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Historic American engineering record Humboldt Bay Power Plant

Rand Herbert

Garret Root

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HUMBOLDT BAY POWER PLANT
1000 King Salmon Avenue, Fields Landing
Eureka vicinity
Humboldt County
California

HAER CA-2293
HAER CA-2293

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD

National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD

HUMBOLDT BAY POWER PLANT

HAER No. CA-2293

Location: 1000 King Salmon Avenue, Fields Landing, Eureka vicinity, Humboldt County, California

USGS *Fields Landing* Quadrangle 7.5 minute, 1973
UTM Coordinates: 10T 397831 mE 4510730 mN

Date of Construction: 1956-1963

Engineer: Bechtel Corporation

Builder: Bechtel Corporation (Units 1, 2, and 3), General Electric Corporation (Unit 3 Turbine, Generator, reactor except vessel), Combustion Engineering, Inc. (Unit 3 Reactor Vessel), Ben C. Gerwick, Inc. (Unit 3 Caisson).

Present Owner: Pacific Gas & Electric (PG&E)
77 Beale Street
San Francisco, CA

Present Use: Power Plant (inactive/decommissioned)

Significance: PAR Environmental Services evaluated the Humboldt Bay Power Plant in 2003; they found that Unit 3 appeared to meet the criteria for listing in the National Register of Historic Places at a national level of significance under Criterion A and C. California's Office of Historic Preservation concurred in this assessment. In 2006 Pacific Legacy evaluated two structures and one building, agreed with PAR's findings, and called the plant a district. (Full significance found on pages 37 through 39).

Report Prepared by: Rand Herbert, Vice President
Garret Root, Research Assistant
JRP Historical Consulting, LLC
2850 Spafford Street
Davis, California 95618

Date: March 2012

Introduction

Humboldt County has long been resourceful and innovative in its search for electrification. Independent lumber mills, starting in the 1870s, have been primary local sources of power, producing and selling their excess energy. This gave rise to independent power companies competing, consolidating, and growing until one company, Pacific Gas and Electric (PG&E), owned them all. PG&E continued to utilize lumber mills but also added a gas and hogged fuel power plant, a substation, transmission lines, and a salvaged World War II tanker before constructing Humboldt Bay Power Plant (HBPP) in 1956. HBPP consisted of three units: two fossil fuel steam plants built in 1956 and 1958 and the world's first privately owned, funded, operated, and commercially viable nuclear power plant, completed in 1963. Unit 3, HBPP's nuclear unit, pioneered the use of a pressure suppression system consisting of large chamber partially filled with water to condense vented steam. The pressure suppression design would be integrated into future boiling water reactor nuclear power plants. Unit 3's design also involved locating the reactor and suppression system underground in a concrete caisson constructed to ensure it would not disturb two existing fuel fired units. From 2010-2014 these three plants underwent decommissioning after a new, more efficient, and environmentally friendly power plant, Humboldt Bay Generating Station (HBGS), replaced them. Throughout its history Humboldt County and Pacific Gas and Electric have continued to evolve and adapt with the ever-changing power industry.

The Electrification of Humboldt County

When Thomas Edison first publicly displayed the incandescent light bulb at his laboratory in Menlo Park, New Jersey in December 1879, followed by the world's first steam generating power station in 1882, he demonstrated that such systems could provide electricity to power street lamps and houses. In the 1880s, the residents of Humboldt County began to use local natural resources to power their towns before they were served by power companies and connected with the greater California power grid. As of 1878, residents of Eureka and its environs lit their streets and homes with gaslights. Small local companies like the Eureka Gas Company and Eureka Gas Works provided fuel. However, gas was not the only source; in 1883, the Excelsior Lumber Mill on Gunther (Indian) Island in Humboldt Bay generated electrical power for carbon arc lighting to provide nighttime illumination at its mill.

The original power companies that supplied the Humboldt area with electricity were small competitors who, pressured by finance and fires, were forced to consolidate (See **Figure 1** on

page 6). Humboldt County power thus developed at the local level but quickly resulted in regional ownership, culminating in 1927 with Pacific Gas and Electric Company takeover of Western States Gas and Electric Company.

Eureka is the largest Humboldt county town and was the first to use electricity. Its first power company, Humboldt Light and Power Company founded on October 23, 1885, was owned by the Vance Mill and Lumber Company. The power plant, attached to the mill, was located on Waterfront and G Streets in downtown Eureka. The first business to have arc lights was the Vance Hotel, which had eight 2,000 candlepower arc lights installed. In 1892 a fire completely destroyed the Vance Mill and Humboldt Light and Power Company plant. As a result, Humboldt Light and Power sold their electric distribution system and customers to Eureka Electric Light Company. Eureka Electrical Light Company was founded on May 17, 1886 and its plant was located on the north side of the alley between First and Second Streets, spanning I and J Streets in Eureka. On March 21, 1894 Eureka Electric Light Company was consolidated into a new company, Eureka Lighting Company, which became Eureka's sole provider of gas and electricity. Eureka Lighting Company's plant was located on the southwest corner of First and C Streets, adjacent to the Occidental Mill. The steam electric power plant was powered by four boilers that burned sawdust and mill waste. Without a way to catch hot embers emanating from its four smoke stacks, three small fires damaged the plant and a fourth completely destroyed it. The plant was rebuilt with the addition of a corrugated iron roof to prevent future fires. In 1907 Eureka Lighting Company merged with North Mountain Power Company to form the Humboldt Gas & Electric Company. The Occidental Mill at the foot of First Street in Eureka also contributed to the local power load. Built ca. 1890, it provided steam heat to surrounding businesses before it was sold to the North Mountain Power Company in 1907.¹

By the turn of the twentieth century electricity had become more commonplace and entrepreneurs found new ways to utilize it. In 1902 the North Mountain Power Company formed in San Francisco (later moving its headquarters to Eureka) to build an electric street car system. North Mountain Power Company built a hydroelectric power plant in Trinity County, a substation in Eureka, and a transmission line linking the two (discussed in greater detail below). In 1907 North Mountain Power Company merged with Eureka Lighting Company to form Humboldt Gas & Electric Company. Humboldt Gas & Electric Company would be the last

¹ Dan Villa, "The Inception of the Electrical Industry in Humboldt County," *Humboldt County Historical Society Newsletter* (Nov.-Dec. 1963): 16-18.

independent locally owned power company in Humboldt County; it operated until 1911 when it was sold to Western States Gas and Electric Company.²

In 1895, the town of Arcata, located eight miles north of Eureka, allowed the installation of a motive wheel in the city's water mains. The flow of the water powered five street arc lights. Arcata's first power company, Humboldt Manufacturing Company, was formed on April 23, 1895 with a plant located on 8th and K Streets. It operated until February 28, 1905 when it was sold to Arcata Light and Power Company. Arcata Light and Power Company was formed on January 23, 1905 and operated until December 5, 1910 when it was sold to North Mountain Power Company.³ On March 24, 1906 the Humboldt Manufacturing Company, the same company that sold its power operations a year earlier to Arcata Light and Power, decided to re-enter the power industry under the same name. The company operated until March 20, 1912 before selling to Western States Gas and Electric.⁴

Smaller towns in Humboldt County such as Blue Lake, Fortuna, and Ferndale all operated their own power companies as well. Blue Lake Manufacturing Company operated on the shore of Blue Lake at the rear of the old Blue Lake Hotel. A 100 horsepower steam engine powered the machinery to manufacture shingles and illuminate 600 incandescent bulbs for the city. It operated from 1902 until 1912 when it sold to Western States Gas and Electric. In 1896 Humboldt Milling Company of Fortuna formed and provided power to the surrounding towns of Loleta, Rohnerville, Alton, Hydesville, and Carlota. The milling company, which manufactured redwood products, used the plant's wood waste to fire the boilers which supplied steam to a 60 kW generator. Humboldt Milling Company operated until August 23, 1904 when it was sold to the newly formed Fortuna Lighting Company, which in turn operated until 1912 until it sold to Western States Gas and Electric. Ferndale Electric Company, located adjacent to Crowley Ranch on Waddington Road, operated from 1903 until 1911 when it was sold to Western States Gas and Electric Company.⁵

Western States Gas and Electric Company was based in Chicago and expanded into California in the 1910s. The outsider company bought and consolidated Blue Lake Manufacturing Company,

² Villa, "The Inception," 17.

³ The sources conflict here, the date Arcata Light and Power's demise is listed both as December 5, 1910 sold to North Mountain Power Company, a company that has consolidated into Humboldt Gas and Electric three years earlier.

⁴ Villa, "The Inception," 18, 19. John A. Mitchell, "Water Wheel Brought Lights to Arcata," *The Humboldt Historian* (Mar. Apr. 1978).

⁵ Villa, "The Inception," 20.

Ferndale Electric Light Company, Fortuna Lighting Company, Humboldt Manufacturing Company, and Humboldt Gas & Electric Company. Pacific Gas & Electric Company acquired Western States Electric Company in 1927 and has since provided the region with its electrical and gas power.⁶

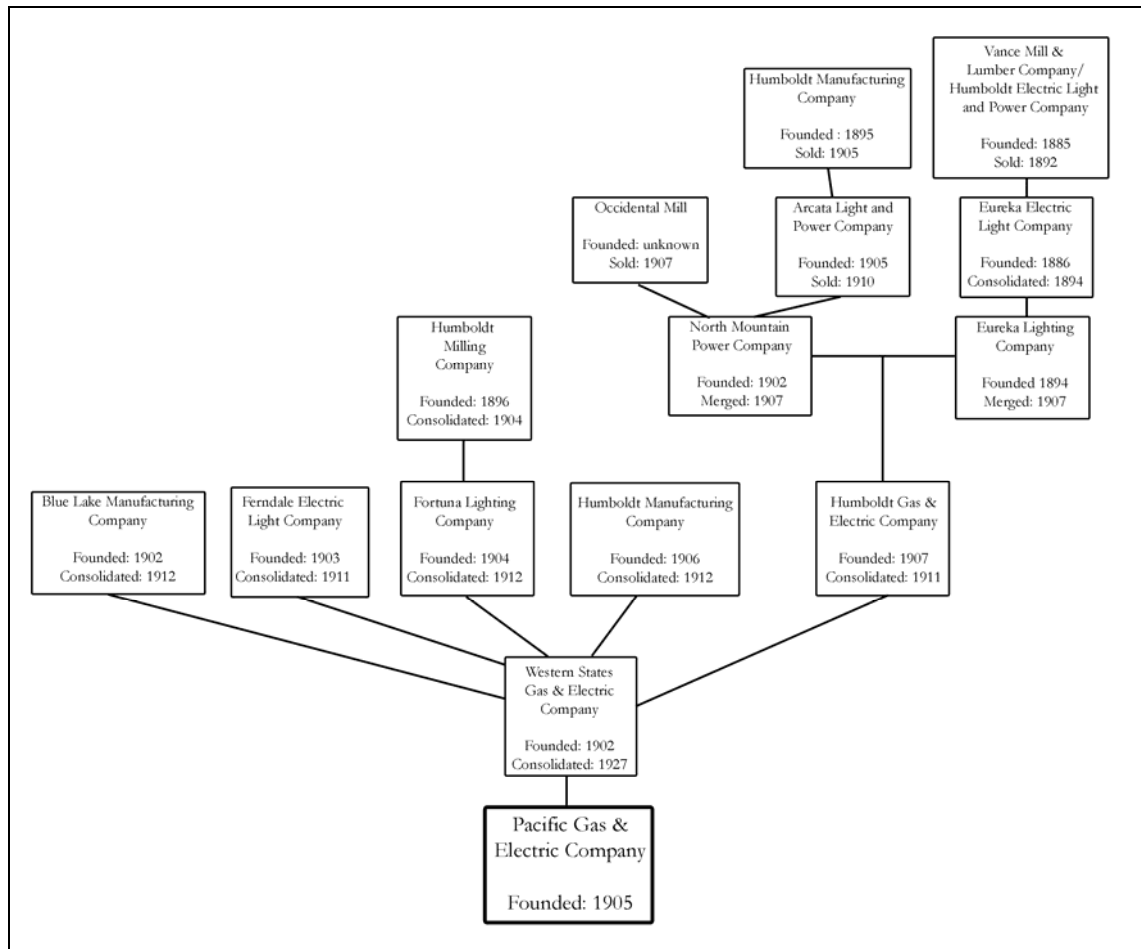


Figure 1. Acquisition tree of Humboldt County power companies showing name and the date they were founded, consolidated, merged, or sold.

PG&E in Humboldt County

When PG&E acquired Western States Gas & Electric Company, it inherited its generating equipment and distribution network. In Eureka, this included a transmission line from the small dam and powerhouse in Trinity County. The Junction City Powerhouse was located where

⁶ Coleman, *PG&E of California*, 281, 350, 362; Villa, "The Inception," 14, 17,18; Mitchell, "Water Wheel Brought Lights to Arcata," 1; Villa, "The Inception," 19.

Canyon Creek joined the Trinity River. The dam and powerhouse were constructed in 1902 by the North Mountain Power Company to supply Eureka, 65 miles west, with electricity. The powerhouse was built on a concrete slab foundation with concrete walls, steel trusses, and a corrugated metal roof. Water from Canyon Creek was diverted through a 12 foot long, 80 foot high stone filled crib dam. The dam channeled the water into a flume which traveled roughly seven miles, ending in a solid rock forebay. From the forebay, three penstocks delivered the water into the powerhouse. The water turned steel water wheels which powered two 750 kW Bullock generators producing 1500 kW of power. Improvements over the years increased its output increased to 30,000 kW.⁷

The electricity from the Junction City Powerhouse traveled along a 65-mile transmission line to Eureka's Station C, located at the foot of X Street (see **Appendix, Figure 4**). The transmission line was strung in a nearly straight course, but the dramatic rise and fall of the terrain, coupled with the catenary effect of the wires, required over 40,000 feet of line to span the Trinity Alps.⁸

⁷ "Eight Lights Signaled Birth of a Bright Era" *The Humboldt Historian* (July-August 1958): 6-9. R.G. MacDonald, "'Pacific Service' in the Redwood Empire—Humboldt Division," *Pacific Service Magazine* XVII (January 1930): 331-341.; Pacific Gas & Electric. *Pacific Gas and Electric Company Annual Report of the Department of Electrical Operation and Maintenance*. 1930.

⁸ Catenary is the curve the line assumes because it is supported at both ends and pulled down by its own weight.



Photograph 1: Photograph taken in 1947 of Station C located in North Eureka at the foot of X Street indicated by the red arrow. (Photograph courtesy the Humboldt State University, Special Collections).

The line crossed heavily wooded terrain, four mountain ranges, and three rivers before reaching the coast. The densely forested terrain made it necessary to clear a 100 to 400 foot wide swath the entire length of the transmission line to reduce the chance of limbs or trees falling on the line. North Mountain Power Company also had to maintain the line, so 36 miles of trails were constructed for their line crews. The entire task was completed in four and a half months. Station C was built the same year as the dam and powerhouse (1902), and featured a 1,000 kW steam-powered generator. Humboldt Gas & Electric added 500 more kW to the station after 1907. Station C was constructed of concrete and iron and is 128 feet long by 30 feet wide. The building is elevated by redwood piles driven underneath the entire structure, to prevent flooding from the nearby slough. The transmission line from the Junction City powerhouse entered the fire-proof switch room on the east side of the building. This room originally housed three banks of General Electric Lightning arresters and one General Electric oil switch. In an adjacent room transformers stepped the power down so it could be distributed throughout the Humboldt area grid. In 1916, the company closed Station C and moved one of the generators to Station B to be

used as a synchronous motor. Later on, the Station C building was used as a trolley station, shipwrights' building, and a dune buggy factory. It is currently owned by the Blue Ox millwork.⁹



Photograph 2: 1946 photograph of Station C. (Photograph courtesy of Blue Ox Millworks Company).

Station B was built in 1910 at the waterfront (western) end of Whipple (now 14th) Street. Its 1,700 kW oil fueled, steam turbine-powered generator became the center of Eureka's power distribution system (see **Appendix, Figure 4**). The annual report of PG&E's Department of Electrical Operation and Maintenance from 1930 reported that in 1929 Station B used 26,455 barrels of oil and produced 6,393,000 kW hours of electricity. In 1930 Station B used 13,222 barrels of oil and produced 13,538,000 kW hours. The reduction of fuel oil and the increase in power produced in 1930 was the result of burning sawdust and mill waste, as shown in **Photographs 3 and 4** which shows two conveyers that carried sawdust into the boiler house. Station B closed in 1956, soon after the Humboldt Bay Power Plant's (HBPP) Unit 1 was constructed to more adequately supply the region. The hydroelectric plant closed in 1966 following a flood two years prior.¹⁰

⁹ California Railroad Commission, Decisions of the Railroad Commission, 895; Villa, "The Inception," 14,18.; Leigh H. Irvine, *History of Humboldt County California with Biographical Sketches of Leading Men and Women* (Los Angeles: Historic Record Company, 1915), 128; James C. Williams, *Energy and the Making of Modern California*, (Akron, Ohio: University of Akron Press, 1997), Map 9.3 in Appendix; Villa, "The Inception of the Electrical Industry," 20.; "'Pacific Service' in the Redwood Empire—Humboldt Division," *Pacific Service Magazine* XVII (January 1930): 331-341.

¹⁰ Pacific Gas & Electric, *Pacific Gas and Electric Company Annual Report of the Department of Electrical Operation and Maintenance*, 1930, 164; Villa, "The Inception," 18; Interview with Richard McKenna, May 28, 2009; Current aerial photographs indicate that Station B has been demolished, and Station C remains. Blue Ox, "The Life and Times of The Blue Ox Millworks," <http://www.blueoxmill.com/history.htm> (accessed 11/24/2010).

From 1947 through 1958 a unique electrical generator composed of the salvaged stern of a wrecked World War II tanker became part of Eureka's power distribution. The tanker, christened the *SS Beacon Rock*, was built in 1944 and given to the Soviet Union under the Lend Lease Act, whence it was renamed *Donbass III*. It survived the war, but in February 1946 broke in two during a storm on the Bering Sea. The stern section, which contained the engine room, stayed afloat, and was salvaged. On November 3, 1946, PG&E bought the wreck and had it towed to a waterfront site near Station B in Eureka (see **Appendix, Figure 4** and **Photograph 5**). PG&E connected the *Donbass III*'s 6,700 kW steam generator to the main grid. The makeshift system produced 4.996 Megawatts (MW) for the power-hungry, post war booming lumber mills found throughout the area. In 1956 the ship's hull leaked an estimated 400 barrels of oil into Humboldt Bay; however, PG&E continued to use the generator until 1958. The company took the ship off-line after completion of Unit 1 and later Unit 2, PG&E's new fuel oil/natural gas powered steam plants. The-ship-turned-power-station was pulled out of the mud, engineers shored up her hull, making her seaworthy, and dredged a new channel to pull the ship out to sea. The hull was sold to the naval scrapping company National Metal and Steel of San Pedro, California, but the *Donbass*'s role with PG&E did not end. While the ship was sold, the company retained and reused the ship's power plant (steam turbine and electric generator). The generator and the General Electric Type T-2 SE-A1 marine turbine were installed at the Vallecitos Boiling Water Reactor, the world's first privately-owned-and-operated test nuclear power plant. Vallecitos laid the foundation for commercial nuclear power in the United States with its utilization of a boiling water reactor; more specifically, it was the reactor model that the HBPP's Unit 3 emulated. It had been initially reported that the *Donbass III*'s watertight doors were also salvaged and used as airtight doors on Unit 3, however this has turned out to be untrue as the *Donbass III* had been removed prior to the announcement of construction of Unit 3 and the markings of the door used indicate they were from a salvaged World War II destroyer.¹¹

The *Donbass III* was a life-saver for the secluded county however it was only a temporary fix to the Humboldt Area grid, and PG&E sought a more reliable and permanent solution. In 1952 the company installed a 110 kV transmission line from Cottonwood to Eureka, in addition to the existing 60,000 kV line from Junction City. However, even this addition did not adequately supply the PG&E Humboldt Division's demands nor was it entirely reliable. Winter storms regularly damaged the transmission lines across the Trinity Alps, resulting in power shortages

¹¹ Villa, "The Inception," 18; Scott Blakey, "Can-Do!" PG&E Intranet Site; *The Humboldt Standard*, February 7, 1956; September 26, 1958; *The American Society of Mechanical Engineers*, "International Mechanical Engineering Landmark the Vallecitos Boiling Water Reactor," Vallecitos Nuclear Center, Pleasanton, California October 7, 1987; *The Humboldt Beacon*, February 26, 1998; Interview conducted by Garret Root with LeRoy Marsh Sr. February 28, 2012; Interview conducted by Garret Root with John Paul February 24, 2012.

and outages. In the event of line damage, the *Donbass III* became the main power supply; during these times, customers were often asked to unplug unnecessary electrical appliances or equipment, and lumber mills without their own generating systems came to a standstill.¹²

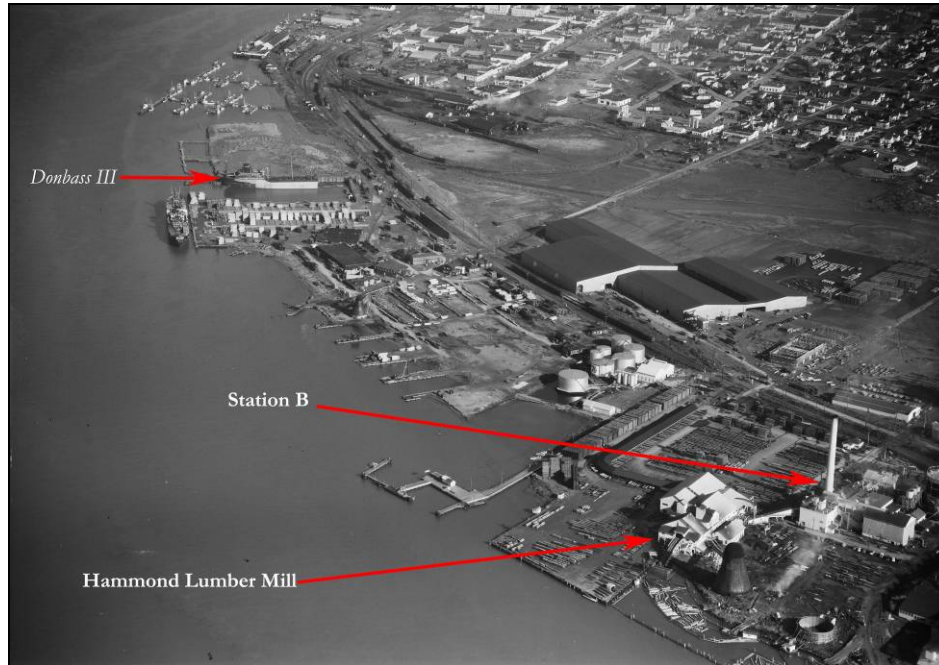


Photograph 3: Station B view to the southwest; note the conveyer at extreme right of photograph. This is the same conveyer located on the upper left corner of **Photograph 3** (Photograph courtesy of PG&E).

In an era of post-war growth, the population of the Humboldt Division's service area increased by nearly 150% and energy consumption by 600%. PG&E realized that it could no longer rely on the long transmission lines and salvaged World War II-era tanker to supply the Humboldt region. The Humboldt Bay Power Plant complex was born out of necessity, as the company needed to provide the Humboldt region with a reliable, local energy source.¹³

¹² *Humboldt Standard*, December 20, 1952; January 15, 1952; March 24, 1952; October 12, 1956.

¹³ *Humboldt Standard*, December 20, 1952; January 15, 1952; March 24, 1952; October 12, 1956.



Photograph 4: Aerial view looking to the northeast, photograph shows the *Donbass III* moored at the top and Station B at the bottom right. (Photograph taken in 1948. Courtesy of Humboldt State University, Special Collections.)

Building Units 1, 2, and 3

In 1952 PG&E secured 147 acres on Buhne Point, north of Fields Landing and southwest of Eureka, on which it planned to build a new complex, the Humboldt Bay Power Plant (see **Appendix, Figure 3**). The company planned to build two 50,000 kW steam-generating units. The first unit was completed in 1956, and the second unit two years later. Dan Villa, then PG&E's Humboldt Division manager, observed that Buhne Point was chosen as the plant site based on four advantageous factors:

- (1) A plentiful supply of cold water for condensing the steam;
- (2) sufficient room for future plant expansion;
- (3) a favorable route for transmission lines from the new plant to Humboldt substation, east of Eureka, tying the plant into the company system; and
- (4) adequate berthing for ships delivering the plant's fuel oil.¹⁴

¹⁴ *Humboldt Standard*, February 12, 1952.

PG&E chose steam generating units owing to the location and preference over other electrical generating sources. By 1950 steam turbine units were based on well established, proven technologies. British designer Sir Charles Parsons built the first steam turbine-generator in 1884. At the beginning of the twentieth century, engineers designed steam turbines to replace the aging steam engine power plants. Aegidius Elling of Norway is credited in 1903-1904 as being the first to apply the method of injecting steam into the combustion chambers of a gas turbine engine. Within a relatively short time, the technology and capacity of these engines to supply power and electricity grew exponentially. These advances brought electricity to a wide range of industrial and domestic applications; however, the materials needed to withstand the high temperatures of modern turbines were not yet available. Improvements in steam turbines advanced throughout the 1920s and 1930s, leading to a generation of more efficient turbine power plants in the 1950s. During this time, utilities closed or replaced many of the older steam-electric plant generators and constructed more modern units.¹⁵

Steam power generation was part of California's power production throughout the twentieth century, though it declined considerably in the period leading up to World War II as large hydroelectric generating plants came online throughout the state. As early as 1920, hydroelectric power accounted for 69% of all electrical power generated. In 1930, that figure had risen to 76%, and by 1940 hydroelectric sources provided 89% of California's electricity. After World War II this trend reversed and construction of steam-powered electric generating units grew, accounting for most of the new construction. By 1950, hydroelectricity accounted for only 59% of the total power generated, falling to 27% in 1960. Some new hydroelectric plants were built during the 1960s, chiefly associated with federal and state water projects, but by 1970, hydroelectric plants accounted for only 31% of all electricity generated in California.¹⁶ A combination of drought, discovery and tapping of natural gas, and lack of new hydroelectric sites led to its decline.

These statistics, however, tend to obscure the work of PG&E, one of California's largest electrical utility providers, which built large-scale steam generation plants as early as the 1920s. James Williams, a historian of energy policies and practices in California, noted that the decision by PG&E to build steam plants might be attributed to several converging trends in the mid-to-late-1920s. First, a persistent drought in California caused the major utilities to question the

¹⁵ Heinz Termuehlen, *100 Years of Power Plant Development: Focus on Steam and Gas Turbines as Prime Movers* (New York: ASME Press, 2001), 11, 21-28; Douglas Stephen Beck and David Gordon Wilson, *Gas Turbine Regenerators* (New York: Chapman & Hall, 1996), 30; William A. Myers, *Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company* (Glendale, CA: Trans-Anglo Books, 1984), 8.

¹⁶ Williams, *Energy and the Making of Modern California*, 374.

reliability of systems dependent on abundant water flows, like hydroelectricity. This drought began in 1924 and continued, on and off, for a decade. At about the same time, new fuel power steam plants on the East Coast (where steam was more prevalent than in California) achieved far greater effectiveness than had previously been possible. For example, between 1900 and 1930, the fuel efficiency of steam plants, measured in kW per barrel of oil, increased more than nine-fold. In the 1920s San Joaquin Valley's natural gas reserves were discovered, tapped, and lines completed supplying both Northern and Southern California. Natural gas has since played an important role in steam electric power generation in California.¹⁷

The confluence of these various factors – drought, new steam generator technologies, and new supplies of natural gas – prompted PG&E and other utilities to begin constructing large steam plants. In 1929, the Great Western Power Company (acquired by PG&E in 1930) built a large steam plant on San Francisco Bay, near the Hunters Point shipyard, fitted with two 55 MW generators.¹⁸ PG&E also built a steam plant in Oakland in 1928 called Station C, and a few years later a PG&E vice-president for engineering wrote, “Under the circumstances which now prevail, it is natural to question the future of hydro in California.”¹⁹ Steam came to dominate California power post World War II consumption.

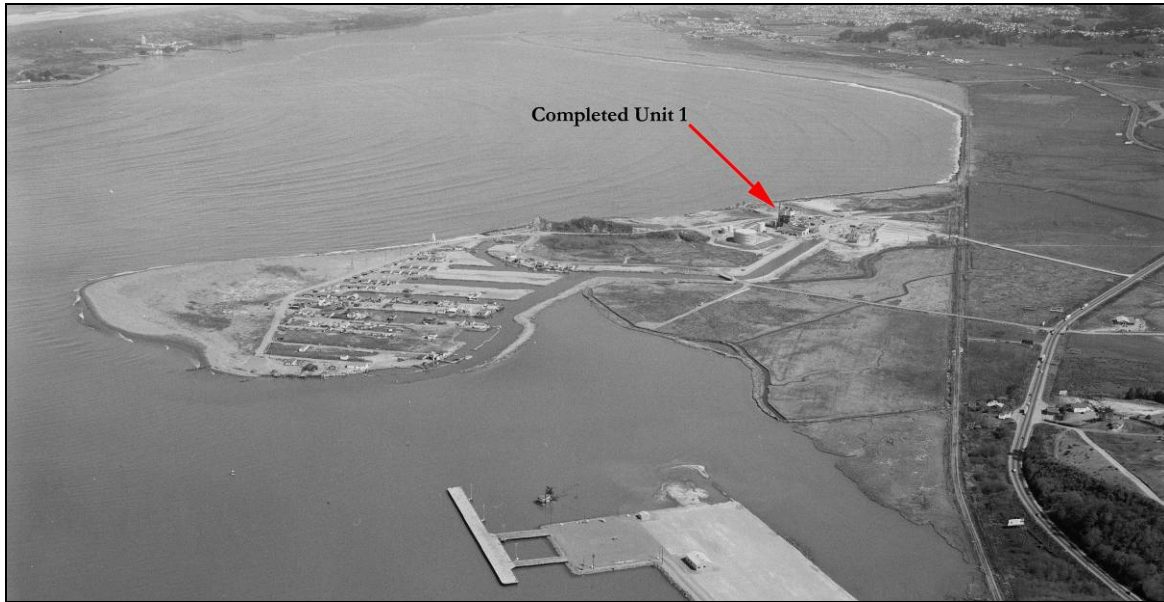
PG&E continued its pre-war pattern of constructing steam generation plants in postwar California. Population increased after the war and general statewide economic expansion spurred rapid residential, commercial, and industrial growth. The need for more power was imperative, and PG&E expanded its systems along with the rest of California's energy industry. Between 1946 and 1953 the company invested one billion dollars in energy infrastructure and generating facilities. Steam plants became the most favored option. They were cheaper, easier to build than hydroelectric plants, and they conserved water, which kept costs down for consumers.²⁰ PG&E steam generating plants built during the postwar period relied on proven technologies, that were quick and inexpensive to construct compared to other power sources.

¹⁷ Williams, *Energy and the Making of Modern California*, 278; Coleman, *PG&E of California*, 306.

¹⁸ This plant still exists. It was fitted with new units in 1948, at the same time that the Kern Power Plant was being constructed, it was decommissioned in 2006. Coleman, *PG&E of California*, 298.

¹⁹ “1928 Steam Plants Account for 45 Percent of New Generating Capacity,” *Electrical West* (February 2, 1929), 80-81; R.W. Spencer, “Cooling Water For Steam Electric Stations in Tidewater,” *Transactions of the American Society of Civil Engineers* 126 (1961): 294, 300; Williams, *Energy and the Making of Modern California*, 279.

²⁰ Myers, *Iron Men and Copper Wires*, 200; Williams, *Energy and the Making of Modern California*, 277-78, 282-83; Coleman, *PG&E of California*, 331.



Photograph 5: Buhne Point in 1955. The arrow marks the location of the HBPP. Visible are the completed Unit 1, a fuel tank, and the start of Unit 2. (Courtesy of the Humboldt State University, Special Collections).

In a 1950 article in *Civil Engineering*, PG&E Chief Engineer I.C. Steele summarized the design criteria of four major steam plants under construction by the company: Moss Landing, Contra Costa, Kern, and Hunters Point. These plants had much in common with each other and with plants throughout the state. The site selection criteria were the same: locations close to load centers to reduce transmission costs, easy and efficient access to fuel supplies, near a water supply, on inexpensive land, and on geological formations that could provide a good foundation. By the mid-1950s, Walter Dickey, an engineer from Bechtel Corporation, examined design innovations in an article prepared for *ASCE Transactions* that improved the economics of steam plant construction. These plants, he argued, could be built economically by minimizing the structural materials and creating semi-outdoor turbo-generator units. Furthermore, these plants could be expanded if the demand increased.²¹

California utility companies' steam generating capacity expanded during the period of 1950-1970. PG&E operated 15 steam electric plants in 1950 California, adding several new plants and expanding others over the ensuing decade. Chief among these were the Kern plant (1948-50), Contra Costa (1951-53), Moss Landing (1950-52), Pittsburg (1953-54), Morro Bay (1955), Hunters Point (addition 1958), and the subject of this report, Humboldt Bay (1956-58). By the

²¹ I.C. Steele, "Steam Power Gains on Hydro in California," *Civil Engineering* (January 1950): 17-21; Edgar J. Garbarini, "Design Saves Construction Dollars on Contra Costa Power Plant," *Civil Engineering* (May 1953): 31-33; Walter L. Dickey, "The Design of Two Steam Electric Plants," *ASCE Transactions* (1956): 253-273.

late 1970s, there were more than 20 fossil fuel steam-generating plants in California owned by various power companies and clustered near urban areas such as San Francisco Bay, the greater Los Angeles area, San Diego County, along with a few interior plants in San Bernardino, Riverside, and Imperial Counties. Others existed on the Central Coast, and the HBPP complex in Humboldt County was situated in the far northwest corner of the state.²² After 1970, the major utilities began looking for alternative energy sources, from nuclear power to wind, geothermal, and other “green” or renewable energy. However, fossil fuel steam generation remains the backbone of electrical generation capacity in California. Today 34 steam turbine power plants are operating in California.

HBPP Units 1 and 2 were steam-generating units like the ones described above. With the addition of 50,000 kW of steam turbine units at Units 1 and 2 of the HBPP complex, power production grew exponentially within the Humboldt region. In the event of line failure, the new power plant would increase its output to compensate until the line was restored. The power plant was intended to exclusively supply the Humboldt region with power, and only if there was any excess was it to be transmitted elsewhere via the Cottonwood transmission line.²³

Atomic Power at HBPP

At the Unit 1 dedication on October 12, 1956, Norman R. Sutherland, president of PG&E, expressed his excitement in the company’s pursuit of atomic energy. He revealed that the HBPP had been considered as a site for an atomic plant, but the cost for the customer would have been too great. Only 16 months later Sutherland reported that the cost barrier had been broken and that PG&E planned for HBPP to be the location of the first privately owned, constructed, maintained, and economically viable nuclear power plant in the world. The project proposed constructing a 60,000 kW boiling water nuclear power unit, to be completed by 1962.²⁴ This achievement was made possible by the passage of two key Federal Acts.

The Atomic Energy Act of 1954, under the guidance of the Atomic Energy Commission (AEC) (later replaced by the Nuclear Regulatory Commission (NRC) in 1977), allowed private industry to use nuclear material for peaceful purposes and made PG&E’s HBPP Unit 3 possible. The

²² *Annual Reports of the Southern California Edison Company*, various years; Spencer, “Cooling Water For Steam Electric Stations in Tidewater,” 280-302; Steele, “Steam Power Gains on Hydro in California,” 17-19; Dickey, “The Design of Two Steam Electric Plants,” 253-255; “Haynes Steam Plant Will Grow With Demand,” *Southwest Builder and Contractor* (October 12, 1962): 24-27; Williams, *Energy and the Making of Modern California*, 257.

²³ *Humboldt Standard*, October 12, 1956; Richard McKenna, interviewed by Rand Herbert, May 28, 2009.

²⁴ *Humboldt Standard*, October 12, 1956; February 19, 1958.

1954 Act was a continuation of the Atomic Energy Act of 1946 that put nuclear power under civilian control and stated that nuclear material could be used for peaceful means; however, it was not until the 1954 Act and President Dwight Eisenhower's "Atoms for Peace" program that really made this a feasible reality. The Atomic Energy Act of 1954's purposes were (a) research and industrial growth; (b) declassification of material for safe use by the scientific and industrial communities; (c) the government to maintain control and act as steward over the rights to nuclear material; (d) "a program to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security and with the health and safety of the public;" and (e) protection and expansion of peaceful applications in the international community. The act gave Congress the right to amend the act in the future.²⁵

The first venture into privately-funded nuclear power was outside Pleasanton, California at Vallecitos, as mentioned previously. Vallecitos was a joint project between General Electric, Bechtel Corporation and PG&E to erect the world's first private, test nuclear power plant. PG&E helped fund the project, provided the turbine, and distributed the power generated by the plant into the grid. The test plant served as a research, learning, and training facility for the commercial atomic power industry.²⁶

PG&E had already constructed Units 1 and 2 at HBPP when on February 19, 1958 the *Humboldt Standard* proclaimed "Atomic Power Plant Will be Built Here." Members of the community welcomed the new and innovative nuclear power plant, as shown by a joint proclamation by the Chamber of Commerce and the Humboldt County Board of Supervisors stating,

[we] feel definitely proud that the great Pacific Gas & Electric Company has chosen the Humboldt Bay area for its nuclear plant. This shows faith in the continued development of Eureka and Humboldt County. This third unit will be located on Humboldt Bay and will provide firm power for commercial and industrial expansion. This nuclear unit puts Eureka and Humboldt County in an enviable position as far as power development is concerned...²⁷

²⁵ U.S. Congress, Senate, 1954. *Nuclear Regulatory Legislation*, NUREG-0980, 101st Cong., 1st sess., Vol. 1. No. 6.

²⁶ Norman R. Sutherland, "P. G. and E. in Nuclear Power," *The Arrival of Atomic Electricity*, (Pacific Gas and Electric Company, 1958): 2.

²⁷ *Humboldt Standard*, February 19, 1958.

News of the groundbreaking plant reached Washington D.C. and Chairman of the AEC Lewis L. Strauss. Strauss informed the board that PG&E intended to build the first economically competitive nuclear power plant free from governmental financial assistance.²⁸

HBPP was chosen as the site of the new atomic reactor largely for economic reasons. Humboldt's isolated location caused PG&E to pay high transportation costs for the fuel that ran Units 1 and 2. The atomic generator cut these costs because the reactor could be refueled less often and produced the same amount of energy as traditional fuel/oil powered plants. It would also meet the expected power demand in the region. Based on population growth between 1940 and the late 1950s, the company estimated energy use would increase to 155,000 kW by 1960. PG&E's President Sutherland provided two additional reasons for choosing an atomic plant for HBPP. First, the boiling water reactor used at Vallecitos proved the idea viable, and second, the location benefited from the close proximity to the ocean, a desirable feature for nuclear reactors and fossil fuel power plants alike. Both need a constant supply of water for the production of steam. For nuclear plants specifically water is used to cool the nuclear core rather than building a more expensive air-cooled system such as the classic "cooling towers." These factors helped make nuclear a competitive alternative to traditional fossil fuels in Humboldt County.²⁹

PG&E had its engineering department design the plant with help from General Electric engineers who had designed the Vallecitos plant. The engineers changed the Vallecitos design, which used an aboveground large concrete container dome, to an innovative underground design that included a pressure suppression system, the worlds first. The new system consisted of an airtight, underground chamber built out of concrete and steel that was partially filled with water to condense any radioactive steam so as to reduce its pressure and better contain its radioactivity in the event of an accident. This pressure suppression design became the model for future boiling water reactors built in the United States. It used less concrete, had fewer seams, provided better radiation shielding, and was less visible. The containment structure for the reactor extended 85 feet underground, had four-foot thick walls, and a 72 ton concrete and steel shield plug on top of the reactor. The unit design included a 250 foot tall stack for the diffusion of ventilated air, other gases, and minor radioactivity. All of the new design elements created a cheaper, yet safer, facility.³⁰

²⁸ *Humboldt Standard*, February 19, 1958.

²⁹ PAR Environmental Services, Inc., *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, 19; *Humboldt Standard*, February 19, 1958.

³⁰ PAR, *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, iii, 20; *Humboldt Standard*, September 23, 1963; January 23, 1961; Richard McKenna, Interviewed by Rand Herbert, Eureka, California, May 28, 2009.

PG&E submitted their plans to the California Public Utilities Commission and the AEC in late 1959, and construction began after the company received the required approvals in November 1960.³¹ The plant's components were sub-contracted by several companies throughout the United States. Ben C. Gerwick built the caisson, Combustion Engineering, Inc. built the reactor vessel in Chattanooga, Tennessee, General Electric built the turbine and generator at their plant in Lynn, Massachusetts, with other components fabricated at a plant in San Jose, California. The AEC supplied the fuel from their Portsmouth, Ohio, DuPont plant. The fuel pellets were sent to General Electric's San Jose plant, which turned them into fuel rods.³²

Construction of Unit 3 began on November 10, 1960. The start of the work focused on a 60 feet in diameter caisson to be sunk in sections 80 feet into the ground. This was accomplished using an innovative and unique construction technique. The Bechtel Corporation, a San Francisco based engineering and construction firm contracted to construct HBPP, sub-contracted the caisson/pressure suppression tank to another San Francisco based firm, Ben C. Gerwick, Inc. which specialized in bridges, bridge foundations, tunnels, water resources, offshore marine structures, wharves, piers, ports and harbors, costal engineering, buildings, and foundations. Ben C. Gerwick Jr. took over his father's construction company, founded in 1926, and transformed it into a pioneering engineering and construction firm. Gerwick is credited with pioneering the development of pre-stressed concrete piling for deep foundations, marine structures, and bridge piers, and helped develop high quality tremie concrete (underwater structural concrete) which is used in underwater structures among many other important innovations.³³

³¹ PAR, *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, 20; *Humboldt Standard*, September 23, 1963; January 23, 1961; Richard McKenna, Interviewed by Rand Herbert, Eureka, California, May 28, 2009.

³² *Humboldt Eureka Standard*, January 23, 1961.

³³ *Humboldt Standard*, October 25, 1962, September 23, 1963; *Humboldt Standard*, January 14, 1961.; Howard W. Wahl, "Foundation Caisson Provides Underground Containment for Nuclear Power Plan" *Nuclear Engineering and Design* 3 (1966): 488.; COWI – Ben C. Gerwick, Inc. <http://www.gerwick.com/menu/home/Pages/ben-c-gerwick.aspx> (accessed 7/12/2011).



Photographs 6 & 7: Top, completed Units 1 and 2 prior to Unit 3 groundbreaking. Bottom, Unit 3's dedication with Chairman Edward M. Patterson of the Board of Supervisors pouring the first bucket of concrete for the caisson to contain the reactor and suppression pool, January 23, 1961 (photographs courtesy of PG&E).

Construction of Unit 3 required creative engineering because of its design and close proximity to Unit 2. The exterior face of the caisson was a mere 14 feet away from Unit 2's building column support caps and 34 feet away from the boiler structure caps. These caps rested on wooden piles driven 30 feet into the ground in an effort to prevent damage and reduce settlement effects. A sheet piling wall was driven into the ground between Units 2 and 3 prior to installing the caisson. Caissons have typically been used in marine applications; Unit 3's use of a caisson as a reactor containment structure and the development of the pressure suppression system were pioneering achievement in the history of nuclear energy. HBPP's caisson is different in four regards than its marine caisson cousin (1) this caisson has two concentric circular walls connected by radial walls and a rectangular structure built on the top of the round caisson shape; (2) it is very unusual to sink a caisson next to a pre-existing structure; (3) the amount of accuracy required was unusual; and (4) typically caissons do not have as strict a requirement for water tightness.³⁴

The round concrete caisson consisted of four cylindrical "lifts" (concrete cast in sections 18 feet, 7.5 feet, 13 feet and another 13 feet high, from bottom to top layer), sunk first, followed by construction of the two rectangular lifts (16 feet and 15 feet high) on top of the round caisson section. In the cylindrical section, the space between the inner and outer walls would become the pressure suppression chamber. Approximately 30 degrees of space between the inner and outer walls was separated from the suppression chamber to provide access to the bottom of the caisson. To prepare the area for the caisson, the work area was excavated 20 feet below ground level, and a circular steel cutting edge was placed where the caisson was to be sunk. The steel cutting edge included openings used to "jet" water into the soil below the edge. The first lift was formed, cast, forms removed and exterior coated as described below, and then the work area was back-filled almost to grade level. Then the next lifts were formed and sunk as follows: (1) erect reinforced steel forms; (2) pour the concrete into the forms; (3) wait for the concrete to set and remove the forms; (4) apply exterior waterproofing, excavate waste from interior; (5) sink caisson by further excavation and water jetting until the top of the caisson was at the work area grade; (6) repeat. For the rectangular sections, the soil below the portions protruding from the round section was excavated before sinking that section. Each lift was constructed in one day shift and was sunk over three shifts. Gerwick engineers utilized water jets because they did not cause ground disturbances like more traditional excavation techniques. The engineers devised a three pronged water and air jet attack. There were 45 degree angle jets placed below the cutting edge to remove material, air jets used to reduce friction, and a high pressure water jet used to probe below the outside periphery of the caisson to clear any unseen debris.³⁵

³⁴ Wahl, "Foundation Caisson Provides Underground Containment," 494.

³⁵ Wahl, "Foundation Caisson Provides Underground Containment," 488.

The water level within the caisson during sinking was typically three to six feet below ground level. A crane with a two cubic feet bucket carefully excavated the dirt from within the caisson during sinking. After the six sections of the caisson were sunk, the bottom of the caisson was sealed with “tremie” concrete poured into the bottom of the caisson through pipes which reached the bottom, and the water was removed. Subsequently, seven more items were constructed. First, the drywell was erected; second, the suppression chamber floor and ceiling liner plates were constructed and welded to the steel walls of the suppression chamber; third, the interior concrete walls and floor were constructed to grade; fourth, the spent fuel pit was constructed; fifth, the reactor vessel was placed in the drywell; sixth, the refueling building was completed; and last was the installation of the electrical equipment.³⁶

In March of 1963, PG&E loaded Unit 3 with fuel assemblies containing 17 tons of uranium dioxide – three years worth – which was estimated as having the same power potential as 750,000 tons of coal. That same year PG&E reported that it had used eight million barrels of oil and 170 billion cubic feet of natural gas to run twelve conventional steam electric generating plants. Months were needed after the unit was loaded with fuel rods to pass inspections and have time for the plant to begin producing enough steam for commercial use. It was set to produce 60,000 kW, enough to power a city of 100,000, equivalent to 1962 Berkeley. By August, it had reached that point, a month before the dedication ceremony on September 23, 1963.³⁷

³⁶ Wahl, “Foundation Caisson Provides Underground Containment,” 493.

³⁷ *Humboldt Standard*, March 13, 1963; October 25, 1962; September 23, 1963; *Oakland Tribune*, January 7, 1962; PAR, *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, 22.



Photograph 8: The reactor vessel before being lowered into Unit 3's Reactor. The vessel reads: "Steam Generating Equip't for General Electric Co. Manufactured by Combustion Engineering Inc. for Installation Pacific Gas and Electric Humboldt Bay Station" (photograph courtesy of PG&E).

At the dedication ceremony, PG&E President Robert H. Gerdes announced that atomic energy facilities were going to be the source of cheap power that would enable California to grow and prosper in years to come. He predicted that after 1970, nuclear plants would become the "conventional" power plants of the day. HBPP's nuclear unit was to be the catalyst for this change because, as Gerdes stated,

It embodies design innovations, which improve the efficiency and add to the security of the plant, while reducing the cost. It is history making in many accounts, which you will hear about today, and for some time to come.³⁸

After being online for 18 months, Unit 3 had produced 428,506,000 kW hours of electricity and was so reliable that two years later the AEC allowed the plant to increase its capacity from 52,000 kW to the full capacity of 72,000 kW.³⁹

Norman R. Sutherland, President of PG&E from 1955 to 1963, had dedicated the HBPP to "the service of the public, to the advancement of the atomic age," and predicted Unit 3

³⁸ *Humboldt Standard*, September 23, 1963.

³⁹ PAR, *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, 30.

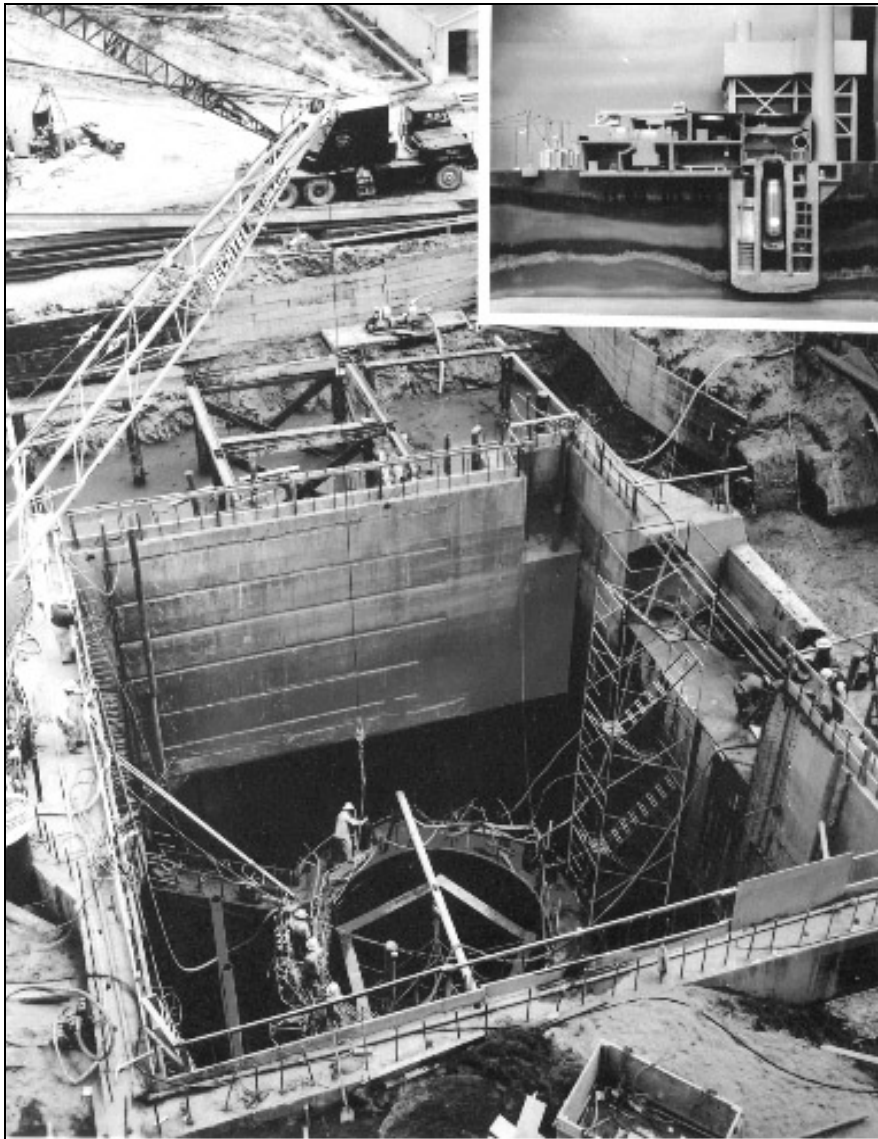
would bring “progress and prosperity of Humboldt County,” but in terms of population growth, the Humboldt Bay pocket did not meet this expectation.⁴⁰

HBPP Operations

Operating HBPP, with its two fuel-fired and one nuclear unit was unique when compared to other PG&E plants. Rod Nelson, a 13-year veteran of plant operations, reported that Unit 3 ran at full load as much as possible, while Units 1 and 2 operated at a minimum. If needed, Units 1 and 2 could balance the fluctuations in the Humboldt region’s load or compensate for a downed transmission line because of their “quick pick up” design. He explained that the quick pick up design of Units 1 and 2 used oversized boiler steam drums, so that in the event of sudden demand, they could supply a surge of steam. Standard fuel-fired plant boiler steam drums were sized smaller in proportion to output, and designed to provide a constant pressure and load. When power lines that linked HBPP to the rest of the PG&E system were suddenly broken, usually by a tree blown down on the line, the turbine throttle valves on Units 1 and 2 opened, which resulted in a reduction of pressure in the separate boilers. This produced a flash of steam for a short-term boost in power. Former HBPP operators Nelson and Richard McKenna agreed, however, that use of the quick pick up system was unrelated to Units 1 and 2 operating in conjunction with Unit 3, since it was in the design of the two Units before Unit 3 was planned. The three units’ coordinated operations were used to meet unreliable, varying local demands, and supported by the two transmission lines which often faced the effects of weather, fire, and rough terrain.⁴¹

⁴⁰ *Humboldt Standard*, January 23, 1961.

⁴¹ Interviews with Rod Nelson and Richard McKenna, May 28, 2009; Edits by Randy Parker, current HBPP employee. JRP interviewed veteran plant operators Rod Nelson and Richard “Mac” McKenna to help understand these differences, and to learn how the plant operated on a day-to-day basis.



Photograph 9: Workers constructing Unit 3, at upper right a cut-away model shows Unit 3 (photograph courtesy PG&E).

Nelson noted that Units 1, 2, and 3, combined with the Cottonwood-Humboldt Transmission Line (as well as MEPPs / Mobile Emergency Generators Power Systems after Unit 3 was decommissioned), all acted to balance loads and provide a reliable supply. McKenna observed that the units provided power to residential customers, businesses, and government entities. Large industrial customers such as sawmills generally continued to operate their own systems fueled by mill waste. Unit 3 ran at a consistent output of about 65 MW, producing enough

energy to power 65,000 homes.⁴² In terms of standard operation, McKenna noted that Unit 3 was easy to operate, with basic supervision, while Units 1 and 2 required more attention.

Decommissioning and the Future

Unit 3 operated as designed for several years. In 1976, PG&E shut down Unit 3 in July for what was to be a year-long, \$30 million seismic retrofit, as well as for modifications to reduce radioactivity releases, and for routine refueling. The same year, geological surveys discovered that the Little Salmon Fault near the plant, previously reported as dormant, was active. In the end Unit 3 would remain inactive and its fate uncertain until 1986. In order to compensate for the power lost when Unit 3 went offline, PG&E brought in two Mobile Emergency Power Plants (MEPPs), which began operation in 1976, each of which produced 15 MW of power. They were “trailer-mounted combustion turbine units with separate control trailer. Each MEPP uses a jet engine and gas turbine to drive an electric generator.” The combined 30 MW of power along with the 105 MW of Units 1 and 2 resulted in 135 MW when running at full power, enough to power 135,000 homes, adequately supplying the region.⁴³

The refueling and retrofit took longer than the projected year, and in that time the NRC informed PG&E that additional seismic studies were needed before Unit 3 could be restarted. On March 28, 1979, the accident at Three Mile Island occurred and the NRC put in place new guidelines for atomic plants. PG&E’s evaluation of the new guidelines and standards concluded that at least \$300 million would be needed for improvements, so the company decided in 1983 to decommission Unit 3.⁴⁴ The decommissioning of Unit 3 was delayed because of the radioactivity in Unit 3 systems that remained following 13 years of nuclear operations. PG&E proposed letting the radioactivity decay for roughly 30 years so that lower radiation levels would then be safer to handle. In addition, the Spent Fuel Pool and reactor contained nuclear fuel that could not be deposited at the site. In 1986 PG&E requested and two years later were approved for an amendment to their NRC license for a decommissioning status designated as “SAFSTOR” which the NRC defines as, “method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.”

⁴² 1 million watts is 1 megawatt and 1 megawatt could power 1000 homes.

⁴³ Pacific Gas & Electric, “Humboldt Bay Power Plant Fossil Units,”

<http://www.pge.com/about/environment/pge/minimpact/humboldtbay/fossil/index.shtml> (accessed 1/4/2011).

⁴⁴ PAR, *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, 33.



Photograph 10: Completed Unit 3 gets a delivery of nuclear fuel rods (photograph courtesy of PG&E).

The amendment allowed for storage of nuclear fuel but did not permit operation of the reactor. In 1999, PG&E began design and licensing activities for an Independent Spent Fuel Storage Installation (ISFSI) to be built on a hill overlooking the original complex. The ISFSI is a concrete vault with individual cells where the spent fuel will be stored. The ISFSI facility was constructed in 2007 following approval by the NRC in 2005. There are five casks containing the spent fuel which were transferred during the second half of 2008; a sixth vault cell is available for storage of the remaining waste which is scheduled to be moved late 2012. The first step in this stage of decommissioning was taken in 1998 with the removal of Unit 3's 250 foot high vent stack.⁴⁵

⁴⁵ *The Daily Herald*, December 4, 1984; Pacific Gas and Electric, "Humboldt Bay Power Plant—Past, Present and Future," <http://www.pge.com/about/environment/pge/minimipact/humbolddb/timeline/index.shtml> (accessed 1/4/2011); United States Nuclear Regulatory Commission, "Glossary SAFSTOR" <http://www.nrc.gov/reading-rm/basic-ref/glossary/safstor.html> (accessed 1/4/2011); PAR, *Cultural Resources Study for the PG&E Humboldt Bay Power Plant*, 33-34.



Photograph 11: The Humboldt Bay Power Plant, from left to right: Units 1, 2, with the shorter black stacks; the location of Unit 3, is indicated by the taller striped stack (photograph courtesy of PG&E).

On December 10, 2008 PG&E began work on the newest power plant in Humboldt County: the Humboldt Bay Generating Station (HBGS). The new facility consists of 10 Wärtsilä model 18V50DF reciprocating engines, which run on natural gas with a back up of ultra-low sulfur diesel. HBGS is 33 % more efficient than HBPP's Units 1 and 2. PG&E's website states that HBGS will have "83 percent fewer ozone precursors and 33 percent fewer CO₂ emissions. It will use a closed-loop cooling system with negligible water usage, eliminating the need to use water from Humboldt Bay for once-through cooling." In April 2010 these new units came online, and by July 2010 were operating at full capacity, producing 163 MW, enough to power 120,000 homes. HBGS's completion allowed for Units 1 and 2 to be shut down and for their decommissioning to begin. They will be fully decommissioned by April 2012. In parallel, decommissioning of Unit 3 commenced, starting with turbine equipment in 2009. Work on the reactor vessel began in the spring of 2011 and is to be completed in late 2012. Preparation for Unit 3 building demolition will occur in 2012 and demolition will likely take place a year later. Unit 3's decommissioning will involve removal of its components, piping and some structures. Ultimately, all structures and materials associated with Unit 3 will be decontaminated and removed. In June of 2014, the site of the former HBPP will undergo restoration, returning the

land to its original condition. The last step will come in December 2015 when the site will be fully restored and the Unit 3 NRC license will be terminated.⁴⁶

Humboldt Bay Power Plant Description

Humboldt Bay Power Plant is located five miles southwest of the town of Eureka across from the mouth of Humboldt Bay. The 147 acre power plant is located on Buhne Point northeast of the small community of King Salmon. PG&E modified Buhne Point by adding intake and discharge canals, and rip-rap along the shore. HBPP consists of three electrical generating structures, a transformer yard, oil tanks, storage tanks, shops, maintenance buildings, a nuclear storage facility, administrative, and security buildings. The electrical generating structures and associated buildings were constructed between 1956 and 1963 and the ISFSI in 2007. HBPP has been undergoing a decommissioning and removal process since 2009. PG&E constructed the replacement power plant, Humboldt Bay Generating Station (HBGS) in 2010 just east of the current HBPP.

HBPP has several different groupings of buildings and structures. For ease of description they are divided into seven different groups:

- Electrical generation Units 1 and 2
- Electrical generation Unit 3
- Infrastructure associated with electrical generation (intake and discharge canals, oil-water separators, transformers, and transmission lines, rail spur etc.)
- Fuel oil storage
- Shops/warehouses
- Administration/office/security
- Miscellaneous buildings and structures

Units 1 and 2

⁴⁶ Pacific Gas and Electric, "Humboldt Bay Power Plant—Past, Present and Future," <http://www.pge.com/about/environment/pge/minimimpact/humboldtbay/timeline/index.shtml> (accessed 1/4/2011); Pacific Gas and Electric, "Humboldt Bay Generating Station," <http://www.pge.com/about/environment/pge/minimimpact/humboldtbay/hbgs/index.shtml> (accessed 1/4/2011); Pacific Gas and Electric, "Nuclear Plant Decommissioning," <http://www.pge.com/about/environment/pge/minimimpact/humboldtbay/nuclear/index.shtml> (accessed 1/4/2011).

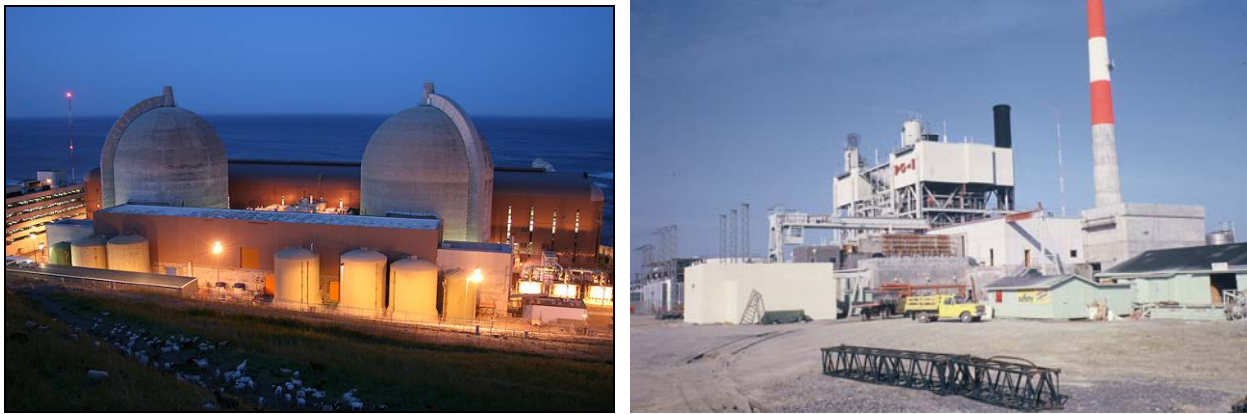
Of the three electrical generating structures, two (Units 1 and 2) are conventional power plants. Unit 1, completed in 1956, and Unit 2, completed in 1958 are essentially identical open air, fuel-fired, steam electric plants. They were designed by Pacific Gas & Electric and constructed by Bechtel Corporation. They are massive, multi-level, steel frame structures, built on a concrete foundation with asbestos cement siding covering upper level portions of the exterior. They operate around an 83-foot high furnace and boiler built within the steel structure. The boilers' exhaust stacks, located on the northwest side of the two units, stand 120 feet high with an inside diameter of ten feet. Water is pumped through 15 miles of small diameter pipes that are suspended close together to form the interior walls of the furnace. Water is pumped through the boiler tubing, where it boils and turns into superheated steam, which is then piped to the Babcock & Wilcox turbine. Within the turbine, the steam passes through the turbine static nozzles and rotating turbine blades, turning a shaft connected to the electric generator. Below the turbines, the condensers cool the steam, and the water is returned to the boilers. Each rapidly rotating turbine powers a generator that produces 52,000 kW of electricity.

The ground level of Units 1 and 2 is enclosed in concrete block walls, with the second level sheathed in asbestos cement, creating an enclosed turbine deck sheltering operators and equipment. Between the generators on the first level are personnel doors that lead to the interior of the structure containing the boilers and control room. Water is pumped from the intake canal on the west side of Units 1 and 2 and piped into the condensers before being piped to the outfall canal northeast of the plant. Water from deep freshwater wells was distilled before being used in the power plant. Four water distillation tanks are located northwest of Unit 1 and 2. On the southwest side of Unit 1 are the administration building, offices and a garage; on the northeast side of Unit 2 is electrical generating Unit 3, discussed below. On the southeast side of Units 1 and 2 at the second story level are the turbines, generators and exciter houses, with a traveling gantry crane above. Both Units 1 and 2 are joined at the center by a complex array of pipes, walkways, steel structures, and electrical systems.

Unit 3

Unit 3 is the most significant of the three power plants. It is a boiling water nuclear reactor, the first commercially viable, privately-funded nuclear power plant in the world. This uniquely crafted plant pioneered new construction techniques and laid the groundwork for not only boiling water nuclear power plants, but public utilities' use of nuclear energy. Unit 3, constructed between 1961 through 1963, is located immediately northeast of Units 1 and 2. It is less noticeable than other nuclear power plants which have iconic groupings of two or three massive concrete cooling towers and containment domes. HBPP's pressure suppression system, which

utilized underground water and air chambers (and discussed thoroughly below), served the same purpose as other plant's containment domes. Water circulated into the plant from the adjacent Humboldt Bay, eliminating the need for cooling towers. The 250 foot tall vent stack diffused ventilated air, other gases, and minor radioactivity; the stack was removed in 1998. **Photograph 13** shows where Unit 3's stack once stood, located at the center of the photo.



Photograph 12 (left) and **13** (right) show two very different PG&E nuclear power plants. At left is the Diablo Canyon Nuclear Generating Station which went online in 1985 (Unit 1) and 1986 (Unit 2). Diablo Canyon uses two concrete containment domes where as HBPP (right) has an underground suppression chamber and only the refueling building and concrete stack are visible (Photograph courtesy of Jim Zimmerlin (left) and PG&E (right)).

PG&E engineers planned the majority of the structure to be located underground. All nuclear reactors require some way to ensure the nuclear fuel rods do not reach a temperature high enough for the fuel to melt, as that melting would release large amounts of radioactivity. For a boiling water reactor, water is used to carry heat away from the fuel rods, which creates a large quantity of high pressure steam. During operation, this steam is used to generate electricity. In case of an accident, the steam is not sent to the turbine, because of potential radioactivity, so the steam must be contained. On other nuclear plants a pressure containment structure usually consists of a dome or sphere that has enough strength to hold the steam pressure. Unit 3's pressure suppression containment uses a large pool of water to condense the steam, resulting in the water being warmed, while keeping the containment system pressure considerably lower than that of a spherical or dome pressure containment structure. As a result of the lower pressure, HBPP was able to employ a smaller containment structure.

At HBPP, PG&E engineers employed the innovative pressure suppression system design, the world's first. The new system consisted of an airtight, underground chamber built of concrete and steel that was partially filled with water to condense any radioactive steam from the reactor in the event of an accident. The container for the reactor was 85 feet underground, had four-foot

thick walls, and a 72 ton concrete and steel shield plug on top of the reactor. There was also a 250 foot tall ventilation stack for the diffusion of ventilated air, other gases, and minor radioactivity. This is why Unit 3's profile is so different from later nuclear power plants.

Aboveground is the "power block", the refueling building, the ventilation stack, buildings for handling liquid and solid radioactive waste, and a machine shop for working on radioactive equipment. The refueling building encloses the spent fuel storage pool, and provides access and containment for refueling the reactor. The "power block" includes the condenser, turbine and generator, exciter house, the feed water pump room, a radioactive chemical laboratory, an instrument repair shop, the control room and part of the ventilation system. The control room, instrument shop, laboratory, turbine, generator and exciter house are located on the second story, on the southeast side of the refueling building containment structure. The turbine is enclosed in reinforced concrete several feet thick to provide radiation shielding.

The refueling building, also constructed of thick reinforced concrete to provide radiation shielding, encloses the refueling room at grade. The refueling building is located on the northwest side of Unit 3; it is accessible by a rail spur to a large access door, located on the east side of Unit 3. The ventilation stack base and stack exhaust ventilation system is located on the northwest side of the refueling building. During operation, access to Unit 3 was normally through Units 1 and 2. At the end of Unit 2 (on the second level) a door leads into the Unit 3 control room, from which the rest of Unit 3's areas were accessed.

The control room is where technicians remotely monitored the temperature and nuclear conditions within the reactor. Continuing northeast, personnel would pass through a clothing change area to reach the air lock to the refueling building. From the airlock, a stairwell leads down to the refueling floor.



Photograph 14 shows two unidentified Bechtel Corporation employees studying plans in the control room during construction of Unit 3 (Photograph courtesy of PG&E).



Photograph 15 Three unidentified employees discussing the installation of equipment in the Unit 3 control room. (Photograph courtesy of PG&E).

The refueling room contains the spent fuel pool, emergency condenser tank, reactor vessel shield plug, connection to the railroad spur, a decontamination facility (not present during operation, added for decommissioning), technicians' workspace, and 25 ton gantry crane. The spent fuel pool, located at the north end of the refueling room, was designed to hold fuel assemblies after they were used for power generation but were too radioactive to store elsewhere. The design of the plant anticipated that after they had cooled they would be transferred to a reprocessing facility, by loading the assemblies in shielded cask and shipping it from the adjacent rail spur. The emergency condenser, a long cylindrical tank, is positioned above the spent fuel pool. In the event of an abrupt reactor shutdown, the emergency condenser prevents the core from overheating due to immediate post-shutdown heat from the decay of radioactivity created during reactor operation. The emergency condenser was filled with water, through which several hundred tubes ran to piping connected through a valve to the reactor. When the valve was opened, steam from the reactor would be cooled by the water in the emergency condenser and the cooled steam (now water) would return to the reactor.

Also located in the refueling room is the reactor shield plug, a four foot thick, 72 ton concrete and steel plug that covers the reactor (HBPP 79 through 84). Along the northeastern wall the rail spur enters from two thick concrete doors at the northeast side of Unit 3 (HBPP-60, 62, 63, 85, 86, and 107). In addition to the concrete doors, there are two steel panel doors which were added during the 1976 modification work.

Below the refueling floor are two floors with rooms reached by ladder (a storage vault for new reactor fuel, above a room for the power block waste water collection tank, aka "Turbine Building Drain Tank") and rooms reached by a stair well (shielded heat exchanger rooms for the reactor water purification system, aka "Cleanup Heat Exchanger Room", and for the reactor cooling during shutdown, aka "Shutdown Heat Exchanger Room"). Below the level of the shutdown heat exchanger room, is the "access shaft" in the 60 degree portion of the caisson that is not occupied by the suppression chamber. The various levels in the access shaft are accessible by a man lift, which is a motor driven endless belt running from rollers at elevation -8 foot to elevation -63 foot, on which there are mounted handholds and platforms, permitting personnel to step on a platform at one level and ride to another. A worker travels from -14 foot elevation (26 feet underground) to -66 foot elevation (78 feet below grade) to reach the bottom of the access shaft and the space below the reactor. The reactor vessel, constructed by Combustion Engineering, was lowered into the drywell which is within the pressure suppression caisson. The drywell is a steel vessel (lining inner circular walls of the caisson) which encloses the reactor, and which is connected to the suppression chamber by way of six large pipes. These pipes run to

a circular pipe extending around the upper part of the suppression chamber, from which many pipes extend down into the water in the lower half of the suppression chamber. This is so that any steam leaking from piping around the reactor is routed to reach the water in the suppression chamber where it can be cooled and condensed. The top and bottom of the drywell are closed by large round doors, and on top the drywell is shielded by the 72 ton reactor shield plug.

Infrastructure

There are several items of infrastructure that help HBPP operate and others required to facilitate transfer of electricity into the electrical grid. Two canals support HBPP operations. The first, an intake, draws water into the plant on the southwest end of Buhne Point through a rip rap lined canal dredged by the Bechtel Corporation. The channel wraps around the south side of the point and into the HBPP property. The water travels under a pedestrian bridge that connects the main gate to an employee parking lot (the non-employee parking lot is located at the southeast end of the power plant property), is screened by a seaweed boom, and is pumped into the plant through traveling screens and circulating water pumps, two for each Unit, located just east of the Security building and just south of the transformer yard. The discharge canal is located northeast of Unit 3, serving all three units, and discharges back into the bay. Areas where water mixes with oil from plant is collected, passed through a series of Oil-Water Separators located northeast of Unit 3, then discharged back into Humboldt Bay. They consist of a series of cylindrical and rectangular water tanks connected by pipes. The tanks rest on a concrete foundation both at grade and sub-grade connected by catwalks.

An inactive rail spur to the Northwestern Pacific Railroad is located on the property. It was used during the construction Units 1, 2 and 3 (aligned with the turbine generators) and rerouted afterwards to extend into the Unit 3 refueling building for transportation of nuclear fuel rods. It ran east to west and entered Unit 3 at the northeast side of the main building. The track into Unit 3 has since been removed (HBPP-060, 062, 063, 107). Another associated infrastructure feature, constructed jointly by PG&E, Army Corps of Engineers, and Humboldt County was the breakwater on Buhne Point for erosion control.



Photograph 16 was taken on June 23, 1948 before the community of King Salmon and HBPP was constructed. (Photograph courtesy of Humboldt State University, Special Collections)

As noted above, each of the facility's three power units produced high pressure steam that turned turbines which powered generators and created electricity. The electricity is harnessed in the 60 kV switchyard located east of Units 1, 2, and 3. The structures consist of electrical transmission equipment such as transformer banks, Siemens circuit breakers and control boxes, oil circuit breakers, and transmission towers. The transmission towers are the original steel frame structures built in the late 1950s and early 1960s. The towers are located east of the intake canal while the transformer banks for the three units are located to the north, next to the electrical generators.

Fuel Oil Storage

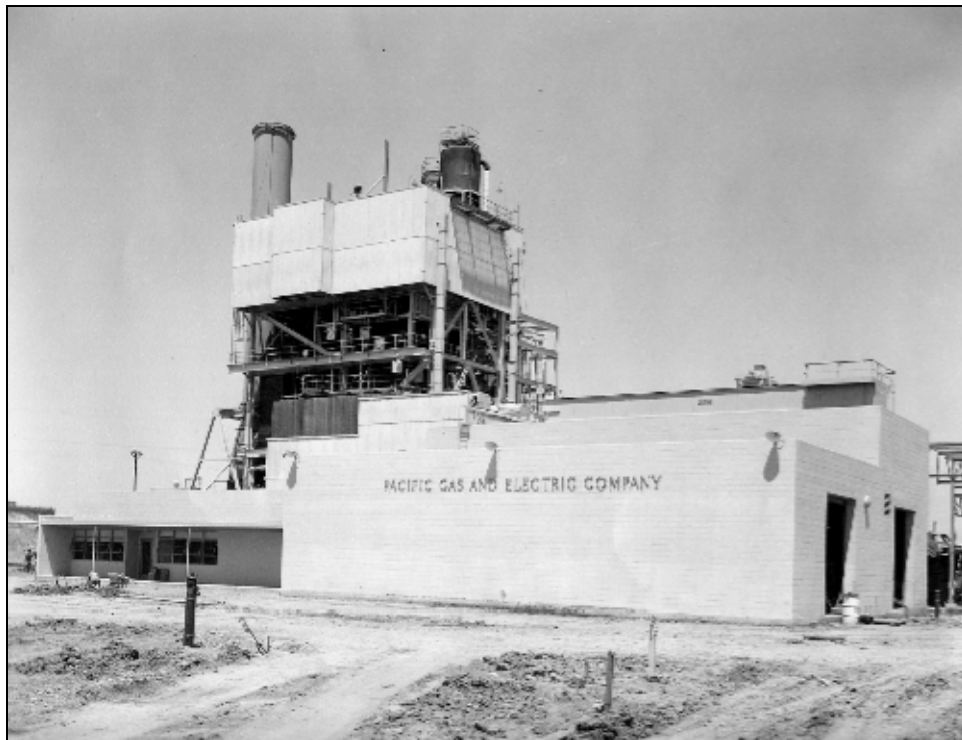
HBPP had two fuel oil storage tanks and three fuel service tanks associated with Units 1 and 2. The two largest and most prominent, were constructed for the respective unit starting in 1956. They were located west and north-northwest of the Administration Building. Three smaller fuel service tanks were located north of the southernmost fuel storage tank. All have since been removed.

Shops/Warehouses

HBPP features a number of permanent buildings and facilities which are used for maintenance and operation of the plant. The Welding Shop is a modern addition to the Office and Main Warehouse. It is a corrugated metal building with a side gabled, low pitch, corrugated metal roof with a roll-up front door facing south. A personnel door is located on the eastern side at the northeast end, under the gable. The Machine Shop is the taller portion of the building shown in

Photograph 17; it is attached to the Office and the Main Warehouse. It is a concrete block structure with a roll-up door; it is built on a poured concrete foundation.

The third shop is the “Hot Shop,” also formally referred to as Building # 4. It is a concrete block, rectangular building with a flat roof. It is used to work on radioactive equipment used in Unit 3. It also contained a calibration well, where a radioactive source was kept for calibrating radiation instruments. It does not have any windows but does have two personnel doors and one roll-up door on the west side of the building.



Photograph 17: In the foreground on the left is the original 1956 office with multi-pane windows as it appeared before the office addition. The shorter section to the right is the Main Warehouse, the taller is the Machine Shop, and Unit 1 stands behind. Later a welding shop would be added on the eastern end of the building blocking the back recessed door. (Photograph courtesy PG&E).

The Main Warehouse is connected to the Office building located just north of the security check point. It is a single story concrete block building with a recessed roll-up door on the eastern side. The taller portion on the northeast is the Machine Shop. The warehouse is one of the oldest buildings at HBPP, and was completed in 1956, the same year as Unit 1.

Administration/Office/Security

The Administration Building, completed in 1956, is located southwest of Unit 1 and the Office and north of the water intake canal along the plant access road. The exterior features walls of rectangular concrete blocks, sliding windows, and recessed doors, with a flat roof. It is built on a poured concrete slab. A mural depicting the history and the culture of the plant wraps around two of the four sides.

The Office building is northeast of the Administration building. It is a concrete block building with an irregular footprint, with additions on the northwest and southwest sides, and the main warehouse attached to the southeast. It has sliding pane windows and a recessed entry with a metal covered porch. The southwest addition was made in 1961, further additions were made in the early 1990s, and the windows which flank the recessed doors were changed from four over three fixed pane to triple sliding glass windows. Construction was completed by 1956, making it one of the plant's oldest buildings, along with Unit 1.

The Security Building (originally, and currently), also known as the Training Building (for its use after entering SAFSTOR and before 9/11), is located on the north side of the plant driveway from the northeast side of King Salmon Avenue. It is a rectangular structure formed by concrete blocks and sits on a poured concrete foundation. It has a wide, flat, boxed roof with overhanging eaves. There are sliding glass and single pane windows with a personnel door on the east side of the building.

Miscellaneous Buildings and Structures

The Low Level (Radioactive Waste) Storage Building, also known as Building 15, is northeast of Unit 3. It is a rectangular, metal roof, concrete block, flat-roofed building with two sliding metal doors on the southeast side. This building is currently used for temporary storage of low level radioactive materials. A larger and more modern building located to the south of Building 15 encloses the Liquid Radioactive Waste Treatment System and is also used for storage of low level radioactive waste. It is a metal frame shed, with corrugated metal exterior siding and roofing. The sheet metal building covers the original concrete structure, which has five cylindrical liquid radioactive waste storage tanks at the south grade level, and three more tanks inside concrete vaults for higher level waste. A catwalk and ladders provide access down to the top of the non-vaulted tanks. North of the Liquid Radioactive Waste building is the concrete cover for the (three) High Level (Solid) Waste Vaults. These vaults are fully below grade, only accessible by removing the concrete slab tops.

Building 7069 is a rectangular, concrete block wall, low pitched, front gable roofed building built on a poured concrete foundation located southeast of Units 1, 2, and 3. It has a roll-up door on the northwest side, and personnel doors on the southeast and northeast. A corrugated metal shed roof building, Building 8048, is located on the southeast side of Building 7069. It also has a roll-up door on the northwest side. The two buildings are used for storage.

The Relay Building, also known as Building 31, is a square concrete block building on a poured concrete foundation. On the southeast side there are two ribbons of 2 over 4 awning windows. The northwest side of the building has one personnel door and a ribbon of 2 over 4 awning windows. The southwest side of the building is the same, with the exception that it has one additional personnel door. This building, located southeast of Units 1, 2, and 3, is also one of the oldest at the plant. It was built in conjunction with Unit 1, the Office, Main Warehouse, and Machine Shop buildings.

The Drawing Control Room, also known as Building 7, is located northeast of the Security Building and southwest of the Main Warehouse. It is a square building built out of concrete blocks and sits on a poured concrete foundation. It has a wide, flat, boxed roof with overhanging eaves. There are sliding glass and single pane windows and personnel doors near the north, west and east corners of the building.

Discussion of Significance

This recordation in the form of a Historic American Engineering Record has been prepared to partially mitigate for the demolition of the Humboldt Bay Power Plant. This mitigation is required because the plant was determined to be a historic resource under the National Register of Historic Places criteria of significance.

In 2003 PAR Environmental Services, Inc. evaluated Unit 3 and concluded that it met Criteria A and C for listing in the National Register of Historic Places. PAR suggested that it was eligible on the national level of significance, under Criterion A, “For the role it played in development and ongoing research of the nuclear power industry at a national level,” because it was built “based on electrical demand and competitive economics as a profit-making venture, rather than research and development of a new technology.” HBPP was not the first nuclear reactor built in the United States, it was the seventh; however, the design of the pressure suppression system and construction techniques contributed greatly to the burgeoning nuclear power industry. Earlier nuclear power plants, like Vallecitos, were experiments in harnessing nuclear power. Unit 3 was the first power plant that was built for the sole purpose of providing its customers with energy.

It was also found eligible on the national level of significance Under Criterion C, Consideration G “for its precedent-setting engineering design.” Under Criterion C, Unit 3’s “precedent setting engineering design” was apparent in both design and construction. Other nuclear power plants, like Vallecitos, used concrete and steel containment domes that proved costly. PG&E engineers devised the pressure suppression chamber which eliminated the need for a containment dome by placing the reactor underground, flanked by air space and water suppression pools. The pressure suppression chamber required less steel and concrete. This pressure suppression design became the basic model for design for future boiling water reactors. The below ground chamber was formed by using space within a below ground caisson built with an innovative technique, employing circular “cookie cutter” equipped with water jets. The jets softened the ground while the weight of the concrete walls formed on the cutter pushed the suppression chamber caisson down. The evaluators recommended that Unit 3 be determined an exceptionally significant structure in the nation’s history and thus did not need to be 50 years old to be deemed significant under National Register criteria. The State of California’s Office of Historic Preservation concurred with PAR’s assessment.

In 2006 Pacific Legacy recorded two structures and one building that would be demolished with the construction of the HBGS. This effort identified the entire Humboldt Bay Power Plant a district, based in the plant’s fence line. In the DPR523 they concurred with PAR’s finding that Unit 3 met Criteria A and C for listing in the National Register. They also recorded the two structures and one building slated for demolition as elements of the district. They determined the boundary of the district as HBPP’s fence line; therefore the current report covers all the buildings and structures located at HBPP.

Units 1 and 2 are not individually eligible for listing in the National Register however they are part of the district as outlined in Pacific Legacy 2006 report. The construction of Units 1 and 2 improved the reliability of Humboldt County power, but in the greater history of power generation the gas fired, steam electric plants were a well established technology found throughout the state. However, the location of Units 1 and 2 is one of the reasons why Unit 3’s engineering is unique. The design placed Unit 3 adjacent to the existing Unit 2 which proved to be a challenge for marine caisson specialists Ben C. Gerwik, Inc., the engineering firm responsible for building the caisson which was used as a pressure suppression system. Unable to use traditional excavation techniques because of the possibility of damaging Unit 2’s subsurface pilings and compromise the structure, Gerwick engineers opted to use water jets and a steel plate

“cookie cutter” to sink the caisson. This innovative technique worked and did not disturb any subsurface piling.

HBPP’s Unit 3 pioneered the commercially feasible use of atomic energy. PG&E chose to construct Unit 3 not because of fundamental scientific breakthroughs related to nuclear power, but because it proved to be the most cost effective way to deliver power to its customers. Cost efficient construction methods and innovative engineering made Humboldt Bay Power Plant’s Unit 3 the first economically viable, privately funded nuclear power plant in the world. Its pressure suppression system became the preferred design for boiling water power plants. Soon nuclear power became an important source of energy in the United States and the world. Furthermore, following its shutdown and decision to decommission, HBPP staff continued contributing to the nuclear power industry by aiding the NRC in drafting plans to ensure safe, on-site fuel storage for future nuclear plant decommissioning.

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APPENDIX A

MAPS

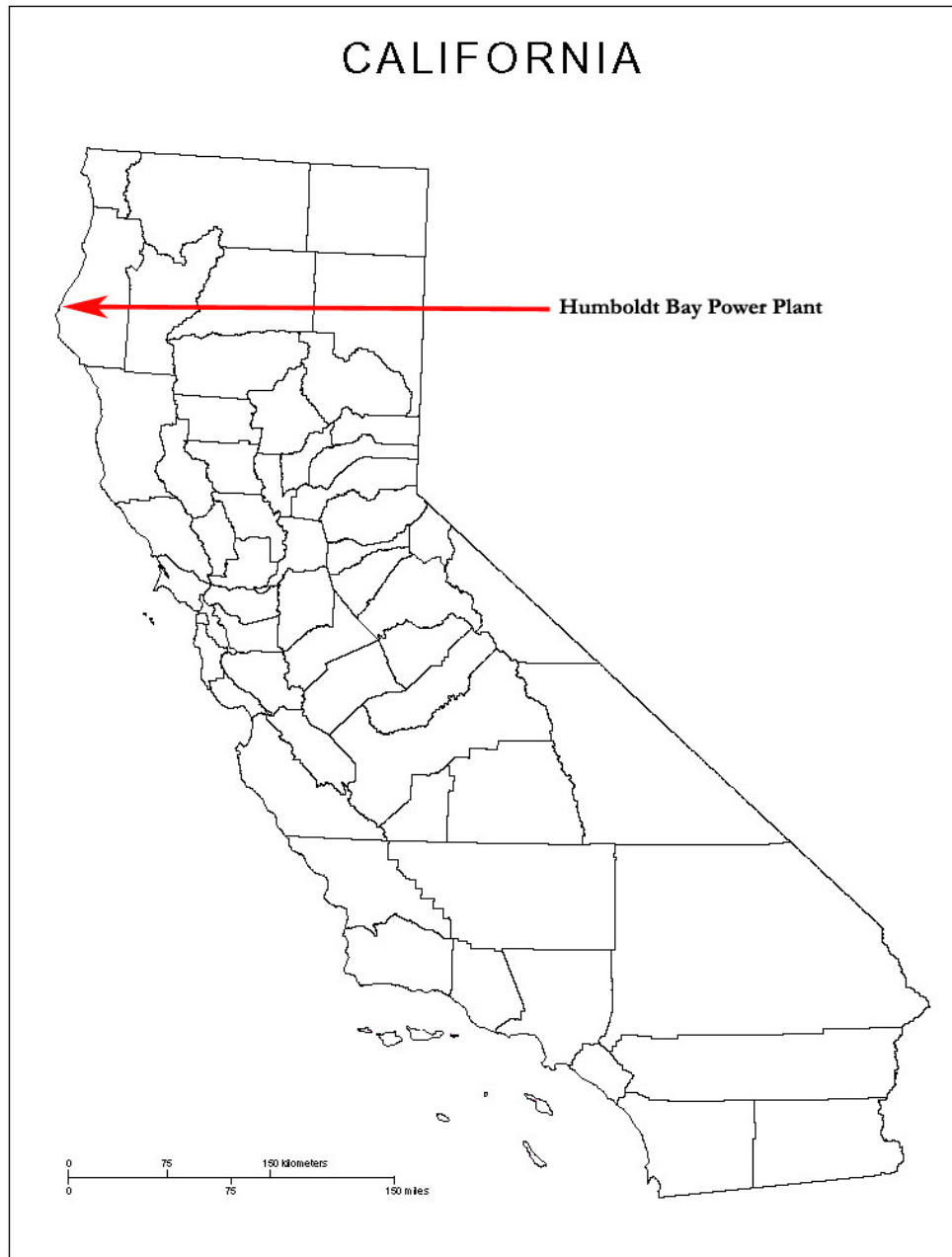


Figure 2. Location Map

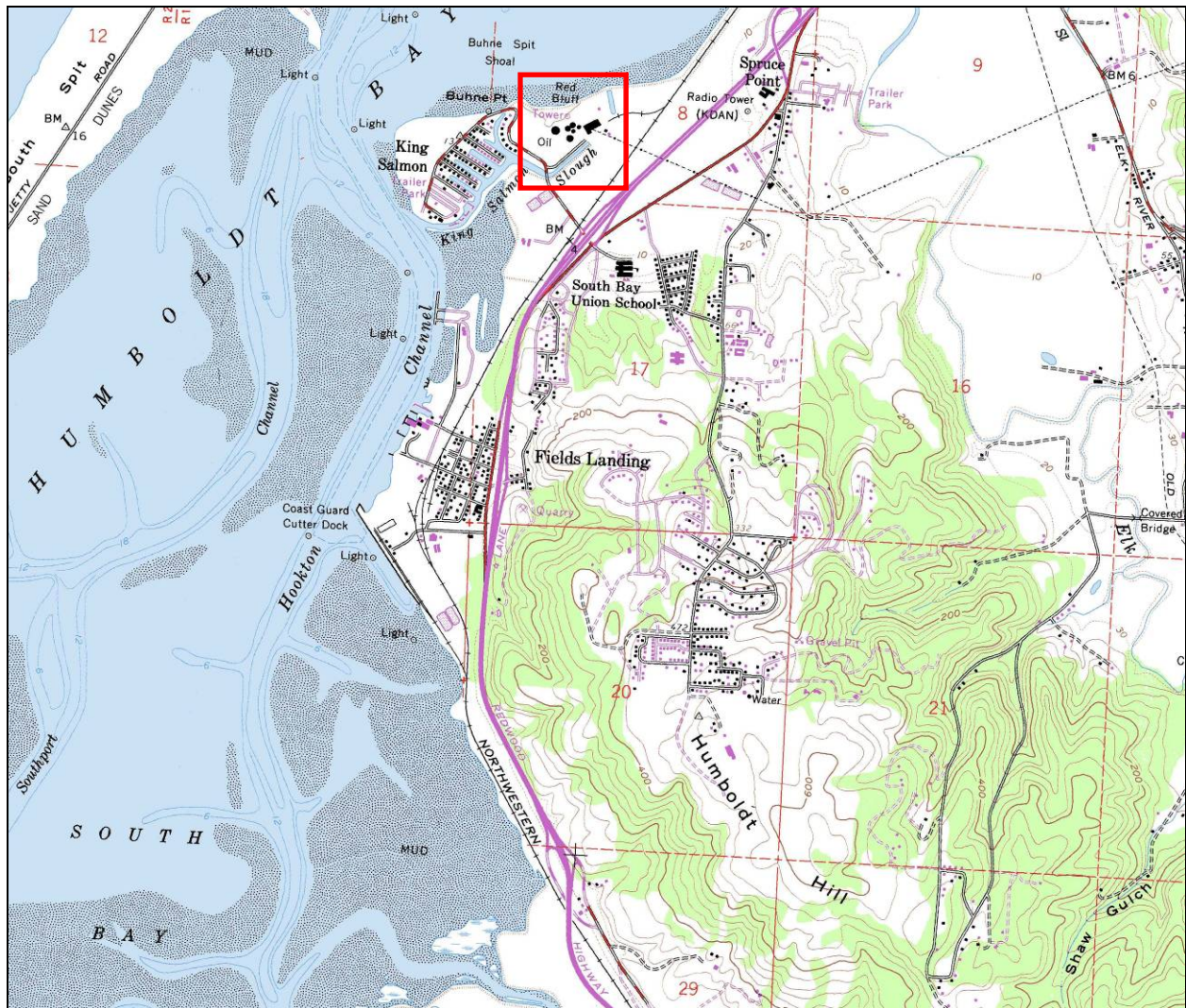


Figure 3. Fields Landing Map

The red box indicates location of Humboldt Bay Power Plant, 1973 *Fields Landing* USGS 7.5 Minute Quadrangle.

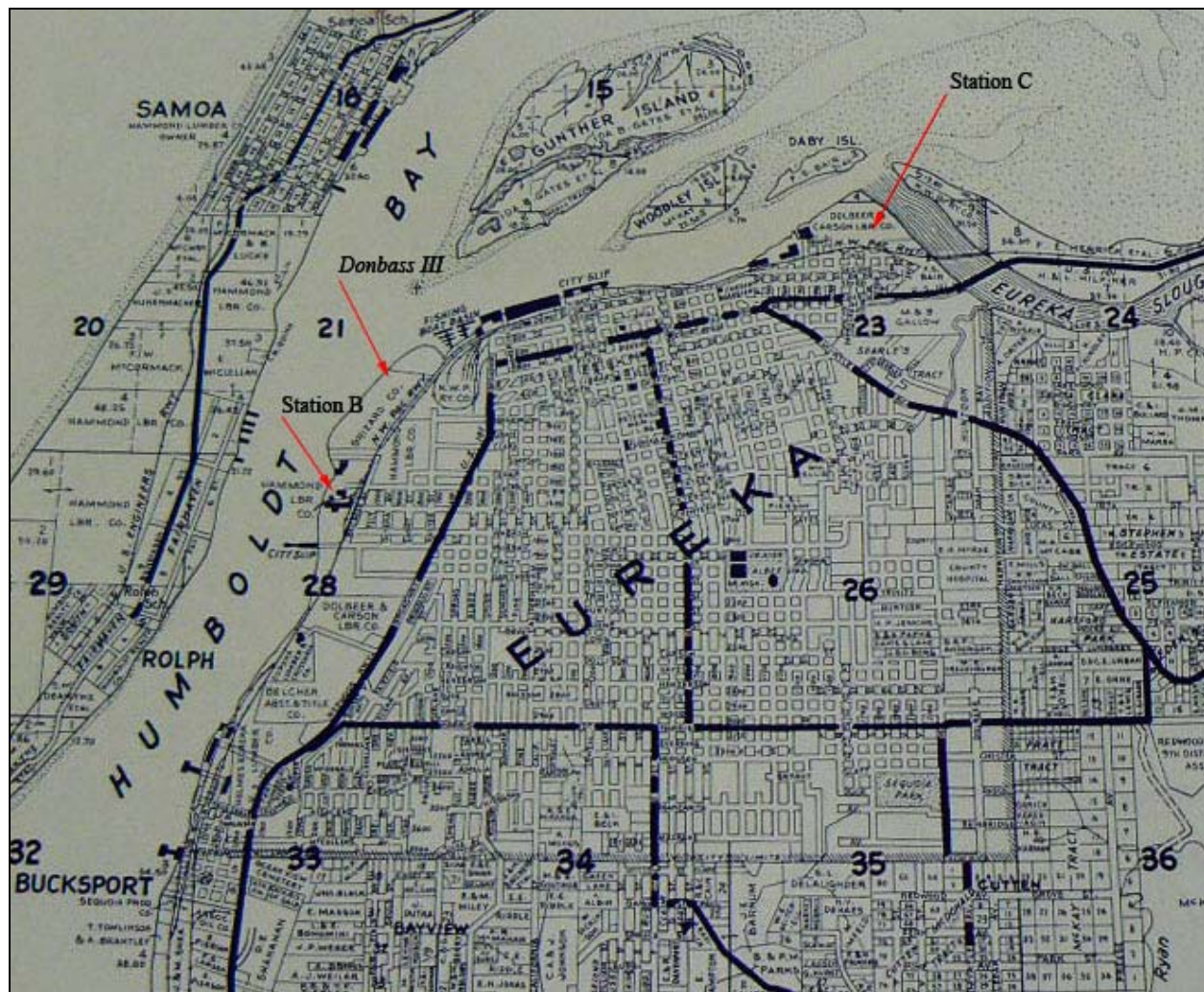


Figure 4. Map of Eureka 1950

A portion of Metsker's County Map showing Eureka in 1950. The red arrows indicate the locations of three PG&E power facilities that pre-date the Humboldt Bay Power Plant. From left to right: Station B, the *Donbass III*, and Station C.

APPENDIX B

PRINT OUTS OF SCANNED ENGINEERING DRAWINGS

PRINT OUTS OF SCANNED HISTORIC ENGINEERING DRAWINGS

Note: The following are non-archival paper printouts of scanned files made from original drawings. The scan files were obtained from staff at PG&E headquarters at 77 Beale Street, San Francisco, California. The following companies created the original drawings during the indicated time periods:

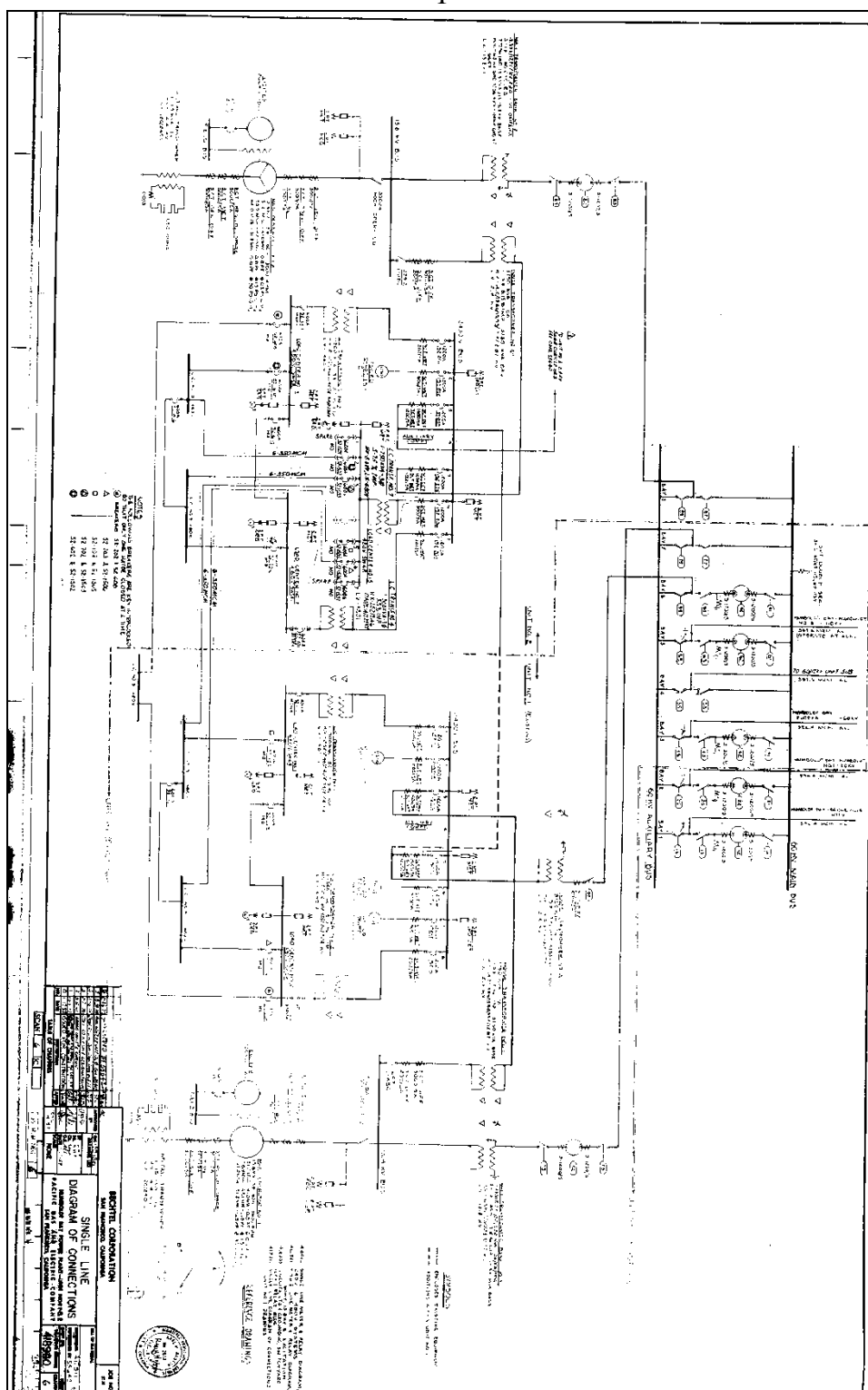
Pacific Gas & Electric	1985, 1998, 2000-2002
Bechtel Corporation	1957-1961
Combustion Engineering	1959-1961

- 1 SINGLE LINE DIAGRAM OF CONNECTIONS FOR UNITS 1 & 2 DRAWN BY BECHTEL CORPORATION, JANUARY 17, 1957. DRAWING NUMBER 418940, SHEET 6.
- 2 FIRE WATER SYSTEM PLAN & PROFILE FOR UNIT 1. DRAWN BY PACIFIC GAS & ELECTRIC, JUNE 25, 1998. DRAWING NUMBER 417014, SHEET 10.
- 3 CIRCULATING WATER SYSTEM INTAKE STRUCTURE PLAN AND SECTIONAL FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, FEBRUARY 19, 1960. DRAWING NUMBER 55412, SHEET 11.
- 4 CIRCULATING WATER SYSTEM INTAKE STRUCTURE MISCELLANEOUS DETAILS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, FEBRUARY 19, 1960. DRAWING NUMBER 55413, SHEET 5.
- 5 SITE PLAN FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, FEBRUARY 19, 1960. DRAWING NUMBER 55401, SHEET 10.
- 6 UTILITY AND ROUGH GRADING PLAN FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, OCTOBER 31, 1960. DRAWING NUMBER 55403, SHEET 11.
- 7 RADIATION ZONES PLOT PLAN. DRAWN BY BECHTEL CORPORATION, JULY 3, 1960. DRAWING NUMBER 55595.
- 8 ARCHITECTURAL FLOOR PLANS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, NOVEMBER 9, 1959. DRAWING NUMBER 55476, SHEET 4.
- 9 ARCHITECTURAL PLANS AND ELEVATIONS PRE-ENGINEERED BUILDING FOR EXISTING RADIOACTIVE WASTE FACILITY FOR UNIT 3. DRAWN BY PACIFIC GAS & ELECTRIC, AUGUST 12, 1985. DRAWING NUMBER 518328, SHEET 4.

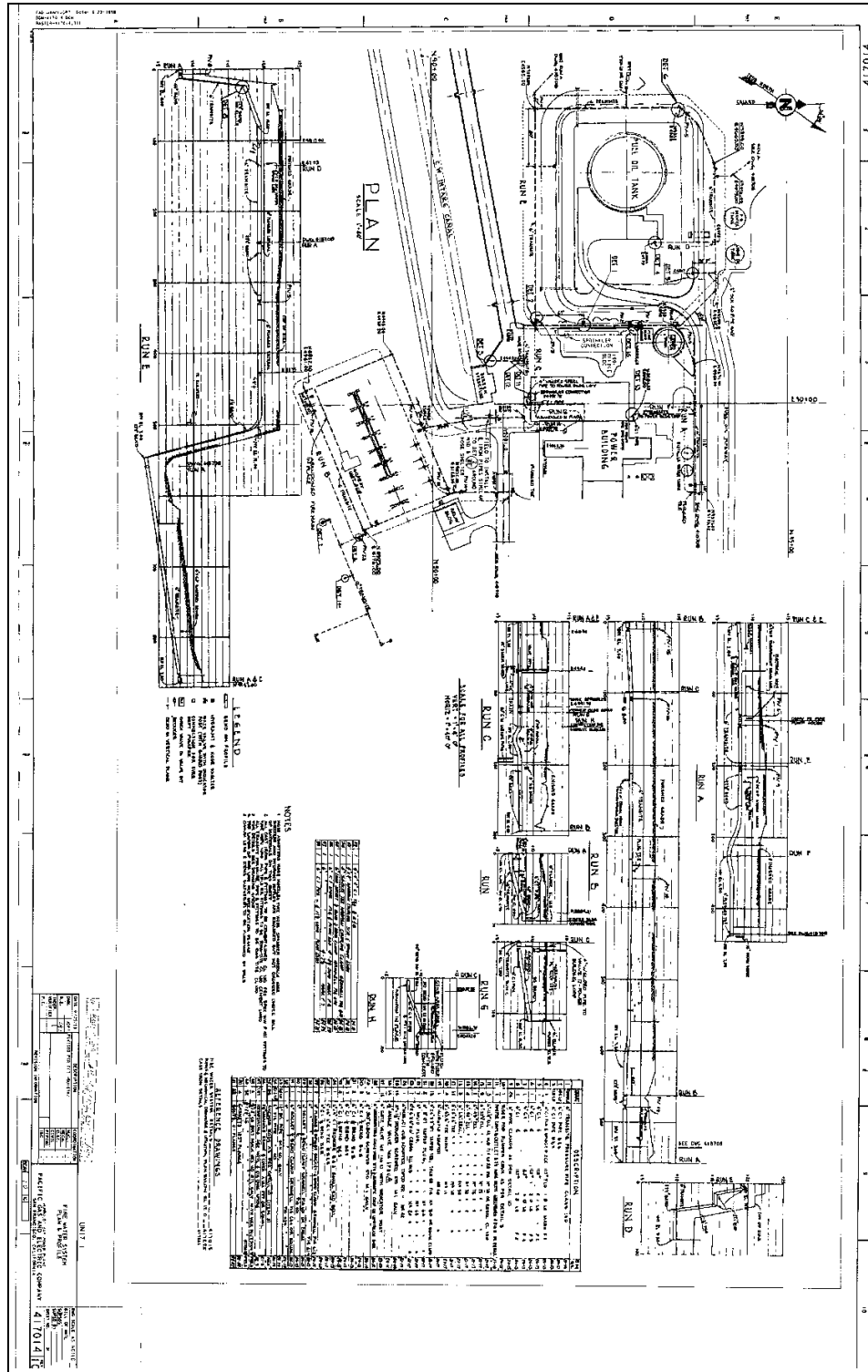
- 10 ARCHITECTURAL PLANS AND DETAILS FOR UNIT 3. DRAWN BY PACIFIC GAS & ELECTRIC, FEBRUARY 25, 2002. DRAWING NUMBER 55479, SHEET 6.
- 11 STATION BUILDING FOUNDATION PLAN AND ELEVATION FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, OCTOBER 31, 1960. DRAWING NUMBER 55421, SHEET 9.
- 12 ARCHITECTURAL ELEVATIONS AND SECTIONS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, NOVEMBER 17, 1959. DRAWING NUMBER 55477.
- 13 STATION BUILDING CROSS-SECTIONS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, NOVEMBER 9, 1960. DRAWING NUMBER 55423, SHEET 8.
- 14 STATION BUILDING EQUIPMENT FOUNDATIONS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, NOVEMBER 9, 1960. DRAWING NUMBER 55434, SHEET 2.
- 15 ARCHITECTURAL INTERIOR ELEVATIONS & DETAILS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, JULY 11, 1961. DRAWING NUMBER 55482, SHEET 3.
- 16 FOUNDATION PILING PLAN FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, MARCH 14, 1960. DRAWING NUMBER 55420, SHEET 2.
- 17 CAISSON GENERAL ARRANGEMENT FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, MARCH 21, 1960. DRAWING 55426, SHEET 3.
- 18 REACTOR CAISSON DETAILS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, MARCH 21, 1960. DRAWING NUMBER 55430, SHEET 7.
- 19 CIVIL REACTOR CAISSON HORIZONTAL SECTIONS FOR UNIT 3. DRAWN BY PACIFIC GAS & ELECTRIC, JANUARY 2, 2001. DRAWING NUMBER 55427, SHEET 10.
- 20 CIVIL REACTOR CAISSON VERTICAL SECTIONS FOR UNIT 3. DRAWN BY PACIFIC GAS & ELECTRIC, JANUARY 2, 2001. DRAWING NUMBER 55428, SHEET 8.
- 21 CIVIL REACTOR CAISSON DETAILS FOR UNIT 3. DRAWN BY PACIFIC GAS & ELECTRIC, DECEMBER 22, 2000. DRAWING NUMBER 55429, SHEET 8.

- 22 GENERAL ARRANGEMENT SIDE ELEVATION OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, MARCH 3, 1959. DRAWING NUMBER 645292, SHEET 1.
- 23 VESSEL FORMING AND WELDING OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, APRIL 14, 1959. DRAWING NUMBER 645292, SHEET 2.
- 24 NOZZLE ASSEMBLY AND DETAILS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, JULY 23, 1959. DRAWING NUMBER 645292, SHEET 3.
- 25 VESSEL SUPPORTS ARRANGEMENT AND DETAILS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, AUGUST 13, 1959. DRAWING NUMBER 645292, SHEET 4.
- 26 VESSEL SUPPORTS DETAILS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, SEPTEMBER 25, 1959. DRAWING NUMBER 645292, SHEET 5.
- 27 DRYER ASSEMBLY OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, JULY 26, 1960. DRAWING NUMBER 645292, SHEET 15.
- 28 COOLING SPRAY SPARGER ASSEMBLY OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, AUGUST 27, 1960. DRAWING NUMBER 645292, SHEET 16.
- 29 CLOSURE HEAD FINAL MACHINING OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, JULY 31, 1959. DRAWING NUMBER 645292, SHEET 17.
- 30 LOWER HEAD PENETRATIONS NOZZLE DETAIL OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, JANUARY 9, 1959. DRAWING NUMBER 645292, SHEET 18.
- 31 VESSEL FINAL MACHINING – PLAN VIEWS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTIONS ENGINEERING, AUGUST 16, 1959. DRAWING NUMBER 645292, SHEET 19.
- 32 CLOSURE HEAD FORMING AND WELDING OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, AUGUST 27, 1959. DRAWING NUMBER 645292, SHEET 20.

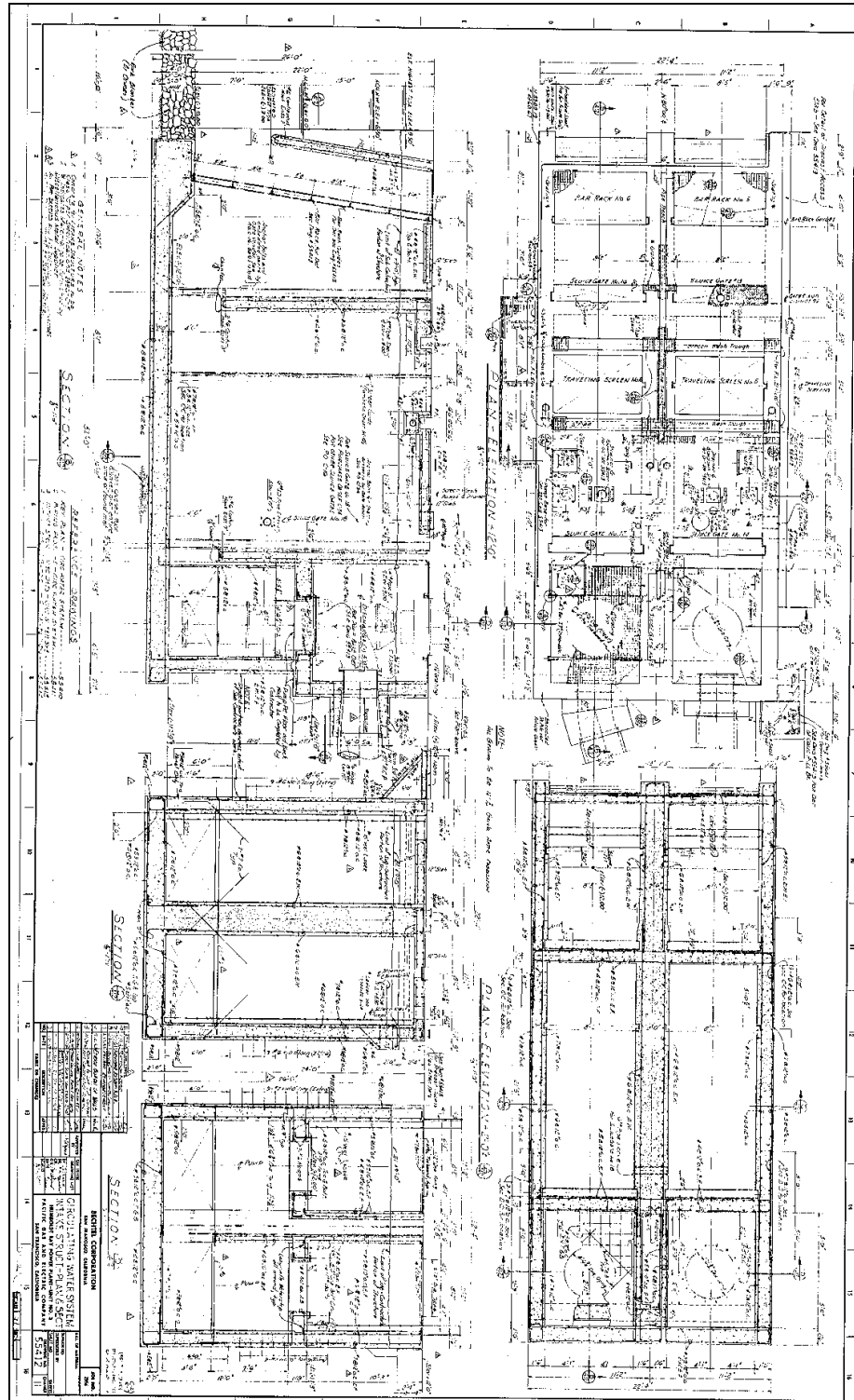
- 33 DRYER (STEAM MOISTURE SEPARATOR) DETAILS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, AUGUST 8, 1960. DRAWING NUMBER 645292, SHEET 21.
- 34 VESSEL INSERTS ASSEMBLY AND DETAILS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, DECEMBER 27, 1960. DRAWING NUMBER 645292, SHEET 22.
- 35 GENERAL ARRANGEMENT – PLAN VIEWS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, AUGUST 8, 1959. DRAWING NUMBER 645292, SHEET 23.
- 36 AS-BUILT DIMENSIONS OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, 1961. DRAWING NUMBER 645292, SHEET 24.
- 37 VESSEL LIFTING RIG OF REACTOR VESSEL FOR UNIT 3. DRAWN BY COMBUSTION ENGINEERING, MARCH 22, 1959. DRAWING NUMBER 645292, SHEET 25.
- 38 TURBINE PEDESTAL CROSS-SECTIONS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, MARCH 27, 1960. DRAWING NUMBER 55436, SHEET 3.
- 39 TURBINE PEDESTAL PLAN AND LONGITUDINAL SECTION FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, MARCH 21, 1960. DRAWING NUMBER 55435, SHEET 6.
- 40 CIVIL REFUELING BUILDING EXHAUST STACK FOUNDATION FOR UNIT 3. DRAWN BY PACIFIC GAS & ELECTRIC, JANUARY 21, 2000. DRAWING NUMBER 55465, SHEET 7.
- 41 STRUCTURAL STEEL COLUMN SCHEDULE AND ELEVATIONS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, MARCH 23, 1960. DRAWING NUMBER 55451, SHEET 5.
- 42 ARCHITECTURAL EXTERIOR DETAILS FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, DECEMBER 16, 1959. DRAWING NUMBER 55478, SHEET 2.
- 43 PLAN AND ELEVATIONS OF CONTAMINATED EQUIPMENT STORAGE BUILDING FOR UNIT 3. DRAWN BY BECHTEL CORPORATION, JANUARY 4, 1960. DRAWING NUMBER 55447, SHEET 2.

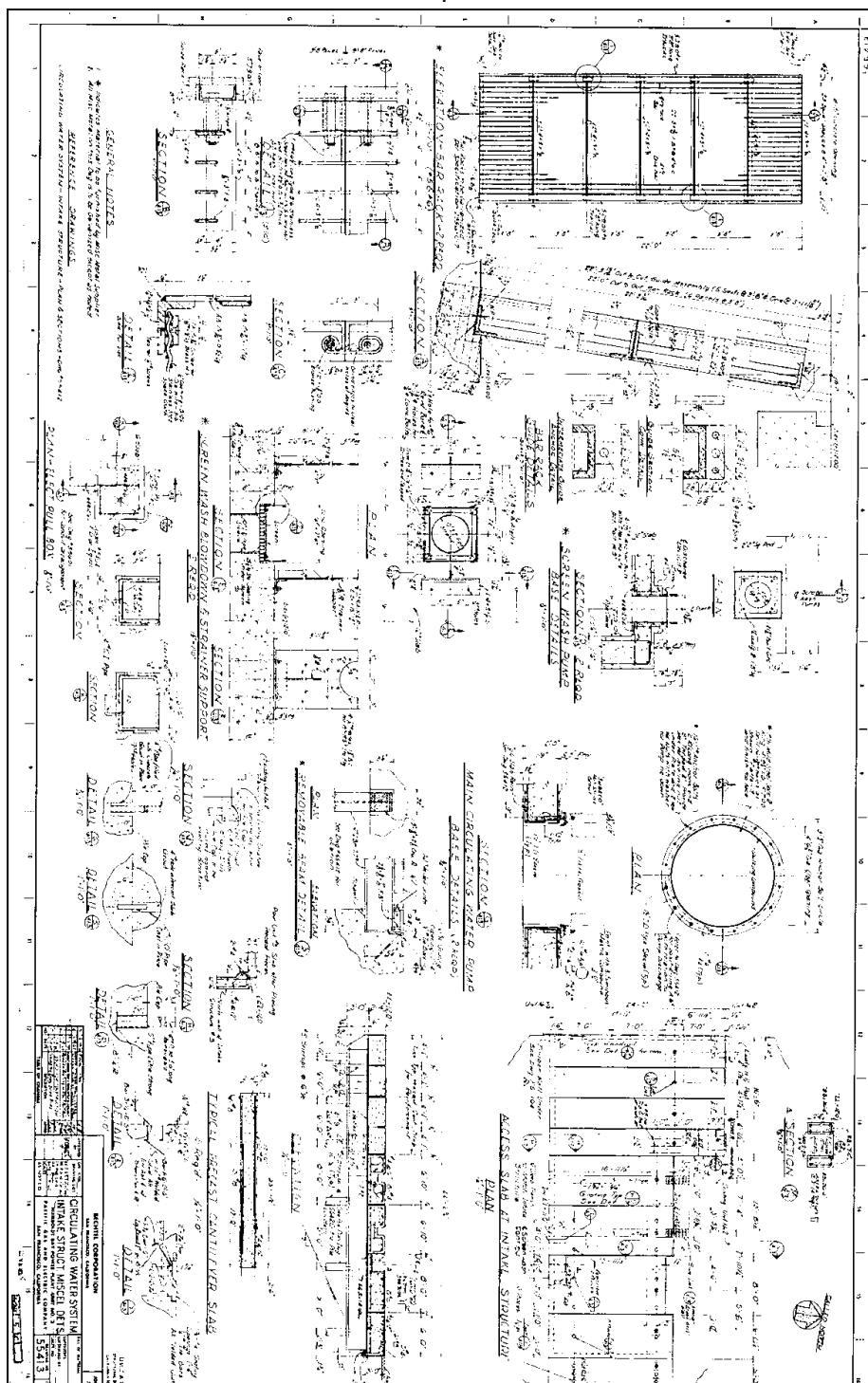


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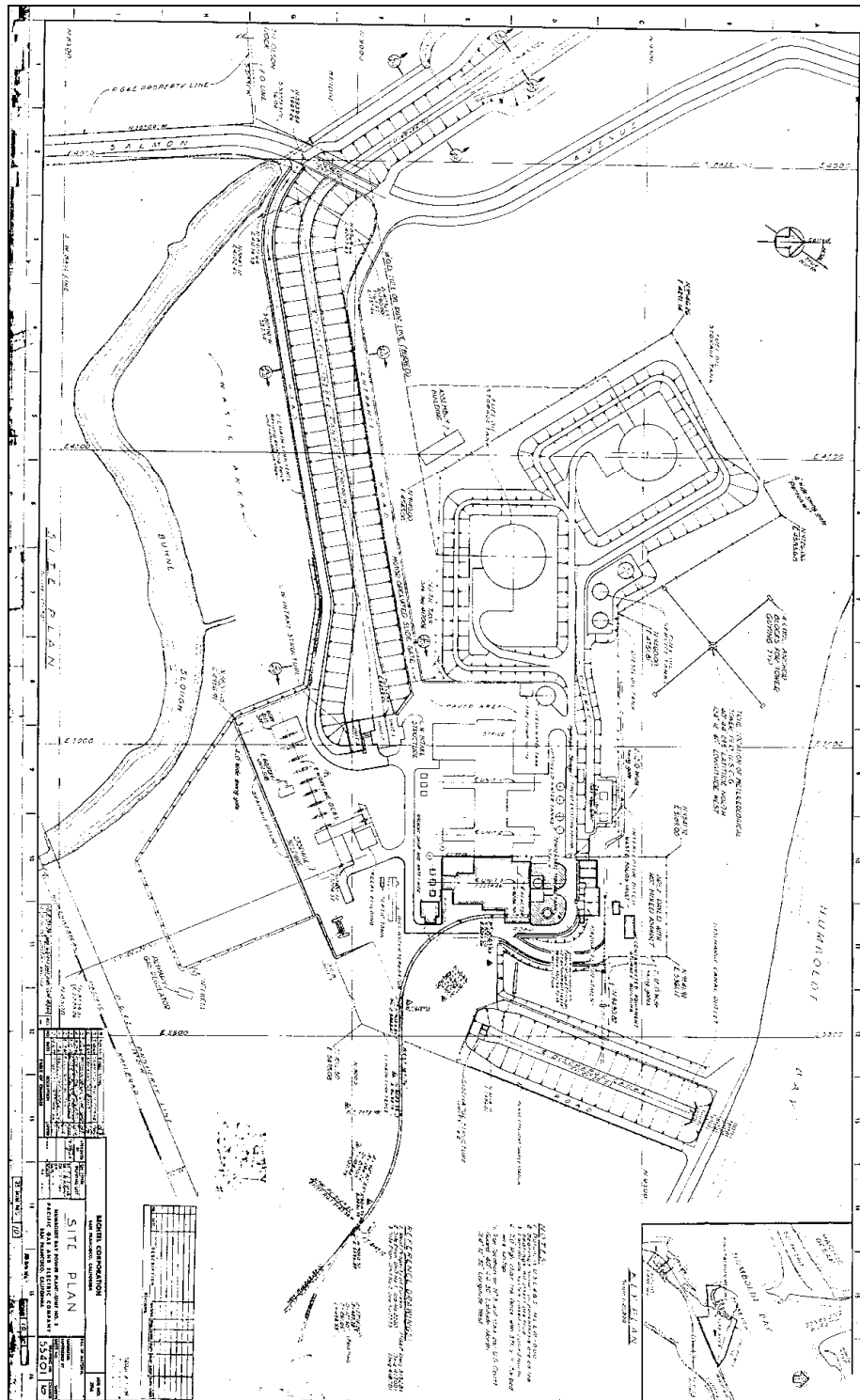


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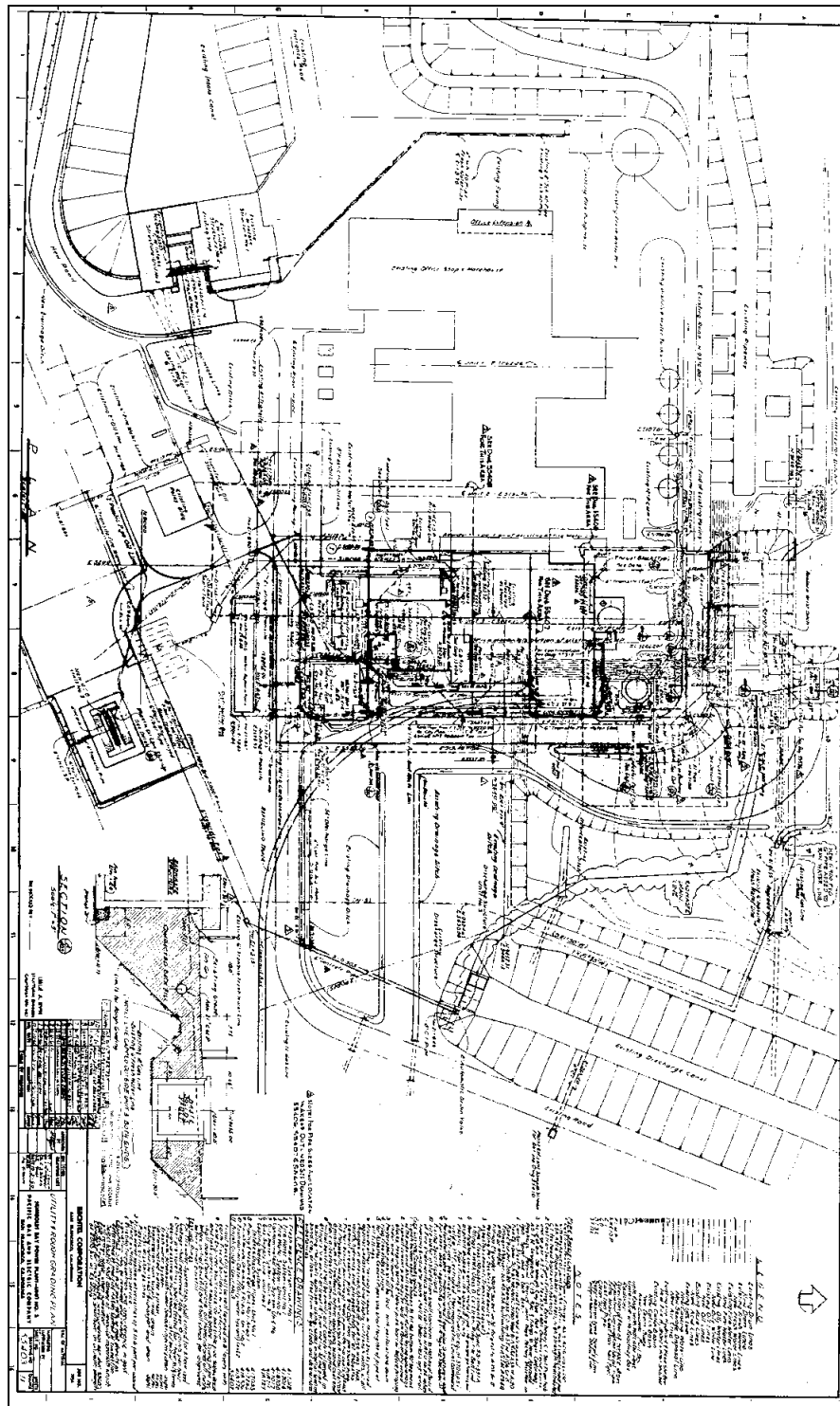
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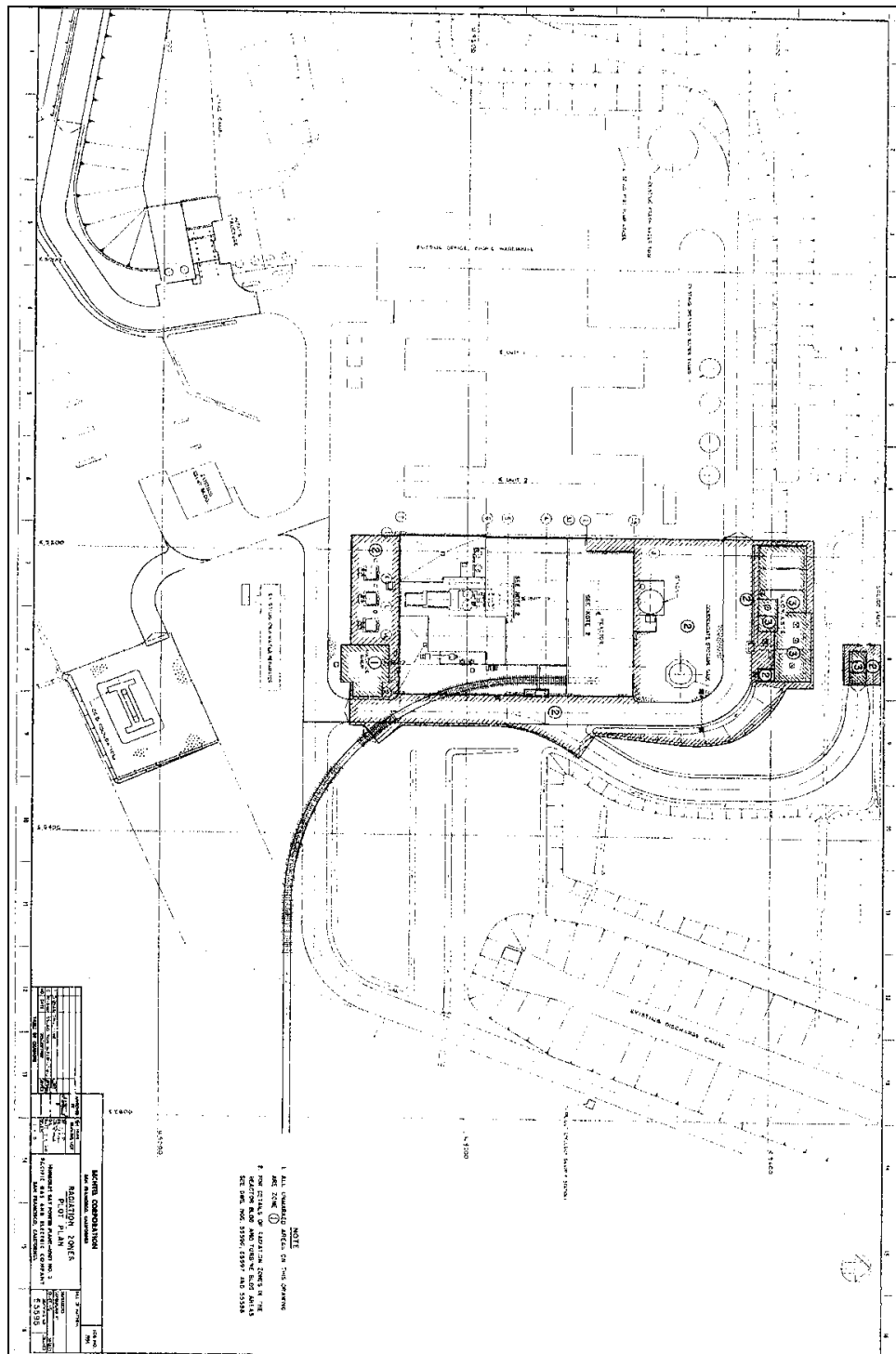
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HUMBOLDT BAY POWER PLANT

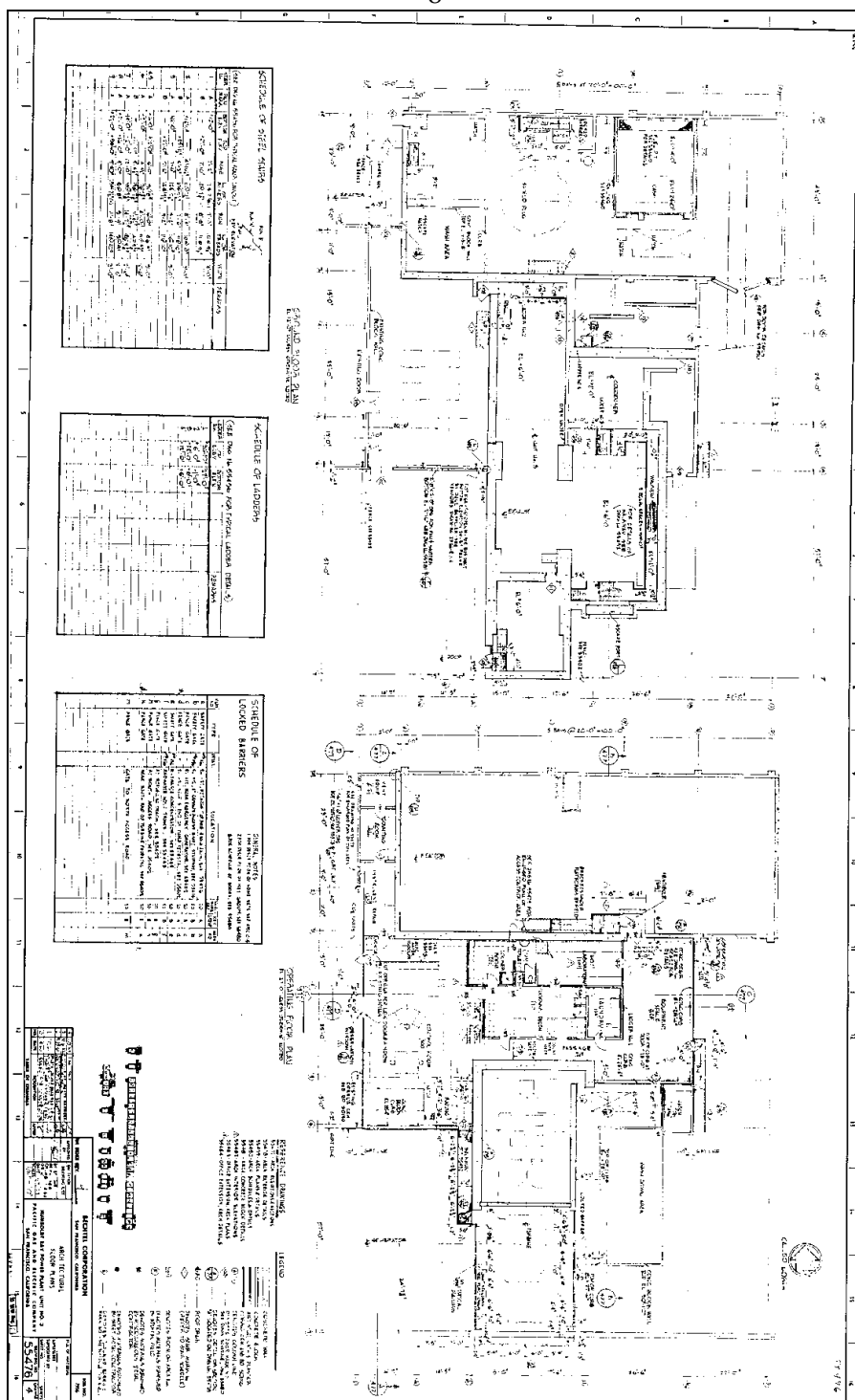
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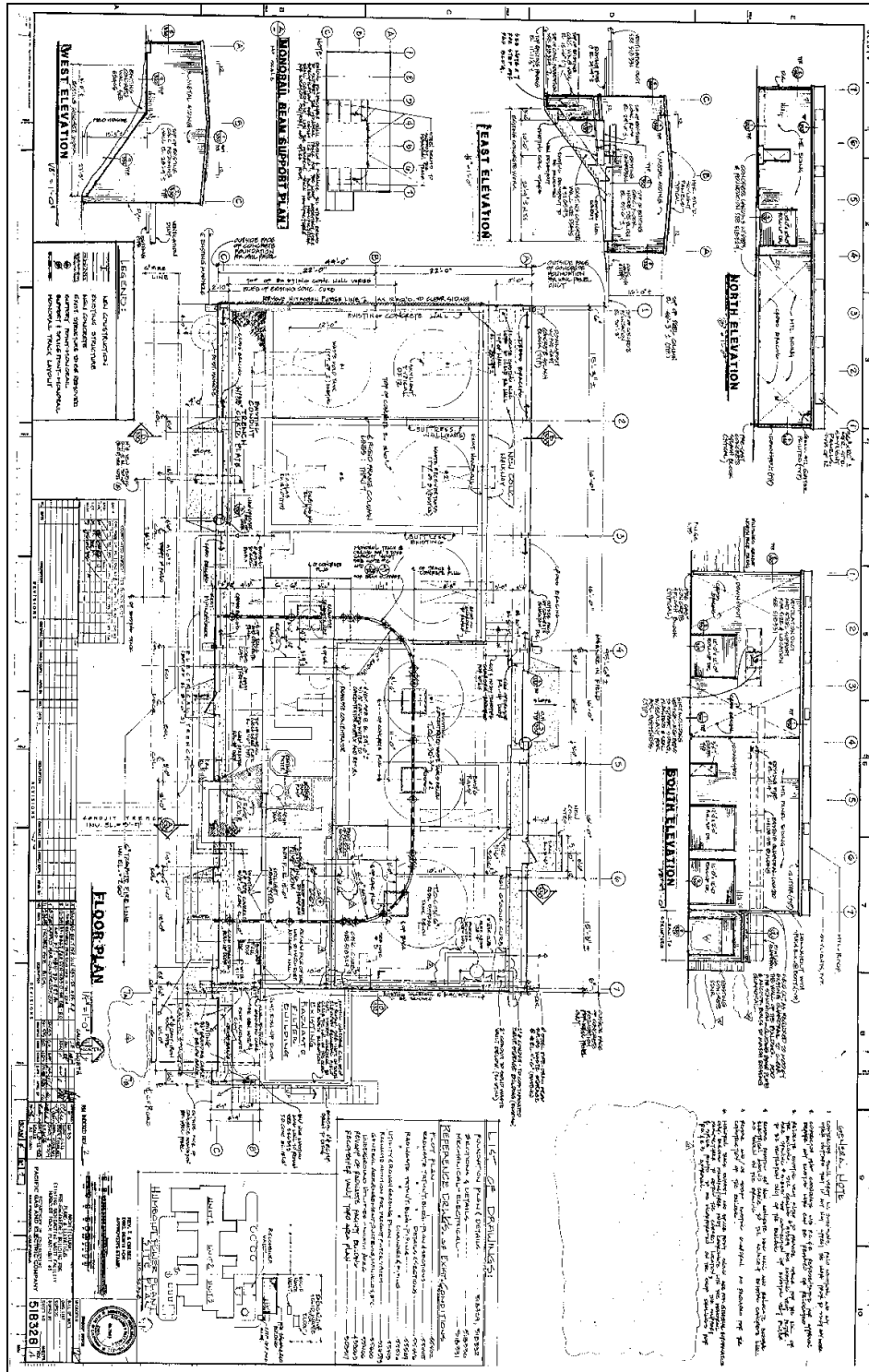
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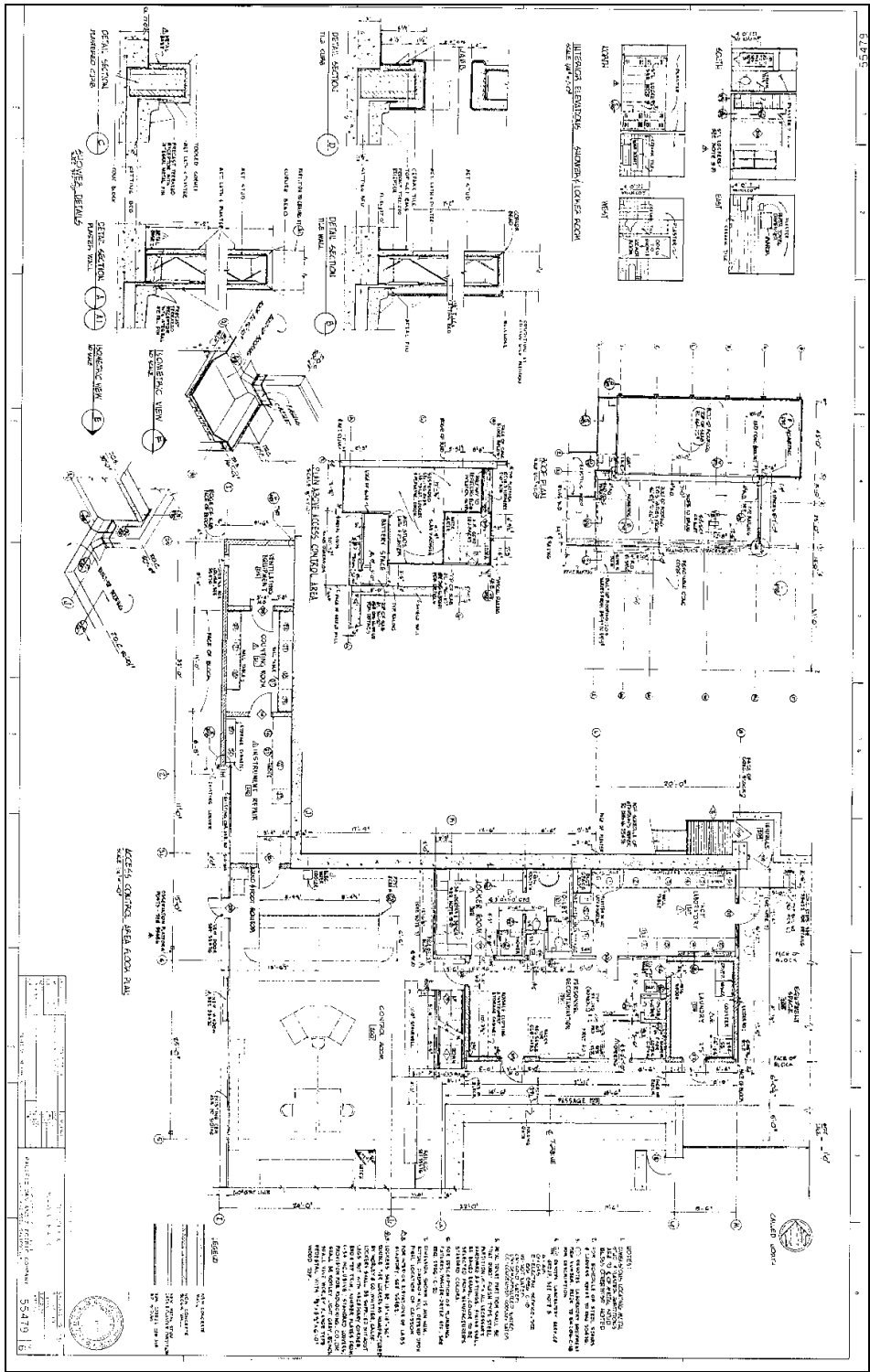


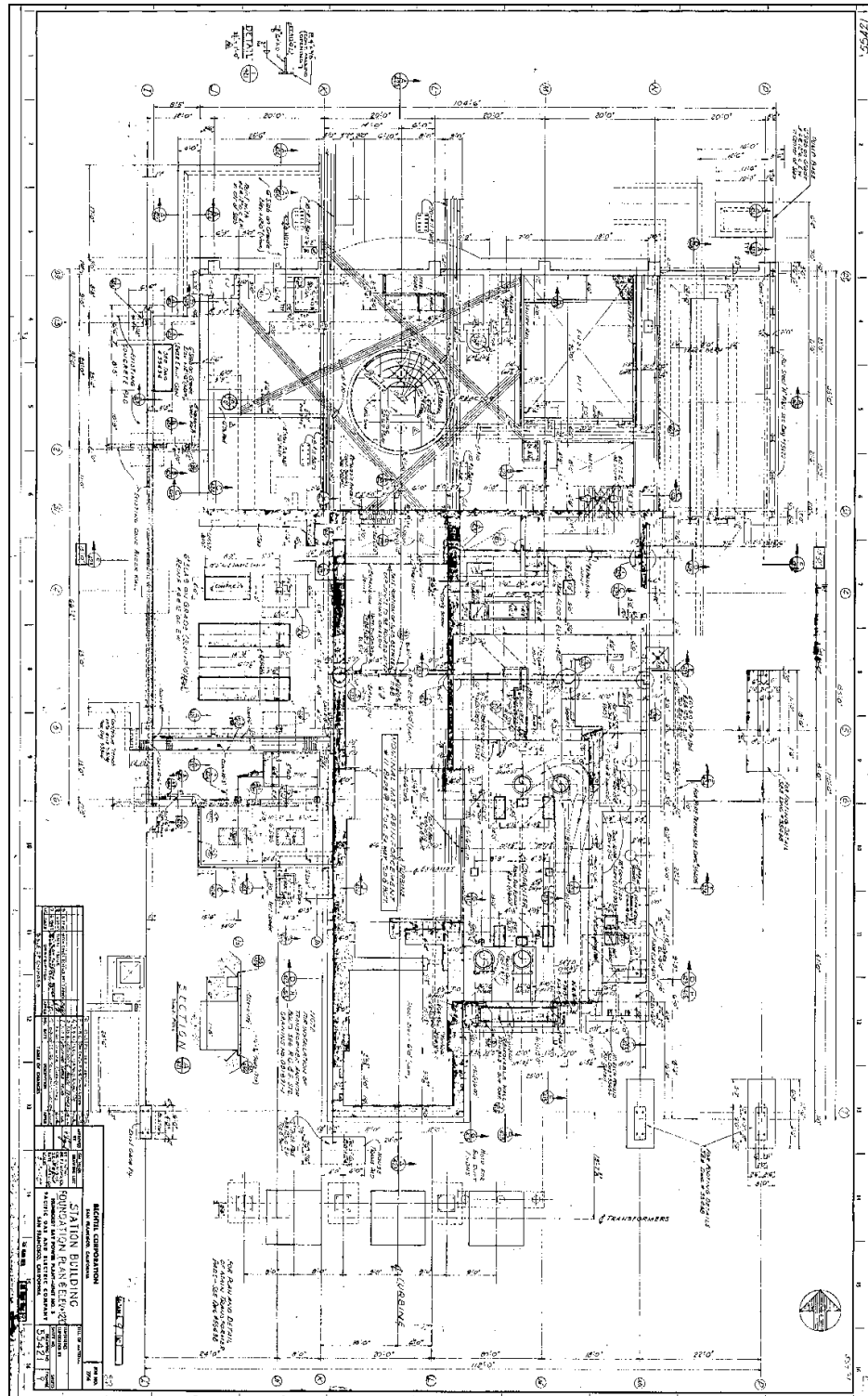
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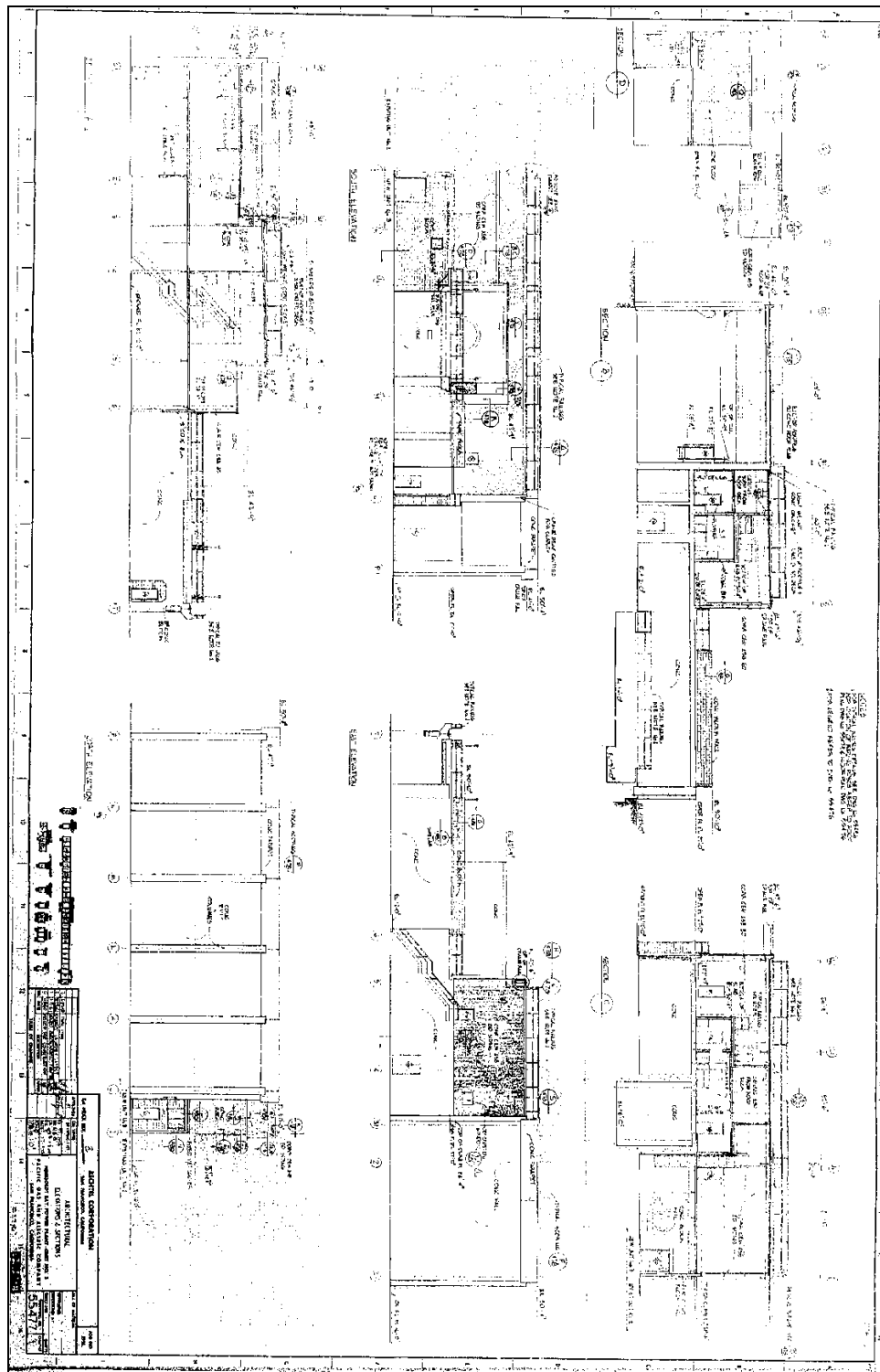


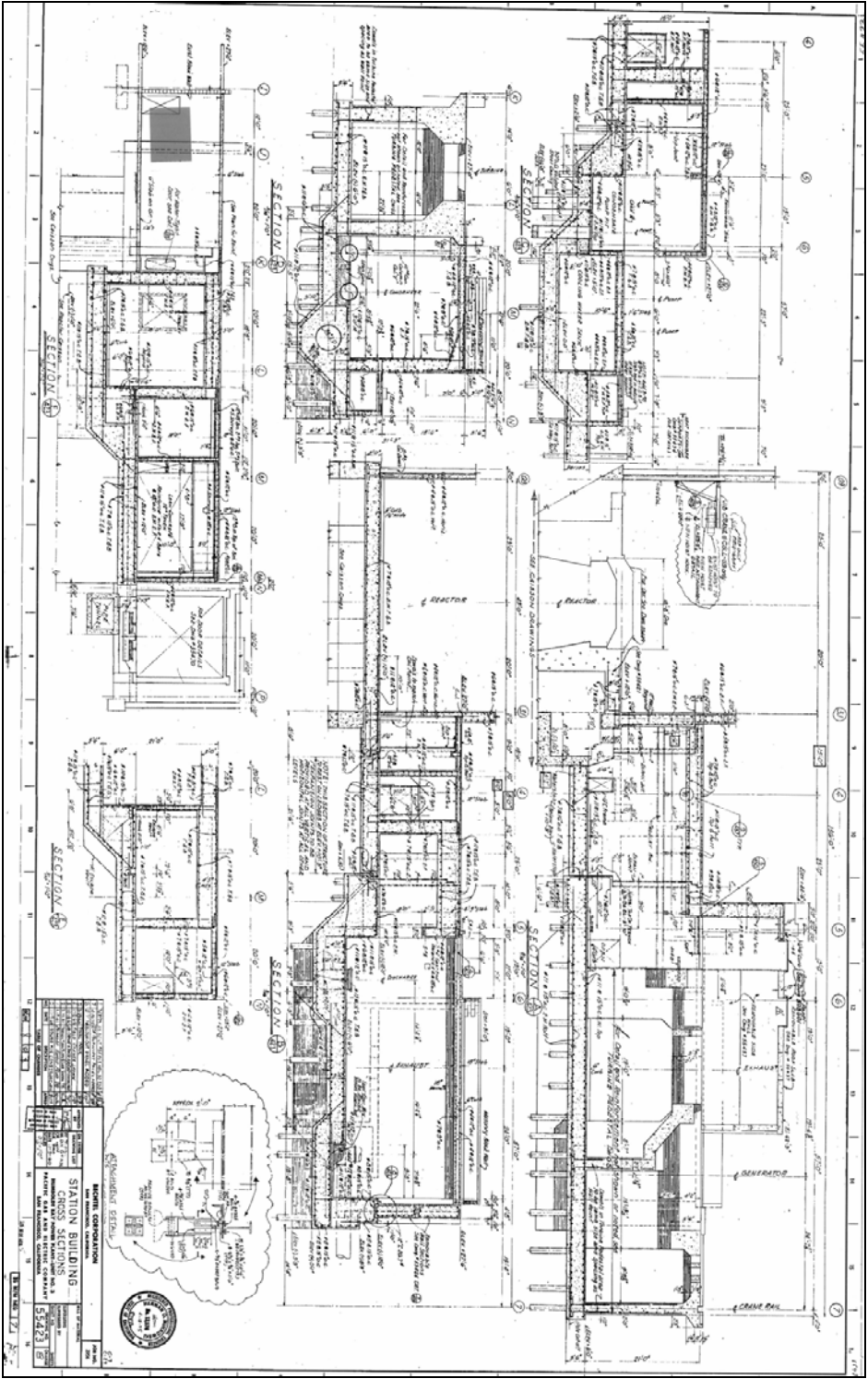


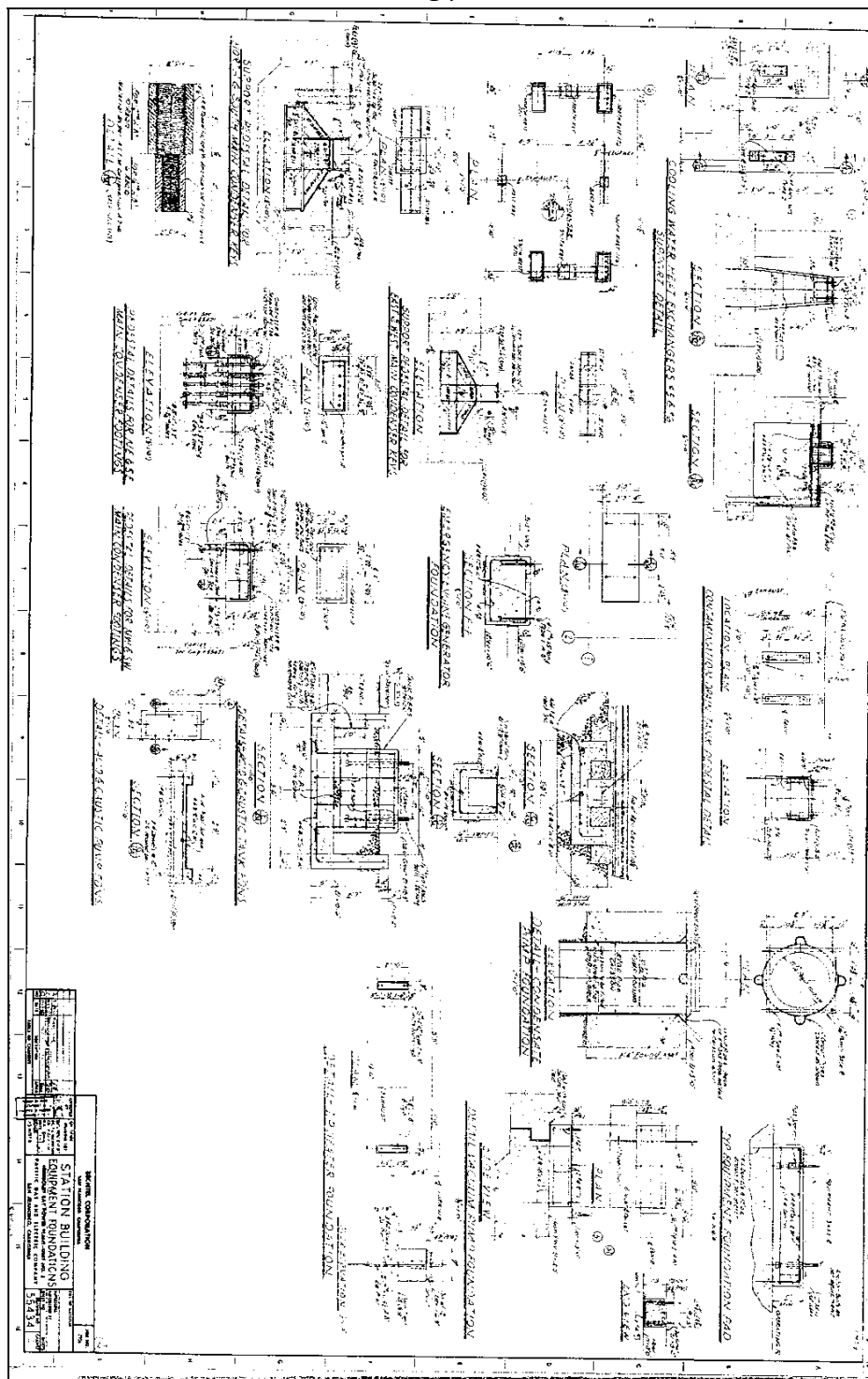


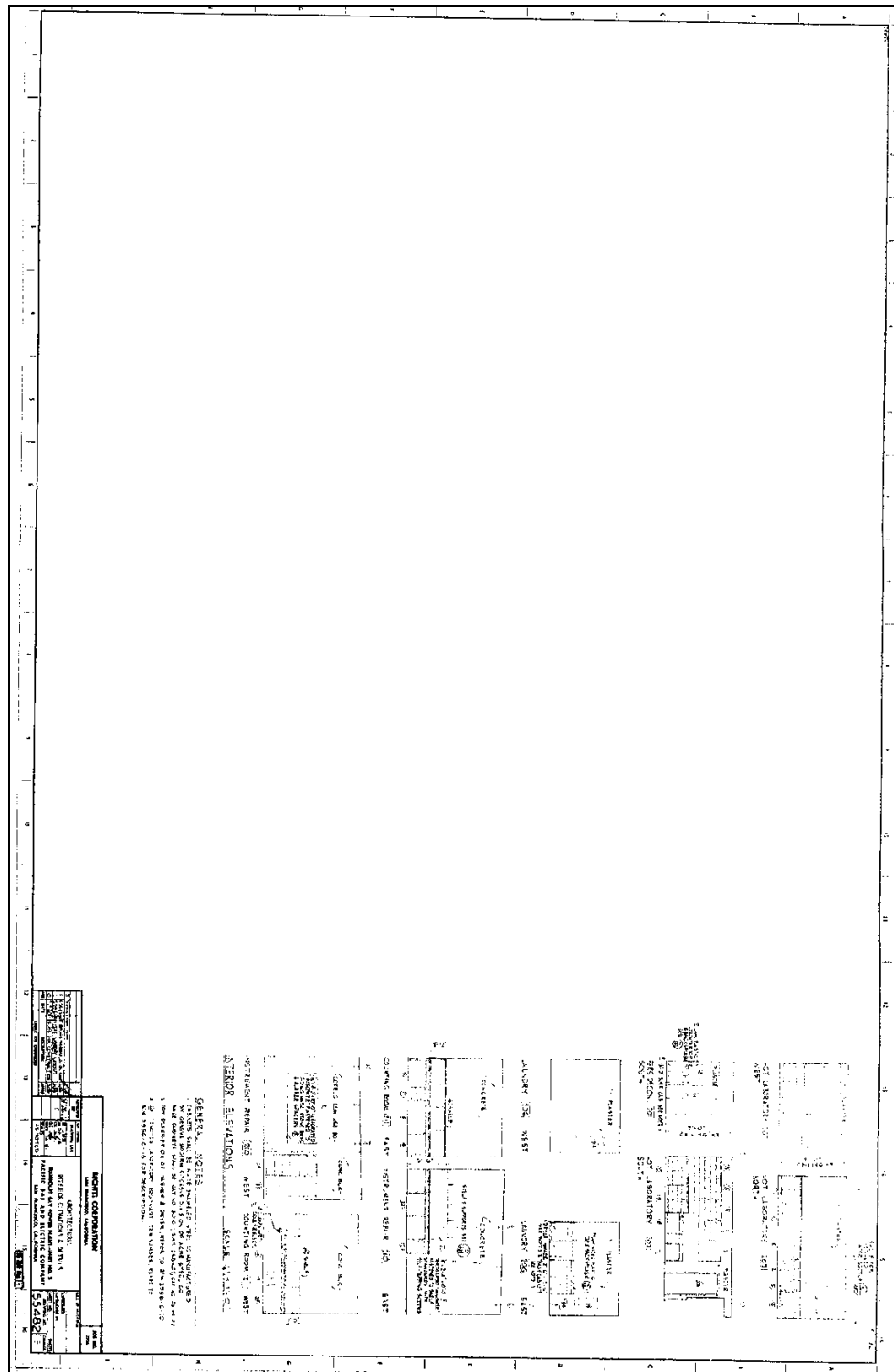


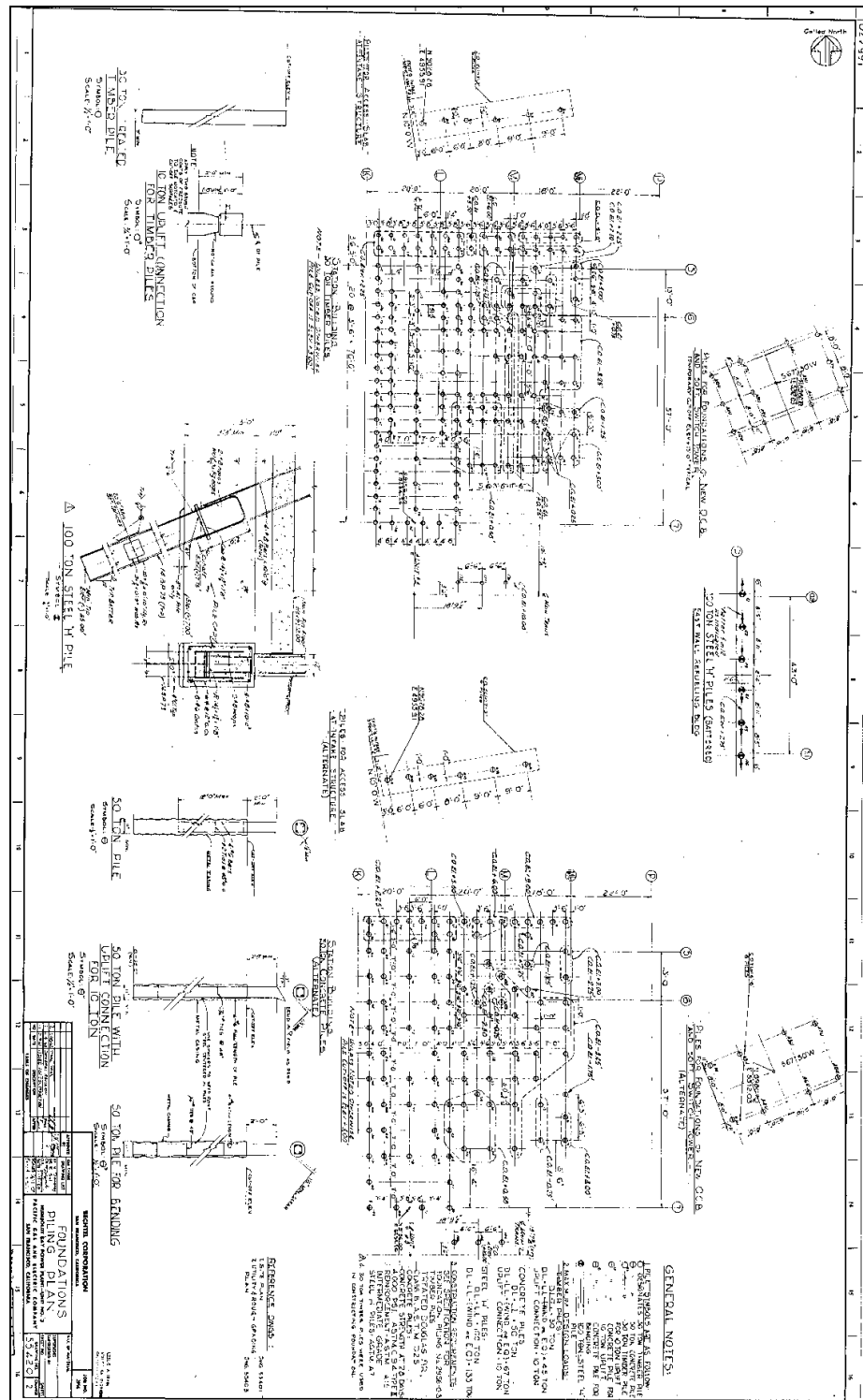


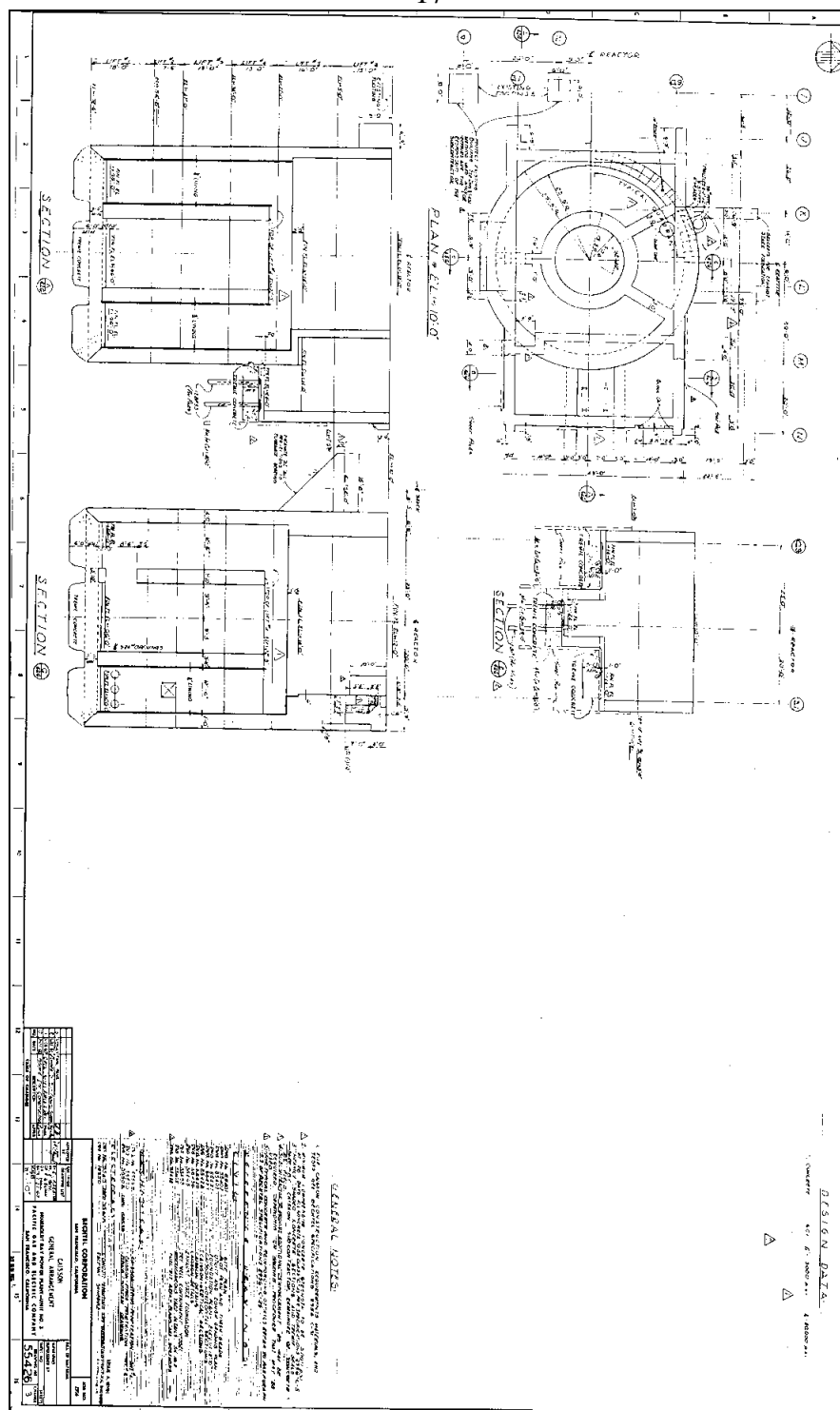


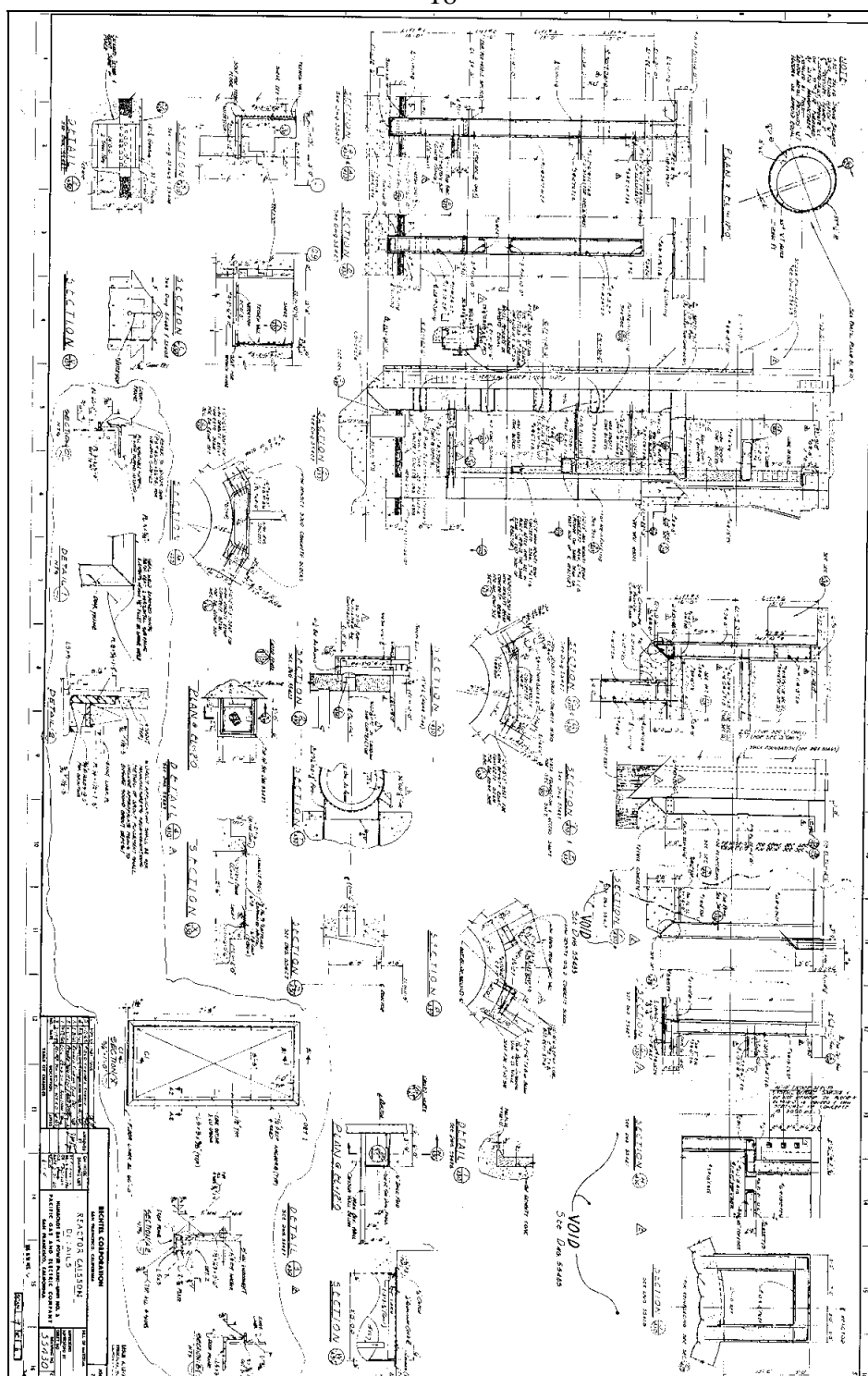


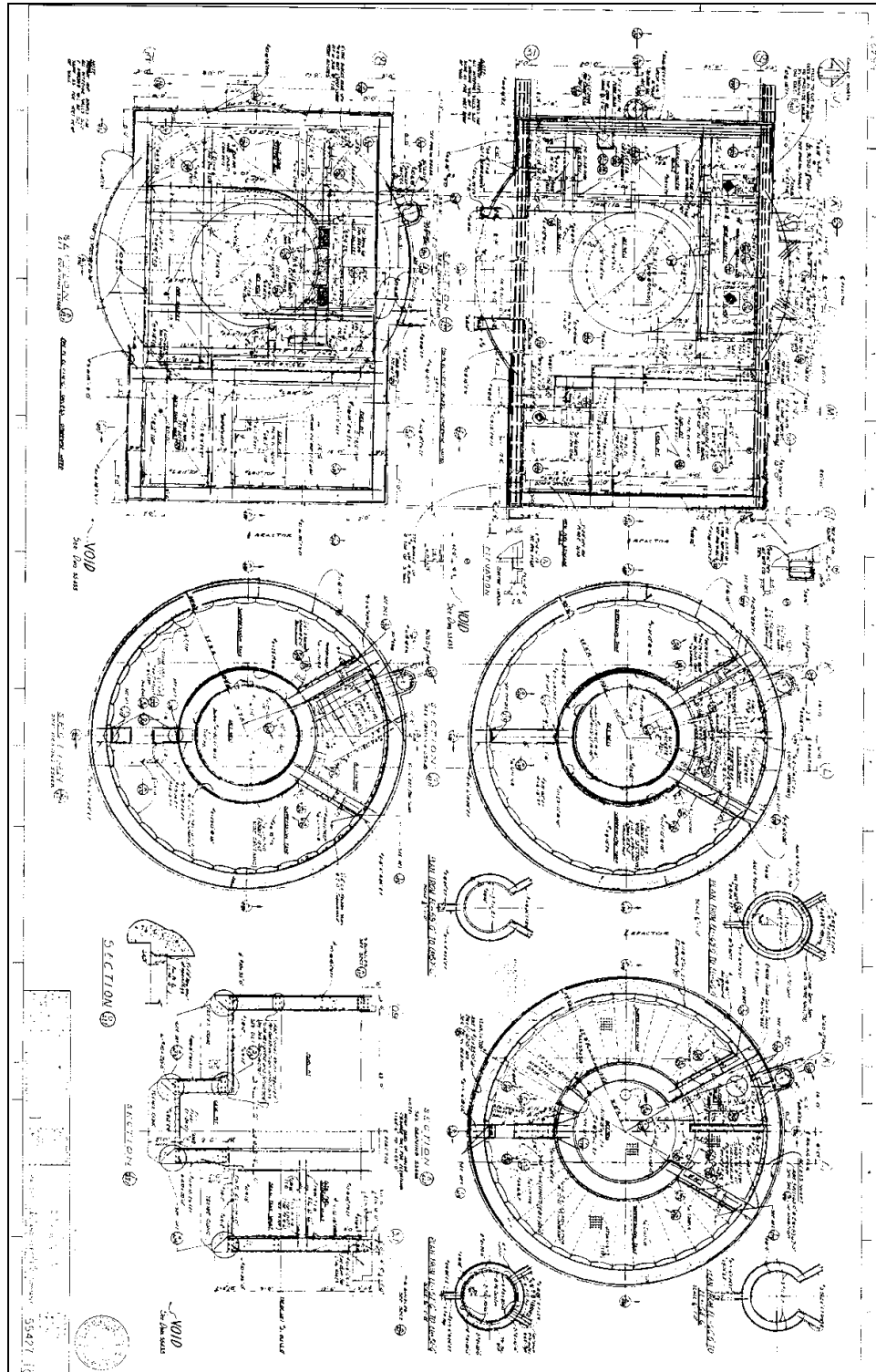


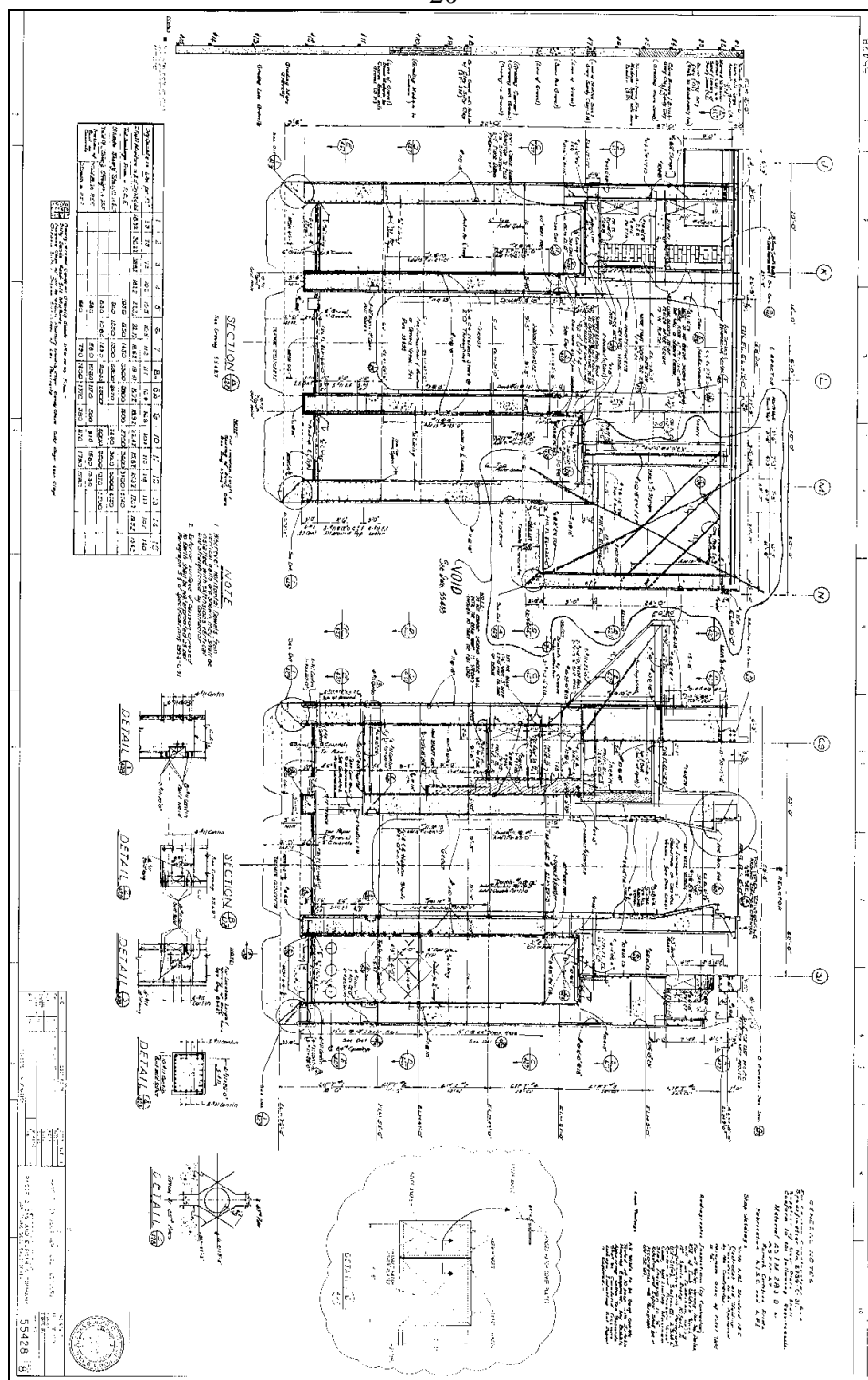




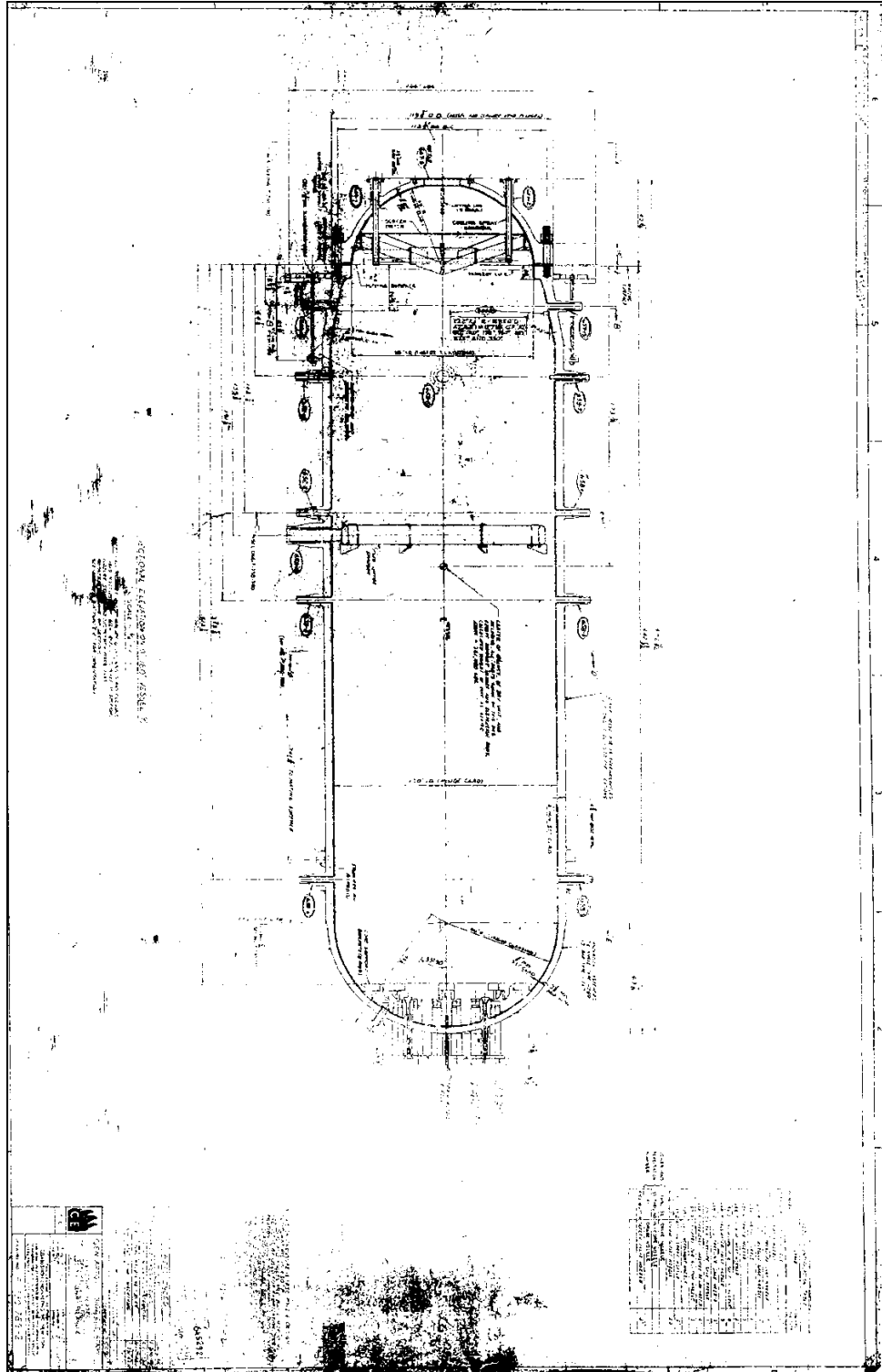


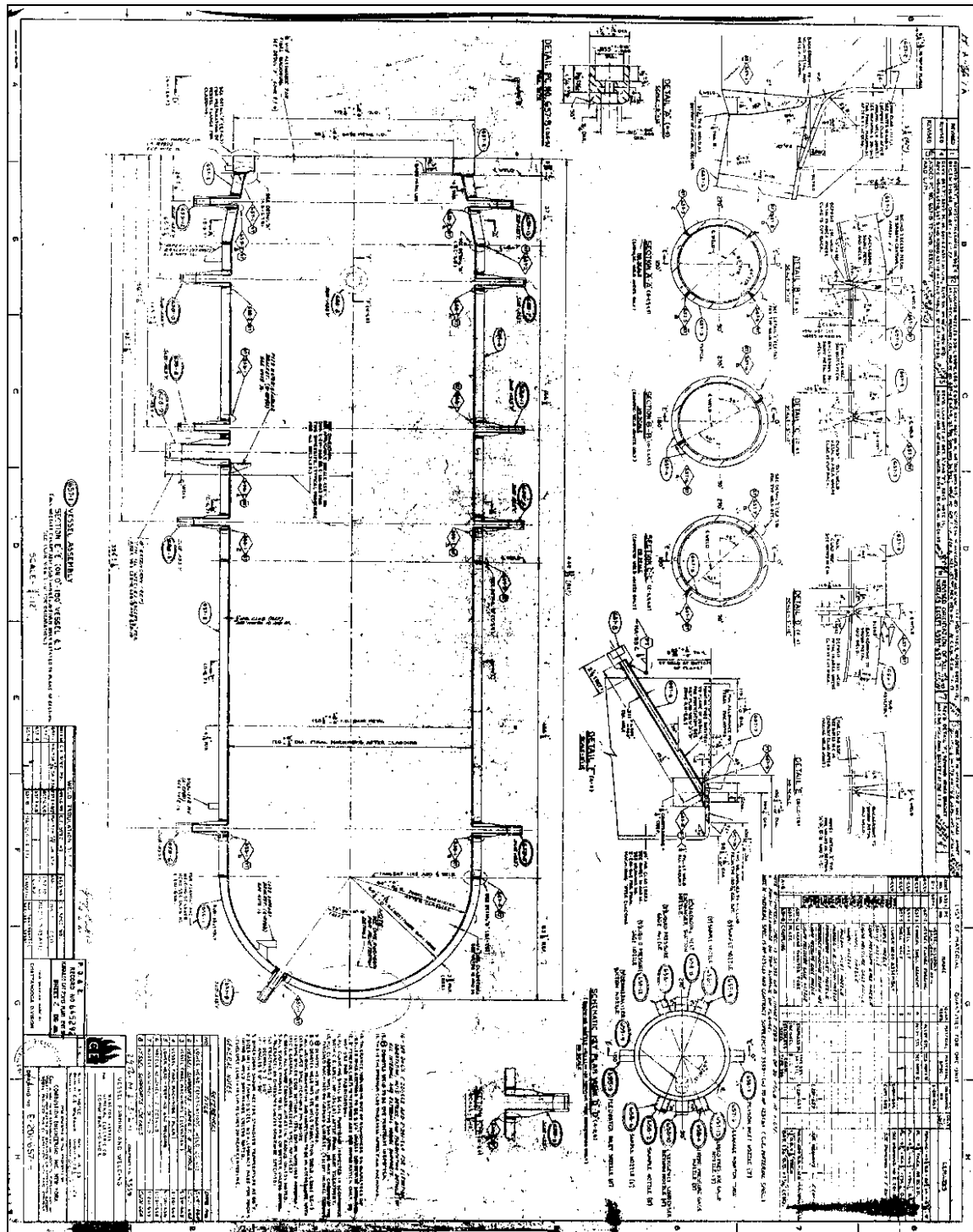


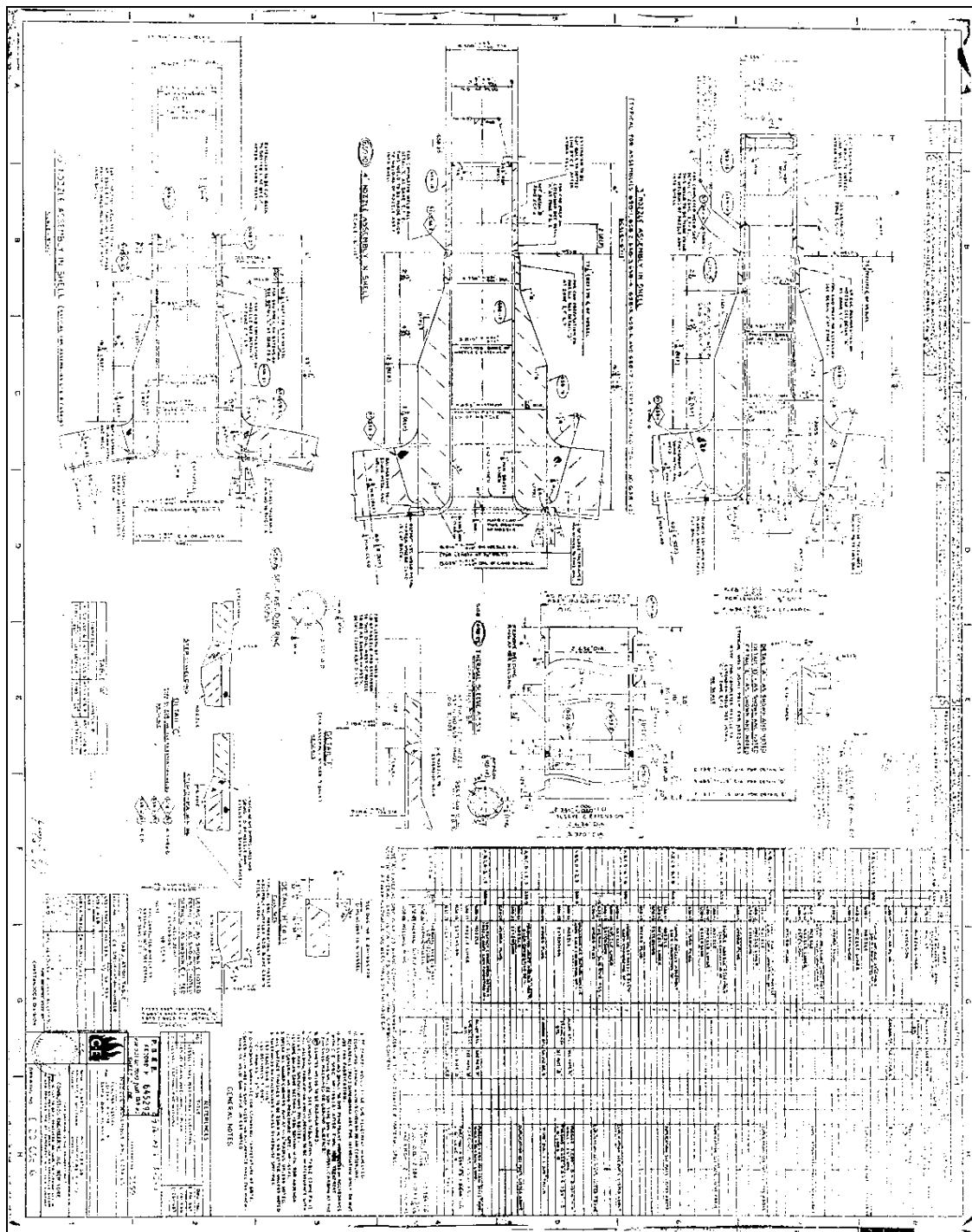




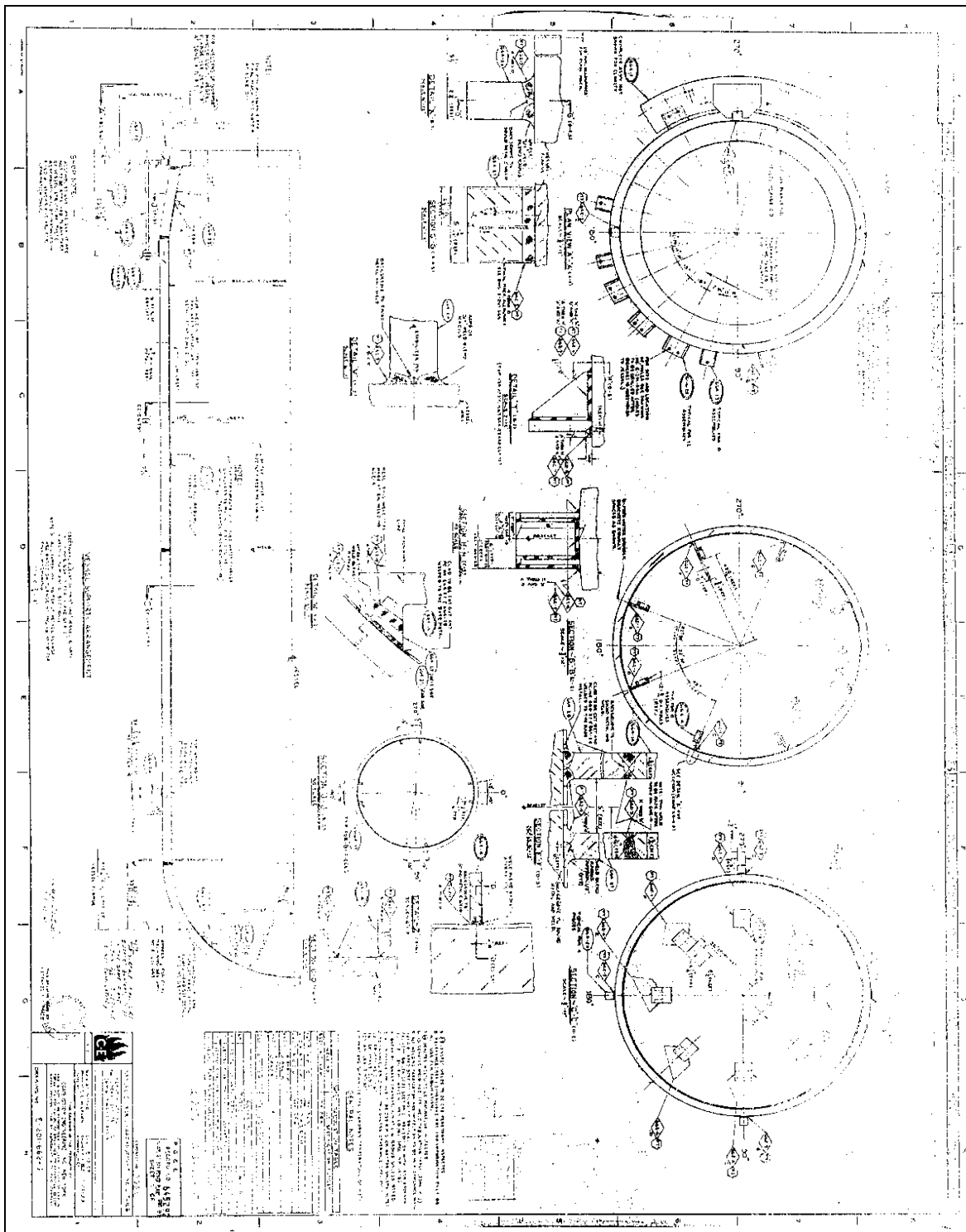
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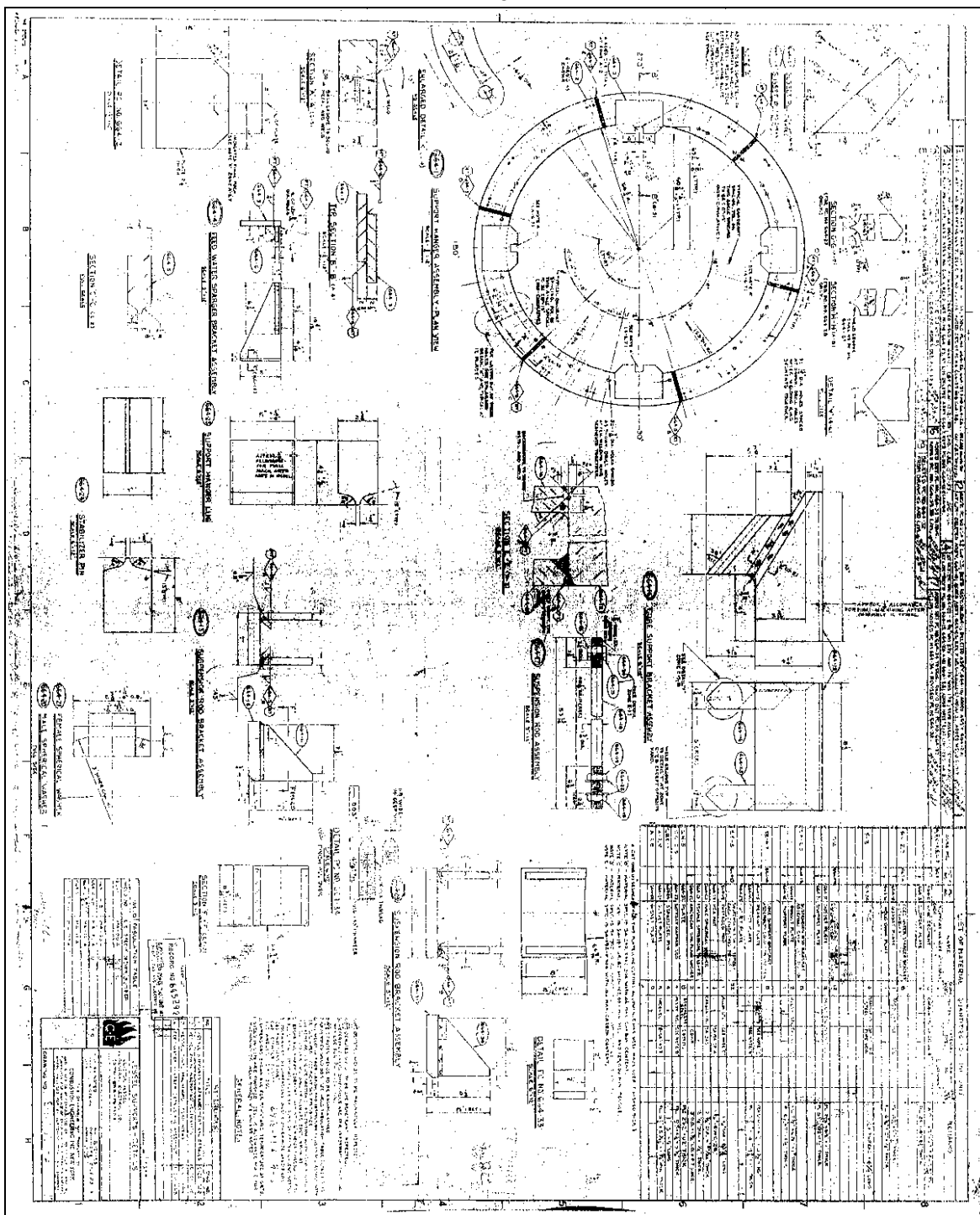


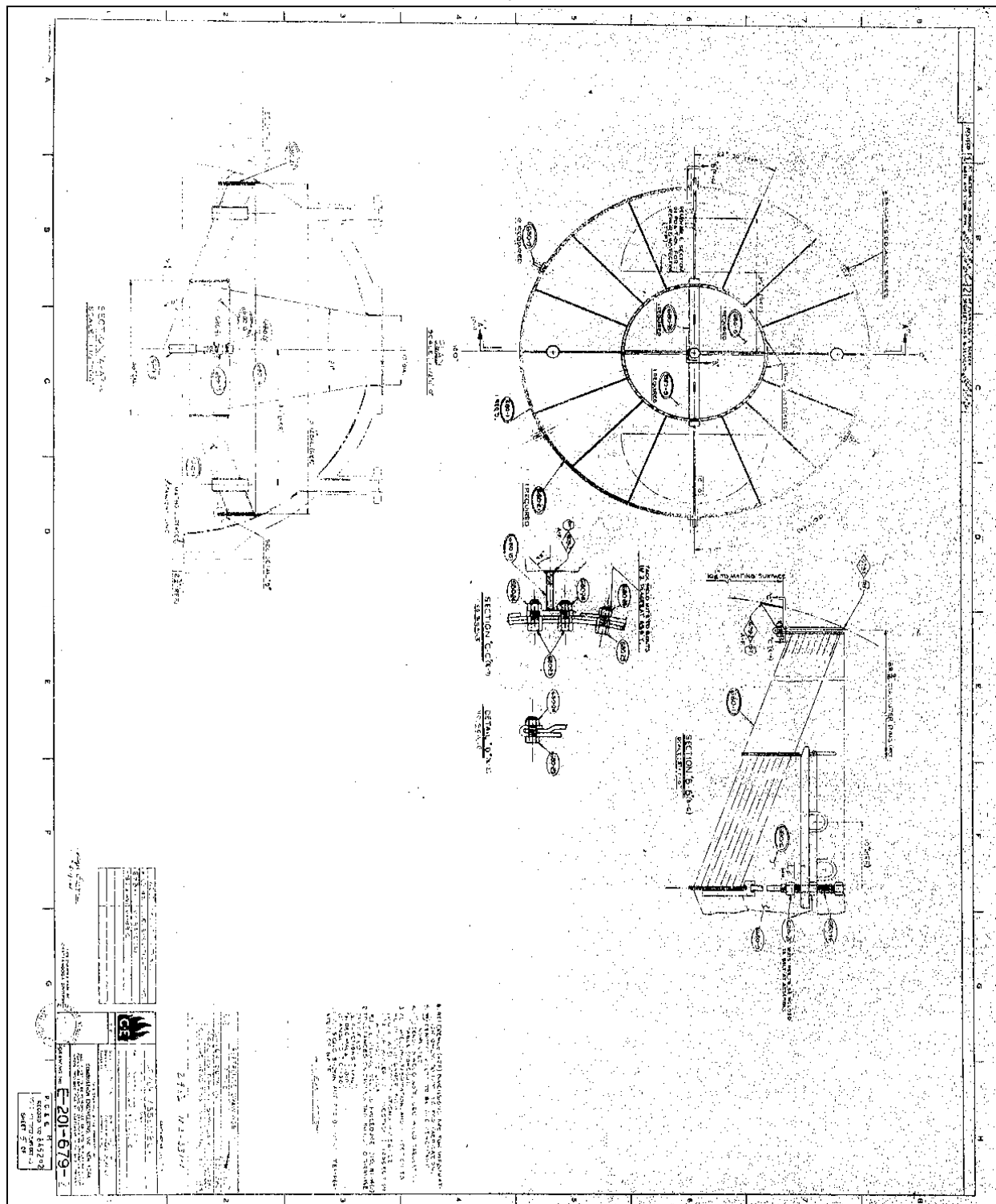


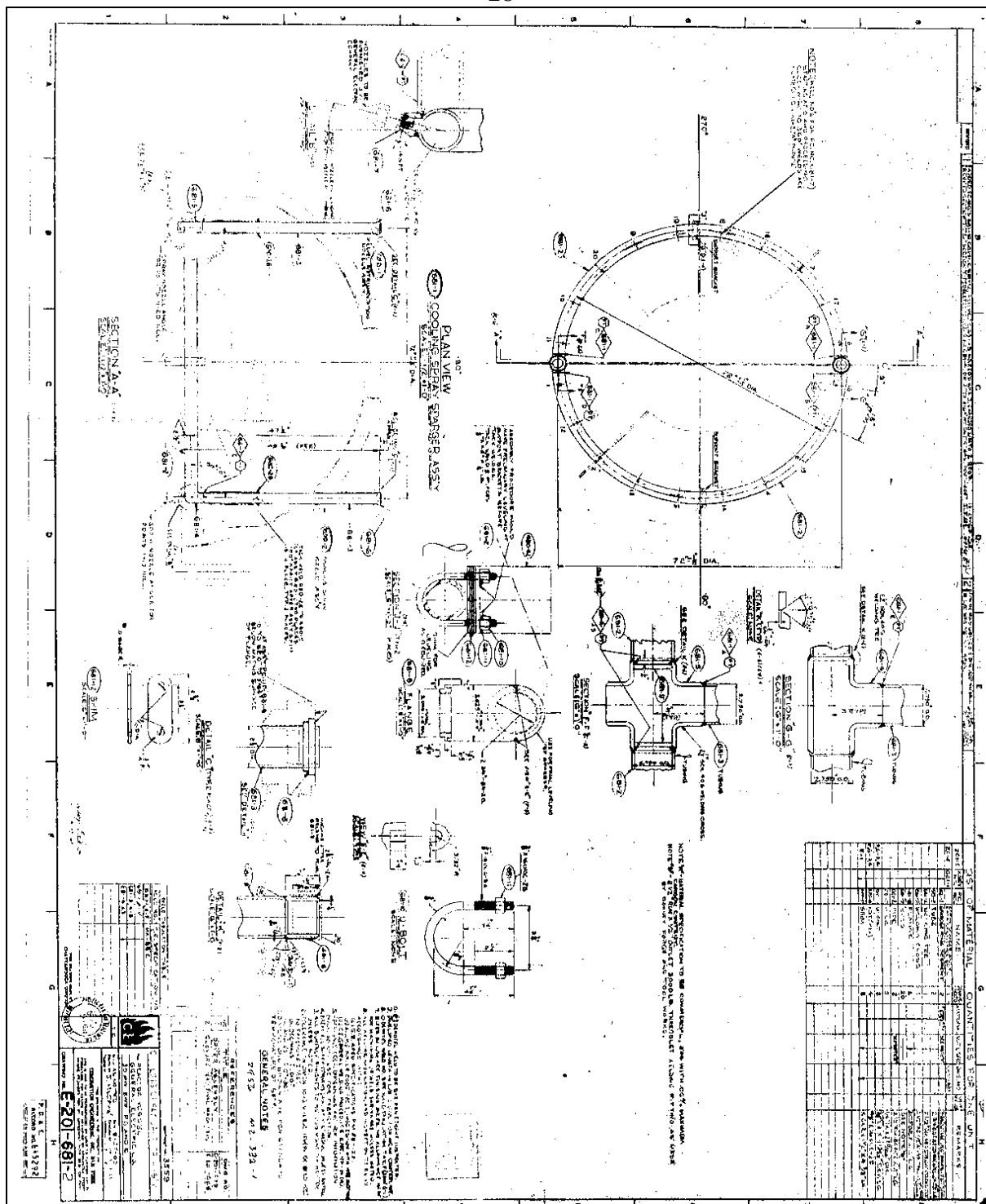
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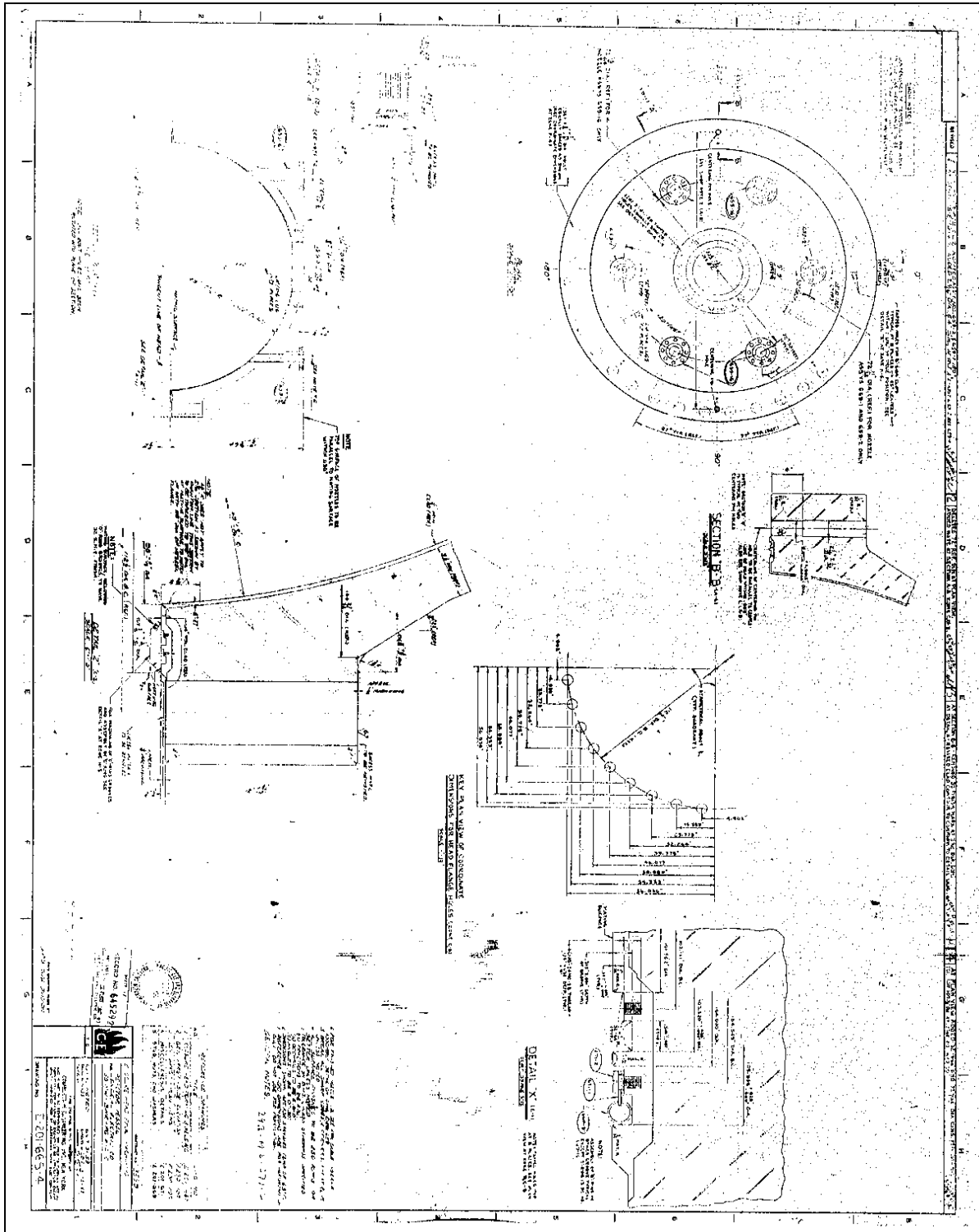


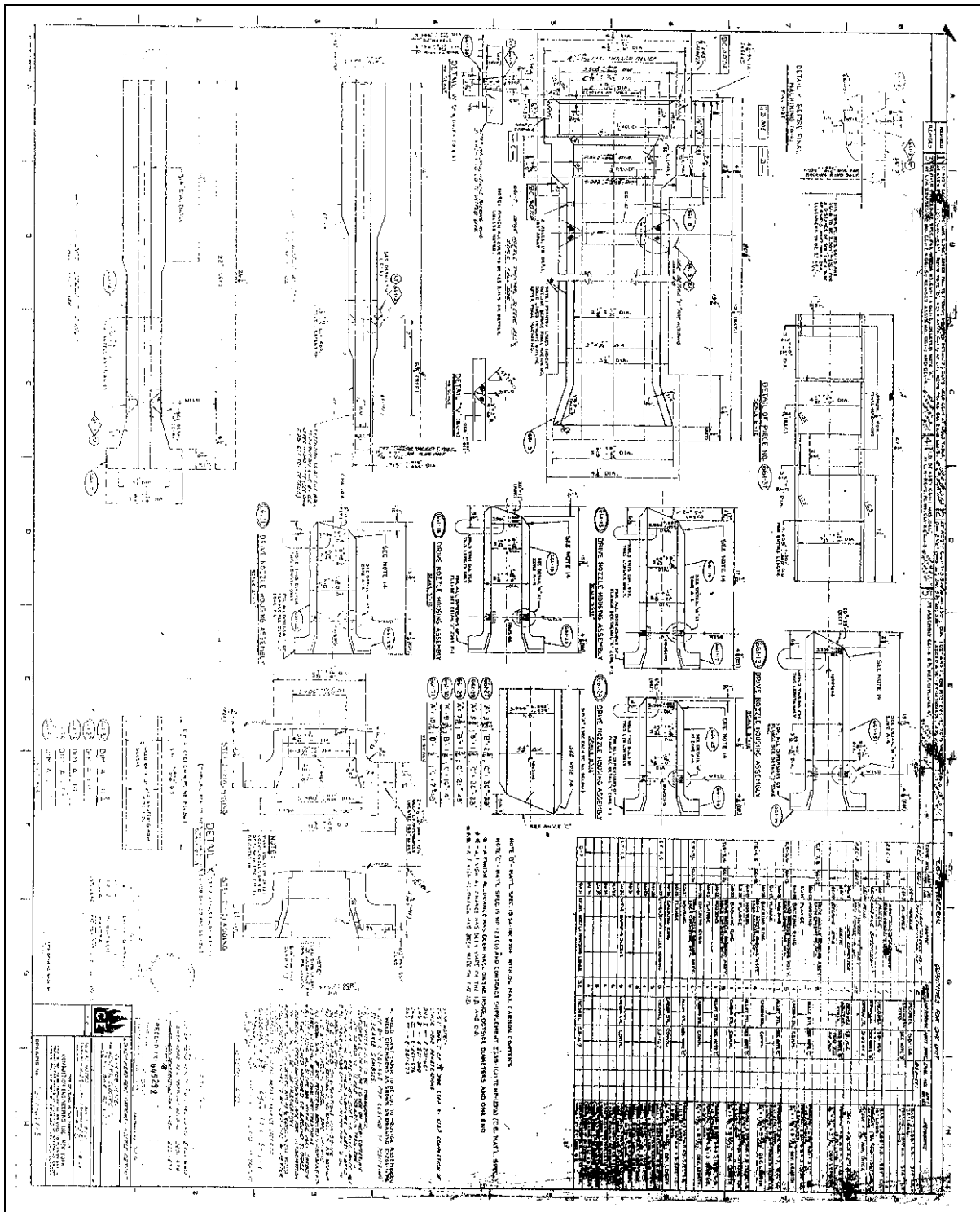
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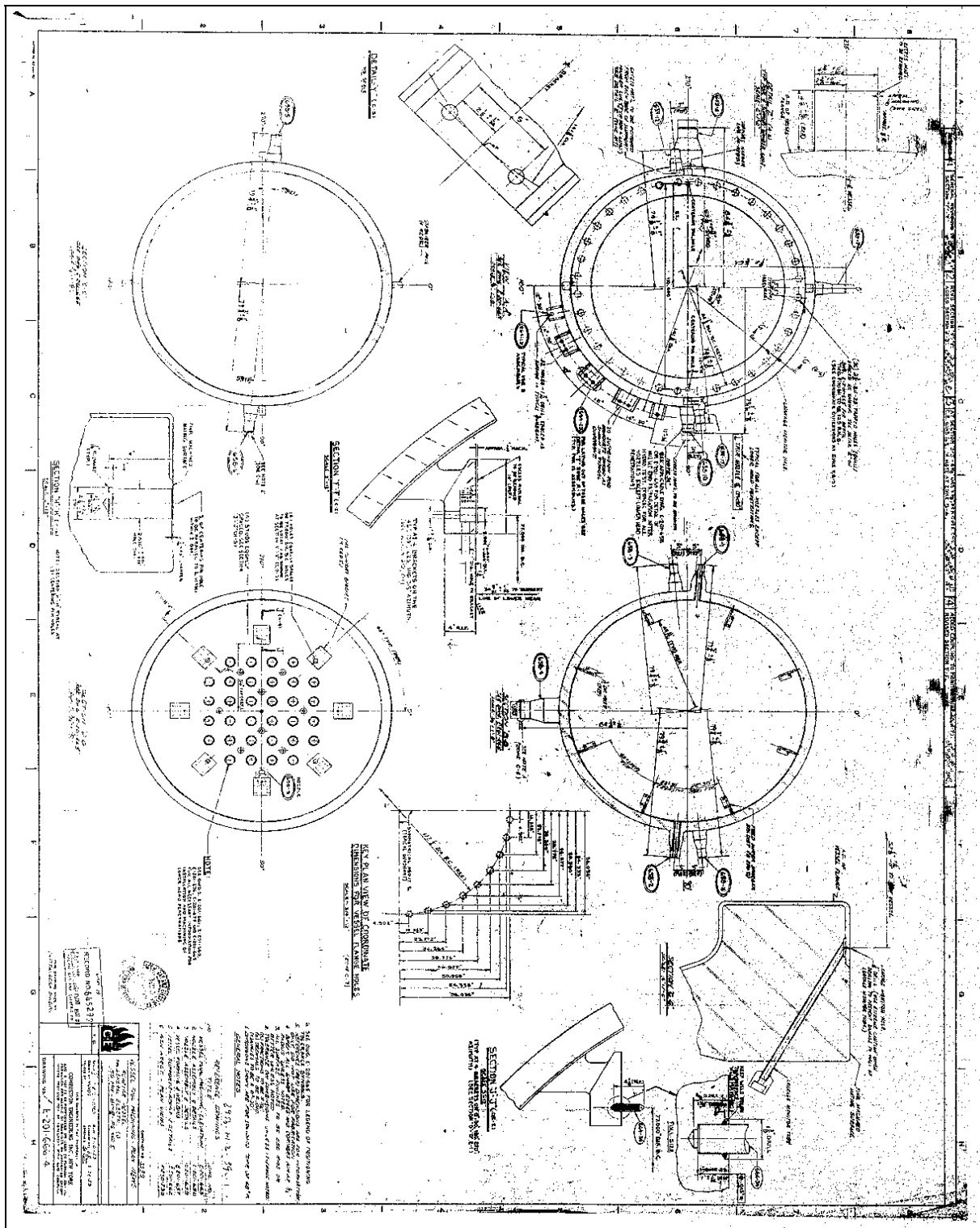




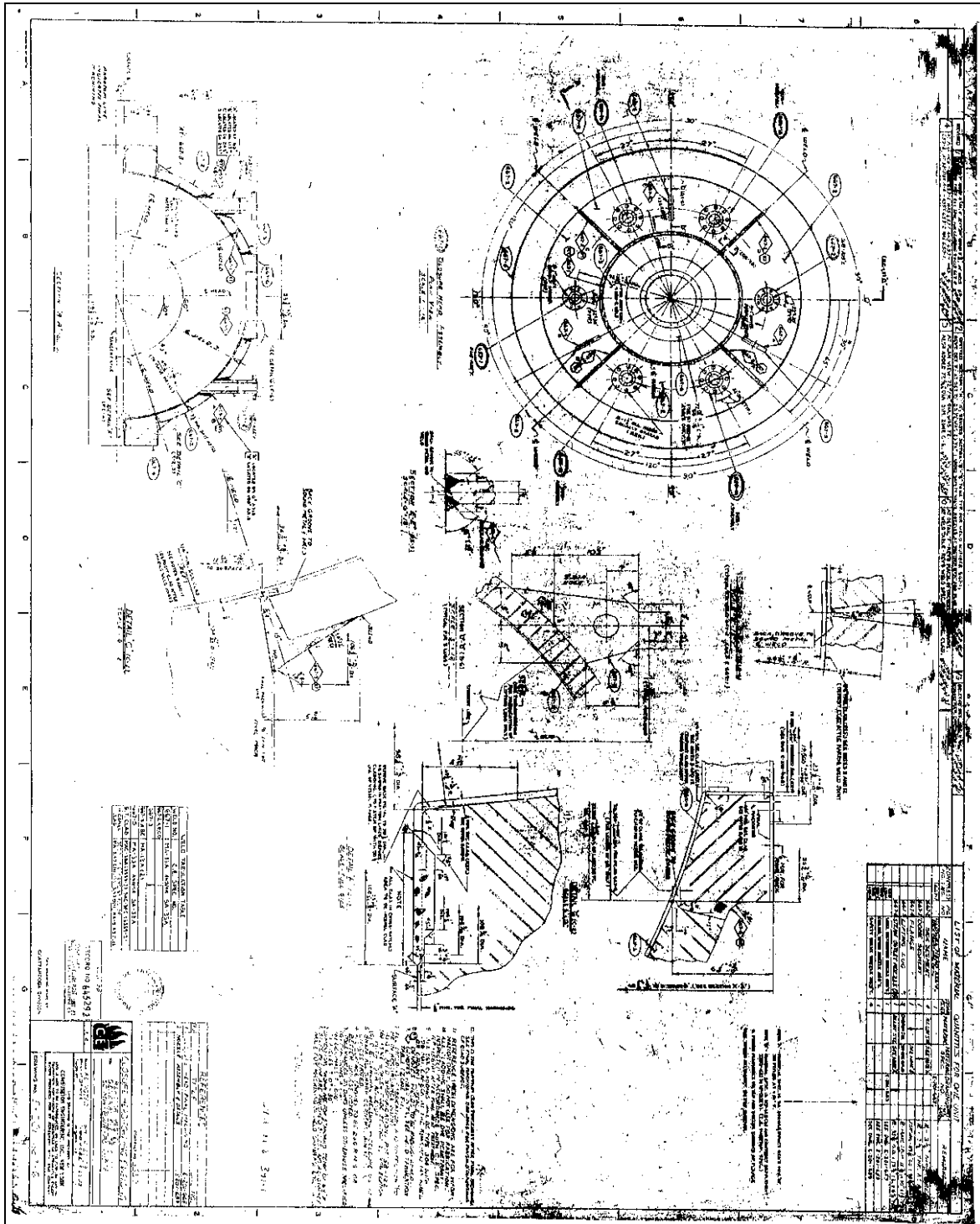


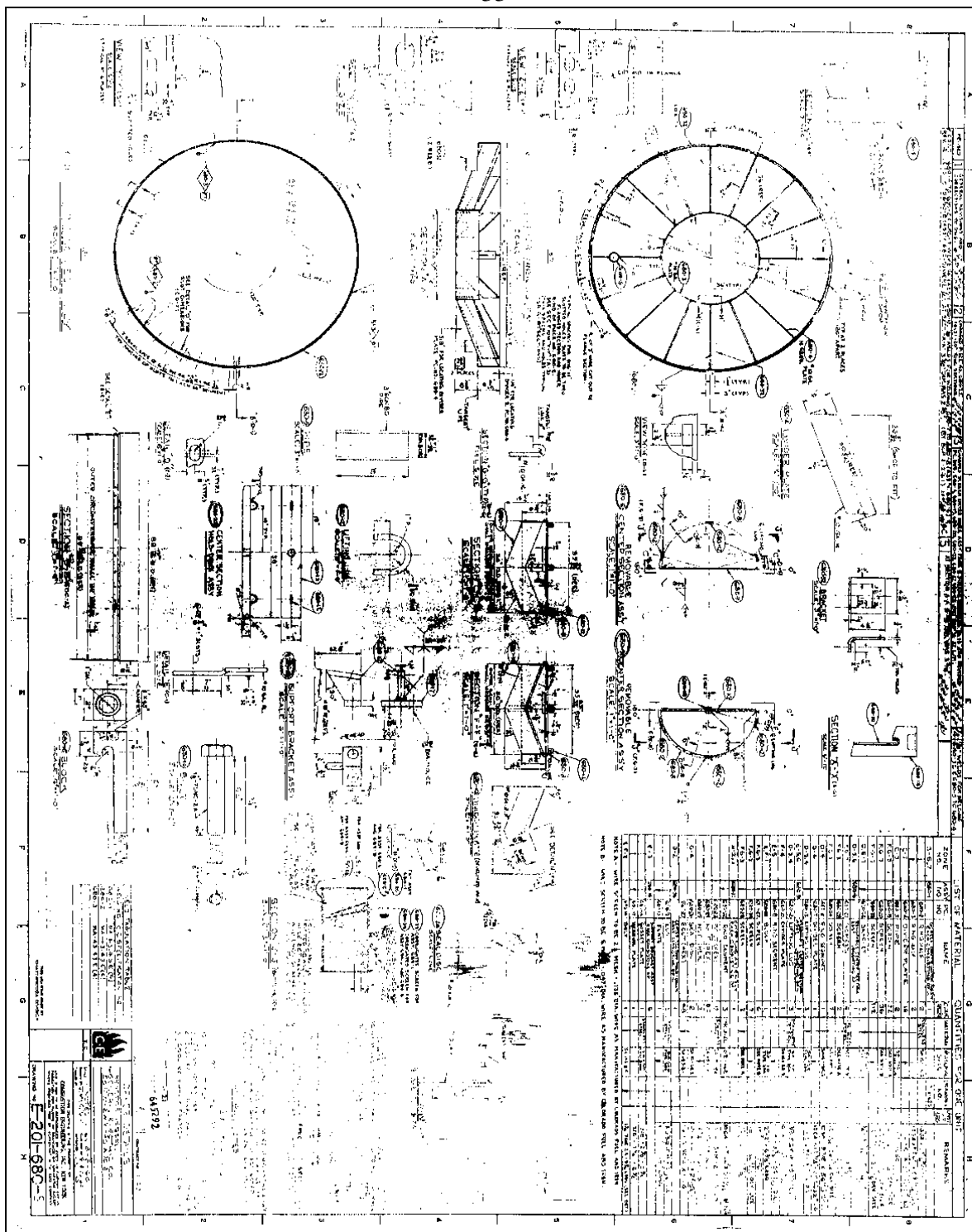


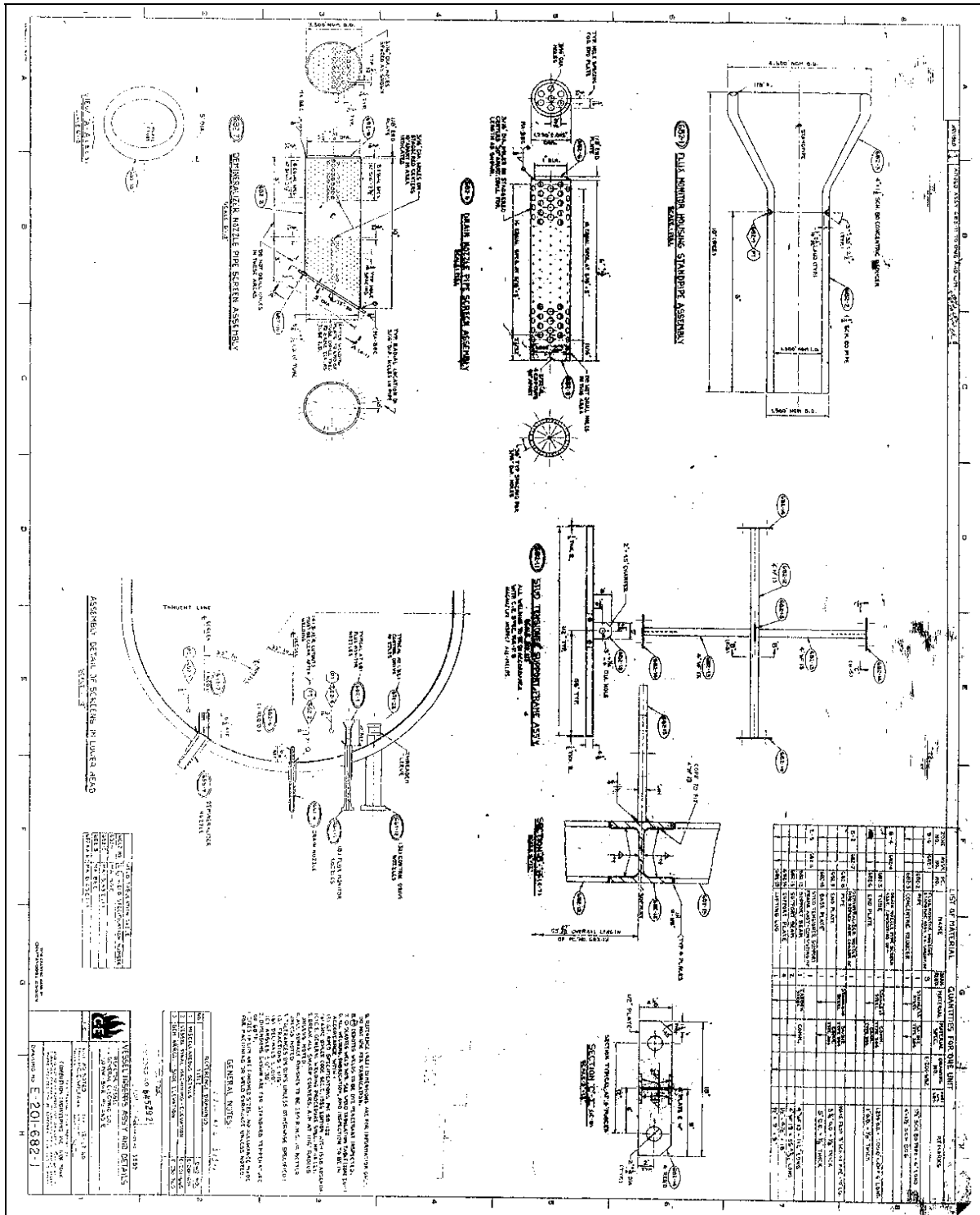
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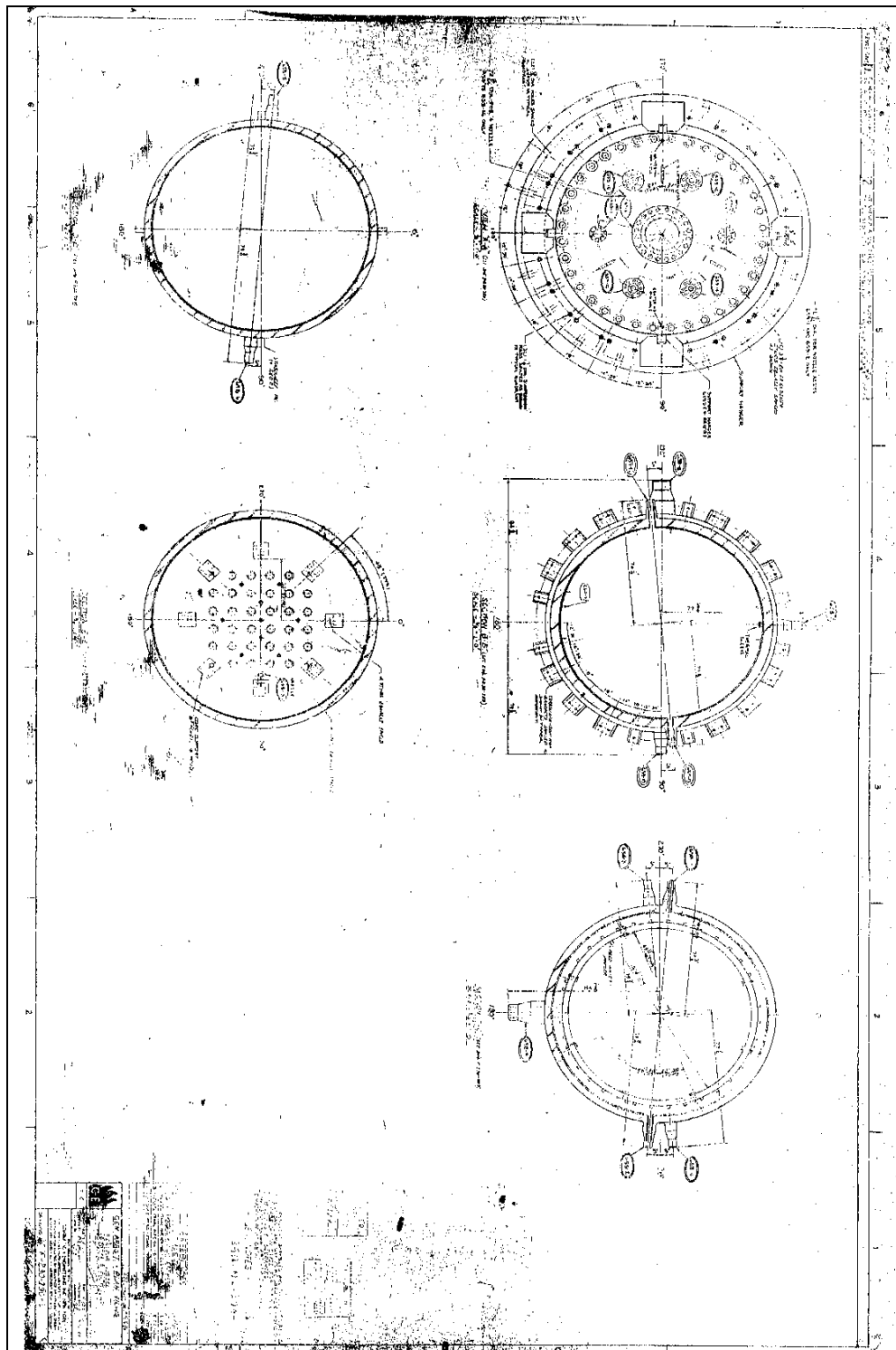


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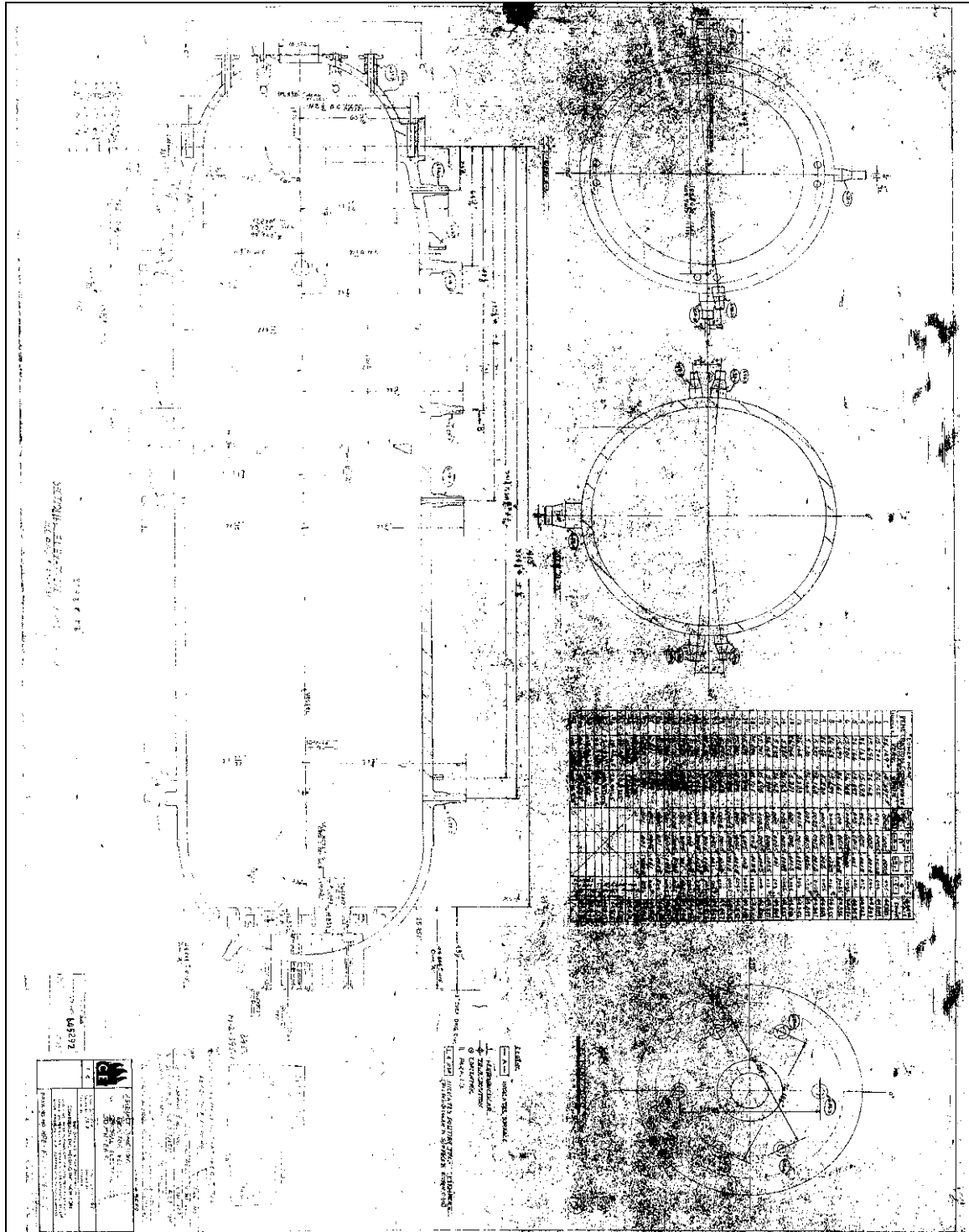


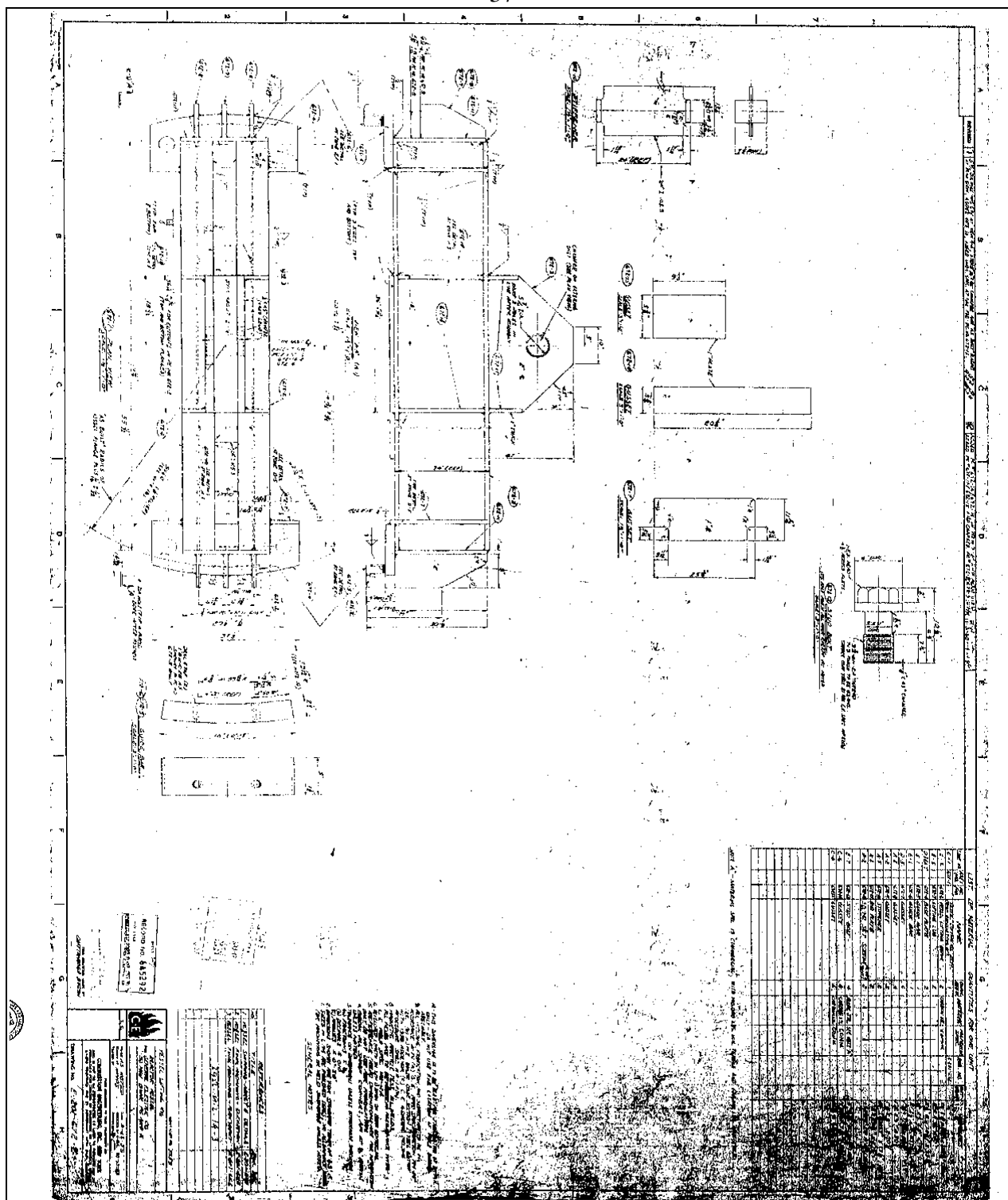




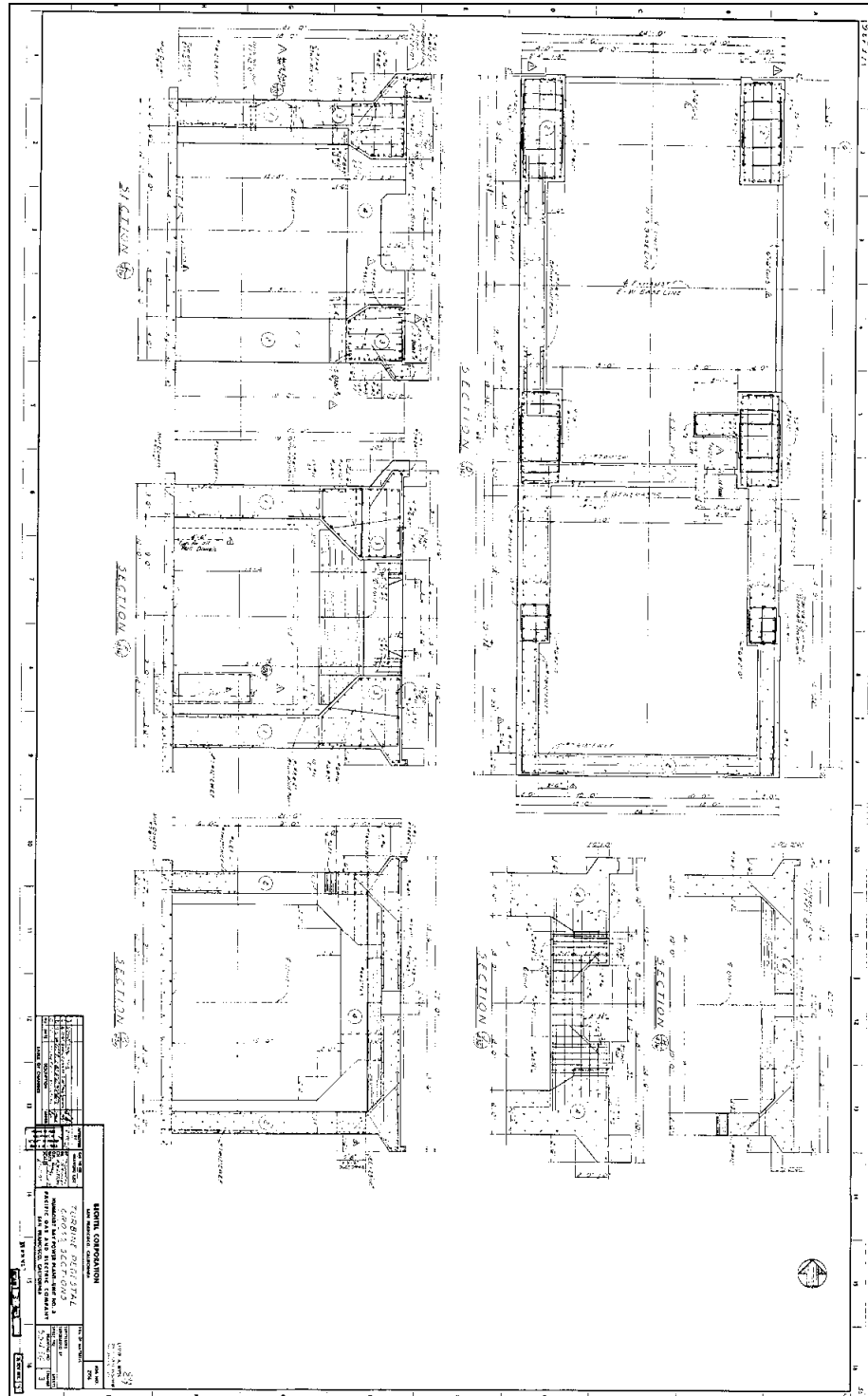


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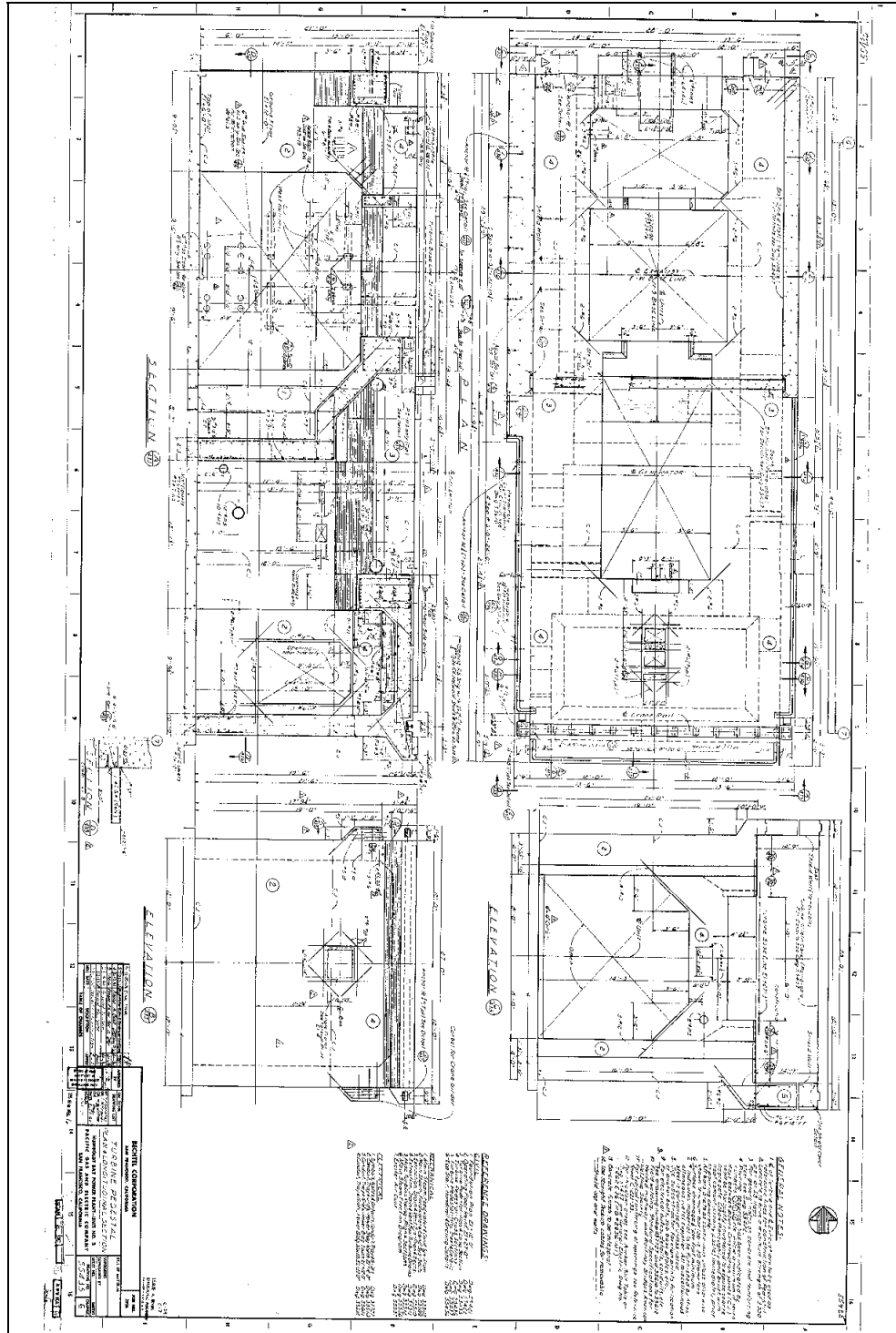


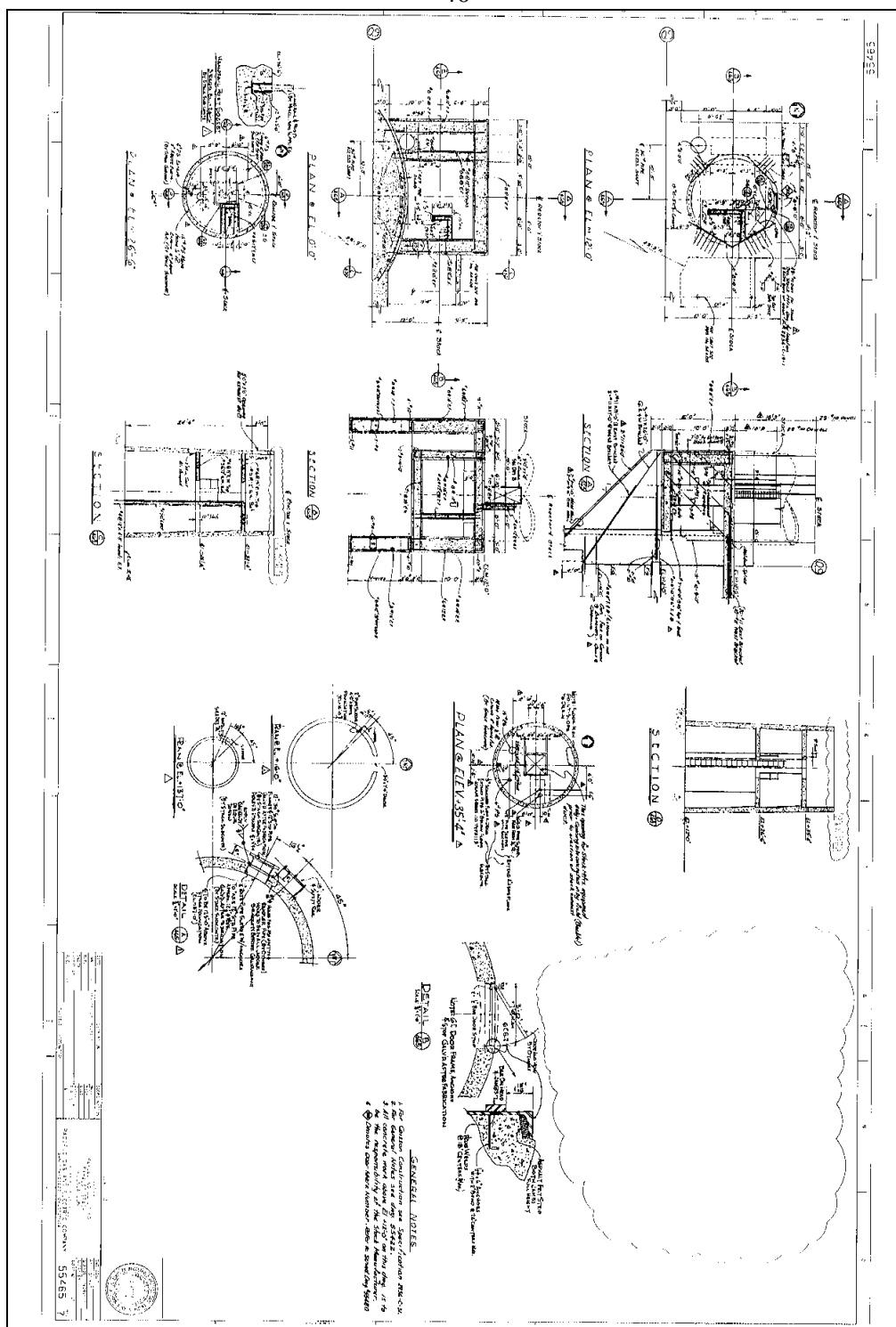


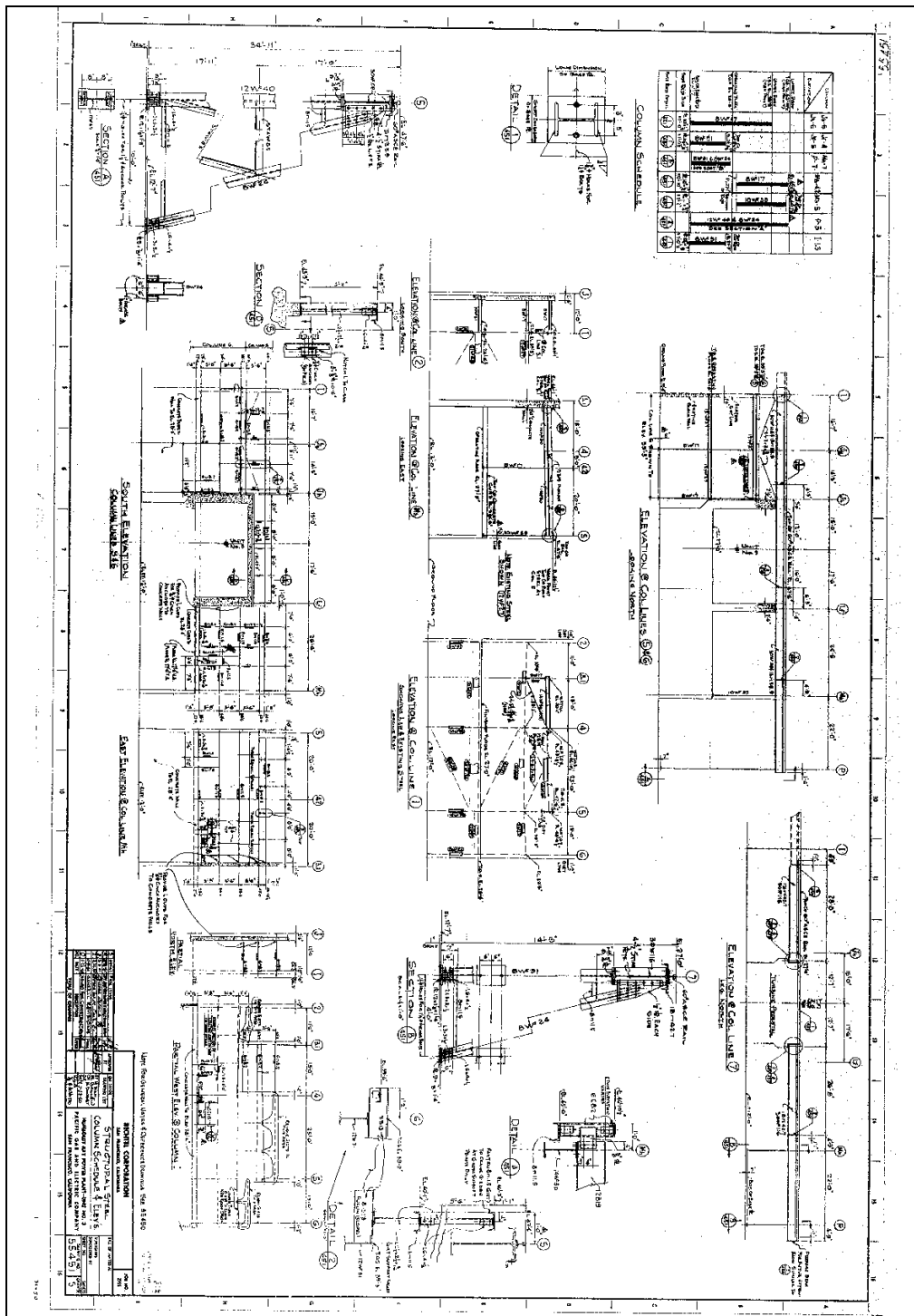
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