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**Contamination Limits for Real and
Personal Property
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by

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**CONTAMINATION LIMITS FOR
REAL AND PERSONAL PROPERTY**

JANUARY — JUNE 1976

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J. W. Healy and W. J. Wenzel

ABSTRACT

Progress is reported on the plutonium in soils limit and on the surface contamination study. The report on the soils limit is being typed in draft form for review at other ERDA facilities. A model for surface contamination was derived and programmed but parametric studies have not yet been done.

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I. INTRODUCTION

Significant progress has been made on the two current projects - plutonium in soils and surface contamination. The timing of issuance of the soils report depends upon the number and nature of the comments received on the draft completed during this period. However, the text is on type which will facilitate editing. A preliminary model for surface contamination has been derived and programmed ready for parametric analysis.

W. J. Wenzel left this program toward the end of the period. A search for an individual to continue the work is in progress.

The Division of Safety, Standards and Compliance has indicated that priority should be given to studying uranium in soils. Accordingly, this will be the next project with surface contamination studies continued on a low priority.

II. PLUTONIUM IN SOILS

The write up of the report on plutonium in soils was completed during this period and is being typed in draft form for distribution to other ERDA facilities for comments.

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The study had a well-defined objective: to provide a reasonable limit which could be used in a general situation where property is to be returned to the public. Thus, it did not cover weapons accidents where the contamination is in a thin layer on the surface of the ground. It was assumed that any property falling under the study would not have further controls on its use so that it could be used for any purpose, including the building of an urban area. However, it was pointed out that because of these restrictions it was not applicable to areas which are under federal control and are not expected to be used on a continuous basis by the public. Consideration was given to providing principles upon which a limit could be developed for an individual area for a particular use, thereby removing some of the conservatism for many areas. However, the problem of justifying a larger limit in one area as compared to another area plus the frequent need for a value which can be applied immediately seemed to indicate that it would be better to provide a single value, even if somewhat conservative. It is noted that we did not attempt to prorate the amount of radiation from this source with that from other sources since this will vary widely depending upon the particular area. Instead, as in the maximum permissible limits for internal emitters, this is left to the user.

Since the study was intended to provide a limit based upon safety considerations, the basis used was the NCRP recommendation of 0.5 rem per year to any organ for the public. No attempt was made to relate the calculated doses to health effects nor was an overall model developed to allow summing of the doses resulting from the individual pathways. Instead, each pathway was estimated separately using conservative estimates of the transfer coefficients as based on available data and assumed actions in the area using what were believed to be reasonably extreme actions for the individual pathway. After examining these data, a value lower than any of them was chosen along with recommendations on sampling depth and areas over which the value may be averaged from the knowledge of the parameters. This approach was used because of the very limited amount of data available for most of the pathways and the inability to obtain realistic probabilities for the types of actions which actually occur. This approach was considered to be justified for this type of problem since the areas expected to be contaminated are relatively small and the population at risk will not be large. At any rate, the use of conservative factors both for the transfer coefficients and for the actions of people is expected to result in a situation where the dose to an average individual will be well less than 10% of the dose limit of 0.5 rems

per year after 70 years with only a few, if any, individuals approaching this limit.

Wind resuspension, as a pathway of intake, appeared to be relatively unimportant from the formulation used. This provided for the increase of resuspension rate with wind speed using powers of the wind speed much greater than had previously been used. The conclusion on the importance of wind resuspension appears to be supported by the data on air concentrations around Rocky Flats and the GMX area in Nevada where significant soil concentrations result in low air concentrations. There is one reservation on this conclusion which requires more study. This is the possibility of persistent dust storms in a very large contaminated area. While many of the particles carried by such a dust storm are much greater in size than that normally considered to be respirable, the application of the ICRP lung model,¹ as modified by the Task Group on Plutonium Metabolism,² indicates a high absorption from the upper respiratory tract which makes the skeleton the critical organ for all particle sizes from 0.1 μm to 50 μm with little change with particle size even in the Class Y material. If it is assumed that the plutonium in the soil follows such a model (as appears unlikely although there are no hard data to indicate this) then such dust storms may be an important factor.

Mechanical resuspension such as can occur from any action in a contaminated area appears to be of far greater importance than wind resuspension in any inhabited area. Data for the interpretation of this pathway are very meager and considerable work should be done in measuring resuspension rates in various types of soil with different degrees of activity in the area. In both of these resuspension pathways, as well as for local resuspension, the "respirable" fraction in the soil was considered and it was shown that, with present data, the total soil limit can be derived considering this parameter and the soil limit is the same for various soils with different fractions of respirable particles. For this reason, the present recommended limit has eliminated the requirements for a surface sample and for sizing of the particles in the sample in favor of a total soil limit with a sampling depth of 2.5 cm. If a respirable particle limit is to be used, it should be increased according to the fraction of the small particles in the soil as compared to the total soil. Further, if such a sampling procedure is used, another sample of the total soil must be analyzed since the respirable particle sample does not provide a total picture of all the potential hazards, some of which appear to be as important as inhalation.

For ingestion, both the intake from foods and more direct intake of the soils themselves were considered. For foods, an absorption from the GI tract of ten times that recommended by the ICRP was used to provide some allowance for possibly greater uptake of plutonium metabolized by plants and animals and for the possible influence of some of the preservatives and flavoring agents in foods today. The uptake ratios for plants and animals were obtained from the data on the New York diet and the cumulative fallout given in the Liquid Metal Fast Breeder Reactor Environmental Statement³ since these appeared to be the most comprehensive data available on the actual diet. It was also noted that many of the field experiments have shown higher quantities of plutonium in plants and animals than would be expected from laboratory studies presumably due to the direct attachment of soil to plants or intake by animals. Again, to provide a degree of conservatism, the uptakes used were higher than actually measured for human diets. This examination indicated that the food pathway could be of importance to those individuals who raise a major portion of their own food in gardens or small farms. In particular, the highest dose would be to a vegetarian who raises all of his own vegetables and grains.

For other sources of ingestion, casual ingestion did not appear to be of great importance. However, the data on pica indicates that a significant intake could be attained by those children who have a severe case of pica for soil. This condition is apparently more prevalent than is normally thought even among those who are not in the lower socio-economic bracket. In reviewing the data on lead in children an interesting situation developed which may have some applicability to the studies of internal dose from the environment. Those who made measurements of the environment, for example concentrations of lead in home dust and quantities of dust on the children's hands, all expressed the opinion that such environmental sources were indeed a very significant source of lead intake for children with elevated blood levels. However, those who measured the intake of lead along with measurements of the environment, concluded that this was not an important source. These data from the lead studies were of considerable assistance in assessing the possibility of plutonium intake by children.

The more complex transfers from the soil to the home are still difficult to evaluate because of the lack of data on such factors as the amount of dust in the home which is derived from the outdoor soil over an area of reasonable contamination, the transfer of such dust from one place to another or from one person to

another, and the real probabilities of various actions which could result in exposure. Studies of a practical nature in real situations, similar to those of the lead studies but extending to measurement of actual intake, are badly needed if we are to assess the full impact of such conditions. Such studies could be made either in areas already lightly contaminated with plutonium or by using a series of tracer experiments using known non-toxic tracers of various particle sizes, such as may be devised from the stable isotopes now available given sufficient funds. It is noted that such studies would also provide a basis for estimating the potential effects of other radioactive materials or of non-radioactive toxic materials or carcinogens produced in the energy program and deposited in unrestricted areas.

Since the methods and results are yet to be reviewed in detail, we will not discuss the recommendations in this report. For use in any particular situation, the user should be aware of the many assumptions and factors of conservatism before attempting to apply to a particular situation or to make a rational judgment on the application of the minimum practicable concept in this situation.

III. SURFACE CONTAMINATION

A start was made on assembling all submodels into a single model for calculating dose to members of the public from a contaminated object. For this purpose, a specific case of an object, such as a table, located in a ventilated room was used and equations were derived for beta and gamma external dose, contact dose, dose to the lungs and dose to other critical organs. The model has been programmed but only tentative evaluations have been made.

While some additional work on the radiological calculations for external and contact doses are needed, these are relatively straightforward with the chief uncertainty being the estimation of the individual placement with respect to the source. The overwhelming uncertainty appears to be the transfer coefficients, particularly the resuspension rate, the movement to the hands or body, and movement into the body from the skin. We plan a parametric analysis, varying these factors as well as the time of use of the object, to determine the sensitivity to these parameters.

While extensive investigations have not as yet been done, we believe that this model will permit evaluation for a number of situations and modifications will cover others. This will be done by changing the parameters to be appropriate to the object and the actions upon it. For example, if a table is to be used

for writing, the transfer from the table to the hand and forearm is of importance while resuspension will be relatively minimal. However, if it is to be used as a mechanical work table, then resuspension is of great importance and transfer to the body correspondingly smaller.

In a previous report⁴ we gave a curve of rate of transfer versus an arbitrary action level which was obtained by analysis of a number of different experimental results. This curve will be invaluable in obtaining preliminary results but it suffers from several defects, the most obvious of which are that it uses a single exponential and was, mostly, derived from freshly contaminated surfaces. A possible method of obtaining more applicable data is being considered. This would consist of a small chamber into which a contaminated object could be placed. Devices for simulating various actions, such as rubbing with material similar to skin, hammering, dusting, or any of the other actions required, would be included. The resuspension and deposition would be obtained from measurements of filters in the exit air and test patches on the walls. Transfer to hands and clothing would be measured directly on the rubbing manipulator. Such experiments could be carried out for periods of time long enough to establish the change in each transfer rate with time.

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