INDIANA MICHIGAN POWER

Form 53

DONALD C. COOK NUCLEAR PLANT

PROCEDURE COVER SHEET

Procedure No.	PMP 6010.OSD.001
Revision No.	3

TITLE Off-Site Dose Calculation Manual

SCOPE OF REVISION

Revision 3 - Minor Revision. Incorporated the new liquid waste radiation monitor RRS-1000, replacing Westinghouse R-18. Changed the environmental sampling locations (Attachment 3.33 through Attachment 3.36) to reflect current status of program. Incorporation of change sheets 1-8 as applicable. The portion of Change Sheet 2 excluding the consideration of entrained or dissolved noble gases has not been incorporated into this procedure. The technical specification (3/4 11.1) concentration pertaining to entrained and dissolved noble gases is now utilized when determining monitor setpoints. Added radionuclides and associated dose conversion factors per AEPSC to Attachment 3.20. Marginal markings used.

SIGNATURES	REVISION NUMBER			
******	Revision 3			
PREPARED BY	[signature]			
DEPARTMENT HEAD APPROVAL	[signature]			
INTERFACING DEPARTMENT HEAD CONCURRENCE	[signature]			
QUALITY ASSURANCE SUPERVISOR APPROVAL	[signature]			
PLANT NUCLEAR SAFETY COMMITTEE	Meeting #2367			
PLANT MANAGER APPROVAL	[signature]			
APPROVAL DATE	6/7/90			
EFFECTIVE DATE	2/6/91			

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INDIANA MICHIGAN POWER COMPANY
DONALD C. COOK NUCLEAR PLANT

OFF-SITE DOSE CALCULATION MANUAL

1.0 OBJECTIVE

The Off-Site Dose Calculation Manual (ODCM) is a supporting document to the Radiological Effluent Technical Specifications (RETS), as defined in NUREG-0472. The ODCM contains the methodology and parameters to be used in the calculation of offsite doses due to radioactive liquid and gaseous effluents and in the calculation of liquid and gaseous monitoring instrumentation alarm/trip setpoints. The ODCM provides flow diagrams detailing the treatment path and the major components of the radioactive liquid and gaseous waste management systems. The ODCM also presents a map of the radiological environmental monitoring sample locations and the meteorological model used to estimate the atmospheric dispersion and deposition parameters. The ODCM specifically addresses the design characteristics of the Donald C. Cook Nuclear Plant based on the flow diagrams contained on the "OP Drawings" and plant "System Description" documents.

1.1 The Technical Physical Sciences Department is responsible for implementation of the Off-Site Dose Calculation Manual. The Radiation Protection Section of the Technical Physical Sciences Department will conduct periodic review and update of the ODCM. Any design related change will be reviewed and approved by the Radiological Support Section Manager, AEPSC and forwarded to the Plant Radiation Protection Section for implementation.

2.0 REFERENCES

2.1 10CFR20, Standards for Protection Against Radiation.

2.2 10CFR50, Domestic Licensing of Production and Utilization Facilities.

2.3 12 THP 6010 ENV.051-.061, Radiation Protection Environmental Sampling Procedures.

2.4 12 THP 6010 RAD.332, Batch Liquid Waste Releases Using Monitor RRS-1001.

2.5 12 THP 6010 RAD.337, Gaseous Waste Releases, Manual Calculations.

2.6 12 THP 6010 RAD.548, Radiation Monitoring System Setpoints.

2.7 12 THP 6010 RPP.005, Radiation Protection Records Control and Retention.

2.8 PMI 6010, Radiation Protection Plan.

2.9 NUREG-0472

2.10 NUREG-0133

2.11 Regulatory Guide 1.109.

2.12 Regulatory Guide 1.111.

2.13 Regulatory Guide 1.113.

2.14 Final Safety Analysis Report (FSAR).

2.15 Technical Specifications, Appendix A, Sections 6.8.1.H; 6.15, Offsite Dose Calculation Manual.

2.16 Final Environmental Statement D. C. Cook Nuclear Plant, August 1973.

2.17 NUREG-0017

2.18 Watts-Bar Jones Primary Calibration of Eberline Instrument Corporation DAM-4 and Water Monitor, no revision date.

3.0 ATTACHMENTS

3.1 Characteristics and Functions of Radiation Monitor RRS 1000.

3.2 Characteristics and Functions of Radiation Monitor R-19 (Tag No. DRA-300).

3.3 Characteristics and Functions of Radiation Monitor R-24 (Tag No. DRA-353).

3.4 Characteristics and Functions of Radiation Monitors 1R20/2R20 (Tag No. WRA713 and WRA714).

3.5 Characteristics and Functions of Radiation Monitors 1R28/2R28 (Tag No. WRA717 and WRA718).

3.6 Characteristics and Functions of the Unit Vent Effluent Monitor (VRS-1500/2500).

3.7 Characteristics and Functions of the Lower Containment Airborne Monitor (ERS-1300/2300).

3.8 Characteristics and Functions of the Lower Containment Airborne Monitor (ERS-1400/2400).

3.9 Characteristics and Functions of the Containment Area Radiation Monitor (VRS-1201/2201; 1101/2101).

3.10 Characteristics and Functions of the Steam Jet Air Ejector Vent Monitor (SRA-1900/2900).

3.11 Characteristics and Functions of the Gland Steam Condenser Vent Monitor (SRA-1800/2800).

3.12 Plant Liquid Effluent Parameters.

3.13 Plant Gaseous Effluent Parameters.

3.14 Volumetric Detection Efficiencies and MPC of Principle Gamma Emitting Radionuclides.

3.15 Bioaccumulation Factor for Freshwater Fish.

3.16 Site Related Ingestion Dose Commitment Factor.

3.17 Ground Average χ/Q (sec/m^3).

3.18 Deposition D/Q (1/m^2).

3.19 Dose Factors for Noble Gases and Daughters.

3.20 Dose Parameters for Radioiodines and Radioactive Particulate, Gaseous Effluents.

3.21 Pathway Dose Parameters for Radionuclides Other than Noble Gases, for Infant.

3.22 Pathway Dose Parameters for Radionuclides Other than Noble Gases, for Child.

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3.27 Volumetric Energy Efficiency Curve, for RRS 1000 Liquid Waste.

3.28 Graph cpm vs. µCi/ml for R-19 Steam Generator Blowdown.

3.29 Graph cpm vs. µCi/ml for R-24 Steam Generator Blowdown Treatment.

3.30 Graph cpm vs. µCi/ml for R-20, R-28 Essential Service Water.

3.31 Liquid Effluent Release Systems.

3.32 Gaseous Effluent Release Systems.

3.33 Environmental Sampling Location Codes.

3.34 Maps of TLD, Air, and Water Sampling Stations on Plant Site.

3.35 Map of TLD Stations Within 4-5 Mile Radius of the Plant.

3.36 Map of TLD, Air, Drinking Water and Milk Sample Stations Within a 20 Mile Radius.

3.37 Annual Evaluation/Update of χ/Q values for all sectors.

3.38 Definitions of terms/variables used in this procedure.

4.0 DETAILS

4.1 Liquid Effluent Wastes:

4.1.1 The Donald C. Cook site is located on Lake Michigan. The lake provides supply and discharge capacity for the plant's circulating water system. The plant's liquid effluents are discharged into the environment via six release points. Except for the Turbine Building Sump, all liquid effluents are discharged into Lake Michigan via the site's Circulating Water Discharge Tunnels. The Turbine Building Sump is discharged into the absorption field located southeast of the facility. Each effluent pathway and its discharge point are described below.

4.1.2 Identification of Liquid Effluent Release Points

4.1.2.1 Waste Disposal System Liquid Effluent Line (WDS)

The liquid processing portion of the WDS is shared by both units, 1 and 2 and discharges liquid effluents into Lake Michigan. The liquids are generally categorized as either "clean" or "dirty" waste. Liquid effluents originating from the Monitor Tanks, Waste Evaporator Condensate Tanks, Chemical Drain Tank, and the Laundry and Hot Shower Tanks are released via a radiation monitor RRS-1000 and liquid effluent flow monitoring device. The Liquid Waste Effluent Monitor (RRS-1000) is comprised of an Eberline Data Acquisition Module (DAM-4/6) coupled to an SA-5 sampler. The SA-5 sampler employes an RDA-5A (2 in. x 2 in. diameter NaI(Tl)) detector surrounded by a 2700 cc sample volume. This provides the monitor with an energy response range of 60 KeV-1.5 MeV and concentration range of 10^{-7} to 10^{-3} uCi/cc for Cs-137.

The SA-5 sampler obtains its sample of the effluent by differential pressure across a pneumatically operated valve (RRV-284) in the discharge line. Sample flowrate can be varied in the range of 0-13 gpm and is normally set at ~10 gpm. Prior to each release to the lake, adjustments will be made to ensure adequate sample flow is available. In-line rotometer (RFS-1010) provides local indication of the sample flow. The regulating valve RRV-284 controls flow through the sample loop.

The radiation monitor, upon a high level alarm or fail alarm conditions, automatically terminates the liquid effluent release by tripping off the pumps of the Waste Evaporator Condensate Tank, monitor tank pumps and closes discharge valve (RRV-285).

A delay line is provided to allow time for alarm detection and subsequent valve closure prior to the liquid passing the discharge valve (RRV-287 for Unit 1 and RRV-286 for Unit 2).

Discharge valve RRV-285 isolates all liquid effluent releases identified above. Attachment 3.1 presents the characteristics and functions of liquid waste radiation monitor RRS 1000 Attachment 3.31 schematically presents the sources of liquid effluerts, major treatment systems, and their release points.

4.1.2.2 Steam Generator Blowdown and Blowdown Treatment System

a) Steam Generator Blowdown System (SGBD)

During normal operation, the Steam Generator Blowdown System directs secondary side water to the normal Steam Generator Blowdown Flash Tank. The water is flashed to steam, approximately 40% of the fluid flashes to steam and 60% remains liquid. When it enters the normal blowdown flash tank, the steam is vented to the A Condenser and the liquid is directed to the blowdown treatment system. The steam is returned to the condensate system via the unit "A" turbine condenser. The fluid stream is directed to the blowdown treatment pump, between the flash tank and the heat exchanger. The radiation monitor R-19 (Tag No. DRA-300) monitors the fluid stream from all four (4) steam generators via a sample line (Attachment 3.31). Upon a high level alarm on c = the setpoint, in μCi/ml, of the radioactive monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint, which is inversely proportional to the volumetric flow of the effluent line and proportional to the volumetric flow of the dilution stream plus the effluent stream, represents a value which, if exceeded, would result in concentrations exceeding the limits of 10 CFR 20, Appendix B, Table II for the unrestricted area.

f = the effluent flow rate as measured at the radiation monitor location, in unit of volume per time, but in the same units as F below (gpm). Attachment 3.12 presents the effluent flow rate parameter.

F = the dilution water flow rate as estimated prior to the release point, in unit of volume per time (gpm). Attachment 3.12 presents the dilution flowrate parameters. The minimum available dilution water flow rate (F) is 230,000 gpm for one circulation pump in operation. For two or more pumps, the available dilution flowrates are:

2 circulation pumps - 460,000 gpm
3 circulation pumps - 690,000 gpm
4 circulation pumps (Unit 2 only) - 920,000 gpm

C = effluent concentration limit, implementing 10 CFR 20, Appendix B, Table II column 2 and Technical Specification 3/4.11.1 (noble gas), in μCi/ml.

Since f<F, equation (1) can be rewritten as follows, to obtain the minimum required dilution flow rate for any discharge:

2) Compute $(\Sigma \frac{C_i}{MPC_i})_T$ for all diluted effluent stream, T, discharged into the environment.

3) Ratio 1) to 2) above to compute the MRP for each release point j.

4) Repeat steps 1) through 3) for each of the site's liquid release points.

Normally no more than one tank is lined up for sampling or release simultaneously. But in case of an accident, combined liquid effluent discharges through radiation monitor RRS-1000, i.e., two or more tank leakages or discharges from either the Waste Evaporator Condensate Tanks (CT), Laundry and Hot Shower Tanks (L), and Monitor Tanks (MT), equation (3) is rewritten as follows to accomodate each subsystem's effluent flow rate (f):

$$F \geq [(\Sigma \frac{C_i}{MPC_i} f_{CT}) + (\Sigma \frac{C_i}{MPC_i} f_L) + (\Sigma \frac{C_i}{MPC_i} f_{MT})] \qquad (5)$$

The condition for an acceptable single or combined release from one or more subsystems is met if equations (3) and/or (5) are satisfied. If this condition cannot be met, the intended discharges can proceed only if any one of the following conditions (1), (2), or (3) are satisfied:

(1) Increase the minimum dilution flow rate, F, while maintaining a constant effluent flow rate, f.

(2) Decrease the maximum effluent flow rate, f, while maintaining a constant dilution flow rate F.

(3) Reprocess liquid effluents as is necessary.

In case of the liquid waste monitor RRS 1000, the monitor alarm setpoint,c, may be displayed in µci/cc or cpm, using the monitor volumetric detection efficiency for CS-137 (3.0×10^{7} cpm/µci/cc). The monitor efficiency can also be obtained from Attachment 3.27 or Attachment 3.14 for the identified gamma emitting radionuclides. Attachment 3.14 presents the isotopic volumetric detection efficiencies and their respective MPC's for the principle gamma emitting radionuclides.

If no discharges are planned through liquid effluent radiation monitor RRS-1000, the monitor set-point will be set as close to the ambient background radiation level as practicable to prevent

D_w = dilution factor at the nearest potable water intake. A value of 2.6 is used for the Lake township intake located approximately 2800 feet SW of the station discharge points. See reference 2.16.

Inserting the usage factors of R.G. 1.109 as appropriately into equation (14), the following equation is derived:

$$A_{io} = 1.14 \times 10^5 \ (730/D_w + 21 \ BF_i) \ DF_i \quad (15)$$

The value of A_{io} for those elements listed in Attachment 3.15 are tabulated in Attachment 3.16.

4.1.4.4 Shore Line Activities Doses

Based on the D.C. Cook nuclear power plant semi-annual radioactive effluent release reports, it has been shown that the exposures due to swimming and boating activities are less than 1% of the dose due to all liquid effluents. See NRC regulations position C. in Regulatory Guide 1.109. Therefore, only shoreline activities are considered here. Shoreline activities doses, D_{SL}, due to liquid effluents are determined, based on equation (A-6) of R.G. 1.109, using the following methodology:

$$D_{SL} = 1.14 \times 10^7 \ W_{LM} M_p U_{ap} \sum_i (T_i c_{i\ell} DF) \sum_{\ell=1}^{m} \Delta t_\ell \ [1-\exp(-\lambda_i t_b)] \quad (16)$$

where:

D_{SL} = dose due to shore line activities from deposited radionuclides, in mrem.

T_i = radiological half-life of nuclide i, in days.

S_p = the maximum setpoint of the monitor in μCi/cc for release point p, based on the most limiting organ.

SF = an operating safety factor, ≤1.0. (see page 10)

MRP= a weighed multiple release point factor (≤1.0), such that when all site gaseous releases are integrated, the applicable dose will not be exceeded based on the release rate of each effluent point. The MRP will be based on the release rate or the volumetric flow rate of each effluent point to the total respective value and will be consistent with past operational experience. The MRP is computed as follows:

1) compute the average release rate, Q_p, (or the volumetric flow rate, f_p) from each release point p.

2) compute ΣQ_p (or Σf_p) for all release points.

3) ratio $Q_p/\Sigma Q_p$ (or $f_p/\Sigma f_p$) for each release point. This ratio is the MRP for that specific release point.

4) repeat 1) through 3) for each of the site's eight gaseous release points.

F_p = the maximum volumetric flow rate of release point p, at the time of the release in cc/sec. The maximum Unit Vent flow rate, by design, is 139,600 cfm for Unit 1 and 103,500 cfm for Unit 2. CS-2

The plant vent radiation monitor low range noble gas channel setpoint, Sp, will be set such that the dose rate in unrestricted areas to the whole body, skin and thyroid (or any other organ), whichever is most limiting, will be less than or equal to 500 mRem/yr, 3000 mRem/yr, and 1500 mRem/yr, respectively. The thyroid dose is limited to the inhalation pathway only. The plant vent radiation monitor low range noble gas channel setpoint, Sp will be recomputed whenever gaseous releases from the Containment and gas decay tanks are discharged through the plant vent to redetermine the most limiting organ. The setpoint, Sp, may be established at less concentration level than the lowest computed value via equation 17.

At certain times, it may be desirable to increase the setpoint, if the vent flowrate is decreased and this may be accomplished in one of two ways.

a) $\frac{\text{(Max. Concentration-}\mu\text{Ci/cc)(Max. Flowrate-cfm)}}{\text{(New Max. Concentration-}\mu\text{Ci/cc)}}$

= New Max. Flowrate in cfm

b) $\frac{\text{(Max. Flowrate-cfm)(Max. Concentration }\mu\text{Ci/cc)}}{\text{(New Max. Flowrate-cfm)}}$

= New Max. Concentration in μCi/cc

a) Waste Gas System Decay Tanks

The gaseous effluents discharged or leaked from the Waste Gas System will be monitored by the vent stack monitors VRS-1505 and 2505.

Due to a high radiation alarm, an automatic termination of the release from the waste gas system will be initiated from the plant vent radiation monitor low range noble gas channel (VRS-1505 or VRS-2505). Therefore, for any gaseous release configuration, which include normal operation and waste gas system gasecus discharges, the alarm setpoint of the plant vent radiation monitor will be recomputed to determine the most limiting organ based on all gaseous effluent source terms.

b) Containment Purge and Exhaust System

The gaseous effluents discharged by the Containment Purge and Exhaust Systems and Instrumentation Room Purge and Exhaust System will be monitored by the plant vent radiation monitor noble gas channels (VRS-1505 for Unit 1, VRS-2505 for Unit 2); and alarms and trip actions will occur prior to exceeding the Technical Specifications 3.3.3.10 and 3.11.2.1.

For the Containment System, continuous air sample from the Containment atmosphere is drawn through a closed, sealed system to the radiation monitors (Tag No. ERS-1300/1400 for Unit 1 and ERS-2300/2400 for Unit 2). The sample is constantly mixed in the fixed, shielded volume, where it is viewed by the monitor detector. The sample is then returned

CHARACTERISTICS AND FUNCTIONS OF THE LIQUID WASTE RADIATION MONITOR

RRS-1000

ALARM LOCATION	CONTROL ROOM
MONITOR TYPE, LOCATION	DAM 4/6, El. 587'
POWER SOURCE	120 VAC, DIST. CABINET CCRP-2, CIRC-1 CHECK SOURCE, ASSEMBLY SUPPLIED FROM CCRP-2, CIRC.1
CHANNEL NO.	RRS-1001, EBERLINE SA-5 LIQUID SAMPLER INCLUDING RDA-5A NaI(. .) SCINTILLATION DETECTOR AND EBE LINE CSM-1 CHECK SOURCE MECHANISM. RRS-1002, EBERLINE IB-2 INTERFACE BOX. RRA-1003, EBERLINE DA1-4CC AREA MONITOR DETECTOR WITH INTERNAL INTERFACE BOX AND CHECK SOURCE.
CHANNEL RANGE (RRS-1001)	10^{-7} to 10^{-2} µCi/cc FOR CS-137 (x 8 circuitry)
EFFLUENT ISOLATION CONTROL DEVICE	DISCHARGE VALVE RRV-285 CLOSES. ALSO RRV-287 (UNIT 1 DISCHARGE) OR RRV-286 (UNIT 2 DISCHARGE) CLOSES. TRI .S WASTE EVAPORATOR CONDENSATE TANK PUMPS AND MONITOR TANK PUMPS
LOCATION OF DEVICE	LIQUID WASTE DISCHARGE LINE
SAMPLE FLOW RATE	0 - 13 gpm, NORMALLY SET AT ≅10 gpm
TECHNICAL SPECIFICATION REFERENCES	3.3.3.9, TABLE 3.3-12 AND TABLE 4.3.8. ITEM 1.a; ACTION STATEMENT 23 DURING RELEASES.
DIAGRAM REFERENCES	98810, 98313, 5104F

PLANT GASEOUS EFFLUENT PARAMETERS

SYSTEM	EXHAUST UNIT	FLOW RATE (CFM)	CAPACITY	NO. OF TANKS	
I PLANT UNIT VENT:	UNIT 1	139,600			CS-2
	UNIT 2	103,500			
+WASTE GAS DECAY TANKS	UNIT 1		600 FT^3	8	
+WASTE GAS DECAY TANK DISCHARGE HEADER		125		2	
+AUXILIARY BUILDING	UNIT 1	72,600			
EXHAUST	UNIT 2	64,500			
+ENG. SAFETY FEATURES VENT	UNIT 1&2	25,000			
+FUEL HANDLING AREA VENT SYSTEM	UNIT 1	30,000			
+CONTAINMENT PURGE SYSTEM	UNIT 1&2	12,000			CS-2
+CONTAINMENT PRESSURE RELIEF SYSTEM	UNIT 1&2	1,000			
+INSTRUMENT ROOM PURGE SYSTEM	UNIT 1&2	1,000			
II CONDENSER AIR EJECTOR SYSTEM	UNIT 1&2	120*		2 Release Points One for Each Unit	
III TURBINE SEALS SYSTEM	UNIT 1	1,260			
	UNIT 2	5,508		2 Release Points for Unit 2	
IV START UP FLASH TANK VENT	UNIT 1	1,536			CS-2
	UNIT 2	1,536			

*The measured startup flowrate is approximately 230 SCFM by switching to the hoggers.

VOLUMETRIC DETECTION EFFICIENCIES AND MPC
OF PRINCIPLE GAMMA EMITTING RADIONUCLIDES

ISOTOPE	MPC (µCi/cc)	EFFICIENCY (cpm/µCi/cc)
I-131	3.00E-07	3.78E7
Cs-137	2.00E-05	3.0 E7
Cs-134	9.00E-06	7.9 E7
Co-60	3.00E-05	5.75E7
Co-58	9.00E-05	4.60E7
Cr-51	2.00E-03	3.60E6
Mn-54	1.00E-04	3.30E7
Zn-65	1.00E-04	1.58E7
Ag-110M	3.00E-05	9.92E7
Ba-133	3.00E-06	4.85E7
Ba-140	2.00E-05	1.92E7
Cd-109	2.00E-04	9.60E5
Ce-139	3.00E-06	3.27E7
Ce-141	9.00E-05	1.92E8
Ce-144	1.00E-05	4.82E6
Co-57	4.00E-04	3.80E7
Cs-136	9.00E-05	1.07E8
Fe-59	5.00E-05	2.82E7
Sb-124	2.00E-05	5.92E7
I-133	1.00E-06	3.40E7
I-134	2.00E-05	7.22E7
I-135	4.00E-06	3.95E7
Mo-99	2.00E-04	8.67E6
Na-24	3.00E-05	4.45E7
Nb-95	1.00E-04	3.27E7
Nb-97	9.00E-04	3.50E8
Rb-89	3.00E-06	5.00E7
Ru-103	8.00E-05	3.47E7
Ru-106	1.00E-05	1.22E7
Sb-122	3.00E-05	2.55E7
Sb-125	1.00E-04	3.15E7
Sn-113	8.00E-05	7.32E5
Sr-85	1.00E-04	3.70E7
Sr-89	3.00E-06	2.87E3
Sr-92	7.00E-05	3.67E7
Tc-99M	3.00E-03	3.60E7
Y-88	3.00E-06	5.25E7
Zr-95	6.00E-05	3.37E7
Zr-97	2.00E-05	3.10E7
Kr-85	N/A	1.56E5
Kr-85M	N/A	3.52E7
Kr-88	N/A	4.10E7
Xe-131M	N/A	8.15E5
Xe-133	N/A	7.77E6
Xe-133M	N/A	5.75E6
Xe-135	N/A	3.82E7

NOTE: MPC value for the total dissolved gas concentration shall be limited to 2.0E-4 µCi/cc.

χ/Q GROUND AVERAGE (sec/m^3)

01JAN90 - 31DEC90

DISTANCE

DIRECTION (WIND FROM)	594.	2416.	4020.	5630.	7240.
N	3.66E-06	4.26E-07	2.02E-07	1.21E-07	8.47E-08
NNE	2.51E-06	3.03E-07	1.46E-07	8.78E-08	6.19E-08
NE	3.19E-06	3.78E-07	1.84E-07	1.11E-07	7.90E-08
ENE	4.26E-06	4.83E-07	2.44E-07	1.52E-07	1.08E-07
E	5.66E-06	6.18E-07	3.17E-07	1.99E-07	1.43E-07
ESE	6.39E-06	6.94E-07	3.59E-07	2.27E-07	1.64E-07
SE	8.43E-06	9.15E-07	4.71E-07	2.96E-07	2.15E-07
SSE	9.66E-06	1.06E-06	5.45E-07	3.42E-07	2.46E-07
S	1.09E-05	1.26E-06	6.27E-07	3.87E-07	2.76E-07
SSW	5.17E-06	6.10E-07	2.97E-07	1.80E-07	1.28E-07
SW	3.66E-06	4.26E-07	2.03E-07	1.22E-07	8.61E-08
WSW	2.54E-06	2.75E-07	1.32E-07	7.93E-08	5.61E-08
W	3.15E-06	3.57E-07	1.71E-07	1.03E-07	7.28E-08
WNW	3.26E-06	3.86E-07	1.82E-07	1.08E-07	7.57E-08
NW	2.64E-06	3.03E-07	1.42E-07	8.44E-08	5.91E-08
NNW	3.66E-06	4.20E-07	1.98E-07	1.18E-07	8.24E-08

DISTANCE

DIRECTION (WIND FROM)	12067.	24135.	40225.	56315.	80500.
N	4.24E-08	1.65E-08	8.22E-09	5.26E-09	3.31E-09
NNE	3.13E-08	1.24E-08	6.17E-09	3.96E-09	2.50E-09
NE	4.04E-08	1.62E-08	8.07E-09	5.18E-09	3.29E-09
ENE	5.59E-08	2.28E-08	1.15E-08	7.39E-09	4.75E-09
E	7.46E-08	3.08E-08	1.55E-08	9.98E-09	6.45E-09
ESE	8.54E-08	3.54E-08	1.79E-08	1.15E-08	7.44E-09
SE	1.11E-07	4.61E-08	2.32E-08	1.50E-08	9.66E-09
SSE	1.28E-07	5.28E-08	2.66E-08	1.71E-08	1.11E-08
S	1.42E-07	5.77E-08	2.90E-08	1.87E-08	1.19E-08
SSW	6.49E-08	2.59E-08	1.29E-08	8.28E-09	5.25E-09
SW	4.33E-08	1.71E-08	8.49E-09	5.44E-09	3.44E-09
WSW	2.84E-08	1.13E-08	5.64E-09	3.62E-09	2.31E-09
W	3.68E-08	1.46E-08	7.26E-09	4.66E-09	2.95E-09
WNW	3.79E-08	1.47E-08	7.29E-09	4.66E-09	2.9[illegible]E-09
NW	2.94E-08	1.14E-08	5.64E-09	3.60E-09	2.25E-09
NNW	4.10E-08	1.59E-08	7.86E-09	5.02E-09	3.15E-09

DIRECTION - SECTOR

N = A	S = J
NNE = B	SSW = K
NE = C	SW = L
ENE = D	WSW = M
E = E	W = N
ESE = F	WNW = P
SE = G	NW = Q
SSE = H	NNW = R

Current X/Q = 1.09 E-05 sec/m^3 in Sector A

D/Q DEPOSITION ($1/m^2$)

01JAN90 - 31DEC90

DISTANCE

DIRECTION (WIND FROM)	594.	2416.	4020.	5630.	7240.
N	2.25E-08	2.18E-09	9.97E-10	5.18E-10	3.30E-10
NNE	9.87E-09	9.53E-10	4.32E-10	2.27E-10	1.45E-10
NE	1.26E-08	1.22E-09	5.53E-10	2.90E-10	1.85E-10
ENE	1.27E-08	1.22E-09	5.55E-10	2.91E-10	1.86E-10
E	1.39E-08	1.34E-09	6.07E-10	3.18E-10	2.03E-10
ESE	1.22E-08	1.18E-09	5.36E-10	2.81E-10	1.79E-10
SE	1.67E-08	1.62E-09	7.33E-10	3.85E-10	2.45E-10
SSE	2.42E-08	2.33E-09	1.06E-09	5.55E-10	3.54E-10
S	4.41E-08	4.26E-09	1.93E-09	1.01E-09	6.46E-10
SSW	2.97E-08	2.87E-09	1.30E-09	6.83E-10	4.35E-10
SW	2.51E-08	2.42E-09	1.10E-09	5.76E-10	3.68E-10
WSW	2.00E-08	1.93E-09	8.74E-10	4.58E-10	2.92E-10
W	1.98E-08	1.92E-09	8.69E-10	4.56E-10	2.91E-10
WNW	1.83E-08	1.77E-09	8.01E-10	4.20E-10	2.68E-10
NW	1.74E-08	1.68E-09	7.60E-10	3.99E-10	2.55E-10
NNW	2.30E-08	2.22E-09	1.01E-09	5.28E-10	3.37E-10

DISTANCE

DIRECTION (WIND FROM)	12067.	24135.	40225.	56315.	80500.
N	1.38E-10	4.49E-11	1.65E-11	8.83E-12	4.43E-12
NNE	5.04E-11	1.97E-11	7.24E-12	3.86E-12	1.94E-12
NE	7.74E-11	2.52E-11	9.27E-12	4.95E-12	2.48E-12
ENE	7.76E-11	2.53E-11	9.30E-12	4.96E-12	2.49E-12
E	8.48E-11	2.76E-11	1.02E-11	5.43E-12	2.72E-12
ESE	7.49E-11	2.44E-11	8.98E-12	4.79E-12	2.40E-12
SE	1.02E-10	3.34E-11	1.23E-11	6.56E-12	3.29E-12
SSE	1.48E-10	4.82E-11	1.77E-11	9.47E-12	4.75E-12
S	2.70E-10	8.79E-11	3.24E-11	1.73E-11	8.66E-12
SSW	1.82E-10	5.92E-11	2.18E-11	1.16E-11	5.84E-12
SW	1.54E-10	5.00E-11	1.84E-11	9.83E-12	4.93E-12
WSW	1.22E-10	3.98E-11	1.46E-11	7.82E-12	3.92E-12
W	1.21E-10	3.96E-11	1.46E-11	7.77E-12	3.90E-12
WNW	1.12E-10	3.65E-11	1.34E-11	7.16E-12	3.59E-12
NW	1.06E-10	3.46E-11	1.27E-11	6.80E-12	3.41E-12
NNW	1.41E-10	4.58E-11	1.69E-11	9.00E-12	4.52E-12

DIRECTION - SECTOR

N = A		S = J	
NNE = B		SSW = K	
NE = C		SW = L	
ENE = D		WSW = M	
E = E		W = N	
ESE = F		WNW = P	
SE = G		NW = Q	
SSE = H		NNW = R	

Current D/Q = 4.41 E-08 $1/m^2$ in Sector A

DOSE PARAMETERS FOR RADIOIODINES AND RADIOACTIVE PARTICULATE, GASEOUS EFFLUENTS*

RADIONUCLIDE	P_i INHALATION PATHWAY (mRem/yr per uCi/m^3)	P_i FOOD & GROUND PATHWAYS (m^2 . mRem/yr per uCi/sec)	RADIONUCLIDE	P_i INHALATION PATHWAY (mRem/yr per uCi/m^3)	P_i FOOD & GROUND PATHWAYS (m^2 . mRem/yr per uCi/sec)
H-3	6.47E+02	2.40E+03	Rb-88	5.57E+02	4.74E+04
C-14	2.65E+04	2.38E+09	Rb-89	3.21E+02	1.76E+05
Na-24	1.06E+04	3.28E+07	Sr-89	2.03E+06	1.28E+10
P-32	2.03E+06	1.63E+11	Sr-90	4.09E+07	1.24E+11
Cr-51	1.28E+04	1.15E+07	Sr-91	7.34E+04	3.41E+06
Mn-54	1.00E+06	1.14E+09	Sr-92	1.40E+05	1.11E+06
Mn-56	7.17E+04	1.29E+06	Y-90	2.69E+05	9.64E+05
Fe-55	8.69E+04	1.38E+08	Y-91m	2.79E+03	1.44E+05
Fe-59	1.02E+06	7.89E+08	Y-91	2.45E+06	6.86E+06
Co-58	7.77E+05	5.89E+08	Y-92	1.27E+05	2.59E+05
Co-60	4.51E+06	4.62E+09	Y-93	1.67E+05	2.80E+05
Ni-63	3.39E+05	3.56E+10	Zr-95	1.75E+06	3.45E+08
Ni-65	5.01E+04	4.43E+05	Zr-97	1.40E+05	4.29E+06
Cu-64	1.50E+04	4.75E+06	Nb-95	4.79E+05	4.06E+08
Zn-65	6.47E+05	2.01E+10	Mo-99	1.35E+05	3.23E+08
Zn-69	1.32E+04	3.01E-09	Tc-99m	2.03E+03	2.81E+05
Rb-86	1.90E+05	2.27E+10	Tc-101	8.44E+02	2.92E+04
Te-131m	1.99E+05	3.48E+07	Ru-103	5.52E+05	1.55E+08
Te-131	8.22E+03	4.18E+04	Ru-105	4.84E+04	9.12E+05
Te-132	3.40E+05	7.26E+07	Ru-106	1.16E+07	3.02E+08
I-130	1.60E+06	8.99E+08	Ag-110m	3.67E+06	1.80E+10
I-131	1.48E+07	1.07E+12	Te-125m	4.47E+05	1.56E+08
I-132	1.69E+05	1.79E+06	Te-127m	1.31E+06	1.06E+09
I-133	3.56E+06	9.78E+09	Te-127	2.44E+04	1.53E+05
I-134	4.45E+04	6.40E+05	Te-129m	1.68E+06	1.45E+09
I-135	6.96E+05	2.40E+07	Te-129	2.63E+04	3.76E+04
Cs-134	7.03E+05	7.21E+10	Ce-143	1.16E+05	4.88E+06
Cs-136	1.35E+05	6.13E+09	Ce-144	9.84E+06	1.95E+08
Cs-137	6.12E+05	6.25E+10	Pr-143	4.33E+05	7.98E+05
Cs-138	8.76E+02	5.15E+05	Pr-144	4.28E+03	2.63E+03
Ba-139	5.10E+04	1.52E+05	Nd-147	3.22E+05	1.26E+07
Ba-140	1.60E+06	2.75E+08	W-187	3.96E+04	5.90E+06
Ba-141	4.75E+03	5.98E+04	Np-239	5.95E+04	2.55E+06
Ba-142	1.55E+03	6.43E+04			
La-140	1.68E+05	2.77E+07			
La-142	5.95E+04	1.09E+06			
Ce-141	5.17E+05	3.35E+07			

*If SR-90 analysis is performed, use P_i given in RU-106 for unidentified components.

If SR-90 and RU-106 analyses are performed, use P_i given in I-131 for unidentified components.

If SR-90, RU-106 and I-131 analyses are performed, use P_i given in P-32 for unidentified components.

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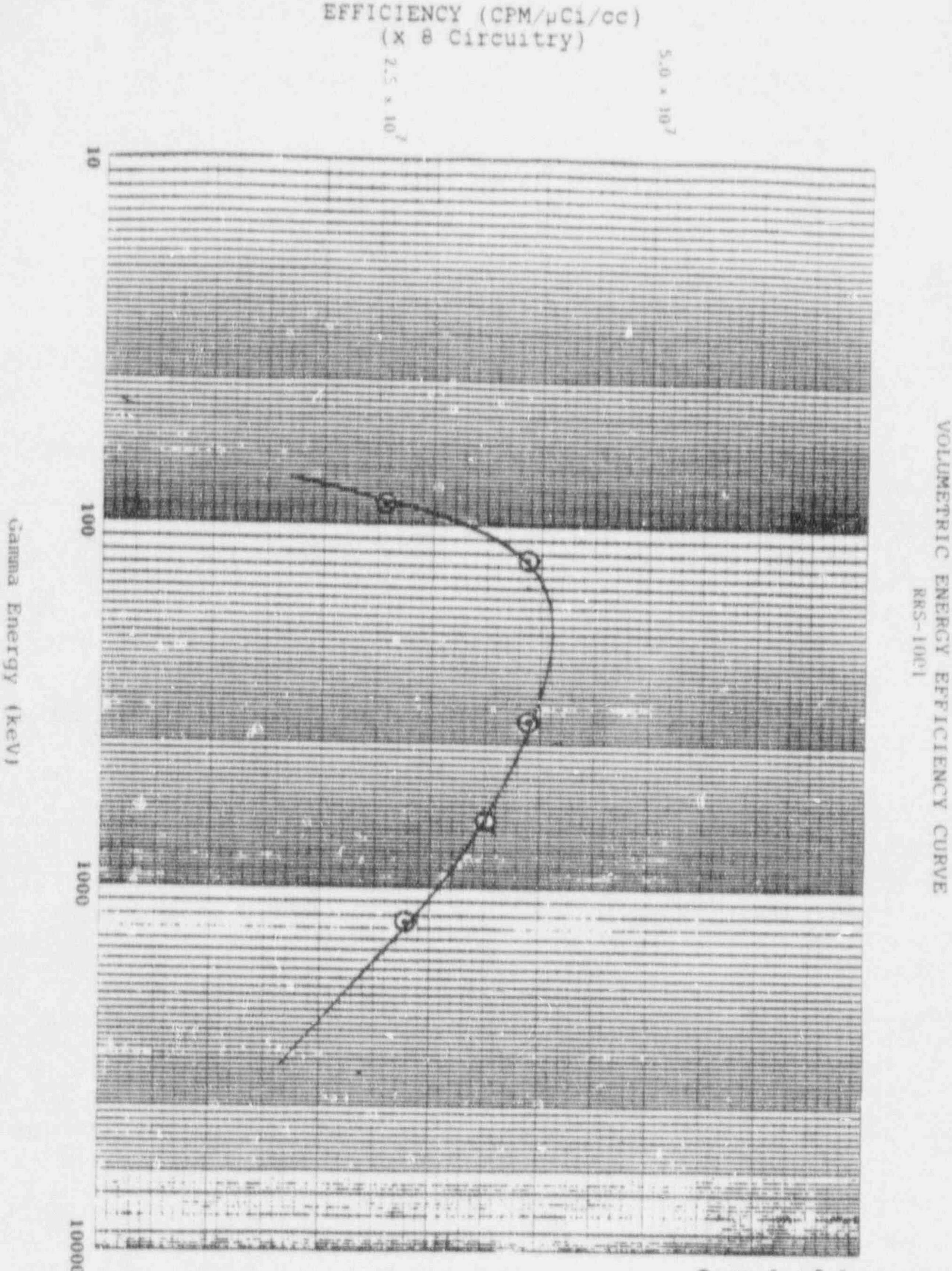
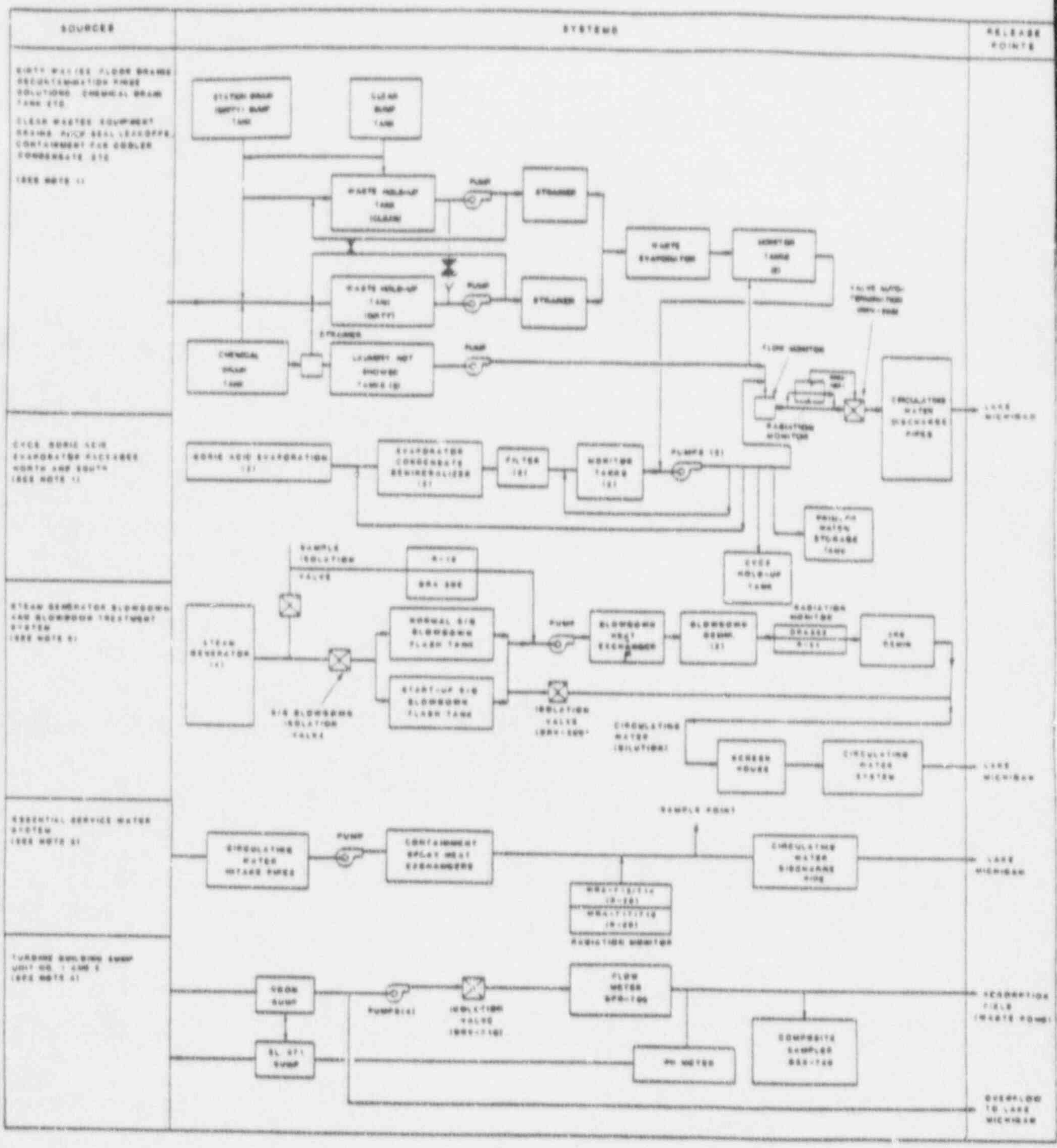

EFFICIENCY (CPM/µCi/cc)
(x 8 Circuitry)
2.5 x 10^7
5.0 x 10^7
10
100
1000
10000
Gamma Energy (keV)
VOLUMETRIC ENERGY EFFICIENCY CURVE
RRS-1001


SOURCES
SYSTEMS
RELEASE POINTS
WASTE EVAPORATOR
BORIC ACID EVAPORATION (2)
FILTER (2)
PUMP
CIRCULATING WATER DISCHARGE PIPES
LAKE MICHIGAN
STEAM GENERATOR (4)
SCREEN HOUSE
CIRCULATING WATER SYSTEM
SAMPLE POINT
CONTAINMENT SPRAY HEAT EXCHANGERS
RADIATION MONITOR
FLOW METER
COMPOSITE SAMPLER
OVERFLOW TO LAKE MICHIGAN

NOTES

NOTE 1: Drawings: OP-12-5119, -5123B, -5133, -5134, -5138, -5138A, 1-5661, -2-5661, 5104F.

System Descriptions: SD-DCC-CH113, -NE101, -HP119. Engineering Control Procedure ECP-12-R2-08.

NOTE 2: Drawings: OP-12-5105, -5105B, -5141, -5141A, -5119, -5125, -1-5661, -2-5661, 5104F.

System Descriptions: SD-DCC-CH114, -NE101, -HP119.

NOTE 3: Drawings: OP-12-5113, -5119, -1-5661, -2-5661.

System Descriptions: SD-DCC-HP102, -HP119, NE101.

NOTE 4: Drawings: OP-12-5125, -5125A, -12-5160.

System Descriptions: SD-DCC-CH117.

USE THE MOST CURRENT DRAWING AND SYSTEM DESCRIPTIONS

ENVIRONMENTAL SAMPLING LOCATIONS CODES

LOCATION CODE	DESCRIPTION#	SAMPLE TYPES
ONS-1 (A1)	0.4 mi NNE, Rosemary Beach	Air, TLD
ONS-2 (A2)	0.4 mi NE, Visitors Center road	Air, TLD
ONS-3 (A3)	0.5 mi E, 765 KV Yard	Air, TLD
ONS-4 (A4)	0.4 mi ESE, Onsite	Air, TLD
ONS-5 (A5)	0.4 mi S, Onsite	Air, TLD
ONS-6 (A6)	0.4 mi SSW, Shoreline and Fence Line Junction	Air, TLD
NBF	16.0 mi SSW, New Buffalo Substation	Air, TLD
SBN	24.0 mi SE, Kankakee Substation	Air, TLD
DOW	26.0 mi ENE, Dowagiac Substation	Air, TLD
COL	20.0 mi NNE, Coloma Substation	Air, TLD
ONS-7 (A7)	0.4 mi NNE, Onsite	TLD
ONS-8 (A8)	0.4 mi ENE, Onsite	TLD
ONS-9 (A9)	0.3 mi SSE, Onsite	TLD
ONS-10 (A10)	0.3 mi SE, Onsite	TLD
ONS-11 (A11)	0.4 mi NNE	TLD
ONS-12 (A12)	0.4 mi NE	TLD
OFS-1	4.5 mi NE, Intersection of Red Arrow Highway and Marquette Woods Road, Pole #B294-44	TLD
OFS-2	3.0 mi NE, Stevensville Substation	TLD
OFS-3	5.0 mi ENE, Pole #B296-13	TLD
OFS-4	4.2 mi E, Pole #B350-72	TLD
OFS-5	4.0 mi ESE, Intersection of Shawnee and Cleveland, Pole #B387-32	TLD
OFS-6	4.5 mi SE, Intersection of Snow Road and Holden, Pole #B426-70	TLD

ENVIRONMENTAL SAMPLING LOCATION CODES

LOCATION CODE	DESCRIPTION#	SAMPLE TYPES
OFS-7	2.5 mi S, Bridgman Substation	TLD
OFS-8	4.0 mi SSE, California Road, Pole #B424-20	TLD
OFS-9	4.5 mi E, Ruggles Road, Pole #B369-214	TLD
OFS-10	3.8 mi SSW, Intersection of Red Arrow Highway and Floral Lane, Pole #B422-152	TLD
OFS-11	3.8 mi S, Intesection of Snow Road and Baldwin Road, Pole # B423-12.	TLD
W1	0.4 mi NNE, Rosemary Beach	Well Water
W2	0.4 mi ENE, Training Center	Well Water
W3	0.6 mi E, 500 feet east of 765 Kv yard	Well Water
W4	0.1 mi NNW, Onsite	Well Water
W5	0.1 mi WNW, Onsite	Well Water
W6	0.1 mi SW, Onsite	Well Water
W7	0.4 mi S, Livingston Beach	Well Water
#2 (M)	4.5 mi NE, Totzke Farm, Sector D	Milk
M2 (M)	18.0 mi E, Wyant Farm	Milk
#5 (M)	9.0 mi SE, Lozmack Farm, Sector J	Milk
#1 (M)	4.25 mi ESE, Shuler Farm, Sector C	Milk
M1 (M)	20 mi S, Ray Livinghouse Farm	Milk
#4 (M)	7.8 mi SE, Warmbein Farm, Sector J	Milk
#3 (M)	4.8 mi SSE, Zelmer Farm, Sector H	Milk
*ONS-S	0.5 mi S (maximum), Lake Michigan	Fish
*ONS-N	0.5 mi N (maximum), Lake Michigan	Fish
*OFS-S	0.5 mi S (minimum), Lake Michigan	Fish
*OFS-N	0.5 mi N (minimum), Lake Michigan	Fish

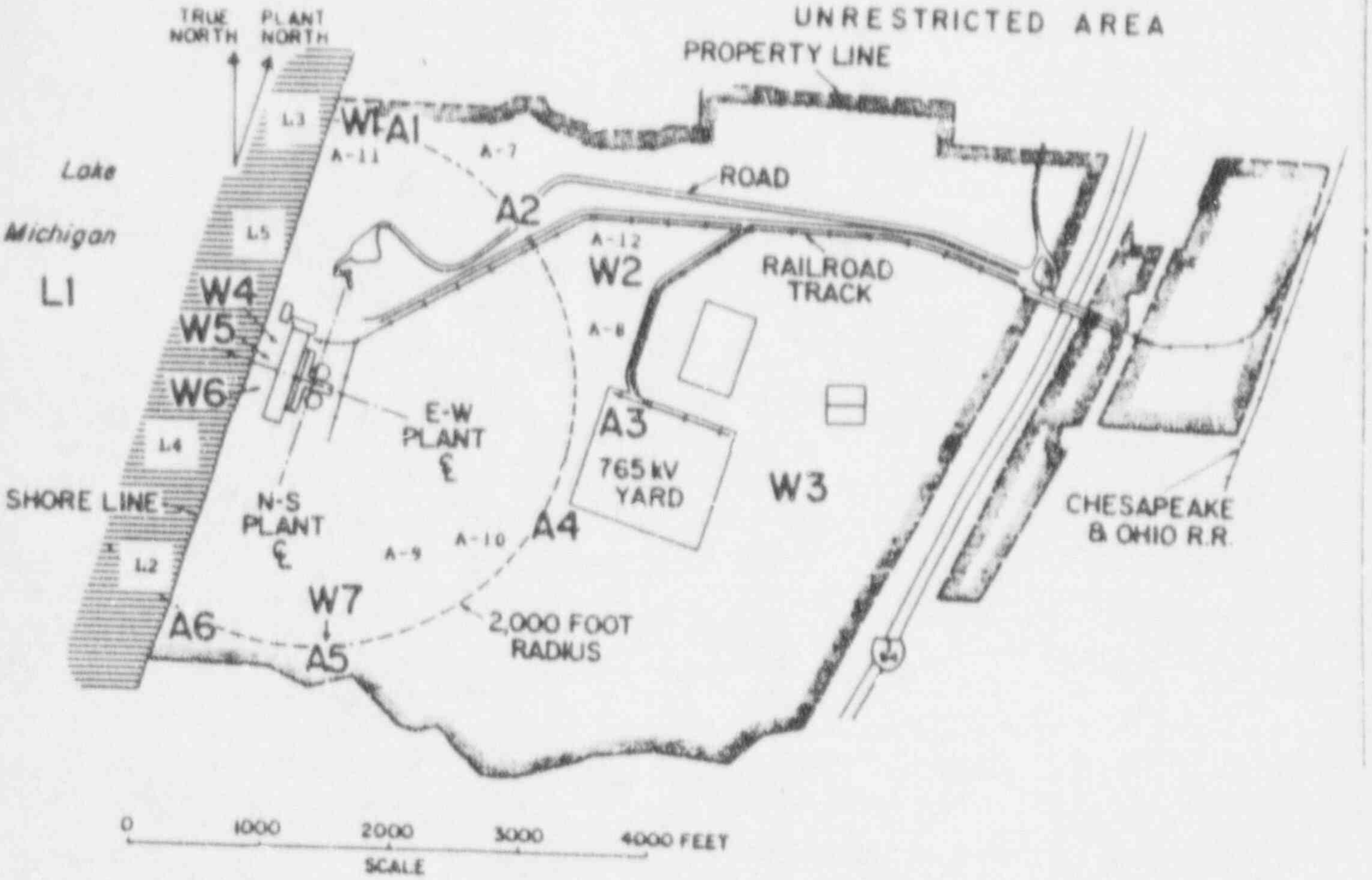
*Actual location will vary due to fluctuating water levels in Lake Michigan.

ENVIRONMENTAL SAMPLING LOCATION CODES

LOCATION CODE	DESCRIPTION#	SAMPLE TYPES
L1	Condenser cooling water intake	Lake Water
L2	At Plant south, red and white range pole, 0.35 mi SW	Lake Water, Sediment
L3	At Plant, north, red and white range pole, 0.24 mi NE	Lake Water, Sediment
L4	Shoreline, 0.1 mi SSW	Lake Water, Sediment
L5	Shoreline, 0.1 mi NNE	Lake Water, Sediment
**V1	Onsite	Broadleaf Vegetation
**V2	Onsite or Offsite	Grapes
STJ (I)	St. Joseph Station	Drinking Water
LTW (I)	Lake Township Station	Drinking Water

*All distances are measured from the center line between Unit 1 and Unit 2.

**Actual location determined by sector with highest annual average D/Q.



A Air, TLD Stations

W Well Water Sample Stations

L Lake Water Sample Stations

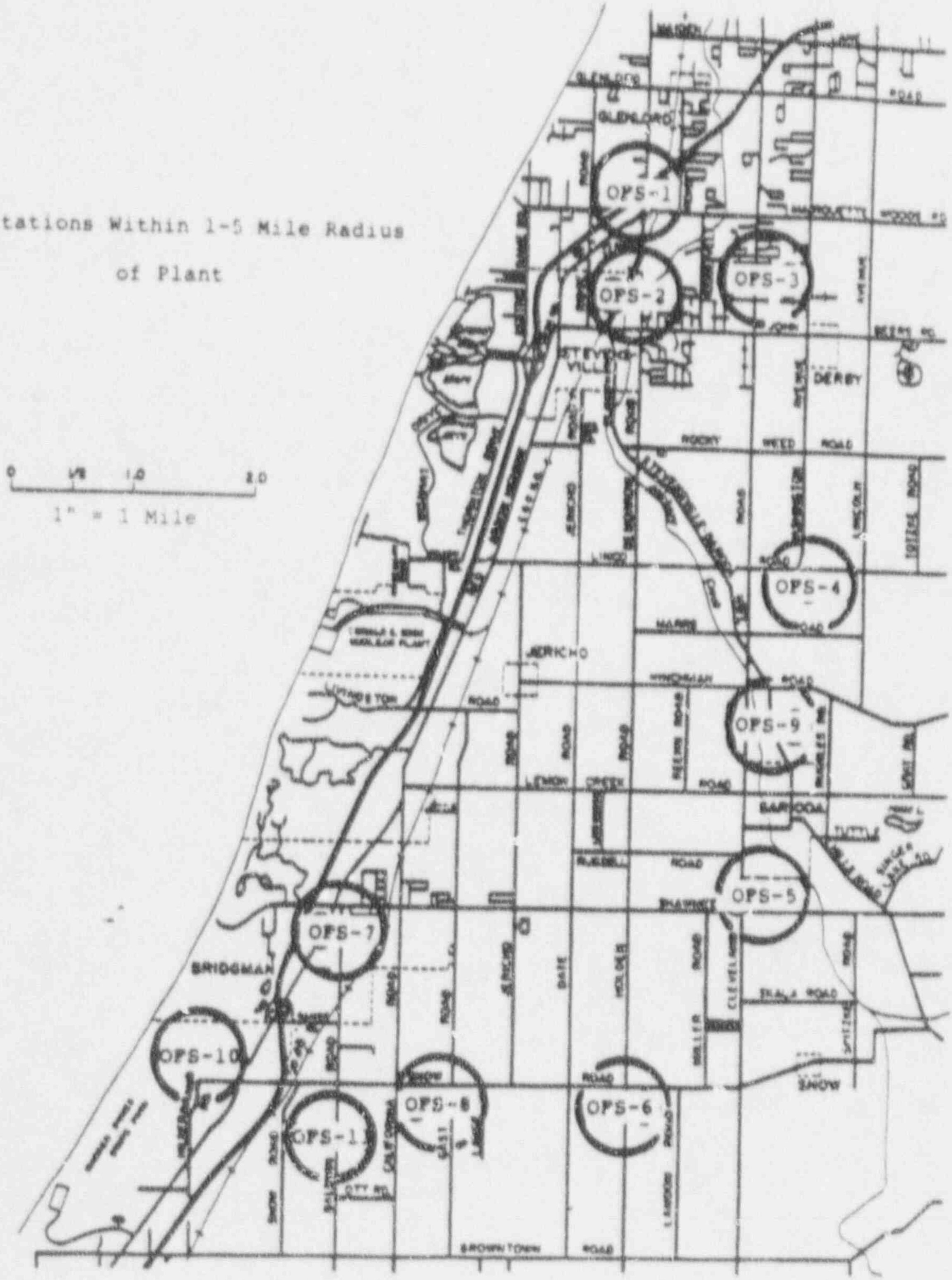
NOTE

Stations A7 through A12 are TLD Stations only

Station L2, L3, L4, L5 are also sediment sample stations.

TLD Stations Within 1-5 Mile Radius

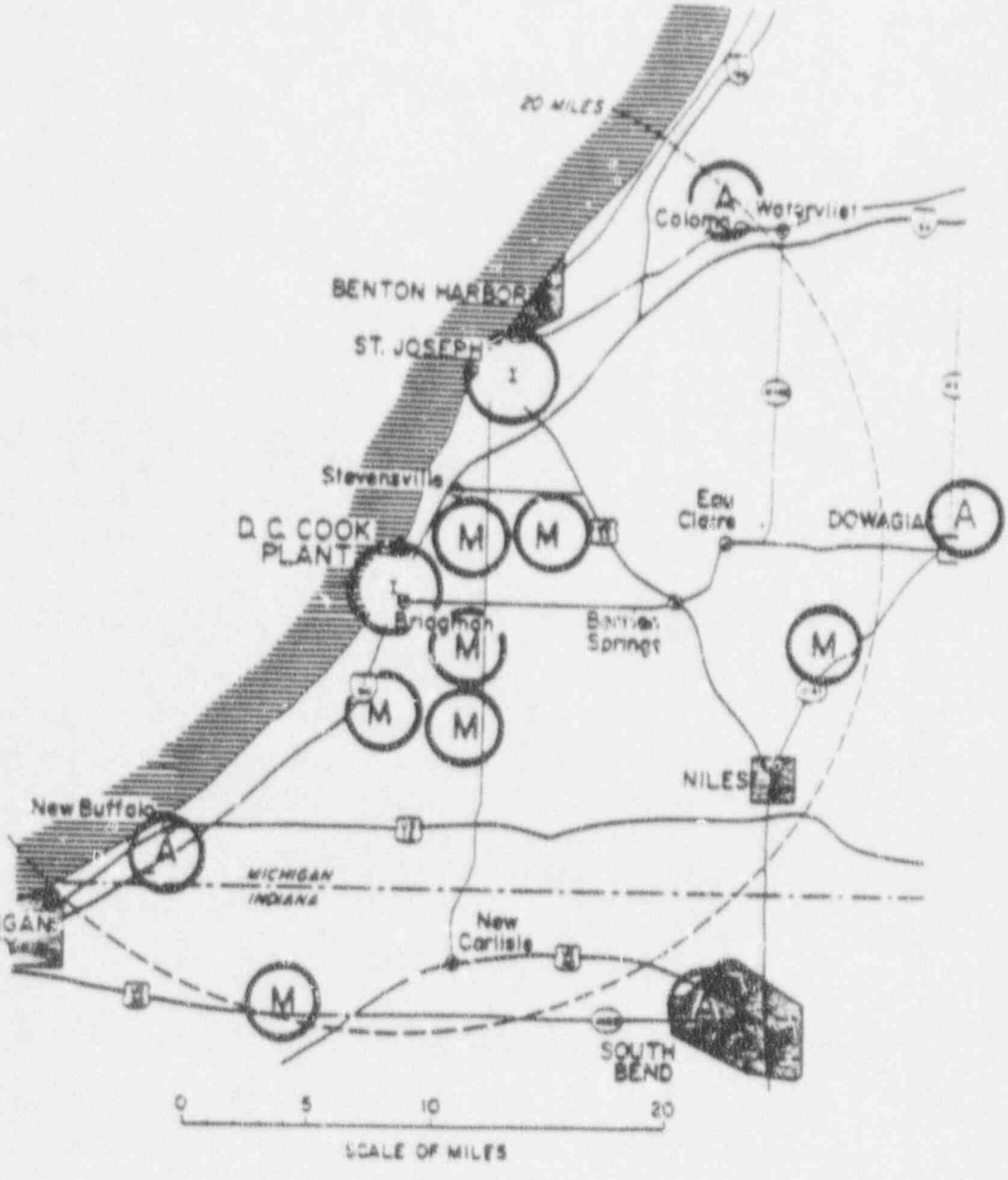
of Plant



A - Control Air and TLD Stations

M - Milk Sample Stations

I - Intake Sample Station



ANNUAL EVALUATION OF X/Q AND D/Q VALUES FOR ALL SECTORS

1. Received annual update of X/Q and D/Q values from Environmental Section.

   ____
   Signature

   ____
   R.P. Section
   (print name, title)

2. Worst X/Q and D/Q value and sector determined. PMP 6010 OSD.001 and Computer Program have been updated. CS-2

   ____
   Signature

   ____
   R.P. Section
   (print name, title)

3. Approved and verified by:

   ____
   Signature

   ____
   R.P. Section
   (print name, title)