SECTION 2.0

Project Description

The Rice Solar Energy Project (RSEP) is a 150-megawatt (MW) concentrating solar thermal power project with a central receiver tower, sun-tracking heliostat field and an integral thermal storage system using liquid salt as the heat transfer and storage medium. When electricity is to be generated, the heated salt will be routed to a steam generation system, which generates steam for use in a high-efficiency reheat steam turbine cycle. The RSEP has elected to use dry cooling technology for the steam turbine cycle using an air-cooled condenser (ACC). RSEP's maximum total project water consumption will be approximately 180 acre-feet per year.

Section 2.1 provides a general overview of RSEP's technology and energy generation process. Section 2.2 covers the generating facility description, design, and operation. The engineering information is provided in Section 2.3. Section 2.4 discusses facility closure. Discussions of the applicable laws, ordinances, regulations, and standards (LORS) are included in each discipline section in the environmental report (Section 5.0), and also Section 3.0, Electrical Transmission.

2.1 Technology Overview

RSE's concentrating solar power (CSP) technology generates power from sunlight by focusing energy onto a tower-mounted central receiver, using an integral thermal storage system. Because all the solar energy is focused on one central point, central receiver tower technology can achieve high temperatures, resulting in efficient energy collection, thermal storage and electricity production systems. The thermal storage system allows renewable solar energy to be stored efficiently and used when needed. Because the storage system effectively decouples solar energy collection from electricity generation, a stable electricity supply can be produced.

Another attribute that distinguishes RSEP technology is the use of liquid salt as the heat transfer medium in the receiver. In the liquid state, salt has viscosity and appearance similar to that of water, and has several highly beneficial properties in solar applications. First, liquid salt has highly efficient heat transfer properties and retains heat for long periods with minimal losses. Second, the salt can be heated to high temperatures without degradation, resulting in efficient energy storage and electricity production systems. Finally, once melted and in the liquid state, the salt does not change phase and will not be subject to the negative operational impacts of intermittent cloud cover. Thus, the combination of liquid salt as both the heat transfer and storage medium in a central receiver/tower application produces the following benefits.

- Decouples the collection of solar energy from the generation of electricity and hence can generate power at any time of day
- Maximizes the cost-effectiveness of its storage system by heating the liquid salt to high temperatures with very little thermal loss in storage

- Achieves high steam-turbine cycle efficiencies
- Allows power production to be dispatched during periods of peak demand, reducing the overall cost of power

One characteristic of the technology is a tall tower, described in further detail below. The tower height and heliostat field size have been chosen based on an economic optimization analysis to determine the project configuration that allows electricity to be produced at the most competitive cost. The key drivers in this analysis include the amount of solar energy collected, the amount of electricity produced, and capital cost. The amount of solar energy collected is related to the size of the heliostat field and number of heliostats. As the number of heliostats increases, more energy can be collected, but the size of the field and tower height grows. The height of the tower is increased to ensure that the reflected energy from the heliostats at the outermost edge of the solar array will reach the receiver on top of the tower without being blocked or shaded by other heliostats located closer to the tower. A lower tower would therefore result in proportionally lower energy collection per acre. The heliostats located farthest from the tower, however, are also the least efficient, so the cost-effectiveness of adding more heliostats to collect additional energy diminishes as the field size increases. Another factor driving the optimal tower height and field size is economy of scale. Smaller plants tend to be less economical because it is relatively inexpensive to increase equipment size once a project has already incurred the fixed costs of installation.

2.2 Facility Description, Design, and Operation

The RSEP's technology generates power from sunlight by focusing energy from a field of mirrors called heliostats onto a central receiver. Liquid salt is circulated through tubes in the receiver, collecting the energy gathered from the sun. The heated salt is then routed to an insulated storage tank where it can be stored with minimal energy losses. When electricity is to be generated, the hot salt is routed to a steam generation system to produce steam. The steam is then used to generate electricity in a conventional steam turbine cycle. After exiting the steam generation system, the salt is sent to the cold salt thermal storage tank and the cycle is repeated.

The plant is designed to capture the maximum available solar energy by the collector and receiver systems whenever the sun is shining. The thermal storage system is sized such that the receiver and collector systems are able to continuously capture solar energy on long summer days. The thermal storage aspect of the liquid salt system allows the plant operator to collect solar energy in the morning and to shift power production to the hours in the day when power demand is greatest.

The salt has a melting temperature of approximately 450 degrees Fahrenheit (°F). In the liquid state, the salt has a viscosity and appearance similar to that of water. Salt is a heat storage medium that retains thermal energy very effectively over time. Once the salt is melted to a liquid form during construction, it will remain heated and in a liquid state throughout the plant's operating life, continuously circulated through the steam receiver and steam generation systems. The salt does not degrade over time, and will be used throughout the life of the facility.

At the start of any given operating day, the cold tank contains an adequate inventory of "cold" salt at 550°F. When sunrise begins, the receiver is filled with 550°F cold salt and is preheated by incremental redirection of small numbers of heliostats onto the receiver panels. The cold salt is returned to the cold tank. As the sun rises above the horizon, the full array of heliostats is directed onto the receiver, and salt temperature begins to rise as salt flow is established through the receiver panels. Salt flow through the receiver is recirculated back to the cold tank until the salt outlet temperature reaches 1,050°F. Salt is then transferred continuously from the cold salt tank, through the receiver and into the hot salt tank. The quantity of liquid salt in the cold tank decreases while the quantity in the hot tank increases proportionally during solar energy collection.

As a decoupled process, a small amount of cold salt is circulated continuously through the steam generation system to produce small quantities of steam. The steam is continuously applied to the steam seals on the turbine to help keep the turbine warm while it rotates slowly on the turning gear when the steam turbine is not in production. When generation is scheduled, a hot salt pump will gradually send a fraction of the hot salt to mix with the cold salt flow through the steam generation system to increase the temperature of the steam generation equipment.

As steam production continues, salt flow will gradually be drawn more from the hot tank and when the appropriate steam pressure and temperature are achieved, the steam turbine generator is taken off the turning gear and rolled with steam. At this point, the hot salt pumps are brought to full flow. Salt flow through the steam generator system is then returned to the cold tank. Once the steam turbine is at full speed and heated to operating temperature, the turbine generator output breaker is closed and the generator is brought to full power. Throughout the day, cold salt flow is throttled to maintain receiver outlet temperature at the maximum temperature of 1,050°F.

Normally by late afternoon, salt inventory in the hot tank will have reached its peak, cold tank inventory will be near depletion, heat energy from the receiver will have greatly decreased, and cold salt flow will be further reduced by throttling flow to maintain receiver outlet temperature. Once the sun has dropped below the horizon, solar energy collection will cease, the receiver will be shut down, and the liquid salt will be drained back to the cold salt tank. The turbine generator, however, continues to operate until its scheduled shutdown or when hot salt inventory reaches its minimum preset level. Once the steam turbine generator is disengaged, the steam generator system is reduced in temperature and pressure at a controlled rate by gradually reducing hot salt flow. For overnight hold, the steam generation modules will be kept warm with a small flow of cold salt until ready for start-up the following morning. The turbine is also kept warm with auxiliary steam on its steam seals and on the turning gear with condenser vacuum maintained until the next operating cycle.

A primary advantage of the central receiver tower/liquid salt technology is that the salt can be heated to and stored at high temperatures. Steam can be generated at utility-standard temperatures and pressures, allowing the use of highly efficient steam turbines. The solar receiver tower, described in further detail below, is sized to ensure that the reflected energy from the heliostats at the outermost edge of the solar array will reach the receiver on top of the tower without being blocked or shaded by other heliostats located closer to the tower. The tower height and field size represent an economically optimized tower and solar array

combination. In addition, aside from initial melting and conditioning of the salt prior to plant commissioning, no fossil fuels are required by RSEP technology.

Daily operating hours for the RSEP facility will vary based on the solar potential available daily and by season. Because the thermal storage system allows electricity generation to be scheduled independently from the collection of solar energy, the plant will be capable of producing power at a consistent output of 150 MW (net) annually. Thus, the plant will operate for longer periods during the summer months, when solar insolation is at its peak, and for shorter periods during the winter months when less solar energy is available for collection. Additionally, it is likely that the power purchaser for the facility will schedule power production to occur during the periods of peak electricity demand. Therefore, for example, during a typical summer day, the plant may start collecting solar energy shortly after sunrise, but reserve the energy for use until the peak demand period occurs at noon, and not generating any electricity until that time.

2.2.1 Principal Design Elements

The RSEP includes the following principal design elements:

- Up to 17,500, solar-tracking heliostats, or mirrors, each 672 square feet in area, in a circular array that will reflect solar energy to the solar receiver tower. The heliostats will be approximately 24 by 28 feet in size, and each will be mounted on a 12-foot-tall pedestal.
- A 538-foot-high concrete solar receiver tower with a 100-foot-tall solar receiver and 15-foot crane (for a total height of 653 feet).
- A liquid salt circulation and storage system featuring hot (approximately 1,050°F) and "cold" (approximately 550°F) salt storage tanks, capable of storing 70 million pounds (4.4 million gallons) of liquid salt (sodium nitrate/potassium nitrate mixture).
- A net 150-MW single condensing steam turbine generator (STG) system and associated equipment.
- A 20-cell ACC for cooling of the steam turbine exhaust.
- A 10.0-mile-long generation tie-line that will connect with the Western Area Power Administration's (Western) Parker-Blythe transmission line. The new facilities will be constructed to design standards that allow operation at 230 kilovolts (kV) (the design rating of Western's existing system). The new facilities will be operated at the voltage level of Western's system, currently 161 kV, which may be upgraded to 230 kV in the future. The generation tie-line will be constructed partly on federal land and partly on private land, and will require construction of 4.6 miles of new unpaved access road and use of 5.4 miles of existing dirt roads.

- A new interconnection substation[1] (currently estimated to be approximately 300 feet by 400 feet) located at the point of interconnection with Western's existing transmission line.
- An onsite switchyard to step up power from the STG for transmittal on the generator tie-line to the interconnection substation.
- Two new onsite wells for industrial water use and a water treatment system to provide water that will be treated for both domestic and process use.
- Three evaporation ponds, approximately 5 acres each, to process wastewater discharge from the water treatment system and oil/water separator.
- A 30-acre stormwater detention pond basin area consisting of the portion of the heliostat field along its southern boundary and the southern boundary road berm.
- Two diesel fire-water pumps and two emergency diesel generator sets for backup emergency power supply.
- Extension of the existing 12-kV electrical distribution line from a location 175 feet east of the project parcel boundary for approximately 1.1 miles to the facility fenceline boundary.

2.2.2 Process Description

The three primary elements of the power generation are (1) heliostat field, (2) steam-turbine power generator, and (3) thermal energy storage system. Figure 2.2-1 provides the overall site plan and conceptual general arrangement of the facility. Figure 2.2-2 is a general arrangement of the power block area. Figures 2.2-3a and 2.2-3b are elevation drawings of the power block area. This section describes each element in greater detail.

2.2.2.1 Heliostat Field

The proposed facility will consist of up to 17,500 heliostats occupying approximately 1,370 acres. Each heliostat will be approximately 672 square feet in size (24 x 28 feet), yielding a total reflecting surface of about 12,000,000 square feet (1,100,000 m^2). Each heliostat has a 12-foot-tall post or pier-type foundation to support and anchor the unit.

The arrangement of the heliostats within the array is optimized to maximize the amount of solar energy that can be collected by the field, and to avoid interference among heliostats as they track the sun during the day. The heliostats are arranged in arcs encircling the receiver tower extending in concentric rings from the central tower. The solar receiver tower is offset somewhat to the south of the true center of the heliostat field. Because the plant is situated in the northern hemisphere, this layout optimizes the various sun angles between heliostats and receiver, given that the sun, on a calendar year basis, remains primarily to the south of the receiver. This arrangement allows the optimum annual angle for the heliostats of the north field to reflect back to the receiver tower. When the plant is off-line for a period of

[1]In this document, the fenced area containing transformers, breakers, and other electrical switch gear located at the interconnection point with Western's Parker-Blythe transmission line is referred to as the substation. The area in the onsite power block that contains transformers and switching gear area where the turbine-generator interconnects with the generator tie-line is called the switchyard.

time, the heliostats are stowed horizontally at an elevation of approximately 14 feet above the ground surface.

The heliostat field is nominally sized to provide maximum cost-effective thermal energy input to the system given the practical constraints of land area, particularly distance from the receiver and the pointing accuracy of the heliostat hardware. The field size and salt inventory results in collection of excess energy, relative to the rate of energy consumed in the power generating cycle.

2.2.2.2 Solar Receiver/Tower

The solar receiver will be located on the top of a cylindrical concrete tower. The tower structure will be approximately 538 feet tall. The overall height of the receiver will be 100 feet, and will project above the top of the concrete tower. The top of the receiver will be 638 feet above the ground surface. A 15-foot-tall crane will be mounted on top of the receiver to facilitate receiver panel maintenance for a total height of the tower and receiver of 653 feet above the ground. The tower will include the necessary aircraft warning lights delineated by FAA regulations.

The receiver is constructed of a series of manifolds and tubes. The cold salt enters the manifold system, and is distributed to the panels of receiver tubes where the solar energy from the heliostats heats the salt. The heated salt then flows to the hot salt storage tank

2.2.2.3 Thermal Energy Collection and Storage

The thermal energy storage system includes “hot” and “cold” liquid salt tanks to retain and store solar energy, as well as associated pumps and piping necessary to circulate the salt through the receiver and the steam generation system. Thermal energy storage provides the facility with several advantages compared with other types of solar energy production, including other forms of concentrating solar technology.

The thermal energy storage capability allows the excess heat to be stored until required for production of electrical power, allowing electric power generation to operate independently of solar energy capture. Thermal energy storage offers the ability to extend the generation day of the facility well beyond the hours between sunrise and sunset. Heated salt can be retained in insulated storage tanks for withdrawal as a heating source, for example, well after the sun has set. This feature allows the plant to operate in harmony with the load demands of the electrical grid system, which typically peak in the late afternoon and into the evening hours. In the event of transmission congestion or line outage that would otherwise prevent a solar or wind energy facility from delivering power, stored solar thermal energy can be almost entirely conserved for later conversion once the transmission constraint is resolved.

The thermal storage system includes extensive thermal insulation as well as an auxiliary electric heat source (“heat tracing”) to keep the tanks and piping hot so that salt remains in a liquid state through protracted outages for maintenance and inspection.

The thermal storage system contains two storage tanks: a cold tank storing liquid salt at 550°F, and a “hot” tank storing liquid salt at 1,050°F. Cold liquid salt is pumped from the cold liquid salt tank through the tubes inside the receiver. After absorbing the energy from concentrated sunlight, the temperature of the salt is increased to the design outlet

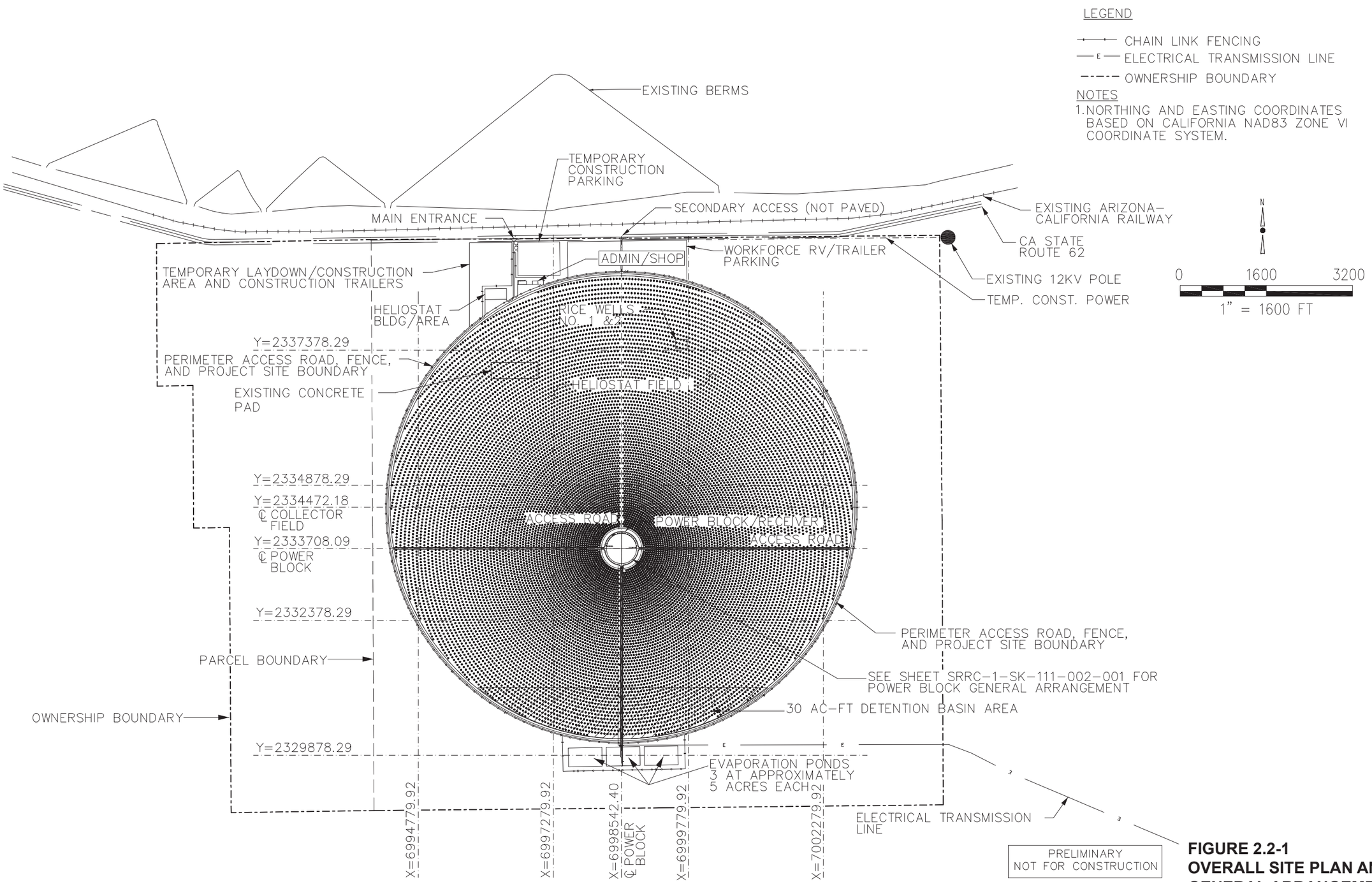
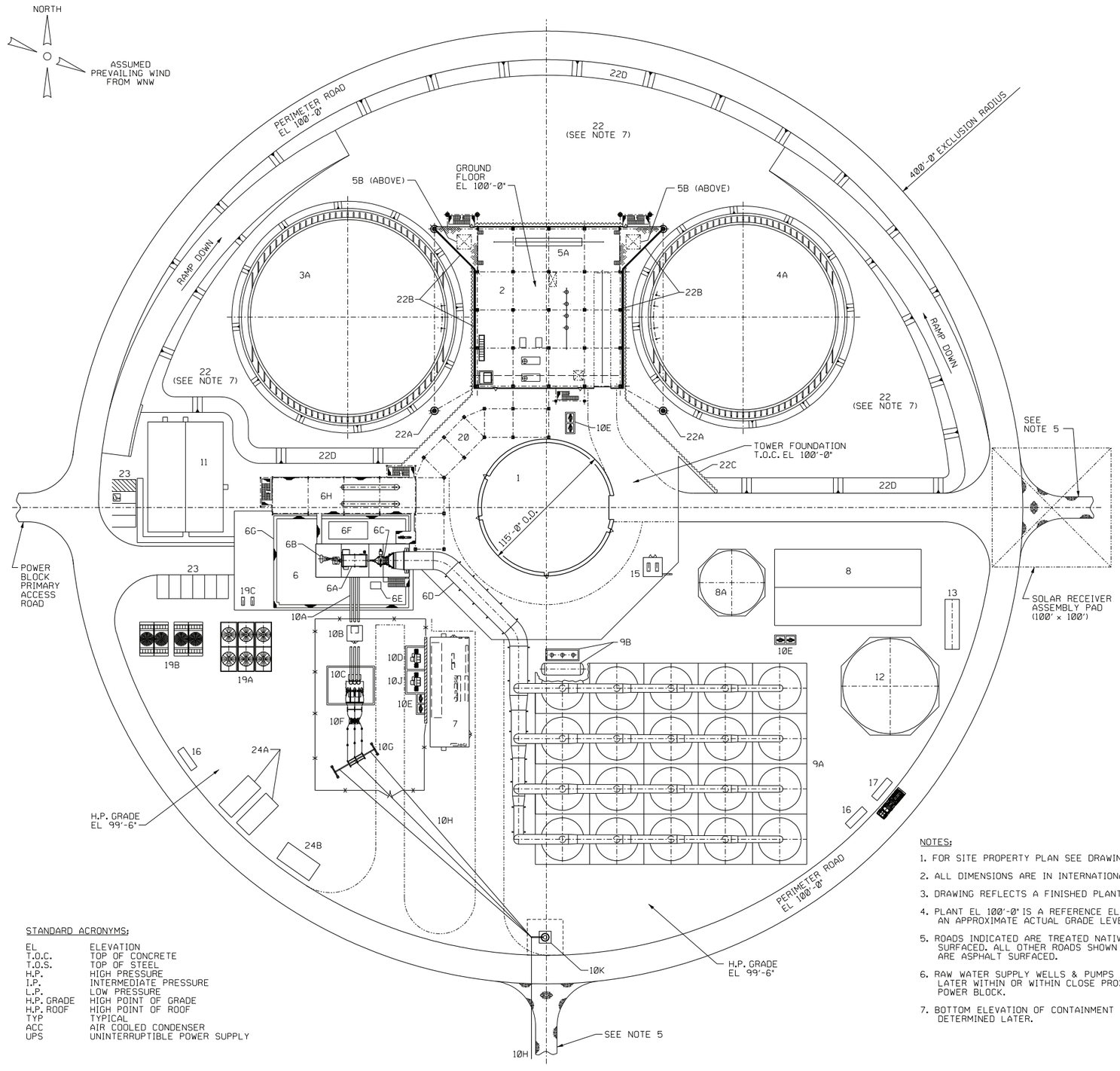


FIGURE 2.2-1
OVERALL SITE PLAN AND CONCEPTUAL GENERAL ARRANGEMENT
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Drawing SRRC-0-SK-112-111-001 Rev. G.



LEGEND

1 SOLAR RECEIVER TOWER

2 STEAM GENERATION BUILDING

3 HOT SALT STORAGE TANK AREA
- 3A HOT SALT STORAGE TANK

4 COLD SALT STORAGE TANK AREA
- 4A COLD SALT STORAGE TANK

5 PUMP SUPPORT & MAINTENANCE AREA
- 5A PUMP MAINTENANCE AREA
- 5B PUMP REMOVAL HATCH

6 STEAM TURBINE/GENERATOR AREA
- 6A GENERATOR
- 6B H.P. TURBINE
- 6C I.P./L.P. TURBINE
- 6D TURBINE EXHAUST DUCT
- 6E HYDRAULIC OIL UNIT
- 6F LUBE OIL UNIT
- 6G FLOOR TRENCH
- 6H HEATER BAY
- 6J BOILER FEEDWATER PUMPS (NOT SHOWN)
- 6K DEAERATOR (NOT SHOWN)

7 ELECTRICAL BUILDING/PDC

8 WATER TREATMENT AREA/BUILDING
- 8A DEMINERALIZED WATER TANK
- 8B DEMINERALIZED WATER PUMPS (NOT SHOWN)
- 8C SERVICE WAER PUMPS (NOT SHOWN)

9 AIR COOLED CONDENSER AREA
- 9A AIR COOLED CONDENSER
- 9B CONDENSATE DRAIN TANK & PUMPS (UNDER ACC)

10 ELECTRICAL TRANSMISSION AREA
- 10A SEGREGATED PHASE BUS DUCT
- 10B GENERATOR CIRCUIT BREAKER SWITCHGEAR
- 10C GENERATOR STEP-UP TRANSFORMER
- 10D UNIT AUXILIARY TRANSFORMER
- 10E STATION SERVICE TRANSFORMER
- 10F STEP-UP CIRCUIT BREAKER
- 10G TRANSMISSION TOWER
- 10H OVERHEAD POWER LINES
- 10J BACKFEED UTILITY TRANSFORMER
- 10K TUBULAR STEEL POLE

11 CONTROL & OPERATIONS BUILDING

12 SERVICE/FIRE WATER STORAGE TANK

13 FIRE WATER PUMP HOUSE

14 NOT USED

15 FIRE WATER BOOSTER PUMPS

16 ABOVE GROUND DIESEL FUEL STORAGE TANK

17 HELIOSTAT WASH TRUCK FILL AREA

18 OIL/WATER SEPARATOR - LATER

19 AUXILIARY COOLING SYSTEM
- 19A FIN FAN COOLER
- 19B WET SURFACE AIR COOLER (WSAC)
- 19C CLOSED COOLING WATER PUMPS

20 HIGH ENERGY PIPE BRIDGE

21 NOT USED

22 MOLTEN SALT CONTAINMENT AREA
- 22A CAISSON FOUNDATION
- 22B DIVERSION WALL
- 22C RETAINING WALL
- 22D 2:1 SLOPED SOIL

23 DESIGNATED PARKING AREA

24 HELIOSTAT UPS AREA
- 24A EMERGENCY GENERATOR
- 24B HELIOSTAT DISTRIBUTION SWITCHGEAR

25 RAW WATER SUPPLY WELLS & PUMPS (SEE NOTE 6)

NOTES:

1. FOR SITE PROPERTY PLAN SEE DRAWING "LATER".
2. ALL DIMENSIONS ARE IN INTERNATIONAL FEET.
3. DRAWING REFLECTS A FINISHED PLANT CONDITION.
4. PLANT EL 100'-0" IS A REFERENCE ELEVATION EQUAL TO AN APPROXIMATE ACTUAL GRADE LEVEL OF EL "LATER".
5. ROADS INDICATED ARE TREATED NATIVE SOIL OR GRAVEL SURFACED. ALL OTHER ROADS SHOWN ON THIS PLAN ARE ASPHALT SURFACED.
6. RAW WATER SUPPLY WELLS & PUMPS TO BE LOCATED LATER WITHIN OR WITHIN CLOSE PROXIMITY TO THE POWER BLOCK.
7. BOTTOM ELEVATION OF CONTAINMENT AREA TO BE DETERMINED LATER.

STANDARD ACRONYMS:

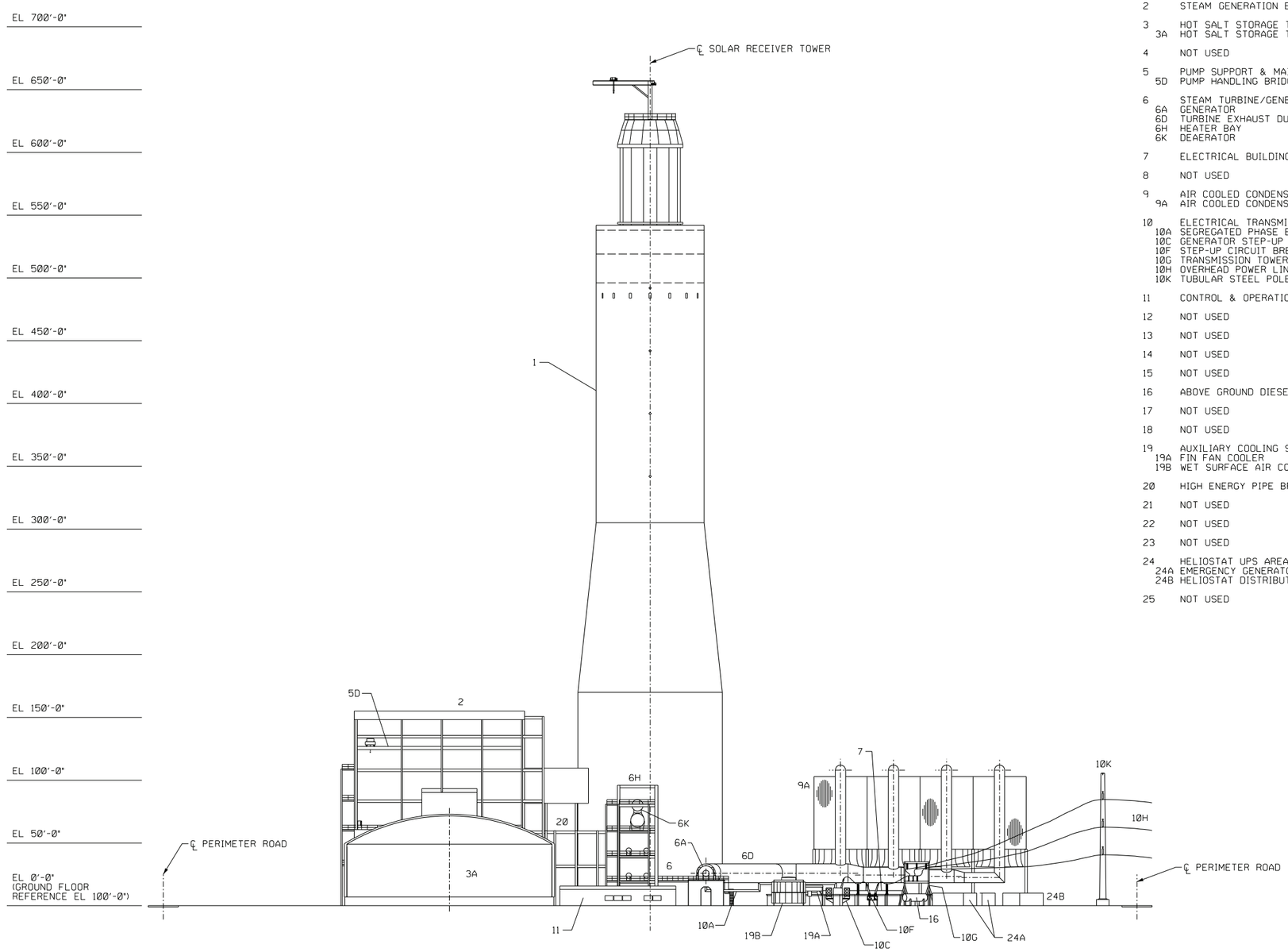
EL	ELEVATION
T.O.C.	TOP OF CONCRETE
T.O.S.	TOP OF STEEL
H.P.	HIGH PRESSURE
I.P.	INTERMEDIATE PRESSURE
L.P.	LOW PRESSURE
H.P. GRADE	HIGH POINT OF GRADE
H.P. ROOF	HIGH POINT OF ROOF
TYP	TYPICAL
ACC	AIR COOLED CONDENSER
UPS	UNINTERRUPTIBLE POWER SUPPLY

40 0 40 80 120

SCALE: 1" = 40'

FIGURE 2.2-2
GENERAL ARRANGEMENT OF THE POWER BLOCK AREA
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Drawing SRRC-0-SK-112-002-002 Rev. B.



POWER BLOCK ELEVATION LOOKING EAST

LEGEND

1 SOLAR RECEIVER TOWER

2 STEAM GENERATION BUILDING

3 HOT SALT STORAGE TANK AREA
- 3A HOT SALT STORAGE TANK

4 NOT USED

5 PUMP SUPPORT & MAINTENANCE AREA
- 5D PUMP HANDLING BRIDGE CRANE

6 STEAM TURBINE/GENERATOR AREA
- 6A GENERATOR
- 6D TURBINE EXHAUST DUCT
- 6H HEATER BAY
- 6K DEAERATOR

7 ELECTRICAL BUILDING/PDC

8 NOT USED

9 AIR COOLED CONDENSER AREA
- 9A AIR COOLED CONDENSER

10 ELECTRICAL TRANSMISSION AREA
- 10A SEGREGATED PHASE BUS DUCT
- 10C GENERATOR STEP-UP TRANSFORMER
- 10F STEP-UP CIRCUIT BREAKER
- 10G TRANSMISSION TOWER
- 10H OVERHEAD POWER LINES
- 10K TUBULAR STEEL POLE

11 CONTROL & OPERATIONS BUILDING

12 NOT USED

13 NOT USED

14 NOT USED

15 NOT USED

16 ABOVE GROUND DIESEL FUEL STORAGE TANK

17 NOT USED

18 NOT USED

19 AUXILIARY COOLING SYSTEM
- 19A FIN FAN COOLER
- 19B WET SURFACE AIR COOLER (WSAC)

20 HIGH ENERGY PIPE BRIDGE

21 NOT USED

22 NOT USED

23 NOT USED

24 HELIOSTAT UPS AREA
- 24A EMERGENCY GENERATOR
- 24B HELIOSTAT DISTRIBUTION SWITCHGEAR

25 NOT USED

NOTES:

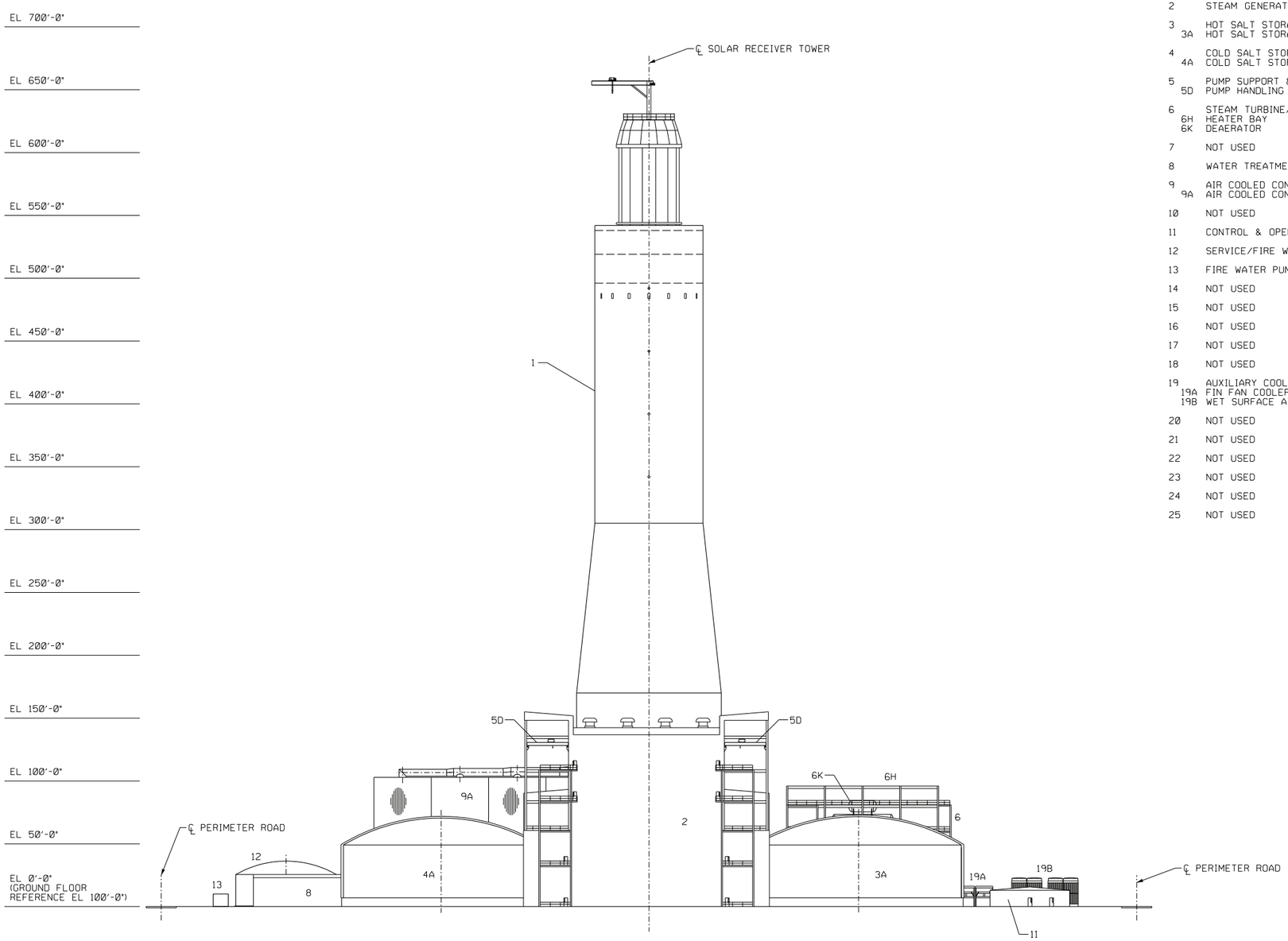
1. FOR POWER BLOCK PLAN SEE DRAWING SRRC-1-SK-111-002-002.
2. FOR ALL OTHER NOTES, REFERENCES AND STANDARD ACRONYMS SEE DRAWING SRRC-1-SK-111-002-002.

40 0 40 80 120

SCALE: 1" = 40'

FIGURE 2.2-3A
ELEVATION DRAWINGS
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Drawing SRRC-0-SK-112-002-006 Rev. B.



POWER BLOCK ELEVATION LOOKING SOUTH

LEGEND

1	SOLAR RECEIVER TOWER
2	STEAM GENERATION BUILDING
3	HOT SALT STORAGE TANK AREA
3A	HOT SALT STORAGE TANK
4	COLD SALT STORAGE TANK AREA
4A	COLD SALT STORAGE TANK
5	PUMP SUPPORT & MAINTENANCE AREA
5D	PUMP HANDLING BRIDGE CRANE
6	STEAM TURBINE/GENERATOR AREA
6H	HEATER BAY
6K	DEAERATOR
7	NOT USED
8	WATER TREATMENT AREA/BUILDING
9	AIR COOLED CONDENSER AREA
9A	AIR COOLED CONDENSER
10	NOT USED
11	CONTROL & OPERATIONS BUILDING
12	SERVICE/FIRE WATER STORAGE TANK
13	FIRE WATER PUMP HOUSE
14	NOT USED
15	NOT USED
16	NOT USED
17	NOT USED
18	NOT USED
19	AUXILIARY COOLING SYSTEM
19A	FIN FAN COOLER
19B	WET SURFACE AIR COOLER (WSAC)
20	NOT USED
21	NOT USED
22	NOT USED
23	NOT USED
24	NOT USED
25	NOT USED

NOTES:

1. FOR POWER BLOCK PLAN SEE DRAWING SRRC-1-SK-111-002-002.
2. FOR ALL OTHER NOTES, REFERENCES AND STANDARD ACRONYMS SEE DRAWING SRRC-1-SK-111-002-002.

40 0 40 80 120

SCALE: 1" = 40'

FIGURE 2.2-3B
ELEVATION DRAWINGS
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Drawing SRRC-0-SK-112-002-007 Rev. B.

temperature of 1,050°F. The heated salt is then discharged to the hot salt tank. To produce steam and generate electricity, the hot salt is pumped through a steam generating system that supplies superheated steam for use in a conventional Rankine cycle steam turbine generator. Upon leaving the steam generation system, the salt is returned to the cold tank where it is stored prior to reheating in the receiver. This arrangement allows for excess heat to be stored for power generation outside the direct solar-heating period of the day. The system also includes piping, valves, pumps, expansion tanks, and electric heaters. The salt mixture of sodium nitrate ($NaNO_3$) and potassium nitrate (KNO_3) is designed to remain liquid over a wide temperature range. The salt mixture must be preheated and maintained above the minimum temperature of 450°F to remain in liquid form. The salt storage tanks will be located in an area of the power block with a containment basin that will retain liquid salt, should it leak from the tanks.

The liquid salt system incorporates several "fail safe" features, including gravity drain of the salt loop and steam generation system on loss of grid power in order to avoid solidification should the system cool down before normal operation can resume. In order to prevent thermal damage to the receiver panels in the event of an interruption of salt flow, an emergency coolant vessel located in the interior of the receiver is filled with low temperature liquid salt pressurized with compressed air to fill the receiver. If the heliostats cannot be directed away from the receiver when salt flow is lost (due to a loss of power), the emergency coolant vessel discharges its contents into the receiver panels to maintain approximately one minute of salt flow. Emergency diesel generators also will be installed to provide emergency power for "off-pointing" of heliostats (pointing them at one of four target points in the air away from the receiver) to prevent potential overheating of the receiver in the event of a stoppage of salt flow. If power is lost, the diesel generators have a 10-second start time in order to power the heliostats for off-pointing. A 10,000-gallon diesel storage tank will provide sufficient capacity to run the diesel engines in the event of an extended power outage.

2.2.2.4 Steam Generation System

When electric power generation is desired, hot salt is pumped from the hot thermal storage tank by a set of low-head pumps (hot salt pumps) flowing through a series of feedwater heaters and steam generation modules to produce superheated steam. This steam is used in a Rankine cycle reheat steam turbine generator to produce electricity in a highly efficient cycle. Cycle waste heat contained in steam exhausted from the turbine is then rejected to the atmosphere through a dry cooling process utilizing an ACC. Condensed steam is returned to the steam generation cycle by way of multi-stage condensate and feedwater preheaters and a deaerator.

When the plant is started, the steam turbine will be fully warmed and ready for electrical load, the generator output frequency is matched to grid frequency (60 Hz), and output voltage is raised just slightly higher than voltage on the low side of the generator step-up (GSU) transformer. The generator output breaker is then closed when the phase rotation is matched, and the steam turbine generator accepts electrical load. Dispatch will then direct the operator to load the generator to the output needs of the electrical grid at that time, typically nameplate rated generator output.

The steam generation system is the core of the steam supply system for the power block and consists of an economizer, boiler, two superheaters, and two reheaters. High pressure

feedwater enters the system from the feedwater heaters, passes through the economizer, the steam drum, through the evaporator, back to the steam drum, and leaves as saturated steam that subsequently flows to the superheaters. Superheated steam passes through the high pressure steam turbine and is exhausted to the reheaters. Reheat steam is then directed to the inlet of the intermediate pressure turbine. Hot salt pumped from the hot storage tank enters the shell side of the steam generation system heat exchangers and flows through the superheaters, reheaters, the boiler and finally the economizer. The salt is then directed to the cold storage tank.

The steam generation system components are described more in detail below.

- **Economizer –** The economizer is a shell and tube design heat exchanger. High pressure feedwater enters the economizer tubes from the feedwater heaters and is directed from there to the boiler steam drum.
- **Boiler –** Feedwater from the steam drum is transferred by a recirculation pump to the evaporator section to produce saturated steam. Saturated steam from the evaporator section is directed back to the steam drum. Moisture separators in the steam drum help to remove moisture droplets from the steam as it passes on to the superheater. The evaporator tubes receive heated, high pressure feedwater from the steam drum via the recirculation pump and evaporate the water into saturated steam. The evaporator section is a shell and tube design heat exchanger. The saturated steam leaving the evaporator section flows back to the steam drum.
- **Superheaters and Reheaters –** The saturated steam flows through the tubes of the shell and tube design superheater to heat the steam to the desired temperature and pressure for steam turbine operating conditions. The reheater receives "cold" outlet steam into its tubes from the high pressure turbine exhaust and reheats the steam before being reintroduced into the intermediate pressure turbine.

2.2.2.5 Steam Turbine Generator

The STG system consists of a multi-stage, reheat, condensing STG with extraction, a gland seal steam system, lubricating oil system, hydraulic control system, and steam admission and control valving. Once the pressurized steam has reached the optimum temperature in the superheater, it flows to the steam turbine, which converts thermal energy in the steam into mechanical power (rotation), driving an attached power generator. Superheated steam is expanded through the high-pressure stages of the turbine, routed back to the steam generation system where it is reheated, and then returned to expand through the intermediate and low-pressure turbine sections. On exiting the turbine, the steam is directed into the ACC.

2.2.2.6 Air-Cooled Condenser

The RSEP steam-turbine cycle uses a dry cooling system. This cooling system consists of an exhaust transfer duct (extending between the exhaust flange of the steam turbine and the condenser inlet), an ACC, a condensate collection tank, and a condensate pumping system. The ACC receives exhaust steam from the steam turbine exhaust duct into the bundled finned-tube sections of the condenser. Fans located beneath the condenser force ambient air across the heat transfer fins, cooling and condensing the steam into condensate. The finned

tubes are usually arranged in the form of an A frame (or delta) above the forced draft fans, which minimizes the overall footprint of the ACC and optimizes air flow and heat transfer. Condensed steam is manifolded to a condensate collection tank from which the condensate pumps take suction, pumping the condensate back into the cycle.

The ACC can condense steam to within 30°F to 50°F of the ambient dry-bulb temperature depending on actual operating conditions. This air-cooled system does not require any water for cooling and condensing the steam back into a liquid state. Liquid-ring vacuum pumps or steam jet air ejectors will be used to initially draw and maintain vacuum on the condenser for startup and during normal operation.

2.2.2.7 Condensate and Feedwater Systems

The condensate pumps draw water from the condensate tank and deliver water to the deaerator through a series of feedwater heaters. Condensate flows through the shell and tube design feedwater heaters receiver preheating before entering the deaerator. Heating steam flowing through the shell side of the feedwater heaters is taken from various extraction points on the steam turbine. Five stages of feedwater heating are provided to maximize cycle efficiency. The condensate system will include three 50-percent-capacity multistage, vertical, motor-driven condensate pumps.

The deaerator is a direct-contact heat exchanger that serves to strip and expel dissolved oxygen and other non-condensable gases entrained in the condensate (de-aeration). The process also serves to preheat the condensate and to store it as source of supply to the boiler feed pumps. The deaerator uses extraction steam from the steam turbine for heating and to aid the deaeration process. Steam is in direct contact with the incoming condensate stream, which is atomized to enhance heat transfer and aid the liberation of non-condensable gases from the water. Gases are vented from the tank to atmosphere, together with trace amounts of steam under low pressure to ensure air cannot enter the system.

Deionized cycle makeup water is introduced at the inlet of the deaerator to allow for heating and deaeration. Cycle makeup water is necessary to compensate for system losses, primarily due to steam drum blowdown.

Multi-stage feedwater pumps take suction from the deaerator, developing sufficient pressure to flow feedwater through the tubes of additional feedwater heaters and finally into the evaporator steam drum. Additional feedwater heaters receive steam on the shell side of the heat exchangers either by extraction steam from the steam turbine, or by a small amount of saturated steam directly from the steam drum outlet. The final preheat for the feedwater prior to entering the steam drum is from the economizer where liquid salt provides additional heat. The system will consist of two pumps, each pump sized for 100 percent capacity.

2.2.3 Major Electrical Equipment and Systems

This section describes the RSEP major electrical systems and equipment. All of the net power produced by the facility is currently expected to be delivered to Western's transmission grid through the project's interconnection with a proposed new substation located approximately 10.0 miles southeast of the site (see Section 3.0). Roughly 10 percent of the gross generator output will be used onsite for plant auxiliaries such as pumps, control

systems, and general facility loads including lighting, and heating, ventilation, and air conditioning. Some of the power needed for onsite uses will be converted from alternating current (AC) to direct current (DC) for power plant control systems and emergency backup systems such as lube oil pumps and STG turning gear. The descriptions of the major electrical systems and equipment provided in the following subsections reflect AC power unless otherwise noted. An overall one-line diagram of the major electrical system is presented in Figure 2.2-4.

The new RSEP generator tie-line will interconnect with Western's existing Parker-Blythe #1 transmission line, which is currently operated at 161 kV but is built and designed to operate at 230 kV. The RSEP electrical system will be designed to 230 kV, but operated at 161 kV until a time when/if the Western line is operated at 230 kV.

Construction power will be brought to the RSEP site via a 1.1-mile-long extension of an existing 12-kV distribution line operated by Southern California Edison (SCE). The extension will extend from a point 175 feet east of the project's eastern parcel boundary, along the northern boundary of the project parcel paralleling State Route (SR) 62, to the administration building area. This line will serve the construction workforce trailer and RV camp and other uses during project operation as needed.

2.2.3.1 Major Electrical Equipment and Systems

Power will be generated by the STG at 13.8 kV and increased to transmission voltage by a fan-cooled generator step-up transformer (GSU) to 161/230 kV for output to the grid. Startup power will be back-fed through the 161/230-kV GSU or through a separate connection through the construction power line discussed in the previous paragraph, to a 4.16-kV step-down transformer. Once the STG is running, it will supply the plant auxiliary power needs through a separate Unit Auxiliary Transformer (UAT). The plant stand-by electrical power requirements and the majority of the plant auxiliary "house" (parasitic) load will be back-fed either through a separate connection to the local SCE distribution network to a 4.16-kV step-down transformer as shown on the one-line, or the generator step-up transformer (GSU) and unit auxiliary transformers (UAT) from the interconnected Parker-Blythe #1 Transmission Line. Emergency power will be provided by two diesel generator sets, each with 2.5-MW output capacity. Additional detail regarding the distribution network is included in Section 3.0.

2.2.3.2 Electrical Generation

The RSEP STG will tie into a 230-kV-capable onsite switchyard. As noted above, the existing Western Parker-Blythe #1 Transmission Line is operated at 161 kV, although is built and designed to operate at 230 kV. The RSEP electrical system will be designed to 230-kV standards, but operated at 161 kV until a time when/if the Western line is operated at 230 kV. The STG produces electricity at 13.8 kV that will connect to the switchyard at 161 kV via a generator circuit breaker and a GSU. The generator circuit breaker will include current transformers and voltage transformers for generator and bus duct protection. 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 GSU. The GSU will be 13.8-161/230-kV, two-winding, delta-wye grounded, using oil-immersed

NOTES:

1. FOR CONSTRUCTION POWER AND ALTERNATE POWER.
2. EQUIPMENT SUPPLIED BY STG MANUFACTURER.
3. HIGH VOLTAGE SYSTEM IS DESIGNED FOR 230KV, BUT OPERATES AT 161KV.

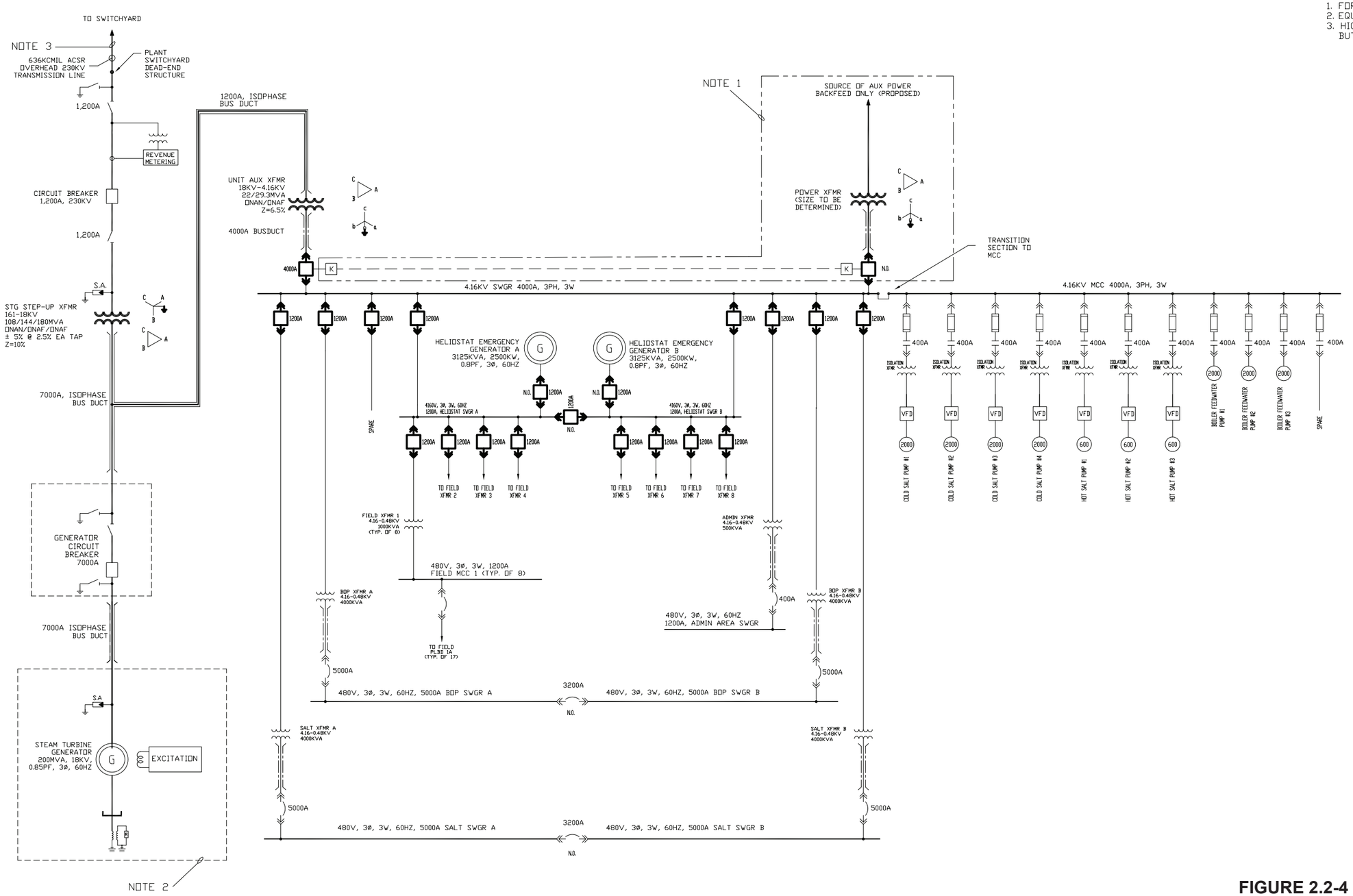


FIGURE 2.2-4
ELECTRICAL SYSTEM ONE LINE DIAGRAM
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Drawing SRRC-1-SK-623-206-001 Rev. B.

natural circulation, multi-stage, forced air cooling. The neutral point of high-voltage winding will be solidly grounded. The GSU 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 secondary voltage plus or minus five percent with a 2.5 percent differential to allow for transmission line voltage variations. The GSU will rest on a concrete pad with a perimeter containment wall designed to contain the transformer non-PCB insulating oil in the event of a leak or spill.

The RSEP onsite plant site switchyard will be located near the GSU and will require an overhead conductor for connection to the GSU. The switchyard will consist of a 230-kV switchyard circuit breaker for the protection of the line to the grid, with disconnect switches on each side of the breaker for breaker maintenance. The switchyard breaker will be a dead tank design with current transformers on each bushing and voltage transformers contained within the breaker control cabinet for protection of the line during normal operation or the GSU and the UATs during back-feed. The instrument transformers will also be used for generator synchronization to the grid.

A disconnect switch will be located at the generator tie-line termination within the switchyard for line isolation. The switchyard will be equipped with sensitive current transformers and capacitor-controlled voltage transformers located on the 230-kV switchyard bus for net revenue metering. 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. Tube, cables, and support structures will meet electrical and mechanical design requirements.

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 and meet Western standards.

2.2.3.3 Electrical System for Plant Auxiliaries

When the steam turbine is not running, power for plant essential loads (auxiliary loads) is backfed from the electrical grid through the 161/230-kV power lines, the switchyard isolation breaker, and the GSU to unit auxiliary and station service transformers on site. Typically the loads will include plant lighting at night, administration building needs, an air compressor, the plant controls system and control room loads, pumps to circulate water, heat tracing for liquid salt, lubricating oil, etc.

Power for plant auxiliaries is supplied at 4.16 kV, either from a two-winding UAT or a two-winding station utility transformer (SUT) connecting to the local distribution network, for redundancy. The bus duct from the generator to the GSU is provided with a tap connection to a 13.8/4.16-kV oil-filled, step-down UAT. The winding of the 4.16-kV side is connected to one main-tie-main 4.16-kV switchgear/motor control center (MCC). The UAT auxiliary bus tap is located between the generator breaker and the GSU. This configuration allows power for plant auxiliaries to be supplied from the plant switchyard through the GSU regardless of whether the STG is online or offline. Both the UAT and SUT rest on concrete pads designed to contain the transformer oil in the event of a leak or spill.

The 4.16-kV switchgear/MCC distributes power to the plant's 4-kV motors and to various 4160/480-volt (V) station unit service (SUS) transformers. The low voltage side of each of the SUS transformers is connected to the 480-V switchgear, which distributes power to the plant's large 480-V loads and to the various 480-V MCCs supplying power to the small plant loads. The MCCs distribute power to the plant's intermediate 480-V loads and to power panels serving small 480-V loads.

The 4.16-kV switchgear/MCC also distributes power to the heliostat field for normal and emergency operation. The two diesel generator sets are sized to provide emergency power to the entire field for "off-pointing" of the heliostat field (pointing them at one of four targets in the air away from the receiver) within 60 seconds.

2.2.3.4 DC Power Supply System

The plant's DC power supply system consists of a bank of 125-V DC batteries, a 125-V DC battery charger, metering, ground detectors, and distribution panels. Under normal operating conditions, the battery charger supplies DC power to the DC loads. The battery charger receives 480-V, three-phase AC power from the electrical distribution system serving plant auxiliaries. The battery charger continuously charges the battery bank while supplying DC power to the DC loads. Under abnormal or emergency conditions when AC power is not available, the battery bank supplies DC power directly to the DC loads. The battery bank is sized to power the DC loads and essential service AC loads through an inverter for a sufficient amount of time to provide for safe and damage-free shut down of the power plant. Recharging the battery bank occurs whenever AC power becomes available.

The DC power supply system provides power for critical control circuits, power for control of the 13.8-kV, 4.16–kV, and 480-V switchgear, and power for DC emergency backup systems. Emergency backup systems include power to the distributed control system (DCS) and DC lube oil and hydraulic oil pumps for the STG, etc.

2.2.3.5 Photovoltaic Panels

RSE may use to use solar photovoltaic (PV) panels positioned throughout the facility to power "home loads" such as some lighting, building power, and miscellaneous electrical loads, if it is economical to do so. PV panels will be situated in either stand-alone applications (e.g., roadway lighting) or harnessed to plant ancillary equipment that is normally supplied from the low-voltage distribution systems. Solar panels can provide economical mid-day energy that can supply building lighting, remotely located equipment, and miscellaneous onsite parasitic energy uses. In so doing, RSEP expects to trim its daily parasitic energy use by a modest amount. Incremental parasitic energy consumption achieved by use of PV panels will contribute favorably to overall efficiency of the energy facility. Applications for PV panel installation will be considered during the detailed design phase for buildings and miscellaneous equipment, including rooftop installation on the key buildings. The PV panels may be installed on building rooftops and open ground surface areas (e.g., on the maintenance building, warehouse, heliostat assembly building, steam generation building, and in open areas near load centers).

2.2.3.6 Essential Service AC System

An essential service AC system (120 V, single-phase) provides power to essential instrumentation, critical equipment loads, safety systems, and equipment protection systems that require uninterruptible AC power. The essential service AC system and the DC power supply system are both designed to ensure that critical safety and equipment protection control circuits are always energized and able to function in the event of unit trip or loss of AC power.

The essential service AC system consists of an inverter, a solid-state transfer switch, a manual bypass switch, an alternate AC source transformer and voltage regulator, and AC panel boards. The DC power supply system is the normal source of power to the essential service AC system. Power flows from the DC power supply system through the inverter to the AC essential service panel boards. The solid-state transfer switch continuously monitors both the inverter output and the alternate AC source. Upon loss of the inverter output and without interruption of power, the transfer switch automatically transfers essential service AC loads from the inverter output to the alternate AC source. The manual bypass switch enables isolation of the inverter and transfer switch for testing and maintenance without interruption of power to the essential service AC loads.

2.2.3.7 AC Power—Transmission

Power will be generated by the STG at 13.8 kV and then stepped-up by the GSU for transmission to the grid. The plant will connect to the utility at 161 kV. Surge arresters will be provided at the high-voltage bushings to protect the transformer from surges on the system caused by lightning strikes or other system disturbances. A detailed discussion of the transmission system and interconnection substation is provided in Section 3.0, Electric Transmission.

2.2.3.8 Construction Power

Power for construction will be partly supplied by extending the existing 12-kV distribution line into the RSEP site. This new service line would extend from an existing pole located just south of SR 62 and 175 feet east of the RSEP parcel boundary for about a mile to the administration building area at the north end of the heliostat field. From this point, the line can serve the construction workforce recreational vehicle (RV)/trailer park and other construction loads. During operation, the line can serve the administration building and other loads as needed.

2.2.4 Fossil Fuels

Aside from initial melting and conditioning of the salt prior to plant commissioning, no fossil fuels are utilized in the solar-thermal power generation process. The RSEP will have no connection to the natural gas pipeline network. Fossil fuel use for normal facility operations is strictly limited to emergency equipment and plant vehicles, principally heliostat wash trucks. Propane and compressed natural gas are being considered by RSE as alternative heating fuels for the initial salt melting and conditioning processes, which take place prior to plant commissioning. Propane is readily available from multiple sources and suppliers within a reasonable delivery radius of the project site. Compressed natural gas is

presently available only from a single source of supply at Topock, Arizona, approximately 95 miles away.

2.2.5 Water Supply and Use

This subsection describes the quantity of water required, the sources of the water supply, and water treatment requirements. Water balance diagrams for the plant are included as Figures 2.2-5a and 2.2-5b. A complete set of water balance diagrams is provided as Appendix 2A. As noted in Section 2.2.2.5, the RSEP will use a dry-cooled system to significantly reduce water consumption, given the project's desert environment location, thereby significantly reducing water consumption as compared with a wet-cooled system. Raw water will be needed to replenish blowdown of boiler water for proper chemistry control in the steam cycle and as well as for washing of the heliostats. Raw water will be drawn from two onsite wells. Each well will have sufficient capacity to supply water for the plant needs throughout the expected 30-year operational life of the plant. Groundwater will be put through a pre-treatment system and further purified for use as boiler makeup water and for pressure-washing of the heliostat field.

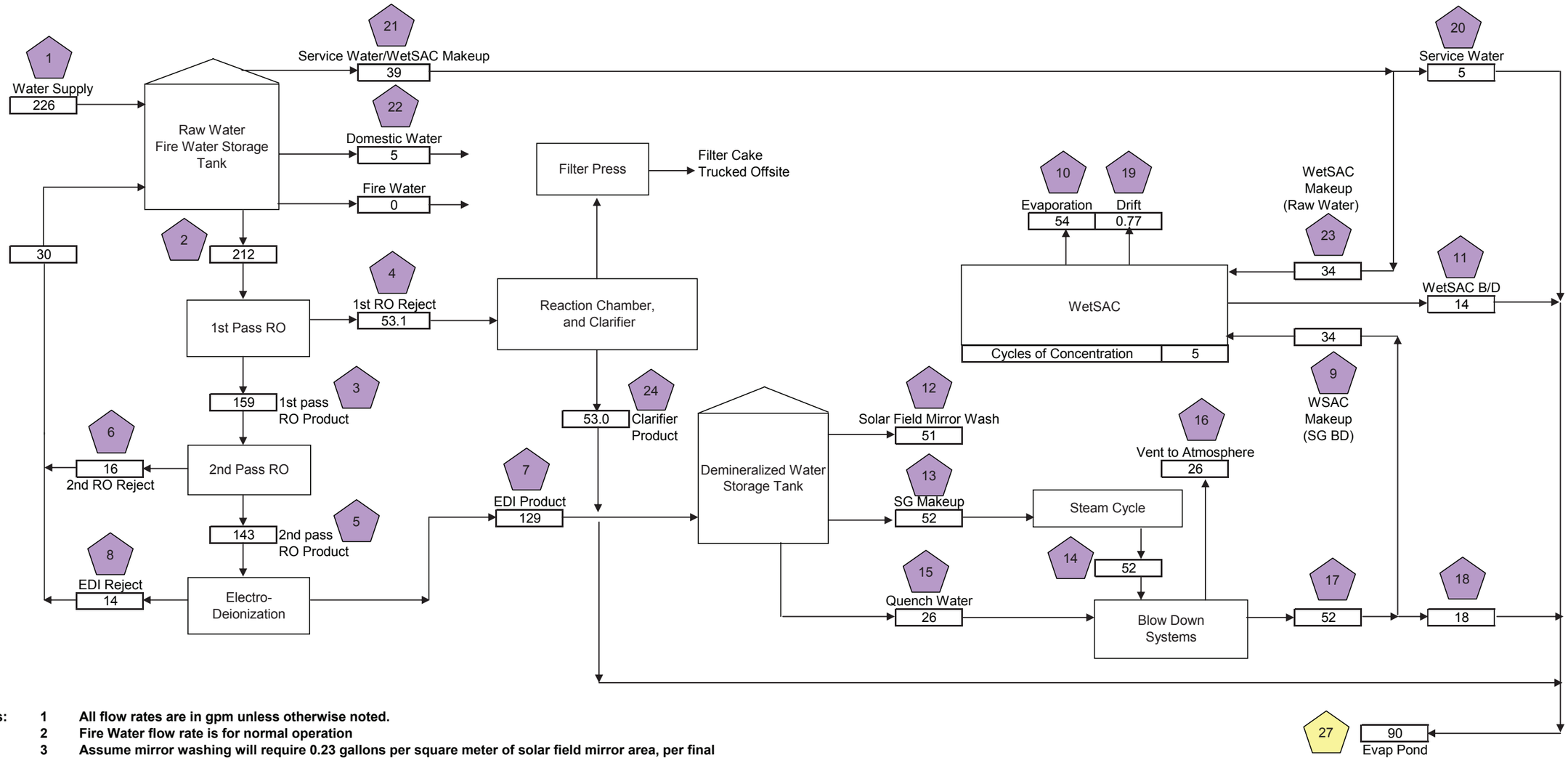
The well pumps will deliver water to a large raw water storage tank with a capacity of up to 840,000 gallons. The major portion of the raw water is for plant use while a smaller portion of the raw water (360,000 gallons) will be reserved for fire water. Raw water will be pumped from the storage tank to the water treatment system for demineralized water production. The project will require up to 235 gallons per minute (gpm) raw water makeup, which will be drawn from the wells and distributed to the plant via underground HDPE and/or PVC pipe.

The treatment process includes two multi-stage reverse osmosis (RO) units, and electrodeionization (EDI) equipment. Pure demineralized water from the process is pumped into a separate demineralized water storage tank. Demineralized water is added to the deaerator for steam plant makeup, for steam cycle blowdown quench water, and for heliostat washing. Wastewater from water treatment system, including first-pass RO reject and EDI as well as a portion of the steam cycle blowdown, will be discharged to the evaporation ponds. The other portion of the steam cycle blowdown will provide a source of makeup water to the steam turbine oil wet surface air cooler. Blowdown from this cooler also will be discharged to the evaporation ponds.

The project will operate (generate electricity) an average of about 8.4 hours per day, 7 days a week throughout the year, with the exception of scheduled shutdowns for maintenance. However, to minimize water treatment system size and capital cost, and to use off-peak energy at night, the water treatment plant will operate an average of approximately 60 percent of each day. A more detailed description of the water supply system, treatment, and permits is provided in Section 5.15, Water Resources.

2.2.5.1 Water Requirements

A breakdown of the estimated average daily quantity of water required for operation of the plant is presented in Table 2.2-1. The average daily use and maximum annual water requirements shown are estimated quantities based on the plant operating at full load.



Notes:

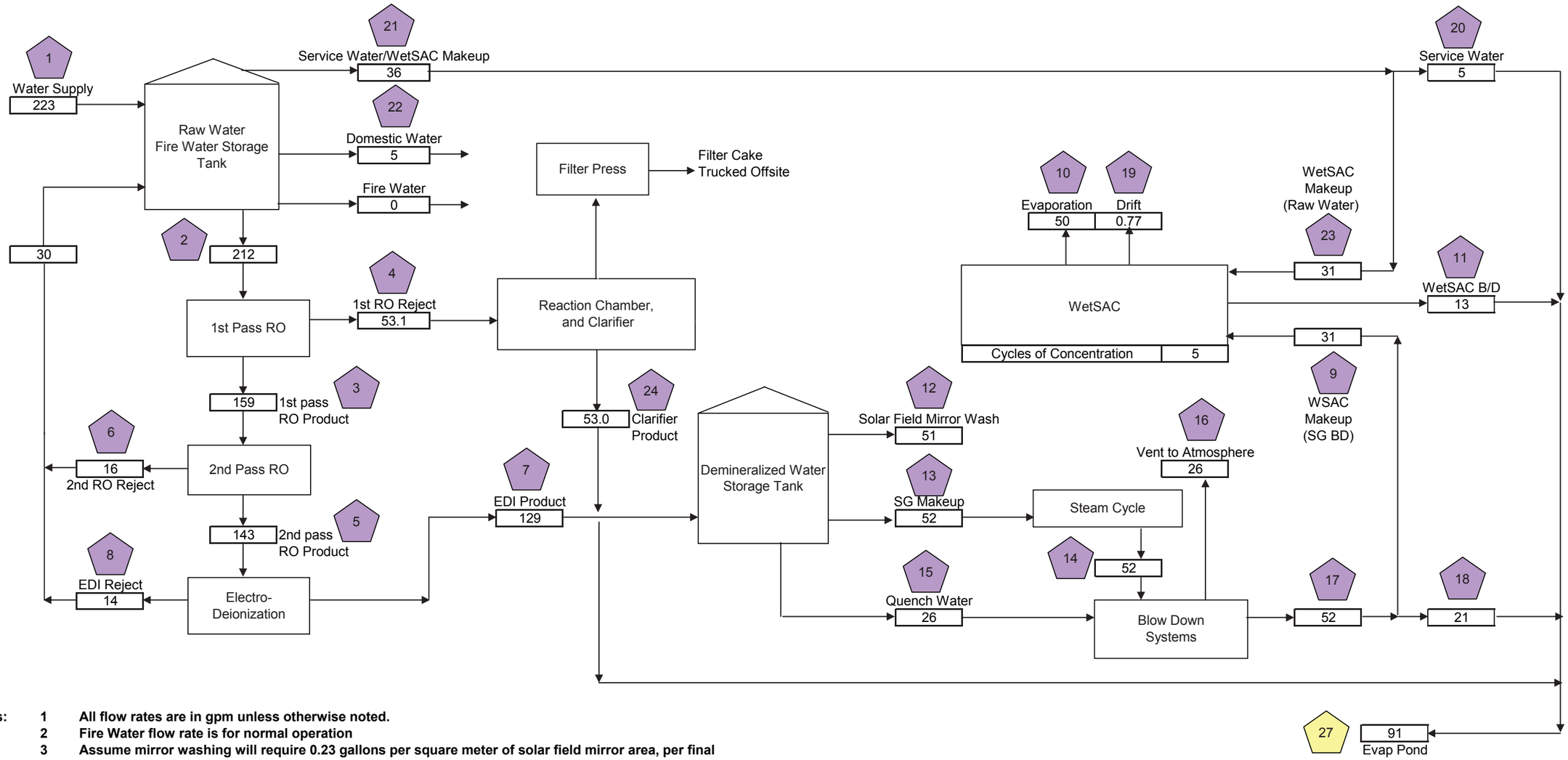
1. **All flow rates are in gpm unless otherwise noted.**
2. **Fire Water flow rate is for normal operation**
3. **Assume mirror washing will require 0.23 gallons per square meter of solar field mirror area, per final Report on the Operation and Maintenance Improvement Program for Concentrating Solar Power Plants.**
4. **Mirror washing will not be performed in the event of water plant shutdown or well shutdown.**
5. **Demin Plant will be sized to operate 24 hours per day.**
6. **Assume 25% reject on 1st pass RO**
7. **Assume 10% reject on 2nd pass RO**
8. **Assume 10% reject on EDI**

Design Case:

Configuration	Solar/Steam Cycle	
Dry bulb Temp	117.0	Deg F
Wet Bulb Temp	73.8	Deg F
Amb Pressure	14.7	psia

FIGURE 2.2-5A
WATER BALANCE DIAGRAM
SUMMER PEAK
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Rev. E.



Notes:

1. **All flow rates are in gpm unless otherwise noted.**
2. **Fire Water flow rate is for normal operation**
3. **Assume mirror washing will require 0.23 gallons per square meter of solar field mirror area, per final Report on the Operation and Maintenance Improvement Program for Concentrating Solar Power Plants.**
4. **Mirror washing will not be performed in the event of water plant shutdown or well shutdown.**
5. **Demin Plant will be sized to operate 24 hours per day.**
6. **Assume 25% reject on 1st pass RO**
7. **Assume 10% reject on 2nd pass RO**
8. **Assume 10% reject on EDI**

Design Case:

Configuration	Solar/Steam Cycle	
Dry bulb Temp	80.0	Deg F
Wet Bulb Temp	59.7	Deg F
Amb Pressure	14.7	psia

FIGURE 2.2-5B
WATER BALANCE DIAGRAM
ANNUAL AVERAGE
Rice Solar Energy Project
Riverside County, California

Source: WorleyParsons, Ltd., Rev. E.

TABLE 2.2-1
RSEP Water Requirements

Water Use	Average Daily Use (gpm)[b]	Annual Use (afy)[a, c]
Heliostat wash	51	31[f]
Steam cycle makeup	52	31
Potable water	5	3
Water treatment reject	53	32
Other uses including wet-surface air cooler (WSAC), service water, quench water	62	38
Margin for other uses[d]	25	15
Total Plant Consumption	248	150
Maximum Annual Use[e]		180

[a]afy = acre-feet per year.

[b]The peak and average daily use figures are based on the water balance diagrams which show instantaneous flow rates through the system based on an operational schedule of 3,286 hours per year.

[c]The annual use is based on the flows for a period of operation of 3,286 hours.

[d]A margin for the uses shown is included to provide for additional items such as additional heliostat wash water, longer run times for the WSAC, contingency, and other items.

[e]The maximum annual use is shown to provide a maximum amount the project expects to use in any given year.

[f]The 31 AF per year is based on washing each heliostat 37 times per year, on a 5 day per week schedule using 2 crews operating 8 hours per day.

2.2.5.2 Water Supply

Water use will mainly be to replenish blowdown of boiler water for proper chemistry control in the steam cycle and for washing of the heliostats. The latter is required to clean the entire field on a 2-week cycle to maintain the heliostats at full optical performance. Lesser volumes of water are required for auxiliary system cooling in a closed-loop system with dry fin-fan coolers for general plant service water and sanitary uses.

2.2.5.3 Water Quality

Section 5.15, Water Resources, includes a projection of the water quality based on data from the existing well on site.

2.2.5.4 Water Treatment

The main water treatment subsystems will be constructed in the water treatment building/area shown on the site general arrangement, and will include the following components.

- **Multimedia Filter –** The multimedia filter (MMF) contains multiple types of media with the coarse media layers in the top of the tank to trap large particles, and successively smaller particles trapped in the finer layers of media deeper in the bed. A coagulant will be introduced before the MMF inlet to capture fine particles for ease of filtration in the MMF. The multi-media filter is backwashed using reverse or upward flow of water

through the filter bed. The various layers of media retain their stratification because each material has a different density.

- **Reverse Osmosis** – The RO system is a filtration process that works by using pressure to force water through a membrane, retaining the contaminants on one side and allowing the pure water to pass to the other side. The RO will be a one- or two-pass system. An anti-scalant and dechlorinator will be injected upstream of the RO skids to reduce the cleaning cycle of the membranes.
- **Electrodeionization** – EDI is a continuous and chemical-free process of removing ionized and ionizable species from the water using DC power. EDI is used to polish the RO permeate and to replace conventional mixed-bed ion exchange, which eliminates the need to store and handle hazardous chemicals used for resin regeneration and associated waste neutralization requirements.

2.2.6 Plant Cooling Systems

The steam-power generation cycle heat rejection system will consist of an air-cooled steam condenser as described previously. Plant auxiliary equipment—including the generator, turbine lube oil system, and various pumps—will be cooled by a closed-loop cooling circuit that utilizes fin-fan heat exchangers that are cooled by mechanical-draft ambient airflow forced across the finned-tubes to cool the water circulating within. Makeup water is required to compensate for minor leakage from the system and for adjustment of system chemistry for corrosion control.

2.2.7 Waste Management

Waste management is the process whereby all wastes produced at the RSEP are properly collected, treated (if necessary), and disposed of. Wastes include process and sanitary wastewater, nonhazardous waste and hazardous waste, both liquid and solid. Waste management is discussed in more detail in Section 5.14.

2.2.7.1 Wastewater Collection, Treatment, and Disposal

The primary wastewater collection system will collect process wastewater from all of the plant systems, including the boiler and steam system drains and water treatment process equipment. To the extent practicable, process wastewater will be recycled and reused. The aggregate discharge from this waste stream will be sent to double-lined evaporation ponds where the water will be retained on site to evaporate, leaving solid waste constituents behind.

The plant will include a potable water treatment system to treat raw water to potable quality water for personnel health, safety, and sanitary uses around the facility. The system will be sized to accommodate a maximum of 47 operations and maintenance personnel consuming a maximum of 150 gallons of water per day. The rate of consumption on this basis is approximately 5 gpm.

2.2.7.2 Plant Drains and Oil/Water Separator

General plant drains will collect containment area washdown, sample drains, and drainage from facility equipment drains. Water from these areas will be collected in a system of floor

drains, hub drains, sumps, and piping and routed to the wastewater collection system. Drains that potentially could contain oil or grease will first be routed through an oil/water separator. Water from the plant wastewater collection system will be sent to the evaporation ponds.

2.2.7.3 Boiler Blowdown

The boiler blowdown stream consists of water purged continuously from the boiler during normal operations to control the concentration of dissolved solids, silica and pH in the boiler following accepted practices and guidelines for corrosion control. Boiler blowdown flow is purged directly from the boiler steam drum and discharged to a flash tank. Demineralized water is injected into the blowdown flow to limit the temperature of (quench) the blowdown water to prevent rapid flashing and over-pressurization when the blowdown water reaches the flash tank, which is vented to atmospheric pressure. The flash tank collects and retains a minimum volume of water and drains excess volumes in equilibrium discharging to the evaporation ponds in a relatively continuous flow. When the power plant is operating normally under steady-state conditions, cycle feedwater makeup rate and boiler blowdown rate is equal. Flows may vary during transient conditions such as startup, load-changes and shut-down.

2.2.7.4 Sanitary Waste

Sanitary waste streams will be generated at both the administrative building near the entrance to the plant at the north, and at the operations building and maintenance areas within the power block. Each area will have a kitchen as well as the requisite quantity of toilets and or showers to support the crew size. At these locations, a septic tank and leach field will be used to capture and treat the flows. As and when required, the septic tank (solids holding tank) will be cleaned out by a vacuum truck and the wastes will be trucked and disposed at a licensed facility. This activity will adhere to the plant safety program as administered by plant personnel.

2.2.7.5 Solid Wastes

The RSEP will produce maintenance and plant wastes typical of power generation operations. Generation plant wastes include oily rags, broken and rusted metal and machine parts, defective or broken electrical materials, empty containers, broken mirrors, salt that has leaked and hardened, and other solid wastes including the typical refuse generated by workers. Solid wastes will be trucked off site for recycling or disposal (see Section 5.14, Waste Management).

2.2.7.6 Hazardous Wastes

Several methods will be employed to properly manage and dispose of hazardous wastes generated by the RSEP. Lubricating oil will be rigorously analyzed to ensure maximum equipment reliability and operational life. When end-of-life lubricating oil is replaced, the spent oil will be flushed from the system and recycled by a properly licensed waste oil recycling contractor. Spent lubricating oil filters will be changed at the appropriate frequency and disposed of in a Class I landfill.

Salt spills from the system or salt samples extracted pose no significant concerns with respect to hazardous waste; however, this inert material is controlled under Homeland

Security regulations. As such, any salt handled outside the closed salt circulation and storage systems will be treated as a controlled substance in accordance with the applicable laws and statutes.

During pre-commissioning activities, water is flushed through most plant systems to remove particulate debris. Accordingly, this waste stream is subject to contain high iron concentrations and other impurities. The drained fluids will be temporarily retained on site in portable fractionating tanks or other vessels for settling and neutralization, and the water will eventually be disposed of off site by the system cleaning contractor in accordance with applicable regulatory requirements.

Following construction and before initial filling and commissioning of boiler and steam systems, all two-phase (water-steam) system piping and vessels will be chemically treated for removal of mill scale, weld slag, and other imperfections, and to "passivate" the internal surfaces of system components. Weak alkali and acid solutions (such as EDTA) are introduced and the systems are allowed to soak. Chemical reactions result in a tightly adherent layer of iron oxide which improves durability of the internal surfaces against oxygen attack and other corrosion mechanisms once the system is placed in service. Lastly, the pressure systems are completely filled and then subjected to hydro-static testing above the normal operating pressure in order to validate the integrity of the pressure parts. Due to the remote location of the project site, the steam blow and hydro testing processes will be conducted continuously around the clock until completed.

Plant personnel and maintenance workers will be trained to handle hazardous wastes generated at the site in accordance with all applicable regulations and protocols.

2.2.8 Management of Hazardous Materials

A variety of chemicals will be stored and used during construction and operation of the RSEP. The storage, handling, and use of all chemicals will be conducted in accordance with applicable LORS. Chemicals will be stored in appropriate chemical storage facilities. Bulk chemicals will be stored in storage tanks, and most other chemicals will be stored in returnable delivery containers (totes). Chemical storage and chemical feed areas will be designed to contain leaks and spills. Concrete containment pits and drain piping design will allow a full-tank capacity spill without overflowing the containment. For multiple tanks located within the same containment area, the capacity of the largest single tank will determine the volume of the containment area and drain piping. Drain piping for reactive chemicals will be trapped and isolated from other drains to eliminate noxious or toxic vapors.

Safety showers and eyewash stations will be provided adjacent to, or in the vicinity of, chemical storage and use areas. Plant personnel will use approved personal protective equipment (PPE) during chemical spill containment and cleanup activities. Personnel will be properly trained in the handling of these chemicals and instructed in the procedures to follow in case of a chemical spill or accidental release. Adequate supplies of absorbent material will be stored on site for spill cleanup.

A list of the chemicals anticipated to be used at the RSEP and their storage locations is provided in Section 5.5, Hazardous Materials Handling. This list identifies each chemical by type, intended use, and estimated quantity to be stored on site.

2.2.9 Emission Control and Monitoring

Diesel-powered equipment on site will include two fire pumps and two emergency generators. The diesel engines will only be operated during bona fide emergencies and periodically for brief periods as required by relevant codes and standards for reliability testing or maintenance within strict limitations on acceptable fuels and maximum allowable run hours. Accordingly, these emissions sources will not require monitoring. Section 5.1, Air Quality, includes additional information on emission control and monitoring.

2.2.9.1 NO_x Emission Control

NO_x will not be generated during operation of the RSEP. However, during plant commissioning, the initial melting, heating, and conditioning of the salt will result in limited NO_x emissions. For the melting and heating segments of the process, two small boilers each employing ultra low NO_x burners, flue gas recirculation, and a four-step chemical scrubber will be used to mitigate emissions from the combustion of propane or compressed natural gas. An alternative process to control NOx would be selective catalytic reduction (SCR) using aqueous ammonia. The salt conditioning process is a one-time event that takes place during plant commissioning, resulting in a closed loop system of liquid salt storage and circulation that will be continued for the life of the project. At no other time will NO_x be generated during the operation of the RSEP. Section 5.1, Air Quality, includes additional information on emission control and monitoring.

2.2.9.2 Particulate Emission Control

Particulate emissions will only be of concern during the salt melting, heating, and conditioning processes described above. Particulate emissions will be controlled by the use of best combustion practices, including the measures discussed in the preceding paragraph.

2.2.9.3 Continuous Emission Monitoring

Continuous emission monitoring will not be used at the RSEP, because there will be no source of emissions once the plant is fully commissioned, or throughout the life of the plant.

2.2.10 Fire Protection

The fire protection system will be designed to protect personnel and limit property loss and plant downtime in the event of a fire. The primary source of fire protection water will be the raw water storage tank.

Two sets of diesel fire pumps will be used at the RSEP in accordance with relevant National Fire Protection Association (NFPA) guidelines (NFPA-22, 850, etc.). Each set of fire pumps will be provided with an electric jockey pump and electric motor-driven main fire pump to increase the water pressure in the plant fire main to the level required to serve all fire fighting systems. In addition, each will have a back-up diesel-engine-driven fire pump to pressurize the fire loop if the power supply to the electric-motor-driven main fire pump fails. A fire pump controller will be provided for each fire pump. One fire pump set will serve the fire needs within the power block and the central receiver tower and the second fire pump set will serve the needs at the administration/shop areas outside the perimeter of the heliostat field.

Each set of fire pumps will discharge to a dedicated fire-water loop piping system consisting of both underground piping and aboveground hydrants, sprinklers, and risers. During normal service, the jockey pump will operate randomly in order to maintain normal pressure within the fire-water loop. Both the fire hydrants and the fixed suppression systems will be supplied from the main fire-water loop. Fixed fire-suppression systems will be installed at determined fire risk areas such as the steam turbine lube oil and hydraulic oil equipment. Sprinkler systems will also be installed in the administration building, shop maintenance building, water treatment building, and fire pump enclosures as required by the NFPA and local code requirements. Handheld fire extinguishers of the appropriate size and rating will be located throughout the facility in accordance with NFPA 10, and subject to detail design and requirements established by local authorities.

Section 5.5, Hazardous Materials Handling, includes additional information on fire and explosion risks, and Section 5.10, Socioeconomics, provides information on local fire protection capability.

2.2.11 Plant Auxiliaries

The following systems will support, protect, and control the generating facility.

2.2.11.1 Service Air

The compressed air system provides instrument air and service air to points of use throughout the facility. The compressed air system will include two 100-percent-capacity motor-driven air compressors, two air dryers with prefilters and after filters, an air receiver, instrument air header, and service air header. All instrument air will be dried. A control valve will be provided in the service air header to prevent high consumption of service air from reducing the instrument air header pressure below critical levels.

An instrument air compressor will also be located in the receiver tower at an upper elevation. In addition to control and instrumentation use, this compressor will be used to maintain constant pressure on the receiver's emergency coolant vessel (ECV). The ECV provides a reserve volume of liquid salt that will maintain salt flow through the receiver tubes during short-duration emergency incidents involving loss of normal salt pump flow.

2.2.11.2 Instrument Air

The instrument air system will provide dry, oil-free air to pneumatic actuators and various control and instrumentation devices throughout the plant. Instrument air header piping and tubing will be routed to locations within the facility equipment areas and within the water treatment facility where pneumatic operators and devices will be located. An instrument air compressor will be located in the receiver tower at an upper elevation. In addition to control and instrumentation use, this compressor will be used to maintain constant pressure on the receiver's ECV. The ECV provides a reserve volume of liquid salt that will maintain salt flow through the receiver tubes during short-duration emergency incidents involving loss of normal salt pump flow.

2.2.11.3 Distributed Control System

The DCS provides modulating control, digital control, monitoring, and indicating functions for the plant power block systems. The following functions will be provided:

- Controlling the STG, steam generation system, heliostat mirrors, and other systems in a coordinated manner
- Controlling the balance-of-plant systems in response to plant demands
- Monitoring controlled plant equipment and process parameters and delivery of this information to plant operators
- Providing control displays (printed logs, liquid-crystal diode [LCD] video monitors) for signals generated within the system or received from system control input /output (I/O)
- Providing consolidated plant process status information through displays presented in a timely and meaningful manner
- Providing alarms for out-of-limit parameters or parameter trends, displaying on alarm video monitors(s), and recording on an alarm log printer
- Providing storage and retrieval of historical data

The DCS will be a redundant microprocessor-based system and will consist of the following major components:

- Personal computer (PC)-based operator consoles with LCD video monitors
- Engineering work station
- Distributed processing units
- I/O cabinets
- Historical data unit
- Printers
- Data links to the steam turbine control system

The DCS will have a functionally distributed architecture comprising a group of similar redundant processing units linked to a group of operator consoles and the engineering workstation by redundant data highways. Each processor will be programmed to perform specific dedicated tasks for control information, data acquisition, annunciation, and historical data storage and retrieval purposes. Being redundant, no single processor failure can cause or prevent a plant shutdown.

The DCS will interface with the control systems furnished by heliostat mirror and STG suppliers to provide remote control capabilities, as well as data acquisition, annunciation, and historical storage of turbine and generator operating information.

The system will be designed with sufficient redundancy to preclude a single device failure from significantly affecting overall plant control and operation. This also will allow critical control and safety systems to have redundancy of controls, as well as an uninterruptible power source.

As part of the quality control program, daily operator logs will be available for review to determine the status of operating equipment.

2.2.11.4 Lighting

Plant lighting will be provided throughout the facility at the minimum luminescence in any given area as required for personnel and plant safety. Relevant codes and standards will dictate design with due regard to minimize spillage and lighting efficiency. Lighting will generally be applied in the following areas:

- Building interior equipment, office, control, shop maintenance, water treatment, and steam generation buildings
- Building exterior entrances and driveways
- Outdoor equipment within the power block and switchyard areas including the steam turbine, pipe rack, and ACC
- Thermal storage tank containment areas to observe for leakage
- Power transformers and outdoor power and control panels
- Power block perimeter roadway and internal driveways
- Administration building parking, parking areas within the power block
- Plant entrance road, signage, and main gate
- Water treatment building exterior where any cycle treatment chemical tanks are located

Lighting levels shall be as recommended in the IES Illumination standards, and in accordance with applicable permits and regulations of the State of California. Suitable fixtures shall be specified and installed according to the hazardous area classification. Emergency lighting shall be provided for safe egress from all plant areas.

Outdoor lighting shall be photocell controlled through contactors that feed or control the outdoor lighting. To reduce the visual impact created by outdoor lighting, the following mitigation measures shall be adopted:

- Even though the project is in the remote area, according to California Energy Commission (CEC) requirements, lighting on the project site shall be limited to areas required for safety and shall be shielded from public view to the extent possible.
- Lights shall be directed on site so that significant light or glare shall not be created.
- Nighttime backscatter illumination shall be avoided by directional shielding of lights.

Low-voltage distribution panelboards for lighting and receptacles shall be sized to distribute the capacity of the dedicated supplying transformer and shall be located near the loads connected to each panel. All lighting panelboards shall be located indoors, to the extent practical.

2.2.11.5 Grounding

The electrical system is susceptible to ground faults and lightning and switching surges that can pose hazards to site personnel and electrical equipment. The station grounding system will provide an adequate path to ground to permit the dissipation of large current flows created by these events. The station grounding grid will be designed for adequate capacity to dissipate heat from ground current under the most severe conditions in areas of high ground fault current concentration.

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.

The station grounding grid will be designed for adequate capacity to dissipate the ground fault current from the ground grid under the most severe conditions in areas of high ground fault current concentration. The grid spacing will maintain safe voltage gradients.

2.2.11.6 Cathodic Protection

The cathodic protection system will be designed to limit the electrochemical corrosion of designated metal piping buried in the soil. Depending on the corrosion potential and the site soils, either passive or impressed current cathodic protection will be provided.

2.2.11.7 Emergency Protection

Two emergency diesel generator sets of approximately 2.5 MW each will be employed to protect critical systems during loss-of-power emergencies. Additionally, the plant will include two diesel-engine-driven fire pumps as required by fire protection codes to protect facilities in the event of fire.

2.2.12 Project Construction

Construction of the generating facility, from site preparation and grading to commercial operation, is expected to take place from the first quarter of 2011 to the third quarter of 2013 (30 months total). Major milestones are listed in Table 2.2-2.

TABLE 2.2-2
Project Schedule Major Milestones

Activity	Date
Begin construction	First Quarter 2011
Begin startup and testing	First Quarter 2013
Begin commercial operation	Third Quarter 2013

There will be a peak workforce of approximately 438 construction craft people, supervisory, support, and construction management personnel on site during construction. The peak construction site workforce level is expected to occur between months 8 and 20.

Construction activities will generally occur between 5 a.m. and 7 p.m. on weekdays and Saturdays. Construction at times may take place on a 24-hour, 7-day-per-week basis to make up schedule deficiencies, to work around extreme mid-day heat during summer months and other extreme weather events, or to complete critical construction activities (e.g., pouring concrete at night during hot weather, working around time-critical shutdowns and constraints). During the commissioning phase of the project, some limited work activities may continue around the clock.

Table 2.2-3 provides an estimate of the average and peak construction traffic during the 30-month construction period for the plant and associated linear facilities.

TABLE 2.2-3
Average and Peak Construction Traffic

Vehicle Type	Average Daily Trips	Peak Daily Trips
Construction Workers	306	438
Deliveries	51	90
Total	**357**	**528**

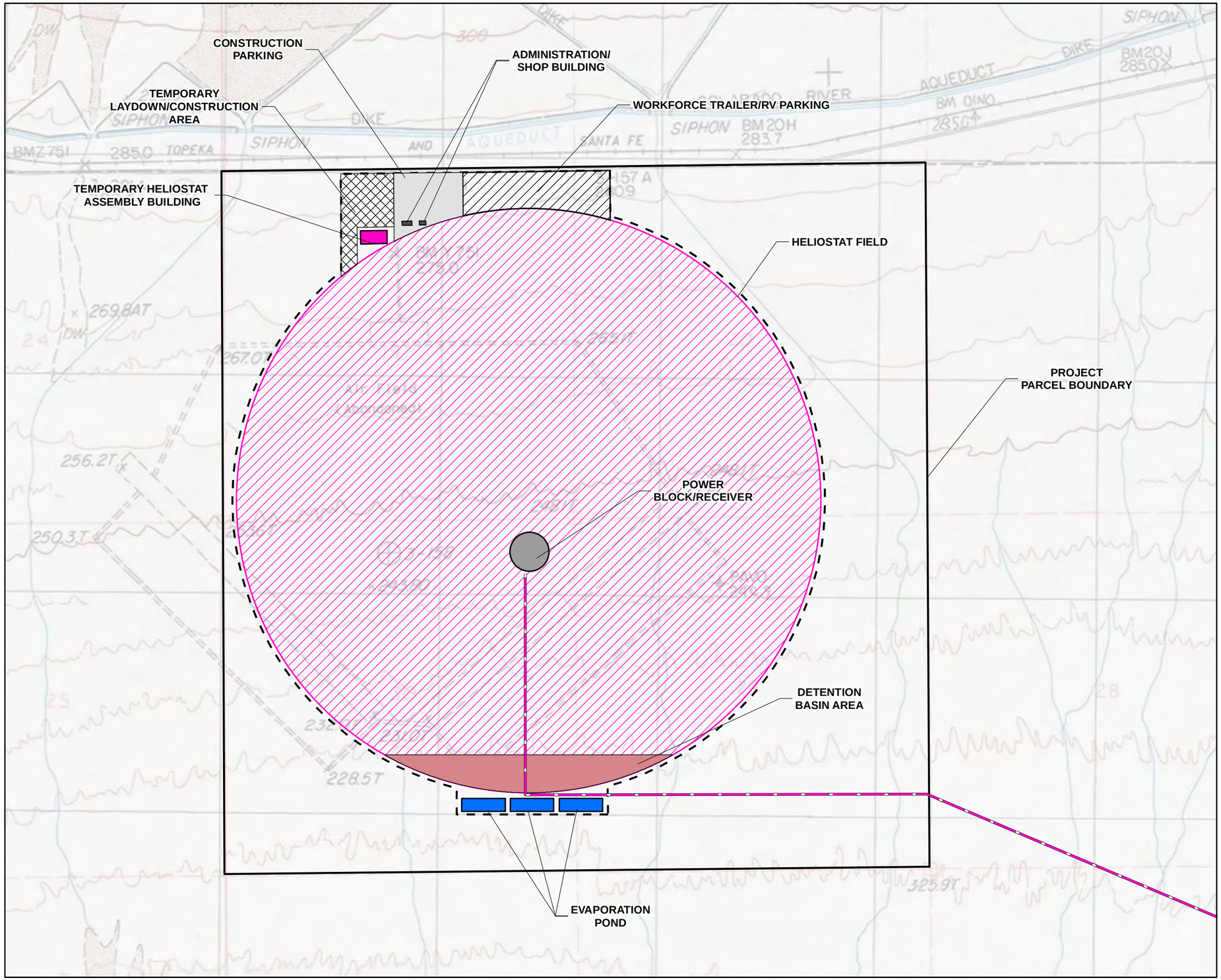
The construction laydown and parking areas will occupy those areas of the plant site that are both inside and outside the edges of the heliostat fields (see Figure 2.2-6). Construction access will be from SR 62 to the plant entrance road. All materials and equipment will be delivered to the site by truck.

The RSEP will receive deliveries of materials from local, regional, and some international points of origin including bulk commodity materials, engineered equipment and machinery, and general construction materials. The RSEP site is not currently served by rail. The RSEP will rely on transport by truck for the final delivery of materials to the site including those materials that are brought into the region by rail or ship. These materials will be trans-loaded onto trucks at various ports and depots for delivery to the site.

Heavy and oversized loads will be delivered using trucks and trailers equipped to handle these specialized loads. Oversized loads will be individually permitted to transport each such load to the site. Heavy and oversized loads are typical of a common power plant or process facility and may include items such as the step-up transformer, the solar receiver panels, steam turbine, generator, tanks and certain heavy equipment.

The RSEP site is approximately 40 miles from Blythe, 65 miles from Needles, and 75 miles from Twentynine Palms. Major cities in the surrounding region include Yuma, Arizona, (85 miles), San Bernardino, California (140 miles), Phoenix, Arizona (150 miles), Riverside, California (172 miles), and Las Vegas, Nevada (200 miles). The port of Long Beach is 235 miles from the RSEP.

Given the remote location of the project site, regional truck deliveries may be routed to the RSEP from Interstate 10 and Interstate 40, accessing the site via US 95, Desert Center Road, and SR 62. It may be possible to route some deliveries into the local area via rail and off-load the deliveries onto drayage trucks at nearby, existing rail sidings close to the site. If this proves possible, this may reduce by some amount the quantity and or frequency of



LEGEND

- GENERATOR TIE-LINE
- ADMINISTRATION/SHOP
- CONSTRUCTION PARKING
- DETENTION BASIN AREA
- EVAPORATION POND
- PROJECT FENCELINE BOUNDARY
- HELIOSTAT FIELD
- PROJECT PARCEL BOUNDARY
- POWER BLOCK/RECEIVER
- TEMPORARY HELIOSTAT AREA
- TEMPORARY LAYDOWN/CONSTRUCTION AREA
- WORKFORCE TRAILER/RV PARKING

This map was compiled from various scale source data and maps and is intended for use as only an approximate representation of actual locations.

N

0 750 1,500
Feet

FIGURE 2.2-6
CONSTRUCTION LAYDOWN AREAS
RICE SOLAR ENERGY PROJECT
RIVERSIDE COUNTY, CALIFORNIA

long-haul truck trips and may ease traffic burden on surrounding highways and through local communities.

Also because of the remote location of the site, RSE will make available a construction workforce RV/trailer parking camp on the project site (see Figure 2.2-6) near the parking and laydown areas at the north end of the heliostat field. The workforce camp will offer spaces for up to 300 trailers or RVs (in keeping with the county requirement that limits trailer parks to 20 per acre), electrical hookups, and mobile water and sanitary sewer service for the trailers and RVs.

2.2.13 Salt System Charging

Following the construction of the salt storage tanks, the salt will be blended, melted, and loaded into the liquid salt storage tanks. Salt is delivered to the project site in solid form and as two separate components, sodium nitrate and potassium nitrate. These must be blended, melted into liquid form, and then conditioned to thermally inactivate certain impurities. This subsection describes the salt mixing, melting, and conditioning processes.

2.2.13.1 Salt Mixing

Dry solid crystalline salt (in powder or prill form) is delivered to an onsite storage and staging location that is covered and secure. The salt is delivered in 1.2 metric ton (MT) sacks of woven polypropylene known as flexible intermediate bulk containers (FIBC), which are designed for ease of handling, shipping, and storing of dry, flowable products. FIBC sacks are moved by forklifts or other mechanized conveyance to a hammer mill that breaks up the solidified salt blocks into the granular (or prill) state. The salt is then loaded into large hoppers allowing for control of solid product flow rate for precise blending. Separate hoppers hold each component (sodium nitrate or potassium nitrate) of the final salt mixture. The salt is conveyed from each respective hopper and mixed into a composition of approximately 60 percent sodium nitrate and 40 percent potassium nitrate by weight. The proportioned salt mixture is then fed into the gas-fired salt melter.

2.2.13.2 Salt Melting and Heating

The salt melter is an insulated tank that will be heated by combustion of propane (or, alternatively, natural gas). The solid salt blend is brought to a temperature between 550°F and 700°F (at least 90°F above its melting point of 460°F) and then pumped out of the salt melter into a secondary gas-fired heater and further heated to elevate temperature to a range required for the final conditioning process. The melting and heating process is expected to operate continuously, 24 hours per day and 7 days per week, until the plant's total inventory of 35,000 tons of salt has been melted. Refer to Section 5.1, Air Quality, for information on emission controls for the salt melting and heating equipment.

2.2.13.3 Salt Conditioning

The additional heating of the salt in the secondary gas-fired heater will oxidize (inactivate) impurities naturally occurring in the salt product, most notably magnesium nitrate. Oxidation of magnesium nitrate, occurring at high temperatures generally in excess of 900˚F, results in the release of nitrogen oxides (NOx) in amounts proportional to its actual concentration (as a trace impurity) in the delivered salts.

This thermal conditioning of the salt intentionally oxidizes magnesium nitrate and liberates NOx during a discrete, one-time process taking place prior to placing the solar-thermal

system in service. This allows for the effective and efficient removal of all but trace amounts of NOx once the conditioning process has been completed. The salt conditioning process occurs concurrently with and downstream of the salt melting and heating process. Refer to Section 5.1, Air Quality, for information on temporary emission controls for the salt conditioning process.

2.2.14 Generating Facility Operation

The RSEP is designed to maximize solar energy collection during daylight hours while enabling a highly efficient steam turbine power generation cycle to operate during hours of highest system demand, which generally occur during afternoons and early evenings. The process is more efficient than other solar-thermal processes by enabling a highly controllable generation platform that is highly responsive to system load conditions. The project will be dispatchable, load-following, and operated at an annual capacity factor of approximately 35 percent.

2.2.14.1 Operating Modes

It is anticipated that all the electricity produced by the plant will be sold under contract to one or more contract power purchasers. The exact operational profile of the plant will be dependent on weather conditions, and generation controlled by the power purchaser's economic dispatch decisions and portfolio resource scheduling, transmission constraints and other factors. Given the inherent properties of the thermal energy storage system, the power plant will participate in the day-ahead scheduling market controlled by California Independent System Operator (CAISO) with the power purchaser acting as Scheduling Coordinator for the generating unit.

On a daily basis, however, the facility would be operated in the following modes:

- **Long-Term Hold.** The facility is shut down with the heliostats in the stow position, the salt pumps off, the receiver panels, riser, and downcomer are drained, electric heat trace set to trickle heat, and positive air flow is established through the salt side of the receiver. The salt side of the steam generation modules is drained, with heat trace set to low temperature or off on the heat exchangers and associated piping for maintenance, as applicable. The feedwater side of the steam generation modules is also depressurized and drained, with a nitrogen blanket maintained to preclude corrosion inside the system. Salt in the storage tanks is maintained in a liquid state by means of installed electrical heat trace. The ACC is at atmospheric pressure, the steam turbine is shutdown, cold, and off the turning gear. This condition is expected to occur only during periods of extended maintenance outage (more than about 7 days).
- **Short-Term Hold**. This is a transition mode from Long-Term Hold to Standby as the facility is prepared for operation. The heliostats remain in the stow position. Heat trace on the salt side of the steam generation modules and associated piping is energized. A condensate pump is started to fill the water side of the steam generation modules. A cold salt pump is started to fill the salt side of the steam generation modules and bring the temperatures up to 550°F. The receiver panels, riser, and downcomer remain

drained; however, air flow through the salt side of the receiver is terminated in preparation for filling. The feed booster pump is started in preparation to supply feedwater for seal steam demand. The steam turbine is placed on the turning gear in preparation for startup, and the ACC remains at atmospheric pressure.

- **Standby**. The heliostats are moved from the stow position to standby aim points, and salt flow is established to the tower. Salt is pumped from the cold salt tank, up the riser, through the upper bypass, the downcomer, the lower bypass and back into the cold salt tank. The heat trace is fully energized. The condensate and the feed booster pumps are running to supply feedwater for seal steam demand. The steam turbine remains on the turning gear, and seal steam is admitted to the turbine gland seals as soon as steam conditions permit. Vacuum is established in the ACC.

- **Preheat**. Heliostats are moved from standby aim points to the receiver panels to preheat the receiver. Salt flow is diverted to fill the receiver panels. Hot salt flow is now initiated and blended with cold salt to bring the steam generation modules up to operating temperature. Hot salt out of the receiver passes through the downcomer and is redirected into the hot salt tank once the salt temperature reaches 1,050°F. Steam from the superheater is admitted to the steam system to preheat the piping and begin heating the steam turbine. The heat trace cycles off. The steam turbine is on the turning gear, seal steam is maintained to the turbine gland seals, and vacuum is maintained in the ACC.

- **Normal Operation**. Cold salt flow from the riser is directed through the receiver panels, the downcomer, and to the hot salt tank. The heliostats are focused on the panels, and salt flow control is set to limit salt temperature exiting the receiver to 1,050°F, and the heat trace is de-energized. Hot salt is now flowing through the steam generating modules and steam flow is being generated in the steam system. As steam temperature, pressure, and flow steadily increase, the steam turbine is taken off the turning gear, and the unit rolled with steam. Once the steam parameters are sufficient, and the turbine metal temperatures have stabilized, the steam turbine generator is ramped to full speed, synchronized to the transmission network, and load increased to rated (dispatched) output.

- **Cloud Standby**. The salt flow is taken off automatic control. Cold salt flow from the riser continues through the receiver panels, the downcomer, and to the hot salt tank until the salt temperature exiting the receiver drops below 700°F. At the operator's discretion, salt flow from the downcomer may then be redirected back to the cold salt tank. The heliostats remain focused on the panels, and the heat trace remains de-energized. This is intended to be a short-term condition. If cloud cover persists and will not allow further solar collection, the stored energy in the hot salt may be used to continue to produce steam and operate the steam turbine. Once the hot salt temperature drops and steam quality cannot be maintained, the plant can be placed back into a Standby or Overnight Hold mode, depending on the ambient conditions at that time.

- **Overnight Hold**. The facility is partially shutdown with the heliostats in the stow position, a limited number of cold salt pumps running for attemperation to reduce heat exchanger temperatures and maintain the steam generation modules at or near 550°F. The receiver panels, riser, and downcomer are drained to the cold salt tank, and electric heat trace is energized as needed. A condensate pump and the feed booster pump are

running to supply feedwater for seal steam demand. The steam turbine, once disconnected from the transmission network and steam flow stopped, is placed on the turning gear. Seal steam is maintained to the turbine gland seals, and vacuum is maintained in the ACC.

2.2.14.2 Operations and Maintenance Personnel

The RSEP is expected to employ up to 47 full-time employees. Anticipated job classifications are shown in Table 2.2-4.

TABLE 2.2-4
Typical Plant Operation & Maintenance Workforce

Department	Personnel	Shift*	Workdays
Operations	(20) Plant Operating Personnel (1) Plant Chemist	Standard 8-hour days, 4 operators per shift (5 crews of 4)	7 days per week, 24 hours per day
Heliostat Washing	(8) Heliostat Servicemen	Standard 8-hour days	5 days a week, with additional coverage as required by seasonal and other effects
Maintenance	(4) Mechanical Technicians (4) Electrical/I&C Technicians (4) Laborers (Semi-Skilled)	4x10 hour shifts or 5x8 hour shifts	Monday through Friday (Maintenance crews may also work unscheduled days and hours as needed to support plant outages)
Administration	(6) Total (1) Plant General Manager (1) Operations Superintendent (1) Plant Engineer (1) Maintenance Manager (1) Maintenance Planner (1) Administrative Assistant	4x10 hour shifts or 5x8 hour shifts	Monday through Friday with additional coverage as needed

Note:
Operation & maintenance shifts may include nighttime work routines, particularly during conditions of extreme summer heat.

The plant operating personnel are responsible for the overall operation of the facility. A shift supervisor, a control room operator, and two field operators will attend to the plant around the clock. Maintenance technicians will attend to the plant equipment maintenance schedule daily, and will be available as needed to attend to urgent needs during evening and night shift operations. The Plant General Manager will be responsible for the plant and all activities associated with operations and maintenance. The Operations Superintendent will be responsible for all matters pertaining to plant operations and report to the Plant General Manager. The Maintenance Manager, with the aid of the Maintenance Planner, will be responsible to the Plant General Manager for maintenance of the plant. The Plant Engineer will also report to the Plant General Manager, and provide engineering support for maintenance

and operations needs. The Administrative Assistant will report to the Plant General Manager and provide administrative support as directed.

A separate crew dedicated solely to heliostat washing will report to the Maintenance Manager. Heliostat washing is accomplished by filling a number of diesel-fueled tank trucks specially fitted with high-pressure washers. The trucks are filled with demineralized water and then driven slowly through the heliostat field, spraying high pressure water onto the heliostat mirrors effectively removing any accumulated dust or foreign matter. The trucks will be fueled by a separate onsite 10,000-gallon diesel storage tank. They will draw water from the demineralized water storage tank via a gravity-fed filling station located adjacent to the power block perimeter road.

2.2.14.3 Unplanned Outages

In the unlikely event of an unplanned (forced) outage situation that causes a long-term cessation of facility operations, security of the facilities will be maintained on a 24-hour basis, and the CEC will be notified. Depending on the length of shutdown, a contingency plan for the long-term cessation of operations may be implemented. Such contingency plan will be in conformance with all applicable LORS and protection of public health, safety, and the environment. The plan, depending on the expected duration of the shutdown, could include the draining of all chemicals from storage tanks and other equipment and the safe shutdown of all equipment. Salt in the storage tanks would be maintained in a liquid state through means of the installed electrical heaters. All wastes from equipment shutdown will be disposed of according to applicable LORS. If the cessation of operations becomes permanent, the plant will be decommissioned (see Section 2.4, Facility Closure).

2.3 Engineering

In accordance with CEC regulations, this section, together with the engineering appendices, presents information concerning the design and engineering of the RSEP. The LORS applicable to the engineering of the RSEP are provided along with a list of agencies that have jurisdiction, the contact persons within those agencies, and a list of the permits that will be required.

2.3.1 Facility Design

A detailed description of the RSEP is provided in Section 2.1, Generating Facility Description, Design, and Operation. Design for safety is provided in Section 2.2.1.1, Facility Safety Design. A preliminary geotechnical report for the RSEP site based on borings taken at the project site is included as Appendix 2B, and summary descriptions of the design criteria for all major engineering disciplines are included in Appendix 2C.

Design and engineering information and data for the following systems are found in the following sections of this AFC:

- **Power Generation**—See Section 2.1.3, Process Description. Also see Appendix 2C and Sections 2.1.4 through 2.1.15, which describe the various plant auxiliaries.
- **Heat Dissipation**—See Section 2.1.3.6, Air-Cooled Condenser, and Appendix 2C.

- **Air Emission Control System**—See Section 2.1.10, Emission Control and Monitoring, and Section 5.1, Air Quality.
- **Waste Disposal System**—See Section 2.1.8 and Section 5.14, Waste Management.
- **Noise Abatement System**—See Section 5.7, Noise.
- **Switchyards/Transformer Systems**—See Section 2.1.4, Major Electrical Equipment and Systems; Section 2.1.12.5, Grounding; Section 2.1.4.2, Electrical Generation; Section 3.0, Electric Transmission; and Appendix 2C.

2.3.1.1 Facility Safety Design

The RSEP will be designed to maximize safe operation. Potential hazards that could affect the facility include earthquake, flood, and fire. Facility operators will be trained in safe operation, maintenance, and emergency response procedures to minimize the risk of personal injury and damage to the plant.

2.3.1.1.1 Natural Hazards

The principal natural hazard associated with the project site is earthquakes. The site is located in a seismic area of the state of California. Structures will be designed to meet the seismic requirements of the California Code of Regulations Title 24 and the 2007 California Building Code (CBC). Section 5.4, Geologic Hazards and Resources, includes a review of potential geologic hazards, seismic ground motion, and potential for soil liquefaction due to ground shaking events. Potential seismic hazards will be mitigated by implementing the 2007 CBC construction guidelines. Appendix 2C includes the structural seismic design criteria for the buildings and equipment.

Flooding is not a hazard of concern at the RSEP site. According to the Federal Emergency Management Agency (FEMA), the site is not within the 100 year flood plain. Section 5.15, Water Resources, includes additional information on the potential for flooding.

2.3.1.1.2 Emergency Systems and Safety Precautions

This subsection discusses the fire protection systems, emergency medical services, and safety precautions to be used by project personnel. Section 5.10, Socioeconomics, includes additional information on area medical services, and Section 5.16, Worker Health and Safety, includes additional information on safety for workers. Appendix 2C contains the design practices and codes applicable to safety design for the project. Compliance with these requirements will minimize project effects on public and employee safety.

- **Fire Protection Systems** – The project will rely on both onsite fire protection systems and local fire protection services.
- **Onsite Fire Protection Systems** – The fire protection systems are designed to protect personnel and limit property loss and plant downtime from fire or explosion. The project will have the following fire protection systems:
  - **Steam Turbine Oil Areas Water Spray System.** This system provides suppression for the steam turbine area lube oil and hydraulic oil piping and storage.
  - **Fire Hydrants/Hose Stations.** This system will supplement the plant's fixed fire suppression systems. Water will be supplied from the plant fire water system.

- **Fire Extinguishers.** The plant administration building, control room, shop maintenance building, water treatment building, and other structures will be equipped with fixed fire suppression systems and portable fire extinguishers as required by the local fire department.

- **Local Fire Protection Services –** The RSEP is within the jurisdiction of Riverside County's Lake Tamarisk Fire Station #49 in Desert Center, California, which provides fire and emergency medical technician (EMT) services to the area. Their approximate response time is 45 minutes. Station #49 has a Type 1 engine and a paramedic response vehicle. They have three staff on duty at all times (one captain and one firefighters/EMTs). Lake Tamarisk Fire Station also receives assistance from the Blythe Fire Station #46 for responses requiring more assistance.

  Additional emergency services are available via air lift by helicopter from the Desert Resorts Regional Airport near Thermal, California. Mercy Air, Reach, and California Highway Patrol can be available with a response time of approximately 25 to 30 minutes.

  The Hazardous Materials Risk Management Plan (see Section 5.5, Hazardous Materials Handling) for the plant will include all information necessary to allow fire-fighting and other emergency response agencies to plan and implement safe responses to fires, spills, and other emergencies.

- **Personnel Safety Program –** The RSEP will operate in compliance with federal and state occupational safety and health program requirements. Compliance with these programs will minimize project effects on employee safety. These programs are described in Section 5.16, Worker Health and Safety.

2.3.2 Facility Reliability

This subsection discusses the expected facility availability, equipment redundancy, fuel availability, water availability, and project quality control measures.

2.3.2.1 Facility Availability

Because of the RSEP system needs, it is anticipated that the facility will normally operate at high average annual capacity factors during periods of sunlight. The plant will be designed for an operating life of 30 years. Reliability and availability projections are based on this operating life. Operation and maintenance procedures will be consistent with industry standard practices to maintain the useful life status of plant components.

The percent of time that power plants are projected to be operated is defined as the service factor. The service factor considers the amount of time that a unit is operating and generating power, whether at full or partial load. The projected service factor for the power block, which considers projected percent of time of operation, differs from the equivalent availability factor (EAF), which considers the projected percent of energy production capacity achievable.

The EAF may be defined as a weighted average of the percent of full energy production capacity achievable. The projected equivalent availability factor for the RSEP is estimated to be approximately 92 to 98 percent.

2.3.2.2 Redundancy of Critical Components

The following subsection identifies equipment redundancy as it applies to project availability. A summary of equipment redundancy is shown in Table 2.3-1.

TABLE 2.3-1
Major Equipment Redundancy

Description	Number	Note
Solar Receiver	One	There are 14 individual panels – all are required for the receiver to operate.
STG	One	Short-duration (< 7 days) periodic outages for inspection and maintenance will be required.
Boiler feedwater pumps	Two x 100% capacity	Pumps are alternated on a daily basis to equalize run-time on both pumps.
Condensate pumps	Three x 50% capacity	The operating pumps will be rotated daily to equalize run-time on each pump.
GSU	One	Based on reliability, no spare will be maintained in inventory.
Air-Cooled Condenser	One	As the ambient temperature decreases, the number of running fans can be reduced.
Water Treatment System	One	A limited number of spare components will be maintained in inventory.

2.3.2.3 Fuel Availability

The RSEP will not require fossil fuel to generate power for sale to the grid. Instead, the RSEP will use the sun's power as a "fuel" to heat the liquid salt for use as a heat transfer medium to enable the Rankine cycle. Solar transmissivity in this portion of the Sonoran Desert is excellent.

2.3.2.4 Water Availability

The RSEP will use up to 180 acre-feet per year of well water for general process use. Boiler blowdown flow is purged directly from the steam drum, which is discharged to a flash tank. Demineralized water is injected into the blowdown flow to limit the temperature of (quench) the blowdown water to prevent rapid flashing and over-pressurization when the blowdown water reaches the flash tank, which is vented to atmospheric pressure. The flash tank collects and retains a minimum volume of water and drains excess volumes in equilibrium discharging to the evaporation ponds in a relatively continuous flow.

Potable water for drinking, safety showers, and sanitary uses will be served from the onsite wells and treated appropriately. Fire protection water and service water will be taken directly from the raw water storage tank, which will provide up to 48 hours of water storage to service all facility needs.

The availability of water to meet the needs of the project is discussed in more detail in Section 5.15, Water Resources.

2.3.2.5 Project Quality Control

The quality control program that will be applied to the RSEP is summarized in this section. The objective of the quality control program is to ensure that all systems and components have the appropriate quality measures applied, whether it be during design, procurement, fabrication, construction, or operation. The goal of the quality control program is to achieve the desired levels of safety, reliability, availability, operability, constructability, and maintainability for the generation of electricity.

The required quality assurance for a system is obtained by applying controls to various activities, according to the activity being performed. For example, the appropriate controls for design work are checking and review, and the appropriate controls for manufacturing and construction are inspection and testing. Appropriate controls will be applied to each of the various activities for the project.

2.3.2.5.1 Project Stages

For quality assurance planning purposes, the project activities have been divided into the following nine stages that apply to specific periods of time during the project:

- **Conceptual Design Criteria –** Activities such as definition of requirements and engineering analyses.
- **Detail Design –** Activities such as the preparation of calculations, drawings, and lists needed to describe, illustrate, or define systems, structures, or components.
- **Procurement Specification Preparation –** Activities necessary to compile and document the contractual, technical, and quality provisions for procurement specifications for plant systems, components, or services.
- **Manufacturer's Control and Surveillance –** Activities necessary to ensure that the manufacturers conform to the provisions of the procurement specifications.
- **Manufacturer Data Review –** Activities required to review manufacturers' drawings, data, instructions, procedures, plans, and other documents to ensure coordination of plant systems and components, and conformance to procurement specifications.
- **Receipt Inspection –** Inspection and review of product at the time of delivery to the construction site.
- **Construction/Installation –** Inspection and review of storage, installation, cleaning, and initial testing of systems or components at the facility.
- **Startup/Commissioning –** Actual operation of generating facility components of a system in a controlled manner to ensure that the performance of systems and components conform to specified requirements.
- **Plant Operation –** Operation of the facility's systems and equipment by operations personnel according to manufacturer's recommendations and instructions.

As the project progresses, the design, procurement, fabrication, erection, and checkout of the facility system will progress through the nine stages defined above.

2.3.2.5.2 Quality Control Records

The following quality control records will be maintained for review and reference:

- Project instructions manual
- Design calculations
- Project design manual
- Quality assurance audit reports
- Conformance to construction records drawings
- Procurement specifications (contract issue and change orders)
- Purchase orders and change orders
- Project correspondence

For procured component purchase orders, a list of qualified suppliers and subcontractors will be developed. Before contracts are awarded, the subcontractors' capabilities will be evaluated. The evaluation will consider suppliers' and subcontractors' personnel, production capability, past performance, and quality assurance program.

During construction, field activities are accomplished during the last four stages of the project: receipt inspection, construction/installation, startup/commissioning, and plant operations. The EPC (engineer, procure, construct) contractor will be contractually responsible for performing the work in accordance with the quality requirements specified by contract.

The subcontractors' quality compliance will be surveyed through inspections, audits, and administration of independent testing contracts.

A plant operation and maintenance program, typical of a project this size, will be implemented by RSE to control the quality of operations and maintenance. A specific program for this project will be defined and implemented during initial plant startup.

2.4 Facility Closure

Facility closure can be temporary or permanent. Temporary closure is defined as a shutdown for a period exceeding the time required for normal maintenance, including closure for overhaul or replacement of the combustion turbines. Causes for temporary closure include damage to the plant due to earthquake, fire, storm, or other natural acts. Permanent closure is defined as a cessation in operations with no intent to restart operations owing to plant age, damage to the plant beyond repair, economic conditions, or other reasons. Section 2.3.1 discusses temporary facility closure and Section 2.3.2 discusses permanent facility closure.

2.4.1 Temporary Closure

For a temporary facility closure, where there is no release of hazardous materials, security of the facilities will be maintained on a 24-hour basis, and the CEC and other responsible agencies will be notified. Depending on the length of shutdown necessary, a contingency plan for the temporary cessation of operations will be implemented. The contingency plan will be conducted to ensure conformance with all applicable LORS and the protection of public health, safety, and the environment. The plan, depending on the expected duration of

the shutdown, may include the draining of all chemicals from storage tanks and other equipment and the safe shutdown of all equipment. All wastes will be disposed of according to applicable LORS, as discussed in Section 5.14.

Where the temporary closure includes damage to the facility, and there is a release or threatened release of regulated substances or other hazardous materials into the environment, procedures will be followed as set forth in a Risk Management Plan and a Hazardous Materials Business Plan to be developed as described in Section 5.5. Procedures will include methods to control releases, notification of applicable authorities and the public, emergency response, and training for plant personnel in responding to and controlling releases of hazardous materials. Once the immediate problem is solved, and the regulated substance/hazardous material release is contained and cleaned up, temporary closure will proceed as described above for a closure where there is no release of hazardous materials.

2.4.2 Permanent Closure

The planned life of the generation facility is 30 years. However, if the generation facility were still economically viable, it could be operated longer. It is also possible that the facility could become economically noncompetitive earlier than 30 years, forcing early decommissioning. Whenever the facility is permanently closed, the closure procedure will follow a plan that will be developed as described below.

The removal of the facility from service, or decommissioning, may range from "mothballing" to the removal of all equipment and appurtenant facilities, depending on conditions at the time. Because the conditions that would affect the decommissioning decision are largely unknown at this time, these conditions would be presented to the CEC when more information is available and the timing for decommissioning is more imminent.

To ensure that public health and safety and the environment are protected during decommissioning, a decommissioning plan will be submitted to the CEC for approval prior to decommissioning. The plan will discuss the following:

- Proposed decommissioning activities for the facility and all appurtenant facilities constructed as part of the facility
- Conformance of the proposed decommissioning activities to all applicable LORS and local/regional plans
- Activities necessary to restore the site if the plan requires removal of all equipment and appurtenant facilities
- Decommissioning alternatives other than complete restoration
- Associated costs of the proposed decommissioning and the source of funds to pay for the decommissioning

In general, the decommissioning plan for the facility will attempt to maximize the recycling of all facility components. RSE will attempt to sell unused chemicals back to the suppliers or other purchasers or users. All equipment containing chemicals will be drained and shut down to ensure public health and safety and to protect the environment. All nonhazardous

wastes will be collected and disposed of in appropriate landfills or waste collection facilities. All hazardous wastes will be disposed of according to all applicable LORS. The site will be secured 24 hours per day during the decommissioning activities.