CULTURAL RESOURCES STUDY FOR THE PG&E HUMBOLDT BAY POWER PLANT, ISFSI LICENSING PROJECT

FINAL REPORT

Prepared for:

Pacific Gas and Electric
245 Market Street
San Francisco, CA 94106

Prepared by:

PAR ENVIRONMENTAL SERVICES, INC.
1906 21st Street
P.O. Box 160756
Sacramento, CA 95816-0756

Revision 1
August 2003

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August 12, 2003

EXECUTIVE SUMMARY

Pacific Gas and Electric Company (PG&E) is planning to submit a license application to the Nuclear Regulatory Commission (NRC) for the construction of an independent spent fuel storage installation for the Humboldt Bay Power Plant in Eureka, California. As a part of the licensing process, the NRC requires compliance with federal environmental and cultural resource legislation. Consequently, PG&E contracted with PAR ENVIRONMENTAL SERVICES, INC. to conduct a cultural resource study in order to meet the requirements set forth by the NRC. The study examined resources within the project (Zone A), and within a five-mile (Zone B) and 10-mile (Zone C) radius. The results of this study are summarized below and a detailed discussion is given in the accompanying document.

No registered scenic or natural landmarks were located within the three zones. No registered cultural resources were identified within Zone A. However, several buildings, structures, and objects (BSOs) that are listed in federal and state registers are located within Zones B and C. One archaeological site that is listed on the National Register of Historic Places (NRHP) is located within Zone C. Several archaeological sites that have not been evaluated with regard to their eligibility for state and federal listings are located within zones B and C as well. No cultural resources were identified during the field study conducted within the study area (Zone A), consequently none will be impacted by the proposed project.

In addition to the archaeological survey the Humboldt Bay Power Plant Unit 3 was assessed for its historical and engineering importance in light of the NRHP criteria. Units 1 and 2 are fossil fuel units built in the late 1950s, are not included in the current project and were not evaluated at this time.

Unit 3 was built in 1963, during the early years of commercial nuclear power development in California and the nation. It was also the first privately-subsidized, sole ownership nuclear facility built in California based on energy demand and projected economic competitiveness with fossil fuel plants, rather than on research and development. Its success confirmed that nuclear power for commercial use was feasible and triggered further development of similar plants across the nation. Unit 3 was also the first nuclear facility in the world to employ a pressure suppression chamber for containment of the reactor, rather than above-ground steel and concrete domes. This innovative design by PG&E engineers cut capital costs of plants substantially, and became the model for similar boiling water reactor facilities built in the United States. Even in decommissioning Unit 3 took an innovate role in the industry. PG&E's design and implementation of long-term storage of spent fuel in a spent fuel pool on site set a national precedent and was emulated by the Nuclear Regulatory Commission (NRC). At least 14 other decommissioned plants across the United States now use this storage method.

Unit 3 appears exceptionally significant (Criterion Consideration G) in the history of the commercial nuclear power industry and appears to meet Criteria A and C of the NRHP at a national level. Unit 3 has had few modifications since it went on line in 1963 and retains integrity of location, setting, design, workmanship, materials, feeling and association. Its period of significance under Criterion A stretches from 1961 when the unusual construction methods and design elements used in the pressure suppression chamber began, until 1984 when the spent fuel pool was completed and the fuel was stored in a SAFSTOR status. The period of significance under Criterion C is 1963, the date the plant went on line.

PG&E does not plan to register Unit 3 with the NRHP. The eligibility of Unit 3 for the NRHP was previously reviewed by the NRC and the State Historic Preservation Officer (SHPO) during decommissioning licensing. The topic was addressed in the Final Environmental Statement for Unit 3 SAFSTOR issued by the NRC in 1987. Establishment of the ISFSI does not alter plans for the decommissioning and dismantlement of Unit 3.

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Pacific Gas and Electric Company (PG&E) is planning to submit a license application to the Nuclear Regulatory Commission (NRC) for an independent spent fuel storage installation (ISFSI) for the Humboldt Bay Power Plant (HBPP) in Eureka (Figures 1 and 2). Upon acceptance of the application, the NRC will issue a license to PG&E that would allow the construction and operation of an ISFSI for the purpose of storing spent nuclear fuel. The NRC is requiring that PG&E conduct a cultural resources study for the location of the spent fuel storage facility as a part of the licensing procedure in order to ensure compliance with Section 106 of the National Historic Preservation Act of 1966 and its implementing regulations (36 CFR 800).

In addition, the NRC is requiring that the National Park Service (NPS) be contacted in order to identify scenic and natural resources that have been listed on the National Registry of Natural Landmarks (NRNL) established under the authority of 37 CFR 1496 that are located within a ten-mile-radius of the study area. Identification of these resources will ensure compliance with the National Environmental Policy Act of 1969 (NEPA) and the Historic Sites Act of 1935 (16 USC. 461-467).

For the purposes of the environmental studies associated with the application procedure the project was divided into the following three zones of concern (Figure 3):

A) Site - Zone of direct impact (actual site and fill area, alternatives S-2 and S-4 [Figure 4]);
B) Vicinity - Area of indirect impact (a five-mile radius from the site); and
C) Region - A 10-mile radius from the site.

Project Description

As described above, PG&E is planning to construct and operate an Independent Spent Fuel Storage Installation (ISFSI) to store the spent nuclear fuel from Unit 3 of the Humboldt Bay Power Plant (HBPP). The project objective is to relocate the fuel assemblies from the wet storage in a spent fuel pool, located in Unit 3, to dry storage containers at an ISFSI. The ISFSI would be located on the same property as the existing PG&E facility. The spent fuel would be held there until the U.S. Department of Energy (DOE) is prepared to take possession of the spent fuel and transport it to a long-term repository. An ISFSI will facilitate the dismantling of the existing Unit 3 structures, thereby providing for earlier conversion of the Unit 3 facility to unrestricted use and termination of the SAFSTOR 10 CFR Part 50 (10 CFR 50) license. (SAFSTOR refers to "safe storage.") In contrast with the current wet storage method, dry storage of spent fuel is a passive storage process, which does not require extensive operating equipment or personnel to maintain. There are essentially no effluents, liquids or gases from the operation of an ISFSI, as compared to the allowable effluents in SAFSTOR.

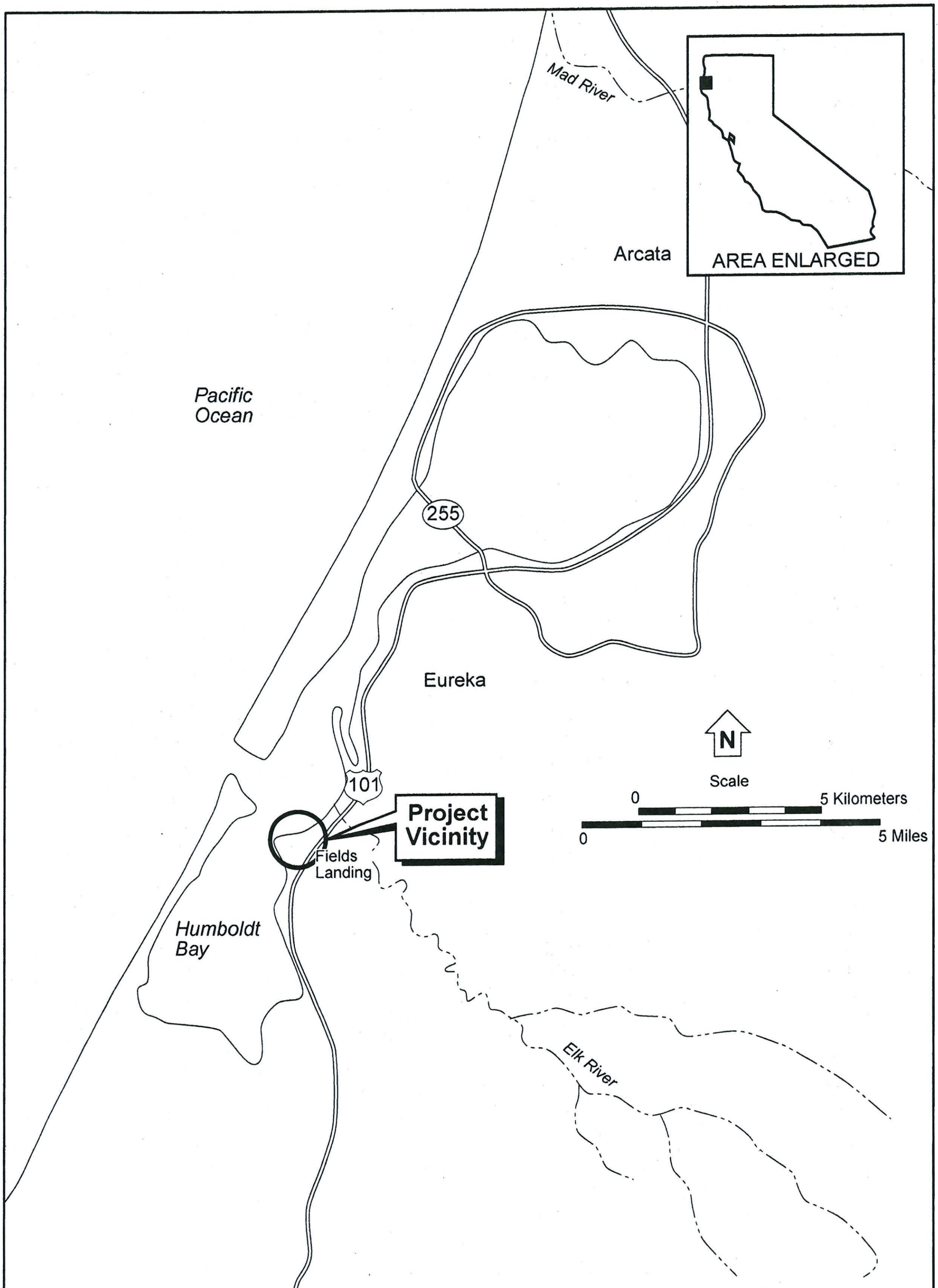


Figure 1. Project Vicinity Map

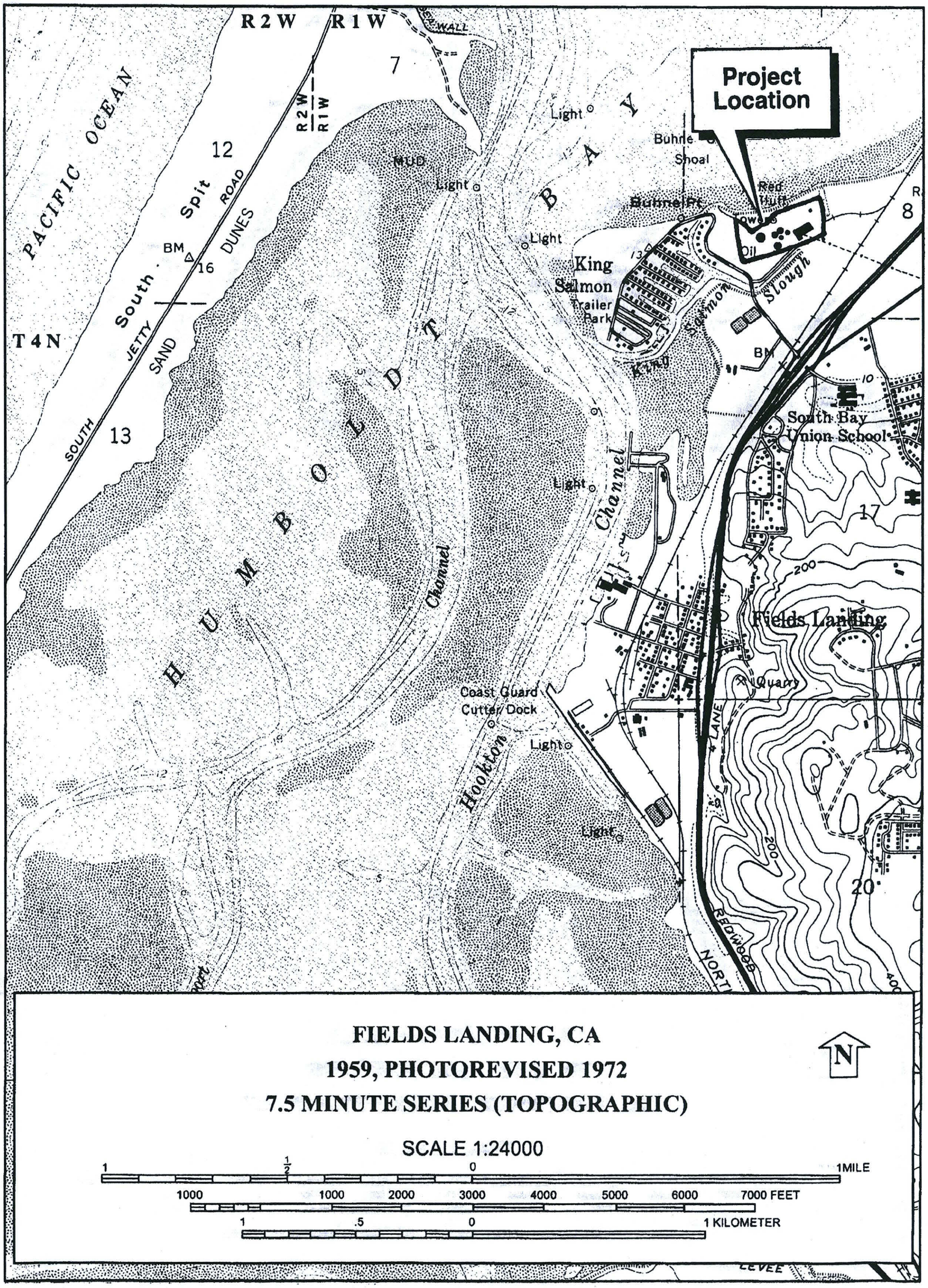


Figure 2. Project Location Map

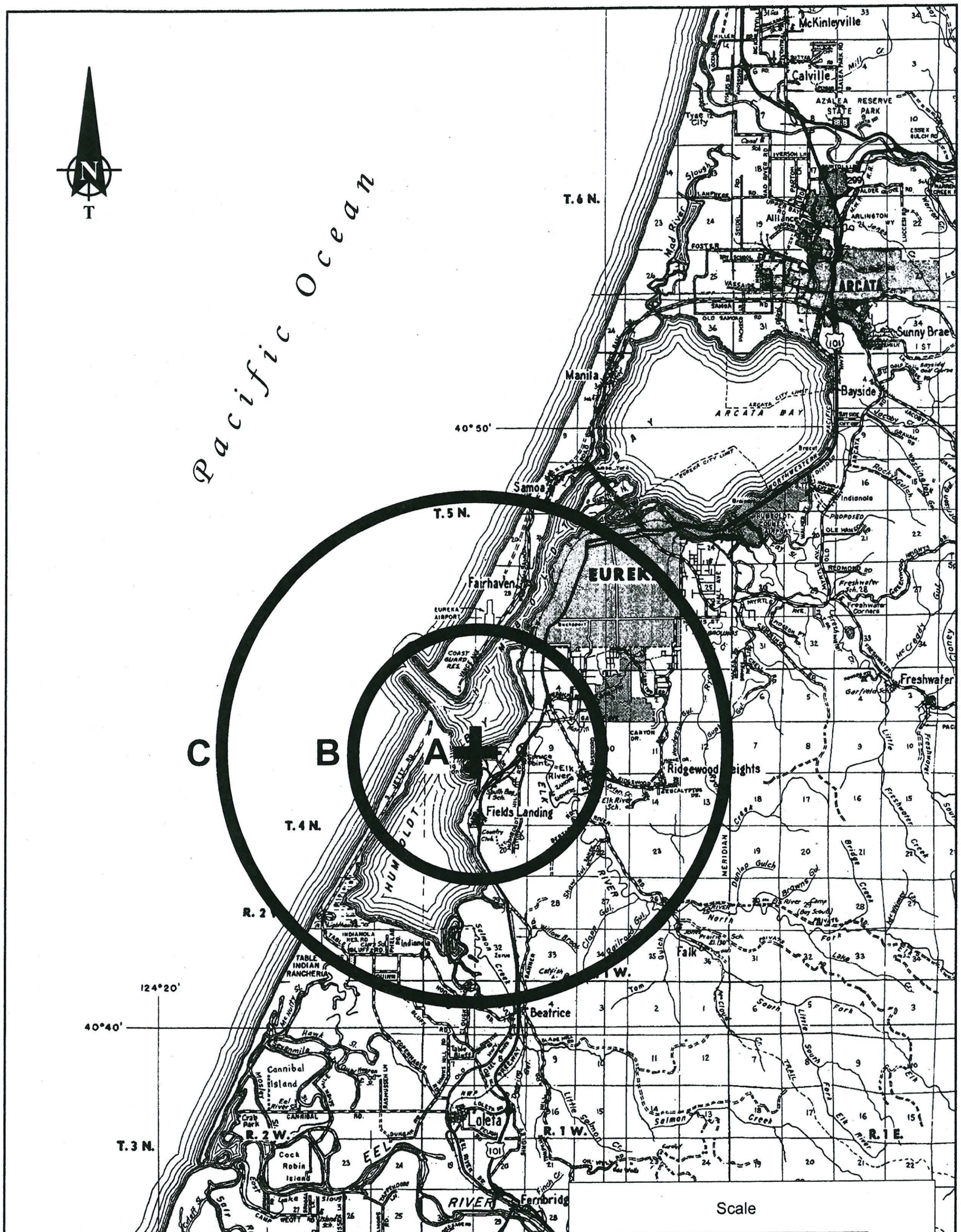


Figure 3. Zones of Concern

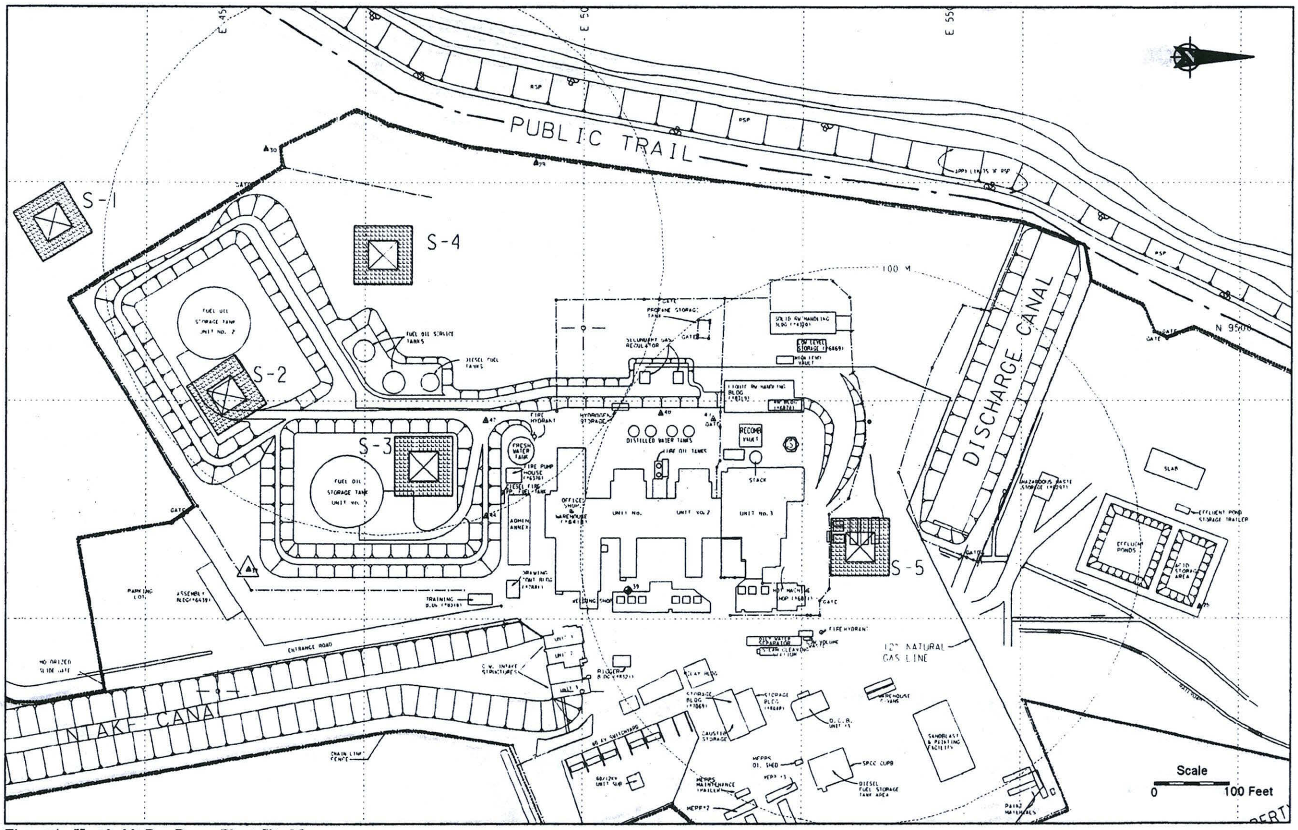


Figure 4. Humboldt Bay Power Plant Site Map

The ISFSI construction process will involve: (1) placement of a six-vault in-ground concrete and steel reinforced structure (approximately 30 ft x 70 ft); (2) installing a chain-link security fencing (approximately 70 ft x 112 ft), perimeter lighting and security surveillance/monitoring equipment; (3) installation of a small single story security building with approximate dimensions of 20 ft x 40 ft and no more than 20 ft in height; and (4) the use of a construction spoils disposal site located east of the ISFSI and adjacent to the discharge canal for the disposal of excavated material from the ISFSI. The total lot areas for the ISFSI will be approximately 11,340 sq. ft which includes the ISFSI security fenced perimeter, the small security building, and the roadway added to the fuel approximately 90,000 sq. ft that will be subject to minor grading practices to keep the site consistent to it regular ground contour. This work will involve customary grading equipment (e.g., front-end loader, compaction roller) and concrete construction equipment (e.g., forms, concrete tooling, mobile crane).

Location and Environmental Setting

The study area is located on Buhne Point between the towns of Eureka and Fields Landing, California adjacent to Humboldt Bay. The terrain along this portion of the Humboldt Bay coastline is mostly flat, ranging from 0 to 20 feet above mean sea level (amsl). However, the HBPP is located on one of the highest points along this portion of the shoreline at approximately 16 feet amsl, or 12 feet above mean lower low water (mllw).

Zone A has been heavily disturbed by the construction of the power plant facilities. According to documentation from the HBPP library in Fields Landing, a large portion of the site was cut and filled during plant construction (Figure 5). Soils visible in the area are loosely consolidated deposits that vary from light tan to dark brown sandy clay loam. Geologically this area is composed of Quaternary Pleistocene-Holocene alluvial deposits (Jennings et al. 1977). The area has been landscaped with several types of native and non-native grasses. Tule, sedge, and other aquatic plants can be found in the marshlands located southeast and southwest of the site, while dune grass can be found on the beaches to the west and south of Zone A.

Zones B and C encompass terrain that varies from rolling hills beyond the city of Eureka to alluvial flats surrounding Humboldt Bay. Elevations within Zone B vary from 0 to 300 feet amsl; they range from 0 to 1,500 feet amsl in Zone C. Geologically Zone B is composed mostly of Quaternary Pleistocene-Holocene alluvial deposits from the many rivers that empty into Humboldt Bay, as well as from the bay itself. Further inland moderately consolidated Tertiary Pliocene sandstones are inter-fingered with the alluvial deposits (Jennings et al. 1973). Several species of fir and grass can be found amongst hills beyond the city, while the alluvial flats are mostly grasslands.

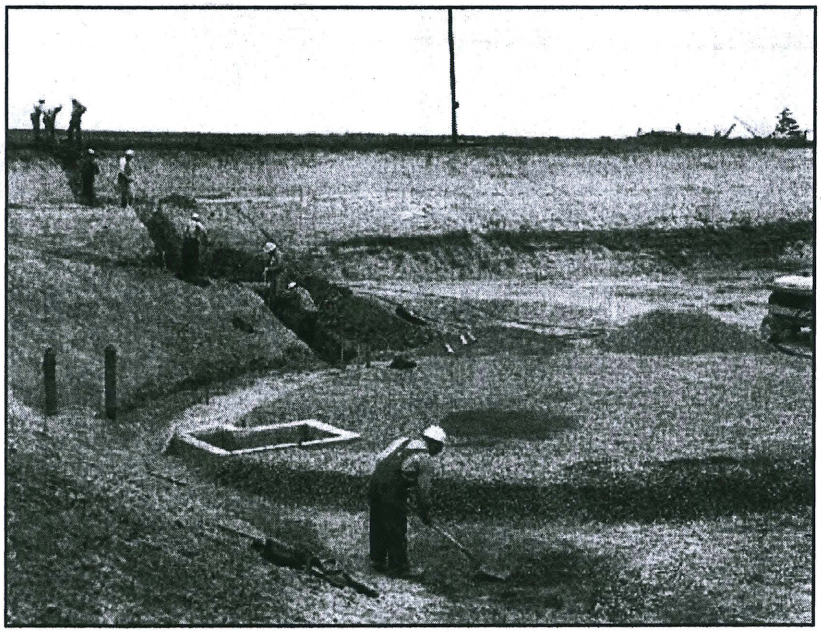


**Figure 5. Fuel Oil Storage Tank Unit 2 Under Construction (May 25, 1955)
This is the Location of Alternative S-2 for the Current Project**

The geological composition of Zone C is similar to that described for Zone B. Quaternary Pleistocene-Holocene alluvial deposits inter-fingered with Tertiary Pliocene sandstone can be found near the seashore and along the rolling hills. However, further inland Tertiary Eocene Shales and Tertiary Paleocene sandstones and shales make up the landscape. Zone C includes the vegetation noted earlier for Zones A and B, as well as redwood forest which is composed mainly of Sitka spruce, grand fir, redwood, red alder, and Douglas fir. Several other types of vegetation can be found within the redwood forest including sugar pine, Monterey pine, California bay, sword fern, deer fern, coast rhododendron, and coyote bush.

All of Zone B and the southern and eastern portions of Zone C remain sparsely populated with ranching and logging being the main industries. The northern portion of Zone C encompasses most of the town of Eureka, which is the main commercial and residential center for the area.

CULTURAL SUMMARY

Prehistoric Setting

Present knowledge of the cultural development of Humboldt Bay and surrounding areas is derived from a combination of archaeological and linguistic information. The earliest studies focused on coastal and riverine archaeological sites (Loud 1918; Heizer and Elsasser 1964; Elsasser and Heizer 1966; and Gould 1966). The analysis of data from the sites studied contributed to the development of a tentative prehistoric cultural sequence for northwestern California. While more recent work (Origer et al. 1976; Stradford and Fredrickson 1978; Milburn and Fredrickson 1979; Winter 1979; Chartkoff et al. 1979) has been conducted in mountainous areas as well as the coast. The more recent studies have not only furthered our understanding of the cultural sequence of the area, but subject matter has also focused on settlement patterns and resource procurement strategies (Moratto 1970, 1971, 1973a; Flynn and Roop 1976; Jackson 1977; Levulett 1979; Milburn and Gredrickson 1979; King and Bickel 1980).

In general, the earliest occupants of the Humboldt county coastal area, arrived before 3000 B.C. and spoke a language of the Hokan stock known as ancestral Karok (Fredrickson 1984:481; Hildebrandt 1981:35; Rammiller and Rammiller 1982:2). Diagnostic data recovered from this occupational period can be attributed to the Borax Lake Aspect of the Borax Lake Pattern. The assemblages are characterized by pointed and round stemmed projectile points. Sites of this age are rarely found in coastal areas and the lithic technology is indicative of interior hunting and gathering adaptations (Hildebrandt 1981:35; Rammiller and Rammiller 1982:7). Consequently, they may have occupied coastal areas on a seasonal basis.

Archaeological and Linguistic evidence suggests speakers of ancestral Karok were replaced by speakers of ancestral Yurok and Wiyot (Algic stock) whom are thought to have arrived in the North Coastal areas at approximately 900 A.D. (Hildebrant 1981:35; Rammiller and Rammiller 1982:3). The Wiyot settled along the Pacific coast, Humboldt Bay and along the major streams of the area, such as the Mad River. Archaeological data recovered from this occupation can be attributed to the Gunther Pattern. Assemblages include Gunther-barbed points, haliotis ornaments, bone harpoons, and other fishing technologies that are indicative of coastal rather than interior adaptations (Hildebrandt 1981:36; Fredrickson 1984:483; Rammiller and Rammiller 1982:4).

This cultural sequence presented here and else where will evolve and be developed further over time as work continues in the region. Overviews of Humboldt Bay prehistory, as well as the prehistory of the region can be found in Elsasser (1978a); Fredrickson (1973, 1984), Gould (1968, 1972), Heizer and Mills (1952); Hildebrandt (1981), Hildebrant and Hayes (1993), Loud (1918), Meighan (1955), Rammiller and Rammiller (1982), Theodoratus et al. (1980), and Whistler (1979).

Ethnographic Setting

At the time of Euroamerican contact, the project area was inhabited by speakers of Wiki, a dialect of Wiyot, an Algonquian language (Elsasser 1978b:154, 162). Wiyot speaking people inhabited an area that extended from the Little River northwards to the Bear River Mountains and that extended east from the ocean to the top of the crest of the first mountain range beyond the coastal plain (Elsasser 1978b:155; Kroeber 1925:113; Loud 1918:226-229).

Wiyot settlements were mostly along the Pacific coast and along several of the rivers in the area. No ethnographic sites are located within the AREA (Loud 1918:Map). According to a map of ethnographic site locations made by L. L. Loud near the turn of the century, one village site was located adjacent to the project on Buhne Point. However, Loud indicated that the site had been washed away by 1918 (Loud 1918:279).

Twenty-two ethnographic sites recorded by Loud are located within Zone B and 35 ethnographic sites have been recorded within Zone C. Most of the sites are located near the coast, bayshore, or along the rivers. Many of these sites are camps or villages, while others are resource procurement or resource processing areas. In general, the Wiyot exploited the forest, riverine, and coastal environments for resources. Both salt water and fresh water fish and shellfish played a primary role in their diet (Elsasser 1978b:158; Kroeber 1925:117; Loud 1918:237). Several varieties of plants were also utilized. L. L. Loud gives an extensive overview of the Wiyot culture and settlements in his 1918 ethnography. Additional sources of ethnographic information about the Wiyot are found in Gould (1968), Elsasser (1978b), Kroeber (1925), Kroeber and Barrett (1960), and Loud (1918).

Historic Setting

Humboldt Bay and an associated town were both named in 1850 by a group of explorers known as the Laura Virginia Association (named after the ship that transported them to America). The name Humboldt was given in honor of a German naturalist. Historic maps indicate that the project site is situated on the same place that the town site was planned (Elliott 1881). This town was surveyed and laid out almost immediately after the passengers of the Laura Virginia had landed; however, it never grew as large as its founders' dreamed. Maps from 1850 (Coy 1929:55) depict a town that spans three to four miles of the shoreline and that was about one mile wide. These maps were planning maps and, in reality, the town consisted of approximately 12 houses in a 40-acre tract of land, all of which were abandoned by the late 1800s (Bledsoe 1956:58). The buildings associated with the town fell into disrepair and collapsed or were gradually removed. No buildings from this era can be seen standing in a 1950s aerial photograph of the PG&E property. Cultural remains associated with the 1850s town of Humboldt were probably removed during construction of the power plant facilities.

The introduction of electricity to Humboldt County occurred as a direct result of the region's widespread lumber industry. The town of Eureka was lit via gas lights by 1878, after Herbert Kraft built a small plant and established a gas utility. Kraft used a poor quality of gas in his system and was unsuccessful, forcing the sale of his Eureka Gas Company in 1883. By the time Kraft sold his gas company, lumber mills on Gunther Island had begun generating electricity for arc lamps through steam-powered generators. The success of the steam generators led to the formation of the Eureka Electric Light Company on May 17, 1886, and on March 21, 1894 the gas and electric utilities of the city were consolidated under the umbrella of the Eureka Lighting Company (Coleman 1954:44-45, 78).

The new light company was able to use the steam engine facilities at the many lumber mills in the region and installed electric generators to service Eureka and the surrounding communities. In the 1890s street lights illuminated with arc lamps were put up in Arcata, Fortuna, Ferndale, Loleta, Rohnerville, Alton, Hydesville, and Carlotta. These electric street lights were soon followed by service to individual homes and businesses within the communities (Coleman 1954:78). In the late 1890s and the first decade of the twentieth century, ownership of Humboldt County's growing utility system changed hands several times, from the Eureka Lighting Company to Pacific Light Company to Western States Gas and Electric Company (WSGEC). WSGEC's system, including the Eureka facility, was acquired by Pacific Gas and Electric Company in 1910 (Coleman 1954:45, 362).

PG&E's Eureka System

When PG&E acquired WSGEC's system they made few changes to the operation. PG&E continued to operate the one steam generator plant and transmission system through World War II. As postwar construction began across the nation in 1945 Humboldt County's lumber industry expanded rapidly to meet the new demand and the area boomed with industrial, commercial, and residential growth. This boom resulted in a demand for more electrical power than PG&E could quickly produce (Coleman 1954:79).

In response to this need PG&E planned both short-term and long-term solutions. The short term solution was to create a temporary steam plant, called the DonBass, on the waterfront of Eureka. The DonBass plant was unique in electrical history because it used part of a shipwrecked tanker as the base for the steam plant. The *DonBass III* was an electrically-propelled ship built by Americans and turned over to Russia on a lend-lease agreement during the war. The tanker broke apart during a storm, with a loss of all personnel, but was found still afloat five days after the disaster by an American tanker, the S.S. *Puente Hills*. The captain of the S.S. *Puente Hills* towed the *DonBass III* to Port Angeles, Washington and sold it as salvage to the War Shipping Administration for $110,000 (Coleman 1954:79).

The stern half of the *DonBass III* still contained a 4,800-kilowatt generator and a steam plant for its operation. Both were in good working order, despite the wrecked condition of the ship. PG&E purchased the stern half of the tanker from the War Shipping Administration and had it towed from Puget Sound to Humboldt Bay, where it was beached on the waterfront in 1946. PG&E engineers converted the power plant from marine to land purposes and brought it on line December 16, 1946 as a way to meet the emergency needs of the growing region. The DonBass plant continued to serve stand-by and peak-load requirements until PG&E's new fossil fuel plants came on line in the late 1950s (Coleman 1954:79).

The DonBass plant, combined with the original steam plant, met the short term needs of the region, but the lumber industry continued to grow, as did the demand for increased amounts of power. To meet the long term growth needs of the region PG&E began plans to build two oil-burning plants just south of Eureka in Field's Landing, in the vicinity of the old town of Humboldt. This new facility would replace the two steam generating plants that PG&E operated in Eureka and would support a new 115 kV transmission line connecting the Humboldt Bay area to the California electric grid via the Sacramento Valley.

As designed, PG&E's new Humboldt Bay Power Plant site consisted of two fossil fuel plants, oil storage tanks, a 60 kV switchyard, and associated facilities like a warehouse, fire pump house, office, shop, yard relay building, and an intake structure. Unit 1 was completed in 1956 and Unit 2 came on line in 1958. These new plants operated on oil and natural gas and were capable of producing 25,000 Kilowatts (kW) of power each. However, PG&E knew that this power output still was not enough to meet the needs of the vast and growing northwest region and its booming lumber industry. Even as the two fossil fuel units came on line, PG&E was already examining options to meet long term regional electrical demands.

The Nuclear Power Industry

August 1945 is a month that will live forever in the collective American memory. In that month World War II effectively ended when the United States dropped a uranium bomb on Hiroshima on August 6, followed three days later by a plutonium bomb destined for Nagasaki. The Nagasaki bomb alone flattened the city and killed 40,000 people on impact, leading to Japan's surrender on August 14, 1945. The widespread destruction, great loss of life, and total annihilation of portions of both cities, from only one bomb dropped at each location, plunged the international community into a new era of uneasy peace. This peace was maintained by the sheer terror of world-wide destruction if similar bombs were used by opposing forces in an all-out war. Along with the terror wrought by these atomic weapons was a drive by nuclear scientists to develop and publicize the peacetime benefits of atomic energy. It was this atmosphere of atomic weaponry experimentation on the one hand and peaceful inventions on the other that led to the technological development of commercial nuclear power plants.

The Early Years of Atomic Discovery

The nuclear industry has its beginnings in the work conducted in the late 1890s by German physicist Wilhelm Roentgen. Roentgen discovered that electromagnetic radiation waves could penetrate a person's body, allowing a clear view of the skeleton. He called his discovery "x-rays," with "x" representing an unknown factor in the makeup of the rays (Holland 1996:13).

Roentgen's work with x-rays inspired other scientists to explore the composition and structure of the rays and other applications. In 1897 J. J. Thomson, an English physicist, found that x-rays were not rays of light but were actually streams of particles or electrons, each carrying an electrical charge, and that all were parts of an atom. His student, Ernest Rutherford, found that the electrons traveled around a central nucleus and by 1911 identified the structure of an atom (Figure 6). Independently Henri Becquerel, a French physicist, found that the rays were caused by uranium reacting to ultraviolet light and postulated that uranium contained a powerful energy source. His work inspired Marie Curie and her husband, Pierre, to experiment extensively with uranium (Holland 1996:15).

Initially, Marie Curie set out to measure the strength of the rays emitted by uranium. Her experiments found that the rays remained the same, regardless of external stimuli such as heat and light. She then began testing all other metals to test their capacity for the rays. Only pitchblende, a mineral ore that contains uranium, produced rays. Curie found that the rays emitted by pitchblende were stronger than those produced by uranium. Working together the Curie's separated the pitchblende and, in 1898, found two additional elements that produced rays, naming them polonium and radium. Radium occurred in such small quantities that the Curie's actually processed eight tons of ore to extract the few grams of radium needed for their experiments. Marie Curie named the rays emitted by the combination of the two elements "radioactivity." The Curie's shared the Nobel Prize in physics with Henri Becquerel in 1903 for their groundbreaking work (Holland 1996:14-17).

The research of these early scientists set the stage for further work with the anatomy of an atom. By late 1932 another particle in an atom, the neutron, had been identified by an Englishman, James Chadwick. Chadwick called this new element a neutron because it was electrically neutral, an important fact when scientists later tried to split an atom to release nuclear energy. Throughout the 1930s work focused on bombarding the nucleus of the atom with slow-speed neutrons in efforts to release the energy contained in the nucleus. Forefront in this new wave of researchers were a group of Austrian and German chemists and physicists, Otto Hahn, Fritz Strassman, Lise Meitner, Otto Frisch, and Albert Einstein, and an Italian, Enrico Fermi. These researchers recognized that nuclear fission (splitting the nucleus of the atom) released an incredible amount of energy and had great potential as a wartime weapon (Daley 1997:31-32; Holland 1996:18-21).

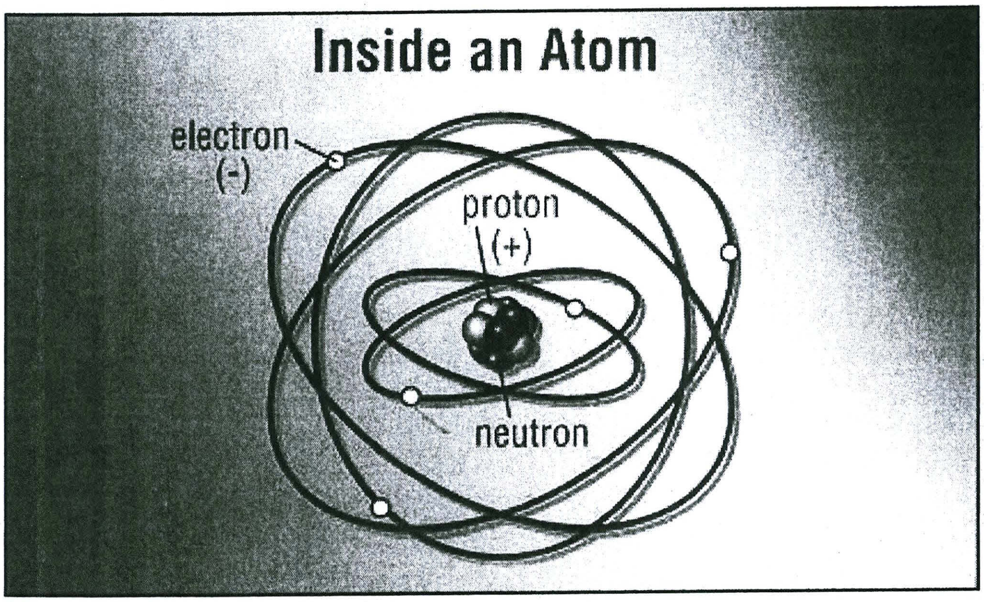


Figure 6. Structure of an Atom

Meitner, Frisch, Einstein and Fermi were forced to flee their homelands in the 1930s to escape from Nazi persecution of Jews. One of their greatest concerns was that the Nazis would invent and use the atomic bomb before the Allies. They knew that the Nazis controlled Czechoslovakia, a country that had the largest source of uranium in Europe and had stopped the sale of uranium, keeping it for their own experiments. At the prompts and pleading of his colleagues, Einstein wrote a letter to President F. D. Roosevelt in 1939, expressing their fears. Einstein informed the President that "It may be possible to set up a nuclear reaction in uranium. This new phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed." Einstein went on to state, "A single bomb of this type, carried by boat and exploded in a port, might very well destroy the port together with some of the surrounding territory" (as quoted in Stoler 1985:19). He also informed Roosevelt about Germany's acquisition of the Czech uranium mines and urged the United States to explore this new technology themselves, before the Nazis could act. Roosevelt responded by establishing the Advisory Committee on Uranium in 1939, renamed the Manhattan Project in 1942 (Holland 1996:19; Stoler 1985:19-20).

Working in a squash court underneath a University of Chicago stadium, Fermi and a group of scientists used results of Meitner and Frisch's experiments to test another theory. Fermi believed that it would be possible to create a fission chain reaction by using a neutron released from a split atom to hit another atom, releasing its neutron, which would then split another atom, and so on. Fermi controlled the experiment in December 1942 by inserting bricks between lumps of uranium and using rods of cadmium (a substance that absorbs the escaping neutrons to stop the fissioning) to start and stop the reaction. When the rods were pulled out, neutrons from split atoms began rebounding and splitting other atoms and the chain reaction began, releasing a high level of energy. This was in effect the first nuclear reactor built in the world. Fermi believed that a uranium bomb, allowed to continue a chain reaction uninterrupted until it became so hot it liquefied, vaporized and finally exploded, would be 20,000,000 times as powerful as dynamite (Holland 1996:22-23; Stoler 1985:20-22).

The bombs made as part of the Manhattan Project were designed and tested under the direction of American physicist, J. Robert Oppenheimer, in Alamo, New Mexico. The project was so secret that vice-president Harry Truman did not know about it until he became president in April 1945. The first above ground testing of the bomb occurred on July 16, 1945. Less than a month later Truman, desperate to end the war with Japan, authorized the dropping of an atomic bomb on Hiroshima, followed by a drop on Nagasaki and ushered in the age of atomic power.

The Peaceful Atom

The world was shocked, awed, and terrified by the destruction of Hiroshima and Nagasaki, especially by the effects of radiation. While the inventors of the atomic bomb had anticipated the wholesale physical destruction, no one had expected the short- and long-term effects of radiation on the human population within the cities. Some researchers believe that a sense of guilt felt by politicians and scientists was the catalyst that forced examination of more peaceful uses of nuclear fission. In any event, the ten years following the explosive end of

World War II were characterized by a bizarre mix of international atomic weapon buildup, creation of atomic bomb shelters and school drills on nuclear bomb safety, science fiction plots centered on radioactive mutant animals like *Godzilla*, production of children's movie entitled *Our Friend the Atom* and research into the use of fission to produce electricity (Ford 1982; Holland 1996; Pringle 1989).

On August 1, 1946, almost a year after the end of World War II, President Truman signed the Atomic Energy Act. This act established a five-person Atomic Energy Commission (AEC) that would oversee and control both military and civilian development of atomic energy. The AEC was charged with both building up an atomic weapons arsenal and with developing peaceful uses for atomic energy. All materials and equipment and facilities used in atomic research and development remained in ownership and control of the government under the direction of the AEC.

Part of this new development and research phase consisted of building a National Reactor Station in attempts to produce electricity. This research lab, located in Idaho, produced the first usable electricity from nuclear fission in December 1951, a fact much heralded by the AEC. The development of nuclear-generated electricity was pushed by President Eisenhower in a December 1953 speech entitled *Atoms for Peace*. This speech proposed a joint international cooperation to develop peaceful applications of nuclear energy. In part Eisenhower said, "The United States knows that peaceful power from atomic energy is no dream of the future . . . The United States pledges . . . to help solve the fearful atomic dilemma – to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to this death, but consecrated to his life" (Stoler 1985:28).

The Atomic Energy Act (AEA) of 1954 was passed by Congress in August 1954, partially to implement the *Atoms for Peace* program. Unlike the earlier AEA, the AEA of 1954 was passed to promote peaceful use of nuclear energy through private enterprise, rather than government control. The new law allowed the AEC to license private companies to build and operate reactor plants and charged the AEC with the protection of public health. The government would retain ownership of all nuclear fuel but would allow use by licensed privately-owned power stations. The AEC continued in their responsibility to develop nuclear weapons (Ford 1982a; Stoler 1985:28).

During the early 1950s the AEC explored various designs of nuclear reactors for their electrically-generating capabilities. By the time the AEA of 1954 was passed, the AEC had settled on two feasible light water reactor designs; a pressurized water reactor (PWR) and a boiling water reactor (BWR). Both reactors were similar in operation and had a core of fuel rods activated by the withdrawal of graphite and boron control rods. In the PWR, heated water circulated around the fuel rods, was pumped through radioactive primary loops and onto a steam generator. There it heated water used to produce steam and the steam then drove a turbine. The BWR followed the same principal but had fewer loops, the steam generator was eliminated, and the boiling water drove the turbine, not the steam used in the PWR (Figure 7).

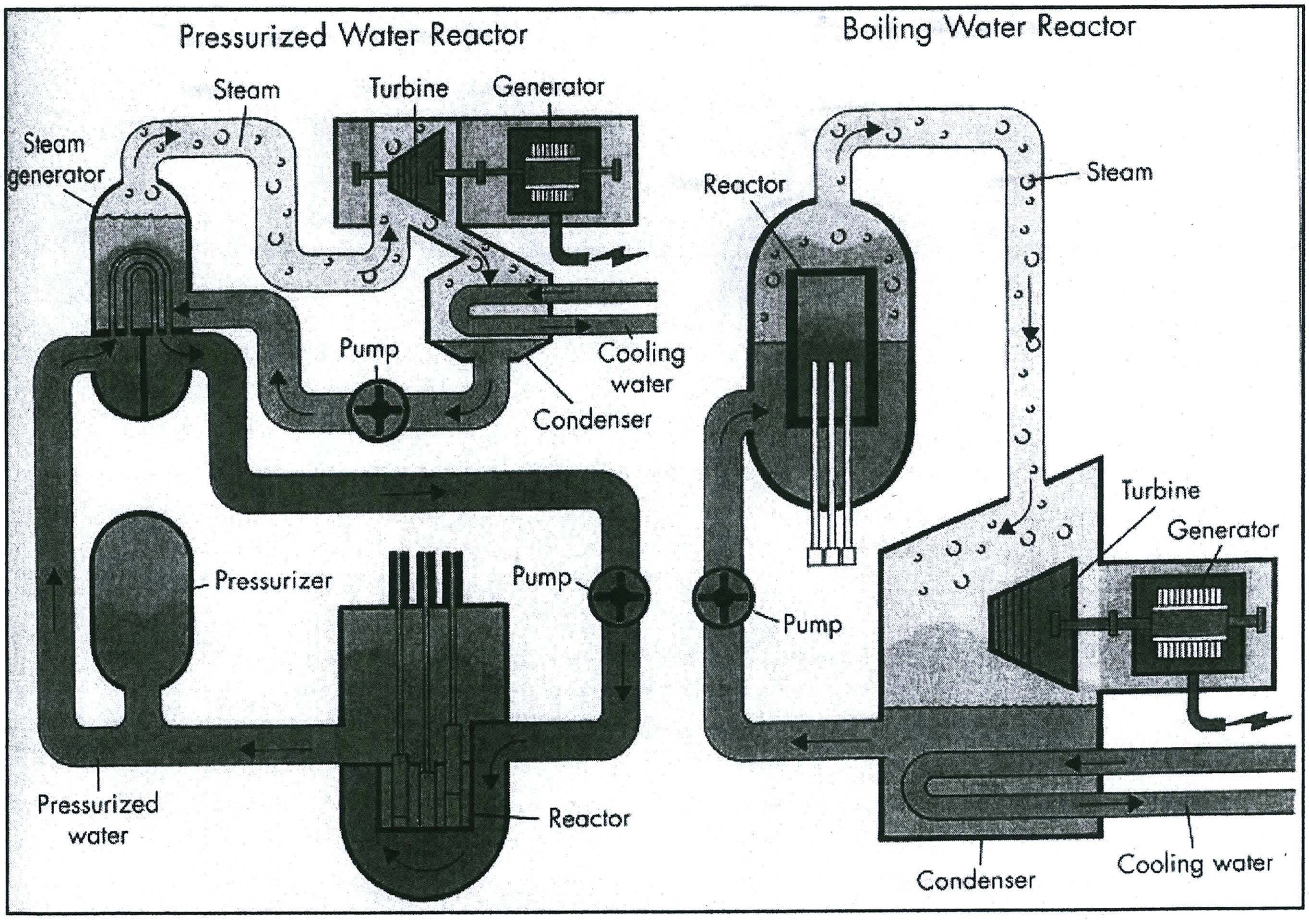


Figure 7. The Pressurized Water Reactor and the Boiling Water Reactor

The reactors were designed by two competing companies, with Westinghouse manufacturing the PWR reactor, and General Electric (GE) producing the BWR. Although both designs appeared to work, the AEC settled on the BWR as a test reactor and in 1954 began construction of the first commercial nuclear plant — the Shippingport Atomic Power Station (Stoler 1985:36).

Shippingport, located on the Ohio River in Pennsylvania, was a technical success when it came on line in 1957. It proved that Eisenhower's vision of *Atoms for Peace* was grounded in reality. The plant was a visual testimony that the atom could be controlled and harnessed for peaceful purposes. Its success, however, did not inspire private utility companies to jump on the bandwagon and fund their own plants.

The biggest drawback regarding development of nuclear facilities centered on the financial risks involved in developing a new technology, especially one using such a dangerous fuel. The fear of a nuclear accident (and the subsequent costs involved in cleanup) was also a deciding factor. After seeing the damage caused by radiation, companies knew the potentially exorbitant cost of liability should anything happen to their facility that caused a leakage of radiation to the surrounding areas. An AEC report, called WASH-740 was released in 1957 and noted that a major accident at a small nuclear power plant located 30 miles from a city would result in 3,400 deaths, 43,000 serious injuries, and cause $7 billion in property damage. Even though the AEC argued that these findings were meaningless in light of the extraordinary safety measures built into the atomic plants, insurance companies would not cover damage liability for utility companies interested in building nuclear plants and the electric companies could not build without the insurance (Ford 1982a; Okrent 1981:xiii; Pringle 1989:6-7).

In order to alleviate this concern, the AEA of 1954 was amended in 1957 with the passing of the Price-Anderson Act. The Price-Anderson amendments put a ceiling on the total amount of liability of any nuclear plant licensee in the event of an accident. This ceiling was lower than the estimated costs of an accident. The Act also established a $560 million fund to which the AEC and private companies were to contribute. In case of an accident, that money would be used to pay off claims, but once it was all distributed there would be no further liability. With a cap on the cost of liability, insurance companies were willing to provide coverage to the private enterprises, removing the last stumbling block in commercial development. What followed was one of the largest industrial building booms in the twentieth century (Pringle 1989:6-7; Stoler 1985:36-37).

PG&E and Nuclear Power

PG&E's interest in atomic-powered facilities was sparked many years before the Price-Anderson amendments were passed. In 1951 PG&E and Bechtel Corporation were commissioned by the AEC as one of four two-company teams charged with exploring the possible use of nuclear energy for electrical power generation. These studies lead to the formation of the Nuclear Power Group in 1953, a group of five, later eight, firms (*Electrical West* 1962). Soon after the AEA of 1954 was signed PG&E joined in partnerships with other firms to explore the economic feasibility of atomically powered facilities. In 1956 PG&E was

one of 44 electric companies participating in building nine reactor plants in the United States, primarily in the east. The company also remained a member of the Nuclear Power Group, by then a coalition of eight firms involved in designing and constructing the large 180,000-kilowatt (kW) Dresden plant near Chicago in Morris, Illinois. Two of the other firms involved in the Dresden project, General Electric (GE) and Bechtel Corporation, would prove to be long-time partners with PG&E in nuclear development (PG&E 1956a).

PG&E President and General Manager, Norman R. Sutherland, sincerely felt that nuclear electricity was the wave of the future and he dedicated his company's scientific and technological resources to find a way to make that electricity economical and useful. To this end, PG&E partnered with GE and Bechtel Corporation to build a small 5,000-watt plant in Vallecitos near Livermore as an experimental facility. Planned as the first privately-subsidized plant in the United States, Vallecitos was given AEC License No. 1 in 1959 (PG&E 1956a:1, 1956b:2, 1965:1; Shiffer n.d.a.:1).

GE's Vallecitos plant was the first to generate power from a BWR and served as a pilot plant or prototype for the much larger Dresden facility. This BWR was intended as a training and research experimental facility and many of the top nuclear physicists in the country worked there before moving on to other plants (PG&E 1956b:1-2). One nuclear engineer who began his career at Vallecitos likened its atmosphere to a college campus, where intense instruction and learning was mixed with nightly volleyball games (Shiffer n.d.a.:1). He wrote, "In the 1950s nuclear power was new, exciting and fun. The people involved felt that they were doing important scientific work that would ultimately be of great benefit to society. They took their work seriously . . . and contributed greatly to the first generation of commercial nuclear plants, both here and abroad" (Shiffer:n.d.a:2).

PG&E's role in Vallecitos included partially funding the project, and providing the turbine and the market for any electricity generated. The design, construction, and operation of the plant, however, were under the direction of GE. With the success of the Dresden and Vallecitos partnerships and the training of personnel at Vallecitos, PG&E was eager to prove itself in the nuclear industry by building the first economically feasible plant in the nation. To this end they began looking around for a likely location for the plant, based on need and economics. After much consideration the executive board settled on a site near Eureka, California in Humboldt County (Shiffer n.d.b.:1).

Humboldt Bay Power Plant

In the 1950s Humboldt County was little changed from a century earlier. The best way to transport freight and other goods to the area was by sea; the roads leading to and from the region were narrow, windy routes that often washed out in winter. PG&E had built two oil- and natural gas-operated plants just south of Eureka in 1956 and 1958, but these units only produced 25,000 watts each, not enough to meet the needs of the growing region. PG&E estimated that the demand would grow to 115,000 watts by 1960 and they could not meet this need with their existing fossil fuel units (Shiffer n.d.b.:2).

The cost of transporting fossil fuel to these units was very expensive, as was the overall cost of producing power in this remote and isolated rural environment. PG&E realized that in this area a nuclear plant could compete economically with a fossil fuel plant. First, once the plant was in full operation it would require refueling less often, eliminating many of the transport costs associated with fossil fuel plants. Second, it was projected that when it reached full power (65,000 to 70,000 kW) it would be producing electricity for 0.8 cents per kilowatt-hour, the same or less than the cost of the fossil fuel plants. By looking at demand and economics and projecting the cost saving of the nuclear energy plant, the planned Humboldt Bay plant became the first in the nation justified solely on the basis of competitive economics (Shiffer n.d.b.:2).

In keeping with their successful partnerships of the past, PG&E hired Bechtel Engineering as the architect-engineer to build the plant and GE to provide the nuclear reactor and other equipment and the atomic fuel. PG&E's Engineering Department, under the management of Jim Schuyler, completed the main design of the plant, with input from GE researchers (Shiffer n.d.b.:8). Traditionally, nuclear reactors were built on the ground floor of a plant and covered with containment domes, large steel and concrete domes built over the reactor. These domes were large and highly visible and were a signature of a nuclear facility. They were also extremely expensive to construct and, because of their seams, potentially could leak radiation if an accident occurred (Ford 1982a; Shiffer n.d.b.:8).

The large capital outlay needed to build a containment dome was one reason nuclear reactor plants had not been able to compete economically with fossil fuel plants (Ford 1982a; Shiffer n.d.b.:8). For example, the Indian Point plant, built outside New York City by Consolidated Edison around 1960, cost $125 million to construct, instead of the $55 million that had been estimated. AEC figures published in 1961 showed that nuclear energy was 30 to 60 percent more expensive than conventional power sources (Ford 1982a:132). The expense of nuclear energy was causing a reassessment of the technology and a widespread disillusionment with atomic energy in general (Ford 1982a:133).

PG&E's design for Humboldt Bay Power Plant Unit 3 included an innovative and unique element that the company referred to as a pressure suppression system. Instead of an above-ground containment dome, PG&E proposed to build an airtight, underground chamber or cavity out of steel and concrete (Figure 8). This cavity would be partially filled with water to suppress the condensation of the steam that could be freed from the reactor system in the case of an accident (PG&E 1961:1; Shiffer n.d.b.:8).

PG&E received approval to proceed from the California Public Utilities Commission on December 15, 1959 and applied to the AEC for permission to construct in April. The AEC issued Power Reactor Construction Permit No. 10 to PG&E on October 18, 1960 and commended the company for the new safety features evident in the pressure suppression system. In a company newsletter, PG&E (1965:1) listed the safety features noted by the AEC:

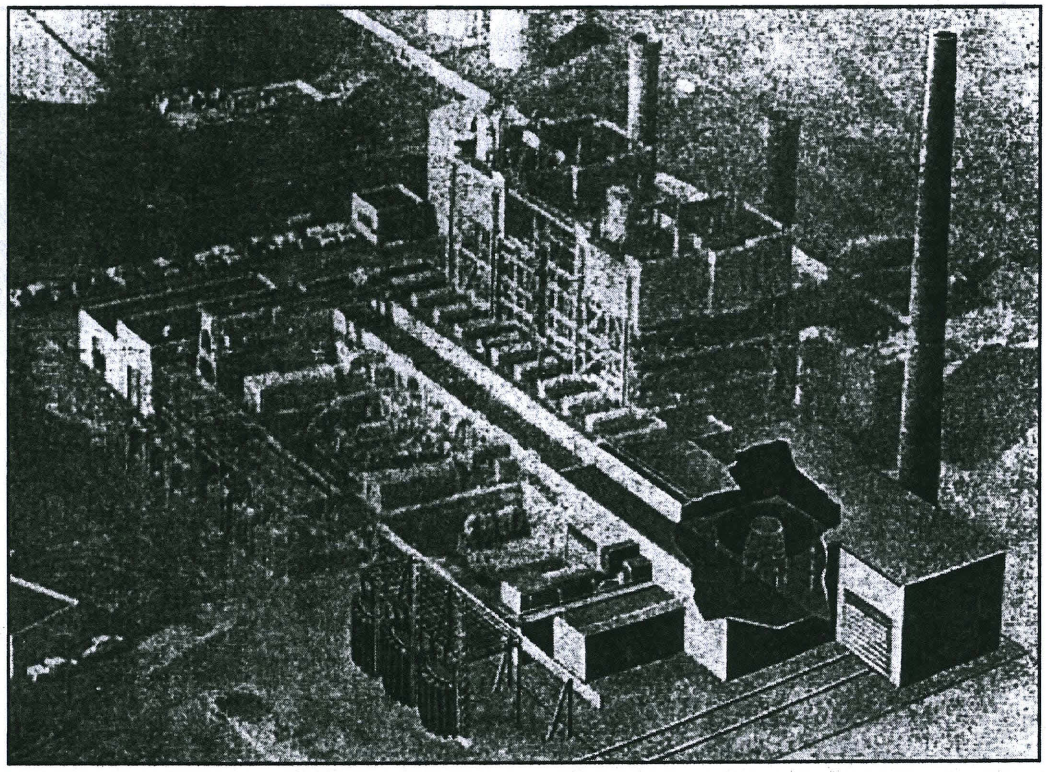


Figure 8. Artist Rendition of Humboldt Bay Power Plant Showing Subsurface Reactor Beneath Building Cutaway at Lower Right, 1961 (Source: *PG&E Progress*, January 1961)

1. No personnel will be present inside the containment structure when the reactor is in operation.
2. The small size of the containment structure, with fewer welds, will lower the probability of imperfections in the containment that could permit fission products to be freed to the environment; and
3. Containment and reactor systems will be located underground in reinforced concrete which will provide an excellent direct radiation shield.

Estimated construction costs for the plant were $20 million, substantially cheaper than those of similarly-sized plants using the containment dome. PG&E's pressure suppression system design (Figure 9) became the industry standard for boiling water reactors and was used in at least three subsequent plants across the nation and on others overseas, primarily because of the savings in capital costs (PG&E 1965:1; Shiffer n.d.c.:1).

Construction began at the new unit on November 10, 1960. Like the design elements, the construction technique used to build the plant was also innovative and unusual. The tank designated as the pressure suppression chamber was built on the surface of the ground. Its bottom was equipped with "cookie cutter" edges and water jets were placed under it (see Figure 9). As water from the jets softened the soil, the "cookie cutter" edges cut through and the tank began sinking by its own weight. By the time this slow process was completed, the bottom of the chamber was 90 feet underground (Figure 10), securely wedged in place, creating a chamber without excavation (Shiffer n.d.b.:9).

The plant was completed in 1963 and received Operating License No. 7 from the AEC, indicating it was the seventh in the nation (including experimental plants) to go on-line (Table 1). It was loaded with uranium fuel rods and started up in February. It began producing electricity for commercial use on August 1, 1963. The dedication ceremony for the new plant took place on September 23, 1963 and received national attention (Figure 11). Telegrams arrived from Jerome Wiesner, special assistant to President Kennedy for Science and Technology and from California Governor Edmund G. Brown. Both commended PG&E's leadership in developing atomic power for the economic generation of electricity and for their innovation. The Humboldt County Board of Supervisors also sent a letter of support (PG&E 1963:3-4; Shiffer n.d.c:7).

The key speaker at the dedication was U.S. Senator John O. Pastore of Rhode Island. Pastore was chairman of the Congressional Joint Committee on Atomic Energy and was a great supporter of commercial nuclear plant development. In part he said:

> I am certain that the utility companies, following the lead of Pacific Gas and Electric and others, will shortly be able to construct and operate commercial power reactors as privately financed ventures, standing on their own economic merits. . . Atomic power appears to be crossing soon its economic 'Rubicon' - it shortly will stand on its own feet as a competitor of fossil fuel, and this competition must inevitably benefit one very important group - the electric consumers of American which happens to mean every single one of us. [PG&E 1963:1].

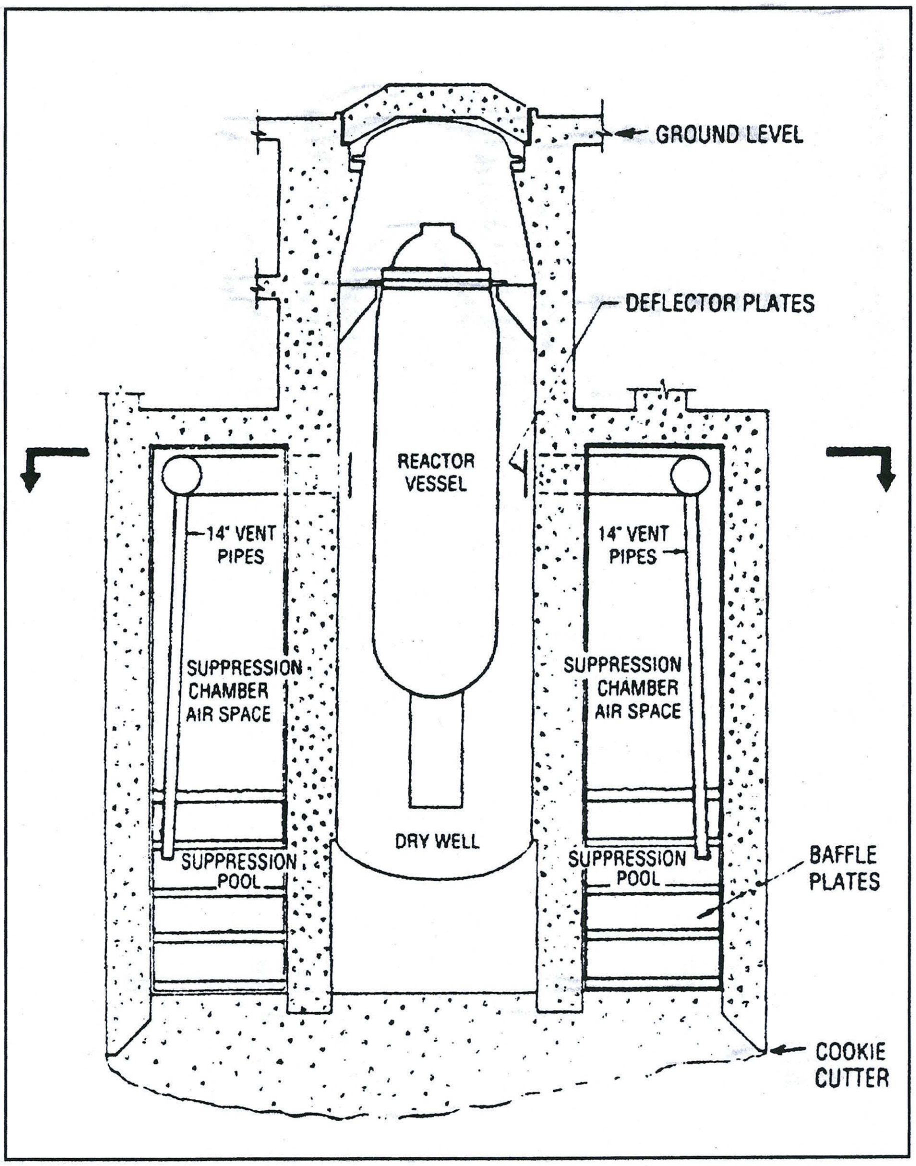


Figure 9. Schematic Cross-Section of the Suppression Chamber

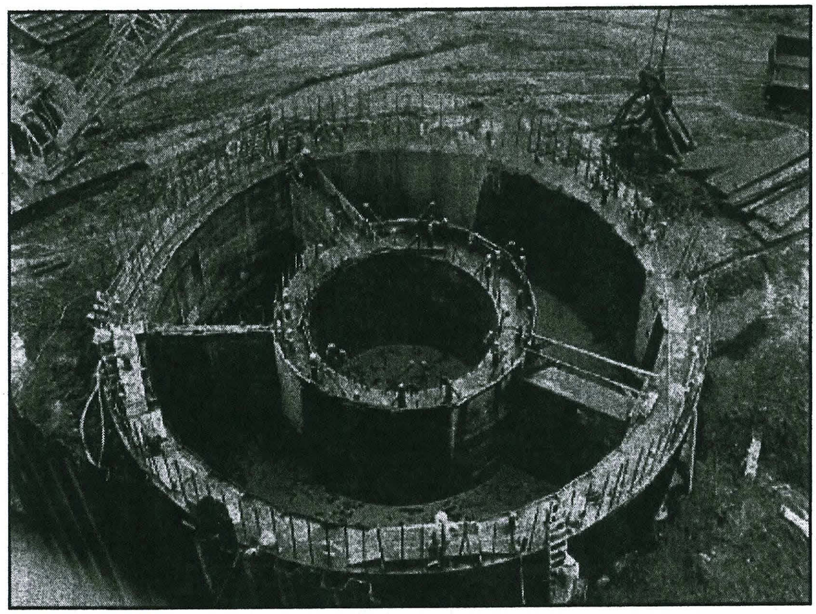


Figure 10. Suppression Chamber and Tank under Construction 1961

Figure 11. Dedication Ceremony, September 23, 1963

Table 1. Commercial Nuclear Power Reactors in the United States (as of March 2003)

State	Facility Name	Unit	Plant Type*	Capacity (kilowatts)	Date Opened	Date Closed
Alabama	Browns Ferry Nuclear Power Station	1	BWR	1,064,500	1974	
		2	BWR	1,118,000	1975	
		3	BWR	1,118,000	1977	
	Joseph M. Farley Nuclear Plant	1	PWR	924,000	1977	
		2	PWR	924,000	1981	
Arizona	Palo Verde Nuclear Generating Station	1, 2, 3	PWR	1,248,000	1986	
		2	PWR	1,248,000	1986	
		3	PWR	1,247,000	1988	
Arkansas	Arkansas Nuclear One	1	PWR	850,000	1974	
		2	PWR	858,000	1980	
California	Diablo Canyon Nuclear Power Plant	1	PWR	1,087,000	1986	
		2	PWR	1,087,000	1986	
	Humboldt Bay Power Plant	3	BWR	68,500	1963	1976
	Ranch Seco Nuclear Generating Station	1	PWR	800,000	1975	1989
	San Onofre Nuclear Generating Station	1	PWR	430,000	1968	1992
		2	PWR	1,070,000	1983	
		3	PWR	1,080,000	1984	
	Vallecitos	1	BWR	5,000	1957	1963
Colorado	Ft. St. Vrain Nuclear Generating Station	1	HTGR	333,000	1971	1989
Connecticut	Haddam Neck Plant	1	PWR	565,000	1968	1996
	Millstone Nuclear Power Station	1	BWR	652,100	1969	1995
		2	PWR	828,000	1975	
		3	PWR	1,137,000	1986	
	Connecticut Yankee Atomic Power Plant	1	PWR	575,000	1967	
Florida	Crystal River Nuclear Plant	3	PWR	825,000	1977	
	St. Lucie Plant	1	PWR	810,000	1976	
		2	PWR	810,000	1983	
	Turkey Point Plant	3	PWR	693,000	1972	
		4	PWR	693,000	1973	
Georgia	Edwin I. Hatch Nuclear Plant	1	BWR	880,000	1975	
		2	BWR	880,000	1979	
	Alvin W. Vogtle Jr. Nuclear Plant	1	PWR	1,215,000	1987	
		2	PWR	1,215,000	1989	

Table 1. Commercial Nuclear Power Reactors in the United States (as of March 2003) *(Continued)*

State	Facility Name	Unit	Plant Type*	Capacity (kilowatts)	Date Opened	Date Closed
Illinois	Byron Nuclear Power Station	1	PWR	1,120,000	1985	
		2	PWR	1,120,000	1987	
	Clinton Power Station	1	BWR	950,000	1987	
	Dresden Nuclear Power Station	1	BWR	700,000	1959	1978
		2	BWR	715,000	1970	
		3	BWR	795,000	1971	
	LaSalle County Station	1	BWR	1,147,000	1984	
		2	BWR	1,147,000	1984	
	Quad Cities Station	1	BWR	715,000	1973	
		2	BWR	787,000	1973	
	Zion Nuclear Plant	1	PWR	1,050,000	1972	1998
		2	PWR	1,050,000	1973	1998
	Braidwood Station	1	PWR	1,241,000	1988	
		2	PWR	1,155,000	1988	
Iowa	Duane Arnold Energy Center	1	BWR	580,000	1975	
Kansas	Wolf Creek Generating Station	1	PWR	1,200,000	1985	
Louisiana	River Bend Station	1	BWR	1,060,000	1986	
	Waterford Generating Station	3	PWR	1,075,000	1985	
Maine	Maine Yankee Atomic Power Plant	1	PWR	790,000	1972	1996
Maryland	Calvert Cliffs Nuclear Power Plant	1	PWR	820,000	1975	
		2	PWR	820,000	1974	
Massachusetts	Pilgrim Nuclear Power Station	1	BWR	625,000	1972	
	Yankee Nuclear Power Station	1	PWR	175,000	1960	1991
Michigan	Big Rock Point Nuclear Plant	1	BWR	70,400	1965	1995
	Donald C. Cook Nuclear Power Plant	1	PWR	1,054,000	1972	
		2	PWR	1,060,000	1973	
	Fermi Atomic Power Plant	1	SCFB	60,900	1963	
		2	BWR	1,126,000	1988	
	Palisades Nuclear Plant	1	PWR	700,000	1969	
Minnesota	Monticello Nuclear Generating Plant	1	BWR	578,000	1971	
	Prairie Island Nuclear Generating Plant	1	PWR	530,000	1973	
		2	PWR	530,000	1974	
	Elk River Reactor	1	BWR	22,000	1962	

Table 1. Commercial Nuclear Power Reactors in the United States (as of March 2003) *(Continued)*

State	Facility Name	Unit	Plant Type*	Capacity (kilowatts)	Date Opened	Date Closed
Mississippi	Grand Gulf Nuclear Station	1	BWR	1,210,000	1985	
Missouri	Callaway Plant	1	PWR	1,171,000	1985	
Nebraska	Cooper Nuclear Station	1	BWR	778,000	1974	
	Fort Calhoun Station	1	PWR	478,400	1973	
New Hampshire	Seabrook Nuclear Station	1	PWR	1,160,000	1990	
New Jersey	Hope Creek Nuclear Generating Station	1	BWR	1,049,000	1986	
	Oyster Creek Nuclear Power Plant	1	BWR	515,000	1969	
	Salem Nuclear Generating Station	1	PWR	1,090,000	1977	
		2	PWR	1,090,000	1981	
New York	James A. FitzPatrick Nuclear Power Plant	1	BWR	825,000	1975	
	Robert Emmett Ginna Nuclear Power Plant	1	PWR	495,000	1970	
	Indian Point Station	1	PWR	265,000	1962	1974
		2	PWR	957,000	1974	
		3	PWR	980,300	1976	
	Nine Mile Point Nuclear Station	1	BWR	500,000	1969	
		2	BWR	1,148,000	1988	
	Shoreham Nuclear Power Station	1	BWR	819,000	1975	1989
North Carolina	Brunswick Steam Electric Plant	1	BWR	767,000	1977	
		2	BWR	754,000	1975	
	McGuire Nuclear Station	1	PWR	1,100,000	1981	
		2	PWR	1,100,000	1984	
	Shearon Harris Nuclear Power Plant	1	BWR	860,000	1987	
Ohio	Davis-Besse Nuclear Power Station	1	PWR	873,000	1978	
	Perry Nuclear Power Plant	1	BWR	?	Post-1975	
Oregon	Trojan Nuclear Power Plant	1	PWR	1,118,000	1974	
Pennsylvania	Beaver Valley Power Station	1	PWR	821,000	1976	
		2	PWR	831,000	1987	
	Limerick Generating Station	1	BWR	1,153,000	1986	
		2	BWR	1,156,000	1990	
	Peach Bottom Atomic Power Station	1	BWR	40,000	1966	1974
		2	BWR	1,110,000	1974	
		3	BWR	1,115,000	1974	
	Susquehanna Steam Electric Station	1	BWR	1,065,000	1983	
		2	BWR	1,065,000	1985	
	Three Mile Island Nuclear Station	1	PWR	831,000	1974	1979
	Shippingport Atomic Power Station	2	PWR	90,000	1957	1982

Table 1. Commercial Nuclear Power Reactors in the United States (as of March 2003) *(Concluded)*

State	Facility Name	Unit	Plant Type*	Capacity (kilowatts)	Date Opened	Date Closed
South Carolina	Catawba Nuclear Station	1	PWR	1,129,000	1985	
		2	PWR	1,129,000	1986	
	CVTR	1	PWR	?	?	1967
	Oconee Nuclear Plant	1	PWR	846,000	1973	
		2	PWR	846,000	1974	
		3	PWR	846,000	1974	
	H. B. Robinson Plant	2	PWR	700,000	1971	
	Virgil C. Summer Nuclear Station	1	PWR	954,000	1984	
South Dakota	Pathfinder Nuclear Station	1	BWR	59,000	1966	1967
Tennessee	Sequoyah Nuclear Plant	1	PWR	1,133,000	1981	
		2	PWR	1,150,000	1983	
	Watts Bar	1	PWR	1,150,000	1996	
		2	PWR	1,170,000	Indef.	
Texas	South Texas Project	1	PWR	1,268,000	1988	
		2	PWR	1,250,000	1989	
	Comanche Peak	1	PWR	1,150,000	1990	
		2	PWR	1,150,000	1993	
Vermont	Vermont Yankee Nuclear Power Station	1	BWR	513,900	1971	
Virginia	North Anna Power Station	1	PWR	925,000	1978	
		2	PWR	917,000	1980	
	Surry Power Station	1	PWR	810,000	1972	
		2	PWR	810,000	1973	
Washington	Washington Nuclear Project	2	BWR	?	Post-1975	
	Columbia Nuclear Power Plant	1	BWR	1,150,000	1984	
Wisconsin	Kewaunee Nuclear Power Plant	1	PWR	527,000	1974	
	La Crosse Nuclear Generating Station	1	BWR	50,000	1967	
	Point Beach Nuclear Plant	1	PWR	517,000	1970	
		2	PWR	519,000	1972	

*BWR = Boiling Water Reactor
PWR = Pressurized Water Reactor
HTGR = High Temperature Gas Reactor
SCFB = Sodium Cooled Fast Breeder Reactor
Source: Gofman and Tamplin 1971:366-368; Pacific Gas and Electric Company 2003; United States Department of Energy, Environmental Web Page (http://www.em.doe.gov) (DOE list taken from "World List of Nuclear Power Plants", *Nuclear News*, March 1994)

PG&E president Robert H. Gerdes also spoke, reiterating that PG&E as a company was dedicated to the task of meeting the electrical needs of California's people. He also noted that the company planned to continue their pioneering efforts in the nuclear field. He closed his talk by noting, "We are proud of this nuclear unit. It is the culmination of twelve years of intensive effort by PG&E in the nuclear power field. It embodies design innovations, which improve the efficiency and add to the security of the plant while reducing the cost. It is history-making on many counts" (PG&E 1963:1).

During its first 18 months of operation, Unit 3 produced more than enough electricity (428,506,000 kW hours) to light about 100,000 homes a year. It was available for service 92 percent of this time, the best record for nuclear plants in the United States. This readiness of reliability led the AEC to revise its operating license from 52,000 kW to 70,000 kW. By late 1965 the plant had been refueled and was operating at full capacity (PG&E 1964:1-2; 1965:1).

The Changing Tide

In 1963, as fuel was being loaded into the Humboldt facility, Norman Sutherland, president of the company, announced PG&E's future growth plan, named the *Super System.* This plan called for construction of 16 new electric generating units; 12 of these would be run with atomic fuel. Even as construction was beginning at Humboldt Bay Unit 3, PG&E engineers were busy designing a new, larger plant, the first in the *Super System*, to be built at a site on Bodega Bay. The Bodega Bay Atomic Park was planned to have over twice the generating capacity of the Humboldt unit and would provide 325,000 kW, enough electricity to light a city of about half a million people. During initial testing of the site, however, a minor fault was discovered in the lower portion of the sedimentary deposits and underlying granitic rock. While PG&E felt that this would not cause a problem, local opposition to constructing a plant on a seismic fault was extensive, particularly since PG&E planned to use a pressure suppression system. Hearings in front of the CPUC and AEC board were held in Santa Rosa in 1963 and lasted eight days (*Electrical West* 1962; PG&E 1963:4).

During the summer of 1963, marchers from the *Sierra Club*, *Young Democrats,* and *Parents and Others for Pure Milk* protesting the plant picketed PG&E offices in San Francisco. Protests were also staged at the proposed plant site in Bodega Bay. Local musicians held benefits for the protesters and the local and national media gleefully reported on the progress of the marchers (Shiffer n.d.d:10).

The anti-nuclear groups were aided by a problem at Humboldt Bay Power Plant Unit 3. The initial fuel used at Unit 3 was clad in stainless steel that developed cladding defects. Similar defects also occurred at the Dresden and Big Rock Point plants; both used the same type of fuel rods. The defect resulted in a contamination of many of the plant systems, but did not exceed the allowable limited for release as regulated by the AEC. Nevertheless, the protestors found out about the leakage and dubbed the Humboldt plant the "dirtiest nuclear plant in the country." While the stainless steel clad fuel was replaced and the problem quickly taken care of, the label remained with the plant throughout its lifetime. This reputation of

running the "dirtiest nuclear plant" would follow PG&E for many years whenever they attempted to gain support for another nuclear facility (Shiffer n.d.d.:8).

The Bodega Bay protestors used the label liberally, spreading it to the national media. As a result, in June 1963 Secretary of the Interior Stewart Udall issued a press release expressing the Kennedy administration's concern over Bodega Bay and urging the AEC to conduct thorough investigations. PG&E responded by verbally attacking the publicity campaign and reaffirming that scientific testing and authorities backed up the company's assertion that the site was safe (Shiffer n.d.d.:7-9).

On October 30, 1964 PG&E President Robert Gerdes (Sutherland's replacement) shocked the scientific community by announcing that PG&E was withdrawing their application to the AEC for Bodega Bay. In his statement he noted that the company was convinced that the site was safe and noted that the Advisory Committee on Reactor Safeguards, an independent group of 12 well known scientists and engineers established by law to advice the AEC, agreed. He noted that the staff of AEC, however, continued to express doubt and questioned PG&E's knowledge regarding seismic safety. It was this doubt raised by some staff members that caused PG&E to withdraw the application. As stated by Gerdes, "We would be the last to desire to build a plant with any substantial doubt existing as to public safety." He went on to state that PG&E remained committed to nuclear electric generation and would continue its role in development (Shiffer n.d.e:8). PG&E indeed began investigating other sites, concentrating on a site called Diablo Canyon near Avila Beach in San Luis Obispo County, but by 1970 the national tide had turned against nuclear facilities and a subtle decline began.

A Declining Industry

During the second half of the 1960s large numbers of utility companies ordered nuclear power reactors from GE and Westinghouse and nuclear power appeared to be a commercial reality in the United States. By 1969, 15 commercial nuclear reactors were operating and many more were under construction, ordered, or planned (see Table 1). While the utility companies were enthusiastic about the future of commercial nuclear energy, there was a growing and vocal opposition from environmentalists throughout the nation.

The Bodega Bay protests were the first in a series of "not in my backyard" demonstrations that occurred across the nation at proposed sites in the late 1960s and early 1970s. People were concerned about radioactive fallout in case of a nuclear accident and increased risks of cancer for residents living near plants. Opposition to planned sites became more vocal in the mid-1960s when the AEC received applications for new "megaplants," proposed facilities that were a minimum of four times larger than the largest existing plant. Environmentalists voiced strong opposition to these large plants when it became known that one of them, Indian Point Unit 2, was planned for a site only 35 miles north of Manhattan and that ten percent of the United States population resided within a 50-mile radius of the proposed plant (Ford 1982a:146).

Critics of the AEC charged that the commission was more interested in promoting nuclear power use than in regulating the plants and watching out for public safety. In response to these acquisitions, Congress passed the Energy Reorganization Act in October 1974. This act abolished the AEC and created two new agencies; the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Administration (ERDA). The NRC was charged with safety issues and regulating existing and proposed plants while the ERDA was designed to continue AEC's research and development tasks (Ford 1982b; Pringle 1989:24-25; Shiffer n.d.e.:10). Despite this reorganization, antinuclear demonstrators continued to protest across the nation at proposed nuclear plant sites.

On March 22, 1975 a fire occurred in electrical cables at the Brown's Ferry plant in Alabama. The plant had two nuclear reactors in operation and the fire burned out of control for over six hours. When the incident was over, proponents of nuclear energy noted that the safeguards at Brown's Ferry worked; no radiation was released and the reactor core was not damaged. Opponents, however, stated the fire was a near catastrophe. This incident caused the NRC to carefully examine and implement even more safeguards for nuclear plants (Ford 1982b:85; Pringle 1989). Even after this incident, however, polls showed that most people in the United States were in support of building more plants.

This opinion level changed in 1979 when a major accident occurred at the Three Mile Island (TMI) plant in Harrisburg, Pennsylvania. During routine maintenance at one of the reactors at TMI several valves were tagged open. The plant's control panel indicated that the valves had been directed to close, but gave no indications if that direction had been followed. Operator error also occurred, with plant technicians misinterpreting information and shutting off the emergency cooling system, resulting in severe damage to the reactors' nuclear fuel core. Some radiation escaped into the atmosphere, but the greatest concern was the formation of a small hydrogen gas bubble inside the containment, a situation that could have resulted in a total meltdown of the reactor core. Amid much panic and voluntary evacuation of over 100,000 people, workers scurried to stabilize the plant, succeeding in this endeavor that same day (Ford 1982b; Pringle 1989:31-34).

The aftermath of TMI was felt for many years. First and foremost, the NRC came under extensive attack because they had been told of a similar valve situation and potential accident at another plant in 1977 and had not taken action. Second, public opinion polls indicated that after TMI 85 percent of Americans opposed construction of new plants. Third, in response to TMI, nuclear regulatory requirements became even more strict, requiring significant upgrades of existing plants. The cost of installing all the required safeguards and meeting new regulations caused many companies to abandon ongoing and planned construction of nuclear facilities; they were no longer economically competitive with fossil fuel and hydroelectric plants (Pringle 1989:35; Shiffer n.d.f.:10).

PG&E found itself in a precarious position during this time of trial, particularly regarding their Humboldt Bay Power Plant Unit 3. In the early 1970s oil company geologists exploring for natural gas near the plant discovered that a local earthquake fault called the Little Salmon Fault, was active. Previous studies conducted before the plant was built suggested that

this fault was dormant. In response to this new information PG&E began its own seismic studies and began designing plans to retrofit the plant (Shiffer n.d.f:8).

On July 9, 1976 Unit 3 was shut down for routine refueling and for seismic retrofit work. The work was projected to cost $30 million, $10 million more than it took to build the initial unit in 1963. A year later, as work was nearing completion, the NRC told PG&E it would not supporting restarting the plant until further studies were performed to resolve what they viewed as outstanding seismic questions. PG&E immediately suspended work at Unit 3 and began additional seismic studies. It was in the midst of these new studies that the TMI accident occurred.

Following the TMI incident the NRC immediately put a hold on all major licensing efforts while they reevaluated the industry as a whole. In 1980 the NRC issued new standards for all plants, requiring their compliance. In light of these studies PG&E evaluated the cost of completing the seismic work and upgrading the plant, the feasibility of refueling Unit 3 with fossil fuel, and the cost of decommissioning the plant. Their analysis indicated that costs for restarting or repowering the plant could cost between $300 to $400 million given the new standards. In light of this fact PG&E chose to decommission the plant, announcing their decision in July 1983 (Shiffer n.d.f.:9).

Decommissioning Unit 3 followed a process defined by the NRC as SAFSTOR. The NRC provides three different alternatives for decommissioning: DECON, SAFSTOR, or ENTOMB. Under DECON (immediate dismantlement) parts of a facility containing radioactive contaminants are removed or decontaminated to a level that permits release of the site for unrestricted use soon after the facility closes. Radioactive material is transported to a facility for permanent storage. Under SAFSTOR, a nuclear facility is maintained and monitored in a condition that allows radioactivity to decay, then it is dismantled. ENTOMB status encases radioactive contaminants in a structurally sound material like concrete and maintains and monitors the structure until radioactivity decays to a level permitting unrestricted release of the property. The NRC requires that decommissioning must be completed within 60 years (*Federal Register* 10 CFR Parts 50.75, 50.82, and 51.95).

Unit 3 formally entered SAFSTOR status in 1988. Under this NRC storage mode, most of the plants' radioactive parts, including the spent fuel, can remain in place until 2015. At that time, the United States Department of Energy would take possession of the fuel and transport it to a central repository.

According to Shiffer (n.d.f.:9), SAFSTOR "is a preferred alternative to dismantling when the site contains too much irradiated spent fuel to find an off-site storage location." Today, all spent fuel assemblies have been removed from the reactor and housed in the spent fuel pool inside Unit 3. Under the SAFSTOR decommissioning process at Unit 3 the fuel remains in the pool; all systems containing radioactive fluids were flushed, drained and sealed. Plant staff monitor and maintain the spent fuel pool in accordance with NRC regulations. In the fall of 1998, the containment "stack," a 250-foot-high concrete vent stack was removed and disposed of by Bechtel because of its higher radioactive content and to eliminate the threat

it posed in the event of an earthquake. The remainder of the building was decontaminated and repainted (Shiffer n.d.f.:9).

Even in its closure Unit 3 led the field. It was the first commercial nuclear plant to plan decommissioning while retaining the spent fuel on site. As such it was extensively studied and used as an example for other plants considering decommissioning, yet retaining possession of the fuel on site. Today, 14 other plants in the United States also store spent fuel in pools on site. The methods used to remove the stack (wrapping sections of the stack before dismantling) were also innovative and were followed closely by NRC and other utility companies. PG&E worked with the NRC to shape the regulatory process for more recent decommissioning, based on the results and work at Humboldt Bay Unit 3. In 1998 PG&E announced that it would seek to fully decommission Humboldt Bay Power Plant's Unit 3 sooner than the end of the SAFSTOR license in 2015. This decision was made in consideration of the latest technological developments in decommissioning and earthquake science, as well as economics and community opinion. Today, as PG&E prepares to move the spent fuel to another on-site facility, another chapter is occurring in the history of Unit 3. At the end of this final chapter PG&E will be left with only one operating nuclear reactor plant, Diablo Canyon.

METHODS

Archival and Background Research

A cultural resource record search for zones A-C was conducted at the Northwest Information Center, Sonoma State University, Rohnert Park, California. The research was conducted to identify recorded or otherwise known cultural resources within or adjacent to Zone A, previous surveys of the study area, and archaeologically sensitive portions of the study area, as determined by the locations of previously recorded archaeological sites nearby and their relationship to environmental factors and topography.

In addition, records on file at Humboldt Bay Power Plant Unit 3 were examined. These records included power plant construction reports, engineering designs, and photographs. Historical photographs housed at the PG&E Photo Library in San Francisco were also examined. Information regarding the development of commercial nuclear energy was also obtained from the United States Department of Energy's Internet web site (www.em.doe.gov/timeline), Sacramento City Library main collection and special collections, and the California State Library. The Humboldt County Historical Society in Eureka was contacted by telephone on August 4, 1999. This facility was closed to researchers at that time.

Native American Consultation

The Native American Heritage Commission and several local area Native American groups and individuals were contacted by letters dated May 24, 1999. The letters stated PG&E's plan to construct and operate an ISFSI at HBPP and requested the recipients to provide PG&E with any comments or concerns regarding the proposed project. No responses to the letter were received.

During a meeting with the Table Bluff Tribal Council on July 12, 1999, PG&E described its plans to decommission Unit 3 and construct an ISFSI. The Council expressed an interest in monitoring the progress of the work and participating in the Humboldt Bay Power Plant Community Advisory Board (CAB).

PG&E will keep the Native American Heritage Commission and other interested Native American groups and individuals informed of the ISFSI progress through periodic, publicly announced, meetings of the CAB. PG&E will address any Native American comments and concerns through appropriate communication channels.

Scenic and Natural Resources

A record search for significant natural features that are listed on the National Register of Natural Landmarks was conducted by contacting the NPS Land Management Division. The research indicated that no natural landmarks located within any of the three areas of concern have been listed on the registry.

Field Survey

A field survey of Zone A was conducted by Lynn Compas, PAR and Glenn Caruso, PG&E, on May 18, 1999. The two alternative spent core facility locations (S-2 and S-4), as well as three previous alternative locations (S-1, S-3, and S-5) and an area that will contain the proposed access road were visually examined for Native American and other cultural remains.

Survey Coverage

Lynn Compas and Glenn Caruso used complete survey coverage techniques to examine alternatives S-2 and S-4, and the areas encompassing the proposed roads (see Figure 4, Figure 12, Figure 13). Several zig-zag transects that varied between 20 and 30 meters apart were walked in these areas. The ground was covered with dense grass in most areas; therefore, trowels were used intermittently to clear the vegetation and improve ground visibility.

Cursory survey coverage techniques were used to examine alternatives S-1 and S-5 (see Figure 13). Transects varied from 30 to 50 meters apart. Grass obscured most of the two areas; therefore, trowels were used to clear the ground surface for visual inspection. Alternative S-3 is located within an area that is paved; consequently, the ground surface was not visible and it could not be surveyed.

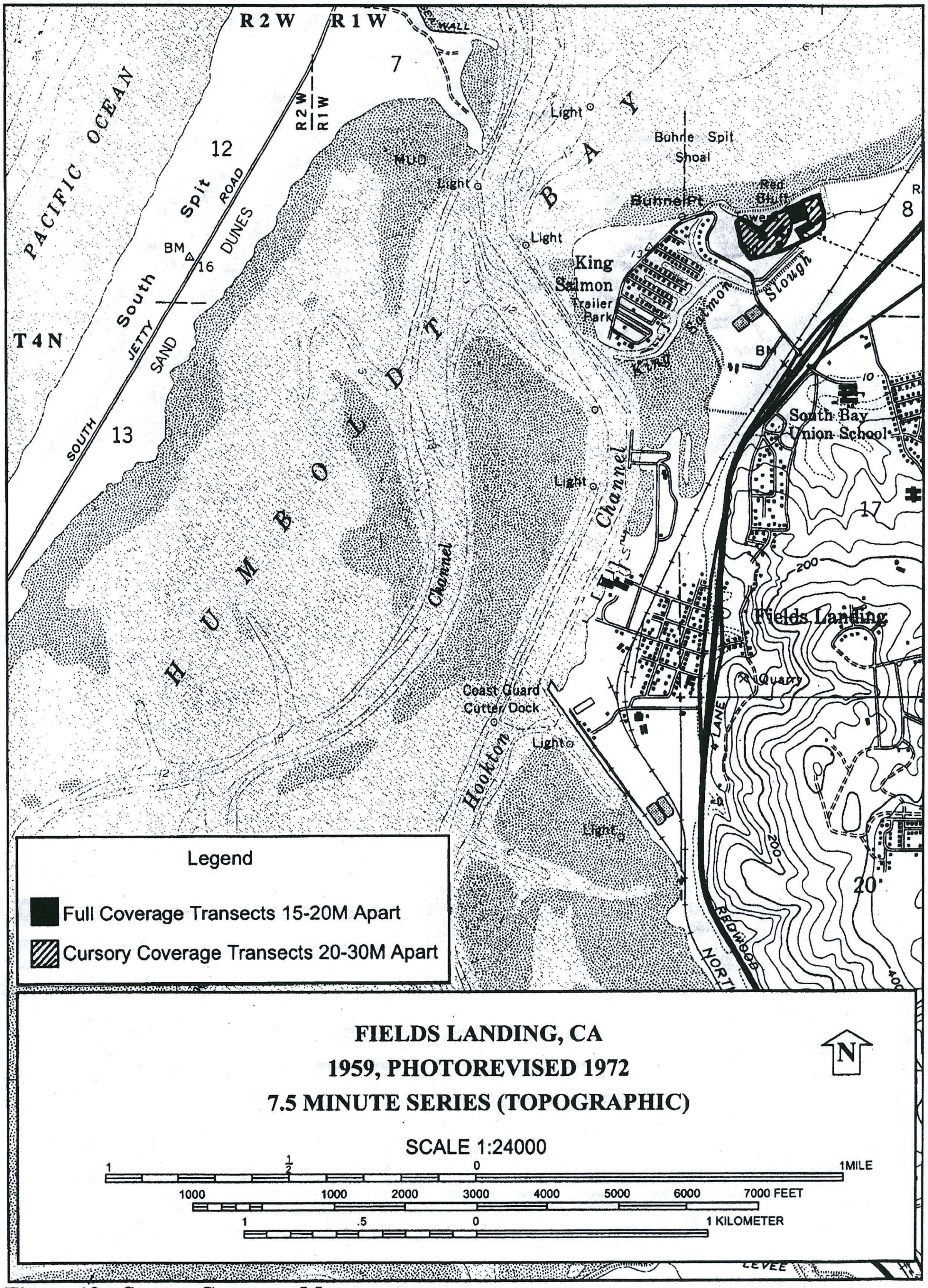


Figure 12. Survey Coverage Map

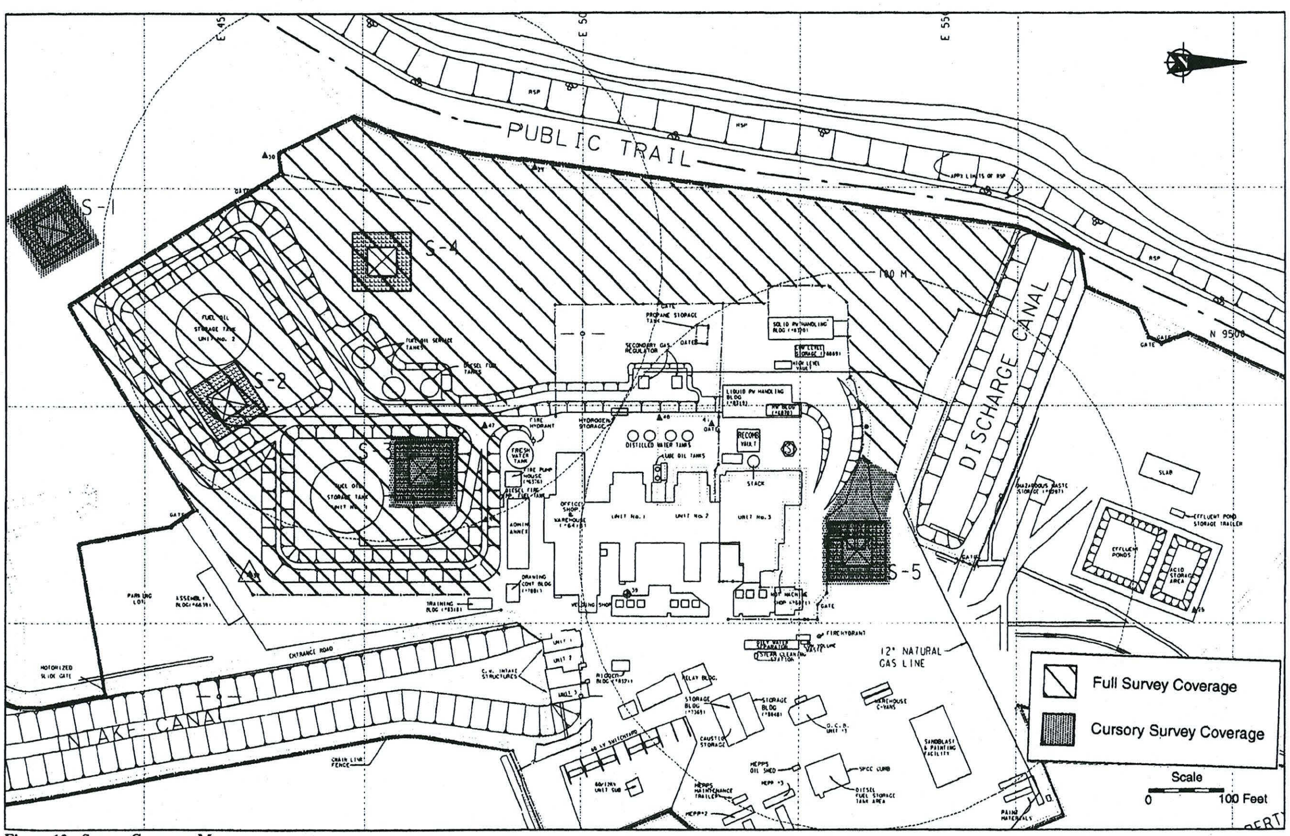


Figure 13. Survey Coverage Map

RESULTS

The following sections list the results of the archival and background research, field survey, and architectural/engineering research.

Record Search

The record search at the NWIC concentrated on the three zones described above under the project description. Results of this search are discussed below by zone.

Zone A

The research gave no indications of previous cultural resource studies or recorded prehistoric and historic archaeological resources or historical buildings, structures, or objects (BSOs) within Zone A. However, historic maps indicated that the bluff where the power plant is located was 100 feet above mean sea level during the historic period (USGS 1938; U.S. Geodetic Survey Map 1912). As noted above, the current elevation is 16 feet above mean sea level. Over 115,700 cubic yards of soil were removed during the construction of the power plant facilities (storage tank locations and buildings) and over 51,467 cubic yards of soil were used as fill (PG&E 1956c, 1958). Unless the elevations given on the historic maps are inaccurate, HBPP construction documents indicate that human alterations may have brought the bluff to its current height of 16 feet amsl.

Of the two alternative locations, number S-2 was heavily disturbed by the construction of the oil tank that is now standing. The tank is situated in a large man-made depression at an elevation that is approximately 10 feet below grade. Figure 5 depicts the amount of ground disturbing activity that took place to construct the depression. Alternative location S-4 was once the site of the met-tower (weather tower). The tower was removed many years ago and the area was heavily disturbed during geological investigations that required the excavation of several trenches (Caruso, pers. comm. 1999).

As noted earlier, review of the historic literature indicated that this was the location of the first town adjacent to Humboldt Bay and was settled by 1850 (Bledsoe 1956:58; Coy 1929:54). Due to the amount of human earth-moving activities it is considered unlikely remnants of the town or any prehistoric remains would be identified. Information about the construction of the plant and the town are presented above.

Zone B

No archaeological resources that have been listed on national or state registries are located within a five-mile-radius of the project area. However, there are approximately 30 archaeological sites that have been recorded within a five-mile-radius of the Power Plant. The archaeological base maps at the Northwest Information Center indicate that the site was once

located on the beach west of Buhne Point and the King Salmon subdivision. These sites have not been evaluated with regard to their eligibility for listing in national or state registers.

The site that lies closest to the power plant is CA-HUM-79. This is the same site as the one noted by Loud at Bunhe Point (Loud 1918:27). An examination of this site in 1976 by J. Goodrich indicated that a remnant of the site still remained on the beach. His records noted two net sinkers, six chert flakes, shell casts from baked bivalves, and midden. Two subsequent letters written by U.S. Army Corps Archaeologist Susan Berry indicate that the site was inundated in 1983 and retained little or not integrity (Berry 1983a, 1983b).

Several historic period building, structures, and/or objects (BSO) are located within Zone B. However, none of them have been listed on any federal or state inventories.

Zone C

Record search data indicated that one Native American archaeological site, CA-HUM-67/H, listed on the National Register of Historic Places, the California Register of Historical Resources, and the California Inventory of Historic Resources, is located within a 10-mile-radius of the Humboldt Bay Power Plant. No other archaeological resources that have been listed on national or state registers are located within a 10-mile-radius of the project area. However, there are approximately 184 archaeological sites that have been recorded within a 10-mile-radius of the power plant. Like the sites in Zone B, these resources have not been evaluated with regard to national or state registers criteria.

Over 200 registered historical BSOs are located within a 10-mile-radius of the power plant. Most of the BSOs are part of the Eureka Historic District, which is listed on the National Register of Historic Places and the California Register of Historical Resources. However, 13 of the BSOs are listed on the National Register of Historic Places and California Register of Historical Resources as individual properties. Fifteen of the aforementioned buildings are also listed on the California Inventory of Historic Resources. One State Point of Historic Interest is located within the town of Eureka—the E. Janssen Building at 422 1st Street. Finally, two State Historic Landmarks (SHL) lie within a 10-mile-radius of the project area; Fort Humboldt (SHL No. 154) and the Town of Eureka (SHL No. 477). No other historical BSOs that are listed on national and/or state inventories are located within a 10-mile-radius of the project area.

Archaeological Survey

No prehistoric or historical archaeological resources were identified within any of the alternative areas (S-1 through S-5) or within the proposed access road. A housing subdivision, known as King Salmon, is located near the project area. However, the homes in this subdivision are less than 50 years old and are not considered historic.

The location of CA-HUM-79 was field checked and found to be well out of the study area. Consequently, no impacts will occur as a result of this project.

Humboldt Bay Power Plant

HBPP consists of five electric generation units located in a line trending west to east. Unit 3, a boiling water reactor (BWR), operated for approximately 13 years before being shut down for refueling in July 1976. The reactor has remained inactive since that time. Units 1 and 2 are collocated conventional 53 megawatt-electric (MWe) units capable of operating on fuel oil or natural gas. Unit 3 is located in a separate building, but is adjacent to Unit 2. There are also two gas turbines, rated at 15 MWe each, located in the vicinity of the Units 1, 2 and 3 structures. The five generating units, as well as the plant site, are owned by PG&E.

Units 1 and 2 were completed in 1956 and 1958 and are nearly identical in construction and design (Figure 14). Both plants are semi-outdoors types with only the turbine front pedestal of the unit housed. The lower portions of the boiler are opened to the weather. The power building walls are made of non-bearing concrete block. The buildings initially had corrugated asbestos siding, rolled asphalt roofing and insulation board on a steel roof deck. Both buildings have a bank of windows across the south face and Unit 1 has an office on the operating floor. Steel stacks extend 120 feet above grade and vent the boilers (PG&E 1956c, 1958). Fuel storage tank areas are located to the west of the power plant units. Additional buildings include a shop and warehouse to the west of Unit 1, a relay building, two diesel-powered turbines, fire pump house, generators, and intake structure. A 60 kV switchyard is south of the power units.

Unit 3 is situated on the east side of Unit 2. Unit 3 is a natural circulation 65-megawatt boiling water plant reactor (Figure 15). The reactor's primary containment, located below grade, consists of a drywell vessel, which contains the reactor and the suppression chamber (Figure 16). The drywell and suppression chamber are located inside a concrete caisson. The refueling building encloses the open space above the caisson and contains the spent fuel storage pool and a new fuel storage vault in addition to the reactor caisson. The spent fuel pool contains aluminum storage racks capable of holding 486 fuel assemblies. The power building and turbine pedestal are located next to the refueling building. The power building contains the condenser, feedwater and condensate systems, steam cycle auxiliary systems and control room (see Figure 16). The turbine generator is located on the turbine pedestal. A radwaste treatment facility processes the liquid and solid waste and is near the generator (PG&E 1989). A site plan of the entire plant indicating important features of all units is presented in Figure 4.

HBPP Unit 3 received a construction permit on October 17, 1960. Provisional Operating License DPR-7 was issued in August 1962 and commercial operation began in August 1963. On May 17, 1976, the NRC issued an order which required the satisfactory completion of a specified seismic design upgrade program and resolution of specified geological and seismic concerns prior to power operation following the 1976 refueling shut down. In 1983, PG&E concluded that the seismic modifications and other modifications required (in response to the Three Mile Island accident in 1979) were not economical and opted to decommission the plant. In 1988, the NRC approved the SAFSTOR Plan for Unit 3 and revised the operating license to a possess-but-not-operate license that expires on November 9, 2015.

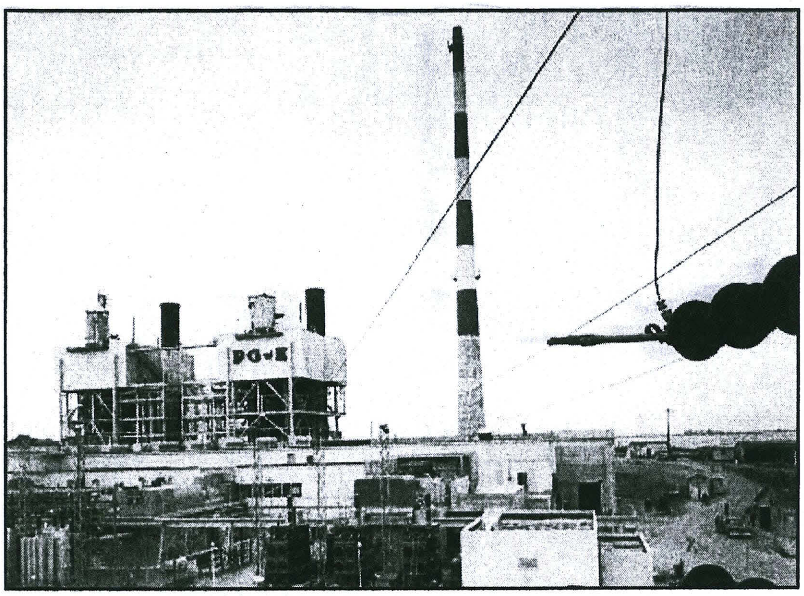


Figure 14. Overview of the Humboldt Bay Nuclear Power Plant

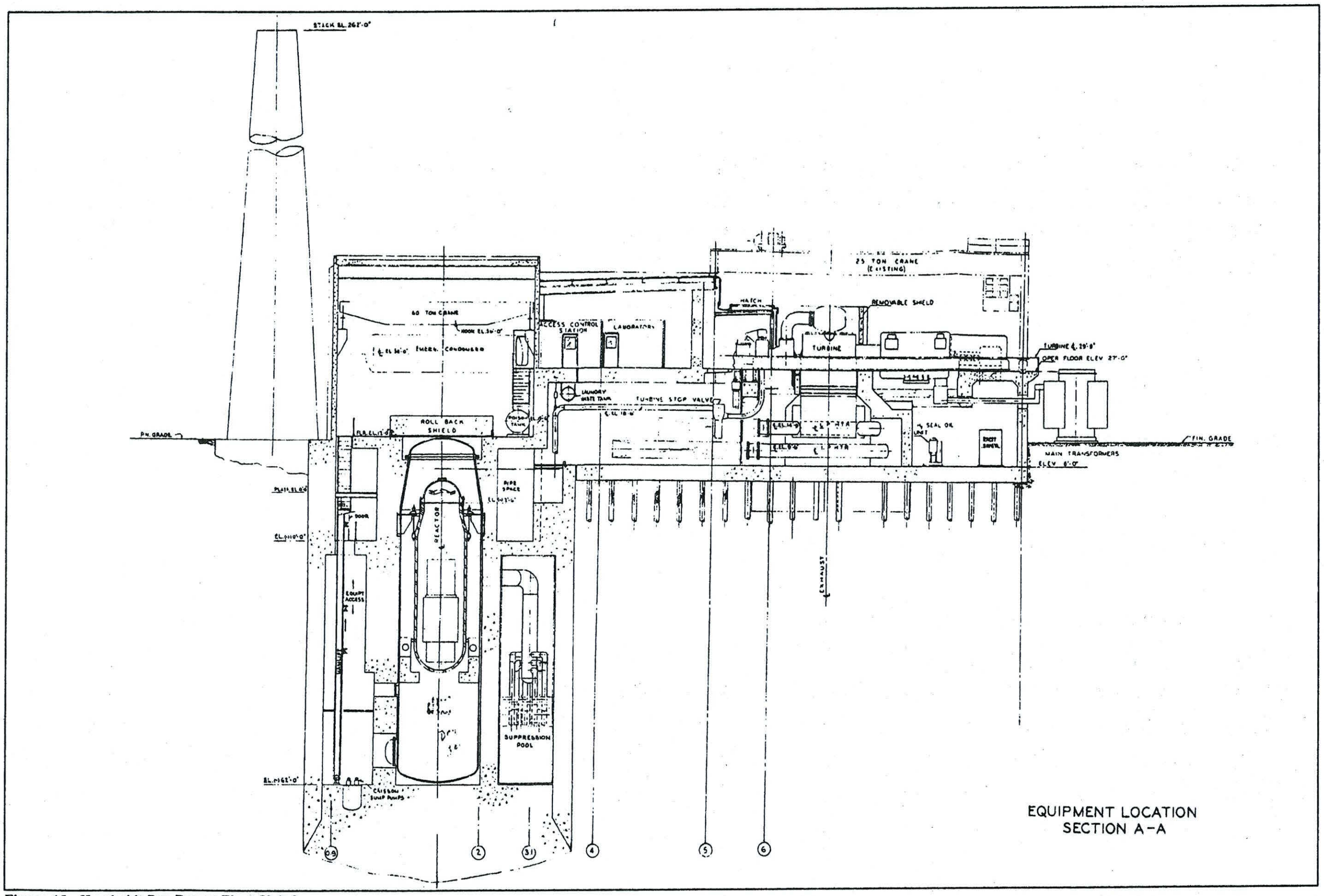
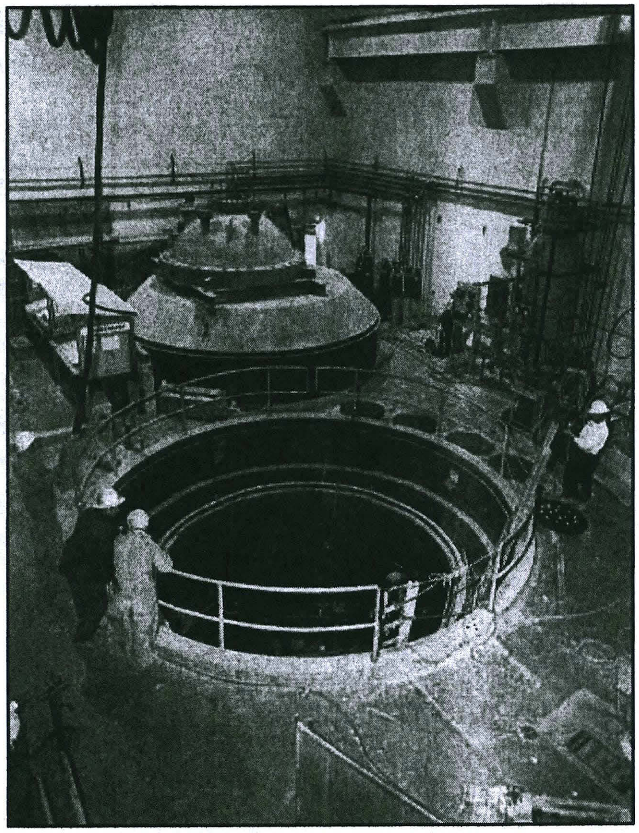


Figure 15. Humboldt Bay Power Plant Unit 3

Pacific Gas and Electric Company © 2003



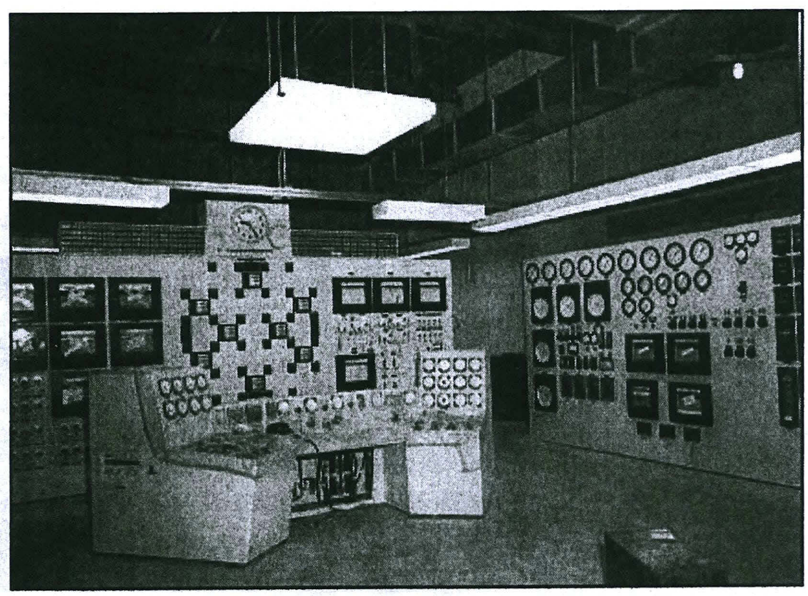


Figure 16. Top: Drywell and Reactor Drywell Vessel Bed, 1962
Bottom: View of Control Panel, April 5, 1962

NATIONAL REGISTER EVALUATION

Framework for Analysis

Cultural resource significance is evaluated in terms of a resource's eligibility for listing in the National Register (36 CFR 60.6 [48 R 46306]) as outlined below.

> The quality of significance in American history, architecture, archaeology and culture is present in districts, sites, buildings, structures, and objects of state and local importance that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and;
>
> (a) That are associated with events that have made a significant contribution to the broad pattern of our history; or
> (b) That are associated with the lives of persons significant in our past; or
> (c) That embody the distinct characteristics of a type, period, method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
> (d) That have yielded, or may be likely to yield, information important in prehistory or history.

Sites younger than 50 years, unless of exceptional importance, are not eligible for the National Register because a passage of time is usually necessary in order to clearly define a property's role in history and its importance at a local, state, or national level.

Exceptional importance, as defined by the National Park Service, is applied to "the extraordinary importance of resources or to an entire category of resources so fragile that survivors of any age are unusual" (USDI, NPS 1991:42). This distinction was designed to eliminate properties that reflect passing fads that do not reflect historically significant events. Exceptional significance on a local level may include resources that by appearance or association with persons or events provide communities with a sense of past and place (Sherfy and Luce 1996:1). On a national level it may include resources that were significant in the entire American experience. For example, the squash court at the University of Chicago where Fermi built the first nuclear reactor is a National Historic Landmark based on its exceptional significance in the development of the atomic industry.

An integral part of assessing cultural resource significance, aside from applying the above criteria, is the physical integrity of the resource. Prior to assessing a resource's potential for listing on the National Register, it is important to understand the subtleties of the seven kinds of integrity mentioned above. To summarize a National Park Service (NPS) bulletin entitled *How to Apply the National Register Criteria for Evaluation* (1991:44-48), the types of integrity are defined as:

Location is the place where the historic property was constructed or the place where the historic event occurred;

Design is the combination of elements that create the form, plan, space, structure, and style of a property;

Setting is the physical environment of historic property;

Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property;

Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory;

Feeling is a property's expression of the aesthetic or historic sense of a particular period of time; and

Association is the direct link between an important historic event or person and a historic property.

Integrity is based on significance: why, where and when a property is important. Only after significance is fully established is the issue of integrity addressed. Ultimately, the question of integrity is answered by whether or not the property retains the identity for which it is significant. A resource must have at least two types of integrity and meet one of the four criteria listed above in order to qualify for the National Register.

The following evaluation of the Humboldt Bay Power Plant examines this facility in light of the National Register Criteria A through C. There are no archaeological resources known to occur within the plant and Criterion D does not apply. The plant is less than 50 years of age. Therefore, the resource is examined in light of the bulletin *Guidelines for Evaluating and Nominating Properties that Have Achieved Significance Within the Past Fifty Years* (Sherfy and Luce 1996), specifically Criterion Consideration G.

Humboldt Bay Power Plant

Units 1 and 2 of the Humboldt Bay Power Plant were built by PG&E in 1956 and 1958, respectively. They are outside the study area proposed for the project and will not be impacted; therefore, they are not included in the following evaluation.

Unit 3 went on line in 1963, only 40 years ago. The beginnings of commercial nuclear power plants, however, lay in the establishment of the Atomic Energy Act in 1946 and the formation of the Atomic Energy Commission in that same year. The context of nuclear power development, therefore, begins over 50 years ago and has been the focus of much scientific

research, social history studies, and environmental concerns. The information available on nuclear power development allows for establishment of a firm context within which to evaluate the Humboldt Bay Power Plant Unit 3.

Unit 3 represented the culmination of 12 years of research and development on the part of PG&E. In 1951 PG&E was picked by the AEC as one of only a handful of companies nationwide to receive top-secret information regarding nuclear fission and atomic energy. The government hoped to encourage private enterprise to develop commercial nuclear energy plants. PG&E worked with other firms to design plants, experimenting with various reactors and light water systems. They were part of a team that built the first plant in California, Vallecitos, intended as a research and development facility.

Eager to build a plant for their own use, PG&E designed the Humboldt Bay Unit 3 facility in the late 1950s and it went on line in 1963. Although it was the second plant built in California and the seventh completed in the nation, it was the first constructed and privately subsidized by one company based on electrical demand and competitive economics as a profit-making venture, rather than research and development of a new technology. The abandonment of traditional steel and concrete above-ground containment domes reduced the capital outlay considerably, adding to the economic success of the unit.

The success of Unit 3 proved that nuclear energy was a viable and economically competitive form of energy and contributed to the nationwide industry growth. The dedication of the plant was a nationally recognized event, with PG&E receiving congratulatory telegrams from the Kennedy Administration, Atomic Energy Commission, and state and local politicians and officials. Once in operation, the plant functioned as intended for a dozen years.

Unit 3 was the first commercial nuclear plant to plan decommissioning while retaining the spent fuel on site in a pool (a list of shutdown plants is provided in Table 2). As such it was extensively studied and used as an example for other plants considering on-site fuel storage. PG&E worked with the NRC to shape the regulatory process for more recent decommissioning, based on the results and work at Humboldt Bay Unit 3. Humboldt Bay Unit 3 appears to be exceptionally important under Criterion A for the role it played in development and ongoing research of the nuclear power industry at a national level.

Unit 3 also appears to meet National Register Criterion C, Consideration G for its precedent-setting engineering design. Previous plants used a dome-shaped structure made of concrete and steel to house the reactor unit. The dome was excessively costly to construct and was one reason that nuclear plants were not economically feasible. PG&E engineers devised a pressure suppression chamber, sunk into the ground by its own weight, to eliminate the more traditional domes. The "cookie-cutter" bottom of the chamber and its airtight, one-piece construction method was unique in the industry and was built and sunk at only a fraction of the cost of containment domes. This cost savings added to the commercial success of Unit 3.

Table 2. Commercial Nuclear Power Plants in the United States No Longer in Service (as of March 2003)

Facility Name/Location	Net Mwe	Type	Started	Closed	Status*
Big Rock Point (Charlevoix, MI)	67	BWR	11/65	8/97	DECON*
BONUS (Rincon, PR)	72	BWR	8/64	6/68	Unknown
Dresden 1 (Morris, IL)	200	BWR	7/60	10/78	SAFSTOR*
Fermi 1 (Monroe, MI)	61	LMFBR	8/66	11/72	SAFSTOR*
Fort St. Vrain (Platteville, CO)	330	HTGR	1/79	8/89	DECON*
Haddam Neck (Haddam Neck, CN)	590	PWR	1/68	12/96	Unknown*
Hallam (Hallam, NEB)	75	LMGMR	11/63	9/64	Unknown*
Hanford-N (Richland, WA)	860	LGR	7/66	2/88	SAFSTOR
Humboldt Bay 3 (Eureka, CA)	63	BWR	8/63	7/76	SAFSTOR
Indian Point 1 (Buchanan, NY)	257	PWR	1/63	10/74	SAFSTOR*
LaCrosse (Genoa, WI)	50	BWR	11/69	4/87	DECON*
Maine Yankee (Wiscassai, ME)	860	PWR	12/72	8/97	Unknown*
Millstone-1 (Waterford, CN)	660	BWR	6/71	8/98	DECON
Pathfinder (Sioux Falls, SD)	59	BWR	7/66	10/67	SAFSTOR
Peach Bottom 1 (Peach Bottom, PA)	40	HTGR	6/67	11/74	SAFSTOR*
Rancho Seco (Clay Station, CA)	913	PWR	4/75	6/89	SAFSTOR*
San Onofre 1 (San Clemente, CA)	436	PWR	1/68	11/92	Unknown
Shippingport (Shippingport, PA)	60	PWR/LWBR	12/57	10/82	N/A
Shoreham (Brookhaven, NY)**	809	BWR	---*	5/89	SAFSTOR
Three Mile Island 2 (Londonderry Twp, PA)	792	PWR	12/78	3/79	SAFSTOR
Trojan (Prescott, OR)	1095	PWR	5/76	11/92	DECON*
Yankee (Rowe, MA)	167	PWR	7/61	9/91	DECON*
Zion 1 (Zion, IL)	1040	PWR	12/73	1/98	SAFSTOR*
Zion 2 (Zion, IL)	1040	PWR	9/74	1/98	SAFSTOR*

* Fuel stored on site.

** The Shoreham unit achieved criticality and produced power, but closed before it could begin commercial operation.

The innovative engineering design represented in the pressure suppression chamber received national attention and soon became the preferred construction and design method employed for boiling water reactors. It was implemented at three other plants constructed in the United States in the 1960s and was incorporated as the preferred design plan for numerous other plants that were planned but never built due to more stringent safety controls imposed by the NRC in the 1970s and the changing political climate. Therefore, the unique engineering design of Unit 3 was exceptionally important on a national level in further development of the nuclear power plant industry, both for its increased safety features and cost-efficient construction technology.

With the exception of the original stack (now removed), the plant maintains excellent integrity. The control room is generally intact, although most of the annunicators in the annunciator panel, recorders and meters were removed in 1988. The control room, however, still has the gauges, valves and dials that were initially installed in the plant; as such it conveys a strong sense of time and place. The design of the original plant (pressure suppression chamber) has not been altered. The turbine and other equipment contained within the unit is also original. As a whole, Unit 3 retains integrity of location, setting, design, workmanship, materials, feeling and association.

Under Criterion A, the period of significance for Unit 3 begins in 1961 when the pressure suppression chamber was built and the controlled sink began as part of the innovative construction method first used at Humboldt Bay. It ends in 1984, when the plant was decommissioned, placed in SAFSTOR status, and the fuel removed from the reactor. This period includes the transfer of fuel into the spent fuel pool for long-term storage, an event closely watched and nationally heralded by the nuclear power industry. The period of significance under Criterion C is 1963, when Unit 3 was completed.

The eligibility of Unit 3 for the NRHP has previously been reviewed by the NRC and the SHPO during decommissioning licensing. In the Final Environmental Statement (FES) for Unit 3 SAFSTOR, published by the NRC in April 1987, the NRC stated that "No impacts to any properties in or eligible for the National Register of Historic Places are expected." The FES included and referenced a SHPO letter on the same subject, which stated that the Unit 3 decommissioning "does not involve National Register or eligible properties." The status of Unit 3 with regard to the NRHP has not changed since the issuance of the FES, and establishment of the ISFSI does not alter the approved decommissioning of Unit 3 itself. Therefore, PG&E believes that no further review of Unit 3 is necessary pursuant to the NHPA.

To confirm the findings of the NHPA review, PG&E initiated consultation with SHPO in September 1999. In a letter to PG&E dated October 25, 1999, SHPO stated that input from the NRC is needed before SHPO review can proceed. Consequently, no further action will be taken by PG&E on this matter unless required by the NRC following review of this section.

MANAGEMENT CONSIDERATIONS

Avoidance of Impacts to Archaeological Resources

No cultural resources were identified within the area during the current study. As noted previously, the location of CA-HUM-79 was found to be well out of the area and will not be impacted by project activities. Considering the amount of ground disturbance that has taken place in the project area in the past it is highly unlikely that additional unidentified resources may be present. However, certain conditions, such as dense vegetation or pavement, may have prevented a resource from being detected during the inventory.

Prehistoric resources that may be identified include, but are not limited to, concentrations of stone tools and manufacturing debris made of obsidian, basalt and other stone materials; milling equipment (e.g., bedrock mortars, portable mortars, and pestles); locally darkened soils (midden) that may contain dietary remains such as shell and bone, and human remains. Historic resources that may be identified include, but are not limited to structural foundations, wire nails, fragments of ceramic or porcelain, cans with soldered seams or tops, and bottles or fragments of clear and colored glass. If any new cultural resources are located during project activities, all work must stop and the PG&E archaeologist should be notified immediately.

Human Remains

Section 7050 of the California Health and Safety Code states that it is a misdemeanor to knowingly disturb a human burial. If human remains are encountered, work should halt in that vicinity and the County Coroner should be notified immediately. At the same time, an archaeologist should be contacted to evaluate the situation. If the human remains are of Native American origin, the coroner must notify the Native American Heritage Commission within 24 hours of such identification. The California Environmental Quality Act details steps to be taken if human burials are of Native American origin.

Humboldt Bay Power Plant

The proposed ISFSI project consists of building an on-site facility to store spent fuel. The facility would be constructed within the PG&E power plant property and would not directly impact any existing buildings, including Unit 3. Unit 3 was constructed as the third unit of an existing power plant and the addition of a dry cast storage area will not change the industrial setting of the facility.

Under Criterion A Unit 3 is important for its association with the development of nuclear power on a national level. Under Criterion C, certain elements of the unit, such as the pressure suppression chamber and the spent fuel pool, are key factors of its importance, while other equipment (e.g., the control room, turbine, reactor) are contributing features of overall plant design. The key factors of the unit will not be impacted by the project. Removal of the spent fuel to an outside facility will not change the design elements of the spent fuel pool and therefore will not affect the overall integrity of the resource. Therefore, the ISFSI project will have no effect on Unit 3.

If project plans change to include removal of any parts of the Unit 3 facility, other than the spent fuel, then it is recommended that a PG&E archaeologist be notified and the new project impacts be assessed in light of Section 106 of the National Historic Preservation Act. If it is determined that those elements of the Unit 3 facility that contribute to its historical and engineering significance will be impacted, then mitigation measures designed in consultation with the NRC and the State Office of Historic Preservation may need to be outlined and completed prior to project implementation.

REFERENCES CITED

Berry, S.

1983a Letter reply to Maureen Steiner, Assistant Coordinator, regarding Public Notice No. 16007N21. On file with CA-HUM-79 file, California Historic Resources Information System, Northwest Information Center, Sonoma State University, Rohnert Park, CA.

1983b Letter reply to Jack Farless regarding Buhne Point Shoreline Erosion Project Archaeological Resources. On file with CA-HUM-79 file, California Historic Resources Information System, Northwest Information Center, Sonoma State University, Rohnert Park, CA.

Bledsoe, A. J.

1956 *Indian Wars of The Northwest: A California Sketch*. Biobooks, Oakland.

California, State of

1999 Directory of Historic Properties (October 14, 1999). On file, Northwest Information Center, Sonoma State University, Rohnert Park.

Coleman, C.

1954 *PG&E of California: The Centennial Story of Pacific Gas and Electric Company, 1985-1952*. McGraw-Hill Book Company, Inc. New York, New York.

Coy, O. C.

1929 *The Humboldt Bay Region 1850-1875: A Study in the American colonization of California*. The California State Historical Association, Los Angeles.

Daley, M. J.

1997 *Nuclear Power: Promise or Peril*? Lerner Publications Company, Minneapolis.

Electrical West

1962 *Pacific Gas and Electric Company: The Second Century Begins*. August 1962.

Elliott, W. W.

1881 *History of Humboldt County California, with Illustrations Descriptive of Its Scenery, Farms, Residences, Public Buildings, Factories, Hotels, Business Houses, Schools, Churches, Etc., From Original Drawings Including Biographical Sketches*. Wallace W. Elliott and Co. Publishers, San Francisco.

Elsasser, A. B.

1978a Development of Regional Prehistoric Cultures. In *California,* edited by R. F. Heizer pp. 37-57. Handbook of North American Indians, vol. 8, W. C. Sturtevant, general editor, Smithsonian Institution, Washington, D. C.

Elsasser, A. B.
1978b Wiyot. In *California,* edited by R. F. Heizer pp. 155-163. Handbook of North American Indians, vol. 8, W. C. Sturtevant, general editor, Smithsonian Institution, Washington, D. C.

Ford, D.
1982a A Reporter at Large: The Cult of an Atom - I. *The New Yorker,* October 25, 1982:107-159.

1982b A Reporter at Large: The Cult of an Atom - II. *The New Yorker,* November 1, 1982:45-101.

Fredrickson, D. A.
1973 *Early Cultures of the North Coast Ranges, California.* Unpublished Ph.D. Dissertation, University of California, Davis.

1984 The North Coastal Region. In *California Archaeology*, edited by M. Morratto pp. 471-527. Academic Press, Inc., New York.

Gofman, J. W., and A. R. Tamplin
1971 *Poisoned Power: The Case Against Nuclear Power Plants.* Rodale Press, Inc., Emmaus, PA.

Gould, R. A.
1968 Seagoing Canoes Among the Indians of Northwestern California. *Ethnohistory* 15(1):11-42.

1972 *A Radiocarbon date from the Point St. George Site, Northwestern California.* University of California Archaeological Research Facility Contributions 14:41-44.

1980 Archaeology of the Point St. George Site and Tolowa Prehistory. *University of California Publications in Anthropology,* no. 4, Berkeley.

Heizer, R. F., and J. E. Mills
1952 *The four ages of Tsurai: A Documentary History of the Indian Village on Trinidad Bay*. University of California Press, Berkeley.

Hildebrandt, W. R.
1981 *Native Hunting Adaptations on the North Coast of California.* Unpublished Ph.D. Dissertation, University of California, Davis.

Hildebrandt, W. R., and J. F. Hayes
1993 Settlement Pattern Change in the Mountains of Northwest California: A view From Pilot Ridge. In *There Grows A Green Tree: Papers In Honor of David A. Fredrickson* edited by G. White, P. Mikkelsen, W. R. Hildebrandt, and M. E. Basgall. Center for Archaeological Research at Davis, no. 11:107-120.

Holland, G.
1996 *Nuclear Energy*. Marshall Cavendish Co. New York, New York.

Jennings, C. W., R. G. Strand, and T. H. Rogers
1977 Geologic Map of California. California Geologic Data Map Series Map No. 2. State of California Resources Agency, Department of Conservation.

Kroeber, A. L.
1925 *Handbook of the Indians of California.* Bureau of American Ethnology Bulletin 78, Washington, D.C. Reprinted 1976 by Dover Publications, Inc. New York.

Kroeber, A. L., and S. A. Barrett
1960 Fishing Among the Indians of Northwestern California. *University of California Publications In Anthropological Records* 21:1-210.

Lilienthal, D. E.
1980 *Atomic Energy: A New Start*. Harper and Row Publishers, New York.

Loud, L. L.
1918 Ethnogeography and Archaeology of the Wiyot Territory. *University of California Publications in American Archaeology and Ethnography*, 14(3):221-436.

Meighan, C. W.
1955 Archaeology of the North Coast Ranges, California. *University of California Archaeological Survey Reports* 30:1-39.

Pacific Gas and Electric Company
1956a Nuclear Power Report. *PG&E Progress* 33(2):1.

1956b Atomic Power Here in 1957. *PG&E Progress* 33(4):1.

1956c *Humboldt Bay Power Plant Unit 1, Completion Cost Report*. Document on file, PG&E Humboldt Bay Power Plant, Fields Landing.

1958 *Humboldt Bay Power Plant Unit 2, Completion Cost Report*. Document on file, PG&E Humboldt Bay Power Plant, Fields Landing.

1961 Eureka Atomic Plant Under Way. *PG&E Progress* 38(1):1.

Pacific Gas and Electric Company
1963 Atomic Plants to Dot U.S., Senator Says. *PG&E Progress* 40(11):1-2.

1964 Nuclear Plant One Year Old. *PG&E Progress* 41(10):1.

1965 Nuclear Unit Sets Reliability Record. *PG&E Progress* 42(7):1.

Okrent, D.
1981 *Nuclear Reactor Safety: On the History of the Regulatory Process*. University of Wisconsin Press, Madison.

Pringle, L.
1989 *Nuclear Energy: Troubled Past, Uncertain Future*. Macmillan Publishing Company, New York.

Ramiller, S., and N. Ramiller
1982 *Prehistoric Overview Northwest Region: California Archaeological Inventory*. Anthropological Studies Center, Sonoma State University, Rohnert Park.

Sherfy, M., and W. R. Luce
1996 Guidelines for Evaluating and Nominating Properties that have Achieved Significance within the Past Fifty Years. *National Register Bulletin* 22. United States Department of the Interior, National Park Service, Washington D.C.

Shiffer, Jim
n.d.a. *On PAR with Jim Shiffer (or How I spent my Summer Vacation)*. On file, Pacific Gas and Electric Company, San Francisco.

n.d.b. *On PAR with Jim Shiffer (The Trail Led North)*. On file, Pacific Gas and Electric Company, San Francisco.

n.d.c. *On PAR with Jim Shiffer (Iron Pants versus the Luftwaffe)*. On file, Pacific Gas and Electric Company, San Francisco.

n.d.d. *On PAR with Jim Shiffer (Bloody stumps and other friends)*. On file, Pacific Gas and Electric Company, San Francisco.

n.d.e. *On PAR with Jim Shiffer (The Boulevard of broken dreams)*. On file, Pacific Gas and Electric Company, San Francisco.

n.d.f. *On PAR with Jim Shiffer (Humboldt Bay: the final chapter)*. On file, Pacific Gas and Electric Company, San Francisco.

Shrader-Frechette, K. S.
1980 *Nuclear Power and Public Policy: The Social and Ethical Problems of Fission Technology*. D. Reidel Publishing Company, Dordrecht, Holland.

Stoler, P.
1985 *Decline and Fail: The Ailing Nuclear Power Industry*. Dodd, Mead and Company, New York.

Theodoratus, D. J., T. L. Jackson, M. E. Peters, and B. Porter
1980 *Cultural/Historical Overview: Six Rivers National Forest*. Unpublished manuscript on file at United States Department of Agricultural, Forest Service, Six Rivers National Forest, Eureka, California.

United States Department of the Interior, National Park Service
1991 How to Apply the National Register of Historic Places Criteria. *National Register Bulletin* 15. United States Department of the Interior, National Park Service. Washington D.C.

United States Geological Survey
1938 Rohnerville Quadrangle. U. S. Army Corps of Engineers, Tactical Map. U. S. Geological Survey, Menlo Park.

U.S. Coast and Geodectic Survey
1912 Humboldt Bay California. U.S. Coast and Geodectic Survey, Washington, D.C.

Weinberg, A., I. Spiewak, J. Barkenbus, R. Livingston, and D. Phung
1985 *The Second Nuclear Era: A New Start for Nuclear Power*. Praeger Special Studies, Praeger Scientific, New York.

Whistler, K. W.
1979 Linguistic Prehistory of the Northwest California Coastal Area. In *A Study of Cultural Resources in Redwood National Park*, edited by P. Bickel. Manuscript on file Redwood National Park, Arcata, California.