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Architectural/Historical Assessment of the Oak Ridge National Laboratory, Oak Ridge Reservation, Anderson and Roane Counties, Tennessee

Martha Carver
Margaret Slater

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ARCHITECTURAL/HISTORICAL ASSESSMENT OF THE OAK RIDGE NATIONAL LABORATORY, OAK RIDGE RESERVATION, ANDERSON AND ROANE COUNTIES, TENNESSEE

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TABLE OF CONTENTS

		PAGE
	MANAGEMENT SUMMARY	xvii
I.	INTRODUCTION	1
	Statement of Determination	1
	Study Area	2
	Survey Background and Methodology	5
	Previous Survey or National Register Work	6
	Special Considerations	13
	Survey Results	14
II.	HISTORICAL CONTEXT	20
	Introduction	20
	Pre-1942 Period	22
	Buildings Remaining from Pre-1942	25
	1942-1945 Period	26
	Los Alamos	35
	Hanford	40
	Oak Ridge Reservation	43
	Clinton Laboratories	54
	Electromagnetic Process	67
	Gaseous Diffusion	69
	Liquid Diffusion	72
	Merger of the Plants and Outcome of Bombs	74
	Buildings Remaining from 1942-1945	80
	Post-1945 Period	81
III.	SURVEYED PROPERTIES	131
	Introduction	131
	0900 AREA	132
	1000 AREA	140
	1500 AREA	145
	ORNL Main Facilities Complex	148
	6000 AREA	275
	7000 AREA	280
	7500 AREA	290
	7503 AREA	294
	7600 AREA	299
	7700 AREA	303
	7709/7710 AREA	311
	7813/7846 AREA	314
	7852/7860 AREA	317
	7900 AREA	320
	Solid Waste Storage Areas	327
	Outlying Properties	330
	Summary	334

IV. ASSESSMENT OF EFFECTS - PROPOSED BUILDING PROGRAM 335
Statement of Determination 335
Survey Results 335
Project Description 336
Discussion of Effects 347
Oak Ridge National Laboratory Historic District 350
New Bethel Baptist Churck and Cemetery .. 352
Buildings 7001 and 7002, East Support Area 353
Aircraft Reactor Experiment Facility 353
White Oak Lake and Dam, Structure 7864 .. 353
Tower Shielding Facility, 7700 Area 354
Summary 354

V. CONCLUSIONS 355

BIBLIOGRAPHY

APPENDICES

A. Preservation Specialist Resumes
B. Fact Sheets
C. Related Correspondence
D. Manhattan Period Chronology
E. AEC Period Chronology

LIST OF FIGURES

		PAGE
I-1.	Map of Inventoried Properties	3
I-2.	ORNL Numbering System	4
I-3.	Map of Properties Listed in National Register in 1991 Multiple Property Nomination	8
II-1.	Location Map of Oak Ridge	21
II-2.	Map of Major Sites Associated with Manhattan Project	36
II-3.	Map of Los Alamos	38
II-4.	Map of Hanford	44
II-5.	1942 Map of East Tennessee	46
II-6.	Map of Clinton Engineer Works	48
II-7.	1940s Map of Oak Ridge Reservation	52
II-8.	Schematic Drawing of X-10 Pile (Graphite Reactor)	55
II-9.	1943-1945 Map of Facilities within Clinton Engineer Works	58
II-10.	1943 Photograph of X-10 Site	59
II-11.	1943 Photograph of X-10 Site	63
II-12.	1943 Photograph of X-10 Site	64
II-13.	Trinity Test Site	76
II-14.	Map of Bombing Routes	79
II-15.	Map of Atomic Energy Commission Offices and Laboratories	88
II-16.	Late 1940s Photograph of Laboratory Site	93
II-17.	Map of Original Reservation and 1949 Boundaries and Gates	96
II-18.	1935 U.S.G.S. Quadrangle Map of Area	97
II-19.	1942 U.S.G.S. Quadrangle Map of Area	98
II-20.	1953 U.S.G.S. Quadrangle Map of Area	99
II-21.	1968 U.S.G.S. Quadrangle Map of Area	100
II-22.	Undated Photograph of Laboratory, Between 1954 and 1961	101
II-23.	Flow Chart of Reactor Division at ORNL	108
II-24.	Flow Chart of Origins of Department of Energy	127
III-1.	0900 Pistol Range	132
III-2.	0901 161 kV Substation	133
III-3.	0902 Main Reservoir	134
III-4.	0903 New Bethel Baptist Church	135
III-5.	0907 Katy's Kitchen	138
III-6.	0907 Katy's Kitchen	138
III-7.	0961 Visitor Overlook	139
III-8.	1000 Area, Site Plan	140
III-9.	1000 Plan Dated March 1947	142
III-10.	1000 Engineering Division Headquarters	143
III-11.	1000 Engineering Division Headquarters	143
III-12.	ORNL Hstry 75	144
III-13.	1500 Area, Site Plan	145
III-14.	1503 Plant Services Laboratory	147

III-15. 2000 Solid State Laboratory Annex 165
III-16. 2001 Information Center 166
III-17. 2003 Process Water Control System 167
III-18. 2007 Calibration Laboratory 168
III-19. 2008 Health Physics Technology Internal Dosimetry Laboratory 170
III-20. 2009 Cafeteria Storage Building 171
III-21. 2010 Cafeteria 172
III-22. 2011 Mechanical Properties Laboratory 174
III-23. ORNL Hstry 193 174
III-24. 2013 West Maintenance Service Center 176
III-25. 2016 West Portal 177
III-26. 2017 East Research Satellite Service Shop 178
III-27. 2018 Electrical and Air Conditioning Service Center 179
III-28. 2019 Solar Energy Laboratory 180
III-29. 2061 Stack 181
III-30. 2069 Change House 182
III-31. 2506 Fabrication Shop and Timekeeping 183
III-32. 2517 Personnel Development and Systems Department 184
III-33. 2518 Plant and Equipment Division Office 185
III-34. 2519 Steam Plant 186
III-35. 2519 Steam Plant 187
III-36. 2521 Sewage Treatment Plant 188
III-37. 2523 Decontamination Laundry 189
III-38. 2525 Fabrication Department Shop A 190
III-39. 2531 Radioactive Waste Evaporator Facility ... 191
III-40. 2624 Solid Waste Storage Area 1 192
III-41. 3000 13.8 kV Substation 193
III-42. 3001 Graphite Reactor 195
III-43. ORNL Hstry 190 196
III-44. 3002 Filter House 197
III-45. 3003 Solid State Accelerator Facility 199
III-46. 3004 Water Demineralizer 200
III-47. 3005 Low Intensity Testing Reactor 202
III-48. 3008 Source and Special Materials Vault 203
III-49. 3009 Pump House 204
III-50. 3010 Bulk Shielding Reactor Facility 206
III-51. 3012 Rolling Mill 207
III-52. 3013 Geological Disposal Laboratory 208
III-53. 3017 Chemical Technology Division Annex 209
III-54. 3018 Exhaust Stack 210
III-55. 3019A Radiochemical Processing Pilot Plant and 3019B 213
III-56. 3019A Radiochemical Processing Pilot Plant ... 214
III-57. ORNL Hstry 268 214
III-58. 3019B High Level Radiation Analytical Laboratory 215
III-59. 3020 Stack 216
III-60. 3021 Turbine House 217
III-61. 3023 North Tank Farm 218
III-62. 3025M Physical Exam Hot Cells A 219
III-63. 3025E Solid State Division Laboratory 220

III-64. 3026C Radioisotope Development Laboratory B .. 222
III-65. 3026C Radioisotope Development Laboratory B .. 222
III-66. 3026D Dismantling and Examination Hot Cells .. 224
III-67. 3026D Dismantling and Examination Hot Cells .. 224
III-68. 3026D Dismantling and Examination Hot Cells .. 225
III-69. ORNL Hstry 267 225
III-70. 3027 Safeguard Nuclear Materials Vault 226
III-71. Isotope Circle 229
III-72. 3029 Radioisotope Production Laboratory B 229
III-73. 3032 Radioisotope Production Laboratory E 230
III-74. 3037 and 3038 Operations Division Offices and Radioisotope Development Laboratory 230
III-75. 3042 Oak Ridge Research Reactor 231
III-76. 3044 Special Materials Machine Shop 232
III-77. 3074 Interim Manipulator Repair Facility 233
III-78. 3077 Air Cooler for LITR 234
III-79. 3080 Reactor Experiment Control Room 235
III-80. 3091 Filters for 3019 236
III-81. 3092 Off Gas Facility 237
III-82. 3500 Instrumentation and Controls Division Offices and Research Facility 239
III-83. 3501 Sewage Pumping Station 240
III-84. 3502 East Research Service Center 241
III-85. 3503 High Radiation Level Engineering Laboratory 242
III-86. 3504 Geosciences Laboratory 243
III-87. 3505 Fission Product Development Laboratory .. 245
III-88. 3506 Waste Evaporator Facility 246
III-89. 3507 South Tank Farm 247
III-90. 3508 Chemical Technology Laboratory 248
III-91. 3518, 3513, 3524 Process Waste Treatment Plant and Basins 250
III-92. 3515 Fission Product Pilot Plant 251
III-93. 3523 Storage 252
III-94. 3550 Research Laboratory Annex 255
III-95. 3550 Research Laboratory Annex 255
III-96. ORNL Hstry 211 256
III-97. 3587 Instrument Laboratory Annex 257
III-98. 3592 Coal Conversion Facility 258
III-99. 4000 13.8 kV Substation 259
III-100. 4003 Solid Waste Storage Area 2 260
III-101. 4500N Central Research and Administration Building North 262
III-102. 4500N Central Research and Administration Building North 262
III-103. 4501 High Level Radiochemical Laboratory 263
III-104. 4505 Experimental Engineering 264
III-105. 4507 High Radiation Level Chemical Development Laboratory 265
III-106. 5000 Main Portal 266
III-107. 5500 High Voltage Accelerator Laboratory 268
III-108. Oak Ridge National Laboratory Historic District Boundaries 270
III-109. 6000 Area, Site Plan 276

III-110. 6000 Holifield Heavy Ion Research Facility ... 278
III-111. 6007 Joint Institute for Heavy Ion Research .. 279
III-112. 7000 Area, Site Plan 281
III-113. 7001 General Stores 287
III-114. 7007 Paint Shop 288
III-115. 7012 Central Mechanical Shop 288
III-116. 7035 Material and Equipment Storage 289
III-117. 7077 Guard and Laborers Building 289
III-118. 7500 Area, Site Plan..... 291
III-119. 7500 Area, Nuclear Safety Pilot Plant 293
III-120. 7503 Area, Site Plan 295
III-121. 7503 Area, Overview 298
III-122. 7503 Molten Salt Reactor Experiment Building . 298
III-123. 7600 Area, Site Plan 300
III-124. 7600 Experimental Gas-Cooled Reactor Containment Building 302
III-125. 7602 CFRP Engineering Building 302
III-126. 7700 Area, Site Plan 305
III-127. 7700 Area Tower Shielding Facility 309
III-128. 7703 Hoist House 309
III-129. 7702 Control House 310
III-130. 7751 Sentry Post No. 22 310
III-131. 7709 Area, Site Plan 312
III-132. 7709 Health and Physics Research Reactor 313
III-133. 7710 Dosimetry Applications Research Facility 313
III-134. 7813 White Oak Dam 316
III-135. 7871 Stream Flow Monitoring Station No. 3 316
III-136. 7852 Old Hydrofracturing Facility 319
III-137. 7860 New Hydrofracturing Facility 319
III-138. 7900 Area, Site Plan 321
III-139. 7900 Area, Overview 324
III-140. 7900 High Flux Isotope Reactor Experiment Facility 325
III-141. Radiochemical Engineering Development Center . 325
III-142. 7962 Neutron Users Office and Laboratory 326
III-143. Solid Waste Storage Area 6 329
IV-1. Proposed Development Sites, ORNL 337
IV-2. Color Code System for Maps IV-3 through IV-9 . 339
IV-3. Proposed Improvements at Bethel Valley 340
IV-4. Proposed Improvements at Oak Ridge National Laboratory Historic District 341
IV-5. Proposed Improvements near New Bethel Church and Cemetery 343
IV-6. Proposed Improvements at East Support Area ... 344
IV-7. Proposed Improvements near the Aircraft Reactor Experiment Building 345
IV-8. Proposed Improvements to SR-95 at White Oak Lake and Dam 346
IV-9. Proposed Improvements to Tower Shielding Facility 347

LIST OF TABLES

PAGE

II-1. List of National Laboratories and Research Centers 89
II-2. Chart of AEC Five-Year Power Program 113
II-3. List of Experimental Power Reactors 114
III-1 ORNL Main Facilities Complex Building Inventory 149
III-2 Contributing/Non-Contributing Properties in the Oak Ridge National Laboratory Historic District 271
III-3 Outlying Properties Not Eligible for Inclusion in National Register 331

MAP POCKETS

March 1943 Plan Sheet
Proposed Oak Ridge National Laboratory Historic District

LIST OF ACRONYMS FREQUENTLY USED IN REPORT

ACHP	Advisory Council on Historic Preservation
AEC	Atomic Energy Commission
ANP	Aircraft Nuclear Propulsion Project (Nuclear Energy for Propulsion of Aircraft Program)
ANS	Advanced Neutron Source
ARE	Aircraft Reactor Experiment Facility
ART	Aircraft Reactor Test
BSR	Bulk Shielding Reactor
Corps	U. S. Army Corps of Engineers
DOE	Department of Energy
DOI	Department of Interior
DOSAR	Dosimetry Applications Research Facility
EGCR	Experimental Gas-Cooled Reactor Facility
ERDA	Energy Research and Development Administration
HFIR	High Flux Isotope Reactor Facility
HPRR	Health Physics Research Reactor
HPS	Historic Preservation Specialist
HRE	Homogeneous Reactor Experiment Facility
LITR	Low Intensity Testing Reactor
LLLW	Liquid Low-Level Waste
MSRE	Molten Salt Reactor Experiment Facility
MTR	Materials Testing Reactor
NHPA	National Historic Preservation Act
NRC	Nuclear Regulator Commission
ORACLE	Oak Ridge Automatic Computer and Logical Engine
ORAU	Oak Ridge Associated Universities
ORIC	Oak Ridge Isochronous Cyclotron
ORINS	Oak Ridge Institute of Nuclear Studies
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORSORT	Oak Ridge School of Reactor Technology
OSRD	Office of Scientific Research and Development
S-1	Section One of OSRD
SHPO	State Historic Preservation Office or Officer
SWSA	Solid Waste Storage Area
TN-SHPO	Tennessee State Historic Preservation Office or Officer
TSF	Tower Shielding Facility
TVA	Tennessee Valley Authority
UNISOR	University Isotope Separator of Oak Ridge
WAG	Waste Area Grouping

LIST OF KEY PERSONS AND PLACES

Alamogordo: Alamogordo Air Force Base, New Mexico; site of the Trinity Test on 16 July 1945.

Argonne: University of Chicago conducted some of its larger experiments off-campus at the Argonne Forest Preserve. After World War II, the facility was relocated to rural Illinois and renamed the Argonne National Laboratory.

Berkeley: University of California, Berkeley.

Bush, Vannevar: President of Carnegie Foundation, later Director of National Defense Research Committee, Director of Office of Scientific Research and Development.

Compton, Arthur H.: Director of Manhattan Project efforts at the University of Chicago.

Groves, Leslie General: Director Manhattan Project.

Hanford: Hanford, Washington; site of nuclear reactors that produced plutonium used in bomb dropped on Nagasaki, Japan.

K-25 Site: Site of gaseous diffusion plant at Clinton Engineer Works (Oak Ridge Reservation.

Lawrence, Earnest O.: University of California, Berkeley, professor; oversaw the electromagnetic process at the Y-12 Plant.

Los Alamos: Los Alamos, New Mexico; site of secret laboratory where first atomic bombs were designed.

Marshall, James Colonel: Original director of Manhattan Project but shortly replaced by General Groves, served briefly as District Engineer for Manhattan Project.

Nichols, Kenneth Lieutenant Colonel: Assistant to General Groves, later promoted to District Engineer.

Oppenheimer, J. Robert: University of California, Berkeley, professor; oversaw bomb development at Los Alamos

Site W: Plutonium plant at Hanford, Washington

Site X: Clinton Engineer Works, Oak Ridge Reservation, Tennessee; contained X-10, Y-12, and K-25 plants.

Site Y: Weapons Research Center at Los Alamos, New Mexico.

Townsite: Present City of Oak Ridge.

Urey, H. C.: Director of Research for the Substitute Alloy Materials Laboratory at Columbia University, oversaw the gaseous diffusion process at K-25.

Weinberg, Alvin: Director of Physics Division 1945-1948, Laboratory Research Director 1948-1955, Director of the Oak Ridge National Laboratory, 1955-1974.

X-10 Site: Site of X-10 Pile/Graphite Reactor at Clinton Engineer Works (Oak Ridge Reservation), present Oak Ridge National Laboratory.

Y-12 Plant: Site of electromagnetic process at Clinton Engineer Works (Oak Ridge Reservation).

MANAGEMENT SUMMARY

The Department of Energy (DOE) is required by the National Historic Preservation Act (NHPA) of 1966, as amended, to identify any properties under its jurisdiction that are included in or eligible for inclusion in the National Register of Historic Places (National Register). In March 1993 Duvall & Associates, Inc., was engaged to survey the Oak Ridge National Laboratory (ORNL), a DOE facility located on the Oak Ridge Reservation (ORR) in Anderson and Roane Counties, Tennessee, and to prepare a determination of National Register eligibility for all ORNL properties. The purpose of this report is to summarize the results of research into the historical context of ORNL and to identify historic properties at ORNL that are included in or eligible for inclusion in the National Register. The identification of archaeological properties at ORNL that are included and eligible for inclusion in the National Register is addressed in a separate report.

The report is comprises five chapters: (I) Introduction, (II) Historical Context, (III) Surveyed Properties, (IV) Assessment of Effects - Proposed Building Program, and (V) Conclusions. Chapter I, Introduction, provides a brief statement of purpose, describes the surveyed areas, outlines the survey methods and those factors that required special consideration, and summarizes the results of the survey. Chapter II, Historical Context, provides a compilation of the historical facts used to properly assess the historical significance of ORNL properties within the framework of the National Register criteria as defined at 36 CFR 60.4. Chapter III, Surveyed Properties, contains the data collected during the ORNL property identification effort and provides individual facility determinations of National Register eligibility. Chapter IV, Assessment of Effects-Proposed Building Program, addresses the effects of proposed site development activities as outlined in the 1992 "ORNL Site Development Plan" on historical properties at ORNL pursuant to Section 106 of the NHPA. Chapter V, Conclusions, provides a summary of the results of the survey.

It is the opinion of the authors of this report that the following properties are eligible for inclusion in the National Register: the ORNL Historic District, which is located in the central portion of the ORNL main facilities complex and includes facilities within the 2000-5000 Areas; Buildings 7001 and 7002 in the East Support Area (7000 Area); Building 7503, the Aircraft Reactor Experiment Building now referred to as the Molten Salt Reactor Experiment Facility; the Tower Shielding Facility (7700 Area), which includes Buildings 7700, 7701-7704, and 7751;

and White Oak Lake and Dam. The Graphite Reactor, Building 3001, is the only property located within the ORNL main facilities complex that is presently included in the National Register. The Graphite Reactor operated between 1943 and 1966 and was designated a National Historic Landmark in 1966 by the National Park Service. The Graphite Reactor is located within the boundaries of the proposed ORNL Historic District. The New Bethel Baptist Church, Building 0903, was also identified as being presently included in the National Register. The authors of this report believe that the proposed site development activities outlined in the "ORNL Site Development Plan" pose a potential adverse effect to the ORNL Historic District, the New Bethel Baptist Church, and the Aircraft Reactor Experiment Building. It is the opinion of the authors of this report that the proposed site development activities would pose no adverse effect to the Tower Shielding Facility and no effect to the White Oak Lake and Dam and to Buildings 7001 and 7002, if carried out as proposed.

CHAPTER I: INTRODUCTION

STATEMENT OF DETERMINATION: The Department of Energy (DOE) as a federal agency must comply with the National Historic Preservation Act (NHPA) of 1966, as amended, which requires DOE to identify any properties (e.g. buildings, structures, objects, historic sites, and archaeological sites) of historic significance. For the purposes of NHPA and related legislation, a property is of historic significance if it is included in or eligible for inclusion in the National Register of Historic Places (National Register). Once properties of historic significance have been identified, DOE is required to develop a preservation program for these properties as well as to determine if they are being affected by any agency actions. If historic properties are being affected, DOE is required to provide the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on the effects.

In March 1993, DuVall & Associates, Inc., was engaged to identify properties at the Oak Ridge National Laboratory (ORNL), a DOE facility located on the Oak Ridge Reservation (ORR) in Anderson and Roane Counties, Tennessee, that are included or eligible for inclusion in the National Register. Between March and September 1993, two architectural historians/historic preservation specialists (hereafter referred to as HPS) with DuVall & Associates, Inc. conducted a systematic, intensive architectural survey at ORNL. Copies of their resumes are contained in Appendix A.

The purpose of this report is to present the results of the ORNL architectural survey and to identify any architectural/historic properties at ORNL that are included or eligible for inclusion in the National Register. The report first provides in Chapter II, Historical Context, the historical information that was used to assess the historical significance of ORNL properties within the framework of the National Register criteria. Chapter III, Surveyed Properties, provides a compilation of the data collected during the ORNL property identification effort as well as individual facility determinations of National Register eligibility. Chapter IV, Assessment of Effects - Proposed Building Program, addresses the effects of proposed site development activities as outlined the 1992 "ORNL Site Development Plan" on historical properties at ORNL pursuant to Section 106 of the NHPA. The identification of archaeological properties at ORNL that are included or eligible for inclusion in the National Register is addressed in a separate report.

A brief fact sheet about the processes involved in complying with Sections 106 and 110 of the NHPA, a copy of the National Register eligibility criteria as defined in 36 CFR 60.4, and a copy of the Criteria of Effect as defined at 36 CFR 800.9 are contained in Appendix B.

STUDY AREA: DuVall & Associates, Inc., was directed to evaluate the National Register eligibility of ORNL facilities located at the ORNL main facilities complex, Environmental Sciences and Engineering Division facilities in the 1000 Area, Engineering Physics and Mathematics Division facilities in the 6000 Area, East Support Area, Tower Shielding Facility, Dosimetry Applications Research Facility, Health Physics Research Reactor Facility, High-Flux Isotope Reactor, the Old and New Hydrofracture Facilities, Hazardous Waste Management Area, Robotics and Process Systems Complex (formerly named the Experimental Gas-Cooled Reactor Experiment Facility), Molten Salt Reactor Experiment Facility (formerly named the Aircraft Reactor Experiment Facility), Nuclear Safety Pilot Plant (formerly named the Homogeneous Reactor Experiment Facility), Waste Area Groupings (WAGS) and/or Solid Waste Storage Areas (SWSAs) in Melton Valley, Environmental Sciences Division Research Facilities in the 0800 Area, Katy's Kitchen (formerly referred to as Installation Dog), and assorted facilities within the 0900 Area north of Bethel Valley Road. Locations of these facilities are shown on Figure I-1.

ORNL facilities are allocated building numbers using a simple geographic numbering system (Figure I-2). The ORNL main facilities complex is located in Bethel Valley immediately south of Bethel Valley Road and consists of facilities within the 2000-5000 Areas. Immediately west of the ORNL main facilities complex is the 1000 Area. The 0900 Area is located north of the ORNL main facilities complex on the north side of Bethel Valley Road. Immediately east of the ORNL main facilities complex is the 6000 Area, which contains the Holifield Heavy Ion Research Facility. To the east of the 6000 area is the 7000 Area, which is referred to as the East Support Area. Other areas included in the survey are located at satellite facilities around the ORNL main facilities complex in Bethel Valley. The 0800 Area is located west of State Route 95/White Wing Road adjacent to the Clinch River about 2.0 miles southwest of the ORNL main facilities complex. The White Oak Lake and Dam are located along State Route 95 about 1.5 miles southwest of the ORNL main facilities complex. The Tower Shielding Facility (7700 Area) is located on the south face of Copper Ridge approximately 1.5 miles southeast of the White Oak Dam and 2.0 miles due south of the ORNL main facilities complex. The New and Old Hydrofracture Facilities (7800 Area) are located in Melton Valley about 0.75 mile south of the ORNL main facilities complex. The Nuclear Safety Pilot Plant and

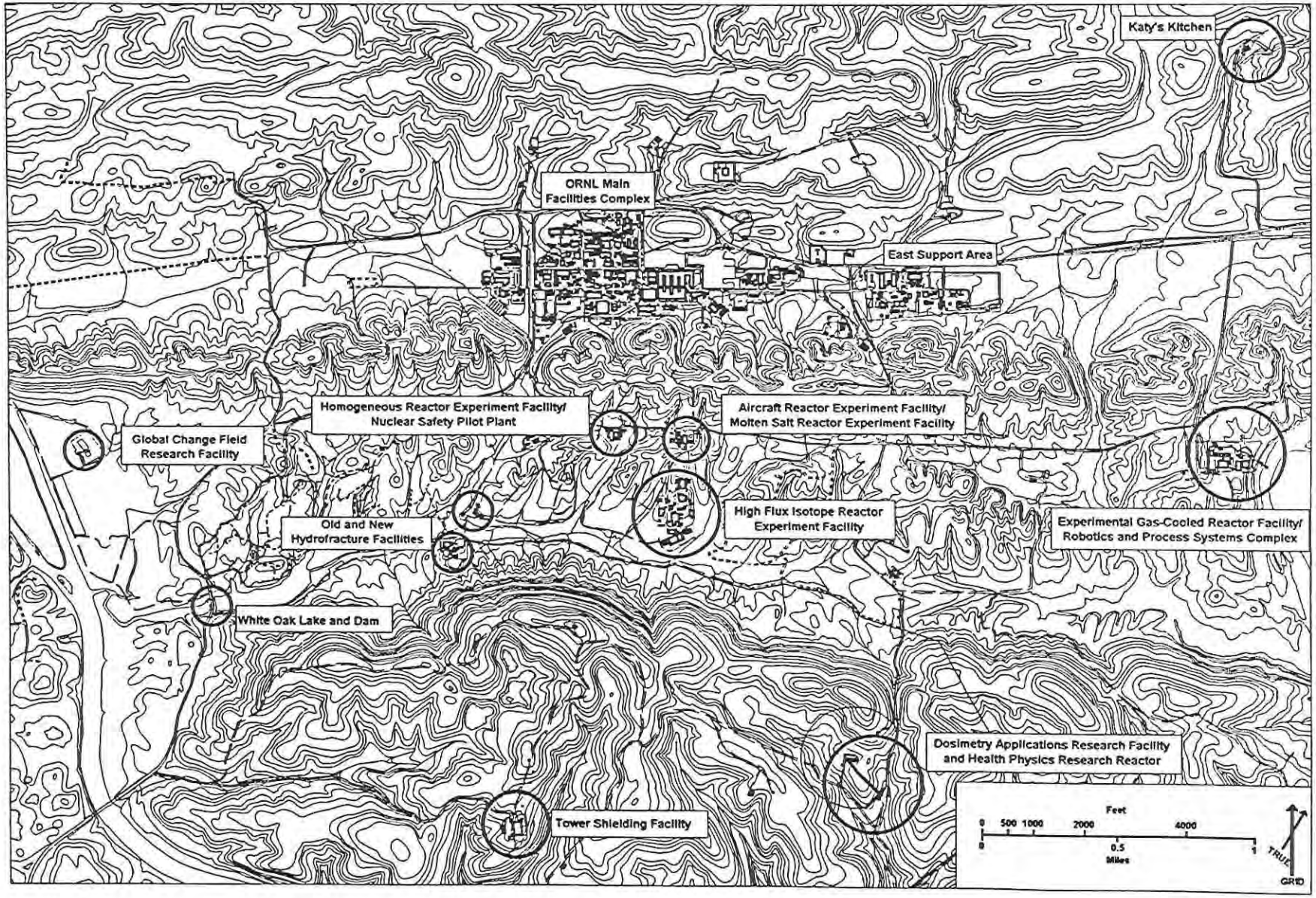


FIGURE I-1: MAP OF INVENTORIED PROPERTIES

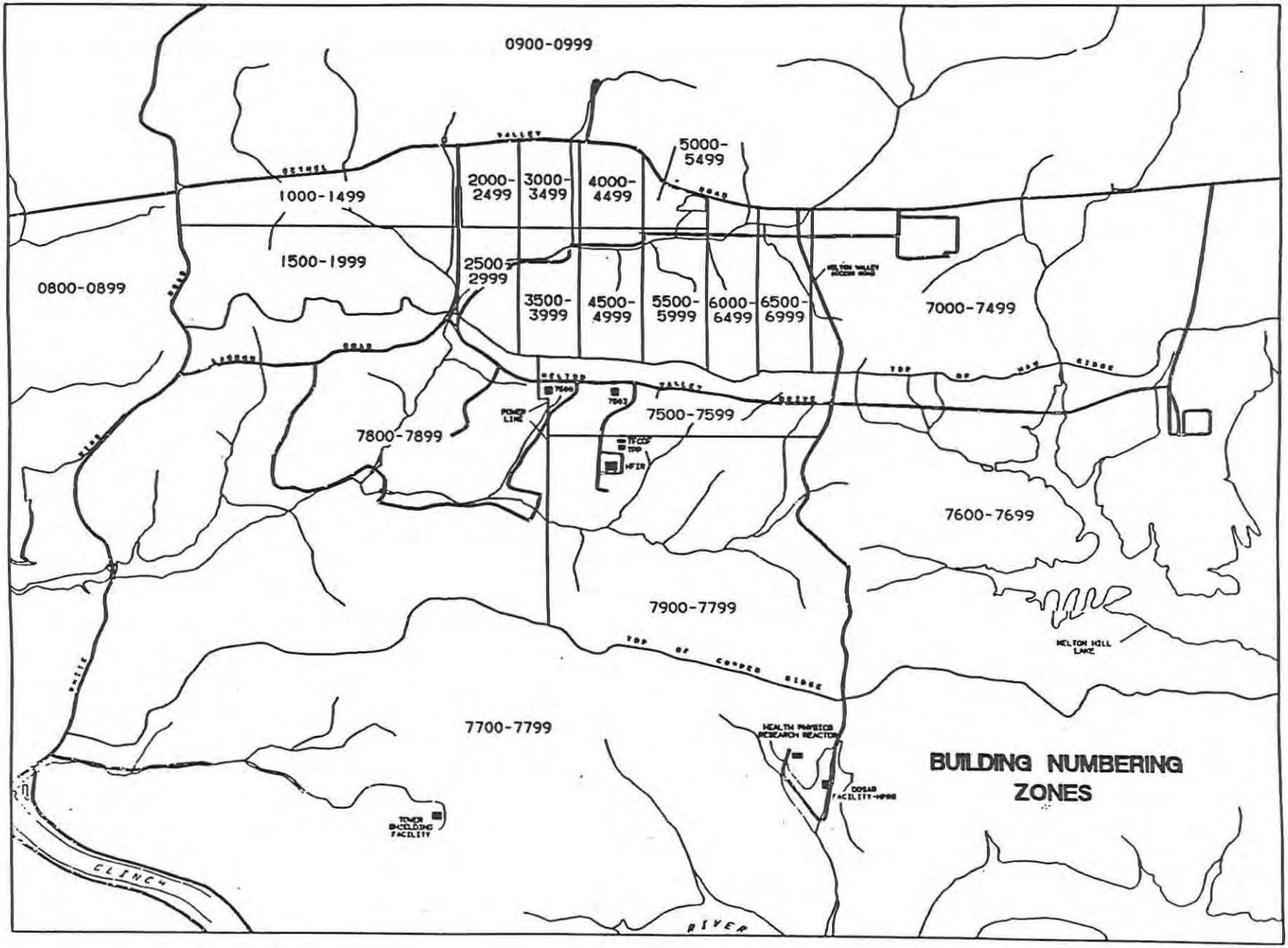


FIGURE I-2: ORNL NUMBERING SYSTEM

Molten Salt Reactor Experiment Facility are both located in the 7500 Area in Melton Valley along Melton Valley Drive approximately 0.5 mile south of the ORNL main facilities complex. The High Flux Isotope Reactor Experiment Facility is located within the 7900 Area in Melton Valley about 0.25 mile south of the Molten Salt Reactor Experiment Facility and about 0.75 mile south of the ORNL main facilities complex. The Robotics and Process Systems Complex is located within the 7600 Area in Melton Valley about 2.0 miles east-southeast of the ORNL main facilities complex. Katy's Kitchen is located within the 0900 Area on the southern slopes of Chestnut Ridge approximately 2.0 miles northeast of the ORNL main facilities complex.

SURVEY METHODOLOGY: Before beginning field work, the HPS contacted the Tennessee State Historic Preservation Office (TN-SHPO) and requested information about any properties in the vicinity of ORNL that are presently included or have been determined to be eligible for inclusion in the National Register. The HPS also requested a listing of any previous architectural surveys that have been conducted in the area. A copy of this correspondence and the TN-SHPO's response is provided in Appendix C. Secondary research into the historical context of ORNL and, in general, the Oak Ridge, Tennessee area, involved (1) visiting the TN-SHPO's office at the Tennessee Historical Commission in Nashville and examining files that contain information on the Oak Ridge area; (2) conducting research at the Tennessee State Library and Archives and the Oak Ridge Public Library; and (3) contacting noted historians such as Roger Anders, a historian with DOE.

Through secondary research, a minimum of 10 major archaeological reconnaissance-level surveys were found to have been conducted on the ORR, including a study by Fielder et al. (1977) that evaluated pre-World War II farmsteads.

Secondary research also revealed that a three-volume history of the Atomic Energy Commission (AEC) (Hewlett and Anderson 1962; Hewlett and Duncan 1969; and Hewlett and Holl 1989) provides a general national context for the period 1939 through January 1961. The AEC volumes specifically address trends affecting nuclear research and the development of ORNL. In addition, AEC and DOE have published several brief documents on various historical topics. However, the three-volume AEC series is the basic reference work for the period, and beyond this series, little scholarly work has been done to provide a contextual overview of nuclear research or the development of the national laboratories.

Field work and research undertaken at ORNL involved (1) reviewing ORNL documents such as current and past building directories, an ORNL history document written in 1963 (Thompson:1963), ORNL Division histories prepared as part of ORNL's fiftieth anniversary (1943-1993), and a general history of ORNL prepared in 1992 by Leland Johnson and Daniel Schaffer; (2) reviewing ORNL Engineering records and drawings; (3) photographing the exteriors of ORNL facilities; (4) describing the architectural features of ORNL facilities and noting their condition and any alterations that have been made to the facilities; and (5) viewing the interiors of selected facilities.

The HPS and representatives from DOE and ORNL met with the TN-SHPO staff on 26 August 1993 to discuss eligibility issues.

Up to this point, the survey methodology has been to examine each of the individual components (Townsite, the X-10 Site, the Y-12 Plant, and the K-25 Site) of the ORR as opposed to looking at the ORR as a historical entity. The ORR's topographic features are historically related to the original selection of this area for "Site X" as well as to the development of these specific facilities. However, until all four elements of the ORR are inventoried and evaluated, it is not possible to determine if the ORR, either all of it or a portion of it, would be eligible for the National Register as a historic landscape with the individual components as contributing elements. Therefore, it is the HPS's recommendation that, as part of the last inventory, the entire ORR be evaluated as a historic landscape.

PREVIOUS SURVEY OR NATIONAL REGISTER WORK: The TN-SHPO has not previously conducted any survey work on the ORNL site as part of its ongoing state-wide survey of all pre-1942 buildings. Although the TN-SHPO has not surveyed Anderson County, Roane County is in the process of being surveyed. Based on a conversation with the TN-SHPO's survey coordinator, the HPS prepared 18 TN-SHPO survey forms for the Manhattan Project era buildings at ORNL. The TN-SHPO directed the HPS that it was not necessary to prepare forms for the post-1945 buildings, for the New Bethel Baptist Church or the Graphite Reactor because they are included in the National Register, or for the underground storage areas. The TN-SHPO directed the HPS when appropriate to include related properties as a complex on a single survey form.

The only property within the ORNL main facilities complex that is included in the National Register is the Graphite Reactor, Building 3001. This facility operated between 1943 and 1963 and was designated a National Historic Landmark in 1966 by the National Park Service. It is open to the public. Immediately northeast of the ORNL main

facilities complex is the National Register included New Bethel Baptist Church (0903). The TN-SHPO also stated that pursuant to Section 106 review it had determined at a consensus level one property at ORNL eligible for the National Register in 1992, Stack 2017, which was scheduled for demolition.

In 1991 the City of Oak Ridge (Townsite) engaged the preservation consulting firm of Thomason and Associates to prepare a National Register nomination for all eligible properties within the Townsite. Thomason and Associates prepared a Multiple Property Nomination that contains a Cover Nomination for the area encompassed by the original 59,000-acre ORR (which would include the original Townsite and the three production facilities X-10 Site, Y-12 Plant, and K-25 Site). The Cover Nomination justifies three Historic Context Periods: (1) Valley Before World War II, ca. 1840-1942; (2) World War II Era, 1942-1945; and (3) Post War II Era, 1945-1959. However, post-World War II material in the Cover Nomination primarily deals with the Townsite rather than the Manhattan Project industrial complexes.

The following properties in Anderson and Roane counties were included in the National Register as a result of the 1991 Multiple Property Nomination: Bethel Valley Road Checking Station, Bear Creek Road Checking Station, George Jones Memorial Baptist Church, Freels Cabin, Luther Brannon House, Jones House, New Bethel Baptist Church, Oak Ridge Historic District, Oak Ridge Turnpike Checking Station, and Woodland-Scarboro Historic District. Figure I-3 contains a map showing these properties.

The Cover Nomination contains the following text pertaining to the industrial components (X-10 Site, Y-12 Plant, and K-25 Site) (Thomason and Murphy 1991:F12-14, F19-20, F24, F31-32):

> *F. DESCRIPTION: e. Industrial Buildings, 1942-45*
>
> *The industrial complexes at Oak Ridge, K-25, X-10, and Y-12, are not included in either of the district nominations. They will therefore be described in more detail than other property types.*

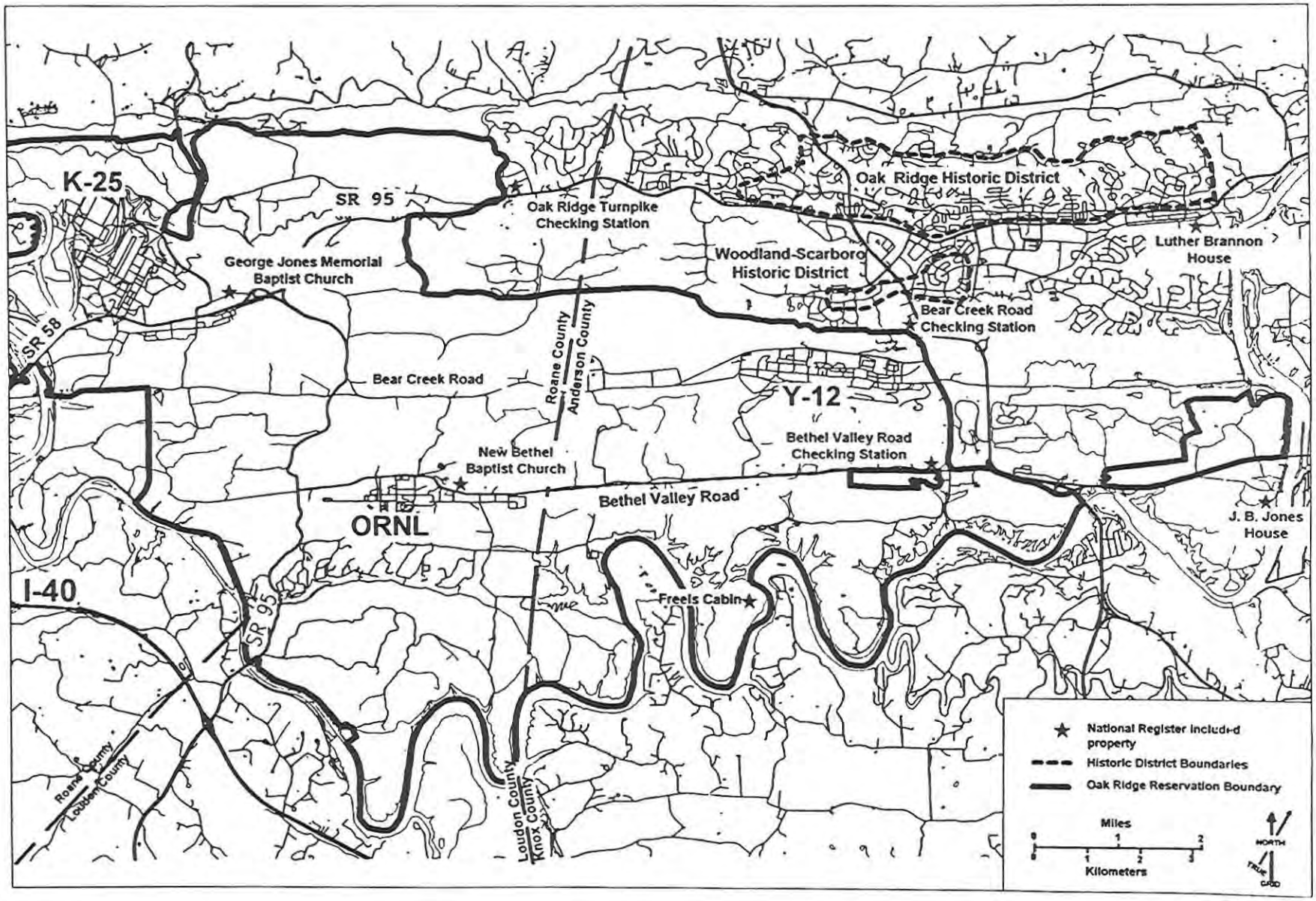


FIGURE I-3:
MAP OF PROPERTIES LISTED IN THE NATIONAL REGISTER IN 1991 MULTIPLE PROPERTY NOMINATION

Industrial buildings at Oak Ridge are concentrated at three separate plant sites which are known as K-25, Y-12, and X-10. The K-25 plant is located on the western edge of Oak Ridge adjacent to the Clinch River. Y-12 is located to the south of the residential section of Oak Ridge in a valley between Pine Ridge and Chestnut Ridge on Bear Creek Road. The X-10 plant is located in [the] south southwest section of the community in a valley between Haw Ridge and Chestnut Ridge on Bethel Valley Road. The plants were located away from each other and between ridges for security and safety reasons.

The separation of uranium through gaseous diffusion took place at K-25. The process of gaseous diffusion was developed expressly for the purpose of manufacturing an atomic weapon. Construction of the main plant began in September of 1943 and the plant was designed by the Kellex Corporation, a unit of M. W. Kellogg Corporation, of New York City. The chief construction contractor was the J. A. Jones Construction Company of Charlotte, North Carolina. The first four units began operating seventeen months after construction began. The main gaseous diffusion plant is U-shaped and covers 44 acres. Each side of the building is 2450 feet long and averages 400 feet wide. At one time, K-25 was the largest building under one roof in the world. A smaller, 1/4 size gaseous diffusion plant is nearby. The plant area contains an additional 70 buildings. The original buildings are of reinforced concrete to the main floor with steel frame and cemesto siding to the roof. A third processing plant was completed in 1951 at a cost of $65,000,000.

Y-12 was another uranium processing plant. The electromagnetic process is the ionization of uranium particles and the acceleration of these particles in a mass spectrometer at a velocity close to the speed of light. The stream of particles is bent by an electromagnet in an almost absolute vacuum. U-235 separates from U-238 in an arc that has a greater radius and is thus "captured" and stored. Stone and Webster designed and built the Y-12 plant and production began in January, 1944. The plant was operated by Tennessee Eastman Corporation, a subsidiary of Eastman Kodak. The original plant contained 170 buildings and covered 500 acres. The electromagnetic plant was the first and only of its kind in the world.

The pumps needed to create the nearly perfect vacuum for the electromagnetic separation were of a higher speed and lower pressure than any previously developed. The vacuum produced by the pumps was 30,000,000 times that commonly used in power plants. The magnets used were nearly 100 times larger than any magnet previously built. They were 230 feet long and were so strong that the pull on the nails in shoes made it difficult for workers to walk. 14,000 tons, or $400,000,000 worth of silver was borrowed from the U. S. Treasury to replace unavailable copper needed for the many magnets. Stone and Webster designed and built the Y-12 plant at a cost of $427,000,000. Production began in January, 1944, and the plant was operated by Tennessee Eastman Corporation, a subsidiary of Eastman Kodak. The original plant contained 170 buildings and covered 500 acres. The electromagnetic plant was the first and only of its kind in the world. There was no time even to construct a pilot plant that could test the methods of electromagnetic separation, making Y-12 one of the biggest gambles in history. The equipment was manufactured by General Electric, Westinghouse, and Allis-Chalmers. The enormous amount of electricity required for the operation of the plant was produced by TVA. The materials required to build the plant included 275,000 cubic yards of concrete and 37,562,000 board feet of lumber.

Built by E. E. Dupont de Nemours and Company in 1943, the graphite reactor at X-10 was the prototype for the huge plutonium processing plant that was later built at Hanford, Washington. X-10 was the location of the first plutonium-producing graphite reactor in the world, becoming operational November 5, 1943. The plant is made up of over 150 buildings, including three chemistry buildings, a technical laboratory, a pile building, a physics lab, a power house, an electrical instrument development building, machine shop and research development shops, a lead shop, a medical building and several administration buildings and warehouses. The graphite reactor was listed on the National Register in 1965.

The construction cost of the plant was $13,000,000. Operation of the plant was

supervised by the University of Chicago until July 1, 1945, when the Monsanto Chemical Company took over operations as a research center. Carbide and Carbon Chemicals Corporations (Union Carbide Corporation) operated the plant beginning March 1, 1948, and the site name was changed to the Oak Ridge National Laboratory. Operations are presently managed by Martin Marietta Energy Systems. The Lab is made up of over 150 buildings, including three chemistry buildings, a technical laboratory, a pile building, a physics lab, a power house, an electrical instrument development building, machine shop and research development shops, a lead shop, a medical building and several administration buildings and warehouses.

Since the construction of the plants there have been numerous additions and alterations to the original buildings and many other buildings have been built in recent decades at each plant site. Due to security considerations an accurate number of original buildings at each plant site is not available nor has there been access to ascertain the integrity of remaining original buildings. Former plant workers have provided information on buildings from these years which may retain sufficient integrity to meet National Register criteria. These buildings are the original K-25 building; and Buildings 9731 and 9204-3 at the Y-12 plant.

REGISTRATION REQUIREMENTS: II) War Time Reservation Buildings, 1942-45

All industrial buildings in Oak Ridge are located outside the boundaries of the two historic districts. Industrial buildings at Oak Ridge may be considered eligible for the National Register individually or as part of a complex if they meet the following requirements:

1) If they retain sufficient form, structural design, and exterior detailing to identify them as built in this period, and evoke feelings and associations of the era. These properties should maintain their original form, retain original roof forms, location of fenestration, and maintain their original site and setting.

2) If they are significant in the manufacture of fuel for the atomic bomb as part of the Manhattan project. These may include buildings which housed significant machinery used in the gaseous diffusion, electromagnetic, and graphite reactor processes. Significant buildings may also include those important in research and development and secondary buildings associated with the process of uranium separation by gaseous diffusion.

3) If they are significant for their engineering or construction techniques to facilitate the development of nuclear energy. These may include buildings which are unique in their construction methods or engineering.

4) Industrial areas may be eligible as historic districts if they retain concentrations of buildings built during the War years; if they were of significance in the nuclear fuel processes; and if the area possesses clear and definable boundaries.

DESCRIPTION e. Industrial Buildings, 1945-1959

Post-War industrial buildings at Oak Ridge continued to be concentrated at the three separate plant sites known as K-25, Y-12, and X-10. Since the construction of the plants there have been numerous additions and alterations to the original buildings and many other buildings have been built in recent decades at each plant site. Due to security considerations an accurate number of buildings constructed between 1945 and 1959 at each plant site is not available nor has there been access to ascertain the integrity of remaining buildings from this period.

REGISTRATION REQUIREMENTS

All industrial buildings in Oak Ridge are located outside the boundaries of the two historic districts. Industrial buildings at Oak Ridge may be considered individually eligible for the National Register if they meet the following requirements:

1) If they retain sufficient form, structural design, and exterior detailing to identify them as built in this period, and evoke feelings and associations of the era. These properties should maintain their original form, retain original roof forms, location of fenestration, siding materials, and maintain their original site and setting.

2) If they are significant for their engineering or construction techniques to facilitate the development of nuclear energy. These may include buildings which are unique in their construction methods or engineering.

3) Industrial areas may be eligible as historic districts if they retain concentrations of buildings built during the Post-War years; if they were of significance in the nuclear fuel processes; and if the area possesses clear and definable boundaries.

SPECIAL CONSIDERATIONS: Virtually none of the ORNL properties under review in this report meet the 50-year age criterion of the National Register. The purpose of the 50-age criterion is to ensure that appropriate perspective and context are given to each property and that only *historic* properties are included in the National Register. This methodology is designed to avoid current trends and fads while ensuring an objective, dispassionate, and impersonal evaluation of each property. However, the Department of the Interior (DOI) recognized that an arbitrary definition of 50 years would not always be appropriate. Therefore, it developed National Register Criteria Consideration G which allows properties less than 50 years of age to be nominated if they are of "exceptional significance." The phrase "exceptional significance" does not require that the property be of national significance but that it be exceptionally important within its historic context even if that context is local. [DOI's National Register program has published two documents that deal with Consideration G. For more information refer to *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* and *National Register Bulletin 22: Guidelines for Evaluating and Nominating Properties That Have Achieved Significance Within the Last Fifty Years.*]

There are two general cases of "exceptional importance." The first involves properties that have attained significance within the past 50 years and which are clearly recognized as important. A key element in this determination is scholarly evaluation which provides historical perspective and historical context. This particular case for "exceptional significance" is bolstered when there is a substantial amount of professional, documented materials on the property itself and on the property type. For instance, in recent years substantial

studies have been done on World War II buildings. Such studies provide context to evaluate these buildings. The second case of "exceptional significance" is when an entire class or category of properties is so fragile or threatened that they are not expected to last 50 years. Examples of this case include temporary frame buildings from World War II or early motel courts. It should be noted that the more recently a property has achieved significance, the more difficult it is to demonstrate "exceptional significance."

Another unusual feature about ORNL properties is their evolution. As a research facility, ORNL's mission has been tied to ever changing views of what needs to be researched, an element compounded by changing federal administrations and priorities, as well as research projects at other facilities. Therefore, new research projects are continually being developed and integrated into the existing environment. Thus, as one experiment is terminated, the technical equipment is often discarded and new equipment installed. Many ORNL facilities have not only been altered on the exterior, but technological equipment that would date from ORNL's period of significance has also been replaced.

Another unusual feature of ORNL is that it is a highly technical and scientific facility, a type of property not routinely assessed for National Register eligibility. Recognizing the problems in this area, the Advisory Council published a document in 1991 addressing some of the problems associated with identifying and administering such properties: *Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities*. This document discusses exceptions to the 50-year age criterion, since many scientific facilities that have been developed since World War II do not meet this criterion. It also emphasizes the need for adequate perspective due to changing perceptions of historicity and due to the capricious nature of public taste and scholarly interest. It also states, "In theory considerations of the uniqueness of a property, whether it is 'one of a kind,' should not enter into decisions about whether a property is historic." It further states that both common and rare properties can be eligible for the National Register.

<u>SURVEY RESULTS</u>: Approximately 26 properties within ORNL's main facilities complex were built in the 1943-45 period as part of the X-10 Site of the World War II Manhattan Project, and due to their age, they do not necessarily need to meet the "exceptional" criterion of the National Register program. The X-10 Pile/Graphite Reactor with its support buildings produced plutonium that was used

for research purposes at Los Alamos that led to the development of the "Fat Man" implosion device, one of the two atomic bombs dropped on Japan in August 1945. It also served as a prototype reactor for the main reactor built at Hanford, Washington, that produced the plutonium used in the "Fat Man" implosion device, and served as a training laboratory for many of Hanford's employees. The role of the X-10 site in the Manhattan Project is well documented and is well recognized as is the overall context of World War II. A sign of this significance was the designation of the Graphite Reactor as a National Historic Landmark in 1966 by the National Park Service. The associated support facilities such as the chemical processing plant, Building 3019, and administrative facilities at the X-10 Site were not included in that designation.

Today, the Manhattan Project period buildings at ORNL are somewhat of a remnant. Of the approximately 150 buildings originally at the site, only 17 buildings remain. Other properties from the Manhattan Project era at the ORNL main facilities complex are three stacks, two underground SWSAs, two underground tank farms, and two settling basins. The White Oak Lake and Dam is the only other Manhattan Project period property remaining at the X-10 site. Many of the Manhattan Project period buildings have been drastically altered, so altered that even within a historic district, they could not be considered contributing properties.

The ORNL main facilities complex currently reflects the post-World War II transition to a national laboratory and more strongly evokes that period of significance than the Manhattan Project period. It is this post-World War II development that must meet the criterion of "exceptional significance." ORNL is representative of the post-World War II movement that believed that technological breakthroughs would revolutionize our lives. All things in this "Buck Rogers" era seemed possible, and it was widely believed that nuclear energy would be harnessed to do everything from curing cancer to providing regular shuttle service to outer space. Beginning in the late 1940s, the national laboratories were a component of this movement. However, by the late 1950s, a shift in focus had occurred, and while important research trends continued at the laboratories, the public prominence of the national laboratories was to a large degree eclipsed by the development of the space exploration program with the passage of the National Aeronautics and Space Act in 1958 and the ensuing manned and unmanned space flights. By the early 1960s ORNL had begun to diversify its research programs beyond nuclear research and to increasingly work on smaller but more numerous projects.

During the 1950s, ORNL received national prominence in at least three fields. In chemical processing, ORNL conducted the pilot plant experiments for chemical processing of nuclear fuels that came to be used worldwide. ORNL is perhaps best known for its work in the field of isotope production and was a worldleader in this area during the 1950s and later. Between 1949 and 1957, one of the primary programs from a funding and staffing perspective at ORNL was the Aircraft Nuclear Propulsion Project. This program resulted in the construction of reactors and related facilities at ORNL and was a critical element of ORNL's existence during the 1950s. In 1957 Congress ordered this program to be halted because other research projects had made it obsolete. However, it was not until 1961 that it was formally ended by President Kennedy.

While there is not a clear time-line for significance at ORNL, the HPS chose 1957 as the end of the period of significance for ORNL for several reasons. This period covers the establishment of ORNL and the initial $20 million building program from 1949 through about 1954 when the AEC opened the roads through the ORR to the public. It also includes the primary period that ORNL was engaged in "exotic" reactor experiments. Cancellation of the Aircraft Nuclear Propulsion Project was a distinctive event at ORNL that resulted in a reduction of staff and led to a shift in research focus. As a result, in the late 1950s and early 1960s, ORNL reexamined its mission and substantially broadened its research base to maintain its viability in an increasingly competitive budget process. This transition period represents a look to the future for ORNL rather than a closure of the past, and for that reason, the HPS chose the beginning of the transition period as a cut-off date rather than the end. Overall, the 1957 date reflects an ending to the initial development of ORNL, the closure of a significant research program, and the end of certain national trends in scientific research.

In short, after World War II, ORNL emerged as a nuclear research facility with a primary directive for research in peaceful applications of nuclear power (with some military applications such as the joint U.S. Navy Aircraft Nuclear Propulsion Project). Although there is not a "clean" time line, a variety of research projects emerged in the late 1940s and 1950s that culminated in construction activities in the 1950s. Administratively, the facility deliberately chose in the late 1950s, and again in the late 1960s, to expand into new research fields with corresponding building programs. Although many of the research efforts at ORNL after the 1950s were important, they also get further and

further from the 50-year age criterion of the National Register. Based on the available histories, there does not seem to be sufficient context to justify exceptional significance for ORNL programs and related facilities built in the 1960s or later. Many of the research activities related to several of these programs were conducted in existing buildings such as the 4500N. In future years, as more scholarly work is conducted within the context of National Register eligibility on the research activities of this period and the national laboratories themselves, a sufficient time lapse will have occurred to allow a better historical perspective of this work to emerge. At that time, these later research efforts and buildings can be re-evaluated for National Register eligibility. As properties within the facility become 50 years old, such as those properties constructed between 1948 and 1952, they should be re-evaluated. Also, it is common to re-evaluate an evolving class of structures every 10 years.

The AEC did not designate reactor development as a primary mission of ORNL. However, the AEC did give ORNL permission to build specific research and experimental reactors. Thus, in addition to a general period of exceptional significance for ORNL, the HPS evaluated the reactors at ORNL as a finite property class that was not expected to have a 50-year lifespan and thus might be exempted from the 50-year criterion. Commercial reactors are licensed for a 40-year period with the potential for renewal. However, this field is still so new that a "standard" life expectancy for reactors cannot be definitively given. Research reactors, on the other hand, tended to be built for a specific research function and then dismantled. Thus, their life expectancy depended on the original research mission. By the 1960s research reactors were relatively common, and not all of them would necessarily be significant (Personal communication, Roger Anders). It is the opinion of the HPS that none of the post-1957 reactors are eligible for inclusion in the National Register at this time due to the absence of a scholarly context in which they can be evaluated. The following reactors are included within the ORNL Historic District and are considered to contribute to the district: Graphite Reactor (1943), Bulk Shielding Reactor (1950), Low Intensity Test Reactor (1952), and Oak Ridge Research Reactor (1955-1958). It is the opinion of the HPS that the Tower Shielding Facility complex (1954) and the Aircraft Reactor Experiment Building (1954) are eligible for inclusion to the National Register. It is the opinion of the HPS that the Homogeneous Reactor Experiment Facility

(1951)and the Homogeneous Reactor Experiment-2 (1956), the Molten Salt Reactor Experiment Facility (1961-1965, which includes modifications to the Aircraft Reactor Experiment Building 7503 and construction of associated facilities), the Health Physics Research Reactor (1962), the Experimental Gas-Cooled Reactor (1964), and the High-Flux Isotope Reactor(1965) are not eligible for inclusion in the National Register.

The Old and New Hydrofracture Facilities were also evaluated within the context of a finite property not expected to survive 50 years. This technology is a long-standing and standard method used in other fields such as for oil wells and water wells. As an experiment, beginning in the mid-1960s, ORNL applied this method to liquid low-level waste (LLLW) disposal with little success. It is doubtful that this method was used elsewhere, and due to its lack of success, was not attempted afterwards. For these reasons, it is the opinion of the HPS that these properties are not eligible for inclusion in the National Register.

In summary, it is the opinion of the HPS that a district at the original X-10 Site, ORNL Historic District, is eligible for inclusion in the National Register under Criterion A for its historical associations with the Manhattan Project, development as a national laboratory within the overall post-World War II government sponsored scientific movement, and early nuclear research. It is the HPS's opinion that the ORNL District is also eligible for inclusion in the National Register under Criterion C for the engineering merits of many of the properties and for its contributions to scientific research. Further, it is the HPS's opinion that the proposed district meets Criteria Consideration G for exceptional significance with the period of significance extending through 1957.

Of the 26 Manhattan Project period properties at the ORNL main facilities complex, 15 are within the boundaries of the proposed historic district, although one of these is noncontributing. The TN-SHPO had previously determined at a consensus level that Stack 2017 was eligible for inclusion in the National Register. Within the context of a facility-wide inventory, this property fell outside the boundaries of the proposed district, and it is the opinion of the HPS that this structure is not eligible for inclusion in the National Register.

It is the opinion of the HPS that the following properties outside the ORNL main facilities complex meet

Criteria Consideration G for exceptional significance and are also eligible for inclusion in the National Register: Buildings 7001 and 7002 in the East Support Area under Criterion A, Building 7503 Aircraft Reactor Experiment Building under Criterion A, Tower Shielding Facility (7700) under Criteria A and C, and White Oak Lake and Dam (Structure 7846) under Criterion A. A discussion of the proposed district and the individual properties is contained in Chapter III.

Although many respected scientists worked at ORNL over the years, most of the research projects have been a team effort that extended over many years with a wide variety of personnel. In addition, many of these scientists are still alive. For these reasons, it was the opinion of the HPS that there was no significance under Criterion B.

Pursuant to Section 106 of the NHPA, the HPS applied the Criteria of Effect as defined at 36 CFR 800.9 to a proposed building program at ORNL as presented in the "ORNL Site Development Plan.'' This effect assessment is contained in Chapter IV. It is the opinion of the HPS that this building program will have an adverse effect to (1) ORNL Historic District, (2) New Bethel Baptist Church (Building 0903), and (3) Aircraft Reactor Experiment Building (7503). These activities would have the potential to have no adverse effect on the Tower Shielding Facility (7700 Area). The proposed plans would have no effect on White Oak Lake and Dam (Structure 7846) and on Buildings 7001 and 7002.

CHAPTER II: HISTORICAL CONTEXT

INTRODUCTION: The purpose of this report is to evaluate the National Register eligibility of DOE properties at ORNL. ORNL is located south of Oak Ridge, in Andersone and Roane counties, Tennessee (Figure II-1). The history of this complex is inseparable from the history of the Manhattan Project, the world famous effort to produce an atomic bomb for use in World War II. The history of the Manhattan Project includes efforts all across the United States, but there are three key areas that are pivotal to the history of this project. These areas are the plutonium plant in Hanford, Washington, code-named "Site W"; the headquarters and production plant site near Clinton, Tennessee, code-named "Site X," which contained four components, the Townsite (present-day City of Oak Ridge, X-10 (present-day ORNL), K-25, and Y-12; and a weapons research center at Los Alamos, New Mexico, code-named "Site Y."

The X-10 Site, renamed the "Oak Ridge National Laboratory" in 1948, is located within the ORR, an approximately 59,000-acre area acquired by the United States Government between 1942 and 1944 as part of the Manhattan Project. The ORR is a sprawling and varied area roughly 17 miles long and 7 miles wide that includes areas in both Roane and Anderson counties in Tennessee. The ORR is located about 20 miles northwest of Knoxville, the largest city in East Tennessee. The area is located in the "Ridge and Valley" physiographic province between the Appalachian Mountains to the southeast and the Cumberland Plateau to the northwest. The topography in the area has a "washboard" appearance that consists of a series of parallel steep ridges and narrow valleys that trend northeast/southwest through the region.

In 1943 Tennessee Governor Prentiss Cooper, perhaps in part due to the amount of the State of Tennessee's land that had already been lost to Tennessee Valley Authority (TVA) dams and the Great Smoky Mountain National Park and, perhaps disturbed over the secrecy of the Manhattan Project and the absence of coordination with state officials, declined to cede sovereignty over the land comprising the ORR to the federal government. Thus, this area was not legally a military reservation but rather a militarily restricted area Robinson 1950:60-61).

When the government acquired this land, it was an isolated rural area with scattered crossroad communities

FIGURE II-1: GENERAL LOCATION MAP OF OAK RIDGE

such as Scarboro, Elza, and Wheat. In January 1943, the U.S. Army named the ORR the Clinton Engineer Works, which included the three production facilities and the Townsite for the workers. The name Clinton was chosen because the closest rail center and town was Clinton, the Anderson County seat. After the Townsite was laid out along the side of Black Oak Ridge, the U.S. Army named the Townsite "Oak Ridge," and the post office in the town bore this name (Jones 1985:79; Tennessee Historical Commission [THC] N.D.:683). However, the three production facilities (the X-10 Site, the K-25 Site, and the Y-12 Plant) were still generally referred to as the Clinton site, and historical sources from the 1940s and early 1950s also refer to the area in general as Clinton. It was only after World War II that the name Oak Ridge came into usage for the area. Since "Clinton," as a location, is now understood to refer to the City of Clinton, the Anderson County seat, to avoid confusion, the term ORR will primarily be used in this report to refer to the Tennessee production site.

PRE-1942 PERIOD: Through archaeological excavations, it is known that the East Tennessee region has experienced a long history of human occupation which cover all of the major periods defined by archaeologists. Chronologically, occupation begins with the Paleo-Indian Period which started about 10,000 years ago. This period primarily consisted of nomadic tribes without "settlement patterns" as we define them. The next period, the Archaic Period, began about 6000 years ago and lasted until about the beginning of the Christian era. During this period, settlements focused on low elevations along rivers and streams. The Woodland Period lasted from about the beginning of the Christian era to about 1000 A.D. During the Woodland Period, settlement patterns were based on seasonal migration to maximize the exploitation of natural resources. Peoples tended to settle along streams in the summer months to gather aquatic resources, and in the fall when flooding made these areas unsafe and food scarce, they moved to the hillsides living in rockshelters gathering nuts. They also had an extensive trading network, farming system, and ceramic technology. The Mississippian Period began around 1000 A.D. and lasted until the arrival of Europeans in the late 1600s. A distinctive feature of this Period is that humans switched from a nomadic hunting-and-gathering economy to a system based on large, sedentary villages dependent on agriculture. When Europeans arrived in the late 1600s and early 1700s, they encountered the last segment of human occupation before Euroamerican settlement, a group of people known as the Cherokee Indians who comprise the Historic Native American Period (Fielder 1974:7-11).

Early Euroamericans in this area were primarily English and French. They were often known as "longhunters" due to the extended times they were absent from their home bases. While the French explorers tended to be more interested in trading with the Indians, the English tended to be more interested in long term settlement in the area. The construction of Fort Loudoun in 1756 on the Tellico River, about 15 miles from present day Oak Ridge, among other things, was a statement to the Cherokees and the French that the English had long range plans to remain in the area. The English established claim to this area over the French when it won the French and Indian War in 1763. Afterwards, the English established permanent settlements in the region. After extensive settlement by Euroamericans and further land disputes with the Cherokees, the Cherokees were forced in 1838 to relocate to present-day Oklahoma traveling along the infamous "Trail of Tears."

Most of the X-10 Site, as well as the K-25 Site, is located in northern Roane County. Settlement by Euroamericans in present day Tennessee first occurred in eastern Tennessee as settlers from North Carolina, Virginia, and Pennsylvania migrated westward. During this period, Kingston, the Roane County seat, was a pivotal community in the state. After North Carolina in 1789 ceded the territory that was to become Tennessee to the federal government, the government in 1792 established a military post, Fort Southwest Point, a mere mile from Kingston, which gave great stature to the community. The town was located along a major stage route from Nashville to Washington and was a well-known stopping point. Also, during a period when water transport was as important if not more important than overland transport, Kingston was ideally situated either on or near the Tennessee, Clinch, Emory, and Little Emory Rivers. In 1801, Roane County, named for Tennessee Governor Archibald Roane, was formed from Knox County. During this period, virtually the only area of the state to be settled was East Tennessee, and the State's capitol was in Knoxville. Due to Kingston's prominence, the State Legislature selected Kingston as Tennessee's state capitol for one day, 21 September 1807. However, the Tennessee General Assembly moved the capitol back to Knoxville the next day. Again in 1843 Kingston was discussed as the potential site for the state capitol. Although the State Legislature named Kingston as the State's capitol, the House of Representatives chose Murfreesboro. As a compromise measure, the Legislature selected Nashville, which has been the State's capitol since (Robinson 1950:27-28).

The two other major components of the ORR, the Townsite and the Y-12 Plant, are located in Anderson County. Anderson County was established in 1801 and named for Joseph Anderson, a United States Senator and former territorial judge who lived in nearby Knoxville. The county seat, which is located about nine miles north of the Townsite, was originally named Burrville in honor of Aaron Burr who was then Vice-President. However, after the scandals of his duel with Alexander Hamilton and his treasonous Western colonization scheme, the name of the county seat was changed to Clinton. It is unclear if the town was named in honor of George Clinton who was then Vice-President or his nephew DeWitt Clinton who was then Mayor of New York, both of whom were nationally recognized (Hoskins 1979:16-19). Early settlers included William Tunnell, Anne Howard, Isaac Freels, and Collins Roberts. Descendants of most of these people still occupied the area around Clinton in 1942. Place names within the Manhattan Project site such as Freels Bend and Robertsville were derived from the names of these early settlers.

The economy of the area prior to 1942 was somewhat typical for the region and was primarily based on small-scale farms. Most settlers resided within the narrow valleys along the bottom lands of streams and rivers. The adjoining mountainous terrain prevented large-scale farming, and there was little ownership of slaves in the area. One exception is Collins Roberts who settled in the area in 1804 (Young N.D.:6). Around the Roberts farm, the site of the present-day downtown of the City of Oak Ridge, a community name Robertsville evolved. East Tennessee, including this area, generally supported the Union cause during the Civil War while the remainder of the state tended to support the Confederacy. From the early settlement period through the Depression, farmers in this area tended to be "subsistence farmers" who survived by producing crops and livestock primarily for their own use with minimal trading or bartering.

The area is somewhat atypical in the amount of nineteenth and early twentieth century industrial development in the area. Coal is the region's most abundant natural resource, and the western third of Anderson County lies in the Cumberland coal fields (Jones 1987:69). In the late 1800s, as an outgrowth of the industrial revolution, groups of investors hoping to capitalize on the abundant natural resources along the Cumberland Mountains built company towns all along the mountain range. Two of these, Rockwood and Harriman, are located in Roane County. Although farming was the main occupation in the region, some residents worked in the coal mines or for other industries.

Like most areas in the United States, Anderson and Roane counties were hard hit by the Great Depression, perhaps more so due to their partial dependence on the coal industry. An event that dramatically changed the region and greatly affected employment in the area was the of TVA in 1933. Although TVA is often perceived as a "power" agency, TVA's legislative mandate was to solve many of the problems in the Tennessee River Watershed (including areas in seven states) through the development of a multi-state plan that would involve the proper use, conservation, and development of Tennessee Valley natural resources. Within this context, the implementation of flood control and the production of inexpensive hydro-electric power were two of the major directives of TVA. As a result, TVA built a series of dams along the Tennessee River. The first project by this unique agency was the construction of Norris Dam across the Clinch River in the northern tip of Anderson County. Built between 1933 and 1936, this dam resulted in the inundation of 34,000 acres of land in Anderson, Campbell, Claiborne, Grainger, and Union counties. The Norris Dam had dramatic and far-reaching effects on the area as well as the entire Southeast. The Anderson County historian put the construction of the dam in this context:

> *...The construction of Norris Dam, its impact on Anderson County life, and the potentialities it created for the future constituted one of the major turning points which determined the ultimate direction Anderson County's social, economic, and political development would take (Hoskins 1979:78).*

Although the Norris Dam brought many beneficial results to the region, it was also a frustrating and enraging experience for many people who were forced to leave farms that had been in their families for over 100 years. It is ironic that the dam itself, only six years after its construction, became a pivotal reason that this area was chosen as the location for "Site X" in the Manhattan Project. Like the dam, the selection of this area as part of the Manhattan Project also brought benefits to the area while embittering many residents. Some were forced to leave their farms and homes with as little as two weeks notice for a nebulous and mysterious "war effort."

BUILDINGS REMAINING FROM PRE-1942: After the government purchased the ORR, most of the existing buildings were demolished. However, about 180 houses were retained for residential use. Immediately after World War II, all but a handful of these were demolished. Only a few pre-1942

buildings remain within the 59,000-acre ORR and none are within the ORNL main facilities complex (although the New Bethel Baptist Church and Cemetery, a National Register property, is immediately across Bethel Valley Road from ORNL). It is unknown at this time how many pre-1942 buildings are located at the Y-12 Plant or the K-25 Site. Five known pre-1942 buildings exist outside the complexes but within the original ORR boundaries, all of which are included in the National Register: (1) the ca. 1810 Freels Log Cabin, (2) the ca. 1900 New Bethel Baptist Church and Cemetery, (3) the 1901 George Jones Memorial Baptist Church, (4) the ca. 1920 J. B. Jones House, and (5) the 1942 Luther Brannon House.

1942-1945 PERIOD: The selection of Anderson and Roane counties for the location of Site X of the Manhattan Project in 1942 had its roots in research extending back several years. [A general chronology of the Manhattan Project is contained in Appendix D.] Several European scientists conducted research and experiments in atomic studies throughout the 1930s. It should be kept in mind that during the 1930s, the European scientific community was unsettled and in flux as many scientists from Germany and Italy, fearful of the political unrest and oppressions in their countries, fled to the United States or more stable areas of Europe. Ironically, many of these scientists were instrumental in the research that led to the United States being the first country to develop the atomic bomb.

A cornerstone of this research was work conducted by Enrico Fermi in Italy in 1934. Fermi systematically bombarded the atoms of all known elements with neutrons. This work was not fully understood until 1938 when research, conducted by German radiochemists Otto Hahn and Fritz Strassmann, on uranium expanded the scientific community's understanding of the process. Hann and Strassmann showed that the new substances created during the experiment were lighter elements and weighed less than the original uranium nucleus, thereby concluding that the splitting process must produce a surplus amount of energy. Based on the work of the German scientists, Lise Meitner and her nephew Otto Frisch, two Austrian scientists who had fled Germany, concluded that so much energy had been released that a previously undiscovered process was involved. Frisch, using the term for cell division in biology, binary fission, named the newly discovered process "fission." Although Fermi had not recognized it, he had produced fission in his 1934 experiments (Gosling 1990:2).

As a result, the scientific community came to the conclusion that, theoretically, there was the possibility that atomic energy could be realized. Scientists soon

discovered that splitting the uranium atom not only released energy but also released two or three additional neutrons. Further, under the right conditions, scientists theorized that it might be possible that these newly released neutrons would smash other atoms, thereby releasing more neutrons to bombard still more atoms thus generating a continuous emission of energy. In theory, this process, or chain reaction, would be self-sustaining and would continue for as long as uranium atoms were present (Jones 1985:6-7).

One of the keys to this process is, of course, uranium, a rare element that is found in a variety of locations but rarely in concentrated form. Prior to World War II, the uses of uranium were limited and it was not widely mined. In the 1930s, the major known location of uranium was the Shinkolobwe mine in the Belgian Congo in Africa, which was owned by the Belgian firm of Union Miniere du Haut Katanga. This firm dominated the world market, and with ores stockpiled in warehouses sufficient to meet anticipated demands for the next 30 years, closed its mining operations in 1937 (Jones 1985:8). Eventually, the Manhattan Project acquired this ore as well as new ores mined from their African mines. In addition, more uranium ores were acquired from the Eldorado mine in Canada and mines on the Colorado Plateau (Jones 1985:79-80; THC N.D.:659). Surprisingly, from this start, the United States became the leading uranium producer in the western world by the late 1950s (Little 1958:73).

In the 1930s scientists discovered that atoms of the same element could contain different numbers of neutrons, and that this different number of neutrons caused them to weigh differently. The term *isotope* was then used to designate any of two or more forms of an element having the same atomic number but different atomic weights. Natural uranium is composed of three isotopes: uranium-238, uranium-235, and uranium-234. All three uranium isotopes have 92 protons in their nuclei and 92 electrons in orbit. However, uranium-238, which composes about 99.28 percent of uranium, has 146 neutrons in its nucleus; uranium-235, which composes only about 0.71 percent, has 143 neutrons; and uranium-234, which composes just a trace. Scientists soon discovered that the common uranium-238 isotope is not fissionable, but when bombarded with neutrons becomes radioactive and disintegrates. On the other hand, the much rarer isotope, uranium-235 is fissionable by both slow and fast neutrons. To maintain a self-sustaining chain reaction, at least one neutron emitted by the uranium-235 atom has to penetrate another uranium-235 atom. Scientists also discovered that when uranium-235 does fission, due to the prevalence of uranium-238 and the fact that fast neutrons were subject to capture by uranium-238, it

becomes improbable for neutrons emitted by uranium-235 to avoid being captured by the more abundant uranium-238 atoms. In addition, many neutrons either escape completely from the uranium or are absorbed by impurities within the uranium. This is why uranium does not fission in its natural state. Further research led to the discovery of the isotopes neptunium and plutonium and the fact that plutonium behaves much like uranium when split, meaning that it was also subject to fission and therefore conducive for use in a bomb (Thomason and Murphy 1991:E7).

Scientists concluded that one method to create fission was through the separation of uranium-235 from uranium-238 to increase the chances of a chain reaction occurring. However, because the two uranium isotopes are chemically identical, this separation could not be achieved by chemical means. Also, the small difference in mass between them meant that separation by physical means would be virtually impossible. By the late 1930s, scientists at various laboratories and universities across the United States, literally from New York to California, had identified six primary methods of separating fissionable material: electromagnetic separation, centrifugal separation, thermal diffusion, gaseous diffusion, the production of plutonium by a uranium chain-reaction in enriched piles of graphite, and the production of plutonium by a uranium chain-reaction in enriched piles of heavy water (Thomason and Murphy 1991:E8).

In general, by 1939, available research suggested it was theoretically possible to use atomic energy to develop a bomb more powerful than anything then known. Yet, it was all theory. Even the uranium-graphite system, which in 1941 appeared to be one of the more promising systems, seemed more likely as a power source for large ships or planes than for use in a bomb (Jones 1985:11). In fact, in 1939 Fermi wrote that there is "little likelihood of an atomic bomb, little proof that we were not pursuing a chimera" (Gosling 1990:6).

However, several of the European refugee scientists, including Fermi, Hungarians Leo Szilard, Eugene Wigner and Edward Teller were well aware the Nazis were supporting nuclear research in Berlin. The possibility that the Germans might develop an atomic bomb made them terrified. While there was no certainty that the process could produce a bomb, they felt that they could not afford to ignore the possibility. Thus, they pursued two avenues to prevent the Germans from gaining a nuclear advantage. The first was to

get all scientists conducting research in this field to agree not to publish their findings. Amazingly, this goal was nearly achieved in 1939 when leading scientists in Great Britain and the United States agreed. However, one French scientist, Frederic Joliot-Curie, refused. His determination to publish his own findings led other scientists to publish their own papers, and a wide variety of articles appeared through late 1940 at which time the publication of articles on atomic energy generally ceased (Jones 1985:11-12).

The second approach used by Fermi and his colleagues was to approach the United States government and encourage it to sponsor research in this field. From March to July 1939, these men met with various military personnel but to no avail. They then decided to enlist the aid of Albert Einstein who was far more famous. Szilard drafted a letter to President Roosevelt for Einstein's signature and through friends arranged a meeting with Einstein. Szilard explained the situation, and Einstein quickly understood the ramifications of the research. It is unclear if Einstein rewrote the letter, or if he merely signed it, but the end result was a signed letter by Einstein to the President. This letter noted the possibility that chain reactions utilizing uranium could produce "extremely powerful bombs," and that since Germany was pursuing this avenue of research, the United States should pursue it as well (Gosling 1990:vii). President Roosevelt never directly responded to Einstein's letter, but he did meet two months later on 11 and 12 October 1939 with his close friend and adviser Alexander Sachs who had served as an intermediary between Szilard and Einstein. Although the President was initially noncommittal, on the second day of the meeting he acknowledged the need to pursue research into atomic energy.

President Roosevelt appointed an Advisory Committee on Uranium which met for the first time on 21 October 1939. This committee included both civilian and military representatives. Its role was to investigate current research in uranium and to develop a recommendation for the role the United States would play in its further development. On 1 November 1939 the Committee recommended limited funding for the Fermi-Szilard pile experiments already underway at Columbia University. In early 1940, the committee also recommended limited research on isotope separation and chain reactions.

In September 1939, after the German invasion of Poland, Vannevar Bush, president of the Carnegie Foundation, approached the Roosevelt administration to request that the

government sponsor a national science organization as part of the war effort. In June 1940, President Roosevelt appointed Bush as head of the newly created National Defense Research Committee. This Committee eliminated military membership on the Uranium Committee and reorganized it as the Office of Scientific Research and Development Section on Uranium, which was code-named "S-1" (Section One of the Office of Scientific Research and Development) (Gosling 1990:9). One of Bush's first actions was to block further publication of articles on uranium research (Gosling 1990:7). On 28 June 1941, less than a week after Germany invaded the Soviet Union, an executive order established the Office of Scientific Research and Development (OSRD). Bush, as director, now reported directly to the President, and James Conant who was president of Harvard University became the head of the National Defense Research Committee. Bush and Conant's role in bringing these research concepts to reality was critical. On 9 October 1941 Bush met with President Roosevelt and discussed various aspects of the research project. President Roosevelt gave Bush the authority to determine if a bomb could be made and at what cost, but did not give Bush the authority to proceed with the development of a bomb (Hewlett and Anderson 1962:46). At this meeting President Roosevelt approved U.S. Army involvement.

Throughout the fall of 1941 and early 1942, research at various universities indicated that an atomic bomb could be produced. Japan's attack on Pearl Harbor in December 1941 and the subsequent entry of the United States into World War II increased the focus to proceed with such a research program. Bush was in frequent contact with President Roosevelt outlining advancements in the research. In May 1942, Bush directed Conant to meet with various individuals and make recommendations on all approaches to the bomb disregarding cost. Conant's S-1 Committee analyzed the four leading methods of isotope separation: gaseous diffusion, centrifuge, electromagnetic, and pile. Since none of the four methods could be said to be clearly superior to the others, the S-1 Committee recommended that all four be pursued and that all four have plants and full scale production facilities built as if each were the only method under consideration. While this may seem irresponsible, if not excessive, the key concern was winning World War II rather than developing the bomb as cost efficiently as possible.

Bush outlined the proposed program for President Roosevelt in a 17 June 1942 letter. Bush advised President Roosevelt that a full scale bomb development program was feasible and recommended the initiation of such a project including the search for an appropriate production site.

The President signed Bush's report with an "OK" beside his initials, and the as yet unnamed Manhattan Project was formally launched. As one historian wrote, "The United States was now firmly and fully committed to an all-out effort to build an atomic bomb" (Jones 1985:39).

However, this firm and full commitment did not include a AAA priority rating. When the project was rated in July 1942, it received an assignment of only an AA-3 rating. This comparatively low ranking was given because, within the overall context of the effort to win World War II, the atomic bomb was a long shot. Under standard rules, AA-3 was the highest possible classification for plant construction jobs (THC N.D:657). Tying up strategic materials and personnel for its development might risk losing World War II (THC N.D.:657). The higher AA-1 and AA-2 ratings were assigned only to essential weapons scheduled for early production. The special AAA rating was reserved for breaking bottlenecks. However, after much maneuvering, the project was awarded the coveted AAA rating in September 1942 on an as needed basis and an overall upgrade to AA-2X in March 1943 (THC N.D.:660, 682). With the AAA rating, the project was able to edge out competing interests for materials, gaining enemies in the process and a reputation for robbing other programs (THC N.D.:682).

President Roosevelt's commitment to the basic atomic research program as a war-related effort meant military involvement and control. Security needs logically placed the program within a military context, and construction needs logically placed the program within jurisdiction of the U.S. Army Corps of Engineers (Corps). Within hours of President Roosevelt's approval, the U.S. Army designated Colonel James C. Marshall, a 25 year veteran of the Corps, to organize and administer the construction work for the new program. The U.S. Army and the Corps thus became responsible for site selection; the design, construction and operation of the plants; the organization of a special laboratory to design, manufacture, and test atomic weapons; and the responsibility for security for the entire project (Jones 1985:603). An army officer would be in overall command of the entire project, and the S-1 Committee, comprised of scientists, would be in charge of university research and pilot plant studies. As one historian wrote, "With this reorganization in place, the nature of the American atomic bomb effort changed from one dominated by research scientists to one in which scientists played a supporting role in the construction enterprise run by the United States Army Corps of Engineers" (Gosling 1990:12).

Colonel Marshall moved his operation from Syracuse, New York to New York City, New York where he set up temporary headquarters and opened a liaison office in Washington. He also recruited several of his former employees from the Syracuse Corps District. However, some U.S. Army personnel did not feel that Colonel Marshall was decisive or fast-acting enough to manage this specific type of program. Thus, on 17 September 1942 the 48 year old U.S. Army Colonel Leslie R. Groves, who was promoted to Brigadier General within a week, was appointed to head the Manhattan Project. Colonel Marshall remained as District Engineer where his more cautious temperament proved useful (Gosling 1990:14). General Groves selected as his assistant Lieutenant Colonel Kenneth D. Nichols who had been Colonel Marshall's assistant. [In 1943, Nichols was promoted to Colonel Marshall's position as District Engineer.]

General Groves had been assigned to the Corps for two years where he had been in charge of all construction activities including the just completed Pentagon (National Historic Landmark) (Groves 1962:3). He had been anticipating an overseas assignment and was furious about his appointment to what he termed a "pipe dream" (THC N.D.:660). Yet General Groves, who had an engineering degree from West Point and had strong administrative abilities, threw himself completely into the project. Within two days, General Groves moved to obtain a site for plant production in Tennessee, secured the coveted AAA priority rating for the project, and had moved the District headquarters from New York to Washington. The role of General Groves in this project, which has been described as "the equivalent of building a Panama Canal each year for three consecutive years," cannot be underestimated (Construction 1945:114; Robinson 1950:42). "The project did go forward on time and virtually every aspect of it, from the site location in Tennessee to the final details of the bombing run at Hiroshima, bore the general's personal imprint" (Johnson and Jackson 1981:4).

While few kind things have been written about him personally, his skills were never questioned. Perhaps the only really personal anecdote in the histories of this project concerned the only weakness a Federal Bureau of Investigation check turned up, a passion for chocolate. During World War II, he stored his chocolate supply in the same safe where the project's most important documents were kept (Johnson and Jackson 1981:3). By most accounts, General Groves was abrasive, arbitrary, and ill tempered. He was a man who was driven to do a job well regardless of other people's feelings or opinions. His intelligence was more than matched by a rare ability to juggle and merge all of the personalities, obscure scientific and technical components, and one of the largest construction jobs ever

undertaken in the United States into a completed product in three years.

One historian wrote this of General Groves:

> *Groves was practical-minded military man, brusque and goal-oriented. His aide, Colonel Nichols, characterized his heavyset boss as ruthless, egotistical, and confident, "the biggest S.O.B. I have ever worked for. He is most demanding. He is most critical. He is always a driver, never a praiser. He is abrasive and sarcastic." Nichols admitted, however, that if he had it to do over again, he would once again "pick General Groves [as his boss]" because of his unquestioned ability (Gosling 1990:37).*

Another historian wrote of General Groves:

> *"Those who like him recall that he was hard-driving, courageous, tough, responsible, and efficient. They say he demanded respect and got the job done. Those less fond of his style remember him as blunt, impatient, ruthless, tyrannical, severe, and inconsiderate. For them, he was a strict taskmaster (Johnson and Schaffer 1992:21).*

The initial cover name given to the project was Laboratory for the Development of Substitute Materials, or DSM. However, General Groves did not like the name. Since typically, Corps districts were geographically defined and given the name of the city in which they were headquartered, Colonel Marshall and General Groves decided to use the name Manhattan after the city in which Colonel Marshall had established his temporary headquarters. The name "DSM" was used periodically after that, but over time, the name was completely superseded by "Manhattan." There was some criticism for setting up the new district in a large urban area, but an argument for it was that it is easy for a small bureaucratic office to blend into a large urban landscape. Regardless, on 16 August 1942, a new Corps district was formally established, the Manhattan Engineer District (Jones 1985:40-44). However, this district broke tradition in that it had no geographic boundaries but was rather bounded by the common theme of producing an atomic bomb. Taking its name from the Corps designation, the project soon became known as the Manhattan Project.

As the Corps searched in the summer and fall of 1942 for a site to build its plant(s), scientists at various universities across the United States vied, not only to complete the project before Germany, but to establish their university as the premiere research center. As the fall

approached, the competing universities knew that some of the methods, perhaps all but one, could be eliminated. Competition was keen among these scientists to prove that their process was the most workable and promising (Gosling 1990:14). After extensive evaluations, the S-1 Committee, in November 1942, made a preliminary decision as to which methods to implement. The committee chose to eliminate the centrifuge process. This process involved the separation of uranium-235 and uranium-238 isotopes by using centrifugal force in a cylinder spinning rapidly on its vertical axis to pull off the lighter isotope at the center and top of the cylinder (Hewlett and Anderson 1962:30; Gosling 1990:7; Jones 1985:10). The committee decided to retain the gaseous diffusion, the pile, and the electromagnetic processes and orders were given to proceed with full-scale production (Gosling 1990:14-15). (Of the six methods originally under consideration, the liquid diffusion process had previously been eliminated in 1940. The debate over using heavy water or graphite in the pile continued.)

After the November meeting of the S-1 Committee, as a checks-and-balance approach, Bush appointed Warren Lewis of the Massachusetts Institute of Technology to head a final review committee (Lewis Committee), which again visited all the university research facilities. While the S-1 Committee had strongly endorsed University of California, Berkeley (Berkeley) professor Earnest O. Lawrence's electromagnetic process and even considered funding only it, the Lewis Committee expressed grave reservations about the process. In December, the S-1 Committee again met to discuss the Lewis Committee recommendations. Ultimately, a compromise program was developed which was approved by President Roosevelt on 28 December 1942. This program, which would ultimately cost more than two billion dollars, involved the construction of full-scale gaseous diffusion, pile, and electromagnetic plants as well as heavy water production facilities (Gosling 1990:14-16). With no separation process as a clear leader, the stage was set for debates to range throughout the length of the Manhattan Project as to which process would be most successful and for various scientists to request that facilities for certain methods be expanded or reduced.

In the meantime, during the summer and fall of 1942, while scientists were thoroughly and at great length debating which methods to pursue in developing an atomic bomb, the Corps turned its attention to selecting and developing a construction site for the production plants that would be appropriate for whichever methods that were ultimately chosen. One of the first decisions involved choosing a contractor, and in June 1942, the Corps selected Stone and Webster Engineering Corporation (Stone and Webster) as the principal contractor for the entire project (Hewlett and Anderson 1962:76). Various individual

components of the project would be let to other firms, for instance, the architectural firm of Skidmore, Owings and Merrill of Boston was selected to develop the plans for the Townsite.

In general terms, the Corps Manhattan Engineering District was a national district with facilities scattered across the United States. The one under primary consideration in this report is the X-10 Site within the Clinton Engineering Works (CEW or the ORR) at Oak Ridge. Yet, the ORR was only one member of a very large "team." Concurrent work was also underway at universities, laboratories, and plants across the United States. The team was composed of various research efforts at places such as Columbia University, University of Chicago, and Berkeley. Minor plants produced the materials to build the facilities as well as for use in them. For instance, over 20 firms worked on the design and manufacturing problems for the K-25 Site and 15 principal firms provided structural components (which did not include university research and more minor subcontractors). Raw materials were procured from uranium mines such as those in Colorado. A map showing the location of some of the major sites associated with the Manhattan Project is shown on Figure II-2.

There were three large sites where substantial construction activities specifically for this project occurred: the Hanford Site (Hanford), code-named "Site W"; the Clinton Engineer Works (ORR), code-named "Site X"; and the Los Alamos Laboratory (Los Alamos), code-named "Site Y". The history of these three areas developed concurrently and greatly overlap making it difficult to develop a linear chronological history of the project. However, before discussing the ORR in detail, a brief history of Los Alamos and Hanford is given below.

LOS ALAMOS: Even as the land was being purchased in Tennessee for "Site X," the Corps began its search for a site where the bomb would be assembled, a facility code-named "Site Y." Unlike the ORR or Hanford, which were production sites to deliver a raw material, Site Y was a scientific center designed to coordinate the weapons program. The task of those working at Los Alamos was to design and assemble a bomb or bombs using the enriched uranium and plutonium produced at the ORR and Hanford.

Throughout 1942 there were discussions about how to coordinate the military applications of an atomic bomb. Dr. J. Robert Oppenheimer, a Berkeley professor who spearheaded the construction of the bomb, proposed that the scientists would work together in a single facility where theoretical and experimental work could be done, rather than continuing their research at individual universities as they were then doing. For security reasons, Oppenheimer suggested that the

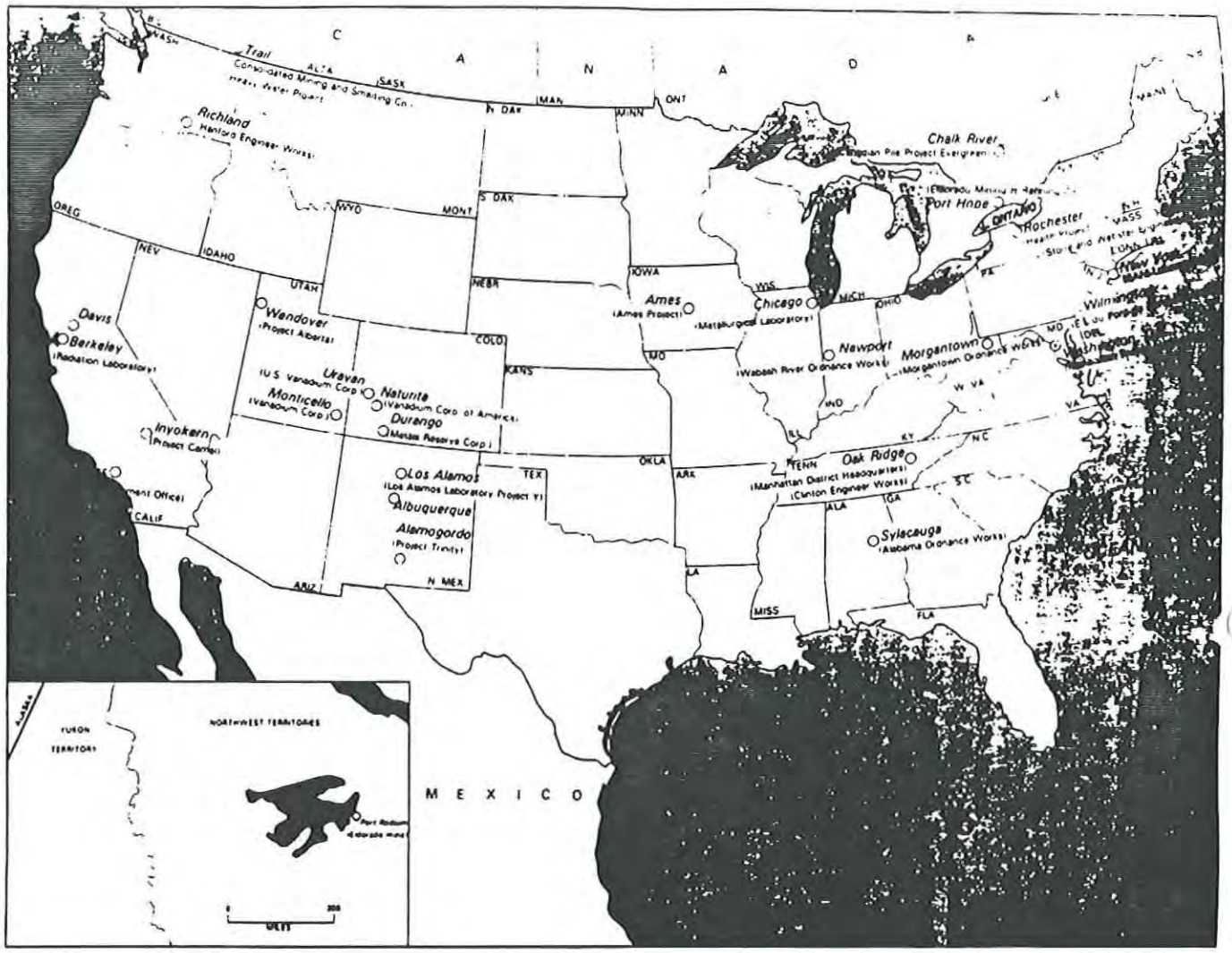


FIGURE II-2:
MAP OF MAJOR SITES ASSOCIATED WITH MANHATTAN PROJECT

(Jones 1985:Map 2)

bomb laboratory be located secretly in an isolated area so that the scientists could freely exchange ideas (Gosling 1990:35). This free-flow of ideas approach was radically different than the "need to know" approach that permeated Hanford and the ORR. The associate director at Los Alamos was Enrico Fermi.

General Groves approved this approach and he and Oppenheimer developed site criteria. The criteria dictated that the site be surrounded by hills in a thinly settled area of the southwest where a community of 250-400 persons could live in isolation. It also had to meet the basic generic requirements of the U.S. Army which included good rail and motor transportation, adequate water, isolated areas for testing, and a climate suitable for year-round construction. Corps personnel evaluated several sites, some by horseback, and narrowed the search to the Santa Fe area. The first site shown to General Groves and Oppenheimer, Jemez Springs, was rejected by both. Oppenheimer stated that the tall cliffs around the valley floor would give his people claustrophobia and that the existing houses were too humble for his staff. General Groves thought the site looked prone to flooding. The next site, the 790-acre Los Alamos Ranch School for Boys sat on a mesa overlooking the upper Rio Grande Valley. It had an attractive campus with over 50 log and stone buildings and well-kept grounds. The site pleased Oppenheimer, and the only fault General Groves found with it was an inadequate road to the facility which was rebuilt as part of the project (THC N.D.:664). The School was willing to sell because it was having problems finding teachers due to World War II. Nearby, the U.S. Forest Service owned about 45,000 acres of land which could be acquired relatively easily through federal transfer agreements. Thus, this site of about 54,000 acres was acquired with few problems (Jones 1985:328). A map of the Los Alamos site is shown on Figure II-3.

By late 1942, the Corps had orders to begin construction and Berkeley was contracted to provide supplies and personnel. As many of the United States's top scientists and their families came to this tiny boy's school perched on its near inaccessible mesa, Los Alamos virtually became an "ivory tower frontier boomtown" (Gosling 1990:38). In addition to secrecy, in which Los Alamos was considered the most secret of the three sites, Los Alamos shared with the ORR and Hanford crude living conditions and limited living quarters.

Research at Los Alamos was primarily aimed at developing weapons that could use uranium-235 and plutonium. Research efforts at Los Alamos as well as at the ORR expanded into related fields. However, General Groves insisted that the research remain tightly focused on issues

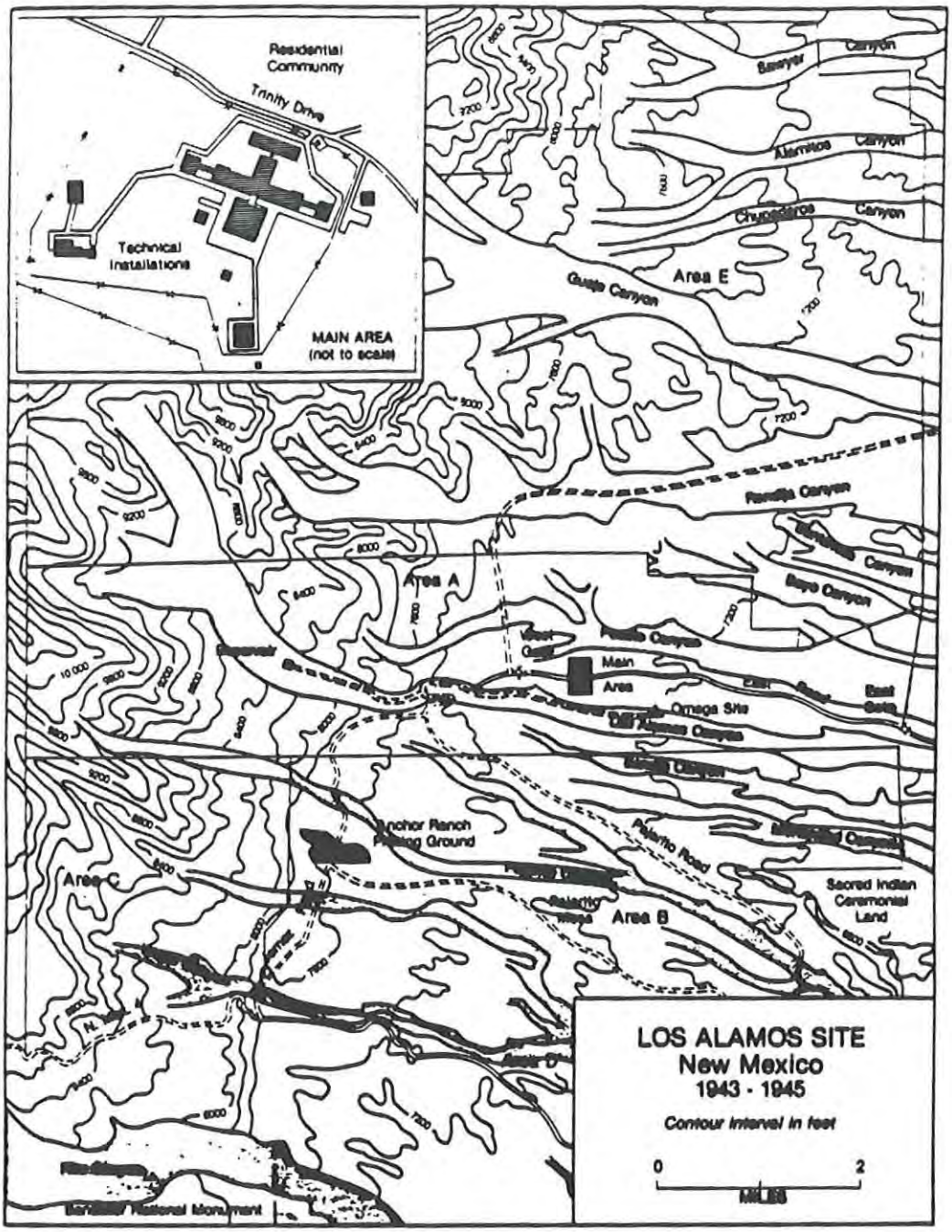


FIGURE II-3: LOS ALAMOS

(Gosling 1990:36)

relevant to bomb development. Scientists primarily worked on the premise of using uranium-235 and plutonium in gun-type weapons. By March 1944, they had developed two bomb models that would use plutonium: "Thin Man," named for President Roosevelt which would use a plutonium gun-type design, and "Fat Man," named for Winston Churchill, which was an implosion device. However, continued research indicated that plutonium could not be used in a gun-type weapon. The "Thin Man" design was eliminated in July 1944. At this point, the scientists and General Groves were faced with the fact that none of the plutonium being produced at Hanford could be used unless an implosion bomb, a much more difficult device to design, could be constructed.

Concurrently, scientists at Los Alamos considered the possibility of a hydrogen or thermonuclear bomb, called The Super, but research on it was always a distant second because they needed to concentrate on the uranium bombs at hand rather than pursuing the remote possibility that the hydrogen bomb could be completed in time to be used during World War II (Gosling 1990:38).

By February 1945, weapon design for a uranium gun had produced a lighter, smaller device that was called Thin Man's brother and nicknamed "Little Boy" (Gosling 1990:40). Due to confidence in this design, research was frozen and no tests were conducted. By March 1945, scientists had developed an implosion device using plutonium (Fat Man), but due to concern about this method, a test was scheduled for July. Scientists at Los Alamos were then assigned to either Project Trinity, the July test of the plutonium implosion bomb at the Alamogordo Air Force Base in New Mexico (Alamogordo), or to Project Alberta (or A) to prepare and deliver the weapons for combat (Gosling 1990:43). On 16 July 1945 the Trinity Test at Alamogordo was successful. Three weeks later, on 6 August 1945, the first atomic bomb, the "Little Boy" gun-type device using uranium from ORR, was dropped on Hiroshima. On 9 August 1945, the second atomic bomb, the "Fat Man" implosion device using plutonium from Hanford, was dropped on Nagasaki, and World War II soon ended.

At the end of World War II, Los Alamos as a research center entered a crisis stage due to a lack of purpose and direction. In general, Los Alamos was not just disorganized but dispirited, not just by the natural feelings of restlessness after the completion of a major project, but by then many scientists had serious reservations about their role in the development of atomic weapons and their future. Many scientists quickly left to return to universities, and

in general, large numbers of the staff left. General Groves had to act quickly and firmly or the site would disintegrate. By the spring of 1946, General Groves had made the decision that it was necessary for the site to remain active for the next few years. He felt that it was in the United States's best interest to continue to use Los Alamos as a civilian research center, although under U.S. Army control, for future weapons development while a separate military facility would take over the details of weapons production and stockpiling (Hewlett and Anderson 1962:632-633). To ensure the long-range retention of Los Alamos, he arranged for the construction of more permanent utilities, housing, and community facilities. As a result, beginning in 1946, many of the existing buildings at Los Alamos were demolished and at least 500 permanent residences and 100 prefabricated units were built. In 1964 the government began selling the homes to private individuals and extensive renovations occurred to the buildings (Howe et al. N.D.:89-91).

As of 1991, the New Mexico SHPO had not undertaken an inventory of housing associated with the Manhattan Project at Los Alamos but did not believe that the area retained much historic integrity (Thomason and Murphy 1991:E10).

HANFORD: Soon after the ORR site was finalized and General Groves had seen preliminary plant designs, he realized that the Tennessee site would not be large enough to accommodate the full-scale plutonium plant. He also felt that it was too close to Knoxville in the event of an explosion and that the water supply was not adequate for all of the production plants to be at one site (Hewlett and Anderson 1962:188). While the small proto-type plutonium pile would remain at the X-10 Site at the ORR, General Groves decided to construct the full-scale plutonium plant, code-named Site W, elsewhere. General Groves quickly assembled a list of potential sites. However, the excessive amount of water needed for this site shortened the list, and a site at Hanford, Washington, on the Columbia River, with its dams at Grand Coulee and Bonneville, was selected in January 1943 (Hewlett and Anderson 1962:18-19). Since the Corps had briefly looked at this area as an alternative to the Tennessee site, in part due to the fact that the Corps had built the Bonneville Dam, it is perhaps not surprising that the Corps readily turned to this site. Land acquisition began in February 1943. Unlike the X-10 Site at the ORR where E. I. Du Pont de Nemours and Company (Du Pont) of Wilmington, Delaware, only built the facility, Du Pont both built and ran the plutonium plant at Hanford.

Due to the fears of the consequences of an explosion at Hanford, the Corps acquired over 400,000 acres of land with only 1,500 residents (as opposed to the 54,000 acres and a school at Los Alamos and 59,000 acres and 3,000 residents at the ORR site). The Hanford site met size and isolation requirements, although its location on the west coast did not meet typical inland criteria that were reinforced by the near-manic obsession about the possibility of a Japanese invasion along the west coast. The Hanford site did have one key asset though, the almost endless supply of water available from the Columbia River. At approximately 25,000 gallons per minute, it was one of the largest in water flow in the United States (Overholt 1987:104). Also, electrical power was readily available from the nearby Bonneville and Grand Coulee Dams. The Corps placed the plants and their operators at the center of the site, and the outlying land was reserved as a safety zone. No town with more than a population of 1,000 was allowed closer than 20 miles to the site. A nearby town, Richland, which had a population of 250, was purchased to serve as a residential center for operating personnel. It was expected that Richland would house 6,500 persons but it was later expanded to 17,500. Employment, and thus housing needs, peaked at 45,000 workers (Overholt 1987:103-104). Unlike the ORR, where many of the workers commuted to their jobs at the plants, most workers at Hanford (and Los Alamos) moved to the plant site and left only infrequently. It was not until 1948 that Richland was developed into a planned community (Thomason and Murphy 1991:E9). A map of Hanford is shown on Figure II-4.

Work began at Hanford in February 1943. The site contained three water-cooled piles designated B, D, and F, four chemical separation plants, a facility to produce fuel slugs, various support buildings, plus living quarters at Hanford and Richland. Ground-breaking for the 100-B pile took place on 27 August 1943, and work continued steadily through the year. The plant at Hanford was completed in the fall of 1944. In September 1944 Fermi loaded the pile, but almost immediately it shut down. Since nothing comparable had occurred at the graphite pile at the X-10 Site or at the heavy-water pile (named CP-3 pile and finished in May 1944) at the University of Chicago's laboratory at the Argonne Forest Preserve (Argonne), the scientists were totally puzzled. Quickly they began working with the CP-3 pile to understand the problem. Although General Groves had ordered Arthur Compton at the University of Chicago to run the CP-3 pile at full power to fully test it, Compton had never done so. Now, when the scientists did, they quickly discovered xenon poisoning. Scientists converged at Hanford and

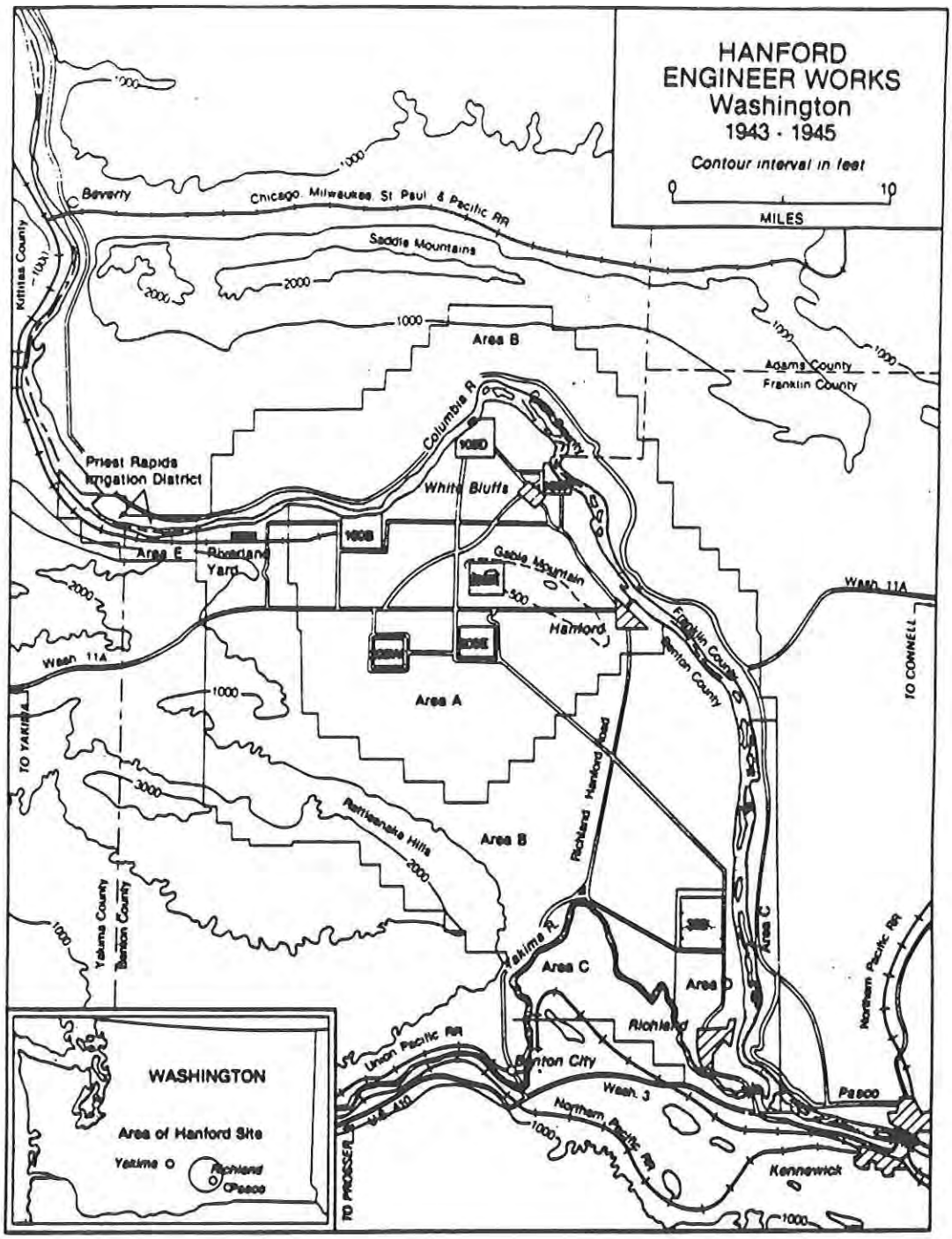


FIGURE II-4: HANFORD

(Gosling 1990:29)

resolved the problem that fall. The plutonium production facility at Hanford operated for the first time with a full loading on 17 December 1944. By the summer of 1945, the plant had produced enough plutonium for use in a bomb. As previously noted, the plutonium was first used in the successful Trinity Test at Alamogordo on 16 July 1945, and later used in the "Fat Man" implosion device that was dropped on Nagasaki, Japan, on 9 August 1945.

After World War II, Hanford continued producing fissionable material for national defense. Also, scientists used the B Pile/Reactor to develop nuclear power as a source of electricity (Chatters 1989:8-2) and the site evolved into a major nuclear power production facility. Over the years, the four plutonium production reactors constructed during the Manhattan Project were gradually phased out; the last of which was shut down in the late 1980s. Today Hanford is home to three new nuclear power reactors (Thomason and Murphy 1991:E9). Much of the 1942-1945 Hanford reactor site has been demolished, but a determination of eligibility was submitted to the Washington SHPO in 1990 for the "B Reactor." The Washington SHPO determined the resource eligible pursuant to 36 CFR 800.4(c)(2) but returned it with the suggestion that prior to submission to the Keeper of the National Register that the document be revised to include more information on surrounding buildings and a more complete assessment of site integrity. [As of 1991, the Washington SHPO had not undertaken an inventory of housing associated with the Manhattan Project at Hanford and Richland but did not believe that the area retained much historic integrity (Thomason and Murphy 1991:E10).]

OAK RIDGE RESERVATION (CLINTON ENGINEER WORKS): At first glance, it seems difficult to understand how this specific area of Anderson and Roane counties came to be selected. Yet, under close scrutiny, the numerous and varied criteria of the U.S. Army greatly narrowed the choice, and ultimately, there probably were no ideal sites. It was simply that this site came closer to meeting those criteria than any other site. One must also wonder how relevant it was that the chairman of the Senate Appropriations Committee, which approved financing for this special but secret project, was Senator Kenneth McKellar from Tennessee who had a large share in making possible such an enormous appropriation (Folmsbee et al. 1969:485).

For security reasons, the site was briefly given the misleading name of the Kingston Demolition Range after the

nearby town of Kingston, the Roane County seat (Jones 1985:319; Robinson 1950:27). In January 1943 the site was officially designated the Clinton Engineer Works, the name the entire site was known by throughout World War II, although the town's post office was named Oak Ridge. To avoid confusion, in this report the entire project site will be referred to as the ORR (historical texts generally refer to it as Clinton). The ORR site had four components, the Townsite or residential portion along Black Oak Ridge named Oak Ridge, the gaseous diffusion plant code-named K-25, the electromagnetic plant code-named Y-12, and the graphite pile site code-named X-10. In April 1943, the X-10 Site was officially named the Clinton Laboratories.

General U.S. Army guidelines for the location of new munitions plants required that they be out of range of enemy carrier-based planes, in an inland zone between the Appalachian and Rocky Mountains, and approximately 200 miles from the nation's borders with Canada and Mexico. To increase security and to facilitate construction, it was originally intended that all of the manufacturing plants would be built at a single site, thus making it necessary to acquire an extensive area. The site also had to be large enough to accommodate a town to house workers. The site needed to be isolated from a population center, have a moderate climate suitable for year-round construction, a ready supply of labor, accessibility to both rail and motor transportation, and a terrain with flat areas separated from each other by natural barriers such as ridges that would limit the effects of an accidental explosion. In short, the project needed a large isolated site that contained at least four smaller isolated sites within the larger boundaries. Also, substantial amounts of electricity and water would have to be readily and continuously available. In addition, the substratum would have to provide an adequate foundation but not be so full of rocks that it would make excavation too difficult or time-consuming (Jones 1985:46; THC N.D.:69). Further, under ideal circumstances, the land had to be sparsely populated and inexpensive.

While East Tennessee meets many of the above criteria, other sites did as well. It seems apparent that the people involved in this project early in the process focused on East Tennessee in large part due to the location of the Norris Dam in Anderson County (Folmsbee et al. 1969:536; Overholt 1987:102; Owings 1973:86). TVA had extensive personnel who could assist the Corps in evaluating sites in the region, and TVA had extensive experience in appraising and relocating residents due to the dams it had built in the area. In turn, these dams offered great potential as power and water sources.

An OSRD committee had picked out an area near Knoxville as early as April 1942 (Jones 1985:46). A 1944 map of the general area is shown in Figure II-5. Colonel Marshall and others visited the area on the last day of June 1942 and toured several areas including those around Harriman, Dayton, and Athens. Initially, attention focused on the Tennessee River above the Watts Bar Dam, but the people involved found the surrounding terrain too rugged and inaccessible for convenient railroad or power connections (Hewlett and Anderson 1962:77). However, when the group visited the "Elza site" south of Clinton, they were favorably impressed with the topography, the relatively convenient location (its isolation yet closeness to Knoxville), water supply, and sparse population. By the end of the trip, Colonel Marshall had recommended a site near Clinton that included areas in both Anderson and Roane County. In the following months there were minor skirmishes over the location of the production site. For instance, Lawrence wanted the plant for "his" method, the electromagnetic process, to be built near the Shasta Dam in California near his home base. Also, scientists at the University of Chicago pushed to have the plutonium pilot plant built near Chicago at Argonne. There was also discussion that a site near the Corps's own Bonneville Dam on the Columbia River on the west coast would be preferable. However, it seems as if the Tennessee site was always the main one under consideration, and the decision was finalized in September 1942.

The ORR is bordered on the east, south, and west by the Clinch River and on the north by a steep mountain range called Black Oak Ridge and by the L & N Railroad. The area, although sited on a northeast slant, was roughly rectangular in shape and almost evenly divided by the Roane-Anderson County line. Three distinct valleys extend through the area, also on a northeast slant. At that time, each valley had a road running along the valley floor and two small roads that ran across the ridges connecting the valleys. The westernmost road was State Route 95. Due to security reasons, State Route 95 was rerouted to the northwest and the old alignment of the two-lane State Route 95 was widened to four lanes and renamed the Oak Ridge Turnpike. Originally, the turnpike was the southern limits of the Townsite (Robinson 1950:62).

For additional security and as limited protection against explosions, each of the three production facilities was sited separately within the three valleys. The plutonium semiworks, which was code-named X-10 and contained the experimental plutonium pile and separation facilities, was built in Bethel Valley. The electromagnetic plant, code-named Y-12, was built in Bear Creek Valley. The

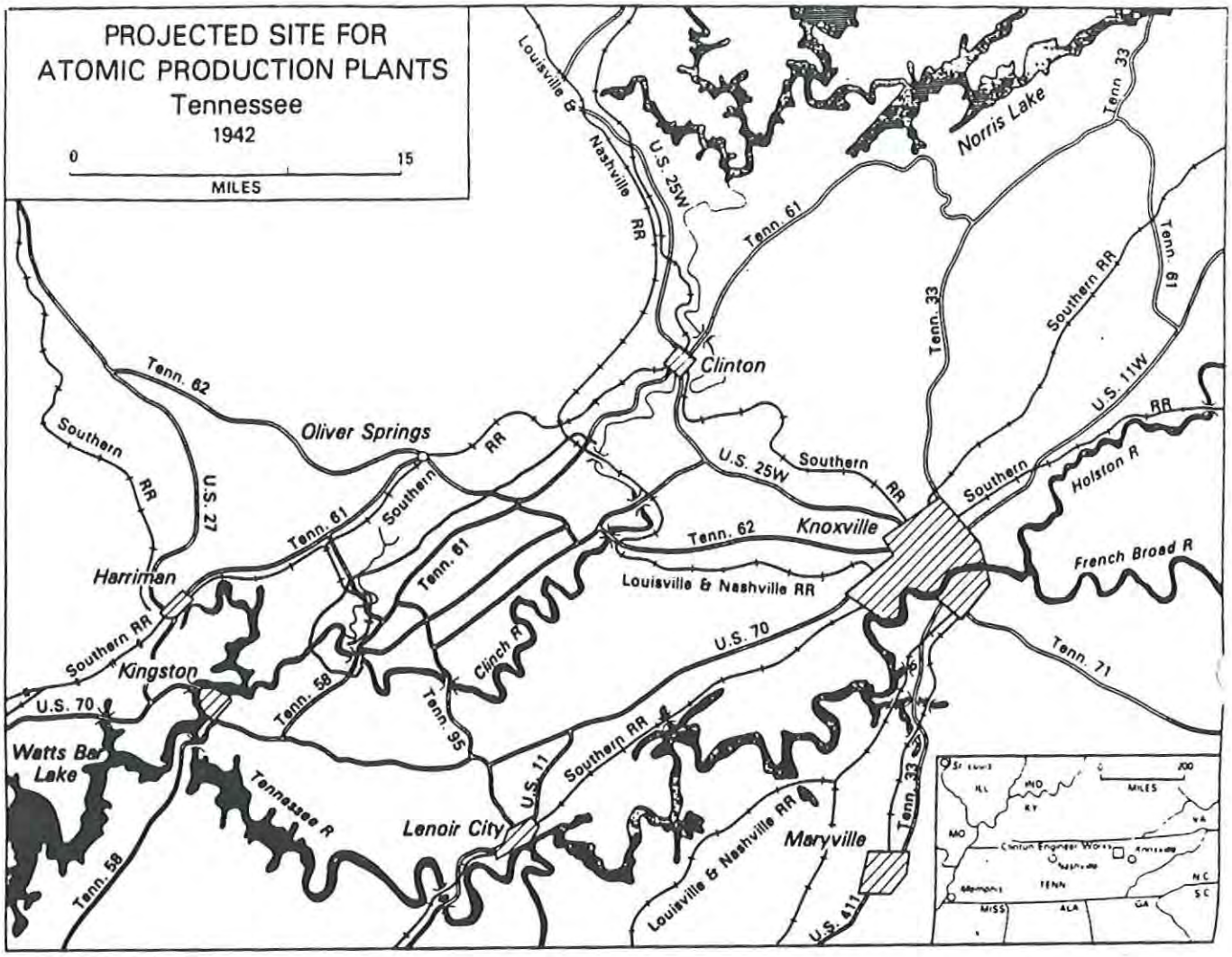


FIGURE II-5: 1942 MAP OF EAST TENNESSEE

(Jones 1985:48)

gaseous diffusion plant, code-named K-25, was built along the Clinch River and Poplar Creek in East Fork Valley. In 1944, when the S-50 thermal diffusion plant was added to the project, it was built adjacent to the K-25 Site. A map of the project site is shown on Figure II-6.

Even though President Roosevelt would not formally authorize the project until 28 December 1942, on 6 October 1942 a U.S. Army attorney filed a declaration of taking for 59,000 acres of land with the Federal Court at Knoxville and obtained immediate possession using the War Powers Act. The Corps was originally given authority to purchase 56,200 acres of land at the ORR for the project. However, from June 1943 through August 1944, authority was given to acquire 10 additional parcels of land which brought the total acreage to 58,900 (Jones 1985:320). This area contained four small communities: Elza, Robertsville, Wheat, and Scarboro. Many texts refer to these communities as "crossroad communities," however, the term is somewhat misleading if "crossroad community" is defined as one in which two roads cross with a scattering of buildings. For instance, Robertsville was large enough to have an elaborate two-story brick high school (Young N.D.:6). Wheat was a bustling town that had at least two Baptist Churches, a Presbyterian Church, a Methodist Church, Roane College, Wheat High School, and the Gallaher Ferry.

Some of the residents in the area had previously been evicted from their homes due to the construction of Norris Dam to the north and the development of the Great Smoky Mountains National Park to the east and had come here to settle within the past 10 years (Young N.D.:6). Many others lived on farms that had been in their families since the early 1800s.

Altogether, roughly 1,000 landowners and their families and tenants (approximately 3,000 people) were relocated (Overholt 1987:102). Most residents felt that they were substantially underpaid for their farms and sought redress in the federal court system. In 1943 there were congressional hearings on the charges of unfair appraisals (Jones 1985:324). The Corps did not provide any assistance to people to help with relocation efforts, and due to the time-frame, most were forced to move before they had received any payment for their land. Due to shortages caused by World War II, relocation itself was extremely difficult because so few vehicles or even tires for the vehicles were available. For instance, officials in Clinton traveled to Nashville to appeal to Wage and Price Stabilization officials for increased tire allocations

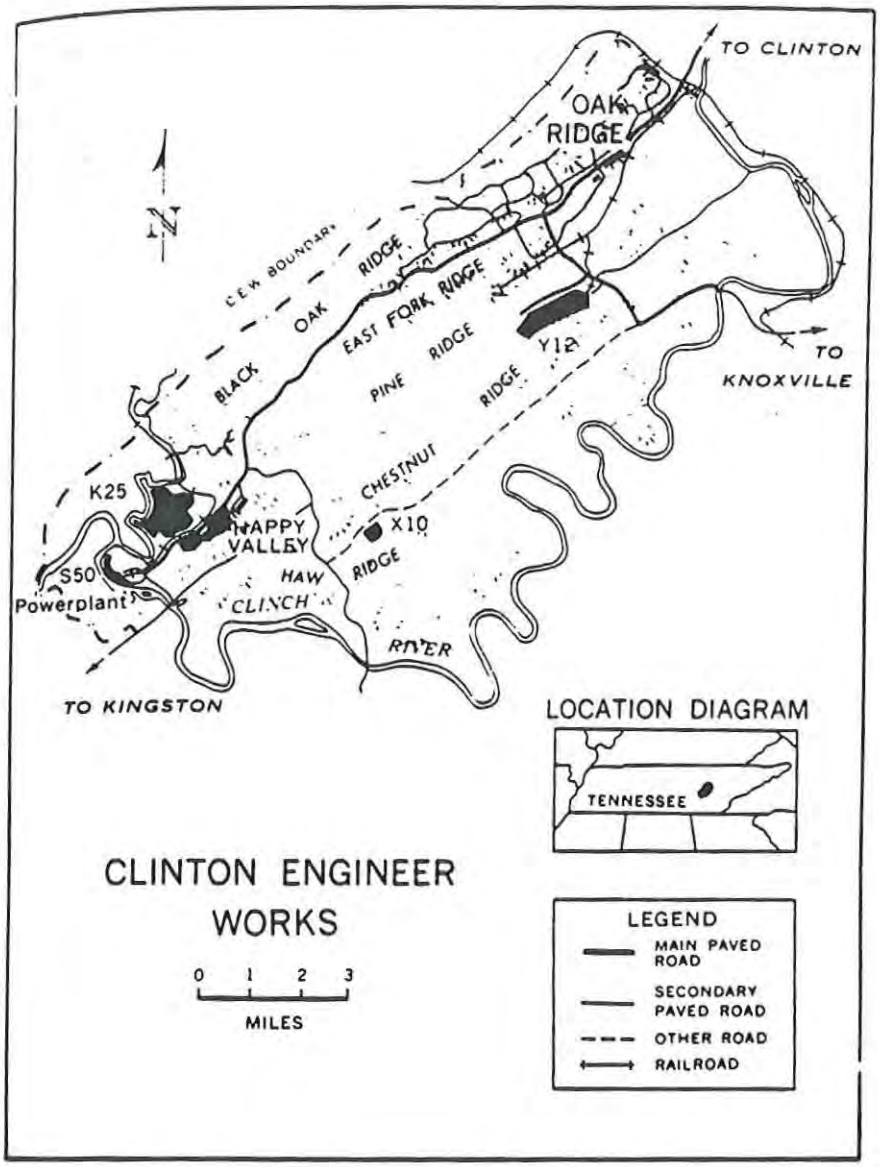


FIGURE II-6:
CLINTON ENGINEER WORKS

(Hewlett 1962:120)

(Johnson and Jackson 1981:44-45). Relocation in the immediate area was further complicated by the loss of farmland in the 1930s due to the inundation of Norris Dam and other dams under construction in the region by TVA coupled with the influx of workers for all of these projects. Although there was extensive opposition, there was little that local residents could do. By mid-November of 1942, United States marshalls were nailing notices to vacate on farmhouse doors, barns, and even trees in the yards. By the end of November, residents had begun to leave and construction related activities had started. Although there was bitterness about the appraisal process and actual sums paid, many people felt that by leaving they could contribute to the effort to win World War II. One resident was quoted as reputedly saying:

> *I was born in the house my grandfather built back in 1846 (when the United States and Mexico began war). This is mighty pretty country around here--the Great Smoky Mountains to the east and the Cumberland Mountains to the west. Don't blame my grandfather a bit for settling here.*
>
> *All the folks in these parts were farmers.... [W]e didn't pay much attention to the outside world and they didn't bother with us. That was up to 1942 anyway, when one day a man came to our house and said he was from the Government. "We're going to buy up your land," he said to me. "All of it?" I asked. "Yes, sir," he said, "we're going to buy all the land in this section. Everyone has to go."*
>
> *Well, I went outside the house with the visitor and looked around me...up at the green hills my grandfather had come across 100 years earlier, and I looked at the farm I'd worked for half a century. I asked the visitor what the Government was going to do and he said he didn't rightfully know, but it was for winning the war. I had three sons in service--two overseas--and I figured if giving up my home and my land would help bring them home sooner, I'd be happy to do it... (Young N.D.:4-5).*

Once the land was acquired, the U.S. Army moved quickly to clear the site for construction which resulted in the demolition of many of the buildings. However, speed was a primary consideration and efforts were made to avoid problems if possible. For instance, of the 61 cemeteries located within the ORR, only two were relocated for this project, and these two were at the X-10 Site and the Y-12

Plant. In other areas, local roads were rerouted or buildings resited to avoid the cemeteries to save time (Overholt 1987:431; Owings 1973:95). In the Townsite, roads were typically placed along natural contour lines rather than using a traditional grid pattern in order to avoid cut and fill work (Overholt 1987:50; Robinson 1950:62). When possible, the U.S. Army utilized existing buildings. For instance, it used about 180 of the pre-World War II houses to alleviate the severe housing shortage. One of these, the Luther Brannon House (a National Register property) was built only months prior to the government's acquisition and served for a short time as the residence and headquarters of General Groves (Thomason and Murphy 1991:E5). After the main administration building, nicknamed "the Castle" was finished in early 1943, headquarters were moved to that building. Later, General Groves stayed at a special suite permanently reserved for him at the Guest House (a National Register property) rather than using the Luther Brannon House (Johnson and Schaffer 1992:19).

Security was tightly maintained at the ORR, and with the exception of a few top officials, all employees worked on a "need to know" basis with information compartmentalized and each individual knowing only what was essential to complete his/her job. In fact, in July 1943, the intelligence and security division for the entire Manhattan Project was headquartered at the ORR (Overholt 1987:431). Although many people had a vague idea about what type of research was being undertaken, (Overholt 1987:91-92, 149) (for instance, the town's newspaper was ordered to stop running a cartoon called "Atom Man"), most ORR workers and residents learned that they had participated in making a bomb from a radio broadcast shortly after the bombing of Hiroshima in 1945.

The entire 92 square mile ORR was enclosed with barbed wire fencing that, in an unusual act of economy, was salvaged from existing farmsteads (Johnson and Jackson 1981:10). In addition to the fencing, mounted guards patrolled the perimeter. Seven gates provided access control to the facility. Beginning at the northwest corner these were the Elza Gate on the north end of the Oak Ridge Turnpike that provided access control from Clinton, the Edgemoor Gate at the northeast end of Bethel Valley Road that also provided access control from Clinton, the Solway Gate to the east off Bethel Valley Road that provided access control from Knoxville, the White Wing Gate to the southeast off White Wing Road that provided access control from Lenoir

City, the Gallaher Gate on the south end of the Oak Ridge Turnpike that provided access control from Kingston, the Blair Gate to the southwest off Poplar Creek Road that provided access from Harriman, and the Oliver Springs Gate to the northwest off Scarboro Road that provided access control from Oliver Springs. The White Wing, Gallaher, and Blair Gates provided direct access to the plants. Within the ORR, four additional security checking stations were located at each facility. In the 1940s, the main gate was the Elza Gate which was the closest to Clinton and rail access. The gates marked the limits between the outside world and the ORR, but once within the ORR, the checking stations were an additional security measure that marked the limits between the Townsite and each production facility. Figure II-7 contains a 1940s map of the ORR.

In early 1943 the Boston architectural firm of Skidmore, Owings and Merrill began to prepare detailed plans for housing and commercial facilities for the Townsite in the northeast corner of the site, in a hilly area along Black Oak Ridge. The Townsite was originally planned to accommodate about 13,000 workers, but it peaked at 75,000 (as opposed to the 5,000 at Los Alamos and 45,000 at Hanford). Unlike most "company towns," "management" expended a great deal of effort on the design and layout of the residential and commercial portion of the ORR. This was in large part due to the shortage of workers during World War II as well as due to the keen competition for scientists who could be lured to other research projects that were far better known and where they would have more academic freedom. Even so, the combination of providing housing for so many people within such a short period of time created extremely crowded conditions that were far from ideal. Many types of socializing, such as private parties, were discouraged. "And, above all, everyone's life was ruled by the need for security" (Overholt 1987:105).

The Townsite "existed merely to serve the mammoth production sites" (Hewlett and Anderson 1962:119). The Townsite contained a post office, supermarkets, drugstores, shops, churches, nurseries (so that women could work in the facilities), movie theaters, cafeterias, laundries, a guest house/hotel, schools, a hospital, recreational facilities, trailers, hutments, barracks, dormitories, and houses. [For more information on the buildings at the Townsite, the National Register nominations prepared in 1991 by Thomason and Associates may be consulted.]

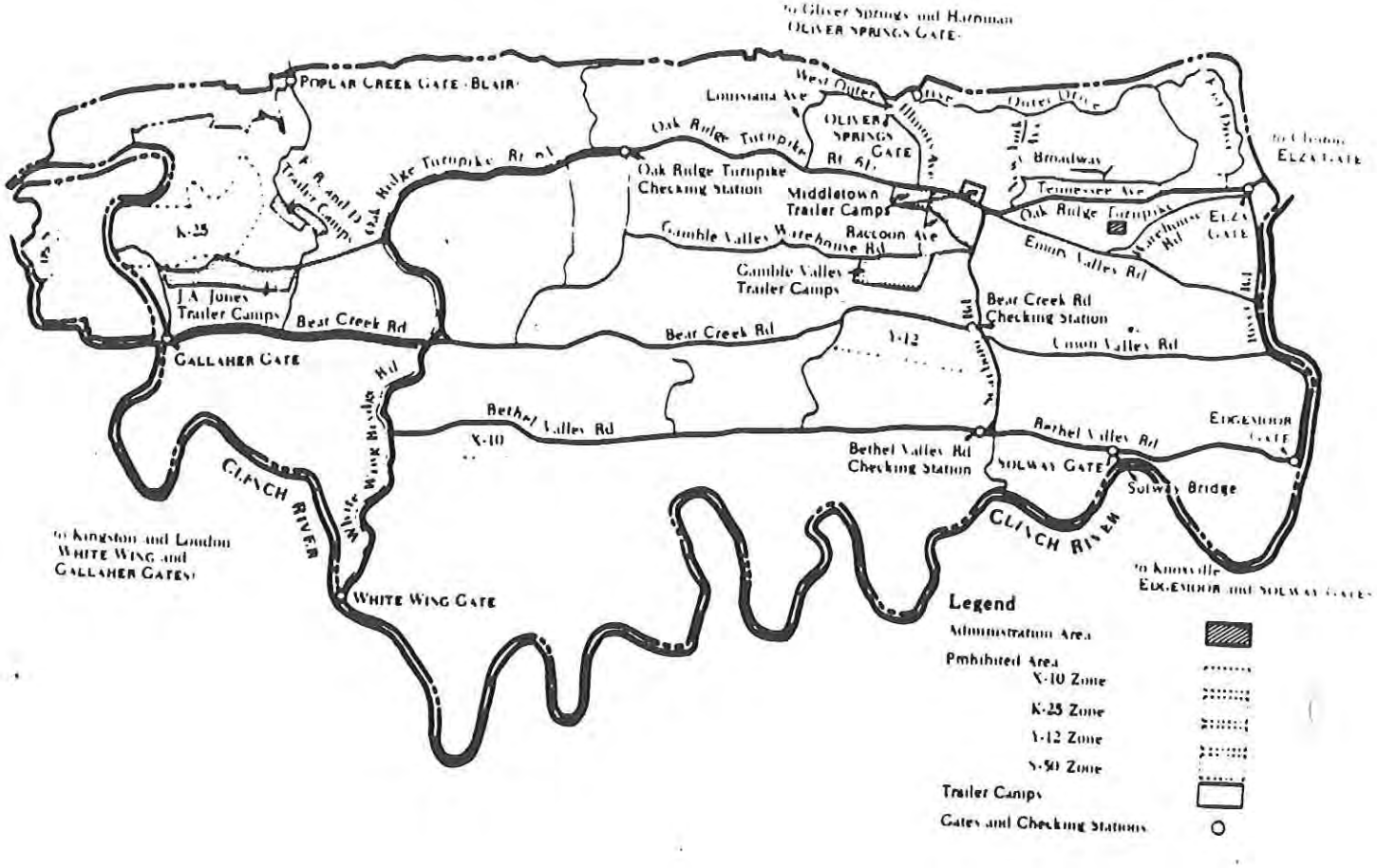


FIGURE II-7: 1940s MAP OF THE OAK RIDGE RESERVATION

(Johnson and Jackson 1981:27)

Originally, the U.S. Army had intended to manage the Townsite, but decided to concentrate its efforts on the plants instead. The U.S. Army requested the New York firm of Turner Construction Company to form a subsidiary management company to undertake this task. This firm, the Roane-Anderson Company, served as "landlord and housekeeper" for the Townsite collecting rent and garbage, providing maids, and repairing houses. The Anderson-Roane Company also supervised eating establishments that served a million and a quarter meals a month, ran a chicken ranch and a cattle farm, maintained schools, operated public utilities, and operated a railroad that hauled 3,000 cars of construction materials to the plants each month. Since housing was limited, high ranking military and scientific personnel were given the houses at the Townsite, and most of the physical laborers commuted, some from as far away as Chattanooga. As a result, the Roane-Anderson Company created a special bus system which by 1944 was the sixth largest in the United States.

The Townsite not only contained residential and commercial buildings, but it also contained administrative buildings. One of the first structures built at the Townsite was the administration building which was nick-named "the Castle," presumably, not only because of its appearance, but also as an "insider" reference to the Corps emblem which contained a crenelated castle. Built on a small rise, "the Castle" served as headquarters for the Clinton Engineer Works until the summer of 1943 when Lieutenant Colonel Nichols, who succeeded Colonel Marshall as District Engineer, transferred the headquarters of the Manhattan District from New York to this building. From here, Lieutenant Colonel Nichols directed the construction activities of the entire Manhattan Project and supervised administrative management. "As the control center for the Manhattan project, 'the castle' was second only to General Groves's liaison office in Washington" (Hewlett and Anderson 1962:117). This building was demolished in recent years.

As intricate and as detailed as the Townsite was, it was in essence a support facility for the nearby production plants. Just as the histories of Los Alamos, Hanford and the ORR greatly overlapped making a chronological history difficult, so do the histories of the three production facilities (the X-10 Site, the Y-12 Plant, and the K-25 Site) at the ORR.

CLINTON LABORATORIES (the X-10 Site): In 1942, the pile process appeared to the Military Policy Committee to be a gamble, but the other methods (electric and gaseous diffusion) were also questionable, and the scientists could see at least two factors in its favor. From a military standpoint, if successful, the process would produce not only fissionable material, but also as a by-product, radioactive fission materials that might be utilized in chemical warfare. They also thought that the pile could be used as a power source after World War II. Given all of these considerations, the Military Policy Committee chose to include the pile process (Jones 1985:184-185).

Unlike the electromagnetic (Y-12) and gaseous diffusion (K-25) methods, the pile process did not involve isotope separation methods. Rather, this process used a combination transmutation-chemical separation process to create plutonium. The feed material, which is slugs of pure uranium (a natural element), is transmuted into the new element plutonium (a man-made element) by allowing moderators (such as carbon which contains graphite) to slow down neutrons in order for them to escape capture by uranium-238 and remain free to penetrate uranium-235. The plutonium can then be separated from the original uranium using a chemical separation process (Robinson 1950:44-45). Since the graphite pile produced plutonium, this process set parameters for an entirely different kind of bomb than that based on uranium-235 that was being produced at the K-25 Site and the Y-12 Plant.

The transmutation occurs in a "pile" which is a solid mass of graphite pierced at intervals by tubes that run from one side to the other. The uranium slugs are placed in these tubes in certain geometric designs. Fission in the form of a chain reaction then occurs and transmutes a small portion of the uranium into plutonium. The structure for this process was called a "pile" throughout World War II, so named by Fermi because the structure was composed of graphite and uranium stacked or piled on top of each other in a lattice arrangement, but about 1952, the term "reactor" commonly replaced the term "pile" (Johnson and Schaffer 1992:11). A schematic drawing of the pile is shown on Figure II-8.

The most visibly successful work in developing fissionable material in the early 1940s was the work in pile research at the University of Chicago under Compton, Fermi and Szilard. It should be noted that due to the close involvement of these individuals and the involvement of the University of Chicago with the pile process, the history of the X-10 Site is closely linked to the University of Chicago. Fermi and Szilard had pursued research at

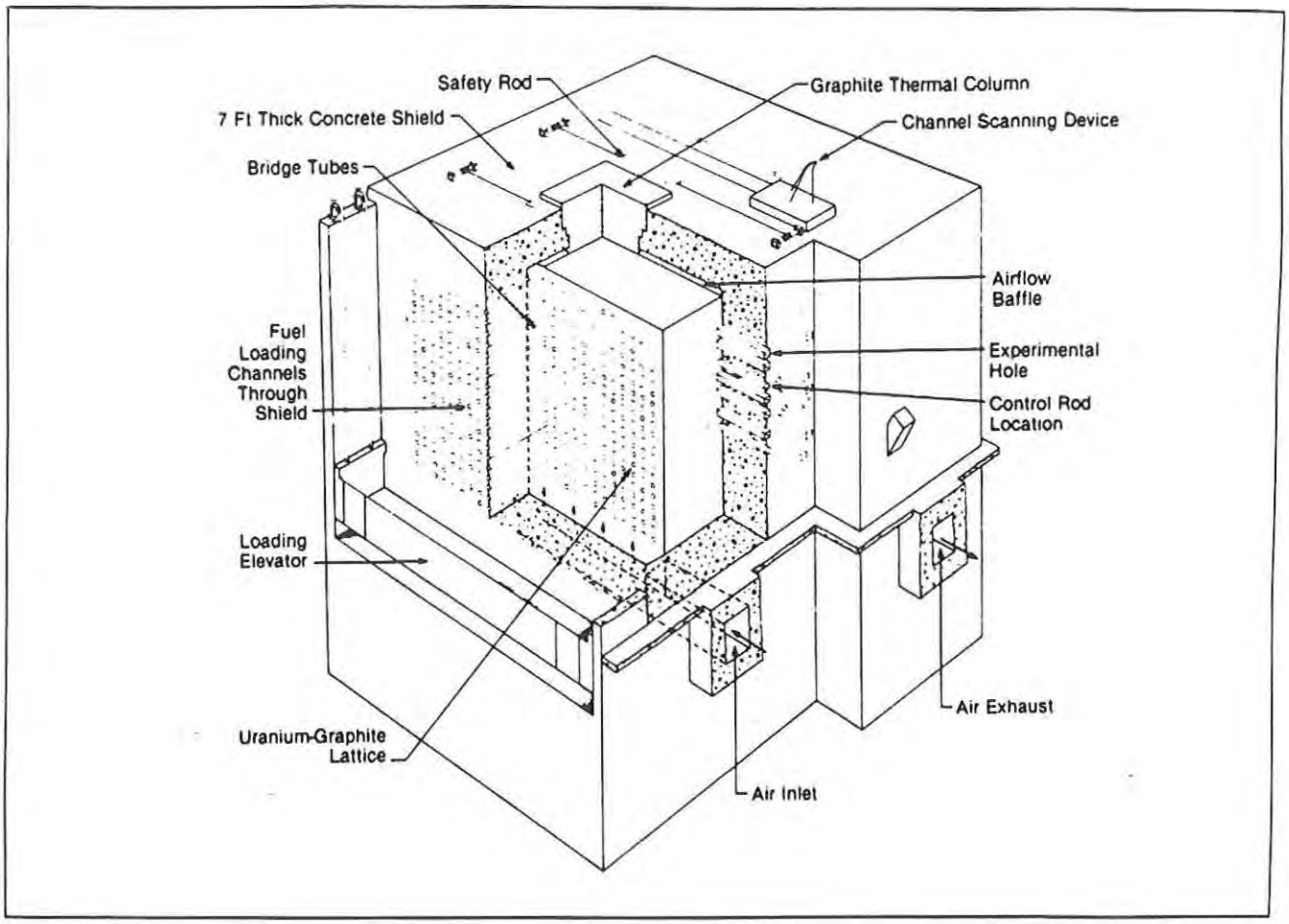


FIGURE II-8: X-10 PILE (GRAPHITE REACTOR)

(Gosling 1990:31)

Columbia University in the 1930s, but by 1941, both were working at the University of Chicago (Jones 1985:10-11). By the fall of 1942, the U.S. Army had become actively involved in the work at the University of Chicago. To provide a liaison and to assist Compton in procurement and personnel matters, Colonel Marshall opened the Corps Chicago Area Engineers Office in the University of Chicago's physics building under Captain James F. Grafton. As Captain Grafton's responsibilities expanded and his staff grew from less than 100 in 1943 to 250 in 1945, the Corps leased the State of Illinois' 124th Field Artillery Armory. The Corps and the University of Chicago staff shared this facility. To assist the University of Chicago in research, between 1942 and 1944, the Corps oversaw construction of over 500,000 square feet of space which included a new chemistry building and annex, several new buildings at the Argonne site, and extensive remodeling of existing structures (Jones 1985:184-187).

One of the critical questions in 1942 concerning the pile process involved cooling. Early in the project, Compton and his scientists would have preferred to use "heavy water" which could have functioned as both the moderator and coolant. However, it was unavailable in large quantities so they did not feel that they could proceed with a heavy water pile design. The recommendations for a heavy water pile by Compton and others resulted in General Groves pushing for the completion of a heavy water plant at Trail in British Columbia, Canada, as rapidly as possible. The work was planned to be completed by 1 May 1943 (Jones 1985:72, 190). In addition, Du Pont believed that a back-up type of pile design, one that used heavy water as the moderator rather than graphite, should be developed. Therefore, Du Pont urged, and General Groves agreed, to modifying three existing munitions facilities in the United States for them to produce heavy water. These facilities were at Morgantown, West Virginia, Wabash River, Indiana, and the Alabama Ordnance Works (Jones 1985:191; Hewlett and Anderson 1962:193). In the spring of 1943, the U.S. Army decided that all future heavy water research would be centered at the University of Chicago under Professor Henry D. Smyth, head of the physics department of Princeton University (Jones 1985:196). In August 1943, General Groves appointed a committee to review what role the heavy water program should play in the Manhattan Project. The Committee agreed with the direction the program was then proceeding and recommended continuation of a relatively modest heavy water pile research program at the University of Chicago as "insurance" in case the graphite piles did not work (Jones 1985:197).

The issue of coolant was still under debate by the fall of 1942. In the fall of 1942, under pressure from General Groves to make a decision on a coolant, Compton directed Fermi to build a low-powered graphite pile to demonstrate the feasibility of a chain reaction and to furnish data about the "k" factor ("k" refers to the excess number of neutrons above unity required to barely sustain fissioning in a critical pile) (Jones 1985:190). Fermi then began to build this pile on the floor of a squash court underneath the West Stands of Staff field, the University of Chicago football stadium (Jones 1985:103). On 2 December 1942, Fermi's "massive lattice pile of 400 tons of graphite, six tons of uranium metal, and 50 tons of uranium oxide achieved the first self-sustaining chain reaction" in the world (Gosling 1990:10). Although Fermi's original pile had been so small that a coolant had not been necessary, the findings about the size of "k" as a result of this experiment proved to the scientists that they had more flexibility in choosing a coolant than previously believed, allowing for the possibility that water or even air could be used as the coolant (Jones 1985:190). However, design was fairly advanced on an air-cooled pile facility at the ORR, and Du Pont pushed for it to be used rather than changing to the water method which some scientists considered more feasible (Jones 1985:190).

Since the University of Chicago staff was the group of scientists most closely associated with the pile process, they strongly supported having the pile production facility located near Chicago at Argonne. However, General Groves and the S-1 Committee decided that while Fermi's smaller pile could be built at Argonne, there was not sufficient room for the pilot plant and decided that it would be located at the ORR. Once this decision was made, it became apparent that the ORR was too small for all the production facilities, and General Groves decided to locate the full-scale plutonium plant at Hanford rather than at the ORR as originally planned.

Consequently, the pilot-scale plutonium-producing pile, with its associated chemical separation buildings, became the primary focus of the X-10 Site. The "X" came from the fact that the University of Chicago used X in its original description of the site. The number "10" had no significance (Robinson 1950:92). A map showing the location of the three plants and the Townsite within the ORR is shown in Figure II-9. Figure II-10 is a 1943 photograph showing construction activities at the X-10 Site. Once the decision to locate the pile at the ORR was made, Fermi's experimental pile from the squash court at the University of Chicago was relocated from the heart of south Chicago to the more isolated Argonne location (Jones 1985:72, 194).

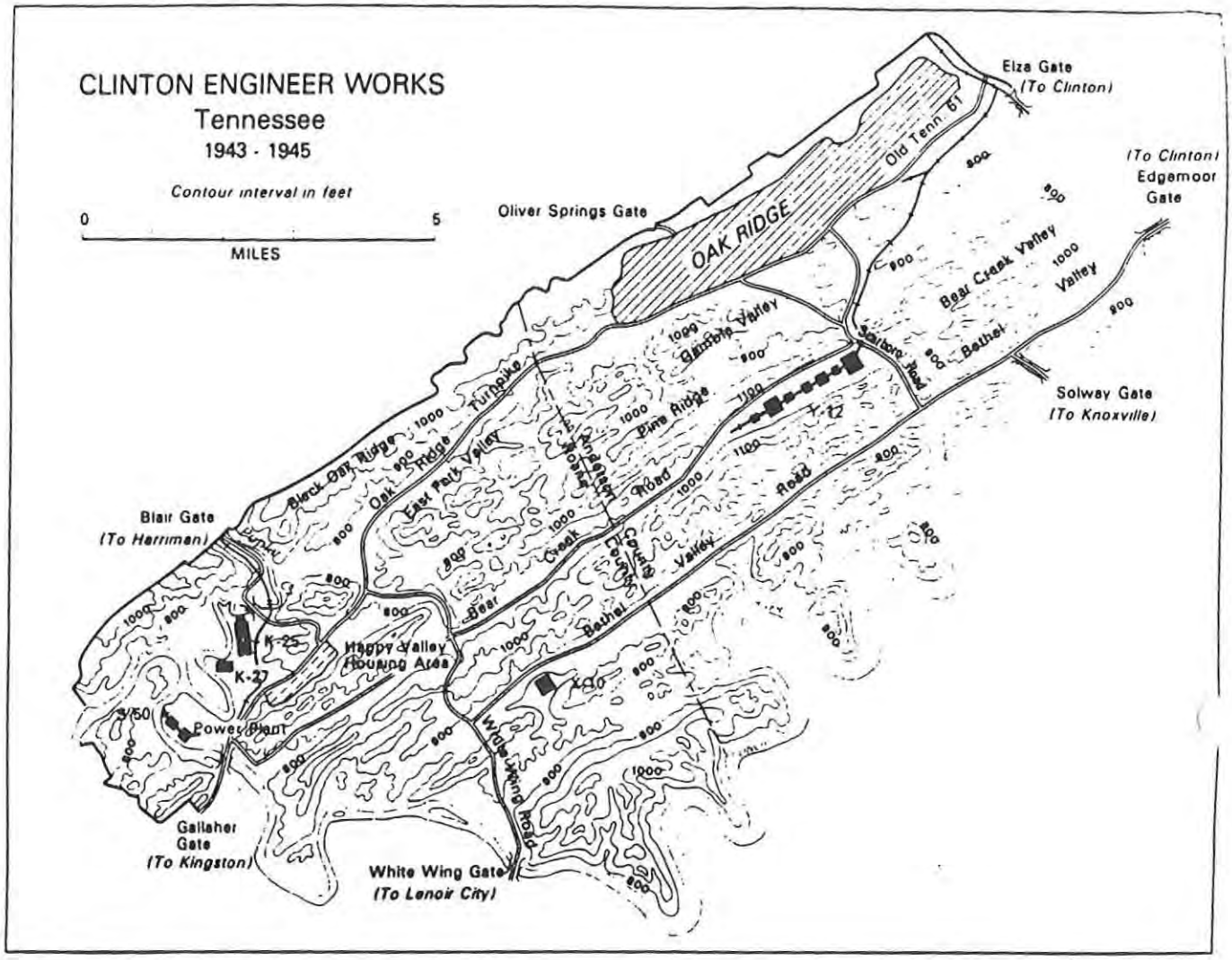


FIGURE II-9:

1943-1945 MAP OF CLINTON ENGINEERING WORKS

(Jones 1985:131)

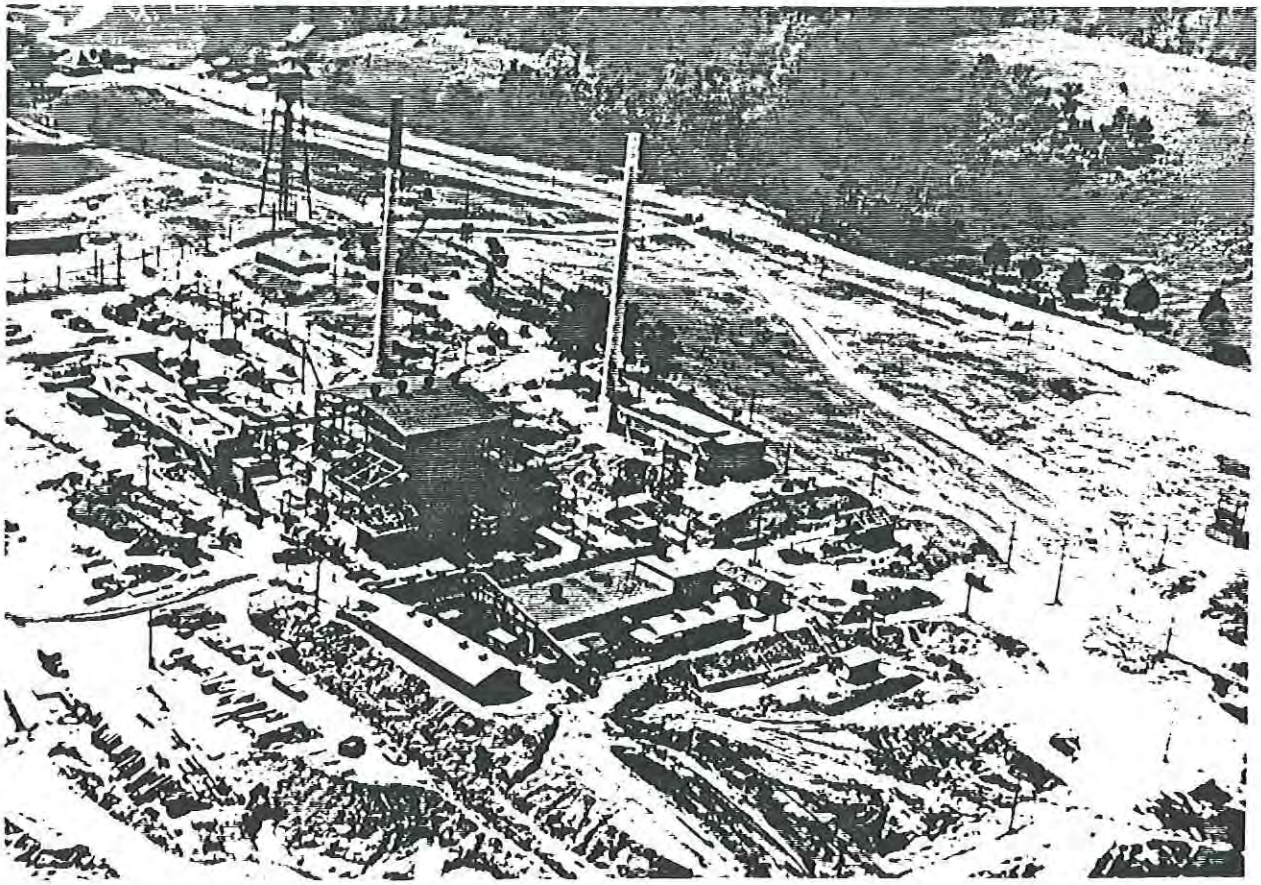


FIGURE 10: 1943 PHOTOGRAPH OF X-10 SITE
(ORNL-HSTRY #152)

Fermi's December 1942 experiment had tested only the physics and purity of the ingredients. Therefore, the pile at the X-10 Site was built for small-scale production which could reveal "glitches" or problems in the basic design (U.S. Department of the Interior [U.S. DOI] 1965). The X-10 pile is not exactly a miniature version of the Hanford plant but more of a working model with specific design differences from which the scientists could extrapolate information for use in the larger and later Hanford development. As a result, there are at least two key differences between the X-10 and Hanford piles (reactors). The X-10 pile is air-cooled, whereas the Hanford pile used the water-cooled approach due to recommendations by the University of Chicago but over Du Pont's objections (Gosling 1990:30). The second difference was that when faced with the choice to use bismuth phosphate or lanthanum fluoride in the chemical separation process at the X-10 Site, the scientists chose to use bismuth phosphate. Based on problems experienced in the use of bismuth phosphate at the X-10 Site, lanthanum flouride was chosen for use in the chemical separation process at Hanford (Gosling 1990:35).

The University of Chicago had not only expected that the pile would be located at Argonne but that it would manage the pile site. However, General Groves strongly believed that each facility should be built by an experienced industrial leader. For the X-10 Site, General Groves selected Du Pont to design and develop the separations pilot plant (Hewlett and Anderson 1962:91). Du Pont's role as a major munitions supplier during World War I had earned it the nick-name "Merchants of Death," and the company was not inclined to accept another war related project. After General Groves appealed to Du Pont's patriotism, it agreed to undertake the project on two conditions. Du Pont stipulated that payment would be limited to costs, resulting in the company not making a profit from the project, and that Du Pont would terminate its role as soon as World War II ended (Hacker 1987:46-47).

Once the University of Chicago realized that it would not be in control of the X-10 Site but that Du Pont would build it, the staff then decided to stay in Chicago and develop a water-cooled pile. However, General Groves and Du Pont believed that the University of Chicago personnel were indispensable to the X-10 Site and requested the University of Chicago to operate the site. Compton and his staff at the University of Chicago were unquestionably miffed over "losing" the pile site and overall control to Du Pont and did not want to continue working on the project. However, after thinking deeply about the problem, Compton and others

at the University of Chicago came to the conclusion that it was their patriotic duty to accept Du Pont's offer and did so (Hewlett and Anderson 1962:190-193). However, after the University of Chicago's role in the decision to have the Hanford plant air-cooled, the University of Chicago occupied a less central role in the bomb project and its research became increasingly unimportant in the overall picture of the Manhattan Project (Gosling 1990:30).

Early in 1943, Compton reorganized his staff based on the principle of independent laboratories of equal rank. Compton himself was the director of the Metallurgical Laboratory at the University of Chicago and appointed three associate directors: Norman Hilberry as Associate Director for Research, Robert Stone as Associate Director for Health Matters, and Wilbur Munnecke as Associate Director for Administration (Jones 1985:200). Research facilities associated with the University of Chicago included the original Metallurgical Laboratory at the University of Chicago, one at Iowa State College in Ames, one at Argonne under Fermi, and the X-10 Site at the ORR under Martin Whitaker. In April 1943, the X-10 Site was formally named the Clinton Laboratories. From 64 employees in July 1943, the Clinton Laboratories staff increased to nearly 1,000 by December (Hewlett and Anderson 1962:210). As many as 70 other institutions conducted related research programs (Jones 1985:200).

Although radiology was an established discipline, the implications of the pile as a radiation source were far beyond the resources of the scientists involved in the project. Concerned, Compton established a health division at the University of Chicago's Metallurgical Laboratory in July 1942 and selected Robert S. Stone of Berkeley, as director. Stone, who had worked with Lawrence at Berkeley, was one of the few persons in the United States with practical experience in applying nuclear physics to medicine (Hewlett and Anderson 1962:206). As a result, pocket ionization chambers and film badges were issued to all personnel working in areas of high radiation. Although other research facilities soon followed suit, the project at the University of Chicago was considered the leader. As such, Stone's research had a special influence on the biomedical programs later established at the ORR and in the overall Manhattan Project (Hewlett and Anderson 1962:206). Ironically, worker training and indoctrination about safely handling routine work assignments were hampered by tight security because such security measures barred many workers from being informed about the nature of the hazards that their work entailed (Hacker 1987:55).

Construction began in February 1943 at the X-10 Site on the ORR. Figure II-11 is a 1943 photograph of the site. The 112-acre site (eventually 150 acres) contained about 150 buildings that included the air-cooled experimental pile (Graphite Reactor), the chemical separations pilot plant, water supply and treatment plant, steam plant, storage area, underwater storage, an underground canal, a series of cells for chemical separation, and supporting laboratory facilities such as machine and instrument shops, warehouses, administration buildings, a training school, and subterranean tanks for radioactive waste (Gosling 1990:31; Johnson and Schaffer 1992:18; Jones 1985:204-205; Thompson 1963:12-13). Two of the world's largest fans were mounted in a building next to the pile and sucked outside air through the pile and then up a stack. The stack and the black building that housed the pile (called the "black barn") were prominent visual features at the site (Johnson and Schaffer 1992:18). A March 1943 plan sheet showing the lay-out of the X-10 Site is contained in Pocket A at the end of this report.

Du Pont began construction of the first temporary buildings on 2 February 1943, and most of the utility installations, and completed them by the end of March (Hewlett and Anderson 1962:208). In early March of 1943 construction began on the foundation for the six large underground cells in which the plutonium would be separated from irradiated uranium slugs. The first cell was linked to the pile building by an underground canal. Along one side of the row of cells, a one-story frame building was erected to house the operating gallery and offices (Hewlett and Anderson 1962:208). Du Pont began construction on the pile building 27 April 1943 but ran into difficulties that included striking a large bed of soft clay which required more foundation work than had been expected. It was June before construction started on the walls of the pile and summer before they were completed (Jones 1985:205). The front face of the pile was composed of seven feet of high-density concrete, and the shield was pierced by hundreds of tubes through which the uranium slugs would be inserted. Concurrently, workmen constructed the four-story building which housed the pile and its auxiliary facilities which included a control room, a small "hot" laboratory to handle radioactive materials, and a core removal area (Jones 1985:206). Figure II-12 contains a 1943 photograph of the site. In order to facilitate the production of the graphite bars to be used in the pile, Du Pont built its own graphite-fabrication plant next to the pile building. The semiworks for the bismuth-phosphate plant at the University of Chicago was disassembled and shipped to the ORR where it was reassembled and working by September (Hewlett and Anderson 1962:210).

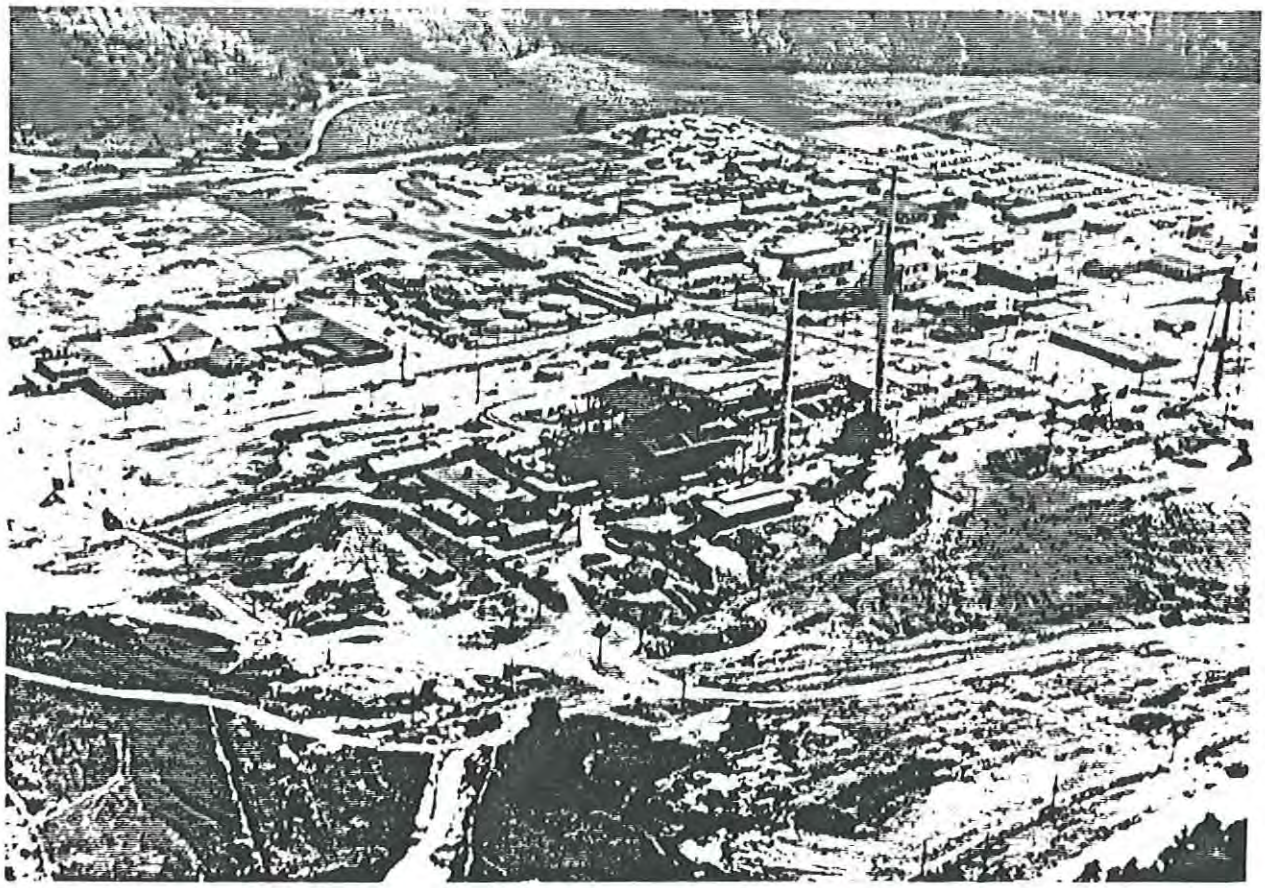


FIGURE 11: 1943 PHOTOGRAPH OF X-10 SITE

(ORNL-HSTRY #153)

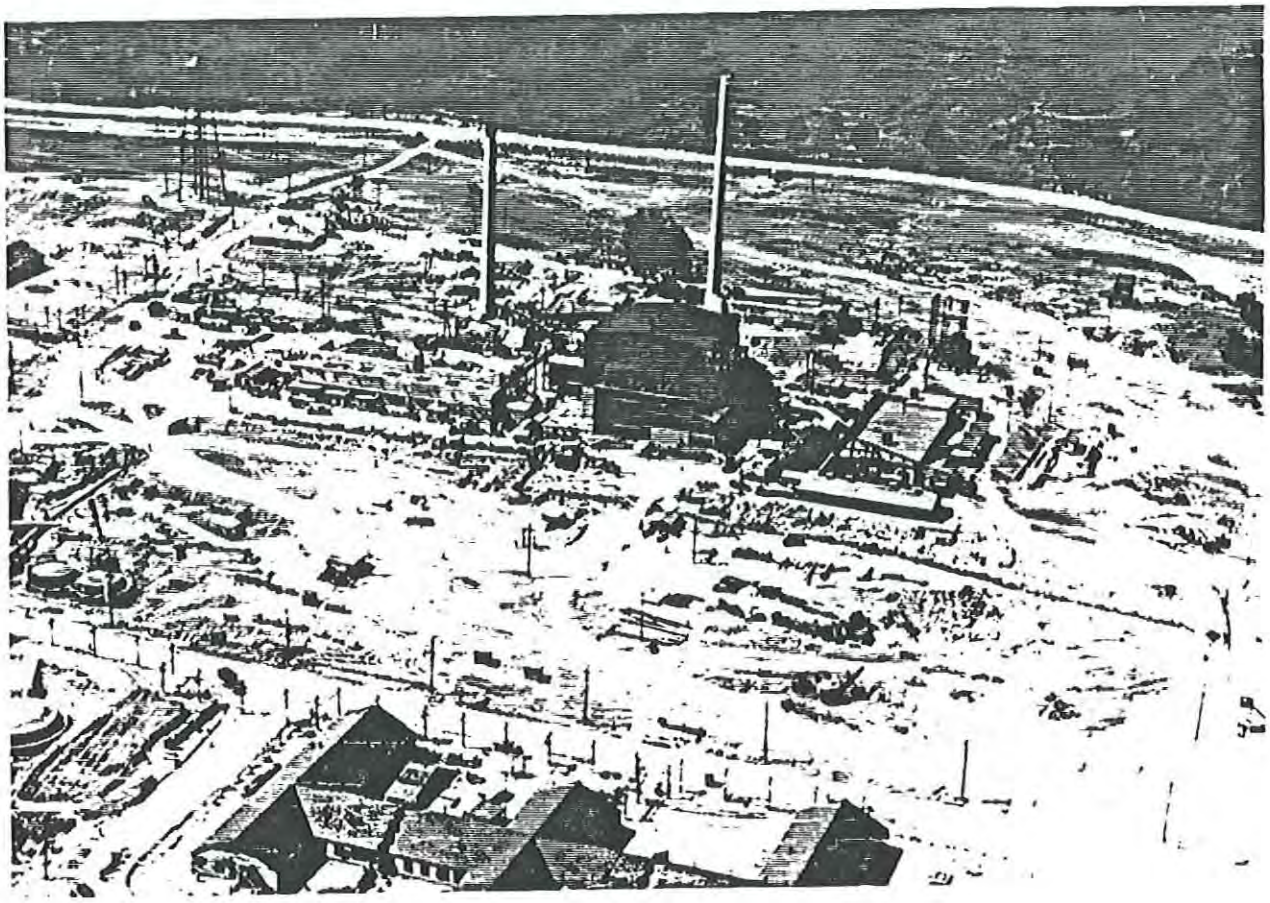


FIGURE 12: 1943 PHOTOGRAPH OF X-10 SITE

(ORNL-HSTRY #183)

In general, construction at the X-10 Site proceeded slower than expected. Because of the isolation of the site, in addition to core buildings, Du Pont had to provide the pile (semiworks) with its own machine shops, water supply and treatment installations, a steam plant, storage areas, and classrooms and laboratories for training. Changes to plans and the addition of installations doubled the amount of construction. In addition, there were persistent shortages in both common and skilled labor during this period that was exacerbated at the ORR by unsatisfactory housing and commuting conditions resulting in increased absenteeism and worker turnover (Jones 1985:206).

At the X-10 Site, research into the various separation processes continued on the chance that some aspect might contribute to the plutonium process. Although research was important, the implementation of the pile was crucial to the primary purpose of the facility. On 4 November 1943 the pile went "critical" meaning that it produced a self-sustained nuclear chain reaction and thus became the world's first power-producing pile (Hewlett and Anderson 1962:211). The pile used uranium-235 to produce plutonium. By early 1944, only weeks later than estimated, the semiworks was largely completed and was fully operational by March (Jones 1985:208). From the first, the pile was a success and produced plutonium in significant quantities for research purposes. The quantities grew larger, and in the spring of 1944, the ORR began shipping samples to Los Alamos. That summer, the first samples of pile-produced plutonium resulted in revolutionary changes in weapon development (Hewlett and Anderson 1962:212).

In addition to being a pilot plant, all of the experimental work and training of operators was performed at either the X-10 Site or at the University of Chicago. The X-10 Site organized and conducted a training school for about 260 Du Pont employees who later worked at Hanford.

Between March 1944 and January 1945, the period of full semiworks operation, the number of employees averaged about 1300 at the Clinton Laboratories (as opposed to 12,000 at the K-25 Site and 22,000 at the Y-12 Plant (Johnson and Schaffer 1992:2). Roughly 75 percent of the Clinton Laboratories's 160-person staff concentrated on product studies to aid the Hanford operation while only 12 percent worked on product production. By May 1944 the pile was operating at almost double the power level conceived by its designers, and by July it had doubled again. Even the chemical separation plant, which had not previously been tested, operated well on its first run. The staff tried modifications that eventually increased the efficiency of the separation plant from 40 to over 90 percent. The separation plant operated until January 1945 when enough plutonium had been produced to meet project needs. At that

time, the staff began to use the pile for experiments with other irradiated materials as fissionable fuel. The staff also used the pile to test materials used at Hanford including aluminum, graphite, brass, neoprene, Bakelite, concrete, and masonite. The separation plant, which was no longer required, ceased operations (Johnson and Schaffer 1992:24; Jones 1985:209).

In early 1945 Oppenheimer urgently requested the Clinton Laboratories to supply Los Alamos with large quantities of pure radioactive lanthanum, nick-named "RaLa," which was the decay product of radioactive barium-140. To provide such large quantities, the Clinton Laboratories designed and built a special production facility. This was probably the first production of a radioisotope on a large scale (Johnson and Schaffer 1992:23-24).

Although originally intended as merely a test for the Hanford site, the Clinton Laboratories at the X-10 Site quickly filled those needs and expanded into a well-rounded institution for nuclear research.

> *The pile, an incredibly complex and costly instrument for research, was the central and indispensable feature of the nuclear laboratory. It provided an abundant supply of neutrons for basic research in physics. It [sic] produced radioactive isotopes and other fission products which promised to have countless uses in science and industry. As a radiation source, the pile offered unprecedented opportunities for research in biology and medicine. The thousands of kilowatts of heat dissipated through the stack were a mute reminder of the eventual possibility of controlled power from the chain reaction. Devised in the exigencies of war, the pile was, even in the summer of 1944, becoming a powerful instrument for the betterment of mankind (Hewlett and Anderson 1962:212).*

Even though the atomic bombs had not been completed by June of 1945, the role of the Clinton Laboratories had essentially ended by then with the production of its quota of plutonium and its completion of experiments and personnel training for Hanford. The University of Chicago was anxious to be relieved of its responsibility as operator of the pile. Therefore, General Groves arranged for the Monsanto Chemical Company of St. Louis (Monsato) to take over operations of the Clinton Laboratories effective 1 July 1945. Martin Whitaker agreed to remain as director with a new mission of overseeing radiation research and overseeing operations for the production of experimental materials, such as radioactive isotopes (Jones 1985:210; Thompson 1962:42).

ELECTROMAGNETIC PROCESS (the Y-12 Plant): The electromagnetic process was pioneered by Alfred O. Nier of the University of Minnesota, but by 1940, the scientist most closely associated with the process was Lawrence and his staff at Berkeley. This process used a mass spectrometer or spectrograph to send a stream of charged particles through a magnetic field. The magnetic field would deflect more atoms from the lighter isotope than the heavier isotope which would result in two streams of isotopes that could then be collected in different receivers (Gosling 1990:6; Jones 1985:10).

Lawrence seems to have been totally and completely confident about this process, and at various times, almost convinced the S-1 Committee and others to concentrate on it primarily or even exclusively (Hewlett and Anderson 1962:96). However, the S-1 Committee chose to pursue this process as one of many, and in the fall of 1942, ordered a five-tank pilot plant and a 200-tank section of a full-scale plant be built at the ORR. This facility was code-named Y-12; neither the letter "Y" nor the number "12" had any significance, they were chosen merely for the purpose of confusion (Robinson 1950:92). The site for this facility was the Bear Creek Valley to the northeast of the X-10 Site and south of the Townsite along Black Oak Ridge.

Like the other facilities, Stone and Webster was the prime contractor for the construction of this facility. In December 1942 General Groves approached Tennessee Eastman Corporation (Tennessee Eastman) and requested that it operate the Y-12 Plant. Like the University of Chicago staff at the X-10 Site and Union Carbide and Carbon Corporation (Union Carbide) at the K-25 Site, Tennessee Eastman served as consultant during construction, undertook research on special problems, trained personnel, and operated the plant (Hewlett and Anderson 1962:148; Robinson 1950:84-85).

The general configuration of the original the Y-12 Plant, called the Alpha plant, involved five racetracks, each containing 96 tanks housed in three long buildings. The racetracks were massive, steel, elliptical structures 122 feet long, 77 feet wide, and 15 feet high. Since two tracks were placed end-to-end on the second floor of each building, the reinforced concrete and masonry structures were nearly 450 feet long. Two-story bays on each side of the racetrack rooms housed the elaborate electrical equipment. The entire ground floor was occupied by massive vacuum pumps and cooling equipment. Separate chemistry buildings were needed nearby (Hewlett and Anderson 1962:149-150). The complex eventually included 170 buildings on approximately 500 acres (Robinson 1950:85).

Since a pilot plant had not been built for the electromagnetic process, several advances were made in the course of designing the original facility. However, many changes could not be incorporated as design and construction progressed due to the chain-reaction delays that even fairly minor changes to one component could cause elsewhere. Partly as a result of this, in March 1943, General Groves decided to build a smaller second plant, called Beta. This facility was only large enough to process the relatively small amount of material accrued from the Alpha process (Hewlett and Anderson 1962:151). Based on problems faced at the Alpha track, the oval racetrack was eliminated and replaced with a rectangular magnet. The Beta building housed two tracks of 36 tanks (Hewlett and Anderson 1962:157).

In the summer of 1943, several events occurred that resulted in the expansion of the Y-12 Plant. In general, work appeared to be progressing smoothly on the Y-12 Plant and the electromagnetic process, but the same could not be said for the gaseous diffusion plant at the K-25 Site which could not resolve barrier problems. In July Oppenheimer, the director at Los Alamos, reported that they would probably need three times as much enriched uranium as originally thought. As a result, in September 1943 General Groves and the Military Policy Committee decided to build a new facility at the Y-12 Plant. The new facility, which he designated Alpha II, consisted of two buildings each containing two tracks of 96 tanks each. The magnets were rectangular and all tanks faced the same side of the magnet. The cold sources used on Alpha I were replaced with hot sources in each tank. It was also believed that another Beta building and additional chemical facilities might be needed (Hewlett and Anderson 1962:161).

The first Alpha track began operation in November 1943, but as early as October minor problems began to appear, and in December, the tracks closed after only one month of operation. The most significant problem was rust within the magnet coils which had to be shipped back to the original manufacturer Allis-Chalmers where they were cleaned and had special oil filters added (Hewlett and Anderson 1962:162-163). With Alpha I shut down, although temporarily, Stone and Webster concentrated on Alpha II, which began operation in January 1944. By the end of February 1944, small amounts of uranium-235 had been produced in Alpha II and sent to Los Alamos. Even so, the Y-12 Plant was beset with minor equipment failures and various problems (Hewlett and Anderson 1962:163-164).

Thus, in 1944 neither the electromagnetic process nor the gaseous diffusion process at the K-25 Site (below) was clearly successful. Since the previous summer, the K-25 Site, which had been originally expected to produce most of the uranium-235 for the project, had been downgraded to provide low-grade enriched uranium as feed material for the Y-12 Plant (Gosling 1990:25; Hewlett and Anderson 1962:164-167). Even so, with both the K-25 gaseous diffusion plant and the plutonium process at Hanford in question, Lawrence, ever confident of his process, urged in the summer of 1944 that the Y-12 Plant be expanded again. In July 1944, with severely limited options on how to proceed and no possibility of turning back, General Groves agreed.

Although General Groves had strongly supported the electromagnetic process, he now decided to further expand on the concept of using more than one separation process in tandem with another to facilitate production of uranium-235. This led to the construction of the S-50 plant for the liquid thermal diffusion process at the K-25 Site (below).

GASEOUS DIFFUSION (the K-25 Site): The gaseous diffusion process was pioneered by British researchers with John R. Dunning and H. C. Urey and their colleagues at Columbia University joining the research effort about 1940. This process was based on the principle that molecules of a lighter isotope would pass through a porous barrier more easily than molecules of a heavier one if there were high pressure on one side and low pressure on the other. Since uranium-235 weighs slightly less than uranium-238, they can be separated from each other using this process through a myriad of repetitions in a system of cascades (Gosling 1990:6-7; Hewlett and Anderson 1962:30-31; Jones 1985:10). At the K-25 Site, these barriers contained billions of holes smaller than two-millionths of an inch (Robinson 1950:83).

Although the decision to include the electromagnetic plant always seems to have been relatively firm, the decision to include a gaseous-diffusion plant in the Manhattan Project wavered. Ultimately, however, the S-1 Committee in its December 1942 report to President Roosevelt chose to recommend building a full-scale plant. This plant was located at the ORR in a 500-acre tract on the western edge of the project site along the Clinch River (Jones 1985:159) and was code-named K-25. The "K" in the name was derived from the name of the designer, the Kellex Corporation, and the number "25" was a common nickname for uranium-235 and was added arbitrarily (Robinson 1950:92; Johnson and Jackson 1981:8).

Initial work on this facility was done by the Kellogg Company and Columbia University. One of the Kellogg Company's Vice-Presidents, Percival Keith, who had served on the S-1's planning board, was in charge of the project. Apparently, Keith was one of a few people in the Kellogg Company who had faith in the project and therefore had trouble recruiting staff from within the company. In an effort to protect the Kellogg Company in case of failure and to ease recruitment, as well as for security reasons, a new company was created to perform the gaseous-diffusion job. This company, the Kellex Company, was completely owned by the Kellogg Company and staffed with many of its officers, but it was a separate entity with its own accounts and name. The Kellex Company was responsible for the design, procurement of materials, preparation of plans for the plant, supervision of plant construction, and the installation and assembly of equipment. Concurrently, Keith suggested to General Groves, and General Groves agreed, to contract with Union Carbide to operate the plant (Hewlett and Anderson 1962:120-121; Jones 1985:150-151). The J. A. Jones Construction Company of North Carolina built the main plants while Ford, Bacon and Davis of New York City designed, constructed and briefly operated a huge auxiliary plant (Robinson 1950:81).

Of the ORR sites, the K-25 Site was the last for construction to begin (with the exception of supplemental items such as the S-50 plant). Although the proximity to TVA power plants had been a key reason to locate the K-25 Site in Tennessee, the project included a giant power plant. On 31 May 1943, the first survey party began to lay out the power plant which was thought necessary to supply a portion of the electrical energy for the cascade. It was also built in large part as a back-up in case of failure of TVA's lines or in the event lines off the site were sabotaged. The scientists also had concerns, which later proved to be unfounded, that even a momentary outage would shut down the K-25 Site and result in loss of production for many weeks (THC N.D.:681). The powerhouse was begun first for two reasons: one, because it required substantial lead-time, and two, partly as a hedge against failure of the gaseous-diffusion process. "Keith later recalled he took comfort in the fact that if all else failed, the power plant could be sold to TVA" (Hewlett and Anderson 1962:130). In June 1943 the J. A. Jones Construction Company began building the power-plant, the world's largest steam-electric power plant to be constructed in a single operation at that time (Hewlett and Anderson 1962:130).

The general form of the complex included a main production area containing a series of 54 contiguous four-story buildings constructed in the shape of a U, almost

half a mile long and averaging 400 feet in width and 60 feet in height. The total area of the main building alone was 44 acres (Hewlett and Anderson 1962:123; Robinson 1950:81). Service facilities were in the middle of the U. The enormous area of the buildings and the weight of the process equipment required an extraordinary amount of earth-moving and unusual techniques in constructing foundations. In September 1943 construction began on the many auxiliary buildings in the area surrounding the U. The cafeteria, laboratories, and other auxiliary buildings were not begun until 1944 (Hewlett and Anderson 1962:131). The U.S. Army built a special railroad spur from the Southern System to the plant. The U.S. Army also built a bridge at the Gallaher Ferry crossing. [The state built a new bridge at this site in 1963.]

The K-25 plant was the most isolated production site at the ORR and operated somewhat as a satellite community. Therefore, housing facilities were provided at the site, ironically called "Happy Valley" by its occupants (Gosling 1990:24-25; Hewlett and Anderson 1962:131). The housing facilities included hutments, central washing facilities, a mess hall, barracks, trailers, a school, commercial center, theater, three recreation halls, and other buildings. The total camp population peaked at about 15,000, but even so, more than half the construction employees at the K-25 Site commuted from surrounding communities over primitive and gruelling roads (Hewlett and Anderson 1962:131).

During the summer of 1943, the future of the gaseous diffusion process began to look bleak, in large part due to an inability to develop a barrier process. Urey, who as Director of Research for the Substitute Alloy Materials (SAM) Laboratory at Columbia University, was in charge of all work on gaseous diffusion in addition to his own projects for the production of heavy water and other isotopes. "A little dynamo of a man, sparked with fiery emotions, Urey was one to exaggerate failure as well as success" (Hewlett and Anderson 1962:128). Although Urey became depressed about the gaseous diffusion process, Lawrence apparently never wavered about the electromagnetic process. During this period, Lawrence strongly promoted the Y-12 Plant and requested that the Y-12 Plant be doubled in size. Lawrence also stressed that work at the Y-12 Plant could be greatly accelerated if partially enriched material from the K-25 Site could be used as feed for the Y-12 Plant. By taking uranium away from the K-25 Site in the middle of the cascading process, the final and upper stages of the cascade process at the K-25 Site could be eliminated. In 1943, at least in part due to Urey's pessimism about gaseous diffusion and Lawrence's faith in the electromagnetic

process, the K-25 plant was cutback and its final cascade stages were not built while the Y-12 Plant was expanded (Hewlett and Anderson 1962:129).

By late fall of 1943, General Groves had decided that Urey's lack of faith in the process would prevent him from aggressively pursing its success. Therefore, he restructured the organization placing Lauchlin Currie as associated director of the SAM Laboratories so that Urey was no longer directly responsible for the gaseous diffusion plant (Hewlett and Anderson 1962:135). Concurrently, since the British scientists who had previously worked in this field had lobbied extensively to be involved in all aspects of the Manhattan Project, General Groves made the decision to bring in a British team to work on this process. The British team worked primarily in New York with the Columbia University team and later at Los Alamos. However, their research into gaseous diffusion was at a different stage than that in the United States and their assistance was somewhat limited (Hewlett and Anderson 1962:134-138). Although security was stringent, it was through a member of the British team, Klaus Fuchs that atomic secrets (specifically involving the K-25 gaseous diffusion plant as well as details on how the bombs were assembled at Los Alamos) were passed to the Russians from 1943 to 1950 when he was caught and subsequently confessed (Moorehead 1952:96-99; Robinson 1950:74-75).

By January 1944, General Groves had to choose how to proceed with the barrier process. On the one hand, the project had invested a great deal of time in the Norris-Adler barrier process, but all the scientists agreed that in the long run, a new process based on nickel would be better. In January 1944, General Groves made the decision, based on Keith's recommendation, to shift priorities and more aggressively pursue the nickel process. By July 1944, both methods had shown improvement (Hewlett and Anderson 1962:134-141).

LIQUID DIFFUSION PROCESS (S-50): In the summer of 1944, General Groves was faced with the fact that the Y-12 Plant and the K-25 Plant were not producing as well as he had hoped. While either could still possibly work, neither was particularly successful and neither showed any likelihood to be so in the short-run. It was in this atmosphere that Oppenheimer wrote General Groves and suggested that he pursue building a liquid diffusion plant at the ORR for the purpose of providing low-grade uranium feed for the Y-12 Plant. Since General Groves had already taken low-grade uranium from the K-25 Site for the same purpose, he was receptive to the idea.

The liquid thermal diffusion process had been considered during 1940 but had been eliminated. In part

this was due to the fact that the U.S. Army was in charge of the Manhattan Project and that leaders in the field of liquid diffusion research were in the U.S. Navy. Individuals associated with the Manhattan Project, including President Roosevelt, saw problems in trying to combine the two agencies on the project. In fact, President Roosevelt specifically forbid the inclusion of the U.S. Navy in the S-1 project. Also at that time, the liquid diffusion process looked more promising for submarine propulsion than for use in bombs and that was the research direction the U.S. Navy pursued (Hewlett and Anderson 1962:169).

In January 1943, the Manhattan Project Committee had decided to investigate the U.S. Navy's work in this field, and although it was suggested that perhaps the gaseous diffusion process should be abandoned and this process take its place, the Manhattan Project Committee rejected this proposal. In 1943, the U.S. Army and U.S. Navy exchanged some information, but by late that year, the two found they could not work together on the process for various reasons and ceased trying to do so.

In November 1943, the U.S. Navy authorized construction of a 300 column plant at the Philadelphia Navy Yard to produce uranium-235 for the U.S. Navy. In January 1944 the U.S. Navy began construction of an interim 100-column plant which would be operated as a seven-stage cascade until the larger plant was built (Hewlett and Anderson 1962:172).

After General Groves received Oppenheimer's April 1944 letter suggesting that he investigate the possibility of adding a thermal diffusion plant to provide low-grade uranium feed to the Y-12 Plant, General Groves requested and received permission to approach the U.S. Navy. In May 1944, the U.S. Army re-opened contact with the U.S. Navy and in June visited the Philadelphia site. As a result, General Groves decided to build a full-scale thermal diffusion plant at the ORR (Gosling 1990:26; Jones 1985:172-177). This plant was code-named S-50 and was known locally as the "Fox Farm" (THC N.D.:690) apparently because Lieutenant Colonel Mark C. Fox was in charge of construction and operation (Construction 1945:132). The thermal diffusion plant was built next to the K-25 Site powerhouse which was virtually complete. It was General Groves's intention to operate the thermal diffusion plant only until the K-25 Site could be finished, and at that time, the steam would be turned back into the turbines to produce electricity for the gaseous diffusion plant. The contractor was given 90 days to complete the thermal diffusion plant which would essentially be a copy of the 100-column plant in Philadelphia except that it would be 21 times as large (containing 2,142 columns as opposed to

the 100 columns at the U.S. Navy's plant). Amazingly, the contractor finished in 75 days (Gosling 1990:26; Hewlett and Anderson 1962:170-173).

MERGER OF THE PLANTS AND OUTCOME OF THE BOMBS: By July of 1944, the Manhattan Project had substantial problems. Although the K-25 Site and the Y-12 Plant were largely built, they were not running smoothly. Construction on the thermal diffusion plan had just begun. At Hanford, the plutonium plant was only about half complete and not expected to be finished until early 1945. Yet, the construction of an atomic bomb or bombs hinged on these plants. In essence, there were two general possibilities of producing an atomic bomb. The first was through the plutonium being produced at Hanford. However, Oppenheimer and his team at Los Alamos had discovered that the neutron background of plutonium-240 ruled out the possibility of a plutonium gun. In July 1944, General Groves and his advisors, based on Oppenheimer's recommendation, agreed that research involving the use of plutonium in a gun-type weapon should be abandoned. Therefore, if the plutonium from Hanford could be used at all, it had to be in a bomb based on a more complicated implosion process. The second possibility was using fissionable material from the K-25 Site or the Y-12 Plant at the ORR in a gun-type device. However, production at the ORR was sporadic and quality varied.

In September, Lieutenant Colonel Nichols appointed a production-control committee whose purpose was to analyze the three plants at the ORR and devise a plan to combine the three plants to produce uranium-235. Previously, in August 1943, General Groves had used Alpha I at the Y-12 Plant and the K-25 Site for the lower stages of enriching the uranium which eliminated the need for the top portion of the K-25 plant cascade. Then the barrier crisis further limited the K-25 Site's production, and General Groves had authorized the construction of S-50. Now the production-control committee had to merge these three facilities in some combination.

In the fall of 1944, operations at all three plants began to look better. In fact, the K-25 Site looked more promising, in large part due to the simplicity of its design, and the only major problem at this stage with the gaseous diffusion process was the barrier issue. In late February 1945, the production-control committee devised a plan that involved the uranium being processed in gradually and successively purer forms from S-50 to the K-25 Site and then to the Y-12 Plant. Many of the leaders of the project had expected World War II to extend into 1946, and some of the construction decisions reflected that belief (Jones 1985:171). For instance, the entire K-25 Site peaked in early 1946. With the possibility that World War II might

extend into 1946, General Groves also decided to build at the K-25 Site a second gaseous diffusion plant to be known as K-27 which could be used to increase capacity in the lower stages of enrichment and to add a fourth Beta facility at the Y-12 Plant for the higher stages. At the earliest, these plants would not be in operation until February 1946. This essentially completed the construction phase of the Manhattan Project at the ORR (Hewlett and Anderson 1962:301-302).

By April 1945, production at all three plants at the ORR, as well as at Hanford, was going very well. At Los Alamos, the scientists had always been confident that a uranium gun would work and progress was being made on placing the uranium-235 from the ORR within such a weapon. Work on an implosion device that could use the plutonium from Hanford did not go well in the spring of 1945 but was beginning to look better by June.

In the meantime, scientists at Los Alamos could not be certain that the implosion device designed for the plutonium from Hanford, the so-called "Fat Man", would work. Therefore, they decided to test the device. Oppenheimer, inspired by the poems of John Donne, named the test Trinity. The test was held on 16 July 1945 within a barren area of the Alamogordo Bombing Range known as Journey of Death, 210 miles south of Los Alamos (Gosling 1990:40). A map of the Trinity Test area is shown on Figure II-13. Project leaders stationed themselves at different areas in case of an accident, but the test was an unqualified success with an explosion far more devastating than the scientists had anticipated. The scientists were relatively confident about the uranium bomb made from the uranium-235 from the ORR, the "Little Boy", and they did not stage any tests for it. The Manhattan Project had succeeded in producing two bombs ready for use against the Japanese.

Before the bombs were ready for use, on 7 May 1945, less than two months after President Roosevelt's death and Harry Truman's succession to the Presidency, Germany surrendered unconditionally. By this time, Japan was virtually defeated, and American aircraft were attacking Japanese cities at will. For instance, a single firebomb raid in March had killed nearly 100,000 people and injured over a million in Tokyo (Gosling 1990:45). Even so, it was generally believed that the Japanese would not surrender unless invaded and only then after a bitter and deathly battle.

As work on the two bombs neared completion, leaders within the project knew that they likely had two bombs for use as early as August 1945. But controversy swirled as to whether or not to use them. Many of the project scientists, including some at the University of Chicago who initiated a

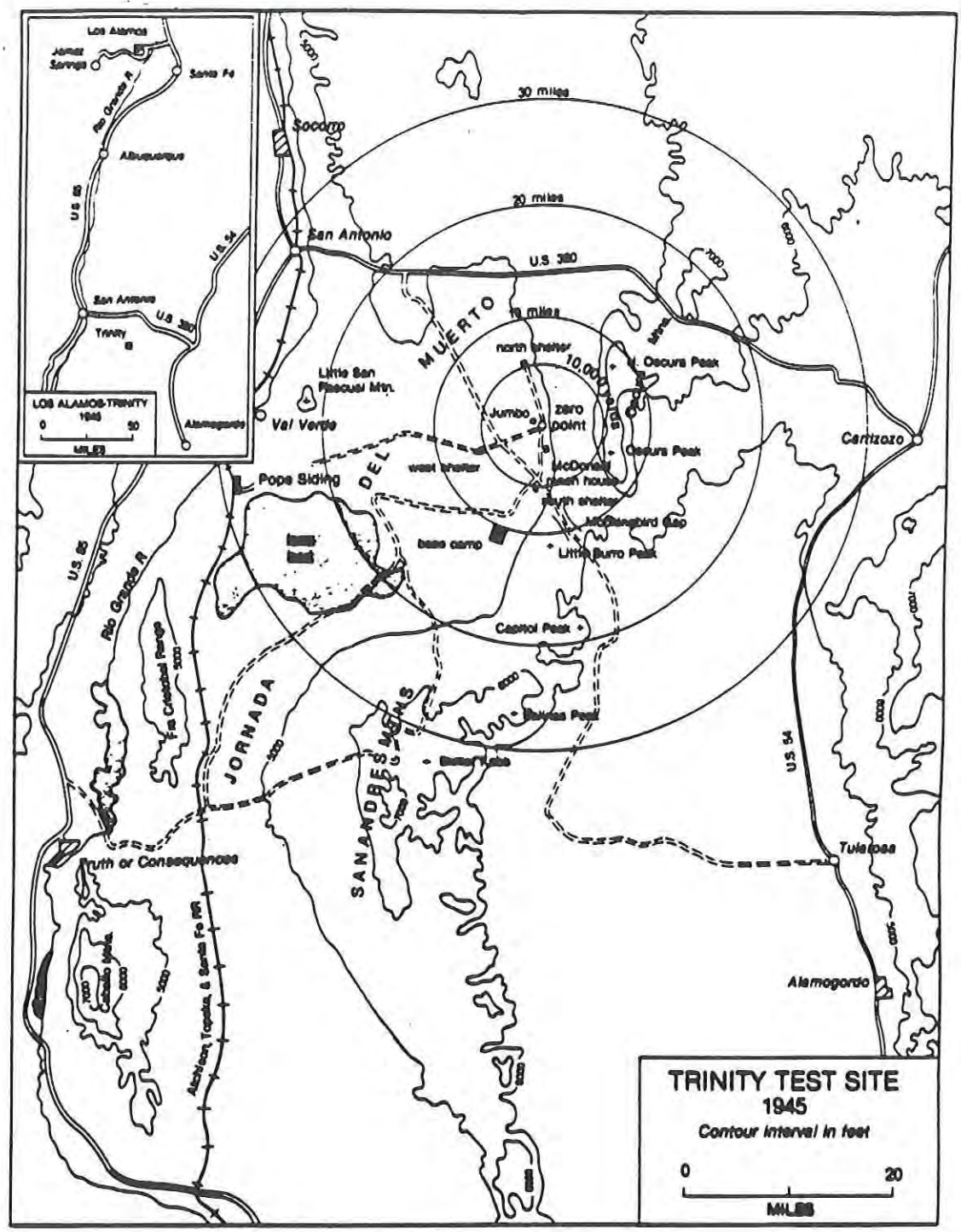


FIGURE II-13: TRINITY TEST SITE

(Gosling 1990:47)

petition drive (Johnson and Jackson 1981:159), urged that it not be used arguing that it preempted the United States from being perceived as a moral leader of the world and that using it would precipitate a world-wide arms race. They pointed out that Japan had been essentially beaten and that it should be given a clear opportunity to surrender. This group of people, including civilians associated with the project, urged that one of the bombs be dropped for demonstration purposes. They further argued that since the U.S. Navy was credited with winning World War II in the Pacific against Japan, the U.S. Army was pushing for use of the bombs from jealousy. It also seemed clear that regardless of other motivations, political and military leaders wanted to use the bomb to establish the United State's military superiority as a means to intimidate Russia as Europe was being partitioned. Those opposed to using the bomb on Japan further argued that racial prejudice against Asians was a motivation.

The other side countered with its own racial arguments. Namely, since many of the leading scientists in the project had been persecuted by Hitler because they were Jewish or for other reasons, they would have gladly used the atomic bomb against Hitler had it been developed in time. They also argued that either of the bombs might not go off in a demonstration test, and that with only two bombs, each was essential for direct military use. They also pointed to Japan's historical unwillingness to surrender even when defeated. Their most potent argument was that by dropping the bomb, they might save thousands if not hundreds of thousands of American lives that would be lost in a land invasion. There was also the feeling among many people that using the bomb would give the United States an edge in negotiations with Russia after World War II.

The Trinity Test was conducted while the Allied leaders met at Potsdam to discuss plans for post-World War II Europe. After learning of the results of the Trinity Test and after considering their options, President Truman and British Prime Minister Attlee issued a statement from Potsdam urging the Japanese to surrender or face utter devastation of her homeland. Although the civilian population and the government wanted to accept this offer, the Japanese military refused, in large part, because terms left the emperor's status unclear (Gosling 1990:51). In a 28 July 1945 statement, the Japanese prime minister publicly rejected the Potsdam statement.

After Japan's refusal to surrender, the United States decided to go ahead with dropping the atomic bomb. The U.S. Army Air Force had begun training with test drops at Wendover Field in Utah in September 1944 and had moved its

people and equipment in June 1945 to Tinian Base in the Marianas where the U.S. Navy had the world's largest airport (Gosling 1990:42). Although the U.S. Army and both bombs were ready by 1 August, bad weather delayed the flight until 6 August 1945. On that day, the *Enola Gay* took off from Tinian carrying the "Little Boy" bomb, the untested uranium-gun bomb made from uranium-235 from the K-25 Site and the Y-12 Plant at the ORR , and dropped it on Hiroshima, Japan. A map showing the bombing routes from Tinian is shown in Figure II-14. The bomb immediately killed nearly 100,000 people (including about 20 American airmen being held as POWs) and fatally injured an equal number leaving the city a pile of rubble for five square miles (Gosling 1990:51).

Within hours President Truman released another statement warning the Japanese that if they still refused to surrender unconditionally, the United States would continue bombing. The Japanese military still refused to surrender, and two days later, the Red Army invaded Manchuria. The next day, 9 August 1945, the Americans dropped a second bomb. The U.S. Army had intended to drop the bomb on Kokura Arsenal, but unacceptable weather conditions eliminated that target. After three passes over Kokura and running low on fuel, the pilot switched to his secondary target, Nagasaki, Japan, the home of the Mitsubishi plant that had manufactured the torpedoes used against the United States at Pearl Harbor. After dropping the "Fat Man" bomb, the implosion device made with plutonium from Hanford, the pilot headed to Okinawa where he was forced to make an emergency landing due to low fuel (Gosling 1990:53). The death rate was comparable to Hiroshima, but the physical devastation to the city was less due to the steep hills surrounding Nagasaki. Even after this, the military objected to unconditional surrender, but after the personal intervention of the Emperor, the Japanese military and the Allies reached an understanding that did not force the removal of the emperor. Japan surrendered on 14 August 1945. The formal act of surrender took place on 2 September 1945.

It was German research that initially propelled Americans into atomic research as a World War II effort. Ironically, the Germans themselves "were little nearer to producing atomic weapons at the end of the war then they had been at the beginning" (Gosling 1990:vii). The British had done extensive research in the field in the late 1930s, but faced with a war literally at their doorstep, they did not have the resources to pursue an atomic bomb research program. Therefore, they joined forces with American research efforts, primarily in the field of gaseous diffusion. The Russians developed a program that expanded greatly by the end of World War II, but its first successful

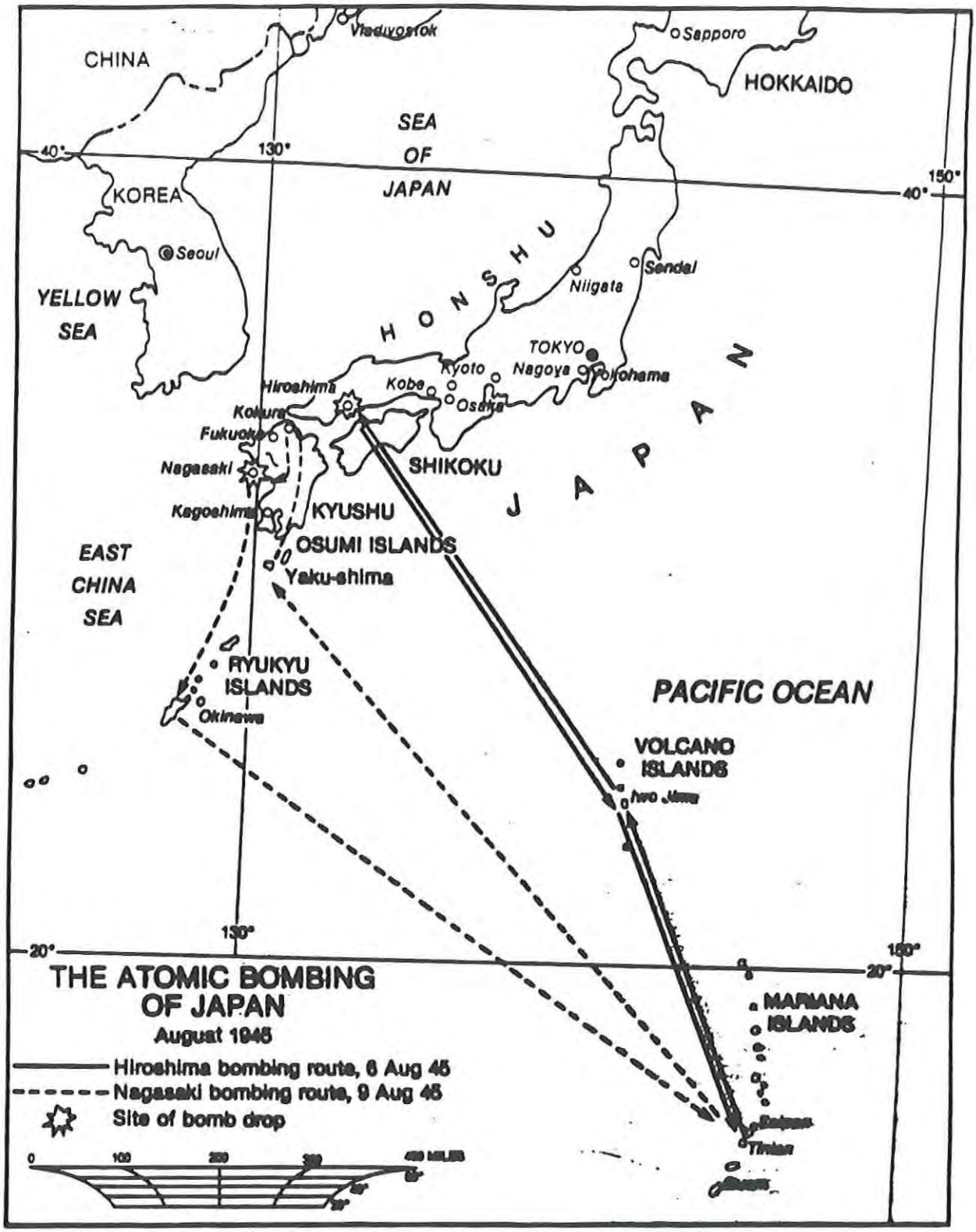


FIGURE 14: BOMBING ROUTES

(Gosling 1990:52)

test was not conducted until 1949. The Japanese achieved some success in the field, but due to its other World War II-related commitments, Japan could not devote the necessary resources to its development. Due to the United States's geographic isolation, later entry into World War II, and a comparatively smaller commitment of its resources (both natural and human) to the World War II effort, the United States was able to develop a monopoly on atomic energy even if it was for only a short time. Regardless of whether or not the development of nuclear research will be defined as a positive or negative development in human history, it can not be denied that it has had a profound impact on the world in the twentieth century.

Immediately after the bombing of Japan, President Truman issued a statement. Ordinarily, he said detailed technical data would have been released to the public. However, in this case, full disclosure would not occur "pending further examination of possible methods of protecting us and the rest of the world from the danger of sudden destruction." Knowing that the public would demand some type of information, the government did release a lengthy and technical document as a public relations effort. This report, called the Smyth Report after its author Henry Smyth, was released on 12 August 1945. This report had been prepared as part of the project and it "contained general technical information calculated to satisfy public curiosity without disclosing any atomic secrets" (Gosling 1990:54). President Truman further stated that he would ask Congress at once to establish a commission to control the production and use of atomic power in the United States while he developed plans to make it a "forceful influence for world peace" (Hewlett and Anderson 1962:415).

So ended the Manhattan Project's efforts to produce atomic weapons for use in World War II.

BUILDINGS REMAINING FROM 1942-45 AT THE ORR: Many buildings erected during the Manhattan Project were intended to be temporary. This is especially true for those constructed at the Townsite where many of the buildings no longer remain. Even so, a substantial number of 1942-1945 period buildings do remain within the original Townsite. The Oak Ridge Townsite along Black Oak Ridge was inventoried in a 1991 survey by the preservation planning firm of Thomason and Associates of Nashville. In addition to the five individual nominations for properties from the pre-1942 period mentioned above, Thomason prepared district nominations for two areas. Both of these districts have a period of significance that extends through 1959 so they contain more than pre-1945 housing. According to the nomination, the Townsite (or the Oak Ridge Historic District) contains approximately 3,585 1942-1945 buildings.

The Y-12 Plant and the K-25 Site also contain pre-1945 buildings, but these complexes have not been inventoried so an exact count is not available at this time. However, both sites have experienced a relatively consistent use of their buildings, unlike ORNL which has experienced several buildings phases. Therefore, the Manhattan Project period of development appears to be more intact at the Y-12 Plant and the K-25 Site than it does at ORNL. It is estimated that roughly 80 to 100 1942-1945 buildings remain at the Y-12 Plant site. It is estimated that roughly 70 to 80 1942-1945 buildings remain at the K-25 Site.

At ORNL, 26 properties from the 1942-1945 period remain. The focal point of these is the National Historic Landmark, the X-10 Graphite Reactor (Pile), 3001. The American Nuclear Society designated the Radiochemical Processing Pilot Plant, Building 3019, a Nuclear Historic Landmark in 1992. Other properties remaining from the 1943-1945 period are the original reservoir, now the Cafeteria Storage Building, Building 2009; steam plant, Building 2011; Medical and Biological Building, Building 2013; Generator Building for Building 2011, Building 2017; Carpenter Shop, Building 2018; Stack, Stack 2061; Cafeteria, Building 2069; Change House, Building 2506; Safety Department Building, Building 2517; SWSA No. 1, Building 2624; Fanhouse for Building 3001, Building 3003; Water Demineralizer, Building 3004; Vault for Building 3001, Building 3008; Stack for Building 3001, Stack 3018; Stack for 3019, Stack 3020; Turbine House for 3019, Building 3021; North Tank Farm, Facility 3023; Laboratory, Building 3026C; South Tank Farm, Facility 3507; Settling Basin, Structure 3513; Process Waste System Basin, Structure 3524; Research Laboratory, Building 3550; and the site of SWSA No. 2, Facility 4003. The White Oak Dam and Lake, Structure 7846, which was built in 1943, is located to the southwest of the main complex.

<u>POST-1945 PERIOD</u>: After World War II, President Truman was faced with the issue of atomic power: of how to use it, and if and how to share it with the rest of the world. President Truman firmly believed that the President and the President alone should have the authority to choose to use such a weapon and that the government, not the military, had to have complete control over all fissionable materials and that the program should be run by civilians. Although the military tried to retain some control, President Truman never wavered from his position of civilian control which ultimately became the cornerstone of the United States's post-World War II atomic program. After extensive wrangling in 1945 and 1946 in Congress by a variety of factions, Congress passed the Atomic Energy Act of 1946 in August which created the AEC. This commission was composed of five individuals appointed by the President and confirmed by the Senate. The first AEC was composed of Sumner Pike, a businessman and former member of the Securities and Exchange

Commission; Lewis Strauss, a banker and naval reserve admiral; David Lilenthal, chairman of TVA who was opposed by Senator Kenneth McKellar of Tennessee because McKellar had tried but failed to influence job hiring at TVA; William Waymack, newspaper editor; and Robert Bacher, a physicist at Los Alamos. In addition, Carroll Wilson was appointed general manager (Buck 1983:1; Folmsbee et al. 1969:539; Hewlett and Anderson 1962:620-622).

Although President Truman appointed the AEC members in the fall of 1946, the AEC did not assume responsibility for the Manhattan Project sites until 1 January 1947. A chronology of the AEC is contained in Appendix E. The Manhattan Engineering District itself was not formally abolished until 15 August 1947. Thus, between August 1945 when World War II ended and January 1947, General Groves operated in a "no man's land" as caretaker for the Manhattan Project, in some ways an even more difficult assignment than he had had during World War II. With the future uncertain, staff at the ORR left in droves. While once he had been able to make all of his decisions with no publicity and a relative disregard for financial reasons, he now had to deal with a wide variety of individuals and begin looking at cost issues. At the ORR, with victory secure, he deemed it time to shut down the uneconomic facilities. As soon as Japan had surrendered, the S-50 plant was put on stand-by. On 4 September 1945 the Corps ordered S-50 to discontinue operations and by 9 September 1945 it was closed. The Alpha facility at the Y-12 Plant was finally working well, but it could not compete with the more efficient plant at the K-25 Site, and therefore, in September it was placed on stand-by. The last tank at the Alpha facility ceased operation 22 September 1945 (Hewlett and Anderson 1962:624). Thus, for several months General Groves was able to make relatively easy decisions or to stall, but by early 1946, he was faced with situations that forced him to make decisions about long-term issues with or without the AEC.

At the X-10 Site, the University of Chicago had resigned as operator in 1945, and Monsanto had become the operating contractor. However, for the other facilities, the major operating contracts for the plants all ended six months after the end of World War II, but to assure uninterrupted production, General Groves had extended them through supplemental agreements until 30 June 1946 with an option for an additional year. At the ORR, General Groves followed through on this option to retain Union Carbide and Tennessee Eastman. General Groves also tried to keep Du Pont at Hanford. However, Dupont had agreed to operate the site with a firm commitment that it would resign its operational role when World War II ended. Upon Du Pont's departure, General Groves then persuaded the General Electric Company to manage Hanford. General Groves

was also faced with a decision about the production process plants, in large part, due to the success of the K-25 and K-27 plants. Together these facilities operated so well that they made the Y-12 Plant superfluous (Hewlett and Anderson 1962:628-630). In December 1946 the newly formed AEC and General Groves decided to close the Y-12 Plant with the exception of one Beta track. This reduced employment at the Y-12 Plant from 8,600 to 1,500 and reduced operation costs by $2 million a month. The news broke in the ORR the day after Christmas. "A stirring chapter in the history of the wartime project was drawing to a close" (Hewlett and Anderson 1962:646). Over the following years, the production of enriched uranium continued at the K-25 Site while the Y-12 Plant largely converted to the precision machining of weapons components, an activity exacerbated by Cold War hostilities.

During World War II, the histories of Los Alamos, Hanford, and the ORR greatly overlapped. But with the end of World War II, although still related by technology and by administration, each of these places evolved into independent complexes with its own unique history. At a local level in the ORR, the individual components of the ORR (the X-10 Site, the Y-12 Plant, the K-25 Site, and the Townsite) also became more independent of each other and their histories, although overlapping to some degree, diverged.

Prior to 1941, the United States government had not been involved in the advancement of scientific research as a national goal. However, in an effort to win World War II, the government had subsidized science and had become increasingly involved. In the late 1940s, science was seen as the road to power, progress, and prestige. In general, beginning in the 1940s, the Federal government invested substantial sums of money in scientific research. Research activities focused on a wide variety of technological advancements such as atomic weapons, spy planes, improved radar systems, advanced computers, and long range missiles. The National Science Foundation, the National Science Board, and the Science Advisory Committee were established. Individual agencies such as the U.S. Navy and the U.S. Air Force pursued technological research.

General Groves also recognized the importance of research and in early 1946 began trying to develop a research budget for fiscal year 1947. To develop some ideas, he appointed an Advisory Committee on Research and Development. This committee supported the expansion of further research and development in the production of fissionable materials and advanced training in nuclear studies. This committee also agreed that national

laboratories should be established. Although neither this committee nor the AEC ever actually defined "national laboratory," it was generally understood that such laboratories were for the primary purpose of pursuing unclassified fundamental research that required equipment too expensive for a university or private laboratory to underwrite. It was also intended that individual research responsibilities would be assigned to each laboratory. The Advisory Committee on Research and Development and later the AEC viewed these national laboratories as channels through which federal funds would flow to support nuclear research. Each laboratory would have a board of directors chosen from the participating universities.

General Groves was in full support of establishing the national laboratories and throughout his tenure with the Manhattan Project did everything in his power to see them implemented. The Advisory Committee on Research and Development viewed a government reservation such as the ORR more as an installation associated with commercial exploitation or as an industrial site than as a university-oriented laboratory and did not originally recommend that it become a national laboratory. However, the committee did propose that national laboratories be established in each region of the United States beginning with two national laboratories, one at Argonne and another in the northeast (both of which could have possibly absorbed elements of the Clinton Laboratories). The 1943 Argonne site contained only a few buildings associated with the rebuilt Fermi pile and the CP-3 heavy-water reactor. Unable to acquire enough land from Cook County for this site to function as a national laboratory, the laboratory was built farther to the west on farmland, but it retained the name Argonne National Laboratory. After much discussion, the second laboratory was placed on Long Island and named the Brookhaven National Laboratory (Hewlett and Anderson 1962:633-637, 645).

After the ORR was not selected as the site for a national laboratory, 14 universities organized the Oak Ridge Institute of Nuclear Studies (ORINS). The leader of this movement was William G. Pollard, a University of Tennessee physics professor who had worked during World War II on the gaseous diffusion process at Columbia University. The 14 universities represented the southeast region and geographically ranged from Washington D.C. to Texas. The purpose of ORINS was to assist Monsanto in scientific staffing and gaining federal support and to use the Clinton Laboratories for academic research. In April, the Manhattan District approved the project, and in October the organization received a state charter of incorporation as the Oak Ridge Institute of Nuclear Studies. "To a considerable degree, the combination of Clinton and

the ORINS gave the Southeast the equivalent of a national laboratory" (Hewlett and Anderson 1962:636). The AEC provided space in existing buildings at the Townsite for ORINS. Since then, ORINS has expanded and erected several new buildings for its use. The AEC in 1949 gave ORINS the responsibility of managing the Museum of Atomic Energy. In 1965 the name of the organization was changed to Oak Ridge Associated Universities (ORAU).

In the immediate post-World War II period, the research focus at the Clinton Laboratories included reactor development, the production of radioactive isotopes for experimental purposes, the recovery of large amounts of uranium from the extraction wastes being held in storage, and the investigation of the effects of radiation on animals (Hewlett and Anderson 1962:627). Research on animals was coordinated through the Agricultural Research Laboratory which was established in 1948 as a joint project between the AEC and the University of Tennessee; in 1981 ORAU acquired responsibility for this facility. Once the AEC was established in 1947, it reviewed a report that had been prepared by the Scientific Panel to the Interim Committee in September 1945. The report focused on the development of weapons, reactors, and radioisotopes for research. Of all of the Interim Committee's proposals, the AEC determined that only one, the production of isotopes at the ORR, had occurred (Hewlett and Duncan 1969:30-31).

In the summer of 1946 at the Clinton Laboratories, a co-directorship of James H. Lum and Eugene Wigner replaced Whitaker who had resigned. The Clinton Laboratories then began to focus on the development of new piles (or reactors as they came to be known). However, in the interim between World War II and the transfer of the facility to the AEC, clear and long-term goals for the Clinton Laboratories were slow to emerge. General Groves's Advisory Committee did recommend the construction of two reactor projects. The first was a fast-fission pile, possibly at Argonne. The second was a high-temperature power pile that Farrington Daniels at the University of Chicago had been planning since 1944. General Groves's Advisory Committee recommended that it be built by Monsanto at the Clinton Laboratories (Hewlett and Anderson 1962:634). As a result, Daniels and his associates designed the Daniels Pile, a low-energy or "thermal" reactor at the Clinton Laboratories in early 1947. The purpose of this reactor was for power production rather than as an experimental breeder reactor which was a high priority of the AEC. (Hewlett and Duncan 1969:28-29, 34). Much of the staff for this project came from outside the Clinton Laboratories leaving it never fully integrated into the "inside" structure. Other research projects seemed to

show that this process was not highly effective, and although the design of the Daniels Pile influenced later developments in high-temperature gas-cooled reactors, the Daniels Pile was never built (Johnson and Schaffer 1992:30, 35-37).

The AEC accepted responsibility for the Manhattan Project sites in January 1947. Late that year, the AEC changed the name of the Clinton Laboratories to the Clinton National Laboratory. In 1948 the AEC changed the name to the "Oak Ridge National Laboratory" (ORNL). However, during 1947 the future of the Clinton Laboratories was not clear. Many of the leading advisors, including Oppenheimer, felt that the Clinton Laboratories should be closed and perhaps merged with Brookhaven. In March 1947, Oppenheimer told the AEC, "Most of us think that the evidence is in that Clinton will not live even if it is built up" (Pollard 1980:28). The stated reason was its geographic isolation and separation from a large university community, but some of the opposition seems to have been based on a regional bias. For the first year of its existence, the AEC, while not closing the Clinton Laboratories, did not clarify its mission, structure, or contractor affiliation.

However, from a practical standpoint, the Clinton Laboratories was an established and working industrial site that the AEC could not easily abandon. Therefore, due to problems with Monsanto as an operator, in December 1947 the AEC terminated its contract with Monsanto and hired the Carbide and Chemical Company (a division of Union Carbide) effective March 1948. At the same time, the AEC designated the facility ORNL (Thompson 1963:61).

In addition, one could speculate that politics might have played a role in the continued existence of the ORR. In the 1946 election, Republicans had gained control of both the Senate and the House in what was perceived as a direct rejection of President Truman. Afterwards, President Truman's re-election chances looked extremely bleak. In part due to President Truman's civil rights activities and other liberal programs, Democrats in the South split into a rival party called the States Rights Democratic Party (commonly called the Dixiecrats) with Strom Thurman as its presidential candidate. Under these conditions, President Truman needed every vote in the South that he could get. Also, while Senator McKellar from Tennessee was no longer Chairman of the Senate Appropriations Committee, he was an enormously powerful senator and he would have been the ranking Democrat on the committee. The one key fact about

McKellar that is always noted is his obsession with obtaining "pork" in the form of jobs or projects for his state. Also, after President Roosevelt's death he had strengthened his ties with the Truman administration when he served as President Pro Tempore of the Senate. As a sign of his power, President Truman asked him to sit in on Cabinet meetings. For more than one reason, the AEC may have deemed it appropriate to designate a southern facility as a national laboratory. [In the 1948 presidential election, President Truman carried 11 of Tennessee's 12 electoral votes with only one vote going to Thurman and that because the elector was on both the Truman and Thurman tickets.]

Thus, early in 1948, ORNL became the third national laboratory in the United States, and although all three laboratories had their roots in the Manhattan Project, ORNL was the only one located on its World War II site. These first laboratories were intended to be regional centers where university scientists could pursue scientific endeavors. Of the three, Brookhaven National Laboratory came the closest to being a true regional research center while ORNL became more of an industrial complex than an academic complex. Instead, the AEC supported ORINS as a regional research center, and in combination with ORNL facilities, the two produced a program in research, training, and eduction that fulfilled its mission as a national laboratory (Hewlett and Holl 1989:253-54; Oak Ridge National Laboratory [ORNL] ca. 1980:2). Over the years, the federal government supported scientific research at a variety of universities and laboratories as shown on Figure II-15 and Table II-1.

As one author has written:

> *One of the most important legacies of World War II has been the Atomic Energy Commission's national laboratories. These large, multipurpose research and engineering development institutions, including those at Los Alamos, Livermore, and Berkeley, have proved to be a source of great scientific strength for the nation. Before the War nothing like them existed, and the government was scarcely involved at all in scientific research and the technologies it spawned. Now, 30 years after the establishment of the Argonne, Oak Ridge, and Brookhaven National Laboratories it is clear that they have become permanent institutions of such proven value to the nation that they are certain to be continued indefinitely (Pollard 1980:51).*

UNITED STATES
ATOMIC ENERGY COMMISSION

OFFICES AND LABORATORIES

December 1973

FIGURE II-15:

MAP OF ATOMIC ENERGY COMMISSION OFFICES AND LABORATORIES

(Buck 1983:21)

National Laboratories and Research Centers
Operated by or Associated with the Department of Energy (1992)
(Compiled by Betsy Scroger)

Facility	Date Established	DOE Program Control	Location	Contractor
Multiprogram laboratories				
Argonne National Laboratory	1946	Energy Research	Argonne, IL	University of Chicago
Brookhaven National Laboratory	1947	Energy Research	Upton, NY	Associated Universities, Inc.
Idaho National Engineering Laboratory	1949	Nuclear Energy	Idaho Falls, ID	EG&G Idaho Inc.
Lawrence Berkeley Laboratory	1931 (1943-gov't lab)	Energy Research	Berkeley, CA	University of California
Lawrence Livermore National Laboratory	1952	Defense Programs	Livermore, CA	University of California
Los Alamos National Laboratory	1943	Defense Programs	Los Alamos, NM	University of California
Oak Ridge National Laboratory	1943	Energy Research	Oak Ridge, TN	Martin-Marietta Energy Systems, Inc.
Pacific Northwest Laboratory	1965	Energy Research	Richland, WA	Battelle Memorial Institute
Sandia National Laboratories	1949	Defense Programs	Albuquerque, NM	AT&T Technologies, Inc.
Program-dedicated facilities				
Ames Laboratory	1945	Energy Research	Ames, IA	Iowa State University
Bettis Atomic Power Laboratory	1949	Nuclear Energy	West Mifflin, PA	Westinghouse Electric Corporation
Continuous Electron Beam Accelerator	1987	Energy Research	Newport News, VA	South Eastern Universities Research Association
Energy Technology Engineering Center	1966	Nuclear Energy	Canoga Park, CA	Rockwell International Corporation
Environmental Measurements Laboratory	1947	Energy Research	New York, NY	Government-operated facility
Fermi National Accelerator Laboratory (Fermilab)	1968	Energy Research	Batavia, IL	Universities Research Association, Inc.
Inhalation Toxicology Research Institute	1960	Energy Research	Albuquerque, NM	Lovelace Biomedical and Environmental Research Institute
Knolls Atomic Power Laboratory	1947	Nuclear Energy	Schenectady, NY	General Electric Company Reactors
Laboratory of Biomedical and Environmental Sciences	1947	Energy Research	Los Angeles, CA	University of California
Laboratory of Radiobiology and Environmental Health	1951	Energy Research	San Francisco, CA	University of California
Morgantown Energy Technology	1946	Fossil Energy	Morgantown, WV	Government-owned facility
National Renewable Energy Laboratory	1977	Conservation and Renewable Energy	Golden, CO	Midwest Research Institute
New Brunswick Laboratory	1949	Security Affairs	Argonne, IL	Government-operated facility
Oak Ridge Institute for Science and Education (Associated Universities)	1946	Energy Research	Oak Ridge, TN	Oak Ridge Associated Universities
Pittsburgh Energy Technology Center	1948	Fossil Energy	Pittsburgh, PA	Government-operated facility
Princeton Plasma Physics Laboratory	1951	Energy Research	Princeton, NJ	Princeton University
Savannah River Ecology Laboratory	1951	Energy Research	Aiken, SC	University of Georgia
Savannah River Laboratory	1951	Defense Programs	Aiken, SC	Westinghouse Savannah River Company
Stanford Linear Accelerator Center	1962	Energy Research	Menlo Park, CA	Stanford University
Stanford Synchrotron Radiation Laboratory	1973	Energy Research	Stanford, CA	Stanford University
Superconducting Super Collider Laboratory	1989	Energy Research	Dallas, TX	Universities Research Association, Inc.

TABLE II-1

As part of its effort to compartmentalize research at each laboratory and eliminate duplicate research efforts, the AEC announced the distribution of work assignments to the national laboratories in December 1947. At that time, it established as its primary focus weapons research at Los Alamos. A second priority was reactor development (Hewlett and Duncan 1969:28-32). The purpose of these reactors was, in part, to produce plutonium for weapons but also to serve as a radiation source for the production of radioisotopes and for general research. However, "the requirements of national defense thus quickly obscured their [the AEC's] original goal of developing the full potential of the peaceful atom bomb. For two decades military-related programs would command the lion's share of the [Atomic Energy] Commission's time and the major portion of the budget" (Buck 1983:1).

The Clinton Laboratories had hoped that the AEC would designate it as "the" reactor laboratory and had formed a Power Pile Division in July 1946. However, the AEC designated Argonne as the center for reactor studies. As a result, most of the Pile Division was transferred to Argonne in 1947 (Thompson 1963:51). The AEC directed the Clinton Laboratories to concentrate in three fields: basic research, chemical technology, and isotope production and research. This allocation, which effectively gave the Clinton Laboratories only a secondary role in reactor development through the field of chemical technology, was seen as a setback for the Clinton Laboratories (ORNL ca.1980:2). However, while it was a "bitter pill" for most of the Clinton Laboratories, it was an advancement for the chemical engineers. "For them designation of chemical process problems as a central mission of ORNL was welcomed as a great opportunity" (Genung et al. 1993:1-18).

However, due to a larger than expected work load, Argonne was unable to handle all of the reactor design work (Pollard 1980:28). The increased workload at Argonne resulted in large part from the escalating hostilities with Russia and its 1949 nuclear test as well as the hostilities in Korea. As a result, the AEC embarked on a vast expansion program over the next three years that included new facilities at Fernald, Ohio, Paducah, Kentucky, Portsmouth, Ohio, Savannah, South Carolina, and new plants at Hanford and the ORR. "The three year three-billion-dollar expansion program represented one of the greatest federal construction projects in peacetime history" (Buck 1983:2). Argonne's increased work load combined with Alvin Weinberg, ORNL Research Director, aggressively lobbying for ORNL resulted in the AEC giving ORNL a series of assignments to study some of the more "exotic" reactor concepts (Hewlett and Holl 1989:254). The AEC also tried very hard to change the public perception of atomic energy being useful only as a destructive weapon into an appreciation for its application

for every-day use such as for generating electrical power (Hewlett and Duncan 1969:28-30). Another top priority was the development of a power-breeder reactor and a high-flux test reactor.

In August 1946, Monsanto established one of the most famous research schools at the Clinton Laboratories, a school for training technical personnel in the various fields of nuclear science, the Clinton Training School, which lasted only one year. Although several renown scientists graduated from the program, perhaps its most famous graduate was Captain (later Vice-Admiral) Hyman Rickover from the U.S. Navy. The U.S. Navy's assignment of Rickover and seven other individuals to this program was a direct outgrowth of the collaboration of the U.S. Army and U.S. Navy on the thermal diffusion plant (S-50) at the K-25 Site during World War II. Rickover aggressively pursued information from various individuals at the facility and welded the other seven members into a team that maximized its time at the school. "Legends about Rickover's activities at Clinton Laboratories still abound. For example, he sometimes elicited information from scientists by introducing himself: 'I'm Captain Rickover; I'm stupid'" (Johnson and Schaffer 1992:43-45). Rickover later established and directed the development of the U.S. Navy's nuclear program which has been described as "probably the most successful reactor program in the 1950s" (Buck 1983:3).

Although the Clinton Training School ended, the field of nuclear science was so new that United States's university system was not in a position to train scientists. Therefore, another advanced training program was developed at ORNL that began in 1950, the Oak Ridge School of Reactor Technology (locally dubbed the Klinch Kollege of Knuclear Knowledge). ORNL erected a structure, Building 3017, for this school in 1952, but generally students were taught at various facilities around ORNL (such as at 2518) (Johnson and Schaffer 1992:43-46, 88-89). The original program was discontinued with the 1956-57 class. At that time, a two-part program consisting of six months at an associated university and six months at the ORR was initiated, but applications were so limited that ORNL discontinued the program in 1958 (Thompson 1963:245-247). A variation of the program continued until 1965 (Johnson and Schaffer 1992:46). Alvin Weinberg, director of ORNL from 1955-1974, described the two training schools as perhaps the most important role functions of ORNL in the development of nuclear power because it was so crucial in the dissemination of information about nuclear reactors and nuclear power (Overholt 1987:358).

The 1947 budget for Manhattan Project sites included roughly $90 million of which $19 million was allocated for housing and utilities at Los Alamos and Oak Ridge Townsite, $20 million for construction related to research purposes at the ORR, and $23 million for operating expenses. In this budget, overall, the ORR and Argonne received the bulk of the money (Hewlett and Anderson 1962:635). However, between 1945 and 1949, there was still an element of uncertainty about the future of the site and the building program reflected that uncertainty. Several buildings deemed necessary were built, but no cohesive building program emerged. Buildings erected during this period included the Quonset huts, Buildings 2000 and 2001, an electrical substation on the north side of Bethel Valley Road opposite the ORNL main facilities complex, Building 0901, a water reservoir, Building 0902, on the north side of Bethel Valley Road, and the first masonry building on the site, a steam power plant, Building 2519, in 1947. Ironically, the latter three buildings had been erected during a period when it was thought that the Materials Testing Reactor would be built at the ORR; however, the AEC later decided to build it in Idaho (Johnson and Schaffer 1992:60, 63-64). The steam plant originally had three boilers; later alterations include the conversion to gas in 1950, a fourth boiler being added in 1956, and a fifth boiler being added in 1963 (NUS 1981:4.2.1). Figure II-16 contains a photograph of the site from the late 1940s. Also, in 1946, an "H" shaped office building, Building 1000, was relocated from the K-25 Site and moved to the west end of the project site and reerected for administrative office space (Thompson 1963:Figure 23). Due to the shifting emphasis at the Y-12 Plant, many buildings were vacant there, and ORNL located several programs there including the Biology Division and offices for the Reactor Division.

In 1946, the Clinton Laboratories established a Metallurgical Division and in 1952 a Ceramics Laboratory. This group conducted intensive research into metallic elements under high temperatures and radiation stress in reactors. The Ceramics Laboratory conducted ceramics research, fabricated crucibles, insulators, and fuel elements, and customized parts for reactors. The Ceramics Laboratory became a world center for metallic alloy and ceramics research (Johnson and Schaffer 1992:38-41). ORNL assigned seven buildings to this division (NUS 1981:4.1-42-45). The first two were built in the late 1940s

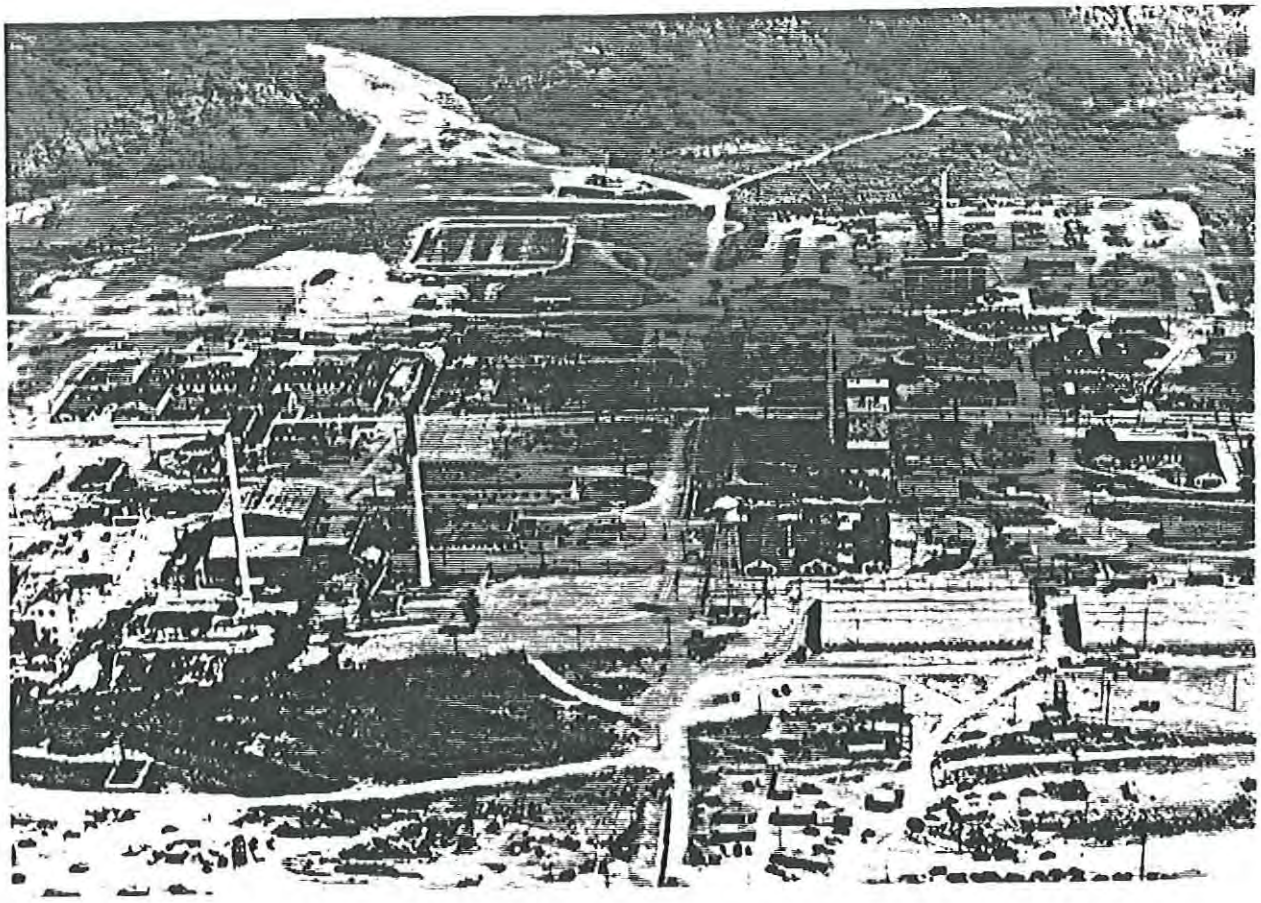


FIGURE 16

LATE 1940s PHOTOGRAPH OF OAK RIDGE NATIONAL LABORATORY

(ORNL-HSTRY #76)

at the X-10 Site: the 1947 rolling mill, Building 3012, to roll, cast, and forge reactor fuel elements and metal parts and the Mechanical Properties Laboratory, Building 2011, built in 1943. This division was also housed in the Quonset huts. Later buildings include the Liquid Metals Cleaning Facility, Building 3534, built in 1961; the Gas Storage Area, Building 3537, built in 1962; space in Building 4500S Wings 1 and 2, Central Research and Administration South built in 1961 (66,605 square feet); the Metals and Ceramics Facility, Building 4508, built in 1962, and the Thorium-Uranium Recycle Facility, Building 7930, built in 1968 at the High Flux Isotope Reactor Facility.

The scientific experiments required various small machine shops. During the Manhattan Project period, these had been scattered around the facility. In 1946 Wigner decided to consolidate these various support facilities into one work area, a central research shop area now known as the East Support Area. This area contained many of the functional support facilities essential for an industrial complex. For instance, one craftsman was a blacksmith who made lead bricks for radiation shielding and produced customized nuts, bolts, and metal parts. The small research shops evolved into central machine shops and became the Fabrication Department in the Plant and Equipment Division (Johnson and Schaffer 1992:38). The J. A. Jones Construction Company erected two of these buildings, 7001 and 7002, as its construction headquarters during this period, and at the completion of its construction activities in the early 1950s, transferred them to ORNL (Thompson 1963:62-2). Buildings at the East Support Area from the late 1940s and early 1950s include the General Stores Building, Building 7001, the Garage and Ironworking Shop, Building 7002, the Welding and Brazing Shop, Building 7003, the Lead Shop, Building 7005, the Paint Shop, Building 7007, the Carpenter Shop, Building 7009, the Storage and Paint Stores, Building 7006, the Fabrication Shop, Building 7012, and the Central Mechanical Shops, Building 7012. This area is a fenced, self-contained area to the east of the ORNL main facilities complex and currently functions as a support area with repair shops and a gasoline station for vehicles assigned to ORNL.

Originally, the ORR consisted of about 59,000 acres, but in 1949 the Townsite was opened to the public and separated from the ORR leaving a fenced area of 35,252 acres. This necessitated the construction of three new sentry posts (National Register included: Bear Creek Road Checking Station, Bethel Valley Checking Station, and the

Oak Ridge Turnpike Checking Station). Figure II-17 contains a map of the ORR that indicates these boundary changes.

Although the 1945-49 period can be seen as somewhat of a transitional period in which great uncertainty existed about the future of ORNL, by the late 1940s, ORNL was firmly established. One author cites the change in direction as due to two factors. The first was that Union Carbide was an "exceptionally able and perceptive contract operator" as opposed to Monsanto who openly sneered at ORNL as "Dogpatch." The second reason was that, although Argonne had been designated the main reactor laboratory, Argonne was not capable of doing all of the reactor-designs, and the AEC chose ORNL to do the overflow designs (Pollard 1980:28). Consequently, the AEC made an administrative commitment to the retention of ORNL and began the task of upgrading the facility and stabilizing it for long-term use. Thus, in 1949 the AEC budgeted $20 million for new construction, and Union Carbide initiated a building program named "Program H" to replace many of the wooden wartime buildings with more permanent brick buildings. This program included paving streets, landscaping the grounds, and renovating some of the older buildings. In addition, about 250,000 square feet of new office and laboratory space was built to the east of the Graphite Reactor or generally in its immediate vicinity. This building program reflected the AEC's allocation of work assignments for the laboratories in that the construction program provided facilities for ORNL's three main programs as defined by the AEC: research, isotope production, and chemical processing.

Copies of U.S.G.S. Quadrangle maps from 1935, 1942, 1953, and 1968 are shown on Figures II-18, II-19, II-20, and II-21. These maps show the interesting evolution of the site from a typical isolated rural Tennessee valley into an industrial complex. Figures II-18 and II-19, 1935 and 1942 maps, show the area before the Manhattan Project when the only building in the immediate area of ORNL was the New Bethel Baptist Church. Figure II-20, a 1953 map, does not show ORNL, presumably due to security reasons. Figure II-21, a 1968 map, shows ORNL development. Figure II-22 contains an undated photograph of the site probably made between 1954 and 1961.

One of the most distinctive buildings constructed during the expansion period is the Central Research and Administration Building North, Building 4500N. This building housed not only offices but numerous laboratories as well as becoming the center for a wide variety of research activities. For instance, the Analytical Chemistry Division was housed in 4500N where it conducted research on material recovered by the Federal Bureau of Investigation after President Kennedy's assassination and later studies on moon rocks (Lyon and Shults 1990:17-19). About 1961, an

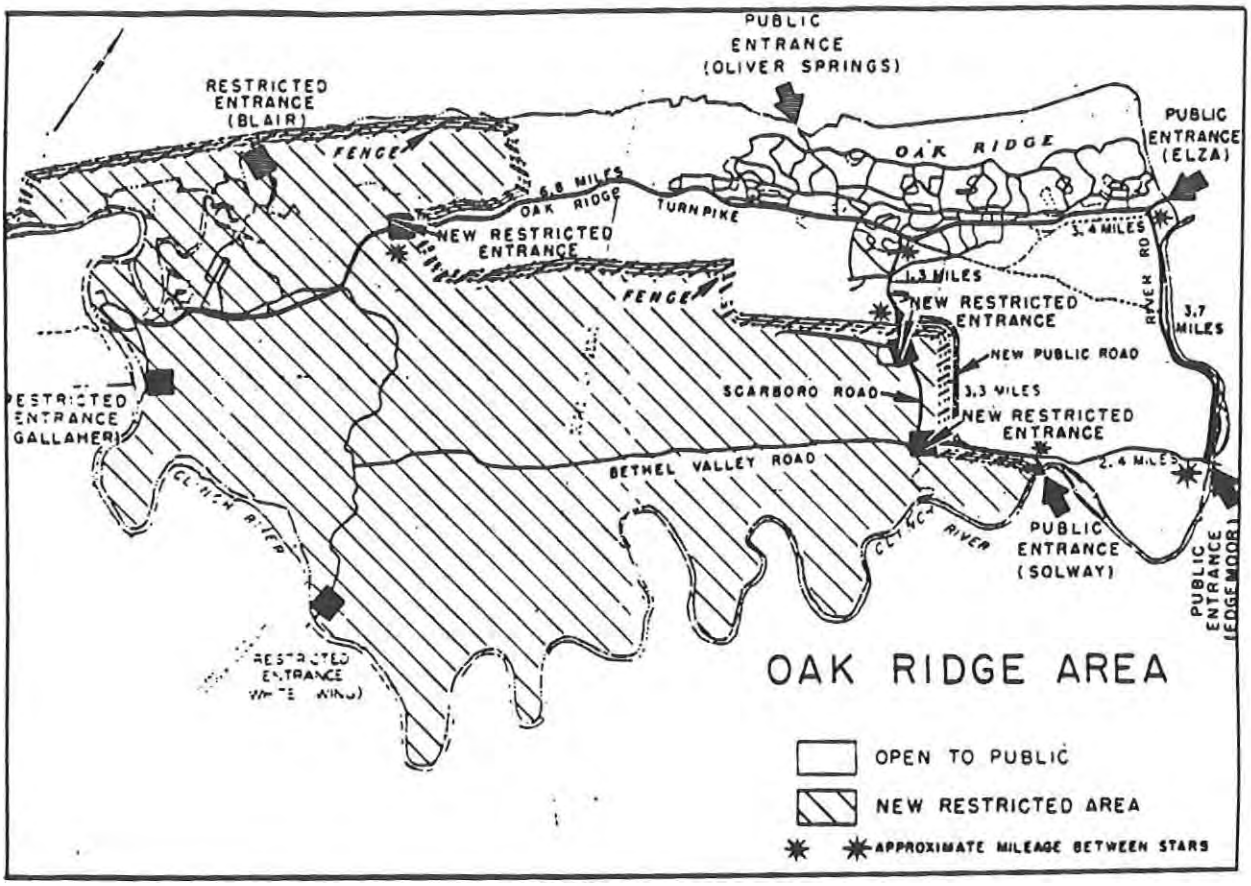


FIGURE II-17:

MAP OF ORIGINAL RESERVATION AND 1949 BOUNDARIES AND GATES

(Present 1985:x)

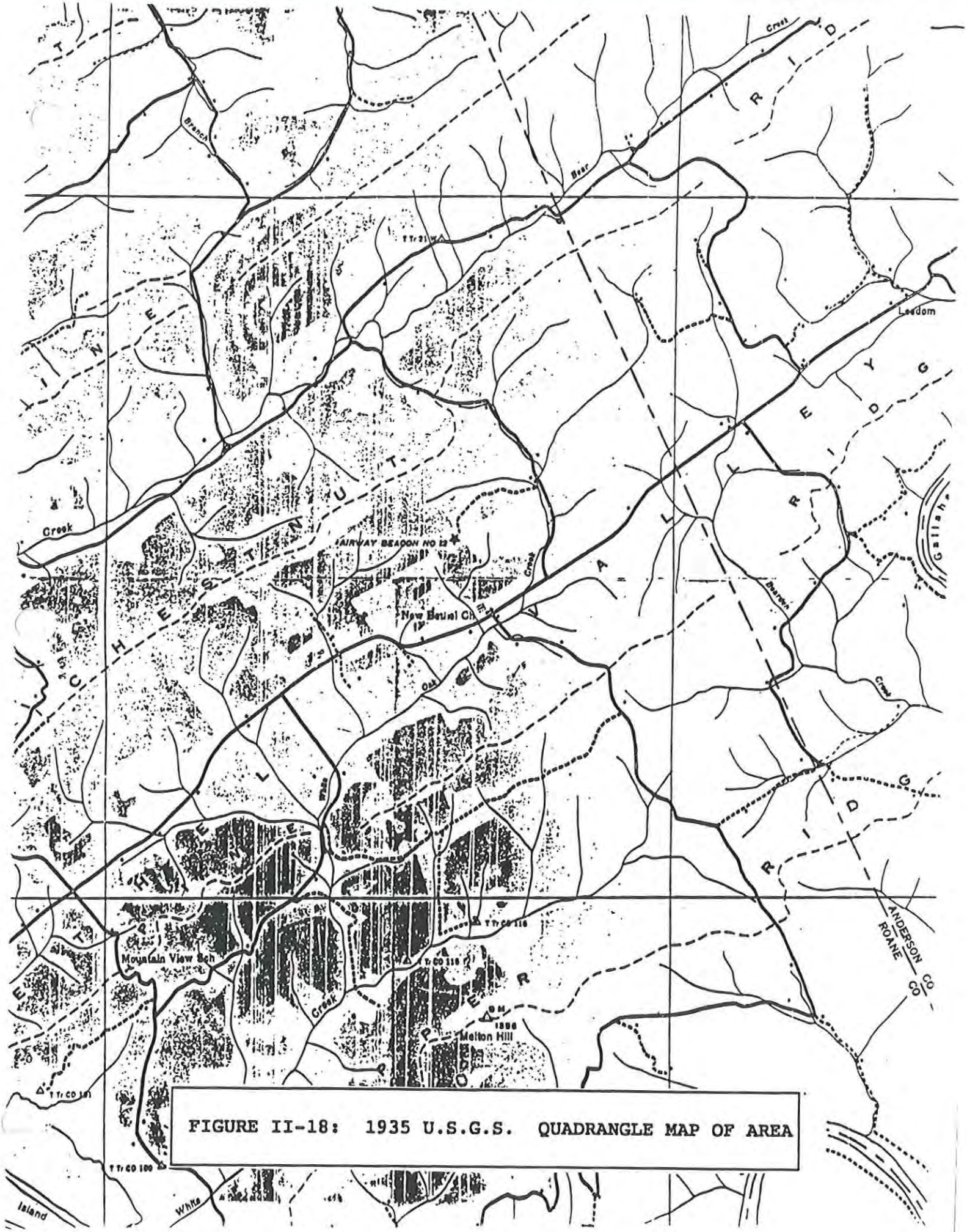


FIGURE II-18: 1935 U.S.G.S. QUADRANGLE MAP OF AREA

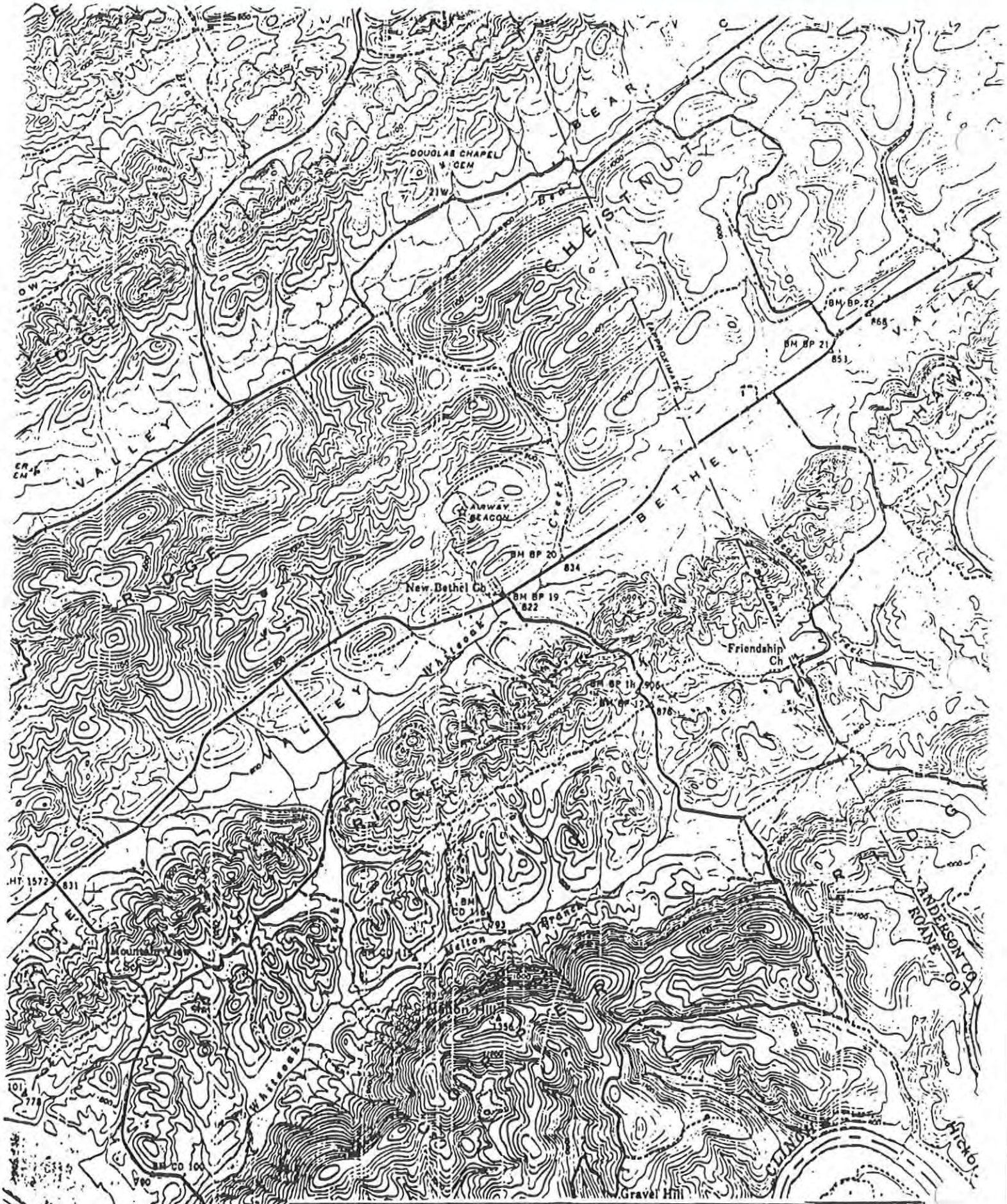


FIGURE II-19: 1942 U.S.G.S. QUADRANGLE MAP OF AREA

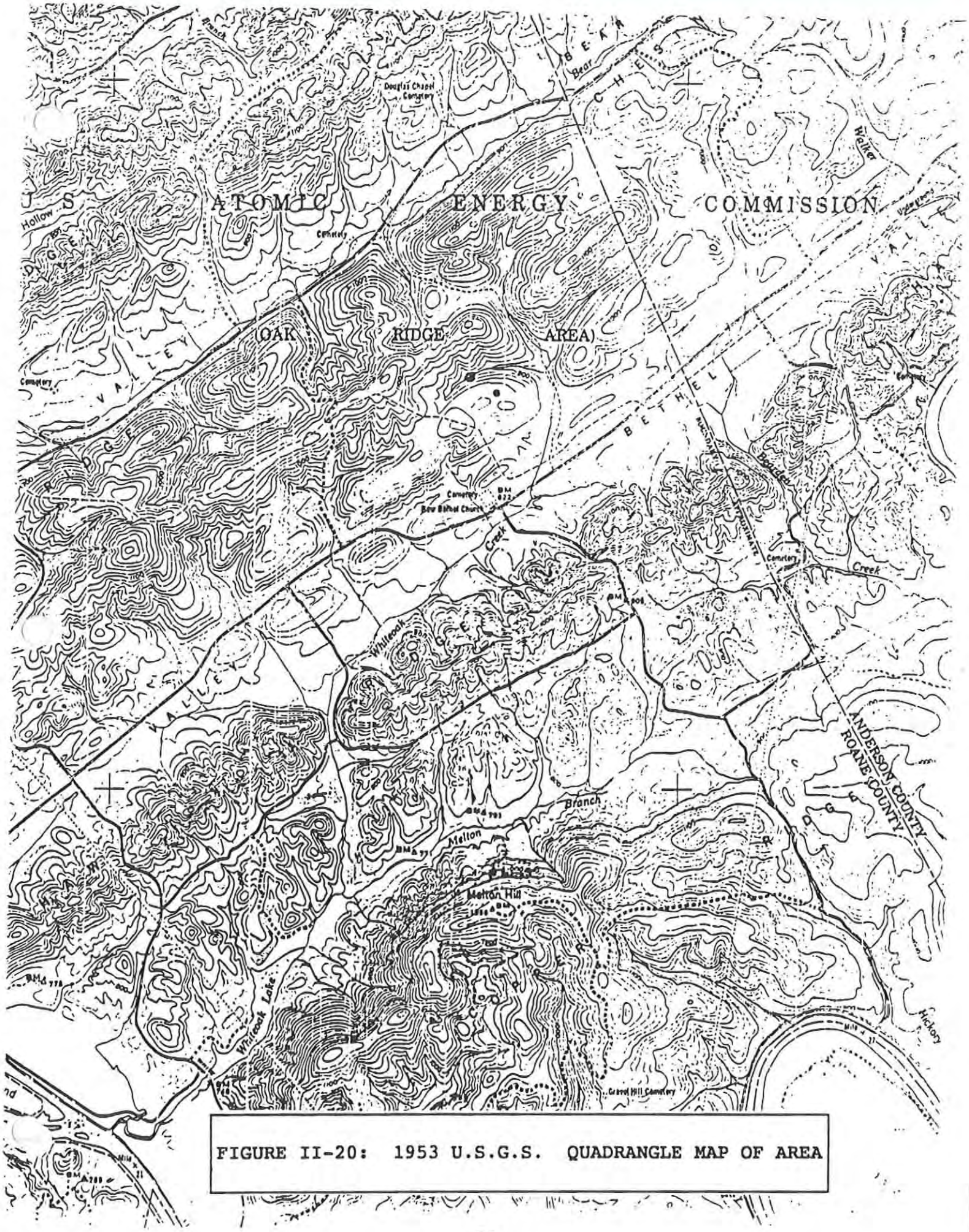


FIGURE II-20: 1953 U.S.G.S. QUADRANGLE MAP OF AREA

FIGURE II-21: 1968 U.S.G.S. QUADRANGLE MAP OF AREA

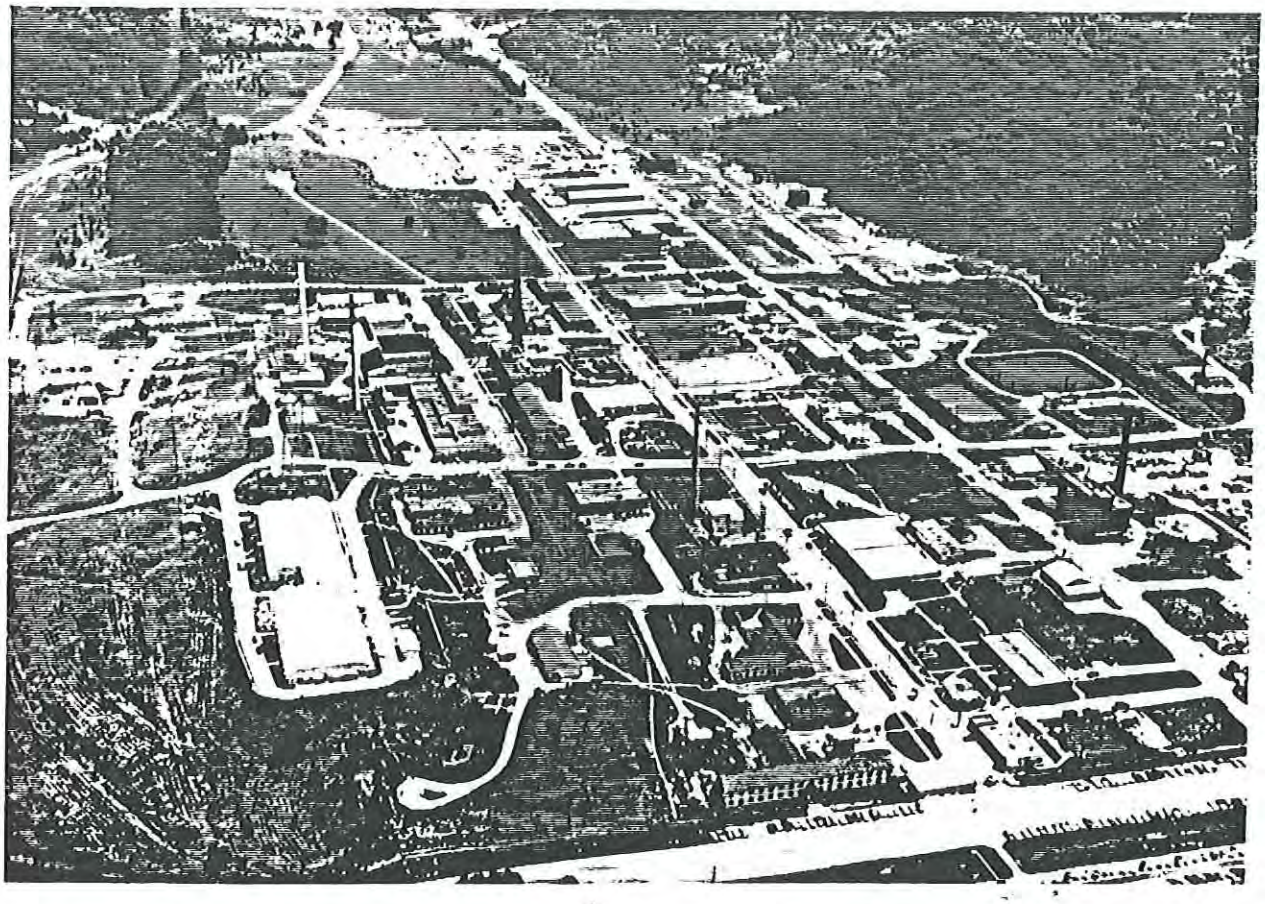


FIGURE II-22:

UNDATED PHOTOGRAPH OF OAK RIDGE NATIONAL LABORATORY BETWEEN 1954 AND 1961

(ORNL HSTRY #269)

addition (Wing 5) was constructed. The building has over 340,000 square feet of space. Also about 1961, ORNL constructed Building 4500S immediately to the rear of 4500N which also houses offices and research facilities.

Originally, the isotope program was scattered in buildings throughout ORNL with pits occasionally being used as storage space. However, as part of this expansion program, ORNL constructed 10 buildings (Buildings 3028, 3029, 3030, 3031, 3032, 3033, 3034, 3036, 3037, and 3038) for two million dollars on Isotope Circle for use in the isotope process (ORINS Newsletter, February 1950:8). In addition, the AEC constructed Building 4501/4505 for use in the isotope production process. During World War II, the products from the Graphite Reactor, Building 3001, "had been particularly important at Los Alamos--alone enough to justify its construction" (Hewlett and Anderson 1962:636), and after World War II, "The reactor served for many years as the principal atomic research facility in the United States" (U.S. DOI 1965). In the post-World War II period, the Graphite Reactor was used extensively to produce radioactive isotopes for research, which was the most publicized activity at ORNL after World War II. Once World War II ended, General Groves's Advisory Committee felt that the isotopes should be distributed at cost for research and gave first priority to the fundamental sciences which needed only small samples, then to therapeutic research for humans, and then for education and training research. On 2 August 1946, Wigner delivered the first peacetime product of the atomic energy plant, a one-millicurie unit of carbon 14, to Dr. E. V. Cowdry of the Barnard Free Skin and Cancer Hospital of St. Louis (Hewlett and Anderson 1962:636).

By the early 1950s, due to the Graphite Reactor, ORNL had become the prime producer for the world's supply of radioisotopes, as well as a source that provided the basis for valuable research to study the effects of radiation on matter. Within a few months of the first shipment of radioisotopes in August 1946, the Clinton Laboratories had nearly 50 different radioisotopes available for distribution. In 1947 the Isotopes Section was established and expanded into the Isotopes Division (Johnson and Schaffer 1992:37). Between August 1946 and January 1950, the number of shipments each month increased from 60 to 630.

ORNL became a world center for the production and distribution of stable and radioactive isotopes which have been called "the most valuable research tool since the invention of the microscope" (Thompson 1963:250). The isotope production was central to the prestige of ORNL as well as to the AEC. As one historian wrote, "During the lean years in the 1950s when the [Atomic Energy] Commission had little to boast about in advancing the peaceful uses of atomic energy, descriptions of the isotope distribution

program filled Commission reports and press releases" (Hewlett and Holl 1989:254). In 1987, Weinberg described the isotope production as perhaps the most important research tool to emerge from ORNL saying, "Had ORNL done nothing else in its 43-year history, the large-scale use of radioisotopes made possible by ORNL would assure the Laboratory an honored place in science" (Overholt 1987:360). In 1992, Weinberg said, "The most important [mission of the Graphite Reactor], I suppose, was the production and distribution of radioisotopes. Much of the work that led to unraveling the genetic code could not have been done without them. They are used in the diagnosis and treatment of cancer. They are used in agriculture to trace phosphorous in fertilizers, and in innumerable other ways. Science couldn't continue today without them. If God has a golden book and writes down what it is that Oak Ridge National Laboratory did that had the biggest influence on science, I would guess that was the production and distribution of radioisotopes" (Genung et al. 1993:4-1). While isotopes are generally perceived as a research tool in cancer studies, they have also had wide applications in dozens of research fields revolving around four principal themes: tracing, measurement and control, radiography, and teletherapy (Little 1958:113). In 1975, ORNL dissolved the Isotope Division and reassigned its functions to various sections. It was reorganized again in 1983 and 1988 (Genung et al. 1993:4-31,32).

The Graphite Reactor operated for 20 years, from 4 November 1943 to 4 November 1963. In 1966 the National Park Service designated it a National Historic Landmark. Following the closing of the Graphite Reactor, the Oak Ridge Research Reactor, Building 3042, built between 1955 and 1958 and closed in 1987, produced most of ORNL's radioisotopes. Currently, the High Flux Isotope Reactor (HFIR), 7900 Area, which opened in 1965, is a major source of radioisotopes for medical and industrial uses (Johnson and Schaffer 1992:36). ORNL is presently proposing a long-term project to build the Advanced Neutron Source (ANS) which would replace the HFIR. ANS start-up is planned for late fiscal year 2000, which is also the estimated end of the useful life of the HFIR (ORNL 1992b:10).

The third major mission designated by the AEC in the late 1940s for ORNL was chemical processing (the process of extracting desired materials from spent natural uranium fuel). Work in this area led ORNL to being "recognized worldwide as a leader in the development of reprocessing technology" (Genung et al. 1993:4-66). When the X-10 Site

was originally developed in 1943, the major installations were the experimental Graphite Reactor, the Radiochemical Processing Pilot Plant, Building 3019, and supporting laboratories. A central focus of this work was the separation of isotopes. Building 3019 was ORNL's central resource for chemical processing as it developed into the principal Research and Development center for fuel reprocessing and waste management studies in the United States from the late 1950s into the early 1970s (Genung et al. 1993:2-20).

The Chemical Technology Division was formed in 1950 from the previous Chemical Technology Department of the Technical Division. At that time, the division was located in several buildings, including two originally assigned to the Chemical Technology Department, the 1943 Chemistry Laboratory, Building 3550 and the 1943 Separations Building, Building 3019. The Chemical Technology Division had also expanded into other buildings. For instance, the Design Section was in Building 2067 (not extant) and the Unit Operations Section was in Buildings 3502 and 3503. In 1948 the High-Radiation-Level Chemistry Laboratory, Building 3503 was erected. In addition, as part of the expansion program an addition to Building 3019 was erected, a new Metal Recovery Plant, Building 3505 was built in 1951, the High Alpha Laboratory, Building 3508 was built in 1951-1952, the High-Level Radiochemical Laboratory, Buildings 4501 and 4505, were built in 1951, the Chemical Technology Division Laboratory, Building 3017, was built in 1952, and the Unit Operation Volatility Laboratory, Building 3592, was built in 1952. In 1951 space was assigned to the Chemical Technology Division in 4500N. Building 3505 was operated from 1952 until 1960 as a pilot and production plant to reprocess spent nuclear fuel (Johnson and Schaffer 1992:33-34). Another building used by this division was Building 3026 on Isotope Circle. In 1957 ORNL erected Building 4507 as a High-Radiation-Level Chemical Development Laboratory, in 1962 ORNL assigned Chemical Technology Division space in the new 4500S building, and in 1965 ORNL erected Building 7920, the Transuranium Processing Plant (Genung et al. 1993:2-1, 4-66, Appendix 39).

The Chemical Technology Division experimented with a wide variety of processing methods and the laboratories were redesigned to accommodate any changes. One process tested at ORNL, the Redox process, was tested in Building 3019 from 1945 to 1951 at which time large scale operations using this process began at Hanford. From 1949 to 1960 the Purex process was carried through the pilot-plant stage in Building 3019. In 1954 this process was put into operation at the Savannah River site and at Hanford in 1956. Several facilities in the United States and all foreign reprocessing

plants now use this process (Genung et al. 1993:2-4). In 1973, due to changing national goals, the Chemical Technology Division was reorganized. The Division's internal history views 1976 as the end of its original period of development. In April 1977, President Carter implemented a new nuclear policy that indefinitely deferred the commercial reprocessing of nuclear fuels resulting in an overall decrease in the emphasis on nuclear fuel reprocessing. Afterwards, the Chemical Technology Division diversified into several other research areas such as waste management and environmental studies, which are the major thrusts of the division today (Genung et al. 1993:2-3, 2-17, 2-27, 4-20, 4-64).

In addition to buildings directly related to ORNL's primary missions, there were numerous other buildings erected at ORNL in the early 1950s as part of the Program H expansion project. These include the Calibration Laboratory, Building 2007, the Instrument Laboratory Building, Building 3500, and the Change House, Building 2518. There were also many smaller support buildings erected during this period. Examples are security facilities such as the Main Portal and division office for security, Building 5000, a cafeteria, Building 2010, the Plant and Engineering Building, Building 2518, and the Special Materials Machine Shop, Building 3044.

After World War II the use, and especially the control, of nuclear power was extensively debated. In 1953, President Eisenhower gave a speech to the United Nations in which he pledged that the United States would use nuclear power for peaceful purposes through international cooperation, the so-called "Atoms for Peace" speech. President Eisenhower's commitment to peaceful application of nuclear energy was a point from which he never wavered, and it dominated much of his political life (Bundy 1988:287). Although the Atoms for Peace program did not seriously deter the nuclear arms race, it did to some degree solidify the mission of ORNL and give it a multifaceted research agenda because ORNL's future was tied to research applications of nuclear energy. Soon afterward, President Eisenhower signed the 1954 Atomic Energy Act which fundamentally revised the 1947 Act. It created a framework for cooperation between the AEC and private industry, and it also allowed the AEC to share technical and scientific information with foreign governments (Buck 1983:3). As a result, the AEC began to declassify nuclear science data for private use. It was during this period of attempting to change the public perception of nuclear energy that the AEC, in July 1953, opened the main roads through the ORR, making it possible for visitors to drive by the nuclear installations (DeCamp and Campbell 1988:12).

By the late 1940s, the AEC had decided that its decision to develop the Materials Testing Reactor (MTR), a water-moderated thin-plate research reactor, at Argonne was a mistake. In 1948, ORNL lobbied to have it built in Tennessee, but the AEC instead acquired a site in Idaho where the reactor was completed in 1952. The MTR was shutdown in 1970 (Greenstreet 1992:14). The AEC gave Argonne responsibility for designing the MTR building and associated facilities and ORNL the responsibility for designing the actual reactor. Consequently, a staff headed by Eugene Wigner worked on the design for this research reactor and built a small mock-up to investigate the design of its controls and hydraulic systems. ORNL received permission from the AEC to convert this mock-up reactor into a research reactor (Thompson 1963:67). Built during Program H, this facility, Building 3005, which was erected at the ORNL main facilities complex, was referred to as the "poor man's pile" by Wigner but was formally named the Low Intensity Test Reactor (LITR). The LITR became one of the design prototypes for commercial nuclear power plants and for reactor propelled naval craft. The 1954 Tower Shielding Facility, the 1954 Bulk Shielding Reactor, the 1958 Oak Ridge Research Reactor, and the 1965 High Flux Isotope Reactor all used variations of this design. "Many dozens of research reactors, all based on this simple principle pioneered at ORNL, are now in use throughout the world; and the United States fleet of nuclear submarines is powered by pressurized versions of the original MTR" (Overholt 1987:361). Another author wrote, "Thus, it is clearly evident that the MTR concept had a profound influence on reactor development at ORNL and internationally as well" (Greenstreet 1992:16). ORNL shut down the LITR in 1968 (Johnson and Schaffer 1992:33-34, 65-66).

In some aspects, the late 1940s represented a period of euphoria about the technological future. There were idealized dreams of running homes and factories with nuclear energy: "drop a pill in our gas tanks and drive for a year. Ships would sail the Pacific on a nuclear charge no bigger than a lump of coal. We would power rockets with it, and spaceships, and cure cancer" (Searcy 1992:27). During this period hopeful "Buck Rogers"-fantasies about atomic-powered ships, submarines, aircraft, trains, cars, and even tractors captivated the public's attention (Johnson and Schaffer 1992:59). Although ORNL was not designated "the" reactor laboratory, Wigner was able to get ORNL the "exotic" reactor programs. One consequence was ORNL's involvement in research into nuclear-powered submarines, aircraft, and

ships during the late 1940s and 1950s. "The application of atomic power to motion and travel became a centerpiece of the Laboratory's research program in the postwar era" (Johnson and Schaffer 1992:59).

In 1946 the U.S. Air Force established the Nuclear Energy for Propulsion of Aircraft Project and began research in this field. In 1948, a separate study, the Lexington Project, recommended that this project be funded, and combined with increasing hostilities in the Cold War, the government decided to fund the project (Greenstreet 1992:11). In 1949, the U.S. Air Force, Union Carbide, the AEC, and others met at the ORR to discuss these agencies joining forces to pursue this research goal. Later that year, the AEC ordered ORNL to pursue such a program which would be called the Aircraft Nuclear Propulsion Program (Thompson 1963:90). At that time, this was the only nuclear-powered aircraft research program in the United States. The AEC sponsored this research and jointly funded it with the U.S. Air Force, which closed out its own research program. The Aircraft Nuclear Propulsion Program was a pivotal feature of ORNL's existence in the 1950s until the program's demise in 1957.

As a result of this program, the Reactor Technology Division was divided into two sections in 1951: the Reactor Experimental Engineering Division and the Aircraft Nuclear Propulsion Division. The Aircraft Nuclear Propulsion Division was later renamed the Aircraft Reactor Engineering Division. In 1951 the headquarters for these divisions were moved from ORNL to the Y-12 Plant (Greenstreet 1992:15). After Congress halted the program in 1957, but before President Kennedy formally abolished it in 1961, these two Divisions were recombined in 1960 to form the Reactor Division (Greenstreet 1992:2). A chart showing the structure of the Reactor Division is shown in Figure II-23.

Although "the plane never got off the ground," the spin-off research into other fields using the data from this project was more useful in the long run than the original research project (Johnson and Schaffer 1992:58). Research was first conducted at the S-50 plant at the K-25 Site and later at the Graphite Reactor. However, as the research progressed, these facilities were not adequate. As a result of this program, ORNL constructed three unique reactors.

One of these reactors was the 2-MW Bulk Shielding Reactor (BSR), Building 3010, which was completed in December 1950 at the ORNL main facilities complex. This reactor was popularly known as the "swimming pool" reactor, but it was "used to study, in bulk, various materials for use in improved radiation shields. The reactor therefore became known officially as the Bulk Shielding Reactor" (Thompson 1963:68). The original purpose of the MSR was

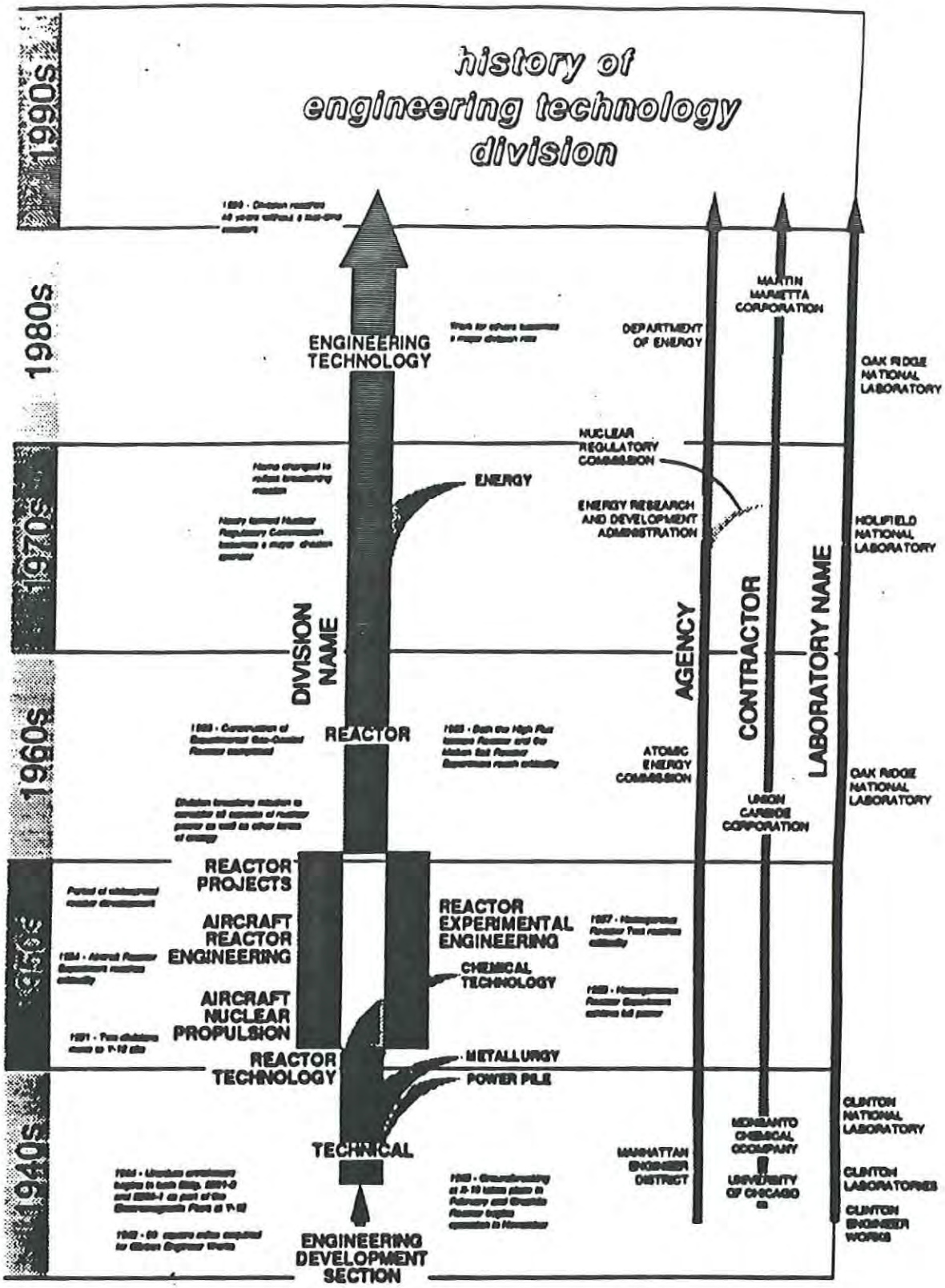


FIGURE II-23: FLOW CHART OF REACTOR DIVISION

(Greenstreet 1992:3)

related to shielding materials for use in aircraft. Relatively inexpensive, safe, and stable, this design became a prototype for many research reactors around the world. Along with the Graphite Reactor, this facility produced important research in radiation damage processes in solids. The BSR was upgraded with a forced cooling system in 1963 when the Graphite Reactor closed (Johnson and Schaffer 1992:66-69, 83). The BSR is no longer in operation.

The second reactor related to the Aircraft Nuclear Propulsion Project, which also related to the study of shielding materials, was the Tower Shielding Facility (TSF), 7700 Area. The TSF was built between March 1953 and February 1954 in a fenced area about two miles south of the ORNL main facilities complex. The TSF is the only reactor facility in the United States designed and built for radiation shielding studies in which both the reactor source and shield samples are raised into the air. The purpose of this research was to answer questions about the effects of radiation from a reactor flying overhead as well as to better understand the type and amount of shielding needed for a nuclear aircraft. The facility consists of four 315-foot towers, erected on the corners of a 100 by 200-foot rectangular concrete pad, associated buildings and equipment. The towers support a reactor core that can be suspended in the air in a spherical container. The Tower Shielding Reactor II was installed at the facility in 1960. In 1965, a modified Space Nuclear Auxiliary Power 2/10A reactor was installed at the facility. Various types of research continued here until the facility was closed in 1992 (Johnson and Schaffer 1992:66-70; Muckenthaler 1992:33-42; NUS 1981:4.1.1.5).

ORNL also developed a liquid-fueled reactor for the propulsion of aircraft, a nuclear-powered engine that could drive long-range bombers. This reactor was an experimental 100-kW aircraft reactor originally known as the Aircraft Reactor Experiment (ARE). The ARE used molten (fused) uranium fluorides (salts) as its fuel. In 1953 ORNL erected a building, Building 7503, to house this reactor in Melton Valley about a half mile south of the ORNL main facilities complex. The location was adjacent to the Homogeneous Reactor Experimental Facility concurrently under construction. The ARE components were installed in 1953 and finished by mid-1954. Operation began in the fall of 1954 (Greenstreet 1992:22). "It is not exaggerating to say that the ARE was the most advanced reactor type the Laboratory had developed and, consequently, its successful operation represented perhaps the greatest achievement of the combined research and development staffs of the Laboratory" (Thompson 1963:95).

As an outgrowth of this successful research, ORNL dismantled the ARE and modified and enlarged the facility for a larger 60-MW "fireball reactor" to conduct more sophisticated experiments. This new reactor was the second step in the testing process and was called the Aircraft Reactor Test (ART). By 1957, ORNL had built an Engineering Test Unit which was a non-nuclear replica of ART and had done preliminary testing and initial fabrication of parts. At that time, Congress announced the cancellation of the entire program.

While ORNL accepted the cancellation of the Aircraft Nuclear Propulsion Project, it did request to continue the ART program because it felt that it would yield information about the development of high-temperature reactors for marine and electric utility service. The AEC refused this request, and the design of the ART was completed and shelved. The enlarged ARE Building was placed on standby for possible future use (Greenstreet 1992:24-25).

The Aircraft Nuclear Propulsion Project directly and indirectly affected other programs at ORNL. For instance, it helped ORNL to justify the acquisition of nuclear particle accelerators, which accelerates charged particles or atoms and propels them into a target, and digital computers (Johnson and Schaffer 1992:71). Neutron research had been initiated in 1948, which required an accelerator program. The Chemistry Division acquired a Van de Graaff electron accelerator from the U.S. Navy which has been used for 30 years. ORNL also acquired a Cockcroft-Walton accelerator. These first accelerators were installed in an abandoned powerhouse, Building 2011, now the Mechanical Properties Building. By the late 1940s, ORNL needed an expanded accelerator program, and the U.S. Air Force agreed to purchase a 5-MV Van de Graaff accelerator if ORNL would construct a building in which it could be housed. The accelerator was installed for a year at the Y-12 Plant, but in 1952 ORNL completed the High Voltage Accelerator Laboratory, Building 5500, the house the Van De Graaff accelerators. The building was expanded in 1962 to house an additional Van De Graaff accelerator and offices. Another building associated with accelerator research is the Solid State Accelerator Facility, Building 3003, at the ORNL main facilities complex. Building 3003 was originally built in 1943 to discharge cooling air from the Graphite Reactor but was modified in 1967 to house an accelerator (NUS 1981:4.1.2). A parallel line of research was pursued at the Y-12 Plant by achieving acceleration with cyclotrons.

Another consequence of the Aircraft Nuclear Propulsion Project and the accelerators was the vast quantities of scientific data that required analysis. By the 1940s, electronic computers were available, and in 1947 Weinberg created a Mathematics and Computing Section which was in

charge of acquiring computers. In the early 1950s, ORNL and Argonne designed and fabricated the Oak Ridge Automatic Computer and Logical Engine (ORACLE). This digital computer became operational in 1954, and for a time, had the fastest speed and largest data storage of any computer in the world. After the ORACLE became obsolete in the 1960s and was phased out, ORNL either purchased or leased its mainframe computers from commercial suppliers (Johnson and Schaffer 1992:71, 80-82; Thompson 1963:147-148).

An additional project that was an out-growth of the Aircraft Nuclear Propulsion Project was research into radiation damage studies which resulted in the Physics of Solids Institute being established in 1950 to study radiation damage and related solid-state investigations. The Physics of Solids Institute occupied a laboratory, Building 3025M, erected in 1951 near the Graphite Reactor (Johnson and Schaffer 1992:71, 83).

However, the Aircraft Nuclear Propulsion Project, which was the "prime force behind Laboratory expansion during the early 1950s," ended in 1957 (Johnson and Schaffer 1992:90). At that time, Congress objected to continuing the costly program because supersonic aircraft and ballistic missile development had made the concept obsolete. In addition, the hazards associated with an accidental crash of a nuclear powered aircraft had always been seen as a serious but perhaps unavoidable problem. Although it was 30 June 1961 before President Kennedy formally canceled the Aircraft Nuclear Propulsion Project, research was halted in this field at ORNL in 1957. Even though ORNL provided technical review for the U.S. Navy's program in nuclear ship design which culminated in the 1959 N.S. Savannah, the first and last U.S. ship of its kind, the research chapter related to the "fantasy" nuclear transportation program ended in 1957 (Johnson and Schaffer 1992:90-91; Thompson 1963:96).

As one historian wrote:

> *Nuclear reactor development at the Laboratory reached a pinnacle in 1956 and began a slow descent in 1957 with the cancellation of its aircraft reactor program and troubles with its second experimental homogeneous reactor. In 1956, when the Laboratory budget was $60 million and its staff reached 4369, Weinberg boasted: "We are the largest nuclear energy Laboratory in the United States, and we are among the half-dozen largest technical institutions in the world."*
>
> *With cancellation of the aircraft reactor in September 1957, the Laboratory budget was slashed 29% and its staffing cut to 3943....Moreover, the Eisenhower administration froze the Laboratory's*

budget in 1957, forcing postponement of a major building expansion program (Johnson and Schaffer 1992:112-113).

Even though the Aircraft Nuclear Propulsion Project, chemical reprocessing, and the isotope projects were in some ways the focal points at ORNL in the 1940s and 1950s, ORNL and other AEC facilities concurrently pursued research into other fields. The other reactor division, the Reactor Experimental Engineering Division, pursued reactor designs. During the 1940s, ORNL had proposed the development of a homogeneous reactor, but due to many problems with its design, the concept was abandoned in 1945 and work was pursued in heterogeneous reactors (such as the MTR in Idaho). However, by 1949, promising research in this field had begun to emerge. In September 1950, the AEC approved the construction of an experimental homogeneous reactor (HR-1) intended to be a pilot-plant model liquid-fuel reactor to investigate the chemical feasibility of maintaining a nuclear chain reaction at temperatures and power levels sufficiently high for the production of electricity (Greenstreet 1992:36). The building for this reactor, 7500 Area, was completed in March of 1951, and the reactor was completed in January 1952. This facility is located near the ARE Complex about one-half mile south of the ORNL main facilities complex. The Homogeneous Reactor Experiment (HRE) operated between 1951 and 1954. By 1954, the HRE had successfully completed its program objectives, and ORNL dismantled it to build a larger reactor (Greenstreet 1992:17; Thompson 1963:76-88).

In 1953, ORNL began construction of a second reactor (HR-2), which was completed in 1956. In a parallel movement, as part of its new focus to make nuclear energy more applicable for peaceful uses, the AEC announced in 1954 a five-year plan to develop five new demonstration nuclear power reactors in its Power Demonstration Reactor Program. Table II-2 contains information about these five reactor projects, and Table II-3 contains a chart of experimental power reactors built in the United States. Four of these reactors, excluding the project at ORNL, were built, and private industry eventually built power plants based on these other four designs (Holl et al. 1986:4-5). The fifth reactor project was the aqueous homogeneous fuel reactor (HR-2) intended for electrical power production then under development at ORNL. The reactor achieved criticality in December 1957 and first operated at full power in February 1958 (Thompson 1963:76-88). This reactor was larger than the first, but even so, it was built on a pilot-plant scale. While the first reactor had been a one-time experiment to prove theoretical principles, the second reactor was intended to be operational. "Perhaps the most exotic nuclear reactor ever built, it gave Laboratory

February 1954
AEC
Five-Year Power Program

Reactor Name	Location	Reactor Designer and Manufacturer	Completion Date	Cost	Electrical Output
Pressurized-Water Reactor (PWR)	Shippingport, Pennsylvania	Westinghouse	December, 1957	$55 million $5 million by Duquesne Light Company	60,000 kw
Experimental Boiling-Water Reactor (EBWR)	Argonne National Laboratory (near Chicago)	Argonne National Laboratory	December, 1956	$6.1 million	5,000 kw
Sodium Reactor Experiment (SRE)	Santa Susana, California	North American Aviation	April, 1957	$15.6 million $2.9 million by North American Aviation	6,500 kw
Homogeneous Reactor Experiment No. 2 (HRE No. 2)	Oak Ridge, Tennessee	Oak Ridge National Laboratory	Abandoned in 1957 after many technical difficulties	(unavailable)	designed for 5,000 kw
Experimental Breeder Reactor No. 2 (EBR No. 2)	Argonne National Laboratory	Argonne National Laboratory	November, 1957	$29.1 million	20,000 kw

U.S. Atomic Energy Commission, *Nineteenth Semi-Annual Report, 1956*, 40-45.

USAEC *Major Activities in the Atomic Energy Programs, January-June, 1957*, 49-53.

TABLE II-2: AEC FIVE YEAR POWER PROGRAM

(Holl 1986:38)

Experimental Power-Reactors

Reactor	Location	Start-up	Shutdown
Experimental Breeder Reactor #1	Idaho National Engineering Lab (INEL), formerly named National Reactor Testing Station	1951	1964
Homogeneous Reactor Experiment #1	Oak Ridge, TN	1952	1954
Boiling Reactor Experiment #1 (BORAX-1)	INEL, ID	1953	1954
Boiling Reactor Experiments (BORAX-2, 3, 4)	INEL, ID	1954	1958
Experimental Boiling Water Reactor*	Argonne, IL	1956	1967
Los Alamos Power Reactor Experiment #1	Los Alamos, NM	1956	1957
Homogeneous Reactor Experiment #2*	Oak Ridge, TN	1957	1957
Sodium Reactor Experiment (with So. Calif. Edison CO.)*	Santa Susana, CA	1957	1964
Organic Moderated Reactor Experiment	INEL, ID	1957	1963
Los Alamos Power Reactor Experiment #2	Los Alamos, NM	1959	1959
Plutonium Recycle Test Reactor	Richland, WA	1960	1969
Los Alamos Molten Plutonium Reactor Experiment	Los Alamos, NM	1961	1963
Boiling Reactor Experiment #5 (BORAX-5)	INEL, ID	1962	1964
Heavy Water Components Test Reactor	Savannah River	1962	1964
Experimental Breeder Reactor #2*	INEL, ID	1963	Operating
Molten Salt Reactor Experiment	Oak Ridge, TN	1965	1969
Experimental Beryllium Oxide Reactor	INEL	construction never completed	terminated in 1966
Experimental Gas Cooled Reactor	Oak Ridge, TN	construction never completed	terminated in 1966
Experimental Organic Cooled Reactor	INEL	construction never completed	terminated in 1962
Saxon Experimental**	Saxon, PA	1962	1972
Vallecitos** (G.E. & Pacific Gas & Elec. Co.)	Pleasanton, CA	1957	1963

*Part of AEC 1954 Five-Year Power Reactor Development Program

**Privately Financed Experiments and Prototypes

TABLE II-3: EXPERIMENTAL POWER-REACTORS

(Holl 1986:40)

staffers trouble from the start" (Johnson and Schaffer 1992:113). Problems plagued the reactor and in 1958 serious consideration was given to abandoning the program. However, ORNL continued to work with the facility and solved some of the problems, but Congress and the AEC ordered it to be discontinued in December 1960. The HR-2 and systems were dismantled and removed from the facility for future study. One direct result of this experiment was that the Pennsylvania Power and Light Company and Westinghouse Corporation abandoned their proposal to build a homogeneous reactor as a central power station. Since 1963, the facility erected for the HRE program has been used as the Nuclear Safety Pilot Plant (Johnson and Schaffer 1992:94-96, 113-14; NUS 1981:4.6.5). After these experiments, due to the problems uncovered, the AEC discontinued the aqueous homogeneous reactor program (Genung et al. 1993:2-32).

In 1953, the AEC gave ORNL permission to construct a new reactor for research purposes, the Oak Ridge Research Reactor, Building 3042. Begun in 1955 at the ORNL main facilities complex, the Oak Ridge Research Reactor was completed in 1958 and closed in 1987. Combining features of the MTR and the BSR, the Oak Ridge Research Reactor had a neutron flux that was second only to the neutron flux of the MTR in Idaho. It was a high-performance reactor that supported many scientific advances in physics and materials research, irradiations, and neutron beam studies. The Oak Ridge Research Reactor attracted many scientists to ORNL as well as visiting dignitaries (Johnson and Schaffer 1992:100-101; NUS 1981:4.1.1.2; Thompson 1963:72-74).

Another research focus effort in the early to mid-1950s involved the construction of an Army Package Power Reactor, later renamed SM-1, to furnish electrical power. Early in 1953, a research team at ORNL began to design a reliable, inexpensive, compact nuclear power plant that could be installed at remote or relatively inaccessible locations. The conceptual design was completed by July 1954. Based on this design, several reactors were built, including one built by the Corps at Fort Belvoir, Virginia between 1955 and 1957 (Thompson 1963:71-72). This facility was shutdown in the 1970s.

Another outgrowth of President Eisenhower's and the AEC's Atoms for Peace program was ORNL's involvement in the Maritime Ship Reactor Program. In 1955, President Eisenhower proposed that the United States build a nuclear powered ship to demonstrate peaceful applications of nuclear energy. Between 1957 and 1964, ORNL provided technical support for the design and development of the N.S. Savannah. In addition, ORNL aided in support work such as obtaining port clearances until the ship was decommissioned in 1971 and the reactor removed (Greenstreet 1992:31-32, 44).

Throughout its existence, ORNL has been involved in a wide range of concurrent research and activities. For instance, in February 1950, ORNL and the research divisions at the Y-12 Plant merged. Research activities by ORNL were conducted at both the X-10 Site and the Y-12 Plant. Among other things, this merger resulted in ORNL acquiring certain state-of-the-art hardware such as cyclotrons, a 1930 invention that was superseded by synchrotrons in the 1990s (Johnson and Schaffer 1992:59-60, 78). An 86-inch cyclotron, which when it became operational in 1950, was the world's largest fixed-frequency proton cyclotron. The 86-inch cyclotron was used to perform radiation damage studies for the Aircraft Nuclear Propulsion Project. This cyclotron, and the Graphite Reactor were two of ORNL's principal research tools in the early 1950s (Hewlett and Holl 1989:254).

Research efforts by the AEC on the "Super" thermonuclear or hydrogen (fusion) bomb was limited and informal until about 1954 when the Sherwood Program was organized, and even then it was far exceeded by fission research. However, as research progressed in this field, there was intense speculation in the scientific community that such a bomb had the potential to set off a chain reaction that would destroy the entire world by burning up the earth's atmosphere. As a result, the AEC asked ORNL to build a cyclotron to determine the probability of whether the atmosphere would burn up and destroy the earth if a hydrogen bomb was detonated. ORNL built a cyclotron to conduct this research in 18 months using excess materials from the Y-12 Plant. Operational in 1952, ORNL scientists at the Y-12 Plant used this facility to show that a hydrogen bomb would not set off such a chain reaction (Johnson and Schaffer:79-80; Thompson 1963:145-146) and the first hydrogen bomb was tested. This research laid the foundation for ORNL to become a center of heavy-ion nuclear science (Overholt 1987:362).

Design work constantly demanded fundamental research into various scientific fields, and entwined with ORNL reactor effort in the 1940s and 1950s were basic research and training programs. For biological studies, ORNL arranged for the United States Public Health Service to furnish personnel and to make recommendations on research needs. As discussed above, in the 1940s Robert Stone at the University of Chicago led the research in health physics, and due to the University of Chicago's relationship with the X-10 Site, the research in this field continued at ORNL. The physicists who worked in this field were called "health physicists." They initiated and refined safety features such as the remote handling of radioactive material, controlled access to "hot" areas, the use of protective clothing, decontamination procedures for those inadvertently

exposed, the development of requirements for personnel monitoring, and the development of radiation surveys of buildings and the environment. At ORNL, the leading health physicists were Karl Morgan, Herbert Parker and Ernest Wollan (known for developing the film badge to monitor personal exposure to radiation prior to coming to the ORR).

In 1943, the Manhattan Project established a Health Physics Section at the ORR. In 1946, this section was split into the Biology Division, which came to be based at the Y-12 Plant and the Health Physics Division, both of which were research oriented. A third section became the Medical Department (Johnson and Schaffer 1992:39, 41, 84-85, 126). In the late 1940s, internal dosimetry (measurement of internal levels of radiation) began to emerge as a research activity within the Health Physics Division, and in 1960 the Internal Dosimetry Section was formed and research was conducted for a variety of agencies. The Health Physics Division was also responsible for conducting radiation fall-out tests at the Operation Teapot Nevada testing site and in Japan in the late 1950s (Johnson and Schaffer 1992:44, 50, 120). In the 1950s, White Oak Lake was drained, and this division conducted experiments on radiation effects to plant life by planting crops such as corn in the lake bed (Johnson and Schaffer 1992:115). Due to the number of people receiving significant radiation doses in the late 1950s, including two such accidents at the ORR, in the 1960s the Health Physics Division conducted extensive research in accident dosimetry which was centered at the Dosimetry Applications Research Facility (DOSAR) (see below). The Health Physics Division, with several other sections, was reorganized as the Health and Safety Research Division in 1977 (Kerr et al. 1992:1-25). This section provided important information to assess radiation doses in nuclear industry and in nuclear medicine. However, in recent years, DOE "has cut back, almost to nothing, studies on the effects of radiation" (Genung et al. 1993:2-18).

At the ORNL main facilities complex, the 1946 Health Physics Internal Dosimetry Building, Building 2008, the 1951 Health Physics Waste Research Laboratory Building, Building 3504, and the 1951 Health Physics Calibration Laboratory, Building 2007, are the primary buildings associated with this research. A small annex was added to the south side of Building 2008 in 1961 to house the steel room for the Whole Body Counter (NUS 1981:4.1.6.6). A complex associated with this research field is the Health Physics Research Reactor (HPRR), Building 7709, which was built in 1962. First called the "fast burst reactor," this reactor is small, unmoderated, and unshielded. "It provided data that guided radiation-instrument development and dosage assessment. During the

1960s, for example, it helped scientists estimate the solar radiation doses to which Apollo astronauts would be subjected" (Johnson and Schaffer 1992:148). Building 7709 sits on a hill overlooking (and is connected to) the DOSAR, Building 7710, which contains the research laboratories and reactor control room. The 1963 DOSAR Low Energy Accelerator, Building 7712, and the 1964 DOSAR Reservoir, Building 7755, are located within the complex along with the 1988 Radiation Calibration Laboratory, Building 7735. The reactor operated until 1987 (Kerr et al 1992:19; Johnson and Schaffer 1992:147-148; NUS 1981:4.1.1.3). These buildings are contained in a small complex to the southeast of the ORNL main facilities complex.

During World War II, the X-10 Site stored its radioactive wastes in underground tanks and released low-level wastes untreated into White Oak Creek. In an effort to prevent the flow of wastes into the Clinch River, a dam was built across the creek which formed a 25-acre lake. Over the following years, a series of solid waste storage areas (often shallow trenches) were used, beginning in 1944 with Solid Waste Storage Area (SWSA) 1 at the ORNL main facilities complex on Central Avenue between Third Street and Fifth Street. Liquid wastes were first stored in underground Gunite tanks. The original facility was perceived as temporary, and the waste sites were chosen primarily for convenience. SWSA 2 at the ORNL main facilities complex, which had been in use from 1944-46, was dug up and relocated to SWSA 3 in the late 1940s, possibly due to the planned construction activity at the site. Between 1955 and 1963, the AEC designated ORNL as the Southern Region Burial Ground, and during this period, other facilities stored their waste here as well (at SWSAs 4 and 5) (Coobs and Gissell 1986:26). "Because Oak Ridge was the first to be confronted with the enormous amounts of radioactivity generated in nuclear reactors and their associated chemical plants, many techniques for dealing with these wastes were pioneered at Oak Ridge" (Overholt 1987:365). Between the late 1950s and early 1970s, ORNL was a national leader in the development of nuclear disposal facilities (Genung et al. 1993:2-20).

Buildings associated with waste processing at the ORNL main facilities complex include a 1951 waste treatment plant, Building 2521 with holding ponds ("aeration lagoons"), the Metal Recovery Building, Building 3505, which was used from 1952-57 for the reclamation of uranium from stored waste, and the 1957 Waste Water Treatment Plant, Building 3518. A new waste treatment plant was erected in 1976 (Coobs and Gissell 1986:2, 5, 52; Thompson 1963:131-134).

By the late 1950s, a major research avenue, the Aircraft Nuclear Propulsion Project, had been cancelled. In addition, ORNL had lost two other major projects (the Materials Testing Reactor in 1947 and the Homogeneous Reactor Test in 1961). At this time, private nuclear companies aggressively questioned the role of the national laboratories and urged that more contracts be given to private industry or even for the national laboratories to be closed. The 1956 Russian launch of Sputnik had resulted in near national panic, and nuclear research in general had become overshadowed by space exploration and the work of the National Aeronautics Space Administration (NASA). By this period, "space issues eclipsed the importance of nuclear research" (Johnson and Schaffer 1992:121).

In this atmosphere, Weinberg and his staff deliberately examined ORNL and its mission in an advanced technologies seminar in 1959. One of the main purposes of this seminar was to identify possible missions beyond nuclear energy (Johnson and Schaffer 1992:121). Concurrently, Congress began to urge the AEC to diversify its national laboratory programs to create more "balanced laboratories."

ORNL was therefore receptive to the concept of diversification among smaller programs that would provide a more stable base of operation rather than depending on a limited number of "flashy" large-scale programs. At this point, ORNL consciously chose to develop missions outside the field of nuclear energy and "became the first national laboratory to turn to research tied only tangentially to nuclear energy," a move which had important and long-term implications for the future of ORNL (Johnson and Schaffer 1992:vi-vii, 122-123). Thus, beginning in the early 1960s, ORNL saw the relatively large programs of the 1950s replaced with projects or programs that became progressively smaller in size but larger in number (Greenstreet 1992:51). Also, the nature of the research changed. For instance, during the 1950s and early 1960s, the Reactor Division had concentrated on the design, development, and construction of reactors, but by the late 1960s, it primarily worked on reactor operation and safety.

This change in direction led ORNL into new research fields with an ever increasing broadness. In the early 1960s, ORNL began doing research projects for agencies other than the AEC, although each project had to be individually approved by the AEC. However, Congress amended the Atomic Energy Act in 1967 to encourage the national laboratories to do contract work for outside agencies such as NASA, the Department of Housing and Urban Development, the Department of the Interior, and the Department of State. By 1969, 14 percent of ORNL's programs were related to non-nuclear work for agencies other than the AEC, as opposed to less than one

percent at any of the other national laboratory (Johnson and Schaffer 1992:136).

A wide variety of programs resulted from this "balanced" approach. One of the programs that Weinberg proposed was "information centers" where scientists developed somewhat of an elaborate annotated bibliography for their field for use by other scientists. About 300 of these were established across the United States including about a dozen at ORNL.

In 1962, Congress funded a four million dollar desalination research project at the ORR to attempt to develop a process to remove salt from seawater to produce fresh water for drinking and agriculture (Greenstreet 1992:76-81; Johnson and Schaffer 1992:124-126; Smyser 1992:50). Scientists studied nuclear powered agro-industrial complexes (nick-named "nuplexes") for several years and built a pilot plant at the Y-12 Plant which was later disassembled. This program received world-wide attention because it was hoped that it could bring an agricultural revolution to desert-based countries. However, by 1968 the costs had become prohibitive, and with the research not encouraging, the project ended.

ORNL's research in cyclotrons and heavy ion research led to the development of ORNL's Oak Ridge Isochronous Cyclotron (ORIC), 6000 Area, which was built between 1960 and 1962. This facility is located immediately to the east of the ORNL main facilities complex outside the security fenced region. In the 1960s, money for research in this field shrank dramatically, and newer and better accelerators than that at ORNL were closed. By 1968 research with beams of argon-40 were available at only two laboratories in the world, and "essentially, no nuclear physics research could be done with projectiles of the known 80 elements heavier than argon" (Pollard 1980:109). However, in an elaborate funding arrangement with the AEC, universities, ORAU, and the State of Tennessee, ORNL expanded this complex with the 1969 Oak Ridge Electron Linear Accelerator, Building 6010, (Johnson and Schaffer 1992:80, 150; Pollard 1980:109-117; Thompson 1963:156-158). After this project, the ORIC complex became one of the most versatile cyclotrons in the world (Pollard 1980:111). The ORIC also represented the first combined funding project for nuclear research hardware in the United States (Johnson and Schaffer 1992:150-153). In 1972, ORNL completed the University Isotope Separator of Oak Ridge (UNISOR) that interfaced with ORIC. This was only one of two on-line separators connected to a heavy-ion accelerator in the world. It was used for research in radioisotopes for medical and industrial purposes as well as in heavy nuclei generation. Additional funding was secured in 1974 to fund a heavy-ion research facility which became operational in 1980 and changed the original function of

ORIC. In addition to being able to function as a stand alone accelerator, ORIC could then be used as an intermediate-energy booster for the heavy-ion tandem accelerator. Together these facilities function as the Holifield Heavy Ion Research Facility (Johnson and Schaffer 1992:152; NUS 1981:4.1.2.3). In the late 1970s, DOE under President Carter adopted the "user" facility approach, which opened certain research facilities to the public for scientific research. The Holifield Heavy Ion Research Facility is one of three such user facilities built in the late 1970s at ORNL (Johnson and Schaffer 1992:196-200).

In the 1960s, in the wake of the Cuban Missile Crisis, Americans became somewhat obsessed with civil defense. In 1963-64, ORNL developed the Civil Defense Research Project. Research under this project included an assessment of the vulnerabilities of the United States in the event of a nuclear attack, the development of homemade dosimeters to measure radiation, an analysis of the feasibility and effectiveness of fallout shelters, methods of shielding livestock from radiation, and even how to decontaminate livestock after exposure to radiation. As part of this program, ORNL built fallout shelters and underground tunnels for research purposes (which no longer remain) (Personal Communication, Harold Greene). In 1974, ORNL discontinued this program (Johnson and Schaffer 1992:130-134; Smyser 1992:50).

Another research avenue was in health research. The Biology Division greatly expanded as a result of the changing emphasis in the 1960s and eventually became ORNL's largest division and the largest biology laboratory in the world (Johnson and Schaffer 1992:39, 41). Much of the Biology Division, including the radiation experiments conducted on mice by William and Liane Russell, was located in buildings at the Y-12 Plant. For instance, the Biology Division opened a Biophysical Separations Laboratory that conducted research into leukemia using centrifuge technology adapted from the centrifuge designs at the Oak Ridge Gaseous Diffusion Plant (the K-25 Site). The Biology Division also conducted research in freezing and transplanting embryos which resulted in changes in animal husbandry. The Biology Division did extensive research in cancer, and in 1965 received support from the National Cancer Institute for a Carcinogenesis Research Laboratory, and in 1968 began smoking related research. An out-growth of this work was the 1967 University of Tennessee-ORNL Graduate School of Biomedical Science. However, after its peak in the 1960s, the changing focus of ORNL pulled research away from this division. By the 1980s, the number of researchers in this division had shrunk by half (Johnson and Schaffer 1992:210).

During the 1960s, ORNL received national exposure for its experiments with a waste disposal method in salt mines

in Kansas, but local opposition halted the project (Hewlett 1978:8; Johnson and Schaffer 1992:156-159). ORNL developed a hydrofracture facility, an experimental and operational plant. This process involved drilling deep wells, applying pressure to fracture the rock substrata, and pumping cement grout mixed with radioactive wastes down the wells into the rock cracks where it dispersed and hardened. In 1964, this work resulted in the construction of the Old Hydrofracture Facility, 7853 Area. This facility operated experimentally in 1964 and 1965 and then became operational in 1966 (Ford and Holder 1992:A-7; Genung et al. 1993:4-51; Johnson and Schaffer 1992:116). However, some of the curies of radioactivity disposed of through this method have escaped. As Weinberg wrote in 1987, this method "may yet be vindicated" (Overholt 1987:365). In 1974, ORNL began testing for a new hydrofracture facility and closed the original hydrofracture facility in 1979-1980. The new facility was begun in 1980, 7860 Area, and discontinued in the 1980s because it did not meet standards of the Underground Injection Control Regulations of the Safe Drinking Water Act (Foundation of Global Sustainability 1992:18). By the late 1980s, ORNL was pursuing a disposal method involving the solidification and sequestration in bedded salt of waste material (Overholt 1987:365).

Although ORNL diversified its programs in the 1960s, it continued its earlier nuclear research as well. Between 1957 and 1960 the AEC studied ways to develop a breeder reactor, and in 1959, after an AEC task force had identified molten salt as the most promising of the liquid fuel reactor systems, the AEC decided that the only way to resolve several issues was to build a Molten Salt Reactor. As a result, the AEC approved the construction of a new Molten Salt Reactor Experiment (MSRE) to be used for power applications. In 1961, ORNL modified the Aircraft Reactor Experiment Facility, Building 7503, which had also used molten salt technology and constructed several new buildings at the complex for the development of a molten-salt-fueled reactor. The MSRE achieved criticality in late 1964. The MSRE operated between June 1965 and December 1969 when it was closed. This experiment was considered critical to any future development of molten salt breeder reactors, and after its closure in 1969, the process was evaluated in the 1970s. The program was suspended in 1973 but reactivated in 1974 before final termination in 1976 (Greenstreet 1992:58-60; Johnson and Schaffer 1992:70-71, 105-107; NUS Corporation 1981:4.6.4; Thompson 1963:92-96).

After the Daniels Power Pile experiments in the 1940s, interest in the United States in gas-cooled reactors had diminished. However, British scientists continued to

conduct research in this field and in the 1950s designed and built several large gas-cooled reactors. As a result, in 1956, Congress directed the AEC to pursue research in this field, and in turn, the AEC directed ORNL to evaluate such a program. In the late 1950s, a private firm designed the reactor and the prototype was built in Idaho. ORNL's primary responsibility was design review. This reactor was originally scheduled to be built in Idaho, but it was felt that the site did not provide adequate power. Therefore, the AEC chose to locate it at the ORR in conjunction with a TVA power source. This reactor was first called the Gas-Cooled Reactor-2 but was later named the Experimental Gas-Cooled Reactor (EGCR), 7600 Area. In 1959, the AEC in cooperation with TVA (who would be the operator) began construction of the facility which was located on the Clinch River opposite the Gallaher Bend about two miles east of the ORNL main facilities complex. The reactor was built by a consultant, beginning in 1959, and ORNL designed the fuel and control rods and developed work on reactor components. The principal purpose of this reactor was to serve as a power-generating prototype. Construction problems and increasing project costs delayed the project, and on 7 January 1966, even though the project including the reactor was virtually complete with the exception of fuel loading and shakedown operations, the AEC ordered that the project be cancelled. In the intervening years between the decision to build the facility and 1966, the light-water reactor industry had advanced so rapidly that the Experimental Gas-Cooled Reactor had become obsolete before it had become operational. Also, there continued to be design and engineering difficulties, and during the intervening years, the Peach Bottom Reactor in Pennsylvania, which reflected a more advanced gas-cooled design, had been completed. The only major equipment items that have been removed are the steam turbine-generator and its auxiliary equipment. The facility is now used as a robotics research complex (Greenstreet 1992:26-29, 52-58; Johnson and Schaffer 1992:104-105; NUS 1981:4.6.1; Thompson 1963:75).

Originally the high-flux reactor designed by Wigner and built in Idaho in the late 1940s had provided the highest neutron flux available, but by the late 1950s the Soviets had designed a reactor that surpassed it. As a result, in January 1958 the AEC Division of Research began to develop a program designed to meet the anticipated needs for transuranium isotopes through existing reactors. Transuranium elements are chemical elements heavier than uranium, which is the heaviest element that occurs naturally on earth. By late 1958, the AEC had determined that existing reactors would not be adequate for this work. Therefore, in November 1958, the AEC recommended that a high-flux reactor, later named the High Flux Isotope Reactor

(HFIR) be designed, built, and operated at ORNL. ORNL submitted a proposal in March 1959 which was approved in July 1959. Design work began in 1959, and construction was completed in 1965. Criticality was reached 5 August 1965, and full power design was reached 6 September 1966. The reactor facility, which contains a 100-megawatt reactor and was considered the most powerful research reactor in the world, was the centerpiece of ORNL's new transuranium facilities (Genung et al. 1993:4-32; Greeenstreet 1992:60-62; Johnson and Schaffer 1992:144-147; NUS 1981:4.1.1.4). The facility, 7900 Area, is located in Melton Valley about one mile south of the ORNL main facilities complex. Several new buildings were erected at this facility in the 1980s. Since 1966 the "HFIR has operated successfully...and has been an outstanding research tool" (Greenstreet 1992:62). DOE has long-range goals to replace the HFIR in the year 2000 with the ANS (ORNL 1992b:10).

Even after the "balanced laboratory" approach of the 1960s, although in no immediate danger of being eliminated, just as it had in the late 1950s, ORNL saw a need to expand its mission in the late 1960s. By 1969, the AEC had cut ORNL's budget and staff due to a combination of factors that included funds being spent on the Vietnam War, an anti-science feeling in the overall 1960s protest movement, and the concentration of the AEC's resources on a liquid-metal fast breeder reactor (Johnson and Schaffer 1992:142). As a result, funding became unavailable for reactor research. Radioisotope and some of the research analysis work was being contracted to private concerns. The staff fell from nearly 5500 in 1968 to 3800 in 1973. Also, many individuals hired during the Manhattan Project reached retirement age, and as they left, new employees with different research goals began working at ORNL.

By the 1970s, there was a growing concern about problems with nuclear waste disposal, the environmental and health effects of radiation, and the possibility of accidents at nuclear power plants. By this period, confidence in both nuclear energy and the AEC had fallen greatly. In response to criticism that the AEC regulated the same energy sources that it helped to produce and operate, the Energy Reorganization Act of 1974 reorganized the AEC as the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC). Originally the AEC had a single mission involving nuclear energy, but ERDA had a more complex mission involving research and development of all energy technologies to the point of commercialization. Within this framework, all of the national laboratories played a less important role in ERDA than they had within the AEC. After

these changes, ORNL became more of a national energy laboratory rather than a national nuclear laboratory (ORNL ca. 1980:4).

As the United States examined the role of the AEC in the 1970s, so did ORNL examine its goals and missions. Concurrently with the reorganization of the AEC in 1974, just as it had in the late 1950s and 1960s, ORNL chose to expand its mission, this time by enlarging its traditional focus on uranium fission for still broader missions that encompassed all forms of energy. Since the increased focus on energy research by ERDA highlighted existing energy research programs at ORNL, ORNL focused on these programs. Also in 1974, the Energy Division was formed. This Division grew out of a special summer study from 1967 by Weinberg that discussed the examination of social science issues. This idea had lain dormant for several years, but with the change in focus at a national level, ORNL revived the idea. This Division included economists, geographers, sociologists, and other social scientists. ORNL also expanded its environmental programs (Johnson and Schaffer 1992:143-144, 164). During the 1970s, ORNL expanded even more into non-nuclear areas including energy conservation, materials resources, recycling, environmental analysis, and regional modeling. In 1971, ORNL began doing contract work on environmental impact statements as a result of the National Environmental Policy Act.

For years ORNL staff had conducted research on the effects of radioactivity on ecological systems, especially the migration of radionuclides from water and soil to plants, animals, and humans. However, after atmospheric bomb testing ended in 1963, this research program refocused its studies. In 1967, the AEC approved the development of the Walker Branch Watershed research facility as an experimental center for studies of the relationships between terrestrial and aquatic ecosystems. Also in 1967, the National Science Foundation funded a program in ecosystem research at ORNL, the first time the foundation had supported a major program at an AEC laboratory (Johnson and Schaffer 1992:137-138). This section greatly expanded and became the Ecological Sciences Division in 1970, and the Environmental Sciences Division in 1972. As questions arose about the safety of nuclear reactors, this section became increasingly visible in its research into environmental and health impacts of nuclear energy. This Division, as well as other sections, also contracted to do environmental impact work (Johnson and Schaffer 1992:136-141, 160). By the late

1970s, as a result of President Carter's emphasis on new energy sources, the Environmental Sciences Division developed a tree and grass study related to renewable energy sources. During this period, the Environmental Sciences Division increased dramatically, and by the end of the 1980s, about 25 percent of ORNL's programs were related to environmental and health fields (Johnson and Schaffer 1992:209). Due to the growing emphasis in environmental work, about 1979-80, ORNL saw the completion of three new facilities related to this field: the Environmental Sciences Laboratory, Building 1505, the Controlled Environment and Animal Building, Building 1506, and the National Environmental Research Park (12,400 acres of protected land within the ORR for environmental sciences research and education and one of only six in the United States).

Just as the AEC ceased to exist in 1974, so did ORNL--briefly. Unexpectedly, Congress renamed the facility the Holifield National Laboratory after retiring California Representative Chet Holifield. The Tennessee Congressional delegation lobbied to have the original name restored and a compromise was reached in late 1975 in which ORNL regained its original name and the heavy ion research center then under construction was named the Holifield Heavy Ion Research Facility, 6000 Area, (Johnson and Schaffer 1992:173-174).

In 1974, the Arab oil embargo brought attention to energy issues which had far-reaching implications for ORNL. Since ORNL was the only national laboratory to have a multi-program mission beyond nuclear science at that time, the AEC turned to it to develop technical solutions to the energy crisis, which led to ORNL becoming a leading research institute in coal technology (Genung et al. 1993:4-74). Increased funding for energy sources allowed ORNL to engage in a broad range of energy-related research endeavors in conservation, coal, and nuclear energy. By the late 1970s, research in this area had contributed to the number of employees increasing to 5000.

The Department of Energy Act of 1977 unified most of the federal government's energy programs (such as ERDA, the Federal Energy Administration, and the Federal Power Commission) under the newly-created, cabinet-level DOE. Figure II-24 contains a chart showing the history of this organizational change. In 1977, President Carter and DOE again changed the nature of ORNL's work. In part, this was due to President Carter's emphasis on energy conservation and "soft" energy such as solar programs as opposed to nuclear energy. In addition, DOE had even more of a diverse program than ERDA,

Institutional Origins of the Department of Energy

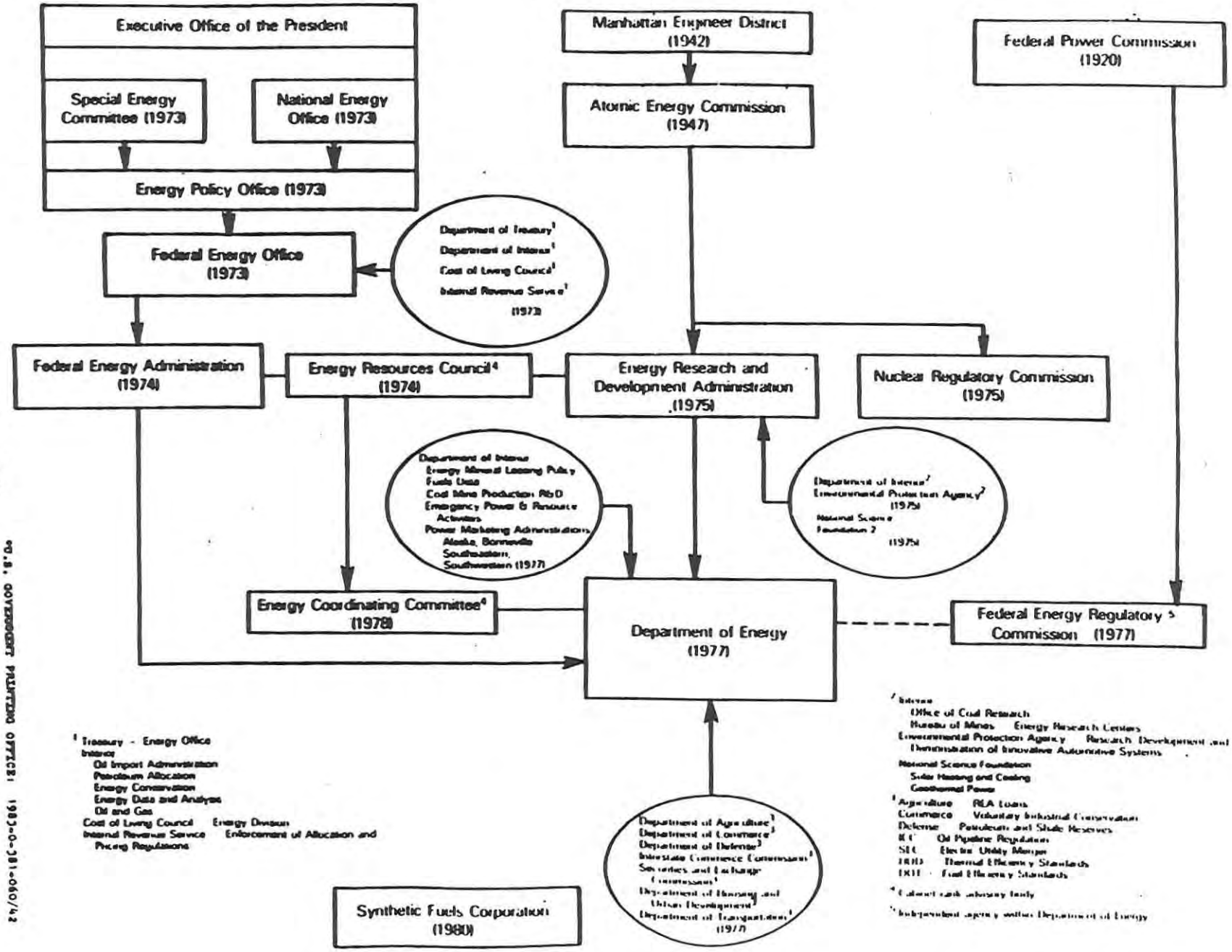


FIGURE 24

U.S. GOVERNMENT PRINTING OFFICE: 1983-0-381-060/42

and it was no longer limited to research and development activities. Since most of the national laboratories had primarily been research and development oriented, this forced another shift in their mission. Also, due to the varied nature of DOE, the national laboratories became even less important to the agency than they had been to ERDA (ORNL ca. 1980:7-8). The Carter administration's new focus for the national laboratories was as centers of excellence in specialized fields. DOE designated ORNL as the lead laboratory for coal technology and fuel reprocessing (Johnson and Schaffer 1992:190). In addition, President Carter and Congress halted the Clinch River Breeder Reactor Project, a major research and development project then underway at the ORR. President Carter stopped the reprocessing of nuclear fuel and moved a proposed centrifuge plant from Oak Ridge to Ohio (Johnson and Schaffer 1992:189, 193). President Carter also issued a moratorium on commercial fuel reprocessing. At that time Exxon was designing a new reprocessing plant for the ORR which was canceled (Brooksbank 1991:5).

The late 1970s saw the completion of the Holifield Heavy Ion Research Facility and the National Center for Small-Angle Scattering Research (Johnson and Schaffer 1992:196-200). These two facilities and the National Environmental Research Park (mentioned above) were "user facilities" reflecting DOE's official policy that DOE facilities were to be opened to outside users for research.

With the election of Ronald Reagan as President in 1980, the "Reagan Revolution" began. Initially, President Reagan proposed to abolish DOE but later abandoned this position. President Reagan also closely scrutinized the national laboratories, in part, due to complaints from private industries that felt that the national laboratories were in competition with them. Although it was an unsettling period, ORNL lost only 700 positions during this time, but it did force some changes in its research programs. ORNL's position was also helped by its contributions in research to the Strategic Defense Initiative ("Star Wars") program proposed by President Reagan, which would have consisted of an antimissile defense system that would have protected the United States from nuclear attack.

A major event at the facility in the 1980s was the withdrawal of Union Carbide in 1982 as the operating contractor. After extensive research, DOE awarded the operating contract in 1983 to Martin Marietta Corporation effective in 1984. To administer the ORR and other facilities, it formed a subsidiary, Energy Systems, Incorporated (Johnson and Schaffer 1992:207). Two other major changes that occurred in the 1980s at ORNL

involved an expanding partnership with industries and universities and the technology transfer of making ORNL's scientific and technological advances available to the private sector to increase their competitiveness in an international market.

In the 1980s, DOE established the Roof Research Center at ORNL as part of its energy conservation program. The primary user facility built in the 1980s was the 1987 High Temperature Materials Laboratory, Building 4515, which houses 49 laboratories and 72 offices. One of the last major buildings to be erected was the Computer Science Research Facility, Building 6012, which is adjacent to the Holifield Heavy Ion Research Facility.

As ORNL entered the 1990s, ORNL had become one of the top research centers in the world and "had emerged as a premier global research center for issues related to energy, environment, and basic science and technology" (Johnson and Schaffer 1992:vi-vii). Today it is one of DOE's three multi-use laboratories and one of DOE's most diverse multi-purpose research laboratories providing research and development not only for government agencies but for institutions and private industries. It has 10 "user" facilities focused around the High Temperature Materials Laboratory, the Oak Ridge National Environmental Research Park, the Surface Modification and Characterization Collaborative Research Center, the Roof Research Center, and the Atomic Physics EN Tandem Accelerator. In the 1990s its primary mission centers around energy research. Six broad areas of ongoing research that will take it into the twenty-first century include energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

Over the years, ORNL has become an extremely diverse facility with a plethora of research programs. This historical context has attempted to briefly describe some of the more major trends at the facility. In short, after World War II, ORNL emerged as a nuclear research facility with a primary directive for research in peaceful application of nuclear power (with some indirect applications for military use such as the joint U.S. Navy aircraft project). Although there is not a "clean" time line after its designation as a national laboratory, a variety of research projects emerged in the late 1940s and 1950s that resulted in a concerted construction period in the 1950s. As an active and evolving facility pursuing

varied and evolving research missions, construction activities continue today. As a result, in a "bricks and mortar" sense, the facility is composed of the core X-10 Site which contains a small number of properties from the Manhattan Project era. Around these buildings are a wide variety of other buildings dating from after World War II related to various research trends, most of which are related to ORNL's original mission of nuclear research. Around this core are scattered complexes, some as far away as two or more miles, many of which relate to the original nuclear research mission of ORNL. In addition, there are newer buildings at the core and at the outer-lying complexes that are either out-growths of the original research or the result of newer missions developed in the 1960s or later.

CHAPTER III: SURVEYED PROPERTIES

INTRODUCTION: This Chapter contains a survey of all properties at ORNL. The property survey was undertaken using a list of buildings in the ORNL Building Directory and maps provided by ORNL. The survey included the ORNL main facilities complex, outlying facilities, waste management areas and other individual outlying properties. Each property surveyed is identified by a building number assigned by the ORNL and is keyed to maps in the pocket at the end of this report.

The HPS conducted a field survey and photographed all accessible properties including buildings, structures, sites and objects. Once inventoried in the field, the HPS conducted research on the properties and dated each using ORNL resources such as printed histories, engineering records, a historic map and photographs, a 1953 Building List, and staff-supplied information.

On the following pages are the survey results, arranged by area, which include a history and architectural description of each property. Changes to buildings are noted in italics in the building description section of the text. Photographs of selected buildings are included with the discussion of each area. At the end of each area discussion is an assessment of the Area's eligibility for inclusion in the National Register.

AREA	
0900	0900 Pistol Range, 0901 Electrical Substation, 0902 Main Reservoir, 0903 New Bethel Baptist Church, 0907 Katy's Kitchen, 0961 Visitor Overlook
1000	Engineering
1500	Environmental Sciences
MAIN	ORNL Main Facilities Complex, Buildings 2000-5554
6000	Holifield Heavy Ion Research Facility
7000	East Support Area
7500	Nuclear Safety Pilot Plant (Homogenous Reactor Experiment Facility)
7503	Molten Salt Reactor Experiment Facility (Aircraft Reactor Experiment Facility)
7600	Robotics and Process Systems Complex (Experimental Gas-Cooled Reactor Facility)
7700	Tower Shielding Facility
7709/7710	Health Physics Research Reactor/Dosimetry Applications Research Facility
7813/7846	White Oak Dam/White Oak Lake
7852/7860	Old Hydrofracture Facility/New Hydrofracture Facility
7900	High Flux Isotope Reactor Experiment Facility
SWSA	Solid Waste Storage Areas 3-7
OTHER	Outlying Properties

0900 AREA

This section discusses five ORNL properties in the 0900 Area north of the ORNL main facilities complex and Bethel Valley Road.

0900 CURRENT USE: Pistol Range
ORIGINAL USE: Pistol Range

HISTORY: This Pistol Range was constructed in 1948 to provide security personnel space for target practice.

DESCRIPTION: The Pistol Range is located north of Bethel Valley Road directly north of Building 1000.

0900 Pistol Range (1948): Plans indicate that in August of 1948, a concrete retaining wall with nineteen targets was erected at this site to provide a target range for plant guards. The area is still used for that purpose today. Buildings at the pistol range are modern prefabricated structures.

ASSESSMENT OF ELIGIBILITY: The Pistol Range was built after World War II to provide space for target practice for the Plant Protection Division. The Pistol Range is important to the safety and operations of the ORNL from the post-World War II period through today, but it does not possess exceptional significance under Criterion Consideration G. Although it is one of a small number of developments from the post-World War II (1945-49) period, it was simply a use accessory to the scientific uses of the ORNL.

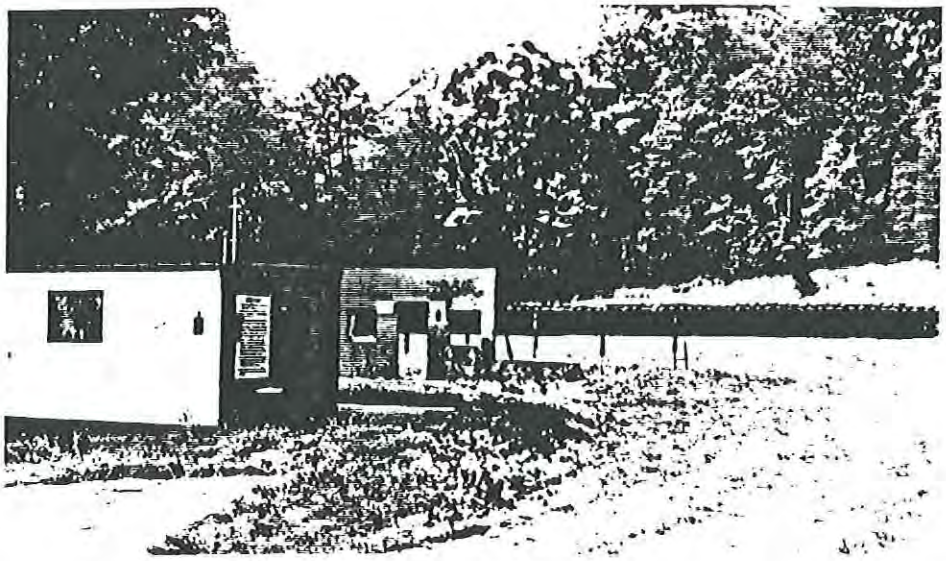


Figure III-1. 0900 Pistol Range (1948). View northwest.

0901 CURRENT USE 161 kV Substation
ORIGINAL USE: 154 kV Substation

HISTORY: The electrical substation was built in 1948. At that time, the ORNL thought they would be the recipient of a large MTR needing a substantial electrical substation. The reactor project, however, went to Idaho.

DESCRIPTION: This electrical substation is located on a dirt road off Bethel Valley Road north of the ORNL main facilities complex. It is comprised of a small, 864 square-foot, brick building and accessory equipment within a fenced area.

ASSESSMENT OF ELIGIBILITY: Although this property is one of a small number of developments from the post-World War II (1945-49) period, it was simply a use accessory to the scientific uses of the ORNL and is, in itself, not considered exceptionally significant under Criterion Consideration G. As stated above, it was constructed in anticipation of the MTR project that was awarded to Idaho.

Figure III-2. 0901 161 kV Substation (1948): View north.

0902 CURRENT USE: Main Reservoir
ORIGINAL USE: Main Reservoir

HISTORY: This Reservoir was built in 1948 "in anticipation of the increased capacity required for a High Flux Research Reactor" (Thompson 1963:Figure 24) which was ultimately constructed in Idaho. Upon completion of construction, it provided water for the ORNL main facilities complex.

DESCRIPTION: The Main Reservoir is a concrete structure located on a dirt road off Bethel Valley Road north of the ORNL main facilities complex.

ASSESSMENT OF ELIGIBILITY: As stated above, the Main Reservoir was built after World War II in anticipation of the MTR project. The Main Reservoir is important to the operations of the ORNL from the post-World War II period through today, but it does not possess exceptional significance under Criterion Consideration G. Although it is one of a small number of developments from the post-World War II period, it was simply a use accessory to the scientific uses of the ORNL.

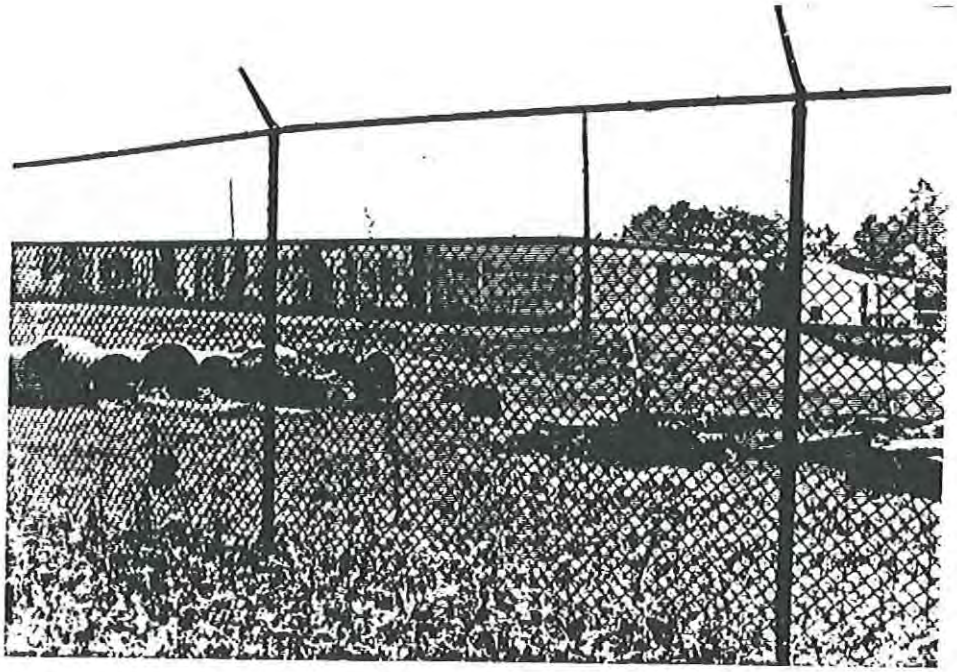


Figure III-3. 0902 Main Reservoir (1948). View northeast.

0903 CURRENT USE: Church/Museum
ORIGINAL USE: New Bethel Baptist Church

HISTORY: The New Bethel Baptist Church was built ca. 1900 in the Scarboro Community. In 1942, the U.S. Government acquired this property and thousands of acres around it as part of the Manhattan Project. The building was used during the Manhattan Project as a meeting room for scientists and engineers during the construction of the X-10 complex. After World War II, the structure was used for storage. In 1992, the church was renovated and reopened as an interpretive center commemorating the pre-World War II residents and activities of the former Scarboro Community.

DESCRIPTION: The New Bethel Baptist Church is located on the north side of Bethel Valley Road adjacent to the northwest corner of the East Support Area. The church is a frame structure with wood siding, a gable roof, two-over-two windows, a central entrance on the front and an off-center entrance on the rear. Behind the church is a cemetery containing two wood-frame gravehouses.

ASSESSMENT OF ELIGIBILITY: The church was included in the National Register in 1991 under Criterion A for its role in the social history of the Oak Ridge area and under Criterion Consideration G for its association with the Manhattan Project. The boundaries of the property include the church, adjacent historical marker and cemetery.

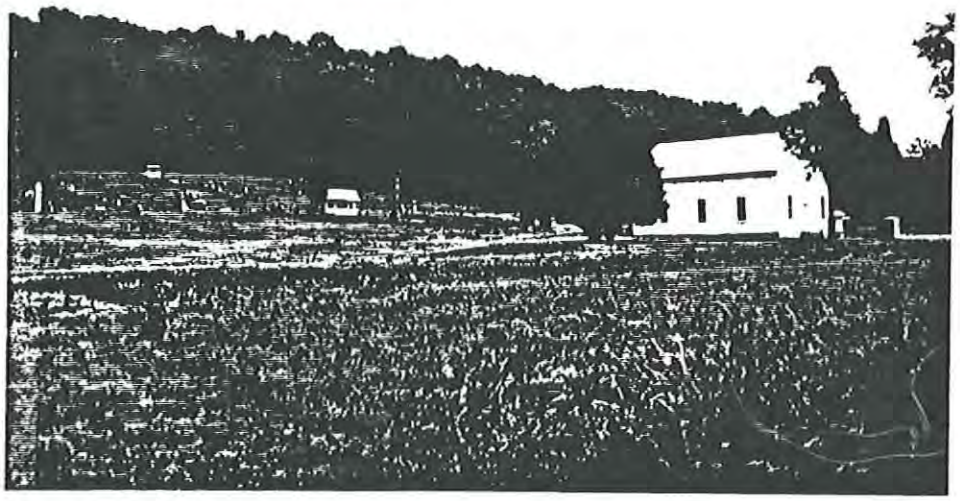


Figure III-4. 0903 New Bethel Baptist Church (ca. 1900). View toward northeast.

0907 CURRENT USE: Walker Branch Watershed Laboratory
ORIGINAL USE: "Installation Dog," later "Katy's Kitchen"

HISTORY: This complex is historically known as "Katy's Kitchen." It was constructed in 1948 as a facility for the temporary storage of enriched uranium, delivered by truck into the bunker, after it was processed at Y-12 and before shipment to a weapons site off the ORR. The facility, then known as "Installation Dog," was designed to camouflage its true use. A barn was originally attached to the entrance of the bunker and adjacent to the barn was a "silo," sheathed in wooden staves (in actuality a watch tower for guards). The bunker was manned around the clock by two guards. Other security included a barbed-wire fence with an alarm system.

Security was tight because the ORR, at that time, was the only facility in the United States producing U-235 and the United States was the only country with nuclear weapon capability. The facility was used for storage of U-235 from May 1948-May 1949 and then stood vacant for eight years.

In 1957, the ORNL Analytical Chemistry Division acquired the facility from the AEC for use as a low-level radiation counting laboratory, a good adaptive use due to the shielded walls and isolated location of the facility. At this time it acquired the name of "Katy's Kitchen," for Katherine Odom, a Secretary for Myron Kelley, then Director of the Analytical Chemistry Division.

In 1988-1990, the facility was totally revamped and converted to the ORNL Environmental Sciences Division Walker Branch Watershed Laboratory. The barn, according to word-of-mouth, had collapsed prior to this time.

DESCRIPTION: This complex is located north of Bethel Valley Road approximately two miles northeast of the ORNL main facilities complex. The buildings are located in an isolated wooded setting and are reached by an approximately 0.75 mile paved road off Bethel Valley Road.

907 Walker Branch Watershed Laboratory: (1948, 1988) one-story, gable-roofed, modern, metal Butler-type building installed in 1988. A flat-roofed section with a concrete base and metal sheathing above connects the main laboratory building to the concrete bunker built into the side of the hill in 1948. The interior of the bunker appears to be relatively unaltered. The bunker consists of four rooms: a pump room, a long narrow room to accommodate trucks, an anteroom leading to a storage vault and the storage vault. The bunker was built of 12" thick reinforced concrete and the vault was of standard bank vault construction with 18" thick walls,

ceilings and floor. An adjacent silo, originally used as a guard tower, also appears relatively unaltered with the exception of either the removal or loss of the wood staves which originally sheathed the silo. Built of 96" concrete pipes, stacked one on top of the other, the tower is capped by a wooden section with eight window bays and an octagonal roof.

955 Walker Branch Storage Building (1968): The prefabricated, gable-roofed building has corrugated-metal siding and is currently used for storage.

956 Spring House (1968): The springhouse is a metal-sided, steel-frame building.

957 Sample Preparation Building (1968): The prefabricated building has metal siding and a low-pitched gable roof.

ASSESSMENT OF ELIGIBILITY: This complex does not meet the criteria of eligibility for exceptional significance. The complex, in itself, is not highly significant for technology or science but instead was simply a temporary storage facility for U-235. The complex no longer serves in its historical purpose as a top secret storage facility but, instead, has been converted to a modern laboratory. In that process, and although the interior of the bunker is relatively intact, the historical fabric of the complex has been greatly compromised by the loss of the "camouflage" barn, wood staves and metal bands on the silo, and the installation of modern Butler-type buildings.

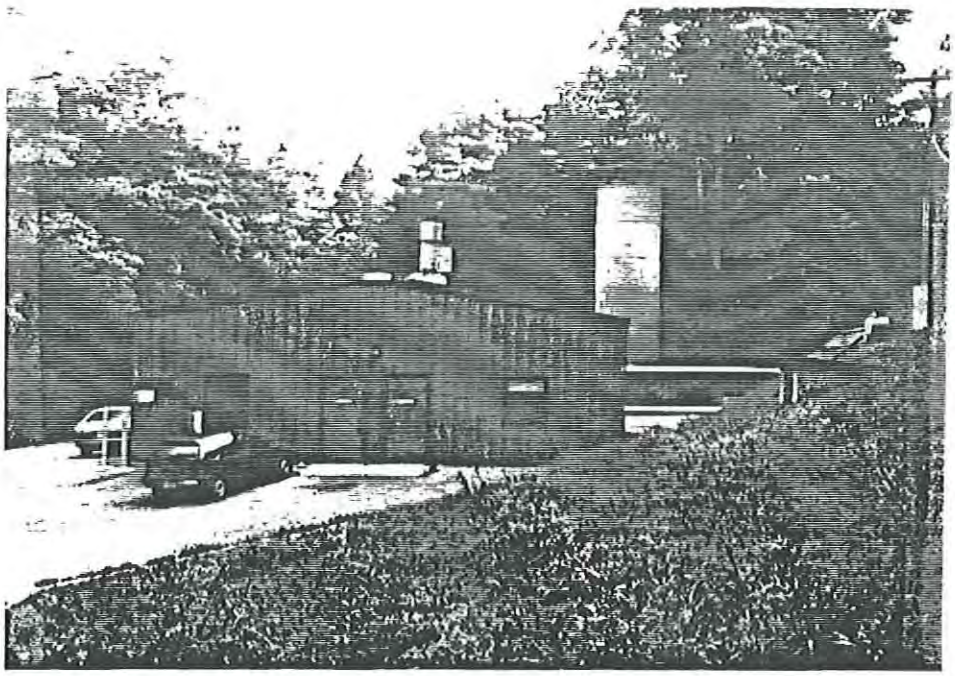


Figure III-5. 0907 Katy's Kitchen (1948). Looking southwest at front of Building 0907, guard tower (silo) in center, 1948 bunker in hill at right.

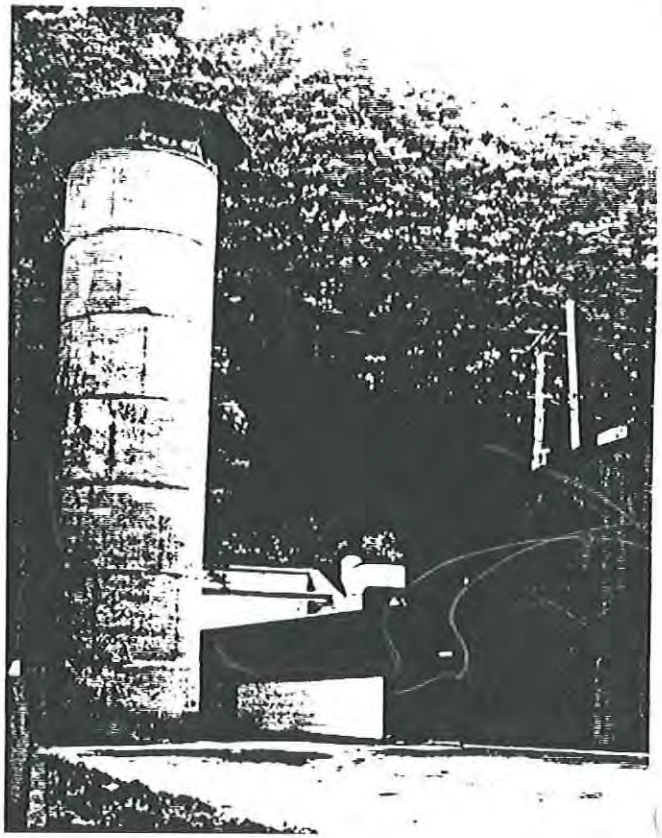


Figure III-6. 0907 Katy's Kitchen (1948). Silo with removed wood staves, 1988 connector from laboratory to bunker at center, new laboratory at right. View northwest.

0961 CURRENT USE: Visitor Overlook
ORIGINAL USE: Visitor Overlook

HISTORY: Building 0961 was built in 1983 as a Visitor Welcome Center and Overlook.

DESCRIPTION: This 5,000 square-foot, steel-frame and concrete structure sits on a hill overlooking Bethel Valley Road and the ORNL main facilities complex. The structure contains a theater and displays depicting the history of the ORNL. Steel trusses are visible below the flat roof.

ASSESSMENT OF ELIGIBILITY: The Visitor Center does not fall within the period of significance and is not associated with the scientific significance of the ORNL. It is the opinion of the HPS that this property is not eligible for inclusion in the National Register.

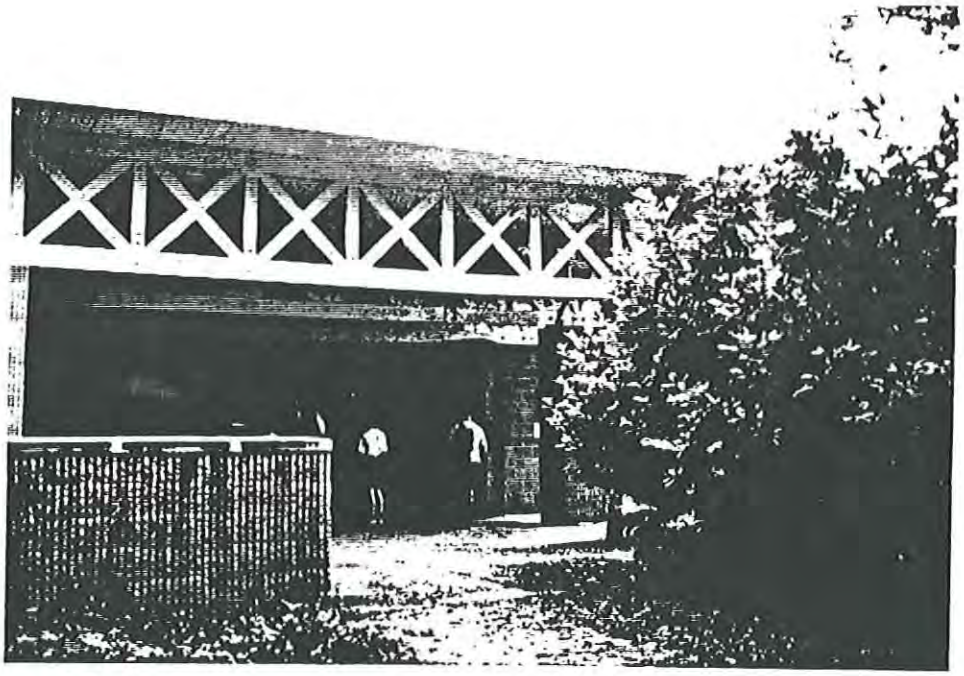


Figure III-7. 0961 Visitor Overlook (1983). View southeast at entrance.

1000 AREA CURRENT USE: Engineering Division Headquarters
ORIGINAL USE: Administrative Offices

HISTORY: In 1946, a U-shaped frame building standing at the K-25 Plant was dismantled and reerected outside the fence of the ORNL main facilities complex at a cost of $370,000. The building provided office and administrative space for the Clinton Laboratories. Today, the building is used as the offices of the ORNL Engineering Division.

DESCRIPTION: Building 1000 and the adjacent support buildings discussed below are located directly west of the ORNL main facilities complex across from the West Portal and outside of the fenced area.

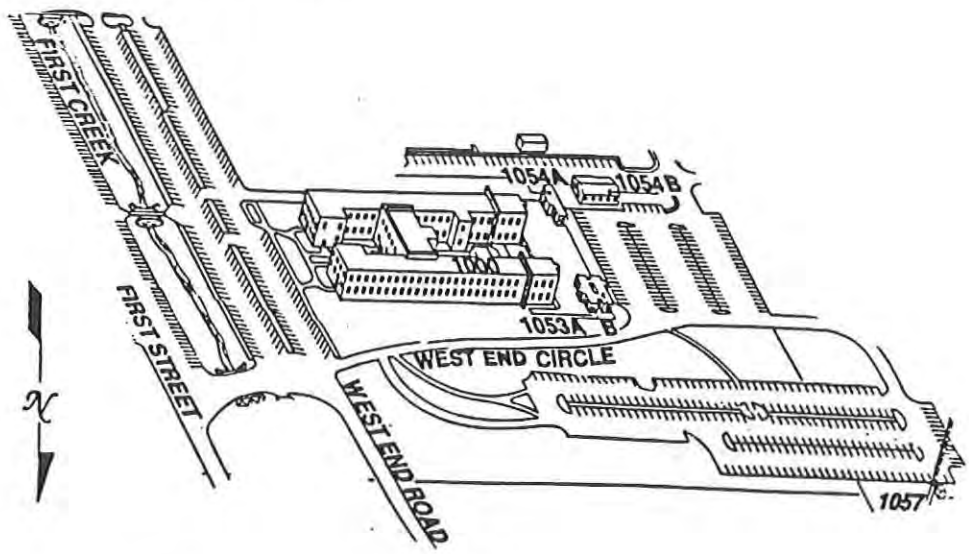


Figure III-8. 1000 Area. Site Plan

1000 Engineering (Built pre 1946, moved to this site in 1946 from K-25): Plans indicate that in 1946 this U-shaped building was moved to this site and enlarged by the addition of 17 bays with a staircase at the rear to form an H-shaped building. ("Additions to new office building--West Wing elevations.") Another set of plans dated a year later show an addition of matching sections, 109 feet long and containing six-over-six windows. Plans indicate that a fence originally erected around the building was moved back to accommodate the additions. *In 1958, most of the interior hardwood walls were removed but the corridor walls remained. In 1969, trailer additions were appended to the rear of the building and then sided with aluminum. Seven "penthouses" were then removed and roof exhausters and roof scuttles were installed.*

Other alterations include 1970 improvements such as new siding, reworking of framing to accommodate new windows (type "A" and "B"), new porches, removal of the overhang on the front porch and installation of new gutters. In 1975 and 1976 , six bay modular structures were added to the southwest and northwest rear. The interior has undergone numerous alterations such as panelling on walls, renovation of the main entrance foyer to accommodate a small conference room and removal of the spiral stairs leading up to the second floor vault. Other alterations include dropped ceilings, new light fixtures, modern panelling, wallpaper and carpeting. The entrance foyer has also been totally reworked and has modern entrance doors and aggregate panels.

1053 (A) Construction Engineering Office (1970): trailer

1053 (B) Construction Engineering Office (1970): trailer

1054 (A) Engineering Model Shop and Construction Engineering Trailer (1970): trailer

1054 (B) Engineering Office Trailer (1970): trailer

1057 100 Meter Meteorological Tower (n.d.): metal tower within fenced area

ASSESSMENT OF ELIGIBILITY: Building 1000 does not meet the criteria of eligibility for exceptional significance. First, the building is historically associated with K-25 during the Manhattan Project and only began its association with the ORNL after World War II. Neither significant scientific nor technological advancements are associated with this building. In addition, the building has been so extensively altered that its integrity is greatly compromised. These alterations are outlined in detail above and because of the lack of significant scientific or technological developments associated with the building and the extensive alterations, it is the opinion of the HPS that this building is not eligible for inclusion in the National Register under Criterion G. In addition, the setting of the complex with its original fence and sentry post at the perimeter is no longer extant.

None of the other buildings in the complex fall within the period of significance.

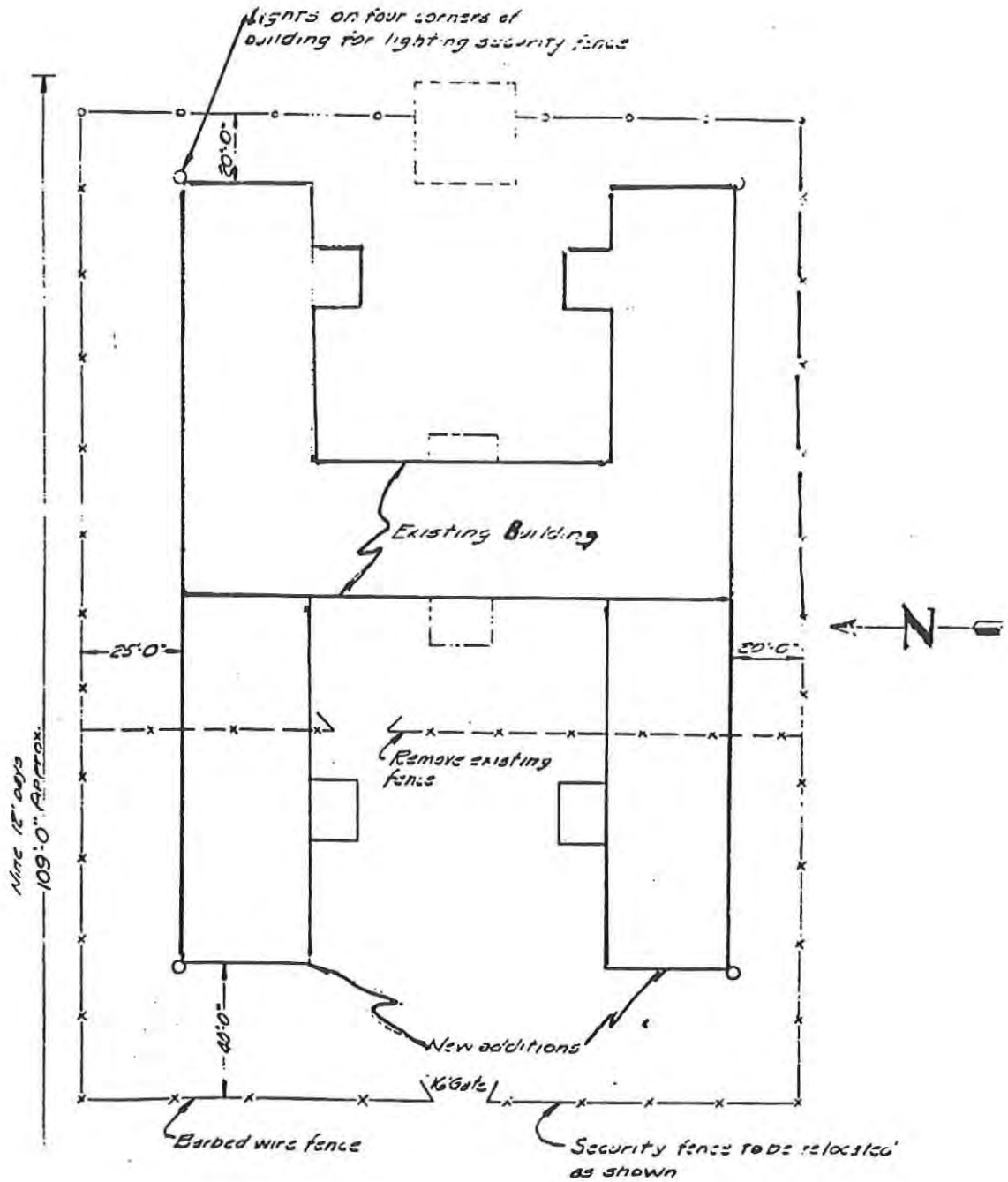


Figure III-9. Plan of Building 1000 dated March, 1947 shows relocation of security fence required to accommodate rear additions.

Figure III-10. 1000 Engineering Division Headquarters (1946). Front (east) facade. View west.

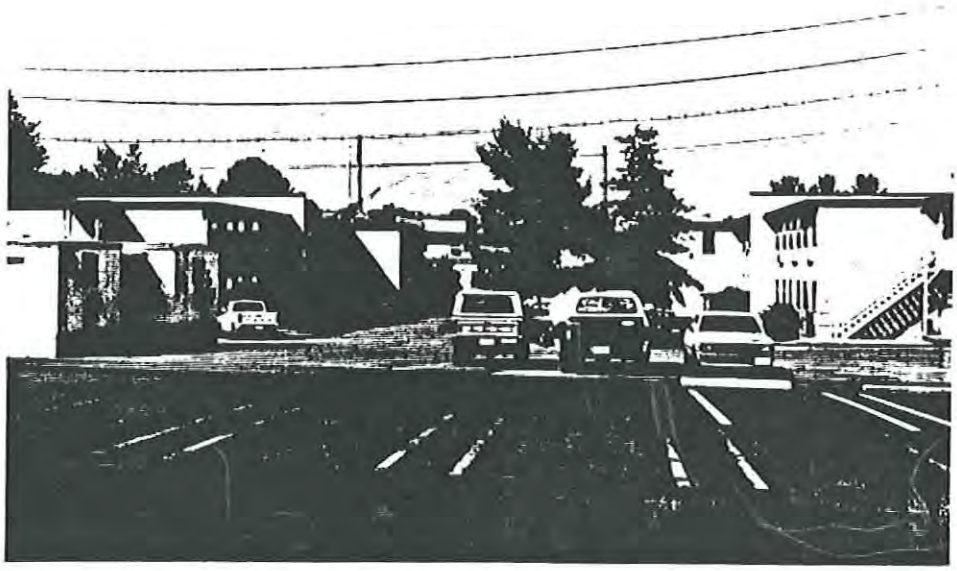


Figure III-11. 1000 Engineering Division Headquarters (1946). West (rear) additions. View east.

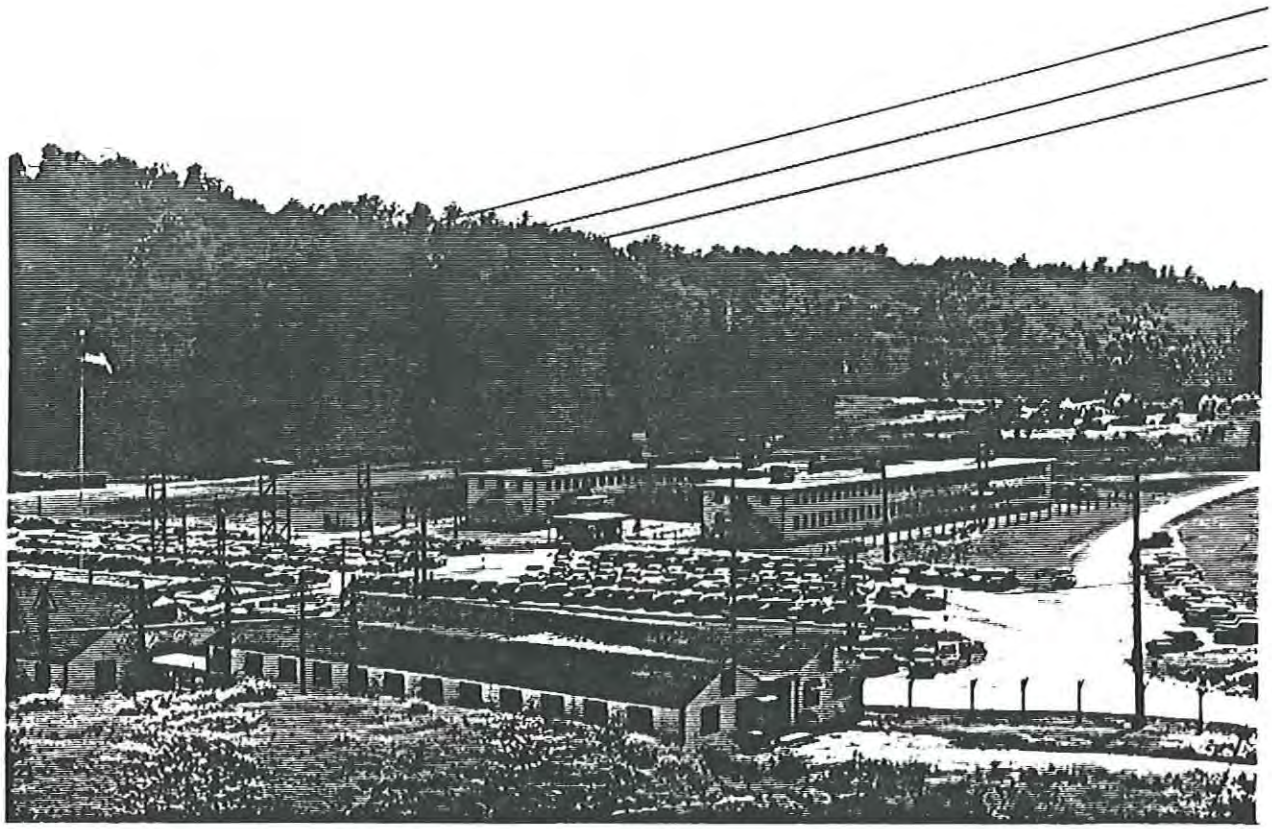


Figure III-12. ORNL Hstry 75 (ca. 1947). Historic photograph of Building 1000. Note fence around complex and guard portal at entrance in center of photograph. View southwest.

1500 AREA

CURRENT USE: Environmental Sciences
ORIGINAL USE: Ecological (Environmental) Sciences

HISTORY: Buildings in the 1500 Area are associated with the Environmental Sciences Division and research on the environmental and health impacts of nuclear energy. One of the buildings, the Plant Sciences Laboratory (Building 1503), was constructed in 1965 and two greenhouses were constructed in 1973. The other buildings in the area were built in the late 1970s and 1980s.

In 1970, the Division of Ecological Sciences was formed and two years later was renamed the Environmental Sciences Division. In addition to in-house governmental research, the division also contracted to do environmental impact work. In the late 1970s, President Carter emphasized new energy sources and subsequently ORNL energies were refocused to related research such as the study of the environmental impacts of fossil fuel plants. During this period, the ORNL built two large laboratories (Buildings 1505 and 1506) for the conduct of research such as a tree and grass study related to renewable energy sources. The buildings in this area continue such research today.

DESCRIPTION: This complex is located outside the fence on the west side of the ORNL main facilities complex and south of Building 1000.

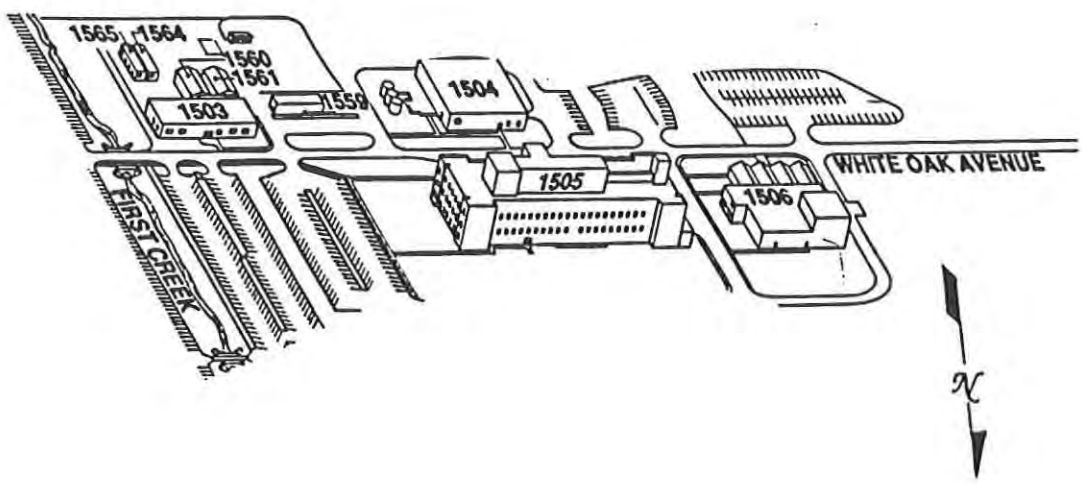


Figure III-13. 1500 Area. Site Plan.

1503 Plant Sciences Laboratory (1965): This 9,578 square foot, brick-faced, flat-roofed building has decorative brickwork, aggregate panels along the top of the front facade, and plate glass windows. The greenhouses to the rear of this building were built in 1973.

1504 Aquatic Ecology Laboratory (1972): This 10,920 square-foot, brick-faced building has a flat roof, plate glass windows, decorative brickwork and a band of soldier bricks around the top of the building.

1505 Environmental Sciences Laboratory (1978): This three-story, 97,925 square-foot building has a flat roof, brick facing, vertical bays of windows with concrete panels above and below, and a one-story, flat-roofed entrance portico.

1506 Controlled Environment and Animal Building (1978): This 16,780 square-foot, steel-frame structure has striated concrete facing, plate glass windows, and a flat roof. Four greenhouses are appended to the south side of the building.

1508 Aquatic Storage Building (n.d.): This 420 square-foot, wood-frame, aluminum-sided building has a gable roof.

1553 Service Pit for 1504 (1972): This concrete-walled service area with three metal tanks stands to the east of Building 1504.

1556 Cooling Tower for 1505 (1978): This metal cooling tower is connected to Building 1505.

1557 Cooling Tower for 1505 (1978): This metal cooling tower is connected to Building 1505.

1559 Boat Shed (1965): This frame building has a shed roof with exposed beams.

1560 Greenhouse (E) (1973): This greenhouse stands at the rear of Building 1503.

1561 Greenhouse (W) (1973): This greenhouse stands at the rear of Building 1503.

1563 Substation 234-4 (1972): Electrical Substation.

1564 West Office Trailer (1987): Standing behind Building 1503 is this metal-sided trailer.

1565 East Office Trailer (1987): Standing behind Building 1503 is this metal-sided trailer.

ASSESSMENT OF ELIGIBILITY: The buildings in the 1500 Area are not fifty years old and do not meet the criteria of eligibility for exceptional significance. Although the research conducted in these laboratories is important, it is not of such exceptional significance to render it eligible for inclusion in the National Register under Criterion Exception G. There is also insufficient information to place the accomplishments of the Environmental Sciences Division in context. When these buildings reach fifty years of age and there is sufficient historical perspective to identify the significance of work conducted in these laboratories, their significance should be reevaluated.

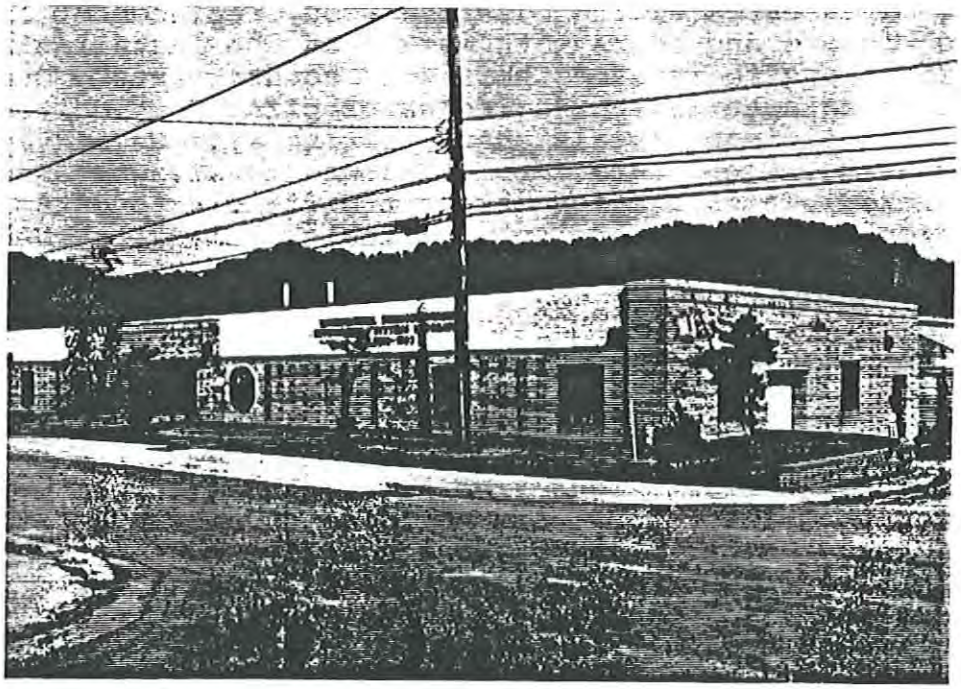


Figure III-14. 1503 Plant Sciences Laboratory (1965). This building is the oldest building in the 1500 Area. View south.

ORNL MAIN FACILITIES COMPLEX
2000 - 5554

OVERVIEW: The first buildings of the ORR, today the ORNL main facilities complex, were constructed as part of the World War II Manhattan project. Surrounding the key Manhattan Project buildings, the Graphite Reactor (Building 3001), the Chemical Separation Pilot Plant (Building 3019A) and the Chemistry Laboratory (Building 3550), were numerous frame support buildings. As the Clinton Laboratories evolved after World War II into the Oak Ridge National Laboratory, many of these early frame structures were replaced with more permanent brick-faced buildings, particularly during the Program H building campaign of the late 1940s and early 1950s. As the remaining frame structures aged, the ORNL prolonged the life of these facilities through a process called "permanentization" in the 1960s. This process entailed installation of corrugated metal or asbestos siding over the wood, replacement of wood-frame windows and doors with metal and the installation of metal awnings to replace their wood counterparts. One interesting note is that a review of plans for additions to several buildings reveals that existing windows and doors were often relocated to the additions or salvaged and reused elsewhere. This at times makes it difficult to date additions when plans are not available. Also, as these frame buildings aged, demolition was undertaken to make room for new buildings.

Along with the exterior alterations, the building uses often changed requiring major alterations. Examples of adaptive reuse in the ORNL main facilities complex include the conversion of Building 2011 from a steam plant to a laboratory, Building 3003 from a fan house for the Graphite Reactor to a laboratory, and Building 2069 from a cafeteria to a change house. During these adaptive reuse projects, original equipment was totally removed. Interior alterations also occurred as technology in the field advanced and obsolete equipment was replaced.

The next fifteen pages (Table III-1) comprise the inventory of all known ORNL numbered properties within the ORNL main facilities complex.

Then beginning with Building 2000, this chapter includes a discussion of individual properties dating within the period of significance. As previously discussed, the HPS established the years of 1943 through 1957 as the period of National Register significance. Photographs follow the discussion of each property dating within this period of significance. At the end of the discussion of the individual properties in the ORNL main facilities complex is an assessment of the National Register eligibility of the ORNL main facilities complex.

TABLE III–1 p. 1 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	SQUARE FEET	BUILDING DESCRIPTION	ALTERATIONS	USE IF DIFFERENT FROM ORIGINAL
2000	Solid State Lab Annex	48		22,680	steel frame, metal sided, Quonset hut series of three connected at side, orig. 4:2 hopper windows	some interior alterations; modern lineoleum, office partitions, drywall, Exterior; brick–faced addition on east end, cut–outs for AC units	Metallurgy Lab
2001	Information Center Complex	48		25,863	same as above	same as above	Health Physics Lab
2003	Process Water Control System	47		270	brick facing, flat roof, 4–pane windows with lug sills		
2007	Calibration Lab	51		1,965	brick facing, 1–story, stone coping, flat roof	modern six–sided tower attached several flat roofed additions to original rectangular building	
2008	Health Physics Technology Internal Dosimetry Lab	46		4,581	wood frame, gable roof, corr. metal siding, slab foundation, 1:1 windows	1959: Whole Body Counting Room Added 1967: Aluminum siding over wood, removal of existing wood windows and doors, install new canopies, Interior: lowered ceilings, rolled lineoleum floors, doors cut in, shed add in west end	
2009	Cafeteria Storage Building	43		4,460	concrete, brick and frame construction, flat roof built into hill, large concrete (reservoir) section with two connected rooms, one w/ b&b siding, one w/brick	1964: former reservoir converted to storage, pump rooms also converted to storage, new roof	Reservoir
2010	Cafeteria	51		11,770	1–story, brick facing, irreg. plan, concrete coping and sills, banks of windows, recessed cast stone panels across top front, loading area in rear	Comparison of 1949 plans to current structure indicate addition on front (east) side of building, removal of orig. east wall and casement windows, new glass portico entrance on south	
2011	Mechanical Properties Lab	43		5,804	3–story, flat roof, asbestos siding, hopper windows on ground floor roll up door on west facade	1947: converted from steam plant to lab, 2 floors added, rear addition, all steam works removed, 1950: 2–story addition on n. side	Steam Plant, 1943 Accelerator Building, 1953
2013	West Maintenance Service Center	43		11,488	1–story, wood frame, gable roof, gabled front section with "L" shaped side section, corr. metal siding, some orig. doors and trim on interior, some original door surrounds with rounded corners	Exterior: replaced 6:6 wood windows with 1:1 aluminum siding, Interior: conversion of x–ray rooms to restrooms, panelled and wallpapered walls interior shop on east side was offices, now open shop	Medical & Biological Bldg., 1943 Health Division, 1953
2016	West Portal Training/Offices	50		2,360	rectangular, flat roof, corr metal siding, orig. steel frame 3–pane windows	Interior: accoustical ceiling, drywall, modern office partitions removal of orig. timeclocks, alleys	
2017	East Research Service Satellite Shop	43		228	concrete block foundation, asbestos siding, adj. to 2011 and stack 2061, shed roof		Generator for 2011, 1953
2018	Electrical and Air Conditioning Service Center	43		6,362	wood frame, bowed roof, metal siding with novelty board siding in entrance foyer, some orig. interior doors, open shop area with exposed wood joists, 1 orig. 8:8 wood frame window in shop modern 1:1 windows and roll up doors	U–shaped, 1–story shed roof addition on front, east and west sides, stone veneer foundation, ac cut–outs in addition	Carpenter Shop, 1953

TABLE III – 1 p. 2 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	SQUARE FEET	BUILDING DESCRIPTION	ALTERATIONS	USE IF DIFFERENT FROM ORIGINAL
2019	Solar Energy Lab	51		820	steel frame, corr. metal sided, gable roof, 12–pane steel frame window, main entrance on gable end	windows on side closed in with siding	Metallurgical Storage
2024	Quality Assurance and Inspection		69	10,300	2–story, concrete block section connecting bldgs. 2000 and 2001, flat roof, 3–pane windows, open shop area inside		Metallurgy Lab Annex
2026	High Radiation Level Analytical Lab		64	27,800	concrete block, 2–story, irreg plan, flat roof, 4–pane horizontal windows., 3 square fixed windows on s. side of east front facade		
2029	Annex C–Info Center Complex		74	1,224	double wide trailer with gable roof		
2030	Mobile Office Unit		76	720	trailer		
2032	Manhole Cover		n.d.	64	prefab manhole cover		
2034	Manhole 95 Monitor		n.d.	64	prefab manhole cover		
2061	Stack	43			concrete stack adjacent to 2011, former powerhouse	all workings removed, inoperable	Out of Service since ca. 1947
2069	Change House	43		7,013	wood frame, 1–story, gable roofed section with side flat roofed section, horizontal aluminum siding, novelty board siding in entryway on east end of front facade, 4–pane horizontal windows	shed roofed section added on front, addition on west w/ concrete block foundation, new windows, Interior: accoustical ceiling; new plumbing, floors, drywall, lockers	Cafeteria School of Reactor Technology, 1953
2087	Storage		59	240	attached to bldg. 2000, concrete block shed with 8–pane hopper windows		
2088	Emergency Generator for 2000		59	90	adjacent to 2000, concrete block, shed roof, 8–pane hopper windows		
2092	Storage		59	112	concrete block, flat roof		
2093	Environmental Storage		59	240	1–story, steel frame, metal sided, gable roof, sliding track door		
2096	Passenger Shelter–West Pkg. Lot		n.d.		prefab shelter		
2097	Cooling Tower for 2001		59		cooling apparatus for 2000		
2098	Substation 6–3 2000 Area		n.d.		equipment in fenced area adjacent to 2000		
2099	LLW Monitoring & Control No. 1		n.d.				
2500	Guard and Fire Headquarters		67		Built on site of 1943 Patrol and Fire Headquarters, five bay garage section attached to 1–story brick office section, 3–pane horiz. windows	1–story rear addition	
2506	Fabrication Shop and Timekeeping	43		8,774	wood frame, gable roof, metal siding, 1:1 alum. windows, alum. awning over front door, south side has shed roofed section	1966: "permanentize building," horiz. wood siding replaced with corr. metal, 8:8 wood windows replaced with 1:1, gable roofed portico replaced with metal awning, wood doors replaced with metal, Interior: modern ceilings, doors modern drywall and wood panelling	Change House, 1953 Instrument Shops
2510	Air Compressor Building		63	770	part of steam plant (2519) complex, steel frame metal sided	1964: upgraded equipment	
2511	Paint Storage Facility		n.d.	380	steel frame, metal sided, steam plant (2519) complex		

TABLE III-1 p. 3 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

BLDG. #	BUILDING NAME	YR. BLT 43-57	YR. BLT POST '57	SQUARE FEET	BUILDING DESCRIPTION	ALTERATIONS	USE IF DIFFERENT FROM ORIGINAL
2517	Personnel Dev't. & Systems and Department Offices	43		4,743	wood frame, 1-story, corr. metal siding, alum. awning, gable roof, 4-pane horiz. alum. windows, raised concrete foundation, interior basically intact	1966: "permanentize building," horiz. wood siding replaced with vertical corr. metal siding, 8:8 windows replaced with alum. 4-pane horiz. windows, new alum. awning	Wartime Safety Department Safety Dept. Offices, 1953
2518	Plant and Equipment Division Office	51		10,125	1-story, brick facing; stone coping, sills and dec. elements; 1:1 windows, main entrance has flat-roofed metal canopy	1966: windows and doors redone	Change House, 1953 Classes, Reactor School
2519	Steam Plant	48		23,614	5-story, irreg plan, core has brick facing horiz. and vert. courses of stone, multi-pane hopper windows, glazed block tower, stack 5 boilers	numerous additions on all sides, many sided with corr. metal, Plans indicate one addition on east built for boiler in 1962 with raised concrete block foundation, roll-up door and metal siding, boilers added in '56 and '63, conversion to gas in 1950	
2521	Sewage Treatment Plant	51		1,472	raised concrete foundation, brick facing, flat roof with metal coping, windows in door	1973: grading plan, aeration system, piping installed	
2522	Fuel Oil Tank		n.d.	550	steel		
2523	Decontamination Laundry	55		3,593	steel frame, metal sided, gable roof, modern doors, orig. multi-pane hopper windows, side shed add.	1965: shed roof addition on e. gable end for office; 1967: building painted	
2525	Fabrication Department-Shop A	57		27,622	concrete block, 1-story, flat roof, rectangular plan, n. (main) facade has banks of paired 8-pane windows with panels in-between and surrounded by a stone course, metal coping, paired original doors under portico on east end		Research Shops, 1957
2528	Coal Research Laboratory		59	2,987	steel frame, metal sided, 1-story gable roofed section attached to 2-story rectangular portion, roof vents	small gable roofed entry portico added to front (north)	Low Level Waste Pilot Plant, 1953
2531	Radioactive Waste Evaporator Facility	54		9,004	concrete block, flat roof, 2-story, loading docks, no windows		
2532	HLW Storage Cooling Pumphouse		65	162	concrete block, flat roof, metal door w/windows		
2533	Cell Filter for 2531		65	136	concrete		
2534	Off Gas Filter Pit for 2531		65	90	concrete		
2535	Cooling Tower for 2531		65	289	wood frame, metal sided		
2636	Sewage Research Building		74	576	concrete block, 1-story, gable roof, sliding track doors		
2537	Evaporator Service Tank		78	305	concrete block, flat roof, solid metal doors		
2539	Cooling Tower for 2531		78		concrete slab, metal stilts, metal vat		
2540	Steam Plant Substation		83	200	concrete slab, metal equip. housing, flat roof		
2542	Gas Storage Facility		n.d.				
2543	Aeration Pond East		75		manmade pond		
2544	Aeration Pond West		75		manmade pond		
2545	Coal Pile Settling Basin		80		manmade pond		

TABLE III-1 p. 4 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

BLDG. #	BUILDING NAME	YR. BLT 43-57	YR. BLT POST '57	SQUARE FEET	BUILDING DESCRIPTION	ALTERATIONS	USE IF DIFFERENT FROM ORIGINAL
2546	Coal Pile Monitoring Station		n.d.		small, gable roof		
2547	New Machine Shop		87	9,430	pre-fab metal building, low-pitched gable roof, roll-up doors		
2549	Steam Plant Storage Bldg.		87	2,000	prefab metal building, low-pitched gable roof, roll-up door		
2572	Emergency Generator for 2500		67	200	1-story section on w. side of 2500, metal siding		
2600	Bethel Valley Collection Tanks		67		2 large tanks SE of White Oak Creek on 3rd ST.		
2609	Sentry Post No. 3		89	75	pre-fab metal guardpost		
2621	Tool Stores		61	5,469	steel frame, metal sided, gable roof, narrow paired windows along eave		
2624	Solid Waste Storage Area No. 1	43		1 acre	Grassed fenced area		Inactive since 1944
2628	Fire Prot. and Main Storage Shop		65	640	gable roof, side open, shed addition, double doors		
2632	5000 KVA Substation		70	620	small concrete block cube, flat roof, metal doors w/windows		
2636	West Precipitator		79		non structure		
2637	East Precipitator		79		non structure		
2638	Steam Plant Control Building		78	640	steel frame, metal sided		
2639	Coal Yard Runoff Treatment Bldg.		68	560	steel frame, metal sided		
2640	Sentry Post No. 6		n.d.	39	pre-fab metal sided guardpost		
2641	Sentry Post No. 6B		n.d.	39	pre-fab metal sided guardpost		
2642	Sentry Post No. 7		n.d.	30	pre-fab metal sided guardpost		
2643	Chlorinator Building		82	96	pre-fab metal sided bldg, gable roof		
2644	Coal Yard Runoff Treatment Bldg.		86	1,500	flat roof, metal sided gambrel-roofed rear section		
2645	Emergency Generator		85		generator for coal handling		
2646	Substation 33-6, 2500 Area		n.d.		concrete block wall enclosure with electrical equipment, pre-fab bldgs.		
2647	Rust Engineering Office		n.d.		trailer with plate glass door		
2648	Fire Training and Test Facility		n.d.				
2650	Chemical Evaporator Shed		91		pre-fab metal		
2652	(A) Trailer for Rad. Monitoring		n.d.	2,016	trailer		
2652	(B) Trailer for Rad Monitoring		n.d.	2,016	trailer		
2652	(C) Trailer for Rad. Monitoring		n.d.	1,008	trailer		
2653	Valve House		n.d.	96	metal		
2654	Sewage Digestor Building		n.d.				
2655	Liquid/Gaseous Waste Support Fac.		n.d.	5,760	pre-fab metal		
2656	Sewage Treatment Plant Water Monitoring Station		n.d.	64			
2657	Manhole Cover		n.d.	64	pre-fab manhole cover		
2658	Metals/Non-Metals Diversion Box		n.d.	64			

TABLE III–1 p. 5 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	SQUARE FEET	BUILDING DESCRIPTION	ALTERATIONS	USE IF DIFFERENT FROM ORIGINAL
3000	13.8 kV Substation	52		1,480	brick–faced, flat roof with stone coping, steel multi–pane windows, fenced area with electrical equipment	Plans dated 1943, 1949, 1952 for substation at this location. Building and equipment from 1952.	
3001	Graphite Reactor	43		29,746	steel frame, metal sided, gable roof, 2–story shed roofed sections on north and east, multi–pane hopper windows, canal in basement	1966: boron rods inserted into Reactor to assure it would not go critical; all control and safety rods disabled, fuel removed, converted to museum & office	Museum/ Offices
3002	Filter House for 3001	48		3,450	concrete, flat roof, metal stairs lead to roof, comparison of '48 plans to existing– – exterior unaltered		
3003	Solid State Accelerator Facility	43		7,605	irreg. plan, flat roof, concrete block and metal frame with metal siding, 1 & 2 stories, stack attached	1969: Converted from original use as fan house for Reactor– –totally modified to house an accelerator; 1979: "Accelerator & Office Addition: onto concrete block portion	Fan House for 3001
3004	Water Demineralizer	43		3,690	4–story, wood frame, novelty board siding, 1:1 windows, orig. holding tank in use; orig water treatment equip. remains in interior but is no longer used, wood frame 1–story gable roofed section on front and rear	Original water treatment process no longer used, water purchased and stored in tanks	
3005	Low Intensity Testing Reactor	48		11,368	3–story, frame and concrete block, metal siding, flat roof, 1–story section on south facade with paired hinged doors, 1–story concrete block section on west side, fixed pane windows	1951: rooms added on east and west side to "existing 2–room control house of pile mock–up structure," addition on west side with roll–up door, shielding added, 1970: two adjacent retention ponds filled in	Mock–up of Materials Testing Reactor (1948)
3008	Source and Spec. Mat. Vault	43		544	concrete block, flat roof, metal doors, no windows		
3009	Pump House for 3010	50		180	concrete block, flat roof		

TABLE III-1 p. 6 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

3010	Bulk Shielding Reactor Fac.	50		8,527	steel frame, corr metal siding, some orig. multi-pane hopper windows, orig door, metal coping, 2-story, flat roof, irreg. plan, 1-story side section with crane opening in upper portion	1963: forced cooling system added 1960: BSR I replaced with BSR II	
3012	Rolling Mill	47		10,792	steel frame, 2-story, metal sided, hopper windows on both levels, large roll up doors on both gable ends, interior is one large open room with track in concrete floor; second hand rolling mill purchased in 47	1951: Addition on east end for offices/ lunchroom	
3013	Geological Disposal Lab	48		720	wood frame, novelty board siding, gable roof, paired doors on gable end, orig. 8:8 windows	paired doors on gable end are new	Source Building, 1953
3017	Chemical Technology Division Annex	52		10,244	concrete block, flat roof, metal coping, single and paired 6-pane steel sash windows		Reactor School Laboratory, 1952
3018	Exhaust Stack for 3003	43		122	reinforced 200' concrete stack equipped with outside irons	1974:rehabbed	
3019 (A)	Radiochemical Processing Pilot Plant	43		29,537	3-story, concrete block and steel frame, flat roof, interior concrete cells were once exterior walls, roof top ductwork, irregular plan	1950: Permanentization 1950: containment structure built around cells 1954: hot cells added to west end (#3019B) 1960: modifications to cells 1 and 2, cell one now gone; interior changes include new equipment in control room, new ventilation system, removal of all "pre-Purex" process equipment,	Pilot Plant for Separating and Purifying Plutonium, 1944
3019 (B)	High Level Radiation Analytical Lab	54		3,787	concrete block, flat roof, roof-top ducts		
3020	Exhaust Stack for 3019	43			concrete freestanding stack n. of 3019		
3021	Turbine House for 3019	44		100	steel frame, flat roof	1955-"turbine & blower installation"	
3023	North Tank Farm	44			roped off area with prefab and concrete buildings concrete block shed, equipment, etc.		

3025 (E) 3025 (W)	Physical Exam-Hot Cells A Solid State Division Lab	51		59,085	two connected buildings, 1-4 stories, flat roof, stone coping and lug sills, 8-pane hopper windows, ductwork on roof, concrete block foundation brick facing, irregular plan		
3026 (C)	Radioisotope Development Lab B	43		8,376	irregular plan, flat roof, banks of modern tinted glass windows,low-pitched gable roof section at rear.	1959: "Modify Cells" 1961: "Tear Down Existing Building Structure and Services-cell structures will remain, construct new building and install new services	By-Product Process Building and Chemistry Separations Lab
3026 (D)	Dismantling and Examination Hot Cells	45		16,110	steel frame, modern aluminum siding, flat roof, overhang on S.E. facade supported by wood brackets, concrete ramp to loading (crane) area, original paired wood doors in loading area, novelty board siding inside entrance at SE facade, single pane fixed windows		Dismantling Cell for Reactor Development Experiments
3027	Safeguard Nuclear Materials Vault	55		3,844	concrete block, flat roof, inside fenced area, no windows		Source and Special Materials Vault
3028	Radioisotope Prod. Lab A	51		17,054	steel frame, corr. metal siding, irreg. plan, ductwork on roof		
3029	Radioisotope Prod Lab B	51		2,273	steel frame, metal sided, flat roof, metal stairs to roof, tall paired doors, no windows		
3030	Radioisotope Prod Lab C	51		720	steel frame, corr. metal siding, flat roof, metal awning over paired doors		
3031	Radioisotope Prod Lab D	51		720	Steel frame, corr. metal siding, flat roof, metal overhang, ductwork on roof		
3032	Radioisotope Prod Lab E	51		720	Steel frame, corr. metal siding, flat roof, metal overhang, ductwork on roof		
3033	Radioisotope Prod. Lab F	51		720	steel frame, corr. metal siding, flat roof		
3033 (A)	Radioisotope Prod. Lab Annex		n.d.	882	steel frame, corr. metal siding, flat roof		
3034	Radioisotope Area Services	51		1,200	steel frame, corr. metal siding, flat roof, paired doors with four pane windows		

3036	Isotope Area Storage & Service	51		1,449	steel frame, metal sided, flat roof, track door with crane protruding from front of bldg.		
3037	Operations Division Offices	51		8,185	2-story, brick facing, multi-pane windows, vertical brick columns divide each elevation into bays, flat roof, stone coping	first floor windows filled in with AC units	
3038	Radioisotope Laboratory	51		7,538	brick-faced, flat roof, vertical brick columns divide each facade into bays, no windows, metal awnings		
3039	Central Radioactive Waste Gas Disposal Facility	51		638	stack		exhaust stack-radioisotope facility
3042	Oak Ridge Research Reactor	55		37,369	3-stories plus basement, steel frame, corr. metal siding, flat roof, no windows inactive, offices occupied	fuel, shim rods and beryllium removed, exam hot cells cleared of equipment remaining from reactor operation	
3044	Special Materials Machine Shop	55		3,059	steel frame, metal sided, gable roof, hopper windows scaloped awnings above windows, roll-up door		
3047	Isotope Technology Building		63	25,630	3-story, flat roof, concrete block, fixed single pane windows, 2nd floor has large multi-pane windows with modern reflective glass on the 3rd floor of the front elevation, ground floor facade entrance has overhang, plate glass doors and windows		
3074	Interim Manipulator Repair Fac.	51		3,153	steel frame , metal sided, gable roof, roll-up door on gable end		Field Service Shop
3077	Air Cooler UTR	52		668	steel frame metal sided structure		
3080	Reactor Experiment Control Room	53			1-story, steel frame, metal sided, multi-pane hopper windows, original awning	some windows closed up	Storage Facility for 3010
3082	Storage Misc. Materials		58	225	steel frame, metal sided, gable roof, 4-pane window, door with 4-pane window		
3083	Neutron Spectrometer Sta. No. 1		58	64	steel frame, metal sided, shed roof, connected to 3010 and 3107		
3084	Neutron Spectrometer Sta. No. 2		58	196	2-story, flat roof, concrete block, part below grade, large pipe connects to 3085		

ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

3085	Pumphouse-ORR		59	800	1-story, concrete block, 2-sections, gabled roof with roof vents		
3086	Cooling Tower No. 1-ORR		58		wood and metal cooling tower on concrete foun.		
3087	Heat Exchanger-ORR		58	4,575	metal equipment adjacent to 3042		
3088	Bulk Shielding Reactor Storage		58	129	metal sided, steel frame, large multi-pane windows		
3089	Cooling Tower ORR		58	454	steel and wood frame, metal sided		
3091	Filters for 3019	50		602	steel frame, metal sided, low-pitched gable roof, no windows		
3092	Off-gas Facility	56			concrete block enclosure for equipment		
3095	Reactor Area Equipment Storage		59	7,008	metal-sided, steel frame, 3 connected gable roofed sections, 1-story, roll-up doors on each gable end, roof vents		
3098	Filter Facility		58	1231			
3099	Storage Pad		60	894	concrete pad between #3031 and #3032		
3100	Source & Special Materials Vault		60	1,231	adj. to 3020, concrete block, low-pitched gable roof		
3101	Storage Shed		59	200	raised concrete foundation, corr. metal siding, open shed		
3102	Heat Exchange No. 2-ORR		64	112	steel frame, concrete base		
3103	Cooling Tower No. 3-ORR		60	3,340	wood and transite, corr. metal at east end		
3104	West Research Service Center		61	7,330	steel frame, flat roof, metal sided, multi-pane windows, roll-up doors		Reactor Services Field Shop
3105	West Monitoring Control Center		62	570	concrete block, flat roof, 2 sections, no windows		
3106	Cell Ventilation Filters		60	1,366	concrete, flat roof		
3107	25-Meter Target House on Flight Path Exit		58	192	steel frame, metal sided, shed roof, no windows, 1 door, connects to 3010		
3108	Cell and Hood Dilters		62	595	concrete enclosure		
3109	Off gas Filters		62	104	concrete enclosure		
3110	Cell Ventilation Filter		62	445	concrete		
3111	Sentry Post No. 88		68	120	pre-fab guard portal		

TABLE III-1 P. 10 OF 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

3112	Misc. Storage Building		61	196	concrete block, shed roof, door w/4-pane window		
3113	Motor House for 3019		67	53	steel frame, metal sided		
3114	Shock Tube Lab		63	1,920	steel frame, metal sided, gable roof, no windows	1987: modern concrete block side addition	
3115	Solid State Office		70	2796	steel frame, metal sided, gable roof, 6-pane windows, door on gable end, basement		
3116	Nitrogen Cylinder Storage Building		58	127	concrete shed in North Tank farm		
3117	BSR Cooling Tower		63	1,059	wood and metal cooling tower adj. to 3010		
3118	Radioisotope Prod. Lab		65	900	1-story, steel frame, metal sided, flat roof, roll up door, infill between 3030 and 3031		
3119	BSR Heat Exchanger & Pumphouse		63	720	concrete block, built into hill, flat roof, door with window		
3121	Cell-Off Gas Filter House for 3019		67	146	concrete block, flat roof		
3123	Emergency Generator for 3019		68	255	concrete block, flat roof, ventilated doors		
3125	Emergency Generator for Stack 3039		74	476	concrete block, flat roof, 1-story, vents		
3136	Charcoal Filter Pit		58	127	concrete lined		
3127	Non Nuclear Research Materials Vault		76	900	concrete block, flat roof, 1-story, roll up door at loading dock		
3129	Personnel Monitoring Station		76	485	concrete block, 1-story, flat roof large fixed plate glass windows		
3130	Waste Operations Control		83	4,100	built into hill, brick faced, flat roof		
3131	Emergency Generator for 3019		60		generator in concrete structure		
3135	Sentry Post No. 80		68	408	1-story, concrete block, flat roof, fixed single pane windows		
3136	Equipment Testing Building		84	600			
3137	Surface Science Lab		84	6,400	2-story, steel frame, brick facing, banks of dark plate glass windows		
3138	Thermal Properties Test Facility		83	260	wood sided, flat roof, paired doors, no windows exterior staircase to roof		
3139	Cell Vent. Filters		58		concrete enclosure		
3140	Cell Vent. Filters		66				
3141	South Passenger Shelter		n.d.		prefab		

TABLE III–1 p. 11 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

3142	North Passenger Shelter		n.d.		prefab		
3143	ORR Demineralization System		58		water treatment equipment		
3144	Roof Test Center		87	7,000	prefab metal, flat roofed section attached to gable roofed section, roll up door		
3145	LLW Collection Building		84	64	concrete block, shed roof, built into hill, metal door		
3146	Emergency Generator for 3020		60		concrete enclosure		
3147	Office for Efficiency Renewable Research		88	10,800	2–story, steel frame, brick faced, banks of dark panels and 1:1 windows		
3151	Mon Sta. MH 25		n.d.	64	prefab		
3153	Envelope Systems Res. Apparatus		n.d.	2,300	concrete block, mostly underground, flat roof		
3154	Manhole 112 Monitor		n.d.	64	prefab		
3155	Manholes 114 and 234 Monitor			100	Pre–fab manhole cover		
3500	Instrumentation and Controls Division Office and Research Facility	51		74,491	1–2 story w/basement, flat roof, banks of windows on facade, entranceway has stone details and square interior intact	1960: Addition for $989,000	
3501	Sewage Pumping Station	49		196	partially underground, brick faced, flat roof with vent, hopper windows		
3502	East Research Service Center	50		12,136	2–story, steel frame, corr. metal siding, irreg. plan with two distinct sections, one with flat roof, other with gable roof, orig. doors & windows	concrete block addition on rear	Solvent Extraction Office
3503	High Radiation Level Engineering Lab	48		12,206	4–story, steel frame, corr. metal siding, gable roof w/vents, no windows		Solvent Extraction
3504	Geosciences Lab	51		7,316	steel frame, metal sided, gable roof, roll up door on gable end, multi–pane hopper windows		Health Physics Waste Research Lab
3505	Fission Product Development Lab Annex	51		6,550	1–2 story, steel frame, corr. metal siding, concrete foundation, flat roof, hopper windows, loading dock, concrete "tower" with metal rail, contains seven concrete cells	some windows infilled; all equipment removed from process cells and control room	Metal Recovery Plant (Reactor Fuels Processing Plant)
3506	Chemical Evaporator Building Waste Evaporator Facility	49		1,075	concrete block, flat roof, 1–story, exterior metal stairs to roof, interior has stainless steel–lined reinforced concrete cell w/underground valves	after 2531, replaced by 2531	
3507	South Tank Farm	43		.9 acres	waste tank farm, adj. to 3506		
3508	Chemical Technology Alpha Laboratory	51		13,950	2–story, steel frame, metal sided, flat roof, series of metal doors on ground level, exterior metal staircase, no windows		Isolation Building
3513	Settling Basin	44			waste settling pond	1950: Alterations, 1952: west treatment pilot plant pump	
3515	Fission Product Pilot Plant	48			concrete cells and equipment entombed in concrete block outer structure	cells and equipment entombed after 1958	

3517	Fission Product Development Lab		58	16,708	irreg. plan, concrete block with taller central steel frame metal–sided section, flat roof, no windows, exterior metal stairs, concrete block pull in loading area with paired metal hinged doors		High Rad. Level Chemical Deve. Lab
3518	Process Waste Treatment Plant	57		1,092	2–story, concrete block, flat roof, hopper windows exterior metal staircase		
3523	Storage	54		1,200	1–story, gable roof, corr. metal siding, hopper multi–pane windows, roof vents	some windows closed up	
3524	Process Waste Systems Basin/ Equalization Basin	44		.5 acres	manmade waste settling basin adjacent to 3518		
3525	High Radiation Level Examination Lab		63	26,543	1–2 story w/basement, brick faced, banks of windows, front elevation divided by cast concrete panels, entrance has decorative concrete panels and plate glass doors, ductwork and equipment on roof		
3531	Environmental Experimental Greenhouse		63	364	adj. to 3539, steel frame, glass		
3534	Liquid Metal Cleaning Fac.		61	450	brick–faced, 1–story, flat roof, portico		
3535	Filter Enclosure		58		concrete		
3536	Nitrogen Cylinder Tank Storage Bldg		61		concrete		
3537	Hydrogen & Oxygen Dist Sta		62	3,000	concrete slab containing equipment, surrounded with decorative concrete block wall		
3538	Cooling Tower for 3525		63		wood frame, metal sided		
3539	Process Waste Pond 1		64		manmade pond		
3540	Process Waste Pond 2		64		manmade pond		
3541	MSR Process Dev. Lab.		65	800	steel frame, metal sided, gable roof, exterior ductwork, attached to 3592		

TABLE III-1 p. 13 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

3542	Storage Building for 3505 & 3517		65	612	steel frame, metal sided, gable roof		
3543	MSR Development Lab		68	600	steel frame, metal sided, gable roof, roll-up door	new overhead door on gable end	
3544	Process Waste Treatment Plant		76	2,837	steel frame, metal sided on front, low-pitched gable roof, roll-up door, stuccoed rear section		
3546	I & C Office Annex		76	7,320	2-story, brick facing, modular building, flat roof, windows with concrete panels above		
3547	Cell Vent. Filter for 3517		58	50	concrete		
3548	Cell Vent. Filter		58	140	concrete		
3550	Research Laboratory Annex	43		12,327	1-story, wood frame, gable roof, novelty board siding, original 8:8 wood frame windows, irreg plan, brick wall with crow stepped gable at east end of cross gable; interior has some original baseboards and some original doors	Numerous additions and demolitions have altered the configuration of this building. It is vastly scaled down. Plans indicate: 1946: Addition on east side of crow stepped gable (now gone), 1947: addition "Van de Graaaf Room with Exhaust (now gone), 1953: Addition on north front elevation, removal of 1946 addition Interior: new drywall, modern doors, AC units cut outs in windows and walls, some replacement 2:2 windows	Chemistry Laboratory
3587	Instrument Laboratory Annex	50		3,405	steel frame, metal sided, gable roof, hopper windows, L-plan, gabled roof wing on ell	modern door	Field Service Shop
3592	Coal Conversion Facility	52		1,200	steel frame, metal sided, 2-story, gable roof, original hopper windows, exterior metal stairs		Unit Operations Volability Lab
3594	Waste Management Storage Bldg.		58	144	steel frame, metal sided, gable roof, no windows		Hydrogen Storage Fac.
3597	Hot Storage Garden		60	642	small, metal sided, gable roof		
3598	Emergency Generator for 3500		62	220	concrete block, flat roof, vent, door w/ 1-pane window		
3601	HEPA Filter House		66	68	prefab with metal siding		
3602	Cylinder Tank Storage Bldg.		63	117	concrete block		
3605	Storage		85	375	pre-fab, metal, flat roof, modern windows		
3606	Instrument and Controls Off. Annex		85	7,500	2-story, brick faced, flat roof, brick columns divide window bays on facade		
3607	Cask Storage Building		85	682	pre-fab metal		
3608	Nonradiological Waste Water Treatment Plant		89		steel frame, corrugated metal siding, two large tanks		
3609	Substation 25-1 3500 Area		n.d.	860	pre-fab, gable roofed metal bldg. in fenced-in area containing equipment		
3610	Storage Building for Emergency Response		89	480	metal, low-pitched gable roof		
3613	Pump Station No. 1, Diversion Bldg.		n.d.	160	1-story, gable roof, metal siding		
3614	Mon. Sta. MH 190		n.d.	100	prefab		
3615	Mon. Sta. MH 235		n.d.	64	prefab		
3616	Mon. Sta MH 149		n.d.	64	prefab		
3617	Mon. Sta. MH 229		n.d.	64	prefab		

TABLE III–1 p. 14 of 15 ORNL MAIN FACILITIES COMPLEX BUILDING INVENTORY

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	SQUARE FEET	BUILDING DESCRIPTION	ALTERATIONS	USE IF DIFFERENT FROM ORIGINAL
4000	13.8 KV Substation	55			electrical substation		
4003	Solid Waste Storage Area 2	44		3.5 acres	inactive waste storage area, grassed unfenced area	1946 – 49: drums removed, hillside bulldozed, contoured and seeded	
4005	Guard Portal # 80		n.d.		pre–fab metal sentry post, L–shaped, awning		
4500 (N)	Central Research & Administration	52		341,242	rectangular flat roofed front section with four gable roofed ells at rear, north front brick–faced, facade is 2–stories on east side and 1–story stepping back to two on the west side, horizontal emphasis to facade with banks of 6 paned windows separated by brick panels and surrounded by a stone course, on east side of facade panels between windows are stone, entrance bay has plate glass doors with transoms, 3 entrances on front, 4 gabled ells	1960: addition on east end	
4500 (S)	Central Research & Administration		62	274,451	2–stories with basement, flat roofed rectangular front section with four 2–story gable roof ells connecting to 4500N, built into hill, basement exposed on front, banks of windows		
4501	High Level Radiochemical Lab	51		36,246	3–story and basement, flat roof, stone belt courses, banks of windows with stone surround, brick facing, hooded vents on front facade		
4505	Experimental Engineering	51		78,445	3–stories and basement, brick facing, flat roof, brick soldier courses, decorative stone courses		
4507	High Radiation Level Chem. Dev. Lab	57		3,812	1–2 story, brick–faced bldg. attached to rear of 4505, contains 4 shielded hot cells	unoccupied	Pilot Plant for Development Studies of Reactor Fuel
4508	Metal and Ceramics Lab		62	99,030	2–story + penthouse, raised concrete foundation, brick facing, no windows, plate glass doors, large banks of vents on rear		
4509	Compressor House		68	5,950	1–story, metal frame, asbestos siding, flat roof, equipment on roof in enclosure	1968: Plans indicate that the 1957 building on this site was either replaced or totally rebuilt	
4510	Cooling Tower		60	2,354	cooling apparatus attached to 4509, 4521, 4511		
4511	Cooling Tower		59	1,318	cooling apparatus attached to 4509, 4521, 4510	1984: repairs	
4512	Lab Emergency Response Ctr.		87	4,900	1–story, flat roof, brick and concrete faced attached to 4500S, loading area in rear		
4513	Substation for HTML (4515)		87		concrete structure containing electrical substation for 4515		
4514	Electrical Equip. Bldg. for 4515		87	650	concrete, flat roof		
4515	High Temperature Material Lab		87	64,500	2–story, concrete, irreg. plan, red metal details, reflective glass, round concrete columns on facade, concrete bridge spans creek to entrance		
4516	Cooling Tower for 4515		87		cooling apparatus/tower to SE of 4515		

4521	Cooling Tower		85		cooling apparatus adj. to 4510-11, behind 4500S		
4556	Filter Pit for 4507		72	592	concrete		
4557	Sentry Post 7B, S. Parking Lot		n.d.	30	metal siding, prefab		
5000	East Portal	52		6,300	1-story, brick facing, stone coping and lug sills under 6-pane windows, square concrete pillars support portico on front (N) facade, drive-through portico on west facade		Lab Protection Division
5500	High Voltage Accelerator Lab	52		51,595	irreg. plan, brick faced one and two story sections surrounding corrugated metal faced tower, basement, office section with banks of windows, glassed-in entrance portico	1976: addition on south side of bldg.	
5505	Transuranium Research Laboratory		68	23,248	2-story, flat roof, brick facing, banks of windows, metal-sided portico extending from the roof at the rear of the building		
5506	East Portal Building		63	560	flat roofed portico with bricked faced sidewalls, security gates		
5507	Electron Spectrometer Facility		69	2,356	pre-fab metal sided, gable roof, paired doors on gable end		
5510	Analytical Mass Spectrometer Lab		89	6,300	steel frame, brick faced, 1-story, flat roof, fixed pane windows, connected to 5510A, also a 1-story flat roofed, brick faced bldg. by a covered walkway		
5553	Sentry Post 1E		64	60	prefab		
5554	Electrical Substation for 5505		68	330	concrete block, flat roof, contains electrical substation		

2000 MAIN CURRENT USE: Solid State Laboratory Annex
ORIGINAL USE: Metallurgy Laboratory

HISTORY: This building was originally associated with the Metallurgical Division which was formed at the Clinton Laboratories in 1946. The Clinton Laboratories recruited a half dozen metallurgists at start-up and within a few short years, the Division grew to as many as 300 people (Johnson and Schaffer 1992:38). Metallurgical research at the Clinton Laboratories was first undertaken in connection with the manufacture of fuel systems for an experimental high flux reactor. The purpose was to determine the effect of high temperature and radiation on metals used in the reactor systems. Metals were tested for reliability under simulated reactor operating conditions. Data from these experiments was included in the Clinton Laboratories "experimental high flux pile reports" (Thompson 1963:52).

Building 2000 was constructed in 1948 for use by the Metallurgy Division at a cost of $765,000. The Division used the building primarily for metallurgical research related to the reactor program. Today, the building serves as a laboratory for research into solid state physics, since the 1940s, a key to reactor design. Solid State Research was originally part of the metallurgical research program but grew as increasing recognition was given to radiation damage. Like metallurgy, solid state physics research is strongly influenced by the problems of specific reactor systems but with increasing attention to the fundamental physics of solids involved in understanding the effects of radiation (Thompson 1963:203).

DESCRIPTION: This 22,680 square-foot structure is a three-arched Quonset hut, a building type common at the ORNL in the late 1940s and early 1950s. This steel-frame, arched building has corrugated-metal siding and most of its original four-over-two-pane hopper windows. The interior of the building contains offices and an open shop area. *Alterations include concrete block shed-roofed additions on the south side and wall cut outs for air conditioning units. Interior alterations include modern linoleum, drywall and office partitions. Other alterations include connection of Buildings 2000 and 2001 with Building 2024, a concrete block shed-roofed structure.*

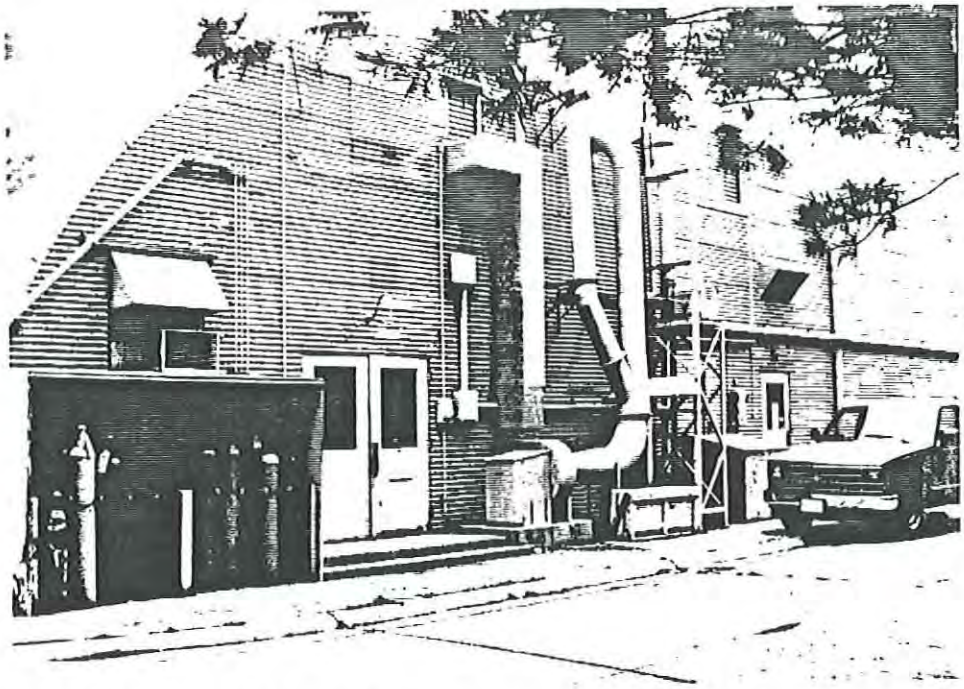


Figure III-15. 2000 Solid State Laboratory Annex (1948).
View southeast at west end of building.

2001 MAIN CURRENT USE: Information Center Complex
ORIGINAL USE: Health Physics Laboratory

HISTORY: Constructed in 1946 at a cost of $397,000, this building served as a laboratory for the Health Physics Division which was formed the same year. Early health physicists worked on ionization chambers, film meters, electroscopes, electrometers, proportional counters and Geiger Muller counters for the monitoring of both the buildings and environment of the Clinton Laboratories. Under the leadership of K.Z. Morgan, research conducted in the Health Physics Division "resulted in many important developments and became the basis for the present Health and Safety Research Division" (Kerr et al. 1992:2). Today, the building houses the information center.

DESCRIPTION: This 25,863 square-foot structure is a steel-frame, three-arched Quonset hut with corrugated-metal siding and most of its original four-over-two-pane hopper windows. *Exterior alterations include cut-outs from the window and sill to accommodate window air conditioning units. On the west end of the building, Building 2024 was constructed in 1969 to connect Buildings 2000 and 2001 and on the east end is a flat-roofed concrete block addition. The interior has some original offices and hallways and some new linoleum, drywall, and new partitions.*

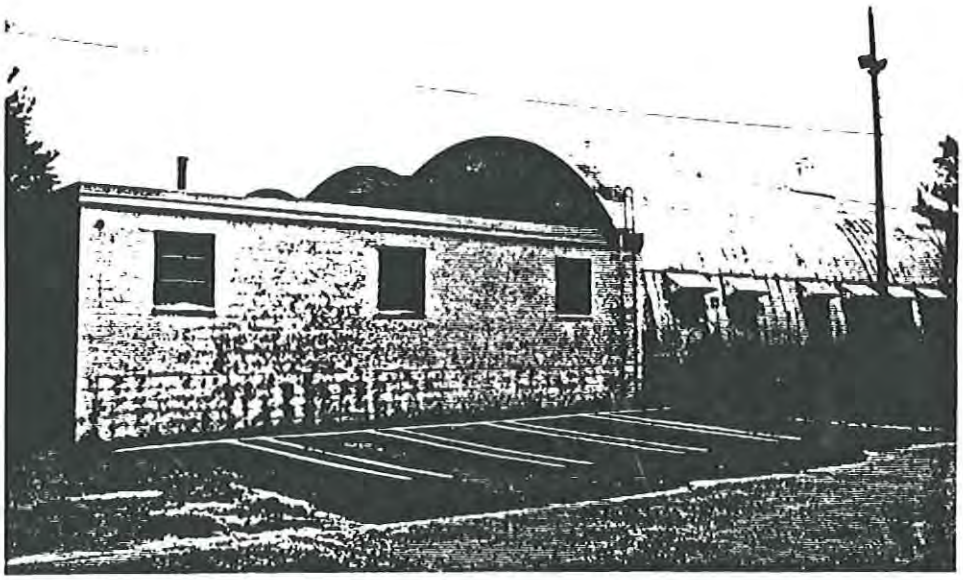


Figure III-16. 2001 Information Center (1948). View southwest at east end of Quonset hut and concrete block addition.

2003 MAIN

CURRENT USE: Process Water Control System
ORIGINAL USE: Process Water Control System

HISTORY: The structure was built in 1947 on Third Street to monitor process waste water. It serves today in the same function.

DESCRIPTION: This 270 square-foot building has a flat roof, brick facing, stone coping and lug sills and four-pane windows.

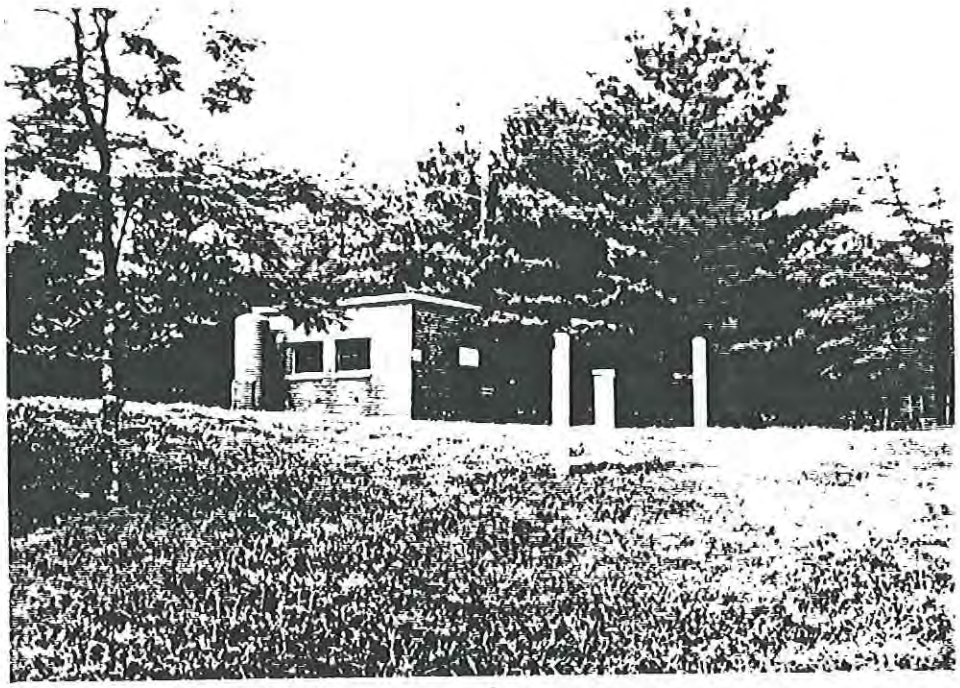


Figure III-17. 2003 Process Water Control System (1948). View northwest.

2007 MAIN

CURRENT USE: Calibration Laboratory
ORIGINAL USE: Health Physics Test Building

HISTORY: Completed in 1951 at a cost of $79,000, this building is part of the ORNL's Program H Expansion. It is associated with the Health Physics Division formed in 1946 and was used to test radiation monitoring systems developed at the ORNL. Today, it retains its association with the Health Physics Division and serves as a calibration laboratory.

DESCRIPTION: This 1,965 square-foot, irregular-plan building has brick facing, a flat roof and is one and two stories in height. A 1950s aerial photograph shows this building as a one-story, rectangular, flat-roofed building. *Today, the building has several one- and two-story brick-faced additions and a six-sided concrete tower.*

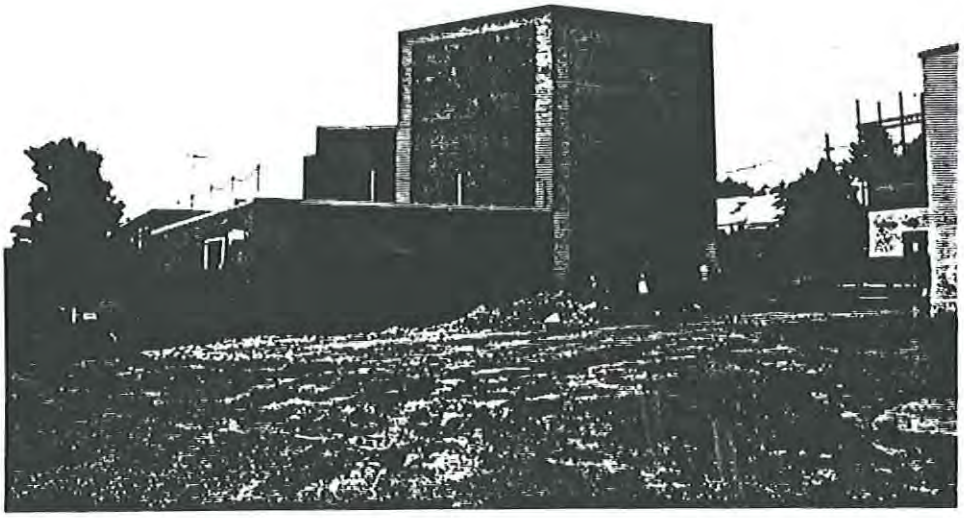


Figure III-18. 2007 Calibration Laboratory (1951). View northwest, original building core at rear, new tower at right.

2008 MAIN

CURRENT USE: Health Physics Technology, Internal Dosimetry Laboratory
ORIGINAL USE: Health Physics Low Level Analysis Laboratory

HISTORY: Constructed in 1946 at a cost of $33,000, this building is associated with the Health and Physics Division of the Clinton Laboratories. The Health and Physics Division was formed the same year. Building 2008 is the primary building at the ORNL associated with research in accident dosimetry, a field of study addressing the accidental exposure to radioactive elements. In 1959, a whole body counting room was added to provide the most accurate counts of body radiation by shielding out all natural radiation. The Whole Body Counting Room, contained within a steel-frame building, is comprised of four-foot thick steel walls with a lead sheathing over the steel on the room's interior. (Pre-World War II ship steel was used for the construction of the room because this steel contains no radiation.) The next year, the Internal Dosimetry Section was formed. This Division expanded dosimetry research to continuously monitor ORNL personnel for permissible exposures to radiation. This building continues research in the field today.

DESCRIPTION: Of wood-frame construction, this structure has a gable roof, corrugated-metal siding, slab foundation and one-over-one windows. *The 1959 addition on the south side of the building is a square, corrugated-metal sheathed, flat-roofed structure on a concrete slab foundation. Exterior alterations include the "permanentization" of the exterior in 1967 which entailed new metal siding over the original wood siding; the removal of existing wood-frame windows, doors and door frames and replacement with metal-frame windows and doors; and the installation of metal awnings over the doors. On the west end of the building is an undated shed addition. The interior has undergone extensive alterations which include dropped ceilings, new linoleum floors, wallpaper over drywall, new doors cut in and room configurations changed.*

Figure III-19. 2008 Health Physics Technology, Internal Dosimetry Laboratory (1946). View southwest.

2009 MAIN CURRENT USE: Cafeteria Storage Building
ORIGINAL USE: Reservoir

HISTORY: This structure was completed around 1943 as a water reservoir. Aerial photographs of the ORNL, dated ca. 1943, clearly show the reservoir. In 1964, the reservoir was drained, modified, and converted to a storage building for the adjacent cafeteria (Building 2010).

DESCRIPTION: This 4,460 square-foot structure is comprised of a poured concrete, rectangular, flat-roofed structure built into the side of a hill. Originally serving as the reservoir but now used as a storage room, this building has battered walls. Paired steel doors provide access to the storage room. On the south side of the concrete reservoir structure are two flat-roofed rooms, one with novelty-board siding and the other with brick facing. Both rooms have original paired wood doors containing four-pane windows. Some original pumping equipment remains in both sections such as pumping apparatus and the main shut off valve. *Alterations include the 1964 drainage of the reservoir and conversion of the structure to a storage facility. Through that process, equipment was removed and/or disabled, a new roof was constructed over the reservoir portion along with a new floorplate, new double metal doors and wiring for electricity.*

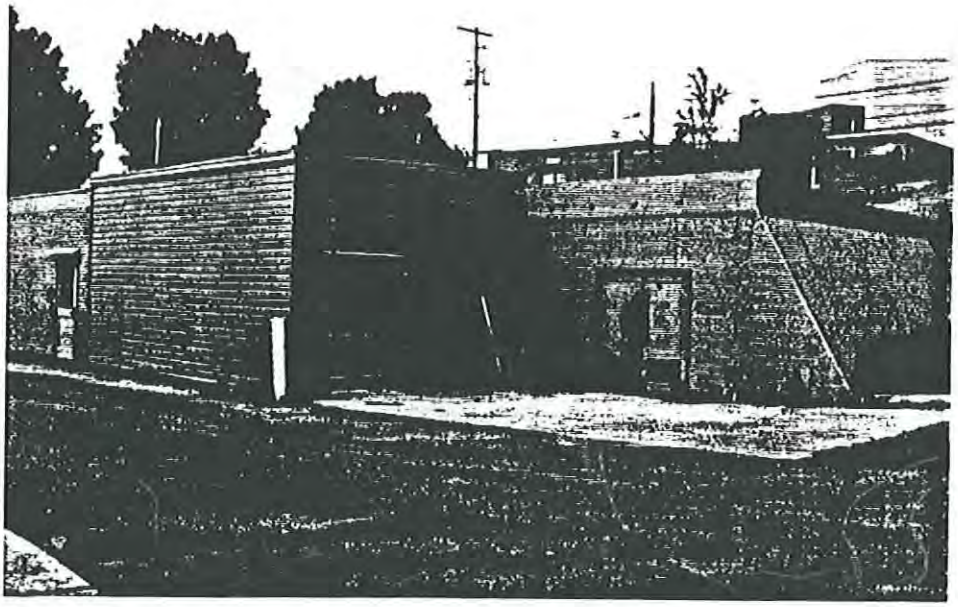


Figure III-20. 2009 Cafeteria Storage Building (1943). The concrete original reservoir is at the right, pump rooms on left. View northwest.

2010 MAIN CURRENT USE: Cafeteria
ORIGINAL USE: Cafeteria

HISTORY: The ORNL constructed this cafeteria in 1951 at a cost of $284,000 to replace the 1943 cafeteria (Building 2069) as part of the Program H Building Expansion. The ORNL expanded the cafeteria after 1960. It serves as the cafeteria today.

DESCRIPTION: This 11,700 square-foot structure is metal-frame with brick facing and a flat roof. The building is comprised of a rectangular core, with a front section approximately five-feet shorter than the core and a side glassed-in portico addition. The front (east) facade has banks of modern plate glass windows. Recessed concrete panels form a frieze along the cornice of this front section. The side portico also has a concrete frieze. At the rear of the building is a metal awning over the loading dock area. Plans dated 1949 show a rectangular uniform-roofed structure (as do aerial photographs of that era). *Comparison of the 1949 plans to the present structure indicates that the east front wall with its entrance on the southeast corner was removed and a seating addition constructed. During this process, the original steel casement windows were removed and the original front entrance was relocated to the south side of the building where a glassed-in entrance portico was built.*

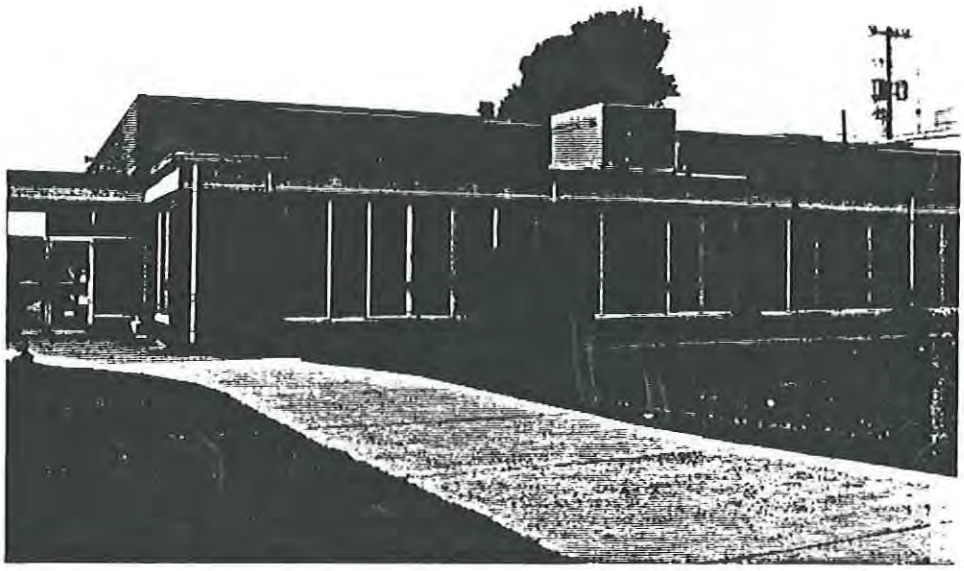


Figure III-21. 2010 Cafeteria (1951). View toward northwest of post-1960 addition on front (east) facade and glassed-in portico on left of photograph.

2011 MAIN

CURRENT USE: Mechanical Properties Laboratory (inactive)
ORIGINAL USE: Steam Plant

HISTORY: Constructed in 1943 at a cost of $186,000, this structure served as the original steam plant for the Clinton Laboratories. It and the adjacent stack (2061) are clearly visible in World War II aerial photographs of the complex. Post-World War II photographs show the plant as still operational with steam coming out of its stack. With the completion of the new steam plant (Building 2519) in 1948, this structure was shut down and converted for use as a laboratory. It first served as a laboratory in the early 1950s for the conduct of neutron research using a Van de Graaf accelerator acquired from the U.S. Navy and a Cockroft-Walton accelerator. The structure continued in use through the 1980s. Today, the facility is closed and is targeted for decommissioning.

DESCRIPTION: This 5,804 square-foot, steel-frame building has an irregular plan, flat roof, corrugated-asbestos siding, a roll-up door and shed-roofed stairway addition on the west facade, and multipane hopper windows on the ground floor (south) facade. *In 1948, when the plant was converted to a laboratory, original equipment associated with the steam plant was removed, floors were added and the building was reconfigured. In 1950, a two-story addition was constructed on the north side. At an unknown date between 1950 and 1963, the upper portion of the building was removed and the roof of the once multilevel shed-roofed structure was converted to a flat roof. Numerous windows shown on this structure in early photographs were also sided over.*

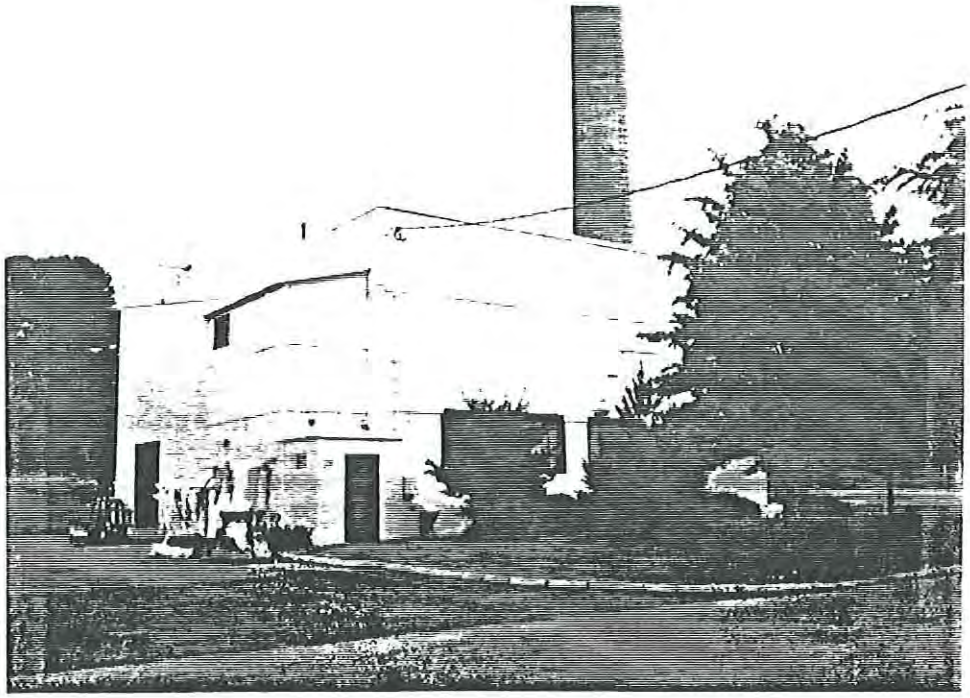


Figure III-22. 2011 Mechanical Properties Laboratory (1943). Built as the original steam plant for the complex, the original upper levels of the building were removed after conversion to a laboratory facility in 1948. View northeast.

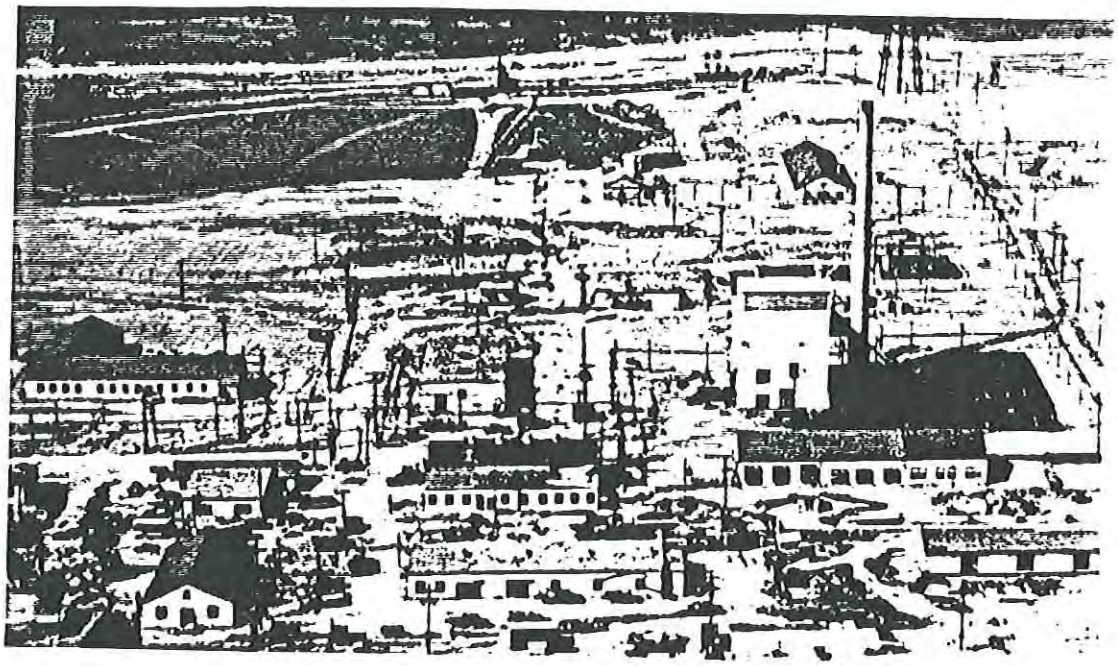


Figure III-23. Historic Photograph ORNL #193 (1940s). Note Steam Plant (Building 2011) at right center of photograph before upper stories were removed. View north.

2013 MAIN

CURRENT USE: West Maintenance Service Center
ORIGINAL USE: Medical and Biological Building

HISTORY: Built in 1943 at a cost of $157,000, Building 2013 served as the "Medical and Biological Building." The Medical Division at the Clinton Engineering Works was responsible for all physical examinations from pre-employment through termination. Also conducted in the building were studies to "establish the proper relationship between detectable chemical conditions of employees and the physical conditions under which they work" (Thompson 1963:14). The Biology Division was closely associated with the Medical Division. The Medical Division maintained monitors in hazardous areas of the laboratory and also studied the biological effects of radiation on animals.

In 1948, Building 2013 became the "Health Building." Floor plans of this era show treatment rooms, rest ward, nurses' room, and x-ray rooms. In 1949 the east section of the building housed the Health and Physics Division who worked in close cooperation with the medical group and under the supervision of the Director of the Medical Division. Their studies addressed radiation and contamination hazards, monitoring, and calibration. The Health and Physics Division also conducted research on decontaminating individuals who had been exposed to radiation. Plans dated 1956 label the building "Health Physics Hospital." By 1965, the building was known as the "West Maintenance Shop" and was associated with the Plant and Equipment Division.

DESCRIPTION: This 11,488 square-foot, wood-frame structure consists of a rectangular gable-roofed section with a gable front and a side L-shaped section (all original to the building). One-story in height, Building 2013 has corrugated-metal siding, modern one-over-one windows, and several flat-roofed and gabled additions on the rear. The interior has some original doors and trim such as door surrounds with rounded exterior corners.

Alterations include the "permanentization" of the building in the 1960s with one-over-one metal-frame windows that replaced the original six-over-six wood-frame windows, aluminum siding over wood siding, new doors, and aluminum awnings. Inside, walls are wallpapered and panelled and original x-ray rooms with their lead-lined walls have been converted to restrooms. The shop area in the east gable-fronted section, which was originally divided up for laboratory, office, and library space, is now an open work shop.

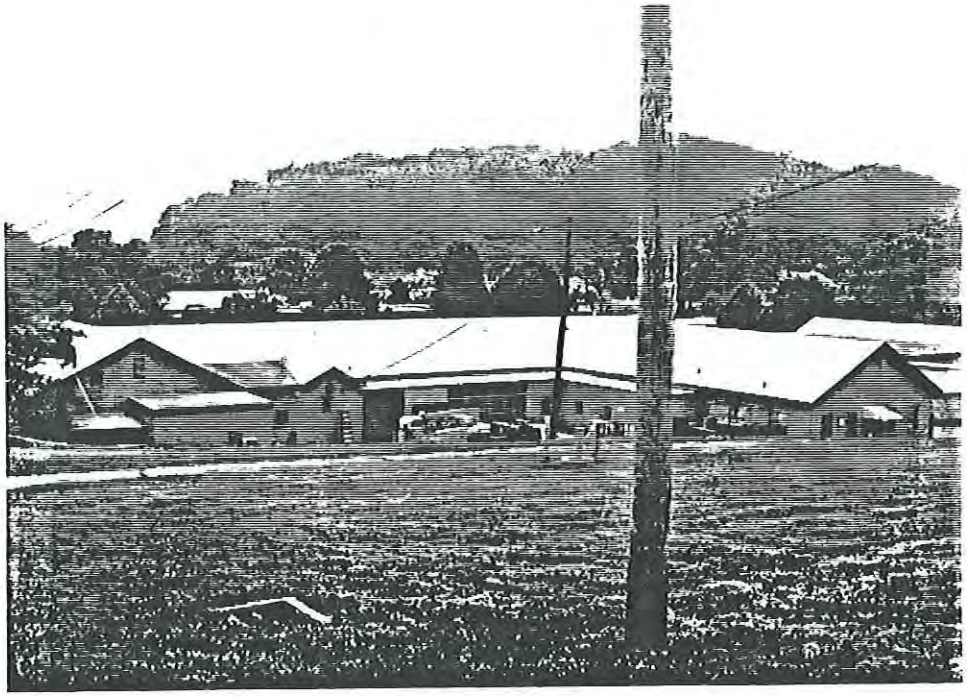


Figure III-24. 2013 West Maintenance Service Center (1943). Rear view of building showing numerous modern additions. View south.

2016 MAIN CURRENT USE: West Portal
ORIGINAL USE: West Portal

HISTORY: Built ca. 1950, this structure is listed as the "West Portal" in a 1953 ORNL Building List. The building is clearly visible in a ca. 1960 aerial photograph. (A 1948 aerial photograph does not show this building.) Building 2016 is associated with the Laboratory Protection Division and once housed time clocks and clock alleys. Today, Building 2016 provides office and training facilities.

DESCRIPTION: This 2,360 square-foot, steel-frame building is rectangular in shape with a flat roof, corrugated-metal siding, metal awnings, and doors containing single-pane windows. *Interior alterations include the removal of the clock alleys and timeclocks and the installation of modern acoustical ceiling, drywall, and office partitions.*

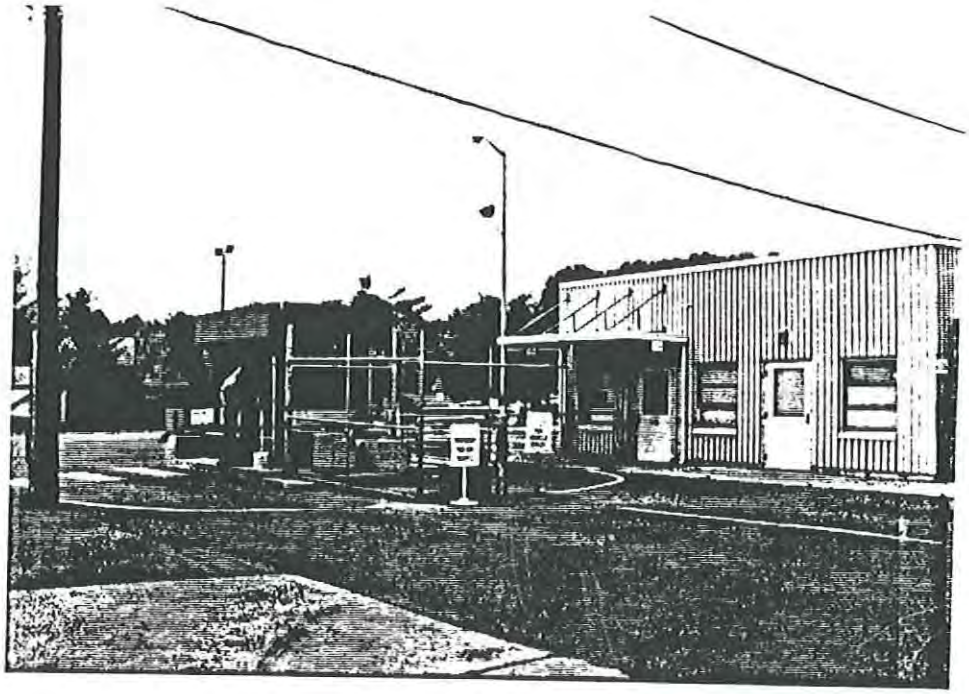


Figure III-25. 2016 West Portal (ca. 1950). View of south facade and sentry post with Building 2609, in center. View northwest.

2017 MAIN

CURRENT USE: East Research Satellite Service Shop
ORIGINAL USE: Generator for Steam Plant (Building 2011)

HISTORY: This small building, built in 1943, housed a generator for the adjacent steam plant. The adjacent Steam Plant (Building 2011) was constructed in 1943 and operated until it was replaced by a new facility in 1948.

DESCRIPTION: This 228 square-foot building has asbestos siding, a shed roof and a large vent on the east facade. *Original equipment associated with the Steam Plant has been removed.*

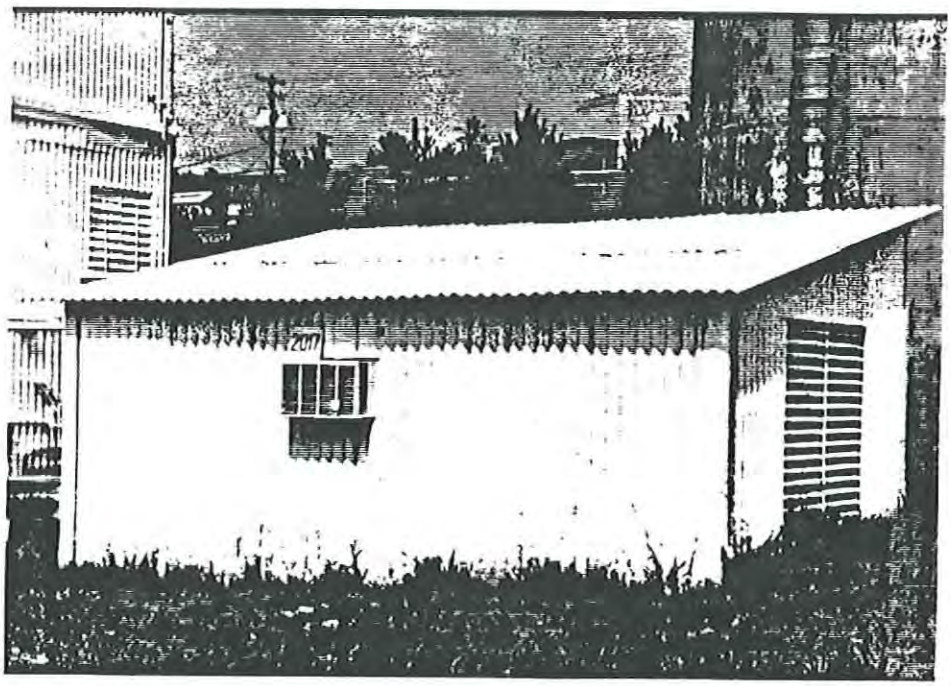


Figure III-26. 2017 East Research Satellite Service Shop (1943). This building housed the generator for the adjacent steam plant which ceased operations in 1948. View northwest.

2018 MAIN CURRENT USE: Electrical and Air Conditioning Service Center
ORIGINAL USE: Carpentry Shop

HISTORY: This structure, shown as completed in a 1943 aerial photograph, housed a carpentry shop and served in that capacity for several years before conversion to a shop for electrical and air conditioning service.

DESCRIPTION: This rectangular, 6,363 square-foot, wood-frame building has a bowed roof, corrugated-metal siding, modern one-over-one aluminum windows, a stone-veneer foundation and a U-shaped one-story, hip-roofed addition that wraps around from the front to the east and west side facades. The interior contains offices with some original doors and an open shop area with exposed wooden roof framing and one original eight-over-eight, wood-frame window. *Alterations include the 1960 U-shaped addition creating a new entranceway, replacement of the original eight-over-eight windows with modern one-over-one windows, and metal siding over the original novelty-board siding.* A section of the original siding is still visible in the front (south) entrance.

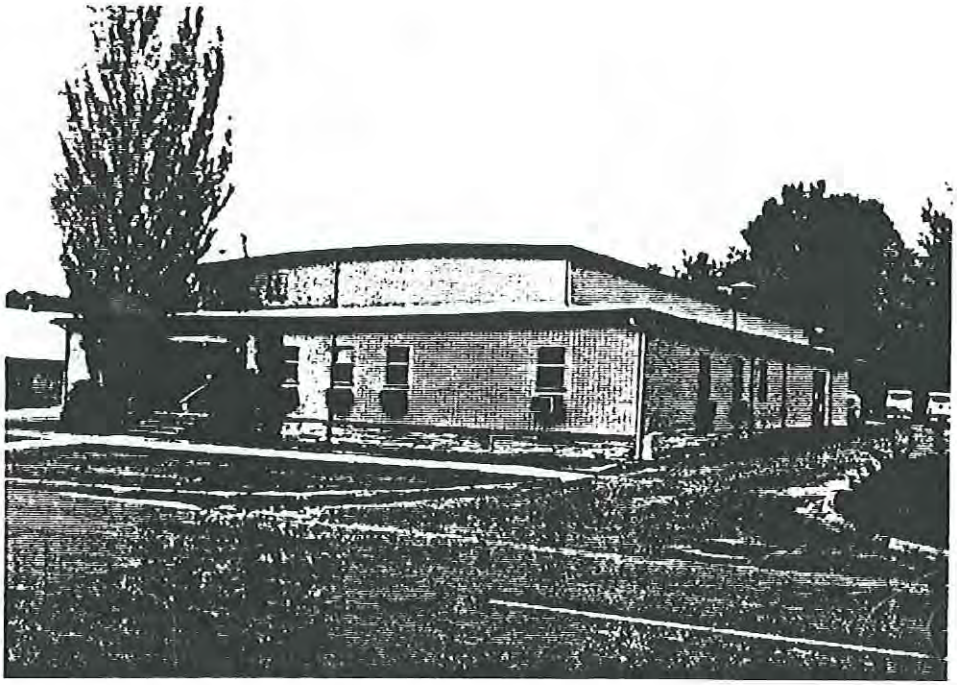


Figure III-27. 2018 Electrical and Air Conditioning Service Center (1943). View toward northwest of front (south) and east elevations showing U-shaped addition.

2019 MAIN

CURRENT USE: Solar Energy Laboratory
ORIGINAL USE: Metallurgy Laboratory
Storage

HISTORY: This small building was constructed in 1951 and is associated with Building 2000, the Metallurgy Laboratory. It served originally as storage and today is used as a solar energy laboratory by the Solid State Division.

DESCRIPTION: This 820 square-foot, steel-frame, rectangular structure has corrugated-metal siding, a gable roof and a gabled main entrance with a metal door containing a two-pane window and an awning. On the north side is one multipane hopper window. *Two other windows on this side have been covered with corrugated-metal siding.*

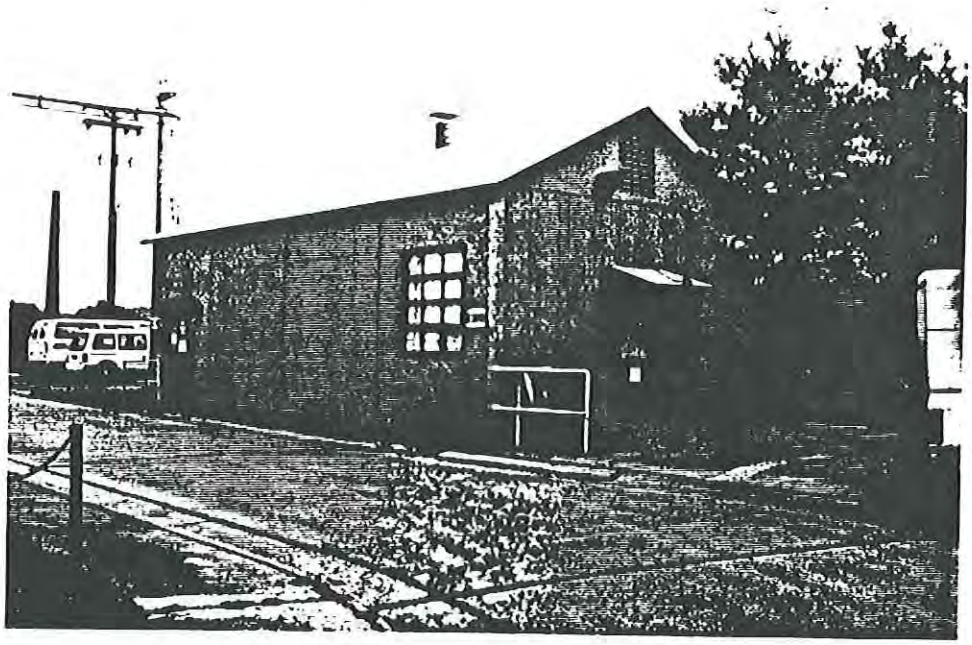


Figure III-28. 2019 Solar Energy Laboratory (1951). This building originally had three hopper windows on the north elevation; two are now covered with siding. View southeast.

2061 MAIN

CURRENT USE: Out of Service Stack
ORIGINAL USE: Stack for Steam Plant (Building 2011)

HISTORY: This stack is associated with a steam plant (Building 2011) which operated at the Clinton Laboratories from 1943 to 1948. The facility shut down when it was replaced by a new Steam Plant (Building 2519).

DESCRIPTION: This concrete stack stands adjacent to the former Steam Plant (Building 2011). *All workings have been removed and the stack is inoperable.*

Figure III-29. 2061 Stack (1943). This concrete stack is inoperable today with all workings removed. View northwest.

2069 MAIN CURRENT USE: Change House
ORIGINAL USE: Cafeteria

HISTORY: This structure was built in 1943 at a cost of $104,000 for use as an employee cafeteria. After the new cafeteria (Building 2010) opened in 1951, this building was converted for use as both laboratory and classroom space for the Oak Ridge School of Reactor Technology. The school grew out of a training school operated at the Clinton Laboratories between 1946 and 1947. In 1950, the ORNL decided to establish a full-fledged training program which operated in Building 2069 until 1965. At that time, Building 2069 was converted for use as the Change House.

DESCRIPTION: This 7,013 square-foot, wood-frame, one-story building has an irregular plan and is comprised of a gable-roofed section with a flat-roofed addition on each side, and a shed-roofed addition on the front. The building is sided with horizontal aluminum siding and has four-pane windows on the front addition. *A ca. 1960 aerial photograph shows the east side addition but does not include the addition on the west side. All additions were constructed on concrete block foundations. Other exterior alterations include the covering over of the original novelty-board siding with modern aluminum siding. This siding is visible on the entranceway on the southeast corner of the south (front) facade. The interior has new drywall, acoustical ceilings and floors and has been converted from classroom/laboratory space to house locker and shower facilities.*

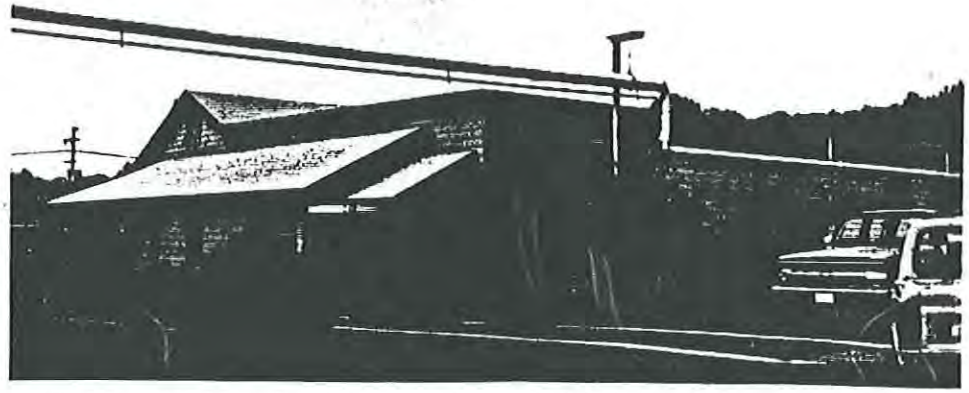


Figure III-30. 2069 Change House (1943). This structure, constructed for use as a cafeteria, has front additions shown in this photograph. View northwest.

2506 MAIN

CURRENT USE: Fabrication Shop and Timekeeping
ORIGINAL USE: Instrument Shops

HISTORY: Built in 1943 at a cost of $135,000, the structure housed the Instrument Shop for the Clinton Laboratories. A decade later, Building 2506 was listed as "Tool Stores, Pipe Stores and Timekeeping" (ORNL 1953). Today, Building 2506 is used as a fabrication shop and for timekeeping.

DESCRIPTION: This 8,774 square-foot, wood-frame rectangular building has a gable roof, metal siding, one-over-one aluminum-frame windows, an aluminum awning over the west gable-end entrance and a shed-roofed addition on the south side. *In 1966, the building was "permanentized" with corrugated metal over wood siding, eight-over-eight wood-frame windows replaced by one-over-one metal-frame windows and a gable-roofed, wood-frame portico replaced by a metal awning. The interior has been altered with acoustical ceilings, linoleum floors, new doors, and new drywall and wood panelling in the timekeeping office.*

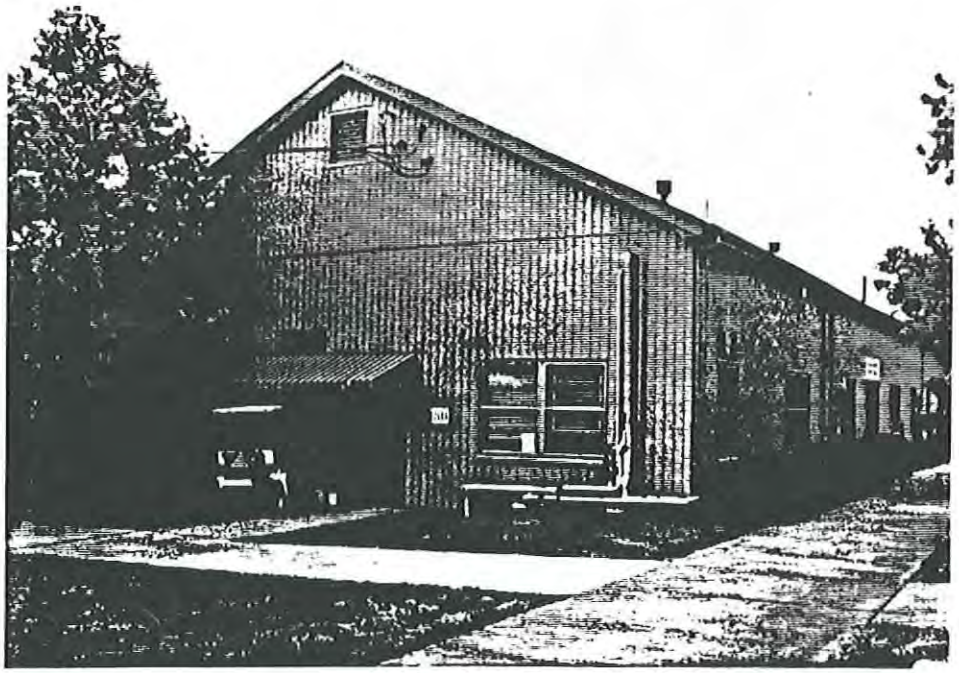


Figure III-31. 2506 Fabrication Shop and Timekeeping (1943). The original wood siding was replaced with metal siding in a 1966 "permanentization." View southwest.

2517 MAIN

CURRENT USE: Personnel Development and Systems Department Offices
ORIGINAL USE: Safety Department Offices

HISTORY: This structure was built in 1943 at a cost of $45,000 to house the Safety Department. The Safety Department introduced and enforced personal safety procedures at the plant to avoid radiation exposure. The Safety Department continued to occupy the building through the 1960s. Today, the building is the Employee Relations Division and houses the Personnel Development Offices.

DESCRIPTION: Built on a raised concrete foundation, this 4,743 square-foot building has a gable roof, corrugated-metal siding, modern four-pane windows and aluminum awnings. The interior is basically intact. Alterations include the 1966 "permanentization" of the structure with the horizontal wood siding covered with metal siding, eight-over-eight wood-frame windows replaced by steel-frame windows, and new aluminum awnings.

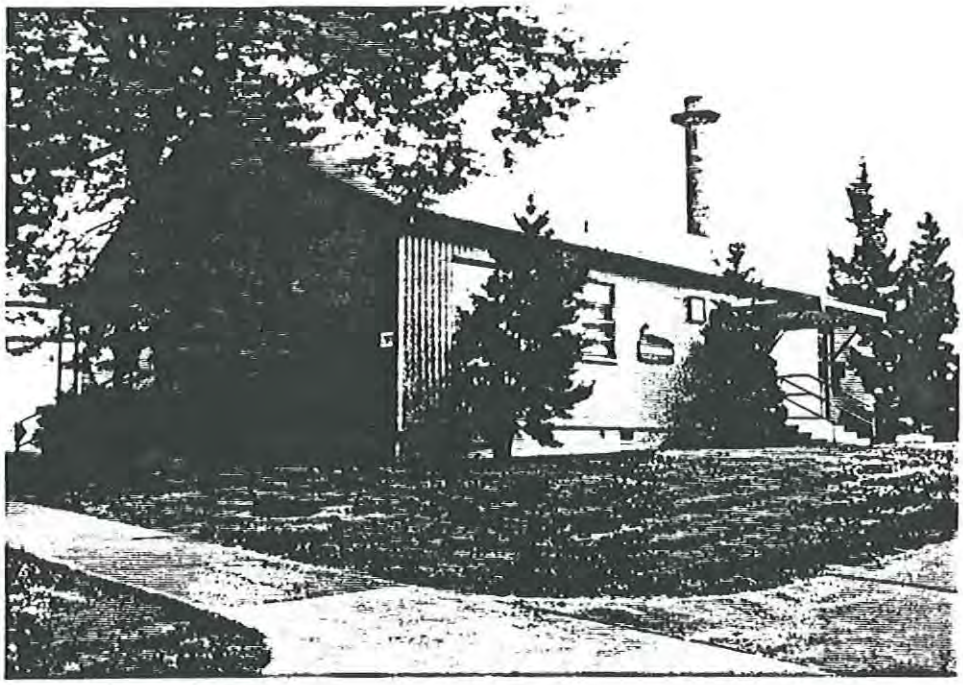


Figure III-32. 2517 Personnel Development and Systems Department Offices (1943). The structure originally housed the Safety Department Offices. View southeast.

2518 MAIN

CURRENT USE: Plant and Equipment Division Office
ORIGINAL USE: Change House

HISTORY: This building was constructed in 1951 as part of the Program H building expansion at a cost of $137,000. Built to serve as a change house, it also provided classroom space for the Oak Ridge School of Reactor Technology. Today, Building 2518 provides office space for the Plant and Equipment Division.

DESCRIPTION: This 10,125 square-foot, one-story building has brick facing, a flat roof, one-over-one windows, and decorative stone elements such as coping, lug sills and courses outlining rectangular brick sections. The main entrance on the north facade has a flat-roofed metal canopy.

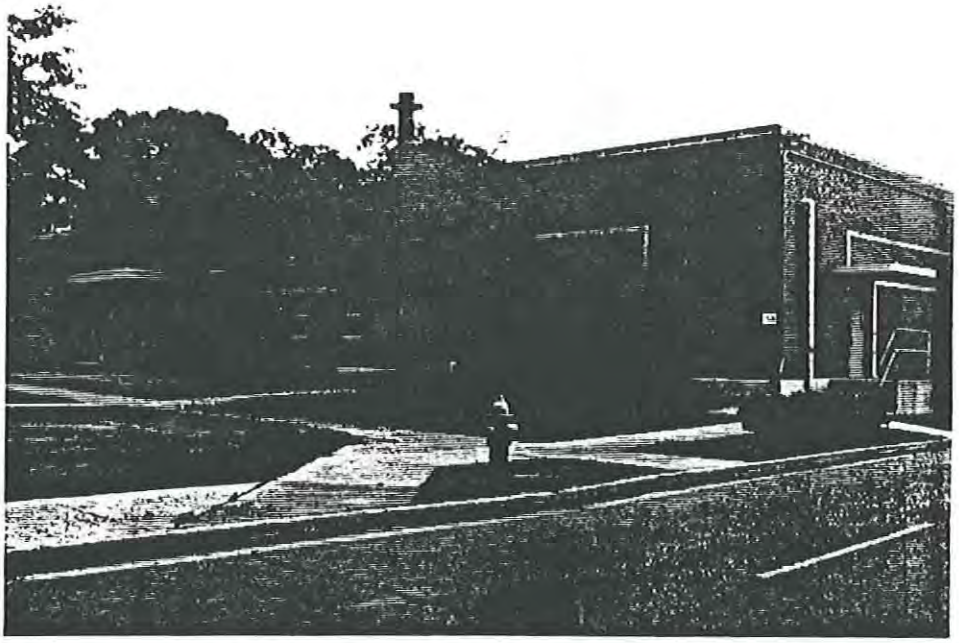


Figure III-33. 2518 Plant and Equipment Division Office (1951). View toward southeast at north facade.

2519 MAIN CURRENT USE: Steam Plant
ORIGINAL USE: Steam Plant

HISTORY: This structure was the first permanent masonry building constructed at the ORNL. Built in 1948 at a cost of $912,000 to serve as a steam plant, the facility replaced the original steam plant (Building 2011). Building 2519 continues in service today.

DESCRIPTION: This irregular plan, 23,614 square-foot building has a brick-faced, five-story core. Horizontal and vertical bands of stone are decorative features of the building. The building retains many of its original multipane hopper windows. *Surrounding the brick-faced core are numerous additions. These additions date from the mid-50s to the present and include a 1962 three-story boiler facility that has a one-story concrete base, roll-up doors, and corrugated-metal siding above, a glazed block "silo" at the front (north) side of the building, and several one- and two-story, steel-framed, metal-sided additions around the core. The Steam Plant itself has been changed through the conversion to gas in 1950, addition of a boiler in 1956 and the addition of a second boiler in 1963.*

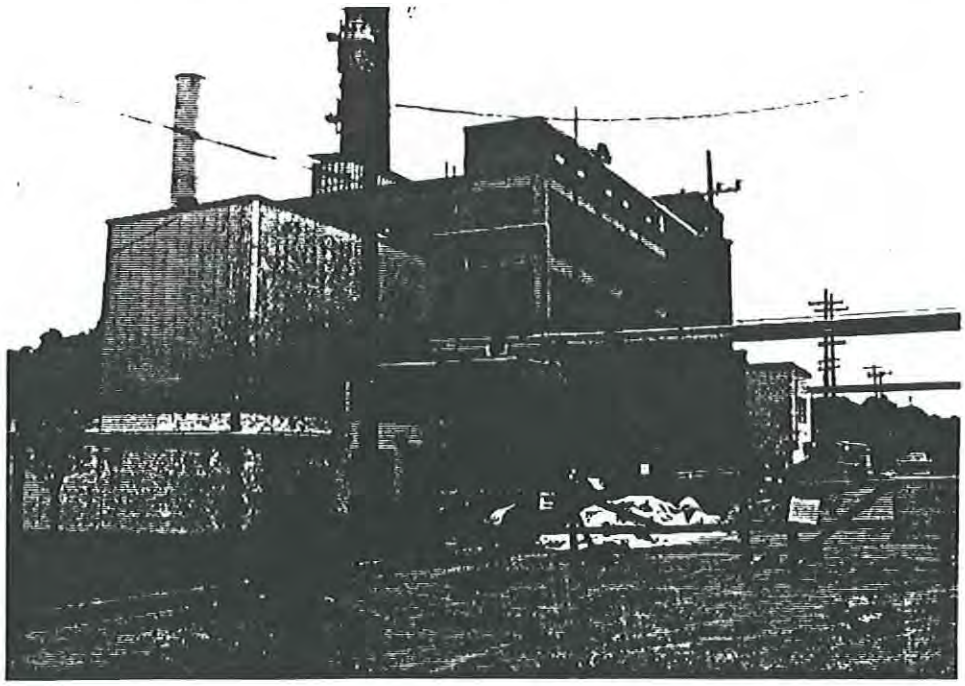


Figure III-34. 2519 Steam Plant (1948). Looking toward southwest at 1948 brick-faced building core and 1962 boiler addition at left of photograph.

Figure III-35. 2519 Steam Plant (1948). Looking toward southeast at brick-faced building core in center of photograph. Modern additions are in the foreground.

2521 MAIN CURRENT USE: Sewage Treatment Plant
ORIGINAL USE: Sewage Treatment Plant

HISTORY: The Sewage Treatment Plant was constructed in 1951 at a cost of $109,000. It was built to treat ORNL sewage before flowing into the Clinch River via White Oak Creek.

DESCRIPTION: The sewage treatment facility consists of Building 2521, holding ponds and aeration lagoons. Building 2521 is 1,472 square-feet in size and has a raised concrete foundation, brick facing, flat roof with metal coping, and a metal door containing a window.

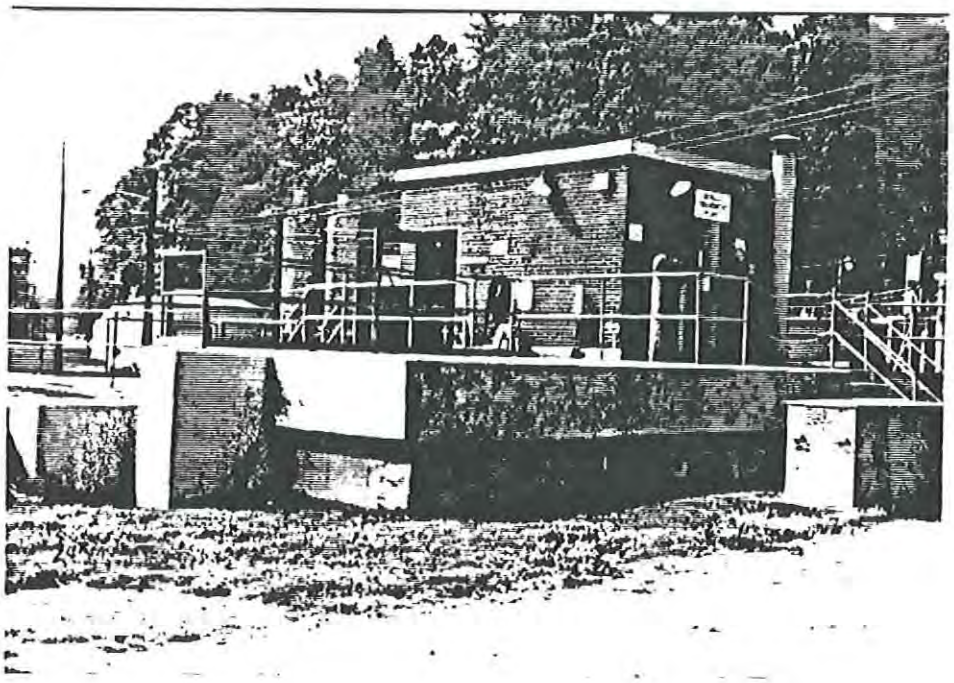


Figure III-36. 2521 Sewage Treatment Plant (1951). View southwest.

2523 MAIN

CURRENT USE: Decontamination Laundry
ORIGINAL USE: Decontamination Laundry

HISTORY: Building 2523 was built in 1955 at a cost of $701,000 to house a decontamination laundry. Building 2523 used processes developed at the ORNL to remove radioactive contamination from clothing and other items used by the ORNL personnel. It continues to serve in that capacity today.

DESCRIPTION: This one-story, 3,593 square-foot, steel-frame building has metal siding, a gable roof, modern doors and original multipane hopper windows. *Additions are found on all four sides of the building. A ca. 1960 aerial photograph shows a shed addition on the west gable end but the shed addition on the north side is not visible. Plans indicate that in 1965, a shed-roofed addition on the east (front) gable end was built for offices.*

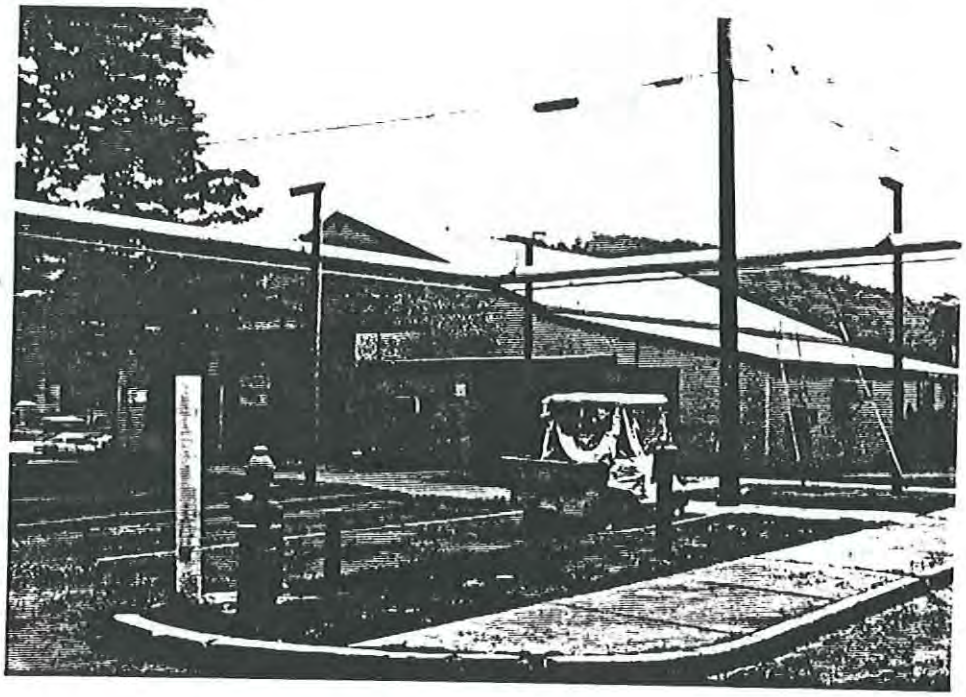


Figure III-37. 2523 Decontamination Laundry (1955). View toward southwest of Building 2523 with 1965 front addition and post-1960 side addition.

2525 MAIN CURRENT USE: Fabrication Department-Shop A
ORIGINAL USE: Research Shop

HISTORY: Constructed in 1957 at a cost of $465,000, this building served as a "Research Shop." Today, it provides space for the Plant and Equipment Division.

DESCRIPTION: This 27,622 square-foot, rectangular structure has a flat roof with metal coping. The north (front) facade has banks of windows enclosed within a raised concrete rectangular band. The two-pane windows in the banks appear to be replacement sash. Each set of windows is separated by a concrete panel. Under a portico on the east end are original paired double doors containing windows.

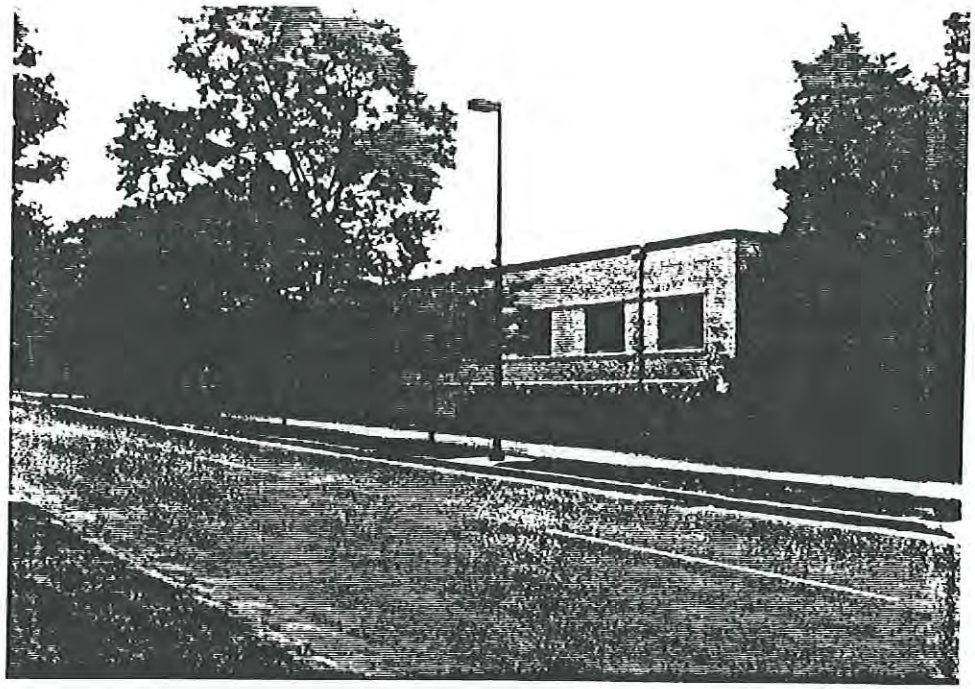


Figure III-38. 2525 Fabrication Department Shop A (1957). The building fronts on Central Avenue. View southeast.

2531 MAIN

CURRENT USE: Radioactive Waste Evaporator Facility
ORIGINAL USE: Radioactive Waste Evaporator Facility

HISTORY: This structure was built in 1954 to replace Building 3506, the Waste Evaporator Facility (Ford et al 1992:A-17). The facility is used today to treat liquid low-level waste (LLLW) prior to discharge to the Process Waste Water Treatment Plant for additional treatment.

DESCRIPTION: This 9,004 square-foot, concrete block structure is two stories in height with a basement, a flat roof, metal doors, no windows, a loading ramp and a crane bay.

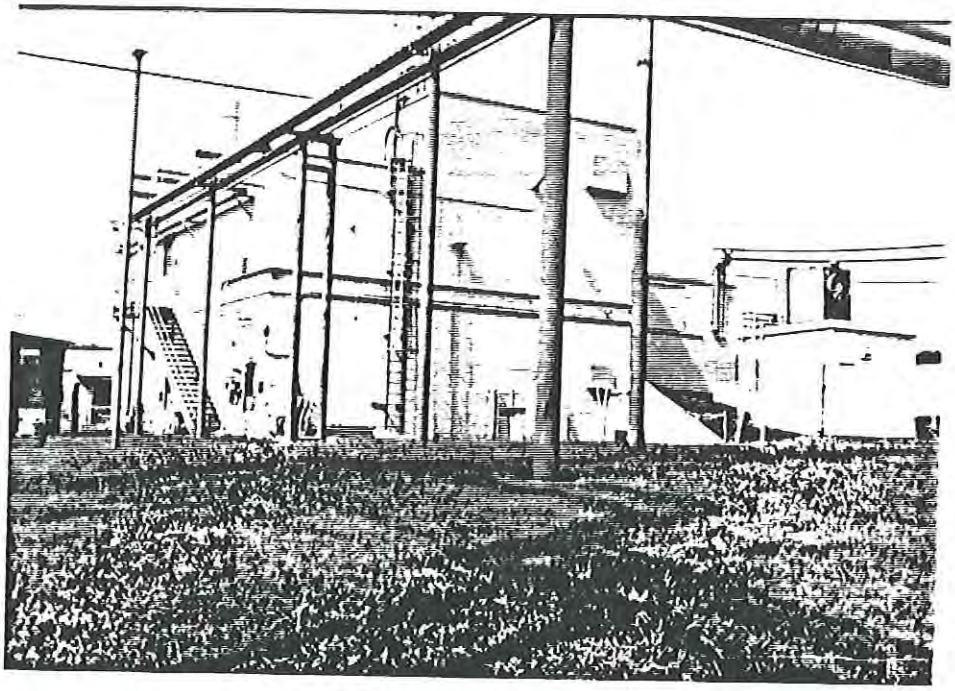


Figure III-39. 2531 Radioactive Waste Evaporator Facility (1954). View toward west with Building 2532 on right of photograph.

2624 MAIN CURRENT USE: Inactive
ORIGINAL USE: Solid Waste Storage Area 1

HISTORY: This area was the first in a series of SWSAs at the ORNL. The facility served as a burial ground for solid radioactive wastes with the earliest recorded burial being in the Spring of 1943 (Ford et al. 1992:27). Auger holes and trenches were purportedly the burial methods utilized (Ford et al. 1992:27). Records do not indicate what was buried or where within the area. No burials occurred after Solid Waste Storage Area 2 was placed in service in 1944.

DESCRIPTION: Located twenty-five feet south of White Oak Creek and bisected by Third Street, SWSA 1 is a trapezoidal area approximately one acre in size. The burials remain in place and the site is grassed and surrounded by a barbed wire fence.

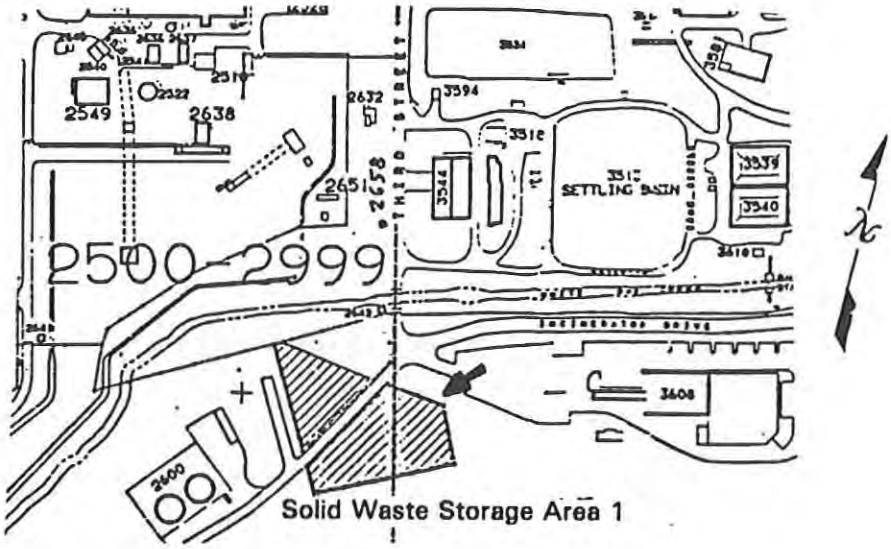


Figure III-40. 2624 Solid Waste Storage Area 1 (1943). This waste burial area remained in service for one year.

3000 MAIN CURRENT USE: 13.8 kV Substation
ORIGINAL USE: Substation

HISTORY: Historic photographs indicate that an electrical substation stood just east of Building 3000 during World War II. The present substation, including Building 3000, dates from 1952.

DESCRIPTION: The substation is comprised of electrical transformer equipment and a 1,480 square-foot, brick-faced building with a flat roof, stone coping, and metal multipaned windows.

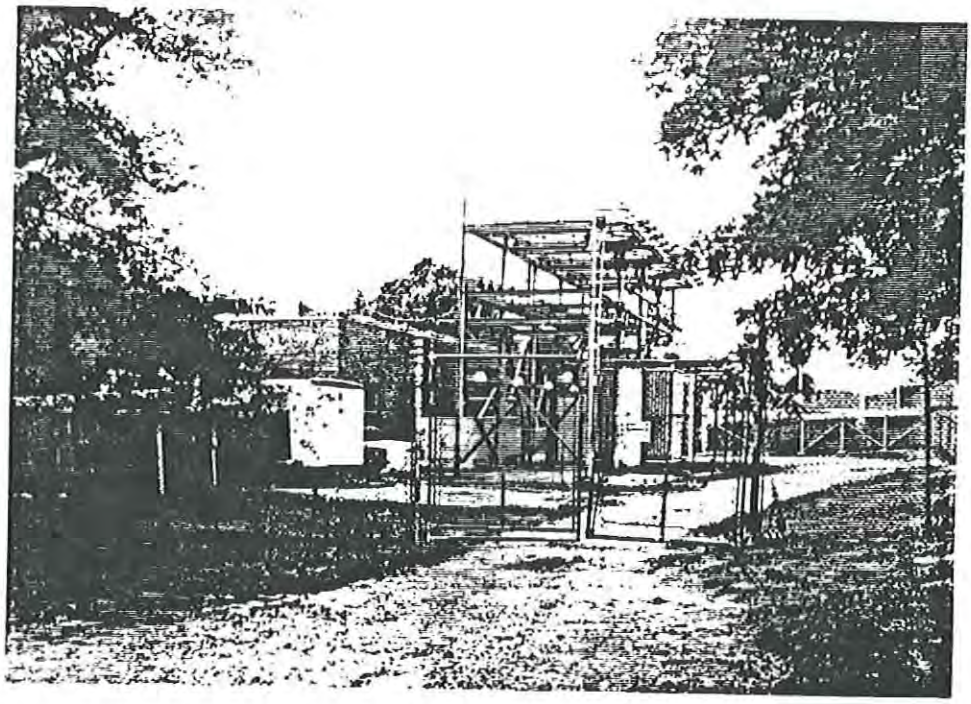


Figure II-41. 3000 13.8 kV Substation (1952). Plans show that Building 3000 was built in 1952. View southwest.

3001 MAIN CURRENT USE: Graphite Reactor Museum, Offices
ORIGINAL USE: Graphite Reactor

HISTORY: Constructed as part of the Manhattan Project in 1943 at a cost of $3,485,000 and reaching criticality in November of that year, the Graphite Reactor used U-235 to produce plutonium. The plutonium produced was used for research on the production of the World's first atomic bomb. The Graphite Reactor and adjacent chemical processing plant (Building 3019) produced the world's first gram quantities of plutonium.

After World War II, the mission of the Clinton Laboratories and the function of the reactor changed. The Graphite Reactor was used for numerous experiments and the highly significant radioisotope production for medical and biological research. Starting in 1947, the reactor also was used in shielding studies which involved testing of various materials for their capacity to prevent escape of radiation from a reactor. A two-foot square hole on the face of the reactor was used in the beginning for the insertion of shield samples. In 1949, the Lid Tank Shielding Facility was added to the west face of the reactor, the "first facility designed for experimental radiation shielding research" (Ingersoll and Ingersoll 1992:4).

The Graphite Reactor continued in operation for twenty years producing isotopes for research. The reactor was also used for the conduct of shielding tests. Three years after its shutdown in 1963, the facility was designated a National Historic Landmark. Today, the building houses offices and the Graphite Reactor Museum.

DESCRIPTION: The 29,746 square-foot, steel-frame, three-story structure which houses the reactor is metal-sided and has a gable roof with ridgeline vents. One- and two-story shed additions are found on the east and south facades. Banks of multipane hopper windows are on each side of the building. The door on the northeast corner of the building provides access to the museum. *The only known exterior alterations are the replacement of the original windows (shown in World War II photographs) with the existing windows sometime in the late 1940s or 1950s. The wartime windows were tripart with each part of equal size while the existing hopper windows are tripart but the central panel is larger.*

The interior of the building contains office space and a museum with the Graphite Reactor as its focus. The reactor is an air-cooled, graphite-moderated reflected heterogeneous natural-uranium-fueled reactor. The moderator is a 24-foot cube of graphite blocks (73 layers) containing spaces for loading of fuel rods and for shielding research

experiments. The graphite core is surrounded by a seven foot thick reinforced concrete shield.

A subsurface canal connects the Graphite Reactor building with the adjacent Radiochemical Processing Pilot Plant (Building 3019) and was used to transfer irradiated fuel slugs from the Graphite Reactor to Building 3019. The canal is approximately seven feet deep and forms an L-shape with 77-foot and 73-foot long corridors connected at 90 degrees. There are walkways on each side of the canal with water working as the shielding medium.

Alterations to the Graphite Reactor include the insertion of boron rods into the reactor to assure that it could not go critical, disablement of control and safety rods, and removal of all fuel. The reactor face and control room serve as a museum today.

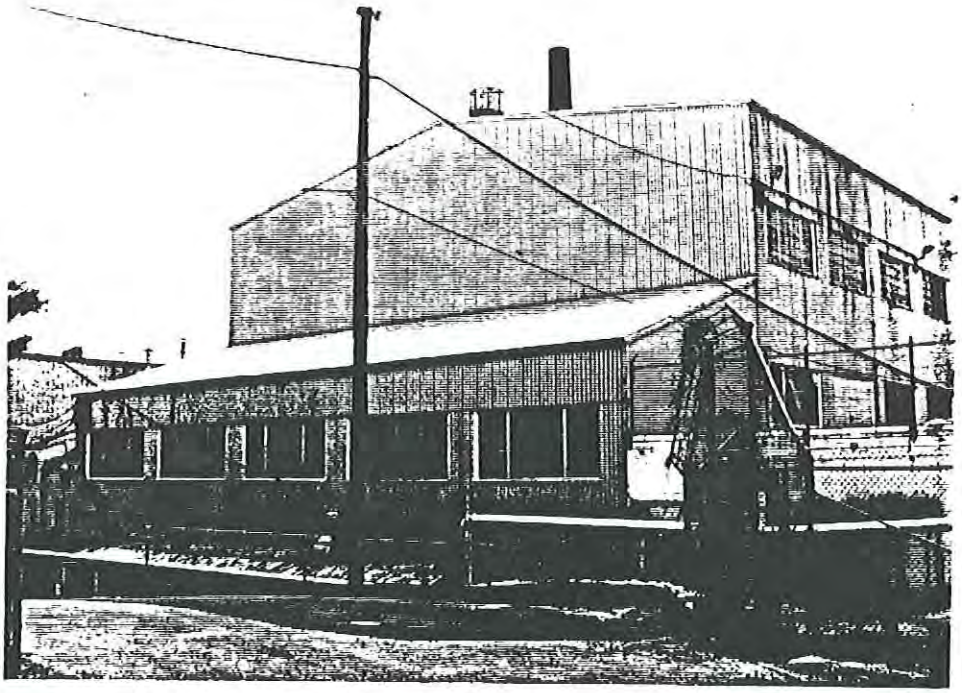


Figure III-42. 3001 Graphite Reactor (1943). North facade. View southeast.

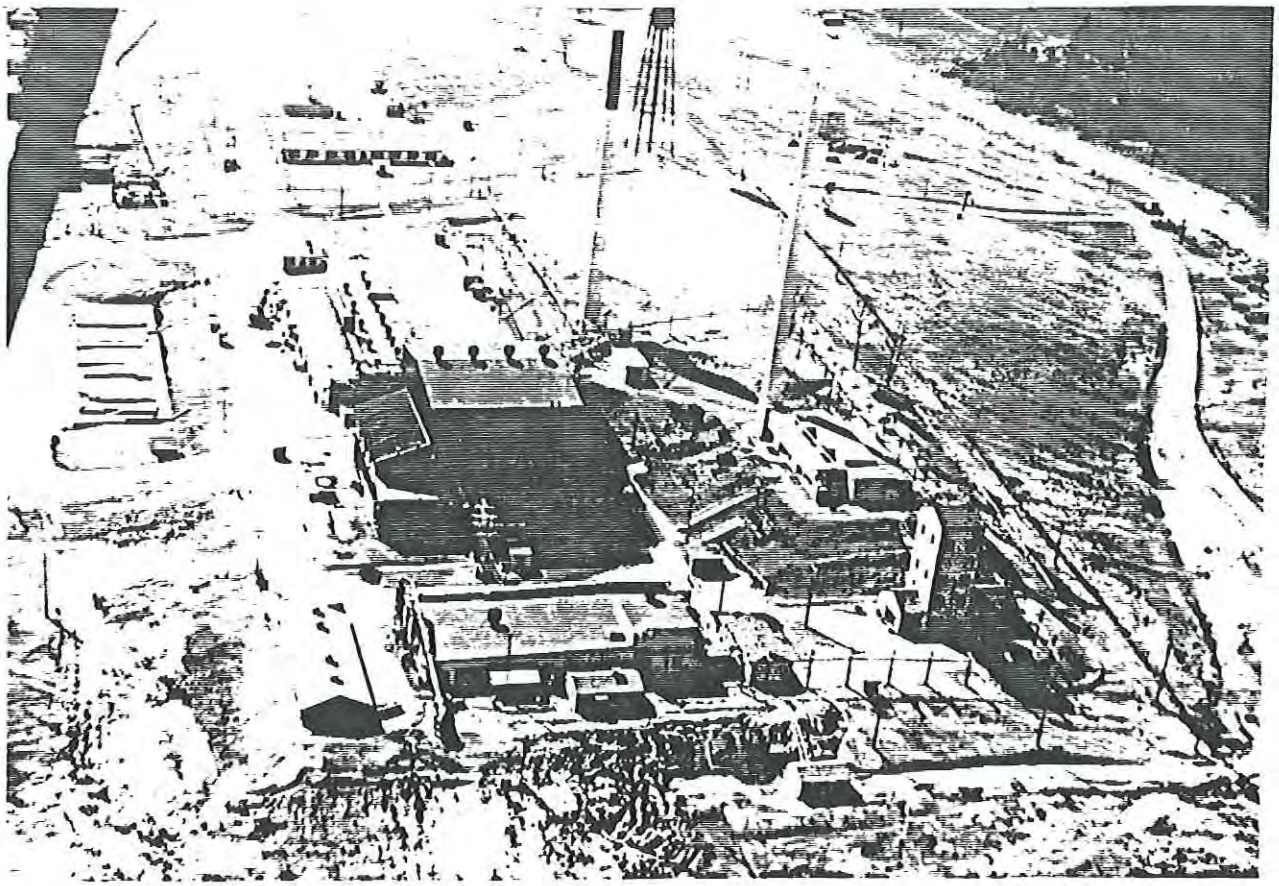


Figure III-43. ORNL Hstry 190. 1944 aerial view with Graphite Reactor in center painted wartime black. View west.

3002 MAIN CURRENT USE: Filter House (not in operation)
ORIGINAL USE: Filter House for 3001

HISTORY: This structure was constructed in 1948 and is associated with the Graphite Reactor (Building 3001). It filtered air from the air-cooled reactor prior to exhaust through the fan house (Building 3003) and adjacent stack (Building 3018). Plans dated 1948 show the structure much as it appears today.

DESCRIPTION: This 3,450 square-foot, concrete structure has a flat roof with a metal rail and a metal staircase leading to the roof. A small, concrete block flat-roofed section is attached to the north facade.

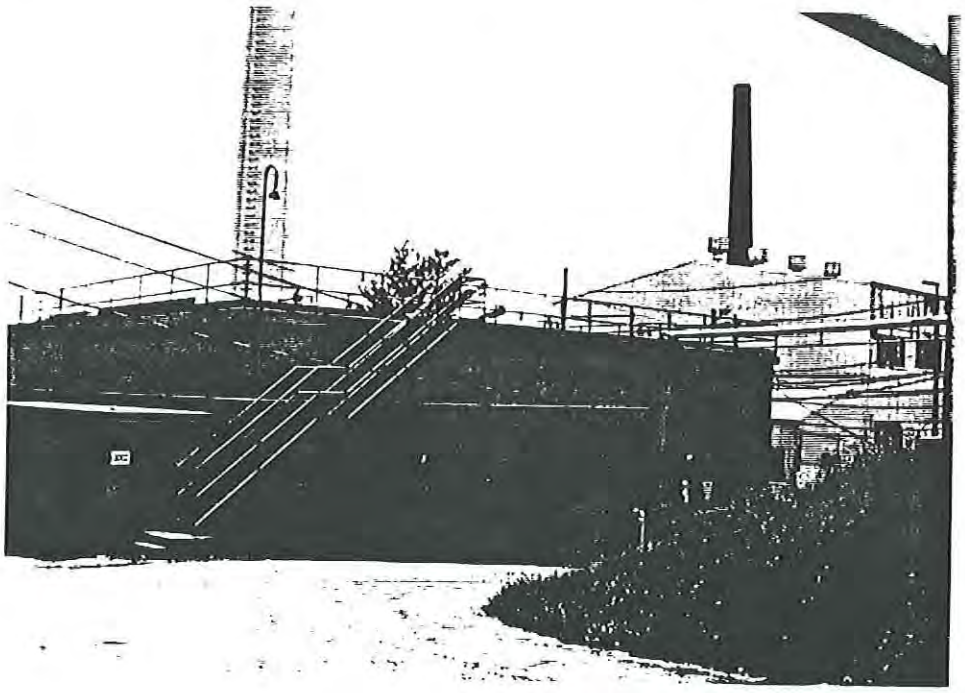


Figure III-44. 3002 Filter House (1948). This structure filtered air from the air-cooled Graphite Reactor before release through Stack 3018. View southeast.

3003 MAIN CURRENT USE: Solid State Accelerator Facility
ORIGINAL USE: Fan House

HISTORY: This 1943 structure is associated with the Manhattan Project and the Graphite Reactor (Building 3001). Built as a fan house, the structure drew air by fan from the reactor through underground ducts and released it through the adjacent exhaust stack (Building 3018). When the filter house was constructed (Building 3002), the air was filtered before release. After the Graphite Reactor was shut down in 1963, the building underwent a 1969 modification to serve as a Solid State Accelerator Facility providing laboratory and office space for the Solid State Division.

DESCRIPTION: This 7,605 square-foot, irregular plan building has sections of both concrete block and metal-frame construction. The concrete block walls are two-feet thick. The metal-frame portions are sided with corrugated-metal siding. The roof is flat and the building is mainly one-story in height with a two-story section on the northwest corner. This structure is connected to a canal that allowed it to receive air from the Graphite Reactor. Two large fans would draw the air from the Graphite Reactor and blow it out the adjacent stack.

In 1951, the building was modified by the addition of a one-story section on the north side which plans indicate had doors with four-pane windows and multipane hopper windows (no longer extant-apparently sided over). In 1978, the shed-roofed building sections received built-up roofing and new metal siding to accommodate an "accelerator and office addition" on the east side of the building. In 1982, interior renovations occurred for the "ion beam and laser user facility."

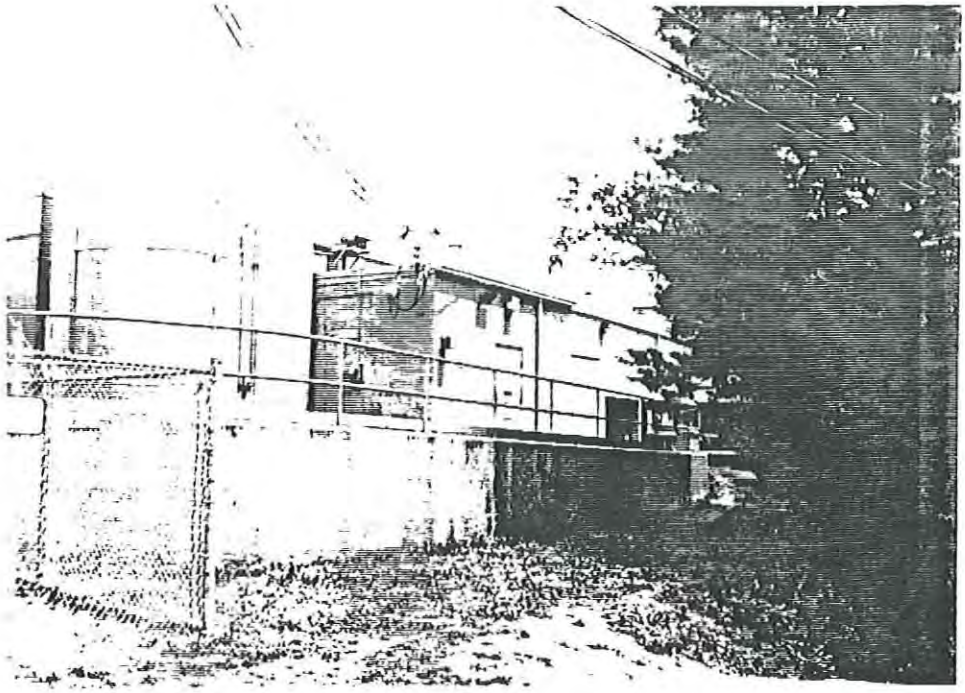


Figure III-45. 3003 Solid State Accelerator Facility (1943). Detail showing south side of facility with concrete block addition in center and tanks at left. View northeast.

3004 MAIN

CURRENT USE: Water Demineralizer
ORIGINAL USE: Water Demineralizer

HISTORY: This Manhattan Project structure is associated with the Graphite Reactor (Building 3001). Built in 1943, the building contained equipment for demineralizing water for use in the Graphite Reactor. Untreated water passed through the system which removed minerals and then transferred the treated water to a 12,000-gallon holding tank in the Building 3004 tower. From there, the demineralized water was piped out as needed to the Graphite Reactor and other facilities. Building 3004 is still used for water treatment but the original equipment is obsolete, and although it remains in the building, it is not in use.

DESCRIPTION: This 3,690 square-foot, wood-frame structure has a four-story, gable-roofed tower flanked by two one-story, gable-roofed sections on the north and south sides. It is sided with the original novelty-board siding and has wood-frame, one-over-one windows. The interior is intact with the original equipment, wooden staircase and 12,000-gallon holding tank in the tower. The structure is still used for water treatment although modern equipment is used today for the process.

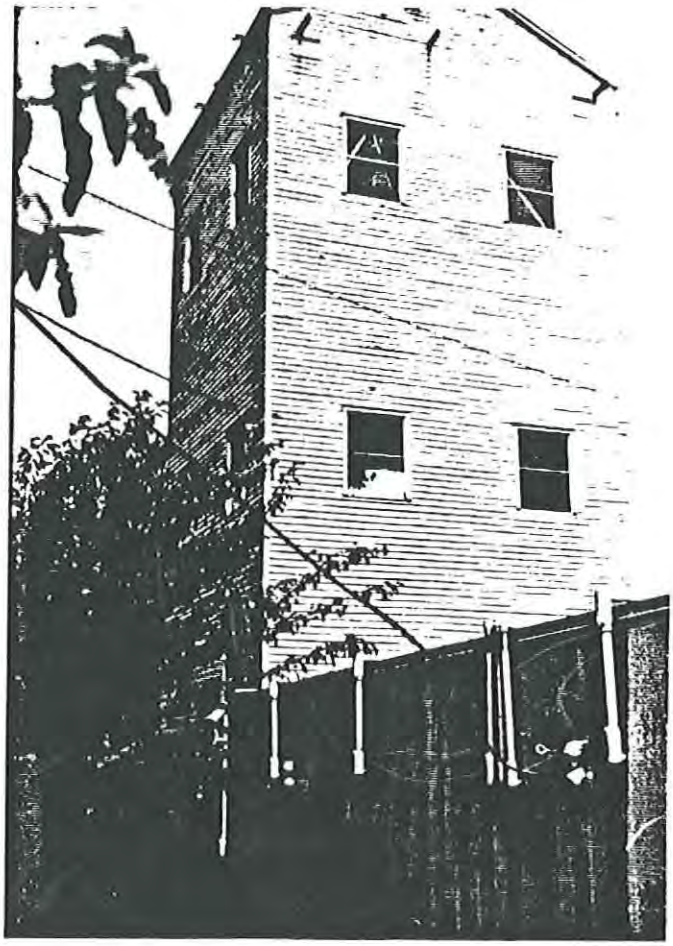


Figure III-46. 3004 Water Demineralizer (1943). This wood-frame structure is one of the few unaltered buildings remaining from the Manhattan Project. View north.

3005 MAIN

CURRENT USE: Low Intensity Testing Reactor
ORIGINAL USE: Mock-up of Materials Testing Reactor

HISTORY: In 1948, the ORNL's reactor development efforts were concentrated on the design of the Materials Testing Reactor (MTR). As part of the development process, a full-scale mock-up of the reactor tank and major components was constructed around 1948 and housed in Building 3005. The purpose of this mock-up was for performance and hydraulic tests to assure that cooling was adequate for the reactor core. Once these tests were completed, the "ORNL had a full-scale mock-up of the MTR with a cooling system and all the basic features necessary for operating a reactor" (Thompson 1963:66). The ORNL then brought the mock-up reactor to criticality. Once its performance was proved, the ORNL requested AEC authorization to add shielding around the mock-up, make necessary modifications and operate it as a research reactor.

The addition of shielding and reactor modifications were accomplished and the Low Intensity Testing Reactor (LITR), as it was known, began operation in 1951. The LITR had a water-cooled and -moderated system using enriched uranium for fuel which supplied "a variety of irradiation facilities for the ORNL and other research groups" (Ford and Holder 1992:A-57).

The LITR design also served as a prototype for the MTR built at Arco in Idaho. This reactor was "essentially identical with the high flux [MTR] reactor designed at the laboratory" (Thompson 1963:60). The MTR was also a design prototype for commercial power plants and for reactor-propelled naval craft. "Many dozens of research reactors, all based on this simple principle pioneered at the ORNL, are now in use throughout the world; and the U.S. fleet of nuclear submarines is powered by pressurized versions of the original MTR" (Overholt 1987:361).

The LITR was permanently shut down in 1968. Today, the east and west rooms of the building are used as shops for the Instrument and Controls Division and the Plant and Equipment Division.

DESCRIPTION: The 11,368 square-foot, LITR building was built in several phases and is of concrete and steel-frame construction. It has a central three-story, flat-roofed tower surrounded by one-story frame and concrete flat-roofed sections. The frame sections, including the tower, are sheathed in corrugated-metal siding. Windows in the tower are single-pane fixed sash. The flat-roofed concrete block section to the northwest of the tower contains a door and two shed-roofed additions.

The building was originally comprised of the mock-up reactor and a two-room control house on the north side of the reactor. When the mock-up was converted to an operational research reactor in 1951, additional shielding (comprised of borated plastic surrounded by loose stacked concrete blocks and river sand) was added around the reactor and rooms were constructed on the east, south and west sides. *These additions had multipaned hopper windows which have since been either removed or covered. In 1953, another addition was built on the west side of the building containing a roll-up door.*

The LITR was shut down in 1968 and the fuel removed in 1970. The beryllium reflector and other reactor components remain.

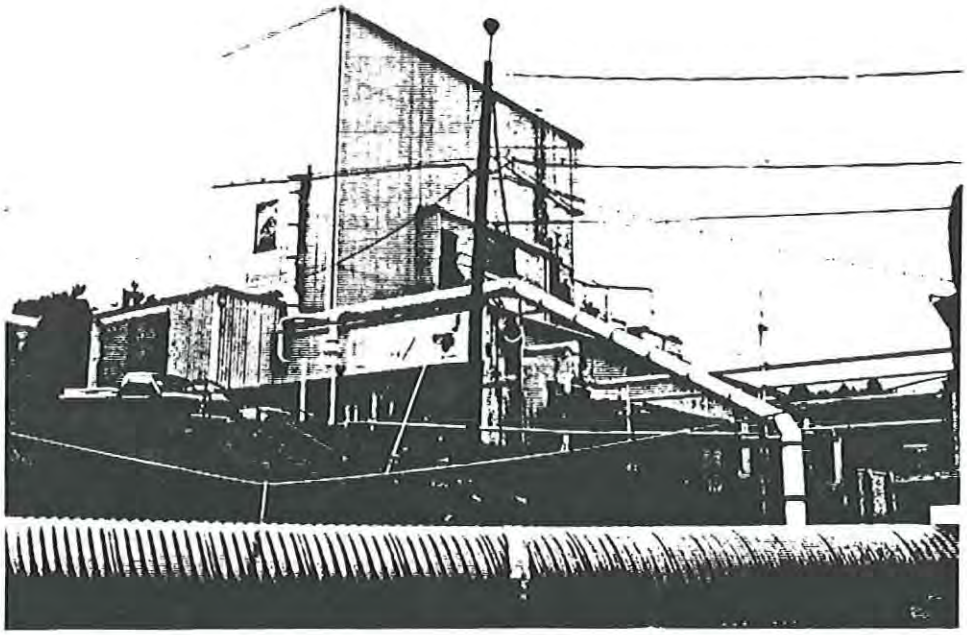


Figure III-47. 3005 Low Intensity Testing Reactor (1948). Built in 1948 as a mock-up, the reactor was converted to a research reactor in 1951. View northwest.

3008 MAIN

CURRENT USE: Source and Special Materials Vault
ORIGINAL USE: Storage Vault

HISTORY: This vault was constructed in 1943 adjacent to the Graphite Reactor (Building 3001) and can be seen in a 1943 aerial photograph. It was used for materials storage. Today, Building 3008 is assigned to the Laboratory Protection Division.

DESCRIPTION: The 544 square-foot, concrete block structure has a flat roof and is one-story in height. The south facade contains two vault-type doors. There are no windows.

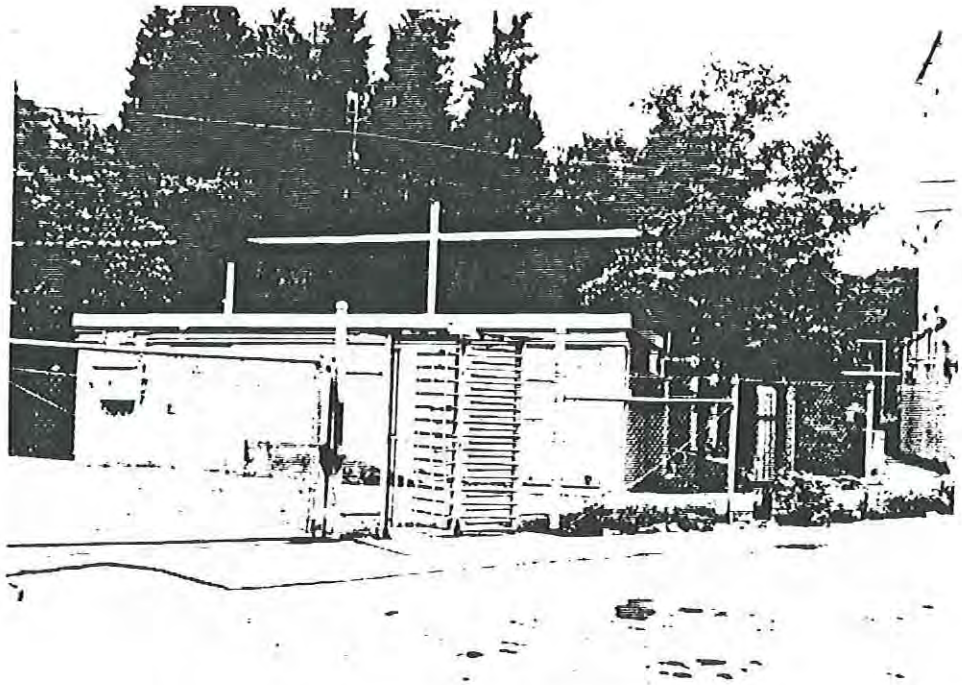


Figure III-48. 3008 Source and Special Materials Vault (1943). This vault stands adjacent to the Graphite Reactor (Building 3001). View northwest.

3009 MAIN

CURRENT USE: Pump House for Building 3010 (Bulk Shielding Reactor)
ORIGINAL USE: Pump House for Building 3010

HISTORY: This ca. 1950 building is associated with the Bulk Shielding Reactor Facility and served as a pump house.

DESCRIPTION: The 180 square-foot structure stands adjacent to Building 3010 and has a flat roof and pumping apparatus.

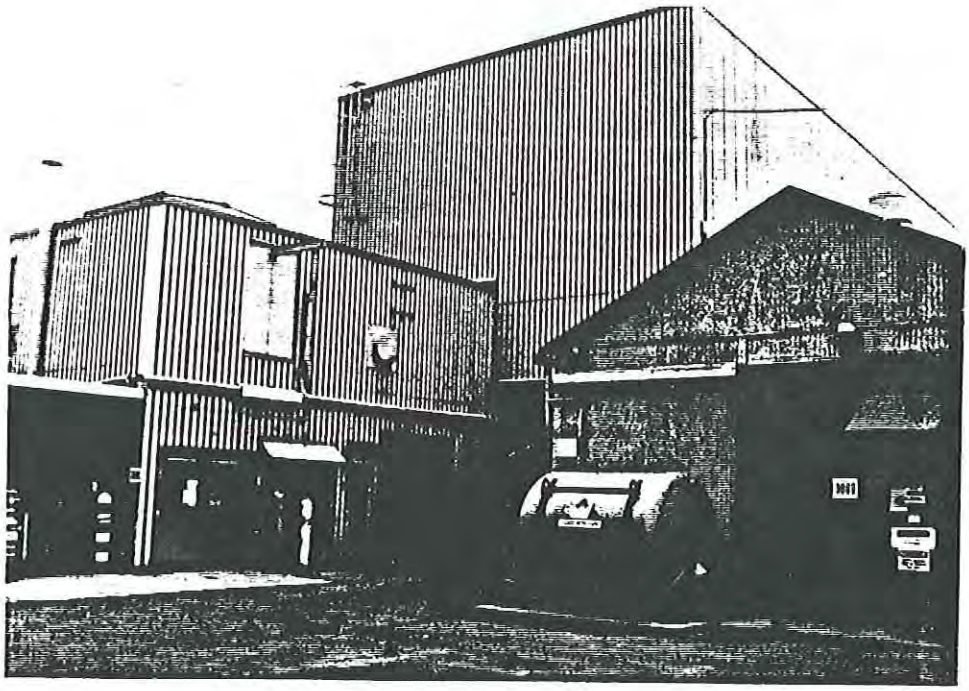


Figure III-49. 3009 Pump House (1950). The Pump House is a support structure for the Bulk Shielding Reactor Facility (Building 3010). View southeast.

3010 MAIN CURRENT USE: Bulk Shielding Reactor
ORIGINAL USE: Bulk Shielding Reactor

HISTORY: The Bulk Shielding Reactor (BSR) is associated with the Aircraft Reactor Experiment (ARE) at the ORNL in the late 1940s and early 1950s. The facility was constructed in 1950 at a cost of $308,000 for use in radiation shielding studies, mainly to test materials for possible use on a nuclear-powered aircraft.

The first post-World War II shielding studies were conducted using the Graphite Reactor. First, core hole shielding tests were done on the face of the reactor and in 1947, the ORNL developed the Lid Tank Shielding Facility on the west face of the Graphite Reactor. This was the first facility built specifically at the ORNL for shielding studies, making the Bulk Shielding Reactor the second.

For the construction of the BSR, the ORNL modified the MTR design to create a "swimming pool" reactor. The core of the BSR was submerged in water for both cooling and moderation purposes. By the use of an overhead crane, the reactor could be moved around in a tank to test shielding in various configurations. A smaller pool and 10K nuclear assembly, the Pool Critical Assembly, allowed the conduct of small-scale experiments in the corner of the building.

After two years of operation, the ORNL realized that this facility was inadequate for some of the tests needed for the ARE and the Tower Shielding Facility (7700 Area) was constructed in 1952 for additional tests. The BSR continued in use for shielding experiments and in 1960, the BSR II was built at the ORNL at a cost of $104,000. The relatively inexpensive, safe and stable BSR became a prototype for many research reactors around the world. In tandem with the Graphite Reactor (Building 3001), the BSR produced important research in radiation damage processes in solids. Building 3010 is presently on stand-by awaiting decontamination and decommissioning.

DESCRIPTION: This 8,527 square-foot, steel-frame structure has an irregular plan and is one and two stories in height. The structure has corrugated-metal siding, a flat roof and original multipane hopper windows. A two-story, flat-roofed section on the north side has a crane bay. *Alterations include replacement of the original reactor core in 1960 with the BSR II reactor core and in 1963, a forced-air cooling system was installed.*

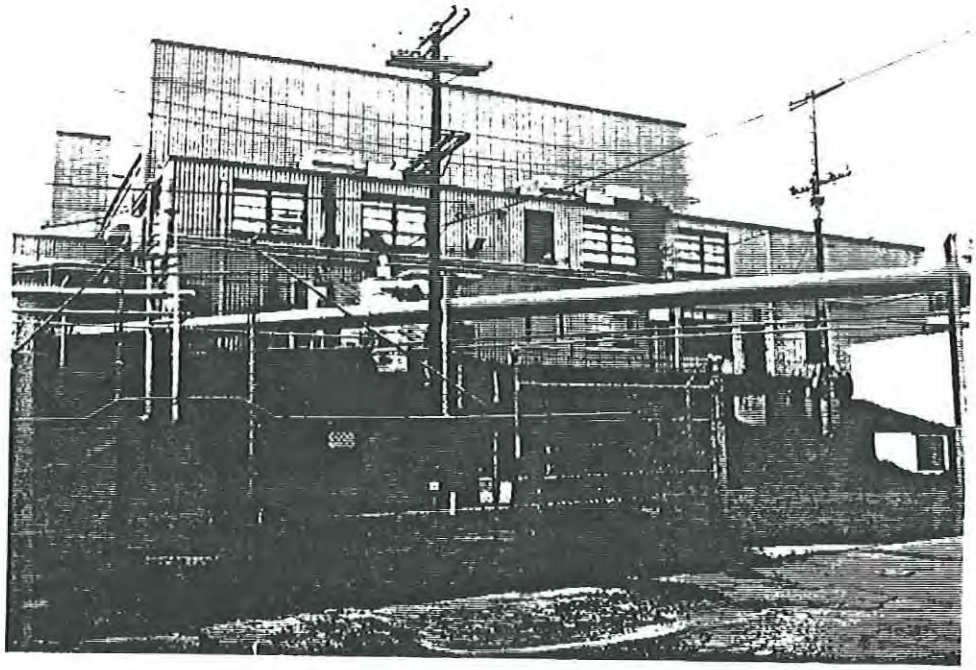


Figure III-50. 3010 Bulk Shielding Reactor Facility (1950). View toward northwest of east facade with original hopper windows.

3012 MAIN CURRENT USE: Rolling Mill
ORIGINAL USE: Rolling Mill

HISTORY: In 1945, Clinton Laboratories purchased a second-hand rolling mill and constructed Building 3012 to house it at a cost of $180,000. The building was completed in 1947 and was assigned to the Metallurgical Division. The Metallurgical Division undertook intensive research into metallic elements under high temperatures and radiation stress produced in reactors. The rolling mill was used to roll, cast and forge reactor fuel elements and metal parts, and is still in use by the Metallurgical Division today.

DESCRIPTION: This 10,752 square-foot, steel-frame, two-story structure has a gable roof with ridgeline vents, original hopper windows on both levels and large roll-up doors on both gable ends. Small shed-roofed additions are located on the north and east sides. The interior of the building contains a large room housing the milling equipment. A track in the concrete floor was for the rolling mill. Equipment plans show a four high, fourteen inch and 20-inch mills, a crane and a furnace.

In 1951, one bay was added to the north end of the building for a shop and the existing roll-up doors and hopper windows were relocated to the new end. Some existing equipment was relocated to the new section and other equipment was purchased.

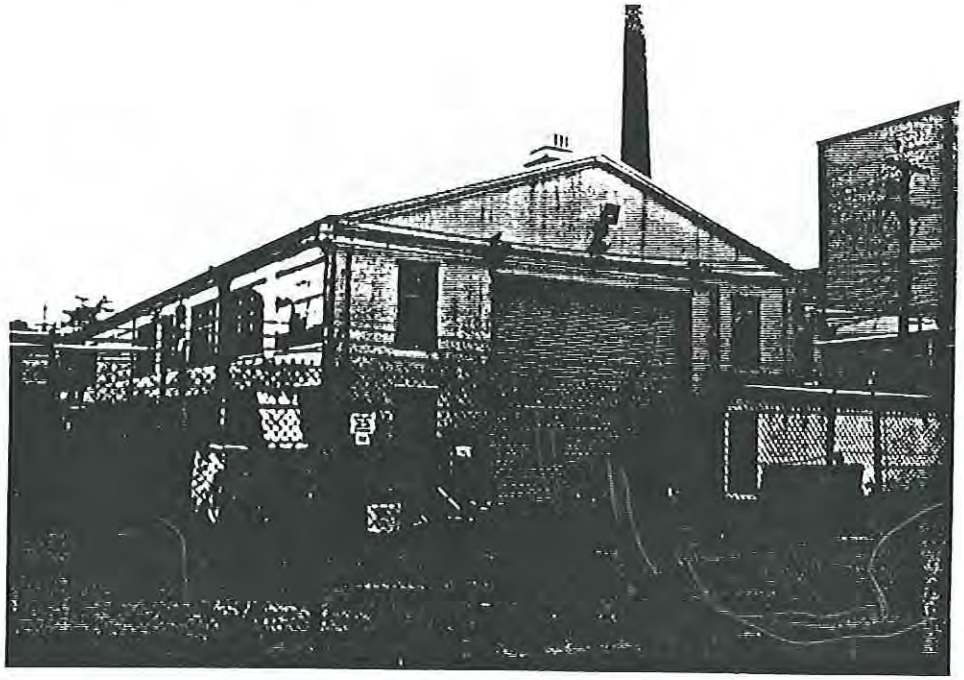


Figure III-51. 3012 Rolling Mill (1945). View toward southwest of east and north elevations.

3013 MAIN CURRENT USE: Geological Disposal Laboratory
ORIGINAL USE: Source Building

HISTORY: Building 3013 was constructed between 1948 and 1951. It does not appear in a 1948 photograph (ORNL Hstry 267) but does appear in a pre-1951 photograph (ORNL Hstry 76). It is assigned today to the Environmental and Health Protection Division and is used as a geological disposal laboratory.

DESCRIPTION: This 720 square-foot, wood-frame structure is one-story in height with a gable roof, novelty-board siding and original eight-over-eight, wood-frame windows. Double steel doors on the west gable end are replacements.

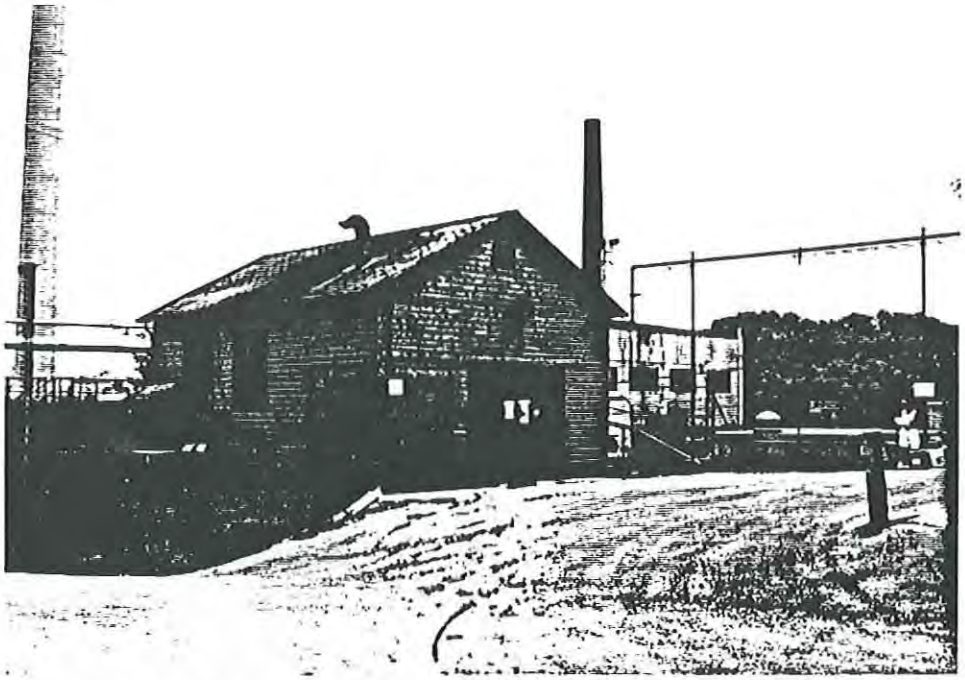


Figure III-52. 3013 Geological Disposal Laboratory (ca. 1949-1950). Paired steel doors on west gable end are replacements. View southeast.

3017 MAIN

CURRENT USE: Chemical Technology Division Annex
ORIGINAL USE: Oak Ridge School of Reactor Technology Laboratory

HISTORY: This 1952 building is associated with the Oak Ridge School of Reactor Technology (ORSORT) and provided laboratory facilities for students. The ORSORT grew out of a program operating at the Clinton Laboratories in 1946 and 1947. In 1950, a decision was made to establish a full-fledged training program, ORSORT, which continued to operate until 1965. Today, the building provides laboratory space for the Chemical Technology Division.

DESCRIPTION: This 10,244 square-foot, concrete block structure has a flat roof with metal coping and paired and single six-pane hopper windows with concrete sills. The main entrance is on the north facade where steps lead down under a flat-roofed portico to the door. The entrance on the west has steps leading up to a recessed entrance with paired doors.

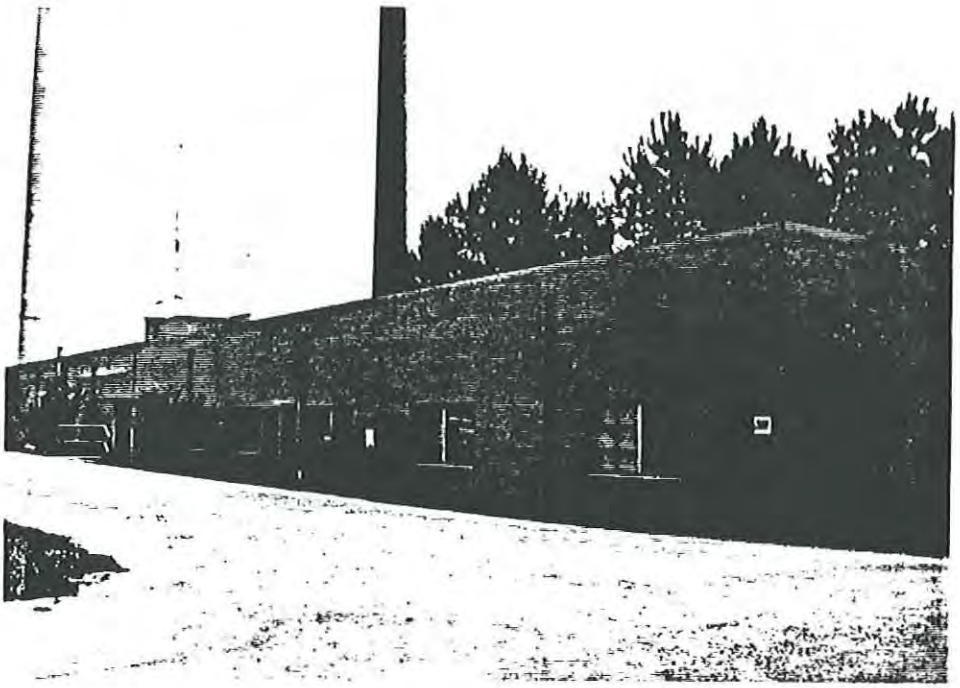


Figure III-53. 3017 Chemical Technology Division Annex (1952). The structure was built in 1952 as laboratory space for students of ORSORT. View southeast.

3018 MAIN

CURRENT USE: Exhaust Stack for 3003
ORIGINAL USE: Exhaust Stack for 3001

HISTORY: Stack 3018 is associated with the Manhattan Project and the Graphite Reactor (Building 3001). Built in 1943, the stack served as exhaust for the air-cooled reactor. Air was drawn through the Fan House (Building 3003) and up through the stack. Today, it serves as an exhaust stack for the Solid State Accelerator Facility (Building 3003).

DESCRIPTION: The 200-foot tall structure is an exhaust stack of concrete construction with outside irons.

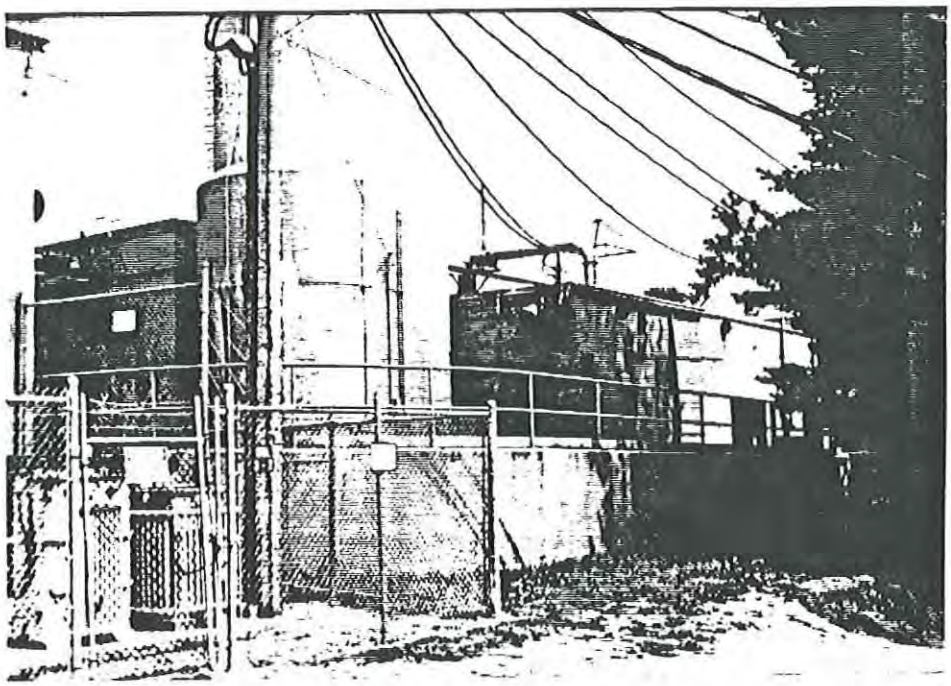


Figure III-54. 3018 Exhaust Stack for Building 3001 (1943). Base of stack to left of center, Building 3003 at right. View northeast.

3019A MAIN CURRENT USE: Radiochemical Processing Pilot Plant
ORIGINAL USE: Chemical Separations Plant

HISTORY: This Manhattan Project facility was completed in December of 1943 at a cost of $681,000. Like the Graphite Reactor (Building 3001), the plant was designed and built by the Dupont Company. Dupont was still in the design phases of the building as construction began.

The purpose of this building was to serve as a pilot plant to process and separate plutonium from irradiated slugs produced in the Graphite Reactor. Technologies would then be used for the construction of the proposed production plant at Hanford. The process involved the movement of the uranium slugs through the reactor. As new slugs were loaded, the slugs irradiated in the reactor would fall out the other side into a bucket. The buckets of slugs underwent radioactive decay for several weeks and then were moved via an underground canal from the Graphite Reactor building to Building 3019. Building 3019 contained six underground concrete cells. The first cell was connected directly to the tunnel and contained a large tank where the aluminum jackets of the uranium slugs were dissolved. The uranium was then passed into the next cells which held equipment for successive oxidation reduction cycles (the sixth cell was for storage of contaminated equipment). In these cells, the actual extraction of the plutonium occurred using remote control equipment and the bismuth phosphate process.

Adjoining the six concrete cells was a frame structure that housed the remote operating gallery and offices. The operation of the Radiochemical Processing Pilot Plant involved the handling of radioactive material on a scale never before attempted. Remote control was needed for even the smallest of operations and television, itself a relatively new technology, was used to monitor activity. By the end of 1944, this pilot plant was processing 0.3 ton per day of irradiated uranium. It produced several grams of plutonium by early 1944, supplying the first gram quantities of plutonium for bomb research at Los Alamos.

The design and technology developed for this chemical processing plant were used for the construction of a full-scale plant at Hanford.

After World War II, Building 3019 continued to play a very important role in the evolution of chemical recovery processes. It served as a pilot plant for testing of the Redox (separation) Method (developed at Argonne) until 1951 when the method was put into use at Hanford. The Purex Process developed by the ORNL, which had significant

advantages over the Redox Method, went through the pilot plant stage at Building 3019 and was put into operation at both Hanford and Savannah River. These and later processes researched and developed at the ORNL played a major role in the advancement of chemical reprocessing techniques used worldwide. Today, Building 3019 continues in use for separation and reprocessing research and development and serves as the National Repository for U-233.

Building 3019 is a Nuclear Historic Landmark designated by the American Nuclear Society. The building possesses significance for its association with the Manhattan Project and the production of plutonium for the development of one of the first atomic bombs. Following World War II, Building 3019 served as a pilot plant for the development of chemical separation processes that have found "plant scale application in both government and commercial facilities on a worldwide basis" (Hightower 1991:1).

DESCRIPTION: This 29,537 square-foot, irregular plan building is, in general, three stories in height with a basement, a flat roof, and concrete block and steel-frame construction. The original facility was comprised solely of six concrete cells rising from basement level to approximately one-story above ground and a wood-frame office and control gallery attached to the north side of the cells. In 1950, a new structure was built around the cells (requiring the removal of the original wood section) for containment, laboratory space and control rooms. The north elevation of the existing building is relatively unaltered when compared to the 1950 plans showing eight-pane hopper windows with louvered vents above on the one-story concrete block section. In 1954, a "hot analytical facility" was built onto the west end of the building (Building 3019B). *Numerous undated additions are found on the south facade.*

Interior alterations include the removal of all pre-Purex equipment, cell one is no longer extant and equipment in the control rooms has been modernized. A new ventilation system was also installed.

An in-house memo best describes the evolution of Building 3019 (Hightower 1991:11,15):

> *Numerous changes have been made to the Building 3019 Pilot Plant to accommodate the multitude of processes requiring demonstration. Considerable credit should be given to the original designers of the facility to permit this flexibility.*

The memo continues:

> *As with all maturing technologies, those processes underway in Building 3019 required the facility to*

undergo numerous changes over the years. Demands made to improve safety, containment, criticality control, process control, safeguards and data collection are among the requirements that have been responsible for the many physical changes that have taken place over these many years.

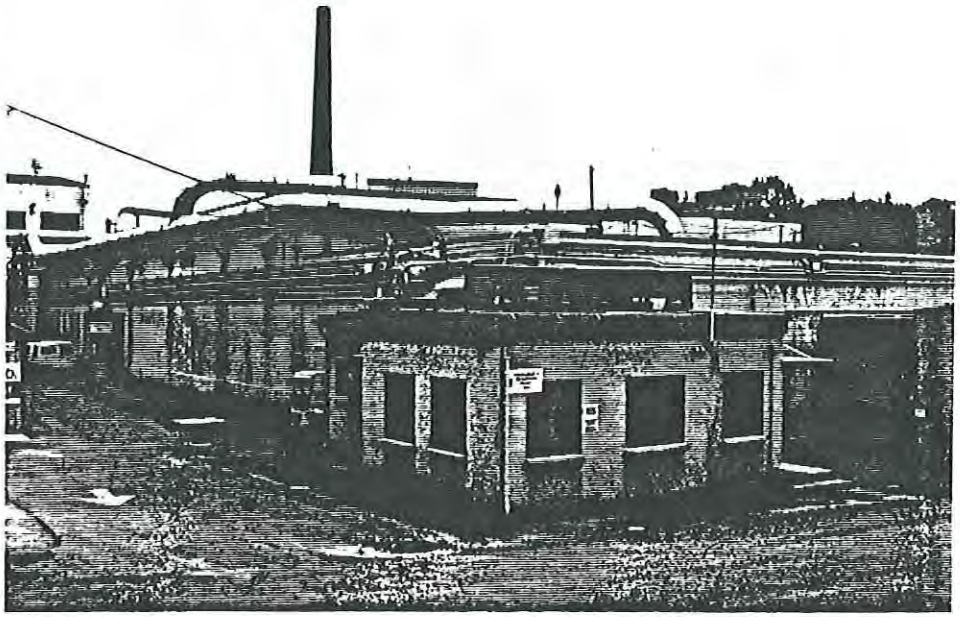


Figure III-55. 3019A Radiochemical Processing Pilot Plant (1943) and Building 3019B (1954). View toward southeast of north side of building with Building 3135 in center of photograph.

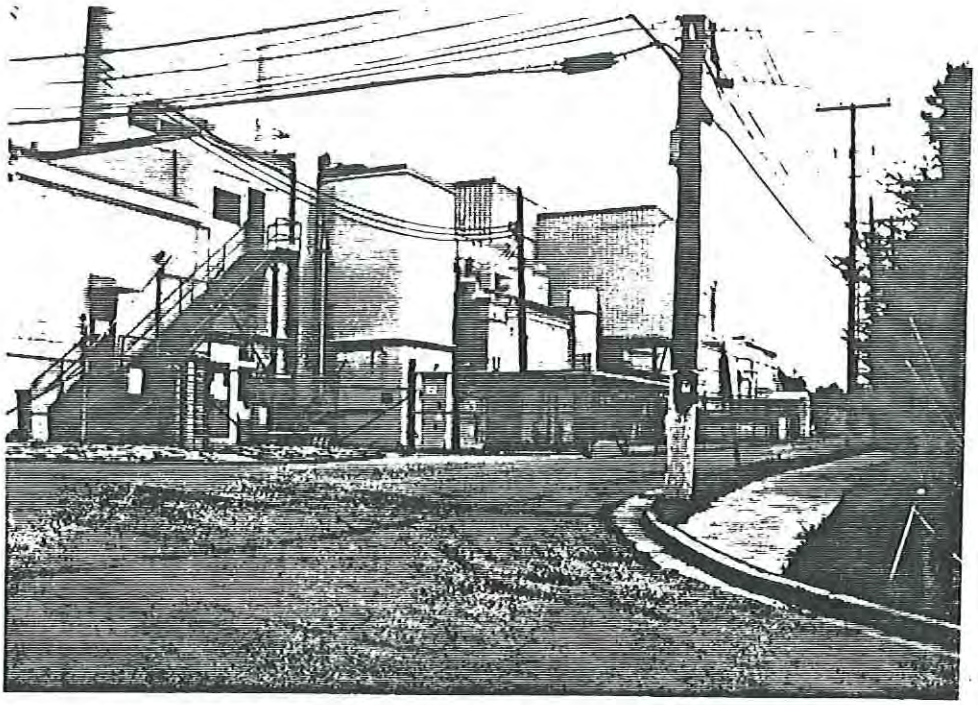


Figure III-56. 3019A Radiochemical Processing Pilot Plant (1943). View northeast of south elevation and Building 3019B at far left dating from 1954.

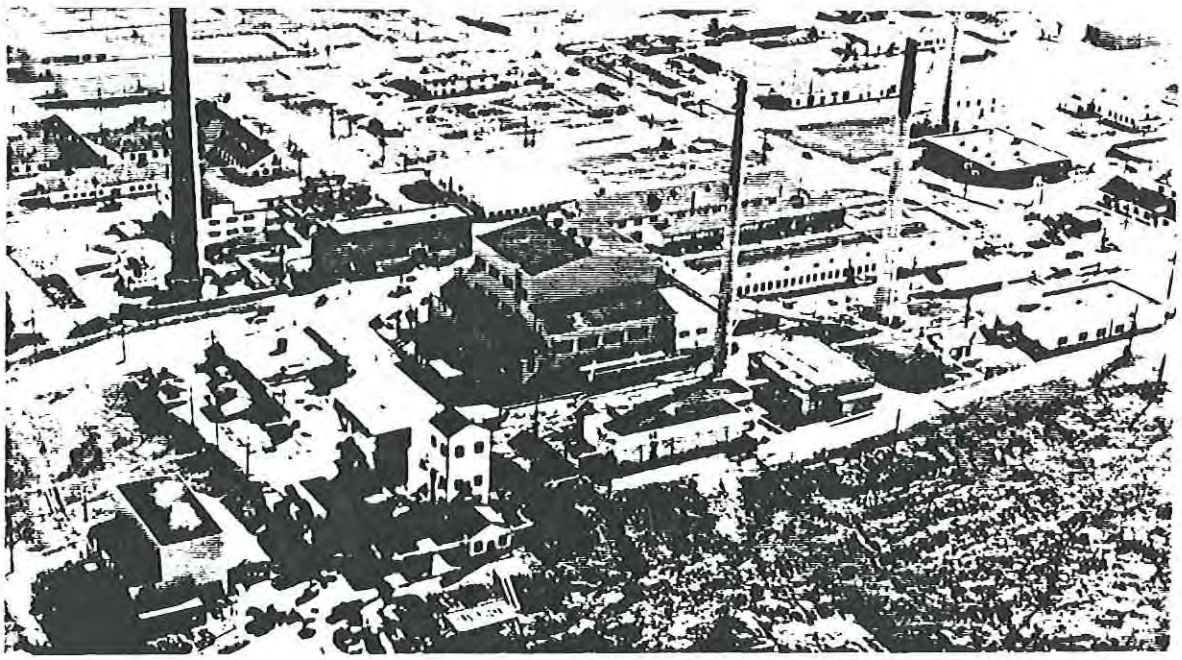


Figure III-57. ORNL Hstry 268. Ca. 1954 photograph looking southwest shows Graphite Reactor at center and Building 3019A at right of photograph after the containment structure was completed. At far west end of building is Building 3019B under construction.

3019B MAIN

CURRENT USE: High Level Radiation Analytical Laboratory
ORIGINAL USE: High Level Radiation Analytical Laboratory

HISTORY: Building 3019B is historically associated and physically connected to Building 3019A, the Radiochemical Processing Pilot Plant. This structure is a 1954 addition on the west end of Building 3019A and was built for the handling of highly radioactive materials.

DESCRIPTION: This 3,587 square-foot, concrete block building is appended to the west end of Building 3019A. It has a flat roof and a small cubical concrete block section on the west end with a flat roof and paired metal doors. *These metal doors replaced the originals which plans show with six-pane windows.*

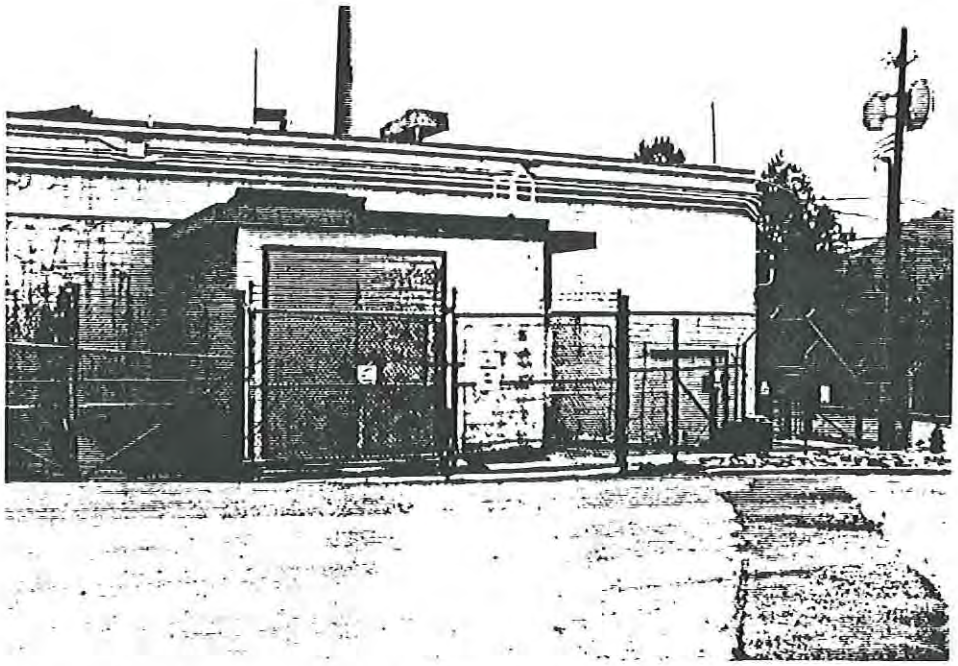


Figure III-58. 3019B High Level Radiation Analytical Laboratory (1954). Paired doors replaced the original doors with six-pane windows. View southeast.

3020 MAIN CURRENT USE: Exhaust Stack for 3019
ORIGINAL USE: Exhaust Stack for 3019

HISTORY: This structure is an exhaust stack historically associated with Building 3019, the Radiochemical Processing Pilot Plant. It is clearly shown in 1943 aerial photographs (ORNL-Hstry 162). It was used for venting the off-gas stack, cells, laboratories and glove boxes (small facilities with manipulators for handling radioactive materials).

DESCRIPTION: This 200-foot tall concrete stack stands to the north of Building 3019 and is operational.

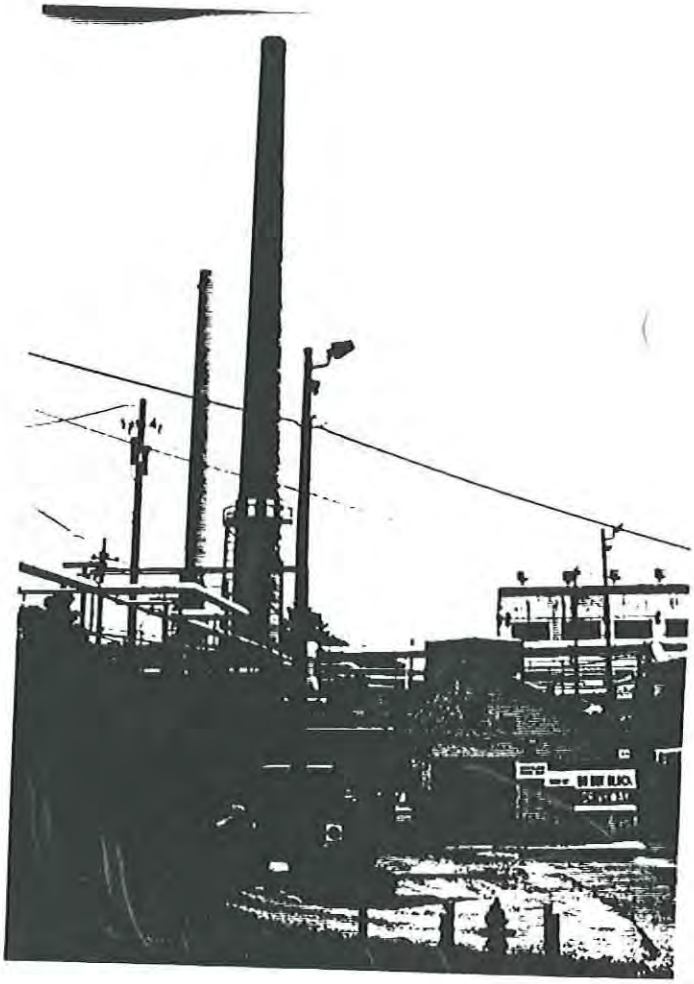


Figure III-59. 3020 Exhaust Stack for Building 3019. Stack 3018 to left. View east.

3021 MAIN

CURRENT USE: Turbine House for Building 3019
ORIGINAL USE: Turbine House for Building 3019

HISTORY: This Manhattan Project era structure is associated with Building 3019 and Stack 3020, the exhaust stack for Building 3019. It was built in 1943 and upgraded in 1955.

DESCRIPTION: This 100 square-foot, steel-frame building is attached to the base of Stack 3020. In 1955, plans indicate a new turbine and blower were installed.

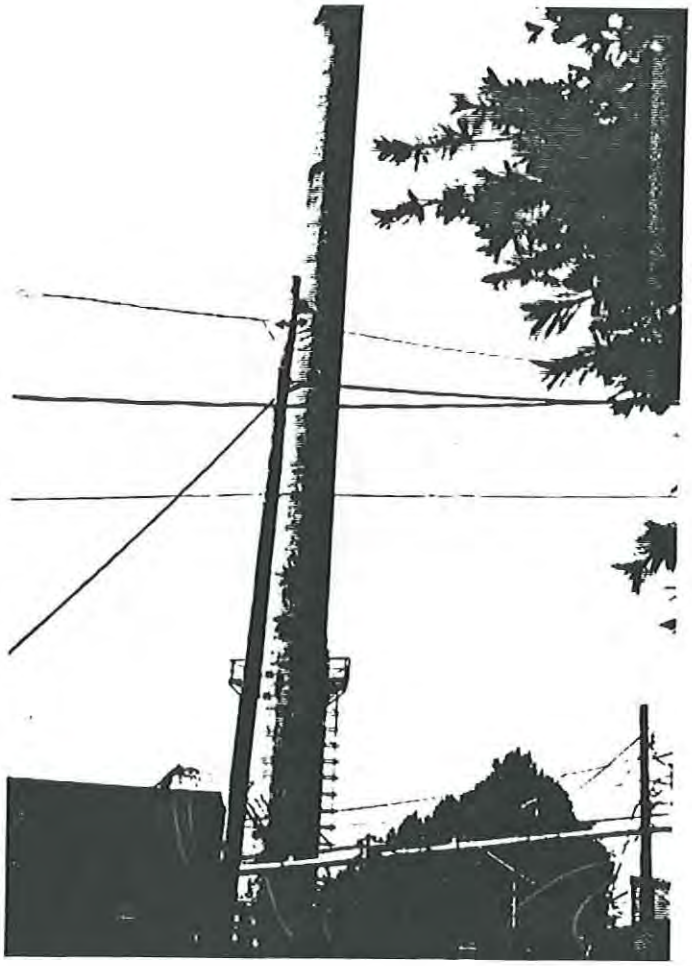


Figure III-60. 3021 Turbine House for Building 3019 (1943). Turbine House is at base of stack. View south.

3023 MAIN CURRENT USE: North Tank Farm
ORIGINAL USE: North Tank Farm

HISTORY: The North Tank Farm began operations during the Manhattan Project and is visible in aerial photographs of that period (ORNL-Hstry 183). The underground tanks were used for the collection and storage of liquid low-level wastes prior to their transfer to waste treatment facilities. In 1963, the tanks were removed from service.

DESCRIPTION: The North Tank Farm contains two underground 5,000-gallon Gunite tanks, two 41,000-gallon Gunite tanks and three 2,000-gallon stainless steel tanks. The tanks were all emptied upon removal from service. The site today is a roped off grassed area with numerous appurtenances protruding from the ground.

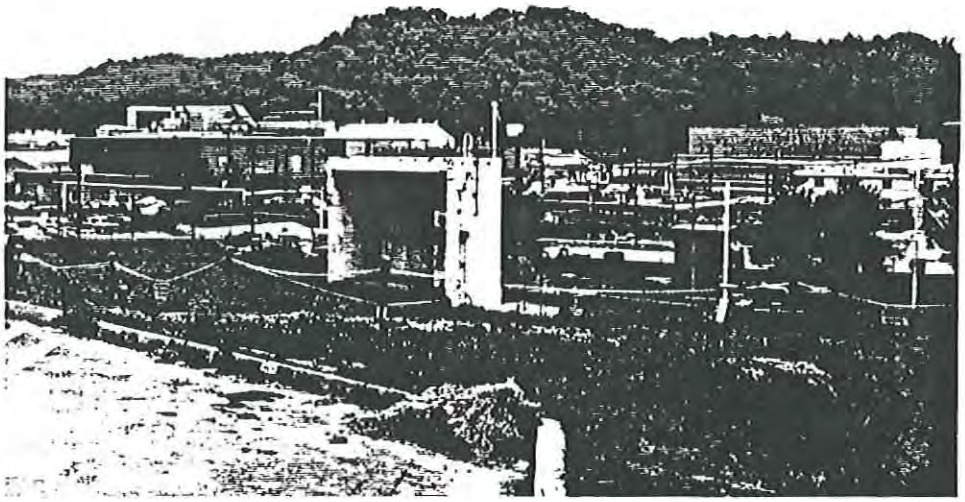


Figure III-61. 3023 North Tank Farm (1943). Looking across tank farm toward southeast.

3026C MAIN

CURRENT USE: Radioisotope Development Laboratory B
ORIGINAL USE: By-Product Process Building and Chemistry Separations Laboratory

HISTORY: This structure was completed in 1943 at a cost of $423,000. Early research here was focused on improving the plutonium separation procedure. At least 150 by-products of fission were known at that time and research revolved around characterizing each as to amounts produced, chemical properties, nature of radiation and rate of decay. In the post-World War II period, the focus changed to the production and development of radioisotopes, one of the ORNL's most successful programs. By 1950, the ORNL was distributing more than fifty different radioisotopes to qualified research centers (Johnson and Schaffer 1992:73).

Today, Building 3026C is associated with the Chemical Technology Division and research and development work is ongoing. Only one of the cells is still active and that is used for nuclear medicine research. This cell, Cell 1, is said to be one of the oldest hot cells in the world (Personal Communication, B.D. Patton and Arnold Beets, 24 June 1993). Two other cells are used for storage.

DESCRIPTION: This 8,376 square-foot, steel-frame structure has an irregular plan and a flat roof. The front (south) facade portion is one-story in height and has modern metal siding and a bank of modern tinted glass fixed-pane windows. Attached to the north side of this section is a one-story, metal-frame section with a low-pitched gable roof and a steel-frame, flat-roofed section. The cells inside the building are in banks and have two-foot thick concrete walls. The lead glass windows on each hot cell are lined with a zinc bromide solution for liquid shielding. There are manipulators in each cell and lead glass windows with liquid shielding.

In 1959, plans indicate the cells were modified by installation of new doors, lowered ceilings, relocated doors and new manipulators. In 1961, plans to rehabilitate the structure indicate that the original portion of Building 3026 which is now Building 3026C was demolished with the exception of the cells. These plans show the building as radically different from its 1940s appearance (ORNL Hstry 211) and similar to its present appearance. Notes on the plan are as follows:

1) *Tear down existing building structure and services. Cell structures will remain.*
2) *Construct new building and services.*

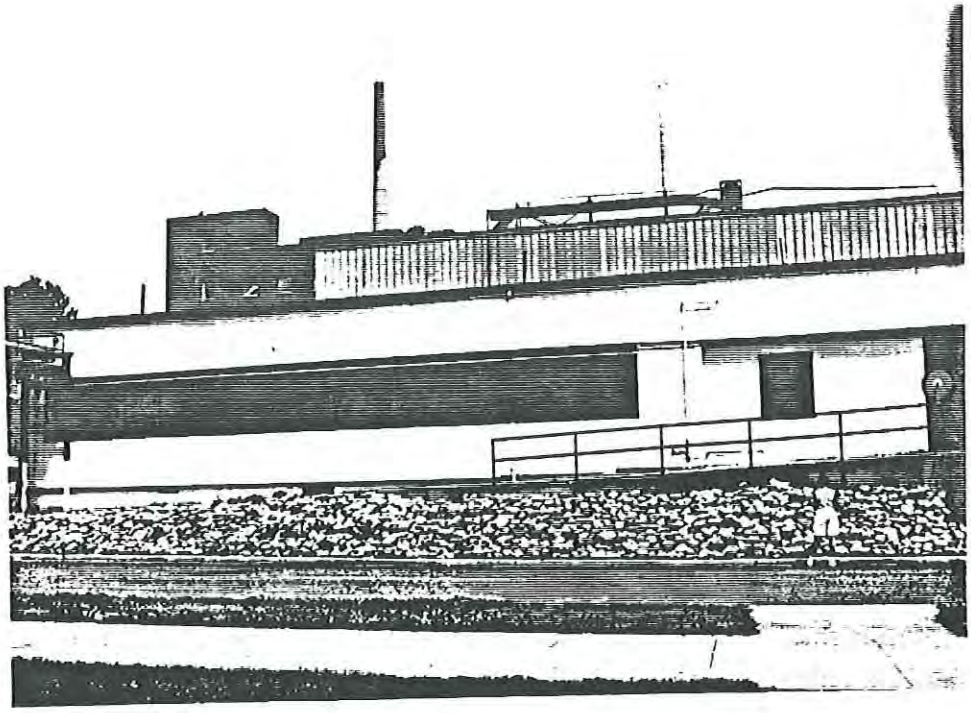


Figure III-64. 3026C Radioisotope Development Laboratory B (1943). View toward north of south facade. The hot cells inside the building are among

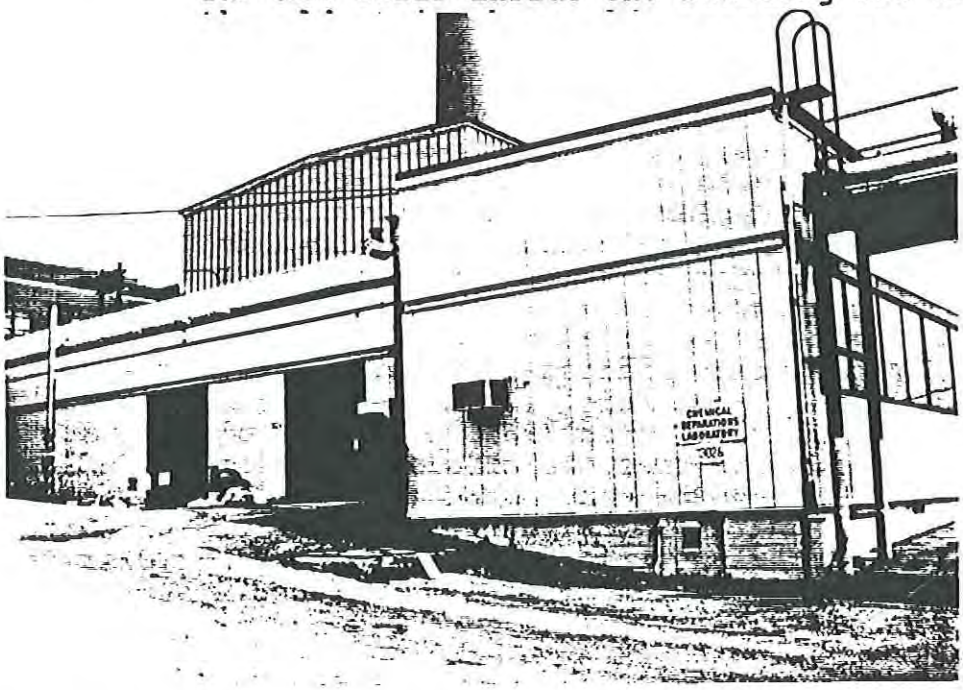


Figure III-65. 3026C Radioisotope Development Laboratory B (1943). West side of building, view northeast.

3026D MAIN

CURRENT USE: Dismantling and Examination Hot Cells
ORIGINAL USE: Dismantling Cell for Power Reactor

HISTORY: Building 3026D was constructed in 1945 at a cost of $473,000 to provide facilities containing a series of examination and hot cells. It is physically and historically connected with Building 3026C. Building 3026D is used by the Chemical Technology Division today.

DESCRIPTION: This 8,376 square-foot, steel-frame structure has an irregular plan, a flat roof and corrugated-metal siding. A concrete ramp leads up to a drive-through frame portico to an overhanging crane bay. Doors at this location are original wood with four-pane windows. The crane bay to the west of this portico also has original wood bracket supports and original wood doors. There are two hinged doors on the ground level and directly above are two additional hinged doors, all have a wood "X" in the panels. To the west of the crane bay is a single-pane fixed window.

In 1961, plans to renovate this and the adjacent Building 3026C contained the following notes:

1) *Tear down existing building structure and Services and cell structures will remain.*
2) *Construct new building and install new services.*

It appears that these notes relate mainly to the adjacent Building 3026C, however, the roof was built up in this portion to provide a full third floor and the interior was reconfigured.

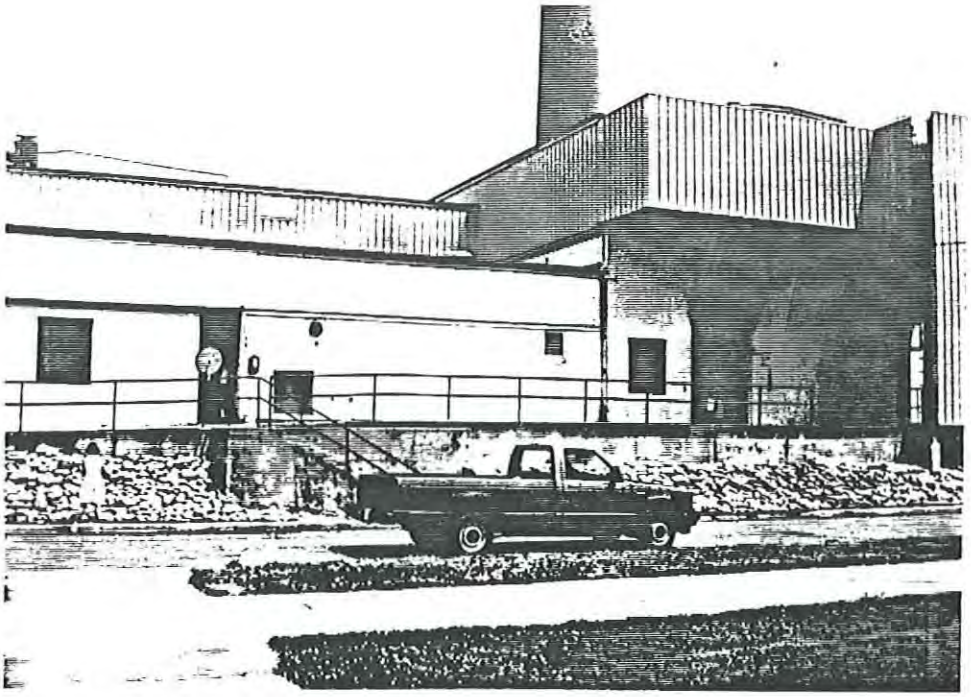


Figure III-66. 3026D Dismantling and Examination Hot Cells (1945). Looking north at original crane bay of Building 3026D on right, Building 3026C on left.

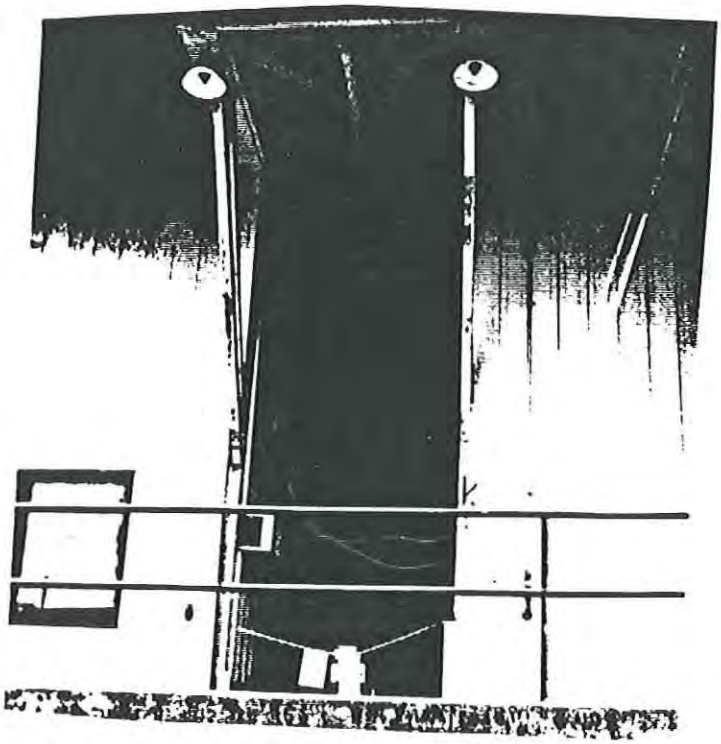


Figure III-67. 3026D Dismantling and Examination Hot Cells (1945). Detail of original crane bay framing and doors. View north.

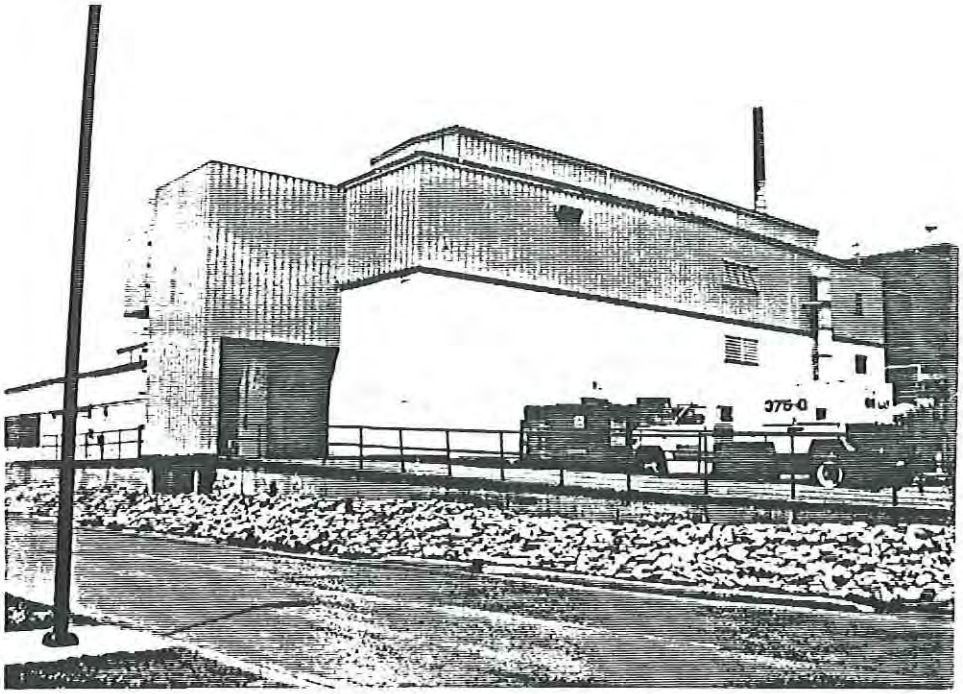


Figure III-68. 3026D Dismantling and Examination Hot Cells (1945). Front (south) and east facades. View northwest.

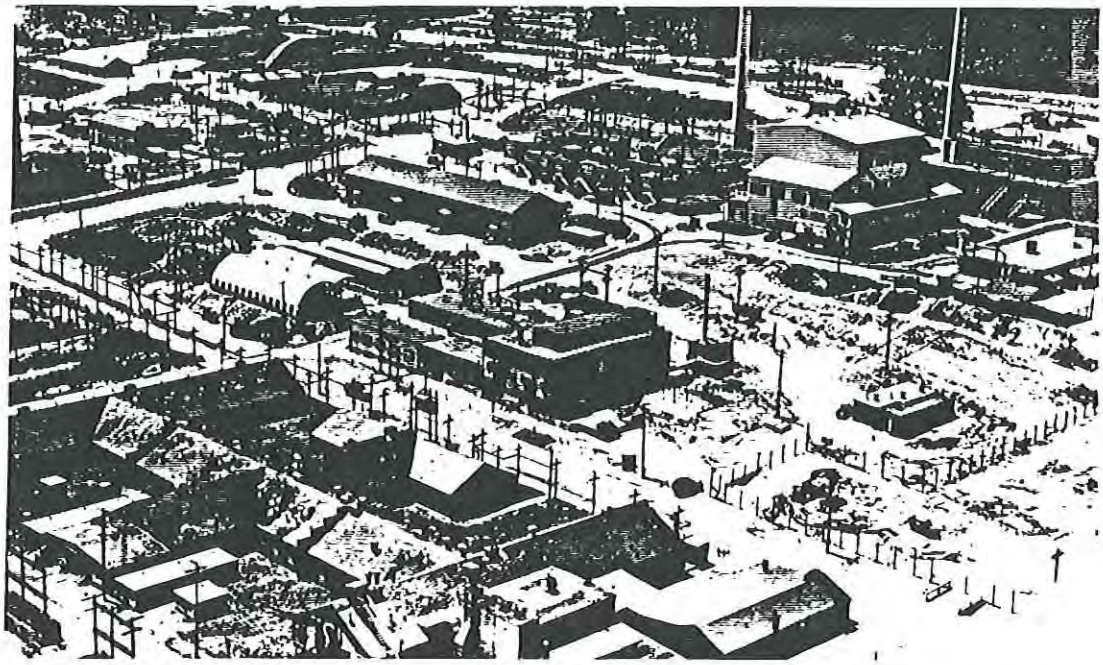


Figure III-69. ORNL Hstry 267 (ca. 1948). Building 3026C and Building 3026D in center of photograph. View northwest.

3027 MAIN

CURRENT USE: Safeguard Nuclear Materials Vault
ORIGINAL USE: Source and Special Materials Vault

HISTORY: This vault was constructed in 1955 at a cost of $17,000 for storage. It is still in use for that purpose today.

DESCRIPTION: This 3,844 square-foot, concrete structure has a flat roof, no windows and a heavy vault-type door. It stands inside a fenced area.

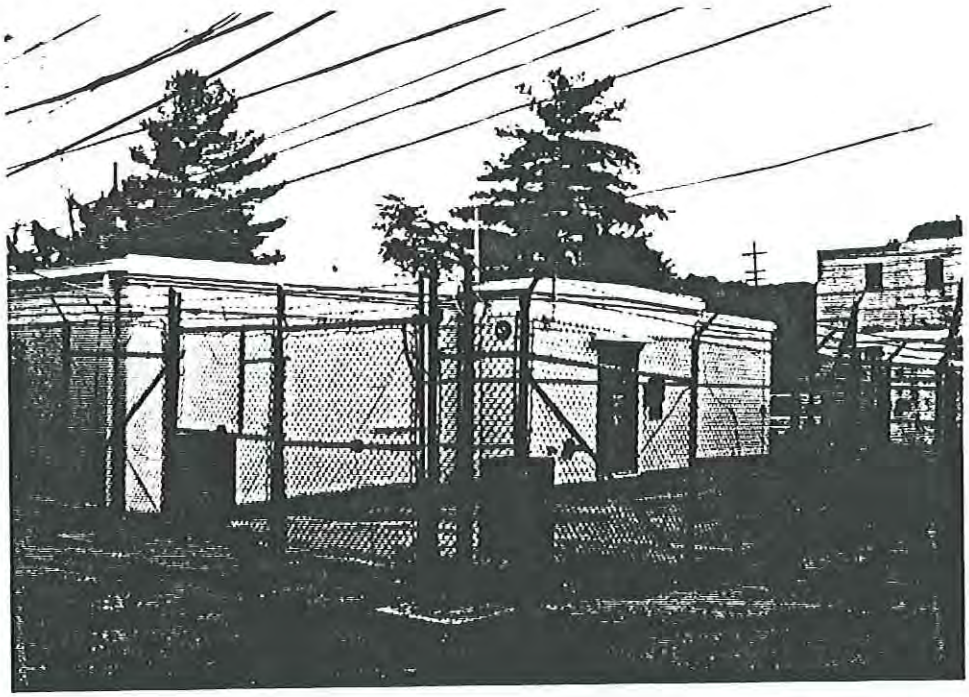


Figure III-70. 3027 Safeguard Nuclear Materials Vault (1955). View southeast.

3028, 3029, 3030, 3031, 3032, 3033, 3034, 3036, 3037, 3038
MAIN

CURRENT USE: Isotope Complex
ORIGINAL USE: Isotope Complex

HISTORY: After World War II, Clinton Laboratories was forced to refocus its research and development efforts. This change in focus produced what was, and is today, perhaps among the ORNL's most important contributions to science, the production of radioisotopes. These isotopes were "the most publicized activity at Clinton Labs [ORNL] in the post war years" (Johnson and Schaffer 1992:37).

Isotopes are produced in reactors, extracted by chemical processes and then utilized for biological, medical and industrial research. As early as 1946, radioisotopes produced in the Graphite Reactor were used for cancer research. The following year (1947), the Isotopes Section was formed at the Clinton Laboratories. By 1950, the ORNL was distributing by order over fifty radioisotopes to research centers throughout the world. One of the most widely distributed was cobalt-60, used in cancer research.

In the late 1940s, the future of the ORNL became more stable because of such successful programs as the production and shipping of isotopes. ORNL manager Union Carbide initiated the Program H expansion to replace the wartime temporary structures with more permanent buildings. A major focus of this program was the provision of a radioisotope complex costing two million dollars and consisting of ten buildings "designed to process, package, and ship the Laboratory's most valuable material exports" (Johnson and Schaffer 1992:60). Radioisotope buildings constructed under Program H are grouped around Isotope Circle. The ten buildings, one stack, and their original designations are:

3028 Radioisotope Processing Building F
3029 Radioisotope Processing Building E
3030 Radioisotope Processing Building D
3031 Radioisotope Processing Building C
3032 Radioisotope Processing Building B
3033 Radioisotope Processing Building A
3034 Radioisotope Service Building
3036 Decontamination Building
3037 Radioisotope Area Office Building
3038 Radioisotope Analytical and Pack Building
3039 Exhaust Stack

In 1957, the Isotope Division was disbanded and reassigned to several other sections. In the 1980s it was reorganized and continuing isotope programs were assigned to the Chemical Technology Division.

DESCRIPTION: The ten buildings (plus an exhaust stack) constructed in 1951 as part of Program H and relating to the Isotope Program are described below. Also included is an annex (Building 3033A).

3028 Radioisotope Production Laboratory A: This 17,054 square-foot, steel-frame building has a flat roof, an irregular plan, corrugated-metal siding, ductwork on the roof, and no windows.

3029 Radioisotope Production Laboratory B: This 2,273 square-foot, steel-frame building has an irregular plan, flat roof, corrugated-metal siding, exterior metal stairs to the roof, roof-top ductwork, a tall-hinged door on the north facade and no windows.

3030 Radioisotope Production Laboratory C: This 720 square-foot, steel-frame building has a flat roof, corrugated-metal siding and an awning over paired doors.

3031 Radioisotope Production Laboratory D: This 720 square-foot, steel-frame, flat-roofed building has corrugated-metal siding, metal awning, and ductwork on the roof.

3032 Radioisotope Production Laboratory E: This 720 square-foot, steel-frame structure has corrugated-metal siding, flat roof, metal awning and ductwork on the roof.

3033 Radioisotope Production Laboratory F: This 720 square-foot, steel-frame building has corrugated-metal siding and a flat roof.

3033 (A) Radioisotope Production Laboratory Annex (n.d.): This 882 square-foot, steel-frame, metal-sided building has a flat roof and is an annex to Building 3033.

3034 Radioisotope Area Services: This 1,200 square-foot, steel-frame structure has a flat roof, corrugated-metal siding and paired doors with four-pane windows.

3036 Isotope Area Storage and Service: This 1,449 square-foot, steel-frame structure has metal siding, flat roof and a track door with a crane protruding from the front of the building.

3037 Operations Divisions Offices: This 8,185 square-foot, two-story structure has brick facing, columns dividing each elevation into bays, flat roof and stone coping.

3038 Radioisotope Laboratory: This 7,538 square-foot, brick-faced structure has a flat roof, vertical brick columns dividing each elevation into bays, metal awnings and no windows.

3039 Central Radioactive Waste Gas Disposal Facility: Exhaust stack adjacent to complex.

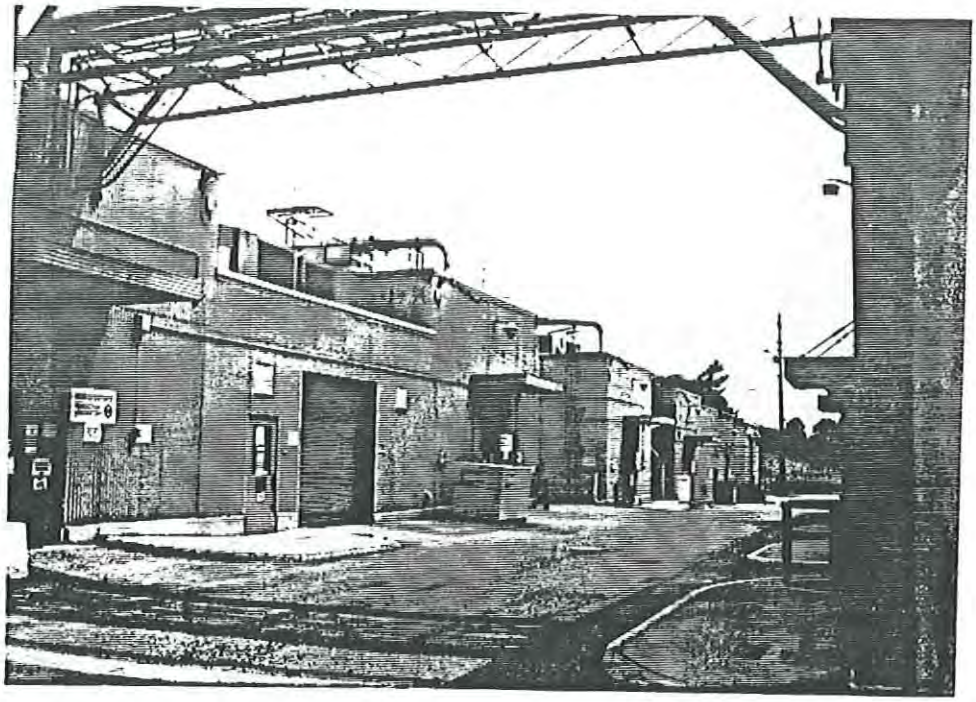


Figure III-71. Isotope Circle. View toward northeast of buildings from left to right, Buildings 3030, 3031, 3032, 3033, 3034, 3036, rear of 3038 on far right of photograph.

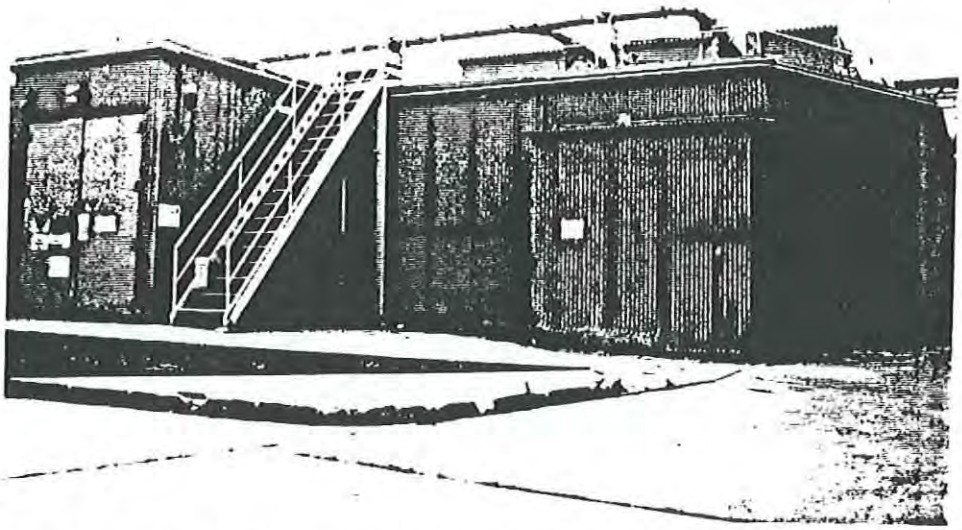


Figure III-72. 3029 Radioisotope Production Laboratory B. View southeast.

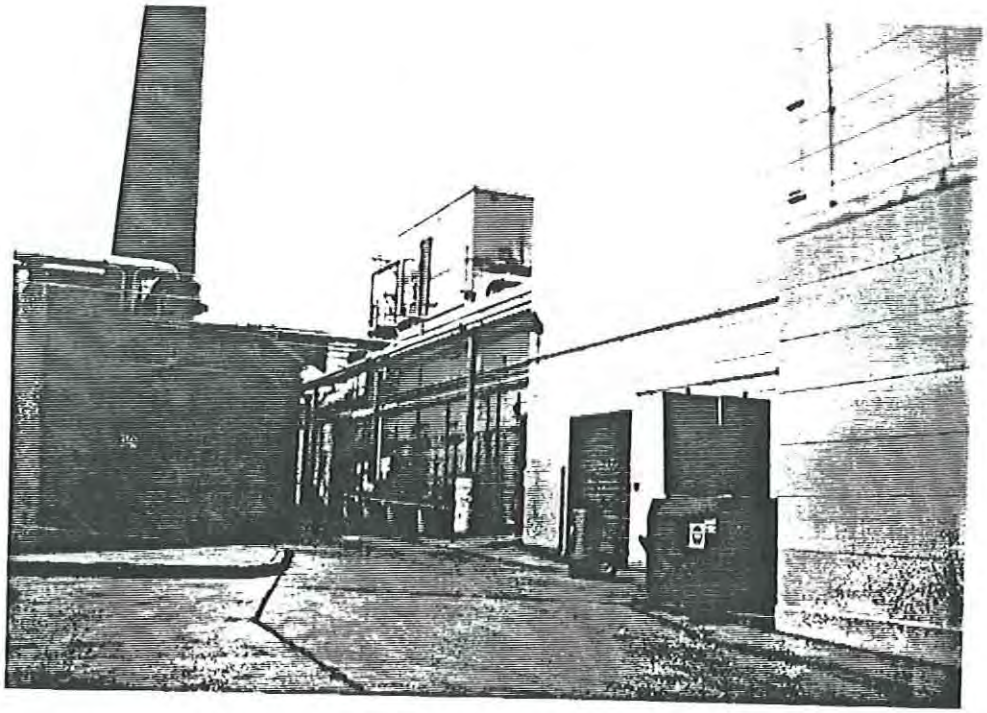


Figure III-73. 3032 Radioisotope Production Laboratory E. View northwest.

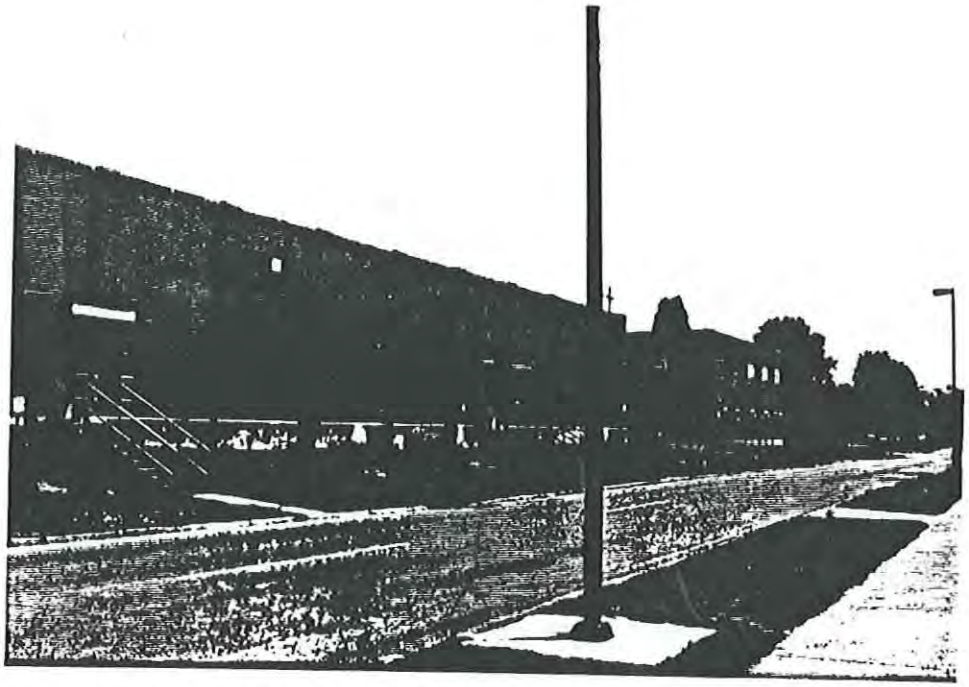


Figure III-74. 3037 and 3038 Operations Division Offices and Radioisotope Laboratory. View east on Central Avenue. Isotope Circle is behind buildings.

3042 MAIN CURRENT USE: Oak Ridge Research Reactor
ORIGINAL USE: Oak Ridge Research Reactor

HISTORY: In 1953, the AEC gave the ORNL permission to construct the Oak Ridge Research Reactor, a general purpose research tool. Construction began in 1955 and was completed in 1958 at a cost of $4,607,000. The Oak Ridge Research Reactor combined the technologies of the earlier MTR and BSR. The Oak Ridge Research Reactor operated for twenty-nine years and facilitated studies in physics, materials research, irradiation, and neutron beam studies. It was a high performance reactor that supported many scientific advances and attracted scientists as well as visiting dignitaries to the ORNL. The Oak Ridge Research Reactor was shut down in 1987 but offices in the building are still occupied by the Research Reactors Division.

DESCRIPTION: This 37,369 square-foot, steel-frame building has a flat roof, corrugated-metal siding and no windows. The core of the building is three stories in height with a basement and to the north and south are one-story, flat-roofed wings. On the west elevation are two massive hinged steel doors and on the east side is an exterior metal stairway. The Oak Ridge Research Reactor was a light water-moderated and -cooled, beryllium-reflected research reactor. *Following shut down in 1987, all of the fuel, shim rods and beryllium were removed and all hot cells cleared of equipment.*

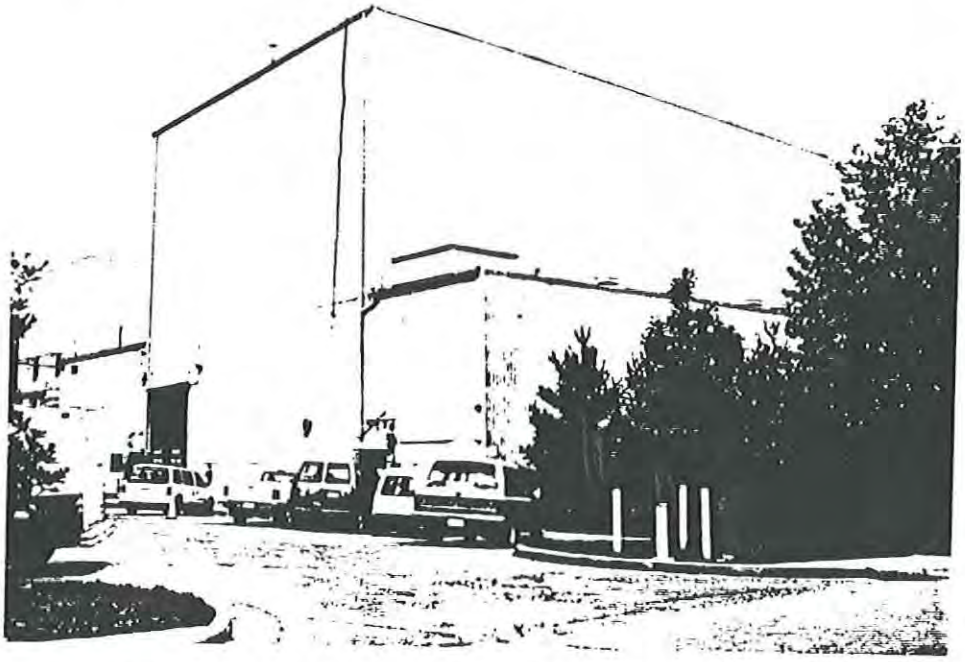


Figure III-75. 3042 Oak Ridge Research Reactor (1955). View northeast.

3044 MAIN

CURRENT USE: Special Materials Machine Shop
ORIGINAL USE: Special Materials Machine Shop

HISTORY: Built in 1955 at a cost of $68,000, this structure continues in use as a machine shop. It is assigned to the Plant and Equipment Division.

DESCRIPTION: This 3,059 square-foot, steel-frame building has a gable roof with ridgeline vents, corrugated-metal siding, and original multipane hopper windows with aluminum awnings. On the west elevation is a roll-up door.

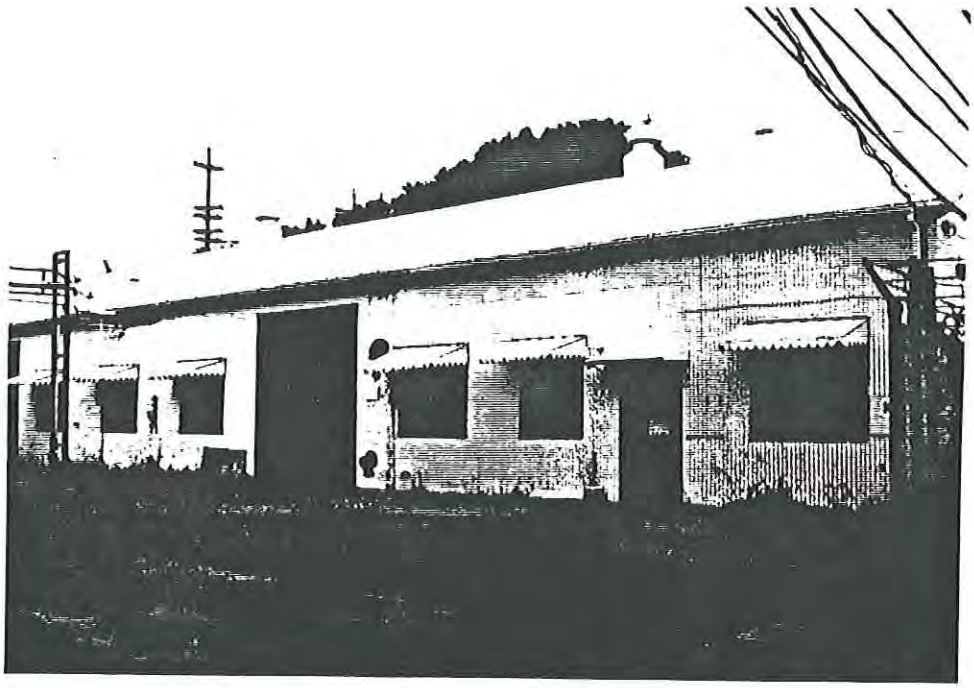


Figure III-76. 3044 Special Materials Machine Shop (1955). This building retains its original multipane hopper windows. View northeast.

3074 MAIN

CURRENT USE: Interim Manipulator Repair Facility
ORIGINAL USE: Field Service Shop

HISTORY: Built in 1954 adjacent to the Radiochemical Processing Pilot Plant (Building 3019), this structure was a maintenance shop. Today, Building 3074 is used for repair of hot cell manipulators and is assigned to the Plant and Equipment Division.

DESCRIPTION: This 3,153 square-foot, steel-frame, metal-sided building has a gable roof, corrugated-metal siding and on the gable end are a roll-up door and a metal door containing a single window.

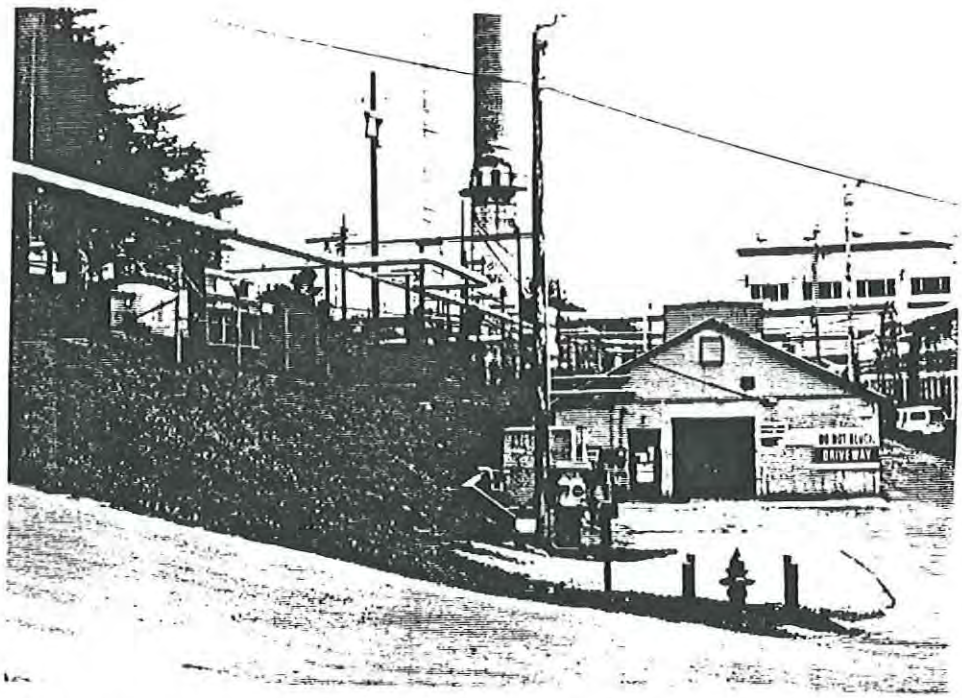


Figure III-77. 3074 Interim Manipulator Repair Facility (1951). View east.

3077 MAIN CURRENT USE: Air Cooler for LITR
ORIGINAL USE: Air Cooler for LITR

HISTORY: This structure was built in 1952 as a cooling tower for Building 3005, the Low Intensity Testing Reactor (LITR).

DESCRIPTION: This 668 square-foot, steel-frame cooling tower is located to the north of the LITR.

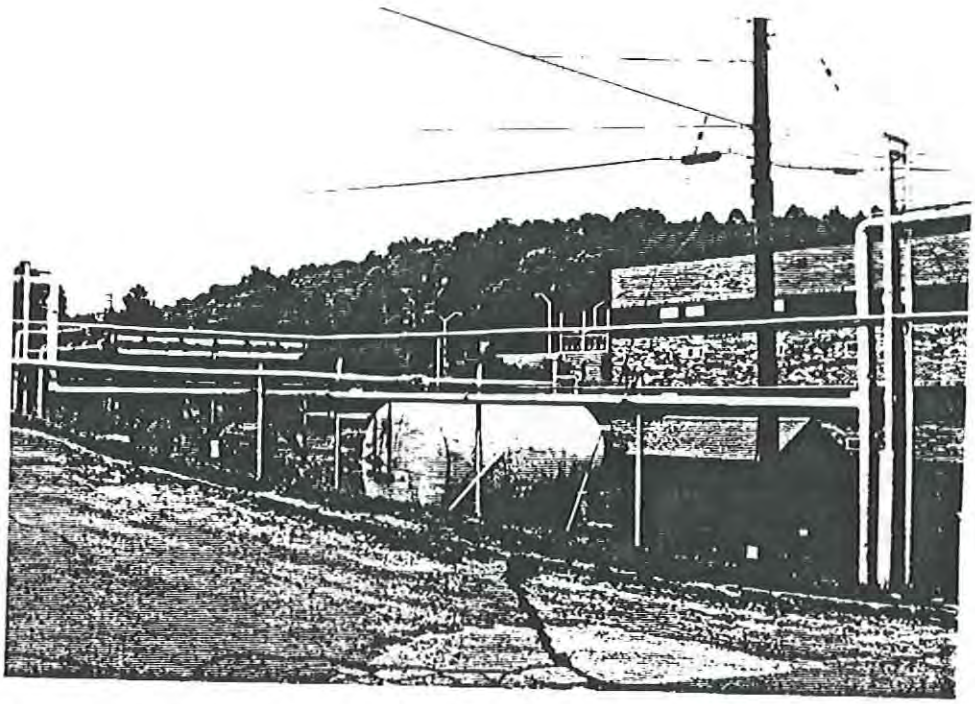


Figure III-78. 3077 Air Cooler for LITR (1952). Air cooler at the left of photograph. View northwest.

3080 MAIN

CURRENT USE: Reactor Experiment Control Room
ORIGINAL USE: Storage Facility for Building 3010

HISTORY: This structure was built ca. 1953. It is shown on a 1953 ORNL Building List as "Storage Facility for Bldg. 3010 (Proposed)" (ORNL 1953). It is historically associated with the BSR as the control house for BSR experiments.

DESCRIPTION: This steel-frame building stands immediately to the west of the BSR. It is one-story in height on a raised concrete foundation and has corrugated-metal siding, and original multipane hopper windows, most of which have been painted over. Some original awnings remain on the west side. *On the south gable end is a modern metal door.*

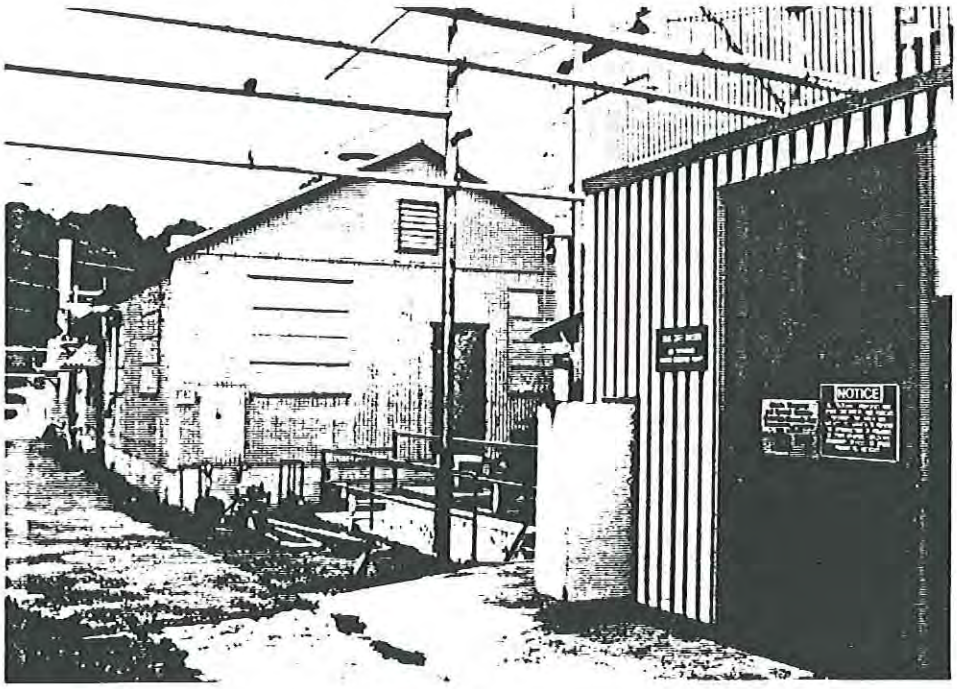


Figure III-79. 3080 Reactor Experiment Control Room (1954). Building 3010, the BSR, is on the right. View northeast.

3091 MAIN

CURRENT USE: Filters for Building 3019
ORIGINAL USE: Filters for Building 3019

HISTORY: Building 3091 is associated with Building 3019. The ca. 1950 structure was used for filtering cell and hood exhausts.

DESCRIPTION: This 602 square-foot, off gas filter house contains filtering and exhaust equipment.

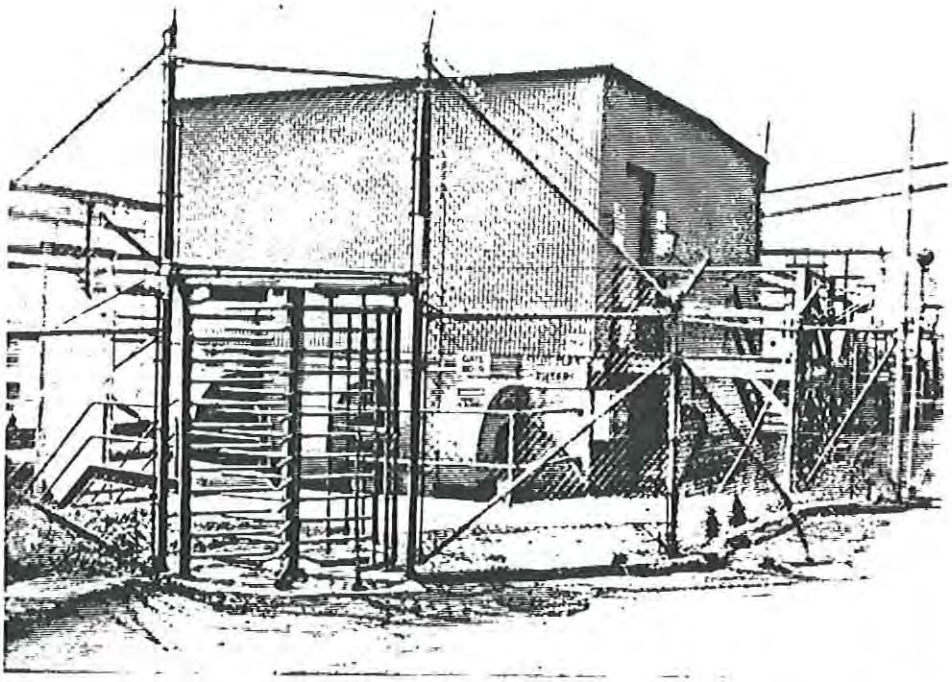


Figure III-80. 3091 Filters for Building 3019. View west.

3092 MAIN

CURRENT USE: Off Gas Facility
ORIGINAL USE: Off Gas Facility

HISTORY: Building 3092 was built in 1956 and serves as an off gas facility.

DESCRIPTION: The structure contains a metal-sided, steel-frame building and a concrete block enclosure for equipment.

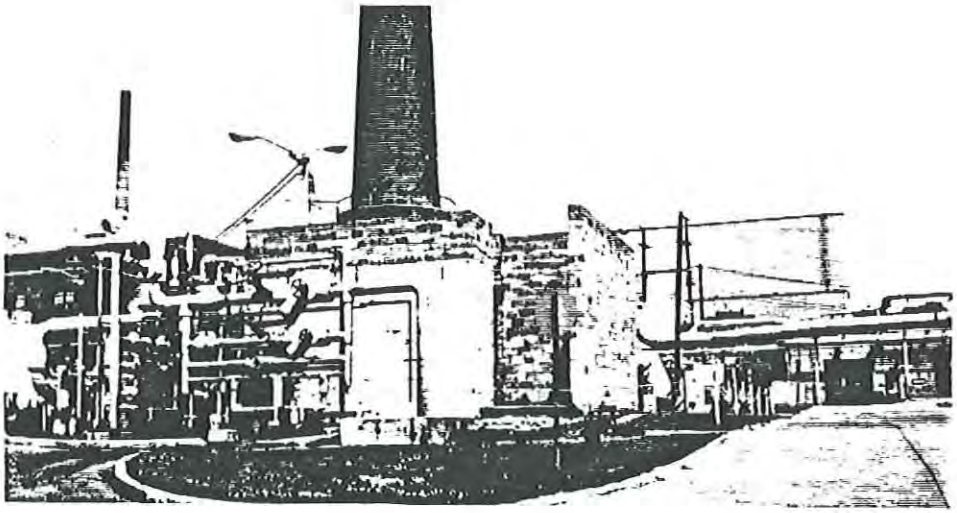


Figure III-81. 3092 Off Gas Facility (1956). View north.

3500 MAIN

CURRENT USE: Instrumentation and Controls Division Offices and Research Facility
ORIGINAL USE: Instrumentation and Controls Division Offices and Research Facility

HISTORY: The Instrumentation and Controls Division Offices and Research Facility was built in 1951 as part of the ORNL's Program H building expansion at a cost of $435,000. In 1963, W.E. Thompson wrote of the program carried out in this building:

> *The basic physics research at ORNL contains a program of instrument development and modifications. In addition to the development of equipment for the physicists use, a program of instrumentation for medical diagnostic use of isotopes has been carried out.*

The facility still serves as an instrument laboratory under the direction of the Instrument and Controls Division.

DESCRIPTION: This 79,491 square-foot building is one and two stories in height with an exposed foundation on the rear (south) side. It has a flat roof, stone coping, and banks of multipane windows surrounded by a decorative stone band. The front (north) facade has a two-story section to the east of the main entrance and a one-story section to the west. The main entrance bay projects from the facade and is comprised of double plate glass doors, an overhang, decorative panels and a six-pane window all surrounded by a raised stone decorative band. The rear of the building has loading docks and a crane bay on the two-story west end and a bank of windows and another loading bay on the east end.

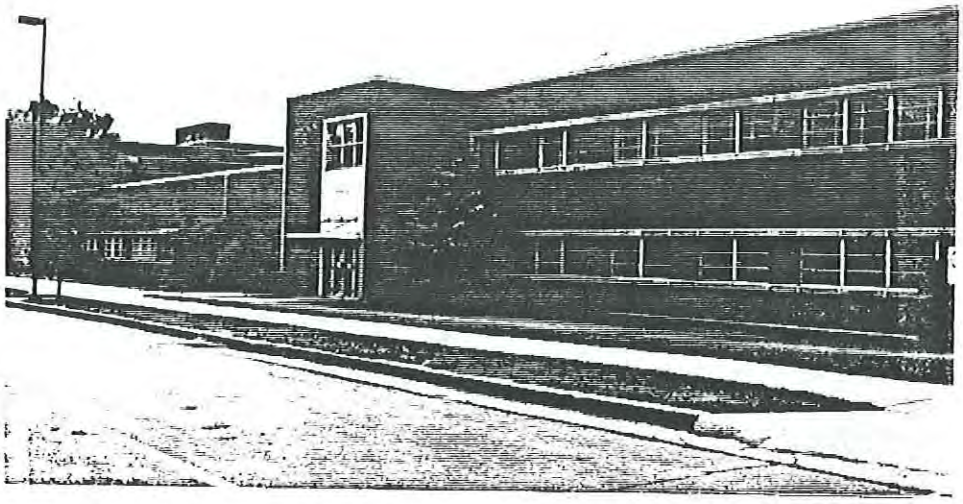


Figure III-82. 3500 Instrumentation and Controls Division Offices and Research Facility (1951). The building was constructed under Program H. View southeast.

3501 MAIN CURRENT USE: Sewage Pumping Station
ORIGINAL USE: Sewage Pumping Station

HISTORY: Plans indicate that Building 3501 was constructed in 1949 as a sewage pumping station, part of the ORNL's storm and sanitary sewer system. It continues in use today.

DESCRIPTION: The Sewage Pumping Station consists of a partially underground 196 square-foot, brick-faced, flat-roofed building with hopper windows and a louvered-metal door. Adjacent to the building are various pumping apparatus housed in concrete below ground open-roofed structures.

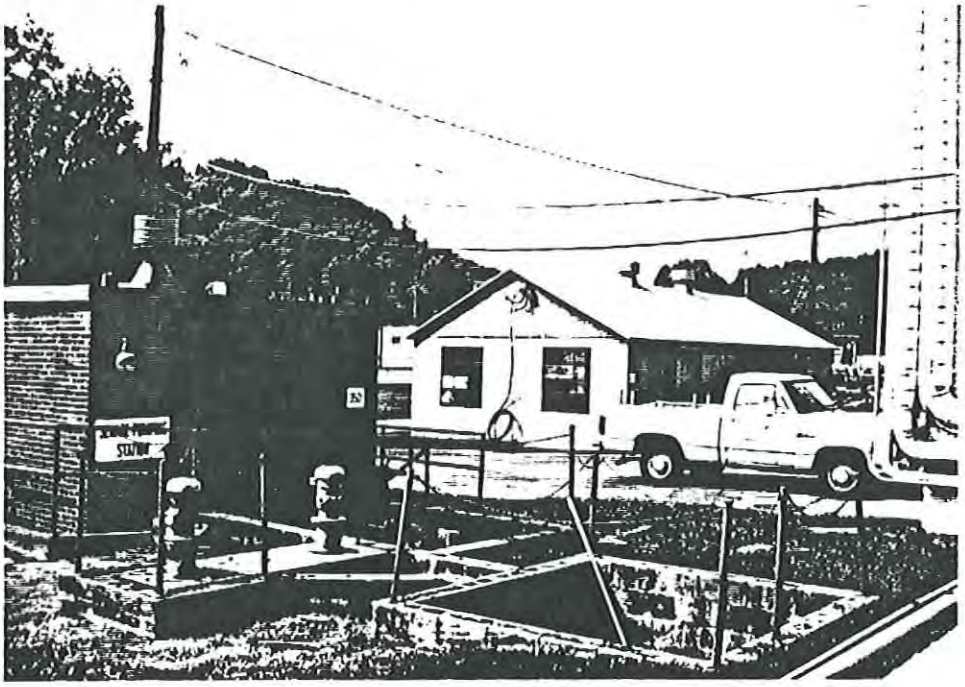


Figure III-83. 3501 Sewage Pumping Station (1949). View southwest.

3502 MAIN CURRENT USE: East Research Service Center
ORIGINAL USE: Solvent Operations Office

HISTORY: Building 3502 was constructed in 1950 to be used as a Solvent Operations Office. The building is historically associated with Building 3503, Solvent Operations. The development of reprocessing methods for nuclear power reactor fuels was a major effort in the Chemical Technology Division during the 1950s (Genung et al. 1993:2-33) and solvent extraction methods were a key to this process. Today, the building is a service center assigned to the Plant and Equipment Division.

DESCRIPTION: This 12,136 square-foot structure is comprised of several sections: a one-story, gable-roofed building with metal siding, original doors and original hopper windows; a concrete block addition on the east end; a one-story, flat-roofed addition on the rear (south) side; and a shed-roofed addition.

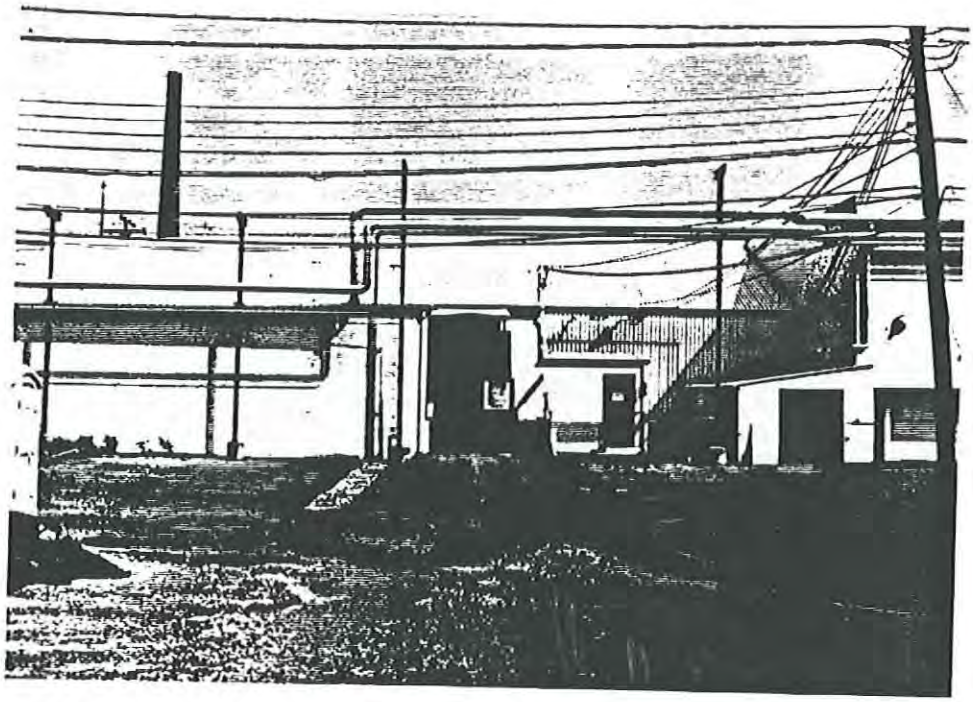


Figure III-84. 3502 East Research Service Center (1950). Rear of gable-roofed section showing additions. View north.

3503 MAIN

CURRENT USE: High Radiation Level Engineering Laboratory
ORIGINAL USE: Solvent Operations

HISTORY: Building 3503 was constructed in 1948 for research on Solvent Operations. The research conducted in this building involved development of solvent extraction methods for the reprocessing of spent nuclear fuel. Assigned today to the Chemical Technology Division, it is a research laboratory.

DESCRIPTION: This structure has a total of 12,206 square-feet on four floors. It is a steel-framed, metal-sided building with track doors, no windows, vents on the west gable end and rooftop vents.

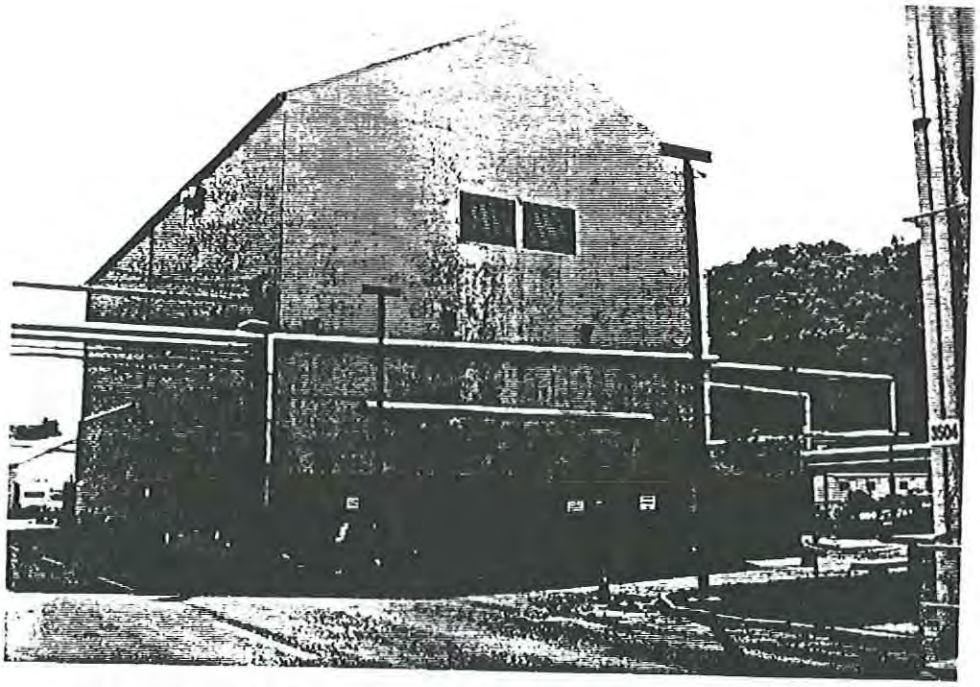


Figure III-85. 3503 High Radiation Level Engineering Laboratory (1948). View southeast.

3504 MAIN

CURRENT USE: Geosciences Laboratory
ORIGINAL USE: Health Physics Waste Research Laboratory

HISTORY: Built in 1951 at a cost of $204,000, Building 3504 was associated with the Health Physics Division which was formed in 1946. It was used for research into the health and biological effects of radioactive wastes. The facility is assigned to the Environmental Sciences Division today.

DESCRIPTION: This 7,316 square-foot, steel-frame structure is two stories in height with a gable roof and modern metal siding. Original paired multipane hopper windows and steel doors with a single window pane remain. On the west gable end is a roll-up door.

Figure III-86. 3504 Geosciences Laboratory (1951). The building has new siding but retains original hopper windows. View southeast.

3505 MAIN

CURRENT USE: Fission Products Development Laboratory Annex
ORIGINAL USE: Reactor Fuels Processing Plant (Metal Recovery Plant)

HISTORY: Built in 1951 at a cost of $487,000, the Reactor Fuel Processing Plant, commonly known as the Metal Recovery Plant, was a pilot plant and small-scale production plant for reprocessing spent fuel, which since World War II had been stored in tank farms at both the ORNL and Hanford. Building 3505 was used for processing various waste solutions, scrap and miscellaneous fuel elements and for the recovery of plutonium, uranium, neptunium and americium. The plant originally recovered uranium by extraction with the tributyl phosphate process (TBP), a successful method which was adopted and installed at Hanford.

A $300,000 expansion of the plant provided equipment for a small-scale production operation. While in operation, the plant successfully recovered elements from Chalk River spent fuel, Hanford slag and waste, the Brookhaven and Argonne reactors and the Fermi pile (Genung et al. 1993:2-30). The plant was remotely operated to prevent exposure of personnel to radiation.

The Metal Recovery Plant was shut down in 1960. The building is used today by the Environmental and Health Protection Division in support of decommissioning operations at the ORNL.

DESCRIPTION: This 6,550 square-foot, irregular-plan building is one and two stories in height and has a flat roof, corrugated-metal siding and original multipane hopper windows. A rectangular three-story portion capped by a metal rail is found on the north side of the building. The structure contains seven concrete cells, offices, a storage area and a control room. Building 3505 also contains a below ground dissolver pit and fuel handling canal. *All equipment has been removed from the process cells and control room.*

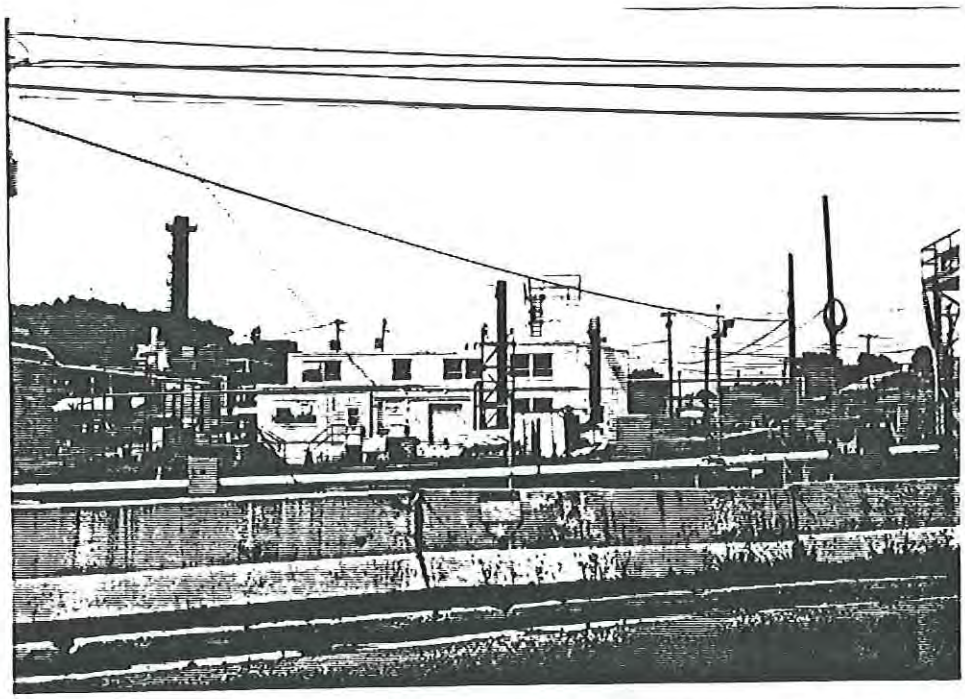


Figure III-87. 3505 Fission Product Development Laboratory Annex (1951). View southwest.

3506 MAIN

CURRENT USE: Waste Evaporator Facility, Out-of-Service
ORIGINAL USE: Waste Evaporator Facility

HISTORY: Building 3506 was constructed in 1949 as a liquid waste evaporator facility designed and built by the ORNL as part of their waste management system. Liquid intermediate-level wastes were piped to the facility for concentration. Condensate was transferred to the Process Waste System and the concentrate was transferred to the Gunite tanks in the South and/or North Tank Farms. The facility was replaced in 1954 by Building 2531, the Radioactive Waste Evaporator Facility. All equipment has been removed from the facility.

DESCRIPTION: This 1,075 square-foot, concrete block, flat-roofed building is one-story in height with exterior metal stairs to the roof. The interior has a stainless steel-lined, reinforced concrete hot cell with underground piping and valves.

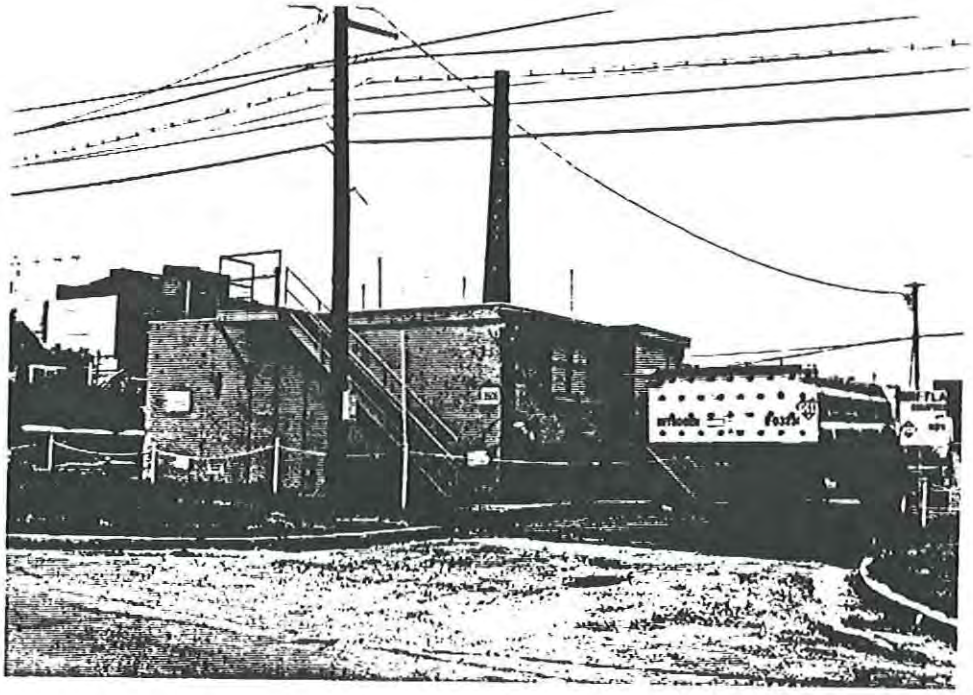


Figure III-88. 3506 Waste Evaporator Facility (1949). The original equipment was removed after 1954. View northeast.

3507 MAIN CURRENT USE: South Tank Farm
ORIGINAL USE: South Tank Farm

HISTORY: These 1943 Gunite tanks were used for storage and transfer of LLLWs. Wartime photographs (ORNL Hstry 153 and 183) clearly show the domed tops of the six tanks. The tanks were used until 1978 and have since been emptied.

DESCRIPTION: The 0.9 acre South Tank Farm contains six cylindrical domed 170,000-gallon waste storage tanks. Each tank is fifty feet in diameter and eighteen feet high. The tanks are constructed of steel reinforced Gunite. Approximately six feet of earth covers the tanks.

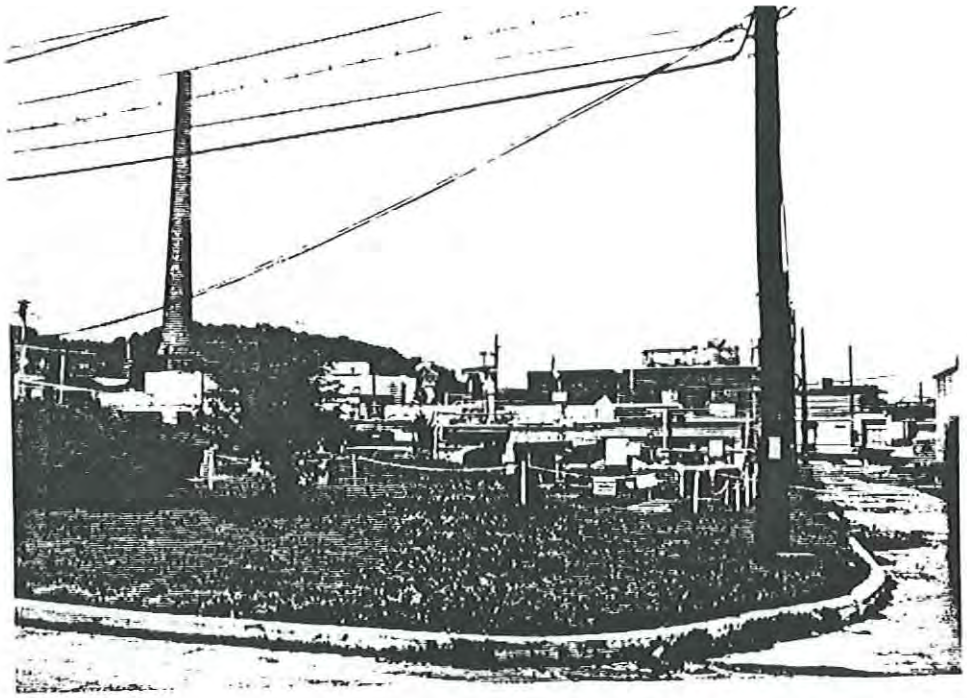


Figure III-89. 3507 South Tank Farm (1943). View northeast.

3508 MAIN

CURRENT USE: Chemical Technology Alpha Laboratory
ORIGINAL USE: Chemical Technology Alpha Laboratory

HISTORY: Building 3508 was constructed in 1951 as part of Program H. The structure was built as a laboratory for the ORNL's Chemical Technology Division. The Chemical Technology Division experimented with a wide variety of methods for reprocessing spent nuclear fuel and waste and this laboratory focused on work with high-alpha activity isotopes. The building retains its association with the Chemical Technology Division.

DESCRIPTION: This 13,950 square-foot, steel-frame, two-story building has a flat roof, corrugated-metal siding, no windows, exterior metal staircase and a series of solid metal doors on the ground level.

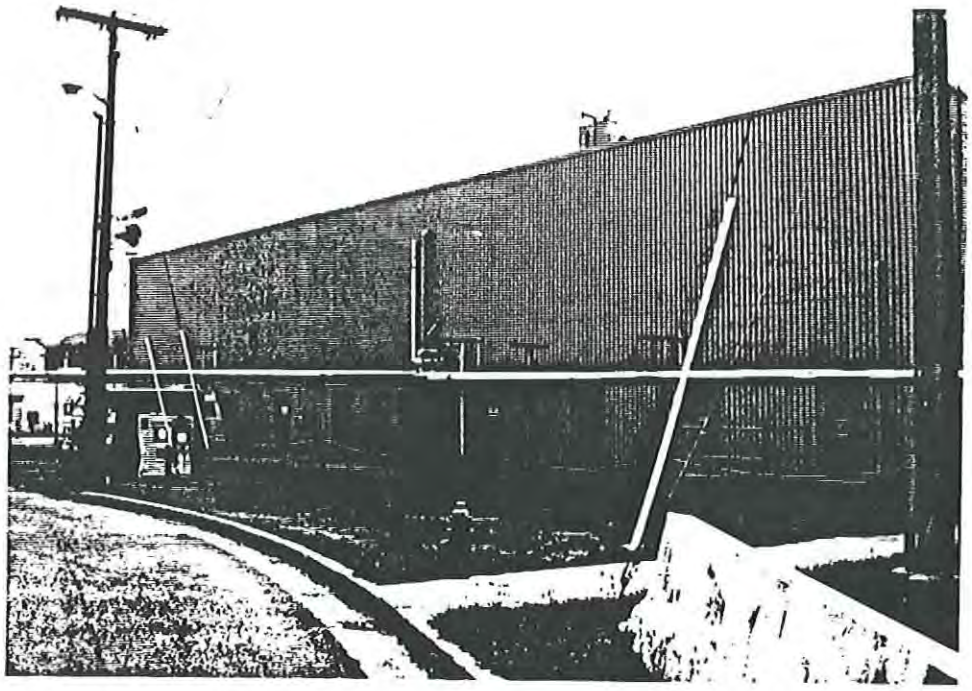


Figure III-90. 3508 Chemical Technology Laboratory (1951). South elevation, view northwest.

3513, 3518, 3524 MAIN

CURRENT USE: Out-of-Service
ORIGINAL USE: 3513 Settling Basin
3518 Process Waste Water Treatment Plant
3524 Process Waste Systems Basin/Equalization Basin

HISTORY: In 1943, large underground Gunite tanks were constructed to store all the intermediate-liquid chemical waste and the liquid uranium waste generated at the site. An extensive underground piping system to transport the liquid waste from the points of generation to the storage site was also installed. To reduce the volume of liquid waste stored in the Gunite tanks, a large fraction of the radioisotopes in the storage tanks was precipitated by adding caustic. The supernatant liquid was decanted and diluted with the Clinton Laboratories' large volume of process waste. At that time, process waste was transferred to an intermediate pond for settling, before being discharged into White Oak Creek. The intermediate pond was constructed in 1943 and destroyed by a flood in 1944.

In 1944, four earthen-diked ponds were built; one with a 1,600,000-gallon capacity, one with a 32,000-gallon capacity, and two with 293,000-gallon capacities. The two 293,000-gallon capacity ponds provided hold-up capacity when the intermediate-liquid waste stream flow was too great for the Gunite tanks to provide sufficient time for radioactive decay. The two 293,000-gallon capacity ponds were separated by an earthen divider that was removed ca. 1953-1954, creating a large pond that became the Process Waste Systems Basin/Equalization Basin (3524). The 1,600,000-gallon capacity pond was used to allow radioactive solids to settle and radioactive liquids to be diluted with large volumes of non-active waste prior to discharge to White Oak Creek. This pond became known as the Settling Basin (3513) and served as a settling basin and sampling facility for the effluent from the Old Process Waste Treatment Plant, Building 3513, which was constructed in 1957. The Settling Basin served in this capacity from 1957 until 1976, and was taken out of service when the new Process Waste Treatment Plant, Building 3544, was constructed.

The old Process Waste Treatment Plant, Building 3518, is unique in that it was "the first to be designed specifically for the removal of radioactive strontium from large volumes of low level wastes" (Thompson, 1963:134). The treatment method used was a modified lime-soda softening process. Once treated, the waste was sampled and discharged to the Settling Basin where it was diluted with large

volumes of non-active waste prior to discharge to White Oak Creek.

DESCRIPTION: The complex consists of two man-made basins and a process waste treatment facility which is a 1,092 square-foot, two-story, concrete block, flat-roofed structure with hopper windows and an exterior metal staircase.

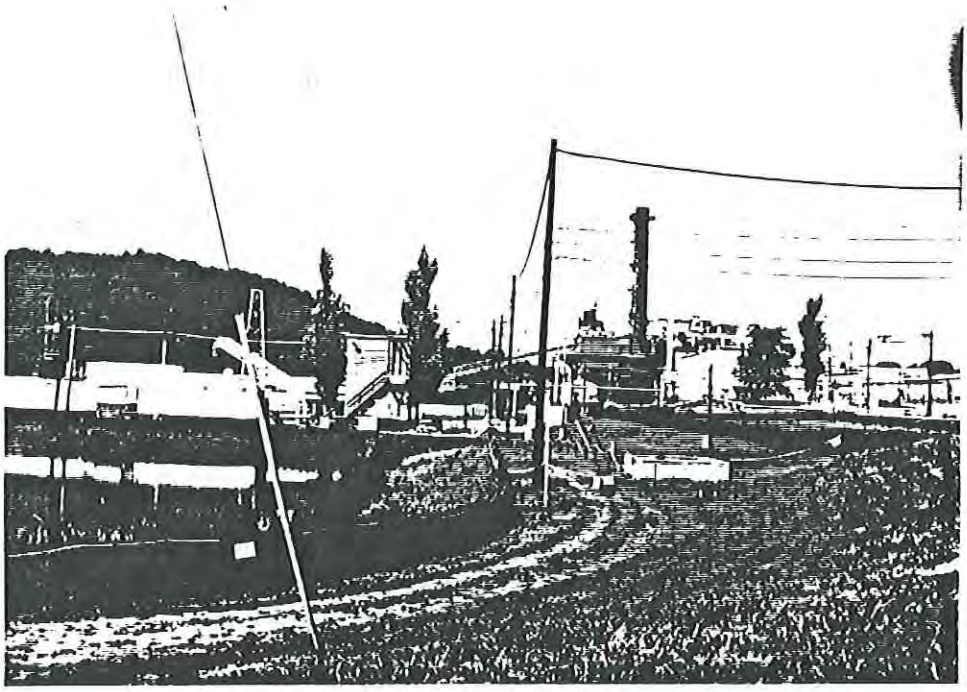


Figure III-91. 3518, 3513 Process Waste Treatment Plant and Settling Basin (1957, 1944). The Settling Basin is on the left of the photograph and to left of center, is the building associated with the Process Waste Treatment Plant. View southwest.

3515 MAIN

CURRENT USE: Fission Product Pilot Plant
ORIGINAL USE: Fission Product Pilot Plant

HISTORY: This 1948 structure was a component of the ORNL's fission product recovery development program. The facility was used to extract radionuclides from LLLW. It was shut down in 1958.

DESCRIPTION: Located on the eastern edge of the South Tank Farm (Building 3507), this facility is comprised of a concrete block structure containing an unlined concrete cell with tanks, valves and controls inside. *The concrete block outer structure dates post-1958 and was built to entomb the cell and equipment.*

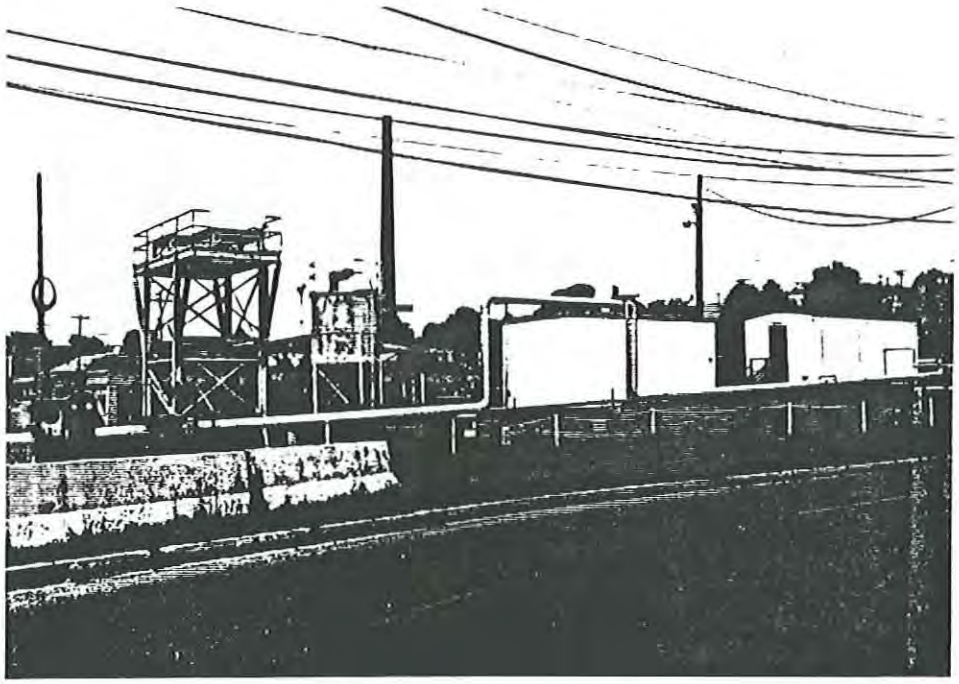


Figure III-92. 3515 Fission Product Pilot Plant (1948). View northwest.

3523 MAIN

CURRENT USE: Storage
ORIGINAL USE: Controls Research Laboratory

HISTORY: Building 3523 was constructed in 1957 as the Controls Research Laboratory. The building is presently used for storage.

DESCRIPTION: This 1,200 square-foot, metal-frame building is one-story in height with corrugated-metal siding, gable roof with ridgeline vents, and multipane hopper windows. *Some of the hopper windows have been sided over.*

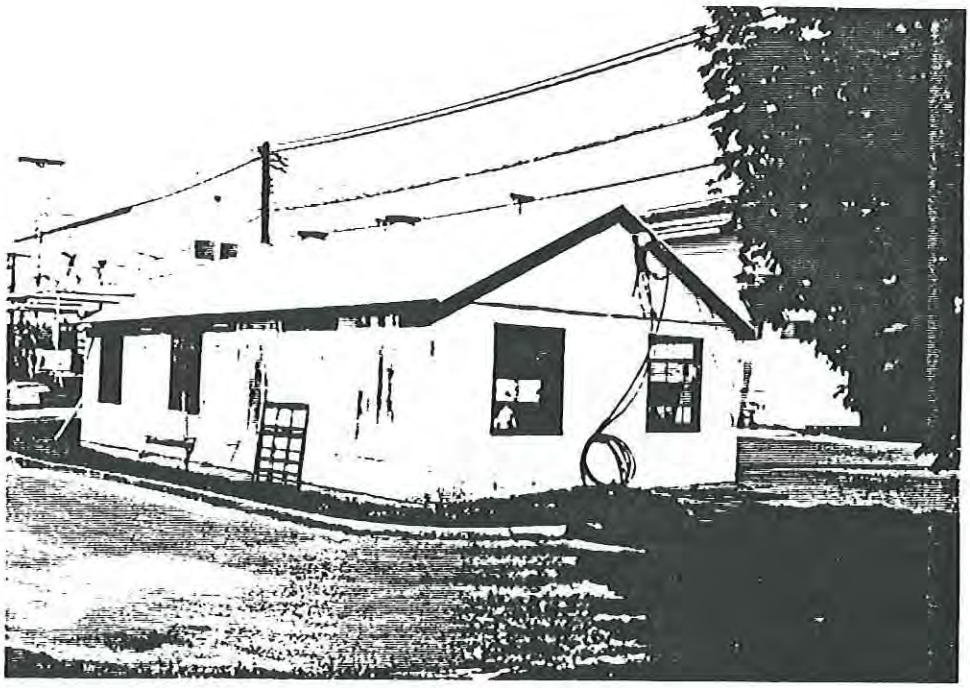


Figure III-93. 3523 Storage (1957). View northwest.

3550 MAIN CURRENT USE: Research Laboratory Annex
ORIGINAL USE: Chemistry Laboratory

HISTORY: The Chemistry Building is associated with the Manhattan Project and was constructed in 1943 at a cost of $804,000. When constructed, it provided laboratory and office space for the Chemistry Division which was divided into three sections: Chemistry, Analytical and Separations Development. The work plan was as follows:

> *The Separations Development Division was expected to complete most of its work on the pilot plant demonstration of the Hanford process by October 1, 1944 and then to be transferred almost in a body to Hanford. After the transfer, it was planned that operation of the [pilot] plant would be put on a research basis. It was recognized that the facilities available at Clinton Laboratories would be of primary importance in laying out a program of research in the new field of nuclear science (Thompson 1963:15)*

The Chemistry Division had two main buildings assigned to it during the Manhattan Project, Building 3550 and the Pilot Plant section of the Radiochemical Processing Pilot Plant (Building 3019A). Building 3550 was the primary research laboratory of the Clinton Laboratories and pioneering research was conducted there in the field of nuclear science. The experiments conducted in Building 3550 mirrored the ORNL's priority activities from the days of weapons research into the nuclear power era. Additional buildings were added to the Chemistry Division through the 1940s and into the 1950s to provide laboratory and office space for the division. Building 3550 expanded on a regular basis during that period. Upon the completion of Building 4500N in 1952, much of the research that took place in Building 3550 was transferred to 4500N. Soon after the move, a section by section removal of Building 3550 occurred as the building became obsolete and modern laboratory space was needed. Today, the building serves as a research laboratory annex for the Chemical Technology Division and the Environmental and Health Protection Division.

DESCRIPTION: The wood-frame structure today has 12,327 square-feet of office and laboratory space and is one-story in height with a gable roof, original novelty-board siding, and most original eight-over-eight wood-frame windows. The plan is comprised of a cross-gable section and then on the north end of this section, a gable-roofed section which contains the front entrance. This entrance has a gabled portico as does the secondary entrance on the east end of this section. At the east gable end of the cross-gable section is a brick crow-stepped gable exterior wall. *Exterior alterations include the replacement of some*

original eight-over-eight windows with aluminum sash, steel doors replacing wood doors and windows cut out to accommodate air conditioning units.

Plans and historic photographs clearly show the evolution of the structure as follows:

1943 Early 1943, Aerial Photo ORNL Hstry 153-cross gable central section with brick crow-stepped gabled portions between two t-sections. On the east end was a heavily shielded concrete building used for high level radioactive experimentation.

1943 May, 1943, Plans dated 5/12/43 show gable-roofed section built onto front of central cross-gable section.

1946 Plans dated 9/9/46 show "addition to east side of change house", conference room added to east end of gable-roofed front section.

1946 Plans dated 11/26/46 show additions to south gable end of central cross gable section and to east end of shielded building. Plans labeled "Van de Graaf Room."

1958 Plans dated 12/17/58 show removal of section west of central cross gable and west of brick crow-stepped gable wall, also removal of brick wall.

1960 After 1960, the section east of the central cross gable and east of the crow-stepped gable wall removed.

What remains of this building is the cross gabled core of the early 1943 building, the 1943 front addition and the 1946 "conference room" addition.

The interior is divided into office, change room, and laboratory space and retains some original baseboards and doors, new wall board and linoleum floors.

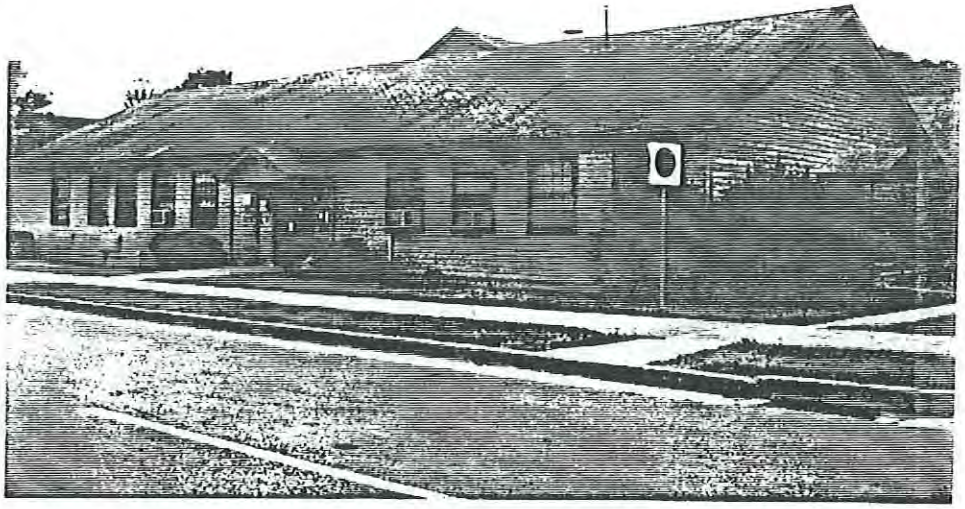


Figure III-94. 3550 Research Laboratory Annex (1943). Addition to front of building dating 5/12/43 and 1946 conference room at far left of photograph. View southeast.

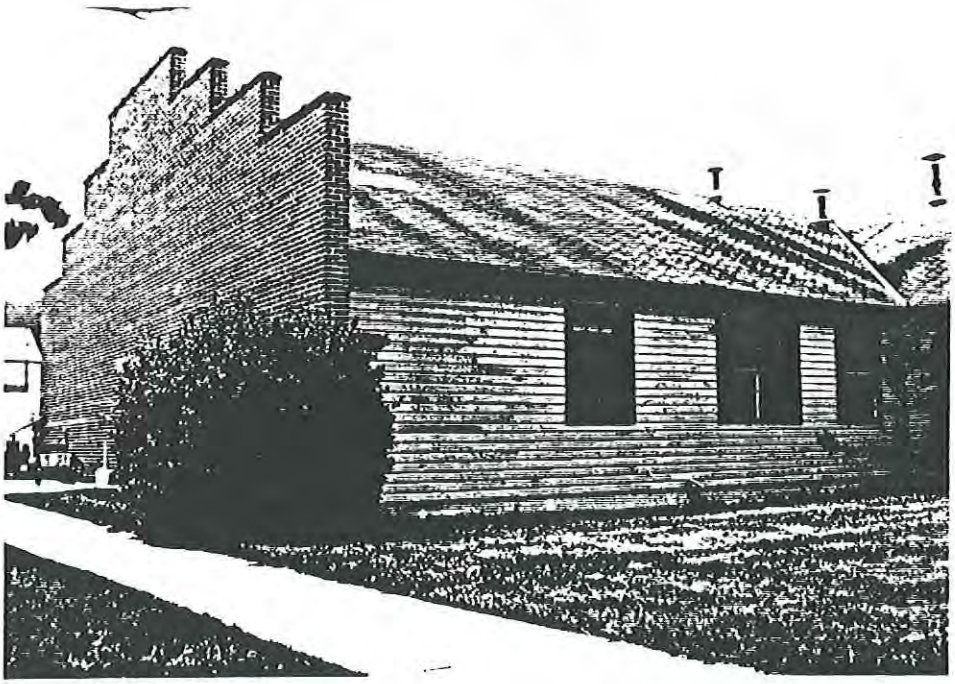


Figure III-95. 3550 Research Laboratory Annex (1943). Everything to the left (east) of this wall was demolished during the 1960s. View southwest.

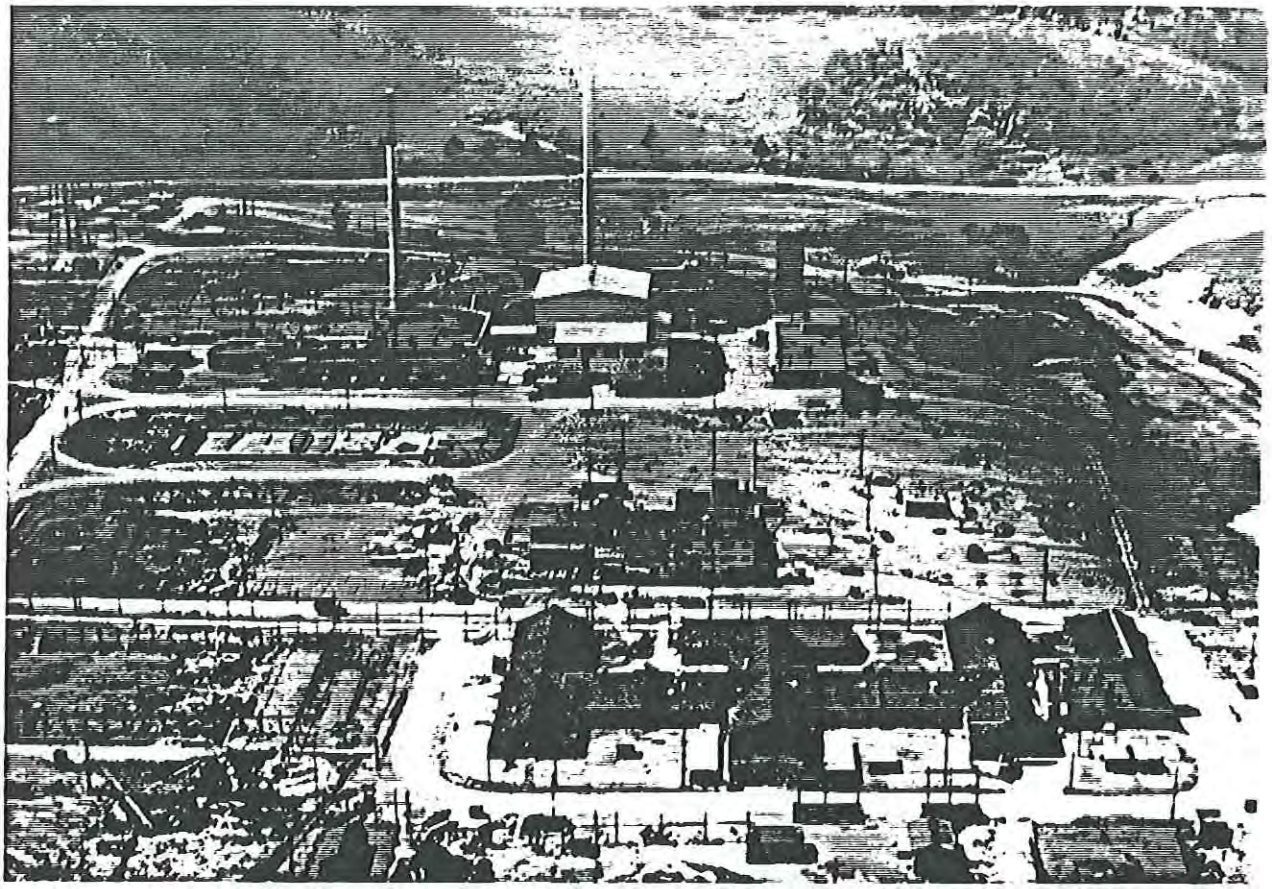


Figure III-96. ORNL Hstry 211 (1946). Aerial view of Building 3550 (at lower right of photograph) showing 1946 additions to south and east ends. View north.

3587 MAIN CURRENT USE: Instrument Laboratory Annex
ORIGINAL USE: Field Service Shop

HISTORY: This building was constructed ca. 1950 as a field service shop. It is visible in a pre-1951 photograph (ORNL Hstry 76) and is listed in a March 1, 1953 ORNL Building List (ORNL 1953). Today, it is a laboratory annex for the Instrument and Controls Division.

DESCRIPTION: This 3,405 square-foot, L-plan, steel-frame building has corrugated-metal siding, a gable roof, multipane hopper windows and a gable-roofed wing addition on the south side of the ell. Most windows have been painted over and doors are metal with a single-pane window.

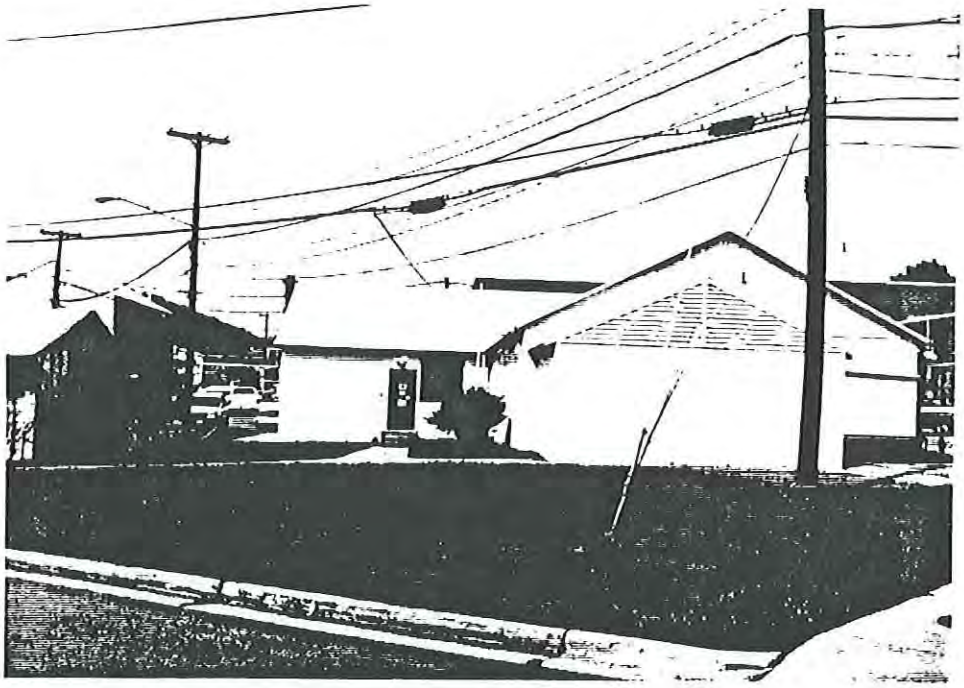


Figure III-97. 3587 Instrument Laboratory Annex (ca. 1950). View north.

3592 MAIN

CURRENT USE: Coal Conversion Facility
ORIGINAL USE: Unit Operations
Volatility Laboratory

HISTORY: Building 3592 is associated with the Chemical Technology Division and was constructed in 1952 at a cost of $34,000. Its major role at that time was its use in the Fluoride Volatility Processing Program being studied in the 1950s at various locations in the United States. The purpose of the program was the development of alternative methods for recovering uranium from spent nuclear fuel. This method had advantages over the conventional aqueous recovery processes which included high concentrations of waste and increased nuclear safety but there were also disadvantages.

The emphasis at the ORNL was in the Molten Salt Fluoride Volatility Process. Developed and tested in Buildings 4500N and 4507, the process underwent unit operation and engineering studies in Building 3592. A full-scale process plant for this recovery process was installed in Building 3019.

DESCRIPTION: This 1,200 square-foot, steel-frame structure is two stories in height with a gable roof, multipane hopper windows, and on the east end are an exterior metal staircase and a one-story shed addition.

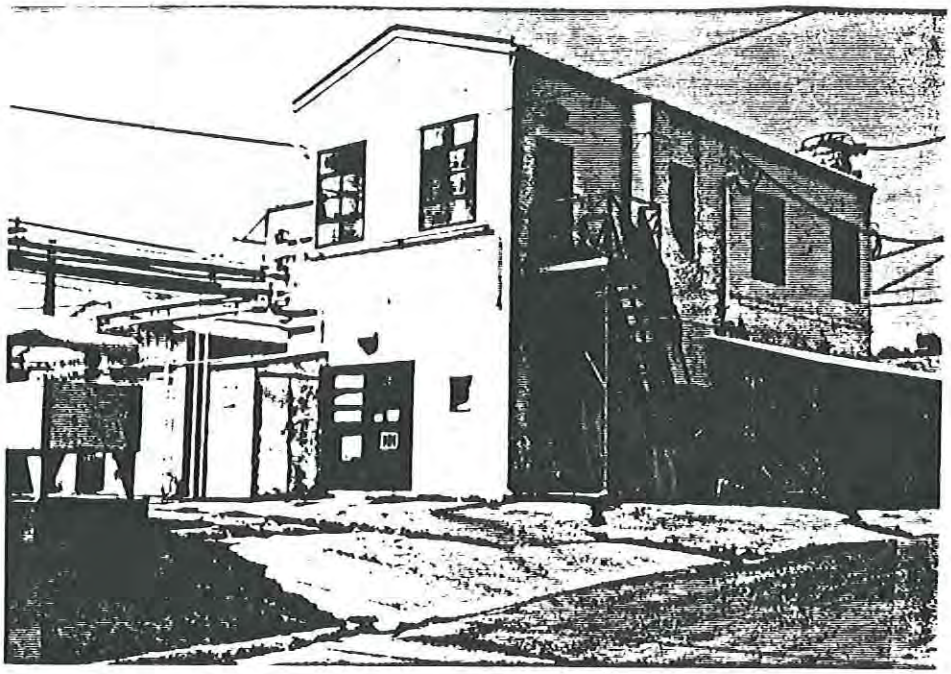


Figure III-98. 3592 Coal Conversion Facility. View northwest.

4000 MAIN CURRENT USE: 13.8 kV Substation
ORIGINAL USE: Substation

HISTORY: This electrical substation was built directly to the east of the SWSA 2 site in the early to mid 1950s.

DESCRIPTION: This substation contains electrical equipment in a fenced area.

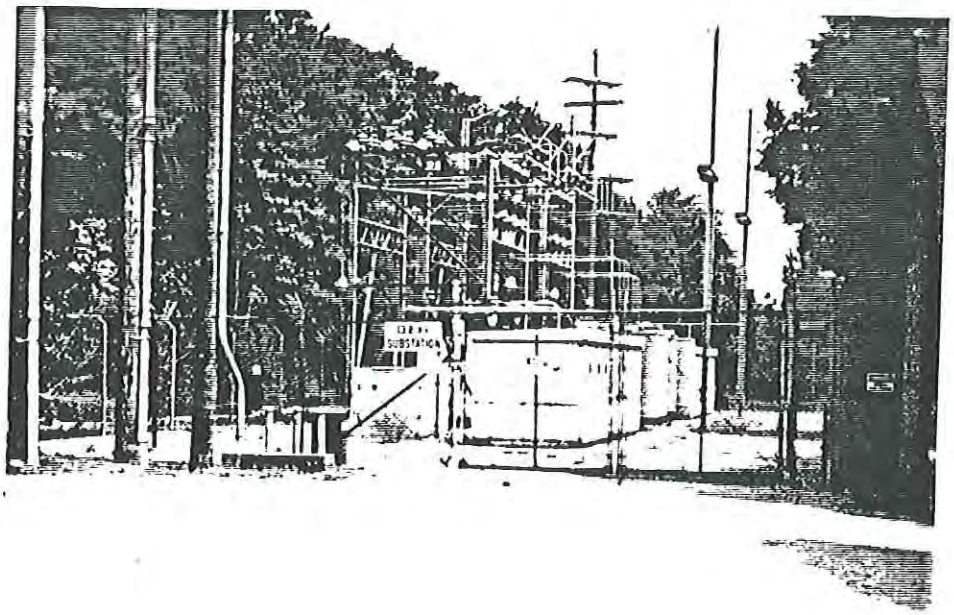


Figure III-99. 4000 13.8 kV Substation (ca. 1955). View north.

4003 MAIN

CURRENT USE: Inactive
ORIGINAL USE: Solid Waste Storage Area (SWSA) 2

HISTORY: SWSA 2 began operations in 1944 and operated until 1946. The site was selected for its close proximity to the Graphite Reactor (Building 3001). When SWSA 3 opened in 1946, this site was closed. Between 1946 and 1949, the storage drums were removed and the hillside bulldozed, contoured and seeded.

DESCRIPTION: This 3.5 acre former storage site is located east of Fifth Street and north of Central Avenue. It is a grassed unfenced site.

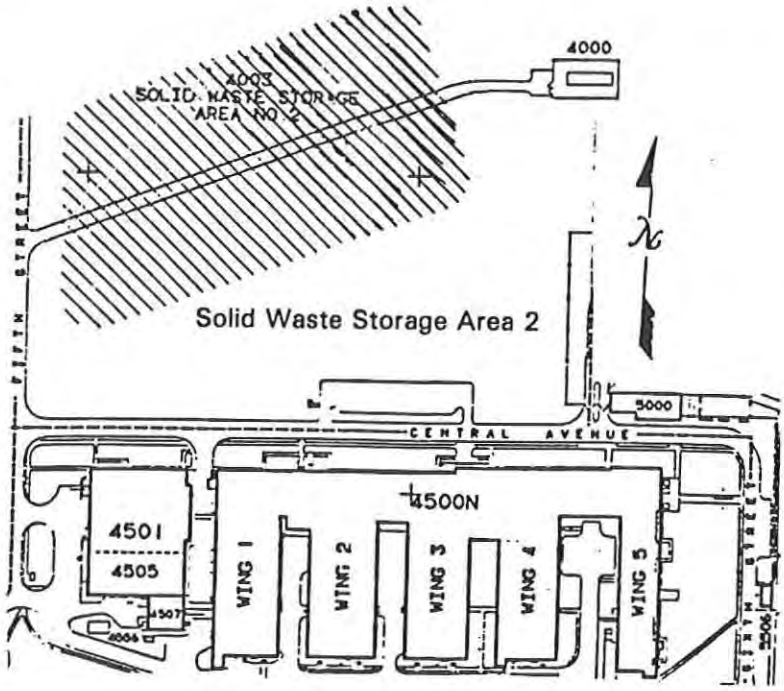


Figure III-100. 4003 Solid Waste Storage Area 2 (1944). All drums have been removed from this site.

4500N MAIN

CURRENT USE: Central Research and Administration North
ORIGINAL USE: Central Research and Administration North

HISTORY: As the research and development efforts of the ORNL expanded in the late 1940s and early 1950s, Union Carbide, the manager of the ORNL, instituted Program H to create needed laboratory and office space and to remove the obsolete "temporary" wood structures of the Manhattan Project. Building 4500N, built in 1952 at a cost of $4,966,000, was one of the primary buildings constructed under the program. The contractor for the project was J.A. Jones Construction Company.

Completion of this building allowed a great expansion and modernization of research and development activities of the ORNL. It remains today as the focal point of research and administration at the ORNL.

DESCRIPTION: This massive 341,242 square-foot, brick-faced structure is two stories in height with a basement. The building is comprised of a rectangular front section with a flat roof with stone coping. Four original, gable-roofed, two-story ell sections are at the rear (south) side of the rectangular section. The front section has a horizontal emphasis with banks of windows stretching across the facade. To the west of the central main entrance, the banks of windows are comprised of four-pane hopper windows separated by brick panels and surrounded by a raised decorative stone band. To the east of the entrance bay is a one-story section with ten-pane windows separated by stone panels. A two-story section is set back from the front.

The main entrance bay extends about three feet above the roof line and has plate glass entrance doors, transoms and windows; decorative stone panels; stone-panelled square pillars; and three small glass block windows (lighting for the stairwells).

Additions are found on the east end (Wing 5), constructed in 1960 at a cost of $1,577,000. This addition is two stories in height and contains banks of windows.

The lobby has been altered but laboratory and office space appears essentially intact.

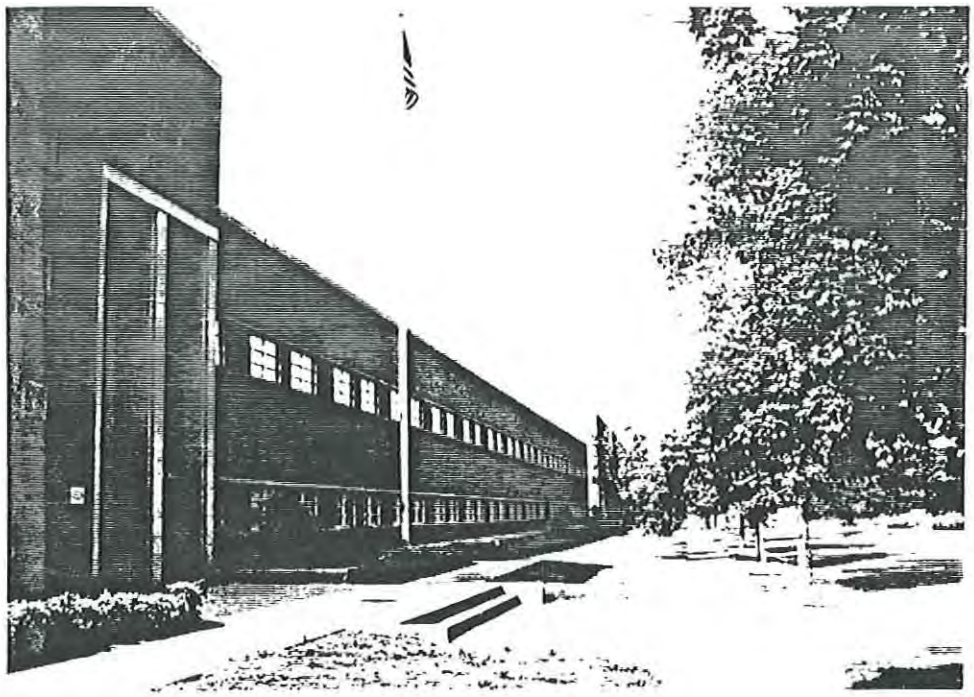


Figure III-101. 4500N Central Research and Administration Building North (1952). View southwest at main entrance and west side of front (north) facade.

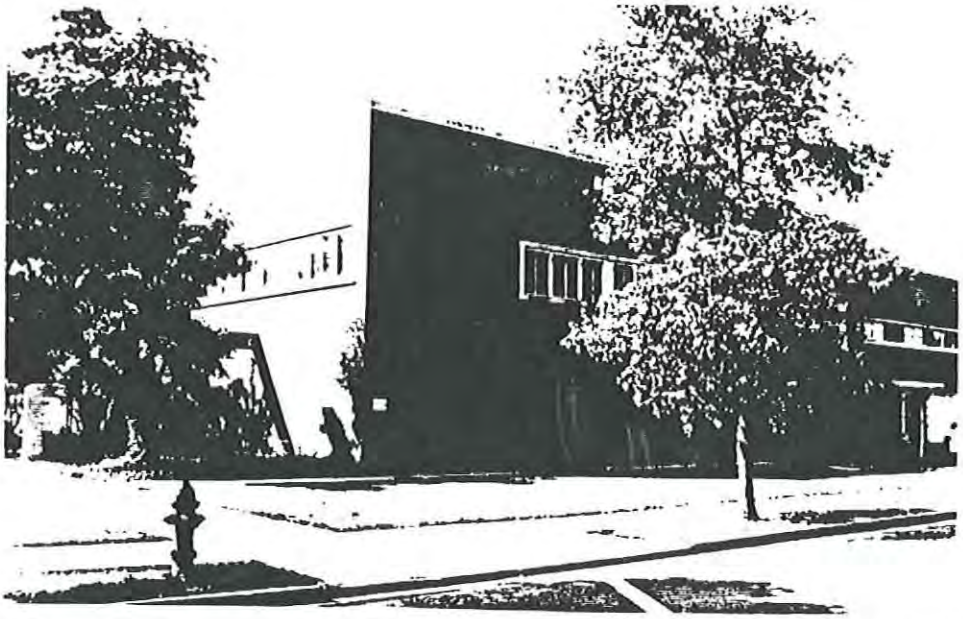


Figure III-102. 4500N Central Research and Administration Building North (1952). View southwest at addition on east end, constructed in 1960.

4501 MAIN

CURRENT USE: High Level Radiochemical Laboratory
ORIGINAL USE: Isotope Development

HISTORY: Built in 1951 at a cost of $3,070,000, this structure was originally one unit with Building 4505, together known as the High Level Radiation Laboratory. The building is associated with the ORNL's isotope program, one of the most prominent programs of the ORNL in the post-World War II period. It is assigned today to the Chemical Technology Division.

DESCRIPTION: This 36,246 square-foot building is three stories in height with a basement. The structure has brick facing, a flat roof, stone belt courses, banks of windows with decorative stone surrounds and hooded vents on the front (north) facade.

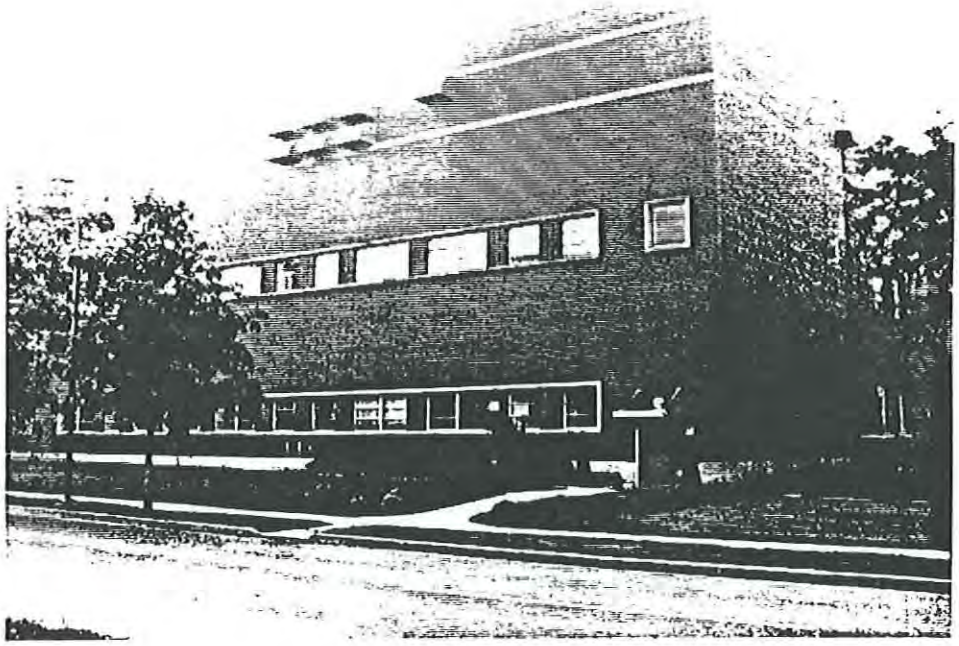


Figure III-103. 4501 High Level Radiochemical Laboratory (1951). Front (north) elevation. View southeast.

4505 MAIN

CURRENT USE: Experimental Engineering
ORIGINAL USE: High Level Radiation Laboratory

HISTORY: This building was constructed in 1951 and is associated with Building 4501. When built, the two connected buildings were considered as one, the High Level Radiation Laboratory. It was built for and continues today in use by the Chemical Technology Division.

DESCRIPTION: This 78,445 square-foot building, connected to Building 4501, has three stories and a basement. It has brick facing, a flat roof, decorative stone belt courses, banks of windows, loading docks and a crane bay on the south side. On the west side are hooded vents and irregularly-spaced hopper windows.

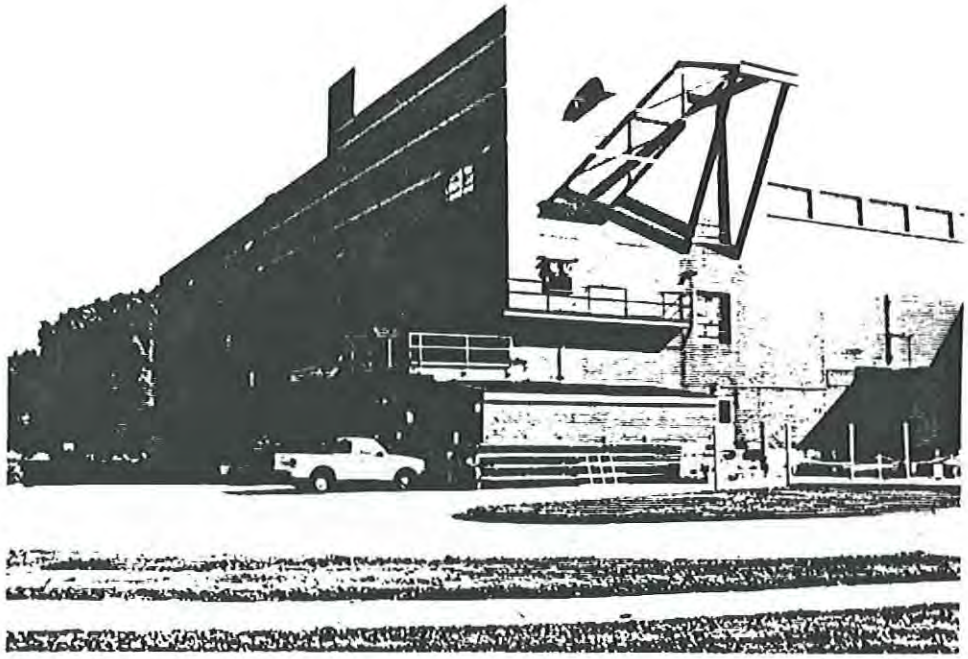


Figure III-104. 4505 Experimental Engineering (1951). Rear (south) and west facades. View northeast.

4507 MAIN

CURRENT USE: Inactive
ORIGINAL USE: High Radiation Level Chemical Development Laboratory

HISTORY: Built in 1957 at a cost of $281,000, this High Radiation Level Chemical Development Laboratory is historically associated with the Chemical Technology Division. It was designed and operated in that period as a laboratory and small scale pilot plant for development studies for reactor fuel reprocessing. Research in Building 4507 was focused on the Fluoride Volatility Processing Program being studied in the 1950s at various locations in the United States. The purpose of the program was the development of alternative methods for recovering uranium from spent nuclear fuel. This method had advantages over the conventional aqueous recovery processes which included high concentration of waste and increased nuclear safety but there were also disadvantages. The emphasis at the ORNL was in the Molten Salt Fluoride Volatility Process. Developed and tested in Building 4500N. The process was then taken to hot cell level in Building 4507 before installation of full-scale production in Building 3019. Building 4507 is currently inactive and unoccupied.

DESCRIPTION: This 3,812 square-foot, one- and two-story building is brick-faced with a flat roof and is connected to the south side (rear) of Building 4505. The building contains four shielded hot cells with master slave manipulators. The cells currently contain material and instrumentation from past operations.

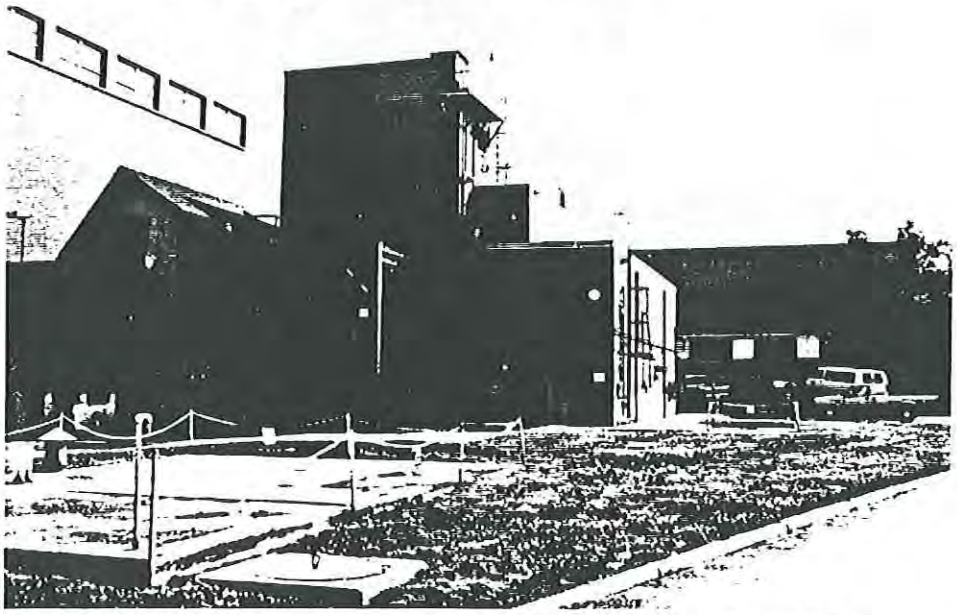


Figure III-105. 4507 High Radiation Level Chemical Development Laboratory (1957). View toward east with Building 4505 on right of photograph.

5000 MAIN

CURRENT USE: Main Portal
ORIGINAL USE: Main Portal

HISTORY: The Main Portal was constructed as part of Union Carbide's Program H building campaign of the early 1950s. It served then, as it does today, as the primary (security protected) entrance to the ORNL main facilities complex. It is assigned to the Laboratory Protection Division.

DESCRIPTION: This 6,300 square-foot, one-story, brick-faced structure has stone coping and lug sills under original multipane windows. Square concrete columns support the porticoes on the front (north) side and the west drive-through side. The interior of the building is essentially intact.

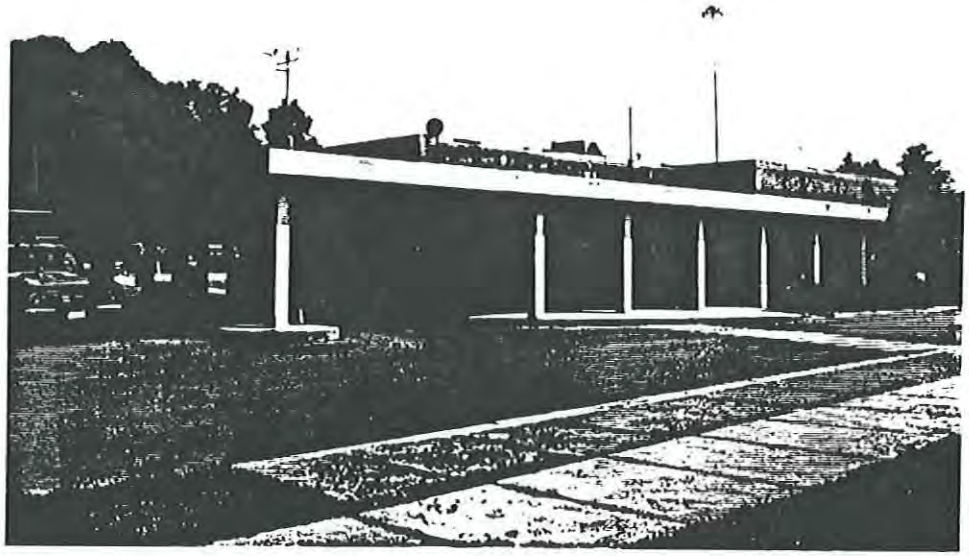


Figure III-106. 5000 Main Portal (1952). View northeast at rear (south side) of the building.

5500 MAIN CURRENT USE: High Voltage Accelerator Laboratory
ORIGINAL USE: High Voltage Accelerator Laboratory

HISTORY: The High Voltage Accelerator Laboratory was constructed in 1952 at a cost of $1,044,000 and is associated with the field of high energy physics, which involves the study of subatomic particles smaller than neutrons, electrons and protons. After World War II, the ORNL purchased their first accelerators, a Van de Graaf and a Cockroft-Walton accelerator, for high energy physics research and installed them in Building 2011. These accelerators enhanced the study of neutrons because:

> *Neutrons were the key to the new frontier of applied nuclear energy; to fully exploit neutrons, their behavior had to be thoroughly understood and the Van de Graaf accelerator was the only known source of neutrons of precisely determined energies (Johnson and Schaffer 1992:75).*

During the ARE program, the U.S. Air Force agreed to purchase an upgraded Van De Graaf if the ORNL would construct a building to house it. In 1952, the ORNL completed Building 5500 and moved three accelerators into its laboratories, the two existing accelerators and the upgraded Van de Graaf. A decade later a tandem Van De Graaf was purchased to increase research capabilities. "Thirty years later, Laboratory physicists still view this accelerator as a valuable research tool" (Johnson and Schaffer 1992:78).

DESCRIPTION: This 51,965 square-foot structure is irregular in plan with brick-faced, one- and two-story sections surrounding a tower faced with corrugated metal. The building has a basement, an office section with banks of windows, and on the front is a glassed-in entrance portico. *Alterations include a 1976 addition on the south side and an post-1960 addition on the east end of the building.*

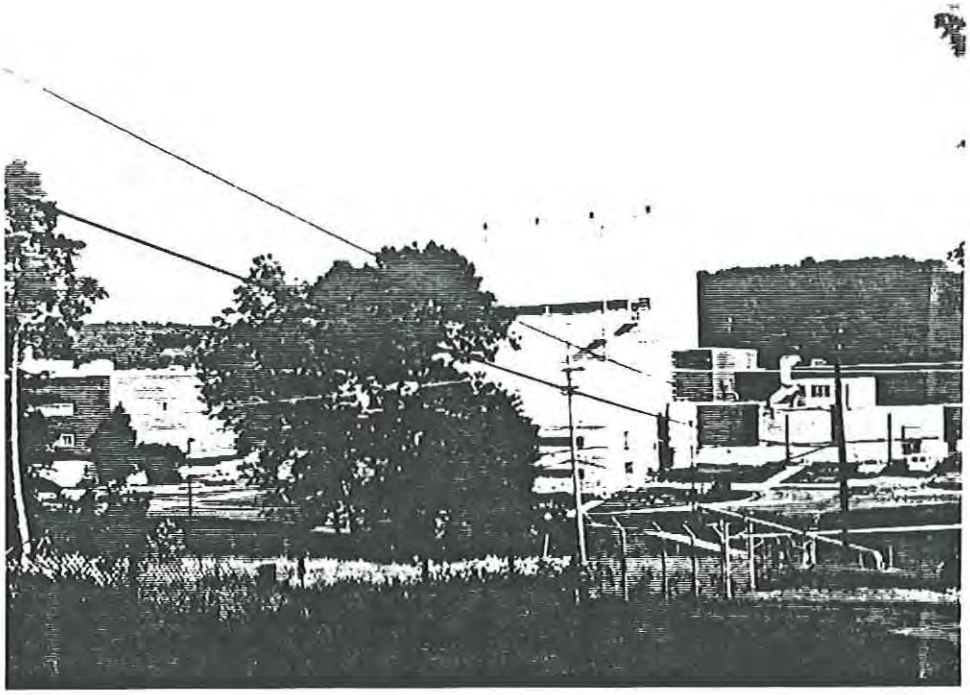


Figure III-107. 5500 High Voltage Accelerator Laboratory (1952). Building 4500S at left of photograph. View north.

ASSESSMENT OF ELIGIBILITY FOR ORNL MAIN FACILITIES COMPLEX: The HPS met with the staff of the TN-SHPO and representatives of the DOE and the ORNL on 30 August 1993 and used the building information presented on the preceding pages to determine whether parts or all of the ORNL main facilities complex would qualify as a National Register Historic District. In consultation with the TN-SHPO, the HPS determined that portions of the ORNL main facilities complex are eligible for inclusion in the National Register as a historic district under Criteria A and C. Under Criterion A, it is eligible for its historical association with the Manhattan Project, the post-World War II government-sponsored scientific movement, and early nuclear research. It is felt to be eligible under Criterion C for the engineering merits of many of the facilities and for contributions to science and technology.

The boundaries of the Oak Ridge National Laboratory Historic District fall entirely within the confines of the ORNL main facilities complex. Boundaries were drawn to exclude areas with high concentrations of buildings outside the period of significance or with a high percentage of buildings altered to a point where they no longer would be considered contributing structures in a district. The boundaries are shown in Figure III-108.

A list of the buildings included in the district follows (Table III-2) with the contributing (C) or non-contributing (NC) status of each. Of the 128 properties in the proposed district, 66 are considered as contributing to the district and 62 are considered non-contributing. Please note that many of the non-contributing properties are small accessory buildings such as manhole covers, filters, and generators.

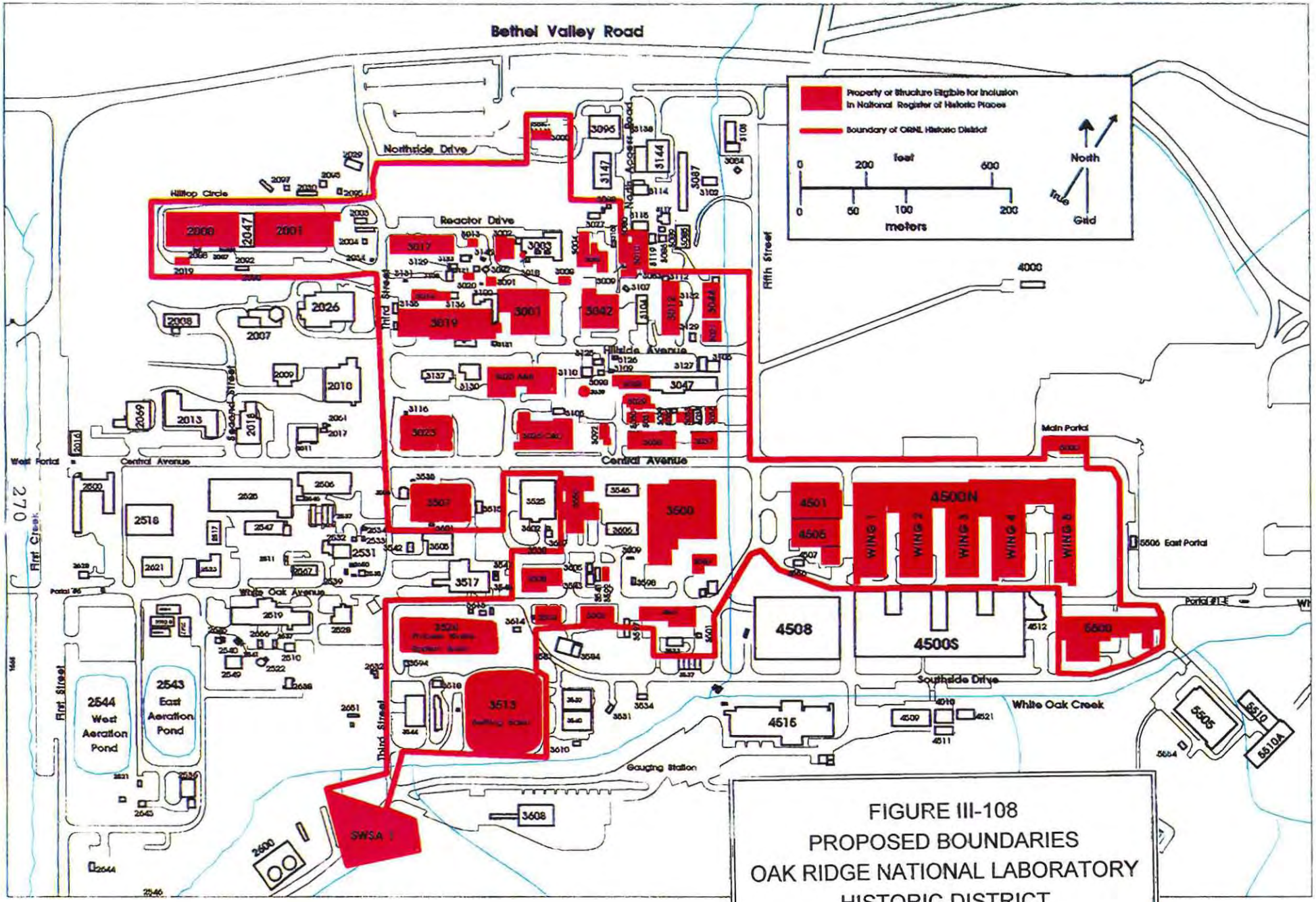


FIGURE III-108
PROPOSED BOUNDARIES
OAK RIDGE NATIONAL LABORATORY
HISTORIC DISTRICT

TABLE III–2 P. 1 of 4
CONTRIBUTING/NON–CONTRIBUTING PROPERTIES IN THE
OAK RIDGE NATIONAL LABORATORY HISTORIC DISTRICT

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	DISTRICT C/NC	REASON
2000	Solid State Lab Annex	48		C	
2001	Information Center Complex	48		C	
2003	Process Water Control System	47		C	
2019	Solar Energy Lab	51		C	
2024	Quality Assurance and Inspection		69	NC	AGE
2034	Manhole 95 Monitor		n.d.	NC	AGE
2087	Storage		59	NC	AGE
2088	Emergency Generator for 2000		59	NC	AGE
2092	Storage		59	NC	AGE
2098	Substation 6–3 2000 Area		n.d.	NC	AGE
2624	Solid Waste Storage Area No. 1	43		C	

TABLE III–2 p. 2 of 4
CONTRIBUTING/NON–CONTRIBUTING PROPERTIES IN THE
OAK RIDGE NATIONAL LABORATORY HISTORIC DISTRICT

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	DISTRICT C/NC	REASON
3000	13.8 kV Substation	52		C	
3001	Graphite Reactor	43		C	NHL
3002	Filter House for 3001	48		C	
3003	Solid State Accelerator Facility	43		NC	ALTERED
3004	Water Demineralizer	43		C	
3005	Low Intensity Testing Reactor	48		C	
3008	Source & Materials–Spec. Vault	43		C	
3009	Pump House for 3010	50		C	
3010	Bulk Shielding Reactor Fac.	50		C	
3012	Rolling Mill	47		C	
3013	Geological Disposal Lab	48		C	
3017	Chem Tech Division Annex	52		C	
3018	Exhaust Stack for 3003	43		C	
3019	(A) Radiochem. Proc. Pilot Plant	43		C	
3019	(B) High Level Rad. Analytical Lab	54		C	
3020	Exhaust Stack for 3019	43		C	
3021	Turbine House for 3019	43		C	
3023	North Tank Farm	43		C	
3025	(E) Physical Exam–Hot Cells A	51		C	
3025	(M) Solid State Division Lab	51		C	
3026	(C) Radioisotope Dev; Lab B	43		C	CELLS ONLY
3026	(D) Dismantling & Exam Hot Cells	45		C	CELLS ONLY
3027	Safeguard Nuclear Materials Vault	55		C	
3028	Radioisotope Prod. Lab A	51		C	
3029	Radioisotope Prod. Lab B	51		C	
3030	Radioisotope Prod. Lab C	51		C	
3031	Radioisotope Prod. Lab D	51		C	
3032	Radioisotope Prod. Lab E	51		C	
3033	Radioisotope Prod. Lab F	51		C	
3033	(A) Radioisotope Prod. Lab Annex		n.d.	NC	
3034	Radioisotope Area Services	51		C	
3036	Isotope Area Storage & Service	51		C	
3037	Operations Division Offices	51		C	
3038	Radioisotope Laboratory	51		C	
3039	Cent. Rad. Waste Gas Disp. Fac.	51		C	
3042	Oak Ridge Research Reactor	55		C	
3044	Special Materials Machine Shop	55		C	
3047	Isotope Technology Building		63	NC	AGE
3074	Interim Manipulator Repair Fac.	51		C	
3077	Air Cooler LITR		59	NC	AGE
3078	Septic Tank for 3000		n.d.	NC	AGE
3080	Reactor Experiment Control Room	53		C	
3082	Storage Misc. Materials		58	NC	AGE
3083	Neutron Spectrometer Sta. No. 1		58	NC	AGE
3088	Bulk Shielding Reactor Storage		58	NC	AGE
3091	Filters for 3019	50		C	
3092	Off–gas Facility	56		C	
3098	Filter Facility BSR		58	NC	AGE
3099	Storage Pad Betw. 3031 & 3032		60	NC	AGE
3100	Source & Special Materials Vault		60	NC	AGE
3101	Storage Shed		59	NC	AGE
3104	West Research Service Center		61	NC	AGE
3105	Waste Monitoring Control Center		62	NC	AGE
3106	Cell Ventilation Filters		60	NC	AGE

TABLE III–2 p. 3 of 4
CONTRIBUTING/NON–CONTRIBUTING PROPERTIES IN THE
OAK RIDGE NATIONAL LABORATORY HISTORIC DISTRICT

3107	25–Meter Target House on Flight Path		58	NC	AGE
3109	Off Gas Filters for ORR		62	NC	AGE
3110	Cell Ventilation Filter		62	NC	AGE
3112	Misc. Storage Building		61	NC	AGE
3113	Motor House for 3019		67	NC	AGE
3116	Nitrogen Cylinder Storage Bldg.		n.d.	NC	AGE
3121	Cell–Off Gas Filter House for 3019		67	NC	AGE
3123	Emergency Generator for 3019		68	NC	AGE
3125	Emergency Generator for Stack 3039		74	NC	AGE
3126	Charcoal Filter Pit		58	NC	AGE
3127	Non Nuclear Research Materials Vault		76	NC	AGE
3129	Personnel Monitoring Station		76	NC	AGE
3130	Waste Operations Control		83	NC	AGE
3131	Emergency Generator for 3019		60	NC	AGE
3135	Sentry Post No. 80		68	NC	AGE
3136	Equipment Testing Building		84	NC	AGE
3137	Surface Science Lab		84	NC	AGE
3138	Thermal Properties Test Facility		83	NC	AGE
3140	Cell Ventilation for 3026		66	NC	AGE
3151	Mon. Sta. MH 25		93	NC	AGE
3154	Manhole 112 Monitor		n.d.	NC	AGE
3155	Manholes 114 and 234 Monitor		n.d.	NC	AGE
3500	Instrumentation & Controls Div.	51		C	
3501	Sewage Pumping Station	49		C	
3502	East Research Service Center	50		C	
3503	High Radiation Level Engineering	48		C	
3504	Geosciences Lab	51		C	
3506	Chemical Evaporator Building	49		C	
3507	South Tank Farm	43		C	
3508	Chemical Technology Alpha Lab	44		C	
3513	Settling Basin	57		C	
3515	Fission Product Pilot Plant	48		C	
3518	Process Waste Treatment Plant	57		C	
3523	Storage	54		C	
3524	Process Waste Systems Basin	44		C	
3525	High Rad. Level Exam. Lab		63	NC	AGE
3535	Filter Enclosure		61	NC	AGE
3541	MSR Process Dev. Lab.		65	NC	AGE
3543	MSR Development Lab		68	NC	AGE
3544	Process Waste Treatment Plant		76	NC	AGE
3546	I & C Office Annex		76	NC	AGE
3550	Research Laboratory Annex	43		C	
3587	Instrument Laboratory Annex	50		C	
3592	Coal Conversion Facility	52		C	
3594	Waste Management Storage Bldg.		58	NC	AGE
3597	Hot Storage Garden		60	NC	AGE
3598	Emergency Generator for 3500		62	NC	AGE
3601	HEPA Filter House		66	NC	AGE
3602	Cylinder Tank Storage Bldg.		63	NC	AGE
3605	Storage		85	NC	AGE
3606	Instrument and Controls Off. Annex		85	NC	AGE
3607	Cask Storage Building		85	NC	AGE
3609	Substation 25–1 3500 Area		n.d.	NC	AGE
3613	Pump Station No. 1, Diversion		n.d.	NC	AGE
3614	Mon. Sta. MH 190		n.d.	NC	AGE
3616	Mon. Sta. MH 149		n.d.	NC	AGE

TABLE III–2 p. 4 of 4
CONTRIBUTING/NON–CONTRIBUTING PROPERTIES IN THE
OAK RIDGE NATIONAL LABORATORY HISTORIC DISTRICT

BLDG. #	BUILDING NAME	YR. BLT 43–57	YR. BLT POST '57	DISTRICT C/NC	REASON
4500N	Central Research & Administration	52		C	
4501	High Level Radiochemical Lab	51		C	
4505	Experimental Engineering	52		C	
4507	High Rad. Level Chem Dev. Lab	57		C	
4556	Filter Pit for 4507		72	NC	AGE
5000	Main Portal	52		C	
5500	High Voltage Accelerator Lab	52		C	

6000 AREA

CURRENT USE: Holifield Heavy Ion Research Facility
ORIGINAL USE: Oak Ridge Isochronous Cyclotron

HISTORY: The 6000 Area saw its beginnings in the early 1960s, a time when the ORNL experienced increased growth in accelerator programs. Accelerator programs provided information in the areas of radiation damage, nuclear physics (forces and reactions) and produced radioisotopes of a type that cannot be produced in reactors (Thompson 1963:145). At this time the ORNL had Van de Graaf accelerators and three cyclotrons designed and built by the ORNL for use in its nuclear physics research program.

In 1961, using the high beam technology developed for these cyclotrons and improving upon it, the ORNL built Building 6000, the Oak Ridge Relativistic Isochronous Cyclotron (ORIC) at a cost of $3,718,000. The ORIC began operations in 1963, firing protons, alpha particles and other light projectiles into various targets with the resulting production of heavy ions. In its day, the design of the ORIC was considered a major technological breakthrough. The ORIC provided ion beams for research in chemistry and physics.

Late in the 1960s, the ORNL built the electron accelerator adjacent to the ORIC. The purpose of this accelerator was to determine the probability that a given shielding, or structural material, would absorb fast neutrons. This program advanced scientific understanding of the strong force that glues a neutron together.

When scientists expressed an interest in expanding the program, a consortium was formed to develop a new accelerator "capable of accelerating heavy ions into an energy range where superheavy transuranic elements could be investigated" (Johnson and Schaffer 1992:152). Upon rejection of this project by President Nixon, the group attempted to secure approval by illustrating its national importance in scientific research through protecting the United States from being surpassed in scientific research by other nations.

This consortium brought together physicists (from eighteen universities) interested in heavy ion research and the development of a national accelerator. Funding was eventually obtained from several sources for an addition to the ORIC to house the University Isotope Separator of Oak Ridge which interfaced with beam lines from the ORIC.

When completed, the consortium scientists "initiated research into new radioisotopes for medical and industrial applications" (Johnson and Schaffer 1992:153). This,

coupled with ongoing ORIC research, resulted in the designation of the facility as a national research facility, dedicated in December of 1980. This designation as a National Department of Energy Facility brought numerous scientists from around the world to the ORNL.

Construction began in 1978 on a concrete tower connected to the ORIC to house a new 25 million volt tandem accelerator. Twice as powerful as any other machine of its type, the accelerator in the tower was coupled with the ORIC to convert heavy ions into high speed projectiles producing results that helped to "illuminate fundamental nuclear science" (Johnson and Schaffer 1992:199).

In 1983, the energy efficient, earth-sheltered Joint Institute for Heavy Ion Research, designed and built by lab architect Hanna Shapira, was completed to provide office space and temporary laboratory accommodations for facility users. Other buildings completed that year were a gas compressor house for Building 6000 and an office/laboratory facility (Building 6008). In 1989 and 1990, Building 6011, the Computing and Telecommunications Facility, and Building 6012, the Computer Science Research Facility, were completed.

DESCRIPTION: The 6000 Area is located just outside the fence to the east of the ORNL main facilities complex. It is comprised of eleven buildings built between 1961 and 1990. The Swan Pond (See Figure III-109) forms a portion of its northern boundary while Bethel Valley Road forms the remaining northern boundary.

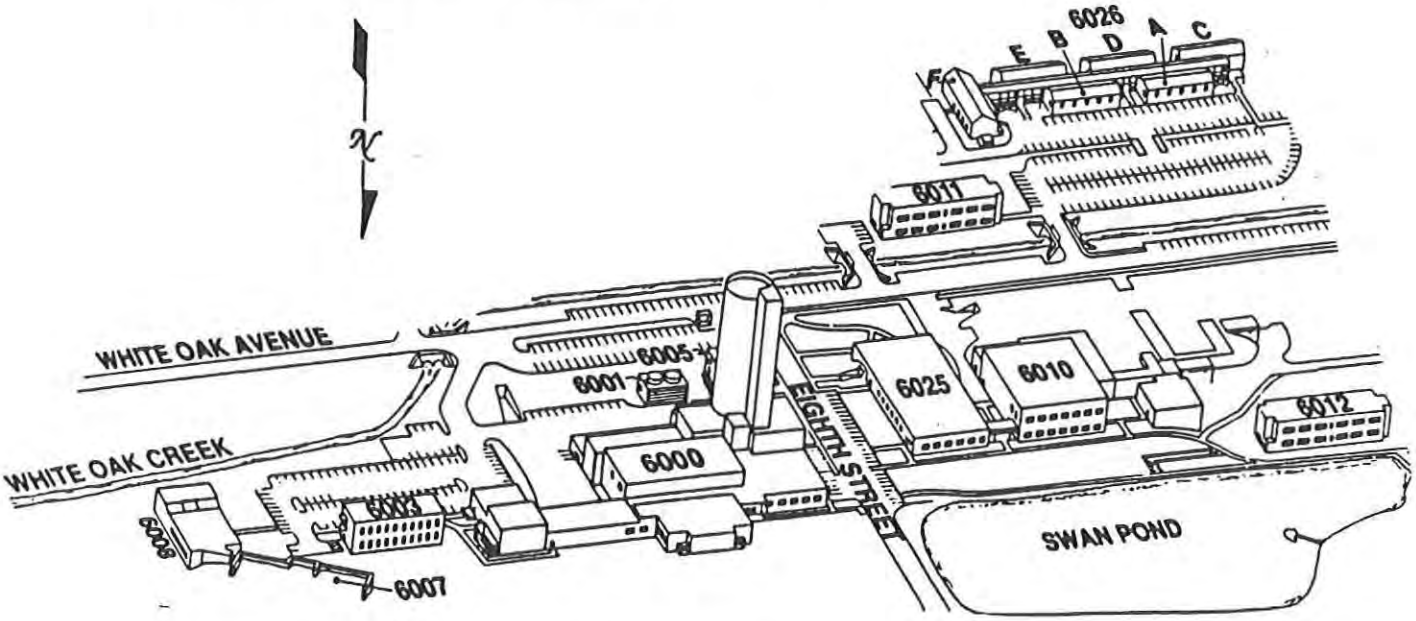


Figure III-109. 6000 Area. Site plan.

6000 Holifield Heavy Ion Research Facility (1961): Built at a cost of $3,718,000, this one- to three-story, 109,808 square-foot building is of steel frame construction. Portions are faced with brick and corrugated metal. The attached tower is of concrete. The building was constructed in three stages. The first part of the building housing the Oak Ridge Isochronous Cyclotron was completed in 1961. *In 1969, an Electron Linear Accelerator was added to the facility and by 1980 a tower was completed to house the new 25 million volt accelerator.*

6001 Cooling Tower for 6000 (1961): This 1,177 wood-frame cooling tower stands to the south of Building 6000.

6003 Office Building (1976): This 7,326 modular frame, brick veneer building is two stories in height with a flat roof.

6005 Gas Compressor House for 6000 (1983): This 2,100 square-foot, concrete block building stands to the north of Building 6000 and has a roll-up door, vents and an exterior metal staircase.

6007 Joint Institute for Heavy Ion Research (1983): This 3,900 square-foot, energy efficient, earth-sheltered concrete and masonry building has a flat roof and banks of windows. It was designed by ORNL architect Hanna Shapira.

6008 JIHIR Office/Laboratory Facility (1984): This 6,000 square-foot, concrete building is one-story in height with a flat roof and banks of windows.

6010 Electron Linear Accelerator (1969): This 41,795 square-foot building has brick facing, a flat roof, and paired windows in banks.

6011 Computing and Telecommunications Building (1989): This 2-story, flat-roofed, brick-faced building has one-over-one windows in banks with concrete and brick panels in between.

6012 Computer Science Research Facility (1990): This 9,000 square-foot, steel-frame, two-story building has a flat roof, banks of tinted glass windows and horizontal bands of corrugated-metal siding across each long side of the building.

6025 Engineering Physics Office/Laboratory Building (1967): This one-story, 17,400 square-foot building has a flat roof, brick veneer siding and banks of paired windows separated by concrete panels.

6026 A,B,C,D,E,F Office Trailers for Planning and Management (1990): Located on the south part of the complex along White Oak Avenue is a grouping of six trailers connected by a covered walkway.

ASSESSMENT OF ELIGIBILITY: It is the opinion of the HPS that there is insufficient historical perspective to assess the significance of facilities in the 6000 Area. At fifty years of age, there should be sufficient historical perspective to evaluate this complex for National Register eligibility.

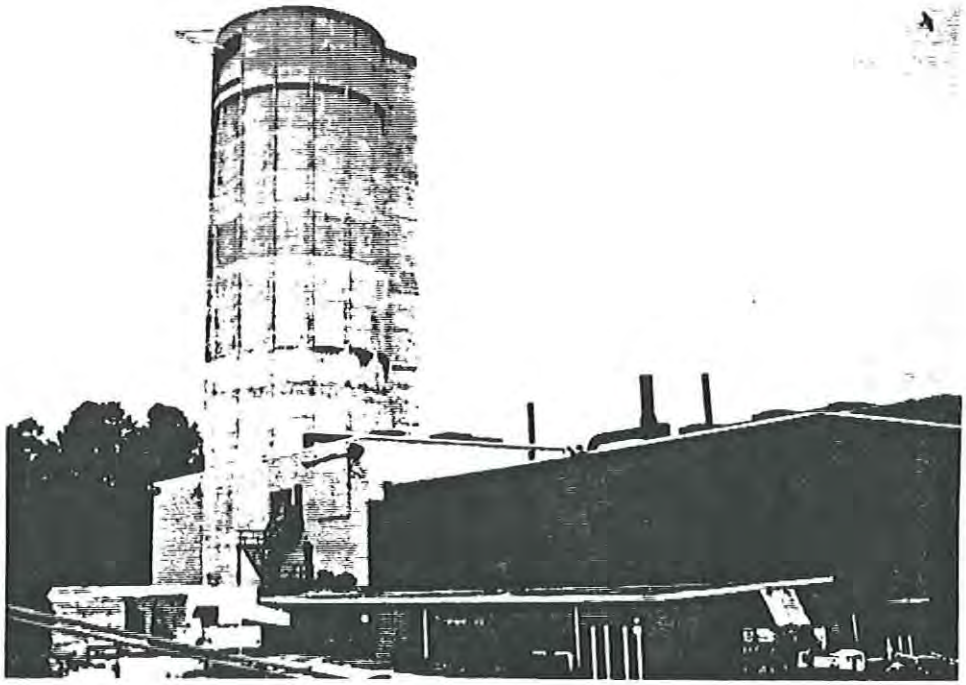


Figure III-110. 6000 Holifield Heavy Ion Research Facility (1961). The facility contains the 1961 Oak Ridge Isochronous Cyclotron, the 1969 Electron Linear Accelerator and the 1980s tower with a 25 million volt accelerator. View northwest.

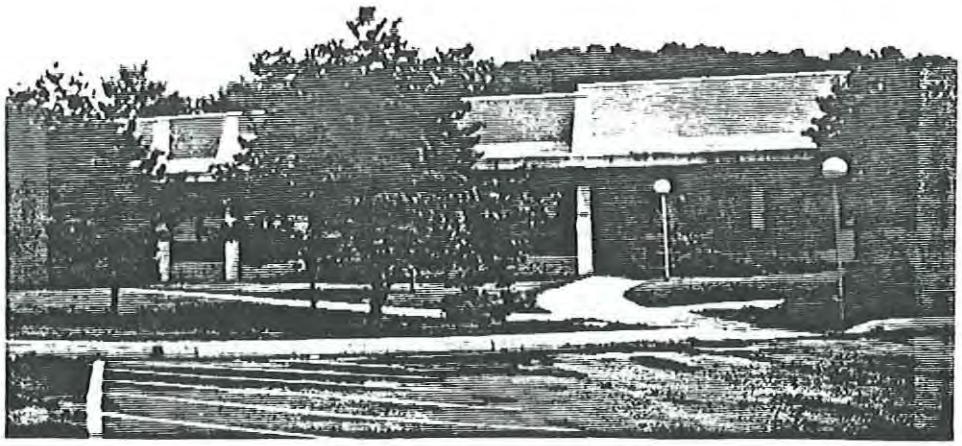


Figure III-111. 6007 Joint Institute for Heavy Ion Research (1983). This building was designed by ORNL architect Hanna Shapira. View north.

7000 AREA CURRENT USE: East Support Area
ORIGINAL USE: East Support Area

HISTORY: The first buildings constructed in this complex were built in 1948 by the J.A. Jones Construction Company. This firm, while serving as building contractor at the ORNL in the late 1940s, established a shops and headquarters area east of the ORNL main facilities complex. This area is known today as the East Support Area. When the construction project in the ORNL main facilities complex was completed, the firm turned the buildings over to the ORNL.

The ORNL soon decided to consolidate support facilities in this area and numerous buildings were constructed throughout the 1950s. The area today contains many functional shop facilities essential to operations.

BUILDING INVENTORY: The East Support Area is located to the east of the ORNL main facilities complex. It is access controlled and contains functional facilities necessary for the operation of the ORNL scientific and research facilities. Buildings in the complex date from the late 1940s to the present.

7000 Septic Tank (1948): wood shed

7001 General Stores (1948): This steel-frame, metal-sided 44,273 square-foot, rectangular building has a gable roof with vents along the ridgeline and a concrete slab foundation. Along each side are one-story gabled sections, partially enclosed. Open sections are used for either storage or loading docks. *Alterations include replacement of original windows, expansion of the loading platform in 1953 and in 1966, two rooms were added to the east end for change and lunch rooms.*

7002 Garage and Iron Working Shop (1948): This steel-frame, metal-sided, 28,262 square-foot, building has a gable roof with vents along the ridgeline. It is comprised of a rectangular main building and an original wing located near the rear of the structure. The main block held the equipment repair areas, paint and body shop and the wing contained a machine shop, an office and a change room. The gable roof wing has some original wood-frame windows and wood doors. A bank of original metal windows remain on the north (rear) gable end. *Alterations include replacement of the majority of the original windows, doors, and roll-up doors, new aluminum siding replacing the original aluminum*

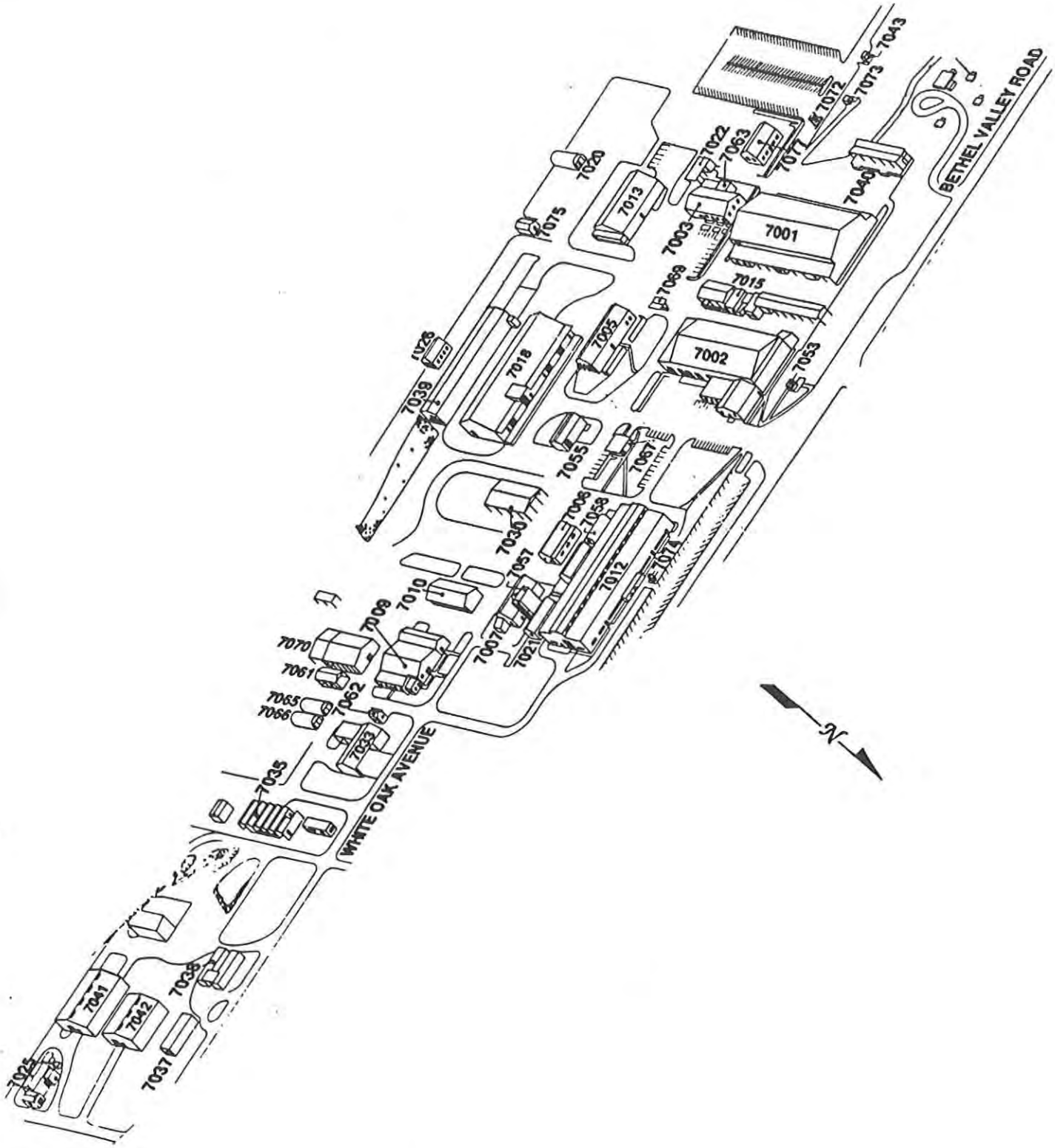


Figure III-112. 7000 Area. Site plan.

siding, and several shed-roofed, front and side additions.

7003 Welding and Brazing Shop (1948): In the early 1950s, this building was used for chemical storage. This metal-sided, steel-frame, 4,977 square-foot building has a low-pitched gable roof and rests on a concrete slab. *Alterations include the installation of an awning, and the construction of an enclosed concrete block addition on the west side.*

7005 Lead Shop (1948): The steel-frame, metal-sided, 4,452 square-foot structure stands on a concrete slab foundation. On the south side is a partially enclosed shed addition. Some original hopper windows remain. *Alterations include replacement of the original roll-up doors and new roof vents.*

7006 Paint Stores (1951): This metal-sided, steel-frame building has a gable roof and is rectangular in shape with a side-shed addition. It stands on a concrete foundation. The foundation is raised at the west end to accommodate a loading dock. The front of the building retains original wood-frame multipane windows. *Alterations include replacement of the original roll-up doors and most of the windows.*

7007 Paint Shop (1948): In the early 1950s, this building served as a "Pipe Shop." This metal-sided, steel-frame building has a gable roof and a concrete slab foundation. It is rectangular in plan with an attached gable-roofed side section. The open shop interior is relatively intact. *Alterations include the change in use from the "electric and pipe shop" (1948), replacement of the steel hopper windows, replacement of the sliding doors with modern roll-up doors and the construction of a shed-roofed addition on the gable end.*

7009 Carpenter Shop (1948): This metal-sided, steel-frame, 3,581 square-foot building stands on a concrete slab foundation. Two connected gable-roofed sections run parallel with a shed section on the east side. At the front of this section is a concrete block room with stepped concrete walls extending above the roofline, built as the "heater room" for the facility. Plans show the facility was mainly an open shop area (much as it appears today) with an office and change room at the front of the building. The building section on the west was the "lumber storage area." Some original steel-frame windows and original doors remain. *Alterations*

include replacement of the original garage doors and covering of the windows on the west side.

7010 Dry Lumber Storage (1951): This wood-frame, 3,200 square-foot building stands on a concrete slab foundation and has a shingled gable roof with exposed wood rafters and braces and board and batten siding. *Alterations are minimal but include a series of plywood panel doors which enclose both long sides.*

7012 Central Mechanical Shop (1953): This building was built in 1953 at a cost of $344,000 as "Central Shops." This 26,864 square-foot building stands on a concrete slab foundation with concrete blocks on the lower level and steel framing above. It has a monitor roof and corrugated-asbestos siding. Original steel hopper windows with pre-cast concrete sills remain on the lower level of the building. Original hopper windows also line the monitor. *Alterations include a 1971 shed-roofed addition on the north for office space which contains windows relocated from the original building, and a 1983 addition on the east elevation which also included relocated windows. Original 14 X 14' rolling steel doors have also been replaced.*

7013 Acid, Chemical & Flammable Liquid Storage (1954): This 1,674 square-foot, gable-roofed, prefabricated, steel-frame building stands on a concrete foundation. On the north side, the foundation is raised for a loading dock. *Alterations include 1991 improvements to the interior and exterior such as added insulation and enclosure of some windows.*

7015 Metal Storage and Cutting Facility (1960): This 2,147 square-foot, concrete block building has a flat roof, original metal coping, and hopper windows, and is comprised of several building sections with the tallest in the front along White Oak Avenue. On the west side are a pair of original sliding doors. *Alterations include some modern roll-up doors, a large open shed appended to the rear and cut outs for air conditioning units.*

7018 Salvage and Reclamation Facility (1959): Built at a cost of $65,000, this 20,000 square-foot, steel-frame, metal-sided building has a gable roof with vents, some original hopper windows and a partially enclosed side-shed addition (Building 7029). *Alterations include installation of modern roll-up doors.*

7019 Hazardous Materials Storage (1958): This structure is located behind a fence at the east end of the complex. It is a metal-sided, steel-frame building with a gable roof containing ridgeline vents. *Alterations include installation of a modern roll-up door.*

7020 Interim Grounds Equipment Storage (1963): This 1,680 structure is a metal-sided Quonset hut with sliding track doors and no windows.

7021 Fabrication Equipment Storage (1964): This 1,064 square-foot, gable-roofed, steel-frame, metal-sided building has fixed nine-pane steel windows and hopper windows. *Alterations include a modern entrance door and a roll-up door.*

7022 Gas Cylinder Storage Shed (1967): This building is an open shed-roofed structure with metal supports and a raised concrete foundation.

7025 Tritium Target Facility (1969): This facility is comprised of three small, gable-roofed, prefabricated buildings; the largest is a 960 square-foot building.

7026 Metals and Ceramics Storage Building (early 1970s): This prefabricated, gable-roofed, 1,000 square-foot, building stands in a fenced in area.

7029 Building 7018 Annex (n.d.): This building is a side-shed addition to Building 7018.

7030 Heavy Equipment Storage Shelter (1977): This 5,000 square-foot, open metal-frame shed has a metal-sheathed gable roof.

7031 Building (1977): This prefabricated, metal-sided building has a gable roof and paired metal doors.

7033 Electrical Material Storage (1977): This steel-frame, metal-sided, gabled-roofed building is comprised of a rectangular front section with an open flat-roofed rear ell.

7035 Material and Equipment Storage (1977): This is a series of six small connected gable-roofed buildings. Five are metal-sided and the sixth is of concrete block construction.

7037 Coal Storage Building (1983): This prefabricated metal building is rectangular in shape and rests on a concrete pad.

7038 Synthetic Fuel Storage Facility (1979): This building is comprised of two rectangular prefabricated metal buildings connected by a flat-roofed awning.

7039 Material Staging Facility (1986): This is a 10,000 square-foot, modern, prefabricated, gable-roofed metal building with a large roll-up door.

7040 Gas Cylinder Storage (1983): This open shed storage building has a "V" roof on metal supports, a concrete slab foundation and a rear concrete block wall.

7041 Coal Storage Building (1983): This 8,000 square-foot, prefabricated metal building has a low-pitched gable roof, metal siding and a roll-up door.

7042 Core Storage Building (1983): This 8,000 square-foot, prefabricated metal building has a low-pitched gable roof, metal siding and a roll-up door.

7043 Passenger Shelter (1985): This prefabricated shelter is outside the fence of the East Support Area.

7053 Personnel Shelter (1985): This is a 240 square-foot, underground shelter with a concrete base and flat metal roof.

7055 Pickling Vats (1958): This is a 1,400 square-foot, metal-sided, steel-frame building with a low-pitched gable roof. *Alterations include new sliding doors and a rear-shed addition.*

7057 Sandblast Cleaning Facility (1959): This facility is comprised of equipment and is attached to Building 7007.

7058 Machine Auxiliaries Storage (1959): This 1,019 square-foot building is a metal-sided Quonset hut with sliding track doors.

7060 Steel Yard (1958): The steel yard contains a modern Butler-type building on a concrete slab.

7061 Health Physics Environmental Storage (1958): This wood-frame building has a gable roof with exposed rafters and wooden braces and post supports. One-half of the building is enclosed while the other half is open.

7063 Emergency Generator (1961): This is a small, 200 square-foot, gable-roofed, metal building adjacent to Building 7003.

7065 Rigger Equipment Storage (1962): This 800 square-foot, metal-sided building is a Quonset hut with sliding track doors.

7066 Grounds Maintenance Storage (1966): This 800 square-foot, metal-sided building is a Quonset hut.

7067 Compressed Gas Hoses and Regulators (1965): This 756 square-foot, concrete block building has a flat roof with exposed rafters, a large overhang, and modern windows.

7069 Gasoline Service Facility (1971): This facility is comprised of an awning on metal supports over a small concrete block, flat-roofed service station and gas pumps.

7070 Storage Shed (1969): This 5,000 square-foot, steel-frame, metal-sided building has a gable roof and a side gable-roofed addition. A large roll-up door is found on the gable end.

7072 Sentry Post 20-B (for 7000 Area) (1988): This is a prefabricated, 36 square-foot, steel-frame, metal-sided building with plate glass windows.

7073 Air Monitoring Station (1981): This prefabricated metal building has a flat roof.

7074 Sentry Post 20C (n.d.): This pedestrian gate and small metal prefabricated building cube are located north of Building 7012.

7075 Waste Chemical Storage Area (n.d.): This modern prefabricated building is inside a fenced area. It has a metal gable roof, metal siding and a large door on the gable end.

7077 Grounds and Laborers Building (1991): This prefabricated metal building has a very low-pitched gable roof and metal siding.

7078 Office Trailers for Env. Rest Program (1990): This is comprised of three modern trailers.

ASSESSMENT OF ELIGIBILITY: The East Support Area evolved from a small temporary construction headquarters for building contractor, J.A. Jones Construction Company, in the

late 1940s and early 1950s. The firm was responsible for construction of most of the buildings constructed under Program H including the highly significant Building 4500N. Buildings 7001 and 7002 were built as the headquarters for the firm and are eligible for inclusion in the National Register under Criterion A for their association with the Program H expansion of the early 1950s. The boundaries are the footprint of each building.

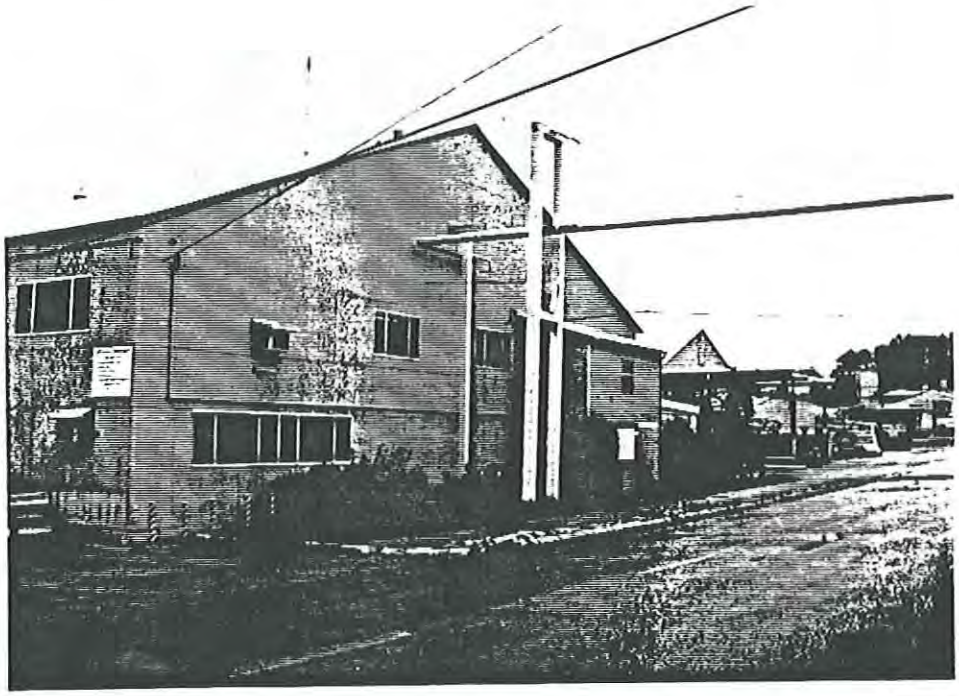


Figure III-113. 7001 General Stores (1948). Built by a contractor as a temporary construction headquarters, this building was turned over to the Lab in 1951. View northeast.

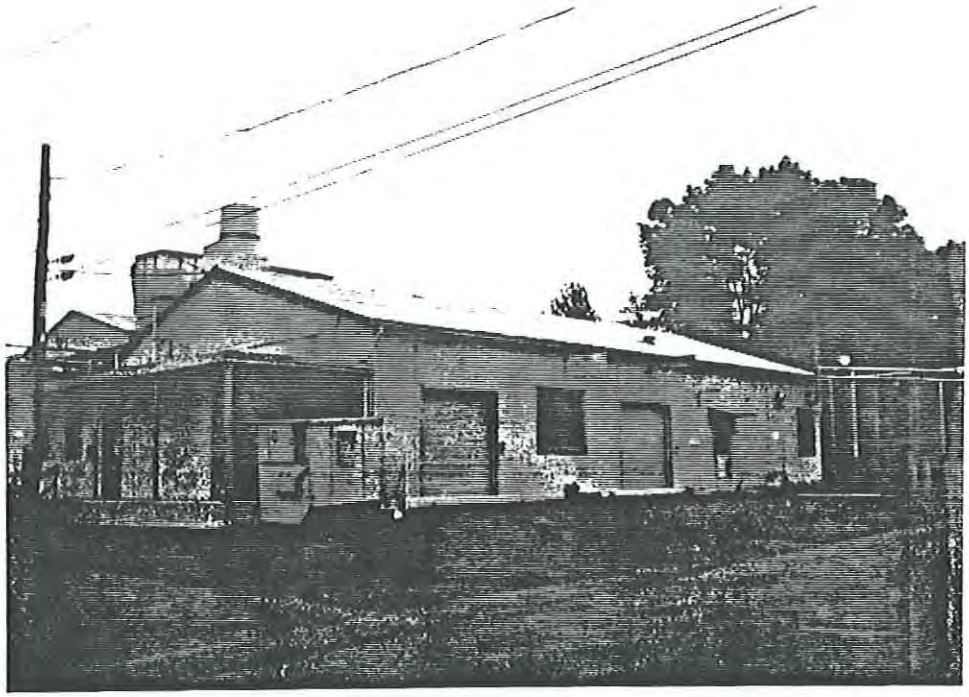


Figure III-114. 7007 Paint Shop (1948). This building served as a "Pipe Shop" in the 1950s. Note modern windows. View northeast.

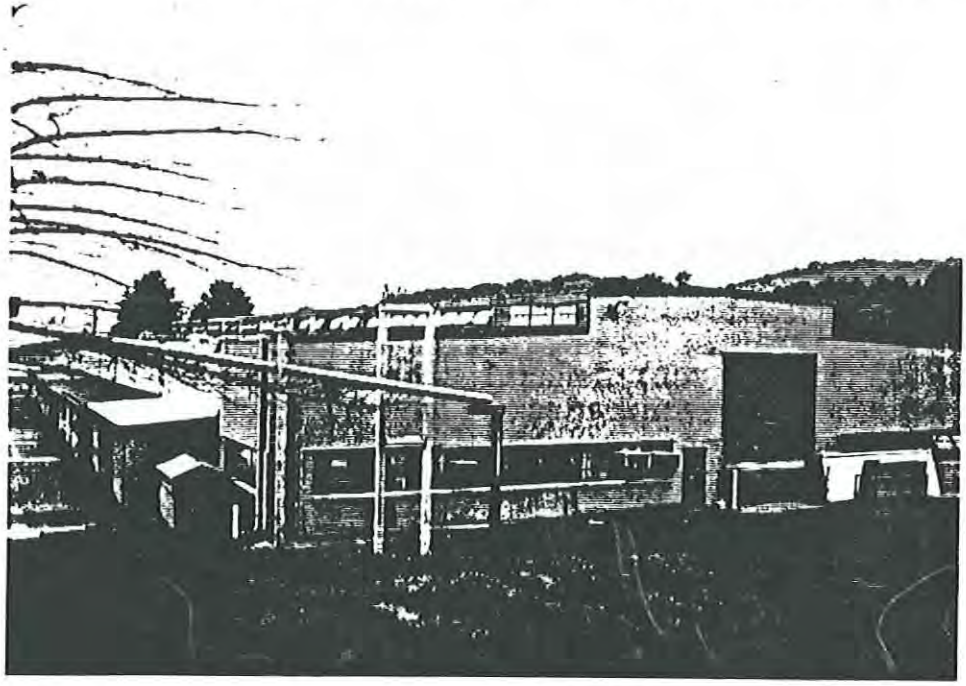


Figure III-115. 7012 Central Mechanical Shop (1953). This asbestos-sided shop building has original hopper windows and numerous additions on the north and west sides. View northwest.

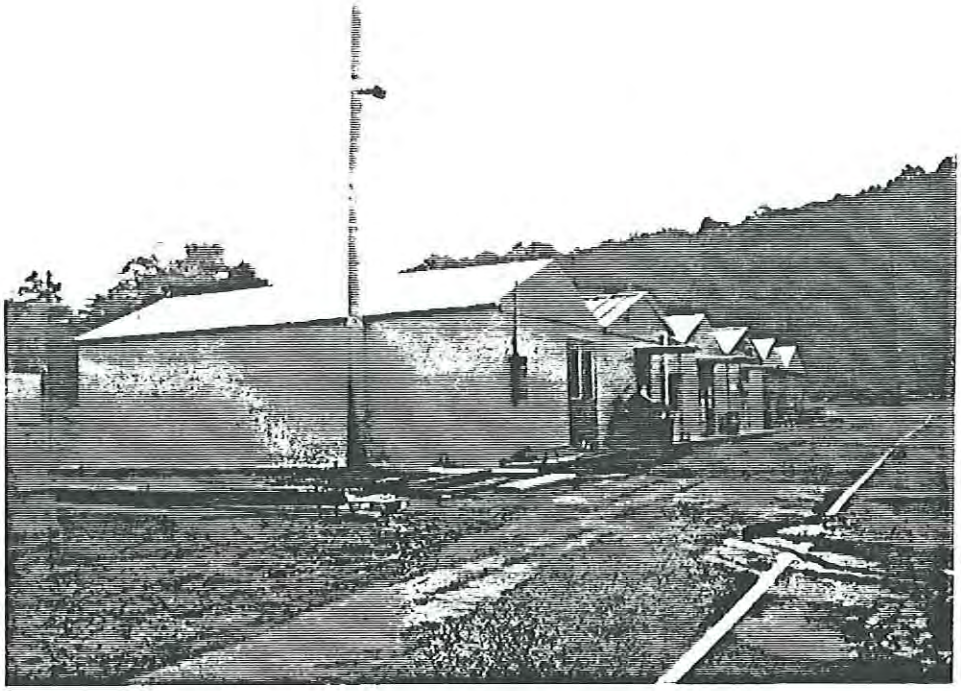


Figure III-116. 7035 Material and Equipment Storage (1977). Prefabricated buildings are common in the East Support Area. View southeast.

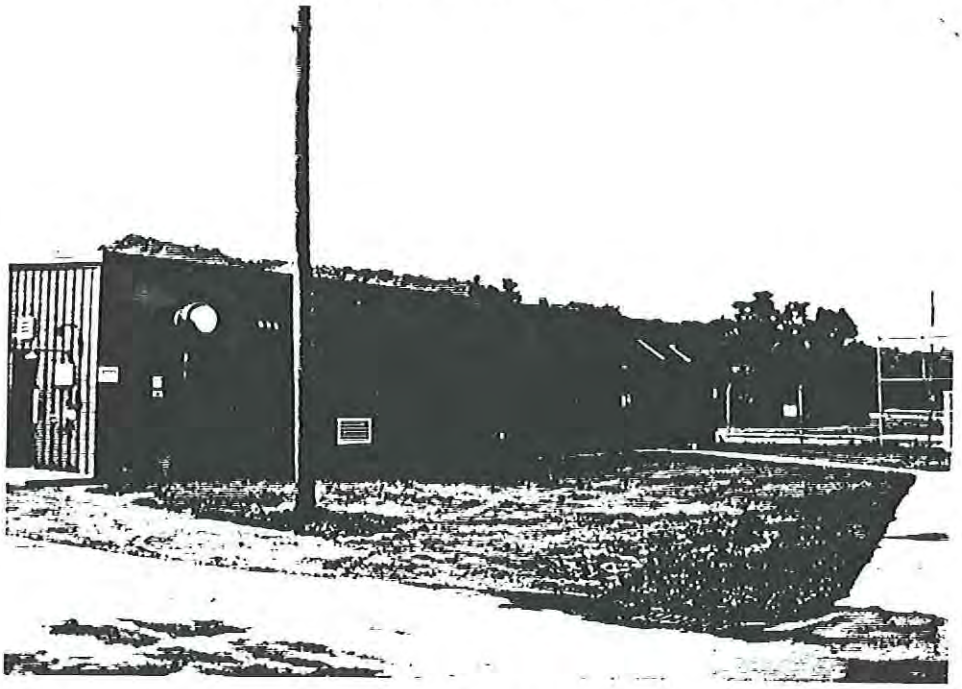


Figure III-117. 7077 Ground and Laborers Building (1991). This prefabricated metal building stands adjacent to the main gate. View southwest.

7500 AREA

ORIGINAL USE: Homogeneous Reactor Experiment Facility
CURRENT USE: Nuclear Safety Pilot Plant

HISTORY: The 7500 Area was originally associated with the Homogeneous Reactor Experiment (HRE) and today serves as the Nuclear Safety Pilot Plant. A homogeneous reactor was "unique because it combined fuel, moderator, and coolant in a single solution" (Johnson and Schaffer 1992:94). Studies of homogeneous reactors took place near the end of World War II but were dropped due to engineering problems. In 1949, technological advances resulted in a reexamination of this reactor type. "Chemical engineers hoped to design a liquid fueled reactor that would dispense with the costly destruction and processing of solid fuel elements" (Johnson and Schaffer 1992:94) and would provide electrical power. The advantages over the conventional solid and liquid coolant reactors were that the reactor would not have to be taken off line to discard spent fuel and the reactor's fuel and solution in which it was dissolved served as the source of power generation.

Upon approval by the AEC, the ORNL constructed a building to house a small experimental homogeneous reactor, HRE I, which was built "as quickly and as cheaply as possible to demonstrate the feasibility and operating characteristics of a reactor of this type" (Thompson 1963:77). The goals of this experiment were to demonstrate operating feasibility and electrical power production. Among the important results obtained from the HRE I were the reactor's "remarkable degree of inherent nuclear stability" (Thompson 1963:79). ORNL staff "marvelled" at the HRE I's "smooth responsiveness to demands" (Johnson and Schaffer 1992:95).

Upon completion of the experiment, HRE I was dismantled to provide space for construction of a second homogeneous reactor, HRE II. Even through the AEC's priorities were elsewhere, they approved construction of a large pilot plant with a two region core tank. The hoped for success of the HRE II would lead to the construction of a full-scale homogeneous reactor as a thorium "breeder" and as a cheap electric power supply for the K-25 Plant. Completed in 1956, HRE II reached criticality in December of 1957. Soon after operations began, the reactor experienced a leak that allowed mixture between the fuel and blanket regions. The reactor continued to operate intermittently and extensive repairs and modifications were made through most of 1960 to no avail. At AEC hearings late that year, the Congress balked at the 10-year price tag of the aqueous homogeneous reactor which had been plagued with problems not yet repaired. The program was subsequently dropped.

In 1961, the Nuclear Safety Program was enlarged at the ORNL. Two of the research and development efforts of the program involved obtaining data for assessment of accidental releases during transport and developing and evaluating counter measures to be deployed in the event of a nuclear accident.

The Nuclear Safety Pilot Plant for the conduct of these experiments was installed in the former Homogeneous Reactor Experiment (HRE) Buildings, primarily in Building 7500, the HRE chemical processing cell. The experiments in Building 7500 involved production of a wide range of fission product types to observe behaviors under various conditions and to carry out tests of engineering safeguards. A portion of the chemical process cells was altered to accommodate these experiments. The building today is under the Engineering Technology Division.

DESCRIPTION: The 7500 Area is located on Melton Valley Drive approximately 0.5 mile to the south of the ORNL main facilities complex. The area contains four buildings and several pits and tanks.

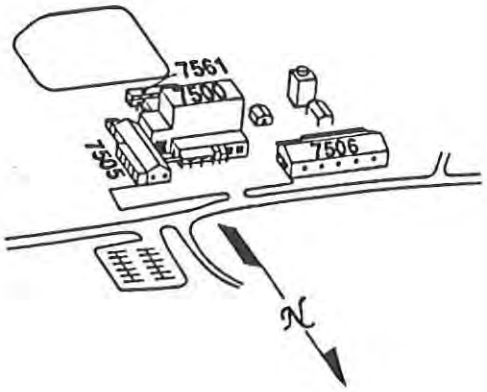


Figure III-118.
7500 Area.
Site Plan.

7500 Nuclear Safety Pilot Plant (1952): Built at a cost of $320,000, this building is a 41-foot tall steel-framed, metal-sided, rectangular structure containing a reactor at the center encased within a concrete shield. When built, the structure was 7,200 square feet at ground level and it had a centrally located reactor with a control room directly to the north abutted by a locker room and office, and on the south were a boiler room, a laboratory, and a service room. At the west end was a crane and on the east was a 9 x 20 foot storage pool. The experimental reactor was housed in three below-grade, steel-lined, concrete cells within a steel and reinforced concrete structure. There is a metal stack at the southwest corner of the building. *Alterations include the change in use from the Homogeneous Reactor Experiment to the Nuclear Safety Pilot Plant. At an*

unknown date, an addition was built onto the south elevation to house a bridge crane. In 1962, portions of the reactor core were removed for studies and systems were dismantled. In 1975, alterations such as relocation of doors and partitions, closing off existing windows and the installation of a "reflected ceiling" were made in rooms 5,6,7,8 located in the original laboratory and undated south addition. Alterations were also made to some of the chemical process cells after 1963 to accommodate research programs at the Nuclear Safety Pilot Plant. A liquid waste storage pool located inside the structure has been filled.

7501 Septic Tank (1952): This tank is encased in a 74 square-foot, concrete enclosure.

7502 Radioactive Waste Evaporator for Building 7500 (n.d.): This is a 757 square-foot, steel-frame, metal-sided structure.

7505 CPAF Contractor Headquarters (1954): This 5,726 square-foot, steel-frame building has corrugated-metal siding and abuts the east side of Building 7500. It has a gable roof with ridgeline vents and windows are original steel multipane sash. *Alterations include a 1957 shed addition.*

7506 CPAF Contractor Shop (1955): The shop stands to the east of Building 7500 and is a 5,726 square-foot, metal-sided, steel-frame structure with a gable roof, multipane steel windows, and track doors at the west gable end. A shed addition is on the south side of the building.

7757 Adsorber Pit (n.d.): Concrete structure.

7558 Waste Evaporator Loading Pit for 7500 (n.d.): This concrete structure is 49 square-feet in size.

7559 Adsorber Valve Pit (n.d.): This pit is lined with concrete.

7560 Waste Tank (n.d.): This steel tank is 72 square-feet in size.

7561 Valve Pit (n.d.): This equipment is adjacent to Building 7500.

7562 Waste Condensate Tank (n.d.): This tank is built of steel.

7563 Circulator Pump Pit (n.d.): This pit is lined with concrete.

ASSESSMENT OF ELIGIBILITY: The Homogeneous Reactor Experiment and associated buildings and equipment are less than fifty years of age and the majority fall outside the period of significance. Subsequently, it is the opinion of the HPS that the 7500 Area is not eligible for inclusion in the National Register. The original equipment has been removed and cells were altered to accommodate the 1963 Nuclear Safety Pilot Plant. Site specific advances in the development of handling equipment and special tools and techniques for maintenance resulted from the HRE. However, the concept was a "dead end" research project (Johnson and Schaffer 1992:114, Thompson 1963:82).

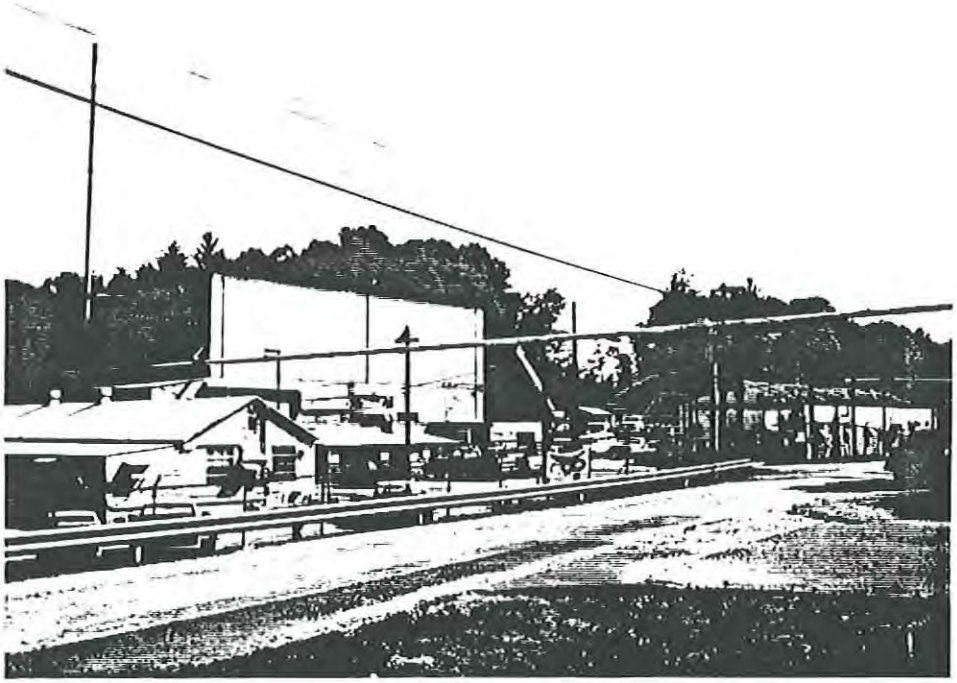


Figure III-119. 7500 Complex, Nuclear Safety Pilot Plant. View of complex looking northeast with Building 7505 on left, Building 7500 in center, and Building 7506 on far right.

7503 AREA

CURRENT USE: Molten Salt Reactor Experiment Facility
ORIGINAL USE: Aircraft Reactor Experiment Facility

HISTORY: In 1949, the ORNL established the Aircraft Reactor Experiment (ARE) to develop a reactor system for aircraft propulsion that would meet demanding requirements regarding weight, size, and performance of the reactor as well as shielding weight and capabilities. The hoped-for reactor design would drive a long range bomber.

In 1953, the ARE Facility, Building 1503, was completed at the ORNL at a cost of $375,000, and in October of the following year, an experimental molten salt fueled reactor with a fuel mixture developed at the ORNL became operational. "The use of molten salt fuel and reliable operation at such elevated temperatures were remarkable technological achievements" (Genung et al. 1993:2-33). No reactor operating at the high temperatures needed for the Aircraft Reactor Experiment had ever been constructed nor had liquid metal cooling of a reactor ever been utilized (Thompson 1963:92). The ORNL built the ARE to operate at a power level of 100 kW, less than would be needed for a full-scale aircraft reactor but otherwise duplicating, as nearly as possible, the essential features of a full-scale aircraft reactor.

The ARE performed well and demonstrated the advantages of fluid fuel reactors. This reactor is said to be "the most advanced reactor type the lab [ORNL] had developed. . . and its successful operation represented perhaps the greatest achievement of the combined research and development staffs of the laboratory [ORNL]"(Thompson 1963:95).

Due to the successful operation of the ARE, the ORNL intensified research and development efforts on a molten salt reactor for aircraft propulsion. The ARE building was enlarged and modified to accommodate a second experimental reactor. Early in 1958, however, the project was discontinued because of "costs as well as changing military needs," and due to the AEC's decision to support aircraft nuclear propulsion efforts elsewhere (Genung et al. 1993:2-33).

During the development and operation of the ARE, and particularly after the cancellation of the project, the ORNL saw the opportunity to further develop the molten salt reactor technology for electric power production. The decision to continue development occurred because of the fact that molten salt fueled reactors almost uniquely combined the advantages of very high temperature, wide solubility limits and low pressure in a liquid system. It

was also felt that the efficiency of the reactor could result in a reduction of fuel costs.

The operation of the reactor for this new experiment began in 1965 in the same building which formerly housed the ARE and was called the Molten Salt Reactor Experiment (MSRE). The purpose of the MSRE was to demonstrate key elements needed for a power reactor. Technological advances in the field of chemical processing gleaned from the molten salt experiments were substantial. Efforts were focused on development of a molten salt breeder reactor, "an exotic concept," (Johnson and Schaffer 1992:149) but the ORNL was denied approval for construction of a molten salt breeder pilot plant. Argonne's fast breeder reactor was the favored choice for funding.

The MSRE continued to operate until 1969 when the reactor was placed on standby. Limited research and development continued in this field until 1976. Some at the ORNL felt that the MSRE was the "laboratory's [ORNL's] greatest technical achievement" but was overlooked because of the "government's preoccupation with the liquid metal fast breeder reactor" (Johnson and Schaffer 1992:149).

Today, the facility contains Building 7503, the only building associated with both the ARE and the MSRE experiments. The other buildings in the complex are all associated only with the MSRE.

DESCRIPTION: This complex is located on Melton Valley Drive approximately 0.5 mile southeast of the ORNL main facilities complex.

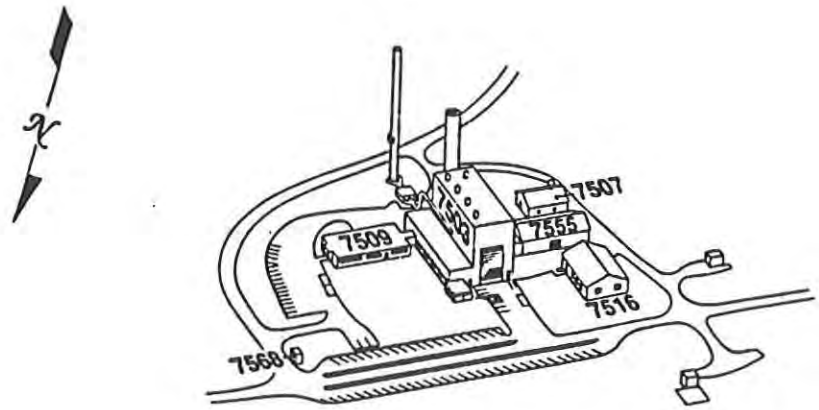


Figure III-120. 7503 Area. Site plan.

7503 Molten Salt Reactor Experiment Facility/ARE Facility (1951): This building was constructed at a cost of $375,000. Shown as the "Test Facilities Building" on plans dated 1951, the 16,996 square-foot, 42-foot tall, steel-frame building has a flat roof and corrugated-asbestos siding. Multipane steel-frame hopper windows are original. Major alterations occurred in 1961 when the building was modified for the MSRE. A plan dated 1961 shows the reactor cell (round in shape) in the southwest quadrant of the building along with a drain tank cell, and in the northwest quadrant are six cells: one for fuel, one for spent fuel, one decontamination cell, one hot storage cell, a hot waste pump cell and a hot waste storage cell. The reactor and the cells are at the basement level and are encased in steel and concrete structures with built in containment features. Access to the cells are from removable concrete roof plugs. The east half of the building contains the control room and the change room. A large stack is on south end of the building. *Following shutdown in 1969, the fuel and coolant salts were drained to storage tanks within the containment cells and isolated. The reactor and drain-tank cells are sealed and the top shield caps (roof plugs) secured.* The building is used today for research, workshop and storage space.

7507 Substores (1961): Built as a compressor house for Building 7503, this building is a 5,726 square-foot, steel-frame, metal-sided structure with a gable roof and concrete slab foundation. It has a large ridgeline vent and tract doors on the north side.

7509 Molten Salt Reactor Office Building (1964): This 3,784 square-foot, rectangular, concrete block structure has a flat roof and is attached to Building 7503 by a corridor. Original features include banks of windows.

7511 Filter Pit for 7503 (1961): This 594 square-foot structure is built of concrete.

7512 Stack for 7503 (1988): This stack is appended to Building 7503 and is constructed of steel. Plans indicate that the stack was built in 1988..

7513 Cooling Tower for 7503 (1961): This cooling tower is constructed of wood.

7514 Filter House for 7503 (1961): This appears to be the "gen house/switch house" shown on 1961 plans. The structure is a 273 square-foot, metal-frame, shed-roofed structure.

7516 Field Service Shop/EMP Test Facility (1967): This 4,025 square-foot, steel-frame, metal-sided building

has a gable roof with four ridgeline vents, multipane steel sash windows and track doors at the gable end.

7518 Temporary Drum Storage Pad (1984): This concrete pad is 1,800 square-feet in size.

7555 Diesel Generator House for 7503 (1961): This structure is shown on 1961 plans as the "Diesel House." The 4,787 square-foot, steel-frame, metal-sided building has a gable roof.

7567 Intermediate Waste Pumping Station (1962): Located outside the fence adjacent to the 7503 area is this 240 square-foot, flat-roofed, concrete block building.

7568 Sentry Post 19 (n.d.): This small prefabricated metal guard post is listed on a 1953 ORNL Building List and is located at the corner of Melton Valley Drive and the road to the HFIR. However, the existing building on the site is a modern prefabricated structure which replaced the 1950s original building.

ASSESSMENT OF ELIGIBILITY: Building 7503 is significant for its association with the ARE of the early 1950s. In the post-World War II era, the nuclear physics developed for war weapons was diverted in an attempt to identify other uses for nuclear power. Although in the end, a nuclear powered airplane was never built, this facility (and the other facilities at the ORNL associated with this program) developed highly significant technologies in shielding and high temperature reactors as well as in the area of chemical processing. It is the opinion of the HPS that the ARE Facility (Building 7503) Criterion Exception G for exceptional significance and is eligible for inclusion in the National Register under Criterion A. The boundaries are the footprint of Building 7503.

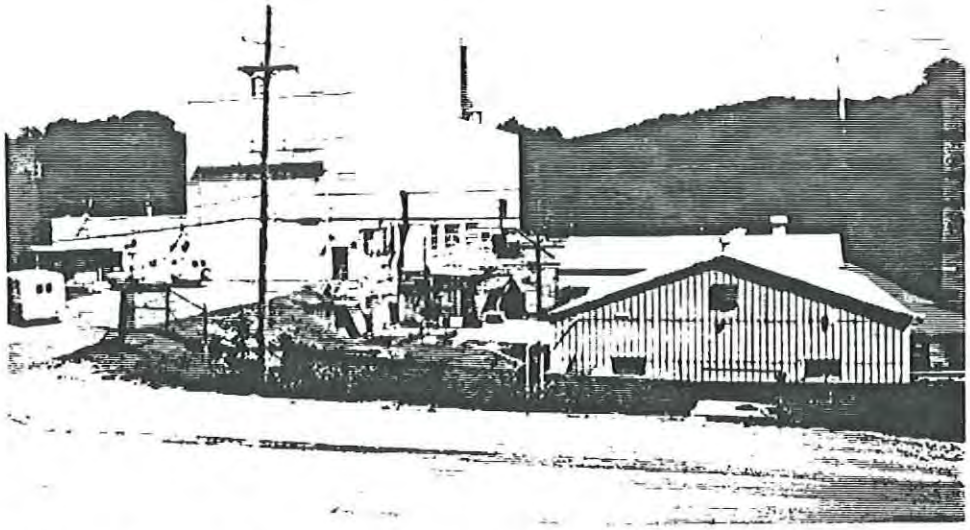


Figure III-121. 7503 Area. Overview of complex, on left is Building 7503 (1951) and on right is Building 7516 (1967). View southeast.

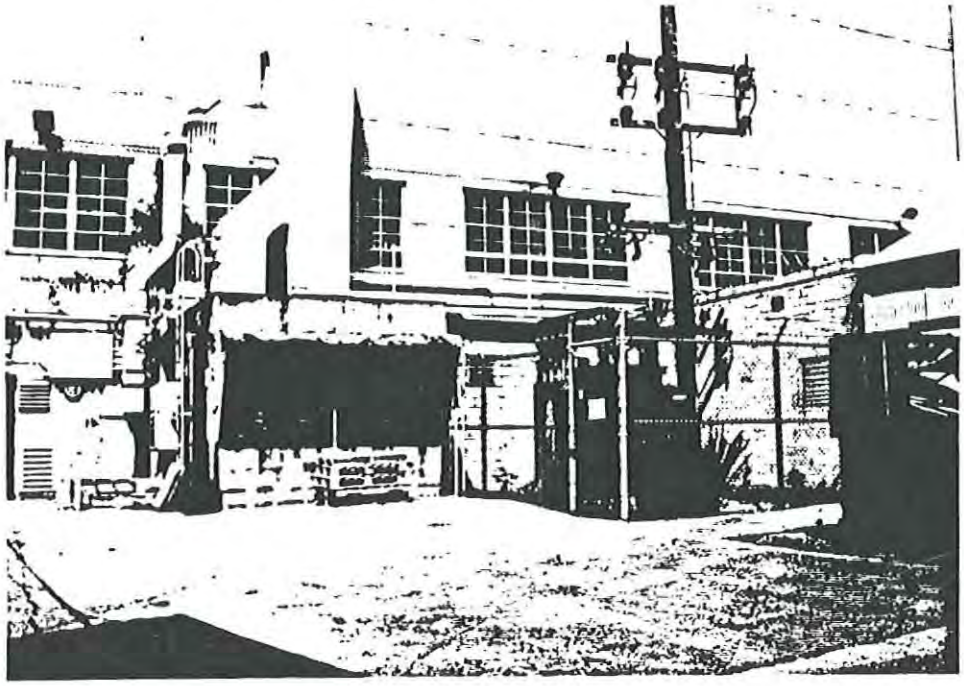


Figure III-122. 7503 Molten Salt Reactor Experiment Facility/ARE Facility (1951). Detail of southwest side elevation. View southeast.

7600 AREA

CURRENT USE: Robotics and Process Systems Complex/Consolidated Fuel Recycle Program
ORIGINAL USE: Experimental Gas-Cooled Reactor Facility

HISTORY: Gas-cooled reactor technology had been explored in the United States in the 1940s but research was essentially terminated in 1948. In the early 1950s, British scientists designed and built several large gas-cooled reactors and in 1956, the United States subsequently decided to initiate a study to determine if gas-cooled reactors could compete economically with other reactor types.

The initial findings of the study seemed promising and the ORNL proceeded with authorization to develop and build an experimental gas-cooled reactor, the first to be built in the United States. The reactor was to serve as a power-generating prototype gas-cooled reactor. Its design called for a helium-cooled, graphite-moderated reactor with a core of uranium oxide clad in stainless steel. The design also included eight test loops to allow testing of different fuel elements. This facility was constructed along the Clinch River because the TVA had made a commitment to serve as the reactor operator.

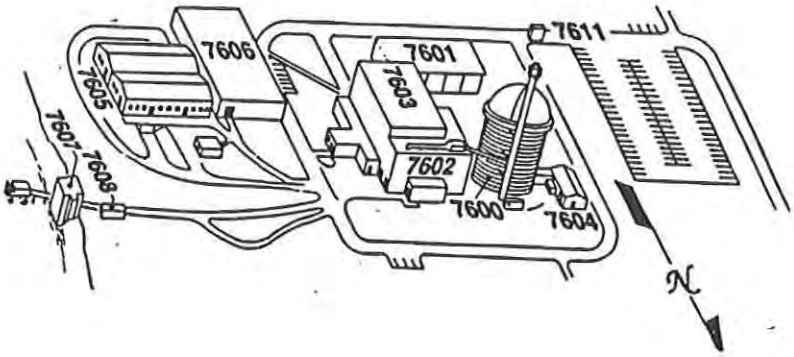
Escalating project costs and project delays resulted in a long, six year construction period and in the elimination of the test loops from the design. Upon completion of the reactor and manufacture of the fuel elements, the AEC stopped the project because "the light water reactor industry has advanced so rapidly that the Oak Ridge prototype could no longer serve the purpose for which it was planned. . . the reactor design had become obsolete before it was operational" (Johnson and Schaffer 1992:106).

After abandonment of the project, the facility was used for research in the Consolidated Fuel Recycling Program, an activity which continues today.

In 1984 and after Martin Marietta Energy Systems, Inc. took over operations of the ORNL, management established the Center for Engineering Systems Advanced Research in the Engineering Physics and Mathematics Division. This unit specialized in the "remote control of operations in hostile environments" (Johnson and Schaffer 1992:220), known as the field of "Robotics." In the early 1990s, the ORNL formed the Robotics and Process Systems Division to be housed in the buildings of the gas-cooled reactor. The program today provides research assistance to agencies such as NASA, DOE, the U.S. Army and the U.S. Air Force.

DESCRIPTION: This complex is located at the intersection of Ramsey Drive and Robotics and Process Systems Complex Access Road approximately two miles to the east of the ORNL main facilities complex. The complex is contained within a fenced area.

Figure III-123.
7600 Area.
Site plan.



7600 Containment Building (1960): This round concrete domed structure was built as containment for the gas-cooled reactor which never became operational.

7601 Office Building (1965): This 19,362 square-foot, concrete block and steel-frame building is two stories in height with a flat roof and a large overhang. The rectangular building features banks of paired windows with square panels above and below. *The lobby has been altered.*

7602 Engineering CFRP (1965): This 14,208 square-foot, steel and concrete block building is faced with metal siding and has a flat roof. It is physically connected to Building 7603. On the north side is a one-story, shed-roofed addition. A large roll-up door is found on the rear (east) side.

7603 Experimental Engineering CFRP (1965): This 32,032 square-foot, metal-sided, steel-frame and concrete block building has a flat roof and is connected to Building 7602 to the north and to the south, to Building 7601.

7604 Utility Building (1965): This 4,420 square-foot, building is comprised of a connector to Building 7600 and a gable-roofed, metal-sided structure.

7605 Storage Building (1964): This 12,120 square-foot, steel-frame, metal-sided structure is comprised of two connected, gable-roofed buildings. Plans dated 1964 label it the "Utility Building."

7606 Maintenance Building (1962): This one-story, 13,120 square-foot, concrete block building has a flat roof. A flat-roofed entrance portico spans one-half of the front (west) facade.

7607 River Pump Station (1965): This 300 square-foot, concrete block pump house with accessory equipment is built on a platform on the banks of the Clinch River.

7608 Component Development (1965): This 530 square-foot, concrete block building is located on the driveway leading to the Clinch River.

7609 Stack Monitoring House (1965): This 780 square-foot, steel-frame building is adjacent to Building 7614.

7610 Storage House (1965): This small, 380 square-foot, concrete building is located to the north of Building 7600 and has a flat roof and roof vent.

7611 Guardhouse (1965): This 64 square-foot guardhouse stands at the entrance to the 7600 Area and is constructed of concrete block with a flat roof.

7612 Elevated Storage Tank (n.d.)

7613 Waste Retention Basin (n.d.)

7614 Exhaust Stack for Buildings 7600 and 7602 (1965): This concrete stack stands adjacent to the containment structure (Building 7600).

7615 Material Storage (1965): This 765 square-foot, concrete block building has a flat roof with vents.

7616 Septic Tanks (1965)

7618 Diesel Generator (1984)

7619 Cooling Tower (1982): This small, metal cooling tower with accessory equipment is located directly to the north of the containment building (Building 7600).

ASSESSMENT OF ELIGIBILITY: The buildings of the 7600 Area were designed to house and support an experimental gas-cooled reactor, a reactor type then in operation in Europe. Although modified by the ORNL as a result of technology and research developed in the United States, the reactor was not an innovator in its field. In fact, sources report that the project "moved so slow that the facility was obsolete before it was operational" (Johnson and Schaffer 1992:106). This complex does not fall within the period of significance and it is the opinion of the HPS that it is not eligible for inclusion in the National Register. The facility did not develop wholly new technology, did not substantially advance the field of the nuclear sciences, and the reactor was never operational.

Figure III-124. 7600 Experimental Gas-Cooled Reactor Containment Building (1960). View toward north with Building 7601, Office Building (1965) on right.

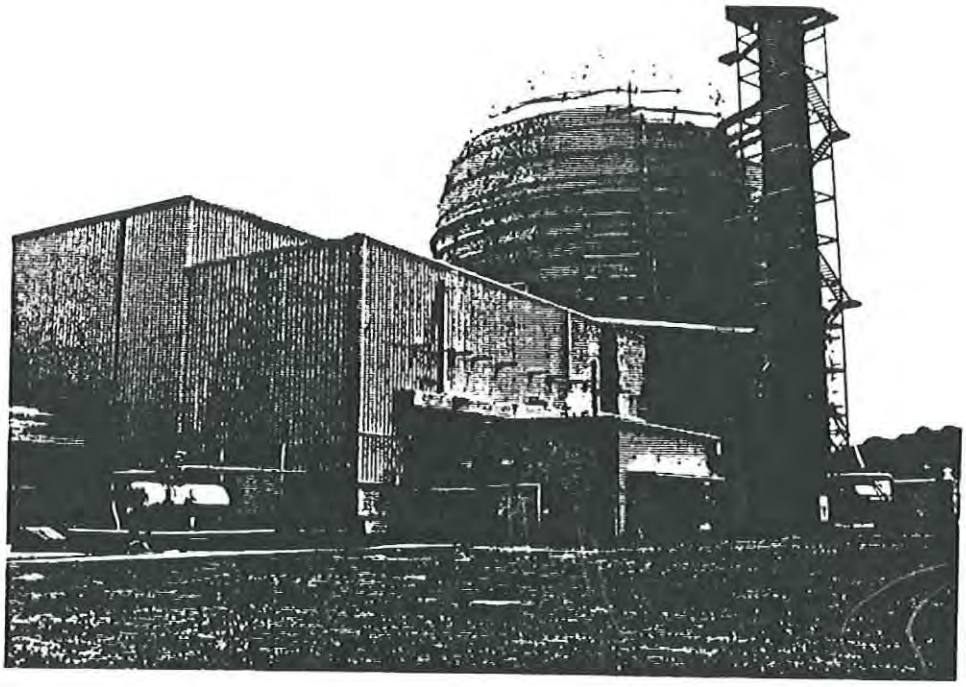


Figure III-125. 7602 CFRP Engineering Building (1965). View toward south with containment building (7600) in background.

7700 AREA CURRENT USE: Tower Shielding Facility
ORIGINAL USE: Tower Shielding Facility

HISTORY: The Tower Shielding Facility (TSF) is associated with the Aircraft Reactor Experiment (ARE) in the late 1940s. This program came about due to the desire of the U.S. Air Force to develop a nuclear powered long-range bomber. Research and development of an experimental reactor to power the aircraft was ongoing at the ORNL. These early efforts revealed that one of the more difficult problems to resolve would be development of a shielding device to protect the crew without adding so much weight as to "sink" the airplane.

Early shielding research was carried out at the ORNL's BSR but findings indicated that the shields needed for an aircraft reactor would be excessively heavy. In order to reduce its weight, the ORNL designed a shield that was divided between the reactor and the crew compartment of the aircraft. This, however, posed a problem with testing since it was not possible to conduct experiments on a divided shield in the existing ORNL facilities.

A design was developed for a TSF where measurements for a divided shield could be taken without interference from the ground or structural scattering. Construction of the TSF began in 1952 to conduct experiments with a divided shield. The Tower Shielding Facility included a reactor patterned after the first swimming pool reactor (the BSR). This reactor was completely enclosed in a spherical container and suspended above the ground on cables between four 300-foot tall towers. Hoists were devised to raise and lower the reactor and crew shields which weighed approximately 75 tons. A pool was built for storing the reactor.

Since the Tower Shielding Reactor (TSR) I had no built-in shielding, operations were built underground and covered with several feet of earth. The building housed the reactor controls, data-recording equipment and hoist controls. The operators viewed the experiments by means of a television system.

A few years into the program, research at other ORNL facilities revealed that a circulating fuel, reflector moderated reactor would have a better likelihood of success than TSR I. The new reactor, TSR II, was designed to more accurately monitor the scattering. This reactor was used for only one experiment before the 1961 cancellation of the ARE Program. Neither researchers at the ORNL or elsewhere were ever able to devise a reactor and shielding light enough to allow safe flight.

According to one writer, "The Tower Shielding Facility has contributed significantly to the outstanding achievements in shielding research that made possible the design of improved reactor shields that were far more compact and lighter than previously thought possible" (Thompson 1963:70). The TSR experiment also helped scientists answer questions about radiation scattering from an airborne reactor and helped researchers better understand the amount of shielding needed aboard an aircraft carrying any nuclear device.

After the ARE Program was terminated, experimental programs continued at the TSF. In the early 1960s, investigations centered on the programs for the U.S. Defense Atomic Support Agency. In 1963, the shielding technology developed at the TSF was applied to the NASA space program concerning silo shields. TSR II was also used to determine the effectiveness of Civil Defense shelters. In the late 1960s, the ORNL participated in the Space Nuclear Auxiliary Power (SNAP) Program. The SNAP reactor at the TSF was used in continued shielding research and measurements of radiation leakage. A SNAP II reactor continued in the conduct of shielding research until the termination of the SNAP Program in 1971.

In the early 1970s, the TSF participated in experiments in support of a breeder reactor development with the addition of an upgraded reactor to the facility. The technology was used for the Clinch River Breeder Reactor and for experiments associated with the gas-cooled fast reactors and the high temperature gas-cooled reactor program.

Also in the 1970s, a large impact pad was installed to assist in packaging research (i.e., the development and testing of safe packaging for shipment of highly radioactive materials). The armored pad surface was designed to accept the impact of a 100-ton package dropped from a height of thirty feet. These tests were discontinued in 1988.

On 1 October 1992, the TSF was shut down by DOE order. The facility is currently on standby.

DESCRIPTION: The TSF is located off State Route 95 approximately two miles to the southeast of the ORNL main facilities complex. It is access controlled and is reached via the TSF Access Road. The fenced complex proper stands in a cleared wooded area and the tower is constructed on a manmade hill. A diagram of the facility is shown in Figure III-126.

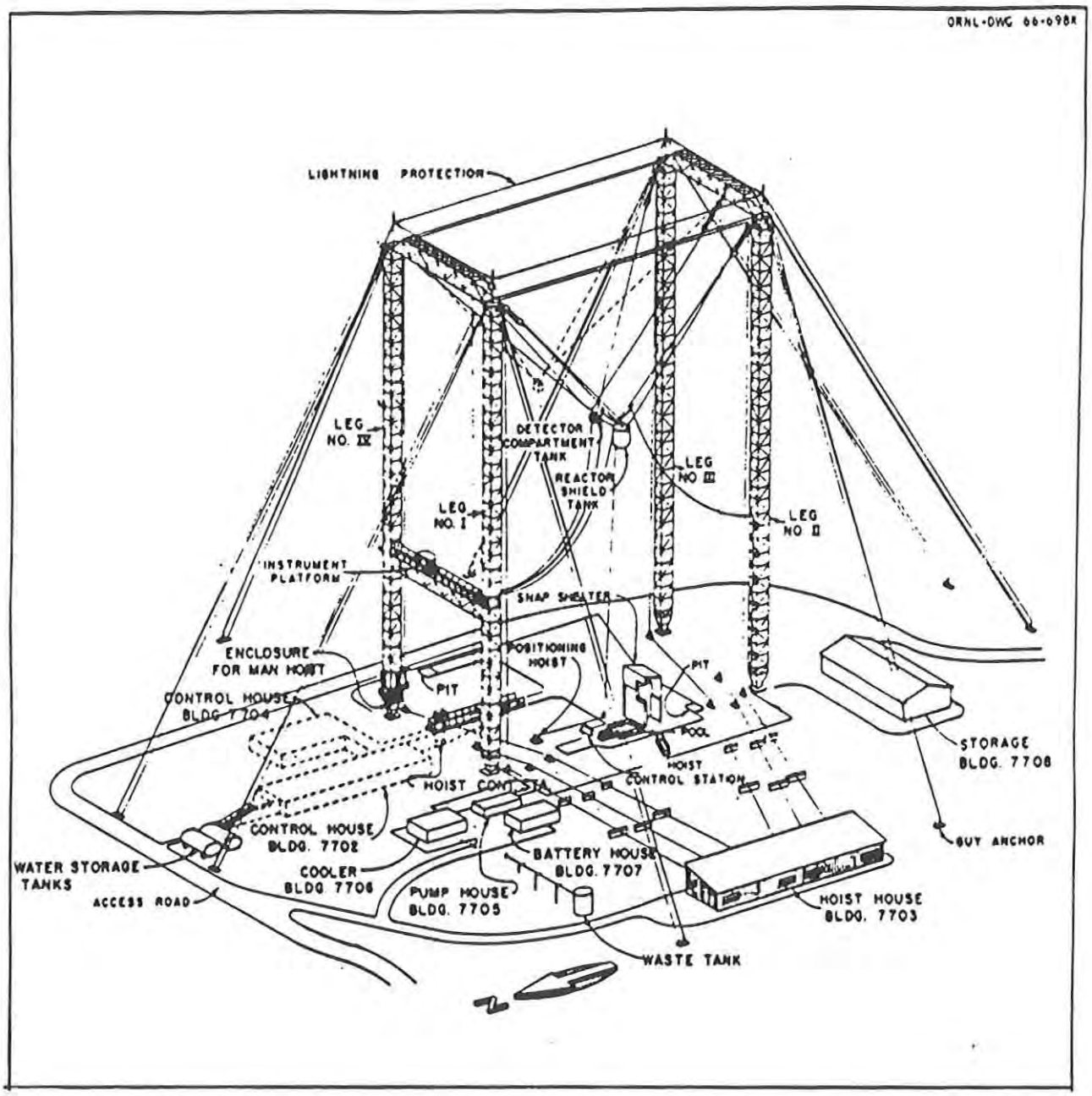


Plate III-126. 7700 Area. Site plan.

7700 Tower (1953): The tower is comprised of four, 315-foot tall steel towers erected at each corner of a rectangular concrete pad, 100' x 200' in size. Towers at the short sides of the rectangle are connected at the top by a cross steel support; the towers at the northwest side of the rectangle have an additional connector in the center which served as the instrument platform. Guy wires (two-inch plow steel guys) connect to anchors at each corner of the tower. The tower is equipped with a hoist system designed to lift the reactor off the ground. The concrete pad originally contained a pool for storage of the reactor, two hoist control stations, a positioning hoist and two pits. In recent years, the pool was infilled. A concrete drainage system leads down from the elevated concrete pad.

7701 Pool (1953): The rectangular pool for reactor storage was located on the north side of the concrete pad. *It is now covered with a 2-foot thick concrete slab.*

7702 Control House (1954): The control house is an underground bunker, 12,768 square-feet in size, built directly under the concrete pad and tower. It is entered on the east side of the elevated tower area and on the west side a ramp descends from the pad to a hoist control station and the west entrance to the control house. The building today contains offices, laboratories and the original control panels.

7703 Hoist House (1954): This metal-sided, shed-roofed building contains the controls for the main hoist operations. On the south side of the building facing the tower are six multipane windows. Below each window are openings for the cables from the tower to connect to the hoisting mechanism. Between the tower and hoist house are cylinders on concrete pedestals which serve as guides for the cables.

7704 Control House No. 2 (1954): This 2,235 square-foot control house is an underground (bunker) facility built of concrete connected by a short tunnel to Building 7702 and to a ramp leading to the concrete pad.

7705 Pump House (1963): This 540 square-foot pump house is a concrete block, flat-roofed structure.

7706 Cooler (1963): This small building is a steel-framed, flat-roofed structure with metal sheathing.

7707 Battery House (1963): Built of concrete block, this 430 square-foot building has a flat roof.

7708 Reactor Shield Storage (1961): Located to the west of the tower, this 3,277 square-foot building is of steel frame construction with a gable roof and corrugated-metal siding. It has sliding track doors on the gable end: one panel contains a door and the other an 18-pane fixed window. Paired 18-pane windows are found to each side of the track doors.

No # Accessory buildings (n.d.): On the concrete pad are a small, square, two-story, metal-sided building with a flat roof which served as the "SNAP Shelter," a number of small Butler-type buildings, and storage tanks.

OUTSIDE FENCE

No # Civil Defense Bunker (ca. 1960): Immediately outside the fence on the northwest side of the complex is a concrete bunker with a flat face, inset room and monitors on top. The building was used to monitor radiation exposure/test shielding thickness.

No # Water Tank (n.d.): Located outside the fence on the north side of the property adjacent to the secondary TSF Access Road is a water tank.

7750 Septic Tank (n.d.)

7751 Sentry Post No. 22 at TSF Exclusion Fence (1947): This 64 square-foot, wood-frame building has a hip roof, novelty-board siding and one-over-one wood-frame windows. It stands off State Route 95 at the perimeter fence and entrance to the TSF facility. It is thought to have been moved here from another location in 1952.

7740 Radio Relay Tower (1964): Located atop Melton Hill east of the TSF, stands this radio transmission tower.

ASSESSMENT OF ELIGIBILITY: It is the opinion of the HPS that the forty-year old TSF is exceptionally significant and is eligible for inclusion in the National Register under Criteria A and C. This innovative facility, with the capability of suspending a reactor in the air, is the only reactor facility in the United States "designed and built for radiation-shielding studies in which both the reactor source and shield samples could be raised into the air to provide measurements without ground scattering or other spurious effects (Muckenthaler 1992:33). The versatility of the TSF has allowed its use for numerous technological advancements in the fields of shielding and radiation scattering. The experiments conducted at the TSF during the ARE and in later years have continued with outstanding achievements in the field of shielding research.

The boundaries of the complex are discontiguous. They include all buildings within the fenced area around the Tower and the Sentry Post at the exclusionary fence. Other buildings outside the main fenced area are not included (Buildings 7740, 7750, Bunker, Water Tank). Following is a list of contributing (C) and non-contributing (NC) structures in the complex.

7700 C
7701 C
7702 C
7703 C
7704 C
7705 NC
7706 NC
7707 NC
7708 NC
7751 C

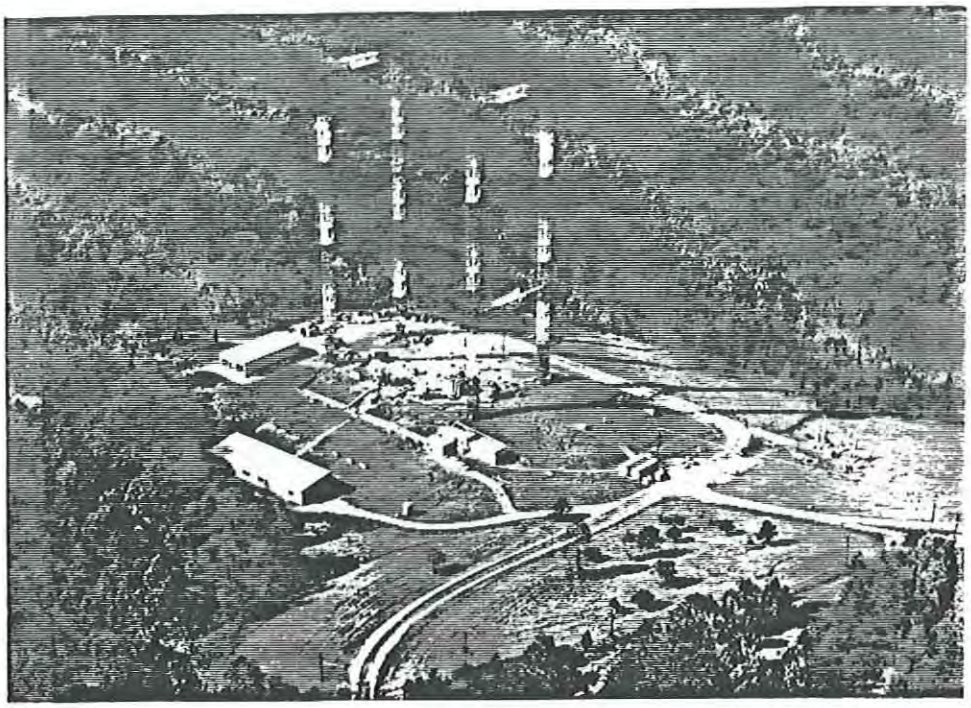


Figure III-127. 7700 Area. Tower Shielding Facility (1953). Aerial view (ORNL 9970-88) of complex. View southwest.

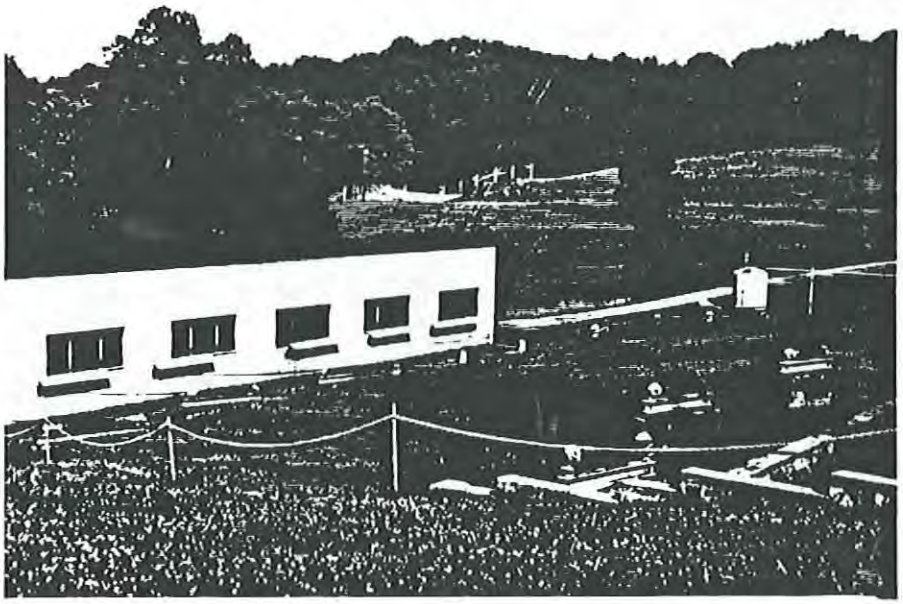


Figure III-128. 7703 Hoist House (1954). Note hoist cables emerging from building below windows and running across top of cable guides. View east.

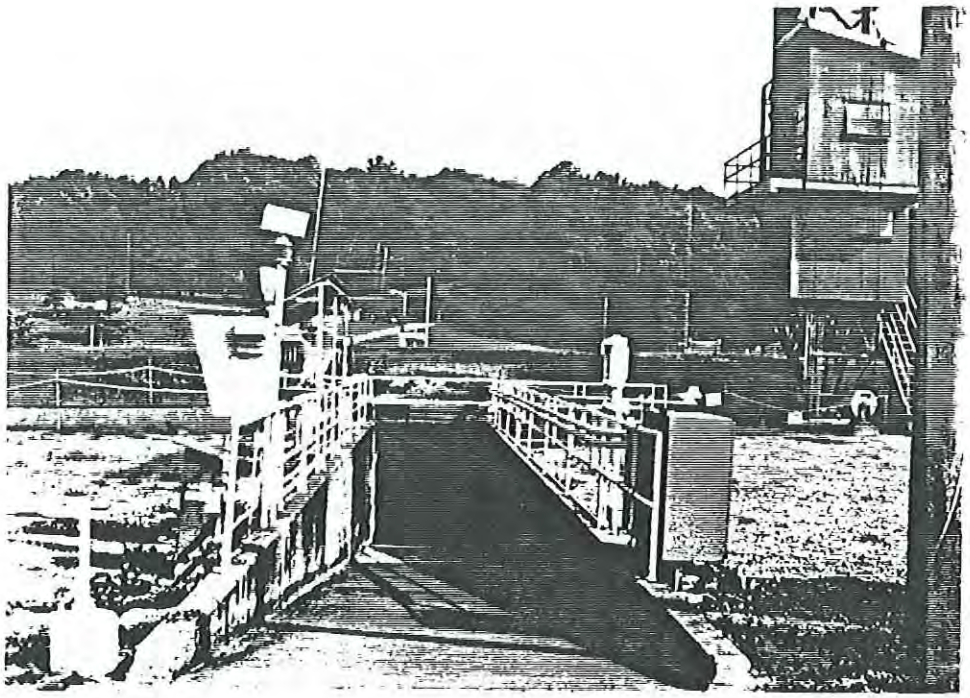


Figure III-129. 7702 Control House (1954). Looking down from tower pad into underground bunker containing controls. Man hoist on tower leg at upper right. View east.

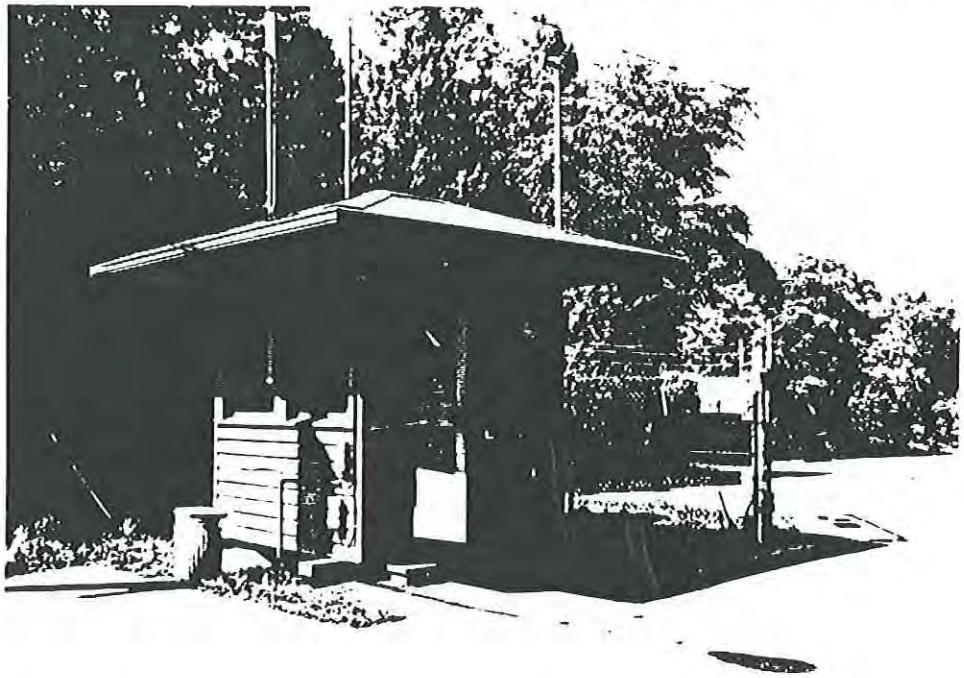


Figure III-130. 7751 Sentry Post No. 22. (1947): Guard Post at exclusionary fence of TSF was moved here ca. 1952. View southwest.

7709 AREA

CURRENT USE: Dosimetry Applications Research Facility
ORIGINAL USE: Health Physics Research Reactor/Dosimetry Applications Research Facility

HISTORY: ORNL in the 1960s and 1970s was a center for nuclear research in the areas of safety, the environment and waste disposal. In 1960, safety concerns were in the forefront since there had been fifteen reported accidents in the 1950s in which thirty people "received significant radiation doses" (Kerr et al. 1992:19). Two of these accidents occurred at Oak Ridge facilities.

The study of radiation exposure is known as dosimetry and in 1960, ORNL created the Dosimetry Applications Research (DOSAR) Group for research, development and testing associated with accident dosimetry.

Two buildings were constructed in 1962 at a remote location for the conduct of studies in this field. One building housed research laboratories, and on the opposite side of a hill was the Health and Physics Research Reactor (HPRR). The HPRR, originally known as the "fast burst reactor," was a research tool that simulated a nuclear criticality accident. The small, unmoderated, unshielded reactor was used throughout the 1960s to test techniques and the hardware of nuclear accident dosimetry.

An example of the HPRR's purpose was the 1960s experiments to help scientists estimate the solar radiation to which Apollo astronauts would be exposed. The HPRR was also made available for testing of various dosimetry systems developed elsewhere. The staff of this facility were chiefly responsible for the development and implementation of the *American National Standard: Dosimetry for Criticality Accidents* which is a standard still in use today. The writers of the publication used information gained from the ORNL research and HPRR test results. The HPRR was shut down in 1987 but dosimetry research continues at the facility today.

DESCRIPTION: This complex is located approximately two miles southeast of the ORNL main facilities complex on the Health Physics Research Reactor Access Road. It is comprised of five buildings and a guardhouse along the road to the northwest of the site.

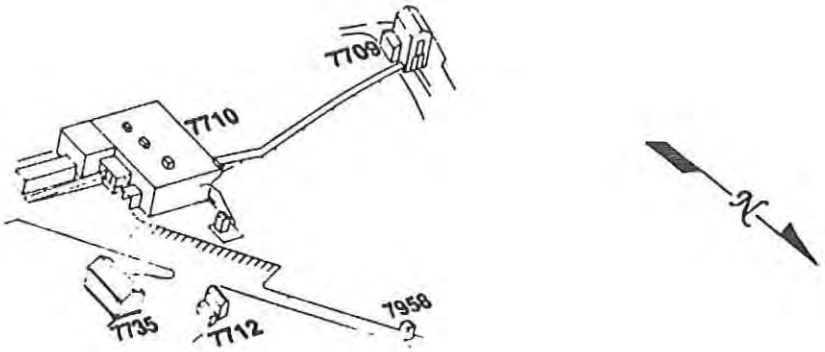


Figure III-131. 7709 Area. Site plan.

7709 Health Physics Research Reactor (1962): Separated from the rest of the complex by a hill and connected to the complex (Building 7710) with a series of pipes, this 3,004 square-foot, steel-frame, metal-sided, gable-roofed building stands alone within a fenced area.

7710 DOSAR Facility (1962): This 2,574 square-foot, flat-roofed, concrete block structure has a loading bay on the front facade. Pipes emerging from the top of the structure at the rear are connected to Building 7709.

7712 Dosar Low Energy Accelerator (1963): This 1,122 square-foot, steel-frame, metal-sided building has a gable roof and roll-up door on the gable end.

7735 Radiation Calibration Laboratory (1988): This new 2,800 square-foot, concrete block building has a flat roof and corrugated-metal overhang.

7953 Pump House-HPRR Waterline (1966): This 270 square-foot, concrete block pumphouse stands on the road to Building 7709.

7958 Sentry Post No. 23-HPRR (1981): This 64 square-foot, prefabricated flat-roofed guardhouse stands on the road to Area 7709.

ASSESSMENT OF ELIGIBILITY: The DOSAR Facility and HPRR are less than fifty years old and do not fall within the period of significance. It is the opinion of the HPS that this facility is not exceptionally significant and is not eligible for inclusion in the National Register. Dosimetry research has been underway at ORNL and other Laboratories since the 1940s. This facility simply added and further advanced the field. In addition, an insufficient historical perspective exists to allow evaluation of the significance of the DOSAR Facility.

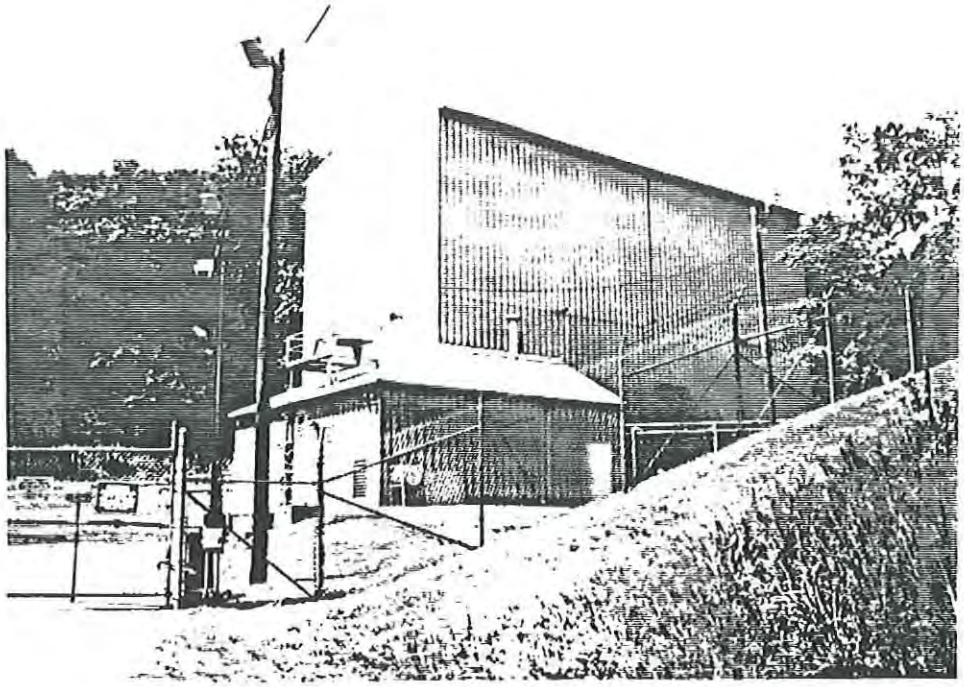


Figure III-132. 7709 Health Physics Research Reactor (1962). The reactor shut down in 1987. View northeast.

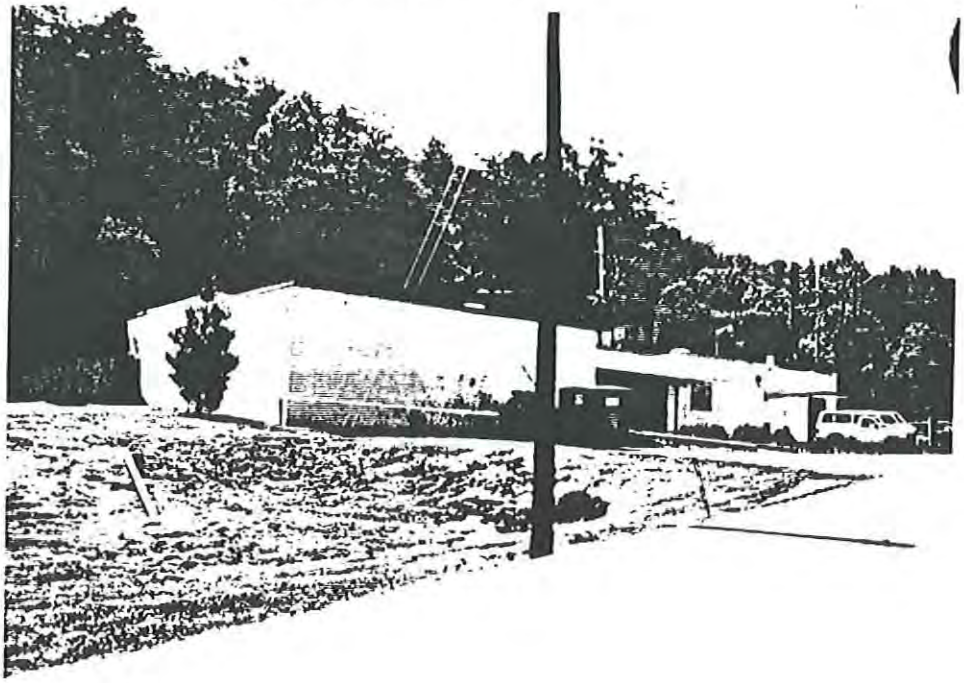


Figure III-133. 7710 Dosimetry Applications Research Facility (1962). The building contains research laboratories and the control room for the Health Physics Research Reactor (Building 7709). View northwest.

7813 AND 7846 AREA CURRENT USE: White Oak Lake and Dam
ORIGINAL USE: White Oak Lake and Dam

HISTORY: White Oak Creek flows through the ORNL main facilities complex and connects with the Clinch River to the west. During World War II, radioactive wastes were stored in underground tanks and low level wastes were released untreated into White Oak Creek. The low level wastes came from floor drains, operating areas and process cooling. Generally low in radioactivity, the waste did pose a hazard in the event of an accident at the plant whereas all waste could go directly into the creek. As designed in early 1943, the system had waste passing through a settling basin and after sampling, it was discharged to White Oak Creek.

In 1943, a dam was constructed on White Oak Creek at White Wing Road (today State Route 95) (Thompson 1963:Figure 19) to provide a means of holding-up radioactive materials should they escape in the event of an accident. The dam created the 25-acre White Oak Lake. The existence of the lake allowed waste to settle to the bottom and lowered levels of radioactive wastes flowing through the dam and weir to the Clinch River.

Due to its role in the disposal of nuclear waste, the lake was well known. The following anecdote concerns a 1965 visit to ORNL by a team of Russians studying waste management.

> *When we arrived at the White Oak Creek Bridge, every Russian raised his camera for permission to shoot. This creek was famous worldwide after the American papers at the Geneva Conference had described it as the outlet for ORNL-treated low level wastes.* (Genung et al. 1993:2-23).

Waste processing at the plant was greatly improved with the construction of a waste water treatment plant in 1957 and the reservoir was subsequently drained. However, the need remained to preserve the dam and weir as both a back up safety device in the event of an accidental release and for the monitoring and sampling of the treated water released from the plant before it flows into the Clinch River.

In recent years, the refilled lake and lakebed have proved valuable tools for research on the effects of radioactivity on ecological systems since radioactive wastes have accumulated in the silt. For example, the Health Physics Division has used the bed of White Oak Lake for plant research concerning the impact of radioactivity on plants.

DESCRIPTION: White Oak Lake, created by the White Oak Dam, is located north of SWSA 6 along White Oak Creek and approximately one and one-half miles southwest of the ORNL main facilities complex. The Dam is located at the point where the creek crosses State Route 95.

7813 White Oak Creek Dam (1943, modified 1980): The structure is a low coffer dam built to back up water to form a lake and to divert water through an apparatus to allow monitoring and flow control. *The coffer dam is a replacement of the original earthen dam. The original weir is no longer present.*

7846 White Oak Lake (1943): Manmade lake created by the damming of White Oak Creek.

7871 Stream Flow Monitoring Station No. 3 (n.d.): This small prefabricated building has corrugated-metal siding and stands atop the White Oak Dam.

ASSESSMENT OF ELIGIBILITY: It is the opinion of the HPS that the White Oak Lake and Dam are eligible for inclusion in the National Register under Criterion A due to their significance in early waste management efforts.

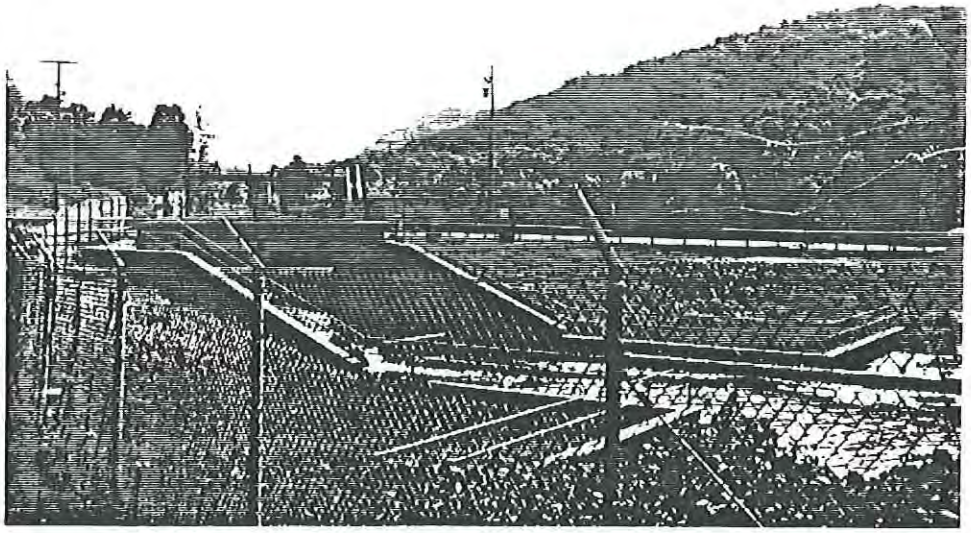


Figure III-134. 7813 White Oak Dam (1943). View southeast from west side of State Route 95.

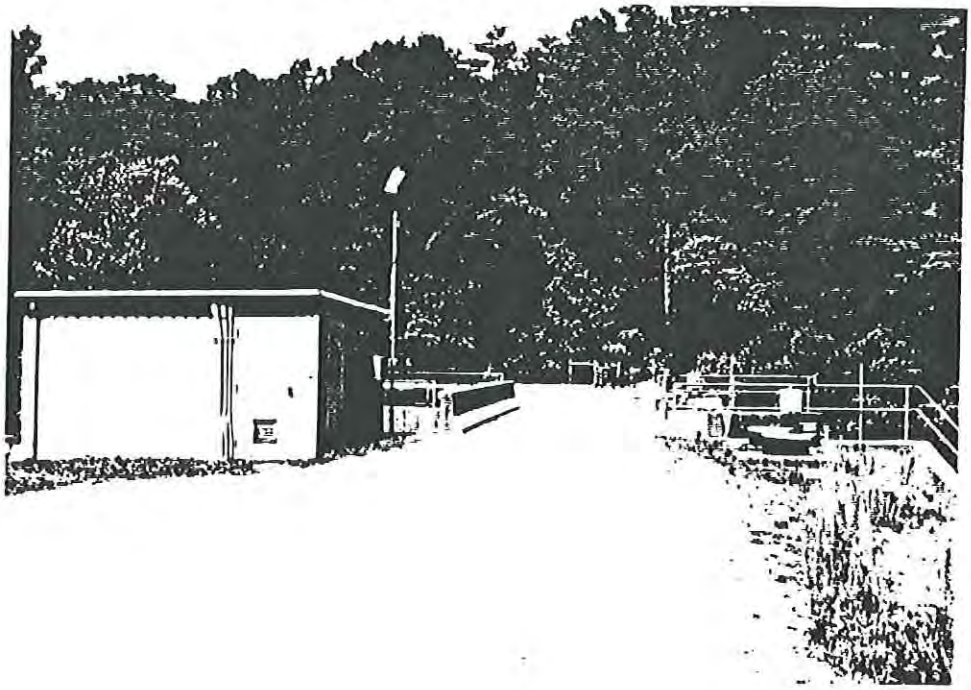


Figure III-135. 7871 Stream Flow Monitoring Station No. 3 (n.d.). The prefabricated building stands atop the dam. View north.

7852 AND 7860 AREA CURRENT USE: Inactive
ORIGINAL USE: Hydrofracture Waste Disposal Process

HISTORY: The safe disposal of radioactive waste and the rapidly growing amounts of stored wastes were an ongoing concern at ORNL in the late 1950s. A study of waste disposal methods resulted in the development in 1959 of the hydrofracture method, based on a common oil field technique of hydraulic fracturing that is also used for water wells. The process entailed drilling deep wells and then applying pressure to crack (fracture) the rock. Once fractured, cement grout mixed with liquid waste was injected into the rock fractures where it dispersed and hardened.

The Old Hydrofracture Facility, Building 7852, was an experimental and operational plant for the injection of waste grout into a fractured shale formation. The experimental design was tested in 1964-65 using diluted and concentrated waste solutions. Beginning in 1966, operational injections of concentrated LLLW from the ORNL system were routinely made until the facility shut down in 1980. The plant was closed when the New Hydrofracture Facility, located just south of this site, was completed. The plant is now inactive and is scheduled for decommissioning in 1996.

The New Hydrofracture Facility (Building 7860) incorporated improved technology to continue the use of the hydrofracture method for liquid waste disposal. This facility shut down in the 1980s as a result of the shift in opinion of preferred waste disposal methods. LLLWs, once disposed of using underground hydrofracture, now undergo volume reduction, solidification and storage in an above ground receptacle.

DESCRIPTION: This complex is located 0.75 mile to the south of the ORNL main facilities complex. It is comprised of two physically separated building complexes: the Old and the New Hydrofracturing Facilities.

Old Hydrofracturing Facility

7852 Shale Fracturing Batch Plant (1964): This 146 square-foot, concrete block structure has a flat roof and is connected to four bulk storage tanks elevated off the ground on metal towers. The storage tanks were designed to hold cement and other solid constituents of the grout mix. *Alterations include extensive work in 1987 and 1988 to improve the deteriorating condition of this structure.*

7853 General Storage (1964): This 600 square-foot building has metal-siding, a gable roof, paired doors on the

gable end and a round silo standing at the front corner of the building.

7854 Equipment Storage for Building 7852 (n.d.)

No # Cells (1964): These concrete cells contain the wellhead, injection pumps and mixer. *Alterations were made to the cells in 1987-1988 to improve their condition. Work done includes repainting, installing metal covers on all hatch openings and penetrations.*

New Hydrofracturing Facility

7860 New Hydrofracturing Facility (1980): This 4,125 concrete, masonry, and steel-frame structure has two sections, a one-story, flat-roofed concrete section and a steel-frame, metal-sided tower with a flat roof.

7830 ILW Waste Storage Tank Facility (1980): This 347 square-foot, concrete block building has a flat roof and is attached to Building 7877.

7863 General Storage for 7860 (1980): This 2,740 square-foot, steel-frame, metal-sided building has a gable roof.

7877 LLW Solidification Facility (1987): This prefabricated metal building has a low-pitched gable roof and roll-up doors on the gable end.

7882 Emergency Generator for Building 7877 (1988)

ASSESSMENT OF ELIGIBILITY: Since the Graphite Reactor reached criticality in the early 1940s, research and development of safe disposal methods for radioactive waste has been ongoing at ORNL. Numerous methods were tried to dispose of the ever growing amounts of temporarily stored wastes and many were eventually discontinued due to advancements in technology and due to the growing concern for the environment and risks posed by disposal to humans. This waste disposal technology continues to evolve today.

The hydrofracture method utilized at ORNL for about twenty-five years was one disposal method among many and was a derivative of a common oil and water well drilling technique. The method did not gain widespread usage and was discontinued due to reasons discussed above.

Those facilities associated with the hydrofracture method of waste disposal are less than thirty years old and do not fall within the period of significance. It is the opinion of the HPS that they are not eligible for inclusion in the National Register.

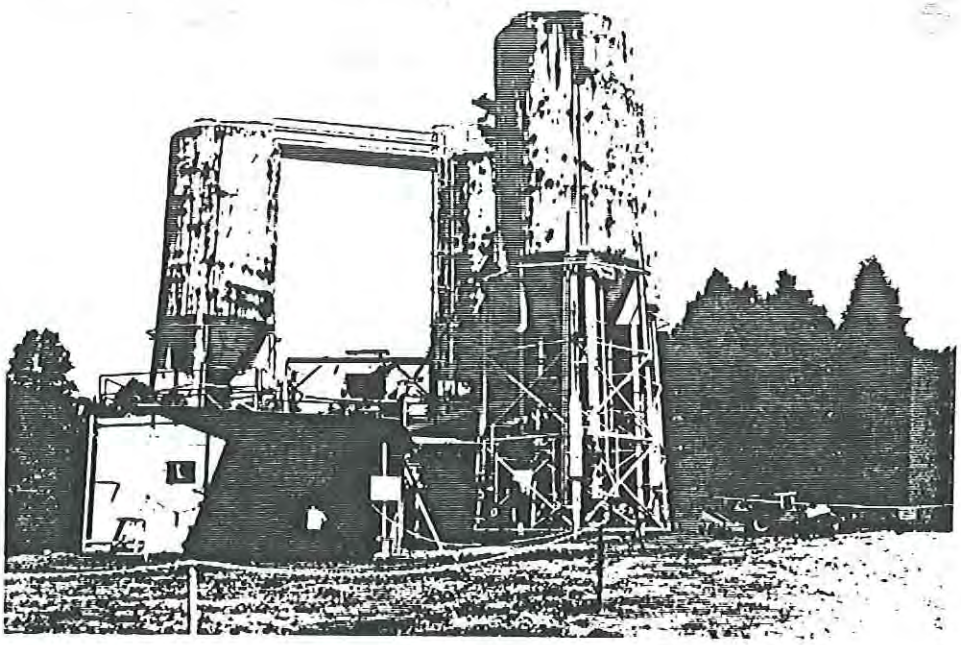


Figure III-136. 7852 Old Hydrofracturing Facility (1964). View of bulk storage tanks designed to hold the grout mixture. View northwest.

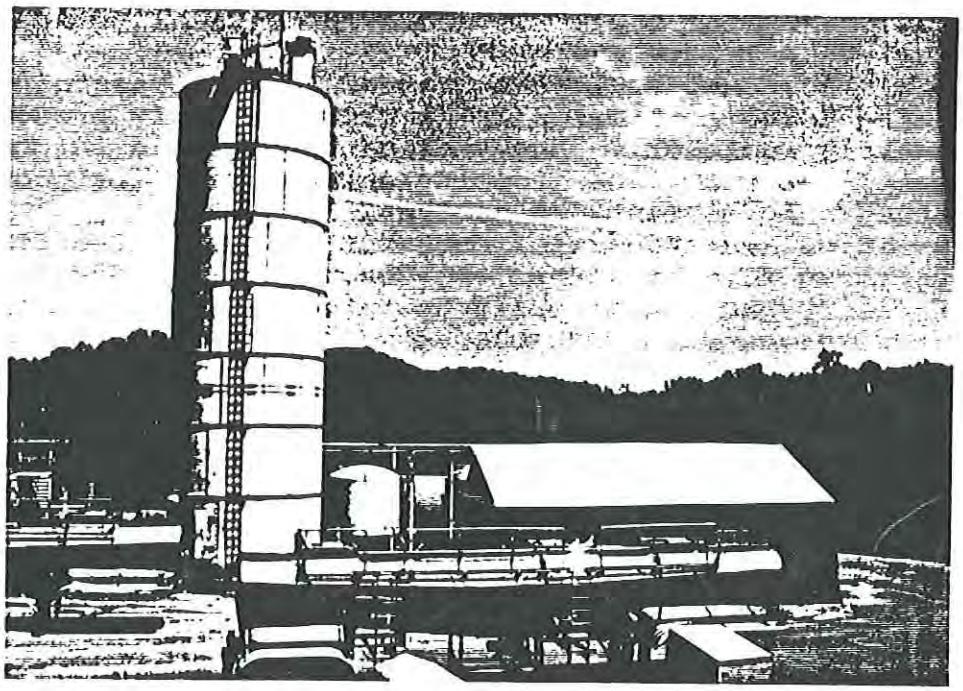


Figure III-137. 7860 New Hydrofracturing Facility (1980). View southeast.

7900 AREA

CURRENT USE: High Flux Isotope Reactor Experiment Facility (HFIR)/Transuranium Element Processing Program
ORIGINAL USE: High Flux Isotope Reactor Experiment Facility (HFIR)/Transuranium Element Processing Program

HISTORY: The 7700 Area is associated with ORNL's Transuranium Element Processing Program, designed to produce transuranic elements (isotopes). In addition to isotope production, the HFIR conducted neutron scattering research used in fields such as chemistry and physics. Studies were also conducted on the effects of irradiation on materials. The main buildings of the complex, the High Flux Isotope Reactor (HFIR) and the Transuranium Processing Facility, contained the two key components of the program.

The first high flux reactor was built in Idaho in 1947 and a decade later, the Soviets "designed a reactor that had surpassed it" (Johnson and Schaffer 1992:144) in technology and performance. The United States responded by a development program aimed at constructing a high flux research reactor that would allow "'purely scientific studies of transuranic elements' and augment the 'production of . . . radioisotopes.'" (Johnson and Schaffer 1992:144)

The HFIR (Building 7900) was completed in 1965 and has the world's highest thermal neutron flux (Greenstreet 1992:60). The flux, trap-type HFIR is a light water-cooled aluminum clad fuel plate reactor that utilizes highly enriched U-235 for fuel. It achieved criticality in 1966.

In 1966, ORNL built the Transuranium Processing Plant (Building 7920) to chemically extract the newly produced, intensively radioactive heavy elements produced in the HFIR. In that first year, the facility shipped over forty orders of transuranic elements to national laboratories, universities and industrial concerns in the United States and to three foreign countries (Genung et al. 1993:2-33). The facility has continuously operated and expanded since 1966 and serves as a valuable research tool, providing isotopes used in basic research throughout the United States.

DESCRIPTION: This complex is located south of the ORNL main facilities complex and south of Melton Valley Drive. It is a controlled access facility within a fenced area.

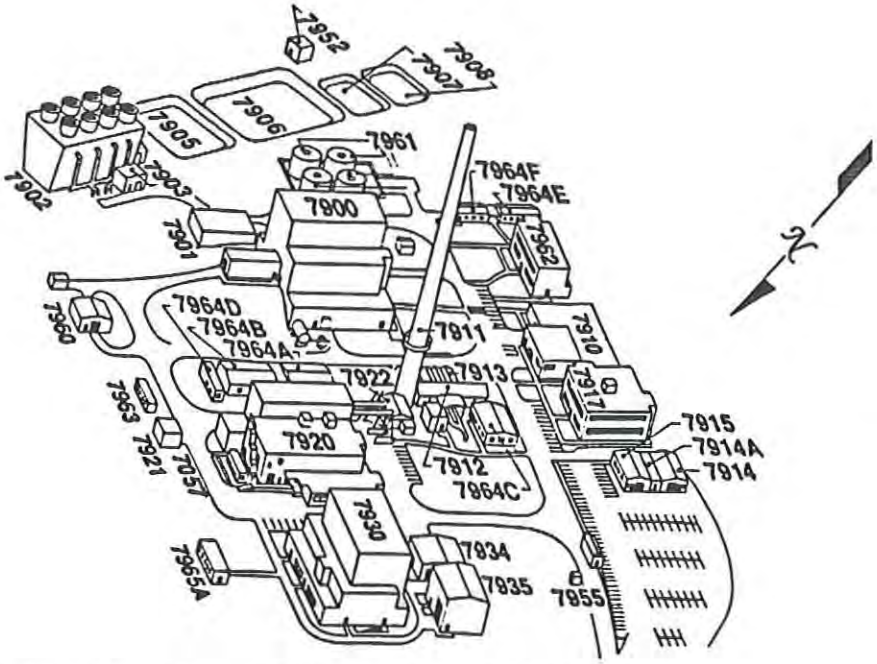


Figure III-138. 7900 Area. Site plan.

7900 High Flux Isotope Reactor (1965): This structure houses the High Flux Isotope Reactor. The 61,758 square-foot structure is of concrete construction and has five stories in the tower section and a basement.

7901 Electrical Building for 7900 (1965): Connected to Building 7900, this 3,140 square-foot, concrete block structure has a flat roof.

7902 Cooling Tower for 7900 (1965): This 7,264 square-foot, wood structure stands to the southeast of the reactor.

7903 Cooling Tower Equipment for 7900 (1965): This small, 640 square-foot, concrete block structure is attached to the cooling tower (Building 7902).

7904 Sewage Treatment Plant for 7900 (1961)

7905 Retention Pond No. 1 (1961): Manmade pond associated with Building 7904.

7906 Retention Pond No. 2 (1961): Manmade pond associated with Building 7904.

7907 Retention Pond No. 3 (1961): Manmade pond associated with Building 7904.

7908 Retention Pond No. 4 (1961): Manmade pond associated with Building 7904.

7910 Office Building for 7900 (1965): This 13,240 square-foot, concrete structure houses offices. It has a flat roof, roll-up door on the main facade and a bank of multipane windows.

7911 Stack for 7900 (1965): This concrete stack stands to the northwest of the reactor.

7912 Fan Shed for 7911 (1965): Attached to 7911, this open shed is on a concrete slab and has metal supports and a gable roof.

7913 Filter pit for 7911 (1965): This pit contains equipment on a concrete pad next to 7911.

7914 Equipment and Parts Storage Building (n.d.): This 2,370 square-foot, metal-sided, gable-roofed structure has a roll-up door on the gable end.

7914 (A) Annex to 7914 (n.d.)

7915 Operations Storage Building (n.d.): This 2,370 square-foot, metal-sided, gable-roofed structure has a roll-up door on the gable end.

7916 Softener Building for Cooling Tower, 7902 (1975): This small, 640 square-foot, concrete block, gable-roofed building stands adjacent to Building 7902.

7917 Research Reactors Division Office Building (1990): This two-story modern office building has a flat roof, brick facing and large banks of tinted glass windows.

7919 Process Waste Monitor (n.d.): This 256 square-foot, prefabricated, metal, gable-roofed building is adjacent to Building 7900.

7920 Radio Chemical Engineering Development Center (1966): This tall 33,215 square-foot, concrete block building is irregular in shape and has a flat roof.

7921 Emergency Generator for 7920 (1966): This 200 square-foot, small, square concrete block structure houses the emergency generator for Building 7920.

7922 Breeching and Fan Area for 7920 (1982): This 1,300 square-foot, prefabricated metal shed has a gable roof.

7930 Radio Chemical Engineering Development Center (1968): This 38,937 square-foot, concrete block building has a flat roof, three floors and a basement.

7931 Emergency Generator for 7930 (1968): This 200 square-foot, concrete block building has a flat roof.

7932 Waste Sampling Building for 7930 (1968): This 146 square-foot, concrete block building has a flat roof.

7934 Volume Reduction Facility (1984): This 2,500 square-foot, prefabricated metal building has a flat roof.

7935 Containerized Waste Storage Facility (1984): This 2,500 square-foot, prefabricated metal building has a flat roof.

7952 Low Level Waste Pumping Station (1966): This 256 square-foot, concrete block building stands adjacent to the settling ponds.

7953 Pump House HPRR Waterline (1966): This small, 270 square-foot, concrete block building has a flat roof.

7955 Sentry Post No. 23. HPRR (1981): This 40 square-foot, prefabricated steel-frame, metal-sided sentry post stands at the gates to the complex.

7957 Office Trailer (1976): This is a modern trailer.

7960 Tool Storage Building (1988): Located to the east of Building 7900, this 1,600 square-foot, prefabricated metal building has a gable roof.

7961 Melton Valley Waste Collection Tanks (1987): These round tanks and accessory equipment are to the southeast of Building 7900.

7962 Neutron Users Office and Laboratory (1988): This 5,590 square-foot building is two stories in height with a flat roof, brick and metal siding and banks of windows.

7963 Fan Shed for 7930 (n.d.): This is a 432 square-foot, prefabricated metal-sided building.

7964 (A) Office Trailer for Research Reactor Division (1988): This is a modern 2,160 square-foot trailer.

7964 (B) Office Trailer for Research Reactor Division (1988): This is a modern 2,160 square-foot trailer.

7964 (C) Office Trailer for Research Reactor Division (1988): This is a modern 2,160 square-foot trailer.

7964 (D) Office Trailer for Research Reactor Division (1989): This is a modern 2,160 square-foot trailer.

7964 (E) Office Trailer for Research Reactor Division (1990): This is a modern 2,160 square-foot trailer.

7964 (F) Office Trailer for Research Reactor Division (1990): This is a modern 2,160 square-foot trailer.

7965 (A) Office Trailer for Chemical Tech (1988): This is a modern 2,160 square-foot trailer.

ASSESSMENT OF ELIGIBILITY: The HFIR is less than fifty years old and does not fall within the period of significance. Thus, it is the opinion of the HPS that this facility is not eligible for inclusion in the National Register. The HFIR was the third of its kind developed, the first elsewhere in the United States in 1947 and the second by the Soviets in 1958. Subsequently, the development of this reactor facility was not a new significant technology. It is the opinion of the HPS that insufficient time has passed to develop a historical perspective to assess the National Register eligibility of the facility.

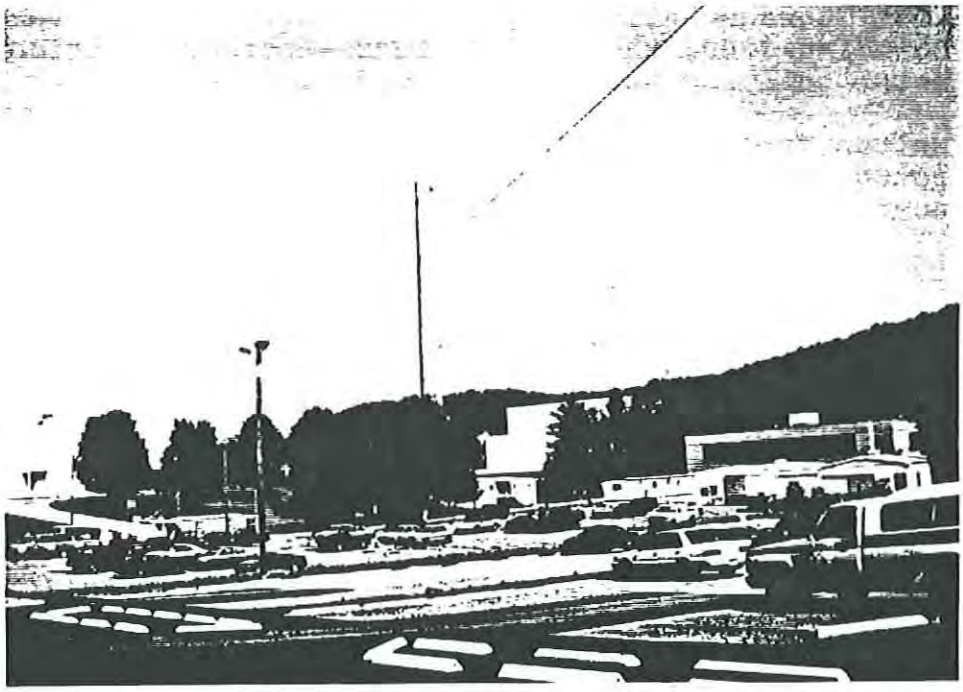


Figure III-139. 7900 Area. High Flux Isotope Reactor Experiment Facility. View of complex looking northwest.

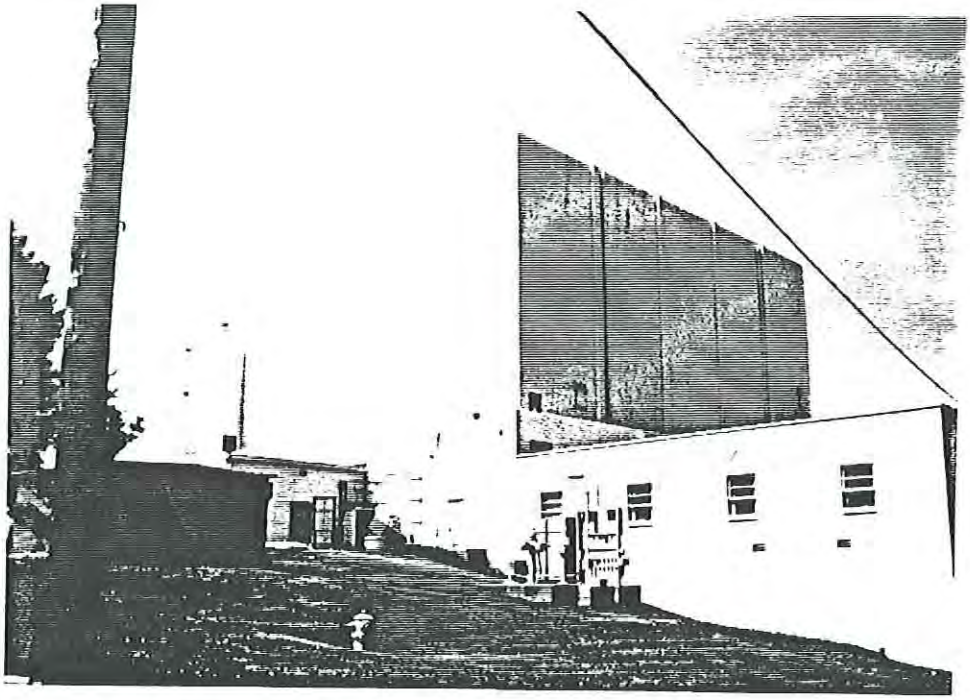


Figure III-140. 7900 High Flux Isotope Reactor (1966). This building houses the reactor which is still operational. View northeast.

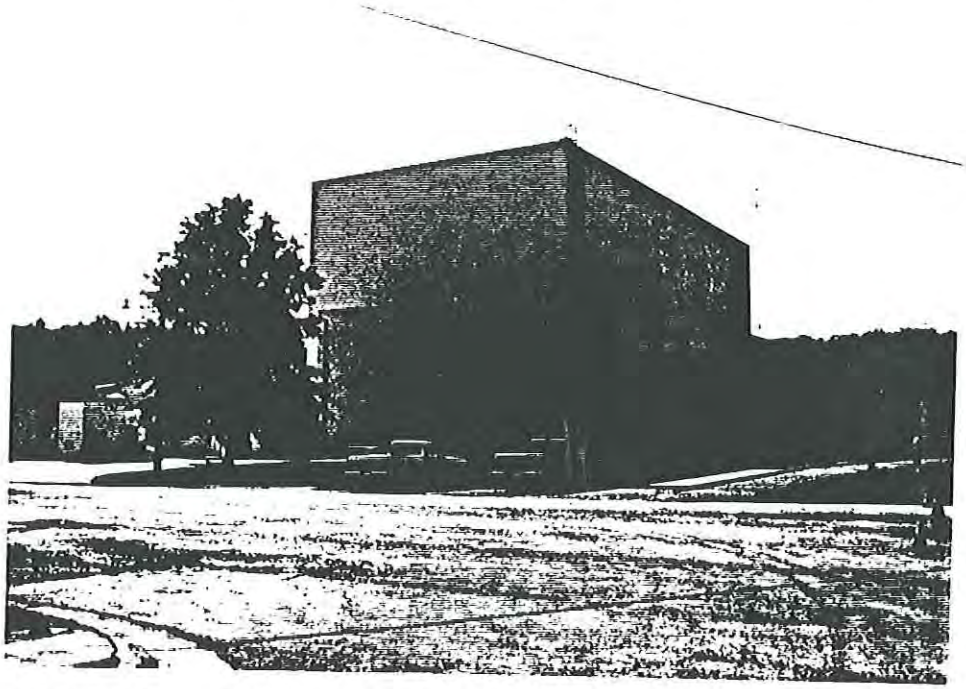


Figure III-141. 7920 Radiochemical Engineering Development Center/Transuranium Processing Plant (1966). View southwest.

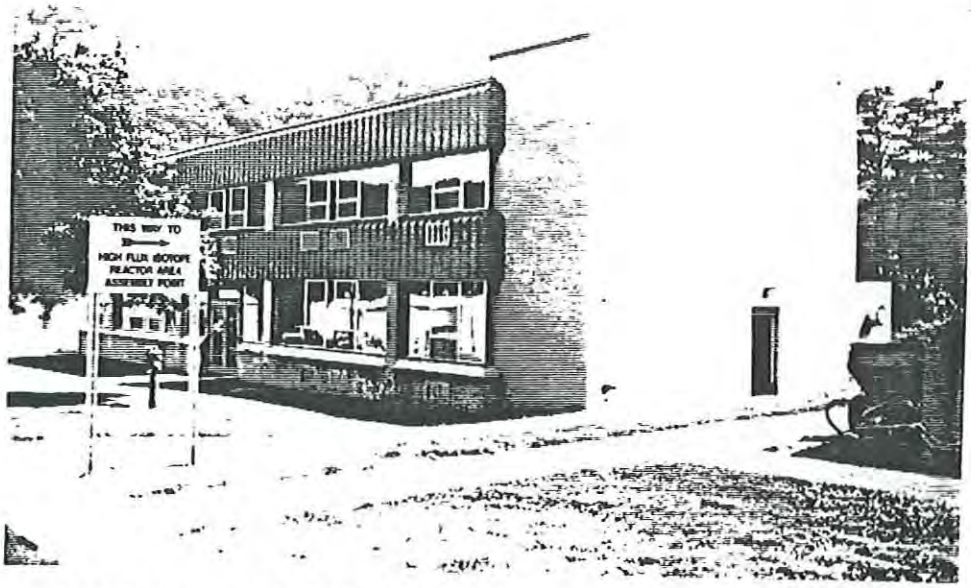


Figure III-142. 7962 Neutron Users Office and Laboratory (1988). The building is one of two facilities built in the complex since 1988. View southwest.

SOLID WASTE STORAGE AREAS (SWSAs)
SWSA 3, SWSA 4, SWSA 5, SWSA 6, SWSA 7

CURRENT USE: Temporary and/or Permanent Storage of Wastes (some inactive)
ORIGINAL USE: Temporary and/or Permanent Storage of Wastes

HISTORY: As soon as operations got underway in 1943 for the Manhattan Project, the Clinton Laboratories recognized the importance of, and difficulties in, the disposal of nuclear waste. Since nuclear science was a relatively new field and disposal of nuclear waste a very new challenge, the Chemical Technology Division had to develop a new technology and in the meantime waste was "temporarily" stored. Since 1943, storage areas were active at ORNL, the first two were located within the ORNL main facilities complex. As technology progressed, methods were tried and proven for the disposal of waste in-ground. Following is a brief history and description of the five SWSAs outside the ORNL main facilities complex, SWSA 3, SWSA 4, SWSA 5, SWSA 6 and SWSA 7.

INVENTORY

1001 Solid Waste Storage Area 3: SWSA 3 began active storage in 1946. It remained active for approximately five years and was then closed to trench disposal. The site was used as a landfill for storage of low-level wastes and to store scrap metal.

SWSA 3 is located in a fenced area 0.6 mile west of the ORNL main facilities complex at the west end of White Oak Avenue. The grassed site encompasses approximately seven acres and contains trench burials and drums.

7800 Solid Waste Storage Area 4: SWSA 4 began operations in 1951 and continued until 1956. Trenches and auger holes were used for disposals. Wastes from ORNL and other AEC facilities are stored here.

SWSA 4 is located approximately 0.5 mile southwest of the ORNL main facilities complex and is bounded by Lagoon Road and Chemical Waste Area Access Road. The grassed site encompasses 23-acres and is surrounded by a fence. Throughout the site are a network of ditches.

Buildings on the site are:

7833 Alpha Greenhouse Facility (1976): prefabricated metal
7874 Environmental Services Division Storage Building (1987): 2,400 square-foot, prefabricated metal

7881 Guard Post 24 (n.d.)

7802 Solid Waste Storage Area 5: SWSA 5 opened in 1959 and operated until 1973. A small portion of the facility remains operational today. Trenches and auger holes were used for disposals.

SWSA 5 is located east of White Oak Creek between SWSA 4 and Melton Branch. SWSA 5 encompasses approximately eighty acres with fifty in use and the remainder as a buffer. Two major areas serve two different functions: one was used for trench burial while the other is currently used to store retrievable waste. The grassed site is fenced and contains several unpaved roads and drainage ditches.

Buildings on the site are:

7823 Underground Storage Building (1972)
7823 (A) Hillside Silos (1971): shed banked into hill
7823 (B) Temporary Waste Storage Facility
7823 (C) Temporary Waste Storage Facility
7823 (D) Temporary Waste Storage Facility
7824 Radioactive Waste Storage Building (1975): corrugated-metal siding
7826 Retrievable Waste Storage Facility (1976): 1,500 square-feet, concrete block
7827 High Level Alpha Storage (1976)
7829 Peach Bottom Storage Wells (1975): 200 square-feet, concrete
7831 Solid Waste Compactor Facility (1978): gable-roofed building with side-shed addition
7831 (A) Shed (n.d.): shed with metal facing, one side open
7831 (B) Trailer (n.d.)
7831 (C) Straw Shed
7834 Retrievable Waste Storage Facility
7855 Storage Facility for HRL Retrievable Waste (1988): 2,900 square-feet, concrete
7879 TRU/LLW Staging Facility

Buildings across from the entrance to SWSA 5:

7819 Interim Decontamination Facility (1964): 2,200 square-foot building, across from the entrance to SWSA 5 in fenced area, corrugated-metal siding and gable roof.

7822 Solid Waste Storage Area 6: SWSA 6 began operations in 1969 and continues in use today. It is a shallow land burial site with wastes disposed of in trenches and auger holes. Due to Resource Conservation and Recovery Act regulations, a protective high-density cap was installed over certain areas which are now inactive.

SWSA 6 is located approximately 0.75 mile from the ORNL main facilities complex and is bounded by Lagoon Road, White Oak Lake and State Route 95. Approximately ten acres contain high-density polyethylene caps over the burials trenches.

Buildings on the site are:

7842 Storage Shelter (1983): Gable-roofed building
7878 SWSA 6 Staging Fac. (1987): Gable-roofed building
7886 Interim Waste Management Facility (n.d.): Open shed structure with prefabricated metal-sided building underneath.
No # Tumulus Pads with prefabricated gambrel-roofed structures: rubberized buildings manufactured by Rubb.
No # Burial pits

7575 Solid Waste Storage Area 7 (Under development in 1990s): SWSA 7 is located on the south side of Melton Valley Drive immediately east of the Molten Salt Reactor Experiment Building (Building 7503).

Buildings under development on the site are:

7576 Bulk Contaminated Soil Facility (n.d.): 5,100 square-feet, prefabricated metal
7577 TRU Storage Facility (n.d.): 7,200 square-feet, prefabricated metal

ASSESSMENT OF ELIGIBILITY: Although these waste disposal areas portray the history of nuclear waste disposal at ORNL from the days of the Manhattan Project to the present, it is the opinion of the HPS that these properties do not possess sufficient significance for inclusion in the National Register.

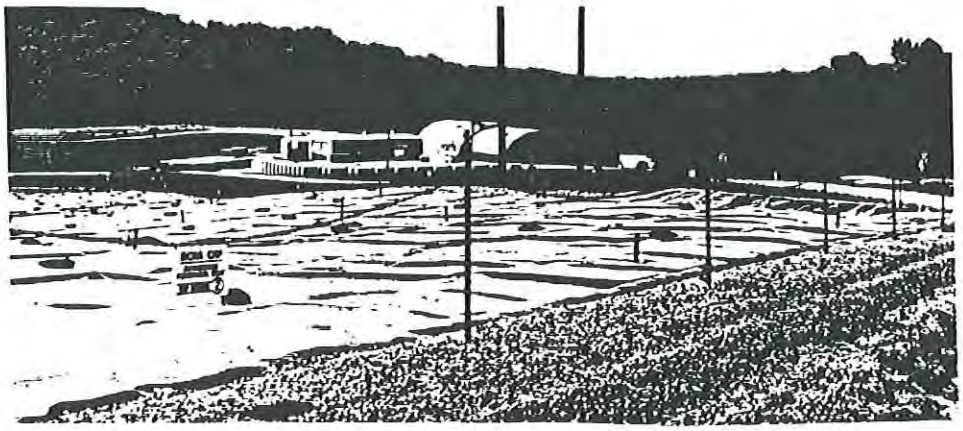


Figure III-143. Solid Waste Storage Area 6 (1969): View of caps, looking toward southeast.

OUTLYING PROPERTIES: In addition to the properties previously discussed by area, there are numerous properties located at outlying areas of the ORR. Examples of property types are: environmental study areas, prefabricated buildings, communication and monitoring instruments and towers, trailers, waste storage areas, and water resources such as creeks and reservoirs.

In consultation with the TN-SHPO and representatives of the DOE and the ORNL, the HPS determined that the outlying properties listed in Table III-3 are not eligible for inclusion in the National Register.

TABLE III–3 p. 1 of 3

OUTLYING PROPERTIES NOT ELIGIBLE FOR INCLUSION IN NATIONAL REGISTER

ORNL #	NAME
0800	ENVIRONMENTAL STUDY AREA
0801	ENVIRONMENTAL STUDY AREA
0802	ENVIRONMENTAL STUDY AREA
0804	ENVIRONMENTAL STUDY AREA
0805	ENVIRONMENTAL STUDY AREA
0806	ECOLOGY
0807	WASTE DISPOSAL STUDY AREA
0809	ENVIRONMENTAL STUDY AREA
0810	ENVIRONMENTAL STUDY AREA
0811	ENVIRONMENTAL STUDY AREA
0812	ENVIRONMENTAL QUAL. RES. AREA
0813	FIELD LAB NO. 1
0814	FIELD LAB NO. 2
0816	CESIUM CONTAMINATED STUDY PLOTS
0817	OZONE GENERATOR BUILDING
0818	ATMOSPHERIC INSTRUMENT TRAILER
0819	FARM IMPLEMENT BUILDING
0820	CARBON DIOXIDE TANK
0821	AMBIENT AIR STATION NO. 39
0822	ESD/NOAA USAF INSTRUMENT TRAILER
0853	WHITE OAK CREEK BELOW DAM
0854	JONES ISLAND
0855	OPERATIONS BUILDING
0856	NOAA TOWER
0857	GOAT BUILDING
0858	WHOLE TREE CANOPY
0870	RACCOON CREEK MONITORING STA.
0911	ENVIRONMENTAL STUDY AREA
0912	ENVIRONMENTAL STUDY AREA
0913	ENVIRONMENTAL STUDY AREA
0914	ENVIRONMENTAL STUDY AREA
0916	ENVIRONMENTAL STUDY AREA
0917	ENVIRONMENTAL STUDY AREA
0918	ENVIRONMENTAL STUDY AREA
0919	ENVIRONMENTAL STUDY AREA
0920	ENVIRONMENTAL STUDY AREA
0921	ENVIRONMENTAL STUDY AREA
0922	ENVIRONMENTAL STUDY AREA
0923	ENVIRONMENTAL STUDY AREA
0924	ENVIRONMENTAL STUDY AREA
0930	CENTRAL WASTE DISPOSAL AREA
0931	1ST CREEK MONITORING STA.
0932	WALKER BRANCH SOIL BLOCK NO.1
0933	WALKER BRANCH SOIL BLOCK NO. 2
0934	WALKER BR. SUBSURFACE WEIR INST. TR.
0935	WALKER BRANCH SUBSURFACE WEIR
0936	ESD TWIN TOWERS
0937	ATDD/NOAA RAIN GUAGE 2 INSTR. BLDG.
0938	ATDD/NPAA STAIRWAY TOWER
0939	ATDD/NOAA SOLAR EXP. TOWERS
0940	ATDD/NOAA INSTRUMENT BLDG. NO. 1
0941	ATDD/NOAA INSTRUMENT BLDG. 2
0942	ATDD/NOAA USAF TRAILER

	Table III–3 p. 2 of 3 Outlying Properties Not Eligible
ORNL #	NAME
0945	WALKER BRANCH WATERSHED AREA
0950	WALKER BRANCH EAST WEIR INSTR. HOUSE
0951	WALKER BRANCH WEST WEIR INSTR. HOUSE
0952	EAST WEIR WALKER BRANCH WATERSHED
0953	WEST WEIR WALKER BRANCH WATERSHED
0954	REFUSE TRANSFER STATION
0958	WATER WELL NO. 1
0960	WATER WELL NO. 2
0962	RADIO TRANSMITTER FAC. CHESTNUT RIDGE
0963	BACKGROUND MEAS. STA.
1554	CONTRACTORS BORROW & DISPOSAL AREA
1558	WEIR NW TRIBUTARY
1566	FIRST CREEK MONITORING STATION
6551	WEST RESERVOIR (HAW RIDGE)
6552	EAST RESERVOIR (HAW RIDGE)
6553	EMERGENCY GENERATOR & VALVE PIT
6554	GRAVEL DRYING SHED
6555	30 METER METEROLOGICAL TOWER
6556	CONTRACTORS STORAGE AND STAGING AREA
6556	(A) CONTRACTORS TRAILERS
6556	(B) CONTRACTORS TRAILERS
6556	(C) CONTRACTORS TRAILERS
6556	(D) CONTRCTORS TRAILERS
7028	ENVIRONMENTAL STUDY AREA
7076	METHANOL STORAGE FACILITY
7079	BOTTLE STORAGE BUILDING
7553	PUMPHOUSE
7565	ENVIRONMENTAL STUDY AREA NO. 821
7569	MELTON VALLEY COLLECTION TANK WC–20
7570	WC–23 TANK VAULT
7571	30 METER METEOROLOGICAL TOWER
7572	CH – TRU WASTE STORAGE FAC.
7573	WCCF FACILITY
7574	NFS WASTE STORAGE FAC.
7650	ENVIRONMENTAL STUDY AREA NO. 613
7651	DRUM STORAGE FACILITY
7652	HAZARDOUS WASTE STORAGE FACILITY
7653	CHEMICAL WASTE STORAGE AND CYLINDER STORAGE
7654	LONG TERM HAZARDOUS WASTE STORAGE FACILITY
7655	ENVIRONMENTAL STUDY AREA
7657	PERIMETER AIR MONITORING STA. NO. 38
7658	CONTRACTORS LANDFILL (CLOSED)
7659	SANDIA SITE
7660	ENVIRONMENTAL STUDY AREA
7661	ELECTRICAL UTILITY BUILDING
7665	INDUSTRIAL WASTE STORAGE & EARTH BORROW AREA
7666	ENVIRONMENTAL EMERGENCY RESPONSE FACILITY
7666	(A) W.M. & R.A. CHANGE HOUSE
7667	EXPLOSIVE & SHOCK SENS. WASTE DISP. FAC.
7668	MIXED WASTE STORAGE FACILITY
7669	MIXED WASTE STORAGE FACILITY
7730	ENVIRONMENTAL STUDY AREA
7731	ENVIRONMENTAL STUDY AREA
7732	ENVIRONMENTAL STUDY AREA
7733	ENVIRONMENTAL STUDY AREA

	Table III-3 p. 3 of 3 Outlying Properties Not Eligible
ORNL #	NAME
7734	ENVIRONMENTAL STUDY AREA
7752	SENTRY POST #21
7753	ENVIRONMENTAL STUDY AREA NO. 911
7754	ENVIRONMENTAL STUDY AREA NO. 1112
7759	CESIUM-137 FOREST RESEARCH AREA
7775	RESERVOIR
7776	METER HOUSE
7805	WASTE PIT NO. 1 ABANDONED
7806	WASTE PIT NO. 2 ABANDONED
7807	WASTE PIT NO. 3 ABANDONED
7808	WASTE PIT NO. 4
7809	WASTE TRENCH NO. 5
7810	CHEMICAL WASTE TRENCH NO. 6 ABANDONED
7811	PILOT PITS 1 & 2
7818	WASTE TRENCH NO. 7
7821	EMERGENCY WASTE BASIN (MELTON VALLEY)
7841	CONTAMINATED EQUIPMENT STORAGE AREA
7845	WHITE OAK DAM MONITORING STA. NO. 5
7847	PROCESS WASTE SLUDGE POND
7848	BURIAL & EQUIPMENT SERVICE PAD
7849	WHITE OAK CREEK WEIR AND GAGING STATION
7850	ENVIRONMENTAL STUDY AREA NO 712
7851	ENVIRONMENTAL STUDY AREA 717
7857	IWMF MONITORING STATION
7864	GAGING STATION EAST SEEP
7865	GAGING STATION WEST SEEP
7866	SAMPLING STATION 7500 BRANCH
7867	WEIR MELTON BRANCH
7868	SAMPLING STATION WHITE OAK CREEK
7869	STREAM FLOW MONITORING STATION NO. 5
7870	PERIMETER MONITORING STATION NO. 34
7871	STREAM FLOW MONITORING STATION NO. 3
7872	STREAM FLOW MONITORING STATION NO. 4
7873	1ST CREEK WEIR
7875	STORAGE BUILDING FOR EMERGENCY RESPONSE
7876	HEALTH PHYSICS OFFICE TRAILER
7879	TRU/LLW STAGING FACILITY
7883	RH-TRU WASTE STORAGE BUNKER
7884	RH-TRU WASTE STORAGE BUNKER II
7936	STORAGE FACILITY FOR REDC
7950	ENVIRONMENTAL STUDY AREA NO. 851
7951	ENVIRONMENTAL STUDY AREA NO. 852
7966	LLW MON. & COLLECTION STATION
7967	(A) MELTON BRANCH SUBSURFACE WEIR
7967	(B) SUBSURFACE WEIR INSTRUMENT BUILDING
7967	(C) MELTON VALLEY SOIL BLOCK

SUMMARY: It is the opinion of the HPS that the following ORNL properties are eligible for inclusion in the National Register.

1) The Oak Ridge National Laboratory Historic District (comprised of portions of the ORNL main facilities complex).

2) Buildings 7001 and 7002 in the East Support Area.

3) Building 7503, Aircraft Reactor Experiment Facility/Molten Salt Reactor Experiment Facility

4) 7700 Area, Tower Shielding Facility

5) 7813 White Oak Dam and 7846 White Oak Lake

As stated in Chapter I of this report, it is the opinion of the HPS that certain ORNL properties should be reevaluated as they reach fifty years of age or once a sufficient time period has passed to allow formation of a historical perspective. It is also common to reevaluate an evolving class of structures such as those at ORNL every ten years.

CHAPTER IV: ASSESSMENT OF EFFECTS - PROPOSED BUILDING PROGRAM

STATEMENT OF DETERMINATION: DOE is proposing an expansion program at ORNL. This expansion program would involve both the demolition of existing structures as well as the construction of new facilities at various locations. Due to the federal funding, DOE is required to comply with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. Regulations detailing the implementation of this act are codified at 36 CFR 800.

The NHPA requires DOE to identify any properties (either above-ground buildings, structures, objects, or historic sites or below ground archaeological sites) of historic significance. For the purposes of this legislation, historic significance is defined as those properties which are included in the National Register or which are eligible for inclusion in the National Register (National Register criteria are codified at 36 CFR 60.4). Once historic properties are identified, DOE is required to determine if they are being affected by the proposed project. If any historic properties are being affected, DOE is required to provide the Advisory Council on Historic Preservation (an independent federal agency) an opportunity to comment on those effects.

SURVEY RESULTS: It is the opinion of the HPS that the following properties at ORNL are eligible for inclusion in the National Register: (1) the ORNL Historic District, which is located in the central portion of the ORNL main facilities complex and includes facilities within the 2000 through 5000 Areas; (2) Buildings 7001 and 7002 located in the East Support Area (7000 Area); (3) Building 7503, the Aircraft Reactor Experiment Facility, now referred to as the Molten Salt Reactor Experiment Facility; (4) the Tower Shielding Facility (7700 Area), which includes Buildings 7700, 7701-7704, and 7751; and (5) White Oak Lake and Dam. The Graphite Reactor, Building 3001, is the only property located within the ORNL main facilities complex (and within the boundaries of the proposed ORNL Historic District) that is presently included in the National Register. The Graphite Reactor operated between 1943 and 1963 and was designated a National Historic

Landmark in 1966 by the National Park Service. The New Bethel Baptist Church, Building 0903, was also identified as being presently included in the National Register.

PROJECT DESCRIPTION: In order to provide adequate facilities for future missions of ORNL, ORNL has evaluated its existing facilities and assessed its needs for future programs. This analysis is contained in a 1992 report produced by ORNL entitled "ORNL Site Development Plan" [ORNL 1992b]. This plan is the basis for the discussion of effects in this chapter.

According to the ORNL Site Development Plan, "Less than 43% of ORNL's building space is deemed adequate. While approximately one-third of the Laboratory's space can be rehabilitated, 22% must be replaced" (ORNL 1992b:4). The ORNL Site Development Plan goes on to say, "ORNL's diverse projects require many types of facilities ranging from ordinary offices to highly specialized and unique laboratory facilities....However, only 40% of the laboratory space and 35% of the office space is considered adequate" (ORNL 1992b:4-5). Many experimental facilities, such as reactors and radioisotope production equipment, have reached the end of their useful life and presently require significant expense for surveillance activities as well as occupy space that could be otherwise utilized. As a result, many of the existing facilities must either be replaced or rehabilitated. In addition, "some roadways retain their pre-World War II alignment, diminishing transportation efficiency" (ORNL 1992b:5) and they need to be widened and realigned.

In addition to addressing the needs of existing sites, ORNL plans to erect three major facilities within the next fifteen years. Figure IV-1 contains a map showing these proposed construction sites. The Advanced Neutron Source (ANS) "will be the world's most powerful neutron research facility. The ANS, designed to replace ORNL's High Flux Isotope Reactor and High Flux Beam Reactor, will greatly enhance research capabilities in neutron scattering for condensed matter physics, materials science, chemistry, and biology" (ORNL 1992b:10). ANS startup is planned for fiscal year 2000. The complex, with its support facilities, utilities, roads and parking will require approximately 85 acres of land. ORNL has proposed to build this complex on the south side of Melton Valley Road on a previously undisturbed site. This site is about 2000 feet east of the Aircraft Reactor Experiment Facility (National Register eligible) and roughly halfway between it and the Experimental Gas-Cooled Reactor/Robotics and Process Systems Complex.

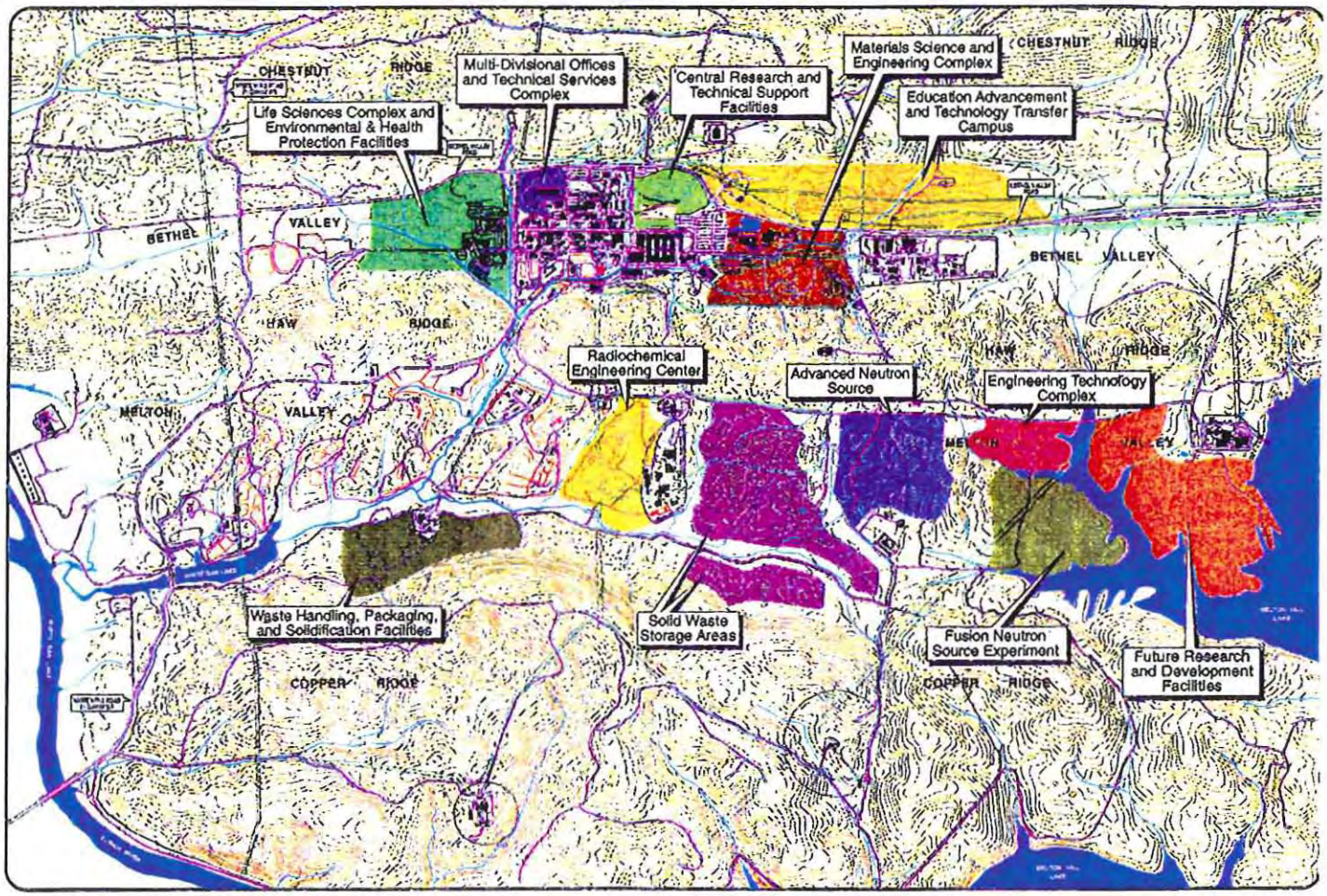


FIGURE IV-1

PROPOSED DEVELOPMENT SITES, ORNL

The second facility is the Life Sciences Complex which will be an expansion of the existing environmental complex that now exists in the 1500 Area. This complex is located immediately to the west of the ORNL main facilities complex where the proposed ORNL Historic District is located. The Life Sciences Complex "will establish an efficient, consolidated research center for biology programs, with emphasis on mammalian genetics, waste R&D [Research and Development], global sciences, and energy efficiency. The Complex will provide new laboratories for the expanding R&D needs of the Biology, Health and Safety Research, Environmental Sciences, and Energy divisions and will offer modern facilities in place of old buildings that are often crowded, inefficient, and in need of repair" (ORNL 1992b:10). This facility will occupy roughly 52 acres.

The third facility is the Materials Science and Engineering Complex (MS&E). This facility would include the existing Holifield Heavy Ion Research Facility, which is located immediately to the east of the ORNL main facilities complex which contains the proposed ORNL Historic District. The proposed facility would provide "state-of-the art research facilities for programs that address national, regional, and local needs for materials R&D. The MS&E Complex includes a new Solid State Sciences Building, a Center for Advanced Microstructural Analysis, a Center for Study of Advanced Materials, and a Composite Materials Laboratory....The Complex will also meet the critical need to replace deteriorated buildings and to alleviate severe crowding in present ORNL materials facilities" (ORNL 1992b:10). This facility will occupy about 45 acres.

In addition, ORNL has placed "high priority on three other new building projects." These three include an Advanced Computing Technology Center, a Technology Transfer Center, and a Waste Handling and Packaging Plant (ORNL 1992b:10).

Thus, as shown on previous Figure IV-1, beginning on the northwest corner and proceeding clockwise, ORNL is planning new construction in the following areas. In the 1500 Area, ORNL plans to build a new 52-acre Life Sciences Complex. This area is roughly 1,000-1,500 feet west of the proposed ORNL Historic District, and several buildings presently exist between them. Figures IV-2, IV-3, and IV-4 contain maps of the proposed development plan and the proposed ORNL Historic District. Immediately adjacent to the proposed ORNL Historic District, and containing a small portion of the proposed ORNL Historic District, is the proposed 10-acre Multi-Divisional

FIGURE IV-2

COLOR CODE SYSTEM FOR MAPS IV-3 THROUGH IV-9

OAK RIDGE NATIONAL LABORATORY

LEGEND

- Existing Building or Other Facility
- Proposed Building or Other Facility
- Improvements to Existing Facility
- Removal of Existing Facility
- Proposed Use Area
- Existing Waste Management Area
- Proposed Waste Management Area
- Existing Road or Parking Area
- Proposed Road Improvement or Addition
- Proposed Bicycle/Jogging Trail
- Proposed Walkway
- Security Fence/Portal
- Utility Corridor
- Grassland, Road Right-of-Way, or Landscape Planting Area
- Woodland Buffer
- Water Feature
- Public Cemetery

METERS
0 50 100 200 300 400
0 250 500 1000 1500
FEET

CONTOUR INTERVAL 20 FEET

NORTH
TRUE GRID

ornl

PROPOSED HISTORIC DISTRICT, SEE FIGURE IV-4

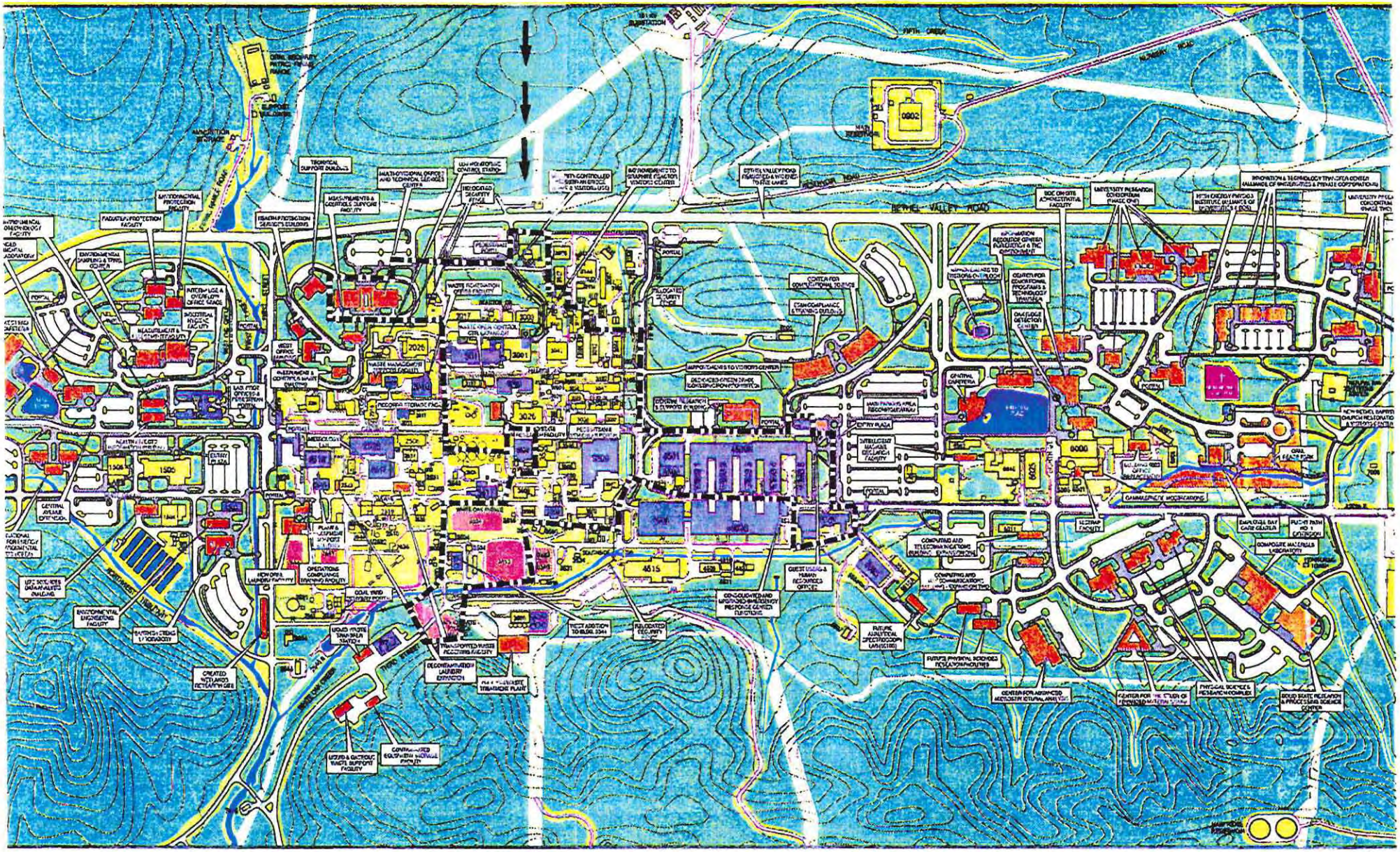


FIGURE IV-3

PROPOSED IMPROVEMENTS AT BETHEL VALLEY

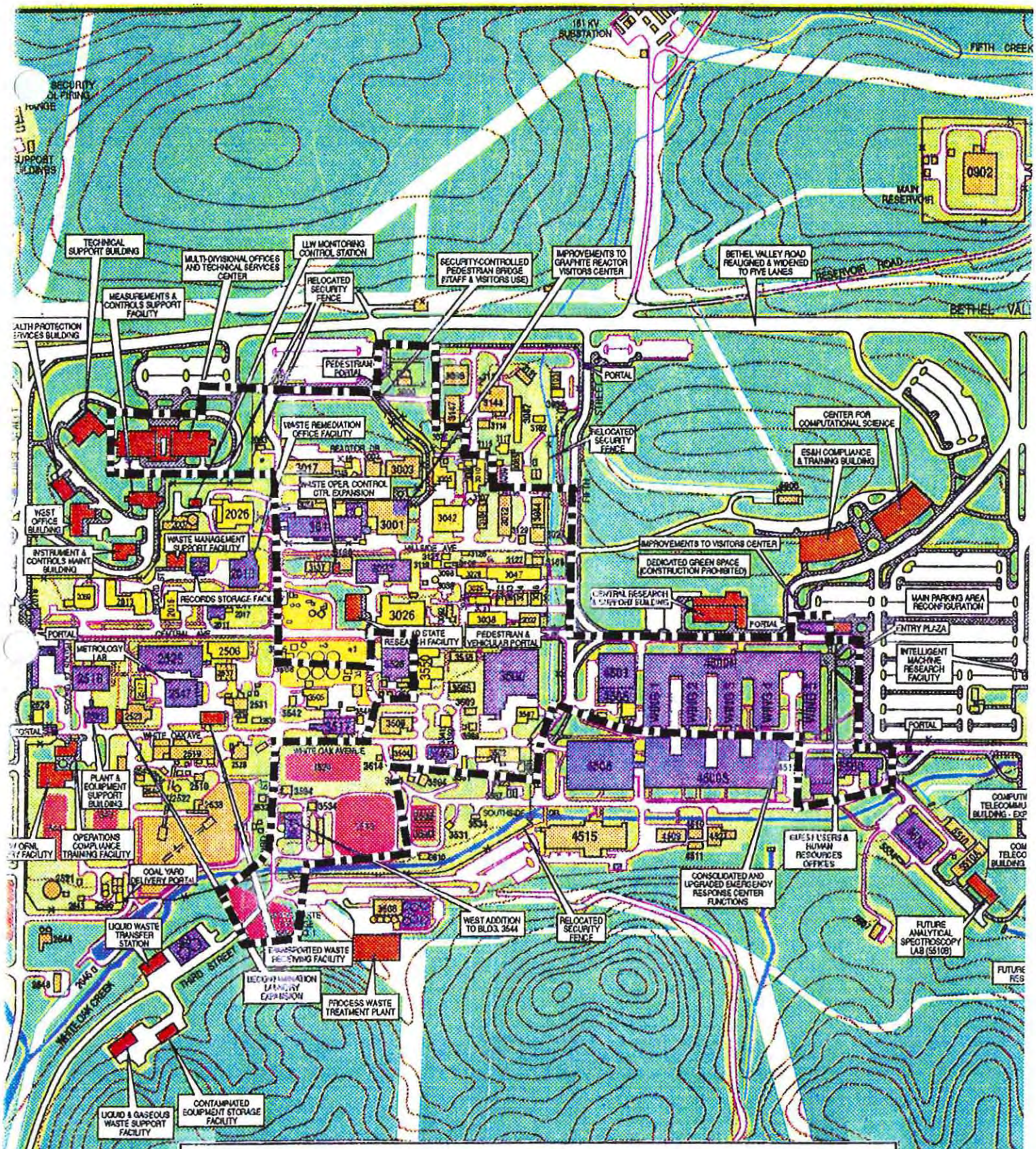


FIGURE IV-4

PROPOSED IMPROVEMENTS AT
OAK RIDGE NATIONAL LABORATORY HISTORIC DISTRICT

Offices and Technical Services Complex. As planned, this complex includes the construction of a new building on the site of two buildings that contribute to the proposed ORNL Historic District, Buildings 2000 and 2001, and would thus require their demolition. In addition, the ORNL Site Development Plan proposes to demolish several buildings within the proposed ORNL Historic District. These include the following contributing buildings: 3004, 3005, 3010, 3023, 3026, 3028, 3029, 3030, 3031, 3032, 3036, 3038, 3039, 3042, 3080, 3523, 3550, 3587, 3592, and 4507. The ORNL Site Development Plan also proposes to rehabilitate the following contributing buildings: 3019, 3025, 3500, 4501, 4500N, 5000, and 5500.

The eight-acre Central Research and Technical Support Facilities complex is located to the northeast of the proposed ORNL Historic District. The MS&E Complex is located to the east of the proposed ORNL Historic District around the existing Holifield Heavy Ion Research Facility. The Education Advancement and Technology Transfer Campus is located to the northeast of the ORNL main facilities complex on the north side of Bethel Valley Road opposite the Holifield Heavy Ion Research Facility and the East Support Area. Figure IV-5 contains a map showing this area. This proposed site presently contains the National Register included New Bethel Baptist Church and Cemetery, which would remain but would be surrounded by the proposed facility. The ORNL Site Development Plan includes limited demolition within the East Support Area and continued use of Buildings 7001 and 7002, which in the opinion of the HPS are eligible for inclusion in the National Register; see Figure IV-6.

The Future Research and Development Facilities, the Engineering Technology Complex, the Fusion Neutron Source Experiment, the Advanced Neutron Source facility, proposed Solid Waste Storage Areas, and the Radiochemical Engineering Center are located on the south side of Melton Valley Drive. The only historic property in this area is the Aircraft Reactor Experiment Facility, Building 7503, which is located between the Radiochemical Engineering Center and the Solid Waste Storage Areas; see Figure IV-7. The ORNL Site Development Plan proposes to demolish the Aircraft Reactor Experiment Facility, Building 7503. The last area shown on Figure IV-1 is the Waste Handling, Packaging, and Solidification Facilities near the existing Old and New Hydrofracture Facilities. It is located to the east of White Oak Lake and Dam which are eligible for inclusion in the National Register in the opinion of the HPS. It is also proposed to widen and relocate State Route 95 and Bethel Valley Road. The ORNL Site Development Plan does not propose any work to the White Oak Lake and Dam except to bypass the property leaving it intact; see Figure IV-8.

FIGURE IV-5

PROPOSED IMPROVEMENTS NEAR NEW BETHEL CHURCH

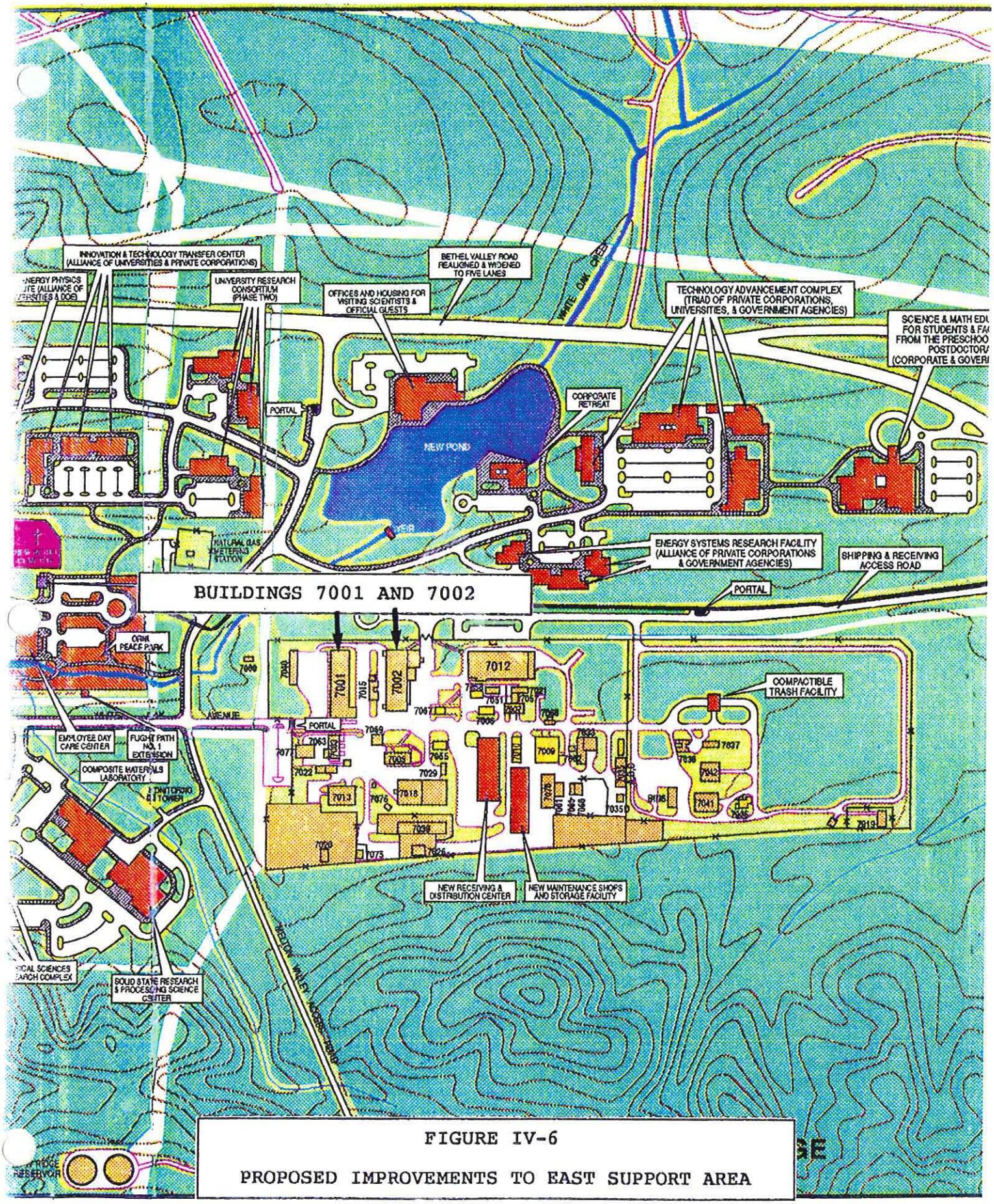


FIGURE IV-6

PROPOSED IMPROVEMENTS TO EAST SUPPORT AREA

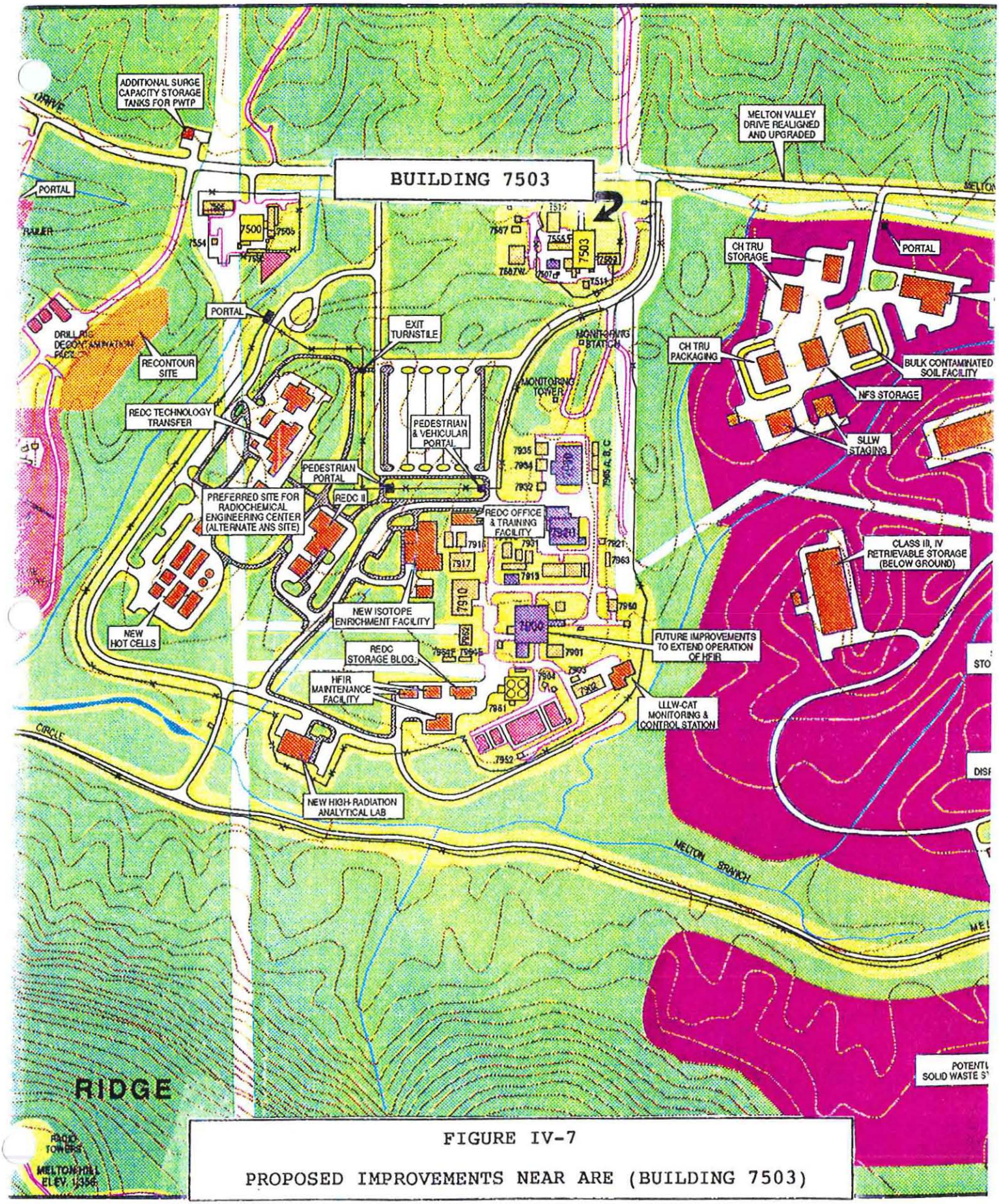


FIGURE IV-7

PROPOSED IMPROVEMENTS NEAR ARE (BUILDING 7503)

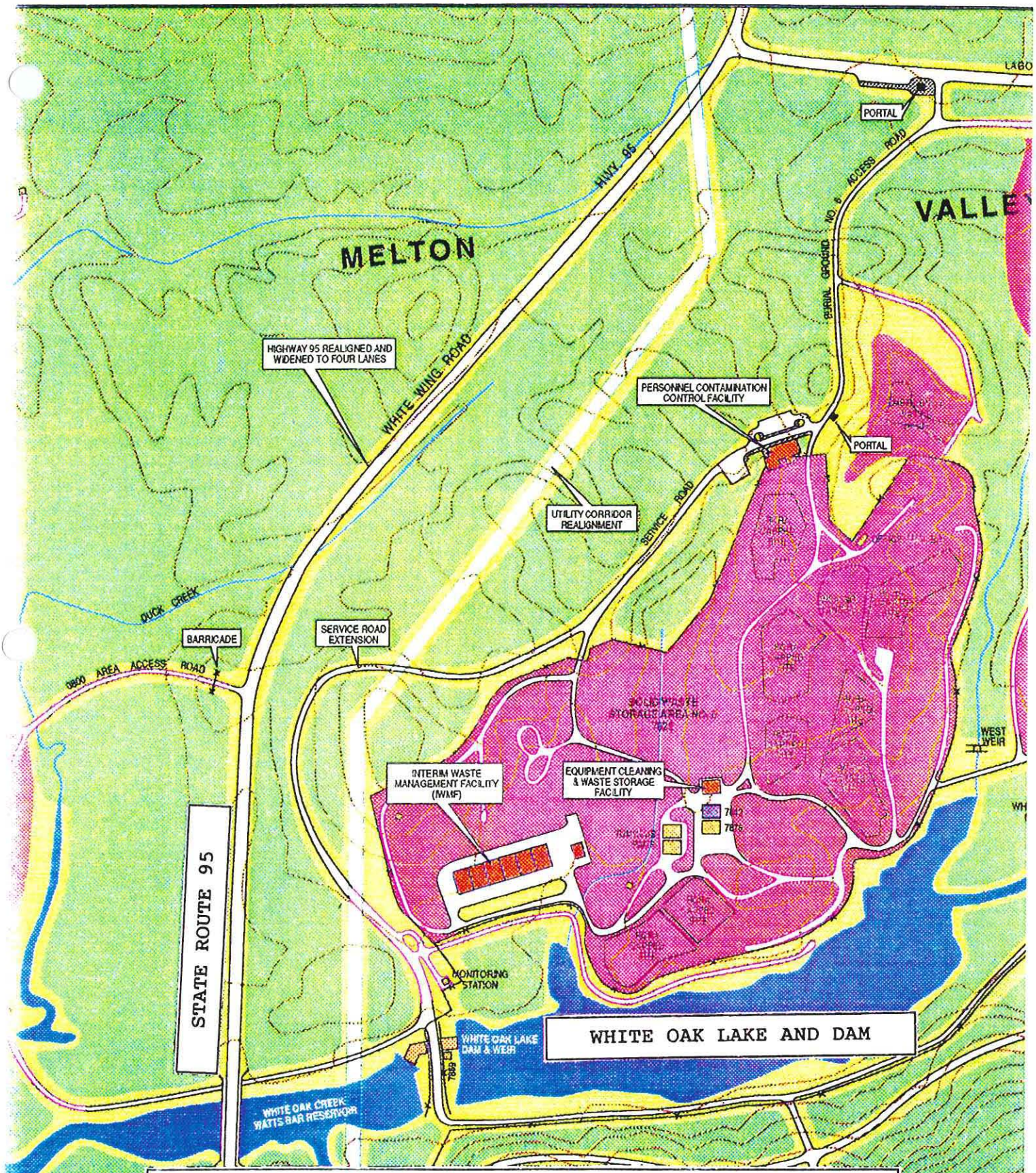


FIGURE IV-8

PROPOSED IMPROVEMENTS TO SR-95 AT WHITE OAK LAKE & DAM

The ORNL Site Development Plan proposes to renovate the Tower Shielding Facility, which in the opinion of the HPS is eligible for inclusion in the National Register, for continued use; see Figure IV-9.

DISCUSSION OF EFFECTS: The HPS was directed to assess effects from new construction as defined in the ORNL Site Development Plan to historic properties identified through this survey. Based on information in this report, it is the HPS's opinion that the proposed expansion program, will have an adverse effect to the proposed ORNL Historic District, the New Bethel Baptist Church, and the ARE. It is the HPS's opinion that the proposed expansion program, as presently defined, will have no adverse effect to the Tower Shielding Facility. It is the HPS's opinion that the proposed expansion program, as presently defined, will have no effect to Buildings 7001 and 7002 in the East Support Area and to the White Oak Lake and Dam.

The geographical setting of ORNL in Bethel Valley is given in detail in other sections of this report. To briefly recap this context, ORNL is sited in an area that was chosen for its geographical isolation and for its trademark ridge and valley topography. ORNL is located on a cleared valley floor surrounded by steep hills. Over the years, ORNL has built other facilities in the Bethel Valley area and still others in surrounding valleys. Only limited development has occurred on the hillsides.

The setting consists of an isolated rural valley with industrial, office, and support facilities concentrated on the cleared valley floor surrounded by steep hillsides covered with forests. This historic setting is related to two historical trends. The first concerns the general tendency of industrial facilities to utilize the more valuable cleared valley floors for their key buildings. The second is that the key sites in the Manhattan Project were deliberately located in isolated valleys in rural settings. Thus, the cleared valley floor setting surrounded by forested hillsides is an essential component of the property's setting, and due to the evolving nature of the property, in the opinion of the HPS, this element is one of the few key setting issues.

It is the opinion of the HPS that, in general, the construction of the new complexes around the property constitutes no effect to the historic properties. It is the HPS's opinion that the no effect determination is dependent on new construction being sited along the valley floors and not on the hillsides due to the importance of the cleared

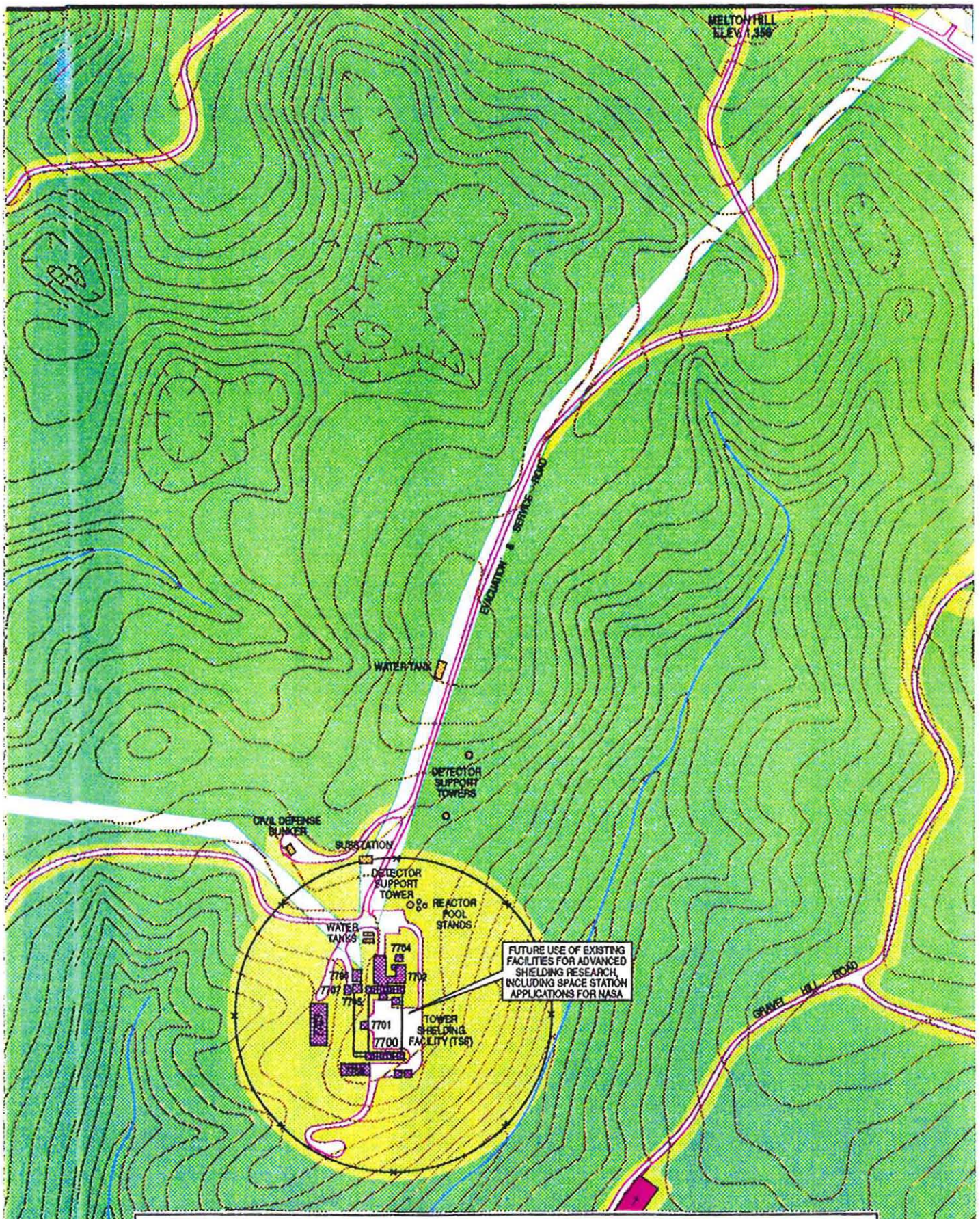


FIGURE IV-9

PROPOSED IMPROVEMENTS TO TOWER SHIELDING FACILITY

valley floor setting. It is also dependent on the new complexes being less than approximately three stories in height except when technological features require taller structures (such as the existing stacks). This height requirement can vary in the outlying areas depending on the topography and siting. The objective is to avoid towering skyscrapers that would mar the hillside vistas of the ridge and valley setting. Construction of new complexes is not in and of itself a problem, the only issue is doing it in such a way that it preserves the ridge and valley setting of the properties.

Potential effects related to activities proposed in the ORNL Site Development Plan are given below for each property included in or identified by the HPS as eligible for inclusion in the National Register. The text of Criteria of Effect and Adverse Effect which is used in the Section 106 process to define effects is given below:

800.9 Criteria of Effect and Adverse Effect

(a) An undertaking has an effect on a historic property when the undertaking may alter characteristics of the property that may qualify the property for inclusion in the National Register. For the purpose of determining effect, alteration to features of the property's location, setting or use may be relevant depending on a property's significant characteristics and should be considered.

(b) An undertaking is considered to have an adverse effect when the effect on a historic property may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties include, but are not limited to:

(1) Physical destruction, damage, or alteration of all or part of the property;

(2) Isolation of the property from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register;

(3) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;

(4) Neglect of a property resulting in its deterioration or destruction; and

(5) Transfer, lease, or sale of the property.

(c) Effects of an undertaking that would otherwise be found to be adverse may be considered as being not adverse for the purpose of these regulations:

(1) When the historic property is of value only for its potential contribution to archeological, historical, or architectural research, and when such value can be substantially preserved through the conduct of appropriate research, and such research is conducted in accordance with applicable professional standards and guidelines;

(2) When the undertaking is limited to the rehabilitation of buildings and structures and is conducted in a manner that preserves the historical and architectural value of affected historic property through conformance with the Secretary's "Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings"; or

(3) When the undertaking is limited to the transfer, lease, or sale of a historic property, and adequate restrictions or conditions are included to ensure preservation of the property's significant features.

OAK RIDGE NATIONAL LABORATORY HISTORIC DISTRICT: The ORNL main facilities complex and surrounding facilities are of an industrial and functional nature. The initial development during the 1943-1945 period occurred quickly, and it was believed that it would be temporary. The primary concerted building effort for permanent buildings was Program H between 1949 and the early 1950s. Several of these buildings reflect a conscious design and layout, such as Building 4500N and the buildings on Isotope Circle. Some of the later buildings in the immediate vicinity of these buildings, such as Building 4500S, also reflect a conscious design effort to blend with these earlier substantial brick buildings. Although some of the streets within the complex are laid out in a grid pattern, and buildings tend to front directly onto these streets, to a large degree, development was random both in

the layout of the buildings and in their design. In general, buildings throughout the ORNL main facilities complex vary tremendously in size and scale, but most tend be rambling low-scale structures one, two, or three stories in height. Although many of the more prominent buildings from the 1950s are of brick construction, exterior materials on many of the contributing buildings vary greatly. Existing buildings tend to be functional with little or no ornamentation.

Many non-historic buildings are situated around the edge of the proposed ORNL Historic District and serve as a buffer between it and new construction. Even so, much of the new development would be visible from the historic district. However, ORNL itself has seen many construction activities over the years, and the evolving nature of it as a research facility is tied to new and evolving construction projects. In a sense, new construction to expand research opportunities is part of the significance of the property. Thus, it is the opinion of the HPS that new buildings in and of themselves do not affect the setting of the proposed ORNL Historic District.

If the design of the new buildings in the immediate vicinity of the proposed ORNL Historic District are consistent with the existing buildings in materials, size, scale, and design, it is the opinion of the HPS that the new construction component of the proposed building program would have no adverse effect to the proposed ORNL Historic District. As discussed above, a wide variety of building materials exist in the proposed district although brick is a predominant material. The size and scale are of particular importance, and the new buildings at the ORNL main facilities complex should be no taller than three stories. The design of most of the buildings is plain and functional in nature. New design should be similar. For instance, the Oak Ridge City Hall is an excellent example of Post-Modern design at its location on the Oak Ridge Turnpike in Oak Ridge, but it is the opinion of the HPS that the same design would be inappropriate at ORNL.

While the new construction can be viewed as not adversely affecting the proposed ORNL Historic District, it is the opinion of the HPS that widening Bethel Valley Road to five lanes would be an adverse effect to the proposed ORNL Historic District. The existing two-lane road conforms to the rural ridge and valley setting and widening it to five lanes would alter a feature of the property's setting which contributes to its National Register eligibility [36 CFR 800.9(b)(2)], and which would introduce a facility out of character with its setting [36 CFR 800.9(b)(3)].

The most detrimental effect to the proposed ORNL Historic District is the proposed demolition of several contributing properties, an adverse effect under 36 CFR 800(b)(1). Several of these buildings are considered key or pivotal buildings within the proposed district (for instance, Buildings 3004, 3005, 3010, 3026, 3028, 3029, 3030, 3031, 3032, 3036, 3038, 3042, and 3550). Although the demolition of one or even a few of these buildings would not necessarily result in the entire historic district no longer being eligible, it is the opinion of the HPS that such wide-scale demolition within the heart of the proposed ORNL Historic District could result in the district no longer being eligible. However, it would be the opinion of the HPS that some of the remaining buildings would be individually eligible.

The ORNL Site Development Plan includes the renovation of several contributing buildings in the proposed ORNL Historic District. If the proposed renovations meet the Secretary of the Interior's "Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings," this work would constitute no adverse effect to the proposed ORNL Historic District [36 CFR 800.9(c)(2)].

NEW BETHEL BAPTIST CHURCH AND CEMETERY: The New Bethel Baptist Church and Cemetery are located on the north side of Bethel Valley Road. The period of significance for the New Bethel Baptist Church extends through 1949, and to a certain degree, its 1949 setting is somewhat intact. Although much of the existing ORNL was built after 1949, ORNL was begun during the church's period of significance. Thus, ORNL itself is not intrusive to the setting of the church, and limited new construction at the ORNL main facilities complex on the south side of Bethel Valley Road would not affect the setting of the church.

However, the ORNL Site Development Plan, as shown on previous Figure IV-5, contains extensive development on the north side of the existing Bethel Valley Road that would completely surround the church. It is the opinion of the HPS that construction of these buildings would be an adverse effect to the church. The existing open space around the church contributes to the rural ridge and valley setting, and the extensive construction of new buildings around the church would alter a feature of the property's setting which contributes to its National Register eligibility [36 CFR 800.9(b)(2)], and which would introduce facilities out of character with the church's setting [36 CFR 800.9(b)(3)].

The ORNL Site Development Plan includes the relocation of Bethel Valley Road from in front of the church to behind

the church to the north. The ORNL Site Development Plan proposes to widen the existing two lane road to five lanes. It is the opinion of the HPS that removing the existing road, realigning the road, and widening it to five lanes would be an adverse effect to the church. The existing two-lane road conforms to the rural ridge and valley setting and widening it to five lanes would alter a feature of the property's setting which contributes to its National Register eligibility [36 CFR 800.9(b)(2)], and which would introduce a facility out of character with its setting [36 CFR 800.9(b)(3)].

BUILDINGS 7001 AND 7002, EAST SUPPORT AREA: The ORNL Site Development Plan proposes to continue using Buildings 7001 and 7002, which are key buildings in the East Support Area. Although the ORNL Site Development Plan includes limited demolition for a few of the smaller buildings in the East Support Area (see previous Figure IV-6), and the construction of three new buildings, the ORNL Site Development Plan proposes few changes to the facility and includes its continued use as a support area, the key element of setting for Buildings 7001 and 7002. Although new construction will occur to the north of the East Support Area, as discussed above, it is the opinion of the HPS that new construction in and of itself would not be an effect. It is the opinion of the HPS that as long as the new construction within the East Support Area is comparable in scale and massing with the existing buildings that the proposed plan would have no effect to Buildings 7001 and 7002.

AIRCRAFT REACTOR EXPERIMENT FACILITY, BUILDING 7503: The ORNL Site Development Plan contains new construction to the east, south, and west of Building 7503 (see previous Figure IV-7). However, as discussed above, it is the opinion of the HPS that new construction in and of itself would not be an effect as long as it is generally not above three stories in height (depending on the specific topography of the site). The ORNL Site Development Plan proposes minor realignments and improvements to Melton Valley Drive, and it is the opinion of the HPS that this work would not affect Building 7503. However, the ORNL Site Development Plan proposes to demolish Building 7503, an adverse effect under 36 CFR 800.9(b)(1).

WHITE OAK LAKE AND DAM, STRUCTURE 7846: The ORNL Site Development Plan proposes to widen State Route 95 from two to five lanes and relocate it to the west of its existing alignment over White Oak Dam (see previous Figure IV-8). Once State Route 95 is realigned, the existing roadway over the dam will become a service road. It is the opinion of the HPS that this work will have no effect to the White Oak Lake and Dam.

TOWER SHIELDING FACILITY, 7700 AREA: The proposed plan includes the renovation of the Tower Shielding Facility for "advanced shielding research including space station applications for NASA" (see previous Figure IV-9). This property presently maintains a high degree of integrity, and its setting is intact. If the proposed renovations meets the Secretary of the Interior's "Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings," this work would constitute no adverse effect to the Tower Shielding Facility [36 CFR 800.9(c)(2)].

SUMMARY: The expansion of ORNL in and of itself is not necessarily an adverse effect to the historic properties at ORNL. The key issue is to expand the facility in a manner that maintains the historic integrity of the properties and their historic setting. Thus, the overall expansion program is not as much an issue as the individual components of that program. It is the opinion of the HPS that under Section 106, if the design for specific components of the proposed expansion program meets the criteria discussed above, the expansion program would have no effect to Buildings 7001 and 7002 and to the White Oak Lake and Dam. The proposed program would have no adverse effect to the Tower Shielding Facility. The proposed development program would have an adverse effect to the proposed ORNL Historic District, the New Bethel Baptist Church, and the Aircraft Reactor Experiment Facility.

CHAPTER V: CONCLUSIONS

DOE is required by the NHPA to identify any properties under its jurisdiction that are included in and eligible for inclusion in the National Register. In March 1993 DuVall & Associates, Inc., was engaged to survey ORNL, a DOE facility located on the ORR in Anderson and Roane counties, Tennessee, and to prepare a determination of National Register eligibility for all ORNL properties. Before beginning field work, the HPS contacted the TN-SHPO and requested information about any properties in the vicinity of ORNL that are presently included or have been determined to be eligible for inclusion in the National Register. The HPS determined that one resource at ORNL is presently included in the National Register, the Graphite Reactor, which is a National Historic Landmark. Also, the TN-SHPO had determined at a consensus level that Stack 2061 is eligible for inclusion in the National Register. In addition, a preservation firm had prepared a cover nomination for the City of Oak Ridge in 1991. The New Bethel Baptist Church and Cemetery, which is located north of Bethel Valley Road east of the ORNL main facilities complex, was included in the National Register as part of this nomination.

The HPS then initiated field surveys, oral interviews, and research in available ORNL histories and records. After carefully analyzing the available material, it is the opinion of the HPS that the period of significance for ORNL should extend through 1957. Within this context, it is the opinion of the HPS that the following properties at ORNL are eligible for inclusion in the National Register of Historic Places: (1) the ORNL Historic District within the 2000 through 5000 Areas of the ORNL main facilities complex; (2) Buildings 7001 and 7002 in the East Support Area; (3) Building 7503, originally named the Aircraft Reactor Experiment Facility; (4) the TSF complex including Buildings 7700, 7701, 7702, 7703, and 7704 at the TSF and Building 7751, the TSF guard portal on State Route 95; and (5) White Oak Lake and Dam on State Route 95. It is the opinion of the HPS that the ORNL Historic District appears to be eligible under Criterion A for its historical associations with the Manhattan Project, ORNL's development as a national laboratory within the overall post-World War II government sponsored scientific movement, and for early nuclear research. It is also the opinion of the HPS that the Oak Ridge National Laboratory appears to be eligible under Criterion C for the engineering merits of many of the properties within the proposed district and for their contributions to scientific research. The Graphite Reactor, a National Historic Landmark, is located within the proposed district. It is the opinion of the HPS that Building 7001

and Building 7002 appear to be individually eligible for inclusion in the National Register under Criterion A for their association with the Program H building expansion and the development of ORNL. It is the opinion of the HPS that Building 7503, the ARE, appears to be eligible for inclusion in the National Register under Criterion A for its association with the Aircraft Nuclear Propulsion Project. It is the opinion of the HPS that the TSF is eligible for inclusion in the National Register as a discontiguous district under Criterion A for its associations with the Proposed ORNL Historic District as well as under Criterion C for the engineering merits of the TSF. It is the opinion of the HPS that the White Oak Lake and Dam appear to be eligible under Criterion A for their association with early nuclear waste disposal methods.

Most of the properties evaluated during this survey do not meet the 50-year age criterion of the National Register program and, thus, have to meet the criterion of exceptional significance under Criteria Consideration G. As some of the properties determined not eligible during this survey become 50 years old, for instance the 1948 Main Reservoir in the 0900 area or some of the 1948 to 1952 support facilities in the 7000 Area, their National Register eligibility should be re-evaluated. Also, other properties may need to be re-evaluated if additional scholarly research in this field is published which provides an adequate context to evaluate National Register eligibility. In general, the National Register eligibility of an evolving property such as ORNL should be periodically re-evaluated, for instance, every 10 years.

In 1992, ORNL prepared the "ORNL Site Development Plan." Based on this plan, it is the opinion of the HPS that the expansion of ORNL, in and of itself, is not necessarily an adverse effect to the historic properties at ORNL. The key issue is to expand ORNL in a manner that maintains the historic integrity of the properties and their historic setting. Thus, the overall issue of an expansion program is not as much an issue as the individual components of that program. It is the opinion of the HPS that under Section 106 of the NHPA, if the design for specific components of the proposed expansion program meets the criteria discussed in Chapter IV, the expansion program would have no effect to Buildings 7001 and 7002 and to the White Oak Lake and Dam. The proposed expansion program would have no adverse effect to the TSF. The proposed expansion program would have an adverse effect to the ORNL Historic District, the New Bethel Baptist Church and Cemetery, and to the ARE.

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APPENDICES

APPENDIX A

HISTORIC PRESERVATION SPECIALISTS RESUMES

MARTHA A. CARVER
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EMPLOYMENT HISTORY

CONSULTANT, Duvall and Associates, Environmental Consultants, Nashville, Tennessee 1984 - Present

Employed as a consultant on an as-needed basis to undertake cultural resource inventories and to prepare written architectural/historical assessments to determine National Register eligibility/non-eligibility; prepared HABS/HAER documentation; have done projects for U.S. Army Corps of Engineers and Kentucky Department of Transportation.

HISTORIC PRESERVATION SUPERVISOR, Tennessee Department of Transportation, Nashville, Tennessee 1980 - Present

Supervises coordination of efforts required by state and federal preservation laws; involves general field surveys, historical and architectural assessments to determine National Register eligibility/non-eligibility, effect reports pursuant to Public Law 699 and 36 CFR 800, Section 4(f) documentation, and documentation for federally required environmental reports; preparation of HAER/HABS documentation, coordination of state-wide survey of potentially historic metal truss, concrete arch, suspension, metal arch and masonry arch bridges.

PRESERVATION PLANNER, Chattanooga-Hamilton County Regional Planning Commission, Chattanooga, Tennessee (1978 - 1980)

Prepared National Register nominations (experience in nominations for individual residential and commercial properties, residential and commercial districts, thematic groupings, and exceptional properties such as buildings less than fifty years old, cemeteries, religious buildings, and objects such as locomotives, railway equipment and statues); worked with compliance of federal regulations regarding properties eligible for the National Register (involved preparing determinations of eligibility and documentations of effect); prepared grant applications; worked with tax program for the rehabilitation of historic properties; organized survey work of historic sites; prepared walking/driving tours.

EDUCATION

David Lipscomb College, Nashville, Tennessee

Field: History, Education
Degree: **B.A. in History and Education**, 1975

Middle Tennessee State University, Murfreesboro, Tennessee

Field: History, Historic Preservation
Degree: **M.A. in History** with emphasis in Historic Preservation, 1979

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MARGARET JANE SLATER

1833 Welcome Lane
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EMPLOYMENT HISTORY

PRESERVATION CONSULTANT, Duvall and Associates, Environmental Consultants, Nashville, Tennessee. 1985 - Present

COMMUNITY PLANNER, Metropolitan Development and Housing Agency, Nashville, Tennessee. April 1990 - Present

PLANNER, Metropolitan Nashville-Davidson County Planning Commission, Nashville, Tennessee. January 1989 - April 1990

HISTORIC PRESERVATION PLANNER, Tennessee Department of Transportation, Nashville, Tennessee. June 1984 - December 1988

PRESERVATION INTERN, Vermont Division for Historic Preservation, SHPO, Montpelier, Vermont. Summer 1983

PRESERVATION INTERN, Michigan History Division, SHPO, Lansing, Michigan Summer 1982

PRESERVATION CONSULTANT, Michigan State University, East Lansing, Michigan. Fall 1981

OTHER EMPLOYMENT, Ten years in the retail field in Lansing, Michigan and five years as a private consultant preparing National Register nominations.

EDUCATION

Lansing Community College, Lansing, Michigan

Field: Art History, History
Degree: **A.A. in Liberal Arts**, 1979

Michigan State University, East Lansing, Michigan

Field: Art History, Planning, Historic Preservation
Degree: **B.A. in Art History with honors**, 1981

Middle Tennessee State University, Murfreesboro, Tennessee

Field: History, Historic Preservation Planning
Thesis: Rural Schoolhouse Architecture in Tennessee
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APPENDIX B

SECTION 110 SHEET

SECTION 106 FACT SHEET

NATIONAL REGISTER CRITERIA

CRITERIA OF EFFECT AND ADVERSE EFFECT

Section 110 *(16 U.S.C. 470h-2)*

(a) (1) The heads of all Federal agencies shall assume responsibility for the preservation of historic properties which are owned or controlled by such agency. Prior to acquiring, constructing, or leasing buildings for purposes of carrying out agency responsibilities, each Federal agency shall use, to the maximum extent feasible, historic properties available to the agency. Each agency shall undertake, consistent with the preservation of such properties and the mission of the agency and the professional standards established pursuant to section 101~~(f)~~*(g)*, any preservation, as may be necessary to carry out this section.

(2) Each Federal agency shall establish (unless exempted pursuant to Section 214), in consultation with the Secretary, a preservation program for the identification, evaluation, and nomination to the National Register of Historic Places, and protection of historic properties. Such program shall ensure-

(A) that historic properties under the jurisdiction or control of the agency, are identified, evaluated, and nominated to the National Register;

(B) that such properties under the jurisdiction or control of the agency as are listed in or may be eligible for the National Register are managed and maintained in a way that considers the preservation of their historic, archaeological, architectural, and cultural values in compliance with section 106, and gives special consideration to the preservation of such values in the case of properties designated as having National significance;

(C) that the preservation of properties not under the jurisdiction or control of the agency, but subject to be potentially affected by agency actions are given full consideration in planning;

(D) that the agency's preservation-related activities are carried out in consultation with other Federal, State, and local agencies, Indian tribes, Native Hawaiian organizations carrying out historic preservation planning activities, and with the private sector; and

(E) that the agency's procedures for compliance with section 106-

(i) are consistent with regulations issued by the Council pursuant to section 211;

(ii) provide a process for the identification and evaluation of historic properties for listing in the National Register and the development and implementation of agreements, in consultation with State Historic Preservation Officers, local governments, Indian tribes, Native Hawaiian organizations, and the interested public, as appropriate, regarding the means by which adverse effects on such properties will be considered; and

(iii) provide for the disposition of Native American cultural items from Federal or tribal land in a manner consistent with section 3(c) of the Native American Grave Protection and Repatriation Act (25 U.S.C. 3002(c)).

(b) Each Federal agency shall initiate measures to assure that where, as a result of Federal action or assistance carried out by such agency, an historic property is to be substantially altered or demolished, timely steps are taken to make or have made appropriate records, and that such records then be deposited, in accordance with section 101(a), in the Library of Congress or with such other appropriate agency as may be designated by the Secretary, for future use and reference.

(c) The head of each Federal agency shall, unless exempted under section 214, designate a qualified official to be known as the agency's "preservation officer" who shall be responsible for coordinating that agency's activities under this Act. Each Preservation Officer may, in order to be considered qualified, satisfactorily complete an appropriate training program established by the Secretary under section 101(*h*).

(d) Consistent with the agency's mission and mandates, all Federal agencies shall carry out agency programs and projects (including those under which any Federal assistance is provided or any Federal license, permit, or other approval is required) in accordance with the purposes of this Act and, give consideration to programs and projects which will further the purposes of this Act.

(e) The Secretary shall review and approve the plans of transferees of surplus federally owned historic properties not later than ninety days after his receipt of such plans to ensure that the prehistorical, historical, architectural, or culturally significant values will be preserved or enhanced.

(f) Prior to the approval of any Federal undertaking which may directly and adversely affect any National Historic Landmark, the head of the responsible Federal agency shall, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to such landmark, and shall afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking.

(g) Each Federal agency may include the costs of preservation activities of such agency under this Act as eligible project costs in all undertakings of such agency or assisted by such agency. The eligible project costs may also include amounts paid by a Federal agency to any State to be used in carrying out such preservation responsibilities of the Federal agency under this Act, and reasonable costs may be charged to Federal licensees and permittees as a condition to the issuance of such license or permit.

(h) The Secretary shall establish an annual preservation awards program under which he may make monetary awards in amounts not to exceed $1,000 and provide citations for special achievements to officers and employees of Federal, State, and certified local governments in recognition of their outstanding contributions to the preservation of historic resources. Such program may include the issuance of annual awards by the president of the United States to any citizen of the United States recommended for such award by the Secretary.

(i) Nothing in this Act shall be construed to require the preparation of an environmental impact statement where such a statement would not otherwise be required under the National Environmental Policy Act of 1969, and nothing is this Act shall be construed to provide any exemption from any requirement respecting the preparation of such a statement under such Act.

(j) The Secretary shall promulgate regulations under which the requirements of this section may be waived in whole or in part in the event of a major natural disaster or an imminent threat to the national security.

(k) Each Federal agency shall ensure that the agency will not grant a loan, loan guarantee, permit, license, or other assistance to an applicant who, with intent to avoid the requirements of section 106, has intentionally significantly adversely affected a historic property to which the grant would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the agency, after consultation with the Council, determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant.

(l) With respect to any undertaking subject to section 106 which adversely affects any property included in or eligible for inclusion in the National Register, and for which a Federal agency has not entered into an agreement with the Council, the head of such agency shall document any decision made pursuant to section 106. The head of such agency may not delegate his or her responsibilities pursuant to such section. Where a section 106 memorandum of agreement has been executed with respect to an undertaking, such memorandum shall govern the undertaking and all of its parts.

WHAT IS "SECTION 106 REVIEW?"

Section 106 of the National Historic Preservation Act requires that Federal agencies consider what effects their actions, and actions they may assist, permit, or license, may have on historic properties, and that they give the Advisory Council on Historic Preservation a "reasonable opportunity to comment" on such actions.

The Advisory Council is an independent Federal agency. Its role in the review of actions under Section 106 is to encourage agencies to consider, and where feasible adopt, measures that will preserve historic properties that would otherwise be damaged or destroyed. The Council's regulations, entitled "Protection of Historic Properties" (36 CFR Part 800), govern the Section 106 process. The Council does not have the authority to require agencies to halt or abandon projects that will affect historic properties.

Section 106 applies to properties that have been listed in the National Register of Historic Places, properties that have been determined to be eligible for inclusion in the Register, and properties that may be eligible but have not yet been evaluated. If a property has not yet been nominated to the Register or determined eligible for inclusion, it is the responsibility of the Federal agency involved to ascertain its eligibility.

The Section 106 Process in a Nutshell

The Council's regulations are set forth in a process consisting of five basic steps, as follows:

Identification and evaluation: The Federal agency responsible for the action identifies the historic properties (if any) that exist in the area to be affected. Identification involves assessing the adequacy of existing survey data, inventories, and other information on the area's historic properties, conducting further studies as needed, consulting with the SHPO, local governments, and other interested parties, and documenting the results of the identification effort. If properties are found that may be eligible for the National Register but have not been listed or determined eligible for listing, the agency consults with the SHPO and, if needed, the Keeper of the National Register to determine eligibility or ineligibility.

Effect determination If properties in, or eligible for, the Register exist in the area that may be affected by the action, the agency consults with the SHPO in determining what effect the action will have on them. The agency may find that the action will have no effect on historic properties, no adverse effect on such properties, or adverse effects on them. Local governments and interested members of the public are to be informed of these findings.

The regulations provide specific criteria for determining whether an action will have an effect, and whether the effect will be adverse. Generally, if the action may alter the characteristics that make a property eligible for the National Register, it is held to have an effect, and if the alterations may be detrimental to those characteristics, including relevant qualities of the property's environment or use, they are held to be adverse.

Consultation: If the action will have an adverse effect, the agency consults with the SHPO, other interested persons, and sometimes the Advisory Council, to seek agreement on ways to avoid or reduce the effects. Local governments, Indian tribes, affected property owners, and others concerned should be involved in the consultation, and the public should be given the opportunity to express their views. Local governments must be invited to participate in consultation regarding effects on historic properties within their jurisdictions, if they so request.

If agreement is reached, a Memorandum of Agreement (MOA) is drawn up and signed. If agreement cannot be reached, the formal comments of the Council are requested.

Agreement and Council comment: Acceptance of a MOA by the Council and implementation of its terms by, or at the direction of, the Federal agency satisfies the requirement of Section 106 that the Council be "given a reasonable opportunity to comment;" it also demonstrates that the agency has "taken into account" the effects of the action. If no agreement is reached, the comments of the Council are sent formally to the head of the agency.

Proceed: Having obtained the Council's comments, the agency either carries out the terms of the MOA or considers the formal comments in making its final decisions about whether and how to proceed with the action.

ELIGIBILITY CRITERIA FOR THE NATIONAL REGISTER OF HISTORIC PLACES AS SET FORTH IN 36 CFR 60.4

The quality of *significance* in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. that are associated with events that have made a significant contribution to the broad patterns of our history; or

B. that are associated with the lives of persons significant in our past; or

C. that embody the distinctive characteristic of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. that have yielded, or may be likely to yield, information important in prehistory or history.

Ordinarily cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years *shall not be considered eligible* for the National Register. However, such properties *will qualify* if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

A. a religious property deriving primary significance from architectural or artistic distinction or historical importance; or

B. a building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

C. a birthplace or grave of a historical figure of outstanding importance if there is no other appropriate site or building directly associated with his productive life; or

D. a cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

E. a reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

F. a property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own historical significance; or

G. a property achieving significance within the past 50 years if it is of exceptional importance.

REGULATIONS SET FORTH IN 36 CFR 800 BY THE ADVISORY COUNCIL ON HISTORIC PRESERVATION DEFINE WHAT CONSTITUTES AN EFFECT AND IF THAT EFFECT IS ADVERSE. THESE REGULATIONS AS CONTAINED IN 36 CFR 800.9 ARE GIVEN BELOW.

800.9 Criteria of Effect and Adverse Effect.

(a) An undertaking has an effect on a historic property when the undertaking may alter characteristics of the property that may qualify the property for inclusion in the National Register. For the purpose of determining effect, alteration to features of the property's location, setting, or use may be relevant depending on a property's significant characteristics and should be considered.

(b) An undertaking is considered to have an adverse effect when the effect on a historic property may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties include, but are not limited to:

(1) Physical destruction, damage, or alteration of all or part of the property;

(2) Isolation of the property from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register;

(3) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;

(4) Neglect of a property resulting in its deterioration or destruction; and

(5) Transfer, lease, or sale of the property.

(c) Effects of an undertaking that would otherwise be found to be adverse may be considered as being not adverse for the purpose of these regulations:

(1) When the historic property is of value only for its potential contribution to archeological, historical, or architectural research, and when such value can be substantially preserved through the conduct of appropriate research, and such research is conducted in accordance with applicable professional standards and guidelines;

(2) When the undertaking is limited to the rehabilitation of buildings and structures and is conducted in a manner that preserves the historical and architectural value of affected historic property through conformance with the Secretary's "Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings"; or

(3) When the undertaking is limited to the transfer, lease, or sale of a historic property, and adequate restrictions or conditions are included to ensure preservation of the property's significant historic features.

APPENDIX C

RELATED CORRESPONDENCE

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
NASHVILLE, TENNESSEE 37243-0334

May 3, 1993

Mr. Herbert Harper
State Historic Preservation Office
B04 Customs House
701 Broad
Nashville, TN 37203-0442

SUBJECT: National Register Determination of Eligibility Inventory of Oak Ridge National Laboratory, Oak Ridge, Anderson County

Dear Mr. Harper:

I have been employed to prepare an assessment of National Register eligibility for properties at the Oak Ridge National Laboratory/X-10 facility in Oak Ridge, Anderson County. To assist me in preparing this assessment, I would like to request any information you have about any property in or adjacent to this facility that has previously been listed in the National Register or determined eligible for listing. If any property has been determined eligible, please state by whom. Also, I would like to know, to your knowledge, if there have been any previous architectural surveys conducted for this area.

The Oak Ridge National Laboratory/X-10 is obviously a unique resource, and if you have any general comments about assessing eligibility or preparing the historical context, I would welcome them.

Thank you for your help in this matter. I am looking forward to working with your office on this project.

Sincerely,

Martha Carver

Martha Carver
2131 West Jefferson Pike
Murfreesboro, TN 37129

TENNESSEE HISTORICAL COMMISSION
701 BROADWAY
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
NASHVILLE, TENNESSEE 37243-0442

May 11, 1993

Martha Carver
Carver & Associates
2131 West Jefferson Pike
Murfreesboro, Tennessee 37129

Re: DOD, ORNL/X-10 NR ELIGIBLE PROPERTIES, OAK RIDGE, ANDERSON COUNTY,

Dear Ms. Carver:

Pursuant to your request, this office has reviewed your letter dated May 3, 1993, relative to the above-referenced information request. Based on available information, we are enclosing a list of all properties determined eligible for listing in the National Register of Historic Places as a consequence of Section 106 review of projects over the past four federal fiscal years. We understand that you have already acquainted yourself with the Oak Ridge National Register file and collateral files in the THC National Register section.

In addition, we are enclosing information concerning project effect determinations which may prove helpful. Questions and comments may be directed to Joe Garrison (615)532-1559. Your cooperation is appreciated.

Sincerely,

Herbert L. Harper
Executive Director and
Deputy State Historic
Preservation Officer

HLH/jyg

ECORD # 5723

TENNESSEE HISTORICAL COMMISSION
REVIEW & COMPLIANCE LOG
ABBREVIATED SCREEN

AGENCY	DOE
AUTHOR	OAK RIDGE
DOCTYPE	REV.REQ.
COUNTY	ROANE
CITY	OAK RIDGE
PROJECT	SOLID STATE RESEARCH FACILITY
RECEIVED	10/19/92
ANSWERED	10/20/92
NOTES	5A1 NAE/RATNAE/11/16/92

RECORD # 2488

TENNESSEE HISTORICAL COMMISSION
REVIEW & COMPLIANCE LOG
ABBREVIATED SCREEN

AGENCY	DOE
AUTHOR	DOE
DOCTYPE	DEED RESTRICTIONS
COUNTY	ANDERSON
CITY	OAK RIDGE
PROJECT	PARCEL A/SITE PROTECTION
RECEIVED	01/07/91
ANSWERED	01/22/91
NOTES	5A2 SCNAE/RATSCNAE/04/11/91

RECORD # 5182

TENNESSEE HISTORICAL COMMISSION
REVIEW & COMPLIANCE LOG
ABBREVIATED SCREEN

AGENCY	DOE
AUTHOR	OAK RIDGE
DOCTYPE	PLANS/PHOTO
COUNTY	ANDERSON
CITY	OAK RIDGE
PROJECT	WEST OFFICE BUILDING
RECEIVED	07/13/92
ANSWERED	07/14/92
NOTES	5A2 SCNAE/RATSCNAE/09/03/92

ECORD # 5578

TENNESSEE HISTORICAL COMMISSION
REVIEW & COMPLIANCE LOG
ABBREVIATED SCREEN

AGENCY	DOE
AUTHOR	ACHP
DOCTYPE	RATMOA
COUNTY	ANDERSON
CITY	OAK RIDGE
PROJECT	MEASUREMENTS & CONTROLS BLDG.
RECEIVED	09/28/92
ANSWERED	09/28/92
NOTES	5A3 RATMOA/09/08/92

ECORD # 5579

TENNESSEE HISTORICAL COMMISSION
REVIEW & COMPLIANCE LOG
ABBREVIATED SCREEN

AGENCY	DOE
AUTHOR	ACHP
DOCTYPE	RATMOA
COUNTY	ANDERSON
CITY	OAK RIDGE
PROJECT	SMOKESTACK 2061/BLDG. 2017 REMOVAL
RECEIVED	09/28/92
ANSWERED	09/28/92
NOTES	5A3 RATMOA/09/08/92

Record#	AGENCY	AUTHOR	CH	DOCTYPE	COUNTY	CITY	PROJECT	DATE	DUE	ANSWERED	S	NOTES	DAYS	BLDGS	SITES	SQMIH	SQMIA	MONTH	IDNUMB
6684	*DOE	DOE	X	REV.REQ.	ANDERSON	OAK RIDGE	DEMOLITION/K-1028-40/K-1028-69	04/13/93	05/12/93	04/15/93	.F.	3 A K-1029B-40	2	0	0	0.000	0.000	G04	778
6685	DOE	DOE	X	REV REQ.	ANDERSON	OAK RIDGE	DEMOLITION/K-1028-40/K-1028-69	04/13/93	05/12/93	04/15/93	.F.	3 A K-1028-40	2	0	0	0.000	0.000	G04	778
6686	DOE	DOE	X	REV.REQ.	ANDERSON	OAK RIDGE	DEMOLITION/K-1028-40/K-1028-69	04/13/93	05/12/93	04/15/93	.F.	3 A K-1028-69	2	0	0	0.000	0.000	G04	778
4536	DOE	OAK RIDGE	X	ELIG.DET.	ANDERSON	OAK RIDGE	SMOKESTACK 2061/BLDG. 2017 REMOVAL	03/09/92	04/08/92	03/13/92	.F.	3 A SMOKE STACK 2061	4	0	0	0.000	0.000	F03	0
4537	DOE	OAK RIDGE	X	ELIG.DET.	ANDERSON	OAK RIDGE	SMOKESTACK 2061/BLDG. 2017 REMOVAL	03/09/92	04/08/92	03/13/92	.F.	3 A BUILDING 2017	4	0	0	0.000	0.000	F03	0
5726	DOE	OAK RIDGE	X	REV.REQ.	ROANE	OAK RIDGE	COOLING TOWER DEMOLITION/K-25 SITE	10/19/92	11/18/92	10/20/92	.F.	3 A COOLING TOWERS	1	0	0	0.000	0.000	G10	652

APPENDIX D

MANHATTAN PROJECT CHRONOLOGY

(SOURCE: Gosling 1990:63-66)

Manhattan Project Chronology

Date	Event
1919	Ernest Rutherford discovers the proton by artificially transmuting an element (nitrogen into oxygen).
1930	Ernest O. Lawrence builds the first cyclotron in Berkeley.
1931	Robert J. Van de Graaff develops the electrostatic generator.
1932	James Chadwick discovers the neutron.
1932	J. D. Cockroft and E. T. S. Walton first split the atom.
1932	Lawrence, M. Stanley Livingston, and Milton White operate the first cyclotron.
1934	Enrico Fermi produces fission.
December 1938	Otto Hahn and Fritz Strassmann discover the process of fission in uranium.
December 1938	Lise Meitner and Otto Frisch confirm the Hahn-Strassmann discovery and communicate their findings to Niels Bohr.
January 26, 1939	Bohr reports on the Hahn-Strassmann results at a meeting on theoretical physics in Washington, D.C.
August 2, 1939	Albert Einstein writes President Franklin D. Roosevelt, alerting the President to the importance of research on chain reactions and the possibility that research might lead to developing powerful bombs.
September 1, 1939	Germany invades Poland.
October 11-12, 1939	Alexander Sachs discusses Einstein's letter with President Roosevelt. Roosevelt decides to act and appoints Lyman J. Briggs head of the Advisory Committee on Uranium.
October 21, 1939	The Uranium Committee meets for the first time.
November 1, 1939	The Uranium Committee recommends that the government purchase graphite and uranium oxide for fission research.
March 1940	John R. Dunning and his colleagues demonstrate that fission is more readily produced in the rare uranium-235 isotope, not the more plentiful uranium-238.
Spring-Summer 1940	Isotope separation methods are investigated.
June 1940	Vannevar Bush is named head of the National Defense Research Committee. The Uranium Committee becomes a scientific subcommittee of Bush's organization.
February 24, 1941	Glenn T. Seaborg's research group discovers plutonium.
March 28, 1941	Seaborg's group demonstrates that plutonium is fissionable.
May 1941	Seaborg proves plutonium is more fissionable than uranium-235.
May 17, 1941	A National Academy of Sciences report emphasizes the necessity of further research.
June 22, 1941	Germany invades the Soviet Union.
June 28, 1941	Bush is named head of the Office of Scientific Research and Development. James B. Conant replaces Bush at the National Defense Research Committee, which becomes an advisory body to the Office of Scientific Research and Development.
July 2, 1941	The British MAUD report concludes that an atomic bomb is feasible.
July 11, 1941	A second National Academy of Sciences report confirms the findings of the first.
July 14, 1941	Bush and Conant receive the MAUD report.
October 9, 1941	Bush briefs Roosevelt and Vice President Henry A. Wallace on the state of atomic bomb research. Roosevelt

	instructs Bush to find out if a bomb can be built and at what cost. Bush receives permission to explore construction needs with the Army.
November 9, 1941	A third National Academy of Sciences report agrees with the MAUD report that an atomic bomb is feasible.
November 27, 1941	Bush forwards the third National Academy of Sciences report to the President.
December 7, 1941	The Japanese attack Pearl Harbor.
December 10, 1941	Germany and Italy declare war on the United States.
December 16, 1941	The Top Policy Committee becomes primarily responsible for making broad policy decisions relating to uranium research.
December 18, 1941	The S-1 Executive Committee (which replaced the Uranium Committee in the Office of Scientific and Research Development) gives Lawrence $400,000 to continue electromagnetic research.
January 19, 1942	Roosevelt responds to Bush's November 27 report and approves production of the atomic bomb.
March 9, 1942	Bush gives Roosevelt an optimistic report on the possibility of producing a bomb.
May 23, 1942	The S-1 Executive Committee recommends that the project move to the pilot plant stage and build one or two piles (reactors) to produce plutonium and electromagnetic, centrifuge, and gaseous diffusion plants to produce uranium-235.
June 1942	Production pile designs are developed at the Metallurgical Laboratory in Chicago.
June 17 1943	President Roosevelt approves the S-1 Executive Committee recommendation to proceed to the pilot plant stage and instructs that plant construction be the responsibility of the Army. The Office of Scientific Research and Development continues to direct nuclear research, while the Army delegates the task of plant construction to the Corps of Engineers.
July 1942	Kenneth Cole establishes the health division at the Metallurgical Laboratory.
August 7, 1942	The American island-hopping campaign in the Pacific begins with the landing at Guadalcanal.
August 13, 1942	The Manhattan Engineer District is established in New York City, Colonel James C. Marshall commanding.
August 1942	Seaborg produces a microscopic sample of pure plutonium.
September 13, 1942	The S-1 Executive Committee visits Lawrence's Berkeley laboratory and recommends building an electromagnetic pilot plant and a section of a full-scale plant in Tennessee.
September 17, 1942	Colonel Leslie R. Groves is appointed head of the Manhattan Engineer District. He is promoted to Brigadier General six days later.
September 19, 1942	Groves selects the Oak Ridge, Tennessee site for the pilot plant.
September 23, 1942	Secretary of War Henry Stimson creates a Military Policy Committee to help make decisions for the Manhattan Project.
October 3, 1942	E. I. du Pont de Nemours and Company agrees to build the chemical separation plant at Oak Ridge.
October 5, 1942	Compton recommends an intermediate pile at Argonne.
Fall 1942	J. Robert Oppenheimer and the luminaries report from Berkeley that more fissionable material may be needed than previously thought.
October 19, 1942	Groves decides to establish a separate scientific laboratory to design an atomic bomb.
October 26, 1942	Conant recommends dropping the centrifuge method.
November 12, 1942	On the recommendation of Groves and Conant, the Military Policy Committee decides to skip the pilot plant stage on the plutonium, electromagnetic, and gaseous diffusion projects and go directly from the research stage to industrial-scale production.
	The Committee also decides not to build a centrifuge plant.
November 14, 1942	The S-1 Executive Committee endorses the recommendations of the Military Policy Committee.
November 1942	The Allies invade North Africa.
November 25, 1942	Groves selects Los Alamos, New Mexico as the bomb laboratory (codenamed Project Y). Oppenheimer is chosen laboratory director.
December 2, 1942	Scientists led by Enrico Fermi achieve the first self-sustained nuclear chain reaction in Chicago.

December 10, 1942	The Lewis committee compromises on the electromagnetic method. The Military Policy Committee decides to build the plutonium production facilities at a site other than Oak Ridge.
December 28, 1942	Roosevelt approves detailed plans for building production facilities and producing atomic weapons.
January 13-14, 1943	Plans for the Y-12 electromagnetic plant are discussed. Groves insists that Y-12's first racetrack be finished by July 1.
January 14-24, 1943	At the Casablanca Conference, Roosevelt and British Prime Minister Churchill agree upon unconditional surrender for the Axis powers.
January 16, 1943	Groves selects Hanford, Washington as the site for the plutonium production facilities. Eventually three reactors, called B, D, and F, are built at Hanford.
January 1943	Bush encourages Philip Abelson's research on the thermal diffusion process.
February 18, 1943	Construction of Y-12 begins at Oak Ridge.
February 1943	Groundbreaking for the X-10 plutonium pilot plant takes place at Oak Ridge.
March 1943	Researchers begin arriving at Los Alamos.
April 1943	Bomb design work begins at Los Alamos.
June 1943	Site preparation for the K-25 gaseous diffusion plant commences at Oak Ridge.
Summer 1943	The Manhattan Engineer District moves its headquarters to Oak Ridge.
July 1943	Oppenheimer reports that three times as much fissionable material may be necessary than thought nine months earlier.
August 27, 1943	Groundbreaking for the 100-B plutonium production pile at Hanford takes place.
September 8, 1943	Italy surrenders to Allied forces.
September 9, 1943	Groves decides to double the size of Y-12.
September 27, 1943	Construction begins on K-25 at Oak Ridge.
November 4, 1943	The X-10 pile goes critical and produces plutonium by the end of the month.
Late 1943	John von Neumann visits Los Alamos to aid implosion research.
December 15, 1943	The first Alpha racetrack is shut down due to maintenance problems.
January 1944	The second Alpha racetrack is started and demonstrates maintenance problems similar to those that disabled the first.
January 1944	Construction begins on Abelson's thermal diffusion plant at the Philadelphia Naval Yard.
February 1944	Y-12 sends 200 grams of uranium-235 to Los Alamos.
March 1944	The Beta building at Y-12 is completed.
March 1944	Bomb models are tested at Los Alamos.
April 1944	Oppenheimer informs Groves about Abelson's thermal diffusion research in Philadelphia.
June 6, 1944	Allied forces launch the Normandy invasion.
June 21, 1944	Groves orders the construction of the S-50 thermal diffusion plant at Oak Ridge.
July 4, 1944	The decision is made to work on a calutron with a 30-beam source for use in Y-12.
July 17, 1944	The plutonium gun bomb (codenamed Thin Man) is abandoned.
July 1944	A major reorganization to maximize implosion research occurs at Los Alamos.
July 1944	Scientists at the Metallurgical Laboratory issue the "Prospectus on Nucleonics," concerning the international control of atomic energy.
August 7, 1944	Bush briefs General George C. Marshall, informing him that small implosion bombs might be ready by mid-1945 and that a uranium bomb will almost certainly be ready by August 1, 1945.
September 1944	Colonel Paul Tibbets's 393rd Bombardment Squadron begins test drops with dummy bombs called pumpkins.
September 13, 1944	The first slug is placed in pile 100-B at Hanford.
September 1944	Roosevelt and Churchill meet in Hyde Park and sign an "aide-memoire" pledging to continue bilateral research on atomic technology.

Summer 1944-Spring 1945	The Manhattan Project's chances for success advance from doubtful to probable as Oak Ridge and Hanford produce increasing amounts of fissionable material, and Los Alamos makes progress in chemistry, metallurgy, and weapon design.
September 27, 1944	The 100-B reactor goes critical and begins operation.
September 30, 1944	Bush and Conant advocate international agreements on atomic research to prevent an arms race.
December 1944	The chemical separation plants (Queen Marys) are finished at Hanford.
February 2, 1945	Los Alamos receives its first plutonium.
February 4-11, 1945	Roosevelt, Churchill, and Soviet Premier Joseph Stalin meet at Yalta.
March 1945	S-50 begins operation at Oak Ridge.
March 1945	Tokyo is firebombed, resulting in 100,000 casualties.
March 12, 1945	K-25 begins production at Oak Ridge.
April 12, 1945	President Roosevelt dies.
April 25, 1945	Stimson and Groves brief President Truman on the Manhattan Project.
May 1945	Stalin tells Harry Hopkins that he is willing to meet with Truman and proposes Berlin as the location.
May 7, 1945	The German armed forces in Europe surrender to the Allies.
May 23, 1945	Tokyo is firebombed again, this time resulting in 83,000 deaths.
May 31-June 1, 1945	The Interim Committee meets to make recommendations on wartime use of atomic weapons, international regulation of atomic information, and legislation regarding domestic control of the atomic enterprise (the Committee's draft legislation becomes the basis for the May-Johnson bill).
June 6, 1945	Stimson informs President Truman that the Interim Committee recommends keeping the atomic bomb a secret and using it as soon as possible without warning.
June 1945	Scientists at the Metallurgical Laboratory issue the Franck Report, advocating international control of atomic research and proposing a demonstration of the atomic bomb prior to its combat use.
June 14, 1945	Groves submits the target selection group's recommendation to Marshall
June 21, 1945	The Interim Committee, supporting its Scientific Panel, rejects the Franck Report recommendation that the bomb be demonstrated prior to combat.
July 2-3, 1945	Stimson briefs Truman on the Interim Committee's deliberations and outlines the peace terms for Japan.
July 16, 1945	Los Alamos scientists successfully test a plutonium implosion bomb in the Trinity shot at Alamogordo, New Mexico.
July 17-August 2, 1945	Truman, Churchill, and Stalin meet in Potsdam.
July 21, 1945	Groves sends Stimson a report on the Trinity test.
July 24, 1945	Stimson again briefs Truman on the Manhattan Project and peace terms for Japan. In an evening session, Truman informs Stalin that the United States has tested a powerful new weapon.
July 25, 1945	The 509th Composite Group is ordered to attack Japan with an atomic bomb "after about" August 3.
July 26, 1945	Truman, Chinese President Chiang Kai-Shek, and new British Prime Minister Clement Atlee issue the Potsdam Proclamation, calling for Japan to surrender unconditionally.
July 29, 1945	The Japanese reject the Potsdam Proclamation.
August 6, 1945	The gun model uranium bomb, called Little Boy, is dropped on Hiroshima. Truman announces the raid to the American public.
August 8, 1945	Russia declares war on Japan and invades Manchuria.
August 9, 1945	The implosion model plutonium bomb, called Fat Man, is dropped on Nagasaki.
August 12, 1945	The Smyth Report, containing unclassified technical information on the bomb project, is released.
August 14, 1945	Japan surrenders.
September 2, 1945	The Japanese sign articles of surrender aboard the U.S.S. *Missouri*.
September 9, 1945	S-50 shuts down.
September 1945	Y-12 shutdown begins.
October 3, 1945	Truman advocates passage of the May-Johnson bill.

December 20, 1945	Senator Brien McMahon introduces a substitute to the May-Johnson bill, which had been losing support, including Truman's.
January 1946	Hearings on the McMahon bill begin.
June 14, 1946	Bernard Baruch presents the American plan for international control of atomic research.
July 1, 1946	Operation Crossroads begins with Shot Able, a plutonium bomb dropped from a B-29, at Bikini Atoll.
July 15, 1946	Operation Crossroads continues with Shot Baker, a plutonium bomb detonated underwater, at Bikini Atoll.
August 1, 1946	President Truman signs the Atomic Energy Act of 1946, a slightly amended version of the McMahon bill.
December 1946-January 1947	The Soviet Union opposes the Baruch Plan, rendering it useless.
January 1, 1947	In accordance with the Atomic Energy Act of 1946, all atomic energy activities are transferred from the Manhattan Engineer District to the newly created United States Atomic Energy Commission. The Top Policy Group and the Military Policy Committee had already disbanded.
August 15, 1947	The Manhattan Engineer District is abolished.
December 31, 1947	The National Defense Research Committee and the Office of Scientific Research and Development are abolished. Their functions are transferred to the Department of Defense.

APPENDIX E

ATOMIC ENERGY COMMISSION CHRONOLOGY

(SOURCE: Holl et al. 1986:35-37)

December 2, 1942	Chicago Pile 1 demonstrated the first self-sustaining nuclear fission chain reaction. Dismantled and rebuilt at Argonne as CP-2, the pile operated until 1954.
August 1, 1946	President Truman signed the Atomic Energy Act of 1946.
January 1, 1947	The AEC assumed control from Manhattan Engineer District of atomic energy facilities and programs.
June 1947	AEC established Reactor Safeguards Committee.
October 6, 1947	AEC appointed an Industrial Advisory Group under Chairman James W. Parker to investigate peaceful uses of atomic energy. Report issued on December 30, 1948.
March 1, 1949	AEC announced selection of a site in Idaho for the National Reacto Testing Station.
December 20, 1951	Experimental Breeder Reactor #1 (EBR-1) produced the first electric power from a nuclear reactor.
March 31, 1952	The Materials Testing Reactor (MTR) went critical at the NRTS.
March 30, 1953	The Navy prototype pressurized water reactor for the Nautilus went critical.
August 9, 1953	AEC established an Advisory Committee on Reactor Safeguards.
December 8, 1953	President Eisenhower delivered his "Atoms-for-Peace" speech before the United Nations and proposed an international agency to promote peaceful applications of atomic energy.
March 23, 1954	Joint Committee on Atomic Energy approved AEC Five-Year Program for reactor development.
August 30, 1954	President Eisenhower signed the new Atomic Energy Act of 1954, opening the way for the civilian power program.
November 11, 1954	E.H. Dixon and E.A. Yates of the Mississippi Valley Generating Company signed a contract with the AEC for power supply to AEC facilities.
January 10, 1955	AEC announced the first round of the Power Demonstration Reactor Program, under which the AEC and industry would cooperate in the construction and operation of experimental power reactors.
August 8-20, 1955	First United Nations International Conference on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland.
September 21, 1955	AEC issued second round of invitations to private industry under the PDRP program.
February 22, 1956	At the direction of President Eisenhower, the AEC made available for sale or lease 20,000 kilograms of U-235 for use in power and research reactors abroad, and 20,000 kilograms for power reactors in the U.S.
Spring 1956	Senator Gore and Representative Holifield introduced legislation to enlarge the reactor development program. The legislation did not pass the House.
January 7, 1957	The AEC sponsored the third round of the PDRP for industry.

July 12, 1957	Power produced by the Sodium Reactor Experiment (SRE), at Santa Susana, California marked the first use of power from a civilian reactor. Deactivation of the SRE announced on December 2, 1966.
September 2, 1957	President Eisenhower signed the Price-Anderson Act, giving financial protection to the public, AEC licensees, and contractors in the event of a major nuclear power plant accident.
October 1, 1957	International Atomic Energy Agency inaugurated in Vienna, Austria. AEC announced U.S. offer to make 5,000 kilograms of U-235 available to the agency.
December 2, 1957	The pressurized water reactor at Shippingport went critical. On December 23 the reactor reached full power rating of 60 MWe and was the first full-scale nuclear power plant in the United States.
May 22, 1958	Keel of the world's first nuclear powered merchant ship, N.S. *Savannah* laid at Camden, New Jersey. Ship launched on July 21, 1959, and mothballed in 1971.
October 15, 1959	The boiling water reactor at Dresden Nuclear Power Station, built by Commonwealth Edison Company (IL) went critical, but did not produce commercial power until June 1960.
February 16, 1960	AEC published a ten year plan of nuclear power development.
August 19, 1960	The Yankee Nuclear Power Station went critical, becoming the third reactor producing commercial power.
March 17, 1962	President Kennedy asked AEC to report on the role of nuclear power in the economy. The report was released November 20, 1962.
August 23, 1962	Modified Round Three of PDRP announced by AEC.
December 12, 1963	Jersey Central Power and Light Company announced the construction of a nuclear power plant at Oyster Creek, and estimated it would be more economical to operate than a conventional fueled power plant.
February 22, 1964	AEC solicited proposals for the advanced converter program.
August 26, 1964	President Johnson signed the Private Ownership of Special Nuclear Materials Act, allowing the power industry to own fuel for power reactors. After June 30, 1973, private ownership of fuels would be mandatory.
November 1965	AEC decided to give the Liquid Metal Fast Breeder (LMFBR) highest priority and to build the Fast Flux Test Facility (FFTF). The FFTF began operation in April 1982.
November 9, 1965	The first major power blackout covered the northeast U.S.
February 1967	AEC published its supplement to 1962 Report to the President.
January 1, 1969	National Environmental Policy Act signed by President Johnson.
August 18, 1969	AEC established the Atomic Safety and Licensing Appeal Board.
September 23, 1970	Electric power "brownouts" hit northeast during heat wave.
June 4, 1971	President Nixon announced as a national goal a commitment to complete LMFBR demonstration plant by 1980.

July 23, 1971	D.C. Court of Appeals ruled in the Calvert Cliffs decision that AEC incorporate wider environmental considerations in its regulatory procedures.
August 7, 1972	AEC announced cooperative agreement with industry to build LMFBR demonstration plant on the Clinch River in Tennessee.
June 29, 1973	President Nixon proposed creation of the Energy Research and Development Administration and the Nuclear Regulatory Commission to replace the AEC.
October 17, 1973	Organization of Arab Petroleum Exporting Countries embargo oil to the United States, sparking first "energy crisis." Embargo lasted until March 17, 1974.
December 1, 1973	AEC Chairman Ray issued report requested by President Nixon on *The Nation's Energy Future*.
October 11, 1974	Energy Reorganization Act signed by President Ford, abolished AEC and created ERDA and NRC.
November 1974	Federal Energy Administration released "Project Independence" report.
January 19, 1975	ERDA activated.
October 1975	The Rasmussen Report, a study of reactor safety, published by NRC.
May 1976	ERDA assumed responsibility for management of the Clinch River Breeder Reactor.
October 28, 1976	President Ford released his nuclear policy statement, emphasizing the fuel cycle, reprocessing and nonproliferation.
April 7, 1977	President Carter announced new policy of deferral of reprocessing of spent fuel from civilian reactors, and delay of the breeder reactor.
August 4, 1977	President Carter signed Energy Reorganization Act creating the Department of Energy, combining ERDA and FEA.
October 1, 1977	DOE activated.
March 28, 1979	Accident occurred at Three Mile Island nuclear power plant.
October 8, 1981	Reagan Administration announced nuclear energy policy which anticipated the establishment of a facility for the storage of high-level radioactive waste, and lifted the ban on commercial reprocessing of nuclear fuel.
January 7, 1983	President Reagan signed Nuclear Waste Policy Act of 1982 into law.
October 26, 1983	The Senate refused to continue funding the Clinch River Breeder Reactor, effectively terminating the project.
May 8, 1984	The Department of Energy established a Civilian Radioactive Waste Management Office.
May 8, 1984	Secretary of Energy Hodel gave the Nuclear Power Assembly his assessment of the state of the nuclear power industry.

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