PORTSMOUTH GASEOUS DIFFUSION PLANT, X-326 PROCESS BUILDING

HAER OH-142-C

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3930 U.S. Route 23 South
Piketon vicinity
Pike County
Ohio

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-326 PROCESS BUILDING

HAER No. OH-142-C

Location: Portsmouth Gaseous Diffusion Plant (PORTS), 3930 U.S. Route 23 South, Piketon vicinity, Scioto Township, Pike County, Ohio

The X-326 Process Building is located at Ohio State Plane South coordinates at easting 1826284.790795 ft, northing 368131.651456062 ft and at Universal Transverse Mercator Zone 17N easting 326790.6404 m, northing 4319753.241 m. The coordinate represents the approximate center of the X-326 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: 1956

Designer/Builder: Peter Kiewit Sons' Construction Company

Previous Owner: N/A

Present Owner: The Atomic Energy Commission 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-326 Process Building. The building is no longer in use and is awaiting demolition.

Significance: The X-326 Process Building housed the final phase of the uranium-235 enrichment process, enriching the uranium to the highest enrichment in the DOE complex. 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. From the end of the Cold War in 1991 until production ceased in 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-326 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-326 Process Building:
Historic photographs of the X-326 Process Building construction are provided in Appendix B. Peter Kiewit Sons' Company was the primary contractor and awarded a number of subcontracts for the construction of the X-326 Process Building. Taylor-Wheless Company, of Milwaukee, Wisconsin, performed the site preparation for the X-326 Process Building, which included stripping, excavation, and placement of fill dirt (Figure 6). By early July 1953, Ferro Construction Company, of Cincinnati, Ohio, had begun excavating for the foundations and underground installations (Figures 7 through 11). Ultimately, they moved 45,423 cubic yards of earth and 11,666 cubic yards of backfill. During excavation activities, workers maintained a semi-finished work area at all times by removing any unnecessary earth from the work area. All excavation had been completed by the end of November 1953.

The Ferro Construction Company was also responsible for performing concrete work for the footers, walls, piers, grade beams, elevator pits, instrumentation tunnels, and the basement Area Control Rooms. They began work in July 1953 and completed all concrete work on the job in February 1954. Ultimately, they poured 17,584 cubic feet of concrete. A separate contract provided for the construction of concrete floors and equipment foundations. The first pour for the ground floor began in January 1954. The ground floor required 26,828 cubic yards of concrete and 563 tons of reinforcing steel. The final pour of the floor occurred on May 21, 1954. The cell floor slab work commenced in January 1954 and ended in July 1954. It required 1,305,595 square feet of wooden forms, 30,076 cubic yards of concrete, and 1,604 tons of reinforcing steel. Concrete work for the process equipment foundations began on February 25, 1954, and ended on September 9, 1954. The equipment foundations required 206,000 square feet of forms, 4,092 cubic yards of concrete, and 275 tons of reinforcing steel.

The United States Steel Corporation, of Cleveland, Ohio, won the contract to furnish and erect the structural steel frame of the X-326 Process Building (Figures 12 through 14). They also erected 20 electric bridge cranes and forty lube oil tanks in the X-326 Process Building. Structural steel work commenced in September 1953. The work progressed from north to south, with all structural steel work completed by mid-April 1954. Specifications called for field connections made with high tensile bolts. This was a relatively new technique, and it required special techniques and close supervision. Altogether, the steel framing required 162,000 machine bolts and 401,000 high tensile bolts. Erection of the bridge cranes and oil lube tanks occurred simultaneously with the construction of each bay. Each crane had a lifting capacity of 5 tons. The cranes were designed to safely lift and transport the motors, converters, compressors, and condensers beneath their travel paths.

Construction of the roof began shortly after the commencement of structural steel work. In December 1953, Brown and Kerr, of Chicago, Illinois, began installing the metal roof deck and built-up roofing. They built-up the roof with vapor seal, insulation and flashing, gutters, downspouts, and roof sumps. They also installed vertical and horizontal copper expansion covers and removed and replaced bent plates. The roof required 1,246,700 square feet of steel deck, 54,000' of board lumber, and 1,258,599 square feet of roofing. Brown and Kerr completed the job in May 1954.

Elwin G. Smith Company, Inc., of Pittsburgh, Pennsylvania, furnished and installed the corrugated cement asbestos siding, corner finishes, special shapes, flashings, sealers, fasteners, and the sealing of explanation joints and flashing. They began work at the northwest corner of the building on

December 18, 1953. Upon completion of the north wall of the X-326 Process Building, work continued from north to south, with workers installing siding on both sides of the building simultaneously. Workers fastened the siding to the building with lead-headed bolts with zinc alloy collar nuts and neoprene sealer. By January 1954, much of the siding work was complete (Figure 15). When the R.G. Smith Company completed the work in June 1954, they had installed 427,000 square feet of siding.

As siding installation continued, workers poured concrete for the ground floor (Figure 16). Shortly before completion of the siding, Goodyear Atomic Corporation, the plant's operating contractor, began installing the process equipment (Figures 17 through 21). They initiated work in mid-March 1954 and continued through early February 1956. The X-326 Process Building would require a total of 2,340 compressors, 2,340 electric motors, and 2,340 converters.

Historical drawings of building plans are included in Appendix C (Figures 22 through 29).

Part II. Site Information

Description of the X-326 Process Building:
The X-326 Process Building is located immediately south of the X-330 Process Building (Appendix A, Figures 1 through 5) and housed the final phase of the uranium enrichment process. The uranium enrichment process was initiated in the X-333 Process Building and continued in series to the X-330 and X-326 Process Buildings. The X-326 Process Building was used for the highest uranium enrichment phase, at PORTS and within the DOE complex, and enriched product withdrawal. Part of the building was used to produce commercial grade nuclear material (i.e., low-enriched uranium [LEU] product) for use in nuclear power reactors for electric power generation. A portion of HEU produced was used for nuclear navy reactor propulsion. 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 LEU for commercial power plants.

Like the other two process buildings (X-330 and X-333), the equipment in the X-326 Process Building is 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 is located on the second floor, known as the cell floor.

The smallest of the process buildings at PORTS, the X-326 Process Building measures 2,230' long by 552' wide, stands 62' tall, and encloses an area of about 29 acres (Appendix A, Figures 1 through 5). The height of the building allowed for the installation of duct work, piping, and conduit in the area below the cell floor, as well as vehicular travel.

The west side of the X-326 Process Building features a truck alley with an imbedded railroad spur that facilitated transfer of supplies and equipment. A series of truck entrances along the sides of the building further facilitate the movement of vehicles into and out of the building. The overall appearance of the building is rather non-descript. It is, essentially, an immense, rectangular box with no stylistic details. The exterior walls of the X-326 Process Building are covered with large, white asbestos cement tiles, also known as transite. A series of elevator shafts protrude from the sides of the X-326 throughout the length of the building. The north side of the building features exhaust ducts and metal louvered openings at the filter rooms. There are no windows in the X-326 Process Building; however, "port holes" within the building can be propped open to allow air flow. Employees and equipment enter and exit the X-326 Process Building via the X-111A and B monitoring portals.

The interior finish of the building was designed for cleanliness and sanitation. All the plastered masonry walls within the building were coated with acid-resistant paint to facilitate decontamination activities. Labels were applied to each of the structural columns in the process buildings, as well as stairways and platforms. Each of the cells and their supporting equipment were labeled, as were electrical panels and equipment. Labels were used for worker safety, maintenance, and operations.

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-326 Process Building contains 2,340 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 12 stages per cell in most of the cells in the X-326 Process Building, and the building houses 200 cells.

Cells were further grouped into "units," which were groups of cells that shared common auxiliary systems. Each operating unit within the building was divided into two groups of ten cells. The 200 cells in the X-326 Process Building are grouped into 10 units. Ten of the cells in the south end of the building comprise the "purge cascades," each containing six stages per cell.

The process equipment, piping, and instrument lines that contained process gas are enclosed by cell housing and bypass housing. The cell housing for the X-326 process equipment is metal, 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 and X-330 Process Buildings, the uranium enrichment process continued in the X-326 Process Building. The X-326 Process Building contains the smallest pieces of gaseous diffusion equipment at PORTS. The two sizes of process equipment in the X-326 Process Building are referred to as the X-27 size, which is the larger of the two sizes, and the X-25 size, which is the smaller of the two sizes. The X-27 and the X-25 facilities were designed to operate independently or together.

The X-326 Process Building also contains the purge and product area. Purging separated and removed light gas contaminants that leaked into the system during the diffusion process. In effect, the X-326 Process Building combined the gaseous diffusion facilities that were found in the K-25 and K-27 installations at the former Oak Ridge Gaseous Diffusion Plant, now the East Tennessee Technology Park.

The waste, or tails stream, of the enrichment process was withdrawn from the gaseous diffusion cascade and packaged into storage cylinders. The PORTS Tails Withdrawal Station is located in the northeast corner of the X-330 Process Building.

B. First Floor:

The first floor of the X-326 Process Building supports the withdrawal and process auxiliary systems, electric power unit substations, control centers for the process equipment, and enclosed areas for operational use. A series of 22 air intake filter rooms extend along the outside walls at roughly 100' intervals. The east wall of the first floor features three drive-through elevators, each with its own accompanying stairway. The elevator shafts protrude on the outside of the building.

Enclosed areas within the X-326 Process Building consist of cinder block structures that stand 10 or 12' in height. They each have a flat, metal deck or concrete slab roof. These enclosures are located along the length of the building. They include Area Control Rooms 4, 5, and 6, a maintenance area, the atmospheric exhaust area, battery rooms, and the withdrawal and purification facilities. Lube oil and coolant system pits are also located on the first floor.

The three control areas of the X-326 Process Building each have their own control room. These rooms include their own office, men's and women's lounge and restrooms, and a datum station. Floors in these areas are covered with either asphalt tiles or are simply bare concrete. A basement that provides access to the underground instrument tunnel system is located below each Area Control Room. Floors in the Area Control Room basements consist of unfinished concrete.

C. Second Floor (Cell Floor):

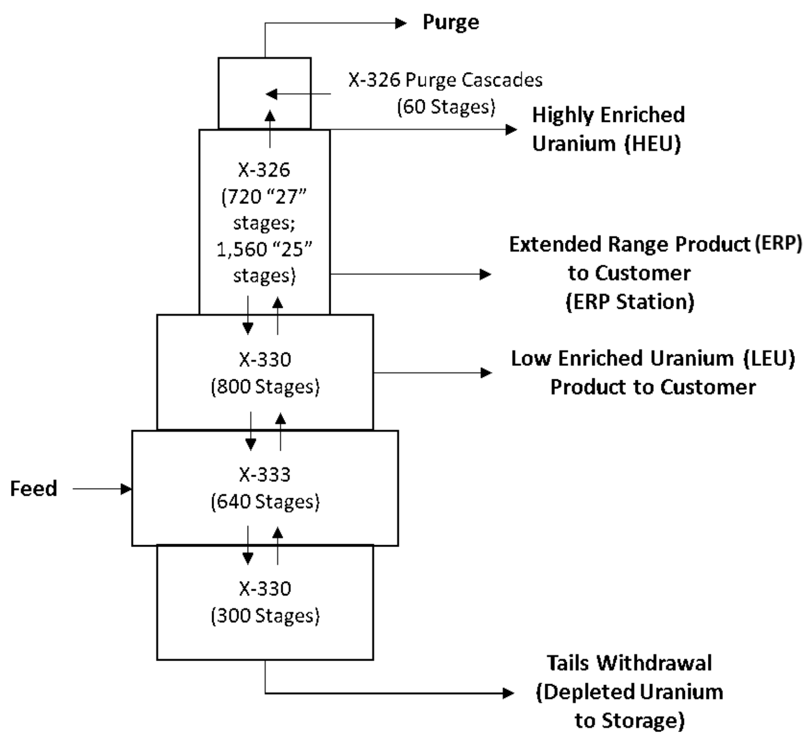
The process equipment is located on the cell floor. The X-27 equipment contains three units (60 cells and 720 stages) and the X-25 contains approximately seven units (130 cells and 1,560 stages). The 10 six-stage "purge cells" are part of the X-25 size equipment and were specially designed to remove light gases from the UF_6 stream.

Access to the cell roofs and overhead valves and equipment is accomplished via steel stairways, ladders, platforms, and catwalks. There are 20 separate stairways per unit. There are also a number of stairways that lead to the roof of the building. In addition to stairways, there are several freight elevators that provided transportation between the first and second floors. Withdrawal and storage of the high assay (HEU) product gas transpired in the Product Withdrawal Station, located in the southwest corner of the X-326 Process Building. Within the Product Withdrawal Station is a gaseous UF_6 purification room that consists of a gravity-type system with a tall column that extends above the cell floor. This tower-like structure is enclosed within masonry walls. There are stairs and platforms around the tower to enable workers to operate and maintain the mechanical equipment. There were two withdrawal streams at the Product Withdrawal Station. One withdrawal stream was from the product gas. The product gas was placed in cylinders for brief storage prior to purification. The purified product was then further processed to make the desired radioactive metal. The other withdrawal stream was valved into other parts of the gaseous diffusion cascade. Ninety to 97 percent uranium-235 was withdrawn during HEU production, and 2 to 5 percent uranium-235 was withdrawn at either the Extended Range Product (ERP) or Low Assay Withdrawal stations.

The ERP Station is located in the northeast corner of the X-326 Process Building and was designed for withdrawal of various enrichments. The ERP station was capable of withdrawing two separate product streams of different enrichments simultaneously. Because of the shift of plant mission toward LEU, the ERP station was primarily used for LEU withdrawal.

The final stage of the diffusion cascade occurred in the Purge and Product Area. The Purge and Product Area contains the 10 six-stage purge cells where the product gas was separated for withdrawal and light gasses were removed from the UF_6 stream. The separative equipment is located on the cell floor.

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



PORTS Gaseous Diffusion "Cascade"

D. Structural Design:

The X-326 Process Building is divided longitudinally by transverse roller-type expansion joints located between each of the ten building units. Engineers designed the columns and framing to accommodate 92' wide crane bays above each of the cells with 20 to 22' wide intermediate braced bays for pipe galleries. Steel trusses, located above the crane bays, provide support for roof purlins (horizontal boards supporting roof rafters). The building's flat, steel deck roof rests atop the purlins. Engineers designed the building's frame to withstand wind loads of 20 pounds per square foot and roof live loads (variable weights on a structure) of 30 pounds per square foot.

The cell floor of the X-326 Process Building is supported by girders and beams, which are connected to the roof support columns and intermediate ground story columns. The remainder of the floor consists of 6½" of reinforced concrete. The ground floor slab measures 6" in thickness and rests atop a compacted stone base.

The basements under the control room areas consist of reinforced concrete walls and columns. These structures rest atop rectangular concrete footers. A reinforced concrete beam and girder slab rests atop the basement walls and columns. This slab comprises the floor of the control rooms.

Part IV. Sources of Information

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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 (2 through 5)

Figure 2: North Side of the X-326 Process Building, August 2014, Facing Southwest

Figure 3: North Side of the X-326 Process Building, August 2014, Facing Southeast

Figure 4: South Side of the X-326 Process Building, August 2014, Facing Northwest

Figure 5: South Side of the X-326 Process Building, August 2014, Facing Northeast

Appendix B: Historical Photographs

Figure 6: Excavation and Grading Work for the X-326 Process Building, July 1953

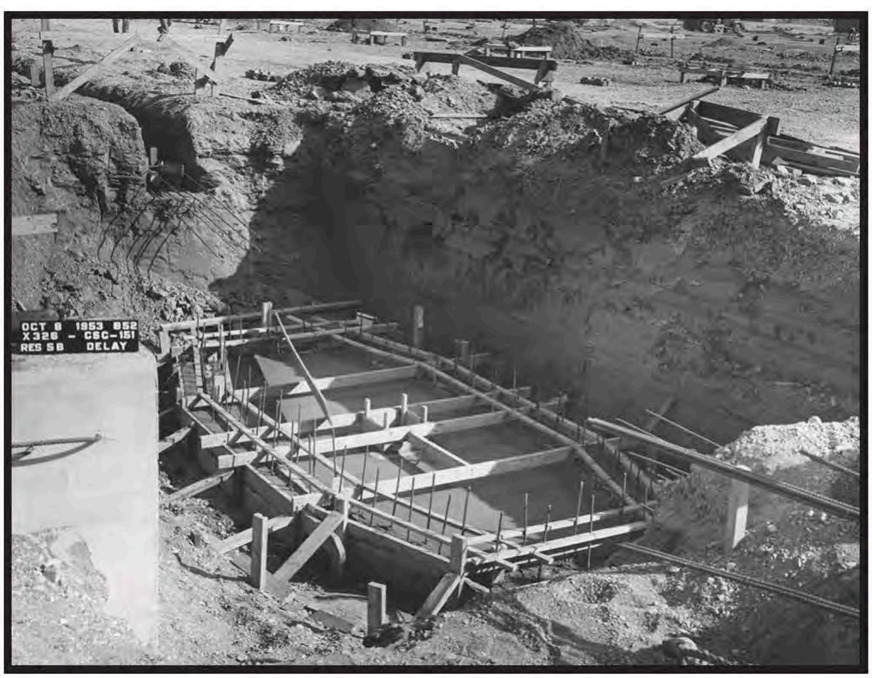

Figure 7: Work Delay Photo for the X-326 Process Building, October 1953

Figure 8: Foundation Work for the X-326 Process Building, October 1953

Figure 9: Work Delay Photo for the X-326 Process Building, October 1953

Figure 10: Excavation and Foundation Work for the X-326 Process Building, October 1953

Figure 11: Work Delay Photo for the X-326 Process Building, September 1953

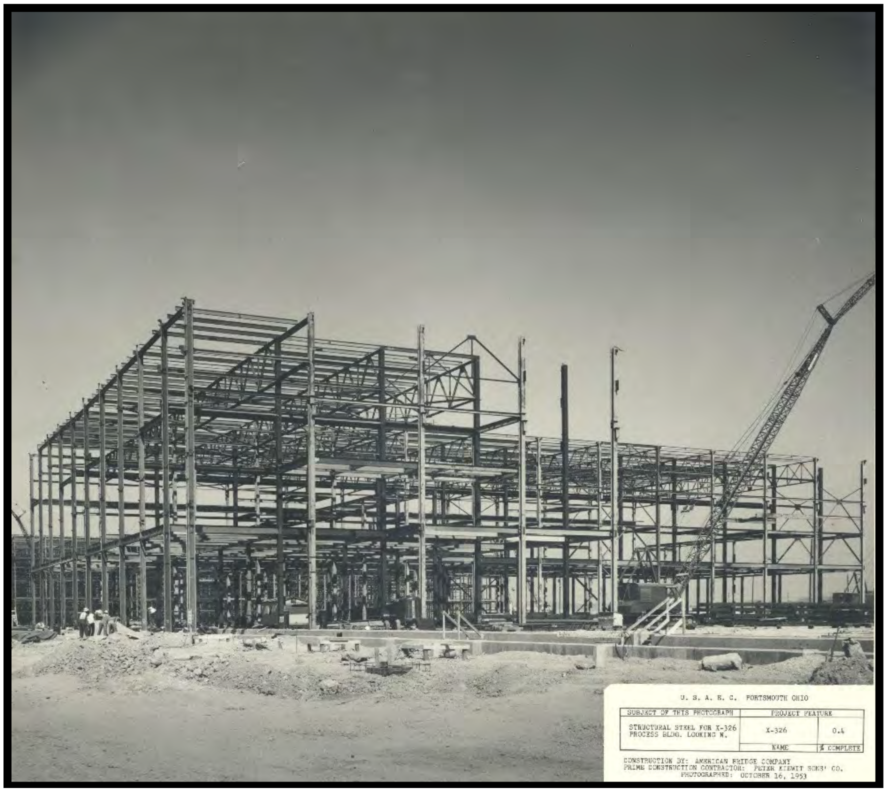

Figure 12: Structural Steel Work for the X-326 Process Building, Looking North, October 1953

Figure 13: Looking North at the X-326 Process Building, December 1953

Figure 14: Overall View of the X-326 Process Building, January 1954

Figure 15: Overall View of the Process Area, January 1954

Figure 16: Looking East at Ground Floor of the X-326 Process Building, February 1954

Figure 17: Looking East at Cell Floor of X-326 Process Building, April 1954

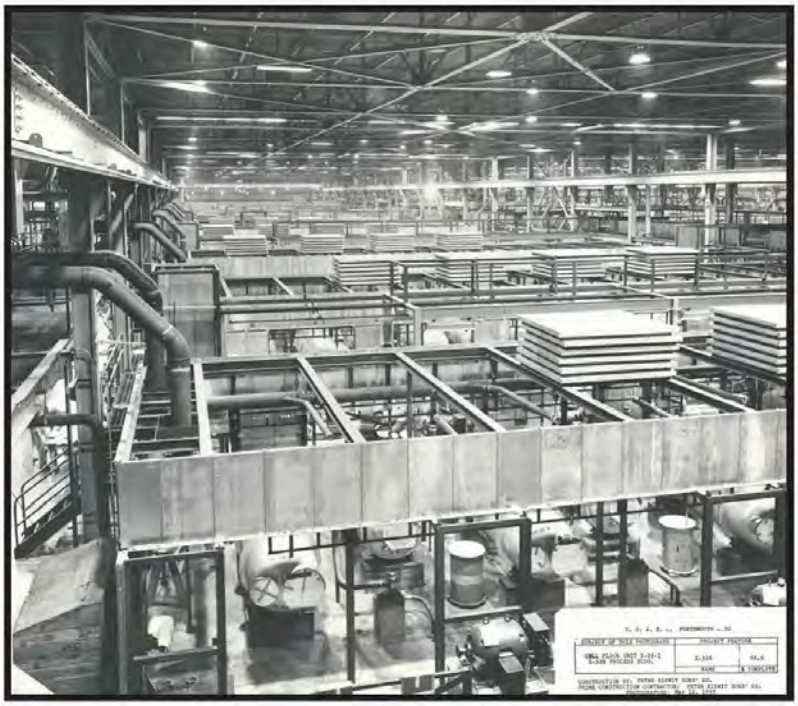

Figure 18: Cell Floor Unit X-25-1 in the X-326 Process Building, May 1955

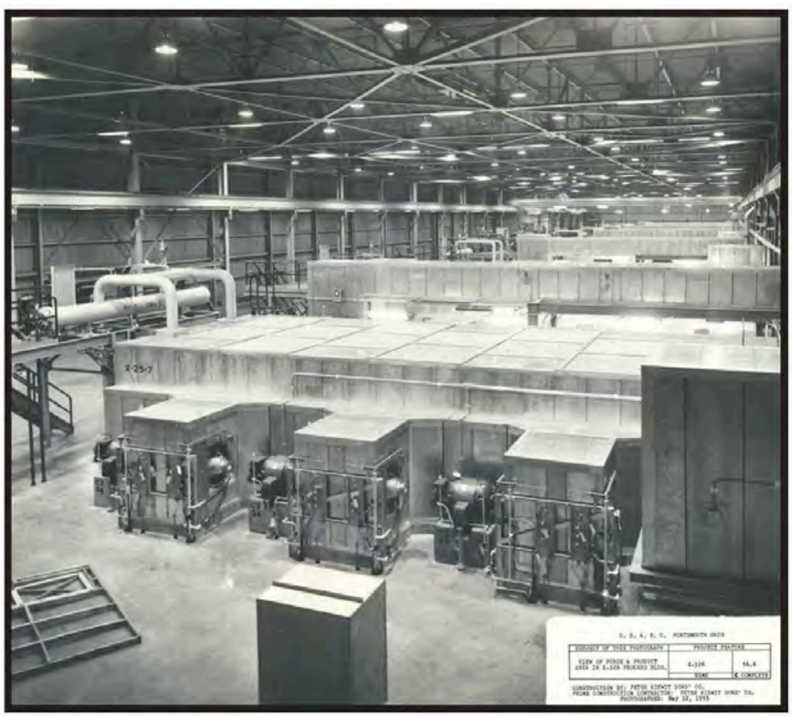

Figure 19: View of Purge and Product Area in X-326 Process Building, May, 1955

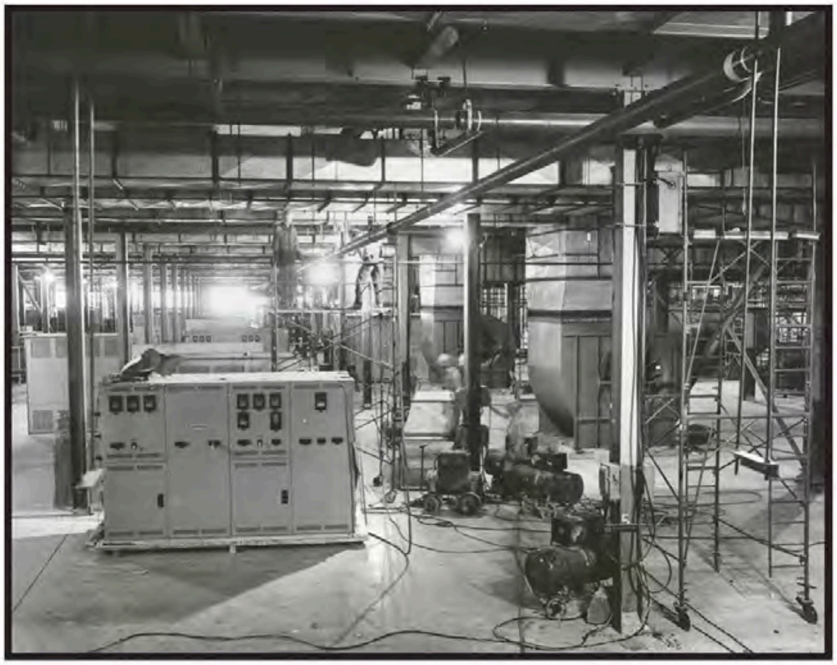

Figure 20: Interior View of the X-326 Process Building, May 1955

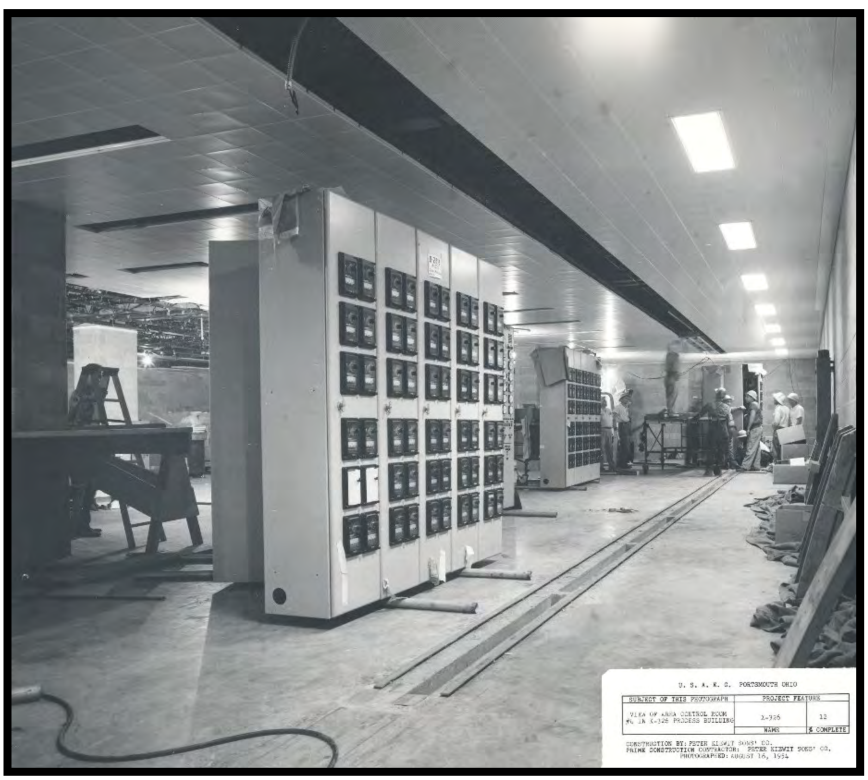

Figure 21: View of the Area Control Room Number 4 in the X-326 Process Building, August 1954

Appendix C: Historical Drawings

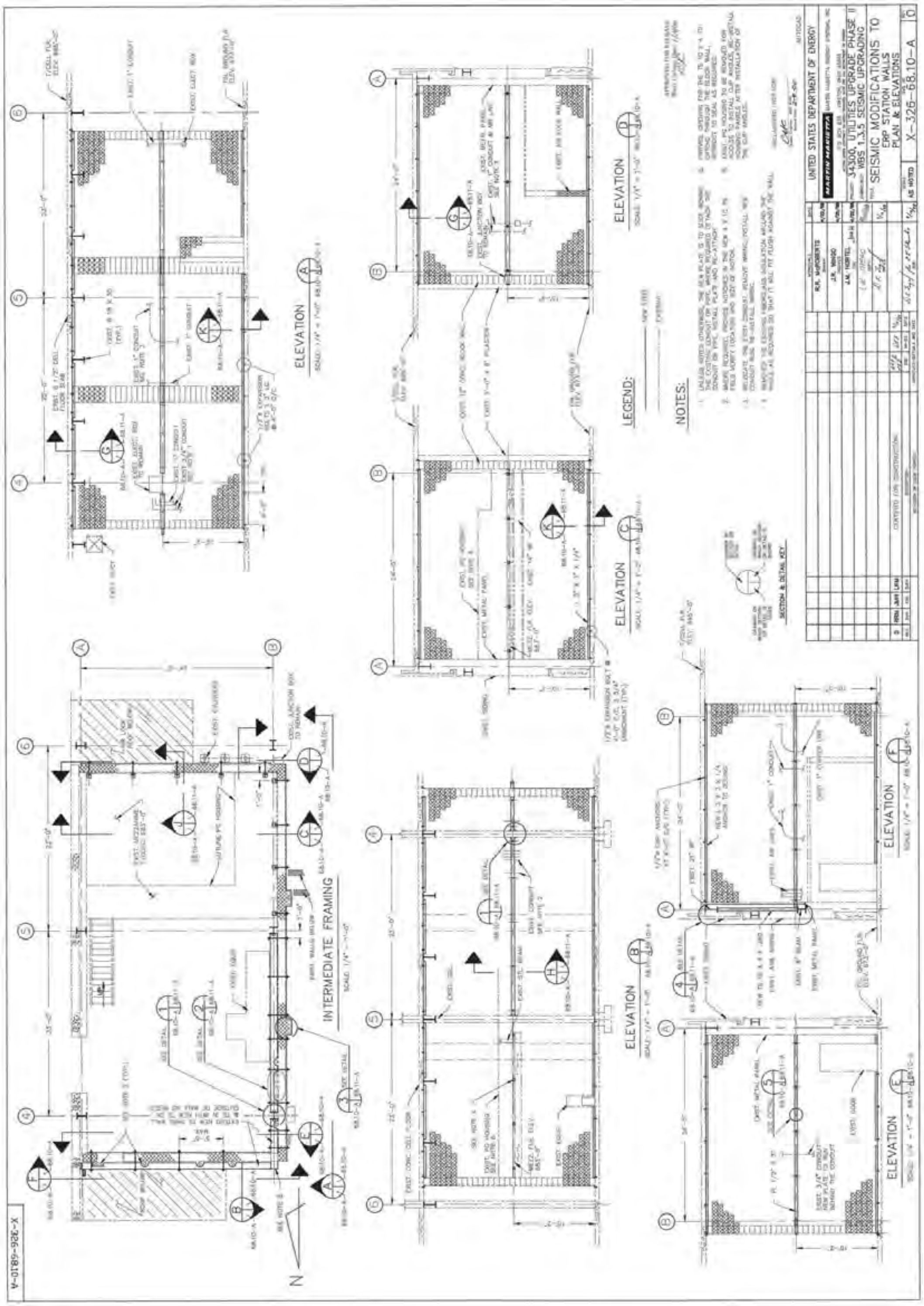

Figure 22: Seismic Modifications to ERP Station Walls, Plan and Elevations

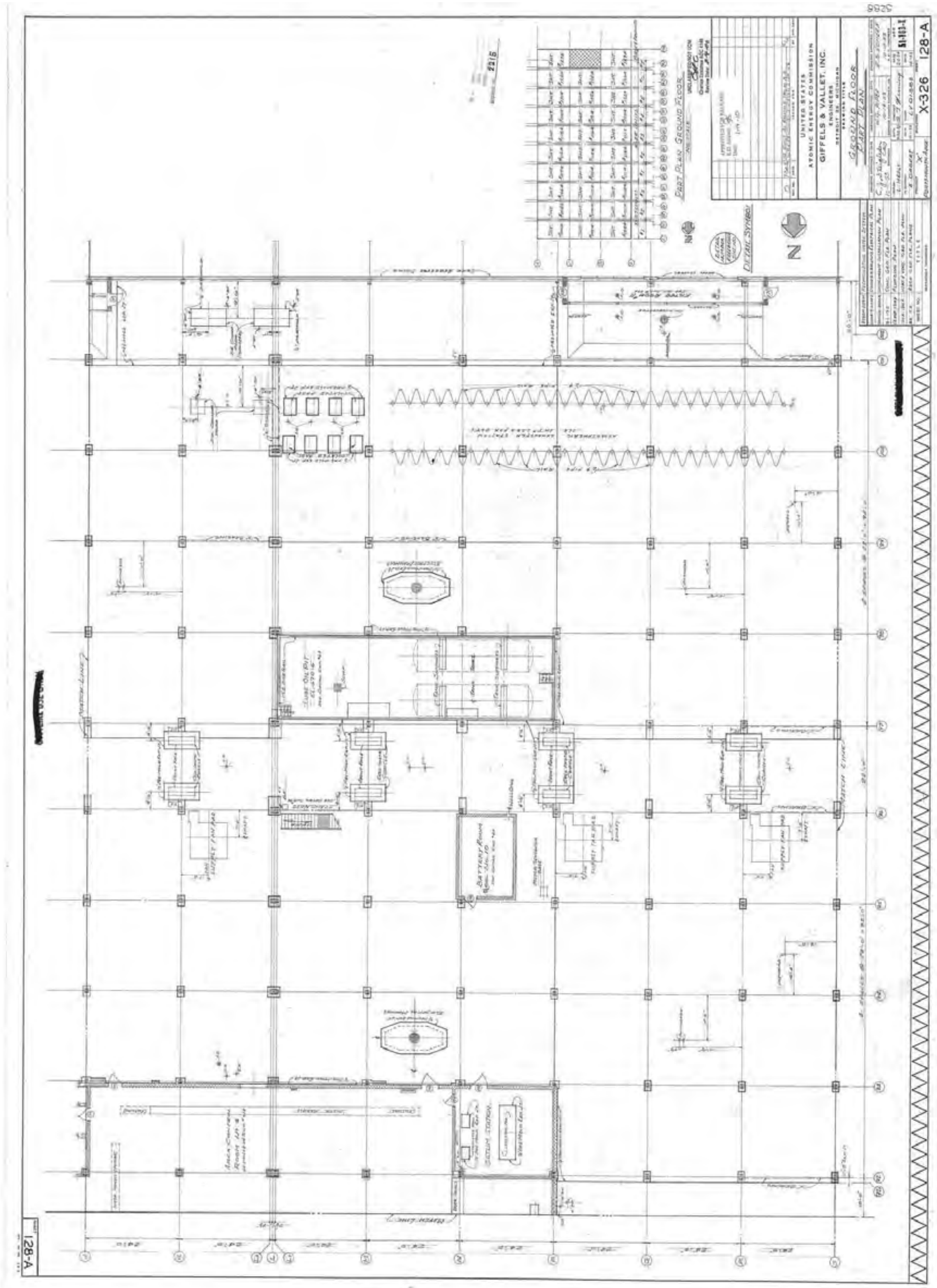

Figure 23: Ground Floor Part Plan

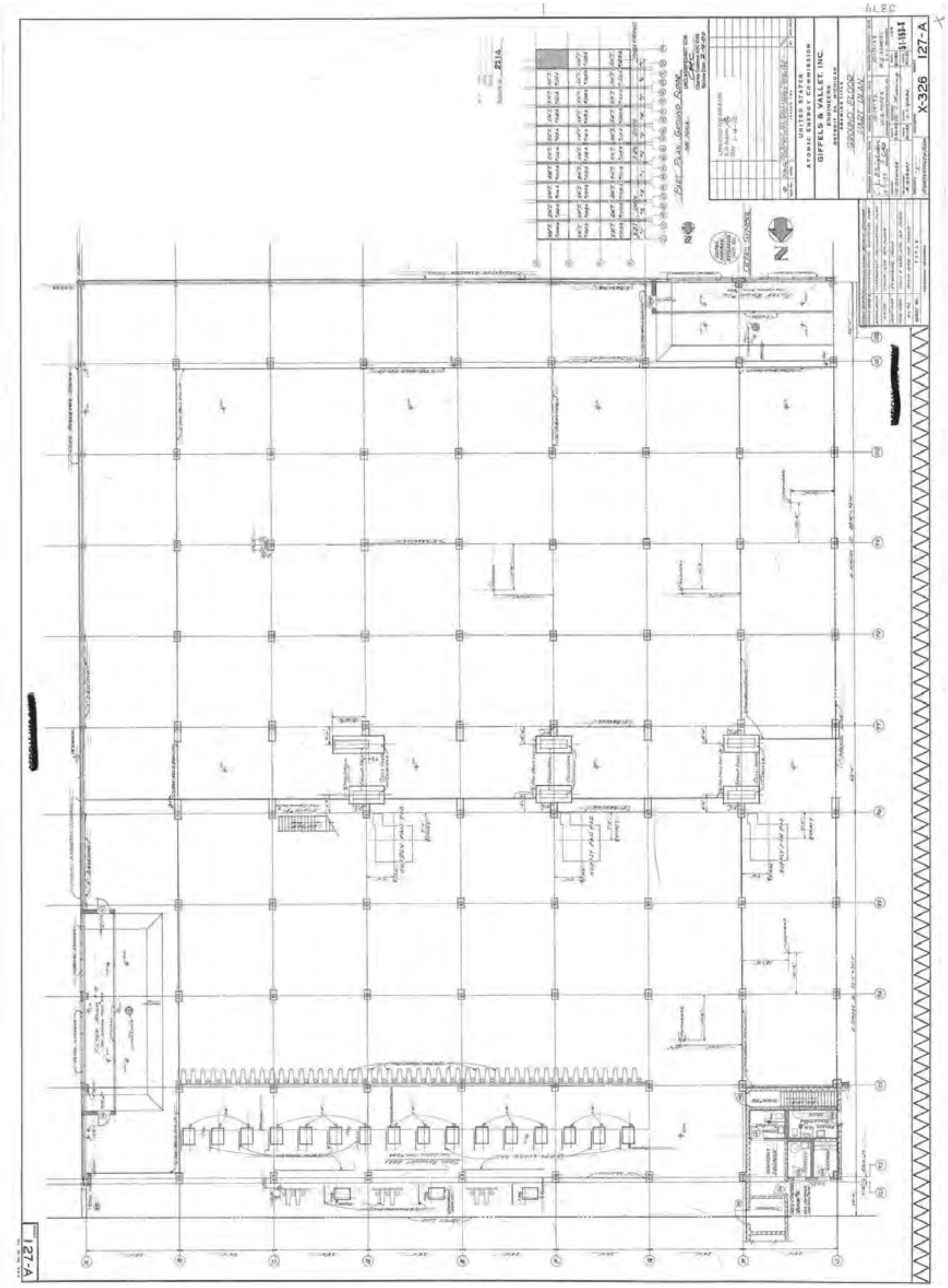

Figure 24: Ground Floor Part Plan

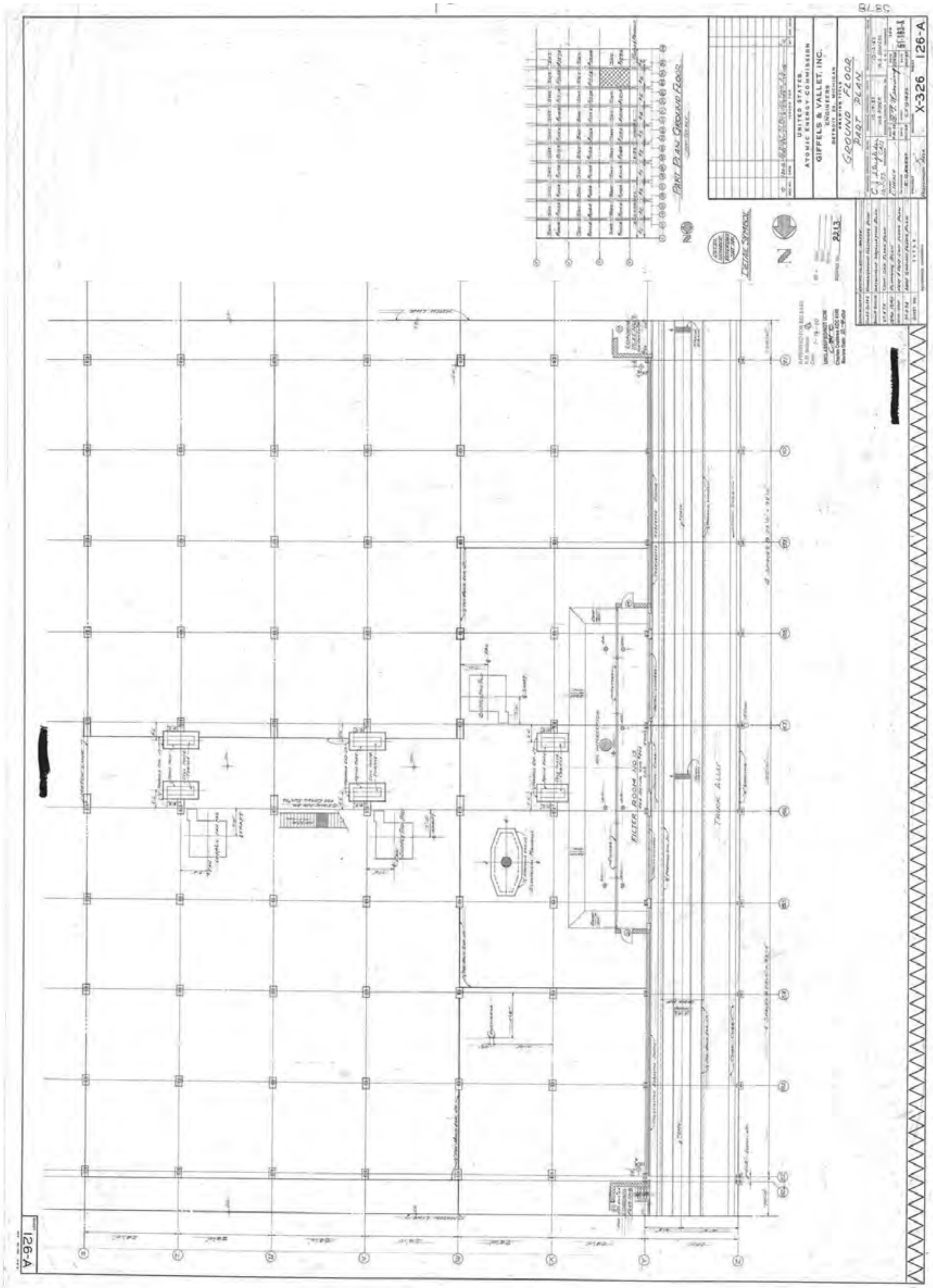

Figure 25: Ground Floor Part Plan

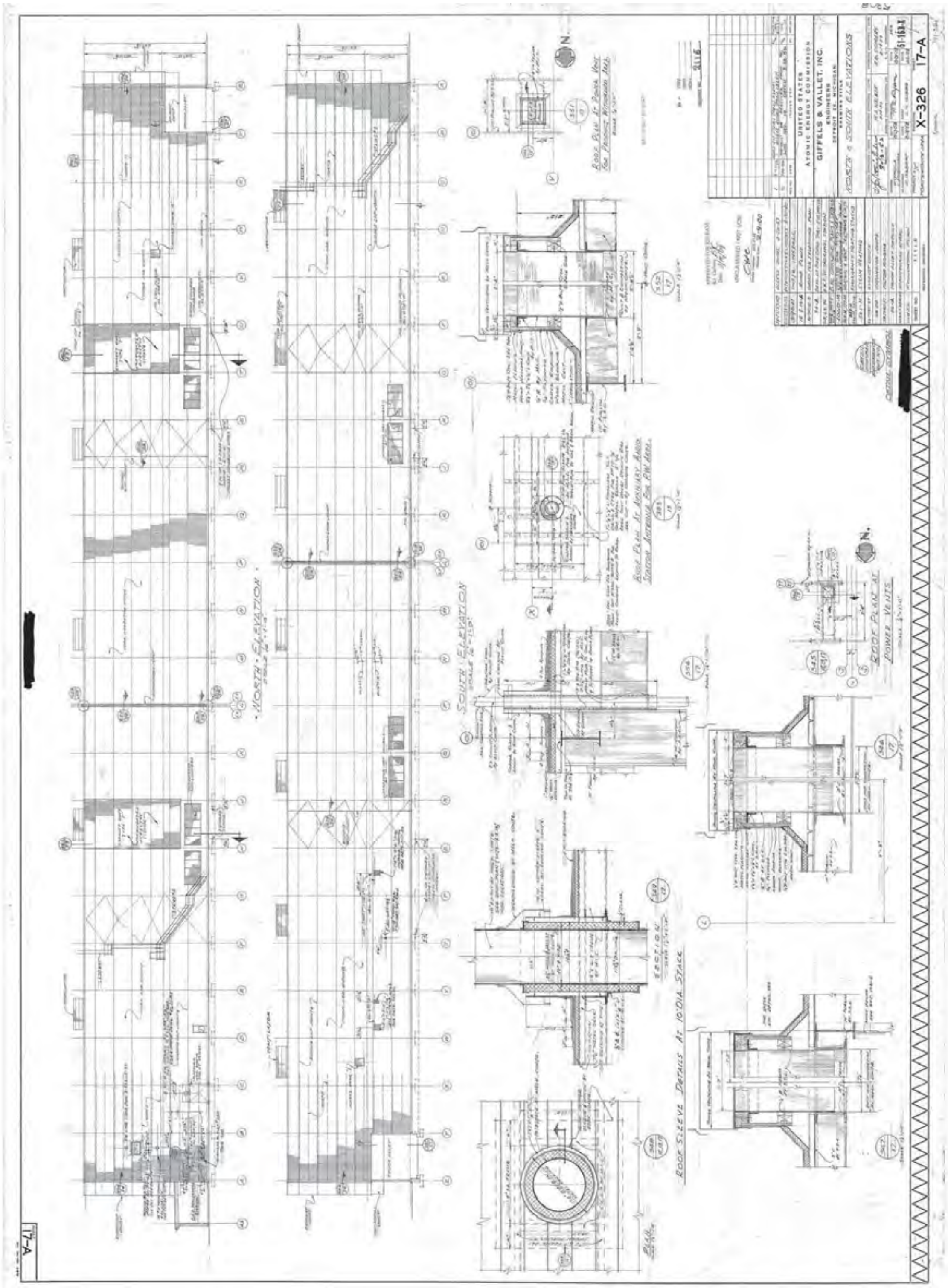

Figure 26: North and South Elevations

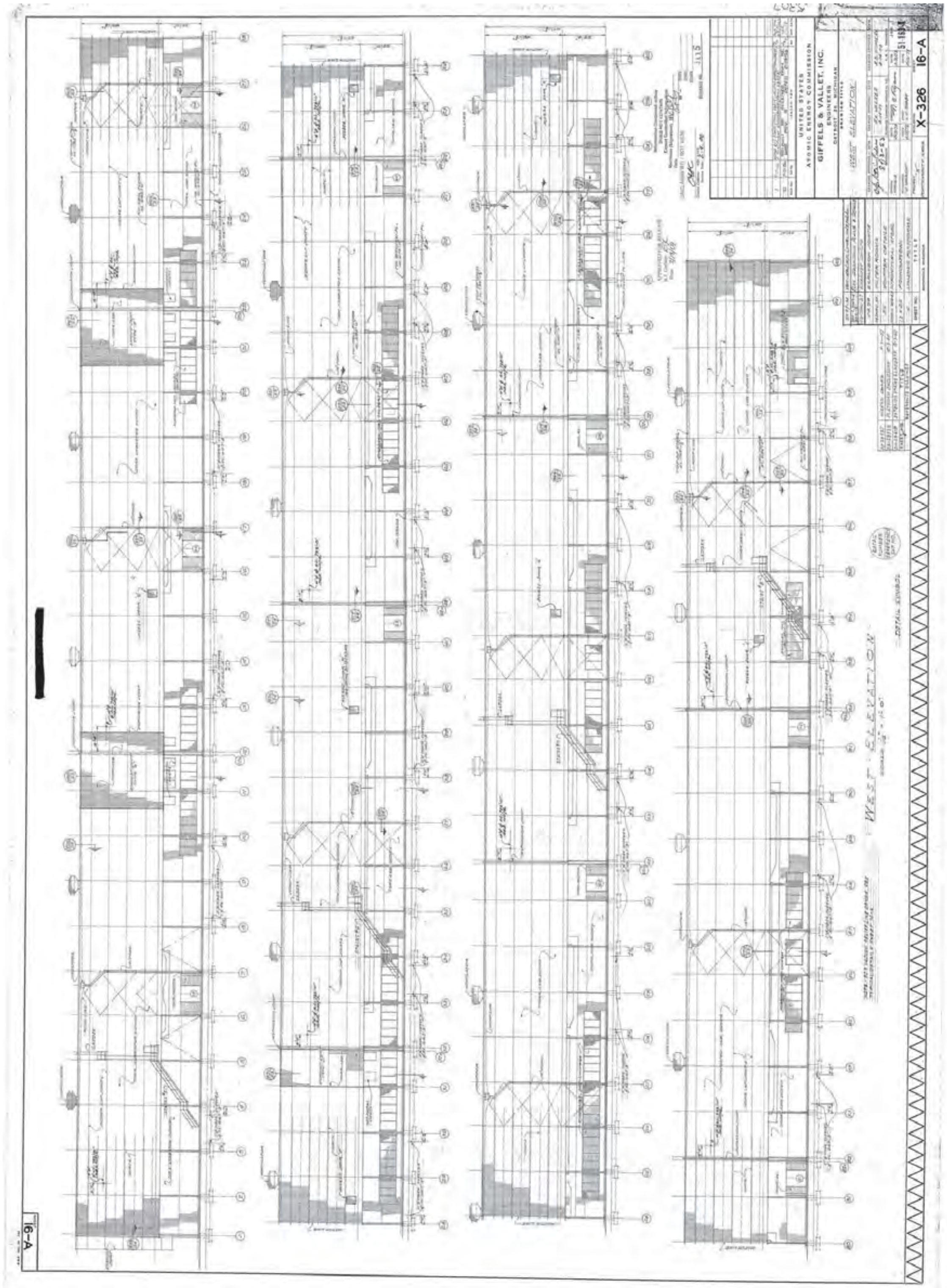

Figure 27: West Elevation

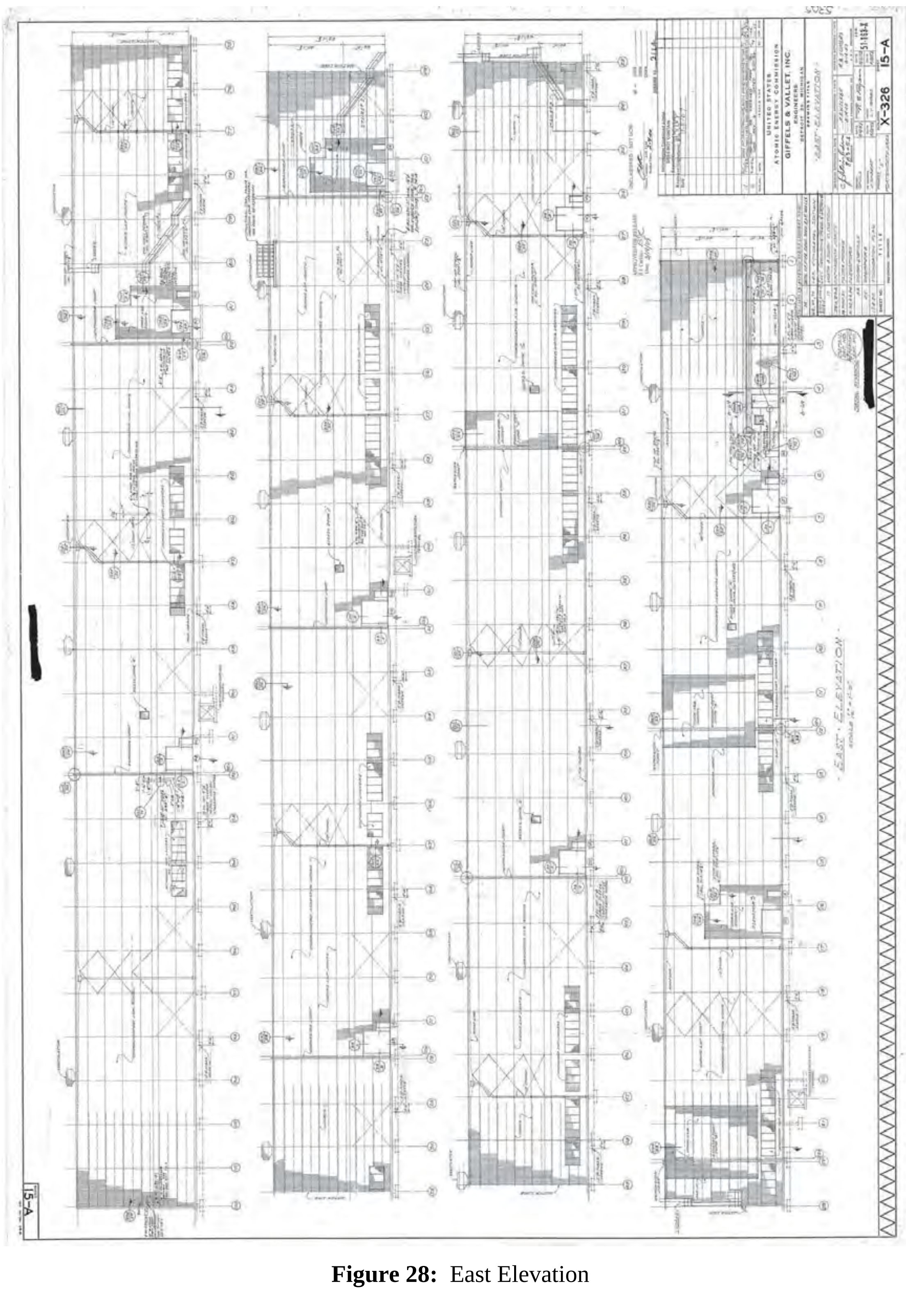

Figure 28: East Elevation

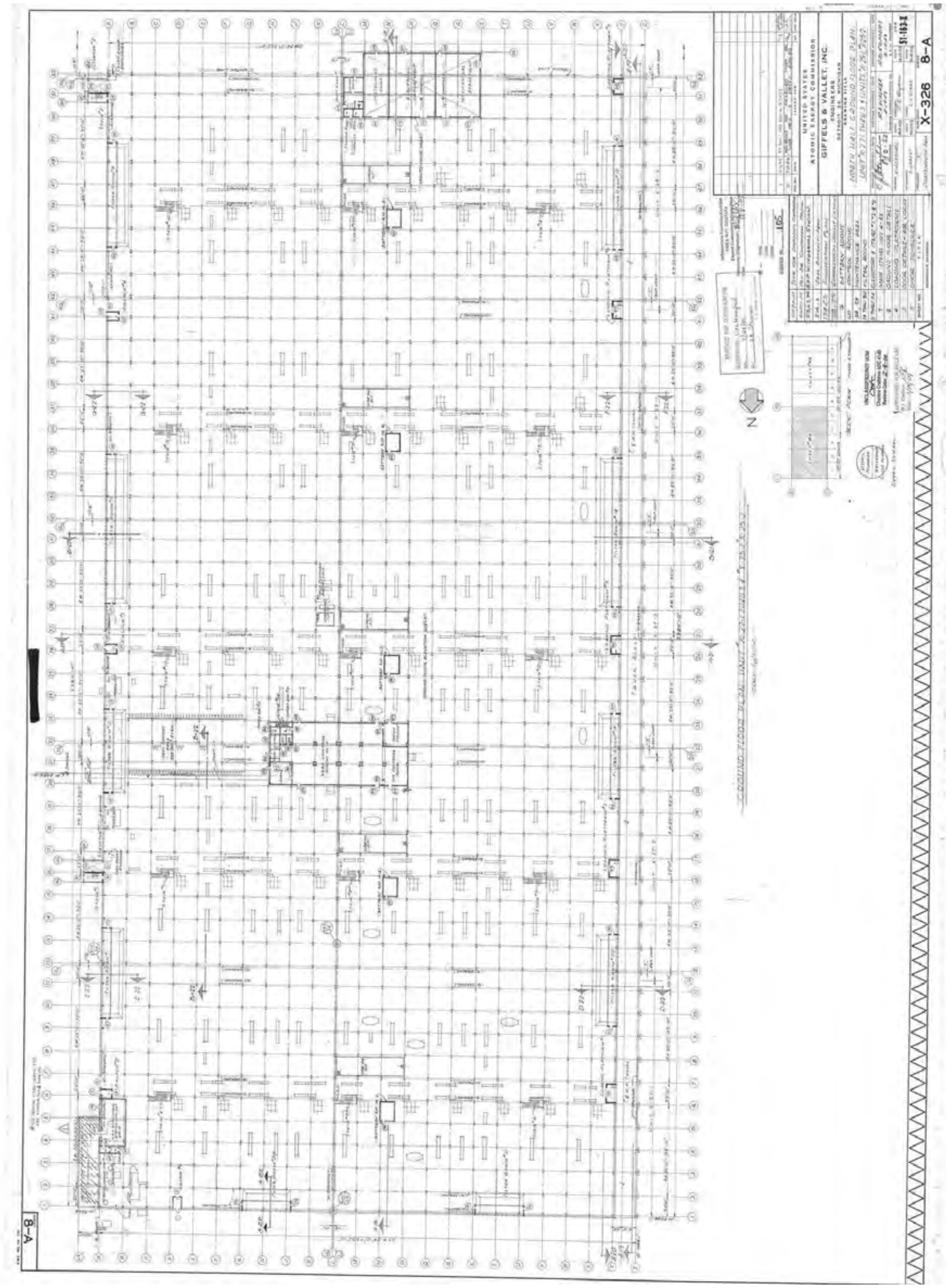

Figure 29: North Half Ground Floor Plan