ADMINISTRATIVE RECORD FOR THE MADISON SITE

MADISON, ILLINOIS

Site Management Records-

Memo- Authorization for Remedial Action at the Former Dow Chemical Company in Madison, IL

US Army Corps of Engineers
St. Louis District®

DOE F 1325.8
(8-89)
EFG (07-90)

095800

United States Government

Department of Energy

memorandum

1992 OCT 13 PM 1:29

DATE: SEP 25 1992

REPLY TO ATTN OF: EM-421 (W. A. Williams, 903-8149)

SUBJECT: Authorization for Remedial Action at the Former Dow Chemical Company Facility in Madison, Illinois

TO: L. Price, OR

The site of the Former Dow Chemical Company in Madison, Illinois, which is currently owned and operated by the Spectrulite Consortium, is designated for inclusion in the Formerly Utilized Sites Remedial Action Program (FUSRAP). This designation is based upon the results of a preliminary radiological survey and other information described in the attached Designation Summary. The authority determination and preliminary survey report also are attached for information.

The site has been assigned a low priority under the FUSRAP protocol, as the contamination is localized to overhead beams and limited in extent. Under present building use, it is highly unlikely that an individual working in or frequenting these remote areas would receive a significant exposure. Because the contamination is limited in extent and contained entirely inside the building, we recommend that cleanup of the site follow the proposed expedited protocol currently under development. We will work closely with your staff, the designation contractor, and the property owner to ensure that remedial action is conducted efficiently.

The effect of this designation on the FUSRAP baseline should be evaluated, documented and submitted for approval under the baseline change control procedures.

James W. Wagoner II
Director
Division of Off-Site Programs
Office of Eastern Area Programs
Office of Environmental Restoration

Attachments

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FORMERLY UTILIZED SITES
REMEDIAL ACTION PROGRAM

DESIGNATION SUMMARY FOR THE FORMER DOW CHEMICAL COMPANY IN MADISON, ILLINOIS

September 1991

U.S. Department of Energy
Office of Environmental Restoration

Designation Summary
Former Dow Chemical Company

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Former Dow Chemical Company

INTRODUCTION

The Department of Energy (DOE), Office of Environmental Restoration, has reviewed the past activities of the Atomic Energy Commission (AEC) at the Former Dow Chemical Company in Madison, Illinois, and has completed a radiological survey of the site (Cottrell and Williams, 1990). DOE has determined that residual uranium dust levels in overhead beam locations exceed current DOE radiological guidelines (USDOE, 1987; 1990) for use of the building without radiological restrictions. Because of the inaccessibility and limited extent of the residual contamination, there is no significant risk to workers or the general public under current site use.

From the results of the survey and a review of available historical documents, the DOE has concluded that this site shall be designated for remedial action under the Formerly Utilized Sites Remedial Action Program (FUSRAP) and assigned a low priority. The remainder of this report summarizes the site information and the designation decision.

BACKGROUND

Site Function (Williams, 1991)

The Dow Chemical Company offices and facilities in the St. Louis area supplied materials (chemicals, induction heating equipment, and magnesium metal products) and services under purchase orders issued by Mallinckrodt Chemical Works, a prime AEC contractor. In 1957, Mallinckrodt subcontracted to Dow to conduct "...certain research and development work in gamma phase extrusion of uranium metal, ...to be done at Dow's Madison, Illinois plant; ...." According to the subcontract, the work was to be performed in monthly work cycles of 28 hours each for 12 consecutive months. The makeup of each work cycle was defined as 6 hours for set-up time, 16 hours for experimentation (extrusion), and 6 hours devoted to cleanup.

In addition to auxiliary equipment and tool design, Dow supplied the use of its press, labor, and plant facilities necessary to perform the work cycles. Mallinckrodt responsibilities included: procurement and installation of the auxiliary equipment designed by Dow; modifications to the dust arresting and other protective equipment required by plant area surveys made from time to time during the course of the work; arrangement for complete survey of breathing zone air quality to be conducted periodically by the AEC Health and Safety Laboratory; establishment of a program for area clearance after each cycle; supply (to Dow) of the uranium billets allocated for each work cycle; and pick up of the billets or extruded metal at the end of a work cycle.

Designation Summary
Former Dow Chemical Company

In March 1960 the Uranium Division of the Mallinckrodt Chemical Works issued a purchase order for the straightening of Mallinckrodt-supplied uranium rods. Delivery of the rods to the Dow plant and pickup after the straightening operation was performed by Mallinckrodt personnel. Two rod straightening campaigns were identified in the purchase order. One was completed in December 1959. The other was completed in January 1960. Cleanup of the area after each campaign was identified and costed as a separate and distinct item in the purchase order. The actual periods of performance and the quantities of uranium metal involved in these operations is unknown. However, the total value of the purchase order and the unit cost identified with lot size indicate that the quantity of metal involved was probably small.

No other operation or period of involvement with the processing or handling of radioactive materials at the former Dow Madison plant have been discovered.

Site Description (Cottrell and Williams, 1990)

Madison, Illinois is located northeast of St. Louis, Missouri, across the Mississippi River. The former Dow Chemical Company Plant is in West Madison at the intersection of College and Weaver Streets. The plant consists of a large, multisectional complex of ten interconnecting buildings with a total area under roof of approximately 1.4 million square feet. The area in which the uranium extrusion and rod-straightening work occurred is located in Building 6, a large multistory metal building with concrete floors. The building is used by the current owner, Spectrulite Consortium, for metal extrusion and storage of equipment and parts.

Owner History

The Dow Chemical Company owned the site until 1969. The current owner and operator of the plant is the Spectrulite Consortium, Incorporated.

Radiological History and Status (Cottrell and Williams, 1990)

Mallinckrodt may have conducted cleanup of the plant facilities after uranium processing operations; however, no records have been located that provide details of the plant cleanup. Consequently, a radiological survey was conducted by Oak Ridge National Laboratory in March, 1989. Survey results indicate the presence of elevated concentrations of Uranium-238 and Thorium-232 in dust sampled from overhead beams in the building where the uranium extrusion and rod straightening work was conducted. The maximum uranium surface contamination in dust was 13.6 times the average DOE guideline, while average uranium contamination from 18 samples was 2.5 times the DOE guideline (USDOE 1987, 1990).

Designation Summary
Former Dow Chemical Company

Authority Review (Williams 1991)

In 1991, the DOE determined that it has the authority to conduct remedial action at the site (USDOE 1986, Williams 1991). This determination of authority under FUSRAP was based in part upon the following significant factors.

Available records indicate that Dow was directly supervised by the Atomic Energy Commission (AEC) prime contractor. AEC staff approved the arrangements to use the facility and provided indemnification of Dow against atomic hazards.

As a part of the operations at the site, there were requirements concerning security, accountability, health, and safety. These were controlled by AEC directly or through its prime contractor. The AEC was expected to periodically monitor air quality during operations. The contamination at the site most likely resulted from airborne deposition of uranium on the roof support beams.

The uranium machined at the site was owned by the government.

AEC staff were substantially involved in the subcontract negotiation; as a result, AEC approved the indemnification clause. Mallinckrodt was also indemnified by the AEC; thus, AEC indemnified Dow against atomic hazards either directly by approving the subcontract or indirectly through the indemnification of Mallinckrodt.

DESIGNATION DETERMINATION

Survey results indicate that there is residual radioactive contamination on overhead beams at the site. The DOE has authority to conduct remedial action at the site under FUSRAP. Consequently, the site is hereby designated for inclusion in FUSRAP.

On the basis of the ranking procedure of the FUSRAP protocol (USDOE, 1986), the site is classified as a low priority site. This classification is based on the inaccessibility and limited extent of the residual contamination. Under current use conditions, there is no significant risk of exposure to site workers or the general public.

Designation Summary
Former Dow Chemical Company

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PRELIMINARY RESULTS OF THE RADIOLOGICAL SURVEY AT THE FORMER DOW CHEMICAL COMPANY SITE, MADISON, ILLINOIS

W. D. Cottrell
J. K. Williams

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

ORNL/TM-11552

HEALTH AND SAFETY RESEARCH DIVISION

Waste Management Research and Development Programs
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PRELIMINARY RESULTS OF THE RADIOLOGICAL SURVEY AT THE FORMER DOW CHEMICAL COMPANY SITE, MADISON, ILLINOIS

W. D. Cottrell and J. K. Williams

Date of Issue – December 1990

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SUMMARY

During the late 1950s and early 1960s, the former Dow Chemical Company plant, now owned and operated by Spectrulite Consortium Inc., supplied materials and provided services for the Atomic Energy Commission (AEC) under purchase orders issued by the Mallinckrodt Chemical Company, a primary AEC contractor. To date, only one Mallinckrodt subcontract with the Dow Chemical Company has been found. Information in this subcontract indicates that research and development work involving gamma-phase extrusion of uranium metal was conducted at the Dow Chemical plant. The extrusion department of the former Dow Chemical plant where this work was performed is currently used by the Spectrulite Consortium Inc. for extruding aluminum and magnesium metal. It is the policy of the U.S. Department of Energy (DOE) to verify that such sites are in compliance with current DOE guidelines. Because documentation establishing the current radiological condition of the property was unavailable, a radiological survey was conducted by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory in March 1989. The survey included: (1) measurement of indoor gamma exposure rates; (2) collection and radionuclide analysis of dust and debris samples; and (3) measurements to determine alpha and beta-gamma surface contamination.

The results of the survey demonstrate that Building 6, the area where uranium extrusion and rod-straightening work occurred, is generally free of radioactive residuals originating from former DOE-sponsored activities. Most indoor radiological measurements were within the range of background values for southwestern Illinois. However, ^{238}U- and ^{232}Th-contaminated dust was found on overhead beams at the south end of Building 6. The major contaminant in the beam dust was ^{238}U with lesser amounts of ^{232}Th occurring in a few locations. The maximum concentration of ^{238}U found in dust, 310 pCi/g, corresponds to a surface concentration of 6.8×10^4 dpm/100 cm^2. This value is about 13 times the DOE average ^{238}U surface contamination limit of 5000 dpm/100 cm^2. The average ^{238}U surface contamination (18 samples) was 2.5 times the DOE limit. The presence of ^{232}Th in beam dust samples and thorium-containing magnesium-alloy objects (e.g., grinding wheels, shims) found throughout Building 6 are not DOE related, but the result of a separate, licensed process of the current owner, Spectrulite Consortium, Inc. The highest ^{232}Th concentrations in beam dust samples (S1, 7.8 pCi/g, and S8, 7.0 pCi/g) were collected near the Building 6–Building 4 intersection.

These findings suggest that past DOE-supported operations (i.e., uranium extrusion and rod-straightening activities) were responsible for uranium-contaminated beam dust in excess of guidelines in Building 6. However, the contamination is localized and limited in extent, rendering it highly unlikely that under present use an individual working in or frequenting these remote areas would receive a significant radiation exposure. We recommend that

additional scoping survey measurements and sampling be performed to further define the extent of indoor uranium contamination southward to include Building 4 and northward throughout Building 6.

PRELIMINARY RESULTS OF THE RADIOLOGICAL SURVEY AT THE FORMER DOW CHEMICAL COMPANY SITE, MADISON, ILLINOIS*

INTRODUCTION

Madison, Illinois, is located northeast of St. Louis, Missouri, across the Mississippi River (see Fig. 1). The former Dow Chemical Company plant, now owned and operated by Spectrulite Consortium Inc., is in west Madison at the intersection of College and Weaver streets. The Madison plant was apparently owned and operated by the Dow Metal Products Division of Dow Chemical Company during the 1950s and 1960s. The plant was sold by Dow Chemical in 1969. During the late 1950s and early 1960s, Dow supplied materials and provided services for the Atomic Energy Commission (AEC) under purchase orders issued by the Mallinckrodt Chemical Company, a primary AEC contractor. Materials supplied included chemicals, magnesium metal products, and induction heating equipment.[1]

To date, only one Mallinckrodt subcontract with the Dow Chemical Company has been found (No. 25034-M, March 15, 1957). Information in this subcontract indicates that research and development (R&D) work involving gamma-phase extrusion of uranium metal was to be conducted at the Dow Chemical Company in Madison, Illinois. Reportedly, the R&D work was performed in monthly work cycles of 28 h each for 12 consecutive months. Each work cycle was defined as 6 h for setup time, 16 h for experimentation (extrusion), and 6 h for cleanup operations. In addition to auxiliary equipment and tool design, Dow supplied the use of its press, labor, and plant facilities necessary to perform the work cycles.[1]

Mallinckrodt Chemical Company's responsibilities as outlined in the Dow Chemical subcontract were (1) procurement and installation of auxiliary equipment designed by Dow; (2) modifications to the dust-arresting equipment and other protective equipment required by plant area surveys made from time to time during the course of the work; (3) arrangement for a complete survey of breathing-zone air quality to be conducted periodically by the AEC Health and Safety Laboratory; (4) establishment of a program for area clearance after each cycle; (5) supply of the uranium billets allocated for a work cycle (tentatively determined as 20 billets) to Dow; and (6) cleanup of billets or extruded metal at the conclusion of a work cycle.[1]

A search of the files of the former AEC Weldon Spring Feed Material Plant covering the period July 1957 through November 1965 found only one purchase order that involved

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*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under U.S. DOE contract DE-AC05-84OR21400.

the processing or handling of radioactive materials at the Madison Dow plant. This purchase order was issued by the Uranium Division of the Mallinckrodt Chemical Company in March 1960 and was for the straightening of Mallinckrodt-supplied uranium rod. Delivery of the rod to the Dow plant and pickup after the straightening operation were performed by Mallinckrodt personnel. Two rod-straightening campaigns were identified in the purchase order. One was completed in December 1959. The other was completed in January 1960. Cleanup of the area after each campaign was identified and costed as a separate item in the purchase order. Actual periods of performance and quantities of uranium metal involved in these operations are unknown. However, the total value of the purchase order and the unit cost identified with lot size indicate that the quantity of metal involved was probably small. No other operation or period of involvement with the processing or handling of radioactive materials at the former Dow Madison plant has been discovered.[1]

Both the subcontract and purchase order described above indicate that the Mallinckrodt Chemical Company was responsible for cleanup of the plant facilities after completion of operations involving the processing of uranium metal and health and safety during the operations. However, no records have been found that provide details of Mallinckrodt's health and safety program at the plant or the degree of success of the cleanup operation. The subcontract and purchase order indicate that Mallinckrodt retained accountability for the uranium metal throughout the operations and was responsible for removing unused metal, finished product, and residues from the plant. Records showing the configuration and quantities of uranium metal involved in these operations have not been found. Additionally, documents describing the plant layout during the 1950s and 1960s have not been obtained.[1]

The extrusion department of the former Dow Chemical plant where the work was performed is currently used by the Spectrulite Consortium Inc. for extruding aluminum and magnesium metal.

It is the policy of the U.S. Department of Energy (DOE) to verify that radiological conditions at such sites or facilities comply with DOE residual radioactivity guidelines. If deviation from the guidelines is found, remedial actions shall be implemented (where DOE has the authority to do so) to correct any unacceptable condition. The uranium extrusion and rod-straightening processes with which the Madison site was involved were relatively small scale and do not represent a potential for significant radiological contamination. However, there is a limited potential for residual radioactive materials to be present in excess of DOE guidelines at the site of the uranium extrusion.[2]

Because no documentation has been discovered to establish the current radiological condition in and around the building in which the uranium extrusion and rod-straightening work occurred, Oak Ridge National Laboratory (ORNL) conducted a preliminary survey at the request of DOE to obtain site residual radioactivity information which would support a decision by DOE for inclusion or elimination from further consideration in the Formerly Utilized Sites Remedial Action Program (FUSRAP). The survey was conducted by ORNL in March 1989. The remainder of this report discusses survey procedures and results.

SITE DESCRIPTION

The Madison plant consists of a large, multisectioned complex of ten interconnecting buildings. The total area under roof is estimated to be 1,458,375 ft^2. The area in which past uranium extrusion and rod-straightening work occurred is located in Building 6. Because this building is in active use by Spectrulite Consortium Inc., survey activities were limited to off-shift hours during the weekend. Building 6, a large, multistory metal building with concrete floors, is currently used in metal extrusion processes. Much of the building area is used for storage of various equipment and parts. Several indoor views of Building 6 are shown in Figs. 2-6. Figure 7 is a diagram of the entire plant complex (note that shading on the figure indicates areas surveyed).

SURVEY PROCEDURES

The radiological survey included: (1) gamma scanning at accessible floor and wall surfaces throughout the building and on overhead beams; (2) collection and radionuclide analysis of indoor dust and debris; and (3) determination of direct and removable beta-gamma and alpha activity levels on overhead beam surfaces. A comprehensive description of the survey methods and instrumentation used in this survey is provided in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987).[3]

Using a portable gamma scintillation [sodium iodide (NaI)] survey meter, ranges of exposure rates were recorded by scanning near the floor and on selected wall and beam surfaces of Building 6. Beta-gamma dose rates and total alpha activity levels were determined by direct measurement on overhead beam surfaces. In addition, smears were taken on overhead beams to assess possible removable alpha and beta-gamma activity levels. Samples of indoor debris and overhead beam dust were collected from locations without regard to gamma levels (i.e., systematic sampling). The samples were analyzed for radionuclide content. Figure 8 provides a diagram of Building 6 showing overhead beam locations and numbers.

SURVEY RESULTS

Applicable DOE guidelines for sites included within FUSRAP are summarized in Table 1 (ref. 4). Typical radiation background levels and concentrations of selected radionuclides in soil samples taken in the southwestern Illinois area are presented in Table 2 (ref. 5). These data are provided for comparison with survey results. With the exception of measurements of removable activity, which are reported as net disintegration rates, all direct measurements presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in dust and debris samples.

BUILDING SURVEY

Gamma Exposure Rate Measurements

Near-surface scan measurements of the concrete floor of Building 6 generally ranged from 3 to 7 μR/h. Slightly higher gamma levels were measured on contact with the interior and exterior walls. These levels are within the range of gamma levels normally found associated with concrete block building materials and are due to naturally occurring radioactivity in the materials used to make the blocks. A diagram of Building 6 with ranges of gamma exposure rates is provided in Fig. 9. The floor gamma levels are below the DOE indoor guideline of 20 μR/h above background (Table 1). Highest indoor gamma exposure rates (100 μR/h) resulted from contact measurements of a piece of magnesium-alloy metal that contained ^{232}Th. The metal piece was found at the east end of a metal stretcher pit. Numerous other items (e.g., grinding wheels, shims, spacers) similarly composed of magnesium-alloys were found throughout Building 6 and measured as high as 100 μR/h on contact. Although several of these items had contact gamma exposure rates that exceeded DOE guidelines, these items were fabricated from thorium-containing magnesium-alloy and resulted from current operations. These findings were brought to the attention of plant management, and the source from the metal stretcher pit was subsequently moved to another part of the plant licensed to handle these materials.

In addition to floor and wall surfaces, selected gamma readings were taken on contact with overhead beams only. The range of these measurements was 1 to 4 μR/h (see Table 3). These very low gamma levels are due to the shielding properties of the iron beams and distance from the floor surface.

Alpha Activity Levels and Beta-Gamma Dose Rates

Table 3 lists measurements of direct alpha and beta-gamma contamination levels made on overhead beam surfaces. Alpha levels ranged from below minimum detectable activity (MDA)* values (<25 dpm/100 cm^2) to 150 dpm/100 cm^2. All direct alpha measurements are lower than the DOE guideline of 5000 dpm/100 cm^2 (average contamination limit) for the uranium alpha emitter (Table 1). Beta-gamma dose rates on overhead beams ranged from <0.01 to 0.06 mrad/h. These values are below the DOE surface dose rate limit of 0.20 mrad/h averaged over not more than 1 m^2.

Smear and Sample Analyses

Results of analysis of smears taken on overhead beam surfaces (Table 3) showed that all removable alpha and beta-gamma activity levels were below their respective MDAs with the exception of a smear sample taken at the west section of beam Z48-DD48. At that location, the alpha activity level was 12 dpm/100 cm^2, a value below DOE guidelines (Table 1).

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*The instrument-specific MDAs for directly measured and removable alpha radiation levels are 25 and 10 dpm/100 cm^2, respectively. For directly measured and removable beta-gamma radiation, the respective MDAs are 0.01 mrad/h and 200 dpm/100 cm^2.

Eighteen systematic (S1-S18) dust samples were collected from overhead beam locations as shown on Fig. 10. In addition, a systematic debris sample was collected from the pit area, ~15 ft west of the Z48 column (S19), and from the metal stretcher pit (S20). Results of the analyses are given in Table 4. Concentrations of ^{226}Ra, ^{232}Th, and ^{238}U in dust samples (S1-S18) ranged from 0.22 to 1.3 pCi/g, 0.48 to 7.8 pCi/g, and 3.7 to 310 pCi/g, respectively. Each dust sample was collected from an area of ~200 cm². The radionuclide concentration (pCi/g), the total sample weight (g), and the area of collection (200 cm²) were used to calculate the radionuclide surface contamination in units of disintegrations per minute per 100 cm². These values were compared to their respective average surface contamination guideline limits given in Table 1.

All dust samples had ^{226}Ra and ^{232}Th surface contamination below applicable DOE guidelines (except sample S8, which measured 100% of the ^{232}Th guideline value). Radium-226 contamination ranged from 40 to 46% of the guideline value and averaged ~43%. Thorium-232 ranged from 9.0% to 100% and averaged 45%. All averages were below guideline limits. Uranium-238 surface contamination ranged from 10% to 1360% of the guideline limit and averaged 250% of the guideline. Figure 11 depicts the areal extent of beam dust contamination.

SIGNIFICANCE OF FINDINGS

Survey results demonstrate the presence of elevated concentrations of ^{238}U and ^{232}Th in dust sampled from overhead beams at the south end of Building 6. The maximum uranium surface contamination in dust was 13.6 times the average surface contamination guideline limit of 5000 dpm/100 cm² in sample S12, where ^{238}U concentrations of 310 pCi/g were measured. Additionally, the average ^{238}U activity from 18 beam dust samples was 2.5 times the DOE average ^{238}U contamination limit of 5000 dpm/100 cm².

It should be noted that the presence of ^{232}Th in beam dust samples and thorium-containing magnesium-alloy objects (e.g., grinding wheels, shims) found throughout Building 6 are not DOE related, but the result of a separate, licensed process of the current owner, Spectrulite Consortium, Inc. The highest ^{232}Th concentrations in beam dust samples (S1, 7.8 pCi/g, and S8, 7.0 pCi/g) were collected near the Building 6–Building 4 intersection.

In general, low levels of gamma radiation were measured over accessible concrete floor areas (3 to 7 μR/h) and on contact with the interior and exterior building walls (8 to 9 μR/h). All elevated gamma levels found indoors resulted from materials composed of magnesium-alloy metal which contained ^{232}Th.

These findings suggest that past DOE-supported operations (i.e., uranium extrusion and rod-straightening activities) were responsible for uranium-contaminated beam dust in excess of guidelines in Building 6. However, the contamination is localized and limited in extent, rendering it highly unlikely that under present use an individual working in or frequenting these remote areas would receive a significant radiation exposure. We recommend that additional scoping survey measurements and sampling be performed to further define the

extent of indoor uranium contamination southward to include Building 4 and northward throughout Building 6.

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3. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Remedial Survey Activities Program*, ORNL/TM-8600, Oak Ridge National Laboratory, September 1982.

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5. T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975–1979*, Oak Ridge National Laboratory, ORNL/TM-7343, November 1981.

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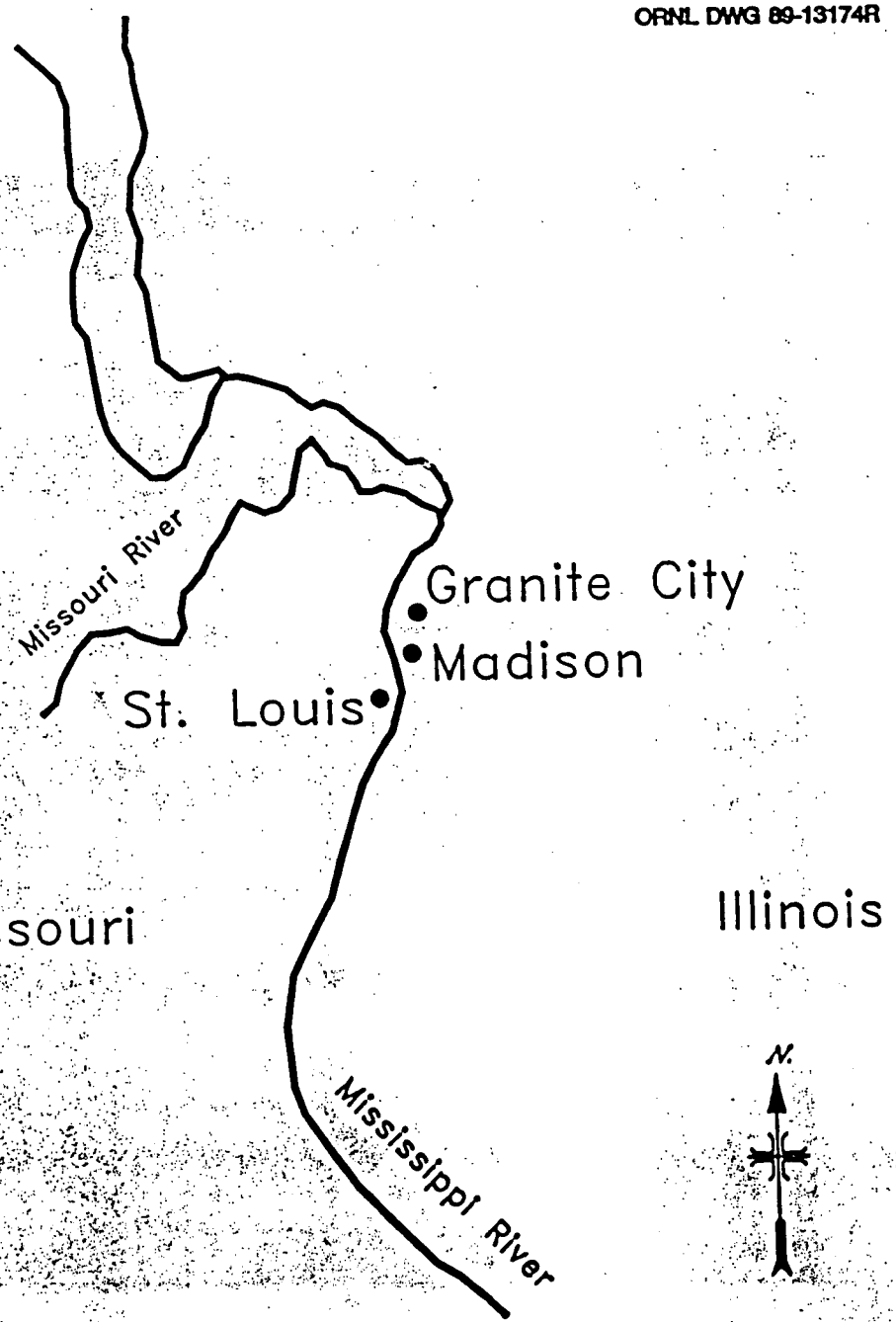

Fig. 1. General location of the Spectrulite Consortium Inc. (former Dow Chemical Company site), Madison, Illinois.

ORNL PHOTO 3038-90

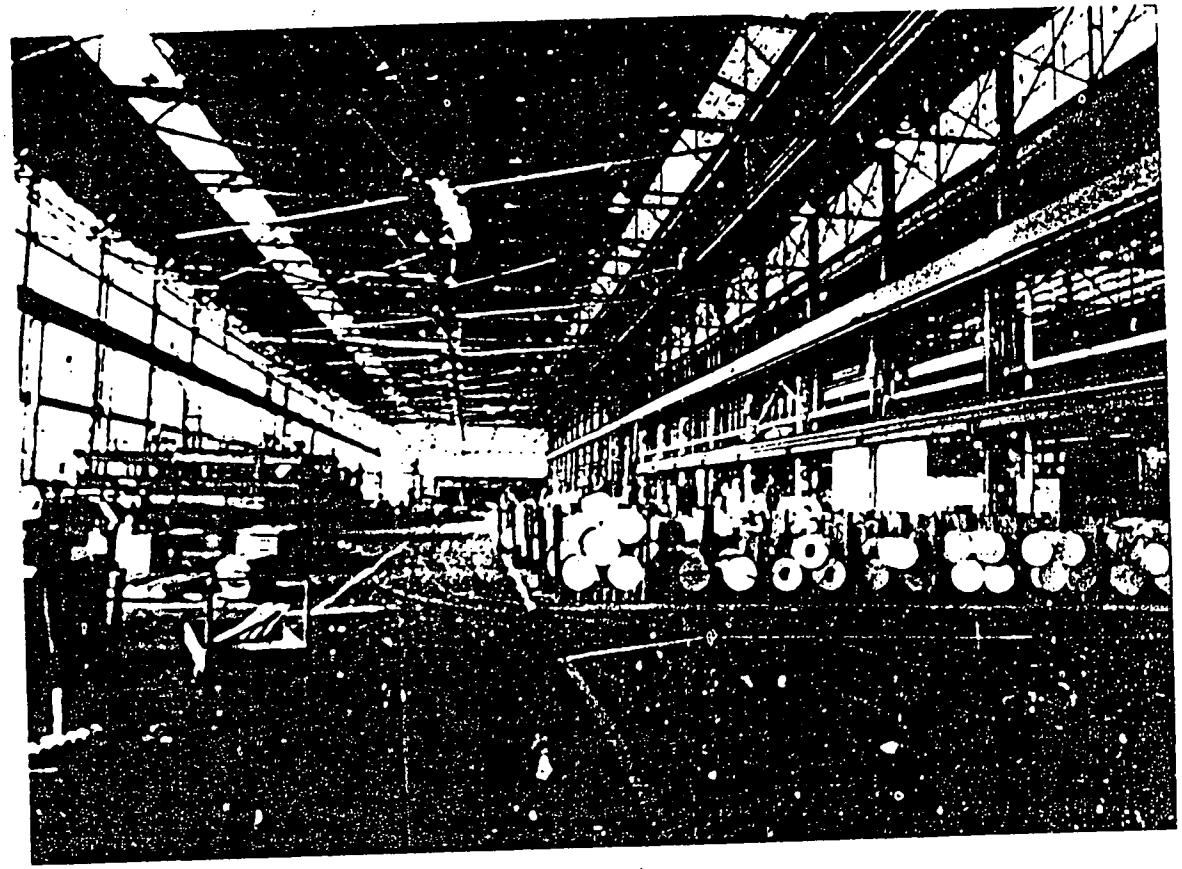

Fig. 2. View looking northeast in Building 6 (former Dow Chemical Company site).

ORNL PHOTO 3039-90

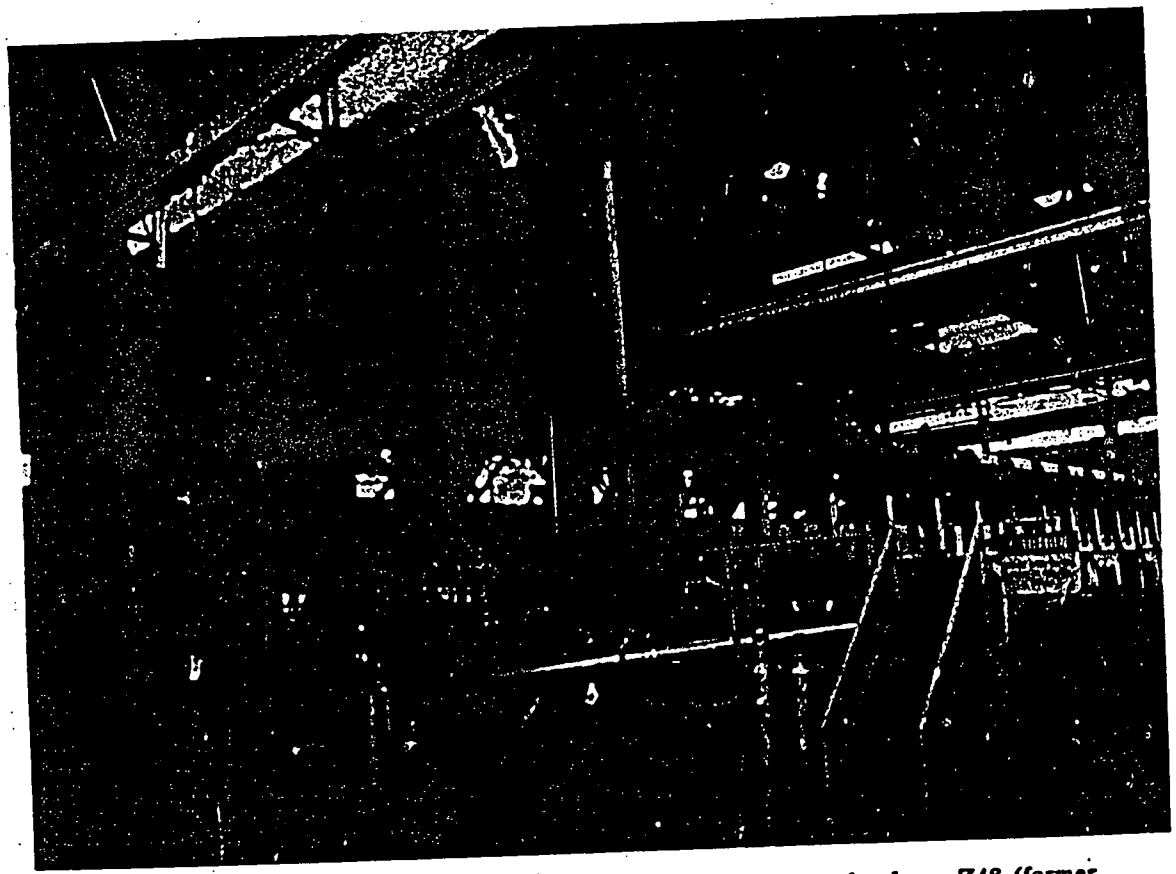

Fig. 3. View looking southwest showing roller bed/cutoff saw and column Z48 (former Dow Chemical Company site).

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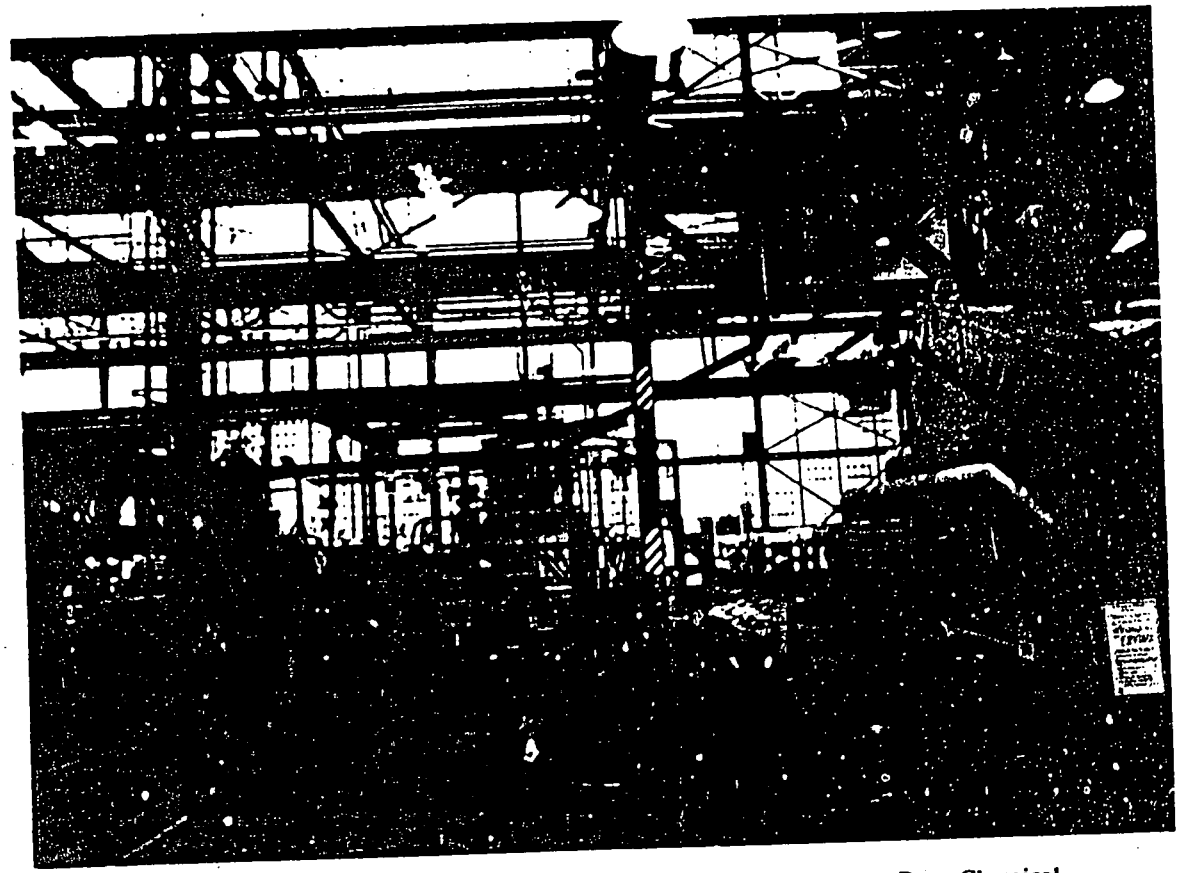

Fig. 4. Photo looking south at column line 46, Building 6 (former Dow Chemical Company site).

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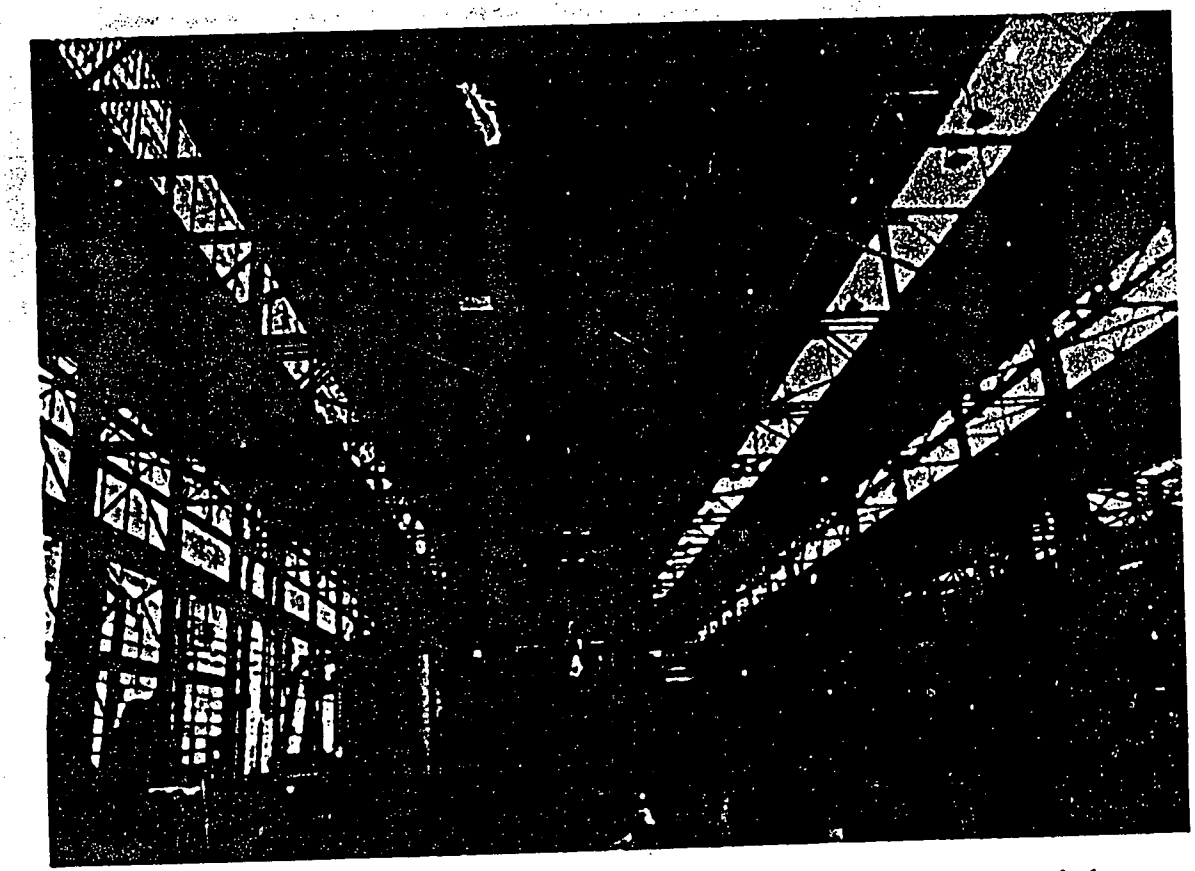

Fig. 5. View looking southwest at column ZDD, Building 6 (former Dow Chemical Company site).

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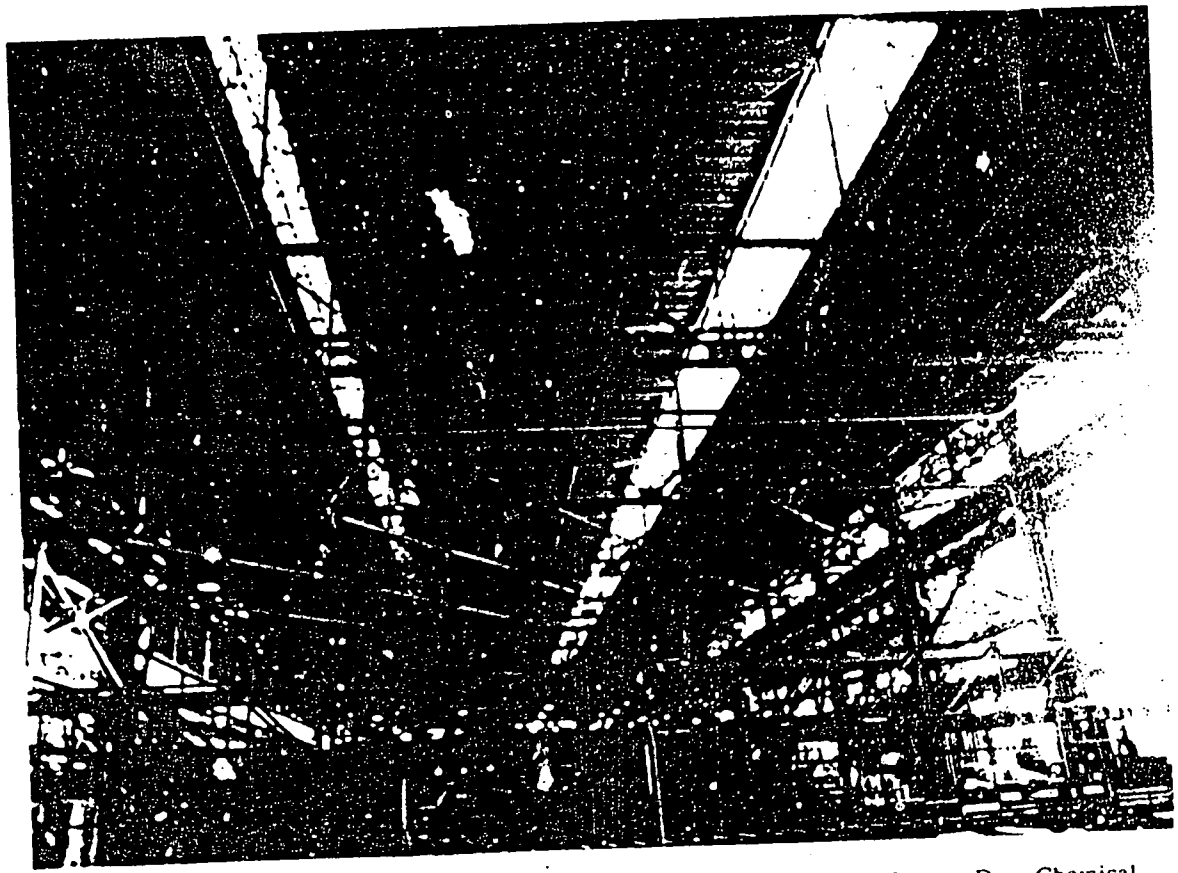

Fig. 6. View of contaminated beam area in Bay WZ, Building 6 (former Dow Chemical Company site).

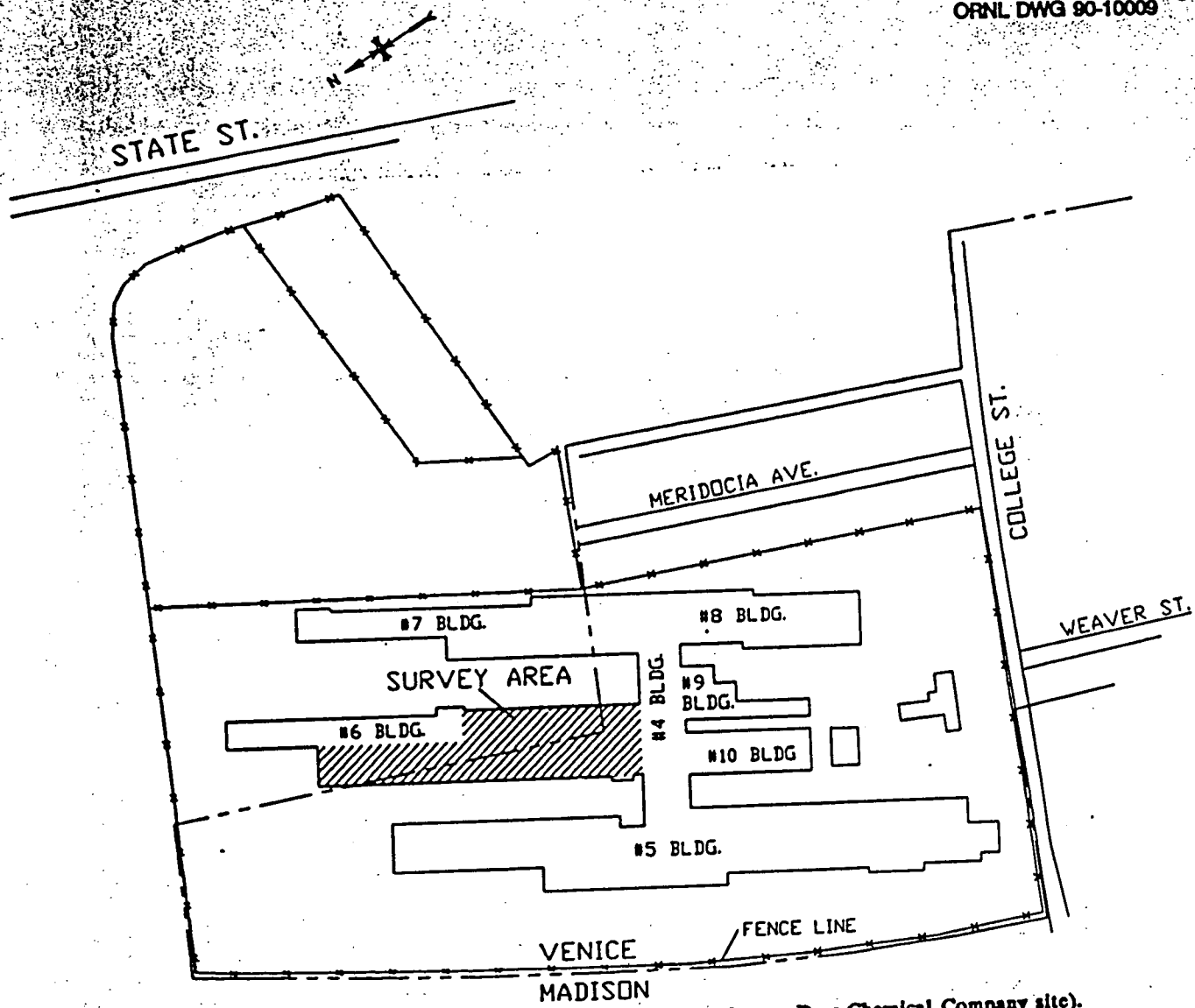

Fig. 7. Diagram of the Spectralite Consortium Inc. (former Dow Chemical Company site). Shading indicates area surveyed in Building 6.

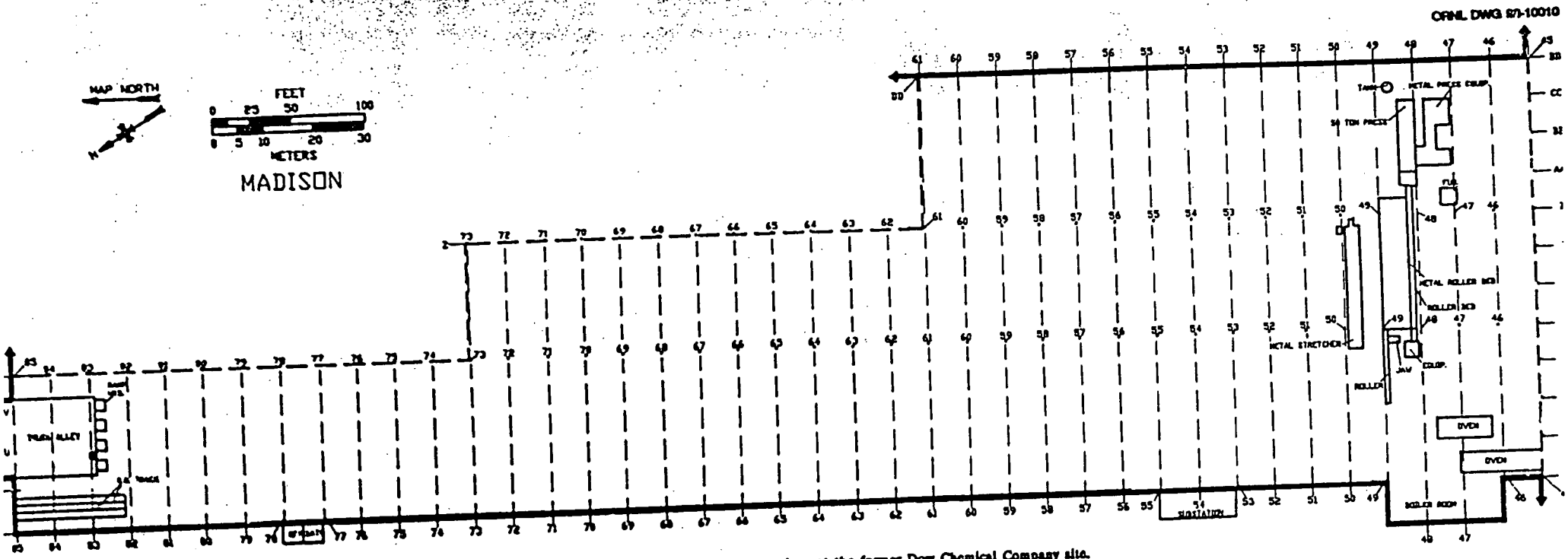

Fig. 8. Diagram of Building 6 showing overhead beam numbers at the former Dow Chemical Company site.

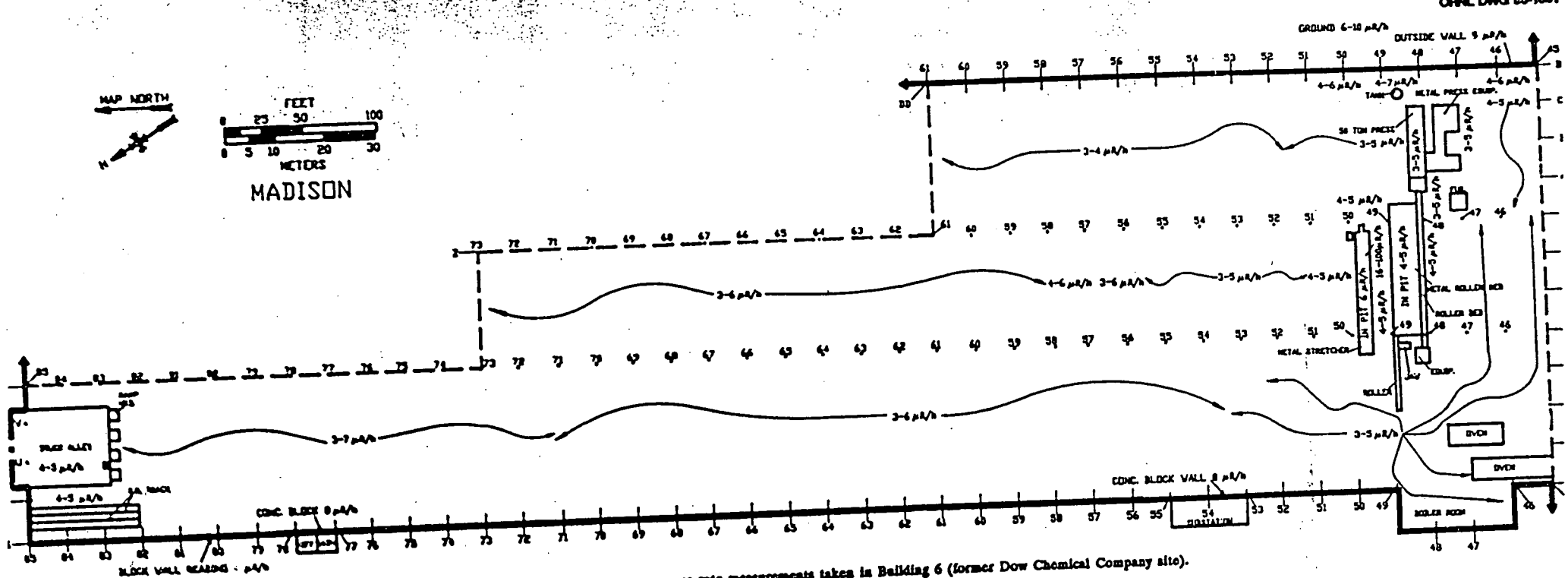

Fig. 9. Range of surface gamma exposure rate measurements taken in Building 6 (former Dow Chemical Company site).

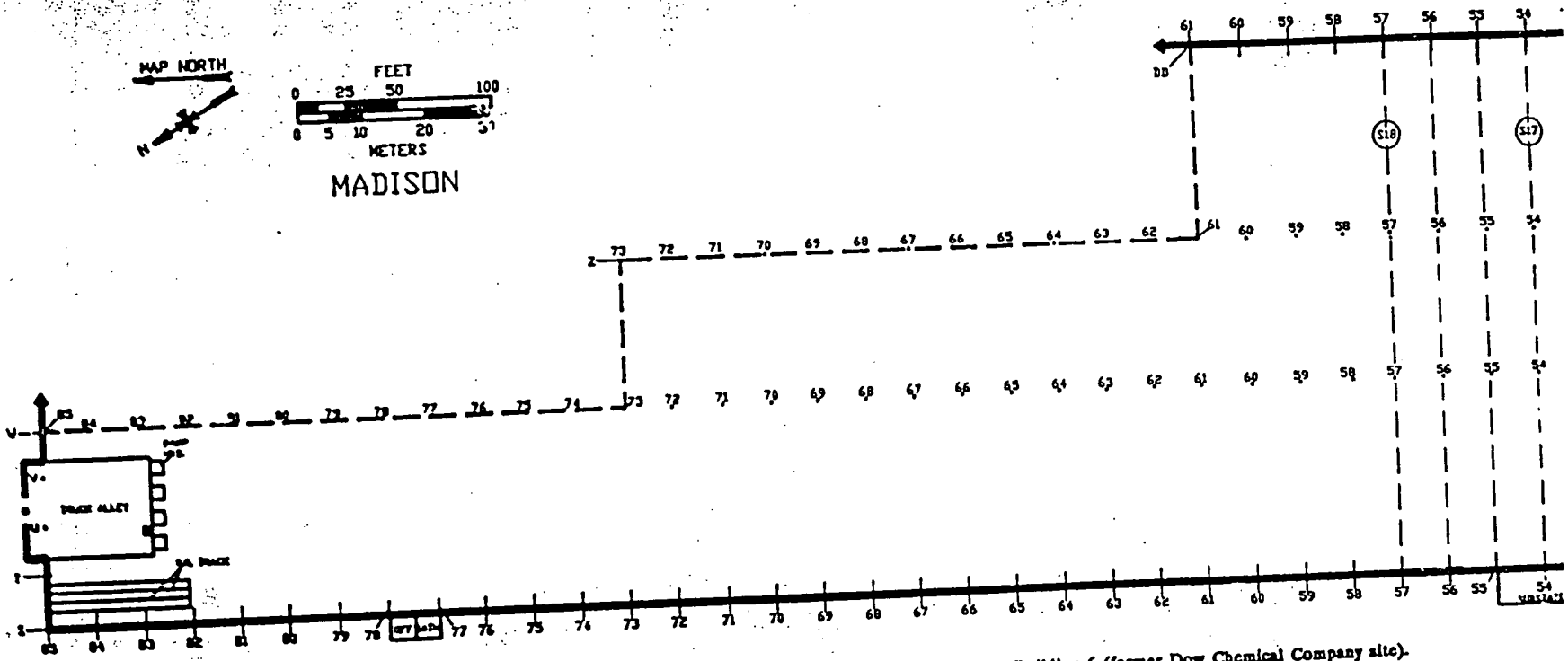

Fig. 10. Locations of beam dust samples in Building 6 (former Dow Chemical Company site).

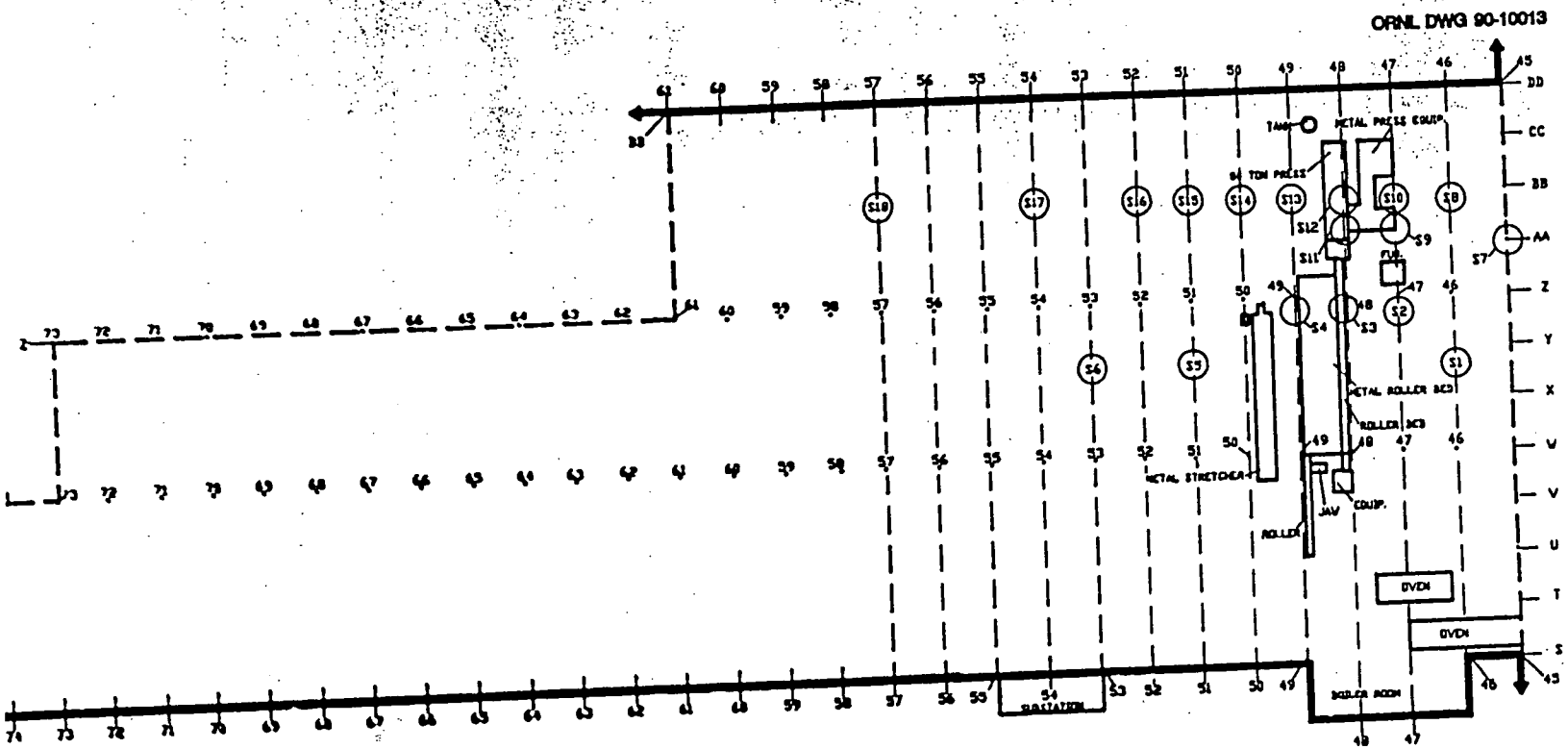

Fig. 10. Locations of beam dust samples in Building 6 (former Dow Chemical Company site).

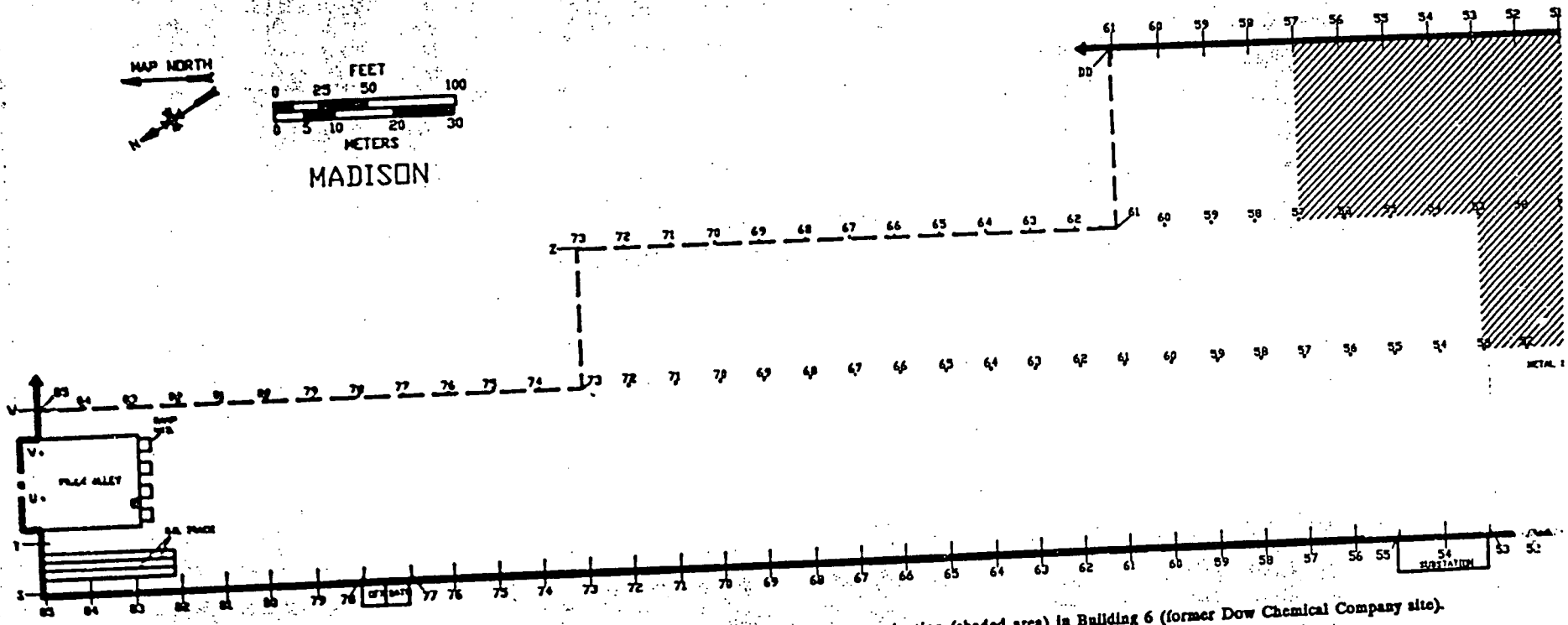

Fig. 11. Location of overhead beam dust contamination (shaded area) in Building 6 (former Dow Chemical Company site).

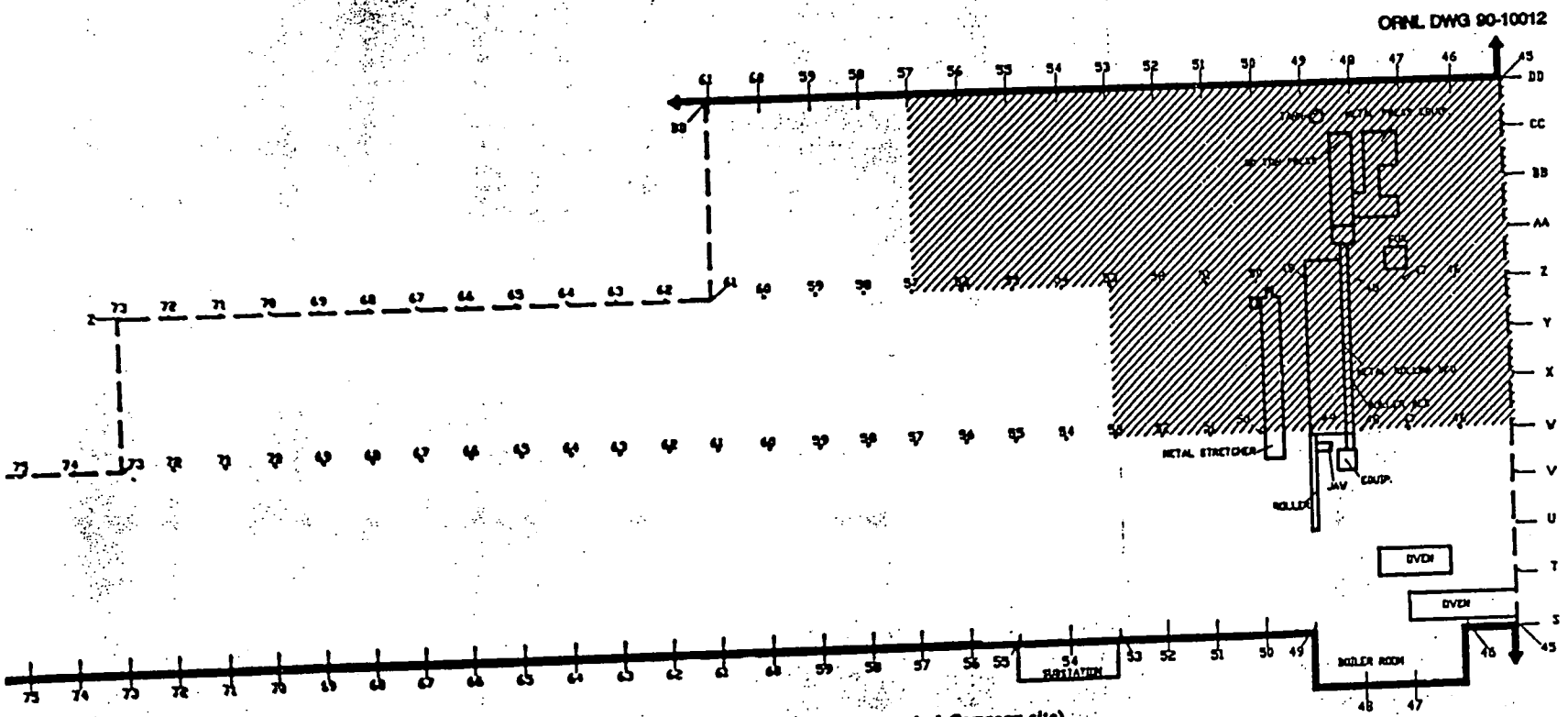

Fig. 11. Location of overhead beam dust contamination (shaded area) in Building 6 (former Dow Chemical Company site).

Table 1. Applicable guidelines for protection against radiation[a]
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h[b]
Surface contamination[c]	^{238}U, U-natural	
	Total residual maximum	15,000 dpm/100 cm^2
	Total residual average	5,000 dpm/100 cm^2
	Total residual removable	1,000 dpm/100 cm^2
	Beta-gamma emitters[d]	
	Total residual maximum	15,000 dpm/100 cm^2
	Total residual average	5,000 dpm/100 cm^2
	Total residual removable	1,000 dpm/100 cm^2
	^{232}Th, Th-natural	
	Total residual maximum	3,000 dpm/100 cm^2
	Total residual average	1,000 dpm/100 cm^2
	Total residual removable	200 dpm/100 cm^2
	^{226}Ra, transuranics	
	Total residual maximum	300 dpm/100 cm^2
	Total residual average	100 dpm/100 cm^2
	Total residual removable	20 dpm/100 cm^2
Beta-gamma dose rates[d]	Surface dose rate averaged over not more than 1 m^2	0.20 mrad/h
	Maximum dose rate in any 100-cm^2 area	1.0 mrad/h
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100-m^2 area	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm-thick soil layers more than 15 cm below the surface
	^{230}Th	
	^{232}Th	
	^{226}Ra	
	^{228}Ra	
	^{238}U	Derived (site specific)

[a] *U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites* (Revision 2, March 1987).

[b] The 20 μR/h level shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.

[c] DOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted use or Termination of Licenses for By-Product, Source, or Special Nuclear Material* (May 1987).

[d] Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr, ^{226}Ra, ^{228}Ra, ^{227}Ac, ^{125}I, ^{131}I, ^{129}I, ^{126}I, ^{125}I.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil samples taken in southwestern Illinois

Type of radiation measurement or sample[a]	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at 1 m above ground surface (μR/h)	7–11	9
Concentration of radionuclides in soil (pCi/g dry wt)		
^{232}Th	1.0–1.2	1.1
^{226}Ra	0.88–0.93	0.90
^{238}U	1.0–1.1	1.0

[a]With the exception of ^{226}Ra concentrations that were derived from two sampling locations, values were obtained from three locations in southwestern Illinois.[3]

Table 3. Direct and removable radiation measurements and locations of dust samples taken on overhead beams in Building 6 (former Dow Chemical Company site)

Beam number	Location[a]	Gamma exposure rate at surface (μR/h)	Directly measured contamination		Removable contamination		Dust sample[b]
			Alpha (dpm/100 cm²)	Beta-gamma dose rates at 1 cm (mrad/h)	Alpha (dpm/100 cm²)	Beta-gamma (dpm/100 cm²)	
Z45-DD45[c] (upper)[d]	West	2	<25[e]	<0.01[e]	f	f	S7
	Center	2	29	<0.01	f	f	f
	East	2	109	0.01	<10[e]	<200[e]	f
Z45-DD45[c] (lower)[d]	West	2	<25	<0.01	f	f	f
	Center	2	29	0.02	<10	<200	f
	East	f	f	f	f	f	f
Z46-DD46	West	2	69	0.02	<10	<200	f
	Center	3	<25	0.05[g]	f	f	S8
	East	2	89	<0.01	<10	<200	f
Z47 DD47	West	2	49	0.02[g]	<10	<200	S9
	Center	2	49	0.06[g]	<10	<200	S10
	East	1	49	0.03	<10	<200	f
Z48-DD48	West	2	149	0.02[g]	12	<200	S11
	Center	4	<25	0.03[g]	<10	<200	S12
	East	1	<25	<0.01	<10	<200	f
Z49-DD49	West	2	49	<0.01	<10	<200	f
	Center	2	109	0.06[g]	<10	<200	S13
	East	1	49	<0.01	<10	<200	f
Z50-DD50	West	1	69	0.01	<10	<200	f
	Center	2	<25	0.05	<10	<200	S14
	East	1	49	0.01	f	f	f

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Table 3 (continued)

Beam number	Location[a]	Gamma exposure rate at surface (μR/h)	Directly measured contamination		Removable contamination		
			Alpha (dpm/100 cm²)	Beta-gamma dose rates at 1 cm (mrad/h)	Alpha (dpm/100 cm²)	Beta-gamma (dpm/100 cm²)	Dust sample[b]
Z51-DD51	West	∫	∫	∫	∫	∫	∫
	Center	2	69	0.02	<10	<200	S15
	East	∫	∫	∫	∫	∫	∫
Z52-DD52	West	∫	∫	∫	∫	∫	∫
	Center	2	<25	0.02	<10	<200	S16
	East	∫	∫	∫	∫	∫	∫
Z53-DD53	West	∫	∫	∫	∫	∫	∫
	Center	2	29	0.01	<10	<200	∫
	East	∫	∫	∫	∫	∫	∫
Z54-DD54	West	∫	∫	∫	∫	∫	∫
	Center	2	29	<0.01	<10	<200	S17
	East	∫	∫	∫	∫	∫	∫
Z55-DD55	West	2	<25	<0.01	<10	<200	∫
	Center	∫	∫	∫	∫	∫	∫
	East	2	<25	<0.01	∫	∫	∫
Z57-DD57	West	∫	∫	∫	∫	∫	∫
	Center	2	<25	0.01	∫	∫	S18
	East	∫	∫	∫	∫	∫	∫
Z59-DD59	West	∫	∫	∫	∫	∫	∫
	Center	2	<25	<0.01	<10	<200	∫
	East	∫	∫	∫	∫	∫	∫

Table 3 (continued)

Beam number	Location[a]	Gamma exposure rate at surface (μR/h)	Directly measured contamination		Removable contamination		Dust sample[b]
			Alpha (dpm/100 cm²)	Beta-gamma dose rates at 1 cm (mrad/h)	Alpha (dpm/100 cm²)	Beta-gamma (dpm/100 cm²)	
Z61-DD61	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	<25	<0.01	ƒ	ƒ	ƒ
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
W45-Z45	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	35	<0.01	<10	<200	ƒ
	East	2	<25	0.02	<10	<200	ƒ
W46-Z46	West	2	55	<0.01	<10	<200	ƒ
	Center	3	26	0.01	ƒ	ƒ	S1
	East	2	53	0.01	<10	<200	ƒ
W47-Z47	West	3	53	<0.01	<10	<200	ƒ
	Center	3	53	<0.01	<10	<200	ƒ
	East	3	<25	0.03	ƒ	ƒ	S2
W48-Z48	West	3	35	<0.01	<10	<200	ƒ
	Center	3	35	0.02	<10	<200	ƒ
	East	2	150	0.05	ƒ	ƒ	S3
W49-Z49	West	2	35	<0.01	ƒ	ƒ	ƒ
	Center	3	44	<0.01	ƒ	ƒ	ƒ
	East	3	<25	0.01	ƒ	ƒ	S4
W50-Z50	West	3	<25	<0.01	ƒ	ƒ	ƒ
	Center	2	35	0.01	<10	<200	ƒ
	East	3	35	0.01	ƒ	ƒ	ƒ

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Table 3 (continued)

Beam number	Location[a]	Gamma exposure rate at surface (μR/h)	Directly measured contamination				Dust sample[b]
			Alpha (dpm/100 cm²)	Beta-gamma dose rates at 1 cm (mrad/h)	Removable contamination		
					Alpha (dpm/100 cm²)	Beta-gamma (dpm/100 cm²)	
W51-Z51	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	<25	<0.01	ƒ	ƒ	S5
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
W52-Z52	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	<25	0.01	<10	<200	ƒ
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
W53-Z53	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	<25	0.01	ƒ	ƒ	S6
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
W55-Z55	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	<25	<0.01	<10	<200	ƒ
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
W56-Z56	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	26	<0.01	<10	<200	ƒ
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
S49-W49	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	3	<25	<0.01	<10	<200	ƒ
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
S52-W52	West	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
	Center	2	<25	<0.01	<10	<200	ƒ
	East	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ

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Table 3 (continued)

Beam number	Location[a]	Gamma exposure rate at surface (μR/h)	Directly measured contamination		Removable contamination		Dust sample[b]
			Alpha (dpm/100 cm²)	Beta-gamma dose rates at 1 cm (mrad/h)	Alpha (dpm/100 cm²)	Beta-gamma (dpm/100 cm²)	
S56-W56	West	f	f	f	f	f	f
	Center	3	<25	<0.01	<10	<200	f
	East	f	f	f	f	f	f
S59-W59	West	f	f	f	f	f	f
	Center	2	26	<0.01	<10	<200	f
	East	f	f	f	f	f	f

[a]Beam locations are shown on Fig. 10.
[b]See Table 4 for analytical results.
[c]Dust thickness on beam <1 cm.
[d]The instrument-specific minimum detectable activities (MDAs) for directly measured and removable alpha radiation levels are 25 and 10 dpm/100 cm², respectively.
[e]The instrument-specific minimum detectable activities (MDAs) for directly measured and removable beta-gamma radiation levels are 0.01 mrad/h and 200 dpm/100 cm², respectively.
[f]Measurement not made or sample not taken.
[g]Upper beam height is estimated to be 24 ft from concrete floor surface.
[h]Lower beam height is estimated to be 18 ft from concrete floor surface.
[i]Primarily beta contamination after dust removal. White material beneath dust at west and center of beam.
[j]Primarily beta contamination after dust removal at center of beam and at east end of beam. Gray to rust-colored material at center of beam.

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Table 4. Concentrations of radionuclides in beam dust and debris samples at the former Dow Chemical Company site

Sample ID	Location[a]		Radionuclide concentration (pCi/g)		
			^{226}Ra[b]	^{232}Th[b]	^{238}U[b]
			Beam dust samples[c]		
S1	W46-Z46	Center	1.3 ± 0.11	7.8 ± 0.28	45 ± 4.4
S2	W47-Z47	East	0.49 ± 0.08	3.6 ± 0.20	54 ± 4.0
S3	W48-Z48	East	0.70 ± 0.05	5.0 ± 0.11	130 ± 4.4
S4	W49-Z49	East	0.88 ± 0.08	4.8 ± 0.19	89 ± 8.0
S5	W51-Z51	Center	0.57 ± 0.04	1.3 ± 0.07	10 ± 1.0
S6	W53-Z53	Center	0.41 ± 0.02	0.66 ± 0.04	6.2 ± 1.5
S7	Z45-DD45	West	0.36 ± 0.03	1.3 ± 0.06	6.2 ± 1.6
S8	Z46-DD46	Center	0.92 ± 0.04	7.0 ± 0.11	160 ± 5.3
S9	Z47-DD47	West	0.53 ± 0.03	3.2 ± 0.07	50 ± 2.2
S10	Z47-DD47	Center	0.82 ± 0.05	6.3 ± 0.12	200 ± 5.8
S11	Z48-DD48	West	0.47 ± 0.05	2.7 ± 0.12	49 ± 3.5
S12	Z48-DD48	Center	0.54 ± 0.04	3.1 ± 0.09	310 ± 5.7
S13	Z49-DD49	Center	0.47 ± 0.06	2.9 ± 0.14	170 ± 8.2
S14	Z50-DD50	Center	0.69 ± 0.06	3.3 ± 0.13	130 ± 5.0
S15	Z51-DD51	Center	0.34 ± 0.02	1.1 ± 0.05	43 ± 2.5
S16	Z52-DD52	Center	0.27 ± 0.02	0.83 ± 0.04	15 ± 0.71
S17	Z54-DD54	Center	0.22 ± 0.01	0.48 ± 0.03	7.5 ± 1.1
S18	Z57-DD57	Center	0.35 ± 0.03	0.64 ± 0.06	3.7 ± 0.91
			Debris samples[c]		
S19	*d*		0.17 ± 0.02	0.16 ± 0.02	0.95 ± 0.33
S20	*e*		0.54 ± 0.02	0.60 ± 0.04	1.2 ± 0.48

[a]Locations of samples are shown on Fig. 10.
[b]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$).
[c]Systematic samples are taken at selected locations irrespective of gamma exposure rates.
[d]Debris from pit area, ~15' west of Z48 column.
[e]Debris from metal stretcher pit.

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