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Mr. John Hickman
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U.S. Nuclear Regulatory Commission
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SUBJECT: FINAL REPORT— CONFIRMATORY SURVEY OF THE TURBINE BUILDING AND PORTIONS OF THE SERVICE BUILDING OUTSIDE THE RCA, YANKEE NUCLEAR POWER STATION, ROWE, MASSACHUSETTS [DOCKET NO. 50-29; RFTA NO. 03-026]

Dear Mr. Hickman:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed confirmatory survey activities in the Turbine Building and portions of the Service Building outside the RCA at the Yankee Nuclear Power Station (YNPS) Plant in Rowe, Massachusetts. At the request of the NRC site representative, limited radiological surveys of the Front Office Rubble Pile were also performed. Survey activities included document and data reviews; beta and gamma surface scans; and, beta surface activity measurements.

Enclosed are five copies of the subject report with your comments incorporated. If you have any additional questions or comments, please direct them to me at (865) 576-0065 or Timothy J. Vitkus at (865) 576-5073.

Sincerely,

Wade C. Adams

Wade C. Adams
Health Physicist/Project Leader
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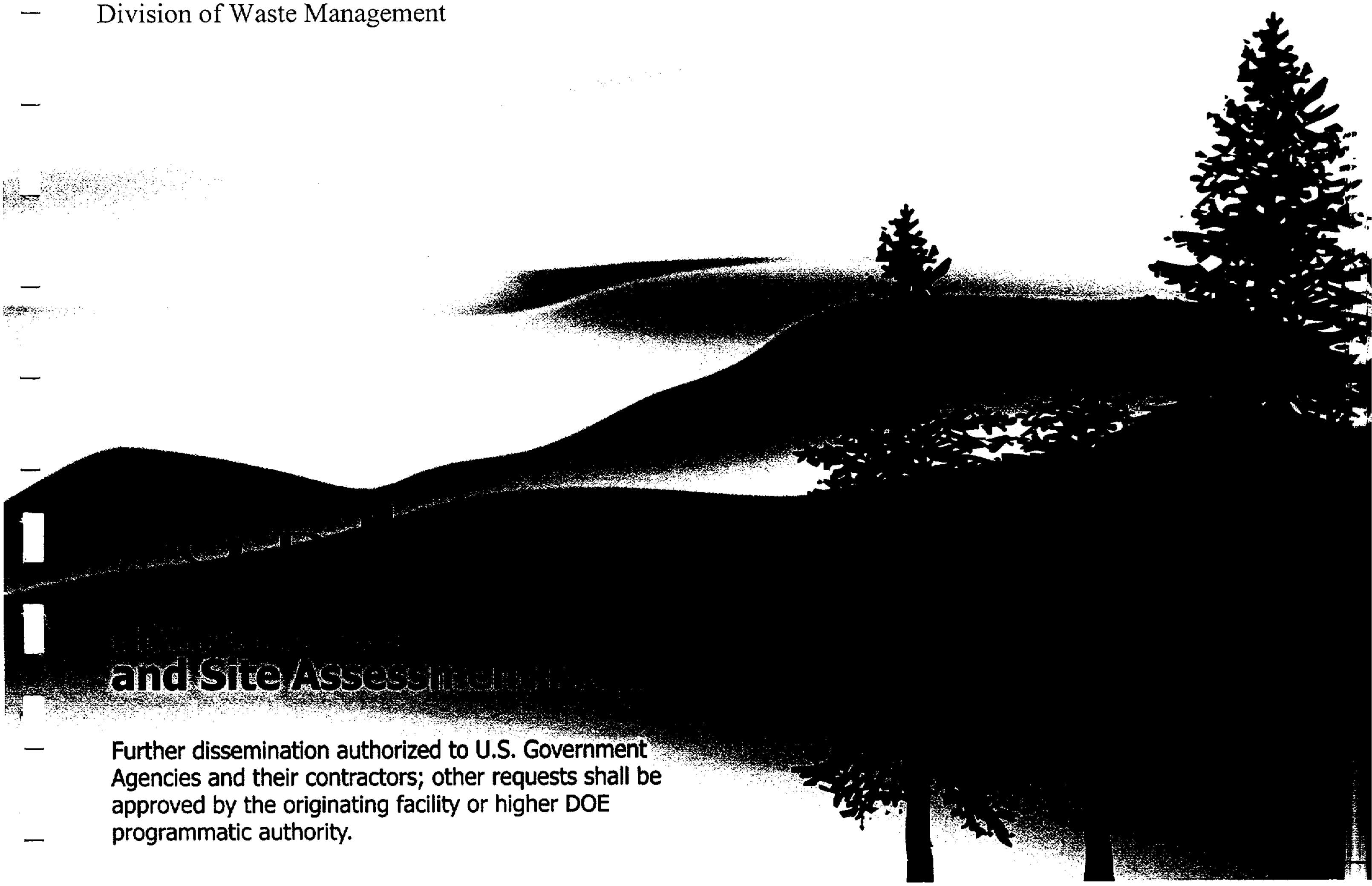
CONFIRMATORY SURVEY OF THE TURBINE BUILDING AND PORTIONS OF THE SERVICE BUILDING OUTSIDE THE RCA YANKEE NUCLEAR POWER STATION ROWE, MASSACHUSETTS

W.C. ADAMS

Prepared for the
U.S. Nuclear Regulatory Commission
Division of Waste Management



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CONFIRMATORY SURVEY OF THE TURBINE BUILDING AND PORTIONS OF THE SERVICE BUILDING OUTSIDE THE RCA YANKEE NUCLEAR POWER STATION ROWE, MASSACHUSETTS

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Division of Waste Management

FINAL REPORT

DECEMBER 2003

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CONFIRMATORY SURVEY OF THE TURBINE BUILDING AND PORTIONS OF THE SERVICE BUILDING OUTSIDE THE RCA YANKEE NUCLEAR POWER STATION ROWE, MASSACHUSETTS

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TABLE OF CONTENTS

PAGE

List of Figures ii

List of Tables iii

Abbreviations and Acronyms iv

Introduction and Site History 1

Site Description 3

Objectives 3

Document Review 4

Procedures 4

Sample Analysis and Data Interpretation 5

Findings and Results 6

Comparison of Results with Guidelines 7

Summary 7

Figures 9

Tables 16

References 25

Appendices:

Appendix A: Major Instrumentation

Appendix B: Survey and Analytical Procedures

Appendix C: IE Circular No. 81-07: Control of Radioactively Contaminated Material

LIST OF FIGURES

PAGE

FIGURE 1: Location of the Yankee Nuclear Power Station—Rowe, Massachusetts 10

FIGURE 2: Layout of the Surveyed Areas at the Yankee Nuclear Power Station—Rowe, Massachusetts 11

FIGURE 3: Turbine Building, Ground Floor Level—Measurement and Sampling Locations 12

FIGURE 4: Turbine Building, Mezzanine Level—Measurement and Sampling Locations 13

FIGURE 5: Turbine Building, Operating Floor Level—Measurement and Sampling Locations 14

FIGURE 6: Service Building—Measurement and Sampling Locations 15

LIST OF TABLES

PAGE

TABLE 1: Surface Activity Levels—Ground Floor Level, Turbine Building 17

TABLE 2: Surface Activity Levels—Mezzanine Level, Turbine Building 19

TABLE 3: Surface Activity Levels—Operating Floor Level, Turbine Building 21

TABLE 4: Surface Activity Levels—Front Office Rubble Pile, Turbine Building 23

TABLE 5: Surface Activity Levels—Service Building 24

ABBREVIATIONS AND ACRONYMS

β-γ	beta-gamma
ε_i	instrument efficiency
ε_s	surface efficiency
ε_{total}	total efficiency
AEC	Atomic Energy Commission
b_i	number of background counts in the interval
BKG	background
cm	centimeter
cm^2	square centimeter
Co-60	cobalt-60
cpm	counts per minute
Cs-137	cesium-137
d'	index of sensitivity
DOD	Department of Defense
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
ft	feet
FSS	final status survey
H-3	tritium
ISM	integrated safety management
ISO	International Standards Organization
ITP	Intercomparison Testing Program
JHA	job hazard analysis
keV	kiloelectron volts
LSA	liquid scintillation analyzer
LTP	license termination plan
m	meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MeV	million electron volts
min	minute
mm	millimeter
MW	megawatt
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORISE	Oak Ridge Institute for Science and Education

ABBREVIATIONS AND ACRONYMS (continued)

sec	second
Tc-99	technetium-99
YAEC	Yankee Atomic Electric Company
YNPS	Yankee Nuclear Power Station

CONFIRMATORY SURVEY OF THE TURBINE BUILDING AND PORTIONS OF THE SERVICE BUILDING OUTSIDE THE RCA YANKEE NUCLEAR POWER STATION ROWE, MASSACHUSETTS

INTRODUCTION AND SITE HISTORY

The Yankee Atomic Electric Company (YAEC) was incorporated in Massachusetts in 1954. YAEC was sponsored by ten New England utilities for the purpose of constructing and operating New England's first nuclear power plant (and the United States third nuclear plant), the Yankee Nuclear Power Station (YNPS). YAEC is the holder of YNPS Facility Operating License DPR-3 issued under the authority of the Atomic Energy Commission (AEC) Docket Number 50-029. The plant achieved initial criticality in 1960 and began commercial operations in 1961. The original thermal power design limit of 485 megawatts (MW) was upgraded to 600 MW in 1963 (YAEC 2003a).

On February 26, 1992, the YAEC Board of Directors decided to cease power operations permanently at YNPS. On August 5, 1992 the U.S. Nuclear Regulatory Commission (NRC) amended the YNPS Facility Operating License to a possession-only status.

Three decommissioning approaches have been submitted to the NRC. The first approach was a Decommissioning Plan submitted on March 29, 1994, which received final approval in October 1995. In May 1997, Yankee submitted to the NRC for approval a License Termination Plan (LTP) for YNPS, pursuant to 10 CFR 50.82 (a)(9). The initial YNPS LTP employed a survey methodology based upon the "Manual for Conducting Radiological Surveys in Support of License Termination," also referred to as the Draft NUREG/CR-5849 methodology (NRC 1992). Subsequently the NRC, jointly with the DOD, DOE, and EPA, approved an alternate survey methodology documented in MARSSIM [Multi-Agency Radiation Survey and Site Investigation Manual (NRC 2000)]. In May 1999, YAEC advised the NRC that it intended to shift from the survey methodology in NUREG/CR-5849 to the MARSSIM methodology, and withdrew its previously submitted LTP application. The current LTP is written to reflect the MARSSIM methodology, as well as regulatory guidance made available since the previous LTP submittal (YAEC 2003a).

The turbine system components processed steam, from the steam generators, that rotated the turbine blades and produced electrical power via the motor end of the turbine—the system was not intended to involve radioactive materials. Currently, YAEC is decommissioning the Turbine Building and has submitted radiological survey data to support the release of the shell and supporting structural components of the Turbine Building (YAEC 2003b). YAEC intends to demolish the structure and dispose of the debris. The following information identifies conditions and events where radioactive material was present in the Turbine Building.

A portion of the Turbine Building became contaminated in 1967 while a main coolant pump was being refurbished on the turbine deck; at that time the area was decontaminated. The event was incorporated into plans for decommissioning activities and survey plans developed for this area.

The condensate system contained radioactive materials as a result of primary to secondary system leakage that occurred in the steam generators. Contamination from this leak was identified in the floor drain system and in the soil around and under the floor drains. Additional contaminated concrete surfaces and soil below the concrete floor were identified near turbine support pedestal #4. All of these identified sub-surface locations have undergone a remediation process and have been backfilled to grade. The interior of the structure and slab were surveyed under Draft NUREG/CR-5849 criteria after decommissioning activities were complete.

There is also a known plume of tritium (H-3) beneath the building. The general sub-surface conditions are the subject of a continuing investigation.

Current decontamination and decommissioning activities for the Turbine Building are as follows:

- Removal of secondary systems;
- Removal of equipment;
- Removal of sub-floor systems (floor and equipment drains, service water piping);
- Removal of soil from around the sub-floor systems; and
- Soil excavations backfilled.

Planned decommissioning activities for the Turbine Building include the demolition of the entire structure to elevation 1022' 8" (grade).

In May 1999, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed decommissioning inspection activities at YNPS which included survey activities of the Turbine Building (ORISE 1999).

The NRC's Headquarters and Region I Offices requested that ESSAP perform additional confirmatory surveys of the Turbine Building and limited confirmatory survey activities in the Service Building at the YNPS. During the survey activities, the NRC site representative also requested that ESSAP perform limited radiological survey activities on the Turbine Building Front Office Rubble Pile.

SITE DESCRIPTION

The YNPS is located at 49 Yankee Road in Rowe, Massachusetts (Figure 1). The Turbine and Service Buildings are located within the restricted area of the power plant (Figure 2). The Turbine Building, which contained the turbine system, measures 48 m (159 ft) by 23 m (77 ft) high by 27 m (87 ft) wide and consists of three floors. The Mezzanine Level and the turbine deck (Operating Floor Level) have a large area of open space in the center where the turbine was previously located. The Turbine and Service Buildings are constructed of heavy steel framework with a concrete block lower structure and a steel frame and metal panel upper structure (YAEC 2003a). The concrete (and concrete block) surfaces were either found to be free of paint and other surface coatings in some locations, were painted in some areas, or had been scabbled in other locations during remediation. Other surfaces included metal grating used for the Mezzanine Level floor and the stairways, metal structural support beams and some sheetrock used on the walls.

OBJECTIVES

The objectives of the confirmatory survey were to provide independent contractor field data reviews and to generate independent radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's procedures and final status survey (FSS) results and conclusions.

DOCUMENT REVIEW

ESSAP personnel reviewed the licensee's FSS documentation and survey data for the Turbine Building and the Turbine Building Front Office for adequacy and appropriateness (YAEC 2003b and c). FSS results were not yet available for the Service Building at the time of the ESSAP confirmatory survey activities.

PROCEDURES

ESSAP personnel visited the YNPS facility during the period of September 24 to 25, 2003 and performed visual inspections and independent measurements and sampling of portions of the site. Survey activities were conducted in accordance with a site-specific survey plan and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2003a, b, and c).

Additional survey activities were performed on various Front Office Building Rubble Pile remains, which included various construction materials such as concrete block, metal siding, sheetrock, wood and metal beams. Survey activities were not performed on the floor surface of the Ground Floor since the planned demolition of the Turbine Building structure will be down to the Ground Floor elevation (YAEC 2003a).

REFERENCE SYSTEM

Measurements and sampling locations for'the Turbine and Service Buildings were referenced to the existing YAEC-established grid system and on figures prepared by ESSAP (Figures 3 through 6). A figure is not provided for the Turbine Building Front Office Rubble Pile measurement locations.

SURFACE SCANS

Surfaces in each survey unit were scanned for total beta radiation using gas proportional detectors and scanned for gamma radiation using NaI scintillation detectors. Total beta and gamma radiation scans were performed on approximately 25% of the concrete floors and walls.

Particular attention was given to cracks and joints in the concrete surfaces, scabbled surface areas, and other locations where material may have accumulated. All detectors were coupled to ratemeters or ratemeter-scalers with audible indicators.

SURFACE ACTIVITY MEASUREMENTS

The construction material-specific beta background for concrete and metal surfaces for the gas proportional detectors was determined while on site. Direct measurements for total beta activity on Turbine Building surfaces were performed at 152 locations which were identified by surface scans or corresponded to licensee measurement locations (Figures 3 through 5). Direct measurements for total beta activity on the Service Building (Figure 6) and the Front Office Rubble Pile surfaces were performed at 23 and 20 locations, respectively. Measurements were performed using gas proportional detectors coupled to portable ratemeter-scalers. Smears, for determining removable gross alpha and gross beta activity, were collected at each direct measurement location. A second wet smear, for determining removable H-3 activity, was collected from ten of the direct measurement locations on each floor of the Turbine Building—H-3 smears were not collected from the Service Building or the Front Office Rubble Pile.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Samples were analyzed in accordance with the ESSAP Laboratory Procedures Manual (ORISE 2003d). Smears were analyzed for gross alpha and gross beta activity using a low-background gas proportional counter and for H-3 using a liquid scintillation analyzer (LSA). Smear data and direct measurements for surface activity were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2).

Survey data were then compared with the site-specific guideline levels for the Turbine Building which are from the NRC Circular 81-07 (NRC 1981). The primary contaminants of concern for the Turbine Building (and other areas) were beta-gamma emitters—fission and activation products—resulting from reactor operation. Appendices A and B provide additional information

concerning major instrumentation, sampling equipment, and analytical procedures discussed in this report, including minimum detectable concentrations for field and laboratory instruments.

FINDINGS AND RESULTS

DOCUMENT REVIEW

Information provided in YAEC's FSS documentation was evaluated to assure that areas identified as exceeding guidelines had undergone decontamination and that residual activity levels satisfied the established guidelines.

SURFACE SCANS

Beta surface scans of the floors and walls of the Turbine and Service Buildings and the Front Office Rubble Pile did not identify any areas of elevated radiation. Gamma scans did not identify any indications of volumetric or subsurface contamination (i.e., gamma radiation levels were consistently within background ranges) except for portions of the northern walls which are in proximity to the reactor containment vessel.

SURFACE ACTIVITY LEVELS

Turbine Building

Results of total and removable surface activity for the Turbine Building are provided in Tables 1 through 3. Total beta surface activity for the Ground Floor, Mezzanine, and Operating Floor levels of the Turbine Building ranged from -610 to 850 dpm/100 cm^2, -580 to 970 dpm/100 cm^2, and -330 to 1,200 dpm/100 cm^2, respectively. Removable surface activity for all the levels ranged from 0 to 5 dpm/100 cm^2 for gross alpha, -6 to 8 dpm/100 cm^2 for gross beta, and -16 to 52 dpm/100 cm^2 for H-3.

Front Office Rubble Pile

Results of total and removable surface activity for the Front Office Rubble Pile are provided in Table 4. Total beta surface activity ranged from 130 to 1,300 dpm/100 cm^2. Removable surface activity ranged from 0 to 1 dpm/100 cm^2 for gross alpha and -5 to 6 dpm/100 cm^2 for gross beta.

Service Building

Results of total and removable surface activity for the Service Building are provided in Table 5. Total beta surface activity ranged from -310 to 1,300 dpm/100 cm^2. Removable surface activity ranged from 0 to 3 dpm/100 cm^2 for gross alpha and -4 to 5 dpm/100 cm^2 for gross beta.

COMPARISON OF RESULTS WITH GUIDELINES

The primary contaminants of concern for the YNPS are beta-gamma emitters—fission and activation products—resulting from reactor operation. Cesium-137 (Cs-137) and cobalt-60 (Co-60) were identified during characterization as the predominant radionuclides present on surfaces. The minimal detection criteria from NRC Circular 81-07 (NRC 1981) are as follows:

Total Activity
5,000 β-γ dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity
1,000 β-γ dpm/100 cm^2

No direct measurements performed in the Turbine and Service Buildings or the Front Office Rubble Pile exceeded the guidelines.

SUMMARY

At the request of the Nuclear Regulatory Commission's Headquarters and Region I Offices, the Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education conducted a confirmatory survey of the Turbine Building and the Service Building and a limited radiological survey of the Front Office Rubble Pile at the Yankee Nuclear Power

Station in Rowe, Massachusetts. Confirmatory activities performed during the period September 24 through 25, 2003 included reviews of final status survey data, surface scans and direct surface activity measurements. Overall, the results of the survey activities confirmed that the radiological conditions of the Turbine Building and the Service Building met the approved site-specific criteria for unrestricted use or release. The results of the limited radiological survey of the Front Office Rubble Pile also indicated that this material met the criteria for unrestricted use or release.

FIGURES

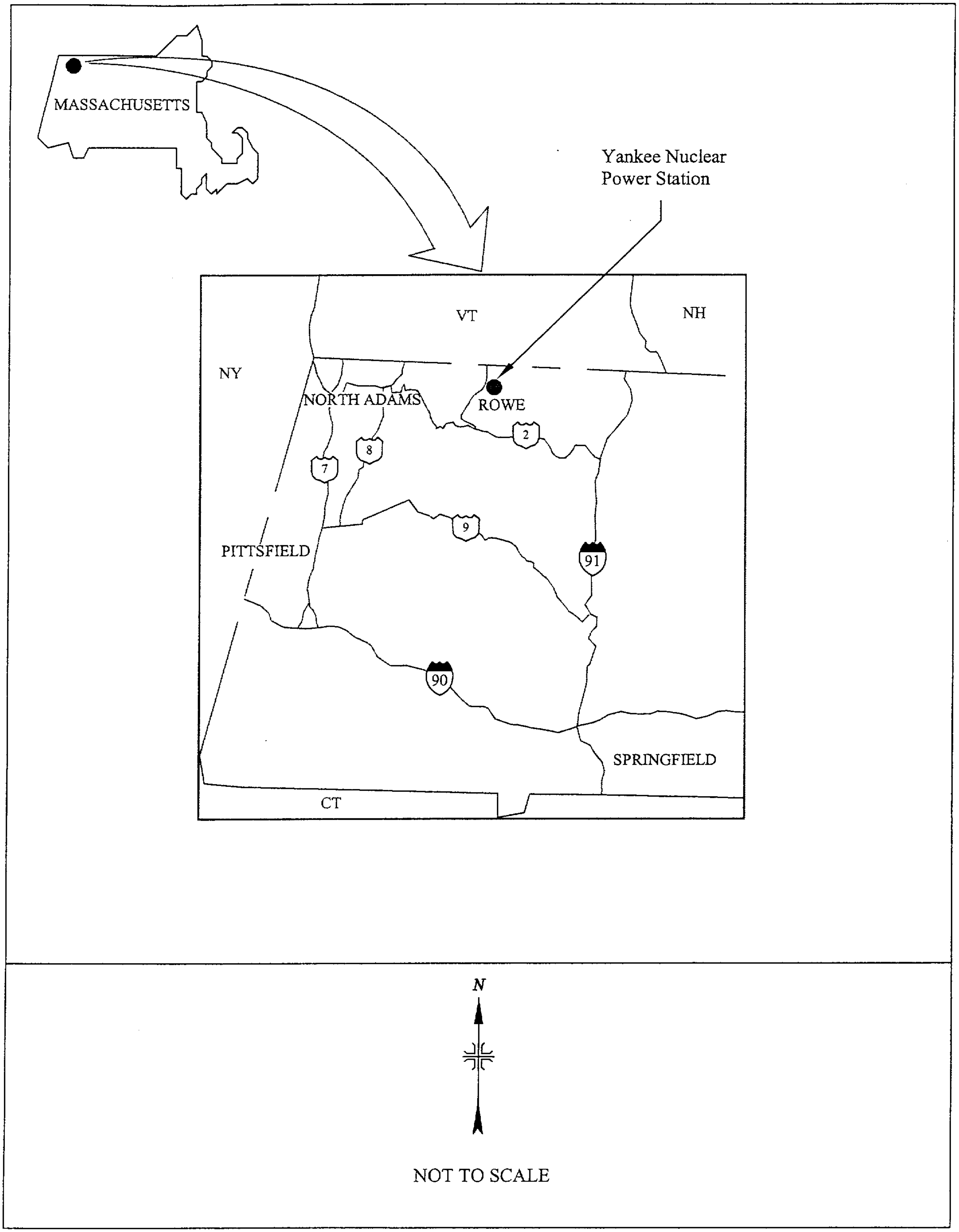


FIGURE 1: Location of the Yankee Nuclear Power Station - Rowe, Massachusetts

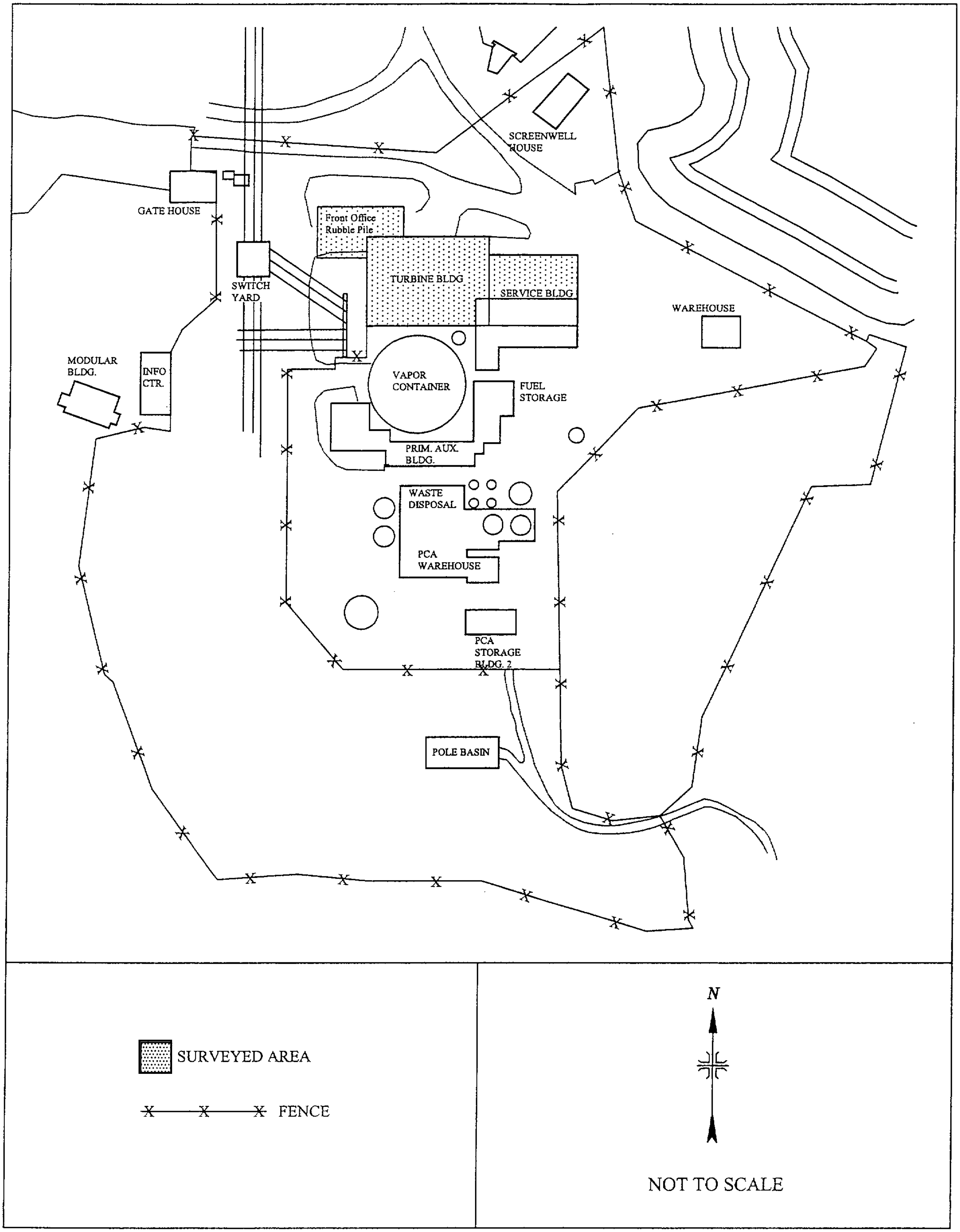
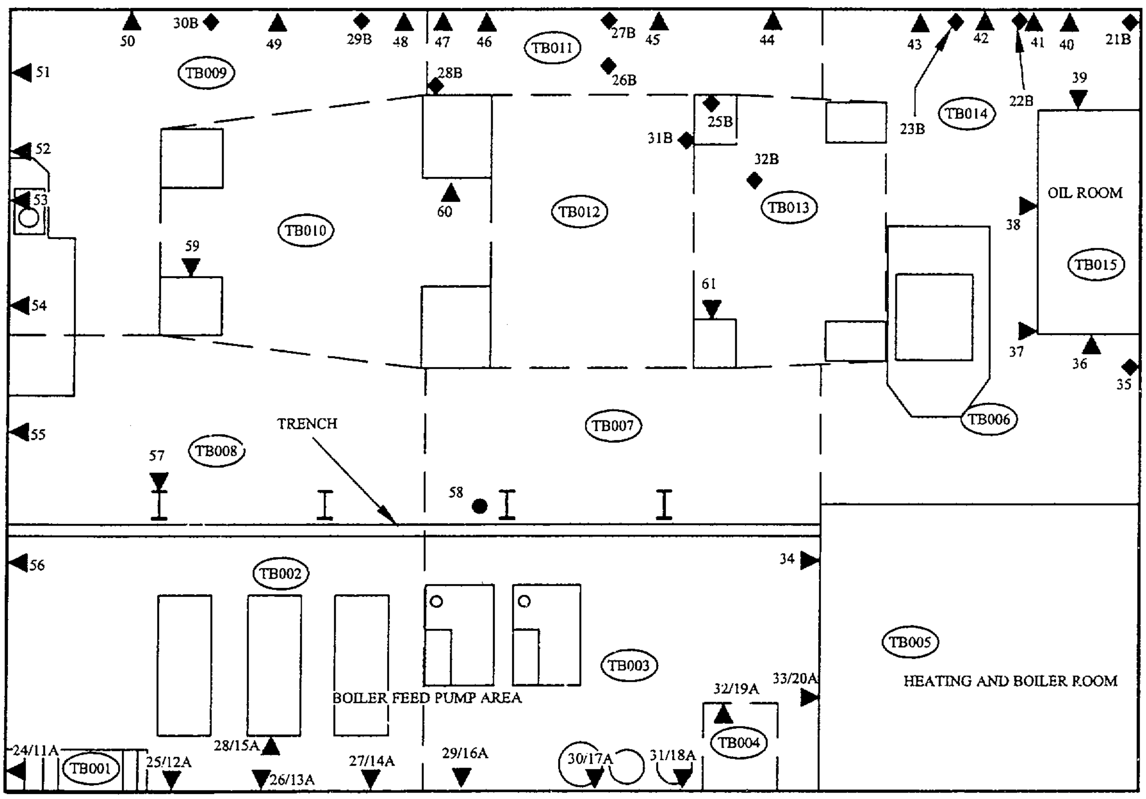


FIGURE 2: Layout of the Surveyed Areas at the Yankee Nuclear Power Station - Rowe, Massachusetts

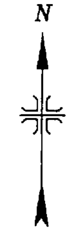


MEASUREMENT/SAMPLING LOCATIONS

● # SINGLE-POINT FLOOR

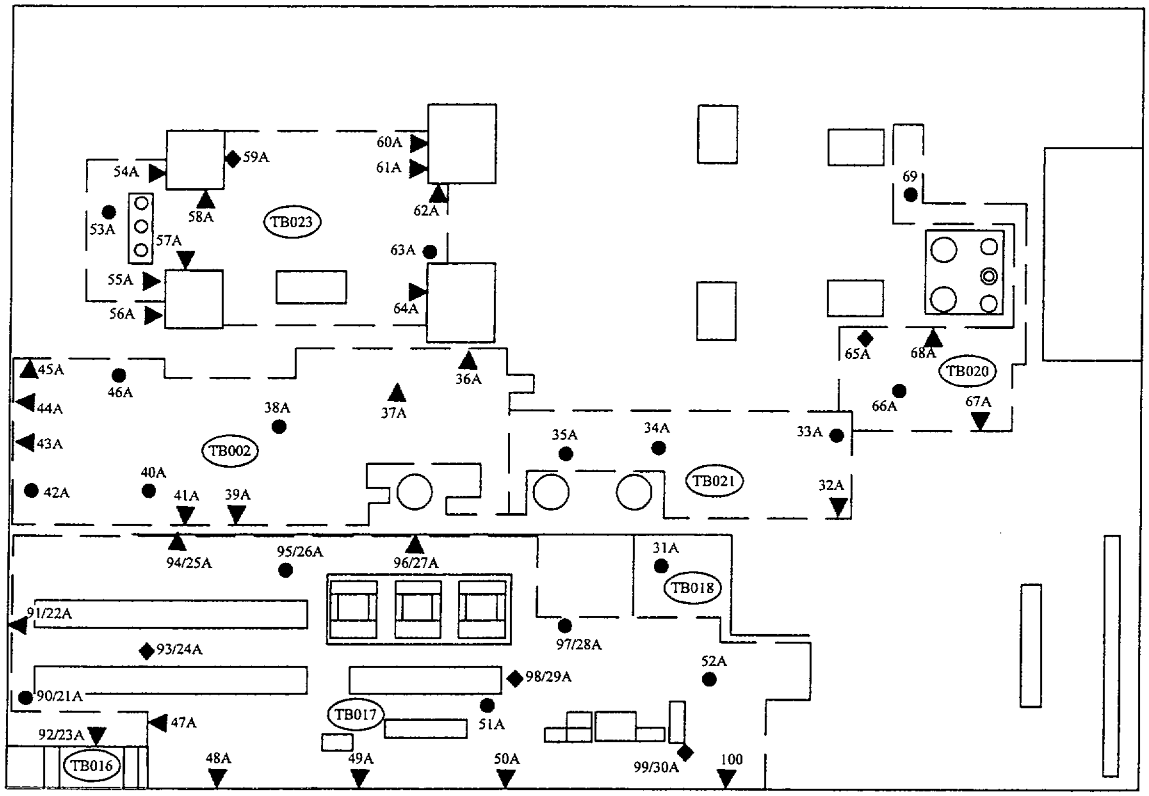
▲ # SINGLE-POINT LOWER WALLS

◆ # SINGLE-POINT UPPER SURFACES



NOT TO SCALE

FIGURE 3: Turbine Building, Ground Floor Level - Measurement and Sampling Locations

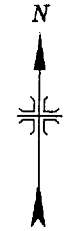


MEASUREMENT/SAMPLING LOCATIONS

● # SINGLE-POINT FLOOR

▲ # SINGLE-POINT LOWER WALLS

◆ # SINGLE-POINT UPPER SURFACES



NOT TO SCALE

FIGURE 4: Turbine Building, Mezzanine Level - Measurement and Sampling Locations

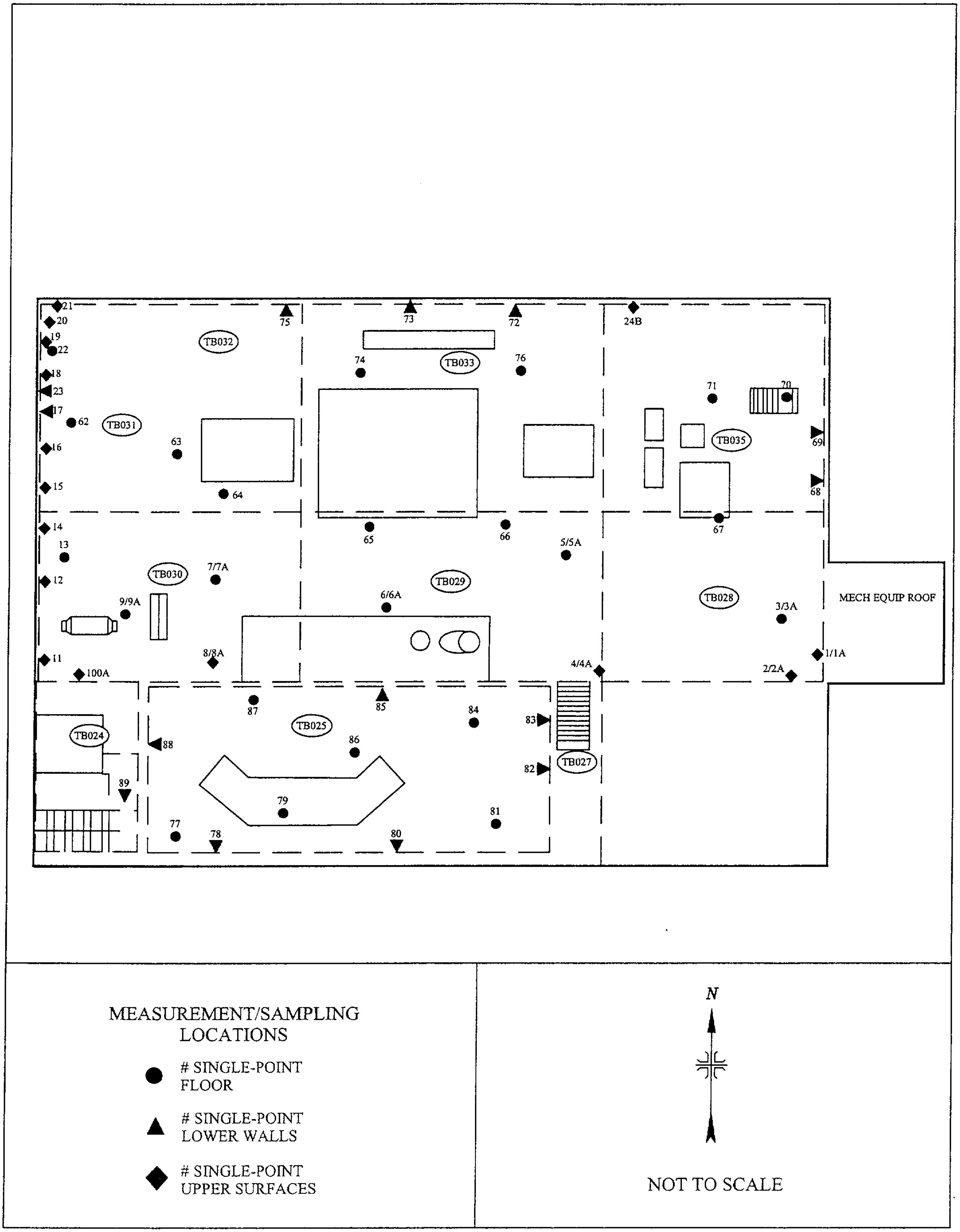


FIGURE 5: Turbine Building, Operating Floor Level - Measurement and Sampling Locations

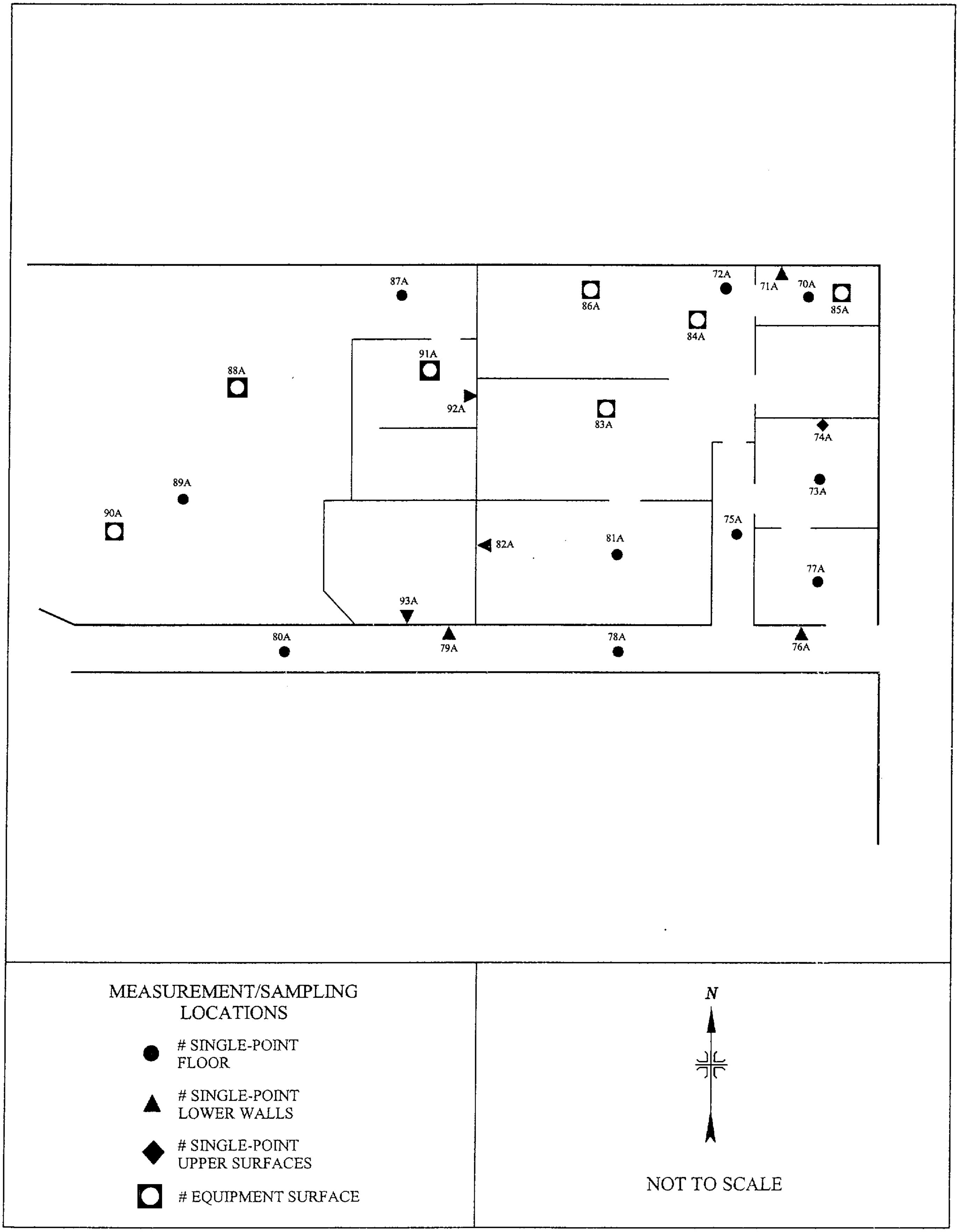


FIGURE 6: Service Building - Measurement and Sampling Locations

TABLES

TABLE 1

SURFACE ACTIVITY LEVELS
GROUND FLOOR LEVEL
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		
			Alpha	Beta	H-3
SU TB002					
24/11A	LW	48	0	-4	-10
25/12A	LW	24	0	-1	3
26/13A	LW	-210	0	-4	-10
27/14A	LW	-63	1	1	22
28/15A	LW	87	0	-3	3
32B	US	-330	0	-2	--[c]
33B	US	850	0	3	--
SU TB003					
29/16A	LW	320	0	-2	21
30/17A	LW	-79	3	3	-1
31/18A	LW	-410	0	1	15
32/19A	LW	-8	0	-1	13
SU TB006					
35	US	-370	0	-6	--
36	LW	-380	0	2	--
37	LW	-130	1	-6	--
SU TB007					
33/20A	LW	-600	0	2	14
34	LW	-450	5	-3	--
58	LW	480	0	3	--
SU TB008					
55	LW	-330	0	-1	--
56	LW	-170	0	-1	--
57	LW	-71	0	1	--
SU TB009					
49	LW	40	0	-2	--
50	LW	-56	1	-4	--
51	LW	-320	0	2	--
52	LW	710	0	-4	--
53	LW	-610	1	-4	--
54	LW	250	1	-1	--
29B	US	16	0	4	--
30B	US	-40	0	2	--

TABLE 1 (continued)

SURFACE ACTIVITY LEVELS
GROUND FLOOR LEVEL
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		
			Alpha	Beta	H-3
SU TB010					
59	LW	16	0	-2	--
60	LW	-170	0	1	--
SU TB011					
44	LW	24	0	1	--
45	LW	740	0	-3	--
46	LW	180	1	1	--
47	LW	-120	1	1	--
48	LW	-370	0	-1	--
25B	US	-510	1	-1	--
26B	US	400	0	3	--
27B	US	110	0	2	--
28B	US	-250	3	-1	--
SU TB012					
31B	US	-140	1	-1	--
SU TB013					
61	LW	-95	0	-3	--
SU TB014					
38	LW	-280	0	3	--
39	LW	-320	1	-2	--
40	LW	-250	1	1	--
41	LW	-310	0	2	--
42	LW	390	0	1	--
43	LW	-300	0	-2	--
21B	US	-100	0	-1	--
22B	US	370	0	-3	--
23B	US	56	0	-3	--

[a]Refer to Figure 3.
[b]LW = lower wall and US = upper surface.
[c]Measurement not performed.

TABLE 2

SURFACE ACTIVITY LEVELS
MEZZANINE LEVEL
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		
			Alpha	Beta	H-3
SU TB006					
65A	US	-430	0	-4	--[c]
SU TB017					
90/21A	F	600	1	-5	17
91/22A	LW	-340	1	-3	15
92/23A	LW	63	0	3	5
93/24A	US	290	0	2	0
94/25A	LW	-370	0	3	15
95/26A	F	280	0	-1	0
96/27A	LW	63	0	1	6
97/28A	F	490	1	3	3
98/29A	US	560	0	1	0
99/30A	US	140	0	-2	-5
100	LW	-270	0	-1	--
47A	LW	87	0	-3	--
48A	LW	-150	0	8	--
49A	LW	-24	1	3	--
50A	LW	-100	0	-1	--
51A	F	540	1	3	--
52A	F	440	0	-1	--
SU TB018					
31A	F	-71	0	3	--
SU TB020					
66A	F	570	0	-2	--
67A	LW	180	0	-1	--
68A	LW	520	1	-3	--
69A	F	700	0	-4	--
SU TB021					
32A	LW	-580	1	5	--
33A	F	870	0	2	--
34A	F	750	1	2	--
35A	F	440	0	-2	--

TABLE 2 (continued)

SURFACE ACTIVITY LEVELS
MEZZANINE LEVEL
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		
			Alpha	Beta	H-3
SU TB022					
36A	LW	-520	0	-5	--
37A	US	79	1	-3	--
38A	F	410	1	3	--
39A	LW	-140	0	2	--
40A	F	220	0	-4	--
41A	LW	790	1	-1	--
42A	F	280	0	1	--
43A	LW	420	1	4	--
44A	LW	110	1	-1	--
45A	LW	-310	1	3	--
46A	F	400	0	1	--
SU TB023					
53A	F	970	1	-2	--
54A	LW	-290	0	-4	--
55A	LW	-400	5	-1	--
56A	LW	-260	0	1	--
57A	LW	87	1	-3	--
58A	LW	-180	1	-2	--
59A	US	210	3	2	--
60A	LW	140	1	-2	--
61A	US	180	0	-2	--
62A	LW	-150	0	2	--
63A	F	430	0	-2	--
64A	LW	-56	0	1	--

[a]Refer to Figure 4.
[b]F = floor, LW = lower wall and US = upper surface.
[c]Measurement not performed.

TABLE 3

SURFACE ACTIVITY LEVELS
OPERATING FLOOR LEVEL
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		
			Alpha	Beta	H-3
TB024					
89	LW	32	1	-4	--[c]
TB025					
77	F	630	0	-3	--
78	LW	480	0	-3	--
79	F	530	0	1	--
80	LW	440	0	-3	--
81	F	1,000	1	-1	--
82	LW	250	1	-1	--
83	LW	330	0	-3	--
84	F	910	1	-3	--
85	LW	440	1	1	--
86	F	700	1	-2	--
87	F	600	0	-2	--
88	LW	470	0	1	--
TB028					
67	F	710	1	1	--
1/1A	LW	1,200	0	1	-8
2/2A	LW	700	1	-1	13
3/3A	F	950	5	1	-4
TB029					
4/4A	LW	-250	0	-2	5
5/5A	F	600	0	4	-16
6/6A	F	900	1	-3	0
65	F	810	3	2	--
66	F	710	0	-1	--
TB030					
7/7A	F	640	0	-3	-6
8/8A	LW	-48	0	-2	5
9/9A	F	590	1	4	-10
10/10A	LW	-150	0	5	52
11	LW	220	0	2	--
12	LW	370	3	-4	--

TABLE 3 (continued)

SURFACE ACTIVITY LEVELS
OPERATING FLOOR LEVEL
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		
			Alpha	Beta	H-3
TB030 (continued)					
13	F	480	0	1	--
14	LW	430	1	5	--
64	F	710	1	-2	--
TB031					
15	LW	130	0	3	--
16	LW	-32	0	1	--
17	LW	140	0	7	--
18	LW	680	5	1	--
19	LW	-8	0	2	--
20	LW	-330	0	-1	--
21	LW	-250	0	3	--
22	F	360	0	-3	--
23	LW	-63	0	-1	--
62	F	390	0	-1	--
63	F	430	0	-1	--
75	LW	-8	3	3	--
TB033					
72	LW	830	0	2	--
73	LW	290	0	-1	--
74	F	560	0	-3	--
76	F	520	3	4	--
TB035					
68	LW	290	0	1	--
69	LW	830	1	5	--
70	F	500	5	6	--
71	F	760	1	-1	--
24B	US	130	1	-1	--

[a]Refer to Figure 5.
[b]F = floor, LW = lower wall and US = upper surface.
[c]Measurement not performed.

TABLE 4

SURFACE ACTIVITY LEVELS
FRONT OFFICE RUBBLE PILE
TURBINE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)	
			Alpha	Beta
1B	Concrete	440	0	-2
2B	Concrete	690	1	6
3B	Metal	880	0	1
4B	Metal	510	0	-4
5B	Concrete	290	0	-2
6B	Concrete	1,100	0	-1
7B	Concrete	420	0	-5
8B	Concrete	130	0	-4
9B	Sheetrock	750	0	3
10B	Wood	1,000	0	-3
11B	Concrete	680	1	2
12B	Concrete	140	0	-3
13B	Metal	650	0	2
14B	Metal	710	1	-2
15B	Metal	780	0	1
16B	Metal	920	1	-2
17B	Metal	1,300	0	3
18B	Metal	1,100	0	-1
19B	Metal	280	1	-1
20B	Metal	440	1	-3

[a]The Front Office portion of the Turbine Building was dismantled and placed in several rubble piles; a figure was not provided.
[b]Construction material surface type.

TABLE 5

SURFACE ACTIVITY LEVELS
SERVICE BUILDING
YANKEE NUCLEAR POWER STATION
ROWE, MASSACHUSETTS

Location[a]	Surface[b]	Total Beta Activity (dpm/100 cm²)	Removable Activity (dpm/100 cm²)	
			Alpha	Beta
70 A	F	370	0	-3
71 A	LW	71	1	1
72 A	F	890	1	5
73 A	F	920	0	5
74 A	LW	-140	0	2
75 A	F	1,100	0	-1
76 A	LW	-160	1	3
77 A	F	980	0	1
78 A	F	1,000	0	1
79 A	LW	260	0	2
80 A	F	790	0	-4
81 A	F	1,300	0	2
82 A	LW	-260	0	-2
83 A	E	850	1	-1
84 A	E	560	1	-1
85 A	E	870	0	-1
86 A	E	280	0	1
87 A	F	760	0	1
88 A	E	620	3	3
89 A	F	540	0	1
90 A	E	870	0	-1
91 A	E	800	0	-2
92 A	LW	-310	0	3
93 A	LW	-79	0	-4

[a]Refer to Figure 6.
[b]F = floor, LW = lower wall and E = equipment surface.

REFERENCES

Oak Ridge Institute for Science and Education (ORISE). Final Report—Decommissioning Inspection Activities Performed During the Period May 17 to 20, 1999 at the Yankee Nuclear Power Station, Rowe, Massachusetts (Docket No. 50-29, RFTA No. 98-09). Oak Ridge, Tennessee; July 14, 1999.

Oak Ridge Institute for Science and Education. Confirmatory Survey Plan for the Turbine Building and Portions of the Service Building Outside the RCA, Yankee Nuclear Power Station, Rowe, Massachusetts [Docket No. 50-29; RFTA No. 03-026]. Oak Ridge, Tennessee; September 23, 2003a.

Oak Ridge Institute for Science and Education. Survey Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; February 2003b.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; April 2003c.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program. Oak Ridge, Tennessee; February 2003d.

U.S. Nuclear Regulatory Commission (NRC). IE Circular No. 81-07: Control of Radioactively Contaminated Material. May 14, 1981.

U.S. Nuclear Regulatory Commission. Draft—Manual for Conducting Radiological Surveys in Support of License Termination. NUREG/CR-5849; Washington, DC; June 1992.

U.S. Nuclear Regulatory Commission. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). NUREG-1575; Revision 1. Washington, DC; August 2000.

Yankee Atomic Electric Company (YAEC). Draft - Yankee License Termination Plan, Rowe, Massachusetts; September 2003a.

Yankee Atomic Electric Company. Radiological Release Data Package for the Turbine Building and the Service Building Area. Rowe, Massachusetts. September 2003b.

Yankee Atomic Electric Company. Internal Communication, RE: Review of Turbine Building Front Office Pre-Demolition Survey. Rowe, Massachusetts. September 10, 2003c.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Beta

Ludlum Floor Monitor Model 239-1
combined with
Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Gamma

Eberline Pulse Ratemeter Model PRM-6
(Eberline, Santa Fe, NM)
coupled to
Victoreen NaI Scintillation Detector Model 489-55, Crystal: 3.2 cm x 3.8 cm
(Victoreen, Cleveland, OH)

DIRECT MEASUREMENT INSTRUMENT/DETECTOR COMBINATIONS

Beta

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter
Model LB-5100-W
(Tennelec/Canberra, Meriden, CT)

Tri-Carb Liquid Scintillation Analyzer
Model 3100
(Packard Instrument Co., Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

The proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in current job hazard analyses (JHAs). All survey and laboratory activities were conducted in accordance with ORISE health and safety and radiation protection procedures.

A walkdown of the survey areas was performed in order to evaluate and identify potential health and safety issues. Falls from the stairs, floor openings, manlifts and ladders were of the greatest concern. YAEC provided general site-specific safety awareness and manlift training. Survey work was performed per the ORISE generic health and safety plans, a site-specific integrated safety management (ISM) pre-job hazard checklist, and the safety procedures discussed during the training.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, (February 2003)
- Laboratory Procedures Manual, (February 2003)
- Quality Assurance Manual, (April 2003)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1A and the U.S. Nuclear Regulatory Commission

Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, ITP, and EML Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Detectors used for assessing surface activity were calibrated in accordance with ISO-7503[1] recommendations. The total efficiency (ε_{total}) was determined for each instrument/detector combination and consisted of the product of the 2π instrument efficiency (ε_i) and surface efficiency (ε_s): $\varepsilon_{total} = \varepsilon_i \times \varepsilon_s$

Tc-99 was selected as the calibration source (maximum beta energy of 292 keV) as it provides a conservative representation of the radionuclide mixture. ISO-7503[1] recommends an ε_s of 0.25 for beta emitters with a maximum energy of less than 0.4 MeV (400 keV) and an ε_s of 0.5 for maximum beta energies greater than 0.4 MeV. Since the maximum beta energy for the chosen YNPS calibration source was less than 0.4 MeV, an ε_s of 0.25 was used to calculate ε_{total}.

Surface Scans

Hand-held detectors were placed on contact with the calibration sources. A postulated hot-spot size of 100 cm^2 was assumed *a priori* for determining scanning instrument efficiencies. The scanning ε_i value was 0.34 for the hand-held gas proportional detectors; with the scanning ε_{total} calculated was 0.08. Calibration source emission rates were not corrected for geometry when sources larger than the detectors were used.

[1]International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

Surface Activity Measurements

The static ε_i values for the single gas proportional detector used for the confirmatory survey surface activity measurements was 0.40; the static ε_{total} was calculated to be 0.10. The calibration source emission rates were corrected to the physical area of the detectors when the source area exceeded the detector area.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detectors slowly over the surface; the distance between the detector and the surface was maintained at a minimum—nominally about 1 cm. A NaI scintillation detector was used to scan for elevated gamma radiation. Floor and wall surfaces and indentations (scabbled areas) were scanned using small area (126 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Scan minimum detectable concentrations (MDCs) were estimated using the calculational approach described in NUREG-1507[2]. The scan MDC is a function of many variables, including the background level. The beta activity background count rates for the gas proportional detectors averaged 325 cpm for concrete and 180 cpm for metal (and other miscellaneous surfaces such as wood or sheetrock). Additional parameters selected for the calculation of scan MDC included a two-second observation interval, a specified level of performance at the first scanning stage of 95% true positive rate and 25% false positive rate, which yields a d' value of 2.32 (NUREG-1507, Table 6.1), and a surveyor efficiency of 0.5. To illustrate an example for the hand-held gas proportional detectors, the minimum detectable count rate (MDCR) and scan MDC can be calculated as follows for concrete surfaces:

[2]NUREG-1507. Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. U.S. Nuclear Regulatory Commission. Washington, DC; June 1998.

b_i = (325 cpm) (2 sec) (1 min/60 sec) = 10.8 counts

MDCR = (2.32) (10.8 counts)$^{1/2}$ [(60 sec/min) / (2 sec)] = 229 counts

$MDCR_{surveyor}$ = 229 / (0.5)$^{1/2}$ = 324 cpm

The scan MDC is calculated using the scanning ε_{total} of 0.08:

$$Scan\,MDC = \frac{MDCR_{surveyor}}{\varepsilon_{total}}\ \text{dpm} / 100\ \text{cm}^2$$

The scan MDC for the gas proportional detectors used was approximately 4,000 dpm/100 cm^2 for concrete surfaces; for other surfaces, the scan MDC was approximately 3,000 dpm/100 cm^2.

Specific scan MDCs for the NaI scintillation detector for Cs-137 and Co-60 in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma radiation for possible concrete sampling.

Surface Activity Measurements

Measurements of total beta surface activity levels were performed using a gas proportional detector with portable ratemeter-scalers. Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net count rate by the total static efficiency ($\varepsilon_i \times \varepsilon_s$) and correcting for the physical area of the detector.

Because different building materials (poured concrete, brick, wood, steel, etc.) may have different background levels, average background count rates were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The beta activity background count rates for the gas proportional detectors averaged 325 cpm for concrete and 180 cpm for metal (and other miscellaneous surfaces such as wood or sheetrock). The static beta MDCs—calculated using the average construction material background count rates for concrete and metal—for the single gas proportional detector (calibrated to Tc-99) used for direct measurements were 690 and 520 dpm/100 cm^2, respectively. The physical surface area assessed by the gas proportional detector used was 126 cm^2.

Removable Activity Measurements

Removable gross alpha and gross beta activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

For H-3 determinations, a second smear was moistened with deionized water and an adjacent 100 cm^2 was wiped. The smear was then sealed in a labeled liquid scintillation vial with the location and pertinent information recorded.

RADIOLOGICAL ANALYSIS

Gross Alpha/Beta

Smears were counted for two minutes on a low-background gas proportional system for gross alpha and beta activity. The MDCs of the procedure were 8 dpm/100 cm^2 and 15 dpm/100 cm^2 for gross alpha and gross beta, respectively.

Liquid Scintillation

Smears were counted in a liquid scintillation analyzer for low-energy beta activity to determine H-3 activity with the typical MDC for the procedure being 22 dpm/100 cm^2.

DETECTION LIMITS

Detection limits, referred to as MDCs, were based on 3 plus 4.65 times the standard deviation of the background count $[3 + (4.65\sqrt{BKG})]$. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

APPENDIX C

IE CIRCULAR NO. 81-07: CONTROL OF RADIOACTIVELY CONTAMINATED MATERIAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

May 14, 1981

IE Circular No. 81-07: CONTROL OF RADIOACTIVELY CONTAMINATED MATERIAL

Description of Circumstances:

Information Notice No. 80-22 described events at nuclear power reactor facilities regarding the release of radioactive contamination to unrestricted areas by trash disposal and sale of scrap material. These releases to unrestricted areas were caused in each case by a breakdown of the contamination control program including inadequate survey techniques, untrained personnel performing surveys, and inappropriate material release limits.

The problems that were described in IE Information Notice No. 80-22 can be corrected by implementing an effective contamination control program through appropriate administrative controls and survey techniques. However, the recurring problems associated with minute levels of contamination have indicated that specific guidance is needed by NRC nuclear power reactor licensees for evaluating potential radioactive contamination and determining appropriate methods of control. This circular provides guidance on the control of radioactive contamination. Because of the limitations of the technical analysis supporting this guidance, this circular is applicable only to nuclear power reactor facilities.

Discussion:

During routine operations, items (e.g., tools and equipment) and materials (e.g., scrap material, paper products, and trash) have the potential of becoming slightly contaminated. Analytical capabilities are available to distinguish very low levels of radioactive contamination from the natural background levels of radioactivity. However, these capabilities are often very elaborate, costly, and time consuming making their use impractical (and unnecessary) for routine operations. Therefore, guidance is needed to establish operational detection levels below which the probability of any remaining, undetected contamination is negligible and can be disregarded when considering the practicality of detecting and controlling such potential contamination and the associated negligible radiation doses to the public. In other words, guidance is needed which will provide reasonable assurance that contaminated materials are properly controlled and disposed of while at the same time providing a practical method for the uncontrolled release of materials from the restricted area. These levels and detection capabilities must be set considering these factors: 1) the practicality of conducting a contamination survey, 2) the potential of leaving minute levels of contamination undetected; and, 3) the potential radiation doses to individuals of the public resulting from potential release of any undetected, uncontrolled contamination.

Studies performed by Sommers[1] have concluded that for discrete particle low-level contamination, about 5000 dpm of beta activity is the minimum level of activity that can be routinely detected under a surface contamination control program using direct survey methods. The indirect method of contamination monitoring (smear survey) provides a method of evaluating removable (loose, surface) contamination at levels below which can be detected by the direct survey method. For smears of a 100 cm^2 area (a de facto industry standard), the corresponding detection capability with a thin window detector and a fixed sample geometry is on the order of 1000 dpm (i.e., 1000 dpm/100 cm^2). Therefore, taking into consideration the practicality of conducting surface contamination surveys; contamination control limits should not be set below 5000 dpm/100 cm^2 total and 1000 dpm/100 cm^2 removable. The ability to detect minute, discrete particle contamination depends on the activity level, background, instrument time constant, and survey scan speed. A copy of Sommers studies is attached which provides useful guidance on establishing a contamination survey program.

Based on the studies of residual radioactivity limits for decommissioning (NUREG-0613[2] and NUREG-0707[3]), it can be concluded that surfaces uniformly contaminated at levels of 5000 dpm/100 cm^2 (beta-gamma activity from nuclear power reactors) would result in potential doses that total less than 5 mrem/yr. Therefore, it can be concluded that for the potentially undetected contamination of discrete items and materials at levels below 5000 dpm/100 cm^2, the potential dose to any individual will be significantly less than 5mrem/yr even if the accumulation of numerous items contaminated at this level is considered.

Guidance:

Items and material should not be removed from the restricted area until they have been surveyed or evaluated for potential radioactive contamination by a qualified* individual. Personal effects (e.g., notebooks and flash lights) which are hand carried need not be subjected to the qualified individual survey or evaluation, but these items should be subjected to the same survey requirements as the individual possessing the items. Contaminated or radioactive items and materials must be controlled, contained, handled, used, and transferred in accordance with applicable regulations.

The contamination monitoring using portable survey instruments or laboratory measurements should be performed with instrumentation and techniques (survey scanning speed, counting times, background radiation levels) necessary to detect 5000 dpm/100 cm^2 total and 1000 dpm/100 cm^2 removable beta/gamma contamination. Instruments should be calibrated with radiation sources having consistent energy spectrum and instrument response with the

*A qualified individual is defined as a person meeting the radiation protection technician qualifications of Regulatory Guide 1.8, Rev. 1, which endorses ANSI N18.1, 1971.

radionuclides being measured. If alpha contamination is suspected appropriate surveys and/or laboratory measurements capable of detecting 100 dpm/100 cm^2 fixed and 20 dpm/100 cm^2 removable alpha activity should be performed.

In evaluating the radioactivity on inaccessible surfaces (e.g., pipes, drain lines, and duct work), measurements at other appropriate access points may be used for evaluating contamination provided the contamination levels at the accessible locations can be demonstrated to be representative of the potential contamination at the inaccessible surfaces. Otherwise, the material should not be released for unrestricted use.

Draft ANSI Standard 13.124 provides useful guidance for evaluating radioactive contamination and should be considered when establishing a contamination control and radiation survey program.

No written response to this circular is required. If you have any questions regarding this matter, please contact this office.

REFERENCES

1 Sommers, J. F., "Sensitivity of Portable Beta-Gamma Survey Instruments," Nuclear Safety, Volume 16, No. 4, July-August 1975.

2 U.S. Nuclear Regulatory Commission, "Residual Radioactivity Limits for Decommissioning, Draft Report," Office of Standards Development, USNRC NUREG-0613, October 1979.

3 U.S. Nuclear Regulatory Commission, "A Methodology for Calculating Residual Radioactivity Levels Following Decommissioning," USNRC NUREG-0707, October 1980.

4 Draft ANSI Standard 13.12, "Control of Radioactive Surface Contamination on Materials, Equipment, and Facilities to be Released for Uncontrolled Use," American National Standards Institute, Inc., New York, NY, August 1978.

Attachments:
1. Reference 1 (Sommers Study)
2. Recently issued IE Circulars