ATTACHMENT 1

CULTURAL RESOURCES INVENTORY REPORT

Malburg Generating Station

Cultural Resources Inventory Report

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1.0 SUMMARY OF FINDINGS

The City of Vernon has conducted a cultural resources inventory for the Malburg Generating Station (MGS) Project, in Vernon, California. The project is for the construction and operation of the MGS, a 134 megawatt (MW) combined cycle power plant, which will be located on approximately 3.4 acres of the City of Vernon's existing Station A. The existing site includes 5.9 acres, located at 2715 East 50th Street, in Vernon, California.

The archaeological and architectural area of potential effects (APE) for this project was established in coordination with the California Energy Commission Cultural Resources staff. Several cultural resources surveys were conducted over the course of this project, and are documented within the body of this report. Only two (2) previous cultural resources surveys had been conducted within a ½-mile radius of the project APE (excluding the reports prepared as part of this project). No previously recorded prehistoric or historic archaeological sites were located within this same ½-mile radius.

The project area is characterized primarily by industrial/commercial facilities and the infrastructure to support those facilities (i.e. railroad lines and spurs). Residential structures account for less than one-quarter of the buildings in the APE, all of which are located within Huntington Park along its boundaries with the City of Vernon. Historic structures account for approximately 25 percent of all buildings within the APE. There are no residential structures located within the APE above Belgrade Ave. (south of Slausen Ave.), and there are no industrial/commercial structures within the APE along Randolph Street (a residential neighborhood and the boundary between the City of Vernon and Huntingdon Park).

The project APE is an industrial-urban complex with 100 percent ground coverage. The archaeological findings in this report are based on a geoarchaeological assessment of available literature and a surface reconnaissance of the project area. No archaeological sites are located within the APE and the likelihood of encountering intact, significant subsurface cultural resources is very low.

The architectural survey conducted by William Self Associates in August 2001, identified and recorded the City of Vernon Power and Light Plant (Station A) (see Appendix C for all site records). The architectural survey conducted by Parsons in June 2002 identified and recorded an additional 31 historic structures within the APE; 8 residential structures (25 percent of all historic structures), and 23 industrial/commercial buildings (75 percent of all historic structures).

No adverse effects have been identified related to the construction or operation of the Malburg Generating Station project. The construction of the project adjacent to Station

A will not create an adverse visual effect on the potentially historical structure as it is appropriate to the historic setting of the site and the region as an "exclusively industrial" city. Additionally, construction of the project linears will have no adverse effect on any historic structures as the linears will be constructed below the centerline of the roads, which will be returned to their pre-construction appearance prior to completion of the project. None of the 32 historic structures appear to be structurally unsound or at risk for collapse or damage, therefore, vibrations related to construction activities would have no adverse effect on these historic structures.

2.0 INTRODUCTION

The City of Vernon has conducted a cultural resources investigation for the Malburg Generating Station Project, in Vernon, California. All cultural resources work was performed in compliance with the California Environmental Quality Act (CEQA) Section 15064.5, and Public Resources Code, Section 5024.1.

2.1 Project Location and Description

The project is for the construction and operation of the Malburg Generating Station, a 134 MW combined cycle power plant, which will be located on approximately 3.4 acres of the City of Vernon's existing Station A. The existing site includes 5.9 acres, located at 2715 East 50th Street, in Vernon, California.

The Project will be located in an industrial land use area in Vernon (Appendix A, Figure 1). The City is located near the geographic center of metropolitan Los Angeles County. The City is bordered on the north and west by the City of Los Angeles, on the east by the cities of Commerce and Bell, and on the south by the cities of Huntington Park and Maywood. Vernon is three miles southeast of downtown Los Angeles and 15 miles north of the major harbor and port facilities in San Pedro and Long Beach.

The project will include two gas combustion turbine generators (CTGs) that will burn natural gas, and a steam turbine generator (STG) driven with steam produced by two heat recovery steam generators (HRSGs). Each CTG and the STG will be connected to one of three separate electric generators. The new generation will be connected to the existing 69-kilovolt (kV) bus in the Vernon Substation on the MGS. The power generated by these three generators will be distributed through the existing Vernon Substation and transmission lines.

The Project will use reclaimed water for the cooling tower make up, purchased by the City and supplied by the Central Basin Municipal Water District (CBMWD). This will significantly reduce the additional consumption of potable water by the MGS. Potable water will only be utilized for domestic and sanitary use.

The City is part of the California Independent Systems Operator (Cal-ISO) control area, which in the last couple of years has meant that the City has been exposed to substantial uncertainty with respect to the Cal-ISO providing a functional energy market and a reliable control area. Many aspects of the Cal-ISO energy market are associated with numerous Federal Energy Regulatory Commission (FERC) related proceedings. Vernon currently depends on third party suppliers for over 90% of its ancillary services and energy needs.

The above facts create uncertainty over reliability of energy supplies for the City. Furthermore all the large power plants in the Southern California Edison service area in the LA basin are owned by entities that may not have the same interest as a load serving entity may have. The Project will allow Vernon to self-supply much of its ancillary services and energy needs. Due to the past price volatility of the wholesale power market, Vernon has had to increase its rates by approximately 50 percent since July 2000. The City's loads are represented primarily by industrial and commercial accounts, which depend on reliable and low cost energy in order to be competitive with their products and services. Many local jobs depend on the longevity of the businesses located in Vernon.

The MGS is an electrical generating facility, which will be located on approximately 3.4 acres of Vernon's existing Station A. Station A began operation in 1933. It consists of the Vernon Substation 69 kV switchyard, a building that contains the Johnson & Heinze Diesel Plant (five diesel-fueled reciprocating, internal combustion generators, Units 1 through 5, each rated at 3.5 MW gross output), the H. Gonzales Generating Station (two natural gas-fired CTG units, Units 6 and 7, each rated at 5.5 MW gross output), and the Control Room. The diesel-fueled generators began operating in 1933, and the combustion turbine units began operating in 1988. These units are located indoors. Natural gas is brought to the site by pipeline, and diesel fuel is brought by tanker truck. The site also contains a cooling tower, heat exchangers, and transmission towers. All power from the site is distributed through the Vernon Substation 69 kV switchyard.

The Project will consist of two ALSTOM GTX100 frame-type natural gas combustion turbine-generators with dry low-NO_X (DLN) combustors for oxides of nitrogen (NO_X) control including nitrogen dioxide (NO_2), which is a regulated criteria air pollutant. The CTGs will each be equipped with evaporative inlet air coolers/filters to enhance turbine performance in hot weather.

Linear facilities for the MGS include new 1,300-foot long natural gas and sewer pipelines to the existing gas system and existing sewer system respectively, and a new 18-inch diameter, 10,000-foot long reclaimed water pipeline to deliver reclaimed water to the MGS site from the existing CBMWD reclaimed water supply system. The Project is designed to use reclaimed water as the primary source of cooling tower, evaporation coolers, and steam cycle makeup water needed by MGS.

The MGS is designed to serve the City's electric utility customers. The City expects that MGS, because it incorporates state-of-the-art pollution control and generation equipment and with its combined cycle configuration, will be one of the most efficient generation facilities available. MGS will operate with a capacity factor between 60 and 85 percent, and have an availability factor of 90 to 98 percent. It is projected that the MGS will operate from 5 to 7 days per week and generally 24 hours per day depending upon customer load and weather conditions. Other factors that can affect the operation of the

Project are market and control area conditions for both energy and ancillary services requirements.

2.2 Area of Potential Effects

The archaeological and architectural APE (Appendix A, Figure 2) for this project was established in coordination with the California Energy Commission Cultural Resources staff. The APE includes the site of the Vernon Power and Light Plant and the laydown, parking and storage areas (the "staging areas"), and extends to include each structure facing the site. Along the linears, the APE extends to 100 feet from the centerline of the pipelines.

2.3 Project Construction Activities

The average depth of excavation at the Station A site will be 4 feet. In addition, the depth of excavation will be 8 feet under the HRSG foundation. Grading will not be required at the staging areas.

The maximum depth of excavation for the gas line installation will be approximately 9 feet (under the railroad tracks that cross Seville Ave.). The average depth of excavation for the gas line installation will be approximately 7.5 feet. The maximum width will be approximately 3 feet. Approximately every 40 linear feet, the trench will be approximately 4 to 5 feet wide to facilitate access for manual welding of pipe segments. The location of the gas line installation will be 10 feet west of the Seville Ave. centerline.

Installation of the new sewer line will be at the same location as the existing, which runs along the centerline of Seville Ave. The deepest point of the existing sewer line along the replacement route will be approximately 10.5 feet at the intersection of the main line and the lateral to the plant. The average depth of the existing sewer line along the replacement route is approximately 9 feet. The maximum width for the sewer line trench excavation will be approximately 5 feet.

The reclaimed water pipeline alignment will be located along the centerline of Randolph Street, S. Boyle Avenue and E. 50th Street, and will not be located in the shoulder or sidewalk. The maximum depth of construction will be approximately 12 feet and the average depth of the pipeline will be 7 feet. The maximum width will be 10 feet and the average width of the pipeline construction will be 42 to 48 inches. The maximum depth and width of the pipeline construction are dedicated for the three railroad/spur line crossings which will involve jacking and receiving pits for the boring and jacking operation.

3.0 NATURAL SETTING

3.1 Geomorphology

The proposed project area lies within the Transverse Range geomorphic province. The Transverse Ranges trend east-west as they bisect the state for a distance of 500 kilometers (km), separating central and southern California. The Transverse Ranges meet the Coast Ranges and the Sierra Nevada on the north, the Mojave Desert on the north and east, and the Salton Trough and Peninsular Ranges on the south. The Transverse system embodies many ranges including the Santa Ynez, Santa Monica, San Gabriel, San Bernardino, Eagle, and Orocopia Mountains. Rising from the Mojave Desert in the east, only 62 miles (100 km) from the Colorado River, the Transverse Ranges extend westward in a band 15-55 miles (25-90 km) wide into the sea, forming the islands of Santa Rosa, San Miguel, and Santa Cruz. The folded and faulted sediments of the Transverse Ranges are among the thickest on earth. Massive erosion has cut deep valleys, leaving often high, narrow ridges and peaks. Crests in the Transverse Ranges reach 3,280-8,200 feet (1,000-2,500 meters [m]) and higher above sea level, with the highest peaks occurring in the east. The summit of San Gorgonio looms 10,078 feet (3,072 m) above the San Bernardino Range as the highest peak in southern California (Moratto 1984).

The stratigraphic sequence of the Santa Monica Mountains and the Channel Islands illustrate the various geologic formations found in some parts of the Transverse Range Province. The Santa Monica Mountains have a granitic and metamorphic basement similar to the Sierra Nevada. One of the oldest rocks present is the Santa Monica slate. With its regular bedding, the slate is thought to be of marine origin. It has yielded Jurassic fossils and resembles rocks found in the Santa Ana Mountains. During Miocene time, extensive volcanic activity occurred in this part of the Transverse Range; extruded rocks include andesite, diabasic and basaltic flows, sills and dikes, plus a few silicic rocks. Post-Miocene rocks are mainly Pleistocene and younger marine and non-marine terrace materials. These thick bedded, coarse, non-marine gravels were probably deposited as broad alluvial fans and make up the high, prominent cliffs that have generated destructive landslides at Pacific Palisades and Santa Monica (Norris and Webb 1976).

Additionally, a series of active faults underlie the sediments of the Los Angeles Basin, making geologic instability, e.g. the potential for earthquakes, a daily concern.

3.2 Hydrology

There are few sizable permanent streams within the Transverse Ranges. The largest drainage system wholly within the province is that of the Santa Clara River, which drains most of the northern portion of the province. In the west, the Santa Ynez and the Los Angeles Rivers drain a major portion of the province. Important streams in the East include the San Gabriel, and one of its branches, the Rio Hondo; these intermingle with the Los Angeles River near Downey, where they flow into the Pacific Ocean near Seal Beach. The Santa Ana River has the largest drainage basin in Southern California; it drains both the San Bernardino and the eastern San Gabriel Mountains (Norris and Webb 1976). At the proposed project area, the nearest source of fresh water is the Los Angeles River, approximately 0.9 miles (1.4 km) northeast of the project area. In modern times, this river has been channelized and dammed to prevent flooding in the densely populated Los Angeles Basin.

3.3 Climate

The climate of southern California is a combination of maritime and Mediterranean climates with the maritime prevailing in the Los Angeles Basin, causing a temperature inversion layer that creates the haze or smog for which Los Angeles is known. During the summer months, a high pressure zone covers the region, generally preventing summer rains. Also at this time, temperatures tend to range from the 80s to the 90s. During the fall, hot Santa Ana winds blow from the Mojave, pushing the maritime weather out to sear. A mix of clear, sunny days and rainstorms characterizes winter. The proximity of the mountain ranges creates a large range in the amount of precipitation over the region. At the coast an average of only 7.5 inches falls annually while at the Los Angeles Civic Center, rainfall is twice that amount and at Mount Wilson the average rainfall is 30 inches (City of Vernon 2002; 8.3-3).

3.4 Vegetation

The Los Angeles Basin is a low-lying area adjacent to the Pacific Ocean, flanked to the north by the Transverse Ranges and to the south and east by the Peninsular Ranges. Prior to urban development much of the basin was vegetated by coastal scrub, willow riparian and grassland vegetation communities. The surrounding hills supported diverse southern oak woodland and chaparral communities. Currently much of the Los Angeles Basin is managed in one way or another for human interests (Holland 1995). The project area is an urban-industrial complex with 100 percent ground coverage. There are no designed landscapes associated with the project site. Existing vegetation is characterized solely by non-native, unwanted species typically found in urbanized areas.

3.5 Fauna

Cismontane Southern California is divided into two separate geographic locations: the Southern Oak Woodland and the Scrub Community. The scrub community is a relatively hot, dry, food-poor ecosystem populated by small animals such as arthropods and reptiles that have low metabolic requirements. Mammals of the scrub community are various rodents including the California mouse, deer mouse, squirrels, chipmunks, and woodrats. Large predatory animals include the coyote, mountain lion, gray fox, and the bobcat. Before its extinction in California, the grizzly bear was a chaparral and scrub dweller also.

Marine fish hunted prehistorically in California include the California Moray, American Shad, Pacific Herring, Jacksmelt, California Grunion, California Scorpionfish, Striped Bass, California Yellowtail, Dorado, Garibaldi, Sheephead, Chub mackerel, Albacore, and White Sea Bass.

4.0 ETHNOGRAPHY

The Gabrielino derive their name from the local Spanish mission San Gabriel the Arcangel. While it is true that many Gabrielino peoples worked in servitude to the mission, many Native Americans also died because of disease and harsh conditions at the mission. The modern movement of the Gabrielino people not only moves towards federal recognition of their tribe and nation, but also towards educating the young and old alike about traditions and culture prior to the coming of Europeans. Part of this reaffirmation is the use of the name of the tribe as they were known prior to being called "Gabrielino," that name was Tongva, which simply means "the people."

The Tongva spoke a Cupan language of the Takic family, which is part of the Uto-Aztecan linguistic stock (Bean and Smith 1978). Generally the Tongva territory included the watersheds of the Los Angeles, San Gabriel and Santa Ana rivers, all of the Los Angeles Basin, the coast from Aliso Creek in the south to Topanga Creek in the north, and the islands of San Clemente, San Nicolas and Santa Catalina. This region included multiple ecological regions that supported a diversity of resources.

The ecological zones included Interior Mountains/Adjacent Foothills, Prairie, Exposed Coast and Sheltered Coast. Each area consists of a floral-faunal-geographical relationship that allows delineation of subsistence-settlement patterns. The interior mountains provide many resources including small animals, deer, acorns, sage, pinon nuts, and a variety of plant and animal foods. Settlement patterns indicate the existence of both primary subsistence villages occupied continuously, and smaller secondary gathering camps, occupied at various times of the year. All settlements in this and other zones were near watercourses. The Prairie had as its dominant food resources acorns, sage, yucca, deer, small animals, cacti, and many resources associated with marshes. Both primary and secondary sites are found throughout this region. The Exposed Coast from San Pedro south to Newport Bay was an area of concentrated secondary subsistence gathering camps with no primary subsistence villages adjacent to the coast, but rather located inland. Various shellfish (urchin, chiton, abalone, clam, mussel), some rays, sharks, and fish were the more important resources, the kelp beds just off the coast supplied numerous fish such as tuna, swordfish, bonito and barracuda, as well as some sea mammals; seal, sea lions and otter. The Sheltered Coast zone stretching from San Pedro north to Topanga Canyon was characterized by primary subsistence villages on the coast and secondary camps inland near areas of plant-food abundance. The primary food resources of the Sheltered Coast were shellfish, sharks, rays, sea mammals and water fowl (Bean and Smith 1978).

5.0 HISTORY

5.1 Greater Los Angeles—Agriculture and Industry, 1880-1930

Up until the mid-1880s, Los Angeles was largely a sparsely populated agricultural community on the cusp of becoming a metropolis. The first major railroad to build into the city was the Southern Pacific in 1876. Still, this had little effect on stimulating migration and growth throughout the region. Not until 1886 when the Santa Fe Railroad began service to the region did an increase in migration begin, due largely to a rate war between the two aforementioned carriers. As Harrison Newmark relates in *Sixty Years in Southern California*, "with the extension of the Southern Pacific to the east and the building of the Santa Fe Railroad…brought here a class of tourists who not only enjoyed the winter, but ventured to stay through the summer season; and who, having remained, were not long in seeking land and homesteads" (Newmark 1930; Marshall 1945).

With the increase of migration, Los Angeles in 1888 boasted a population of 77,000. This so-called boom, however, soon went bust, and according to the Los Angeles Chamber Of Commerce (LACC) "1000 people were leaving the City each month" (LACC 2002). To many, it was clear that Mediterranean weather and an abundance of citrus products was not enough to attract an increased population and economic growth. Hence in 1890, some 57 business men joined to form the LACC. Initially it was the job of the newly formed Chamber to attract Midwestern farmers with proven expertise to Los Angeles. The major stumbling block, according to Willard (1899), was that "most of the country thought of Southern California as a 'far distant country with a thousand hardships to balance against few chances of gain." This perception was based largely on the fact that what made California great was the Gold Rush, something that Southern California clearly lacked (Willard 1899 as quoted in LACC 2002). The Chamber's goal in these early years consisted of building upon what it already had, agriculture (Willard 1901).

With the increase of citrus production in the Southland, a new problem arose concerning the future of a now burgeoning enterprise. Water. The Los Angeles River may have provided enough water for domestic purposes and small scale farming prior to the boom of the 1880s, but with the increase in agriculture, an increase in population, and industrial growth on the horizon, a new source had to be found. With this in mind, the LACC wasted no time in whole-heartedly endorsing the Los Angeles Aqueduct, which when completed in 1913 would, on the one hand would supply the growing city's needs; while on the other, literally dry up the Owens Valley some 250 miles to the north (Fogelson 1967; Nadeau 1950; Reisner 1984; Mulholland; 2000).

Industrial/manufacturing growth in the greater Los Angeles area was slow to materialize in part due to its lack of a deep water harbor. Though San Pedro had been recognized as the Southland's main Port as early as the 1850s, its amenities were few. With an extremely narrow and shallow channel, unprotected roadstead and primitive landing facilities, the port was accessible to only the smallest of vessels (Fogelson 1967). However, following a lengthy decision-making process, San Pedro was awarded Port status in 1896. Actual construction began (to increase depth, width, and placement of breakwaters) in 1899 and completed in 1912 (Fogelson 1967; Pomeroy 1965).

The Port of Los Angeles would eventually increase the viability of Los Angeles as an up and coming industrial giant to be reckoned with. The Southland could now compete on the international playing field, increasing its trade with "the Orient directly, the eastern United States and Latin America via the Panama Canal, and the southwestern states and northern California by railroads and highways" (Fogelson 1967).

However, the Port of Los Angeles was only one part of the industrial equation. Increased population, a cheaper source of energy and railroad tariffs all figured into building a commercial and industrial complex in Los Angeles and along its periphery. The Chamber's Executive Secretary, however, remained optimistic that with the completion of the harbor project, the discovery of rich oil deposits, and continued migration, would create a suitable climate for industrial investment (Davis in Sitton and Deverell, ed. 2001).

When branch plants did come to California it was the rubber and automotive industries that led the way. The decentralization of these industries just made good sense, particularly considering the growth of the automobile culture in Southern California after the First World War. Though cities such as San Francisco and Portland, Oregon were more centrally located, Los Angeles had "better access to the Far East rubber plantations, the Imperial Valley cotton fields, and even, more importantly, the southern California tire market" (Coons and Miller 1941; Fogelson 1967). Shortly after 1920, tire manufacturers Goodyear, Goodrich and Firestone all moved to the Southland. Others were to follow including Procter and Gamble, U.S. Steel, Bethlehem Steel, Pittsburgh Plate Glass, Willys-Overland, Willard Storage Battery, and finally by 1930, the Ford Motor Company.

Because of this large-scale manufacturing movement into the Los Angeles area, a geographic shift occurred whereby development of the region immediately south and east of the downtown core was well underway by the decade of the 1920s. To avoid gridlock due to expanded railroad trackage in the City's core, several organizations emerged to create a new industrial district to the south of the core and east of Alameda Street. No group was more active to achieve this end than the "tax-phobic hog ranchers" of Vernondale (later to be incorporated as the City of Vernon in 1905, see below). Other industrial areas were to follow, and included the Union Pacific, Bandini, and the huge Central Manufacturing District (CMD). Hence, the future of greater Los

Angeles and its destiny with industrial greatness seemed almost secure by the end of the 1920s (Sitton and Deverell 2001; Fogelson 1967).

5.2 Greater Los Angeles—Transportation

Interurban cable railways began early in the City of Los Angeles. Between the 1870s and 1880s, nearly 35 franchises were awarded to private contractors in order to facilitate lines throughout the city, some covering distances of less than a mile. Today, interurban transportation is a publicly funded enterprise, whereas, between 1870 and 1910, it was private enterprise that constructed and maintained virtually all of these lines (Electric Railway Historical Association 2001; Fogelson 1967; Keilty and Heller 1999). As most of the early cable railways were dependent on high real estate values, most could not meet expenses and ultimately failed. Equipment was then sold to other companies who also failed. Eventually, electrification would soon replace the cable system, requiring even more capital (Fogelson 1967; Lewis n.d; Swett 1951).

Ultimately, two individuals would be left standing once the interurban dust settled in the Southland. Both Henry E. Huntington and Edward H. Harriman had a tremendous stake in Los Angeles' interurban electric railways. Huntington, already successful in electric power and real estate development was at one time the largest single landowner in southern California, while the New York-based railroad magnate Harriman held the reins as president of the Southern Pacific Railroad. Both wanted to expand their empires in the Southland (Fogelson 1967; Pomeroy 1965).

Huntington initially entered the interurban business in 1898 with the organization and operation of the Pacific Electric Railway Company; operation commenced, however, in 1901. The Pacific Electric would later evolve into what was referred to as the Red Car system, a system that would dominate Los Angeles transportation for many years to come (Fogelson 1967; Pomeroy 1965; Mulholland 2000).

Southern Pacific president Edward Harriman became concerned that the Pacific Electric would eventually have an impact on his freight business. Using his influence in transportation affairs, Harriman took advantage of Huntington's partners concern for "excessive costs of the Pacific Electric." In due course, Harriman was extended an offer of 45 percent interest in the Pacific Electric Railway, of which Harriman gladly accepted and soon became a minority stockholder.

Today, Union Pacific Railroad owns and operates a railline that follows the route of the Pacific Electric Railway parallel to Randolph Street within the project area.

The largest concern at the time for the City of Vernon involved train crossings along their streets. Three major rail carriers and the Los Angeles Junction Railway (LAJ) created increased traffic problems in the region that included no less than 200 grade crossing conflicts. In an effort to improve the situation, construction of the Alameda Corridor began in April of 1997. The 20-mile long corridor that runs parallel to Downey Road is a dedicated cargo expressway linking the Ports of Los Angeles and Long Beach via Vernon, Bell, and the City of Commerce. Highlighting the project is the Mid-Corridor Trench, which carries freight trains "in an open trench that is 10 miles long, 33 feet deep and 50 feet wide between State Route 91 in Carson and 25th Street in Vernon where it veers northeast to the yards." In essence, the Corridor consolidates four low-speed branch lines, which in turn eliminates hundreds of grade-crossing conflicts (*Business Voice* May 2002).

5.3 The City of Vernon—"Exclusively Industrial"

As industrial expansion in the Southland spread south and east, so to did the growth of outlying communities. One such community started early in developing its commercial base, and although slow in coming, the City of Vernon would soon become "Exclusively Industrial."

Founded and incorporated in 1905 by the Furlong brothers and John Leonis, establishing this future industrial hub actually began 12 years earlier. Attempts were made by the City of Los Angels to annex the area as early as 1893 whereby the City of Los Angeles had already acquired the western portion of Vernon (then known as Vernondale). Leonis is often credited with mounting the first campaign to incorporate in 1902 in order to thwart annexation attempts. Leonis also feared preemption efforts by Henry Huntington, who attempted to incorporate the Vernon area into his newly developed Huntington Park. Lying between Alameda Avenue and the Los Angeles River, and criss-crossed by three major railroads (Southern Pacific, Santa Fe and the Union Pacific) "Vernon, like the state of Nevada, possessed one priceless resource: sovereignty" (Davis in Sitton and Deverell 2001; Vernon Chamber of Commerce 2002).

Vernon's march towards industrial hub was a slow one, however. Until industry became a household word, the City of Vernon was better known as a "sporting town." After the incorporation of the eastern portion of the farming township of Vernondale in 1905, only a handful of manufacturers migrated south to the newly incorporated city, most notably the Los Angeles Storage Company. Others, however, were "dissuaded by the tax-less city's inability to finance paved streets or sewers, as well as by the area's punitively high electrical rates." For a time, Vernon would be more well known for its "liquor, sports and vice" (Davis in Sitton and Deverell 2001).

It was in 1907, on land leased from Leonis, that entrepreneur Jack Doyle opened what some claimed was the longest bar in the world. Doyle could boast it took 37 bartenders with 37 cash registers to run the place. Next door to the bar, Doyle constructed a world class boxing arena (Vernon Avenue Arena). Soon, nightclubs, slot machines and "working women" turned Vernon into what resembled a "Las Vegas *avant l' lettre*, as

Leonis and the Furlong shared the spoils with the era's most colorful gamblers and sports promoters." In addition, the Pacific Coast Baseball League built a stadium that supported the newly formed Vernon Tigers who won three consecutive league pennants (Vernon Chamber of Commerce 2002; Davis in Sitton and Deverell 2001).

The goal of building an industrial base in the Southland, however, continued despite the city's reputation as a sporting town. As early as 1912, Vernon annexed the Santa Fe railroad's classification yards, "establishing a partnership with the giant corporation that became the city's leading landowner and industrial developer." Promoters also used sporting profits to construct a viaduct across the Los Angeles River, while Pacific Light and Power constructed a new transformer station "that brought Vernon cheap power from the Big Creek Project." The firm, General Petroleum, also constructed a natural gas pipeline from their Midway Field in the San Joaquin Valley. By 1914, these improvements eventually lured even more companies from the downtown core, including the Union Iron Works and Pinney and Boyle (Davis in Sitton and Deverell 2001).

Vernon also enjoyed a lucrative stockyard industry. Leonis opened up two huge stockyards sometime after 1919, creating a meat packing industry that would become one of Vernon's signature industries. No less than "Twenty-seven slaughterhouses lined Vernon Avenue from Soto Street to Downey Road until the late 1960s" (City of Vernon 2002). The push for this Chicago-style industry began in earnest in the winter of 1921. Arthur G. Leonard, President of the Union Stockyards and Transit Company of Chicago visited Los Angeles, and after a month recommended the establishment of a stockyard south and east of the City's core. In November of 1922, the Los Angeles Union Stockyards Company opened for business (Poronto 1923).

With the establishment of the Los Angeles Union Stockyards came the creation of the CMD. Under the auspices of the of the group Central Manufacturing District, Inc., property was financed and developed along the lines of its Chicago counterpart. By 1923, nearly a half dozen buildings were under construction, costing over $1,000,000, with plans for further expansion, which would eventually add to the commercial wealth of Los Angeles. In addition, the Los Angeles Junction Railway was established (1922), cutting out expensive switching charges with the three major railroads that bisected the region (Poronto 1923; Davis in Sitton and Deverell 2001).

When finally on line, the Los Angeles Junction Railway (LAJ) was "one of the smallest, but busiest railroads in the nation." The line eventually served the industrial "communities" of Bell, Commerce and Maywood, as well as Vernon. An exclusively industrial rail carrier, the fact that it was, and still is, a neutral switching line with connections to all the major carriers, the Los Angeles Junction Railroad eliminates tie-ups, delays, and reduces excess rates. The LAJ also services the Ports of Los Angeles and Long Beach (*Business Voice* May 2002).

With the establishment of the CMD and the vast internal improvements that followed (i.e., paved streets, sewer systems etc.,) the City of Vernon began to thrive during the decade of the 1920s. Heavy industries such as Bethlehem and American Steel, Alcoa (aluminum), American Can and a Studebaker automobile plant, among others, located in the area. In the following decades other diversified manufacturers including box and paper concerns, aerospace, drug companies and food processing enterprises would also occupy a place in Vernon's industrial enclave. Gone were the hog ranches, cauliflower fields, and the slaughter houses—Vernon was now "Exclusively Industrial" (City of Vernon 2002; Davis 2001).

Vernon's industrial growth skyrocketed during the decade of the 1920s. Firms established in this time period included: the Los Angeles Wood and Letter Company (1929), Consolidated Steel (1926), Santa Fe Industrial Center (1926-27), Gavina and Sons (originally York Ice Machinery Company, 1921), U.S. Steel (1924), Williams Warehouse and Distribution Center (1928), Norton Containers (1920), and Farmer John Meat Company (originally the Pioneer Provision Company) as early as 1918. Even more industrial expansion occurred during the 1930s and beyond.

According to a City of Vernon publication, one of the most important events to take place during the 1920s was the development of the East Los Angeles Industrial District by the Union Pacific Railroad Company. Beginning in 1922, the Union Pacific acquired some "900 acres of flat agricultural land, six miles east of downtown. The new facility occupied 230 acres, while the remainder was to be developed into a great industrial tract" (Moruzzi ca. 1990). The new complex would include 70 miles of new trackage, house a large machine shop, office buildings, a hospital, and an athletic field. With projects like these, Vernon's industrial complex (along with the CMD) would soon become one of the largest entities of its kind on earth (Sitton and Deverell 2001).

Today, the City of Vernon continues to live up to the motto "Exclusively Industrial." Combined with the CMD and surrounding industrial communities, the City of Vernon shares a role in the ever-increasing industrial growth of southern California in particular, and the west coast in general.

5.4 Vernon Light and Power Plant

From the beginning, the concern for cheap power absorbed much of the energies of Vernon's founding fathers. After being turned down by the Edison Company to reduce power rates, the City decided to provide its own power in an effort to attract even more industrial tenants within the city limits. Hence in 1932, the City laid plans to construct a 35,000 horsepower light and power plant. Led by the City and the non-profit Vernon Industrial Development Association, America's largest Diesel power plant was soon to become reality (*Diesel Power Magazine* 1933).

The building itself was styled in the art deco tradition of the times, unique for an industrial complex. Measuring 240 feet by 170 feet, the finished mission stucco edifice required over 620 tons of steel within reinforced concrete, netting a total volume of 1,600,000 cubic feet. The central structure measures 240 feet long by 73 feet wide and 55 feet high. This central area contains five 7,000 horsepower diesel engines with their generators, and room for two more engines should expansion be necessary. In addition, a traveling crane, similar to those used at hydroelectric dam facilities, hovers above the central area for maintenance purposes. The electric crane is affixed to runways (rails) that have been bolted to the interior building columns, approximately 38 feet above the floor. The crane has two hoists; the main 50-ton hoist has the capacity to handle the immense generators, while the 10-ton hoist is designed for lighter loads. The remainder of the structure houses an electrical control room, a machine shop, a switch gear room and offices (Garcia n.d.).

From the outset it was decided that diesel engines were "the logical generating units to install, due first to cost, ability to burn a wide range of cheap California fuel, high efficiency, extremely favorable flexibility, and low maintenance costs." Not only was the Vernon Power Plant the second largest plant of its kind in the world (the largest being the Shanghai plant), it also included some engineering attributes not earlier employed. These nuances had to do with the evaporator units. While a routine fixture in steam plants, installation in the Vernon plant was a first. The steam created from the waste-heat boilers is "led to evaporators where the steam, after condensation, is added to the engine cooling system as make up, as well as stored for other uses." Exhaust gases from the Diesels were sent to the waste-heat boiler where they were in turn converted to steam. Ordinarily, this excess energy was lost, but because of the "capture" system in the evaporators, the energy could be reused (*Diesel Power Magazine* 1933; Garcia n.d.).

After five years of operation, the City of Vernon and the Edison Company "negotiated a truce" in 1937 with regards to industrial power rates. Hence the City "handed over operation of the City's electric system" to Edison. The Diesel-powered generators were rewound in 1947 to accommodate the frequency changes from 50 to 60 cycles, although by 1972, the engines were retired due to rising fuel costs. By 1980, once again the city realized that power consumption could be best handled through its own plant and returned to supplying its own power in 1987 after the engines went through a rebuild process. Two 7,400 horsepower Allison 571-KA combustion turbines were added to the two open expansion bays. Today, Vernon power customers enjoy some of the lowest power rates in the State of California (City of Vernon n.d.).

6.0 METHODS AND RESULTS

6.1 Archival Research

A record search was conducted by William Self Associates on July 2, 2001 at the South Central Coastal Information Center (SCCIC) of the California Historical Resources Information System at California State University-Fullerton, Fullerton, California, by SCCIC staff (Appendix B, Exhibit A). The search included a review of all recorded historic and prehistoric archaeological sites within a ½-mile radius of the project site on E. 50th Street, as well as a review of all known cultural resource reports. In addition, historic maps, the California State Historic Resources Inventory, the National Register of Historic Places, the listing of California Historical Landmarks in the region, and the California Points of Historical Interest were also reviewed by SCCIC staff. No prehistoric or historic archaeological sites were identified by the record search. One previous archaeological investigation (CA-LA-3408) has been conducted within a ½-mile radius of the project site (Table 1).

California Historical Landmark Number 167, the La Mesa battlefield is located 1.7 miles east of the project site at 4490 Exchange Ave. and Downey Road. This historical battlefield served as a campsite for California forces during the United States occupation of California during the Mexican War. The last military action on the California front, the battle of La Mesa was fought on January 9, 1847.

An additional record search was conducted in person by Juliet L. Christy of Greenwood and Associates on October 18, 2001. The search included a review of available literature, archaeological site archives, and relevant historical maps on file at the SCCIC, for the area within a ½-mile radius of the project linears along Seville Avenue, E. 50th Street, Boyle Avenue/State Street, and Randolph Street (Appendix B, Exhibit B). Two archaeological investigations were identified within this ½-mile radius, CA-LA-3408 (previously identified by William Self Associates) and CA-LA-4834 (Table 6-1).

Additional archival research was conducted in June 2002 at the California State University-Northridge Map Library, the Los Angeles County Assessors Office, the City of Vernon Chamber of Commerce, and the Bureau of Land Management Office, Sacramento, California. Documentation reviewed included Sanborn Fire Insurance Maps, General Land Office (GLO) maps, tax assessors rolls, and photographs.

A review of the earliest Sanborn Maps available for the project area (1920, 1928, 1929) confirms that the City of Vernon has always been, as it claims, an “exclusively industrial” city. The industrial and commercial structures over 50 years of age that remain extant within the project area continue, for the most part, to be used for their original purpose, if not also by the original owners (i.e. textile manufacturing, glass manufacturing, auto repair, etc.). Rail lines and spurs that remain in place today are indicated on the Sanborn maps in many of their original configurations, evidencing that the parceling system of the City has not been altered significantly over the past 80 years. The oldest residential structures in the project area, 1918-1919, appear on the Sanborn maps amongst other scattered dwellings and the occasional restaurant; south of Slauson Ave. and along Randolph Street as is the case today.

In June 2002, Parsons contacted interested parties by letter and followed up with telephone inquiries regarding any information on the history of the City of Vernon or cultural resources that might be affected by the project (Appendix B, Exhibit C). Interested parties include the Los Angeles City Historical Society, the Historical Society of Southern California, and the Downey Historical Society (the City of Vernon does not have a library or historical society). The results of these contacts were negative.

On June 20, 2002, Kelly Heidecker, Parsons Senior Cultural/Historical Specialist, met with Delores M. Petullo, Executive General Manager of the City of Vernon Chamber of Commerce, to discuss the historical development of the City of Vernon and to review historical photographs of the area. The results of this meeting are incorporated into the History Section above.

6.2 Field Survey

The following surveys were conducted for this project:

- An archaeological survey was conducted of 2715 E. 50th Street (the subject property) and the pipeline linear on Seville Ave. by Dan Falt of William Self Associates, on July 3, 2001. The principal investigator in charge of the work was William Self. No archaeological resources were located.
- An architectural survey was conducted of the subject property and the pipeline linear on Seville Ave., including an inspection of the built environment one building deep surrounding the subject property, by Michael P. Pumphrey of EarthTech for William Self Associates, on August 24, 2001. As a result of this survey, the City of Vernon Power and Light Plant, Station A Building, was recorded on Department of Parks and Recreation, (DPR) 523 series forms (Primary Record and Building, Structure, Object [BSO] forms) (Appendix C).
- An archaeological survey was conducted of the reclaimed water pipeline route by Juliet Christy of Greenwood and Associates, on October 30, 2001. The survey area at this time was determined to be "back of curb to back of curb. No archaeological resources were located.
- A architectural and archeaological survey was conducted on June 10-11, 2002, to identify potential historical and archaeological resources located within 100 feet of the centerline of the project along the linears, and adjacent to the project

site on E. 50th Street, Vernon, California. The staging areas were visually inspected from the parcel boundaries as the sites were inaccessible. The staging areas are covered by asphalt and structural foundations over 100 percent of their areas. No archaeological resources were located. Thirty-one additional historic architectural structures were located and recorded on DPR 523 series forms (Appendix C).

Table 6-1
Previously Identified Cultural Resources Reports Within ½-Mile of Project Area

SCCIC Project Number	Title	Type of Investigation	Author/Date	Resources
CA-LA-3408	Rio Hondo Water Reclamation	Literature and records review	E. Gary Stickel 1994	Negative
CA-LA-4834	Fiber Optic Cable System Installation	Survey	Jones & Stokes Associates 1999	Negative

Source: William Self Associates 2001; Greenwood and Associates 2001; Parsons 2002.

7.0 EVALUATION CRITERIA

7.1 National Register of Historic Places

National Register of Historic Places (NRHP), authorized under the National Historic Preservation Act of 1966, as amended. The criteria defined in 36 CFR 60.4 are as follows:

- 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, association, and one of the following.

  a. That are associated with events that have made a significant contribution to the broad patterns of our history.

  b. That are associated with the lives of persons significant in our past.

  c. That embody the distinctive characteristics of a type, period, or 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.

  d. That have yielded, or may be likely to yield, information important to prehistory or history.

Sites younger than 50 years, unless of exceptional importance, are not eligible for the National Register.

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 in the National Register, it is important to understand the seven kinds of integrity mentioned above. To summarize a National Park Service bulletin, entitled *How to Apply the National Register Criteria for Evaluation* (National Park Service 1991), 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 a 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.
- **Association** is the direct link between an important historic event or person and a historic property.

To qualify for the National Register, a property must be significant; that is, it must represent a significant part of the history, architecture, archeology, engineering, or culture of an area and it must have the characteristics that make it a good representative of properties associated with that aspect of the past.

All properties change over time. It is not necessary for a property to retain all its historic physical features or characteristics to be eligible for the National Register. The property must retain, however, the essential physical features that enable it to convey its historic identity. The essential physical features are those features that define both why a property is significant and when it was significant. A property that is significant for its historic association is eligible if it retains the essential physical features that made up its character or appearance during the period of its association with the important event, historical pattern, or persons. A property important for association with an event, historical pattern, or person ideally might retain some feature of all seven aspects of integrity. A basic integrity test for a property associated with an important event or person is whether a historical contemporary would recognize the property as it exists today (National Park Service 1984:6, 46, 48).

7.2 California Environmental Quality Act

The California Environmental Quality Act Guidelines Section 15064.5 includes provisions for significance criteria related to archaeological and historical resources. A significant archaeological or historical resource is defined as one which meets the criteria of the California Register of Historical Resources, is included in a local register of historic resources, or is determined by the lead agency to be historically significant. A significant impact is characterized as a "substantial adverse change in the significance of a historical resource".

Public Resource Code Section 5024.1 authorizes the establishment of the California Register of Historical Resources. Any identified cultural resources must, therefore, be evaluated against the California Register criteria. In order to be determined eligible for the California Register, a property must be significant at the local, state, or national level under one or more of the following four criteria, modeled on the National Register criteria:

- It is associated with events or patterns of events that have made a significant contribution to the broad patterns of the history and cultural heritage of California and the United States.
- It is associated with the lives of persons important to the nation or to California's past.
- It embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.
- It has yielded, or may be likely to yield, information important to the prehistory or history of the state and the nation.

In addition to meeting one of the above criteria, a significant property must exhibit a measure of integrity. Properties eligible for listing in the California Register must retain enough of their historic character or appearance to be recognizable as historic properties and to convey the reasons for their significance. Integrity is judged in relation to location, design, setting, materials, workmanship, feeling, and association. It must also be judged with reference to the particular criteria under which a property is thought to be eligible.

Public Resource Code Section 21083.2 governs the treatment of unique archaeological resources, defined as "an archaeological artifact, object, or site about which it can be clearly demonstrated" as meeting any of the following criteria:

- Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
- Has a special and particular quality such as being the oldest of its type or the best available example of its type.
- Is directly associated with a scientifically recognized important prehistoric or historic event or person.

If it can be demonstrated that a project will cause damage to a unique archaeological resource, appropriate mitigation measures shall be required to preserve the resource in-place, in an undisturbed state. Mitigation measures may include, but are not limited to 1) planning construction to avoid the site, 2) deeding conservation easements, or 3) capping the site prior to construction. If a resource is determined to be a "non-unique archaeological resource" no further consideration of the resource by the lead agency is necessary.

8.0 FINDINGS AND CONCLUSIONS

8.1 Malburg Generating Station

The main building (Station A Power Plant), constructed in 1932, and the switchyard, constructed circa 1947, are the only remaining features at the project site that are older than 45 years. The Station A building contains the Johnson & Heinze Diesel Plant (five diesel-fueled reciprocating, internal combustion generators, Units 1 through 5, each rated at 3.5 MW output) the H. Gonzales Generating Station (two natural gas-fired CTG units, Units 6 and 7, each rated at 5.5 MW output), and the Control Room.

The construction of the original cooling tower started in 1932 and was placed into operation on June 19, 1933. This cooling tower was replaced with a new cooling tower in 1990. All other original structures at the MGS project site, including the pump house and above ground fuel/oil tanks were removed in 2001. Review of records on file at the SCCIC revealed no indication that any of these structures were formally recorded prior to demolition and removal. However, the pump house and cooling towers are listed as "Associated Structures" in the August 22, 2001 Primary Record for the City of Vernon California Power Plant, prepared by Michael Pumphrey.

There are no changes planned to the H. Gonzales Generating Station or the Control Room. The Control Room is the dispatch center for the City's electrical and water systems, provides switching operations via Supervisory Control and Data Acquisition (SCADA), and houses the staff that performs real-time power scheduling. If the MGS Project is closed as discussed in Section 4.0 of the AFC, the H. Gonzales Generating Station and the Control Room will continue to function as they are prior to the Project. The H. Gonzales Generating Station will continue to operate to supply the peak load of the City. Operation of the City's electric and water systems and real-time power scheduling will continue to be provided from the Control Room. The City intends to allow a non-profit historic preservation corporation to take over the upkeep, care and preservation of the Station A building and the Johnson & Heinze Diesel Plant, including the Control Room.

The project site is located in an area of industrial-urban development varying widely from large-scale plant/manufacturing, to distribution, and small sole-proprietorships. Structures in the project area range in construction dates from 1916 (a residence at the corner of Hood Avenue and Randolph Street) to the 1990s. Building functions and heights also vary widely from low, sprawling one-story warehouses to silos, smoke stacks, and conveyor belt systems exceeding four-story heights (for example, the Owens-Brockway/Owens-Illinois Glass Container Manufacturing complex located between E. 50th Street and Fruitland Ave.).

The main building on the site (Station A) is 55 feet tall. Related structural features at the site include a cooling tower, 33.5 feet wide by 92 feet long by 64.5 feet high, located directly behind Station A (northwest corner of site), and an electrical substation covering a 40,000-square foot area, located adjacent to and immediately east of Station A. Transformers within the substation do not exceed 20 feet in height. Additionally, as recent as 2001, three steel tanks, the largest measuring 18.5 feet in diameter and 25.75 feet high, were located on the property to the north of the substation (northeast of Station A). These tanks were removed in 2001 during the diesel fuel remediation process.

Station A is eligible to the National and California Registers under criteria A and 1 (respectively) (significant events in our National and State history) because of its importance in the industrial development of the City of Vernon, and thus the Los Angeles area, by providing a source of cheap electrical power separate from what was being offered by the corporate giant, the Edison Company.

Station A is also eligible to the National and California Registers under criteria C and 3 (respectively) (significant design characteristics) because of its strong Art Deco vernacular architectural style in an industrial area, as well as the innovative use of the electric generating equipment for its period of significance (1930-1940). Both the building and the equipment it contains retain a high level of integrity in location, design, setting, materials, workmanship, feeling, and association.

The two combustion turbine generator stacks proposed for construction on the site will be 110 feet in height; however, the main bulk of the structure – the turbine – will not exceed 30 feet in height. Although the stacks will exceed the height of the historic building, the “mass” of the structure will be hidden behind Station A. Given that the building is located in a highly industrialized area as described above, the stacks, extending 55 feet above the roofline of Station A, will not impact the integrity of design, materials, workmanship, setting, feeling, association, or location of the historic structure; but will instead be in keeping with the characterization of the City as an industrial nexus.

8.2 Historic Structures

The architectural survey conducted by William Self Associates in August 2001, identified and recorded the City of Vernon Power and Light Plant - Station A. The architectural survey conducted by Parsons in June 2002 identified and recorded 31 additional historic structures within the APE; 8 residential structures (25 percent of all historic structures), and 23 industrial/commercial buildings (75 percent of all historic structures) (Appendix A, Figure 3).

Research of the available literature did not reveal any information on the 32 historic structures (excluding the Vernon Power Plant) that would justify their being considered potentially eligible to the National or California Registers under any of the standard criteria. Therefore, the structures (again, excluding the Vernon Power Plant) have been recorded on DPR Primary Record and BSO forms, but have not been formally evaluated for historical significance.

No adverse effects have been identified related to the construction or operation of the Malburg Generating Station project. The construction of the project adjacent to Station A will not create an adverse visual effect on the potentially historical structure as it is appropriate to the historic setting of the site and the region as an "exclusively industrial" city. Additionally, construction of the project linears will have no adverse effect on any historic structures as the linears will be constructed below the centerline of the roads, which will be returned to their pre-construction appearance prior to completion of the project. None of the 32 historic structures appear to be structurally unsound or at risk for collapse or damage, therefore, vibrations related to construction activities should have no adverse effect on these historic structures.

8.3 Railroads

Railroads within the project APE are recommended as ineligible for listing on the National and California Registers. While it is apparent that the building and construction of a railroad helped to shape events that have made a significant contribution to the broad patterns of national and state history (criteria A and 1 respectively), the building of railroad segments and spurs occur throughout the Los Angeles Basin for both passenger cargo transportation. These individual segments have been built, removed and rebuilt countless times as Los Angeles continues to grow. The constituent properties, the ballast, ties and rails are frequently replaced and maintained throughout the existence of the railroad and do not maintain integrity of the original design.

8.4 Geoarchaeology

Prehistoric archaeological resources in urban areas are frequently buried beneath the modern built environment of fill, roadways, asphalt, and structures. Standard field survey methods for identifying sites, therefore, runs the inherent risk of missing a large portion of the potential sites in a given area. By reviewing GLO Historic Plat maps and historic Sanborn Fire Insurance Maps, it is possible to assess the likelihood of discovering intact, buried cultural resources. The present general land use of the project area has historically been commercial and industrial in nature. While this general land use pattern exists today it was not always so.

According to the GLO Plat of the Rancho Aguaje De La Centinella, confirmed to Bruna Abila in February 1868, the project area once contained a spring, and the spring's drainage, which was known as Centinella Creek. This spring and creek were the main water source for Bruno Avila's Ranch. Rancho De La Centinella contained the ruins of

Antonio Abila's house, Mr. Lancaster Burnett's house, a road to San Pedro and the salt works there, and a road to Centinella Creek. All of these landmarks are mentioned in the survey notes taken when the Rancho was established and confirmed to Bruno Abila.

The earliest available Sanborn Maps reviewed for this project date from 1920, which coincides with the upsurge in industrial development in the City. As depicted on those maps, much of the project area remained undeveloped prior to the arrival of the many industrial and commercial establishments that came to the "exclusively industrial" city. Additionally, the Geologic Hazards Section (8.15) of the AFC indicates that the plant site rests upon approximately 4 feet of modern or historic fill containing some amount of rubble in the form of "asphaltic concrete" (City of Vernon 2002; 8.15-2). Therefore, it is unlikely that there will be any near-surface intact cultural deposits within this 4-foot fill zone.

It is always possible, with any ground disturbing activity, to encounter previously unknown archaeological resources during construction and operation of the proposed project. It can be assumed that if the original spring, and/or the creek bed of historic Centinella Creek are located, then there is a possibility of discovering intact archaeological resources near or at creek side. However, the historic and current land use patterns of the project area make any discovery of intact, significant archaeological resources a very low probability. The fact that the original land use of this area was as a ranch, with limited residential constituents relative to the overall size of the ranch (approximately 2,200 acres), and that the area is now an urbanized, commercial and industrial region, suggests that intensive land altering construction and development has taken place. Therefore, the possibility of these deposits being intact and significant resources is very low.

9.0 SUMMARY AND MANAGEMENT RECOMMENDATIONS

The project APE is an industrial-urban complex with 100 percent ground coverage. The archaeological findings in this report are based on a geoarchaeological assessment of available literature and a surface reconnaissance of the project area. No archaeological sites are located within the APE and the likelihood of encountering intact, significant subsurface cultural resources is very low.

The architectural survey conducted by William Self Associates in August 2001, identified and recorded the City of Vernon Power and Light Plant (Station A). The architectural survey conducted by Parsons in June 2002 identified and recorded an additional 31 historic structures within the APE; 8 residential structures, and 23 industrial/commercial buildings.

No adverse effects have been identified related to the construction or operation of the Malburg Generating Station project. The construction of the project adjacent to Station A will not create an adverse visual effect on the potentially historical structure as it is appropriate to the historic setting of the site and the region as an “exclusively industrial” city. Additionally, construction of the project linears will have no adverse effect on any historic structures as the linears will be constructed below the centerline of the roads, which will be returned to their pre-construction appearance prior to completion of the project. None of the 32 historic structures appear to be structurally unsound or at risk for collapse or damage, therefore, vibrations related to construction activities should have no adverse effect on these historic structures.

No other cultural resources were located within the archaeological and architectural APE. No further cultural resources work should be necessary unless project plans change to include unsurveyed areas. In the event that buried cultural resources are discovered during the course of project activities, construction operations shall immediately stop in the vicinity of the find and the City shall consult with the appropriate local, state, or federal entities and a qualified archaeologist to determine whether the resource requires further study. Cultural resources could consist of, but not be limited to, artifacts of stone, bone, wood, shell, or other materials, or features, including hearths, structural remains, or dumps.

If human burials are encountered, all work in the area will stop immediately and the Los Angeles County Coroner's office shall be notified within 48 hours. If the remains are determined to be Native American in origin, both the Native American Heritage Commission and any identified descendants must be notified by the coroner and recommendations for treatment solicited (CEQA Section 15064.5; Health and Safety Code Section 7050.5; Public Resources Code Section 5097.94 and 5097.98).

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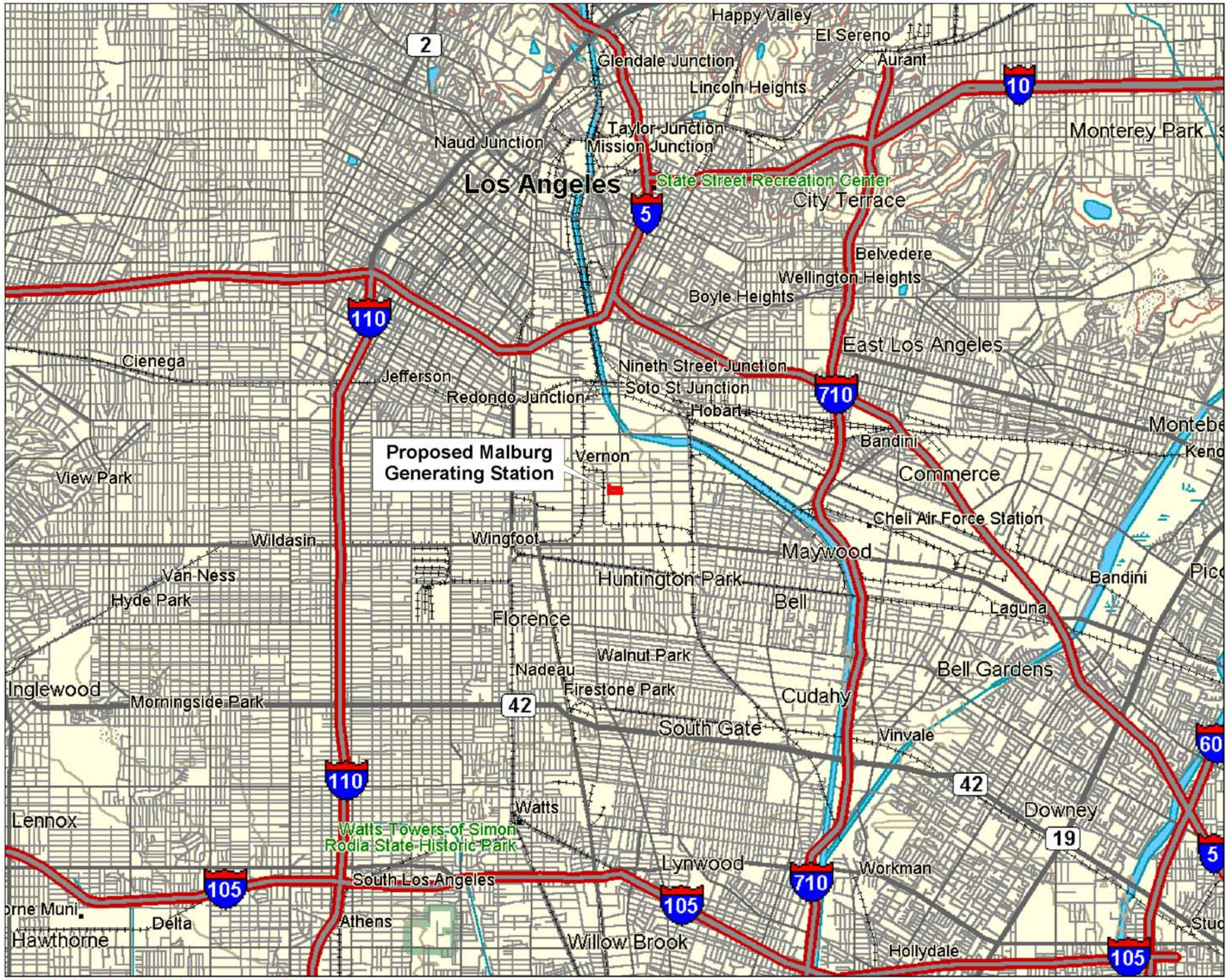
APPENDIX A: FIGURES



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096   3000 ft Scale: 1 : 100,000 Detail: 10-0 Datum: WGS84

N

3-D TopoQuads
Copyright © 1999 DeLorme Yarmouth, ME 04096

Scale: 1 : 100,000 Detail: 11-0 Datum: WGS84

0   8,000'   16,000'

SCALE IN FEET

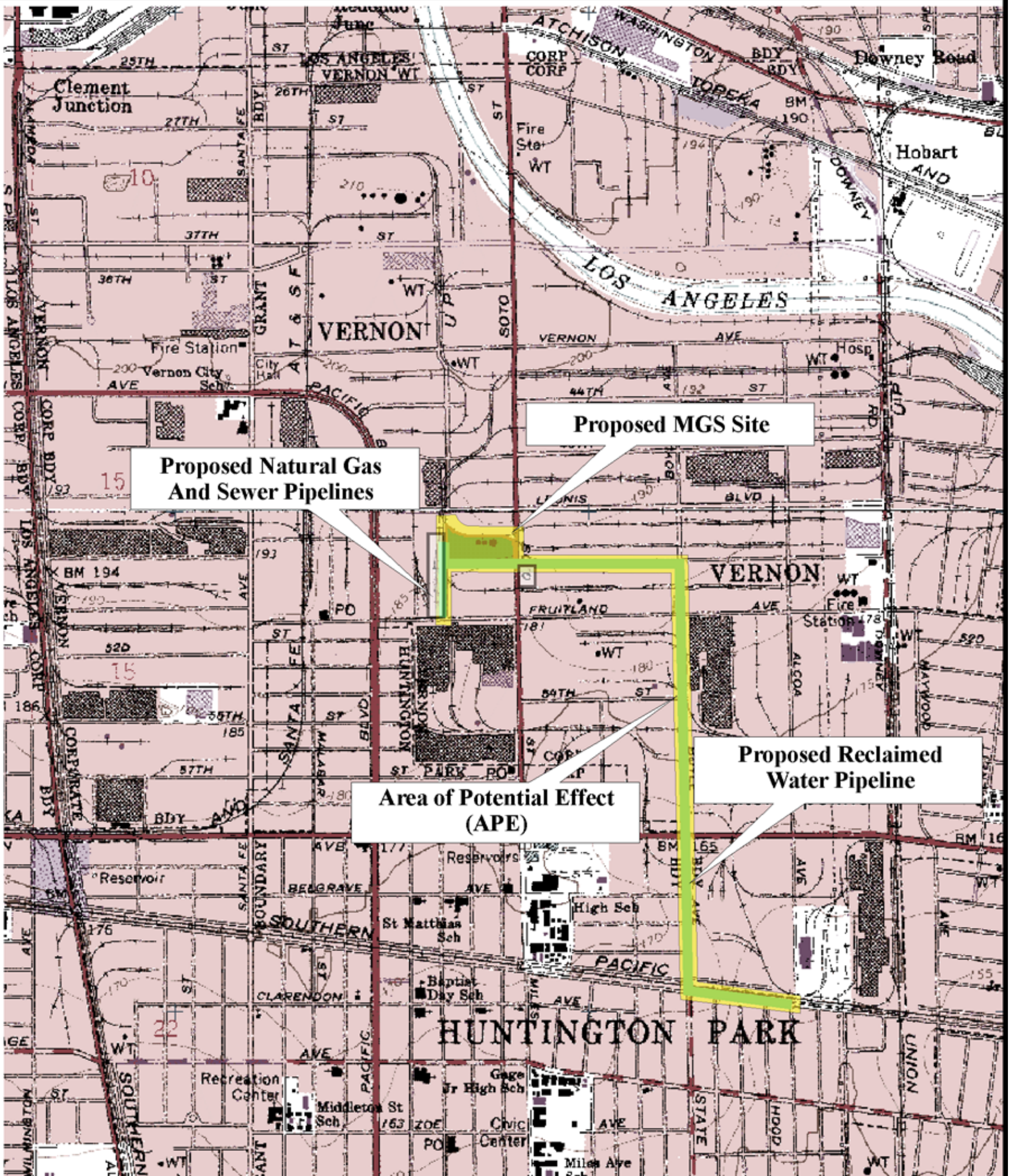
PARSONS

Figure 1

Project Regional Location

Malburg Generating Station

Vernon, California



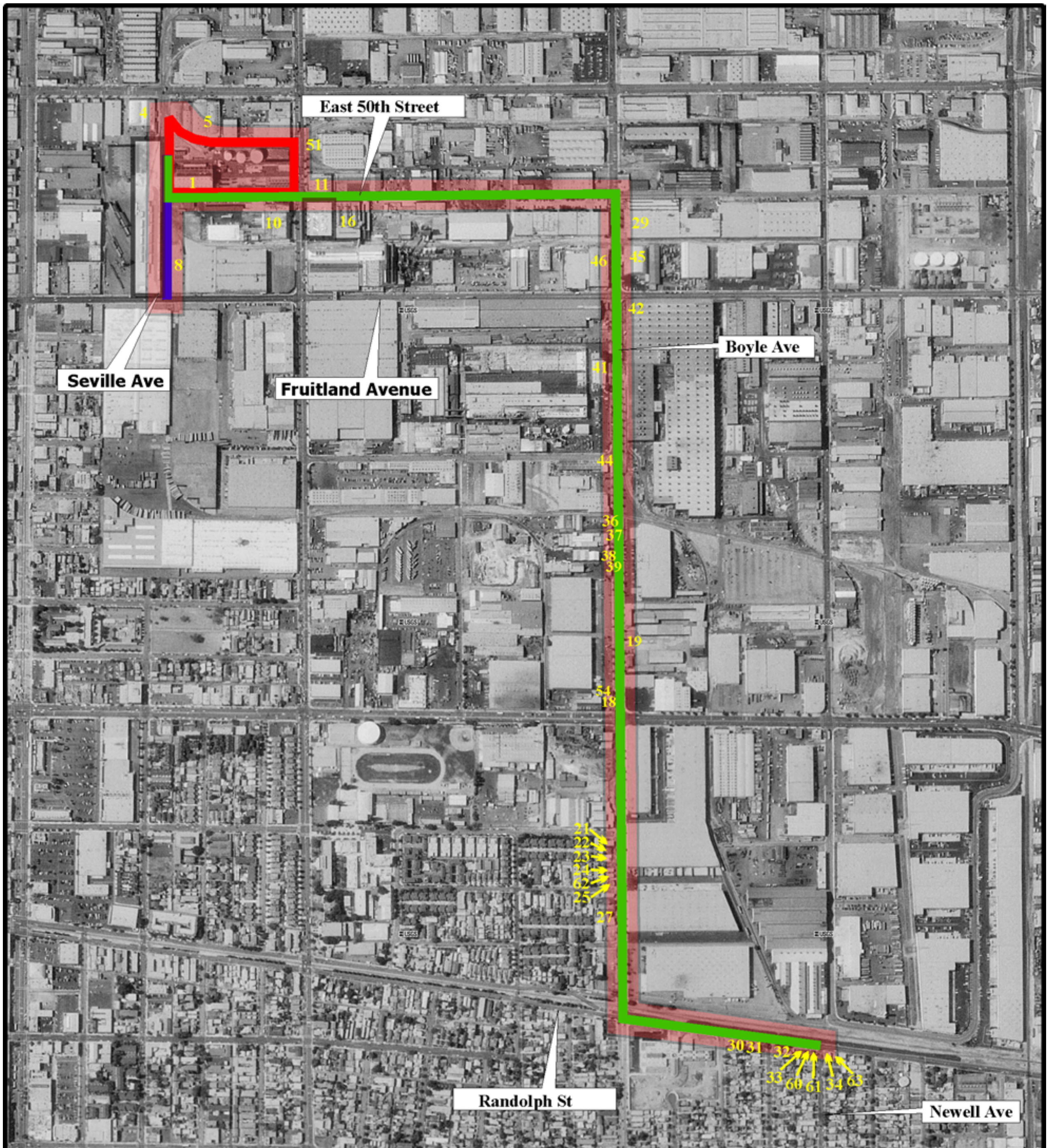
0 500 1,000 2,000
Scale in Feet
1:24,000

Area of Potential Effect

Source: Delorme, TopoTools, 2000

PARSONS

Figure 2
MGS Project Site, Linears and
Architectural Areas of Potential Effect
on a Map in a Scale of 1:24,000
Malburg Generating Station
Vernon, California



Proposed Malburg Generating Station

Proposed Reclaimed Water Pipeline

Proposed Natural Gas & Sewer Pipelines

Area of Potential Effect (APE)

Parking & Laydown Areas

0 250 500 1,000
Scale in Feet

N

Source: USGS May 31, 1994

PARSONS

Figure 3

Locations of Historic Structures

Malburg Generating Station

Vernon, California

APPENDIX B: EXHIBITS

[Spacer for Exhibits]

APPENDIX C: SITE RECORDS

[Spacer for Site Records]

ATTACHMENT 2

HYDROLOGY REPORT

[This document is not available electronically.]

ATTACHMENT 3

SOUTHERN CALIFORNIA EDISON SYSTEM IMPACT REPORT

City of Vernon Project Summary

This Technical Assessment was performed for two system conditions: (a) 2004 heavy summer load forecast with very high internal L.A. Basin area generation, and (b) 2004 light spring load forecast (65% of 2001 heavy summer) with very high internal L.A. Basin area generation. The table below provides load flow details from light spring and heavy summer cases.

Case Summary

SCE AREA TOTAL GENERATION, IMPORT, LOAD AND LOSSES (MW)				
	Summer 2004		Spring 2004	
	Pre-Project	Post-Project	Pre-Project	Post-Project
Generation	18,863	18,732	12,774	12,639
Import	3,210	3,210	1,472	1,472
Load	21,621	21,487	14,001	13,867
Losses	453	455	246	244

The Technical Assessment identified that the existing facilities are adequate to provide service beyond 2004 to the proposed Malburg Generating Station "MGS" project under normal conditions with all facilities in service. There are no base case problems identified.

Single Contingency Results

Under heavy summer conditions, there is no overload on transmission facilities due to single contingencies. However, under light spring conditions, two single contingencies resulted in overloads on two transmission lines. The tables below summarize the affected lines, highest pre and post project loadings on those lines, and the maximum (generation reductions) required to mitigate the highest overload seen on each line. Implementation of RAS in this case to mitigate the overload is less than the1150 MW limit in the ISO guidelines for Special Protection System.

SINGLE CONTINGENCY OVERLOADS

Transmission Line	Pre-Project	Post-Project	Δ Increase	Congestion*
Lighthipe-Hinson 230-kV*	122%	123%	1%	654 MW
Lighthipe-Mesa Cal 230-kV*	113%	114%	1%	374 MW

*Light Spring N-1 only

*Includes 134 MW at VERNON

Double Contingency Results

Under heavy summer condition, one double contingency resulted in an overload of one transmission line. Under light spring conditions, a total three transmission lines are overloaded under eight double contingencies. The table below summarizes the affected lines, summarizing the highest pre and post project loading on the lines, and the maximum congestion (generation reductions) required to mitigate highest overloads. Implementation of RAS in this case to mitigate the overloads is less than the 1400 MW limit in the ISO guidelines for SPS.

DOUBLE CONTINGENCY OVERLOADS

Transmission Line	Pre-Project	Post-Project	Δ Increase	Congestion*
Lighthipe-Hinson 230-kV[1]	175%	177%	2%	654 MW
Lighthipe-Mesa Cal 230-kV[2]	136%	138%	2%	654 MW
Long Beach - Lighthipe 230-kV[2]	140%	142%	2%	264 MW

1) Heavy Summer and Light Spring N-2 overloads *Includes 134 MW at VERNON
2) Light Spring N-2 overloads only

The attached tables (2-1 and 2-2) provide details of the overloaded lines and its contingencies

Short Circuit Results

The short circuit study identified six 230kV substation locations where three-phase short circuit duty was increased by more than 0.1 KA and breaker rating was in excess of 60% nameplate rating. Based upon previous study in the same area, single line to ground faults were lower than three phase faults. Table below shows the summary of Short Circuit Duty.

TABLE 3
SHORT - CIRCUIT DUTY
(3-Phase Duty)
City of Vernon - Vernon Project

		Off		On		
SCE Substations	KV	X / R	KA	X / R	KA	Increase
CENTER S	230	15.8	39.4	15.8	39.5	0.1
LA FRESA	230	26.7	46.5	26.7	46.6	0.1
LAGUBELL	230	16.6	33	16.7	33.3	0.3
MESA CAL	230	15.6	48.6	15.6	48.7	0.1
RIOHONDO	230	15.4	30.3	15.4	30.4	0.1
SERRANO	230	24.1	52.7	24.1	52.8	0.1

A Facilities Study will be required to determine the facilities and upgrades required to interconnect the proposed MGS Project beyond 2004. The Facilities Study should:

1. Review feasibility and develop costs associated with upgrades to mitigate N-1 contingency overloads.

   - **Lighthipe - Hinson 230 kV:** Increase thermal capacity from 650 kcmil to bundle 1033 ACSR or mitigate the contingency by RAS, which includes the whole 134 MW at Vernon.
   - **Lighthipe-Mesa Cal 230-kV:** Replace wave traps at both ends to 4000 amps.

2. Review feasibility and develop costs associated with upgrades to mitigate N-2 contingency overloads.

   - **Lighthipe – Hinson 230 kV:** Increase thermal capacity from 650 kcmil to bundle 1033 ACSR or mitigate the contingency by RAS, which includes the whole 134 MW at Vernon.
   - **Longbeach – Lighthipe 230 kV:** Re-conductor existing line from 650 kcmil to bundle 1033 ACSR or mitigate the contingency by RAS, which includes the whole 134 MW at Vernon.
   - **Lighthipe – Mesa Cal 230-kV:** Upgrade wave traps at both ends to 4000 amps.

3. Review circuit breakers at the six 230-kV substation locations (See Table 3) to determine need for breaker replacement and cost allocation.

TABLE 2-1
CITY OF VERNON
134MW TECHNICAL ASSESSMENT LOAD FLOW STUDY RESULTS

2004 HEAVY SUMMER LOAD - MAXIMUM GENERATION

Line Conductor Rating: 1185 **Limiting Component Rating:** 1185

Overload:	Lighthipe-Hinson 230-kV	**No Malburg Project**			**With Malburg Project**			**Impact***
Outage #	**Outage**	**Amp**	**Limiting Component**	**Line Conductor**	**Amp**	**Limiting Component**	**Line Conductor**	**Limiting Component**
N-2								
29	Hinson-Del Amo 230-kV Lighthipe-Long Beach 230-kV	1695	143%	143%	1717	145%	145%	2%

Comment: Increase thermal capacity from 650 kcmil to 1033 ACSR.
***Note: In all cases the whole project 134 MW needs to be curtailed to mitigate its contribution to the overload**

TABLE 2-2
CITY OF VERNON
MALBURG GENERATION STATION PROJECT

2004 LIGHT SPRING LOAD - MAXIMUM GENERATION

Line Conductor Rating: 1185 **Limiting Component Rating:** 1185

Overload:	Lighthipe-Hinson 230-kV	**No Malburg Generation Project**			**With Malburg Generation Project**			**Impact***
Outage #	**Outage**	**Amp**	**Limiting Component**	**Line Conductor**	**Amp**	**Limiting Component**	**Line Conductor**	**Limiting Component**
N-1								
34	Hinson-Del Amo 230-kV	1446	122%	122%	1462	123%	123%	1%
N-2								
29	Hinson-Del Amo 230-kV Lighthipe-Long Beach 230-kV	2072	175%	175%	2093	177%	177%	2%
31	Redondo-Mesa Cal 230-kV Hinson-Del Amo 230-kV	1711	144%	144%	1730	146%	146%	2%
32	Hinson-Del Amo 230-kV Redondo - Lighthipe 230-kV	1742	147%	147%	1767	149%	149%	2%

Comment:
*Note: In all cases the whole project 134 MW needs to be curtailed to mitigate its contribution to the overload

Line Conductor Rating: 2480 **Limiting Component Rating:** 2400

Overload:	Lighthipe-Mesa Cal 230-kV	**No Malburg Generation Project**			**With Malburg Generation**			**Impact***
Outage #	**Outage**	**Amp**	**Limiting Component**	**Line Conductor**	**Amp**	**Limiting Component**	**Line Conductor**	**Limiting Component**
N-1								
5	Alamitos-Barre No.2 230-kV	2721	113%	110%	2755	114%	111%	1%
N-2								
2	Alamitos-Barre No.1 230-kV Alamitos-Barre No.2 230-kV	2749	115%	111%	2784	116%	112%	1%
5	Alamitos-Center S 230-kV Alamitos-Barre No.2 230-kV	2722	113%	110%	2757	114%	111%	1%
7	Alamitos-Barre No.2 230-kV Del Alamo-Ellis 230-kV	2878	120%	116%	2920	122%	118%	2%
31	Redondo-Mesa Cal 230-kV Hinson-Del Amo 230-kV	3275	136%	132%	3304	138%	133%	2%

Comment: Replace wave trap from 2400 Amps to 4000 Amps.
***Note: In all cases the whole project 134 MW needs to be curtailed to mitigate its contribution to the overload**

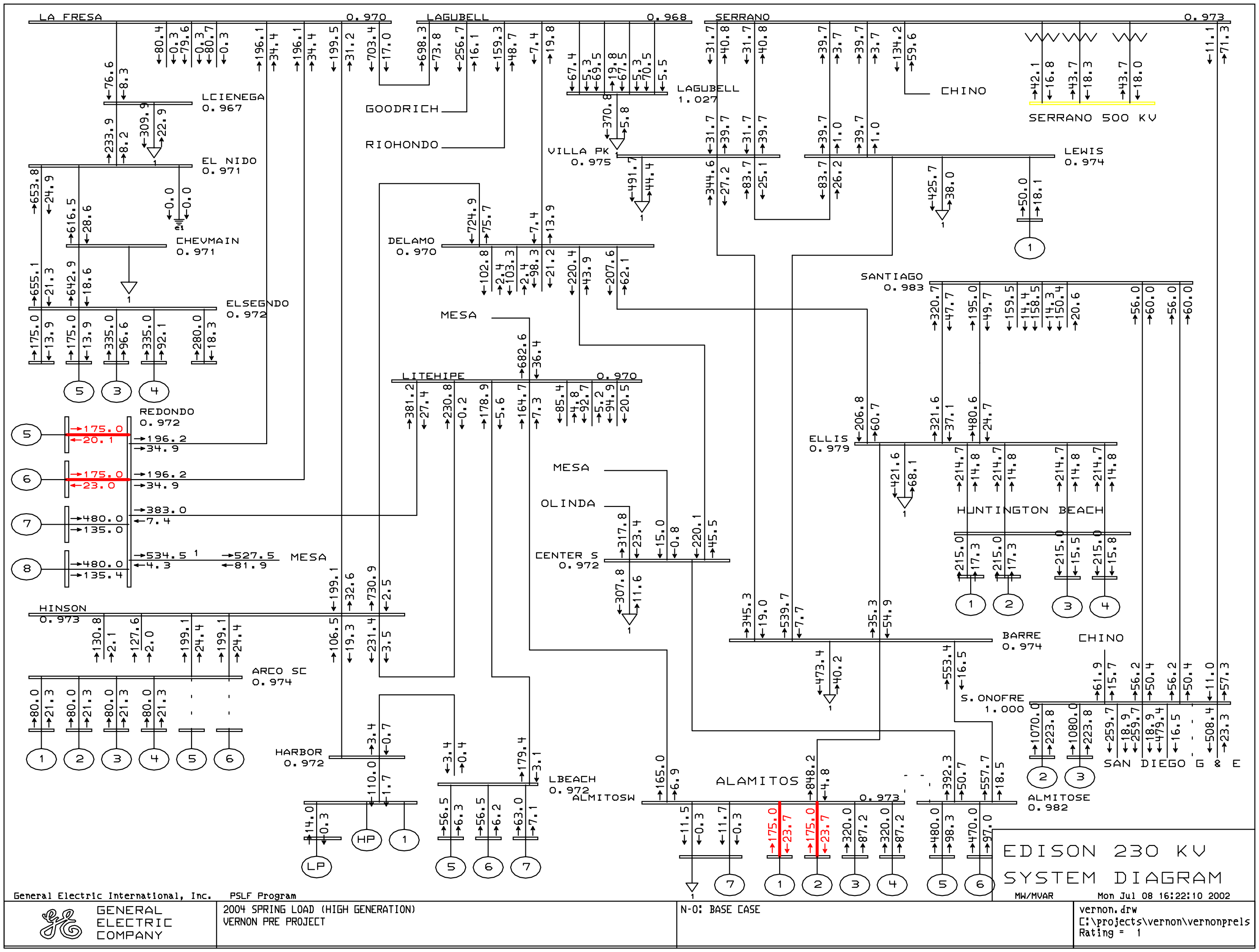
Line Conductor Rating: 1185 **Limiting Component Rating:** 1185

Overload:	Long Beach - Lighthipe	**No Malburg Generation Project**			**With Malburg Generation**			**Impact***
Outage #	**Outage**	**Amp**	**Limiting Component**	**Line Conductor**	**Amp**	**Limiting Component**	**Line Conductor**	**Limiting Component**
N-2								
30	Hinson- Del Amo 230-kV Lighthipe - Hinson 230-kV	1661	140%	140%	1677	142%	142%	2%

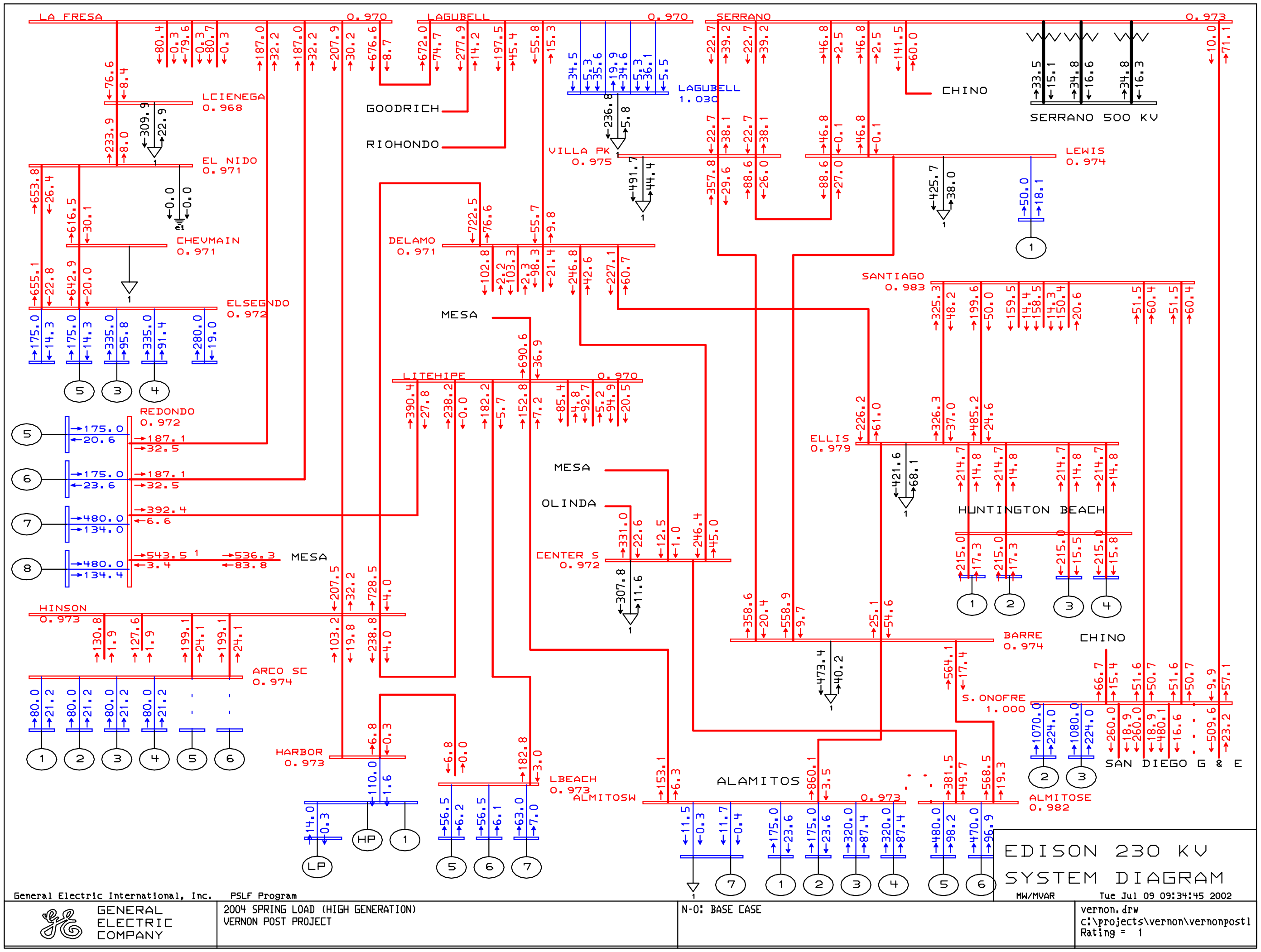
Comments: Congestion Management
***Note: In all cases the whole project 134 MW needs to be curtailed to mitigate its contribution to the overload**

Load Flow Plots

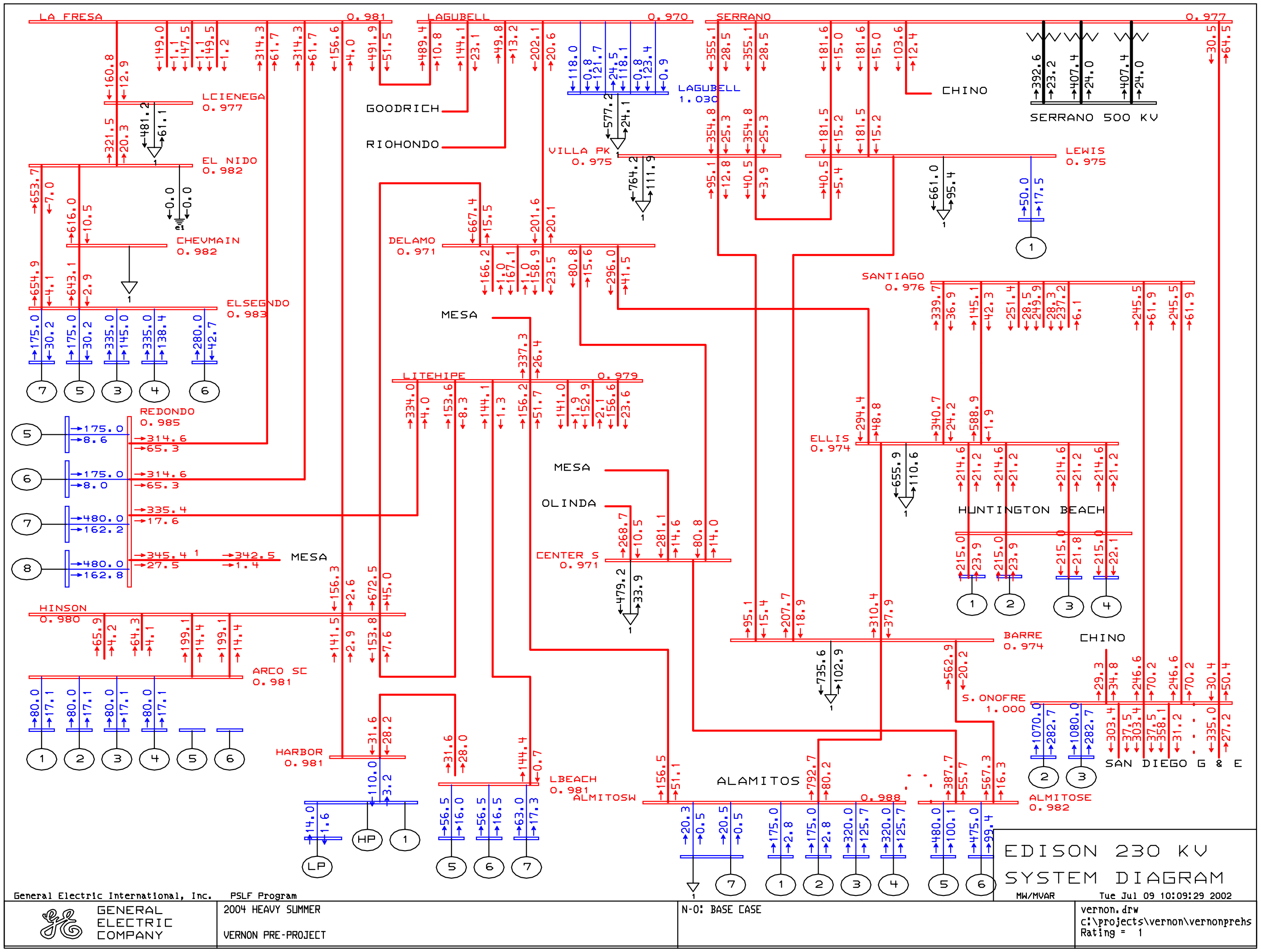
City of Vernon-Light Spring Pre-Project



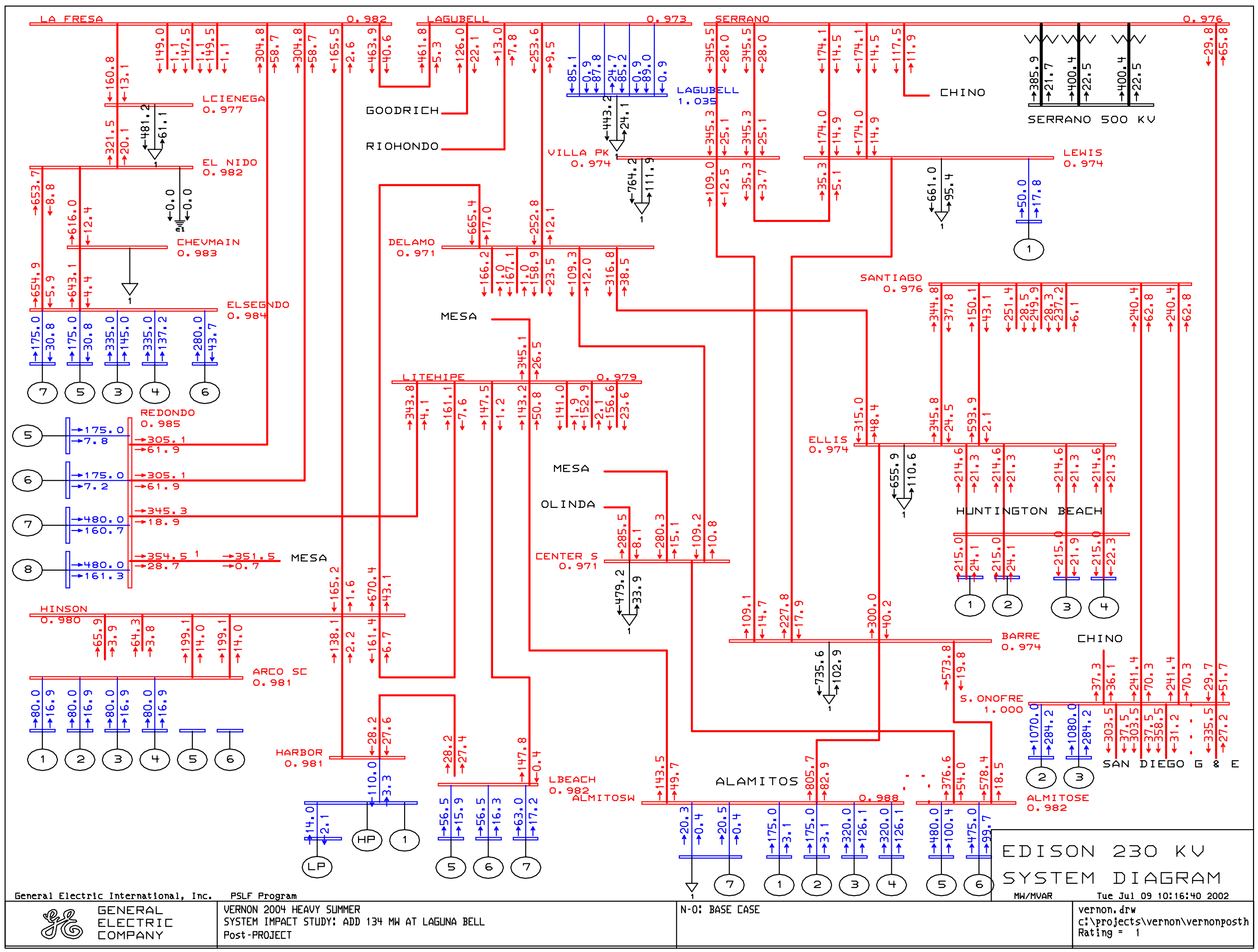
City of Vernon-Light Spring Post-Project



City of Vernon-Heavy Summer Pre-Project



City of Vernon-Heavy Summer Post-Project

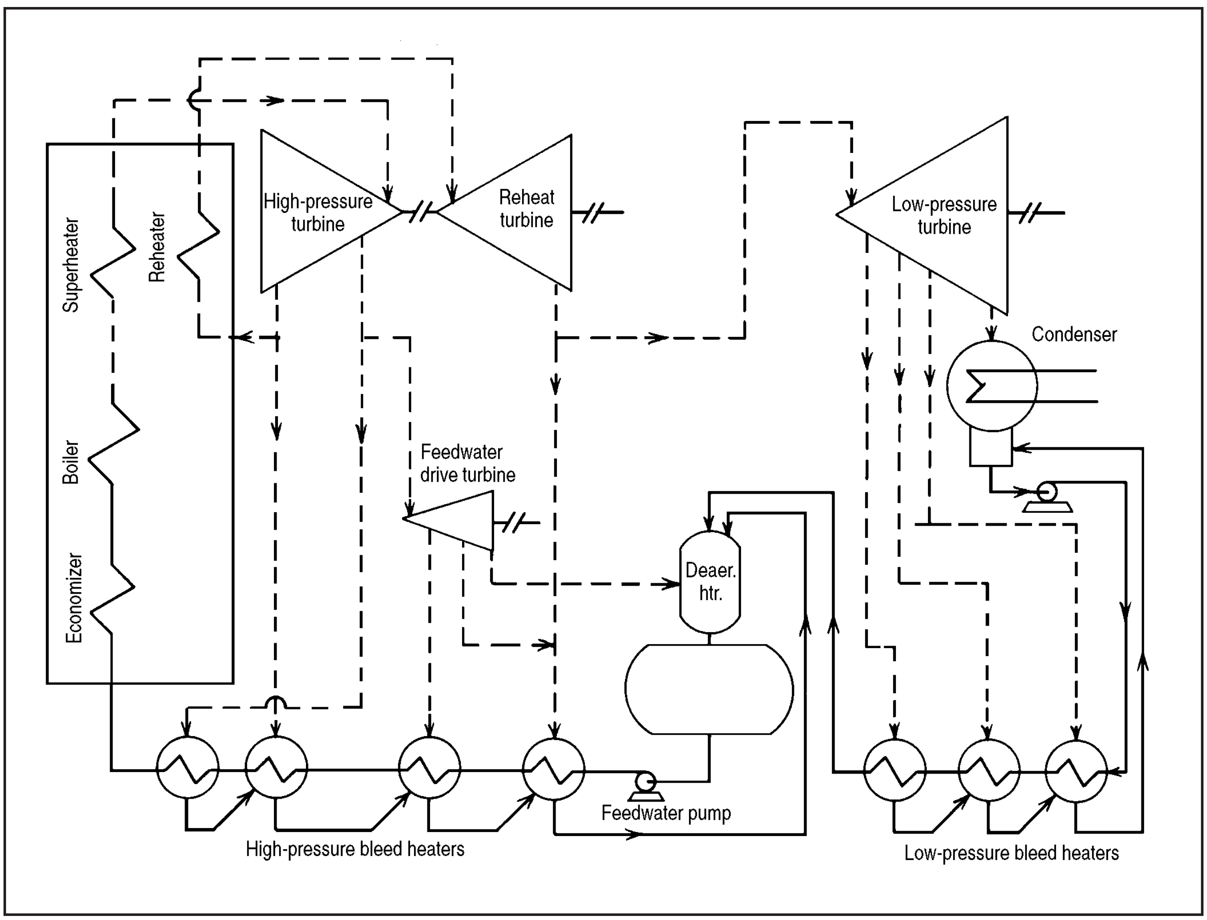


ATTACHMENT 4

ELIMONOX AND CARBOHYDRAZINE FACT SHEETS

QUESTIONS AND ANSWERS

ELIMIN-OX®



Total System Protection

What is ELIMIN-OX®?

ELIMIN-OX uses carbohydrazide as its active ingredient. Its use as a rapidly acting oxygen scavenger and metal passivator is patented. Being an all-volatile, non-solids-contributing chemical, it easily replaces hydrazine in all applications.

Hydrazine reaction with oxygen at low temperatures is known to be poor. How does ELIMIN-OX compare?

Laboratory work by Nalco and others (Figure 1) has clearly documented hydrazine's inability to react quickly with oxygen at low temperatures. Nalco research has shown ELIMIN-OX to be 500 times faster than hydrazine (from developed rate constants) and that ELIMIN-OX reacts stoichiometrically with oxygen at all temperatures. Figure 2 illustrates one piece of comparative data developed in the Nalco laboratory; however, field data from actual operating utility cycles have shown a far greater performance differential than would be predicted by the lab work.

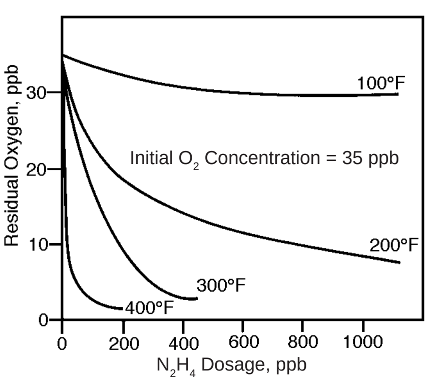


Figure 1 — *Effect of temperature on N_2H_4–O_2 reaction efficiency*. Time of 0.83 minutes in carbon steel tubing.*

**An Experimental Investigation of Hydrazine-Oxygen Reaction Rates in Boiler Feedwater*, N. L. Dickinson, D. N. Felgar, and E. A. Pirsh, Proceedings of the American Power Conference, 1957.

How do you monitor ELIMIN-OX feed rate?

ELIMIN-OX may be effectively monitored by two convenient methods. First, since "excess" ELIMIN-OX is hydrolyzed to hydrazine above 350°F, a standard hydrazine test may be all that is needed for *economizer inlet samples*. A simple drop-wise titration test which measures "total reductant," expressed as ELIMIN-OX, has also been developed by Nalco. This enables easy measurement of ELIMIN-OX levels at any point in the condensate-feedwater system, regardless of system temperature. Any hydrazine present would also be measured.

Like hydrazine, sufficient ELIMIN-OX is fed to achieve an *economizer inlet* residual of chemical reductant equal to 10–30 ppb of hydrazine, expressed as ELIMIN-OX.

I have an on-line hydrazine analyzer. Will that work for ELIMIN-OX?

It may depend upon the particular analyzer that you have and where its sample stream is taken from the cycle.

Where an analyzer is located at the economizer inlet, and when the economizer inlet feedwater temperature is consistently above 400°F, any hydrazine analyzer should work "normally" since only hydrazine will be present at that high a temperature. Many utility stations are using ELIMIN-OX and controlling its feed via analyzer signal just as with the previously used hydrazine.

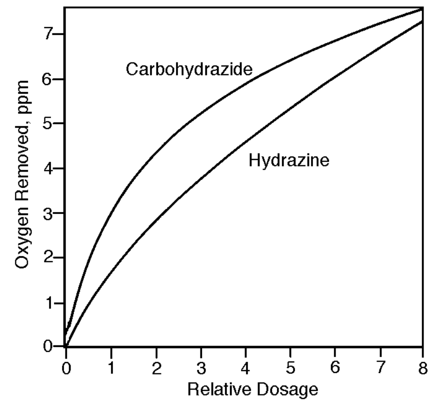


Figure 2 — *Carbohydrazide vs hydrazine in oxygen removal (135°F system)*

Where temperatures may be too low to completely convert excess ELIMIN-OX to hydrazine, the particular model of analyzer may make a difference. Most will "track" with changes in ELIMIN-OX levels, but the meter reading may not be quantitatively correct. Your Nalco Account Manager can provide more specific information.

Is ELIMIN-OX FDA-approved?

No. ELIMIN-OX cannot be used where steam is being exported for central heating, etc., and may come in contact with food or food products. Again, since ELIMIN-OX eventually becomes hydrazine, it is subject to the same FDA restriction as hydrazine.

Where an FDA-approved oxygen scavenger/metal passivator is called for, use Nalco SUR-GARD®.

How does ELIMIN-OX react with oxygen?

At ambient temperature and at temperatures typical of the low pressure feedwater heater system, ELIMIN-OX (carbohydrazide) reacts directly with oxygen as follows:

$$\underset{\text{(active)}}{\text{ELIMIN-OX}} + 2O_2 \rightarrow 2N_2 + 3H_2O + CO_2$$

No conversion to hydrazine is required and, in fact, if hydrazine were to be produced, the rate of reaction with oxygen would be dramatically reduced.

As higher temperatures are reached (initiation at approximately 275°F), hydrazine *is* produced from unused ELIMIN-OX in accordance with:

ELIMIN-OX + H_2O + heat → $2N_2H_4$ + CO_2

The hydrazine reaction with oxygen, which is somewhat improved at temperatures reached after the deaerator, then proceeds:

$N_2H_4 + O_2 \rightarrow 2H_2O + N_2$

I see that carbon dioxide is produced. Is this a problem?

Most systems using ELIMIN-OX will feed 1 ppm of product or less (depending upon oxygen level). At a 1 ppm feed rate, about 29 *ppb* of CO_2 can result. No impact on cycle pH would be expected, and none has been seen. Given the other sources of CO_2 in a cycle, and the quantities of ammonia and/or neutralizing amines normally present, the CO_2 is inconsequential.

Are any volatile organics likely to end up in the steam?

No, not as a consequence of ELIMIN-OX use. This has been confirmed both in the laboratory and in field application using Total Organic Carbon Analyzers and Ion Chromatograph techniques.

Table 1 — *Passivation rating of various oxygen scavengers (3 = best)*

Treatment	Observations*	Rating
Blank	Metal dissolution	
	Some corrosion	0
Hydroquinone	Metal dissolution, pits	
	Active corrosion	0
Diethylhydroxylamine	Gray chemical film deposit	1
Sulfite	Some corrosion	2
Hydrazine	Light passivation	2.5
ELIMIN-OX	Light passivation	3.0

I hear that hydrazine is a metal passivator. How about ELIMIN-OX?

ELIMIN-OX has shown superior metal passivation properties both in laboratory studies and under field conditions.

In one laboratory study, passivation characteristics of various molecules purported to be oxygen scavengers/metal passivators were evaluated in a test boiler operating at 600 psig with test specimen heat transfer rates of 110,000 Btu/ft^2–hr. Passivation ability was then rated based on thickness, hardness, and color of the oxide layers formed on heat transfer surfaces. Table 1 shows the results obtained under these test conditions.

Inspections of feedwater heaters, deaerators, economizers, etc., after only a few months of ELIMIN-OX treatment have shown a dramatic change in color, going from orange-red colored surfaces to the gray-black color associated with the superior protective coating of magnetite.

Unit start-up times after ELIMIN-OX use have often been shortened from several days to several hours, where feedwater iron is no longer the limiting factor in the start-up schedule. Better passivated surfaces produce less "crud" following unit outages.

With better O_2 scavenging and metal passivation, does ELIMIN-OX lower the amount of "crud" transported to the boiler and turbine?

The reduction is dramatic! A 60–85% reduction in transported iron and copper oxides is typical. The beneficial effects on the utility cycle include:

1. Longer feedwater heater/deaerator/economizer life — maintenance costs reduced.
2. Cleaner superheater, reheater, and turbine due to the improved quality of the attemperation water. In some plants, an immediate MW gain has been noted.
3. Reduced boiler deposition rates, leading to extended intervals between cleanings, fewer overheating or corrosion-related furnace wall tube failures, cleaner steam separation equipment and cleaner steam — *all* meaning greater operating reliability and reduced operating costs.

This 60–85% reduction in metal oxides has been repeatedly demonstrated in cycles of all pressures and metallurgies. See Case Studies CH-167, 169, 170 and 171 for additional details.

Is there a pressure limit on ELIMIN-OX use?

No. All utility cycles can benefit from ELIMIN-OX use, including once-through, supercritical cycles. Performance results are consistent across all pressures.

What is the best way to compare the performance of hydrazine and ELIMIN-OX?

Compare O_2 levels, hydrazine/ ELIMIN-OX levels, and iron/ copper levels at several points in the condensate-feedwater portion of the cycle. Typical sample points include: condensate pump discharge, deaerator inlet, deaerator outlet (boiler feed pump suction), and economizer inlet. Proper sample coolers and continuously flowing samples are needed.

One dramatic demonstration is a "consumption comparison" across the low pressure heaters — which is really where the scavenger/ metal passivator *must* perform. Figure 3 illustrates the difference between hydrazine and ELIMIN-OX "consumption" in one supercritical cycle. Note that virtually no hydrazine was consumed up to the outlet from the No. 4 heater. Almost 65% of the ELIMIN-OX being fed was "consumed" across the same system segment. A miscellaneous drains tank with oxygen-saturated condensate (approximately 5 ppm) was piped in just ahead of the deaerator, accounting for the drop in level for both chemicals just ahead of the DA. Overall, a 60% reduction in transported copper was seen.

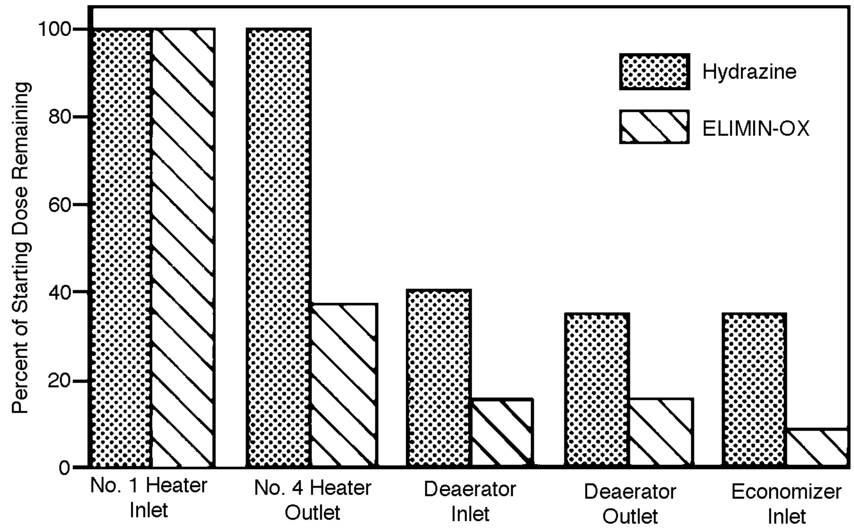


Figure 3 — *Consumption patterns for hydrazine vs ELIMIN-OX in a supercritical utility cycle*

Comparison of metal oxide levels is the real proof. With a good data base on hydrazine (or *no* scavenger if that is your present program), ELIMIN-OX results are usually very evident in 3 months or less. System "demand" for ELIMIN-OX is usually high at the outset due to the presence of unpassivated surfaces in the system. Figure 4 shows the demand profile exhibited by a supercritical cycle that had used hydrazine for several years. Two to three weeks may be required (depending on mode of operation) before a downward trend in dosage is seen.

Finally, inspect your system components. The difference will be evident.

I also use hydrazine for wet lay-up of out-of-service units. Can ELIMIN-OX improve system protection here as well?

Laboratory and field results have shown equal or better performance at dosage levels which are cost-competitive with hydrazine.

Your Nalco Account Manager can provide a Program Profile (PR-42) and a Nalco Reprint (No. 390) with the details. Superior out-of-service protection is every bit as important — maybe more important — as proper in-service protection.

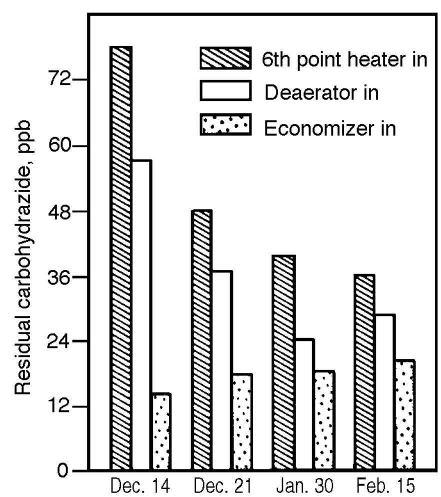


Figure 4 — *ELIMIN-OX passivation profile for Western supercritical unit*

Where else can ELIMIN-OX be used?

Any place that you are currently using hydrazine — and others as well.

ELIMIN-OX has been used very successfully in post-chemical cleaning passivation, and in pre-operational flush steps in various types of plants. Using its ability to scavenge oxygen at ambient or very low temperatures, ELIMIN-OX has also been used to chemically deaerate condensate which is to be used in the chemical cleaning of boilers. Your imagination may be the only limit to where ELIMIN-OX can replace hydrazine.

Can ELIMIN-OX be injected into the cross-over line to the LP turbine?

While it has not yet been tried, there is no reason to believe that it would not be as effective, if not more effective, than hydrazine. Even though ELIMIN-OX will convert to hydrazine at the temperatures encountered in the steam at this point, the rate at which the steam traverses the LP turbine may well be faster than the kinetics of the conversion. In any case, the turbine and condenser will see either ELIMIN-OX, hydrazine, or a combination of the two, all or any one of which may afford additional protection to this end of the cycle.

Table 2 — *Comparison of acute toxicology of ELIMIN-OX and 35% hydrazine solution*

Study Performed	ELIMIN-OX	35% Hydrazine Solution
Acute oral LD_{50} — rats	> 5000 mg/kg	370 mg/kg
Acute dermal LD_{50} — rabbits	> 2000 mg/kg	420 mg/kg
Primary eye irritation — rabbits (24 hr)	Non-irritating (0.33/110)	Irritating (26.5/110)
Primary dermal irritation — rabbits	Mild irritant (0.23/8.0)	Severe irritant (7.0/8.0) May be corrosive. (Most suppliers ship as a corrosive liquid)

Table 3 — *Regulatory status of ELIMIN-OX and 35% hydrazine solution*

Federal Regulations	ELIMIN-OX	35% Hydrazine Solution
OSHA's Hazard Communication Rule (29CFR1910.1200)	Product is **not** hazardous	Requires labeling as a suspect carcinogen
CERCLA, 40CFR117,302	Notification of spills **not** required	A 3-lb spill requires notification to the National Response Center
Resource Conservation and Recovery Act (RCRA), 40CFR261 Subparts C&D	Does **not** meet the criteria of a hazardous waste	**Is** a hazardous waste under the RCRA criteria
Federal Water Pollution Control Act 40CFR401.15 and 40CFR116	None of the ingredients are listed	**Is** covered (Hydrazine) by the Clean Water Act, Section 311

How does the use-cost of ELIMIN-OX compare with that of hydrazine?

Overall — with a total budget perspective — ELIMIN-OX will save money. Considering reduced maintenance costs, fewer chemical cleanings, improved unit reliability and megawatt capability, and extended equipment life, any change in scavenger cost is easily justified. While ELIMIN-OX will cost more than hydrazine (typically 2–4 times, varying as a function of oxygen in-leakage and current hydrazine cost/pound), in absolute dollars spent as a percentage of the total chemical budget, the increase is usually quite small. The payout, however, is clearly in the reduced expenses elsewhere.

Is ELIMIN-OX safer to handle than hydrazine?

On the basis of standard acute toxicity tests, ELIMIN-OX does not pose any significant handling problems. Comparable tests with a 35% hydrazine solution indicate that it is toxic by ingestion and by skin absorption. Hydrazine solutions are eye and skin irritants and can cause burns. ELIMIN-OX was shown to be non-irritating to eyes, and only a very mild skin irritant. Table 2 shows the results of these tests for both products. Table 3 provides a useful comparison of the regulatory status of ELIMIN-OX versus 35% hydrazine.

Has ELIMIN-OX enjoyed wide acceptance in the utility industry?

At this writing, 70 companies representing over 200 operating or laid-up units are using ELIMIN-OX as a replacement for hydrazine. Results have been widely discussed by Edison Electric Institute committees and in other industry forums.

ELIMIN-OX is in use in systems of every describable metallurgy and in systems using equipment from all major manufacturers. A partial application summary, covering 66 applications of ELIMIN-OX, is shown in Table 4.

Nalco will be pleased to furnish references upon request.

Table 4 — *Application summary*

General Information*

Boiler Manufacturer	
Babcock & Wilcox	– 25
Combustion Engineering	– 22
Foster Wheeler	– 6
Riley	– 8
Other	– 3
No response	– 2

Cycle Pressure	
< 1000 psig	– 9
1000–1799 psig	– 15
1800–1999 psig	– 11
2000–2399 psig	– 13
2400–2799 psig	– 12
2800–3200 psig	– 1
> 3200 psig	– 1
No response	– 4

Turbine Manufacturer	
General Electric	– 38
Westinghouse	– 14
Allis-Chalmers	– 10
Other	– 2
No response	– 2

Metallurgy*

Condenser	
Admiralty Inhibited	– 14
Admiralty brass	– 22
90/10 Cu:Ni	– 2
70/30 Cu:Ni	– 3
304 SS	– 7
316 SS	– 4
Arsenical Copper	– 10
Aluminum Brass	– 1
Titanium	– 1
No response	– 2

Low Pressure Heaters	
Arsenical Copper	– 3
Admiralty Inhibited	– 6
Admiralty Brass	– 16
90/10 Cu:Ni	– 8
70/30 Cu:Ni	– 8
304 SS	– 9
316 SS	– 4
Carbon Steel	– 3
Other	– 2
No response	– 7

High Pressure Heaters

90:10 Cu:Ni	– 8	304 SS	– 7	Other	– 1
70:30 Cu:Ni	– 15	316 SS	– 2	No response	–7
Monel	– 8	Carbon Steel	– 3		

Operational Data*

DA in Cycle	
Yes	– 60
No	– 6

Condensate Polishers	
No	– 51
Yes	– 15

Usual Oxygen Scavenger	
Hydrazine	– 56
Catalyzed hydrazine	– 0
Other	– 6
No response	– 4

Usual pH Control Agent	
Ammonia	– 14
Morpholine	– 36
Cyclohexylamine	– 2
Other	– 10
No response	– 4

Cycle Chemistry	
All-volatile	– 10
Phosphate	– 56

Point of O_2 Scavenger Feed	
Hotwell pump discharge	– 44
Hotwell	– 3
Deaerator	– 6
Other	– 9
No response	– 4

Point of pH Control Agent Feed	
Hotwell pump discharge	– 32
Hotwell	– 2
Deaerator	– 5
Other	– 18
No response	– 9

**Number of units treated in categories noted*

NALCO CHEMICAL COMPANY ONE NALCO CENTER ▫ NAPERVILLE, ILLINOIS 60563-1198

SUBSIDIARIES AND AFFILIATES IN PRINCIPAL LOCATIONS AROUND THE WORLD

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Carbohydrazide — A Hydrazine Replacement: 10 Years of Utility Experience

By A. Banweg, D. G. Wiltsey and B. N. Nimry, Nalco Chemical Company

Reprint R-556

ABSTRACT

Carbohydrazide, in just ten years time, has replaced hydrazine in 20% of the United States electric utility industry. By far the most widely used replacement for hydrazine, carbohydrazide is now in use in over 275 utility boilers, accounting for over 60,000 MW of installed capacity. It is timely to report on this experience, which covers the entire range of utility boiler pressures, including 3500 psi supercritical units. Data will be presented on the effects of carbohydrazide use on: lay-up, start-up, chemical cleaning frequency, and cycle corrosion control.

INTRODUCTION

Carbohydrazide was originally introduced to the utility industry as a "safer-to-use" alternative to hydrazine. It was then, and still is — in its commercialized form — a safer-to-handle product, not requiring elaborate, closed handling and feeding systems. Neither is the commercialized product subject to the several pieces of recent legislation dealing with hazardous materials and disposal of packaging materials.

Carbohydrazide has gained its market position, not on the safety-related issues, but rather because of its repeatedly demonstrated performance benefits. Moreover, these benefits have been achieved without producing any disruption to normal condensate/feedwater/boiler water/steam parameters designated by the EPRI Consensus Guidelines. These benefits can be listed as:

- Improved low temperature reactivity with oxygen
- Greatly reduced corrosion in all pre-boiler condensate/feedwater system components, as evidenced by consistent reductions in transported corrosion products of 50 to 85%
- Reductions in chemical cleaning requirements — especially notable for cycling units
- Significant improvement in desuperheating water quality, minimizing this source of turbine foulants
- Reduced start-up times following short or long-term outages (especially following lay-up with carbohydrazide)
- Superior lay-up program characteristics

This paper will present case histories that demonstrate several of these benefits. In addition, more recently developed, and corroborating, laboratory data will be shown.

CHEMISTRY OF CARBOHYDRAZIDE

REACTION WITH OXYGEN

For over fifty years, hydrazine has been the utility industry oxygen scavenger of choice, primarily because it contributes no dissolved solids to the boiler system. Its direct reaction with dissolved oxygen is classically shown as:

$$N_2H_4 + O_2 \rightarrow 2H_2O + N_2 \quad (1)$$

At the 1957 American Power Conference, Dickenson, Felgar, and Pirsh reported that the above reaction proceeds very slowly at the low temperatures common to the low temperature end of a utility cycle (Figure 1).[1] As a consequence, the low temperature end of the cycle is rarely, if ever, completely protected when hydrazine is used.

In the early 1980's, carbohydrazide* was introduced to the utility industry as a replacement for hydrazine. Carbohydrazide, a derivative of hydrazine, reacts with dissolved oxygen along two pathways:

Direct reaction (<275°F/135°C):

$$(N_2H_3)_2CO + 2O_2 \rightarrow 2N_2 + 3H_2O + CO_2 \quad (2)$$

**U.S. Patent No. 4, 269,717 Nalco Chemical Company (marketed as ELIMIN-OX®)*

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Indirect reaction (beginning at >275°F/135°C):

$$(N_2H_3)_2CO + H_2O \rightarrow 2N_2H_4 + CO_2 \quad (3)$$

$$2N_2H_4 + 2O_2 \rightarrow 4H_2O + 2N_2 \quad (4)$$

It should be noted from Equation 2 that oxygen scavenging is accomplished at low temperatures by the carbohydrazide molecule itself; no conversion to hydrazine is required. At higher temperatures, the reaction with dissolved oxygen is with either carbohydrazide or hydrazine — or both — depending upon system residence time, fluid temperature, and, to some extent, system metallurgy (Figure 2).

METAL PASSIVATION

Laboratory work, and subsequent field experience, have shown carbohydrazide to be an extremely effective metal passivator. Passivation reactions of carbohydrazide can be shown as:

$$12Fe_2O_3 + (N_2H_3)_2CO \rightarrow + 8Fe_3O_4 + 3H_2O + 2N_2 + CO_2 \quad (5)$$

$$8CuO + (N_2H_3)_2CO \rightarrow + 4Cu_2O + 3H_2O + 2N_2 + CO_2 \quad (6)$$

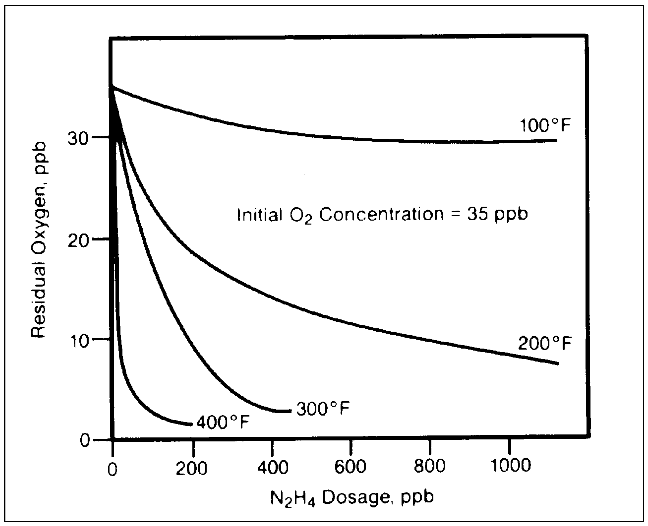

Figure 1 — *Effect of temperature on N_2H_4-O_2 reaction efficiency*. Time of 0.83 minutes in carbon steel tubing.*

**An Experimental Investigation of Hydrazine-Oxygen Reaction Rates in Boiler Feedwater,* N. L. Dickinson, D. N. Felgar, and E. A. Pirsh, Proceedings of the American Power Conference, 1957.

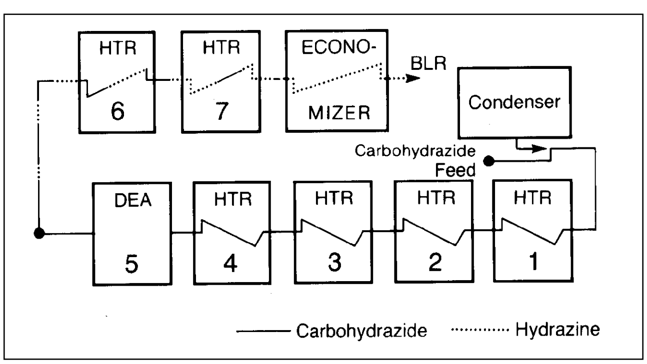

Figure 2 — *Typical carbohydrazide-to-hydrazine conversion pattern*

Table 1 — *Standard FEEDSIM test conditions*

Mild steel (AISI 1008) tube specimens
Deaerated (<2 ppb) double de-ionized water
pH adjusted to 9.0 using caustic
Heat flux approximately 9300 Btu/ft^2-hr
Temperature across tube rack 96–182°C
6 day test —
First 3 days, no scavenger feed
Second 3 days, scavenger feed
Scavenger is fed stoichiometric to oxygen plus a theoretical residual of 100 ppb as hydrazine equivalents

Early laboratory data comparing the passivation capability of various oxygen scavengers was based upon the solubility of the oxide film in an 18% HCl solution.[2] In recent years, ex-situ linear polarization measurements were performed on laboratory-generated specimens to determine the degree of passivation attained by various materials.[3] To support this work, a process simulation unit (FEEDSIM) that mimics a condensate/ feedwater heater array was constructed to enhance the understanding of pre-boiler passivation (Figure 3). The FEEDSIM unit can simulate specific chemistries, specific metallurgies, specific heat fluxes, etc. Table 1 summarizes one set of test conditions. Specimens are removed from FEEDSIM, dried, and then properly stored in nitrogen-blanketed containers for subsequent electrochemical and scanning electron microscope (SEM) analyses.

The use of this new laboratory procedure has confirmed the earlier data that showed carbohydrazide to be a better low temperature passivator than hydrazine. Results of ex-situ linear polarization tests on untreated, hydrazine-treated, and carbohydrazide-treated FEEDSIM tube specimens are summarized in Figure 4. The bigger the Rp (polarization resistance) value, the more protective the oxide film that has been formed on the metal surface. It is evident from this graph that carbohydrazide, under these test conditions, is a much more effective metal passivator than hydrazine at temperatures below 350°F (180°C). Table 2 summarizes the physical observations made on the specimens. Both the untreated and the hydrazine-treated specimens exhibited pitted surfaces at temperatures below 280°F (138°C) and 205°F (96°C), respectively.

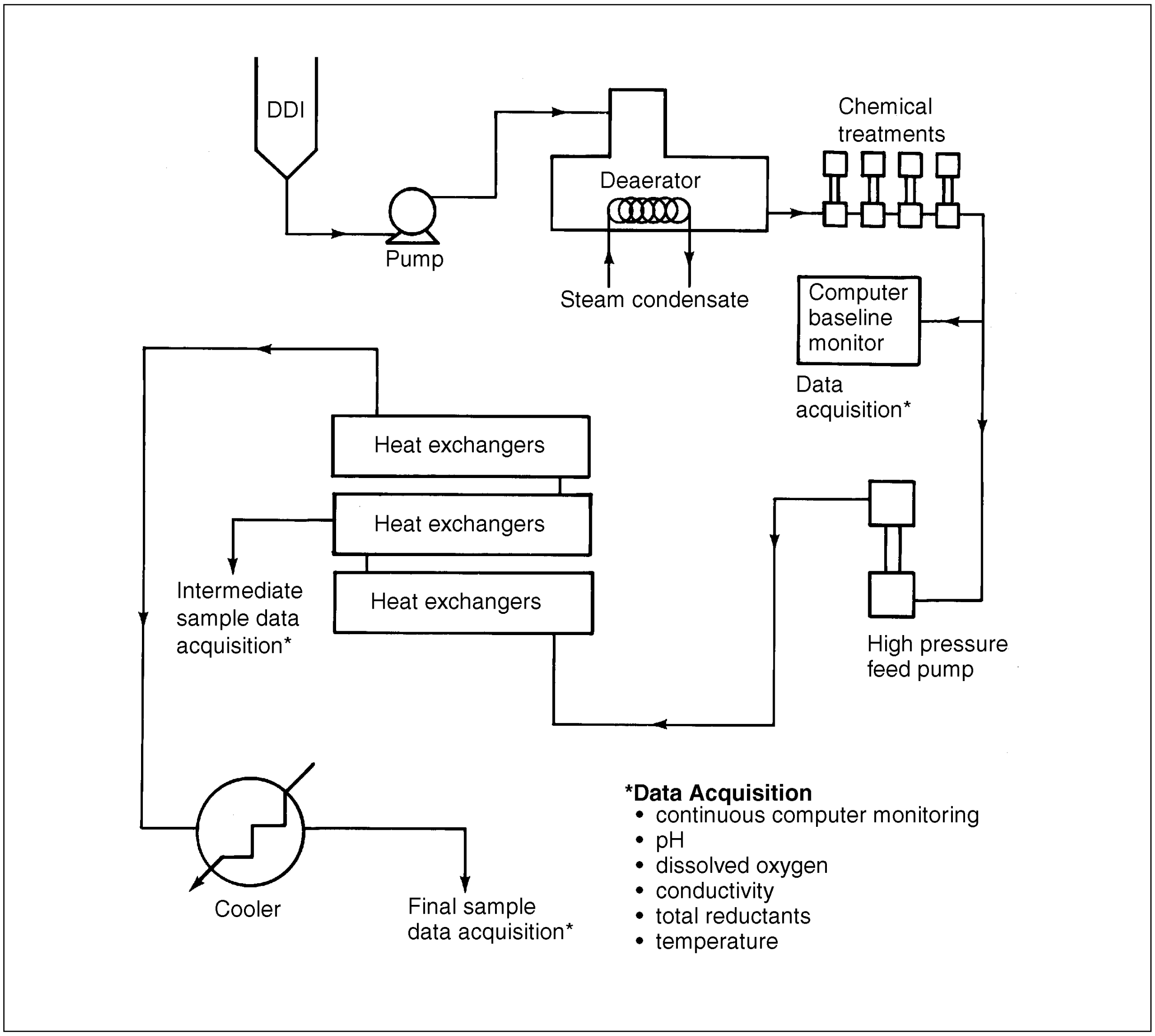

Figure 3 — ***FEEDSIM test unit***

Confirmation of the laboratory data in an actual field application of carbohydrazide has been published previously,[4] but bears repeating at this point. The data derived from a carbohydrazide application in an 800 MW supercritical unit is typical of that noted on essentially all units that have converted from hydrazine to carbohydrazide. Figure 5 shows that the "passivation demand" for carbohydrazide — even after years of treating this unit with hydrazine — took almost two months to satisfy. The final dosage required to produce the control residual in the feedwater was less than 50% of that needed originally.

CASE HISTORIES

The following examples of the successful use of carbohydrazide are typical of the many applications in the U.S. utility industry and in the fast-growing international market segment.

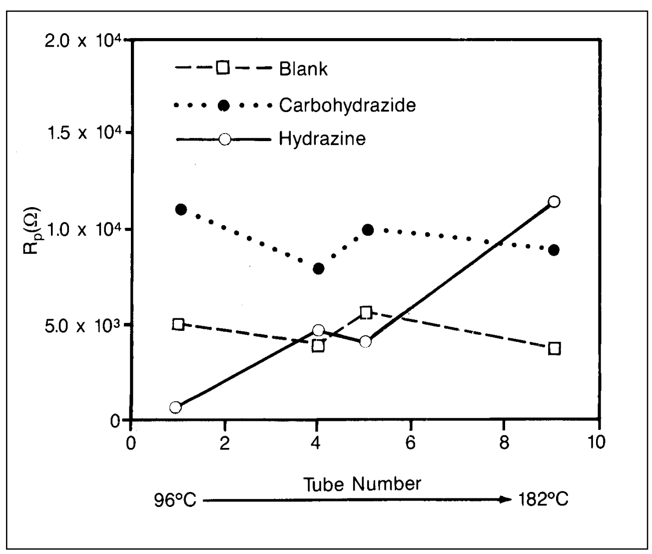

Figure 4 — ***Variation of Rp with tube specimen (temperature)***

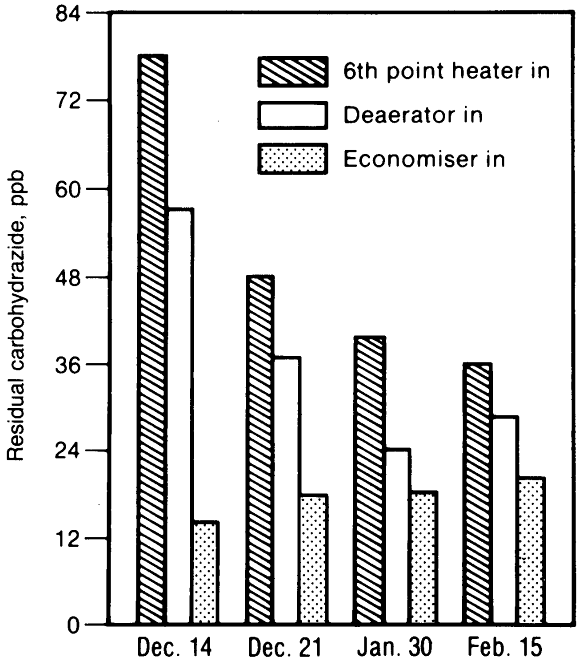

Figure 5 — *Carbohydrazide passivation western utility*

CASE ONE

At a Western utility operating two 500 MW, oil-fired once-through supercritical units, frequent chemical cleaning was required to remove the accumulated iron oxide deposits from the steam generator. These deposits caused an increase in pressure drop across the generating tubes. In 1983, and after an acid cleaning, a carbohydrazide treatment program was initiated in place of hydrazine, to evaluate its effect on chemical cleaning frequency. Prior to the use of carbohydrazide, this unit was acid cleaned 19 times over a period of 13 years; after the use of carbohydrazide, the unit was cleaned twice over a period of 6-1/2 years (Table 3). In 1985, Unit B was switched to carbohydrazide from hydrazine. Similar results were accomplished on this unit; prior to carbohydrazide, this unit was acid cleaned 24 times in 19 years, and with the new program it had been cleaned twice in 5 years.

In Summary:

1. When Units A and B were on hydrazine, the rate of deposit accumulation was 2700 and 2300 pounds per year respectively. When on carbohydrazide, this rate was reduced to 830 and 623 pounds per year.
2. Replacement of hydrazine with carbohydrazide resulted in improved unit availability through the extension of periods between chemical cleanings.
3. Reduced costs associated with chemical cleanings.
4. Reduced periods of load limited operation due to high pressure drop.

Table 2 — *Visual appearance of specimen surface*

Tube #	No scavenger	Carbohydrazide	Hydrazine
1	Lt. grey Pits Non-uniform Metal substrate	Blue No pits Uniform	V. Lt. grey Few pits Non-uniform Metal substrate
5	Lt. grey Few pits Uniform	Lt. grey No pits Uniform	Lt. grey No pits Non-uniform
9	Lt. grey No pits Uniform	Black No pits Uniform	Dk. grey No pits Uniform

CASE TWO

An East Coast utility, operating a coal-fired unit (1450 psi, 110 MW and superheat of 1000°F) under base load condition with periodic outages due to reduced system demand, converted from hydrazine to carbohydrazide in June 1985. Metallurgy of the cycle is arsenical admiralty condenser, admiralty LP heaters, and Monel HP heaters. The unit LP heater drips cascade to the condenser hot well.

Prior to the use of carbohydrazide, the unit experienced high levels of iron and copper in the feedwater (Figures 6 and 7). Average concentration of iron at the deaerator outlet and economizer inlet were 9 and 10 ppb, respectively; copper concentration averaged 7 and 17 ppb. Six months after the introduction of carbohydrazide, the iron levels were dropped to about 2 ppb at both sample points. In the case of copper, it took almost a year to bring the levels to less than 4 ppb at the deaerator outlet and less than 2 ppb at the economizer inlet.

When the unit was on hydrazine, it experienced increased boiler circulation pump pressure drop. Historically, ΔP would increase by 17 psi per year; with carbohydrazide treatment, the ΔP increase has been less than 1 psi per year. Also, with hydrazine treatment, the station was acid cleaning the unit with hydrochloric acid once a year, removing 3500 lb of iron and 750 lb of copper per cleaning. With carbohydrazide treatment, this period was extended to three years and the amount of iron removed reduced to less than 700 lb and copper to 60 lb per cleaning.

CASE THREE

A Western utility, operating three 1550 psi and three 2050 psi natural circulation drum type boilers with mixed metallurgy feedwater systems, has evaluated alternatives to the traditional storage procedures employing hydrazine. The use of carbohydrazide has demonstrated significant benefits.

Table 3 — *Western Utility, two 500 MW, oil-fired units*

Unit A Date	Unit A Months since last cleaning	Unit A lb Fe	Unit A lb Cu	Unit B Date	Unit B Months since last cleaning	Unit B lb Fe	Unit B lb Cu
Hydrazine				**Hydrazine**			
5/69	—	1583	11	7/66	—	1800	—
2/70	9	1440	5	4/68	21	15/85	25
10/70	8	1481	6	5/69	13	1807	10
4/71	6	1185	0	1/70	8	1404	9
11/71	7	1206	0	11/70	28	1670	28
6/72	7	1498	9	6/71	7	1373	65
4/73	10	1457	0	11/71	5	1232	0
1/74	9	2175	0	7/72	8	1430	0
5/74	4	1750	11	1/73	6	1830	15
9/74	4	1468	11	5/73	4	1760	0
4/75	7	2060	0	4/74	11	1748	0
8/76	16	2517	12	10/74	6	1648	13
3/77	7	1837	5	6/75	8	2097	17
8/77	5	1592	7	2/76	8	1986	0
5/78	9	1935	5	10/76	8	2125	0
5/79	12	2577	8	6/77	8	2032	15
5/80	12	1550	9	2/78	8	1957	8
3/81	10	2676	17	3/79	13	2107	21
2/82	9	1934	16	3/80	12	2126	7
1/83	11	2412	20	1/81	10	2059	5
				10/81	9	2049	11
Carbohydrazide				4/82	6	1693	12
				11/82	7	1699	168
8/85	31	1300	12	1/84	14	2152	10
6/89	46	2753	20	8/85	19	1615	10
				Carbohydrazide			
				6/87	22	1681	12
				7/90	37	2483	14

The industry's storage recommendations (200 to 500 ppm hydrazine) were intended for maintenance outage protection, long-term storage, etc., and not for economic shutdowns. The boiler manufacturer's recommendations also vary from 4 days to 2 weeks for when to place a boiler into long-term wet storage.

The duration of the economic shutdowns often varied from overnight to 40 days, and wet storage treatment was not considered until the boiler had been off-line for seven days. When the boilers were stored under wet storage treatment (200 to 500 ppm hydrazine), they would have to be drained and refilled prior to return to service. This is based upon the concern that ammonia (a decomposition product of hydrazine) can be very corrosive to copper alloys in the presence of oxygen.

Beginning in 1986, a study of three boilers operating at 1550 psi and three boilers at 2050 psi drum pressure using carbohydrazide wet storage treatment found that they could be fired and returned to service without having to drain the storage-treated boiler water. When a unit comes off-line for economics, it normally takes three days for the boiler pressure to decay to less than 200 psi (~390°F). Utilizing the existing boiler chemical feed system, a low dosage of carbohydrazide (oxygen scavenger) is injected to yield 25 to 50 ppm as product, and the boiler is placed under nitrogen cap when the pressure decays to 5 psi. Preliminary results indicate that the low level carbohydrazide method is effective for boiler storage during economic shutdowns that turn into prolonged standby. Additional benefits gained are reduction of chemicals used for storage, waste minimization, and condensate conservation.

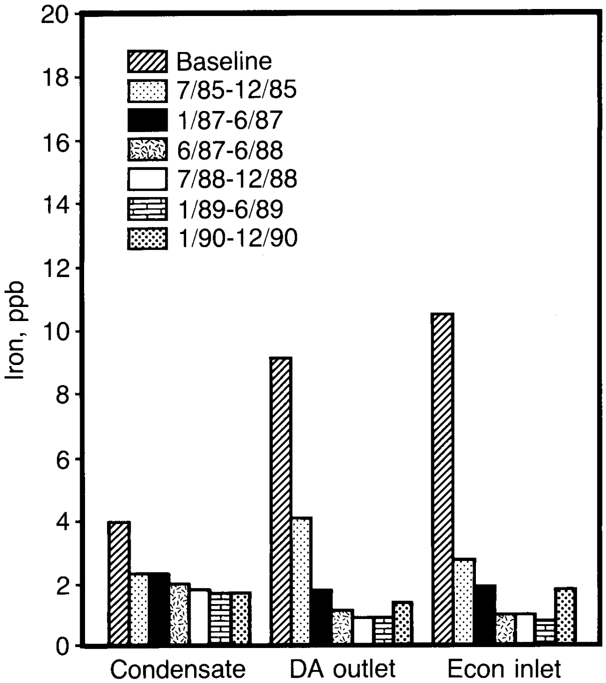

Figure 6 — ***Average feedwater iron levels***

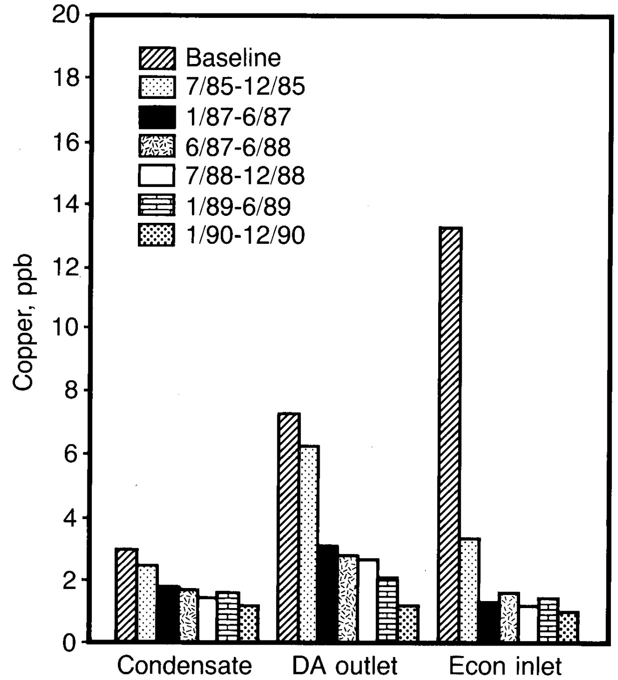

Figure 7 — ***Average feedwater copper levels***

SUMMARY

The above three case histories illustrate typical benefits obtained in 275 utility boilers which are using carbohydrazide as a hydrazine replacement in high purity feedwater systems.

- Reduced system corrosion rates
- Reduced chemical cleaning frequency
- Improved unit availability

High purity utility type systems require that efforts to control corrosion be made a top priority. Many corrosion control benefits cannot be demonstrated in short-term tests. Ten years of carbohydrazide usage have supplied measurable benefits in a wide variety of utility boiler systems.

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