3.0 FACILITY DESCRIPTION AND LOCATION

3.1 INTRODUCTION

The Genesis Solar Energy Project (the Project) will consist of two independent concentrated solar electric generating facilities (aka power plants or plant) with a nominal net electrical output of 125 megawatts (MW) each, for a total net electrical output of 250 MW. The plants will use well-established parabolic trough solar thermal technology to produce electrical power using steam turbine generators (STG) fed from solar steam generators (SSG). The SSG receives heated heat transfer fluid (HTF) from solar thermal equipment comprised of arrays of parabolic mirrors that collect energy from the sun.

Each plant will use natural gas-fueled auxiliary boilers to reduce start-up time and provide HTF freeze protection. Freeze protection will maintain the HTF at a minimum of 100 degrees Fahrenheit (°F).

The Project proposes to use a wet cooling tower for power plant cooling. Water for cooling tower make-up, process water make-up, and other industrial uses such as mirror washing will be supplied from on-site groundwater wells, which will also be used to supply water for employee use (*e.g.,* drinking, showers, sinks, and toilets). A package water treatment system will be used to treat the water to meet potable standards. A sanitary septic system and on-site leach field will be used to dispose sanitary wastewater.

Project cooling water blowdown will be piped to lined, on-site evaporation ponds. The ponds will be sized to retain approximately seven years' worth of solids and will be cleaned out periodically during the life of the plant to ensure the solids do not reach a depth greater than approximately three feet. Dewatered residues from the ponds will be sent to an appropriate off-site landfill as non-hazardous waste.

3.2 LOCATION OF FACILITIES AND ACRES DISTURBED

The Project is located in eastern Riverside County, between the communities of Blythe, California (approximately 25 miles east of the Project site) and Desert Center, California (approximately 27 miles west of the Project site). The Ironwood and Chuckwalla State Prisons (adjacent to each other) are located approximately nine miles to the south of the Project site (Figure 3.2-1).

Surrounding features include the McCoy Mountains to the east, the Palen Mountains (including the Palen/McCoy Wilderness Area) to the north, and Ford Dry Lake, a dry lakebed, to the south. Interstate 10 (I-10) is located approximately two miles south of the southernmost border of the Project site.

Genesis Solar, LLC has applied for a 4,640-acre right-of-way (ROW) grant from the Bureau of Land Management (BLM) for development of the Project. Once constructed, the Project would permanently occupy approximately 1,800 acres within this area (the Project footprint), plus approximately 90 acres for linear facilities. The land around the Project site is predominantly owned and managed by the BLM (Figure 3.2-2).

The Project is located in Township 6S Range 18E and Township 6S Range 19E, San Bernardino Base and Meridian. A summary legal description of the BLM-requested ROW is provided in Table 3.2-1.

Table 3.2-1. Requested ROW for the Project

Section	Aliquot	Estimated Acres
Township 6S, Range 19E, San Bernardino Base & Meridian		
4	S ½ except wilderness	260
5	All except wilderness	550
6	SE ¼	160
7	N ½ NE ¼	80
8	NE ¼, N ½ NW ¼	240
9	N ½	320
10	All except wilderness	580
11	SW ¼	160
13	NW ¼ except wilderness; SW ¼	280
14	N ¾, NW ¼, N ¾, NE ¼	240
15	N ½ NW ¼ , N ½ NE ¼	160
24	W ½ N ½	160
	Subtotal, T 6 S, R 19 E:	3,190
Township 6S, Range 18E, San Bernardino Base & Meridian		
1	S ½ except wilderness	290
2	S ½ except wilderness	260
3	S ½	320
4	All except wilderness	580
	Subtotal, T 6S, R18 E:	1,450
	Total, Modified ROW, 1/4/08	**4,640**

The Project will consist of the main facility footprint and associated linear corridor. Table 3.2-2 provides the total acres of permanent and temporary disturbance associated with the entire Project.

Table 3.2-2. Acres of Temporary and Permanent Disturbance

	Dimensions	Quantity	Acres
Temporary Disturbance:			
Transmission Line			
Construction laydown/assembly areas	100' X 200'	1	0.46
Conductor Pulling Area	50' X 140'	25	4.02
Crossing Structures	100' X 100'	4	1.84
Pole Pad Construction Areas	50' X 50' (note 1)	60	2.91
Gas Line			
Construction Right-of-Way	50' X 6 miles (note 2)	1	36.36
Roads			
Site Access Road Construction	50' X 6.5 miles (note 3)	1	15.76

Table 3.2-2. Acres of Temporary and Permanent Disturbance

	Dimensions	Quantity	Acres
Total Temporary Disturbance			61.35
Permanent Disturbance:			
Transmission Pole Pads	6' X 6'	60	0.05
Spur Roads	70' X 14'	60	1.90
Substation Expansion	75' X 240'	1	0.41
Site Access Road	30' X 6.5 miles	1	23.64
Gas Line	N/A	N/A	N/A
Project Footprint	varies	1	1800.00
Total Permanent Disturbance			**1826.00**

Notes

[1] The 50' X 50' Pole Pad Construction area does not include the 6' X 6' permanent pole pad disturbance or the portion of the spur road that is coincident with the 50' X 50' pole pad construction area.

[2] Approximately 20' of the gas line construction ROW will overlap the access road construction ROW; therefore, it has not been included in the temporary disturbance calculation.

[3] The temporary disturbance shown excludes the permanent disturbance for the access road.

3.3 PHYSICAL SITE DESCRIPTION

The Project is situated within the northeastern portion of Chuckwalla Valley, an east-southeast trending valley in eastern Riverside County. Physiographically, the Project site lies near the toe of alluvial fans emanating from the Palen Mountains to the north and the McCoy Mountains to the east, and the eastern portion of the Project site is underlain by a broad valley-axial drainage that extends southward between these mountains and drains to the Ford Dry Lake playa located about one mile south of the Project site. The Project site is relatively flat and generally slopes from north to south with elevations of approximately 400 to 370 feet above mean sea level. It is occupied by a community of low creosote and bursage scrub vegetation and is shown on the Ford Dry Lake and McCoy Spring United States Geological Survey (USGS) topographic maps. The area has historically been used for both off-highway vehicle use and sheep grazing; however, neither activity currently occurs.

The Project is located in an arid desert climate, and therefore has extreme daily temperature changes, low annual precipitation, strong seasonal winds, and mostly clear skies. Evaporation rates are higher than precipitation rates. Average rainfall in the Project area is around 5 to 6 inches annually, but a single rainstorm, particularly during the monsoon season from mid-July to the end of August, can bring 1 to 3 inches of rain in a few hours. Extreme events in the nearby area have recorded over 10 inches of rain in 24 hours. The vast majority of the time, the area is dry and devoid of any surface flow anywhere in either Project area. Evaporation potential is around 90 to 100 inches annually as described in more detail in Section 5.4, Water Resources. The Federal Emergency Management Agency (FEMA) has not mapped the site for the presence of floodplains.

3.4 POWER PLANT GENERATION FACILITY

3.4.1 Power Plant Site Arrangement

Figure 3.4-1 shows the layout of Project facilities on the plant site including:

- Overall plant area and facilities footprint
- Power blocks
- Control room and local warehouse locations
- Administration building
- Solar collector field arrangements
- Evaporation ponds
- Bioremediation land treatment unit (LTU)
- Onsite transmission facilities
- Onsite gas pipeline facilities
- Drainage realignment
- Existing groundwater wells used for water supply
- Access road from I-10

The Project power block and solar arrays will occupy approximately 1,360 acres of the 1,800-acre site. Additionally, evaporation ponds, access road, administration buildings and other support facilities, LTU, and some open areas will be fenced for a total of 1,800 acres.

Figures 3.4-2 and 3.4-3 are plot plans of the Project's power blocks. As shown on Figures 3.4-2 and 3.4-3, major components of the Project include:

- SSG heat exchangers
- Two STGs and condenser
- Two wet cooling towers
- Two natural gas-fired auxiliary boilers
- Steam-fed HTF freeze protection heat exchangers
- HTF surge volume tanks
- Two firewater pumps and pump house with associated diesel fuel tank
- Emergency diesel generators
- Two raw water storage tanks
- Two treated water storage tanks
- Two demineralized water storage tanks
- Ancillary equipment

Elevation drawings of plant facilities are provided in Figures 3.4-4 and 3.4-5, which include views looking west (Section A-A) and looking north (Section B-B) for Units 1 and 2, respectively.

3.4.2 Process Description

This section describes the power generation process and thermodynamic cycle employed by the Project. Each 125 MW power plant consists of:

- STG
- SSG heat exchangers

- Surface condenser
- Feedwater pumps
- Deaerator
- Feedwater heaters
- Wet cooling tower
- Evaporation ponds
- Natural gas-fired boilers
- Solar thermal collection field

The plant's power cycle is the Rankine-with-reheat thermodynamic cycle. A preliminary heat balance diagram for the process is included in Figure 3.4-6. The thermal input is via heated HTF from the parabolic trough solar field at a temperature of approximately 740 °F.

Overall annual availability for each 125 MW facility is expected to be between 96 to 98 percent of possible operating hours (between 3,000 and 3,200 hours per year). Each plant's capacity factor will depend on the local solar insolation, but has been estimated to be approximately 27 percent, or approximately 300,000 MWh/year. Each 125 MW plant will use the Rankine thermodynamic cycle with reheat described as follows:

Process 1: The working fluid (water) is pumped from low to high pressure. During this process, steam extracted from the STG is used to preheat the water prior to entering the SSG system, which increases overall cycle efficiency.

Process 2: The high pressure liquid enters the SSG system where it is heated theoretically at constant pressure by the HTF to become superheated steam.

Process 3: The superheated steam expands through the high pressure section of the steam turbine, turning the generator to produce electricity. This steam is then reheated in different vessels that are part of the SSG system and sent to the reheat section of the steam turbine. The reheat exhausts into the low pressure (LP) section of the steam turbine.

Process 4: The wet steam from the LP section then enters the surface condenser where it is cooled at a constant low pressure to become a saturated liquid. The condensed liquid returns to Process 1.

As the HTF is circulated from the SSG to the solar field, it absorbs solar energy and provides a high temperature (740°F) energy source for the Rankine cycle. Waste heat is rejected in Process 4. As the turbine exhaust is condensed, the heat is transferred to the cool circulating water. The warm circulating water carries the heat to the wet cooling tower to be rejected.

3.4.3 Steam Turbine-Generator (STG)

As described earlier, steam from the SSG is sent to the STG. The steam expands through the STG turbine blades to drive the steam turbine, which in turn drives the generator. The Project's STG is expected to be a two casing reheat type with six to seven feedwater heater extraction points and down axial flow LP exhaust. The STG is equipped with accessories required to provide efficient, safe, and reliable operation, including the following:

- Governor system
- Steam admission system

- Gland seal system
- Lubrication oil system including oil coolers and filters
- Generator coolers
- Metal enclosures designed for outdoor service for STG auxiliary systems

3.4.4 Energy Conversion Facilities Description

This section describes the major energy conversion components of the Project including the STG, SSG, HTF heater, and solar collection system.

3.4.4.1 Description of Technology

The collector field is made up of multiple single-axis-tracking parabolic trough solar collectors aligned on a north-south axis. Each solar collector has a parabolic-shaped reflector that focuses the sun's direct normal radiation on a receiver known as a heat collection element (HCE) located at the focal point of the parabola.

The collectors track the sun from east to west during the diurnal cycle to ensure the sun is continuously focused on the HCE. The HTF is heated up to approximately 740 °F as it circulates through the HCEs and returns to the SSG where the fluid is used to generate high-pressure steam.

3.4.4.2 Major Solar Equipment

The major pieces of equipment for the solar portion of the Project, each of which is discussed below, are as follows:

- Heat collection element (HCE)
- Solar collector assembly (SCA)
- HTF
- Mirrors
- Connectors
- SSG heat exchangers
- HTF heater
- HTF expansion tanks
- HTF ullage/flash system
- HTF piping headers

3.4.4.3 Heat Collection Elements

The HCE consists of a steel tube with a selective coating, surrounded by an evacuated glass tube insulator. The coating gives it excellent selective heat transfer properties. The evacuated glass tube enclosure protects the selective surface and reduces heat loss by insulating it.

The outer glass cylinder has anti-reflective coating on the inner and outer surfaces to reduce reflective losses (increasing the transmissivity). Typically, getters (metallic substances that are designed to absorb gas molecules) are installed in the vacuum space to absorb hydrogen and other gases that permeate into the vacuum annulus over time to maintain its insulating properties.

3.4.4.4 Solar Collector Assemblies

The SCAs are dynamic structures that rotate around the north/south axis to track the sun as it moves through the sky. The axis of rotation is located at the collector center of mass to minimize the required tracking power. The tracking is controlled by a local controller on each SCA.

3.4.4.5 Heat Transfer Fluid

Therminol™ (VP-1), an aromatic hydrocarbon, biphenyl-diphenyl oxide manufactured by Solutia, is currently being considered as the HTF for the Project. Therminol is a special high-temperature oil that has an excellent operating history and is used in many heat transfer processes. Dowtherm A, an essentially chemically identical product manufactured by Dow, is being considered as an alternative to Therminol™ (VP-1).

3.4.4.6 Mirrors

Low-iron glass mirrors are mounted on the SCA. These mirrors are reliable components that have shown no long-term degradation in reflective quality. Twenty-year-old mirrors can be cleaned and brought back to like-new reflectivity. Long-term endurance of the mirror, as measured by the experience at Solar Electric Generating Station (SEGS), indicates mirror life of 30 years or more can be expected for the Project.

Flexible mirror reflectivity monitoring procedures using demineralized water for mirror washing is critical. The periodic monitoring of mirror reflectivity provides a valuable quality control tool for mirror washing and helps to optimize wash labor.

3.4.4.7 Solar Steam Generator System

The SSG system design is similar to any “kettle boiler” shell and tube heat exchanger in that the hot HTF is circulated through tubes and the steam is produced on the shell side. The SSG system includes heat exchangers for preheating the condensate, superheating the steam, and reheating steam, in addition to the boiler vessels.

3.4.4.8 HTF Freeze Protection Heat Exchanger

The HTF freezes at temperatures below 54 °F. To eliminate the problem of HTF freezing, steam-fed shell and tube heat exchangers will be used to keep the HTF above 100 °F whenever the facility is offline. As discussed above, the auxiliary boilers will supply the heat for this process as well as performing the function of a startup boiler. This dual-use configuration reduces the number of individual emission sources.

3.4.4.9 HTF Expansion Tank

Expansion tanks are required to accommodate the volumetric change that occurs when heating the HTF to the operating temperature. Nitrogen will be used to blanket the headspace of the tanks. The nitrogen purge prevents oxidation or contamination of the HTF by reducing its exposure to atmospheric air.

3.4.4.10 HTF Ullage/Flash System

During plant operation, HTF will degrade into components of high and low boilers (substances with boiling points higher and lower than the HTF). The low boilers are removed from the process as vapors through the ullage system. The high boilers are removed from the process as liquid and sediment through the HTF flash system.

3.4.4.11 HTF Piping Header

Supply and return piping is routed to allow for balanced flow through all the HCEs. Expansion loops will be located as required to maintain the composite pipe stress within American Society of Mechanical Engineers (ASME) B31.1 Power Piping code allowable limits. The steel piping in the mirrored trough sections of the array will be connected with ball joints and will not be rigidly mounted to foundations or other structures.

3.4.5 Major Electrical Systems and Equipment

This section describes the major electrical systems and equipment. Roughly 10 percent of the STG output will be used on-site for plant auxiliary loads such as motors, heaters, control systems, and general facility loads including lighting and heating, ventilation, and air conditioning (HVAC). Some of the power needed for on-site uses will be converted from alternating current (AC) to direct current (DC) for power plant control systems and emergency backup systems. The descriptions of the major electrical systems and equipment provided in the following subsections reflect AC power unless otherwise noted. All electrical facilities equipment will be designed in accordance with applicable codes and standards listed in Section 3.11.

Power will be generated by the STG (size and generation voltage is depending on the final generator selection) and stepped up by a fan-cooled generator step-up transformer (GSUT). Start-up power will be back-fed through the GSUT. Once the STG is running, it will supply the plant auxiliary power through a generator bus tap and the unit auxiliary transformer (UAT). The plant stand-by electrical power requirements will be back-fed through the GSUT and UAT. There will also be an alternate back-feed power source to the main auxiliary switchgear. This will be key-interlocked with the main auxiliary power source to prevent both sources from operating simultaneously.

3.4.5.1 Grounding

The electrical system is susceptible to ground faults, lightning, and switching surges that can pose hazards to site personnel and electrical equipment. The station grounding system provides an adequate path to ground to permit the dissipation of current created by these events. The station ground grid will be designed for adequate capacity to dissipate ground current.

Bare conductors will be installed below-grade in a grid pattern throughout the power block area. Each junction of the grid will be bonded together by an exothermic weld or compression connection. Ground resistivity readings will be used to determine the necessary numbers of ground rods and grid spacing to ensure safe step and touch potentials under severe fault conditions. Grounding stingers will be brought from the ground grid to connect to building steel and non-energized metallic parts of electrical equipment.

3.4.5.2 Electrical Generation

As shown in the key one line diagram, Figure 3.4-7, the Project's STGs will tie into a 230 kV on-site switchyard. The STGs generate electricity at 13.8 kV that will connect to the switchyard at 230 kV via a generator circuit breaker (GCB) and a GSUT. The GCB will be rated at 8000 Amperes (A) and will include an 8000/5 A current transformers and 14.4-0.12 kV voltage transformers for generator bus duct, and UAT protection. A disconnect switch will be included with the generator circuit breaker for generator disconnect and transformer maintenance. An 8000 A isolated phase bus duct will connect the generator to the GCB and the GCB to the GSUT. The GSUTs will be 150 megavolt-amps (MVA), 230-13.8 kV, two-winding, delta-wye grounded, and fan-cooled (using oil-immersed natural circulation, multi-stage, forced air cooling). The neutral point of high-voltage winding will be solidly

grounded. The main step-up transformer will have metal oxide surge arrestors connected to the high-voltage terminals and will have manual de-energized ("no-load") tap changers located in high-voltage windings to allow for a nominal voltage plus or minus five percent with a 2.5 percent differential to allow for generator output voltage variations. The GSUT will rest on a concrete pad with a perimeter berm designed to contain the transformer non-polychlorinated biphenyl (PCB) insulating oil in the event of a leak or spill.

The plant site switchyard will be located near the unit two power block, as shown in Figure 3.4-3, and will require an overhead 795 thousand circular mils (kcmil) size, steel-reinforced, aluminum conductor unit tie line for the connection to both unit's GSUTs. The switchyard will consist of 230 kV switchyard circuit breakers with 230 kV, 1200 A disconnect switches on each side of the breaker for breaker maintenance. The switchyard breakers will be of the dead tank design with 1200/5 multi-ratio current transformers on each bushing and 230-0.12 kV coupling capacitor voltage transformers located near the breaker control cabinet for protection of the gen-tie line during normal operation or the GSUT and the UAT during back-feed. The switchyard breakers will also be coordinated with the GCBs and 4.16 kV station service switchgear main breakers for bus duct, GSUT, UAT, and unit tie line protection and will also be used for generator synchronizing.

A disconnect switch will be located at the gen-tie line termination within the switchyard for line isolation. The switchyard will be equipped with metering accuracy instrument transformers. Lightning arresters will be provided in the area of the takeoff towers to protect against surges due to lightning strikes. Tubular aluminum alloy bus will be used in the switchyard. Cable connections between the tube bus and equipment will be aluminum or aluminum alloy type cable. Electrical faults will be detected, isolated, and cleared in a safe and coordinated manner as soon as practical to ensure the safety of equipment, personnel, and the public. Protective relaying will meet Institute of Electrical and Electronic Engineers (IEEE) requirements and will be coordinated with the utility.

3.4.6 Fuel Supply and Use

As shown in Figure 3.4-1 and discussed in Section 3.4, the auxiliary boilers will be fueled by natural gas supplied from a new six-mile, eight-inch pipeline connected to an existing Southern California Edison (SCE) pipeline located north of I-10. Natural gas delivered to the Project site will flow through a revenue quality flow meter, pressure regulation station, and filtering equipment, and will provide gas to the auxiliary boilers for each 125 MW power plant. Safety pressure relief valves are provided downstream of the pressure regulation valves. The estimated natural gas usage for each auxiliary boiler is 30 million British thermal units per hour (MMBtu/hr) or a total of 60 MMBtu/hr for the Project. The maximum annual natural gas usage is expected to be 60 million standard cubic feet per year (MMSCF/yr) for a maximum of 60,000 MMBtu/year. Table 3.4-1 shows the typical composition of the natural gas used to fuel the Project's auxiliary boilers.

Table 3.4-1. Typical Natural Gas Composition

Component	Molar Percent (%)	Component	Molar Percent (%)
Methane, CH_4	96.11	Butane, C_4H_{10}	0.10
Ethane, C_2H_6	1.80	Pentane, C_5H_{12}	0.00
Propane, C_3H_8	0.30	Hexane, C_6H_{12}	0.03
Carbon Dioxide, CO_2	1.24	Nitrogen, N_2	0.04
Total	**100.00**		
Sulfur (grains per 100 dry standard cubic feet (dscf))			0.20
Higher Heating Value (Btu/scf)			1,020

3.4.7 Water Supply and Consumptive Requirements

The Project's various water uses include makeup for the circulating water system, makeup for the SSG, water for solar collector mirror washing, service water, potable water, and fire protection water. Water balance diagrams corresponding to typical annual (83.2 °F dry bulb/57.8 °F wet bulb) and typical summer (112.9 °F dry bulb/78.6 °F wet bulb) operation are presented in Figures 3.4-8 and 3.4-9, respectively.

Table 3.4-2. Typical Water Usage Estimate

Water Use	Annualized Average Rate [1] (gpm)	Estimated Peak Rate [2] (gpm)	Estimated Annual Use (Acre-Feet)
Plant Operation	1000	4026	1644
Potable water	10	10	16

[1] The estimated groundwater usage in gallons per minute is based on an average daily consumption for (2) 125 MW power plants

[2] The "peak" rate is the instantaneous maximum for summer usage for (2) 125 MW power plants.

3.4.7.1 Water Requirements

The estimated water requirements for the power plant are presented in Table 3.4-2. The average total annual water usage for each 125 MW power plant is estimated to be about 822 acre-feet per year, or 1644 for the Project, which corresponds to an estimated average daily flow rate of about 1000 gallons per minute (gpm). Usage rates will vary during the year and will be higher in the summer months when the peak maximum flow rate is estimated to be as high as about 2,013 gpm for each 125 MW power plant, or 4,026 for the Project. Equipment sizing will be consistent with peak daily rates to ensure adequate design margin. The makeup flow, on average, will be approximately 1,464,000 gallons per day for both units, with a summer peak makeup increasing to approximately 2,622,000 gallons per day.

3.4.7.2 Water Treatment

The peak load (summer) water balance diagram presented in Figure 3.4-9 shows the power plant's various water uses and water treatment processes. The raw water, circulating water, process water, and mirror washing water all require on-site treatment and this treatment varies according to the

quality required for each of these uses. The power plant's design consists of a pre-treatment system upstream of the cooling tower, and a post-treatment system downstream of the cooling tower.

Water is cycled in the cooling tower until the concentration of chemical constituents rises to levels where it becomes unusable and it is blown down as a waste stream. The number of cycles undertaken are called cycles of concentration (COC). The number of COCs in the cooling tower is limited by the incoming water chemistry and the behavior of chemistry constituents as the concentration increases. Without any pre-treatment of the raw water ("makeup water") from groundwater on site, the calcium concentration would limit the process to about five COCs due to the potential to form calcium carbonate ($CaCO_3$) scale, and silica would limit the process to 10 COCs due to the formation of silica (SiO_2) and magnesium silicate scale. Because of the limitation of these constituents in the process, pre-treatment of the makeup water is desirable to reduce the quantity of makeup water required.

The pre-treatment design for the Project takes into account the relatively high concentrations of chloride and sodium present in the makeup water to the site. As the makeup water has high concentrations of highly-soluble species (*e.g.,* sodium, chloride and sulfate), and relatively low concentrations of lower-solubility species (*e.g.,* calcium and magnesium), a multi-media filter (MMF) and two-stage reverse osmosis (RO) unit was selected for pre-treatment upstream of the cooling tower. The MMF removes solids or particulates from the makeup water that may damage or reduce the efficiency of the RO membranes. In the two-stage RO design, the waste stream from the first-stage RO unit is fed into the second-stage RO for additional water recovery, and the treated water from both units combine and are stored in the treated water storage tank before use in the cooling tower. The waste stream from the MMF unit is discharged into the on-site evaporation ponds and waste stream from the second RO unit is discharged into the wastewater storage tank.

A pre-treatment RO unit provides the benefit of reducing the concentration of total dissolved solids (TDS), as well as removing most of the calcium and silica from the makeup water, thus allowing the cooling tower COCs to increase to 15.

The modeled water chemistry of the blowdown from the cooling tower after 15 COCs indicates chloride, sodium, and sulfate will be the primary species, along with lower concentrations of scale forming species (*i.e.,* calcium, magnesium and silica) that were not removed during pre-treatment. Therefore, post-treatment is needed to recover most of the wastewater for reuse to decrease the quantity of makeup water required, and decrease the size of the waste management units (evaporation ponds). Post-treatment will consist of an MMF and RO unit, where similar to the pre-treatment process, the MMF will remove solids from the cooling tower blowdown that may damage or reduce the efficiency of the RO membranes. Treated water through the RO units will be returned to the cooling tower for recycling, further increasing its effective COC, and the waste stream from the MMF and second RO unit will be discharged into on-site evaporation ponds.

As aforementioned, there are several tanks on site which will contain the raw water, treated water, and wastewater, which will have the following capacity:

- Raw Water/Fire Water Storage Tank: 500,000 gallons
- Treated Water Storage Tank: 1,250,000 gallons
- Wastewater Storage Tank: 250,000 gallons

Tanks were sized to provide sufficient water to support operation of the plant during peak operating conditions, as well as provide a 12-hour storage capacity to enable continued operation when a failure interrupts water or wastewater treatment capabilities. The tanks also allow the plant to levelize water supply requirements on a 24-hour basis and eliminate midday demand peaks. The Raw Water/Fire Water Storage Tank provides water for plant operation and fire protection, as discussed in Section 3.4.11.

In addition to the pre- and post-treatment of water for the cooling tower, there is also a demineralizer treatment process for the steam cycle process. The treatment requirements for this process are outlined in Section 3.4.7.5.

3.4.7.3 Water Source and Quality

As discussed in greater detail in Section 5.4, Water Resources, water in sufficient quantity and quality is available by pumping groundwater from wells to be installed at the Project site. A minimum of two groundwater supply wells will be located near each unit's power block area. The Project well field will also include a sufficient number of standby wells to provide the Project with water in the event the primary wells are shut down for maintenance. As currently planned, the wells will pump groundwater from the Bouse Formation and/or underlying Fanglomerate within the Chuckwalla Valley Groundwater Basin. The Bouse Formation occurs at a depth of approximately 260 feet below ground surface (bgs) at the site and extends to approximately 2,050 feet bgs, and the Fanglomerate is inferred to extend from approximately 2,050 to 2,950 feet bgs. On a preliminary basis, the wells are proposed to pump groundwater from below 800 feet bgs. The characteristics and yield of the aquifer that is proposed for the Project water supply, and the long-term effect of pumping of the groundwater system, are discussed in more detail in Section 5.4, Water Resources. As discussed in that section, water quality generally improves with depth, and it is reasonable to expect that further investigation to support detailed Project design will reveal depths within the aquifer that can be developed to produce a better quality (lower TDS) water supply that is still in the brackish range (greater than 1,000 milligrams per liter (mg/L) TDS), but the use of which would result in similar impacts.

The Bouse Formation and Fanglomerate are confined aquifers, so drawdown impacts realized when pumping from this formation or the underlying Fanglomerate will be spread out over a greater distance than in an unconfined aquifer, and impacts to the overlying water table will be similarly diffused. In addition, groundwater in the Bouse Formation and lower Fanglomerate is brackish, and meets State water policy requirements for use as a source of power plant cooling water (SWRCB Resolution No. 79-58). Impacts from pumping groundwater from the Bouse Formation as a source of water supply were investigated and determined to be less than significant. The characteristics and yield of the aquifer that is proposed for the Project water supply, and the long-term effect of pumping of the groundwater system, are discussed in more detail in Section 5.4, Water Resources.

In addition to using on-site groundwater, Genesis Solar, LLC is continuing to explore options that may utilize local industrial facility treated wastewater. Due to the limited quantity of treated water, this would be pursed in order to supplemental the groundwater source.

Groundwater quality varies markedly in the basin. In general, groundwater in the western portion of the basin near Desert Center contains lower concentrations of dissolved solids than groundwater in the eastern portion of the basin near Ford Dry Lake (see Section 5.4, Water Resources). Test wells were drilled on the Project site and samples were collected in June and July 2009. The samples were analyzed for the key chemistry parameters important for determining the water and wastewater treatment systems, as well as for estimating the concentration of species likely to be in the

evaporation ponds. The estimated water quality for the plant makeup water was derived from a sample collected from water-bearing sediments of the Bouse Formation occurring about 800 feet bgs (see Table 3.4-3).

Key findings were the TDS measurement of 5000 mg/L, and the primary contributors to the TDS: chloride (Cl) of 2300 mg/L, sodium (Na) of 1500 mg/L, and sulfate (SO_4) of 800 mg/L. These high-solubility species comprised greater than 90 percent of the TDS, with low-solubility species such as calcium (Ca) of 66 mg/L, magnesium (Mg) of 14 mg/L and silica (SiO_2) of 15 mg/L, making up less than 10 percent. This concentration of high-solubility species suggested precipitation methods of water treatment such as clarification may not be an optimal means for purification, and methods such as membrane separation (*e.g.,* RO) would be more effective for significantly reducing the TDS. Low-solubility species, such as hardness elements and silica, are known to precipitate and deposit on system components when in excess of their solubility limits (sometimes identified by cooling tower manufacturer's limits). Therefore, this was factored into the water treatment design discussed in Section 3.4.7.12.

Table 3.4-3. Typical Water Quality Data in the Project Area

Analyte	Concentration at 800 ft bgs (mg/L unless noted)
pH	7.8 units
TDS	5,000
Total Alkalinity (as CaCO3 @ pH 4.3)	150
Specific Conductance (@ 25 deg. C)	8,800 uS/cm
Total Hardness (as CaCO3)	220
Chloride	2,300
Sulfate	810
Fluoride	1.1
Nitrite	ND
Nitrate	0.5
Dissolved Silica	15
Sodium	1,500
Magnesium	14
Potassium	12
Calcium	66
Manganese	0.029
Iron	0.46
Beryllium	ND
Vanadium	ND
Chromium	ND
Cobalt	ND
Nickel	ND
Copper	ND
Zinc	ND
Arsenic	0.0092
Selenium	ND

Table 3.4-3. Typical Water Quality Data in the Project Area

Analyte	Concentration at 800 ft bgs (mg/L unless noted)
Molybdenum	0.24
Silver	ND
Cadmium	ND
Antimony	ND
Barium	0.033
Mercury	ND
Thallium	ND
Lead	ND

ND – Not Detected

3.4.7.4 Circulating Water Treatment

Circulating water will be modified with chemical treatment to prevent the growth of bacteria, formation of scale, and minimization of corrosion of the Cooling Tower fill and Condenser tubes. These chemicals include a biocide, pH control solution, scale inhibitor, and corrosion inhibitor.

- **Biocide:** An open recirculating cooling system provides a favorable environment for biological growth. If this growth is not controlled, severe biological fouling and accelerated corrosion can occur. Sodium hypochlorite is the most common chemical used for controlling the biological growth, slime, and algae. Sodium hypochlorite is used because is it safer to handle and less likely to precipitate than other chlorine or bromine compounds. Sodium hypochlorite may be continuously fed at lower concentrations (*e.g.,* 0.1 to 0.2 ppm), or may be dosed in higher concentrations (*e.g.,* 1.0 ppm) for short periods a few times each day.
- **pH Control:** With the increase in cycles of concentration, the pH typically increases. Many species have reverse solubility (*i.e.,* they tend to precipitate as the pH increases). To control the scale formation of these species, an acid such as hydrochloric acid or sulfuric acid is added. Lowering pH through acid feed not only reduces the scaling tendencies of calcium carbonate, but many other pH-sensitive species that can precipitate on heat-transfer surfaces and reduce heat-transfer capability.
- **Scale Inhibitors:** Anti-scalants are surface-active materials that interfere with the precipitation reactions by either threshold inhibition, crystal modification, or dispersion. This enables higher cooling water cycles of concentration and permits operation at "supersaturated" conditions.
- **Corrosion Inhibitors:** Corrosion inhibitors may be added to the circulating water to reduce the rate of corrosion of metals or alloys in contact with the water. Circulating water can range from scale-forming to scale-dissolving (corrosive). Changes in the pH and COCs can impact whether or not scale will form and to what extent the water will be corrosive. Corrosion inhibitors such as phosphate and zinc may be added to help reduce corrosion rates.

3.4.7.5 Steam Cycle Process Water

Makeup water for the steam cycle must meet stringent specifications for suspended and dissolved solids. To meet these specifications, water from the treated water storage tank is sent to a DI makeup water tank, and then processed through a demineralized water makeup system consisting of mixed-

bed demineralizers and a 40,000 gallon demineralized water storage tank. Water produced by this system will also be used for the mirror washing described below.

Additional conditioning of the condensate and feedwater circulating in the steam cycle is provided by means of a chemical feed system. To minimize corrosion, an oxygen scavenger for dissolved oxygen control, and an alkaline solution for pH control, are fed into the condensate. To minimize scale formation in the SSG, a solution of disodium phosphate (DSP) and tri-sodium phosphate (TSP) may be fed into each feedwater system. The chemical feed systems include an oxygen scavenger feed tank, an alkaline solution (amine) feed tank, and a phosphate solution feed tank. The feed tanks are provided with two full-capacity metering pumps.

A steam cycle sampling and analysis system monitors the water quality at various points in the plant's steam cycle. The water quality data are used to guide adjustments in water treatment processes and determine the need for other corrective operational or maintenance measures. Steam and water samples are routed to a sample panel where steam samples are condensed and the pressure and temperature of all samples are reduced as necessary. The samples are then directed to automatic analyzers for continuous monitoring of conductivity and pH. All monitored values are indicated at the sample panel and critical values are transmitted to the plant control room. Grab samples are periodically obtained at the sample panel for chemical analyses that provide information on a range of water quality parameters.

3.4.7.6 Solar Mirror Washing Water

To facilitate dust and contaminant removal, deionized (demineralized) water from the demineralized water storage tank is used to spray clean the solar mirrors on a periodic basis, determined by the reflectivity monitoring program. This operation is generally done at night and involves a water truck spraying deionized water on the mirrors in a drive-by fashion. The deionized water production facilities, already in place for SSG makeup water, will be sized to accommodate the additional solar mirror washing demand of about two acre-feet per year and is shown on the water balance diagrams. Water from the washing operation is expected to mostly evaporate on the mirror surface with no appreciable runoff.

3.4.7.7 Cooling Systems

Each power plant includes two cooling systems: 1) the steam cycle heat rejection system (*e.g.,* cooling tower); and 2) the closed cooling water system (equipment cooling), each of which is discussed below.

3.4.7.8 Steam Cycle Heat Rejection System

The cooling system for heat rejection from the steam cycle consists of a surface condenser, circulating water system, and wet cooling tower. The surface condenser receives exhaust steam from the LP section of the STG and condenses it to liquid for return to the SSG. The surface condenser is a shell-and-tube heat exchanger with wet, saturated steam condensing on the shell side and circulating water flowing through the tubes to provide cooling. The warmed circulating water exits the condenser and flows to the cooling tower to be cooled and reused.

The circulating water is distributed among multiple cells of the cooling tower, where it cascades downward through each cell and then collects in the cooling tower basin. The mechanical draft cooling tower employs electric motor-driven fans to move air through each cooling tower cell. The cascading circulating water is partially evaporated, and the evaporated water is dispersed to the

atmosphere as part of the moist air leaving each cooling tower cell. As discussed in Section 5.10, Visual Resources, because of climatic conditions at the site, visible moisture plumes are expected to occur relatively infrequently and largely in winter months, and no need is expected for a plume-abated cooling tower.

The circulating water is cooled primarily through partial evaporation and secondarily through heat transfer with the air. The cooled circulating water is pumped from the cooling tower basin back to the surface condenser and auxiliary cooling water system.

3.4.7.9 Auxiliary Cooling Water System

The auxiliary cooling water system uses water from the cooling tower for the purpose of cooling equipment including the STG lubrication oil cooler, the STG generator cooler, steam cycle sample coolers, large pumps, etc. The water picks up heat from the various equipment items being cooled and rejects the heat to the cooling tower.

3.4.8 Waste Management

Project wastes include wastewater, non-hazardous solid waste, hazardous solid waste, and hazardous liquid waste. Project waste streams and management details are discussed in Section 5.4, Water Resources and Section 5.13, Waste Management.

3.4.8.1 Wastewater

The water balance diagrams (Figures 3.4-8 and 3.4-9) show the power plant's wastewater streams and flow rate during annual average and summer peak conditions.

Wastewater is segregated into two separate collection systems, one for industrial streams and one for sanitary wastes. Industrial wastewater from both the pre-treatment and post-treatment systems will be piped to three 8-acre evaporation ponds for disposal. The evaporation ponds make up a total combined area of 24 acres for each 125 MW unit (48 acres of pond for both 125 MW units). There are three primary and one occasional waste streams discharging into the evaporation ponds:

- Pre-cooling tower water treatment MMF waste stream
- Post-cooling tower water treatment MMF waste stream
- Post-cooling tower water treatment 2nd Stage RO waste stream
- Occasionally, storm water accumulated in the proposed LTU that will be used to treat soil affected by spills of HTF

On an annual average, blowdown to the evaporation ponds will be approximately 90,000 gallons per day for each unit, increasing to approximately 140,000 gallons per day for each unit during peak summer conditions.

The Project's sanitary system will collect wastewater from sanitary facilities such as sinks and toilets. This waste stream will be sent to an on-site sanitary waste septic system designed and permitted in accordance with Riverside County Department of Health Services standards.

3.4.8.2 Evaporation Ponds

As noted above, it is expected each 125 MW unit will have three double-lined evaporation ponds. Each pond will have a nominal surface area of eight acres resulting in a total of 24 acres of evaporation ponds for each unit or a total of 48 acres of ponds for both 125 MW units. The ponds will be designed and

permitted as Class II Surface Impoundments in accordance with Colorado River Regional Water Quality Control Board (CRRWQCB) requirements, as well as the requirements of the California Integrated Waste Management Board (CIWMB). Multiple ponds are planned to allow plant operations to continue in the event a pond needs to be taken out of service for some reason, *e.g.,* needed maintenance. Each pond will have enough surface area so the evaporation rate exceeds the cooling tower blowdown rate at maximum design conditions and annual average conditions.

The average pond depth is eight feet and residual precipitated solids will be removed approximately every seven years to maintain a solids depth no greater than approximately three feet for operational and safety purposes. The precipitated solids will be sampled and analyzed to meet the characterization requirements of the receiving disposal facility. The characteristics of the precipitated solids will determine the transportation and disposal methodology. It is anticipated the pond solids and other non-hazardous wastes would be classified as Class II Designated Waste, a non-hazardous industrial waste. Genesis Solar, LLC will test the pond solids using appropriate test methods in advance of removal from the evaporation ponds to confirm this determination; however, preliminary data estimates show the material will be non-hazardous. Approximately 6,150 tons of evaporative residue will be accumulated yearly, which equates to approximately 50,000 tons of evaporative residue being removed during each cleanout and a total estimated amount of 214,500 tons over 30 years.

The pond liner system will consist of a 60 mil high density polyethylene (HDPE) primary liner and a secondary 40 mil HDPE liner. Between the liners is a synthetic drainage geonet and collection piping that is used as part of the leachate collection and removal system (LCRS). There will be a hard surface protective layer on top of the 60 mil HPDE which will consist of a non-woven geotextile, a one foot thick granular fill/free draining material, and a one foot thick hard surface such as roller-compacted concrete. The hard surface provides protection against accidental damage to the HDPE from falling objects, varying climatic conditions, and worker activities during cleanout and maintenance. Monitoring of the evaporation ponds will be required to detect the presence of liquid and/or constituents of concern. Based on the experience of the existing SEGS plants, it is expected the constituents of concern for this monitoring will include chloride, sodium, sulfate, TDS, biphenyl, diphenyl oxide, potassium, selenium, and phosphate.

3.4.8.3 On-site Bioremediation Land Treatment Unit

The Project will include a bioremediation LTU to treat soil impacted by incidental spills and leaks of HTF at various concentrations. The unit will be designed and permitted as a Class II LTU in accordance with CRRWQCB and CIWMB requirements. The LTU will cover an area of approximately 600 feet by 725 feet, including the staging area, and will cater for both 125 MW units. The LTU will be constructed with a prepared base consisting of two feet of compacted, low permeability, lime treated material and be surrounded on all sides by a minimum two foot high compacted earthen berm with slopes of approximately 3:1 (horizontal:vertical).

HTF-impacted soils must be characterized as hazardous or non-hazardous waste to determine whether the material can be treated in the LTU or must be removed for off-site disposal. HTF-impacted soils will be promptly excavated and relocated to a staging area, and characterized in accordance with California and Federal law. If the soil is characterized as a hazardous waste, the impacted soils will be transported from the site by a licensed hazardous waste hauler for disposal at a licensed hazardous waste landfill. No HTF-impacted soils characterized as hazardous waste will be disposed or treated on site. Based on past experience, it is anticipated that soil containing 10,000

milligrams per kilogram (mg/kg) HTF or more will be managed as hazardous waste, and soil containing less than 10,000 mg/kg HTF will be non-hazardous waste and can be managed at the site.

If the soil is characterized as a non-hazardous waste, it will be spread in the LTU for bioremediation treatment. Treatment of the HTF-impacted soil in the LTU will involve spreading, turning, and moisture conditioning, and may involve addition of nitrogen and phosphorous nutrients (*i.e.,* fertilizers) as needed to simulate consumption of HTF by the indigenous bacteria. In general, more highly impacted soil may be covered with plastic sheeting to prevent contact with storm water and control potential odors and emissions, as well as for moisture and temperature retention. Once the soil has been treated to a concentration of less than 100 mg/kg HTF, it will be moved from the LTU to another portion of the site until it is reused at the facility as fill material.

Based on available operation data from other sites, it is anticipated approximately 750 cubic yards (on average) of HTF-affected soil may be treated per year. Larger or smaller quantities could be generated during some years, depending on the frequency and size of leaks and spills.

3.4.8.4 Other Non-Hazardous Solid Waste

Construction, operation, and maintenance of the Project will generate non-hazardous solid wastes typical of power generation or other industrial facilities (see Section 5.13, Waste Management). These wastes include scrap metal and plastic, insulation material, paper, glass, empty containers, and other miscellaneous solid wastes. These materials will be disposed by means of contracted refuse collection and recycling services.

3.4.8.5 Hazardous Solid and Liquid Waste

Small quantities of hazardous wastes will be generated during Project construction and operation. Hazardous wastes generated during the construction phase will include substances such as paint and primer, thinners, and solvents. Hazardous solid and liquid waste streams generated during Project operations include substances such as used hydraulic fluids, oils, greases, filters, etc., as well as spent cleaning solutions and spent batteries. To the extent possible, both construction and operation-phase hazardous wastes will be recycled. Tables 5.13-2 (construction phase) and 5.13-3 (operations phase) in Section 5.13, Waste Management, summarize Project hazardous waste streams in terms of quantities, origin and composition, and management method(s).

3.4.9 Hazardous Material Management

There will be a variety of hazardous materials used and stored during construction and operation of the Project, as summarized below. Section 5.12, Hazardous Materials Handling, provides additional data on the hazardous materials that will be used during construction and operation, including quantities, associated hazards and permissible exposure limits, storage methods, and special handling precautions.

Hazardous materials that will be used during construction include gasoline, diesel fuel, oil, lubricants, and small quantities of solvents and paints. All hazardous materials used during construction and operation will be stored on site in storage tanks/vessels/containers that are specifically designed for the characteristics of the materials to be stored; as appropriate, the storage facilities will include the needed secondary containment in case of tank/vessel failure.

A variety of safety-related plans and programs will be developed and implemented to ensure safe handling, storage, and use of hazardous materials (*e.g.,* Hazardous Material Business Plan). Plant personnel will be supplied with appropriate personal protective equipment (PPE) and will be properly

trained in the use of PPE and the handling, use, and cleanup of hazardous materials used at the facility, as well as procedures to be followed in the event of a leak or spill. Adequate supplies of appropriate cleanup materials will be stored on site (see Sections 5.12 through 5.15 for additional discussion regarding waste and hazardous materials management, worker safety, and public health).

3.4.10 Air Emissions Control and Monitoring

Installation and operation of the Project will result in a change in the emissions signature for the site. Criteria pollutant emissions from the proposed auxiliary boilers, fire pump engines, emergency generator engines, and cooling towers are delineated in Sections 5.2.2.2 through 5.2.2.5. Construction-related emissions are addressed in Section 5.2.2.6, and emissions of hazardous air pollutants (HAPs) are discussed in Section 5.15, Public Health, and quantified in Appendix B.1.

Operation of the Project will result in emissions to the atmosphere of both criteria and toxic air pollutants from the proposed auxiliary boilers, fire pump engines, emergency generator engines, and cooling towers, and fugitive losses from the HTF system. Construction-related emissions are associated with site disturbance resulting from site preparation and with the typical emissions and associated construction-related activities encountered at any construction site.

Power plants, with individual equipment capacity of 25 MW or greater that use natural gas or other fuels with low sulfur content, are subject to the Phase II Program of Title IV, which requires plants to install Continuous Emission Monitoring Systems (CEMS) in accordance with 40 CFR Part 75 and report annual emissions of sulfur oxides (SO_x) and nitrogen oxides (NO_x).

3.4.11 Fire Protection

Fire protection systems are provided to limit personnel injury, property loss, and Project downtime resulting from a fire. The systems include a fire protection water system and portable fire extinguishers.

Each 125 MW power plant's fire protection water system will be supplied from a dedicated 360,000-gallon portion of the 500,000-gallon raw water storage tank located on the plant site. One electric and one diesel-fueled backup firewater pump, each with a capacity of 3,000 gallons per minute, will deliver water to the fire protection water-piping network for each plant. A smaller electric motor-driven pump jockey pump will maintain pressure in the piping network. If the jockey pump is unable to maintain a set operating pressure in the piping network, the diesel fire pump starts automatically.

The piping network will be configured in a loop so a piping failure can be isolated with shutoff valves without interrupting the supply of water to a majority of the loop. The piping network will supply fire hydrants located at intervals throughout the power plant site, a sprinkler deluge system at each unit transformer, HTF expansion tank and circulating pump area, and sprinkler systems at the STG, and in the operations and administration buildings. Portable fire extinguishers of appropriate sizes and types will be located throughout the plant site.

Fire protection for the solar field will be provided by zoned isolation of the HTF lines in the event of a rupture that results in fire. As vegetation or other combustible materials will not be allowed in the solar field, the HTF will be allowed to extinguish itself naturally, since the remainder of the field is of nonflammable material (aluminum, steel, and glass) (see Section 5.14, Worker Safety, for additional discussion of on- and off-site fire protection measures).

3.4.12 Plant Auxiliary Systems

The following plant auxiliary systems control, protect, and support the power plant and its operation.

3.4.12.1 Distributed Control System

The Distributed Control System (DCS) provides control, monitoring, alarm, and data storage functions for power plant systems. These include:

- Control of the STG, SSG system, and balance-of-plant systems in a coordinated manner
- Monitoring of operating parameters from plant systems and equipment
- Visual display of the associated operating data to control operators and technicians
- Detection of abnormal operating parameters and parameter trends
- 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 a plant outage. The DCS consists of the following major components:

- Computer monitor-based control operator interface (redundant)
- Computer monitor-based control engineering work station
- 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 the control systems furnished by the STG supplier and the solar field controls. These datalinks provide STG control, monitoring, alarm, and data storage functions via the control operator interface and control technician workstation of the DCS.

3.4.12.2 Lighting System

The Project's lighting system will provide operations and maintenance personnel with illumination in both normal and emergency conditions. The system will consist primarily of AC lighting, but will include DC lighting for activities or emergency egress required during an outage of the plant's AC electrical system. The lighting system will also provide AC convenience outlets for portable lamps and tools. Lighting will be designed to provide the minimum illumination needed to achieve safety and security objectives and will be shielded and oriented to focus illumination on the desired areas and minimize additional nighttime illumination in the site vicinity.

3.4.12.3 Cathodic and Freeze Protection Systems

Cathodic protection systems protect against electrochemical corrosion of underground metal piping and structures. Underground metal piping structures will have cathodic protection as necessary based on soil conditions.

Freeze protection systems (heat tracing) will be employed to protect small water and condensate piping systems that cannot be easily drained. Also due to the high freezing temperature of the solar

field's HTF (54°F), steam-fed HTF freeze protection heat exchangers will be provided to protect the system during the night hours and colder months. Overall natural gas fuel usage is included in Section 3.4.6.

3.4.12.4 Service Air and Instrument Air Systems

The service air system supplies compressed air to hose connections located at intervals throughout the power plant. Compressors deliver compressed air at a regulated pressure to the service air-piping network. The instrument air system provides dry, filtered air to pneumatic operators and devices throughout the power plant. Air from the service air system is dried, filtered, and pressure regulated prior to delivery to the instrument air-piping network.

3.4.12.5 HTF Leak Detection

Leak detection of HTF will be accomplished in a combination of ways. Small leaks, possibly at ball joints or other connections, will be located based on daily inspection of the solar field. Those small leaks can then be corrected via repacking of joints or valves or by minor repairs if needed. The ability to isolate loops and sections of the field will allow for quick repairs. In order to identify and react to larger sudden leaks quickly, the Project is considering a combination of remote pressure sensing equipment and remote operating valves that would allow for isolation of large areas of the field, or possibly the entire field. Such features will be developed as part of the detail design process.

3.5 POWER PLANT CIVIL/STRUCTURAL FEATURES

The following subsections describe civil/structural features of the Project, as illustrated in the power block arrangements presented in Figures 3.4-2 and 3.4-3. The power plant will be designed in conformance with 2007 California Building Code and the applicable wind and seismic criteria for site location. As noted earlier, sensitive Project facilities (*e.g.,* power block, evaporation pond) will be placed at specific on-site locations that avoid mapped AP fault zones.

3.5.1 SSG System, STG and Associated Equipment

The SSG system, STG, and condenser will be located outdoors and supported on reinforced concrete mat foundations. The STG foundation will include a reinforced concrete pedestal that supports the STG above the surface condenser. The one step-up transformer and GSUT will be supported on reinforced concrete mat foundations. Balance-of-plant (BOP) mechanical and electrical equipment will be supported on individual reinforced concrete pads. BOP components/materials include piping, valves, cables, switches, etc. that are not included with major equipment and are generally installed or erected onsite.

3.5.2 Solar Array Support Structures

Each solar collector array will be supported by structures (stands) that connect the parabolic troughs to the drive mechanism. Each array will be supported by multiple individual foundations with a foundation located approximately every 40 feet along the array. Foundation design will be based on site-specific geotechnical conditions to ensure the solar array stands are able to support all loading conditions (including wind loading) at the Project site.

3.5.3 Buildings

The Project will include a common administration building and warehouse between the two 125 MW power plants. A control building will be located in each power block. The design and construction of

the administration building and warehouse will be consistent with normal building standards. Other plant site "buildings" will include the water treatment building, as well as a number of pre-engineered enclosures for mechanical and electrical equipment. Building columns are supported on reinforced concrete mat foundations or individual spread footings and the structures rest on reinforced concrete slabs. The total square footage of the various Project buildings and pre-engineered enclosures (*e.g.,* control rooms, administration building, warehouse, electrical equipment enclosures, fire pumps, and diesel generators) is approximately 39,000 square feet.

3.5.4 Water Storage Tanks

There will be a number of covered water tanks on site for each 125 MW power plant. For each plant, there will be a 500,000-gallon raw water storage tank for short-term backup cooling water supply, with a portion (360,000 gallons) dedicated to the plant's fire protection water system; a 1,250,000-gallon treated water storage tank; and a 250,000 waste water storage tank. There also will be a 40,000-gallon storage tank for storage of demineralized water. Water storage tanks will be vertical, cylindrical, field-erected steel tanks supported on foundations consisting of either a reinforced concrete mat or a reinforced concrete ring wall with an interior bearing layer of compacted sand supporting the tank bottom.

3.5.5 Roads, Fencing, and Security

As discussed in Section 5.11, Traffic and Transportation, the Project site is located in a remote section of Riverside County, about four miles north of I-10, and approximately 25 miles west of Blythe. Regional access to the area is limited to I-10. There is very little circulation in the surrounding area other than I-10, mostly consisting of off-road vehicle trails and roadways extending from the Ford Dry Lake exit. The nearest paved road to the site, other than I-10, is Wiley's Well Road, about five miles east of the Project. Wiley's Well Road runs south to the Chuckwalla Valley State Prison complex. All vehicular traffic approaching the site will use I-10.

Only a small portion of the overall plant site will be paved, primarily the site access road and portions of each power block (paved parking lot and roads encircling the STG and SSG areas). The remaining portions of the power block will be gravel surfaced. In total, the power blocks will be approximately 24 acres with approximately 35 acres of paved area for the entire Project. The solar field will remain unpaved and without a gravel surface in order to prevent rock damage from mirror wash vehicle traffic; an approved dust suppression coating will be used on the dirt roadways within and around the solar field.

The entire site will be fenced appropriately to restrict public access during construction and operations. Chain-link security fencing will be installed around the site perimeter, switchyard, and other areas requiring controlled access. The security fence will be eight feet tall, topped with one foot of barbed wire (three strands) mounted on 45-degree extension arms and posts set in concrete (see Figure 3.4-1).

Controlled access gates will be located at the entrances to the facility. Site gates will be swing or rolling type access gates. Access through the main gate will require an electronic swipe card, preventing unaccompanied visitors from accessing the Facility. All Facility personnel, contractors, and visitors will be logged in and out of the Facility at the main office during normal business hours. Visitors and non-Genesis Solar, LLC employees will be allowed entry only with approval from a staff member at the Facility.

3.5.6 Site Drainage

As discussed in Appendix A, Drainage Erosion and Sediment Control Plan (DESCP), natural drainage across the site is episodic, shallow, and occurs over a broad area primarily as sheet flow or in shallow washes. In desert regions, the catchment boundaries and distribution of drainage may shift over time based on the ground conditions, intensity of the storm event, velocity of the flow, and sediment transportation including USGS quadrangle maps and aerial images. The watershed boundary and sub-basin boundaries selected for this Project site were based on existing information. The total watershed modeled encompasses 93,182 acres of which 91,696 acres are off-site.

Under post-developed conditions, it is proposed to divert the off-site watershed in three channels:

- Runoff from sub-basin 1 (north-western) will be diverted through a channel on the west side of the west 125 MW unit.
- Runoff from sub-basin 2 (north) will be diverted through a channel between the two 125 MW units.
- Runoff from sub-basin 3 (north-eastern) will be diverted though a channel along the east side of the east 125 MW unit.

A report titled *Survey for Jurisdiction Waters and Wetlands at the Genesis Solar Energy Project* is included in Appendix C-1 of this AFC. The survey concluded two drainage areas may be considered waters of the State. Consultation with the CDFG and U.S. Army Corps of Engineers (USACE) is underway, but a determination on jurisdiction of the waters has yet to be made.

These three main channels and associated diversion berms on the down slope sides will divert flows downstream of the site following their existing drainage paths, causing no impact to the site. The channels and diversion berms will be sized sufficiently to pass the anticipated flows and entrained sediment volumes; will be armored as necessary for erosion protection using natural gravel derived during site grading activities; and will be maintained periodically or after major storm events as needed to sustain their proper function. The main purposes of the diversion are to prevent interaction with off-site storm water and on-site storm water which will:

- Allow natural groundwater recharge of the off-site storm water with no contact with the changed flow conditions of the on-site water.
- Protect the site infrastructure from flash flood events, which have the potential to damage the solar parabolic troughs.
- Control treatment of the on-site flows from the solar collector array (location of HTF within the solar parabolic troughs).
- Protect the site from upstream sediment loading.
- Control on-site flows in detention basins to ensure there is no increase in post developed flow discharging from the site, minimize the impact on downstream drainage features (lake playas, etc).
- Maximize the developable area within the solar field.

On-site storm water management for the completed facility will be provided through the use of source control techniques, site design, and treatment control.

The storm flows from the solar collector arrays will be treated through the use of swales, ditches, and detention ponds. Preliminary volumes required for the detention basins are 66 acre-feet for the 125

MW unit in the west, and 49 acre-feet for the 125 MW unit in the east. These volumes are based on the detention ponds receiving the 100-year, 24-hour event post-development runoff from the site, and then discharging the run-off at the pre-developed rate into the existing drainage system. The Riverside County Stormwater Quality Best Management Practice Design Handbook requires extended detention basins to release runoff over a 48 hour drawdown period, and the outlet sized to retain the first half of the design volume for a minimum of 24 hours (Riverside County, 2006).

Locations within the power block for the potential of chemical or oil releases will be fully contained. Rainfall within the containment areas will be allowed to evaporate or will be drained through an oil/water separator. Locations within the power block where “contact” storm water may occur will be contained within a system of curbs or trenches. Drains from these curbed areas or containment trenches will be directed to an oil/water separator. The oil separated and captured within the oil/water separator will be trucked off-site to a licensed disposal/recycling facility. Clean water discharged from the oil/water separator will be used on site by discharging it to the cooling tower or to the raw water storage tank. The water discharge from the oil/water separator will not be discharged to the storm water system.

As summarized in Section 5.4, Water Resources, and described in the preliminary DESCP provided in Appendix A, the Project will employ a comprehensive system of management controls, including site-specific Best Management Practices (BMPs), to minimize storm water contact with contaminants and thus minimize pollutants in storm water. These management controls include:

- Erosion Control
- Sediment Control
- Wind Erosion
- Tracking Control
- Non-stormwater discharges
- Waste Management

The site is found within “RIVERSIDE COUNTY AND INCORPORATED AREAS” within FEMA (Federal Emergency Management Agency); however, there are no flood insurance maps provided for this area (WorleyParsons, 2009). It has been assumed all off-site water will be contained within the preliminary drainage channels and routed around the site; therefore, no flooding mapping has been undertaken. On-site, there will be sheet flow across the solar fields and into drainage channels, which shall direct flow into a detention basin. Due to the desert conditions, it is anticipated stormwater will infiltrate into the ground during rainfall events within the channels and detention basin. In a 100 year, 24 hour storm event, only 3.51 inches of rain precipitation are expected (WorleyParsons, 2009).

3.5.7 Earthwork

Solar fields have fairly stringent grading requirements as parabolic troughs must be almost level along their troughs and grades perpendicular to the troughs are generally benched to two percent or less. Under pre-developed conditions, each 125 MW module generally slopes from the northeast to the southwest. Grading for post-developed conditions will slightly modify the existing contours to provide a surface level appropriate for the parabolic troughs. The preliminary grading is designed to ensure the run off from solar fields is directed into the appropriate drainage channel, and the power block, evaporation ponds, and land farm units are protected in the 100-year, 24-hour storm event.

The DESCP includes the finished grade elevations and preliminary contour lines across the entire site. The total site earth work quantities for the Project site, including the evaporation and retention pond excavations and protective berm fill placement, will result in a balanced cut-and-fill earthwork of approximately 712,000 cubic yards of cut and one million cubic yards of fill, based on the preliminary site design and layout (Genesis Solar, LLC, 2009). More exact earthwork quantities will be determined after the detailed aerial and ground surveys are completed. Final site design and layout will take into account additional environmental, land use, and engineering constraints. The final grading design will include adjustments to the grades to provide balanced earthwork cut and fill quantities. This will be accomplished by raising/lowering the grades to obtain a balanced site. Each solar pad will be graded with the intent of balancing the cut-and-fill as much as possible to minimize earth movement on the site. Drainage diversion channels and protective berms will also be developed with a balance of cut and fill earthwork.

3.6 TRANSMISSION FACILITIES

3.6.1 Interconnection to Substation

The power from both units will be transformed through the GSUTs located near each generator to 230 kV. Conductors will connect the GSUTs to the new Genesis switchyard located near the power block for unit two, as shown by Figure 3.4-3.

The Genesis switchyard will contain three breakers and three line takeoff structures. It will have space for a future breaker and line takeoff structure. Air insulated structures will be utilized giving the switchyard a size of approximately 270 feet by 400 feet. The switchyard and interconnections will be built for 230 kV and will operate at that nominal voltage. Instrument transformers (current and capacitive voltage transformers) will be included for protection. Shield wires and lightning arrestors will be included to protect substation equipment and personnel against lightning strikes. The switchyard arrangement is shown in the power block layout general arrangement for unit two.

The generated electrical power from the Project switchyard will be transmitted through a generation-tie (gen-tie) line that will be routed in a southeasterly ROW eventually connecting to the proposed Southern California Edison (SoCal Edison) 500-230 kV Colorado River substation. The line will travel in the southeast direction to a point where it will cross the existing Imperial Irrigation District (IID) Blythe to Eagle Mountain 161 kV transmission line and then I-10. From the I-10 crossing, the gen-tie line will continue south where it will eventually meet the Blythe Energy Project Transmission Line (BEPTL), see Figures 3.6-1 and 3.6-2. From that location, the gen-tie line will travel east and share a length of double-circuit, transmission poles with the BEPTL where it will ultimately terminate at the interconnection point within the Colorado River Substation. For more information on the double circuit portion of the Blythe-Julian Hinds line, see the Blythe Energy Project Request for Staff Approved Project Modifications (99-AFC-8C). The Blythe-to-Eagle Mountain 161 kV transmission line and I-10 crossings will be designed in accordance with the most current revision of the IEEE National Electric Safety Code (NESC) and the California Public Utilities Commission's Rules for Overhead Line Construction, GO-95.

3.6.2 Interconnection Design Considerations

The nominal 250 MW Project net output produces approximately 738A at 230 kV and at a 0.85 power factor. The conductor proposed for the gen-tie is bundled 795.0-kcmil "Drake" with a summer maximum continuous ampacity of approximately 906A per conductor or 1816A per bundle.

The gen-tie line will be constructed for operation at 230kV, the nominal operating voltage of the regional transmission system. The use of 230 kV as the targeted design voltage in this AFC is consistent with the industry use of the 230-kV term to describe the nominal voltage for this class of system. Each circuit will be supported by mono-pole structures at approximately 800 feet intervals with final heights as determined during detailed design. The lines will be insulated from the poles using porcelain insulators engineered for safe and reliable operation at a worst-case voltage of 241.5 kV (nominal, plus five percent). Shield wires will be included along the length of the lines to protect against lightning strikes (see Figure 4.2-1 in Section 4, Safety and Reliability). The pole designs were engineered to provide conceptual design limits for purposes of the electric and magnetic field (EMF) studies and in accordance with the current Blythe-Julian Hinds structures. Final transmission structure design including tangent, angle, dead end, and pull-off structures and associated hardware will be determined during the final engineering of the proposed interconnection.

3.6.3 Transmission System Upgrades

The Project will require an interconnection upgrade at the Colorado River Substation. The feasibility study is complete for the Project. SCE will prepare an interconnection System Impact Study (SIS) under an agreement with the Applicant. This study will define the impacts on the transmission line system and define system upgrades that may be needed (if any) that are attributable to the new generation.

3.7 PROJECT CONSTRUCTION

3.7.1 Power Generation Facility

Major milestones of the planned Project construction schedule are as follows:

- Begin construction Unit 1: Month 1
- Startup and test Unit 1: Month 21
- Commercial operation Unit 1: Month 25
- Begin construction Unit 2: Month 12
- Startup and test Unit 2: Month 33
- Commercial operation Unit 2: Month 37

Project construction is expected to occur over a total of 37 months. Project construction will require an average of 650 employees over the entire 37-month construction period, with manpower requirements peaking at approximately 1100 workers in Month 23 of construction. The construction workforce will consist of laborers, craftsmen, supervisory personnel, support personnel, and construction management personnel. Table 5.8-12 in Section 5.8, Socioeconomics, provides a breakdown of the construction workforce by skill over the entire construction period.

Construction of each 125 MW Unit is expected to take approximately 25 months with each unit being phased by 12 months. Table 3.7-1 depicts a proposed construction plan for the Project.

Table 3.7-1. Proposed Project Construction Plan

Activity	Unit 1	Unit 2
Mobilization	Month 1	Month 12
Delineate and mark the boundaries of the construction zone	Month 1	Month 12
Stabilize construction entrance/exit and roadway; install tire wash	Month 1	Month 12
Establish parking and staging areas for vehicle and equipment storage; maintenance	Month 1	Month 12
Establish laydown area(s) for materials storage/staging	Month 1	Month 12
Establish concrete washout area	Month 1	Month 12
Clear and grub; strip topsoil	Months 1–2	Months 12–13
Install certified weed-free fiber rolls or silt fence at the base of slopes adjacent to delineated sensitive areas (*i.e.,* wetlands), if any	Months 1–2	Months 12–13
Construct stormwater infiltration/evaporation area	Months 2–7	Months 13–19
Assemble and erect parabolic troughs	Months 6–18	Months 18–30
Construct power block	Months 7–22	Months 19–34
Construct reinforced concrete foundations	Months 5–11	Months 17–23
Trench gas line corridor	Months 15–19	NA
Construct administration/warehouse building	Months 24–25	NA
Commissioning and testing	Months 21–25	Months 33–37

Temporary construction laydown and parking areas will be provided within the power plant site (see Figure 3.4-1). Construction power will be provided by the local distribution system and routed to the site along wood poles within the 230 kV ROW. Due to the size of the plant site, the solar field laydown area will be relocated periodically as the solar field is built out. The construction sequence for power plant construction includes the following general steps:

- ***Site Preparation:*** this includes detailed construction surveys, mobilization of construction staff, grading, and preparation of drainage features. Grading for the solar field, power block, and rerouted wash will be completed during the first nine months of the construction schedule.
- ***Foundations:*** this includes excavations for large equipment (STG, SSG, GSUT, cooling tower, etc.), footings for the solar field, and ancillary foundations in the power block.
- ***Major Equipment Installation:*** once the foundations are complete the larger equipment will be installed. The solar field components will be assembled in an on-site erection facility and installed on their foundations.
- ***BOP:*** with the major equipment in place, the remaining field work will be piping, electrical, and smaller component installations.
- ***Testing and Commissioning:*** testing of subsystems will be done as they are completed. Major equipment will be tested once all supporting subsystems are installed and tested.

Equipment and materials will be delivered to the Project plant site by truck; large components (*e.g.,* STG) will be brought by rail to a rail siding in the town of Blythe and then are expected to be trucked to the site on I-10.

3.7.2 Civil Works

The construction sequence for civil works includes the following general steps:

- **Site Disturbance:** Once all areas are appropriately staked and signed and access to the site has been established, grading activities will occur over an extensive portion of the site. Grading will commence with rough grading activities, including grubbing, clearing, moisture conditioning, bulk grading, and initial compaction. The first ground-disturbing activities to take place will be the initial clearing and grading to prepare the site for the storm water drainage, construction, and equipment foundation pads. Temporary drainage ditches and berms will also be designed around construction work areas, soil stockpile areas, and excavation areas to minimize the amount of potential pollutant or sediment-laden surface water runoff.
- **Site Grading:** The solar pad grading of the site will have an average slope of one to three percent on the north-south direction. Each solar pad will be graded with the intent of balancing the cut-and-fill as much as possible to minimize earth movement on the site. Drainage diversion channels and protective berms will also be developed with a balance of cut and fill earthwork.
- **Site Drainage:** The post-development sediment/retention basin at the discharge points will provide storm water pollution prevention BMP controls along with retention time to reduce the peak off-site discharge to match pre-development conditions. The road berm will also be constructed to provide site protection from storm water run-on during a 100-year return storm event. The toe of the western protective berm slope may be armored with soil cement cover and rip rap to provide for slope erosion protection during a heavy storm event.
- **Internal Road System:** A primary access road will be constructed to the power block area. This road will be 24 feet wide and paved with approximately 3,000 tons of imported asphalt concrete material. Auxiliary roads will be 24 feet wide and use compacted native materials or gravel surface.
- **Restoration of Temporary Disturbance:** All temporarily disturbed areas will be restored to their preconstruction conditions, as required by the BLM. Temporary access roads used during construction will also be regraded and restored to pre-existing function and grade. BLM approved seed mixes will be applied to temporarily disturbed areas, as required. No fertilizer will be used during stabilization or rehabilitation activities unless authorized by the BLM. No vegetation will be restored or encouraged within the solar field because of the fire hazard. Vegetation within the LTU area will be controlled to prevent containment from being compromised. When construction of storm water management structures is complete, contours will be carefully restored to the extent feasible.

3.7.3 Generator Tie Line

The gen-tie line will be constructed with crews working continuously along the ROW, with construction of the entire gen-tie line requiring a peak workforce of approximately 34 workers. Gen-tie line construction will include the following activities:

- Preparation of marshalling yards
- Access road and spur road construction

- Clearing and grading of pole sites
- Foundation preparation and installation of poles
- Conductor installation
- Cleanup and site reclamation

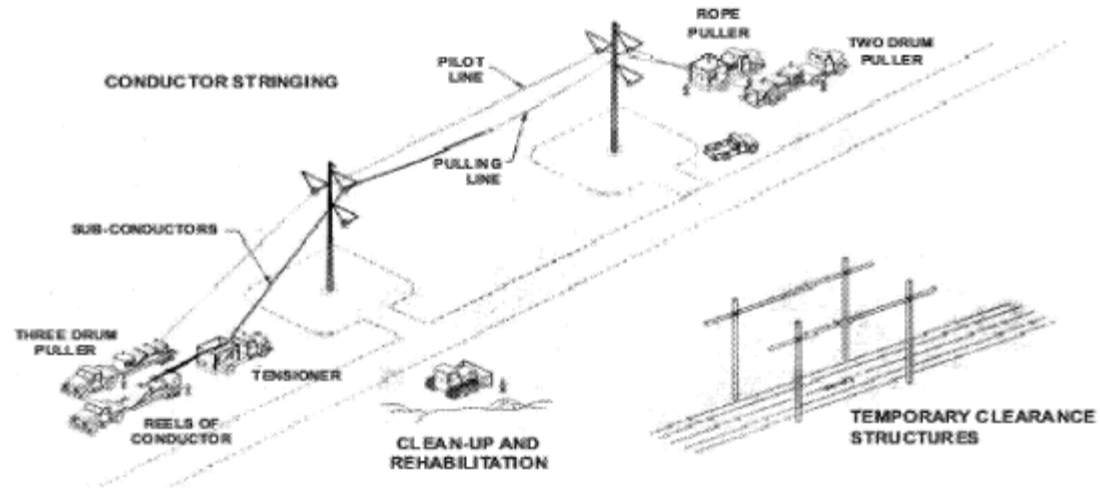
Various construction activities would occur during the construction process with several construction crews operating simultaneously at different locations. Permanent and temporary ground disturbances associated with the construction of the Project gen-tie line are estimated in Table 3.2-2. The following subsections describe in more detail the construction activities associated with the Project gen-tie line.

- ***Marshalling Yards:*** Construction staging/laydown and parking areas are proposed for two locations: 1) within the Project site, and 2) at the Wiley Well Rest area. Construction materials such as concrete, wire and cable, fuels, and small tools and consumables would be delivered to the staging/laydown areas by truck. Mobile trailers or similar suitable facilities (for example, modular offices) would be used for construction offices to be located at the Project staging/laydown areas.
- ***Road Work:*** The construction, operation, and maintenance of the proposed gen-tie line would require that heavy vehicles access structure sites along the road. The Project proposes to use the newly constructed site access road and Wiley Well Road for all construction, operation, and maintenance activities associated with the gen-tie line. If required, new spur roads, approximately 14 feet wide and averaging 70 feet in length, would be constructed from the access roads to the structure sites. Each spur road would lead to a construction pad for a pole structure.
- ***Pole Pads:*** At each site, a work area would be required for the structure footing location, structure assembly, and the necessary crane maneuvers. The work area would be cleared of vegetation only to the extent necessary and the construction pad would be leveled to facilitate the safe operation of equipment such as construction cranes.
- ***Pole Erection:*** Transmission line pole structure foundation excavations would be made with power drilling equipment. A vehicle-mounted power auger or backhoe would be used to excavate for the structure foundation. Although not expected, in some instances blasting could be necessary because of specific geologic conditions. In the unlikely event blasting is necessary, conventional or plastic explosives would be used. Safeguards (*e.g.* blasting mats) would be employed when adjacent areas require protection.

  Installation of new steel or concrete pole structures to support the 230 kV bundled circuit would begin with the excavation of foundations approximately 6 feet in diameter and 20 feet in depth. A truck-mounted auger, backhoe, or similar equipment would typically be used for excavation of this type. Once the foundation holes have been cleaned, the poles with preassembled insulators, hardware, and stringing sheaves would be lifted into position, inserted into the foundation holes, and gravel or concrete would be poured in to backfill the hole and create a foundation. Erecting each pole structure takes approximately two to three hours.
- ***Conductor Installation:*** Typical conductor stringing activities are illustrated below. For public and existing line protection, during wire installation crossing structures would be erected adjacent to the highway and IID's Blythe-to-Eagle Mountain line, or other structures requiring protection during conductor installation. Crossing structures would consist of H-frame wood poles placed on either side of an obstacle. These structures would prevent ground wire, conductors, or equipment from falling on an obstacle and would be removed following the completion of conductor

installation. Equipment for erecting the crossing structures would be the same as the equipment discussed above for transmission pole installation. Crossing structures may not be required for small roads or other areas where suitable safety measures such as barriers, flagmen, or other traffic controls could be used.

Pilot lines would be pulled (strung) from structure to structure and threaded through the stringing sheaves at each structure. This phase of work may be accomplished through the use of helicopters to minimize or otherwise eliminate the need to traverse the ROW along the ground from structure to structure. Following the pilot lines, a larger diameter stronger line would be attached to the conductors to pull them onto the structures. This process would be repeated until the ground wire or conductor is pulled through all sheaves.



- ***Pulling Sites:*** The shield wire and conductors would be strung using powered pulling equipment at one end and powered braking or tensioning equipment would be approximately one mile apart. Tensioners and/or pullers, line trucks, wire trailers, and tractors needed for stringing and anchoring ground wire or conductor would be necessary at each pulling site. The tensioner, in concert with the puller, would maintain tension on the shield wires or conductors while they would be pulled through the structures. There will be approximately 25 pulling sites required to install the conductors along this segment of the gen-tie line. The sites will be accessed from the Project access roads or Wiley's Well Road.
- ***Clean up and Site Reclamation:*** Construction sites, material storage yards, and access roads would be kept in an orderly condition throughout the construction period. Approved enclosed refuse containers would be used throughout the Project. Refuse and trash would be removed from the sites and disposed in an approved manner. Oils or chemicals would be hauled to a disposal facility authorized to accept such materials. Open burning of construction trash would not be acceptable.

  The post-construction ROW would be restored as required by the BLM. All practical means would be made to restore the land to its original contour and restore the natural drainage patterns along the ROW. Because re-vegetation would be difficult in many areas of the Project because of low amounts of precipitation, it would be important to minimize disturbance during construction.

3.7.4 Natural Gas Pipeline

Construction of the gas pipeline will be the responsibility of SoCal Gas (SCG) and is expected to take three to six months with a peak workforce of approximately 46 workers. Provisions for construction contractor employee parking for the pipeline construction will be accommodated by the Applicant at the plant site, except for those supervisory contractor employee and agency inspection vehicles which must be temporarily parked along the route while construction takes place. Most major pieces of pipeline construction equipment will remain along the pipeline ROW during construction with storage and staging of equipment and supplies either located at the Project plant site or other acceptable site selected by SCG at the time construction is underway. Excavated earth material would be stored within the construction ROW. During nonworking hours, any open trench will be covered with wood or other material of sufficient strength to support wildlife.

A “will serve” letter was received from SGC on August 21, 2009. The Project will be served by a high pressure transmission line located near I-10. Capacity analysis detail for the proposed line will be completed as the project progresses.

Genesis Solar, LLC anticipates the construction of the natural gas pipeline will generally consist of the following elements, subject to SCG providing further information.

- ***Trenching:*** The optimal trench will be approximately 48 inches wide and 4 to 10 feet deep. With loose soil, a trench up to eight feet wide at the top and three feet wide at the bottom may be required. The trench depth will provide a minimum cover of 36 inches.
- ***Stringing:*** The pipeline components will be staged along the trench on wooden skids in preparation for installation.
- ***Installation:*** Installation consists of bending, welding, and coating the weld-joint areas of the pipe after it has been strung, padding the ditch with sand or fine spoil, and lowering the pipe string into the trench following non-destructive testing of all wells.
- ***Backfilling:*** consists of returning spoil back into the trench around and on top of the pipe, ensuring the surface is returned to its original grade or level. The backfill will be compacted to protect the stability of the pipe and minimize subsequent subsidence.

Trenchless construction methods may be used for short crossings under existing water lines or other buried pipelines. Boring pits will be dug on each side of the crossing to accommodate the process. Cleanup consists of restoring the surface of the roadway or ROW by removing any construction debris, grading to the original grade and contour, and revegetating or repairing where required.

The pipeline will undergo hydrostatic testing which involves filling the line with water, venting all air, increasing the pressure to the specified code requirements, and holding the pressure for a period of time. After hydrostatic testing, the test water will be chemically analyzed for contaminants and discharged to the surrounding area pursuant to the Project Construction SWPPP unless the analysis shows the water is contaminated; in which case, the water would be trucked to an appropriate disposal facility. Following hydrostatic testing, the pipeline will be cleaned and dried, purged of air, and filled with natural gas for operation.

3.8 FACILITY OPERATION

The Project will have a moderate sized workforce during operation; an estimated total workforce of 40 to 50 full time equivalent personnel will be needed to staff the facility 24 hours per day/seven days per

week. When the plant is not operating (generating electricity), personnel will be present as necessary for maintenance, start-up, and/or site security.

3.9 FACILITY CLOSURE

Facility closure can occur on either a temporary or permanent basis. Temporary closure is a cessation of facility operations for a period of time greater than would be required for routine maintenance, overhaul, or replacement of major plant equipment. Temporary closures may be caused by damage to the facility from events such as fire, earthquake, or other natural occurrences, or by short-term economic considerations.

Permanent closure is a cessation of facility operations with no intent to restart. Permanent closure may result from a combination of facility age and economic considerations, or from damage considered beyond repair or other reasons. Temporary and permanent facility closures are both addressed below.

3.9.1 Temporary Closure

In the case of a temporary closure, security for the Project facilities will be maintained on a 24-hour basis and the CEC and other responsible agencies will be notified. The course of action that will be followed will depend on whether or not the temporary closure involves a release of hazardous materials.

If there is no actual or threatened release of hazardous materials, a contingency plan will be implemented for the temporary halting of facility operations. The purpose of this contingency plan, to be developed prior to the beginning of operations, is to ensure compliance with all applicable Laws, Ordinances, Regulations, and Standards (LORS) and appropriate protection of public health, safety, and the environment. Depending on the expected duration of the temporary shutdown, the contingency plan may include the draining and proper disposal of chemicals from storage tanks and other facility equipment, the safe shutdown of all plant equipment, and various other measures to protect onsite workers, the public, and the environment.

If the temporary closure involves an actual or threatened release of hazardous materials to the environment, procedures will be implemented as provided in a Hazardous Materials Business Plan that will be developed for the Project (see Section 5.12, Hazardous Materials Handling). Procedures will include, but not be limited to, the following:

- Measures to control the release of hazardous materials.
- Requirements for notifying the appropriate agencies and the public.
- Emergency response procedures.
- Training requirements for Project personnel in hazardous materials release response and control.

Once the hazardous materials release has been resolved, temporary closure will proceed as described above for temporary closure without a hazardous materials release.

3.9.2 Permanent Closure

The planned operational life of the Project is 30 years, but the Project facility conceivably could operate for a longer or shorter period depending upon economic considerations or other circumstances. For example, if the Project facility remains economically viable, it could operate for more than 30 years, which would defer environmental impacts associated with closure and with the

development of replacement power generating facilities. However, if the facility were to become economically non-viable before 30 years of operation, it could be closed permanently sooner.

Regardless of when permanent closure occurs, a decommissioning plan specifying the appropriate closure procedures will be developed and implemented. As in the case of a temporary closure, security for the Project facility will be maintained on a 24-hour basis. During permanent closure, the CEC and other responsible agencies will be notified of the decommissioning schedule and plans.

The procedures provided in the decommissioning plan will be designed to ensure public health and safety, environmental protection, and compliance with applicable LORS. Prior to the beginning of permanent closure activities, the decommissioning plan will be submitted to the CEC for review and approval.

Depending on conditions at the time of closure, the closure measures may range from extensive "mothballing" to the complete removal of Project equipment and other structures.

In general, the decommissioning plan for the Project will address the following:

- Proposed decommissioning measures for the power plant and all associated facilities constructed as part of the Project, designation of equipment and appurtenances to be removed or that may remain in place, as applicable.
- Activities necessary for site reclamation.
- Provisions for recycling facility components, collection and disposal of wastes, and resale of unused chemicals back to suppliers or other parties.
- Decommissioning alternatives other than full restoration of the site.
- Costs associated with the proposed decommissioning and reclamation activities and the source of funds to implement these activities.
- Conformance with applicable LORS and with local/regional plans.

As it is not possible to predict at present the conditions that will exist at the time decommissioning decisions must be made, decommissioning details will be developed and provided to the CEC when the time for permanent closure is closer and more information is available.

If the evaporation ponds or LTU require temporary closure, the Closure and Post-Closure Maintenance Plan shall be implemented. A Preliminary Closure and Post-Closure Maintenance Plan for both waste management units will be submitted to the CRRWQCB with the application for a Report of Waste Discharge (RoWD) (see Appendix H). It is anticipated these facilities will undergo "clean closure," meaning post-closure maintenance will not be required. The Detection Monitoring Plan in the RoWD is also based on closure of these waste management units after the 30 year operating life; therefore, if there was a reduction or extension in the operating life of the system, discussions with the CRRWQCB will be undertaken to adjust this plan accordingly.

3.10 ALTERNATIVES

Alternatives to the Project are presented in this section. After a discussion on how alternatives were screened, the alternatives addressed include the following:

- "No Project" alternative
- Alternative plant sites

- Alternative linear corridor routes
- Plant design alternatives
- Water supply alternatives
- Alternative cooling technologies
- Alternative wastewater disposal methods
- Alternative power generation technologies

Alternatives Screening Methodology

Genesis Solar, LLC evaluated a range of potential alternatives to the proposed Project in terms of location, linear facilities routes, design alternatives, etc. While the following screening methodology is presented in terms of alternative Project locations (sites), essentially the same process applies to alternative routes and technologies. Alternatives were not carried forward for further analysis if:

1. The alternative failed to meet most of the basic Project objectives.
2. The alternative would not avoid or substantially lessen significant environmental impacts of the Project.
3. The alternative was not "feasible." Per 14 CRR 15126.6(f)(1) (CEQA), the factors that should be taken into account in determining whether an alternative is feasible are:
   a) Site suitability
   b) Economic viability
   c) Availability of infrastructure
   d) Land use/land use plan consistency or regulatory/jurisdictional limitations
   e) Site control

In order to implement this screening process for selecting the Project site, Genesis Solar, LLC needed to:

1. Define the Project objectives.
2. Identify the potential significant environmental impacts associated with the Project.
3. Further define the feasibility criteria.

Project Objectives

The Project objectives are presented in Section 2 and are restated here as follows:

- To construct, operate and maintain an efficient, economic, reliable, safe and environmentally sound solar powered generating facility throughout its useful life to help: (i) achieve the State of California objectives mandated by SB 1078 (California Renewable Portfolio Standard Program), (ii) AB 32 (California Global Warming Solutions Act of 2006), and (iii) other local mandates adopted by the State's municipal electric utilities to meet the requirements for the long term wholesale purchase of renewable electric energy for distribution to their customers
- To develop a site with an excellent solar resource.
- To develop a site with close proximity to transmission infrastructure in order to minimize environmental impacts.

- To develop a new utility-scale solar energy Project using proven concentrated solar trough technology.
- To develop a site with available water resources to allow wet cooling in order to maximize power generation, optimize efficiency, and reduce the delivered cost of electricity.

Site Feasibility Criteria Defined

An available site must meet the following criteria to achieve the Project objectives noted above:

- **Site Suitability:**
  - *Solar Resource* – The site needs to be located where high solar insolation is available to maximize the plant's output and support efficient utilization of the land area that would be affected by Project development. For a project to be economically viable, solar insolation levels of greater than 7.0 kilowatt-hours per day per square meter are desirable.
  - *Size and Shape* – The site should be large enough (approximately 1,800 acres at a minimum) to support the construction of a facility that can generate 250 MW of power using solar thermal technology, and arranged in a way that allows an efficient and cost-effective layout of the Project facilities.
  - *Slope* – The site needs to be relatively flat, with a slope of three percent or less.
- **Economic Viability:** The Project needs to be economically viable and competitive with other renewable technology projects, including wind, geothermal, and other solar projects. To be viable, the site should be located on property currently available at a reasonable cost, have reasonable proximity to infrastructure, and have good solar resources. Sites with excellent solar resources may be able to carry somewhat higher mitigation costs or infrastructure costs.
- **Availability of Infrastructure:** To minimize cost and potential environmental impacts, the site needs to be located so it can be interconnected with an existing transmission system without the need for new, long dedicated transmission lines, while also providing good access to water for power plant cooling. The site also needs reasonable access to a natural gas pipeline.
- **Site Control:** The land for the power plant site and linear facilities has to be available for purchase or lease.

Application of the above criteria eliminated all other potential project locations from being carried forward for more detailed analysis. The site screening process that led to the selection of the proposed site and elimination of alternative sites is discussed in the following sections.

3.10.1 No Project Alternative

Under the No Project alternative, the Project would not be constructed, and the electrical power that would have been generated will be generated by other facilities, presumably natural gas-fired generation. Because the Project facilities would not exist, its direct environmental impacts would not occur. However, indirect impacts would result in greater fossil fuel consumption and ultimately additional air pollution. It is expected that since solar power is generated close to peak consumption periods of the day, the peaking power needs met by the Project-generated power otherwise would be met by fossil fuel-fired peaking units such as simple-cycle gas turbines and other rapid starting equipment (*e.g.,* reciprocating engines) that would produce higher levels of air emissions than a solar thermal power plant.

In 2002, the State established the Renewable Portfolio Standard (RPS) program, with a goal of increasing the percentage of renewable energy in the State's electricity mix to 20 percent by 2017. The 2003 Energy Report recommended accelerating the 20 percent goal for renewables to 2010, while the 2004 Energy Report and the State's 2005 Energy Action Plan recommended increasing the target percentage to 33 percent by 2020. The 2006 Energy Report Update states "California must accelerate its pace of development if it is to meet its long-term Renewable Portfolio Standard Goal of generating 33 percent of the State's electricity from renewable sources by 2020, as recommended by Governor Schwarzenegger, the Energy Commission, and the California Public Utilities Commission" (CEC, 2006). The 2007 IEPR states "renewable resources are an essential tool for reaching AB 32 goals," but "program adjustments" are needed to meet the 2010 and 2010 Renewable Portfolio Standard goals (CEC, 2007). The 2007 IEPR cites the "critical imperative to reduce greenhouse gas emissions" and "management of the risk borne by ratepayers for electricity generation" as the two main considerations driving the need to achieve the RPS goals. The IEPR states the goal of 33 percent renewables by 2020 is achievable "with a concerted effort by and coordinated support from government, industry, and the public." (CEC, 2007)

The No Project alternative would mean the proposed solar Project would not be developed and thus, the No Project alternative would not support the State's RPS program goals. The purpose of the Project is to generate renewable solar power and provide electric power to Californian electrical users. The No Project alternative is not the appropriate choice because it does not provide the additional power needed in California in a manner that assists the State in meeting its renewable power and greenhouse gas reduction goals.

3.10.2 Alternative Plant Sites

To locate a potential site that met the criteria listed above, Genesis Solar, LLC followed a screening process that included a Geographic Information System (GIS) analysis using NREL data, preparing base maps of solar energy values, and then applying exclusion criteria to identify study areas for further analysis. Maps were prepared reflecting the application of each of the following exclusion parameters separately, and then a final map was created incorporating all exclusion criteria:

- Solar indices less than 7.0 kilowatt-hours per square meter per day (kWh/m^2/day)
- Wilderness, parks, and military
- Special status species habitat conservation areas (*e.g.,* BLM Desert Wildlife Management Areas [DWMAs] and USFWS Critical Habitat)
- Slope greater than three percent
- Populated areas

From this map, and numerous site visits, Genesis Solar, LLC identified public and private lands that had the potential to meet the remaining site suitability and feasibility criteria, namely:

- Size (minimum 1,800 acres)
- Located within 25 miles of an interconnection to a transmission system
- Available for sale or lease

As a result of the above screening, in 2007 the Applicant submitted five requests for ROW (SF-299 forms) to the Palm Springs BLM field office, requesting ROW for solar development in five areas: Desert Center 1, Desert Center 2, McCoy, Mule Mountain, and Black Hill. After additional examination

of environmental concerns, road access, conflicting uses, and transmission options, Desert Center 1, Mule Mountain, and Black Hill were withdrawn.

The name Desert Center 2 was changed to Ford Dry Lake to avoid any appearance of conflict with the town of Desert Center, located about 20 miles west of the Ford Dry Lake site. The name of the site was changed once more to Genesis, or the Genesis Solar Energy Project, the subject of this AFC.

The other probable location for a large solar thermal facility in Riverside County is the McCoy site, on the east side of the McCoy Mountains, closer to Blythe. The Applicant conducted surveys and investigations on both the Genesis and McCoy sites and made a determination to go forward with the Genesis site first. Both sites have an SF 299 ROW filed with the BLM. The McCoy site is anticipated to be developed by the Applicant at a later time.

The Project area for the Project has been reduced in size twice in consultation with the BLM. The original filing, in March 2007 was for approximately 19,000 acres. After initial cultural and biological reviews, a determination was made in October 2007 to avoid sensitive cultural sites and the playa area of Ford Dry Lake. The applicant consulted with BLM on the issues and a decision was made to eliminate substantial acreage from the southern portion of the ROW, reducing the ROW filing to 8,940 acres.

A second reduction of the ROW size was made in January 2008 after completing and analyzing the results of the Class II Cultural survey. Another 4,030 acres were dropped from the southern portion of the filing to the current number of 4,640 acres. This ROW consists of an eastern and western portion. At this time, only the eastern portion of the ROW is anticipated to be needed for the Project.

Throughout this process, Genesis Solar, LLC and their consultants have worked proactively with BLM on the surveys and investigations on the Project site. BLM has stated the Project has correctly followed procedures in the logical termination of portions of the ROW that should be avoided to minimize disruption to potential cultural resource areas and sensitive biological areas.

3.10.3 Alternative Linear Corridor Routes

A transmission line (generation tie-line) is needed to connect the Project power plant to the Colorado River substation. A described earlier, the line will join up with the Blythe Energy Project Transmission Line, directly south of the Project, use the existing power line poles for the lines, and tie into the substation to the east.

Numerous alternative routes were considered for the utilities and infrastructure that would be included in the linear corridor (electric transmission, gas, and an access road). The first consideration was to run a corridor directly south from the Project site through Ford Dry Lake. Although this would be the shortest and most economical route, this alternative was discarded due to the potentially high number of cultural sites existing in the lakebed, some sand dunes, and the presence of some private parcels.

Several other linear corridors were studied that would traverse south and southeast of the Project. Ultimately, after assessing the biological and cultural surveys conducted in the spring of 2009, a route was identified that avoided cultural sites. Additionally, the proposed linear route that is shown in this AFC will utilize a portion of an existing access road, an area that has already been disturbed.

3.10.4 Plant Design Alternatives

The following subsections address alternatives considered for several aspects of the proposed design of the power generation facility. These include project size, alternative heat rejection (cooling) technologies, alternative water supply sources, and alternative approaches for disposing of non-sanitary wastewater generated by the proposed facilities.

Project Size

The selection of a 250 MW project size considers several factors including available land aggregation, transmission capacity where land can be aggregated, design limitations, and operational constraints. The overall project size is also influenced by the demand of potential customers for total aggregate MWs from a single project or contract. Independent studies have indicated a 250 MW size project hits an optimal size range where economies of scale and the potential for excess parasitic losses balance out. While this evaluation is usually based on the 250 MW project being a single unit, in the case of this site, the final available footprint resulted in it being split into two 125 MW units. Due to improved overall plant power production efficiencies with the smaller units, the effective cost between the two options were determined to be similar for the Project, so the split was selected to accommodate this site. Having a single 250 MW site also retains the synergies of the larger unit associated with access, operations, transmission, and water infrastructure.

Since the facility's power output is directly related to the size of the solar collector area, a smaller facility would require a smaller site with a smaller footprint and thus, conceptually, lower potential for adverse environmental impacts. However, the site selection process carefully considered potential environmental issues and the selected site can accommodate the split 250 MW plant without any significant environmental impacts. Therefore, there is no substantial environmental advantage to a smaller size Project, and given that a 250 MW facility is preferable from an economic perspective, the development of a smaller Project was rejected.

A larger project was also considered, but additional contiguous land was not available. The Project site is mostly made up of a number of contiguous parcels owned by the BLM.

3.10.5 Water Supply Alternatives

A comprehensive search was conducted to identify possible alternative sources of water for the Project. This search included inquires to water and wastewater treatment and distribution facilities; agricultural irrigation and drainage districts; commercial and industrial operators; and other potential water supplies.

Groundwater was selected based upon a variety of factors including reliability of source, availability, practicality, and cost. Table 3.10-1 details the potential supply alternatives for the Project and presents a summary of potential impacts and advantages to each alternative.

In addition to using on-site groundwater, Genesis Solar, LLC is continuing to explore options that may utilize local industrial facility treated wastewater. Due to the limited quantity of treated water, this would be pursed in order to supplemental the groundwater source.

Water to supply the Project is proposed to be derived from a minimum of two groundwater supply wells located near each unit's power block area. Alternatively, these wells may be located in the western portion of the site. As currently planned, the wells will pump groundwater from the Bouse Formation and/or underlying Fanglomerate within the Chuckwalla Valley Groundwater Basin. The quality of

groundwater sampled from the Bouse Formation at a depth of 800 feet is summarized in Table 5.4-3. The characteristics and yield of the aquifer that is proposed for the Project water supply and the long-term effect of pumping of the groundwater system are discussed in more detail in Section 5.4, Water Resources. As discussed in that section, water quality generally improves with depth, and it is likely further investigation to support detailed project design will reveal depths within the aquifer that can be developed to produce a better quality (lower TDS) water supply that is still in the brackish range (greater than 1,000 milligrams per liter (mg/L) TDS), but the use of which would result in similar impacts.

Comparison of on-site groundwater wells to the other water supply alternatives considered is presented below.

Table 3.10-1. Potential Supply Alternatives for the Project

Proposed Alternative	Potential Impacts/Disadvantages	Potential Advantages
On-site Groundwater Wells	• Groundwater use is consistent with applicable Federal, State, or local LORS.	• Avoidance of use of surface supplies from the Colorado River. • Avoidance of depletion of Colorado River water resources from decreasing return flow or drawing down the water table below the Colorado River Accounting Surface. • Lower cost for pipelines/pumping. • No impacts from off-site water pipeline construction. • Use of brackish quality is consistent State water policy for use of inland waters for power plant cooling (SWRCB Resolution 75-58). • Avoidance of diminished plant electrical output from pumping loads.
On-site Groundwater Wells on Western ROW	• Similar to preferred alternative. • Additional ground disturbance, road construction and pipeline disturbance required to access well locations.	• Similar to preferred alternative if local groundwater supply conditions are more favorable on the western than the eastern parcel.

Table 3.10-1. Potential Supply Alternatives for the Project

Proposed Alternative	Potential Impacts/Disadvantages	Potential Advantages
City of Blythe Water Production and Treatment Facility, Reclaimed Water	• Advanced secondary treated wastewater is discharged to the groundwater aquifer and recharged return flow to the Colorado River. As such, the discharged return flow is considered Colorado River water and is fully allocated. Palo Verde Irrigation District (PVID) is water rights holder. PVID and Metropolitan Water District (MWD) are implementing a program to reduce water consumption throughout their Districts. • Pipeline disturbance required, resulting in off-site impacts. • Construction and pumping costs would be high due to the distance from the Project site. • Potential supply of water is not sufficient to meet Project demands. • Requires treatment plant upgrades to tertiary treatment standards, which are not currently planned. • Decreased potable water supply. • Decreased net plant electrical output due to increased pumping loads.	• Use of reclaimed water is consistent with SWRCB Resolution 75-58.
Palo Verde Irrigation District, Return Irrigation Flow	• Return flow is discharged to the Colorado River and considered Colorado River water, which is fully allocated. Irrigation use would be deducted from PVID's allocation of Colorado River water. PVID and MWD are implementing a program to reduce water consumption throughout the Districts. • Pipeline disturbance required, resulting in off-site impacts. • Construction and pumping costs would be high due to the distance from the Project site. • Water quantity and quality are variable and uncertain for project. • Decreased potable water supply. • Decreased net plant electrical output due to increased pumping loads.	• Use of irrigation return flow is consistent with SWRCB Resolution 75-58.

Table 3.10-1. Potential Supply Alternatives for the Project

Proposed Alternative	Potential Impacts/Disadvantages	Potential Advantages
Palo Verde Irrigation District, Raw Colorado River Water	• Constitutes direct use of Colorado River water, which is fully allocated. Use would be deducted from PVID's allocation of Colorado River water. PVID and MWD are implementing a program to reduce water consumption throughout the Districts. • Use of water is not consistent with SWRCB Resolution 75-58. • Pipeline disturbance required, resulting in off-site impacts. • Construction and pumping costs would be high due to the distance from the Project site. • Potential water rights allocations would not provide adequate water supply for Project. • Decreased potable water supply. • Decreased net plant electrical output due to increased pumping loads.	• Potential decreased need for on-site water pre-treatment.
Chuckwalla Valley State Prison, Wastewater	• Pipeline disturbance required, resulting in off-site impacts. • Increased construction and pumping costs. • Current supply of water is not sufficient to meet Project demands. Wastewater facilities improvements (anticipated construction start 2010) may further decrease the quantity of water available. • Upgrade of plant to tertiary treatment standards will be required.	• Avoidance of use of surface water supplies from the Colorado River. • Use of reclaimed water is consistent with SWRCB Resolution 75-58. • Avoidance of depletion of Colorado River water resources from decreasing return flow or drawing down the water table below the Colorado River Accounting Surface.

Table 3.10-1. Potential Supply Alternatives for the Project

Proposed Alternative	Potential Impacts/Disadvantages	Potential Advantages
City of Blythe Water System	• Majority of use would be deducted from PVID's allocation of Colorado River water. PVID and MWD are implementing a program to reduce water consumption throughout the Districts. • Use of water is not consistent with SWRCB Resolution 75-58. • Pipeline disturbance required, resulting in off-site impacts. • New wells potentially required, resulting in increased off-site groundwater demand to Colorado River aquifer system. • Construction and pumping costs would be high due to the distance from the Project site. • Decreased potable water supply. • Decreased net plant electrical output due to increased pumping loads.	• None identified.
Offsite Wells in Chuckwalla Valley Groundwater Basin	• Pipeline disturbance required, resulting in off-site impact. • Increased construction and pumping costs.	• Wells can be completed in the Bouse Formation or Fanglomerate and sited/completed to yield brackish water with similar advantages as on-site water supply wells. Potential well sites are currently being investigated.
Colorado River Indian Reservation, Parker, AZ	• Constitutes direct use of Colorado River water, which is fully allocated. • Use of water is not consistent with SWRCB Resolution 75-58. • Requires inter-state water transfer. • Pipeline disturbance required, resulting in off-site impacts. • Construction and pumping costs would be high due to the potential distance from the Project site. • Decreased potable water supply. • Decreased net plant electrical output due to increased pumping loads.	• None identified.

Table 3.10-1. Potential Supply Alternatives for the Project

Proposed Alternative	Potential Impacts/Disadvantages	Potential Advantages
Colorado River Sewage System Joint Venture, Westates, near Parker, AZ (Serves the City of Parker, AZ and Colorado River Indian Tribes)	• Advanced secondary treated wastewater is discharged to the groundwater aquifer and considered return flow to the Colorado River. As such, the discharged return flow is considered Colorado River water and is fully allocated. PVID is water rights holder. PVID and MWD are implementing a program to reduce water consumption throughout their Districts. • Requires inter-state water transfer. • Pipeline disturbance required, resulting in off-site impacts. • Construction and pumping costs would be high due to the distance from the Project site. • Potential supply of water is not sufficient to meet Project demands. • Decreased potable water supply. • Decreased net plant electrical output due to increased pumping loads.	• Use of reclaimed water is consistent with SWRCB Resolution 75-58.
Metropolitan Water District of Southern California, Desert Center Plant Wastewater	• Advanced secondary treated water is discharged to the groundwater aquifer and recharges the Chuckwalla Valley Groundwater Basin. • Potential supply of water is not sufficient to meet Project demands. • Construction and pumping costs would be high due to the distance from the Project site. • Pipeline disturbance required, resulting in off-site impacts. • Decreased net plant electrical output due to increased pumping loads.	• Avoidance of use of surface water supplies from the Colorado River. • Use of reclaimed water is consistent with SWRCB Resolution 75-58. • Avoidance of depletion of Colorado River water resources from decreasing return flow or drawing down the water table below the Colorado River Accounting Surface.

3.10.6 Alternative Cooling Technologies

The current proposed Project configuration is two net 125 MW plants utilizing wet cooling technology, and groundwater as the source of make-up water to the cooling tower. Alternative technologies considered were dry and hybrid cooling systems.

Wet Cooling

Wet cooling uses circulating water to condense turbine-generator exhaust steam in a shell and tube heat exchanger (condenser). Cool circulating water passes through the tube side of the condenser where it is warmed by the shell-side steam, causing the steam to condense such that condensate

pumps may return it to the steam generator feed water system. The warm circulating water then travels to a wet mechanical draft cooling tower. The cooling tower dissipates heat through circulating water evaporation and contact with ambient air. Once cooled, the circulating water is returned to the condenser to complete the cooling circuit. This is the technology currently in use for all operating solar thermal power plants.

Dry Cooling

Dry cooling technology uses an air cooled condenser (ACC) that cools the steam turbine-generator exhaust steam using a large array of fans that force air over finned tube heat exchangers. The exhaust from the steam turbine flows through a large diameter duct to the ACC where it is condensed inside the tubes through indirect contact with the ambient air. The heat is then rejected directly to the atmosphere. While demonstrated in combined cycle fossil plants, this technology has never been demonstrated for a solar thermal facility.

Hybrid Cooling

Hybrid cooling (sometimes called parallel cooling) involves the use of a combination of both wet and dry cooling technologies in parallel, and uses all of the equipment involved in both wet and dry cooling. As in a purely wet cooling system, cool water is circulated in a shell and tube heat exchanger to condense the turbine exhaust steam, and then a cooling tower is used to dissipate the heat in the warmed water. As in a purely dry cooling system, an air-cooled condenser uses a large array of fans to force air over finned tube heat exchangers, and the steam is condensed through indirect contact with the ambient air. Hybrid cooling technology divides the cooling function between the wet and dry systems with the dry cooling system always operating and the wet cooling system picking up the remaining cooling load, which varies with environmental and operational conditions.

3.10.6.1 Comparison of Cooling Technology Alternatives

Wet cooling technology has clear performance advantages over dry cooling for the Project. Performance is enhanced because wet cooling relies primarily on evaporation to remove heat from the circulating water. Since evaporation occurs at the wet bulb temperature (the air temperature at 100 percent humidity), wet cooling achieves a lower temperature cooling media for the condenser than does dry cooling which is tied to dry bulb temperatures (ambient air temperature). Dry bulb temperatures are generally much higher than wet bulb temperatures (especially in regions such as the Project site). As the dry bulb temperature increases and humidity decreases, the dry cooling system becomes less efficient as a heat rejection method. This is the reason wet cooling systems are even more efficient than dry cooling systems in areas with low humidity, as is the case at the Project site. In addition, the decreased efficiency of a dry cooling system at the Project site would be most noticeable in the hot summer months when plant output is highest.

The lower circulating water temperatures of wet cooling systems compared to ambient air temperature result in a significant improvement in cycle performance. This is because the lower temperatures result in lower STG backpressures, which increase the STG's generation output. Conversely, the requirement to operate at the higher temperatures and higher STG backpressures associated with dry cooling would adversely affect the Project's power output. A wet cooling tower would be physically smaller than an ACC because water is more efficient as a heat exchange medium than air. Dry cooling requires much more surface area and very high flow rates of air to remove the same amount of heat as a wet cooling system.

An ACC for the Project is estimated to be approximately 100 feet tall and occupy over 35,000 square feet. The proposed wet tower will be 45 feet tall and occupy less than 13,000 square feet. Because it

is larger, the ACC would be more visible and have greater impacts on visual resources. However, the wet cooling tower may occasionally produce a visible plume, which would not be the case for a dry cooling tower. It should be noted visible plumes would be expected to occur very infrequently at the Project site since the plant will only operate during sunny conditions, which correspond to low humidity periods, and thus would not represent a significant impact. A dry cooling system would have less direct emissions than a wet tower because it would not have the drift emissions of a wet tower (emissions of fine entrained droplets that contain dissolved solids that evaporate and form fine particles). However, dry cooling can cause higher indirect emissions if the resultant power loss is made up by producing the “replacement” power at a fossil-fuel fired power plant. In addition, the condenser of the proposed wet cooling tower system can be evacuated and steam seal established quickly for facility start-up, thus reducing emissions from the auxiliary boiler. Finally, because a dry cooling system requires more fans than a wet system, an ACC would produce greater noise emissions than the proposed wet cooling system. The primary disadvantage of wet cooling (and advantage of an ACC) is water consumption. Since wet cooling relies on evaporation as the primary mode of heat rejection, water consumption is higher. The cooling tower also requires a portion of the circulating water be blown down (removed from the system for reuse or disposal) and replaced with fresh water to maintain water chemistry. Because an ACC does not rely on evaporation for heat transfer, cooling water supply, treatment, and disposal are not issues of concern. Table 3.10-2 summarizes expected water usage for wet and dry cooling.

Both wet and dry cooled plant models were setup and run in GateCycle (GC), which is a commonly used thermodynamic modeling package, at the design point conditions, see Figure 3.4-6. Each cooling technology was evaluated at various part load and ambient conditions to develop technology specific performance curves. These performance curves were input into the Solar Advisor Model, a National Renewable Energy Laboratory model, to analyze annual performance of each technology.

Plant thermal efficiency varies greatly between different cooling technologies. The LP exhaust pressure (backpressure) is directly affected by the condensing load and ambient conditions, and directly affects the overall plant efficiency. A performance analysis was conducted as described below. It was determined there is a 7.4 percent decrease in total annual net MWh generated with dry cooling compared to wet cooling.

Wet Cooling

The cooling tower was modeled with a 10 °F approach and the surface condenser was modeled with a 17 °F rise and a 5 °F Terminal Temperature Difference (TTD). Base load operation at the design point conditions achieves a turbine backpressure of 1.29 psia with a gross plant efficiency of 38.0 percent. As ambient temperature decreases with a constant steam flow, the turbine backpressure decreases correspondingly, approaching the assumed minimum back pressure with a surface condenser of 0.5 psia, and the overall gross plant output increases. It is assumed that for full load operation, all of the cooling tower fans will be in operation for temperatures of 50°F and above. Below this ambient condition, it would be advantageous to reduce the number of cooling tower fans in operation to reduce the cooling auxiliary load while still maintaining a backpressure close to the minimum threshold and staying above the recommended minimum circulating water temperature.

Dry Cooling

ACC performance was based on vendor information. Base load operation at the design point conditions achieves a turbine backpressure of 3.98 psia with a gross plant efficiency of 34.6 percent. Similar to the cooling tower fan operation, it was assumed that for temperatures of 50°F and above,

all ACC fans would be in operation. Below 50°F, it was assumed only 10 of the 18 ACC fans would be required to be in operation while still maintaining the assumed minimum backpressure with an ACC of 1.0 psia.

Hybrid Cooling

No performance estimates for hybrid cooling were completed. The 100 percent dry cooled case and the 100 percent wet cooled case define the boundaries for plant performance. Performance utilizing a hybrid cooling system will fall somewhere between the two. A hybrid system will split the cooling duty between the wet and dry cooling and could be designed for any ratio in between the two extremes of 100 percent dry or 100 percent wet. However, due to the fact the plant will generate most of its annual energy during summer daytime conditions (times when the wet system would be favored), the reduction in water usage with hybrid cooling would be much less than that expected in a traditional fossil fired facility.

3.10.6.2 Installed Cost

Total installed costs for the different cooling options considered were determined using vendor quotes and internal estimating database information. Since many systems will not change from wet to dry cooling, only specific systems that are cooling technology dependent were evaluated. The following equipment and systems were compared:

- Circulating Water System
- Electrical buildings associated with each cooling technology
- Electrical Equipment associated with each cooling technology
- Auxiliary Cooling Water System to the extent the auxiliary cooling system will be supplied by the circulating water system
- Closed Cooling System to the extent the heat exchange/rejection systems are different for each cooling technology
- Steam Condensing System (Surface Condenser for Wet Cooling and Air Cooled Condenser for Dry Cooling)
- Cooling Tower
- Air Cooled Condenser
- Chemical Feed System
- Water Treatment System
- Water Storage Tanks
- Evaporation Pond System

The installed cost for the evaluated equipment and systems associated with the wet cooled plant is approximately one percent less than the evaluated equipment and systems associated with the dry cooled plant.

Although hybrid cooling was not modeled in this evaluation, cost for a hybrid system could potentially be higher than either wet or dry cooling since hybrid cooling requires installation of parallel cooling equipment. A hybrid system could be designed for anything in between, and would be priced accordingly. More specific site constraints, plant model, and vendor information are required in order to come up with an accurate installed cost estimate for a hybrid cooled system.

3.10.6.3 Water Treatment and Consumption

Wet Cooling

Based on initial water quality analysis, the recommended water treatment for the Project utilizes a pre-treatment system upstream of the cooling tower, as well as a post-treatment system downstream of the cooling tower. Calcium concentrations in the water limit the COCs to about 5 due to the potential to form calcite ($CaCO_3$), and silica is limited to 10 COCs due to the formation of silica (SiO_2) and magnesium silicate ($Mg_3Si_4O_{10}(OH)_2$). Because of the limited COCs that can be achieved without makeup water treatment using a wet condenser design, the pre-treatment option is recommended for the Project. Pre-treatment design upstream of the cooling tower includes a two-stage reverse osmosis unit. In the two-stage design, reject from the first-stage RO unit is used to feed the second-stage RO, with the permeate of both units combined as the source of treated water for cooling tower makeup. Multimedia filters have been included upstream of the RO units to ensure larger particles are not caught in the RO membranes. Post-treatment also consists of an RO system which allows for the recovery of most of the wastewater for reuse which reduces the volume of incoming water required and reduces the size of the evaporation ponds.

Dry Cooling

While the ACC does not consume any water for condensing purposes, makeup water for the plant is still required for steam cycle makeup, mirror washing, quench water, and domestic use. Water treatment for the dry cooling option is designed with a multi-media filter (solids removal and protection of reverse osmosis membranes), a reverse osmosis system, and an ion exchange system (*e.g.,* mixed bed polishing vessel).

Water consumption for each option for annual and summer ambient conditions are summarized in the table below:

Table 3.10-2. Water Consumption Comparison

	WET COOLED Pre-Treatment and Post-Treatment	**DRY COOLED Air Cooled Condenser**
Estimated Annual/Summer Makeup (gpm)	3,420/4,026	322/342
Estimated Annual Makeup (AFY)	1,644	132
Annual/Summer Flow to Evap Ponds (gpm)	364/430	184/188

3.10.6.4 Summary of Cooling Technology Comparison

In conclusion, based on the information presented above and the use of concentrating solar trough technology, Genesis Solar, LLC has concluded the use of dry cooling will decrease the Project output, which will render the Project economically unsound or noncompetitive. Dry cooling would reduce the net annual production by 7.4 percent which Genesis Solar, LLC considerers significant since peak demand for the Project would be during the summer when ACC performance is limited. The Project has been optimized for the land available making solar field expansion infeasible. The groundwater resource available to Genesis Solar, LLC, provides for a viable economic plant design that is required for the Project to remain attractive to potential utility customers. The Project has emphasized water conservation measures in its facility design to minimize water consumption associated with the use of wet cooling.

3.10.7 Alternative Wastewater Disposal Methods

In the proposed design, the Project will utilize wet cooling technology and evaporation ponds for treating cooling tower blowdown, reverse osmosis reject, and multi-media filter backwash. A post-treatment reverse osmosis unit takes input from the pre-treatment RO waste and the cooling tower blowdown to minimize the flow to the evaporation ponds, and recycle water back to the cooling tower for reuse. Both streams consist of a brine solution resulting from removal of water and concentration of impurities.

One post-treatment alternative for treating the wastewater is a brine concentrator, where evaporation of the wastewater using a heat source would reduce the volume discharged, although not eliminate it entirely. Therefore, evaporation ponds would still be needed with this alternative (Alternative 1).

Another option that eliminates the need for evaporation ponds is a mechanical zero liquid discharge (ZLD) system consisting of a brine concentrator and a crystallizer combination (Alternative 2), as well as supporting water treatment equipment including pumps, tanks, filters, mixing tanks, piping, control system, etc.

Another option considered for post-treatment is the use of a softener-clarifier (Alternative 3). In this option, wastewater is initially treated by adding an alkali. With the low concentration of calcium in the wastewater, calcium may need to be added in the treatment process as a calcium salt (e.g., $CaCl_2$). After precipitation, a polymer is added to promote coagulation and flocculation to help remove particulates from the system. Solids removed from the system are processed through a filter press, with the waste being dewatered and then trucked off site. The remaining process water is sent to a softener and finally to a reverse osmosis unit to reduce the volume of wastewater discharged to the evaporation ponds.

It should be noted both the proposed Project approach, as well as Alternatives 1, 2, and 3, include raw water pre-treatment using reverse osmosis system to significantly reduce the impurities feeding the cooling tower. The following paragraphs discuss how the evaporation ponds and various treatment components affect the selection of an optimal operation and disposal method.

Evaporation ponds as well as a mechanical ZLD system (Alternative 2) eliminate the wastewater stream. The evaporation ponds accomplish this by using solar energy to evaporate the cooling tower blowdown to the atmosphere, leaving the solids in the pond. The evaporation ponds require no energy input (other than solar energy), and as currently planned, the ponds would be constructed with sufficient capacity so they would require offsite transport of the dewatered salts approximately every seven years throughout the life of the Project. Liquid and precipitated solids in the ponds would be exposed to the environment for an extended period with the associated need for groundwater monitoring. However, because the ponds would be lined and wildlife impacts would be carefully monitored (and measures taken to protect wildlife, if needed), potential pond impacts are considered minimal.

Alternatively, a mechanical ZLD system would concentrate the blowdown stream to produce a wet solid waste product that would require regular offsite truck transport to an appropriately permitted disposal facility. The ZLD system uses an external heat source (*e.g.,* steam or electricity) to evaporate the water. Within the ZLD system, the water removal and crystallization processes occur in closed vessels and systems, with the only outputs being wet solids which are removed and stored in containers prior to offsite disposal, and water which is sufficiently pure that it can be reintroduced as make up water to the power plant cooling system. The crystallizer has minimal potential for

groundwater impacts and wildlife exposure to ponds would not exist; thus, there would be no need for groundwater monitoring or wildlife protection measures. The crystallizer also would require less land area than evaporation ponds.

The crystallizer may use steam, but more likely would use electricity from the power plant and/or the power grid, due to the cycling nature of the solar plant compared with the continuous operation of the ZLD system. The reduction in plant energy output would be expected to be a fraction of the net plant output (*e.g.* ~one to two percent) in the summer and a significant percentage (up to 10 percent) in the winter. The mechanical ZLD requires significant amounts of electric power to drive the process, often in excess of 1 MW (*i.e.,* >24,000 kW-hr/day) depending on the system design. These demands reduce the available electrical output, decrease the overall thermal efficiency of the power facility, and likely would require energy purchase during the Project's non-power-generating hours. In comparison, the treatment with reverse osmosis (proposed design) or the softener-clarifier plus reverse osmosis (Alternative 3) with the waste being fed to evaporation ponds requires less required minimal electrical power and results in higher plant efficiency.

No significant environmental issues have been identified with either option. The evaporation ponds will be required to undergo a permitting review from the CRRWQCB for issuance of Waste Discharge Requirements (WDR) and will be required to meet stringent regulatory requirements in terms of construction, materials, leak detection, etc. to ensure appropriate protection to underlying groundwater. Water quality will be monitored in order to ensure minimal risk to birds.

The off-site truck transport of residual solids from the crystallizer (estimated annual average of two truckloads per week; one from each site) would involve ongoing air emissions and potential traffic impacts throughout the plant's operational life that would not occur with the evaporation ponds. Pond cleaning and sludge removal would occur at the end of approximately a seven-year cycle. Since the plant will operate daily and the ponds will have some amount of water at all times (except during maintenance), particulate emissions from the ponds will be minimal. The total solids generation will be the same for a crystallizer and for ponds; however, the solids from the crystallizer option would need to be trucked offsite regularly compared to the solids from the evaporation ponds, which would remain on site for approximately seven years until the subsequent evaporation pond cleaning. In comparison to the softener-clarifier option (Alternative 3), the process may require the addition of calcium salt (*e.g.* $CaCl_2$) to support the precipitation, and therefore contribute to the amount of solids generated from the process, resulting in increased costs for waste disposal for the life of the plant.

Table 3.10-3 compares the proposed post-treatment reverse osmosis unit and evaporation ponds to Alternative 1, which consists of a brine concentrator with evaporation ponds, and Alternative 2, which is a ZLD system containing a brine concentrator and a crystallizer but without evaporation ponds and a softener-clarifier with evaporation ponds (Note: each option includes a pre-treatment two-stage reverse osmosis unit).

Table 3.10-3. Comparison of Proposed Treatment with Alternatives 1 and 2

	Proposed Design	Alternative 1	Alternative 2	Alternative 3
	Reverse Osmosis and Evaporation Ponds	Brine Concentrator and Evaporation Ponds	ZLDS Brine Concentrator and Crystallizer	Softener-Clarifier WAC and Reverse Osmosis
Pre-treatment RO	YES	YES	YES	YES
Post-treatment RO	YES	NO	NO	YES
Brine Concentrator	NO	YES	YES	NO
Crystallizer	NO	NO	YES	NO
Evaporation Ponds	YES	YES	NO	YES
Evaporation Pond Costs	$11.8	80%	0%	100%
Capital Costs (excluding ponds)	$22.6	200%	230%	200%
Total Capital Installed Costs	$34.4	160%	230%	170%
Annual O&M Costs	$2.0	190%	310%	120%

Estimated Costs shown in $1,000,000 compared to Alternatives

Table 3.10-3 suggests the advantages of the proposed design compared to a waste treatment alternative using a brine concentrator (Alternative 1), or combining a brine concentrator and crystallizer (Alternative 2), or using a softener-clarifier (Alternative 3). First, the total capital cost for Alternative 1 is approximately 160 percent of the installed cost of the proposed design, while Alternative 2 is 230 percent of the installed cost, and Alternative 3 is 170 percent of the installed cost. Not only does the installed cost of the proposed design (reverse osmosis post-treatment) provide the benefit of a lower capital cost, it will continue to incur lower O&M cost throughout the life of the plant, primarily with respect to (1) the cost of power, and (2) the operator-intensive ZLD equipment. Alternative 1 and Alternative 2 both have brine concentrators, which require a significant amount of heat energy on a continuous basis, while in comparison the evaporation ponds require only the energy provided by the sun to enable evaporation. As well as requiring more energy, a brine concentrator would not be the optimal component to use in this particular application for reducing the volume of wastewater. The brine concentrator is used to concentrate salts until they reach their solubility limit, primarily for removal of $CaSO_4$ (calcium sulfate) from waste waters. The wastewater stream in this system has a relatively low concentration of calcium. As a result, calcium would need to be introduced into the system in the form of calcium chloride ($CaCl_2$) in order to precipitate $CaSO_4$. Complications can arise with a brine concentrator or ZLD system since these systems are better suited for base-load operation with relatively constant feed flows and constant heat sources. Similarly, complications and increased operator attention will be needed with a softener-clarifier due to the cycling of the unit from day to night and season-to-season. Reverse osmosis units are less sensitive to an operation that starts and stops, or changes flow rates frequently. Evaporation ponds eliminate potential problems that may occur with frequent or daily cycling of blowdown flow, as well as seasonal flow variations where winter flows may be less than 10 percent of summer flows. For a solar plant, this will require a high level of operator attention. When comparing the proposed design with Alternative 3, both systems can achieve approximately the same flow to the evaporation ponds.

However, Alternative 3 will be more operator intensive and will require the addition of chemicals, thus increasing the mass in the evaporation ponds.

Based on these constraints for Alternative 1, Alternative 2, and Alternative 3, as well as the higher cost, the proposed design is the best choice for this facility.

3.10.8 Alternative Power Generation Technologies

The Project would generate power by using concentrated solar thermal trough technology to produce high-pressure steam to drive a steam turbine generator. The following paragraphs discuss alternative power generation technologies and compare them to the proposed parabolic trough technology for the Project.

Alternative Solar Technologies

Several solar technologies exist, both on a large and small scale. Solar power can be harnessed using a variety of technologies, including photovoltaic technologies, power tower configuration, Stirling engine concepts, and Fresnel reflector based systems, as well as trough technologies.

- Photovoltaic (PV) technologies offer a relatively simple method of power conversion and have certain advantages over solar thermal technologies. Land required for the energy produced is often greater than with CSP, though designs and capital costs are generally higher, depending on location and specific site factors. However, operating costs and water usage for PV options are generally much lower, and large PV projects have a significantly different impact on transmission grid stability because of the potential for rapid change in output from the panels. Based on discussions with various potential customers for large solar projects, a strong preference for the comparatively predictable generation behavior of CSP was expressed, and as a result, solar trough was selected as a basis for development of the Project.
- Stirling engines operate on a thermodynamic that has been around since the early 19th century and utilizes a difference in temperature and is often referred to as an “external combustion engine.” The engine is located at the focal point of a dish shaped collector that may be created by a large dish or an array of smaller mirrors. To scale this technology, the entire system is repeated (multiple engines and collector arrays) many times. While this technology can offer higher thermal efficiencies than parabolic troughs because of higher operating temperatures, it involves more complex mechanical equipment and thus increased operational and maintenance difficulties. Also, using this technology for solar applications has not been proven on a commercial scale. The cost of power produced from this technology on a large scale is not well known and could approach several times the cost of power produced by solar trough mirror technology.
- Power tower configurations concentrate solar radiation on an elevated tower from a large field of mirrors surrounding the tower; facilities may have multiple fields of mirrors surrounding multiple towers. This approach can offer higher thermal efficiencies than parabolic trough technologies because the HTF used in the tower can reach higher temperatures, thus allowing a more efficient steam cycle. Also, most tower technologies do not deal well with the comparatively irregular land arrangement present at the site. Although the tower technology has a promising future, it is not as well proven as parabolic trough mirrors at this time.
- Lastley, there is another concentrating solar technology involving long flat reflectors, each moving on a single axis. Multiple reflectors are installed parallel to each other to create a virtual trough in a Fresnel pattern, all focusing on a set of tubes elevated above the mirrors. The mirrors concentrate the sun’s heat on water-filled pipes and convert the water directly to steam to drive a steam turbine

rather than collecting the heat in a high temperature fluid that then is used to generate steam, as is the case with parabolic trough mirrors. This Fresnel reflector technology results in lower efficiencies throughout the process, but with correspondingly expected lower costs of components. This technology is still under development and while promising, it has not been proven on a commercial scale or even as a stand-alone electrical producing pilot at this time.

To summarize, parabolic trough mirror technology was chosen for this Project primarily because it is the only well proven technology for this scale of power generation. Significant experience at the nine SEGS units takes much of the operational risk out of this technology. In addition, the recent resurge in solar thermal growth has been focused on this technology, including the completed construction and commercial operation of the Nevada Solar One unit. Futhermore, multiple parabolic trough projects are under construction in Spain. This new growth has also spawned the development of new sources for critical components in addition to the current manufacturers.

Other Renewable Technologies

As presented in Section 2.0, Project Objectives, one of the Project objectives is to develop a new utility-scale solar energy project; therefore no other renewable technologies were considered for this Project.

Non-Renewable Technologies

An objective of the Project is to support the State's policies/goals with respect to increasing the use of renewable energy sources. Fossil fuel technologies (simple cycle, combined cycle, advanced combustion turbine technologies, integrated gas combined cycle, fluidized bed boilers, etc.) by definition do not support these goals and objectives and thus were not considered as alternatives for the Project. Nuclear power also is not renewable energy and is prohibited by California law at present because of concerns about nuclear waste disposal.

3.11 DESIGN CRITERIA

3.11.1 Geotechnical and Geological Engineering

3.11.1.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of engineering geology systems for the Project. More specific Project information will be developed during execution of the Project to support detailed design, engineering, material procurement specifications, and construction specifications.

3.11.1.2 Codes and Standards

Unless specifically stated otherwise, the design of all structures and facilities will be based on the laws, ordinances, codes, specifications, industry standards and regulations, and other reference documents in effect at the time of design. Applicable codes and industry standards with respect to the Project's engineering geology will be provided within the Foundations and Civil Engineering Design Criteria and Structural and Seismic Engineering Design Criteria.

3.11.1.3 Earthwork

This section presents preliminary earthwork design recommendations for the Project. These recommendations will be updated after on-site exploratory borings are advanced on-site during the ongoing geotechnical investigation. Based upon the site reconnaissance, the soils encountered at the well site, and the geologic environment of the site, unusually weak, compressible or problematic soils are not expected to be a concern.

Earthwork

Grading for the Project will include, but is not limited to, earthwork to create level pad areas at each of the power blocks, the evaporation pond excavations and slopes, and the administration building/warehouse. Paved and unpaved roads and utility trenches will also be constructed, as well as a drainage berm along the north side of the Project area and drainage channels in selected areas of the site.

Remedial grading may be required below sensitive structures or pavements where loose, compressible, or expansive soils are encountered during the geotechnical investigation. The extent of the required remedial grading will be established during the ongoing geotechnical investigation.

Clearing and Subgrade Preparation

All deleterious materials, such as vegetation, root systems, etc., should be cleared from areas of the site to be built on, paved, or otherwise developed. Excavations that extend below finished grade should be backfilled with structural fill that is water-conditioned, placed, and compacted as recommended in the section of this report titled “Compaction.”

After the site has been properly cleared, stripped, and excavated to the required grades, exposed soil surfaces in areas to receive structural fill, structures, concrete slabs-on-grade or pavements should be scarified to a depth of six inches, moisture conditioned, and compacted as recommended for structural fill in the section of this report titled "Compaction."

Material for Fill

All on-site soil containing less than three percent organic material by volume (ASTM D2974) may be suitable for use as structural fill. Structural fill should not contain rocks or pieces larger than six inches in greatest dimension and no more than 15 percent larger than 2.5 inches. Imported soil and non-expansive fill should have a Plasticity Index no greater than 12, should be predominately granular, and should have sufficient binder so as not to slough or cave into foundation excavations or utility trenches.

Temporary Slopes and Excavations

The contractor should be responsible for the design and construction of all temporary slopes and any required shoring. Shoring and bracing should be provided in accordance with all applicable local, California, and Federal safety regulations, including current OSHA excavation and trench safety standards.

Because of the potential for variation of the on-site soils, field modification of temporary cut slopes may be required. Unstable materials encountered on slopes during and after excavation should be trimmed off even if this requires cutting the slopes back to a flatter inclination. Protection of structures near excavations and trenches will also be the responsibility of the contractor.

Finished Slopes

Finished slopes will be cut or filled to an inclination no steeper than 2:1 (horizontal:vertical). Finished slopes for the evaporation ponds, drainage channels, and berms should not exceed 3:1. Exposed slopes may be subject to minor sloughing and erosion that would require periodic maintenance.

Compaction

Scarified surface soils and all structural fill should be compacted in uniform lifts no thicker than eight inches in uncompacted thickness, conditioned to the appropriate moisture content, and compacted as recommended for structural fill in Table 3.11-1. The relative compaction and moisture content recommended in Table 3.11-1 is relative to American Society for Testing and Materials (ASTM) Test D1557, latest edition.

Table 3.11-1. Compaction Recommendations

	Relative Compaction*	Moisture Content*
General		
Scarified subgrade in areas to receive structural fill.	90 percent	At least 2 percent above optimum
Structural fill composed of native soil or non-expansive fill.	90 percent	At least 2 percent above optimum
Structural fill composed of expansive soil.	90 percent	At least 3 percent above optimum
Pavement Areas		
Upper 8-inches of soil below aggregate base.	95 percent	Above optimum
Aggregate base.	95 percent	Near optimum
Utility Trench Backfill		
On-site soil.	90 percent	At least 2 percent above optimum
Imported sand.	95 percent	Near optimum

Surface Drainage

Finished grades should be designed to prevent ponding of water and direct surface water runoff away from foundations, edges of slabs and pavements, and toward suitable collection and discharge points. Slopes of at least two percent are recommended. Preferably, water discharged from roof downspouts and other storm drain systems should be collected in closed pipes that are routed to the storm drain system or other suitable discharge locations. Drainage facilities should be observed to verify they are adequate and that no adjustments need to be made, especially during the first two years following construction.

Drainage facilities should be periodically checked to verify they are continuing to function properly. The drainage facilities will probably need to be periodically cleaned of silt and debris that may build up in the lines.

3.11.1.4 Preliminary Foundation Recommendations

This section presents preliminary foundation design recommendations for the Project. These recommendations will be updated after on-site exploratory borings are advanced on-site during the ongoing geotechnical investigation. Based upon site reconnaissance, the soils encountered at the well site, and the geologic environment of the site, unusually weak, compressible or problematic soils are not expected to be a concern.

The Project includes relatively heavy facilities in the power block areas, including the steam turbine/generator, cooling tower and other equipment or tanks that will likely require mat foundation support, possibly augmented by deep foundations where differential settlements are of concern.

Lightly to moderately loaded equipment and buildings likely can be supported on shallow foundations in the native alluvial soils or compacted fill where loose or expansive soils are present. Drilled pier foundations likely will be appropriate for the solar collectors and overhead piping and electrical infrastructure. The foundation criteria will be updated when exploratory borings are advanced within the Project limits during the ongoing geotechnical investigation.

Shallow Foundations

Lightly to moderately loaded buildings and equipment may be supported on continuous foundations bearing in undisturbed stiff/dense native soils or compacted structural fill. On a preliminary basis, footings should have a width of at least 24 inches and should extend at least 24 inches below exterior grade and at least 24 inches below the bottom of slab elevation, whichever is deeper. Footings with at least these minimum dimensions may be designed for an allowable bearing pressure of 2,500 pounds per square foot for combined dead plus live loads, with a one-third increase allowed when considering additional short-term wind or seismic loading. The weight of the footings may be neglected for design purposes.

Lateral loads will be resisted by friction between the bottom of the foundations and the supporting subgrade. A coefficient of friction of 0.3 may be assumed on a preliminary basis assuming granular soil or fill conditions. In addition, lateral resistance may be provided by passive soil pressure acting against the sides of foundations cast neat in the foundation excavations or backfilled with compacted structural fill. An equivalent fluid pressure of 250 pounds per cubic foot may be used for passive soil resistance, where appropriate. The upper foot of passive soil resistance should be neglected where soil adjacent to the footing will be landscaped or subject to softening from rainfall and/or surface water runoff.

Thirty-year differential settlement due to static loads is not expected to exceed ¾-inch along and between shallow foundations designed in accordance with the criteria presented above. The amount of total and differential settlement should be evaluated once structural loads and subsurface conditions are confirmed.

Mat Foundations

The steam turbine/generator, cooling tower and other structures where differential settlement is a concern may be supported on reinforced concrete mat foundations bearing on a properly prepared and compacted soil subgrade or on structural fill. An allowable bearing pressure of 3,000 to 4,000 pounds per square foot is expected to be appropriate for combined dead plus live loads with a one-third increase allowed when considering additional short term wind or seismic loading.

Mat foundations should be reinforced to provide structural continuity and permit spanning of local irregularities. The coefficient of friction and passive soil pressure recommended above for shallow foundations may also be used for mat foundations.

Total and differential settlement of mat foundations depends on the size of the mat, the structural load it supports, and the modulus of the supporting subgrade materials. Individual estimates of total and differential settlement will be developed during the ongoing geotechnical investigation. If the

estimated settlements are not tolerable, the mats could be supported with reinforced concrete piers or piles to reduce differential settlement.

Drilled Pier Foundation

The solar collectors and some of the overhead piping and electrical infrastructure will be supported on reinforced concrete pier foundations laid out in a grid pattern across the collection area. The lateral loading on the foundations is expected to be the controlling factor. Drilled piers are expected to be a practical foundation to construct at the site and to use for the solar collectors and overhead infrastructure and may also be used where total and differential settlement below shallow or mat foundations exceed equipment or structural tolerances. Recommended allowable vertical and lateral pier capacity will be developed during the ongoing geotechnical investigation.

Slabs On Grade

Concrete floor slabs, walkways, and exterior flatwork should be at least 4 inches thick and should be constructed on at least 6 inches of select fill or granular native soil. The actual thickness of the floor slabs will be determined by the structure engineer based on the loading and use of the slab. Exterior slabs-on-grade may be constructed with a thickened edge to improve edge stiffness where desired. It is expected that reinforced slabs will perform better than unreinforced slabs. Consideration should be given to using a control joint spacing on the order of 2 feet in each direction for each inch of slab thickness.

In areas where dampness of concrete floor slabs would be undesirable, such as within the administrative, warehouse, control and other building interiors, concrete slabs should be underlain by at least four inches of clean, free-draining gravel, such as ½- to ¾-inch clean crushed rock with no more than five percent passing the ASTM No. 200 sieve. Pea gravel should not be used for this capillary break material. The crushed rock layer should be densified and leveled with vibratory equipment. To reduce vapor transmission up through concrete floor slabs, the crushed rock section should be covered with a high-quality, ultraviolet (UV)-resistant membrane vapor barrier meeting the minimum ASTM E 1745, Class C requirements or better and preferably should be placed directly below the slab. All seams and penetrations of the vapor barrier should be sealed in accordance with manufacturer's recommendations. The crushed rock layer may be considered as the select fill recommended above.

3.11.1.5 Pavements

The Project will include asphaltic concrete pavements for the main traffic drives around and between each of the power block areas with unpaved roads used between the solar collectors and for maintenance and construction access. Some Portland Cement Concrete (PCC) pavements may be used locally for specific facilities or applications. Extensive cutting and filling is not anticipated.

Based on our review of the preliminary grading plan for the Project and the results of our site reconnaissance, it appears soils at the site are typically expected to consist of silty and clayey sands with some limited areas of moderately to highly plastic clay possible. An R-value of 40 was selected for use in pavement thickness design where the pavements will be supported on competent granular native soil and a design R-value of 15 for areas underlain by soils with significant silt or clay content. The pavement recommendations will be updated following advancing exploratory borings at the site during the ongoing geotechnical investigation. After rough grading to pavement subgrade elevation is completed, the R-value of the subgrade should be further evaluated and the final pavement section thicknesses confirmed.

Asphalt Concrete Pavement

Using a range of traffic indices selected to simulate the currently anticipated traffic loading, minimum pavement section thicknesses, presented in Tables 3.11-2 and 3.11-3 and based on Procedure 608 of the Caltrans Highway Design Manual, were selected. The minimum pavement section thicknesses shown on Table 3.11-2 assume the pavement subgrade will be composed of native soil. The pavement section thicknesses shown on Table 3.11-3 assume the pavement subgrade will be composed of weathered bedrock or imported soil with an R-value of at least 15.

The traffic indices used in our pavement thickness calculations are based on engineering judgment rather than a detailed analysis of future pavement loading conditions. The traffic indices of 9 and 10 that were selected for thickness design of the truck traffic isles assume 50 trucks per day and 100 trucks per day, respectively, throughout a 20-year pavement service life. The heavy truck traffic was assumed to be composed of 50 percent 4-axle trucks and 50 percent 5-axle trucks.

Asphalt concrete and aggregate base should conform to and be placed in accordance with the requirements of the Caltrans Standard Specifications, latest edition, except that compaction should be based on ASTM Test D1557.

Table 3.11-2. Minimum Asphalt Concrete Pavement Thicknesses

General Traffic Condition	Traffic Index (inches)	AC Thckness (inches)	Agrregate Base* (inches)	Total Section (inches)
Automobile Traffic Lanes	4.5	3.0	4.0	7.0
Occasional Fire Trucks	5.5	3.0	6.0	9.0
Truck Drive Isles	9.0	5.0	10.0	15.0

Design R-value = 40 (Competent Granular soil subgrade)
* Caltrans Class 2 Aggregate Base (minimum R-value = 78)

Table 3.11-3. Minimum Asphalt Concrete Pavement Thicknesses

General Trafic Condition	Traffic Index (inches)	AC Thckness (inches)	Agrregate Base* (inches)	Total Section (inches)
Automobile Traffic Lanes	4.5	3.0	7.0	10.0
Occasional Fire Trucks	5.5	3.0	10.0	13.0
Truck Drive Isles	9.0	5.5	17.0	22.5

Design R-value = 15 (subgrade soils with significant silt or clay content
* Caltrans Class 2 Aggregate Base (minimum R-value = 78)

Measures should be taken to limit the amount of surface water that seeps into the aggregate base and subgrade below vehicle pavements, particularly where the pavements are adjacent to bio-retention basins and landscaping. Seepage of water into the pavement base can soften the subgrade, thereby increasing the amount of pavement maintenance that is required and shortening the pavement service life. Deepened curbs extending at least four-inches into the subgrade below the aggregate base and subbase layers are generally effective in limiting excessive water seepage. Other types of water cutoff devices or edge drains may also be considered to maintain pavement service life.

Portland Cement Concrete Pavement

If PCC pavement will be used in areas to be occasionally driven on by fire trucks or other heavy vehicles, it is recommended the PCC pavement section be constructed at least seven inches thick on six inches of compacted Class 2 aggregate base on a properly prepared and compacted subgrade. This pavement section thickness is based on guidelines published by the Portland Cement Association and assumes concrete for the pavement will have a modulus of rupture of 550 psi, which roughly corresponds to a concrete compressive strength of 3,700 psi. Concrete pavement should have adequate construction joints and crack control joints. The geotechnical engineer will work with the design engineer to provide additional information and alternatives based on the expected traffic loading regarding the use of concrete pavements for this Project during the final geotechnical investigation.

3.11.1.6 Corrosion Potential Testing

Corrosion potential tests were performed on three surface samples of soil obtained across the site. All of the samples were tested for resistivity, pH, chloride content, sulfate content, and oxidation-reduction potential (ORP).

Resistivity of the lab-saturated soil samples measured in accordance with ASTM Test G57 ranged from 11,540 to 16,450 ohm-cm. ASTM STP 1013 titled “Effects of Soil Characteristics on Corrosion” indicates soil resistivity of 10,000 to >100,000 ohm-cm would classify soil as very mildly corrosive.

The pH of the soil samples ranged from 7.9 to 8.1. A pH between 5 and 8.5 is generally considered relatively passive from a corrosion standpoint. As ph increases, the soil is considered more alkaline and less corrosive. Chloride content was less than 2 mg/kg (ppm). The oxidation-reduction potential (Redox) ranged from 128 to 188 mv.

The water-soluble sulfate content of the samples that were tested in accordance with California Test Method 417-modified were measured to be <5 parts per million (<0.0005 percent by dry weight). Table 19A-A-4 of the California Building Code classifies a water-soluble sulfate content of 0.0 to 0.10 percent by dry weight as producing negligible sulfate exposure.

Additional testing should be performed during the geotechnical investigation to further investigate the corrosion potential. A corrosion specialist could be consulted for a more complete analysis and additional design recommendations.

3.11.2 Civil Engineering

3.11.2.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of civil engineering systems for the Project. More specific Project information will be developed during execution of the Project to support detailed design, engineering, material procurement specification and construction specifications.

3.11.2.2 Codes and Standards

The design of civil engineering systems for the Project will be in accordance with the laws and regulations of the Federal government, the State of California, and the Riverside County Code of Building Regulations. The current issue or edition of the documents at the time of filing this AFC will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

3.11.2.3 Civil Engineering Codes and Standards

The following codes and standards have been identified as applicable, in whole or in part, to civil engineering design and construction of power plants and related offsite improvements.

- American Association of State Highway and Transportation Officials (AASHTO)—Standards and Specifications
- American Concrete Institute (ACI) - Standards and Recommended Practices
- American Institute of Steel Construction (AISC) - Standards and Specifications
- American National Standards Institute (ANSI) - Standards
- American Society of Testing and Materials (ASTM) - Standards, Specifications, and Recommended Practices
- American Water Works Association (AWWA) - Standards and Specifications
- American Welding Society (AWS) - Codes and Standards
- Asphalt Institute (AI) - Asphalt Handbook
- Riverside County Flood and Water Conservation District Hydrology Manual
- State of California Department of Transportation (CALTRANS) Standard Specification
- State of California Department of Transportation (CALTRANS) Highway Design Manual
- American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railroad Engineering
- California Energy Commission - Recommended Seismic Design Criteria for Non-Nuclear Generating Facilities in California, 1989
- Concrete Reinforcing Steel Institute (CRSI) - Standards
- Factory Mutual (FM) - Standards
- National Fire Protection Association (NFPA) - Standards
- California Building Standards Code (CBC) 2007
- Steel Structures Painting Council (SSPC) - Standards and Specifications

3.11.3 Structural Engineering

3.11.3.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of structural engineering systems for the Project. More specific Project information will be developed during execution of the Project to support detail design, engineering, material procurement specification and construction specifications.

3.11.3.2 Codes and Standards

The design of structural engineering systems for the Project will be in accordance with the laws and regulations of the Federal government, the State of California, Riverside County ordinances, and the industry standards. The current issue or edition of the documents at the time of filing of this AFC will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

The following codes and standards have been identified as applicable, in whole or in part, to structural engineering design and construction of power plants.

- California Building Code (CBC), 2007 Edition
- American Institute of Steel Construction (AISC):
  - Manual of Steel Construction—13th Edition
  - Specification for Structural Steel Buildings—AISC 360-05
  - Specification for Structural Joints Using ASTM A325 or A490 Bolts
  - Code of Standard Practice for Steel Buildings and Bridges –AISC 303-05
  - Seismic Provisions for Structural Steel Buildings – AISC 341-05
- American Concrete Institute (ACI):
  - ACI 318-05, Building Code Requirements for Structural Concrete
  - ACI 301-05, Specifications for Structural Concrete
  - ACI 543R-00, Design, Manufacture, and Installation of Concrete Piles
- American Society of Civil Engineers (ASCE):
  - ASCE 7-05, Minimum Design Loads for Buildings and Other Structures
- American Welding Society (AWS):
  - D1.1—Structural Welding Code—Steel
  - D1.3—Structural Welding Code—Sheet Steel
- Code of Federal Regulations, Title 29—Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA).
  - Part 1910—Occupational Safety and Health Standards.
  - Part 1926—Construction Safety and Health Regulations
- National Association of Architectural Metal Manufacturers (NAAMM)—Metal Bar Grating Manual.
- Hoist Manufacturers Institute (HMI), Standard Specifications for Electric Wire Rope Hoists (HMI 100).
- National Electric Safety Code (NESC), C2-1993
- National Fire Protection Association (NFPA Standards).
  - NFPA 850 Fire Protection for Electric Generating Plants.
- OSHA Williams-Steiger Occupational Safety and Health Act of 1970.
- Steel Deck Institute (SDI)—Design Manual for Floor Decks and Roof Decks.

3.11.3.3 CEC Special Requirements

Prior to the start of any increment of construction, the proposed lateral-force procedures for Project structures and the applicable designs, plans and drawings for Project structures will be submitted for approval.

- Proposed lateral-force procedures, designs, plans, and drawings
- Major project structures
- Major foundations, equipment supports, and anchorage

- Large, field-fabricated tanks
- Switchyard structures

3.11.3.4 Structural Design Criteria

Datum

Site topographic elevations will be based on an elevation survey conducted using known elevation benchmarks.

Frost Penetration

The site is located in an area free of frost penetration. However, bottom elevation of all foundations for structures and equipment will be maintained at a minimum of 12 inches below the finished grade.

3.11.3.5 Design Loads

General

Design loads for structures and foundations will comply with all applicable building code requirements.

Dead Loads

Dead loads will consist of the weights of structure and all equipment of a permanent or semi-permanent nature including tanks, bins, wall panels, partitions, roofing, drains, piping, cable trays, bus ducts, and the contents of tanks and bins measured at full operating capacity. However, the contents of the tanks and bins will not be considered as effective in resisting structure uplift due to wind forces, but will be considered as effective for seismic forces.

Live Loads

Live loads will consist of uniform floor live loads and equipment live loads. Uniform live loads are assumed equivalent unit loads that are considered sufficient to provide for movable and transitory loads, such as the weights of people, portable equipment and tools, small equipment or parts, which may be moved over or placed on the floors during maintenance operations and planking. The uniform live loads will not be applied to floor areas that will be permanently occupied by equipment.

Lateral earth pressures, hydrostatic pressures, and wheel loads from trucks will be considered as live loads.

Uniform live loads will be in accordance with ASCE Standard 7, but will not be less than the following:

- Roofs 20 pounds per square foot (psf)
- Floors and Platforms (steel grating and checkered plates) 100 psf

In addition, a uniform load of 50 psf will be used to account for piping and cable trays. However, where the piping and cable loads exceed 50 psf, the actual loads will be used.

Furthermore, a concentrated load of 5 kips will be applied non-concurrently to the supporting beams of the floors to maximize stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

- Floors (elevated concrete floors) 100 psf

In addition, elevated concrete slabs will be designed to support an alternate concentrated load of two kips in lieu of the uniform loads, whichever governs. The concentrated load will be treated as a uniformly distributed load acting over an area of 2.5 square feet, and will be located in a manner to produce the maximum stress conditions in the slabs.

- Control Room Floor 150 psf
- Stairs, Landings, and Walkways 100 psf

In addition, a concentrated load of one kip will be applied non-concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

- Pipe Racks 50 psf

Where the piping and cable tray loads exceed the design uniform load, the actual loads will be used. In addition, a concentrated load of 8 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

- Hand Railings

Hand railings will be designed for either a uniform horizontal force of 20 pounds per linear foot (plf) applied in any direction, or a 200-pound concentrated load applied at any point and in any direction, whichever governs.

- Slabs on Grade 250 psf
- Truck Loading Surcharge Adjacent to Structures 250 psf
- Truck Support Structures AASHTO-HS-20-44
- Special Loading Conditions Actual loadings

Laydown loads from equipment components during maintenance and floor areas where trucks, forklifts, or other transports have access, will be considered in the design of live loads.

Live loads may be reduced in accordance with the provisions of CBC Section 1607.

Posting of the floor load capacity signs for all roofs, elevated floors, platforms and walkways will be in compliance with the OSHA Occupational Safety and Health Standard, Walking and Working Surfaces, Subpart D. Floor load capacity for slabs on grade will not be posted.

Earth Pressures

Earth pressures will be in accordance with the recommendations contained in the Project-specific geotechnical report.

Groundwater Pressures

Hydrostatic pressures due to groundwater or temporary water loads will be considered.

Wind Loads

The wind forces will be calculated in accordance with CBC 2007, Chapter 16 with a basic wind speed of 85 miles per hour (mph), an Importance Factor of 1.15 and an exposure category of “C.”

Seismic Loads

Structures will be designed and constructed to resist the effects of earthquake loads as determined in CBC 2007, Section 1613 and applicable sections of ASCE 7-05. The occupancy category of all the structures is III. The Importance Factor (I) is 1.25 for all the structures except those related to fire safety and hazardous materials; the importance for theses structures is 1.50. Other seismic parameters are summarized on a preliminary basis in Section 5.4 and will be obtained from the Project geotechnical report.

Snow Loads

Snow loads will not be considered.

Turbine-Generator Loads

The steam turbine-generator loads for foundation design will be furnished by the equipment manufacturers, and applied in accordance with the equipment manufacturers' specifications, criteria, and recommendations.

Special Considerations for Steel Stacks

Steel stacks will be designed to withstand the normal and abnormal operating conditions in combination with wind loads and seismic loads, and will include the along-wind and across-wind effects on the stacks. The design will meet the requirements of ASME/ANSI STS-1-1992, "Steel Stacks," using allowable stress design method, except increased allowable stress for wind loads as permitted by AISC will not be used.

Special Considerations for Structures and Loads during Construction

For temporary structures, or permanent structures left temporarily incomplete to facilitate equipment installations, or temporary loads imposed on permanent structures during construction, the allowable stresses may be increased by 33 percent.

Structural backfill may be placed against walls, retaining walls, and similar structures when the concrete strength attains 80 percent of the design compressive strength (f'_c), as determined by sample cylinder tests. Restrictions on structural backfill, if any, will be shown on the engineering design drawings.

Design restrictions imposed on construction shoring removal that are different from normal practices recommended by the ACI Codes will be shown on engineering design drawings.

Metal decking used as forms for elevated concrete slabs will be evaluated to adequately support the weight of concrete plus a uniform construction load of 50 psf, without increase in allowable stresses.

3.11.3.6 Design Bases

General

Reinforced concrete structures will be designed by the strength design method, in accordance with the CBC and ACI 318, "Building Code Requirements for Structural Concrete."

Steel structures will be designed by the working stress method, in accordance with the CBC and the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

Allowable soil bearing pressures for foundation design will be in accordance with the "Final Subsurface Investigation and Foundation Report" for the Facility.

Factors of Safety

The factor of safety for all structures, tanks, and equipment supports will be as follows:

Against Overturning	1.50
Against Sliding	1.50 for Wind Loads
	1.10 for Seismic Loads
Against Uplift Due to Wind	1.50
Against Buoyancy	1.25

Allowable Stresses

Calculated stresses from the governing loading combinations for structures and equipment supports will not exceed the allowable limits permitted by the applicable codes, standards, and specifications.

Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the strength design equations will be determined based on CBC 2007 and ACI-318-05. The Allowable Stress Design load combinations of CBC 2007 will be used to assess soil bearing pressure and stability of structures per CBC 2007.

Steel-framed structures will be designed in accordance with CBC 2007 and the AISC Specification for the Structural Steel Buildings. Connections will conform to Research Council on Structural Connections of the Engineering Foundation Specification for Structural Joints.

3.11.3.7 Construction Materials

Concrete and Grout

The design compressive strength (f'_c) of concrete and grout, as measured at 28 days, will be (minimum) as follows:

Electrical ductbank encasement and lean concrete backfill (Class L-1)	500 psi
Structural concrete (Class S-1)	3000 psi
Structural concrete (Class S-2)	4000 psi
Grout (Class G-1)	5000 psi

The classes of concrete and grout to be used will be shown on engineering design drawings or indicated in design specifications.

Reinforcing Steel

Reinforcing steel bars for concrete will be deformed bars of billet steel, conforming to ASTM A 615, Grade 60.

Welded wire fabric for concrete will conform to ASTM A 185.

Structural and Miscellaneous Steel

Structural and miscellaneous steel will generally conform to ASTM A 36, ASTM A 572, or ASTM A992 except in special situations where higher strength steel is required.

High strength structural bolts, including nuts and washers, will conform to ASTM A 325 or ASTM A 490.

Bolts other than high-strength structural bolts will conform to ASTM A307, Grade A.

Concrete Masonry

Concrete masonry units will be hollow, normal weight, non-load bearing Type I, conforming to ASTM C 129.

Mortar will conform to ASTM C 270, Type S.

Grout will conform to ASTM C 476.

Other Materials

Other materials for construction, such as anchor bolts, shear connectors, concrete expansion anchors, embedded metal, etc., will conform to industry standards and identified on engineering design drawings or specifications.

3.11.4 Mechanical Engineering

3.11.4.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of mechanical engineering systems for the Project. More specific Project information will be developed during execution of the Project to support detailed design, engineering, material procurement specifications, and construction specifications.

3.11.4.2 Codes and Standards

The design of the mechanical systems and components will be in accordance with the laws and regulations of the Federal government, State of California, Riverside County ordinances, and industry standards. The current issue or revision of the documents at the time of the filing of this AFC will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirements will apply.

The following codes and standards are applicable to the mechanical aspects of the power facility.

- California Building Standards Code, 2001
- American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code
- ASME/ANSI B31.1 Power Piping Code
- ASME Performance Test Codes
- ASME Standard TDP-1
- American National Standards Institute (ANSI) B16.5, B16.34, and B133.8
- American Boiler Manufacturers Association (ABMA)
- American Gear Manufacturers Association (AGMA)
- Air Moving and Conditioning Association (AMCA)
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- American Welding Society (AWS)
- Cooling Tower Institute (CTI)

- Heat Exchange Institute (HEI)
- Manufacturing Standardization Society (MSS) of the Valve and Fitting Industry
- National Fire Protection Association (NFPA)
- Hydraulic Institute Standards (HIS)
- Tubular Exchanger Manufacturer's Association (TEMA)

3.11.4.3 Mechanical Engineering General Design Criteria

General

The systems, equipment, materials, and their installation will be designed in accordance with the applicable codes; industry standards; and local, State, and Federal regulations, as well as the design criteria; manufacturing processes and procedures; and material selection, testing, welding, and finishing procedures specified in this section.

Detailed equipment design will be performed by the equipment vendors in accordance with the performance and general design requirements to be specified later by the Project A/E firm. Equipment vendors will be responsible for using construction materials suited for the intended use.

Materials

Asbestos will not be used in the materials and equipment supplied. Where feasible, materials will be selected to withstand the design operating conditions, including expected ambient conditions, for the design life of the plant. It is anticipated some materials will require replacement during the life of the plant due to corrosion, erosion, etc.

Pumps

Pumps will be sized in accordance with industry standards. Where feasible, pumps will be selected for maximum efficiency and reliability at the normal operating point. Pumps will be designed to be free from excessive vibration throughout the operating range.

Tanks

Large outdoor storage tanks will not be insulated except where required to maintain appropriate process temperatures or for personnel protection. Overflow connections and lines will be provided. Maintenance drain connections will be provided for complete tank drainage.

Manholes, where provided, will be at least 24 inches in diameter and hinged to facilitate removal. Storage tanks will have ladders and cleanout doors as required to facilitate access/maintenance. Provisions will be included for proper tank ventilation during internal maintenance.

Heat Exchangers

The surface condenser will be designed in accordance with HEI standards. Other heat exchangers will be provided as components of mechanical equipment packages and may be shell-and-tube or plate type. Heat exchangers will be designed in accordance with TEMA or manufacturer's standards. Fouling factors will be specified in accordance with TEMA.

Pressure Vessels

Pressure vessels will include the following features/appurtenances:

- Process, vent, and drain connections for startup, operation, and maintenance.
- Materials compatible with the fluid being handled.
- A minimum of one manhole and one air ventilation opening (*e.g.,* handhole) where required for maintenance or cleaning access.
- For vessels requiring insulation, shop-installed insulation clips spaced not greater than 18 inches on center.
- Relief valves in accordance with the applicable codes.

Piping and Piping Supports

Stainless steel pipe may be Schedule 10S where design pressure permits. Underground piping may be high-density polyethylene (HDPE) or polyvinyl chloride (PVC) where permitted by code, operating conditions, and fluid properties. In general, water system piping will be HDPE or PVC where embedded or underground and carbon steel where aboveground. Appropriately lined and coated carbon steel pipe may alternately be used for buried water piping.

Threaded joints will not normally be used in piping used for lubricating oil and natural gas service. Natural gas piping components will not use synthetic lubricants. Victaulic, or equal, couplings may be used for low-energy aboveground piping, where feasible.

Piping systems will have high-point vents and low-point drains. Drains with restricting orifices or steam traps with start-up and blowdown drains and strainers will be installed in low points of steam lines where condensate can collect during normal operation.

Steam piping systems and steam drain lines in the plant will typically be sloped in the direction of steam flow. Condensate collection in piping systems will be avoided by installing automatic drain devices and manual devices as appropriate.

Steam lines fitted with restricting devices, such as orifices in the process runs, will include adequate drainage upstream of the device to prevent condensate from collecting in lines.

Hose and process tubing connections to portable components and systems will be compatible with the respective equipment suppliers' standard connections for each service.

Stainless steel piping will be used for portions of the lubricating oil system downstream of the filters. Carbon steel piping may be used elsewhere.

3.11.4.4 Valves

General Requirements

Valves will be arranged for convenient operation from floor level where possible and, if required, will have extension spindles, chain operators, or gearing. Hand-actuated valves will be operable by one person. Gear operators will be provided on manual valves eight inches or larger.

Valves will be arranged to close when the handwheel is rotated in a clockwise direction when looking at the handwheel from the operating position. The direction of rotation to close the valve will be clearly marked on the face of each handwheel.

The stops that limit the travel of each valve in the open or closed position will be arranged on the exterior of the valve body. Valves will be fitted with an indicator to show whether they are open or closed; however, only critical valves will be remotely monitored for position.

Valve materials will be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Steel valves will have cast or forged steel spindles. Seats and faces will be of low-friction, wear-resistant materials. Valves in throttling service will be selected with design characteristics and of materials that will resist erosion of the valve seats when the valves are operated partly closed.

Valves operating at less than atmospheric pressure will include means to prevent air in-leakage. No provisions will be made to repack valve glands under pressure.

Drain and Vent Valves and Traps

Drains and vents in 600-pound class or higher piping and 900ºF or higher service will be double-valved.

Drain traps will include air cocks and easing mechanisms. Internal parts will be constructed from corrosion-resistant materials and will be renewable.

Trap bodies and covers will be cast or forged steel and will be suitable for operating at the maximum working pressure and temperature of the piping to which they are connected. Traps will be piped to drain collection tank or sumps and returned to the cycle if convenient.

Low Pressure Water Valves

Low-pressure water valves will be the butterfly type of cast iron construction. Ductile iron valves will have ductile iron bodies, covers, gates (discs), and bridges; the spindles, seats, and faces will be bronze. Fire protection valves will be UL-approved butterfly valves meeting NFPA requirements.

Instrument Air Valves

Instrument air valves will be the ball type of bronze construction, with valve face and seat of approved wear-resistant alloy.

Nonreturn Valves

Nonreturn valves for steam service will be in accordance with ANSI standards and properly drained. Nonreturn valves in vertical positions will have bypass and drain valves. Bodies will have removable access covers to enable the internal parts to be examined or renewed without removing the valve from the pipeline.

Motor-Actuated Valves

Electric motor actuators will be designed specifically for the operating speeds, differential and static pressures, process line flowrates, operating environment, and frequency of operations for the application. Electric actuators will have self-locking features. A handwheel and declutching mechanism will be provided to allow handwheel engagement at any time except when the motor is energized. Actuators will automatically revert back to motor operation, disengaging the handwheel, upon energizing the motor. The motor actuator will be placed in a position relative to the valve that prevents leakage of liquid, steam, or corrosive gas from valve joints onto the motor or control equipment.

Safety and Relief Valves

Safety valves and/or relief valves will be provided as required by code for pressure vessels, heaters, and boilers. Safety and relief valves will be installed vertically. Piping systems that can be over-pressurized by a higher-pressure source will also be protected by pressure-relief valves. Equipment or parts of equipment that can be over-pressurized by thermal expansion of the contained liquid will have thermal relief valves.

Instrument Root Valves

Instrument root valves will be specified for operation at the working pressure and temperature of the piping to which they are connected. Test points and sample lines in systems that are 600-pound class or higher service will be double-valved.

3.11.4.5 Heating, Ventilating, and Air Conditioning (HVAC)

HVAC system design will be based on site ambient conditions.

Except for the HVAC systems serving the control room, maintenance shop, lab areas, and administration areas, the systems will not be designed to provide comfort levels for extended human occupancy.

Air conditioning will include both heating and cooling of the inlet-filtered air. Air velocities in ducts and from louvers and grills will be low enough not to cause unacceptable noise levels in areas where personnel are normally located.

Fans and motors will be mounted on an anti-vibration base to isolate the units from the building structure. Exposed fan outlets and inlets will be fitted with guards. Wire guards will be specified for belt-driven fans and arranged to enclose the pulleys and belts.

Air filters will be housed in a manner that facilitates removal. The filter frames will be specified to pass the air being handled through the filter without leakage.

Ductwork, filter frames, and fan casings will be constructed of mild steel sheets stiffened with mild steel flanges and galvanized. Ductwork will be the sectional bolted type and will be adequately supported. Duct joints will be leaktight.

Grills and louvers will be of adjustable metal construction.

3.11.4.6 Thermal Insulation and Cladding

Parts of the facility requiring insulation to reduce heat loss or afford personnel safety will be thermally insulated. Minimum insulation thickness for hot surfaces near personnel will be designed to limit the outside lagging surface temperature to a maximum of 140°F.

The thermal insulation will have as its main constituent calcium silicate, foam glass, fiber glass, or mineral wool, and will consist of pre-formed slabs or blankets, where feasible. Asbestos-containing materials are prohibited. An aluminum jacket or suitable coating will be provided on the outside surface of the insulation. Insulation system materials, including jacketing, will have a flame spread rating of 25 or less when tested in accordance with ASTM E 84.

Insulation at valves, pipe joints, steam traps, or other points to which access may be required for maintenance will be specified to be removable with a minimum of disturbance to the pipe insulation. At each flanged joint, the molded material will terminate on the pipe at a distance from the flange

equal to the overall length of the flange bolts to permit their removal without damaging the molded insulation. Outdoor aboveground insulated piping will be clad with textured aluminum of not less than 30 mil. thickness and frame-reinforced. At the joints, the sheets will be sufficiently overlapped and caulked to prevent moisture from penetrating the insulation. Steam trap stations will be “boxed” for ease of trap maintenance.

Design temperature limits for thermal insulation will be based on system operating temperature during normal operation. Outdoor and underground insulation will be moisture-resistant.

3.11.4.7 Testing

Hydrostatic testing, including pressure testing at 1.5 times the design pressure, or as required by the applicable code, will be specified and performed for pressure boundary components where an in-service test is not feasible or permitted by code.

3.11.4.8 Welding

Welders and welding procedures will be certified in accordance with the requirements of the applicable codes and standards before performing any welding. Records of welder qualifications and weld procedures will be maintained.

3.11.4.9 Painting

Except as otherwise specified, equipment will receive the respective manufacturer’s standard shop finish. Finish colors will be selected from among the paint manufacturer’s standard colors.

Finish painting of uninsulated piping will be limited to that required by OSHA for safety or protection from the elements. Piping to be insulated will not be finish painted.

3.11.4.10 Lubrication

The types of lubrication specified for facility equipment will be suited to the operating conditions and comply with the recommendations of the equipment manufacturers.

The initial startup charge of flushing oil will be the equipment manufacturer’s standard lubricant for the intended service. Subsequently, such flushing oil will be sampled and analyzed to determine whether it can also be used for normal operation or must be replaced in accordance with the equipment supplier’s recommendations.

Rotating equipment will be lubricated as designed by the individual equipment manufacturers. Oil cups will be specified. Where automatic lubricators are fitted to equipment, provision for emergency hand lubrication will also be specified. Where applicable, equipment will be designed to be manually lubricated while in operation without the removal of protective guards. Lubrication filling and drain points will be readily accessible.

3.11.5 Electrical Engineering

3.11.5.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of electrical engineering systems for the Project. More specific Project information will be developed during execution of the Project to support detailed design, engineering, material procurement specification, and construction specifications.

3.11.5.2 Codes and Standards

The design of the electrical systems and components will be in accordance with the laws and regulations of the Federal government and the State of California, Riverside County ordinances, and industry standards. The current issue or revision of the documents at the time of filing this AFC, will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirement will apply.

The following codes and standards are applicable to the electrical aspects of the power facility:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Anti-Friction Bearing Manufacturers Association (AFBMA)
- California Building Standards Code 2001
- California Electrical Code 1998
- Insulated Cable Engineers Association (ICEA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Illuminating Engineering Society (IES)
- National Association of Corrosion Engineers (NACE)
- National Electrical Code (NEC)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- Underwriters Laboratories, Inc. (UL)

3.11.5.3 Switchyard

The Project consists of two solar trough power plants which will tie into a 230 kV on-site switchyard, as shown in Figure 3.4-3. The plant has steam turbine generators that will connect to the switchyard via GSUTs, generator circuit breakers, and high voltage switchyard breakers. The generator and generator circuit breaker will conform to IEEE C50.13 and IEEE C37.013 standards, respectively. A disconnect switch will be included with the generator circuit breaker for generator disconnect and transformer maintenance. Isolated phase bus duct will connect the generator to the generator circuit breaker and the generator circuit breaker to the GSUT. The high-voltage disconnect switches and bus will conform to IEEE C37.32-2002.

The Project switchyard will be located near the power block for unit two and will require an overhead line for the connection to the GSUTs. The high voltage circuit breaker and switchyard protection scheme will conform to IEEE C37 standards. All instrument transformers associated with the Project will comply with IEEE 57.13. The design and construction of the plant switchyard will conform to all applicable codes and standards including, but not limited to IEEE 1127, 1267, 1427, and 1527 and the NESC.

A grounding grid will be provided to control step and touch potentials in accordance with IEEE Standard 80, Safety in Substation Grounding. Metallic equipment, structures, and fencing will be connected to the grounding grid. The ground grid will consist of buried conductors and ground rods that will be installed as required for personnel safety. The substation ground grid will be tied to the plant ground grid.

Lightning protection will be provided by shield wires or lightning masts and surge arrestors. The lightning protection system will be designed in accordance with IEEE 998 guidelines.

All faults will be detected, isolated, and cleared in a safe and coordinated manner as soon as practical to ensure the safety of equipment, personnel, and the public. Protective relaying will meet IEEE C37 requirements for each piece of equipment and be coordinated with the utility.

Revenue metering will be provided on the switchyard bus to record net power to or from the Project switchyard. Meters and a metering panel will be provided. Metering will conform to IEEE C51.1 and utility standards.

3.11.5.4 Transformers

The generators will be connected to the Project switchyard through the GSUT and the UAT will supply the plant loads. The alternate back-feed transformer will supply non-operational loads when it is necessary. These transformers will be designed in accordance with ANSI C57 standards.

3.11.6 Control Systems Engineering

3.11.6.1 Introduction

This section summarizes the codes, standards, criteria, and practices that will be generally used in the design and installation of instrumentation and controls for the Project. More specific Project information will be developed during execution of the Project to support detailed design, engineering, material procurement specification and construction specifications.

3.11.6.2 Codes and Standards

The design specification of all work will be in accordance with the laws and regulations of the Federal government, the State of California, and local codes and ordinances. A summary of general codes and industry standards applicable to design and control aspects of the power facility follows:

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- The Institute of Electrical and Electronics Engineers (IEEE)
- International Society of Automation (ISA)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- American Society for Testing and Materials (ASTM)

3.11.6.3 Control Systems Design Criteria

General Requirements

The Plant Control System (PCS) will be a fully integrated, flexible, and expandable microprocessor-based control and data information management system. The PCS will monitor, control, display, alarm, record, and trend all assigned plant inputs and outputs as described in this section. Each of the system's functional processors will be a configurable unit programmed to execute a specific dedicated task using available advanced applications software. The control system will be capable of performing coordinated modulating control and sequential logic in all plant process areas.

The system will have a distributed architecture based on industry standard technology including field bus technology. The PCS will control the system controller or intelligent field device. The system will

be capable of interfacing with local analog and discrete I/O, field busses, smart devices, and Device Busses such as Profibus and DeviceNet.

Pressure Instruments

In general, pressure instruments will have linear scales with units of measurement in pounds per square inch, gauge (psig).

Pressure gauges will have either a blowout disk or a blowout back and an acrylic or shatterproof glass face.

Pressure gauges on process piping will be resistant to plant atmospheres.

Siphons will be installed on pressure gauges in steam service as required by the system design. Steam pressure-sensing transmitters or gauges mounted above the steam line will be protected by a loop seal.

Pressure test points will have isolation valves and caps or plugs. Pressure devices on pulsating services will have pulsation dampers.

Temperature Instruments

In general, temperature instruments will have scales with temperature units in degrees Fahrenheit. Exceptions to this are electrical machinery resistance temperature detectors (RTDs) and transformer winding temperatures, which are in degrees Celsius.

Bimetal-actuated dial thermometers will have 4.5- or 5-inch-diameter (minimum) dials and white faces with black scale markings and will consist of every angle-type. Dial thermometers will be resistant to plant atmospheres.

Temperature elements and dial thermometers will be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points will have thermowells and caps or plugs.

RTDs will be a 100-ohm platinum, 3-wire type. The element will be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly.

Thermocouples will be Type J or K dual-element, grounded, spring-loaded, for general service. Materials of construction will be dictated by service temperatures. Thermocouple heads will be the cast type with an internal grounding screw.

Level Instruments

Reflex-glass or magnetic level gauges will be used. Level gauges for high-pressure service will have suitable personnel protection.

Gauge glasses used in conjunction with level instruments will cover a range that includes the highest and lowest trip/alarm set points.

Flow Instruments

Flow transmitters will typically be the differential pressure-type with the range similar to that of the primary element. In general, linear scales will be used for flow indication and recording.

Magnetic flow transmitters may be used for liquid flow measurement below 200 degrees F.

Control Valves

Control valves in throttling service will generally be the globe-body cage type with body materials, pressure rating, and valve trims suitable for the service involved. Other style valve bodies (*e.g.,* butterfly, eccentric disk) may also be used when suitable for the intended service.

Valves will be designed to fail in a safe position.

Control valve body size will not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping.

Control valves in 600-Class service and below will be flanged where economical. Where flanged valves are used, minimum flange rating will be ANSI 300 Class.

Critical service valves will be defined as ANSI 900 Class and higher in valves of sizes larger than two inches.

Severe service valves will be defined as valves requiring anticavitation trim, low noise trim, or flashing service, with differential pressures greater than 100 pounds per square inch (psi).

In general, control valves will be specified for a noise level no greater than 90 decibel A rated (dBA) when measured three feet downstream and three feet away from the pipe surface.

Valve actuators will use positioners and the highest pressure, smallest size actuator, and will be the pneumatic-spring diaphragm or piston type. Actuators will be sized to shutoff against at least 110 percent of the maximum shutoff pressure and designed to function with instrument air pressure ranging from 80 to 125 psig.

Handwheels will be furnished only on those valves that can be manually set and controlled during system operation (to maintain plant operation) and do not have manual bypasses.

Control valve accessories, excluding controllers, will be mounted on the valve actuator unless severe vibration is expected.

Solenoid valves supplied with the control valves will have Class H coils. The coil enclosure will normally be a minimum of NEMA 4 but will be suitable for the area of installation. Terminations will typically be by pigtail wires.

Valve position feedback (with input to the DCS for display) will be provided for all control valves.

Instrument Tubing and Installation

Tubing used to connect instruments to the process line will be stainless steel for primary instruments and sampling systems.

Instrument tubing fittings will be the compression type. One manufacturer will be selected for use and standardized as much as practical throughout the plant.

Differential pressure (flow) instruments will be fitted with three-valve manifolds; two-valve manifolds will be specified for other instruments as appropriate.

Instrument installation will be designed to correctly sense the process variable. Taps on process lines will be located so sensing lines do not trap air in liquid service or liquid in gas service. Taps on

process lines will be fitted with a shutoff (root or gauge valve) close to the process line. Root and gauge valves will be main-line class valves.

Instrument tubing will be supported in both horizontal and vertical runs as necessary. Expansion loops will be provided in tubing runs subject to high temperatures. The instrument tubing support design will allow for movement of the main process line.

Pressure and Temperature Switches

Field-mounted pressure and temperature switches will have either NEMA Type 4 housings or housings suitable for the environment.

In general, switches will be applied such that the actuation point is within the center one third of the instrument range.

Field-Mounted Instruments

Field-mounted instruments will be of a design suitable for the area in which they are located. They will be mounted in areas accessible for maintenance and relatively free of vibration and will not block walkways or prevent maintenance of other equipment.

Field-mounted instruments will be grouped on racks. Supports for individual instruments will be prefabricated, off-the-shelf, 2-inch pipestand. Instrument racks and individual supports will be mounted to concrete floors, platforms, or on support steel in locations not subject to excessive vibration.

Individual field instrument sensing lines will be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected.

Liquid level controllers will generally be the non-indicating, displacement-type with external cages.

Instrument Air System

Branch headers will have a shutoff valve at the takeoff from the main header. The branch headers will be sized for the air usage of the instruments served, but will be no smaller than 3/8 inch. Each instrument air user will have a shutoff valve, filter, outlet gauge, and regulator at the instrument.

3.12 REFERENCES

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