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FEB 0 6 2017

Dr. David Snyder
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PPPO-03-3743024-17

Dear Dr. Snyder:

TRANSMITTAL OF THE ROLE OF THE PORTSMOUTH GASEOUS DIFFUSION PLANT IN COLD WAR HISTORY

Enclosed for your information is the report "*The Role of the Portsmouth Gaseous Diffusion Plant in Cold War History*." This report fulfills a commitment made by the U.S. Department of Energy in the Comprehensive Environmental Response, Compensation and Liability Act Record of Decision for the Site-Wide Waste Disposition Evaluation Project and the Record of Decision for the Process Buildings and Complex Facilities Decontamination and Decommissioning Evaluation Project.

The purpose of the report is to document the history of the operations and facilities at the Portsmouth Gaseous Diffusion Plant (PORTS) from the announcement of the plant in 1952 through the end of the Cold War. This historic context report has two goals: to place the role of PORTS in the context of the larger United States nuclear weapons complex, and to place individual architectural resources at PORTS in context as to how they were related to the plant's mission.

Over the past several years PORTS has prepared and submitted numerous reports to your office which can be found at https://www.energy.gov/pppo/downloads/national-historic-preservation-act-documents-portsmouth. This Historic Context report should be a useful resource in understanding and interpreting PORTS role as a part of the United States Cold War nuclear weapons complex.

A copy of the report is enclosed and can also be obtained at the Environmental Information Center by contacting 740-289-8898 or at portseic@pma-iss.com. Additionally, an electronic copy can be found at https://www.energy.gov/pppo/downloads/national-historic-preservation-act-documents-portsmouth.

If you have any questions, please contact Amy Lawson of my staff at 740-897-2112.

Sincerely,

Robert E. Edwards III

Robert E. Edwards, III
Manager
Portsmouth/Paducah Project Office

Enclosure:
The Role of the Portsmouth Gaseous Diffusion Plant in Cold War History

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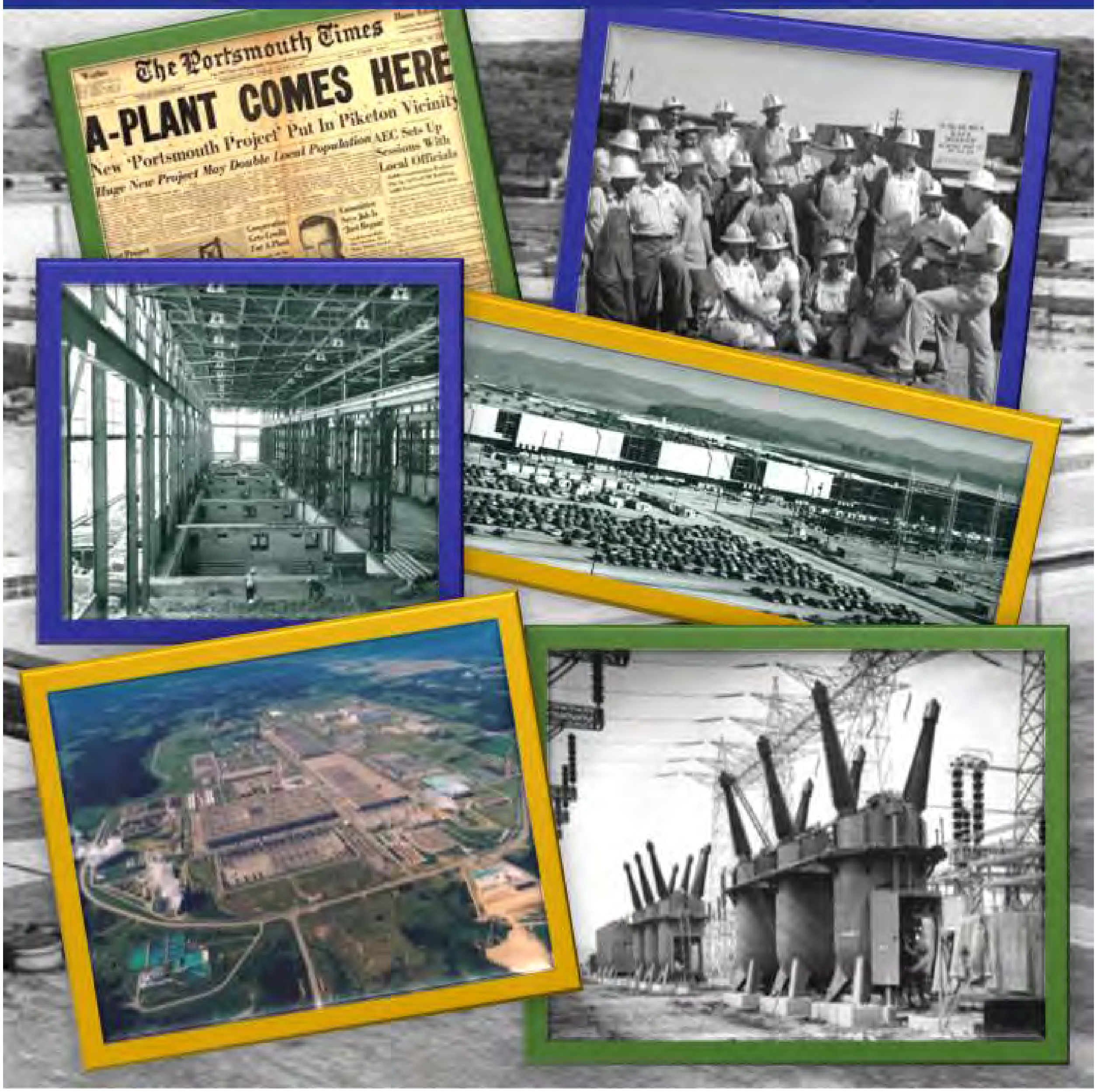
The Role of the Portsmouth Gaseous Diffusion Plant in Cold War History



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THE ROLE OF THE PORTSMOUTH GASEOUS DIFFUSION PLANT IN COLD WAR HISTORY

U.S. Department of Energy
DOE/PPPO/03-0683&D1

February 2017

This document is approved for public release per review by:

Samuel Eldridge (signature on file) 2-1-2017
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THE ROLE OF THE
PORTSMOUTH GASEOUS DIFFUSION PLANT
IN COLD WAR HISTORY

U.S. Department of Energy
DOE/PPPO/03-0683&D1

February 2017

Prepared for
U.S. Department of Energy

Prepared by
Fluor-BWXT Portsmouth LLC, Under Contract DE-AC30-10CC40017
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ACRONYMS

ACR	area control room
AEC	U.S. Atomic Energy Commission
AEP	American Electric Power
AFL	American Federation of Labor
AST	aboveground storage tank
CCD	Columbus, Cincinnati, Dayton
CIO	United Gas, Coke and Chemical Workers of America
CIP	Cascade Improvement Program
CUP	Cascade Upgrade Program
DLA	Defense Logistics Agency
DOE	U.S. Department of Energy
DUF_6	depleted uranium hexafluoride
EPA	U.S. Environmental Protection Agency
EPABX	Electronic Private Automatic Branch Exchange
ERDA	Energy Research and Development Administration
ERP	Extended Range Product
FHA	Federal Housing Administration
GAT	Goodyear Atomic Corporation
GCEP	Gas Centrifuge Enrichment Plant
GDP	gaseous diffusion plant
GTE	General Telephone and Electronics Corporation
HEU	highly-enriched uranium
HHFA	Housing and Home Finance Agency
HPFW	high-pressure fire water
LAW	low-assay withdrawal
NHPA	National Historic Preservation Act
NRC	U.S. Nuclear Regulatory Commission
OCAW	Oil, Chemical, and Atomic Workers
OVEC	Ohio Valley Electric Corporation
PCB	polychlorinated biphenyl
PHA	Public Housing Administration
PORTS	Portsmouth Gaseous Diffusion Plant
RCW	recirculating cooling water
SNM	special nuclear material
STRESS	Security Training Evaluation Shooting System
SWU	separative work unit
TCE	trichloroethene
TLD	thermoluminescent dosimeter
UPGWA	United Plant Guard Workers of America

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PREFACE

The Portsmouth Gaseous Diffusion Plant (PORTS), Piketon, Ohio, was a part of the U.S. Cold War nuclear weapons complex. PORTS' primary Cold War era mission was the production of highly-enriched uranium (HEU) by the gaseous diffusion process for defense/military purposes. PORTS was the last of three gaseous diffusion plants (GDPs) to be constructed, the first being in Oak Ridge, Tennessee, and the second in Paducah, Kentucky. PORTS' sister plant, Paducah, processed low-enriched uranium to provide fuel for nuclear reactors. HEU was processed at only two facilities, Oak Ridge and PORTS. PORTS was the largest producer of HEU, enriched to the highest levels, and its production of HEU spanned the longest period.

This report, *The Role of the Portsmouth Gaseous Diffusion Plant in Cold War History*, aims to place PORTS in its historic context and offers a visual history of PORTS from its construction era in the early 1950s to the end of the Cold War era upon the collapse of the Soviet Union in 1991. It includes numerous photographs and captions, narrative histories, tables, and figures to help the public and future generations have a better understanding of why the plant was built and the contributions of the many workers who were employed over the years to serve our country's defense and energy needs.

This historic context has been completed by the U.S. Department of Energy (DOE) as one of the mitigation measures agreed to in the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, *Record of Decision for the Process Buildings and Complex Facilities Decontamination and Decommissioning Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio* (DOE 2015) to meet the substantive requirements of the National Historic Preservation Act (NHPA). This report supports DOE in fulfilling its commitments to the comprehensive site interpretation for the Environmental Management mission of environmental remediation and decontamination and decommissioning of PORTS, which has resulted in the decision to demolish the site's facilities.

This document supports DOE's commitment to preserve the plant's history in words, diagrams, and images of various structures and facilities that make up PORTS and to mitigate adverse impacts from demolition of GDP facilities. DOE has worked closely with the Tribal nations, Ohio Historic Preservation Office, the Advisory Council on Historic Preservation, and the public with an interest in historic preservation to receive input on how best to portray and preserve the site's history in accordance with substantive requirements of the NHPA. Additionally, Gray & Pape, Inc., a national consulting firm specializing in cultural resources management and historic preservation services, contributed to this document by providing supporting research and historic architectural and preservation expertise.

This document was compiled using guidance presented in the *Portsmouth Gaseous Diffusion Plant, Pike County, Ohio, Recommended Cold War Era Mission Documentation Model*. In addition to this historic context, Historic American Engineering Record and Historic American Building Survey documents are being completed for a number of site facilities associated with the historic mission.

This historic context is the result of extensive research into plant record archives and interviews with former and current employees. The document complements the PORTS history website, currently www.portsvirtualmuseum.org, and will be made accessible on the internet.

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1. HISTORIC OVERVIEW: PORTSMOUTH GASEOUS DIFFUSION PLANT

1.1 THE COMING OF A NEW AGE

On August 1, 1946, with the stroke of President Harry S. Truman's pen, the Atomic Energy Act was signed, and the newly formed U.S. Atomic Energy Commission (AEC) assumed its civilian duties of fostering peacetime nuclear science. Although production facilities and nuclear reactors would be owned by the government due to security reasons, the AEC was granted independent control over development and research activities in search of promising new peaceful utilizations of the atom.

An exciting, but daunting task had been given to the AEC and challenges lay ahead. The Cold War era, which began with the Yalta Conference in 1945 and continued until the collapse of the Soviet Union in 1991, called for focus on the support of national defense, and lessened the time and resources directed toward the goal of research and installation of non-military uses for the atom. For the security of the nation, weapons development and production took precedence and quickly created a growing need for enriched uranium.

The need for increased production would become even more apparent in the years that followed. In 1949, it was discovered that the Soviet Union had detonated a nuclear device, prompting the AEC to discuss the need for developing a thermonuclear weapon for national security. After much discussion within the government, President Truman settled the debate and made the imperative decision that work must begin on such a weapon. More motivation for augmenting production goals came when the United States sent forces to aid South Korea during the Korean War in response to Communist China's advancement into North Korea.

The urgency of the situation and the imminent possibility of exhausting the country's enriched uranium production capacity at existing facilities dictated that expansion begin immediately. Because the key production sites across the country relied on one another for different functions of uranium processing, modifications and additions to a number of facilities became necessary.

Prior to construction of the Portsmouth Gaseous Diffusion Plant (PORTS), six key sites each played a vital role in supporting the government's weapons production program. The Feed Material Production Center in Fernald, Ohio, (Fernald) was a uranium processing facility that fabricated high-purity uranium metal products ("feed materials"). In addition to its role of gaseous diffusion for separating uranium-235 from uranium-238 at the Oak Ridge, Tennessee K-25 site, the Oak Ridge, Tennessee Y-12 facility enriched lithium-6, a necessary component to increase the yield of thermonuclear weapons. The Paducah, Kentucky, facility (Paducah) would meet the increased demand for enriched uranium by sending its low-enriched uranium on to PORTS for additional enrichment. The "Jumbo reactors," K-East and K-West, at the Hanford site near Richland, Washington, (Hanford) were the largest reactors built to produce plutonium at the time and greatly improved the government's ability to meet the supplementary demands for defense purposes. During this time, Hanford also erected the most advanced chemical separation facility to enhance plutonium production. The Savannah River Site, located near Aiken, South Carolina, contributed materials used in the nuclear weapons manufacturing process, primarily tritium and plutonium-239. The Los Alamos National Laboratory in New Mexico was established in 1943 as part of the Manhattan Project for a single purpose: to design and build an atomic bomb. Locations of key nuclear facilities built during the WWII and Cold War eras are shown on Figure 1.

Figure 1. Locations of Government Cold War Nuclear Facilities in the United States

1.2 THE PORTSMOUTH GASEOUS DIFFUSION PLANT ARRIVES

To complement the Oak Ridge K-25 site and Paducah enriched uranium production capabilities, a third site was needed to be able to produce enriched uranium-235 by the process of gaseous diffusion. In addition to the goal of having new gaseous diffusion capability to enhance production at the other two sites, the third site had to meet the "security through dispersion" requirement that called for the site to be located at least 150 miles away from both the Oak Ridge and Paducah plants. This would place the new site in a "strategically safe" zone.

The Paducah site, built in 1951, had been chosen partially because it was constructed on land already owned by the government. While this decision was certainly affected by time constraints imposed due to the Korean War, selection of the third site could be addressed with more time and consideration. The chronic labor strikes and lack of adequate housing at the Paducah location caused construction delays, and these problems were well noted by AEC personnel seeking the third site.

As early as June 1951, the AEC requested Oak Ridge staff to begin planning for a third uranium enrichment facility to augment production from the Oak Ridge and Paducah plants. A nationwide search for a location began in October 1951. In the initial phase of site evaluation, Stone & Webster Engineering, the site survey contractor, considered a limited set of criteria. The primary criteria for judging the merit of a location included: (1) readily available and cost-efficient means of producing significant amounts of electricity, (2) a nearby and adequate water supply, (3) access to a necessary labor force while meeting essential transportation requirements, and (4) location in a region where climate and weather would not impede operations and would provide a large area of mainly flat terrain.

By December 1951, the site survey had focused on seven areas: three in the Ohio River Valley, and one each in the Kansas City, Missouri area; Birmingham, Alabama area; Shreveport, Louisiana area; and one in Oklahoma. Of these, only the Ohio River areas had adequate power supply for the plant during early operation before the plant's planned dedicated power plants were operational.

Focused on the three Ohio River Valley areas at Louisville, Kentucky; Cincinnati, Ohio; and Portsmouth-Chillicothe, Ohio, in early 1952, the contractor began a second, more detailed evaluation of potential sites in the region. Louisville and Cincinnati were strong candidates, but Portsmouth was considered a weak third choice due to a deficient highway system and remoteness from a major population center.

However, by March 1952, Louisville had been eliminated due to widespread protests from area business and civic groups who did not want an "Atomic Plant" in their community. Cincinnati emerged as the primary candidate location, but it was not optimum, so the AEC sought additional investigation. This more detailed investigation noted that the nearby Fernald site was having conflict with skilled trade unions regarding wages. Despite this concern, by April 1952 the AEC authorized further planning for a Cincinnati plant.

On July 7, 1952, the U.S. Congress passed the First Supplemental Appropriations Act, Fiscal Year 1953, which allotted $2.9 billion to fund the estimated construction costs to expand the nation's facilities for producing fissionable materials. President Truman signed into law an estimated $1.2 billion to be used for construction of a new gaseous diffusion plant (GDP) and granted authority for its inception on July 15, 1952 (Figure 2). Work to locate a site for the new enrichment plant actually began a year before the President signed the bill authorizing the construction, but no site had been selected at the time the law was enacted.

In early July 1952, the AEC selected Peter Kiewit Sons' Company as construction contractor for the new plant and directed the company to negotiate with unions in Cincinnati, Louisville, and Portsmouth. By late July, Fernald had experienced work stoppages over pay issues and it was anticipated the same issues would affect the planned enrichment facility.

By contrast, unions at Portsmouth were eager for the jobs and were willing to make commitments favorable to the AEC. Additionally, there was strong community support for the Portsmouth site, with numerous businesses, civic organizations, elected officials, and even churches sending letters of support for the "A-Plant" (Figure 3). Ultimately, these factors were instrumental in site selection. On August 12, 1952, the AEC announced selection of Portsmouth as the location for the new uranium enrichment plant (Figures 4 and 5), and construction of the plant began later that year.

Figure 2. President Truman Signed the Authorization for Construction of the Portsmouth Plant

Figure 3. "An Invitation from the Portsmouth Area"

Weather

The Portsmouth Times

Home Edition

A-PLANT COMES HERE

New 'Portsmouth Project' Put In Piketon Vicinity

Huge New Project May Double Local Population

AEC Sets Up Sessions With Local Officials

Vast Project Will Cover 6,500 Acres

Cooperation Gets Credit For A-Plant

Committee Says Job Is 'Just Begun'

Rev. Hall Goes To Cathedral In Cleveland

Gov. Lausche Hails Ohio A-Plant Site Selection

17 Men Serve On Committee

Free Trips Set For Dollar Day

H-Plant Brings Big Boom To Nearby Georgia City

Inside The Times

Figure 4. A-Plant Official Announcement August 12, 1952

Figure 5. Welcome Sign Located at the Entrance to Piketon (1952)
The original sign announcing the excitement in the area was painted by high school boys.
The Piketon Civic Club replaced it with a permanent sign, but made no changes in the wording.

1.3 LAND ACQUISITION

Without the urgent time constraints that had played a major role in selecting the Paducah site, availability of government land was not a chief concern. The U.S. Army Corps of Engineers was selected to manage the acquisition of land because of the availability of personnel especially qualified and experienced in the work. Arrangements were made in Washington, D.C., to use such personnel in the acquisition of all properties required for the new site.

A letter dated August 11, 1952, to Lt. General Pick, commanding general of the U.S. Army Corps of Engineers, from the General Manager for the AEC, Mr. M. W. Boyer, designated the approximate boundaries of the selected site near Portsmouth, and requested that the U.S. Army Corps of Engineers start the purchase of the land immediately (Figure 6). The Huntington, West Virginia District Office of the U.S. Army Corps of Engineers was assigned this task and promptly set up headquarters in Waverly, Ohio.

In order to prohibit speculation and soaring prices, condemnation proceedings were filed with the U.S. Justice Department on all affected tracts simultaneously with the public announcement of the site location on August 12, 1952. The originally designated plant area encompassed some 6,450 acres. The final decisions for plant layout to meet security requirements reduced the necessary land area to approximately 4,000 acres, with the remainder released for reversion to private ownership late in 1952.

Ownership of 50 farms in the designated plant area needed to be traced before negotiations for purchase could begin. Aged books from the Pike County Records office revealed that some of the titles being researched dated back as far as 150 to 200 years. Information obtained from the records was noted, and the lengthy process of acquiring the land continued.

Figure 6. Site Surveying (1952)
While the U.S. Army Corps of Engineers prepared for land acquisition, the site was being surveyed.

The AEC selected the approximate 4,000 acre tract of land in the midst of rolling farm hills along the Scioto River in southern Ohio (Figure 7). Unlike the property adjacent to it, the PORTS site was flat, ideal for the government's intended purpose. PORTS is located near the intersection of U.S. Highway 23 and State Route 32/124, about 4 miles southeast of the village of Piketon, 25 miles north of Portsmouth, 22 miles south of Chillicothe, 23 miles east of Jackson, and about 75 miles south of Columbus (Figure 8).

Figure 7. Land Acquired for PORTS Construction (1953)
The above photograph provides a view, looking northwest, of the land acquired as construction commenced to build PORTS.

Figure 8. Location of PORTS

1.4 PERSONNEL

With the land acquired for building the plant and the impending site construction in the works, the stage was set for the arrival of the tremendous number of construction workers and future operations personnel and their families. This meant increased traffic to and from the area and the plant site (Figure 9). U.S. Highway 23 was a two-lane road that grew to a four-lane highway as a result of this demand (Figure 10).

An analysis of personnel requirements for accomplishing the construction of PORTS indicated that practically every construction craft, many of the industrial shop crafts, engineers, administrators, clerks, others of various fields and experience, lawyers, and medical personnel would be needed to complete the work.

The original estimates of peak manpower demand indicated that a total of 26,550 persons would be required for construction. The personnel requirements, by crafts, are presented in Table 1, prepared by the original construction contractor, Peter Kiewit Sons'.

Figure 9. Increased and Congested Traffic Exiting PORTS in the Early 1950s

Figure 10. Construction to Convert Highway 23 to a Four-lane Highway (1954)
PORTS site entrance ramp and highway overpass were also under construction.

Table 1. Comparison Chart of Estimated Labor Demands versus Actual Hires, Listed by Job Type (1954)

Job Classification	Estimated			Actual Totals				
	Labor Demand	Local Supply	In-migrant	Gross Hires	Terminations	Net Hires	Migrant	In-migrant
Non-manual Salaried	1,908	20	1,888	1,132	345	787	8	779
Non-manual Hourly	2,342	1,522	820	5,005	1,967	3,038	2,287	751
Total Non-manuals	**4,250**	**1,542**	**2,708**	**6,137**	**2,312**	**3,825**	**2,295**	**1,530**
Asbestos Workers	200	25	175	0	0	0	0	0
Boilermakers	150	20	130	62	45	17	1	16
Bricklayers	80	70	10	48	29	19	17	2
Carpenters & Millworkers	1,390	500	890	1,393	398	995	398	597
Cement Masons	455	145	310	773	429	344	96	248
Electricians	1,825	350	1,475	3,727	1,227	2,500	250	2,250
Glaziers	--	--	--	0	0	0	0	0
Ironworkers	1,290	190	1,100	1,199	510	689	69	620
Laborers	6,100	5,100	1,100	3,512	1,015	2,497	2,247	250
Lathers	--	--	--	11	5	6	3	3
Machinists	595	150	445	321	83	238	95	143
Operating Engineers	1,420	310	1,110	1,491	646	845	211	634
Painters	390	240	150	282	85	197	79	118
Pipe Fitters & Plumbers	4,365	410	3,955	4,946	1,190	3,756	75	3,681
Plasterers	--	--	--	24	6	18	16	2
Roofers	300	155	145	72	55	17	9	8
Sheet Metal Workers	1,140	145	995	928	282	646	19	927
Tile Layers	--	--	--	5	0	5	3	2
Teamsters	1,220	550	670	1,156	662	494	346	148
Welders	1,380	75	1,305	1,868	922	946	19	927
Total Manuals	**22,300**	**8,435**	**13,865**	**21,818**	**7,589**	**14,229**	**4,031**	**10,198**
PKS & CPFF Employees	--	--	--	27,955	9,901	18,054	6,326	11,728
General Fixed-price Subcontractors (within 100 miles) Employees	--	--	--	14,418	11,300	3,118	873	2,245
Total Employees	**26,550**	**9,977**	**16,573**	**42,373**	**21,201**	**21,172**	**7,199**	**13,973**

CPFF = cost plus fixed fee PKS = Peter Kiewit Sons' Co.

In addition to the personnel engaged directly, the resultant growth of services and trade in the community, off-site construction of necessary highways, power facilities, public and commercial buildings, and dwellings was estimated to bring the total new employment resulting from construction and operation of PORTS to approximately 38,000 workers.

A special survey of the labor market in the Piketon area was made at the inception of construction by the Division of Research and Statistics of the Bureau of Unemployment Compensation, Columbus, Ohio, in cooperation with the Division of Reports and Analysis of the Bureau of Unemployment Security, Washington, D.C. This survey covered seven Ohio counties: Ross, Pike, Scioto, Jackson, Vinton, Highland, and Adams. The first four named counties constituted the Central, or Portsmouth-Chillicothe, labor market area.

Industrially, the entire area, surveyed by the Division of Research and Statistics, had not been advancing, and a comparison of the census figures for the years 1940 and 1950 indicated an actual decrease in overall population. The survey of the area showed a local surplus estimated to consist of 2,650 available unemployed: 6,500 as new entrants into the labor force, 2,050 as out-commuters who would accept local employment; and 1,150 to become available from declining industry in the central area. In addition to this labor surplus, it was anticipated that approximately 6,100 workers were available and would commute from outside the immediate four-county area, giving a total of 18,500 workers available within commuting distance to meet part of the overall prospective labor demand.

The anticipated local labor supply within the construction commuting area was tabulated by counties as shown in Table 2.

Table 2. Anticipated Labor Supply by County

County	Total	Men	Women
Adams	1,400	1,000	400
Highland	1,900	1,350	550
Jackson	1,650	1,200	450
Pike	900	650	250
Ross	3,100	2,200	900
Scioto	6,700	5,050	1,650
Vinton	2,200	1,750	450
All Others – (outside area*) *Principally Greenup and Lewis Counties, Kentucky; and Gallia, Pickaway, and Lawrence Counties, Ohio.	600	450	150
Total	**18,450**	**13,650**	**4,800**

Of the locally available labor supply, relatively few were skilled construction craftsmen, which indicated that most of the demand for this type of labor would have to be met by the in-migration of workers from more distant areas, leaving the local labor surplus to fulfill the demand for clerical help, teamsters, laborers, and less skilled trades.

Because of the magnitude and complexity of constructing PORTS, a field recruiting program was established in the latter 3 months of 1952. Its purpose was to fill the tremendous need for qualified engineers, draftsmen, and administrative personnel, with the primary requirement being experienced and qualified professional personnel and the second requirement being qualified sub-professional and clerical personnel. Due to the inherent migratory nature of construction manual employment, it was not planned, nor was it necessary, to actively recruit this type of worker.

In 1952 it was announced that Goodyear Tire and Rubber Company would be AEC's operator of PORTS. Goodyear Tire assigned 28 of its key personnel to develop the Goodyear Atomic Corporation (GAT).

Recruiting areas were selected through information supplied by various state employment offices, the U.S. Department of Labor and from a study of "Help Wanted" advertisements in the major newspapers. Areas in which another large project was nearing completion were given particular attention, and often recruiting in such areas proved to be very successful. The State Employment Services were helpful and cooperative in carrying out the recruiting program by making available a desk and telephone in their offices, screening applicants, and supplying information on local conditions and possible sources of personnel.

After recruiting areas were selected, arrangements were made for newspaper advertising and employment recruiters to be sent to the areas to interview applicants, accept their applications, and refer them to the jobsite office for action. In the early months, recruiting was restricted to the cities and towns within a 100-mile radius of the jobsite, but beginning in February 1953, recruiters were sent to such distant cities as Minneapolis, Tampa, Boston, and Salt Lake City.

In addition to sending out recruiters to build the PORTS construction workforce (Figures 11 and 12), advertisements were placed in newspapers of other major cities. A total of 1,402 letters and 569 applications were received. All other placements were accomplished by jobsite personnel through the use of telephone, telegraph, and jobsite interviews. Many personnel aids such as tests, investigations, and patterned interviews were used.

Figure 11. Group of the PORTS Workforce in 1952

Figure 12. Daily Briefing of Construction Workers (1952)

1.5 HOUSING

Concurrent with the announcement of construction of PORTS, Gordon Dean, then chairman of the AEC, requested the Housing and Home Finance Agency (HHFA) to undertake the responsibility of assuring adequate housing for the permanent operating personnel. Immediately thereafter, the HHFA was also requested to assume the task of providing the temporary housing necessary for construction workers. Barracks were constructed to temporarily house site workers and trailer parks quickly began to emerge around the plant site (Figures 13 and 14).

The role of the AEC was to primarily supply the HHFA and its components with employment estimates and other employment details relative to probable in-migration wage and salary structure. Authority for action by the HHFA was contained in Public Law 139, "The Defense Housing and Community Facilities and Services Act of 1951." Title 9 of this public law, *National Defense Housing Insurance*, provided a somewhat more attractive mortgage loan insurance commitment to private builders as an inducement for the construction of rental and sale houses in areas affected by the impact of federal defense installations. Title 9 was to be administered as actual building commitments.

Figure 13. Housing (barracks) for PORTS Workers Erected in Piketon, Ohio (Early to mid-1953)

Figure 14. "Trailer City" Established to House PORTS Employees and their Families (1953)
These were established until HHFA and FHA could complete negotiations for permanent housing.

The Act also provided for the construction and operation of temporary housing by the Public Housing Administration (PHA) and for federal aid to local communities for the development and expansion of municipal facilities. As a prerequisite to the realization of any of the provisions of the Act, the area affected was to be first classified as a Critical Defense Housing Area by an Advisory Committee consisting of the representatives of six federal departments or agencies appointed by the Defense

Production Administration. The actual certification as a Critical Defense Housing Area was made by the Director of Defense Mobilization on September 16, 1952.

Arrangements were made with the Columbus Director of the Federal Housing Administration (FHA) for meetings with realtors, contractors, bankers, and building and loan associations in Chillicothe and Waverly on August 18, 1952, and at Portsmouth and Jackson on August 19, 1952. The meetings were held primarily to acquaint local businessmen with the mechanics of the FHA program and procedures, but also to assure that interested local firms and individuals would not be bypassed in whatever housing programs might ultimately develop.

On August 26, 1952, representatives from the Washington and Chicago offices of HHFA and the District Director of FHA arrived in Portsmouth for discussions with AEC relative to temporary and permanent housing requirements, and for the purpose of conducting a survey of available housing in the area.

On the basis of results derived from housing and labor market surveys, AEC agreed with representatives of HHFA and FHA, in a meeting on October 3, 1952, to an initial permanent housing program (Title 9) of 1,000 units, to consist of 750 rental units, with rents of $75 for two bedrooms and $85 for three bedrooms; and 250 sale houses priced at $10,500 for two bedrooms and $11,500 for three bedrooms.

It was also agreed at this time that 200 of the programmed houses would be allocated for key construction personnel, thus effectively removing these houses from the housing program for permanent plant employees. This was done with the thought that the area could absorb the 200 units upon completion of construction. Agreement on an initial temporary housing program of 400 units to be built and operated by PHA was reached on October 3, 1952.

Following approval of the housing program on October 10, 1952, the FHA released an invitation through the newspapers for interested builders to submit proposals on Title 9 housing projects. The expressed position of the AEC was that a fairly equal distribution of housing among the four communities of Portsmouth, Jackson, Waverly and Chillicothe would be satisfactory. On December 6, 1952, FHA allocated several housing projects near PORTS (Table 3).

Following the announcement of the permanent housing projects, the Chicago Regional Office, HHFA approached the AEC in December 1952, relative to the establishment of additional temporary and permanent housing programs. The need for additional housing was based on studies made of the findings of the Special Labor Market Survey as related to the estimated employment figures.

The need for additional housing was discussed by AEC and the HHFA in a meeting held in Chicago on January 12, 1953. The labor survey had indicated probable in-migration of construction workers in the order of 60 percent of the total employment, and a factor of 50 percent had been used for housing requirements by the AEC. The ensuing discussion looked toward an additional housing program of about 600 permanent units and 1,000 temporary units (Figure 15). As an outgrowth of the January 12, 1953, meeting, the HHFA shortly thereafter authorized an additional program of 400 rental trailers and followed this with a third program of 150 rental trailers.

The AEC was somewhat concerned in the early spring of 1953 at the apparent lack of progress in getting the temporary and permanent housing projects under way. Many problems were encountered by PHA and by the private builders, involving availability and extension of utility services. A fairly constant liaison was maintained by AEC with the parent Housing Agency and with PHA and FHA in an effort to expedite the programs.

Table 3. Housing Projects in the Vicinity of PORTS in 1952

Location	Housing and Rent/Sale
Portsmouth	
Scioto Terrace Manor	106 two-bedroom apartments Base shelter rent – $75
Forest Heights	134 two-bedroom, duplex type Base shelter rent – $75
Jackson	
Jackson Heights	70 two-bedroom, duplex type Base shelter rent – $75 75 three-bedroom houses Base shelter rent – $85
Town & Country Homes	10 two-bedroom sale houses – $10,500
Waverly	
Waverly Heights	115 two-bedroom sale houses – $10,500 Base shelter rent – $75
Waverly Estates	115 three-bedroom rental houses Base shelter rent – $85
Waverly Place	75 three-bedroom sale houses – $11,500
Chillicothe	
Western Hills	160 two-bedroom, row-type units Base shelter rent – $75
Chillicothe Manor	90 three-bedroom houses Base shelter rent – $85 50 three-bedroom sale houses – $11,500

Figure 15. PORTS Employee Temporary Housing West of PORTS in Early 1953
Construction of the housing facilities began in May 1953. The housing projects constructed in the respective communities are described in Table 4.

Table 4. Housing Projects Constructed in Neighboring PORTS Communities

Location	Housing
Portsmouth	
Scioto Terrace Manor	Construction commenced October 8, 1953, and the first units were available for occupancy in March 1954. Rentals were at $97/ month, which included heat, water, range, refrigerator, central television antenna, and janitorial service.
Forest Heights	Construction got under way August 26, 1953, and the first units were available for occupancy in May 1954. The gross rent was $88.50/month, which included range, refrigerator, washer, dryer, and grounds maintenance.
Waverly	
Waverly Heights	Construction commenced on May 6, 1953, and the first units were available for occupancy in October 1953. Interim attempts to arouse interest in purchasing the homes were not satisfactory and ultimately resulted in conversion of approximately 95 of the 115 houses to rentals. The remainders were sold. No appliances were furnished and the rents remained constant at $75/month.
Waverly Place	Construction got under way October 13, 1953. The builder ran into considerable trouble getting utilities into this project. As of the end of December 1954, when Title 9 houses in Waverly were decontrolled, these houses were not available for occupancy. They were finally put on the market around March 1955. They remained in a sale category at a price of $10,500.
Jackson	
Jackson Heights	Construction commenced on June 16, 1953, and the first units were available for occupancy in March 1954. No appliances were furnished and rents remained constant at $75 and $85/ month.
Town & Country Homes	Two of the 10 houses were completed and sold. The FHA commitment on the remaining 8 houses was cancelled and these houses were transferred to Waverly Heights and completed along with the initial project.
Chillicothe	
Western Hills	Construction commenced on May 26, 1953, with the first units available for occupancy in September 1953. Gross rents were $87.50 per month, which included water, range, refrigerator, washer, and dryer.
Chillicothe Manor	The builder had considerable difficulty with the City of Chillicothe concerning utilities. Eventually, arrangements were made for the construction of a sewage disposal and water system by the project developer. All of the houses were completed as three-bedroom units. Construction got under way on February 16, 1954.

FHA = Federal Housing Administration

By September 1954, all of the Title 9 housing units in the area were completed with the exception of the 75 houses in the Waverly Place project.

In addition to the housing programmed under Title 9 for direct assignment by the AEC, several major housing projects were initiated by private developers under Title 2 of the Housing Act. Title 2 housing included the following private projects at Waverly, Ohio:

- Bristol Homes, located just north of Waverly on State Route 335 – This project provided 325 rental houses with rents reportedly $95 per month including the use of four major appliances. Construction of this project by the Chipley Realty Company began in May 1954.
- Waverly Estates (Title 2 Project), located adjoining the Title 9 Project – This project provided 240 rental houses. Construction began in May 1954 (Figure 16).
- Chipley Realty Company development at Waverly Estates – This project provided 90 Title 2 single family rental units. Construction began in January 1954.

Figure 16. Waverly Estates Housing Project Built to Support the Influx of Workers at PORTS (1955)
(Hillside Avenue looking west)

During the period in which arrangements were being made for privately constructed housing under Title 9, meetings were held with representatives of the PHA relative to the location of the PHA housing development. It was learned that PHA planned to obtain land to accommodate at least 1,000 units in addition to the initial program of 400 units.

During this period also, in conjunction with the Oak Ridge Operations Office, PHA was approached on the possibility of utilizing, on a transfer basis, 500 demountable-type housing units located in Oak Ridge. After some consideration of the cost of demounting, moving, re-erecting and rehabilitating these units, PHA rejected this offer.

It was generally conceded that temporary housing to be provided by PHA should be located as near to the plant site as practicable. The matter of utilities was a critical problem, and consideration was given to permitting tie-ins with project sewer and water systems to serve the housing. The sites ultimately selected for the temporary housing were on Route 220, on the south edge of Waverly, and on Route 124, approximately 1 mile east of Piketon.

PHA was authorized to acquire 80 acres on State Route 220, just south and east of Waverly, to accommodate 250 temporary houses on about January 20, 1953. Shortly thereafter, 120 acres of land were acquired on the north side of State Route 124, approximately 1 mile east of Piketon, to accommodate 150 temporary houses and 350 rental trailers. Views of temporary housing are shown in Figures 17 through 20.

Both sites were of sufficient size to permit future expansion. The site at Piketon also included space for a temporary school building. Locations for the temporary housing projects were coordinated with FHA in order to avoid any conflict with the permanent housing program.

Figure 17. Trailer Park Housing for Employees and their Families (1953)
A young boy is seen entertaining himself outside the family dwelling.

Figure 18. PORTS GAT Employees Temporary Housing near Piketon (1954)

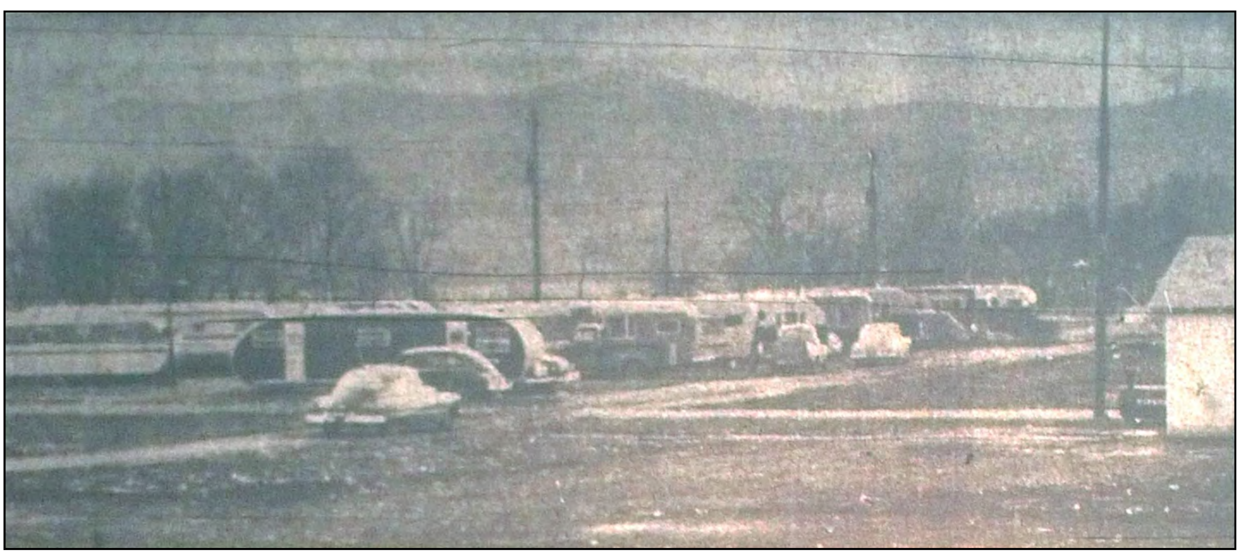

Figure 19. Sun Valley Trailer Court on Rt. 23, South of Waverly (1953)
Taken from *The Waverly News and Republican Herald*, January 8, 1953

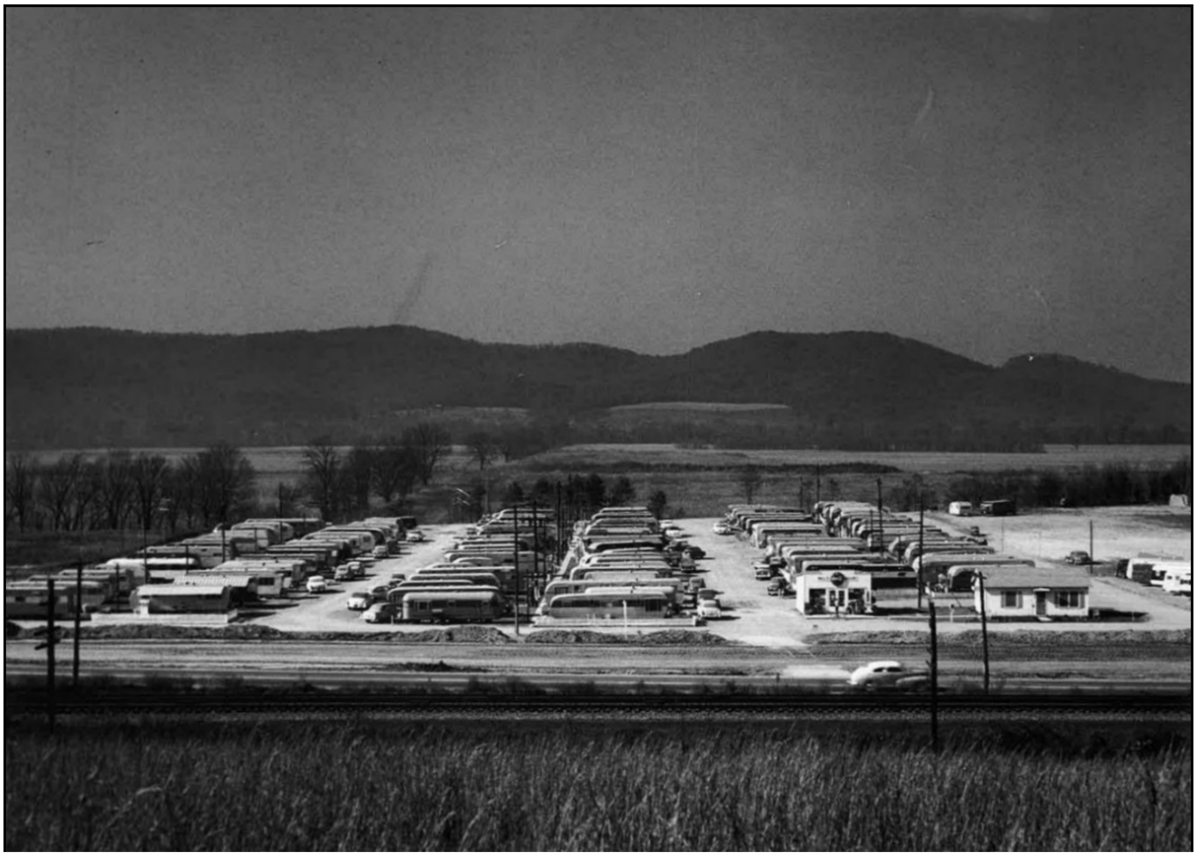

Figure 20. Schmidt's Trailer Court, November 10, 1953

Waverly received a federal grant under Public Law 139 in the amount of $598,300 during the early part of 1953 for expansion of its sewage system, and a loan of $75,000 in connection with expansion of the water system. The community of Waverly voted for a bond issue of $600,000, which defrayed the major portion of the water program.

Piketon financed the construction of a water system entirely with its own funds through a bond issue of $230,000 and special assessments of $34,000. The village received a federal grant in the amount of $390,000 for the construction of a sewage disposal system, with a provision that services be extended at federal expense to the temporary housing site.

Temporary houses for the two PHA sites were prefabricated, portable, demountable, single-family units equipped with cook stoves using bottled gas, refrigerators, and oil-burning heaters. Each unit was connected to sanitary sewers, electric power lines, and a sanitary water supply. Rental for each unit was established at $56.75 per month, with fuel and utility costs to be paid by the tenant.

Construction of 250 temporary houses at Waverly, including the site work, began shortly after the award of a $1,484,500 contract by PHA to the Central Construction Company, Oshkosh, Wisconsin, on April 14, 1953. These houses were completed and fully occupied by August 31, 1954.

Construction of 150 similar houses and site work at the Piketon site was accomplished under a $1,078,000 contract, which included trailer installation, awarded by PHA to the Vitt Construction Company, Pocatello, Idaho. These houses were also completed and fully occupied by August 31, 1954.

Trailers provided by PHA for the two sites were completely furnished, and all units were metered for electricity and water. Oil burning stoves were provided for heating. Four-sleeper and six-sleeper trailers were installed, which rented for $44 and $48 per month, respectively.

Installation, mounting, and servicing of the initial 400 trailers for the Waverly site was accomplished by C. Ray Sykes & Associates, Inc., Columbus, Ohio, under a $454,000 contract awarded in April 1954, by PHA. Another trailer installation contract with the Vitt Construction Company in June 1954, provided an additional 150 trailer units at this site.

The 350 trailers for the Piketon site were installed by the Vitt Construction Company in conjunction with their contract for the temporary houses at this location. The PHA trailer projects were likewise completed and occupied by August 31, 1954. Privately owned trailer lots in the four-county area accommodated an estimated 3,700 privately owned trailers at the peak of construction.

According to the information available to AEC at the time, vacancies in permanent housing projects in the area, including Title 2 and Title 9, totaled 650 units in August 1955. This figure does not take into account individual non-project type dwelling units which may have been available in the several communities. Four hundred of the vacancies were in Waverly.

As noted above, the construction employment peaked in May 1954. In late spring and early summer of 1955, the private housing developers in the area made substantial reductions in rental rates in an effort to attract tenants.

The Waverly temporary housing project was completely vacated and closed to further occupancy on September 30, 1955. The few tenants remaining either moved into permanent type housing or transferred to the Piketon temporary housing project, which at that time had less than 200 occupants. The initial target date for closing this housing project was March 31, 1956. The trailers in both projects were assigned to disaster areas or were transferred to other government agencies, and subsequently removed. Utilities were abandoned and temporary housing was sold by the PHA under sealed bids with the provision that the purchasers remove the houses from the sites.

The expansion of Piketon and Waverly due to the increase in building to support an influx of population can be seen by viewing aerial photographs taken prior to and following construction of PORTS. An aerial map of Waverly, obtained from the Ohio Department of Transportation for the time prior to the construction of PORTS (1946), is shown in Figure 21. An aerial map showing the expansion of Waverly following construction of PORTS (1960) is shown in Figure 22. Similar aerial maps, included as Figures 23 and 24, illustrate the effect of PORTS construction on the expansion of the community of Piketon.

Figure 21. 1946 Aerial Map Showing Waverly, Ohio, Prior to the Construction of PORTS

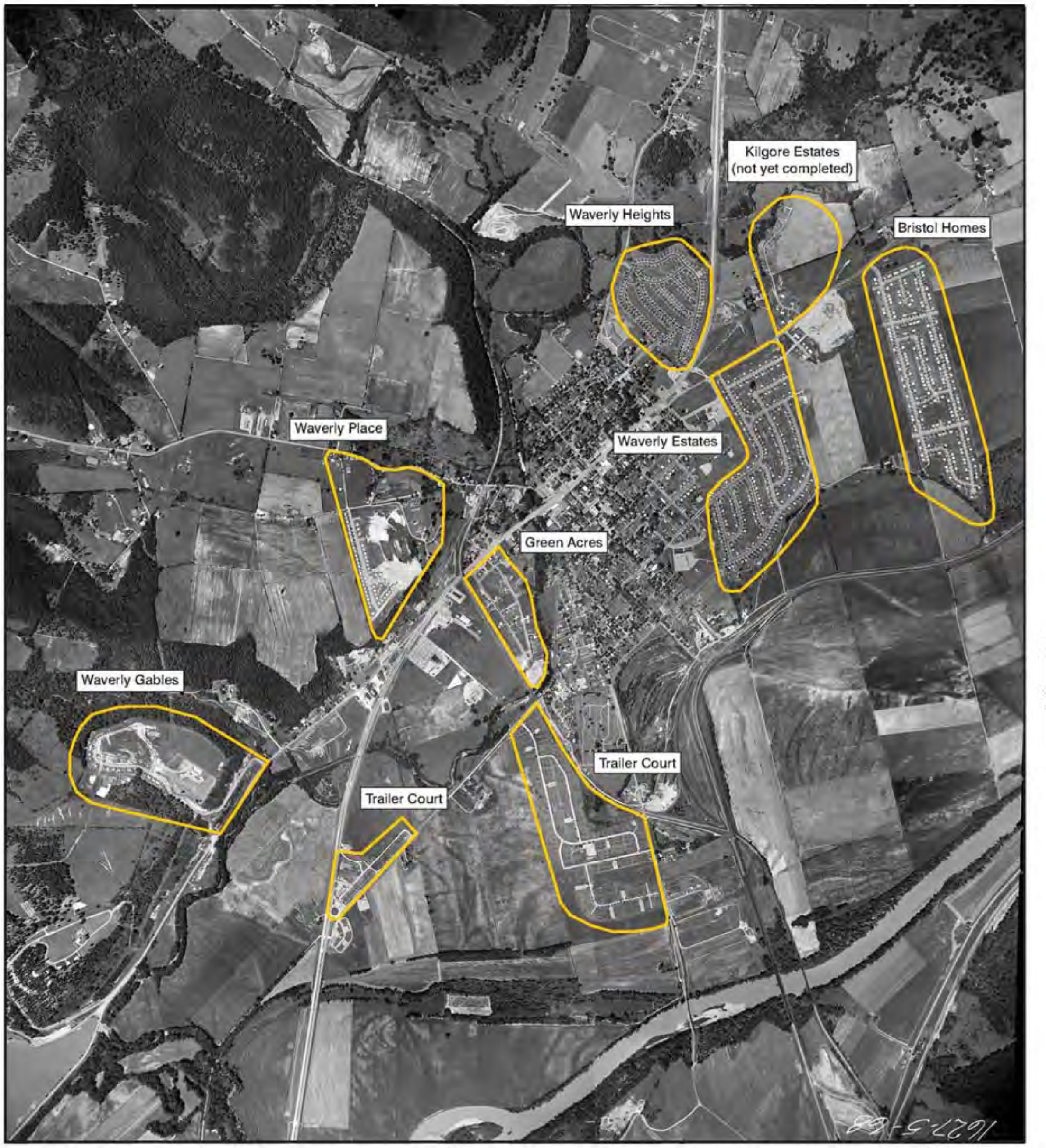

Figure 22. 1960 Aerial Map Showing the Expansion of Waverly, Ohio, Following Construction of PORTS

Figure 23. 1946 Aerial Map Showing Piketon, Ohio, Prior to the Construction of PORTS

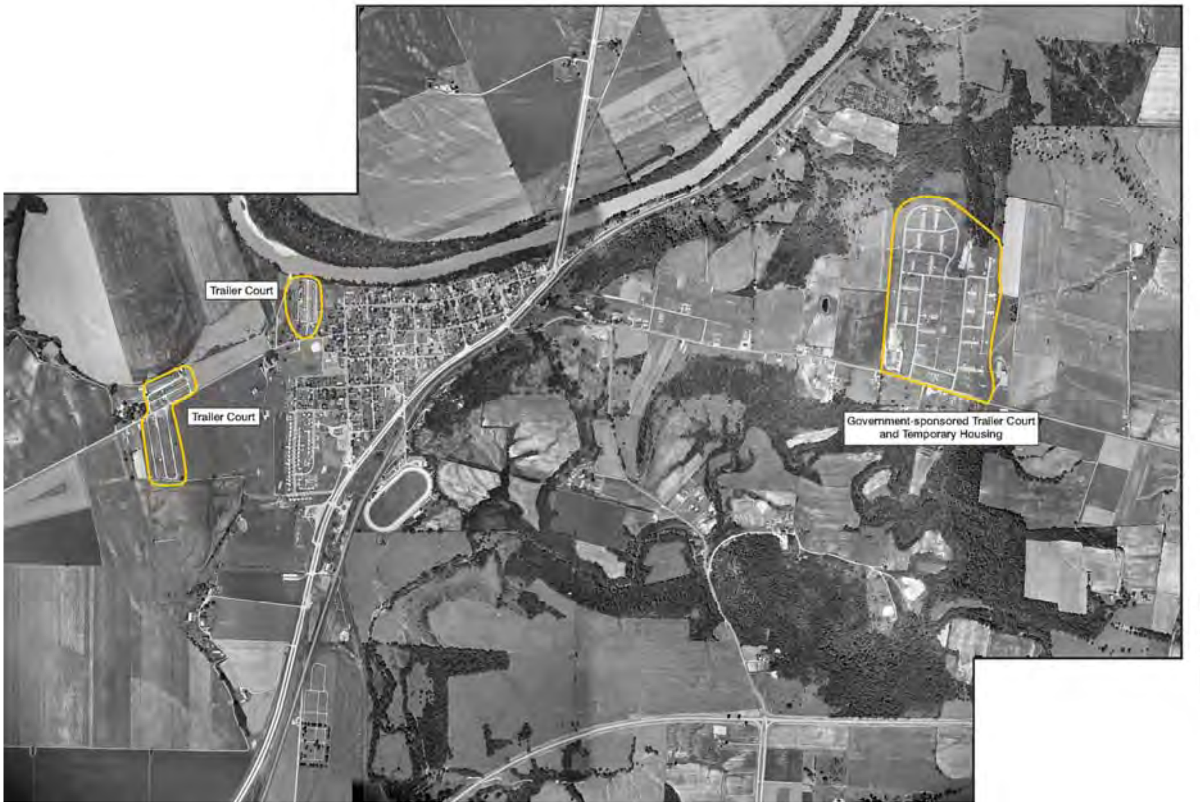

Figure 24. 1960 Aerial Map Showing the Expansion of Piketon, Ohio, Following Construction of PORTS

1.6 SCHOOLS

In 1954, the U.S. Office of Education approved federal aid for construction of permanent schools in the area. Table 5 lists the funding provided for the construction of PORTS area schools.

Table 5. Funding Provided for the Construction of PORTS Area Schools

School	Funding (Dollars)
Waverly	$865,150
Piketon No. 1	$476,450
Piketon No. 2	$225,500
Clay Township – Scioto County	$246,350
Valley Township – Scioto County	$518,700
Minford	$138,450
Jackson	$241,800
TOTAL	**$2,712,400**

In addition, temporary schools were constructed with federal funds:

- Jasper District, approximately 1/4 mile west of Jasper on a 10-acre site. Occupancy of the 13-room elementary school was scheduled for January 1955. The contract was awarded to H & N Construction Company and Blake Brothers of Columbus at a cost of $223,050 in July 1954.

- Piketon District, adjacent to the east edge of the PHA project on Route 124 approximately 1 mile east of Piketon on a 10-acre site, with access walks leading from the PHA housing. Occupancy of the 11-room elementary school was scheduled for January 1955. The contract was awarded to H & N Construction Company and Blake Brothers of Columbus at a cost of $192,050 in July 1954.

- Scioto District, southwest of Wakefield, adjacent to the southwest corner of the Wakefield trailer court on a 10-acre site. Occupancy of the 18-room elementary school was scheduled for January 1955. The contract was awarded to Knowlton, Inc. of Bellefontaine, Ohio, at a cost of $298,800 in July 1954.

Under the permanent school program, a new 14-room elementary school was constructed at the northwest corner of re-routed State Route 124 and State Route 220, and in Waverly, an 18-room elementary school was constructed.

1.7 SITE CONSTRUCTION

PORTS was designed on the primary basis that its production rate would be approximately one-half of the expanded Oak Ridge-Paducah combination. It was also part of the design philosophy to provide for sufficient flexibility, wherever the economics justified it, to permit efficient combined operation of any two of the three sites in case the third was rendered inoperable for any extended period. The chief implication of this design criteria was the inclusion at the new site of sufficient flow capacity to permit efficient operation under production conditions equivalent to those of the Oak Ridge-Paducah combination.

The gaseous diffusion process at all three plants occurred in the same manner. Compressors forced pressurized uranium hexafluoride gas (UF_6) through a long series of pervious barriers. These barriers are housed inside converters. Each converter and its compressor comprise a cascade, and each converter within a cell constitutes a single stage. PORTS consisted of five types of stages, and had approximately the same ultimate production capacity as the expanded Oak Ridge Plant, but with nearly 800 fewer stages.

The construction contractor, Peter Kiewit Sons' Company, had a background consisting of two generations of construction experience (Figure 25). Since its founding in 1884 by Peter Kiewit, Sr., father of the then-president of the firm, the company had grown to be one of the largest construction organizations in the United States.

Early construction planning took place in city buildings in Portsmouth, including the National Guard Armory and the Elks Club (Figure 26). Each building was packed with architects, engineers, and drafting tables. Even the old farmhouses on the site served temporarily as offices for architect engineers.

Figure 25. Signing of the PORTS Construction Contract (1952)
Kenneth Dunbar (left), AEC Manager for the Portsmouth Area, watches as Peter Kiewit, Jr., president of Peter Kiewit Sons' Company, signs the construction contract.
Looking on is Kiewit's General Manager George Holling.

Figure 26. PORTS Employees in Makeshift Offices at the Elks Club, Portsmouth (1952)

Eight architect engineering firms shared in the design of the plant. Approximately 12,000 architectural-engineering drawings were used during construction – enough to cover approximately 2.5 acres. In addition, general engineering drawings totaled roughly 40,000 along with 16,000 shop drawings.

Advanced planning and scheduling were very important since the plant was designed to go into operation or "on stream" as soon as each unit was completed in a process building. This meant that sections of the building could be operational even though construction continued in other parts of the same building.

Groundbreaking for the plant occurred on November 18, 1952. To provide a suitable area for constructing the process and auxiliary buildings, a tract of land roughly 4,000 to 6,000 ft was graded to minimum slope for surface drainage. Altogether, site grading required 9 million cubic yards (cy) of excavation and backfill. There were strict guidelines on the type of backfill that could be used, the method in which the fill was compacted and the final density of the fill. A well-compacted base was important for buildings that measured in acres instead of square feet. The assurance of a minimum of settlement was essential because of the miles of piping which would be mounted in the buildings.

At this early stage of the project, a number of activities occurred almost simultaneously. Roads were built around and through the site to allow easy access to locations of construction. "Track alleys," needed for plant operation, were constructed to facilitate movement of materials and supplies into buildings using tracks. In addition to the track alleys, 22 miles of railroad track and 25 miles of road were laid inside the plant area. The proximity of rail lines figured heavily in the plant site selection process, as rail service was critical for the success of the construction project as well as long-term operation (Figures 27 and 28).

Figure 27. Shipping and Receiving Personnel Standing on an AEC-owned Locomotive (ca. 1955)

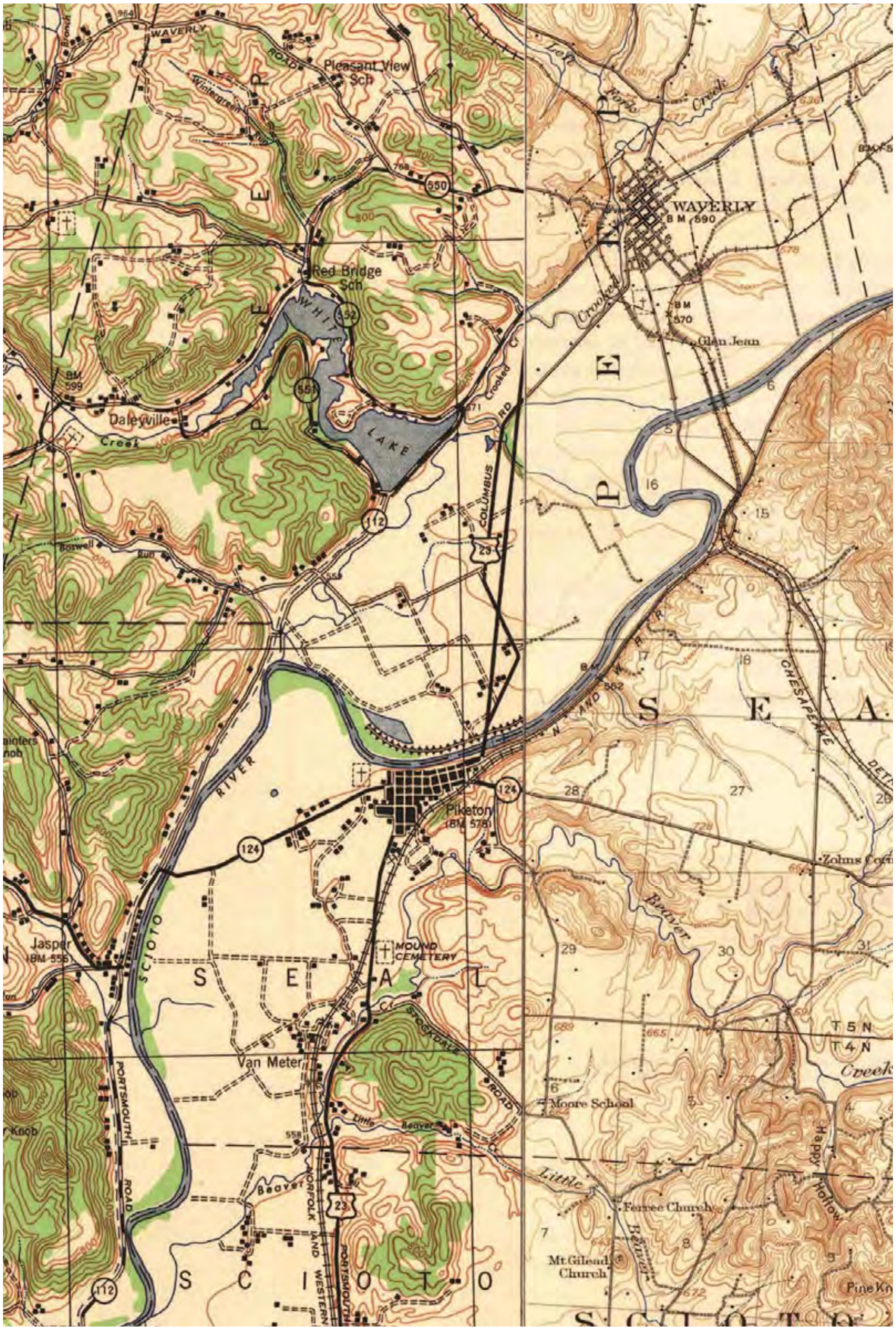

Figure 28. 1944 Piketon and Waverly Topographical Maps Showing the Transportation Networks of the Area Prior to PORTS (U.S. Geological Survey 1944)

Administration offices, warehouses, cafeteria, and services buildings were constructed as temporary buildings with utilities such as power, water, sewage, and communications (Figure 29).

One of the basic construction materials was concrete. To speed up construction, one central batching and mixing plant was erected at the site to supply all contractors (Figure 30). This plant had a capacity of 200 cy/hour and produced more than 500,000 cy for the project. Daily cement requirements averaged 2,500 barrels. Transit mixers delivered concrete from the mixing plant to the job. Permanent overhead building cranes capable of handling up to 23 tons were installed early in order to use them for moving heavy equipment as well as pouring concrete.

During construction, there were on-site meteorologists to provide contractors with up-to-date weather forecasting so they could both schedule work properly and protect existing construction. Many times, this allowed contractors to cover fresh concrete with canvas to protect it from rain which was predicted to arrive as a result of a sudden change in the weather.

Approximately 100,000 tons of structural steel were used in the framework of the main buildings. Receiving, unloading, and sorting the thousands of tons of steel at the site on schedule called for efficient teamwork. Standard lumber carriers transferred most of the material to the contractors' job locations (Figure 31).

Blue Rock Quarry of Greenfield, Ohio, supplied the crushed stone for the temporary PORTS roads as well as other plant construction purposes (Figure 32). Some 35 to 50 carloads of stone were transported via rail each day during the height of construction. Blue Rock maintained its own yards in Waverly, where contractors retrieved the material for delivery to the construction site. Prior to the PORTS project, the quarry employed 30 to 35 men in one shift. As work commenced on the massive project, Blue Rock scheduled two shifts of 25 men each.

The three process buildings were of a standard industrial type with concrete foundations and floors, structural steel frames, siding, and steel deck roof with built-up roofing (Figures 33 and 34). Functional and plain, lined sheets of corrugated siding were bolted to the steel structures. Placement of the baseplates for columns of the buildings was held off as long as feasible to permit maximum foundation settlement. After placing the baseplates at an exact elevation, they were grouted beneath by a placement of low-shrinkage grout. In constructing ground floors of the process buildings, wire mesh was put into place and then concrete poured to form a continuous slab 6 to 8 in. thick. Concrete was struck off by a finishing machine which advanced the process and decreased labor cost. However, finishing to exact dimensions had to be done by hand.

The process building roofs were nearly flat with just enough slope for roof drainage. The roof was constructed by spot welding a metal decking to the structural steel. One-inch fiberglass insulation was laid, covered with four-ply built-up roofing, and finished with a wearing course of cement and gravel.

One of the largest and most important operations in the construction work was the fabrication and assembly of the thousands of feet of piping for the process buildings (Figure 35). Piping conveyed the gas from one stage to another in the gaseous diffusion cascade. Altogether, the plant required 620,000 linear ft of automatic and hand-welding on pipes ranging from 1/4 in. to 4½ in. in diameter. Prefabrication of more than 100,000 individual piping assemblies and 225,000 pipe hanger assemblies provided great savings in time and money. Welders had to pass rigid qualification tests to determine the type of work they were qualified to do. This was necessary because of the variety of processes and variety of metals and alloys. At peak effort, 1,200 welders were employed.

Figure 29. Temporary Administration Building (ca. 1953)

Figure 30. Central Concrete Batching and Mixing Plant (in background) (1953)

Figure 31. Standard Lumber Carrier Transferring Construction Materials (1954)

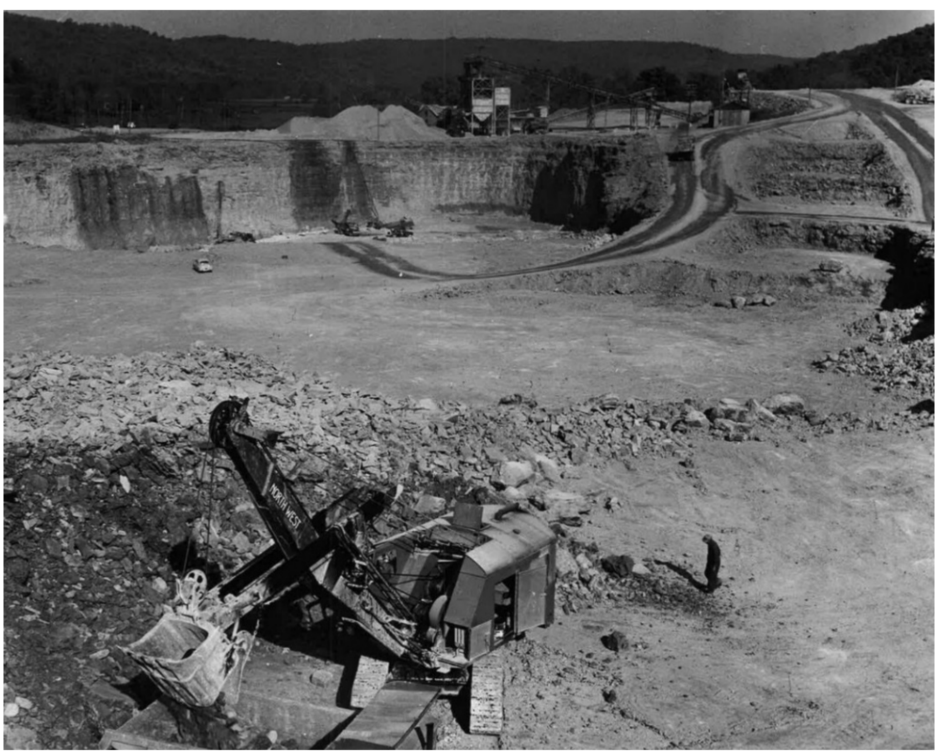

Figure 32. Blue Rock Quarry, Greenfield, Ohio, October 12, 1953 (PORTS History Collection)

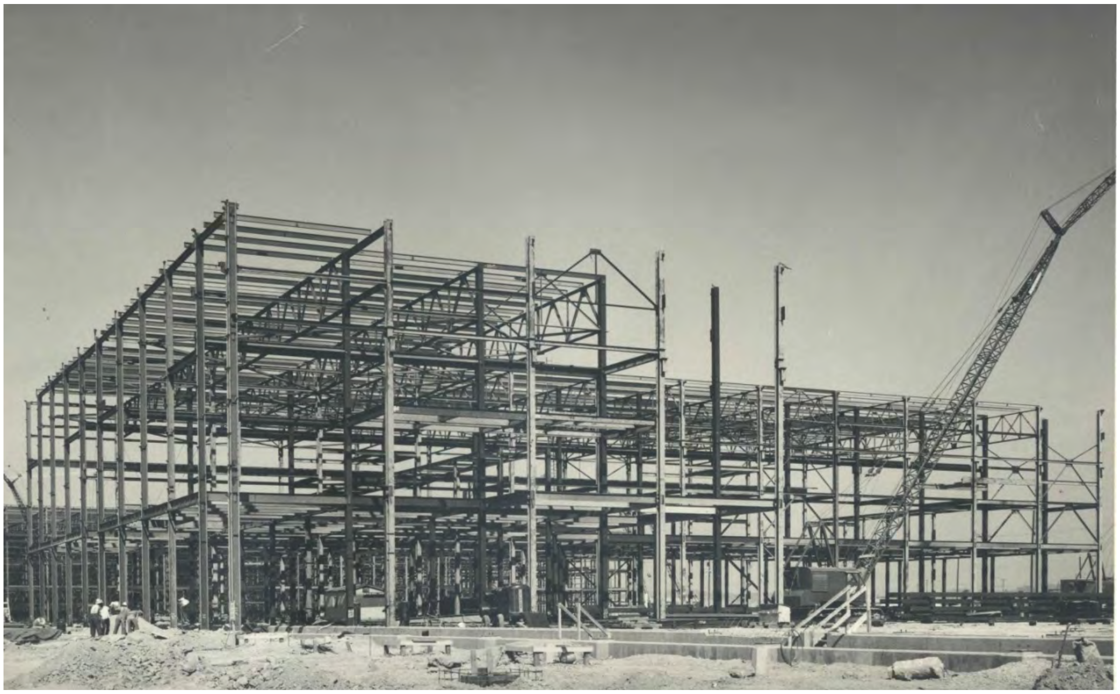

Figure 33. X-326 Process Building under Construction, October 16, 1953

Figure 34. Peter Kiewit Sons' Workers amid the Framework of One of the Processing Facilities (1953)

Figure 35. PORTS Workers Assembling Fabricated Piping (1954)

Because of the highly corrosive nature of uranium gases, all steel piping had to be lined with pure nickel. In addition, cleanliness control was essential since the process gas is so highly reactive that it combines and reacts with almost every substance, forming solids that could clog the system. Sections of pipe were dipped in chemical reagents in huge cleaning vats to remove foreign matter. Each piece of pipe was handled carefully to avoid contamination with dirt, dust, or water. After dipping and cleaning, the ends of the pipes were sealed to prevent matter from entering until piping was welded in place. Process building floors were not only swept but vacuum cleaned to be spotless. The air pressure inside the buildings was kept higher than the air pressure outside to keep dust from getting in.

Since the gaseous diffusion process produced great quantities of heat, principally "heat of compression," cooling towers were constructed for each of the process buildings to remove the heat. The towers were erected on concrete slabs 20 in. thick. Huge forms were used and reused in the pouring of the concrete walls. Columns and beams that were prefabricated at another area were hauled to the site on trucks and set in place by cranes. Redwood was used in the super structure of the towers to reduce decay. The cooling towers released 20 million gal/day of evaporated water (steam) into the atmosphere.

The towers were one of the reasons that an adequate water supply was important to the location of the new plant. A pumping station at the Scioto River in Piketon with a daily pumping capacity of 40 million gal was erected to furnish the plant with water. The water was piped to the plant through a pipeline to the plant's water treatment plant, where it was then distributed throughout the site.

Power for the plant was generated by the Ohio Valley Electric Corporation (OVEC) and was delivered to the plant by two double-circuit lines at a nominal 330,000 V that was in 1956 equal to the all-time high voltage record in the United States (Figure 36). Each circuit had a capacity of 1,000,000 kW for line sections 50 to 75 miles in length. At the plant, the circuits fed into substations that consisted of switchyards, switch houses, and control houses. The two on-site switchyards required the largest oil circuit breakers ever used in this country. Once the enormous amount of power was stepped down by transformers in the switchyards, it was sent to the thousands of electrical motors and other machines within the plant by way of underground ducts containing a network of conduit, cable, and wiring running from the substation.

Figure 36. Large Oil Circuit Breakers in the Former X-533 Electrical Switchyard Complex (1954)

The building of the plant entailed 69 million man-hours from as many as 22,500 workers at the peak of construction in 1954. More than 7.5 million cy of earth had been moved and 1,200 acres of land cleared. In the first year of construction, an astonishing 35,000 tons of steel were erected and 190,000 cy of cement poured. Site wide, 500,000 tons of crushed stone were distributed. To complete the construction phase, staggering amounts of materials were required, including 14,500 tons of railroad rails; 600 miles of pipe (all sizes); 1,065 miles of copper tubing; 4,600 miles of electrical wiring; and 620,000 ft of welding. In addition, during the construction phase, the 1.2 million gal of water per day were supplied by three wells.

The transformation of the PORTS landscape from rural southern Ohio Appalachian farmland to an industrial expanse occurred over the course of approximately 2 years. A series of panoramic views shows the progression of PORTS construction from February 1953 to October 1954 (Figures 37 through 40).

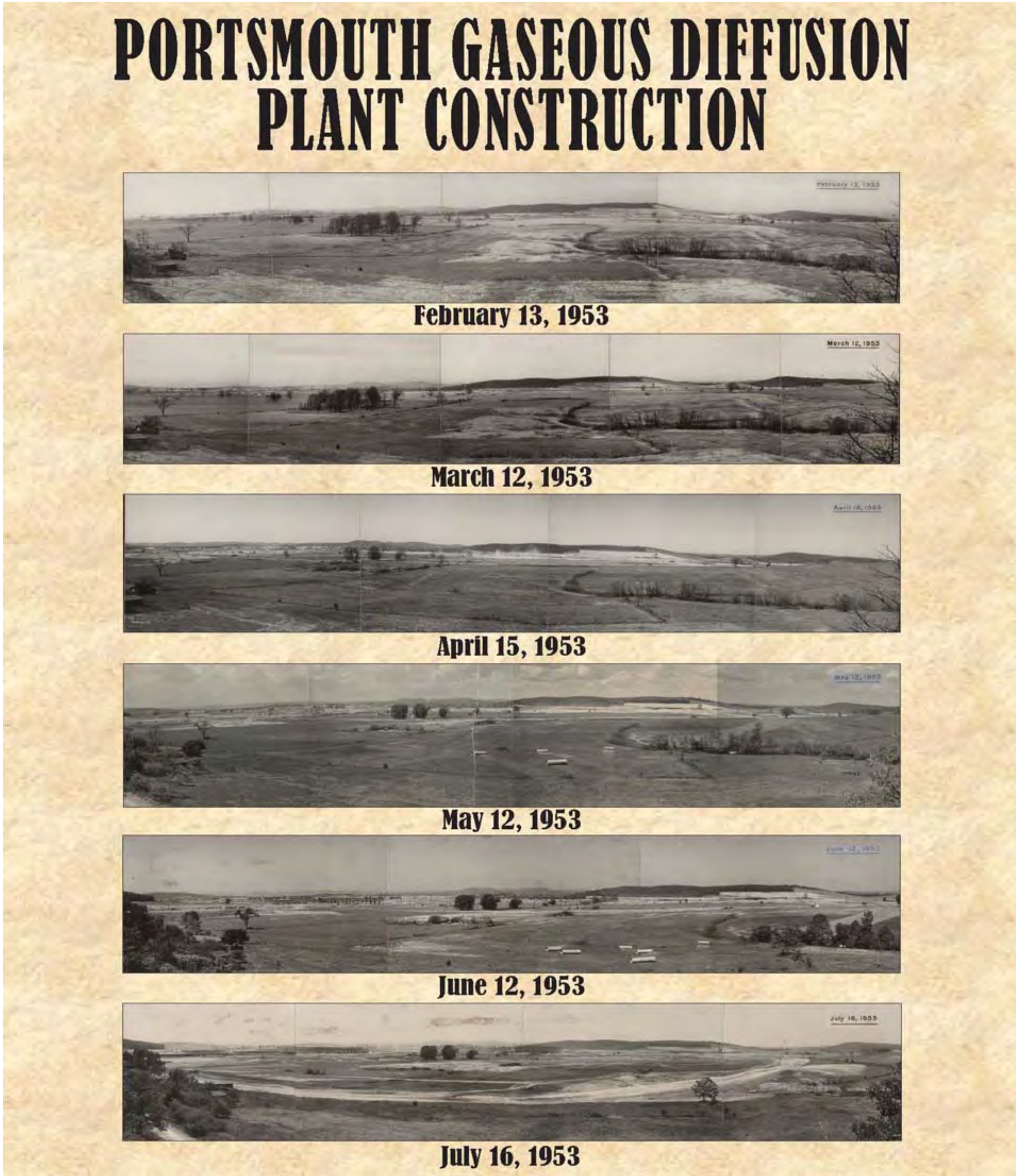

Figure 37. Panoramas Showing PORTS Construction Progression February 1953 to July 1953

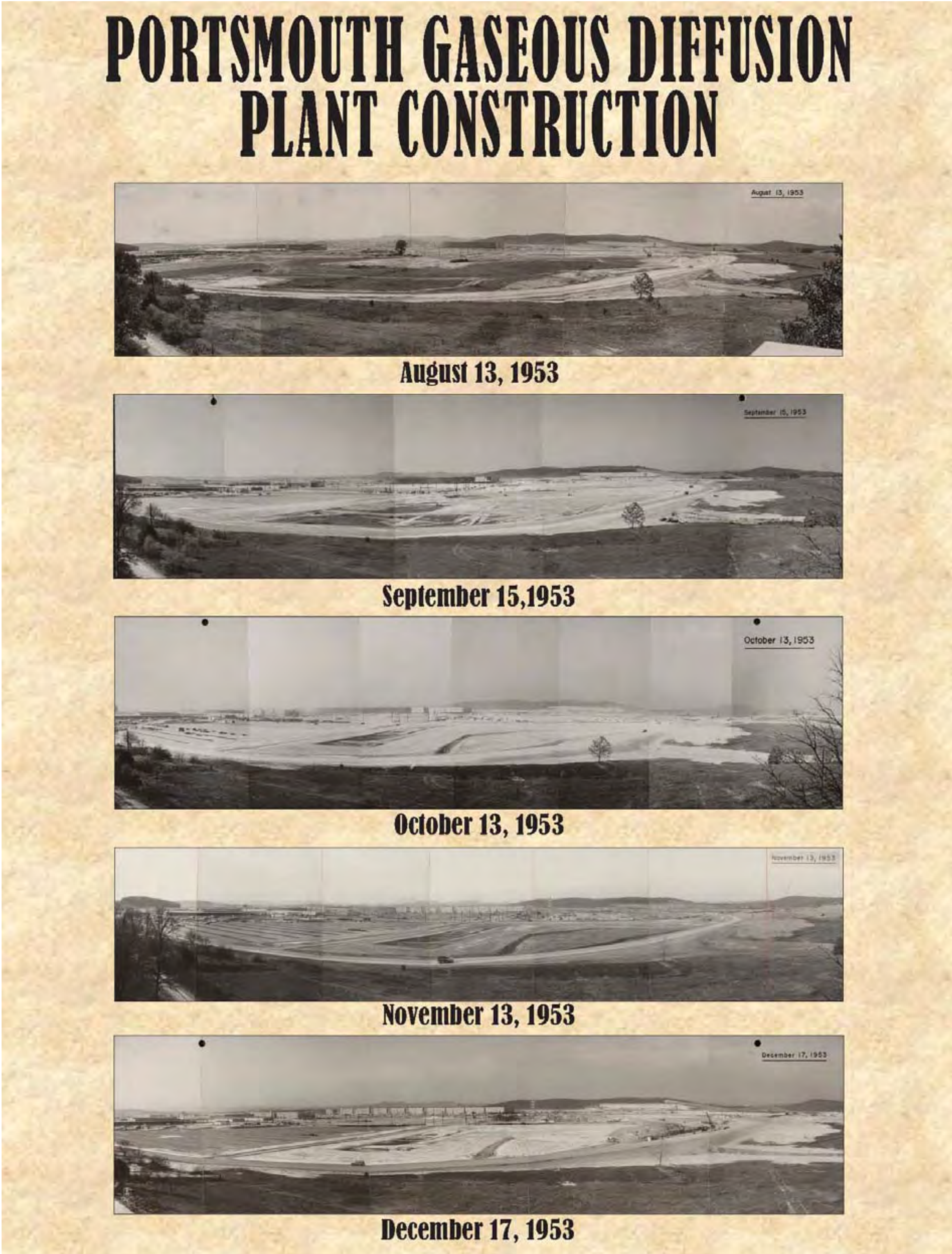

Figure 38. Panoramas Showing PORTS Construction Progression August 1953 to December 1953

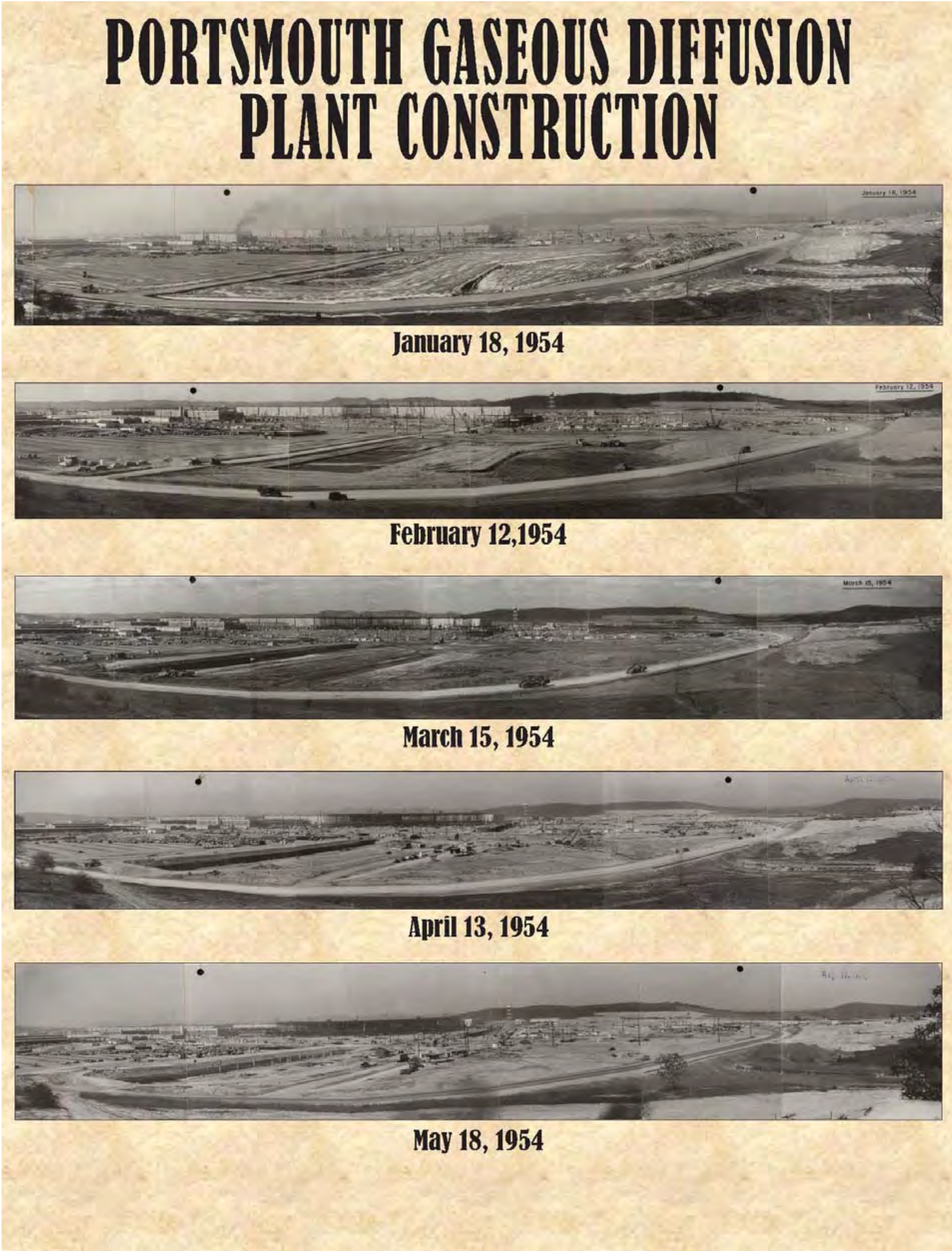

Figure 39. Panoramas Showing PORTS Construction Progression January 1954 to May 1954

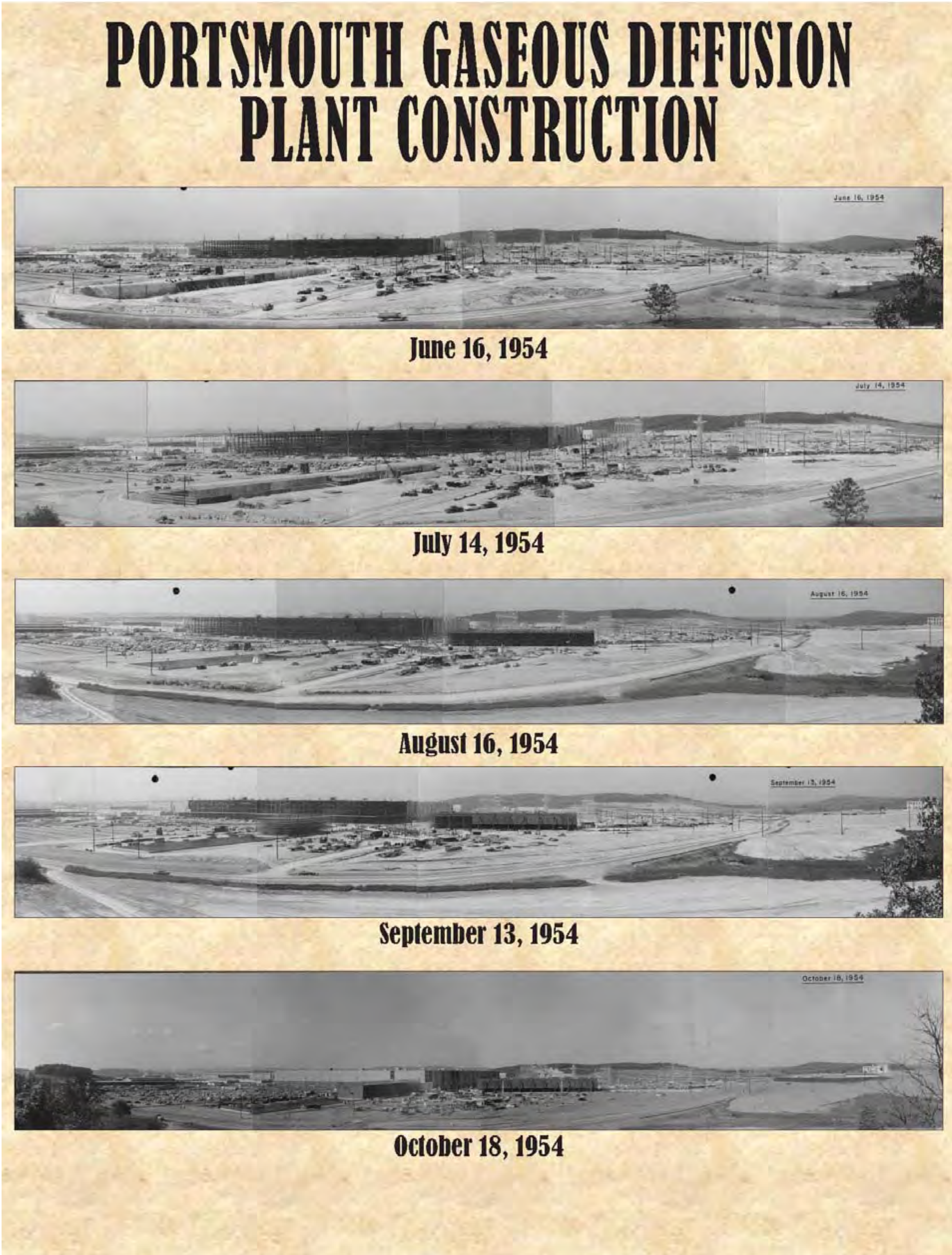

Figure 40. Panoramas Showing PORTS Construction Progression June 1954 to October 1954

The first production operation at PORTS began in 1954. Full operation was achieved in March 1956, 6 months ahead of schedule. By August of 1956, only a handful of construction workers remained on site. As the construction phase came to an end that month, the AEC advertised an auction for surplus materials. Auctions occurred as early as May 14, 1955, and continued through at least August of 1956 (Figures 41 and 42). Some $5.25 million worth of construction materials and machinery went on the auction block on August 22 and 23, 1956. The auction featured 1,004 lots, which included a vast array of items. Virtually every building material, tool and machine used in the construction industry came available for bidding, including trucks, railroad ties, welding equipment, safety equipment, testing devices, plumbing supplies, nails, nuts, bolts, clothing, generators, and countless other items. Douglas Corp., the auctioneer in charge of the event, provided buyer's guides and maps detailing the types and locations of the various items. Potential buyers could only bid on entire lots, as Douglas Corp. would not sell individual tools or materials. The public sale was the largest to occur in south-central Ohio up to that time.

Figure 41. PORTS Surplus Auction, May 14, 1955

Figure 42. PORTS Surplus Auction, May 14, 1955

Once built, the huge complex, with more than 130 buildings, became much like its own small city within the plant site. As seen in Figure 43, services such as a police force and a fire department (complete with emergency equipment), a water treatment facility, a sewage system, an electrical switchyard, a hospital, transportation provisions, maintenance shops, offices, and laboratories, all centered around the three huge uranium processing buildings. Office space accommodated those working in finance, human resources, training, and support functions.

Fire Chief with dogs, Atom & Eve (1954)

Site Police Force (1954)

X-611 Water Treatment Plant

Former X-533 Electrical Switchyard Complex

Site Medical Services (1954)

Communications Switchboard (1954)

Figure 43. Support Services at PORTS

Adding GAT personnel was a slow process at first, but increased more steadily as construction progressed. By the summer of 1954, GAT had 1,800 people on staff of the expected 4,000 projected number of employees required for running the plant at full operation. With construction still in progress, employee offices were first located off site. In Portsmouth, cramped quarters of the Elks City Club, the local Armory, and even the Court House served as temporary work stations. When the first wing of the training building opened, employees moved in, and instruction continued accompanied by the sound of construction. Some of the first operational aspects that GAT assumed included switchboard functions and command of the fire department.

On March 20, 1956, it was announced that the plant was in full operation, approximately 6 months ahead of the 4 years it was scheduled to take. The final cost of the plant was $750 million, an amazing $470 million less than the original estimated cost of $1.2 billion.

The plant's production operation was an outstanding example of automation. Control was achieved through delicate instruments connected to operating equipment by means of tubing. More than 1,000 miles of tubing threaded through the plant and eventually ended in the control room. This allowed immediate detection on any malfunction such as a burned out motor, clogged barrier, broken compressor blade, increase in pressure, etc.

In the 1960s, the mission of PORTS changed from enriching uranium for nuclear weapons to one focused on producing fuel for commercial nuclear power plants. PORTS still produced highly-enriched uranium (HEU) for the U.S. Naval submarine reactor program until 1991. PORTS and its sister facility in Paducah worked in tandem to enrich uranium for use in commercial nuclear power plants until 2001. The Paducah plant enriched uranium-235 up to 2.75 percent and then shipped it to PORTS to be further enriched to approximately 4 to 5 percent for nuclear power reactors.

Throughout its life, PORTS experienced many changes to update equipment, modify processes, and increase efficiency or production. Two significant programs were initiated in 1973: the Cascade Improvement Program (CIP) and the Cascade Upgrade Program (CUP). These multi-year initiatives increased PORTS production by 65 percent.

President Gerald R. Ford signed the Energy Reorganization Act of 1974 on October 11, 1974, marking the end of the 28-year era of the AEC. By January 19, 1975, the AEC research and development duties became the responsibility of the newly-formed Energy Research and Development Administration (ERDA), and the U.S. Nuclear Regulatory Commission (NRC) assumed regulatory and licensing tasks.

Meeting the increasing energy needs facing the nation continued to be a pressing issue for the government. President Jimmy Carter took action again as he signed the Department of Energy Organization Act of 1977. This Act placed all federal energy agencies and their corresponding programs into one entity: the U.S. Department of Energy (DOE). The one exception was the nuclear power industry, which the NRC governed. Additionally, the Act stipulated that DOE was to interact with other related agencies, such as the U.S. Environmental Protection Agency (EPA), the Bureau of Mines, and the NRC in a joint effort to serve the nation.

DOE assumed the former responsibilities of ERDA as well as other energy-related agencies, including management of the nuclear weapons program. The Act also directed DOE to adhere to the highest ecological and environmental standards as it conducted research and development efforts concerning new energy technologies. DOE was required to submit a National Energy Policy Plan biennially that detailed the status of the nation's energy needs and actions taken to meet those demands. The first secretary of the agency, James R. Schlesinger, was sworn in on August 5, 1977, 1 day following the signing of the Act that established the Cabinet-level department. The official date of record for the formation of DOE was October 1, 1977.

Also in 1977, President Carter announced plans to construct the next generation of uranium-enrichment technology at the PORTS site – a gas centrifuge enrichment plant (GCEP) project. Construction began in 1979. Two 303,000-sq ft process buildings, a centrifuge recycle and assembly building and several support facilities were constructed before the project was terminated in 1985 due to decreased demand for enriched uranium and increased international competition. DOE has leased the centrifuge facilities since 1993.

Beginning in the 1970s and growing significantly in the 1980s, environmental and safety concerns became prominent issues nationally, and PORTS was no exception. Significant changes occurred at PORTS in response to environmental issues raised both within the PORTS organization and by external parties. An extensive environmental cleanup program began at PORTS in 1989 as a result of a Consent Decree, signed between DOE and the State of Ohio, and an Administrative Consent Order with DOE and EPA (amended in 1997 to a tri-party agreement between DOE, EPA and the Ohio Environmental Protection Agency). The primary regulatory driver of the cleanup program at PORTS is the Resource Conservation and Recovery Act of 1976, as amended.

In response to environmental concerns and to eliminate stockpiles of a by-product of the uranium enrichment process, DOE awarded a contract in 2002 to design, build, and operate depleted uranium hexafluoride (DUF_6) conversion facilities at PORTS and Paducah, Kentucky, and process nearly 700,000 metric tons of DUF_6 to a stable form for reuse or disposal. More than 25,000 DUF_6 cylinders are in inventory for processing at PORTS, including inventory from the Oak Ridge, Tennessee, uranium enrichment facility.

An aerial view of PORTS is shown in Figure 44. The three large processing buildings are seen in the central portion of the plant site, and the former GCEP buildings are seen in the upper right portion of the plant site.

Figure 44. View of PORTS (2006)

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2. TIMELINE AND KEY DATES

The AEC built PORTS in the early 1950s as a significant component of an overall expansion of the process for providing enriched uranium for weapons production. In addition to the Oak Ridge and Paducah production facilities, the third site (PORTS) was needed to produce enriched uranium-235 by the process of gaseous diffusion. During its years of operation, PORTS supplied enriched uranium to be used for weapons production and by nuclear power plants to generate electricity worldwide. Also, under a peace initiative, the plant provided enriched uranium for use in research, medicine, testing, and development programs throughout the world. This time line, presented as Table 6, traces the history of PORTS through its management, operations, and role in the uranium-enrichment industry until the collapse of the Soviet Union and end of Cold War hostilities in 1991.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s - 1991

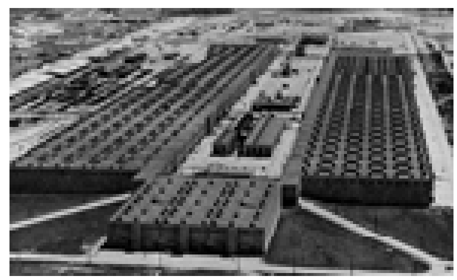
Year	Events
Early 1940s	Uranium enrichment begins as a U.S. defense initiative to produce fissionable material for the atomic bomb.
1945	The first U.S. gaseous diffusion plant, K-25, at Oak Ridge, Tennessee, went on line. 
1946	In July, the AEA is passed, which established the AEC to replace the Manhattan Project. The Act also placed further development of nuclear technology under civilian (not military) control. The AEA, signed by President Harry Truman on August 1, 1946, transferred all atomic energy activities to the AEC on January 1, 1947.
1952	In April, the AEC announced a proposed expansion of the nation's atomic energy program, specifically a new gaseous diffusion uranium enrichment plant.
	In August, the AEC announces the selection of the Ohio River Valley of Pike County, Ohio, for the third uranium enrichment plant to be built in the United States.
	In September, the AEC selects Goodyear Tire & Rubber Corp. as the PORTS operator. Goodyear creates GAT to operate the plant. The Paducah GDP's original plant design was completed and in operation two months ahead of schedule, with the first production cells on line.
	In October, Peter Kiewit Sons' Company was named as the prime contractor for PORTS by the AEC.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s – 1991 (Continued)

Year	Events
1953	In February, the first five GAT employees were hired: Don Jones, Gene Newman, Ben Kalmon, Virginia McDonald, and Marvin Lowman. The first employee group (38) was assigned that month to Oak Ridge and Paducah for training.
	The first process and plant description training course was started in September.
	On December 8th, President Dwight D. Eisenhower speaks before the 470th General Assembly of the United Nations and gives his "Atoms for Peace" address, which proposes joint international cooperation to develop peaceful applications of nuclear energy. 
1954	The plant telephone system was placed into operation in February. A total of 24,863 calls were made during the first day of operation.
	Peter Kiewit Sons', the prime contractor, released eight buildings to GAT and the U.S. Highway 23 cloverleaf opened in June.
	First cascade unit at PORTS was placed in operation and first product withdrawal was made in September.
	Also, in September, the first GAT employees began moving into the X-100 Administration Building.
	OCAW were selected to represent production and maintenance employees in November.
	Employee population increased from 1,019 in early 1954 to 2,700 by the end of the year.
1955	In February, Clifty Creek Unit #1 in Madison, Indiana, and Kyger Creek Unit #1 in Gallipolis, Ohio, were placed in operation, representing the first two of 11 215,000 kW generating units at these plants that would be required to supply the electrical power requirements for PORTS.
	UPGWA was selected to represent guard force in April.
	The first contract was signed with OCAW.
	Uranium was sold by the federal government to a public utility for the production of electricity for the first time.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s – 1991 (Continued)

Year	Events
1956	Contractors complete PORTS construction 6 months ahead of schedule and full production begins in March. 
1957	The first shipment of uranium under the Atoms for Peace Program was made from PORTS in August.
1958	In April, a new test loop was completed in the X-770 Building at a cost of $300,000.
	Construction began on a new water tank as part of the process building sprinkler system in December.
1962	Operational review showed that GAT had shipped $86 million of enriched uranium for peacetime use.
	The annual payroll reached $11.5 million.
1964	Production of weapons grade material ceases. Plant shifts from military (weapons-related) mission to defense and commercial application. Specifically, HEU continued to be produced for the U.S. Naval submarine reactor program and enriched uranium was supplied to electric utilities operating nuclear power plants.
	In October, employment was 1,139, its lowest level since operations began.
1966	U.S. government authorizes a program for a 50 percent increase in enriched uranium production for peacetime uses.
1967	Planning and preliminary engineering activities began for expansion of the Oak Ridge, Paducah, and Piketon GDPs as part of the CIP/CUP.
1968	In January, a new half-million dollar oxide conversion facility was completed and placed in operation at PORTS for the purpose of converting enriched uranium to UF_6.
	CIP and CUP plans were developed for upgrades to the three-plant complex located in Oak Ridge, Paducah, and Piketon. The $270 million combined total upgrade was projected to result in an investment of $78 million at PORTS by 1980.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s – 1991 (Continued)

Year	Events
1969	The first shipment of privately owned UF_6 for Enrichment Program services arrived at PORTS in February.
1974	Extensive progress is made in the CIP at PORTS, from the conceptual stage to engineering design to having 75 percent of the work completed for the required improvements in the production support facilities. Procurement activities began for the $84 million CUP at PORTS. The purpose of CIP/CUP improvements at the existing GDPs was to increase plant capacities to equal the production of a new plant in order to support the growing nuclear industry.
	A new transportation system for shipping fissile UF_6 using “Paducah Tiger” protective packages and specially-modified rail cars was developed and successfully passed extensive testing to meet AEC, U.S. Department of Transportation, and Association of American Railroad regulations for the safe transport of radioactive materials.
	On October 4th, President Gerald Ford signs the Energy Reorganization Act, abolishing the AEC and establishing the ERDA.
1975	On January 19th, NRC and ERDA assume AEC functions. NRC takes over regulatory oversight of nuclear power plants and ERDA assumes responsibility for uranium enrichment.
1976	Thirteen active subcontracts valued at $13,435,000 were undertaken at PORTS. Two of the contracts were for the cooling tower system at the X-633 Recirculating Water Pump House and Cooling Towers and the X-616 Liquid Effluent Control Facility, which reduced the hexavalent chromium content of the recirculating water blowdown to a limit that met the NPDES permit as designed to handle a flow of 1.5 million gal/day.
	Announcement of the plant “Add-on” project was made in November. This $4.4 billion project would make PORTS the largest enrichment facility in the world.
1977	The GCEP project was announced to supersede proposed gaseous diffusion “add-on” expansion at PORTS.
	President Jimmy Carter signed the Department of Energy Organization Act. Functions of the federal energy administration, ERDA, and the federal Power Commission were assigned to the newly-established DOE, which was officially formed on October 1st.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s – 1991 (Continued)

Year	Events
1978	On March 7, a 14-ton UF_6 cylinder rupture results in modifications to improve the cylinder-handling equipment used to transport UF_6. Improvements made in UF_6 handling practices, including the elimination of transporting UF_6 in the liquid state, further reduced the potential for accidents involving the handling of UF_6 cylinders. This incident also led to the implementation of a public warning system.
	Operation of the Oxide Conversion Facility ceased.
	Stone & Webster was named construction management contractor for GCEP by DOE.
1979	Ground is broken for the $3 billion DOE construction of GCEP at PORTS and first footers for the X-3001 Process Building are poured.  **Gas Centrifuge Enrichment Plant (2006)**
1981	Aluminum smelting project to recover usable materials completed at the X-744G Bulk Storage Building. The 411,000 lb of metal, which had been accumulated during CIP/CUP, is melted into 1,000 lb ingots for further disposition.
	392 cylinders of depleted uranium were shipped to France for use in its Eurodif GDP.
1982	DOE announced in March that GAT's contract was being extended 5 years and would be modified to include the operation of GCEP.
	Operations began in the plant's new uranium feed facility (X-343 Feed, Vaporization and Sampling Facility).
1983	Activation of the four large aeration tanks at the new X-6619 Sewage Treatment Plant took place in January.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s – 1991 (Continued)

Year	Events
1985	On June 5, DOE announced its intent to halt construction of GCEP and discontinue further research into advanced centrifuge uranium enrichment technology.
1986	On November 16, operation of the plant becomes the responsibility of Martin Marietta Energy Systems, Inc., with the transfer of GAT's contract for operating PORTS from the Goodyear Tire & Rubber Company to Martin Marietta Corporation.
1987	The Low-Assay Withdrawal (LAW) Station in the X-333 Process Building came on line in February.
	The Waste Management department was established in June to assure compliance with waste disposal regulations and planning for future PORTS waste disposal measures.
1988	A new public warning system of five sirens was installed along the perimeters of the plant; neighbors within the 2-mile radius of plant were given the opportunity to attend informational sessions in April and May 1988.
	The first full-scale emergency exercise with participation by the State of Ohio and federal agencies was held; use of the Joint Public Information Center was introduced.
1989	Uranium customers worldwide attended a conference at PORTS on the safe packaging and transportation of UF_6; the 75 participants represented six countries, 11 international companies, and 14 private companies.
	DOE consolidates responsibilities within its offices of environmental management activities and establishes the Office of Environmental Management to address and focus on environmental restoration, waste management, technology development, and facility transition and management. This centralized oversight demonstrated the government's commitment for environmental cleanup needed at the various locations within the U.S. nuclear complex due to past operations related to Cold War activities.
	DOE signs consent agreements with Ohio EPA and EPA to provide oversight for the Environmental Restoration Program at PORTS.
	PORTS was the site of the first known cooperative industry/union health protection course utilizing union members as trainers. In October, all of the plant's hourly employees received 3 days of hazardous materials and hazardous waste handling training from OCAW.

Table 6. Timeline of Key Events Related to PORTS and its Role within the Uranium Enrichment Industry, 1940s – 1991 (Continued)

Year	Events
1990	On July 19, DOE hosts the first public meeting on the clean-up program at PORTS. Speakers from DOE, EPA, Ohio EPA, the Ohio Department of Health, and various site contractors presented information on the historic changes in waste handling and disposition, environmental regulations, and the roles of the regulatory agencies.
1991	Conversion of the plant's cooling towers from the use of chromates to phosphates was completed.
	The year 1991 marked the collapse of the Soviet Union and an end to Cold War hostilities. On November 8, DOE Secretary of Energy Hazel O'Leary announces the decision to suspend the remaining production of HEU at PORTS (i.e., suspend production of HEU for the Naval submarine reactor program).

AEA = Atomic Energy Act
AEC = Atomic Energy Commission
CIP = Cascade Improvement Program
CUP = Cascade Upgrade Program
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
ERDA = Energy Research and Development Administration
GAT = Goodyear Atomic Corporation
GCEP = Gas Centrifuge Enrichment Plant
GDP = gaseous diffusion plant
HEU = highly-enriched uranium
LAW = low-assay withdrawal
NPDES = National Pollutant Discharge Elimination System
NRC = U.S. Nuclear Regulatory Commission
OCAW = Oil, Chemical, and Atomic Workers
Ohio EPA = Ohio Environmental Protection Agency
PORTS = Portsmouth Gaseous Diffusion Plant
UPGWA = United Plant Guard Workers of America

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3. URANIUM PRODUCTION FACILITIES

3.1 THE GASEOUS DIFFUSION PROCESS

Natural uranium ore contains several isotopes which differ by atomic weight. Isotopes are two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons. Atomic weight is determined from the total number of protons and neutrons in an atom. The two principal isotopes of uranium are uranium-238 and uranium-235. Every uranium atom contains 92 protons. In addition to the 92 protons contained in all uranium atoms, uranium-238 contains 146 neutrons and uranium-235 has 143 neutrons.

Uranium-235 contains a higher proportion of atoms compared to uranium-235, and these atoms can be split by the process of fission to sustain a reaction that can be used to generate power in a nuclear reactor. Only 0.711 percent of naturally occurring uranium is the uranium-235 isotope. Although some nuclear reactor concepts permit the use of natural uranium, most reactor designs require uranium that has been enriched. The process of enrichment increases the proportion of uranium-235 to that of uranium-238. Enriched uranium contains uranium-235 at approximately 4 to 5 percent of the total uranium mass. At PORTS, uranium was enriched using a process called gaseous diffusion.

The gaseous diffusion process requires the use of UF_6 to separate the uranium-238 and uranium-235 isotopes. UF_6 is a chemical compound consisting of one atom of uranium combined with six atoms of fluorine. By manipulating the temperature and pressure of its container, UF_6 can be maintained as a gas, liquid, or solid making it ideal for use in the diffusion process. During the first stages of diffusion, UF_6 gas is used to create $U(238)F_6$ and $U(235)F_6$ molecules which are then fed though porous tubes called barriers.

Barriers are used to achieve separation in the gaseous diffusion process. To maximize the amount of separation achieved, the porous barrier material must meet exacting standards so that “diffusive” flow occurs. That is, the pore sizes must be such that individual molecules collide only with the pore walls rather than with each other (Figure 45). To ensure diffusive flow, a uniform pore size of less than two-millionths of an inch diameter must be maintained. The $U(235)F_6$ molecule has slightly less mass than a $U(238)F_6$ molecule; thus, the $U(235)F_6$ molecule can pass through a properly constructed barrier more quickly. That tendency for the $U(235)F_6$ molecule to pass through the barrier more quickly is the basis for the gaseous diffusion process.

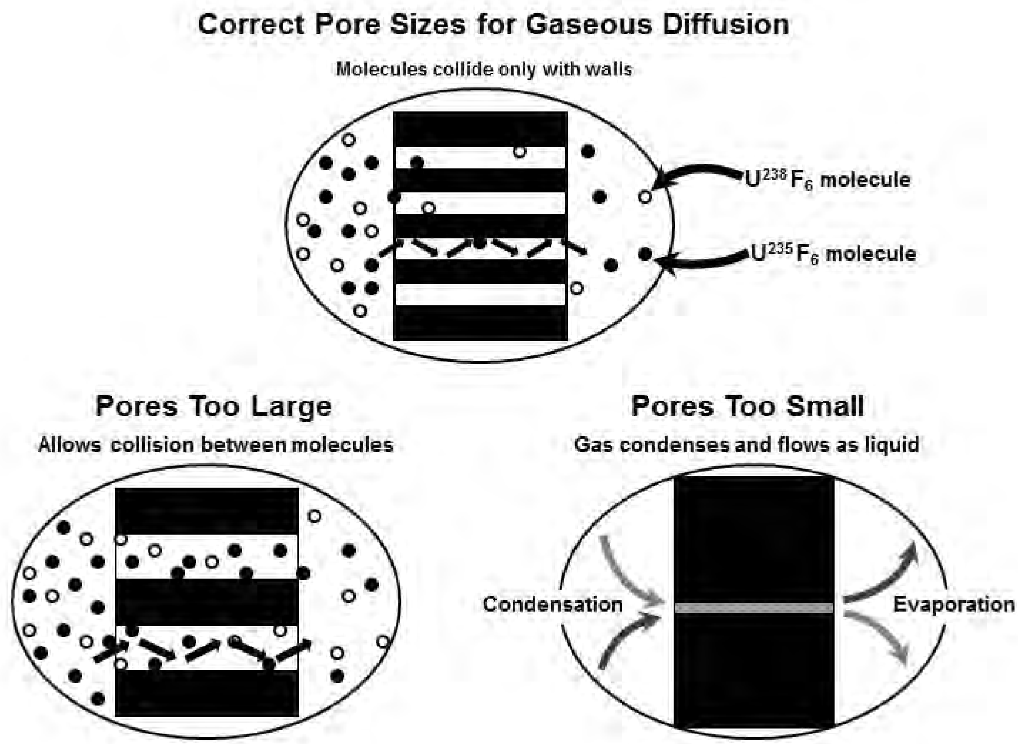

Figure 45. Molecular Flow-thru Porous Membrane

The fundamental principle on which the gaseous diffusion process is based was discovered by Thomas Graham in 1829. The principle states that the average velocities of gas molecules at a given temperature depend on their masses. This same principle was used by Francis William Aston in 1920 and Gustav Ludwig Hertz in 1936 to separate the isotopes of neon. In 1940, scientists at Columbia University utilized the same principle to achieve the large-scale separation of uranium-235. The success of the large-scale isotope separation strongly suggested the potential for highly-enriched material to be used for nuclear weapons. The scientists initiated extensive studies to improve the enrichment process in 1941. By August 1945, the first large-scale GDP was in operation in Oak Ridge, Tennessee at the K-25 Site.

Graham's law states that relative rates of diffusion of gases under the same conditions are inversely proportional to the square roots of the densities of those gases. According to this law, in a gas made up of different isotopic molecules, the lighter isotopic molecule will, on the average, have a velocity slightly greater than that of the heavier isotopic molecule. Applying this principle to the separation of the uranium isotopes that exist as gaseous UF_6, the theoretical maximum separation that can be achieved is small since the differences in gas densities are small. By using this separative capability, even though limited, and by serially multiplying separations many times, a GDP can produce highly-enriched UF_6.

The basic concept of the gaseous diffusion process is shown in Figure 46. It shows what takes place in any single stage in the process system. Gaseous UF_6 ("feed stream") is introduced into the "diffuser" or "converter", which is an assembly of barrier tubes used for uranium enrichment, under pressure and made to flow along the inside of barrier tubes. About one-half of the gas diffuses through the barrier and is fed to the next higher stage; the remaining undiffused portion is recycled to the next lower stage. The diffused stream is slightly enriched with respect to uranium-235 (“enriched stream”), and the undiffused stream is depleted of uranium-235 (“depleted stream”) to the same degree. A converter and the associated compressor used to push the UF_6 through the converter is called a stage. By cascading the separation stages together, the desired level of enrichment can be achieved. Because the separative capability per stage is so small, the exact number of stages required is determined by the enrichment needed. The pore size necessary for diffusive flow is so small that literally acres of barrier surface are required in a large production plant. The amount of barrier surface in each stage, or the number of porous tubes, depends on the required plant capacity.

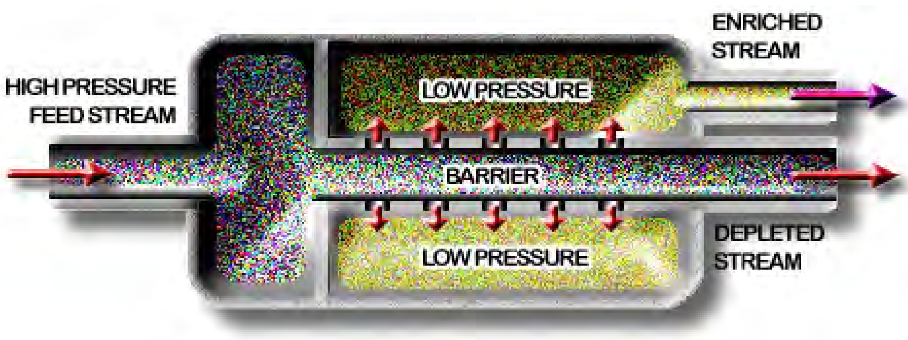

Figure 46. Graphic of a Gaseous Diffusion Converter

Figure 47 shows how the single stages are cascaded together to accomplish significant separations. It also shows the essential equipment components required for the process. In this case axial-flow compressors, driven by electric motors, are used to move the process gas through the converter. Stage coolers are required to remove the excess heat of compression.

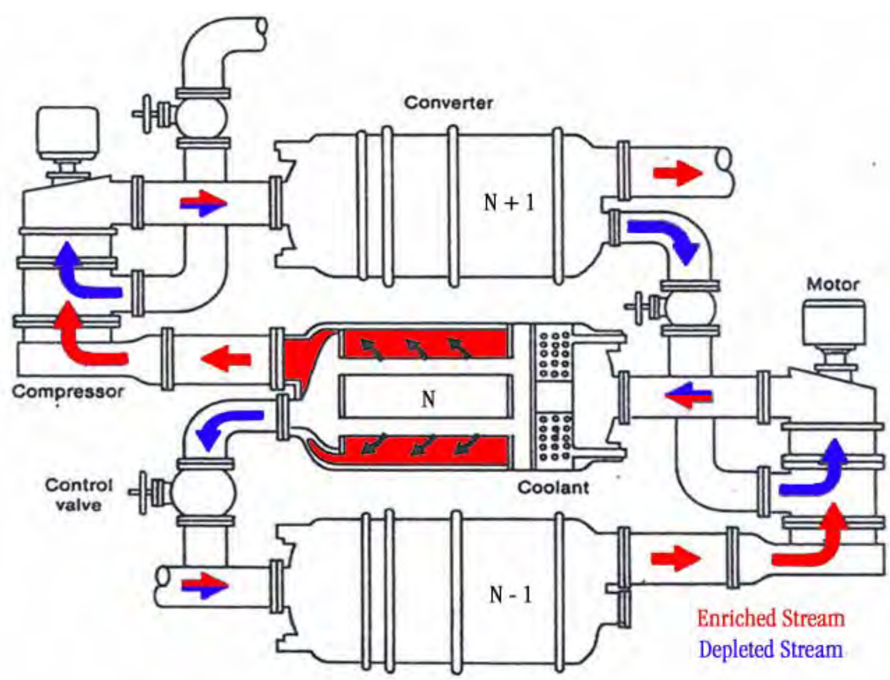

Figure 47. Graphic of Cascaded Stages in Gaseous Diffusion Process

Although UF_6 is a stable compound under process conditions, the chemical properties of the material present unique design problems. The issues stemming from those properties are as follows: (1) it is extremely reactive with water; (2) it is very corrosive to most metals; and (3) it is not compatible with organics, such as lubricating oils. Therefore, containment of the UF_6 material and cleanliness are essential. Because of this chemical activity, the structural metals used in the construction of the systems are primarily nickel-plated steel, monel, and aluminum. The corrosiveness of the process gas also indirectly contributes added difficulties in the fabrication of the barrier. The barrier must maintain its separative capability over long periods of time.

3.2 A GASEOUS DIFFUSION CASCADE

In a cascade, the flows at each stage are slightly different from the flows in stages immediately above or below. The converters that contain the largest flows and barrier area are located at the normal assay (0.711 percent uranium-235) feed point. Those stages located above the feed point are referred to as the enriching section, and the stages located below the feed point are called the stripping section.

Economics and operating conditions dictate the use of large blocks or groups of process equipment, thus limiting the number of different basic sizes. The cost of designing and building separate sized equipment for each stage would be obviously too great. On the other hand, using one size of equipment throughout would result in a large amount of wasted power and equipment capacity. Calculations showed that the use of five equipment sizes would be the most practical.

To facilitate maintenance activities and to minimize resulting productivity losses, stages were grouped together to form cells. A cell has inlet and outlet block valves; it can be taken off-stream, bypassed, or shut down. A schematic of a typical cooled cell is shown in Figure 48.

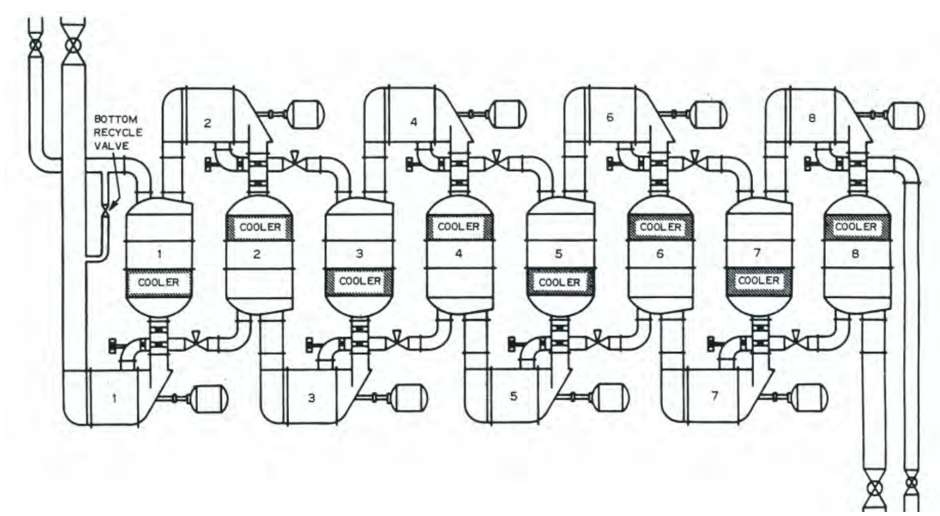

Figure 48. Typical Cooled Cell

3.3 THE PORTSMOUTH GASEOUS DIFFUSION PLANT

Numerous facilities were constructed at the site throughout the history of PORTS. Building numbers at PORTS started with an "X". Similarly, building numbers at the Paducah plant started with a "C" and at the Oak Ridge facility, building numbers started with a "K". The numbering series were significant:

- X-100 series refers to administrative type structures
- X-300 series refer to process operations facilities
- X-500 series refer to electrical facilities
- X-600 series refer to water facilities
- X-700 series refer to process support facilities.

Facilities that were engaged in the mission of PORTS during the Cold War era as either "core" processing facilities or processing support facilities are eligible for listing on the National Register of Historic Places. In addition to this historic context document, Historic American Engineering Records and Historic American Building Surveys will be completed for the "core" processing facilities and processing support facilities identified at PORTS (as listed below).

Facilities that were directly essential to the "core" operations conducted at PORTS during the Cold War era are discussed in detail in this section and include:

<u>"Core" Processing Facilities</u>

- X-220A Instrumentation Tunnels (Section 3.12)
- X-300 Plant Control Facility (Section 3.10)
- X-326 Process Building (Section 3.3.4)
- X-330 Process Building (Section 3.3.3)
- X-333 Process Building (Section 3.3.2)
- X-342A Feed, Vaporization and Fluorine Generation Facility (Section 3.6)
- X-344A UF_6 Sampling Facility (Section 3.8.1).

Other Cold War era processing support facilities and their role at PORTS are discussed in this document within Sections 3 through 6 and include:

<u>Processing Support Facilities</u>

- X-100 Administration Building (Section 6.3.1)
- X-103 Auxiliary Office Building (Section 6.3.4)
- X-104 Guard Headquarters (Section 5.7)
- X-108B Security Portal (North Portal) (Section 5.10)
- X-109A Personnel Monitoring Station (Section 4.1.2)
- X-111A Special Nuclear Material (SNM) Monitoring Portal (Section 5.11)
- X-111B SNM Monitoring Portal (Section 5.11)
- X-230J2 South Environmental Sample Station (Section 4.2.12)
- X-300A Process Monitoring Building (Section 3.11)
- X-342B Fluorine Storage Building (Section 3.6)
- X-344B Maintenance Storage Building (Section 4.2.1)
- X-530A Switchyard (Section 4.1.1.5)
- X-530B Switch House (Section 4.1.1.5)

- X-530C Test and Repair Facility (Section 4.1.1.5)
- X-530D Oil House (Section 4.1.1.5)
- X-530E Valve House (Section 4.1.1.5)
- X-600 Steam Plant (Section 4.1.3)
- X-611 Water Treatment Plant (Section 4.1.6)
- X-612 Elevated Water Tank (Section 4.1.7)
- X-614A Sewage Pumping Station (Section 4.1.12)
- X-626-2 Cooling Tower (Section 4.1.8.3)
- X-700 Converter Shop and Chemical Cleaning Facility (Section 4.2.2)
- X-705 Decontamination Building (Section 4.2.3)
- X-710 Technical Service Building (Section 4.2.4)
- X-720 Maintenance and Stores Building (Section 4.2.5)
- X-744H Bulk Storage Building (Section 4.2.7)
- X-750 Mobile Equipment Maintenance Garage (Section 4.2.9).

In addition to these Cold War era "core" processing facilities and processing support facilities, other auxiliary facilities and their role at PORTS are described in this document. An aerial view of PORTS and its facilities looking southwest during the 1980s is shown in Figure 49.

Figure 49. View of PORTS (1980s)

3.3.1 Uranium Enrichment Process at PORTS

The PORTS plant consisted of the following basic process facilities:

- Three large process buildings housing the compressors and converters used for uranium separation (X-326, X-330, and X-333 Process Buildings)
- Product withdrawal facilities (located within the X-326 and X-333 Process Buildings)
- Tails withdrawal facilities (located within the X-330 Process Building)
- Feed plant used to convert UF_6 to gas form and feed it to the process (X-342A Feed, Vaporization, and Fluorine Generation Facility [original facility]; X-343 Feed, Vaporization, and Sampling Facility; and X-344A UF_6 Sampling Facility)
- Transfer facilities to fill customer cylinders (located within the X-326 and X-333 Process Buildings, and the X-344A UF_6 Sampling Facility)
- Central control facility to provide high-level control of plant operations (X-300 Plant Control Facility).

A general schematic of the gaseous diffusion uranium enrichment process is presented in Figure 50.

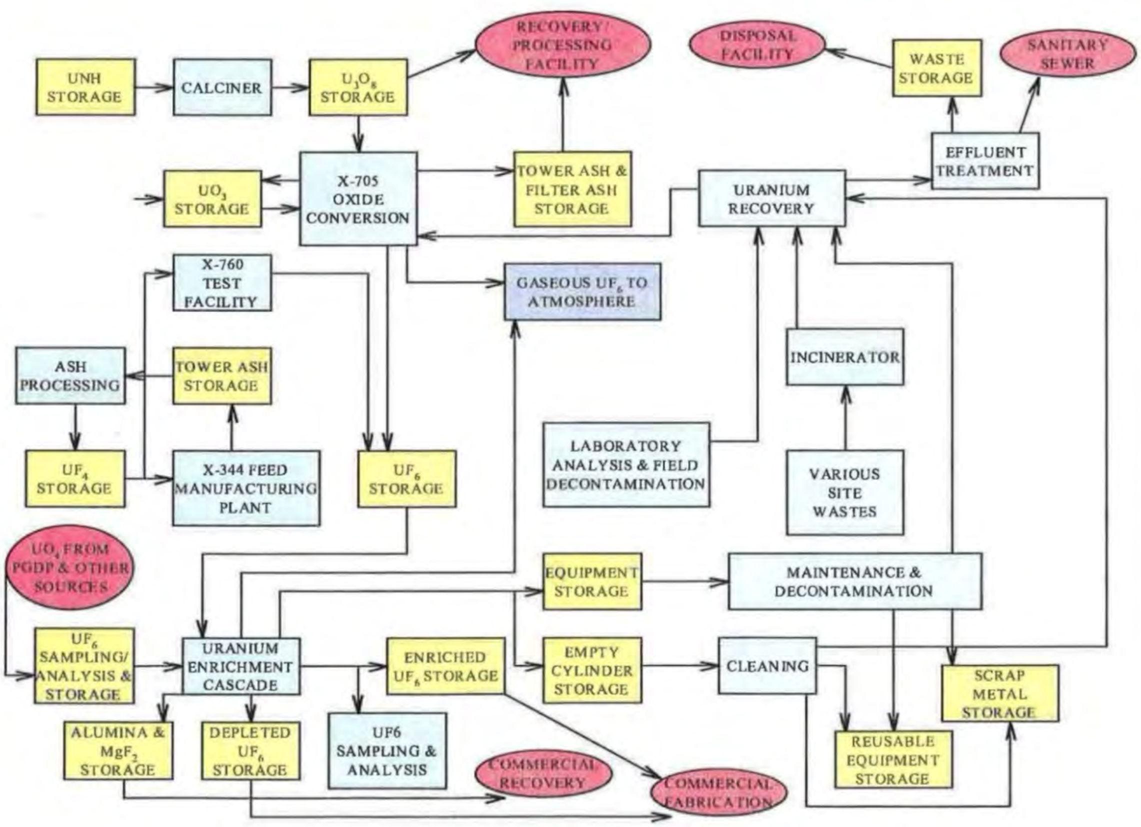

Figure 50. Schematic of PORTS Uranium Enrichment Process

The cascade at PORTS was capable of producing very highly-enriched (97.65 percent uranium-235) product. The total cascade originally contained over 4,000 isotopic stages that enriched uranium-235, while purge stages separated and purged the light gas contaminants that leaked into the system. Five basic separative equipment sizes (compressors and converters) were used in the isotopic stages, with motors that ranged from 3,300 horsepower (hp) rated capacity down to 15 hp. The largest stages, which were driven by the largest (3,300 hp) motors, were located in the X-333 Process Building and the smallest stages were located in the X-326 Process Building. Since the X-333 Process Building equipment served as the entry point for all feed material into the cascade, the equipment had to be larger in order to handle the increased capacities. Equipment in the X-330 Process Building was similar to that of the X-333 Process Building except for necessary size and capacity changes to service the installed process equipment. A primary difference between the process system in the X-326 Process Building and the systems in the in the X-330 and X-333 Process Buildings were that the stage compressors were centrifugal rather than axial flow.

Highly enriched UF_6 was located in the X-326 Process Building based on original plant design and a need for highly enriched UF_6. When the PORTS mission transitioned from producing weapons grade material to nuclear reactor material, an extended range production station was installed at the X-326 Process Building and a low-assay withdrawal station was put into operation in the X-333 Process Building. Similar to the original product withdrawal system in the X-326 Process Building, the withdrawal system in the X-330 Process Building used compressors to promote flow of UF_6 through condensers to liquefy the material before transfer to storage cylinders.

The ancillary processes, systems, and operations that served the diffusion process included a Freon® primary cooling system to remove the excess heat of compression from the process gas and a recirculating cooling water (RCW) system to cool the Freon®. The water system rejected heat at the cooling towers and another system removed metallic contaminants from the blow-down of the cooling water system. Additionally ancillary systems necessary for the diffusion process included:

- Two electrical switchyard complexes for delivering electric power to the process facilities and area auxiliaries (X-530 Electrical Switchyard Complex and former X-533 Electrical Switchyard Complex)
- Water treatment plant for providing sanitary water (X-611 Water Treatment Plant)
- Steam plant that furnished steam for process and building heat (X-600 Steam Plant)
- Dry-air plant that furnished dry air required for operation of plant equipment and instruments (located in the X-326, X-330, and X-333 Process Buildings)
- Nitrogen manufacturing facility (X-330 Process Building)
- Sewage collection, treatment, and disposal system (X-615 and X-6619 Sewage Treatment Plants)
- Furnace for melting scrap aluminum (located in the X-744G Bulk Storage Building)
- Decontamination and cleaning facility (X-705 Decontamination Building)
- Detention ponds for detaining waste waters and providing emergency treatment when necessary (X-701B and X-230K Holding Ponds)

- Fluorine manufacturing plant (X-342A Feed, Vaporization, and Fluorine Generation Facility; and X-343 Feed, Vaporization, and Sampling Facility)

- Radio and telephone communication system (located in the X-300 Plant Control Facility)

- Laboratories for process control and development (X-710 Technical Services Building [main])

- Maintenance shops (site-wide locations)

- Personnel services, including a hospital and a cafeteria (X-101 Dispensary Building and X-102 Cafeteria, respectively)

- Material storage and warehouse facilities (site-wide locations)

- Security system, including barriers (fences) (X-1020 Emergency Operations Center, X-104 Guard Headquarters, and site-wide security portals)

- Fire and police department (former X-106 Tactical Response Station/former X-106B Fire Training Building, X-1007 Fire Station, X-1020 Emergency Operations Center, X-104 Guard Headquarters and site-wide security portals)

- Various administrative services (X-100 Administration Building [main] and site-wide locations).

3.3.2 X-333 Process Building

The X-333 Process Building, which has two floors and houses the largest size equipment (designated 000). The X-333 Process Building is approximately 970 ft wide and 1,456 ft long and 82 ft high, comprising 65 acres of floor area. The X-333 Process Building contained over 600 isotopic stages. A typical stage designation might be X-33-5-4.3, which means the X-333 Process Building, unit 5, cell 4, stage 3.

Figure 51 shows the early construction of the X-333 Process Building and Figure 52 provides an aerial view of the completed building.

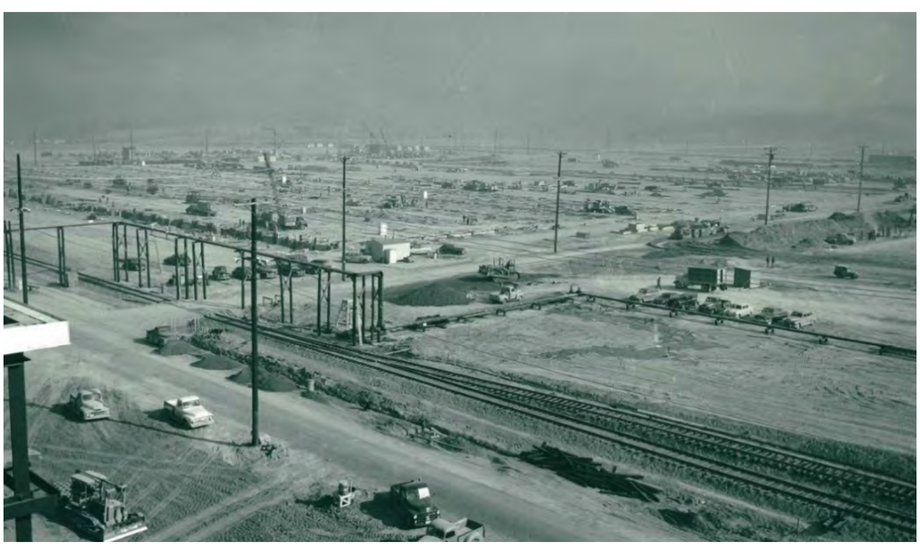

Figure 51. Construction of X-333 Process Building Foundations Looking Northeast (1953)

Figure 52. X-333 Process Building Looking Northwest (2006)

The separative or process gas equipment and associated valves and piping were located on the second, or cell, floor. A typical 33 or 000 cell (Figure 48) had compressors of the axial-flow design driven by electric motors that were rewound during the CIP/CUP program. For cascade optimization, the higher horsepower motors were used in the middle units and the lower horsepower motors were in the units at each end of the building flow.

Control valves, located in the depleted or B stream piping to each compressor, were used to control the interstage flow pressures. Cell pressures either could be maintained at a constant level over a group of cells or tapered by means of the control valves across a cell or several cells to various operating levels.

Process gas, heated during the compression operation, was cooled by means of stage coolers. These coolers contained heat exchanger surfaces and, in some cases, supplemental or extension coolers that were added during CIP/CUP. Because Freon®-114 is compatible with UF_6, it or a similar coolant was used as the cooling medium in the intermediate heat-transfer system. The waste heat was transferred from the coolant to a recirculating water system by means of condensers. Suitable instrumentation was used to control the half-cell coolant temperatures and pressures by controlling the supply-water flow to the coolant condenser. Provisions were made for automatic cell shutdown if the coolant pressure got too high. For additional system protection, each half-cell cooling system was equipped with a pressure relief system.

Buffer systems were used at appropriate places in the process gas system to prevent process gas outleakage or wet-air inleakage. External pressures in the buffer systems were kept higher than the process gas pressure to assure that leakage would be inward; provisions were made to purge the light nitrogen or dry air from the process gas system.

An area control room (ACR-1) was the main control facility for the building. Monitoring of the cell operations and many of the auxiliary systems was possible from this location. Cells could be taken off stream or put back on stream, and the motors could be shut down from the cell panels in the control room.

Administrative offices, a kitchen, and rest room facilities also were located in rooms adjacent to the control room.

Local control centers were located on the operating floor just below the equipment on the cell floor (Figure 53). They were arranged in a manner that facilitated quick movement from one cell center to an adjacent cell center in an emergency. The local control centers provided the operator with the capability to read and adjust stage pressures, read stage temperatures, open or close valves, and start or stop stage motors.

There were 160 process electrical substations in the X-333 Process Building with transformers for each cell that supplied power to the stage motors. Their capacities depended on their projected service requirements. In addition to the process transformers, there were 33 auxiliary substations with transformers. These supplied power to pumps, valve control centers, normal and standby lighting, transformers, and controls.

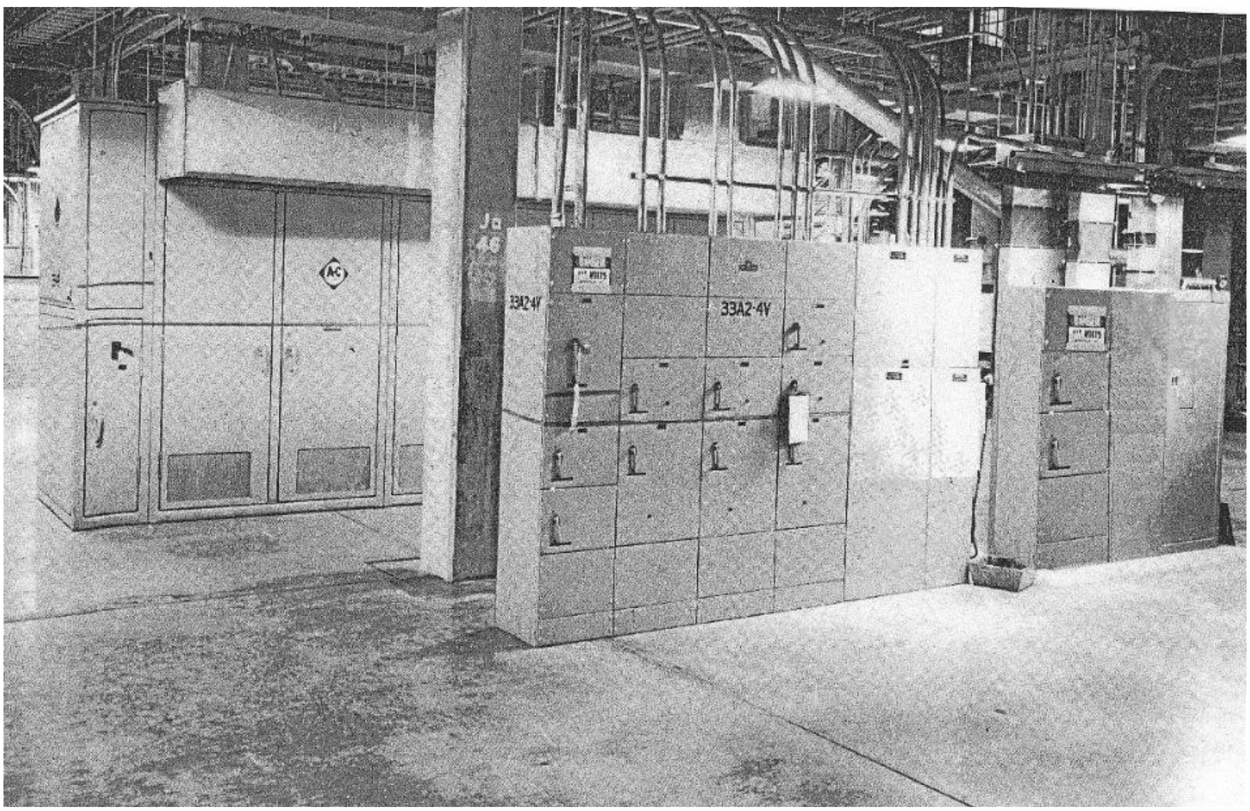

Figure 53. Local Control Center for Unit 33-3, X-333 Process Building (1955)

Each process unit had its own lubricating oil system, which provided a continuous supply of oil for motor and compressor bearings. The supply to the equipment was by gravity flow from a gravity-feed tank located on or near the building roof. From the bearings, the lubricant flowed into a drain tank located in a special pit (without a drain) on the operating floor (Figure 54). A constant supply level was maintained in the gravity-feed tank by means of an operating pump, and a spare pump was instrumented to start automatically in case of failure of the operating pump. The gravity-feed tank provided time for orderly shutdown of process equipment in case of failure of both pumps. An average of 27,600 gal of oil per year was added to replace that which was lost as a result of maintenance activities, bearing and hose leaks, and accidental spills.

The Cold Recovery System in the X-333 Process Building includes the surge-drum room, a holding drum room, a refrigeration system, and a cold-trap room located on the ground floor between units X-33-3 and X-33-6. The system was designed to handle up to 5 percent uranium-235 assay material. Its primary function was to limit excessive leakage into the cascade during emergency repairs by providing a means for removing UF_6 from a cell or equipment in need of repair and storing it during the repair. Gas mixtures with high UF_6 concentrations were returned to the point of withdrawal at a controlled rate, and the light contaminants were allowed to flow up to the cascade for purging in the side purge cascade. The cold-trapping equipment provided a means for freezing out UF_6 to separate it from mixtures of process gas and air and from nitrogen purge gases.

Figure 54. Unit X-33-1 Lube Oil Drain Tank (2010)

Evacuation of wet air from cells that were opened to the atmosphere was accomplished with the purge and evacuation compressors and an air-jet. Before any gases were vented, they were routed through traps to remove traces of UF_6. The vent gases were monitored by means of a space recorder.

A coolant drain, recovery, and transfer station, used to serve the cell cooling systems, was located on the ground floor just south of the ACR. The system included two 11,000-gal drain and storage tanks (Figure 55), two coolant transfer pumps, two water-cooled vapor compressors, one condenser cooled by sanitary water, an exhaust pump, and associated piping. Coolant could be unloaded from rail tank cars and transferred to or received from the coolant stations at the X-330 and X-326 Process Buildings.

Located in the west control section of the building were the maintenance facilities, which contain shop equipment (mechanical, electrical, and instrumental) used in minor fabrication and rebuilding of components. The shop areas were also used to store the special tools necessary for maintaining the 000-size equipment.

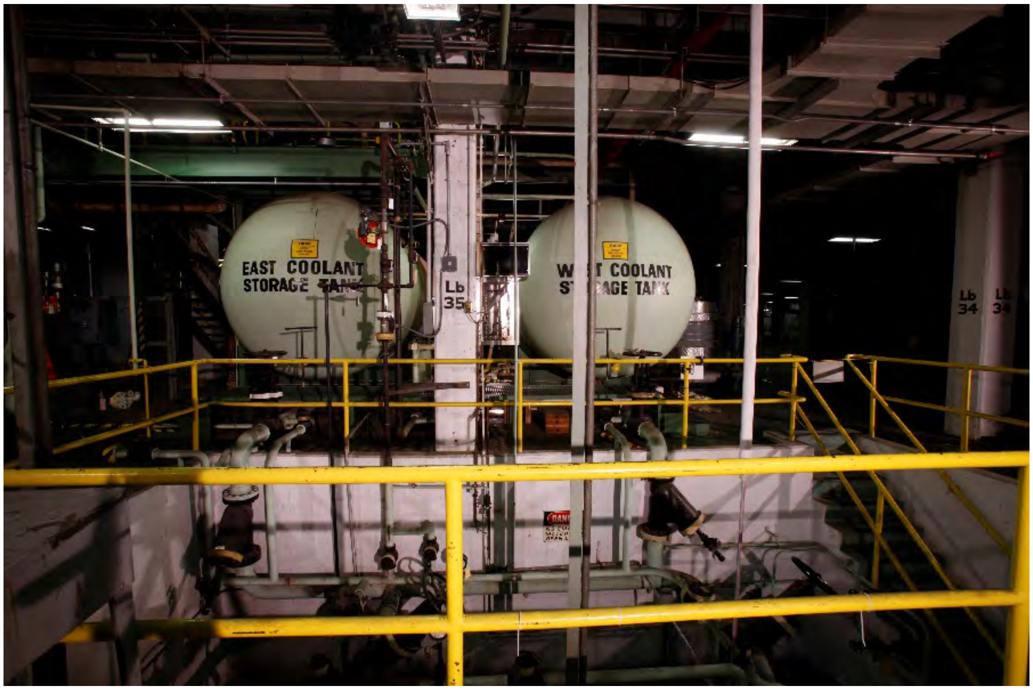

Figure 55. X-333 Process Building Coolant Storage Tanks (2010)

Four emergency diesel generators were strategically located to provide emergency power to selected valves, lights, and such other special auxiliary equipment such as pumps and rectifiers. The emergency generators functioned automatically in case of failure of the auxiliary power system (either complete or partial plant failure). Each diesel generator had its own distribution system for supplying power to special equipment in two units; however, provisions were made to cross to another system in case of diesel generator failure. Also located within the building were air compressors that are part of the plant air system.

An elaborate ventilation system provided the building with adequate protection for equipment and with suitable ambient conditions for personnel performance. Process heat from the cell floor was used to heat the operating floor during cold weather. Similar ventilation systems were used in all process buildings.

A truck alley and a railroad spur track extended along the east and west sides of the X-333 Process Building and the west side only of the X-330 and X-326 Process Buildings, and were used for delivery and pickup of process equipment. The cell floor extended over the truck alley and had hatches located under each crane bay. Heavy process equipment and motors were lifted to the cell floor for installation or storage.

3.3.3 X-330 Process Building

The X-330 Process Building is approximately 640 ft wide and 2,176 ft long and 66 ft high, comprising 55 acres of floor area. It is located between the X-333 and X-326 Process Buildings. The X-330 Process

Building housed multiple units of X-29 (0-size) and X-31 (00-size) equipment. Figures 56 and 57 show early stages of construction of the X-330 Process Building. Figures 58 and 59 show views of the completed building.

Figure 56. Construction underway for the X-330 Process Building Foundations (1953)

Figure 57. Construction of the X-330 Process Building (1954)

Figure 58. X-330 Process Building Looking Southeast (1955)

Figure 59. X-330 Process Building Looking from Southeast to Northwest (1995)

Unit X-29-1 and unit X-31-1 were in the stripping section of the cascade. Cell 1 of X-29-1 was the bottom cell in the cascade, and the depleted, or B, stream from this cell became the waste, more commonly known as the "tails"; this material was withdrawn at the tails withdrawal facility, which is located in the northeast corner of the building. Unit X-31-2 was the first unit above the X-33 equipment. Unit X-29-6 was the top unit in the building, and the enriched, or A, stream from the top cell in the unit was sent to unit X-27-1 in the X-326 Process Building. The B stream from X-27-l returned into the top X-29-6 cell stream.

Physically, the X-29 and X-31 converters and compressors were the same size; however, the barrier area was less for the X-29 converters. The internal components of the compressor differ to some degree because of the required characteristics and the differences in interstage flow. Figure 60 shows a typical cell arrangement. The X-31 motors were rated at 1,700 hp and the X-29 motors ranged from 700 hp in X-29-2 down to 300 hp in X-29-6, depending on their location in the cascade configuration and projected cascade loadings (Figure 61).

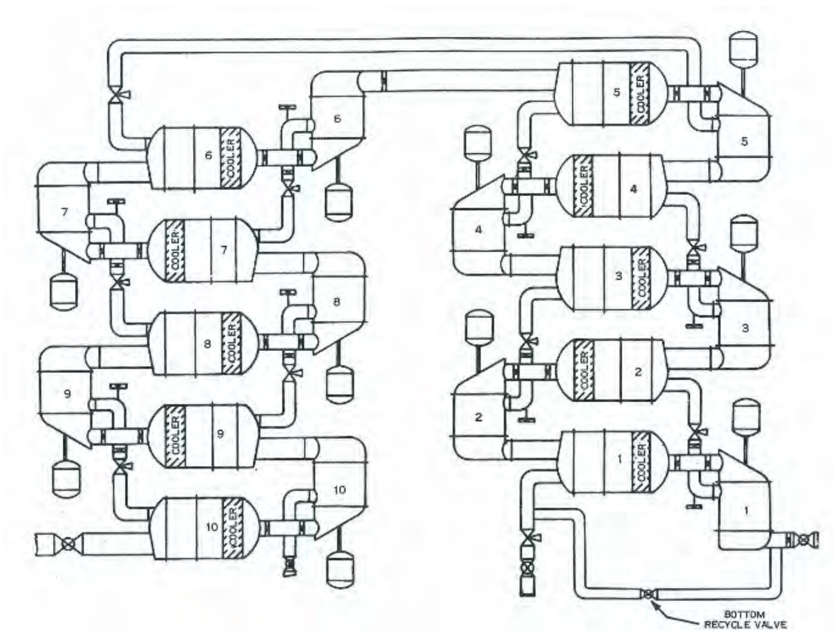

Figure 60. Typical X-330 Process Building Cell

Figure 61. The First Compressor Motor Installed in the X-330 Process Building (1953)

Two ACRs (ACR-2 and ACR-3) were located on the ground floor of the X-330 Process Building because of the number of process units. Local cell control centers were similar to those in the X-333 Process Building except for necessary changes in line sizes and equipment capacities to service the installed process equipment.

The cold-recovery system was located at the east side of the building. This facility was used in the recovery of UF_6 from comparatively large volumes of purge gases collected from locations throughout the plant. The purge gases had low UF_6 concentrations with assays of less than 27 percent uranium-235. The purge gases were passed through refrigerated cold traps to freeze out UF_6 and then through sodium fluoride traps for removal of remaining traces of UF_6 prior to being discharged to the atmosphere by means of air-jet exhausters. When the traps were full, they were valved to holding drums and heated to vaporize the UF_6. After assay determination, the material was fed back to the cascade at the proper location.

The interim-purge facility, located on the ground floor at the east end of unit X-29-5, was similar in design to the cold-recovery facility except that it had fewer surge drums. Its original purpose was to serve as a purge facility during the early stages of plant construction. It later was a standby emergency purging facility. The surge drums were grouped into three banks of 6,000 cf each and were used for additional purge storage and as storage drums for special product withdrawals. Special refrigerated trichloroethene (TCE) baths were used to withdraw material by the freeze-out method into 5- or 8-in. cylinders.

Air compressors, which were a part of the plant air system, and a nitrogen plant were located on the ground floor in the southeast corner of the building. The nitrogen plant was designed to produce gaseous nitrogen for purging various UF_6 processing systems and liquid nitrogen for use as a low-temperature refrigerant.

The building maintenance shop area was located approximately in the center of the building. All of the process and auxiliary switchgear were located on the ground floor. Ninety substations supplied power to over 100 cells, 3 process-power-booster substations, and 44 auxiliary substations. A 13.8 kV feeder from the X-530A Switchyard supplied power to two substations.

3.3.4 X-326 Process Building

The X-326 Process Building is another cascade building and is approximately 552 ft wide and 2,280 ft long and 62 ft high, comprising 58 acres of floor area. Like the other two process buildings, the equipment in the X-326 Process Building was on two floors, with the diffusion equipment on the upper cell floor and the electrical switchgear and control instrumentation on the lower operating floor. Figure 62 shows a view of the X-326 Process Building area during early stages of construction and Figure 63 shows a completed view of the X-326 Process Building.

Figure 62. X-326 Process Building during Construction (January 1954)

Figure 63. X-326 Process Building from Southwest Looking Northeast (1990)

Because of the equipment sizes and economics involved, a 12-stage, in-line, cell configuration was used in the X-326 Process Building. Figure 64 shows a typical cell arrangement.

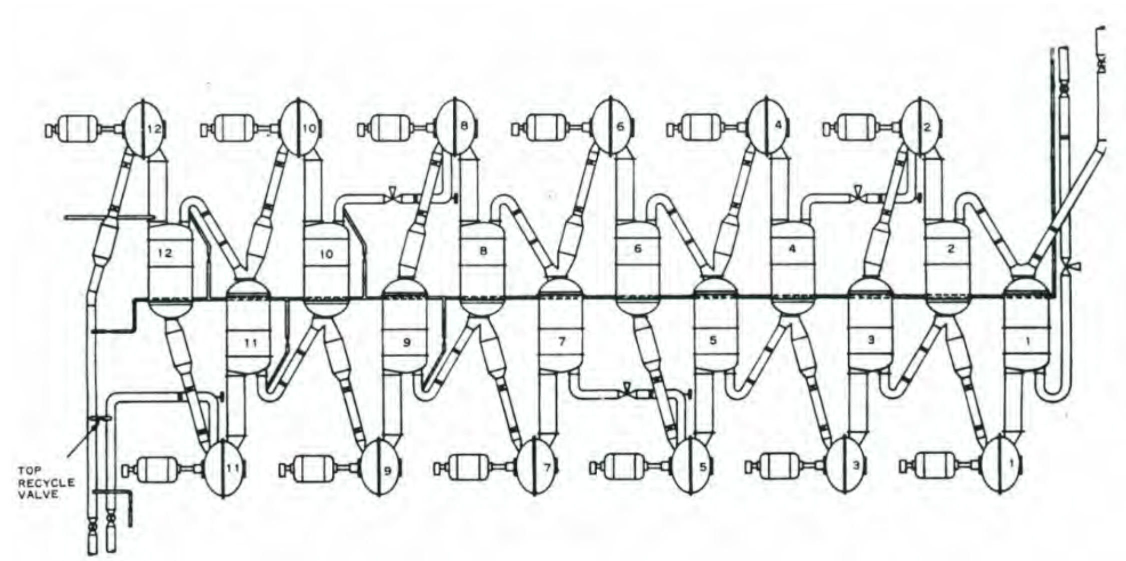

Figure 64. Typical X-326 Process Building Cell

The same considerations were given to the unit arrangement in which 20 cells were used to establish the capacities for the unit auxiliaries. The same basic auxiliary service designs were used in X-326 Process Building as used in the other buildings, including such items as the building ventilation system.

There were two basic equipment sizes for interstage flows and as with the other process buildings, the separative equipment was located on the cell floor. The cell enclosures were made up of insulated panels with removable access covers that allow removal of equipment for maintenance. Cell, unit, and bypass housings were insulated and electrically heated.

There were three ACRs in the X-326 Process Building, numbered 4, 5 and 6. ACR-4 was located between units X-27-2 and X-27-3 on the ground floor and ACR-5 was located between X-25-3 and X-25-4. ACR-6 was in the south end of the building between units X-25-6 and X-25-7. The compressors for the Extended Range Product (ERP) station were located at the northeast corner of the cell floor.

There were two coolant drain stations that serve the cell coolant systems. The station in X-27-3 was a full-service facility (storage tanks, transfer pumps, vapor condensing compressors, air exhauster pump, and a tank-car unloading capability); the station located in X-25-5 has only storage and transfer equipment. The piping arrangement permitted transfer between pumping stations and any of the other three stations in the plant (one in X-333 Process Building and two in the X-330 Process Building).

The heated surge-drum room was located on the east side of the building at the end of unit X-25-3. Drum banks A, B, and C have two 2,000-cf drums each. These could be used for surges from any cell in the building. Cell operating pressures permit the use of these drums without the need of booster compressors. Wet air remaining in cells after maintenance was evacuated by means of a jet-air exhauster located in the purge facility in the south end of the building.

The maintenance shop for this building was located in the center of the building between units X-25-2 and X-25-3. The coolant (Freon®) degrader, used to facilitate purging of the coolant contaminant in the light-contaminant up-flow, was located near unit X-25-7.

The top product withdrawal facility was located at the southwest corner of the building and the traps and air jets for the purge cascade were located at the south end.

An air-model test facility was located between units X-25-5 and X-25-6. In this facility, a compressor was used as a prime mover for testing the gas flow characteristics of scaled models of cascade equipment components.

Process and auxiliary electrical substations were situated throughout the building on the ground floor. Approximately 160 process and auxiliary transformers supplied power to the equipment motors used in the building. In addition to the normal power supply, six diesel-operated emergency generators were strategically located to handle specified systems to provide means of isolating the process gas systems, emergency lighting, etc. Two generators were located in each area.

A diesel-operated emergency air compressor, part of the plant air system, was located in the northeast corner of the building.

3.4 PRODUCT WITHDRAWAL

The original plant design was based on a need for highly enriched UF_6, and the primary withdrawal facility was the top product station, which was located in the southwest corner of the X-326 Process Building, on the ground floor.

Supply and return lines provided a two-assay simultaneous withdrawal capability. One withdrawal stream was from the top isotopic cells. The other withdrawal stream could be valved into other parts of the cascade to provide flexibility.

Material was withdrawn from this facility by feeding it into cylinders that were cooled in refrigerated TCE baths; upon cooling, the gaseous UF_6 changed phase and became a solid. Assay monitoring was done with mass spectrometers to assure that the assay was maintained within set limits.

A booster compressor was provided to boost the supply pressure of the very-highly-enriched material to the withdrawal facility to increase the withdrawal rate when necessary. For withdrawal of other assays, the cell pressures could be increased to provide additional flow. Limited cylinder storage was provided in the product withdrawal facility.

Two facilities were used to withdraw commercial nuclear reactor materials at required rates. The ERP station (capacity, 25,000 lb of UF_6/day) was located in the northeast corner of the X-326 Process Building, and the low-assay withdrawal (LAW) station (capacity, 105,000 lb of UF_6/day) was located in the west central section of the X-333 Process Building. Both stations were similar in design, using compressors to pressurize the UF_6 stream and then passing the stream through condensers to liquefy the material. The liquid UF_6 was normally withdrawn into 10-ton cylinders for storage until it was transferred into 2½-ton cylinders for shipment to customers.

The ERP station (Figure 65) was originally designed to maintain continuity of operation during the construction of the plant and was considered safe for all uranium assays. Modifications to the original station occurred to increase its capacity by the addition of two special high-speed compressors.

Figure 65. Extended Range Product Station in the X-326 Process Building (2010)

The large-cylinder withdrawal positions utilized air-operated dollies to move a 10-ton cylinder into position for attachment to the valving manifold. An overhead crane was used to move cylinders onto and off of the dolly. Filled cylinders were allowed to cool in outdoor storage racks to convert to a solid material before being moved to open storage lots.

A special air-conditioned control room was provided for the operating panels, assay spectrometers, and gamma enrichment monitors. The control room was adjacent to the withdrawal room. There was no direct connection between the rooms, but a window allowed visual observation of the withdrawal positions.

The LAW station, located in the X-333 Process Building, was installed during the CIP/CUP and provided additional withdrawal capacity for reactor-grade material. It was similar in design to the ERP station, using multiple compressors. The compressors were located on the cell floor; the condensers, accumulator, and associated piping were on a mezzanine below the cell floor; the withdrawal positions were on the ground floor. Two condensing loops equipped with large condensers and accumulators (safe for up to 10 percent uranium-235) and four withdrawal positions provided a means for uninterrupted withdrawal operations. Cylinder handling was similar to that in the ERP station. The process gas supply to the station could be routed from any unit and cell in the cascade, provided the uranium-235 content did not exceed 10 percent.

An air-conditioned equipment room, adjacent to the withdrawal room, housed control panels containing the components necessary for adequate control of the entire station; included were compressor start-stop stations, ammeters, current-sensing surge alarms, valve open-stop-close stations, indicator lights, alarms, temperature recorders, etc. Two assay spectrometers for monitoring and supervisory control of withdrawal and two gamma enrichment monitors were provided in the equipment room. The ACR contained additional instrumentation: a semigraphic console for control of the station; a radiation-alarm-system alarm; a remote tape printer for the assay spectrometer;

compressor-vibration and trip-alarm indicators; a smoke and gas-release concentration analyzer-indicator; a UF_6 accumulator liquid-level indicator and alarm; cylinder weighing scale remote indicators; and a television monitor of the withdrawal area.

3.5 TAILS WITHDRAWAL

The Tails Withdrawal Facility was located in the X-330 Process Building (Figure 66). Its operating control panels were in ACR-2. Although this facility was primarily used for tails withdrawal, the valving and piping design was such that two different assays could be withdrawn simultaneously.

Figure 66. Tails Withdrawal Facility in the X-330 Process Building (1987)

Compressors were provided for each loop. If necessary, both loops could be used for tails withdrawal. Heat exchangers (for liquefaction of the high-pressure process gas) and accumulators were located in an enclosed housing on a mezzanine floor. Access to this area was from the withdrawal room on the ground floor.

Pressure would vary significantly during different cascade conditions. A bottom surge system with drum banks was used to level out the pressure. Valving and instrumentation were provided for automatic control.

Four withdrawal positions were located in a special room adjacent to the operating area on the ground floor. Each position was designed for either 10-ton or 14-ton cylinders. Tails material was normally withdrawn into the larger cylinders. The large accumulator in the normal tails loop had a capacity of approximately 13,500 lb, which permitted time for a change of cylinders without requiring shutdown of the station. Since product withdrawals were at a much lower rate than tails withdrawal, these accumulators also allowed sufficient time for cylinder change. Each withdrawal position had its own scales and an air-operated cart on a set of rails. After a cylinder was filled, the cart was moved out of the building, where it could be lifted by crane and placed in a special rack for cooling prior to movement to permanent storage. Provisions were made to eliminate movement of the cart before the cylinder was disconnected.

3.6 X-342 FEED, VAPORIZATION, AND FLUORINE GENERATION FACILITIES

The X-342A Feed, Vaporization, and Fluorine Generation Facility is housed in a one-story, 13,800-sq ft steel-framed building with a concrete slab floor. It shares the north side and half of the west side wall with the X-344A UF_6 Sampling Facility. The X-342B Fluorine Storage Building is a one-story, 1,500-sq ft concrete and steel structure covering three 1,000-cf fluorine storage tanks connected to a covered outside manifold station. Figure 67 shows the X-342A and the X-342B building foundations during construction. Figure 68 shows the completed and operational X-342A Feed, Vaporization, and Fluorine Generation Facility.

Figure 67. Construction of Foundations for the X-342A Feed, Vaporization, and Fluorine Generation Facility and the X-342B Fluorine Storage Building Looking Northwest (1954)

Figure 68. X-342A Feed, Vaporization, and Fluorine Generation Facility Looking Southwest (2010)

The ground floor, partitioned into 17 separate areas, constituted the main operating level and provided the high-story receiving and vaporizer bay which occupied almost the entire south half at this level. Maintenance and storage areas adjacent to the west wall and adjoining fluorine cell room and electrical room occupied the northwest portion. The northeast portion of the ground floor contained the sodium fluorine traps, compressor room and disposal room. The balance of this area constituted corridors. The office personnel facilities were adjacent to the north wall.

The original X-342A Feed, Vaporization, and Fluorine Generation Facility was used to feed and sample UF_6 and to generate and purify fluorine. Vaporization of the feed material was accomplished by heating. Ten-ton UF_6 cylinders were received, weighed, and transferred to steam-heated vaporizers. The gaseous UF_6 merely passed through a piping system to the point of use. Originally, the X-342A Feed, Vaporization, and Fluorine Generation Facility supplied three types of feed material, varying in assay, to the process buildings. The feed vaporization equipment consisted of 12 steam vaporizers, manifolded into three banks of four units, each bank directly connected to a separate cascade pipeline (Figure 69). Provisions were made to interconnect either one or both banks of vaporizers to the third vaporizer and cascade pipeline.

Figure 69. Vaporizer Bay in the X-342A Feed, Vaporization, and Fluorine Generation Facility (1986)

Fluorine was generated in this facility by the electrolysis of anhydrous hydrogen fluoride (HF) and potassium fluoride (KF), as a mixture. The HF and KF are raw materials used for fluorine generation and were supplied to the plant from storage facilities via piping or in steel cylinders. Once generated, the fluorine was piped to the various plant facilities or stored in cylinders for miscellaneous uses. A portion of the by-product or carry-over was salvaged and recycled, and the balance vented to the atmosphere or was disposed of by neutralization and discharged to the storm-sewer system. The fluorine-generation equipment consisted of electrolytic cells provided with direct current from rectifiers (Figure 70). An electrolyte-preparation tank and an electrolyte-settling tank were provided, as well as a sodium fluoride absorber for HF-KF removal from the fluorine and two fluorine compressors.

Figure 70. Fluorine Generation Units in the X-342A Feed, Vaporization, and Fluorine Generation Facility (1986)

The waste-fluorine disposal equipment consisted of two units, each including a steam preheater, fluorine preheater, reaction chamber, and a scrubber. The waste hydrofluoric acid from these units and other HF-KF mixed waste from the plant were piped to the Neutralization Pit.

The primary role of the X-342A Feed, Vaporization, and Fluorine Generation Facility was generating fluorine, which it did for the entire plant. Upon completion of the X-343 Feed, Vaporization, and Sampling Facility in 1982, the X-342A Facility was renovated by installing two autoclaves, one cold trap system, one 18,000-kg scale, and piping to connect to autoclaves in the X-344A UF_6 Sampling Facility and feed headers. The X-342A Feed, Vaporization, and Fluorine Generation Facility later served as a backup to the X-343 Feed, Vaporization, and Sampling Facility and X-344A UF_6 Sampling Facility for the feed, vaporization, and sampling of UF_6.

3.7 THE X-343 FEED, VAPORIZATION, AND SAMPLING FACILITY

The X-343 Feed, Vaporization, and Sampling Facility is approximately 89 ft wide by 155 ft long by 42 ft high, comprising 18,500 sq ft of floor area. The X-343 Feed, Vaporization, and Sampling Facility handled all feed operations, shipping and receiving, and sampling of feed materials for the GDP. The X-343 Facility was designed to provide for a range of feed options in light of future projections for separative capacity at the plant, power input and assays of uranium feed and withdrawal streams. It replaced the X-342A Feed, Vaporization, and Fluorine Generation Facility, which was shut down for complete renovation in order to provide back-up feed and sampling capability. Figure 71 shows construction of the X-343 Feed, Vaporization, and Sampling Facility. A view of the completed facility is shown in Figure 72.

Figure 71. Construction of Foundations for the X-343 Feed, Vaporization, and Sampling Facility (1981)

Figure 72. X-343 Feed, Vaporization, and Sampling Facility (1986)

The X-343 Feed, Vaporization, and Sampling Facility enabled the introduction of uranium feed material at an increased rate under much safer and efficient conditions through the use of new high-pressure designed steam autoclaves. The building contained autoclaves for heating both 10-ton and 14-ton uranium cylinders. Four autoclaves were equipped only for feed operations. The other three were equipped to feed uranium, but also capable of withdrawing samples of cylinder contents for verification. During start-up of the X-343 Facility, the existing X-342A Facility was kept operational. Once the X-343 Facility underwent an initial operational test period, the X-342A Facility was remodeled to provide additional capabilities.

The facility had auxiliary services required for UF_6 vaporization, cylinder storage yards, truck and rail loading and unloading facilities, and administrative services.

The X-343 Feed, Vaporization, and Sampling Facility is housed in a steel frame structure, covered with 2-in. insulated metal siding, and a built-up roof. The north and south sides were designed so that a 20-ton bridge crane carrying a 17-ton weight (standard 14-ton cylinder plus lifting fixture) could pass through the building.

Two concrete pads for cylinder staging, handling, and storage are located adjacent to the building, one to the south and the other to the north. These pads had cylinder supports when used for standard 14-ton cylinders. A steel dock on each pad provides access to the beds of both trucks and railcars. Twenty-ton capacity bridge cranes were installed on a set of overhead crane tracks that extend through the building and span the length of both storage pads.

Steam-heated autoclaves were operated at higher temperatures than conventional vaporizers and provided containment of any UF_6 leakage that might occur from the cylinder or piping connections. Instrumentation was provided for early UF_6 detection and system isolation. Autoclaves were required to maintain a constant gas flow. A view of operations at the X-343 Feed, Vaporization, and Sampling Facility is shown in Figure 73.

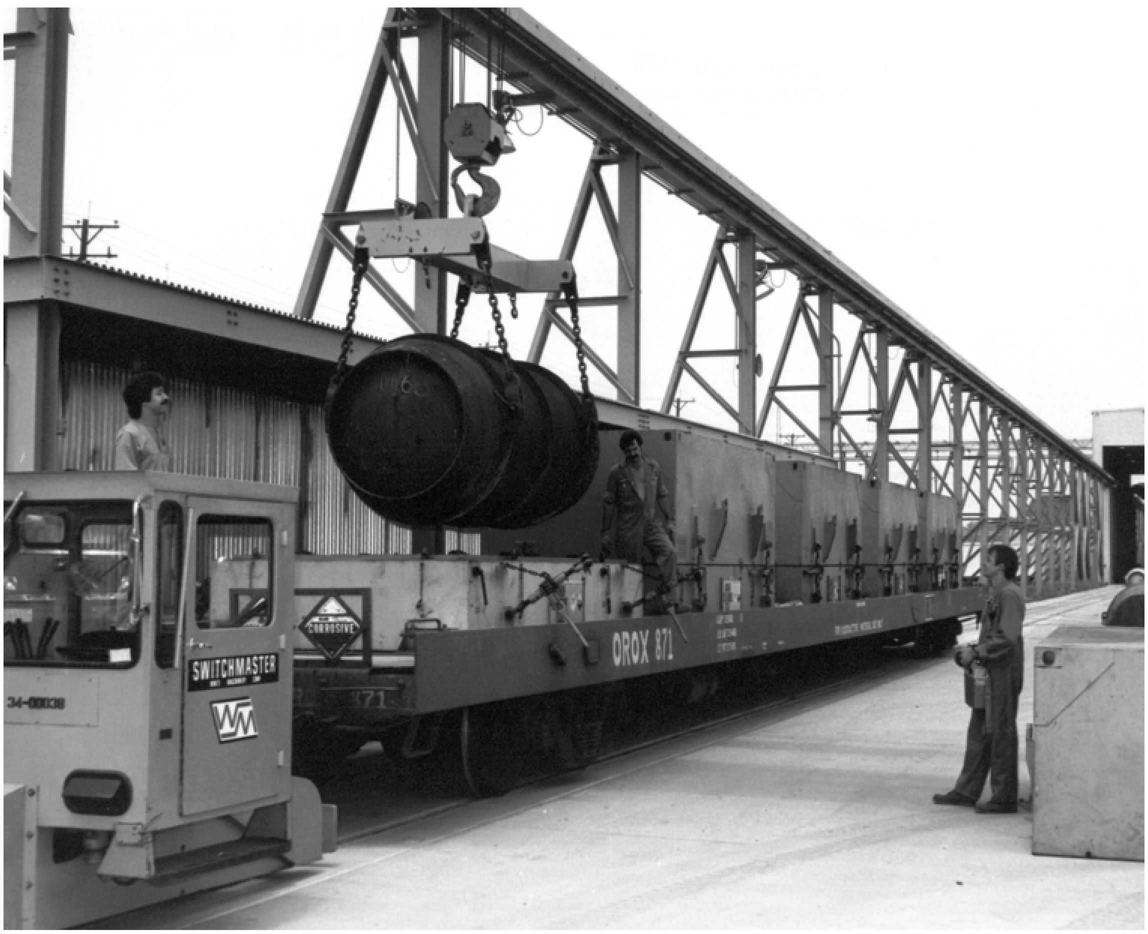

Figure 73. X-343 Feed, Vaporization, and Sampling Facility Operations (1982)

3.8 PRODUCT TRANSFER

X-344A UF_6 Sampling Facility and X-744G Bulk Storage Building

"Toll" enrichment involved an arrangement where privately-owned uranium could be enriched in uranium-235 content in U.S. Government facilities upon payment of a fee by a licensee. The original toll enrichment facilities for PORTS were the X-344A UF_6 Sampling Facility, X-744G Bulk Storage Building, and six outside cylinder storage lots. These facilities were used for receiving, sampling, and storing uranium materials from licensees; for transferring and delivering this material to the cascade feed facility; for picking up, transferring, and storing product cylinders from the cascade; and for sampling, transferring the UF_6 to customer cylinders, and shipping to the fabrication facilities. The same facilities were also used for handling government-owned uranium materials; this included low-assay and very-highly-enriched product storage.

The X-344A UF_6 Sampling Facility was originally designed as a feed manufacturing facility to produce UF_6 from uranium tetrafluoride. The X-344A Facility is housed in a steel framed building with insulated metal siding and concrete block partitions. The X-344A Facility is located adjacent to the west side of the original X-342A Feed, Vaporization, and Fluorine Generation Facility. The building is approximately 210 ft wide and 210 ft long with a ground floor area of 62,678 sq ft and a second floor of 13,015 sq ft. The facility included four fluorination towers, two cleanup reactor towers for scavenging excess fluorine gas, compressors and cold traps to collect the UF_6, and cylinder fill stations. A view of the X-344A Facility in 1964 is shown in Figure 74.

Figure 74. X-344A UF_6 Sampling Facility Looking South in 1964

The feed manufacturing operations in the X-344A Facility ceased in 1962 when the decision was made to obtain feed for PORTS from Paducah. In the early 1970s, work was begun to convert the X-344A to a UF_6 sampling facility. This work was completed in 1975.

The north high-bay area of the X-344A Facility housed four autoclaves (Figure 75). These autoclaves were containment-type sampling and transferring units for 2.5-, 10-, and 14-ton cylinders. They were equipped with instrumentation that provides for detection of UF_6 out-leakage and for automatic steam cutoff and isolation of the system. Scales were installed for each autoclave to facilitate monitoring cylinder filling to avoid overfilling. The north high-bay area was also used for rail shipments, and the south high-bay area was used for receiving and shipping low-assay feed and product. Each bay was equipped with two 20-ton cranes, and two accountability scales were accessible from either high-bay area.

Figure 75. X-344A UF_6 Sampling Facility Autoclaves (1986)

High-assay cylinder sampling was conducted in a special room adjacent to the east end of the north high-bay area. Electrically heated containment-type glove boxes were used in this operation. A vault-like storage room was used for accountability storage of high-assay UF_6 cylinders awaiting sampling and shipping.

Outside storage of large cylinders (2.5-, 10-, and 14-ton) was originally in six storage lots (X-745A, B, C, D, E, and F; Figure 76). The lots were surfaced with either crushed stone or reinforced concrete. The cylinders were placed in saddles to provide additional load-bearing surface and to maintain cylinder position. In some of the lots the cylinders were double-stacked to conserve storage space (Figure 77).

"Straddle buggies" were used to transport the large 10- and 14-ton cylinders around the plant site for servicing the feed, withdrawal, and transfer operations (Figure 78). A mobile crane was used in the lots to stack the cylinders.

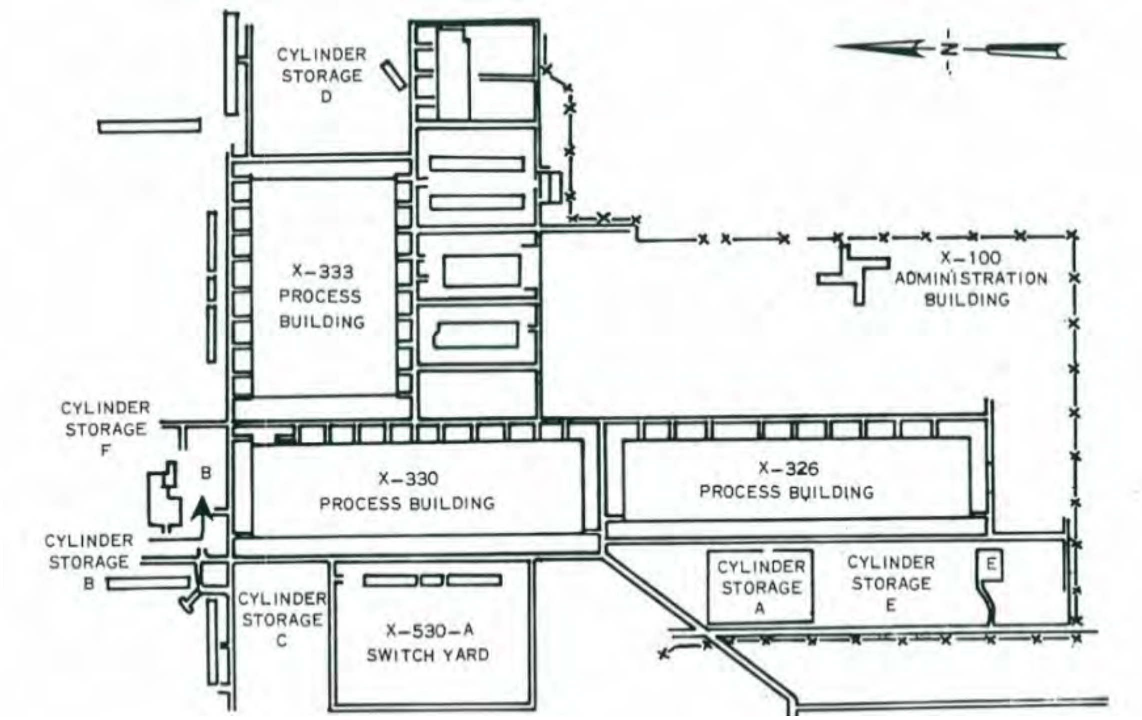

Figure 76. Outside Cylinder Storage Areas A, B, C, D, E, and F (1979)

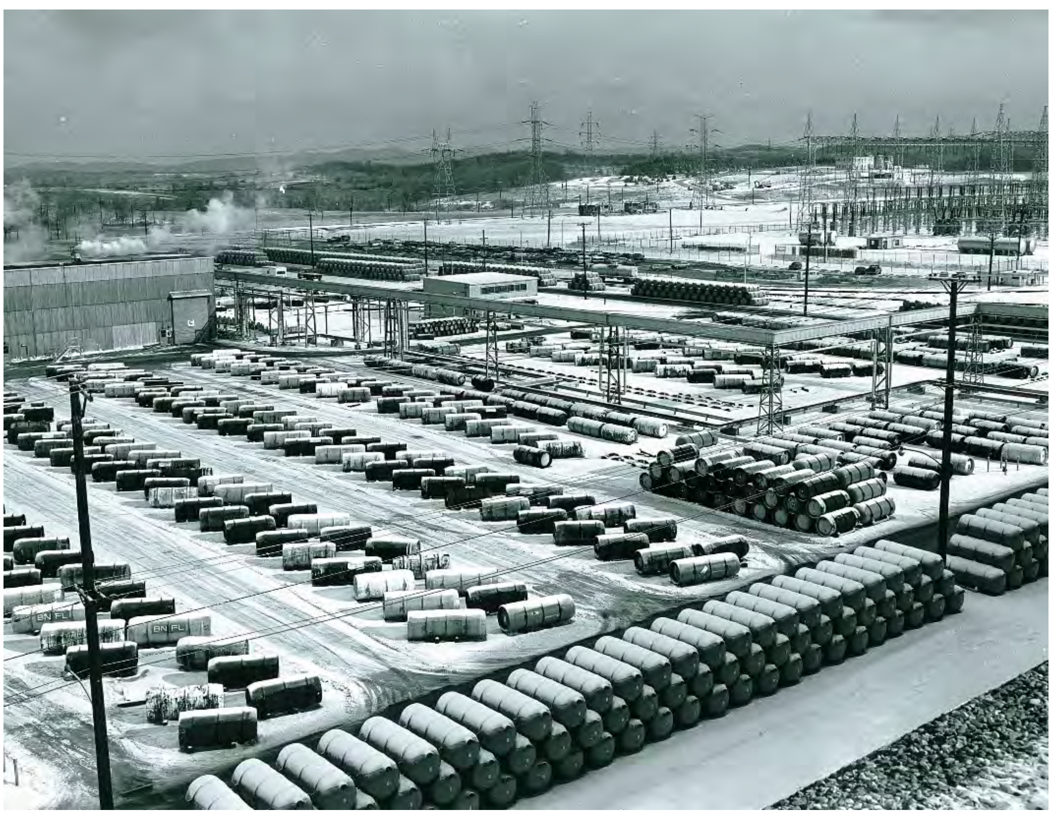

Figure 77. Outside Cylinder Storage Areas B, C, and F Looking Southwest (1979)

Figure 78. Cylinder Straddle Buggy (left) and Customized Crane Used for Transporting and Stacking UF_6 Cylinders (2009)

3.9 X-345 SPECIAL NUCLEAR MATERIAL STORAGE AND SAMPLING BUILDING

The X-345 SNM Storage and Sampling Building is a single-story reinforced-concrete structure built in 1980. The X-345 Building is approximately 161 ft wide and 219 ft long with a total floor area of 35,260 sq ft. There were north and south vaults for storage of highly-enriched UF_6 in 5-, 8-, and 12-in. cylinders and for storage of non-UF_6 materials such as triuranium octoxide, uranium dioxide, and uranyl nitrate hexahydrate. The central area contained the high-assay sampling area, a small laboratory, and some area for storage. Also included in this building was an enclosed glovebox for the sampling and repackaging of non-UF_6 materials generated at PORTS, as well as similar materials returned from the Toll Enrichment Program and other ERDA/DOE contractors. The X-345 Building had the highest security of any on-site facility, owing to the presence of highly-enriched, well-contained, uranium in storage.

Figure 79 shows a view of early construction of the X-345 Building.

Figure 79. Early Construction of the X-345 SNM Storage and Sampling Building Looking West (1980)

3.10 X-300 PLANT CONTROL FACILITY

The X-300 Plant Control Facility provided all control, instrumentation, and communication equipment required for supervision, direction, and coordination of overall plant operations in one central location. The exterior walls, roof, floor slabs, stairs, tunnels, vault, and other structural members are constructed of reinforced concrete, which has considerable shielding qualities and resistance to blasts or shocks. At the time it was built in 1954, the building was said to be designed to be both earthquake proof and bomb proof. Also, the circular shape of the building and the dome-shaped roof offered similar resistance (Figure 80).

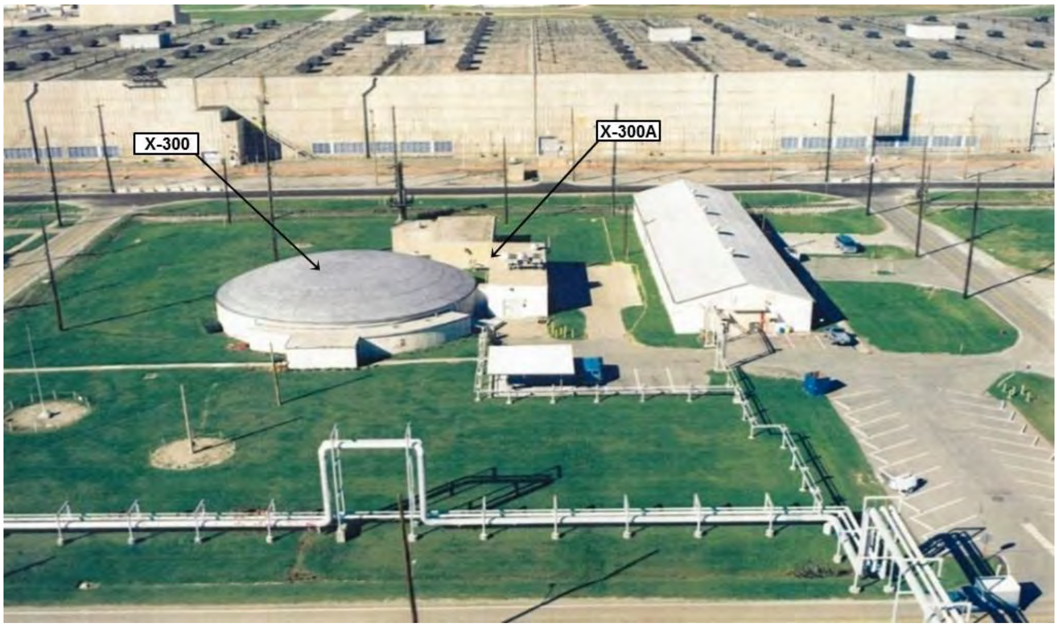

Figure 80. X-300 Plant Control Facility (Dome Structure) and X-300A Process Monitoring Building Looking West (1991)

Supervisory control equipment, offices, and auxiliary rooms were located on the ground floor, and the building power equipment, communication equipment, and air-conditioning and ventilating equipment were located in the basement. Control and instrumentation tunnels extended from the basement to each of the process buildings. Communication, control, and instrumentation cables from all process buildings, switch houses, and the telephone building entered the X-300 Plant Control Facility through these tunnels.

Sufficient equipment was installed to monitor operating conditions that were vitally important to the successful operation of the production cascade and power systems. Also provided was the control equipment required to continue process operations from this location for an indefinite period if all operating personnel were evacuated from the rest of the site. Several views of the construction of the X-300 Plant Control Facility are shown in Figure 81.

The first floor of the building contained the circular central control room, three offices, toilet, kitchen and janitor’s facilities, and a specially-designed entry. The X-300 Plant Control Facility is a dome-shaped building approximately 110 ft in diameter, with a total floor area of 8,246 sq ft. An additional exit opening permits material and equipment delivery (or removal) to the first story area. The three offices, with radial side walls, extended from the southeast quadrant exterior wall halfway to the center of the room. A record desk, fronting on the offices, was located in this quadrant near the center of the room.

A series of panels for the three gaseous diffusion buildings, extended in an arc around three quadrants of the room. Within this partial ring, and in the northwest half of the room, a semicircular depressed floor area created a pit for the power control instrument panels and a power communications console. The two stairs from either side of the record desk area extended from the main floor to the pit level. The area between these stairs, which occurs adjacent to the center of the room, was the location of three communication consoles from which the operators could observe every panel provided in the room.

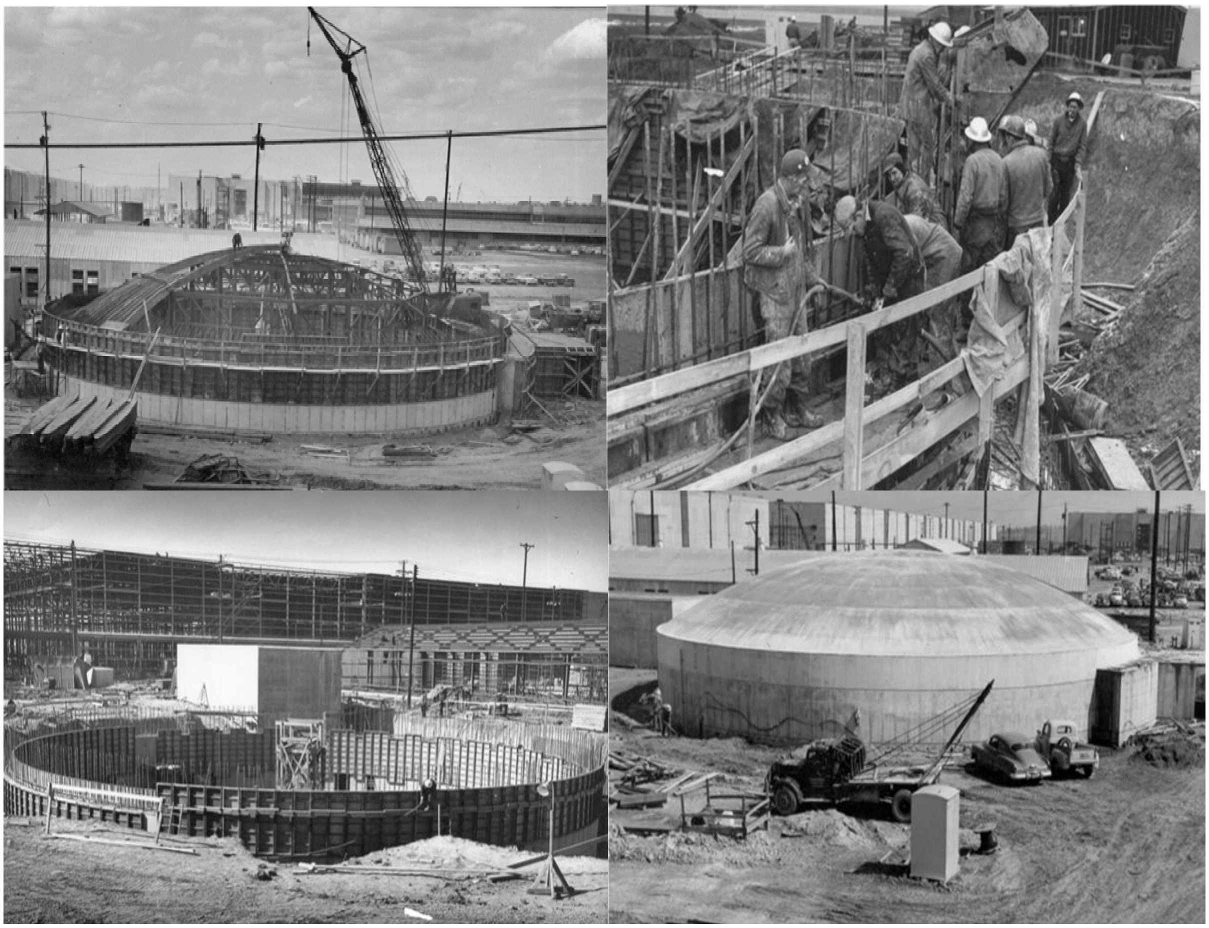

Figure 81. Early Construction of the X-300 Plant Control Facility (1954)

3.11 X-300A PROCESS MONITORING BUILDING

The X-300A Process Monitoring Building is adjacent to the X-300 Plant Control Facility located east of the X-326 Process Building (Figure 80). The X-300A Process Monitoring Building was built about 1954, has masonry exterior walls, and covers an area of 1,400 sq ft. It contains equipment to track plant processing. Utilities in the X-300A Process Monitoring Building include electricity; telephone; heat; central air conditioning; motion, heat, and smoke detectors; and a sprinkler-type fire protection system.

3.12 X-220A INSTRUMENTATION TUNNELS

The X-220A Instrumentation Tunnels were built in 1954 to electrically link the X-300 Plant Control Facility to the process buildings and switchyards. The tunnels contain communication cables and allow access for maintenance and general upkeep. The cables, which transmit information, rest in trays mounted on the tunnel walls. The trays that hold the cables are transite. The floor, ceiling, and walls of the X-220A Instrumentation Tunnels are concrete and are approximately 8 ft wide and 8 ft high. The tunnels can be accessed either at the X-300 Plant Control Facility, the X-326, X-330, and X-333 Process Buildings, or at several manhole and head-house locations spaced regularly along the tunnels' lengths. No production support operations are carried out in the tunnels. Water that may come from surface runoff or groundwater seepage through the walls accumulates in the tunnels. This water is pumped from the tunnels and routed to the X-622 Groundwater Treatment Facility for treatment before being released.

3.13 PROCESS FACILITY CHANGES

Throughout PORTS history, the process facilities have undergone numerous changes as the plant's mission changed. The original facilities were constructed to meet the nation's needs for enriching uranium for nuclear weapons. In the 1960s, the mission of PORTS changed from enriching uranium for nuclear weapons to one focused on producing fuel for commercial nuclear power plants and supplying enriched uranium for U.S. Naval submarine reactors. As the need for enriched uranium increased to support the growing energy needs, it became obvious that the combined production of the three GDPs (i.e., PORTS, Paducah, and Oak Ridge) could not meet the projected needs.

In the late 1960s, in lieu of building a fourth plant, the decision was made to upgrade the three GDPs. In 1973, the CIP/CUP began with the improvement of the converters, compressors, control valves, and vented cavity seals which would upgrade the plant to higher power with additional electrical modifications and heat transfer modes (cooling towers). The programs included upgrading converters, motors, compressors, valves, expansion joints, switch gears, transformers, building ventilation, etc. (Figure 82). During CIP/CUP, a "000" or "00" cell was shut down, gutted, rebuilt, and on stream within 25 days (there were four cells at a time down in various stages of the retrofit). At the height of the program, the plant was placing a modified cell on stream every 2 weeks. When completed in March 1983, the CIP/CUP program provided a 65 percent increase in production capacity.

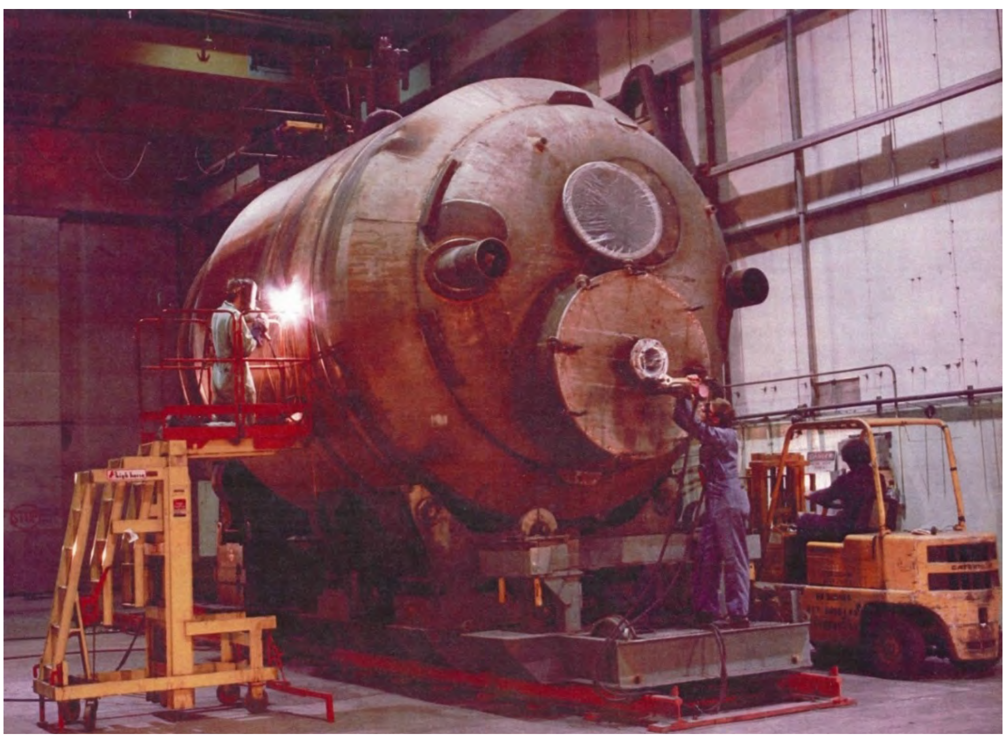

Figure 82. Converter Upgrade in the X-700 Converter Shop and Chemical Cleaning Facility (1973)

4. SITE INFRASTRUCTURE FACILITIES

The construction and operation of PORTS represented a monumental, multi-million dollar effort in support of the nation's nuclear science and security initiatives during the Cold War. For the security of the nation, weapons development and production took precedence over peacetime research programs and quickly created a growing need for enriched uranium. Numerous facilities were constructed at PORTS during the period of 1952 to 1956 to support the gaseous diffusion enrichment process. The engineered PORTS infrastructure was massive and unique at the time of its construction, and there is still little else like it today. Plant facilities were designed, constructed, and operated that were directly related to and supportive of the uranium enrichment operations at PORTS. The plant was often compared to a town because, in addition to the main process buildings, it had its own fire department, police force, hospital, sewage disposal, water sanitation, repair shops (including a fully functional garage), heating systems, and cafeteria.

Five general categories of site services were needed to support the gaseous diffusion enrichment process:

- Utilities (electrical power, recirculating cooling water, air, steam, nitrogen, sanitary water, etc.)
- Cleaning and decontamination facilities
- Maintenance facilities
- Mechanical equipment testing facilities
- Laboratory services.

The primary facilities supplying these services are listed below and discussed in this section.

- X-530 Electrical Switchyard Complex and former X-533 Electrical Switchyard Complex for delivering electrical power to the process facilities and area auxiliaries

- X-109A Personnel Monitoring Station (originally a switch house)

- X-600 Steam Plant that furnished steam for process and building heat

- X-605 Sanitary Water Wells and Facilities

- X-608 Raw Water Pump House and Wells

- X-611 Water Treatment Plant

- X-612 Elevated Water Tank

- X-626, X-630, and X-633 RCW systems

- X-330 Nitrogen Manufacturing Facility

- Dry-air plants in the X-326, X-330, and X-333 Process Buildings that furnished dry air required for operation of plant equipment and instruments

- X-615 and X-6619 Sewage Treatment Plants

- X-614A Sewage Pumping Station
- X-640 Firewater Pump House and Elevated Water Tank
- X-344B Maintenance Storage Building
- X-700 Converter Shop and Chemical Cleaning Facility
- X-705 Decontamination Building
- X-710 Technical Services Building
- X-720 Maintenance and Store Building
- X-744G and X-744H Bulk Storage Buildings
- X-746 Materials Receiving and Inspection Building
- X-750 Mobile Equipment Maintenance Garage
- X-760 Chemical Engineering Building
- X-770 Mechanical Testing Building.

Various facilities at PORTS are seen in aerial views from the 1960s and 1990s as shown in Figures 83 and 84, respectively.

Figure 83. PORTS from the Northeast Corner of the Reservation (1960s)

Figure 84. PORTS Looking South (1998)

4.1 SITE UTILITIES

During the Cold War era, electrical power was purchased from power stations within the OVEC grid. Electricity entered PORTS at the X-530A and X-533A Switchyards and from there was distributed to site-wide facilities for plant use. The X-611 Water Treatment Plant provided high-quality water for use on the plant site. Raw water used at the plant came from either the Scioto River or the X-605, X-608, and X-6609 Well Fields. This raw water needed to be treated to remove the bicarbonate hardness inherent in the waters of this region before it can be used in plant operations or for human consumption. Water was transported from the Scioto River and local well fields to the X-611 Water Treatment Plant via pipelines. From the X-611 Water Treatment Plant, treated water was distributed for site operations and sanitary use. Sewage and wastewater from plant operations entered the X-615 and X-6619 Sewage Treatment Plants via the plant site sewer system. Treated effluent was discharged to a regulated outfall in the Scioto River.

Details of site utilities used for PORTS operations during the Cold War era, including electrical power; water supply and storage; recirculating water systems; water treatment; steam, dry air and nitrogen generation; and sewage and wastewater treatment are discussed in this section. A general schematic of electrical, water, and sewage/wastewater utilities used at PORTS is shown in Figure 85.

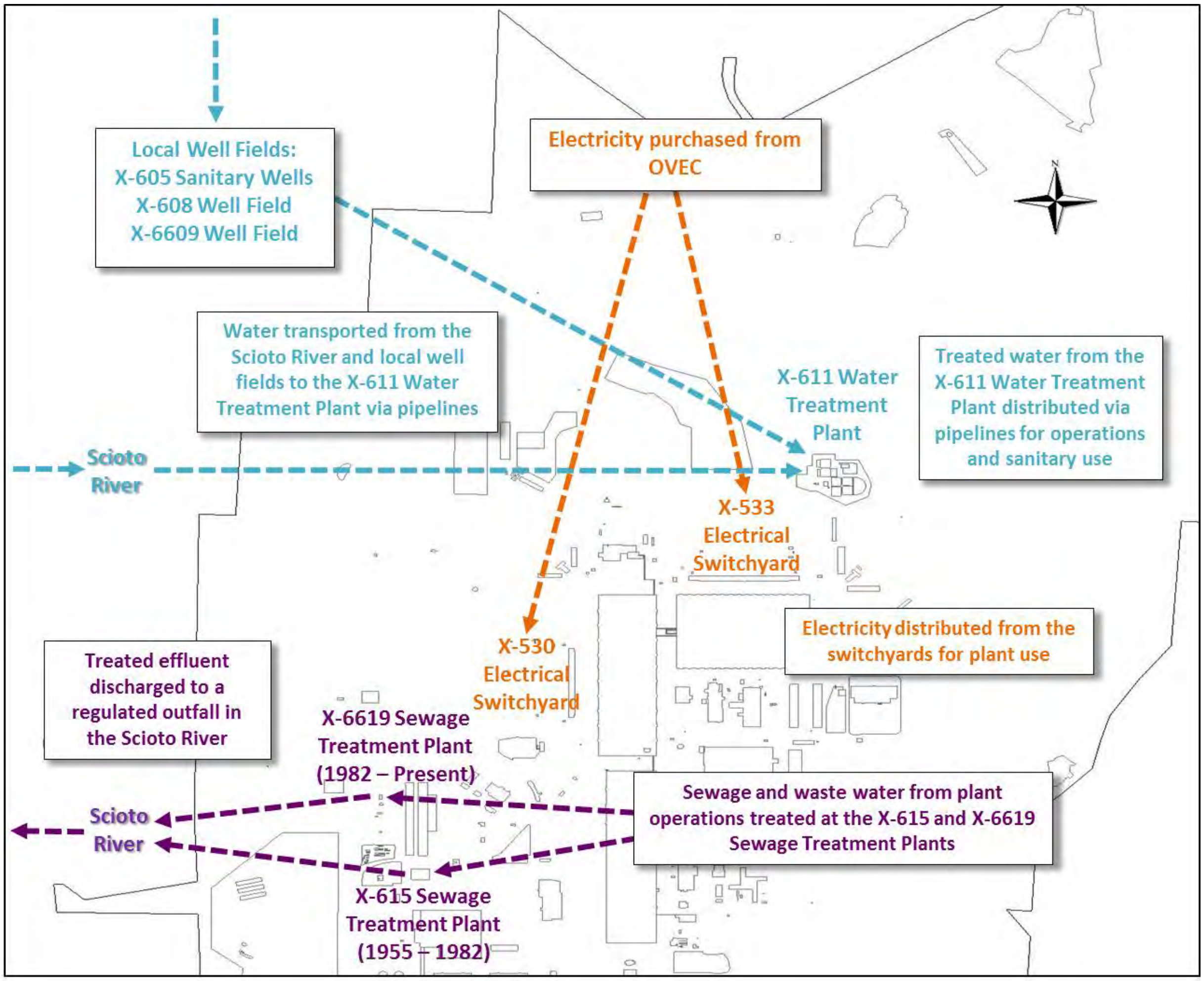

Figure 85. General Schematic of Electrical, Water and Sewage/Wastewater Utilities Used at PORTS

4.1.1 Electrical Power

PORTS received its electrical power from the OVEC grid at 345 kV nominal power from two dedicated coal-fired power stations: Kyger Creek in Cheshire, Ohio, and Clifty Creek in Madison, Indiana. At the time of construction in the early 1950s, these two power plants were the largest ever built by private industry (i.e., OVEC). Kyger Creek and Clifty Creek can generate enough electrical power to supply all the requirements for every home in a city of 1,000,000 population while burning nearly 7.1 million tons of coal annually (19,500 tons daily). OVEC and its wholly owned subsidiary, Indiana-Kentucky Electric Corporation, along with their sponsoring companies, still own and operate the Kyger Creek and Clifty Creek power plants.

On December 8, 1952, OVEC delivered the first power for construction purposes to PORTS. This was accomplished by means of hastily built 138-kV lines interconnecting the site to the network of one of OVEC's sponsoring companies. The OVEC System office in Piketon, Ohio, is shown in Figure 86.

Figure 86. OVEC System Office off West Access Road Piketon, Ohio (2001)

OVEC was formed in 1952 by 15 investor-owned power companies of the Ohio River Valley for the sole purpose of delivering electrical power to PORTS. The 15 sponsor companies were:

- Appalachian Electric Power Company[*]
- The Cincinnati Gas and Electric Company
- Columbus and Southern Ohio Electric Company
- The Dayton Power and Light Company
- Indiana and Michigan Electric Company[*]
- Kentucky Utilities Company
- Louisville Gas and Electric Company
- Monongahela Power Company[†]
- Ohio Edison Company
- Ohio Power Company[*]
- Pennsylvania Power Company[‡]
- The Potomac Edison Company[†]
- Southern Indiana Gas and Electric Company
- The Toledo Edison Company
- West Penn Power Company[†].

Subsidiary of:
[*]American Gas and Electric Company (AEP)
[†]The West Penn Electric Company
[‡]Ohio Edison Company

The original power agreement, signed by OVEC and AEC on October 15, 1952, was for 25 years and called for continuous delivery of 1,800 MW (later in 1956 increased to 1,950 MW). This was the largest single purchase block of electrical power to a single company in the nation.

Kyger Creek and Clifty Creek transmitted their power over 776 circuit miles of 345-kV lines via two switching stations: Dearborn at Lawrenceburg, Indiana, and Pierce at New Richmond, Ohio, before being stepped down to 13.8 kV for distribution to the process buildings and area auxiliaries. The transmission system, when finished, contained 1,558 steel towers, averaging 4/mile, 158 ft in height, and 15 tons in weight. To operate and control this system, there were 35 transformers with a total capacity of 2.8 million kilovolt-amperes (kVA) and 49 oil circuit breakers with a total interrupting capacity of 25 million kVA. Total investment for OVEC was approximately $385,000,000 (in 1954 dollars).

Upon termination of the original power agreement, OVEC, AEC, and OVEC's owners of their utility-company affiliates (called sponsoring companies) entered into power agreements to ensure the availability of the AEC's substantial power requirements.

4.1.1.1 Kyger Creek

In 1952, construction began on the Kyger Creek Power Plant located in Cheshire, Ohio (near Gallipolis, Ohio). The Kyger Creek Power Plant was built, owned and operated by OVEC (Figure 87). It consists of five coal-fired 214 MW units with a total design capacity of 1,070 MW. Each of these units operate off a single boiler and under steam conditions of 2,000 psi and 1,050°F, for both initial main steam and reheat temperatures. No large units of that pressure and temperature and no single boilers of that kind had ever been operated before that time. The plant is located along the bank of the Ohio River immediately upstream of Kyger Creek and receives the majority of its coal via river barges. The plant uses Ohio River water for once-through cooling of its steam condensers. There were approximately 2,400 skilled workmen needed at the height of construction of the Kyger Creek plant.

Figure 87. Two Views of Kyger Creek Plant Gallipolis, Ohio (2005)

4.1.1.2 Clifty Creek

In 1952, construction began on the Clifty Creek Power Plant located in Madison, Indiana. The Clifty Creek Power Plant was built, owned, and operated by an OVEC subsidiary, Indiana-Kentucky Electric Corporation (Figure 88). It consists of six coal-fired 214 MW units with a total design capacity of 1,284 MW. The design and operation of the units were similar to Kyger Creek. The plant is located along the bank of the Ohio River immediately upstream of Clifty Creek and receives the majority of its coal via river barges. The plant uses Ohio River water for once-through cooling of its steam condensers. The three reinforced concrete stacks were 682 ft above ground and were the tallest in the world at the time of construction. There were approximately 3,000 skilled workmen needed at the height of construction of the Clifty Creek plant.

Figure 88. Two Views of Clifty Creek Plant Madison, Indiana (2005)

4.1.1.3 AEP Don Marquis Substation

The Don Marquis Substation, built and owned by AEP, is located adjacent to the plant, high on a hill west of Perimeter Road (Figure 89). The substation was completed in 1969 for the purpose of providing an interconnection network between OVEC, the 15 OVEC sponsors, and the Columbus, Cincinnati, Dayton (CCD) Group: Columbus & Southern Electric Company, Cincinnati Gas and Electric Company, and Dayton Power and Light. The substation was an intricate part of a giant extra-high voltage (765 kV) transmission network built by AEP which covered nearly 2,000 miles. The 765-kV substation contained three 765/345 kV, 500 MVA transformers and a multitude of high-voltage switchgear and circuit breakers. The 345-kV yard contained five lines which acted as ties between the site's switchyards (X-530A and X-533A Switchyards) and surrounding CCD facilities. A 68-mile, 765-kV extra-high voltage line leads to AEP's Big Sandy generating station near Ashland, Kentucky.

Figure 89. AEP Don Marquis Substation

4.1.1.4 Former X-533 Electrical Switchyard Complex

The former X-533 Electrical Switchyard Complex provided power in the quantity and at the voltage required for the operation of the X-333 Process Building, attendant facilities, and for general purposes (Figure 90).

The switchyard was built between October 1953 and January 1956 (Figures 91 and 92). Electrical power was received at the X-533 substation over four 330-kV transmission lines of the OVEC, two of the lines being extended from the Kyger Creek steam plant along the Ohio River in Cheshire, Ohio, and the other two from the Pierce switching station and from the tie line to the X-530A Switchyard. The former X-533 Electrical Switchyard Complex was generally similar in design, appearance and arrangement to the X-530 Electrical Switchyard Complex.

Figure 90. Former X-533 Electrical Switchyard Complex Looking Northwest from above the X-333 Process Building (2006)

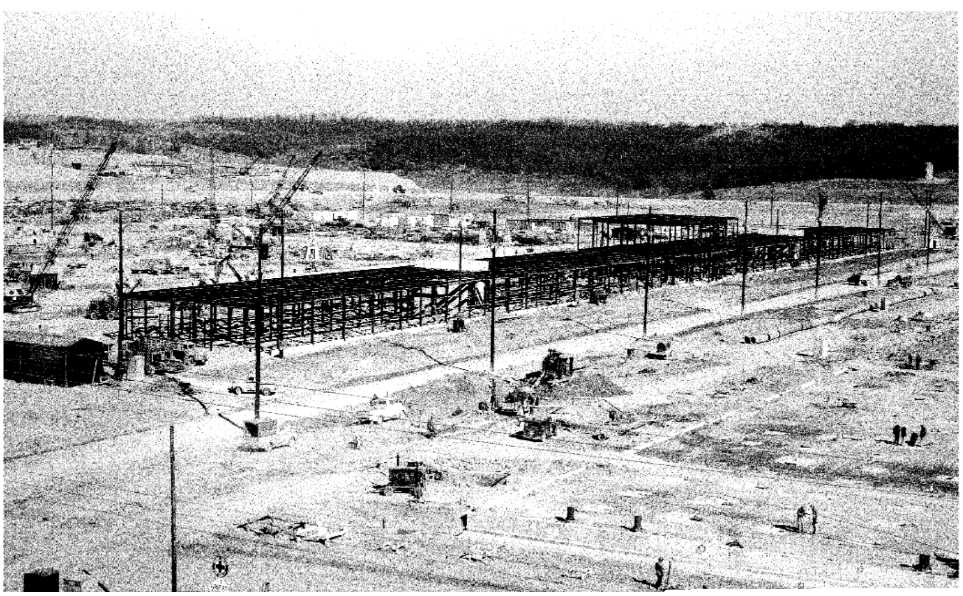

Figure 91. Former X-533 Electrical Switchyard Complex under Construction Looking Northeast (1954)

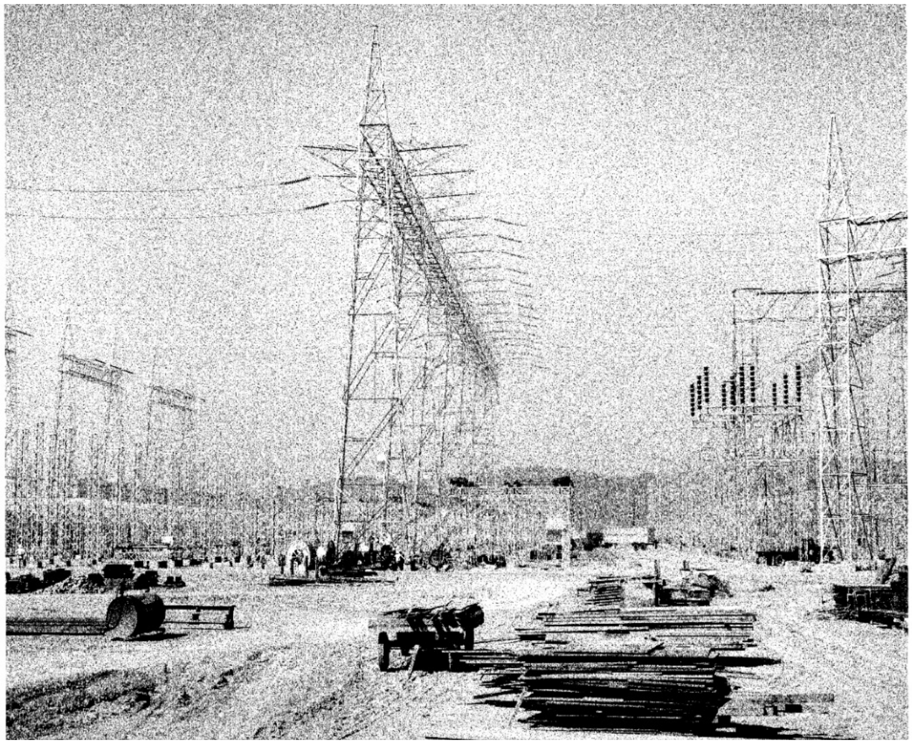

Figure 92. Former X-533 Electrical Switchyard Complex under Construction Looking West (1954)

As described in Table 7, the former X-533 Electrical Switchyard Complex contained:

- A 770,000 sq ft equipment switchyard area (X-533A Switchyard)
- A two-story control room with two switchgear houses (X-533B Switch Houses and Control House)
- A general maintenance crew area for housing the yard maintenance equipment and performing minor maintenance activities (X-533C Test and Repair Facility)
- An oil pumping/reclaiming station (X-533D Oil House)
- Two below-ground head houses for housing the fire water valves used to transition the fire water system from a wet to dry system for transformer fire suppression (X-533E and X-533F Valve Houses)
- A metal pole barn type structure for housing the sulfur hexafluoride (SF_6) reclamation cart, spare SF_6 cylinders, and an air monitoring station (X-533J Gas Reclaiming Cart Garage)
- An outbound transformer cleaning slab.

Demolition of the X-533 Electrical Switchyard Complex was completed in 2011with funding provided by the American Reinvestment and Recovery Act of 2009.

Table 7. Structures in the Former X-533 Electrical Switchyard Complex

Facility	Identification	Date Built	Area (sq ft)	Construction
X-533A	Switchyard	1954	772,174	Limestone gravel bed
X-533B	Switch Houses and Control House	1955	148,874	Steel-framed, transite
X-533C	Test and Repair Facility	1955	1,200	Steel-framed, transite
X-533D	Oil House	1955	500	Steel-framed, transite
X-533E	Valve House	1955	500	Reinforced concrete
X-533F	Valve House	1955	500	Reinforced concrete
X-533H (renamed X-533J)	Gas Reclaiming Cart Garage	1985	1,200	Metal sides, roof

4.1.1.5 X-530 Electrical Switchyard Complex

The X-530 Electrical Switchyard Complex is located west of the X-330 Process Building and south of the former X-630 Cooling Towers. This switchyard area, including the switch houses and control house, oil house, the test and repair facility, the valve houses, and oil pumping station, covers an area of approximately 18 acres (660 ft wide and 1,210 ft long). A patrol road is provided outside the perimeter fence. The X-530 Electrical Switchyard Complex contains several structures as listed in Table 8. An aerial view of the X-530 Electrical Switchyard Complex is shown in Figure 93.

Table 8. Structures in the X-530 Electrical Switchyard Complex

Facility	Identification	Date Built	Area (sq ft)	Construction
X-530A	Switchyard	1954	780,000	Limestone gravel bed
X-530B	Switch Houses and Control House	1954	112,600	Steel frame, transite
X-530C	Test and Repair Facility	1954	1,200	Steel frame, transite
X-530D	Oil House	1954	500	Steel frame, transite
X-530E	Valve House	1954	500	Reinforced concrete
X-530F	Valve House	1954	500	Reinforced concrete
X-530G	GCEP Oil Pumping Station	1980	500	Metal sides, roof

The X-530 Electrical Switchyard Complex is connected to the power supplier's system by one double-circuit tower line from the Kyger Creek generating station and by one double-circuit tower line from the Pierce switching station. The X-530 Electrical Switchyard Complex also has an incoming line from the adjacent OVEC 345 to 138 kV autotransformer switchyard that is located at the west side of the switchyard complex. The X-530A and X-533A Switchyards each have a 345-kV tie line connecting to the AEP Don Marquis Substation, located just west of the plant site. Power from the switchyard transformers is fed via isolated-phase bus duct to the 13.8-kV switchgear located on the deck of the switch house. The X-530 Electrical Switchyard Complex is enclosed by a perimeter fence on three sides and the X-530B Switch House on the fourth side. The X-530 Electrical Switchyard Complex will continue to operate and be upgraded as needed throughout the decontamination and decommissioning of PORTS.

Figure 93. X-530 Electrical Switchyard Complex (2006)
The former X-533A Switchyard can be seen in the upper right portion of the photograph.

Switchyard equipment includes power transformers, grounding transformers, synchronous condensers, oil circuit breakers, lightning arrestors, disconnect switches, potential transformers, coupling capacitors, line tuning units, and wave traps.

The switchyard arrangement is a double-bus, breaker-and-a-half scheme. In this scheme, three breakers are used to provide two breakers for a line and two breakers for a transformer; that is, the middle breaker in a bay is both a line breaker and a transformer breaker.

The X-530A Switchyard has six bays that feed 12 power transformers and in the X-533A Switchyard, seven bays fed 16 transformers. The power transformers are connected in pairs from the switchyard bays (except for X-533A, where one bay had three transformers). A stub bus is provided for each pair of power transformers.

The X-530 Electrical Switchyard Complex has a switch house area identified as X-530B, which consists of two switch houses with a control house in the center. The function of the switch house is to supply power at a nominal voltage of 13.8 kV to the process buildings and area auxiliaries and to provide a control operating point for the substation.

The switch house receives power from the switchyard transformers and feeds that power to the underground distribution system. The X-530B Switch Houses supply power to the X-326 and the X-330 Process Buildings and all other area auxiliaries. Tunnels at the north and south ends of the X-530B Switch Houses carry the 13.8-kV feeder cables to points where underground duct runs take them into the process or auxiliary buildings. Overhead 15-kV cables are extended from the switch houses to the X-330 and X-333 Process Buildings, paralleling the underground cables. Similarly, the X-533 Electrical Switch Houses supplied power to the X-333 Process Building and to the X-633 Pump House via 13.8-kV feeder cables in concrete ducts.

The switch houses and the control house run parallel to the length of the switchyard and are located on the boundary line of the substation area. The control house is located between the switch houses and is connected to each switch-house operating deck by a walkway from the operating-floor level of the control house. Underground cable tunnels also connect the switch houses with the control house.

The switch houses are one-story, rectangular structures, 67 ft wide by 394 ft long. Foundations for the building, equipment, and cable tunnels are reinforced concrete, and the floor slab is a reinforced monolithic concrete placed on compacted fill. The superstructure is a structural steel frame with columns that support steel rook-beam members. The roof is a reinforced concrete slab covered with membrane waterproofing and a cement topping. The roof area of the switch houses is a deck, which contained the 13.8-kV switchgear and the synchronous condensers. A parapet wall projects above the roof deck slab, and, for personnel safety, a pipe railing is provided on top of the parapet wall. The exterior walls are aluminum siding bolted to a horizontal steel girt. Aluminum flashing covers the parapet wall and the top of the siding.

The control house is a two-story rectangular structure, 67 ft wide and 120 ft long. The building and equipment foundations are reinforced concrete, and the basement floor slab, which is at ground level, is a monolithic concrete slab placed on compacted fill. The second floor, or operating floor, is also reinforced concrete. The construction of the superstructure of this building is similar to that of the switch house, except for the roof construction, which is built up with gravel topping.

The switch houses are arranged with outdoor 13.8-kV switchgear and synchronous condensers located on the roof deck. The basement houses auxiliary equipment such as synchronous-condenser controls and pumps, switchgear air compressors, low voltage switchgear, heating and ventilating equipment, distribution transformers and panels, and lighting transformers and panels.

The operating floor of the control house contains two groups of panels for control of 345-kV and 138-kV equipment, one recording and metering control panel, and two groups of 13.8-kV switchgear controls. An operator's console, which was part of the communication system, is located in the approximate center of the operating floor, and a control panel for lighting and auxiliary power is located behind the recording and meter panel. The operator's floor also includes a kitchen with built-in sink, range, refrigerator, a dark room, relay test room, locker room, toilet, and shower.

The control-house basement floor houses carrier current equipment, 250- and 48-V control batteries; supervisory cabinets; alarm relay cabinets; heating, ventilating, and air conditioning equipment; and synchronous condenser amplidyne and field rheostat controls.

The X-530C Test and Repair Facility (Figure 94) is a 1,200-sq ft steel-frame building that provides an electrical maintenance shop for the switchyards. It contains work benches and a lunch room; drinking water is supplied. Utilities include fluorescent lighting, heat, air conditioning, phones, and a restroom.

Figure 94. X-530C Test and Repair Facility (2010)

The X-530D Oil House is a 500-sq ft steel-frame building that encloses the equipment that provides oil exchange in electrical equipment at the switchyard (Figure 95). Oil drained from the non-polychlorinated biphenyl (PCB) transformers and circuit breakers is stored, filtered, and recycled through this building.

Figure 95. X-530D Oil House and Equipment (2010)

The X-530E Valve House is a 500-sq ft reinforced-concrete structure located on the north side of the switchyard (Figure 96). It houses an emergency sprinkler main with distribution lines leading to transformers on the northern half of the switchyard. A below-ground pump house contains eight water pumps and distribution lines that are part of the deluge fire water system protecting high-voltage transformers on the north side of the switchyard.

Figure 96. X-530E Valve House and Equipment (2010)

The X-530F Valve House is a 500-sq ft reinforced-concrete structure located on the south side of the switchyard. It houses an emergency sprinkler main with distribution lines leading to transformers on the southern half of the switchyard.

The X-530G GCEP Oil Pumping Station is a 500-sq ft structure with metal sides and roof that contains pumps that maintain positive pressure on oil-filled underground pipes containing power cables. It contains two pumps, a diked aboveground storage tank (AST), fluorescent lights, and a sprinkler system.

4.1.2 X-109A Personnel Monitoring Station

The X-109A Personnel Monitoring Station (Figure 97), built in 1955, is a 1,100-sq ft block building with a concrete slab roof and floor. It is located south of the X-530A Switchyard near the former X-740 Waste Oil Storage Facility. The X-109A Personnel Monitoring Station was originally used as a switch house for a temporary power switchyard during original PORTS construction. As a personnel monitoring station at PORTS, the building served as an assembly point for personnel evacuating buildings when alarm systems sounded or when directed to do so during evacuation drills.

Figure 97. X-109A Personnel Monitoring Station

4.1.3 Former X-600 Steam Plant

The former X-600 Steam Plant (Figure 98), which was demolished in 2013, was located near the southern end of PORTS. The plant provided steam for the enrichment process, heating of auxiliary buildings, and other purposes. Steam was generated by combinations of three coal-fired boilers.

Figure 98. Former X-600 Steam Plant Looking Southwest (1990s)

The purpose of the former X-600 Steam Plant was to produce 125-psi saturated steam that was used to: (1) heat buildings, (2) vaporize UF_6, (3) obtain UF_6 samples, (4) maintain process temperatures, (5) clean equipment, and (6) provide heat for other miscellaneous process operations. It consisted of three boilers of the bent-tube design, each rated for continuous operation at 125,000 lb of steam per hour at 125 psi, plus the necessary auxiliary equipment. The boilers were fired with coal fed through stokers.

The plant building consisted of a basement and a main floor. The basement was completely enclosed and constructed of reinforced concrete. The main structure of the building was of the semi-outdoor type, with the firing aisles and boiler fronts enclosed with transite siding over the beams and girders. The beams and girders were constructed of structural steel. The basement housed the forced draft fans, boiler feed pumps, water-softening system, over-fire air blowers, pressure reducing station, necessary piping for steam and water, and ash removal equipment. The operating floor was located above the ground floor, and the coal bunkers were directly above the operating floor. The induced-draft fans were located on the top floor outside the boilers.

An ample supply of boiler feed water of good quality was a necessity for economic and efficient operation of the former X-600 Steam Plant. Water used at the diffusion plant is obtained from underground wells and the Scioto River.

When the GDP was in production, coal was consumed at a rate of 80 tons per day. Coal was trucked into the plant from a nearby mine. The trucks could dump into the coal storage yard or directly into the coal chute. The former X-600A Coal Pile Yard (Figure 99) was located approximately 300 ft from the steam plant and had a capacity of 50,000 tons of coal; however, normal storage was approximately 10,000 tons.

Figure 99. Former X-600A Coal Pile Yard Looking West (1991)

Coal dumped into the coal chute was fed onto a system of large belt conveyors that transported it to the coal elevator. The elevator lifted the coal to the coal bunker room, where a flight conveyor distributed it to the nine coal bunkers. Coal from the bunkers slid down chutes into stokers that fed onto a moving grate, where combustion took place, releasing heat and forming ashes and hot gases. The entrained coal particulates were reduced by mechanical dust collectors and electrostatic precipitators before the gases were released to the atmosphere through the boiler stacks. Ashes were removed from the boilers by a pneumatic conveying system.

4.1.4 X-605 Sanitary Water Wells and Facilities

The X-605 Sanitary Water Wells and Facilities consisted of four wells (X-605A) and a control facility in a field east of the Scioto River and west of U.S. Highway 23; and three metal buildings on the DOE Reservation, north of Perimeter Road near a set of railroad tracks: the former X-605H Pump House, the former X-605I Chlorinator, and the former X-605J Generator Building. These three buildings were demolished in 2011.

The control house is a 500-sq ft steel-framed building on an engineered mound 20 ft above the surrounding field. The four X-605A Sanitary Water Wells are located near the control house. The former X-605H Pump House was a 600-sq ft metal building housing four booster pumps and their controls. The former X-605I Chlorinator was housed in a 300-sq ft metal building beside the former X-605H Pump House. The former X-605J Generator Building was a 200-sq ft wood-framed structure with steel siding that housed two diesel-driven generators. A pole mounted platform beside the X-605J Generator Building supported three transformers.

4.1.5 X-608 Raw Water Pump House and Wells

The X-608 Raw Water Pump House is located on the east bank of the Scioto River at the village of Piketon 4 miles northwest of PORTS and is an 11,600-sq ft reinforced-concrete building. The X-608A and B Well Fields are located beside the Scioto River about 1 mile from the pump house.

The X-608 Raw Water Pump House is a six-story structure, of which one level is above grade. The lowest level is at the river level and has sluice gates on the river side for water to enter its wet well. Five vertical pumps are driven by motors on the fifth level. Transformers are located on the sixth level. An elevated platform mounted on poles outside the building supports transformers that supply power to the X-608A and B Well Fields pump motors.

The X-608A Well Field has four pumps and the X-608B Well Field has 11 pumps. All pumps are rated at 1,000 gpm. Individual Well 6B is permanently out of service. In 1964, the X-608 Raw Water Pump House was placed on automatic, unmanned operation. In 1979, the pump house was shut down and is not used to pump river water to PORTS. Water is pumped from the X-608B Well Field to the X-608 Raw Water Pump House and then pumped to the X-611 Water Treatment Plant for distribution to specific plant processes.

In addition, water is pumped from wells associated with the X-6609 Well Field that was installed during construction of the GCEP facilities to the X-611 Water Treatment Plant. The X-6609 Well Field is located near Piketon along the Scioto River.

4.1.6 X-611 Water Treatment Plant

The X-611 Water Treatment Plant (Figure 100) provides chlorinated, sand–filtered, and carbonated water for the supply of potable water to the plant. The plant has the design capacity to process 40 million gal/day but typically processed over 10 million gal of makeup water daily for the plant's RCW system when the GDP was in operation.

The X-611 Water Treatment Plant provides high quality water for use on the plant site. The raw water, which is readily available to PORTS, is taken either from the Scioto River or from well fields located near the Scioto River. This water must be treated to remove the bicarbonate hardness inherent in the waters of this region before it can be used in the cooling system. If this bicarbonate hardness were not removed, the heat rejection system would be damaged through fouling of heat transfer equipment. Any water intended for human consumption must also be treated to kill harmful bacteria and to remove any material that would cause discoloration. Water used for sanitary purposes is either treated at the X-611 Water Treatment Plant or supplied directly from the X-605A Sanitary Wells. At the X-611 Water Treatment Plant, the water is softened, filtered, and chlorinated. Water supplied directly from the X-605A Sanitary Wells is chlorinated only.

Figure 100. X-611 Water Treatment Plant Looking East from above Perimeter Road (1991)

The raw water that is treated at the X-611 Water Treatment Plant comes from the Scioto River via the X-605A Sanitary Wells and the X-608A and B Well Fields. The former X-605H Pump House was a backup system that was used only when the well systems were unable to produce sufficient water to meet the plant demand (maximum of 5 percent of a typical year). When the former X-605H Pump House operated, the pumping rates normally were only about 4 million gal/day, a fraction of the existing capacity of about 32 million gal/day. The intake channels to the pumps were provided with outer bar screens with 4-in. openings and inner bar screens with 2-in. openings to prevent wood and debris from entering.

The X-611 Water Treatment Plant consists of two concrete-block houses, a series of mixing and settling basins, and the necessary chemical storage bins. The main building, which houses the lime slackers, ferric sulfate feeders, activated carbon feeders, a chlorinator, and the office and laboratory areas, is 81 ft long, 49 ft wide, and 30 ft high. The filter house, which houses the sanitary water filtration and pumping facilities, is 61 ft long, 59 ft wide, and 40 ft high. The water treatment plant is designed to treat 36 million gal/day for recirculating water make-up and 4 million gal/day for sanitary water.

The water treatment process is based on conventional water treatment techniques, which include softening, coagulation, flocculation, sedimentation, filtration, chlorination, and pH adjustment. A schematic flow diagram and layout of the X-611 Water Treatment Plant is presented as Figures 101 and 102, respectively. The X-611 Water Treatment Plant was used as a model during planning of other local water treatment plants (Figure 103).

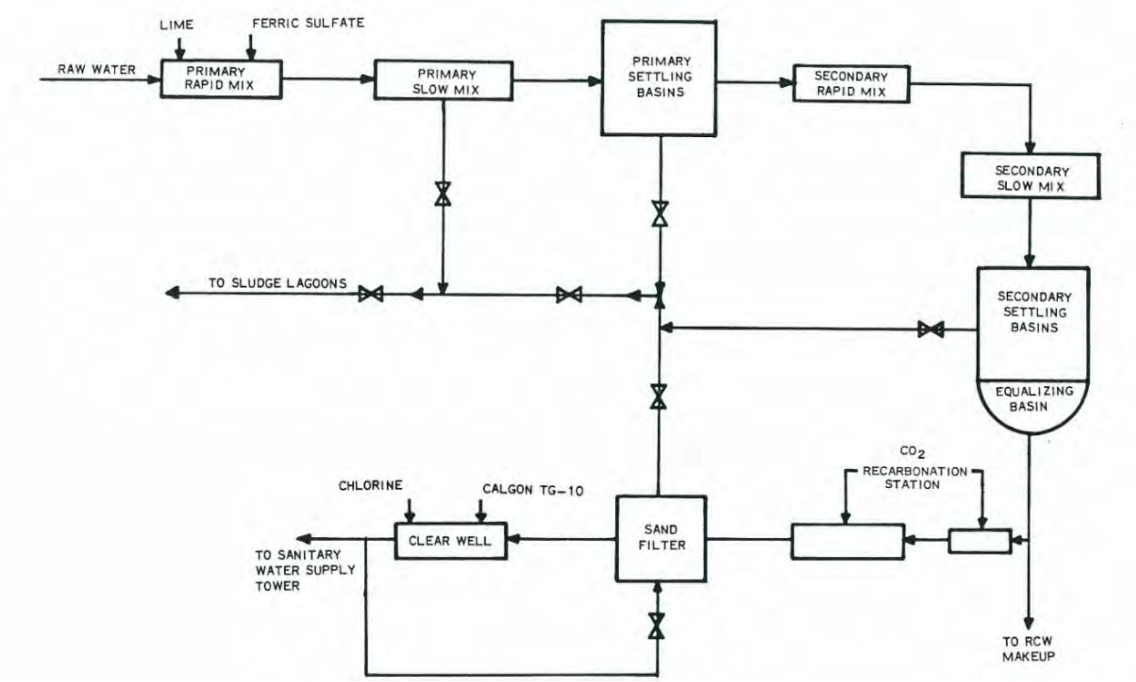

Figure 101. Flow Diagram of the X-611 Water Treatment Plant

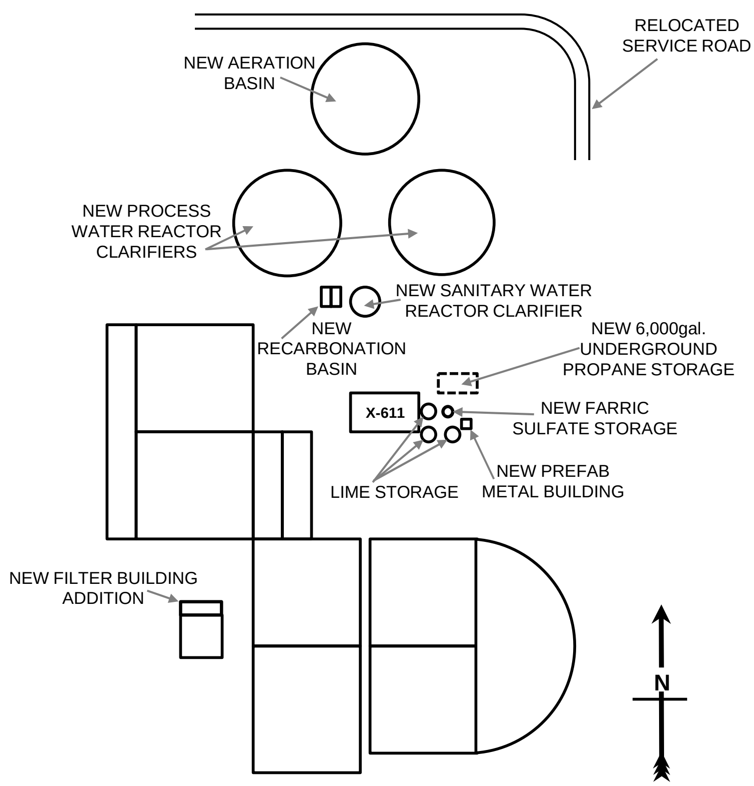

Figure 102. X-611 Water Treatment Plant Layout

Figure 103. X-611 Water Treatment Plant (1969)
Officials from the City of Waverly visited in anticipation of the planning, construction and operation of their own local facility.

4.1.7 X-612 Elevated Water Tank

The X-612 Elevated Water Tank is located beside Perimeter Road on the west side of PORTS and is a 250,000-gal, 200-ft-high elevated water storage tank (Figure 104 and 105). The X-612 Elevated Water Tank stores sanitary water for the Sanitary Fire Water System and general use by DOE and DOE contractors.

Figure 104. X-612 Elevated Water Tank Looking Southwest (1980s)

Figure 105. Inspection of the X-612 Elevated Water Tank (1971)
Clay Cottle and Ernie Dardenne conduct annual inspection of the X-612 Elevated Water Tank. Standing 200 ft over the plant site, the water tank was checked for corrosion, deterioration and other unsafe conditions. From their lofty perch, Clay and Ernie prepare to inspect the interior of the water tank.

4.1.8 Process Cooling

Process cooling was accomplished by recirculating water systems, which dissipated the waste heat to the environment through evaporative cooling towers. An independent system was associated with each cascade process building.

The RCW system removed the heat of compression from the process gas, along with waste heat from a few auxiliary processes, and dissipated this energy to the environment. A flow schematic diagram is presented as Figure 106, which shows how the system was assembled. Approximately 90 percent of the electrical energy consumed on the plant site was converted to heat in the enrichment process when UF_6 was compressed to force it through the stage converter.

Excess energy was removed and dissipated by a double-loop system designed to reduce the possibility of a large amount of water contacting the process gas. The primary loop removed energy from the UF_6 by passing the process gas through a heat exchanger (the coolant evaporator), where coolant was converted from liquid to vapor as it absorbed the heat. The coolant vapor was collected with a manifold, liquefied in the water-cooled condenser, and returned to the evaporators. The water in the condenser absorbed the latent heat from the coolant in the transfer of heat from the primary loop to the secondary loop. The recirculating water flowed to the cooling towers, where the heat energy was dissipated to the atmosphere. The cooled water was pumped through the building supply piping systems, back to the condensers.

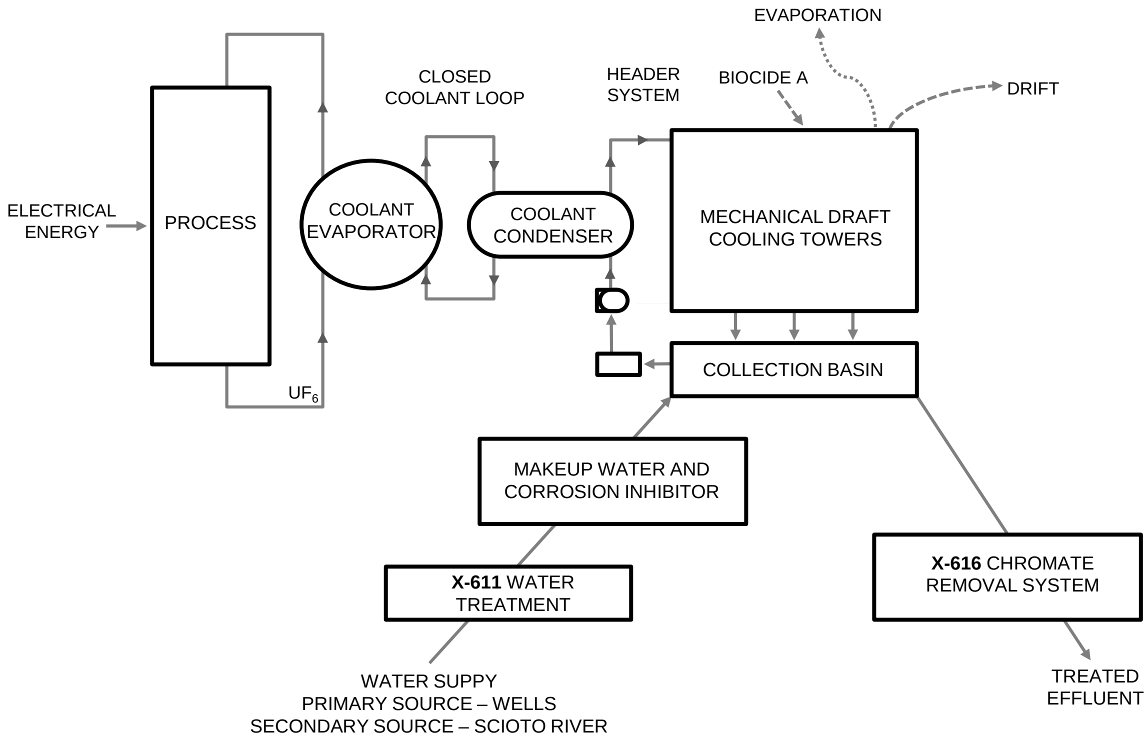

Figure 106. Waste Heat Removal System

The cooling towers dissipated heat from the recirculating water by directly contacting the heated water with cool atmospheric air. The former X-630 and X-633 Cooling Towers were counterflow towers; the air and the water flowed in opposite directions. The X-626 Cooling Tower was of cross-flow design in that the air flowed across the falling water. In both types, the heated air was discharged at the top of the tower and the cooled water was collected in a basin below the tower.

The air was both heated and humidified as it was pulled up through the tower by the fans. The amount of humidification that occurred depended on the moisture content of the incoming air; thus, the rate of evaporation of the recirculating water varied with weather conditions. As the water fed through the tower, it was broken into small drops for better contact with the air, and some of the droplets (those specified as drift) were carried out of the tower with the heated air. Evaporation of the recirculating water concentrated the dissolved solids that were present in the make-up water, and deterioration of the heat transfer characteristics of the water-cooled condensers would result if the dissolved solids concentrations were not optimal. To limit the dissolved solids concentration, a quantity of water (called b1owdown) was removed from the system continuously to remove dissolved solids.

Since the onset of plant operations, hexavalent chromium was used as a corrosion inhibitor in the cooling towers at the plant. In 1976, the X-616 Liquid Effluent Control Facility was constructed to treat RCW blowdown from the PORTS process cooling systems. Hexavalent chromium was reduced to a less toxic, trivalent form, precipitated as chromium sludge and collected within sludge lagoons. Treated water was discharged to the Scioto River through a regulated outfall.

In mid-1984, the plant's Utilities Department began evaluating non-chromate based corrosion inhibitors from a cost reduction standpoint and as a response to more stringent environmental controls (Figure 107). The introduction of phosphates into the system began in 1991 and the concentrations of chromate was reduced. The X-616 Liquid Effluent Control Facility stayed in operation during the transition period until residual chromium was eliminated. Conversion from chromates to phosphates first occurred in systems at the X-626 Recirculating Water Pump House and the X-630 Recirculating Water Pump House. The system at the X-633 Recirculating Water Pump House was the last of the three systems to be converted.

Figure 107. Recirculating Cooling Water Sampling
Tom Houk takes an RCW sample as part of the close monitoring done in 1989.
The plant converted from chromate to phosphate as a corrosion inhibitor
in the recirculating systems.

4.1.8.1 Former X-633 Recirculating Water Pump House and Cooling Towers

The former X-633 Recirculating Water Pump and Cooling Towers (i.e., X-333 Process Buildings cooling system) consisted of more than 700 coolant evaporators, more than 160 water-cooled coolant condensers, one pumping station, four cooling towers, and connecting piping and instrumentation. A view of the former X-633 Cooling Towers is shown in Figure 108.

Figure 108. Former X-633 Cooling Towers Looking Northwest from above Perimeter Road (1990s)

The coolant evaporators were an integral part of the stage converter, and, therefore, were located within the cell housing in the X-333 Process Building. Each evaporator was constructed of copper tubes with mechanically bonded aluminum fins and was located within a converter. Four evaporators in the X-333 Process Building were serviced by one coolant condenser, which was a shell-and-tube condenser with the coolant on the outside of the copper tubes. Each condenser was supplied with cool water from a header system that was composed of 12 individual headers; each of eight headers supplied 16 condensers through 24-in.-diameter pipe, and each of four headers supplied eight condensers through 18-in.-diameter pipe. The heated water was returned from the condenser to the cooling towers through a similar header system.

In order to provide for continuous operation, the supply and return header systems were connected by duplicate 72-in.-diameter pipes to the pump station and cooling tower, respectively. The X-633-1 Pump House stood at the end of the X-633-2A and X-633-2B Cooling Towers; it was 125 ft wide, 178 ft long, and 36 ft high. The building contained 10 pumps rated at 20,000 gpm, four pumps rated at 13,000 gpm, and their associated valves and pipes. All were vertical shaft turbine pumps that were driven by 2,400-V 3-phase, 60-cycle induction motors. The pumps picked up the cooled water from a wet well below the pump station and discharged it to the condenser supply piping. The wet well was fed from the cooling tower basins through a flume. The X-633-2A and -2B Cooling Towers were constructed of redwood in 1954 as part of the initial plant construction and were 40 ft high, 72 ft wide, and 360 ft long. Each tower was divided into 10 cells by wooden walls to allow maintenance to be performed without shutting down the entire tower. Two axial-flow, 20-ft-diameter fans per cell were used to pull the air up through the towers to cool the water as it fell down over the redwood louvers and to the collection basin. Each tower had drift eliminators to reduce the amount of water droplets discharged with the heated air and water vapor. The X-633-2C and -2D Cooling Towers were also constructed of redwood in 1976 and 1978, respectively. The X633-2C Cooling Tower was 29 ft high, 45 ft wide, and 320 ft long; the X-633-2D Cooling Tower was 35 ft high, 44 ft wide, and 420 ft long. The X-633-2C Cooling Tower had eight cells; X633-2D had 10 cells; each cell has one 22-ft-diameter fan. The X-633 RCW system was removed from service in 2008. The X-633 Recirculating Water Pump House and Cooling Towers were demolished in 2010 with funding provided by the American Reinvestment and Recovery Act of 2009.

4.1.8.2 Former X-630 Recirculating Water Pump House and Cooling Towers

The former X-630 Recirculating Water Pump House and Cooling Towers (i.e., X-330 Process Building cooling system) consisted of about 1,200 coolant evaporators, about 110 coolant condensers, one pump station, two cooling towers, and connecting piping and instrumentation. A view of the former X-630 Cooling Towers is shown in Figure 109.

Figure 109. Former X-630 Cooling Towers Looking East (1990s)

The X-330 Process Building coolant system was similar to the X-333 Process Building coolant system; however, in this system 10 evaporators were serviced by one condenser. Cooling water was supplied to the condensers through 16-, 18-, and 20-in. headers within the X-330 Process Building and the building was connected to the former X-630 Recirculating Water Pump House system by duplicate 54-in.-diameter pipes. Cool water was supplied to the X-330 Process Building by some or all of the 10 pumps located in X-630-1, which was 120 ft wide, 162 ft long, and 36 ft high. Six pumps were rated at 17,000 gpm, and four were rated at 8,500 gpm. All were vertical-shaft turbine pumps driven by 2,400-V, 3-phase, 60-cycle induction motors. The X-630-2B Cooling Tower was 47 ft high, 55 ft wide, and 260 ft long and contained 10 cells. The X-630-2A Cooling Tower was 47 ft high, 55 ft wide, and 364 ft long and contained 14 cells. Both were constructed of redwood; and each cell had one 22-ft-diameter fan.

Demolition of the X-630 Recirculating Water Pump House and Cooling Towers was completed in March 2011.

4.1.8.3 X-626 Recirculating Water Pump House and Cooling Tower

The X-626 Recirculating Water Pump House and Cooling Tower (i.e., X-326 Process Building cooling system) consists of approximately 2,340 coolant evaporators, 200 coolant condensers, one pump station, one cooling tower, and connecting piping and instrumentation.

During plant operations, the X-326 Process Building coolant system was similar to the other systems except that one condenser served 12 evaporators. Cooling water was supplied to the condenser through either a 12-, 14-, 16-, or 18-in. header within the X-326 Process Building, and the headers were connected to the X-626 RCW system by underground 42-in.-diameter pipes. The X-626-l Pump House (70 ft wide, 115 ft long, and 30 ft high) contains six pumps rated at 8,000 gpm each. All were driven by 2,400-V, 3-phase, 60-cycle induction motors. The X-626-2 Cooling Tower is an induced-draft, cross-flow tower constructed of redwood. It is segmented into four cells, each with two 20-ft-diameter fans to draw air through the tower. The tower is about 86 ft wide, 145 ft long, and 40 ft high.

During plant operations, the X-626-1 Pump House and X-626-2 Cooling Tower circulated and recirculated water that was used to remove the heat of compression from the process gas, along with waste heat from a few auxiliary processes, and to dissipate this energy to the environment from the X-326 Process Building. They, like systems connected with the X-330 and X-333 Process Buildings, functioned as an independent unit for the most part, but they belonged to an overall plant-wide RCW system.

Each process building's cooling system consists of a primary loop, which came into contact with the hot UF_6, and a secondary loop, which received the heat through a heat exchanger and carried it to the cooling towers. In the cooling towers, the heated water in the secondary loop came into contact with cool atmospheric air, which absorbed the heat. The heated air was discharged at the top of the tower and as the cooling water fell through the tower, it was collected in a basin below the tower and then recirculated. Blowdown water was routed from the X-626 RCW system through the X-630 RCW system to the X-633 RCW system and thence to the X-616 Liquid Effluent Control Facility.

The X-626 RCW system was shut down in 2016.

4.1.9 X-330 Process Building Nitrogen Plant

The Nitrogen Plant is located in the extreme south end of the X-330 Process Building. The generating equipment consisted of an air scrubber, air compressor dryers, a separation column, high-pressure storage facilities and piping. It was designed to produce 100 standard cubic ft (scf) of nitrogen/minute. Gaseous nitrogen was used at PORTS chiefly for purging various UF_6 processing systems; liquid nitrogen was used as a low-temperature refrigerant. Some of the X-330 Process Building equipment is shown in Figure 110.

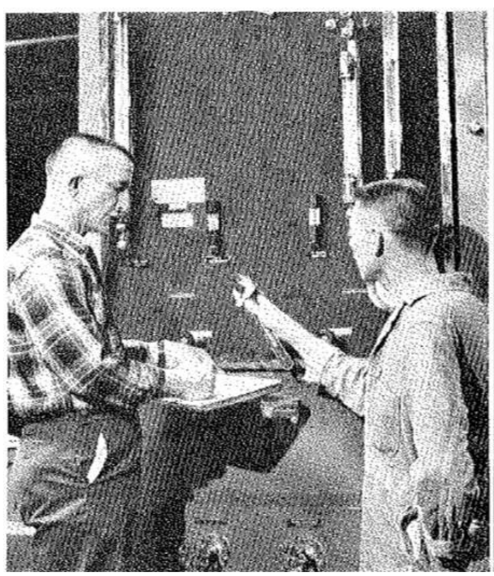

Figure 110. Operator Paul Perroud and Maintenance Mechanic Joe Henson Working With Some of the X-330 Process Building Equipment (1969)

4.1.10 Air Plant Facilities

The Air Plant Facilities were located in the X-326, X-330, and X-333 Process Buildings. A view of the Dry Air Plant in the X-326 Process Building is shown in Figure 111.

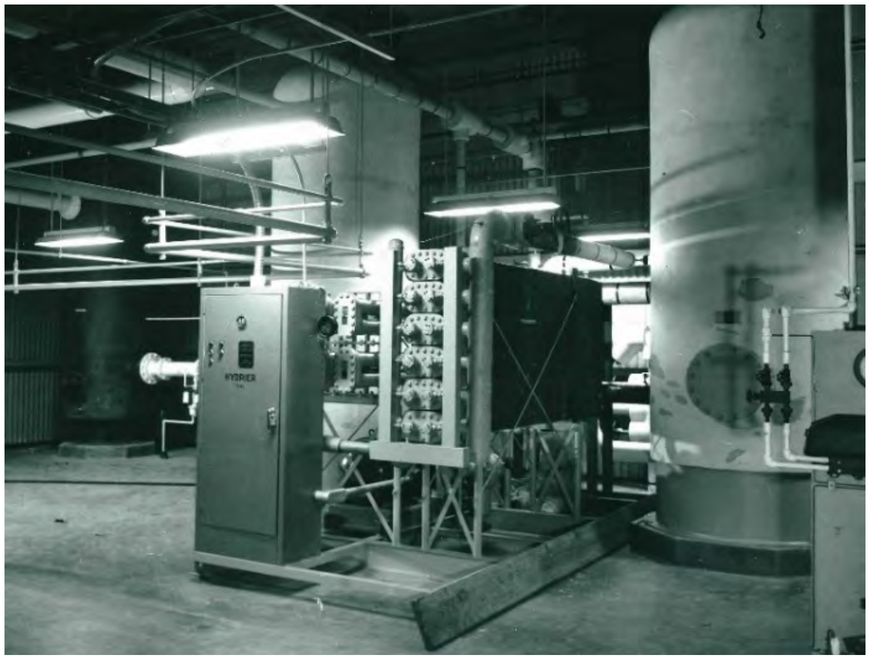

Figure 111. Dry Air Plant in the X-326 Process Building (1954)

UF_6 reacts with the moisture in the air to form gaseous HF and uranyl fluoride. Cascade performance would be degraded if significant quantities of wet air were allowed to come in contact with the UF_6. Dry air, along with nitrogen, was used to provide a buffer between the cascade system and the atmosphere to limit wet air from leaking into the process gas stream.

The X-330 and X-333 Process Buildings contained five electrically driven compressors that were used to produce the required plant dry air. Two emergency diesel-driven units, one located in the X-330 Process Building and the other in the X-326 Process Building, started automatically when the pressure in the dry-air distribution system decreased significantly, as could occur in case of a power failure or when there was an abnormally large demand for air. The five electrically driven compressors were capable of producing 27 million scf of clean dry air per day to the three process and auxiliary buildings in a loop system. This permitted flexibility in operation and provided an easy means for isolating areas when emergency operating conditions occurred while still maintaining service to the unaffected areas.

The plant air distribution system was used primarily for process systems, instrumentation, and other types of air-operated equipment. The air was supplied at 110 psi and was dried to the -60°F dew point (0.0034 lb of water/1,000 ft^3 of air).

4.1.11 Former X-615 Sewage Treatment Plant and X-6619 Sewage Treatment Plant

The former X-615 Sewage Treatment Plant treated nearly all of the PORTS sewage through treatment consisting of primary clarification, biodegradation in trickling filters, secondary clarification, and chlorination.

The X-615 Sewage Treatment Plant operated from 1955 to 1982, when it was deactivated following construction of the X-6619 Sewage Treatment Plant. The former X-615 Sewage Treatment Plant covered approximately 9.4 acres and was bordered by the truck access road to the east, the construction road to the north, Perimeter Road to the west, and the GCEP security fence to the south. The sludge from the treatment was stabilized in an anaerobic digester, dewatered in three drying beds, and finally land farmed on the oil degradation plots. Figures 112 and 113 provide schematics of the former X-615 Sewage Treatment Plant.

The X-615 Sewage Treatment Plant was demolished in May 2006.

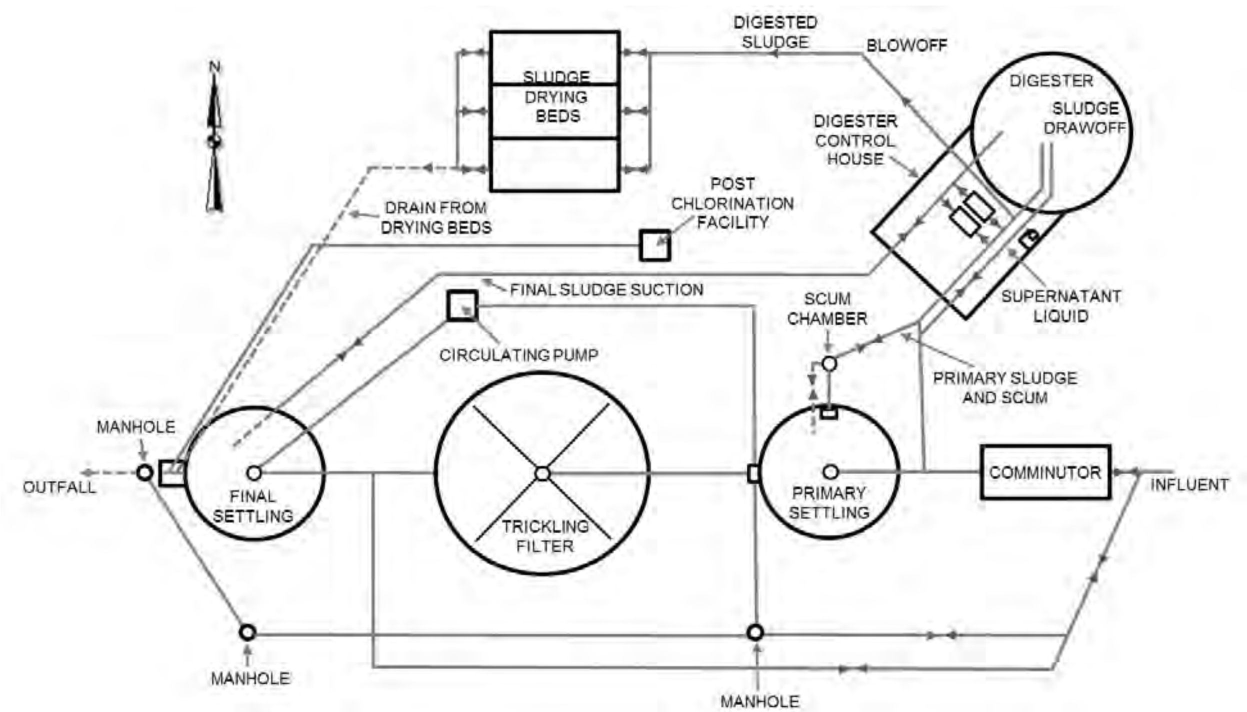

Figure 112. Schematic of the Former X-615 Sewage Treatment Plant

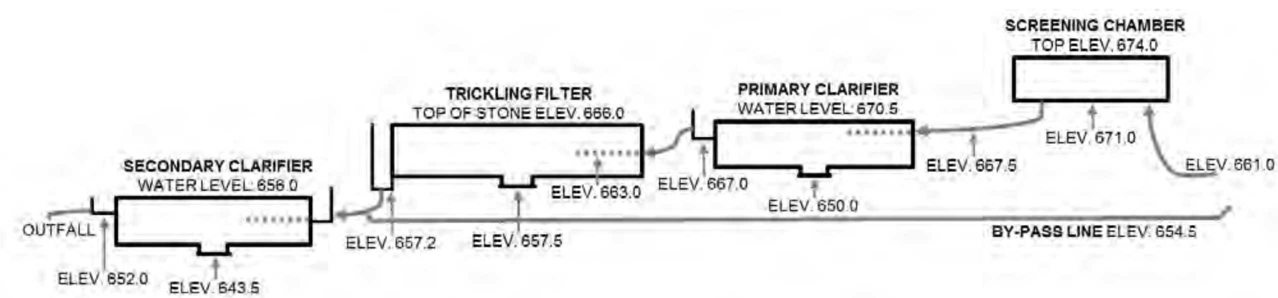

Figure 113. Cross-sectional Schematic of the Former X-615 Sewage Treatment Plant

The X-6619 Sewage Treatment Plant services the entire DOE reservation (Figure 114). Sewage from the reservation facilities is fed into a series of underground sanitary sewers. The plant's sanitary sewers feed into several lift stations located around the DOE reservation. From the lift stations, the sewage is pumped to the X-6619 Sewage Treatment Plant. The design capacity of the treatment plant is 601,000 gal/day and is currently operating at 40 percent of that capacity.

Figure 114. X-6619 Sewage Treatment Plant Looking North (1994)

The X-6619 Sewage Treatment Plant is an activated-sludge facility utilizing the plug flow process, aerobic digestion, secondary clarification, and granular-media filtration for effluent polishing (tertiary treatment). Post-chlorination followed by de-chlorination with sulfur dioxide is used. The treated effluent is discharged to the Scioto River via an underground pipeline to a permitted outfall.

A view of the X-6619 Sewage Treatment Plant during the activation of the four large aeration tanks is shown in Figure 115.

Figure 115. Activation of Four Large Aeration Tanks at the New X-6619 Sewage Treatment Plant (1983)

4.1.12 X-614A Sewage Pumping Station

The X-614A Sewage Pumping Station (Figure 116) is located in the outfall of the sanitary sewer system to pump sanitary wastes from the plant area collection system into a force main that discharges into the X-6619 Sewage Treatment Plant. This station, located just south of the X-330 Process Building, consists of an underground pumping vault, with a concrete slab top; the latter forms the floor of a pump house where the pumping equipment motors and controls are installed.

The concrete pumping vault, which is 15 ft × 29 ft × approximately 27 ft deep, is divided into a dry well section containing the pumps, valves, and piping, and the wet well, which constitutes a reservoir for receiving and temporarily storing sewage for intermittent pump operations. The pump house is a concrete block building 15 ft square and 9 ft high. A single entrance door provides access to the building, and manholes in the floor provide access to the wet and dry wells below.

Figure 116. X-614A Sewage Pumping Station (2010)

4.1.13 X-640 Firewater Pump House and Elevated Water Tank

Pumps for the high-pressure fire water system are housed in the X-640-1 Pump House, located near the northeast corner of the X-333 Process Building. Flow from the pump house is to the X-640-2 Elevated Water Tank which is 300 ft above-grade level, producing a pressure of 125 psi. The water tank is a 300,000-gal, elevated tank located between the X-326 Process Building and the X-720 Maintenance and Stores Building beside Pike Avenue (Figure 117). The X-640-2 Elevated Water Tank stores RCW water for the High-Pressure Fire Water (HPFW) System. The HPFW System protects the process buildings and cooling towers.

Figure 117. X-640-2 Elevated Water Tank Looking North (1990s)

4.2 SUPPORT FACILITIES

In addition to facilities for process operations (Section 3) and site utilities (Section 4.1), multiple ancillary facilities supported operations at PORTS during the Cold War era. Primary support facilities provided for maintenance and storage of equipment and supplies, decontamination and cleaning of equipment, equipment testing and inspection, research and pilot testing, laboratory operations, welding and painting, laundry operations, vehicle maintenance and storage, and water and air monitoring.

4.2.1 Former X-344B Maintenance Storage Building

The former X-344B Maintenance Storage Building was constructed in 1958 and was located in the northern portion of the plant site west of the former X-533 Electrical Switchyard Complex. The north half of the building was used for repair and modification of cooling tower equipment, while the south half was used for road and grounds equipment storage and materials storage. It was always used for storage and as a repair shop; however, the building was not always used for road and grounds equipment storage. Initially, the building was used for interim storage of canisters of uranium oxides that resulted from operations in the X-344A UF_6 Sampling Facility. The former X-344B Building enclosed 6,000 sq ft and was of metal construction.

There were two 300-gal ASTs located on the southeast corner of the building that contained gasoline and diesel. Both ASTs were set in concrete dikes. A hazardous materials storage room used to store cylinders of uranium oxides was reportedly located in the building. Waste oils that were removed from the waste oil tank at the X-750 Mobile Equipment Maintenance Garage were pumped to a portable oil tank that was equipped with spray nozzles. This portable tank was then stored at the former X-344B Building until it was used to apply oil to various areas of the plant site for dust control. This practice stopped in the mid-1980s. The X-344B Building was demolished in 2011.

4.2.2 X-700 Converter Shop and Chemical Cleaning Facility

The X-700 Converter Shop and Chemical Cleaning Facility (Figure 118) is located approximately 1,800 ft directly north of the former X-100 Administration Building, about 250 ft north of the X-720 Maintenance and Stores Building, and 200 ft east of the X-705 Decontamination Building. It is 200 ft wide (east-west), 520 ft long, and 50 ft high. The X-700 Facility also houses maintenance facilities.

The building column foundations of the X-700 Facility are reinforced concrete, the columns are structural steel shapes, and the roof is supported by roof trusses. The western portion (120 ft in width) has a concrete floor 6 in. thick; the concrete floor of the eastern portion is 8 in. thick. The exterior of the building is covered with corrugated asbestos siding, with continuous windows in several locations. The roof is of the built-up type. Cranes and crane runways in the north-south direction provide for movement the full length of the building in order to transport equipment and machinery. The main floor is at grade level.

Figure 118. X-700 Converter Shop and Chemical Cleaning Facility
Looking North from above the X-720 Maintenance and Stores Building (1990s)
The X-333 Process Building is in the background.

In general, the building is divided into two main sections. The east section is the cleaning area; the west section houses the converter shop, which is divided into three subsections: the north half, the south half, and the west addition. The converter shop is designed to perform maintenance on, and has provisions for testing and inspecting converters and coolers.

The location of the shop provides easy access to cleaning and stabilizing facilities. The extension to the west side of this building is used for converter stabilization (Figure 119). Offices for the foreman and inspectors are located on a mezzanine floor. A separate building adjacent to the converter shop houses the air-conditioning equipment for the shop.

Figure 119. Construction of the West Side of the X-700 Converter Shop and Chemical Cleaning Facility to House the Furnace Stand (1955)

In the south half of the X-700 Facility, the maintenance operations include cooler maintenance, inlet and outlet head cutting, spherical transition preparation, spool building, shell opening, and shell modification. Most of the welding operations were performed in this area.

Figures 120 and 121 show views of the clean tank and acid pits at the X-700 Facility. Figure 122 shows a view of the Biodenitrification Facility housed within the X-700 Facility.

Figure 120. X-700 Converter Shop and Chemical Cleaning Facility Looking South at Cleaning Tank Pits (1953)

Figure 121. X-700 Converter Shop and Chemical Cleaning Facility Acid Pits (1958)

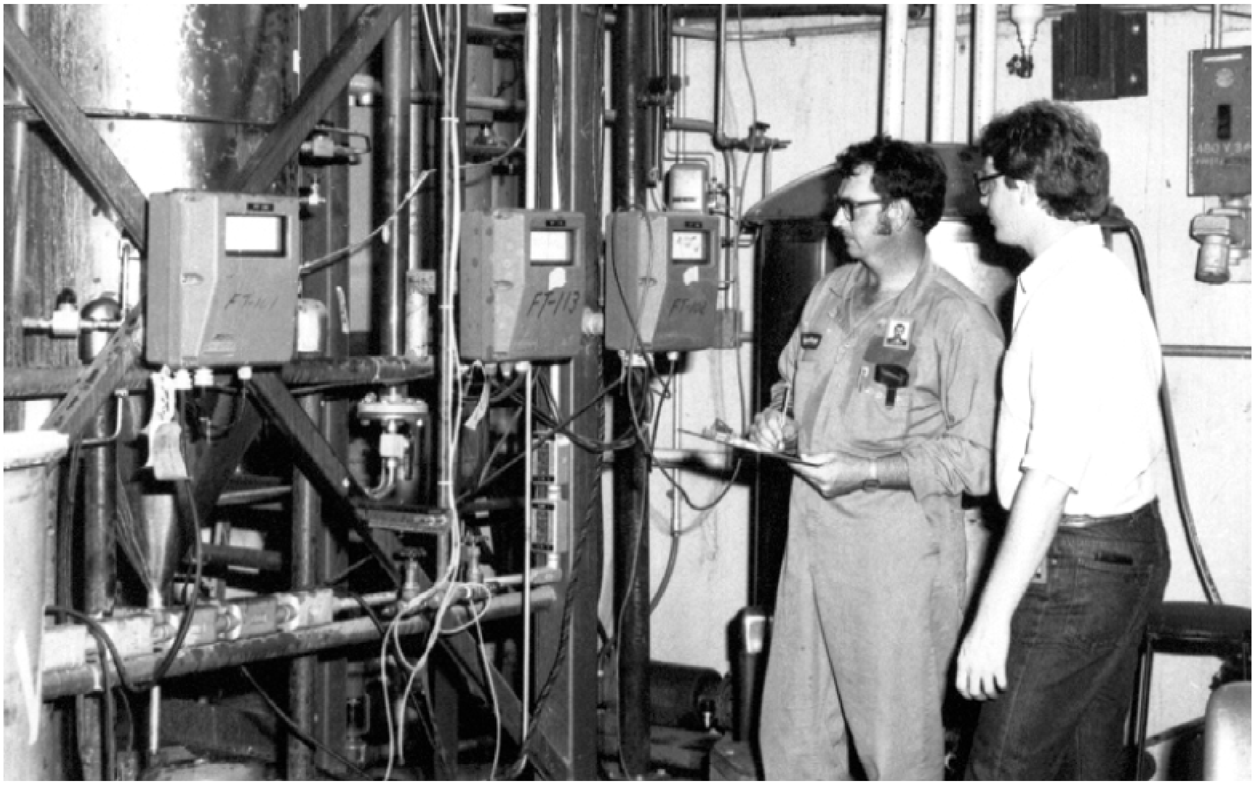

Figure 122. Biodenitrification Facility Housed within the X-700 Converter Shop and Chemical Cleaning Facility
The Biodenitrification Facility was built in 1984. The facility's purpose was converting nitrates in discarded plant cleaning solutions to harmless gaseous nitrogen and carbon dioxide. Monitoring the ongoing biological conversion process are chemical operator Terry Robertson and engineer Jeff Balog. (1984)

4.2.3 X-705 Decontamination Building

Although the X-705 Decontamination Building currently houses on-going site-related operations, during the Cold War, this building housed equipment for the disassembly and decontamination of process equipment, for uranium recovery, and for plant laundry. The facility is centrally located with respect to the X-326, X-330 and X-333 Process Buildings, as well as the X-700 Converter Shop and Chemical Cleaning Facility and the X-720 Maintenance and Stores Building.

The X-705 Decontamination Building has a concrete slab floor on grade. Steel column, 10-ft-high concrete block walls (upper part is transite), and steel trusses support a metal roof deck covered with insulation and built-up roofing. The building is 520 ft by 160 ft and consists of a high- and a low-bay area.

The X-705 Decontamination Building provided space, special handling equipment, and fixtures to meet the requirements for disassembly, decontamination, and radiation monitoring of cascade process components removed for maintenance and repair in the X-700 Converter Shop and Chemical Cleaning Facility and the X-720 Maintenance and Stores Building. The recovery of uranium from decontamination solutions was also accomplished in the X-705 Decontamination Building. The recovered uranium oxide was processed to obtain UF_6, which was reintroduced as feed in the cascade for enrichment in the uranium-235 isotope.

The X-705 Decontamination Building was designed and functioned so that each of its separate operating systems performed a necessary and vital operation in support of the task of equipment decontamination at a reasonable cost. Each major system was described to permit an understanding of: (1) the purpose, (2) the theory of operation, and (3) the interrelationship to other systems or processes.

Equipment removed from the cascade after exposure to UF_6 had to be disassembled for decontamination of component parts prior to the performance of maintenance or repair work. Decontaminated parts were routinely monitored to assure that all parts met approved plant allowable limits for surface and “wipe” radioactivity counts. Any part or component not meeting the plant allowable limits was retained for further decontamination or handled in the shops with approved protective clothing and respiratory protection.

Large equipment, such as converters and compressors, entered the X-705 Building on large special wagons or carts. Large bridge cranes in the high-bay area were used to transfer the equipment to special fixtures for disassembly.

The spray booth decontamination system was designed for processing large parts, such as compressor and converter parts. The building contains five booths in series. All decontaminated parts were normally sent to the maintenance shop in either the X-720 Maintenance and Stores Building or the X-700 Converter Shop and Chemical Cleaning Facility for rework. In some cases, the parts were sent to salvage or the aluminum smelter.

There were hand tables, which used a recirculating solution for decontamination of small parts contaminated with uranium. All solutions from this operation were placed in storage columns for eventual processing at the solution recovery facility.

The Small Parts Steam Pit was a final decontamination area for small parts after they have been processed at the hand tables. Parts were further cleaned in the pit area to remove any trace of uranium as detected by Health Physics personnel.

The Cylinder Decontamination Station (Figure 123) was designed for the decontamination, including “heel” removal. A heel is a small mass of leftover UF_6 and non-volatile uranium products. The uranium solution obtained from the decontamination process was stored for eventual processing or discarding at the solution recovery facility. After decontamination, the cylinders were completely cleaned and rinsed inside and out with water (steam) and dilute nitric acid to remove trace uranium, as detected by Health Physics personnel.

The laundry facility contained two 200- and one 400-lb-capacity water-extractors, eight 100-lb-capacity dryers, and two washers and two dryers of 25-lb capacity each. All protective clothing worn by employees was laundered daily. The clothing consisted of coveralls, socks, underclothing, towels, laboratory coats, and jackets. The cleaned clothing was distributed to the various locker rooms throughout the plant. The Goodyear Company Newsletter, Wingfoot Clan, in 1968 reported that on average some 200 tons of laundry were washed and 2,400 articles of wearing apparel repaired each year. To demonstrate the scale of the operation, approximately 90 gal of detergent, 30 gal of anti-acid, 30 gal of emulsifier, and 30 gal of softener were used each month in March 1985.

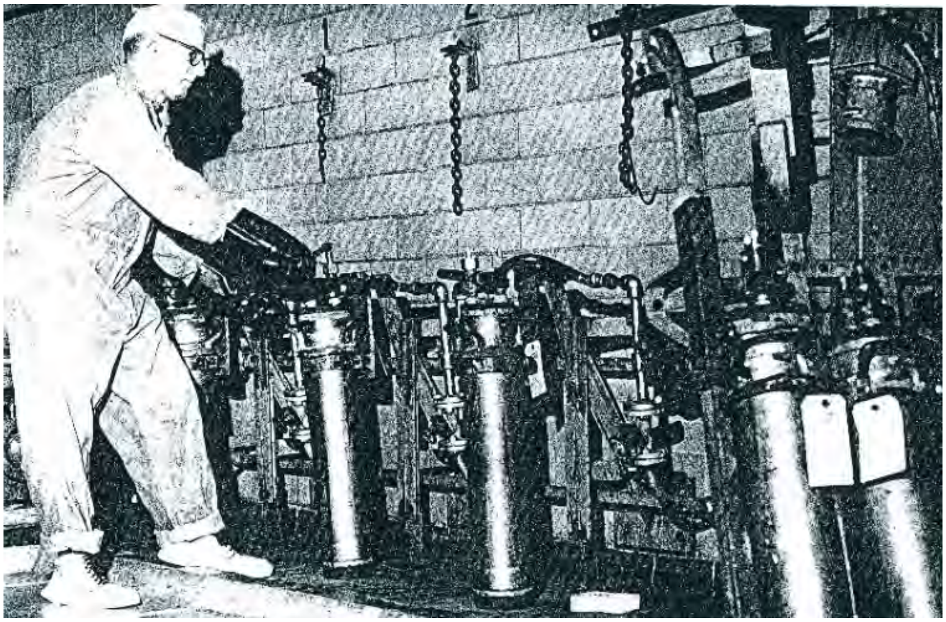

Figure 123. Cylinder Decontamination Station (1970s)

The uranium recovery system was located in the X-705 Decontamination Building. This reprocessing solution recovery system was the only facility system in the plant for reclaiming valuable uranium from decontamination operations, laboratory wastes, chemical traps across the site, and other process operations.

A spool destruction facility, located in the south high bay of the X-705 Decontamination Building, contained equipment for the destruction of the barrier bundles in the converters being removed from the cascade for the CIP/CUP. A view of the spool destruction facility added to the X-705 Decontamination Building in 1975 is shown in Figure 124.

Figure 124. A Spool Destruction Facility Added to the X-705 Decontamination Building in 1975

4.2.4 X-710 Technical Services Building

The X-710 Technical Services Building is a two-story 139,000-sq ft building in two parts (Figure 125). The north portion, built in 1953, having 109,000 sq ft, is made of reinforced concrete and concrete block. The south portion, built in 1975, having 30,000 sq ft, is a steel-framed addition with steel siding. The interior of both parts is subdivided into a matrix of separate laboratory rooms, technical library and offices that provided technical support and development activity for the PORTS Plant. The X-710 Technical Services Building contains 187 fume hoods for laboratory operations. The building's heating, ventilation, and air conditioning system handles approximately 265,000 cf/minute of fully-conditioned air.

Figure 125. X-710 Technical Services Building Looking West (1990s)

The laboratory in the X-710 Building provides mass spectrometry analysis for determining assays of samples and analysis for minor isotopes. In addition, the laboratory provides wet chemistry and other analyses for almost any need at the plant (Figures 126, 127, and 128). This included contaminants in the process gas during plant operations, and currently includes environmental samples. During plant operations, the laboratory also provided support services to the continuous vent stack samplers at facilities processing UF_6 and fluoride-containing gases. Asbestos determinations are performed in the laboratory using phase contrast light microscopy within a self-contained hood. The technical library housed in the X-710 Building contains technical information, documents, books, magazines, and reports that are needed by the various departments on site.

The X-710A Loading Dock is a 240-sq ft covered gas manifold loading dock/pad with no walls on the west side of the building served by a paved parking lot and driveway on 9th Street. The X-710B Explosion-proof Testing Facility is housed in a 200-sq ft reinforced-concrete structure located west of the laboratory.

The X-710 Technical Services Building was expanded in 1975 with the addition of 29,697 sq ft of working area on the south end of the building (Figure 129). This addition made possible the relocation and consolidation of several working groups (X-100 Administration Building Computer Systems, X-105 Electronic Maintenance Building - Instrumentation Development, and X-760 Chemical Engineering Building - Materials Technology).

Figure 126. X-710 Laboratory Personnel Performing Analysis (X-710 Technical Services Building, 1970s)

Figure 127. Laboratory Personnel Performing Analysis (X-710 Technical Services Building, 1970s)

Figure 128. Laboratory Personnel Bill Levier Working at Lab Bench (X-710 Technical Services Building, 1980s)

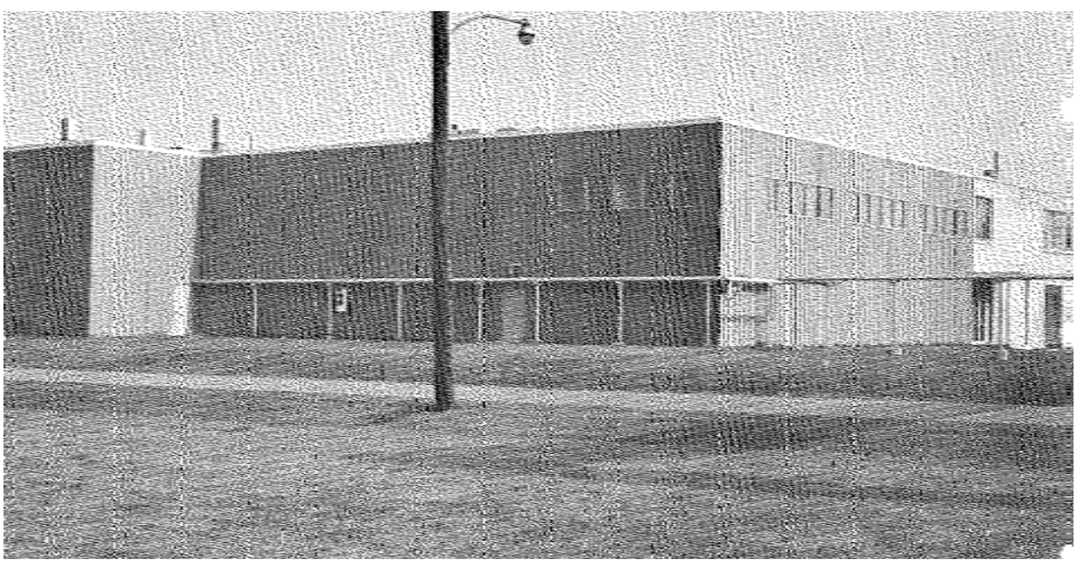

Figure 129. X-710 Technical Services Building Addition Completed in 1975

4.2.5 X-720 Maintenance and Stores Building

The X-720 Maintenance and Stores Building is centrally located with respect to the three process buildings (Figure 130). It is designed to: (1) permit maintenance of process and auxiliary equipment, (2) house the spare parts and expendable items needed for maintaining the equipment, and (3) provide areas for equipment testing and inspection. Maintenance activities for these areas are described in this section, as are the effluents and wastes generated by the performance of the work in the various shops.

The building, 370 ft by 760 ft, has a reinforced concrete floor on grade, steel columns and roof trusses with metal deck roof, insulated and built-up roofing. The building has low- (22 ft) and high- (42 ft) bay areas. Outer walls are concrete to 7 ft 6 in. with windows and corrugated asbestos siding above 7 ft 6 in. Inner walls are concrete block.

The carpenter shop is equipped to handle maintenance and modifications to plant facilities. A local exhaust system, equipped with a cyclone separator, removes sawdust from the shop.

The paint shop has equipment for painting buildings, signs, office equipment, etc. This shop has a paint vault, a bake oven, a spray booth, and brush cleaning tanks. The paint vault is a vented storage area for paints, lacquers, thinners, and other painting supplies.

The electric shop (Figure 131) is designed for motors and generators of many sizes (1/4 hp to 3,300 hp) to be completely overhauled. The operations include disassembly, cleaning, rewinding, replacing defective and worn parts, impregnating with varnish, bake out, assembly, inspection, test running, and painting. This shop also conducts high-potential testing of protective equipment as well as insulation oil testing.

The instrument shop restores, modifies, replaces, calibrates, and tests electrical, electronic, and pneumatic instruments. These instruments include spectrometers, leak detectors, line recorders, potentiometers, telemetering devices, process control valves, radiation counters, gas analyzers, computers, and others.

Additional views from within some of the shops housed in the X-720 Maintenance and Stores Building are shown in Figures 132 through 134.

Figure 130. X-720 Maintenance and Stores Building Looking Northeast (1980s)

Figure 131. **X-720 Maintenance and Stores Building Looking West at Electrical Shop (1958)**

Figure 132. X-720 Maintenance and Stores Building Maintenance Shops (1958)

Figure 133. **Sheetmetal Shop Fabrication Operating Console (1956)**

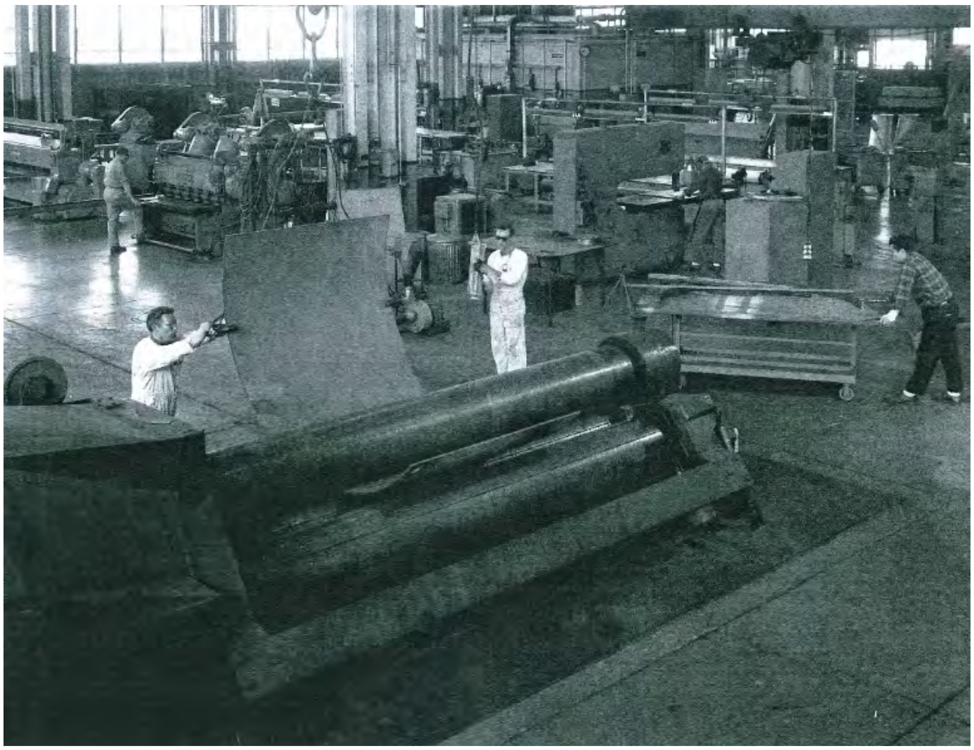

Figure 134. X-720 Maintenance and Stores Building Sheetmetal Shop Area (1958)

4.2.6 X-744G Bulk Storage Building

The X-744G Bulk Storage Building is a 114,000-sq ft steel-framed building (Figure 135). The building is located at the corner of 18th Street and Brown Avenue. It was built in 1956 for use as a pipe yard (for assembly of cascades for the process buildings). From 1957 until the early 1990s, it warehoused UF_6 cylinders. From the late 1960s until 1981, part of the building was also used for the melting of aluminum parts into aluminum ingots. The building is now used to store low-level uranium waste material.

Figure 135. X-744G Bulk Storage Building Looking Southwest (1990s)

4.2.7 X-744H Bulk Storage Building

The X-744H Bulk Storage Building (Figure 136), also known as Warehouse #18, is a 58,700-sq ft steel-framed building constructed in 1953 with corrugated steel walls and roof and a concrete slab floor. The X-744H Bulk Storage Building is located southeast of the X-333 Process Building and west of the X-744G Bulk Storage Building. The X-744H was used as a fabricating shop and workshop in 1953 and 1954. In 1956, the X-744H Building was converted to a warehouse; the water service and connections were removed and the drains plugged. Documentation indicates that from 1958 through 1964, the X-744H Building was used for supplemental storage of pure material (UF_6) and for inactive storage, i.e., storage of cylinders that contained heel quantities. The X-744H Building was also used for storage of spill control equipment. At one time, radioactively-contaminated wastes were stored in the North Waste Management Unit on the north end of the building. There were two 1,200-gal diesel fuel ASTs kept near the building, one north and one west of the building; however, the tanks have been removed.

Figure 136. X-744H Bulk Storage Building (2010)

4.2.8 Former X-746 Materials Receiving and Inspection Building

The former X-746 Materials Receiving and Inspection Building was a steel-framed building covering approximately 19,975 sq ft of floor space (Figure 137). Built in 1954, the building was originally designed to be the Uranium Material Handlers Building for storage of uranium, a key component of PORTS mission operation. This use ended in 1970 when the building became the Materials Receiving and Inspection Building and it was subsequently used for that purpose until the building was emptied in 2002 and the shipping and receiving activities were transferred to the X-7721 Maintenance, Stores, and Training Facility. The X-746 Materials Receiving and Inspection Building was demolished in September 2009.

Figure 137. Former X-746 Materials Receiving and Inspection Building Looking West from the Parking Lot (2006)

4.2.9 X-750 Mobile Equipment Maintenance Garage

The X-750 Mobile Equipment Maintenance Garage maintained a fleet of plant vehicles, including sedans, vans, trucks, buses, mobile cranes, and other specialized equipment (Figure 138). The X-750 Garage is a 15,500-sq ft masonry building with a vehicle repair shop, tire change bay, wash bay, and oil change bay. Three underground storage tanks store gasoline (20,000 gal), diesel (20,000 gal), and alcohol (10,000 gal) fuels for dispensing into mobile equipment on site. The X-750A Building is a 500-sq ft metal storage building for tires and parts. Some of the facility's personnel in the 1950s are pictured in Figure 139.

Figure 138. X-750 Mobile Equipment Maintenance Garage Looking East (1991)

Figure 139. Goodyear Atomic's Motor Pool and Garage Personnel (1954)
These men were members of Goodyear Atomic's motor pool and garage: Kneeling, left to right are: Virgil Smith, Dan Chandler, Paul Neff, Leroy Price, and Gene Henry. Standing from left to right: George Nichols, Everett Strausbaugh, Oscar Tennant, Bob Skaggs, Leo Simon, Harold Chandler, and Glenn Miller. Gene Pelto and Jack Kinker were absent when the picture was taken.

4.2.10 Former X-760 Chemical Engineering Building

The former X-760 Chemical Engineering Building was constructed in 1954 (Figure 140). It consisted of a 63-ft-wide by 83-ft-long and 30-ft-high two-story flat-roofed masonry building that was approximately 8,000 sq ft. The building was located in the south-central portion of PORTS, on the corner of 9th Street and Pike Avenue. Two high bay areas (north and south), a dry chemical storage room, a maintenance and storage room, a mechanical equipment room, restrooms, and lockers were located on the ground floor. A laboratory, offices, and an electrical load center were located on the second floor. A two-story wall separated the two high-bay areas, and a steel walkway balcony surrounded the entire high bay area. Spent wastes from processes at the building were discharged to a neutralization pit, located north of the building.

Figure 140. Former X-760 Chemical Engineering Building Looking East (2006)

The former X-760 Chemical Engineering Building was located within the core GDP area. The building was significant at PORTS because of its use as a chemical test and small-scale instrumentation test building to improve the gaseous diffusion process. Specifically, this building was used to develop leak detection systems based upon the dynamics of UF_6 within the building environmental chamber. The systems developed in the building were utilized not only at the PORTS facility, but also at other gaseous diffusion facilities within the DOE complex. The former X-760 Chemical Engineering Building was instrumental in performing tests that led to enriching uranium at above-atmospheric conditions rather than sub-atmospheric conditions, which significantly increased production at all DOE gaseous diffusion operations.

The former building was used for chemical and mechanical engineering pilot- and demonstration-scale investigations. Examples of studies conducted at the building included methods to recover uranium from solutions, studies of UF_6 releases in an environmental chamber (north high bay), and the treatment of PCBs with sodium. The X-760 Building was demolished in June 2010 with funding provided by the American Reinvestment and Recovery Act of 2009.

4.2.11 Former X-770 Mechanical Testing Building

The former X-770 Mechanical Testing Building (Figure 141) housed test facilities that evaluated the performance and reliability of equipment and components used in the gaseous diffusion process (Figure 142). The building built in 1955, was a steel frame structure with a gravel roof and corrugated asbestos siding. It was 100 ft wide, 220 ft long, 30 ft high and was located between the former X-760 Chemical Engineering Building and the former X-600 Steam Plant. The building covered a control room and several enclosed test areas that were designed for evaluating equipment of various sizes by using UF_6 as the test gas. The actual components and arrangements used varied with each test. This building contained many of the operations that would be found in a gaseous diffusion building. These operations, as well as the frequent change-out of equipment, necessitated the use of industrial solvents in cold baths for UF_6 sampling purposes and as cleaning agents. Operations at the X-770 Mechanical Testing Building ceased in the mid-1980s. The building was demolished and removed (down to the concrete pad) in early 2007.

Figure 141. Former X-770 Mechanical Testing Building Looking Northeast from above the X-326 Process Building (1990s)
The former X-760 Chemical Engineering Building is in the background.

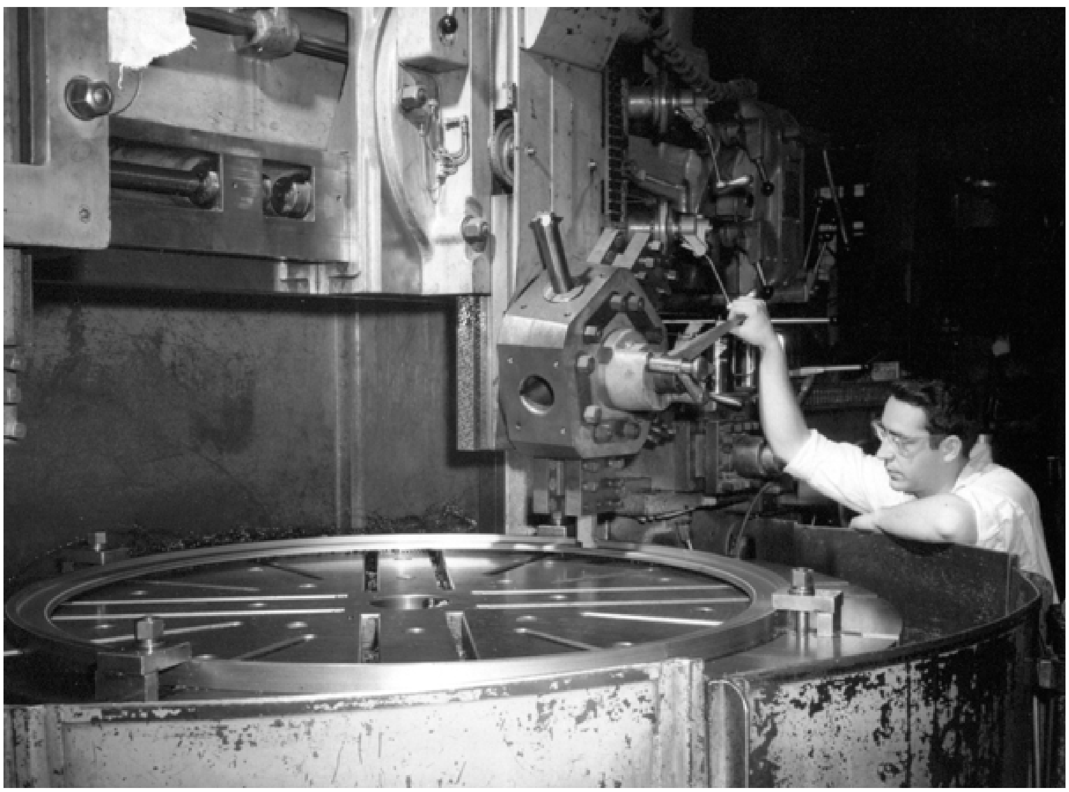

Figure 142. Test Loop Facility in the Former X-770 Mechanical Testing Building (1970s)
Equipment of the future was thoroughly tested in mechanical development's newly improved Test Loop Facility. Hundreds of precision parts were fabricated by machinist Jim Patton and his co-workers in the huge CIP/CUP program.

4.2.12 X-230J2 South Environmental Sample Station

The X-230J2 South Environmental Sample Station is a 100-sq ft structure of masonry wall construction (Figure 143). The station is located on the north side of Hewes Road, south of the X-230K South Holding Pond and just east of the X-617 pH Control Facility. The building houses equipment for composite water sampling of the South Holding Pond effluent, as well as the equipment to support ambient air monitoring. This station was constructed in 1968 and has been upgraded to support continuous water sampling. Water is pumped from the South Holding Pond up to the X-230J2 Station. There, it is sampled and then returned to the pond. Ambient air that is monitored is pumped in through an aperture in the wall, passed through a filter, and returned through another hole to the outside.

Figure 143. X-230J2 South Environmental Sample Station (2010s)

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5. SITE SECURITY AND EMERGENCY MANAGEMENT

When PORTS was first under construction by Peter Kiewit Sons' Company in 1952, the firm hired its own internal guard force whose members became affiliated with Local 129 of the United Plant Guard Workers of America (UPGWA). During the construction of the diffusion plant, the Peter Kiewit Sons' Company Guards had the task of supporting the thousands of construction workers assigned at the plant. Members of the early guard force at PORTS are shown in Figure 144.

Figure 144. Troop B Guard Force at PORTS in October 1953

In 1953, GAT initiated the hiring of plant security officers. Later, in July 1955, Goodyear Atomic officers signed a charter to become members of an organized union, the United Plant Guard Workers of America, UPGWA Local 66.

Over the years, protective force officers played an important role in the security of PORTS. Although many of the duties and tasks have changed and expanded somewhat since the early 1950s, their role in plant protection remains of critical importance.

The variety of duties performed by the guard force over the years include:

- In the early 1950s, small aircraft landings on plant site were quite common. In 1 year, officers had the responsibility of providing security for 90 aircraft landings.

- Bargaining-unit personnel maintained responsibility for supporting site Visitor Control activities through the logging and processing of visitors at site portals prior to permitting access to the limited area of the plant. In the early 1950s, it was not uncommon to issue as many as 5,000 temporary badges in 1 day (Figures 145 and 146).

- Identification and seizure of contraband was another responsibility. The magnitude of this aspect of service was monumental in the early years of the plant's operation (Figure 147).

- Processing incoming telephone calls during off-shift hours and on the weekend was a task assigned to the site's Protective Force from the early 1950s until the late 1990s. In 1954, it was recorded that the Security Department handled 10,390 phone calls that year.

Figure 145. Carolyn Hand (left) and Betty Pratt (right) Process Passes and Temporary Badges through the Site Visitor Control (1953)

Figure 146. Sitting for Photo Identification in the Badge and Pass Photography Area (1954)

Figure 147. Contraband Seized by Protective Force Officers during a Road Check in May 1953

The Protective Force provided support activities that have existed since the early 1950s, including:

- Enforcing facility rules and regulations and patrolling and observing designated plant security areas
- Challenging of persons and or vehicle movement to prevent unauthorized access to the site or removal of facility property
- Performing special assignments during emergencies including responding to alarms, providing escort services, maintaining traffic control, and riot control
- Posting approved bulletins
- Controlling access to the plant and designated areas
- Collecting and properly destroying classified scrap and waste documents
- Plant protection, like many other plant functions, is a 24-hours-a-day responsibility for the department.

Plant security evolved conceptually from the early 1950s through the Cold War era. With the expanding international threat of terrorist group actions centered on the theft or sabotage of SNM, significant increases in the protective measures employed by the site Protective Force were experienced. Driven by DOE initiatives, a higher degree of security awareness was imposed beginning in the early 1980s. To satisfy these evolving DOE requirements concerning the protection of SNM, Protective Force officers were required to meet stringent physical fitness and weapons qualification standards and a dedicated Tactical Response Team was trained and deployed by mid-1983.

The Protective Force Department grew from approximately 50 to 180 officers and specialized training increased by the mid-1980s. Protective forces participated in extensive force-on-force drills and tactical building entries, stairwell assaults, hallway and room clearing, and rappelling to maintain and refine these required skills.

Enhanced and expanded physical fitness requirements were a significant element of DOE’s security requirements. Protective Force officers were required to meet yearly physical fitness qualification. An exercise room was built in the X-104 Guard Headquarters building to provide security personnel a location on site to work toward meeting and maintaining the required standards.

All Protective Force personnel were required to qualify each year using his or her assigned weapon. During certain periods of site operations, training and qualification on other special weapons, including rifles, shotguns, and tactical armament were also required. A minimum qualification score was required for all Protective Force personnel, and those assigned to special tactical duties were required to maintain a higher standard.

Collecting and properly destroying classified scrap and waste documents no longer required was completed using the Police Department’s confidential paper destroyer (Figure 148). This unique incinerator, using a triple-chamber combustion principle, reduced all types of paper and cardboard materials to a fine white ash. Papers, documents, and records were placed into the loading door, ignited, and then secured in the chamber. Holes drilled into the sides of the incinerator provided an extremely effective draft to achieve complete combustion. The ashes were collected in two compartments, both of which were locked to insure maximum security. The incinerator was so effective that magazines, ledger books, and similar materials were destroyed completely without first being separated.

Figure 148. PORTS Police Officers Destroying Confidential Papers in the Incinerator (1955)

During a period of heightened security in the mid-1980s, weapons training and qualification increased. Selected personnel were trained in tactical weapons such as the M16 rifle, the MP5 submachine gun, the M60 light machine gun, and 9 mm automatic side arms. To support this growth and expansion of assignments, a modern indoor range was built in an area behind the X-104 Guard Headquarters in the mid-1980s. In addition, a six-lane, 220-yd, outdoor firing range was constructed on site in 1988 at a cost of more than $2 million.

Specialized training equipment, including Multiple Integrated Laser Engagement System weapons modification, were used to provide the realism of actual combat. Laser transmitters attached to specially-designated training weapons and laser detectors attached to the officers engaged in the combat training supported realistic indications of a hit or a near miss during tactical exercises.

The use of a Security Training Evaluation Shooting System (STRESS) was also implemented in the late 1980s. STRESS utilized an interactive video program that was to advance training in weapons use in the field. Using an interactive video to simulate potential life threatening situations, an officer, using a specially modified “weapon” would fire infrared “bullets” towards a screen. Behind the screen, a camera captured the beam and recorded an officer’s hit or miss. The system focused on the officers’ maintenance of an appropriate tactical mind set in responding and resolving the scenarios using the minimal amount of force necessary to overcome the resistance. It was designed to test the officer’s judgment in dealing with potential hostile situations.

STRESS functioned as life-size computer simulation of tactical scenarios. Operated from a laser disk, the system's computer generated commands to match the ongoing scenario and permitted the scenario to branch instantly throughout the progression of the training scenario. The officer in training would also wear a lightweight vest equipped with sensors. The sensors would reflect body hits if the officer failed to implement appropriate cover for the scenario. The system also tracked the shot fired by the officer and the shots remaining.

5.1 EMERGENCY MANAGEMENT

In July 1982, GAT representatives and the Pike County Disaster Services Agency met to discuss development of a preparedness plan which would encompass not only plant emergencies, but other incidents that might have impacts on Pike County. The Goodyear Atomic/Pike County Disaster Services Agency Emergency Preparedness Plan was developed in 1982 and provided coordinated response efforts not only in the event of a plant emergency, but for other types of incidents such as natural disasters and non-plant related chemical transportation accidents that might affect Pike County residents. Plant and community emergency seminars and drills were held periodically to expand and improve on procedures contained in the plan and demonstrate integrated emergency response capabilities (Figures 149 through 152).

Figure 149. Emergency Preparedness Seminar Held to Initiate Development of the Goodyear Atomic/Pike County Disaster Services Agency Emergency Preparedness Plan (1982)

Figure 150. Emergency Preparedness Seminar Held to Initiate Development of the Goodyear Atomic/ Pike County Disaster Services Agency Emergency Preparedness Plan (1982)

Figure 151. Emergency Preparedness Drill Held on Plant Site in 1988

Figure 152. Workers at Emergency Preparedness Drill Held on Plant Site in 1988

5.2 FORMER X-106 TACTICAL RESPONSE STATION

The former X-106 Tactical Response Station was approximately 58 ft (north-south) by 91 ft (east-west). Built in 1955, it is a one-story building housing the fire-control equipment for the plant (Figure 153). The north wall consisted mostly of five wooden overhead doors with glass panes. The wall above those doors was made of corrugated asbestos cement boards. The outer walls were of concrete block and the roof was tar and gravel. A concrete block tower on the west side was formerly a fire hose drying facility. The floor was reinforced concrete, with floor drains in the truck parking area. Approximately 40 ft by 75 ft of the building served as a parking area for fire vehicles. The building was most recently used by the Protective Forces physical fitness staff for office spaces and for storage of some of the Protective Forces equipment and gear. The station was demolished in 2013.

Figure 153. Former X-106 Tactical Response Station (1982)

5.3 X-106C FIRE TRAINING BUILDING

The X-106C Fire Training Building is a two-story, all steel structure (super structure, siding, floor, and roof) with outside stairway to a partial third level for roof fire training. This building was constructed in the 1990s for firefighting training exercises and is currently still in use for this type of training.

5.4 FORMER X-344F SAFETY BUILDING

The former X-344F Safety Building was located west of Pike Avenue and just inside Perimeter Road. The building was constructed in 1958. The former X-344F Safety Building enclosed approximately 100 sq ft, and was constructed of concrete block. It contained an emergency shower, a sink, a portable eye wash station and a control panel. This building was used for storage of safety supplies/materials and was used as an emergency first aid station. This X-344F Safety Building was demolished in May 2006.

5.5 X-1007 FIRE STATION

The X-1007 Fire Station (Figure 154) was built in 1981 and is constructed of concrete block and brick. The station provides 24-hour fire and emergency medical technical response and serves as the off-shift medical facility. It houses garages for response equipment, fire protection training areas, and the central alarm and dispatch station for fire and non-security emergency responses. Mobile response equipment includes three pumpers, two ambulances, and an emergency truck with hazardous material capabilities. The building served as administrative offices for GCEP operations from 1981 to 1984, and as the X-1007 Fire Station thereafter.

Figure 154. X-1007 Fire Station Looking Northeast (1994)

An output for the X-220T Fire and Supervisory Alarm System is located in the X-1007 Fire Station. This alarm system provides a means to monitor approximately 350 automatic sprinkler systems, containing more than 150,000 sprinkler heads, throughout the plant site. In addition, 380 strategically-located fire alarm pull boxes are tied into the system (Figure 155). Another output for the alarm system is located in the X-300 Plant Control Facility.

Figure 155. Fire Alarm Box Test (1975)

5.6 X-1020 EMERGENCY OPERATIONS CENTER

The X-1020 Emergency Operations Center, located in the southeastern part of PORTS, is a 7,180-sq ft building built in the early 1980s. It was originally built and briefly used as a security headquarters for GCEP. In 1985, the building was converted to an emergency operations center for PORTS. The building (Figure 156) houses the Emergency Operations Center and the backup Protective Force Alarm Communications Center for the PORTS site. The X-1020 Emergency Operations Center facilitates timely processing and disseminating of information during emergency conditions.

The X-1020 Emergency Operations Center provides stand-alone computer records for Emergency Operations Center functions and includes operational areas for the Emergency Information Center, Crisis Management Room, technical assistance support, and backup site communications. A networked computer system provides full records of all events and transactions.

Figure 156. X-1020 Emergency Operations Center Looking East (1980s)

5.7 X-104 GUARD HEADQUARTERS

The X-104 Guard Headquarters (Figure 157) has served as the headquarters for the plant's protective force since its construction in 1954. It also houses administrative offices and training areas. It is a 10,600-sq ft concrete and concrete block building with offices, training room, physical fitness room, locker rooms, locksmith shop, kitchen, lunchroom, storage lockers for guard equipment, and emergency generator. It was built as a permanent structure with nominal dimensions of 109 ft (north-south) by 76 ft (east-west), and is located directly north of the former X-100 Administration Building. The walls of the building are concrete block with precast concrete sills and wood mullions between the windows. The floor is a concrete slab. The roof is built-up tar and gravel. Exhaust fans and air intake louvers are located on the roof and in the walls.

Figure 157. X-104 Guard Headquarters Looking East (1980s)

5.8 X-104A INDOOR FIRING RANGE

The X-104A Indoor Firing Range (Figure 158) provides six shooting lanes with remote and independently controlled targets for indoor small arms practice and qualification. The facility also contains classroom areas for Protective Force training. The X-104A Indoor Firing Range is housed in a 3,600-sq ft concrete block and cinder block, single-story building with a steel bullet trap for the six shooting stations. The building has an office, training room, and ammunition locker.

Figure 158. Security Officer Training at the X-104A Indoor Firing Range (1980s)

5.9 FORMER X-106B FIRE TRAINING BUILDING

The former X-106B Fire Training Building was located on Construction Road on the west side of the plant. The building was 2,400 sq ft and constructed of corrugated metal on a steel frame built on a concrete slab. Along the top of all the walls near the roof were steel flaps that provided ventilation during training exercises. A concrete slab on the east and south sides of the facility accommodated fire trucks brought in for fire training and pumper testing. The facility contained a smoke tunnel. At the far south end of the outdoor concrete slab was a concrete fire test pit that contained water for pumper testing. The facility was built in 1967. Until 1987, it operated for fire training exercises, pumper testing, and occasional storage by various departments at PORTS. This X-106B Fire Training Building was demolished in March 2006.

5.10 X-108 SECURITY PORTALS

The X-108 Security Portals are manned by security personnel and used as checkpoints for workers, visitors, and equipment entering and exiting controlled areas of the plant site. The X-108A Security Portal (Figure 159), built in 1955, is also known as the South Portal or Main Drive Gate to the GDP and is located near the X-104 Guard Headquarters. It is a 1,000-sq ft structure with a porch area facing the X-206A Parking Lot. A covered vehicle drive gate is part of this portal, and there is a small restroom with sanitary water and sewer utilities.

The X-108B Security Portal is also known as the North Portal and is located near the southeast corner of the X-720 Maintenance and Stores Building. The X-108B Security Portal is a 330-sq ft structure with a small porch facing Knox Ave. It has served as a security check post since its construction in 1955.

The X-108E Security Portal is also known as the Construction Portal. It is on the west side of PORTS between the X-326 and X-330 Process Buildings. It is a 600-sq ft structure and includes an uncovered vehicle drive gate. It has served as a security check post since its construction in 1975.

The X-108H Security Portal is also known as the Pike Avenue Portal and is located near the west fence of the X-533A Switchyard. It is a 100-sq ft structure and has no sanitary water supply. It has been used as a security check post since it was built in 1976.

Figure 159. X-108A Security Portal and Drive Gate Looking West (1990s)

5.11 X-111A/B SNM MONITORING PORTALS (X-326 PROCESS BUILDING)

The X-111A and X-111B SNM Monitoring Portals are security portals used for safety screening of employees and equipment entering and exiting the X-326 Process Building. These portals were built in 1981. The X-111A SNM Monitoring Portal is located on the east side of the X-326 Process Building at Unit 5 and has 900 sq ft under roof, and the X-111B SNM Monitoring Portal is located at the northwest corner of the X-326 Process Building and has 300 sq ft under roof. Both portals are of masonry construction with concrete floors and steel roofs. Both the X-111A and X-111B SNM Monitoring Portals are unoccupied and shutdown as security portals.

5.12 FORMER X-114A OUTDOOR FIRING RANGE

The original X-114A Outdoor Firing Range was located near the X-611B Sludge Lagoon and was used for target practice by plant security personnel from 1970 to 1990. A later X-114A Outdoor Firing Range (Figure 160), built around 1990, was located in a remote area at the north end of the DOE reservation and was used for routine Protective Forces training activities. This range, which was removed in 2016, covered about 5.5 acres, and the entire area was fenced and bermed to a height of about 20 ft.

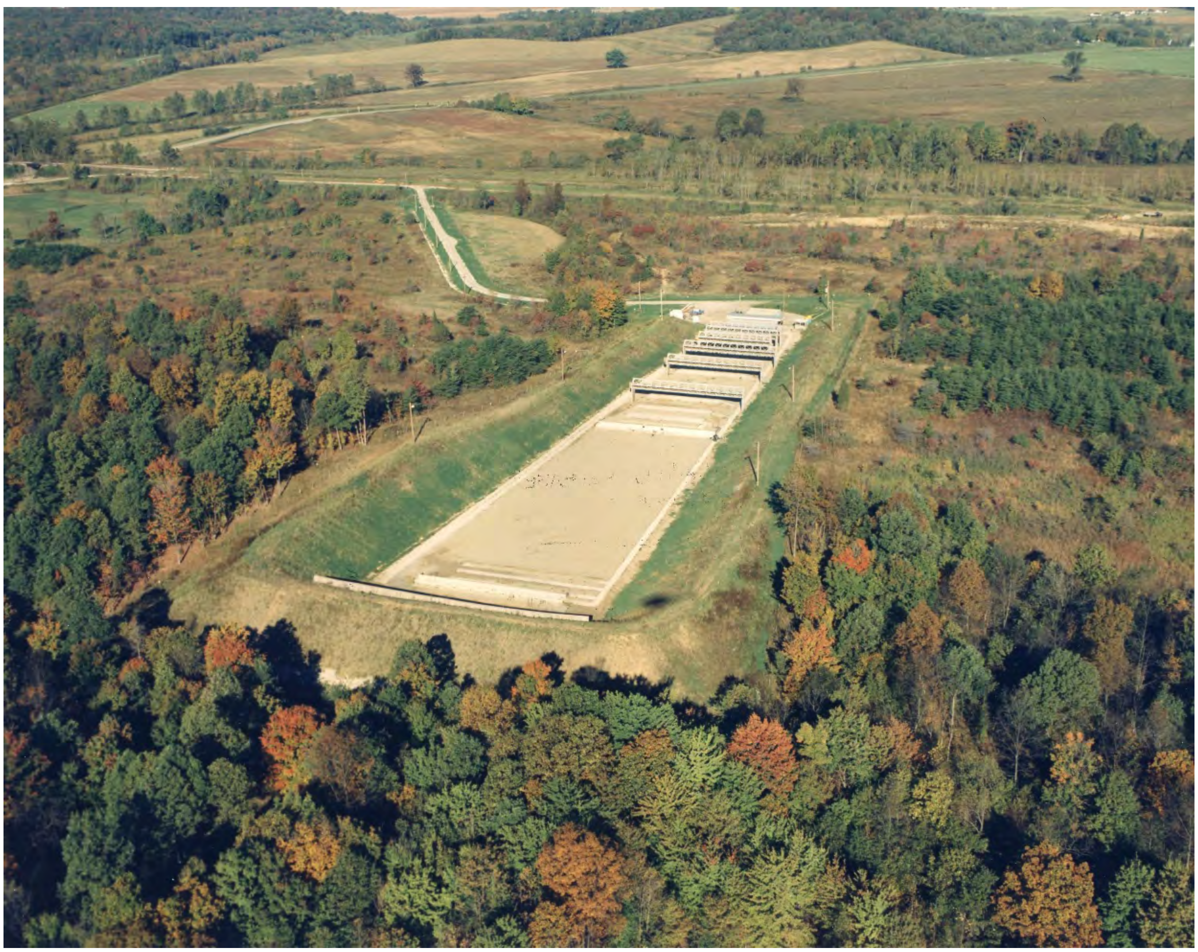

Figure 160. Former X-114A Outdoor Firing Range (1991)

6. TRANSPORTATION, COMMUNICATIONS, AND OTHER SUPPORT FUNCTIONS

6.1 TRANSPORTATION

Many of the employees required for construction and operation of PORTS were recruited from the small communities surrounding the nearly 4,000-acre site; from the cities of Portsmouth and Chillicothe, each of which was some 20 miles from the site; as well as from cities across the nation.

Two major problems of transportation resulted from the fact that not only was it necessary to reach the plant site, but once at the massive facility, a means of transportation to the actual work area was essential.

It was recognized that transportation within the PORTS construction site was essentially a question of construction economy, both from the standpoint of saving working time as well as physical effort. An arrangement was subsequently made to provide a project-specific bus system to transport employees to and from the site.

Travel to and from PORTS by personally-owned automobiles or by pooled automobiles was anticipated for many of those to be employed, but others would probably require public transportation either from necessity or for their own convenience. These methods of transportation were subsequently analyzed on the basis of: (1) the number of workers to be employed, (2) the distance to be traveled, (3) demands on existing road systems, and (4) existing public carriers which were presently serving the general area.

At the time the site was selected, the closest public transportation available was the bus system operated by the Greyhound Lines over U.S. Highway 23 serving Portsmouth, Chillicothe, Waverly, and other cities along the highway. The Norfolk and Western Railroad, although more or less following the general route of the highway, handled very little of the local travel. Another railroad, the Chesapeake and Ohio, served Portsmouth, Waverly, and Chillicothe and other communities, but the main line was a considerable distance from the PORTS construction site.

The public carriers were contacted prior to start of plant site construction. The two railroads indicated no interest in furnishing passenger train service. Later, in 1954, the Chesapeake and Ohio Railroad contacted the Peter Kiewit Sons' Company regarding passenger service from Huntington, West Virginia, to the site. After several conferences, the proposal was abandoned as the railroad would not render the service without some type of guarantee. The Greyhound Bus Company, however, agreed to augment their service and to provide transportation to the project construction site.

The Greyhound Lines began their bus service from Portsmouth and Chillicothe on February 11, 1953, with convenient schedules for workers. Buses were routed from the Greyhound depots in each city directly to the plant site via U.S. Highway 23, making stops along the route as required. Initially, two buses were scheduled from each city, but because of lack of customers, both Chillicothe buses were discontinued on February 14, 1953, and one bus from Portsmouth was discontinued on March 13, 1953. On November 30, 1953, one bus was again scheduled from Chillicothe and continued until August 1, 1954, when it was again discontinued because of lack of customers. A bus was again instituted on the Portsmouth run on November 30, 1953, and discontinued in February 1955, when the passenger load decreased. The maximum Portsmouth passenger load was approximately 65; the Chillicothe passenger load was approximately 25. Practically all bus passengers were office personnel working in the Temporary Administration or Personnel Buildings. No other plant locations were served.

6.1.1. Roadways and Fencing

The system of roads for PORTS was designed to provide vehicle access from the various centers of population expected to provide personnel for the construction and operation of the plant, to regulate the entry of vehicles and personnel into the plant area, to provide for plant protection, and to serve the various buildings and facilities in the general plant area. During construction and early start-up of the plant, U.S. Highway 23 was one big traffic jam around the clock. It took an hour and a half for a worker to drive the 22 miles from Portsmouth to the plant. In 1954, the stretch of highway was widened to four lanes and a huge cloverleaf and access roads were constructed for access to the plant (Figure 161).

Figure 161. Improved U.S. Highway 23 and Main Plant Access Cloverleaf under Construction (1954)

In addition, off-site roadways were provided to serve auxiliary facilities remotely located from the main developed area. Roads were built around and through the site to allow easy access to locations of construction. Track alleys needed for plant operation were constructed to facilitate movement of materials and supplies into buildings. In addition to the track alleys, 22 miles of railroad track and 25 miles of road were laid inside the plant area. An additional 12 miles of road were constructed, including a perimeter road with a circumference of 7 miles (Figure 162).

The perimeter road was provided to encircle completely the developed area and major construction facilities and to provide access to two main permanent portals controlling entry to (or egress from) the plant area. During the various phases of construction, additional portals were provided.

Figure 162. Perimeter Road Construction (1953)

Four access roads were constructed to connect the perimeter road with the existing state and county road networks and to permit passage around the large area occupied by the plant. These access roads intersect the north, south, east, and west portions of the perimeter road.

The plant road system consists of a series of north-south streets, named for counties in Ohio, and east-west numbered streets. The network served all buildings within the enclosed area. Driveways from the streets serve the vehicular entrances of the various facilities and the various parking areas provided for plant vehicles and mobile equipment. In addition to these streets and drives, a series of roads in the west portion of the site, designated as “A-Road,” “B-Road,” and “C-Road,” were provided to serve construction facilities and some permanent installations in this area.

Separate patrol roads were provided in the northeast and the southeast corners and on the south side of the plant area within and adjacent to the security fence. At all other locations, the normal plant roadways were sufficiently close to the security fence to serve for security patrol.

Construction of the permanent roads began essentially with the initial grading operations in November 1952. The roadways utilized for construction purposes became the base for permanent roadways upon the completion of major phases of building and utility construction.

The Peter Kiewit Sons’ Company and the Taylor-Wheless Company, under subcontract, completed the rough grading for the major portion of the paving in November 1953. The streets and avenues east of Pike Avenue and south of Sixteenth Street were paved by the Peter Kiewit Sons’ Company during the 1954 construction season. The balance of the paving work, including the remaining streets and avenues, access roads, the perimeter road, parking lots, and other paved areas was performed by the Ralph Rogers Company under a construction subcontract and was completed in November 1955.

Roadway widths as well as the thickness of pavements were varied to meet functional requirements. In general, the main streets in the area are 20 ft wide and service drives are 14 ft wide, but vary on the basis of use. In general, separate patrol roads are 10 ft wide and the perimeter road is 40 ft wide.

All road sections are crowned, and, except for Tenth Street and other isolated portions of roadways, are provided with wide shoulders sloping to open ditches or drainage swales. Combined curbs and gutters with drainage inlets were provided for Tenth Street and a portion of the service drive dedicated for delivery access and service activities at the X-344C Feed Manufacturing Plant.

Turns and intersections of plant roads were generally designed for a 40-ft radius to edges of paving. Guard rails or bumpers were provided in high-fill areas. Heavy duty roads, designed for a 11,700-lb wheel load were surfaced with two layers of asphaltic concrete, each layer being 1.5 in. in thickness.

Two main fences were constructed at PORTS: one to permanently define the boundary of the federal reservation, and the other to restrict access to the portion of the plant area under Security Control. The boundary fence, with few exceptions, follows the property line, except where access road property extends for a distance beyond the adjoining general boundary of the Government-owned property. This fence, which replaced existing privately-owned fencing, consists of four strands of galvanized barbed wire supported by galvanized-steel fence posts. The top strand of barbed wire was located 4.5 ft above the ground. The line posts and pull posts were driven. Steel framed swing gates, with gate posts set in concrete foundations, were provided at all access roadways.

6.1.2 Rail System

Rail facilities were provided to PORTS to facilitate the delivery, transfer, and handling of materials and equipment necessary in the operation of the overall plant, and the shipment of similar items to other parts of the country for further processing, use, or maintenance.

Two main railroads originally served the site. The Norfolk and Western Railroad installed approximately 1.49 miles of track from their main line near Piketon entering the general area from the northwest and connecting with the Government-owned freight classification yard at the plant boundary. Another main spur, 4.12 miles in length, was installed by the Chesapeake and Ohio Railroad from their main line near Robbins, Ohio to the northeast end of the DOE property. This spur entered the plant from the northeast. The Norfolk & Western and Chesapeake & Ohio Railroads started construction of their spurs into the plant site during September 1952. Both of these spurs terminated at the classification yard, which was an area used to classify and sort materials delivered to PORTS by rail prior to distribution to other areas of the plant site. A general schematic of the rail system at PORTS is shown in Figure 163.

The system of trackage provided from the classification yard consisted of the initial switchyard at the northeast corner of the site, a main track, a “Y” connected with a main double-loop system (looping and paralleling the X-326 and X-330 Process Buildings and serving the west, south, and central portions of the site), and a main spur, extending east from the “Y”, which provided the spurs serving the facilities in the extreme eastern part of the development.

The design of the permanent railroads was coordinated with that of the rail facilities required for construction operations and consequently, the major portion of the permanent trackage was in use during the early stages of construction. The plant railroad system originally utilized motorized car movers.

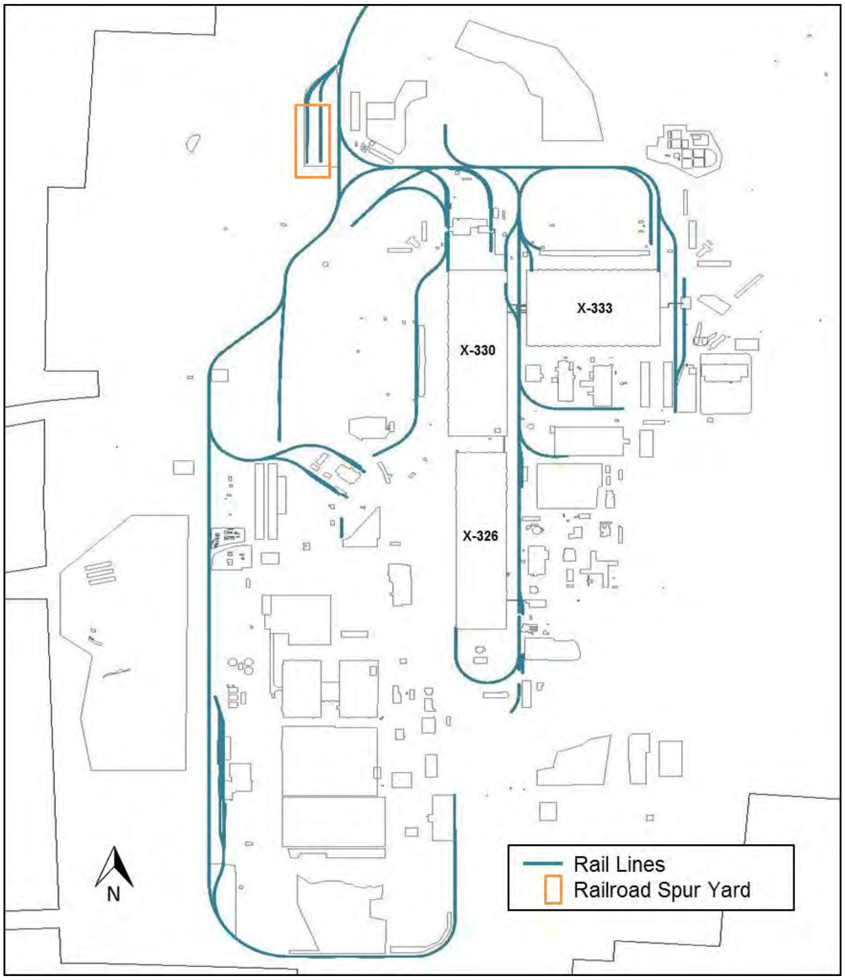

Figure 163. General Schematic of Rail System at PORTS

Rails and ties for the plant were furnished by the AEC. In general, 131-lb rail was provided for the main spurs and 90- to 100-lb rail for the balance of the system. Standard wood ties were spaced at 2,640 ties/mile of track, and bank run gravel was used as ballast. Both timber plank and paved crossings were employed in paved areas.

First grading for railroad work within the plant site was done by V. N. Holderman, under subcontract in November 1952. The Girdler Corporation, a subcontractor of V. N. Holderman, installed trackage at the classification yard and to the main lines in the northwest quadrant of the DOE property.

A subsequent subcontract was awarded to Royce Kershaw Company for the construction of the balance of the classification yard and the railroad system within the plant area. The grading for this track work was performed by the Taylor-Wheless Company, with minor portions of the work being done by Peter Kiewit Sons' Company.

This phase of the track construction was completed in February 1954. Later in 1954, Peter Kiewit Sons' Company forces constructed permanent spurs to several of the buildings in the plant area. All trackage was maintained and adjusted to grade by Peter Kiewit Sons' Company for turnover to GAT during 1954 and 1955. During the fall of 1955, Peter Kiewit Sons' Company relocated a portion of the existing spur serving the X-330 Process Building track alley and installed two spurs for the X-344A UF_6 Sampling Facility and the X-344C Feed Manufacturing Plant.

Approximately 17 miles of standard gauge (56.5 in. wide) railroad track lie within the boundaries of PORTS. Beginning near the northwest corner of the site, the on-site track generally runs south, branches in several locations, and then runs adjacent to the X-326, X-330 and X-333 Process Buildings, various support facilities (e.g., X-343 Feed, Vaporization, and Sampling Facility and X-745B Cylinder Storage Yard), the Depleted UF_6 Conversion Plant, and parallel with the perimeter road along the northern, western, and southern portions of the site (Figure 164).

Figure 164. Rail Spur to X-330 Process Building (1995)

The on-site rail system is connected to the off-site rail system in the northwestern corner of PORTS. At that point, a rail spur (called the NS Lead) connects the site with a main railroad line that runs parallel with U.S. Highway 23 to the west of the site. This rail spur and main line are both controlled by Norfolk Southern, which is a Class 1 railroad. Near the northeastern corner of PORTS, there is a rail spur (called the Mead Lead) that previously connected a local forest products company to a section of on-site track and eventually to the rail spur controlled by Norfolk Southern. There is also another connection point (called the CSX Lead) in the northeastern corner of PORTS.

6.2 COMMUNICATIONS

Operation of the telephone system at PORTS began in February 1954. The switch board, Private Automatic Branch Exchange, located in the X-540 Telephone Building, was all automatic and had 1,200 lines. The first day of the change-over saw a great amount of pressure applied to the new system. There were 24,113 local calls and 750 long-distance calls the first full day of operation. The new switch board had nine positions (Figure 165). In addition, there were two information positions. A position consists of the number of lines an operator controls.

Figure 165. GAT Employees Handling the New Switchboard at PORTS (1954)

In addition to the 1,200 intraplant lines, there were 35 long-distance lines. The telephone system was one of the most modern in the Piketon area. The equipment belonged to the General Telephone Company of Ohio. The maintenance, repair, and upkeep of the new system were handled by General Telephone maintenance crew under the supervision of Peter Kiewit Sons' Company.

In May 1976, a new telephone system, a General Telephone and Electronics Corporation (GTE) 1600 Electronic Private Automatic Branch Exchange (EPABX), was placed in service after more than 18 months of negotiations among representatives from the General Telephone Company of Ohio, ERDA, and GAT. The EPABX was the largest EPABX in use by the General Telephone Company and the largest in total lines of any GTE operating company. The EPABX handled 1,500 stations and was expandable for an additional 900 stations.

In the spring of 1991, video conferencing services with two-way audio and video communications were installed at PORTS, Paducah, and Oak Ridge. The use of these video conferencing rooms greatly reduced travel costs. Each state-of-the-art video conferencing room featured dual 25-in. color picture monitors, a graphics camera, a participant camera, microphones, and monitor speakers.

Also in 1991, the administrative telephone switch became defective, setting off a chain of unintentional disconnections. The old system was found to be unrepairable. A new state-of-the-art switch was installed, complete with computer features and services such as call forwarding and conference calling.

The plant radio systems, consisting of the Guard Radio System and the Process Maintenance Radio Systems operating on different frequencies, were provided for security control and normal maintenance requirements. The basic design for the radio systems, including the methods of operation, types of equipment, and over-all scope was developed by the AEC.

One feature of the dual channel system was the X-520 Repeater Station, which had sending and receiving antennas and equipment that received and retransmitted messages from mobile equipment outside the plant to the main plant area. The station also provided a common emergency channel separate from the standard routine frequencies. The X-520 Repeater Station comprised the radio relaying facilities necessary to maintain frequency modulation radio communication with all areas of PORTS. This station, located about 1.25 miles west of the Administration Building on a ridge along the western plant boundary, consists of a 150-ft-high steel antenna tower for radio reception and transmission; the radio and emergency power generating equipment are housed in a concrete block building.

Another feature of the system was the provision for continuous recording of the radio systems whenever they are on the air by Dictaphone recording equipment with a voice actuated control relay. The messages were recorded on plastic belts and filed for future reference.

In the Process Maintenance Radio System, two main stations were located in the X-300 Plant Control Facility. Three fixed auxiliaries were located in the X-720 Maintenance and Stores Building, and one each in the X-530 and X-533 Electrical Switchyard Complexes, X-611 Water Treatment Plant, and X-750 Mobile Equipment Maintenance Garage buildings. In the Guard Radio System, two main stations were located in the X-104 Guard Headquarters, three fixed auxiliaries were located in the former X-100 Administration Building, and one each in the X-104 Guard Headquarters, X-106 Tactical Response Station, X-108A Security Portal, X-108B Security Portal, X-300 Plant Control Facility, and X-326 Process Building. In addition to the fixed stations, fire department, guard and other vehicles were equipped with mobile two-way radios.

6.3 OTHER SUPPORT FACILITIES

Several other facilities that provided support to PORTS operations and staff needs are discussed in this section and include:

- X-100 Administration Building
- X-101 Dispensary Building
- X-102 Cafeteria
- X-103 Auxiliary Office Building
- X-120 Weather Station.

6.3.1 Former X-100 Administration Building

The former X-100 Administration Building provided the offices and the other facilities for the administration of the overall PORTS operation (Figure 166). It was originally constructed as a temporary facility for administration. This building, located in the southeast portion of the site, was conveniently situated for plant supervisory use and for accessibility to those of the public having official business in the area. The X-100 Administration Building was demolished in 2012.

The former X-100 Administration Building consisted of four two-story wood-framed wings, each approximately 240 ft in length, arranged at right angles in pinwheel fashion around a central two-story-and-basement vault structure. The building provided a total of 135,000 sq ft of floor area and a building volume of 1,522,400 cf (Figure 167). The immediate area adjacent to the northeast portion of the building was fenced to permit public access to the lobby, or main entrance, located on the north side of the building. Entrance doors in the end of each wing, and at the intersection of the wings, provided use by employees holding security clearances.

Figure 166. Former X-100 Administration Building (1991)

Figure 167. Interior of South Wing of Former X-100 Administration Building After Construction (1954)

The exterior of the building was finished with cement-asbestos shingle siding. Windows in both the first and second stories were commercial projected-type steel sash with screens, arranged in continuous rows along the sides of the long wings and as multiple groups adjacent to the exit doors in the ends of the wings. The relatively flat roof, which projects beyond the wall line, was of wood construction and was insulated and covered with built-up roofing coated with gravel. Eaves troughs and downspouts conducted roof drainage to the storm sewer system.

The interior of the building was divided into divisional and functional areas primarily by the arrangement of the wings around the control vault unit and by the fire walls extending across the wings from the walls of the vault.

Building finishes throughout the structure were utilitarian and were consistent with those of the facilities in the area. In general, all exposed surfaces other than those finished at the factory were painted in contrasting colors for light reflection, to reduce glare, and to provide other suitable working conditions. The neutral gray marble tile floor covering aided materially in brightening the interior.

Heating of the building was accomplished by steam obtained from the area steam distribution system. Finned-tube radiators were provided under the windows to heat the wings. Other areas of the building, except the business machine rooms, were heated by a forced-hot-air duct system with ceiling outlets. Air conditioning units provided for the business machine rooms supplied cooled air in summer and tempered air in winter as necessary to maintain the constant temperature and humidity required for satisfactory operation of the machines.

An automatic sprinkler system, with exposed piping, provided fire protection for all building areas. This system was zoned to indicate, via the fire alarm system, the general location of any fire which may have occurred in the building.

6.3.2 Former X-101 Dispensary Building

The former X-101 Dispensary Building (Figure 168) was one of the first buildings to be constructed on site and provided the facilities for first aid treatment of plant personnel, physical examinations, and medical services in connection with the plant operation. The former dispensary had round-the-clock staffing with over 30 medical personnel. At the dispensary, employees received routine yearly check-ups and were fitted for prescription safety glasses. Medical staff at the dispensary also treated more serious injuries, such as fractures and heart attacks.

The former X-101 Dispensary Building, located on the same block with the former X-100 Administration Building and less than 100 ft to the west, covered a gross area of 10,315 sq ft and comprised a gross volume of 125,100 cf.

Figure 168. Former X-101 Dispensary Building Looking Northwest (1995)

The main entrance of the former X-101 Dispensary Building was at the north end and was served by an east-west walkway connecting Mahoning Avenue and the former X-100 Administration Building. A driveway from this street served the ambulance entrance located in the west side of the building.

The building was a single-story, rectangular structure with cement-asbestos shingle sided walls and a relatively flat roof. An equipment penthouse near the center of the building constituted a second-story flat-roofed structure with walls similar to those of the main story. There were windows in all walls of the building, those in the east wall and part of the north wall formed a continuous row.

The plan of the building provided a general office and a waiting room, with separate toilet facilities for men and women in the north bay of the building. A full-length corridor beginning at the waiting room and extending south through the building separated a row of offices and examining rooms in the east part of the building from the technical facilities. The rooms were arranged to permit the various facilities to function without conflict. The building housed two four-bed wards, full X-ray facilities, electro-cardiograph and blood testing equipment, pulmonary function test equipment, treatment rooms, doctor's offices with examination rooms, a laboratory, an emergency room, a decontamination area, a physical therapy area, an audio booth, a medical record storage room, a secure storage closet for prescription drugs, a reception area, and work stations. Infirmary staff members with the plant site ambulance during the 1950s are shown in Figure 169.

The X-101 Dispensary Building was demolished in August 2012.

Figure 169. Plant Site Ambulance and Drivers in Front of the Infirmary (1956)

6.3.3 Former X-102 Cafeteria

The former X-102 Cafeteria (Figure 170) was a single-story, 19,000-sq ft wood-framed building with plywood exterior sheathing covered by cement asbestos shingles. The building was constructed on a 6-in. concrete floor with walls 11.5 ft high. Asphalt tile covered the floor surface. The north half of the building was a kitchen, food storage, and food preparation area. The south half of the building consisted of dining rooms and a serving area.

The former X-102 Cafeteria served as a place for preparation of food where employees from across the plant site would gather and enjoy a meal and conversation with one another. The cafeteria contained dining areas that could be separated and used for guests visiting the plant or to host more private gatherings such as employee recognition dinners. Breakfast and lunch were served daily to hundreds of employees. The cafeteria served a rotating menu of items with limited short-order options.

The X-102 Cafeteria was demolished in 2013.

Figure 170. Former X-102 Cafeteria (1995)

6.3.4 Former X-103 Auxiliary Office Building

The former X-103 Auxiliary Office Building, constructed in 1954, was located within the core GDP area (Figure 171). The X-103 Auxiliary Office Building housed the PORTS respirator facility where respirators were issued and cleaned. The X-103 Auxiliary Office Building was significant because of its use to irradiate thermoluminescent dosimeters (TLDs) for calibration of on-site TLD readers, meaning that the TLDs were exposed to a level of known radiation to aid in calibrating the TLD readers. TLDs are devices that PORTS uses in its human radiation protection program to measure gamma radiation exposure. When exposed to penetrating radiation, thermoluminescent materials absorb and store a portion of the radiation energy. When the material is heated during analysis procedures, this energy is released as light that can be measured to estimate radiation exposure.

Figure 171. Former X-103 Auxiliary Office Building (2010)

The former X-103 Auxiliary Office Building was a 10,000-sq ft, one-story (200 ft × 50 ft), steel-framed building with steel siding set on a concrete slab. It was used initially as a garage and later as administrative offices. The building is described as a “butler-type building” with a gabled metal roof supported by rigid-type steel framing bents spanning the width of the building. In general, the building floors were concrete covered in asphalt tile, with the exception of the floors in the utility room and vaults, which were smooth-finished concrete. Glazed-metal type partitions were installed to divide the building interior into a corridor and offices. Partitions associated with the toilet room and utility room were wall board on wood stud framing. The walls of the vault were concrete block.

The X-103 Auxiliary Office Building was demolished in 2011.

6.3.5 Former X-100B Weather Station

During construction of the plant, the former X-100B Weather Station (Figure 172) was used by on-site meteorologists to provide contractors with up-to-date weather forecasting, so they could both schedule work properly and protect existing construction. Many times, this allowed contractors to cover fresh concrete with canvas to protect it from rain which was predicted to arrive as a result of a sudden change in the weather. The instruments collected and transmitted temperature, dew point, and wind velocity data. A new weather station, the X-120 Weather Station, was constructed to replace outdated equipment associated with the former X-100B Weather Station, which was demolished in 2013.

Figure 172. Former X-100B Weather Station (1977)

7. OTHER SITE MISSIONS AND PLANS AT PORTS

PORTS was originally designed and constructed to enrich uranium for nuclear weapons. In the 1960s, this primary mission changed to production of fuel for commercial and military nuclear power reactors. A number of other missions were historically undertaken at PORTS. These missions include:

- CIP/CUP in the late 1970s and early 1980s
- Add-on GDP (later cancelled)
- GCEP in the early 1980s (never placed into operation)
- Ohio Army National Guard Facilities.

7.1 CASCADE IMPROVEMENT PROGRAM/CASCADE UPGRADE PROGRAM

PORTS underwent a major facility upgrade program, referred to as the CIP/CUP, between 1974 and 1983. In lieu of building a fourth enrichment plant, PORTS and the Oak Ridge and Paducah plants were upgraded due to the need for enriched uranium to supply the growing energy needs at that time. The CIP program involved the installation of improved barrier in the process equipment and modifications to the compressors, piping, and cooling systems. The CUP program, which ran partially concurrent with CIP, involved the uprating of electrical equipment and increasing the efficiency of the process cooling systems (Figure 173). In 1968, the estimated cost for the PORTS upgrades was $257 million with an expected 63 percent increase in plant capacity.

Figure 173. Transformer Being Installed in the Switchyards
The transformer shown above was one of seven installed in the switchyards as part of the CIP/CUP Program. At the time, these 345 kV transformers cost approximately $525,000 each and could handle 125 million volt amperes of power. (United States Enrichment Corporation [Centrus] Archives)

During implementation of the CIP/CUP, a cell was typically shut down, gutted, rebuilt and on stream within 25 days (there were four cells at a time down in various stages of the retrofit) (Figure 174). At the height of the program, the plant was placing a modified cell on stream every 2 weeks. Equipment which was removed from the cascade was transported to either the X-705 Decontamination Building or the X-720 Maintenance and Stores Building for disassembly. As the disassembly progressed, the equipment subassemblies were decontaminated in the X-705 Decontamination Building within either the spray tunnel or on hand tables. Uranium-bearing solutions, which were recovered from the decontamination steps, were collected and processed through the solution recovery process in the X-705 Decontamination Building and converted into uranium oxide. A portion of the uranium oxide was then converted into UF_6 within the oxide conversion process within the X-705 Decontamination Building and fed back into the cascade, thereby avoiding a loss of enriched uranium.

The Oxide Conversion Facility was located in the northeast part of the X-705 Building and operated from 1968 to 1978. In this facility, oxide powder, in the form of U_3O_8, was ground and fed into a fluorination reactor, and the UF_6 was withdrawn into cold traps, where it solidified. Cold traps were removed and heated, and the liquefied UF_6 was drained into cylinders for feeding to the cascade.

Figure 174. Converter Removed from the Cell for Retrofitting during CIP/CUP (1982)

Besides the upgrade of the equipment, several buildings/systems were also upgraded to handle the increased support needed for the CIP/CUP work. These included:

- The X-700 Converter Shop and Chemical Cleaning Facility had an addition completed to provide space for additional stabilization stands and support equipment. Another building was erected nearby to house the air conditioning equipment to control the humidity within the facility.

- The laboratory addition within the X-710 Technical Services Building was completed which provided for 25 percent additional floor space within that building. This made possible the relocation and consolidation of chemical, physical and instrumentation development areas, and it consolidated all data processing operations for the plant site.

- The restoration of the X-344A UF_6 Sampling Facility was completed which centralized all low- and high-assay sampling and transfer activities.

- The X-720 Maintenance & Stores Building addition provided more compressor assembly space.

- The X-608 Raw Water Pump House and Wells project was completed to provide sufficient cooling water to operate the plant at the increased megawatt loading.

- The rail system on site was expanded and upgraded to accommodate the increased movement of uranium cylinders.

The program was successfully completed in March of 1983 (Figure 175). The CIP/CUP final cost for all three diffusion plants (Oak Ridge, Paducah, and PORTS) approached $1.5 billion, which was three times the original estimate but saved $3 billion compared to the cost of building a new plant ($4.5 billion). A workforce reduction at that time brought the plant to its lowest employment level in 6 years.

Figure 175. Last Converter under CIP/CUP in the Converter Shop (1982)

7.2 PORTSMOUTH ADD-ON GASEOUS DIFFUSION PLANT

In addition to the CIP/CUP expansion, another project to add enrichment capacity to PORTS, the Add-on GDP expansion, was planned. The CIP/CUP expansion effort was to provide new enrichment capacity to provide nuclear power reactor fuel for existing contracts beginning in the mid-1980s (Figures 176 and 177). After the completion of the CIP/CUP programs in 1983, the plant capacity was increased from its original 5.2 million separative work units (SWU) per year to 8.4 million. The Add-on GDP expansion was to add an additional four process buildings with a capacity of 8.75 million SWU/year at a constructed cost of $3.1 billion (1978 dollars) and annual operating cost, including electrical power, of $680 million. Construction was scheduled to begin in spring 1977 with operation to begin in 1984. The design was completed by Catalytic Inc. Engineers, Constructors (Catalytic, Inc.) in Philadelphia, Pennsylvania in the mid-1970s.

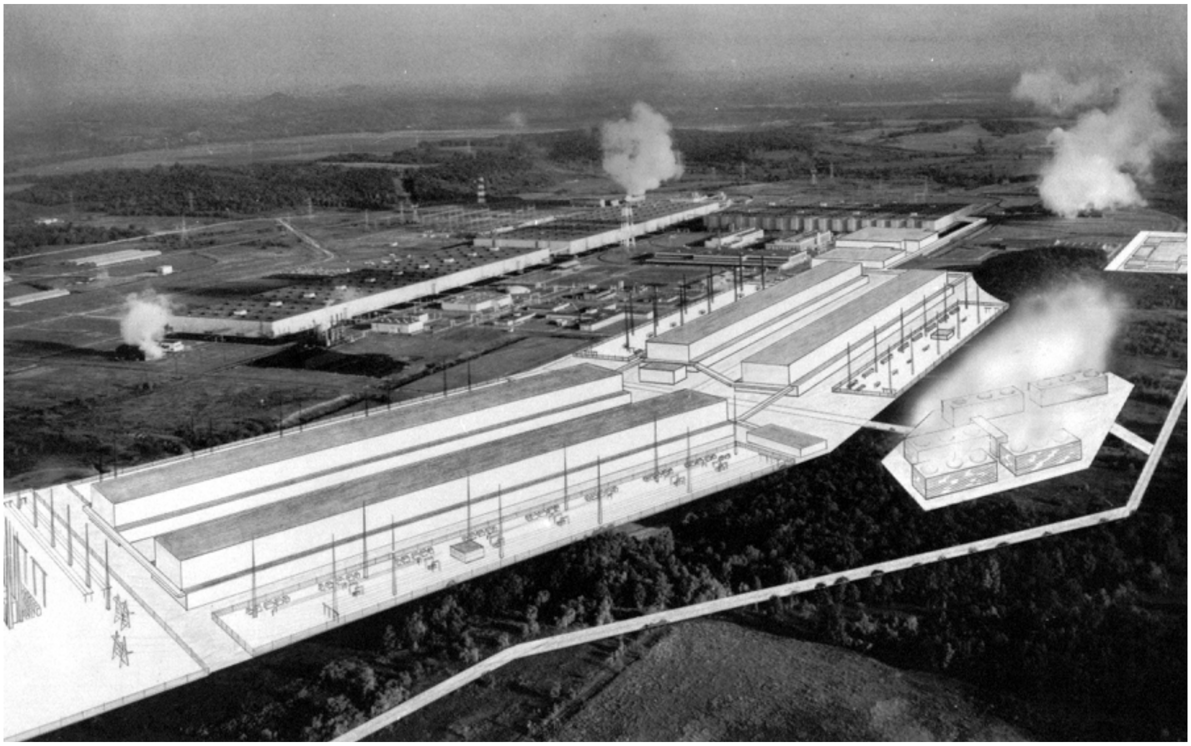

Figure 176. PORTS Looking Northwest with Artist's Rendering of the Plant Once the Add-on Gaseous Diffusion Plant was Completed (1977)

Figure 177. Announcement of the GDP Add-on

The announcement of the GDP Add-on was made on November 18, 1975, at a Press Conference at the Lake White Club (Waverly, Ohio) for Local Media. Pictured l to r: Robert J. Hart, Manager of ERDA's Oak Ridge Operations; James Rhodes, Governor of Ohio; and Charles Pilliod, Chairman of the Board, Goodyear Tire & Rubber Company.

The proposed Add-on GDP would have required approximately 600 acres for process buildings, 765-kV transmission-line tower bases, support facilities, access roads, and pipelines. The new process buildings, generally rectangular about 255 ft wide and 2,000 ft long, were to house much larger diffusion enrichment equipment (converters, compressors, 5,000-hp double-ended motors, etc.) that were designated as "0000" (quad 0). The Add-on GDP would have been located north of the existing X-326 and X-330 Process Buildings, and would have required the relocation of the perimeter road that encircles the DOE property. The Add-on GDP was to have consisted of 528 stages, all of one size, which were to be approximately 40 to 50 percent larger in capacity than the "000" stages within the X-333 Process Building. Each new motor for the Add-on GDP was to have been of an advanced design and very large, since each was expected to drive two of the "0000" size compressors over the design range of thermal conditions. Approximately 2,700 MW of electrical power was required for an Add-on GDP, which was assumed at the time to have been supplied by coal-fired power plants with a total installed capacity of 3,900 MW.

In early 1977, President Jimmy Carter cancelled the Add-on GDP project he had announced a year earlier. The cancellation of the project was due to the government's desire to save power costs and pursue an advanced form of enrichment, the high-performance centrifuge.

7.3 GAS CENTRIFUGE ENRICHMENT PLANT

In the late 1970s, PORTS was selected as the site for a new uranium enrichment facility that would employ the gas centrifuge technology. The new centrifuge technology was anticipated to require only about 4 percent of the electrical energy required for gaseous diffusion enrichment. Testing of the gas centrifuge technology for the purpose of enriching uranium-235 for a nuclear weapon occurred in the U.S. during the 1940s. By the 1960s, a program housed at the Oak Ridge GDP tested improvements to the centrifuge theory.

During the 1980s, the GCEP was DOE's largest construction project at the time. The construction site consisted of about 300 acres of relatively level land lying approximately west and south of the GDP. It was to consist of eight process buildings, plus additional auxiliary, administrative support, test, and service facilities. The full plant capacity was to have been 8.8 to 13.2 million SWU/year depending on the introduction of higher-performance centrifuges. The projected construction cost was $9.3 billion (in 1978 dollars). The total area under roof was to have been about 90 acres, and each process building was to be large enough to hold four football fields. The project required new industrial manufacturing capacity as well as the talents of a number of architect-engineers and construction contractors. Locating the centrifuge enrichment plant at an existing gaseous diffusion site provided advantages of shared facilities, administration, and overhead. In addition, heating of GCEP facilities was provided by waste heat from the existing GDP. The Process Waste Heat Utilization system, which was installed under GCEP, extracted heat from the compression of UF_6 gas, and then transferred it to a recirculating hot water system that provided heating for several facilities within the GCEP and the GDP.

Design of the GCEP was an outgrowth of conceptual engineering design studies which began in 1973 as an enrichment planning contingency measure. These studies were performed by Union Carbide Corporation-Nuclear Division and two architect-engineering firms, Catalytic, Inc. (Philadelphia), and Gilbert/Commonwealth Associates (Jackson, Michigan), with contributions by AiResearch, the University of Virginia, and industry. The conceptual studies were completed in December 1975 with the publication of a complete conceptual design and cost estimate for a full-size GCEP. Development of design criteria for the GCEP to be built at PORTS was initiated in mid-1977. Functional requirements were developed and Catalytic, Inc. was selected for overall coordination and publication of the plant design criteria, detailed designs for auxiliary facilities, and site-related improvements. Facility design was initiated in March 1978 with the selection of Fluor Engineers and Constructors (Irvine, California) for the process buildings. Bechtel (San Francisco) was selected to design the Recycle/Assembly facility, and Gilbert/Commonwealth Associates was selected to design the electrical power distribution system. At its peak, the project employed approximately 2,900 employees.

Construction progressed on schedule, and initial site preparation began in 1977. Steelwork for the first process building was completed in 1980, and installation of the exterior steel shell was essentially completed in April 1981 (Figure 178). The placing of the first floor module in Process Building 1 and steel erection for other major structures was initiated in early 1981. Stone and Webster Engineering Corporation (Boston) was the construction contractor and overall coordinator of construction at the plant site. Boeing, Garrett, and GAT manufactured an initial quantity of gas centrifuge machines for the first process building. The assembly of the first GCEP machine was completed in July of 1983, and the first machine was installed within Process Building 1 on November 7, 1983. Through a double elimination coin toss, the first machine to be installed was manufactured by GAT. Machines manufactured by Boeing and Garrett were installed the following day. By March of 1985, more than 1,000 GCEP machines had been successfully assembled at the plant.

Figure 178. GCEP Site Looking Northeast (2006)

Construction of the GCEP was terminated in 1985 due to a significant decrease in demand for enriched uranium and due to development of a promising new technology that was deemed to be more efficient and economical. When construction was halted, the Recycle and Assembly facility, two process buildings and numerous support facilities had been constructed. A small test cascade had been configured within Process Building 1, and was successfully running on process gas.

7.4 OHIO ARMY NATIONAL GUARD

After the decision was made in 1985 to suspend construction of the GCEP, DOE searched for alternative uses for the facilities. In 1988, the Ohio Army National Guard began accepting facilities for use in their ongoing operations. The X-751 Mobile Equipment Garage became an Army National Guard facility in May 1988 under lease agreement with DOE (Figure 179). In addition, the Defense Logistics Agency (DLA) showed interest in the GCEP facilities. In August 1988, the X-7721 Maintenance, Stores, and Training Facility, the north half of Process Building No. 2, Vehicular and Pedestrian Portals X-1107DV and X-1107DP, and the X-2207D parking lot were leased to the DLA. Later, only the X-751 Mobile Equipment Garage is retained by the Ohio Army National Guard. As of June 2015, the Ohio National Guard no longer maintained a presence at PORTS.

Figure 179. Representatives from the Ohio Army National Guard Accept the Keys to the X-751 Mobile Equipment Garage from DOE (1988)

8. HISTORY OF THE WORKERS AT THE SITE AND IN THE COMMUNITY

"A-Plant Comes Here." That was the headline in August 1952 when Goodyear Tire & Rubber Company was awarded a contract to operate a government-owned uranium enrichment plant in southern Ohio. The decision to construct such a facility awakened a sleepy rural valley and turned it into an industrial complex. GAT was created as a wholly-owned subsidiary of Goodyear Tire & Rubber Company to develop and operate the newest of the three GDPs. The construction and start-up of the facility at Piketon was a direct result of the AEC's desire to maintain the United States' superiority in the advancement and development of atomic energy. To more than 14,000 residents of rural Pike County, location of this large industrial facility was a tremendously exciting happening. More importantly, construction and operation of the plant would give the economy of the region a much-needed lift.

Peter Kiewit Sons' Company, the general construction contractor, headed a team of other construction and architect-engineer contractors (Figure 180). In December 1952, the first earth-moving equipment was moved onto the plant site. At the end of 1953, a little over a year after ground breaking, grading and site work were nearly completed. As personnel with many skills descended upon the local area to participate in construction activities, the gigantic plant took shape quickly (Figure 181).

9

Figure 180. Grinnell Engineering, a Subcontractor to Peter Kiewit Sons', Office Staff (1955)

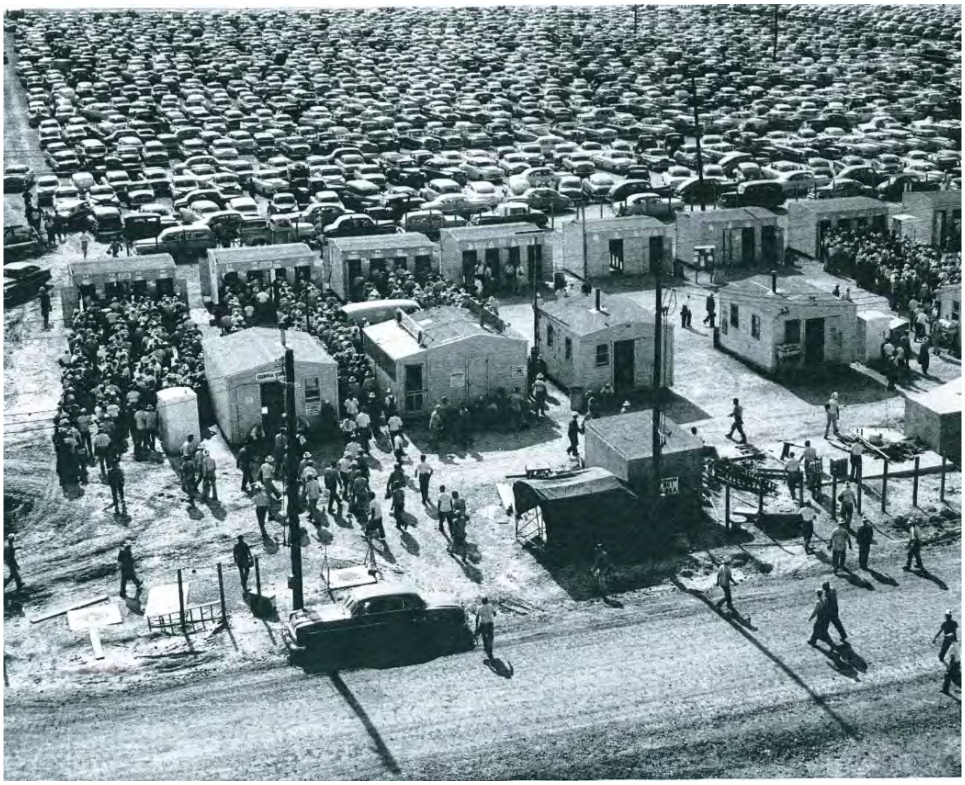

Figure 181. Construction Personnel Leaving the Site (1953)

8.1 UNION WORKERS

As presented in Section 1.2, the unions at PORTS were eager for the jobs and were willing to make commitments to the AEC. Commitments from the union and strong community support were instrumental in selection of the PORTS site. During construction, before an agreement was signed, limited union picketing was evidenced at entrances to the PORTS facility (Figure 182).

On September 28, 1954, United Gas, Coke and Chemical Workers of America (CIO) sent a letter to GAT that included a request to discuss a collective bargaining agreement. Through a series of meetings and a secret ballot election by GAT employees, representation of a union as a bargaining unit was established in November 1954. The initial vote was for either no union representation, or representation by CIO or Pike County Atomic Trades Council. Ballots were cast by 96.7 percent of those employees eligible to vote. CIO obtained the most votes and was awarded representation rights. The contract negotiations between GAT and CIO were held on plant site. The initial meeting between representatives of the two was held on February 1, 1955. These meetings would continue to be held until April 6, 1955, when the first union contract was signed. By this time, CIO, the bargaining unit selected by the employees, had been renamed Oil, Chemical and Atomic Workers (OCAW). This had happened when CIO merged with United Mine Workers after the two unions had enjoyed frequent organizing successes with one another and both had continued to grow. That same year, the American Federation of Labor (AFL) and the CIO merged, creating the AFL-CIO known today.

Figure 182. Teamsters Picket PORTS Construction in September 1954

When announcing the agreement between GAT and its employees in the bargaining unit, General Manager A. J. Gracia pointed out that great credit was due all the negotiators, union and management alike. He said that both sides set the highest of standards in the negotiations and that this resulted in the formulation of a workable contract embodying mutually satisfactory arrangements. In May 1955, copies of the newly agreed upon contract were distributed to all bargaining unit employees. Contract interpretation meetings were also held with more than 400 members of supervision attending and union officials setting in on the sessions. The contract covered various phases of hours and working conditions. Later that month, an election was held at plant site to determine new officers for OCAW Local 10-689. On June 7, 1955, at the Piketon Community Hall, the newly elected officers were installed. They included C. A. Romine, President, and E. L. Hill, Vice President.

During OCAW's first two decades at the plant, four union work stoppages occurred and they ranged in duration from 1 day to nearly 4 months. In 1977, OCAW and management established a Joint Labor Management Committee. The committee was to meet monthly in a joint discussion of mutually identified problems for the purpose of seeking solutions. In 1978, the union and management also initiated a joint training program for stewards and supervision. This was intended to review, train and discuss items of mutual concern. These steps were taken to strengthen the labor-management relationship. Despite the attempts at improving the working relationship between labor and management, the most aggressive strike in the plant's history began on May 2, 1979, and lasted nearly 8 months. On December 16, 1979, the workers ratified a new contract and returned to work the next day. Contracts were agreed upon without incident in 1982, 1985, and 1988.

8.2 PORTS IN THE COMMUNITY

The four-county area surrounding the plant site (Pike, Scioto, Ross, and Jackson counties) underwent a tremendous physical change during the building and operation of the GDP. Service industries such as grocery stores, barber shops, churches, schools, and houses were all mutually inadequate to handle the large influx of people who came to build and to operate the plant.

To meet this problem, GAT established a community relations department to encourage progress for employees to support their respective communities. This involvement included church, school, civic, health, recreational, welfare, local government and other organizations (Figures 183 through 186). Specifically, employees became involved in many activities in their communities including:

- Business-Education Day
- United Fund Drive
- American Red Cross blood bank
- High school science demonstration teams and science fairs
- Monetary and time donations to many community programs
- Youth opportunity programs
- Co-op student work-study programs
- College recruiting campus visits
- Environmental fair sponsorship
- Adopt a Highway cleanup program
- Speakers bureau to tell the “Atomic Story.”

Figure 183. Bloodmobile (1953)

Figure 184. Bloodmobile (1982)

Figure 185. Students in the Summer Science Employment Program (1982)

Figure 186. Adopt-A-Highway Volunteers

In addition, PORTS developed a diversified recreational program designed to contribute to the physical and social well-being of its employees. In 1953, Dick Jones was named supervisor of recreation for Goodyear Atomic. Later that year, Jones announced that a recreation program for GAT employees was beginning to "shape up." Functions were being planned in Portsmouth, Waverly, Jackson, and Chillicothe.

GAT employees enjoyed annual Christmas parties (Figure 187). The first GAT Christmas Party was held on December 19, 1953, at Waverly High School. Refreshments were served while Santa Claus made his rounds handing out toys and balloons to the children.

The next company-wide event held in 1953 was GAT's first Employee Picnic at Camden Park near Huntington, West Virginia. Approximately 5,000 people attended the inaugural event. Company summer picnics were held at Camden Park until 1979 (Figure 188) and then moved to King's Island in 1980 (Figure 189). In 1981, GAT employees participated in many events, such as the first old-fashioned picnic at the Scioto County Fairgrounds (Figure 190). Christmas parties and company picnics would be enjoyed by employees for many more years before the events were replaced with other small scale events.

Figure 187. GAT Chorus Performing at the Annual Christmas Party (1957)

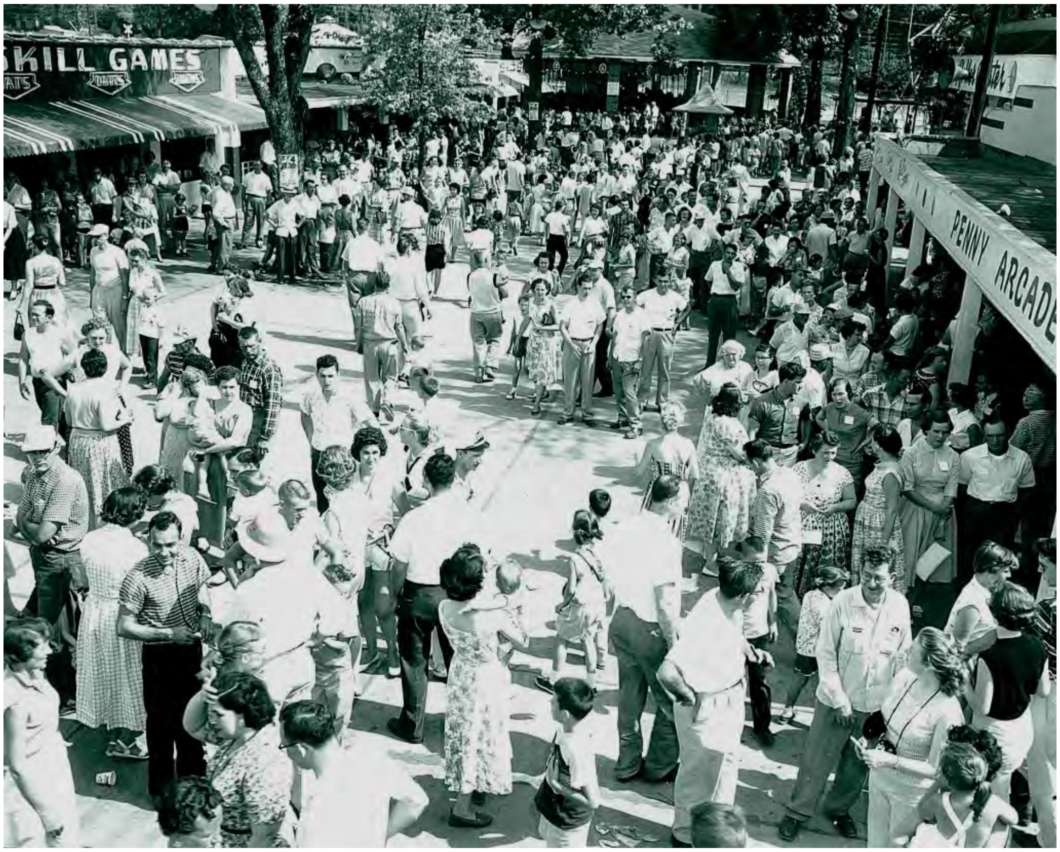

Figure 188. GAT Employees at Camden Park (1960s)

Figure 189. GAT Family on the Water Log Ride at King's Island (1980)

Figure 190. GAT Family Picnic at the Scioto County Fairgrounds (1981)

The recreation program was also responsible for the creation of many leagues and clubs formed for employees and, in some cases, their family members (Figures 191 and 192). From softball to weightlifting to bridge, if employees enjoyed an activity chances were that they could join other employees who had the same interest. The recreation program also sold group tickets for baseball games, basketball games, shows, ice revues, etc., to employees who needed help organizing leisure time. Over the years, interest in recreation activities faded as the times changed and the focus of the employees changed.

Figure 191. Basketball Championship Team (1983)

Figure 192. Chillicothe League Softball Team (1954)

9. IN CONCLUSION

PORTS was a part of the U.S. Cold War nuclear weapons complex. PORTS' primary Cold War era mission was the production of HEU by the gaseous diffusion process for defense/military purposes. From 1952 to 1991, the PORTS mission evolved from enriching uranium for weapons, to enriching uranium for nuclear power plants, to site cleanup in preparation for future site uses. During this time, PORTS has had a profound effect on the communities it calls neighbors, the southern Ohio region, the state of Ohio, the nation, and the world.

From the thousands of jobs it has provided for several generations of dedicated workers, the nuclear power plant fuel stock it has enriched to provide electricity, the materials it has provided for the nation's defense, to the downblending of Russian weapons-grade uranium to fuel for power plants, this facility has left a positive mark. While there have been challenges during its history, they have been met by dedicated workers who have strived to make PORTS an efficient, more productive, safer, and cleaner facility over the years.

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10. BIBLIOGRAPHY

Bentor, Yinon 2015, *Seaborgium*, available at http://www.chemicalelements.com/elements/sg.html.

Buck, Alice 1983, *A History of the Atomic Energy Commission*, DOE/ES-0003/1, U.S. Department of Energy, July.

Dispatch Magazine 1953, *Piketon, Ohio at the Coming of the Atomic Plant*, November, available at http://www.piketoninfo.net/piketon-november-1953.html.

DOE 2015, *Record of Decision for the Process Buildings and Complex Facilities Decontamination and Decommissioning Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio*, DOE/PPPO/03-0425&D2, U.S. Department of Energy, Piketon, OH, July.

DOE 2011, *Portsmouth Gaseous Diffusion Plant, Pike County, Ohio, Recommended Cold War Era Mission Documentation Model*, U.S. Department of Energy, Piketon, OH, May.

DOE 2011, *National Historic Preservation Act Section 110 Survey of Architectural Properties at the Portsmouth Gaseous Diffusion Plant, in Scioto and Seal Townships, Piketon, Ohio,* U.S. Department of Energy, Piketon, OH (DOE/PPO/03-0147&D1).

DOE 2010, *Production Operations, 1951 - 1989 - Complete Story*, U.S. Department of Energy, Fernald, OH, available at http://www.lm.doe.gov/land/sites/oh/fernald_orig/50th/prod2.htm.

DOE 2010, *Projects and Facilities,* U.S. Department of Energy, Hanford, WA, available at http://www.hanford.gov/page.cfm/ProjectsFacilities.

DOE 2010, *Y-12 Plant Prepares to Separate Lithium Isotopes*, U.S. Department of Energy, Oak Ridge, TN.

DOE 2010, *Paducah Gaseous Diffusion Plant,* U.S. Department of Energy, Portsmouth/Paducah Project Office, available at http://www.pppo.energy.gov/paducah.html.

DOE 2010, *Portsmouth Gaseous Diffusion Plant*, U.S. Department of Energy, Portsmouth/Paducah Project Office, available at http://www.pppo.energy.gov/portsmouth.html.

DOE 2000, *Independent Investigation of the Portsmouth Gaseous Diffusion Plant*, U.S. Department of Energy Office of Oversight Environment, Safety and Health, May, available at http://defendingscience.org/sites/default/files/upload/Portsmouth_vol1.pdf.

DOE 1993, *Report for Environmental Audit Supporting Transition of the Gaseous Diffusion Plants to the United States Enrichment Corporation*, DOE/OR/1087&V2, June.

Dwight D. Eisenhower Memorial Commission 2010, available at http://www.eisenhowermemorial.org/#.

Energy Systems at Portsmouth, Inc. Monthly Newspaper December 1986-1993, Martin Marietta Energy Systems.

Enterprise SRS 2010, *SRS History Highlights*, U.S. Department of Energy and National Nuclear Security Administration, available at http://www.srs.gov/general/about/history1.htm.

Exelon Corporation 2010, available at http://www.exeloncorp.com/Pages/home.aspx.

Farlex 2010, *Radioisotope*, available at http://medical-dictionary.thefreedictionary.com/radioisotope.
Fehner, Terrence R. and Holl, Jack M. 1994, *Department of Energy, 1977-1994: A Summary History*, DOE/HR-0098, U.S. DOE, November.

Final Environmental Impact Statement, Portsmouth Gaseous Diffusion Plant Site, Piketon, Ohio, ERDA – 1555, May 1977.

Goodyear Atomic Corporation 1953-1986, *The Wingfoot Clan*, Newsletters.

Goodyear Atomic Corporation, *The Goodyear Atomic Corporation 10th Anniversary, 1952-1962*.

Goodyear Atomic Corporation, 1973, *The Goodyear Atomic Story*.

Hamilton Daily New Journal 1954, *Senate Passes Atomic Energy Bill*, August 17.

Hicks, Clifford 1956, *Look What Happened When the Storm Strikes a Valley*, Popular Mechanics, Volume 105, No. 5, May.

History Associates Incorporated 1987, *History of the Production Complex: The Methods of Site Selection*, U.S. Department of Energy, September.

LATA/Parallax Portsmouth LLC 2010, *Historical Narrative of the X-533 Electrical Switchyard Complex*, LPP-0314/R0, U.S. Department of Energy, Portsmouth/Paducah Project Office, February.

International Atomic Energy Agency 2010, About IAEA: History: Atoms for Peace, available at https://www.iaea.org/about/history/atoms-for-peace-speech.

Introduction to Uranium Enrichment Operations, UEO-1004, Vol. 3 - Portsmouth. April 5, 1993. Uranium Enrichment Organization. Martin Marietta Energy Systems, Inc.

Kiewit 2010, *History*, available at http://www.kiewit.com/about-us/history/.

Kubiszewski, Ida 2008, *DOE Organization Act of 1977, United States*, The Encyclopedia of Earth, September, available at http://www.eoearth.org/view/article/151692/.

Lawrence Livermore National Laboratory 2003, *Atoms for Peace after 50 Years: The New Challenges and Opportunities*, UCRL-TR-200927, University of California, Lawrence Livermore National Laboratory, December.

NASA 2010, available at http://www.nasa.gov/.

National Park Service 1990, *Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation: HABS/HAER Standards*, U.S. Department of the Interior.

NEPA 2000, *NEPA of 1969*, December 31.

Nuclear Files 2010, Key Issues: Nuclear Energy: History: Court Case, July 23, 1971, available at http://www.nuclearfiles.org/menu/key-issues/nuclear-energy/history/court-case_1971-07-23.htm.

Portsmouth Daily Times 2006, *Piketon Plant Celebrates 50 Years Since Completion*, March 31.
Power for Peace, The OVEC- Indiana-Kentucky Electric Corporation stories, American Electric Power, May 23, 1956.

Portsmouth Gaseous Diffusion Plant Virtual Museum – accessed at http://www.portsvirtualmuseum.org, operated and managed by Fluor-BWXT Portsmouth for DOE.

Reference.com 2010, *U.S. Atomic Energy Commission*, available at http://www.reference.com/browse/united+states+atomic+energy+commission?s=t.

Research and Development Accomplishments 2013, *Glenn T. Seaborg – Contributions to Advancing Science*, U.S. Department of Energy, November.

The Portsmouth Project. "Magnitude!" Film.

The Portsmouth Times. Vol. 101 – No. 126. Portsmouth, OH, August 16, 1952.

The Portsmouth Times. August 11, 1956:1, 5

The Sunday Register. Vol. 73 – No. 48. Beckley, W. VA. August 17, 1952.

Theta Pro2Serve Management Energy LLC 2006, *Facility Condition Survey of Portsmouth Gaseous Diffusion Plant* Facilities, Piketon, Ohio, TPMC/PRTS-59/R1, August.

Timelines and Key Dates of Events. September 2010.

U.S. Atomic Energy Commission, Gaseous Diffusion Plant at Portsmouth, OH - Project No. E2-24X-3701. *Project History and Completion Report.*

U.S. Energy Information Administration 2010, *Separative work unit*.

U.S. Enrichment Corporation 1998, *Safety Analysis Report (SAR)-PORTS, Emergency Plan-PORTS,* Rev. April.

U.S. Nuclear Regulatory Commission. Resource: Fact Sheet.

The Waverly News and Republican Herald, January 1, 1953 gg:1.

The Waverly News and Republican Herald, January 8, 1953 jjj:1.

World Nuclear Association 2010, *Peaceful Nuclear Explosions*, July.

World Nuclear Association 2015, *Nuclear Radiation and Health Effects,* January.

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