BISHOP CREEK HYDROELECTRIC SYSTEM, PLANT 5,
POWERHOUSE NO. 5
Bishop Creek
Bishop vicinity
Inyo County
California

HAER CA-145-5-A
HAER CA-145-AA

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

Bishop Creek Hydroelectric System, Plant 5, Powerhouse No. 5
Bishop Creek, Bishop vicinity, Inyo County, California
HAER No. CA-145-5-A

Location: The Bishop Creek Hydroelectric Powerhouse No. 5 (Powerhouse No. 5) is located on the southeast side of California State Route 168 in Inyo County, California. From the intersection of California State Route 168 (West Line Road) and U.S. Route 395 (Three Flags Highway) in the Town of Bishop, California, Powerhouse No. 5 is located approximately 5.28 miles southwest on California State Route 168, 0.26 miles south on East Bishop Creek Road, 0.24 miles southeast on Plant 5 Road, and 0.17 miles south on a private access road.

The approximate center of Powerhouse No. 5 is located at UTM Zone 11S, easting 368920.45m, northing 4133001.16m. Distances and coordinates were obtained on January 17, 2012, by plotting location using Google Earth. The coordinate datum is World Geodetic System 1984.

Present Owner: Southern California Edison Company
P.O. Box 800
Rosemead, California 91770

Present Use: Powerhouse No. 5 is a hydroelectric power generating facility that uses reaction turbines to generate electricity for transmission to distant customers, as it was designed and constructed to do. Powerhouse No. 5 is one in a chain of five similar power generating facilities located in the Bishop Creek system.

Significance: Powerhouse No. 5, a steel-frame metal-clad industrial building constructed in 1907 and expanded in 1919 by the Nevada-California Power Company, is significant because of its association with the early construction periods of the Bishop Creek Hydroelectric System and because it is a valuable example of Utilitarian, early twentieth century industrial architecture.

The Bishop Creek Hydroelectric System Historic District is significant for its position in the expansion of hydroelectric power generation technology, its role in the development of eastern California, and its contribution to the development of long-distance power transmission and distribution. The System is significant under National Register of Historic Places criterion A (broad patterns of history) and C (distinctive characteristics of period and type of engineering and construction). The Period of Significance for the Bishop Creek Hydroelectric System is identified as 1905-1938.

Historian: Matthew Weintraub, Senior Architectural Historian
Galvin Preservation Associates
231 California Street
El Segundo, CA 90245

Project Information: The Historic American Engineering Record (HAER) is a long-range program that documents and interprets historically significant engineering sites and structures throughout the United States. HAER is part of Heritage Documentation Programs (Richard O'Connor, Manager), a division of the National Park Service (NPS), United States Department of the Interior. The Powerhouse No. 5 recording project was undertaken by Galvin Preservation Associates (GPA) for the Southern California Edison Company (SCE) in cooperation with Justine Christianson, HAER Historian (NPS). SCE initiated the project with the intention of making a donation to NPS. As recommended by Justine Christianson (NPS), the report describes how water flows in and out of the powerhouse to produce electricity, and a vital component of the report documents changes in operating machinery that have occurred over time. Archaeologist Crystal West (SCE) oversaw the project and provided access to the site. Historian Andrea Galvin (GPA) served as project leader. Architectural Historian Matthew Weintraub (GPA) served as the project historian. Jeff McCarthy, Supervisor of Operations (SCE), and Keith Inderbieten, Hydro System Operator (SCE), provided research assistance. James Sanderson produced the large format photographs. The field team consisted of Andrea Galvin (GPA), Matthew Weintraub (GPA), Crystal West (SCE), Neil Sliger (SCE), James Sanderson (photographer) and Matthew Pegler (photographer assistant).

Researchers can be directed to also see:
HAER No. CA-145-5, Bishop Creek Hydroelectric System, Plant 5.

PART I. HISTORICAL INFORMATION

A. Physical History of Building:

The physical history of Powerhouse No. 5 was determined by reviewing available original construction drawings including a framing plan[1] and a foundation plan.[2] Also, drawings for alterations and additions to Powerhouse No. 5 which occurred after its original construction were reviewed.[3] These plans were retained by the power companies that successively owned and operated the plant (currently SCE). In addition, articles describing construction and operation of the powerhouse which originally appeared in the trade journals *Journal of Electricity Power and Gas*[4] and *Electrical World*[5] and reprinted by SCE were reviewed. They included a series of articles written by Charles O. Poole, who served as chief engineer of the Nevada-California Power Company. The building itself provided physical evidence of its history and development via field inspection,[6] as did historical photographs and contemporary drawings in the possession of SCE. Further information was found in previously completed HAER documentation[7] and evaluations of eligibility for listing in the National Register of Historic Places.[8] These sources provided thorough and detailed information regarding the historic design, construction, improvement and operation of the building.

Overview

Powerhouse No. 5 was constructed in 1907 by the Nevada-California Power Company. It was the second of five powerhouses to be constructed in the Bishop Creek system (preceded only by No. 4). Powerhouse No. 5 is the second lowest plant in the Bishop Creek system at an elevation of 4,730 feet (higher only than No. 6). The powerhouse is a tall single-story, steel-frame, corrugated metal-clad industrial building designed in the

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[1] Nevada-California Power Company, "Power Plant No. 5 Framing of Power House #5," April 20, 1907.

[2] NCPC, "Foundation Plans of Power House No. 5," April 16, 1907, revised on December 3, 1966.

[3] Southern Sierras Power Company (SSPC), "Framing and Elevation Section - Showing Elevations of Proposed New No. 2 Unit," October 31, 1918; SSPC, "Cross Section Power House No. 5," January 16, 1919, revised December 5, 1938 and July 14, 1943; SCE, "Powerhouse Circuit Breaker Room Floor and Ceiling Plan," April 23, 2004, revised May 12, 2008.

[4] Rudolph W. Van Norden, "System of Nevada-California Power Company and the Southern Sierras Power Company. Part 1 – Power Plants," *Properties and Power Developments of the Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted from the *Journal of Electricity Power and Gas*, Volume XXXI, Numbers 1-2, July 5-12, 1913, p. 1-20.

[5] C. O. Poole, "Hydraulic and electric features of stations Nos. 4 and 5 of the Nevada-California Power Company – Static head at the former station, 1100ft," *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*, 1915, p. 27-31. Reprinted from *Electrical World*, New York, 1914.

[6] Field inspections were conducted on October 20 and December 7, 2011.

[7] Thomas T. Taylor, "Bishop Creek Hydroelectric System," HAER No. CA-145, Historic American Engineering Record, National Park Service, U.S. Department of the Interior, 1994, p. 7-8.

[8] Robert Clerico and Ana Beth Koval, "An Architectural and Historical Evaluation of Structures Associated with the Bishop Creek Hydroelectric Power System, Inyo County, California," Southern California Edison Company, December 1986, p. 52-54; Valerie Diamond, Stephan G. Helmich, and Robert A. Hicks, "Evaluation of the Historic Resources of the Bishop Creek Hydroelectric System," Southern California Edison Company, July 1988, p. A-53-57.

Utilitarian, early twentieth century industrial architectural style. It contains a large ell-shaped room that houses two rotating generators driven by a pair of reaction water wheels. The building was expanded and additional facilities were put into operation in 1918-1919. In 2004, a north wing addition was constructed. Currently, Powerhouse No. 6 continues to operate as the only reaction turbine plant in the Bishop Creek system. The powerhouse plant is situated on the northwest bank of the lower stretch of Bishop Creek, below Bishop Creek Canyon. The plant originally consisted of the powerhouse (extant) and two residence cottages (not extant).

In 1913, the *Journal of Electricity Power and Gas* briefly described Powerhouse No. 5 and highlighted its utilitarian character:

> After the first plant, which was No. 4, came No. 5, built in 1907, a much smaller but low cost plant…[It] is a corrugated iron building over a steel frame covering a ground space 40 x 60 ft. It is placed close to the creek, which at this point is between deeply eroded banks forming a ravine or arroyo, and is almost hidden from sight on approaching until one is very close.[9]

1. **Date of Construction:**
   Construction of Powerhouse No. 5 commenced in 1907, based on framing plan and foundation plan drawings dated April 1907. As stated in 1914 by Charles O. Poole, chief engineer of the Nevada-California Power Company, "This plant was the second one installed on the system, having been put into service in 1908."[10] The powerhouse was expanded in 1918-1919, according to a framing plan dated October 1918 and a foundation plan dated January 1919. A north wing addition was constructed in 2004, as indicated by a construction plan for the addition dated April 2004.

2. **Architect/Engineer:**
   The engineer of the original construction of Powerhouse No. 5 was John D. Galloway, who was listed as the civil engineer in plans dated 1905. Galloway served as a consulting engineer for the Nevada Power, Mining and Milling Company. Other architects and/or engineers are not known.

3. **Builder/Contractor/Supplier:**
   Powerhouse No. 5 was likely built by contractors and/or day labor force hired by the power company in 1905. The powerhouse was expanded in 1918-1919 by the Southern Sierras Power Co. of Riverside, California (a subsidiary of the Nevada-California Power Company), as indicated by expansion plans dated 1918 and 1919. Individual builders, contractors and material suppliers are not known.

[9] Van Norden, "System of Nevada-California Power Company," p. 4, 15.
[10] Poole, "Hydraulic and electric features of stations Nos. 4 and 5," p. 30.

4. Original Plans:

The powerhouse was originally designed as rectangular in plan with exterior wall-to-wall dimensions of 39'6" x 55'0". It was framed with steel posts and beams, clad in corrugated iron panels, and capped by a saltbox roof sheathed in corrugated metal panels. The longer side of the saltbox faced north. The north side wall, 24'0" tall, and the south side wall, 29'3" tall, were each divided into three bays of equal size as defined by structural steel columns separated by 18'0" (center-to-center). End walls (east and west) were divided into two unequal bays by off-center steel columns that corresponded to a symmetrical steel framework at the heart of the saltbox-roofed building. The larger bays in the end walls were further subdivided into three bays by timbers. All bays were framed and cross-braced by square timbers. The metal saltbox roof was supported by Fink steel trusses. At the ridgeline, a centrally located, gable-roofed, sheet metal monitor contained louvered panels.

The north and south side walls were designed with a centrally located opening in every bay. At the south wall, the central bay contained a 7'0" x 3'0" entrance filled with a wood two-panel man-door, and side bays contained tall wood windows of dimensions similar to the door. At the opposite side of the building, two bays in the north wall were fenestrated identically to the windowed bays of the south wall, and the eastern bay was pierced by a large service opening 14'0" high and 12'0" wide. The service opening contained double-leaf, side-hinged wood doors, with each leaf divided into upper and lower panels crossed by diagonals. The upper portion of the north wall also contained a pair of three-light transoms in the end bays. The 36" x 36" transom panes were pierced by 6" circular holes in the centers that allowed electrical transmission wires to pass from the interior of the powerhouse to the exterior. The east and west walls each contained two windows identical to those on side walls, one off-center and one at the north corner.

The powerhouse was built with a concrete foundation 12'0" deep that was originally designed to house a reaction turbine generator unit. At the interior of the powerhouse, the generator room that occupied the structure measured 37'10" x 54'0". It was open in plan. The steel framing and timber bracing was exposed at interior walls and ceiling. The building was open vertically through the trusses. A 20-ton overhead traveling crane furnished by the Cyclops Iron Works of San Francisco spanned the width of the room below the level of the trusses. The rolling crane was mounted on rails and supported by an interior steel post-and-beam system that adjoined the south wall.

5. Alterations and Additions:

Powerhouse No. 5 was expanded and modified with a single-bay addition at the north side in 1918-1919, resulting in an L-shaped plan. This expansion was completed in order to add a second turbine/generator assembly to the plant. It involved the removal of the entire original north wall, reconstruction of the first bay (counting from east to west), and construction of an addition that projected 20’3” (measured to the roof eave) from the second and third bays. The newer structure was steel-framed and coupled to the original, cross-braced with timbers, clad in corrugated iron, and capped by an extension of the original sloped metal roof. At the newer north wall, which was 13’0” in height, an original wood window, 3’3-¼” x 7’1”, was salvaged and reused in the central bay. In the adjacent bay to the west, a new service entrance was constructed 14’0” high and 12’0” wide, identical to the entrance that was removed from the first bay of the original north wall. The original tall double-leaf wood doors from the removed entrance were salvaged and reused in the newer opening. The reconstructed first bay of the north wall was filled by an exceptionally large entrance, 11’0” x 22’0”. The large service opening contained double-leaf, side-hinged wood doors, with each leaf divided into upper and lower panels crossed by diagonals. The doors, 16’0” high, were topped by a two-panel, wood transom door crossed with diagonals that completed the six-panel arrangement. The east and west walls of the addition were pierced by centrally located, rectangular wood windows, 2’9” x 6’0”.

Since the expansion was completed in 1919, various other structural and/or material changes to the powerhouse have occurred. Although most original doors and windows were reported to have remained intact until at least 1988, in its current state almost every opening has been modified or eliminated by covering with corrugated metal panels similar to existing siding. At the east wall, two original windows were removed and covered. At the opposite west wall, the corner window was removed and covered and the middle window was replaced with a man-door. On the south side wall, the centrally located man-door was replaced in the existing opening (the only original opening that remains intact on the building); the window to the west was removed and covered; and the window to the east was replaced by a metal roll-up service door. At the north walls, the tall service opening in the first bay was reduced in height and the wood doors were replaced with a roll-up metal door; the window in the second bay on the north wing was converted into a man-door and covered with a gabled, knee-braced hood; and the wall in the third bay, which contained a service door, was replaced when an addition was appended to the wall in 2004. Also, some metal roof panels have been replaced over time, including reversal of non-original skylights. At the interior, an operators room with bead-board siding and extensive wood-framed glazing was constructed and occupied part of the west side of the generator room until approximately 2004, when an external addition was constructed and the internal enclosure was removed.

In 2004, an addition was constructed at the north end that had previously been expanded in 1918-1919. The single-story addition was rectangular in plan with a concrete foundation, paneled metal siding, and a flat roof sheathed in metal panels. It extended 28’0” from the northwest corner, offset from the existing west wall by 3’0”, and it measured 25’0” wide. The addition was partitioned from the main generator room and housed a circuit breaker room and a small office. A door located in the southeast corner of the circuit breaker room provided internal access to the generator room; a door in the north wall provided external access.

B. Historical Context:

The following historical context was included in previously completed documentation which established the eligibility of the Bishop Creek Hydroelectric System for listing in the National Register of Historic Places.[11]

The turn of the twentieth century saw a dramatic change in technological history. The production of cheap, dependable hydroelectric power, and the ability to transport the power over great distances, was perfected at this time. In short order, drainages with sufficient flow for hydroelectric power generation began to be developed. By 1923, the only suitable streams draining the east slope of the Sierra Nevada which were not being used for electricity production were the Carson and Walker river systems. The first hydroelectric power generation along Bishop Creek was a small plant operated by the Bishop Light and Power Company. The facility was reported to be a half mile west of the Standard Flouring Mills (present site of Plant 6) and two and a half miles from the town of Bishop. The plant consisted of a Stanley polyphase generator (capable of 150 horsepower) driven by a 48-inch Pelton wheel. The power was generated for local use.

Through the efforts of Loren B. Curtis, an engineer, and Charles M. Hobbs, a banker and financier, the Nevada Power, Mining and Milling Company was incorporated on December 24, 1904. The first facility built by the Nevada Power, Mining and Milling Company was put into operation in September, 1905, supplying hydroelectric power to the mining communities of Tonopah and Goldfield, Nevada. Executives of the power company had purchased controlling interest in the locally operated facilities in Tonopah and Goldfield, so that, when production began, there was a market ready for their product. The original transmission line extended east across Owens valley, the White Mountains, Fishlake Valley, and the Silver Peak Range to the town of Silver Peak in Clayton Valley. Here the line split, diverging northeast to Tonopah and due east to Goldfield. The line distance from Bishop Creek to Goldfield was 95 miles, and that to Tonopah was 118 miles. This was a new record for long distance transmission. On January 5, 1907, the Nevada-California Power Company, successor to the Nevada power, Mining and Milling Company, was incorporated; most of the original corporate officers remained with the new company.

Between 1905 and 1913, four more generating plants were placed on line, in tandem along Bishop Creek, and additional generators were placed in existing plants. As a result

[11] Clerico and Koval, “An Architectural and Historical Evaluation,” p. 5-12.

of this additional power generation, the "Tower Line" from Bishop to San Bernardino was completed in 1912 and put into operation, again creating a new record for long distance transmission (239 miles). The directors of the Nevada Power, Mining and Milling Company were well aware of the vicissitudes of the boom-bust mining industry and took steps to secure a more constant market for their product. In 1911, the Southern Sierra Power Company was incorporated with the main purpose of creating and servicing the power needs of southeast California. From then until 1918, several smaller power companies were purchased by the new company. The development of southern California's Imperial Valley corresponds directly with Bishop Creek's production of cheap, reliable electricity.

By the end of 1913, the Bishop Creek system was essentially complete with all five plants operating. In descending order down the drainage, the Bishop Creek facility then consisted of:

> Power Plant 2: Three Westinghouse generators, each capable of 2,000 kw of power (total output of 6,000 kw). Units 1 and 2 were driven by Pelton wheels and unit 3 by a Doble wheel.
>
> Power Plant 3: Three Crocker-Wheeler generators, each capable of 2,250 kw of power (total output of 6,750 kw). All three units were direct connected to Henry impulse wheels.
>
> Power Plant 4: Five generating units consisting of: two National Electric Company, 750 kw, generators connected to Pelton wheels; one Bullock, 1,500 kw, generator driven by a Pelton wheel; one Allis-Chalmers, 1,500 kw, connected to a Pelton wheel; and one Allis-Chalmers, 1,500 kw, machine driven by a Doble wheel (total output of 6,000 kw).
>
> Power Plant 5: Two generating units, one of which was a 1,500 kw, Allis-Chalmers machine driven by a Doble wheel and the other a 1,850 kw unit connected to a Pelton-Francis wheel (total output of 3,350 kw).
>
> Power Plant 6: A single generator capable of 2,250 kw driven by a Pelton-Doble wheel.

It is interesting to note that Power Plant 1 was to have been built at the present site of Intake No.2, but the plant was never built due to the vulnerability of the site to avalanches. The plant number designators were not adjusted accordingly, so that there is no Power Plant 1, nor has there ever been.

In 1936, the Nevada-California Electric Corporation again was reorganized to become an operating company. The corporation became California Electric Power Co. and continued to operate under this name until 1964, when the company known as Calectric was subsumed by Southern California Edison Company. Since 1964, as a result of acquisition through merger consolidation, Southern California Edison (SCE) has owned and operated the Bishop Creek plants.

PART II: SITE INFORMATION

A. General Description of Building:

The following description of Powerhouse No. 5 incorporates information included in previously completed HAER documentation[12] and evaluations of eligibility for listing in the National Register of Historic Places.[13] This information was verified and new information was gathered via field inspection to inform the building description.[14]

Overview

Powerhouse No. 5 is a one-story, metal industrial building resting on a deep concrete foundation and topped by a metal saltbox roof. It was designed and constructed in the Utilitarian, early twentieth-century architectural style. An expansion of the original building resulted in an L-shaped plan. The main volume houses two hydroelectric power generation units which are mounted in the concrete foundation and driven by reaction turbines.

Exterior

Powerhouse No. 5 is a tall one-story, L-shaped-in-plan, steel-framed metal-clad building covered with a saltbox metal-clad roof and resting on a concrete foundation. It is clad in corrugated sheet metal panels at walls and roof. The long end of the saltbox roof faces north and extends to the top of the ell as a shed roof wing. Boxed metal eaves overhang the exterior walls. The roof is capped with a rectangular, gabled rooftop monitor that straddles the ridge with four louvered panels on each side. At the north end of the building, a rectangular flat-roofed addition connects to the northwest corner, with its roof meeting the eaves of the older structure, and its west wall offset and projecting three feet beyond the older structure. The walls and roof of the north end addition are clad in metal panels. On the roof of the addition, a circular metal fan is mounted on a flat metal support beam and a large mechanical unit occupies the west side.

The powerhouse contains entrances on all sides and no windows. Metal grates secure all openings. At the north side, the first bay (counting from east to west) is recessed on the L-shaped building and contains a square service opening filled with a roll-up metal door. The second bay projects forward and contains a centrally located solid metal man-door with knee-braced gabled hood. At the third bay, the north end addition contains a solid metal door in the north wall. The west and south walls also contain centrally located solid metal man-doors. The south wall includes a square service opening filled with a roll-up metal door at the east corner opposite the identical opening on the north side. The projecting east wall does not have any openings. The recessed portion of the east wall on the L-shaped building contains a glazed three-panel wood door with a nine-light transom. All man-door entrances on the primary structure are detailed with flat wood surrounds.

[12] Taylor, "Bishop Creek Hydroelectric System," p. 7-8.
[13] Clerico and Koval, "An Architectural and Historical Evaluation," p. 52-54; Diamond, Helmich, and Hicks, "Evaluation of the Historic Resources," p. A-53-57.
[14] Field inspections were conducted on October 20 and December 7, 2011.

Aside from the openings for entrances, walls are blank except for a simple timber structure that project horizontally from the west wall and carries electrical wiring.

Wall and roof surfaces exhibit physical evidence of changes over time. Originally, the exterior corrugated sheet metal panels were laid regularly in equal sizes and with flush edges. This was true of the north wing extension constructed in 1918-1919, which displays flush, regularly-laid wall panels equivalent to the original structure built in 1907, but slightly offset in vertical positioning as indicated on the west side. However, some wall and roof areas are covered with metal panels of the same type but varied in size, laid in different patterns, and/or overlapping other panels. Areas of irregularly shaped and/or laid corrugated metal panels include: the north wall service opening which was reduced in height and modified for a roll-up door; two covered original window openings on the east wall; a covered original window opening on the west wall near the south corner; the area on the west wall around the timber wire supports; and two covered non-original skylights on the north end of the roof. Other areas where wall surfaces changed are not readily apparent.

Interior

The L-shaped interior of the main generator room is open in plan. The floor is poured concrete with areas of metal foundation plates bolted into place. Two sets of water-wheel/generator assemblies are mounted in pits along the north-south centerline of the building. The generator room also contains water pipelines, valves, governors, exciters and other support equipment around the periphery. A concrete platform supported by a steel post-and-beam system stands along the west wall where transformers and circuit breakers were formerly located. Two overhead traveling cranes are mounted on steel post-and-beam supports. The higher crane runs east-west within the larger portion of the building that was constructed in 1907; the lower crane runs north-south within the smaller portion extension that was built in 1918-1919. The original 20-ton overhead traveling crane furnished by Cyclops Iron Works of San Francisco is not extant. Walls are open to the steel posts and beams and cross-braced timbers and covered only by the exterior corrugated metal cladding. The timber framing at the interior retains most of the outlines for non-extant windows and doors that have been removed and covered at the exterior. The generator room is open vertically through the Fink steel trusses and the underside of the corrugated metal roof sheathing is exposed. A contemporary one-light wood door in the north end of the generator room provides access to the partitioned addition, which houses circuit breakers, cabinets and racks for electronic equipment, and a small office. A storage closet containing tools occupies the southeast corner and a lavatory occupies the southwest corner.

Along the middle of the generator room are found the water wheel housings, generator housings and rotors, and shaft mountings. The wheel housings are spiral-shaped with tapering bases, made of riveted cast iron, and bolted to the floor over the operating water wheels. At Unit No. 1, the original spiral-shaped volute is intact with raised lettering at the side that reads: WORTHINGTON. A stylized metal nameplate is attached to the metal housing of the turbine and reads: WORTHINGTON PUMP AND MACHINERY CORPORATION, WORTHINGTON WORKS, HARRISON, N.J., U.S.A. At Unit No. 2, the original spiral-shaped volute is intact with raised lettering at the side that reads: PELTON. The generator housings are donut-shaped with open interiors, also made of cast iron, and suspended around the stator cores and rotors. The generator housings displays stylized metal plates that reads: WESTINGHOUSE A.C. GENERATOR; and includes original machine specifications. Also, the generator housing at Unit No. 1 is mounted on a metal base with raised lettering at the side that reads: WESTINGHOUSE.

1. **Character:**
   Powerhouse No. 5 is the best example of Utilitarian industrial architecture in the Bishop Creek system. Entirely lacking in any decoration, embellishment, or pretense, it demonstrates practicality and adaptability like the machines that it houses. Powerhouse No. 5 retains the significant majority of exterior and interior features that convey its historic architectural character, including (but not limited to) corrugated metal cladding and roofing, tall blank exterior walls, saltbox roof with monitor, open building plan, exposed interior framing, and centrally located water wheel/generator assemblies. The overall design of the powerhouse is intact, despite changes in wall openings, replacement of some corrugated metal panels, and construction of a contemporary addition. Powerhouse No. 5 continues to operate and it serves as an excellent example of a Utilitarian, early twentieth century California hydroelectric power plant.[15]

2. **Condition of Fabric:**
   Powerhouse No. 5 is in good physical condition. The exterior corrugated iron cladding and roof is intact, as are the interior steel posts and beams, timber framing, and Fink steel trusses. There is no visible damage to the walls or roofing at the exterior or the interior. The concrete foundation appears to be sound with only minor surface cracking and spalling. Doors are operable.

B. Site Layout:

The terrain surrounding Powerhouse No. 5 consists of high desert foothills covered with natural vegetation. The plant is located on a graded level area on the northwest bank of Bishop Creek, which is deeply incised in this location. To the northwest, topography rises moderately towards Plant 5 Road, East Bishop Creek Road, and California State Route 168. To the southeast is found Bishop Creek and the terrain rises moderately at the opposite bank. The powerhouse stands with its long axis running east-west. An area located directly to the west of the powerhouse contains transformers and chain-link perimeter fencing. Originally, the power plant complex included a powerhouse (extant), a small utility building (not extant), a residential building (not extant), and a garage (not extant). The latter three buildings were removed sometime after 1988. Also, the original

[15] The expansion of Powerhouse No. 5 in 1918-1919 occurred during the identified Period of Significance for the Bishop Creek system, 1905-1938. The expansion is significant and contributory because it is characteristic of operational improvements that occurred in the Bishop Creek system during the early twentieth century.

highway (California State Route 168) followed the northwest bank of Bishop Creek directly past all the powerhouse sites including Plant 5 (apparently along the route of the current East Bishop Creek Road and/or Plant 5 Road). The new highway, which bypasses the powerhouses, was constructed to the northwest in 1965-1966.

PART III: OPERATIONS AND PROCESS

A. Operation:

This section describes the process that creates hydroelectric power at Powerhouse No. 5, in the context of Power Plant 5 and the chain of power plants that comprise the Bishop Creek Hydroelectric System. This section is divided into two subsections: (1) Basic Components of Hydroelectric Systems, which provides a general background for understanding the operations of hydroelectric plants; and (2) Operation of Plant 5, which describes how water moves through the power plant in order to drive turbines and generate electricity that is transmitted long distances.

Basic Components of Hydroelectric Systems

In a hydroelectric power generating unit, the force of moving water is used to spin a turbine (or "water wheel"). A turbine is connected via a shaft to a rotor, the moving part of an electric generator. The movement of the turbine spins the rotor within the generator and sweeps coils of wire past the generator's stationary coil, or stator, which produces electricity. Once electricity is produced, transformers raise the voltage to allow transmission over long distances through power lines.[16]

There are two basic types of hydroelectric systems. The first of these, low-head hydro, uses a large volume or mass of water from relatively low dams in order to turn the angled surfaces of screw-shaped turbines. The other type, high-head hydro, uses streams with relatively low volume flows, where water is diverted away from the natural stream course and elevated by artificially reduced fall far above the natural stream through a man-made canal or pipeline. At some point downstream the water is directed downslope were it achieves a very high pressure. The water at the base of the slope is directed against a bucketed wheel which receives an energy impulse by its impact.

The basic features of a high-head hydro system, of which the Bishop Creek Hydroelectric System is an example, are outlined below.

1. Water from a stream channel is separated from the natural stream using a diversion dam, headgates, screens and a spillway. The headgate regulates the flow of water, while the screens prevent debris from entering the water conduit. The reservoir behind the intake dam acts as the principal regulator of the water flow, allowing excess water to escape into the natural water channel. The dam, headgate, and regulating and cleaning apparatus are all known collectively as the *intake.*

2. Following intake, water is conducted by flumes or canal systems, pipes, tunnels or siphons (pipes in the case of Bishop Creek). The length of the system varies

[16] U.S. Department of the Interior, Bureau of Reclamation Power Resources Office, "Reclamation: Managing Power in the West – Hydroelectric Power," July 2005, unpaginated. Found at http://www.usbr.gov/power/edu/pamphlet.pdf, accessed on January 30, 2012.

greatly, depending on the area's topography and amount of water-pressure desired. Sluices and sandboxes are usually built into the system to allow sand and gravel, which could clog or damage the downstream equipment, to settle out of the water. *Flowlines* generally incorporate pressure-relief valves, installed at regular intervals along their length. These open and permit outside air to enter the line to prevent the line from collapsing should there be an accidental break in the pipe. A large vacuum would normally be formed by the sudden acceleration of water through a break, which could easily destroy either wood or steel pipe.

3. At the end of the canal system, a pipe is installed as nearly vertical as conditions will allow providing the water pressure needed to operate the water wheel(s). This pressure pipe is known as a *penstock.* At the top of this pipe is a small reservoir, expansion tank or standpipe (standpipe in the case of Bishop Creek) which helps to regulate and smooth the flow of water within the penstock.

4. A *powerhouse* is located at the bottom of the penstock. This consists of a building within which is housed the power generation and distribution equipment. The machinery within the building includes water wheels, generators, batteries and exciters. Exciters provide direct current to energize the electromagnets within the larger alternating current generator(s). The powerhouse also includes the distribution equipment used to initiate transmission of electricity. This equipment consists of switches, circuit breakers and related controls which are connected to a nearby transformer. The transformer increases voltage so that power can be transmitted over long distances. The powerhouse also contains a variety of other apparatus used in the operation of the system. This often includes a small generating unit to operate the powerhouse lights and equipment, as well as telephone links with other system components. Other buildings associated with the operation of the hydro system are usually located in close proximity to the powerhouse(s). These may include such facilities as administrative headquarters, garages, housing for system personnel, equipment storage sheds, pump houses, and machine shops.

5. Where there is more than one power-generating source, it is not uncommon for there to be a *control station* where the transmission of energy may be monitored and regulated. If electrical generating facilities are close by, many functions may be automated or operated from a centralized control point; the control station may serve this additional function.

6. *Transmission lines* carry power to users. Normally a step-down transformer is used near the point-of-use to reduce the voltage to normal house currents.[17]

[17] Diamond, Helmich, and Hicks, "Evaluation of the Historic Resources," p. 10-11.

Operation of Power Plant 5

At Plant 5, the static head of water (or vertical drop in elevation from intake to water wheel) is only 407 feet, which is the second lowest operating head in the Bishop Creek system (with only Plant 6 operating at lower head). The water that operates Plant 5 is delivered from distant Intake No. 5, an equalizing pond located to the southwest directly below the tailrace of Plant 4. Water is transferred from the intake over a distance of 3,500 feet by Flowline No. 5, a metal pipeline (originally a redwood stave pipe) which runs along the lowest portion of the moraine that terminates at the bottom of Bishop Creek Canyon. The water is conveyed from the flowline to the powerhouse via Penstock No. 5, a metal pipeline that begins at the height of the flowline and descends from the southwest, thereby using gravity to deliver water at substantial velocity to the plant. The penstock encounters an uneven Y-split and enters the powerhouse as two separate feeder pipelines on the west side. The original southern penstock feeder pipeline constructed in 1907 is located partially above grade where it enters the west wall on its path to Unit No. 1. The northern penstock feeder pipeline that was put into operation in 1919 for Unit No. 2 in the expanded plant runs entirely below grade and within the substructure.

The complex substructure of Powerhouse No. 5 was originally designed to house a reaction turbine unit (No. 1) which relied on large volumes of water moving under constant pressure. However, operation of the original reaction turbine was not successful and "after eighteen months' service it was taken out, completely ruined by the sharp sand and gravel carried in the water during the flood season."[18] The original reaction turbine was replaced by a pair of impulse wheels similar to those used in other Bishop Creek plants. Nonetheless, the technology of reaction turbines progressed substantially during the first quarter of the twentieth century and when plant facilities were expanded, the power company saw fit to implement newer reaction turbines. In 1918-1919, an additional power generation unit (No. 2) with a reaction-type wheel was installed and operated concurrently with the older impulse turbine unit. Then in 1943, the older impulse turbine at Unit No. 1 was replaced with a newer reaction turbine, which completed the conversion of the plant.

Currently, Powerhouse No. 5 contains two power generation units with reaction turbines encased in spiral-shaped housing or "volutes". Water is delivered to the volutes via the penstock feeder pipelines. The wicket gates pass pressurized water through to the propeller-shaped wheels, which rotate and turn the direct-connected generators. Water passes through the center of the wheels and into curved, vertical draft tubes that create moving pressurized columns of water. The draft tubes connect with separate 8'0" wide, square-bottomed concrete tailraces that convey water out of the powerhouse substructure and into Bishop Creek and nearby Intake No. 4. At Unit No. 1, the tailrace runs at a southeasterly angle away from the unit and exits the foundation at the southeast corner. At Unit No. 2, the tailrace runs east away from the unit and exits the foundation at the northeast corner.

[18] Poole, "Hydraulic and electric features of stations Nos. 4 and 5," p. 30.

B. Machines:

This section provides an inventory of extant machinery within Powerhouse No. 5, including descriptions of purposes, manufacturer names and dates of installation (as available), and information regarding changed and removed machinery (as available). This section is divided into several subsections beginning with a general description of the power generation units, followed by detailed descriptions of individual machines and sets of machines. The individual machinery is described in the following order: turbines (water wheels); generators; exciters; transformers and switchwork; and additional machinery.

Power Generation Units

The power generation machinery in Powerhouse No. 5 has changed substantially over time. The original installation included a "Francis" reaction turbine assembly, which was the only one of its type in the Bishop Creek system. This reaction turbine operated by submerging the wheel and its blades entirely within a flowing volume of water, rather than striking buckets with a high-velocity stream of water as occurred with an impulse wheel. To accommodate the reaction turbine, the foundation housed a ¼" steel vertical draft tube with inside diameter of 4'0" and depth of 6'0". The vertical draft tube pierced the floor plate and connected to a subsurface tailrace 8'0" wide and 9'9" deep at a point directly beneath the turbine. However, the original reaction turbine in Powerhouse No. 5 was not successful. According to the *Journal of Electricity Power and Gas* in 1913:

> Formerly the prime mover for this unit was a Francis [reaction] type water wheel. This proved unsatisfactory in operation from the fact that the water, while apparently clear and pure, carries much glacial sand and the cost of renewing chutes and runners due to erosion from this suspended matter resulted in the substitution of wheels of the tangential type.[19]

The replacement unit, an impulse water wheel/generator assembly with a water-driven exciter similar to those installed at other Bishop Creek plants, was put into operation in 1908. The double-wheel, main-and-auxiliary-nozzles configuration was most similar to the machinery that was installed at Powerhouse No. 6, which like No. 5 was located in a low-head, low-volume environment below Bishop Creek. In 1914 the power generation machinery was described and its operation was evaluated by Charles O. Poole, chief engineer of the Nevada-California Power Company, in *Electrical World*:

> [Powerhouse No. 5] contains one unit at the present time. This is a 1500-kw Allis-Chalmers machine wound for 2200 volts, three-phase, and operated at 400 r.p.m. by a Doble tangential waterwheel. The two wheels are mounted on the extended shaft of the generator with an extra outboard bearing. Water passes to the wheels through a 42-in. hydraulically

[19] Van Norden, "System of Nevada-California Power Company," p. 15.

> operated gate valve, the wheels being equipped with auxiliary nozzles and controlled by a Lombard governor. The needles can be connected either singly or doubly to the governor and can be set in any position by hand and locked to any predetermined load. A 50-kw Allis-Chalmers exciter is driven by a Doble water-wheel. The unit has been in operation for six years and has given excellent service…Another unit will be installed in this plant.[20]

As chief engineer Poole indicated, the power company expanded Powerhouse No. 5 in 1918-1919 and began operation of additional facilities in 1919. At that time, the building was extended to the north, the main generator room was increased in size, and a second power generation unit was installed in the expanded area, in line with the original impulse-wheel unit. The newer unit utilized a Pelton-manufactured reaction (Francis) water wheel made of steel with a 32” diameter. The wheel operated at 720 rpm (rotations per minute) and water flow was regulated by 14 wicket gates. The reaction turbine connected to a Westinghouse-manufactured generator rated at 1,500 kw that delivered current at 2,300 volts.

In 1943, the older impulse wheels at Unit No. 1 were removed and replaced with a reaction turbine similar to that found at Unit No. 2. The installation of the reaction turbine at Unit No. 1 included a Worthington-manufactured steel water wheel with a 40” diameter, which was somewhat larger than the wheel at Unit No. 2. The wheel operated at 720 rpm and it was regulated by 14 wicket gates, similar to Unit No. 2. Also, a Westinghouse-manufactured generator that previously operated at another of the company’s hydroelectric plants located to the northwest on the Lee Vining River was relocated to Powerhouse No. 5 and installed at Unit No. 1. This generator rated at 2,000 kw and delivered current at 2,300 volts. In order to install the reaction-turbine unit, a new concrete foundation pit was poured to accommodate the machinery. However, the existing tailrace was reused. Also, an existing draft tube, which may have been present since the original “Francis” wheel unit operated in 1907-1908, was reduced in length by 37” and reused in the installation.

Currently, from north to south, each generating unit within Powerhouse No. 5 consists of the following: a curved draft tube that creates a pressurizing column of water between the turbine and the tailrace; a reaction wheel that rotates within a spiral-shaped volute (wheel housing); a central bearing mount that supports the shaft; a direct-connected rotary generator that produces electricity; and an end bearing mount. At Unit No. 1, two shaft bearings are found between the wheel and the generator in the location where the second of two impulse wheels was mounted when the unit operated with two tangential runners. The shaft length at Unit No. 1 is approximately 26’6-½” and the center-to-center distance between the wheel and generator is 10’8”. The rotary generator at Unit No. 1 occupies a pit that is 4’1” deep with a floor opening 6’9” x 5’10”. Unit No. 2 is smaller with a shaft

[20] Poole, “Hydraulic and electric features of stations Nos. 4 and 5,” p. 30-31.

length of approximately 16'10-¾" and center-to-center separation between the wheel and generator of 5'9". The generator at Unit No. 2 occupies a pit that is 2'0" deep with a floor opening 6'5" x 5'6".

Turbines (Water Wheels)
Since the reaction turbines were installed in 1919 and 1943, the wheels have been serviced and upgraded. In 1957, the Pelton-manufactured wheel in Unit No. 2 was replaced with a Leffel-manufactured steel wheel with an equivalent runner diameter of 32", rotation speed of 720 rpm, and 14 wicket gates. Likewise, in 1968 the Worthington-manufactured wheel at Unit No. 1 was replaced with an equivalent 40"-diameter Worthington steel wheel that operated at 600 rpm with 14 wicket gates. These wheel replacements did not change the operating specifications of the power generation units and they occurred within the original cast iron machine housings and mountings which are extant.

At Unit No. 1, a massive curved metal draft tube connects to the center of the wheel and arcs down into the substructure on the north side. The draft tube extends 8'5" below the floor surface into the tailrace chamber, which is 11'2" deep at a point directly below the draft tube. Directly to the east of the turbine, a 30" gate valve is mounted atop the penstock feeder pipeline that is located partially above grade and that provides water to the unit. Directly to the west of the turbine, an 11" relay valve is found adjacent to a governor. The gate valve and relay valve display stylized metal plate that read: WORTHINGTON PUMP AND MACHINERY CORPORATION, WORTHINGTON WORKS, HARRISON, N.J., U.S.A. The governor consists of a Woodward motor-operated governor head married to a Worthington governor body that was relocated from the company's Lee Vining plant in 1946.

At Unit No. 2, a curved metal draft tube 30" in diameter connects to the center of the wheel and arcs down into the substructure on the north side. The draft tube extends 7'11" below the floor surface into the tailrace chamber, which is 11'2" deep at a point directly below the draft tube. A gate valve with hand wheel is attached to the front of the volute where the penstock feeder pipe connects to the unit. Directly to the east of the turbine is found a governor with a Woodward motor-operated governor head adapted to the original Pelton Type O-5 governor mechanism.

Generators
Additionally, the rotary generators were serviced at various times during their operation. The Westinghouse generator at Unit No. 2 was serviced in 1929, 1943, and 1986. On April 1, 1986, the Westinghouse Electric Corporation installed generator components that increased the rating of Unit No. 2 to 2,532 kw and current delivery to 2,400 volts. In 1964, the stator core in the Westinghouse generator at Unit No. 2 (which was previously located and operated at the company's Lee Vining plant) was replaced and rewound by the Westinghouse Electric Co. with no change in capacity. These generator upgrades retained the original rotors and the original generator housings which are extant.

Exciters
Until recently, both power generation units had Westinghouse 125-volt exciters attached at the south ends of the unit shafts. These older exciters were removed and replaced by Speed Indication & Control panels. Newer solid-state exciter units were installed at the northwest corner of the generator room in the former location of the switchboard.

Transformers
Transformers originally occupied the northwest corner of the room underneath a rectangular concrete platform with steel post-and-beam frame that held circuit breakers. The four transformer units (including one spare) were 500-kw water-cooled models by Stanley. Powerhouses No. 4 and No. 5, which were the earliest to be constructed in the Bishop Creek system, were the only plants that originally contained transformers within the powerhouses. By 1914, plans were underway to relocate the transformers at Powerhouse No. 4 outside of the building; removal of transformers from inside Powerhouse No. 5 probably occurred at about the same time.

Additional Equipment
Other notable details of operating machinery within the powerhouse include: an air compressor located along the east wall; service water strainers located on top of the above-grade penstock feeder pipeline to Unit No. 1; batteries lined up along the south wall; and various electrical panels located on the west wall.

C. Technology:
This section describes the technology of reaction turbines, also known as Francis wheels, which are used to create hydroelectric power at Powerhouse No. 5.

Reaction Turbines (Francis Wheels)
The “Francis” or reaction wheel is the most common type of water wheel currently used in the United States. The Francis wheel was named for its inventor, James Bicheno Francis of Lowell, Massachusetts, who established the technology in the 1850s. However, power plant development in typical high-head environments such as the steep eastern slopes of the Sierra Nevada favored Pelton wheels, not Francis wheels, during the early period of great expansion in commercial power markets and facilities.

> The application of the Francis turbine in its early stage of development was rather limited to a narrow range of head, due to a number of circumstances… the fact should not be overlooked that the early Francis turbine appeared at a time when electrical transmission of energy was practically unknown… Successful Francis turbines for operating heads exceeding 400 feet were an unknown quantity prior to 1906. A few attempts to install this type were made at an earlier date, the results,

> however, were such that it seems to be advisable to eliminate same from the records.[21]

Nonetheless, as operating thresholds for Pelton water wheels were encountered, and more varied environments were considered, it behooved hydroelectric engineers to explore using variations of the Francis wheel as a hydraulic prime mover.

> With the development of electrical transmission of energy an enormous field of application of water was power was at once opened up. The ever increasing demands in regard to speed and capacity of turbines suitable for direct connection with generators, and the greater possibilities for commercial development of water power with heads heretofore outside of the practical range, made it imperative to develop the hydraulic prime movers to such an extent that they now cover the entire range of head found within the limits of nature. The intense studies made have brought about an almost entire elimination of the numerous designs previously used, and today we find only two principal types applied – the Francis type, or reaction turbine, and the impulse type, or action turbine. The Francis turbine is designed for low and medium heads exclusively and for moderately high heads when large capacities are involved. The impulse wheel is limited to very high heads exclusively and moderately high heads when moderate capacities are involved. From the above it follows that there is a so-called twilight-zone of application of both types.[22]

A reaction turbine ("Francis wheel") is a propeller-like wheel mounted horizontally or vertically that uses the constant pressure of flowing water against its "blades" to cause rotation. A reaction turbine is completely submerged and/or encased within a spiral-shaped "volute" in order to contain water pressure. Water flow enters the larger end of the volute and is directed inward towards the turbine which spins in reaction to the water pressure. The volume of water that reaches the turbine is regulated by adjusting the position of a "wicket gate" (also referred to as "guide vane"), which can variously restrict or permit the flow of water that reaches the turbine. The wicket gate is comprised of adjustable elements located around the circumference of the wheel within the volute casing. Water that passes through the turbine is funneled to a "draft tube", a water conduit that maintains a moving column of water between the turbine outlet and the tailrace. The draft tube extends from the center of the turbine housing and terminates at the tailrace, and it may be either straight or curved based on the axial orientation of the turbine.[23]

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[21] Arnold Pfau, "High-head Francis turbines and their operating records," *Journal of Electricity*, February 1, 1918, Vol. 49, No. 3, p. 157.
[22] Pfau, "High-head Francis turbines," p. 157.
[23] U.S. Department of the Interior, "Reclamation: Managing Power in the West – Hydroelectric Power," unpaginated.

Currently and historically, Plant 5 contains the only reaction turbines located in the Bishop Creek system. The powerhouse at Plant 5, which is located at the lower reaches of Bishop Creek where low-head (low-pressure) conditions prevail, was originally outfitted with a single reaction turbine in 1907. This original reaction turbine was ruined by sediments suspended in the water flow and it was removed after eighteen months of service. It was replaced with a pair of impulse wheels arranged similarly to the double-wheel power generation unit in Plant 6 which was also established in low-head conditions. However, improvements in reaction wheel technology during the early twentieth century prompted further changes at Plant 5. In 1918-1919, the facilities at the powerhouse were expanded to include a second power generation unit operated by a reaction turbine; and in 1943, the impulse wheels were removed from the original unit and replaced with a reaction wheel, which resulted in a total of two reaction turbines at Plant 5 and within the Bishop Creek system. This is the current arrangement.

PART IV: SOURCES OF INFORMATION

A. Primary Sources:

Clerico, Robert and Ana Beth Koval. "An Architectural and Historical Evaluation of Structures Associated with the Bishop Creek Hydroelectric Power System, Inyo County, California." Prepared for Southern California Edison Company, Rosemead, CA: Intermountain Research, December 1986. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Diamond, Valerie, Stephen G. Helmich, and Robert A. Hicks. "Evaluation of the Historic Resources of the Bishop Creek Hydroelectric System." Prepared for Southern California Edison Company, Rosemead, CA: Theodoratus Cultural Research, Inc., July 1988. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Myers, William A. *Iron Men and Copper Wires: A Centennial History of the Southern California Edison Company*. Glendale, California: Trans-Anglo Books, 1986.

National Park Service, "Lowell Notes: James B. Francis," U.S. Department of the Interior, Lowell National Historical Park, unpaginated. Found at http://www.nps.gov/lowe/historyculture/upload/JB%20Francis_%20Lowell%20Notes.pdf, accessed on January 30, 2012.

Pfau, Arnold. "High-head Francis turbines and their operating records," *Journal of Electricity*, February 1, 1918, Vol. 49, No. 3, p. 157-159.

Poole, C. O. "Hydraulic and electric features of stations Nos. 4 and 5 of the Nevada-California Power Company – Static head at the former station, 1100ft." Pages 27-31 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

________. "Hydroelectric Development on Bishop Creek, Cal." Pages 3 -7 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York. 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Southern California Edison Company. Eastern_Hydro_Facilities_Data. Microsoft Excel databases transmitted on October 19, 2011. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

__________. "Southern California Edison Hydro Generation Division." October 25, 1983. Appended April 26, 1988 and October 11, 1990. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Taylor, Thomas T. "Bishop Creek Hydroelectric System." HAER No. CA-145. Historic American Engineering Record, National Park Service, U.S. Department of the Interior, 1994.

U.S. Department of the Interior, Bureau of Reclamation Power Resources Office. "Reclamation: Managing Power in the West – Hydroelectric Power," July 2005, unpaginated. Found at http://www.usbr.gov/power/edu/pamphlet.pdf, accessed on January 30, 2012.

Van Norden, Rudolph, W. "System of Nevada-California Power Company and the Southern Sierras Power Company. Part 1 – Power Plants." Pages 1-20 in *Properties and Power Developments of the Nevada-California Power Company and the Southern Sierras Power Company*. Reprint from the *Journal of Electricity Power and Gas*. Volume XXXI. Numbers 1-2. July 5-12, 1913, by Technical Publishing Company (San Francisco). Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

Drawings available from Southern California Edison Company (located in SCE company archives at 4000 Bishop Creek Road, Bishop, California):

California Electric Power Company. "Foundation Plan and Details No. 1 Unit Plant 5." August 21, 1942; revised January 15, 1943, SCE Drawing No. 571019-1.

__________. "General Arrangement Control Wiring for No. 1 Governor Auxiliaries Plant 5." June 24, 1946; revised September 9, 1947 and December 15, 2003, SCE Drawing No. 571005-2.

Nevada-California Electric Corporation. "Below Grade Raceway Plan Plant No. 5." August 30, 1938; first revised April 3, 1939; most recent revision May 12, 2008, SCE Drawing No. 571007-5.

__________. "General Arrangement No. 2 Governor & Control Equipment." March 30, 1938; first revised September 8, 1938; most recent revision October 17, 1947, SCE Drawing No. 571006-7.

Nevada-California Power Company. "Foundation Plans of Power House No. 5." April 16, 1907; revised on December 3, 1966, SCE Drawing No. 570997-0.

__________. "Power Plant No. 5 Framing of Power House #5." April 20, 1907, SCE Drawing No. 570996-0.

Southern California Edison Company. "Bishop Creek Plant 5, Intake 6 Overview and Area Map." November 18, 2003, SCE Drawing No. 5305826-0.

_________. "Bishop Creek Powerhouse No. 5 Floor Plan Elevation, Exhibit F." April 28, 2002, SCE Drawing No. 5166973-1.

_________. "Floor Plan and Panel Elevation 2.4KV Switchgear Cubicles A01 thru A04." December 5, 2005, SCE Drawing No. 5292027-0.

_________. "Powerhouse Circuit Breaker Room Floor and Ceiling Plan." April 23, 2004; revised May 12, 2008, SCE Drawing No. 5308107-1.

_________. "Powerhouse Equipment Location Plan and Section." April 23, 2004; revised May 12, 2008, SCE Drawing No. 5308106-1.

_________. "Security Features for Powerhouse #5 on Bishop Creek." November 13, 2003, SCE Drawing No. 245972-0.

Southern Sierras Power Company. "Cross Section Power House No. 5." January 16, 1919; revised December 5, 1938 and July 14, 1943, SCE Drawing No. 570983.

_________. "Foundation for No. 2 Unit Power Plant No. 5, Bishop Creek, Inyo County, CA." January 10, 1919, SCE Drawing No. 570982-0.

_________. "Framing and Elevation Section - Showing Elevations of Proposed New No. 2 Unit." October 31, 1918, SCE Drawing No. 577278-0.

B. Secondary Sources:

Poole, C. O. "Hydraulic and electric features of stations No. 2 and No. 3 of the Nevada-California Power Company – Tailrace water of former discharges directly into intake of latter." Pages 19-26 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York, 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

________. "Power house and equipment of station No. 6 of the Nevada-California Power Company – All water leaving station used for irrigation purposes." Pages 32-34 in *Power Development and Transmission Systems of The Nevada-California Power Company and the Southern Sierras Power Company*. Reprinted in 1915 from *Electrical World*, New York, 1914. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

White, David R. M. "Management Plan for Historic and Archaeological Resources Associated with the Historic and Archaeological Preservation Plan for the Bishop

Creek Hydroelectric Project (FERC Project 1394), Inyo County, California." Prepared for the Southern California Edison Company, Rosemead, California: March 1989. Located in SCE company archives at 4000 Bishop Creek Road, Bishop, California.

A. Likely Sources Not Yet Investigated:

An inquiry was made to The Huntington Library, Arts Collections, and Botanical Gardens (The Huntington) located in San Marino, California, regarding the availability of construction drawings for Bishop Creek plants that may be stored in the Southern California Edison Records, 1848-1989 (SCE Records). According to The Huntington personnel and finding aids, the SCE Records do not contain indexed construction drawings. However, a vast volume of materials is indexed in the SCE Records in a variety of categories that include: Administrative Records; Department/Division Records; Financial Records; Generation, Distribution, and Transmission Records; Project Records; Research Files; Topical Records; and Oversize Materials. These materials could potentially yield additional information related to the historical development of Bishop Creek power plants. This information could be gathered by conducting a thorough review of materials indexed in the SCE Records.

In addition, the Huntington maintains a Digital Library that includes a Southern California Edison Photographs and Negatives Collection (SCE Photograph Collection). This SCE Photograph Collection contains numerous historical photographic images of SCE facilities that could potentially yield additional information related to the historical development of Bishop Creek power plants. This information could be gathered by conducting a thorough review of photographic images indexed in the SCE Photograph Collection.

Other potential sources of information that could be investigated include current and former power company employees, who may have knowledge of the historical development of Bishop Creek power plants which may not be contained in available documents, drawings, or other materials. This information could be gathered by contacting and conducting interviews with individuals who potentially have this knowledge.

Appendix A: Images

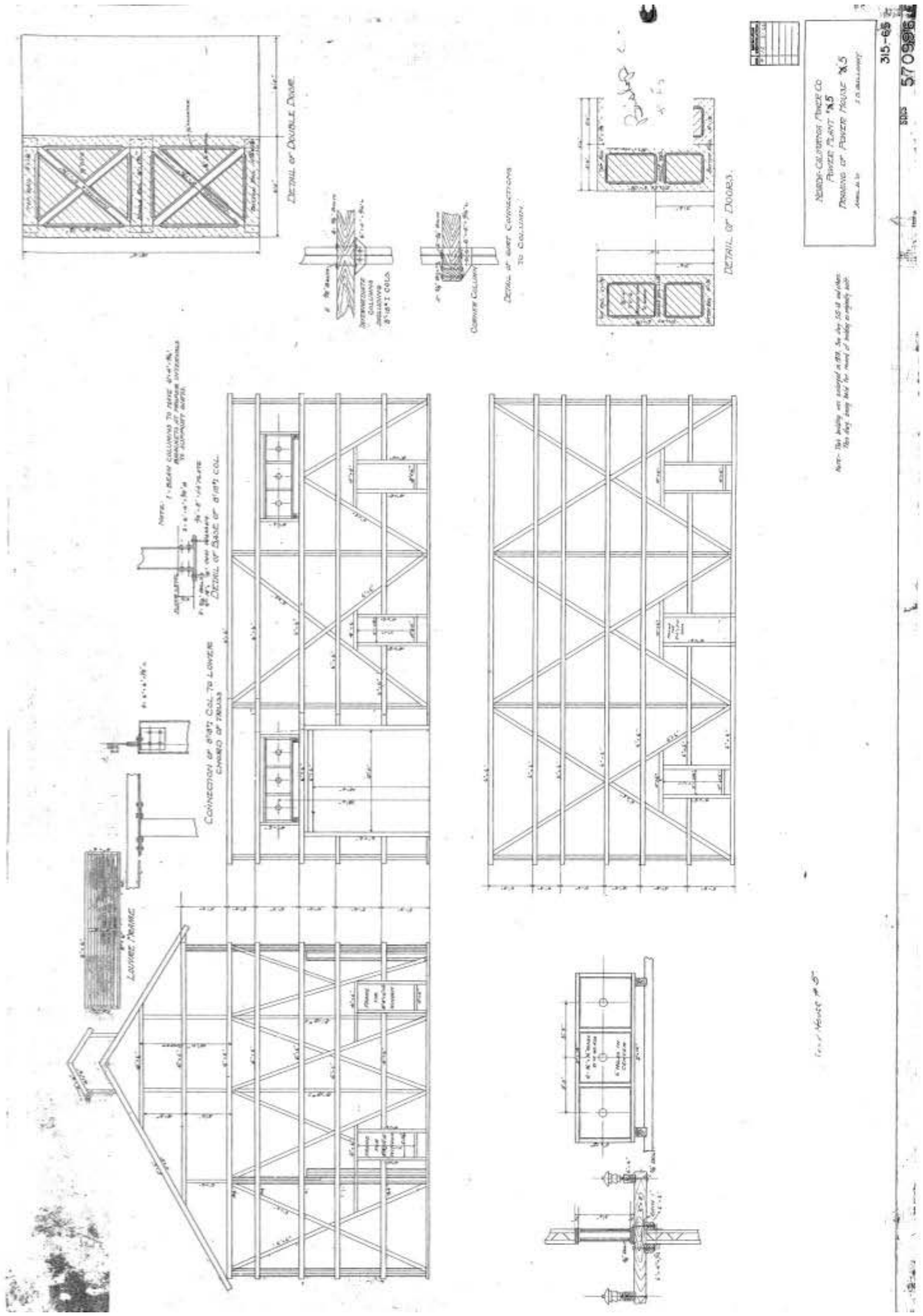

Figure 1: Nevada-California Power Company, "Power Plant No. 5, Framing of Power House #5," April 20, 1907. SCE Drawing No. 570996-0.

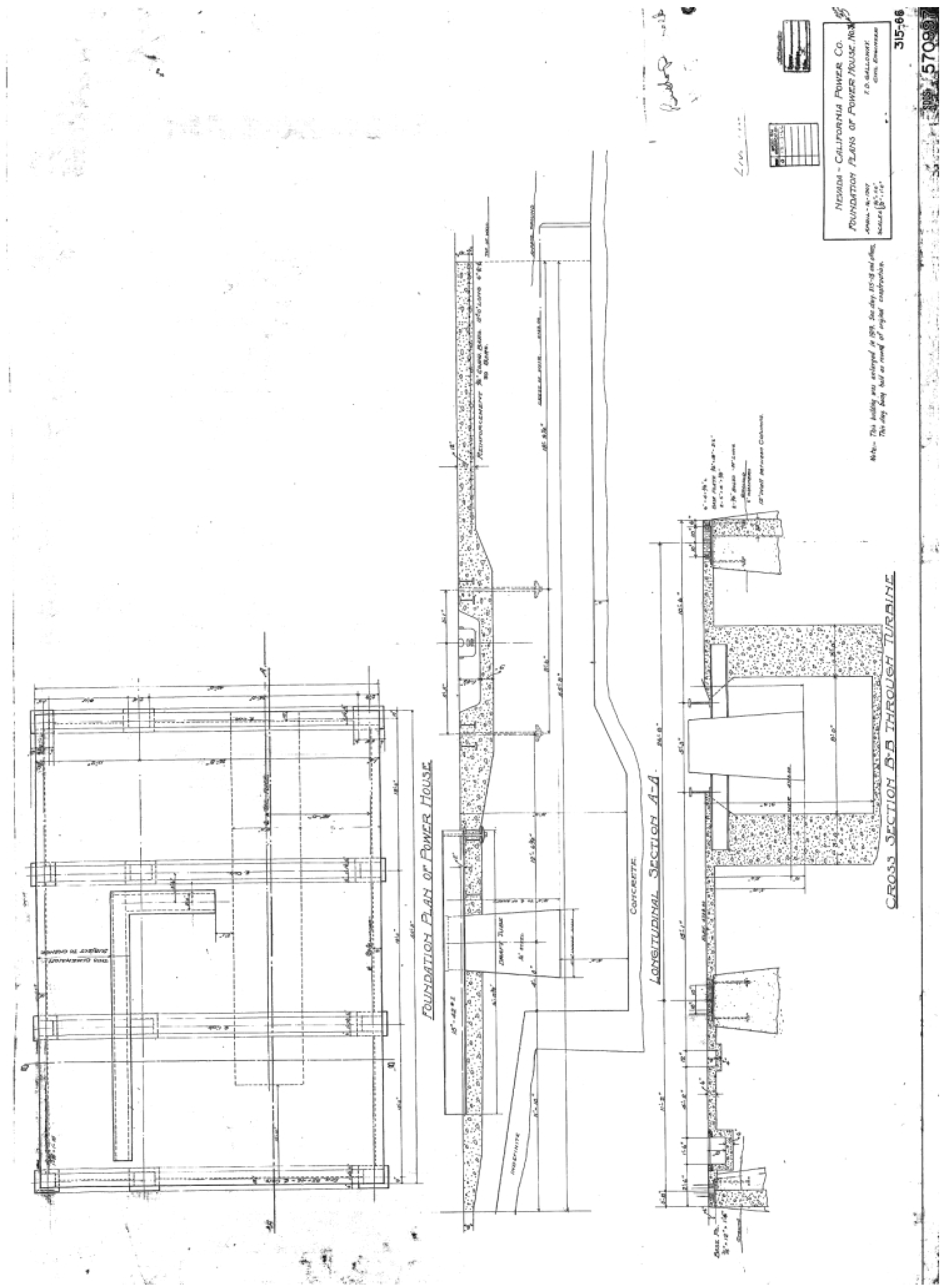

Figure 2: Nevada-California Power Company, "Foundation Plans of Power House No. 5," April 16, 1907; revised on December 3, 1966. SCE Drawing No. 570997-0.

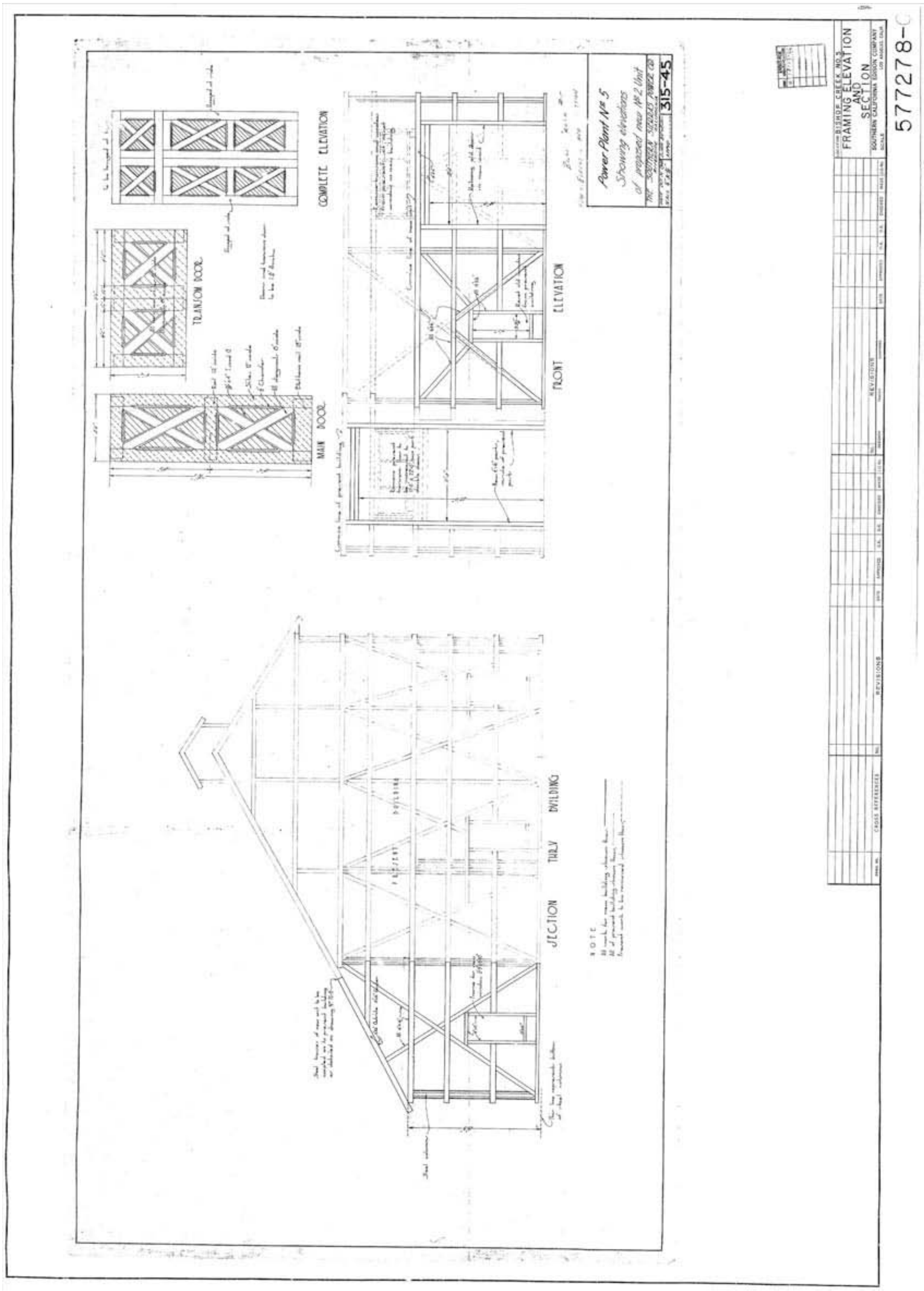

Figure 3: The Southern Sierras Power Company, "Framing and Elevation Section - Showing Elevations of Proposed New No. 2 Unit," October 31, 1918. SCE Drawing No. 577278-0.

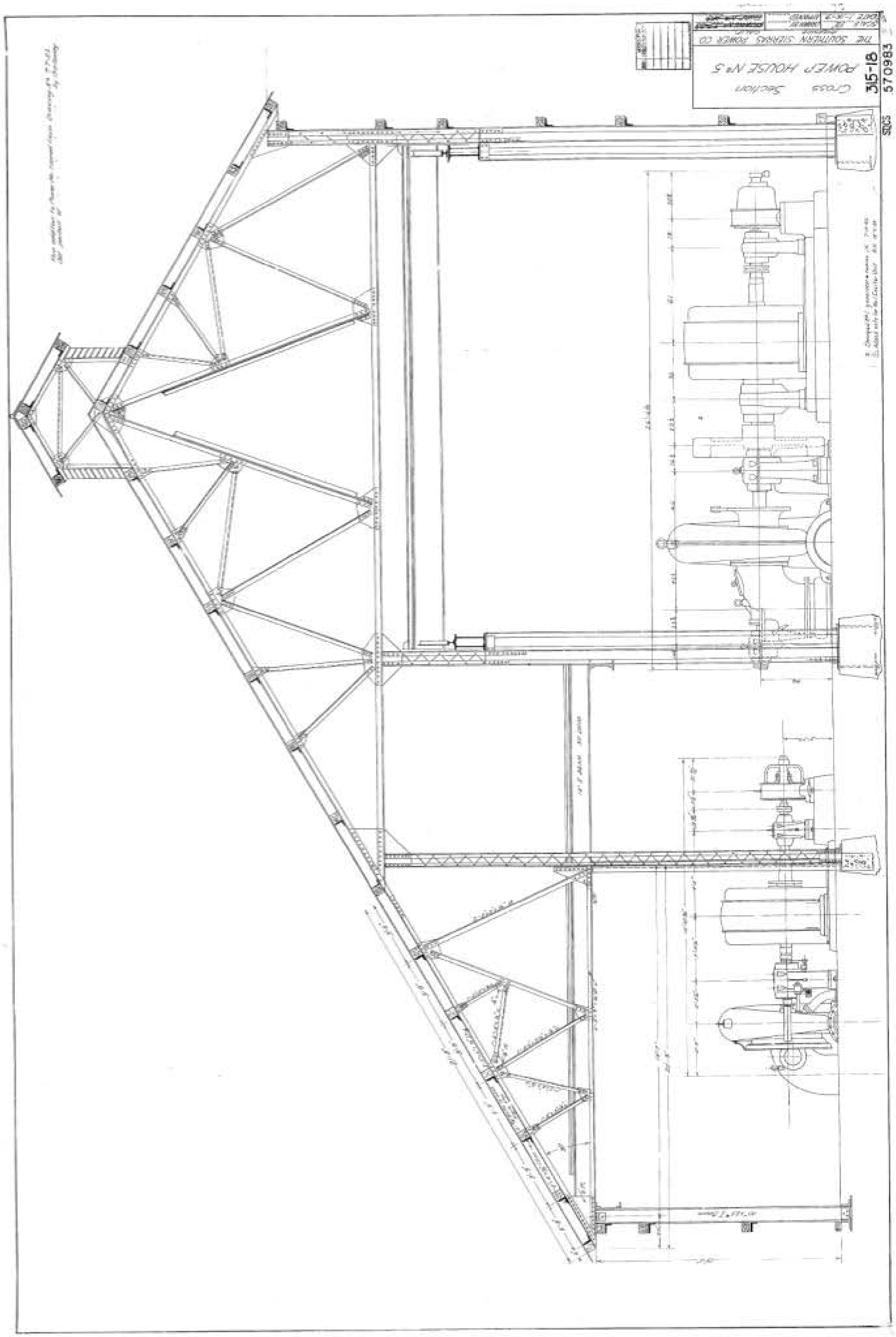

Figure 4: The Southern Sierras Power Company, "Cross Section Power House No. 5," January 16, 1919; revised December 5, 1938 and July 14, 1943. SCE Drawing No. 570983.

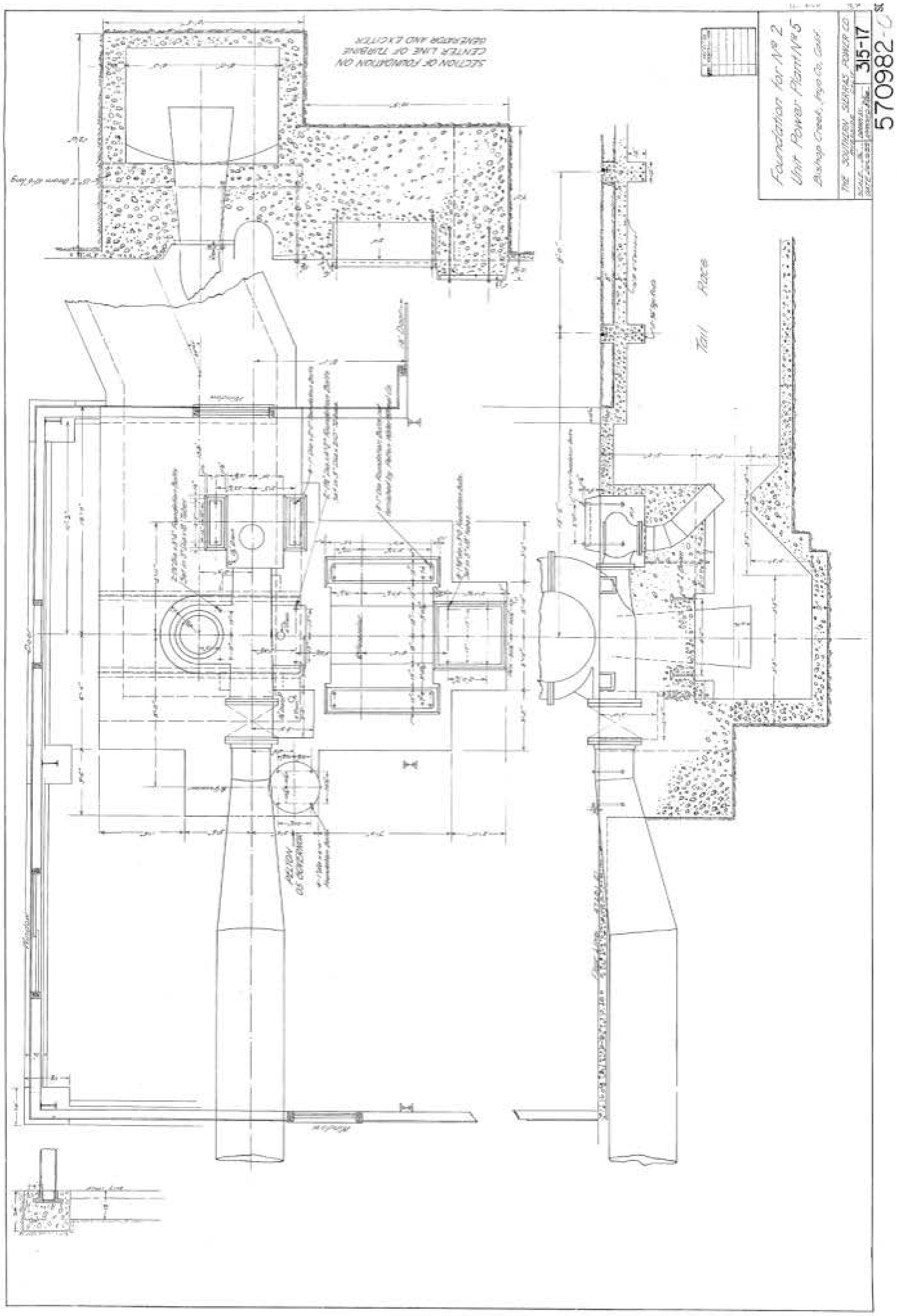

Figure 5: The Southern Sierras Power Company, "Foundation for No. 2 Unit, Power Plant No. 5, Bishop Creek, Inyo County, CA," January 10, 1919. SCE Drawing No. 570982-0.

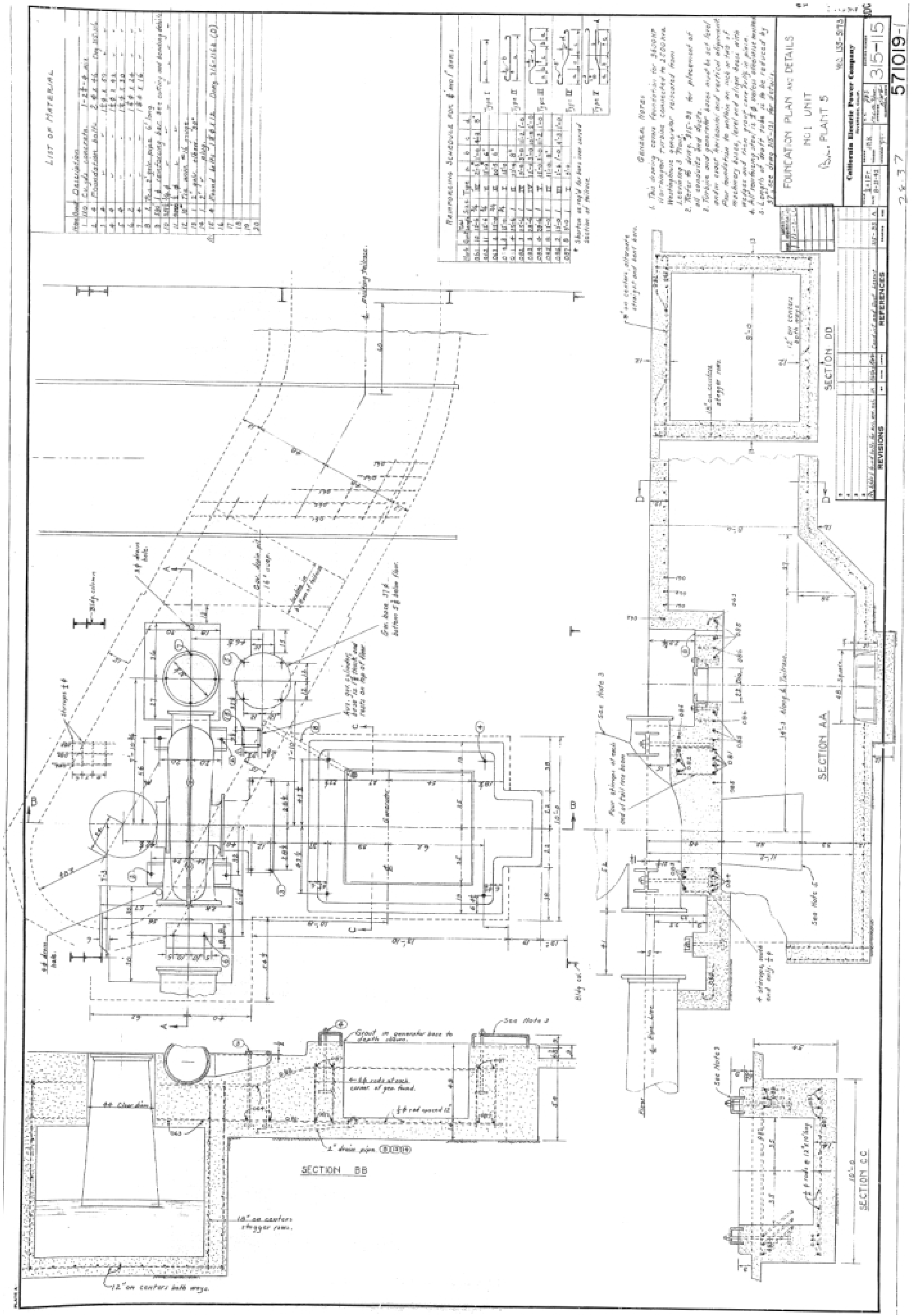

Figure 6: California Electric Power Company, "Foundation Plan and Details, No. 1 Unit Plant 5," August 21, 1942; revised January 15, 1943. SCE Drawing No. 571019-1.

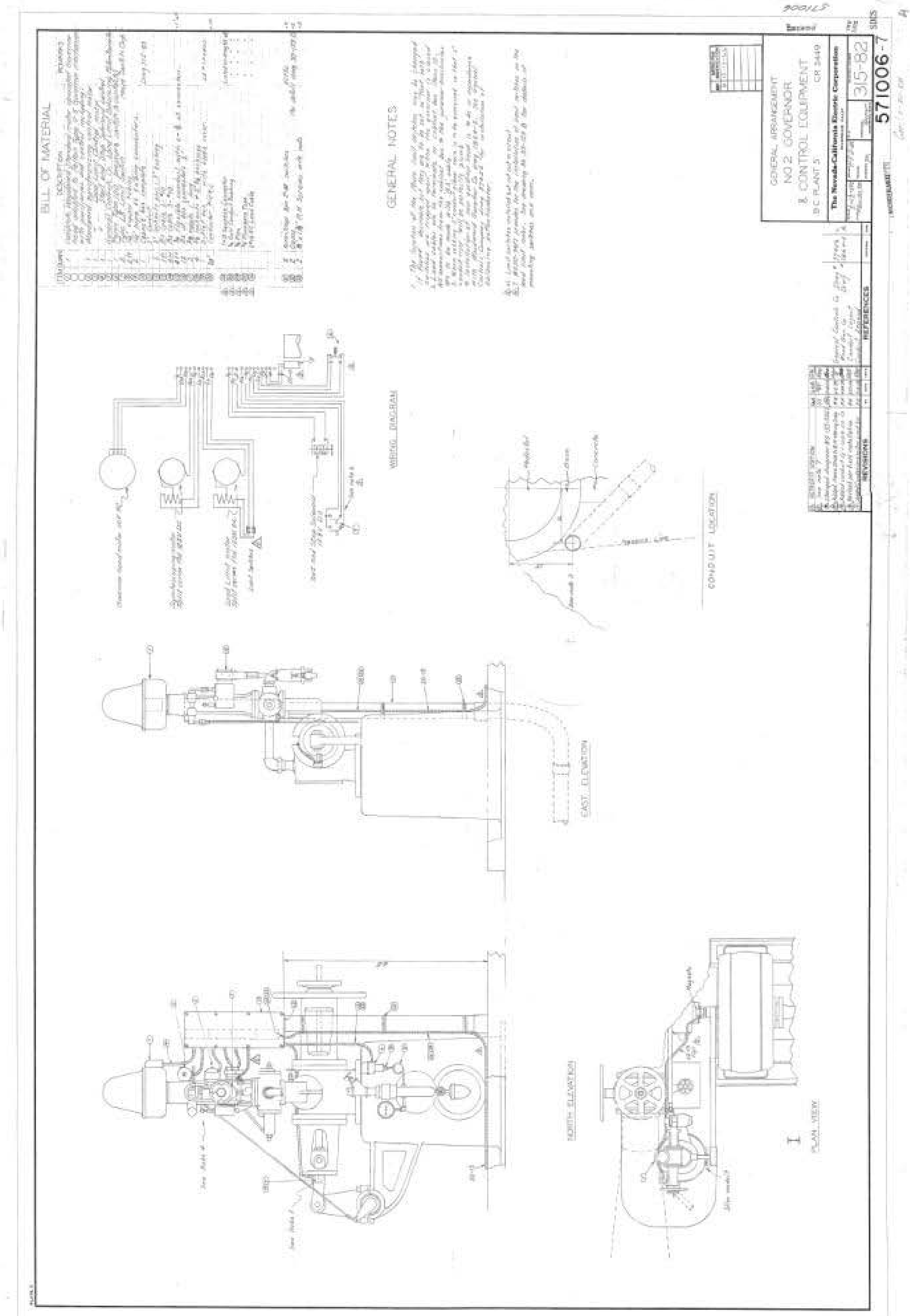

Figure 7: The Nevada-California Electric Corporation, "General Arrangement No. 2 Governor & Control Equipment," March 30, 1938; first revised September 8, 1938; most recent revision October 17, 1947. SCE Drawing No. 571006-7.

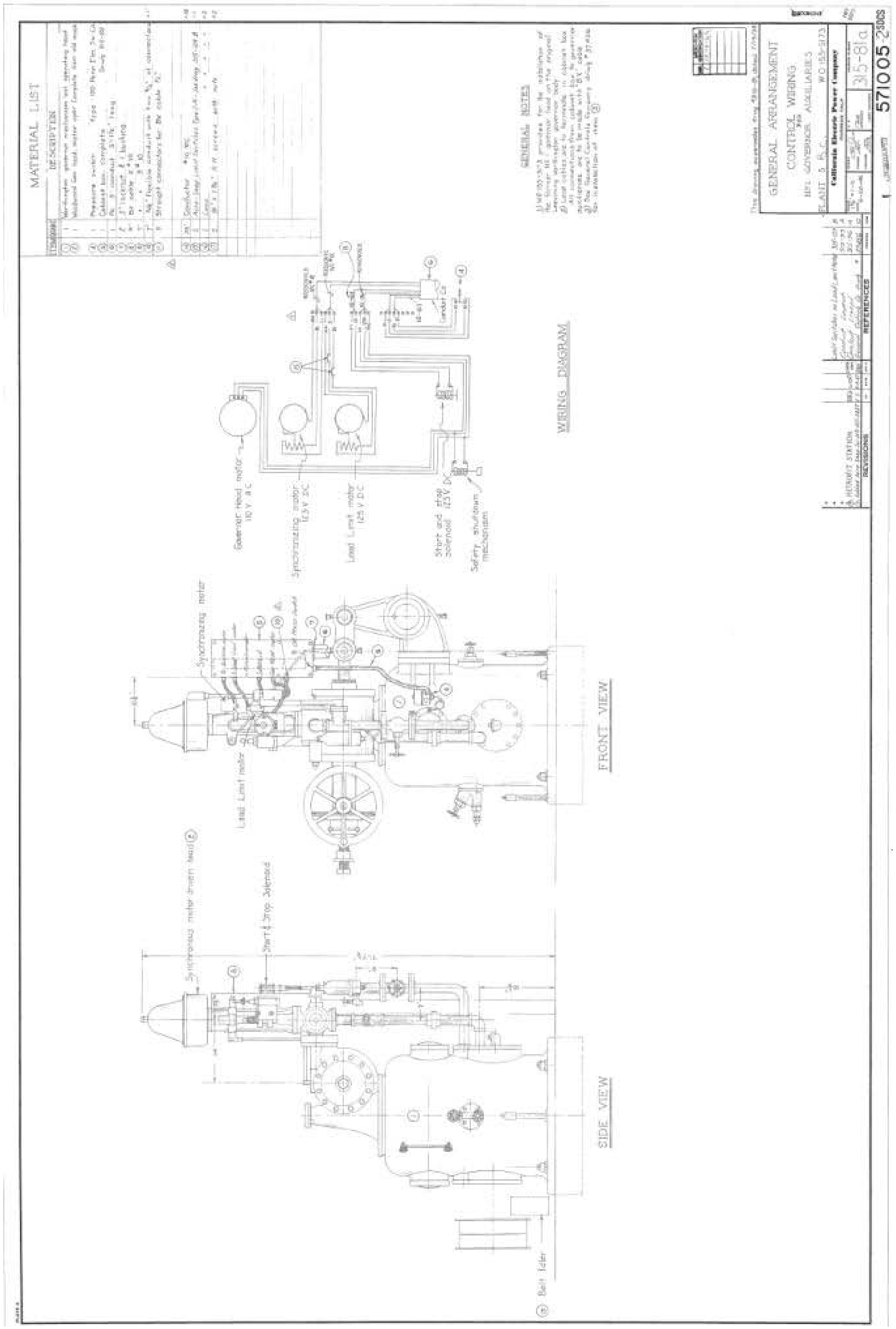

Figure 8: California Electric Power Company, "General Arrangement Control Wiring for No. 1 Governor Auxiliaries Plant 5," June 24, 1946; revised September 9, 1947 and December 15, 2003. SCE Drawing No. 571005-2.

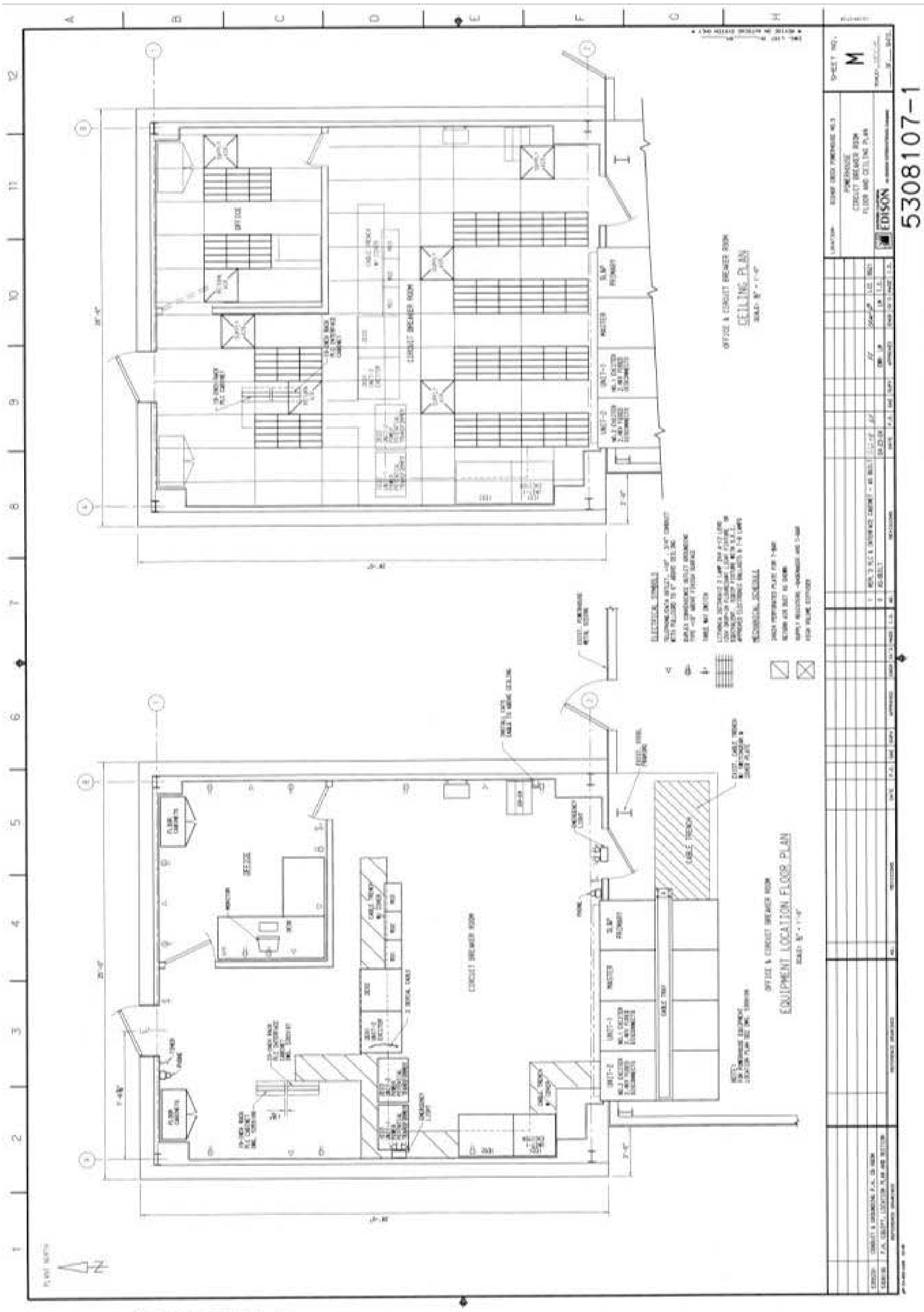

Figure 9: Southern California Edison Company, "Powerhouse Circuit Breaker Room Floor and Ceiling Plan," April 23, 2004; revised May 12, 2008. SCE Drawing No. 5308107-1.