PAGE 1 OF
Liquid Monitor Alert Emergency Action Level (EAL) Set Points	**ERS-LMR-14-001**	10

Reference

HPP_____EPP : NEI 99-01 rev 6 T/S _____ CR _____ DCP_____

Category	Unit 1	Unit 2
☐ Technical Position ■ Technical Evaluation ☐ Calculation	☒	☒

Purpose

NEI 99-01 Revision 6 changed the methodology for calculating Alert set points for Liquid Radiation Monitors. The previous Alert set points were to be 200 x ODCM set points. However, they are now to be calculated for 10 mrem TEDE or 50 mrem thyroid CDE.

Note: This Technical Evaluation is not an implementing document. Any application of the information contained herein must be reviewed and approved using the established review/approval process for that application.

☐ **ORIGINAL ISSUE**

☒ **REVISION # 1**

Made correction to page 3: annual drinking water ingestion volume of 730 liters per year, not per day.

by	*checker/reviewer*	*independent review (calculation only)*
Lara M Renz 4-20-15	John Lebda 4.20.15	

Checklist		Attachments
■ Purpose	■ Results	■ Data Sheets
■ Methodology	■ References	☐ Illustrations
■ Input Data		☐ Printouts
		☐ Code Listings

■ Transmittal to BVRC	☐ Supt, Rad Ops	■ Author: Dr. Lara Renz
■ Original RP ERF FILE	☐ Supv, RP Services	■ John Lebda
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DISCUSSION:

This technical evaluation used ODCM source terms for liquid discharges, radiation monitor nuclide detection efficiencies, and nuclide dose conversion factors to calculate radiation monitor readings that correspond to offsite doses of 10 mrem TEDE and 50 mrem child thyroid. These monitor indicator values may be used for an Alert level in Emergency Plan Emergency Action Levels (EAL), EPP-I-1a and EPP-I-1b, when NEI 99-01 revision 6 is implemented (Reference 1). The calculated radiation monitor readings may be used for Emergency Action Level (EAL) determination following an accident with consequent release of radioactivity, and when the results of more rigorous assessments are not available.

METHODOLOGY

The bases for the EAL values for the four emergency classifications are:

Unusual Event (UE): ODCM limit multiplied by two (x2) for greater than 60 minutes. ODCM limits are calculated in ERS-ATL-93-021 (Reference 2).

Alert: Effluent pathway radiation monitor indication that corresponds to 10 mrem TEDE or 50 mrem child thyroid dose. The lower of the two values is used. Gaseous doses are calculated at the site boundary; liquid doses are calculated at Midland Water Intake.

There are no liquid effluent pathways associated with a Site Area or General Emergency.

INPUT DATA/ASSUMPTIONS	References
1. A_i = Particulate Activity from the release path (Ci/yr)	[3, 5]
2. ALIg = Ingestion Annual Limit of Intake from 10 CFR 20 Appendix B Table 2	[4]
3. F = Dilution Water Flowrate = 22,800 GPM (= 15,000 GPM BV-1 + 7,800 GPM BV-2)	[3]
4. ODCM site specific mixing effect of the discharge structure = 3	[3]
5. ODCM river dilution factor = 200	[3]
6. f = Maximum Acceptable Discharge Flowrate (GPM) = 35 gpm for RM-1LW-104 = 15 gpm for RM-1LW-116 = 80 gpm for 2SGC-RQ100	[3]
7. Ei = Monitor Sensitivity (cpm/uCi/cc)	[6, 7]
8. DCF = Dose Conversion Factors for child thyroid from RG 1.109	[9]

Release source terms (A_i) used to determine the monitor EAL values are listed in the spreadsheets in Attachments 1 through 3.

NEI 99-01 revision 6 discusses assumptions and requirements for this set point calculation. Site-specific dose receptor points are expected to be used in the calculation with a one hour exposure duration. The ODCM liquid effluent receptor point is a down river potable drinking water intake structure with in ¼ mile of

the release point. With the assumption that the release concentration is fully mixed by the Ohio River, the nearest drinking water supply is at the Midland Water Intake (at 1.3 miles down river from the release point). ICRP 23 (Reference 8) gives an annual drinking water ingestion volume of 1950 ml per day (for adults). USNRC Regulatory Guide 1.109 Table E-5 (Reference 9) gives an annual drinking water ingestion volume of 730 liters per year (for adults), which equates to approximately 2000 ml per day. In order to equate this to drinking water per hour, it is assumed that all 2000 ml are consumed during the one hour release. For child thyroid doses, the ICRP 23 value of 1400 ml is utilized in the same way.

Radiation monitor nuclide detection efficiencies for each monitor and for each nuclide are taken from ERS-SFL-92-039 [Unit 1] and ERS-SFL-86-026 [Unit 2] (Reference 6 and 7). Due to the availability of both 843-30 and 843-30R detectors at Unit 1, set points for both detectors were calculated (Reference 6). Detection Efficiencies are listed in the spreadsheets in Attachments 1 through 3.

The TEDE conversion factors were derived from 10 CFR 20 stochastic ALIg with 1 ALI = 5000 mrem CEDE, and 1 CEDE = 1 TEDE for a liquid ingestion scenario with the assumption that no external exposure occurs during this release.

NEI 99-01 revision 6 acknowledges that the use of EPA PAG guidance provides adult thyroid dose conversion factors, which are not always consistent with state required methodologies. BVPS has previously agreed with the states of PA, OH and WV that child thyroid doses will be calculated. This technical evaluation will remain consistent with past practices. The child thyroid dose conversion factors (DCF) are taken from USNRC Regulatory Guide 1.109 Table E-13 (units of mrem/pCi ingested) (Reference 9). DCFs are listed in the spreadsheets in Attachments 1 through 3.

The following is a description of the math performed by the EXCEL spreadsheets used in this Technical Evaluation.

An EXCEL spreadsheet was made utilizing the ODCM default source term for each unit and radiation monitor combination. Each spreadsheet consists of 15 columns with a row for each radionuclide. At the bottom of each spreadsheet, there is a section to total the count rate (CR) in cpm for 10 mrem TEDE and the count rate in cpm for 50 mrem child thyroid. Unit 2 is calculated for both cpm and uCi/ml. Details of all spreadsheet math is provided below:

Column 1 – List of the individual isotopes that comprise the ODCM source term. Each isotope occupies a row.

NOTE: Isotopes individually listed in the ODCM but not included in the dose calculation are Br-85 (172s half-life), Rh-106 (29.9s half-life). As short lived daughters of longer lived parents, production & intake limits are included with the parent values. Because of the short half life, the initial individual quantities are assumed to be insignificant. Ba-137m and Cs-137 isotopes are also individually listed in the ODCM. However, Ba-137m (2.55 min half life) will contribute to the count rate at the monitor, but will be decayed by the time it reaches Midland Water Intake. All Ba-137m daughter isotopes that an individual is exposed to are included in the Cs-137 dose factors. Therefore, Ba-137m is included in total count rate, but not dose calculations.

Column 2 – [A_i] - Total release quantity (Ci) for each isotope, specific to Unit 1 or Unit 2.

Column 3 - Stochastic Annual Limit of Intake (ALIg) for ingestion taken from 10 CFR 20 Appendix B Table 2.

Column 4 – TEDE mrem amount associated with each individual radionuclide, based upon 10 CFR 20 definition 1 ALI = 5000 mrem TEDE.

Col 4 = [(Col 2 uCi * 1E6 uCi/Ci) / Col 3 uCi] * 5000 mrem / ALI

Column 5 – Intake amount scaled to 10 mrem TEDE:

Col 5 = [(Col 2 uCi * 1E6 uCi/Ci) / Σ col 4 mrem] * 10 mrem

Column 6 – Concentration of individual radionuclide at Midland Water Intake equal to 10 mrem TEDE for a one hour adult intake. (Assumes water ingestion occurs over a 1 hour period.)

Col 6 = [Col 5 uCi / (2000 ml/hr)]

Column 7 and 10 – Concentration of individual radionuclide at associated BVPS radiation monitor equal to 10 mrem TEDE for a one hour adult intake. The concentrations at the radiation monitor(s) were calculated using:

$$C_i = \frac{F * 3 * 200}{f} * C_t$$

Col 7 = [(22800 * 3 * 200) gpm/ f gpm] * Col 6 uCi/ ml]

where: C_i = Liquid effluent concentration prior to dilution

C_t = Liquid effluent concentration after dilution

F = Dilution water flow rate (gpm)

= 22,800 gpm (15,000 gpm U1 CTBD+ 7,800 gpm U2 CTBD)

3 = ODCM site specific mixing effect of the discharge structure

200 = ODCM river dilution factor

f = Maximum acceptable discharge flow rate prior to dilution (gpm)

= 35 gpm for RM-1LW-104

= 15 gpm for RM-1LW-116

= 80 gpm for 2SGC-RQ100

Column 8 & 11 – [E_i] - List of the monitor specific isotope detection efficiencies. A set of calculations is done for the 843-30 and the 843-30R detectors available for Unit 1 monitors (isotope efficiencies in units of cpm/uCi/ml).

Column 9 & 12 –The monitor count rate (CR) was calculated using: [Reference 2]

$$CR = \sum_i C_i * E_i$$

where: CR = monitor count rate attributed from each radionuclide in ncpm

C_i = previously described

E_i = detection efficiency for the appropriate monitor (cpm/uCi/cc)[References 6 and 7]

FOR UNIT 2 ONLY:

The Unit 2 monitor display value (DV) was calculated using:

$$DV = CF11 \sum_i C_i E_i$$

where:

CF11 = 5.61E-9 uCi/ml/cpm; calculated in ERS-ATL-93-021: [Reference 2]

E_i = Previously described

C_i = Previously described

Application of Monitor Background: Because the liquid monitors do not have a background subtract feature, the indicated values are net values. Therefore, monitor background needs to be accounted for when changing the set points on a monitor.

Column 13 – Dose Conversion Factors (DCF) for child thyroid taken from Regulatory Guide 1.109 (Reference 9) in mrem/pCi ingested.

Column 14 – Converted RG 1.109 DCFs into mrem/uCi.

Col 14 = [Col 13 mrem / pCi* 1E6 pCi/ uCi]

Column 15 – Child Thyroid dose per hour from ingestion concentrations equal to 10 mrem TEDE. (Assumes water ingestion occurs over a 1 hour period.)

Col 15 = [Col 14 mrem / uCi * Col 6 uCi / ml * 1400 ml / hr]

Conversion of Child Thyroid Dose to a Count Rate equal to 50 mrem Committed Dose Equivalent (CDE):

$$\text{CR for 50 mrem CDE (CThy)} = \frac{\text{CR for 10 mrem TEDE}}{\sum_i \text{CDE}_i \,/\, 50 \text{ mrem}}$$

RESULTS

An EXCEL spreadsheet was generated to perform the alarm set point calculations. See Attachments 1 through 3.

Alarm Set Point Calculation Summary - Unit 1 [all units in cpm]				
	10 mrem TEDE	50 mrem Child Thyroid	Minimum Set Point	Monitor Range
RM-1LW-104 843-30	1.81E+09	5.89E+08	5.89E+08	10 to 1E6
RM-1LW-104 843-30R	2.09E+09	6.80E+08	6.80E+08	10 to 1E6
RM-1LW-116 843-30	4.22E+09	1.38E+09	1.38E+09	10 to 1E6
RM-1LW-116 843-30R	4.87E+09	1.59E+09	1.59E+09	10 to 1E6

Alarm Set Point Calculation Summary - Unit 2 [all units in uCi/ml]				
	TEDE	Child Thyroid	Minimum Set Point	Display Range
2SCG-RQ100	5.89E+00	2.42E+00	2.42E+00	5.6E-8 to 5.6E-2

Readability/Range Discussion:

As displayed in the tables above, all calculated set points are significantly greater (>4000%) than the range of the associated instrument. Generally when an over range EAL value occurs, it has been acceptable to choose a value of approximately 80% of the high range of the monitor. For example, 80% of 1E6 = 8E5 cpm. However, if this value would be employed as an EAL indication, an ALERT level would be declared significantly sooner than required for 10 mrem TEDE and/or 50 mrem child thyroid dose. More specifically, even at the 95% range values, ALERT EAL indication would be declared at doses less than 0.1 mrem TEDE and less than 1 mrem child thyroid for all available radiation detectors at both units. These values are far below the required EAL thresholds of 10 mrem TEDE and 50 mrem thyroid, which, if employed, would cycle plant and industry resources unnecessarily.

Conclusions/Recommendations:

NEI 99-01 recognizes that this Initiating Condition may result in a value beyond the display range of the monitor. Therefore, guidance states that if the calculated set point is greater than approximately 110% of the highest accurate monitor reading, then developers may choose not to include this monitor value as an EAL indication and are instructed to identify an alternate EAL threshold. The only viable alternate methodology is a liquid isotopic sample analysis. Sampling methodology is covered under its own distinct EAL according to NEI 99-01 revision 6. Therefore, it is recommended that BVPS EALs do not contain a liquid effluent monitor threshold value that equates to 1% of the PAG for an ALERT classification.

REFERENCES

1. NEI 99-01, Development of Emergency Action Levels for Non-Passive Reactors, Revision 6, 2012.
2. FENOC, Process Alarm Set Points for Liquid Effluent Monitors, ERS-ATL-93-021, Revision 4, 2012.
3. FENOC, Offsite Dose Calculation Manual Procedure 1/2-ODC-2.01, ODCM: Liquid Effluents, Revision 14, 2014.
4. 10 CFR 20 Appendix B Table 2.
5. SWEC, UR(B)-160, BVPS Liquid Radwaste Releases and Concentrations - Expected and Design Cases: Per Unit and Site, Revision 3; 1983
6. FENOC, Isotopic Efficiencies For Unit 1 Liquid Process Monitors, ERS-SFL-92-039, Revision 3; 2010.
7. FENOC, Unit 2 DRMS Isotopic Efficiencies, ERS-SFL-86-026, Revision 6; 1991
8. ICRP 23, Report of the Task Group on Reference Man, 1974.
9. Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Revision 1, 1977.

ATTACHMENTS

Attachment 1 - Unit 1 Liquid Monitors Alert EAL Set Points for 843-30 Detectors

Unit 1 Liquid Monitors Alert EAL Set Points
843-30 Detectors

RG 1.109 Annual (ml)

Adult water intake = 7.30E+05 ml
Child water intake = 5.10E+05 ml

ICRP 23 total daily (ml) = 1950 (Adult) 1400 (Child)
RG 1.109 Daily (ml) = Annual ml / 365.25 days = 2.00E+03 (Adult) 1.40E+03 (Child)
ODCM site specific mixing effect cf the discharge structure = 3
ODCM river dilution factor = 200
U1/U2 Combined CTBD (gpm) = 22800
Discharge Rate (gpm) = 35
Discharge Rate (gpm) = 15

NUCLIDE	A_i ANNUAL RELEASE (Ci)	10 CFR 20 stochastic Alt/g (uCi)	TEDE (mrem)	Intake for 10 mrem TEDE (uCi)	C_i Midland intake conc for hour intake (uCi/ml)	C_i =(22800*3*200)/35* LW-104 undiluted conc (uCi/ml)	E_i DETECTION EFFICIENCY (cpm/uCi/ml)	10 mrem TEDE LW-104 (cpm)	=(22800*3*200)/15* LW-116 undiluted conc (uCi/ml)	DETECTION EFFICIENCY (cpm/uCi/ml)	10 mrem TEDE LW-116 (cpm)	RG 1.109 Child thyroid DCF (mrem/pCi ingested)	RG 1.109 Child thyroid DCF (mrem/uCi ingested)	Cthy CDE (mrem)
Cr-51	1.30E-03	4.E+04	1.63E+02	2.64E-04	1.32E-07	5.16E-02	1.18E+07	6.09E+05	1.20E-01	1.18E+07	1.42E+06	4.94E-09		9.11E-07
Mn-54	3.70E-04	2.E+03	7.75E+02	6.29E-05	3.15E-08	1.23E-02	8.59E+07	1.06E+06	2.87E-02	8.59E+07	2.47E+06			
Fe-55	1.60E-03	9.E+03	8.89E+02	3.25E-04	1.62E-07	6.35E-02	0.00E+00	0.00E+00	1.48E-01	0.00E+00	0.00E+00			
Fe-59	8.30E-04	8.E+02	5.19E+03	1.68E-04	8.43E-08	3.29E-02	9.17E+07	3.02E+06	7.69E-02	9.17E+07	7.05E+06			
Co-58	1.40E-02	1.E+03	7.00E+04	2.84E-03	1.42E-06	5.56E-01	1.16E+08	6.45E+07	1.30E+00	1.16E+08	1.50E+08			
Co-60	2.00E-03	5.E+02	2.00E+04	4.06E-04	2.03E-07	7.94E-02	1.73E+08	1.37E+07	1.85E-01	1.73E+08	3.20E+07			
Zn-65	2.69E-02	4.E+02	3.36E+05	5.46E-03	2.73E-06	1.07E+00	4.67E+07	4.99E+07	2.49E+00	4.67E+07	1.16E+08			
Np-239	1.40E-04	2.E+03	3.50E+02	2.84E-05	1.42E-08	5.56E-03	0.00E+00	0.00E+00	1.30E-02	0.00E+00	0.00E+00			
Br-83	2.50E-05	7.E+04	1.79E+00	5.07E-06	2.54E-09	9.92E-04	1.36E+06	1.35E+03	2.32E-03	1.36E+06	3.15E+03			
Br-84	2.50E-05	3.E+04	4.17E+00	5.07E-06	2.54E-09	9.92E-04	9.75E+07	9.68E+04	2.32E-03	9.75E+07	2.26E+05			
Br-85	2.70E-06		0.00E+00	5.48E-07	2.74E-10	1.07E-04	6.19E+06	6.63E+02	2.50E-04	6.19E+06	1.55E+03			
Rb-86	7.50E-05	5.E+02	7.50E+02	1.52E-05	7.62E-09	2.98E-03	0.00E+00	0.00E+00	6.95E-03	0.00E+00	0.00E+00			
Sr-89	2.50E-04	5.E+02	2.90E+03	5.89E-05	2.95E-08	1.15E-02	0.00E+00	0.00E+00	2.69E-02	0.00E+00	0.00E+00			
Sr-90	1.10E-05	4.E+01	1.38E+03	2.23E-06	1.12E-09	4.37E-04	0.00E+00	0.00E+00	1.02E-03	0.00E+00	0.00E+00			
Y-90	9.40E-06	5.E+02	9.40E+01	1.91E-06	9.55E-10	3.73E-04	0.00E+00	0.00E+00	8.71E-04	0.00E+00	0.00E+00			
Y-91m	8.70E-06	1.E+05	4.35E-01	1.77E-06	8.84E-10	3.45E-04	8.98E+07	3.10E+04	8.06E-01	8.98E+07	7.24E+04			
Y-91	5.70E-05	6.E+02	4.75E+02	1.16E-05	5.79E-09	2.26E-03	2.60E+05	5.88E+02	5.28E-03	2.60E+05	1.37E+03			
Y-93	7.40E-07	1.E+03	3.70E+00	1.50E-07	7.52E-11	2.94E-05	0.00E+00	0.00E+00	6.85E-05	0.00E+00	0.00E+00			
Zr-95	5.10E-05	1.E+03	2.55E+02	1.04E-05	5.18E-09	2.02E-03	8.60E+07	1.74E+05	4.72E-03	8.60E+07	4.06E+05			
Nb-95	5.20E-05	2.E+03	1.30E+02	1.06E-05	5.28E-09	2.06E-03	8.64E+07	1.78E+05	4.82E-03	8.64E+07	4.16E+05			
Sr-91	1.30E-05	2.E+05	3.25E+01	2.64E-06	1.32E-09	5.16E-04	6.97E+07	3.60E+04	1.20E-03	6.97E+07	8.39E+04			
Mo-99	1.10E-02	1.E+03	5.50E+04	2.23E-03	1.12E-06	4.37E-01	2.84E+07	1.24E+07	1.02E+00	2.84E+07	2.89E+07			
Tc-99m	1.10E-02	8.E+04	6.88E+02	2.23E-03	1.12E-06	4.37E-01	8.99E+07	3.91E+07	1.02E+00	8.99E+07	9.13E+07			
Ru-103	3.40E-05	2.E+03	8.50E+01	6.90E-06	3.45E-09	1.35E-03	9.50E+07	1.28E+05	3.15E-03	9.50E+07	2.99E+05			
Ru-106	1.00E-05	2.E+02	2.50E+02	2.03E-06	1.02E-09	3.97E-04	0.00E+00	0.00E+00	9.26E-04	0.00E+00	0.00E+00			
Rh-103m	3.40E-05	4.E+05	3.95E-01	6.90E-06	3.45E-09	1.35E-03	0.00E+00	0.00E+00	3.15E-03	0.00E+00	0.00E+00			
Te-125m	2.50E-05	1.E+03	1.25E+02	5.07E-06	2.54E-09	9.92E-04	1.83E+05	1.82E+02	2.32E-03	1.83E+05	4.24E+02	3.20E-06	3.20E+00	1.13E-05
Te-127m	2.60E-04	6.E+02	2.17E+03	5.28E-05	2.64E-08	1.03E-02	4.09E+04	4.22E+02	2.41E-02	4.09E+04	9.85E+02	6.91E-06	6.91E+00	2.55E-04
Te-127	2.70E-04	7.E+03	1.93E+02	5.48E-05	2.74E-08	1.07E-02	1.38E+06	1.48E+04	2.50E-02	1.38E+06	3.45E+04	3.26E-07	3.26E-01	1.25E-05
Te-129m	1.10E-03	5.E+02	1.10E+04	2.23E-04	1.12E-07	4.37E-02	4.02E+06	1.76E+05	1.02E-01	4.02E+06	4.10E+05	1.57E-05	1.57E+01	2.45E-03
Te-129	6.70E-04	3.E+04	1.12E+02	1.36E-04	6.80E-08	2.66E-02	1.12E+07	2.98E+05	6.21E-02	1.12E+07	6.95E+05	9.56E-08	9.56E-02	9.08E-06
I-130	1.20E-04	1.E+03	6.00E+02	2.44E-05	1.22E-08	4.76E-03	3.08E+08	1.47E+06	1.11E-02	3.08E+08	3.42E+06	6.50E-04	6.50E+02	1.11E-02
Te-131m	1.60E-04	6.E+02	1.33E+03	3.25E-05	1.62E-08	6.35E-03	1.82E+08	1.15E+06	1.48E-02	1.82E+08	2.70E+06	5.12E-06	5.12E+00	1.16E-04
Te-131	3.00E-05	6.E+03	2.50E+01	6.09E-06	3.05E-09	1.19E-03	1.20E+08	1.43E+05	2.78E-03	1.20E+08	3.33E+05	6.35E-08	6.35E-02	2.70E-07
I-131	1.60E-01	9.E+01	8.89E+06	3.25E-02	1.62E-05	6.35E+00	1.11E+08	7.05E+08	1.48E+01	1.11E+08	1.64E+09	5.72E-03	5.72E+03	1.30E+02
Te-132	4.30E-03	7.E+02	3.07E+04	8.73E-04	4.37E-07	1.71E-01	1.17E+08	2.00E+07	3.98E-01	1.17E+08	4.66E+07	6.51E-06	6.51E+00	3.97E-03
I-132	4.90E-03	9.E+03	2.72E+03	9.95E-04	4.98E-07	1.95E-01	2.66E+08	5.17E+07	4.54E-01	2.66E+08	1.21E+08	6.82E-05	6.82E+01	4.74E-02
I-133	4.00E-02	5.E+02	4.00E+05	8.12E-03	4.06E-06	1.59E+00	9.90E+07	1.57E+08	3.70E+00	9.90E+07	3.67E+08	1.36E-03	1.36E+03	7.71E+00
I-134	8.00E-05	3.E+04	1.33E+01	1.62E-05	8.12E-09	3.18E-03	2.70E+08	8.57E+05	7.41E-03	2.70E+08	2.00E+06	1.79E-05	1.79E+01	2.03E-04
Cs-134	4.60E-02	2.E+01	3.29E+06	9.34E-03	4.67E-06	1.83E+00	1.99E+08	3.63E+08	4.26E+00	1.99E+08	8.48E+08			
I-135	4.30E-03	3.E+03	7.17E-03	8.73E-04	4.37E-07	1.71E-01	1.19E+08	2.03E+07	3.98E-01	1.19E+08	4.74E+07	2.79E-04	2.79E+02	1.70E-01
Cs-136	8.90E-03	4.E+02	1.11E+05	1.81E-03	9.04E-07	3.53E-01	2.80E+08	9.89E+07	8.24E-01	2.80E+08	2.31E+08			
Cs-137	3.30E-02	1.E+02	1.65E+06	6.70E-03	3.35E-06	1.31E+00	8.01E+07	1.05E+08	3.06E+00	8.01E+07	2.45E+08			
Ba-137m	3.10E-02	1.E+02		6.29E-03	3.15E-06	1.23E+00	8.01E+07	9.86E+07	2.87E+00	8.01E+07	2.30E+08			
Ba-140	1.10E-04	6.E+02	9.17E+02	2.23E-05	1.12E-08	4.37E-03	4.37E+07	1.91E+05	1.02E-02	4.37E+07	4.45E+05			
La-140	1.10E-04	6.E+02	9.17E+02	2.23E-05	1.12E-08	4.37E-03	2.00E+08	8.73E+05	1.02E-02	2.00E+08	2.04E+06			
Ce-141	5.10E-05	2.E+03	1.28E+02	1.04E-05	5.18E-09	2.02E-03	5.07E+07	1.03E+05	4.72E-03	5.07E+07	2.39E+05			
Ce-143	2.80E-06	1.E+03	1.40E+01	5.68E-07	2.84E-10	1.11E-04	7.27E+07	8.08E+03	2.59E-04	7.27E+07	1.89E+04			
Ce-144	3.20E-05	3.E+02	5.33E+02	6.50E-06	3.25E-09	1.27E-03	1.06E+07	1.38E+04	2.96E-03	1.06E+07	3.14E+04			
Pr-143	2.70E-05	1.E+03	1.35E+02	5.48E-06	2.74E-09	1.07E-03	1.04E+00	1.11E-03	2.50E-03	1.04E+00	2.60E-03			
Pr-144	3.20E-05	4.E+04	4.00E+00	6.50E-06	3.25E-09	1.27E-03	2.25E-06	2.86E+03	2.96E-03	2.25E+06	6.67E+03			
H-3	5.50E+02	8.E-04	3.44E+07	1.12E+02	5.59E-02	2.18E+04	0.00E+00	0.00E+00	5.09E+04	0.00E+00	0.00E+00	2.03E-07	2.03E-01	1.58E+01
Total =	5.50E+02		4.93E+07				CRIn cpm =	1.81E+09			4.22E+09			1.54E+02
							CRIn cpm =	5.89E+08	<<<< based on 50 mrem Cthy >>>>		1.38E+09			

Isotopes individually listed in the ODCM but not included in the dose calculation are Br-85 (17s half-life), Rh-106 (29.9s half-life. As short lived daughters of longer lived parents, production & intake limits are included with the parent values. Because of the short half life, the initial individual quantities are assumed to be insignificant.

Ba-137m and Cs-137 isotopes are also individually listed in the ODCM. However, Ba-137m (2.55 min half life) will contribute to the count rate at the monitor, but will be decayed by the time it reaches Midland Water Intake. All Ba-137m daughter isotopes that an individual is exposed to are included in the Cs-137 dose factors. Therefore, Ba-137m is included in total count rate, but not dose calculations.

Assumes daily drinking water intake occurs in 1 hour period at Midland water intake.
*Flow rates from 1/2-ODC-2.01
Source Term for (RM-1LW-104 and RM-1LW-116) from 1/2-ODC-2.01 (Stone and Webster Calculation Package UR(B)-160)
Detection Efficiency for (RM-1LW-104 and RM-1LW-116) from 1/2-ODC-2.01 (Calculation Package ERS-SFL-92-039)

Assumptions -
Dose calculation is for one hour exposure. Reference Man daily water intake in one hour.
Intake concentration is calculated using CT blowdown flow rate (default 15000+7800 gpm) prior to the river with ODCM outfall and river dilution prior to intake.

Attachment 2 - Unit 1 Liquid Monitors Alert EAL Set Points for 843-30R Detectors

Unit 1 Liquid Monitors Alert EAL Set Points
843-30R Detectors

	RG 1.109 Annual (ml)		ICRP 23 total daily (ml)	RG 1.109 Daily (ml) = / 365.25 days	Annual ml	ODCM site specific mixing effect of the discharge structure =	3
Adult water intake =	7.30E+05	ml	1950	2.00E+03		ODCM river dilution factor =	200
Child water intake =	5.10E+05	ml	1400	1.40E+03		U1/U2 Combined CTBD (gpm) =	22800
						Discharge Rate (gpm) =	35
						Discharge Rate (gpm) =	15

NUCLIDE	A: ANNUAL RELEASE (Ci)	10 CFR 20 stochastic ALlg uCi	TEDE mrem	Intake for 10 mrem TEDE uCi	C_f Midland Intake conc for hour intake uCi/ml	C: =(22800*3*200)/35* LW-104 undiluted conc uCi/ml	E_f DETECTION EFFICIENCY (cpm/uCi/ml)	10 mrem TEDE LW-104 cpm	=(22800*3*200)/15* LW-116 undiluted conc uCi/ml	DETECTION EFFICIENCY (cpm/uCi/ml)	10 mrem TEDE LW-116 cpm	RG 1.109 Child thyroid DCF mrem/pCi ingested	RG 1.109 Child thyroid DCF mrem/uCi ingested	Cthy CDE mrem
Cr-51	1.30E-03	4.E+04	1.63E+02	2.84E-04	1.32E-07	5.16E-02	1.24E+07	6.40E+05	1.20E-01	1.24E+07	1.48E+06	4.94E-09	4.94E-03	9.11E-07
Mn-54	3.10E-04	2.E+03	7.75E+02	6.29E-05	3.15E-08	1.23E-02	1.05E+08	1.29E+06	2.87E-02	1.05E+08	3.01E+06			
Fe-55	1.60E-03	9.E+03	8.89E+02	3.25E-04	1.62E-07	6.35E-02	0.00E+00	0.00E+00	1.48E-01	0.00E+00	0.00E+00			
Fe-59	8.30E-04	8.E+02	5.19E+03	1.68E-04	8.43E-08	3.29E-02	1.04E+08	3.43E+06	7.69E-02	1.04E+08	8.00E+06			
Co-58	1.40E-02	1.E+03	7.00E+04	2.84E-03	1.42E-06	5.56E-01	1.06E+08	5.89E+07	1.30E+00	1.06E+08	1.37E+08			
Co-60	2.00E-03	5.E+02	2.00E+04	4.06E-04	2.03E-07	7.94E-02	1.94E+08	1.54E+07	1.85E-01	1.94E+08	3.59E+07			
Zn-65	2.69E-02	4.E+02	3.36E+05	5.46E-03	2.73E-06	1.07E+00	5.02E+07	5.36E+07	2.49E+00	5.02E+07	1.25E+08			
Np-239	1.40E-04	2.E+03	3.50E+02	2.84E-05	1.42E-08	5.56E-03	0.00E+00	0.00E+00	1.30E-02	0.00E+00	0.00E+00			
Br-83	2.50E-05	7.E+04	1.79E+00	5.07E-06	2.54E-09	9.92E-04	1.48E+06	1.47E+03	2.32E-03	1.48E+06	3.43E+03			
Br-84	2.50E-05	3.E+04	4.17E+00	5.07E-06	2.54E-09	9.92E-04	3.16E+08	3.14E+05	2.32E-03	3.16E+08	7.32E+05			
Br-85	2.70E-06		0.00E+00	5.48E-07	2.74E-10	1.07E-04	6.71E+06	7.19E+02	2.50E-04	6.71E+06	1.68E+03			
Rb-86	7.50E-05	5.E+02	7.50E+02	1.52E-05	7.62E-09	2.98E-03	0.00E+00	0.00E+00	6.95E-03	0.00E+00	0.00E+00			
Sr-89	2.90E-04	5.E+02	2.90E+03	5.89E-05	2.95E-08	1.15E-02	9.84E+03	1.13E+02	2.69E-02	9.84E+03	2.64E+02			
Sr-90	1.10E-05	4.E+01	1.38E+03	2.23E-06	1.12E-09	4.37E-04	0.00E+00	0.00E+00	1.02E-03	0.00E+00	0.00E+00			
Y-90	9.40E-06	5.E+02	9.40E+01	1.91E-06	9.55E-10	3.73E-04	0.00E+00	0.00E+00	8.71E-04	0.00E+00	0.00E+00			
Y-91m	8.70E-06	1.E+05	4.35E-01	1.77E-06	8.84E-10	3.45E-04	1.07E+08	3.70E+04	8.06E-04	1.07E+08	8.62E+04			
Y-91	5.70E-05	6.E+02	4.75E+02	1.16E-05	5.79E-09	2.26E-03	2.53E+05	5.72E+02	5.28E-02	2.53E+05	1.34E+03			
Y-93	7.40E-07	1.E+03	3.70E+00	1.50E-07	7.52E-11	2.94E-05	0.00E+00	0.00E+00	6.85E-05	0.00E+00	0.00E+00			
Zr-95	5.10E-05	1.E+03	2.55E+02	1.04E-05	5.18E-09	2.02E-03	1.06E+08	2.15E+05	4.72E-03	1.06E+08	5.01E+05			
Nb-95	5.20E-05	2.E+03	1.30E+02	1.06E-05	5.28E-09	2.06E-03	1.06E+08	2.19E+05	4.82E-03	1.06E+08	5.11E+05			
Sr-91	1.30E-05	2.E+03	3.25E+01	2.64E-06	1.32E-09	5.16E-04	8.13E+07	4.20E+04	1.20E-03	8.13E+07	9.75E+04			
Mo-99	1.10E-02	1.E+03	5.50E+04	2.23E-03	1.12E-06	4.37E-01	1.41E+08	6.16E+07	1.02E+00	1.41E+08	1.44E+08			
Tc-99m	1.10E-02	8.E+04	6.88E+02	2.23E-03	1.12E-06	4.37E-01	1.11E+08	4.85E+07	1.02E+00	1.11E+08	1.13E+08			
Ru-103	3.40E-05	2.E+03	8.50E+01	6.90E-06	3.45E-09	1.35E-03	1.13E+08	1.53E+05	3.15E-03	1.13E+08	3.56E+05			
Ru-106	1.00E-05	2.E+02	2.50E+02	2.03E-06	1.02E-09	3.97E-04	0.00E+00	0.00E+00	9.26E-04	0.00E+00	0.00E+00			
Rh-103m	3.40E-05	4.E+05	3.95E-01	6.90E-06	3.45E-09	1.35E-03	0.00E+00	0.00E+00	3.15E-03	0.00E+00	0.00E+00			
Te-125m	2.50E-05	1.E+03	1.25E+02	5.07E-06	2.54E-09	9.92E-04	2.40E+05	2.38E+02	2.32E-03	2.40E+05	5.56E+02	3.20E-06	3.20E+00	1.13E-05
Te-127m	2.60E-04	6.E+02	2.17E+03	5.28E-05	2.64E-08	1.03E-02	1.62E+07	1.67E+05	2.41E-02	1.62E+07	3.90E+05	6.91E-06	6.91E+00	2.55E-04
Te-127	2.70E-04	7.E+03	1.93E+02	5.48E-05	2.74E-08	1.07E-02	1.48E+06	1.59E+04	2.50E-02	1.48E+06	3.70E+04	3.26E-07	3.26E-01	1.25E-05
Te-129m	1.10E-03	5.E+02	1.10E+04	2.23E-04	1.12E-07	4.37E-02	1.11E+05	4.85E+03	1.02E-01	1.11E+05	1.13E+04	1.57E-05	1.57E+01	2.45E-03
Te-129	6.70E-04	3.E+04	1.12E+02	1.36E-04	6.80E-08	2.66E-02	1.69E+07	4.49E+05	6.21E-02	1.69E+07	1.05E+06	9.56E-08	9.56E-02	9.08E-06
I-130	1.20E-04	1.E+03	6.00E+02	2.44E-05	1.22E-08	4.76E-03	2.65E+08	1.26E+06	1.11E-02	2.65E+08	2.95E+06	6.50E-04	6.50E+02	1.11E-02
Te-131m	1.60E-04	6.E+02	1.33E+03	3.25E-05	1.62E-08	6.35E-03	1.15E+08	7.30E+03	1.48E-02	1.15E+08	1.70E+04	5.12E-06	5.12E+00	1.16E-04
Te-131	3.00E-05	6.E+03	2.50E+01	6.09E-06	3.05E-09	1.19E-03	1.11E+08	1.32E+05	2.78E-03	1.11E+08	3.08E+05	6.35E-08	6.35E-02	2.70E-07
I-131	1.60E-01	9.E+01	8.89E+06	3.25E-02	1.62E-05	6.35E+00	1.18E+08	7.49E+08	1.48E+01	1.18E+08	1.75E+09	5.72E-03	5.72E+03	1.30E+02
Te-132	4.70E-03	7.E+02	3.07E+04	8.73E-04	4.37E-07	1.71E-01	1.21E+08	2.07E+07	3.98E-01	1.21E+08	4.82E+07	6.51E-06	6.51E+00	3.97E-03
I-132	4.90E-03	9.E+03	2.72E+03	9.95E-04	4.98E-07	1.95E-01	3.16E+08	6.15E+07	4.54E-01	3.16E+08	1.43E+08	6.82E-05	6.82E+01	4.74E-02
I-133	4.00E-02	5.E+02	4.00E+05	8.12E-03	4.06E-06	1.59E+00	1.16E+08	1.84E+08	3.70E+00	1.16E+08	4.30E+08	1.36E-03	1.36E+03	7.71E+00
I-134	8.00E-05	3.E+04	1.33E+01	1.62E-05	8.12E-09	3.18E-03	3.17E+08	1.01E+06	7.41E-03	3.17E+08	2.35E+06	1.79E-05	1.79E+01	2.03E-04
Cs-134	4.60E-02	7.E+01	3.29E+06	9.34E-03	4.67E-06	1.83E+00	2.42E+08	4.42E+08	4.26E+00	2.42E+08	1.03E+09			
I-135	4.30E-03	3.E+03	7.17E+03	8.73E-04	4.37E-07	1.71E-01	1.47E+08	2.51E+07	3.98E-01	1.47E+08	5.85E+07	2.79E-04	2.79E+02	1.70E-01
Cs-136	8.90E-03	4.E+02	1.11E+05	1.81E-03	9.04E-07	3.53E-01	3.19E+08	1.13E+08	8.24E-01	3.19E+08	2.63E+08			
Cs-137	3.30E-02	1.E+02	1.65E+06	6.70E-03	3.35E-06	1.31E+00	9.30E+07	1.22E+08	3.06E+00	9.30E+07	2.84E+08			
Ba-137m	3.10E-02	1.E+02		6.29E-03	3.15E-06	1.23E+00	9.85E+07	1.21E+08	2.87E+00	9.85E+07	2.83E+08			
Ba-140	1.30E-04	6.E+02	9.17E+02	2.23E-05	1.12E-08	4.37E-03	4.78E+07	2.09E+05	1.02E-02	4.78E+07	4.87E+05			
La-140	1.10E-04	6.E+02	9.17E+02	2.23E-05	1.12E-08	4.37E-03	2.22E+08	9.69E+05	1.02E-02	2.22E+08	2.26E+06			
Ce-141	5.10E-05	2.E+03	1.28E+02	1.04E-05	5.18E-09	2.02E-03	6.20E+07	1.26E+05	4.72E-03	6.20E+07	2.93E+05			
Ce-143	2.80E-05	1.E+03	1.40E+01	5.68E-07	2.84E-10	1.11E-04	7.87E+07	8.75E+02	2.59E-04	7.87E+07	2.04E+04			
Ce-144	3.20E-05	3.E+02	5.33E+02	6.50E-06	3.25E-09	1.27E-03	1.36E+07	1.75E+04	2.96E-03	1.36E+07	4.03E+04			
Pr-143	2.70E-05	1.E+03	1.35E+02	5.48E-06	2.74E-09	1.07E-03	0.00E+00	0.00E+00	2.50E-03	0.00E+00	0.00E+00			
Pr-144	3.20E-05	4.E+04	4.00E+00	6.50E-06	3.25E-09	1.27E-03	2.32E+06	2.95E+03	2.96E-03	2.32E+06	6.88E+03			
H-3	5.50E+02	8.E+04	3.44E+07	1.12E+02	5.59E-02	2.18E+04	0.00E+00	0.00E+00	5.09E+04	0.00E+00	0.00E+00	2.03E-07	2.03E-01	1.58E+01
Total =	5.50E+02		4.99E+07				CRin cpm =	2.09E+09			4.87E+09			1.54E+02
							CRin cpm =	6.80E+08	<<<< based on 50 mrem Cthy >>>>		1.59E+09			

Isotopes individually listed in the ODCM but not included in the dose calculation are Br-85 (172s half-life), Rh-106 (29.9s half-life. As short lived daughters of longer lived parents, production & intake limits are included with the parent values. Because of the short half life, the initial individual quantities are assumed to be insignificant.

Ba-137m and Cs-137 isotopes are also individually listed in the ODCM. However, Ba-137m (2.55 min half life) will contribute to the count rate at the monitor, but will be decayed by the time it reaches Midland Water Intake. All Ba-137m daughter isotopes that an individual is exposed to are included in the Cs-137 dose factors. Therefore, Ba-137m is included in total count rate, but not dose calculations.

Assumes daily drinking water intake occurs in 1 hour period at Midland water intake.
*Flow rates from 1/2-ODC-2.01
Source Term for (RM-1LW-104 and RM-1LW-116) from 1/2-ODC-2.01 (Stone and Webster Calculation Package URIBJ-160)
Detection Efficiency for (RM-1LW-104 and RM-1LW-116) from 1/2-ODC-2.01 (Calculation Package ERS-SFL-92-038)

Assumptions -
Dose calculation is for one hour exposure. Reference Man daily water intake in one hour.
Intake concentration is calculated using CT blowdown flow rate (default 15000+7800gpm) prior to the river with ODCM outfall and river dilution prior to intake.

Attachment 3 - Unit 2 Liquid Monitors Alert EAL Set Points

Unit 2 Liquid Monitor Alert EAL Set Points

	RG 1.109 Annual (ml)		ICRP 23 total daily (ml)	RG 1.109 Daily (ml) =	Annual ml /365 25 days	ODCM site specific mixing effect of the discharge structure =	3
Adult water intake =	7.30E+05	ml	1950	2.00E+03		ODCM river dilution factor =	200
Child water intake =	5.10E+05	ml	1400	1.40E+03		U1/U2 Combined CTBD (gpm) =	22800
						Discharge Rate (gpm) =	80

NUCLIDE	A, ANNUAL RELEASE (Ci)	10 CFR 20 stochastic ALIg uCi	TEDE mrem	Intake for 10 mrem TEDE uCi	C, Midland intake conc for hour intake uCi/ml	C, =(22800*3*2001)/80* 2SGC-100 undiluted conc uCi/ml	E, DETECTION EFFICIENCY (cpm/uCi/ml)	10 mrem TEDE 2SGC-100 cpm	RG 1.109 Child thyroid DCF mrem/pCi ingested	RG 1.109 Child thyroid DCF mrem/uCi ingested	Cthy CDE mrem
Cr-51	1.00E-04	4.E+04	1.25E-05	2.24E-05	1.12E-08	1.92E-03	2.01E+07	3.86E+04	4.94E-09		
Mn-54	2.50E-05	2.E+03	6.25E-05	5.61E-06	2.81E-09	4.80E-04	1.27E+08	6.10E+04			
Fe-55	1.30E-04	9.E+03	7.22E-05	2.92E-05	1.46E-08	2.50E-03	0.00E+00	0.00E+00			
Fe-59	6.50E-05	8.E+02	4.06E-04	1.46E-05	7.30E-09	1.25E-03	1.26E+08	1.57E+05			
Co-58	1.10E-03	2.E+03	5.50E-03	2.47E-04	1.24E-07	2.11E-02	1.82E+08	3.84E+05			
Co-60	1.40E-04	5.E+02	1.60E-03	3.59E-05	1.80E-08	3.07E-03	2.36E+08	7.31E+05			
Zn-65	5.10E-02	4.E+02	6.38E-01	1.14E-02	5.73E-06	9.75E-01	6.50E+07	6.37E+07			
Np-239	3.20E-05	7.E+03	8.00E-05	7.18E-06	3.59E-09	6.14E-04	1.65E+08	1.01E+05			
Br-83	2.90E-05	2.E+01	2.07E-06	6.51E-06	3.26E-09	5.57E-04	2.42E+06	1.35E+03			
Br-84	5.90E-09	3.E+04	9.83E-10	1.32E-09	6.63E-13	1.13E-07	1.38E+08	1.56E+01			
Rb-86	3.70E-05	5.E+02	3.70E-04	8.30E-06	4.16E-09	7.11E-04	1.04E+07	7.39E+03			
Sr-89	2.20E-05	5.E+02	2.20E-04	4.94E-06	2.47E-09	4.22E-04	1.83E+04	7.73E+00			
Sr-90	8.50E-07	4.E+01	1.06E-04	1.91E-07	9.55E-11	1.63E-05	0.00E+00	0.00E+00			
Y-90	6.00E-07	5.E+02	6.00E-06	1.35E-07	6.74E-11	1.15E-05	0.00E+00	0.00E+00			
Y-91m	3.60E-06	1.E+05	1.80E-07	8.08E-07	4.04E-10	6.91E-05	1.59E+08	1.10E+04			
Y-91	4.40E-06	6.E+02	3.67E-05	9.88E-07	4.94E-10	8.45E-05	3.55E+05	3.00E+01			
Y-93	3.00E-07	1.E+03	1.50E-06	6.73E-08	3.37E-11	5.76E-06	2.03E+07	1.17E+02			
Zr-95	4.00E-06	1.E+03	2.00E-05	8.98E-07	4.49E-10	7.68E-05	1.35E+08	1.04E+04			
Nb-95	4.00E-06	2.E+03	1.00E-05	8.98E-07	4.49E-10	7.68E-05	1.33E+08	1.02E+04			
Sr-91	5.30E-06	2.E+03	1.33E-05	1.19E-06	5.95E-10	1.02E-04	1.04E+08	1.06E+04			
Mo-99	2.90E-03	1.E-03	1.15E-02	5.16E-04	2.58E-07	4.42E-02	4.47E+07	1.97E+06			
Tc-99m	2.10E-03	8.E+04	1.31E-04	4.71E-04	2.36E-07	4.03E-02	1.40E+08	5.65E+06			
Ru-103	2.70E-05	2.E+03	6.75E-06	6.06E-07	3.03E-10	5.18E-05	1.71E+08	8.87E+03			
Ru-106	8.20E-07	2.E+02	0.00E+00	1.84E-07	9.21E-11	1.57E-05	0.00E+00	0.00E+00			
Rh-103m	2.70E-06	4.E+05	3.38E-08	6.06E-07	3.03E-10	5.18E-05	0.00E+00	0.00E+00			
Rh-106	8.20E-07	8.E+03	5.13E-07	1.84E-07	9.21E-11	1.57E-05	5.65E+07	8.90E+02			
Te-125m	1.90E-06	1.E+03	9.50E-06	4.26E-07	2.13E-10	3.65E-05	3.94E+05	1.44E+01	3.20E-06	3.20E+00	9.53E-07
Te-127m	2.10E-05	6.E+02	1.75E-04	4.71E-06	2.36E-09	4.03E-04	1.26E+05	5.09E+01	6.91E-06	6.91E+00	2.28E-05
Te-127	2.50E-05	7.E+03	1.79E-05	5.61E-06	2.81E-09	4.80E-04	2.43E+06	1.17E+03	3.26E-07	3.26E-01	1.28E-06
Te-129m	8.20E-05	5.E+02	8.20E-04	1.84E-05	9.21E-09	1.57E-03	6.53E+06	1.03E+04	1.57E-05	1.57E+01	2.02E-04
Te-129	5.30E-05	3.E+01	8.83E-06	1.19E-05	5.95E-09	1.02E-03	1.96E+07	1.99E+04	9.56E-08	9.56E-02	7.94E-07
I-130	2.30E-04	1.E+03	1.15E-03	5.16E-05	2.58E-08	4.42E-03	5.18E+08	2.29E+06	6.50E-04	6.50E+02	2.34E-02
Te-131m	5.20E-05	6.E+02	4.33E-04	1.17E-05	5.84E-09	9.99E-04	2.85E+08	2.85E+05	5.12E-06	5.12E+00	4.17E-05
Te-131	9.40E-06	6.E+03	7.83E-06	2.11E-06	1.06E-09	1.81E-04	1.88E+08	3.39E+04	6.35E-08	6.35E-02	9.36E-08
I-131	1.00E-01	9.E+01	5.56E+00	2.24E-02	1.12E-05	1.92E+00	1.96E+08	3.75E+08	5.72E-03	5.72E+03	8.97E+01
Te-132	7.80E-04	7.E+02	5.57E-03	1.75E-04	8.76E-08	1.50E-02	1.76E+08	2.64E+06	6.51E-06	6.51E+00	7.96E-04
I-132	2.30E-03	9.E+03	1.28E-03	5.16E-04	2.58E-07	4.42E-02	4.22E+08	1.86E+07	6.82E-05	6.82E+01	2.46E-02
I-133	6.50E-02	5.E+02	6.50E-01	1.46E-02	7.30E-06	1.25E+00	1.75E+08	2.16E+08	1.36E-03	1.36E+03	1.39E+01
I-134	4.60E-06	3.E+04	7.67E-07	1.03E-05	5.17E-10	8.83E-05	4.06E+08	3.59E+04	1.79E-05	1.79E+01	1.29E-05
Cs-134	3.00E-02	7.E+01	2.14E+00	6.73E-03	3.37E-06	5.76E-01	3.25E+08	1.97E+08			
I-135	9.20E-03	5.E+03	1.53E-02	2.06E-03	1.03E-06	1.77E-01	1.71E+08	3.02E+07			
Cs-136	3.90E-03	4.E+02	4.88E-02	8.75E-04	4.38E-07	7.49E-02	4.28E+08	3.21E+07			
Cs-137	2.20E-02	1.E+02	1.10E+00	4.94E-03	2.47E-06	4.22E-01	1.28E+08	5.41E+07			
Ba-137m	2.10E-02	1.E+02	0.00E+00	4.71E-03	2.36E-06	4.03E-01	1.33E+08	5.36E+07			
Ba-140	9.30E-06	6.E+02	7.75E-05	2.09E-06	1.04E-09	1.79E-04	7.50E+07	1.34E+04			
La-140	8.40E-06	6.E+02	7.00E-05	1.89E-06	9.43E-10	1.61E-04	3.08E+08	4.97E+04			
Ce-141	4.00E-06	2.E+03	1.00E-05	8.98E-07	4.49E-10	7.68E-05	7.75E+07	5.95E+03			
Ce-143	9.50E-07	1.E+03	4.32E-06	1.93E-07	1.66E-11	1.65E-05	1.20E+08	1.98E+03			
Ce-144	2.70E-06	3.E+02	4.38E-05	5.84E-07	2.92E-10	4.99E-05	1.87E+07	9.34E+02			
Pr-143	2.30E-06	1.E+03	1.15E-05	5.16E-07	2.58E-10	4.42E-05	1.63E+00	7.20E-05			
Pr-144	2.80E-05	4.E+04	3.25E-07	5.84E-07	2.92E-10	4.99E-05	3.40E+06	1.70E+02			
H-3	5.50E+02	4.E+04	3.44E+01	1.23E+02	6.18E-02	1.06E+04	0.00E+00	0.00E+00	2.03E-07	2.03E-01	1.75E+01
Total		8.E+04				1.06E+04					
			4.46E+01			CR in cpm =	1.05E+09				1.22E+02
						CR in cpm =	4.32E+08		<<<based on 50 mrem Cthy		5.00E+01
						DV in uCi/ml =	5.89E+03				
						DV in uCi/ml =	2.42E+00				

CF 11 from OEC Calcs = 5.61E-09 uCi/ml/cpm

Isotopes individually listed in the ODCM but not included in the dose calculation are Br-85 (172s half-life), Rh-106 (29.9s half-life. As short lived daughters of longer lived parents, production & intake limits are included with the parent values. Because of the short half life, the initial individual quantities are assumed to be insignificant.

Ba-137m and Cs-137 isotopes are also individually listed in the ODCM. However, Ba-137m (2.55 min half life) will contribute to the count rate at the monitor, but will be decayed by the time it reaches Midland Water Intake. All Ba-137m daughter isotopes that an individual is exposed to are included in the Cs-137 dose factors. Therefore, Ba-137m is included in total count rate, but not dose calculations.

Assumes daily drinking water intake occurs in 1 hour period at Midland water intake.
*Flow rates from 1/2-ODC-2.01
Source Term for (RM-1LW-104 and RM-1LW-116) from 1/2-ODC-2.01 (Stone and Webster Calculation Package UR(B)-160)
Detection Efficiency for (RM-1LW-104 and RM-1LW-116) from 1/2-ODC-2.01 (Calculation Package ERS-SFI-92-09*)
ODCM source term CF11 Conversion factor from ERS-ATL-93-021.
Assumptions -
Dose calculation is for one hour exposure. Reference Man daily water intake in one hour.
Intake concentration is calculated using CT blowdown flow rate (default 15000-7800 gpm) prior to the river with ODCM outfall and river dilution prior to intake.