REMEDIAL ACTION AT THE NATIONAL GUARD ARMORY AND THE UNIVERSITY OF CHICAGO IN CHICAGO, ILLINOIS

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ABSTRACT

In 1987, the U.S. Department of Energy (DOE) conducted remedial action at the University of Chicago and the National Guard Armory (NGA) as part of its Formerly Utilized Sites Remedial Action Program (FUSRAP). In 1941, The National Defense Research Committee, and later the Manhattan Engineer District (MED), contracted the University of Chicago to conduct research related to the development and production of the first nuclear weapon. To alleviate space constraints at the University, the MED leased the Illinios NGA. This paper describes the nature of the radiological/chemical contamination at these sites as a consequence of the MED work, and the construction techniques used to perform the successful remediation.

National Guard Armory

The National Guard Armory is a 70- by 189-m concrete building with stone outer walls (Fig. 1). A 70- by 100-m arena with a ceiling more than 30-m high occupies the center of the building. Stadium bleachers are located on the east and west sides of the arena. Before the dirt floor was surfaced with concrete, the arena was used by National Guard Cavalry to train horses and later to play polo. The north and south ends of the building are divided into four floors that contain offices, classrooms, storage areas, and garages.

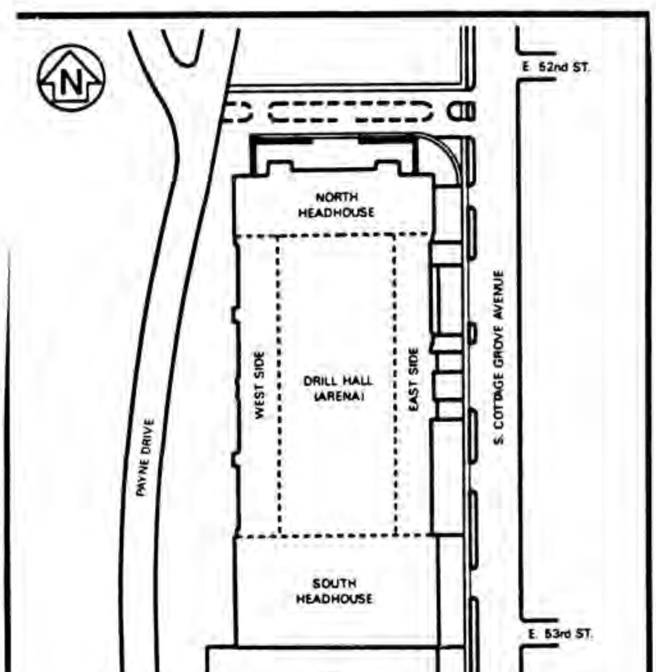

Fig. 1. Plan View of the National Guard Armory.

Although historical information relative to specific activities conducted at NGA is limited, it appears likely that it was used for chemical processing and metal casting of uranium. A radiological survey conducted by Argonne National Laboratory (ANL) in 1977 and 1978 indicated that areas inside the building were contaminated with uranium above DOE guidelines. However, it was concluded that considering the low levels and current building use conditions, the potential for exposure above guidelines to individuals at the NGA was minimal. As a result, the NGA was designated under FUSRAP for future remedial action, and given a low priority. During 1986, DOE was advised that the National Guard was planning to renovate the building; consequently, remedial action at NGA was given a higher priority.

During January and February 1987, Bechtel National, Inc. (BNI) conducted a radiological and limited chemical characterization at NGA. This characterization was necessary to locate the exact boundaries of contamination identified in an initial investigation conducted by ANL.

The following areas and materials were investigated: the exterior grounds of the property, the interior building surfaces, subsurface soils beneath the arena floor, and sludges from the catch basin system serving several rooms. Additionally, any suspect areas were scanned and sampled.

An initial walkover scan on the NGA property was performed using a Field Instrument for Detection of Low-Energy Radiation (FIDLER). The FIDLER is specially designed to detect low-energy radiation, such as that emitted by uranium, in areas identified during the walkover scan. Surface and subsurface soil samples were collected from suspect areas to quantify radionuclide concentrations. During the characterization effort a compass with a radium dial was discovered and removed from a depth of approximately 0.5 m. This was the only material enountered outside the building that exceeded current guidelines.

The entire floor area (27,000 m^2) of the NGA was *scanned* using FIDLERS. All suspect areas were marked. Within these areas, alpha and beta-gamma radiation measurements were taken to better define the areal extent of contamination. Based on these measurements, contaminated areas were permanently marked with spray paint. Ceilings, ledges, ventilation ducts, furniture, selected roof areas, and other suspect areas were surveyed for alpha and beta-gamma contamination.

Samples consisted of smear (or wipe) samples, a sample of concrete expansion joint material, soil samples from beneath the arena floor, brick and floor tiles, and sludge samples from the catch basin system.

Surface contamination above DOE guidelines was found in 10 rooms. The soils from beneath the arena floor were found not to be contaminated. The sludges in the catch basins were found to be both radioactively and chemically contaminated. The sludges contained mixed waste and had a very low ignition temperature (22°C).

Remedial action at NGA consisted of removing surface contamination (floor slabs and joints, ceiling, and walls), and cleaning six interior catch basins. The catch basins were found to contain chemically hazardous materials in addition to the radioactive contamination.

The ceilings, which were determined to have easily removable surface contamination, were cleaned (465 m^2) using filter-exhausted vacuum cleaners. All adjacent walls were covered with plastic sheeting, and rooms were partitioned off to preclude the spread of dust and make the areas accessible only to workers wearing respiratory protection. Isolated spots, which could not be vacuumed clean, were successfully cleaned using a "scabbler" (a rotary impact hammer with a bushhammer-type bit).

Contaminated areas of floors (16 m^2), walls and columns (total 0.4 m^2) required scabbling of approximately 0.6 to 1.25 cm of the concrete surface. The ends of the scabblers were enclosed in a vacuum box to control dust. After verification that the contamination had been removed, all damaged or disturbed concrete surfaces were repaired using a quick-setting concrete material. In addition to surface contamination, approximately 28 meters of expansion and control joints in the floor slab was found to be contaminated to a depth of approximately 7.6 cm. These were *chipped* open, and all contaminated material was removed. The areas were verified free of contamination, and rebuilt using 1.25-cm fiber board, grout, and sealant.

The most challenging work was cleaning the six interior catch basins (see Fig. 2) located in the south end of the NGA. Sludge depths in each catch basin ranged from 0.5 to 1.0 m, with the flowline of the interconnecting drain line partially submerged in certain catch basins. The catch basins were only 0.7-m in diameter, which made access difficult. Additionally, when the sludges were disturbed, the intense odors emitted could be detected throughout the lower portions of the south end of the NGA.

Workers were supplied with respiratory protection and protective clothing. Using spark-resistant hand tools, the sludges were removed from the basins. The interconnecting lines were flushed with a minimal amount of water to remove the sludges between the basins. This water was captured by plastic bags at the ends of the lines. A subsequent radiological scan indicated that portions of the line from basin 1 to basin 5, as well as basin 3, were radioactively contaminated. Most of the line (15.2-cm cast iron soil pipe) was successfully cleaned using a rotary cleaner with a 19-m drive extension. Several passes through portions of the line reduced surface contamination to less than guideline concentrations. Portions of the lines between basins 3 and 4 could not be cleaned with the rotary cleaner; there continued to be an area of high radioactivity in the line. By reviewing available drawings, it was determined that a junction existed from the interconnecting drain line to a 10-cm lateral line to Room 5 (see Fig. 2). This junction could not be successfully accessed for cleaning. Therefore, the junction and the portion of the main line from the junction to basin 3 was removed and replaced. The walls of basin 3 were sandblasted in an attempt to decontaminate the basin, but this was also unsuccessful. All the basins were constructed with bricks and mortar, and with basin 3, portions of the mortar had either deteriorated or were contaminated and could not be cleaned to DOE guidelines because they were inaccessible. Therefore, the entire basin was removed and replaced. Subsurface soils around the lines and beneath and around basin 3 were sampled and analyzed for radioactive contamination. All analytical results were below DOE guidelines.

During remedial action, measures were taken to monitor airborne radioactivity (resulting primarily from dust) and to limit personnel exposure to organic vapors from the sludges. Continuous air sampling was performed at several points within the building to ensure that these measures were successful.

Immediately following remedial action, areas were resurveyed and then released to an independent contractor to verify that the remedial action was successful. The entire building structure and grounds have presently been verified for release for unrestricted use.

It should be noted that pending treatment and/or disposal, 19 barrels of mixed wastes removed from the catch basin system are currently stored in a secured area at the NGA.

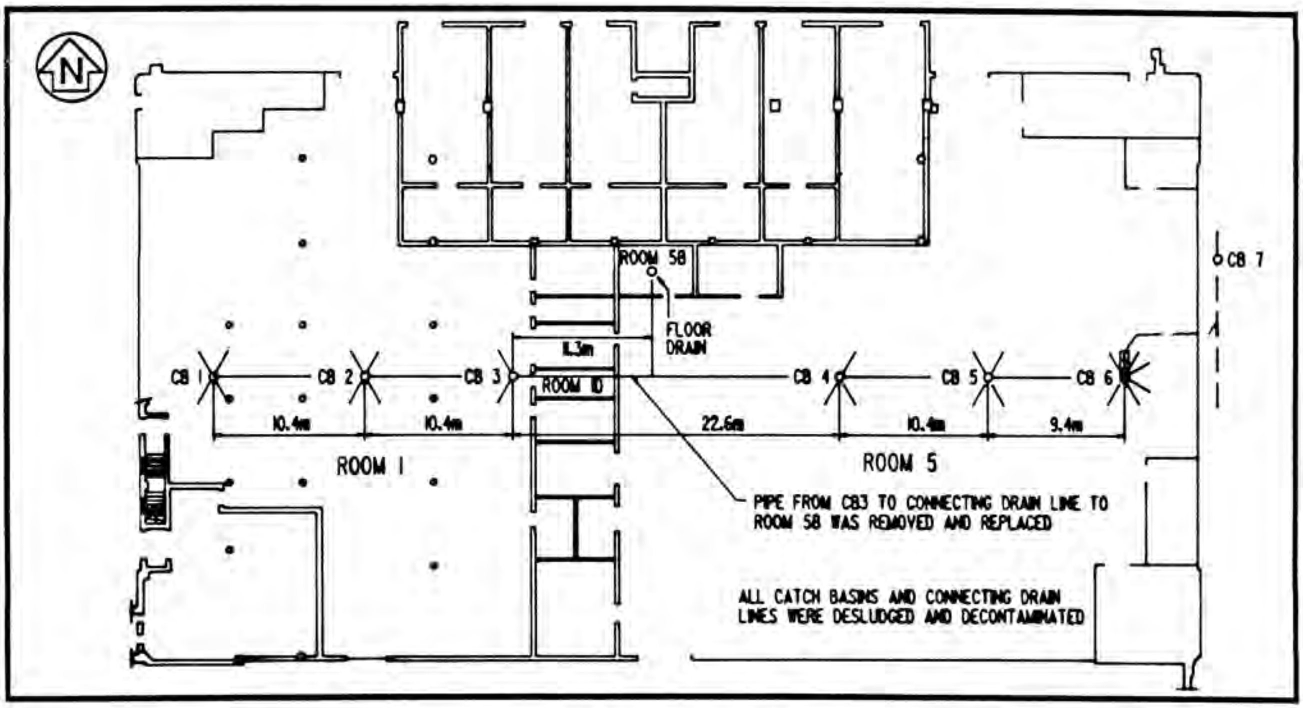

Fig. 2. The Catch Basin System on the First Floor of the South Headhouse (NGA).

University of Chicago

The University of Chicago was involved in theoretical, radiochemical, and physical research associated with the first successful nuclear pile. This pile was constructed and operated in the West Stands under Stagg Field. Research conducted under MED/AEC during the 1940s and 1950s included developing a process for producing high-purity uranium compounds, the testing of uranium metal, research associated with operation of the pile, and plutonium separation.

Jones Chemical Laboratory, as well as several other buildings on campus, were used for the MED/AEC work. Records indicate that all the buildings had been decontaminated before release. However, some documentation was unavailable. Radiological surveys were conducted in 1976 and 1977 that indicated contamination above current guidelines throughout the laboratory at low levels, except for small isolated areas. Remedial action by ANL was completed during 1982 and 1983. At that time, structural surfaces were decontaminated, and contaminated hoods and accessible ductwork were removed. Ductwork remained inside interior walls and thus was inaccessible without extensive demolition. Since the contamination within the ductwork did not represent an immediate hazard, it was decided that the risers/ducts would remain and be remediated at a later date. These remaining items comprise the scope of the remedial action performed in 1987.

Jones Chemical Laboratory houses research facilities as well as university office space. The remedial action was required to be completed without closing the facility and without impacting ongoing research.

A radiological and limited chemical characterization was conducted on the fume hood exhaust ducts, storage cabinet exhaust ducts; roofs; the drains inside Jones Laboratory, Ryerson, and Eckhart buildings; and the city sewer system originating in the Jones, Kent, Ryerson, and Eckhart buildings. All characterization activities were conducted immediately before remedial action.

Based on historical information, there was a high probability that both perchloric acid and picric acid salts could be present in the duct system. Thus, tests were performed on the inlet and exhaust ends of all ducts to check for the presence of these explosive, shock-sensitive salts. Eighty percent of the ducts tested positive; therefore, before radiological characterization began, the ducts were steam-cleaned to dissolve the salt crystals (see remedial action discussion). Then the ducts were re-checked and verified to be free of potential explosive hazard before the survey.

During the radiological survey, all metal fume ductwork and caps in the attic were surveyed for both alpha and beta-gamma activity, including the flues from the attic through the roof. An alpha and beta-gamma survey was conducted at both the inlet and exhaust openings of the ducts. If elevated readings were noted, a smear was obtained from those areas. Ten percent of the ducts were checked along the entire length of the duct. A collapsible, "spider-like" duct swiper, operated like a marionette, was lowered from upper levels to collect swipes from the duct interiors. Four ducts were determined to be contaminated above DOE surface criteria and were removed during remedial action.

The roof of the Jones Chemical Laboratory was checked for alpha and beta-gamma contamination. Several roof tiles were analyzed for Pu-239, RA-226, TA-232, and total U. Characterization results indicated the roof was not contaminated.

Drain and sewer characterization activities were conducted by obtaining biased samples from sediments and effluents found in the floor drains and sewer systems of the building in question.

The major focus of the remedial action was the decontamination of the exhaust system, which consisted of three main segments: the vertical risers in the walls, the attic ductwork, and the chimneys (see Fig. 3).

The vertical risers were constructed of clay tile flue liners totally encased within tile block walls. The risers were approximately 30.5 by 35.6 cm in cross section. The risers were constructed in chases with one to six risers in a chase. A gap of one inch separated the risers from the chase walls. Thirty chases were distributed throughout the building, with risers originating from each of the five floor levels and terminating at either of two attic levels. A total of 62 of 64 risers shown on the original building drawings (dated 1927) were found within the chases. The remedial action team also found that the risers included a lower section that was completely separated from the upper riser section. This lower section was approximately 1 meter long. An additional two risers were identified which were not shown on the original building drawings and were constructed of asbestos fiber board.

The attic metal ductwork functioned as a collection system connecting groups of risers to the exhaust fans and chimneys.

The chimneys consisted of clay tile flue liners encased in stonework, with the liner arranged in groups of from 2 to 10. Each flue liner was approximately 30.5 by 35.6 cm in cross section.

The original work plan called for the steam cleaning to be performed with a portable boiler to be located in an exterior parking area with steam lines to be run through the

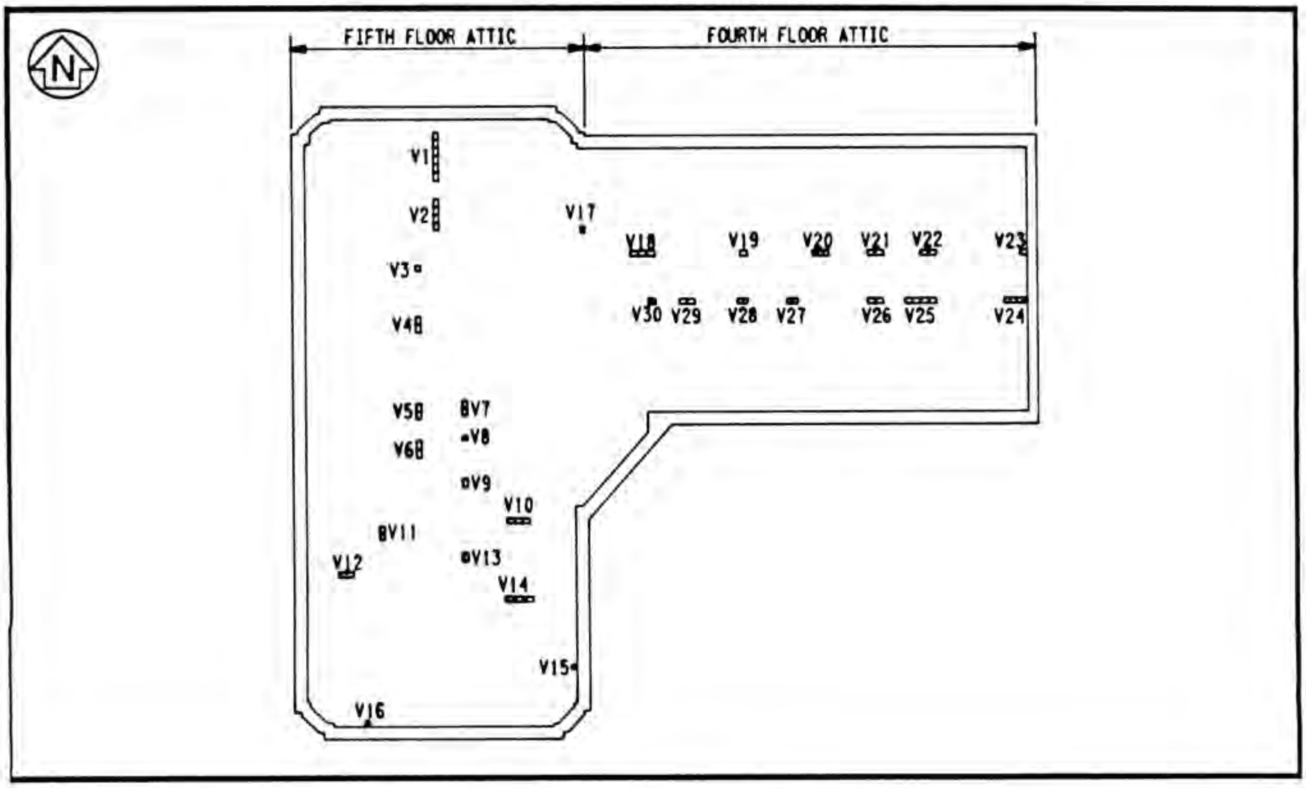

Fig. 3. Attic Plans Showing Chase Locations.

corridors of the building. However, the remedial action team was able to tie into the University's steam system in both attic levels, thus permitting the crew to route steam to the risers at the attic levels. This avoided the need to run the steam lines throughout the building. Reinforced rubber steam lines were used to route steam to the riser locations. A nozzle was inserted into each duct/riser just above the attic floor level. The top of the chimneys were capped to prevent the escape of steam. Outlets were cut at the base of the risers. These were plugged, however, during steaming.

The steam lines were usually connected to six to eight risers at a time, although a maximum of 11 were connected while cleaning the shorter runs. The flow of steam was controlled by a valve located at the point of tie-in to the university's system. Steam was permitted to flow for up to 2 hours through the duct/riser segment being cleaned.

The steaming process was followed with a washdown of the ducts and risers. A standard garden hose was used with a spray nozzle that directed the water laterally to rinse the duct/riser wall surfaces. A wet/dry vacuum was used to remove the water that collected at the bottom of the risers from both operations. The steam and water rinse procedure generated 1040 liters (five barrels) of waste water. Four barrels were contaminated above guidelines and were solidified; water from the uncontaminated barrel was released into the city sewer system.

The system was then scanned for radioactive contamination. This survey indicated that four risers were contaminated. The remedial action continued with the removal of the risers and the associated ductwork. Access to the risers was provided by removing one face from each of the chases. The flue liners were removed in segments where possible. The tile material was then moved to a controlled area where the segments were reduced to smaller pieces.

The University's plans for the facility were such that it was not necessary to replace the risers or ductwork that were removed. The chase walls were reconstructed and the wall and ceiling surfaces finished to match the surrounding areas.

The survey also identified eight contaminated chimney flue liners. To avoid demolishing the stonework, the liners were removed and the voided space partially plugged with concrete.

Immediately following characterization and/or remedial action, the ducts were re-surveyed by an independent verification contractor and released for unrestricted use.

CONCLUSIONS

Based on the data collected, the NGA and the University of Chicago sites now conform to all applicable DOE radiological guidelines established for release of these sites for unrestricted use. BNI's approach to performing the work, in which on-site teams were performing both characterization and remediation activities simultaneously, proved to be both technically and economically successful. Additionally, all equipment and procedures employed were standard, off-the-shelf items and methods, easy to use and implement. It should be noted that for both facilities, although only limited and very out-of-date (1920s) drawings were available, they proved indispensable in the preparation of field work documents. To facilitate similar work in the future, detailed as-builts should be maintained on all of todays facilities.

REFERENCES

1. "Report of the Decontamination of Jones Chemical Laboratory, Ryerson Physician Laboratory, and Eckhart Hall, The University of Chicago, Chicago, Illinois" Argonne National Laboratory August 1984.