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2.1 INTRODUCTION AND PROJECT OVERVIEW

Hydrogen Energy International LLC (HEI) is proposing an Integrated Gasification Combined Cycle (IGCC) project called Hydrogen Energy California (the "Project"). The facility will gasify 100 percent petroleum coke (or blends of petroleum coke and coal, as needed) to produce hydrogen to fuel a combustion turbine operating in combined cycle mode. HEI is jointly owned by BP Alternative Energy North America Inc. and Rio Tinto Hydrogen Energy LLC. The Project will produce electricity while substantially reducing greenhouse gas emissions by capturing carbon dioxide (CO_2), transporting it for enhanced oil recovery (EOR) and sequestration. The facility will be located near an oil producing area near the unincorporated community of Tupman in western Kern County, California as shown on Figure 2-1, Vicinity Map.

Highlights of the Project are as follows:

- The Project is designed to operate with 100 percent petroleum coke from California refineries, and has the flexibility to operate with up to 60 percent western bituminous coal as needed.
- The feedstock will be gasified to produce a synthesis gas (syngas) that will be processed and purified to produce a hydrogen-rich gas, which will be used to fuel the combustion turbine for electric power generation. A portion of the product (hydrogen-rich gas) will also be used to supplementally fire the heat recovery steam generator (HRSG) that produces steam from the combustion turbine exhaust heat.
- At least 90 percent of the carbon in the raw syngas will be captured in a high-purity carbon dioxide stream during steady-state operation, which will be compressed and transported by pipeline off-site for injection into deep underground oil reservoirs for enhanced oil recovery and sequestration.
- Project greenhouse gas emissions (e.g., CO_2) and sulfur emissions will be reduced through state-of-the-art emission-control technology and carbon dioxide sequestration. The power produced by the Project will have a low-carbon emission profile significantly lower than would otherwise be produced by traditional fossil-fueled sources, including natural gas.
- The net electrical generation output from the Project will provide approximately 250 megawatts (MW) of low carbon baseload (8,322 hours) power to the grid; feeding major load sources to the north and to the south. In addition, approximately 100 MW of natural gas generated peaking power will be available from the Project.
- The water source for the Project will be brackish groundwater supplied by the Buena Vista Water Storage District (BVWSD), and treated on-site to meet Project standards. Potable water will be supplied by West Kern Water Bank for sanitary purposes.
- There will be no direct surface water discharge of industrial wastewater or storm water. Process wastewater will be treated on-site and recycled within the gasification and power plant systems. Other wastewaters from cooling tower blowdown and raw water treatment will be collected and directed to on-site underground injection wells.

- The Project gasification process will feature near zero sulfur emissions during steady-state operation.
- The Project is designed to avoid flaring during steady-sate operation. The Project is also designed to incorporate state-of-the-art technology to minimize flaring during startup and shut down operations.

Section 2, Project Description, of this Application for Certification (AFC) describes the Project information summarized above in detail. An artist's rendering of the Project is shown on Figure 2-2, Project Artist Rendering. A simplified block flow diagram of the Project is shown in Figure 2-3, Overall Block Flow Diagram.

2.1.1 Project Objectives

This Project will provide several benefits, such as:

1. Providing approximately 250 MW of new, baseload low carbon generating capacity, enough to power over 150,000 homes, when the CEC estimates that the State will need to add over 9,000 MW capacity between 2008 and 2018 to meet demand (CEC 2007).
2. Providing approximately 100 MW of natural gas generated peaking power.
3. Preventing the release of more than 2 million tons (roughly equivalent to the carbon dioxide output of 500,000 automobiles) per year of greenhouse gases to the atmosphere by sequestering them underground.
4. Producing additional energy from existing California oil fields by injecting carbon dioxide and increasing production by an estimated 5 to 15 percent.
5. Boosting the Southern California economy with an estimated 1,500 jobs associated with construction and 100 permanent positions associated with Project operations.
6. Reducing stress on United States natural gas supplies by using a by-product from the oil refining process and coal.
7. Preserving fresh water sources by using brackish groundwater for Project process water needs.

Project objectives are summarized as follows:

- Provide an efficient, reliable, and environmentally sound power generating facility to help meet future electrical power needs.
- Mitigate impacts related to climate change by dramatically reducing greenhouse gas (GHG) emissions relative to the GHG emitted from a conventional power plant by capturing and sequestering carbon dioxide emissions.
- Facilitate and support the development of hydrogen infrastructure in California.
- Support energy security by utilizing an available domestic energy source.
- Reduce the stress on domestic natural gas supplies by using a byproduct from the oil refining process.

- Preserve California's limited freshwater resources by utilizing non-potable water such as brackish groundwater or wastewater for plant cooling purposes.
- Ensure the economic feasibility of the project based on the economic benefits of the project and related costs.

2.1.2 Project Ownership

HEI is jointly owned by BP Alternative Energy North America Inc. and Rio Tinto Hydrogen Energy LLC, with the prime objective of producing hydrogen for low-carbon power generation. HEI proposes to be the owner and operator of the IGCC facilities and carbon dioxide (CO_2) pipeline and will enter into a long-term lease for the Kern County Project Site, as defined below, with the site owner.

The transmission line will be owned by HEI up to the point of interconnect (Midway Substation) as stipulated by the California Independent System Operator (CAISO).

Natural gas and water supply lines will be owned by others.

2.1.3 Schedule

The milestones for the Project are anticipated to be as follows:

Completion of CEC permitting process	July 2010
Start of construction	March 2011
Completion of construction	April 2014
Commissioning and initial startup	January 2014 through October 2014
Full-scale operation of the Project	December 2014

2.1.4 Location

The Project Site is located near an oil producing area in Kern County, California, as shown in Figure 2-1, Vicinity Map. It is approximately 2 miles northwest of the unincorporated community of Tupman. The legal description is as follows: North ½ of Section 22 within Township 30 South, Range 24 East in Kern County and the Assessor's Parcel Number (APN) is 159-180-12.

2.1.5 Affected Project Study Areas

The Project Site and linear facilities comprise the affected study area and are entirely located in Kern County, California. These Project components are described below.

Major on-site Project components will include, as shown on Figure 2-4, Preliminary Plot Plan:

- Solids Handling, Gasification, and Gas Treatment
  - Feedstock delivery, handling and storage
  - Gasification

- Sour shift/gas cooling
- Mercury removal
- Acid gas removal

- Power Generation
  - Combined-cycle power generation
  - Auxiliary combustion turbine generator
  - Electrical switching facilities
- Supporting Process Systems
  - Natural gas fuel systems
  - Air separation unit (ASU)
  - Sulfur recovery unit
  - Zero liquid discharge
  - Carbon dioxide compression
  - Wastewater injection wells
  - Raw water treatment plant
  - Other plant systems

The Project also includes the following off-site facilities, as shown on Figure 2-5, Project Location Map:

- **Electrical Transmission Line** – An electrical transmission line will interconnect the Project to Pacific Gas & Electric's (PG&E) Midway Substation. The interconnection voltage is expected to be 230 kilovolts (kV). The Project is considering two alternative transmission routes, both of which extend from the western edge of the Project Site to the north, and west to the north side of the substation. Transmission Alternative 1 is approximately 9 miles long and transmission Alternative 2 is approximately 9.5 miles long.
- **Natural Gas Supply** – A natural gas interconnection will be made with either PG&E or Southern California Gas Company natural gas pipelines, both located southeast of the Project Site. The natural gas pipeline will be approximately 7 miles in length. The interconnect will consist of one tap off the existing natural gas line, one meter set, one service pipeline service connection, and a pressure limiting station located on the Project Site.
- **Water Supply Pipelines** – The Project will utilize brackish groundwater supplied from the Buena Vista Water Storage District (BVWSD) located to the northwest. The raw water supply pipeline will be approximately 18 miles in length. Potable water for drinking and sanitary use will be supplied by West Kern Water District located near the State Route 119 (SR 119)/Tupman Road intersection (southeast of the Project Site). The potable water supply pipeline will be approximately 5.5 miles in length.
- **Carbon Dioxide Pipeline** – The carbon dioxide pipeline will transfer the carbon dioxide captured during gasification from the Project Site southwest to the custody transfer point.

The Project is considering two alternative pipeline routes. Alternative 1 is approximately 2 miles in length, while Alternative 2 is approximately 2.5 miles in length.

The Project components described above are shown on Figure 2-5, Project Location Map, which depicts the region, the vicinity, and Project Site and its immediate surroundings for Project components.

All temporary construction equipment laydown and parking, including construction parking, offices, and construction laydown areas, will be located on the Project Site.

The disturbed acreage associated with the Project is summarized in Table 2-1, Project Disturbed Acreage.

Table 2-1
Project Disturbed Acreage

Project Component	Temporary Disturbance	Permanent Disturbance
Project Site	315 acres	315 acres
Electrical transmission line	Alternative 1 – 15 acres	Alternative 1 – 2 acres
	Alternative 2 – 15 acres	Alternative 2 – 2 acres
Natural gas line	PG&E – 2 acres	PG&E – previously disturbed
	Southern California Gas Company – 2 acres	Southern California Gas Company – previously disturbed
Water supply line	BVWSD – 15 acres	BVWSD – previously disturbed
CO_2 line	Alternative 1 – 1 acre	Alternative 1 – previously disturbed
	Alternative 2 – 1 acre	Alternative 2 – previously disturbed
Temporary Construction Areas	Included in Project Site	None
Total Project Disturbance	**348 acres**	**317 acres**

Source: HECA Project
Notes:
~ = approximately
CO_2 = carbon dioxide

Table 2-2, Site Characteristics, summarizes site meteorology and other characteristics which the Project design has been based on.

Table 2-2
Site Characteristics

Elevation	Existing surface elevations vary from about 445 feet in the southwest corner to about 310 feet in the northeast corner above mean sea level (msl).	
Design Ambient Temperature & Humidity	Dry Bulb (F)	Relative Humidity (%)
Average Ambient	65°	55
Summer Design	97°	20
Winter	39°	82
Extreme Maximum Ambient	115°	15
Design Ambient Barometric Pressure		14.46 psia
Rainfall		
Average Precipitation per year		5.7 inches (avg. 2000 – 2006)

Table 2-2
Site Characteristics

24-hour Max Precipitation (50-year storm)	2.0 inches
Prevailing Wind Direction & Ave. Speed	Wind Rose

Source: Computed from Annual and Monthly Summaries (year span) of Bakersfield, CA Meteorological Data, NOAA, National Climate Data Center, Asheville, NC.

Notes:

The 25-year, 24-hour maximum precipitation is 1.8 inches

°F = degrees Fahrenheit
% = percent
msl = mean sea level
psia = pounds per square inch absolute

2.1.6 Site Plan and Access

Figure 2-4, Preliminary Plot Plan, presents a scaled, overall plot plan for the Project. The Plot Plan also identifies the primary site access, which will be from Tupman Road east of the Project Site. The access road will be approximately 2,000 feet long from Tupman Road to the Project Site, and will be constructed on an existing unimproved road. A description of the alternative sites considered is discussed in Section 6.0, Alternatives.

Table 2-3, Project Linear Tie-in Location on Plot Plan, provides a list of the currently anticipated Project pipelines, communication, and electrical interfaces at the site boundaries.

Table 2-3
Project Linear Tie-in Location on Plot Plan

Interface Description	Tie-In Location
Communications Conduit	Within other linear facility easements
Raw Water Tie-In	East Side of Plot
Potable Water	East Side of Plot
Plant Wastewater Discharge	On-site
Natural Gas Tie-In	East Side of Plot
Carbon Dioxide Export Tie-in	West Side of Plot
Transmission Line	West Side of Plot

Source: HECA Project

2.1.7 Resource Inputs

Unlike most power plants in California, this Project uses domestic supplies of solid feedstock. The feedstocks for the Project include the following and are discussed below in more detail:

- Petroleum coke and western bituminous coal
- Fluxant
- Oxygen
- Nitrogen

- Water
- Natural gas

2.1.7.1 Petroleum Coke and Western Bituminous Coal

The primary feedstock for the gasifier is petroleum coke. Petroleum coke will be supplied from refineries in the Los Angeles, Santa Maria, or Bakersfield areas, and/or other regional sources. The petroleum coke that will be used for the Project is a by-product from the oil refining process which is predominantly exported overseas for use as a low-grade fuel. Western bituminous coal may also be blended (up to 60 percent) with petroleum coke to diversify the feedstock supply.

A representative feedstock analysis is provided below for each of the feedstocks. The representative feedstock analysis for petroleum coke is provided in Table 2-4, Petroleum Coke Design Range. The representative feedstock analysis for western bituminous coal is provided in Table 2-5, Typical Analysis for Western Bituminous Coal.

Table 2-4
Petroleum Coke Design Range

Ultimate Analysis, wt% (dry)		
	Carbon	84 – 91
	Hydrogen	3 – 5
	Nitrogen	1-4
	Sulfur	0.8 – 6.0
	Oxygen	<1.0
	Ash	0.3 – 1.0
Moisture, wt% (AR)		5 – 15
Chloride Content, ppmw (dry)		100 - 300
Gross Heating Value, Btu/lb (dry)		14,500 – 15,500
Bulk Density, lb/ft3 (AR)		40 – 50
Ash Analysis, ppmw (dry)		
	Vanadium	900 – 1,100
	Nickel	700 – 1,250
	Iron	500 – 1,000
	Chromium	<10
	Sodium	50 – 500
	Calcium	50 – 500

Source: HECA Project
Notes:
% = percent
< = less than
> = greater than
AR = as received
ppmw = parts per million by weight

Table 2-5
Typical Analysis for Western Bituminous Coal

Ultimate Analysis, wt% (dry)		
	Carbon	70 – 74.3
	Hydrogen	4.4 – 6.7
	Nitrogen	0.6 – 1.6
	Sulfur	0.1 – 2.0
	Oxygen	9.2 – 14.5
	Ash	4.8 – 11.2
Moisture, wt% (AR)		5.0 – 11.0
Gross Heating Value, Btu/lb (dry)		11,300 – 13,600
Ash Analysis, ppmw (dry)		
	Vanadium	8 – 9
	Nickel	4 – 12
	Chromium	7 – 15
	Mercury	0.02 – 0.08

Source: HECA Project
Notes:
AR = as received (with delivered free moisture)
ppmw = parts per million by weight

2.1.7.2 Fluxant

Slagging gasifiers require that the mineral matter in the feedstock melt and flow by gravity out of the bottom of the gasifier reaction chamber. When using petroleum coke feedstock, the addition of a fluxant is required to achieve the proper molten "gasification solids" flow characteristics at acceptable gasifier operating temperatures; thus facilitating gravity flow.

As part of the design process, the Project underwent an extensive fluxant evaluation to assess more than 30 fluxant candidates for environmental, operational, technical, and commercial criteria. As a result of this evaluation, three primary sources of fluxant that will meet the Project's requirements have been selected. These include common products such as: construction and industrial grade materials, such as crushed aggregate, rock, and sand. Table 2-6, Example Fluxant Composition, presents a representative composition of the fluxant candidates required for the Project.

Table 2-6
Example Fluxant Composition

Constituent	Dry wt%
Silicon Dioxide (SiO_2)	47
Aluminum Oxide (Al_2O_3)	14
Iron Oxide (Fe_2O_3)	16
Calcium Oxide (CaO)	8
Magnesium Oxide (MgO)	4
Sodium Oxide (Na_2O)	4
Potassium Oxide (K_2O)	1
Titanium Dioxide (TiO_2)	2
Manganese Dioxide (MnO_2)	0.04
Phosphorus Pentoxide (P_2O_5)	3
Strontium Oxide (SrO)	0.1

Table 2-6
Example Fluxant Composition

Constituent	Dry wt%
Barium Oxide (BaO)	0.1
Sulfur Trioxide (SO_3)	0.3
Balance	1.1
Total (dry)	**100.00**
Water, wt%	0.70 (normal) – 3 (max)

Source: HECA Project

2.1.7.3 Natural Gas

Natural gas is required to startup the combustion turbine to the load required to accept hydrogen-rich fuel. Natural gas serves as a backup fuel to allow electric power generation to continue when hydrogen-rich fuel is not available due to, for example, maintenance of gasifier unit. Natural gas is also used to fuel the auxiliary combustion turbine, auxiliary boiler, flare pilots, startup of the sulfur recovery unit (SRU), and support fuel for the SRU tail gas thermal oxidizer. Natural gas is also used to preheat the gasifier refractory. The natural gas supply meter station will be located on the south side of the Project Site.

Two large natural gas pipelines systems (PG&E and Southern California Gas Company) appear to be potentially suited to supply natural gas to the Project. The distance between the main pipeline system headers and the Project Site is approximately 7 miles.

- The estimated minimum delivery pressure of the PG&E line is between 335 pounds per square inch gauge (psig) up to 600 psig.
- The minimum operating pressure range of the Southern California Gas Company pipeline is 350 psig. Historical data from 2007 shows that the pipeline pressure was at 500 psig or higher for 99.9 percent of the time.

The interconnect will consist of one tap off the existing transmission line, one meter set, one service pipeline service connection, and a pressure limiting station located on the Project Site. The pipeline route is shown on Figure 2-5, Project Location Map.

Southern California Gas Company natural gas will be the base case for the design of the Project.

Typical yearly averages for the natural gas composition and physical properties are given below in Table 2-7, Typical Natural Gas Composition.

Table 2-7
Typical Natural Gas Composition

Pressure, psig (for CTG startup and as a backup fuel)	>350 psig
Specific Gravity	0.588
Higher Heating Value, Btu/scf	1,035
Composition, mol%	
Hydrogen (H_2)	0.00
Methane (CH_4 or C_1)	95.165
Ethane (C_2)	2.52

Table 2-7
Typical Natural Gas Composition

Propane (C_3)	0.58
iso-Butane (i-C_4)	0.115
normal Butane (n-C_4)	0.1
iso Pentane (i-C_5)	0.035
normal Pentane (n-C_5)	0.025
Hexanes plus higher carbon compounds (C_6+)	0.025
Carbon Monoxide (CO)	0.00
Carbon Dioxide (CO_2)	0.885
Nitrogen (N_2)	0.565
Hydrogen Sulfide (H_2S)	<1/4 grain/100 scf
Total Sulfur	<3/4 - 1 grain/100 scf

Source: Southern California Gas Company
Notes:

<	=	less than
>	=	greater than
Btu	=	British thermal units
CO	=	carbon monoxide
CO_2	=	carbon dioxide
CTG	=	combustion turbine generator
H_2	=	hydrogen
H_2S	=	hydrogen sulfide
psig	=	pounds per square inch gauge
mol%	=	mole percent
N_2	=	nitrogen
scf	=	standard cubic feet

The minimum natural gas pressure required at the General Electric (GE) 7FB combustion turbine generator (CTG) fuel supply interface is 400 psig. Due to the relatively small amount of time the natural gas supply pressure is less than 400 psig, natural gas compression will not be required to supply fuel to the GE 7FB combustion turbine.

The minimum natural gas pressure required at the GE LMS100® auxiliary turbine fuel supply interface is 960 psig. A natural gas compressor will be required to meet the pressure requirements for this turbine.

2.1.7.4 Water

The Project will use approximately 7 million gallons a day (mgd) of various qualities of water on a calendar year average basis. This volume is seasonally variable, with rates as high as 9 mgd on a hot summer day, and as low as 5 mgd in winter.

The Project will utilize local brackish groundwater treated on-site to meet Project standards. The brackish groundwater will be supplied from the BVWSD, which is a local water district with impaired groundwater sources not suitable for agricultural use. These impaired sources currently have a negative impact on agricultural and subsurface water quality in the area. Project consumption of this brackish water source will beneficially impact local agricultural activity and subsurface water quality. Potable water will be supplied by West Kern Water District located near the SR 119/Tupman Road intersection, southeast of the Project Site.

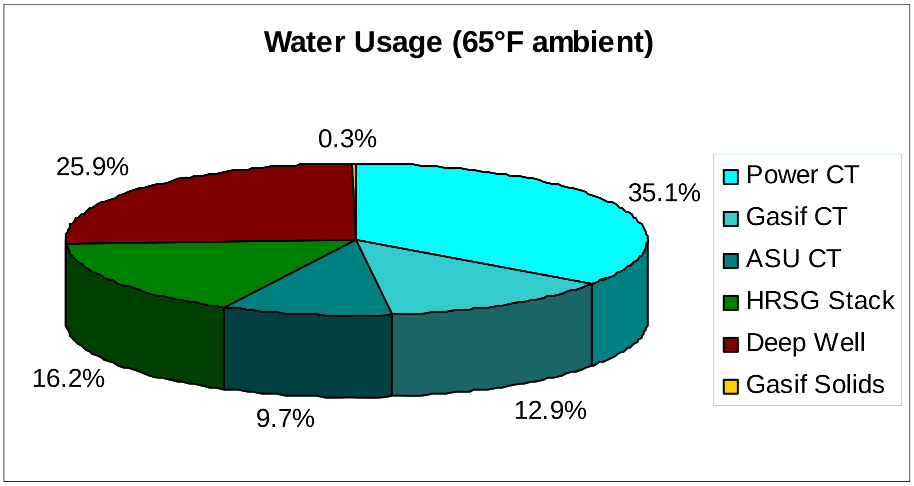
Water usage in the Project can be divided into six categories, of which there are five major areas. Figure 2-6, Water Usage and Figures 2-7A and B, Water Integration System Diagram, depicts the water usage allocated by category. Each area of water usage may then be attributed to either feed gasification or power generation. The portion of water usage for power generation is comparable to a natural gas fired combined cycle power plant. The remaining water usage is attributed the production of the hydrogen-rich fuel and the capture and compression of carbon dioxide.

Most of the water usage is for heat rejection. Three of the five major areas of water usage are for heat rejection in the form of evaporation from cooling towers. Two of the three cooling towers (Gasification cooling tower and the ASU cooling tower) are associated with the gasification process with the other cooling tower (Power block cooling tower) used by the power block, the majority of which is for condenser duty. Compared to similar sized combined cycle power plants, the power block cooling duty is somewhat greater due to the heat integration with gasification resulting in the generation of additional steam for power production in the steam turbine.

The HRSG stack water content is a direct result of combustion of the hydrogen-rich fuel gas. The petroleum coke feedstock to the gasification block has virtually no hydrogen; therefore, nearly all of the hydrogen in the fuel started as raw water feed to the plant. Water is converted to hydrogen in the gasifier and in the shift reactors. In the gasifier, carbon and carbon monoxide react with water to form hydrogen, carbon monoxide, and carbon dioxide. The shift reactors convert carbon monoxide and water into hydrogen and carbon dioxide.

The last major stream of water is the deep well injection (DWI) of the cooling towers' blowdown and raw water treatment effluent. The quantity of the DWI is a direct result of using a low-quality raw water feed to the plant, which has very limited uses elsewhere.

Figure 2-6



2.1.7.5 Oxygen and Nitrogen

The gasification process requires high pressure, high purity oxygen (95 volume percent). The oxygen is supplied from the ASU, which separates and purifies oxygen and nitrogen from the ambient air. The ambient air is filtered, compressed, dried, and cooled to cryogenic temperatures. The resultant oxygen is sent to the gasifier as one of the feeds. The ASU also supplies oxygen to the SRU and high purity nitrogen needed for other equipment purges.

The ASU supplies compressed nitrogen to the combustion turbine. The nitrogen is used as a diluent which reduces thermal nitrogen oxide (NO_x) produced when hydrogen-rich gas is combusted.

2.1.8 Product Output

Unlike a typical power plant, an IGCC produces several products including the following which are discussed below in more detail:

- Electricity
- Carbon dioxide
- Molten sulfur
- Gasification solids

2.1.8.1 Electricity and Transmission Line

An electrical transmission line will interconnect the Project Site to PG&E Midway Substation. The interconnection voltage is expected to be 230 kV, to be verified by California Independent System Operator (CAISO). Seven alternative routes were initially considered (as discussed in Section 4, Electrical Transmission) of which two routes remain for further detailed evaluation in this AFC. Each extend predominantly northwest and enter the substation on its north side, as PG&E has proposed constructing two new 230 kV bays on the north side of the substation. Both potential routes are approximately 10 miles in length. While a preferred alternative has not been selected, the decision criteria for selecting the preferred route shall include: environmental impact; engineering design and construction considerations; land availability; transmission loss; and future operation and maintenance requirements.

Table 2-8, Electrical Specification, describes the general specification for electricity delivery.

Table 2-8
Electrical Specification

Terminal Point	230 kV Plant Switchyard
Utility Interconnection Location	PG&E Midway 230 kV Substation
Line Voltage	230 kV
Frequency	60 Hz
Switchyard	Outdoor Switchyard

Source: HECA Project
Notes:
Hz = Hertz
kV = kilovolts

2.1.8.2 Carbon Dioxide

Carbon dioxide will be compressed and transported by pipeline to a custody transfer point in the Elk Hills Oil Field Unit for enhanced oil recovery and sequestration. Two possible custody transfer points and associated pipeline routes are being evaluated in this AFC. Each route extends predominantly southwest to the respective custody transfer point and parallels existing private roads. Both potential routes are approximately 3 miles in length. The preferred custody transfer point will be determined by the carbon dioxide customer. Based on the determined custody transfer point, only one pipeline route will be developed.

Table 2-9, Carbon Dioxide Characteristics, provides the typical characteristics of the carbon dioxide to be delivered to the Elk Hills Oil Field Unit.

Table 2-9
Carbon Dioxide Characteristics

Maximum Flow	145 mmscfd (including diluents)
Maximum Pressure at CO_2 Compressor Discharge	2,800 psig
Length of Pipeline to CO_2 Injection Point	Alternative 1 is approximately 2 miles Alternative 2 is approximately 2.5 miles
Supply Temperature to Pipeline	120 ºF or less
Composition	
Water (H_2O)	0.61 lb/MMSCF (13 ppmv) (11 ºF dew point, no free water)
Total Sulfur (H_2S + COS)	<30 ppmv
Carbon Dioxide (CO_2)	>97.0 vol%

Source: HECA Project
Notes:

%	=	percent
<	=	less than
>	=	greater than
CO_2	=	carbon dioxide
COS	=	carbonyl sulfide
H_2O	=	water
H_2S	=	hydrogen sulfide
MMSCF	=	million standard cubic feet
ºF	=	degrees Fahrenheit
ppmv	=	parts per million by volume
psig	=	pounds per square inch gauge
scf	=	standard cubic feet

2.1.8.3 Molten Sulfur

As part of the gasification process, the Project will produce molten sulfur; which will be sold and transported by truck off-site for agricultural and other uses. Table 2-10, Sulfur Specification, describes the sulfur specification.

Table 2-10
Sulfur Specification

Maximum Quantity	180 stpd
Quality	Commercial Grade Degassed Liquid Sulfur
Degassed H_2S Content	<10 ppmw

Source: HECA Project
Notes:
< = less than
H_2S = hydrogen sulfide
ppmw = parts per million by weight
stpd = short tons per day

2.1.8.4 Gasification Solids

Estimated production of gasification solids will range from 140 and 680 short tons per day (stpd) (wet). The exact composition of the gasification solids cannot be determined until the plant is built and typical gasification solids are generated. Consequently, the composition can only be projected, based on feed materials. Although other IGCCs generate similar solids, there is no exact match between gasification equipment, process specifications, and feed material blends. Table 2-11, Example Composition Range of Gasification Solids, presents an expected range of compositions for the gasification solids. Potential options are being evaluated by the Project and include applications in the cement industry, aggregate or road base industry, metal recovery (for vanadium and nickel recovery), and/or blending with petroleum coke to form a saleable solid fuel.

Table 2-11
Example Composition Range of Gasification Solids

Compound	Example Weight %, Wet
Vanadium Pentoxide (V_2O_5)	0.2 – 0.7
Nickel Sulfide (NiS)	0.03 – 0.2
Nickel (III) Oxide (Ni_2O_3)	0.0 – 1.9
Iron (II) Sulfide (FeS)	0.02 – 2.9
Iron (III) Oxide (Fe_2O_3)	0.0 – 7.5
Chromium (III) Oxide (Cr_2O_3)	0.0 – 0.05
Sodium Oxide (Na_2O)	0.8 – 2.0
Calcium Oxide (CaO)	1.6 – 6.5
Mercury (Hg)	0.0
Silicon Dioxide (SiO_2)	9.0 – 26
Aluminum Oxide (Al_2O_3)	2.6 – 6.8
Magnesium Oxide (MgO)	0.7 – 1.7
Potassium Oxide (K_2O)	0.2 – 0.5
Titanium Dioxide (TiO_2)	0.2 – 0.9
Manganese Dioxide (MnO_2)	0.0 – 0.1
Phosphorus Pentoxide (P_2O_5)	0.05 – 0.9
Strontium Oxide (SrO)	0.0 – 0.05
Barium Oxide (BaO)	0.0 – 0.05
Sulfur Trioxide (SO_3)	0.0 – 0.2

Table 2-11
Example Composition Range of Gasification Solids

Carbon (C)	0.9 – 31
Water (H_2O)	41 – 56
Unknowns	0.05 – 0.3

Source: HECA Project
Note:
% = percent

2.1.8.5 Wastewater Discharge

The Project's wastewater is primarily from cooling tower blowdown and reject water from the water treatment plant. The process condensate from gasification is recycled to the maximum practical extent. Gasification blowdown that cannot be recycled is sent to a zero liquid discharge (ZLD) unit where it is treated and recovered as high purity water and a solid filter cake. Any contaminants in the gasification blowdown water are concentrated in the filter cake and are not allowed to mix with the cooling tower blowdown and reject water from the raw water treatment plant. The latter will be injected into deep underground wells that do not impact underground sources of drinking water.

Sanitary wastewater from the Project restrooms, showers, and kitchens will be disposed of in an on-site leach field. No municipal system is available in the immediate area to serve the Project.

2.1.9 Plant Performance Summary

The following tables show representative Project performance information. Table 2-12, Representative Heat and Material Balances, presents heat and material balances for the various operating configurations and ambient conditions. Table 2-13, Maximum Feeds and Products, shows the maximum feed and product rates anticipated for the Project.

Table 2-12
Representative Heat and Material Balances

Fuel & Ambient Temperature	Hydrogen-Rich Fuel		Natural Gas			Natural Gas		
	100% Petroleum Coke	60%/40% Coal/ Petroleum Coke Blend	Combined Cycle PG7321 (FB)			Auxiliary CTG LMS100®		
Ambient Temperature, °F	65[1]	65[1]	20	65	115	20	65	115
Feeds:								
Feedstock, stpd (AR)	3,150	3170	0	0	0	0	0	0
Feedstock, MMBtu/hour (HHV)	3,400	3,200	2,548	2,407	2,308	883	909	860
Fluxant, stpd	80	0	0	0	0	0	0	0
Raw Water, gpm	4,500	4,500	1,586	2,076	3,020	249	372	588
Products & By-products:								
Hydrogen, mmscfd[2]	177	177	0	0	0	0	0	0
CO_2, stpd	7,400	7,300	0	0	0	0	0	0
Sulfur, stpd	160	70	0	0	0	0	0	0

Table 2-12
Representative Heat and Material Balances

Fuel & Ambient Temperature	Hydrogen-Rich Fuel		Natural Gas			Natural Gas		
	100% Petroleum Coke	60%/40% Coal/ Petroleum Coke Blend	Combined Cycle PG7321 (FB)			Auxiliary CTG LMS100®		
Gasification Solids, stpd	215	380	0	0	0	0	0	0
Deep Well Injection Water, gpm	1,225	1,225	450	580	834	91	125	187
Power Balance:								
Combustion Turbine, MW	232	232	200	182	189	101	103	96
Steam Turbine, MW	155	154	150	150	147	0	0	0
H_2 Fuel Expander, MW	2	2	0	0	0	0	0	0
Gross Power, MW	389	388	350	332	316	101	102	96
Total Aux Load, MW	142	141	11	11	11	2	2	2
Air Separation Unit, MW	76	76	0	0	0	0	0	0
CO_2 Compression, MW	28	27	0	0	0	0	0	0
Other Internal Users, MW	38	38	0	0	0	0	0	0
Net Power, MW	247	247	339	321	305	99	100	94

Source: HECA Project
Notes:
[1]Ambient temperature variations have minimal effect on hydrogen-rich gas fueled combustion turbine generator output and gasification operation. Results are nearly constant for plant output across the ambient temperature range.
[2]Hydrogen contained in the hydrogen rich fuel used by power generation equipment.

% = percent
CO_2 = carbon dioxide
CTG = combustion turbine generator
°F = degrees Fahrenheit
gpm = gallons per minute
HHV = higher heating value
MMBtu/hour million British thermal units per hour
MW = megawatt
stpd = short tons per day

Table 2-13
Maximum Feeds and Products

Feeds	Maximum Amounts
Feedstock (AR)	3,600 stpd
Fluxant	140 stpd
Raw Water (High Ambient)	6,600 gpm
Products/By-products:	
Maximum Net Power	
Normal Baseload Low Carbon Power	250 MW
Maximum Peak Power Capability[1]	400 MW
Carbon dioxide	8,400 stpd
Sulfur	180 stpd

Table 2-13
Maximum Feeds and Products

Feeds	Maximum Amounts
Gasification Solids (wet)	680 stpd
Deep Well Injection Water (High Ambient)	1,800 gpm

Source: HECA Project
Notes:
[1]Maximum peak power capacity as submitted in the CAISO Interconnection Request
AR = as received
CTG = combustion turbine generator
gpm = gallons per minute
MW = megawatt
stpd = short tons per day

2.2 SOLIDS HANDLING, GASIFICATION, AND GAS TREATMENT

2.2.1 Overview of Gasification Technology

Gasification typically involves two distinct processes: pyrolysis and gasification. In practice, the processes may either occur in two different reactors or be combined in one reactor. Definitions of pyrolysis and gasification are:

- **Pyrolysis** – The thermal degradation of carbon-based materials through the use of an indirect, external source of heat, typically at temperatures of 750 degrees Fahrenheit (°F) to 1,650°F, in the absence or almost complete absence of free oxygen (O_2). This thermally decomposes and drives off the volatile portions of the organic materials, generating syngas composed primarily of hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4).
- **Gasification** – The thermal conversion of carbon-based materials in the presence of internally produced heat, typically at temperatures of 1,400°F to 3,000°F, and in a limited supply of air/oxygen (less than stoichiometric, or less than is needed for complete combustion) to produce syngas composed primarily of hydrogen and carbon monoxide.

The Project uses GE's quench gasification technology. The GE quench gasifier feeds petroleum coke (or coal/petroleum coke blends) as a water slurry along with oxygen into a refractory-lined reactor vessel. The gasifier operates between 2,400 and 2,700°F. Part of the feed to the gasifier is initially oxidized very rapidly providing the necessary heat for the gasification reactions. The feed to the gasifier passes through the pyrolysis temperature region very rapidly (in a few thousandths of a second) and the gasification reactions determine the gasifier chemistry and performance.

Overall gasification reactions are shown in Table 2-14, Primary Gasification Reactions. Some of these reactions are actually endothermic, requiring heat input to go forward—unlike combustion, which is completely exothermic.

Table 2-14
Primary Gasification Reactions

Devolatilization/Pyrolysis = CH_4 + CO + Oils + Tars + C (char)	
$C + O_2 \rightarrow CO_2$	Oxidation – exothermic – rapid
$C + ½ O_2 \rightarrow CO$	Partial oxidation – exothermic – rapid
$C + H_2O \rightarrow CO + H_2$	Water/gas reaction – endothermic – slower than oxidation
$C + CO_2 \rightarrow 2CO$	Boudouard reaction – endothermic – slower than oxidation
$CO + H_2O \rightarrow CO_2 + H_2$	Water gas shift reaction – exothermic – rapid
$CO + H_2 \rightarrow CH_4$ + H2O	Methanation – exothermic
$C + 2H_2 \rightarrow CH_4$	Direct methanation – exothermic

Source: Multiple Publicly Available Sources
Notes:
C = carbon
CH_4 = methane
CO = carbon monoxide
CO_2 = carbon dioxide
H_2 = hydrogen
H_2O = water
O_2 = oxygen

Gasification is a chemical conversion process. It occurs in a reducing environment. Gasification differs from combustion in that gasification produces syngas, an intermediate product that can then be used for other purposes such as generating electricity or producing chemicals. Typical components of syngas from an oxygen-blown gasifier are shown in Table 2-15, Components of Syngas from Oxygen-Blown Gasification.

Table 2-15
Components of Syngas from Oxygen-Blown Gasification

Constituent	Percent by Volume
Hydrogen	24-40
Carbon monoxide	35-50
Carbon dioxide	2-30
Water	0.4-23
Methane	0-4
Hydrogen Sulfide	0.2-2.0
Carbonyl sulfide	0-0.1
Nitrogen + Argon	0.2-7
Ammonia + Hydrogen cyanide	0-0.3
Higher Heating Value	~200-300 Btu/scf

Notes:
Btu = British thermal unit
scf = standard cubic foot

The primary components of syngas are carbon monoxide and hydrogen. The syngas must be thoroughly cleaned prior to further use, especially if it will be used in a combustion turbine or for producing chemicals.

While the term "IGCC" usually infers coal gasification, feedstocks typically include coal (bituminous, sub-bituminous, and lignite), petroleum coke, biomass, and blends of these materials. The Project will use petroleum coke and coal/petroleum coke blends.

2.2.2 Feedstock Delivery, Handling & Storage

A simplified process flow diagram of the Feedstock, Handling, and Storage system is shown in Figure 2-8, Flow Diagram Feedstock Handling and Storage.

Petroleum Coke and Coal Handling

The primary feedstock for this Project is petroleum coke from California refineries, which will be delivered to the plant via truck. Western bituminous coal can be blended into the feedstock, and will be brought by rail to an existing delivery point, trans-loaded to trucks and delivered to the Project Site.

Feedstock trucks will be unloaded into underground hoppers inside a truck-unloading building, which will be provided with dust abatement systems. The feedstock will be transported via enclosed conveyors to one of three cone-bottom feedstock storage silos. Only one type of feedstock will be stored in each silo.

Feedstock reclaimed from the silos will be transported via enclosed conveyors to a pre-crushing system and then to the two feedstock bins in the Grinding and Slurry Prep building. Feedstock blending (when required) will be accomplished by reclaiming appropriate amounts of feedstock simultaneously from multiple feedstock storage silos.

Tramp metal removal will be accomplished using magnets and metal detectors. A dust collection system consisting of hoods and baghouses will control particulate emissions.

On-site feedstock storage will include active storage in the feedstock storage silos and inactive emergency storage in an open pile covered with stabilizer. Buildup and reclaiming of the inactive emergency storage pile will be accomplished using mobile equipment.

Fluxant

Fluxant is added to the petroleum coke feedstock to achieve the proper molten flow characteristics of the gasification solids at acceptable gasifier operating temperatures.

Fluxant will be delivered to the Project Site via truck from regional sources. The fluxant trucks will be unloaded using a pneumatic transport system into the fluxant storage bins. A dust collection system consisting of hoods and baghouses will control particulate emissions.

2.2.3 Gasification

Gasification Technology Selection

GE has been selected as the gasification technology provider for the Project. As part of the design evaluation, both of GE's gasification designs were evaluated, referred to as radiant and quench. GE's radiant design has been incorporated in their IGCC reference plant, and GE considers it to be the preferred choice for IGCC power plants that do not require high levels of carbon capture. GE's quench design is simpler and has been applied widely in syngas generation for chemical production, particularly where sour shift is used to increase syngas hydrogen content. The Project uses GE's quench gasification technology because of the synergies with the sour shift process that increase hydrogen production and facilitate high levels of pre-combustion carbon capture (carbon dioxide removal).

GE's quench gasifier design routes the hot gasifier effluent directly into a water bath at the bottom of the gasifier without any high-level heat recovery. Molten gasification solids in the gasifier effluent are solidified in the water bath and removed, and the resultant gas is scrubbed to remove fine particulates. Both designs also have similar grinding and slurry preparation systems and gasification solids handling systems. Figure 2-9, Gasification Process Sketch for Permits, shows a schematic process sketch of GE's quench gasification technology.

Grinding and Slurry Preparation

Feedstock is continuously delivered from feed bins to the grinding mills. Fluxant is also continuously conveyed from feed bins to the grinding mills.

The grinding mills crush the feedstock, fluxant, and recycled gasifier solids (fine slag/ash and unconverted carbon) with water to form slurry. The slurry is pumped into slurry tanks, which are sized to provide several hours of storage.

Gasifiers

GE's quench gasifier is a slurry-fed, pressurized, entrained flow, slagging downflow gasifier, consisting of a refractory-lined pressure vessel capable of withstanding the required gasification process temperature and pressure range. For the gasification reaction, slurry and oxygen are introduced into the gasifier through a specialty equipment item called the feed injector.

All slagging gasifiers require that the mineral matter in the feedstock melt and flow by gravity out the bottom of the gasifier reaction chamber. When using petroleum coke feedstock, the addition of a fluxant is required to achieve the proper molten "gasification solids" flow characteristics at acceptable gasifier operating temperatures, and thus facilitate gravity flow.

The slurry is pumped from the slurry tanks to each gasifier by a slurry charge pump. This high pressure metering pump supplies a steady, controlled flow of slurry to the feed injector. The slurry and a measured amount of high pressure oxygen from the ASU react in the gasifier reaction chamber at high temperatures to produce syngas. The feedstock is almost totally gasified in this environment to form syngas consisting principally of hydrogen, carbon monoxide, carbon dioxide, and water.

Hot syngas, along with ash, fluxant, and unconverted carbon from the gasifier reaction chamber flow down into the water-filled quench chamber located below the gasifier. The syngas is cooled in this water pool, and exits the quench chamber to be further washed. Coarse slag and a portion of the unconverted carbon settle to the bottom of the quench pool, where they enter the coarse slag handling section.

Syngas Scrubbing

The syngas from the gasifier enters the syngas scrubber, where solids are removed from the syngas. Raw syngas from the overhead of the syngas scrubber is routed to the downstream sour shift and low-temperature gas-cooling section.

Water condensed from the syngas in the downstream sour shift and low-temperature gas cooling section is returned as process condensate to the syngas scrubber. The syngas scrubber bottoms water contains solids removed from the raw syngas exiting the quench pool.

Gasification Solids and Water Handling

Gasification solids (slag as defined by GE) are comprised of ash and unconverted carbon that exit the gasifier. Gasification solids and water handling includes both coarse and fine slag handling sections.

The coarse slag handling section removes coarse solid material from the gasifier. Coarse solid material exiting the bottom of the gasifier quench chamber flows into the lockhopper. After the solids enter the lockhopper, the particles settle to the bottom. The solids that have accumulated in the lockhopper are water-flushed into the slag collection sump, using process water return from the fine slag handling section.

In the slag collection sump, the gasification solids are separated from the water. The gasification solids are washed and the discharged washed low carbon gasification solids are transported by truck off-site. The fine slag recycle from the slag collection sump is pumped to the fine slag handling section.

The water utilized in the gasifiers, syngas scrubbing, and gasification solids handling sections is referred to as black water. The solids-laden water in the gasifier quench pool is blown down to the fine slag handling section. This black water is sequentially let down in pressure through a series of flash drums, where all dissolved gases flash out of the black water. The flash gases are combined and sent to the SRU. A settler tank is used to concentrate the solids in the black water. The overflow process water from the settler is pumped to the syngas scrubbing section. Part of the process water is also sent to the lockhopper for flushing in the coarse slag handling section. A small fraction of the process water is discharged as gasification blowdown water to the process wastewater treating/ZLD system.

Most or all of the settler bottoms are pumped to the grinding and slurry preparation section to recycle fines. Some of the settler bottoms can alternatively be sent to a fine gasification solids filter to produce filter cake, which can be either recycled to the grinding and slurry preparation section or transported by truck off-site.

Gasifier Refractory Heaters

Natural gas-fired gasification refractory heaters are required to preheat the gasifier refractory prior to startup if starting from cold conditions and also to keep the refractory warm when the gasification train is in hot standby. The combustion products from the gasification refractory heaters are released through vent stacks located on top of the gasifier structures.

2.2.4 Sour Shift/Low Temperature Gas Cooling

The Sour Shift/Low Temperature Gas Cooling (LTGC) unit performs several functions:

- Substantially increase the syngas hydrogen content using a 2-stage carbon monoxide shift process
- Cool the shifted syngas by generating steam for additional power production and for internal plant consumption

- Collect hot process condensate formed during the shifted syngas cooling process for recycle to the gasifier syngas scrubbing section
- Collect additional process condensate formed during the shifted syngas cooling process for recycle to Gasification and/or discharge to Sour Water Stripping
- Remove ammonia from the cooled syngas

The carbon monoxide shift process converts water vapor and carbon monoxide to hydrogen and carbon dioxide using the water gas shift (a.k.a. CO shift) reaction, which can be expressed as follows:

$$CO + H_2O \leftrightarrow CO_2 + H_2 + Heat$$

The reaction is highly exothermic (i.e., releases heat). High conversions are favored by high temperatures; however, equilibrium is favored by lower temperatures.

In addition to increasing the hydrogen content of the syngas, the carbon monoxide shift process substantially increases the fraction of carbon present as carbon dioxide in the syngas, and consequently the extent of pre-combustion carbon capture (e.g., as carbon dioxide removal) that can be achieved.

Selection of the carbon monoxide shift technology is dependent upon whether the process gas is essentially sulfur-free ("sweet") or contains appreciable sulfur compounds ("sour"). Iron/chrome oxides (at higher temperatures) and copper/zinc oxides (at lower temperatures) are used as catalysts with sulfur-free gas streams, whereas cobalt-molybdenum oxides are used as catalysts if sulfur tolerance is required.

Sulfur-tolerant, sour shift technology was selected for the Project because the sour syngas produced by GE's quench gasification process also contains a substantial amount of water vapor, which drives the carbon monoxide shift reaction to near completion, maximizing the potential for carbon capture. The many synergies between the two technologies yield a simple and cost effective means of achieving high carbon capture with only a single carbon dioxide absorption step. Additionally, the low carbon monoxide content of the shifted syngas allows production of a carbon dioxide by-product gas with a carbon monoxide content of less than 800 parts per million by volume (ppmv). Examples of existing gasification plants with GE's quench gasification and sour shift technology include the Shell Convent Refinery Hydrogen Plant in Louisiana and the Coffeyville Resources Ammonia Plant in Kansas.

The Sour Shift unit for the Project will be designed with two sour shift reactors in series to achieve a residual carbon monoxide concentration in the cooled, shifted syngas of about one volume percent. As a co-benefit, the carbon monoxide shift process will also substantially reduce carbonyls, formates, cyanides, and other impurities in the syngas.

Simplified process flow sketches of the Sour Shift/LTGC unit are included in Figure 2-10, Flow Diagram Sour Shift System and Figure 2-11, Flow Diagram Low Temperature Gas Cooling. The following discussion provides a brief description of the processing steps in this unit.

Scrubbed syngas from the Gasification unit is heated against hot reactor effluent and fed to the two sour shift reactors in series. The sour shift catalyst also promotes conversion of most of the carbonyl sulfide (COS) present in the syngas to hydrogen sulfide (H_2S) via the following reaction:

$$COS + H_2O \leftrightarrow CO_2 + H_2S$$

The shift reactions are highly exothermic, and the hot syngas is cooled in-between the two shift reactors by feed/effluent exchange and by raising steam for generating additional power and internal plant consumption.

The shifted syngas from the second shift reactor is cooled by generating steam at multiple pressure levels, and by heating boiler feedwater and vacuum condensate to efficiently utilize the available but relatively low-temperature heat. Final cooling of the shifted syngas to near ambient temperature is achieved with air and water coolers.

Water condenses from the shifted syngas as it is cooled. The majority of the ammonia (NH_3) and a small portion of the carbon dioxide and hydrogen sulfide present in the syngas are absorbed in this condensed water. A fraction of this process condensate is reheated against shifted syngas and returned as hot process condensate to the syngas scrubbers in the Gasification unit, and the rest is routed to the Sour Water Stripping unit.

The cooled shifted syngas is washed with cold water in a trayed column to remove residual ammonia, and then fed to the Mercury Removal unit.

A simplified process flow sketch of the Mercury Removal System is shown in Figure 2-12, Flow Diagram Wash Column and Mercury Removal.

2.2.5 Mercury Removal

Tests of petroleum coke sources show occasional trace levels of mercury in the elemental analyses. Western bituminous coals typically contain trace levels of mercury as well. In order to minimize potential mercury emission, the Project has elected to incorporate mercury capture technology. The petroleum coke and coal procurement requires purchase of spot market supplies, effectively limiting any potential for controlling the supplier’s processes. The mercury capture technology will also ensure that any spot market supplies do not introduce mercury emissions.

Downstream of the shift reactors and low-temperature gas cooling, the syngas passes through fixed beds of activated carbon that are prepared with special impregnate additives to remove mercury, if any is present. Multiple beds are used to obtain optimized adsorption. The mercury removal system will remove at least 90 percent mercury, if present, from the syngas. After mercury removal, the product syngas is treated in the Acid Gas Removal (AGR) unit.

2.2.6 Acid Gas Removal System

The term “acid gas” refers to materials containing significant concentrations of acidic gases such as hydrogen sulfide or carbon dioxide. This section describes how acid gas will be removed from the shifted syngas to produce the hydrogen-rich fuel for the power block.

Rectisol Process Description

The Rectisol process is shown in Figure 2-13, Flow Diagram Rectisol Acid Gas Removal. Shifted, hydrogen-rich sour syngas feed is chilled and enters the pre-wash section of the hydrogen sulfide absorber column where condensed or dissolved impurities are removed. The gas then flows up the column where it is contacted with carbon dioxide-laden methanol solvent for absorption of hydrogen sulfide and other sulfur compounds. The solvent preferentially absorbs sulfur while releasing carbon dioxide in the process. The now hydrogen sulfide-laden solvent is withdrawn from the chimney tray of the column and flashed, with the flash gas being recycled to the hydrogen sulfide absorber column and the separated liquid solvent is sent to a hot regenerator.

Overhead gas from the hydrogen sulfide absorber flows to the carbon dioxide absorber where it is contacted with cold regenerated solvent for carbon dioxide removal. The treated hydrogen-rich gas, now very low in hydrogen sulfide and carbon dioxide, exits the top of the carbon dioxide absorber and is heated before flowing to a turbo expander for energy conservation. The hydrogen-rich product gas is then heated and used as fuel in the combined cycle power block.

Carbon dioxide-laden solvent flows from the bottom of the carbon dioxide absorber column where a portion is diverted to the hydrogen sulfide absorber for hydrogen sulfide removal. The remainder is flashed, with the separated gases recycled to the hydrogen sulfide absorber, and chilled before being routed to the flash regenerator. In the flash regenerator, absorbed carbon dioxide is removed from the solvent by sequentially decreasing the pressure in multiple steps. Separated carbon dioxide flows to carbon dioxide compression equipment for sales export.

Carbon dioxide-free solvent from the bottom of the flash regenerator combines with solvent from the hydrogen sulfide absorber and flows to the hot regenerator where hydrogen sulfide and other sulfur compounds are released from the solvent by increasing the temperature and stripping with methanol vapor generated in a reboiler. The separated acid gas is routed to the sulfur recovery unit for further processing. Most of the regenerated, now carbon dioxide- and hydrogen sulfide-free solvent is cooled by heat exchange with cool solvent, chilled, and returned to the carbon dioxide absorber for reuse. A small portion of the regenerated solvent and the bottom liquid of the hydrogen sulfide absorber column which contains water from the feed gas are sent to the methanol-water column for separation of dissolved water and impurities from the methanol by distillation. The methanol overhead is retuned to the hot regenerator and the separated column bottoms water is cooled and sent to the gasification area.

2.3 POWER GENERATION

2.3.1 Summary

The combined cycle portion of the power block is similar to a state of the art combined cycle power plant. Major equipment consists of a heavy duty gas turbine, a steam turbine and an HRSG. Other power block equipment consists of condenser, cooling tower, deaerator, boiler feedwater, and condensate pumps, etc. Power is produced by the consumption of hydrogen-rich fuel and/or natural gas to meet the parasitic load for the accompanying gasification plant and for export to the PG&E electrical grid. The power block integrates the process heat generated within the gasification plant by the exothermic water-gas shift reaction and the SRU hydrogen sulfide oxidation reaction. Boiler feedwater from the power block deaerator is used to generate high pressure (HP) and low pressure (LP) saturated steam. This steam and that generated in the HRSG with gas turbine exhaust heat and duct burner heat release is superheated in the HRSG before being admitted to the reheat steam turbine generator (STG).

The STG exhausts into a water cooled condenser, where the heat is rejected to a multi-cell mechanical draft wet cooling tower via a circulating water system. The condensate leaving the condenser hot well is heated and deaerated before returning to the HRSG LP system and integrated process heat exchangers.

The power block also includes a single natural gas fired auxiliary gas turbine, an aeroderivative simple cycle machine, to provide backup power to the gasification plant during forced outage periods and to provide beneficial spot market power production to the grid.

Both the heavy duty and aeroderivative gas turbines in the power block incorporate diluent injection and post combustion control technologies to meet the stack emissions Best Available Control Technology (BACT) requirements.

Utilities are supplied to the power block from off-site (natural gas) or from other operating units within the facility (hydrogen-rich fuel from the gasification plant, make-up and demineralized water from the water treatment plant and nitrogen diluent from the ASU). Electrical power generation is distributed in the switchyard for transmission to the grid or satisfying the auxiliary loads within the facility.

2.3.2 Major Power Block Equipment Description

The major equipment is described in the following sections, covering the topics of fundamental operation and the function within the power block and overall facility. Equipment highlights are provided. An overall sketch of the power block system is shown in Figure 2-14, Flow Diagram Power Block Systems.

2.3.2.1 Heavy Duty Gas Turbine

The heavy duty gas turbine, also known as the CTG, is made up of an axial flow air compressor, diffusion-flame combustion system, an axial flow turbine, and a hydrogen cooled generator. Ambient air is filtered and cooled in an evaporative cooler before entering the compressor section. The compressor is multi-stage design, which nearly adiabatically compresses the air through a process of transferring the energy imparted by the rotating blade to pressure rise in the diffusing stationary blade. This compression process also raises the air temperature before discharging to the combustion system. The compressor has air extraction ports on the outer stationary shell and the inner rotor. During startup, air is extracted from the shell side to balance the flow passing ability of the front stages with the later stages. During normal operation, air is extracted for cooling the hot gas path parts that make up the turbine section. Air extracted through the outer shell is used to cool the stationary turbine parts, including the nozzles, bucket stationary shrouds, and the turbine shell. Air extracted inward through the rotor supplies cooling air for the inner passages and rotating parts, including the buckets, the rotors, and the wheelspaces between the rotors.

Air leaves the compressor at elevated pressure and temperature, and enters the combustion section. The combustion system is made up multiple combustion cans (chambers) that equally divide the flow, allowing for controlled combustion reaction zones. Each combustor can have a set of hydrogen fuel and natural gas fuel nozzles, as well as nitrogen and steam diluent injection nozzles. Dilution holes in the combustion liners are designed to control the combustion zone air, fuel, and diluent mixing in such a way to suppress the combustion temperatures and thus limit the amount of nitrogen oxides formed. The hot combustion gases leave the combustion system through the transition piece and enter the turbine section.

The high pressure and temperature gas entering the turbine passes through the stationary nozzle to the rotating bucket. There are three such stages in the turbine which extracts energy from the expanding gases; providing the torque that drives the axial compressor and the generator. The machine is a cold-end drive design, where the shaft torque generated in the turbine section is transmitted through the compressor shaft to the generator. This allows for the turbine exhaust gas leaving the last rotating bucket to enter a long diffuser, where velocity or kinetic energy is converted to pressure or potential energy. The advantage of the diffuser is that it allows the turbine to operate at a lower back pressure, increasing power generation. Flow exiting the diffuser enters the HRSG transition duct upstream of the first superheater coils.

The hydrogen cooled generator shaft is connected through a coupling to the CTG shaft at the compressor end of the machine. The generator typically converts mechanical energy to electrical energy, with additional auxiliary loads required to energize the excitation system, operate the lubricating oil system, and other support systems. Mechanical losses from the bearings also take away from the net electrical generation. Hydrogen is used as the coolant, which requires carbon dioxide and compressed air purging systems to ready the generator for safe maintenance.

The CTG operation is supported by separate skids that house the lube oil system, the fuel, and diluent metering systems, and other services, including fire detection and protection, control system, and compressor wash system, etc. The enclosure around the CTG has a controlled operating environment, with a ventilation system designed to protect against undesirable outside temperatures and maintain safe conditions, with fire detection and protection.

Table 2-16, Combustion Turbine Generator, summarizes the combustion turbine model, fuels, temperature ranges, output and other aspects relevant to the Project.

Table 2-16
Combustion Turbine Generator

Model	GE PG7321 (FB) w/IGCC Combustor
Fuels	H_2-Rich Fuel, Natural Gas, Co-Firing
Inlet Air Cooling	Evaporative Coolers, 85% Effectiveness
Emissions Control Diluent	Nitrogen for H_2-rich fuel, Steam Injection for Natural Gas
Ambient Temperature Range	20°F to 115°F, Average 65°F
Ambient Pressure/Elevation/Elevation	14.46 psia/390′ above msl
Exhaust Pressure Loss @ ISO	18.0″ H_2O
Air Extraction	Not Included, limited for high H_2 fuels
H_2 & Diluent Temperature	400°F at the GE interface
Base Load Generator Output	232 MW, constant up to 97°F (max IGV), then drops
Exhaust Flow & Temperature	4,104 kpph, 1,053°F @ average ambient

Table 2-16
Combustion Turbine Generator

Min Output in Compliance	60% of Base Load

Source: General Electric
Notes:

%	=	percent
°F	=	degrees Fahrenheit
GE	=	General Electric
H_2	=	Hydrogen
H_2O	=	water
IGV	=	inlet guide vane
ISO	=	International Standards Organization standard conditions of 1 atmosphere 59° F, and 60% relative humidity
kpph	=	kilopounds per hour (thousands of pounds per hour)
psia	=	pounds per square inch absolute
msl	=	mean sea level

2.3.3 Heat Recovery Steam Generator

The CTG exhausts into the HRSG after a short transition duct. The HRSG is a triple pressure level reheat design. The HRSG is comprised of a series of heat exchangers that utilize the CTG exhaust energy to heat boiler feedwater to saturation conditions, then vaporize and superheat the steam. Also, HP STG exhaust steam is reheated in the HRSG before being returned to the intermediate pressure (IP) section of the STG. The HRSG includes a duct burner to elevate the exhaust gas temperature, a selective catalytic reduction (SCR) system to control the stack nitrogen oxide emissions and a carbon monoxide catalyst system to control the stack carbon monoxide emissions.

Each HRSG pressure level system consists of economizing, evaporating, and superheating sections. The LP economizer is fed from the deaerator and the IP and HP economizers are fed from the LP drum. Condensate enters the HRSG feedwater heater section after leaving the condenser hotwell, combined with the make-up water and heated with process heat. The feedwater heater heats the feedwater to within 20°F of the deaerator saturation temperature at the deaerator operating pressure of 30 pounds per square inch absolute (psia). The off-base deaerator utilizes stripping steam from the LP drum to remove entrained oxygen before supplying the HRSG and the process LTGC system with boiler feedwater.

The LTGC system transfers heat from the hot syngas leaving the shift converters to a multi-pressure level system that generates saturated steam from deaerated feedwater. This steam satisfies the requirements of the gas processing units and other users, with the excess HP and LP saturated steam sent to augment HRSG steam production.

2.3.3.1 Emissions Controls Systems

Emissions control systems are required to meet the permit levels of nitrogen oxides, carbon monoxide, and volatile organic compounds (VOCs). Maintaining these levels is critical to plant operations. Project emission control systems are described in detail below.

SCR Emissions Control System

The SCR system reduces nitrogen oxide emissions from the HRSG stack gases by up to about 80 percent. Diluted 19 percent aqueous ammonia is injected into the stack gases upstream of a catalytic system which converts nitrogen oxide and ammonia to nitrogen and water.

The expected components in the SCR system are as follows:

Aqueous Ammonia Storage Tank – The aqueous ammonia storage tank is a horizontal or vertical vessel which stores aqueous ammonia for the SCR system. The storage tank will be complete with relief valves, level gauges, local audio alarms, and will also be located inside a containment area.

Aqueous Ammonia Forwarding Pumps – The aqueous ammonia forwarding pumps will transfer aqueous ammonia from the storage tank to the aqueous ammonia vaporizer.

Ammonia Vaporizer – The aqueous ammonia vaporizer atomizes and vaporizes the ammonia and water solution. Plant air or steam will atomize the aqueous ammonia to assist in the vaporization. The energy to vaporize the aqueous ammonia will come from a slip stream of hot stack gas or by heating ambient air with a heating element.

Vaporizer Blower – The vaporizer blower delivers fresh air or recycled hot stack gas from the HRSG into the aqueous ammonia vaporizer.

Ammonia Injection Grid – Once the aqueous ammonia is properly vaporized, the ammonia is sent to an injection grid where the ammonia stream is divided into various injection points upstream of a catalyst. The flow of ammonia to each injection point can be balanced to provide optimum nitrogen oxide reduction.

SCR Catalyst – The SCR catalyst provides the surface area and the catalyst to react ammonia and nitrogen oxide to form nitrogen and water. The SCR catalyst will be installed in a reactor housing located within the HRSG at the proper flue gas temperature-point for good nitrogen oxide conversion.

CO Oxidation System

A carbon monoxide catalyst will be installed in the HRSG casing upstream of the SCR ammonia injection location to reduce carbon monoxide emissions. The carbon monoxide catalyst will oxidize the carbon monoxide and VOCs produced from the CTG.

Continuous Emissions Monitoring System

The Continuous Emissions Monitoring System (CEMS) records the emissions out of the HRSG stack to comply with local, state, and federal emission requirements. The CEMS monitors the nitrogen oxide, oxygen, and carbon monoxide levels. It uses flow rate signals from the CTG power output and fuel gas to the CTG to calculate the total mass rate of emissions released, and may also be used as part of the ammonia injection controls for the SCR system. The CEMS will be designed, installed, and certified in accordance with the applicable San Joaquin Valley Air Pollution Control District (SJVAPCD) and USEPA standards for analyzer performance, data acquisition, and data reporting.

2.3.3.2 Steam Turbine Generator

The STG is a 160 MW (nominal) sliding-pressure reheat design, with the HP section discharge steam sent back to the HRSG to be reheated before admission to the IP section. The IP section discharges into the cross-over pipe where LP steam from the HRSG is admitted before entering the double flow LP section. The flow splits and expands through separate LP turbines before exhausting downward into the condenser. The turbine sections are on a common shaft, which connects through a coupling to a hydrogen cooled generator.

The STG has supporting systems including, gland steam condenser, steam seal regulator, lube oil and hydraulic oil systems, and control system. The steam seal system manages the use of leakages from the HP section seals to provide sealing for the lower pressure sections, as well as provide excess steam to the gland seal condenser.

2.3.4 Heat Rejection System

The excess thermal energy in the steam exhausted to the condenser is dissipated in the heat rejection system. This system is comprised of a condenser, a circulating water system, and a multi-cell cooling tower.

The condenser is a shell and tube heat exchanger with the steam condensing on the shell side under a vacuum and the cooling water flowing through the tubes in a single or double pass design. The shell side operates in a typical pressure range of 0.9 inches HgA (inches mercury, absolute pressure) to 2.25 inches HgA. The condensate collects in the condenser hotwell, where it supplies the condensate pumps that feed the HRSG.

The heat in the condenser is picked up by the circulating water system and transferred to the cooling tower. An auxiliary cooling water system also transfers heat to the cooling tower from the cooling duties of the hydrogen-cooled generators, the auxiliary CTG, and other power block equipment.

2.3.5 Auxiliary CTG

The auxiliary CTG is a natural gas fired GE LMS100® PA in a simple cycle configuration, equipped with water injection for nitrogen oxide control. Post combustion emissions controls will include SCR and carbon monoxide Catalyst systems to meet the permitted stack emissions given in Table 2-17, Auxiliary CTG.

Table 2-17
Auxiliary CTG

Model	GE LMS100® PA
Fuel	Natural Gas
Inlet Air Cooling	Evaporative Coolers, 85% Effectiveness
Emissions Control Diluent	Water Injection
Ambient Temperature Range	20°F to 115°F, Average 65°F
Ambient Pressure/Elevation / Elevation	14.46 psia/390′
Exhaust Pressure Loss @ ISO	12.0″ H_2O
Compressor Intercooler	100°F Return Air Temperature
Base Load Generator Output	103.3 MW @ 65°F Ambient

Table 2-17
Auxiliary CTG

Stack Emissions Control	SCR for NOx and CO Catalyst for CO & VOCs
Min Output in Compliance	50% of Base Load

Notes:

%	=	percent
CO	=	carbon monoxide
CTG	=	combustion turbine generator
°F	=	degrees Fahrenheit
psia	=	pounds per square inch, absolute
H_2O	=	water
ISO	=	International Standards Organization standard ambient conditions (one atm,, 59 deg F, 60% relative humidity)
MW	=	megawatt
NOx	=	nitrogen oxide
SCR	=	selective catalytic reduction
VOC	=	volatile organic compounds

The basic components of the auxiliary CTG are the same as indicated above in the heavy duty gas turbine section, which are a compressor, combustor, turbine, and generator. This model integrates features of GE's heavy duty frame design and aeroderivative technology. Unlike the 7FB heavy duty design, the LMS100® is a multi-shaft machine, with the LP compressor (LPC) and the IP turbine (IPT) on a common shaft, the HP compressor (HPC) and HP turbine (HPT) on a common shaft and an independent power turbine on a common shaft with the generator. The LPC is derived from an existing heavy duty frame machine design with several years of field experience. The HPC, HPT, and IPT sections, referred to as the super-core, are based on proven aeroderivative technology with many millions of operating hours. The power turbine, a new design optimized to operate in either the 50 Hz or 60 Hz market, is pneumatically coupled to the super-core and transmits power to the generator.

Featured also is an intercooler, between the LPC and the HPC, which cools the air entering the HPC, reducing compressor power demand, increasing air flow and pressure ratio capability. The intercooler rejects heat to the auxiliary cooling system and ultimately to the power block cooling tower.

A single annular combustor system, a common aeroderivative design, is utilized, with water injection to control nitrogen oxide emissions. Post combustion emission controls include an SCR and carbon monoxide Catalyst.

The auxiliary CTG is equipped with the following accessories to provide safe and reliable operation: evaporative coolers, inlet air filters, metal acoustical enclosure, duplex shell; and tube lube oil coolers for the turbine and generator, compressor water wash system, fire detection and protection system, hydraulic starting system, and compressor variable bleed valve vent.

2.3.6 Major Electrical Equipment and Systems

The Project electrical distribution system configuration is shown on Figures 2-15 through 2-18, Electrical Overall One Line Diagrams.

The Project will have a 230 kV air insulated switchyard using a breaker and a half scheme with redundant 230 kV transmission lines for interconnection to the PG&E Midway Substation. The breaker and a half scheme allows each breaker to be isolated and also each 230 kV bus to be isolated without affecting the reliability of the Project. Each of the 230 kV transmission lines is sized for the total plant output. Revenue metering is provided on each of the transmission lines to PG&E.

The combined cycle power block has two prime movers: the GE Frame 7FB (CTG-1) and the associated steam turbine generator (STG-1) (see Figures 2-15, Electrical Overall One Line Diagram). CTG-1 and STG-1 each have 18 kV generator breakers. The auxiliary simple cycle (CTG-2) provides an independent source of generation when the combined cycle gas turbine CTG-1 is not operating, or when additional peaking power is needed. The CTG-2 uses 230 kV generator breakers.

Startup power for the plant will be obtained by back feeding from the 230 kV grid through the main transformer to the unit auxiliary transformers which are tap connected to the CTG-1 and STG ISO phase buses (see Figure 2-16, Electrical Overall One Line Diagram).

The Project's auxiliary loads are served by various Power Distribution Centers (PDCs). PDC-1 and PDC-2 serve major 13.8 kV loads excluding the ASU loads which are supplied from a dedicated 230-13.8 kV transformer. The 13.8 kV AGR refrigeration compressor, the 13.8 kV carbon dioxide compressor, as well as the medium voltage PDCs are fed from PDC-1 and 2. Each of the 4,160 volts (V) and 480 V PDCs have a double ended substation with two 100 percent sized transformers.

Dual 2 MW standby diesel generators (see Figure 2-17, Electrical Overall One Line Diagram) provide emergency power to essential services in the event of a grid failure.

Medium voltage (MV) and low voltage (LV) switchgear, MV and LV motor control centers (MCCs), 125 Vdc batteries, chargers, uninterruptable power supply (UPS), and DCS I/O racks shall be located indoors in pre-fabricated electrical PDCs with redundant heating, ventilation, air conditioning (HVAC) units. The Major Electrical Equipment will be in accordance with American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE)/National Electrical Manufacturers Association (NEMA)/American Society for Testing and Materials (ASTM) standards. The electrical system design and installation shall be in accordance with the National Electrical Code (NEC). For specific details of the Major Electrical Equipment, refer to Appendix B – Electrical Design Criteria.

2.4 SUPPORTING PROCESS SYSTEMS

2.4.1 Natural Gas Fuel System

2.4.1.1 Natural Gas Metering Station

The natural gas fuel system provides natural gas to all the Project components at the required pressure, temperature, and flow rates. The natural gas system is shown on Figure 2-19, Flow Diagram Natural Gas System. The natural gas underground transmission line enters the Project Site at the Natural Gas Metering Station. The metering station is provided by the gas supplier and contains the gas revenue meters and gas analyzers. The gas metering station also contains a knockout drum which is included as a precaution against any liquids that could get into the main transmission line. The Project takes custody of the natural gas at the outlet of the metering station.

2.4.1.2 High Pressure Natural Gas

The power block combined cycle CTG (GE Frame 7FB) is the largest gas user, although hydrogen is the primary fuel for this unit. All the combined cycle startups are on natural gas and the power block can operate independently on natural gas when hydrogen-rich fuel is not available. The combined cycle CTG requires natural gas at about 400 psig which is near the pipeline minimum operating pressure. When the pipeline pressure is higher than the CTG requires, the gas pressure is let down in a pressure control station. The natural gas to the CTG passes through a knockout drum, is heated to about 50°F above the natural gas dew point with an electrical heater, and is filtered before entering the CTG fuel control skid.

The auxiliary simple cycle CTG (GE LMS100®) requires a booster compressor to increase the natural gas pressure to about 950 psig at the fuel control skid. The heat of compression will ensure the gas is above the dew point and a filter separator is included to make sure only clean dry natural gas enters the CTG.

2.4.1.3 Low Pressure Natural Gas

The HRSG duct burners, when operating, require low pressure natural gas which will be supplied from a letdown station located in the power block. A separate pressure reduction station and knockout drum are provided to supply the Project's other low pressure natural gas users. A list of the other low pressure natural gas users follows:

- Auxiliary boiler
- SRU reaction furnace (for refractory preheating and startup)
- Tail gas thermal oxidizer
- Elevated flare pilots and support fuel
- Ground flare pilots
- Building space heating and miscellaneous users

2.4.2 Air Separation Unit

High purity oxygen and nitrogen are supplied from the ASU, which separates and purifies oxygen and nitrogen from the ambient air. The ambient air is filtered, compressed, dried, and cooled to cryogenic temperatures, and is then separated into purified oxygen and nitrogen streams.

Most of the high purity oxygen is supplied at high pressure to the gasification process as one of its feeds. The rest is supplied at low pressure to the oxygen-blown SRU as one of its feeds.

High-purity nitrogen (<1% oxygen) is supplied at medium pressure as a diluent to the combustion turbine, which uses it to reduce thermal nitrogen oxide formation when combusting the hydrogen-rich gas. Ultra-high purity nitrogen (< 100 ppmv oxygen) is used for purging and blanketing throughout the Project.

The ASU separates and purifies oxygen and nitrogen from the ambient air. Ambient air is filtered, compressed, dried, and cooled to cryogenic temperatures. The oxygen and nitrogen are then separated by cryogenic distillation within a heavily insulated "cold box." Because operating temperatures for air separation are at cryogenic levels, distillation equipment is enclosed within cold boxes and insulated from heat leakage. A simple process flow diagram for the ASU is presented as Figure 2-20, Air Separation Unit.

High pressure gaseous oxygen for gasification is normally supplied from the ASU by pumping liquid oxygen (LOX) to the required pressure and then vaporizing the oxygen. A LOX system provides a backup oxygen supply to the gasifiers during short-term trips of the ASU. The LOX system consists of a LOX storage tank, LOX pump, and LOX vaporizer. The gaseous oxygen exiting the vaporizer is at a pressure suitable for delivery to the gasifier without additional compression.

Gaseous nitrogen for combustion turbine nitrogen oxide control is compressed to delivery pressure in the ASU and sent to the power block. The compressor discharge is not cooled.

Gaseous high-purity nitrogen purging and inerting of equipment is normally supplied directly to the Project's nitrogen distribution system. A liquid nitrogen (LIN) storage system provides a backup supply of high purity nitrogen to the plant during ASU trips. The LIN system consists of a LIN tank, LIN pump, and LIN vaporizer. The gaseous nitrogen exits the vaporizer at a pressure suitable for feeding into the plant's nitrogen distribution system.

2.4.3 Sulfur Recovery Unit

Sulfur is removed from the processing facility through a sulfur complex which consists of a Claus unit (thermal stage) plus catalytic converters otherwise known as the Sulfur Recovery Unit (SRU), a Tail Gas Treatment Unit (TGTU), and a tail gas thermal oxidizer. The sulfur process facility consists of 2 by 50 percent SRUs, 1 by 100 percent TGTU, and 1 by 100 percent thermal oxidizer. The Claus unit and TGTU give an overall sulfur recovery efficiency of 99.9 percent. The following is a process description of the Claus unit, TGTU, and thermal oxidizer:

2.4.3.1 Claus Section

The acid gas stream from the Rectisol AGR Unit, plus a low concentration acid gas stream from the gasification section and the carbon dioxide/ammonia/hydrogen sulfide stripped from sour water, are fed to two identical, parallel Claus-type SRUs. The total sulfur concentration in the SRU feed (H_2S plus COS) will be 45 mol % (minimum). Pressure at the boundary limit will be 30 psia (minimum).

In the SRU, the hydrogen sulfide carried in the acid-gas streams is converted to elemental sulfur and water vapor based on the industry-standard Claus process. Each unit consists of a thermal stage and two catalytic reaction stages. The sulfur is selectively condensed and collected in molten form in the sulfur pits. The SRU is designed for both air and oxygen-blown Claus technologies. Figure 2-21, Flow Diagram Sulfur Recovery Unit, presents a simplified process flow sketch of the SRU.

The Rectisol AGR acid gas and recycle acid gas from the Tail Gas Treating Unit (TGTU) regenerator enter the SRU through the Acid Gas Wash Drum to remove any liquid from operating upsets of upstream units to protect the Claus reaction furnace and catalyst. Similarly, low concentration acid gas from the gasification section and sour water stripper gas are routed to a Sour Water Stripper (SWS) Acid Gas Knockout Drum.

The resulting acid-gas streams are preheated using high-pressure steam; the oxygen feed is pre-heated using medium-pressure stream prior to feeding the reaction furnace. All of the acid gas from the SWS Acid Gas Knockout Drum and the oxygen is sent to the main reaction furnace to ensure complete destruction of ammonia.

One-third of the hydrogen sulfide is combusted with oxygen to produce the proper ratio of hydrogen sulfide and sulfur dioxide, which then react to produce elemental sulfur vapor in a reaction furnace ($2H_2S + SO_2 \rightarrow 2S + 2H_2O$). A waste heat boiler is used to recover heat before the furnace off-gas is cooled to condense the first increment of sulfur. Gas exiting the first sulfur condenser is fed to a series of heaters, catalytic reaction stages, and sulfur condensers, where the hydrogen sulfide and sulfur dioxide is incrementally converted to elemental sulfur and condensed.

2.4.3.2 Sulfur Storage

Liquid sulfur from the SRU is collected in two fully-enclosed subsurface sulfur storage pits (SSP). In order to provide for containment, the SSPs are constructed with structural concrete with a sealed solid roof, built in accordance to applicable LORS. The liquid sulfur drains into the SSP which contain a pump well and Sulfur Transfer Pumps. Sweep air is introduced into the SSP to prevent the accumulation of hydrogen sulfide, and to control fugitive emissions. The sweep air inlet and outlet are located at opposite ends of the SSP to ensure proper sweep of the vapor space. The sweep air is drawn through the SSP and will be routed back to the reaction furnace through the SSP ejector.

Liquid sulfur is pumped from sulfur storage to a sulfur Degassing Unit. The sulfur degassing unit strips dissolved hydrogen sulfide out of the liquid sulfur. The degassed sulfur is routed from the degassing unit to the sulfur storage SSP. The stripped hydrogen sulfide stream is routed to the Claus reaction furnace.

Sulfur loading involves pumping liquid sulfur from the sulfur storage to trucks. The sulfur loading equipment will have vapor recovery systems to control fugitive emissions by returning displaced vapors to the SRU.

The SRU is a totally enclosed process with no discharges to the atmosphere.

2.4.3.3 Tail Gas Treating Unit

A process flow sketch for this unit is shown in Figure 2-22, Flow Diagram Tail Gas Treating Unit. The tail gas from the SRU is composed mostly of carbon dioxide, water vapor, and sulfur vapor with trace amounts of hydrogen sulfide and sulfur dioxide. The tail gas from both SRU trains is sent to a single TGTU where it is first preheated using high-pressure steam and then catalytically hydrogenated in the hydrogenation reactor to convert the remaining sulfur species to hydrogen sulfide. The resulting gas stream is then cooled, washed with caustic for unconverted sulfur dioxide removal, and finally contacted with lean amine in the Absorber where hydrogen sulfide is preferentially absorbed. The rich amine leaving the bottom of the absorber is pumped to the regenerator where hydrogen sulfide and carbon dioxide are stripped from the amine. Overhead gas from the regenerator, containing the separated hydrogen sulfide and carbon dioxide, is recycled to the front of the Claus SRU section. The lean solvent from the bottom of the regenerator is cooled and pumped to the absorber.

The treated TGTU vent gas from the absorber contains mostly carbon dioxide and trace levels of sulfur compounds. The treated tail gas is normally compressed, dried, and blended with the much larger product carbon dioxide from the AGR unit. The combined carbon dioxide stream is compressed for export as carbon dioxide product.

2.4.3.4 Sour Water Stripper

The stripped gasses from the SWS containing ammonia, hydrogen sulfide, and carbon dioxide are sent to the Claus unit for sulfur recovery and ammonia destruction. The SWS is shown schematically in Figure 2-23, Flow Diagram Sour Water Stripper.

The majority of the SWS feed is produced in the Sour Shift Unit. Numerous other small sour water streams are collected from within the Project and sent to the SWS feed tank along with the condensate from the shifted syngas knockout drums.

The SWS feed pumps, which takes suction from the feed tank, deliver sour water to the SWS. The stripper is injected with low pressure steam at the bottom of the column. The rising steam strips ammonia, carbon dioxide and hydrogen sulfide out of the sour water. The overhead vapors are cooled in an air-cooler condenser. The condensate is refluxed back to the column and the overhead non-condensable gasses are sent to the Claus unit.

The stripped condensate is drawn off the bottom of the column and pumped to the gasification process for reuse.

2.4.3.5 Tail Gas Thermal Oxidizer

Associated with the operation of the sulfur recovery process is the integral use of a thermal oxidizer as a control device to provide for the safe and efficient destruction of the hydrogen sulfide contained in the TGTU vent gas during startup and shutdown. The miscellaneous oxidizing streams from the gasification area are directed to the thermal oxidizer during normal operation.

In the thermal oxidizer, the TGTU tail gas and other oxidizing streams are subjected to a high temperature and a sufficient residence time to cause an essentially complete destruction of reduced sulfur compounds such as hydrogen sulfide. The thermal oxidizer uses natural gas to reach the necessary operating temperature for optimal thermal destruction.

2.4.4 Zero Liquid Discharge

Most of the gray water from the Fine Gasification Solids Handling System is recycled to the Gasification process as wash water or slurry water. A small fraction of the gray water is blown down to the ZLD unit to maintain the Gasification unit water chemistry within corrosion limits.

The process wastewater from the gasification unit will be treated in a ZLD system which will include a mechanical vapor compression evaporator and crystallization unit. The pure distillate produced from the evaporator will be returned to the gasification or power block for reuse. The solid crystals produced in the crystallizer will be trucked to an approved off-site material disposal facility.

The gasifier wastewater feed first enters a clarification/softening system to reduce precipitant levels for scale-free evaporator operation. Lime and soda ash are used in the clarifier. Small silos for storage of solids or delivery of liquid reagents (slaked lime and soda ash) will be used. A thickener tank and filter will be provided to concentrate clarifier sludge and produce a filter cake for off-site disposal in accordance with applicable federal, state, and local regulations. Polymer additives for the clarifier will be used as necessary. The clarified water will be fed to the evaporator.

The evaporators will concentrate the wastewater to a volume that is about 25 times less than the evaporator feed. The evaporator waste is primarily sodium chloride and sodium formate and is dried into crystallized solids using steam-heated dryers. The dryers and associated equipment will be located in an enclosure protected from the wind and other elements.

The evaporator/crystallizer distillate is recycled to the gasifier system and the crystallized solids are removed by truck for approved off-site disposal. The thickener overflow and filter press filtrate are recycled back to the clarifier/softener system for re-processing.

2.4.5 Deep Well Injection

The Project will have an on-site DWI System for disposal of wastewater. The majority of this disposal stream will be cooling tower blowdown and reject water from the water treatment plant. The DWI system will consist of collection piping to route all streams to a common sump system. From the sumps the wastewater will be routed to deep well injection pumps. The deep well pump discharge will be routed to a system of deep wells of capacity sufficient to handle the maximum expected Project wastewater rate of about 1,800 gallons per minute (gpm), with sufficient redundancy for performing maintenance without impacting Project ability to dispose of wastewater. The total number of deep wells is expected to be approximately 20 (15 operating plus five spares).

2.4.6 Carbon Dioxide Compression and Pipeline

At least 90 percent of the carbon in the raw syngas will be captured in a high purity carbon dioxide stream during steady-state operation. The carbon dioxide is transported by pipeline to the custody transfer point for enhanced oil recovery and sequestration. The Carbon Dioxide Compression System is shown in Figure 2-24, Flow Diagram CO_2 Compressor. In order to transport the carbon dioxide, it must first be compressed. The carbon dioxide for compression comes from two sources: (1) the bulk of the carbon dioxide comes from the Rectisol acid-gas removal unit, and (2) a small portion comes from the TGTU absorber. The carbon dioxide is very dry to avoid pipeline corrosion.

The Rectisol acid-gas removal unit produces high purity carbon dioxide at two pressure levels: (1) the lower pressure level is near atmospheric pressure, and (2) the higher pressure carbon dioxide is available at about three atmospheres. The Rectisol process contacts the syngas with refrigerated methanol so the product carbon dioxide is dry at the compressor suction.

The TGTU carbon dioxide stream is near atmospheric pressure and contains moisture. It is compressed to the just above the higher carbon dioxide pressure from the Rectisol unit, dried, and then combined with the higher carbon dioxide pressure stream from the Rectisol unit.

The maximum pressure requirement for the carbon dioxide pipeline is about 2,800 psig at the compressor discharge. Once the carbon dioxide pressure reaches about 1,200 psig it becomes super-critical[1]. The significance of this is that at high pressures the carbon dioxide remains a dense single phase. Heating or cooling the fluid will change its density but will not develop into a separate liquid phase. So while the compression to high pressure is needed for carbon dioxide injection operations, it is also needed to keep the carbon dioxide in a super-critical phase throughout the carbon dioxide pipeline.

The electrical loads required for the carbon dioxide compression are substantial. Specially designed compression systems have been developed to improve the compression efficiency and reduce the electrical power consumption. Multi-stage centrifugal compressors have been selected for the Project. The compressors are inter-cooled between stages and provided with inlet guide vane capacity controls.

The captured and compressed carbon dioxide will be compressed and transported by pipeline at a pressure greater than 1,500 psig, but no greater than 2,800 psig. The stream will be at least 95 percent purity carbon dioxide. The pipeline facilities will consist of a pipeline up to 12 inches in diameter, two metering facilities at the custody transfer point, one pig launcher, one pig receiver, and two block valves. The carbon dioxide will be delivered to the custody transfer point for injection into deep underground oil reservoirs for EOR and sequestration.

Currently, federal and state laws and regulations do not require modeling worst-case release scenarios for carbon dioxide. Although not required by regulation, this analysis was performed by the Applicant to examine the potential risks associated with the worst-case release scenario in order to assess the possible consequences and implement appropriate safety systems to reduce the possibility of this remote event from occurring and to further reduce the potential hazard. Appendix E, Carbon Dioxide Technical Report, presents the Off-site Consequence Analysis (OCA) performed using the methodology prescribed under the California Accidental Release Prevention (CalARP) program and the federal Clean Air Act Risk Management Program (RMP).Other Plant Systems

2.4.7 Heat Rejection Systems

Waste heat (i.e., low-grade thermal energy that is impractical to recover and reuse) from the Project will be rejected to the atmosphere. Two types of heat rejection systems are used depending on the process requirements. Air coolers (fin-fan exchangers) are used for direct heat rejection to the atmosphere where low process outlet temperatures are not critical to efficiency.

[1] Super-critical refers to a material at a temperature and pressure above its critical temperature pressure. At these conditions there is no defined phase difference between liquid and vapor.

Mechanical draft cooling towers are used where indirect heat rejection is required and/or where low process outlet temperatures are critical to overall plant efficiency.

Air coolers are dedicated to specific services primarily within the Shift/LTGC, TGTU, and SWS Units. Mechanical draft cooling towers serve multiple heat loads in more than one process unit. The Project has three mechanical draft cooling towers which are described below. Figure 2-25, Flow Diagram Cooling Water System, shows the power block cooling water system. The configuration shown in this figure is similar to the ASU and gasification cooling towers.

2.4.7.1 Power Block Cooling Tower

The largest heat rejection load in the Project is the steam turbine surface condenser in the combined cycle power block. The main Cooling Water Pumps supply water from the cooling tower basin and pump it through the surface condenser tubes and back to the top of the cooling tower cells. The return water flows into distribution piping below high efficiency drift eliminators and above the cooling tower fill material. Electric motor driven induced draft fans move air up through the tower fill material, contacting the cooling water with air and promoting evaporative cooling. A separate set of Auxiliary Cooling Pumps supply water from the cooling tower basin and pump it through plate type closed cooling water (CCW) exchangers and return the water to the cooling tower fill material. The CCW Pumps circulate higher purity water through the CCW Exchangers which cool the water before it removes heat from the closed circuit cooling water users. The closed circuit cooling water users include the CTG and STG generator coolers and lube oil coolers. The use of a separate closed cooling water system also reduces the electric power load by enabling the shutdown of the large, main circulating pumps when the power block is in standby, ready to start, or following an STG shutdown.

A chemical feed system will supply water conditioning chemicals to the circulating water to minimize corrosion and control the formation of mineral scale and biofouling. Sulfuric acid will be fed into the circulating water system for alkalinity reduction to control the tendency for scaling. The acid feed system will consist of storage and two full-capacity metering pumps. A polyacrylate solution is also fed into the circulating water system as a sequestering agent to further inhibit scale formation. This system also requires storage and two full-capacity metering pumps. To prevent biofouling in the circulating water system, sodium hypochlorite is added. The system requires storage and two full-capacity metering pumps.

The total circulation rate for the power block cooling tower is about 175,000 gpm. The cooling tower is provided with high efficiency drift eliminators designed to reduce drift to less than 0.0005 percent of the circulating water flow rate.

2.4.7.2 Gasification Block Cooling Tower

The gasification block cooling water system design is similar to the power block, only the duty is substantially lower. The major heat rejection duties are from the Carbon Dioxide Compressor and the AGR Refrigeration Unit. Cooling water is also supplied to the gasification, Shift/LTGC, SRU, TGTU, SWS units and some other miscellaneous users. Compressor lube oil systems, large motor cooling, and other services that require higher purity cooling water are supplied by the closed circuit cooling water loop. The gasification unit cooling tower is co-located with the power block cooling tower. Each tower has a separate cooling water basin, pumps, and piping system, and operates independently. The gasification cooling tower circulation rate is about

42,000 gpm and the tower is supplied with high efficiency drift eliminators designed to reduce drift to less than 0.0005 percent of circulation.

2.4.7.3 Air Separation Unit Cooling Tower

The ASU cooling water system design is also similar to the power block and the duty is also substantially lower. The major heat rejection duties are from the Main Air Compressor Intercooler and Aftercooler, the Booster Air Compressor Intercooler, and the Nitrogen Compressor Intercooler. Compressor lube oil systems, large motor cooling, and other services that require higher purity cooling water are supplied by the closed circuit cooling water loop. The ASU cooling tower is located in the ASU unit near the cooling loads. The ASU cooling tower has separate pumps and piping systems and is operated independently of the other cooling water systems. The ASU cooling tower circulation rate is about 40,000 gpm and the tower is supplied with high efficiency drift eliminators designed to reduce drift to less than 0.0005 percent of circulation.

2.4.8 Auxiliary Boiler

The auxiliary boiler is a pre-engineered package boiler that will provide steam for pre-startup equipment warm-up and for other miscellaneous purposes when steam from the gasification process or HRSG is not available. During normal operation, the auxiliary boiler may be kept in warm standby (steam sparged, no firing) or cold standby (no firing), and will not have emissions. The boiler will produce a maximum of about 100,000 pounds per hour of steam and will be fueled only by pipeline natural gas. The boiler will be equipped with low nitrogen oxide burners and flue gas recirculation to minimize emissions.

2.4.9 Flares

The Project employs two pressure relief systems and flares (a Ground Flare and an Elevated Acid Flare) to protect the Project operators and equipment. Vessels, towers, heat exchangers, and other equipment are connected to piping systems that will discharge gases and vapors to a relief system in order to prevent excessive pressure from building up in the equipment and to allow safe venting of equipment during routine startup, shutdown, or emergency operations.

2.4.9.1 Ground Flare

The gasification block will be provided with a totally enclosed ground flare to safely dispose of gasifier startup gases, syngas during AGR startup, hydrogen-rich gas during short-term emergency combustion turbine outages, or other various streams within the Project during other unplanned upsets or equipment failures. The power block, AGR, Shift, and gasification unit vents are collected in a HP Flare Header. A simplified process flow sketch of the ground flare is shown in Figure 2-26, Flow Diagram Ground Flare System.

Low pressure sour gas vents from the gasification and shift units during shutdown depressurizing operations are first scrubbed in the Gasification Amine Absorber to remove essentially all the sour sulfur compounds and then fed to an LP Flare Header. Both the HP and LP flare headers are routed to a common Flare Knockout Drum to remove potentially entrained liquids.

Cold reliefs and vents from the AGR Unit and its associated Refrigeration Unit are heated in a Cold Flare Heater using medium-pressure steam to raise the temperature of the gas to ambient levels. After the heater, the gas stream merges into the LP Flare Heater.

The ground flare is designed with multiple burner tiers and sufficient residence time at about 1,600^{o}F to ensure complete combustion.

2.4.9.2 Elevated Acid Flare

Acid gas derived from the AGR, gasification unit, and SWS overhead is normally routed to the SRU for recovery as elemental sulfur. During cold plant startup of the gasifiers, AGR, and Shift units, these acid-gas streams will be diverted to the Acid Flare Header for a short time. To reduce the emissions of sulfur compounds to the environment, the acid gas is routed to the Emergency Caustic Scrubber where the sulfur compounds are absorbed with caustic solution. After scrubbing, the gas is then routed to the elevated Acid Gas Flare Stack via the Acid Gas Flare Knockout Drum. Fresh and spent caustic tanks and pumps are provided to allow delivery of fresh caustic and disposal of spent caustic. A simplified process flow sketch of the elevated flare is shown in Figure 2-27, Flow Diagram Elevated Sulfur Flare System.

2.4.10 Emergency Engines

The following is a description of the emergency engines required for the Project. Both will be fueled using ultra low sulfur diesel fuel.

2.4.10.1 Diesel Generator

Two 480 V, 60 Hz, 3-Phase, 2,000 kW, 0.8 PF standby diesel generator(s) in an outdoor enclosure will be connected to the 480 V switchgear to supply emergency essential service power to critical lube oil and cooling pumps, gasification and auxiliary steam systems, gasification quench system, station battery chargers, UPS, heat tracing, control room, and emergency exit lighting, and other critical plant loads.

A Local Control Panel (LCP) will be located on base with standard microprocessor based engine and generator controls, interlocks, metering, alarms, and synchronizing system. Remote control of the diesel generator shall be from DCS operators via a fiber optic cable to Sellers control system.

2.4.10.2 Emergency Diesel Firewater Pump

One approximately 600 horsepower (hp), 415 kilowatts (kW) standby firewater pump, located adjacent to the firewater tank.

2.4.11 Fire Protection

2.4.11.1 Fire Protection Program

The Project Fire Protection Program includes both fire prevention and protection measures. Employment of conservative equipment layouts, segregation of critical components, and the remote location of non-essential resources are the backbone of the fire mitigation/suppression measures employed.

Conservative equipment spacing and segregation of potentially hazardous activities from the balance of the Project are the guiding principals employed to protect personnel and property. The extensive use of temperature detectors in the gasification area provides the capability to monitor the equipment and annunciate early warnings of abnormal excursions. Flammable gas monitors will be strategically located in the Project Site to detect and alarm hazardous levels. Oil containment sumps and fire walls will be erected to isolate large transformers from adjacent facilities. Structural steel will be protected with fire proofing materials in strategic areas. Process liquid drains will be configured to contain liquid spills within the unit of origin. Grading and paving plans will be prepared to complement this objective. An extensive plant grounding system will be installed to dissipate static electrical charges. Emergency lighting is provided to illuminate egress lanes.

Fire suppression will be provided by various means. A dedicated fire water storage and site-wide loop distribution system, including automatic fire suppression (deluge/mist), and manual fire water fighting equipment (monitors and hydrants), will be provided. Inert gas suppression systems will be installed in areas where water systems would otherwise cause damage to plant equipment. Carbon dioxide fire suppression systems will be provided in the combustion turbine enclosures. Provisions for the deployment of aqueous fire fighting foam (AFFF) will be included with the methanol storage tanks. Steam is utilized to smother fires originating in hot equipment which may otherwise be further damaged by the application of relatively “cold” fire water.

The degree and extent of fire protection and suppression systems provided will be in complete compliance with applicable city, state, and national codes; insurer requirements; and industry standards.

The Project Site is subdivided into discrete fire areas to identify potential hazards, protect personnel, control a fire incident within a defined area, limit the spread of fire to other areas, and to minimize the possibility of consequential fire damage in other areas of the Project. Fire area boundaries are based on:

- The type, quantity, density, and locations of each fire hazard (solid, liquid, and gaseous)
- Location and configuration of critical plant equipment
- Consequence of losing plant equipment
- Location of fire detection alarm panels, fire water storage and pumping systems

The Project Fire Protection System design is based on the single risk area concept. This considers that only one fire will occur in any one of the identified fire areas at any given time. The major hazard identified in the material handling area is dust from the petroleum coke conveying, storage, and sizing operations. The primary hazards in the gasification area are the syngas and hydrogen-rich fuel intermediate streams. Multiple hazards are present in the power block including natural gas and hydrogen-rich gas, hydrogen generator coolant, ammonia for emissions control, and the hydrocarbons contained in the lube/seal oil systems. The methanol system and storage represents an additional risk in the AGR area. Toxic and potentially flammable sulfur compounds are present in the AGR and the SRU. The capacity of the fire water storage, supply, and distribution system described below was sized based on the demand of the largest fire risk area.

The following provides an overview of the salient points of the Project's plan for fire detection and suppression.

2.4.11.2 Firewater Storage and Distribution System

The Firewater Distribution System is shown in Figure 2-28, Flow Diagram Fire Water System and includes the following equipment:

- Firewater Storage Tank (~ 3 million gallons)
- Firewater Pump (Electric Motor) (6,000 gpm)
- Firewater Pump (Diesel Motor) (6,000 gpm)
- Jockey Pump
- Fire water ring header, laterals, hydrants and monitors

2.4.11.3 Automatic Fire Suppression System

The Automatic Fire Detection Systems are intended to identify the presence of hazardous/toxic/inert dust, gases, abnormal heat, and/or smoke. In the event that a hazardous situation is detected within any one of the designated fire areas, an alarm will sound, strobe lights will flash, and the applicable suppression system will automatically be deployed. The primary Automatic Fire Suppression System will employ firewater as the fire fighting media. The Control Room, Rack Room, and "under floor" areas will use inert gas suppression systems. The type of inert gas and deployment method will be selected to minimize personnel exposure and plant equipment damage. The Gas Turbine enclosures will be flooded with carbon dioxide to displace oxygen to suppress any incident identified therein. Wherever an inert gas is used for fire suppression, a pre release alarm will sound to inform any personnel working in the area to leave immediately. The meaning of these pre-alarms (tone, duration, etc,) and the time allotted for personnel to leave an area will be stressed during the each unit's pre entry training session.

An Automatic Fire Suppression System is planned to be employed at the following locations:

Deluge Spray Systems:

- Gas Turbine Main Transformers
- Gas Turbine Isolation Transformers
- Steam Turbine Main Transformers
- Steam Turbine Lube Oil Equipment
- Auxiliary Simple Cycle Gas Turbine Main Transformer
- Main Air Compressor Lube Oil Equipment
- Booster Air Compressor Lube Oil Equipment
- AGR Methanol Systems

- Aqueous Ammonia storage facility

Pre-Action Water Spray Systems:

- STG Bearing Area
- STG Pedestal Area
- Turbomachinery Lubrication systems (air, nitrogen, carbon dioxide)
- AGR Methanol System

2.4.12 Plant and Instrument Air

Utility and instrument air for the entire plant will normally be supplied by taking a relatively small slip stream of compressed air from the ASU. Backup air is provided by an air compressor/dryer skid located in the power block.

Primary plant service and instrument air will be taken from a connection downstream of the interstage cooler of the ASU booster air compressor. This air is clean and dry as it comes from this source. Therefore, it is ready to be directly fed to the plant and instrument (P&I) air distribution system without further conditioning.

Secondary backup P&I air is supplied from a stand alone package air compressor/dryer/ accumulator skid. The quality and quantity of air provided from this source is similar to that of the primary air system.

Both primary and secondary air sources will be piped to the plant-wide distribution systems. The instrument air piping distribution system is sized to ensure that adequate quantities are supplied to the various instrument and control air consumers. Accumulators/volume bottles will be installed nearby large intermittent air consumers (i.e., fast acting control valves) to make certain that the required response times are attained.

Project service air system utility stations are positioned throughout the facility to provide plant air for house keeping and maintenance activities. The source of the air to these utility air users will be automatically shut off on low air pressure. This feature will ensure that priority is given to the instrument air system to make certain that adequate volumes are available to safely operate and control the facility.

2.4.13 Emission Monitoring Systems

CEMS will be installed on several stack emission sources as required by applicable regulations and permit conditions. These analyzers will be designed, installed, certified, and calibrated in accordance with the applicable federal, state, and local standards. In general, it is expected that these systems will sample, analyze, and record stack emission data for several specified pollutants. CEMS will incorporate data handling and acquisition systems to automatically generate emissions data logs and compliance documentation. Alarms will alert operators if stack emissions exceed specified limits. Each CEMS system will undergo periodic calibration, audits, and testing to verify accuracy. It is anticipated that the following CEMS systems will be required for the indicated emissions:

- HRSG – nitrogen oxide, carbon monoxide, and oxygen

- Auxiliary CTG – nitrogen oxide, carbon monoxide, and oxygen
- Tail Gas Thermal Oxidizer – sulfur dioxide and oxygen
- Hydrogen-rich Fuel – Total sulfur

In addition to continuous monitoring, periodic stack emission tests to verify compliance with emission limits will likely be required.

2.4.14 Hazardous Material Management

A variety of hazardous reagents and materials will be stored and utilized at the Project in conjunction with construction, operation, and maintenance (O&M) of the Project. In general, the type and character of these materials will be the same as those for other IGCC projects.

Hazardous materials used during the construction of the Project would mainly be limited to fuels and construction materials including:

- Gasoline, diesel fuel, and motor oil for construction equipment
- Compressed gas cylinders containing oxygen, acetylene, and argon for welding
- Paint and cleaning solvents
- Concrete form release
- Miscellaneous lubricants, adhesives, and sealants

Each construction contractor will be responsible for maintaining a set of Material Safety Data Sheets (MSDSs) for each on-site chemical they control and construction workers will be made aware of their location and content.

The most likely accidents involving hazardous materials during construction might occur from small-scale spills during cleaning or use of other materials in the storage areas or during refueling of equipment. Such spills would be immediately cleaned up and materials containing hazardous substances will be properly disposed in accordance with applicable LORS.

Hazardous materials that may be routinely stored in bulk and used in conjunction with the Project operations include, but are not limited to, petroleum products, flammable and/or compressed gases, acids and caustics, aqueous ammonia, water treatment and cleaning chemicals, paints, and some solvents. Table 2-18, Hazardous Materials Usage and Storage During Operations Based on Title 22 Hazardous Characterization, and Table 2-19, Hazardous Materials Usage and Storage During Operations Based on Material Properties, lists each material and describes the approximate annual quantity needed and use of the material during operations.

Figure 2-29, Preliminary Hazardous Material Location Plan, shows the location of major sources of hazardous materials on the Project Site.

Table 2-18
Hazardous Materials Usage and Storage During Operations
Based on Title 22 Hazardous Characterization[1]

Material	Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Stored	Storage Type
Sodium Hydroxide (5-20 wt% NaOH)	Corrosivity	Sour Water Treatment, Gasification, Caustic Scrubber	Outdoor	135,000 gallons	2 carbon steel ASTs with secondary containment
Molten Sulfur	Ignitability, Reactivity	By-product for sale	Outdoor	150,000 gallons	Two sulfur pits constructed of compatible material
Methanol	Ignitability	AGR solvent make-up	Outdoor	2 x 300,000 gallons	ASTs with secondary containment
Compressed Gases (Ar, He, H_2)	Ignitability	Lab	Indoor	Minimal	Cylinders of various volumes
Chemical Reagents (acids/bases/standards)	Corrosivity, Reactivity	Lab	Indoor chemical storage	<5 gallons	Small original containers
Flammable/Hazardous Gases (H_2, CO, H_2S) Syngas and Hydrogen-Rich Gas	Ignitability, Toxicity	Primary power generation fuel	Process Piping / Vessels	In process quantities only, no storage on site	None
Miscellaneous Industrial Gases - Acetylene, Oxygen, Other Welding Gases, analyzer calibration gases	Ignitability, Toxicity	Maintenance Welding/ Instrumentation Calibration	Gas cylinder Storage in Shop/ instrument shelters	Minimal	Cylinders of various volumes
Pipeline Natural Gas	Ignitability	Startup/Backup / Auxiliary Fuel	Supply piping only	Utility supply on demand	None
Diesel Fuel	Ignitability	Emergency generator/fire water pump fuel	Outdoor	2,000 gallons	ASTs with secondary containment
Aqueous ammonia (19 wt%)	Reactivity, Toxicity	Emissions control (SCR), Gasifier pH control	Outdoor	20,000 gallons	Pressurized horizontal AST within a secondary containment berm, filled with HDPE poly balls (floating cover).
Sulfuric Acid	Corrosivity, Reactivity, Toxicity	Cooling water and BFW pH control	Outdoor	12,000 gallons	AST with secondary containment
Paint, Thinners Solvents, Adhesives, etc.	Ignitability, Toxicity	Shop/Warehouse	Indoor chemical storage area	<20 gallons	Small original containers

Table 2-18
Hazardous Materials Usage and Storage During Operations
Based on Title 22 Hazardous Characterization[1]

Material	Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Stored	Storage Type
Boiler Feedwater Chemicals (e.g., Carbonic Dihydrazide, Morpholine, Cyclohexamine, Sodium Sulfite)	Corrosivity	Boiler feedwater pH/corrosion / dissolved oxygen/biocide control	Outdoor chemical storage area	<500 gallons	Small quantities in original containers
Hydrogen	Ignitability	STG & CTG generator cooling	Outdoor	29,000 standard cubic feet	Pressurized multi-tube trailer
CTG and HRSG Cleaning Chemicals (e.g., HCl, Citric Acid, EDTA Chelant, Sodium Nitrate)	Toxic, Reactive	HRSG Chemical Cleaning	Stored off site or temporarily on site	Intermittent cleaning requirement/temp storage only	Small original containers

Source: HECA Project.
Notes:
[1] All numbers are approximate.
[2] Hazardous characteristics identified per California Code of Regulations Title 22 §§ 66261.20 *et seq*., for hazardous wastes.

Table 2-19
Hazardous Materials Usage and Storage During Operations
Based on Material Properties[1]

Material	Potential Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Stored	Storage Type
Methyldiethanol amine	Mild Irritant, Mildly Toxic	Solvent for sulfur removal	Tail Gas Treating Unit (TGTU) – in process inventory, not otherwise stored	70,000 pounds	Contained in process vessels of TGTU
Sodium Hypochlorite	Corrosivity, Reactivity	Cooling tower biological control	Outdoor	2,000 gallons	Polyethylene ASTs with secondary containment
Water Treatment Chemicals	Irritant, Midly Toxic	Raw water, Demineralized water, and Cooling Water Treatment	Indoor chemical storage area	<500 gallons	Drums or ASTs
Oxygen (95%), liquid	Oxidizer	Gasification, SRU	Outdoor	2,200 tons	AST within the ASU
Nitrogen[3]	Asphyxiant	Syngas fuel diluent for NOx control, inert gas	Outdoor	50 tons	AST within the ASU

Table 2-19
Hazardous Materials Usage and Storage During Operations
Based on Material Properties[1]

Material	Potential Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Stored	Storage Type
Cooling Water Chemical Additives (e.g., Magnesium Nitrate, Magnesium Chloride)	Mild Irritant, Mildly Toxic	Corrosion Inhibitor/ Biocides	Outdoor chemical storage area near each cooling tower	<500 gallons	Small quantities in original containers
Diethylene glycol monobutyl ether (industrial cleaner)	Basic Compound, Toxic, Mild Irritant	Routine cleaning, degreasing, oxygen pipeline cleaning	Indoor	None	Temporary storage as needed provided by contractor
Compressed Carbon Dioxide Gas[3]	Asphyxiant	Generator purging and fire protection	Outdoor	50,000 standard cubic feet for purging	Carbon dioxide, for fire suppression, stored in pressurized cylinders or tank

Notes:
[1] All numbers are approximate.
[2] Potential hazardous characteristics based on material properties.
[3] Nitrogen and carbon dioxide are not hazardous materials but may be an asphyxiant under some circumstances.

% = percent
< = less than
AGR = Acid Gas Removal
Ar = argon
AST = aboveground storage tank
BFW = boiler feed water
CO = carbon monoxide
CTG = combustion turbine generator
CCW = closed cooling water system
EDTA = ethylene diamine tetra-acetic acid
H_2 = hydrogen
H_2S = hydrogen sulfide
HCl = hydrochloric acid
He = helium
HRSG = heat recovery steam generator
NaOH = sodium hydroxide
NO_x = nitrogen oxide
SO_2 = sulfur dioxide
SRU = sulfur recovery unit
STG = steam turbine generator

The storage, handling, and use of hazardous materials will be in accordance with applicable LORS. Storage will occur in appropriately designed storage areas. Bulk tanks will be provided with secondary containment to contain leaks or spills. Safety showers and eyewashes will be provided in appropriate chemical storage and use areas. Personnel with potential to handle hazardous materials will be properly trained to perform their duties safely and to respond to emergency situations that may occur in the event of an accidental spill or release.

2.4.15 Hazardous Waste Management

Hazardous wastes will be generated in various quantities as a result of construction waste and operational waste.

Hazardous Construction Waste

The majority of hazardous waste generated during construction will consist of liquid waste such as waste oil from routine equipment maintenance, flushing and cleaning fluids, waste solvents, and waste paints or other material coatings. Additionally, some solid waste in the form of spent welding materials, oil filters, oily rags and absorbent, spent batteries, and empty hazardous material containers may also be generated.

Generally, the construction contractor will be responsible for the proper handling of all hazardous wastes in accordance with all applicable LORS. This includes all licensing requirements, training of employees where required, accumulation limits and duration, and record keeping and reporting requirements. Wastes that are deemed hazardous will be collected in hazardous waste accumulation containers placed near the area of generation. After the end of each workday, the accumulation containers would be moved to the contractor's licensed hazardous waste accumulation area where hazardous wastes can be stored for up to 90 days after the date of generation. All hazardous wastes will be removed from the Project Site by a licensed hazardous waste management facility.

Table 2-20, Summary of Construction Waste Streams and Management Methods, lists the anticipated construction wastes which includes both hazardous and non-hazardous waste, and identifies the likely disposition of the waste.

Table 2-20
Summary of Construction Waste Streams and Management Methods[1]

Waste Stream	Waste Classification	Amount	Disposal Method
Used Lube Oils, Flushing Oils	Hazardous or Non-hazardous	7 55-gallon drums per month	Recycle
Hydrotest Water (One time per commissioning, reuse as practical, test for hazardous characteristics)	Hazardous or Non-hazardous	2.8 million gallons total	Characterize. Drain non-hazardous to the Detention Basin. Dispose of hazardous at a hazardous waste disposal facility.
Chemical Cleaning Wastes (Chelates, Mild Acids, TSP, and/or EDTA – During Commissioning)	Hazardous or Non-hazardous Recyclable	525,000 gallons total	Hazardous or non-hazardous waste disposal facility.
Solvents, Used Oils, Paint, Adhesives, Oily Rags	Hazardous[2]Recyclable	160 gallons per month	Recycle or dispose of as hazardous waste.
Spent Welding Materials	Hazardous	260 pounds per month	Dispose at a hazardous waste landfill.
Used Oil Filters	Hazardous	100 pounds per month	Dispose at a hazardous waste landfill.
Fluorescent/Mercury Vapor Lamps	Hazardous Recyclable	50 units per year	Recycle
Misc. Oily Rags, Oil Absorbent	Non-hazardous or Hazardous Recyclable	1 55-gallon drum per month	Recycle or dispose at a hazardous waste landfill.

Table 2-20
Summary of Construction Waste Streams and Management Methods[1]

Waste Stream	Waste Classification	Amount	Disposal Method
Empty Hazardous Material Containers	Hazardous Recyclable	1 cubic yard per week	Recondition, recycle, or dispose at a hazardous waste landfill.
Used Lead/Acid and Alkaline Batteries	Hazardous Recyclable	1 ton per year	Recycle
Sanitary Waste from Workforce (Portable Chemical Toilets)	Non-Hazardous	390 gallons per day	Pump and dispose by sanitary waste contractor.
Site Clearing – Grubbing, Excavation of Non-Suitable Soils, Misc. Debris	Non-Hazardous	Minimal	Reuse Soils or dispose at a non-hazardous waste landfill.
Scrap Materials, Debris, Trash (Wood, Metal, Plastic, Paper, Packing, Office Waste, etc.)	Non-Hazardous	40 cubic yards per week	Recycle or dispose at a hazardous waste landfill.

Source: HECA Project
Notes:
[1] All Numbers are estimates
[2] Under California regulations
CTG = combustion turbine generator
EDTA = ethylene diamine tetra-acetic acid
STG = steam turbine generator
TSP = trisodium phosphate

Hazardous Operations Waste

Estimated operations waste streams are shown in Table 2-21, Summary of Operating Waste Streams and Management Methods. This table includes both hazardous and non-hazardous waste sources. Used catalysts, carbon filters, and filter cakes will be characterized and disposed of in accordance with applicable LORS. Spent caustic will be treated off-site to oxidize sulfides to sulfates, and will be disposed of as a non-hazardous material.

Chemical cleaning wastes may also be generated from the periodic cleaning of machinery and piping. Waste lubricants such as waste oil will be periodically generated during the operations and maintenance of the Project. Waste oil will be collected and stored in appropriate containers and recycled by an approved contractor.

As with construction hazardous waste described above, where appropriate, hazardous waste resulting from operation activities will also be collected in hazardous waste accumulation containers placed near the area of generation. After the end of each workday, the accumulation containers will be moved to hazardous waste accumulation areas where hazardous wastes can be stored for up to 90 days after the date of generation. All hazardous wastes will be properly removed from the Project Site in accordance with applicable LORS.

Table 2-21
Summary of Operating Waste Streams and Management Methods[1]

Waste Stream	Waste Classification	Anticipated Annual Amount	Disposal Method
Spent Claus Sulfur Recovery Catalyst (Activated Alumina)	Non-Hazardous	7 tons	Dispose at a non-hazardous waste landfill.
Claus Catalyst Support Balls (Activated Alumina)	Non-Hazardous	3 tons	Recycle
Spent Sour Shift Catalyst (Cobalt Molybdenum)	Non-Hazardous	67 tons	Send to reclaimer for metals recovery.
Spent Titania (TiO_2)	Non-Hazardous	2 tons	Send to reclaimer for metals recovery.
Spent Hydrogenation Catalyst (Cobalt Molybdenum)	Non-Hazardous	2 tons	Send to reclaimer for metals recovery.
Hydrogenation Catalyst Support Balls (Alumina Silicate)	Non-Hazardous	1 ton	Recycle
Spent SCR Catalyst (Titanium, vanadium, tungsten, combustion contaminants, and inert ceramics)	Hazardous	TBD	Return to supplier to reclaim/dispose.
Spent CO/VOC oxidation catalyst (Noble metals, other inerts, and combustion contaminants)	Non-Hazardous	TBD	Send to reclaimer for noble metals recovery.
Amine Regenerator Carbon Filter TGTU (Activated Carbon)	Hazardous	26 tons	Stabilize and dispose at a hazardous waste landfill.
Spent Mercury Removal Carbon Beds (Impregnated activated carbon)	Hazardous	14 tons	Stabilize and dispose at a hazardous waste landfill.
Sour Water Carbon Filter (Activated Carbon)	Hazardous	48 tons	Stabilize and dispose at a hazardous waste landfill
ZLD Filter Cake (Inorganic and organic salts)	Hazardous	5200 tons	Stabilize and dispose at a hazardous waste landfill
Refractory Brick and Insulation	Probably Non-Hazardous	360 tons	Characterize and dispose at a non-hazardous or hazardous waste landfill.
MDEA Sludge TGTU	Hazardous	2,000 gallons	Dispose at an incinerator or hazardous waste landfill.
Sour Water Sludge	Hazardous	30 tons	Dispose at an incinerator or hazardous waste landfill.
Waste Char and Ash	Non-Hazardous	160 tons	Dispose at a non-hazardous waste landfill.
Amine Absorber Residues TGTU (Iron and salts)	Non-Hazardous	20 cubic yards	Dispose at a non-hazardous waste landfill.
Spent Caustic	Hazardous	400,000 gallons	Offsite treatment to oxidize sulfides to sulfates. Adjust pH and dispose as non-hazardous.
Spent Sulfuric Acid	Hazardous	14,000 gallons	Hazardous waste disposal facility. May need to adjust pH first and re-characterize.
Off-Line Combustion Turbine Wash Wastes (Detergents and residues)	Hazardous or Non-Hazardous	15,000 gallons	Characterize and dispose as non-hazardous or hazardous waste.
HRSG Wash Water (Infrequent) (Detergent, residues, neutralized acids)	Hazardous or Non-Hazardous	100,000 gallons	Characterize and dispose as non-hazardous or hazardous waste
Raw Water Treatment Sludge and Used Water Filter Media	Non-Hazardous	TBD	Characterize and dispose as non-hazardous or hazardous waste.

Table 2-21
Summary of Operating Waste Streams and Management Methods[1]

Waste Stream	Waste Classification	Anticipated Annual Amount	Disposal Method
Used Oil	Hazardous or Non-Hazardous	8000 gallons	Recycle. Expected to meet the regulatory exemption for used oil when recycled.
Spent Grease	Hazardous	16 55-gallon drums	Characterize and dispose as hazardous waste.
Miscellaneous Filters and Cartridges	Hazardous or Non-Hazardous	150 cubic yards	Characterize and dispose as non-hazardous or hazardous waste.
Miscellaneous Solvents	Hazardous	2 55-gallon drums	Recycle or disposal as hazardous waste.
Flammable Lab Waste	Hazardous	2 55-gallon drums	Characterize and dispose as hazardous waste.
Waste Paper and Cardboard	Non-Hazardous	320 cubic yards	Recycle
Combined Industrial Waste (Used PPE, materials, small amounts of refractory, slurry debris, etc.)	Non-Hazardous	320 cubic yards	Dispose at a non-hazardous waste landfill.
Gasification solids (Solid slag-like product)	Anticipated to be excluded or Non-Hazardous	51,000-248,200 standard tons (wet); 25,550-124,100 standard tons (dry)	Reuse, reclaim sellable metals, or characterize and dispose at a non-hazardous or hazardous waste landfill.

Source: HECA Project
Notes:
[1]All numbers are estimates.
HRSG = heat recovery steam generator
MDEA = methyldiethanol amine
PPE = personal protective equipment
SCR = selective catalytic reduction
TGTU = tail gas treating unit
ZLD = zero liquid discharge

2.4.16 Storm Water Management

Storm water management for the Project will be designed to avoid direct discharge to surface waters. Clean storm water runoff will be routed to an on-site storm water retention pond before it is used as makeup water to the cooling towers. Potentially contaminated water will be treated as appropriate and either used for cooling tower makeup or used for gasifier slurry water makeup.

Project Site storm water runoff in non-process areas will be routed to a retention pond capable of holding the site runoff from a-once-in 50 years, 24-hour duration storm event. Any rainfall in excess of this event would overflow to the existing off-site drainage. A preliminary site drainage plan is presented in Figure 2-30, Preliminary Storm Water Drainage Plan.

Storm water from non-process areas should be relatively clean and can be used as makeup water with little treatment. Runoff from process areas will be separately collected and treated or (at a minimum) tested to determine if contaminant concentrations are within the acceptable criteria for reuse.

Storm water generated at the Project will be managed as follows:

- Non-contact storm water runoff outside the power block and process areas will be routed to the storm water retention pond. After solids have settled and water is determined to be suitable for reuse, storm water will be filtered for suspended solids removal before being used as cooling tower makeup water. If this collected storm water is determined to be contaminated and unsuitable for cooling tower use then it will be reused in the slurry preparation area.
- Storm water that may be contaminated with oil will be separately collected and routed to an oil/water separator. Recovered waste oil from the separator will be disposed off-site in accordance with applicable LORS. The separated water will be reused or disposed as described above.
- Storm water runoff from chemical and oil storage areas will be held within the associated secondary containment. Storm water held in these areas will first be tested. If it is acceptable for cooling water makeup, then it will be routed to the retention pond. Oily storm water will be routed through an oil/water separator.
- The solids handling water collection system will capture runoff (storm water and washdown water) from solids handling areas, which include gasification, gasifier solids temporary storage, and inactive feedstock storage. The collection facility will be constructed of concrete, and will provide for mobile equipment access to remove accumulated solids. Water that accumulates within the solids handling collection facility will be reused as make-up to gasification.

A Storm Water Pollution Prevention Plan (SWPPP) will be developed prior to operations. The Project storm water runoff will be managed in accordance with this plan, which will include the measures outlined above.

2.4.17 Control System

The Project Control System will require the integration of many available technologies related to sensors, control elements and data acquisition and control (as shown on Figure 2-31, Control System Block Diagram). It is intended to assemble the total system so that the Plant Operations Personnel will have the best control and monitoring capabilities available with modern technology. The Project will be designed around a DCS supported by auxiliary systems to allow personnel to analyze Project conditions and react to upset conditions within the shortest period of time. Multi-level system architecture will be provided with security levels between each level in order to prevent accidental manipulation of Project operations.

The overall design of the instrumentation and control systems will be in accordance with applicable national and local standards such as IEEE, NFPA, and ISA. Electrical equipment and components will also be purchased requiring third party approvals from Underwriter's Laboratories (UL), Factory Mutual Research Corporation (FM), or Canadian Standards Association (CSA) as required.

2.4.18 Project Buildings

Essential buildings and kiosks will be provided on-site to facilitate the hourly operating requirements. The Project will be established on a "stand alone" basis for certain key infrastructure items as shown by the Project components listed below. The buildings and kiosks located on the Project Site will likely include:

- Control room and laboratory
- Fire hall and emergency first dispatch center
- Power distribution centers
- Instrument and control kiosks
- Analyzer shelters/kiosks
- Solids handling maintenance and warehouse
- Operator shelters
  - Solids handling
  - Power block
- Administration building
- Warehousing
- Guard houses

2.4.18.1 Security Systems

A motorized operator will control the main gate. The main gate operator will include inputs from control room and receptionist switches, exit loop, and a local keypad or card reader station. An intercom system will be provided to allow voice communications between the main gate and the control room and receptionist area. The main gate intercom station will be located with the local keypad or card reader.

2.5 PLANT OPERATING SCENARIOS AND EMISSIONS

2.5.1 Normal Operations

The Project will operate as a baseload low-carbon power generation facility using hydrogen-rich fuel. The gasification unit has three GE quench gasifiers: two are normally operating and one is a spare. This configuration will maximize the availability of hydrogen-rich fuel sufficient to baseload the GE Frame 7FB CTG. Depending on the gasifier feedstock, surplus hydrogen-rich fuel may be available for duct firing in the HRSG. If only one gasifier is operating, the GE Frame 7FB can be co-fired with natural gas. The allowable co-firing range is from 45 percent hydrogen-rich fuel to 90 percent hydrogen-rich fuel. The CTG can also operate on 100 percent hydrogen-rich fuel or 100 percent natural gas. The GE Frame 7FB CTG can operate across its emission compliance load range of 60 to 100 percent of baseload on either hydrogen-rich fuel or natural gas. The HRSG can be duct fired on either surplus hydrogen-rich fuel or natural gas. Duct firing is only allowed during baseload CTG operation.

An auxiliary simple cycle CTG (GE LMS100®) is provided to supply plant power when the combined cycle block is not available. The simple cycle CTG is designed to operate independently from the rest of the facility and can be used to supply additional export peaking power when needed. The auxiliary simple cycle CTG requires high pressure natural gas and the natural gas compressor will be operated whenever the auxiliary simple cycle CTG is operated.

Table 2-22, Project Emissions Summary for Normal Operations, presents a summary of the steady state emissions and emission control devices associated with the normal operating modes discussed above. Figure 2-32, Preliminary Emissions Sources Plot Plan, identifies the emission sources on the Project Site plot plan. Figure 2-33, Block Flow Diagram with Air Emission Sources, shows the process sequence and emission points for the Project.

Table 2-22
Project Emissions Summary for Normal Operations

Pollutant	Total Annual (ton/yr)	HRSG Stack Maximum[1] (ton/yr)	Auxiliary CTG (ton/yr)	Cooling Towers[2] (ton/yr)	Auxiliary Boiler (ton/yr)	Emergency Generators[3] (ton/yr)	Fire Water Pump[4] (ton/yr)	Ground Flare (ton/yr)	Elevated Flare (ton/yr)	Tail Gas Thermal Oxidizer (ton/yr)	CO_2 Vent (ton/yr)	Gasifier (ton/yr)	Feedstock[5] (ton/yr)
NO_X	199.0	167.2	17.4	--	1.7	0.2	0.1	4.3	0.2	5.9	--	2.1	--
CO	337.9	150.2	27.6	--	5.8	0.1	0.2	44.9	0.1	1.6	106.9	0.6	--
VOC	40.7	32.5	4.6	--	0.6	0.03	0.01	0.003	0.002	0.3	2.4	0.1	--
SO_2	42.5	29.2	3.8	--	0.3	0.001	0.0003	0.004	0.1	8.8	--	0.3	--
PM_{10}	148.6	99.7	20.6	24.1	0.8	0.01	0.001	0.01	0.004	0.4	--	0.1	2.9
$PM_{2.5}$ [6]	136.9	99.7	20.6	14.5	0.8	0.01	0.001	0.01	0.004	0.4	--	0.1	0.9
NH_3	100.0	75.9	24.1	--	--	--	--	--	--	--	--	--	--
H_2S	3.9	--	--	--	--	--	--	--	--	--	3.9	--	--

Source: HECA Project

Notes:

[1] Total annual HRSG emissions represents the maximum emissions rate from a composite firing scenario (all three fuels)

[2] Includes contributions from all three cooling towers

[3] Includes contributions from both emergency generators

[4] ** VOC emissions for fire pump engine are combined with NOx

[5] Feedstock emissions are shown as the contribution of all dust collection points

[6] Where $PM_{10} = PM_{2.5}$ it is assumed all PM_{10} is $PM_{2.5}$

CO = carbon monoxide
CTG = combustion turbine generator
H_2S = hydrogen sulfide
HRSG = heat recovery system generator
NH_3 = ammonia
NO_X = nitrogen oxide
PM_{10} = particles less than 10 micrometers in diameter
$PM_{2.5}$ = particles less than 2.5 micrometers in diameter
SO_2 = sulfur dioxide
yr = year
VOC = combustion turbine generator

2.5.2 Startup

This section describes a "cold" startup. A cold startup assumes the plant was shutdown for a period of time and the plant is at ambient conditions. This sequence assumes that all the necessary utility and support systems are already in service (Project distributed control system, fire protection and other safety systems, electrical switchyard and in-plant electrical distribution, water treatment, wastewater DWI, natural gas, steam, instrument and power plant air, purge nitrogen, etc.).

The IGCC takes 4 to 6 days from cold start to export of low carbon power. The following summarizes the startup sequences.

Once all the startup permissives are met, the GE Frame 7FB start signal is given and the gas turbine generator is used as a motor to rotate the gas turbine and accelerate it until the operation is self sustaining (static start). The gas turbine compressor is first partially loaded to provide enough air flow and duration to purge the HRSG. Following the purge, natural gas is introduced into the CTG combustors and the gas turbine operation becomes self sustaining and the static start is discontinued. Natural gas is required to startup the combustion turbine. When the gas turbine reaches 3,600 revolutions per minute (RPM), or "full speed, no load," it is synchronized with the electrical grid and the main breaker is closed. Shortly after the CTG is synchronized it is loaded to a minimum or "spinning reserve" load. All the preceding steps are executed automatically by the CTG's control computer. At this point the HRSG begins warming up and rapidly begins to produce steam. The steam is initially vented to the atmosphere and as pressure builds in the steam system the atmospheric vents close and the steam flow is diverted to the surface condenser. Once dry steam is available, the steam turbine startup sequence can be initiated. The steam turbine metal temperature determines how quickly the steam turbine can be loaded. The cold start sequence requires the CTG to operate at reduced load (below the emission compliance level) for up to 3 hours, based on manufacturer's literature. During this time the gas turbine load is slowly increased to match the steam temperature to the steam turbine metal temperature to heat the steam turbine while minimizing thermal stress. Once the gas turbine reaches the required load, steam is introduced to control nitrogen oxide formation. Once the SCR catalyst reaches the required temperature, ammonia injection is initiated and the HRSG stack emissions will fall to the required compliance levels. The CTG can then be loaded normally to baseload and the steam turbine will reach a load based on the available steam.

The ASU will require 3 to 4 days to startup and reach full capacity. Because the ASU operates at cryogenic conditions, the startup sequence includes an extensive cooldown and drying period. During this time, the Main Air Compressor (MAC) and Booster Air Compressor (BAC) will be operated to provide the "auto refrigeration" necessary to cool and dry the ASU. Near the end of the startup sequence, the ASU will begin producing LOX and LIN. The LOX is stored to provide a backup oxygen supply to cover a compressor trip or other short ASU outage. The LIN storage is provided as a backup supply for the purge nitrogen system. Once the ASU is producing enough oxygen to operate at least one gasifier, the LOX pumping and vaporization system can be started to make high-pressure oxygen vapor available to the gasification unit.

The AGR Unit is assumed to be ready to start (purged with nitrogen and with startup methanol levels established in the circulating system). Methanol circulation is started and the refrigeration system is started to begin cooling the methanol to normal operating temperature (approximately minus 40°F). This sequence is expected to take about 2 days and will complete at about the same time that sufficient oxygen is available to start a gasifier.

The SRU includes two conventional Claus reactor trains. Operation of the second Claus reactor train is not required if only one gasifier is operating, or if both gasifiers are operating on low sulfur coal/petroleum coke blends. This sequence assumes that both trains will be needed and that the first train is started up along with the single TGTU. The SRU reactor furnace is refractory lined. After an extended outage, both the refractory and the SRU catalyst require a gradual heating program that will take about 3 days. The heating is provided by firing natural gas with air in the reaction furnace. The combustion products flow through the reactor furnace, catalyst beds and boilers to the tail gas thermal oxidizer. During the refractory dryout/cure period, the hydrogenation reactor in the TGTU will also be preheated. The hydrogenation reactor catalyst requires pre-sulfiding which will be timed to complete when the SRU is feed-ready and the first gasifier is feed-ready. At the end of this sequence the amine circulation in the TGTU will be established and operating conditions will be established.

The gasifier vessels are refractory lined and require about 1 to 2 days to heat up to the temperature that allows oxygen and the feedstock to be introduced.

The shift reactors require warm up and pre-sulfiding before sour syngas (containing hydrogen sulfide) can be introduced. The shift reactor catalyst is heated by circulating hot nitrogen across the catalyst beds for about 2 days. The nitrogen is heated indirectly with a high pressure steam heater. Once the catalyst is hot, a small amount of sulfur containing compound is added to the circulating nitrogen. The pre-sulfiding is completed when traces of sulfur are detected in the effluent of the second shift reactor. The shift reactors are then isolated hot and ready for feed.

The carbon dioxide compression system will be purged and ready to compress carbon dioxide. The carbon dioxide compressor startup sequence will be timed to coincide with the time the AGR is producing carbon dioxide in sufficient quantity to allow sustained operation of the carbon dioxide compressor.

When the gasifier refractory reaches operating temperature, and the gasifier system has been purged with nitrogen, the gasifier can be started by introducing oxygen and a sulfur-free feedstock, then switching to the petroleum coke and/or petroleum coke-coal blend feedstock. Produced raw syngas is sent to ground flare until the system pressure and flow are stabilized. For normal start-up, the syngas sent to flare is essentially sulfur-free. The second gasifier can be started up as described above.

Syngas is diverted through the shift reactors and low-temperature gas cooling sections and then to AGR. The AGR unit solution will begin absorbing the carbon dioxide in the syngas. Once the carbon dioxide concentration in the "rich" solution reaches the required level, the flash drums will begin separating carbon dioxide vapor. This carbon dioxide will be washed to remove any traces of methanol and vented to the atmosphere.

Once sufficient hydrogen-rich fuel production is available, the GE Frame 7FB can initiate a switch either to co-firing or to 100 percent hydrogen-rich fuel. At this point, the startup is complete and normal operation begins.

Note that if the IGCC is being restarted after a short outage, when the equipment is still close to operating conditions, the durations of each step will be much shorter than indicated in the previous description.

2.5.3 Transient Operations

The Project normally operates with the combined cycle unit baseloaded on hydrogen-rich fuel. Transient operations associated with combined cycle load following are limited to the transition periods required to move from one operating mode to another. The following subsections describe the primary operating modes and the transient operations associated with them, as well as, outage scenarios that are likely during annual operation.

The gasifier reactors operate at severe conditions and the typical run length can be as short as one month. For planning purposes, the Project expects about 24 gasifier shutdowns and startups per year in total. A single gasifier shutdown and restart can normally be accomplished without shutdown or restart of the other process units. Most of these gasifier shutdowns are expected to be planned, based on on-line diagnostics and maintenance history. A single gasifier can be shutdown and switched to the spare gasifier in a few hours assuming that the spare gasifier has been heated up to operating condition. If the spare gasifier is cold then about 2 additional days of single gasifier operation will be required while the spare gasifier is preheated to operating temperature.

The GE Frame 7FB will automatically switch from hydrogen-rich fuel to natural gas on loss of hydrogen-rich fuel pressure. During normal operation there is a small excess of hydrogen-rich fuel production which is fired in the HRSG duct burners. This allows the amount of duct firing to vary with the normal variations in gasifier operation. When a single gasifier is shutdown, the duct firing will stop and the GE Frame 7FB CTG will switch to the co-firing mode. The CTG will continue to operate at baseload co-firing natural gas and hydrogen-rich fuel until the second (spare) gasifier is returned to operation. When sufficient hydrogen-rich fuel is available, the CTG will switch to 100 percent hydrogen-rich fuel and hydrogen-rich duct firing can be restored. If additional power is required, the HRSG can be duct fired with natural gas during a single gasifier operation.

The combined cycle unit can also operate on 100 percent natural gas with, or without, natural gas duct firing.

Combined cycle unit outages can either be planned or unplanned. Normal planned outages will be timed to occur with scheduled maintenance outages of the rest of the Project. Unplanned combined cycle outages can occur for a variety of reasons. A CTG shutdown will result in an immediate surplus of hydrogen-rich fuel which will be sent to the ground flare. The feed rate on the operating gasifiers can be reduced to minimum while the cause of the outage is being determined. If the combined cycle unit can be brought back online in a relatively short time, the Gasification Block will continue to operate until the power block is back online. The Gasification Block is defined as the Balance of Plant (BOP) and all the process units needed to produce on-spec hydrogen-rich fuel, carbon dioxide, and sulfur. If the combined cycle outage is expected to be long in duration, then the gasification block will be shutdown.

The gasification block can operate for limited periods (up to 3 days) without the combined cycle block operating. The gasification block auxiliary loads will be initially supplied from the grid following a GE Frame 7FB trip. The auxiliary simple cycle CTG can be started and loaded rapidly to provide the gasification block auxiliary loads.

2.5.4 Commissioning

Construction is initially scheduled by area and major equipment erection. Later construction transitions to completion by system in order to support turnover to the commissioning team. Commissioning is completed by system with the utilities (power, water, natural gas, steam, etc.) completed first. The major process units will be commissioned in a sequence that begins with the feed producing units and ends with the product producing units and systems.

The major gasification block units, including the ASU, consume substantial amounts of electrical power. The power block also needs to be highly reliable before commissioning on hydrogen-rich fuel begins. For these reasons the power block will be commissioned about 6 months ahead of the gasification block. The commissioning for the project will require four distinct phases which are described in the following sections.

2.5.4.1 Combined Cycle Unit Commissioning on Natural Gas

The combined cycle unit will be initially commissioned on natural gas. The GE Frame 7FB uses diffusion combustors with steam injection, rather than dry-low nitrogen oxide combustors, so the nitrogen oxide tuning procedure is the primary difference. The following list briefly describes the steps for commissioning on natural gas:

- First fire
- Green rotor run-in
- Support of steam blows
- Initial steam turbine roll
- Nitrogen oxide tuning with steam injection
- Water wash and simple cycle CTG performance and emissions testing
- Duct burner testing
- Installation of SCR and oxidation catalyst
- CEMS drift test and source testing
- Combined cycle functional testing
- Water wash and combined cycle performance testing and continuous operation test

2.5.4.2 Commissioning the Auxiliary Simple Cycle CTG on Natural Gas

The auxiliary simple cycle CTG (GE LMS100®) uses only natural gas and is provided with water injection for primary nitrogen oxide control. The following list briefly describes the steps for commissioning on natural gas:

- First fire
- Nitrogen oxide tuning with water injection
- Installation of SCR and oxidation catalyst

- CEMS drift test and source testing
- Water wash and performance and functional testing

2.5.4.3 Gasification Block and BOP Commissioning

The following description includes the activities that are expected to have air emissions. The description assumes that the major utility support systems are already operational (power distribution, firewater, power plant and instrument air, water treatment, steam, boiler feedwater, etc.). The key activities and events are listed below:

- Auxiliary boiler initial firing and burner tuning
- Auxiliary boiler source testing
- Auxiliary boiler operation to support gasification commissioning (typically when the combined cycle block is not operating)
- Operation of the combined cycle block in support of gasification block commissioning
- Operation of the auxiliary simple cycle CTG in support of gasification block commissioning (typically when the combined cycle block is not operating)
- Cooling tower operation supporting the ASU, combined cycle block, and gasification block
- Ground flare testing and operation in support of gasification block commissioning
- Elevated flare testing and operation in support of gasification block commissioning
- Gasifier testing and operation
- Testing and operation of the AGR, SRU, and TGTU
- Testing and operation of the carbon dioxide compression system

2.5.4.4 Combined Cycle Block Commissioning on Hydrogen-Rich Fuel

The combined cycle block will require additional testing and nitrogen oxide tuning with hydrogen-rich fuel. The testing will cover the range of natural gas/hydrogen-rich fuel blends and allowable load ranges. The combined cycle block is assumed to have been commissioned first on natural gas. The oxidation catalysts are assumed to be in service and active when the HRSG operating temperature is sufficient. The SCR catalyst and ammonia injection system are assumed to be operating whenever the SCR catalyst temperature is in the required range and operation is sufficiently stable. Ammonia injection may be off-line during the initial phases of nitrogen oxide tuning. The key activities and events that are expected to produce air emissions are listed below:

- Startup and shutdown of GE's Frame 7FB on natural gas
- Standby operation of the combined cycle block on natural gas
- CTG nitrogen oxide tuning on co-firing
- CTG nitrogen oxide tuning on 100 percent hydrogen-rich fuel

- CTG nitrogen oxide tuning on part load
- Water wash and performance testing on hydrogen-rich fuel
- Duct burner testing on hydrogen-rich fuel
- Source testing on hydrogen-rich fuel blends across the load range
- Functional testing including fuel transfers and load changes
- Plant wide performance test
- Plant wide operational reliability test

2.5.5 Plant Staffing

The operating staff will consist of management and engineers, shift supervision, and shift operating personnel. There will be five operating shifts with a shift supervisor and an operating/maintenance crew of approximately 10 people on each shift rotation basis. In addition to the operation and management personnel, the Project will require qualified staffing in the following areas: production planning; equipment maintenance; instrument, electrical and control support; material coordinating/inventory/procurement; health/safety/security/environmental protection; administrative support; benefit/human relations; training; laboratory; and other necessary functions. It is estimated that the Project will employ approximately 100 full-time workers, with about 50 to 60 shift workers, and the remaining day workers.

In addition to the permanent staff, there will be ongoing contract maintenance work for scheduled and un-scheduled outages. There are scheduled and unscheduled maintenance activities of the gasification system and contract maintenance will be involved in the routine startup and shutdown of the gasifiers. Also, the gasification block will follow the gas turbine scheduled inspection maintenance cycle, typically on an annual basis. The contract maintenance will typically include inspections and overhauls for the large compressors and rotating machinery, the combustion turbine, generators, electrical transmission equipment, the steam turbine and other steam generating boilers and heat exchangers, gasifier refractory repair and replacement, catalyst and sorbent change out, tower and vessel inspection, and repair/replacement of internals, as well as other non-routine maintenance.

There is truck traffic on a 24 hour basis in and out of the Project Site to deliver feedstocks (petroleum coke, etc.) and to export by-products (gasification solids, etc.). Facility design and management program will be established to include traffic control and employee/contractor/ visitor training requirements, hazard communications training, hazardous material storage, emergency response procedures and training, personnel protective equipment training. Environmental emissions and compliance monitoring and reporting systems will be based on federal, state, and local guidelines, as well as performance standards adopted by parent owners and by other responsible agencies.

2.5.6 Materials and Equipment Delivery During Operations

Table 2-23, Power Project Material Delivery, describes the delivery schedule and general, origination location of each product for the Project. The total maximum 300 truck trips per day, 150 in the morning and 150 at night.

Table 2-23
Power Project Material Delivery

Product	Mode	Product Origination	Maximum Delivery Interval
Petroleum Coke	truck	Santa Barbara/Kern County/ Los Angeles County	6-8/hour
Coal	truck	Wasco, California	6-8/hour
Fluxant	truck	Kern County	daily
Methanol	tanker truck – 6,700-gallon maximum load	Los Angeles Region	daily
Aqueous Ammonia	tanker truck – 6,700-gallon maximum load	Los Angeles Region	weekly
Caustic (AGR)	tanker truck – 6,700-gallon maximum load	Los Angeles Region	monthly

Note:
AGR = acid gas removal

The following are the anticipated delivery routes during operations:

- Petroleum Coke and Fluxant Route - from I-5 to westbound Stockdale Highway, left turn on southbound Morris Road (local road), right turn on westbound Station Road, left turn on southbound Tupman Road, then right turn to the Project Site and vice versa.
- Coal Route - from Wasco southbound Highway 43 to westbound Stockdale Highway, left turn on southbound Morris Road (local road), right turn on westbound Station Road, left turn on southbound Tupman Road, then right turn to the Project Site and vice versa.

2.6 PROJECT CONSTRUCTION

The following section describes the construction process for the Project Site and linear facilities.

2.6.1 Project Site Construction

Construction activities for the Project will occur throughout the 37-month construction period. Figure 2-34, Preliminary Temporary Construction Facilities Plan shows the on-site construction areas, including laydown and parking. On-site construction activities include clearing and grubbing of sparse vegetation (if present at the onset of construction), grading, hauling and layout of equipment, materials and supplies, Project construction and testing. The Project Site occurs in an area of relatively gentle rolling topography. Site grading will occur as necessary to form level building pads for major process units and achieve a cut/fill balance. The maximum cut and fill depths are estimated to be between 25 and 30 feet.

Construction site access will be via Tupman Road. The Project Site access road, storm water retention basin, and storm water interceptor channel (along the northern boundary of the site) will be constructed as part of initial site grading. The storm water interceptor channel will collect sediment carried by the site runoff during construction and route it to the storm water retention basin. Storm water and natural runoff from off-site will be directed through channels and/or culverts around the site boundary.

Figure 2-35, Preliminary Grading Plan, and Figure 2-36, Preliminary Paving Plan, show the proposed grading and paving at the Project Site.

2.6.1.1 Construction Planning

The Engineering Procurement Construction (EPC) contractor will be responsible for the design, procurement, and construction of the Project. The EPC contractor will select subcontractors for certain specialty work as required. A separate EPC contractor will be used for the ASU.

Modules fabricated off-site will minimize field construction and optimize the schedule.

2.6.1.2 Mobilization

The EPC contractor is expected to mobilize approximately in the first quarter of 2011. Project Site preparation work will include site grading and storm water/erosion control. Gravel and road base material will be used for temporary roads, laydown, parking, and work areas.

2.6.1.3 Construction Offices, Parking, Warehouse, and Laydown Areas

Mobile trailers or similar suitable facilities (e.g., modular offices) will be used as construction offices for owner, contractor, and subcontractor personnel. Construction laydown and parking areas will be within the 315 acre site as shown in Figure 2-34, Preliminary Temporary Construction Facilities Plan. All construction laydown areas, parking, and trailer areas will be covered with 6 inches of crushed rock.

Site access will be controlled for personnel and vehicles. A security fence will be installed around the site boundary, including the laydown area.

2.6.1.4 Emergency Facilities

Emergency services will be coordinated with the local fire department and hospital. An urgent care facility will be contacted to set up non-emergency physician referrals. First-aid kits will be provided around the Project Site and regularly maintained. At least one person trained in first aid will be part of construction staff upon mobilization. Fire extinguishers will be located throughout the site at strategic locations at all times during construction.

2.6.1.5 Construction Utilities and Site Services

During construction, temporary utilities will be provided for the construction offices, laydown area, and Project Site. Temporary construction power will be initially generator-powered and will transition to utility-furnished power. Area lighting will be strategically located for safety and security. Average construction water use is estimated to be about 10,000 gallons per day.

For construction activities including hydrotesting of the HRSGs and associated piping, a maximum daily water usage is estimated at 85,000 gallons. The hydrotesting of the HRSG and other piping is normally done toward the end of project construction after the mechanical construction is complete. The hydrotest water will be sampled and tested. Water with suitable chemistry will be routed to the storm water retention basin. Water that is not suitable for routing to the retention basin will be transported by truck to an appropriately licensed off-site treatment or disposal facility.

The EPC contractor will provide the following site services:

- Environmental health and safety training
- Site security
- Site first aid
- Construction testing (Non-Destructive Examination (NDE), hydro, etc.)
- Site fire protection and fire extinguisher maintenance
- Furnishing and servicing of sanitary facilities
- Trash collection and disposal
- Disposal of hazardous materials and waste in accordance with LORS
- Erosion control during construction activities
- Warehousing mitigation management logistics

2.6.1.6 Construction Materials and Heavy Equipment Deliveries

Both rail and major freeway access are available in the vicinity of the Project Site. Construction materials such as concrete, structural steel, pipe, wire and cable, fuels, reinforcing steel, and small tools as well as consumables will be delivered to the Project Site by truck.

Major equipment such as the gasifier vessels, absorber vessels, shift converters, CTG, STG, transformers, elements of the HRSG and other equipment will be delivered to the Project Site by special conveyance due to their weight and size.

Most large or heavy equipment will be transported to the area via Interstate 5 or by rail. Rail deliveries will be off-loaded and transported by a specialized heavy-haul contractor near Buttonwillow and hauled to the Project Site. Large pieces of apparatus will be barged in to the Port of Stockton and delivered to the Project Site by a heavy haul contractor.

2.6.1.7 Hazardous Materials Storage

Table 2-24, Hazardous Materials Usage and Storage During Construction Based on Title 22 Hazardous Characterization, and Table 2-25, Hazardous Materials Usage and Storage During Construction Based on Material Properties, lists each material and describes the approximate annual quantity needed and use of the material during construction. Hazardous materials generated during the construction period will be placed in properly identified and approved storage bins until they are recycled or disposed of off-site. The storage area will be adjacent to the construction warehouse. Hazardous materials and commodities for use on-site will be inventoried and stored in the warehouse or adjacent to it. Warehouse personnel will maintain the records for these materials.

Non hazardous refuse and construction rubbish will be sorted and stored in containers until removed from the Project Site for recycling or disposal.

Table 2-24
Hazardous Materials Usage and Storage During Construction
Based on Title 22 Hazardous Characterization[1]

Material	Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Stored	Storage Type
Diesel Fuel	Ignitability, Toxicity	Refueling construction vehicles and equipment	Laydown area	2,000 gallons	Tank
Acetylene, Oxygen, Other Welding Gases	Ignitability	Maintenance Welding	Temporary Gas Cylinder Storage Area	2,000 standard cubic feet	Cylinders of various volumes
Lead/acid and Alkaline batteries	Corrosivity, Toxicity	Power for Equipment	Warehouse/ shop area	<50 units	Unit
Paints, Solvents, Adhesives, etc.	Toxicity, Ignitability	Painting and Paint Removal, general construction activities	Temporary Chemical Storage Area	100 gallons/week	Drum
Gasoline	Ignitability, Toxicity	Refueling Construction Vehicles and Equipment	Warehouse/ Shop Area	2,000 gallons/week	Tank

Source: HECA Project.
Notes:
[1] All numbers are approximate.
[2] Hazardous characteristics identified per California Code of Regulations Title 22 §§ 66261.20 *et seq*., for hazardous wastes.

Table 2-25
Hazardous Materials Usage and Storage During Construction
Based on Material Properties[1]

Material	Potential Hazardous Characteristics[2]	Purpose	Storage Location	Maximum Stored	Storage Type
Lubricating Oil	Mildly Toxic	Lubricating Equipment Parts	Laydown area	200 gallons	Tanks
Cleaning Chemicals/ Detergents	Toxic, Irritant	Periodic Cleaning	Contained in storage tanks on equipment skids	1,000 pounds	Tanks and containers or equipment

Source: HECA Project.
Notes:
[1] All numbers are approximate.
[2] Potential hazardous characteristics based on material properties.

2.6.1.8 Construction Disturbance Area

The Project Site is presently unimproved, sparsely vegetated sage land that has been subjected to some disturbance and past construction and oil development use. It has very sparse native vegetation or natural habitat. The estimated acreages of land that will be occupied by construction of the Project is presented in Table 2-1, Project Disturbed Acreage.

2.6.1.9 Storm Water Runoff Prevention Plan

The Project Site erosion control will be accomplished through the use of strategically placed berms, swales, and culverts to redirect runoff toward the retention basin. Sand bag, filter bales, silt fences, and temporary dams will be installed to minimize the volume of sediment carried by storm runoff and to prevent the erosion of slopes and temporary drainage facilities. Grades will be designed to prevent the effects of ruts and ponding. Following each significant precipitation event, a site review of the effectiveness of the erosion control plan will take place. Storm water will be retained on-site for impoundment in the Storm Water Retention basin at the north-east corner of the Project Site (shown in Figure 2-34, Preliminary Temporary Construction Facilities Plan).

2.6.2 Transmission Line

The power generated by the Project will be connected to the existing PG&E system by constructing a single tower, double-circuit, 230-kV transmission line from the existing PG&E Midway Substation. The new transmission line will extend from the western edge of the Project Site to the north and west to the north side of the substation (shown on Figure 2-5, Project Location Map).

Approximately 75 steel poles are expected to be required for the 10-mile long electrical line interconnection. Construction of the interconnection line will consist of footing installations at 700-foot intervals, pole installation, insular and hardware installation, and pulling of conductor and shield wires. This double-circuit line will be connected to a new switchyard at the Project Site. The new transmission line interconnection will be placed in an approximately 150-foot right-of-way.

Construction of the new 230-kV transmission line interconnection will require approximately 4 months. It will be scheduled for completion and be operational in time for generation testing of the Project. Upgrades required within the PG&E Midway Substation will be performed by PG&E as required to accommodate the interconnection of the new transmission line to the Project Site.

2.6.3 Water Supply Lines

The Project's raw water requirement will be met using brackish water supplied from the BVWSD. The brackish water will be supplied from BVWSD's main trunk line, located in back of the West Side Drain and running roughly northwest to southeast from 7th Standard Road to Tupman Bridge. The brackish water will be treated on-site to meet all process and utility water requirements.

Potable water for drinking and sanitary use will be supplied from the West Kern Water District facility located at Tupman Road and SR 119 (shown on Figure 2-5, Project Location Map). The potable water pipeline will be placed in the same trench as the natural gas pipeline.

Water pipelines will be installed underground using cut and fill techniques. Installation of the water supply pipelines will involve typical construction activities, including: trenching; hauling and stringing of pipe along the routes; welding; radiographic inspection and coating of pipe welds; lowering welded pipe into the trench; hydrostatic testing; backfilling and restoring the approximate surface grade. Construction of the water pipelines is expected to take approximately 3 months to complete.

2.6.4 Natural Gas Line Interconnection

Natural gas will be supplied to the Project from either PG&E's or Southern California Gas Company's natural gas pipelines; both located about 5 miles southeast of the Project Site. The interconnect will consist of one tap off the existing natural gas line, one meter set, one service pipeline connection, and a pressure limiting station located on the Project Site

Construction of the natural gas pipeline interconnection will take approximately 3 months. It will be scheduled to be finished and operational in time to provide test gas to the Project. Construction will occur in accordance with a traffic management plan to minimize impacts to traffic traveling on Tupman Road and SR 119.

Construction of the natural gas pipeline interconnection will involve a variety of crews performing the following typical pipeline construction activities: hauling and stringing of the pipe along the route; welding, radiographic inspection, and coating of the pipe welds; trenching; lowering of the pipe into the trench; backfill of the trench; hydrostatic testing of the pipeline; tie-in to the existing pipeline, purging the pipeline; and cleanup and restoration of construction areas. Roads and right of ways will be restored to specifications of the Project and affected agencies. An access agreement with the county will be obtained for construction of the pipeline within the right-of-way.

The potable water pipeline will be within the same right of way as the natural gas pipeline. Every effort will be made to ensure the grade cuts will be restored to their original contours and that effected areas will be restored to the original state so as to minimize erosion.

2.6.5 Supercritical Carbon Dioxide Pipeline

Supercritical carbon dioxide produced by the Project will be routed via pipeline to the custody transfer point for injection into deep underground oil reservoirs for EOR and sequestration. The pipeline will extend no more than 2.5 miles off-site, and will be contained within the confines of company-owned land and not traverse any public rights-of-way or roads. The pipeline will be buried at least 5 feet below grade to minimize the likelihood of third-party disturbance, and will be protected by cathodic protection and provided with at least two leak detection systems.

Construction of the supercritical carbon dioxide pipeline will take approximately 3 months.

Construction of the supercritical carbon dioxide pipeline interconnection will involve a variety of crews performing the following typical pipeline construction activities: hauling and stringing of the pipe along the route; welding, radiographic inspection and coating of the pipe welds; trenching; lowering of the pipe into the trench; backfill of the trench; hydrostatic testing of the pipeline; tie-in to the existing pipeline, purging the pipeline; and cleanup and restoration of construction areas. Every effort will be made to ensure the grade cuts will be restored to their original contours and that affected areas will be restored to the original state so as to minimize erosion.

2.6.6 Combined Construction Workforce

Construction is expected to begin in the first quarter of 2011 and continue for 37 months. The schedule has been estimated on a single shift, 50-hour weeks, between the hours of 7 a.m. and 5:30 p.m., Monday through Friday. Additional hours and/or a second shift may be necessary to make up schedule deficiencies or to complete critical construction activities. During Project startup and testing, some activities may continue up to 24-hours per day, 7-days per week.

Most construction workers traveling to the Project Site from the south and east (e.g., Arvin, Taft, Bakersfield) will reach Tupman Road from SR 119 and Interstate 5. Construction workers traveling to the Project Site from the north (e.g., Buttonwillow, Shafter, Bakersfield) will reach Tupman Road via Stockdale Highway and Interstate 5.

Traffic management plans will be implemented for construction workers, shift changes, and hauling of oversize loads to the Project Site. Estimates of average and peak construction traffic during the on-site construction period, and traffic management for construction, are described in Section 5.14, Traffic and Transportation.

Table 2-26, Estimated Monthly Construction Workforce, shows the estimated construction labor by craft.

2.6.7 Combined Construction Equipment Requirements

Table 2-27, Construction Equipment Estimate, shows an estimate of construction equipment by type and by days of use per month.

Table 2-26
Estimated Monthly Construction Workforce

Hydrogen Energy California, Kern County Power Project
Rev. C
6/27/2008

Estimated Monthly Construction Workforce

FLUOR®

Months after Mobilization

Job Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
CRAFT																						
Boilermakers	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	9	15	15	15	29	32
Carpenters	0	3	3	3	8	8	8	35	48	58	85	85	87	87	87	87	150	136	141	141	141	128
Cement Finishers	0	0	0	0	0	0	0	5	8	11	16	16	16	16	16	16	16	13	16	16	16	13
Electricians	0	5	5	5	16	16	16	16	16	7	7	7	12	13	13	13	15	16	16	16	74	76
Insulation Workers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron Workers	0	1	1	1	4	4	4	13	17	19	28	28	29	51	62	84	87	84	90	102	119	150
Laborers	10	15	15	15	29	29	33	45	51	42	53	53	60	60	59	54	81	79	83	84	88	85
Millwrights	0	1	1	1	4	4	4	4	4	2	2	2	3	9	8	8	21	32	33	33	62	68
Operators	16	16	16	14	15	15	21	31	40	35	38	38	41	39	33	26	30	41	49	58	85	98
Painters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipefitters	0	1	1	1	4	4	4	67	131	129	129	129	130	83	19	19	53	85	150	213	422	502
Sheet Metal Workers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	3	3
Teamsters	0	2	2	2	5	5	6	6	6	4	4	4	5	5	5	3	4	6	6	6	6	6
Off plot Construction craft	6	6	6	6	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Craft Subtotal	**32**	**51**	**51**	**49**	**98**	**98**	**109**	**236**	**335**	**323**	**377**	**377**	**397**	**380**	**320**	**327**	**483**	**523**	**616**	**702**	**1060**	**1176**
STAFF																						
Management	4	4	7	7	7	7	11	15	15	19	34	41	49	52	60	60	60	75	82	90	97	105
Engineering	2	2	2	2	2	4	4	6	10	10	10	10	10	12	14	15	15	15	15	15	15	15
Document Control	2	2	2	2	2	2	4	4	5	5	5	5	6	6	6	6	6	6	6	6	6	6
Subcontractors Staff	3	5	5	5	10	10	11	24	34	32	38	38	40	38	32	33	48	52	62	70	106	118
Off plot construction staff	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Commissioning																						
Admin / Operating Staff																						
Staff Subtotal	**12**	**13**	**17**	**17**	**23**	**25**	**32**	**50**	**65**	**67**	**88**	**95**	**106**	**110**	**113**	**115**	**130**	**149**	**166**	**182**	**226**	**245**
Project Total	**44**	**64**	**68**	**65**	**120**	**122**	**141**	**286**	**400**	**390**	**464**	**472**	**502**	**490**	**433**	**442**	**613**	**672**	**782**	**884**	**1286**	**1421**
Schedule																						
Site Mobilization	▼																					
Site Prep/Piling	///	///	///	///	///	///	///															
Construction						///	///	///	///	///	///	///	///	///	///	///	///	///	///	///	///	///
Commissioning & Start-up																						

Job Category	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
CRAFT																						
Boilermakers	32	29	29	23	15	15	6	6	6	6	3	0	0	0	0	0	0	0	0	0	0	0
Carpenters	128	128	128	128	123	123	119	119	119	108	108	81	81	82	82	82	81	77	77	0	0	0
Cement Finishers	13	13	13	13	11	11	8	8	8	5	5	0	0	0	0	0	0	0	0	0	0	0
Electricians	76	154	157	157	156	184	185	214	242	249	276	275	224	176	138	110	52	37	37	0	0	0
Insulation Workers	0	0	0	2	3	5	8	10	12	13	16	16	16	18	16	15	8	5	5	0	0	0
Iron Workers	150	149	116	91	84	84	77	44	44	29	16	7	7	6	6	5	5	3	3	0	0	0
Laborers	85	84	86	85	77	78	79	78	79	81	81	69	67	68	67	65	61	47	47	0	0	0
Millwrights	68	62	62	50	32	32	14	14	14	15	10	4	4	4	4	4	4	2	2	0	0	0
Operators	98	94	96	89	80	82	79	75	76	76	67	56	53	37	35	26	22	17	17	0	0	0
Painters	0	0	0	0	0	7	9	10	12	14	15	15	17	19	19	17	10	7	7	0	0	0
Pipefitters	502	496	506	484	508	518	479	490	500	511	442	362	362	235	193	119	99	76	76	0	0	0
Sheet Metal Workers	3	3	3	3	2	2	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Teamsters	6	5	6	6	4	4	5	5	5	6	6	6	6	6	6	6	6	4	4	0	0	0
Off plot Construction craft	15	15	15	15	21	21	21	21	21	21	21	21	21	21	21	21	11	11	11	11	11	11
Craft Subtotal	**1176**	**1232**	**1216**	**1147**	**1115**	**1166**	**1089**	**1094**	**1139**	**1136**	**1068**	**912**	**859**	**673**	**589**	**471**	**358**	**285**	**285**	**11**	**11**	**11**
STAFF																						
Management	105	105	106	106	106	106	106	106	106	105	105	105	97	97	75	25	22	15	15	8	0	0
Engineering	15	15	15	15	15	15	15	15	15	15	15	15	15	15	10	10	10	10	5	5	5	5
Document Control	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5	5	5	4	3	2
Subcontractors Staff	118	123	122	115	112	117	109	109	114	114	107	91	86	67	59	47	36	29	29	1	1	1
Off plot construction staff	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
Commissioning						10	10	10	20	30	30	30	30	30	30	30	30	30	30	20	20	20
Admin / Operating Staff							40	40	40	40	50	50	50	75	75	75	87	87	87	87	87	87
Staff Subtotal	**245**	**250**	**250**	**243**	**241**	**256**	**288**	**288**	**303**	**311**	**314**	**299**	**286**	**292**	**257**	**194**	**191**	**177**	**172**	**126**	**117**	**116**
Project Total	**1421**	**1482**	**1466**	**1390**	**1356**	**1422**	**1377**	**1382**	**1442**	**1447**	**1382**	**1211**	**1145**	**966**	**845**	**665**	**550**	**462**	**457**	**137**	**128**	**254**
Schedule																						
Site Mobilization																						
Site Prep/Piling																						
Construction	///	///	///	///	///	///	///	///	///	///	///	///	///	///	///							
Commissioning & Start-up													///	///	///	///	///	///	///	///	///	///

Notes:
(1) These are approximate values
(2) Off plot include preliminary estimates for work performed outside of the plot (pipe and transmission lines)

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Table 2-27
Construction Equipment Estimate

Hydrogen Energy California, Kern County Power Project
Rev. C
5/19/2008

FLUOR®

Construction Equipment Estimate

TABLE X.X-X

Equipment	Number of Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
		Days of Use Per Month																																											
Truck Crane - Greater than 300 ton	38															1	1	1	1	1	2	2	2	3	3	3	3	3	3	3	2	2	1	1											
Truck Crane - Greater than 200 ton	72												1	1	1	1	1	2	2	3	3	4	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	1							
Crane - Mobile 65 ton	119													1	2	4	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	5	5	4	4	3	2	2							
Cranes - Mobile 45 ton	74											2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	2	1	1							
Cranes - Mobile 35 ton	163							1	1	1	4	4	4	4	7	7	7	7	7	7	7	7	7	7	7	7	7	5	5	5	5	5	5	5	5	2	2	2	1	1	1	1	1	1	1
Bulldozer D10R	23	3	3	3	2	2	2	2	2	2	1	1																																	
Bulldozer D4C	26	3	3	3	3	2	2	2	2	2	2	1	1																																
Excavator - Trencher (CAT320)	0																																												
Excavator - Earth Scraper 623	28	8	8	6	6																																								
Excavator - Motor Grader (CAT140H)	16	3	3	2	2	2	2	2																																					
Excavator - Backhoe/loader	58	2	2	3	4	4	4	4	4	4	4	4	2	2	2	2	2	1	1	1	1	1	1	1	1	1																			
Excavator - loader	24	2	2	2	2	2	2	2	2	2	2	2	2																																
Vibratory Roller Ingersol-Rand 20 ton	40	5	5	5	5	2	2	2	2	2	2	2	2	2	2																														
Portable Compaction Roller	50			3	3	3	3	3	3				2	2	2	2	2	2	2	2	2	2								2	2	2	2	2	2										
Truck - Water	58	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
Forklift	76								1	1	1	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
Dump Truck	34	3	4	4	3	3	3	3	3	3	3	1	1																																
Service Truck - 1 ton	82	1	2	2	4	4	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Truck - Fuel/Lube	44	1	2	2	1	1	1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1							
Concrete Pumper Truck	20									1	1	2	2	2	2	2	2	2	1	1	1	1																							
Tractor Truck 5th Wheel	0																																												
Trucks - Pickup 3/4 ton	502	5	5	5	5	5	6	7	8	8	8	8	9	11	11	11	12	12	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	12	12	12	9	9	6	6
Trucks - 3 ton	159	1	1	1	1	1	1	1	1	2	2	2	2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4	3	1	1	1	1				
Diesel Powered Welder	101				1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	4	5	5	5	5	5	5	5	5	5	4	4	4	2	2	1	1	1	1	1	1
Light Plants	215					2	2	2	2	2	2	2	2	6	6	6	6	6	6	6	6	6	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4	4	4	3	3	3	3	3
Portable Compaction - Vibratory Plate	45								3	3	3	3	3	3	3	3	3	3	3	3	3	3	3																						
Portable Compaction - Vibratory Ram	0																																												
Articulating Boom Platform	0																																												
Pumps	89	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	1	1	1	1	1	1		
Air Compressor 185 CFM	0																																												
Air Compressor 750 CFM	97	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
Concrete Vibrators	38							1	2	3	3	3	3	3	3	3	3	3	2	2	1	1	1	1																					
Concrete Trowel Machine	26									2	2	2	2	2	2	2								2	2	2	2	2	2																
Fusion Welder	0																																												
Portable Power Generators	133	1	1	1	1	1	1	1	2	2	2	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	3	3	3	2	2	1	1	1	1	1	1	
Pile Driver Truck	15			1	3	3	3	3	2																																				
Fired Heaters	113					1	2	2	3	3	3	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4												
Heavy Haul / Cranes	32																				4	4	4	4	4	4	4	4																	
Cranes 100 / 150 ton cap	79												2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	2	1	1	1								
Misc equip for off plot construction (2)	364	6	6	6	6	12	12	12	12	12	12	12	12	12	12	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6	6	6	6	6	6	6	6	6
Project Total	**3053**	**52**	**55**	**57**	**60**	**57**	**59**	**63**	**66**	**67**	**69**	**74**	**75**	**84**	**89**	**86**	**88**	**88**	**89**	**93**	**97**	**99**	**96**	**98**	**98**	**99**	**98**	**96**	**92**	**90**	**83**	**82**	**79**	**74**	**68**	**58**	**53**	**41**	**31**	**30**	**29**	**25**	**25**	**21**	**20**
Schedule																																													
Site Mobilization																																													
Site Prep/Piling																																													
Construction																																													
Commissioning & Start-up																																													

Notes:

1 These are approximate values

2 Misc. equip for off plot include preliminary estimates for work performed outside of the plot (pipe and transmission lines)

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2.6.8 Combined Construction Traffic

During the construction phase, vehicular traffic will be created both on and off of the Project Site. This includes traffic generated from the following activities:

- Delivery of heavy equipment to the Project Site such as bulldozers and cranes
- Delivery of structures, construction material, and other equipment to the Project Site
- Daily commuting of construction workforce and managers
- Occasional visits from inspectors, officials, and regulators

General and heavy haul loads access to the Project Site will be from Tupman Road to the Project Site. Regional access to the Project Site will be via Interstate 5, which runs north-south to the east of the Project Site, and State Route 58, which runs east west and is located about 6 miles north of the Project Site. Direct access to the Project Site is provided by the following three routes:

- Construction Worker Route 1 – locally sourced or temporary workers lodging in Metro Bakersfield and nearby communities via westbound Stockdale Highway, left turn on southbound Morris Road (local road), right turn on westbound Station Road, left turn on southbound Tupman Road, then right turn to the Project Site and vice versa.
- Construction Worker Route 2 – locally sourced or temporary workers lodging in Metro Bakersfield and nearby communities via westbound Taft Highway (SR 119), right turn on northbound Tupman Road, then left turn to the Project Site and vice versa.
- Material Delivery and Construction Haul Route – westbound Stockdale Highway, left turn on southbound Morris Road (local road), right turn on westbound Station Road, left turn on southbound Tupman Road, then right turn to the Project Site and vice versa.

However, some of the heavy equipment is expected to be delivered via rail, due to the extreme weight and size. The rail line is located in Bakersfield, near the Project Site where these heavy loads will be transferred to heavy duty trailers. The Project will comply with Caltrans regulations and weight restrictions for state highways.

Based on peak workforce requirements and average vehicle occupancy rates of 1.3 people per vehicle, it is estimated that 2,308 vehicle round trips per day will result from construction worker traffic. In addition to the workforce traffic, an average of 300 Passenger Car Equivalent (PCE) truck deliveries per day is anticipated during the construction period. Due to the temporary nature of these impacts, and the fact that such impacts will be largely restricted to specific, relatively short time periods, it is not expected that long-term changes in traffic will occur.

It is anticipated that security measures will be required at the access gate to control construction traffic.

Table 2-27, Construction Equipment Estimate, shows the type of construction equipment that will be used continuously throughout the life of the Project, including O&M. It can be assumed that most of this equipment will also be used during the early construction phase of the on-site development. This equipment list includes trucks, cranes, bulldozers, excavators, rollers, forklifts, pumpers, etc.

Overall, traffic impacts associated with Project construction are not expected to be substantial.

2.6.8.1 Traffic Control Plan During Construction

An On-site Traffic Control Plan will be developed prior to construction. This plan will assist in the development of roads on-site, parking areas, security issues, and site access. Additionally, the plan will be used to develop protocol for the driving of large equipment on-site. Additional features of the plan may include the following:

- Using proper signs and traffic control measures in accordance with Caltrans, particularly as it pertains to nearby roads under their jurisdiction.
- Installing crossing structures if needed to avoid obstructing roads.
- Coordinating construction activities with appropriate jurisdiction such as the county if closures of major roads are necessary during transmission line or pipeline construction.
- Scheduling of traffic lane or road closures during off-peak hours whenever possible.
- Limiting vehicle traffic to approved access roads, construction yards, and construction sites.
- Constructing off-site pipelines in accordance with applicable state and local encroachment permit requirements and covering trenches in roadways during non-work hours.

A detailed traffic control plan, pursuant to Caltrans and county requirements, will be developed and submitted at the request of CEC. The Project will obtain the appropriate transportation-related permits prior to construction.

2.7 FACILITY SAFETY DESIGN

Inherently Safe Design Philosophy

The "Inherently Safer Design Process" will be implemented to deliver a safer design to the benefit of the Project asset. The Inherently Safer Design Process is focused on the following:

- Mitigate risks associated with inherent hazards
  - Throughout the work process: inherent hazards are identified, assessed, understood, documented and mitigated.
- Minimize causes and reduce severity
  - Opportunities to minimize risks at the source will be evaluated. This process includes identifying the actual risks and considering what is to be done to mitigate them. At the conclusion of this activity, a decision is made to implement those measures that are feasible and practicable and that are likely to reduce the potential severity of identified potential risks. This includes reducing on-site inventory of hazardous materials to the minimum necessary to support operations.
- Manage the Process to:
  - Increase equipment integrity, equipment reliability, and longevity to minimize the probability of an unwanted event occurring.

- Minimize risks throughout the design life of the Project.
- Make certain that the risk management strategy has been accepted by those who will implement strategy.
- Ensure timely implementation of effective and reliable combinations of the identified mitigation measures to make certain that the desired goals are achieved.

Health, Safety, Security, and Environmental Design Focus Areas

The overall goal of "Health, Security, Safety, and Environmental (HSSE) in Design" is to protect human health (employees, contractors, and the general public), the environment, and property against possible accidents (fires, explosions, liquid spills to ground or to water, or emissions to the air) resulting from the failures of facilities or components on the site.

The main focus of HSSE in Design is to ensure that adequate measures are used to minimize the risks and to mitigate the consequences of accidental hazardous material releases, fires, or explosions. While the probability of these incidents occurring may be low, each potential risk will be addressed, and methods identified to minimize or eliminate them will be established.

During the course of the work (at a minimum) the following focus areas will be addressed:

- Review unit and component location, access, and spacing for O&M
- Internal Project road layout and operating unit set backs
- Fire water storage and distribution system
- Deluge System(s)
- Area/Unit fire and gas detection
- Identification of all materials requiring MSDS documents

Health, Safety, Security, and Environmental Goals

The Project's objective is to achieve exemplary HSSE performance within all of its business activities. This is summarized in the Project's HSSE goals:

- People will be motivated and empowered to work safely and protect their long term health.
- Processes will be provided to identify hazards and manage risks.
- Project will meet or exceed regulatory compliance requirements.
- Performance will be measured at all levels to ensure continuous improvement.

2.7.1 Natural Hazards

The Project will be planned, engineered, designed, constructed and operated to meet the requirements of all applicable LORS as described in detail in Appendix B, Design Criteria. An overview of hazards that will be addressed in the Project is provided below.

Earthquake

Brief summary of the local earthquake hazards:

- The Project Site is situated between two seismically active regions.

- The San Andreas Fault is located approximately 19 miles to the west.
- The groundwater level is approximately 70 feet below the lowest portion of the Project Site.
- The Project Site is susceptible to strong ground shaking during earthquakes on nearby faults.
- Due to the absence of groundwater, the potential for liquefaction is low to nil.
- Without site improvements, seismic-induced settlement could occur within the susceptible native, loose to medium dense sandy soils situated in the upper 50 feet of the site.
- Removal or improvement of the existing upper 10 feet of soils should reduce the anticipated seismic settlement to about 1/2 inch or less at the foundation level.

The Project Site is located in high earthquake zone and the mapped maximum credible accelerations and design response spectrum shall be determined from Section 1613 of IBC 2006.

The Project Site is located in Seismic Risk Zone 4. Structures, their foundations, and equipment anchors will be designed in accordance with the CBC 2007 and ASCE 7-05.

When there is conflict in code requirements, the most conservative requirements will govern. Also, the substation equipment will meet requirements of IEEE 693-1997 Recommended Practice for Seismic Design of Substations.

Floods

Based on Kern County, California Flood Insurance Rate Map (FIRM) dated 29 September 1986, the Project Site is in an unmapped area and is not in the 100-year flood zone.

Wind Loads

This basic design wind speed (3-second gust) is 85 miles per hour as per CBC 2007. Wind loads on structures, systems, and components will be determined from ASCE 7-05 and CBC 2007

2.7.2 Emergency Systems and Safety Precautions

2.7.2.1 Community and Stakeholder Awareness

The Project values the importance of community awareness in the Kern County area and will actively engage in dialogue with the community and various stakeholders to maintain public confidence in the integrity of Project’s operations and products and the commitment to HSSE performance.

HSSE issues will be identified by listening and consulting with employees, contractors, regulatory agencies, public organizations, and communities concerned. All communications will be responded to in a timely manner.

The Project Team will establish and maintain open and proactive communications with employees, contractors, regulatory agencies, public organizations, and communities regarding the HSSE aspects of the Project.

2.7.2.2 Emergency Preparedness

Project personnel will develop and utilize Project communications and response plans for emergency situations. Prior to any activity the response plan will be reviewed by the appropriate manager who will take necessary actions to prepare to respond to an emergency event. All plans will be coordinated with the local emergency response organizations within Kern County and the Bakersfield area in particular. Area hospitals and clinical medical services have been identified along with fire protection.

2.7.2.3 Specific Project Emergency Systems

The Project's auxiliary systems described below support, protect, and control the Project.

Fire Protection

See Section 2.5.5, Fire Protection, for details on the fire protection system for the Project.

Lighting System

The lighting system provides O&M personnel with illumination in both normal and emergency conditions. The system consists primarily of alternating current (AC) lighting, and includes direct current (DC) lighting for activities or emergency egress required during an outage of the Project's AC electrical system. Lighting fixtures will be directionally oriented, shielded, and hooded to minimize off-site migration of light. The electrical distribution system also provides AC convenience outlets for portable lamps and tools.

Grounding System

The Project's electrical systems and equipment are susceptible to ground faults, switching surges, and lightning, which can impose hazardous voltage and current on Project equipment and structures. To protect against personnel injury and equipment damage, the grounding system provides an adequate path to dissipate hazardous voltage and current under the most severe conditions. Bare conductor is installed below grade in a grid pattern, and each junction of the grid is bonded together by welding or mechanical clamps. The grid spacing is designed to maintain safe voltage gradients. Ground resistivity readings are used to determine the necessary grid spacing and numbers of ground rods. Steel structures and non-energized parts of Project electrical equipment are connected to the grounding grid.

Distributed Control System

The DCS provides control, monitoring, alarm, and data storage functions for Project systems.

The following functions will be provided:

- Control of the CTGs, STG, HRSGs, gasification and other process units, and balance-of-plant systems in a coordinated manner.
- Monitoring of operating parameters from Project systems and equipment, and visual display of the associated operating data to control operators and technicians.
- Detection of abnormal operating parameters and parameter trends, and provision of visual and audible alarms to apprise control operators of such conditions.
- Storage and retrieval of historical operating data.

The DCS is a microprocessor-based system. Redundant capability is provided for critical DCS components such that no single component failure will cause an outage. The DCS consists of the following major components:

- Visual display-based control operator interface (redundant)
- Visual display-based control technician workstation
- Multi-function processors (redundant)
- Input/output processors (redundant for critical control parameters)
- Field sensors and distributed processors (redundant for critical control parameters)
- Historical data archive
- Printers, data highways, data links, control cabling, and cable trays

The DCS is linked to any local control systems furnished by packaged equipment vendors.

Emergency Relief System

The Project is furnished with relief devices and two flares to protect equipment from overpressure. Any excess gas or liquid accumulated in equipment will be routed to the flares prior to building up pressure.

Cathodic and Lightning Protection System

Cathodic protection may be provided, using an impressed current or buried anode system to prevent corrosion of buried carbon steel piping and structures. Protective coatings are applied as primary protection and to minimize cathodic protection current requirements. The requirement for a cathodic protection system will be determined during detailed design. Lightning protection will be furnished for buildings and structures. Lightning protection for the switchyard will be installed in accordance with industry practice.

Personnel Protection Insulation

Though not required for process consideration, insulation will be provided on equipment and piping that operate above 140°F to avoid heat injury to personnel.

Instrument Air System

The instrument air system provides dry, filtered air to pneumatic operators and devices throughout the Project. Air from the service air system is dried, filtered, and pressure-regulated prior to delivery to the instrument air piping network. This ensures continual safe operation of the instrument controlling the Project operation.

Emergency Facilities

Emergency services will be coordinated with the local fire department and hospital. An urgent care facility will be contacted to set up non-emergency physician referrals. First-aid kits will be provided around the Project Site and regularly maintained. One nurse and at least one person trained in first aid will be part of the construction staff. In addition, all foremen and supervisors will be required to have first-aid training. Fire extinguishers will be located throughout the Project Site at strategic locations at all times during construction.

Fire Safety Program

Prior to the beginning of construction, the contractor, the owner, Project management, and the assigned operations and management staff will meet and develop a site-specific fire safety program which coordinates construction activity with the owner's existing procedures. The developed programs will be reviewed with local government emergency response organizations to ensure completeness and proper coordination.

Additional requirements that are unique to construction will necessitate the development of construction-specific programs. The construction contractor's safety program will include safety procedures that address Welding, Thermal Cutting, and Gas Cylinders; Fire Protection; and Emergency Response.

Emergency Response Procedures

Prior to commencement of construction activities, the contractor, the owner, Project management, and the assigned operations and management staff will meet and develop a site-specific construction emergency response program. A review of the developed programs with local government emergency response organizations will ensure completeness and proper coordination.

2.8 FACILITY RELIABILITY

The Project is designed for an operating life of a minimum of 30 years. O&M procedures will be consistent with industry standard practices to maintain the useful life status of Project components. The hydrogen-rich fuel availability for mature operation is estimated to be greater than 80 percent. The power availability for mature operation is estimated to be greater than 90 percent. The primary fuel to the gas turbine is hydrogen-rich fuel, with natural gas as a backup fuel when hydrogen-rich fuel is not available, due to, for example, maintenance of gasifier unit. The commissioning and startup period of the Project is expected to be completed within approximately 1 year from mechanical completion. Commercial operation will start when the commissioning and startup activities are completed and the licensor/contractor guarantees and milestones have been achieved. The ramp up period to maturity is estimated to be 3 years from the start of commercial operation.

In addition to the IGCC operation, a simple cycle gas turbine using GE LMS100® technology is used as a peaker and backup power supply for the IGCC. The design life is expected to be at least 30 years, and reliability is estimated to be 98 percent.

GE gasification technology for solid fuels has been demonstrated in many commercial applications worldwide. The GE gasification technology for 100 percent petroleum coke feed is currently utilized in the Valero Refinery in Delaware and the Coffeyville Resources Ammonia Plant in Kansas. The GE gasification technology for mixed petroleum coke and coal operation has been demonstrated at Tampa Electric IGCC in Florida and in different chemical plants in China.

The downstream unit technologies (including carbon monoxide sour gas shift reactors, Rectisol AGR technology, and Claus sulfur removal technology) have been demonstrated in commercial applications in the United States (including Eastman Chemical Plant in Tennessee) and many chemical plants in China (mostly ammonia and methanol plants).

The gas turbine technology employed in this project is the GE Frame 7FB. Both Tampa Electric and Duke Wabash (Indiana) IGCC facilities have been operating the 7FA gas turbine, which is substantially similar to the 7FB, on syngas over the last 10 years. The remaining components of the power block (HRSG, steam turbine, and generator) will employ conventional proven technology.

To incorporate the lessons learned from the existing IGCC in United States and worldwide, the following design features are included.

A constant supply of oxygen is important to reliable operation of the Project. This constant supply is achieved by installing LOX and LIN storage in the event of a short outage of the ASU.

Most existing solid feedstock IGCCs do not have spare gasifiers and, consequently their availability is typically at or below 80 percent. Chemical plant gasification units ordinarily have a spare gasifier or a spare gasification train, which results in high reliability (95% to 99%), as reported in the literature (Eastman Chemical Plant in Tennessee, Coffeyville Ammonia Plant, and many Chinese gasification units). In the Project design, there is one complete spare gasification train, including the slurry storage and pumping, the spare gasifier and slag removal, and black water handling system. Each gasification train will be shutdown on a planned basis to do the required maintenance. Because of the proactive scheduled maintenance, it is expected that unplanned outage of the gasification train can be minimized.

There are two SRUs in the design. In the event of the outage of one SRU, the other SRU can be ramped up to partially take up the duty. In the meantime, the feedstock can be adjusted to a lower sulfur blend so that the total throughput (in terms of power production) will not be compromised significantly by the outage of one of the two SRUs.

Because of the scheduled maintenance of the GE 7FB gas turbine, the entire IGCC complex will be shutdown when the power block is out of service. The remaining process block (AGR, Shift reactors, low temperature cooling section) has demonstrated high reliability in historical industry practice. However, in order to match the gas turbine outage schedule, the process block will also be shutdown during the gas turbine scheduled maintenance period. This offers an opportunity to perform much of the maintenance for the AGR and Shift systems in a manner that can further enhance the reliability of the Project

The simple cycle LMS100® gas turbine will enable peaking power supply during the times of high demand, as well as providing backup power supply for the gasification process block when the 7FB power block is not available, enabling the Project to come back to normal production status within a minimum period of time.

BP and Rio Tinto both have a long history of project execution and operating experience, as well as high standards of engineering and safety design criteria. The EPC contractor will be a reputable company, with experience in handling large capital projects. Comprehensive training and simulation programs will be established to ensure the integrity of the design and safety awareness of all O&M personnel.

2.9 REFERENCES

California Energy Commission. 2007. *2007 Integrated Energy Policy Report.* Report Number CEC-100-2007-008-CMF-ES.

Major Cities
Major Highways
State Boundaries
County Boundaries

N E S W

0 20 40 80 Miles

Sources:
ESRI (Counties, State Boundaries, Highways, Cities).

Vicinity

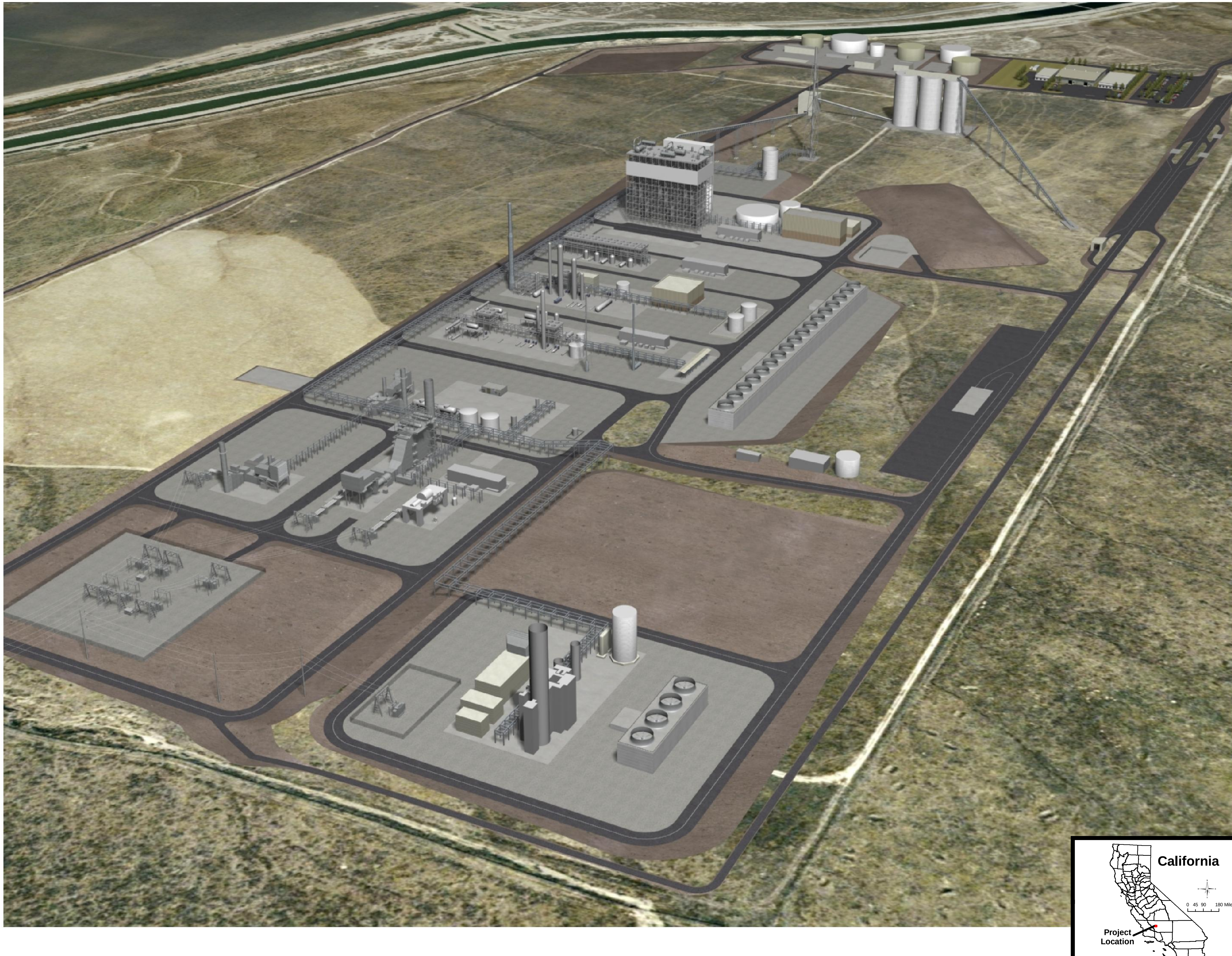
Hydrogen Energy California (HECA)

FIGURE 2-1

URS

Created July, 2008

Y:\GIS\Projects\BPAE_HECA_Kern_County\maps\Vicinity_Proposed_Projects\HECA_GIS_Vicinity.mxt



Source:
HECA project team.

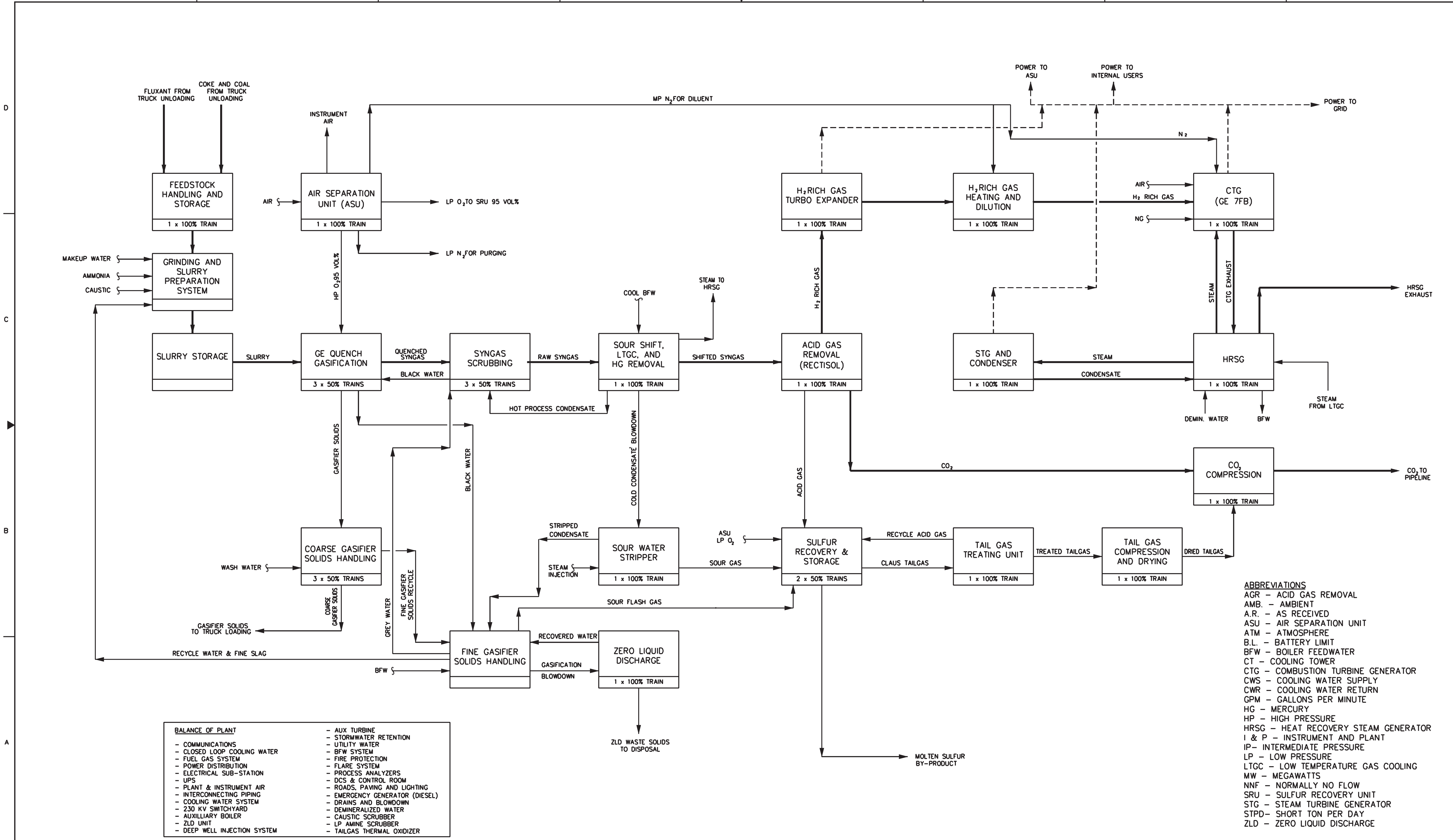
Project Artist Rendering

Hydrogen Energy California (HECA)

FIGURE 2-2

Created July, 2008

Y:\GIS\Projects\BPAE_HECA_Kern_County\maps\visual\HECA_Visual_Artist_Rendering.mxt



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CHECKED BY H. SANDLER
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LEAD ENGR/SPEC. G. SIMS — APP DATE 6/4/08
FLUOR W. BECKTEL — APP DATE 6/4/08
CLIENT HEI — APP DATE 6/4/08

HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-3
BLOCK FLOW DIAGRAM

SCALE NONE — DRAWING NUMBER A3RW-BFD-25-001 — REV 0

PLOT DATE:
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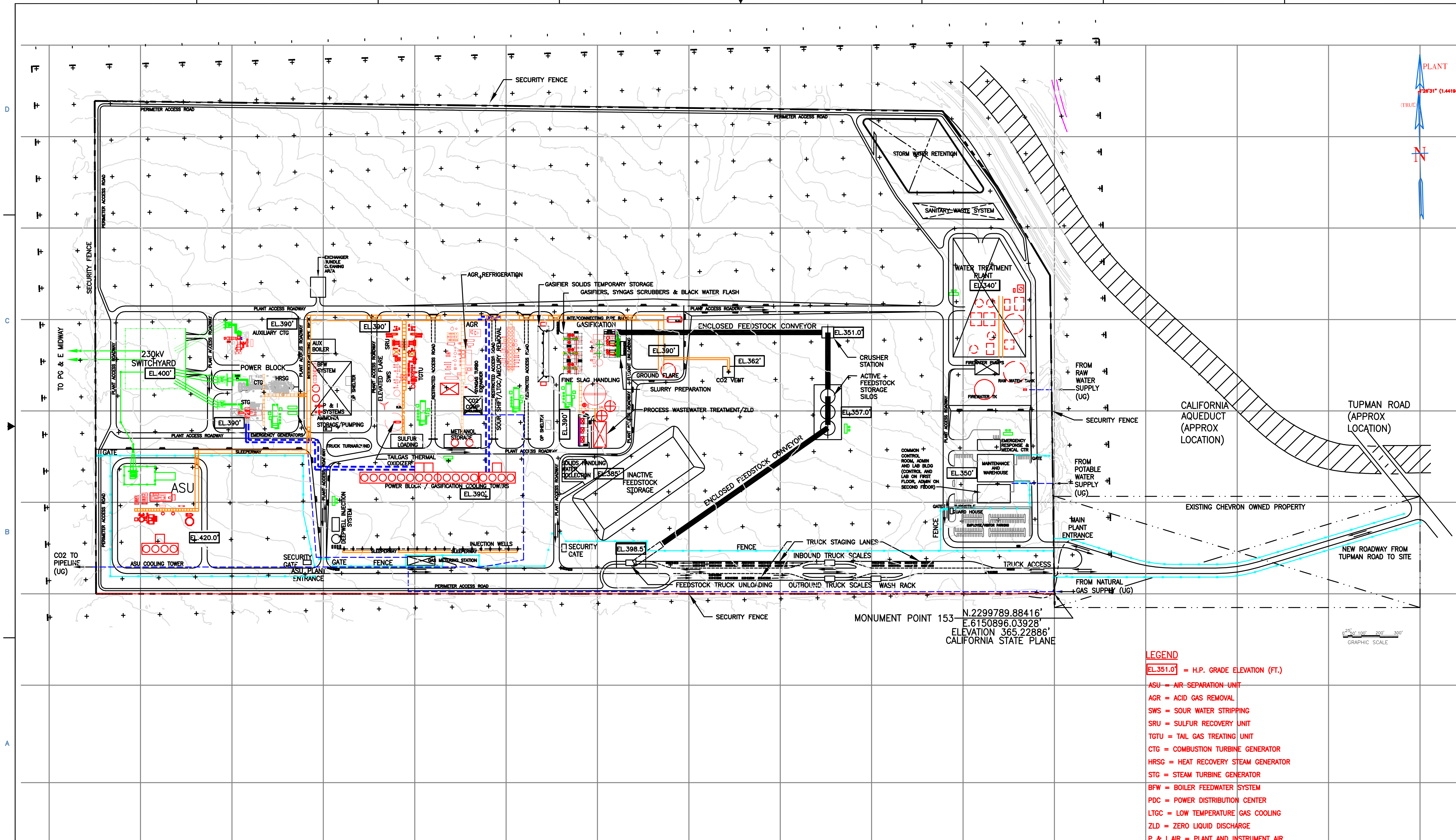

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							FROM D.WOOLLEY & ASSOCIATES – LAND SURVEYOR
						URS MAP, APR292008	HECA PROJECT SITE and TENTATIVE LINEARS (SITE UTILITIES MAP)

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HYDROGEN ENERGY CALIFORNIA KERN COUNTY POWER PROJECT

FIGURE 2-4 PRELIMINARY PLOT PLAN

SCALE 1:250
DRAWING NUMBER SK-250-0001
REV 0
CAD FILE NAME SK2500001_r0-OVA-PP.DWG

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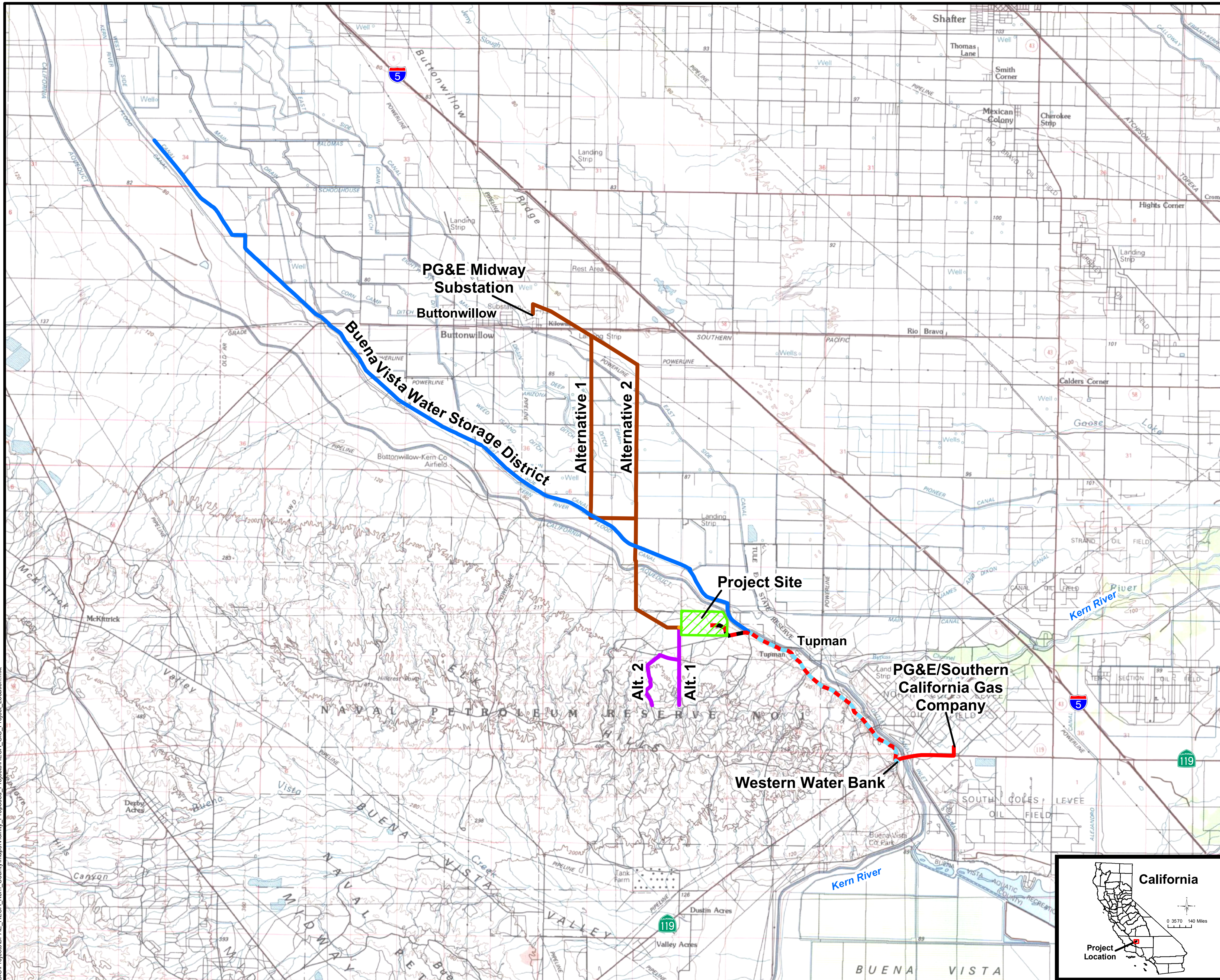
PLOT DATE:



Project Site
CO2
Natural Gas (NG)
Potable Water
Process Water
Potable Water/NG
Process & Potable Water/NG
Transmission
Transmission/CO2

0 1 2 4 Miles

Sources:
USGS (30'x60' quads: Taft 1982, Delano 1982). Created using TOPO!, ©2006 National Geographic Maps, All Rights Reserved.

Project Location Map

Hydrogen Energy California (HECA)

FIGURE 2-5

URS

Created July, 2008

Y:\GIS\Projects\BPAE_HECA_Kern_County\maps\Vicinity_Proposed_Projects\HECA_GIS_Project_Location.mxd

HECA Water Integration System Diagram (65℉)

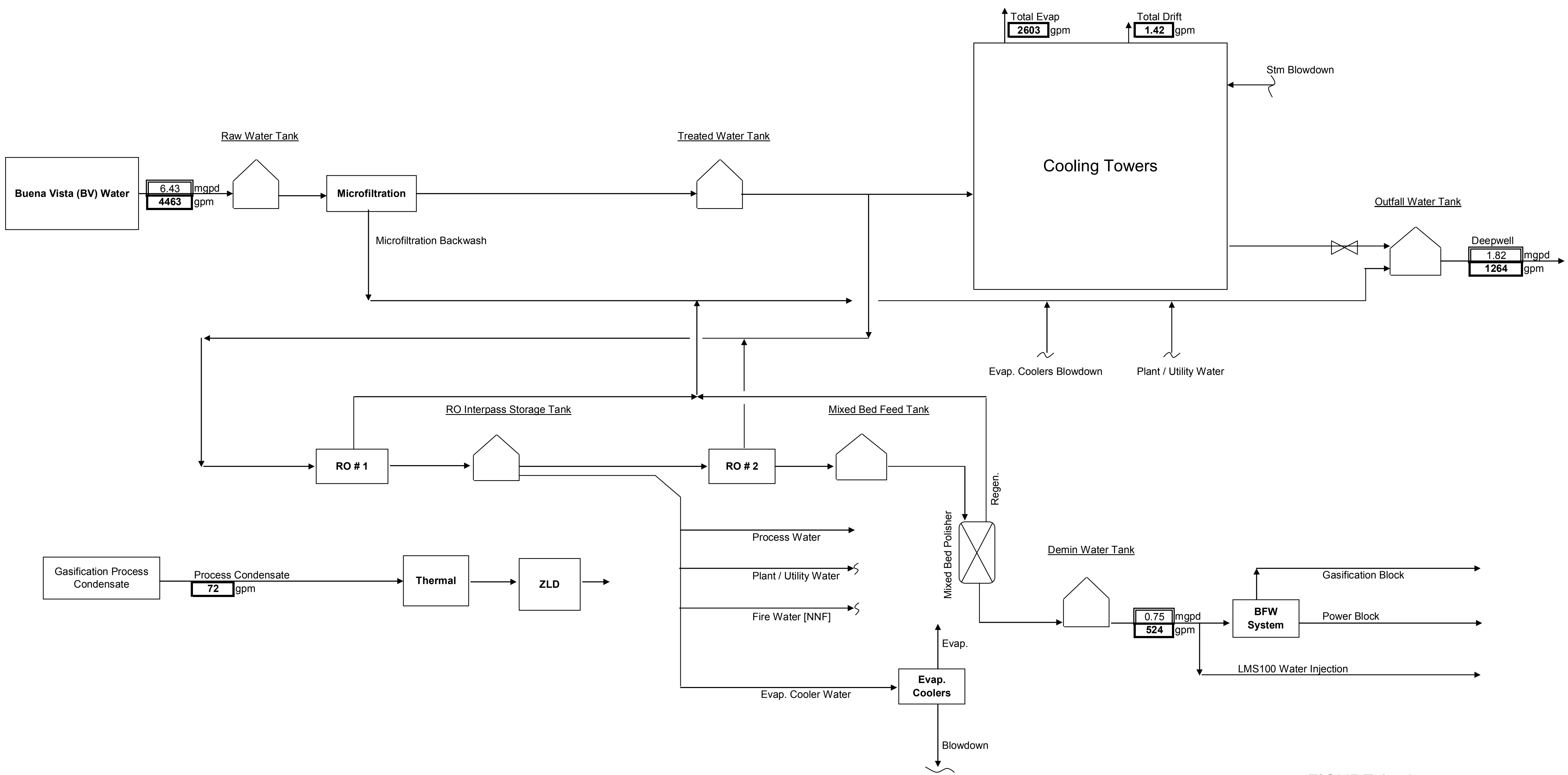


FIGURE 2-7A

Hydrogen Energy California Kern County Power Project	
Drawing Number: A3RW-PFD-25-013A	
Rev 0	Issued for Permitting: 6/26/08

HECA Water Integration System Diagram (97°F)

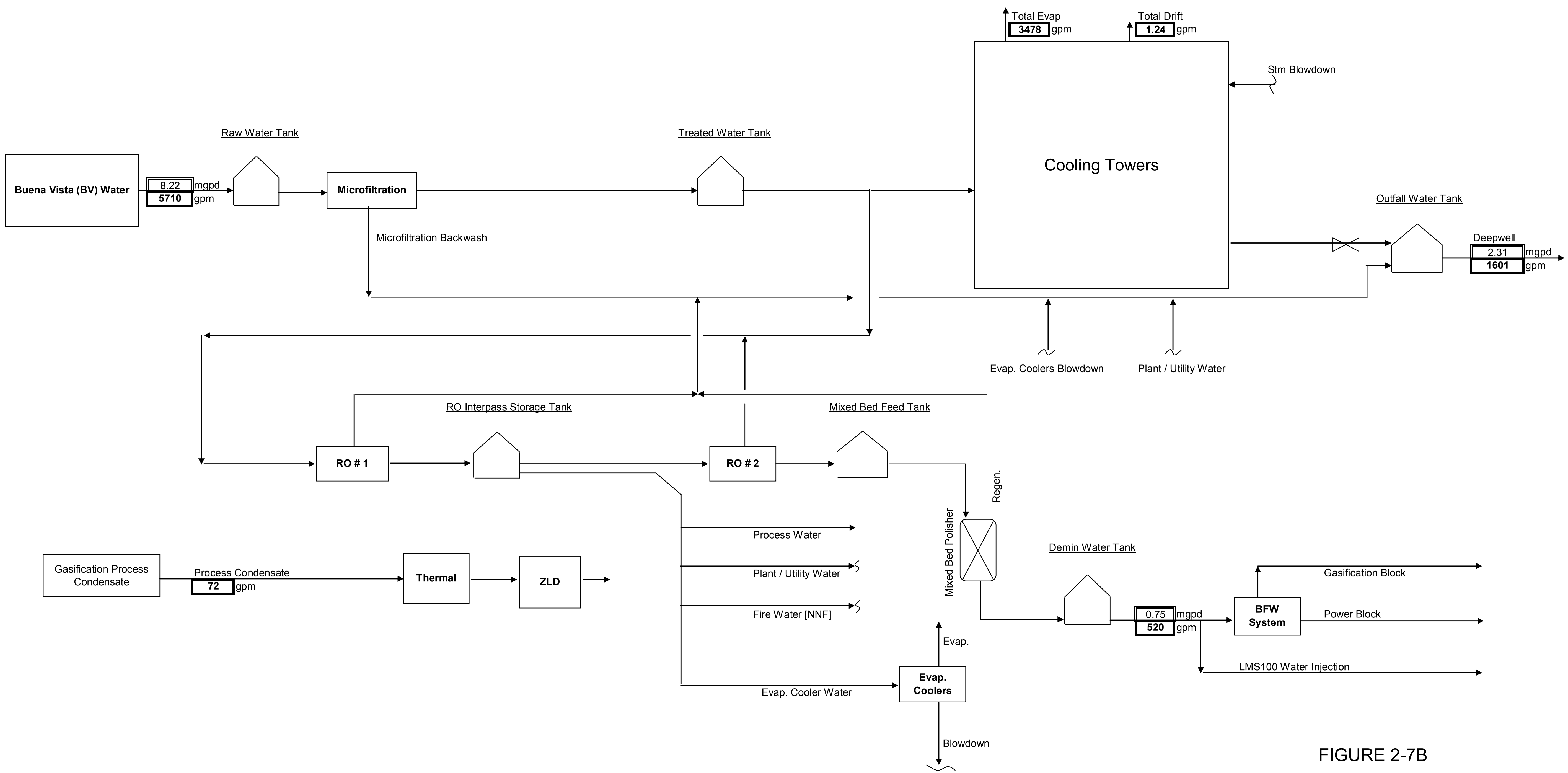


FIGURE 2-7B

Hydrogen Energy California Kern County Power Project	
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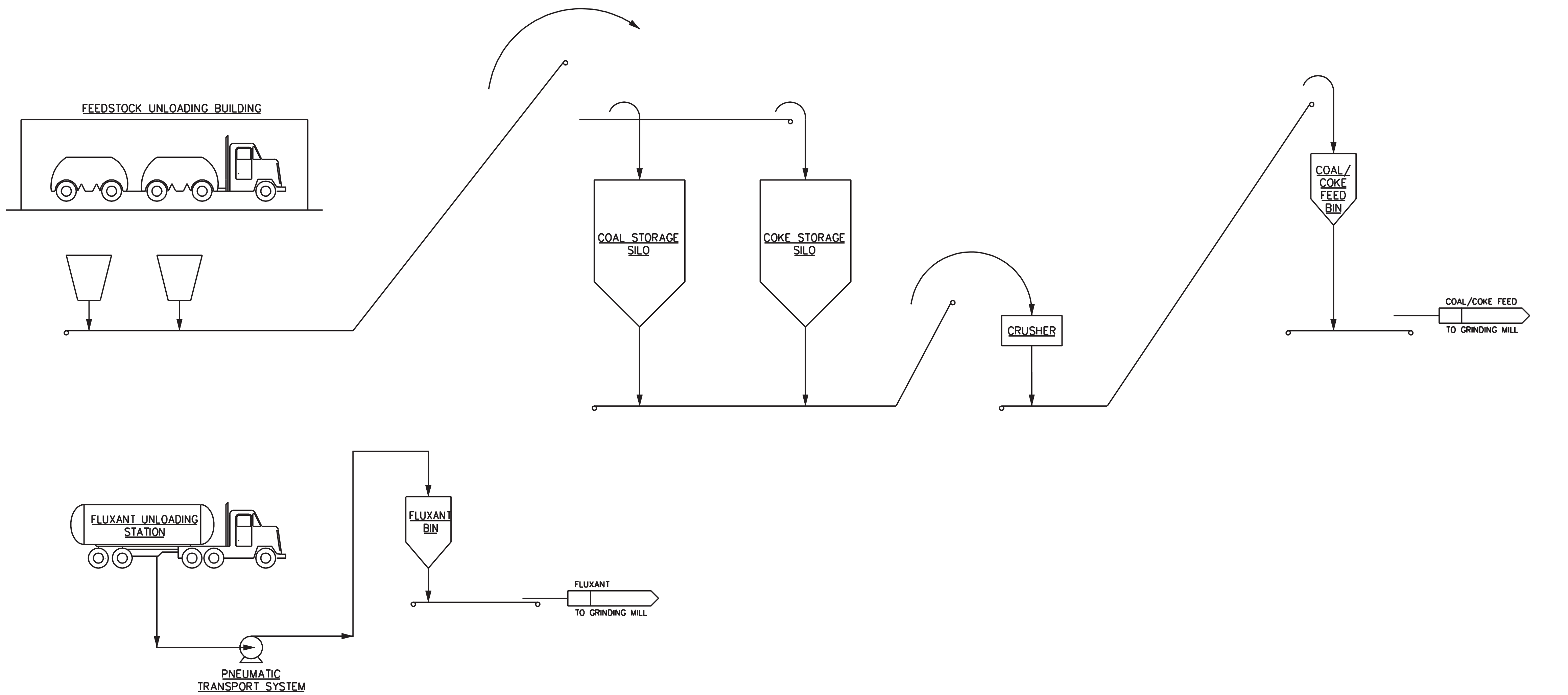
Rev 0	Issued for Permitting: 6/26/08



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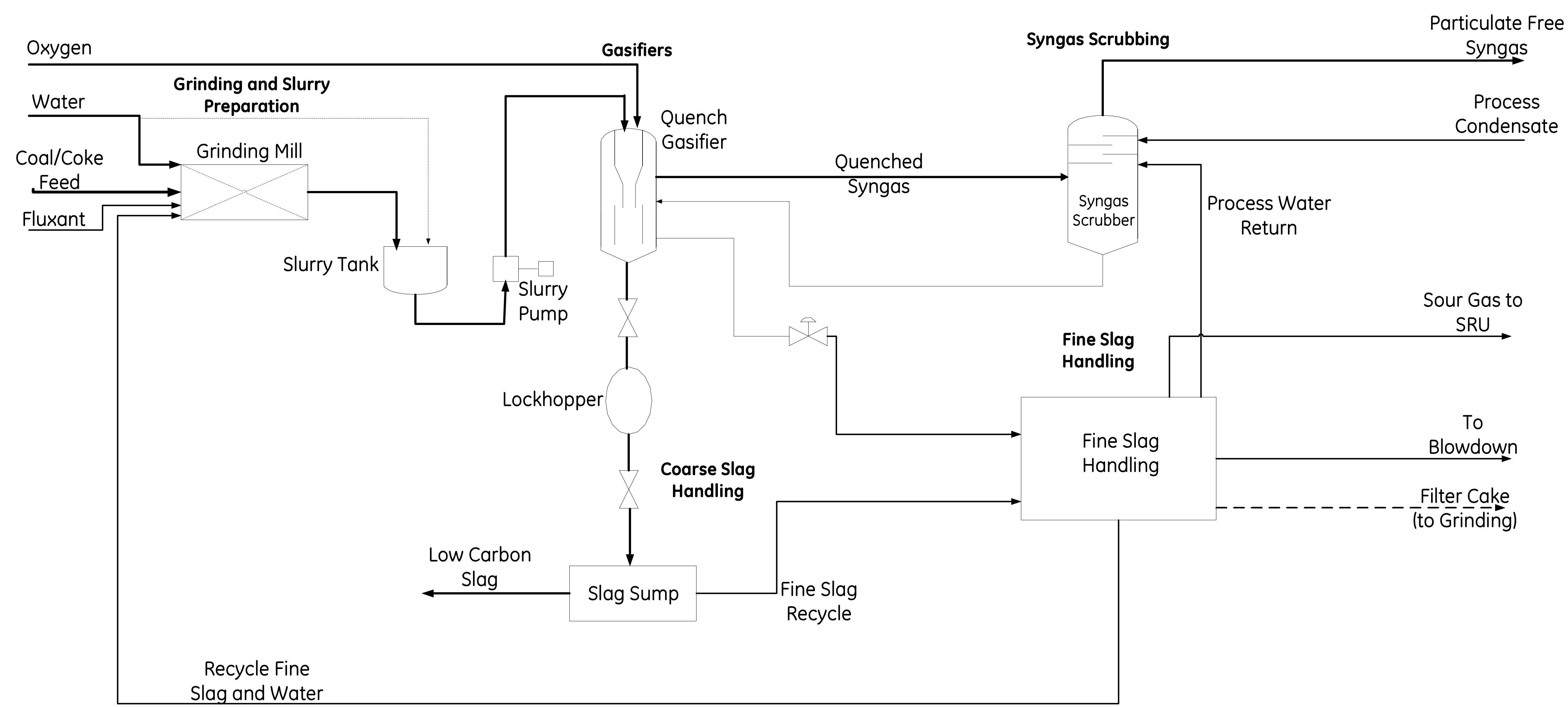
HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-8 FLOW DIAGRAM FEEDSTOCK HANDLING AND STORAGE

SCALE NONE
DRAWING NUMBER A3RW–PFD–25–003
REV 0
CAD FILE NAME .DWG
DIST CODE
SAP NWA

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐



GE ENERGY (USA) LLC
HOUSTON, TEXAS

NOTES:

REVISION

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0	Issued for Approval	12MAY08	RK	RK	DDF	

ISSUED	JLM	15MAY08
ENGINEER	RK	12MAY08
CHECKED	RK	12MAY08
APPROVED	DDF	12MAY08

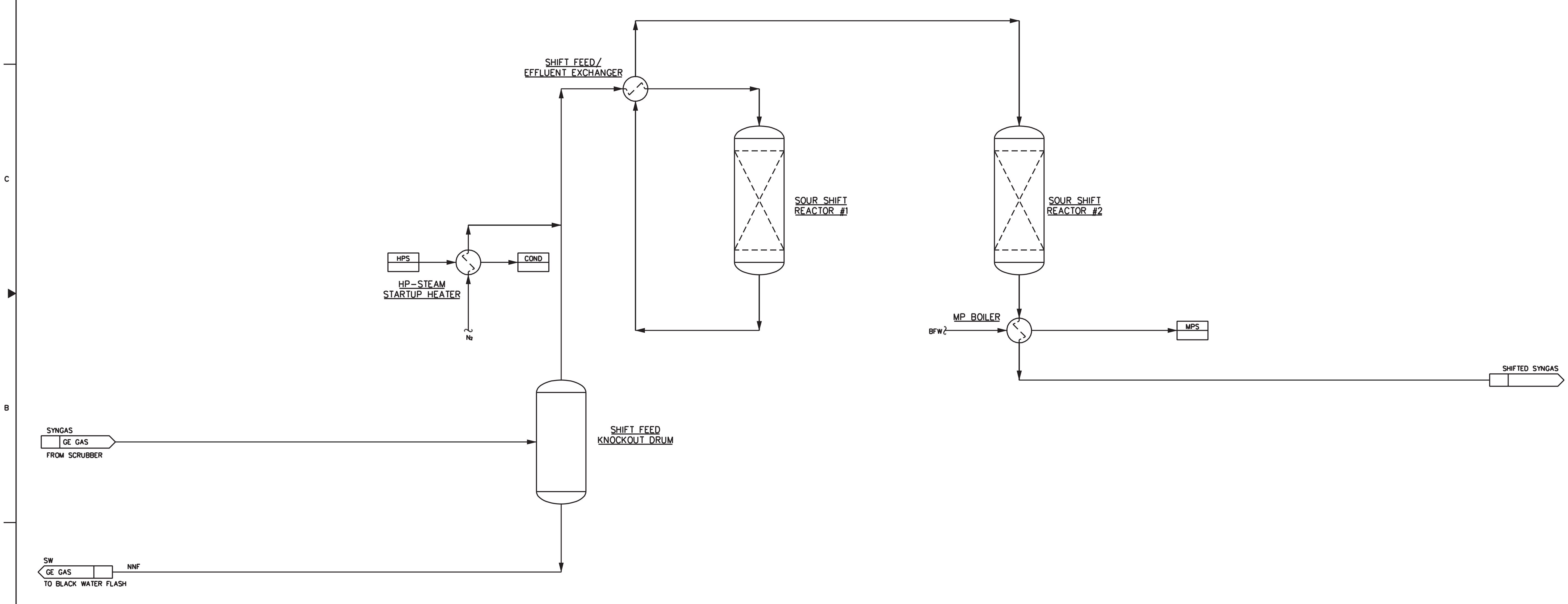
HYDROGEN ENERGY CALIFORNIA FEASIBILITY STUDY
BAKERSFIELD, CA
USA

FIGURE 2-9 GASIFICATION PROCESS SKETCH FOR PERMITS — SHEET 1 OF 1

SIZE: A — JOB NO.: JF0004 — GE DRAWING NO.: 334A2456 — REV: —

SCALE: N/A — ITEM NO.: N/A — REV: 0

DT-12C THIS DOCUMENT SHALL BE REVISED IN ITS ENTIRITY



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HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-10 FLOW DIAGRAM
SOUR SHIFT SYSTEM

SCALE NONE
DRAWING NUMBER A3RW–PFD–25–006A
REV 0
CAD FILE NAME A3RW-PFD-25-006.DWG
SAP NWA
DIST CODE

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐

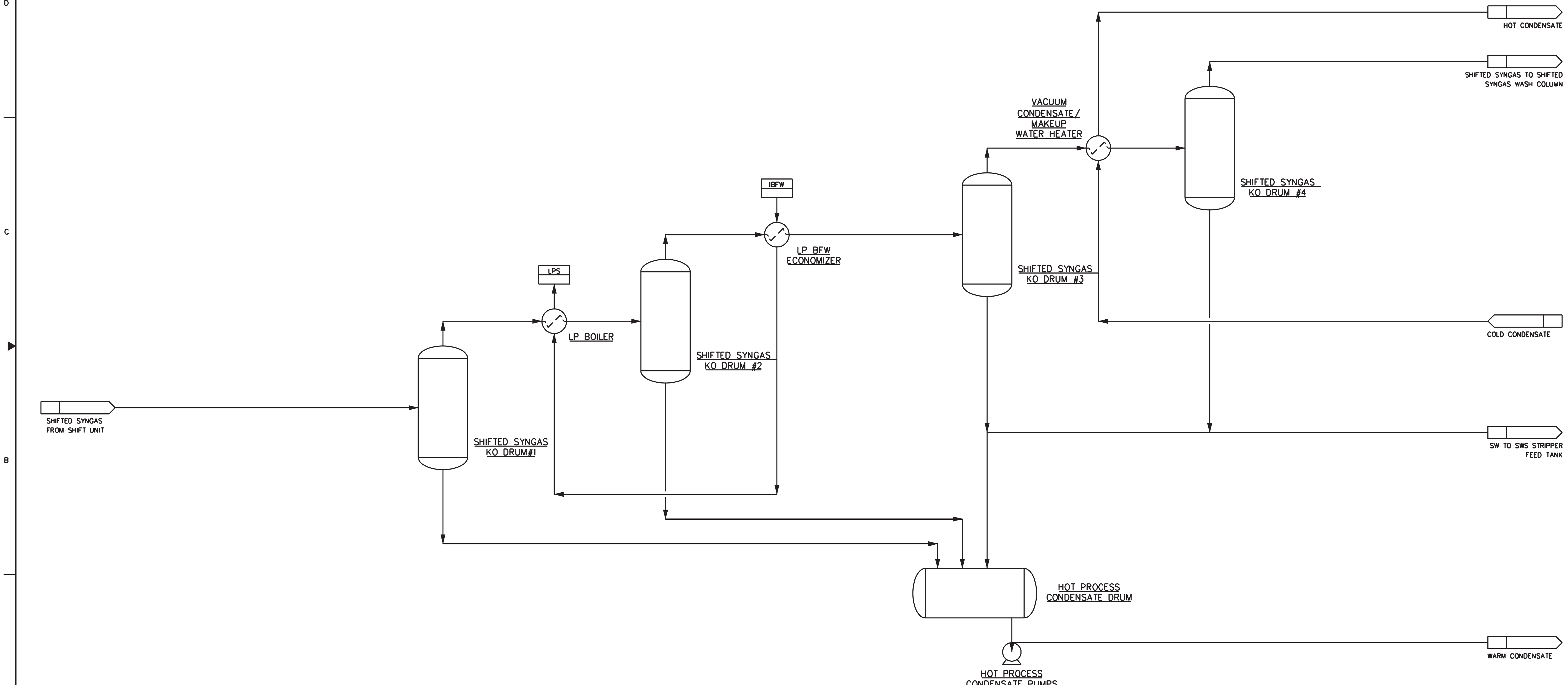

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FIGURE 2-11 FLOW DIAGRAM
LOW TEMPERATURE GAS COOLING (LTGC)

SCALE NONE | DRAWING NUMBER A3RW–PFD–25–006B | REV 0

CAD FILE NAME A3FN-PFD-25-001B.DWG

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐

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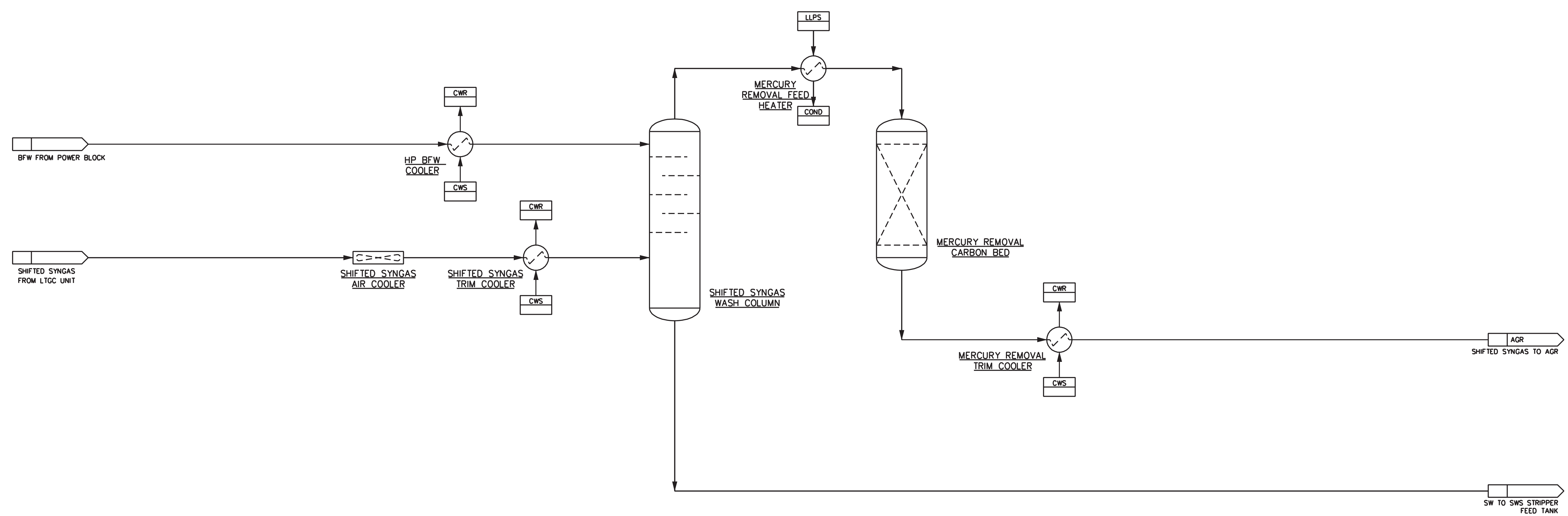
DIST CODE



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HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-12 FLOW DIAGRAM
WASH COLUMN AND MERCURY REMOVAL

SCALE NONE | DRAWING NUMBER A3RW–PFD–25–006C | REV 0

CAD FILE NAME A3FN–PFD–25–001C.DWG

SAP NWA | DIST CODE

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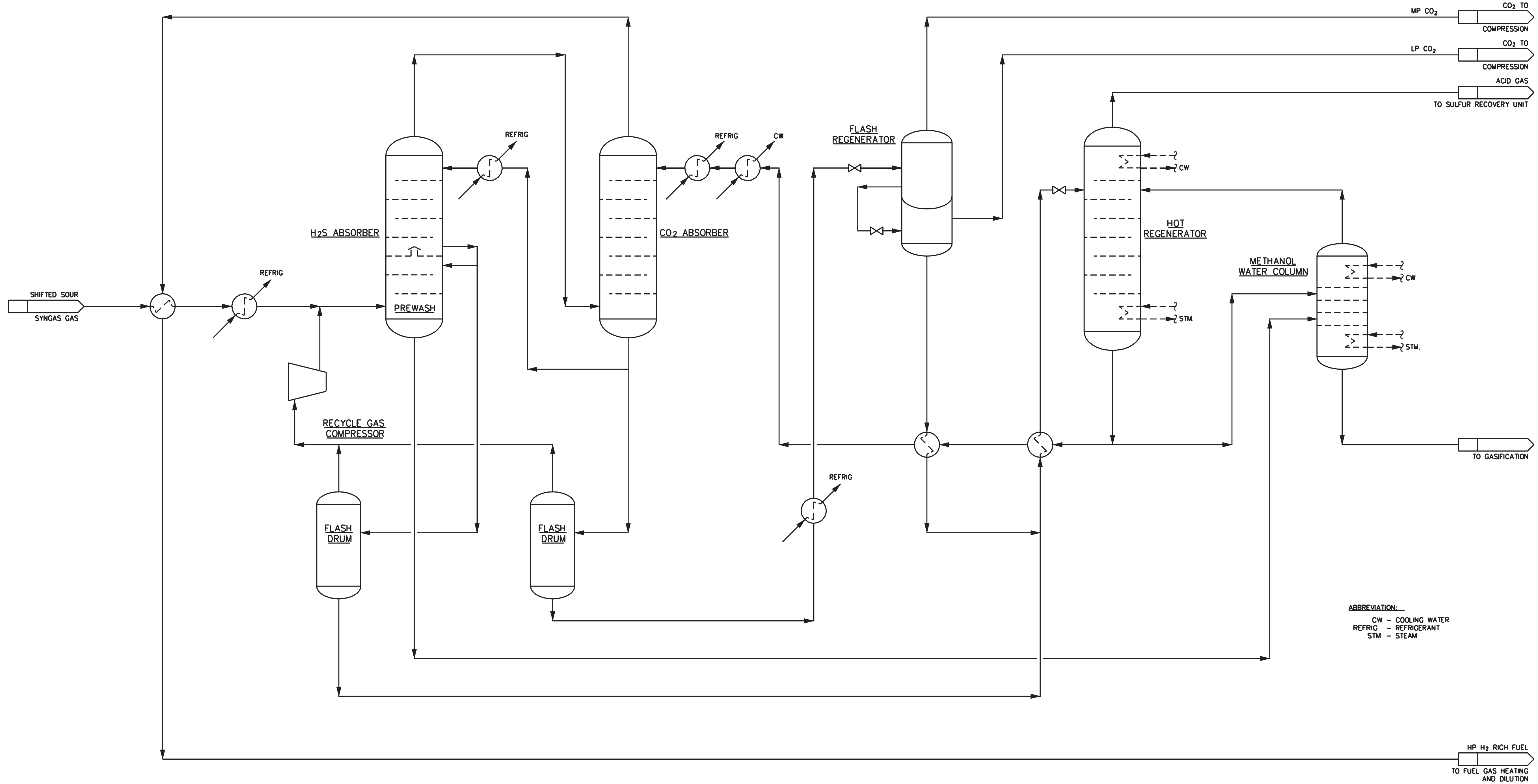

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CLIENT: HEI — APP DATE 6/4/08

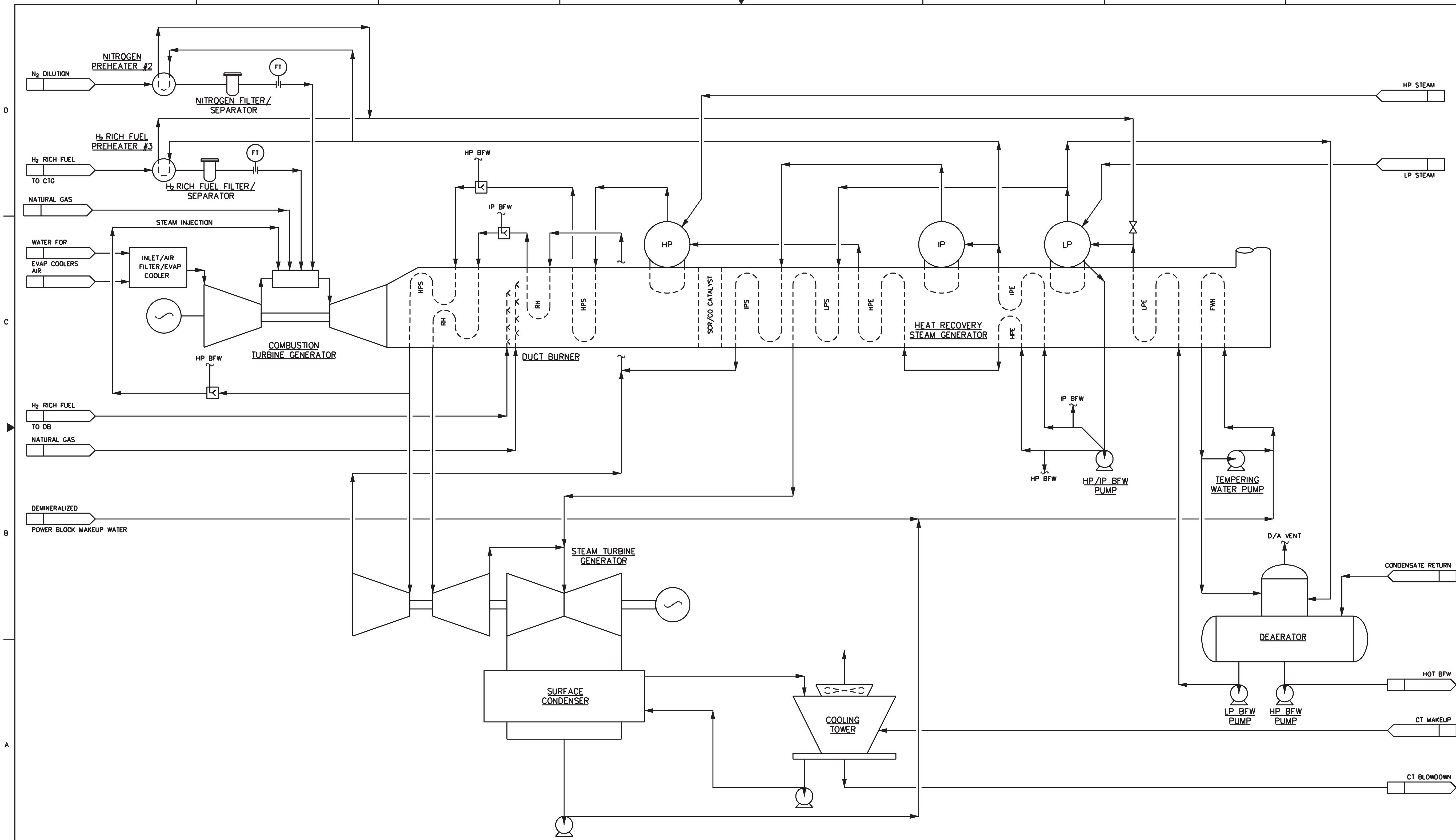
HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-13 FLOW DIAGRAM RECTISOL ACID GAS REMOVAL SYSTEM

SCALE: NONE
DRAWING NUMBER: A3RW-PFD-25-007
REV: 0
CAD FILE NAME: A3RW-PFD-25-007.DWG

PLOT DATE:

XREF ATTACHED - YES ☐ NO ☐ MANUAL CHANGES MADE - YES ☐ NO ☐ DWG FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐



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HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-14 FLOW DIAGRAM POWER BLOCK SYSTEMS

SCALE NONE | DRAWING NUMBER A3RW-PFD-25-010 | REV 0

CAD FILE NAME A3RW-PFD-25-010.DWG

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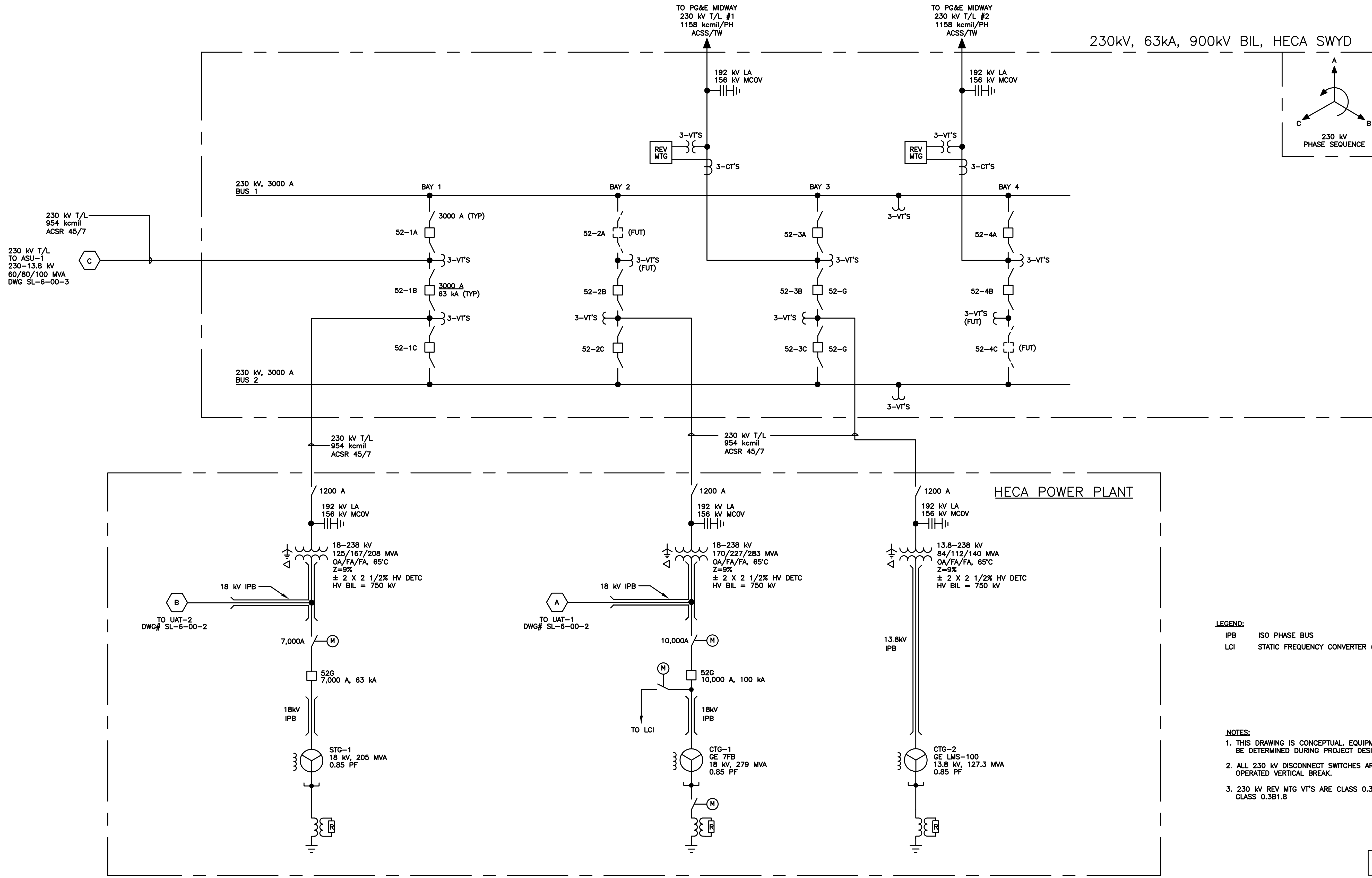

LEGEND:

IPB	ISO PHASE BUS
LCI	STATIC FREQUENCY CONVERTER (BY GE)

NOTES:

1. THIS DRAWING IS CONCEPTUAL. EQUIPMENT RATINGS WILL BE DETERMINED DURING PROJECT DESIGN.
2. ALL 230 kV DISCONNECT SWITCHES ARE MANUAL GROUP OPERATED VERTICAL BREAK.
3. 230 kV REV MTG VT'S ARE CLASS 0.3ZZ AND CT'S ARE CLASS 0.3B1.8

PRELIMINARY

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	12JUN08	ISSUED FOR PERMITTING	MT	PS								SL-6-00-2, 3, 4	ELECTRICAL OVERALL ONE LINE DIAGRAM

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FIGURE 2-15
ELECTRICAL OVERALL ONE LINE DIAGRAM

SCALE NONE | DRAWING NUMBER A3RW00-0-SL-6-00-1 | REV 0

CAD FILE NAME SL6001.DWG

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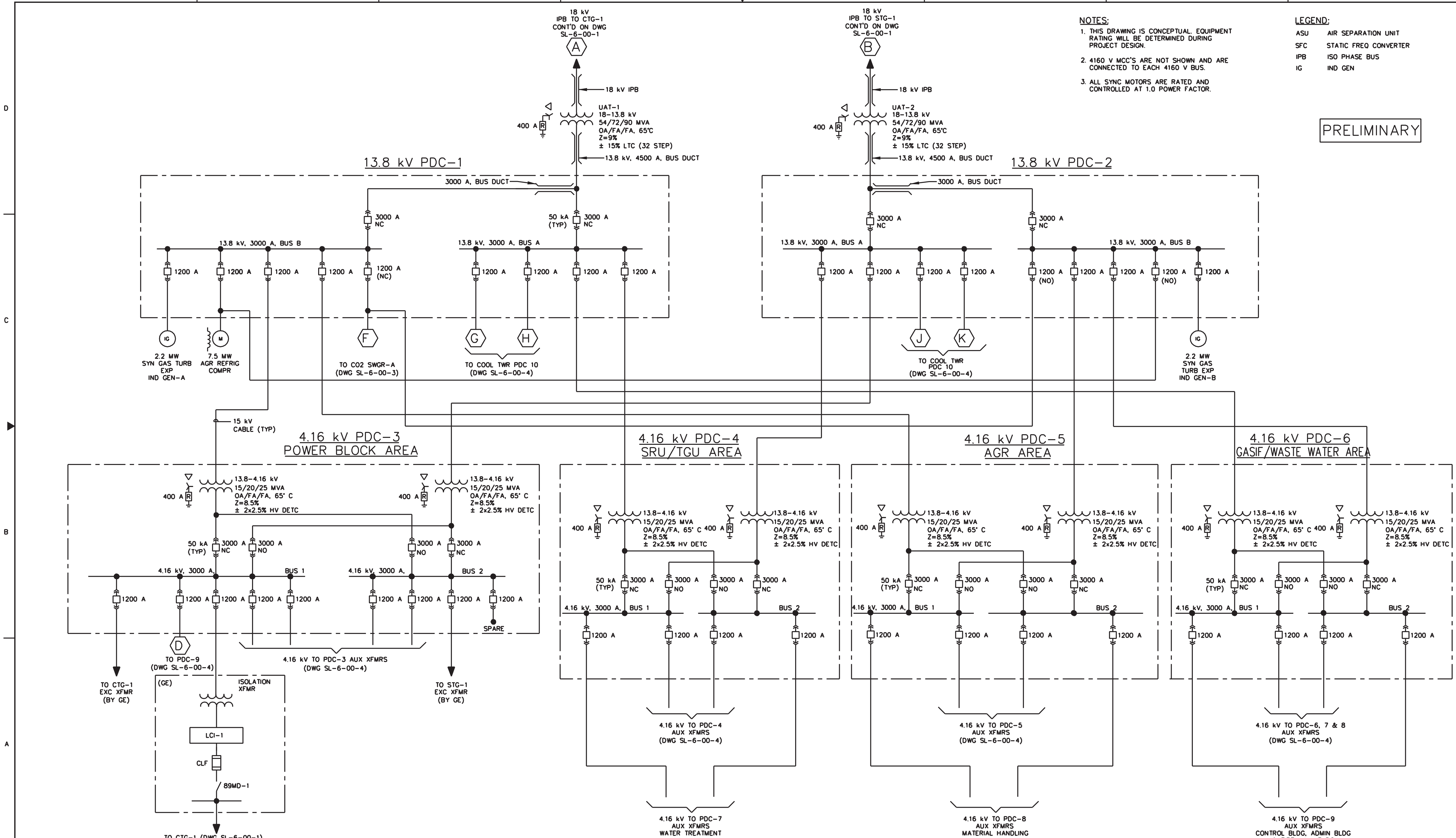

NOTES:

1. THIS DRAWING IS CONCEPTUAL. EQUIPMENT RATING WILL BE DETERMINED DURING PROJECT DESIGN.
2. 4160 V MCC'S ARE NOT SHOWN AND ARE CONNECTED TO EACH 4160 V BUS.
3. ALL SYNC MOTORS ARE RATED AND CONTROLLED AT 1.0 POWER FACTOR.

LEGEND:

ASU	AIR SEPARATION UNIT
SFC	STATIC FREQ CONVERTER
IPB	ISO PHASE BUS
IG	IND GEN

PRELIMINARY

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	6/4/08	ISSUED FOR PERMITTING	MT	PS								SL-6-00-1, 3 & 4	ELECTRICAL OVERALL ONE LINE DIAGRAM

PLOT DATE:

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CLIENT HEI — APP DATE 6/4/08

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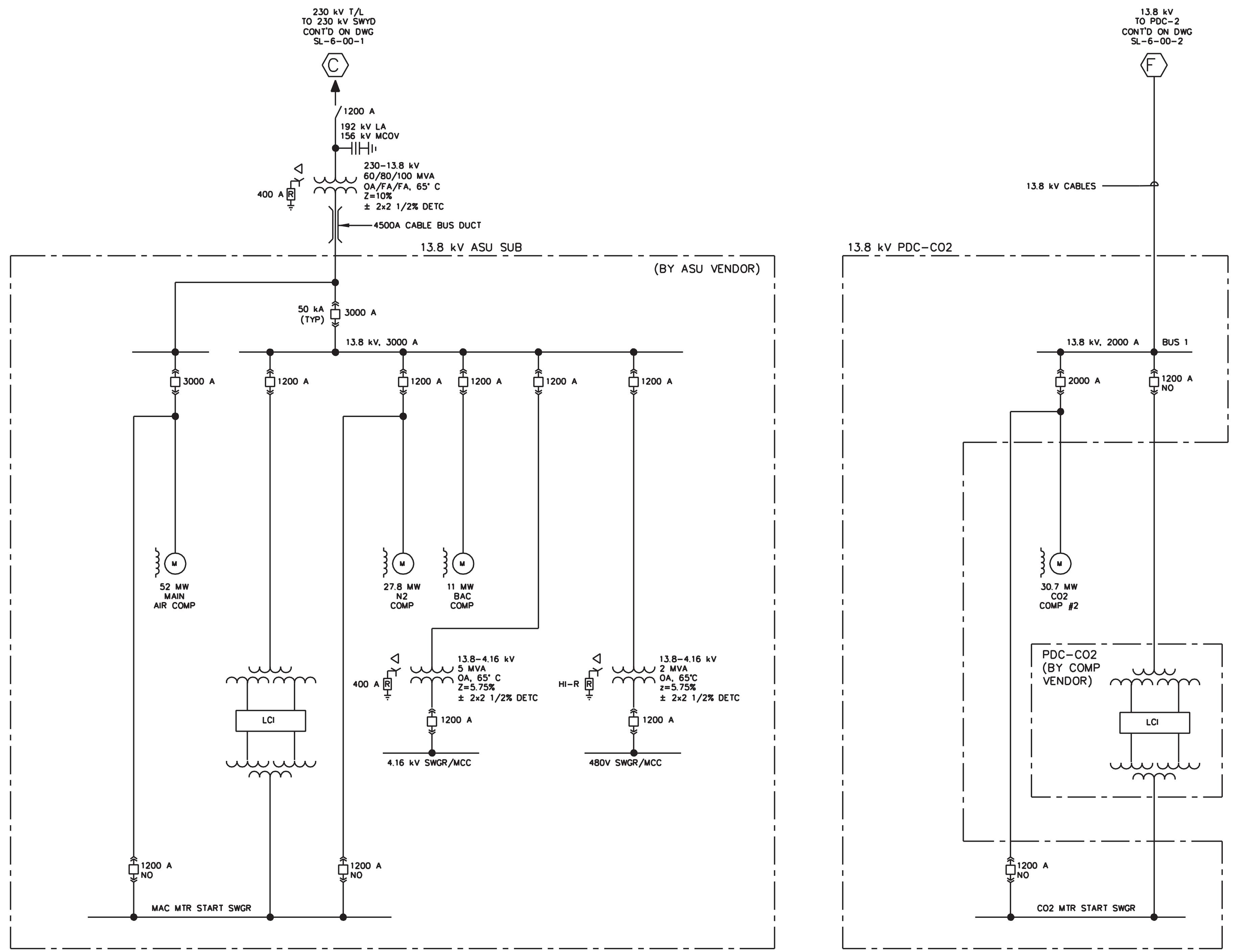
FIGURE 2-16
ELECTRICAL OVERALL ONE LINE DIAGRAM

SCALE NONE — DRAWING NUMBER A3RW00-0-SL-6-00-2 — REV 0
CAD FILE NAME SL6002.DWG

XREF ATTACHED - YES ☐ NO ☐ MANUAL CHANGES MADE - YES ☐ NO ☐ DWG FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐



NOTES:
1. THIS DRAWING IS CONCEPTUAL. EQUIPMENT RATING WILL BE DETERMINED DURING PROJECT DESIGN.
2. ALL SYNC MOTORS ARE RATED AND CONTROLLED AT 1.0 POWER FACTOR.

PRELIMINARY

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0	6/4/08	ISSUED FOR PERMITTING	MT	PS								SL-6-00-1, 2 & 4	ELECTRICAL OVERALL ONE LINE DIAGRAM

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FLUOR: W. BECKTEL — APP DATE 6/4/08
CLIENT: HEI — APP DATE 6/4/08

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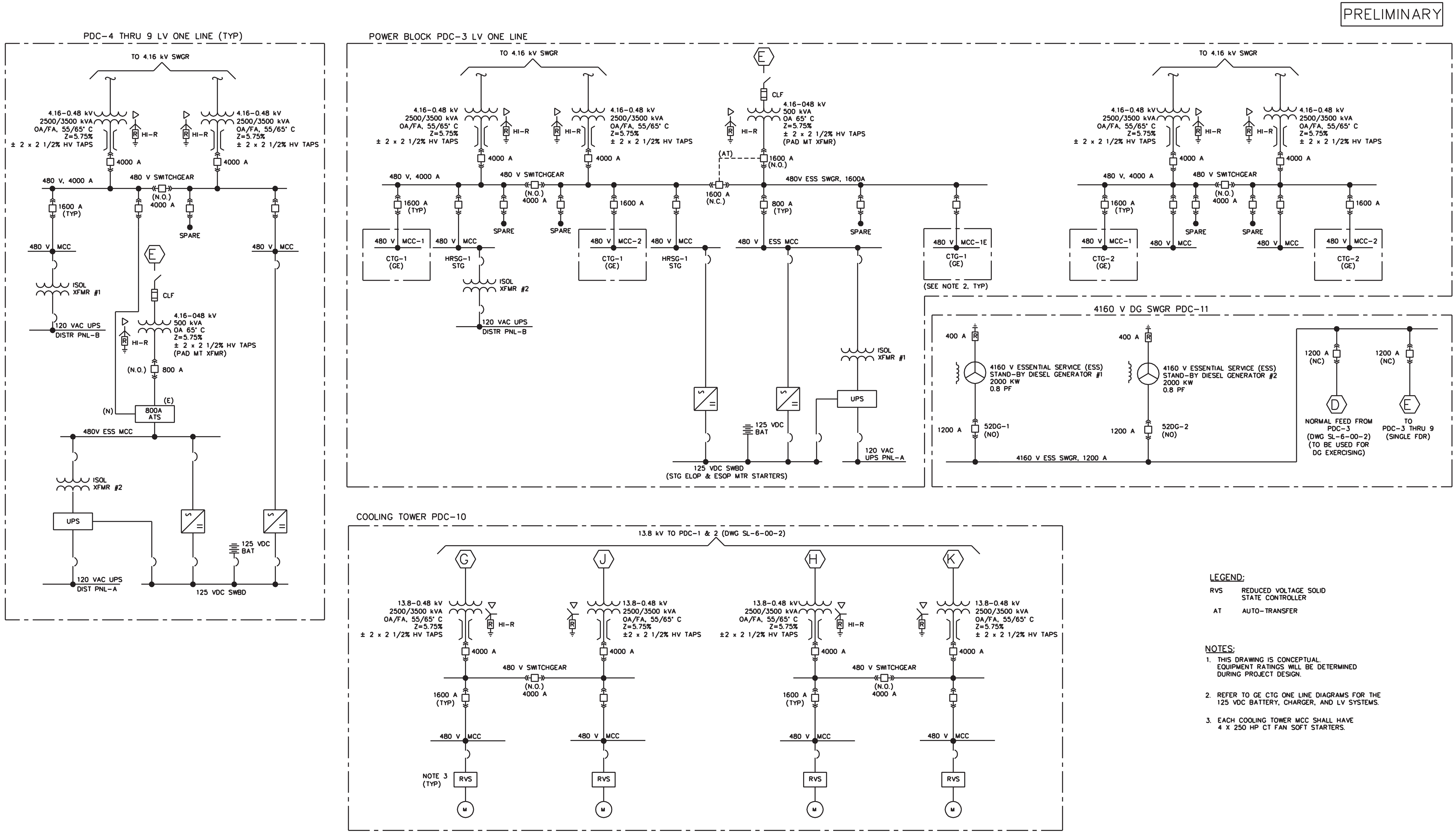
FIGURE 2-17
ELECTRICAL OVERALL ONE LINE DIAGRAM

SCALE: NONE
DRAWING NUMBER: A3RW00-0-SL-6-00-3
REV: 0

PLOT DATE:

XREF ATTACHED - YES ☐ NO ☐ MANUAL CHANGES MADE - YES ☐ NO ☐ DWG FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

CAD FILE NAME: SL6003.DWG



LEGEND:

RVS REDUCED VOLTAGE SOLID STATE CONTROLLER

AT AUTO-TRANSFER

NOTES:

1. THIS DRAWING IS CONCEPTUAL. EQUIPMENT RATINGS WILL BE DETERMINED DURING PROJECT DESIGN.
2. REFER TO GE CTG ONE LINE DIAGRAMS FOR THE 125 VDC BATTERY, CHARGER, AND LV SYSTEMS.
3. EACH COOLING TOWER MCC SHALL HAVE 4 X 250 HP CT FAN SOFT STARTERS.

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0	6/4/08	ISSUED FOR PERMITTING	MT	PS		SL-6-00-1, 2 & 3	ELECTRICAL OVERALL ONE LINE DIAGRAM

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FIGURE 2-18
ELECTRICAL OVERALL ONE LINE DIAGRAM

SCALE NONE — DRAWING NUMBER A3RW00-0-SL-6-00-4 — REV 0

CAD FILE NAME SL6004.DWG

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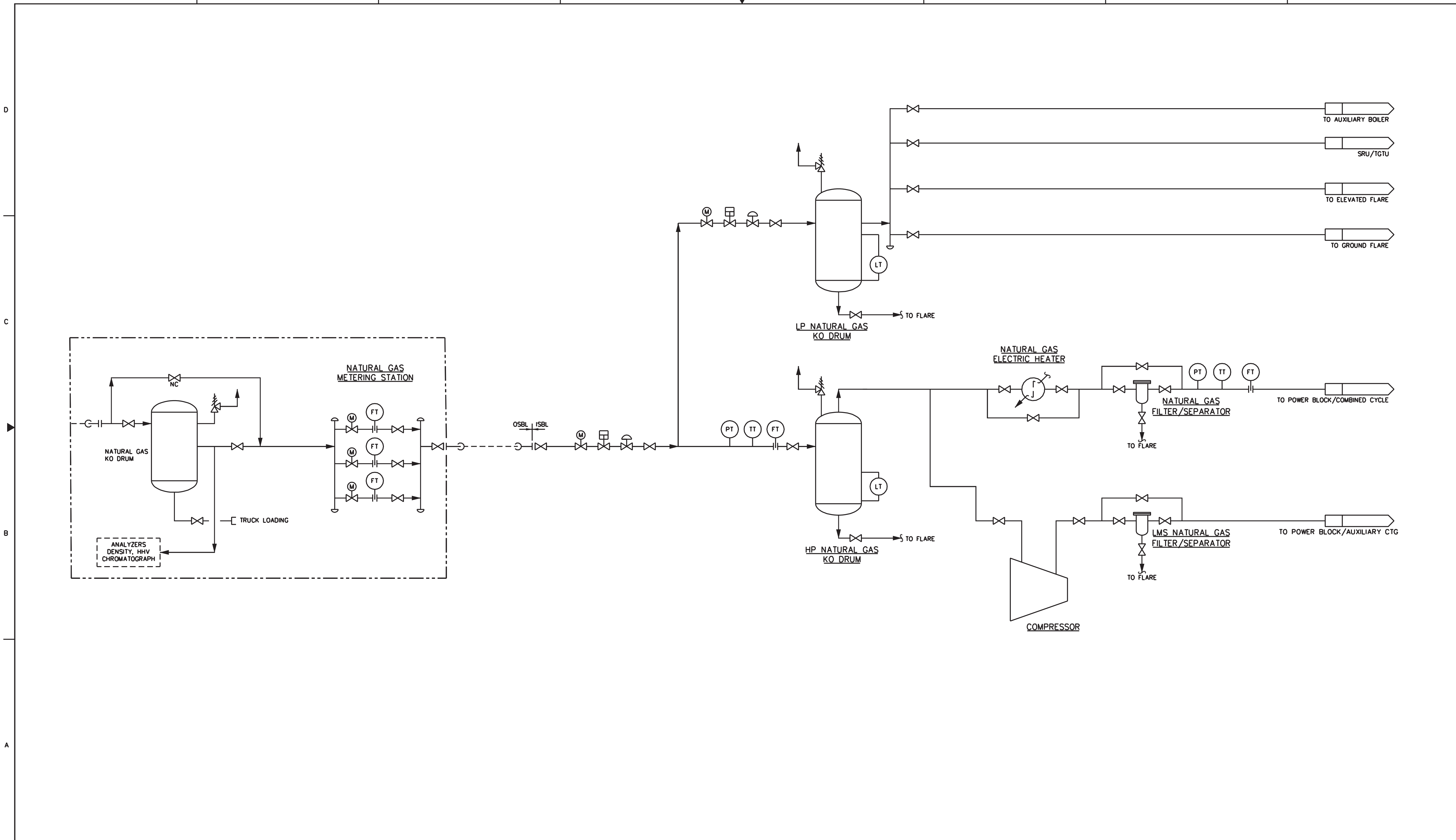

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FIGURE 2-19 FLOW DIAGRAM
NATURAL GAS SYSTEM

SCALE NONE
DRAWING NUMBER A3RW–PFD–25–019
REV 0
DIST CODE
SAP NWA

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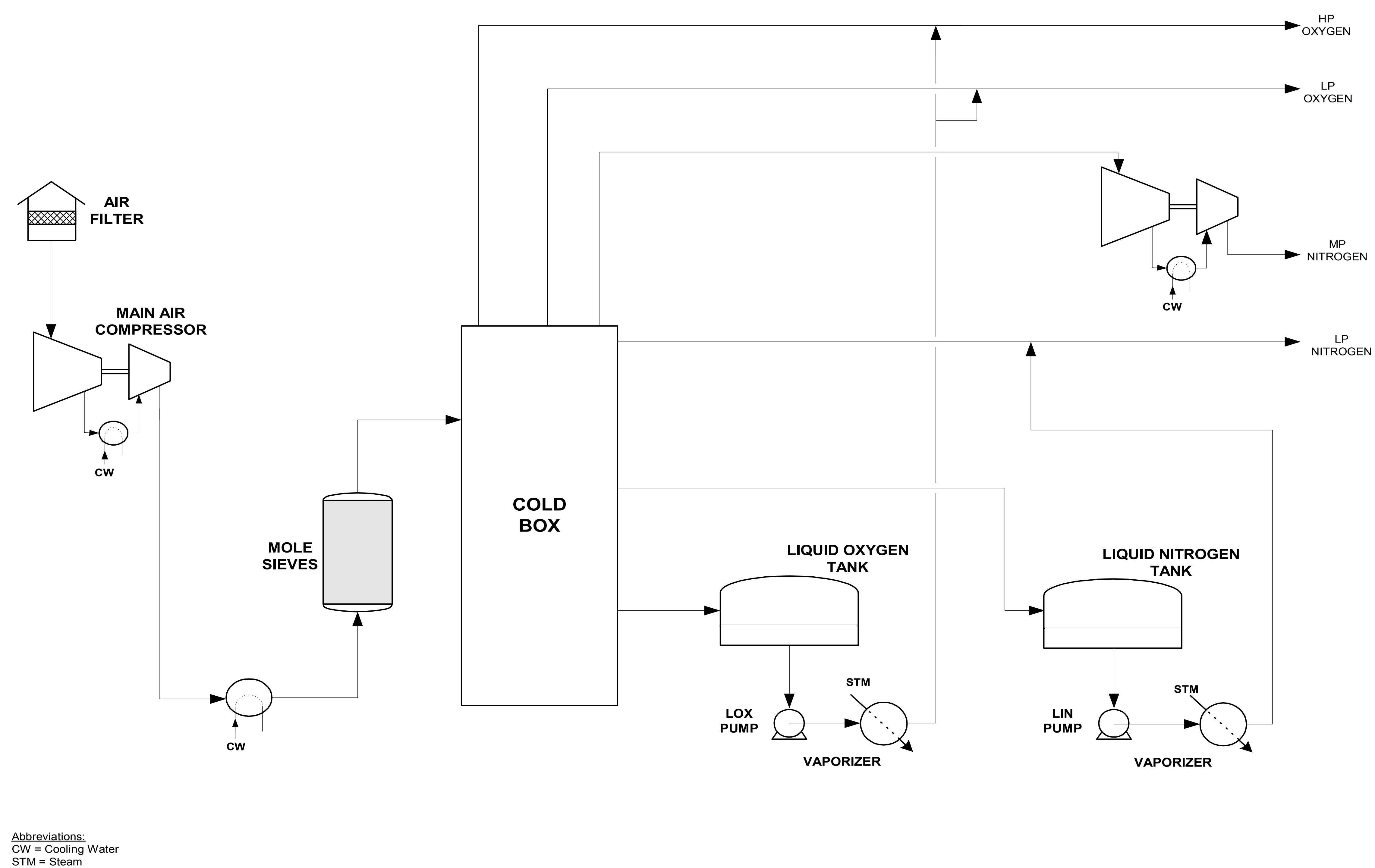
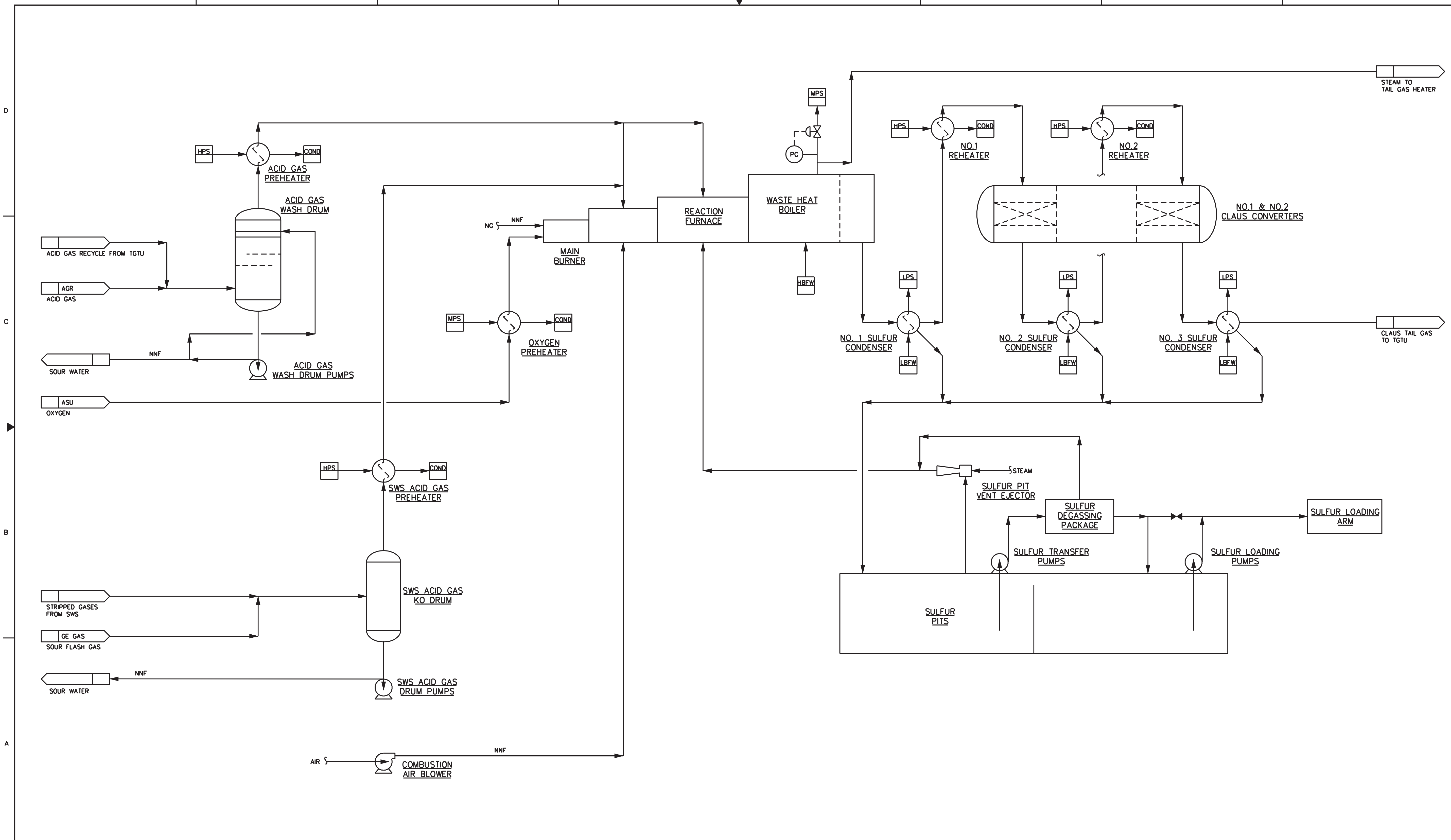
CAD FILE NAME A3RW-PFD-25-019.DWG

FIGURE 2-20 Air Separation Unit



Drawing Number: A3RW-PFD-25-024



REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
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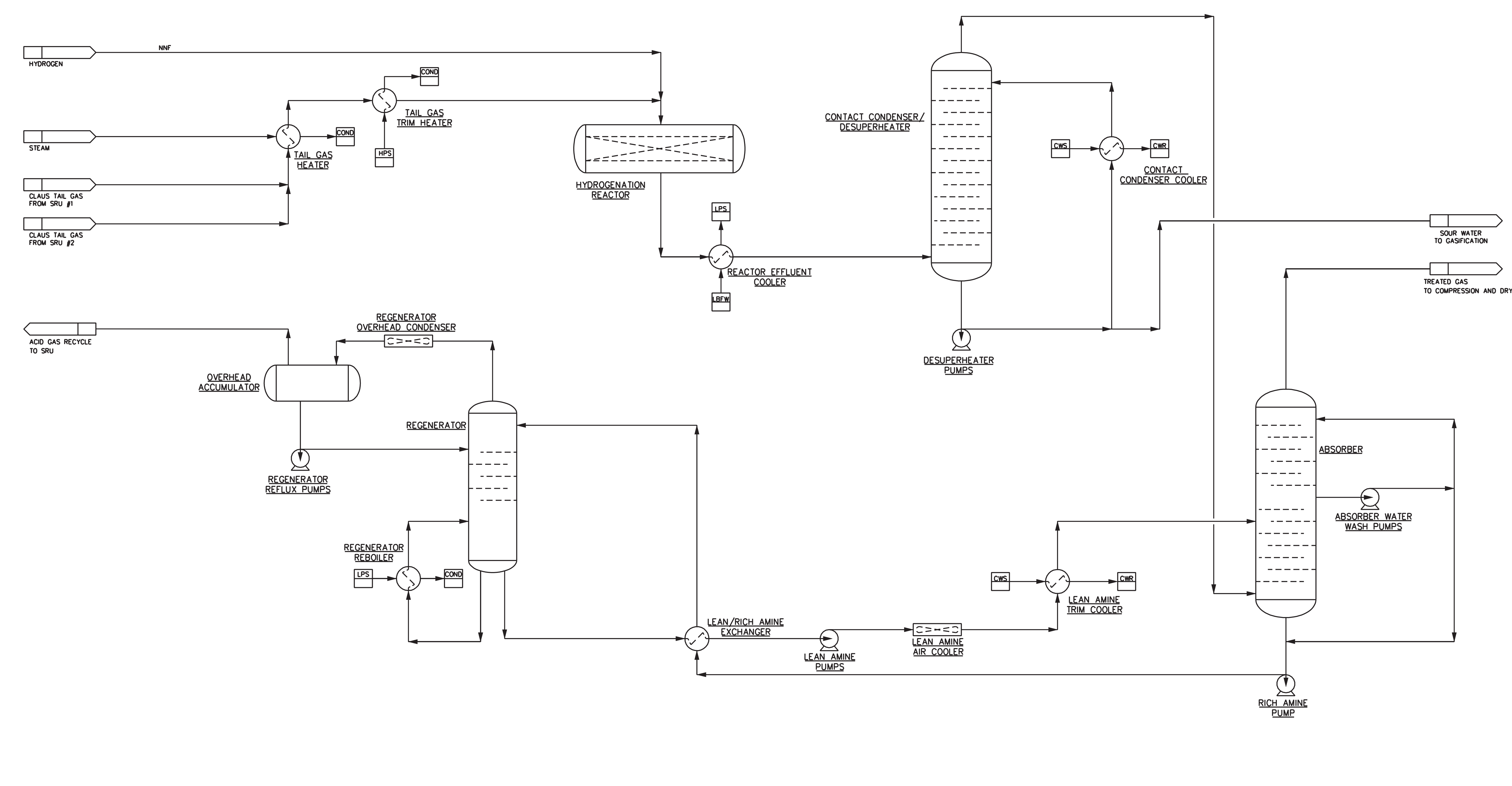
FIGURE 2-21 FLOW DIAGRAM
SULFUR RECOVERY UNIT

SCALE NONE | DRAWING NUMBER A3RW-PFD-25-008 | REV 0

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐ CAD FILE NAME A3RW-PFD-25-008.dwg.DWG



REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
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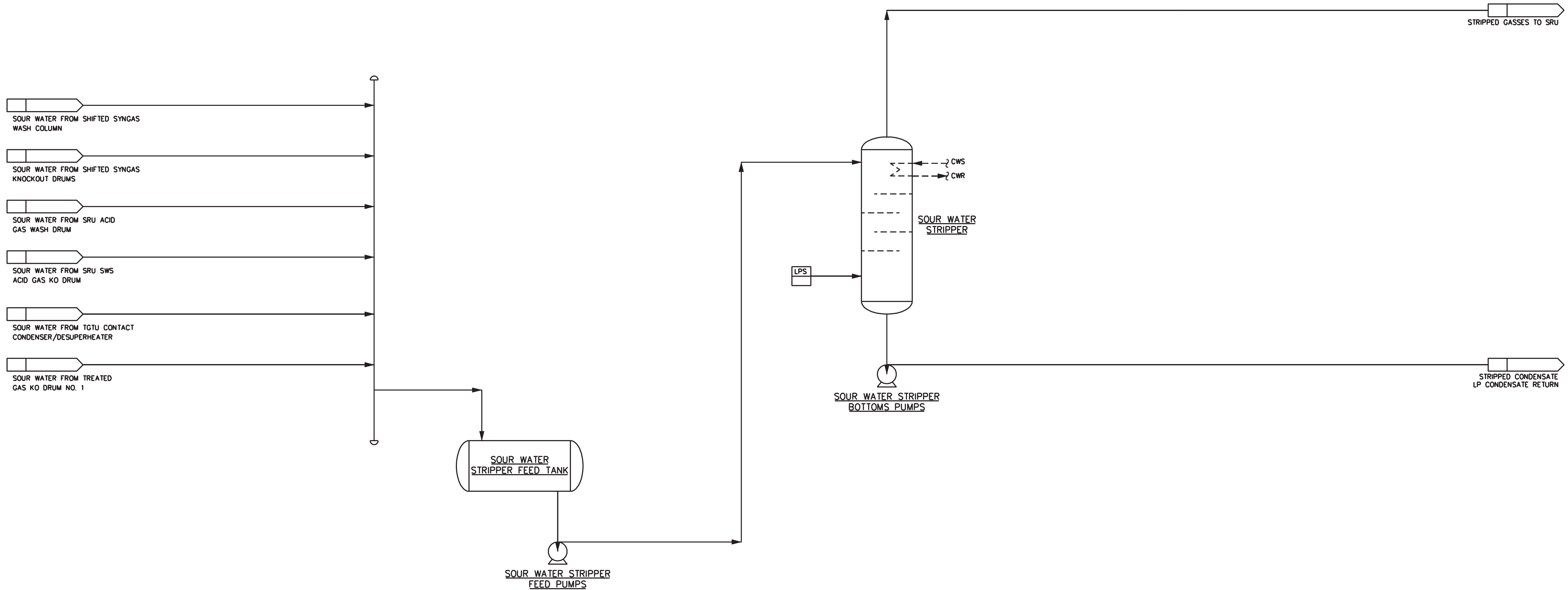
FIGURE 2-22 FLOW DIAGRAM
TAIL GAS TREATING UNIT

SCALE NONE | DRAWING NUMBER A3RW-PFD-25-009 | REV 0

CAD FILE NAME A3RW-PFD-25-009.dwg.DWG

XREF ATTACHED - YES ☐ NO ☐ MANUAL CHANGES MADE - YES ☐ NO ☐ DWG FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

PLOT DATE:



REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
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CLIENT HEI	APP DATE 6/4/08

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FIGURE 2-23 FLOW DIAGRAM
SOUR WATER STRIPPER

SCALE NONE | DRAWING NUMBER A3RW–PFD–25–012 | REV 0

SAP NWA | DIST CODE

PLOT DATE:

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐

CAD FILE NAME A3RW-PFD-25-012.DWG

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FIGURE 2-24 FLOW DIAGRAM
CO_2 COMPRESSION SYSTEM

SCALE: NONE
DRAWING NUMBER: A3RW-PFD-25-011
REV: 0
CAD FILE NAME: A3RW-PFD-25-011.DWG

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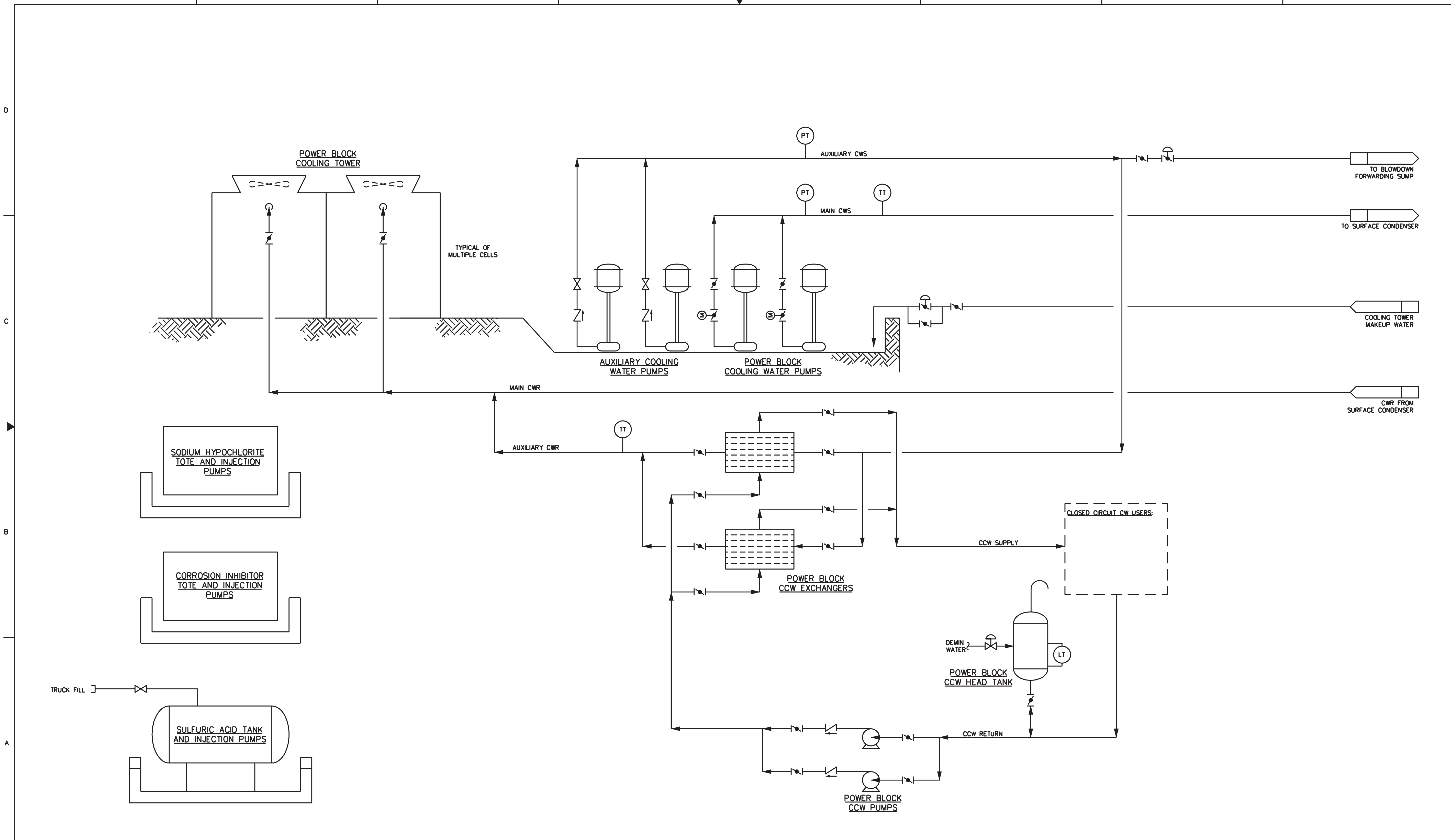

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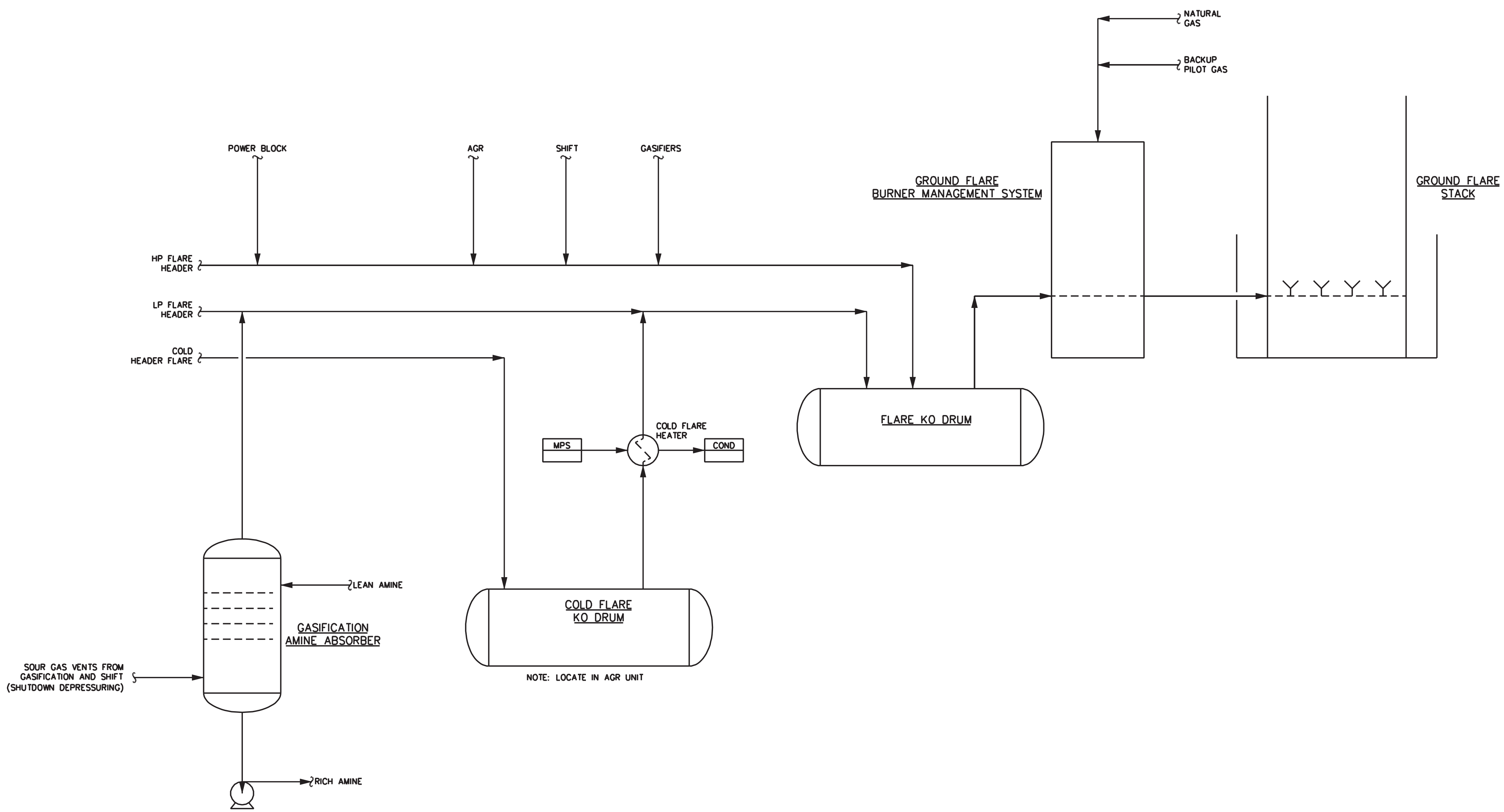
FIGURE 2-25 FLOW DIAGRAM
COOLING WATER SYSTEM

SCALE NONE
DRAWING NUMBER A3RW–PFD–25–022
REV 0

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐
CAD FILE NAME A3RW–25–022.DWG.DWG



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CLIENT: HEI — APP DATE 6/4/08

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FIGURE 2-26 FLOW DIAGRAM
GROUND FLARE SYSTEM

SCALE: NONE
DRAWING NUMBER: A3RW-PFD-25-016
REV: 0
DIST CODE
SAP NWA

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CAD FILE NAME: A3RW-PFD-25-16A.DWG

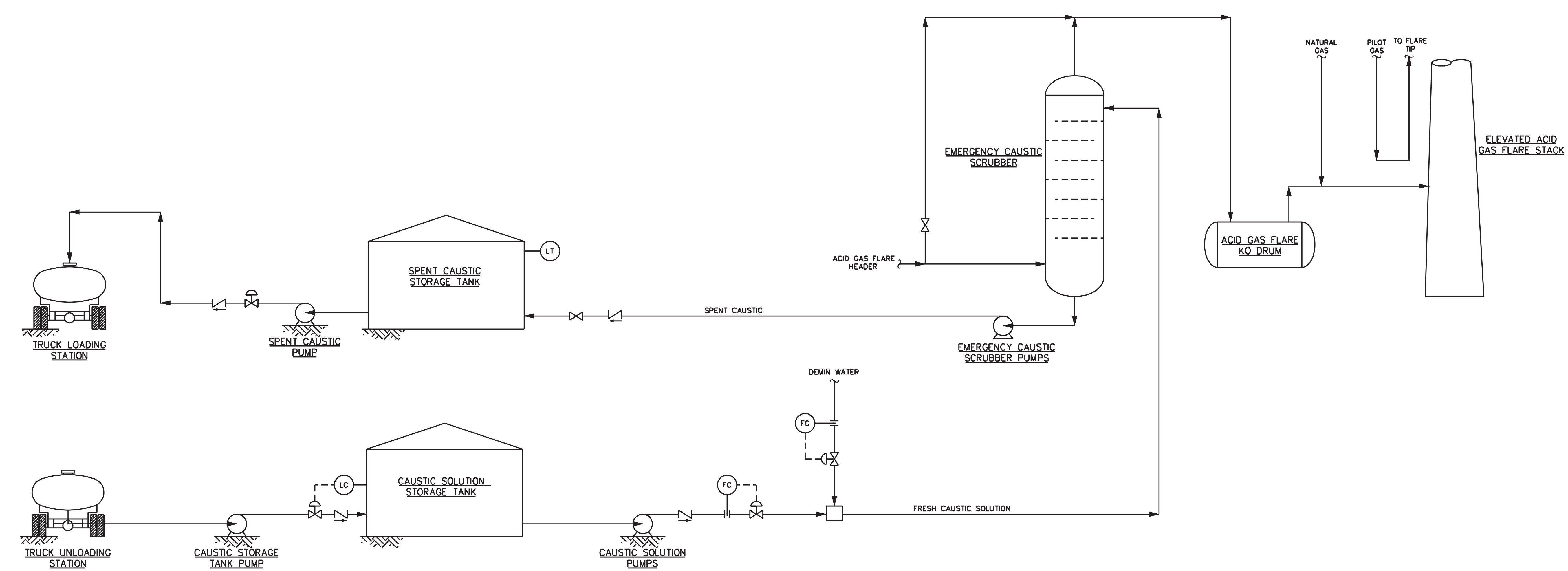

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FIGURE 2-27 FLOW DIAGRAM
ELEVATED FLARE SYSTEM

SCALE NONE
DRAWING NUMBER A3RW–PFD–25–017
REV 0

DIST CODE
SAP NWA

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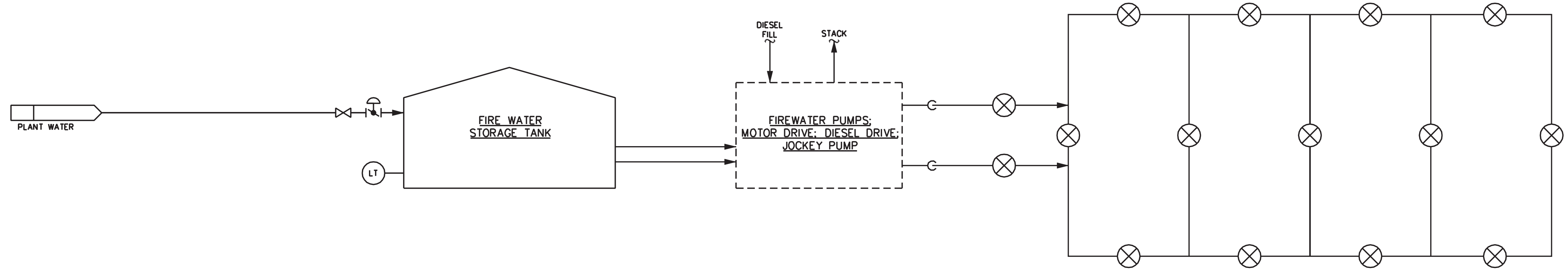

FIRE WATER LOOP:

- ________ PIVs
- ________ HOSE STATIONS
- ________ MONITORS
- ________ ACTIVATED VALVES

FIREWATER VALVE HOUSES (TYPICAL OF):

- POWER BLOCK COOLING TOWER
- GASIFICATION COOLING TOWER
- STG LUBE OIL & BEARINGS
- CTG MAIN TRANSFORMER
- ASU COOLING TOWER

BUILDING FIRE PROTECTION:

- CONTROL ROOM
- ADMIN
- MAINTENANCE

NOTES:

(1) ASSUME PREFABRICATED PUMPHOUSE CONTAINING
- ELECTRIC FW PUMP
- DIESEL FW PUMP
- JOCKEY PUMP
- CONTROLS & ALARMS
- INTERNAL HEATING & LIGHTING

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	6/4/08	ISSUED FOR PERMITTING	JC	HSS									

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CLIENT HEI	APP DATE 6/4/08	

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FIGURE 2-28 FLOW DIAGRAM
FIRE WATER SYSTEM/
EMERGENCY GENERATOR

DRAWING NUMBER A3RW-PFD-25-018 | REV 0

SAP NWA | DIST CODE

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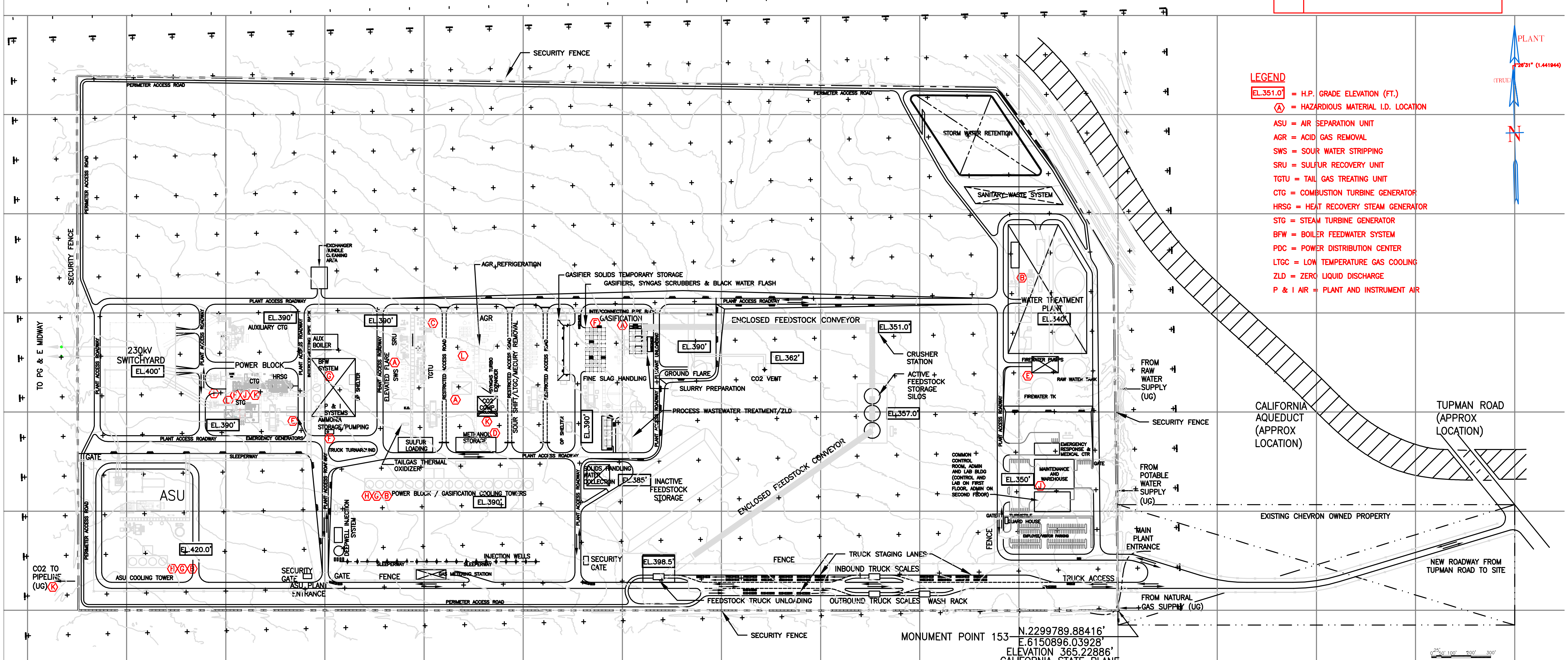
CAD FILE NAME A3RW-PFD-25-018.DWG

HAZARDOUS MATERIALS

ID	DESCRIPTION
Ⓐ	SODIUM HYDROXIDE
Ⓑ	WATER TREATMENT CHEMICALS
Ⓒ	MOLTEN SULFUR
Ⓓ	METHANOL
Ⓔ	DIESEL FUEL
Ⓕ	AQUEOUS AMMONIA
Ⓖ	SULFURIC ACID
Ⓗ	SODIUM HYPOCHLORITE
Ⓘ	MINERAL INSULATING OIL
Ⓙ	LUBRICATING OIL
Ⓚ	CARBON DIOXIDE
Ⓛ	HYDROGEN

LEGEND

- EL.351.0' = H.P. GRADE ELEVATION (FT.)
- Ⓐ = HAZARDIOUS MATERIAL I.D. LOCATION
- ASU = AIR SEPARATION UNIT
- AGR = ACID GAS REMOVAL
- SWS = SOUR WATER STRIPPING
- SRU = SULFUR RECOVERY UNIT
- TGTU = TAIL GAS TREATING UNIT
- CTG = COMBUSTION TURBINE GENERATOR
- HRSG = HEAT RECOVERY STEAM GENERATOR
- STG = STEAM TURBINE GENERATOR
- BFW = BOILER FEEDWATER SYSTEM
- PDC = POWER DISTRIBUTION CENTER
- LTGC = LOW TEMPERATURE GAS COOLING
- ZLD = ZERO LIQUID DISCHARGE
- P & I AIR = PLANT AND INSTRUMENT AIR



REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV
0	11JUN08	ISSUED FOR PERMITTING	LDA	ADL	WMB
1	8JUL08	UPDATED FOR PERMITTING	LDA	ADL	WMB

REFERENCE DWG NUMBER	REFERENCE DRAWINGS
SK-250-0001	PRELIMINARY PLOT PLAN

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SUPERVISOR: A. DeLUCIO — APP DATE 11JUN08
LEAD ENGR/SPEC.: G.SIMS — APP DATE 11JUN08
FLUOR: W.M.BECKTEL — APP DATE 11JUN08
CLIENT: HEI — APP DATE 12JUN08

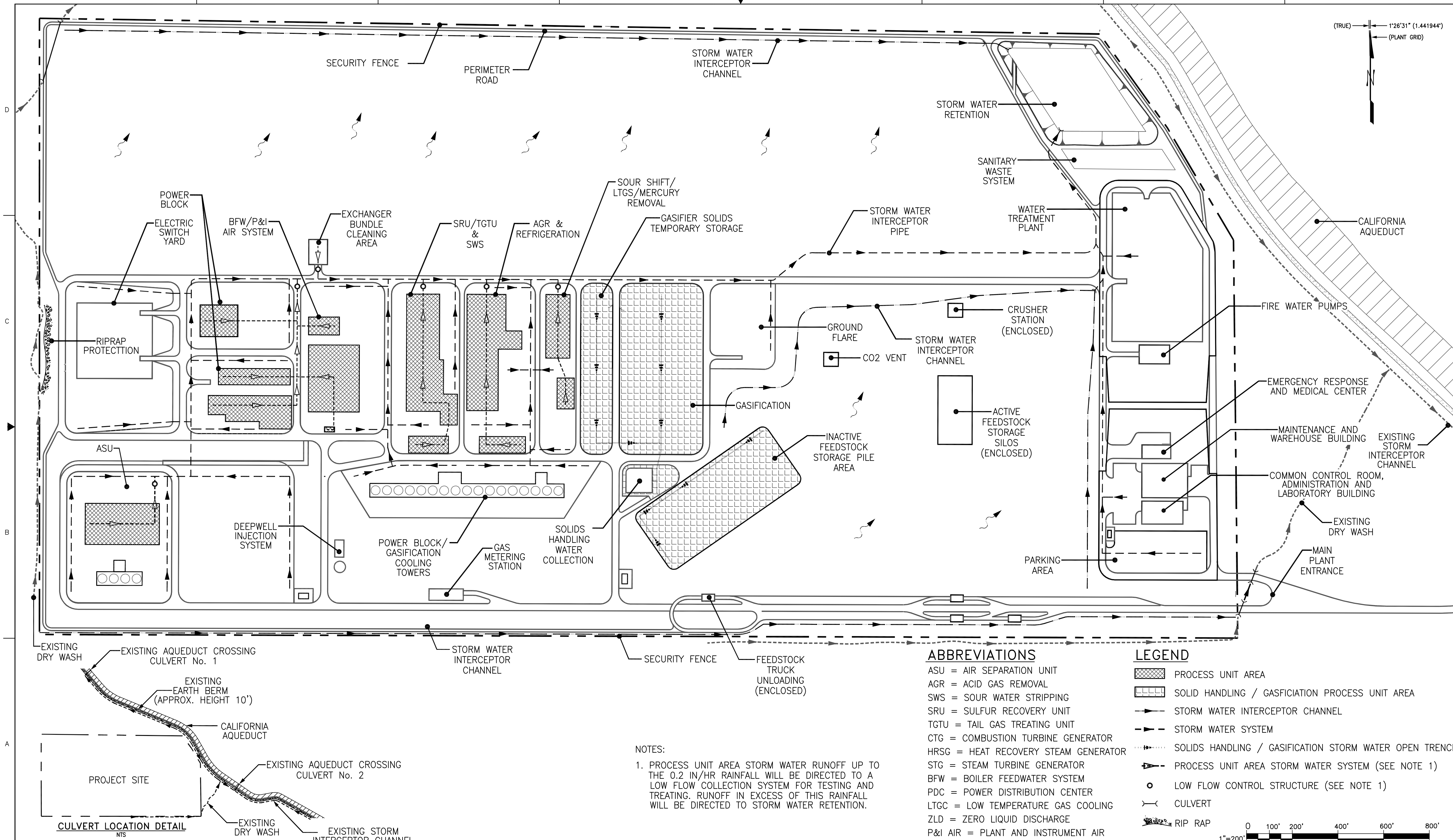
HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-29 PRELIMINARY HAZARDOUS MATERIAL LOCATION PLAN

SCALE: 1:250
DRAWING NUMBER: SK-250-0003
REV: 1
CAD FILE NAME: SK2500003_r1-ova-hazmat-pp.DWG

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐

PLOT DATE:



NOTES:

1. PROCESS UNIT AREA STORM WATER RUNOFF UP TO THE 0.2 IN/HR RAINFALL WILL BE DIRECTED TO A LOW FLOW COLLECTION SYSTEM FOR TESTING AND TREATING. RUNOFF IN EXCESS OF THIS RAINFALL WILL BE DIRECTED TO STORM WATER RETENTION.

ABBREVIATIONS

ASU = AIR SEPARATION UNIT
AGR = ACID GAS REMOVAL
SWS = SOUR WATER STRIPPING
SRU = SULFUR RECOVERY UNIT
TGTU = TAIL GAS TREATING UNIT
CTG = COMBUSTION TURBINE GENERATOR
HRSG = HEAT RECOVERY STEAM GENERATOR
STG = STEAM TURBINE GENERATOR
BFW = BOILER FEEDWATER SYSTEM
PDC = POWER DISTRIBUTION CENTER
LTGC = LOW TEMPERATURE GAS COOLING
ZLD = ZERO LIQUID DISCHARGE
P&I AIR = PLANT AND INSTRUMENT AIR

LEGEND

PROCESS UNIT AREA
SOLID HANDLING / GASFICIATION PROCESS UNIT AREA
STORM WATER INTERCEPTOR CHANNEL
STORM WATER SYSTEM
SOLIDS HANDLING / GASIFICATION STORM WATER OPEN TRENCH
PROCESS UNIT AREA STORM WATER SYSTEM (SEE NOTE 1)
LOW FLOW CONTROL STRUCTURE (SEE NOTE 1)
CULVERT
RIP RAP

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	06/09/08	ISSUED FOR PERMITTING	OD	PMF									
												SK-250-0002	OVERALL PLOT PLAN

FLUOR

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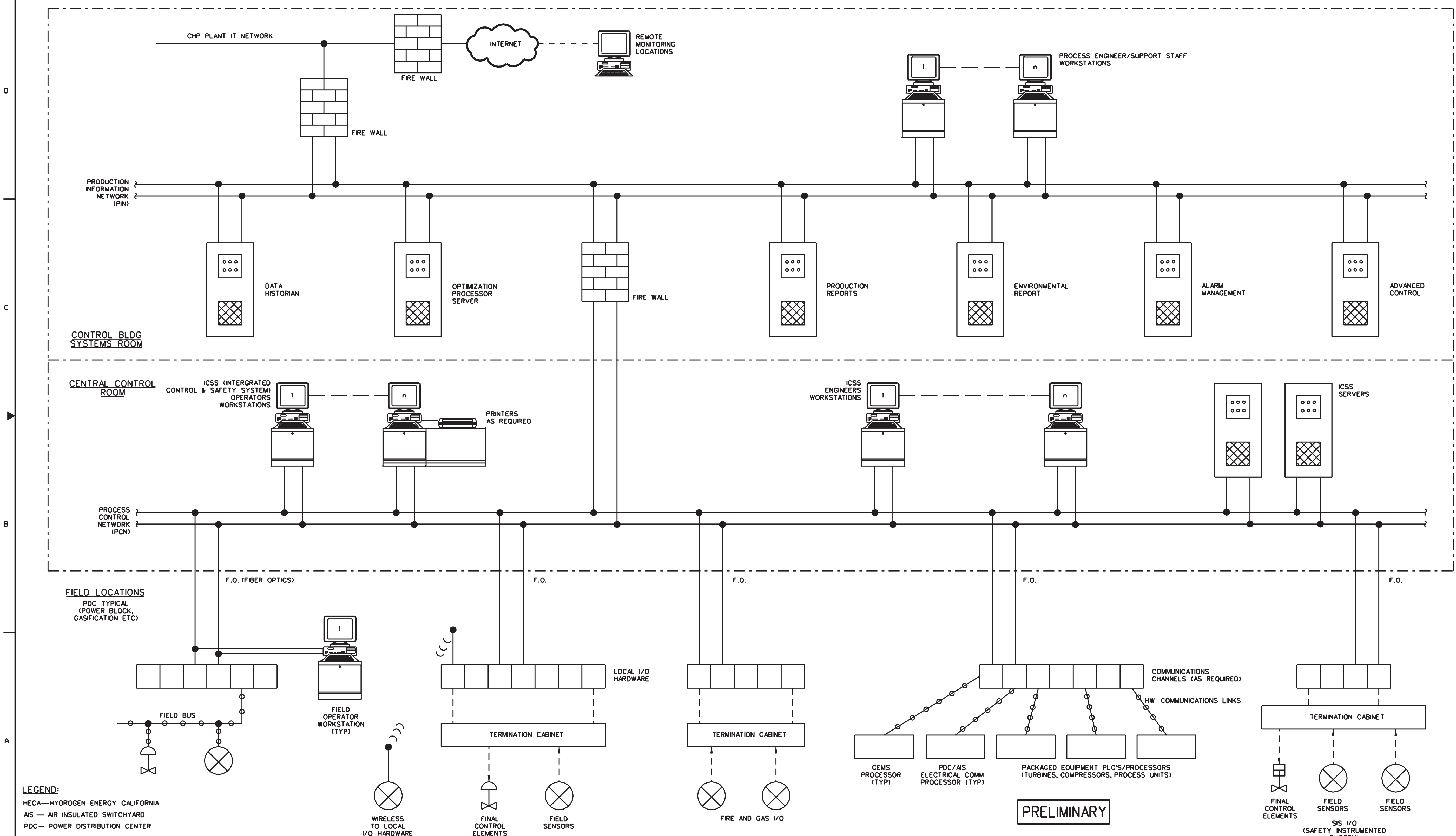
HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-30 PRELIMINARY
STORM WATER DRAINAGE PLAN

SCALE 1:200'
DRAWING NUMBER SK-210-0002
REV A
CAD FILE NAME A3RWSK2100002.DWG
SAP NWA
DIST CODE

PLOT DATE: 05-27-08
XREF ATTACHED - YES ☐ NO ☐ MANUAL CHANGES MADE - YES ☐ NO ☐ DWG FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐



LEGEND:
HECA—HYDROGEN ENERGY CALIFORNIA
AIS — AIR INSULATED SWITCHYARD
PDC— POWER DISTRIBUTION CENTER

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	6/4/08	ISSUED FOR PERMITTING	KC	PS									

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FLUOR W. BECKTEL — APP DATE 6/4/08
CLIENT HEI — APP DATE 6/4/08

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KERN COUNTY POWER PROJECT

FIGURE 2-31
CONTROL SYSTEM BLOCK DIAGRAM

SCALE NONE — DRAWING NUMBER A3RW-CC-70-001 — REV 0

PLOT DATE:

XREF ATTACHED · YES☐ NO☐ MANUAL CHANGES MADE · YES☐ NO☐ DWG FILE UPDATED · YES☐ NO☐ MODEL UPDATED · YES☐ NO☐ CAD FILE NAME .DWG

MAJOR STRUCTURES/EQUIPMENT AND TANKS

ID	DESCRIPTION	APPX. ELEVATIONS FROM GRADE (FT.)
A	ASU MAIN AIR COMPRESSOR ENCLOSURE	40
B	LIQUID OXYGEN STORAGE (LOX) TANK	90
C	AIR SEPARATION COLUMN CAN	205
D	FEEDSTOCK STORAGE SILOS	175
E	SLURRY PREPARATION BUILDING	165
F	SLURRY RUN TANKS (QTY 3)	75
G	GASIFICATION STRUCTURE	200
H	FINE SLAG HANDLING ENCLOSURE	70
I1	AGR REFRIGERATION COMPRESSOR ENCLOSURE	40
I2	AGR METHANOL WASH COLUMN	235
J	CO2 COMPRESSOR ENCLOSURE	50
K	STEAM TURBINE GENERATOR STRUCTURE	50
L	COMBUSTION TURBINE GENERATOR STRUCTURE	50
M1	HEAT RECOVERY STEAM GENERATOR STRUCTURE	90

ID	DESCRIPTION	APPX. ELEVATIONS FROM GRADE (FT.)
M2	AUXILIARY CTG STRUCTURE	45
N	FLARE K.O. DRUM	35
O	POWER DISTRIBUTION CENTERS	25
P	OUTFALL WATER TANK	65'DIA X 40'H
Q	GREY WATER TANK	30'DIA X 40'H
R	SETTLER	85'DIA X 35'H
S	METHANOL STORAGE TANKS (QTY 2)	40'DIA X 40'H
T	SOUR WATER STRIPPER FEED TANK	48'DIA X 32'H
U	PROCESS WASTEWATER TREATMENT FEED TANK	35'DIA X 32'H
V	CONDENSATE STORAGE TANK	34'DIA X 24'H
W	DEMINERALIZED WATER STORAGE TANK	40'DIA X 40'H
X	FIREWATER STORAGE TANK	110'DIA X 48'H
Y	RAW WATER TANK (INCLUDED IN WATER TREATMENT PLANT)	120'DIA X 48'H
Z	TREATED WATER TANK (INCLUDED IN WATER TREATMENT PLANT)	110'DIA X 48'H

TANKS SET AT GRADE ELEVATION

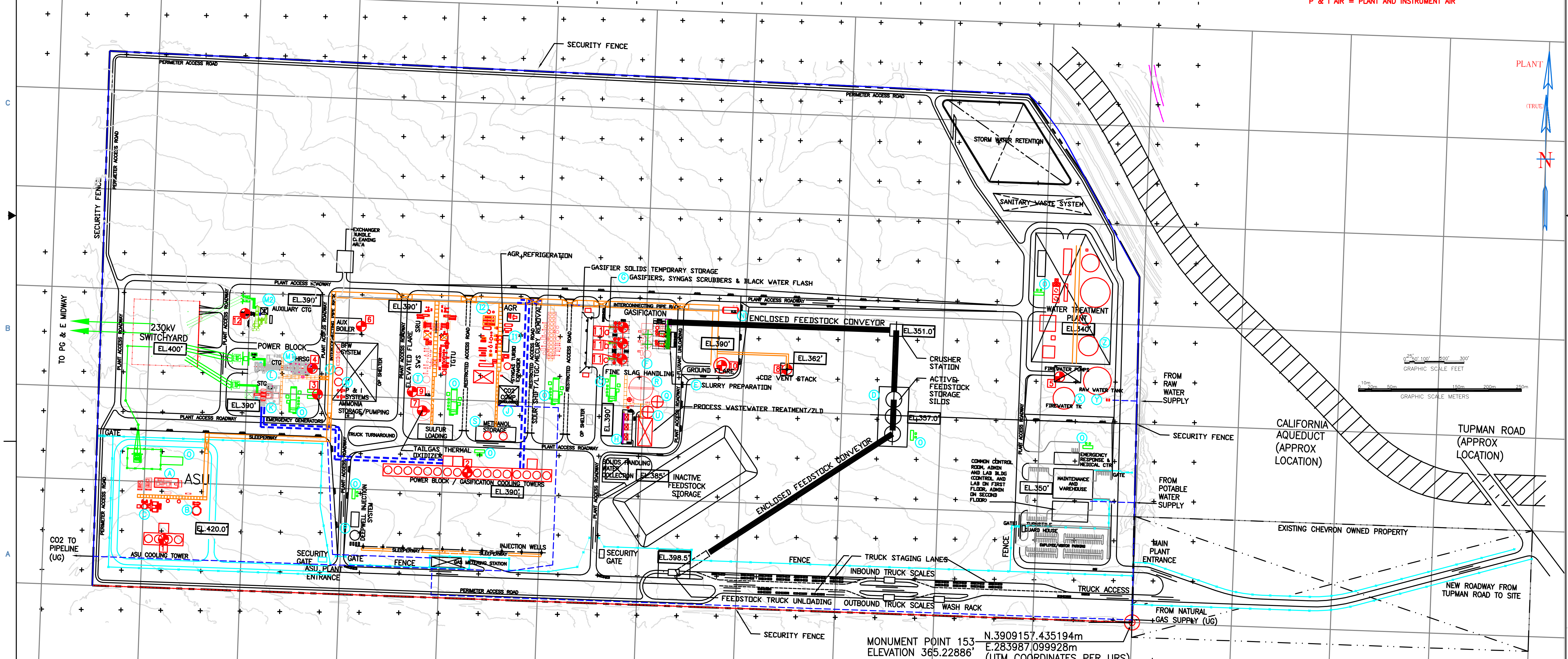
EMISSIONS SOURCES (LEGEND):

ID	SOURCE	UTM COORDINATES (ROUNDED) (METERS) EAST	NORTH	APPX. ELEVATIONS FROM GRADE (FT.)
1	ASU COOLING TOWER	282499	3909285	55
2	POWERBLOCK & GASIFICATION COOLING TOWERS	282966	3909388	55
3	EMERGENCY GENERATORS	282735	3909508	20
4	HRSG STACK	282728	3909548	213
5	FIRE WATER PUMP DIESEL ENGINE	283876	3909535	20
6	AUXILIARY BOILER	282803	3909613	80
7	TAIL GAS THERMAL OXIDIZER	282897	3909483	165
8	CO2 VENT	283457	3909546	288
9	ELEVATED FLARE	282881	3909512	213
10	GROUND FLARE	283357	3909552	80
11a	GASIFIER WARMING VENT	283205	3909611	210
11b	GASIFIER WARMING VENT	283204	3909586	210
11c	GASIFIER WARMING VENT	283203	3909562	210
12	AUXILIARY CTG STACK	282624	3909632	110

LEGEND

EL.351.0' = H.P. GRADE ELEVATION (FT.)

- ASU = AIR SEPARATION UNIT
- AGR = ACID GAS REMOVAL
- SWS = SOUR WATER STRIPPING
- SRU = SULFUR RECOVERY UNIT
- TGTU = TAIL GAS TREATING UNIT
- CTG = COMBUSTION TURBINE GENERATOR
- HRSG = HEAT RECOVERY STEAM GENERATOR
- STG = STEAM TURBINE GENERATOR
- BFW = BOILER FEEDWATER SYSTEM
- PDC = POWER DISTRIBUTION CENTER
- LTGC = LOW TEMPERATURE GAS COOLING
- ZLD = ZERO LIQUID DISCHARGE
- P & I AIR = PLANT AND INSTRUMENT AIR



REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV
0	11JUN08	ISSUED FOR PERMITTING	LDA	ADL	WMB
1	8JUL08	UPDATED FOR PERMITTING	LDA	ADL	WMB

REFERENCE DWG NUMBER | REFERENCE DRAWINGS

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FLUOR W.M.BECKTEL — APP DATE 11JUN08
CLIENT HEI — APP DATE 12JUN08

HYDROGEN ENERGY CALIFORNIA KERN COUNTY POWER PROJECT

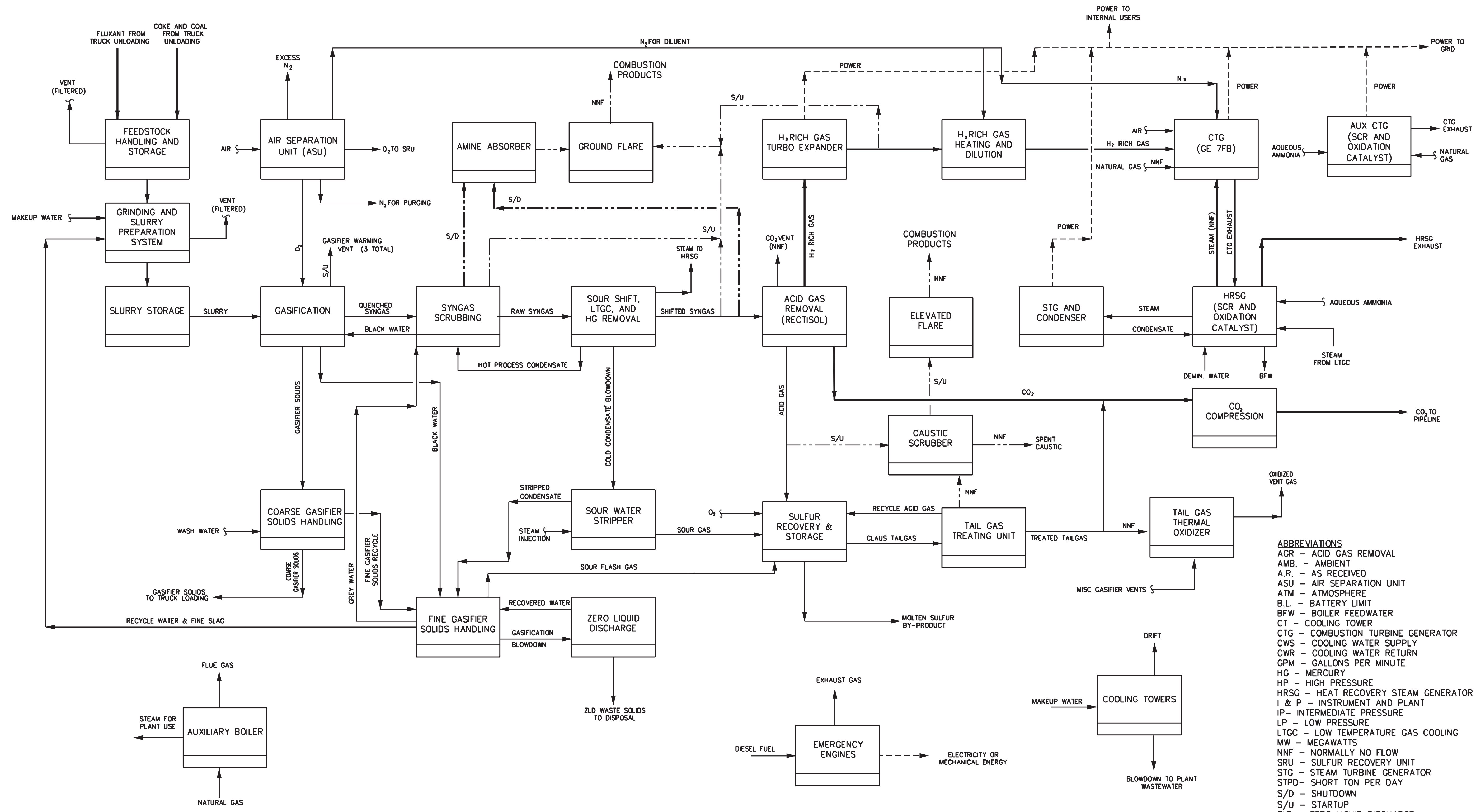
FIGURE 2-32 PRELIMINARY EMISSIONS SOURCES PLOT PLAN

SCALE: SEE SCALES NOTED | DRAWING NUMBER: SK-250-0002 | REV: 1

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐

CAD FILE NAME: sk2500002_r1-emissions 7-8.DWG

PLOT DATE:



ABBREVIATIONS
AGR – ACID GAS REMOVAL
AMB. – AMBIENT
A.R. – AS RECEIVED
ASU – AIR SEPARATION UNIT
ATM – ATMOSPHERE
B.L. – BATTERY LIMIT
BFW – BOILER FEEDWATER
CT – COOLING TOWER
CTG – COMBUSTION TURBINE GENERATOR
CWS – COOLING WATER SUPPLY
CWR – COOLING WATER RETURN
GPM – GALLONS PER MINUTE
HG – MERCURY
HP – HIGH PRESSURE
HRSG – HEAT RECOVERY STEAM GENERATOR
I & P – INSTRUMENT AND PLANT
IP– INTERMEDIATE PRESSURE
LP – LOW PRESSURE
LTGC – LOW TEMPERATURE GAS COOLING
MW – MEGAWATTS
NNF – NORMALLY NO FLOW
SRU – SULFUR RECOVERY UNIT
STG – STEAM TURBINE GENERATOR
STPD– SHORT TON PER DAY
S/D – SHUTDOWN
S/U – STARTUP
ZLD – ZERO LIQUID DISCHARGE

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	6/26/08	ISSUED FOR PERMITTING	JC	JR									
1	7/9/08	UPDATED FOR PERMITTING											

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LEAD ENGR/SPEC. G. SIMS — APP DATE 6/26/08
FLUOR W. BECKTEL — APP DATE 6/26/08
CLIENT HEI — APP DATE 6/27/08

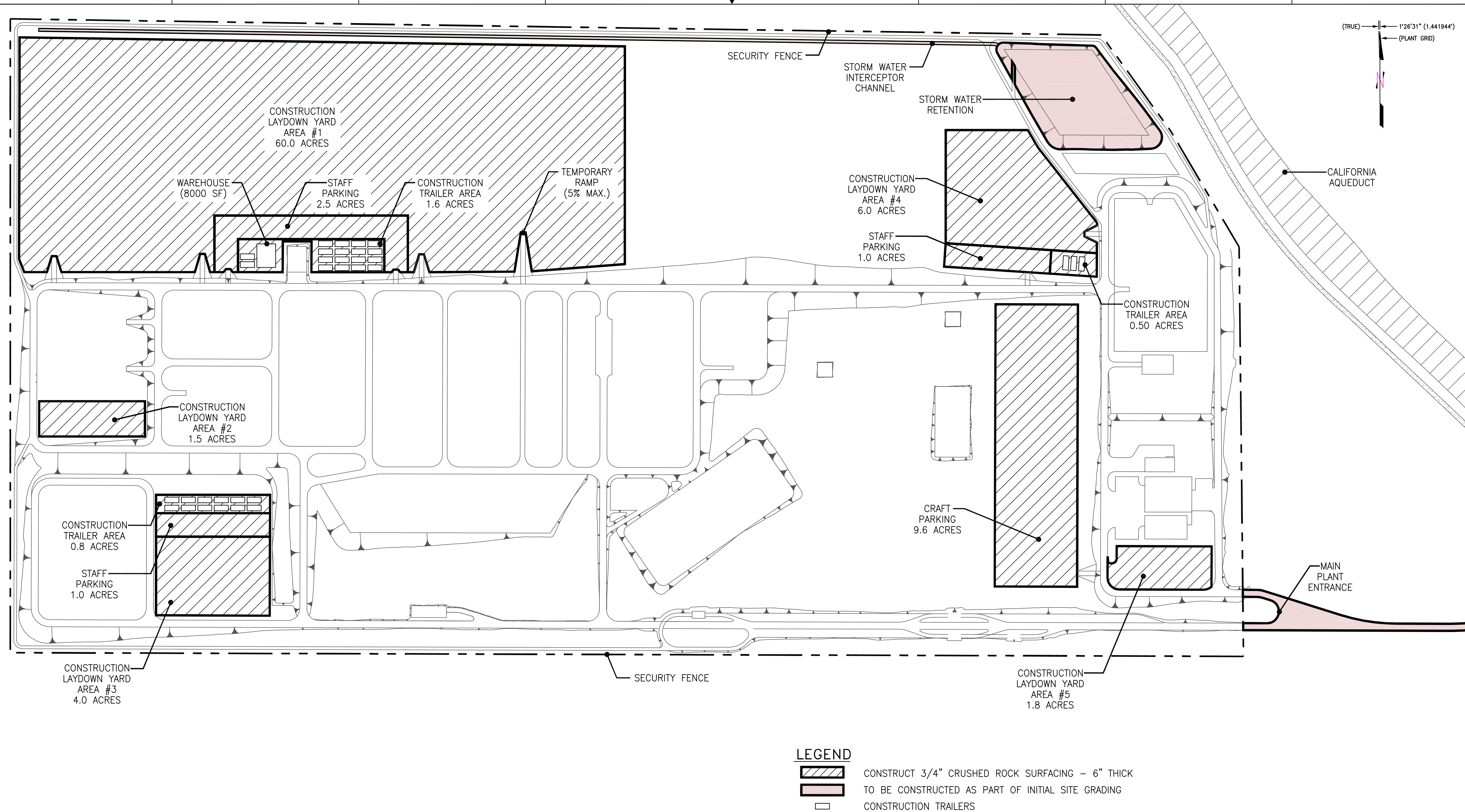
HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-33 BLOCK FLOW DIAGRAM WITH AIR EMISSION SOURCES

SCALE NONE
DRAWING NUMBER A3RW-BFD-25-023
REV 1
SAP NWA
DIST CODE
CAD FILE NAME A3RW-BFD-25-023.DWG

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐

PLOT DATE:



REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	06/09/08	ISSUED FOR PERMITTING	OD	PMF								SK-250-0002	OVERALL PLOT PLAN

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FLUOR W.M.BECKTEL — APP DATE 06/09/08
CLIENT HEI — APP DATE 06/09/08

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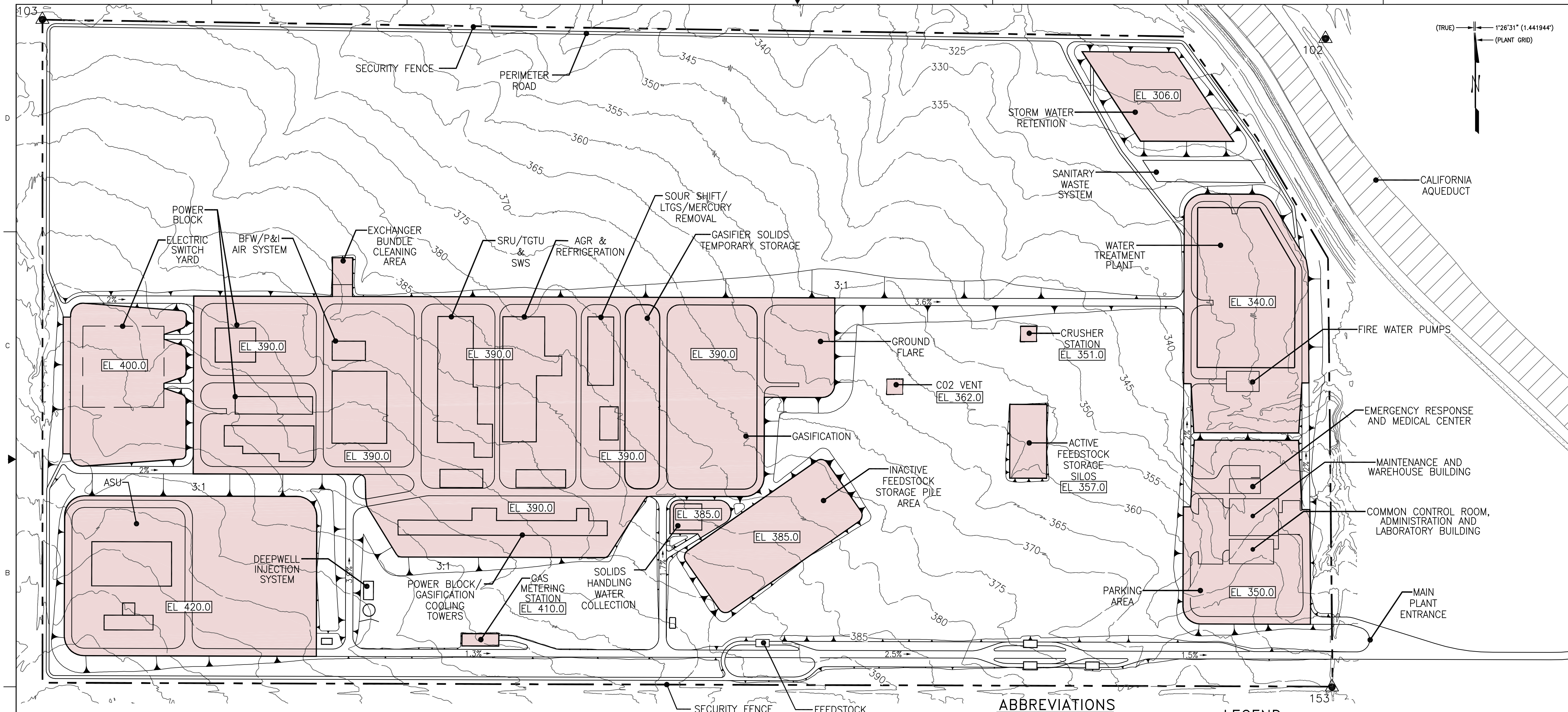
KERN COUNTY POWER PROJECT

FIGURE 2-34 PRELIMINARY TEMPORARY CONSTRUCTION FACILITIES PLAN

SCALE 1:200'
DRAWING NUMBER SK-500-0001
REV 0

PLOT DATE: 05-19-08

XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐ CAD FILE NAME A3RWSK5000001.DWG



SURVEY MONUMENT DATA

CALIFORNIA STATE PLANE COORDINATES			
POINT NO.	NORTHING	EASTING	ELEVATION
102	2,302,425.80	6,150,926.48	305.75
103	2,302,616.09	6,145,714.76	377.10
153	2,299,789.88	6,150,896.04	365.23

NOTE:
COORDINATE LOCATIONS SHOWN ARE BASED ON THE CALIFORNIA COORDINATE SYSTEM (CCS 83), ZONE V, 2007.0 EPOCH, RELATIVE TO THE NORTH AMERICAN DATUM OF 1983 (NAD 83).

EARTHWORK VOLUME

CUT	FILL	NET
1,030,000	985,000 CY	45,000 CY

NOTE:
1. EARTHWORK QUANTITIES ARE APPROXIMATE AND ARE BASED ON DIFFERENCES IN ELEVATIONS BETWEEN PROPOSED AND EXISTING GRADES. QUANTITIES DO NOT TAKE INTO CONSIDERATION ALLOWANCES FOR BULKING OF SOILS. RECLAMATION OR FILLING OF SWAMP AREAS; AND REMOVAL OF DELETERIOUS AND UNSUITABLE MATERIALS DURING CLEARING AND GRUBBING OPERATIONS.
2. EARTHWORK CALCULATIONS ARE BASED ON TOPOGRAPHIC DATA PROVIDED BY D. WOOLEY AND ASSOCIATE AND COORDINATE LOCATIONS SHOWN. EARTHWORK QUANTITIES WILL VARY DEPENDING ON FINAL PLOT LOCATION.
3. GRADED SLOPES HAVE A MAXIMUM GRADE OF 3 HORIZONTAL AND 1 VERTICAL.

ABBREVIATIONS

ASU = AIR SEPARATION UNIT
AGR = ACID GAS REMOVAL
SWS = SOUR WATER STRIPPING
SRU = SULFUR RECOVERY UNIT
TGTU = TAIL GAS TREATING UNIT
CTG = COMBUSTION TURBINE GENERATOR
HRSG = HEAT RECOVERY STEAM GENERATOR
STG = STEAM TURBINE GENERATOR
BFW = BOILER FEEDWATER SYSTEM
PDC = POWER DISTRIBUTION CENTER
LTGC = LOW TEMPERATURE GAS COOLING
ZLD = ZERO LIQUID DISCHARGE
P&I AIR = PLANT AND INSTRUMENT AIR

LEGEND

EL 400.0 — PAD GRADE ELEVATION
TOP / BOTTOM — DENOTES SLOPE
SURVEY MONUMENT POINT
PAD AREA

0 100' 200' 400' 600' 800'
1"=200'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	06/09/08	ISSUED FOR PERMITTING	OD	PMF		SK-250-0002	OVERALL PLOT PLAN

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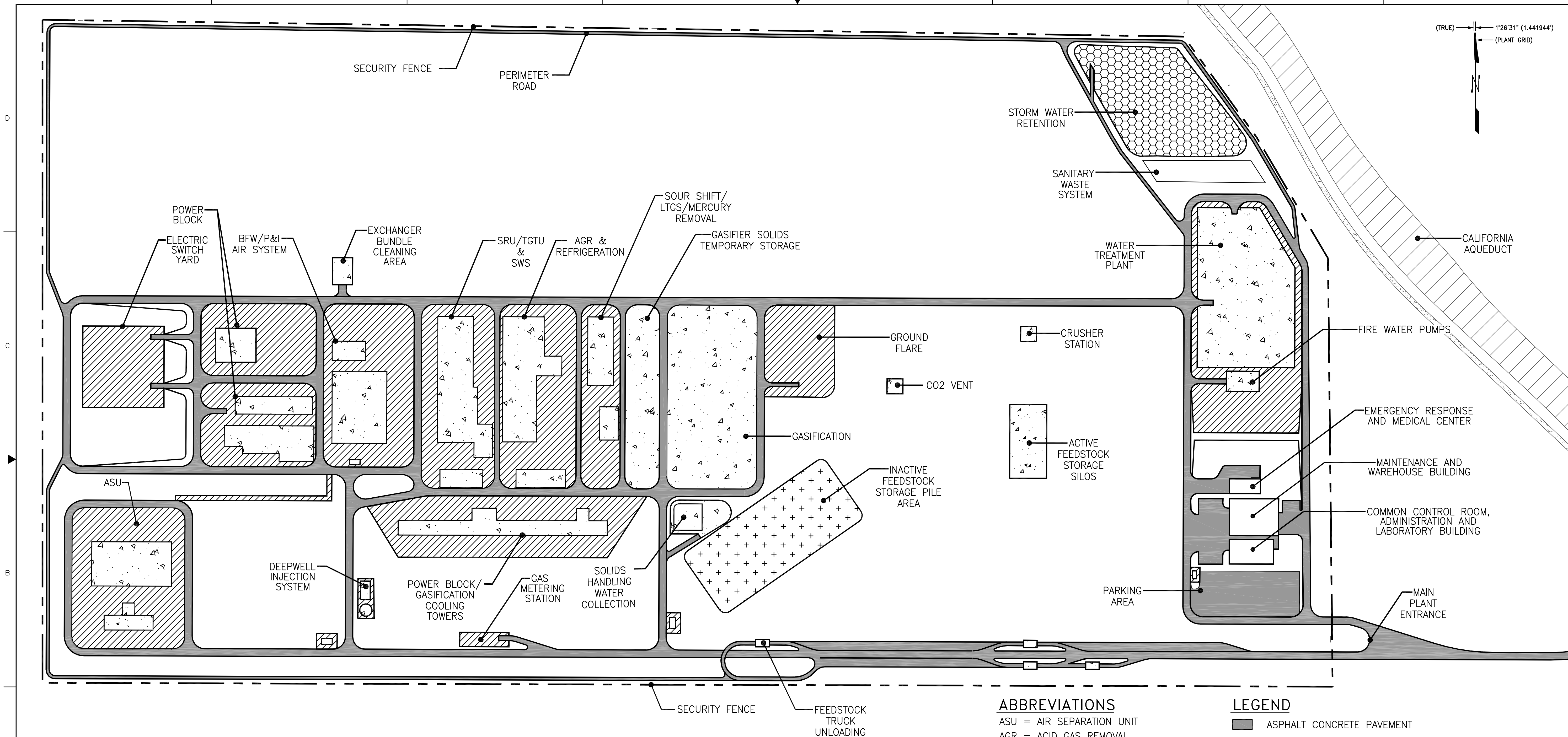
FLUOR W.M.BECKTEL — APP DATE 06/09/08
CLIENT HEI — APP DATE 06/09/08

HYDROGEN ENERGY CALIFORNIA
KERN COUNTY POWER PROJECT

FIGURE 2-35
PRELIMINARY GRADING PLAN

SCALE 1:200'
DRAWING NUMBER SK-210-0001
REV 0
CAD FILE NAME A3RWSK2100001.DWG

PLOT DATE: 05-19-08
XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐



ABBREVIATIONS

ASU = AIR SEPARATION UNIT
AGR = ACID GAS REMOVAL
SWS = SOUR WATER STRIPPING
SRU = SULFUR RECOVERY UNIT
TGTU = TAIL GAS TREATING UNIT
CTG = COMBUSTION TURBINE GENERATOR
HRSG = HEAT RECOVERY STEAM GENERATOR
STG = STEAM TURBINE GENERATOR
BFW = BOILER FEEDWATER SYSTEM
PDC = POWER DISTRIBUTION CENTER
LTGC = LOW TEMPERATURE GAS COOLING
ZLD = ZERO LIQUID DISCHARGE
P&I AIR = PLANT AND INSTRUMENT AIR

LEGEND

- ASPHALT CONCRETE PAVEMENT
- CONCRETE PAVEMENT
- CRUSHED ROCK SURFACING
- CLAY LINER (12" CLAY)
- IMPERMEABLE HDPE LINER

0 100' 200' 400' 600' 800'
1"=200'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DWG NUMBER	REFERENCE DRAWINGS
0	06/09/08	ISSUED FOR PERMITTING	OO	PMF		SK-250-0002	OVERALL PLOT PLAN

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FLUOR W.M.BECKTEL — APP DATE 06/09/08
CLIENT HEI — APP DATE 06/09/08

HYDROGEN ENERGY CALIFORNIA KERN COUNTY POWER PROJECT

FIGURE 2-36 PRELIMINARY PAVING PLAN

SCALE 1:200' | DRAWING NUMBER SK-210-0003 | REV 0

PLOT DATE: 05-16-08
XREF ATTACHED – YES ☐ NO ☐ MANUAL CHANGES MADE – YES ☐ NO ☐ DWG FILE UPDATED – YES ☐ NO ☐ MODEL UPDATED – YES ☐ NO ☐
CAD FILE NAME A3RWSK2100003.DWG
SAP NWA DIST CODE

DATA ADEQUACY WORKSHEET

Adequacy Issue: Adequate ____ Inadequate ____ Revision No. 0 Date ____

Technical Area: **Efficiency** Project: ____ Technical Staff: ____

Project Manager: ____ Docket: ____ Technical Senior: ____

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (1)	...provide a discussion of the existing site conditions, the expected direct, indirect and cumulative impacts due to the construction, operation and maintenance of the project, the measures proposed to mitigate adverse environmental impacts of the project, the effectiveness of the proposed measures, and any monitoring plans proposed to verify the effectiveness of the mitigation.	Entire AFC		
Appendix B (h) (4) (A)	Heat and mass balance diagrams for design conditions for each mode of operation.	Table 2-12		
Appendix B (h) (4) (B)	Annual fuel consumption in BTUs for each mode of operation, including hot restarts and cold starts.	Table 2-12		
Appendix B (h) (4) (C)	Annual net electrical energy produced in MWh for each mode of operation including starts and shutdowns.	Page 2-1, Table 2-12		
Appendix B (h) (4) (D)	Number of hours the plant will be operated in each design condition in each year.	Page 2-6		
Appendix B (h) (4) (E)	If the project will be a cogeneration facility, calculations showing compliance with applicable efficiency and operating standards.	N/A		
Appendix B (h) (4) (F)	A discussion of alternative generating technologies available for the project, including the projected efficiency of each, and an explanation why the chosen equipment was selected over these alternatives.	Pages 6-5 – 6-7		

DATA ADEQUACY WORKSHEET

Adequacy Issue: Adequate ____ Inadequate ____

Revision No. 0 Date ______

Technical Area: **Efficiency**

Project: ______

Technical Staff: ______

Project Manager: ______

Docket: ______

Technical Senior: ______

Siting Regulations	Information	AFC Page Number and Section Number	Adequate Yes or No	Information Required To Make AFC Conform With Regulations
Appendix B (i) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, leases, and permits applicable to the proposed project, and a discussion of the applicability of, and conformance with each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed; and	Table 7-1		
Appendix B (i) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits, leases, and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Sections 5.1 – 5.16		
Appendix B (i) (2)	The name, title, phone number, address (required), and email address (if known), of an official who was contacted within each agency, and also provide the name of the official who will serve as a contact person for Commission staff.	Sections 5.1 – 5.16		
Appendix B (i) (3)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	Sections 5.1 – 5.16		

Adequacy Issue: Adequate ____ Inadequate ____

DATA ADEQUACY WORKSHEET

Revision No. 0 Date ____

Technical Area: **Facility Design** Project: ____ Technical Staff: ____

Project Manager: ____ Docket: ____ Technical Senior: ____

Siting Regulations	Information	AFC Page Number and Section Number	Adequate Yes or No	Information Required To Make AFC Conform With Regulations
Appendix B (h) (1) (A)	A description of the site conditions and investigations or studies conducted to determine the site conditions used as the basis for developing design criteria. The descriptions shall include, but not be limited to, seismic and other geologic hazards, adverse conditions that could affect the project's foundation, adverse meteorological and climatic conditions, and flooding hazards, if applicable.	Entire AFC		
Appendix B (h) (1) (B)	A discussion of any measures proposed to improve adverse site conditions.	Entire AFC		
Appendix B (h) (1) (C)	A description of the proposed foundation types, design criteria (including derivation), analytical techniques, assumptions, loading conditions, and loading combinations to be used in the design of facility structures and major mechanical and electrical equipment	Appendix B1 subsection 3.1.2		
Appendix B (h) (1) (D)	For each of the following facilities and/or systems, provide a description including drawings, dimensions, surface-area requirements, typical operating data, and performance and design criteria for protection from impacts due to adverse site conditions:			
Appendix B (h) (1) (D) (i)	The power generation system;	Pages 2-25 – 2-31, 2-55 – 2-61 Figure 2-3, 2-4		
Appendix B (h) (1) (D) (ii)	The heat dissipation system;	Pages 2-38 – 2-39 Figure 2-25		
Appendix B (h) (1) (D) (iii)	The cooling water supply system, and, where applicable, pre-plant treatment procedures;	Pages 2-10 Figures 2-6, 2-7A, 2-7B		

Adequacy Issue: Adequate ____ Inadequate ____

DATA ADEQUACY WORKSHEET

Revision No. 0 Date ____

Technical Area: **Facility Design** Project: ____ Technical Staff: ____

Project Manager: ____ Docket: ____ Technical Senior: ____

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (h) (1) (D) (iv)	The atmospheric emission control system;	Pages 2-43, 2-55 – 2-61 Table 2-22 Figure 2-33		
Appendix B (h) (1) (D) (v)	The waste disposal system and on-site disposal sites;	Pages 2-15, 2-36		
Appendix B (h) (1) (D) (vi)	The noise emission abatement system;	Pages 5-26 – 5-32 Table 5-11 Appendix K		
Appendix B (h) (1) (D) (vii)	The geothermal resource conveyance and re-injection lines (if applicable);	N/A		
Appendix B (h) (1) (D) (viii)	Switchyards/transformer systems; and	Page 2-12 Figures 2-4, 2-15, 2-16, 2-17, 2-18 Section 4		
Appendix B (h) (1) (D) (ix)	Other significant facilities, structures, or system components proposed by the applicant.	Pages 2-17 – 2-24, 2-32 – 2-54 Figures 2-8, 2-9, 2-10, 2-11, 2-20, 2-21, 2-22, 2-23, 2-24, 2-26, 2-27, 2-28, 2-29, 2-30, 2-31		

DATA ADEQUACY WORKSHEET

Adequacy Issue: Adequate ____ Inadequate ____ Revision No. 0 Date ________

Technical Area: **Reliability** Project: ________ Technical Staff: ________

Project Manager: ________ Docket: ________ Technical Senior: ________

Siting Regulations	Information	AFC Page Number and Section Number	Adequate Yes or No	Information Required To Make AFC Conform With Regulations
Appendix B (g) (1)	...provide a discussion of the existing site conditions, the expected direct, indirect and cumulative impacts due to the construction, operation and maintenance of the project, the measures proposed to mitigate adverse environmental impacts of the project, the effectiveness of the proposed measures, and any monitoring plans proposed to verify the effectiveness of the mitigation.	Section 2		
Appendix B (h) (3) (A)	A discussion of the sources and availability of the fuel or fuels to be used over the estimated service life of the facilities.	Pages 2-9, 2-32		
Appendix B (h) (3) (B)	A discussion of the anticipated service life and degree of reliability expected to be achieved by the proposed facilities based on a consideration of:	Pages 2-81 – 2-82		
Appendix B (h) (3) (B) (i)	Expected overall availability factor, and annual and lifetime capacity factors;	Pages 2-81 – 2-82		
Appendix B (h) (3) (B) (ii)	The demonstrated or anticipated feasibility of the technologies, systems, components, and measures proposed to be employed in the facilities, including the power generation system, the heat dissipation system, the water supply system, the reinjection system, the atmospheric emission control system, resource conveyance lines, and the waste disposal system;	Pages 2-81 – 2-82 Section 6		
Appendix B (h) (3) (B) (iii)	Geologic and flood hazards, meteorologic conditions and climatic extremes, and cooling water availability;	Page 2-77 Appendix B2, Appendix O		

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Siting Regulations	Information	AFC Page Number and Section Number	Adequate Yes or No	Information Required To Make AFC Conform With Regulations
Appendix B (h) (3) (B) (iv)	Special design features adopted by the applicant or resource supplier to ensure power plant reliability including equipment redundancy; and	Pages 2-81 – 2-82		
Appendix B (h) (3) (B) (v)	For technologies not previously installed and operated in California, the expected power plant maturation period.	Pages 2-81 – 2-82		
Appendix B (i) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, leases, and permits applicable to the proposed project, and a discussion of the applicability of, and conformance with each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed; and	Table 7-1		
Appendix B (i) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits, leases, and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Table 7-2		
Appendix B (i) (2)	The name, title, phone number, address (required), and email address (if known), of an official who was contacted within each agency, and also provide the name of the official who will serve as a contact person for Commission staff.	AFC		

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Siting Regulations	Information	AFC Page Number and Section Number	Adequate Yes or No	Information Required To Make AFC Conform With Regulations
Appendix B (i) (3)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	AFC		