FINAL

RECORD OF DECISION FOR THE MADISON SITE

MADISON, ILLINOIS

MAY 2000

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter(s)
COC	chemical contaminant of concern
DOE	United States Department of Energy
ft	feet
ft^2	square feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
HI	Hazard index
HQ	Hazard quotient
IDNS	Illinois Department of Nuclear Safety
IEPA	Illinois Environmental Protection Agency
in	inch(es)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MED/AEC	Manhattan Engineer District/Atomic Energy Commission
mrem/yr	millirem per year
NCP	National Contingency Plan
NRC	United States Nuclear Regulatory Commission
pCi/g	picocuries per gram
RESRAD	software program for conducting radiation dose and risk assessment calculations
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure
ROD	Record of Decision
TEDE	total effective dose equivalent
TEDE/DCF	total effective dose equivalent/dose conversion factor
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
yd^3	cubic yard(s)

PART 1

DECLARATION FOR THE RECORD OF DECISION

PART 1 DECLARATION FOR THE RECORD OF DECISION

Site Name and Location

Madison FUSRAP Site (Former Dow Chemical Company)
1001 College Street
Madison, Illinois 62060

Statement of Basis and Purpose

The Madison Site has been evaluated by the St. Louis District of the United States Army Corps of Engineers (USACE) under the Formerly Utilized Sites Remedial Action Program (FUSRAP). Residual radioactivity remains on overhead surfaces in Buildings 6 and 4 from contract activities conducted for the Atomic Energy Commission (AEC), a predecessor agency of the United States Department of Energy (DOE). A Remedial Investigation (RI) and Feasibility Study (FS) was conducted to investigate residual radioactivity from historical AEC-funded operations and to evaluate the potential dose to workers. This Record of Decision (ROD) identifies a selected remedy for removing contamination from overhead areas in Buildings 6 and 4 of the facility based on the potential risks to human health and the environment. The remedial action has been selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Contingency Plan (NCP).

The USACE is the lead agency for the response action selected in this ROD. The USACE is conducting this response action under the legislative authority contained in Public Law 106-60, the Energy and Water Development Appropriations Act for Fiscal Year 2000. This law establishes the authority of USACE to conduct response actions related to the nation's early atomic energy program as the lead federal agency, subject to CERCLA and the NCP. The Illinois Department of Nuclear Safety (IDNS), the Illinois Environmental Protection Agency (IEPA) and U.S. Environmental Protection Agency (USEPA) have been given the opportunity to participate in the evaluation of the alternatives. The IDNS agreed that removal of contamination at the Madison Site is the only responsible approach (IDNS, 2000). The IEPA, has deferred decisionmaking at the Madison Site, to IDNS, the State of Illinois agency responsible for regulating radiological contamination (IEPA, 2000).

Assessment of the Site

The selected remedy in this ROD was chosen to protect workers from actual or threatened releases of hazardous substances from historical AEC-funded operations from the Madison Site. The selected remedy is designed to reduce the potential threats to human health and the environment to acceptable levels.

Description of the Selected Remedy

The selected remedy, Alternative 4 (Decontamination of Accessible Areas) is the final remedy for the Madison Site. This remedy will remove accessible uranium contamination in dust, which is the only contaminant of concern (COC) for this FUSRAP response action, from the overhead steel beams at 7.6-m and 11-m (25-ft and 36-ft) elevations in Buildings 6 and 4 at the Madison Site. The affected areas will be vacuumed, scraped and brushed, and wiped down with cloths, as required. These areas will then be surveyed to verify compliance with the applicable or relevant and appropriate requirement (ARAR). The major components of the selected remedy are described below:

- The radiation dose to the average member of the critical group (an overhead utility worker) will not exceed the ARAR of 25 millirem per year (mrem/yr) as defined in 10 CFR Part 20, Subpart E.

- A post-remedial action dose assessment will be performed to demonstrate compliance with the ARAR of 25 mrem/yr.

- Uranium contaminated surfaces on the overhead steel beams will be decontaminated using vacuuming, scraping and brushing, and wiping to meet the 25 mrem/yr dose limits. This dose corresponds to a remediation goal of 6,000 dpm/100 cm^2 for surficial contamination or 20 picocuries per gram (pCi/g) of total uranium for volumetric contamination. A separate remediation goal of 300 pCi/g was calculated for the difficult-to-access areas again based on the 25 mrem/yr limit and conditions specific to the difficult-to-access areas.

- Controls and monitoring will be implemented during the remedial action to ensure worker and public protection, and to eliminate the spread of contamination to floors and equipment.

- Material will be transported for off-site disposal at a licensed or permitted facility.

- Decontaminated surfaces will be painted and restored, as required;

- A final status survey using protocols compatible with NUREG-1575, the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), will be conducted to demonstrate compliance with the unrestricted use criteria in the ARAR and the results documented in a Post-Remedial Action Report.

- Difficult-to-access areas, defined as those areas above the window sills at an elevation from 13.7 to 18.3 meters (m) [45 to 60 feet (ft)] above the area containing the uranium extrusion press, are below the remediation goal for that area and will not be decontaminated.

- Supplemental dose calculations show that the potential dose to the utility worker in the difficult-to-access areas is 2.5 mrem/yr. This dose meets the ARAR and is ALARA.

Statutory Determinations

The selected remedy for the Madison Site has been determined to be protective of human health and the environment, to comply with Federal and State requirements that are ARARs to the remedial action, and to be cost effective. The selected remedy of decontamination will result in a permanent solution for removal of residual radioactivity so that the radiation dose to a worker meets the ARAR of 25 mrem/yr.

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy since it would be impracticable to treat such a small volume of material. Uranium contamination in the dust on overhead steel beams does not constitute a principal threat waste as defined in the NCP §300.430(a)(l)(iii)(A).

Because the selected remedy removes residual radioactivity and there are no reliances on institutional control, a five-year review will not be required for this remedial action.

ROD Data Certification Checklist

The following information may be found in the Decision Summary (Part 2) of this Record of Decision. Additional information can be found in the Administrative Record file for the Madison Site maintained by the USACE FUSRAP Project Office in Berkeley, Missouri and the Madison Public Library in Madison, Illinois.

Record of Decision Data Checklist Item	Decision Summary Page Number
☑ Contaminants of concern (COCs) and their respective concentrations	8, 9
☑ Baseline risk represented by the COCs	8
☑ Cleanup levels established for the COCs and the basis for these levels	11
☑ How source materials constituting principal threats are addressed	No principal threat wastes identified; page 16
☑ Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of ground water used in the Baseline Risk Assessment and Record of Decision	Ground water is not a significant pathway; page 10
☑ Potential land use that will be available at the site as a result of the selected remedy	8
☑ Estimated capital, annual operation and maintenance, and the total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	18
☑ Key factor(s) that led to selecting the remedy	18

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Hans A. Van Winkle — Date
Deputy Commander for Civil Works

PART 2

DECISION SUMMARY

PART 2 DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

The Madison Site is an industrial complex located east of St. Louis, Missouri, on the eastern side of the Mississippi River in Madison, Illinois (Figure 1). The plant was used to perform extrusions of uranium metal and straightening of extruded uranium rods for the AEC, during the late 1950s and early 1960s. This work was conducted by the Dow Metal Products Division of Dow Chemical Company (Dow) under subcontract to the Uranium Division of the Mallinckrodt Chemical Works (Mallinckrodt). Research was conducted at the plant to determine what factors in the extrusion of uranium metal affected the selection of tools and auxiliary supplies for use at a planned extrusion press to be located at another AEC production facility. The work included researching the properties of various die metals, the contour of the die cavity, the nature of the lubricant to apply to the uranium metal, the composition of the “follower block” (the material placed between the uranium metal and the ram press), and the speed at which the metal could be extruded. At least two rod straightening campaigns occurred at the Madison Site. Records suggest a small quantity of uranium was involved in these operations. Mallinckrodt retained accountability for the uranium throughout the operations and was responsible for both removing unused uranium and for cleanup of facilities following operations. These historical AEC-funded operations resulted in residual radiological contamination on overhead steel beams in Buildings 6 and 4 at the plant.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The RI/FS was performed to characterize the site and to identify and evaluate remedial alternatives for the Madison Site. The site, which is currently operated by Spectrulite Consortium, Inc., (current owner/operator) is being addressed by the USACE under FUSRAP. In 1974, Congress established FUSRAP to address contamination generated by the activities of the Manhattan Engineer District/Atomic Energy Commission (MED/AEC) during the development of atomic weapons in the 1940s and 1950s. Congress transferred the responsibility for this program from the DOE to the USACE in the 1997 Energy and Water Development Appropriations Act. Public Law 106-60, the Energy and Water Appropriations Act for Fiscal Year 2000 continues to authorize USACE as the lead agency for FUSRAP to conduct activities, which address the presence of MED/AEC-related contamination, subject to the requirements of CERCLA and the NCP.

Historically, the Madison Site has been used as a metal (non-uranium) processing facility under multiple plant owners. A separate, IDNS-licensed process is being conducted by the current facility owners that involves natural thorium. This thorium is not related to the AEC uranium contamination and is not significantly co-located with the AEC uranium contamination, as shown by the data from the RI (USACE, 2000a). The USACE is only authorized to address uranium contamination resulting from the historical AEC-funded operations. There are no known enforcement actions related to the uranium processing.

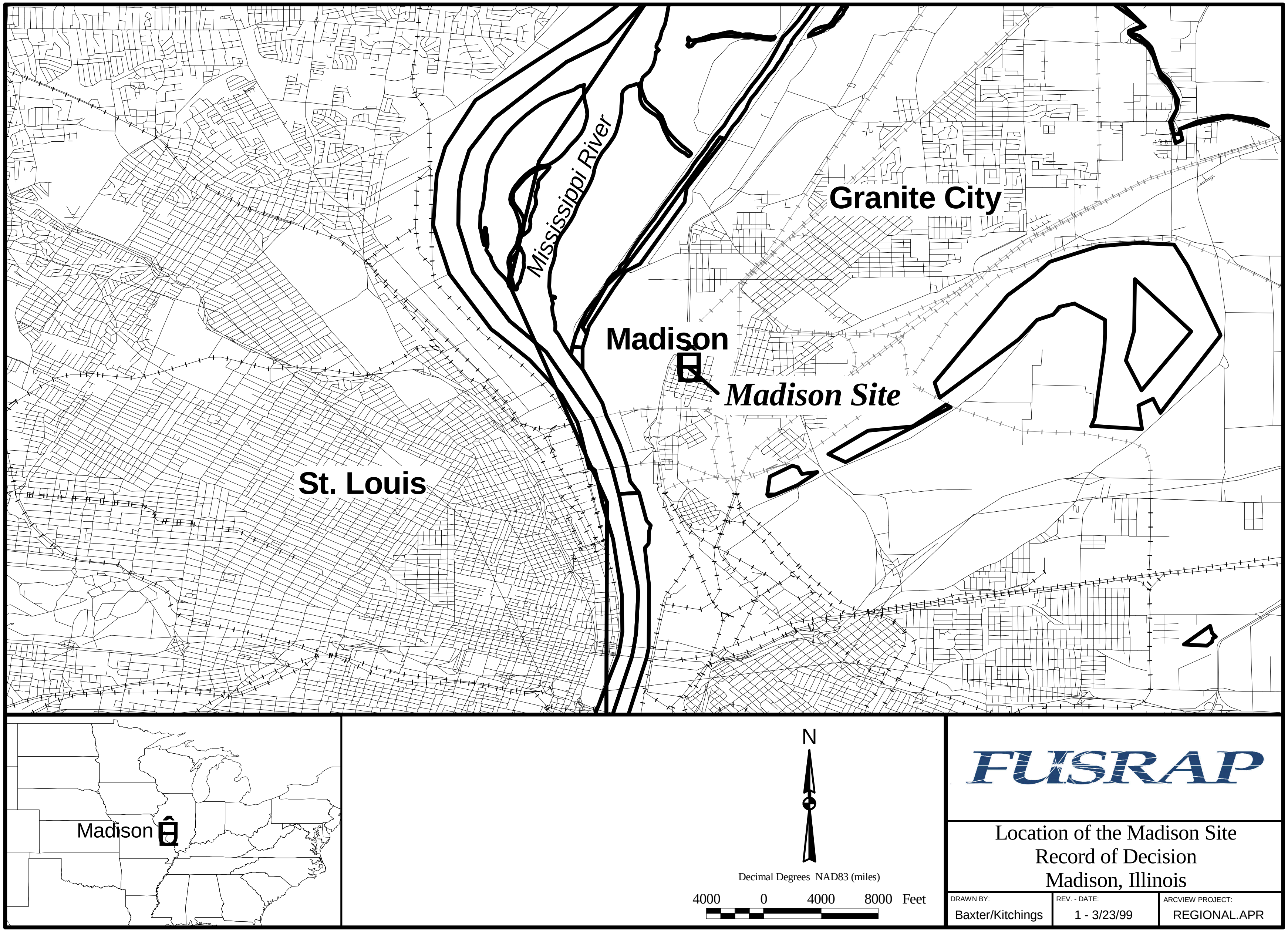

Figure 1. Location of the Madison Site

The United States Nuclear Regulatory Commission (NRC) issued the license for the operating area (Materials License STB-1488) to the current facility owners on October 3, 1986. The State of Illinois became an NRC Agreement State in 1987, at which time the authority for the licenses was transferred from NRC to the State of Illinois. These licenses pertain to operations involving thorium, that are independent of the uranium processing activities addressed in this ROD.

2.3 COMMUNITY PARTICIPATION

The RI/FS and Proposed Plan for the Madison Site were made available to the public in January 2000 (USACE, 2000a and b). They can be found in the Administrative Record maintained by the USACE FUSRAP Project Office in Berkeley, Missouri, and the Madison Public Library in Madison, Illinois.

The notice of availability for these documents was published in the *Federal Register*, January 31, 2000; in the *St. Louis Post Dispatch*, January 31, 2000; in the *St. Louis American*, the week of February 3, 2000; in the *Granite City Journal*, January 30, 2000 and February 2, 2000; and in the *Granite City Press Record*, February 3, 2000. The public comment period was open from January 31, 2000 to February 29, 2000. In addition, a public meeting was held on February 17, 2000 to present the RI/FS and Proposed Plan to the public. At this meeting, representatives from the USACE answered questions regarding the site and the remedial alternatives. The USACE response to comments received during the comment period is included in the Responsiveness Summary, which is Part 3 of this ROD.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

The scope of this ROD is the portions of Buildings 6 and 4 (e.g., overhead steel beams and walls) contaminated by historical AEC-funded operations and underlying floor areas potentially impacted by remediation activities. Inhalation of uranium-contaminated dust by workers working at the 7.6-m and 11-m (25-ft and 36-ft) levels of Buildings 6 and 4 could result in unacceptable doses to current workers. The RI survey also identified the presence of small amounts of thorium-232, which are not attributable to historical AEC-funded operations. The scope of this response action is limited to the authority of the FUSRAP program to address radioactive contamination resulting from MED/AEC activities.

2.5 SITE CHARACTERISTICS

The Madison Site is located in an industrial area surrounded by residences, apartments, and other commercial enterprises. The site is located nearly 1.6 km (1 mile) east of the Mississippi River, across from St. Louis, Missouri, in the State of Illinois (see Figure 1).

The site consists of a large, multi-sectional complex of 10 interconnecting buildings with a total under-roof area of about 130,000 square meters (m^2) [1.4 million square feet (ft^2)] (see Figure 2). Building 6, where the uranium contamination was identified, is near the center of the complex and covers about 26,000 m^2 (250,000 ft^2). The southwest end of Building 6, where the

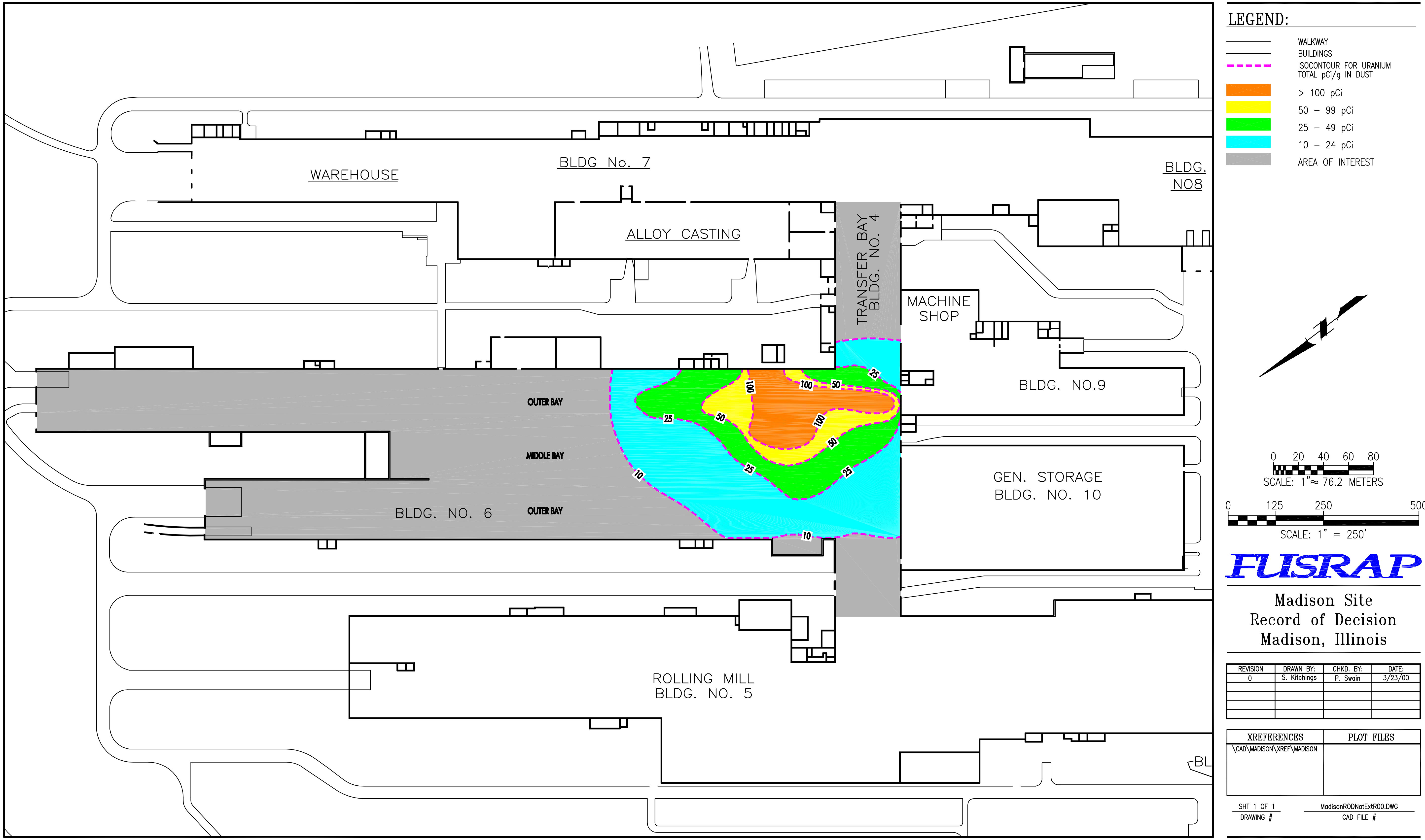

Figure 2. Buildings at the Madison Site, Area of Interest, and the Nature and Extent of Contamination

uranium rod extrusion and straightening operations were performed, adjoins Building 4, a transfer bay. There are no physical barriers between these two buildings. Building 6 is approximately 83 m (275 ft) in width and 303 m (1,000 ft) in length. The ceiling in the main bays of Buildings 6 and 4 are approximately 14 m (46 ft) high, reaching approximately 18 m (60 ft) at the highest point along the building centerlines. Basic structural support consists of steel columns on approximately 7.6-m (25-ft) centers, connected by large horizontal beams and multiple smaller vertical and horizontal cross members. A schematic cross section of the structural support in one of the outer bays is provided in Figure 3. Horizontal overhead surfaces are dust covered. The sensitivity and accuracy of direct measurements of radioactivity on these surfaces is limited because the dust shields a significant portion of the radiation from the uranium.

The plant area addressed by this ROD includes the following overhead structures that are considered accessible within Buildings 6 and 4. At the 7.6-m (25-ft) elevation in the outer bays of Building 6, all accessible horizontal surfaces within the area between the crane rail and the bottom chord of the outer bay trusses are included. These horizontal surfaces are shown in Figure 3. At the 11-m (36-ft) elevation in the outer bay of Building 6, the remaining accessible horizontal surfaces of the outer bay trusses up to the window sill [approximately 13.7 m (45 ft)] are included. In the middle bay of Building 6, all accessible horizontal surfaces of the entire truss at the 7.6 and 11-m (25-ft and 36-ft) level are included. Within Building 4, at the 7.6-m (25-ft) level in the outer and middle bays, all accessible horizontal surfaces in the bottom chord of the outer bay trusses are included in this ROD. At the 11-m (36-ft) level in the outer and middle bays of Building 4, the remaining accessible horizontal surfaces are included. The majority of the residual contamination, and the focus of the remediation is in the southeast corner of Building 6 as shown in Figure 2. The remaining areas of Buildings 6 and 4 will be surveyed as required to show compliance with the ARAR.

The walls of Buildings 6 and 4 consist of concrete block with brick veneer. The floors consist of concrete; with rough and pitted surfaces. Much of the floor in the vicinity of the extrusion press is covered with a thin layer of oily dirt and fine metal debris. There are no floor drains in Buildings 6 and 4, but there are multiple utility trenches, lubrication pits, equipment supports, and other penetrations into the floor. Machinery, feed materials, and product occupy a significant portion of the floor space.

Overhead cranes service most areas of Buildings 6 and 4. The main horizontal support beams are accessible from crane platforms in the center bay of Building 6. Limited access to higher structural surfaces is possible through windows in the upper ceiling areas. Access to other overhead surfaces, including the main horizontal beams in the two outer bays of Buildings 6 and 4, requires an elevated work platform. Access above approximately 10 m (33 ft) is limited, due to the presence of support beams, smaller cross members, piping, electrical lines, cranes, and other obstructions. The positioning of an elevated work platform near the extrusion press in Building 6 in the area of interest is restricted by fixed-place machinery and other materials. In comparison, the floor area of Building 4 is more accessible near the intersection with Building 6.

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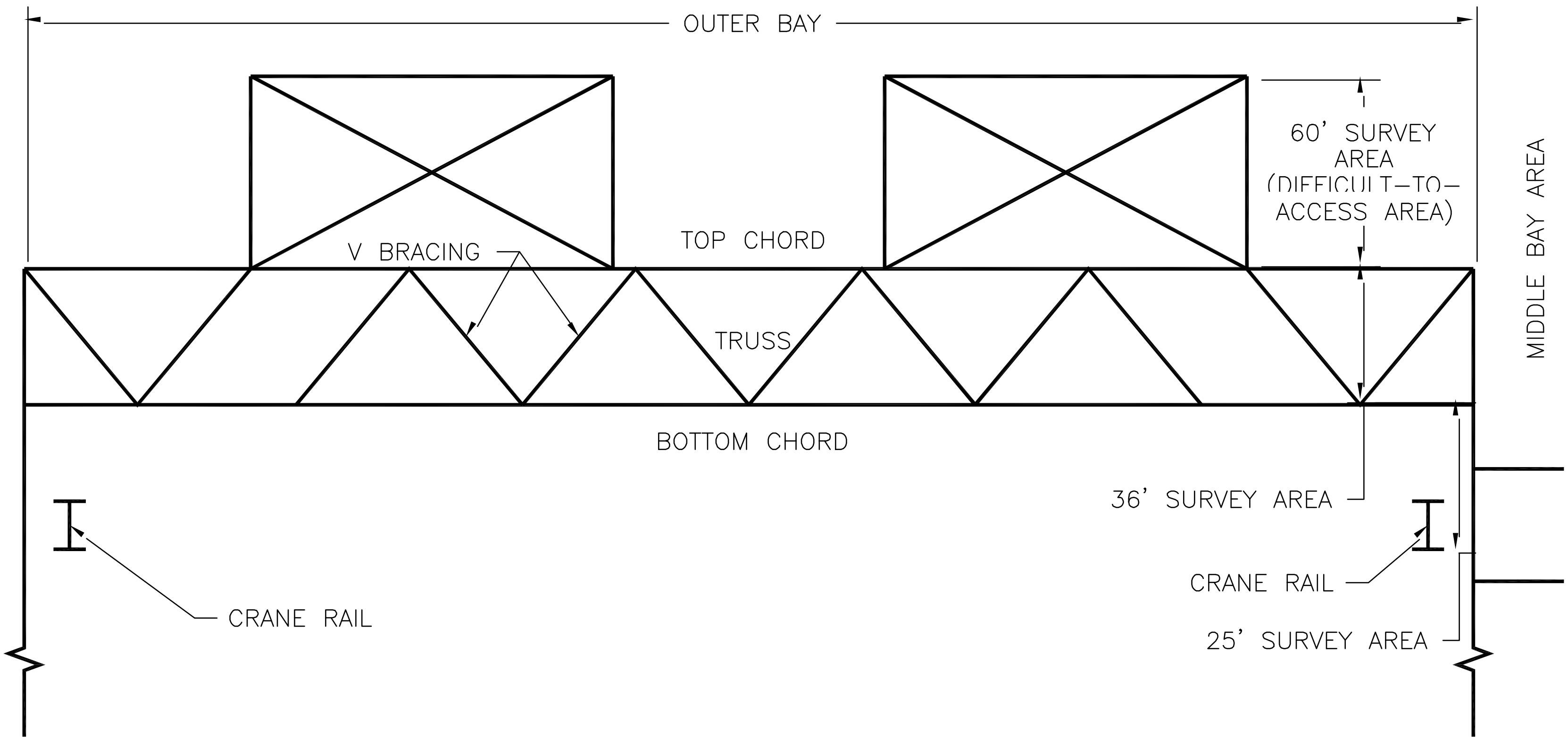

LEGEND:

FUSRAP

Madison Site
Record of Decision
Madison, Illinois

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Figure 3. Schematic Cross Section of an Outer Bay Showing Survey Levels, Madison Site

2.5.1 Nature and Extent of Contamination

Three characterization efforts have been conducted at the Madison Site. Oak Ridge National Laboratory performed a preliminary radiological survey at the site for DOE in March 1990 (ORNL, 1990). The USACE performed a comprehensive radiological survey in 1998 (USACE, 2000a). A third survey was performed by the USACE in 2000 to characterize the contamination in the difficult-to-access areas. The 1989 ORNL survey determined that uranium levels in dust on overhead surfaces above the extrusion press exceeded United States Department of Energy (DOE) Order criteria and recommended further investigations to better define the extent of uranium contamination in Buildings 6 and 4. This study concluded that under present use, it would be highly unlikely for a worker to receive a "significant radiation exposure" from those areas (ORNL, 1990).

The 1998 USACE survey characterized the current radiological conditions of the Madison Site. Gross measurements were performed to identify elevated areas of residual radioactivity and to determine areas of USACE responsibility. A more detailed analysis of elevated areas of residual radioactivity was necessary to determine the radionuclide distribution. Activities conducted during the 1998 USACE characterization included overhead surveys (surface scans, direct measurements, and surface samples), surface scans of building surfaces and equipment, surface activity measurements, soil sampling near building exits, sludge samples from the lubrication pits and utility trenches, and floor scrapings.

Fifty-two dust samples collected from the 7.6-m (25-ft) level surfaces of Buildings 6 and 4 near the extrusion press contained total uranium concentrations ranging from 2 to 349 pCi/g. Ten dust samples collected from the 11-m (36-ft) level contained uranium concentrations ranging from 4 to 361 pCi/g. The pattern of contamination was similar to that observed by the 1989 ORNL survey. The highest uranium concentrations were measured at locations directly above the extrusion press. Figure 2 illustrates the distribution of total uranium in the overhead steel beams.

About 230 beta or gamma surface scan measurements were recorded for building surfaces and equipment. Six locations had direct radiation measurements above the 1,000 dpm/100cm^2 action level established for the RI (five floor locations and one equipment measurement). Eighty surface activity measurements for removable alpha activity and total beta activity (from the equipment, the floor, the walls, and the roof) indicated all were less than the detection sensitivity of the measurement procedures used. Four locations with activity levels above the action level were determined to result from naturally occurring materials found in the walls and roof.

Ten soil samples collected to a depth of 15 centimeters (cm) [6 inches (in)] near seven exits to the plant contained total uranium concentrations ranging from 0.8 to 3.8 pCi/g. Background concentrations of uranium in soil taken on the property ranged from 0.7 to 2.7 pCi/g. An elevated general exposure rate was identified at one location during the RI. Subsequent investigation determined that the exposure rate reading was due to magnesium thorium (i.e., thorium-232) located in a below ground sump. Thorium-232 at the Madison Site is not within the USACE authority to address under the FUSRAP program.

Four sludge samples from the lubrication pits and utility trenches beneath potentially affected overhead structures indicated total uranium concentrations consistent with background. Eleven samples of floor scrapings contained total uranium concentrations ranging from 0.7 to 4.0 pCi/g.

In the February and April 2000 USACE surveys of the difficult-to-access areas, twenty-four locations from the 13.7 to 18.3 m (45 to 60 ft) elevations above the extrusion press were sampled. The total uranium concentrations in these samples ranged from 2 to 124 pCi/g total uranium, with an average of 30 pCi/g total uranium.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCES USES

The buildings at the Madison Site were designed for and are used as an industrial facility. The facility will likely remain industrial into the foreseeable future. The industrialized area is adjacent to residences and apartments.

2.7 SUMMARY OF SITE RISKS

2.7.1 Human Health Risk Assessment

The baseline risk to workers was evaluated in Appendix A of the FS and Appendix B of the RI. Attachment 1 of the Responsiveness Summary in Part 3 of this ROD evaluates the potential dose to utility workers working in the difficult-to-access areas. The results from the baseline dose assessment were used to determine the need for action and to identify the exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results from the baseline dose assessment for the residual contamination attributable to historical AEC-funded operations.

Pure natural uranium is the only COC at the Madison Site attributable to historical AEC-funded operations. The radionuclide analysis showed the isotopic breakdown to be consistent with the isotope ratios found in natural uranium. The concentration range of uranium in dust is summarized in Table 1. Data used to calculate the radiological dose are summarized in Table 2.

Madison Site data were validated in accordance with USEPA regional or National Functional Guidelines, or project-specific guidelines outlined in *Data Management Process for the St. Louis FUSRAP Site* (SAIC, 1999). One hundred percent (100%) of the data generated underwent independent data review, data evaluation, and data validation. A Chemical Quality Assurance Report and a Radiological Quality Assurance Report were generated consistent with Chapter 4 of USACE EM 200-1-6, *Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects.* Information gathered during this validation process was checked for consistency with the information demonstrated by the USACE Data Validation Form. The validation included a review for compliance with established quality criteria for blanks, laboratory control samples, internal standards, etc.

Table 1. Summary of Chemicals of Concern and Mean Value

Scenario Timeframe: **Medium:**	Current (25 years for the average member of the critical group) Uranium-Contaminated Dust						
Exposure Point	**Chemical of Concern**	**Concentration Detected**		**Concentration Units**	**Frequency of Detection**	**Mean Value**	**Statistical Measure**
		Min	**Max**				
Dust on 7.6 m (25 ft) level surfaces	Uranium	2.3	348.7	pCi/g	52/52	48.6 pCi/g	Arithmetic mean
Dust on 11 m (36-ft) level surfaces	Uranium	3.5	360.8	pCi/g	10/10	70.9 pCi/g	Arithmetic mean
Dust on 18.3 m (60 ft) level surfaces	Uranium	3.4	123.6	pCi/g	24/24	30.0 pCi/g	Arithmetic mean

Key:
Min: minimum concentration
Max: maximum concentration
pCi/g: picoCuries per gram

This table presents the concentrations for uranium the only COC detected in the buildings. The mean value is the concentration used to estimate the potential dose from exposure to uranium found in dust on building surfaces. The arithmetic mean was used as the concentration a worker would be exposed to. It was conservatively assumed that the higher average of 70.9 pCi/g was uniformly distributed over all building surfaces.

Table 2. Radiological Dose Data Summary

Pathway: Inhalation					
Chemical of Concern	**Chronic/ Subchronic**	**Dose Conversion Factor**	**Dose Conversion Factor Units**	**Source**	**Source Date**
Uranium-234	Chronic	3.58×10^{-5}	Sv/Bq	FGR 11	1988
Uranium-235	Chronic	3.32×10^{-5}	Sv/Bq	FGR 11	1988
Uranium-238	Chronic	3.2×10^{-5}	Sv/Bq	FGR 11	1988
Pathway: Ingestion					
Chemical of Concern	**Chronic/ Subchronic**	**Dose Conversion Factor**	**Dose Conversion Factor Units**	**Source**	**Source Date**
Uranium-234	Chronic	7.66×10^{-8}	Sv/Bq	FGR 11	1988
Uranium-235	Chronic	7.19×10^{-8}	Sv/Bq	FGR 11	1988
Uranium-238	Chronic	6.88×10^{-8}	Sv/Bq	FGR 11	1988

Key:
Sv/Bq: Sievert per Becquerel; 1 Sv = 100,000 mrem; 1 Bq = 27 pCi
FGR 11: Federal Guidance Report No. 11, USEPA

This table provides radiological dose information for uranium, the only COC detected in the building. Ingestion is a potential pathway for the utility worker.

A range of potential receptors that could be exposed to residual contamination were identified. These receptors included an overhead utility worker (the average member of the critical group), a facility worker on the floor level, a remediation worker (evaluated for removal options only), a building demolition worker, a building dismantlement worker, and a steel recycle worker. The utility worker was projected to receive the highest potential dose and was therefore used to develop cleanup criteria. The cleanup criteria are fully protective for all receptors and will be confirmed using final status survey data documented in a Post-Remedial Action Report. The utility worker, the average member of the critical group, is assumed to work in close proximity to the overhead steel beams for 20 hours per year while pulling cables or changing light bulbs. A 25-year exposure duration is assumed.

The exposure scenarios evaluated in the dose assessment assumed no additional actions were taken to reduce, contain, or remove the contamination in the building, and no additional worker controls were implemented to reduce exposure to the contaminated dusts. Inhalation of uranium-contaminated dust was determined to be the major exposure pathway and accounts for greater than 99 percent of the exposure. An ingestion pathway was also considered for the utility worker since the utility worker would have more contact with the surface contamination. The potential dose from direct contact through the skin (dermal pathway) is not significant for radionuclides such as uranium, and exposure through both the dermal pathway and external radiation accounts for less than 1 percent of the potential dose. Therefore, these pathways are considered insignificant and were dropped from further consideration.

Ground water is not a significant pathway. The uranium was found in dust accumulated on overhead steel beams within Buildings 6 and 4. Even if the uranium-contaminated dust was tilled into the soil, the resulting dose would be less than 0.04 millirem per year (mrem/yr).

The results of the dose assessment show that the annual total effective dose equivalent for some of the modeled receptors would not exceed the ARAR of 25 mrem/yr. However, the utility and dismantlement workers, who work in closer proximity to contaminated surfaces, could receive an exposure in excess of 25 mrem/yr. The utility worker's baseline dose is estimated to be 210 mrem/yr, while the dismantlement worker's baseline dose is estimated to be 38 mrem/yr. Both doses exceed the 25 mrem/yr limit specified in 10 CFR 20.1402. The radiological dose estimates for the site workers are presented in Table 3.

Table 3. Baseline Radiological Dose by Pathway for Current Conditions (mrem/yr)

Scenario Timeframe: **Receptor:** **Receptor Age:** **Medium:**	Current (25 years for the average member of the critical group) Worker Adult Uranium-Contaminated Dust	
Receptor	**Inhalation**	**Exposure Routes Total**
Facility Worker	9.0	9.0
Utility Worker	210	210
Demolition Worker	0.03	0.03
Dismantlement Worker	38	38
Steel Recycle Worker	0.9	0.9
	Comparison Criterion =	25

Key:

"—": Pathway not evaluated. The ingestion pathway was calculated for the utility worker and was determined to be insignificant.

This table compares the radiological dose calculations to the 10 CFR 20.1402 dose limit of 25 mrem/yr for unrestricted use. The dose via the ingestion pathway was calculated but determined to be insignificant. Baseline dose estimates for the utility worker and the building dismantlement worker exceeds the 25 mrem/yr dose limit, assuming no action were taken.

The dose calculations were performed using conservative, yet reasonable exposure parameters that tend to overestimate receptor exposure. While there may be uncertainty associated with each parameter in the dose calculations and evaluation of risk in the RI/FS, the values selected include reasonable maximum values, standard default values that tend to be conservative, and otherwise reasonable values selected to match site conditions.

2.7.2 Ecological Risk Assessment

No ecological risk assessment was performed at the Madison Site. The COC is uranium limited to dust accumulated on overhead steel beams within Buildings 6 and 4; therefore, no significant biota would be exposed.

2.8 REMEDIAL ACTION OBJECTIVES

The objective of the remedial action will be to limit worker exposure to uranium in dust on overhead steel beams in Buildings 6 and 4. This occupational exposure could occur in the area above the extrusion press. The remedial action objective is to prevent direct exposure to radionuclide COCs (i.e., total uranium) that would result in a dose greater than 25 mrem/yr to the average member of the critical group. The remediation goal based on an exposure of 25 mrem/yr to the utility worker would be 6,000 dpm/100cm^2 for surficial contamination and 20 pCi/g for volumetric contamination. A separate remediation goal of 300 pCi/g was calculated for the difficult-to-access areas based on the 25 mrem/yr limit and conditions specific to the difficult-to-access areas.

2.9 DESCRIPTION OF ALTERNATIVES

The alternatives and remedy components considered in the analysis of alternatives for remediation of uranium-contaminated dust on the overhead steel beams at the Madison Site are identified in Table 4 followed by a description of the alternatives. Natural uranium is the only COC at the Madison Site attributable to historical AEC-funded operations authorized for cleanup under the FUSRAP program.

The key ARAR for the Madison Site is the NRC rule on radiological criteria for license termination codified in 10 CFR Part 20, Subpart E. Under 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use," a site is considered acceptable for unrestricted use if residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent to an average member of the critical group that does not exceed 25 mrem/yr including that from the ground-water pathway, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account any consideration of detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

Table 4. Remedial Alternatives and Remedy Components

Remedy Component	Alternative			
	1: No Action	2: Institutional Controls	3: Containment	4: Decontamination
Containment – Apply surface sealant to fix contaminants in place on over head beams			✓	
Institutional Controls – Issue work permits to restrict access to contaminated areas on overhead beams – Perform airborne particulate sampling – Monitor breathing zones if radioactive constituents are detected in airborne particulates – Post signs in contaminated areas – Conduct 5-year reviews by the Government		✓	✓	
Removal - Vacuum contaminated dust - Scrape and brush surfaces – Wipe down surfaces				✓

This regulation provides a dose limitation for all radionuclides from all possible pathways of exposure and is applied by developing a remediation goal as defined above, for the points of exposure that will limit doses to meet the criteria in 10 CFR 20.1402.

Alternative 1, No Action—The No Action Alternative was evaluated to provide a baseline for comparison against other alternatives. Under this alternative, no action would be taken to remove the contamination attributable to historical AEC-funded operations. The dust on the overhead beams would remain in place. The plant would continue to operate under the authority of the current plant owner who is licensed by the IDNS. It is assumed that the plant would be operated in compliance with the existing IDNS and Occupational Safety and Health Administration regulations that impose limitations on occupational and public exposures. A 5-year review would be required to evaluate the potential for exceeding an exposure in excess of the ARAR of 25 mrem/yr. The land use would continue to be industrial.

Alternative 2, Institutional Controls—Under Alternative 2, institutional controls such as those identified in Table 4 would be implemented to protect against human exposure to uranium-contaminated areas on the overhead steel beams. As under Alternative 1, the plant would continue to operate under the authority of the plant owner who is licensed by the IDNS. It is assumed that the plant would operate in compliance with the existing IDNS and Occupational

Safety and Health Administration regulations that impose limitations on occupational and public exposures. If demolition were to occur, controls such as dust suppression measures and use of respirators would be implemented. A 5-year review would be required to evaluate the potential for exceeding an exposure in excess of the ARAR of 25 mrem/yr. The land use would continue to be industrial.

Alternative 3, Containment**—**Under Alternative 3, human exposure to the radiological contamination attributable to historical AEC-funded operations would be reduced by preventing the dust from accessible areas from becoming mobilized. A spray coating would be applied to the overhead steel beams to immobilize the dust. As with Alternatives 1 and 2, the plant would continue to operate under the authority of the current plant owner who is licensed by the IDNS. Under Alternative 3, controls similar to Alternative 2 would be implemented during demolition of the building after final shutdown. A 5-year review would be required to evaluate the potential for unacceptable exposure. The land use would continue to be industrial.

Alternative 4, Decontamination of Accessible Overhead Surfaces**—**Under Alternative 4, radiological contamination on accessible overhead surfaces at the 7.6-m and 11-m (25-ft and 36-ft) levels, such as on the overhead steel beams themselves, window sills, and electrical and water conduits would be decontaminated to achieve the remediation goal for total uranium. Difficult-to-access areas, defined as those surfaces above the window sills at an elevation from 13.7 m to 18.3 m (45 ft to 60 ft), would not be decontaminated because the potential dose in these areas is less than the ARAR of 25 mrem/yr as shown in Attachment 1, and the cost to further reduce the dose would be cost prohibitive as shown in Attachment 2. Waste generated by the decontamination activities would be properly disposed of at either a licensed or permitted facility. A final status survey using protocols compatible with MARSSIM (NUREG-1575) would be conducted to ensure compliance with the remediation goal. The results would be documented in a Post-Remedial Action Report. No 5-year reviews would be required since the decontamination would eliminate the potential for unacceptable exposures. As with Alternatives 1, 2, and 3, the plant would continue to operate under the authority of the current plant owner who is licensed by the IDNS. The land use would continue to be industrial.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The four alternatives discussed in Section 2.9 were evaluated using the nine evaluation criteria as specified by CERCLA.

2.10.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment, and describes how the doses posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

Except for Alternative 1 (No Action), all of the alternatives are protective of human health and the environment. For Alternative 3 (Containment) and Alternative 4 (Decontamination), there would be a short-term dose to the workers involved in the remediation because of the containment and decontamination activities. Alternative 1 (No Action) would not be protective of human health or the environment over the long term. Since the source of contamination is not reduced or controlled, a worker could be exposed. Alternative 2 (Institutional Controls) and Alternative 3 would decrease dose by controlling exposure, but the contamination would not be removed. Alternative 4 would be protective of human health and the environment in the long term because contaminated materials would be removed. There would be a slight increase in the transportation and disposal dose for Alternative 4 (Decontamination) when compared to Alternatives 1, 2, and 3 because material would be disposed of off-site. However, only a small quantity of waste 7.6 to 15 cubic meters (m^3) [10 to 20 cubic yards (yd^3)] would be disposed of off-site. The waste will be containerized per Department of Transportation requirements and, given that external radiation from the waste contributes one percent or less of the dose, the risk to either the drivers or the public along the transportation route would be small-to-negligible.

2.10.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs addresses whether an alternative will comply with the ARAR established and/or a waiver for the Madison Site is justified.

Alternative 1 (No Action) would not comply with the ARAR because the worker could receive a dose that exceeds the 25 mrem/yr standard in 10 CFR 20.1402. Alternative 2 (Institutional Controls) could meet the 25 mrem/yr standard by imposing more stringent work restrictions. However, if institutional controls were lost, the dose could exceed the 100 mrem/yr standard in 10 CFR 20.1403. Alternative 3 (Containment) could satisfy the ARAR by fixing-in-place the contamination on the overhead steel beams and imposing institutional controls. Alternative 4 (Decontamination) would comply with the ARAR without restrictions.

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the expected residual dose and the ability of a remedy to maintain reliable protection of human health and the environment over time, once remediation goals have been met.

Alternative 1 (No Action) would not be effective in the long-term as the contaminated materials would remain and would not be controlled. Alternative 2 (Institutional Controls) and Alternative 3 (Containment) would decrease the dose. Alternative 4 (Decontamination) would be the most effective in the long-term because the contamination would be removed and the affected areas could be used without restriction.

2.10.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of the remedy.

No effective treatment to reduce toxicity, mobility, or volume was identified since radioactivity cannot be destroyed and toxicity cannot be significantly affected. Solidification agents would increase the volume in exchange for a reduction in mobility. Treatment of the uranium in the contaminated dust is not practical for the small volume of waste that will be generated.

2.10.5 Short-Term Effectiveness

Short-term effectiveness addresses any adverse impacts on human health and the environment during the implementation period, and the period of time needed to achieve remediation goals.

Alternative 1 (No Action) and Alternative 2 (Institutional Controls) do not involve intrusive remediation work and therefore, would pose little to no short-term risk to the community or workers. Alternative 3 (Containment) and Alternative 4 (Decontamination) would pose little to no risk to the community, however, the remediation workers would be exposed to increased risks from working at heights or high temperatures during the performance of work. Transportation workers and the public would receive a small-to-negligible dose when the waste was shipped off-site for disposal.

No time period is associated with implementing Alternative 1. Alternatives 3 and 4 could be implemented during plant shutdown. The remedial action schedule for Alternative 3 and Alternative 4 would be driven by the need to complete the action during plant shutdown periods.

2.10.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

All alternatives are technically feasible to implement. Under Alternative 1, the plant would continue to operate as required under the existing license. No additional actions would be implemented. Alternative 2 would require implementing institutional controls such as those identified in Table 6. Alternative 3 and Alternative 4 would require working around equipment and obstacles in the buildings. Services and materials are readily available to implement all alternatives.

2.10.7 Cost

Cost includes the estimated capital and operation costs, expressed as net present worth costs.

Alternative 1 (No Action) would have no additional associated cost, but would not provide additional protection. The cost of Alternative 2 (Institutional Controls) would be very low, but this alternative would not meet the 100 mrem/yr standard for the critical group if institutional controls were lost. Alternative 3 (Containment) would cost more than Alternative 4 (Decontamination). The 30-year cost, in year 2000 dollars with zero discounting, is shown in Table 5 for each alternative. The costs have been updated from those presented in the Proposed Plan based on additional engineering estimates and cost data.

Table 5. Thirty-Year Cost for Implementing Alternatives at the Madison Site

Action	Cost
Alternative 1 – No Action	0
Alternative 2 – Institutional Controls	$60,000
Alternative 3 – Containment	$1,020,000
Alternative 4 – Decontamination	$760,000

2.10.8 State Acceptance

The IDNS agrees with the USACE that "removing contamination at the Madison Site is the only responsible remediation approach" (IDNS, 2000) The IDNS has been involved in the review of the RI/FS report and the Proposed Plan. Comments received from the IDNS have been resolved and incorporated into this ROD accordingly. The IEPA has deferred to the IDNS, the State of Illinois agency responsible for regulatory radiological contamination, on the decision making for the Madison Site (IEPA, 2000).

2.10.9 Community Acceptance

Community participation in the remedy selection process includes review of RI/FS and the Proposed Plan during the public comment period and participation in the public meeting held on February 17, 2000. There were no objections from the public on the selected remedy. The Responsiveness Summary (Part 3) includes oral and written comments from the public, and the USACE's responses to these comments.

2.11 PRINCIPAL THREAT WASTES

No principal threat wastes, as defined in the NCP [§300.430(a)(l)(iii)(A)] have been identified at the Madison Site.

2.12 SELECTED REMEDY

Alternative 4 (Decontamination of Accessible Areas) was chosen as the selected remedy because it eliminates the potential for unacceptable exposures from residual contamination attributable to historical AEC-funded operations. This alternative is protective of human health and the environment, complies with the ARAR, is cost effective, and provides a balanced response for the other CERCLA criteria applied at the site. The proposed alternative will satisfy the ARAR by removing contamination from areas where maintenance operations could result in repeated exposure to the radioactive material for plant workers. This remedy focuses on areas most likely to result in exposures to employees and contract workers in excess of 25 mrem/yr.

The components of the selected remedy are described below:

- The radiation dose to the average member of the critical group (an overhead utility worker) will not exceed 25 mrem/yr as defined in 10 CFR Part 20, Subpart E.

- A post-remedial action risk/dose assessment will be performed to demonstrate compliance with the ARAR of 25 mrem/yr.

- Both detailed work instructions and a health and safety plan will be prepared to address the procedures for handling radioactive materials, procedures for other biological or chemical hazards, and procedures for general industrial safety concerns such as working at heights, and lock out and tag out of energy sources.

- Site mobilization and preparation of designated areas for managing wastes generated during the decontamination activities.

- Uranium contaminated surfaces on the overhead steel beams will be decontaminated using vacuuming, scraping and brushing, and wiping to meet the 25 mrem/yr dose limits. This dose corresponds to a remediation goal of 6,000 dpm/100 cm^2 for surficial contamination or 20 pCi/g of total uranium for volumetric contamination. A separate remediation goal of 300 pCi/g was calculated for the difficult-to-access areas again based on the 25 mrem/yr limit and conditions specific to the difficult-to-access areas.

- Vacuums and hand-held power tools with high efficiency particulate air filters will be used for surface decontamination.

- Controls and monitoring will be implemented during the remedial action to ensure worker and public protection, and to eliminate the spread of contamination to floors and equipment.

- Material will be transported for off-site disposal at a licensed or permitted facility.

- Decontaminated surfaces will be painted and restored as required.

- A final status survey using protocols compatible with MARSSIM (NUREG-1575), will be conducted to demonstrate compliance with the unrestricted use criteria in the ARAR, and the results documented in a Post-Remedial Action Report.

- Difficult-to-access areas above the windows at an elevation from 13.7 to 18.3 m (45 to 60 ft) above the area containing the extrusion press, are below the remediation goal for that area and will not be decontaminated.

- Supplemental dose calculations show that the potential dose to the utility worker in the difficult-to-access areas is less than 2.5 mrem/yr. This dose meets the ARAR and is ALARA.

2.12.1 Summary of the Estimated Remedy Costs

Implementation of the selected remedy will allow unrestricted use of Buildings 6 and 4. Radioactive materials will be shipped by truck in accordance with applicable Department of Transportation requirements. A detailed cost estimate for the selected remedy is provided in Table 6.

Table 6. Cost Estimate Summary for the Selected Remedy

Action	Quantity/Unit	Cost
1. General Conditions		
Project Management	390 Person-hr	35,000
2. Mobilize and Preparatory Work		
Mob Constr. Equip. and Fac.	1 Mobilization	10,000
Submittals and Plans		60,000
Setup/Construction/Maint. Fac.		14,500
Temporary Office		
Decontamination		
Temporary Utilities		1,500
3. Final Status Survey	Class 1, 2, & 3 areas	
Labor		100,000
Equipment		10,000
Materials		
4. Interior Surface Remediation	31,000 sf	450,000
Labor		
Equipment		
Material		
Waste Disposal	20 cy	20,000
5. Restoration		10,000
Labor		
Equipment		
Material		
Demobilization		
Remove Temporary Utilities		2,000
Post-Construction Submittals		45,000
Demobilization		2,000
	TOTAL	**760,000**

Note: The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

2.13 STATUTORY DETERMINATIONS

The selected remedy, Decontamination of Accessible Areas, will remediate those areas previously contaminated by historical AEC-funded operations and will meet the statutory requirements of CERCLA 121. The selected remedy meets the threshold criteria of being protective of human health and the environment and complying with ARARs and is the final remedy for this site. This permanent remedy can be implemented cost effectively. After the remediation goals are met, no 5-year reviews will be required.

2.13.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment by eliminating the risk posed by the uranium-contaminated dust material on overhead steel beams. Residual exposure levels will not exceed the 25 mrem/yr dose limit. There are no short-term threats associated with implementing the selected remedy that cannot be controlled.

2.13.2 Compliance with ARARs

The selected remedy will remove uranium-contaminated dust material from overhead steel beams, resulting in a dose below the ARAR-based limit of 25 mrem/yr to the average member of the critical group.

2.13.3 Cost-Effectiveness

The selected remedy is cost-effective since it is permanent, it removes the contaminant source, and its implementation will not pose an unacceptable risk to remediation workers.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The selected remedy will result in the permanent removal of uranium-contaminated dust material from overhead steel beams.

2.13.5 Preference for Treatment as a Principal Element

The selected remedy does not rely on treatment as a principal element. The contaminated volume to be removed is small [7.6 to 15 m^3 (270 to 540 ft^3 or 10 to 20 yd^3)]. Extraction of the uranium is not practical for the small volume of waste that will be generated.

2.13.6 Five-Year Review Requirements

The selected remedy will remove hazardous contaminants attributable to historical AEC-funded operations. Therefore, a statutory review will not be required every five years.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN

The ROD contains no significant changes to the actions to be implemented for the selected remedy from the Proposed Plan. The ROD contains clarification and supplemental dose analyses in support of the selected remedy.

Additional data on remediation rates has been obtained subsequent to the original cost estimates prepared for the FS. Engineering calculations and testing indicate that the time required to perform remedial activities in the overhead areas of Buildings 6 and 4 will take longer than originally estimated. Therefore, the revised cost estimates are higher. This supplemental information increased the estimated costs for Alternatives 3 and 4 by about $0.5 million.

2.15 REFERENCES

Illinois Department of Nuclear Safety (IDNS), 2000. Letter from J.G. Klinger to S.R.Cotner (USACE), St. Louis, Missouri. February.

Illinois Environmental Protection Agency (IEPA), 2000. Letter from P.T. Lake to S. Cotner (USACE), St. Louis, Missouri. January.

Oak Ridge National Laboratory (ORNL), 1990. *Preliminary Results of the Radiological survey at the Former Dow Chemical Company Site, Madison, Illinois*. ORNL/TM-11552, Oak Ridge, Tennessee. December.

SAIC, 1999. *FUSRAP Laboratory Data Management Process for the St. Louis Site, St. Louis,Missouri.* June (USACE Draft).

U.S. Army Corp of Engineers (USACE), 2000a. *Remedial Investigation Report and Feasibility Study for the Madison Site, Madison, Illinois, St. Louis, Missouri*. January.

USACE, 2000b. *Proposed Plan for the Madison Site, Madison, Illinois, St. Louis, Missouri*. January.

PART 3

RESPONSIVENESS SUMMARY

PART 3 RESPONSIVENESS SUMMARY

3.1 OVERVIEW

At the time of the public comment period, January 31, 2000 to February 29, 2000, the United States Army Corps of Engineers (USACE) had identified a preferred alternative in the Proposed Plan for the Madison Site in Madison, Illinois. The preferred alternative would remove uranium-contaminated dust from overhead steel beams in areas above an extrusion press that was used to support historical Atomic Energy Commission (AEC)-funded operations.

On February 17, 2000, the USACE held a public meeting (1) to present the Remedial Investigation (RI) and Feasibility Study (FS) and Proposed Plan to the public, (2) to answer questions on these documents, and (3) to accept any additional comments the public could provide. In order to retain a record of these verbal comments, a court reporter was present to provide a transcript of the proceedings. All formal verbal comments, as given at the public meeting, and all written comments, as submitted, are included in the Administrative Record for the Record of Decision (ROD).

3.2 BACKGROUND ON COMMUNITY INVOLVEMENT

The U.S. Congress transferred Formerly Utilized Sites Remedial Action Program (FUSRAP) from the U.S. Department of Energy (DOE) to the USACE on October 13, 1997. Meetings with senate, state and local officials were held in spring 1998 to raise awareness of the Madison Site. The USACE also met with site workers to discuss the potential risk.

The St. Louis Sites Community Relations Plan, which documents how the USACE encourages community involvement in site decision making, was released in December 1998. Newsletters detailing progress at the Madison Site have been regularly distributed since the USACE assumed FUSRAP responsibility.

The USACE has responded to requests from the current owner/operator and the Steelworkers to explain the potential risk to workers. The USACE held a public meeting on February 17, 2000, to present the Proposed Plan for the Madison Site, discuss the results of the RI/FS, answer questions regarding these documents, and respond to public comments. A notice of availability for these documents and announcement of the public meeting were published in *the St. Louis Post Dispatc*h, the *St. Louis American*, the *Granite City Journal*, and the *Granite City Press-Record*. Flyers announcing the date, time, and location of the public meeting were placed in local businesses.

At the public meeting, the USACE presented the objectives of the FUSRAP program, the site history, current site conditions, results of the risk assessment, the alternatives evaluated, and the preferred alternative identified in the Proposed Plan. Following the USACE presentation, the meeting was opened for formal public comment.

During the public comment period, a concerned citizen and a worker from the plant voiced concerns about the scope of the proposed action and about the occupational safety in having worked around the overhead steel beams, respectively. The current owner/operator and the United Steel Workers Local 4804 supported the selected remedy and agreed there is no current risk to the general public regarding the conditions at the site. However, they expressed concerns about the decision to not remediate the upper levels of the building to remove the potential risk to site workers. The Illinois Department of Nuclear Safety (IDNS) also supported the selected remedy, but had concerns regarding the adequacy of the assessment of radiological dose and demonstration that the proposed removal would result in a condition that is protective of public health.

3.3 SUMMARY OF COMMENTS RECEIVED AND AGENCY RESPONSES

Issues and comments identified during the public comment period on the Proposed Plan for the Madison Site are summarized in this document. Section 3.3.1 presents those issues identified at the public meeting on February 17, 2000. Section 3.3.2 presents the responses to comments received from IDNS, and Section 3.3.3 presents responses to comments received from the current owner/operator and worker's union.

3.3.1 Public Meeting – February 17, 2000

The five key concerns expressed at the public meeting are identified below and discussed in this section:

1. Reference to uranium and thorium in a past quitclaim deed for the property;
2. Presence of thorium-232 at the facility;
3. Clarification of license information;
4. Worker concerns about occupational exposures; and
5. Information on where Mallinckrodt disposed of waste, if available.

Issue 1**—**A commentor cited the quitclaim deed from the United States Government to Dow Chemical dated 1951, which identified both uranium and thorium, as evidence of the Government's involvement with the occurrence of thorium and uranium contamination. The commentor noted that the thorium contamination was not addressed in the USACE's RI/FS and Proposed Plan.

Response 1**—**The Government has reviewed the 1951 deed to the property. The deed reflects a transfer of the facility from the United States (through the General Services Administration) as the Seller, to Dow Chemical Corporation, as the Buyer, in January 1951. The AEC through its contractor Mallinckrodt, first contracted with Dow Metal Products in March 1957. The deed transfer occurred prior to the time that historical AEC-funded processes were conducted at the Madison Site as part of the AEC program.

The reference to uranium and thorium in the deed are contained within a standard clause included in United States' deeds of conveyance after World War II and during the Cold War. Conveyances of property from the Government to others at that time contained this language to ensure that the Government had access to any undiscovered mineral deposits that were essential to the production of fissionable material. The language was required pursuant to Section 5 (b)(1) of the Atomic Energy Act of 1946 (60 Statute 761).

During the late 1940s and 1950s, the exploration of these extremely rare and valuable minerals was in its infancy. It was prudent for the Government to reserve the right to later explore and mine these minerals to avoid undue cost to the United States if they were later discovered on the property.

Neither the reference to uranium and thorium nor the presence of the clause itself identify specific processes or materials as actually being present at the property. The clause is consistent with the National Security clause (also contained in the deed) which permits re-entry into the facility in the event of war. Landowners today commonly retain the mineral rights (e.g., coal, oil) in conducting land transactions to avoid selling a fortune in undiscovered minerals in the subsurface. This is exactly what the Government did at the Madison Site.

The USACE's authority is limited to FUSRAP materials, which at the Madison Site is limited to uranium used in historical AEC-funded operations. Given that reference to thorium in the deed was a standard mineral rights clause and that only uranium was involved in the historical AEC-funded activities, the USACE has no authority under FUSRAP to address natural thorium.

Issue 2**—**A commentor noted that thorium contamination was not addressed in the Proposed Plan.

Response 2**—**Thorium is a naturally occurring element which consists almost entirely of the isotope thorium-232. Naturally occurring uranium ores containing uranium-238 and uranium-235 were processed to reduce impurities. This process would separate the thorium isotopes to create pure uranium. The thorium contamination that would result from uranium processing would be thorium-230. Thorium contamination from uranium processing would either not be present or would only be present in minute concentrations in metallic uranium rods processed at the Madison Site. The RI detected thorium-232, not thorium-230 contamination. Thorium-232 exists at the site from other licensed processes. These thorium processes and materials are outside the scope of this ROD and the authority of the USACE to remediate.

Issue 3**—**A commentor stated it was their understanding that no one had information on what was processed at the plant prior to 1959. The commentor also requested clarification on the number of rod-straightening campaigns that occurred there.

Response 3**—**There are historical records available regarding the processes that were conducted at the plant prior to 1959; the USACE evaluated and researched these records during the RI. The USACE review indicated that two campaigns occurred. The rod-straightening campaigns that were AEC-funded occurred from 1957 to 1962. The ultimate purpose for which the uranium rods were used is classified. These activities occurred at a single extrusion press in Building 6 and not throughout the entire facility.

Issue 4**—**A current plant worker at the Madison Site expressed concern over occupational exposures since he had worked in the vicinity of the overhead steel beams.

Response 4—The occupational exposure to a worker in the vicinity of the overhead steel beams was evaluated as part of Alternative 1 (No Action) in the Feasibility Study. The details for this calculation are provided in Appendix A of the FS.

In the FS, an overhead utility worker was determined to be the average member of the critical group. That is, the utility worker would receive larger doses of radiation exposure than other site workers. The utility worker works in closer proximity to the contaminated areas on the overhead steel beams while performing activities such as changing light bulbs, or pulling cable, or performing other limited work in overhead areas. The utility worker is assumed to work in close proximity to the contamination for 20 hours per year over a 25-year period.

The analysis of the no action alternative predicted an expected annual dose of 210 mrem/yr. Because resuspension factors vary widely, the annual dose to the utility worker working in the overhead areas could range from 38 mrem/yr to 790 mrem/yr. The expected value was calculated as 210 mrem/yr. Each of these doses is less than the limit for occupational exposure to radiation which is 5000 mrem/yr (IDNS regulation section 340.210; U.S. Nuclear Regulatory Commission (NRC) regulation 10 CFR 21.1201). After the selected remedy (Alternative 4, Decontamination of Accessible Areas) has been implemented, the estimated annual dose to these same workers would be less than 25 mrem/yr.

Issue 5—A commentor stated a belief that barrels and tanks are buried throughout the site and that barrels containing magnesium have been exhumed from the site. The commentor also noted that the location of the buried tanks and barrels are unknown. The commentor questioned how the USACE knew that uranium was not disposed of onsite.

Response 5—The USACE's authority is limited to FUSRAP materials and does not extend to any other materials. Therefore, the USACE's focus in the RI was only on FUSRAP materials. However, in the records searches and sampling conducted, no records were found that indicated that barrels or tanks containing uranium were buried or disposed of onsite relative to the historical AEC-funded activities at the Madison Site.

3.3.2 Comments from the Illinois Department of Nuclear Safety

Comment 1—The Department agrees with the USACE that removal of the contamination at the Madison facility is the only responsible remediation approach presented in the RI. However, the Corps has not demonstrated that the proposed scope of removal is protective of public health, as required by Department and NRC rules and guidance. The Department can not determine the adequacy of the proposed scope of removal, since the submitted dose/risk assessments are inadequate, inappropriate or incomplete.

Response 1—The USACE has concluded that the dose/risk assessments presented in the RI/FS and supplemented by the analysis presented in Attachment 1 to the Responsiveness Summary are adequate and appropriate. The scope of the remedial action will result in a plant condition that is protective of the average member of the critical group (i.e., utility workers) and is in accordance with NRC rules and guidance.

Comment 2—The NRC's Draft Regulatory Guide DG-4006, Demonstrating Compliance with the Radiological Criteria for License Termination, provides guidance for a licensee to demonstrate that a site is suitable for use in accordance with the radiological criteria in 10 CFR Part 20. DG-4006 describes the methods acceptable to the NRC for implementing the requirements in Subpart E, 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use." If the Corps considers the NRC rule and guidance to be applicable or relevant and appropriate requirement (ARAR), then the guidance in DG-4006 must be applied. The Corps has acknowledged an obligation to comply with the NRC rules and guidance, yet fails to implement the guidance as described in DG-4006.

Response 2—The FS references use of DG-4006 and NUREG-5512, among others, in developing the site assessments. USACE recognizes that all analyses do not follow default scenarios as defined in NUREG documents (and associated support documents). These default scenarios are neither fully reasonable nor appropriate for the Madison Site. All analyses are site specific. For example, the default building occupancy scenario used by the DandD code is not intended for exposure to overhead contamination on support beams located 7+ meters above the ground. USACE has concluded (using a conservative model) that a utility worker is the critical group and that this approach is consistent with NRC guidance.

Comment 3—The Corps has described risk assessments covering building use and worker exposure over a period of 25 years. DG-4006 (page 5) calls for a 70-year building-use period, with the remainder of the recommended 1000-year dose-assessment period being based on the assumption that the property is used by resident members of the public (e.g., after the building is demolished). The Corps has inadequately assessed the dose to the first critical group (workers) and has entirely ignored the second critical group (residents).

The Corps must reassess potential worker dose, and conduct the required risk assessment for future-resident scenarios, including all inherent exposure pathways. Since the proposed remediation plan calls for the property to be used without restrictions, the Corps must demonstrate the long-term suitability and effectiveness of the proposed cleanup.

The "post demolition" segment of the required 1000-year dose assessment period should assume that the entirety of the structure's residual radioactivity is transferred to surficial soil after the building is demolished. The assumed "footprint" of the contaminated soil may consider scattering due to demolition and grading, but should not exceed 200% of the original contaminated area of the building (not the entire building). The software program for conducting radiation dose and risk assessment calculations (RESRAD) and DandD codes can then be used to model the estimated dose from all pathways. Surficial soil is defined as being the topmost 15 centimeters. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) does not address subsurface soil contamination beneath 15 centimeters. RESRAD is appropriate for modeling.

Response 3—IDNS is correct in stating that the default building life is 70 years as specified in DG-4006. The assumptions made for purposes of analysis in the RI/FS is that an individual could have a reasonable maximum exposure (RME) duration of 25 years which is commonly used and a widely accepted RME value for a commercial/industrial receptor. The RI/FS conservatively assumes that an individual works in the historical AEC-funded process areas for all of those 25 years performing the same duties. This use of the 25-year exposure duration has no impact on the final dose calculations. The 10 CFR Part 20, Subpart E limit is 25 mrem total effective dose equivalent (TEDE), which is based on assigning a lifetime dose from an intake in the year the intake is received. Additionally, Federal Guidance Report No. 11 dose conversion factors were used in the FS (pg. A-2 of the FS). These dose conversion factors are based on a 50-year committed effective dose equivalent. Therefore, all lifetime doses from intakes of radioactive material will be accounted for in the worker's 25 year exposure duration.

Also, it is USACE's position that this time frame applies to building use for the purposes of defining all reasonable building exposure scenarios (industrial, commercial, office, etc.) that are likely to occur within that time. The remaining use of the building is expected to be the current industrial scenario for a maximum duration of 25 years followed by demolition or dismantlement of the building. Since the facility is over 50 years old, the assumption of continued industrial use for 25 more years exceeds the useful life of 70 years recommended by DG-4006. In summary, the USACE has complied with the recommendations of DG-4006 concerning building use by evaluating an industrial exposure scenario for the remaining building life and evaluating scenarios for demolition and dismantlement after the building has exceeded its useful life.

The following USACE evaluation of the future resident scenario at 1000 years, including all inherent exposure pathways documents that a potential resident's exposure would be negligible both now and 1000 years into the future. (Additional data was collected in April 2000 which indicates that the amount of contamination in the difficult-to-access areas is even less than the value used in this calculation.)

> Data show that the average total uranium concentration in dust on the difficult-to-access areas is 36 pCi/g and covers about 150 m^2 horizontal surface area (Class 1). The post-remedial Class 1 concentration in the lower areas could be a maximum of 20 pCi/g total uranium in dust covering about 2800 m^2 horizontal surface area. The average total uranium concentration in dust the remaining areas (i.e., Class 2 areas) is 9.9 pCi/g covering about 1500 m^2 horizontal surface area. Using these concentrations and areas, the weighted average concentration in dust is calculated as follows:
>
> $$[9.9 \text{ pCi/g x } (1500/4450)] + [36 \text{ pCi/g} \times (150/4450)] + [20 \text{ pCi/g} \times (2800/4450)] = 17.1 \text{ pCi/g}$$
>
> Based on characterization data, this dust material is 0.8 cm thick (before remediation) making the total volume of the material (0.008 m) × (4450 m^2) = 35.6 m^3. It was assumed this dust material was scraped from the overhead steel beams, spread over an area of approximately 10,000 m^2 (the RESRAD default), and tilled into the top 0.15 m (6 inches) of soil. The concentration is adjusted using these parameters as follows:
>
> $$\text{Soil Concentration (pCi/g)} = 17.1 \text{ pCi/g} \times [35.6 \text{ m}^3 / (0.15 \text{ m} \times 10{,}000 \text{ m}^2)] = 0.40 \text{ pCi/g.}$$
>
> This total uranium concentration would contribute negligibly to the natural uranium in soil of 1.8 pCi/g (adding approximately 0.19 pCi/g of U-238, 0.20

pCi/g of U-234, and 0.01 pCi/g of U-235). The resultant maximum dose modeled using RESRAD Version 5.95 and all the standard defaults with all pathways is 0.04 mrem at 1000 years. It should also be noted that the overhead horizontal surface is estimated to be about 20% of the original contaminated area of the building; therefore, the actual Class 1 and 2 areas in the building cover about $(4450\ m^2)/(0.2) = 22{,}250\ m^2$.

***Comment 4*—**The Corps has inappropriately and inadequately applied NRC guidance to set the cleanup criteria. The Corps applied dose conversion factors (DCFs) from NUREG-1640, *Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities*, which is, in essence, a Feasibility Study. The goal of the modeling in NUREG-1640 is to produce estimates of potential radiation exposure to critical-group individuals engaging in specific scenarios describing the recycling of contaminated solid materials. The produced DCFs were modeled using Monte Carlo computer techniques, employing highly-variable parameters to describe material characteristics and "flow" – parameters that were highly customized for specific individual exposure scenarios. The DCFs are invalid for scenarios that do not conform precisely to the modeled scenario; therefore, the DCFs are inappropriate for generic assessment of dose from remediation activities. Due to the extreme variability of parameters from one scenario to another, the DCFs provided in NUREG-1640 can be applied only under specific circumstances where the material characteristic and "flow" exactly match one of the scenarios described in the report. If a valid DCF is required for a different scenario, it must be derived by modifying the modeling characteristics. The Corps has not demonstrated the validity of generically using the DCFs as described in the proposal.

***Response 4*—**NUREG-1640 was not used to estimate dose to the critical group. Appendix A of the FS (Page A-2) states "…incorporates generic modeling analysis guidance for NRC contained in NUREG/CR-5512…" and the "TEDEs were calculated using exposure-to-dose conversion factors from Federal Guidance Report 11…" Guidance from NUREG-5512 and dose conversion factors from FGR 11 were used to estimate the dose to the utility worker (a member of the critical group), a worker on the facility floor, and a remediation worker. Dose to a worker dismantling the building is modeled as a subset to the remediation worker and, therefore, also uses guidance from NUREG-5512 and FGR 11. Doses to other non-critical group receptors including demolition and steel recycle workers were also evaluated for completeness. The demolition and recycle workers were modeled using NUREG-1640 dose conversion factors and a simple scaling factor based on exposure time. Both scenarios are assumed to be recycle scenarios and are consistent with scenarios modeled in NUREG-1640. The actual worst case source term expected after remediation is 17.1 pCi/g, approximately ¼ the modeled value. In summary, the models presented in the RI/FS overestimate dose and risks to account for uncertainties by using reasonable and appropriate, yet conservative, receptor assumptions.

NRC guidance identified by IDNS were used in the dose analysis, as appropriate, including NUREG-1640, NUREG-5849, NUREG-1575 (MARSSIM), NUREG-5512 and supporting documents, and NUREG-1507. DG-4006 was used to perform the as low as reasonably achievable (ALARA) analysis in Section 3 of the FS, but was not included in the references.

Comment 5**—**The Corps should also note that some licensees misuse MARSSIM in their decommissioning analyses. The Department has not determined that the Corps has misapplied MARSSIM, however, to preclude any potential misapplication, the Department recommends familiarity with the limitations of MARSSIM. MARSSIM methodology is designed, not to establish remediation standards, but to statistically demonstrate at the completion of the remediation that a site has been satisfactorily cleaned-up to established regulatory standards.

Response 5**—**Comment noted. The analysis in the RI/FS shows what the risk would be from some level of contamination. USACE used guidance from MARSSIM and NUREG-5849, where appropriate, to design the RI survey and did not intend for the RI to serve as the final status survey plan or a vehicle for presenting the final status survey. The final status survey plan detailing application of MARSSIM by USACE at the Madison Site was provided to IDNS in March of 2000 for their review.

Comment 6**—**The Corps contends that " . . . [t]he difficult to access areas do not contribute to dose exceeding 25 mrem/yr" (page 3-4, Feasibility Study for the Madison Site.") This statement is suppositious, since the Corps has failed to adequately characterize the contamination in these areas, and has failed to perform adequate risk assessments that cover the scenarios and time periods required by the NRC.

Response 6**—**USACE completed a supplemental assessment from February to April 2000 of the material in the difficult-to-access areas. This assessment (see Attachment 1 – Dose Assessment for Difficult-to-Access Areas at the Madison Site) shows that the dose from the material in the difficult-to-access areas would be less than the ARAR dose criteria using reasonable and applicable exposure scenarios.

Comment 7**—**The Department is also concerned that ALARA analyses could be misused to justify not cleaning all areas to comply with required radiological criteria. It is unclear whether the Corps has misapplied ALARA analyses. Any reference to "remediation action(s)" in Section 3.1 (and its subsections) applies only to further ALARA remediation actions, not to the primary remediation actions required to meet the regulatory dose criteria of 10 CFR 20.1402 and 20.1403 (the subject of Regulatory Position 1, DG-4006, page 2).

Response 7**—**USACE believes it has used the ALARA analysis as intended. The analysis was used to justify that no further action is required. As noted in response to Comment No. 6, the dose from the material in the difficult-to-access areas is less than the ARAR dose criteria. See Attachment 2 – Madison Site ALARA Analysis, which demonstrates further action, is not required, because the residual dose is ALARA.

Comment 8**—**Illinois rules regarding radiological criteria for license termination are "relevant and appropriate" since the activities conducted at the site and resulting contamination are similar to those currently requiring an Illinois license. Current NRC regulations do not apply to the Madison Site. Illinois rules on radiological criteria for license termination are "relevant and appropriate since the activities conducted at the site and the resulting contamination are similar to those . . ." currently requiring an Illinois license. If the Corps disagrees with this as an historical argument, note that any similar current decontamination operations with the State of Illinois requires Department license authorization, since the possession, use and handling of radioactive material is involved. Illinois decontamination requirements are therefore "relevant and appropriate."

Response 8**—**The NRC issues licenses to "receive title to, receive, possess, use, transfer, or deliver source and byproduct materials" in accordance with 10 CFR 40 for source materials (e.g., uranium) pursuant to the provisions of the Atomic Energy Act.

The NRC rules on radiological criteria for license termination, set forth at 10 CFR Part 20, Subpart E, Radiological Criteria for License Termination, establish dose criteria that are applicable when a licensee terminates its license. At Madison, possession and processing of uranium at the site was not performed under an NRC license, and thus the rule is not applicable. However, the provisions in 10 CFR 20 Subpart E are considered relevant and appropriate. Source material license requirements would have applied at Madison had it not been specifically exempted from such license requirements. This is particularly true given that the authority of the State of Illinois is derived from the NRC pursuant to "Agreement State" provisions authorized under the Atomic Energy Act (subsequent to the processing that occurred at Madison) and that all federal agencies must necessarily be licensed by the NRC rather than by Agreement States.

The dose criteria provisions under 10 CFR 20 Subpart E, indicate a site can be used without restrictions if the residual radioactivity would result in a dose of less that 25 mrem to the average member of the critical group and the residual radioactivity has been reduced to ALARA levels.

The rules of the State of Illinois regarding radiological criteria for license termination, while not applicable, were carefully evaluated for relevancy and appropriateness. In evaluating the use of the State of Illinois regulations, two factors were considered: (1) the date when the State of Illinois was granted "Agreement State" status and (2) the compatibility of State regulations with NRC standards. First, the State of Illinois was granted "Agreement State" status by the NRC in the early 1980s pursuant to Section 274 (b) of the Atomic Energy Act. The State of Illinois subsequently promulgated regulations with standards for protection against radiation, 32 Ill. Adm. Code 340 et seq. pursuant to the Illinois Radiation Protection Act of 1990, 420 ILCS 40/16. This state regulation established standards for protection against radiation resulting from activities conducted pursuant to Agreement State licenses and product registrations issued by the Illinois Department of Nuclear Safety. These actions occurred a number of years after uranium processing was conducted at Madison. The site was never licensed by the State of Illinois for uranium. Secondly, Agreement States are now required to make their standards compatible with the NRC's. Illinois statutes have not, as yet, been updated to incorporate the provisions of 10 CFR 20 Subpart E and, therefore, are not currently compatible. The policy of the NRC, promulgated under the authority of Section 274 (j)(1) of the Atomic Energy Act, requires State standards be compatible with those of the Commission unless Federal statutes provide the State authority to adopt different standards. A deadline of three years from the promulgation of the NRC radiological criteria, which became effective on July 21, 1997, was established. Thus Illinois, which has not revised its standards to make them compatible with those of the Commission, should be in the process of doing so, with a final deadline of July 21, 2000. This response action will be performed at approximately the same time that the State standards are required to be changed and, therefore, while the State standards may be considered relevant, they are not considered to be appropriate for this response action. In the best professional judgment of the USACE, it is inappropriate to alter the selected remedy on the basis of a state regulation that is in the process of being changed to conform to the NRC standard, and for which the legal deadline for such change will occur at almost the identical point in time that the remedial action will occur.

The contaminant of concern is processed natural uranium (i.e., chemically separated uranium with normal isotopic abundances). The State of Illinois does not have a generic guideline concentration for processed natural uranium in soil or dust. Existing Illinois surface contamination guidelines consist of total activity for alpha emitters of l,000 dpm/l00cm^2, averaged over any one surface, and 5,000 dpm/l00cm^2, maximum, with removable activity guidelines of 33 dpm/l00cm^2, average, over any one surface, and 100 dpm/l00cm^2, maximum. These guidelines are corollary to NRC criteria in NRC Regulatory Guide 1.86 which are not legally promulgated standards and can not be imposed on Agreement States for implementation. Similarly, the corresponding Illinois Standards have not been fully promulgated and thus are not "relevant and appropriate" for processed natural uranium in soil or dust.

***Comment 9*—**The Department is encouraged that the Corps has collected additional samples to further characterize contaminated areas. The first step described in decommissioning guidance is the characterization of the radioactive contamination ("source term" or "source"), upon which all subsequent assessments are based. The Department has not been satisfied with the source characterization at the Madison facility, due to the invalidated assumptions of contamination levels at the upper tiers of the facility. The Department hopes that the Corps has now collected the samples necessary to demonstrate statistical representation of all contaminated areas. The Department is withholding a determination on this issue until the new sampling results and statistical analyses have been documented by the Corps.

***Response 9*—**USACE has completed additional sampling and performed a supplemental risk assessment of the difficult-to-access areas. The results of this assessment are enclosed in Attachment 1.

3.3.3 Comments from Spectrulite Consortium and the United Steelworkers Local 4804 (Steelworkers)

***Comment 1*—**The FS report intimates that Spectrulite is affiliated with Dow Chemical and/or Mallinckrodt Chemical, such is not the case. There is not now, nor has there ever been any affiliation between Spectrulite and those companies. Further, Spectrulite never participated in any activity on behalf of the Atomic Energy Commission which gave rise to this program. Any statements to the contrary are incorrect.

***Response 1*—**The language in the ROD has been revised to remove any implication that there is now or has ever been any affiliation between Spectrulite and Dow Chemical and/or Mallinckrodt as well as any implication that Spectrulite ever participated in any activity on behalf of the Atomic Energy Commission.

***Comment 2*—**Spectrulite and the Steelworkers agree that implementing the selected remedy would not result in a current risk to the general public, although there may be disagreement regarding the assumptions made to evaluate risk to utility workers. Spectrulite and the Steelworkers agree that it is prudent to remove the residual contamination attributable to historical AEC-funded operations at the Madison Site that poses a risk to worker health and safety. This alternative would also be the most protective of the environment.

Response 2—An exposure frequency of 20 hours per year was used in the dose/risk assessment based on conversations with the current owner/operator. In addition, an upper bound exposure duration of 25 years was used. The USACE believes these assumptions are conversative (i.e., tend to overestimate dose/risk) but are reasonable for the exposure conditions at the Madison Site.

Comment 3—Although Spectrulite and the Steelworkers agree with the concept of the selected remedy, the remediation should be expanded to include the difficult-to-access areas at the 60-ft level (monitors) to remove the potential risk to Spectrulite employees from radiological contamination in dust at the upper levels. Spectrulite and the Steelworkers disagree with the USACE determination that the upper levels are inaccessible and, therefore, do not warrant remediation.

Response 3—As noted in the response to Comment No. 6 from IDNS, the residual contamination in the upper levels 18.3 m (60-ft levels) does not pose a significant risk to the workers, is in compliance with the selected ARAR, and the residual dose is ALARA.

ATTACHMENT 1

DOSE ASSESSMENT FOR DIFFICULT-TO-ACCESS AREAS AT THE MADISON SITE

DOSE ASSESSMENT FOR DIFFICULT-TO-ACCESS AREAS AT THE MADISON SITE

1.0 INTRODUCTION

A dose assessment was prepared using the radio-analytical data collected during February and April 2000 from the difficult-to-access areas of the Madison Site. Included in this new data are isotopic uranium results from twenty-four sample locations. The sample locations were distributed in overhead structures near the area containing the uranium extrusion press, which is the area most likely to have elevated uranium concentrations. The purpose of this memorandum is to present the data from the aforementioned sampling events, give the assumptions used in the analysis, and present the results from the dose assessment.

2.0 ADDITIONAL ANALYTICAL DATA COLLECTED

The dose calculations were performed using isotope-specific data, specifically U-234, U-235, and U-238. Table 1 summarizes the sample identification numbers, sample locations, isotopic concentrations, and total uranium concentrations.

Table 1. Data from Difficult-to-Access Areas

Sample ID	Beam/Sample Location	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Total U (pCi/g)
MAD00220	AA-58	9.55	0.34	11.62	21.5
MAD00221	CC-55	20.46	1.24	18.55	40.3
MAD00222	BB-55	54.05	2.89	55.25	112.2
MAD00223	CC-50	23.45	0.73	24.94	49.1
MAD00224	CC-44	22.99	1.16	22.34	46.5
MAD00225	V-42	5.9	0.24	5.25	11.4
MAD00226	YZ-48	39.42	1.89	40.27	81.6
MAD00227	V-49	1.6	0.00	2	3.6
MAD00247	T-44	1.69	0.11	1.34	3.1
MAD00248	AA-42	0.82	0.04	1.09	2
MAD00249	CC-43	5.84	0.45	5.91	12.2
MAD00250	EE-42	6.02	0.40	5.95	12.4
MAD00251	FF-44	5.83	0.28	6.96	13.1
MAD00228	YZ-55	8.97	0.47	10.57	20
MAD00229	YZ-53	2.87	0.24	2.75	5.9
MAD00231	YZ-52	4.05	0.32	3.76	8.1
MAD00232	XY-51	11.63	0.47	13.36	25.5
MAD00006	BB-59	5.77	0.14	5.92	11.8

Table 1. Data from Difficult-to-Access Areas (Cont'd)

Sample ID	Beam/Sample Location	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Total U (pCi/g)
MAD00007	BB-58.5	2.2	0.31	2.84	5.4
MAD00008	BB-53	59.7	2.67	61.2	123.6
MAD00009	BB-52.5	5.68	0.35	5.8	11.8
MAD00010	DD-53	1.49	0.12	1.81	3.4
MAD00011	BB-48	42.54	1.82	44.71	89.1
MAD00012	BB-47.5	3.01	0.14	4	7.2
				Average (pCi/g):	30.0

The beam/sample locations presented in Table 1 are shown in Figure 1 which is based on the hand-drawn map used by field personnel during the sampling event. Figure 1 is not drawn to scale, but does illustrate the distribution of sampling locations in relation to previous sampling events and the extrusion press. For a comparison to previous sampling locations and concentration results (from lower/accessible beams in the study area) see Figure 1-4 from the Feasibility Study (USACE, 2000).

Additional data were gathered in April 2000 to determine the amount of dust in the difficult-to-access areas. The new data shows that the dust thickness is much less than in other parts of the facility and much less than the conservative value used in the Remedial Investigation and Feasibility Study (RI/FS). The RI/FS assumed (1.5 g/cm^3) x (0.8 cm thick) = 1.2 g/cm^2. The data on the areal density of dust in the difficult-to-access areas is shown in Table 2.

Table 2. Areal Density of Dust in Difficult-to-access Areas at the Madison Site

Sample ID	Area, cm^2	Weight, g	Areal Density, g/cm^2
MAD00220	240	16.2	0.0675
MAD00221	240	10.5	0.04375
MAD00222	192	8.9	0.046354
MAD00223	144	7.8	0.054167
MAD00224	192	11.4	0.059375
MAD00225	192	13.7	0.071354
MAD00226	126	16.3	0.129365
MAD00227	500	34.9	0.0698
MAD00228	126	48.99	0.38881
MAD00229	126	46.13	0.366111
MAD00231	126	45.5	0.361111
MAD00232	156	51	0.326923
		Average:	**0.165**

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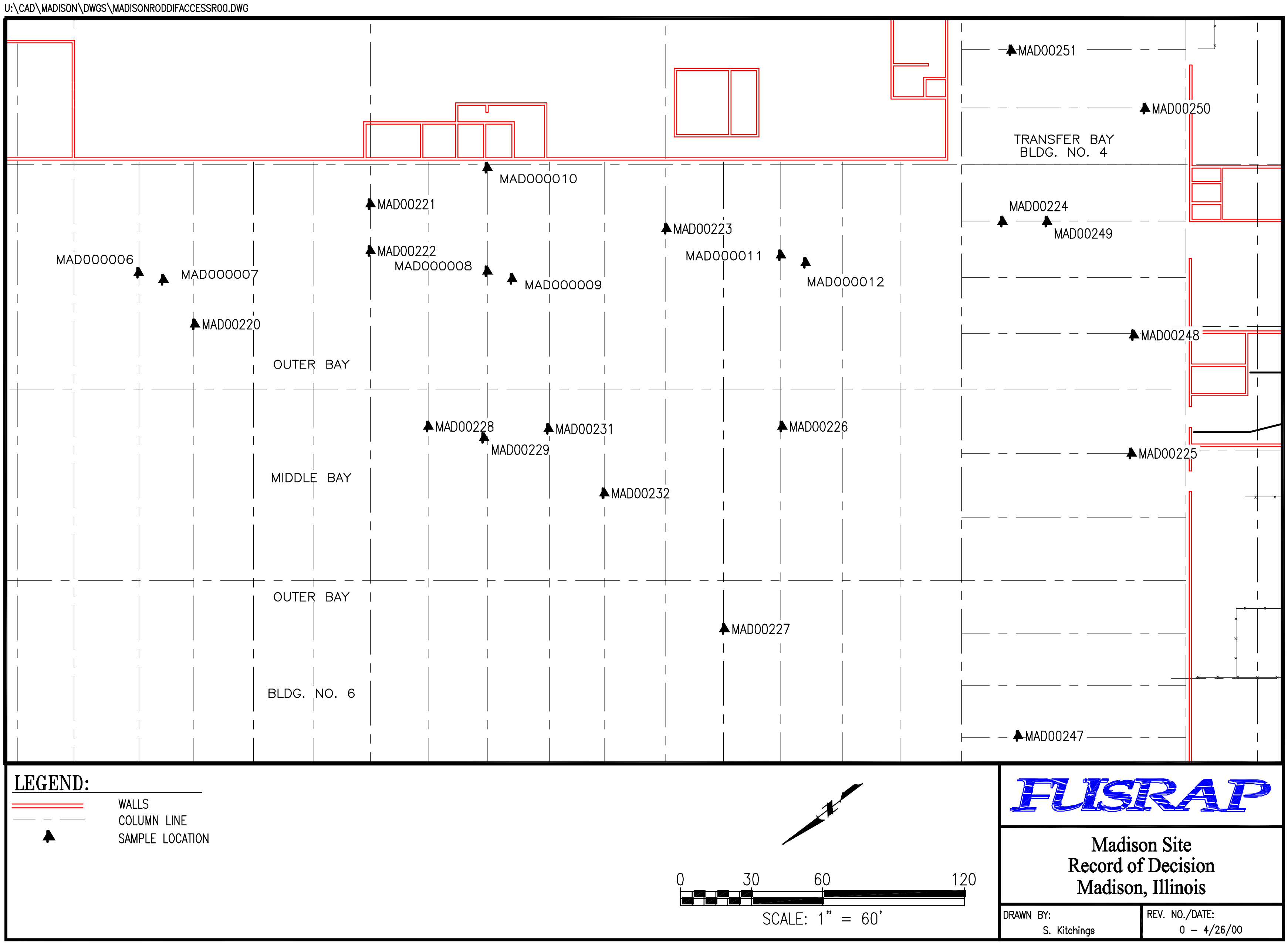

Figure 1. Approximate Sample Locations for Difficult to Access Areas

3.0 DOSE ASSESSMENT METHODOLOGY

The appendices in the RI/FS present the dose assessment methodology for exposure to uranium contamination on the support beam and cross member surfaces in the study area (USACE, 2000). The RI/FS assessment focuses on site workers on the facility floor, utility workers in the beams and trusses no higher than 11 m (36 ft) above the floor, and remediation workers. The assessment also evaluates a building demolition worker, a building dismantlement worker, and a steel recycle worker exposed to uranium contaminants in the lower beams and trusses. The assessment did not calculate doses for the difficult-to-access areas 13.7 to 18.3 m (45 to 60 ft) above the facility floor. The higher areas were not included in the evaluation due in part to a lack of data and in part because there is limited access and little reason for an individual to be exposed to potential contamination 13.7 to 18.3 m (45 to 60 ft) above the facility floor.

Since the RI/FS was issued, the USACE has collected samples from the higher areas. In addition, interviews with site workers have revealed that an individual may spend two hours per year and no more than four hours per year in the difficult-to-access areas. Dose estimates were performed using the following information:

1. newly acquired uranium concentration and dust density data from the difficult-to-access areas;
2. exposure frequency estimates for utility, demolition, dismantlement and steel recycle workers; and
3. assessment methodology from the RI/FS (USACE, 2000).

4.0 WORKER IN DIFFICULT-TO-ACCESS AREAS

The RI/FS reports a dose of 210 mrem/yr if a utility worker is exposed to an average concentration of 70.9 pCi/g total uranium (USACE, 2000). The average concentration in the difficult-to-access areas is 30 pCi/g total uranium as shown in Table 1. The 210 mrem/yr estimate also assumes the worker is exposed for 20 hr/yr. This exposure frequency is overly conservative for the difficult-to-access areas, whereas a 2 and not more than 4 hr/yr frequency more closely represents central tendency and maximum exposure frequency as supported by interviews with site workers. The larger exposure frequency of 4 hours is used to estimate the potential dose. Additionally, the amount of dust in the difficult-to-access area (0.165 g/cm^2) is much less than the conservative value of 1.2 g/cm^2 used in the FS evaluation of the lower beams.

Exposure parameters for the worker who will potentially work very close to the contaminated surfaces in the difficult-to-access areas, are listed in Table 3. Inhalation and ingestion are considered for exposure estimates. Ingestion is added to this scenario because of the worker's contact with contaminated surfaces.

Table 3. Worker Exposure Parameters for Difficult-to-Access Areas

Exposure Parameter	Value	Source/Comments
Inhalation rate (m^3/hr)	1.875	The 1997 Exposure Factors Handbook lists the mean hourly rate for adults as 1.0 m^3/hr for light activities, 1.6 m^3/hr for moderate activities, and 3.2 m^3/hr for heavy activities. Activities for utility workers are typically moderate activities, but the value was increased to account for brief periods of heavy activities. The value used was 1.875 m^3/hr.
Exposure frequency (hours/yr)	4	Based on interviews of plant workers.
Exposure duration (yrs)	25	EPA (1991) Exposure duration for the commercial/industrial use.
Inhalation class	Y	Chemical form inhalation class refers to the clearance half time from the pulmonary region of the lungs. Class Y is the most conservative uranium class.
Resuspension factor (m^{-1})	5 E-5	NRC (1998) The resuspension factor is noted to vary by 6 orders of magnitude depending on the conditions. The value of 5 E-5 is the value cited by the IAEA for operating nuclear facilities.
Transfer rate for ingestion of removable surface contamination (m^2/hr)	1 E-4	NRC (1998) This factor represents a plausible ingestion fraction.
Exposure-to-dose conversion factor for inhalation (Sv/Bq)	U-234 = 3.58 E-5 U-235 = 3.32 E-5 U-238 = 3.2 E-5	EPA (1988) values from Table 2.1 for TEDE for class Y uranium isotopes. The dose conversation factor for U-234 will be conservatively used for the dose assessment.
Exposure-to-dose conversion factor for ingestion (Sv/Bq)	U-234 = 7.66 E-8 U-235 = 7.19 E-8 U-238 = 6.88 E-8	EPA (1988) values from Table 2.2 for TEDE for uranium isotopes. The dose conversation factor for U-234 will be conservatively used for the dose assessment.

Calculations

Surface Activity

The mean surface activity is estimated using the mean concentration of 30.0 pCi/g, the average areal density of dust in the difficult-to-access areas.

$$30 \text{ pCi/g} \times 0.165 \text{ g/cm}^2 \times 10^4 \text{ cm}^2/\text{m}^2 = 4.95 \text{ E4 pCi/m}^2$$

Airborne Concentration

The airborne concentration is calculated using the resuspension factor of 5 E-5 m^{-1} since no remediation of this area is expected to occur.

$$4.95 \text{ E4 pCi/m}^2 \times 5 \text{ E-5 m}^{-1} = 2.5 \text{ pCi/m}^3$$

Calculation of Inhalation and Ingestion Intake of Activity

The total activity the worker is assumed to intake through inhalation over the 4 hours of work per year and the 25-year exposure duration is calculated.

2.5 pCi/m^3 × 1.875 m^3/hr × 4 hours/yr × 25 yrs = 4.7 E2 pCi *from inhalation*.

The intake of activity due to ingestion is similarly calculated using the transfer rate for ingestion.

2.5 pCi/m^2 × 1 E-4 m^2/hr × 4 hours/yr × 25 yrs = 2.5 E-2 pCi *from ingestion*.

Calculation of TEDE

TEDE from inhalation and ingestion is obtained using the exposure-to-dose conversion factors from Federal Guidance Report No. 11 (EPA, 1988)

4.7 E2 pCi × 0.037 Bq/pCi × 3.58 E-5 Sv/Bq × 1 E5 mrem/Sv = 6.2 E1 mrem/25 yrs = 2.5 mrem/yr
2.5 E-2 pCi × 0.037 Bq/pCi × 7.66 E-8 Sv/Bq × 1 E5 mrem/Sv = 7 E-6 mrem/25 yrs ≈ 0 mrem/yr

for comparison with the 25 mrem/yr annual TEDE criterion in 10 CFR 20, Subpart E.

5.0 DEMOLITION WORKER

The demolition worker is intended to represent an individual who helps knock down the building. This individual would likely have little direct contact with contaminants on beams or trusses on any level. The dose estimate is presented in the RI/FS assuming the average total uranium concentration is 70.9 pCi/g on all surfaces results in a dose of 0.03 mrem. For this assessment, it is assumed that the surfaces below the difficult-to-access areas are remediated to an average of 20 pCi/g [the site derived concentration guideline level (DCGL)], which represents 95% of the total surface area. It is also assumed that the average concentration in the difficult-to-access areas is 30 pCi/g, which represents the remaining 5% of the total surface area. Using these conservative assumptions, the resulting average total uranium concentration is [(20 × 0.95) + (30 × 0.05)] = 20.5 pCi/g. The dose estimates for the demolition worker are calculated as follows:

U-234:

- (4.6 μSv/yr/Bq/cm^2) × (3.7E-3 mrem/yr/pCi/cm^2 per μSv/yr/Bq/cm^2) = 0.017 mrem/yr/pCi/cm^2
- [(0.05) × (30 pCi/g) × (0.165 g/cm^2) + (0.95)(20 pCi/g)(1.2 g/cm^2)] × (0.017 mrem/yr/pCi/cm^2) × (0.506) × (0.02 yr) = 0.004 mrem

U-235:

- $(4.3\ \mu Sv/yr/Bq/cm^2) \times (3.7E\text{-}3\ mrem/yr/pCi/cm^2\ per\ \mu Sv/yr/Bq/cm^2) = 0.016\ mrem/yr/pCi/cm^2$
- $[(0.05) \times (30\ pCi/g) \times (0.165\ g/cm^3) + (0.95)(20\ pCi/g)(1.2\ g/cm^2)] \times (0.016\ mrem/yr/pCi/cm^2) \times (0.023) \times (0.02\ yr) = 0.00017\ mrem$

U-238:

- $(4.1\ \mu Sv/yr/Bq/cm^2) \times (3.7E\text{-}3\ mrem/yr/pCi/cm^2\ per\ \mu Sv/yr/Bq/cm^2) = 0.015\ mrem/yr/pCi/cm^2$
- $[(0.05) \times (30\ pCi/g) \times (0.165\ g/cm^3) + (0.95)(20\ pCi/g)(1.2\ g/cm^2)] \times (0.015\ mrem/yr/pCi/cm^2) \times (0.471) \times (0.02\ yr) = 0.003\ mrem$

Total Dose = (0.004 mrem) + (0.00017 mrem) + (0.003 mrem) = 0.007 mrem

These estimates demonstrate that the demolition worker would likely receive an insignificant dose if exposed to uranium-contaminated dust in the difficult-to-access areas.

6.0 DISMANTLEMENT WORKER

The dismantlement worker is assumed to be similar to the remediation worker evaluated in the RI/FS with two noted differences (USACE, 2000). First, the dismantlement worker is assumed to be exposed to an average total uranium concentration of 20.5 pCi/g as described above. Second, the dismantlement worker is expected to have less direct contact contaminated surfaces while disassembling (rather than decontaminating) the building. An exposure reduction of 25% is assumed for this assessment. Given that the remediation worker's estimated dose is 150 mrem, the dismantlement worker dose is estimated as follows:

Dose (mrem/yr) = 150 mrem/yr x (0.25) x (20.5/70.9) = 11 mrem

This estimate demonstrates that the dose to the dismantlement worker, including exposure from uranium-contaminated dust in the difficult-to-access area, is below the ARAR limit of 25 mrem/yr.

7.0 STEEL RECYCLE WORKER

The steel recycle worker in the RI/FS is estimated to receive a dose of 0.91 mrem when exposed to an average of 70.9 pCi/g of total uranium (USACE, 2000). This worker could handle metal beams and trusses in the scrap yard and could be exposed to contaminants from both the lower and difficult-to-access areas. Using the surface area fractions as described above and assuming that the lower surfaces are remediated to an average of 20 pCi/g or less, the steel recycle worker's dose and risk are estimated as follows:

U-234

- 66 μSv/yr/Bq/cm^2 $\times$ (3.7 $\times$ 10^{-3} mrem/yr/pCi/cm^2 per μSv/yr/Bq/cm^2) = 0.24 mrem/yr/pCi/cm^2
- [(0.05) $\times$ (30 pCi/g) $\times$ (0.165 g/cm^2) + (0.95) $\times$ (20 pCi/g) $\times$ (1.2 g/cm^2)] $\times$ 0.24 mrem/yr/pCi/cm^2 $\times$ 0.506 $\times$ 0.04 yr = 0.11 mrem

U-235

- 62 μSv/yr/Bq/cm^2 $\times$ (3.7 $\times$ 10^{-3} mrem/yr/pCi/cm^2 per μSv/yr/Bq/cm^2) = 0.23 mrem/yr/pCi/cm^2
- [(0.05) $\times$ (30 pCi/g) $\times$ (0.165 g/cm^2) + (0.95) $\times$ (20 pCi/g) $\times$ (1.2 g/cm^2)] $\times$ 0.23 mrem/yr/pCi/cm^2 $\times$ 0.023 $\times$ 0.04 yr = 0.005 mrem

U-238

- 59 μSv/yr/Bq/cm^2 $\times$ (3.7 $\times$ 10^{-3} mrem/yr/pCi/cm^2 per μSv/yr/Bq/cm^2) = 0.21 mrem/yr/pCi/cm^2
- [(0.05) $\times$ (30 pCi/g) $\times$ (0.165 g/cm^2) + (0.95) $\times$ (20 pCi/g) $\times$ (1.2 g/cm^2)] $\times$ 0.21 mrem/yr/pCi/cm^2 $\times$ 0.471 $\times$ 0.04 yr = 0.09 mrem

Total Dose = 0.11 mrem + 0.005 mrem + 0.09 mrem = 0.2 mrem

As with the demolition worker, the steel recycle worker would likely receive an insignificant dose if exposed to the contaminants in the difficult-to-access areas.

8.0 CALCULATION OF DCGL FOR DIFFICULT-TO-ACCESS AREAS

A DCGL of 300 pCi/g that is equivalent to the 25 mrem/yr ARAR will be used for volumetric contamination in the difficult-to-access areas.

Surface Activity per pCi/g

The mean surface activity per pCi/g

(1 pCi/g)(0.165 g/cm^2)(10^4 cm^2/m^2) = 1.65 E3 pCi/m^2 per pCi/g

Airborne concentration per pCi/g

The airborne concentration is calculated using the resuspension factor before decontamination of 5E-5 m^{-1}.

(1.65 E3 pCi/m^2) $\times$ (5 E-5 m^{-1}) = 8.25 E-2 pCi/m^3

Inhalation Intake of Activity per pCi/g

The total activity that is assumed to be inhaled over 4 hours of work per year is calculated.

$(8.25\ E\text{-}2\ pCi/m^3)(1.875\ m^3/hr)(4\ hr/yr) = 6.2\ E\text{-}1$ pCi per pCi/g

Calculation of Dose per pCi/g

Using the exposure-to-dose conversion factors from Federal Guidance Report No. 11 (EPA, 1988).

(6.2 E-1 pCi) × (0.037 Bq/pCi) × (3.58 E-5 Sv/Bq) × (1 E5 mrem/Sv) = 8.2 E-2 mrem per pCi/g

Volumetric DCGL for Difficult-to-access Areas

The volumetric DCGL is calculated using the average density and thickness of the dust described earlier.

(25 mrem/yr)(1 pCi/gm/8.2 E-2 mrem/yr) = 3.0E2 pCi/g = 300 pCi/g

9.0 SUMMARY

The results from the dose assessment are shown below in Table 4. The DCGL for the difficult-to-access areas is 300 pCi/g. If the same worker worked in both the lower overheads and the difficult-to-access areas, this worker would receive a dose from both areas. The combined dose from both areas would be less than 25 mrem/yr since the dose from the lower beams after remediation is expected to be less than 10 mrem/yr. Compliance with the 25 mrem/yr ARAR dose limit will be confirmed using actual data collected after remediation.

Table 4. Dose Estimates Using Data from the Difficult-to-Access Areas of the Madison Site

Receptor/Scenario	Dose (mrem/yr)
• Worker in Difficult-to-access Areas for current conditions	2.5
• Demolition Worker after Remediation with no removals from difficult-to-access areas	0.007
• Dismantlement Worker after Remediation with no removals from difficult-to-access areas	11
• Steel Recycle Worker after Remediation with no removals from difficult-to-access areas	0.2

REFERENCES

EPA (U.S. Environmental Protection Agency) 1988. *Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation Submersion, and Ingestion*, EPA 520/1-88-020, Office of Radiation Programs, Washington, D.C.

USACE (United States Army Corps of Engineers), 2000. *Remedial Investigation Report and Feasibility Study for the Madison Site, Madison, Illinois*, St. Louis District Office, January.

ATTACHMENT 2

MADISON SITE ALARA ANALYSIS

DIFFICULT-TO-ACCESS AREAS

MADISON SITE ALARA ANALYSIS FOR DIFFICULT-TO-ACCESS AREAS

The following calculation was performed to determine if further action would be required in the difficult-to-access areas of the Madison Site and if residual contamination is as low as reasonably achievable (ALARA). Calculations methods/equations are consistent with those presented in NRC Draft Guidance 4006 (DG-4006).

$$B_{AD} = \$2{,}000 \times PW(AD_{collective})$$

B_{AD}	=	Benefit from averted dose for a remediation action (dollars);
\$2,000	=	Value of averted dose (person-rem); and
$PW(AD_{collective})$	=	Present worth of future collective averted dose.

P_D = Population density for the critical group scenario (people/m^2);

$$PW(AD_{collective}) = P_D \; x \; A \; x \; 0.025 \; x \; F \; x \; \frac{CONC}{DCGL} \; x \; \frac{1 - e^{-(r+\lambda)N}}{r + \lambda}$$

A	=	Area being evaluated (m^2); The terms P_D and A are used to estimate the number of people exposed. For this assessment and based on interviews at the site, it is assumed that $P_D \times A = 10$ when considering facility workers or $P_D \times A = 4$ when considering “worst case scenario for maintenance worker access to difficult-to-access areas.
0.025	=	Annual dose to an average member of the critical group from residual radioactivity at the DCGL concentration (rem/yr);
F	=	Fraction of the residual radioactivity removed by the remediation action (calculated below);
CONC	=	Average concentration of residual radioactivity in the difficult-to-access area (calculated below in pCi/g or dpm/100cm^2);
DCGL	=	Derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 25 mrem/yr to a worker in the difficult-to-access areas (calculated below in pCi/g or dpm/100cm^2);
r	=	Monetary discount rate (0.07/yr from DG-4006 Table 3);
λ	=	Radiological decay constant equivalent to the natural log of 2 divided by the radiological half-life, or $0.693/t_{½}$ (yr^{-1}). (For uranium isotopes, $\lambda << r$ so that $\lambda + r \approx r$. Therefore, the λ term is dropped.); and
N	=	Number of years over which the collective dose will be calculated (25 years for the Madison Site assumes a reasonable maximum remaining building lifetime).

The average concentration of the difficult-to-access areas is 30 pCi/g. The fraction of residual radioactivity removed by the remediation action (F) is assumed to be relatively high given that the contaminants were deposited in the overheads as settling dust. There is little reason to believe that over the years the contaminants have become embedded in the volume of metal beams, etc. Therefore, a conservative value of 0.9 is adopted for F as the removable fraction if further remediation were to occur.

Given that $P_D \times A = 4$, F = 0.90, CONC = 30 pCi/g, and DCGL = 300 pCi/g, $PW(AD_{collective})$ is estimated as follows:

$$PW(AD_{collective}) = 4 \; x \; 0.025 \; x \; 0.90 \; x \; \frac{30}{300} \; x \; \frac{1 - e^{-(0.07)25}}{0.07} = 0.11$$

Having calculated $PW(AD_{collective})$ for the difficult-to-access areas, the benefit from averted dose is calculated as follows:

$$B_{AD} = 0.11 \times \$2000 = \$220.00$$

The benefit from the averted dose is calculated to be $220.00 while the cost for further action in the difficult-to-access areas is estimated to be $500,000. DG-4006 recommends that if the cost of a proposed remedial action exceeds the value of the benefit and the residual dose is below 25 mrem/yr, then no further action is needed since the residual dose is ALARA. Thus, remediation of the difficult-to-access areas is not recommended, since the residual dose is ALARA.