PORTSMOUTH GASEOUS DIFFUSION PLANT, X-330 PROCESS BUILDING
3930 U.S. Route 23 South
Piketon vicinity
Pike County
Ohio

HAER OH-142-D
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240

HISTORIC AMERICAN ENGINEERING RECORD

PORTSMOUTH GASEOUS DIFFUSION PLANT, X-330 PROCESS BUILDING

HAER No. OH-142-D

Location:	Portsmouth Gaseous Diffusion Plant (PORTS), 3930 U.S. Route 23 South, Piketon vicinity, Scioto Township, Pike County, Ohio The X-330 Process Building is located at Ohio State Plane South coordinates at easting 1826240.272329 ft, northing 370619.269871948 ft and at Universal Transverse Mercator Zone 17N easting 326789.5391 m, northing 4320511.599 m. The coordinate represents the approximate center of the X-330 Process Building. This coordinate was obtained on June 19, 2019 by plotting its location in EnviroInsite 10.0.0.37. The accuracy of the coordinates is +/- 12 meters. The coordinate datum is North American Datum 1983.
Date of Construction:	1955
Designer/Builder:	Peter Kiewit Sons' Construction Company
Previous Owner:	N/A
Present Owner:	The Atomic Energy Commission (AEC) oversaw construction and operation of PORTS until 1974, when the Energy Research and Development Administration was established with responsibility for research and development duties from 1974-1977. In 1977, the U.S. Department of Energy (DOE) was established, overseeing operations at PORTS.
Present Use:	Uranium enrichment no longer occurs within the X-330 Process Building. The building is no longer in use and is awaiting demolition.
Significance:	The X-330 Process Building housed process equipment for the intermediate phase of uranium enrichment, enriching to levels between those of X-333 and X-326, the lower and upper ends of the PORTS diffusion cascade. This building is part of PORTS, which 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. Uranium was enriched at PORTS from 1954 until May 2001. PORTS enriched uranium for the longest period of time and to the highest levels within the DOE complex.
Project Information:	Fluor-BWXT Portsmouth LLC photographed the site in August 2014. Gray & Pape, Inc., Cincinnati, Ohio, served as the primary author of the historical narrative and resource descriptions drawing from numerous historical records and reports, drawings, photographs and plans. For additional contextual information, see Portsmouth Gaseous Diffusion Plant, HAER no. OH-142. This X-330 Process Building HAER was completed in 2021.

Part I. Historical Information

In support of this report, there are three appendices that are provided: Appendix A through C, which consist of survey photographs, historical photographs, and historical drawings, respectively.

Construction History of the X-330 Process Building:
The X-330 Process Building was built under a lump-sum subcontract. Peter Kiewit Sons' Construction Company awarded subcontracts for foundation work and underground installations, structural steel, roofing, siding, exterior doors, freight elevators, acoustic tile, refrigeration systems, glass and glazing, and numerous other tasks necessary for the building's operations. Stripping of the building area in preparation for laying the foundation began in November 1952 by Peter Kiewit Sons' Company. The Penker Construction Company began installation of the concrete footings, piers, grade beams, and walls in March 1953. Approximately 19,000 cubic yards of concrete and 920 tons of reinforcing steel were used in this work, which was complete by November 1953. Pouring of the ground floor slab was completed in February 1954.

The R. C. Mahon Company furnished and erected approximately 23,000 tons of structural steel. Construction of the steel structure began in May 1953 at the north end of the building and proceeded toward the south. Brown and Kerr installed the metal roof deck and built-up roofing. These activities began in July 1953 and were complete by April 1954. Furnishing and installation of all corrugated cement-asbestos siding and related work was performed by Standard Asbestos Manufacturing and Insulating Company. This work was completed during July 1953 through February 1954.

Peter Kiewit Sons' Company laid masonry blocks, face tiles, and ceilings from September 1953 through April 1954. Subcontracts were awarded for tasks such as lathing, plastering, painting, and the installation of tile ceilings, ceiling suspension systems, and exterior doors. Installation of interior electrical systems, plumbing, heating and ventilation, air conditioning, and alarm systems was complete by December 1954, as was the installation of air drying equipment, compressors, motors, converters, process gas and auxiliary piping, and instrumentation. The building was completed and turned over to the AEC in July 1955.

Historical photographs for the X-330 Process Building are provided in Appendix B (Figures 6 through 31). Historical drawings of building plans are provided in Appendix C (Figures 32 through 42).

Part II. Site Information

Description of the X-330 Process Building:
The X-330 Process Building is located just west of the X-333 Process Building and just north of the X-326 Process Building. The X-330 Process Building housed the intermediate phase of the uranium enrichment process. The uranium enrichment process was initiated in the X-333 Process Building and then continued in series to the X-330 and X-326 Process Buildings. The X-330 Process Building was used for the intermediate phase of uranium enrichment and for the withdrawal of waste materials, known as "tails." Uranium was enriched at PORTS until May 2001. From the end of the Cold War in 1991 until production ceased in 2001, PORTS produced only low enriched uranium (LEU) for commercial power plants.

Like the other two process buildings (X-333 and X-326), the equipment in the X-330 Process Building was on two floors, with the auxiliary equipment, support equipment, and control rooms on the first floor, also known as the operating floor or ground floor. The diffusion process equipment was located on the second floor, known as the cell floor. Two Area Control Rooms are located on the first floor. A basement is located below each Area Control Room and provides access to the underground instrument tunnel system.

Measuring 2,176' long by 640' wide, the X-330 Process Building has a combined floor space of 64 acres (two stories) (Appendix A, Figures 1 through 5). It is the second largest of the three process buildings at PORTS. The building stands 66' in height and includes the cell floor at 22', 6" above the ground floor level. The cell floor supports the operating equipment for the many cells that occupy the building.

The design of the X-330 Process Building is based on the C-331 Building at Paducah, KY, PORTS "sister" facility that was completed one year prior to PORTS. The X-330 Process Building is comprised of 11 building units, which house the X-29 and X-31 Facilities. The 11 units are divided by transverse roller-type expansion joints spaced at intervals of 196'. Altogether there are 22 bays across the length of the X-330 Process Building. The framing is arranged to provide an open span of 75'. A travelling crane spans the width of the building.

Engineers designed the X-330 Process Building specifically to house gaseous diffusion equipment, process auxiliaries, and support equipment. Process auxiliaries (e.g., steam, nitrogen and dry air distribution; coolant transport and recovery; heating and ventilation; electrical power) are ancillary systems used to facilitate the primary enrichment process. Support equipment (e.g., computer and communication equipment, sanitary and sewage utilities, security equipment) assist in process building operations, but are not directly associated with the enrichment process. Like the other two process buildings, the exterior of the X-330 Process Building is covered with large, white, corrugated cement asbestos tiles, also known as transite tiles. There are no windows in the building; however, "port holes" within the building can be propped open to allow air flow. Large vents are positioned atop the roof, which consists of a flat metal deck that is covered with insulation and gravel.

The building also includes a depressed truck alley with a railroad spur imbedded in the paving. The alley and spur enter the building at the northwest corner. The truck alley and the railroad spur were used for the delivery and pickup of process equipment. The cell floor extends over the truck alleys, and hatches under each crane bay allowed heavy process equipment to be lifted to the cell floor for installation or storage. Additional truck access doors are located along the other three sides of the building.

The metal roof deck is supported by steel trusses over the crane bays and by steel beams and framing over the pipe galleries. Engineers designed the framing for the building to withstand wind loads of 20 pounds per square foot and live loads on the roof at 30 pounds per square foot.

Part III. Operations and Process

A. Operations:

At PORTS, uranium was enriched using a process called gaseous diffusion. Through the process of diffusion, gaseous uranium hexafluoride (UF_6) is passed through a conversion system to produce enriched, or diffused, uranium-235 and undiffused uranium-238. The process of uranium 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.

The gaseous diffusion process requires the use of UF_6 to separate the uranium-238 and uranium-235 isotopes. During diffusion, UF_6 gas is forced through a series of porous membranes, or "barriers" with microscopic openings. 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. Uranium-235 moved through the barriers more easily, increasing the concentration of uranium-235 as it moved through the process. The tendency for uranium-235 to pass through the barrier more quickly is the basis for the gaseous diffusion process.

The basic separation equipment for gaseous diffusion is a "stage." At PORTS, a stage consisted of a converter that contains porous separation media, a gas cooler, a compressor to move the UF_6 gas through the converter, and interconnecting piping and control valves to contain and control the gas flows. One stage was capable of only very slight enrichment. Stages operated in a cascading system, and thousands of stages in the process buildings were connected in series to produce HEU. The X-330 Process Building contains 1,100 stages.

Stages were grouped into "cells," which were the smallest groups of stages that could be removed from service, bypassed, and shut down for maintenance or other purposes. There are 10 stages per cell in the X-330 Process Building, and the building housed 110 cells.

Cells were further grouped into "units," which were groups of cells that shared common auxiliary systems. The 110 cells in the X-330 Process Building are grouped into 11 units.

The process equipment, piping, and instrument lines that contained process gas were enclosed by cell housing and bypass housing. The cell housing for the X-330 process equipment has a steel frame and transite siding, and the top of the housing has removable hatches that allow for equipment removal.

Feed material entered the uranium enrichment process at the X-333 Process Building. After cascading through the X-333 Process Building, the uranium enrichment process continued in the X-330 Process Building. The X-330 Process Building contains intermediate sized equipment that is smaller than the equipment in the X-333 Process Building but larger than the equipment in the X-326 Process Building. The two sizes of process equipment in the X-330 Process Building are referred to as the X-31 size (i.e., "00"), which is the larger of the two sizes, and the X-29 size (i.e., "0"), which is the smaller of the two sizes.

In the X-330 Process Building, one unit with X-29 sized equipment and two units with X-31 sized equipment served as the stripping section of the cascade. The stripping section consists of the stages located below the feed point of the cascade. From the X-29 sized unit, waste material was withdrawn from the cascade at the PORTS Tails Withdrawal Station. The PORTS Tails Withdrawal Station is located in the northeast corner of the X-330 Process Building. The waste, or tails, from the gaseous diffusion process consisted of depleted process gas. Depleted process gas from the enrichment process was withdrawn from the gaseous diffusion cascade, compressed, and condensed into a liquid that flowed by gravity to cylinders located on scales. Cranes were used to move these cylinders to cooling areas and load them for transport.

B. First Floor:

The first floor of the X-330 Process Building supports the auxiliary systems, electrical power substations, the control centers for the main process equipment, and numerous enclosed areas that were used for operational purposes. Each of the 11 units includes their own battery rooms and open pits for lube-oil equipment. The south end of the first floor also housed nitrogen plant and the main portion of the plant's dry air production facility. Additionally, the first floor housed the Interim Purge system which was utilized to bring the plant on line prior to completing of the Purge Cascade in X-326. The design of the enclosures for the various rooms within the X-330 Process Building follows the same basic plan as that for the X-326 and X-333 Process Buildings. All building finishes were designed for cleanliness and sanitation.

C. Second Floor (Cell Floor):

All of the process equipment is located on the cell floor. The X-29 equipment contains six units (60 cells and 600 stages) and the X-31 contains 5 units (50 cells and 500 stages). Engineers called for reinforcing of the concrete floor to withstand temperature changes and load transfers at the joints.

The cell floor is divided according to functionality, as well as for expansion. Each of the 11 units includes ten cells of ten operating units, also known as stages. Altogether, the X-330 Process Building houses 1,100 stages. These stages were split into enriching stages and stripping stages. The enriching stages were used to further enrich gaseous UF_6 from the X-333 Process Building, which then entered the X-326 Process Building. The stripping stages were used to remove waste materials from the gaseous diffusion cascade.

The east side of the building includes three booster stations and three freight elevators. The three booster stations were used for increasing the pressure of process gas. Two of the booster stations were dedicated to accelerating the flow of enriched gaseous UF_6. One of these two stations transmitted gas to the X-333 Process Building and the other delivered gas to the X-326 Process Building. The third booster station was used to boost the stream of depleted UF_6 gas to X-333.

Access between the ground and cell floors was facilitated by steel stairways, ladders, platforms, and catwalks. Each building unit features three sets of stairs. Each of the 22 bays includes its own electric, overhead crane. Each crane has a lifting capacity of 15 tons.

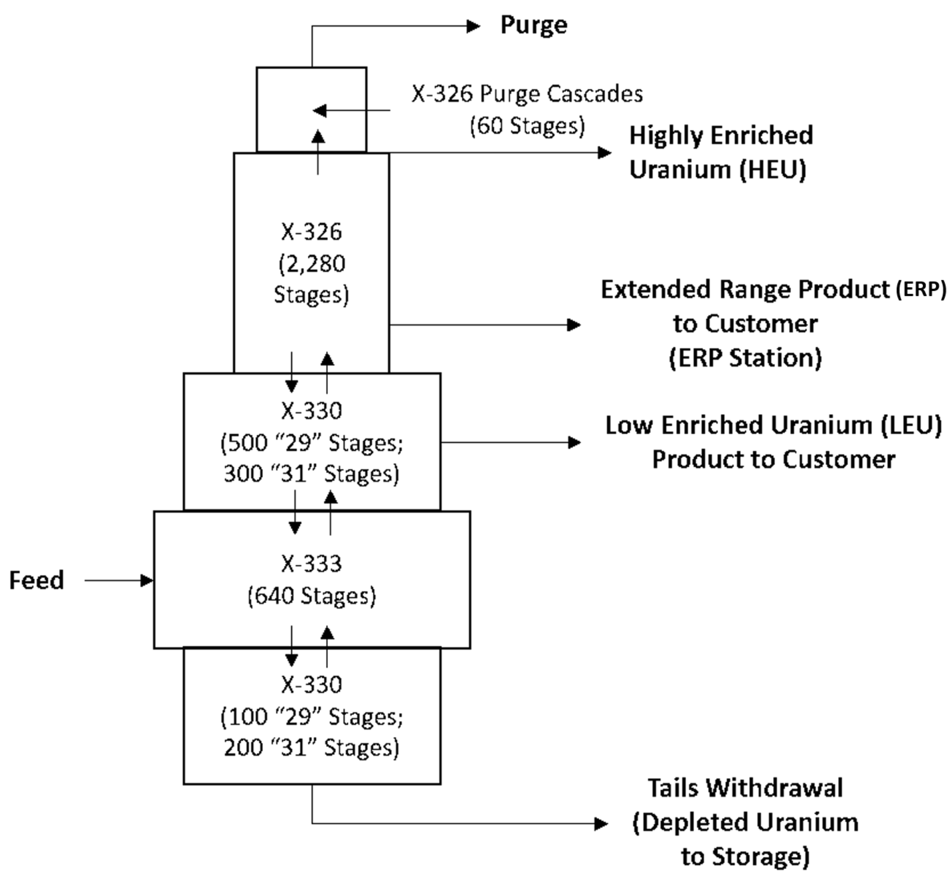
The evacuation system within the X-330 Process Building provided a means for the removal of process gas and light gas contaminants. Evacuation piping is connected to the process piping at each cell and extends to the cold-trapping and surge-drum storage facilities on the first floor of the building. An evacuation station is connected to the evacuation piping. At the evacuation station, process gas and air was withdrawn from the piping and equipment, and pumped into cold-traps or into storage.

Gas evacuated from the system entered into a recovery process. The gas recovery system (Cold Recovery) solidified the UF_6 while venting the light gas impurities. The recovered UF_6 was returned to a gaseous state to be held in drums and later returned to the diffusion cascade.

Steam was supplied to the X-330 Process Building in order to heat the process gas pipe enclosures, the cell enclosures, and the interplant process gas tie-line enclosures. A steam heating system was used to prevent the gas from condensing inside the process piping. In emergency situations, the temperature of the cell enclosures could be increased using unit heaters. A heater could provide heat to five cells and the heating system could heat ten cells simultaneously. The uranium enrichment process was initiated in X-333 Process Building and continued in series to X-330 and X-326 Process Buildings. Materials were withdrawn from the cascade at the following four locations:

- X-326 Product Withdrawal Station (90 to 97 percent uranium-235 during HEU production, 2.0 to 5.0 percent uranium-235 during LEU production)
- X-326 Extended Range Product Station (0.7 to 5.0 percent uranium-235)
- X-333 Low Assay Withdrawal Station (1.0 to 5.0 percent uranium-235)
- X-330 Tails Withdrawal Facility (0.2 to 0.3 percent uranium-235 and 1.0 to 5.0 percent uranium-235).

A diagram showing the gaseous diffusion “cascade” at PORTS is shown below.



PORTS Gaseous Diffusion “Cascade”

Part IV. Sources of Information

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Department Of Energy. *The Role of the Portsmouth Gaseous Diffusion Plant in Cold War History*. Piketon, OH: U.S. Department of Energy, 2017.

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Department Of Energy. *Remedial Investigation and Feasibility Report for the Process Buildings and Complex Facilities Decontamination and Decommissioning Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio*, DOE/PPPO/03-0245&D3, Piketon, OH: U.S. Department of Energy, 2014.

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

Department Of Energy. Highly *Enriched Uranium: Striking a Balance, A Historical Report on the United States Highly Enriched Uranium Production, Acquisition, and Utilization Activities from 1945 to September 30, 1996*, Revision 1. Washington, D.C.: National Nuclear Security Administration, U.S. Department of Energy, 2001.

Giffels & Vallet, Inc. *Gaseous Diffusion Plant at Portsmouth, Ohio, Project History and Completion Report* (Redacted). Washington, D.C.: U.S. Atomic Energy Commission, 1957.

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

Appendix A: Survey Photographs

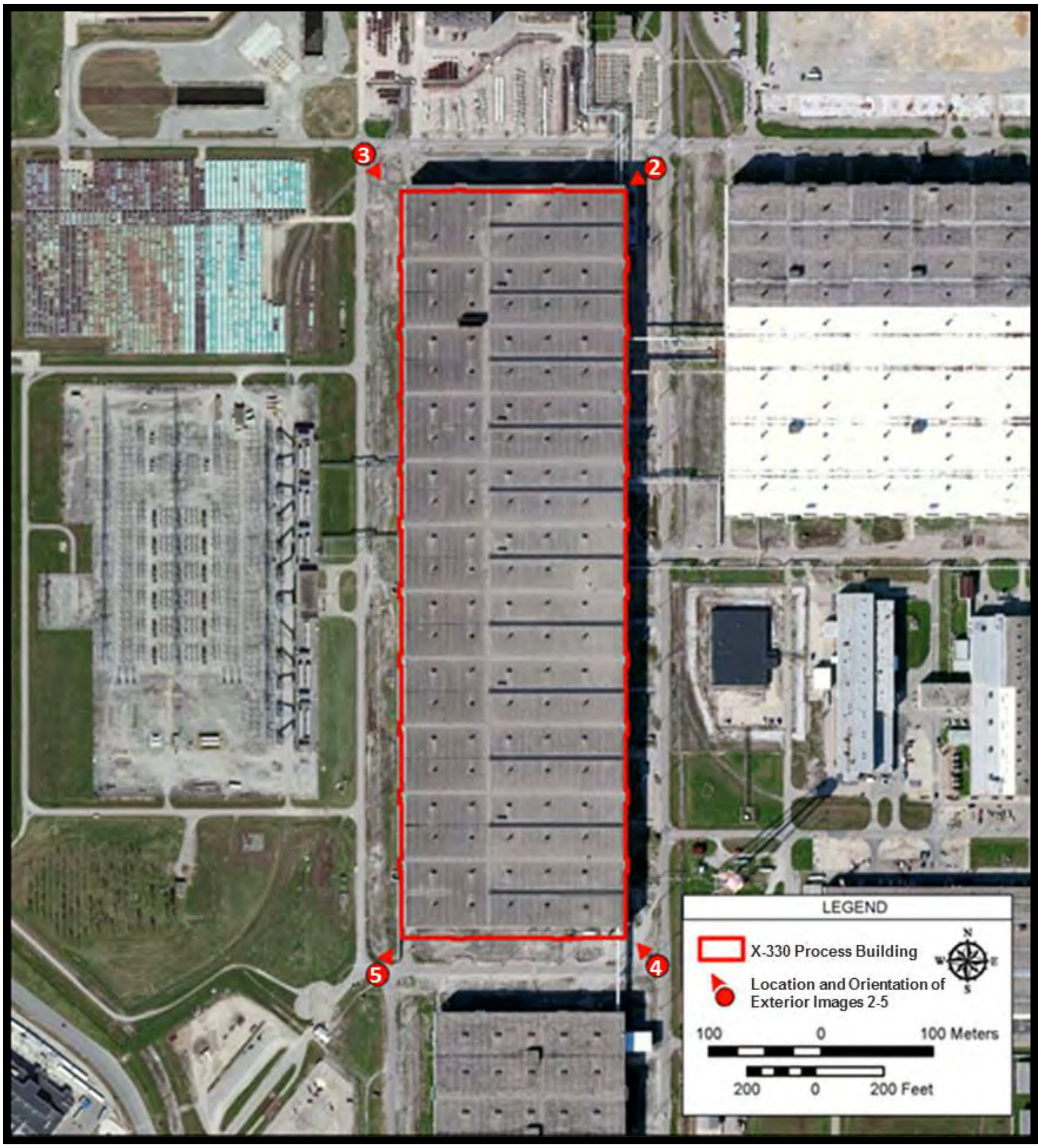

Figure 1: Location and Orientation of Exterior Photographs (Figures 2 through 5)

Figure 2: North Side of the X-330 Process Building, August 2014, Facing Southwest

Figure 3: North Side of the X-330 Process Building, August 2014, Facing Southeast

Figure 4: South Side of the X-330 Process Building, August 2014, Facing Northwest

Figure 5: South Side of the X-330 Process Building, August 2014, Facing Northeast

Appendix B: Historical Photographs

Figure 6: Steel Framework of the X-330 Process Building, June 1953

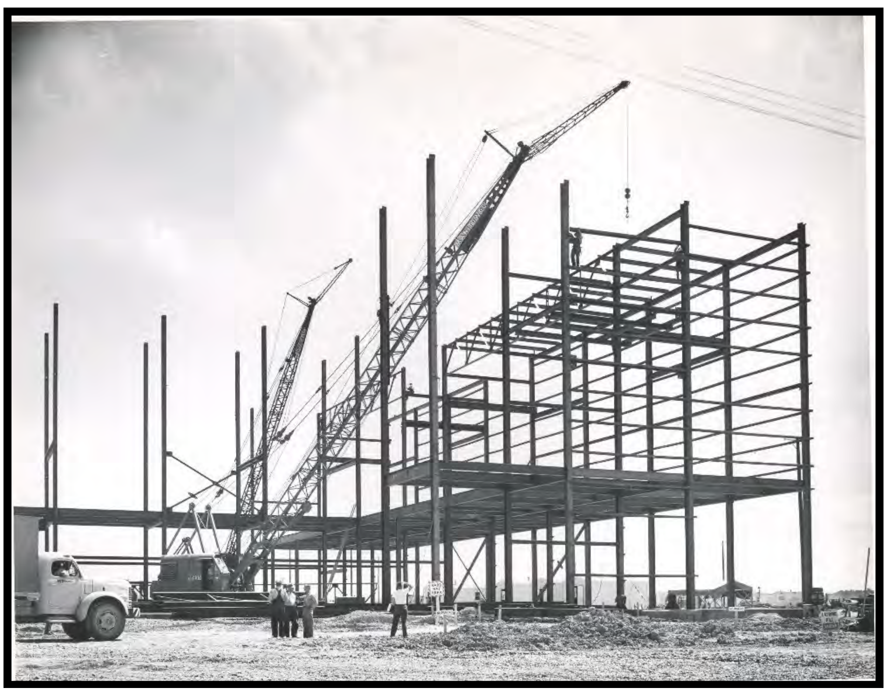

Figure 7: Steel Framework of the X-330 Process Building, June 1953

Figure 8: Grading and Construction for the X-330 Process Building, June 1953

Figure 9: Steel Framework Construction of the X-330 Process Building, August 1953

Figure 10: Foundation Construction of the X-330 Process Building, August 1953

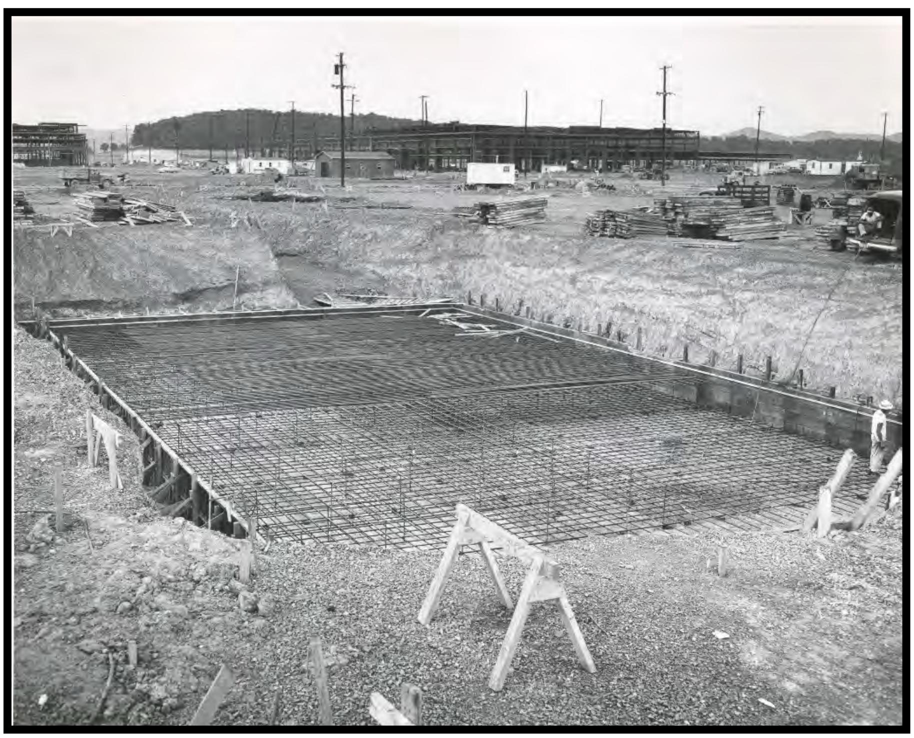

Figure 11: Foundation Construction of the X-330 Process Building, August 1953

Figure 12: Foundation Construction of the X-330 Process Building, August 1953

Figure 13: Foundation Construction of the X-330 Process Building, August 1953

Figure 14: Foundation Construction of the X-330 Process Building, August 1953

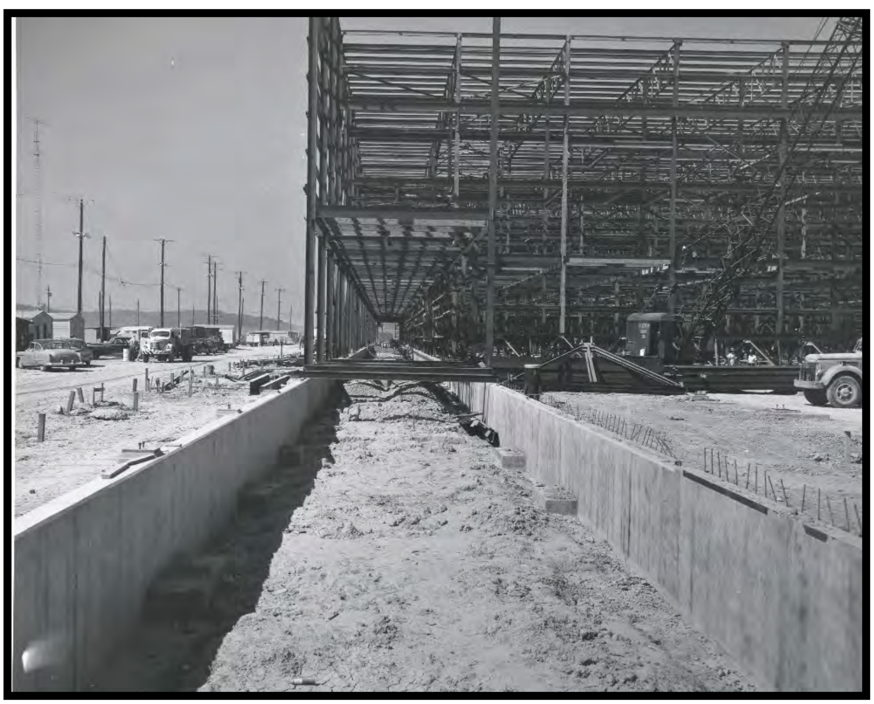

Figure 15: Foundation Construction of the X-330 Process Building, August 1953

Figure 16: Excavation and Grading Work for the X-330 Process Building, August 1953

Figure 17: Foundation Construction of the X-330 Process Building, August 1953

Figure 18: Foundation Construction of the X-330 Process Building, August 1953

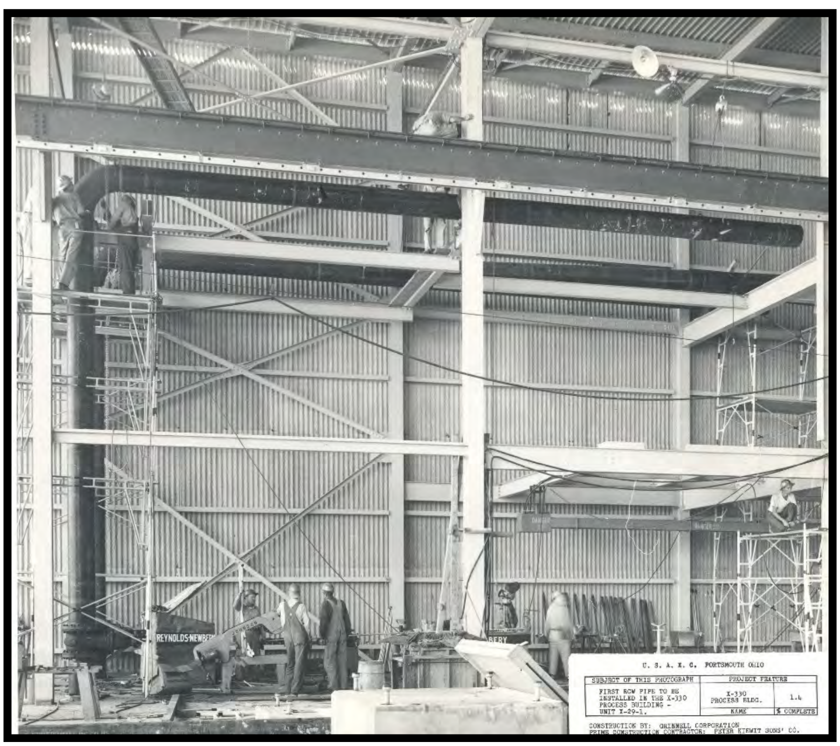

Figure 19: Construction of Unit 29-1 in the X-330 Process Building, August 1953

Figure 20: Looking North at the Construction of the X-330 Process Building, August 1953

Figure 21: Looking East at the Interior of the X-330 Process Building, August 1953

Figure 22: Foundation Construction of the X-330 Process Building, September 1953

Figure 23: Foundation Construction of the X-330 Process Building, September 1953

Figure 24: Construction of the X-330 Process Building, October 1953

Figure 25: Construction of the X-330 Process Building, January 1954

Figure 26: Cell Floor Construction of the X-330 Process Building, January 1954

Figure 27: Cell Floor Construction of the X-330 Process Building, January 1954

Figure 28: Cell Floor of the X-330 Process Building, January 1954

Figure 29: Converter Installation in the X-330 Process Building, February 1954

Figure 30: Looking West at the Cell Floor of the X-330 Process Building, February 1954

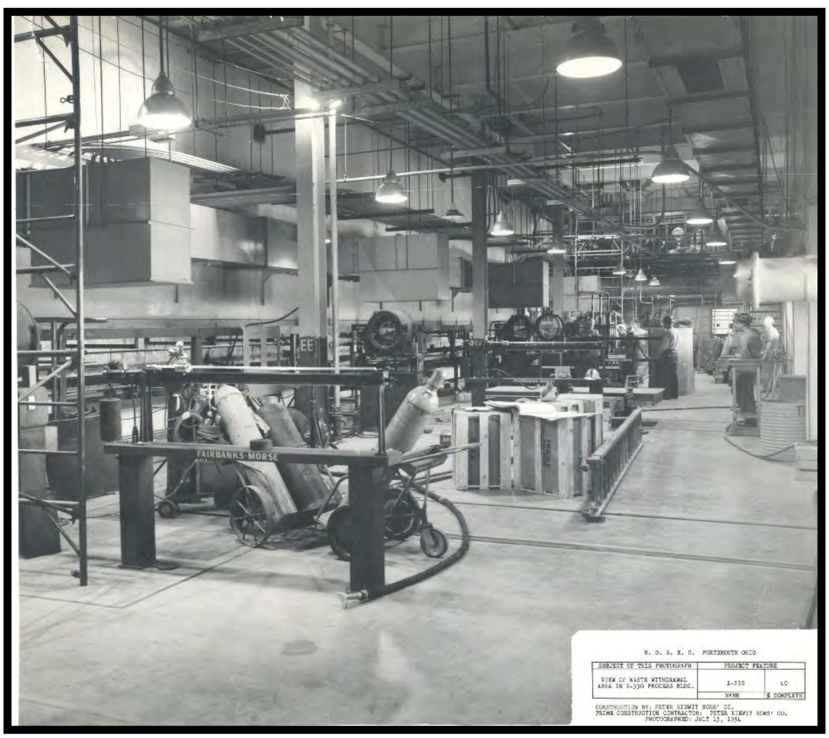

Figure 31: Waste (Tails) Withdrawal Area in the X-330 Process Building, July 1954

Appendix C: Historical Drawings

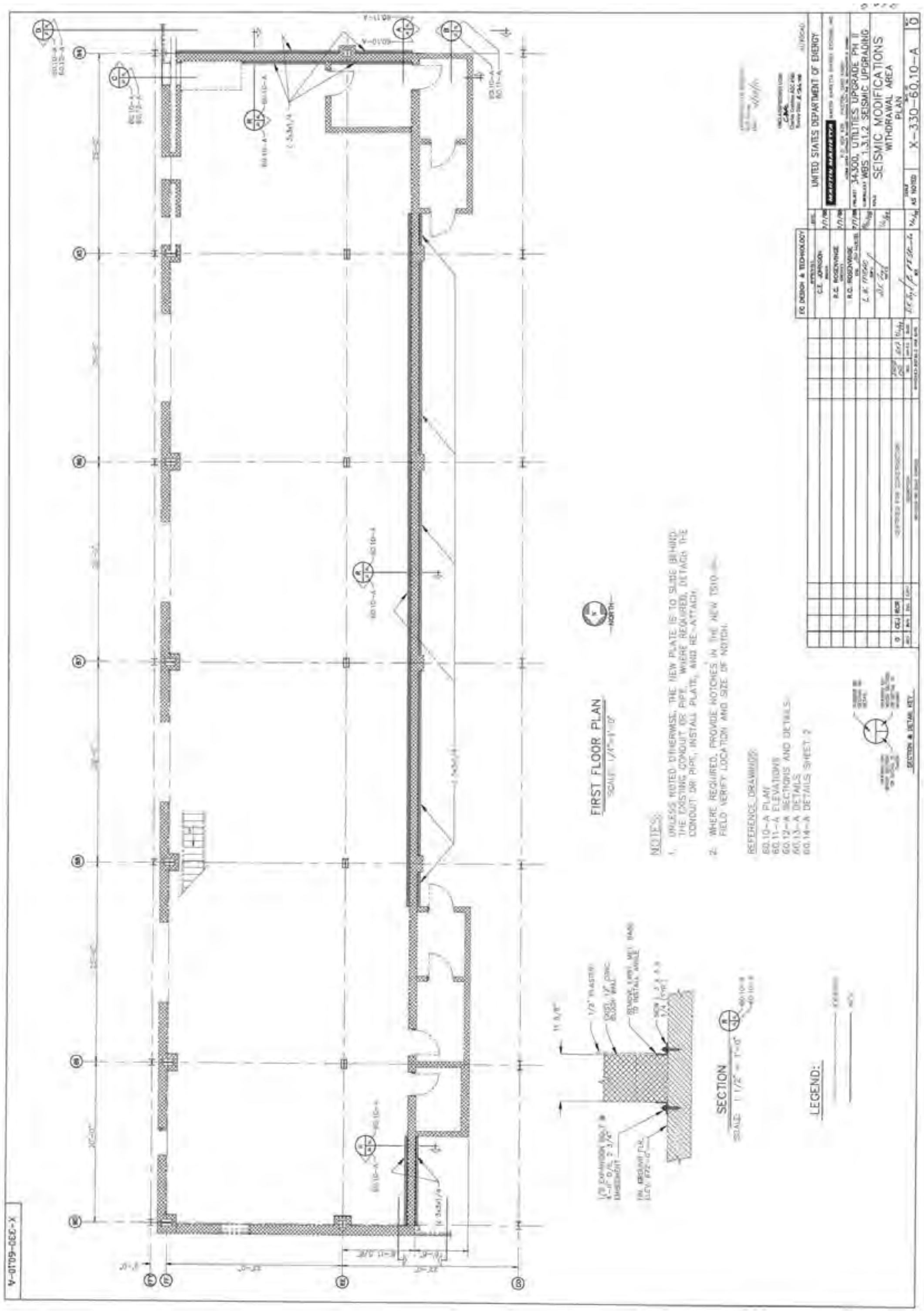

Figure 32: Seismic Modifications

Figure 33: Building Access Plan - North

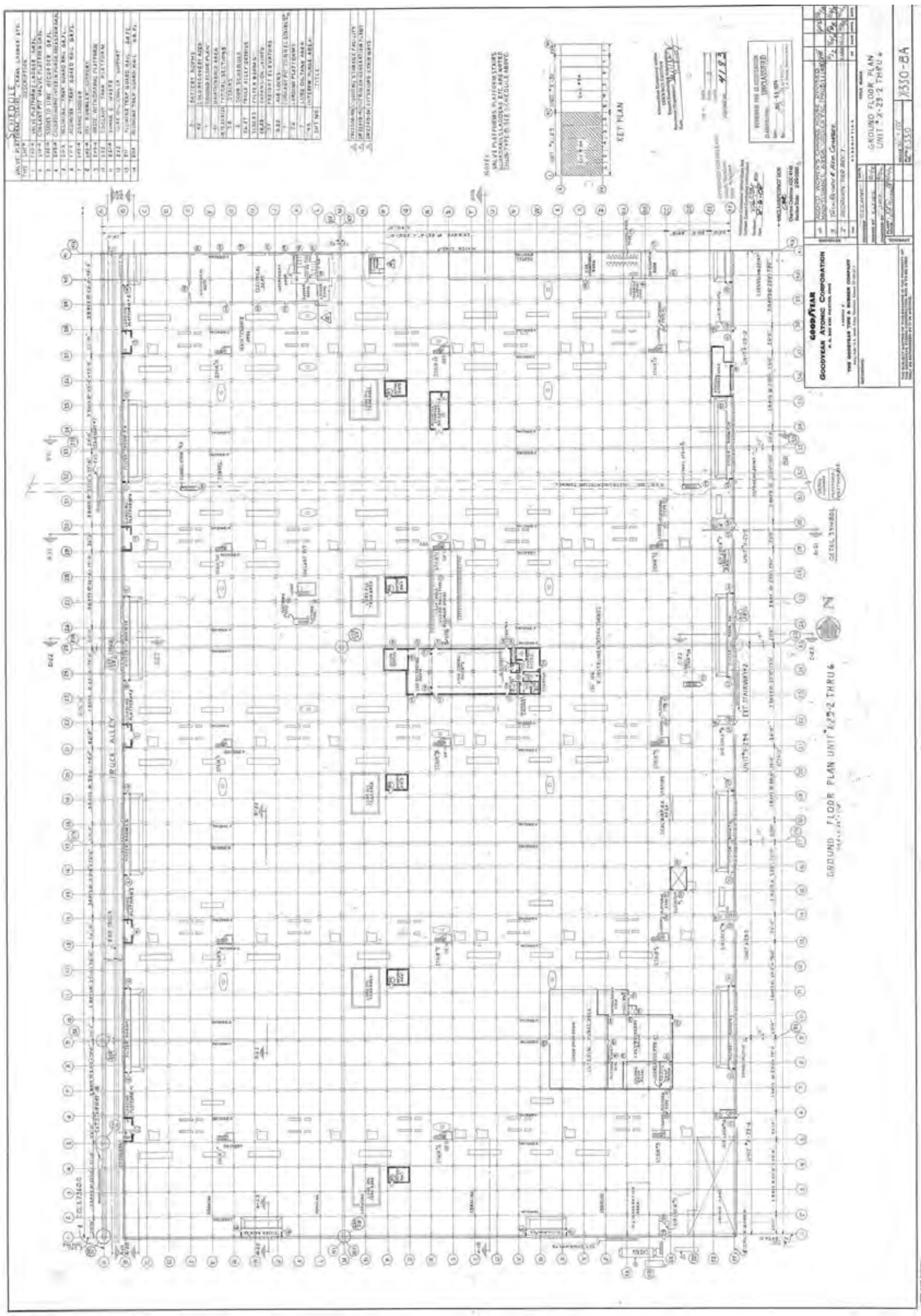

Figure 34: Ground Floor Plan

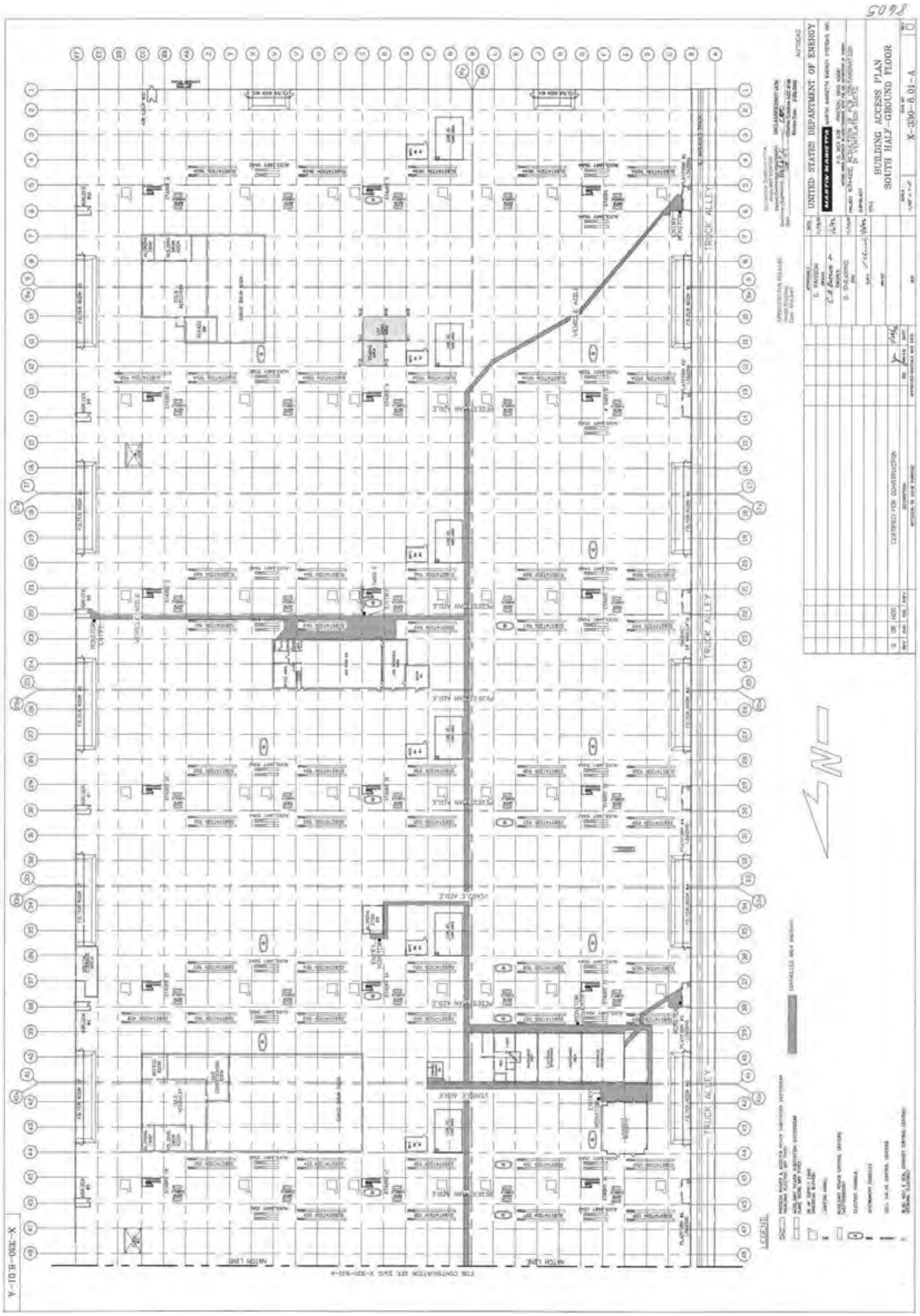

Figure 35: Building Access Plan - South

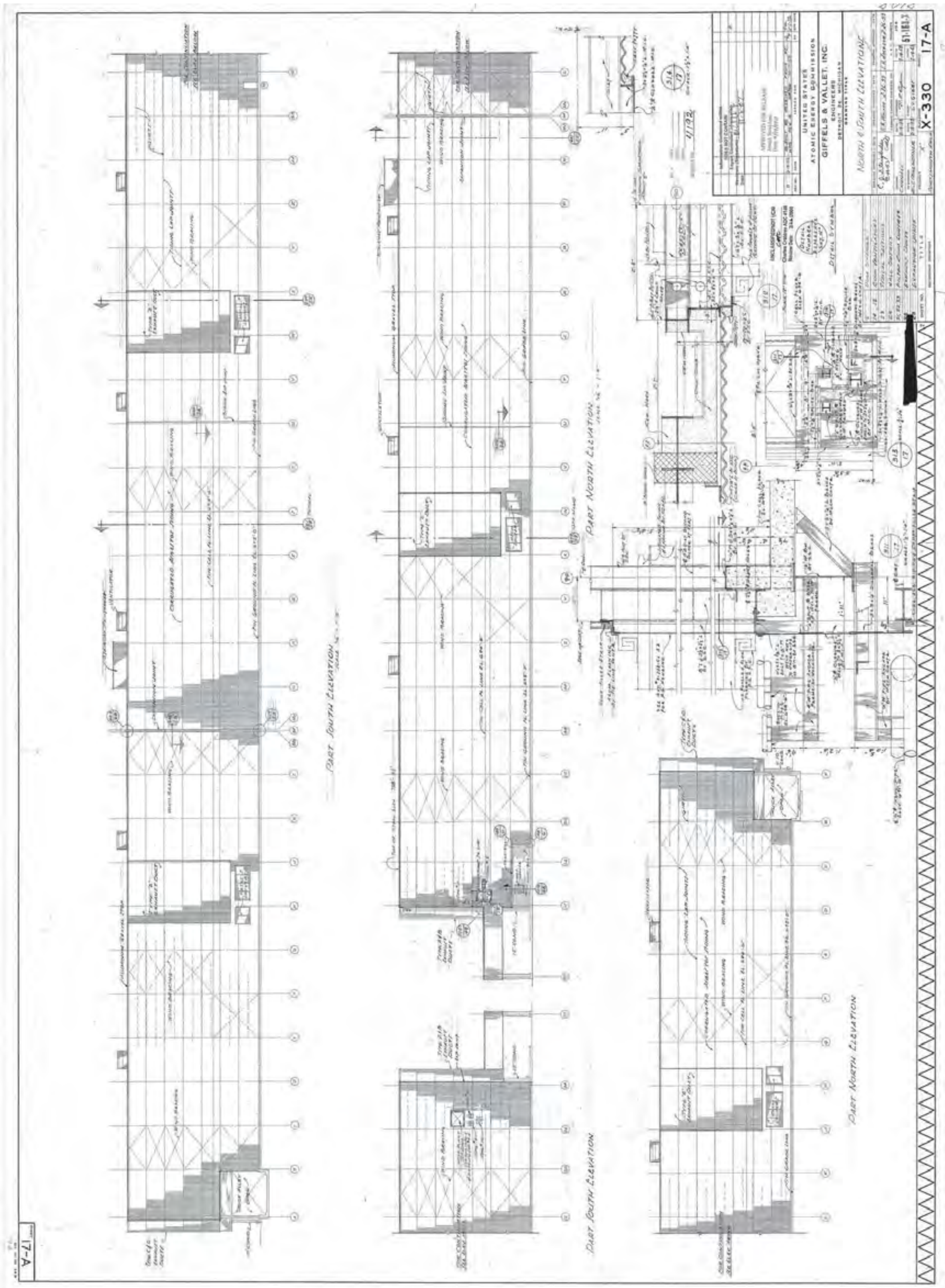

Figure 36: North and South Elevations

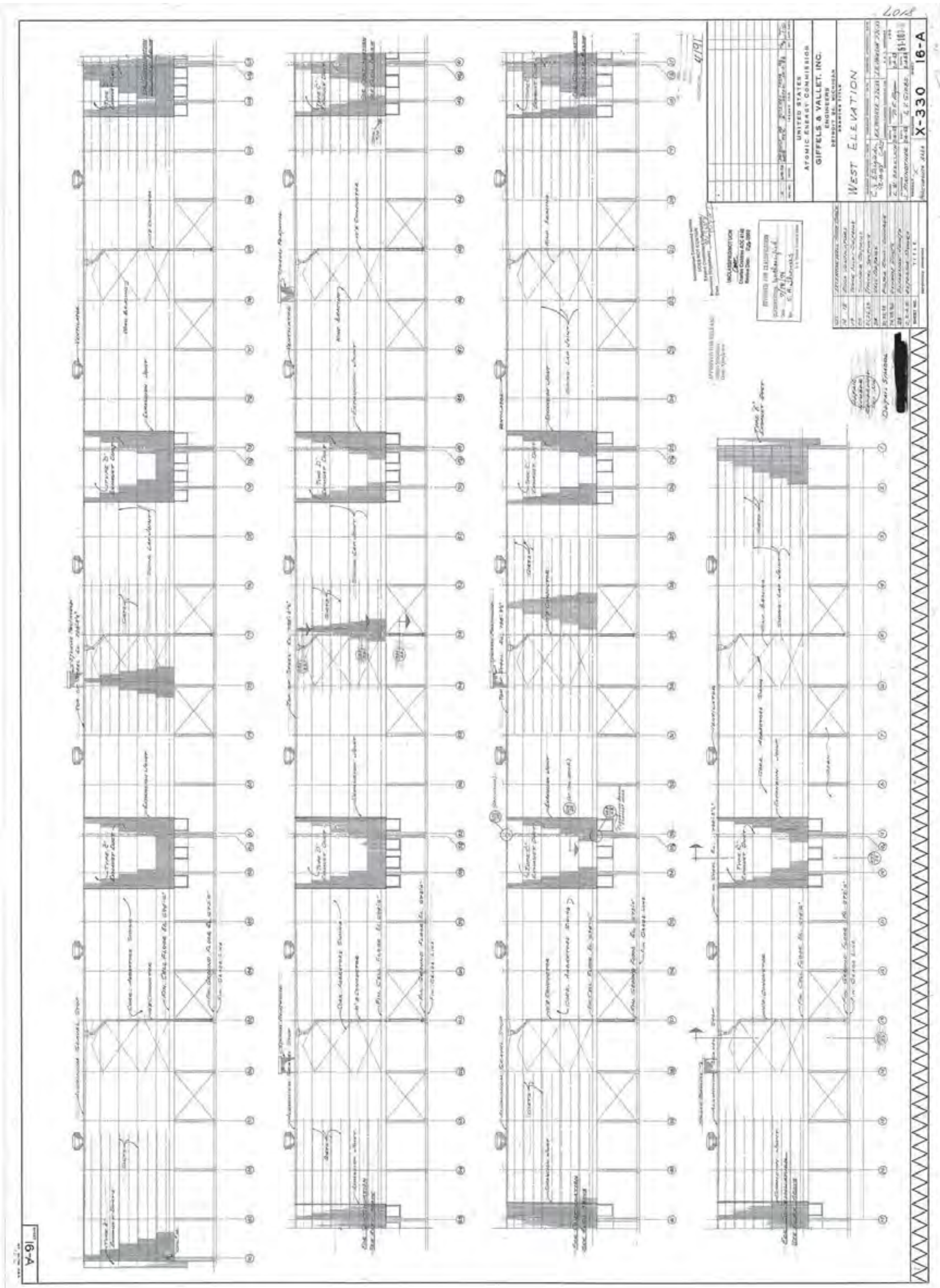

Figure 37: West Elevations

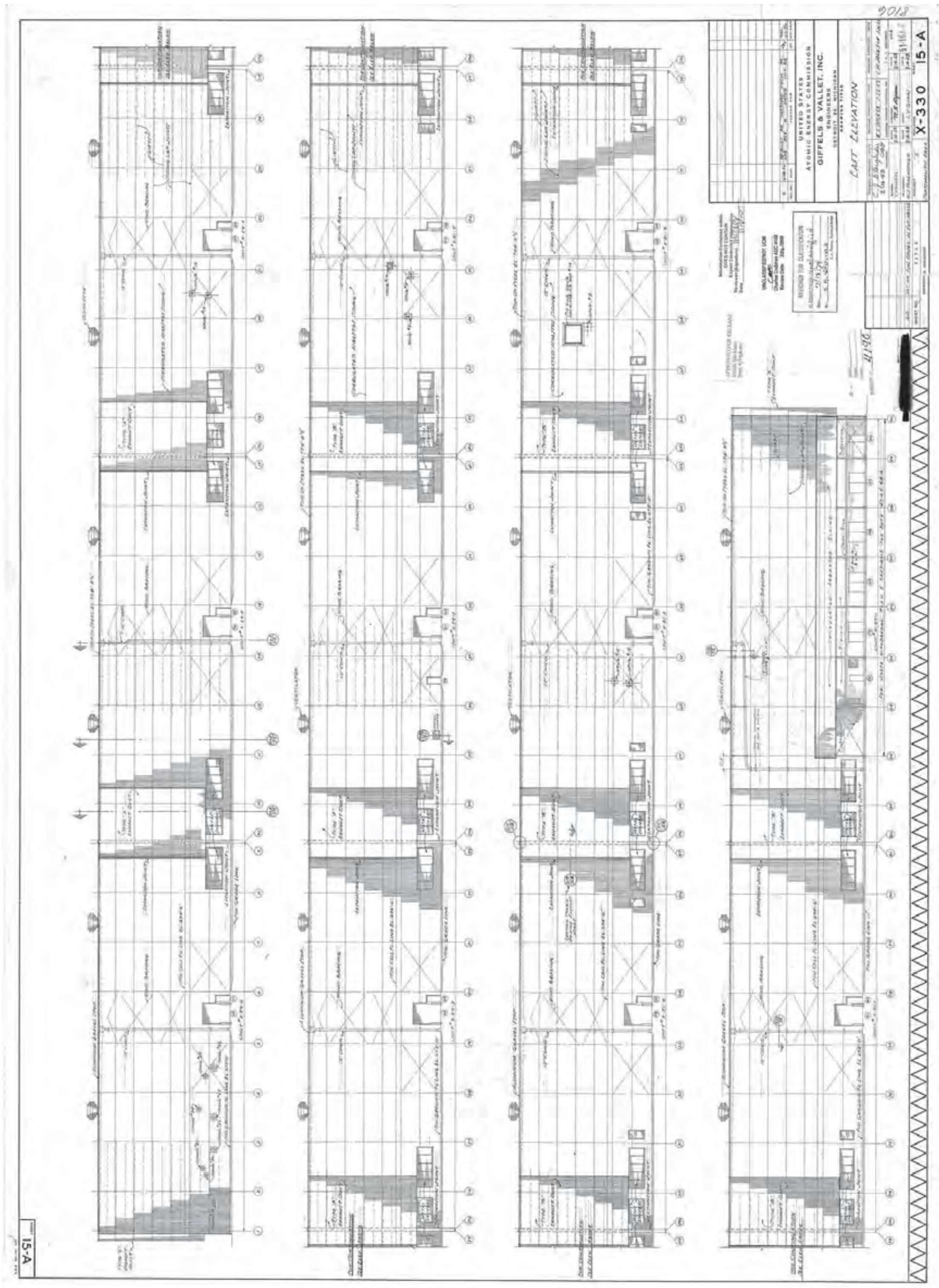

Figure 38: East Elevations

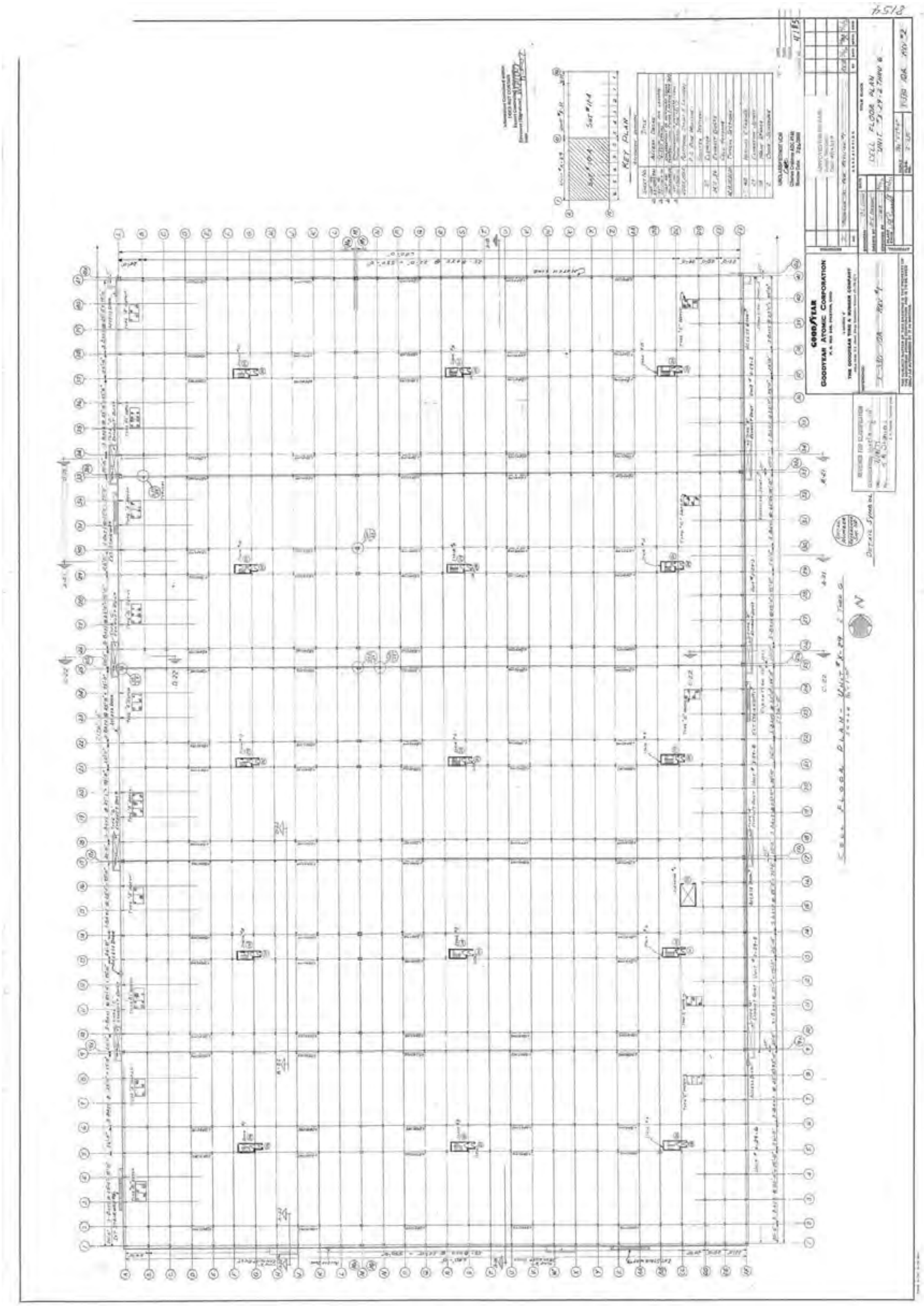

Figure 39: Cell Floor Plan

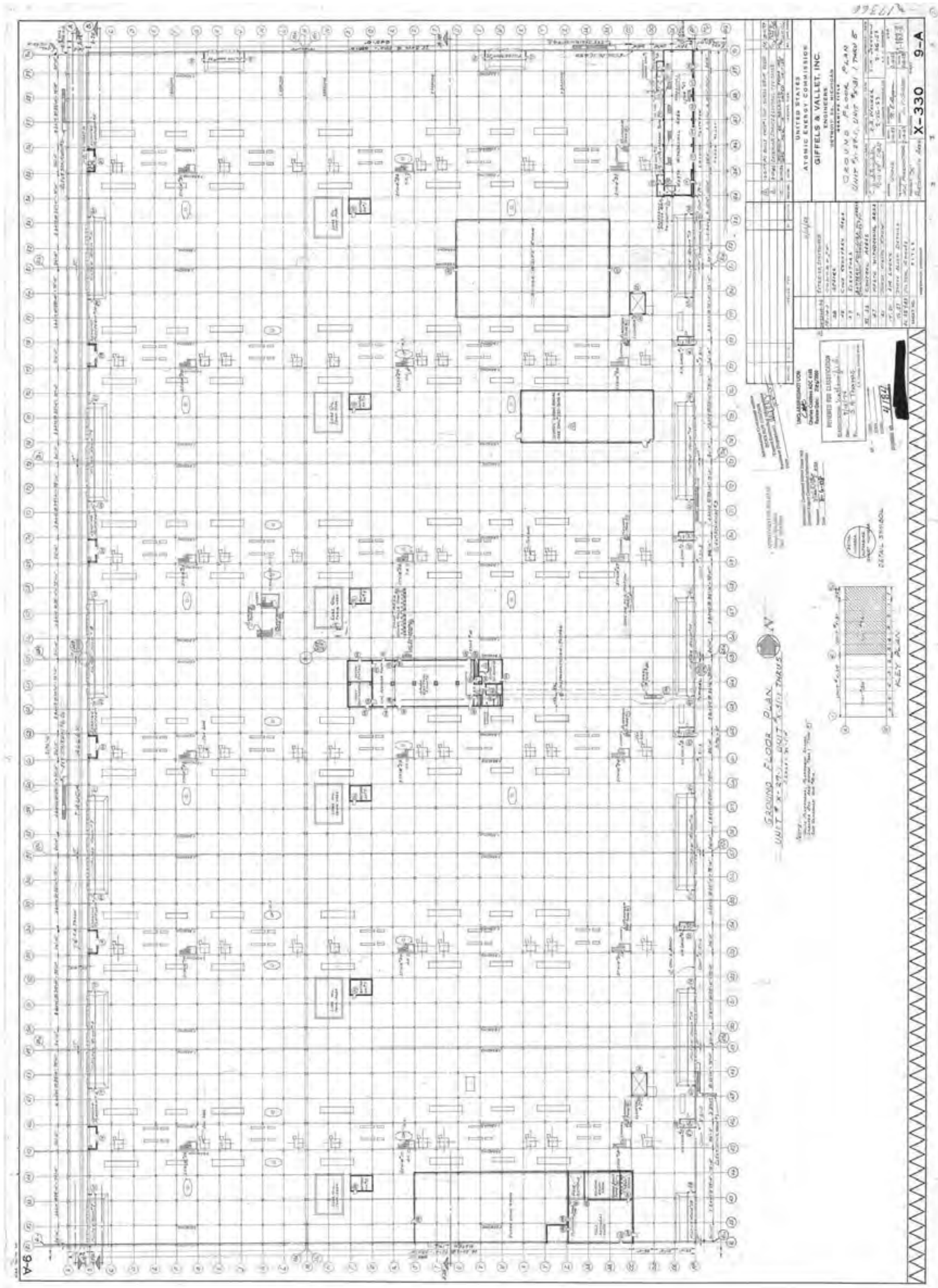

Figure 40: Ground Floor Plan

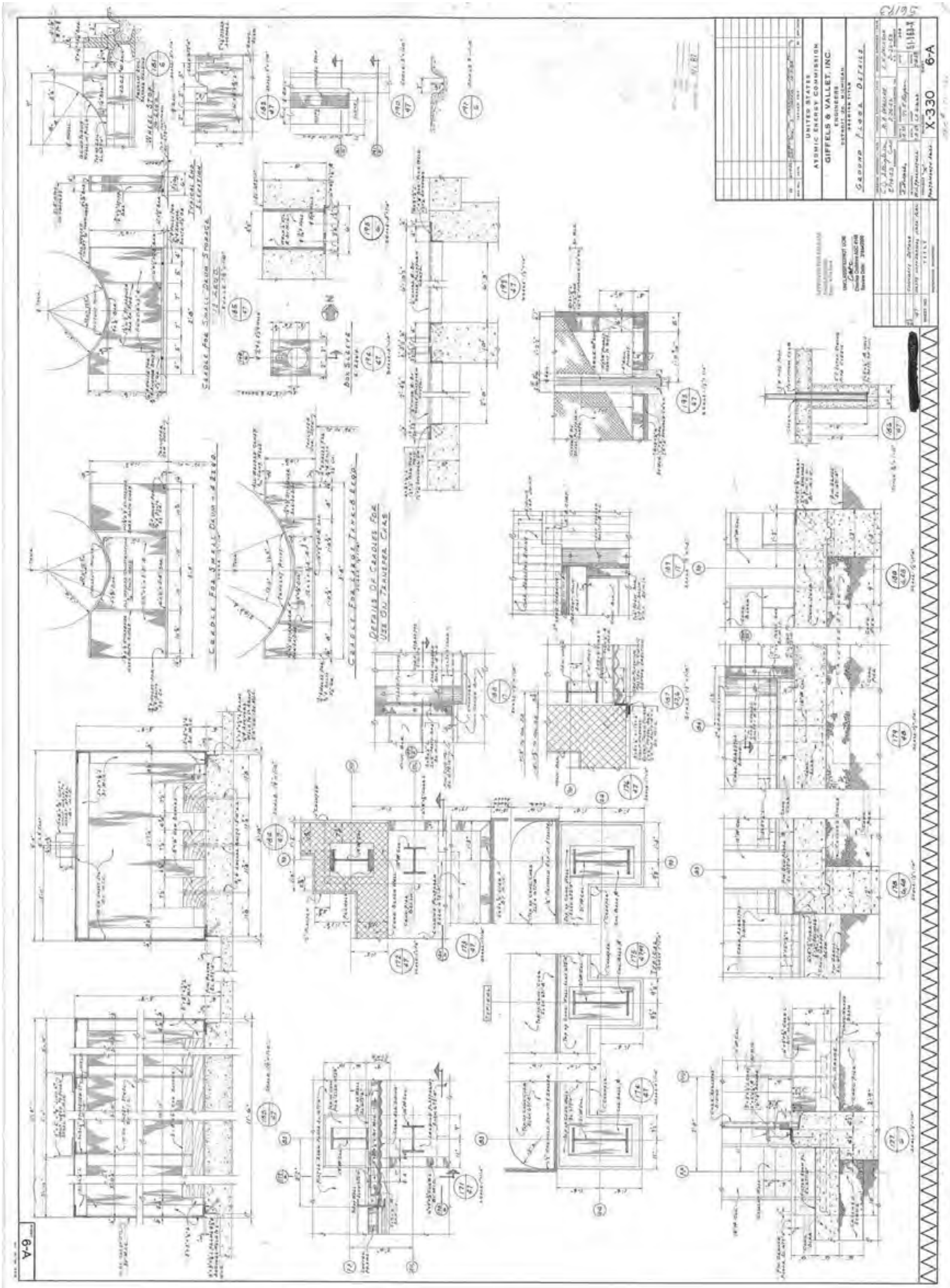

Figure 41: Ground Floor Details

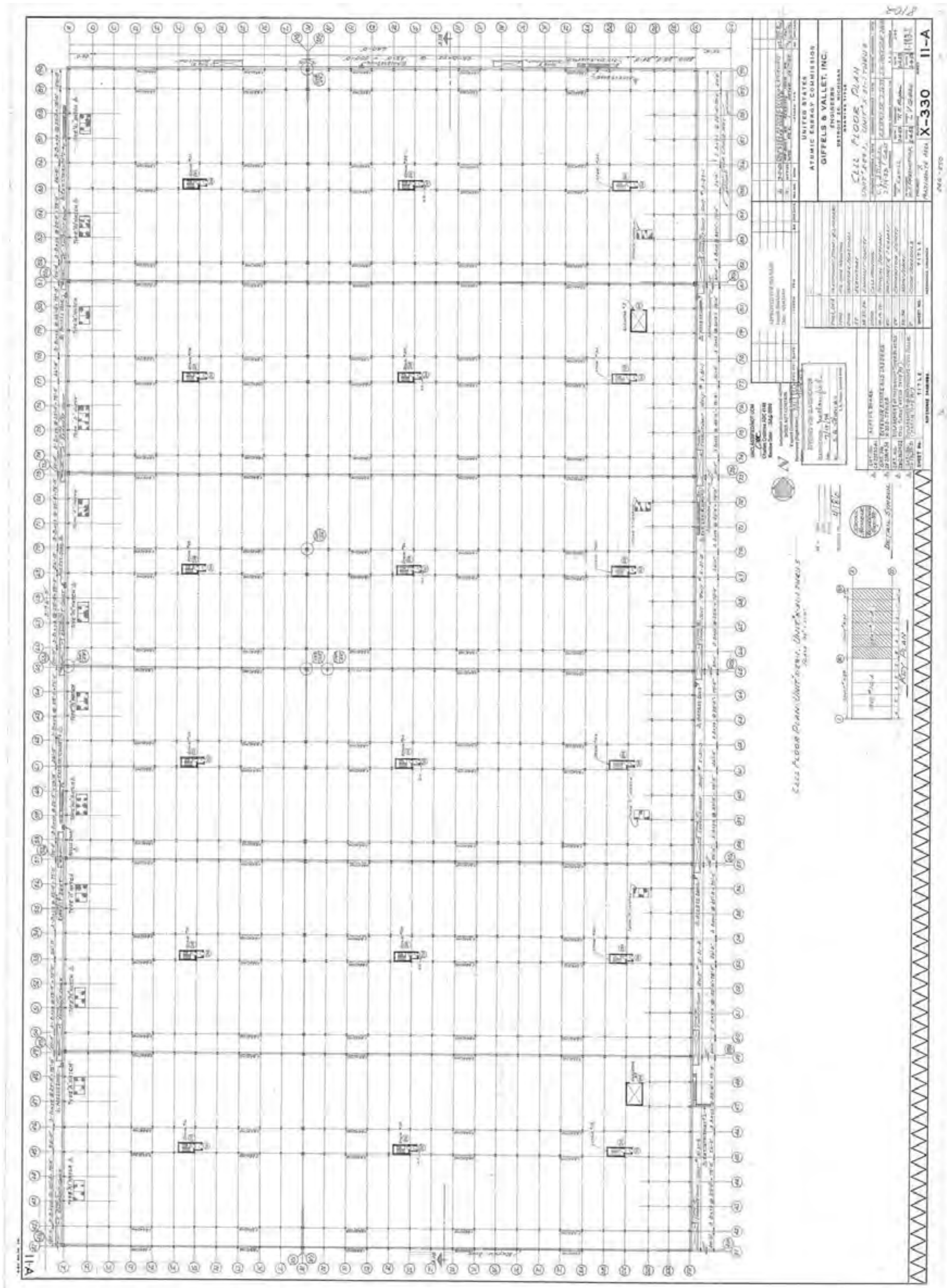

Figure 42: Cell Floor Plan