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Contract No. DE-AC05-81OR20722

POST-REMEDIAL ACTION REPORT FOR THE GEORGE HERBERT JONES CHEMICAL LABORATORY AT THE UNIVERSITY OF CHICAGO SITE

Chicago, Illinois

January 1989

Bechtel National, Inc.

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POST-REMEDIAL ACTION REPORT
FOR THE
GEORGE HERBERT JONES CHEMICAL LABORATORY
AT THE UNIVERSITY OF CHICAGO SITE
CHICAGO, ILLINOIS

JANUARY 1989

Prepared for

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OAK RIDGE OPERATIONS OFFICE

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By

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Oak Ridge, Tennessee

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
ft	foot
g	gram
gal	gallon
h	hour
in.	inch
l	liter
m	meter
m^2	square meter
mi	mile
ml	milliliter
uR/h	microroentgens per hour
mrad	millirad
mrad/h	millirad per hour
mrad/h/m^2	millirad per hour per square meter
mrem	millirem
mrem/yr	millirem per year
pCi/g	picocuries per gram
yr	year

1.0 INTRODUCTION

This report documents the radiological condition of the George Herbert Jones Chemical Laboratory (hereinafter referred to as Jones Laboratory) at the University of Chicago in Chicago, Illinois following remedial action conducted by Bechtel National, Inc. (BNI) from July 1987 through October 1987. The work was performed under the Formerly Utilized Sites Remedial Action Program (FUSRAP), a Department of Energy (DOE) project that was established to identify and decontaminate or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program.

1.1 LOCATION AND DESCRIPTION

The campus of the University of Chicago is on a 171-acre site in Chicago, Illinois, approximately 7 mi south of the downtown business district (see Figure 1-1). The University of Chicago was founded in 1891 and contains over 125 buildings that represent architectural styles of the past nine decades. A major portion of the university is located in the Hyde Park-Kenwood National Historic District; six university buildings (including Jones Laboratory) are listed in the National Register of Historic Places as shown in Table 1-1 (Ref. 1).

The Jones Laboratory is located near the center of the campus on Ellis Avenue (Figure 1-2). This facility is currently used for teaching and research purposes.

1.2 SITE HISTORY

The University of Chicago was one of the focal points for supporting activities conducted by predecessors of DOE: the Manhattan Engineer District (MED) and its successor, the Atomic Energy Commission (AEC). These activities included the handling of radioactive material associated with development of the atomic bomb during World War II (Refs. 2, 3).

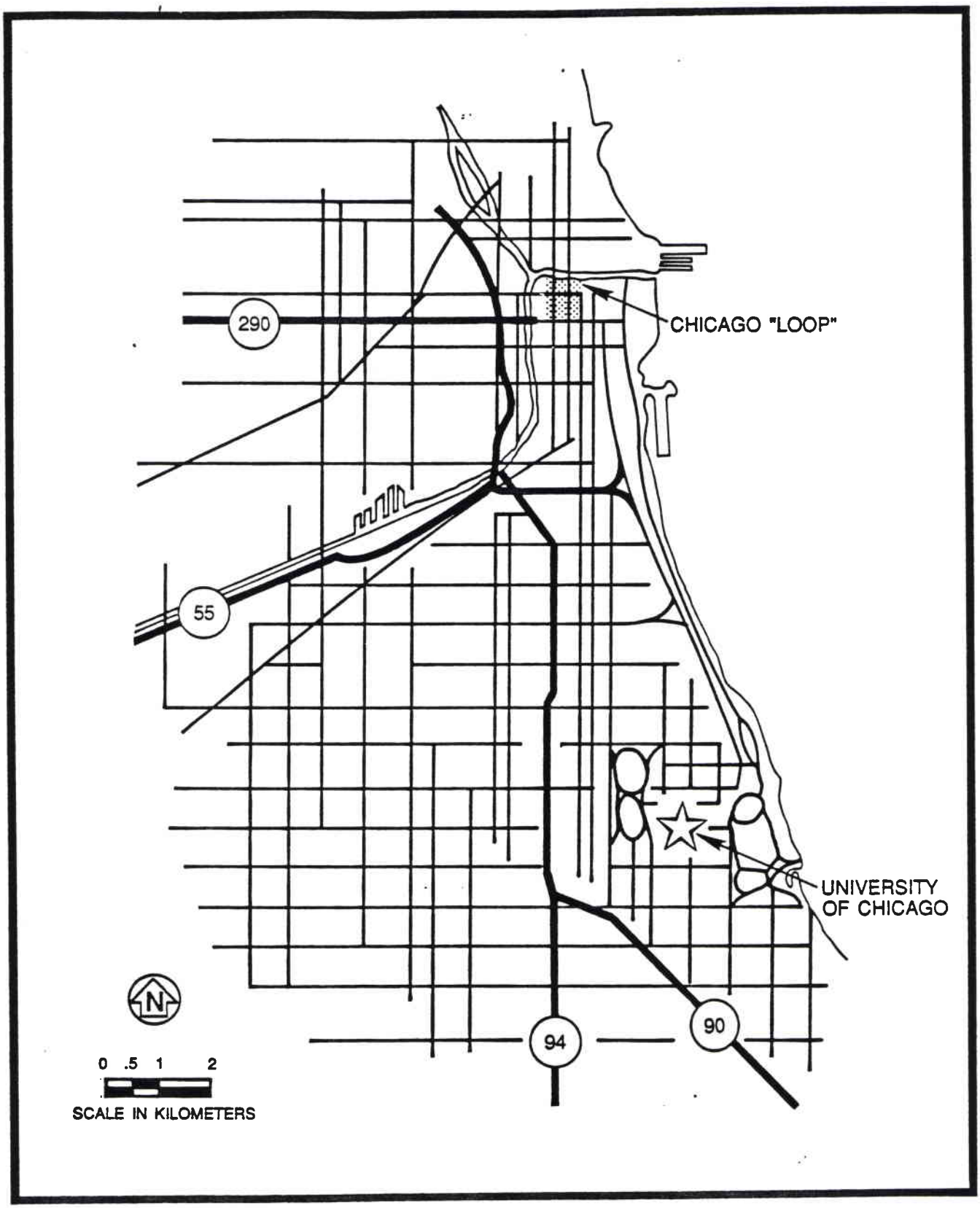


FIGURE 1-1 LOCATION OF THE UNIVERSITY OF CHICAGO SITE

TABLE 1-1

PROPERTIES OF THE UNIVERSITY OF CHICAGO LISTED IN THE NATIONAL REGISTER OF HISTORIC PLACES*

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

*Source: Ref. 1

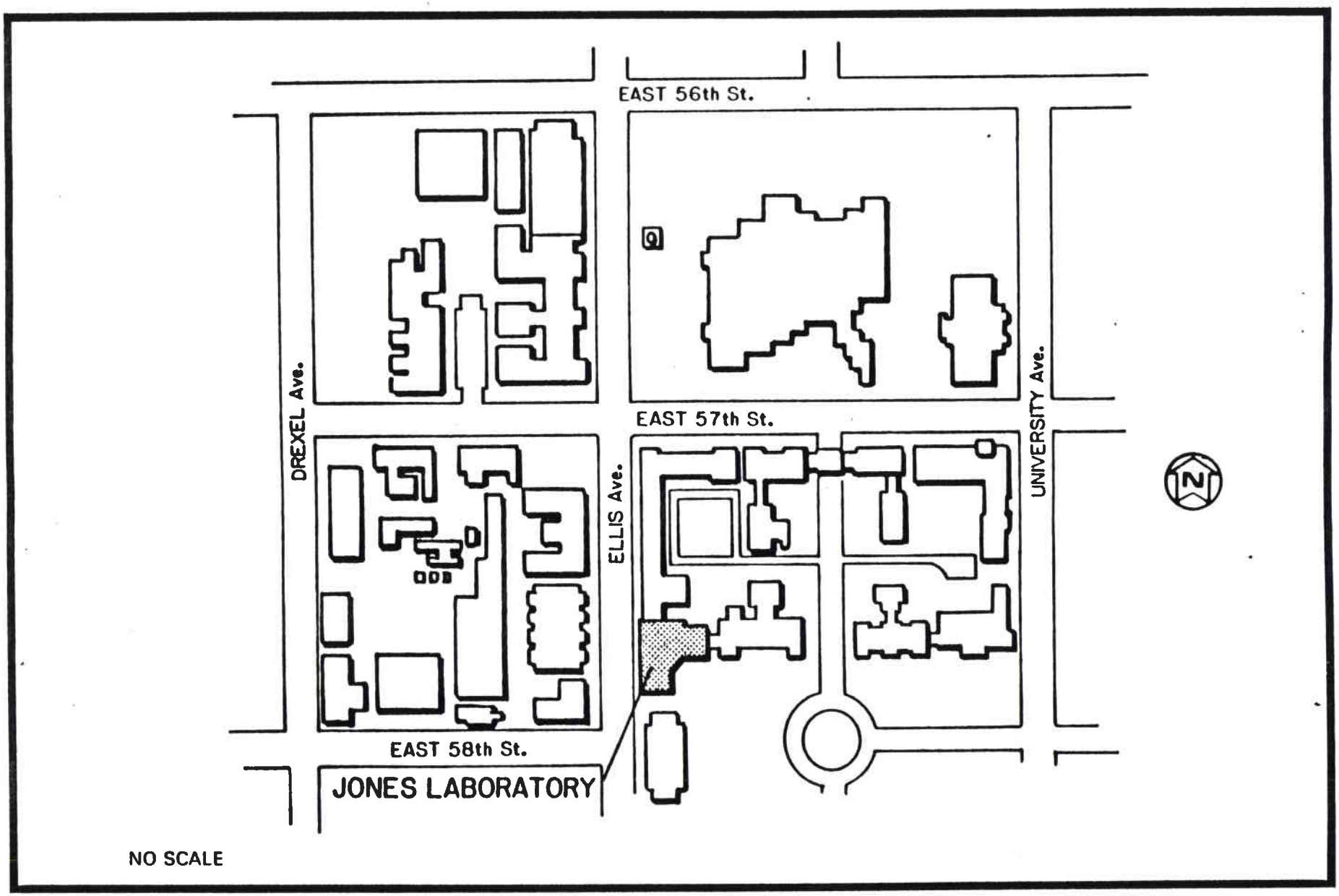


FIGURE 1-2 THE UNIVERSITY OF CHICAGO CAMPUS

The primary focus of activities conducted at the University of Chicago under contract to the MED was the production and purification of plutonium. Additional research and development operations were conducted throughout World War II to support the atomic bomb project. Various laboratories and facilities at the university were used for these activities, including Jones Laboratory (Refs. 2, 3). The remedial action conducted at Jones Laboratory is the subject of this report.

The first contract with the University of Chicago was established through the government's Office of Scientific Research and Development (OSRD) in January 1942. By June of that year, the Army Corps of Engineers assumed responsibility for development of the atomic bomb, forming the MED for this purpose. The contract was transferred from the OSRD to the MED in May 1943. In 1947, the AEC succeeded the MED as the government agency in charge of nuclear programs. AEC-sponsored research continued at the University of Chicago until 1952. When MED/AEC operations at the university ceased, the facilities used by the MED/AEC were decontaminated to meet health and safety criteria then in effect (Refs. 2, 3).

Radiological surveys of these facilities were performed for DOE by Argonne National Laboratory in 1976 and 1977 (Refs. 4-8). These surveys indicated the presence of residual radioactive contamination in four buildings, including Jones Laboratory. DOE performed decontamination operations in these buildings in 1984; however, because Jones Laboratory was renovated after MED/AEC activities ceased, many sections of ductwork were not readily accessible during decontamination operations conducted in 1984 (Ref. 3).

The remedial action described in this report was conducted in areas that were identified on the basis of pre-remedial action activities as being contaminated in excess of guidelines. Pre-remedial action activities are described in Subsection 3.1; the types of remedial action conducted are described in Subsection 3.2.

2.0 REMEDIAL ACTION GUIDELINES

The radionuclides of primary concern at Jones Laboratory prior to remedial action were various isotopes of uranium, plutonium, thorium, and radium. Because other radioactive isotopes such as americium-241 and neptunium-237 are still handled in the laboratory, selected samples were also analyzed for these isotopes. DOE residual contamination guidelines governing the release of the property for future use are listed in Table 2-1. DOE implemented these guidelines on the basis of their compatibility with guidelines established by the Environmental Protection Agency (EPA) (Ref. 9). The guidelines presented in Table 2-1 were applied primarily to surfaces such as walls, floors, ceilings, roofing tiles, and ductwork. On surfaces where contamination exceeded the applicable guidelines, remedial action was repeated until post-remedial action measurements indicated that DOE guidelines had been met.

The remedial action guideline for uranium-238 in soil at the University of Chicago is the 150-pCi/g limit derived for the Illinois National Guard Armory, another FUSRAP site in Chicago (Ref. 10). Remedial action guidelines for surface contamination at the University of Chicago are 100 alpha dpm/100 cm^2, average, and 300 alpha dpm/100 cm^2, maximum; 0.2 mrad/h beta-gamma, average, and 1.0 mrad/h beta-gamma, maximum; and 20 alpha dpm/100 cm^2 for removable contamination (Ref. 9). Guidelines for radionuclide concentrations in water to be released to uncontrolled areas at the University of Chicago site are contained in a DOE memorandum issued in 1986 (Ref. 11).

TABLE 2-1
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES FOR THE UNIVERSITY OF CHICAGO

BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr.

SOIL (LAND) GUIDELINES

Radionuclide	Soil Concentration (pCi/g) above background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232 Uranium-238	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other radionuclides	150 pCi/g* Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that has no radiological restrictions on its use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.[d] In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restrictions on its use shall not exceed the background level by more than 20 μR/h.

Indoor/Outdoor Structure Surface Contamination

Radionuclide[f]	Allowable Residual Surface Contamination[e] (dpm/100 cm^2)		
	Average[g,h]	Maximum[h,i]	Removable[h,j]
Transuranics, Ra-226, Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200

*Argonne National Laboratory. Derivation of a Uranium Residual Radioactivity Guideline for the National Guard Armory in Chicago, Illinois, Chicago, IL, May 1987.

TABLE 2-1

(continued)

Indoor/Outdoor Structure Surface Contamination (continued)

Radionuclide[f]	Allowable Residual Surface Contamination[e] (dpm/100 cm^2)		
	Average[g,h]	Maximum[h,i]	Removable[h,j]
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β - γ	15,000 β - γ	1,000 β - γ

[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that the dose for the mixtures will not exceed the basic dose limit.

[b]These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100-m^2 surface area.

[c]Localized concentrations in excess of these limits are allowable provided that the average concentration over a 100-m^2 area does not exceed these limits.

[d]A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

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

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

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

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

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

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

3.0 REMEDIAL ACTION

After it was determined that buildings at the University of Chicago site were radioactively contaminated in excess of existing DOE guidelines, DOE designated the site for remedial action. Although access to some of the contaminated areas was difficult as a result of renovations performed subsequent to the termination of MED/AEC activities, in 1984 DOE decontaminated those areas of the building to which access could be easily gained. In 1987, the remaining contaminated areas became more easily accessible following additional renovations. In order to determine the specific areas where remedial action was required, DOE radiologically characterized the areas that were suspected to be contaminated.

Based on these characterization activities, remedial action was performed. Figures 3-1 through 3-8 are floor plans of Jones Laboratory from the basement to the roof. These figures are grouped at the end of this section.

3.1 PRE-REMEDIAL ACTION CHARACTERIZATION ACTIVITIES

Several types of areas were suspected to be radioactively contaminated and were radiologically characterized to provide clearer definition of the specific areas requiring remedial action. Detailed characterization results are reported in a separate document (Ref. 12). Pre-remedial action characterization activities are described below.

3.1.1 Ducts

Sixty-four ducts in the Jones Laboratory were suspected of being contaminated. One of these ducts (Duct 19) was never located, even though it appeared on the original drawings of the laboratory that were on file with the university. The 63 ducts that were located were radioactively characterized to support remedial action planning. Surveys of each duct were performed to determine whether above-guideline radioactive contamination was present. Measurements were

taken at several elevations on the north, south, east, and west face of each duct. In addition, it was determined based on a review of historical information that there was a potential presence of perchloric and picric acid salts in the ducts. Perchloric and picric acids salts are explosive; they can be detonated by shock, impact, heat, or friction. Before remedial action was performed on the ducts, field tests were performed to determine whether these salts were present. Where positive results were received, they were verified by laboratory analysis.

Based on visual inspection of the work areas, asbestos-containing material (ACM) was suspected to be present in the construction materials. A survey was performed to determine whether ACM was present.

3.1.2 Chimneys

The duct system in Jones Laboratory terminates on the roof as a series of chimneys. Each of these chimneys was surveyed for radioactive contamination.

3.1.3 Roof

The roof of the Jones laboratory was radiologically surveyed to determine whether it had become contaminated by the deposition of stack exhaust. Figure 3-7 is a plan of the laboratory roof.

The roof tiles were sampled, and analyses were performed to determine the concentrations of plutonium-239, uranium-238, thorium-230, radium-226, and thorium-232. It was determined that the tiles were made from materials containing naturally occurring radioactive materials.

3.1.4 Steam Leaks and Floors

Prior to the performance of remedial action by decontamination or removal, the ducts were steam-cleaned to remove any perchloric or

picric acid that might be present. During steam-cleaning operations, a number of steam leaks occurred. The floors in areas where these leaks occurred were surveyed to determine whether they had become contaminated as a result. Several other floor areas were also radiologically surveyed.

3.1.5 Drains and Sewers

Sediments in the drains inside the laboratory building were sampled based on findings of the survey conducted in 1984 (Ref. 13). To determine whether contamination had reached the public sewer system, water samples were collected from the sewer at points both above and below the inlet from the Jones Laboratory.

3.1.6 Fans and Blowers

The fans and blowers in the duct system were surveyed for contamination. A total of 28 direct alpha measurements, 28 direct beta-gamma, and 7 transferable alpha measurements were made.

3.2 REMEDIAL ACTION ACTIVITIES

Remedial action was performed at Jones Laboratory based on the results of the characterization activities described in Subsection 3.1 (Ref. 12). Since above-guideline contamination was not found in the drains or sewers, no remedial action was performed in these areas. In those areas that were found to be contaminated, remedial action was performed as described below.

Remedial action consisted of removing chemical and radioactive contamination from several areas. Four types of remedial action were performed at the Jones Laboratory. The first two types of remedial action discussed below were performed to protect the health and safety of remedial action workers and other persons occupying the laboratory building.

The first of these activities was the steam cleaning of the duct system. Because the explosive salts of perchloric and picric acids were determined to be present in the duct system, the ducts had to be flushed with steam to remove the salts before further remedial action could be performed.

After the duct system was steam-cleaned, the ACM was removed based on survey results indicating that it was present in areas where work was to be performed. The ACM was removed to protect the worker safety. A total of 512 ft^2 of ACM was removed from the Jones Laboratory.

Following the removal of ACM, remedial action continued, consisting of the removal of radioactively contaminated ducts. Ducts 10, 26, 29, and 64 were removed. The locations of these ducts are shown in Figures 3-9 through 3-11. Finally, the floors were scabbled to remove fixed contamination. The areas that were scabbled are shown in Figures 3-12 through 3-14. Figure 3-15 shows the locations of the chimneys that were cleaned.

Radioactively contaminated wastes removed during remedial action were shipped to Argonne National Laboratory (a DOE facility in Argonne, Illinois) for disposal. The ACM that was not radioactively contaminated was placed in asbestos disposal bags and transported from the site by a waste hauler licensed to dispose of ACM. All water was stored on-site, tested to ensure that it met applicable limits, and then released to the sewer system.

3.3 CONTAMINATION CONTROL DURING REMEDIAL ACTION

During remedial action, measures were taken to prevent the spread of contamination and to keep exposure rates as low as possible for building occupants, including the remedial action workers. Measures were also taken to monitor airborne radioactivity resulting primarily from dust and to limit the exposure of personnel to asbestos.

The following contamination control measures were implemented during remedial action:

- All sanding, scabbling, grinding, or cutting was done within a containment box (a cardboard or plywood box with a plastic top that permitted the operator to use the proper equipment but prevented the uncontrolled release of contaminants). The top also had an opening for the hose of the high-efficiency filtered exhaust vacuum, which was used primarily for dust control.

- All personnel working in areas where ACM was present wore respiratory protection. In addition, a control area was established wherein the affected area was isolated from the rest of the building using a partition made of plastic film. This controlled area served as the only access and egress from the asbestos-containing area. All equipment was vacuumed before it was removed from the area.

Continuous air sampling was performed at several points within the building to ensure that contamination control measures were successful.

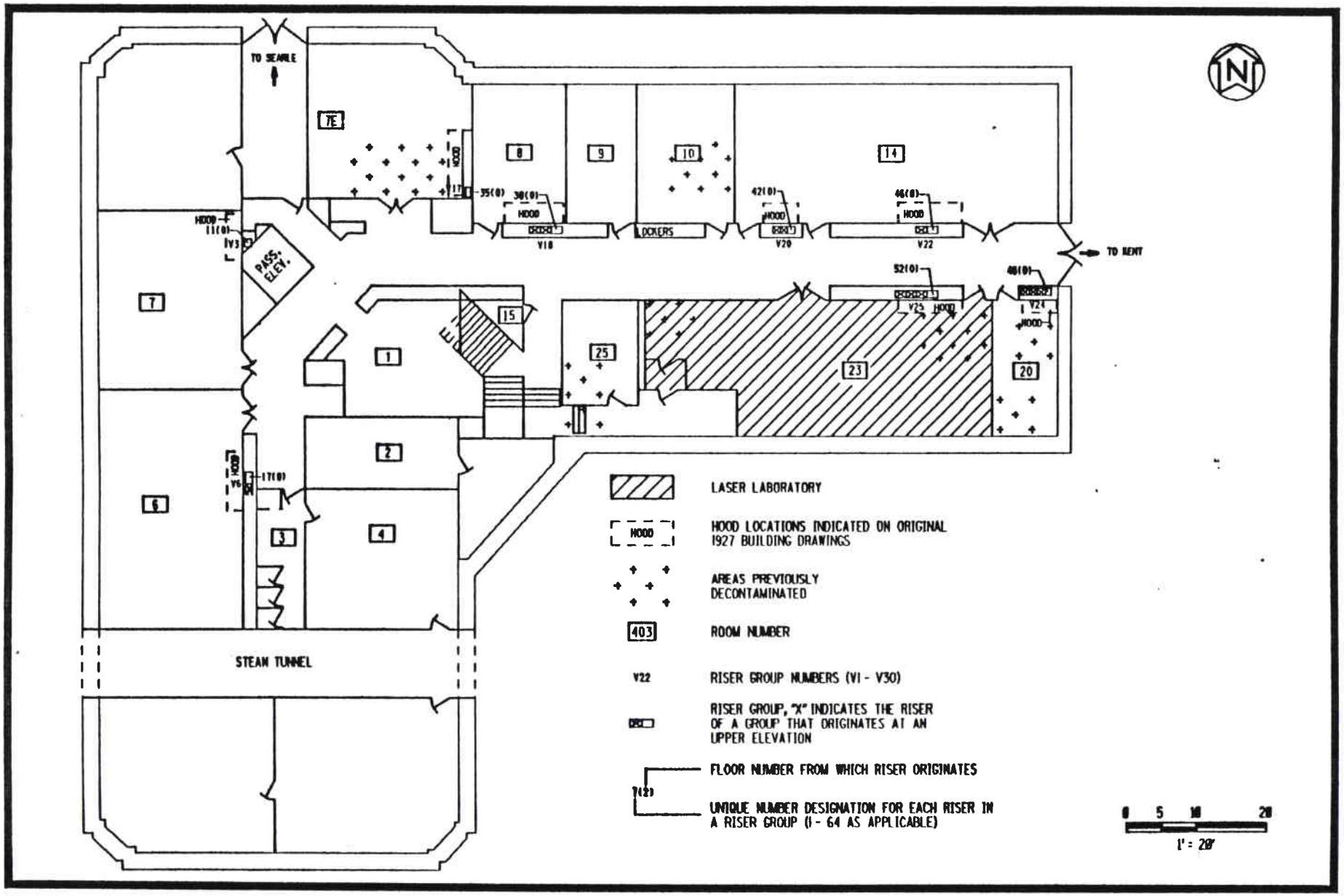


FIGURE 3-1 FLOOR PLAN OF THE BASEMENT

GRB: [42,12] C3IW9801.DGN

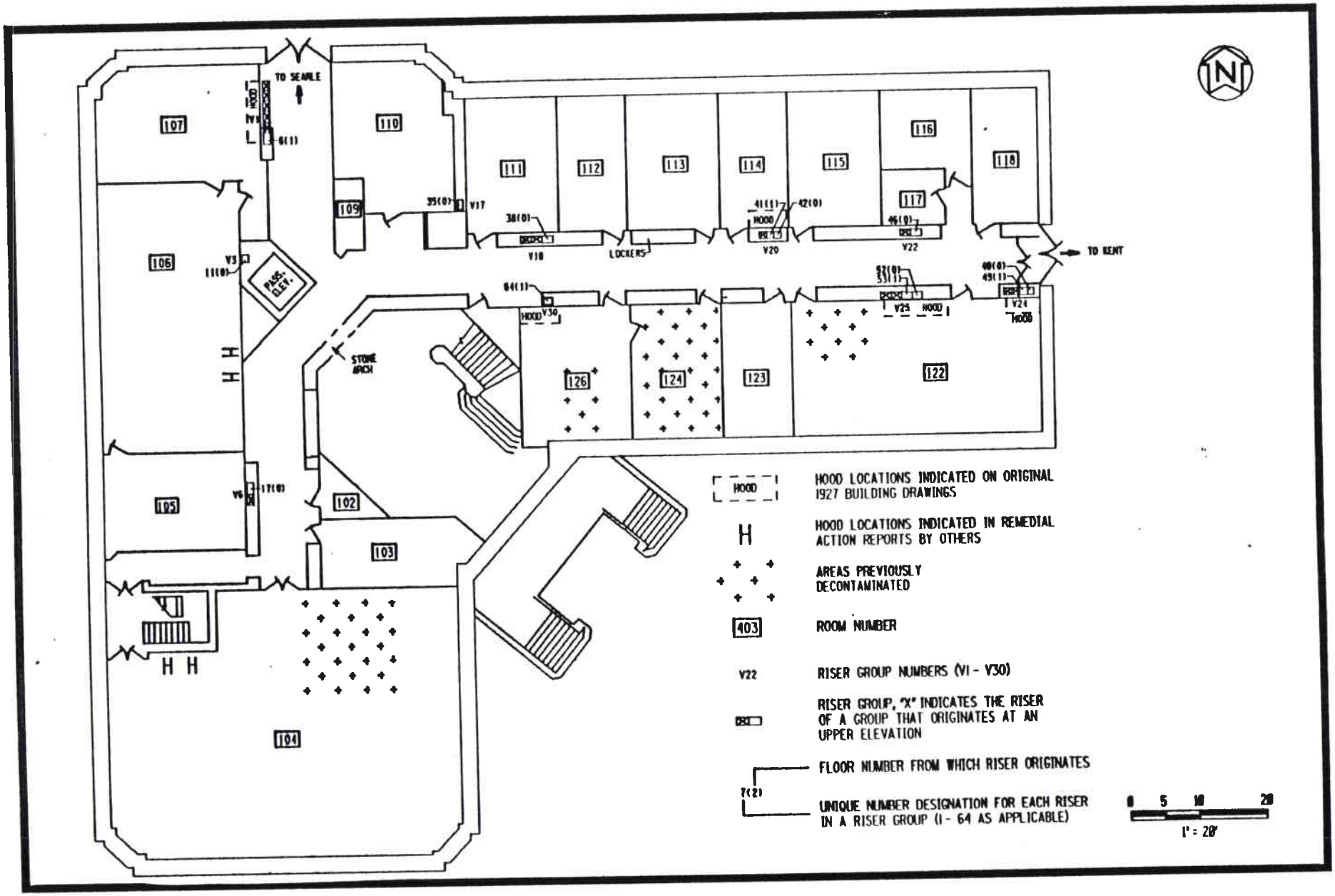


FIGURE 3-2 LAYOUT OF THE FIRST FLOOR

GRB: [42,12] C3IW9802.DGN

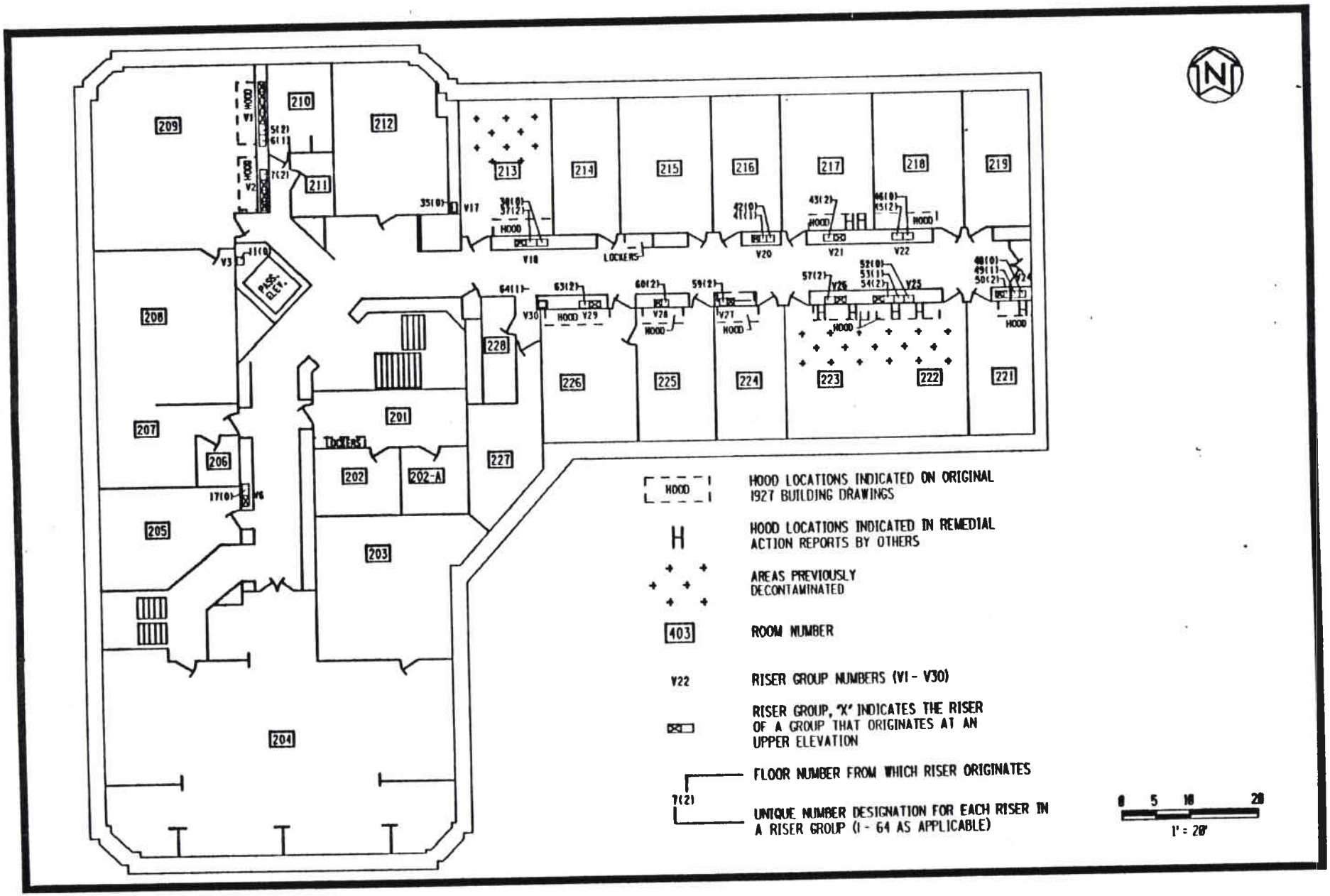


FIGURE 3-3 LAYOUT OF THE SECOND FLOOR

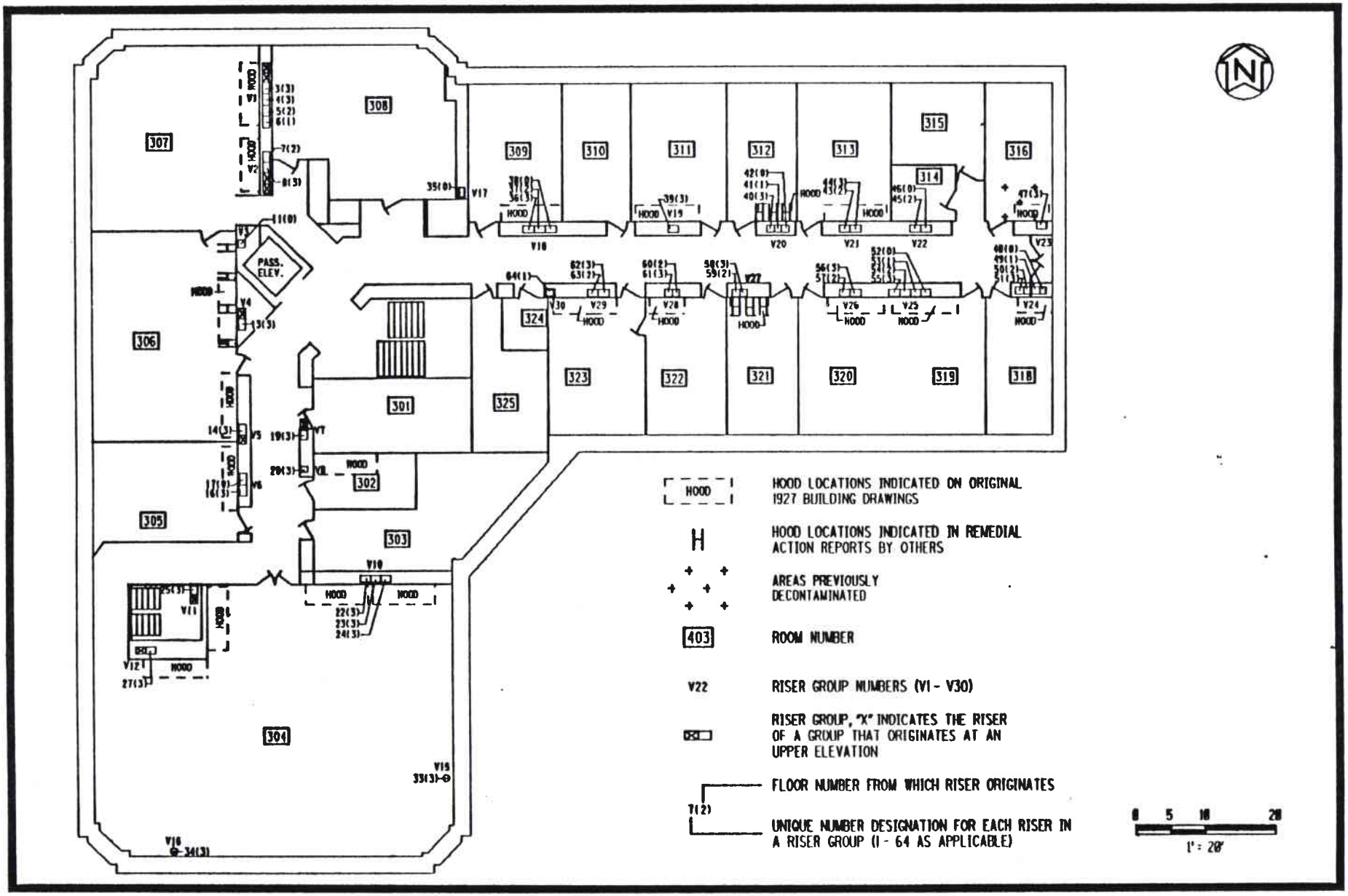


FIGURE 3-4 LAYOUT OF THE THIRD FLOOR

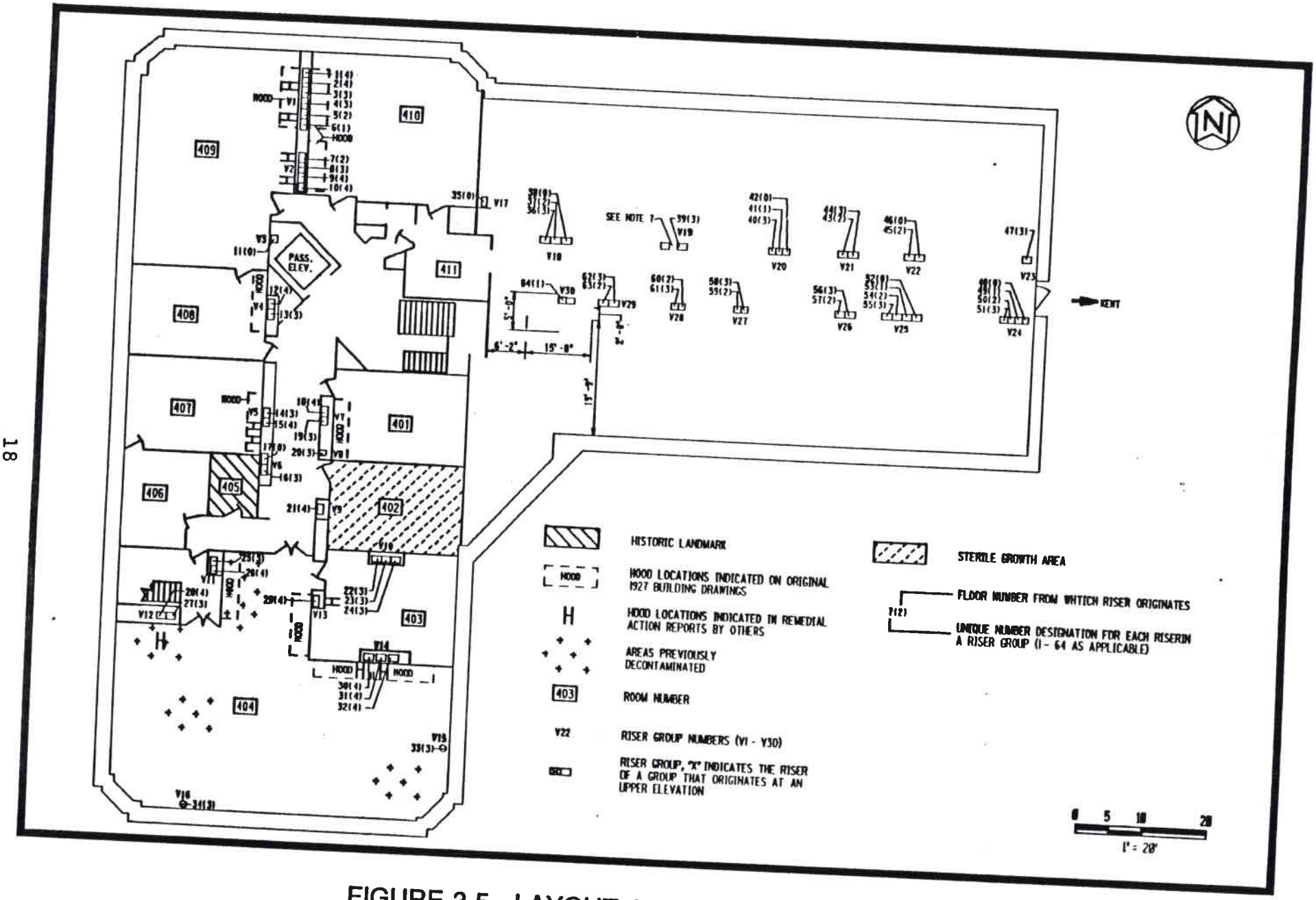


FIGURE 3-5 LAYOUT OF THE FOURTH FLOOR

GRB: [42,12] C3IW9805.DGN

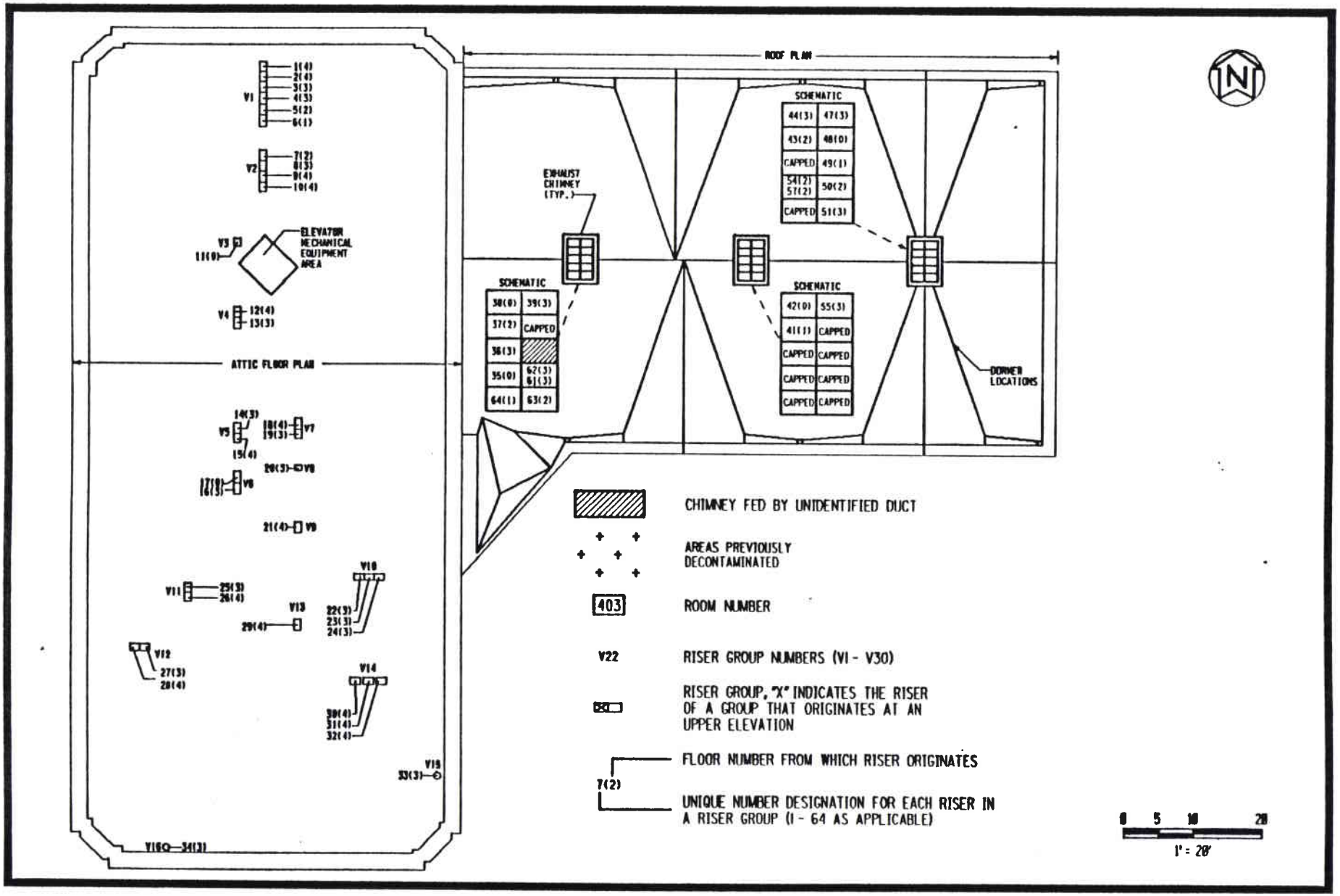


FIGURE 3-6 FLOOR PLAN OF THE ATTIC

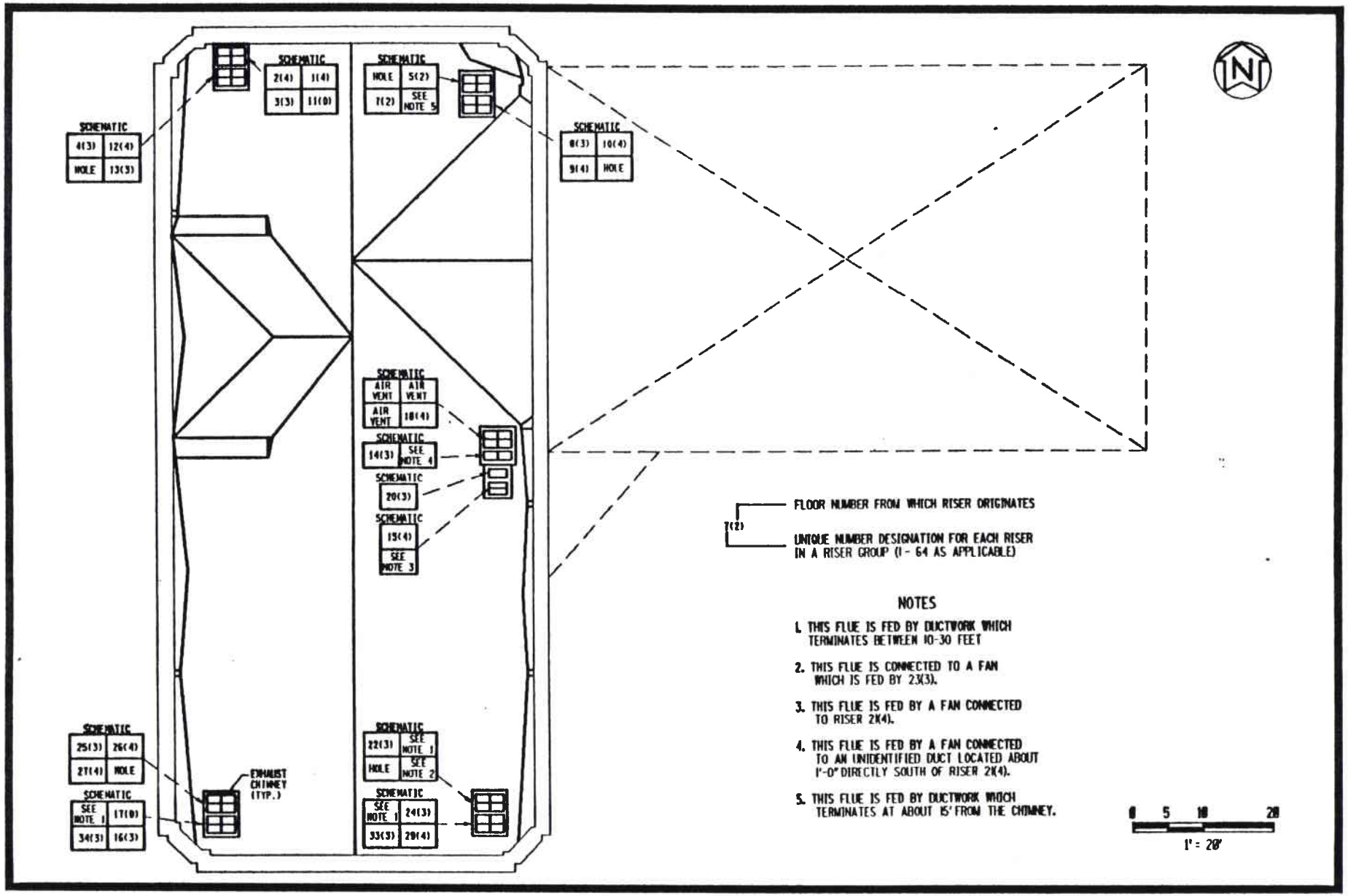


FIGURE 3-7 PLAN OF THE LABORATORY ROOF

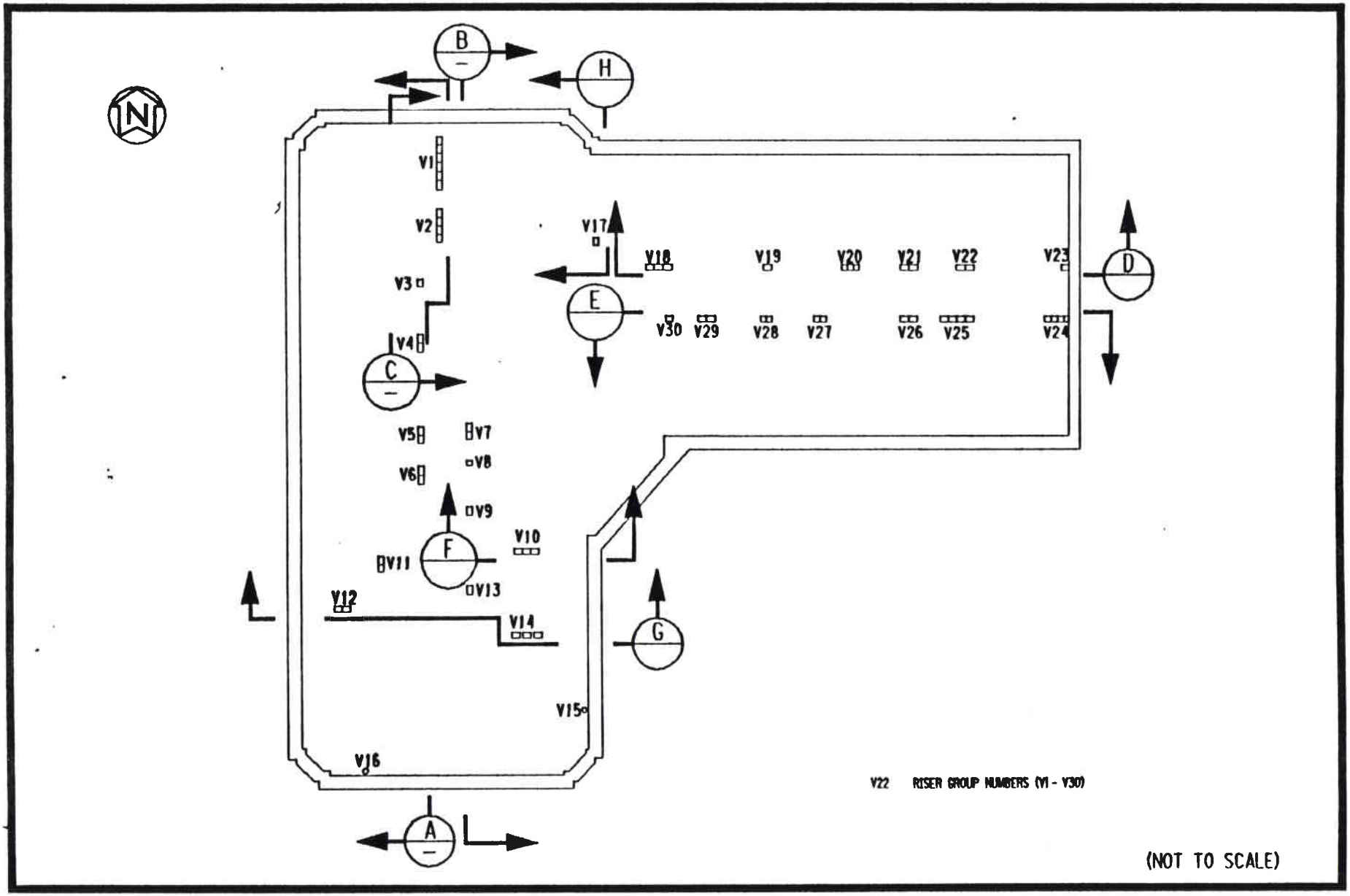


FIGURE 3-8 TYPICAL FLOOR PLAN OF THE JONES LABORATORY

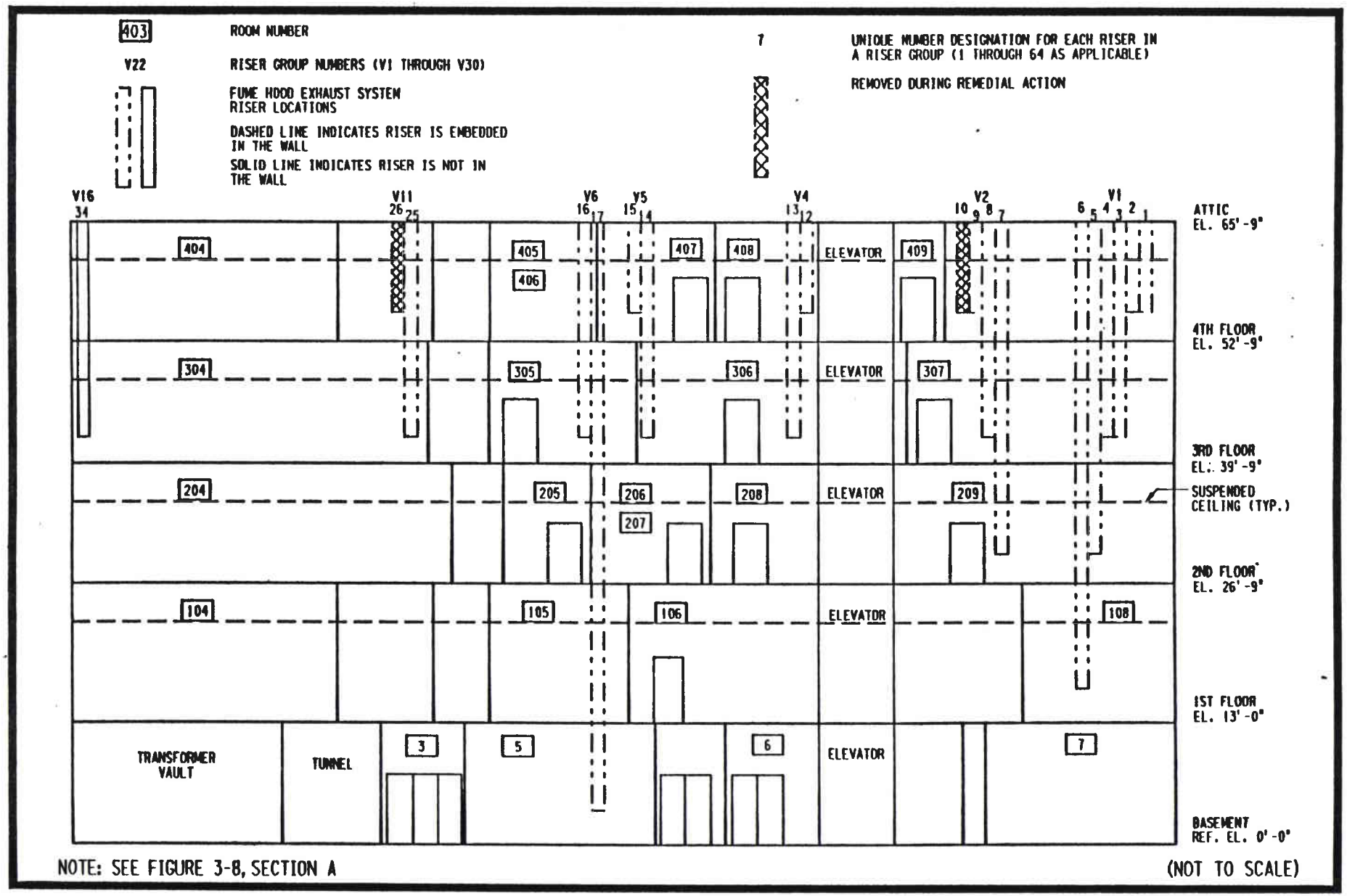


FIGURE 3-9 LOCATIONS OF DUCTS 10 AND 26

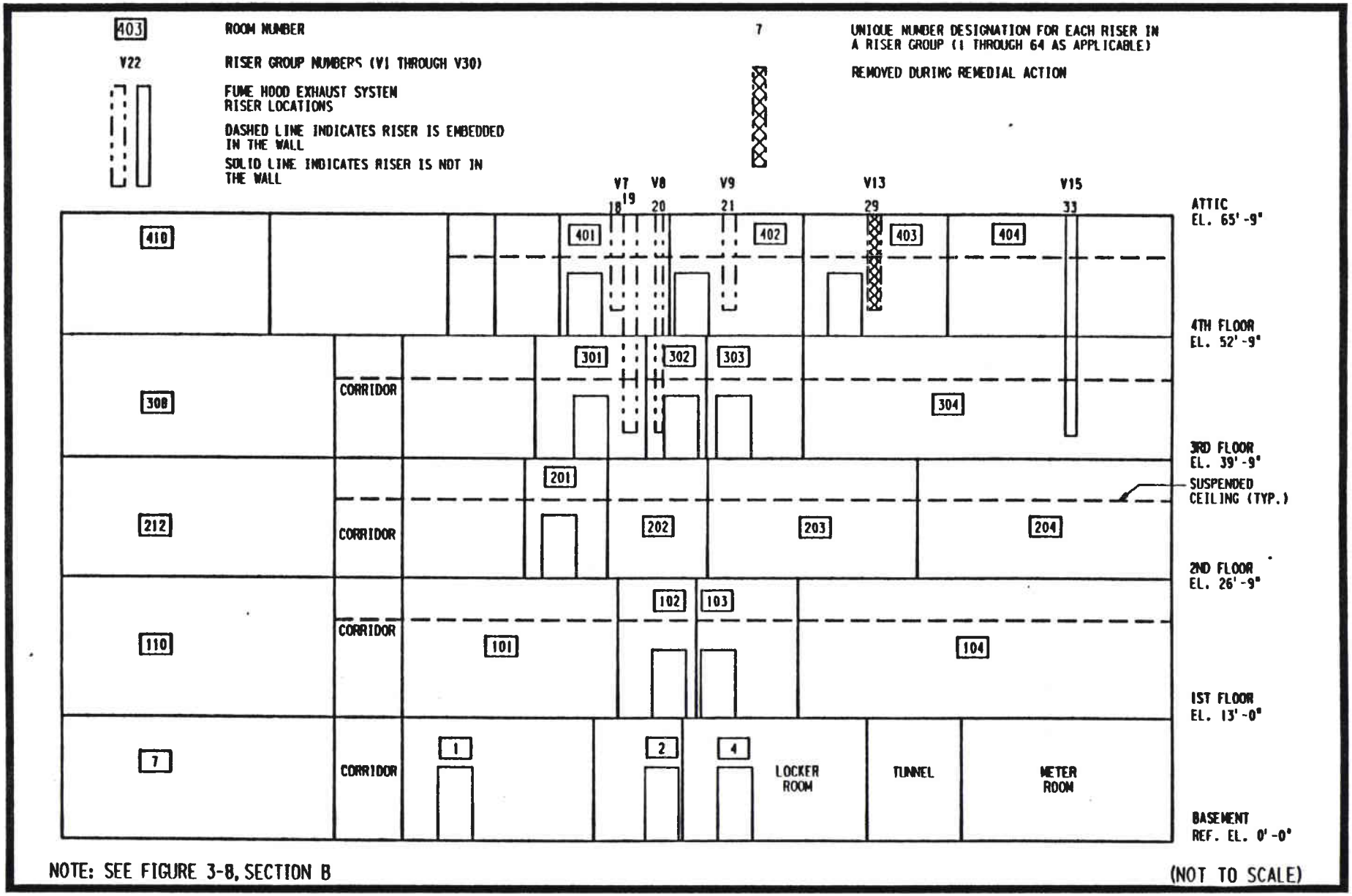
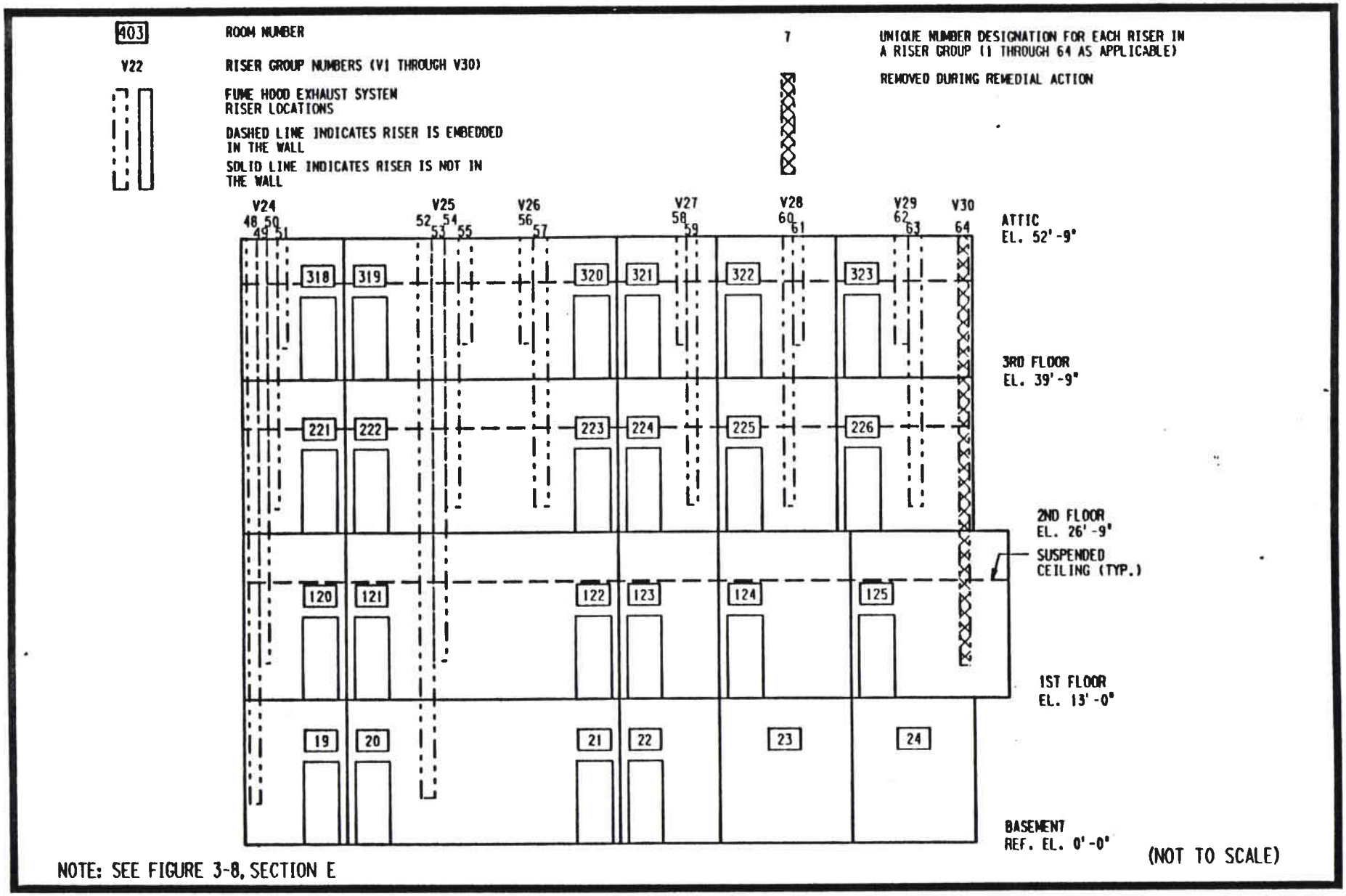


FIGURE 3-10 LOCATION OF DUCT 29



NOTE: SEE FIGURE 3-8, SECTION E

FIGURE 3-11 LOCATION OF DUCT 64

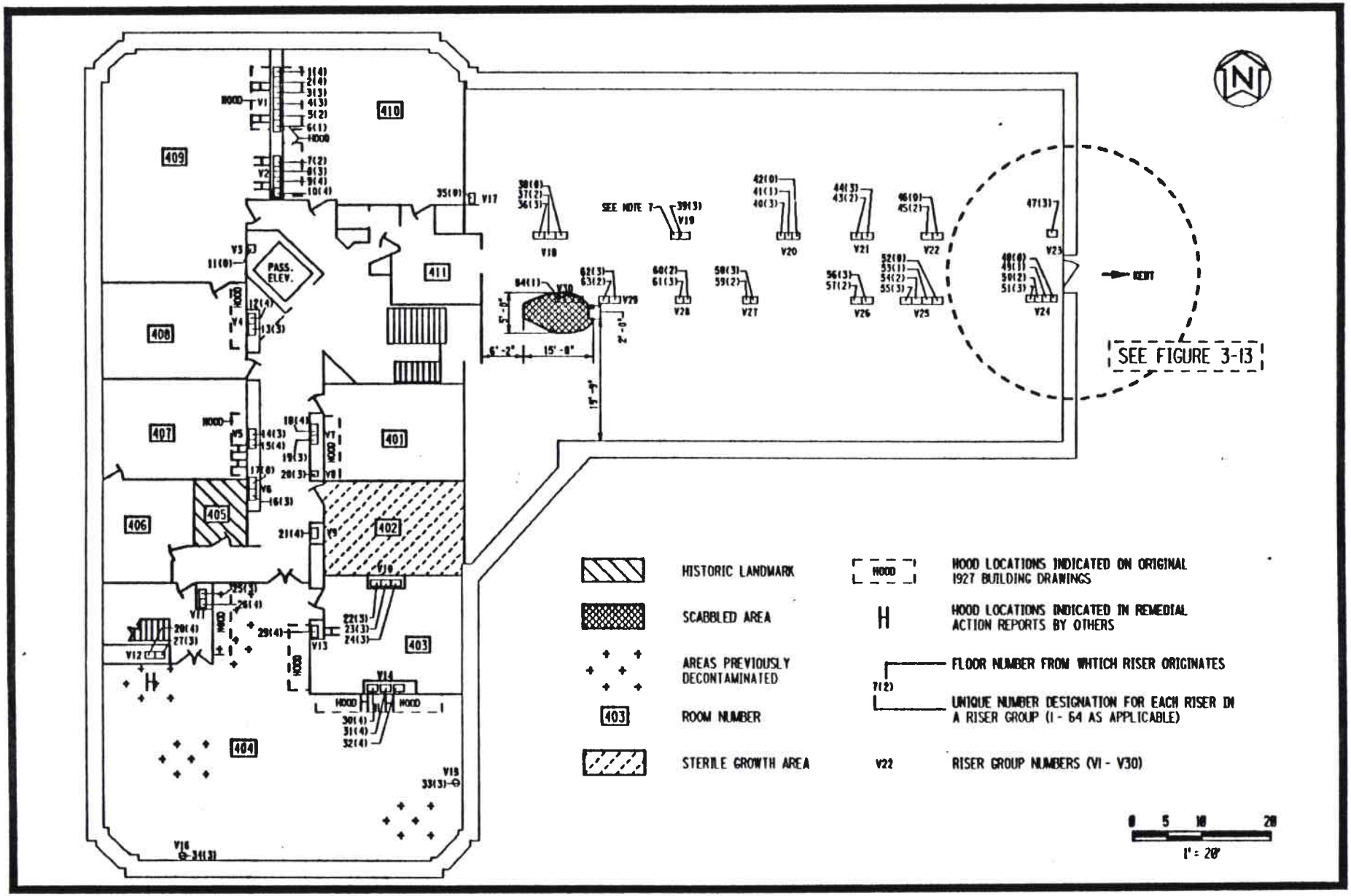


FIGURE 3-12 AREAS SCABBLED ON THE FOURTH FLOOR

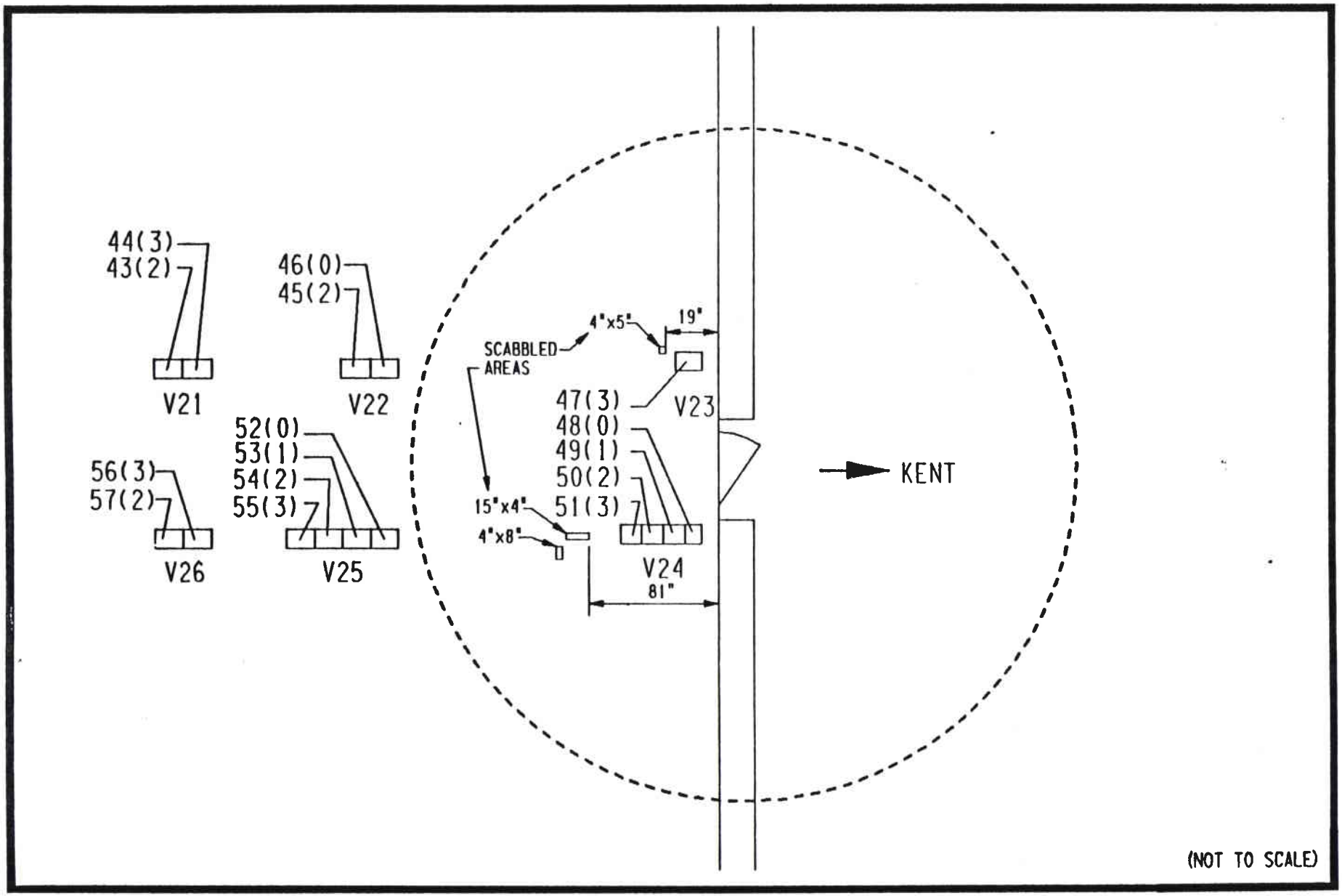


FIGURE 3-13 AREAS SCABBLED ON THE FOURTH FLOOR ATTIC FLOOR

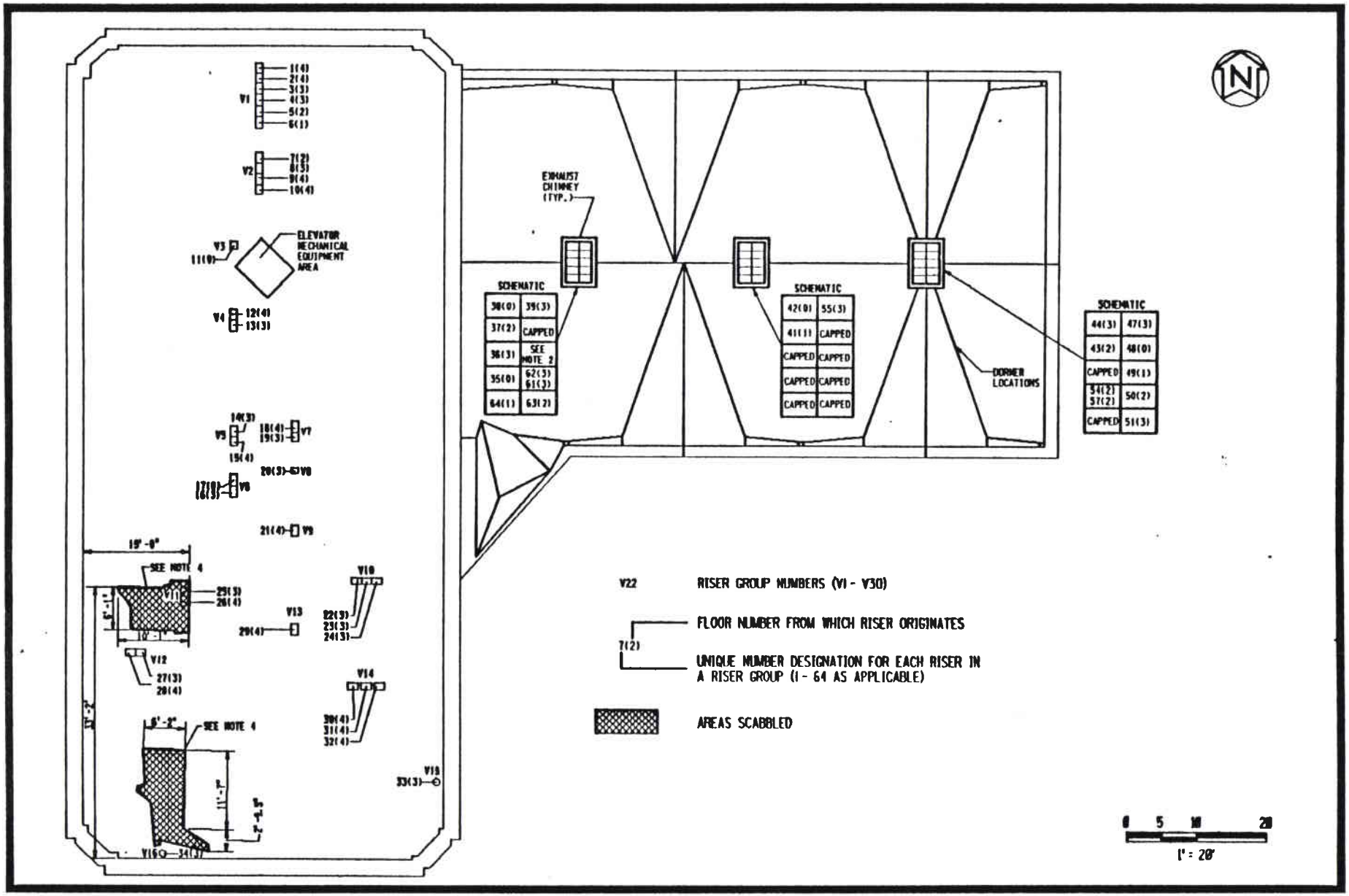


FIGURE 3-14 AREAS SCABBLED IN THE ATTIC

GRD: (42,12) C3IW9823.DGN

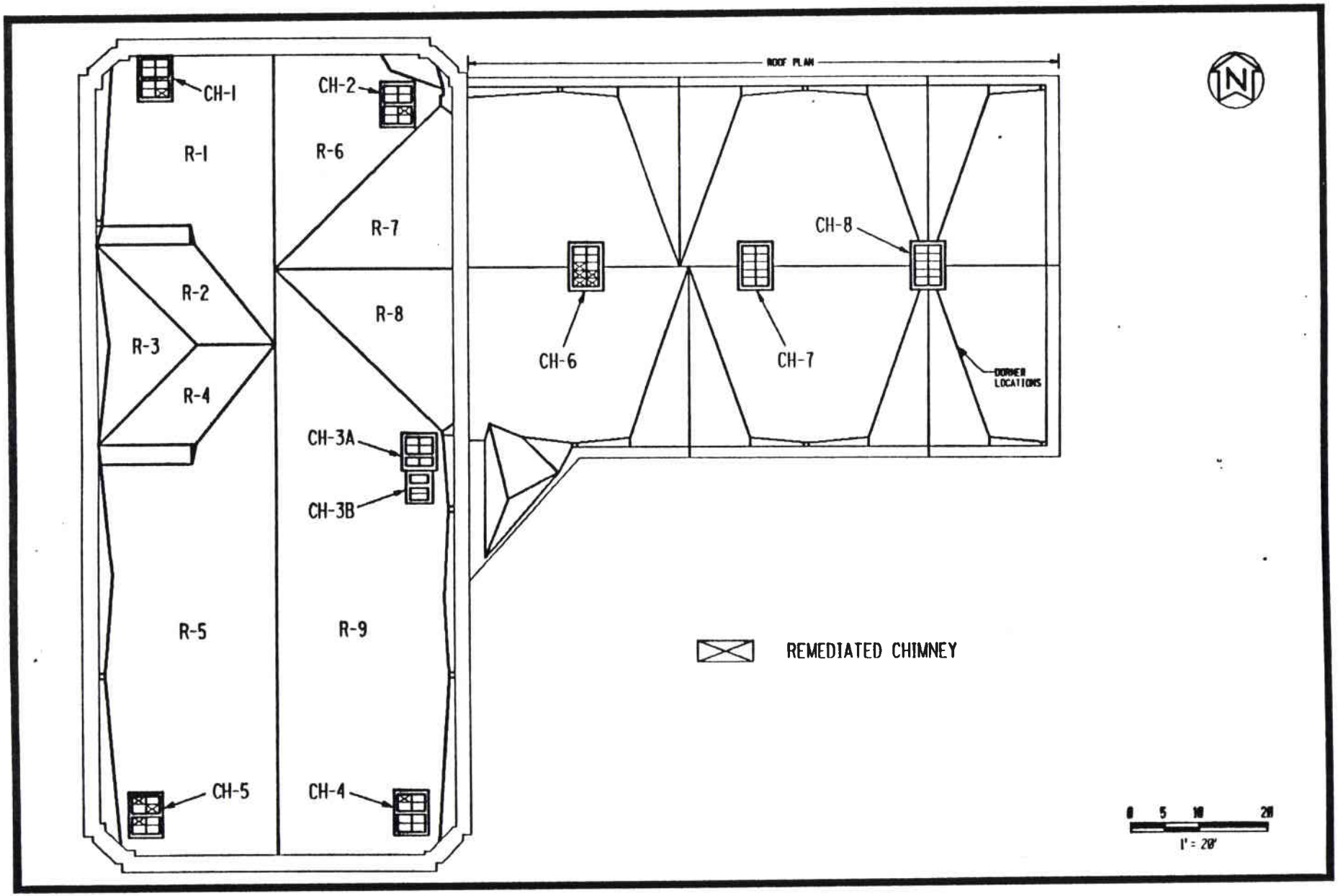


FIGURE 3-15 LOCATIONS OF CHIMNEYS THAT WERE REMEDIATED

4.0 POST-REMEDIAL ACTION MEASUREMENTS

Post-remedial action measurements were taken in areas where remedial action was performed, including the scabbled areas and the walls behind the removed ducts. These measurements consisted primarily of direct alpha and beta-gamma measurements.

In the tables shown in this section, use of the "less than" (<) notation in reporting results indicates that the radionuclide was not present in concentrations that are quantifiable with the instruments and techniques used. The "less than" value represents the lower limit of the quantitative capacity of the instrument and technique used. It is based on various factors, including the volume, size, and weight of the sample for bulk samples; surface area of the detector for direct and transferable measurements; the type of detector used; the counting time, and the background count rate. The actual concentration of the radionuclide is less than the value preceded by the "less than" symbol. In addition, since radioactive decay is a random process, a correlation between the rate of disintegration and a given radionuclide concentration cannot be precisely established. For this reason, the exact concentration of the radionuclide cannot be determined. As such, each value that can be quantitatively determined has an associated uncertainty term ($\pm$), which represents the amount by which the actual concentration can be expected to differ from the value given in the table. The uncertainty term has an associated confidence level of 95 percent.

All the beta-gamma measurements are reported with background included. These measurements were all taken with portable, hand-held instruments. Background measurements recorded with such instruments can vary from room to room for various reasons, including the use of different instruments in the various rooms, the occurrence of small changes in the response of the instrument (e.g., new batteries), and small day-to-day changes in the ambient background.

The areas in which remedial action was conducted were radiologically surveyed to determine whether remedial action guidelines had been met. Direct contact measurements were obtained using a Geiger-Mueller counter. The number of readings obtained generally averaged five per square meter. Where physical features permitted, measurements were obtained in the center of a 1-m by 1-m square and at the four corners of the square. Transferable alpha readings were also obtained, at a minimum, at the locations that exhibited direct alpha measurements above guidelines for transferable contamination. These measurements were obtained by wiping a 10-cm by 10-cm area with a filter and taking a measurement of the filter.

Additional detail about the methods used to obtain post-remedial action measurements in specific areas are contained in the subsections that follow, as are summaries of the findings. Figures and data tables for the areas in which post-remedial action measurements were taken are grouped at the end of Section 4.0.

As shown in the tables, some of the direct post-remedial action measurements exceed 100 alpha dpm/100 cm^2. The applicable remedial action guideline for surface contamination is 100 alpha dpm/100 cm^2 averaged over a 1-m^2 area; while the maximum for an individual measurement is 300 alpha dpm/100 cm^2. The measurements listed in the tables are individual measurements rather than averages, and these measurements are all below the 300-alpha dpm/100cm^2 maximum. For all areas in which measurements exceeding 100 alpha cpm/100 cm^2 were obtained, the average measurement over the inclusive 1-m^2 area was below the 100-alpha dpm/100 cm^2 guideline. Therefore, post-remedial action measurements indicate that applicable remedial action guidelines have been met.

4.1 DUCTS

Measurements taken following decontamination procedures indicated that four of the sixty-three ducts (Ducts 10, 26, 29, and 64) were still contaminated above guidelines. These four ducts were removed,

and samples were subsequently taken from the walls behind the ducts to determine whether all the contamination was removed with the ducts. Measurements taken during the removal of Duct 10 indicated that a small area on the wall in Room 409 was contaminated. This area was cleaned, and post-remedial action measurements were taken. Post-remedial action sampling locations for the ducts are shown in Figures 4-1 through 4-28; associated analysis results are reported in Tables 4-1 through 4-8.

4.2 CHIMNEYS

Eleven air vents in the chimneys were decontaminated to bring them into compliance with current DOE guidelines. Figure 4-29 shows typical post-remedial action measurement locations. The measurements obtained at these locations are reported in Tables 4-9 and 4-10.

4.3 FLOORS

Floors that were found to be contaminated above guideline levels were scabbled to remove fixed contamination. Several areas were grouted before final post-remedial action measurements were taken. These areas were scanned before they were grouted, and all readings were within guidelines. An Independent Verification Contractor (IVC) was employed to survey these areas before they were grouted and determine whether remedial action was successful. Figures 4-30 through 4-33 show the floor areas where post-remedial action measurements were taken. Post-remedial action measurements for the floors are reported in Tables 4-11 and 4-12.

4.4 BLOWERS

While remedial action was being conducted in the fourth floor attic, a small blower and its mounting were found to be contaminated and were removed. Since the entire unit was removed, no post-remedial action measurements of the unit were taken.

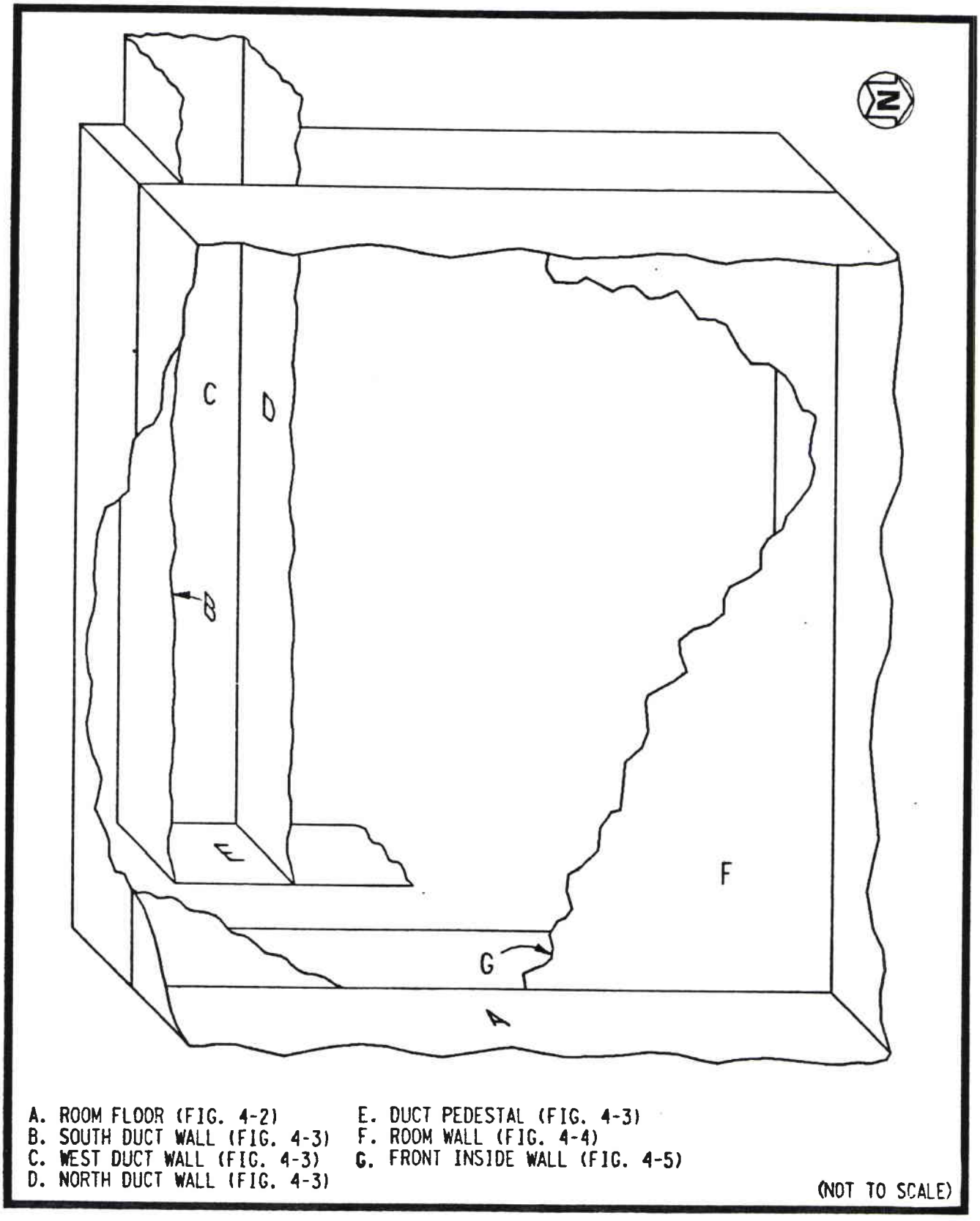


FIGURE 4-1 SURFACES OF DUCT 10 WHERE POST-REMEDIAL ACTION MEASUREMENTS WERE TAKEN

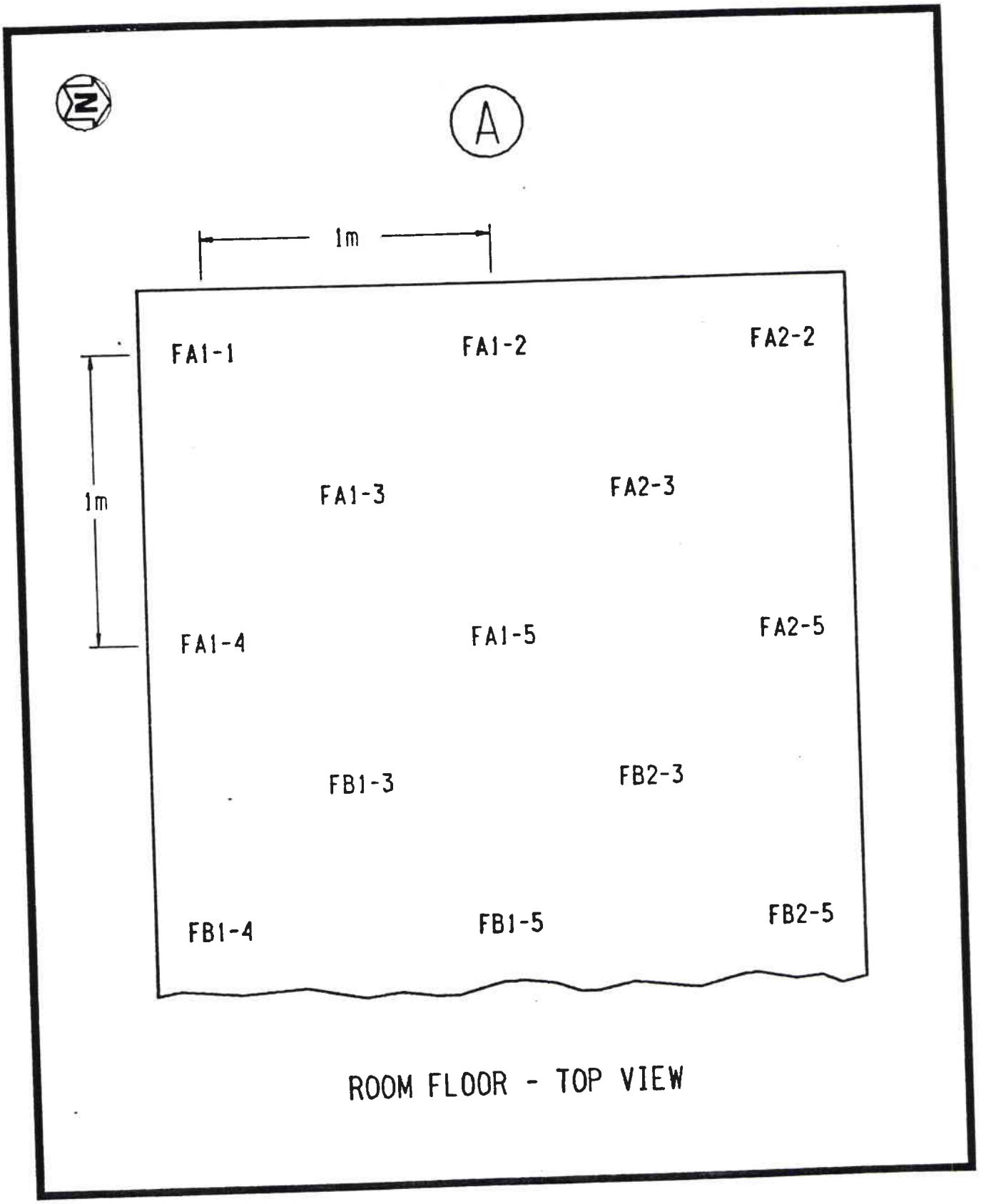


FIGURE 4-2 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE A OF DUCT 10

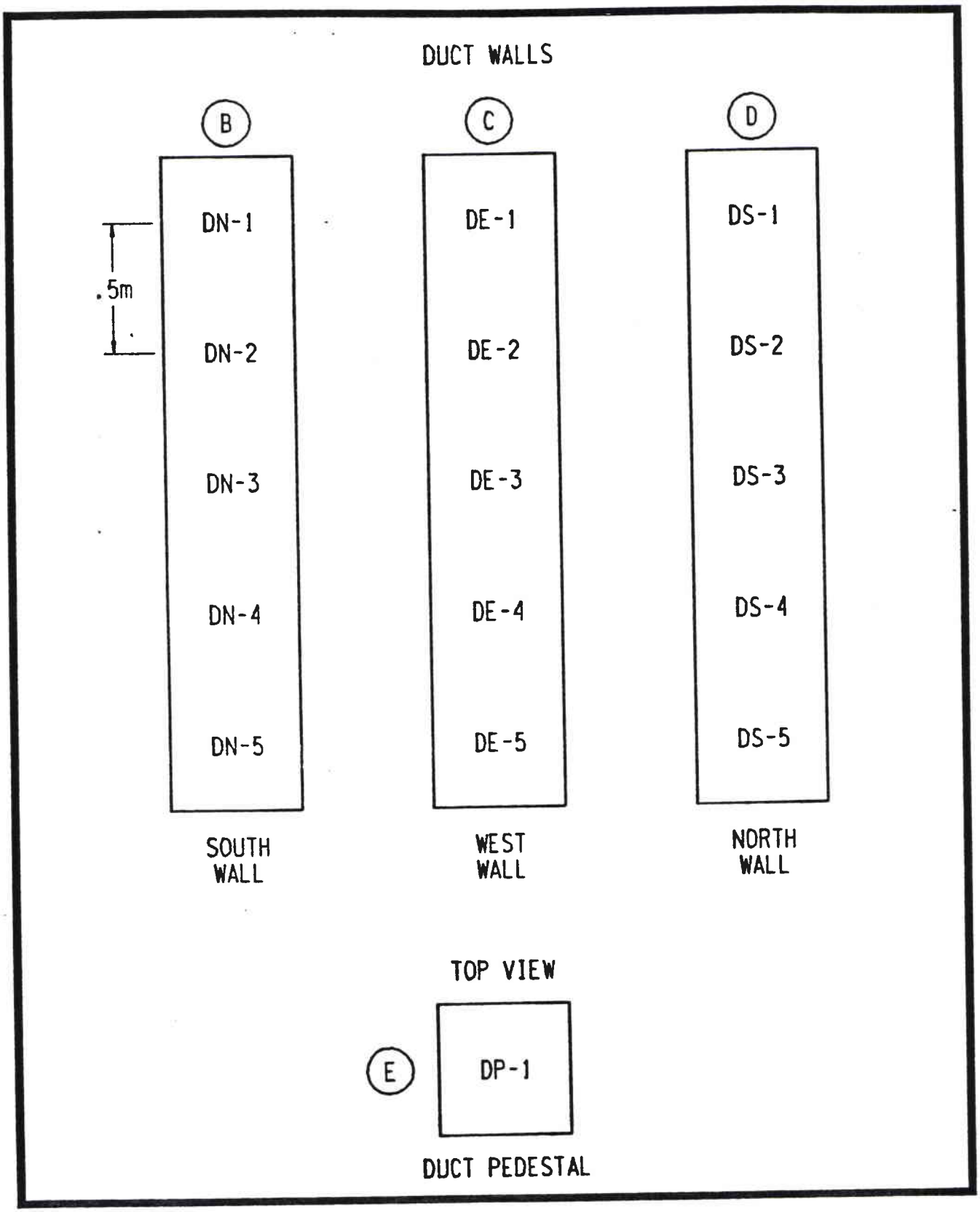


FIGURE 4-3 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACES B, C, D, AND E OF DUCT 10

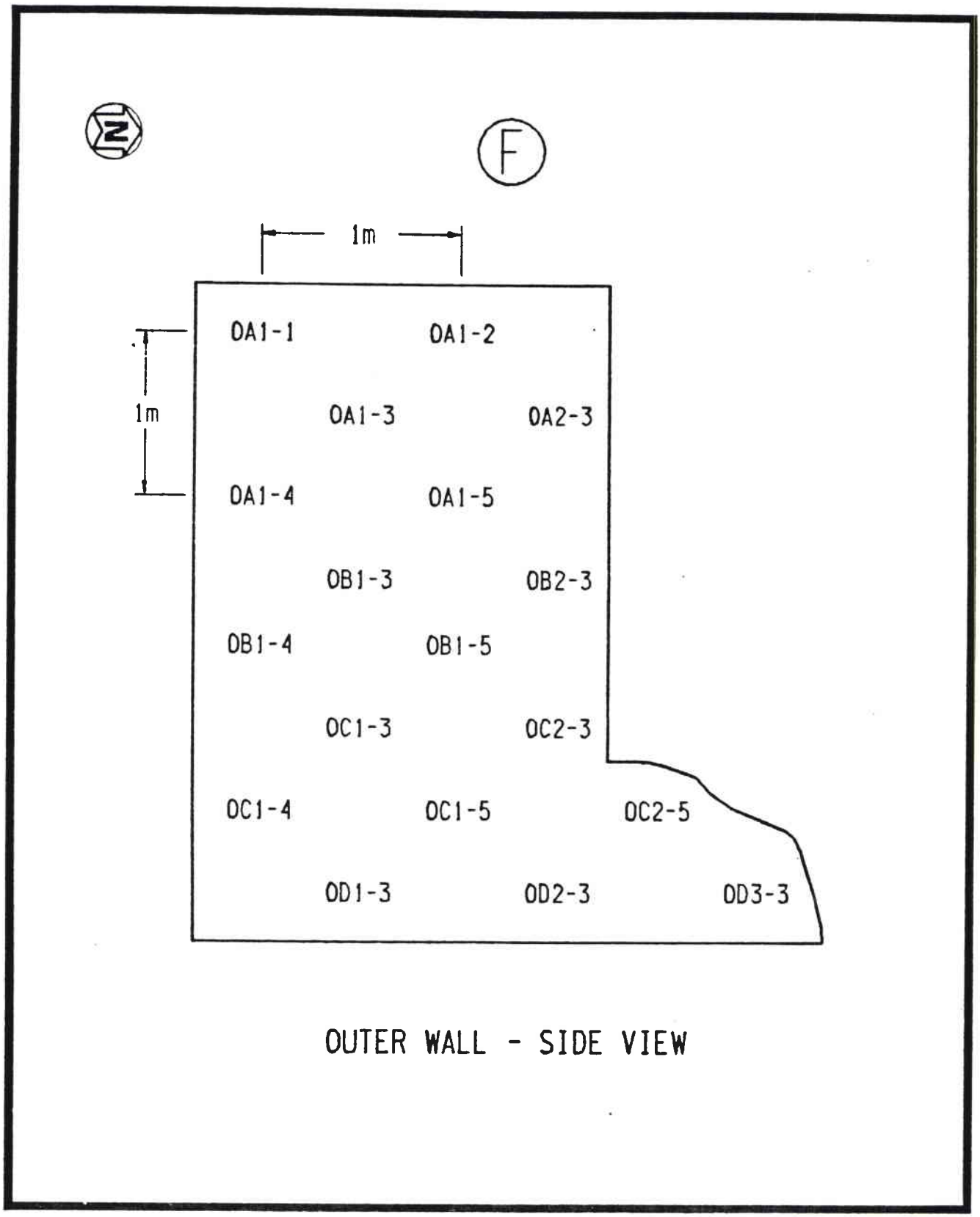


FIGURE 4-4 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE F OF DUCT 10

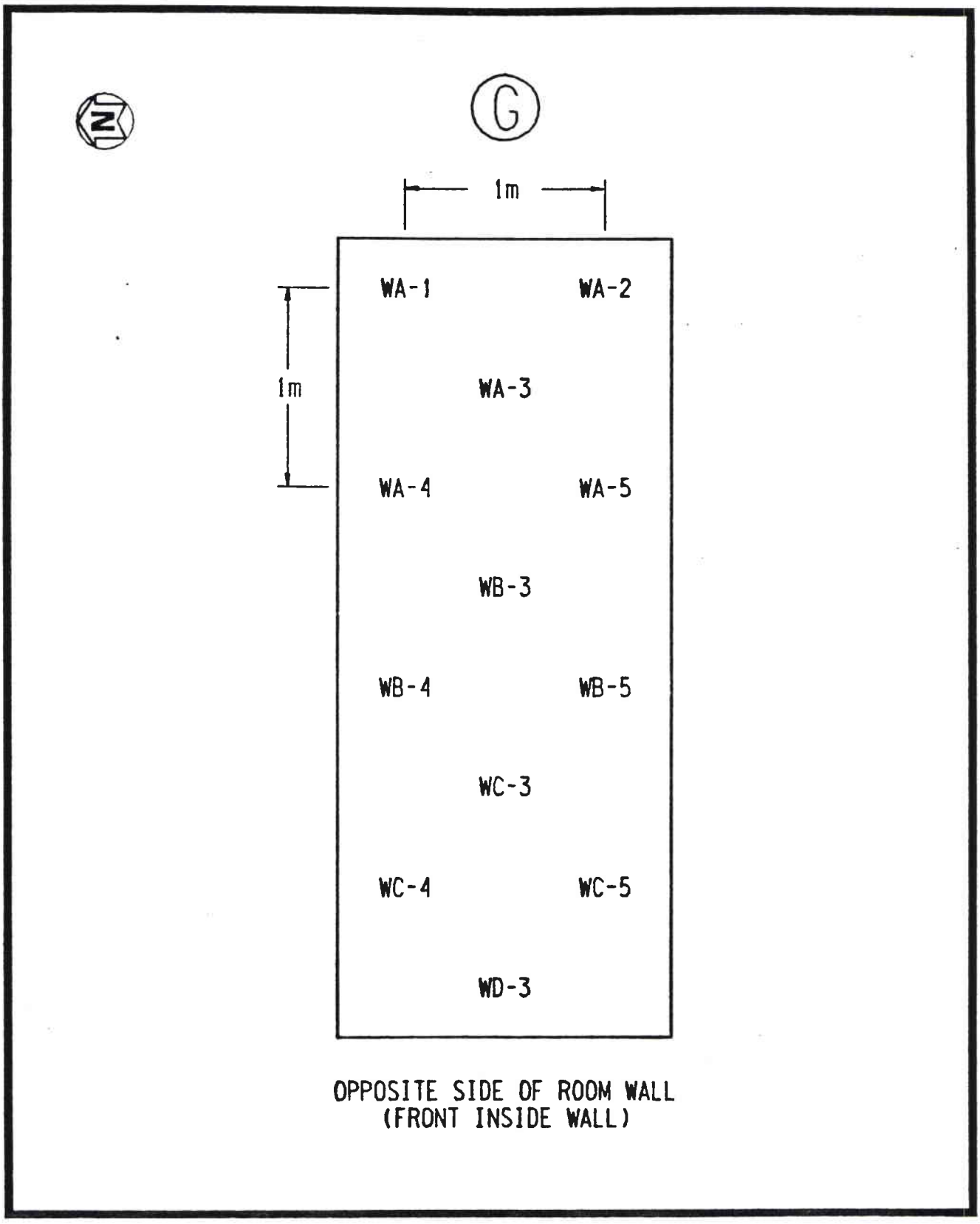


FIGURE 4-5 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE G OF DUCT 10

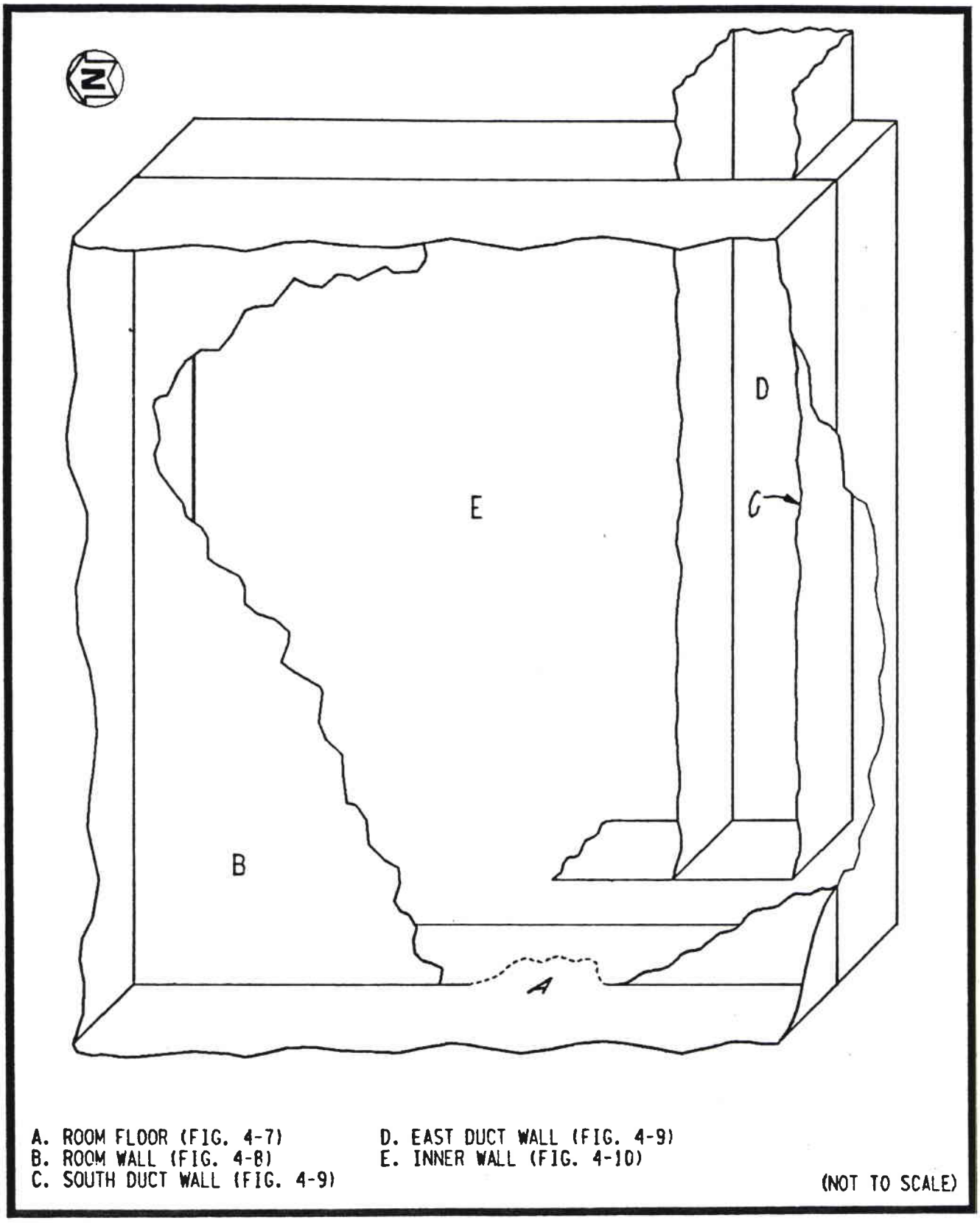


FIGURE 4-6 SURFACES OF DUCT 26 WHERE POST-REMEDIAL ACTION MEASUREMENTS WERE TAKEN

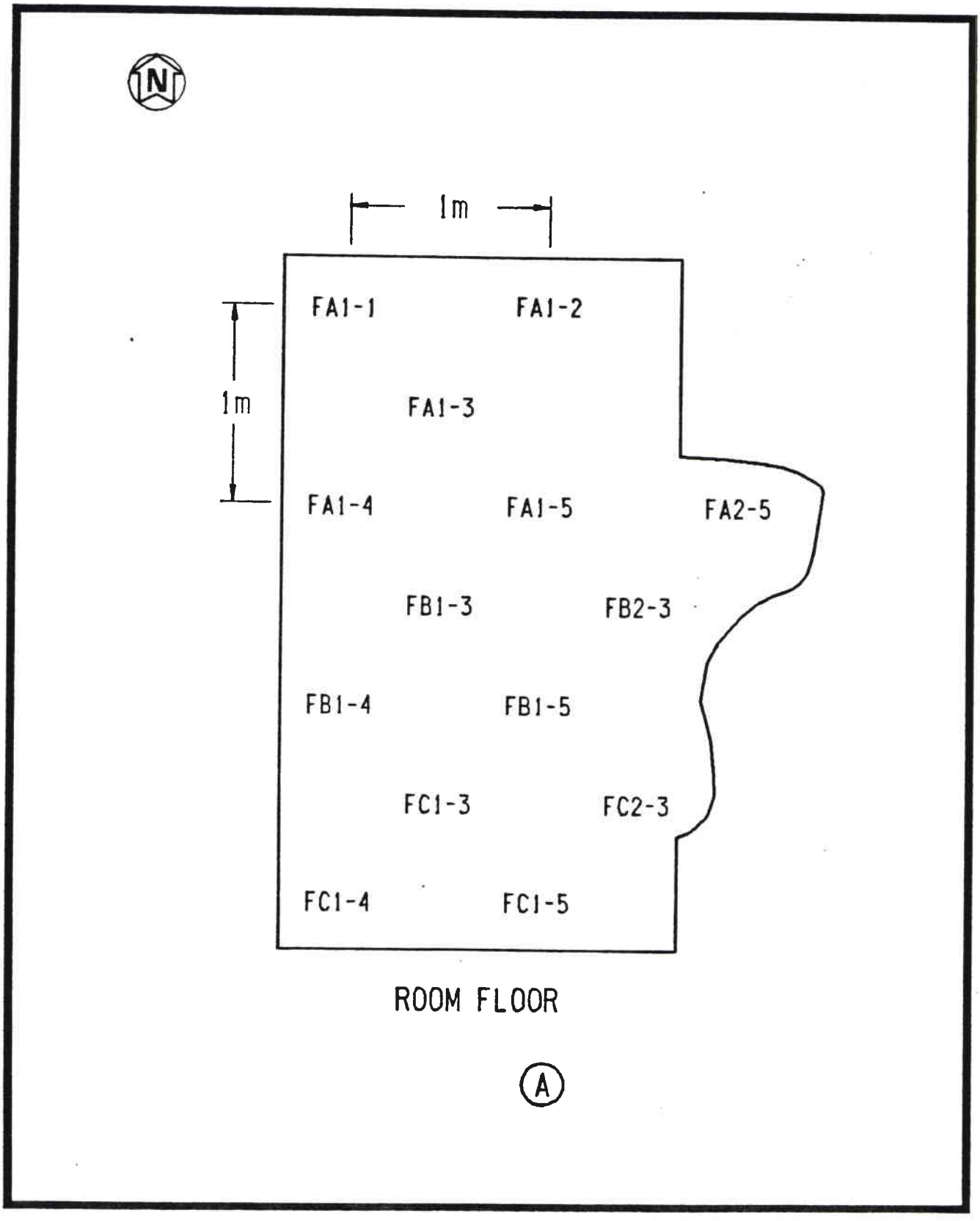


FIGURE 4-7 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE A OF DUCT 26

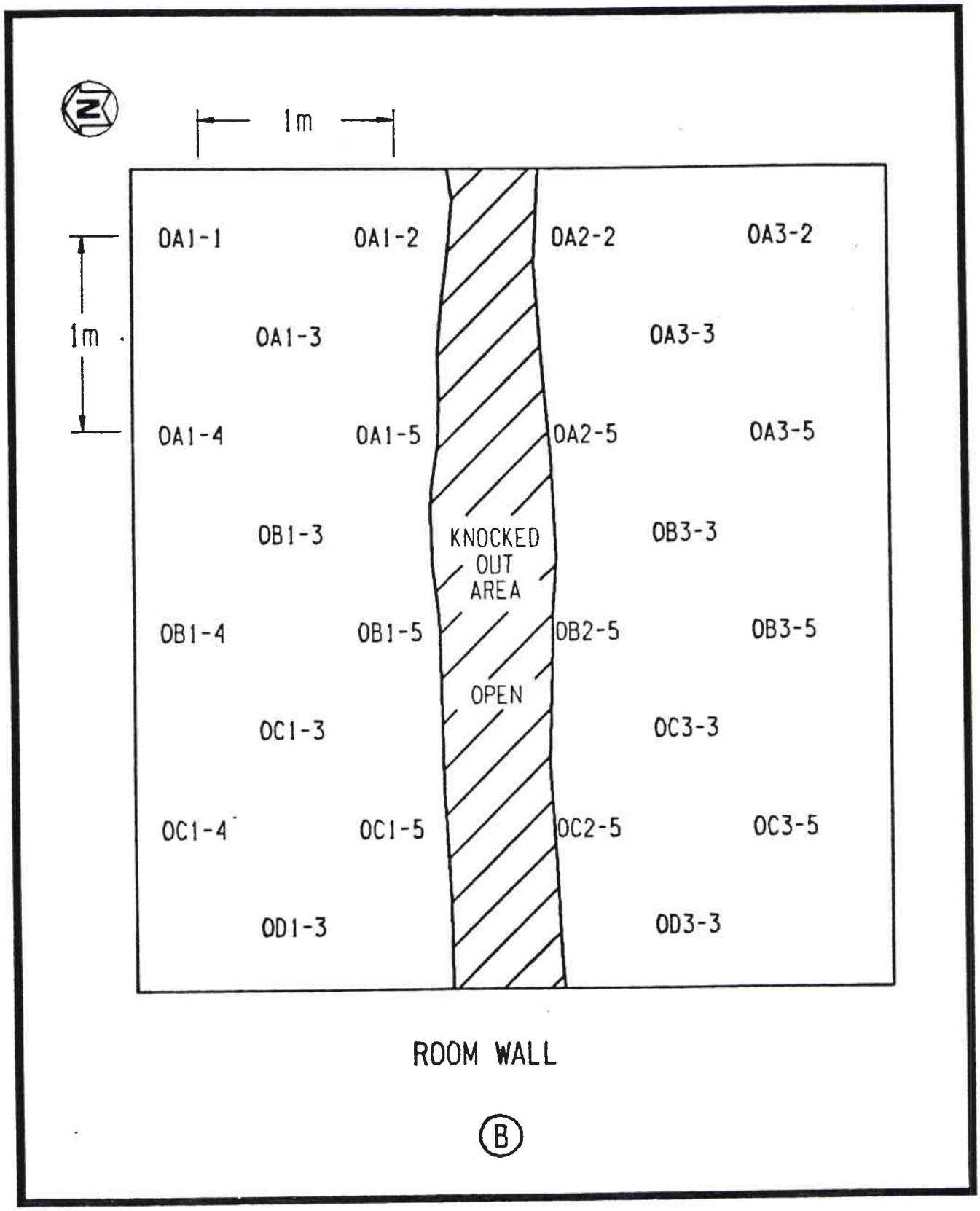


FIGURE 4-8 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE B OF DUCT 26

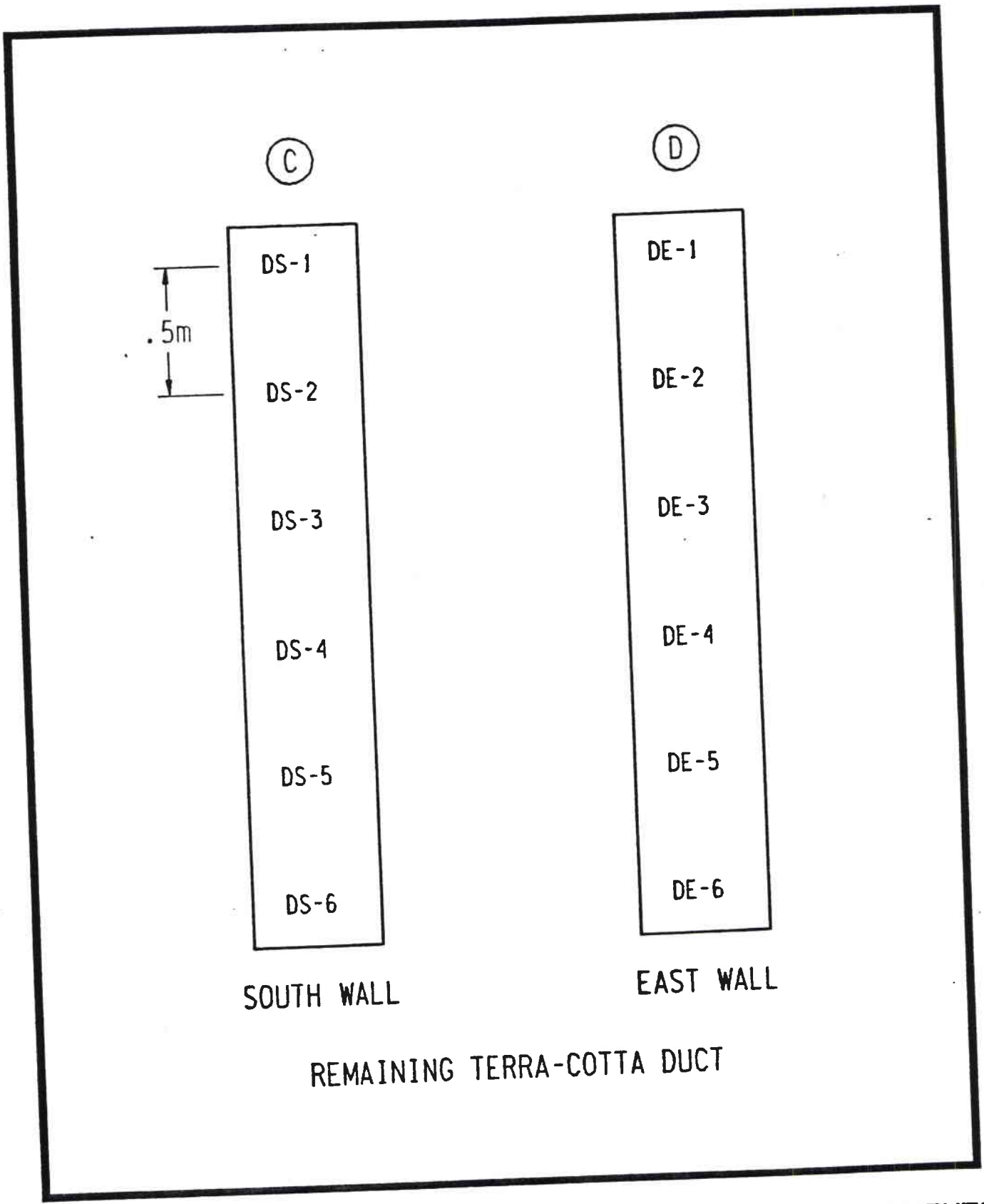


FIGURE 4-9 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACES C AND D OF DUCT 26

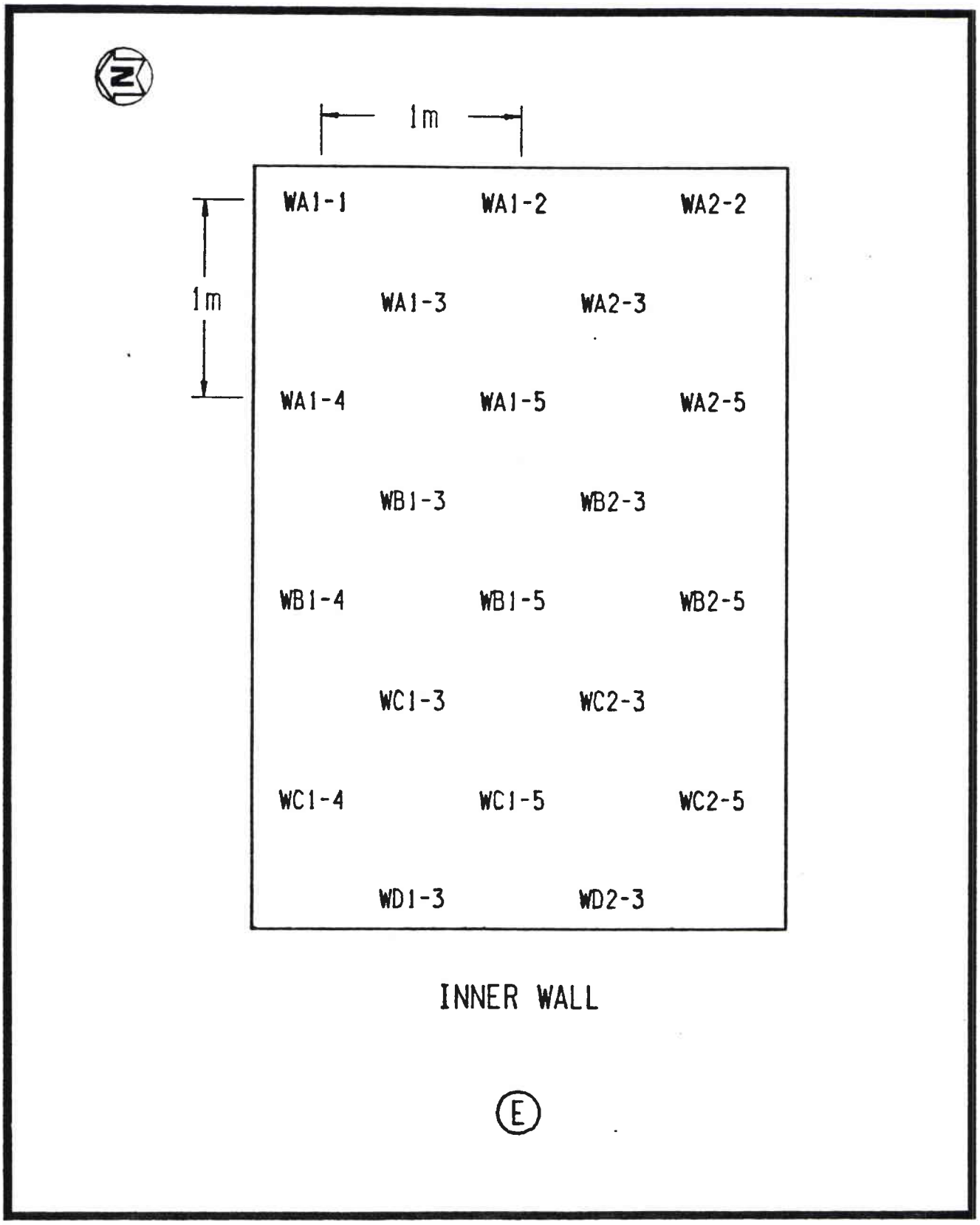


FIGURE 4-10 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE E OF DUCT 26

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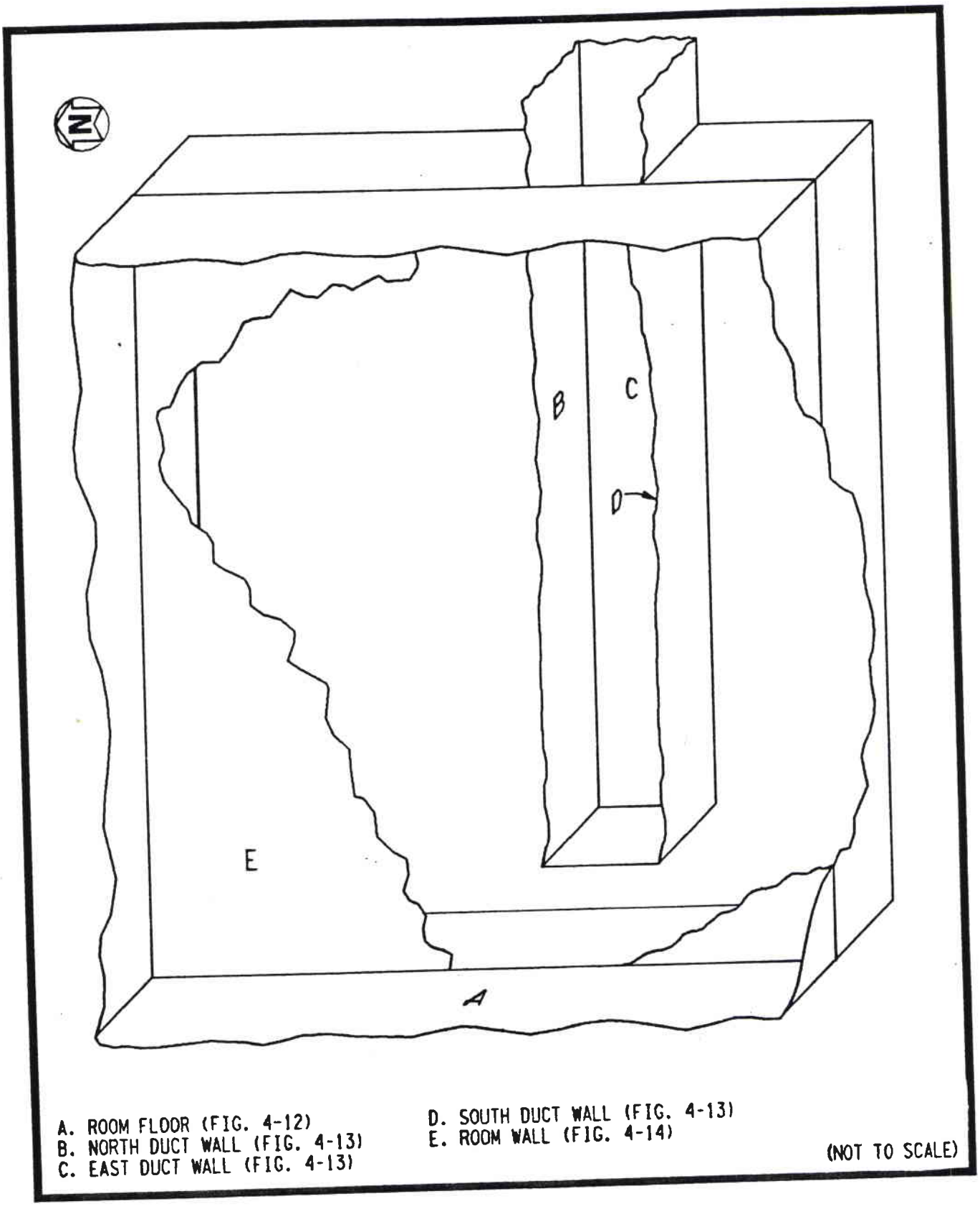


FIGURE 4-11 SURFACES OF DUCT 29 WHERE POST-REMEDIAL ACTION MEASUREMENTS WERE TAKEN

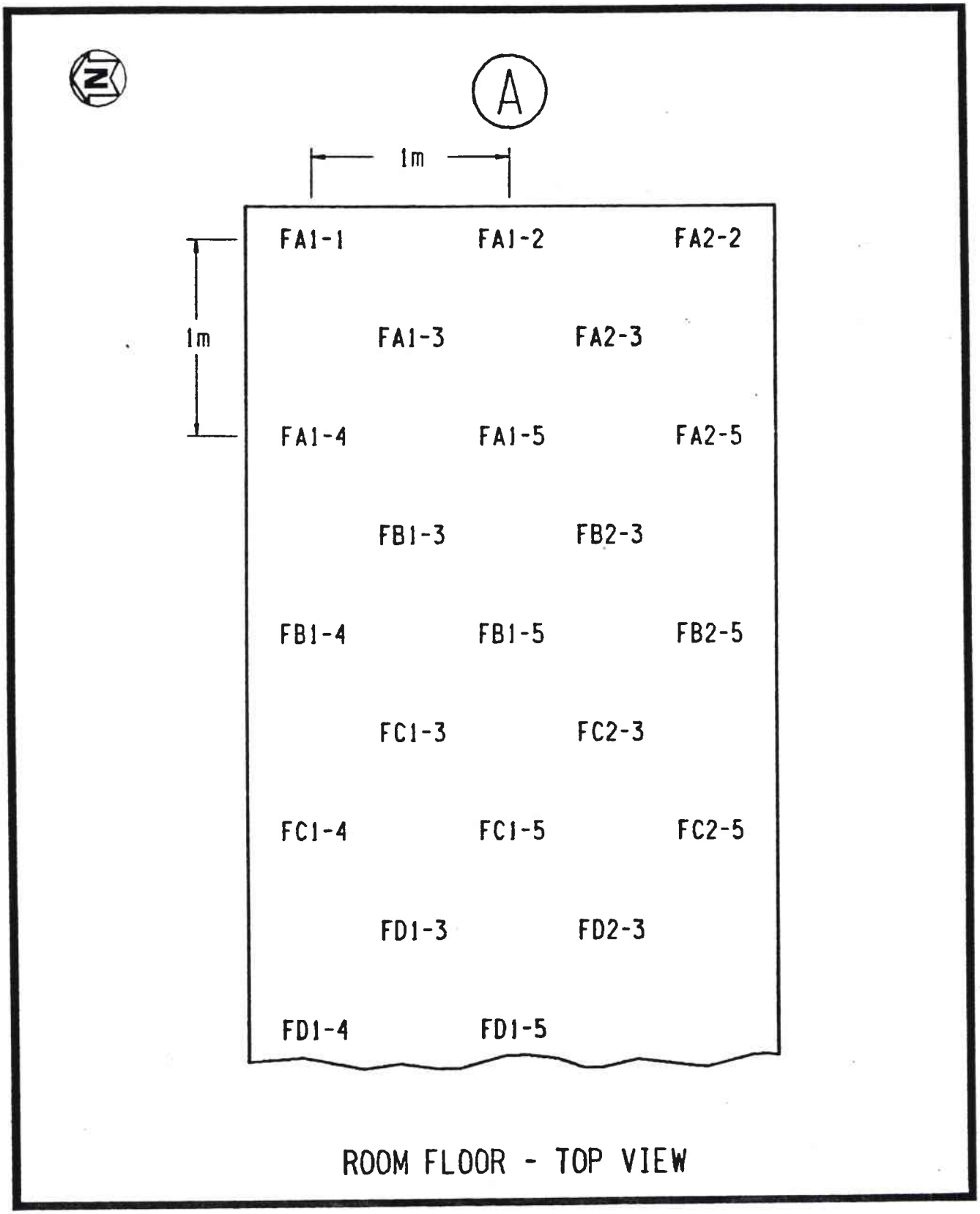


FIGURE 4-12 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE A OF DUCT 29

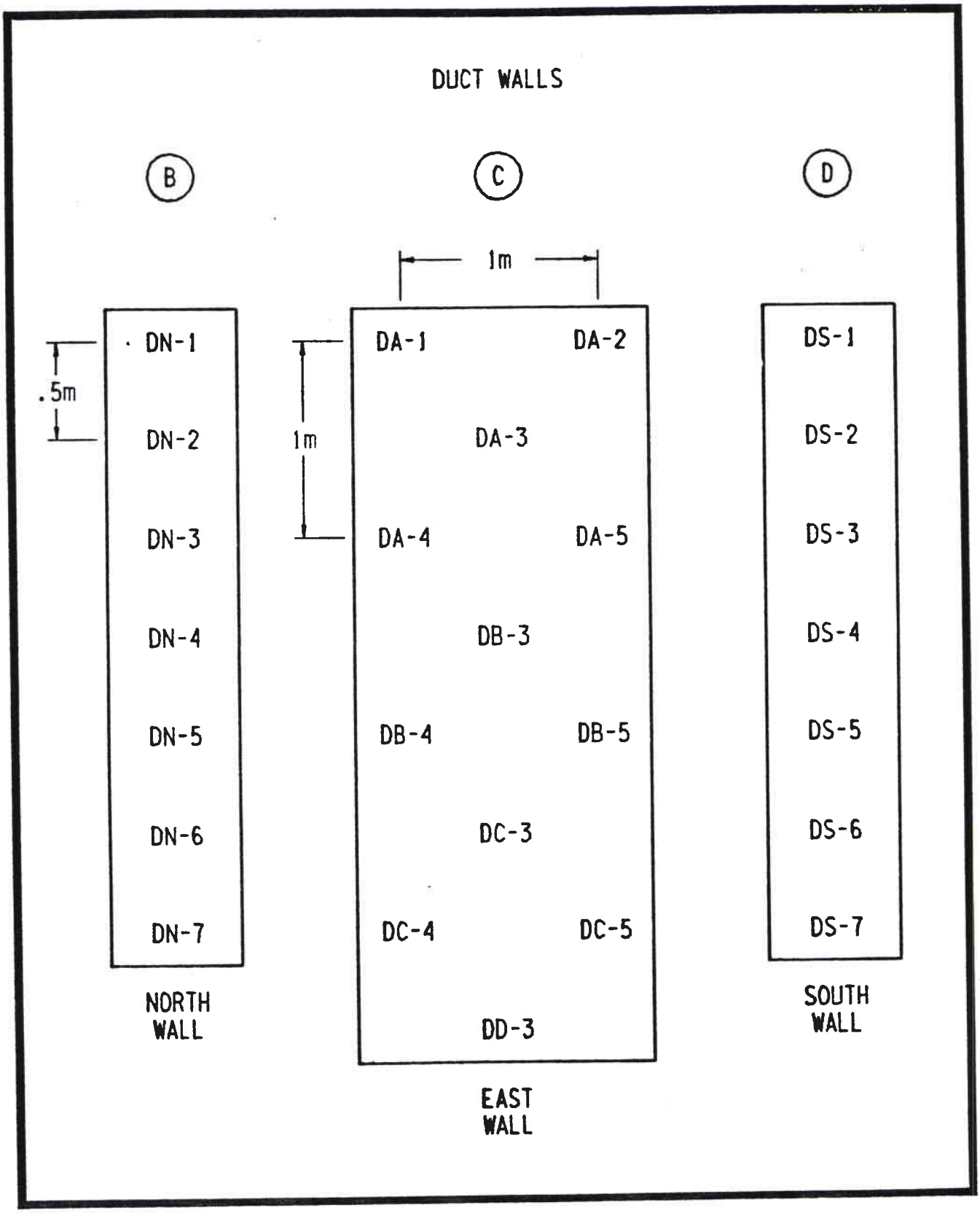


FIGURE 4-13 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACES B, C, D, AND E OF DUCT 29

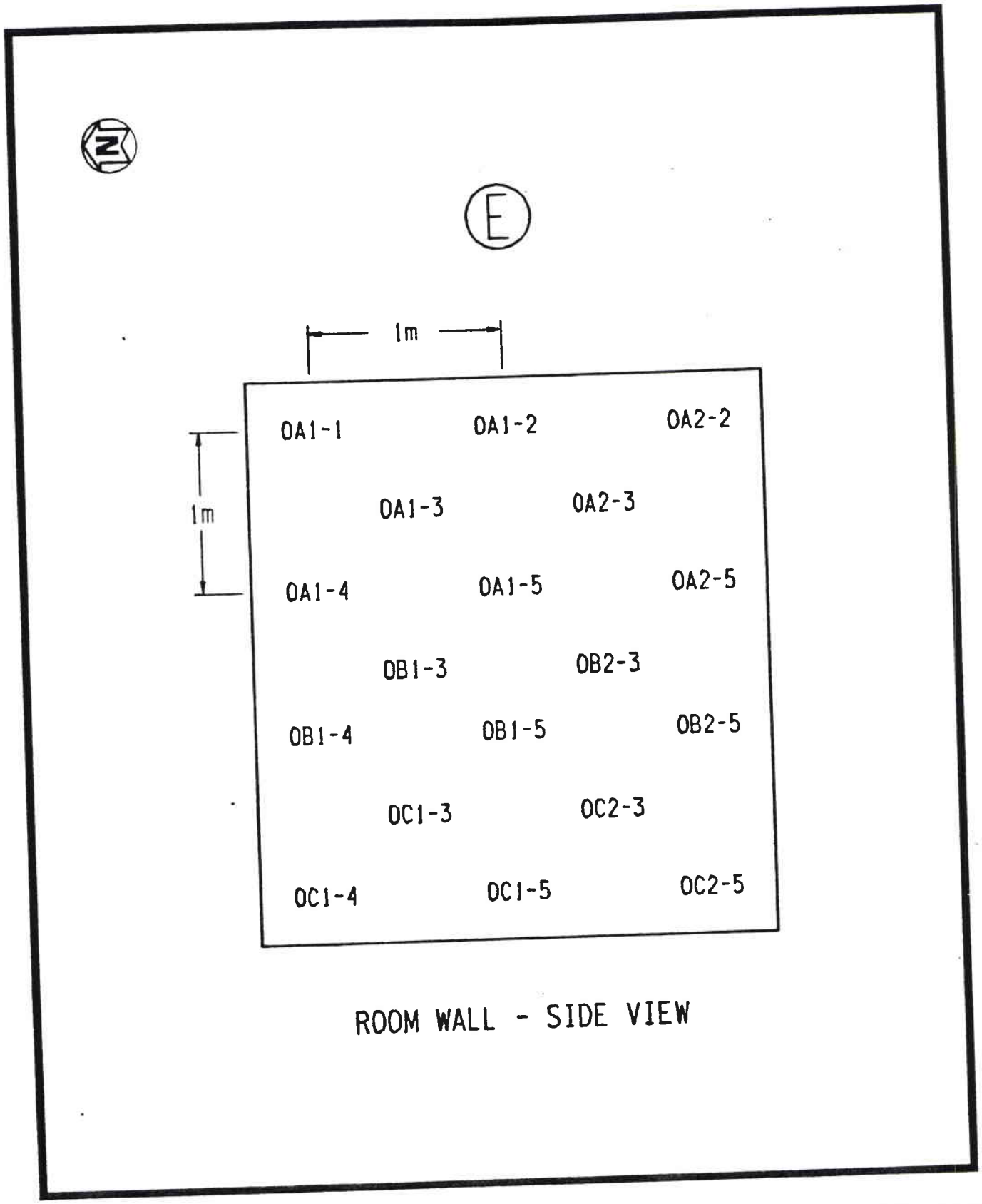


FIGURE 4-14 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE F OF DUCT 29

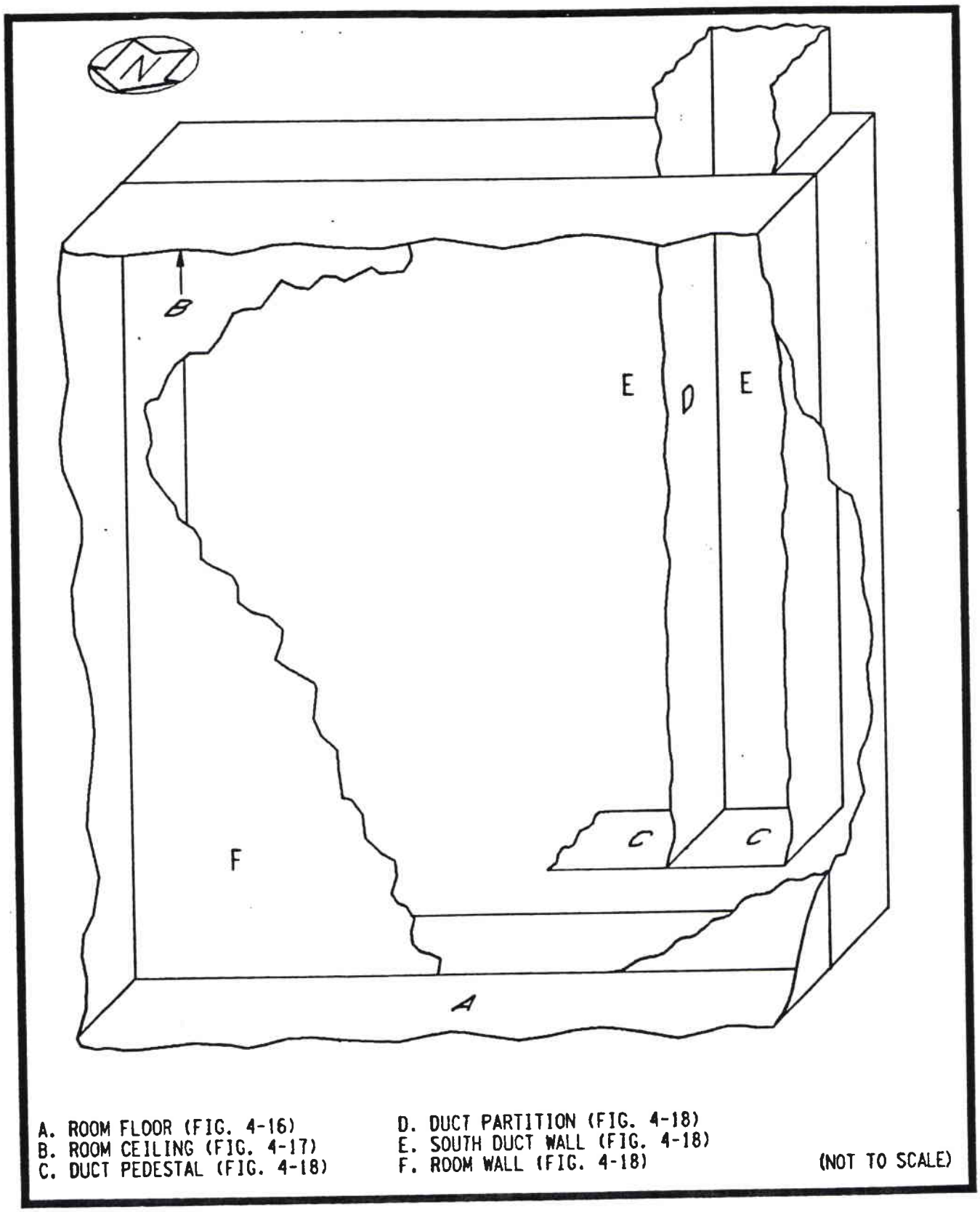


FIGURE 4-15 SURFACES OF DUCT 64 WHERE POST-REMEDIAL ACTION MEASUREMENTS WERE TAKEN (FIRST FLOOR)

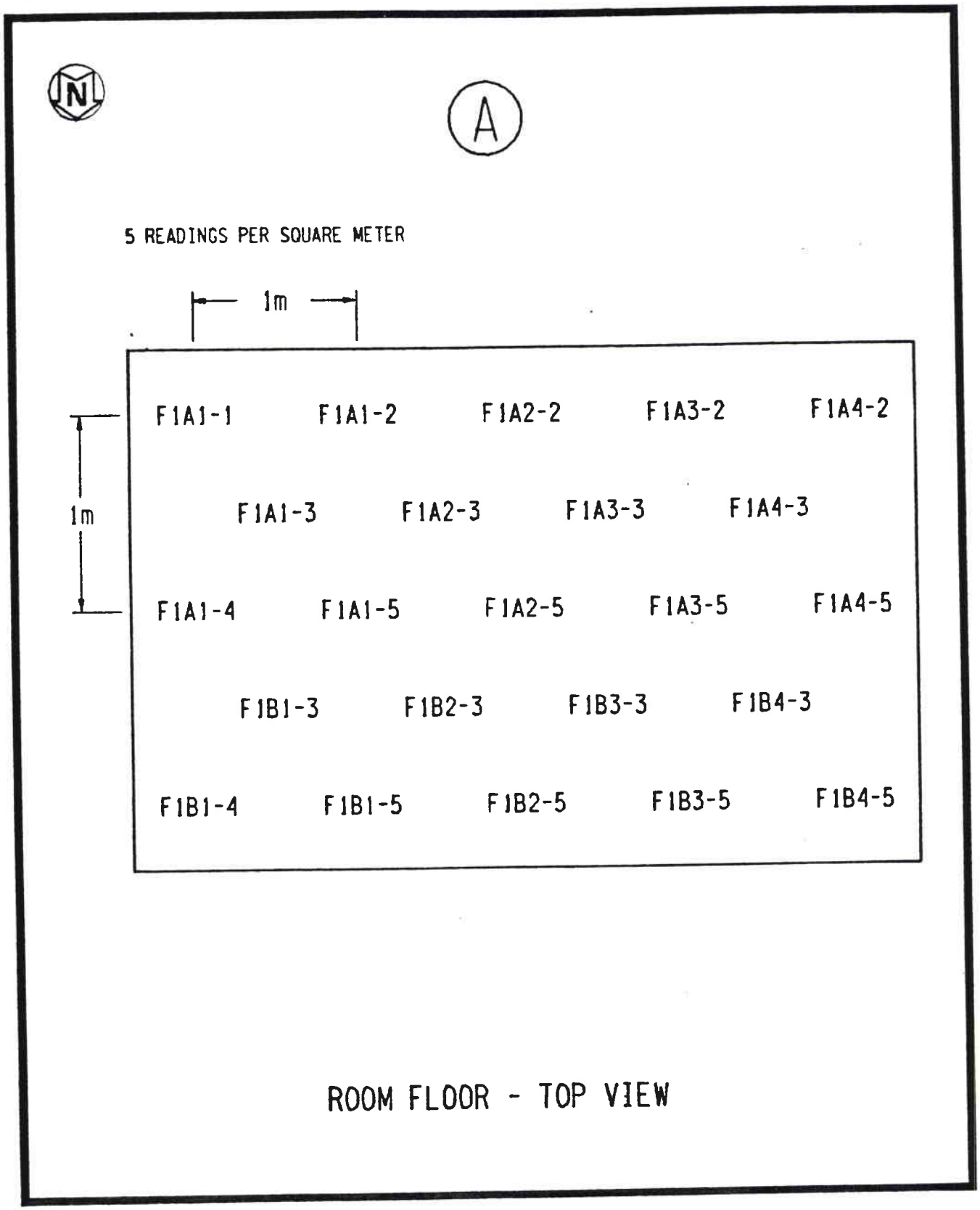


FIGURE 4-16 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE A OF DUCT 64 (FIRST FLOOR)

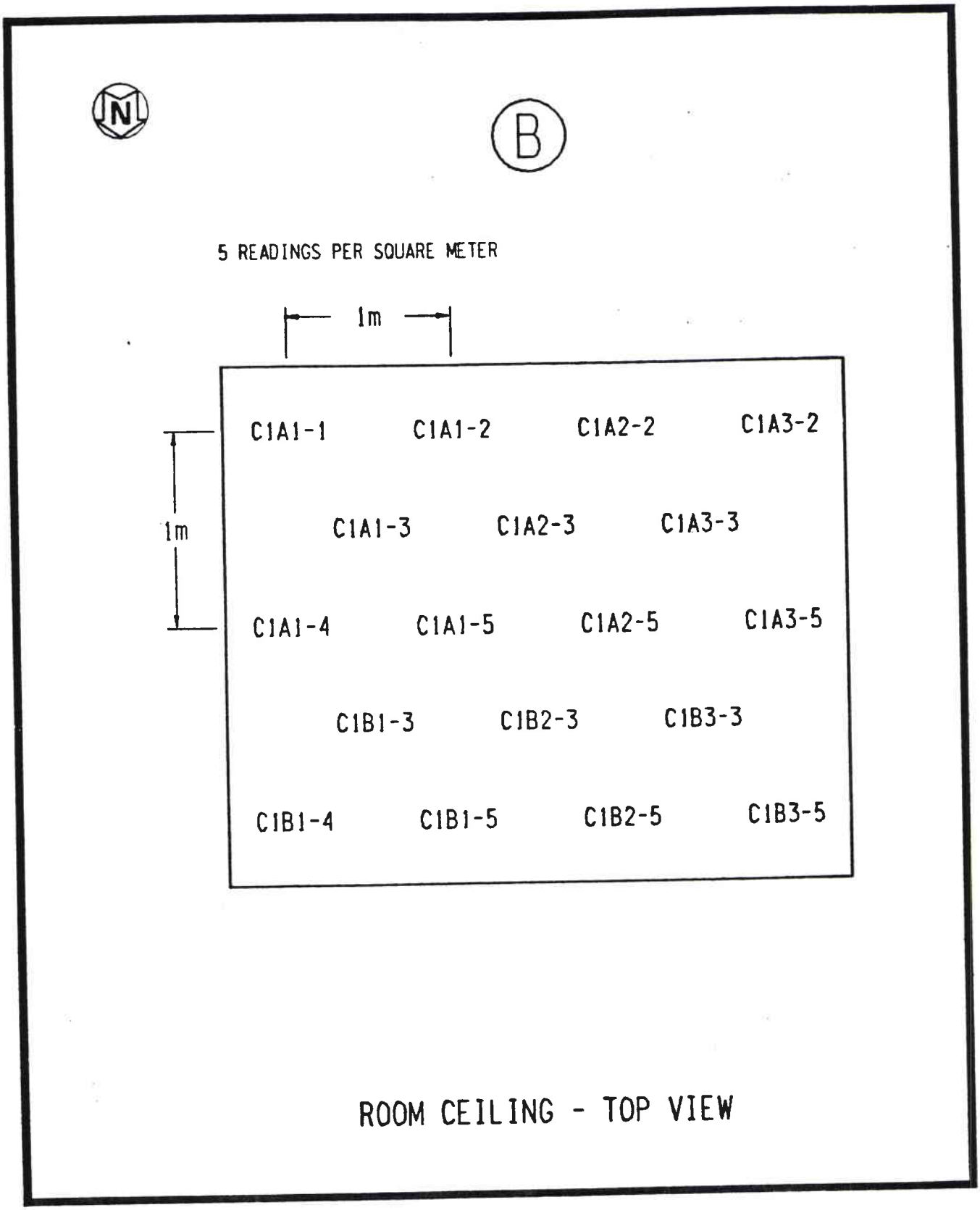


FIGURE 4-17 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE B OF DUCT 64 (FIRST FLOOR)

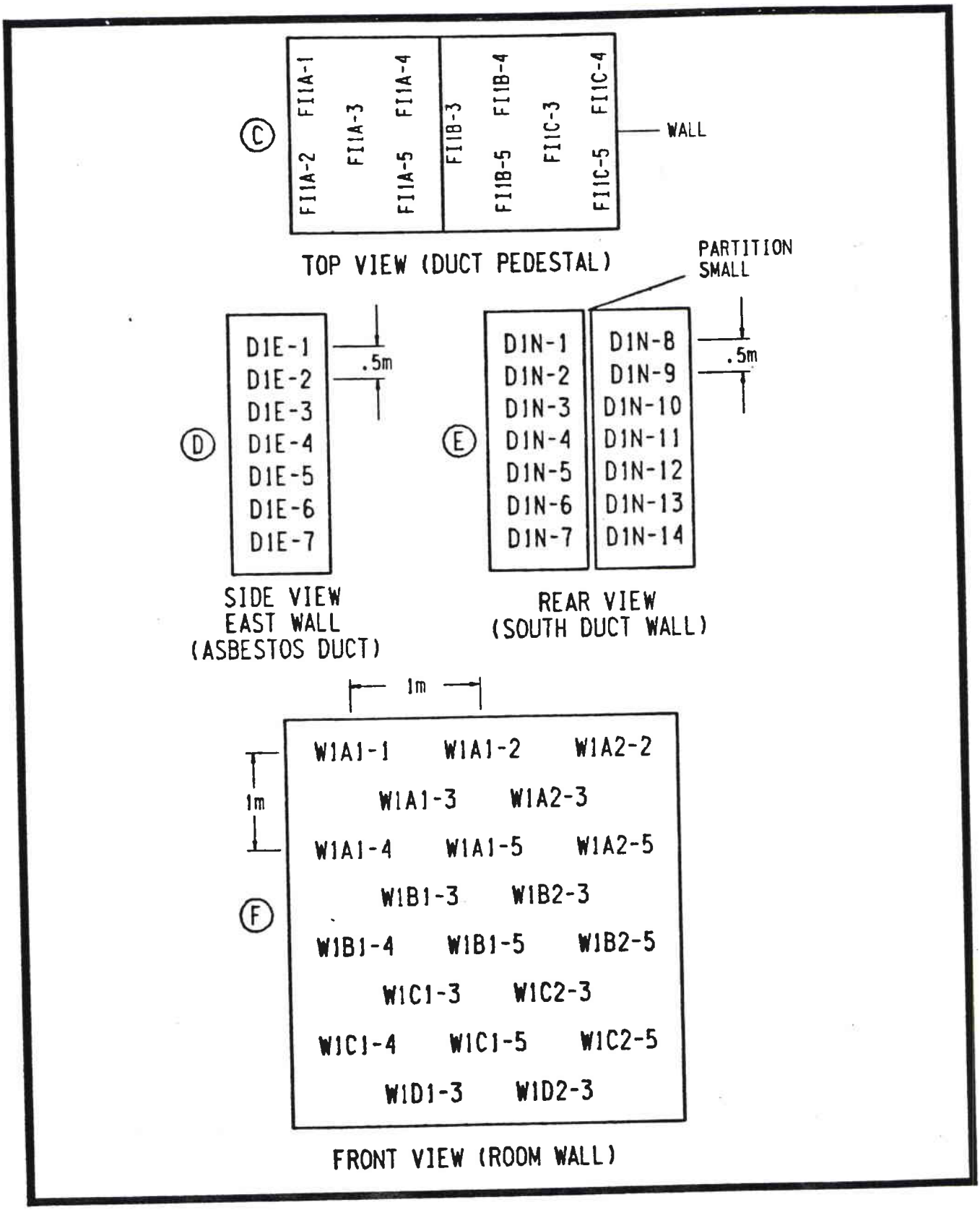
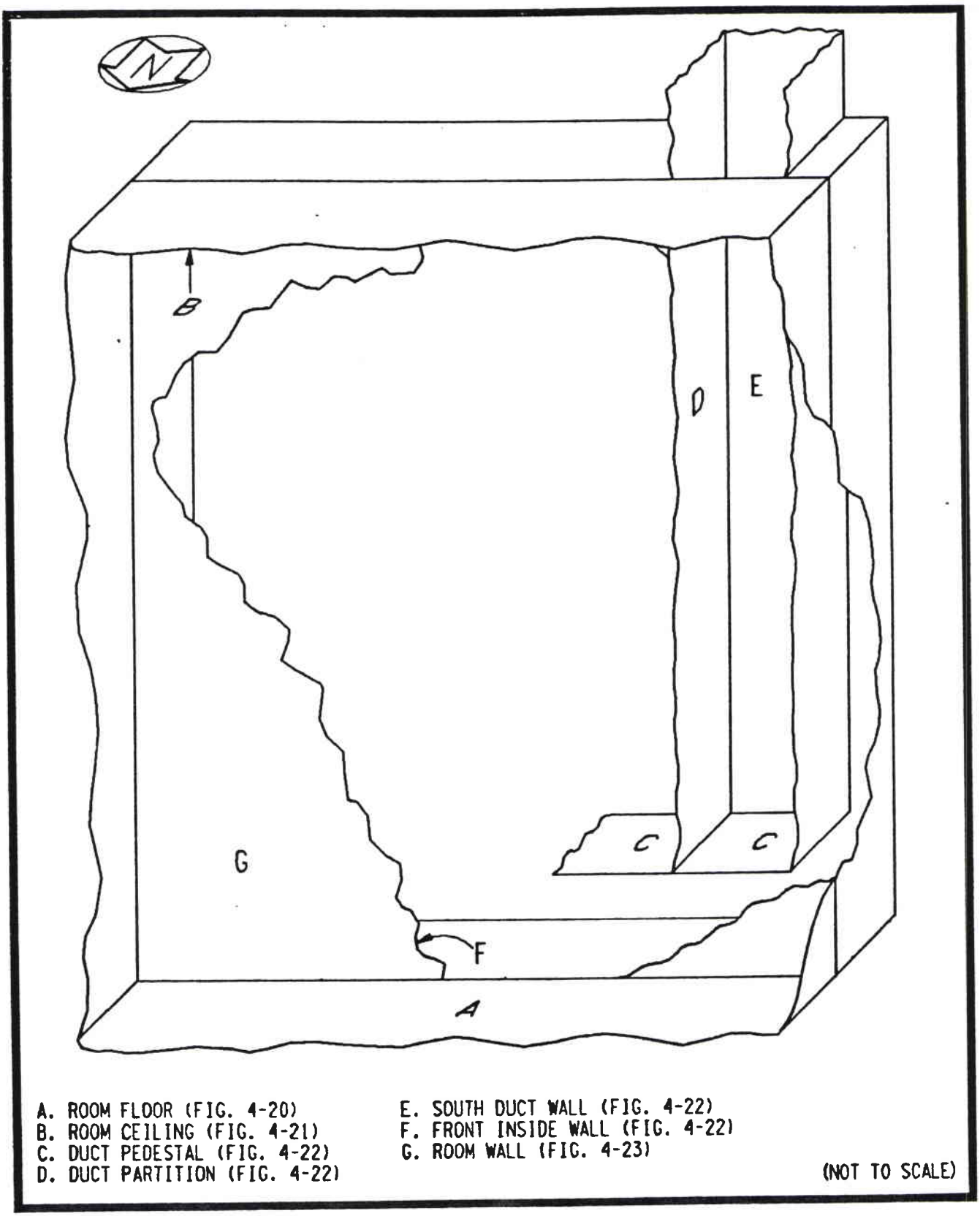


FIGURE 4-18 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACES C, D, E, AND F OF DUCT 64 (FIRST FLOOR)



A. ROOM FLOOR (FIG. 4-20)
B. ROOM CEILING (FIG. 4-21)
C. DUCT PEDESTAL (FIG. 4-22)
D. DUCT PARTITION (FIG. 4-22)
E. SOUTH DUCT WALL (FIG. 4-22)
F. FRONT INSIDE WALL (FIG. 4-22)
G. ROOM WALL (FIG. 4-23)

(NOT TO SCALE)

FIGURE 4-19 SURFACES OF DUCT 64 WHERE POST-REMEDIAL ACTION MEASUREMENTS WERE TAKEN (SECOND FLOOR)

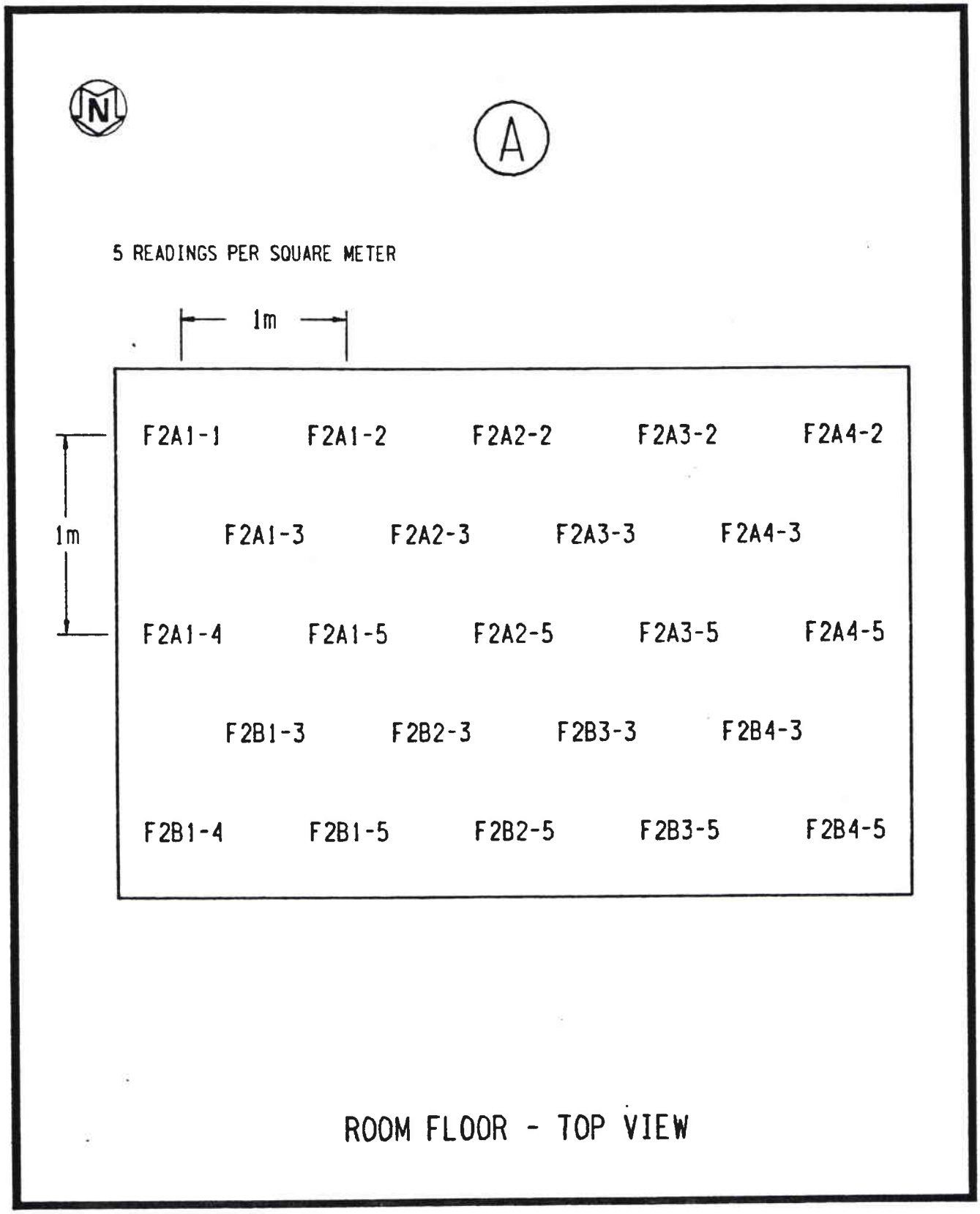


FIGURE 4-20 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE A OF DUCT 64 (SECOND FLOOR)

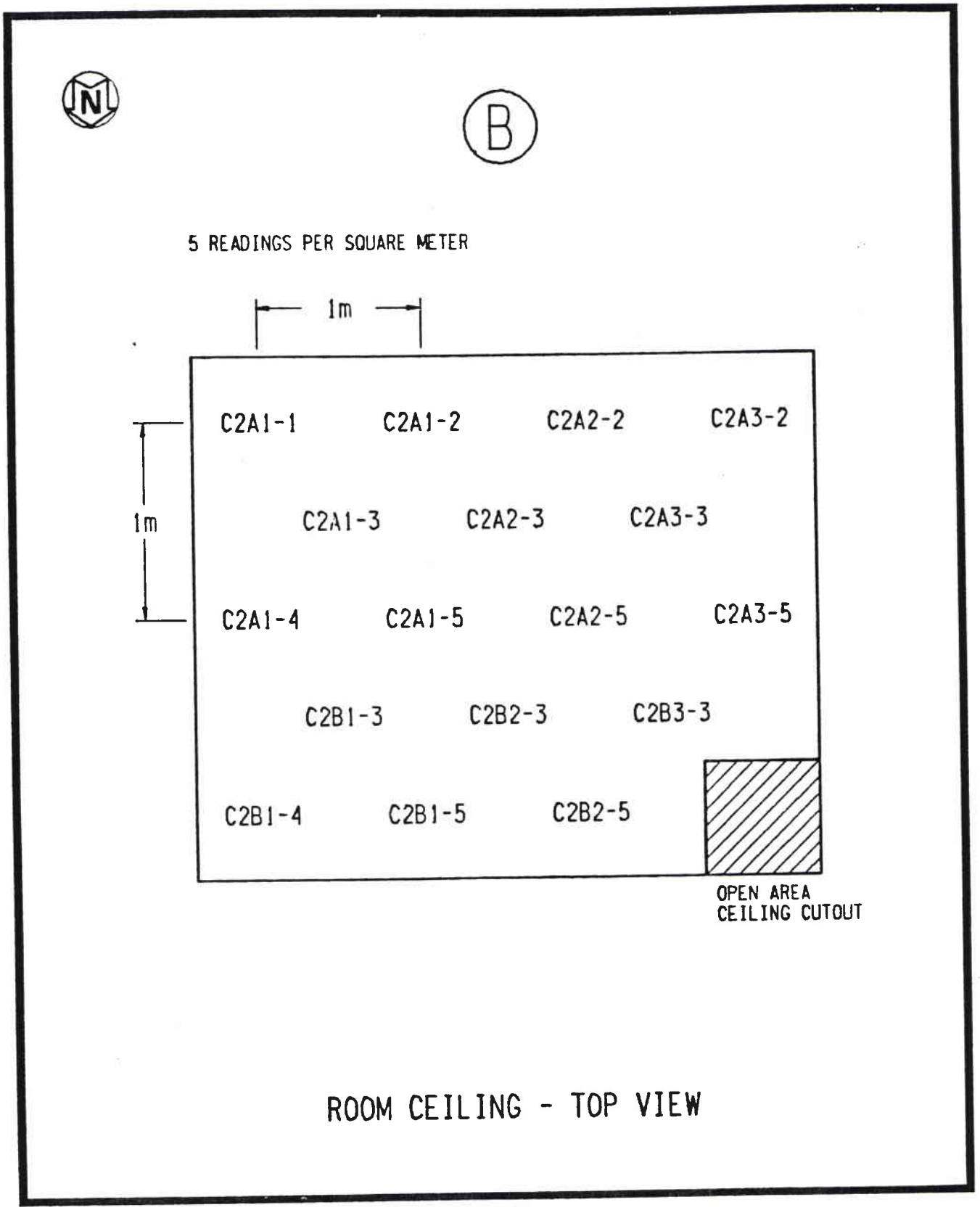


FIGURE 4-21 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE B OF DUCT 64 (SECOND FLOOR)

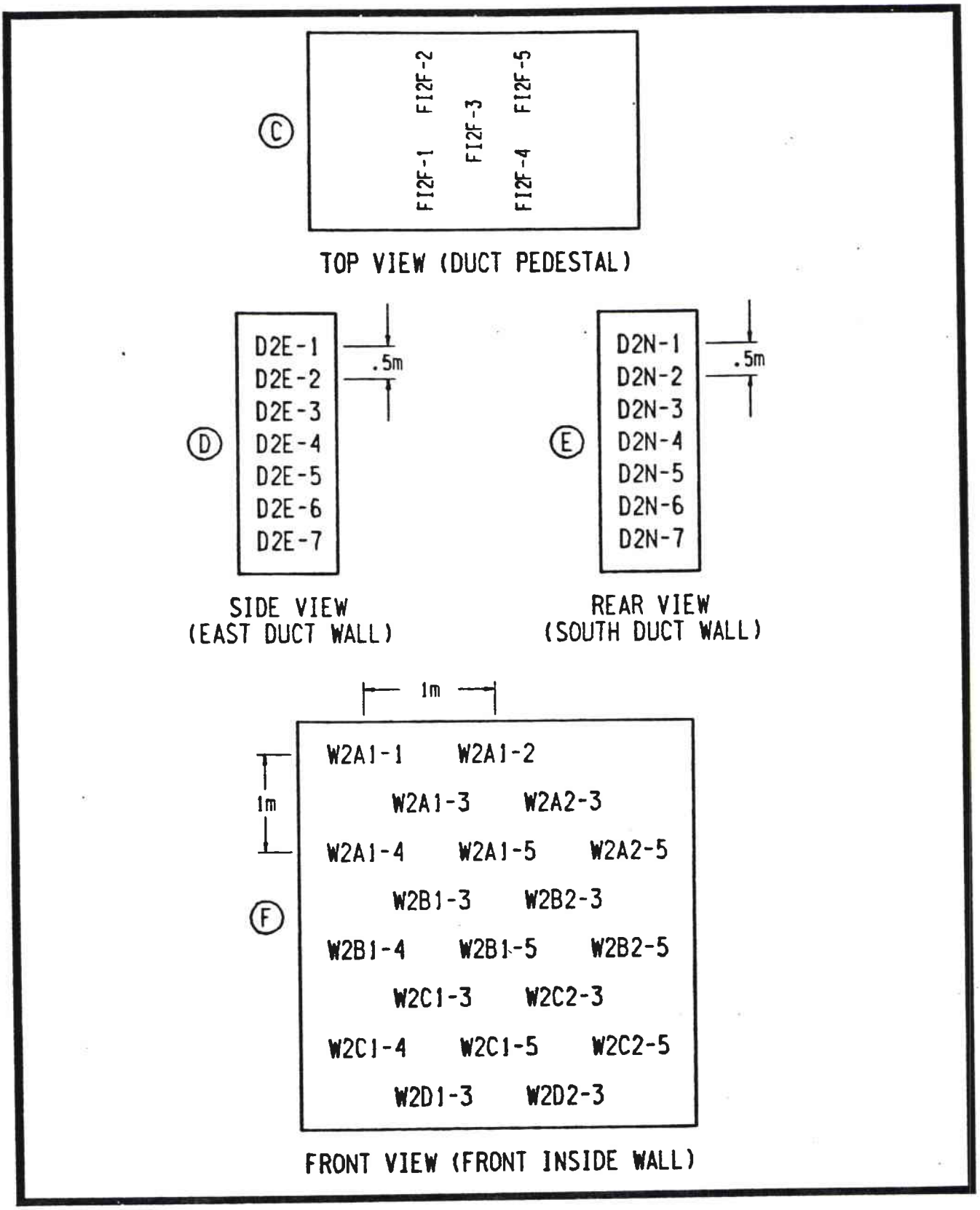


FIGURE 4-22 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACES C, D, E, AND F OF DUCT 64 (SECOND FLOOR)

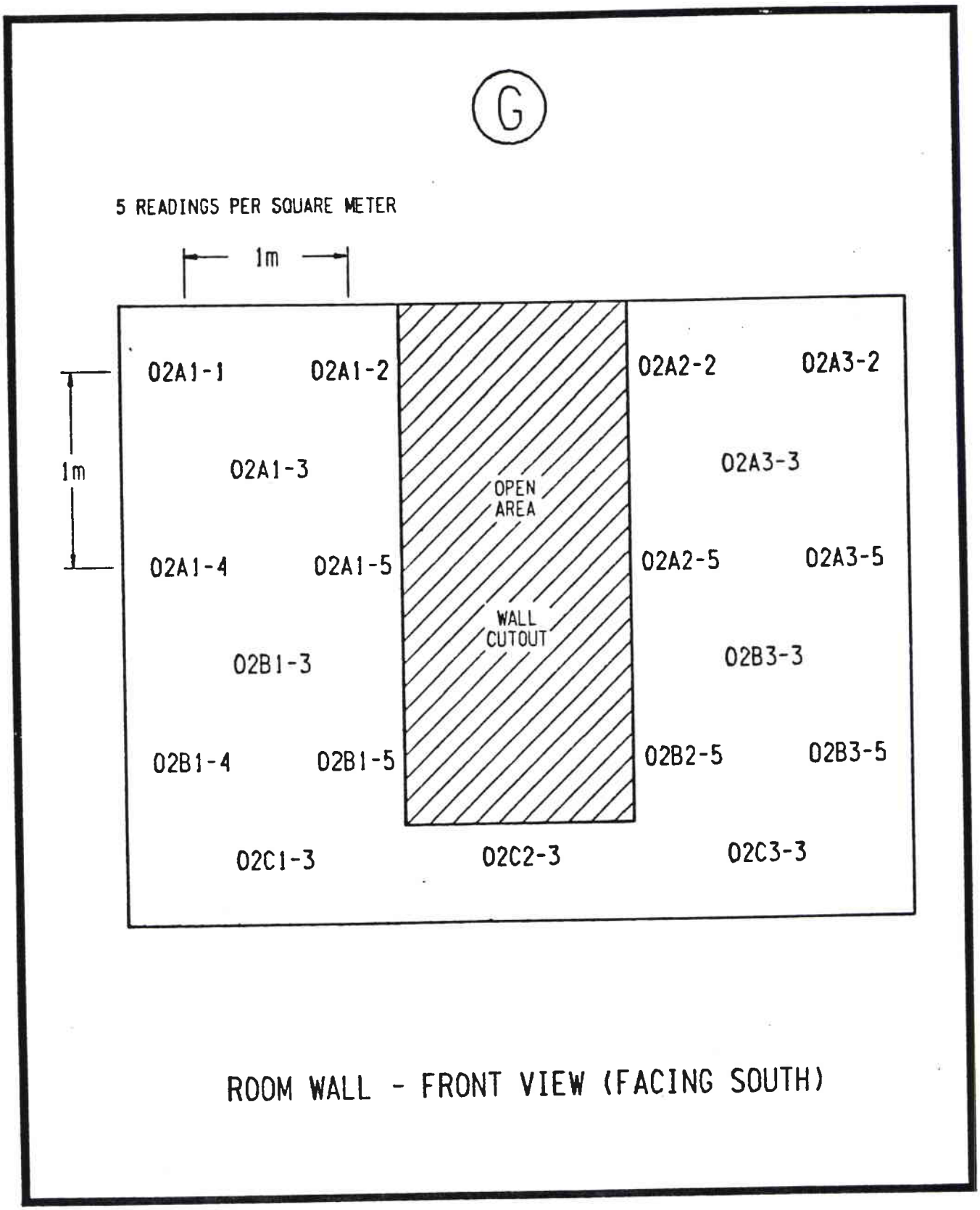


FIGURE 4-23 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE G OF DUCT 64 (SECOND FLOOR)

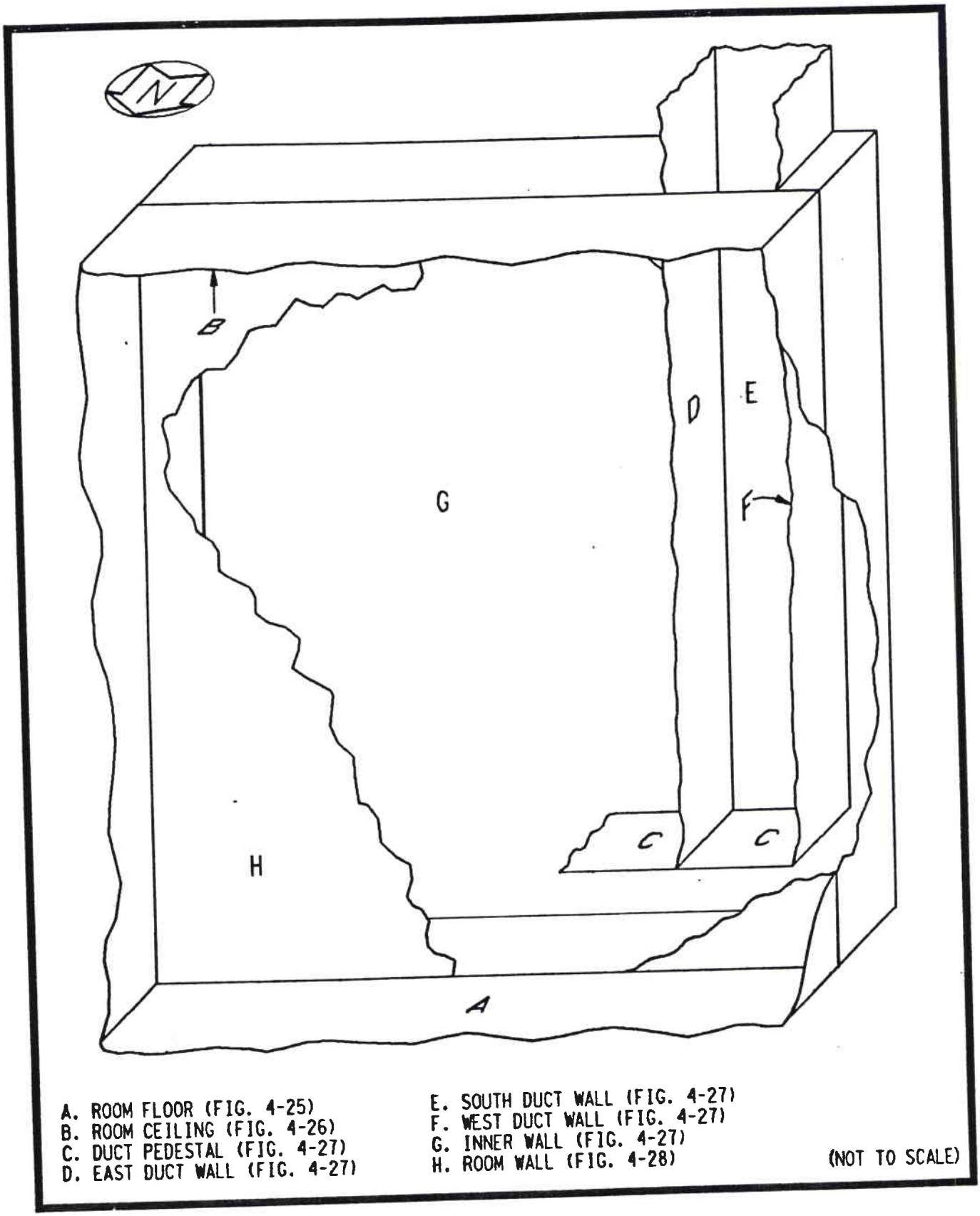


FIGURE 4-24 SURFACES OF DUCT 64 WHERE POST-REMEDIAL MEASUREMENTS WERE TAKEN (THIRD FLOOR)

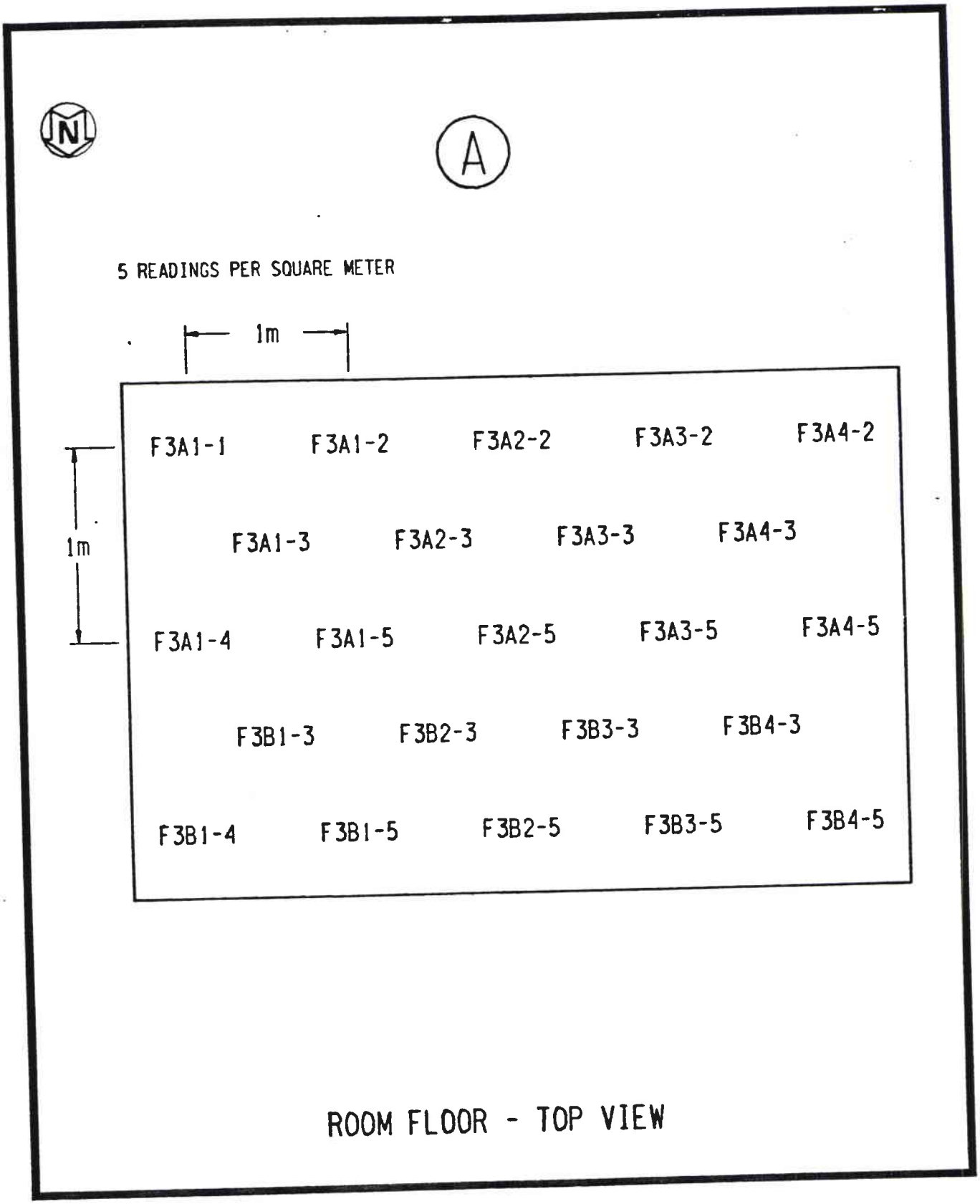


FIGURE 4-25 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE A OF DUCT 64 (THIRD FLOOR)

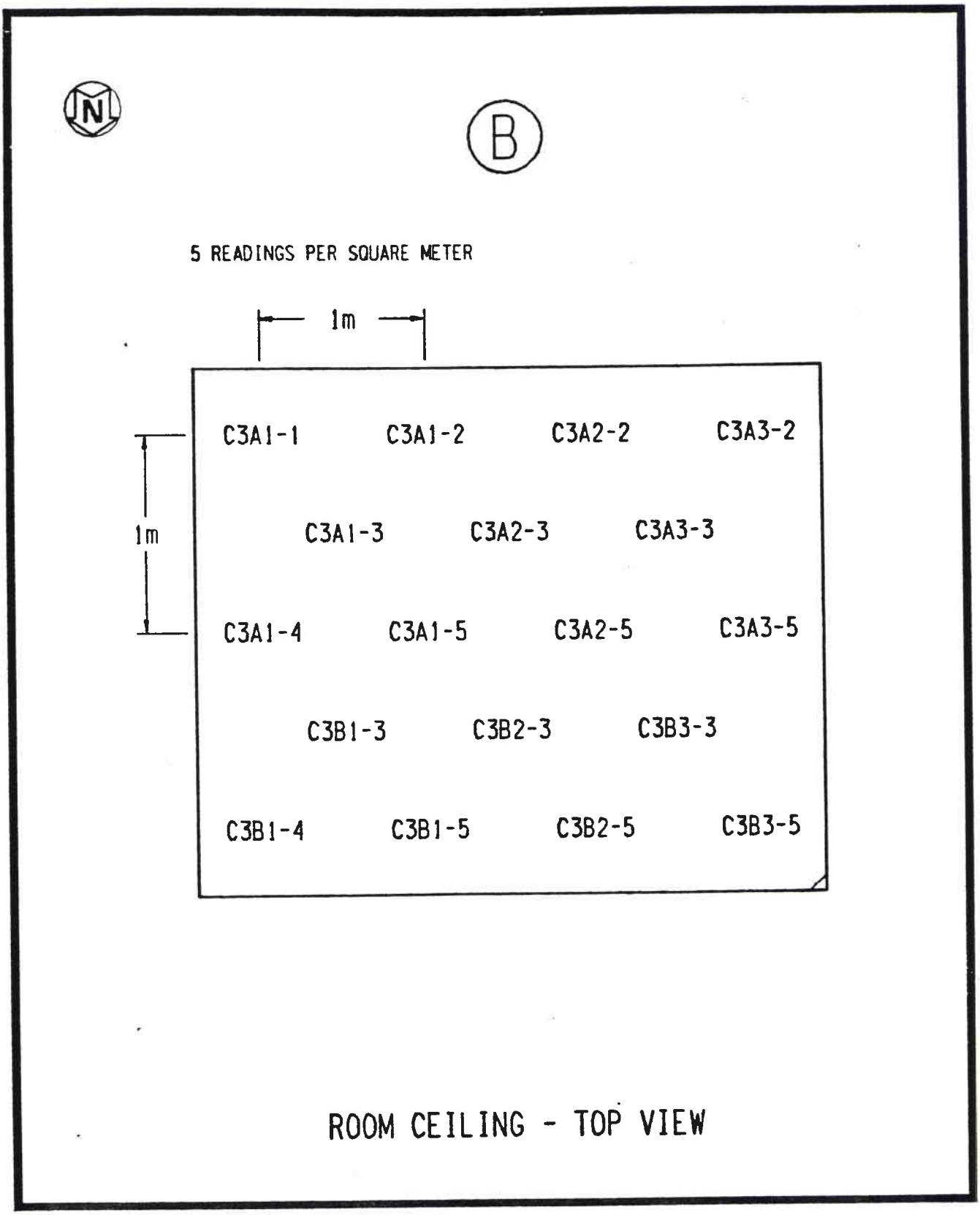


FIGURE 4-26 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE B OF DUCT 64 (THIRD FLOOR)

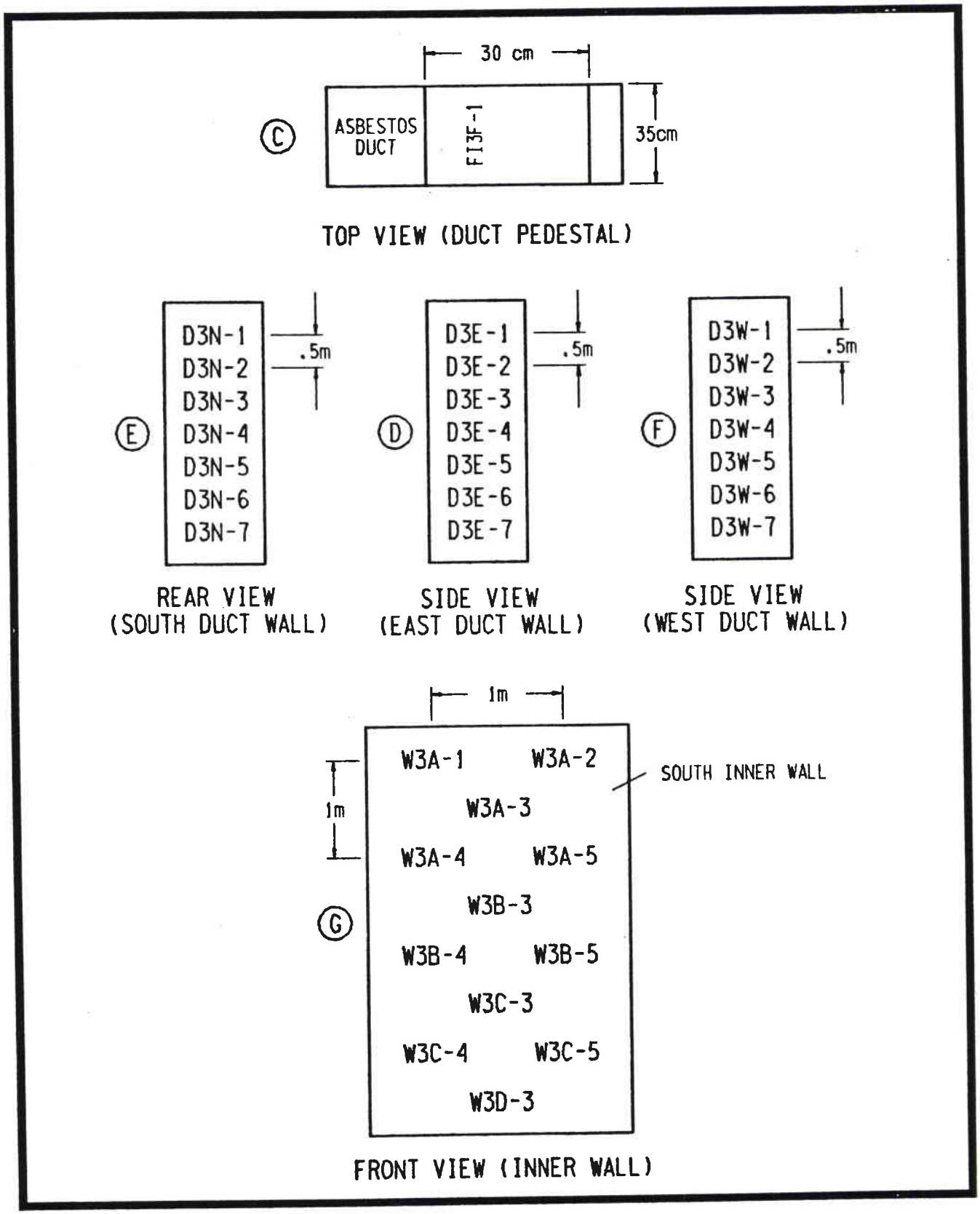


FIGURE 4-27 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACES C, D, E, F, AND G OF DUCT 64 (THIRD FLOOR)

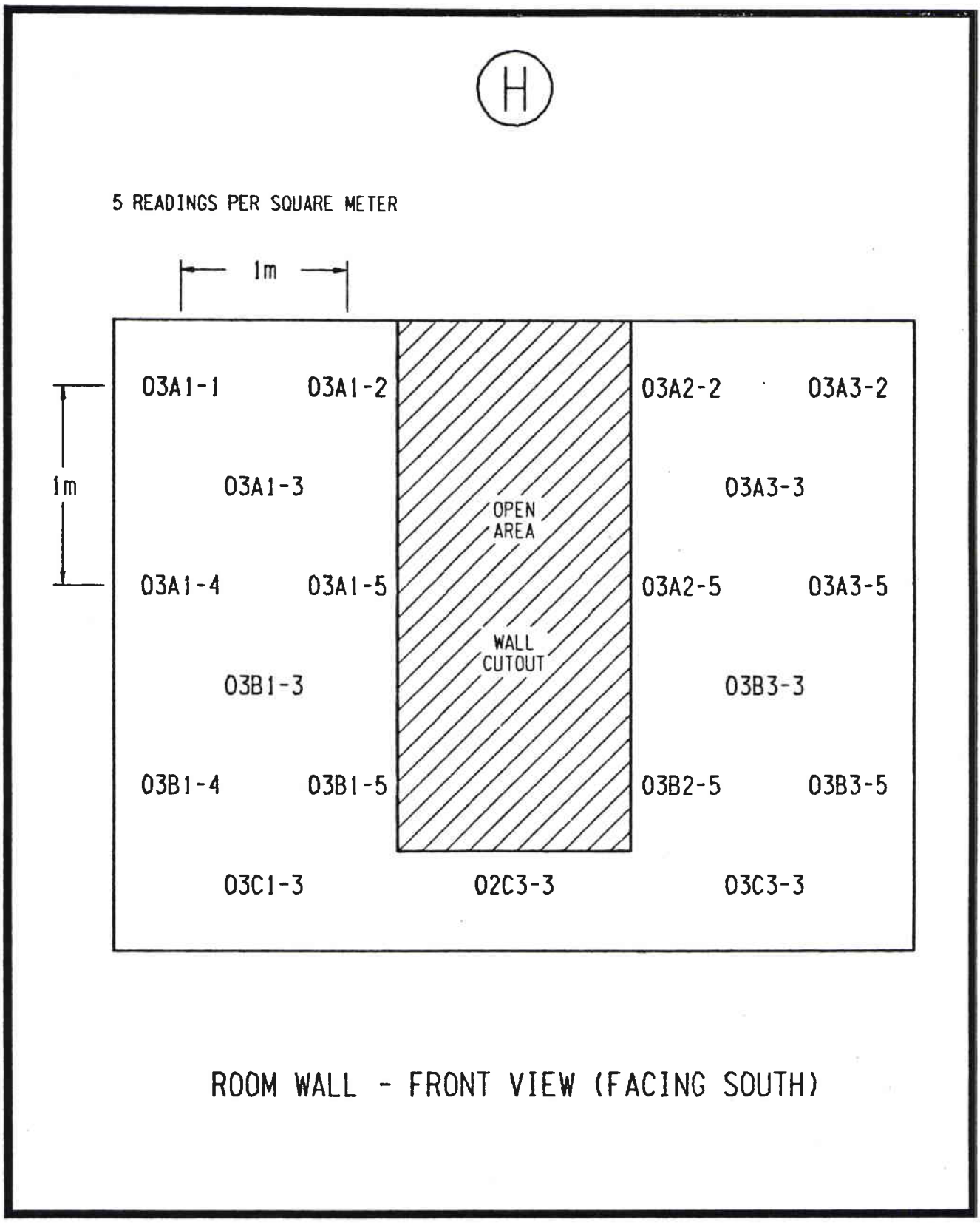


FIGURE 4-28 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON SURFACE H OF DUCT 64 (THIRD FLOOR)

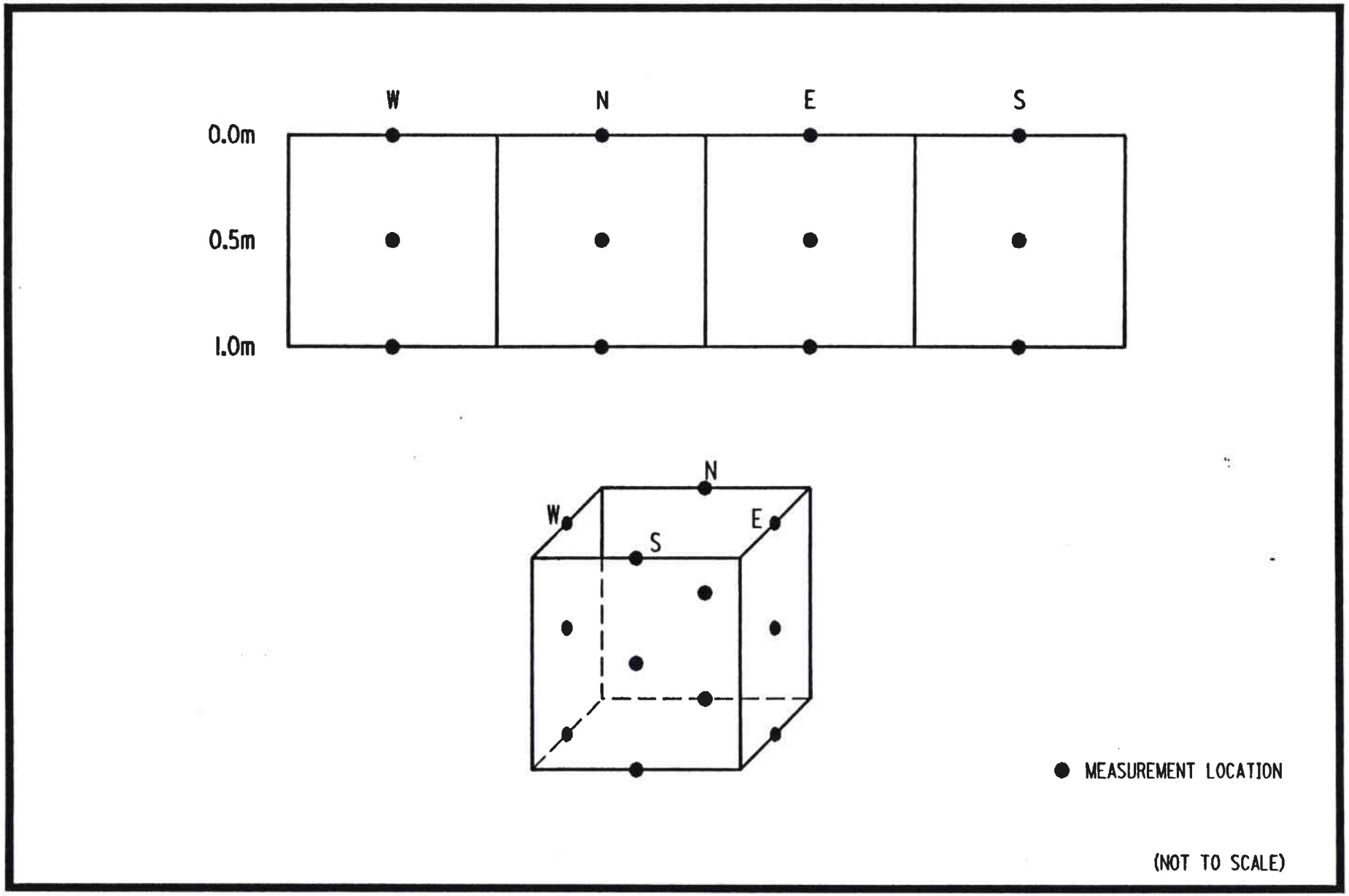


FIGURE 4-29 TYPICAL LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS IN THE CHIMNEYS

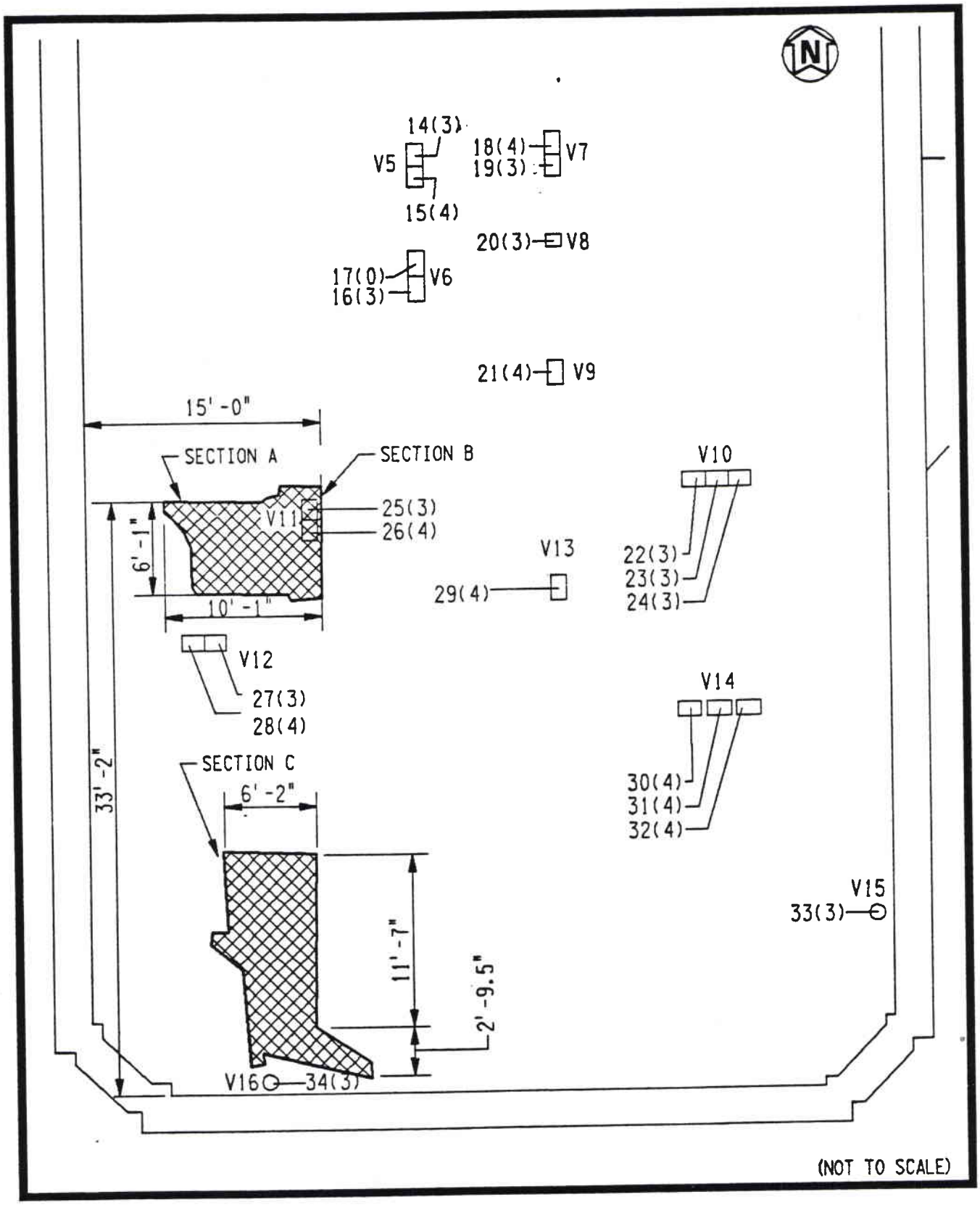


FIGURE 4-30 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS ON THE FLOOR (FIFTH FLOOR)

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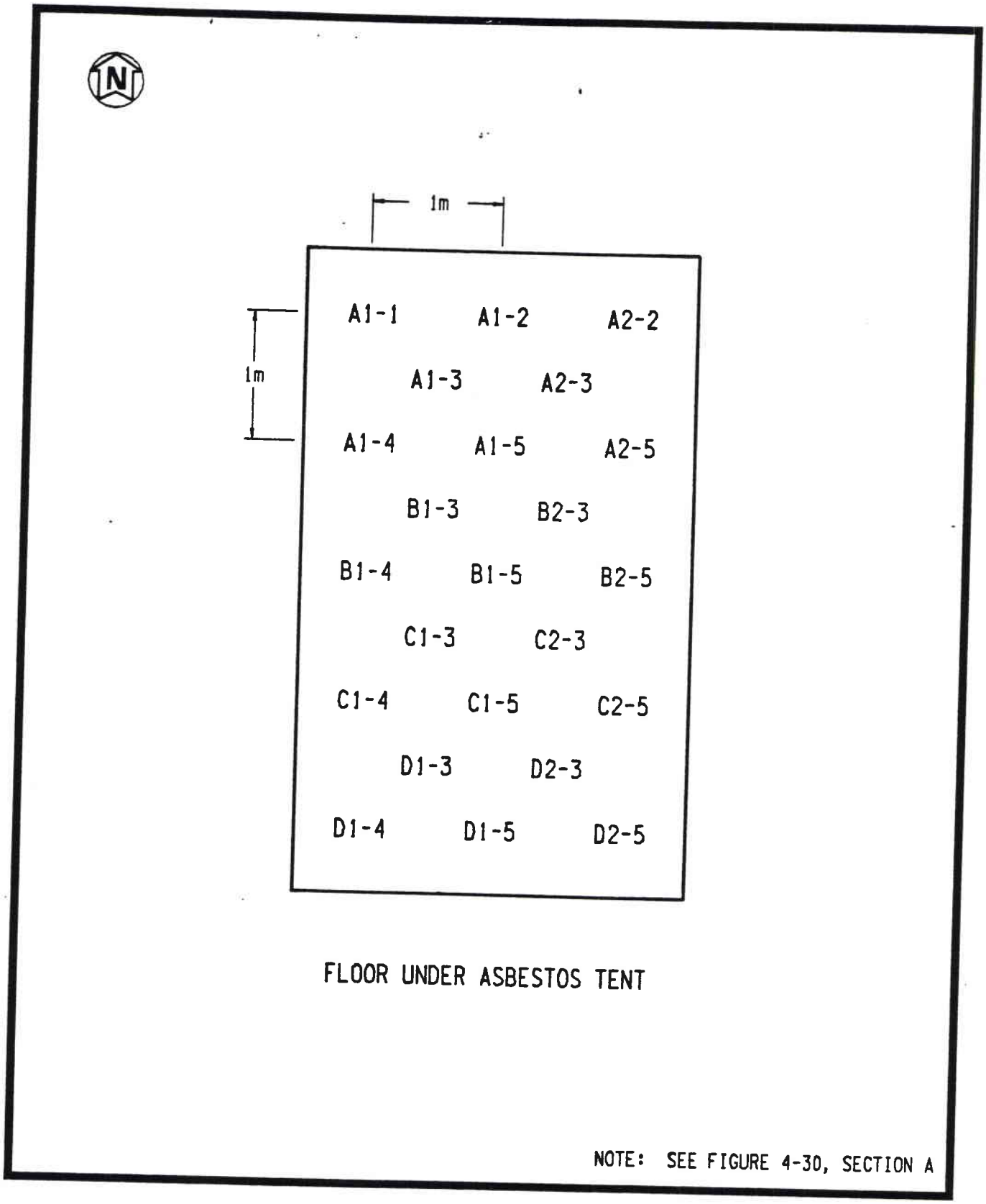

FIGURE 4-31 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS IN THE FIFTH-FLOOR ATTIC, SECTION A

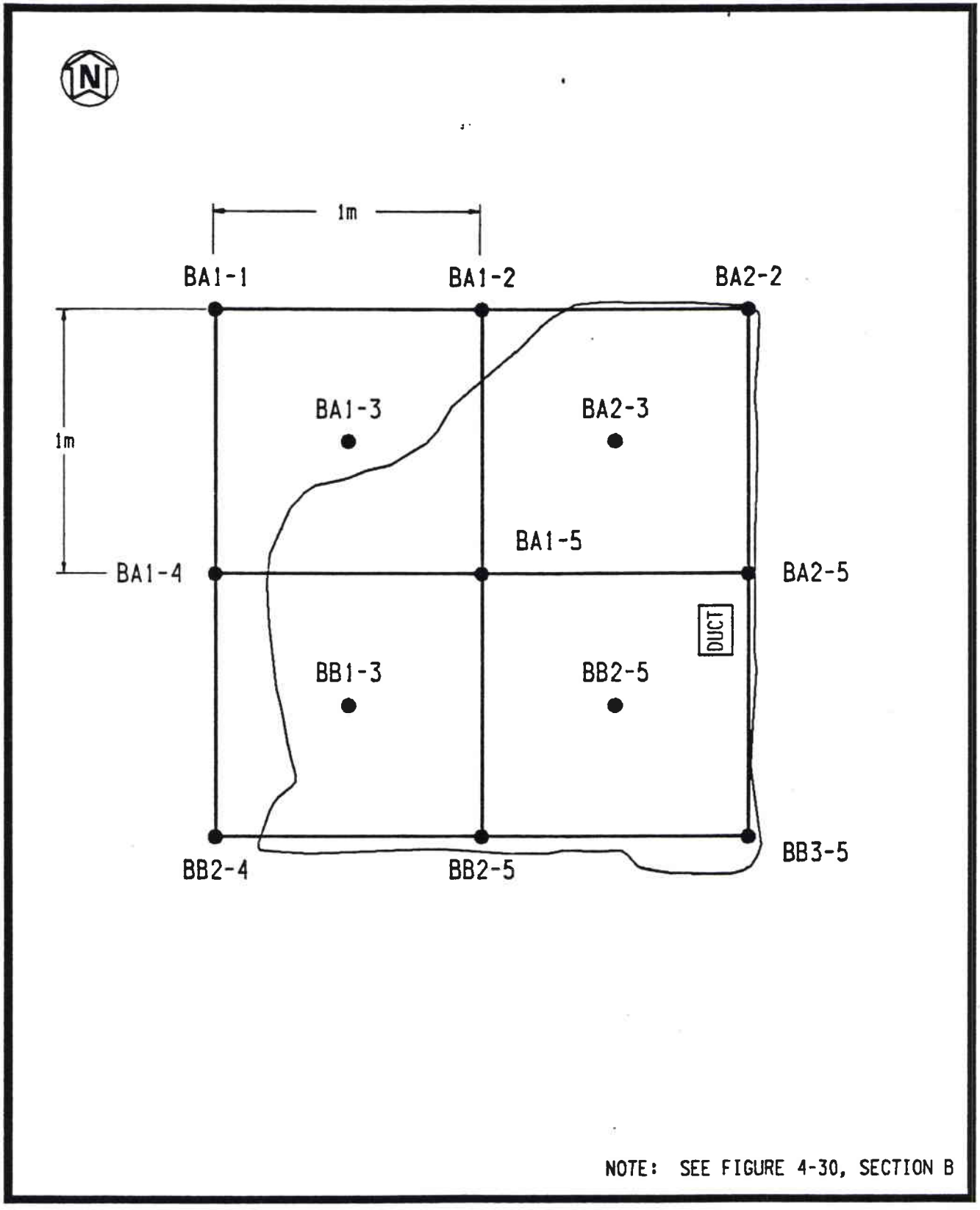

FIGURE 4-32 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS IN THE FIFTH-FLOOR ATTIC, SECTION B

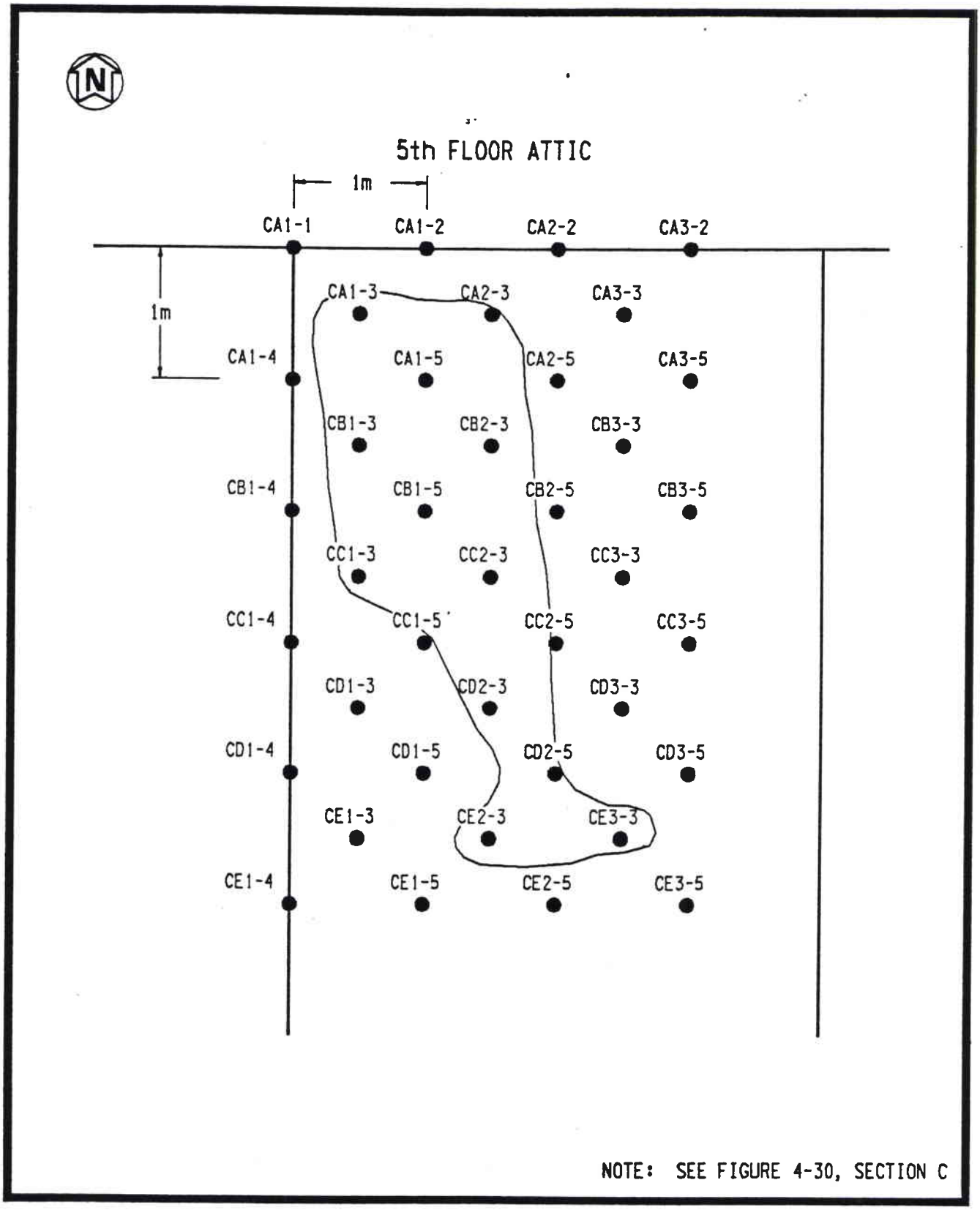

FIGURE 4-33 LOCATIONS OF POST-REMEDIAL ACTION MEASUREMENTS IN THE FIFTH-FLOOR ATTIC, SECTION C

TABLE 4-1

DIRECT POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 10

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
FA1-1[a]	<29	<0.01
FA1-2	<29	<0.01
FA1-3	<29	<0.01
FA1-4	<41	<0.01
FA1-5	<66	<0.01
FA2-2	62 ± 56	<0.01
FA2-3	<41	<0.01
FA2-5	52 ± 53	<0.01
FB1-3	<41	<0.01
FB1-4	<66	<0.01
FB1-5	<41	<0.01
FB2-3	52 ± 53	<0.01
FB2-5	<66	<0.01
OA1-1[b]	<29	<0.01
OA1-2	62 ± 56	0.03 ± 0.01
OA1-3	<41	0.02 ± 0.01
OA1-4	<29	<0.01
OA1-5	43 ± 50	0.02 ± 0.01
OA2-3	<1	0.02 ± 0.01
OB1-3	62 ± 56	0.03 ± 0.01
OB1-4	43 ± 50	<0.01
OB1-5	127 ± 74	0.03 ± 0.01
OB2-3	<41	0.03 ± 0.01
OC1-3	89 ± 65	0.04 ± 0.02
OC1-4	<54	<0.01
OC1-5	34 ± 46	0.02 ±0.01
OC2-3	80 ± 62	0.03 ± 0.01
OC2-5	89 ± 65	0.02 ± 0.01
OD1-3	34 ± 46	0.02 + 0.01
OD2-3	62 ± 56	0.02 ± 0.01
OD3-3	62 ± 56	0.01 ± 0.01
WA-1[c]	<15	<0.02
WA-2	<54	0.01 ± 0.01
WA-3	<15	0.01 ± 0.01
WA-4	<54	0.02 ± 0.01
WA-5	<15	<0.02
WB-3	34 ± 46	0.01 ± 0.01
WB-4	<15	0.02 ± 0.01
WB-5	<15	<0.02
WC-3	<41	0.02 ± 0.01
WC-4	34 ± 46	0.01 ± 0.01
WC-5	34 ± 46	<0.02
WD-3	<41	<0.01

TABLE 4-1

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
DN-1[d]	89 ± 65	0.01 ± 0.01
DN-2	<66	0.03 ± 0.01
DN-3	<54	0.03 ± 0.02
DN-4	62 ± 56	0.03 ± 0.01
DN-5	34 ± 46	<0.01
DE-1	43 ± 50	<0.02
DE-2	<15	0.03 ± 0.01
DE-3	34 ± 46	0.02 ± 0.01
DE-4	<54	0.03 ± 0.01
DE-5	<66	0.02 ± 0.01
DS-1	34 ± 46	0.02 ± 0.01
DS-2	34 ± 46	0.02 ± 0.01
DS-3	<54	0.02 ± 0.01
DS-4	34 ± 46	0.02 ± 0.01
DS-5	52 ± 53	0.02 ± 0.01
DP-1	43 ± 50	<0.02

[a]Location designators beginning with "F" are shown in Figure 4-2.

[b]Location designators beginning with "O" are shown in Figure 4-4.

[c]Location designators beginning with "W" are shown in Figure 4-5.

[d]Location designators beginning with "D" are shown in Figure 4-3.

TABLE 4-2

TRANSFERABLE POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 10

Location	Alpha Activity (dpm/100 cm^2)
FA2-2[a]	<2
FA2-5	3 ± 7
FB2-3	<2
OA1-2[b]	<2
OA1-5	<2
OB1-3	<2
OB1-4	3 ± 7
OB1-5	3 ± 7
OC1-3	<2
OC1-5	<2
OC2-3	<2
OC2-5	<2
OD1-3	<2
OD2-3	3 ± 7
OD3-3	<2
WB-3[c]	<2
WC-4	3 ± 7
WC-5	<2
DN-1[d]	<2
DN-4	<2
DN-5	<2
DE-1	<2
DE-3	<2
DS-1	3 ± 7
DS-2	<2
DS-4	<2
DS-5	<2
DP-1	<2

[a]Location designators beginning with "F" are shown in Figure 4-2.

[b]Location designators beginning with "O" are shown in Figure 4-4.

[c]Location designators beginning with "W" are shown in Figure 4-5.

[d]Location designators beginning with "D" are shown in Figure 4-3.

TABLE 4-3

DIRECT POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 26

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
FA1-1[a]	34 ± 37	<0.02
FA1-2	71 ± 52	<0.02
FA1-3	62 ± 49	<0.01
FA1-4	71 ± 52	<0.01
FA1-5	62 ± 49	<0.01
FA2-5	24 ± 32	<0.01
FB1-3	71 ± 52	<0.01
FB1-4	43 ± 41	<0.01
FB1-5	62 ± 49	<0.02
FB2-3	43 ± 41	<0.01
FC1-3	43 ± 41	<0.01
FC1-4	62 ± 49	0.04 ± 0.02
FC1-5	71 ± 52	<0.02
FC2-3	34 ± 37	<0.01
OA1-1[b]	<24	<0.01
OA1-2	15 ± 26	<0.01
OA1-3	15 ± 26	<0.02
OA1-4	<6	<0.01
OA1-5	<24	<0.02
OA2-2	<24	<0.01
OA2-5	<6	<0.02
OA3-2	<6	<0.01
OA3-3	15 ± 26	<0.01
OA3-5	<24	<0.01
OB1-3	<24	<0.02
OB1-4	<24	<0.02
OB1-5	<6	0.01 ± 0.01
OB2-5	15 ± 26	<0.02
OB3-3	24 ± 32	0.01 ± 0.01
OB3-5	<24	<0.02
OC1-3	<6	0.01 ± 0.01
OC1-4	15 ± 26	<0.01
OC1-5	15 ± 26	0.02 ± 0.01
OC2-5	24 ± 32	<0.02
OC3-3	62 ± 49	0.01 ± 0.01
OC3-5	<24	<0.01
OD1-3	<6	<0.02
OD3-3	24 ± 32	<0.02

TABLE 4-3

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
WA1-1[c]	15 ± 26	0.01 ± 0.01
WA1-2	34 ± 37	0.03 ± 0.01
WA1-3	34 ± 37	0.03 ± 0.01
WA1-4	43 ± 41	0.02 ± 0.01
WA1-5	24 ± 32	0.02 ± 0.01
WA2-2	<24	0.02 ± 0.01
WA2-3	15 ± 26	0.02 ± 0.01
WA2-5	43 ± 41	0.01 ± 0.01
WB1-3	62 ± 49	0.02 ± 0.01
WB1-4	52 ± 45	0.02 ± 0.01
WB1-5	43 ± 41	0.01 ± 0.01
WB2-3	<24	0.01 ± 0.01
WB2-5	24 ± 32	<0.02
WC1-3	34 ± 37	0.01 ± 0.01
WC1-4	24 ± 32	0.03 ± 0.01
WC1-5	24 ± 32	<0.02
WC2-3	43 ± 41	0.02 ± 0.01
WC2-5	<24	0.02 ± 0.01
WD1-3	15 ± 26	0.01 ± 0.01
WD2-3	43 ± 41	<0.02
DS-1[d]	15 ± 26	0.02 ± 0.01
DS-2	24 ± 32	0.02 ± 0.01
DS-3	34 ± 37	0.03 ± 0.01
DS-4	89 ± 58	0.03 ± 0.01
DS-5	34 ± 37	0.01 ± 0.01
DS-6	24 ± 32	0.03 ± 0.02
DE-1	34 ± 37	0.02 ± 0.01
DE-2	34 ± 37	0.02 ± 0.01
DE-3	34 ± 37	0.02 ± 0.01
DE-4	<24	0.02 ± 0.01
DE-5	15 ± 26	0.03 ± 0.02
DE-6	15 ± 26	0.02 ± 0.01

[a]Location designators beginning with "F" are shown in Figure 4-7.

[b]Location designators beginning with "O" are shown in Figure 4-8.

[c]Location designators beginning with "W" are shown in Figure 4-10.

[d]Location designators beginning with "D" are shown in Figure 4-9.

TABLE 4-4

TRANSFERABLE POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 26

Location	Alpha Activity (dpm/100 cm^2)
WA1-3[a]	<1
WA1-4	3 ± 6
WA2-5	<1
WA1-2	<1
WB1-3	<1
WB1-4	<1
WB1-5	<1
WC1-3	<1
WC2-3	3 ± 6
WD2-3	<1
DE-1[b]	3 ± 6
DE-2	<1
DE-3	<1
DS-3	<1
DS-4	<1
DS-5	<1

[a]Location designators beginning with "W" are shown in Figure 4-10.

[b]Location designators beginning with "D" are shown in Figure 4-9.

TABLE 4-5

DIRECT POST-REMEDIAL ACTION MEASUREMENTS IN THE AREAS AROUND DUCT 29

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
FA1-1[a]	<22	0.02 ± 0.01
FA1-2	21 ± 32	0.02 ± 0.01
FA1-3	<22	0.02 ± 0.01
FA1-4	<37	0.08 ± 0.02
FA1-5	21 ± 32	0.01 ± 0.01
FA2-2	<37	0.01 ± 0.01
FA2-3	<22	0.03 ± 0.02
FA2-5	<37	0.04 ± 0.02
FB1-3	<6	0.03 ± 0.02
FB1-4	<37	0.03 ± 0.02
FB1-5	<22	0.07 ± 0.02
FB2-3	<22	0.01 ± 0.01
FB2-5	<6	0.03 ± 0.02
FC1-3	<37	0.02 ± 0.01
FC1-4	<6	0.02 ± 0.01
FC1-5	<22	0.02 ± 0.01
FC2-3	<6	<0.01
FC2-5	<6	<0.01
FD1-3	<22	<0.01
FD1-4	<22	<0.01
FD1-5	<37	<0.01
FD2-3	<22	<0.01
OA1-1[b]	<6	<0.01
OA1-2	<22	<0.01
OA1-3	<22	<0.01
OA1-4	<22	<0.01
OA1-5	<6	<0.01
OA2-2	<6	<0.01
OA2-3	<6	<0.01
OA2-5	<22	<0.01
OB1-3	<37	<0.01
OB1-4	<22	<0.01
OB1-5	<22	<0.01
OB2-3	<6	<0.01
OB2-5	<22	<0.01
OC1-3	<6	<0.01
OC1-4	<6	<0.02
OC1-5	<22	<0.01
OC2-3	<22	<0.02
OC2-5	<6	0.01 ± 0.01

TABLE 4-5

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
DS-1[c]	30 ± 37	0.02 ± 0.01
DS-2	21 ± 32	0.02 ± 0.01
DS-3	<37	0.03 ± 0.02
DS-4	<22	0.03 ± 0.02
DS-5	<37	<0.02
DS-6	39 ± 41	0.03 ± 0.02
DS-7	30 ± 37	0.02 ± 0.01
DN-1	39 ± 41	0.02 ± 0.01
DN-2	21 ± 32	0.02 ± 0.01
DN-3	<37	0.02 ± 0.02
DN-4	<22	0.01 ± 0.01
DN-5	39 ± 41	0.02 ± 0.02
DN-6	30 ± 37	0.03 ± 0.02
DN-7	<37	0.03 ± 0.02
DA-1	<37	0.03 ± 0.02
DA-2	<22	0.02 ± 0.02
DA-3	<22	0.02 ± 0.01
DA-4	<22	0.02 ± 0.01
DA-5	21 ± 32	0.02 ± 0.01
DB-3	58 ± 49	0.02 ± 0.01
DB-4	48 ± 45	0.02 ± 0.01
DB-5	30 ± 37	0.03 ± 0.02
DC-3	<37	0.02 ± 0.01
DC-4	<22	0.02 ± 0.01
DC-5	<22	0.03 ± 0.02
DD-3	48 ± 45	<0.02

[a]Location designators beginning with "F" are shown in Figure 4-12.

[b]Location designators beginning with "O" are shown in Figure 4-14.

[c]Location designators beginning with "D" are shown in Figure 4-13.

TABLE 4-6

TRANSFERABLE POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 29

Location	Alpha Activity (dpm/100 cm^2)
DS-1[a]	<1
DS-2	<1
DS-6	<1
DS-7	<1
DN-1	<1
DN-2	3 ± 6
DN-5	<1
DN-6	<1
DA-5	<1
DB-3	<1
DB-4	<1
DB-5	<1
DD-3	3 ± 6

[a]Location designators beginning with "D" are shown in Figure 4-13.

TABLE 4-7

DIRECT POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 64

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
F1A1-1[a]	<37	<0.01
F1A1-2	<22	<0.01
F1A2-2	<51	<0.01
F1A3-2	<22	<0.01
F1A4-2	<37	<0.01
F1A1-3	<37	<0.01
F1A2-3	<37	<0.01
F1A3-3	<37	<0.01
F1A4-3	<22	<0.01
F1A1-4	<37	<0.01
F1A1-5	<51	<0.01
F1A2-5	48 ± 49	<0.01
F1A3-5	57 ± 52	<0.01
F1A4-5	<22	<0.01
F1B1-3	28 ± 40	<0.01
F1B2-3	<22	<0.01
F1B3-3	28 ± 40	<0.01
F1B4-3	28 ± 40	<0.01
F1B1-4	<22	<0.01
F1B1-5	<22	<0.01
F1B2-5	<37	<0.01
F1B3-5	<6	0.01 ± 0.01
F1B4-5	<22	<0.01
C1A1-1[b]	<21	<0.01
C1A1-2	<6	<0.01
C1A1-3	<21	<0.01
C1A1-4	<35	<0.01
C1A1-5	<21	<0.01
C1A2-3	<35	<0.01
C1A2-4	<6	<0.01
C1A2-5	<21	<0.01
C1A3-3	<21	<0.01
C1A3-4	<21	<0.01
C1A3-5	<6	<0.01
C1B1-3	<35	<0.01
C1B1-4	<6	<0.01
C1B1-5	<21	<0.01
C1B2-3	<35	<0.01
C1B2-5	<35	<0.01
C1B3-3	<6	<0.01
C1B3-5	<6	<0.01

TABLE 4-7

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
D1N-1[c]	21 ± 33	<0.01
D1N-2	<37	<0.01
D1N-3	40 ± 42	<0.01
D1N-4	<23	<0.01
D1N-5	*	<0.01
D1N-6	*	<0.01
D1N-7	*	<0.01
D1N-8	96 ± 62	0.01 ± 0.01
D1N-9	49 ± 46	<0.01
D1N-10	58 ± 49	<0.02
D1N-11	77 ± 56	<0.01
D1N-12	106 ± 64	0.02 ± 0.01
D1N-13	77 ± 56	0.02 ± 0.02
D1E-1[c]	21 ± 33	<0.01
D1E-2	<37	<0.01
D1E-3	<37	<0.01
D1E-4	21 ± 33	<0.01
D1E-5	49 ± 46	<0.01
D1E-6	21 ± 33	<0.01
D1E-7	30 ± 38	<0.01
W1A1-1[c]	21 ± 33	0.03 ± 0.01
W1A1-2	<23	0.03 ± 0.02
W1A1-3	49 ± 46	0.02 ± 0.01
W1A1-4	30 ± 38	0.03 ± 0.01
W1A1-5	21 ± 33	0.02 ± 0.01
W1A2-2	21 ± 33	0.02 ± 0.01
W1A2-3	40 ± 42	0.02 ± 0.01
W1A2-5	58 ± 49	0.02 ± 0.01
W1B1-3	<37	0.02 ± 0.01
W1B1-4	58 ± 49	0.01 ± 0.01
W1B1-5	40 ± 42	0.03 ± 0.02
W1B2-3	77 ± 56	0.02 ± 0.01
W1B2-5	49 ± 46	0.02 ± 0.01
W1B2-4	<37	0.02 ± 0.01
W1C1-3	49 ± 46	0.03 ± 0.01
W1C1-4	87 ± 59	0.02 ± 0.01
W1C1-5	49 ± 46	0.02 ± 0.01
W1C2-3	58 ± 49	0.02 ± 0.01
W1C2-5	77 ± 56	0.02 ± 0.01

* Alpha reading could not be obtained because of rough surface.

TABLE 4-7

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
FI1A-1[c]	77 ± 56	<0.01
FI1A-2	40 ± 42	<0.01
FI1A-3	58 ± 49	<0.01
FI1A-4	30 ± 38	<0.01
FI1A-5	21 ± 33	<0.01
FI1B-3	21 ± 33	<0.01
FI1B-4	30 ± 38	<0.01
FI1B-5	<37	<0.01
FI1C-3	49 ± 46	<0.01
FI1C-4	<23	<0.01
FI1C-5	<37	<0.01
F2A1-1[d]	<6	<0.01
F2A1-2	<22	<0.01
F2A2-2	<22	<0.01
F2A3-2	<6	<0.01
F2A4-2	<6	<0.01
F2A1-3	<6	<0.01
F2A2-3	<6	<0.01
F2A3-3	<6	<0.01
F2A4-3	<6	<0.01
F2A1-4	<22	<0.01
F2A1-5	<6	<0.01
F2A2-5	<6	<0.01
F2A3-5	<6	<0.01
F2A4-5	<6	<0.01
F2B1-3	<6	<0.01
F2B2-3	<6	<0.01
F2B3-3	<6	<0.01
F2B4-3	<6	<0.01
F2B1-4	<22	<0.01
F2B1-5	<22	<0.01
F2B2-5	<6	<0.01
F2B3-5	<6	<0.01
F2B4-5	<6	<0.01
C2A1-1[e]	<6	<0.01
C2A1-2	<22	<0.01
C2A2-2	<6	<0.01

TABLE 4-7

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
C2A3-2[e]	<6	<0.01
C2A1-3	<36	<0.01
C2A2-3	<36	<0.01
C2A3-3	<6	<0.01
C2A1-4	<22	<0.01
C2A1-5	<6	<0.01
C2A2-5	<22	<0.01
C2A3-5	<22	<0.01
C2A1-3	<6	<0.01
C2B2-3	<6	<0.01
C2B3-3	<6	<0.01
C2B1-4	<36	<0.01
C2B1-5	<22	<0.01
C2B2-5	<6	<0.01
D2E-1[f]	26 ± 37	<0.01
D2E-2	<35	<0.01
D2E-3	<21	<0.01
D2E-4	35 ± 41	<0.01
D2E-5	<35	<0.01
D2E-6	<21	<0.01
D2E-7	<35	<0.01
D2N-1	<21	<0.01
D2N-2	<35	<0.01
D2N-3	<21	<0.01
D2N-4	<35	<0.01
D2N-5	<21	<0.02
D2N-6	<48	<0.01
D2N-7	<21	<0.02
W2A-1[f]	<48	0.01 ± 0.01
W2A-2	<35	0.01 ± 0.01
W2A-3	<48	0.02 ± 0.01
W2A-4	26 ± 37	0.02 ± 0.01
W2A-5	35 ± 41	0.02 ± 0.01
W2B-3	<48	0.02 ± 0.01
W2B-4	<48	0.02 ± 0.01
W2B-5	26 ± 37	0.02 ± 0.01
W2C-3	35 ± 41	0.02 ± 0.01
W2C-4	<21	0.02 ± 0.01

TABLE 4-7

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
W2C-5[f]	<35	0.01 ± 0.01
W2D-3	35 ± 41	0.02 ± 0.01
W2A2-3	<35	0.01 ± 0.01
W2A2-5	26 ± 37	0.02 ± 0.01
W2B2-3	<48	0.01 ± 0.01
W2B2-5	26 ± 37	<0.02
W2C2-3	53 ± 49	<0.02
W2C2-5	26 ± 37	<0.02
W2D2-3	44 ± 45	<0.02
FI2F-1[f]	35 ± 41	0.02 ± 0.01
FI2F-2	26 ± 37	0.02 ± 0.01
FI2F-3	53 ± 49	0.02 ± 0.01
FI2F-4	<48	0.02 ± 0.01
FI2F-5	26 ± 37	0.02 ± 0.01
O2A1-1[g]	<22	<0.01
O2A1-2	<22	<0.01
O2A1-3	<6	<0.01
O2A1-4	<22	<0.01
O2A1-5	<6	<0.01
O2B1-3	<22	<0.01
O2B1-4	<6	<0.01
O2B1-5	<6	<0.01
O2C1-3	<6	<0.01
O2C2-3	<22	<0.01
O2A2-2	<22	<0.01
O2A3-2	<22	<0.01
O2A3-3	<6	<0.01
O2A2-5	<6	<0.01
O2A3-5	<22	<0.01
O2B3-3	<6	<0.01
O2B2-5	17 ± 33	<0.01
O2B3-5	<36	<0.01
O2C3-3	<6	<0.01

TABLE 4-7

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
F3A1-1[h]	28 ± 38	<0.01
F3A1-2	19 ± 33	<0.01
F3A1-3	28 ± 38	<0.01
F3A1-4	<22	<0.01
F3A1-5	<6	<0.01
F3A2-2	19 ± 33	<0.01
F3A2-3	38 ± 42	<0.01
F3A2-5	38 ± 42	<0.01
F3A3-2	<36	<0.01
F3A3-3	19 ± 33	<0.01
F3A3-5	28 ± 38	<0.01
F3A4-2	<6	<0.01
F3A4-3	<36	<0.01
F3A4-5	<6	<0.01
F3B1-3	<36	<0.01
F3B1-4	28 ± 38	<0.01
F3B1-5	28 ± 38	<0.01
F3B2-3	<22	<0.01
F3B2-5	38 ± 42	<0.01
F3B3-3	28 ± 38	<0.01
F3B3-5	<6	<0.01
F3B4-3	19 ± 33	<0.01
F3B4-5	<22	<0.01
C3A1-1[l]	<36	<0.01
C3A1-2	<36	<0.01
C3A1-3	<36	<0.01
C3A1-4	28 ± 38	<0.01
C3A1-5	28 ± 38	<0.01
C3A2-2	19 ± 33	<0.01
C3A2-3	<22	<0.01
C3A2-5	<36	<0.01
C3A3-2	47 ± 46	<0.01
C3A3-3	19 ± 33	<0.01
C3A3-5	<6	<0.01
C3B1-3	38 ± 42	<0.01
C3B1-4	<36	<0.01
C3B1-5	38 ± 42	<0.01
C3B2-3	28 ± 38	<0.01
C3B2-5	<22	<0.01
C3B3-3	19 ± 33	<0.01
C3B3-5	<36	<0.01

TABLE 4-7
(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
W3A-1[j]	102 ± 68	<0.01
W3A-2	<17	<0.01
W3A-3	64 ± 57	<0.01
W3A-4	45 ± 50	<0.01
W3A-5	<56	0.01 ± 0.02
W3B-3	36 ± 47	<0.01
W3B-4	<30	<0.02
W3B-5	55 ± 54	<0.02
W3C-3	45 ± 50	<0.01
W3C-4	55 ± 54	<0.01
W3C-5	<43	<0.01
W3D-3	83 ± 62	<0.02
D3E-1[j]	<43	<0.01
D3E-2	64 ± 57	<0.01
D3E-3	<56	<0.01
D3E-4	<30	<0.01
D3E-5	45 ± 50	<0.01
D3E-6	<56	<0.01
D3E-7	36 ± 47	<0.01
D3W-1	55 ± 54	0.01 ± 0.02
D3W-2	<56	<0.02
D3W-3	55 ± 54	0.01 ± 0.02
D3W-4	45 ± 50	0.01 ± 0.02
D3W-5	<43	<0.02
D3W-6	<43	<0.02
D3W-7	<56	<0.02
D3N-1	<56	<0.02
D3N-2	26 ± 43	0.01 ± 0.02
D3N-3	64 ± 57	0.01 ± 0.02
D3N-4	73 ± 60	<0.02
D3N-5	64 ± 57	<0.02
D3N-6	36 ± 47	<0.02
D3N-7	36 ± 47	<0.01
FI3F-1[j]	<43	<0.01

TABLE 4-7

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
O3A1-1[k]	28 ± 38	<0.01
O3A1-2	<6	<0.01
O3A1-3	38 ± 42	<0.01
O3A1-4	19 ± 33	<0.01
O3A1-5	<6	<0.01
O3A2-2	28 ± 38	<0.01
O3A2-5	19 ± 33	<0.01
O3A3-2	38 ± 42	<0.01
O3A3-3	28 ± 38	<0.01
O3A3-5	28 ± 38	<0.01
O3B1-3	47 ± 46	<0.01
O3B1-4	<36	<0.01
O3B1-5	<36	<0.01
O3B2-5	<36	<0.01
O3B3-3	<22	<0.01
O3B3-5	28 ± 38	<0.01
O3C1-3	28 ± 38	<0.01
O3C2-3	<36	<0.01
O3C3-3	57 ± 50	<0.01

[a]Location designators beginning with "F1" are shown in Figure 4-16.
[b]Location designators beginning with "C1" are shown in Figure 4-17.
[c]Location designators beginning with "D1," "FI1," and "W1" are shown in Figure 4-18.
[d]Location designators beginning with "F2" are shown in Figure 4-20.
[e]Location designators beginning with "C2" are shown in Figure 4-21.
[f]Location designators beginning with "FI2," "D2," and "W2" are shown in Figure 4-22.
[g]Location designators beginning with "O2" are shown in Figure 4-23.
[h]Location designators beginning with "F3" are shown in Figure 4-25.
[i]Location designators beginning with "C3" are shown in Figure 4-26.
[j]Location designators beginning with "FI3," "D3," and "W3" are shown in Figure 4-27.
[k]Location designators beginning with "O3" are shown in Figure 4-28.

TABLE 4-8

TRANSFERABLE POST-REMEDIAL ACTION MEASUREMENTS

IN THE AREAS AROUND DUCT 64

Location	Alpha Activity (dpm/100 cm^2)
F1A2-2[a]	<1
F1A1-5	<1
F1A2-5	<1
F1A3-5	3 ± 6
F1B1-3	<1
F1B3-3	3 ± 6
F1B4-3	<1
W1A1-1[b]	
W1A1-3	<1
W1A1-4	<1
W1A1-5	<1
W1A2-2	3 ± 6
W1A2-3	<1
W1A2-5	<1
W1B1-4	<1
W1B1-5	<1
W1B2-3	3 ± 6
W1B2-5	3 ± 6
W1C1-3	<1
W1C1-4	3 ± 6
W1C1-5	<1
W1C2-3	<1
W1C2-5	<1
D1N-1[b]	
D1N-3	<1
D1N-8	<1
D1N-9	<1
D1N-10	<1
D1N-11	3 ± 6
D1N-12	<1
D1N-13	<1
D1E-1	<1
D1E-4	3 ± 6
D1E-5	<1
D1E-6	<1
D1E-7	<1

TABLE 4-8

(continued)

Location	Alpha Activity (dpm/100 cm^2)
FI1A-1[b]	<1
FI1A-2	<1
FI1A-3	<1
FI1A-4	3 ± 6
FI1A-5	<1
FI1B-3	<1
FI1B-4	<1
FI1C-3	<1
D2E-1[c]	6 ± 9
D2E-4	<1
W2A-4[c]	<1
W2A-5	<1
W2B-5	6 ± 9
W2C-3	6 ± 9
W2D-3	<1
W2A2-5	6 ± 9
W2B2-5	<1
W2C2-3	<1
W2C2-5	<1
W2D2-3	<1
FI2F1[c]	<1
FI2F3	<1
F3A3-5[d]	3 ± 6
F3A2-5	<1
F3A2-3	3 ± 6
F3A1-3	<1
F3A1-1	<1
F3B3-3	3 ± 6
F3B2-5	<1
F3B1-5	3 ± 6
F3B1-4	<1
C3A1-4[e]	<1
C3A1-5	<1
C3A3-2	<1
C3B1-3	<1
C3B1-5	<1
C3B2-3	<1
C3B3-3	<1

TABLE 4-8

(continued)

Location	Alpha Activity (dpm/100 cm^2)
W3A-1[f]	<1
W3A-3	<1
W3A-4	<1
W3B-3	<1
W3B-5	<1
W3C-3	3 ± 6
W3C-4	<1
W3D-3	<1
D3E-2[f]	<1
D3E-5	<1
D3E-7	3 ± 6
D3W-1	6 ± 9
D3W-3	<1
D3W-4	3 ± 6
D3N-2	6 ± 9
D3N-3	<1
D3N-4	<1
D3N-5	<1
D3N-6	<1
D3N-7	3 ± 6
O3A1-1[g]	<1
O3A1-3	<1
O3A2-2	<1
O3A3-2	<1
O3A3-3	<1
O3A3-5	<1
O3B1-3	<1
O3B3-5	<1
O3C1-3	<1
O3C3-3	3 ± 6

[a]Location designators beginning with "F1" are shown in Figure 4-16.
[b]Location designators beginning with "W1," "D1," and "F1" are shown in Figure 4-18.
[c]Location designators beginning with "D2," "W2," and "FI2" are shown in Figure 4-22.
[d]Location designators beginning with "F3" are shown in Figure 4-25.
[e]Location designators beginning with "C3" are shown in Figure 4-26.
[f]Location designators beginning with "W3" and "D3" are shown in Figure 4-27.
[g]Location designators beginning with "O3" are shown in Figure 4-28.

TABLE 4-9

DIRECT POST-REMEDIAL ACTION MEASUREMENTS OF THE CHIMNEYS*

Chimney Number	Air Vent Number	Distance to Top of Chimney (m)	Orientation of Area Measured	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
1	8	0	N	54 ± 49	0.02 ± 0.01
1	8	0	E	45 ± 46	<0.01
1	8	0	S	45 ± 46	<0.02
1	8	0	W	45 ± 46	0.02 ± 0.01
1	8	0.5	N	91 ± 61	0.04 ± 0.02
1	8	0 5	E	82 ± 58	0.03 ± 0.02
1	8	0.5	S	45 ± 46	0.01 ± 0.01
1	8	0.5	W	119 ± 69	0.03 ± 0.01
1	8	1.0	N	91 ± 61	0.03 ± 0.01
1	8	1.0	E	35 ± 42	0.02 ± 0.01
1	8	1.0	S	119 ± 69	0.02 ± 0.01
1	8	1.0	W	73 ± 56	0.02 ± 0.01
2	6	0	N	<22	0.02 ± 0.01
2	6	0	E	<37	0.01 ± 0.01
2	6	0	S	39 ± 41	0.01 ± 0.01
2	6	0	W	48 ± 45	0.02 ± 0.01
2	6	0.5	N	20 ± 32	0.03 ± 0.02
2	6	0.5	E	30 ± 37	0.03 ± 0.02
2	6	0.5	S	20 ± 32	0.03 ± 0.02
2	6	0.5	W	<37	0.03 ± 0.01
2	6	1.0	N	30 ± 37	0.02 ± 0.01
2	6	1.0	E	<37	0.02 ± 0.01
2	6	1.0	S	<37	0.02 ± 0.01
2	6	1.0	W	30 ± 37	0.04 ± 0.02
4	1	0	N	17 ± 26	0.01 ± 0.01
4	1	0	E	<24	0.02 ± 0.01
4	1	0	S	36 ± 37	0.04 ± 0.01
4	1	0	W	<24	<0.01
4	1	0.5	N	17 ± 26	0.02 ± 0.01
4	1	0.5	E	36 ± 37	0.03 ± 0.01
4	1	0.5	S	45 ± 41	0.03 ± 0.01
4	1	0.5	W	<24	0.02 ± 0.01
4	1	1.0	N	36 ± 37	0.02 ± 0.01
4	1	1.0	E	36 ± 37	0.03 ± 0.01
4	1	1.0	S	73 ± 52	0.02 ± 0.01
4	1	1.0	W	26 ± 32	0.03 ± 0.01

* Typical measurement locations are shown in Figure 4-29.

TABLE 4-9

(continued)

Chimney Number	Air Vent Number	Distance to Top of Chimney (m)	Orientation of Area Measured	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
5	1	0	N	<21	0.01 ± 0.01
5	1	0	E	95 ± 65	0.03 ± 0.01
5	1	0	S	36 ± 45	0.02 ± 0.01
5	1	0	W	85 ± 62	0.02 ± 0.01
5	1	0.5	N	95 ± 65	0.03 ± 0.02
5	1	0.5	E	95 ± 65	0.04 ± 0.02
5	1	0.5	S	105 ± 68	0.04 ± 0.02
5	1	0.5	W	75 ± 59	0.04 ± 0.02
5	1	1.0	N	65 ± 56	0.02 ± 0.01
5	1	1.0	E	46 ± 49	0.04 ± 0.02
5	1	1.0	S	135 ± 76	0.03 ± 0.02
5	1	1.0	W	36 ± 45	0.04 ± 0.02
5	4	0	N	36 ± 45	0.03 ± 0.02
5	4	0	E	26 ± 40	<0.01
5	4	0	S	46 ± 49	<0.01
5	4	0	W	65 ± 56	0.02 ± 0.01
5	4	0.5	N	65 ± 56	0.02 ± 0.01
5	4	0.5	E	36 ± 45	<0.01
5	4	0.5	S	65 ± 56	<0.02
5	4	0.5	W	36 ± 45	0.05 ± 0.02
5	4	1.0	N	75 ± 59	0.04 ± 0.02
5	4	1.0	E	<36	<0.01
5	4	1.0	S	26 ± 40	<0.01
5	4	1.0	W	*	*
5	5	0	N	55 ± 52	<0.01
5	5	0	E	46 ± 49	0.03 ± 0.02
5	5	0	S	46 ± 49	0.02 ± 0.01
5	5	0	W	36 ± 45	<0.01
5	5	0.5	N	75 ± 59	0.02 ± 0.01
5	5	0.5	E	105 ± 68	0.03 ± 0.01
5	5	0.5	S	46 ± 49	0.03 ± 0.01
5	5	0.5	W	55 ± 52	0.03 ± 0.01
5	5	1.0	N	55 ± 52	0.03 ± 0.01
5	5	1.0	E	65 ± 56	0.03 ± 0.01
5	5	1.0	S	55 ± 52	0.04 ± 0.02
5	5	1.0	W	46 ± 49	0.03 ± 0.01
6	5	0	N	122 ± 68	0.02 ± 0.01
6	5	0	E	85 ± 58	0.04 ± 0.02
6	5	0	S	103 ± 63	0.02 ± 0.01
6	5	0	W	66 ± 52	0.03 ± 0.02

* This portion of the duct was removed during remedial action.

TABLE 4-9

(continued)

Chimney Number	Air Vent Number	Distance to Top of Chimney (m)	Orientation of Area Measured	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
6	5	0.5	N	76 ± 55	0.05 ± 0.02
6	5	0.5	E	57 ± 48	0.03 ± 0.02
6	5	0.5	S	103 ± 63	0.05 ± 0.02
6	5	0.5	W	112 ± 66	0.08 ± 0.02
6	5	1.0	N	57 ± 48	0.03 ± 0.02
6	5	1.0	E	48 ± 45	0.04 ± 0.02
6	5	1.0	S	76 ± 55	0.03 ± 0.02
6	5	1.0	W	103 ± 63	0.03 ± 0.02
6	7	0	N	30 ± 37	0.02 ± 0.01
6	7	0	E	57 ± 48	0.03 ± 0.02
6	7	0	S	85 ± 58	0.02 ± 0.01
6	7	0	W	85 ± 58	0.01 ± 0.01
6	7	0.5	N	20 ± 32	0.03 ± 0.02
6	7	0.5	E	66 ± 52	0.03 ± 0.02
6	7	0.5	S	94 ± 60	0.02 ± 0.01
6	7	0.5	W	48 ± 45	0.05 ± 0.02
6	7	1.0	N	66 ± 52	0.04 ± 0.02
6	7	1.0	E	57 ± 48	0.04 ± 0.02
6	7	1.0	S	85 ± 58	0.04 ± 0.02
6	7	1.0	W	94 ± 60	0.02 ± 0.01
6	8	0	N	76 ± 55	0.02 ± 0.01
6	8	0	E	103 ± 63	0.03 ± 0.02
6	8	0	S	85 ± 58	0.03 ± 0.02
6	8	0	W	57 ± 48	0.02 ± 0.01
6	8	0.5	N	66 ± 52	0.05 ± 0.02
6	8	0.5	E	66 ± 52	0.02 ± 0.01
6	8	0.5	S	57 ± 48	0.04 ± 0.02
6	8	0.5	W	76 ± 55	0.02 ± 0.01
6	8	1.0	N	103 ± 63	0.04 ± 0.02
6	8	1.0	E	20 ± 32	0.04 ± 0.02
6	8	1.0	S	20 ± 32	0.04 ± 0.02
6	8	1.0	W	57 ± 48	0.03 ± 0.02
6	9	0	N	<58	0.04 ± 0.01
6	9	0	E	<58	0.02 ± 0.01
6	9	0	S	<32	<0.01
6	9	0	W	<58	<0.01
6	9	0.5	N	<45	0.03 ± 0.01
6	9	0.5	E	<45	0.03 ± 0.01
6	9	0.5	S	<45	0.01 ± 0.01
6	9	0.5	W	30 ± 42	0.02 ± 0.01

TABLE 4-9

(continued)

Chimney Number	Air Vent Number	Distance to Top of Chimney (m)	Orientation of Area Measured	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
6	9	1.0	N	39 ± 46	0.04 ± 0.02
6	9	1.0	E	<32	0.03 ± 0.01
6	9	1.0	S	<18	<0.02
6	9	1.0	W	58 ± 53	0.02 ± 0.01
6	10	0	N	39 ± 41	0.03 ± 0.02
6	10	0	E	103 ± 63	0.02 ± 0.01
6	10	0	S	76 ± 55	0.02 ± 0.01
6	10	0	W	48 ± 45	0.03 ± 0.02
6	10	0.5	N	39 ± 41	0.05 ± 0.02
6	10	0.5	E	39 ± 41	0.02 ± 0.01
6	10	0.5	S	94 ± 60	0.02 ± 0.01
6	10	0.5	W	48 ± 45	0.04 ± 0.02
6	10	1.0	N	66 ± 52	0.04 ± 0.02
6	10	1.0	E	66 ± 52	0.04 ± 0.02
6	10	1.0	S	20 ± 32	0.03 ± 0.02
6	10	1.0	W	85 ± 58	0.03 ± 0.03

TABLE 4-10

TRANSFERABLE POST-REMEDIAL ACTION MEASUREMENTS

ON THE CHIMNEY SURFACES*

Chimney Number	Air Vent Number	Depth from Top of Chimney	Orientation of Sample in Chimney	Alpha Activity (dpm/100 cm^2)
1	8	0	N	<2
1	8	0	E	6 ± 10
1	8	0	S	6 ± 10
1	8	0	W	<2
1	8	0.5	N	<2
1	8	0.5	E	<2
1	8	0.5	S	<2
1	8	0.5	W	<2
1	8	1.0	N	<2
1	8	1.0	E	<2
1	8	1.0	S	<9
1	8	1.0	W	<9
2	6	0	S	<2
2	6	0	W	3 ± 7
2	6	0.5	N	3 ± 7
2	6	0.5	E	<2
2	6	0.5	S	6 ± 10
2	6	1.0	N	3 ± 7
2	6	1.0	W	<2
4	1	0	S	<2
4	1	0.5	E	3 ± 7
4	1	0.5	S	3 ± 7
4	1	1.0	N	3 ± 7
4	1	1.0	E	3 ± 7
4	1	1.0	S	<2
4	1	1.0	W	3 ± 7
5	1	0	E	<2
5	1	0	W	<2
5	1	0	S	<2
5	1	0	N	3 ± 7
5	1	0.5	E	<2
5	1	0.5	S	<2
5	1	0.5	W	<2
5	1	0.5	N	<2
5	1	1.0	E	<2
5	1	1.0	S	6 ± 9
5	1	1.0	W	3 ± 7

* Typical measurement locations are shown in Figure 4-29.

TABLE 4-10
(continued)

Chimney Number	Air Vent Number	Depth from Top of Chimney	Orientation of Sample in Chimney	Alpha Activity (dpm/100 cm^2)
5	4	0	N	<2
5	4	0	E	<2
5	4	0	S	<2
5	4	0	W	<2
5	4	0.5	N	6
5	4	0.5	E	<2
5	4	0.5	S	3
5	4	0.5	W	3
5	4	1.0	N	<2
5	4	1.0	S	<2
5	5	0	N	<2
5	5	0	E	3 ± 7
5	5	0	S	<2
5	5	0	W	<2
5	5	0.5	N	6 ± 9
5	5	0.5	E	3 ± 7
5	5	0.5	S	<2
5	5	0.5	W	<2
5	5	1.0	N	<2
5	5	1.0	E	3 ± 7
5	5	1.0	S	<2
5	5	1.0	W	3 ± 7
6	5	0	N	3 ± 7
6	5	0	E	3 ± 7
6	5	0	S	<2
6	5	0	W	<2
6	5	0.5	N	<2
6	5	0.5	E	<2
6	5	0.5	S	3 ± 7
6	5	0.5	W	3 ± 7
6	5	1.0	N	<2
6	5	1.0	E	<2
6	5	1.0	S	<2
6	5	1.0	W	<2
6	7	0	N	3 ± 7
6	7	0	E	6 ± 9
6	7	0	S	<2
6	7	0	W	3 ± 7

TABLE 4-10
(continued)

Chimney Number	Air Vent Number	Depth from Top of Chimney	Orientation of Sample in Chimney	Alpha Activity (dpm/100 cm^2)
6	7	0.5	E	<2
6	7	0.5	S	<2
6	7	0.5	W	<2
6	7	1.0	N	3 ± 7
6	7	1.0	E	<2
6	7	1.0	S	3 ± 7
6	7	1.0	W	<2
6	8	0	N	<2
6	8	0	E	3 ± 7
6	8	0	S	<2
6	8	0	W	<2
6	8	0.5	N	<2
6	8	0.5	E	3 ± 7
6	8	0.5	S	3 ± 7
6	8	0.5	W	3 ± 7
6	8	1.0	N	3 ± 7
6	8	1.0	E	<2
6	8	1.0	S	<2
6	8	1.0	W	3 ± 7
6	9	0.5	W	<1
6	9	1.0	N	<1
6	9	1.0	W	<1
6	10	0	S	<2
6	10	0	W	<2
6	10	0.5	N	<2
6	10	0.5	E	3 ± 7
6	10	0.5	S	3 ± 7
6	10	0.5	W	<2
6	10	1.0	N	3 ± 7
6	10	1.0	E	<2
6	10	1.0	S	<2
6	10	1.0	W	<2
6	10	0	N	<2
6	10	0	E	3 ± 7

TABLE 4-11

DIRECT POST-REMEDIAL ACTION MEASUREMENTS ON THE FIFTH FLOOR

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
A1-1[a]	<34	<0.02
A1-2	<34	<0.01
A1-3	34 ± 42	<0.01
A1-4	34 ± 42	<0.01
A1-5	109 ± 67	<0.01
A2-2[a]	34 ± 42	<0.02
A2-3	90 ± 62	<0.01
A2-5	24 ± 38	<0.01
B1-3[a]	90 ± 62	<0.01
B1-4	53 ± 50	<0.01
B1-5	72 ± 56	<0.01
B2-3[a]	43 ± 46	<0.01
B2-5	<34	<0.01
C1-3[a]	53 ± 50	<0.02
C1-4	62 ± 53	<0.02
C1-5	34 ± 42	<0.01
C2-3[a]	43 ± 46	<0.01
C2-5	34 ± 42	<0.01
D1-3[a]	<48	<0.01
D1-4	<48	<0.01
D1-5	34 ± 42	<0.01
D2-3[a]	62 ± 53	<0.01
D2-5	<20	<0.01
BA1-1[b]	<34	<0.01
BA1-2	53 ± 50	<0.02
BA1-3	<34	<
BA1-4	34 ± 42	<0.01
BA1-5	<5	0.01 ± 0.01
BA2-2	<20	<0.01
BA2-3	<48	<0.01
BA2-5	34 ± 42	0.01 ± 0.01
BB1-3[b]	72 ± 56	<0.01
BB1-4	24 ± 38	<0.01
BB1-5	24 ± 38	<0.01
BB2-3	<34	<0.02
BB2-5	24 ± 38	0.01

TABLE 4-11

(continued)

Location	Alpha Activity (dpm/100 cm^2)	Beta-Gamma Activity (mrad/h)
CA1-1[c]	<33	0.01 ± 0.01
CA1-2	51 ± 50	0.02 ± 0.01
CA1-3	98 ± 65	<0.01
CA1-4	117 ± 70	<0.01
CA1-5	32 ± 43	<0.01
CB1-3	60 ± 53	0.04 ± 0.01
CB1-4	32 ± 43	<0.01
CB1-5	51 ± 50	0.11 ± 0.02
CC1-3	89 ± 62	0.13 ± 0.02
CC1-5	145 ± 77	<0.01
CE1-3	<33	0.01 ± 0.01
CE1-5	89 ± 62	<0.01
CA2-2	23 ± 38	<0.02
CA2-3	23 ± 38	<0.01
CA2-5	<19	0.03 ± 0.01
CB2-3	<47	0.09 ± 0.02
CB2-5	60 ± 53	<0.01
CC2-3	<19	<0.01
CC2-5	23 ± 38	0.02 ± 0.01
CD2-3	<33	<0.01
CD2-5	<33	0.01 ± 0.01
CE2-3	164 ± 81	0.06 ± 0.02
CE2-5	51 ± 50	<0.01
CE3-2	<47	<0.01
CE3-3	41 ± 46	<0.01
CE3-5	60 ± 53	<0.01

[a]Location designators beginning with "A1," "A2," "B1," "C1," "C2," "D1," and "D2" are shown in Figure 4-31.

[b]Location designators beginning with "BA" and "BB" are shown in Figure 4-32.

[c]Location designators beginning with "CA," "CB," "CD," and "CE" are shown in Figure 4-33.

TABLE 4-12

TRANSFERABLE POST-REMEDIAL ACTION MEASUREMENTS

ON THE FIFTH FLOOR

Location	Alpha Activity (dpm/100 cm^2)
A1-1[a]	<2
A1-4	3 ± 7
A1-5	<2
A2-2	3 ± 7
A2-3	3 ± 7
A2-5	3 ± 7
B1-3[a]	3 ± 7
B1-3	3 ± 7
B1-4	<2
B1-5	6 ± 9
C1-3[a]	6 ± 9
C1-4	10 ± 12
C1-5	3 ± 7
C2-3	6 ± 9
C2-5	<2
D1-5[a]	3 ± 7
D2-3	3 ± 7
BA1-2[b]	6 ± 10
BA1-4	6 ± 10
BB1-3	<9
BB1-4	<2
BB1-5	<2
BA2-5	<9
BB2-5	10 ± 12
CA1-2[c]	6 ± 10
CA1-3	3 ± 7
CA1-4	6 ± 10
CA1-5	<2
CB1-3	3 ± 7
CB1-4	6 ± 10
CB1-5	6 ± 10
CC1-3	3 ± 7
CC1-5	3 ± 7
CE1-5	17 ± 15
CA2-2	3 ± 7

TABLE 4-12

(continued)

Location	Alpha Activity (dpm/100 cm^2)
CA2-3[c]	3 ± 7
CB2-5	<2
CC2-5	<2
CE2-3	6 ± 10
CE2-5	3 ± 7
CE3-3	<2
CE3-5	<2

[a]Location designators beginning with "A1," "A2," "B1," "C1," "C2," "D1," and "D2" are shown in Figure 4-31.

[b]Location designators beginning with "BA" and "BB" are shown in Figure 4-32.

[c]Location designators beginning with "CA," "CB," "CD," and "CE" are shown in Figure 4-33.

5.0 POST-REMEDIAL ACTION STATUS

The post-remedial action data indicate that the remedial action performed at Jones Laboratory was successful in bringing the site into compliance with applicable DOE remedial action guidelines for the cleanup of radioactive contamination. Based on a review of post-remedial action measurements, measurement procedures, and quality assurance data, the Independent Verification Contractor (IVC) will determine whether the measurements obtained verify that the site has been decontaminated to the extent that it meets the guidelines established for the site or project (Refs. 9-11).

The IVC is responsible for preparing a generic plan outlining the procedures to be used in conducting verification activities. There are two types of verification reviews (Type A and Type B); the IVC will conduct either or both types as specified in the verification plan. The Type A verification review consists of a review of post-remedial action data and data collected by radiological contractors; it may also include the collection and analysis of additional samples. In performing a Type B verification review, the IVC visits the site and conducts a survey that includes direct measurements as well as sampling and/or split sample analyses.

After completing verification activities, the IVC will notify DOE-Headquarters, Division of Facility and Site Decommissioning, and DOE-Oak Ridge Operations, Technical Services Division, of its findings and recommendations. DOE will review the data to determine whether the remedial action was successful. If radiological conditions at the site are determined based on this review to be in compliance with DOE decontamination criteria and standards developed to protect health, safety, and the environment, DOE will certify the site as being appropriate for future use.

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GLOSSARY

Alpha-emitting - See radiation.

Background Radiation - Background radiation refers to naturally occurring radiation emitted from either cosmic (e.g., from the sun) or terrestrial (e.g., from the earth) sources. Exposure to this type of radiation is unavoidable, and its level varies greatly depending on geographic location. For example, New Jersey typically receives 100 millirem (mrem) per year, Colorado receives about 300 mrem/yr, and some areas in South America receive up to 7000 mrem/yr. Naturally occurring terrestrial radionuclides include uranium, radium, potassium, thorium, etc. (see definition of radionuclide below). These dose levels do not include the concentrations of naturally occurring radon inside buildings.

Beta-gamma-emitting - See radiation.

Centimeter - A centimeter (cm) is a metric unit of measurement for length; 1 inch is equal to 2.54 cm; 1 foot is equal to approximately 30 cm.

Contamination - Contamination is used generally to mean a concentration of one or more radioactive materials that exceeds naturally occurring levels. Contamination may or may not exceed the DOE cleanup guidelines.

Counts per minute - A count is the unit of measurement registered by a radiation detection instrument when radiation imparts its energy within the sensitive range of the detector probe. The number of counts registered per minute can be related to the number of disintegrations per minute occurring from a radioactive material. See the definition of disintegrations per minute.

Disintegrations per minute - Disintegrations per minute (dpm) is the measurement indicating the amount of radiation being released from a substance per minute. See the definition of picocurie.

Dose - Dose as used in this report is actually dose equivalent and is used to relate absorbed dose (mrad) to an effect on the body. Dose is measured in mrem. For the purpose of comparison, a dose of 500,000 mrem to the whole body within a short time causes death in 50 percent of the people who receive it; a dose of 5,000,000 mrem may be delivered to a cancerous tumor during radiation treatment; normal background radiation results in an annual dose of about 100 mrem; DOE radiation protection standards limit the dose to members of the general public to 100 mrem/yr above background levels; living in a brick house typically results in a dose of about 75 mrem/yr above the background level.

Exposure rate - Exposure rate is the rate at which radiation imparts energy to the air. Exposure is typically measured in microroentgens (uR), and exposure rate is typically expressed as uR/h. The dose to the whole body can be approximated by multiplying the exposure rate by the number of hours of exposure. For example, if an individual were exposed to gamma radiation at a rate of 20 uR/h for 168 hours per week (continuous exposure) for 52 weeks per year, the whole-body dose would be 170 mrem.

Gamma Radiation - See radiation.

Gram - A gram (g) is a metric unit of weight. There are 454 g in 1 pound, and 28 g in 1 ounce.

Meter - A meter (m) is a metric unit of length; 1 m is equal to approximately 39 inches.

Microcurie - A microcurie is 1,000,000 picocuries (see definition of picocurie for additional explanation).

Microroentgen - A microroentgen (uR) is a unit used to measure radiation exposure. For further information, see the definition of exposure rate.

Milliliter - A milliliter (ml) is a unit of measure for volume. There are 3785 ml in 1 gallon.

Millirad - The millirad (mrad) is used to indicate the amount of energy imparted by radiation to a unit of mass. An absorbed dose rate is expressed in terms of mrad per hour (mrad/h).

Millirem - The millirem (mrem) is the unit used to measure radiation dose to man. The DOE dose limit is 100 mrem above background radiation levels within any one-year period for members of the general public. Naturally occurring radioactive substances in the ground result in a yearly exposure of about 100 mrem to each member of the population. To date, no difference can be detected in the health of population groups exposed to 100 mrem/yr above background and in the health of groups who are not exposed.

Picocurie - A picocurie (pCi) is the unit of measure for radioactivity, just as an ounce is a unit to measure weight. A measurement of 1 pCi means that one radioactive particle is released on the average of every 27 seconds.

Radium-226 - Radium-226 is a naturally occurring radioactive material that spontaneously emits alpha radiation.

Radiation - There are three primary types of radiation: alpha, beta, and gamma. Alpha radiation travels less than an inch in air before it stops. Alpha radiation cannot penetrate the outer layer of skin on the body. Beta radiation can penetrate the outer layers of skin, but cannot reach the internal organs of the body. Gamma radiation is the most penetrating type and can usually reach the internal organs.

Radionuclide - Radioactive elements are also referred to as radionuclides. For example, uranium-235 is a radionuclide, uranium-238 is another, thorium-232 another, and so on.

Remedial Action - Remedial action is a general term used to mean "cleanup of contamination that exceeds DOE guidelines." It refers to any action required so that a property can be certified as being in compliance with guidelines and can therefore be released for future use. In practice, this may mean removing grass and soil, cutting trees, removing asphalt, etc. Remedial action also includes restoring remediated properties to their original conditions, to the extent that this is possible.

Uranium - Uranium is a naturally occurring, radioactive element. The principal use of uranium when refined is for the production of fuel for nuclear reactors. Uranium in its natural form is not suitable for use as a fuel source.

Working Level - Working level (WL) is a unit of measurement for the amount energy expended in air by radon or its radioactive decay products. The term was derived to measure radon progeny concentrations to which uranium miners were exposed.