ARGONNE NATIONAL LABORATORY
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ACTION DESCRIPTION MEMORANDUM

PROPOSED REMEDIAL ACTION ACTIVITIES AT THE UNIVERSITY OF CHICAGO

by

Energy and Environmental Systems Division

July 1987

work supported by

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations
Technical Services Division
Oak Ridge, Tennessee

CONTENTS

1 SUMMARY OF PROPOSED ACTION 1

2 HISTORY AND NEED FOR ACTION 3

2.1 General Setting 3
2.2 History of Site Activities 3

3 DESCRIPTION OF PROPOSED ACTION 8

4 ENVIRONMENTAL CONSEQUENCES 10

4.1 Radiological 10
4.2 Nonradiological 11

5 REFERENCES 13

6 LIST OF CONTRIBUTORS 14

APPENDIX A: DOE Guidelines for Residual Radioactive Material 15

APPENDIX B: State of Illinois Residual Contamination Guidelines 29

APPENDIX C: Letters from Illinois Historic Preservation Agency 31

FIGURES

1 Location of The University of Chicago, Chicago, Illinois 4

2 The University of Chicago Campus 7

TABLE

1 Properties at the University of Chicago Listed in the *National Register of Historic Places* 5

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1 SUMMARY OF PROPOSED ACTION

As part of its Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE), Oak Ridge Operations, proposes to perform remedial action activities in Jones Chemical Laboratory at the University of Chicago and to obtain additional data on the radiological condition of various nearby facilities. Portions of Jones Chemical Laboratory are radioactively contaminated as a result of programs previously conducted by the Manhattan Engineer District (MED) and the U.S. Atomic Energy Commission (AEC). The proposed action is a follow-on activity to previous remedial action conducted in 1984 and involves decontamination of ductwork, much of which is inside interior walls, in Jones Chemical Laboratory. In addition to this decontamination effort, the proposed action will also involve radiological characterization of sediment and water within drain lines of Jones Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall of the University of Chicago and within municipal sewer lines in the vicinity of the university. Radiological characterization of the sewer lines on the university campus was performed in 1984. DOE is also proposing to perform a limited radiological characterization of suspect areas on the roof and in the gutters of Jones Chemical Laboratory to determine if these areas are contaminated in excess of FUSRAP cleanup criteria.

Although the ductwork does not represent an immediate health hazard, it may be contaminated in excess of current cleanup criteria. The purpose of decontaminating the ductwork is to reduce the amount of residual radioactivity to levels below the established DOE cleanup criteria. The drain lines, roof, and gutters will be characterized to determine if additional decontamination activities should be performed in the future. Proposed project actions include:

- Identification of ductwork within Jones Chemical Laboratory that requires decontamination.

- Decontamination of contaminated ductwork, either by cleaning the ductwork to below allowable levels of residual radioactivity or by removal as radioactive waste.

- Packaging, in approved containers, of all radioactive wastes generated during decontamination activities.

- Transport to and disposal of the radioactive wastes at the Idaho National Engineering Laboratory (INEL) near Idaho Falls, Idaho; and transport to and disposal of the nonradioactive wastes at a nearby sanitary landfill.

- Certification that the radioactivity levels meet criteria for unrestricted use.

- Restoration (or monetary compensation) of the facilities as appropriate for intended future uses.

- Collection and analysis of samples from (1) drain lines within Jones Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall; (2) suspect areas on the roof and in the gutters of Jones Chemical Laboratory; and (3) municipal sewer lines in the vicinity of the university.

A more detailed description of the proposed action is given in Sec. 3.

2 HISTORY AND NEED FOR ACTION

2.1 GENERAL SETTING

The University of Chicago is a private university located in the Hyde Park-Kenwood area of the city of Chicago. The Hyde Park-Kenwood neighborhood covers an area of about 400 ha (1,000 acres) and is a residential community of more than 45,000 people; it is about 11 km (7 mi) south of the Chicago downtown business district (Fig. 1). The university covers an area of about 70 ha (172 acres) and has an enrollment of about 8,000 students. The university was founded in 1891 and contains buildings with architectural styles representing the past nine decades. A major portion of the University of Chicago is located within the Hyde Park-Kenwood National Historic District; in addition, six properties on campus are listed in the *National Register of Historic Places* (Table 1).

As part of FUSRAP, DOE is proposing to decontaminate ductwork in Jones Chemical Laboratory at the University of Chicago. This ductwork, much of which is inside interior walls, is radioactively contaminated above current guidelines as a result of programs previously conducted for the MED and AEC. In addition, DOE is proposing to radiologically characterize drain lines within Jones Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall; suspect areas on the roof and in the gutters of Jones Chemical Laboratory; and municipal sewer lines in the vicinity of the university.

2.2 HISTORY OF SITE ACTIVITIES

The University of Chicago was one of the focal points for activities conducted in support of atomic bomb development during World War II. The first contract with the university was initiated by the Office of Scientific Research and Development (OSRD) in January 1942. In June 1942, the MED was established within the U.S. Army Corps of Engineers; the contract with the University of Chicago was transferred from OSRD to MED on May 15, 1943.

The primary goal of the work performed at the university was to develop methods for the production and purification of plutonium. Because plutonium is produced when uranium absorbs neutrons, this work necessitated the construction of a facility that would maintain a self-sustaining nuclear chain reaction and, in turn, provide an intense source of neutrons. The first chain-reacting "pile" was constructed of uranium and graphite beneath the west stands of Stagg Field under the direction of Dr. Enrico Fermi. A self-sustaining condition was achieved on December 2, 1942, thereby demonstrating the feasibility of this technology for producing plutonium.

Additional research and development programs were conducted for the MED throughout World War II to support the atomic bomb project. Various laboratories and facilities at the university were used for these activities. On January 1, 1947, the AEC, a civilian organization, succeeded the military MED as the governmental organization in charge of nuclear programs. Research activities continued at the University of Chicago under the AEC. Research conducted under the MED/AEC during the 1940s and 1950s

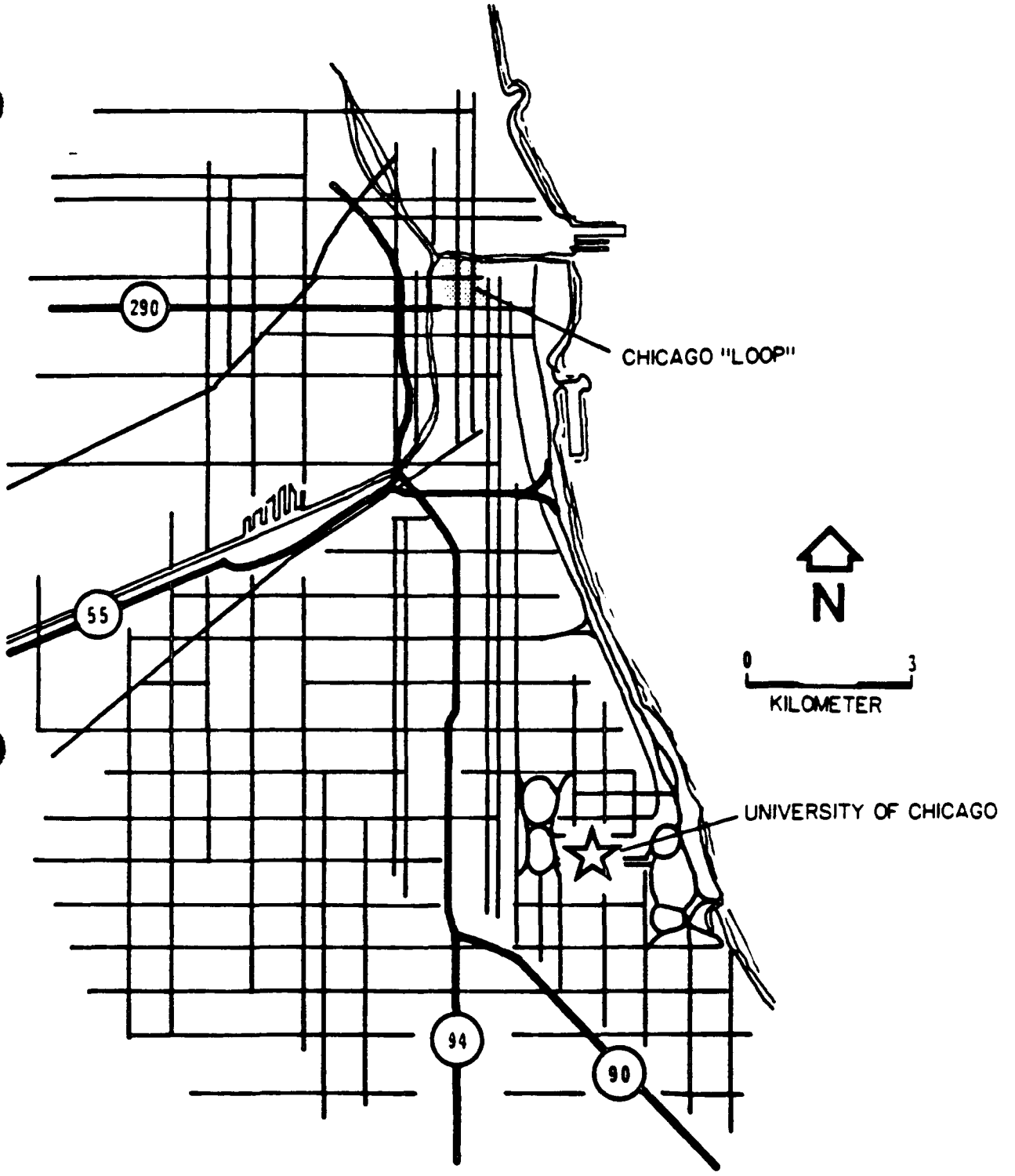

FIGURE 1 Location of the University of Chicago, Chicago, Illinois (Source: Argonne National Laboratory 1984)

TABLE 1 Properties of the University of Chicago Listed in the *National Register of Historic Places*

Property	Notoriety	Date Listed
SITE OF THE FIRST SELF-SUSTAINING NUCLEAR REACTION, 5630 South Ellis Avenue	Site of the first controlled, self-sustaining nuclear chain reaction; now marked by Henry Moore's sculpture, "Nuclear Energy."	10/15/66
FREDERICK C. ROBIE HOUSE, 5757 South Woodlawn Avenue	House designed by Frank Lloyd Wright, completed in 1909; the archetype for the prairie house design that revolutionized the architecture of the American home.	10/15/66
LORADO TAFT MIDWAY STUDIOS, 6016 South Ingleside Avenue	Constructed in 1929 by Lorado Taft from sections of the first campus studio that was built in 1906. The original brick barn continued to be Taft's private sculpture studio until his death in 1936.	10/15/66
ROOM 405, GEORGE HERBERT JONES CHEMICAL LABORATORY, 5747 South Ellis Avenue	Room where a group of scientists under the direction of Dr. Glenn T. Seaborg first isolated (Aug. 18, 1942) and weighed (Sept. 10, 1942) plutonium.	5/28/67
FRANK R. LILLIE HOUSE, 5801 South Kenwood Avenue	Designed by Irving and Allen Pond; regarded as an architectural landmark.	5/11/76
CHARLES HITCHCOCK HALL, 1009 East 57th Street	Designed by Dwight H. Perkins and constructed in 1902. This building combines the neo-Gothic architecture of nearby buildings with a "prairie" motif.	12/30/74

Source: U.S. Department of the Interior (1980).

included development of a process for producing high-purity uranium compounds, testing of uranium metal, research associated with operation of the pile, and plutonium separation (U.S. Dept. Energy 1980a, 1980b).

At the completion of these MED/AEC research activities, the facilities were decontaminated so that they met health and safety criteria then in use. However, radiological surveys were conducted in 1976 and 1977, and these surveys indicated that residual contamination in areas of four buildings -- Jones Chemical Laboratory, Kent Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall -- exceeded currently accepted criteria (see Fig. 2 for the location of these buildings). Decontamination of Kent Chemical Laboratory was completed by the University of Chicago, and Argonne National Laboratory (ANL) performed a post-remedial action survey of this decontamination effort in 1983.

Decontamination of the residual radioactivity in Jones Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall was accomplished by ANL in 1984, using standard procedures such as applying solvents on metals and scabbling concrete (an Action Description Memorandum describing this activity was prepared in 1983 [Argonne Natl. Lab. 1983]). Items and materials that could not be readily decontaminated, e.g., ductwork, were removed and replaced wherever possible. Hoods and ductwork suspected or known to be contaminated as a result of previous activities were removed wherever possible and disposed of as radioactive waste. Ductwork inside the walls of Jones Chemical Laboratory that was inaccessible without extensive demolition within the building and the connecting ductwork in the attic sections of the building are the ductwork that DOE is proposing to remove as part of this action. Items and areas affected by decontamination operations were restored or replaced (as determined on a case-by-case basis) subject to agreement between DOE, ANL, and the University of Chicago.

Radiological characterization of on-campus sewer lines associated with Jones Chemical Laboratory, Kent Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall was also performed in 1984. Sewers were surveyed with portable survey instruments at all available access points. In addition, water and/or sludge samples were taken at the access points, and these samples were radiochemically analyzed to ascertain the type and concentration of any radioactive contaminants. Although measurable levels of radioactive material were found in samples taken from the available access points, the need for any immediate remedial action for the sewer lines was determined to be unnecessary as long as the integrity of the system remains intact. In Jones Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall, DOE is proposing to do additional radiochemical surveys in the drain lines that lead to the on-campus sewer lines and in the nearby municipal sewer lines. DOE is also proposing to radiologically characterize suspect areas on the roof and in the gutters of Jones Chemical Laboratory to more thoroughly ascertain any potential contamination resulting from previous MED/AEC activities conducted at the university.

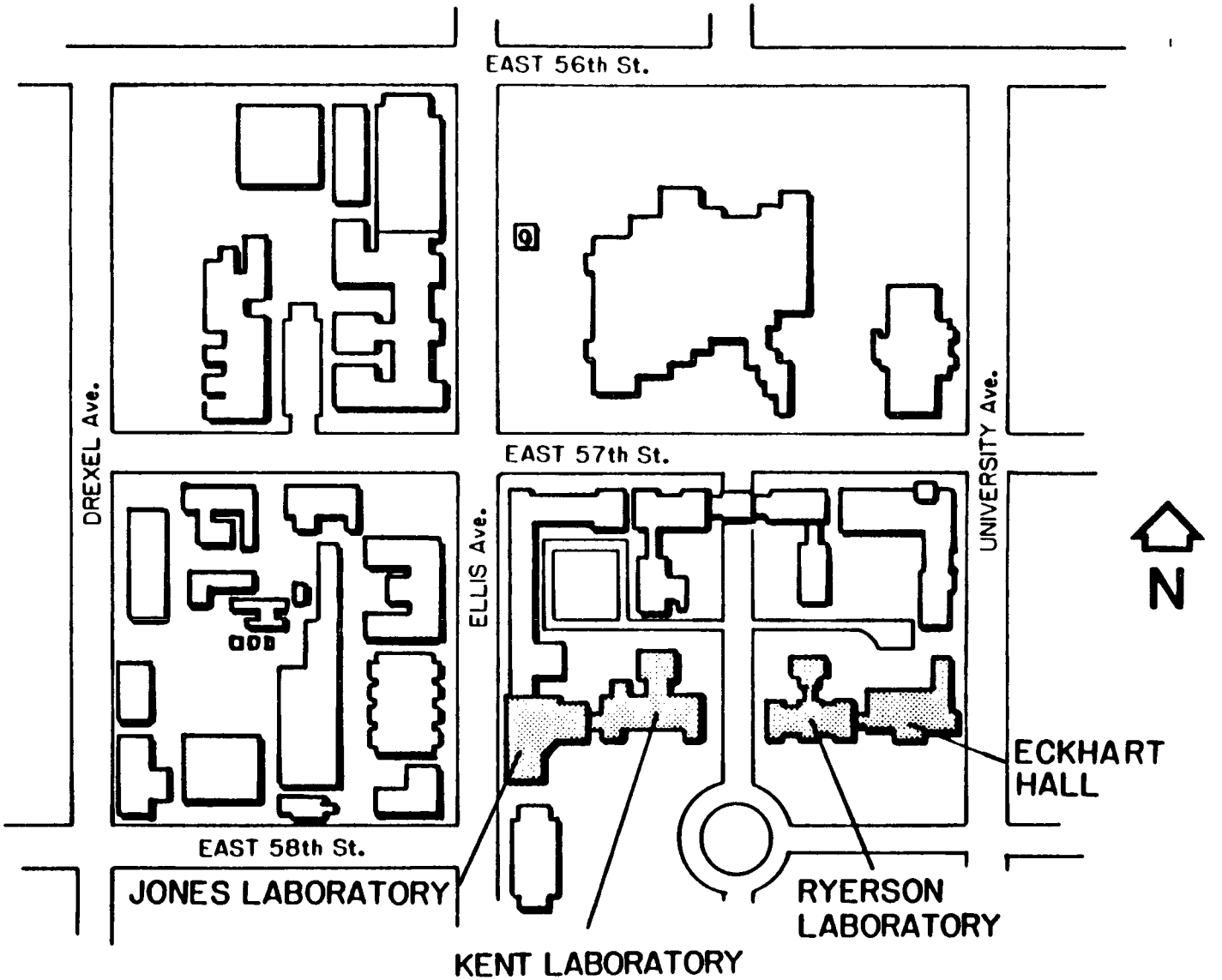

FIGURE 2 The University of Chicago Campus (Source: Argonne National Laboratory 1984)

3 DESCRIPTION OF PROPOSED ACTION

The potentially contaminated ductwork in Jones Chemical Laboratory will either be decontaminated in place or removed as radioactive waste. If decontamination of the ductwork is determined to be appropriate, the ductwork will be cleaned by vacuuming and/or by use of water or special cleaners. These solutions will remove the contamination but leave the surface material essentially intact. If it is necessary to remove portions of the ductwork contained within interior walls, the ductwork will be accessed by partial demolition of the walls as needed. Attic and wall ductwork will be removed in sections where possible. Additional areas in the vicinity of the ductwork will be decontaminated, as necessary. Appropriate precautions will be taken to protect against radiological and chemical hazards, e.g., asbestos. All wastes will be collected, placed in appropriate containers, and labeled. Decontamination will continue until residual radioactivity levels are as low as reasonably achievable (ALARA) and meet criteria developed for FUSRAP (App. A).*

All radioactive waste resulting from the decontamination effort will be transported off-site to an approved disposal site. The waste will be packaged in DOE-approved containers that meet or exceed U.S. Department of Transportation (DOT) requirements for shipment. Current plans call for shipment of the radioactive waste in ANL M-3 bins to Idaho National Engineering Laboratory (INEL) near Idaho Falls, Idaho; these bins have a nominal capacity of 3.4 m^3 (120 ft^3). Assuming that all ductwork in Jones Chemical Laboratory is removed as radioactive waste — a worst-case situation — decontamination of the ductwork is expected to generate approximately 82 m^3 (2,900 ft^3) of low-level radioactive waste. Any radioactive waste that contains chemically hazardous constituents will be packaged, transported, and disposed of in compliance with all applicable regulations. All nonsalvageable or otherwise unusable nonradioactive waste will be disposed of in a local sanitary landfill.

After decontamination, the affected areas will be restored in a manner consistent with their intended future uses. All decontamination activities will be performed by Bechtel National, Inc. (BNI), DOE's project management contractor. Because the areas to be decontaminated are currently being used, it will be necessary to schedule activities with the University of Chicago to minimize disruption of ongoing activities. Restoration requirements will be subject to concurrence by the university and will either be performed by BNI or the university will be monetarily compensated such that it can perform its own restoration activities.

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*The state of Illinois also has surface contamination limits for releasing facilities for uncontrolled use (Ill. Dept. Nucl. Saf. 1981; see App. B). These limits are similar to those developed for FUSRAP but are not radionuclide-specific. The state of Illinois criteria are less stringent than the strictest criteria for FUSRAP — i.e., those for transuranic radionuclides (see Sec. C.4 of App. A). Because the ductwork is probably contaminated with transuranic radionuclides, it will be necessary to decontaminate to levels more stringent than the state limits to meet the FUSRAP cleanup criteria.

It is expected that decontamination will be initiated by the end of July 1987 and completed in September 1987. Following completion of decontamination, the affected areas of Jones Chemical Laboratory will be radiologically surveyed by an Independent Verification Contractor to ensure compliance with applicable cleanup criteria. If necessary, additional selected areas will be decontaminated.

Biased samples of sediment and water from drain lines in Jones Chemical Laboratory, Ryerson Physical Laboratory, and Eckhart Hall that lead to on-campus sewer lines will be collected and analyzed for radioactive contamination. In addition, samples of sediment and water from Chicago municipal sewer lines will be collected upstream and downstream of the university. These samples will be analyzed for radioactive species utilized at the university to determine if increased levels of radioactive materials are present in the municipal sewer lines as a result of university activities. Finally, a limited radiological characterization of suspect areas on the roof and in the gutters of Jones Chemical Laboratory will be performed to assess the need for any future decontamination activities.

4 ENVIRONMENTAL CONSEQUENCES

4.1 RADIOLOGICAL

The incremental radiation doses to the general public from decontamination of the contaminated ductwork in Jones Chemical Laboratory and from transport of the radioactive waste to INEL, as well as from the additional radiological characterization activities, will be immeasurably small compared with doses received from background sources of radiation. The amount of contamination in the ductwork should be very small given the use of chemical laboratories at the university for small-scale experimentation and the use of the ductwork as a conveyance medium for ventilation air moving at a rather fast velocity. No data are currently available on the amount of contamination remaining within the ductwork.

The work environment will be monitored for airborne radioactivity during remedial action activities and, if measurable concentrations of radioactivity are detected, corrective actions will be implemented to confine the radioactivity (i.e., use of localized ventilation). This will ensure that radiation doses to the general public will be kept immeasurably small.

The potential radiation doses to workers performing the remedial action will be kept as low as reasonably achievable (ALARA) by standard health-physics practices and strict compliance with DOE environmental protection, safety, and health protection guidelines given in DOE Order 5480.1A.* Because the measured exposure rates at 1 m from the surface are all at essentially background levels, no external radiation hazard exists. The only pathway by which workers could incur radiation doses in excess of background exposure is by inhalation of airborne radioactive contaminants generated during the decontamination and waste-packaging activities. Radioactive waste-handling and transportation activities will comply with all applicable DOE, DOT, and state of Illinois requirements.

The potential doses to workers will be kept low by minimizing the amount of airborne contamination through standard practices such as wetting surfaces to minimize dust generation and using localized ventilation. In addition, workers will wear respiratory protection equipment, as necessary, to reduce the likelihood of inhaling radioactively contaminated particulates. To ensure a safe environment, air samples will be collected during the entire remedial action period. Procedures to minimize radiation doses will also serve to minimize exposure to any hazardous chemicals that may be present, e.g., asbestos.

The occupational dose commitment was estimated by assuming that a total of 1 μCi of alpha-emitting radioactivity is present in the ductwork. The ductwork is assumed to be removed, resulting in a greater airborne release of radioactivity than if the ductwork was flushed with water or industrial cleaners and left intact. The

*Chapter XI of Order 5480.1A has been amended -- see Vaughan (1985) and U.S. Department of Energy (1986).

contamination is assumed to be plutonium-239 having a deposition velocity of 1 cm/s and a particulate resuspension rate of 1×10^{-6}/s (i.e., 1×10^{-6} of the total amount of contamination in the ductwork is released per second). This deposition velocity and resuspension rate are assumed to be representative of those associated with mechanical disturbances such as are required to section and remove the ductwork. The airborne concentration of plutonium-239 is estimated to be about 0.1 pCi/m^3.

The total length of time associated with decontamination activities is estimated to be 400 hours. During all activities that have the potential for generating airborne radioactivity, it is assumed that workers will wear respiratory protection equipment providing a protection factor of 10 (the same factor that is provided by half-masks — see 10 CFR Part 20). A worker is estimated to incur a dose of about 1.6 mrem during the 400-hour period, assuming a breathing rate of 1.2 m^3/h and a lung clearance class of Y. This dose estimate is based on the dose conversion factors recommended by the International Commission on Radiological Protection (1979). The entire occupational dose commitment to a crew of 10 workers is estimated to be 16 person-mrem. The same work force would incur a dose of about 400 person-mrem from background sources of radioactivity over the same time period. The occupational dose commitment associated with transportation of the wastes to INEL and with radiological characterization activities will be much lower than that associated with removal of the contaminated ductwork.

4.2 NONRADIOLOGICAL

The nonradiological impacts of the proposed action are expected to be minimal. There will be no impacts on surface water or groundwater because current plans do not include any discharges to water bodies and the only below-grade activities involve collection of sediment and water samples from drain lines and municipal sewer lines. There may be small nonradioactive atmospheric releases related to ductwork removal activities, but such releases will be low and further mitigated by using such procedures as localized ventilation during removal activities. Impacts on local biota at the university will be negligible because activities will occur largely within Jones Chemical Laboratory. Transportation of the wastes to INEL will not have a significant impact along the transportation route because only four or five truckloads will be required according to current projections.

The proposed action will have a negligible effect on the local economy due to the relatively small size of the work force and the short duration of the proposed decontamination activities. Because Jones Chemical Laboratory is located at the University of Chicago, there will be limited impact on local traffic patterns, residences, and businesses. The small increase in noise during decontamination activities may cause a short-term nuisance to students and faculty at the university, but such nuisance is expected to be minimal.

It is possible that portions of the ductwork may contain deposits of perchloric acid, perchlorates, picric acid, and picrates as a result of the ductwork's previous use for ventilating laboratories in which perchloric acid and picric acid were used. Perchloric acid and perchlorates are explosive hazards, especially in contact with organic materials

that are likely to be present in the ducts; picric acid and picrates are also explosive. To eliminate these potential hazards, the ductwork will be thoroughly examined for deposits of perchloric acid, perchlorates, picric acid, and picrates. If any such deposits are found, they will be removed or neutralized prior to decontamination or removal of the ductwork.

Because the proposed action would affect structures located within a National Historic Preservation District (and one of the rooms in Jones Chemical Laboratory is also listed separately in the *National Register of Historic Places*), the Illinois State Historic Preservation Agency was asked to determine if there might be any potential adverse impacts on these structures. On July 29, 1987, the agency concluded that the proposed action would have "no effect" on the historic structures (Hild 1987; see Appendix C).

5 REFERENCES

Argonne National Laboratory, 1983, *Action Description Memorandum, Proposed Decontamination of Three Buildings at the University of Chicago Contaminated as a Result of Previous MED/AEC Activities*, prepared by Environmental Research Division for U.S. Department of Energy, Oak Ridge Operations Office, Dec.

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U.S. Department of the Interior, 1980, *National Register of Historic Places*, Fed. Regist. *45*(54):17446-17517, March 18.

Vaughan, W.A., 1985, memorandum on Radiation Standards for Protection of the Public in the Vicinity of DOE Facilities, from W.A. Vaughan (U.S. Department of Energy, Assistant Secretary for Environment, Safety and Health) to Distribution, Aug. 5.

6 LIST OF CONTRIBUTORS

Name	Education/Expertise	Contribution
John F. Hoffecker	Ph.D. Anthropology 14 yr experience in archeological research 4 yr experience in environmental assessment	General setting and non-radiological impacts
John M. Peterson	M.S., P.E. Nuclear Engineering 12 yr experience in nuclear programs, including 9 yr in environmental assessment	History, radiological environment, description of proposed action
John H.C. Wang	Ph.D. Health Physics 6 yr experience in health physics	Radiological impacts
Dimis J. Wyman	M.S. Botany; M.A. Library Science 12 yr experience in technical editing	Overall editorial responsibility

APPENDIX A

DOE GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

U.S. DEPARTMENT OF ENERGY GUIDELINES
FOR RESIDUAL RADIOACTIVE MATERIAL AT
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM
AND
REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Revision 2, March 1987)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).* The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987), referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material and to protect the public and the environment are provided for (1) residual concentrations of radionuclides in soil,** (2) concentrations of airborne

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*A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

**"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and DOE Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are used only when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactivity or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

An "authorized limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The authorized limits for a site will include (1) limits for each radionuclide or group of radionuclides, as appropriate, associated with residual radioactive material in soil or in surface contamination of structures and equipment, (2) limits for each radionuclide or group of radionuclides, as appropriate, in air or water, and, (3) where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F of this document. A site may be released for unrestricted use only if site conditions do not exceed the authorized limits or approved supplemental limits, as defined in Section F.1, at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if site conditions exceed the approved limits, or if there is potential to exceed the basic dose limit if use of the site is not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus the dose from penetrating radiation sources external to the body, shall be used for determining the dose. This dose shall be described as the "effective dose equivalent". Every effort shall be made to ensure that actual doses to the public are as far below the basic dose limit as is reasonably achievable.

Under unusual circumstances, it will be permissible to allow potential doses to exceed 100 mrem/yr where such exposures are based upon scenarios that do not persist for long periods and where the annual lifetime exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/yr. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbable, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m^2. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters,

limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface

- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit or (2) the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR Part 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive material is not the cause.

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*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an appropriate-use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit, considering an appropriate-use scenario for the area.

C.4 Surface Contamination

The generic surface contamination guidelines provided in Table 1 are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory Commission (NRC 1982)* and will be applied in a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

Authorized limits shall be established to (1) ensure that, as a minimum, the basic dose limits specified in Section B will not be exceeded under the worst-case plausible-use scenario consistent with the procedures and guidance provided or (2) be consistent with applicable generic guidelines, where such guidelines are provided. The authorized limits for each site and its vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site-specific data -- including health, safety, and socioeconomic considerations -- that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or provide a level of protection equivalent to other appropriate limits and guidelines (i.e., state or

*These guidelines are functionally equivalent to Section 4 -- Decontamination for Release for Unrestricted Use -- of NRC Regulatory Guide 1.86 (U.S. Atomic Energy Commission 1974), but they are applicable to non-reactor facilities.

TABLE 1 SURFACE CONTAMINATION GUIDELINES

Radionuclides[b]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[a]		
	Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β-γ	15,000 β-γ	1,000 β-γ

[a] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because the documentation covers the entire site.

Remedial action shall not be considered complete unless the residual radioactive material levels comply with the authorized limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should be considered only if it is clearly demonstrated that it is not reasonable to decontaminate the area to the authorized limit or guideline value. The authorized limits are developed through the project offices in the field and are approved by the headquarters program office.

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and subsequent guidance or superceding Orders require compliance with applicable Federal and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

a. 5000.3, Unusual Occurrence Reporting System

b. 5440.1C, Implementation of the National Environmental Policy Act

c. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations, as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution

d. 5480.2, Hazardous and Radioactive Mixed Waste Management

e. 5480.4, Environmental Protection, Safety, and Health Protection Standards

f. 5482.1A, Environmental, Safety, and Health Appraisal Program

g. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities

h. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.

b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed (1) 100 pCi/L at any given point, (2) an annual average concentration of 30 pCi/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-1).

c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive material shall not exceed existing Federal or state standards.

d. Access to a site shall be controlled and misuse of on-site material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, an effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

a. A site may be released under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material is in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.

b. The administrative controls, as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.

c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.

b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the wastes shall not (1) exceed an annual average release rate of 20 $pCi/m^2/s$ and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.

c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).

d. Groundwater shall be protected in accordance with appropriate Departmental Orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.

e. Access to a site should be controlled and misuse of on-site material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site-specific circumstances indicate that the guidelines or authorized limits established for a given site are not appropriate for a portion of that site or for a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field office must justify that the subject guidelines or authorized limits are not appropriate and that the alternative action will provide adequate

protection, giving due consideration to health and safety, the environment, and costs. The field office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section (F) and in the FUSRAP and SFMP protocols and subsequent guidance documents. The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to ensure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of a site and/or vicinity property. Supplemental limits may be applied to a vicinity property or a portion of a site if, on the basis of a site-specific analysis, it is determined that (1) certain aspects of the vicinity property or portion of the site were not considered in the development of the established authorized limits and associated guidelines for that vicinity property or site and, (2) as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

F.2 Exceptions

Exceptions to the authorized limits defined for unrestricted use of a site or vicinity property may be applied to a vicinity property or a portion of a site when it is established that the authorized limits cannot be achieved and restrictions on use of the vicinity property or portion of the site are necessary to provide adequate protection of the public and the environment. The field office must clearly demonstrate that the exception is necessary and that the restrictions will provide the necessary degree of protection and will comply with the requirements for control of residual radioactive material as set forth in Section E of these guidelines.

F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case-by-case basis using site-specific data. Every effort should be made to minimize use of the supplemental limits and exceptions. Examples of specific situations that warrant use of the supplemental standards and exceptions are:

a. Where remedial action would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.

b. Where remedial action -- even after all reasonable mitigative measures have been taken -- would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

c. Where it is clear that the scenarios or assumptions used to establish the authorized limits do not, under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.

d. Where the cost of remedial action for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive material does not pose a clear present or future risk after taking necessary control measures. The likelihood that buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial action will generally not be necessary where only minor quantities of residual radioactive material are involved or where residual radioactive material occurs in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples include residual radioactive material under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the level of residual radioactive material must be included in the appropriate state and local records.

e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
- Basic Dose Limits	
Dosimetry model and dose limits	International Commission on Radiological Protection (1977, 1978)
Generic Guidelines for Residual Radioactivity	
Residual concentrations of radium and thorium in soil	40 CFR Part 192
Airborne radon decay products	40 CFR Part 192
External gamma radiation	40 CFR Part 192
Surface contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
Control of Radioactive Wastes and Residues	
Interim storage	DOE Order 5480.1A and subsequent guidance
Long-term management	DOE Order 5480.1A and subsequent guidance; 40 CFR Part 192; DOE Order 5820.2

H. REFERENCES

International Commission on Radiological Protection, 1977. Recommendations of the International Commission on Radiological Protection (Adopted January 17, 1977). ICRP Publication 26. Pergamon Press, Oxford. [As modified by "Statement from the 1978 Stockholm Meeting of the ICRP." Annals of the ICRP, Vol. 2, No. 1, 1978.]

International Commission on Radiological Protection, 1978. Limits for Intakes of Radionuclides by Workers. A Report of Committee 2 of the International Commission on Radiological Protection. Adopted by the Commission in July 1978. ICRP Publication 30. Part 1 (and Supplement), Part 2 (and Supplement), Part 3 (and Supplements A and B), and Index. Pergamon Press, Oxford.

U.S. Atomic Energy Commission, 1974. Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors. June 1974.

U.S. Department of Energy, 1986. Formerly Utilized Sites Remedial Action Program. Summary Protocol: Identification - Characterization - Designation - Remedial Action - Certification. Office of Nuclear Energy, Office of Terminal Waste Disposal and Remedial Action, Division of Remedial Action Projects. January 1986.

U.S. Department of Energy, 1987. Supplement to U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites. A Manual for Implementing Residual Radioactive Material Guidelines. Prepared by Argonne National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest Laboratory for the U.S. Department of Energy. [In press.]

U.S. Environmental Protection Agency, 1983. Standards for Remedial Actions at Inactive Uranium Processing Sites; Final Rule (40 CFR Part 192). Federal Register 48(3):590-604 (January 5, 1983).

U.S. Nuclear Regulatory Commission, 1982. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material. Division of Fuel Cycle and Material Safety, Washington, D.C. July 1982.

APPENDIX B

STATE OF ILLINOIS RESIDUAL CONTAMINATION GUIDELINES

	Allowable Residual Surface Contamination ($dpm/100\ cm^2$)	
	Average	Maximum
Alpha Emitters		
Removable	33	100
Total	1,000	5,000
	0.25 mrem/h at 1 cm	
Beta-Gamma Emitters		
Removable (except H-3)	220	1,100
(H-3)	2,200	11,000
Total (fixed)	0.25 mrem/h at 1 cm	

Source: Illinois Department of Nuclear Safety, 1981, *Regulations for Radiation Protection,* Springfield, Ill.

APPENDIX C

LETTERS FROM ILLINOIS HISTORIC PRESERVATION AGENCY

Illinois Historic Preservation Agency
Old State Capitol • Springfield • 62701

217/785-4512

COOK COUNTY
Chicago
Eckhart Lab
(University of Chicago)

July 29, 1987

Mr. John F. Hoffecker
Energy & Environmental Systems Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Hoffecker:

We have reviewed the proposed project to perform radiological decontamination and characterization at the University of Chicago for the above mentioned building.

In our opinion, the project as proposed will have no effect on the Hyde Park - Kenwood Historic District which was listed on the National Register of Historic Places on February 14, 1979. We, therefore, have no objection to the undertaking proceeding as planned.

A copy of this letter should be kept on file as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended.

If you have any questions, please contact Anne Haaker, Cultural Resources Coordinator at 217/785-3977.

Sincerely,

Theodore Hild

Theodore W. Hild
Deputy State Historic
Preservation Officer

THH:AMH:bv

cc: Julia Hertenstein
U.S. Department of Energy

Illinois Historic Preservation Agency

Old State Capitol • Springfield • 62701

217/785-4512

COOK COUNTY
Chicago
George Herbert Jones Laboratory - Room 405
(University of Chicago)

July 29, 1987

Mr. John F. Hoffecker
Energy & Environmental Systems Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

Dear Mr. Hoffecker:

We have reviewed the proposed project to perform radiological decontamination and characterization at the University of Chicago for the above mentioned building.

In our opinion, the project as proposed will have no effect on the George Herbert Jones Laboratory - Room 405 which was listed on the National Register of Historic Places on May 28, 1967. We, therefore, have no objection to the undertaking proceeding as planned.

A copy of this letter should be kept on file as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended.

If you have any questions, please contact Anne Haaker, Cultural Resources Coordinator at 217/785-3977.

Sincerely,

Theodore Hild

Theodore W. Hild
Deputy State Historic
Preservation Officer

TWH:AMH:bv

cc: Julia Hertenstein
U.S. Department of Energy

Illinois Historic Preservation Agency

Old State Capitol • Springfield • 62701

217/785-4512

COOK COUNTY
Chicago
Ryerson Physical Laboratory
(University of Chicago)

July 29, 1987

Mr. John F. Hoffecker
Energy & Environmental Systems Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

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In our opinion, the project as proposed will have no effect on the Hyde Park - Kenwood Historic District which was listed on the National Register of Historic Places on February 14, 1979. We, therefore, have no objection to the undertaking proceeding as planned.

A copy of this letter should be kept on file as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended.

If you have any questions, please contact Anne Haaker, Cultural Resources Coordinator at 217/785-3977.

Sincerely,

Theodore Hild

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cc: Julia Hertenstein
U.S. Department of Energy