DECONTAMINATION CRITERIA FOR THE FORMER KELLEX SITE (PIERPONT PROPERTY) REMEDIAL ACTION, JERSEY CITY, NEW JERSEY

U.S. DEPARTMENT OF ENERGY
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Current Federal Policy and Guidance

The current guidance for Federal decisions affecting the exposure of members of the public in the U.S. remains that recommended by the Federal Radiation Council (FRC) and issued by the President in 1960. This guidance defines the Radiation Protection Guide as "the radiation dose which should not be exceeded without careful consideration of reasons for doing so; every effort should be made to encourage the maintenance of radiation dose as far below this guide as practicable."

For members of the public the FRC guidance is: ". . . it is our basic recommendation that the yearly radiation exposure to the whole body of individuals in the general population (exclusive of natural background and the deliberate exposures of patients by practitioners of the healing arts) should not exceed 0.5 rem." In a paragraph particularly suited to our problem, the FRC states "Under certain conditions, such as widespread contamination of the environment, the only data available may be related to average contamination or exposure levels. Under these circumstances, it is necessary to make assumptions concerning the relationship between average and maximum doses. The Federal Radiation Council suggests the use of the arbitrary assumption that the majority of individuals do not vary from the average by a factor greater than three. Thus, we recommend the use of 0.17 rem for yearly whole-body exposure of average population groups." There is urging of the use of reason and judgement and an admonition that the average figure should be applied only when there is a probability of appreciable homegeneity concerning the distribution of dose within the population considered in the average.

These numbers are for whole-body dose and give little guidance for internal organs. However, in applying these guides, the FRC used 1.5 rem/y for the thyroid and 0.5 rem/y for bone marrow. For bone they give an

alternate guide of 0.003 Ci for ^{226}Ra in the adult skeleton, that corresponds to about 1 rem/y. In the derivation of limits for D&D 0.5 rem/y has been used to apply to any organ although one could argue that a limit of 1.5 rems/y was intended for organs such as bone or lung.

The FRC was abolished when the U.S. Environmental Protection Agency (EPA) was created and the responsibilities were assumed by the EPA. The guidance developed by the FRC is still applicable athough the EPA has proposed much more restrictive guidance for specific situations based upon what is considered by them as technically and economically practicable for the situation. The proposed drinking water limits and transuranics in soil limits, as well as the basis for Uranium Fuel Cycle Standard, consider the costs of implementation compared to the benefits derived from the use of the standard. The dose equivalent limits proposed or recommended for these specific sources of exposure are included in Table 1.

Recent ICRP Guidance

The International Commission on Radiological Protection (ICRP) recently published revised guidance in ICRP Publication 26, "Recommendations of the International Commission on Radiological Protection." For individual members of the public, they recommend a limit of 500 mrem to the whole body or the equivalent risk if the dose is distributed non-uniformly. They recognized that this limit when applied to an individual normally results in an average annual dose equivalent to the population of less than 100 mrem or an individual risk in the range of 10^{-6} - 10^{-5} per year. The limit of 500 mrem is also considered adequate to assure that no one or group of individuals will be expected to bear an undue portion of the health related cost. The ICRP goes

TABLE 1 - ENVIRONMENTAL STANDARDS

General Environmental Standards

Organization	Annual Limit	Comments
FRC-EPA	500 mrem	whole body, bone marrow
FRC-EPA	170 mrem	whole body, bone marrow (exposure to average population groups)
ICRP	500 mrem	whole body or equivalent risk from organ doses

Specific Environmental Standards

EPA Fuel Cycle Standard (Effective December 1980)	75 mrem	thyroid
	25 mrem	whole body or other organ (Rn and daughters excluded)
EPA Drinking Water Standard	4 mrem/y	manmade beta-gamma emitting radioactivity
	5 pCi/l	^{226}Ra or ^{228}Ra
	15 pCi/l	gross alpha measurement
EPA Proposed Guidance for Transuranics	1 mrad*	lung
	3 mrad**	bone

*This is equivalent to approximately 20 mrem
**This is equivalent to approximately 150 mrem

on to further state that any manmade contribution to the radiation exposure of a population must be justified by its benefits.

For exposure to radiation such that the organs receive different doses, the ICRP recommends that the "dose limitation be based on the principle that the risk should be equal whether the whole body is irradiated uniformly or whether there is non-uniform irradiation." This is achieved by converting the partial body dose equivalents to whole-body dose equivalents by multiplying the organ dose equivalents by weighting factors (Wt) that express comparative risk factors, provided in Table 2, for each organ, and comparing the sum with the whole-body dose equivalent limit.

TABLE 2 - ORGAN WEIGHTING FACTORS USED BY THE ICRP IN RELATING ORGAN DOSES TO WHOLE BODY DOSE

Tissue	Wt
Gonads	0.25
Breast	0.15
Red Bone Marrow	0.12
Lung	0.12
Bone Surfaces	0.03
Remainder	0.30

Rationale for Cleanup Limits and Sampling Methodology for Soils at the Kellex Site

In proposing limits for soil contamination, it is important to identify the principal pathways of radiation exposure to man and provide soil limits and measurement methodologies which are appropriate for limiting exposure via those particular pathways. The most recent analysis of the hazards associated with soils contaminated with uranium has been done by J. W. Healy, J. C. Rodgers, and C. L. Wienke, "Interim Soil Limits for D&D Projects," Draft LA-UR-79-1865-Rev. (September 1979). In their analysis they estimated, on a conservative basis, the soil contamination levels necessary to deliver a dose equivalent of 500 mrem/y to the organ receiving the highest annual dose of the maximum exposed individual. Their analysis demonstrates that the significant pathway to man is from ingestion. Since surface waters are not consumed, a home gardener living on the site all of his life who grew all of the fruit and vegetables which he ate would be considered the most severely exposed individual. For this extreme situation, the study predicts that a garden with an average concentration of 18 pCi/g of ^{238}U would produce a bone dose equivalent of less than 500 mrem/y. In the analysis, the effects of ^{234}U were included in with the ^{238}U since they are normally in secular equilibrium, i.e., the disintegration rates per soil mass are equal for ^{234}U and ^{238}U. The next most restrictive pathway was shown to be inhalation where continuous occupancy of a large site having a soil concentration of 750 pCi/g of ^{238}U would correspond to a maximum lung dose of less than 500 mrem.

The 18 pCi/g limit for ^{238}U is based upon a very conservative estimate of a quantity that leads to a dose of 500 mrem/year to the highest organ at any time during the lifetime of an individual who has the highest intake of uranium from the contaminated area. Because the inhalation is a minor problem

compared to ingestion of foods from the area, the lung is only slightly involved and the bone-surface becomes the critical organ. If we consider only the bone as irradiated, the new ICRP formulation would indicate that this would be equivalent to a whole-body dose of 15 mrem/y. However, because other organs such as kidney and liver are undoubtedly irradiated also, a more realistic value is on the order of 20-50 mrem/y.

Since the pathway analysis demonstrates that home gardening is by far the most significant concern when using land contaminated with uranium, the soil sampling methodology and limits are being selected accordingly. Garden crops normally extract most of their nutrients from the uppermost 20 cm of soil so that sampling must assure that a garden capable of producing a significant fraction of a person's vegetables will not have an average contamination level in the top 20 cm of soil greater than the proposed limit. The size of a garden plot which could supply this quantity of food is assumed, for purposes of the cleanup, to be 400 square meters. This size is based upon an estimate provided by personnel at the U.S. Department of Agriculture. Dr. Ray Webb of that Department stated that a fertile garden of 1/4 acres (1,000 m^2) could supply all the vegetables for a family of four. Allowing an additional 50 m^2 for each of several fruit trees and assuming only one person per household, the minimum size of concern would be approximately 400 m^2.

The Kellex site (Pierpont Property) is not suitable for home gardening or other agricultural uses at present. The site has been used to deposit waste soils, cinders, and other rubble for many years. These materials would have to be removed or replaced with more fertile top soil before a large fraction of a man's diet could be grown on a 400 m^2 plot. The effect of bringing in top soil would be to reduce the contamination in the root zone to a small fraction of the initial concentration. This dilution factor should be

considered when establishing a maximum allowable limit for this site as described below. One might argue that the plot size could be enlarged and thus the most conservative limit should be retained. We believe that enlarging the garden plot size in this case would also reduce the average uranium concentration, for the contamination has been found in small isolated areas and enlarging the area would have a net result of lowering the average uranium concentration. After considering the physical properties of the land, and the unlikelihood that a family would desire to eat only fruits and vegetables grown on that plot, we estimate that a residual limit of 40 pCi/g of ^{238}U (rather than 18 pCi/g) averaged over 400 m^2 would correspond to less than 500 mrem/y to the bone of the maximum exposed individual. This site specific adjustment factor of approximately 2 is still considered very conservative.

Throughout the cleanup, the principle of As Low As Reasonably Achievable (ALARA) will be applied. The degree and costs of decontamination depend to a great extent upon the ability to detect the contaminant with field instruments. It is normally impractical to assure that decontamination to levels below the detection limit of the field instruments will be achieved. The practical detection limit for presently available field instruments is about 20 pCi/g for uranium-238. Therefore, soils sampled and found to exceed 20 pCi/g will be removed from the top 20 cm layer during remedial action. Since the contamination on this site is expected to occur in small areas compared to 400 m^2, we anticipate that the average contamination for any 400 m^2 will be a small fraction of the 40 pCi/g limit.

Subsurface exploration will be made in suspected contaminated areas by trenching or other methods. Considering the past uses of the site, exploring to a depth of about 3' will be adequate unless indications of burial of radioactive material are found, and then it will be necessary to go deeper.

Care will be taken to explore enough of the subsurface in areas of suspected contamination such that a high degree of assurance is provided that significant quantities of contaminated soils have been located and removed. (A "significant quantity" in this context is defined as a quantity of activity capable of exceeding the soil limits (40 pCi/g) if brought to the surface and mixed with the top soil.) Furthermore, subsurface soil below 20 cm depth identified as contaminated above the sensitivity of the field instruments (20 pCi/g) will be removed to the extent it is practical.

Uranium-238 Soil Limits and Cleanup Criteria*

Soil Limit
40 pCi/g

* Average concentration in the top 20 cm of soil averaged over a 400 m^2 area as specified in the implementation section. The limit of 40 pCi/g has been increased from 18 pCi/g because of site specific considerations (see text).

Implementation

1. A gamma-ray survey or combination of gamma-ray and alpha survey will be made to locate contaminated areas exceeding 20 pCi/g uranium-238 to a depth of 20 cm. All contaminated soil within this depth found to exceed 20 pCi/g will be removed from these areas.
2. In areas where subsurface deposits are suspected, a plan for subsurface sampling shall be followed which will identify and remove quantities of contamination capable of exceeding the soil limit (40 pCi/g) for the Kellex site, if under any possible future land use, this contaminated soil were to be brought to the surface.
3. After decontamination of the site, the excavated areas will be backfilled with clean soil or leveled.

4. A final survey will be performed to describe the condition of the site after cleanup. The following procedure will be followed unless an alternative procedure is agreed to by the DOE and the State of New Jersey. All decontaminated areas will be divided into grid systems described by perpendicular lines 4 m apart, thus forming individual grid blocks of 16 m^2 each. Decontaminated areas larger than 400 m^2 will be subdivided into 2 or more approximately equal subareas of less than or equal to 400 m^2 each. Soil samples from each 16 m^2 area will be taken to a depth of 20 cm. A composite sample will be made from sample aliquots from each 16 m^2 grid block and analyzed, representing the average concentration of the 400 m^2, or less, area. If the average concentration exceeds 20 pCi/g uranium-238, the analyses of the soil samples from the 16 m^2 area will be used to guide further remedial action.

Certification

During cleanup operations, the remedial action radiological support contractor will collect and document radiological data from analyses of soil samples and portable radiation detection instruments to determine the adequacy of decontamination. Concurrently and independently, the DOE Office of Environment's survey contractor will collect and analyze spot soil samples and make in situ radiological measurements.

After completion of the remedial actions, the Office of the Environment's survey contractor will conduct an onsite survey to establish the final radiological condition. Using the data documented by the remedial action contractor and the independently collected radiological data, the Office of Environment will determine the status of certification.