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COMPLIANCE DETERMINATION PROCEDURES FOR ENVIRONMENTAL, RADIATION PROTECTION STANDARDS FOR URANIUM RECOVERY FACILITIES

40 CFR 190

U. S. Nuclear Regulatory Commission

Division of Waste Management

Uranium Recovery Licensing Branch

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Title: Compliance Determination Procedures for Environmental Radiation Protection Standards for Uranium Recovery Facilities - 40 CFR 190

Background

Under Title 40 Code of Federal Regulations Part 190 - Subchapter F - Radiation Protection Programs, the U.S. Environmental Protection Agency (EPA) promulgated "Environmental Radiation Protection Standards for Nuclear Power Operations" which provides limits for the radiation doses received by members of the public in the general environment as the result of operations which are part of the nuclear fuel cycle. Effective December 1, 1980, each uranium milling facility* shall conduct its operations in such a manner to assure that the annual radiation dose equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public is not exceeded. However, the dose from radon and its daughters is excluded from these doses. The following discussion briefly describes the Nuclear Regulatory Commission's (NRC) program for compliance determination for uranium recovery facilities. In April, 1980, the NRC published a proposed amendment to 10 CFR Part 20 "Environmental Radiation Protection Standards for Nuclear Power Operations" and will shortly finalize this amendment which requires that a NRC licensee shall comply with 40 CFR 190. This program is also meant to serve as guidance for the Agreement States in their implementation of 40 CFR 190.

As illustrated by radiological assessments performed in the uranium milling generic environmental impact statement (GEIS), 40 CFR 190 compliance will be achieved only by strict emission controls at the mill. The most significant sources of emissions are the tailings ponds/piles and the yellowcake dryer stacks. The NRC has made strict emission control a specific license condition in its licensing activities over the past several years; and it has been an NRC requirement that exposure limits be met by emission controls to the maximum extent reasonably achievable. Such emission control requirements are contained in the May, 1977 NRC staff position on "Tailings Management Performance Objectives" and in the final regulations on uranium milling issued in the Federal Register on October 3, 1980. A copy of the criteria in these regulations covering emission controls is attached as Appendix B. Certainly land use control, e.g., expanding the buffer zone around a mill site, cannot exclusively be used as a substitute for reducing actual emissions from the various milling processes. The primary means of meeting exposure limits must be by emission control.

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*All uranium extraction facilities; to include mills, in-situ operations and heap leach facilities. (R&D facilities are not included here since initial assessments indicate that their size and potential radiological impact are insignificant; e.g., R&D in-situ operations in general have no airborne particulate releases.)

There are inherent problems in accurately determining source terms, particularly from large area sources such as the tailings impoundments. Also, there are significant uncertainties in the atmospheric transport models used to compute airborne radioactivity concentrations given a source term, particularly where there is irregular terrain. Therefore, the primary means of determining compliance must be by measurements made at the point of receptor and the procedures outlined below reflect this. On the other hand, compliance cannot reasonably be determined and corrective action taken where necessary, by inflexibly and rigidly considering point of receptor data alone. Therefore, environmental measurements at other locations near the mill and at background locations, effluent sampling, meteorologic data, and other similar information must be available to supplement point of receptor data. Such supplemental information is required most in cases where computed doses approach or exceed the limit. Other monitoring data will be necessary, for example, to screen out effects of mines that may be nearby and may be contributing to dose.

By no means will the mere assertion that the mill operations utilize emission controls suffice to show compliance to 40 CFR 190 exposure limits. The licensee must provide some supportable dose assessments based on actual environmental monitoring data which are compatible with the procedures discussed below.

Procedure

The ultimate goal of this program is to establish a standardized procedure which will be used to assess compliance subsequent to the establishment of each licensee's Environmental Monitoring Program (EMP). It will realistically require as much as a year's worth of effluent and environmental monitoring to firmly establish whether compliance exists at mills which are close to the limit or where there are significant nearby sources of radioactive emissions such as mines, which are not covered by the standard. Much of this time will be spent on the fine tuning of the monitoring and analysis program that is normally required in setting up such programs to assure they are operating properly and producing reliable data. It will also take some time to sort out the contributions being made by other sources. This may require some short-term, special environmental measurements. Special studies of the effectiveness of selected emission control measures may be required. These evaluations may be supplemented by computer assessments as needed and appropriate.

Eventually, it is anticipated that concentration and dose action levels (which may even be higher than 25 millirems accounting for contributions from other sources) will be established in combination with specific control measures and levels as the threshold for determining compliance with the standard. This will reduce costs of implementation, eliminate

uncertainty on the part of the licensee, regulatory agency and the public (particularly in cases where there are significant extraneous sources), and assure that the need for remedial action is identified most expeditiously if it exists.

Before environmental monitoring data is available, which is the situation in licensing of new facilities or in authorizing significant modification to existing ones, predictive models must be utilized to evaluate the potential impacts of the prospective new operations. Use of predictive models, in addition to consideration of what limited environmental data exists, is also being used by the staff in the initial 40 CFR 190 implementation efforts in December of 1980. Predictive modeling assessments of radioactivity concentrations to which nearby individuals may be exposed involve making numerous assumptions and simplifications about important, but frequently uncertain, factors such as mill releases and atmospheric transport; for this reason, as discussed above, actual compliance determination will be based on environmental monitoring data which indicate directly what such concentrations are. Predictive models, however, are necessary and valuable tools in evaluating what emission controls are likely necessary, in identifying potential problem areas, and in establishing environmental monitoring requirements.

The following describes the procedures which shall be followed in (A) determining compliance with 40 CFR 190 based on environmental monitoring data, and (B) assessing proposed operations in term of their ability to meet 40 CFR 190.

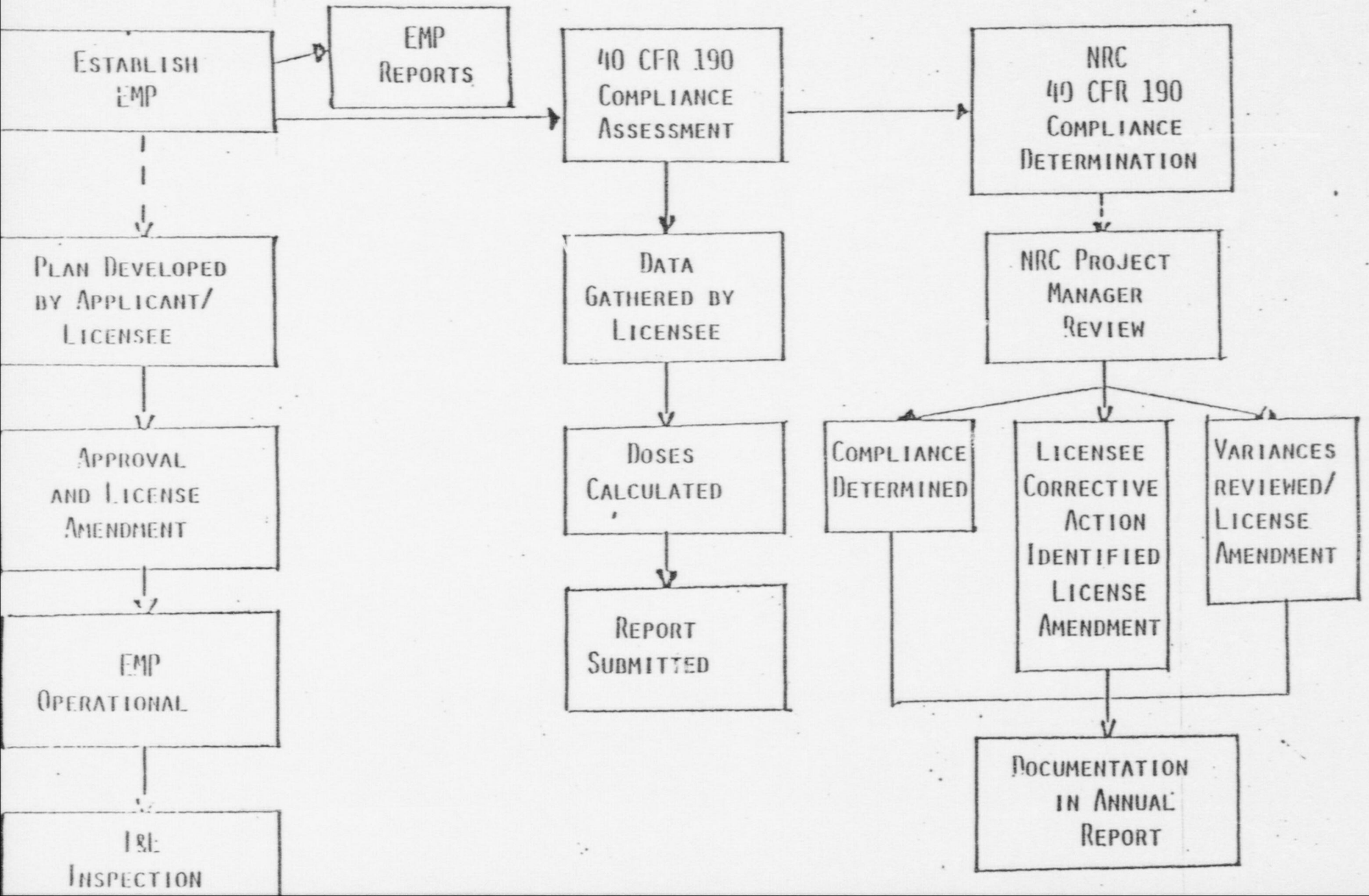
A. Assessment of Actual Environmental Monitoring Data

Figure 1 - "40 CFR 190 Compliance Determination Procedure" shows a diagram of the various steps to be followed to ultimately assure compliance to 40 CFR 190 for all licensing applications.

1. Each licensee shall establish an Environmental Monitoring Program (EMP) consistent with NRC's Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (April 1980). This document provides specific details for both a pre-operational and the operational monitoring programs which are considered adequate by the staff to obtain the necessary information to be used by the licensee to estimate the maximum potential annual radiation dose to any member of the general public as a result of actually measured mill effluent releases. In order to establish such an acceptable EMP, each applicant/licensee shall be required to:

   a. Develop an EMP and submit a plan to the NRC for review and approval. Such a plan shall include specific details of the number, location, collection method (i.e., equipment), sampling frequency and analysis information for all

FIGURE 1
40 CFR 190
COMPLIANCE DETERMINATION PROCEDURE
(BASED ON ACTUAL ENVIRONMENTAL MONITORING DATA)



sample types (e.g., air particulate, radon/WL, stack samples, surface and ground waters, vegetation, food, fish, soil, and direct radiation). For each site (including existing mills), at least one year of site specific meteorological data; e.g., wind speed and direction, stability class, etc., shall be collected, summarized, and reported. A site map, including all affected off-site areas, showing each point of sample collection shall also be provided. Participation in a Quality Assurance Program (QAP) as described in NRC's Regulatory Guide 4.15, "Quality Assurance Programs for Radiological Monitoring Programs (Normal Operations) -Effluent Streams and the Environment" (February 1979) shall also be discussed in the EMP plan.

b. Upon NRC's review and approval, the EMP shall be added to the license and any subsequent change or modification of the approved EMP shall require that a specific license amendment be initiated by the licensee.

c. The EMP plan shall provide a time schedule providing the date when each phase of the EMP will become operational. For new license applicants, at least one year of pre-operational monitoring shall be required. For existing facilities, a realistic time schedule shall be implemented; however, all phases of the EMP shall be operational within 120 days of NRC's approval of the EMP plan.

d. The NRC's Office of Inspection and Enforcement shall conduct periodic on-site inspections of both the actual environmental monitoring systems/locations, as well as all reports and records of such an EMP to ensure that the actual operations of the EMP are within the approved EMP license condition.

2. Each licensee shall provide an EMP report every six months, as required in 10 CFR 40.65, "Effluent Monitoring Reporting Requirements." The report should contain the specific information as outlined in Section 7 "Recording and Reporting Results" of NRC's Regulatory Guide 4.14, supra.

3. As a license condition, each license shall be required to submit, in conjunction with its every six months EMP report (EMPR), its own 40 CFR 190 compliance assessment for NRC review and action, as described below.

a. Such an assessment shall be based on data gathered by the licensee from the approved EMP as discussed above. Such data gathering shall include a semiannual survey of land use (i.e., residences, grazing, water wells, etc.) in the area within 8 km (5 miles) of the mill. Any difference in land use from that previously reported shall be discussed and evaluated with respect to 40 CFR 190 compliance. In order to minimize records keeping and formal reporting requirements, while still maintaining a reasonable and timely review of the EMP, annual averages based on the immediate past two consecutive six month reporting periods shall be used for the compliance assessment and reporting requirements.

b. Dose evaluation using site specific input parameters shall be completed using the standardized procedures delineated in Attachment A - "Dose Calculational Guidance", which are based on NRC's draft Regulatory Guide RH#802-4, "Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations". These attached tables are provided to allow the rapid dose calculational assessment of environmental monitoring data. Variations in specific assumptions made in Attachment A will be considered by the staff upon request.

c. As necessary, a licensee shall indicate in the report what corrective action is being taken if non-compliance is determined. Each licensee shall complete its initial 40 CFR 190 compliance assessment and shall submit its EMP report for NRC review and approval prior to January 1, 1982; and subsequently withing 60 days after January 1 and July 1 of each year thereafter, so long as the license is active.

4. Once each year, the NRC shall review and complete its own independent determination of each licensee's EMPR and 40 CFR 190 compliance assessment. Such a review shall consider the influence of extraneous sources (e.g., mining and transportation activities) and any anomalous data (e.g., the indication of erroneous data generated during sample collection or sample analysis).

a. The NRC Project Manager (PM) shall review all submittals, and shall primarily be responsible for all approvals, license amendments and verification of 40 CFR 190 compliance.

i. Upon determination of compliance to 40 CFR 190, the PM will document such findings via a brief Memorandum to File (standardized form memo) for the subject license within 30 days of receipt of reports submitted under 3(c).

ii. Upon determination of non-compliance to 40 CFR 190, the PM shall assure that the licensee take any necessary corrective actions and shall issue specific license amendments as required to accomplish this.

iii. The PM shall review any variance request per 40 CFR 190.11, and shall initiate appropriate licensing action as required. The EPA shall be notified whenever a variance is granted.

iv. The WMUR PM for 40 CFR 190 Compliance assessment shall issue a brief annual report summarizing the results of the individual license compliance reviews. This report shall also consider the cumulative dose to any member of the population due to exposure from releases from multiple mill facilities in the general area. The EPA shall be provided with a copy of this summary report for their review and comment.

5. The PM shall periodically review and evaluate the EMP, EMP reports, and 40 CFR 190 compliance assessments, and shall eliminate any requirements that experience shows to be nonessential or shall require specific actions necessary to show compliance. For example, if the airborne concentration measurements show that there is no need to continue radium-226, thorium-230, or lead-210 analyses, then such requirements shall be eliminated from the EMP. Effort will be made to streamline the periodic compliance assessment effort by prescribing specific concentration levels which, based on experience and in combination with other readily observable parameters related to mill operations and local land use, could be relied upon to determine compliance.

B. Predictive Modeling

Figure 2 - "NRC 40 CFR 190 Assessment of Prospective Milling Operations" shows a diagram of the various steps to be followed by the NRC Project Manager in licensing reviews.

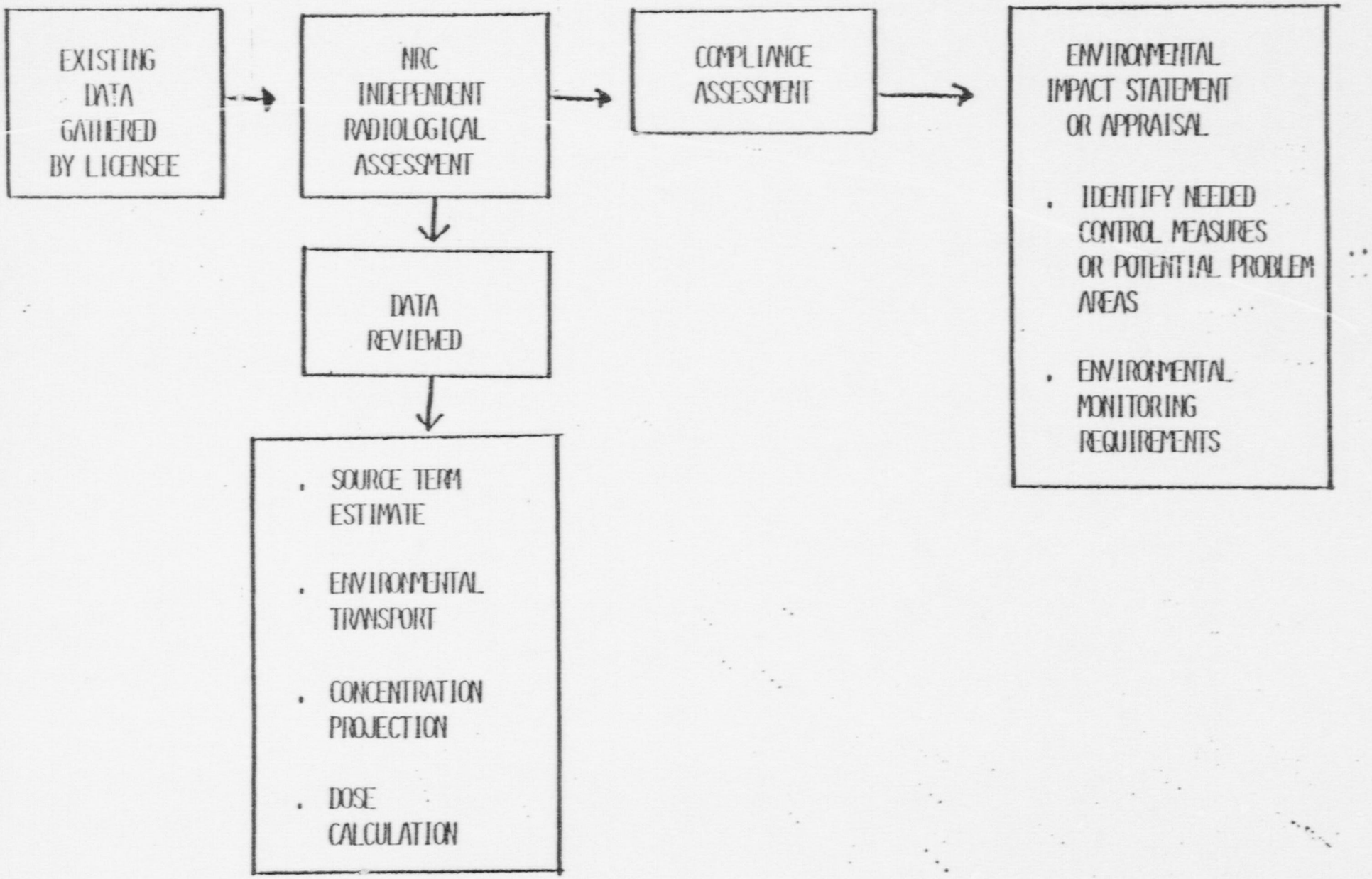
1. All existing data, e.g., source term, environmental monitoring data, land use, population distribution, meteorology, etc., shall be gathered and reviewed by the NRC Project Manager (PM).

2. The NRC PM shall complete an independent radiological assessment to 40 CFR 190 compliance based on predictive modeling using methodology as described in Regulatory Guide RH#802-4.

3. These assessments shall be documented in the Environmental Impact Statement (EIS) or environmental appraisal conducted in support of the licensing action. These assessments shall consider the cumulative dose to any member of the population due to exposure from releases from multiple mill facilities in the general area.

FIGURE 2

NRC 40 CFR 190 ASSESSMENT OF PROSPECTIVE MILLING OPERATIONS (BASED ON PREDICTIVE MODELING)



APPENDIX A

Attachment A
:Dose Calculational Guidance

The estimated dose received by any member of the general population shall be calculated based on the applicable potential exposure of the nearest resident in the off-site area surrounding the mill site. The total dose shall be the sum of the external exposure (i.e., due to radiation sources outside the body) and of the internal exposure (i.e., radioactive materials within the body) as follows:

1. External Radiation Exposure -

   The direct radiation exposure may be assumed to be equal to the actual personal or environmental dosimetric data less the appropriate background contribution.

2. Internal Radiation Exposure -

   The total dose to organs (e.g., lung, bone, whole body, etc.) shall be evaluated based on summing all applicable human pathways, such as:

   a. Inhalation of Airborne Particulates -

      The measured airborne concentration multiplied by the dose conversion factors as given in Table A-1.

   b. Ingestion of Contaminated Food and Milk -

      The measured concentration in the food product multipled by the dose conversion factor as given in Table A-2(a) through (c).

   c. Ingestion of Meat or Milk from Livestock Grazing on Contaminated Vegetation -

      The measured concentration in vegetation (e.g., grasses in grazing areas) multiplied by the dose conversion factor as given in Table A-3(a) and (b).

   d. Ingestion of Contaminated Water -

      The measured concentration in potable water multiplied by the dose conversion factor as given in Table A-4.

e. Ingestion of Meat or Milk from Livestock Watered on Contaminated Water -

The measured concentration in water used by livestock for watering purposes multiplied by the dose conversion factor as given in Table A-5(a) and (b).

If any of the human exposure pathways as given above are not in evidence at a mill site, then that dose contribution obviously does not need to be considered here. The total dose for each critical organ shall be obtained by summing the dose due to each radionuclide of the uranium decay chain series (i.e., uranium, radium-226, thorium-230, lead-210, and polonium-210) and through each pathway, i.e., inhalation plus external exposure plus any applicable ingestion pathways. However, the dose due to the inhalation pathway shall be of primary concern, with the other pathways providing supplemental information regarding possible exposure. Additionally, a thorough evaluation of background conditions must be completed so that any contribution due to the mill operations (i.e., value measured at point of receptor less applicable background level) may be adequately assessed.

The point of receptor data must be reviewed in connection with other environmental and effluent monitoring data, and other appropriate information or assessment tools (such as computer modeling where this may be helpful), in cases where extraneous sources may cause calculated doses to exceed the 40 CFR 190 limits or where anomalous data may be encountered.

Table A-1
Dose Conversion Factors for the Inhalation of Airborne Particulates
(MilliRem per pCi/m^3)*

Radionuclide	Whole Body	Bone	Lung
U-238	4.32	79.2	158
U-234	4.92	79.5	180
Th-230	166	5950	3220
Ra-226	30.9	309	6610
Pb-210	4.36	135	772
Po-210	0.47	1.92	420

*The 50-year dose commitment for each year of exposure to 1 pCi/m^3 of each radionuclide for an adult breathing rate of 20 m^3/day. Particle size of 1.55 µm AMAD (i.e., mean diameter of 1 µm and density of 2.4 g/cm^3) being representative of uranium ore. The Quality Factor for alpha radiations is 10. The total dose per organ is the summation of doses due to each radionuclide. (Regulatory Guide RH#802-4).

Table A-2(a)
Dose Converson Factors for Ingestion of Contaminated Meat

(MilliRem per $\frac{pCi}{kg}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	3.55 E-03	6.01 E-02	0.0	1.37 E-02
U-234	4.05 E-03	6.55 E-02	0.0	1.56 E-02
Th-230	4.46 E-03	1.61 E-01	9.16 E-03	4.42 E-02
Ra-226	3.60 E-01	3.60 E+00	4.49 E-04	1.28 E-02
Pb-210	4.26 E-02	1.20 E+00	3.42 E-03	9.63 E-01
Po-210	7.01 E-03	2.79 E-02	5.92 E-02	1.97 E-01

*The 50-year dose commitment for each year of ingestion of contaminated meat. The above factors correspond to an adult ingestion rate of 78.3 kg/yr of meat (beef, poultry, pork, mutton). (Regulatory Guide RH#802-4).

Table A-2(b)

Dose Conversion Factors for Ingestion of Contaminated Edible Vegetation

(MilliRem per $\frac{pCi}{kg}$)

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	2.38 E-03	4.03 E-02	0.0	9.19 E-03
U-234	2.71 E-03	4.39 E-02	0.0	1.04 E-02
Th-230	2.99 E-03	1.08 E-01	6.14 E-03	2.97 E-02
Ra-226	2.42 E-01	2.42 E+00	3.01 E-01	8.56 E-03
Pb-210	2.86 E-02	8.03 E-01	2.29 E-01	6.46 E-01
Po-210	4.51 E-03	1.87 E-02	3.97 E-02	1.30 E-01

*The 50-year dose commitment for each year of ingestion of contaminated edible vegetation.

A factor of 50% activity reduction through food preparation was assumed, and an adult ingestion rate of 105 kg/yr total vegetable ingestion rate, as well as uniform concentration throughout all vegetable types. Should data be presented as concentration of edible above ground vegetables, C_1; potatoes, C_2; and other below ground vegetables, C_3; then the following weighted concentration C_V should be used when multiplying the above dose factors:

$$C_V = 0.38\ C_1 + 0.58\ C_2 + 0.05\ C_3$$

Table 5 of Regulatory Guide RH#802-4 details the breakdown of vegetable consumption.

Table A-2(c)

e Conversion Factors for Ingestion of Contaminated Milk
(MilliRem per pCi/l)*

Ra ide	Whole Body	Bone	Liver	Kidney
U-238	5.90 E-03	9.97 E-02	0.0	2.28 E-02
U-234	6.72 E-03	1.09 E-01	0.0	2.59 E-02
Th-230	7.41 E-03	2.68 E-01	1.52 E-02	7.35 E-02
Ra-226	5.98 E-01	5.98 E+00	7.46 E-04	2.12 E-02
Pb-210	7.07 E-02	1.99 E+00	5.68 E-01	1.60 E+00
Po-210	1.12 E-02	4.63 E-02	9.83 E-02	3.28 E-01

*The 50-year commitment for each year of ingestion of contaminated milk. These values are based on an adult consumption rate of 730 liters/year. Since children drink greater quantities, the resultant dose is much higher for younger people. Dose conversion factors, as before, are for adults. Proper dose conversion factors and milk consumption rates for other age groups are presented in Regulatory Guide RH#802-4.

Table A-3 (a)
Dose Conversion Factors for Ingestion of Meat from Cattle
Grazing on Contaminated Vegetation
(MilliRem per $\frac{pCi}{kg}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	6.04 E-05	1.02 E-03	0.0	2.33 E-04
U-234	6.88 E-05	1.11 E-03	0.0	2.65 E-04
Th-230	4.46 E-05	1.61 E-03	9.16 E-05	4.42 E-04
Ra-226	9.18 E-03	9.18 E-02	1.15 E-05	3.25 E-04
Pb-210	1.51 E-03	4.25 E-02	1.21 E-02	3.42 E-02
Po-210	2.39 E-04	9.90 E-04	2.10 E-03	7.00 E-03

*The 50-year dose commitment for each year of ingestion of meat. The above values are based on the following.

i) Animal uptake of vegetation: 50 kg/day

ii) Environmental transfer coefficients: $\left(\frac{pCi/kg}{pCi/day}\right)$

U - 3.4×10^{-4}

Th - 2.0×10^{-4}

Ra - 5.1×10^{-4}

Pb - 7.1×10^{-4}

Po - 7.1×10^{-4}

iii) Adult meat ingestion rate: 78.3 kg/year

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

Table A-3(b)
Dose Conversion Factors for Human Consumption
of Milk from Dairy Cows Ingesting Contaminated Vegetation

(MilliRem per $\frac{pCi}{kg}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	1.80 E-04	3.03 E-03	0.0	6.94 E-04
U-234	2.05 E-04	3.31 E-03	0.0	7.89 E-04
Th-230	1.85 E-06	6.70 E-05	3.80 E-06	1.84 E-05
Ra-226	1.76 E-02	1.76 E-01	2.20 E-05	6.25 E-04
Pb-210	4.24 E-04	1.19 E-02	5.97 E-03	9.59 E-03
Po-210	6.70 E-05	2.78 E-04	5.90 E-04	1.97 E-03

*The 50-year dose commitment for each year of ingestion of milk. The above values are based on the following:

i) Animal uptake of vegetation: 50 kg/day

ii) Environmental transfer coefficients: $\left(\frac{pCi/kg}{pCi/day}\right)$

U - 6.1×10^{-4}

Th - 5.0×10^{-6}

Ra - 5.9×10^{-4}

Pb - 1.2×10^{-4}

Po - 1.2×10^{-4}

iii) Adult consumption of milk: 130 liters/year

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

Table A-4
Dose Conversion Factors for Human Consumption
of Contaminated Water

(MilliRem per $\frac{pCi}{l}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	1.68 E-02	2.84 E-01	0.0	6.48 E-02
U-234	1.91 E-02	3.09 E-01	0.0	7.36 E-02
Th-230	2.11 E-02	7.62 E-01	4.33 E-02	2.09 E-01
Ra-226	1.70 E+00	1.70 E+01	2.12 E-03	6.03 E-02
Pb-210	2.01 E-01	5.66 E+00	1.62 E+00	4.55 E+00
Po-210	3.18 E-02	1.32 E-01	2.80 E-01	9.32 E-01

*The 50-year dose commitment for each year of ingestion of contaminated water. The above values are based on an average adult consumption rate of 370 liters/year (Regulatory Guide 1.109) and adult ingestion dose conversion factors (Regulatory Guide RH#802-4).

Table A-5
Dose Conversion Factors for Ingestion
of Meat from Cattle Watered on Contaminated Water

(MilliRem per $\frac{pCi}{l}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	6.04 E-05	1.02 E-03	0.0	2.33 E-04
U-234	6.88 E-05	1.11 E-03	0.0	2.65 E-04
Th-230	4.46 E-05	1.61 E-03	9.16 E-05	4.42 E-04
Ra-226	9.18 E-03	9.18 E-02	1.15 E-05	3.25 E-04
Pb-210	1.51 E-03	4.25 E-02	1.21 E-02	3.42 E-02
Pb-210	2.39 E-04	9.90 E-04	2.10 E-03	7.00 E-03

*The 50-year dose commitment for each year of ingestion of meat. The above values are based on the following:

i) Animal uptake of water: 50 liters/day

ii) Environmental transfer coefficients: $\left(\frac{pCi/kg}{pCi/day}\right)$

U - 3.4×10^{-4}

Th - 2.0×10^{-4}

Ra - 5.1×10^{-4}

Pb - 7.1×10^{-4}

Po - 7.1×10^{-4}

iii) Adult meat ingestion rate of 78.3 kg/year

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

Table A 5(b)
Dose Conversion Factors for Human Consumption
of Milk from Dairy Cows Watered on Contaminated Water

(MilliRem per $\frac{pCi}{l}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	2.16 E-04	3.65 E-03	0.0	8.33 E-04
U-234	2.46 E-04	3.98 E-03	0.0	9.47 E-04
Th-230	2.22 E-06	8.03 E-05	4.56 E-06	2.20 E-05
Ra-226	2.12 E-02	2.12 E-01	2.64 E-05	7.50 E-04
Pb-210	5.09 E-04	1.43 E-02	4.09 E-03	1.15 E-02
Po-210	8.04 E-05	3.33 E-04	7.08 E-04	2.36 E-03

*The 50-year dose commitment for each year of ingestion of milk.
The above values are based on the following:

i) Dairy animal intake rate: 60 liters/day

ii) Adult ingestion milk rate: 130 liters/year

iii) Environmental transfer coefficients: $\left(\frac{pCi/liter}{pCi/day}\right)$

U - 6.1×10^{-4}

Th - 5.0×10^{-6}

Ra - 5.9×10^{-4}

Pb - 1.2×10^{-4}

Po - 1.2×10^{-4}

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

impacts of operation and to detect potential long term effects.

Criterion 8—Milling operations shall be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this shall be by means of emission controls. Institutional controls, such as extending the site boundary and exclusion area, may be employed to ensure that offsite exposure limits are met, but only after all practicable measures have been taken to control emissions at the source. Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamination. The greatest potential sources of offsite radiation exposure (aside from radon exposure) are dusting from dry surfaces of the tailings disposal area not covered by tailings solution and emissions from yellowcake drying and packaging operations.

Checks shall be made and logged hourly of all parameters (e.g., differential pressures and scrubber water flow rates) which determine the efficiency of yellowcake stack emission control equipment operation. It shall be determined whether or not conditions are within a range prescribed to ensure that the equipment is operating consistently near peak efficiency; corrective action shall be taken when performance is outside of prescribed ranges. Effluent control devices shall be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack. Drying and packaging operations shall terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable. Operations may not be re-started after cessation due to off-normal performance until needed corrective actions have been identified and implemented. All such cessations, corrective actions, and re-starts shall be reported to the appropriate NRC regional office as indicated in Criterion 8A, in writing, within 10 days of the subsequent restart.

To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonably achievable. This requirement may be relaxed if tailings are effectively sheltered from wind, such as may be the case where they are disposed of below grade and the tailings surface is not exposed to wind. Consideration shall be given in planning tailings disposal programs to methods which would allow phased covering and reclamation of tailings impoundments since this will help in controlling particulate and radon emissions during operation. To control dusting from diffuse sources, such as tailings and ore pads where automatic controls do not apply, operators shall develop written operating procedures specifying the methods of control which will be utilized.

Criterion 8A—Daily inspections of tailings or waste retention systems shall be conducted by a qualified engineer or scientist and documented. The appropriate NRC regional office as indicated in Appendix D of 10 CFR Part 20, or the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, shall be immediately notified of any failure in a tailings or waste retention system which results in a release of tailings or waste into unrestricted areas, and/or of any unusual conditions (conditions not contemplated in the design of the retention system) which if not corrected could indicate the potential or lead to failure of the system and result in a release of tailings or waste into unrestricted areas.

II. Financial Criteria

Criterion 9—Financial surety arrangements shall be established by each mill operator prior to the commencement of operations to assure that sufficient funds will be available to carry out the decontamination and decommissioning of the mill and site and for the reclamation of any tailings or waste disposal areas. The amount of funds to be ensured by such surety arrangements shall be based on Commission-approved cost estimates in a Commission-approved plan for (1) decontamination and decommissioning of mill buildings and the milling site to levels which would allow unrestricted use of these areas upon decommissioning, and (2) the reclamation of tailings and/or waste disposal areas in accordance with technical criteria delineated in Section I of this Appendix. The licensee shall submit this plan in conjunction with an environmental report that addresses the expected environmental impacts of the milling operation, decommissioning and tailings reclamation, and evaluates alternatives for mitigating these impacts. The surety shall also cover the payment of the charge for long term surveillance and control required by Criterion 10. In establishing specific surety arrangements, the licensee's cost estimates shall take into account total costs that would be incurred if an independent contractor were hired to perform the decommissioning and reclamation work. In order to avoid unnecessary duplication and expense, the Commission may accept financial sureties that have been consolidated with financial or surety arrangements established to meet requirements of other Federal or state agencies and/or local governing bodies for such decommissioning, decontamination, reclamation, and long term site surveillance and control, provided such arrangements are considered adequate to satisfy these requirements and that the portion of the surety which covers the decommissioning and reclamation of the mill, mill tailings site and associated areas, and the long term funding charge is clearly identified and committed for use in accomplishing these activities. The licensee's surety mechanism will be reviewed annually by the Commission to assure that sufficient funds would be available for completion of the reclamation plan if the work had to be performed by an independent contractor. The amount of surety liability should be adjusted to recognize any increases or decreases resulting from inflation, changes in engineering plans, activities performed, and any other conditions affecting costs. Regardless of whether reclamation is phased through the life of the operation or takes place at the end of operations, an appropriate portion of surety liability shall be retained until final compliance with the reclamation plan is determined. This will yield a surety that is at least sufficient at all times to cover the costs of decommissioning and reclamation of the areas that are expected to be disturbed before the next license renewal. The term of the surety mechanism must be open ended, unless it can be demonstrated that another arrangement would provide an equivalent level of assurance. This assurance could be provided with a surety instrument which is written for a specified period of time (e.g., five years) yet which must be automatically renewed unless the surety notifies the beneficiary (the Commission or the State regulatory agency) and the principal (the licensee) some reasonable time (e.g., 90 days) prior to the renewal date of their intention not to renew. In such a situation the surety requirement still exists and the licensee would be required to submit an acceptable replacement surety within a brief period of time to allow at least 60 days for the regulatory agency to collect.

Proof of forfeiture must not be necessary to collect the surety so that in the event that the licensee could not provide an acceptable replacement surety within the required time, the surety shall be automatically collected prior to its expiration. The conditions described above would have to be clearly stated on any surety instrument which is not open-ended, and must be agreed to by all parties. Financial surety arrangements generally acceptable to the Commission are:

(a) Surety bonds;
(b) Cash deposits;
(c) Certificates of deposit;
(d) Deposits of government securities;
(e) Irrevocable letters or lines of credit; and
(f) Combinations of the above or such other types of arrangements as may be approved by the Commission. However, self insurance or any arrangement which essentially constitutes self insurance (e.g., a contract with a state or federal agency), will not satisfy the surety requirement since this provides no additional assurance other than that which already exists through license requirements.

Criterion 10—A minimum charge of $250,000 (1978 dollars) to cover the costs of long term surveillance shall be paid by each mill operator to the general treasury of the United States or to an appropriate State agency prior to the termination of a uranium or thorium mill license.

If site surveillance or control requirements at a particular site are determined, on the basis of a site-specific evaluation, to be significantly greater than those specified in Criterion 12, (e.g., if fencing is determined to be necessary) variance in funding requirements may be specified by the Commission. In any case, the total charge to cover the costs of long term surveillance shall be such that, with and assumed 1 percent annual real interest rate, the collected funds

References

- U.S. Environmental Protection Agency - Title 40 Code of Federal Regulations Part 190 - Subchapter F, "Environmental Radiation Protection Standards for Nuclear Power Operations" (40 CFR 190).

- U.S. Nuclear Regulatory Commission - Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (April 1980).

- U.S. Nuclear Regulatory Commission - Regulatory Guide 4.15, "Quality Assurance Programs for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment" (February 1979).

- U.S. Nuclear Regulatory Commission - Regulatory Guide RH#802-4, "Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations" (draft, May 1979).

- U.S. Nuclear Regulatory Commission - 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, October 1957).

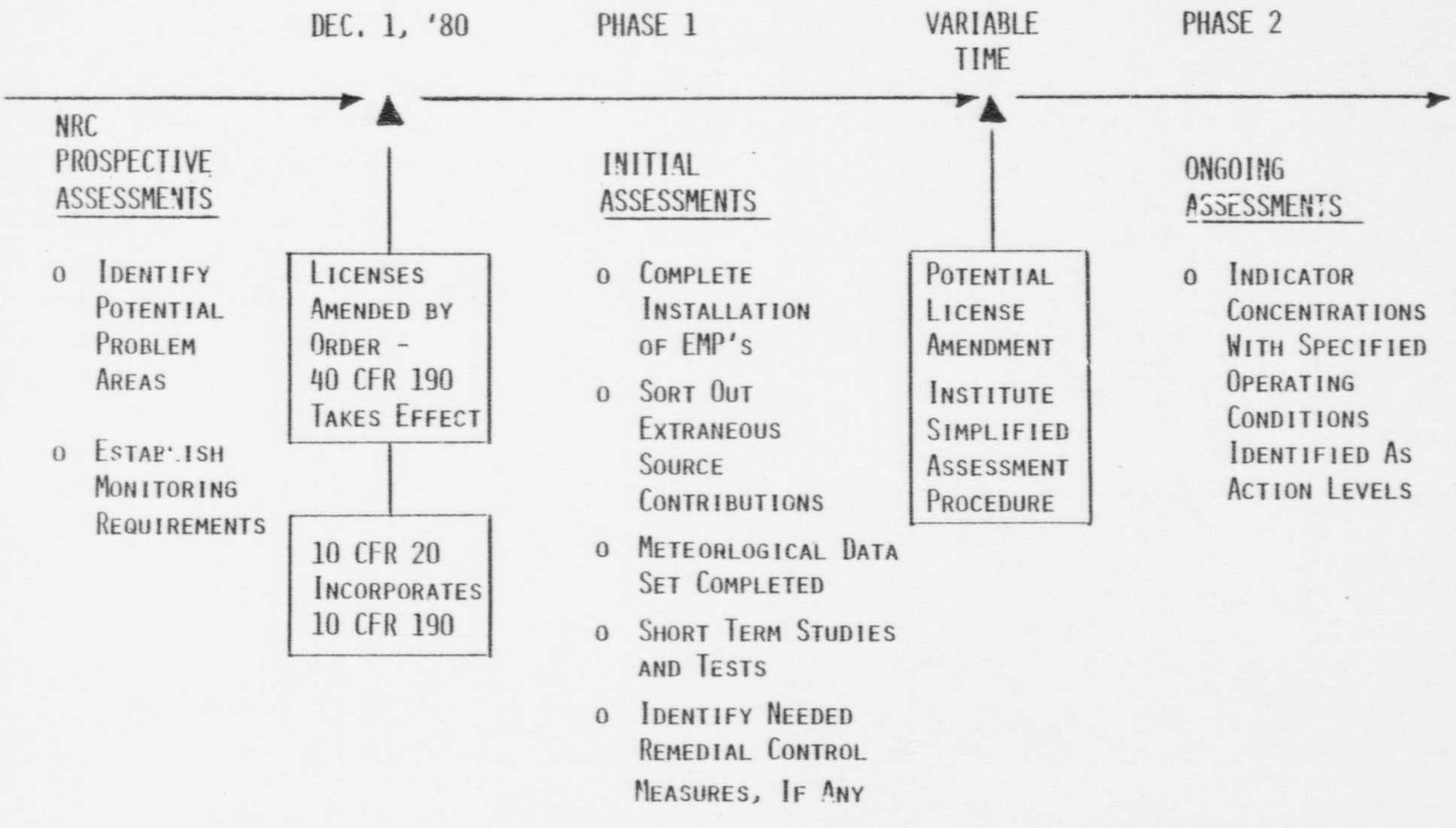
- U.S. Environmental Protection Agency - Final Environmental Statement, "40 CFR 190 Environmental Radiation Protection Requirements for Normal Operations of Activities in the Urnaium Fuel Cycle," EPA 520/4-76-016. (November 1976).

- U. S. Environmental Protection Agency - Part IV - Supplemental Analysis-1976, "Environmental Analysis of the Uranium Fuel Cycle," EPA 520/4-76-017. (July 1976).

DECEMBER 1, 1980

- 40 CFR 190 TAKES EFFECT
- ORDERS ISSUED TO ALL NRC LICENSEES
- NRC ISSUES REPORT
  - Prospective Assessment of Each Facility
- PREVIOUS COMMITMENTS CONTINUE
  - Interim Performance Objectives
  - Environmental Monitoring Programs
- REVISE 10 CFR 20 TO INCORPORATE 40 CFR 190

PHASED IMPLEMENTATION



ORDERS AMENDING LICENSES

- ENVIRONMENTAL MONITORING PROGRAM
  - Establish Program - Where No Approved Program Exists
  - Modify Existing Programs - Minor Changes In Few Cases
  - Specify Schedule For Installation - where not now installed
  - Invoke Quality Assurance Requirements - R.G. 4.15

- PERIODIC DOSE ASSESSMENTS
  - Commit Operator To Periodic Assessment Procedure
  - Reporting

- SPECIAL INFORMATION NEEDS
  - Short Term Studies
  - Meterology - Full Year's Data Where Not Currently Available
  - Identify And Characterize All Significant Nearby Extraneous Sources

- SUPPLEMENT EXISTING DUST CONTROL REQUIREMENTS
  - Written Operating Procedures
  - Weekly Inspections

NUCLEAR REGULATORY COMMISSION REPORT

- PROSPECTIVE ASSESSMENT EACH MILL
- SUPPORTING BASIS FOR ORDERS
- CONCLUSIONS
  - Existing Requirements for Emission Control Should Assure 40 CFR 190 Is Met At Each Facility
  - No Specific Additional Control Measures Appear Required
  - Additional Information Needed at Some Mills to Make Firm Conclusion
    - Current Data Anomalous or Incomplete
    - Screen Out Extraneous Sources
    - Uncertainty About Effectiveness of Controls

40 CFR 190
COVERAGE

- 25 MILLIREMS TO WHOLE BODY AND ANY OTHER ORGANS
  - Reasonable Assurance
- INCLUDES -
  - Routine Releases From Normal Operations
  - Annual Average
  - Cumulative Mill Sources
- EXCLUDES -
  - Radon and Daughters
  - Natural Background Radiation
  - Mining Operations and Associated Activities
  - Transportation
  - Decommissioning and Decontamination
  - Releases Prior To Dec. 1, 1980 and Associated Ground Contamination

CONTROL OF SOURCES

- INTERIM TAILINGS PERFORMANCE OBJECTIVES
  - Control Blowing of Tailings
  - ALARA - 10 CFR 20
  - NEPA - 10 CFR 51

- OCT. 3 - FINAL MILL REGULATIONS
  - Control Dusting from Tailings and Diffuse Sources
  - Flexibility in Methods
  - Written Operating Procedures
  - Weekly Inspections

- EMISSION CONTROL PRIMARY REQUIREMENT
  - Institutional Control Secondary
  - Strict Control Of Dusting Necessary, As GEIS Illustrates

COMPLIANCE ASSESSMENTS

- PHASED IMPLEMENTATION

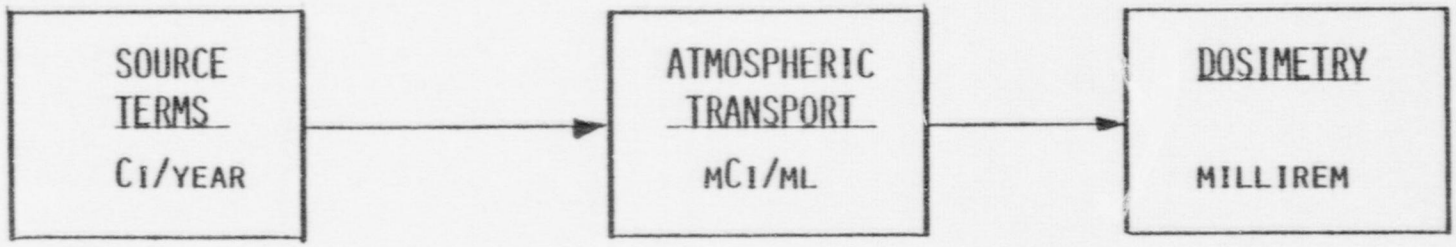
- OBJECTIVES
  - Establish Simple And Standardized Assessment Procedures And Reporting Requirements
  - Assure Consistency
    - BETWEEN MILLS
    - OVER TIME
  - Eliminate Uncertainty
    - PUBLIC
    - MILL OPERATORS
    - REGULATORY AGENCIES
    - OTHER INTERESTED AGENCIES (E.G., EPA, STATE HEALTH SERVICE)
  - Facilitate Prompt Identification Of Problems Where They Exist
  - Minimize Costs And Staff Time For Compliance Assessments

40 CFR 190
COMPLIANCE DETERMINATION

- BASED PRIMARILY ON ACTUAL MONITORING DATA
  - EMPHASIS ON AIR SAMPLING AT NEAREST RESIDENCE

- PREDICTIVE RAD ASSESSMENT MODELS WILL NOT BE BASIS
  - UNCERTAINTY IN SOURCE TERM AND ATMOSPHERIC TRANSPORT MODELS
  - NECESSARY AND VALUABLE TOOLS IN LICENSING OF PROSPECTIVE OPERATIONS
    - IDENTIFY NEEDED CONTROL MEASURES OR POTENTIAL PROBLEM AREAS
    - GUIDE DEVELOPMENT OF ENVIRONMENTAL MONITORING REQUIREMENTS
  - CODES MAY AID IN ACTUAL MONITORING DATA INTERPRETATION

MILDOS


SOURCE TERMS
Ci/YEAR
ATMOSPHERIC TRANSPORT
mCi/ML
DOSIMETRY
MILLIREM

COMPLIANCE DETERMINATION PROCEDURE

- ESTABLISH ENVIRONMENTAL MONITORING PROGRAM

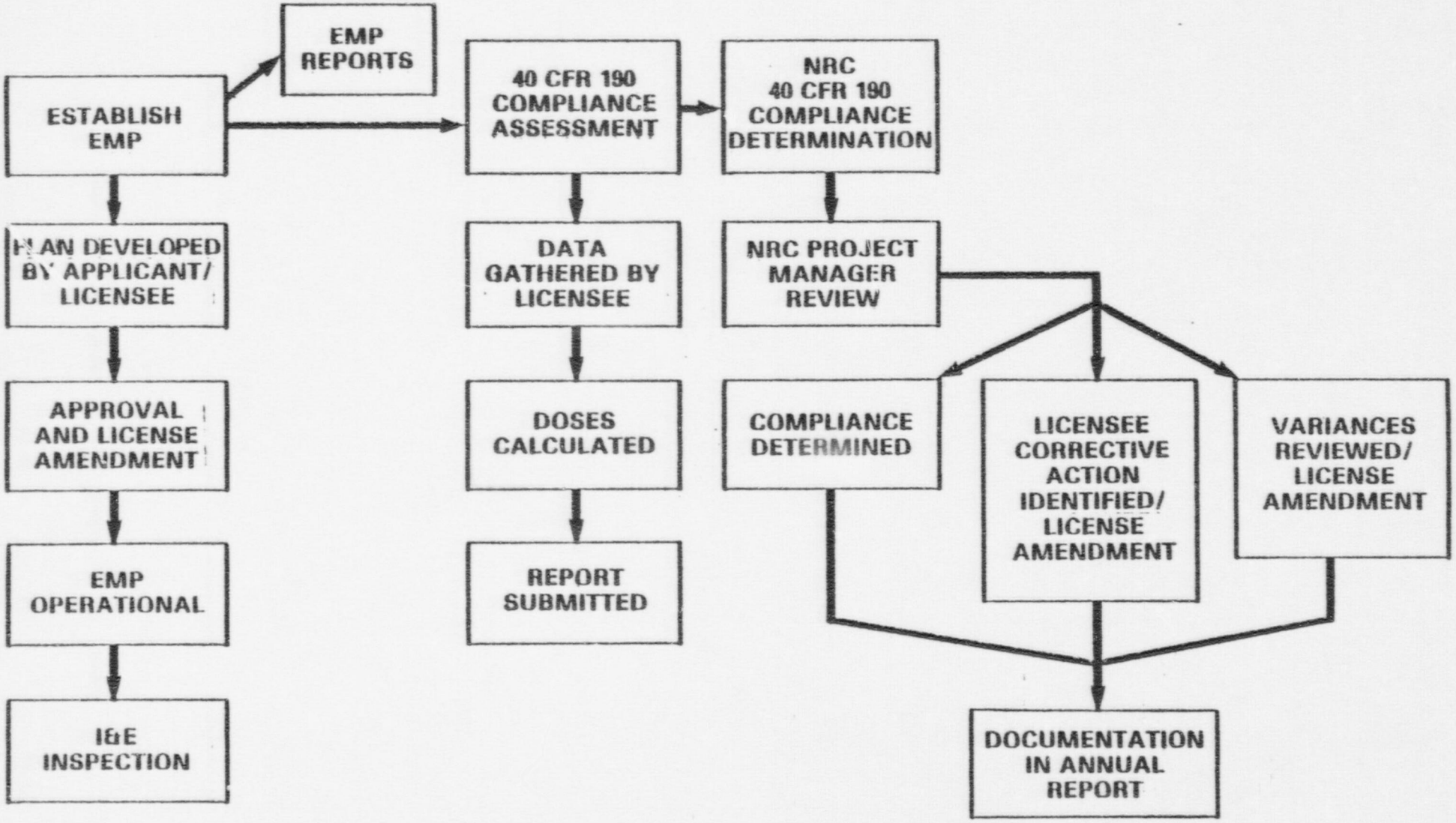
- COLLECT DATA
  - Compute Doses AT Nearest Residence
  - Subtract Dose Contribution From Extraneous Sources And Background

- COMPARE DOSE WITH STANDARD - DETERMINE COMPLIANCE
  - Identify Additional Controls, If Any Needed
  - Identify Further Monitoring, If Appropriate

- REPORT TO NRC

FIGURE 1

40 CFR 190
COMPLIANCE DETERMINATION PROCEDURE
(BASED ON ACTUAL ENVIRONMENTAL MONITORING DATA)



ONGOING COMPLIANCE DETERMINATION - PHASE 2

- SIMPLE, STANDARDIZED PROCEDURE
- POINT OF RECEPTOR CONCENTRATION OR DOSE ACTION LEVELS ESTABLISHED
  - BASED ON PHASE 1 MONITORING AND ANALYSIS
  - MAY BE HIGHER THAN 25 MILLIREM
  - COMBINED WITH PRESCRIBED CONTROL MEASURES
  - NO SIGNIFICANT CHANGES IN LOCAL LAND USE OR NEARBY ACTIVITIES
- SIMPLIFIED PROGRAM IMPLEMENTED THROUGH LICENSE AMENDMENTS

MONITORING AND ASSESSMENTS - PHASE 1

- COMPLETE INSTALLATION OF EMP'S
  - FINE TUNING
  - QUALITY ASSURANCE - R.G. 4.15

- SORT OUT EXTRANEOUS SOURCE CONTRIBUTION
  - IDENTIFY MINING AREAS, ORE STORAGE PADS, TRANSPORTATION ROUTES, ETC.

- ESTABLISH SUPPLEMENTAL AIR PARTICULATE SAMPLING STATION
  - SHORT TERM SAMPLING
  - LIMITED ANALYSIS
  - CORRELATION OF METEROLOGICAL DATA

- RE-EVALUATION OF DOSE ESTIMATES - ESTABLISH SIMPLIFIED CONCENTRATION OR DOSE ACTION LEVELS

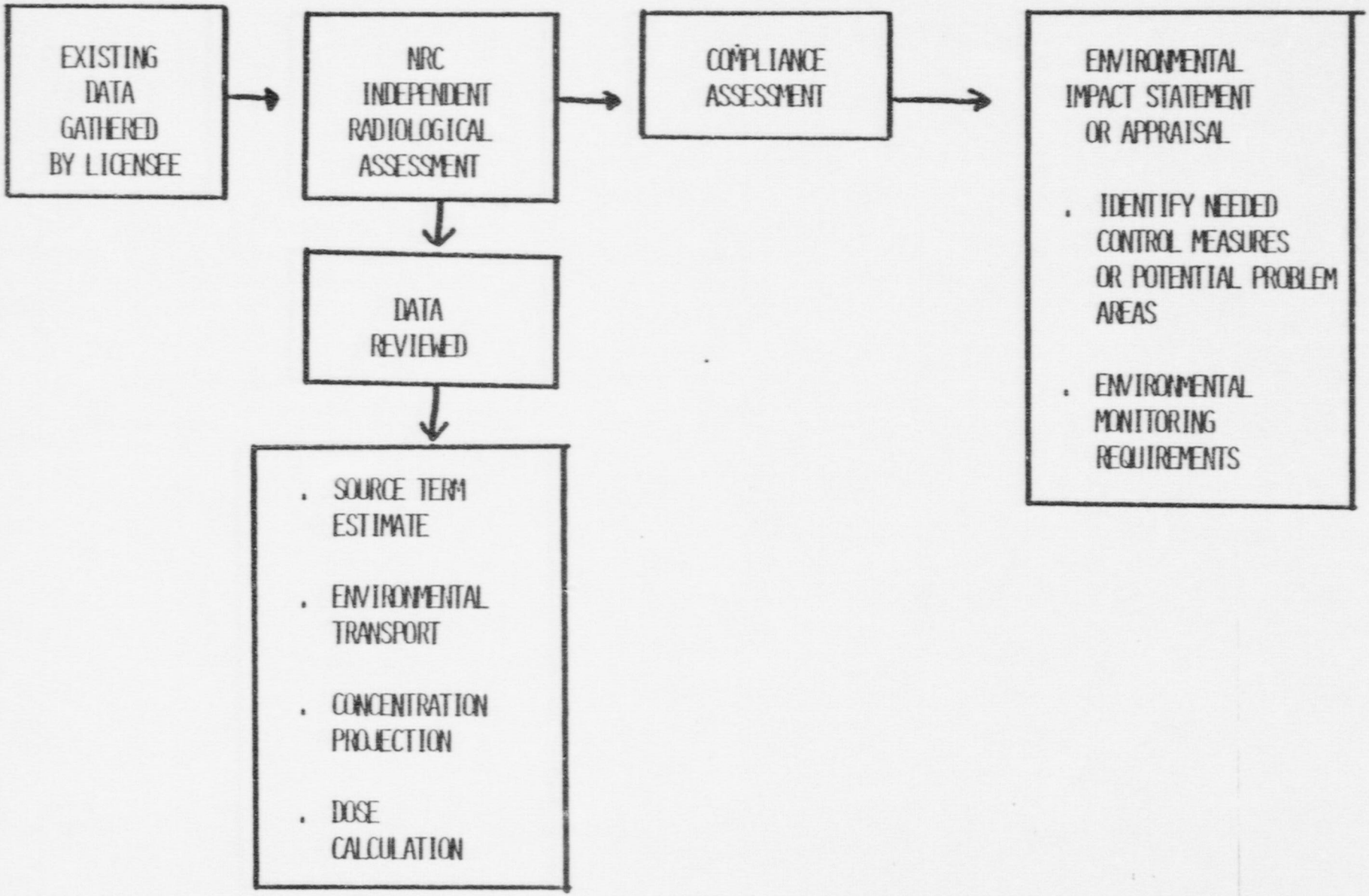
REPORTING REQUIREMENTS

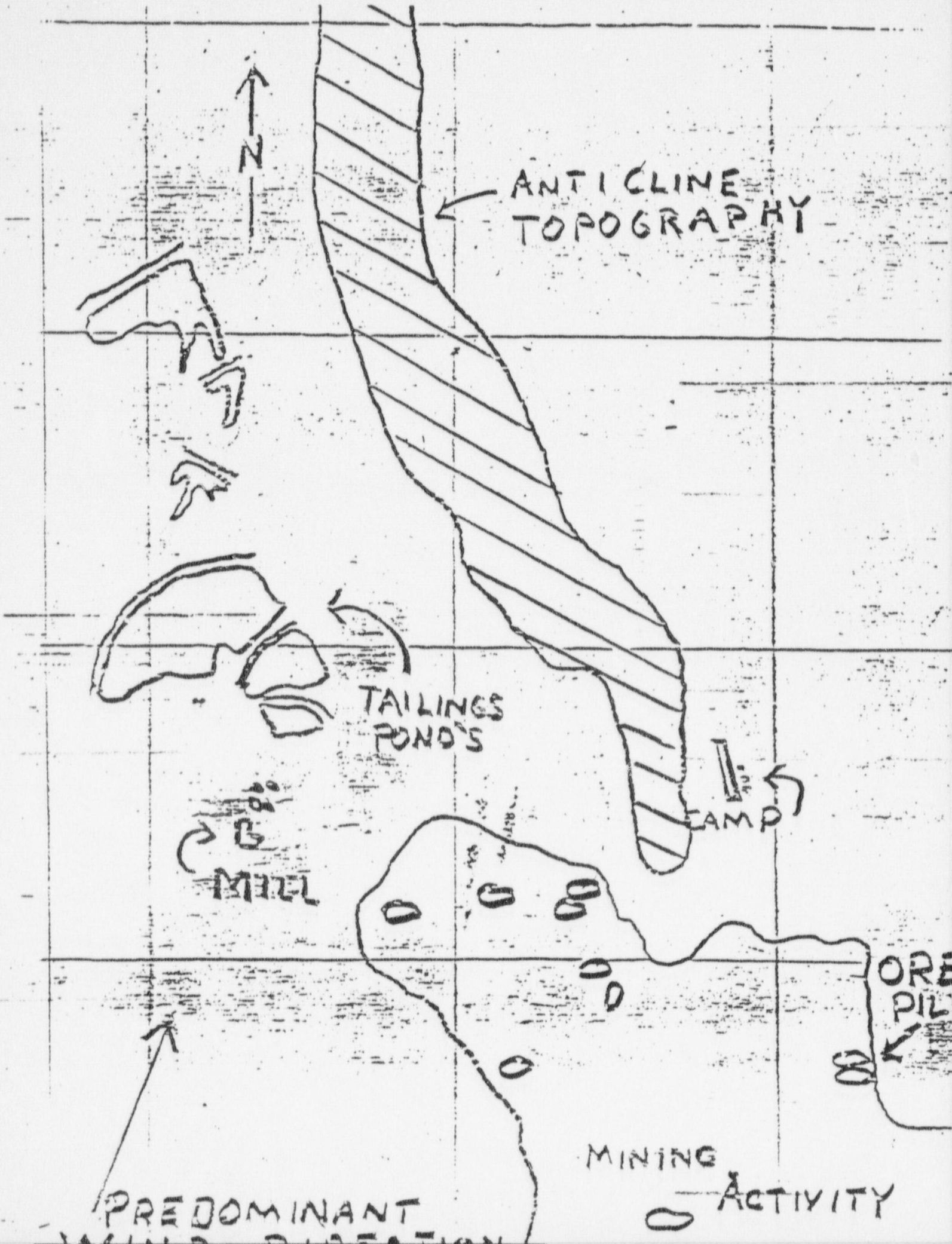
	PHASE 1	PHASE 2
ROUTINE REPORTING	QUARTERLY (60 DAYS AFTER QUARTER END)	SEMI ANNUALLY (60 DAYS AFTER 1 JULY AND 1 JAN) 10 CFR 40.65
o IN REG GUIDE 4.14 FORMAT		
o MEETING WMUR COMPLIANCE DETERMINATION PROCEDURE		
NON-COMPLIANCE REPORTING	NONE	30 DAYS AFTER DETERMINATION
o PURSUANT TO 10 CFR 20		

REGULATORY GUIDANCE

- ENVIRONMENTAL MONITORING PROGRAM - R.G. 4.14
- QUALITY ASSURANCE - R.G. 4.15
- DOSE CALCULATIONS - R.G. 302-4
- MILDOS CODE USER'S MANUAL

FIGURE 2
NRC 40 CFR 190 ASSESSMENT OF PROSPECTIVE
MILLING OPERATIONS (BASED ON PREDICTIVE MODELING)




N
ANTICLINE
TOPOGRAPHY
TAILINGS
POND'S
CAMP
MILL
ORE
PIL
MINING
ACTIVITY
PREDOMINANT

MILDOS COMPUTER CODE GENERATED 50-YEAR DOSE COMMITMENTS (in mrem) FROM TYPICAL MILL

	WHOLE BODY	BONE	LUNG
Direct Exposure Pathway			
o Inhalation	0.173	5.21	7.78
o External Gamma	0.005	0.005	0.005
Ingestion Exposure Pathway			
o Vegetable Intake (1)	0.713	8.60	0.713
o Meat Intake (2)	1.40	17.50	1.40
TOTAL	2.30	31.3	9.90

(1) Vegetables are assumed to be grown in local gardens and the nearest resident is assumed to consume only such vegetables.

(2) Meat ingestion was assumed to be from locally grazed livestock.

ACTUAL ENVIRONMENTAL MONITORING
PROGRAM DATA FOR A TYPICAL MILL

LOCATION	ANNUAL AVERAGE CONCENTRATION pCi/m^3		50-YEAR DOSE COMMITMENT (in mrem)		
			Whole Body	Bone	Lung
Off-Site Nearest Residence - S	U-nat.	= 0.0142	0.0656	1.13	2.40
	Ra-226	= 0.0080	0.247	2.47	52.9
	Th-230	= 0.0085	1.41	50.6	27.4
	Pb-210	= 0.0536	0.234	7.24	41.4
	TOTAL	=	1.96	61.4	124
Off-Site Nearest Residence - N	U-nat.	= 0.0084	0.0388	0.667	1.42
	Ra-226	= 0.0052	0.161	1.61	34.4
	Th-230	= 0.0031	0.515	18.4	9.98
	Pb-210	= 0.0460	0.201	6.21	35.5
	TOTAL	=	0.915	26.9	81.3

DOSE CONVERSION FACTORS FOR THE INHALATION OF AIRBORNE PARTICULATES (MilliRem per pCi/m^3)*

Radionuclide	Whole Body	Bone	Lung
U-238	4.32	79.2	158
U-234	4.92	79.5	180
U-natural	4.62	79.4	169
Th-230	166	5950	3220
Ra-226	30.9	309	6110
Pb-210	4.36	135	772
Po-210	0.47	1.92	420

*The 50-year dose commitment for each year of exposure to 1 pCi/m^3 of each radionuclide for an adult breathing rate of 20 m^3/day. Particle size of 1.55 μm AMAD (i.e., mean diameter of 1 μm and density of 2.4 g/cm^3) being representative of uranium ore. The Quality Factor for alpha radiations is 10. The total dose per organ is the summation of doses due to each radionuclide. (Regulatory Guide RH#802-4).

EXAMPLE EMP MODIFICATIONS

- INVENTORY OF SOURCES
  - IDENTIFY MINING AREAS, ORE STORAGE PADS, TRANSPORTATION ROUTES, ETC.

- ESTABLISH SUPPLEMENTAL AIR PARTICULATE SAMPLING STATION
  - SHORT TERM SAMPLING
  - LIMITED ANALYSIS
  - CORRELATION OF METEORLOGICAL DATA

- REVIEW DATA

- RE-EVALUATION OF DOSE ESTIMATES

PRELIMINARY DATA

COMPOSITE 50-YEAR DOSE COMMITMENTS TO THE INDIVIDUAL RECEIVING MAXIMUM EXPOSURE, FOR ONE YEAR, FOR EACH MILLING FACILITY

Facility	Composite Dose Commitments, mrem: Whole Body	Bone	Lung	Date and Method of Dose Prediction	Reference
1	2.4	74.8	34.6	January 1979, UDAD and HERMES Codes	FES NUREG-0453 Table 4.4
2	.486	6.14	.782	July 1979, MILDOS Code	IEA Table 4 (REF ##)
3	1.22	15.0	6.83	September 1980, MILDOS Code	Appendix 6
4	.799	17.5	22.3	September 1980 MILDOS Code	Appendix 2
5	2.37	16.0	3.22	May 1979, UDAD Code	FES NUREG-0556 Table 4.6
6	.0081	.0831	.038	July 1979, MILDOS Code	Appendix 6
7	1.58	22.7	9.2	September 1980, MILDOS Code	Appendix 1
8	.914	14.5	9.34	September 1980, MILDOS Code	Appendix 3
9	.709	10.4	5.35	September 1980, MILDOS Code	Appendix 4
10	1.57	8.98	8.09	July 1979, UDAD Code	FES NUREG-0583, Table 4.5
11	1.96	45.0*	61.1*	September 1980*, MILDOS Code	Appendix 5
12	0.97	1.81	12.4	July 1980, MILDOS Code	FES NUREG-0702 Table 4.6
13	.08	.34	.28	February 1979, UDAD and HERMES Codes	FES NUREG-0532, Table 4.2
14	2.0	11.5	24.2	February 1980, UDAD and HERMES Codes	FES NUREG-0639 Table 4.9

*Based on overestimate of source terms in initial computer run. Being rerun; expect at least 50% reduction in estimated levels.

PRELIMINARY DATA

DIRECT EXPOSURE AND INGESTION EXPOSURE PATHWAYS DOSE COMMITMENTS FOR EACH MILLING FACILITY

Facility	Location of Individual Receiving Maximum Direct Exposure Dose	Direct Exposure Dose Commitment, mrem			Location Corresponding to Maximum Ingestion Dose	Ingestion Exposure Dose Commitment, mrem		
		Whole Body	Bone	Lung		Whole Body	Bone	Lung
1	8 km E	2.0	74.4	29.6	Grazing 2.7 km SE-Meat	.4	.4	5.0
2	716 km NE	.020	.373	.316	Veg.+Grazing 1.4 km NE-Meat	.466	5.77	.466
3	4.3 km NE	.107	3.26	5.72	Grazing, .5 km W	1.11	11.7	1.11
4	.55 km WNW	.421	12.8	21.9	Grazing 1.24 km NE-Meat	.378	4.71	.378
5	4.5 km NNE	1.03	1.99	1.88	4.5 km NNE-Veg + 1.9 km N-Meat	1.34	14.0	1.34
6	35 km NE	.0021	.0071	.032	Grazing 2.5 km NE-Meat	.006	.076	.006
7	3.1 ENE	.179	5.22	7.79	Grazing 1.9 km NE-Meat	1.4	17.5	1.4
8	4.8 km E	.176	5.24	8.6	Grazing 1.81 km NNW-Meat	.738	9.21	.738
9	3.2 km S	.091	2.77	4.73	Grazing 1.68 km NE-Meat	.618	7.65	.618
10	5.6 km N	.830	4.31	7.35	4.2 km SSW Meat + Veg	.738	7.67	.738
11	2.5 km NW	1.11	34.3*	60.2*	Grazing .4 km SE	.852	10.7*	.852
12	8.7 km NE	.03	.65	.87	Veg. + 1.4 km ENE-Meat	0.94	11.7	0.94
13	10 km N	.06	.08	.26	Veg. + 13 km NW-Meat	.02	.26	.02
14	2 km N	Unavailable			Veg. + grazing 2.7 km ENE-Meat	Unavailable		

*Based on overestimate of source terms in initial computer run. Being rerun; expect at least 50% reduction in estimated levels.

TABLE 2

OPERATIONAL RADIOLOGICAL MONITORING PROGRAM FOR URANIUM MILLS

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
STACKS						
Particulates	One for each stack	Yellowcake dryer and packaging stack(s)	Isokinetic	Quarterly	Each sample	Natural uranium, Th-230, Ra-226, and Pb-210 if not available from other sources. Measure stack flow rate semiannually.
Particulates	One for each stack	Other stacks	Representative grab	Semiannually	Each sample	Natural uranium Th-230, Ra-226, and Pb-210. Measure stack flow.
AIR						
Particulates	Three	locations at or near the site boundaries and in different sectors that have the highest predicted concentrations of airborne particulates[b]	Continuous[a]	Weekly filter change, or more frequently as required by dust loading	Quarterly composite, by location, of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	One or more	At the nearest residence(s) or occupiable structure(s)	Continuous	Weekly filter change, or more frequently as required by dust loading	Quarterly composite, by location, of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	One	Control location(s)[c]	Continuous	Weekly filter change, or more frequently as required by dust loading	Quarterly composite, by location, of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
Radon Gas	Five or more	Same locations as for air particulates	Continuous or at least one week per month[d]	At least one week per calendar month representing approximately the same period each month	Monthly	Rn-222
WATER						
Ground Water	Three or more	Hydrologically down gradient and relatively close to the tailings impoundment[f]	Grab	Monthly (first year) Quarterly (after first year)	Monthly (first year) Quarterly (after first year)	Dissolved natural uranium, Ra-226, Th-230, Pb-210, and Po-210[e]
	At least one control sample	Hydrologically up gradient (i.e., not influenced by seepage from tailings)	Grab	Quarterly	Quarterly	Dissolved natural uranium, Ra-226, Th-230, Pb-210 and Po-210

4-44-13

TABLE 2 (Continued)

OPERATIONAL RADIOLOGICAL MONITORING PROGRAM FOR URANIUM MILLS

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
	One from each well	Each well used for drinking water or watering of livestock or crops within 2 km of the tailings impoundment	Grab	Quarterly	Quarterly	Dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210, and Po-210
Surface Water	Two from each water body	Surface waters passing through the mill site or offsite surface waters that are sufficiently close to the site to be subject to surface drainage from potentially contaminated areas or that could be influenced by seepage from the tailings disposal area.(b) One sample collected upstream of mill site and one sample collected at the downstream site boundary or at a location immediately downstream of location of potential influence	Grab	Quarterly	Quarterly	Dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210, and Po-210(g)
	One from each water body	Large water impoundments (i.e., lakes, reservoirs) near the mill site that are sufficiently close to the site to be subject to drainage from potentially contaminated areas or that could be influenced by seepage from the tailings disposal area.	Grab	Quarterly	Quarterly	Dissolved and suspended natural uranium, Ra-226, Th-230, Pb-210, and Po-210
VEGETATION, FOOD, AND FISH						
Vegetation or Forage(c)	Three or more	From animal grazing areas near the mill site in the direction of the highest predicted airborne radionuclide concentrations	Grab	Three times during grazing season	Each sample	Ra-226 and Pb-210

TABLE 2 (Continued)

OPERATIONAL RADIOLOGICAL MONITORING PROGRAM FOR URANIUM MILLS

Type of Sample	Sample Collection				Sample Analysis	
	Number	Location	Method	Frequency	Frequency	Type of Analysis
Food	Three of each type	Crops, livestock, etc. raised within 3 km of mill site	Grab	Time of harvest or slaughter	Once	Ra-226 and Pb-210
Fish	Each body of water	Collection of fish (if any) from lakes, rivers, and streams in the site environs that may be subject to seepage or direct surface runoff from potentially contaminated areas or that could be affected by a tailings impoundment failure	Grab	Semiannually	Twice	Ra-226 and Pb-210
SOIL AND SEDIMENT						
Soil	Five or more	Same as for air particulate samples[k]	Grab	Annually	Annually	Natural uranium, Ra-226, and Pb-210
Sediment	One or two from each water body	Same as surface water samples[m]	Grab	Annually	Annually	Natural uranium, Th-230, Ra-226, and Pb-210
DIRECT RADIATION	Five or more	Same as for air particulate samples	Continuous passive integrating device	Quarterly change of passive dosimeters	Quarterly	Gamma exposure rate

Footnotes for Tables 1 and 2:

(a) Continuous collection means continuous sampler operation with filter change weekly or as required by dust loading, whichever is more frequent.

(b) The term "nearest" as used here means the location with the highest predicted airborne radionuclide concentrations during milling operations.

(c) Care should be taken in selection of the control sampling location so that it is representative of the site conditions. In general, a location in the least prevalent wind direction from the site should provide a suitable location for a control sampling site.

(d) Various methods are acceptable; for example: (1) Continuous collection of a gaseous air sample with samples being changed about every 48 hours for a 1-week period or (2) continuous sampling.

(e) If the sample contains appreciable suspended material, it should be filtered as soon as possible following collection through a membrane filter and the filtrate acidified to 1% hydrochloric acid.

(f) The location of the ground-water sampling wells should be determined by a hydrological analysis of the potential movement of seepage from the tailings disposal area. In general, the objective is to place monitor wells in all directions around the tailings area with the emphasis on the down gradient locations.

(g) Surface-water samples to be analyzed for dissolved and suspended fractions should be filtered as soon as possible following collection through a membrane filter and the filtrate acidified to 1% hydrochloric acid.

(h) Natural drainage systems (dry washes) that carry surface runoff from the site following a precipitation event should be sampled following the event but at a frequency not greater than monthly.

(i) The milling area refers to the area that includes ore storage pads, mill buildings, and other processing areas.

(j) Thermoluminescent dosimeters should contain two or more chips or otherwise provide for two readings per exposure period (see Regulatory Guide 4.13).

(k) Surface soil samples should be collected using a consistent technique to a depth of 5 cm.

(l) Subsurface soil profile samples should be collected to a depth of one meter. Samples should be divided into three equal sections for analysis.

(m) Several samples should be collected at each location and composited for a representative sample.

(n) Radon exhalation measurements should not be taken during periods when the ground is frozen or covered with ice or snow or following periods of rain. It is recommended that these measurements be taken in the spring through the fall during normal weather conditions.

(o) Vegetation or forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway (an exposure pathway should be considered important if the predicted dose to an individual would exceed 5% of the applicable radiation protection standard).

TABLE 3[a]

SAMPLE FORMAT FOR REPORTING MONITORING DATA

1. STACK SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Stack flow rate (m^3/sec)

Radionuclide	Concentration (μCi/ml)	Error Estimate[b] (μCi/ml)	Release Rate (Ci/qr)	Error Estimate (Ci/qr)	LLD[c] (μCi/ml)	% MPC[c]
U-nat						
Th-230						
Ra-226						
Pb-210						

2. AIR SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection

Radionuclide	Concentration (μCi/ml)	Error Estimate (μCi/ml)	LLD (μCi/ml)	% MPC
U-nat				
Th-230				
Ra-226				
Pb-210				
Rn-222				

(a) This table illustrates format only. It is not a complete list of data to be reported. (See text of guide and Tables 1 and 2.)

(b) Error estimate should be calculated at 95% uncertainty level, based on all sources of random error, not merely counting error. Significant systematic error should be reported separately. See Sections 6.1, 7.1.4, and 7.3.

(c) All calculations of lower limits of detection (LLD) and percentages of maximum permissible concentration (MPC) should be included as supplemental information.

TABLE 3 (Continued)

SAMPLE FORMAT FOR REPORTING MONITORING DATA

3. LIQUID SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Type of sample (for example: surface, ground, drinking, stock, or irrigation)

Radionuclide	Concentration (μCi/ml)	Error Estimate (μCi/ml)	LLD (μCi/ml)
U-nat (dissolved)			
U-nat (suspended)[d]			
Th-230 (dissolved)			
Th-230 (suspended)[d]			
Ra-226 (dissolved)			
Ra-226 (suspended)[d]			
Pb-210 (dissolved)			
Pb-210 (suspended)[d]			
Po-210 (dissolved)			
Po-210 (suspended)[d]			

4. VEGETATION, FOOD, AND FISH SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Type of sample and portion analyzed

Radionuclide	Concentration (μCi/kg wet)	Error Estimate (μCi/kg)	LLD (μCi/kg)
U-nat			
Th-230			
Ra-226			
Pb-210			
Po-210			

[d] But all samples must be analyzed for suspended radionuclides. See Sections 1.2 and 2.2 of this guide.

TABLE 3 (Continued)

SAMPLE FORMAT FOR REPORTING MONITORING DATA

5. SOIL AND SEDIMENT SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Type of sample and portion analyzed

Radionuclide	Concentration (μCi/g)	Error Estimate (μCi/g)	LLD (μCi/g)
U-nat			
Th-230			
Ra-226			
Pb-210			
Po-210			

6. DIRECT RADIATION MEASUREMENTS

For each measurement, report the dates covered by the measurement and the following information:

Location	Exposure Rate (mR/qr)	Error Estimate (mR/qr)

7. RADON FLUX MEASUREMENTS

For each measurement, report the dates covered by the measurement and the following information:

Location	Flux (pCi/m²-sec)	Error Estimate (pCi/m²-sec)

4.1-18

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COMPLIANCE DETERMINATION PROCEDURES FOR ENVIRONMENTAL, RADIATION PROTECTION STANDARDS FOR URANIUM RECOVERY FACILITIES

40 CFR 190

U. S. Nuclear Regulatory Commission

Division of Waste Management

Uranium Recovery Licensing Branch

November, 1980

Title: Compliance Determination Procedures for Environmental Radiation Protection Standards for Uranium Recovery Facilities - 40 CFR 190

Background

Under Title 40 Code of Federal Regulations Part 190 - Subchapter F - Radiation Protection Programs, the U.S. Environmental Protection Agency (EPA) promulgated "Environmental Radiation Protection Standards for Nuclear Power Operations" which provides limits for the radiation doses received by members of the public in the general environment as the result of operations which are part of the nuclear fuel cycle. Effective December 1, 1980, each uranium milling facility* shall conduct its operations in such a manner to assure that the annual radiation dose equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public is not exceeded. However, the dose from radon and its daughters is excluded from these doses. The following discussion briefly describes the Nuclear Regulatory Commission's (NRC) program for compliance determination for uranium recovery facilities. In April, 1980, the NRC published a proposed amendment to 10 CFR Part 20 "Environmental Radiation Protection Standards for Nuclear Power Operations" and will shortly finalize this amendment which requires that a NRC licensee shall comply with 40 CFR 190. This program is also meant to serve as guidance for the Agreement States in their implementation of 40 CFR 190.

As illustrated by radiological assessments performed in the uranium milling generic environmental impact statement (GEIS), 40 CFR 190 compliance will be achieved only by strict emission controls at the mill. The most significant sources of emissions are the tailings ponds/piles and the yellowcake dryer stacks. The NRC has made strict emission control a specific license condition in its licensing activities over the past several years; and it has been an NRC requirement that exposure limits be met by emission controls to the maximum extent reasonably achievable. Such emission control requirements are contained in the May, 1977 NRC staff position on "Tailings Management Performance Objectives" and in the final regulations on uranium milling issued in the Federal Register on October 3, 1980. A copy of the criteria in these regulations covering emission controls is attached as Appendix B. Certainly land use control, e.g., expanding the buffer zone around a mill site, cannot exclusively be used as a substitute for reducing actual emissions from the various milling processes. The primary means of meeting exposure limits must be by emission control.

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*All uranium extraction facilities; to include mills, in-situ operations and heap leach facilities. (R&D facilities are not included here since initial assessments indicate that their size and potential radiological impact are insignificant; e.g., R&D in-situ operations in general have no airborne particulate releases.)

There are inherent problems in accurately determining source terms, particularly from large area sources such as the tailings impoundments. Also, there are significant uncertainties in the atmospheric transport models used to compute airborne radioactivity concentrations given a source term, particularly where there is irregular terrain. Therefore, the primary means of determining compliance must be by measurements made at the point of receptor and the procedures outlined below reflect this. On the other hand, compliance cannot reasonably be determined and corrective action taken where necessary, by inflexibly and rigidly considering point of receptor data alone. Therefore, environmental measurements at other locations near the mill and at background locations, effluent sampling, meteorologic data, and other similar information must be available to supplement point of receptor data. Such supplemental information is required most in cases where computed doses approach or exceed the limit. Other monitoring data will be necessary, for example, to screen out effects of mines that may be nearby and may be contributing to dose.

By no means will the mere assertion that the mill operations utilize emission controls suffice to show compliance to 40 CFR 190 exposure limits. The licensee must provide some supportable dose assessments based on actual environmental monitoring data which are compatible with the procedures discussed below.

Procedure

The ultimate goal of this program is to establish a standardized procedure which will be used to assess compliance subsequent to the establishment of each licensee's Environmental Monitoring Program (EMP). It will realistically require as much as a year's worth of effluent and environmental monitoring to firmly establish whether compliance exists at mills which are close to the limit or where there are significant nearby sources of radioactive emissions such as mines, which are not covered by the standard. Much of this time will be spent on the fine tuning of the monitoring and analysis program that is normally required in setting up such programs to assure they are operating properly and producing reliable data. It will also take some time to sort out the contributions being made by other sources. This may require some short-term, special environmental measurements. Special studies of the effectiveness of selected emission control measures may be required. These evaluations may be supplemented by computer assessments as needed and appropriate.

Eventually, it is anticipated that concentration and dose action levels (which may even be higher than 25 millirems accounting for contributions from other sources) will be established in combination with specific control measures and levels as the threshold for determining compliance with the standard. This will reduce costs of implementation, eliminate

uncertainty on the part of the licensee, regulatory agency and the public (particularly in cases where there are significant extraneous sources), and assure that the need for remedial action is identified most expeditiously if it exists.

Before environmental monitoring data is available, which is the situation in licensing of new facilities or in authorizing significant modification to existing ones, predictive models must be utilized to evaluate the potential impacts of the prospective new operations. Use of predictive models, in addition to consideration of what limited environmental data exists, is also being used by the staff in the initial 40 CFR 190 implementation efforts in December of 1980. Predictive modeling assessments of radioactivity concentrations to which nearby individuals may be exposed involve making numerous assumptions and simplifications about important, but frequently uncertain, factors such as mill releases and atmospheric transport; for this reason, as discussed above, actual compliance determination will be based on environmental monitoring data which indicate directly what such concentrations are. Predictive models, however, are necessary and valuable tools in evaluating what emission controls are likely necessary, in identifying potential problem areas, and in establishing environmental monitoring requirements.

The following describes the procedures which shall be followed in (A) determining compliance with 40 CFR 190 based on environmental monitoring data, and (B) assessing proposed operations in term of their ability to meet 40 CFR 190.

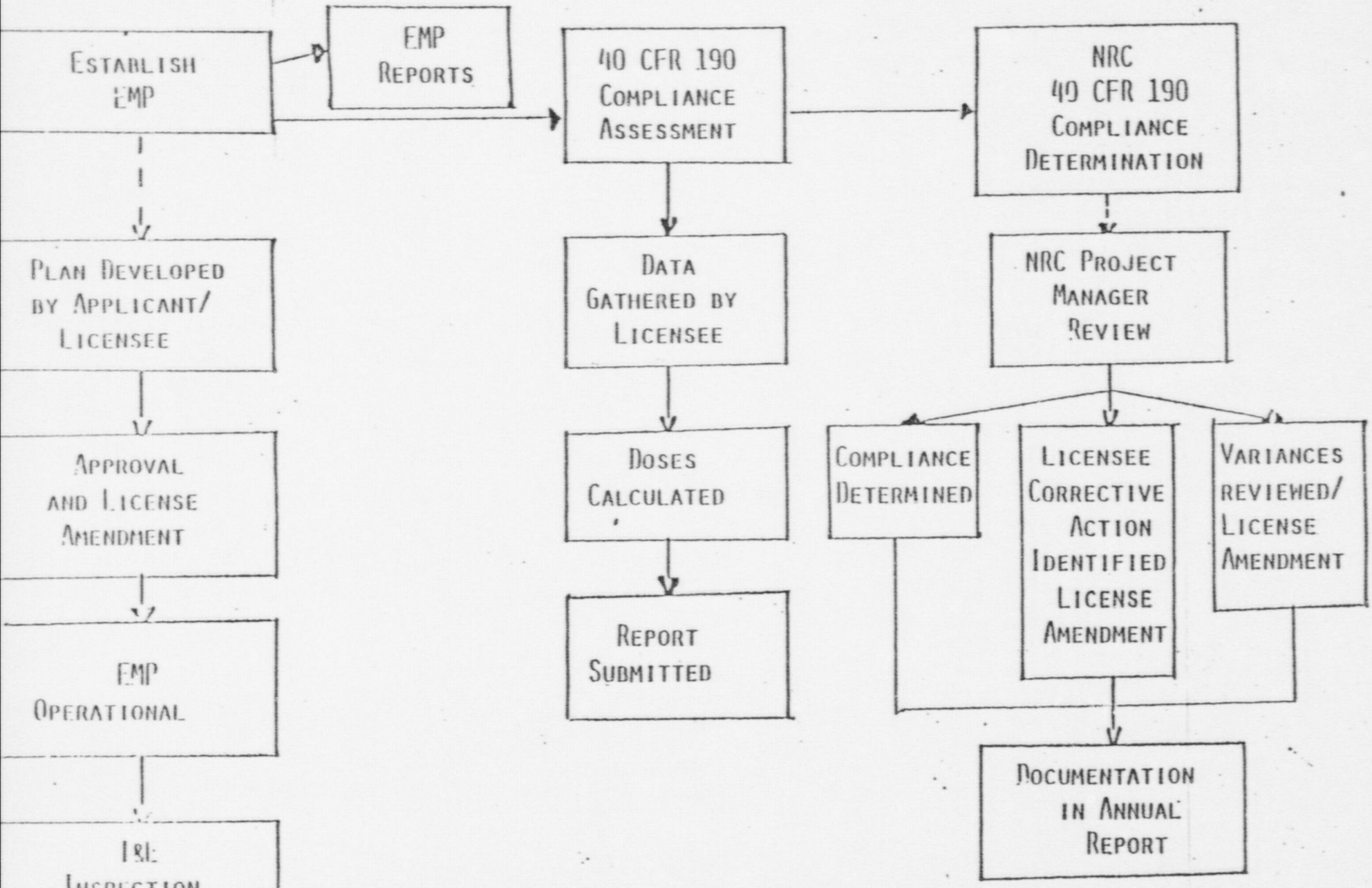
A. Assessment of Actual Environmental Monitoring Data

Figure 1 - "40 CFR 190 Compliance Determination Procedure" shows a diagram of the various steps to be followed to ultimately assure compliance to 40 CFR 190 for all licensing applications.

1. Each licensee shall establish an Environmental Monitoring Program (EMP) consistent with NRC's Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (April 1980). This document provides specific details for both a pre-operational and the operational monitoring programs which are considered adequate by the staff to obtain the necessary information to be used by the licensee to estimate the maximum potential annual radiation dose to any member of the general public as a result of actually measured mill effluent releases. In order to establish such an acceptable EMP, each applicant/licensee shall be required to:

   a. Develop an EMP and submit a plan to the NRC for review and approval. Such a plan shall include specific details of the number, location, collection method (i.e., equipment), sampling frequency and analysis information for all

FIGURE 1
40 CFR 190
COMPLIANCE DETERMINATION PROCEDURE
(BASED ON ACTUAL ENVIRONMENTAL MONITORING DATA)



sample types (e.g., air particulate, radon/WL, stack samples, surface and ground waters, vegetation, food, fish, soil, and direct radiation). For each site (including existing mills), at least one year of site specific meteorological data; e.g., wind speed and direction, stability class, etc., shall be collected, summarized, and reported. A site map, including all affected off-site areas, showing each point of sample collection shall also be provided. Participation in a Quality Assurance Program (QAP) as described in NRC's Regulatory Guide 4.15, "Quality Assurance Programs for Radiological Monitoring Programs (Normal Operations) -Effluent Streams and the Environment" (February 1979) shall also be discussed in the EMP plan.

b. Upon NRC's review and approval, the EMP shall be added to the license and any subsequent change or modification of the approved EMP shall require that a specific license amendment be initiated by the licensee.

c. The EMP plan shall provide a time schedule providing the date when each phase of the EMP will become operational. For new license applicants, at least one year of pre-operational monitoring shall be required. For existing facilities, a realistic time schedule shall be implemented; however, all phases of the EMP shall be operational within 120 days of NRC's approval of the EMP plan.

d. The NRC's Office of Inspection and Enforcement shall conduct periodic on-site inspections of both the actual environmental monitoring systems/locations, as well as all reports and records of such an EMP to ensure that the actual operations of the EMP are within the approved EMP license condition.

2. Each licensee shall provide an EMP report every six months, as required in 10 CFR 40.65, "Effluent Monitoring Reporting Requirements." The report should contain the specific information as outlined in Section 7 "Recording and Reporting Results" of NRC's Regulatory Guide 4.14, supra.

3. As a license condition, each license shall be required to submit, in conjunction with its every six months EMP report (EMPR), its own 40 CFR 190 compliance assessment for NRC review and action, as described below.

a. Such an assessment shall be based on data gathered by the licensee from the approved EMP as discussed above. Such data gathering shall include a semiannual survey of land use (i.e., residences, grazing, water wells, etc.) in the area within 8 km (5 miles) of the mill. Any difference in land use from that previously reported shall be discussed and evaluated with respect to 40 CFR 190 compliance. In order to minimize records keeping and formal reporting requirements, while still maintaining a reasonable and timely review of the EMP, annual averages based on the immediate past two consecutive six month reporting periods shall be used for the compliance assessment and reporting requirements.

b. Dose evaluation using site specific input parameters shall be completed using the standardized procedures delineated in Attachment A - "Dose Calculational Guidance", which are based on NRC's draft Regulatory Guide RH#802-4, "Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations". These attached tables are provided to allow the rapid dose calculational assessment of environmental monitoring data. Variations in specific assumptions made in Attachment A will be considered by the staff upon request.

c. As necessary, a licensee shall indicate in the report what corrective action is being taken if non-compliance is determined. Each licensee shall complete its initial 40 CFR 190 compliance assessment and shall submit its EMP report for NRC review and approval prior to January 1, 1982; and subsequently withing 60 days after January 1 and July 1 of each year thereafter, so long as the license is active.

4. Once each year, the NRC shall review and complete its own independent determination of each licensee's EMPR and 40 CFR 190 compliance assessment. Such a review shall consider the influence of extraneous sources (e.g., mining and transportation activities) and any anomalous data (e.g., the indication of erroneous data generated during sample collection or sample analysis).

a. The NRC Project Manager (PM) shall review all submittals, and shall primarily be responsible for all approvals, license amendments and verification of 40 CFR 190 compliance.

i. Upon determination of compliance to 40 CFR 190, the PM will document such findings via a brief Memorandum to File (standardized form memo) for the subject license within 30 days of receipt of reports submitted under 3(c).

ii. Upon determination of non-compliance to 40 CFR 190, the PM shall assure that the licensee take any necessary corrective actions and shall issue specific license amendments as required to accomplish this.

iii. The PM shall review any variance request per 40 CFR 190.11, and shall initiate appropriate licensing action as required. The EPA shall be notified whenever a variance is granted.

iv. The WMUR PM for 40 CFR 190 Compliance assessment shall issue a brief annual report summarizing the results of the individual license compliance reviews. This report shall also consider the cumulative dose to any member of the population due to exposure from releases from multiple mill facilities in the general area. The EPA shall be provided with a copy of this summary report for their review and comment.

5. The PM shall periodically review and evaluate the EMP, EMP reports, and 40 CFR 190 compliance assessments, and shall eliminate any requirements that experience shows to be nonessential or shall require specific actions necessary to show compliance. For example, if the airborne concentration measurements show that there is no need to continue radium-226, thorium-230, or lead-210 analyses, then such requirements shall be eliminated from the EMP. Effort will be made to streamline the periodic compliance assessment effort by prescribing specific concentration levels which, based on experience and in combination with other readily observable parameters related to mill operations and local land use, could be relied upon to determine compliance.

B. Predictive Modeling

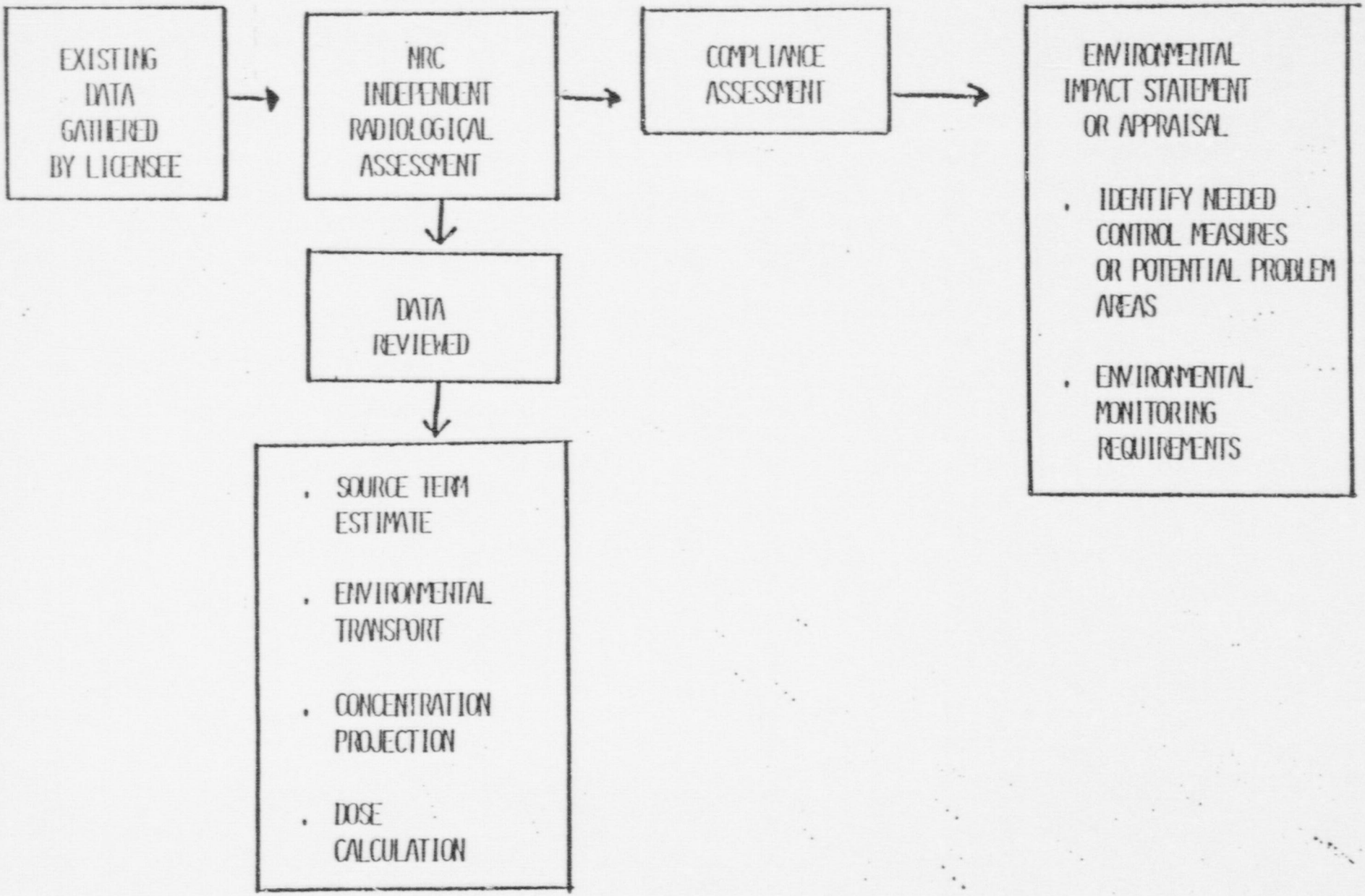
Figure 2 - "NRC 40 CFR 190 Assessment of Prospective Milling Operations" shows a diagram of the various steps to be followed by the NRC Project Manager in licensing reviews.

1. All existing data, e.g., source term, environmental monitoring data, land use, population distribution, meteorology, etc., shall be gathered and reviewed by the NRC Project Manager (PM).

2. The NRC PM shall complete an independent radiological assessment to 40 CFR 190 compliance based on predictive modeling using methodology as described in Regulatory Guide RH#802-4.

3. These assessments shall be documented in the Environmental Impact Statement (EIS) or environmental appraisal conducted in support of the licensing action. These assessments shall consider the cumulative dose to any member of the population due to exposure from releases from multiple mill facilities in the general area.

FIGURE 2
NRC 40 CFR 190 ASSESSMENT OF PROSPECTIVE
MILLING OPERATIONS (BASED ON PREDICTIVE MODELING)



APPENDIX A

Attachment A
:Dose Calculational Guidance

The estimated dose received by any member of the general population shall be calculated based on the applicable potential exposure of the nearest resident in the off-site area surrounding the mill site. The total dose shall be the sum of the external exposure (i.e., due to radiation sources outside the body) and of the internal exposure (i.e., radioactive materials within the body) as follows:

1. External Radiation Exposure -

   The direct radiation exposure may be assumed to be equal to the actual personal or environmental dosimetric data less the appropriate background contribution.

2. Internal Radiation Exposure -

   The total dose to organs (e.g., lung, bone, whole body, etc.) shall be evaluated based on summing all applicable human pathways, such as:

   a. Inhalation of Airborne Particulates -

      The measured airborne concentration multiplied by the dose conversion factors as given in Table A-1.

   b. Ingestion of Contaminated Food and Milk -

      The measured concentration in the food product multipled by the dose conversion factor as given in Table A-2(a) through (c).

   c. Ingestion of Meat or Milk from Livestock Grazing on Contaminated Vegetation -

      The measured concentration in vegetation (e.g., grasses in grazing areas) multiplied by the dose conversion factor as given in Table A-3(a) and (b).

   d. Ingestion of Contaminated Water -

      The measured concentration in potable water multiplied by the dose conversion factor as given in Table A-4.

e. Ingestion of Meat or Milk from Livestock Watered on Contaminated Water -

The measured concentration in water used by livestock for watering purposes multiplied by the dose conversion factor as given in Table A-5(a) and (b).

If any of the human exposure pathways as given above are not in evidence at a mill site, then that dose contribution obviously does not need to be considered here. The total dose for each critical organ shall be obtained by summing the dose due to each radionuclide of the uranium decay chain series (i.e., uranium, radium-226, thorium-230, lead-210, and polonium-210) and through each pathway, i.e., inhalation plus external exposure plus any applicable ingestion pathways. However, the dose due to the inhalation pathway shall be of primary concern, with the other pathways providing supplemental information regarding possible exposure. Additionally, a thorough evaluation of background conditions must be completed so that any contribution due to the mill operations (i.e., value measured at point of receptor less applicable background level) may be adequately assessed.

The point of receptor data must be reviewed in connection with other environmental and effluent monitoring data, and other appropriate information or assessment tools (such as computer modeling where this may be helpful), in cases where extraneous sources may cause calculated doses to exceed the 40 CFR 190 limits or where anomalous data may be encountered.

Table A-1
Dose Conversion Factors for the Inhalation of Airborne Particulates
(MilliRem per pCi/m^3)*

Radionuclide	Whole Body	Bone	Lung
U-238	4.32	79.2	158
U-234	4.92	79.5	180
Th-230	166	5950	3220
Ra-226	30.9	309	6610
Pb-210	4.36	135	772
Po-210	0.47	1.92	420

*The 50-year dose commitment for each year of exposure to 1 pCi/m^3 of each radionuclide for an adult breathing rate of 20 m^3/day. Particle size of 1.55 µm AMAD (i.e., mean diameter of 1 µm and density of 2.4 g/cm^3) being representative of uranium ore. The Quality Factor for alpha radiations is 10. The total dose per organ is the summation of doses due to each radionuclide. (Regulatory Guide RH#802-4).

Table A-2(a)
Dose Converson Factors for Ingestion of Contaminated Meat

(HilliRem per $\frac{pCi}{kg}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	3.55 E-03	6.01 E-02	0.0	1.37 E-02
U-234	4.05 E-03	6.55 E-02	0.0	1.56 E-02
Th-230	4.46 E-03	1.61 E-01	9.16 E-03	4.42 E-02
Ra-226	3.60 E-01	3.60 E+00	4.49 E-04	1.28 E-02
Pb-210	4.26 E-02	1.20 E+00	3.42 E-03	9.63 E-01
Po-210	7.01 E-03	2.79 E-02	5.92 E-02	1.97 E-01

*The 50-year dose commitment for each year of ingestion of contaminated meat. The above factors correspond to an adult ingestion rate of 78.3 kg/yr of meat (beef, poultry, pork, mutton). (Regulatory Guide RH#802-4).

Table A-2(b)
Dose Conversion Factors for Ingestion of Contaminated Edible Vegetation
(MilliRem per $\frac{pCi}{kg}$)

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	2.38 E-03	4.03 E-02	0.0	9.19 E-03
U-234	2.71 E-03	4.39 E-02	0.0	1.04 E-02
Th-230	2.99 E-03	1.08 E-01	6.14 E-03	2.97 E-02
Ra-226	2.42 E-01	2.42 E+00	3.01 E-01	8.56 E-03
Pb-210	2.86 E-02	8.03 E-01	2.29 E-01	6.46 E-01
Po-210	4.51 E-03	1.87 E-02	3.97 E-02	1.30 E-01

*The 50-year dose commitment for each year of ingestion of contaminated edible vegetation.

A factor of 50% activity reduction through food preparation was assumed, and an adult ingestion rate of 105 kg/yr total vegetable ingestion rate, as well as uniform concentration throughout all vegetable types. Should data be presented as concentration of edible above ground vegetables, C_1; potatoes, C_2; and other below ground vegetables, C_3; then the following weighted concentration C_v should be used when multiplying the above dose factors:

$$C_v = 0.38\ C_1 + 0.58\ C_2 + 0.05\ C_3$$

Table 5 of Regulatory Guide RH#802-4 details the breakdown of vegetable consumption.

Table A-2(c)
Dose Conversion Factors for Ingestion of Contaminated Milk
(MilliRem per pCi/l)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	5.90 E-03	9.97 E-02	0.0	2.28 E-02
U-234	6.72 E-03	1.09 E-01	0.0	2.59 E-02
Th-230	7.41 E-03	2.68 E-01	1.52 E-02	7.35 E-02
Ra-226	5.98 E-01	5.98 E+00	7.46 E-04	2.12 E-02
Pb-210	7.07 E-02	1.99 E+00	5.68 E-01	1.60 E+00
Po-210	1.12 E-02	4.63 E-02	9.83 E-02	3.28 E-01

*The 50-year commitment for each year of ingestion of contaminated milk. These values are based on an adult consumption rate of 130 liters/year. Since children drink greater quantities, the resultant dose is much higher for younger people. Dose conversion factors, as before, are for adults. Proper dose conversion factors and milk consumption rates for other age groups are presented in Regulatory Guide RH#802-4.

Table A-3 (a)
Dose Conversion Factors for Ingestion of Meat from Cattle
Grazing on Contaminated Vegetation
(Millirem per $\frac{pCi}{kg}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	6.04 E-05	1.02 E-03	0.0	2.33 E-04
U-234	6.88 E-05	1.11 E-03	0.0	2.65 E-04
Th-230	4.46 E-05	1.61 E-03	9.16 E-05	4.42 E-04
Ra-226	9.18 E-03	9.18 E-02	1.15 E-05	3.25 E-04
Pb-210	1.51 E-03	4.25 E-02	1.21 E-02	3.42 E-02
Po-210	2.39 E-04	9.90 E-04	2.10 E-03	7.00 E-03

*The 50-year dose commitment for each year of ingestion of meat. The above values are based on the following.

i) Animal uptake of vegetation: 50 kg/day

ii) Environmental transfer coefficients: $\left(\frac{pCi/kg}{pCi/day}\right)$

U - 3.4×10^{-4}

Th - 2.0×10^{-4}

Ra - 5.1×10^{-4}

Pb - 7.1×10^{-4}

Po - 7.1×10^{-4}

iii) Adult meat ingestion rate: 78.3 kg/year

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

Table A-3(b)
Dose Conversion Factors for Human Consumption
of Milk from Dairy Cows Ingesting Contaminated Vegetation

(MilliRem per $\frac{pCi}{kg}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	1.80 E-04	3.03 E-03	0.0	6.94 E-04
U-234	2.05 E-04	3.31 E-03	0.0	7.89 E-04
Th-230	1.85 E-06	6.70 E-05	3.80 E-06	1.84 E-05
Ra-226	1.76 E-02	1.76 E-01	2.20 E-05	6.25 E-04
Pb-210	4.24 E-04	1.19 E-02	5.97 E-03	9.59 E-03
Po-210	6.70 E-05	2.78 E-04	5.90 E-04	1.97 E-03

*The 50-year dose commitment for each year of ingestion of milk. The above values are based on the following:

i) Animal uptake of vegetation: 50 kg/day

ii) Environmental transfer coefficients: $\left(\frac{pCi/kg}{pCi/day}\right)$

U - 6.1×10^{-4}

Th - 5.0×10^{-6}

Ra - 5.9×10^{-4}

Pb - 1.2×10^{-4}

Po - 1.2×10^{-4}

iii) Adult consumption of milk: 130 liters/year

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

Table A-4
Dose Conversion Factors for Human Consumption
of Contaminated Water

(MilliRem per $\frac{pCi}{l}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	1.68 E-02	2.84 E-01	0.0	6.48 E-02
U-234	1.91 E-02	3.09 E-01	0.0	7.36 E-02
Th-230	2.11 E-02	7.62 E-01	4.33 E-02	2.09 E-01
Ra-226	1.70 E+00	1.70 E+01	2.12 E-03	6.03 E-02
Pb-210	2.01 E-01	5.66 E+00	1.62 E+00	4.55 E+00
Po-210	3.18 E-02	1.32 E-01	2.80 E-01	9.32 E-01

*The 50-year dose commitment for each year of ingestion of contaminated water. The above values are based on an average adult consumption rate of 370 liters/year (Regulatory Guide 1.109) and adult ingestion dose conversion factors (Regulatory Guide RH#802-4).

Table A-5
Dose Conversion Factors for Ingestion
of Meat from Cattle Watered on Contaminated Water

(MilliRem per $\frac{pCi}{l}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	6.04 E-05	1.02 E-03	0.0	2.33 E-04
U-234	6.88 E-05	1.11 E-03	0.0	2.65 E-04
Th-230	4.46 E-05	1.61 E-03	9.16 E-05	4.42 E-04
Ra-226	9.18 E-03	9.18 E-02	1.15 E-05	3.25 E-04
Pb-210	1.51 E-03	4.25 E-02	1.21 E-02	3.42 E-02
Pb-210	2.39 E-04	9.90 E-04	2.10 E-03	7.00 E-03

*The 50-year dose commitment for each year of ingestion of meat. The above values are based on the following:

i) Animal uptake of water: 50 liters/day

ii) Environmental transfer coefficients: $\left(\frac{pCi/kg}{pCi/day}\right)$

U - 3.4×10^{-4}

Th - 2.0×10^{-4}

Ra - 5.1×10^{-4}

Pb - 7.1×10^{-4}

Po - 7.1×10^{-4}

iii) Adult meat ingestion rate of 78.3 kg/year

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

Table A-5(b)
Dose Conversion Factors for Human Consumption
of Milk from Dairy Cows Watered on Contaminated Water

(MilliRem per $\frac{pCi}{l}$)*

Radionuclide	Whole Body	Bone	Liver	Kidney
U-238	2.16 E-04	3.65 E-03	0.0	8.33 E-04
U-234	2.46 E-04	3.98 E-03	0.0	9.47 E-04
Th-230	2.22 E-06	8.03 E-05	4.56 E-06	2.20 E-05
Ra-226	2.12 E-02	2.12 E-01	2.64 E-05	7.50 E-04
Pb-210	5.09 E-04	1.43 E-02	4.09 E-03	1.15 E-02
Po-210	8.04 E-05	3.33 E-04	7.08 E-04	2.36 E-03

*The 50-year dose commitment for each year of ingestion of milk.
The above values are based on the following:

i) Dairy animal intake rate: 60 liters/day

ii) Adult ingestion milk rate: 130 liters/year

iii) Environmental transfer coefficients: $\left(\frac{pCi/liter}{pCi/day}\right)$

U - 5.1×10^{-4}

Th - 5.0×10^{-6}

Ra - 5.9×10^{-4}

Pb - 1.2×10^{-4}

Po - 1.2×10^{-4}

iv) Adult ingestion dose conversion factors (see Regulatory Guide RH#802-4)

impacts of operation; and to detect potential long term effects.

Criterion 8—Milling operations shall be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. The primary means of accomplishing this shall be by means of emission controls. Institutional controls, such as extending the site boundary and exclusion area, may be employed to ensure that offsite exposure limits are met, but only after all practicable measures have been taken to control emissions at the source. Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamination. The greatest potential sources of offsite radiation exposure (aside from radon exposure) are dusting from dry surfaces of the tailings disposal area not covered by tailings solution and emissions from yellowcake drying and packaging operations.

Checks shall be made and logged hourly of all parameters (e.g., differential pressures and scrubber water flow rates) which determine the efficiency of yellowcake stack emission control equipment operation. It shall be determined whether or not conditions are within a range prescribed to ensure that the equipment is operating consistently near peak efficiency; corrective action shall be taken when performance is outside of prescribed ranges. Effluent control devices shall be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack. Drying and packaging operations shall terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficiency, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable. Operations may not be re-started after cessation due to off-normal performance until needed corrective actions have been identified and implemented. All such cessations, corrective actions, and re-starts shall be reported to the appropriate NRC regional office as indicated in Criterion 8A, in writing, within 10 days of the subsequent restart.

To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonably achievable. This requirement may be relaxed if tailings are effectively sheltered from wind, such as may be the case where they are disposed of below grade and the tailings surface is not exposed to wind. Consideration shall be given in planning tailings disposal programs to methods which would allow phased covering and reclamation of tailings impoundments since this will help in controlling particulate and radon emissions during operation. To control dusting from diffuse sources, such as tailings and ore pads where automatic controls do not apply, operators shall develop written operating procedures specifying the methods of control which will be utilized.

Criterion 8A—Daily inspections of tailings or waste retention systems shall be conducted by a qualified engineer or scientist and documented. The appropriate NRC regional office as indicated in Appendix D of 10 CFR Part 20, or the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, shall be immediately notified of any failure in a tailings or waste retention system which results in a release of tailings or waste into unrestricted areas, and/or of any unusual conditions (conditions not contemplated in the design of the retention system) which if not corrected could indicate the potential or lead to failure of the system and result in a release of tailings or waste into unrestricted areas.

II. Financial Criteria

Criterion 9—Financial surety arrangements shall be established by each mill operator prior to the commencement of operations to assure that sufficient funds will be available to carry out the decontamination and decommissioning of the mill and site and for the reclamation of any tailings or waste disposal areas. The amount of funds to be ensured by such surety arrangements shall be based on Commission-approved cost estimates in a Commission-approved plan for (1) decontamination and decommissioning of mill buildings and the milling site to levels which would allow unrestricted use of these areas upon decommissioning, and (2) the reclamation of tailings and/or waste disposal areas in accordance with technical criteria delineated in Section I of this Appendix. The licensee shall submit this plan in conjunction with an environmental report that addresses the expected environmental impacts of the milling operation, decommissioning and tailings reclamation, and evaluates alternatives for mitigating these impacts. The surety shall also cover the payment of the charge for long term surveillance and control required by Criterion 10. In establishing specific surety arrangements, the licensee's cost estimates shall take into account total costs that would be incurred if an independent contractor were hired to perform the decommissioning and reclamation work. In order to avoid unnecessary duplication and expense, the Commission may accept financial sureties that have been consolidated with financial or surety arrangements established to meet requirements of other Federal or state agencies and/or local governing bodies for such decommissioning, decontamination, reclamation, and long term site surveillance and control, provided such arrangements are considered adequate to satisfy these requirements and that the portion of the surety which covers the decommissioning and reclamation of the mill, mill tailings site and associated areas, and the long term funding charge is clearly identified and committed for use in accomplishing these activities. The licensee's surety mechanism will be reviewed annually by the Commission to assure that sufficient funds would be available for completion of the reclamation plan if the work had to be performed by an independent contractor. The amount of surety liability should be adjusted to recognize any increases or decreases resulting from inflation, changes in engineering plans, activities performed, and any other conditions affecting costs. Regardless of whether reclamation is phased through the life of the operation or takes place at the end of operations, an appropriate portion of surety liability shall be retained until final compliance with the reclamation plan is determined. This will yield a surety that is at least sufficient at all times to cover the costs of decommissioning and reclamation of the areas that are expected to be disturbed before the next license renewal. The term of the surety mechanism must be open ended, unless it can be demonstrated that another arrangement would provide an equivalent level of assurance. This assurance could be provided with a surety instrument which is written for a specified period of time (e.g., five years) yet which must be automatically renewed unless the surety notifies the beneficiary (the Commission or the State regulatory agency) and the principal (the licensee) some reasonable time (e.g., 90 days) prior to the renewal date of their intention not to renew. In such a situation the surety requirement still exists and the licensee would be required to submit an acceptable replacement surety within a brief period of time to allow at least 60 days for the regulatory agency to collect.

Proof of forfeiture must not be necessary to collect the surety so that in the event that the licensee could not provide an acceptable replacement surety within the required time, the surety shall be automatically collected prior to its expiration. The conditions described above would have to be clearly stated on any surety instrument which is not open-ended, and must be agreed to by all parties. Financial surety arrangements generally acceptable to the Commission are:

(a) Surety bonds;
(b) Cash deposits;
(c) Certificates of deposit;
(d) Deposits of government securities;
(e) Irrevocable letters or lines of credit; and
(f) Combinations of the above or such other types of arrangements as may be approved by the Commission. However, self insurance or any arrangement which essentially constitutes self insurance (e.g., a contract with a state or federal agency), will not satisfy the surety requirement since this provides no additional assurance other than that which already exists through license requirements.

Criterion 10—A minimum charge of $250,000 (1978 dollars) to cover the costs of long term surveillance shall be paid by each mill operator to the general treasury of the United States or to an appropriate State agency prior to the termination of a uranium or thorium mill license.

If site surveillance or control requirements at a particular site are determined, on the basis of a site-specific evaluation, to be significantly greater than those specified in Criterion 12, (e.g., if fencing is determined to be necessary) variance in funding requirements may be specified by the Commission. In any case, the total charge to cover the costs of long term surveillance shall be such that, with and assumed 1 percent annual real interest rate, the collected funds

References

- U.S. Environmental Protection Agency - Title 40 Code of Federal Regulations Part [illegible] Subchapter F, "Environmental Radiation Protection Standards for Nuclear Power Operations" (40 CFR 190).

- U.S. Nuclear Regulatory Commission - Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (April 1980).

- U.S. Nuclear Regulatory Commission - Regulatory Guide 4.15, "Quality Assurance Programs for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment" (February 1979).

- U.S. Nuclear Regulatory Commission - Regulatory Guide RH#802-4, "Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations" (draft, May 1979).

- U.S. Nuclear Regulatory Commission - 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, October 1957).

- U.S. Environmental Protection Agency - Final Environmental Statement, "40 CFR 190 Environmental Radiation Protection Requirements for Normal Operations of Activities in the Urnaium Fuel Cycle," EPA 520/4-76-016. (November 1976).

- U. S. Environmental Protection Agency - Part IV - Supplemental Analysis-1976, "Environmental Analysis of the Uranium Fuel Cycle," EPA 520/4-76-017. (July 1976).