THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

PERRY NUCLEAR POWER PLANT OPERATIONS MANUAL

TITLE: INTERNAL EXPOSURE CONTROL

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PREPARED: R. Meschter

SUBMITTED: Steven F. Kenzicki
PERRY PLANT TECHNICAL DEPARTMENT

SUBMITTED: _____
PERRY PLANT OPERATIONS DEPARTMENT

REVIEWED: B P Walsh 2-25-85
NUCLEAR Q.A. DEPARTMENT

APPROVED: Cynthia Thurston 2-26-85
MANAGER - NUCLEAR Q.A. DEPARTMENT

PORC REVIEW AND RECOMMENDATION FOR APPROVAL MEETING NUMBER: 85-08 (B)

APPROVED: J J Woldron
MANAGER - PERRY PLANT TECHNICAL DEPARTMENT

APPROVED: M. D. Lyster
MANAGER - PERRY PLANT OPERATIONS DEPARTMENT

Internal Exposure Control

PAP-0513

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SCOPE OF REVISION:

INTERNAL EXPOSURE CONTROL

1.0 PURPOSE

To establish and describe the Internal Exposure Control Program at the Perry Nuclear Power Plant (PNPP).

2.0 SCOPE

2.1 This procedure provides the method for tracking internal exposure by MPC-HRS based on individual stay times in airborne radioactivity areas, and for calculating MPC-HRS based on whole body count results.

2.2 This procedure provides a bioassay program designed to assess the adequacy of the respiratory protection program and to evaluate individual internal exposures.

The bioassay program includes:

1. Determination of the conditions under which bioassays should be required;

2. Selection of measurement techniques, measurement frequencies, and program participants;

3. Action points and actions to be taken based on measurement results;

4. Interpretation of measurement results in terms of location of radioactive material in the body, quantity present, rate of elimination, and resulting dose commitment.

3.0 RESPONSIBILITY

3.1 The Managers, Perry Plant Technical Department (PPTD)/Perry Plant Operations Department (PPOD) are responsible for ensuring personnel participate in the PNPP bioassay program as required by this procedure.

3.2 The Plant Health Physicist is responsible for the overall development and implimentation of the PNPP Internal Exposure Control Program.

4.0 REFERENCES

4.1 ICRP 2, Permissible Dose for Internal Radiation (1959).

4.2 ICRP 10, Evaluation of Radiation Doses to Body Tissues from Internal Contamination Due to Occupational Exposure (1973).

4.3 ANSI N343, Internal Dosimetry for Mixed Fission and Activation Products (1978).

4.4 Regulatory Guide 8.9, Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program (September 1973).

4.5 PAP-1701, Plant Records Management.

4.6 10CFR20, Standards for Protection Against Radiation.

5.0 DEFINITIONS

5.1 Bioassay

The determination of the kind, quantity or concentration, and location of radioactive material in the human body by direct measurement or by analysis of materials excreted or removed from the body.

5.2 Body Burden

The total quantity of a radionuclide in the human body.

5.3 Maximum Permissible Organ Burden (MPOB)

The quantity of a radionuclide deposited in an organ which if continuously present, would result in the maximum permissible annual dose to the organ.

5.4 Action Level (AL)

The body burden resulting from a single intake of radioactive material which could result in a concentration equal to 5% of the MPOB to the critical organ. The ALs in this procedure are based on lung burdens and assumes that the time between intake and whole body counting is sufficient to allow rapid clearance mechanisms to remove all but 12.5% of the intake from the body.

5.5 Whole Body Count (WBC)

A direct measurement method of bioassay.

5.6 MPC-HRS

The product of the average fractional concentration of airborne radioactivity during a time "t" and that time "t" expressed in hours.

6.0 DETAILS

6.1 Internal Exposure Tracking

Internal exposures are determined by individual stay times in airborne radioactivity areas in accordance with OM11B: HPI-F2, MPC-Hour Determination.

Individual stay times are tracked with Attachment 3, Form: PAP-0513-1, Airborne Radioactivity Area Time Record.

Wherever possible MPC-Hour calculations should be performed based on measured MPC values and exposure times, not back-calculated from body burden analysis results unless no other alternative is available. Should MPC-Hour determination require calculation based on WBC results, the guidance of attachments 1 and 2 of this procedure may be used.

6.2 Routine Whole Body Count (WBC)

All Perry Plant Technical Department (PPTD) and Perry Plant Operations Department (PPOD) personnel shall have a baseline WBC performed prior to working in a Radiation Controlled Area (RCA), annually thereafter, and upon termination as a minimum. All non-PPTD/PPOD personnel assigned work in the RCA are subject to these minimum requirements. The Plant Health Physicist or his alternate may waive the WBC requirements for short-term visitors not entering contaminated areas or if the individual is unlikely to receive greater than 10 MPC-HRs in any seven consecutive days.

NOTE: Any individual receiving medical treatment with radiopharmaceuticals should inform the Health Physics Supervisor prior to WBC.

6.3 Non-Routine WBC

Individuals may receive an additional WBC for any of the following reasons:

a. facial contamination
b. intake of radioactive materials, real or suspected

c. occupancy of an airborne radioactivity area without respiratory protection
d. as directed by Health Physics Supervision

NOTE: Contaminated individuals should be decontaminated in accordance with OM11B: HPI-E7, Personnel Decontamination prior to WBC.

6.4 Excreta Bioassay

Health Physics Supervision will identify personnel for excreta bioassay sampling as required by this procedure.

Excreta samples may be required for determination of internally deposited nuclides such as beta emitters, alpha emmitters, or when the whole body counter is unavailable.

Sample Type (urine or feces) will be determined based on the nuclide of interest (i.e., urine is collected for tritium analysis). Urine sample volume should be at least 250 ml and could range to approximately 1.4 liters per 24 hrs. Fecal sample size will depend on availability.

Sample containers will be provided by Health Physics when excreta samples are required.

6.5 Action Levels

The level of internal contamination should not exceed one Action Level (AL). An AL is calculated by summing the fractional AL's for each nuclide identified in the WBC. The level of internal contamination from a single exposure should not exceed the activity which would result from an acute exposure of 40 MPC-HRs. When the level of internal contamination exceeds an AL, the individual should be checked for surface contamination, decontaminated if necessary, and recounted in accordance with OM11B: HPI-B6, Operation of the Body Burden Counting System.

6.6 Actions

In the event internal contamination exceeds the AL's during WBC, the following actions should be taken:

a. Restrict the individual from further exposure.
b. Perform WBC immediately after skin decontamination and at 24 hours, 72 hours, and 120 hours. WBC may be discontinued and the individuals restriction terminated when the WBC activity drops below 50% of AL.
c. Compile all relevant data such as airborne concentrations, work assignment, source of internal contamination, etc.

d. Following a gross intake of greater than 100 ALs, notify the Company Medical Director for an evaluation of the need to accelerate the elimination of the internal contamination.

e. If internal radioactivity exceeds 10% MPOB at 72 hours following a single intake or immediately following daily chronic exposure, a 50 year dose commitment should be calculated and added to the individuals occupational exposure record for the current quarter.

NOTE: The more detailed and accurate the information about the time and nature of intake, the more reliable the estimate of magnitude of intake and resulting radiation dose.

f. An evaluation of how the exposure occurred should be made. The evaluation should include actions to be taken to prevent recurrence. These evaluations should be kept on record for review.

g. Internal contamination in excess of one AL should be reported to the Plant Health Physicist. If only a single individual in a work group shows this level of body burden, additional training may be necessary. If several members of a work group show this level, air sampling frequencies may be inadequate.

6.7 Internal Dose Calculations

The Plant Health Physicist should calculate the dose commitment to an individual on a case-by-case basis using guidance from ICRP recommendations. The Plant Health Physicist will also evaluate whether the individual has exceeded the 40 MPC-HRs in seven consecutive days control measure. In this case a report should be prepared to evaluate how the control measure was exceeded and actions taken to prevent recurrence. If the individual exceeds the 520 MPC-HR limit, a written report to Region III USNRC, Office of Inspection and Enforcement shall be made in accordance with OM1A: PAP-1604, Reports Management.

6.8 Records

All records generated by this procedure shall be included in the individuals exposure history file and maintained for the life of the plant in accordance with OM1A: PAP-1701 Plant Records Management.

7.0 ATTACHMENTS

7.1 Attachment 1 - MPC-HR Calculation.

7.2 Attachment 2 - Body Burden Calculation.

7.3 Attachment 3 - Form: PAP-0513-1, Airborne Radioactivity Area Time Record.

Attachment 1

MPC-HR Calculation

To calculate MPC-HRS: $$\text{MPC-HRS} = \frac{q_o}{(MPC_n)(BR)}$$

Where q_o = Activity in body at time of intake

MPC_n = Maximum permissible concentration of nuclide

BR = 1 hr. breathing rate or 1.2 E6 cc/hr (breathing rate for 8 hr. workday is 1.0E7cc/d)

To calculate q_o: $$q_o = \frac{q_{24}}{.4}$$

where q_{24} = Activity in body 24 hrs. after intake - results of WBC @ 24 hrs.

If WBC results are for a time greater than 24 hrs., q_o can be calculated by using the body burden calculation and solve for MPC which in this case will be the activity of air breathed at time of the intake. Assume T_1, is 40 hours (1.67 days) unless otherwise known. Then:

q_o = (MPC)(BR)(T)

where MPC = Air activity calculated in Body Burden Formula

BR = Breathing Rate (1.2E6 ml/hr)

T = Actual Time Breathed (use 40 hrs. if time not known).

Attachment 2

Organ Burden Calculation

$$M = (MPC)\ (BR)\ (FO)\ \frac{(1 - e^{-Yt_1})e^{-Yt_2}}{} \times 1000$$

Where:

M = measured activity, nCi

MPC = Maximum Permissible Concentration from 10CFR20, Appendix B, Table I, Col I (uCi/cc)

BR = Breathing rate for standard man, 1 E7 cc/d

FO = Fraction which reaches the whole body from inhalation, from ICRP-2, or 10

t_1 = Breathing time, 40 hours or 1.67d

t_2 = Elapsed time from end of t_1 to measurement time

Y = Decay constant for nuclide using effective half-life (0.693/Te).R(t) may be substituted for (e^{-Yt_2}) in the above equation. R(t) is the fractional retention for a particular radionuclide from ICRP-10.

Examples of Measured Activity with Whole Body Counter After 90 Days Which Would Result in Exceeding 40-MPC Hours in Seven Consecutive Days

Radionuclide	MPC Air (uCi/cc)(1)	FO(2)	Te (days)(3)	M (nCi)(4)
Ce-141	2 E-7	0.125	25.6	36
Co-58	5 E-8	0.125	44.7	26
Co-60	9 E-9	0.125	113.	11
Cr-51	2 E-6	0.125	22.6	263
Cs-134	4 E-8	0.75	64.	191
Cs-137	6 E-8	0.75	69.6	312
Mn-54	4 E-8	0.125	86.	41
Nb-95	1 E-7	0.125	27.1	21
Zr-95	3 E-8	0.125	42.4	14
H-3	5 E-6	1.0	12	4313
I-131	9 E-9	0.75	7.6	55

Footnotes:

(1) All MPC air valves taken from Column 1, Table 1, Appendix B of 10CFR20. All valves are for insolubles except Cs-134 and Cs-137.

Attachment 2

Footnotes: (Cont.)

(2) Fraction of that taken into body by inhalation that is retained in the critical organ.

(3) Use actual half life if known, if not, use the following:
effective half-life $Te = \frac{T_R T_B}{T_R + T_B}$

Where:

T_R = radioactive half-life

T_B = biological half-life

For Ce, Co, Cr, Mn, Nb, Zr, the biological half-life is 120 days from ICRP-2, Table 10

For Cs, the biological half-life is 70 days from ICRP-2, Table 12

(4) Based on 7 days for I-131

Attachment 3
Form: PAP-0513-1

Airborne Radioactivity Area Time Record

NAME	TLD ID#	RWP#	TIME ENTER	TIME EXIT	TIME IN	
					hrs	min