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# Independent Radiological Verification Survey Results for the Remedial Action Performed at the Former Bridgeport Brass Company Facility, Adrian, Michigan (AD001V)

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**ABSTRACT**

This report documents the results of a radiological verification survey of the former Bridgeport Brass Special Metals Extrusion Plant in Adrian, Michigan. The survey was conducted in March 1995 by a team from the former Health Sciences Research Division of the Oak Ridge National Laboratory (ORNL) in response to the Department of Energy's (DOE) Environmental Restoration Program requirements. These requirements dictate that independent verification (IV) of completed cleanup work at DOE FUSRAP sites shall be performed and documented according to prescribed procedures prior to certification of the property for release for unrestricted use. The objective of verification activities is to certify that documentation of post-remedial action radiological conditions on the property is adequate, and that the remedial action reduced contamination levels to within authorized limits.

The survey included directly measured radiation levels and soil collection and analysis to determine concentrations of uranium and certain other, radionuclides, and to compare these data to the DOE guidelines.

The results of the independent verification survey of the property demonstrate that all contaminated areas have been remediated to radionuclide concentrations and activity levels below the applicable DOE guideline limits. Furthermore, from a visual examination of the site and a review of the Project Management Contractor's (PMC) radiological survey and post-remedial action reports, it is concluded that the remediation activities at the former Bridgeport Brass site satisfy the objectives of DOE's FUSRAP program.

**Results of the Independent Radiological Verification Survey of the Remedial Action Performed at the Former Bridgeport Brass Company Facility, Adrian, Michigan (AD001V)**

# INTRODUCTION

This report documents the results of a radiological verification survey of the former Bridgeport Brass Special Metals Extrusion Plant in Adrian, Michigan (Figs. 1 and 2). The survey was conducted in March 1995 by a team from the former Health Sciences Research Division (HSRD), now the Life Sciences Division, of the Oak Ridge National Laboratory (ORNL) in response to the Department of Energy's (DOE) Environmental Restoration Program requirements. These requirements dictate that independent verification (IV) of completed cleanup work at DOE FUSRAP sites shall be performed and documented according to prescribed procedures prior to certification of the property for release for unrestricted use!, 2 The objective of verification activities is to confirm that the remedial action reduced contamination levels to within authorized limits. As the designated Independent Verification Contractor (IVC) for this site, ORNL's Measurement Applications and Development Group was assigned to validate the remedial action and restoration activities conducted at the Adrian site by the Project Management Contractor (PMC), Bechtel National, Incorporated (BNI).

The former Bridgeport Brass Special Metals Extrusion Plant was operated in the 1950s under contract to the Atomic Energy Commission (AEC) to extrude uranium metal for use in the fabrication of fuel for the reactors at Hanford, Washington, and Savannah River, South Carolina. Although no descriptive records are available indicating the full nature of the operations at this site, it is known that the uranium handled included depleted, natural, and up to 2.1% enriched. At the completion of the extrusion activities, equipment was dismantled and scrapped, and, with the exception of one large extrusion press later shipped to and used in Ashtabula, Ohio, the disposition of the materials is unknown. After a period of ownership by Martin Marietta (early 1960s to 1974) the plant was sold to the General Motors Company (GM), the current owner.

There was no documentation of the radiological condition of the site from 1961 until 1976 when the AEC's successor organization, the Energy Research and Development Administration (ERDA), mandated certification of the radiological condition of sites having previously handled radioactive materials in order to determine the status of potential hazards. A 1976 in-house survey demonstrated residual uranium in numerous places that, when decontaminated, resulted in a total of 5 to 6 kg of uranium in collected dust and dirt. A 1977 confirmatory survey by a team from ORNL revealed that the interior building areas had since been decontaminated to radiation levels less than the guidelines for unrestricted use. However, elevated concentrations of $23S^{U}$ were found in some areas below the floor level, most notably in an underground sump. A subsequent survey in 1979 demonstrated residual uranium in concentrations higher than guidelines in additional sumps, service pits, and drains below floor level.[3] Although the amount of uranium found posed little health hazard if left undisturbed, the interior contamination was sufficient to require cleanup action to bring the property into compliance with current Federal guidelines (Table 1), thereby ensuring that the public and the environment are protected.

A hazard assessment was prepared for this facility and conducted on the remaining components of the discharge system and piping systems. Because these areas were either filled in by GM after its purchase of the building in 1974 or rendered inaccessible by placement of heavy machinery or switchgear, attempts to gain normal access would be extremely expensive.

When remedial action was completed in 1995 by BNI, all accessible residual radioactive material above the current guidelines was removed, the underground sumps and manholes were backfilled with flowable concrete or controlled low-strength material (CLSM), and all associated piping was plugged or filled. Direct surface contamination measurements were used to verify the removal of the residual radioactive material from the pipe chase areas to levels below the DOE guidelines. Supplemental limits derived from the hazard assessment were applied to the remaining areas.

## GUIDELINE DEVELOPMENT

A hazard assessment was prepared for the facility by Science Applications International Corp. (SAIC) to determine whether any potential health risk was sufficient to justify the cost of removing the belowground contaminated areas and structures a Because residuals remaining at the GM site following remediation are confined to enclosed areas, the usual methods for assessing doses from residual radioactivity in soils following remedial actions were not applicable. The assessment did not establish a concentration limit that could be measured but, rather, relied on demonstrating that exposures to workers would not be excessive [See 5400.5, IV.7.c (3)].

In order to justify the development of supplementary guidelines that would insure worker safety if the radioactive residuals in drainlines and subfloor areas were not removed, several factors were considered. It was assumed that the property was not likely to be zoned residential and that, therefore, residential exposures to the remaining residuals was deemed unreasonable. Analysis of the environmental mobility of the residual uranium indicated that the residual uranium at the GM site is highly immobile and does not pose a potential groundwater problem in the remote event of a system leak. Inspections performed during the 1995 remediation indicated that the system is intact and that serious leakage into the soil beneath the facility is improbable.

The study projected that only workers could, at some time, be exposed, perhaps through maintenance activities or large scale demolition or renovation operations. The dose assessment included two scenarios: a non-routine maintenance worker and a future renovation worker. Both scenarios were based on reasonable and conservative exposure pathways. It was also necessary to use engineering estimates of time required for the exposure activities in place of the standard U.S. Environmental Protection Agency (EPA) default value of 250 days/yr.

To cause inhalation, ingestion, or direct gamma exposures, a worker would have to physically cut into the filled or plugged drain lines, sumps, or manholes. Similarly, direct gamma exposures would be possible only if the grout and concrete shielding were removed. While some exposures may be possible, these containment measures significantly reduce the potential for future exposures. Nonetheless, the assumption of release of the residual uranium from the concrete or grout was made for exposure point concentrations for the extrusion pits and the former floor drains, as well as for filled drain lines, manholes, and sumps.

An overestimate of actual average contamination conditions was used in exposure point concentration calculations by using maximum measured concentrations of residuals. The net effect of the use of multiple conservative assumptions is that the estimates of future dose are usually much higher than what is really likely to occur. In reality, the release of uranium is highly unlikely, and represents another conservative assumption in the hazard assessment. In addition, it is likely that respiratory protection would be worn by a worker cutting through steel and concrete with a torch or saw.

A non-destructive survey of the drainage system using the Pipe Explorer$^{TM}$ system developed by Science and Engineering Associates, Inc. (SEA) showed that most of the uranium material was found within the piping system. The hazard assessment performed by SAIC, which incorporated the information from the SEA survey, found that a significant potential future risk would not result from leaving the residual uranium in place. Even if no containment measures were to be taken,

projected worst case doses would be less than the international and national protection guidelines for the general public (100 mrem/yr). [4,5,6] Indeed, the cost/benefit ratio for removing only the contaminated drain lines was judged insufficient to justify such an action. After a thorough review of the data by the IVC, it was determined that supplemental limits, as described in Order DOE 5400.5, were warranted for this site.[7]

Under typical circumstances, the DOE maximum limit for uranium residuals is 15,000 dpm/100 $cm^2$ (Table 1). For this GM facility, DOE determined that it would be acceptable to decontaminate the accessible contaminated areas and to fill the affected subsurface pipes, manholes, and sumps with grout or controlled low-strength material to ground-level. This method would result in leaving the remaining inaccessible contamination in place while rendering the possibility 'of human exposures unlikely. Therefore, adoption of a specific surface activity guideline was unnecessary.

## SCOPE OF THE SURVEY

The verification of this property was to include all affected subsurface areas both indoors and outdoors. The ORNL team reviewed the PMC's radiological survey reports to confirm cleanup of the majority of the site. However, the ORNL team took further radiological measurements over the surfaces of a 155-ft section of the electrical pipe chase and its floor-level lids located north of the extrusion pit area (Fig. 3). This indoor area of concern was soon to be completely obscured by the installation of a new system by GM. The shape of the pipe chase is generally rectangular. It is 5.5-ft high and 3.5-ft wide and had not been included in the SAIC hazard assessment because it was one of the areas considered successfully decontaminated.

## SURVEY METHODS

Descriptions of the typical methods and instrumentation providing guidance for this survey are given in Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program, ORNL/TM-8600, April 1987, and in Measurement Applications and Development Group Guidelines, ORNL-6782, January 1995. [8,9]

Using a Geiger-Mueller pancake detector, beta-gamma radiation levels were measured in counts per minute (cpm) over surfaces inside the pipe chase and then converted to activity levels [disintegrations per minute per 100 $cm^2$ (dpm/100 $cm^2$)].

An interview with a former GM employee had revealed that uranium-bearing materials may have been disposed of in the southeast corner of the property in 1953. That area was remediated and a soil sample was collected by ORNL at that location to determine the success of the cleanup. For purposes of comparison, the sample was split between ORNL and BNI for subsequent analysis by the chosen laboratory of each of the custodial institutions.

## SURVEY RESULTS

Current DOE guidelines for FUSRAP sites are summarized in Table 1; the derived site-specific guideline for $^{238}U$ is also listed . Typical background radiation levels and radionuclide concentrations for the Adrian, Michigan, area are presented in Table 2. These data are provided for comparison with the survey results presented in this report. Background concentrations have not been subtracted from radionuclide concentrations in soil.

Following the remediation, all beta-gamma activity levels measured on surfaces within the pipe chase and the pipe chase lids were below the DOE guidelines for surface contamination (Table 1). Analytical results for the soil sample showed 1.8 ± 0.40 pCi/g of $^{238}U$, a concentration slightly higher than background levels for the area (Table 2) but less than typical derived DOE guideline values for properties to be released for unrestricted use (Table 1). Concentrations of $^{226}Ra$ and $^{232}Th$ were 0.90 ± 0.18 and 0.50 ± 0.25 pCi/g, respectively, which are values within the range of background values found near Adrian.

## CONCLUSIONS

The results of the independent verification survey of the property demonstrate that all readily accessible contaminated areas have been remediated to radionuclide concentrations and activity levels below the applicable guideline limits set by DOE.

Although a significant amount of radioactive residuals remain in the sealed underground pipe system of the former Bridgeport Brass property, the results of the independent verification survey demonstrate that the supplementary DOE guidelines adopted specifically for this site appear to be met. Furthermore, from a thorough review of the SAIC hazard assessment and the PMC's post-remedial action report (Refs. 4 and 6), it can be concluded that DOE's objectives for this property were achieved.

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2. *Verification and Certification Protocol Supplement No. 2 to the FUSRAP Summary Protocol*, Rev. l, U.S. DOE, Division of Facility and Site Decommissioning Projects, Office of Nuclear Energy, November 1985.

3. F. F. Haywood, H. W. Dickson, W. D. Cottrell, W. H. Shinpaugh, J. E. Burden, D. R. Stone, R. W. Doane, and W. A. Goldsmith, *Radiological Survey of the Former Bridgeport Brass Company Special Metals Extrusion Plant, Adrian, Michigan,* ORNL-5713, DOE/EV-0005/28, Union Carbide Corp., Oak Ridge Natl. Lab., April 1982

4. *Hazard Assessment for the General Motors Site, Adrian, Michigan,* DOE/OR/21950-1017, U.S. Department of Energy, June 1996.

5. W. A. Williams, Designation and Certification Manager, Division of Off Site Programs, Office of Eastern Area Programs, Office of Environmental Restoration, U.S. Department of Energy, memorandum, "Hazard Assessment for the General Motors Site, Adrian, Michigan" to L. K. Price, Director, Former Sites Restoration Division, Oak Ridge Field Office, U.S. Department of Energy, April 10, 1996.

6. Post-Remedial Action Report for the Remedial Action at the General Motors Site, Adrian, Michigan, DOE/OR/21949-397, U.S. DOE, March 1997

7. Order DOE 5400.5, "Radiation Protection of the Public and the Environment," chapter IV, "Residual Radioactive Material", April 4, 1990.

8. *Procedures Manual for the ORNL Radiological Survey Activities (RASA)* Program, ORNL/TM8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987

9. *Measurement Applications and Development Group Guidelines,* ORNL-6782, Martin Marietta Energy Systems, Oak Ridge, Nat]. Lab., January 1995.

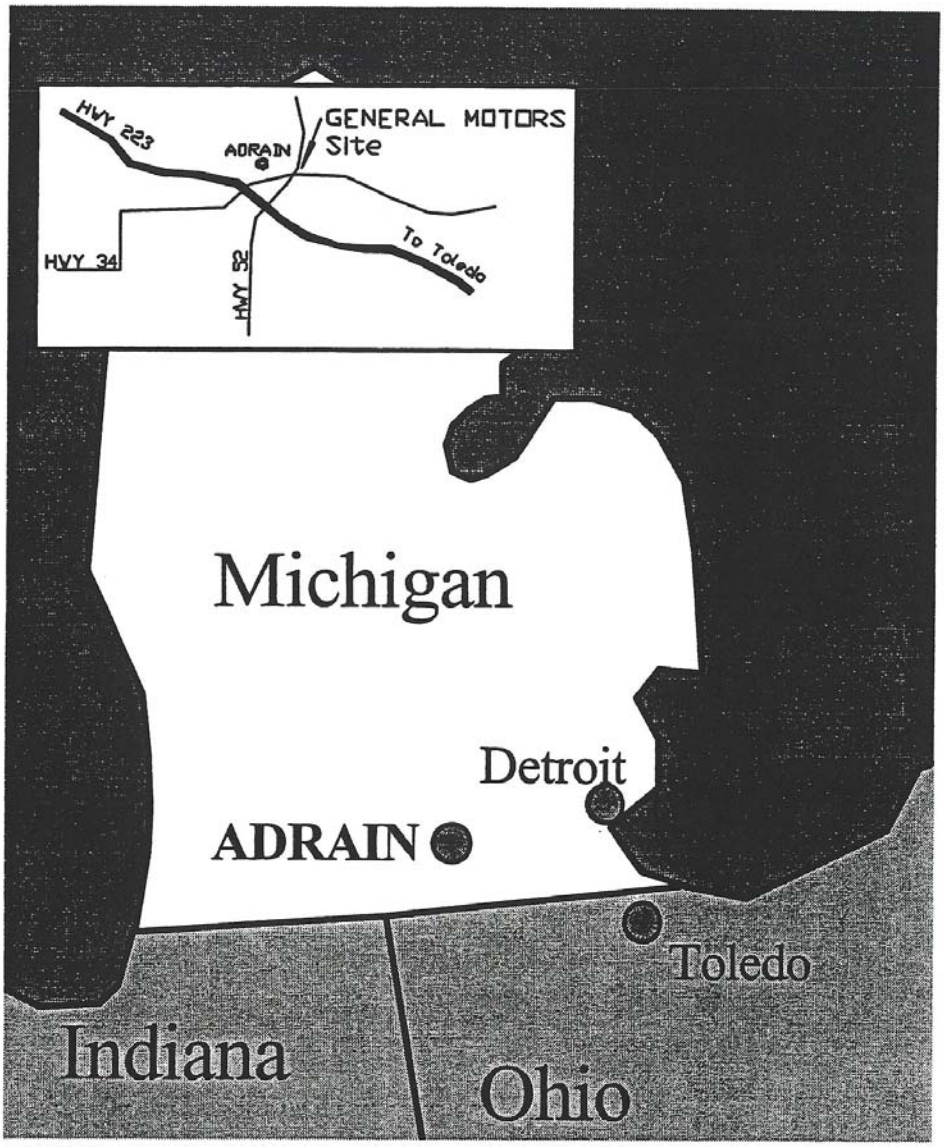


**Fig. 1. General Location of the General Motors Plant and Adrain, Michigan. (Not to scale)**

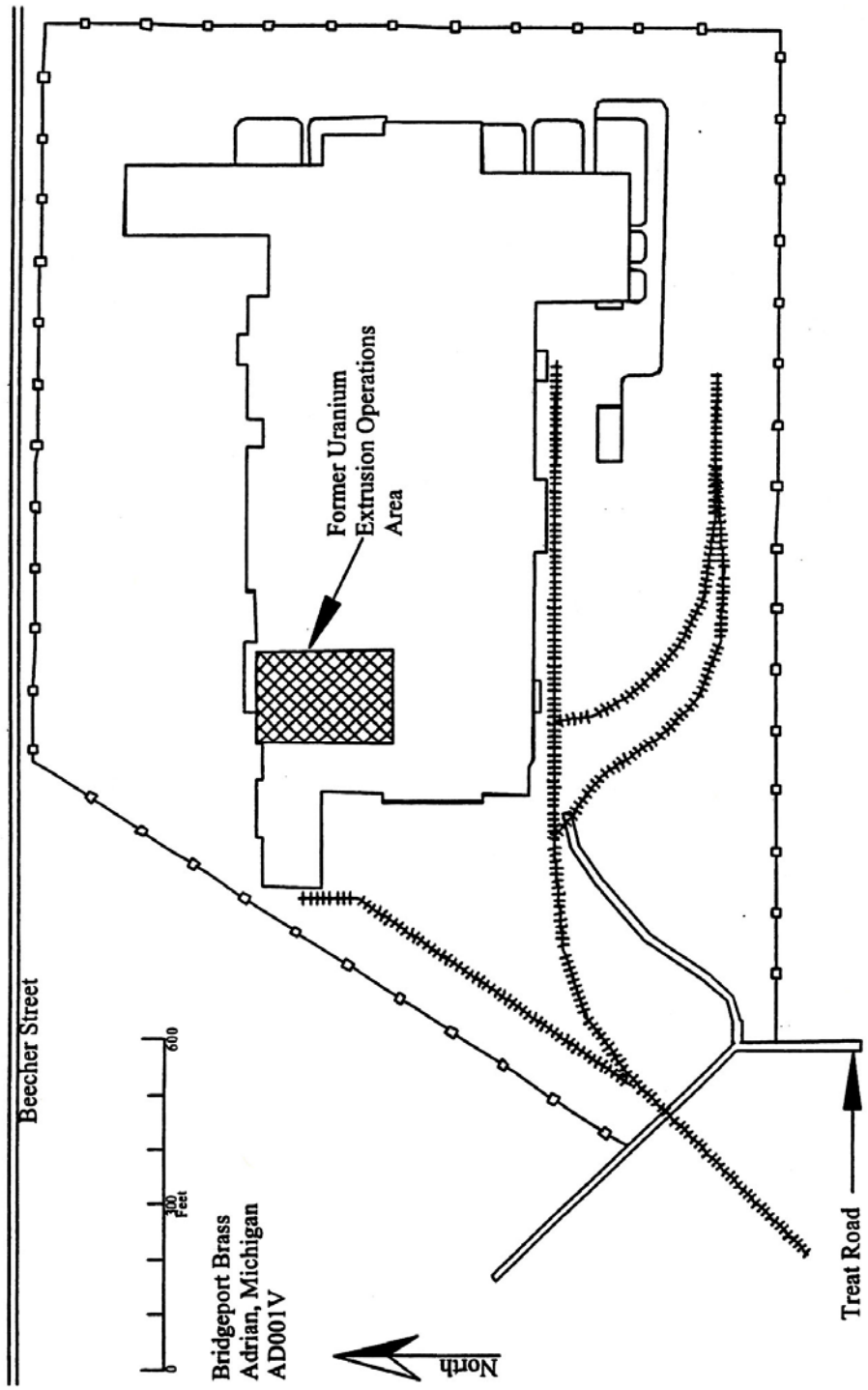


**Fig. 2. Diagram showing the former uranium extrusion operations area within the former Bridgeport Brass Special Metals Extrusion Plant in Adrain, Michigan.** (Scale is approximate)

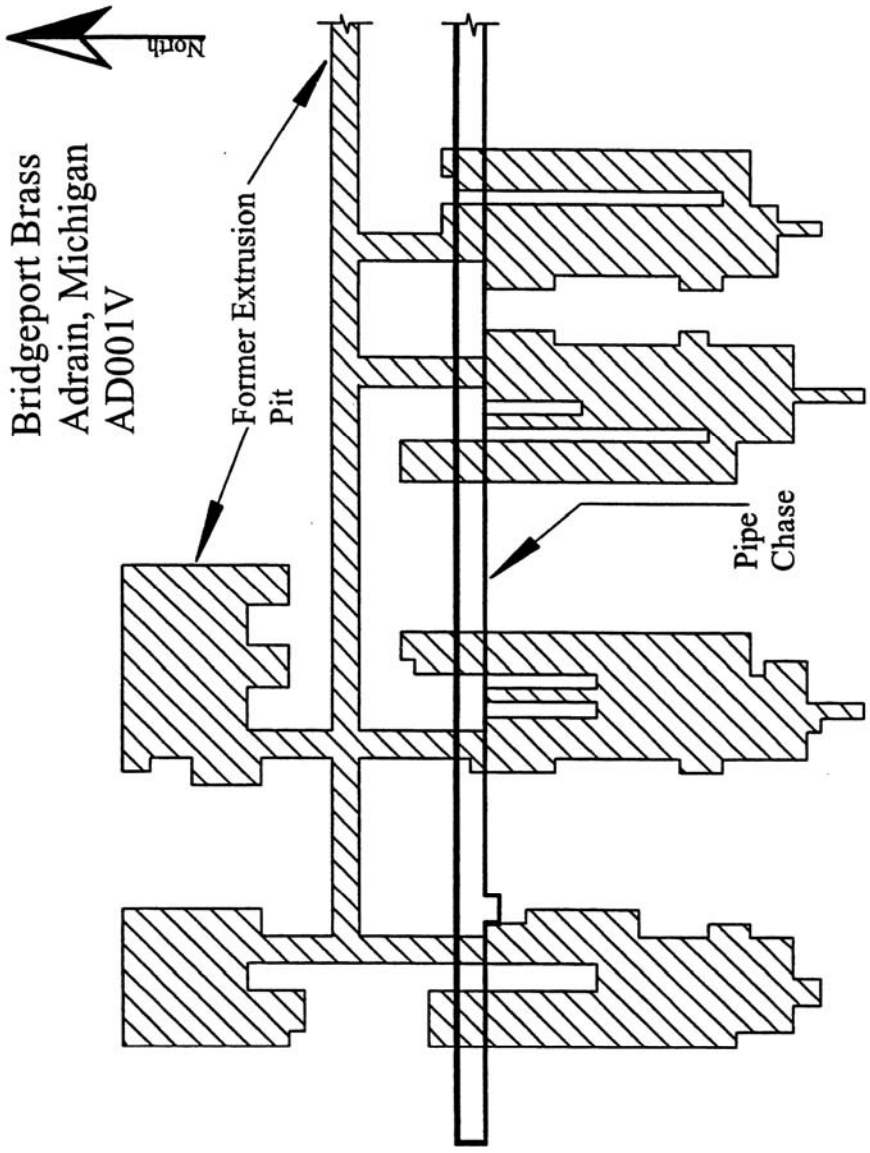


**Fig. 3. Diagram indicating the approximate location of the pipe chase in relation to the former extrusion pits and other areas in the building.** (Not to scale)

**Table 1. Applicable guidelines for protection against radiation**
(Limits for uncontrolled areas)

| Mode of exposure | Exposure conditions | Guideline value |
|---|---|---|
| Gamma radiation | Indoor gamma level (above background) | 20 $\mu$R/h[a] |
| Total residential surface contamination[b] | $^{238}$U, $^{235}$U, U-natural (alpha emitters) and Beta-gamma emitters[c] | |
| | Fixed and removable | |
| | Average | 15,000 dpm/100 cm2 |
| | Removable | 5,000 dpm/100 cm2 |
| | | 1,000 dpm/100 cm$^2$ |
| | Maximum dose rate in any 100-cm$^2$ | |
| | | 1.0 mrad/h |
| Concentrations in soil | Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m$^2$ | 5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface |
| | $^{226}$Ra | |
| | $^{232}$Th | |
| | $^{230}$Th | |
| Derived concentrations | DOE guidelines for uranium are derived on a site-specific basis. | Guidelines of 17.5-50 pCi/g averaged over a 100 m$^2$ have been applied at various DOE sites[d] |

[a]The 20 $\mu$R/h shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.
[b]DOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.
[c]Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except $^{90}$Sr, $^{228}$Ra, $^{223}$Ra, $^{227}$Ac, $^{133}$I, $^{126}$I, $^{125}$I.
[d]K. R. Kleinhans, M. E. Murray, and R. F. Carrier, *Results of the Independent Radiological Verification Survey of the Remedial Action Performed at the Former Alba Craft Laboratory Site, Oxford, Ohio (0X0001)*, ORNL/TM-12968, Lockheed Martin Energy Research Corp., Oak Ridge Natl. Lab., April 1996; J. W. Wagoner II, Director, Division of Off Site Programs, Office of Eastern Area Programs, Office of Environmental Restoration, U.S. DOE, "Uranium Guideline for the Maywood, New Jersey Site," memorandum to L. K. Price, Director, Former Sites Restoration Division Oak Ridge Operations, U.S. DOE, April 25,1994.

Sources: Adapted from U. S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, April 1990 and U.S. Department of Energy, *Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, Rev. 2, March 1987; and *U. S Department of Energy Radiological Control Manual*, DOE N5480.6 (DOE/EH-256T), June 1992.

**Table 2. Background radiation levels and concentrations of selected radionuclides in soil samples taken near Adrian, Michigan**

| | | |
|---|---|---|
| Average gamma exposure rate at lm above ground surface ($\mu$R/h)[a] | | 7.8 |
| Concentration of radionuclides in soil (pCi/g dry wt)[b] | | |
| | Range | Average |
| $^{238}$U | 0.7 - 1.1 | 0.95 |
| $^{226}$Ra | 1.2 - 2.0 | 1.5 |
| $^{232}$Th | 0.4 - 0.8 | .61 |

[a]Results of measurements taken at l location [C. L. Lindekin, K. R. Peterson, D. E. Jones, and R. E. McMillen, "Geographical Variations in Environmental Radiation Background in the United States," pp. 319-331 in *Proceedings of the Second International Symposium on the Natural Radiation Environment*, CONF-720805-P-1(1972)], and the mean of 23 locations [S.. G. Levin, R. K. Stoms, E. Kuerze, and W. Huskisson, "Summary of Natural Environmental Gamma Radiation Using a Calibrated Portable Scintillation Counter," *Radiol Health Data Rep.* **9** 679-695 (1968)] near Adrian, Michigan.

[b]Results of analysis of soil samples obtained from four locations near Adrian, Michigan.

Sources: F. F. Haywood, H. W. Dickson, W. D. Cottrell, W. H. Shinpaugh, J. E. Burden, D. R. Stone, R. W. Doane, and W. A. Goldsmith, *Radiological Survey of the Former Bridgeport Brass Company Special Metals Extrusion Plant, Adrian, Michigan*, DOE/EV-0005/28, ORNL-5713, Union Carbide Corp., Oak Ridge Natl. Lab., April 1982. T. E. Myrick, B. A. Berven, and F. F. Haymore, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7349, Union Carbide Corporation, Oak Ridge National Laboratory, November 1981.

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