City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT SYSTEM
CHAPTER 6: STANDBY POWER

FINAL
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VOLUME 9: ENERGY MANAGEMENT SYSTEM
CHAPTER 6: STANDBY POWER

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STANDBY POWER

6.1 PURPOSE

The purpose of this chapter is to evaluate expansion alternatives for the Regional Water Quality Control Plant (RWQCP) standby power system that will meet California Title 22 standards and EPA reliability criteria. The chapter also presents electrical system modifications that could be implemented to address the standby power requirements.

6.2 CONCLUSIONS AND RECOMMENDATIONS

1. The existing electrical system does not have permanent standby power and the RWQCP receives power from a single utility source.
2. The RWQCP power sources (utility and cogeneration) distribute the power to the plant's substations through a single common 12-kV overhead line. Failure of this overhead line will affect both power sources.
3. The existing RWQCP electrical power system may not meet California Title 22 standards and EPA reliability criteria because it does not have two separate and independent sources of electric power supply and a redundant 12-kV distribution system.
4. The plant overflow storage capability during a power failure is estimated to be between 2 and 3 hours.
5. Recommendations:
    a. Install a 12-kV underground duct bank system to complement the in-plant single 12-kV overhead line distribution system. A 12-kV switching center will need to be provided adjacent to the cogeneration facility to distribute to this underground system.
    b. Retrofit the existing gas engine cogeneration system to a standby power generation system.
    c. Retrofit or install the fuel cell cogeneration systems so that they will provide standby power in parallel with the gas engine generators.
    d. Modify or upgrade the existing RWQCP control system and electrical system to provide a standby power system.

6.3 BACKGROUND

The EPA has electrical equipment reliability requirements for wastewater treatment plants, which include:

- Two separate and independent sources of electric power (e.g., utility and on-site generator). In this respect, independent sources include dual utility feeds, but only if they are provided from two separate utility substations. Feeders that originate from a common utility substation do not satisfy the criterion for source independence.

- The capacity of the backup power source shall be sufficient to operate all “vital” components during peak wastewater flow conditions (Reliability Class I).
- The independent sources of power shall be distributed to the site transformers in such a way as to minimize common mode failures from affecting both sources. For example, power source feeders cannot share common transmission/distribution poles or other common structures.

Similar reliability is also required by Title 22 water reclamation criteria. In addition, Title 22 requires a power supply reliability feature to include short-term retention or disposal for at least a 24-hour period.

The existing RWQCP cogeneration facility was designed to provide cogeneration and backup standby power through the controls in the plant Supervisory Control and Data Acquisition (SCADA) system. However, these backup standby power controls were not implemented in the plant SCADA. In normal operation, the plant cogeneration provides half of the plant’s current total load of 3,000 kW, with the balance provided by the Riverside Public Utilities.

The Riverside Public Utilities provides two feeds into the plant’s single 12-kV overhead line. These two feeds originate from the same utility substation and only the feed coming into the plant entrance on Acorn Street is in service. The other feed is disconnected and is used as a backup when the Acorn feed is out of service for maintenance. Because the two feeds are not from two separate utility substations, the plant will lose power when the utility substation requires maintenance or when the substation experiences a disturbance/electrical fault.

The existing RWQCP electrical configuration and distribution plan are shown in Figure 6.1 and Figure 6.2, respectively. As shown on both Figure 6.1 and 6.2, the plant power sources (utility and cogeneration generation) distribute the power to the plant’s substations through a single common 12-kV overhead line. Failure of this overhead line will affect both power sources. Since the existing in-plant substations are designed in a double-ended configuration, it is recommended that a new 12-kV underground duct bank system be installed as a redundant feed to the overhead line. In addition, a 12-kV switching center should be provided adjacent to cogeneration facility, to distribute the underground system to one end of the double-ended substations. The substations will then have one feed from the 12-kV overhead line and the second feed from the 12-kV underground system.

Currently, when the utility power fails, the cogeneration will shut down and the plant will not have any power except for the headwork facilities that are provided with portable backup generator hook-ups. It is estimated that the plant overflow storage capability during a power failure is between 2 and 3 hours depending on how much water is in the existing and new equalization basins.

Based on the above analysis, the existing RWQCP electrical system may not meet California Title 22 standards and EPA reliability criteria for two reasons:

1. There are no separate and independent sources of electric power supply.
2. There is no redundant power distribution system.

6.4 CRITICAL LOADS

The previous report "TM-1 Backup Power/Cogeneration," May 1992 by Montgomery, estimated that critical power need is about 70 percent of total plant running load. Based on this type of analysis on previous Carollo projects, it is anticipated that the critical loads will be about 75 percent of the total plant running load.

Based on existing and a projection of future electrical loads (estimate shown on the spreadsheet in Appendix A), estimated critical loads at the RWQCP would be 1,800 kW at the current plant flow rate of 33 mgd, and with an additional 2,500 kW required at the future plant flow rate of 52 mgd. This yields a total estimated 4,300 kW of critical loads.

6.5 EXISTING GENERATION CAPABILITIES

There are three 1,100-kW gas engine generators, yielding a total 3,300 kW for standby power. These generators are mainly fueled by digester gas, but have the capability of utilizing natural gas fuel. At present, these generators provide about half of the plant's total running loads of 3,000 kW. They parallel with the utility supply.

By end of year 2007, the RWQCP will have an additional of 1,200 kW of generation capabilities when the fuel cell system is installed. It is assumed that the installed fuel cell system can be configured to provide standby power capability, can be parallel to the gas engine generators, and have the capability of utilizing natural gas as fuel. The City of Riverside (City) also plans to install an additional 1,200-kW fuel cell system by the year 2012.

With the gas engine generators and fuel cell systems, the RWQCP would have 4,500-kW of generation capacity, which exceeds the 4,300 kW of critical loads. The generation capacity would depend on sufficient availability of fuel during a power outage.

6.6 STANDBY POWER ALTERNATIVES

6.6.1 Alternative 1 - Multiple Small Diesel Generators and Automatic Transfer Switches

In this alternative, diesel generators and transfer switches are added to each of the existing double-ended plant substations. The generators will be sized to supply the critical load for the substation.

This alternative would require:

- One 480-volt generator for each double-ended substation.
- One 4.16-kV generator for each double-ended substation.
- One automatic transfer switch for each double-ended substation.
- Modification to the existing main breakers and tie-breaker of each double-ended substation.

When the utility power fails, the cogeneration system will shut down, both main breakers will open, and the tie-breaker will close at the substations. The load will then transfer to standby diesel generators at each substation. When the utility power returns, the main and tie-breakers will return to their normal position and the load will be transferred back to the utility. The cogeneration system will be initiated and parallel back to the utility.

This alternative is relatively simple and requires moderate electrical modification to the existing system. However, this alternative does not make use of existing gas engine generation and fuel cell system capabilities. It also requires maintenance of additional low-voltage electrical equipment and does not optimize and prioritize the diesel generators capacity since these generators operate independent of each other.

6.6.2 Alternative 2 - Retrofit Existing Cogeneration Capabilities to Backup Standby Power

In this alternative, the backup standby power would be derived by operating a combination of existing gas engine generators and the fuel cell system paralleling with each other. As previously stated, the existing generation capacity exceeded the critical load requirements.

This alternative would require:

- Modification/upgrade to the existing control system. This will include generator priority sequencing and optimization, load-shedding sequencing, load adding sequencing, and power monitoring as part of a Computerized Load Management System (CLMS), which is described in Volume 9, Chapter 4 - Energy Saving Options. The control will also include remote I/O for circuit breaker control and monitoring.
- Modify the existing feeder breaker to be electrically operated.

- Develop a detailed critical load ranking for the plant to be used for load shedding and load adding sequencing.
- Retrofit the existing engine generators to meet the SCAQMD Emission Standards for the year 2012 in a standby application. This is discussed in Volume 9, Chapter 5 - Power Supply Alternatives.

When the utility power fails, the utility main breaker will open, the cogeneration system would be disconnected, and all the substation feeders to the loads will open. The gas engine generators and fuel cell system will be paralleled and reconnected back to the electrical system as standby generators. The standby generators will pick up plant loads through the closing of substation feeder breakers. The individual loads are then sequenced by the SCADA system.

When the utility power returns, the system will synchronize the natural gas engine generators with utility power if required, and transfer the power source back to the utility in a seamless transition. The fuel cell will keep running in parallel with the utility and the natural gas engine generators will be shut down.

Even though this alternative will provide a more complex control system, the advantages include a more reliable plant-wide standby power with 12-kV distribution. It also will optimize operation of the generators and fuel cell system.

In line with the City's decision to shut down the gas engine generators as cogeneration in the year 2012 to comply with SCAQMD Emission Standards and make the fuel cell system the main cogeneration system, it would be a logical approach to retrofit the gas engine generators to provide standby power.

During the project workshop on April 16, 2007, the City decided that it does not want to install a diesel generator for standby power. Instead, the City prefers to use the existing cogeneration gas engines, along with the future fuel cells, for standby power.

Appendix A
ELECTRICAL LOAD ESTIMATES

APPENDIX A
Riverside Integrated Master Plan
Electrical Load Estimates

Process Area	**Approximate Connected Electrical Load (HP/kVA)**	**Standby Power Required (HP/kVA)**	**Service Transformer (as noted on Figure 6.1)**
Planned Loads			
Headworks	240	0	TFR1
Primary Clarifiers	198	198	T1 & T2
Primary Equalization	375	300	T1 & T2
MBR Process	2900	2900	T1 & T2
Tertiary Filtration	0	0	
Disinfection	10	10	TA & TB
Sludge Thickening	450	0	T1 & T2
Digestion	240	0	T1 & T2
Total kVA	4413	3408	
Assumed Running 75%	3310	2556	
Total kW	2648	2045	

Optional Load			
UV/Ozone Disinfection	750	750	TA & TB
Total kVA	750	750	
Assumed Running 75%	563	563	
Total kW	450	450	

Existing Loads			
Existing kW Running	3000	2400	
Total kW	3000	2400	
Assumed Running 75%	2250	1800	

Grand Total kW	**5348**	**4295**	

Existing Gas Engine Cogeneration, kW		3300	
Fuel Cell System, kW		1200	
Total Standby Generation		**4500**	

Deficit/Excess Standby (Generation - Standby Load)		**205**	