Pima County

Regional Wastewater Reclamation Department

Pima County RWRD

Energy Master Plan

CH2MHILL

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Acronyms and Abbreviations

ºF	degrees Fahrenheit
ACC	Arizona Corporation Commission
ADEQ	Arizona Department of Environmental Quality
BTUH	British thermal units per hour
CEP	critical event pricing
CMAR	construction manager at risk
DBO	design, build, operate
DCC	demand charge credit
DX	direct expansion
ERF	Energy Recovery Facility
hp	horse power
HPO	high-purity oxygen
HVAC	heating, ventilation, and air conditioning
ISCC	interruptible service capacity constraint
kV	kilovolt
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
LGS	large general service
LLP	large light and power service
LPG	liquefied petroleum gas
MBCP	market based capacity price
MCC	motor control center
MDP	main distribution panel
mgd	million gallons per day
MVA	megavolt-ampere
MW	megawatt
NFPA	National Fire Protection Association
O&M	operations and maintenance
PCRWRD	Pima County Regional Wastewater Reclamation Department
PW	present worth
REC	renewable energy credits
RFQ	request for quotation
ROMP	Regional Optimization Master Plan
scfm	standard cubic feet per minute
SSF	shared saving factor
TEP	Tucson Electric Power
Upgrade Project	Ina Road WRF Capacity and Effluent Quality Upgrade Project
WAS	waste activated sludge
WRC	Water Reclamation Campus
WRF	Ina Road Wastewater Reclamation Facility

Executive Summary

Introduction

The Pima County Regional Wastewater Reclamation Department (PCRWRD) commissioned an Energy Master Plan for the Ina Road Wastewater Reclamation Facility (WRF) in October 2009. The Master Plan is necessary because the electrical and thermal energy requirements for the Ina Road WRF are changing significantly as a result of the Capacity and Effluent Quality Upgrade project being completed at the Ina Road WRF. The purposes and goals of the Ina Road WRF Energy Master Plan are the following:

- ✓ Document the future electrical and thermal energy requirements.
- ✓ Document the electrical energy backup power requirements and the thermal energy reliability requirements.
- ✓ Document the digester gas production.
- ✓ Document the capacity of the existing electrical and thermal energy facilities to meet the future needs and evaluate the condition of these existing facilities.
- ✓ Provide a master plan for the electrical and thermal energy facilities.
- ✓ Provide recommended plan.

The Ina Road Capacity and Effluent Quality Upgrade Project will expand the Ina Road WRF from 37.5 million-gallons-per-day (mgd) to 50 mgd. The buildout year for the expanded facility is projected to occur in 2030. Additionally, the main treatment process scheme is changing to comply with an Arizona Department of Environmental Quality (ADEQ) requirement for nutrient removal. This process for removing nutrients is more energy intensive than the process currently utilized at the Ina Road WRF. Finally, solids handling and treatment is being consolidated at the Ina Road WRF site to accommodate solids from both the Ina Road WRF and from the future Water Reclamation Campus (WRC). The WRC capacity is planned for 32 mgd. With the consolidation of anaerobic digestion of solids at the Ina Road WRF there will be substantial production of digester gas that is planned to be utilized in a new Energy Recovery Facility (ERF) to produce a portion of the Ina Road WRF's electricity needs and provide the Plant's total digester heating water, building heating water, and chilled water for building cooling.

The Energy Master Plan addresses the original goals noted above; however, through the course of performing the work, two major developments occurred that affected the path of the Master Plan. These developments were:

1. During a meeting with Tucson Electric Power (TEP), it was revealed that there is a 46kV line routed along Silverbell Road that could be made available for the Ina Road WRF site. This line has sufficient capacity to meet the expanded and long term electrical energy requirements for the Ina Road WRF. This line is fed from two independent substations, enhancing the reliability of this line and providing both primary and alternate paths of

supply. It is anticipated that this power supply configuration will meet the ADEQ requirements for backup power for the Ina Road WRF.

2. In studying the tariffs available to PCRWRD, it was determined that once the steady electrical demand exceeds 3,000 kW, other tariffs are available that could lower the unit cost of electricity for the Ina Road WRF.

With these developments, two primary alternatives are available to PCRWRD for meeting the electrical and thermal energy demands for the Ina Road WRF:

- Alternative 1 – Utilize digester gas to produce a portion of the electrical energy required for the upgraded Ina Road WRF in the new ERF. The balance of the Plant's electrical energy would be provided from TEP via the Silverbell 46kV line. All of the Plant's thermal energy needs would be supplied from the new ERF.
- Alternative 2 – TEP would supply all of the power to meet the electrical energy required for the upgraded Ina Road WRF. A central heated and chilled water plant would be constructed and would utilize digester gas to meet the thermal needs of the facility. Excess digester gas would be available for future uses (such as sludge drying).

A qualitative and quantitative evaluation of the two alternatives was developed.

Economic Analysis

Present worth costs of the two alternatives were developed, including budgetary construction costs, operations and maintenance costs, electricity purchases, and renewable energy credits. In addition, the present worth includes a credit for the value of extra energy available, in natural gas equivalent terms, for each of the alternatives. Alternative 1 has excess engine heat available, while Alternative 2 has excess digester gas available, beyond what is required to meet the forecast thermal needs of the Plant.

The estimated 20-year present worth (PW) cost of Alternative 1, based on available information, is higher than Alternative 2 by approximately $7 million. The high capital cost and high operations and maintenance costs of Alternative 1 are tempered by the electricity savings and renewable energy credits from the onsite generation, resulting in a 20-year PW cost of $87.6 million. The low construction and operations and maintenance costs of Alternative 2 are countered by the larger electricity purchases, yet tempered by the credit for the available digester gas, resulting in a 20-year PW cost of $80.5 million.

Qualitative Analysis

A qualitative comparison of the two alternatives demonstrates advantages and disadvantages with each option which must be considered by PCRWRD management to determine relative importance of these conditions. Some primary considerations for the two alternatives that must be weighed by PCRWRD staff are presented below.

Alternative 1

- Third-party contractor would be continuously on site. Site security and site administration would have to be adjusted to accommodate this situation.
- Contract administration would be required for design-build-operate (DBO) operation.

- The complex procurement process, which has already begun, needs to be completed.
- All, or nearly all, of the digester gas would be utilized by this alternative. Flaring of gas would be minimal, similar to current practice.
- Significant excess engine heat would be discharged to the plant effluent, similar to the current practice.

Alternative 2

- Immediate capital cost savings of approximately $18 million.
- No third-party contractor on site.
- The complex procurement of an ERF DBO contractor would be replaced with the design of a central heated and chilled water plant and likely Construction Manager at Risk (CMAR) construction as part of the Upgrade Project.
- The less complicated systems fits better with the overall wastewater treatment plant system and would be under the full control of plant operations.
- Opportunity for identifying a future use of excess digester gas.

Path Forward Recommendations

Based on the present worth and the qualitative analyses performed with the available information, CH2M HILL recommends that PCRWRD pursue the development of Alternative 2 for the following reasons:

- Lower present worth costs.
- Presents the opportunity for greater beneficial use of the digester gas.
- Presents simplified procurement and long-term operations that are a better fit with the overall wastewater treatment plant system.
- No site access/security complications from a third-party contractor.
- Does not fully preclude the utilization of digester gas for onsite power generation.
- May help mitigate the future process risk to PCRWRD, by utilizing the digester gas to produce biosolids capable of disposal/reuse via multiple outlets.
- Presents a similar air permitting process to Alternative 1.

Follow-On Actions Recommended

- Evaluate schedule requirements with PCRWRD, Project Manager/Construction Inspection, and the CMAR to determine implementation schedule and potential impacts.
- Although the power supply configuration, including a line supplied by two independent substations, is anticipated to meet the ADEQ requirements for backup power, PCRWRD should assess their comfort level with the proposed electrical supply system to determine if additional backup power is needed at specific facilities.
- Contract and execute a Biosolids/Digester Gas Utilization Master Plan.

1. Documentation of Future Electrical and Thermal Energy Needs

1.1 Electrical Energy Requirements

This section presents electrical load estimates for the Ina Road Wastewater Reclamation Facility (WRF) facilities from present day to the year 2030. The work is based on facilities shown in the 60% Design Development Submittal for the Ina Road WRF Capacity and Effluent Quality Upgrade Project, as built one-line diagrams for existing facilities, and site verification of key existing loads. The electrical load forecast includes loads for the entire site.

Electrical Load Forecast Methodology

In the case of facilities affected by the Capacity and Effluent Quality Upgrade Project (Upgrade Project), one-line diagrams that were prepared for the design development phase of the project were used. The design development phase represents a 60-percent level of design completion, and the number and nature of process loads is well established. In the case of facilities that are not affected by the Upgrade Project, the available record drawings and the load information from those record drawings were used. Field observations were also used to validate information obtained from the record drawings.

For each facility at the site, process loads were tabulated. Rated motor horsepower was used to find rated current in Table 430.250 of National Fire Protection Association (NFPA) 70, National Electrical Code. In turn, the current was used to calculate the connected equipment kVA load.[1] NFPA 70 does not provide rated current for medium-voltage loads (process air blowers and high-purity oxygen compressors). Those data were calculated from motor nameplate data or from equipment vendor information.

Connected load data for a system seldom represent an accurate representation of conditions that will be encountered during system operation. To develop a more realistic estimate of the system operating condition (the operating load), a demand factor is applied to the connected load. The demand factor of a load is the load's maximum expected demand divided by its connected load. For example, consider a pump operating at a design point that requires 50 horsepower applied to its drive shaft. If the pump is driven by a motor rated at 60 horsepower, the motor's demand factor is 0.83 (50hp/60hp).

Most process systems are constructed with built-in redundancy. For example, a pumping system may be equipped with two pumps, with each pump sized to meet the entire flow requirement of its system. It would be highly unusual to find both pumps running at the same time. In order to account for the idle pump, the demand factor for the idle pump is set to zero.

1 The connected load of a facility is the sum of the continuous ratings of the load-consuming apparatus connected to its electrical system (IEEE 100-1984).

Some loads cycle on and off throughout the day. An example of this type of load is an air compressor. Such loads are given a demand factor of 0.50 to reflect the nature of their intermittent operation.

Some loads are expected to operate only occasionally or seldom. Examples of these loads include electric valve operators, sump pumps, and door openers. These are assigned a demand factor of 0.00 to 0.25.

Some of the demand factors used for this study are listed in Table 1-1.

TABLE 1-1
Demand Factors
Ina Road Water Reclamation Facility Energy Master Plan

Load	Typical Demand Factor
Future Process Equipment (Upgrade Project)	1.0
Existing Process Equipment	0.85
Cyclic Equipment (e.g., compressors)	0.50
Seldom-used Equipment (e.g., sump pumps, control valves)	0.00 to 0.25
Redundant Process Equipment	0.00

Electrical Load Forecast

The results of the load forecast analysis, as described above, are as shown in Table 1-2.

TABLE 1-2
Ina Road WRF Load Forecast
Ina Road Water Reclamation Facility Energy Master Plan

Year	Operating Load (MVA)	Operating Load (MW)
2009 (Present-Day Loads)	6.4 MVA	5.1 MW
2011 (Jan-Jun)	6.8 MVA	5.4 MW
2011 (Jul-Dec)	7.3 MVA	5.8 MW
2012 (Jan-Jun)	12.3 MVA	9.8 MW
2012 (Jul-Dec)	12.0 MVA	9.6 MW
2013 (Jan-Jun)	12.0 MVA	9.6 MW
2013 (Jul-Dec)	12.0 MVA	9.6 MW
2014 (Jan-Jun)	12.0 MVA	9.6 MW
2014 (Jul-Dec)	12.6 MVA	10.1 MW
2020	12.8 MVA	10.2 MW
2030	13.2 MVA	10.6 MW

Loads will increase in 2011 with the startup of the digesters and digester control building constructed via the Interim Biosolids – Digester Complex Project. Additional plant loads will occur with the phased construction of the Upgrade Project, including startup of the expanded East Plant and startup of the new West Plant in 2012. Plant loads will dip slightly in 2012 when the existing West Plant high-purity-oxygen generation facility is shut down. Loads will increase again in late 2014 when the remaining Upgrade Project facilities are started. Plant loads will increase more or less proportionally with plant wastewater influent between 2014 and 2030.

1.2 Electrical Energy Backup Requirements

The purpose of this section is to identify the backup power requirements that must be supported in the event that the "normal" supply to the site is disrupted.

Single Component Failure

For purposes of this master plan, only the failure of a single component (piece of electrical or mechanical equipment, or a line or a group of items that may be viewed as a single entity) will be considered. No consideration is given to the simultaneous failure of multiple, unrelated components.

Methodology

Backup power is defined as the power needed to serve:

- Loads that must operate in order for the plant to meet the Arizona Department of Environmental Quality (ADEQ) regulations for effluent treatment.
- Loads that are not controlled by the plant Supervisory Control and Data Acquisition system and, therefore, are not readily shed from the plant electrical system. These loads include non-process buildings and heating, ventilation, and air conditioning systems.

The operating loads were reviewed; refer to Section 1.1, Electrical Energy Requirements. Those that were associated with process loads not needed to meet ADEQ effluent treatment regulations were "turned off." These loads are predominantly those associated with the solids handling processes. The resultant total load is defined as the backup load, as shown in Table 1-3.

TABLE 1-3
Backup Power Requirements
Ina Road Water Reclamation Facility Energy Master Plan

Year	Backup Power (MVA) (Operating Load)	Backup Power (MW) (Operating Load)
2011 (Jan-Jun)	4.8	3.8
2011 (Jul-Dec) [a]	5.1	4.1
2012 (Jan-Jun)	9.2	7.4
2012 (Jul-Dec)	9.4	7.5
2013 (Jan-Jun)	9.4	7.5
2013 (Jul-Dec)	9.4	7.5

TABLE 1-3
Backup Power Requirements
Ina Road Water Reclamation Facility Energy Master Plan

Year	Backup Power (MVA) (Operating Load)	Backup Power (MW) (Operating Load)
2014	9.4	7.5
2020	9.8	7.8
2030	10.6	8.5

[a] Existing Power System (TEP and existing Powerhouse) is Forecast to Reach Capacity by the End of 2011

1.3 Thermal Energy Requirements

The purpose of this section is to provide thermal energy systems load and energy consumption estimates for years 2009, 2011, 2014, 2015, 2020, and 2030, and to describe related issues. This thermal data is useful for determining the best path forward with regards to the new ERF under consideration. The data can also be used for evaluation of the future thermal systems capacities required to meet current and future plant thermal loads.

Existing Central Thermal Energy Distribution Systems

The Ina Road WRF is served by plant wide heating, ventilation, and air conditioning (HVAC) heating and chilled water systems, a sludge heating water system, and a central domestic hot water distribution system. Heating and chilled water, sludge heating water, and domestic hot water for these systems are currently generated in Facility 14, the existing Powerhouse. Digester gas and natural gas are burned in engine generators. Water is circulated through the jackets of the engine generators and is further heated via heat exchangers (ebullient boilers) heated by engine exhaust gases, to create low pressure steam. The low pressure steam is run through an absorption chiller to create chilled water and through separate heat exchangers to create HVAC heating water, sludge heating water, and domestic hot water. Excess low pressure steam is run through a heat exchanger to transfer excess engine heat to the plant effluent at Facility 13, West Chlorine Contact Basins.

The HVAC systems, the sludge heating system, and the heat sink piping systems are closed loop systems with supply and return piping served by pumps located in the Powerhouse. The domestic hot water piping system and the HVAC and sludge heating supply and return piping systems are routed through the tunnels as well as below grade. Table 1-4 indicates the facilities served by the HVAC heating and chilled water systems now and in the future as well as estimated peak loads. Some facilities have two entries in the table, one for the existing condition and one for the renovated condition.

TABLE 1-4
Estimated Peak HVAC Design Loads by Facility
Ina Road Water Reclamation Facility Energy Master Plan

	Facility	Condition/ Status	Total HVAC Heating Load (BTUH)	Total HVAC Cooling Load (BTUH)
1	Administration/Laboratory Building	Existing	390,000	740,000
1	Renovated Admin without lab	Renovated	273,000	484,000
2	Warehouse/Maintenance	Existing	1,080,000	840,000
2	Renovated warehouse without chilled water	Renovated	1,080,000	207,000
5	Oxygen Production Facility	Existing	0	4,717,000
9	Solids Thickening Building	Existing	473,000	540,000
9	Renovated Solids Thickening Building	Renovated	222,000	457,000
11	Digester Control Building	Existing	415,000	300,000
14	Powerhouse	Existing	117,000	270,000
15	Tunnels	Existing	828,000	650,000
16	Training Center	Existing	249,000	520,000
16	Renovated Training facility with no lab	Renovated	237,000	424,000
23	Renovated Centrifuge Facility	Renovated	794,000	205,000
30	Renovated Headworks	Renovated	1,205,000	0
33	Renovated Primary Clarifiers - East	Renovated	291,000	0
34	Renovated Blower Building	Renovated	0	356,000
37	Renovated RAS/WAS Pump Station - East	Renovated	340,000	189,000
46	Blower Building - West	New	0	185,000
60	Digester Complex on DX elec. room cooling	New	807,000	0
60	Digester Complex elec. room chilled water cooling	New	807,000	44,000
70	Sludge Storage Tanks/Pump St new	Renovated	170,000	0
80	Restroom	New	7,300	0
	Misc. Plant Improvements - office space	Future	194,000	230,000
	Misc. Plant Improvements - warehouse space	Future	903,000	0
	Switchgear Building	Future	12,000	141,000
	estimated piping losses existing	Existing	117,000	45,000
	estimated piping losses 2011	Future	128,000	45,000
	estimated piping losses 2014	Future	210,000	57,000

DX = direct expansion BTUH = British thermal units per hour

Timeframes Used in the Analysis

This section evaluates the thermal energy requirements for the time frame specified.

2009 Condition

This condition includes all HVAC thermal loads for existing facilities. The sludge heating water load is the heat required for the existing four digesters. The water is used to heat the digester incoming sludge to mesophilic temperature, approximately 100 degrees Fahrenheit (°F), and to maintain the digesters at mesophilic temperature.

2011 Condition

This includes all HVAC loads for the 2009 condition as well as new loads added for Facility 60, the Digester Control Building, and the new Switchgear Building. The electrical room cooling load for Facility 60 is designed as a direct expansion air conditioning split system that includes exterior air conditioning compressor/condensing units to generate cooling. Therefore, there are no chilled water loads for Facility 60 in the 2011 condition. When additional chilled water capacity comes online, it is the intent that the refrigerant cooling coils will be replaced with chilled water coils, and the electrical room cooling loads would become part of the total chilled water loads under the 2014 condition. The sludge heating water load will increase based on the heat required for the two new digesters brought online in 2011.

2014 Condition

This condition does not include loads for Facility 5, the existing Oxygen Production Facility, which is scheduled for demolition. This condition includes all HVAC loads for the 2009 condition that did not change under the Capacity and Effluent Quality Upgrade Project. It includes all new HVAC loads to be added under the Upgrade Project. It includes HVAC load estimates for a new Switchgear Building. It includes the Facility 60, electrical room chilled water cooling load. It includes HVAC load estimates for the new Miscellaneous Plant Improvements, warehouse/office facility, estimated to have 5,000 square feet of new office space and 20,000 square feet of new warehouse space. No new chilled water cooling loads have been added for the new warehouse and the chilled water demand for the existing warehouse to be renovated was removed. It is assumed the warehouses would be cooled with either indirect or direct evaporative cooling. Heating loads for the new and existing warehouses are included. The digester gas cooler/condenser heat exchanger, currently located in the lower level of Facility 11, is not included under the assumption that the new ERF will have its own digester gas moisture removal and treatment system. The loads for the administration/lab building and training facilities are reduced, since the labs will be removed from these facilities, and HVAC systems will be more efficient after the planned renovations. The sludge heating water load will increase based on the increase in sludge production with the Upgrade Project coming online.

2015 Condition

There are no changes to the 2014 condition for heating water, chilled water, and domestic hot water loads. The sludge heating water load will increase based on the increase in sludge production with additional flow coming into the plant, plus the additional solids transferred from the future Water Reclamation Campus (WRC).

2020 Condition

There are no changes to the 2014 condition for heating water, chilled water, and domestic hot water loads. The sludge heating water load will increase based on the increase in sludge production with additional flow coming into the plant.

2030 Condition

There are no changes to the 2014 condition for heating water, chilled water, and domestic hot water loads. The sludge heating water load will increase based on the increase in sludge production with additional flow coming into the plant.

Heating Water and Chilled Water Thermal Load Requirements

Table 1-4 indicates the facilities served by the HVAC heating and chilled water systems now and in the future as well as estimated peak loads. Some facilities have two entries in the table, one for the existing condition and one for the renovated condition. The sources for the estimated loads were:

- As-built equipment schedules for existing facilities, when available.
- 60-percent design calculations and schedule data for new or renovated facilities in the Upgrade Project.
- Engineering estimates for future facilities and renovated facilities not yet designed and for existing facilities when as-built equipment schedules were not available.

Loads for all the facilities were totaled as appropriate to include in the analysis timeframes. Detailed calculations and pipe length takeoffs were used to estimate the heating and chilled water piping loss loads for each timeframe. A 10 percent factor of safety was applied to load estimates for the 2014 condition. The resulting total peak thermal load requirements are shown in Table 1-5. These peak loads thus represent the peak design capacities for new thermal energy supply systems to be provided as part of the new Energy Recovery Facility.

The HVAC load estimates in Tables 1-4 and 1-5 are the peak thermal loads required on the peak load design day. These values should not be confused with monthly average energy consumption values presented in Table 1-6. The units for both sets of values are British thermal units per hour (BTUH), which adds to potential confusion.

The peak heating and chilled water loads will never occur at the same time. Peak heating is in the winter and peak cooling is in the summer.

TABLE 1-5
Peak Total Thermal Design Capacities
Ina Road Water Reclamation Facility Energy Master Plan

Year	HVAC Heating (BTUH)	Cooling (BTUH)	Domestic Hot Water (BTUH)	Sludge Heating - SUMMER (BTUH)	Sludge Heating - WINTER (BTUH)
2009	3,700,000	8,600,000	1,500,000	1,000,000	3,700,000
2011	4,500,000	8,800,000	1,500,000	1,100,000	4,300,000
2014	8,800,000	4,000,000	1,500,000	1,300,000	5,200,000
2015	8,800,000	4,000,000	1,500,000	1,900,000	6,800,000
2020	8,800,000	4,000,000	1,500,000	2,100,000	7,200,000
2030	8,800,000	4,000,000	1,500,000	2,400,000	8,000,000

BTUH = British thermal units per hour

Building Heating and Chilled Water Thermal Energy Consumption Estimates

Energy consumption for monthly heating and chilled water loads were estimated for the 2009, 2011 and 2014 conditions. Loads remain the same through year 2030 as they are in year 2014 (i.e. no future facility changes included). Sludge heating consumption was estimated for the 2009, 2011, 2014, 2015, 2020, and 2030 conditions. Process space heating estimates were performed using National Fire Protection Association 820 required design ventilation loads or existing ventilation loads and temperature bin data for each month. Office space monthly estimates were performed using a generic building modeled with the Carrier Hourly Analysis calculation program to determine HVAC energy use on a square-foot basis, which was then applied to the square footage of occupancy by office type. Energy consumption for electrical room cooling was estimated using an adjusted design cooling load, temperature bin data, and an adjustment factor for each temperature bin to account for the effect of envelope loads and air side economizer operation. Distribution piping heat loss loads are also included. Resultant data were totaled for the month and were then converted to an hourly average for each month. Monthly thermal energy consumption estimates for the various timeframes under consideration are displayed in Table 1-6, as well as Figures 1-1 through 1-4.

Domestic Hot Water Energy Load and Energy Consumption Estimates

Historical records indicate that domestic hot water energy use is intermittent. The design capacity for this system is the same as indicated in the as-built information for the existing Powerhouse. Domestic hot water delivered varied between 860 and 25,400 gallons per month during the first part of 2009 based on historical data provided. The system has a high design load, but overall energy use is comparatively small. Energy consumption estimates for domestic hot water have not been included in Table 1-6 and Figures 1-1 through 1-4 due to its intermittent nature.

TABLE 1-6
Estimated Average Hourly Monthly Thermal Energy Consumption
Ina Road Water Reclamation Facility Energy Master Plan

Month	Days	Digester Heating Energy Demand (BTUH)	Building Heating Energy Demand (BTUH)	Chilled Water Energy Demand (BTUH)	Total Thermal Energy Demand (BTUH)
2009					
1	31	1,902,064	1,030,428	5,296,758	8,229,250
2	28	2,196,479	849,007	5,321,294	8,366,780
3	31	1,690,636	633,448	5,403,407	7,727,490
4	30	1,157,307	380,265	5,620,313	7,157,885
5	31	846,771	207,864	5,904,192	6,958,828
6	30	491,836	129,311	6,455,252	7,076,398
7	31	162,448	118,777	6,460,234	6,741,458
8	31	208,257	118,895	6,403,630	6,730,783
9	30	337,229	137,344	6,080,112	6,554,684
10	31	556,762	290,416	5,672,743	6,519,921
11	30	889,410	687,754	5,371,867	6,949,030
12	31	1,883,829	1,025,630	5,308,917	8,218,376
2009 Annual Avg.		**1,026,919**	**467,428**	**5,774,893**	**7,269,240**
2011					
1	31	2,159,100	1,174,962	5,301,569	8,635,631
2	28	2,493,300	951,301	5,330,477	8,775,077
3	31	1,919,100	702,651	5,418,547	8,040,298
4	30	1,313,700	412,538	5,651,126	7,377,364
5	31	961,200	220,728	5,951,180	7,133,109
6	30	558,300	139,208	6,520,075	7,217,583
7	31	184,400	128,674	6,528,501	6,841,575
8	31	236,400	128,792	6,476,196	6,841,388
9	30	382,800	147,241	6,137,955	6,667,996
10	31	632,000	308,770	5,708,547	6,649,317
11	30	1,009,600	765,008	5,385,556	7,160,164
12	31	2,138,400	1,166,338	5,314,378	8,619,116
2011 Annual Avg.		**1,165,692**	**520,518**	**5,810,342**	**7,496,551**
2014					
1	31	2,673,171	1,273,988	159,103	4,106,263
2	28	3,086,943	998,753	212,152	4,297,848
3	31	2,376,029	692,945	301,391	3,370,365
4	30	1,626,486	405,268	502,646	2,534,399
5	31	1,190,057	249,782	734,055	2,173,893
6	30	691,229	210,477	1,099,714	2,001,420
7	31	228,305	211,331	1,144,704	1,584,340
8	31	292,686	210,232	1,217,114	1,720,031

Month	Days	Digester Heating Energy Demand (BTUH)	Building Heating Energy Demand (BTUH)	Chilled Water Energy Demand (BTUH)	Total Thermal Energy Demand (BTUH)
9	30	473,943	214,741	898,957	1,587,640
10	31	782,476	312,003	575,730	1,670,210
11	30	1,249,981	766,574	273,875	2,290,430
12	31	2,647,543	1,272,604	176,254	4,096,401
2014 Annual Avg.		**1,443,237**	**568,225**	**607,975**	**2,619,437**
2015					
1	31	3,495,686	1,273,988	159,103	4,928,777
2	28	4,036,771	998,753	212,152	5,247,676
3	31	3,107,114	692,945	301,391	4,101,451
4	30	2,126,943	405,268	502,646	3,034,857
5	31	1,556,229	249,782	734,055	2,540,065
6	30	903,914	210,477	1,099,714	2,214,105
7	31	298,552	211,331	1,144,704	1,654,588
8	31	382,743	210,232	1,217,114	1,810,088
9	30	619,771	214,741	898,957	1,733,469
10	31	1,023,238	312,003	575,730	1,910,972
11	30	1,634,590	766,574	273,875	2,675,039
12	31	3,462,171	1,272,604	176,254	4,911,029
2015 Annual Avg.		**1,887,310**	**568,225**	**607,975**	**3,063,510**
2020					
1	31	3,701,314	1,273,988	159,103	5,134,405
2	28	4,274,229	998,753	212,152	5,485,133
3	31	3,289,886	692,945	301,391	4,284,223
4	30	2,252,057	405,268	502,646	3,159,971
5	31	1,647,771	249,782	734,055	2,631,608
6	30	957,086	210,477	1,099,714	2,267,277
7	31	316,114	211,331	1,144,704	1,672,149
8	31	405,257	210,232	1,217,114	1,832,603
9	30	656,229	214,741	898,957	1,769,926
10	31	1,083,429	312,003	575,730	1,971,162
11	30	1,730,743	766,574	273,875	2,771,192
12	31	3,665,829	1,272,604	176,254	5,114,686
2020 Annual Avg.		**1,998,329**	**568,225**	**607,975**	**3,174,528**
2030					
1	31	4,112,571	1,273,988	159,103	5,545,663
2	28	4,749,143	998,753	212,152	5,960,048
3	31	3,655,429	692,945	301,391	4,649,765
4	30	2,502,286	405,268	502,646	3,410,199
5	31	1,830,857	249,782	734,055	2,814,693
6	30	1,063,429	210,477	1,099,714	2,373,620

Month	Days	Digester Heating Energy Demand (BTUH)	Building Heating Energy Demand (BTUH)	Chilled Water Energy Demand (BTUH)	Total Thermal Energy Demand (BTUH)
7	31	351,238	211,331	1,144,704	1,707,273
8	31	450,286	210,232	1,217,114	1,877,631
9	30	729,143	214,741	898,957	1,842,840
10	31	1,203,810	312,003	575,730	2,091,543
11	30	1,923,048	766,574	273,875	2,963,497
12	31	4,073,143	1,272,604	176,254	5,522,001
2030 Annual Avg.		2,220,365	568,225	607,975	3,396,564

Note: Values are hourly rates averaged for the month.

Figure 1-1 presents the trend in the thermal energy demands for sludge heating water for the anaerobic digesters at the Ina Road WRF. As shown, very little heating energy is required during the summer months. Energy demands increase essentially proportional with solids feed to the digesters. The step increase for year 2015 is the largest, as this is when solids from the future WRC will begin to be transferred to and digested at the Ina Road WRF.

FIGURE 1-1
Monthly Digester Heating Energy Demand
Ina Road Water Reclamation Facility Energy Master Plan

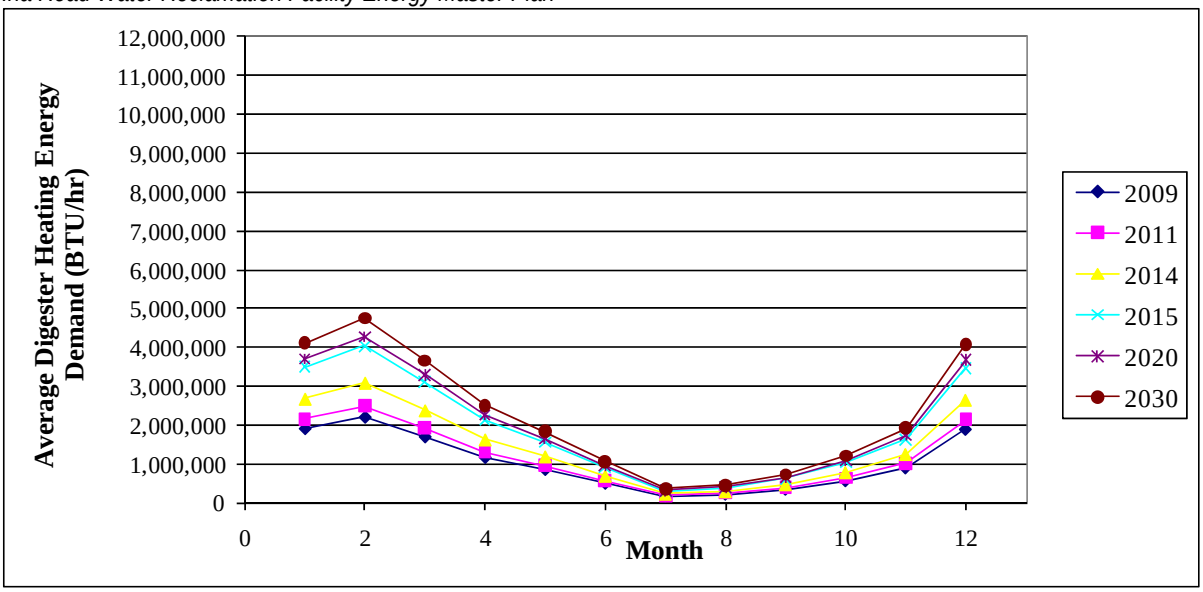


Figure 1-2 presents the trend in the thermal energy demands for building heating water for all existing facilities and facilities added as part of the Upgrade Project construction that are designated to be served by the central building heating water system. Based on the scale of sludge heating and building/process chilled water energy demands, the building heating demands remain essentially unchanged over the course of the years evaluated. This is due to some less efficient buildings being demolished, new more efficient buildings being

added, and some less efficient buildings being renovated with more efficient heating systems.

FIGURE 1-2
Monthly Building Heating Energy Demand
Ina Road Water Reclamation Facility Energy Master Plan

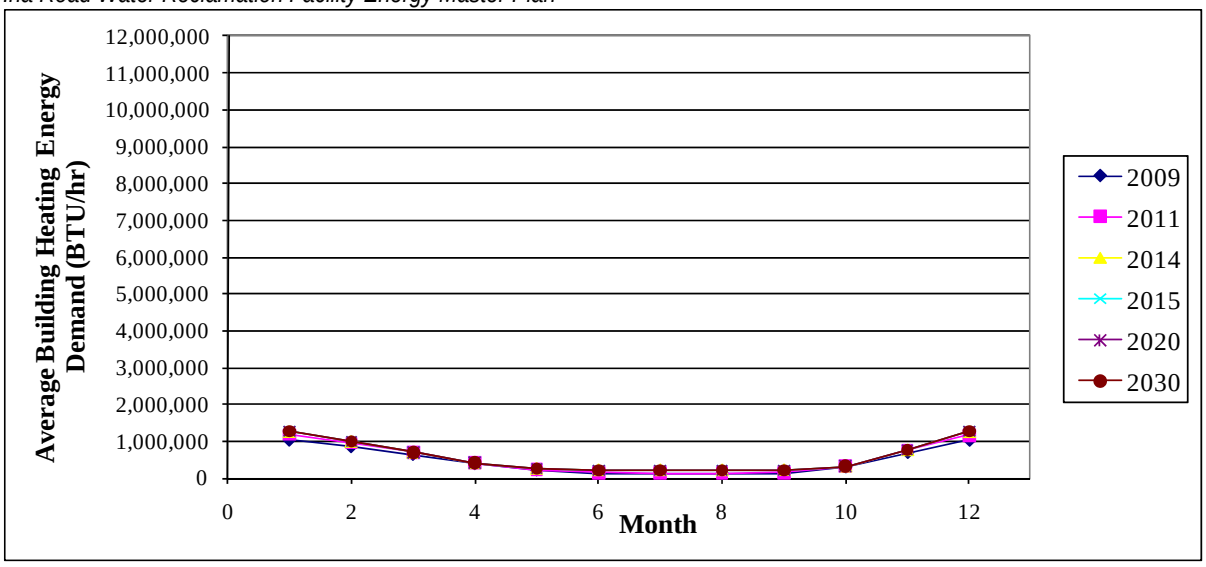


Figure 1-3 presents the trend in the thermal energy demands for building and process cooling chilled water demands. As shown, the energy demands are dramatically decreased for years beyond 2014. This is due to the Oxygen Production Facility being demolished and the planned renovations for the existing Warehouse, Administration Building, and Training Facility.

FIGURE 1-3
Monthly Building/Process Cooling Energy Demand
Ina Road Water Reclamation Facility Energy Master Plan

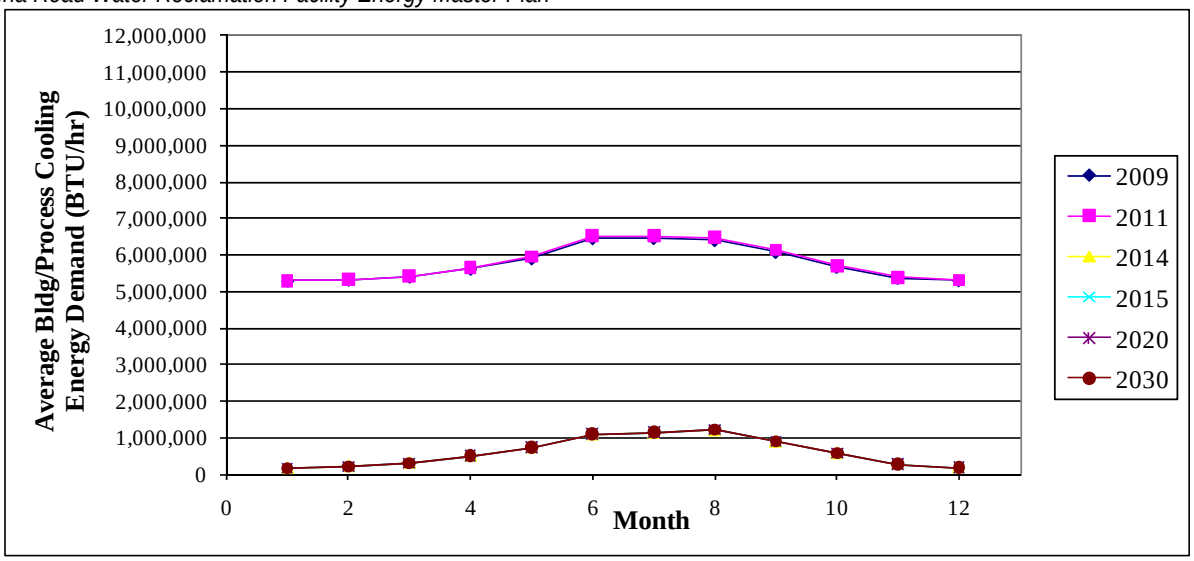
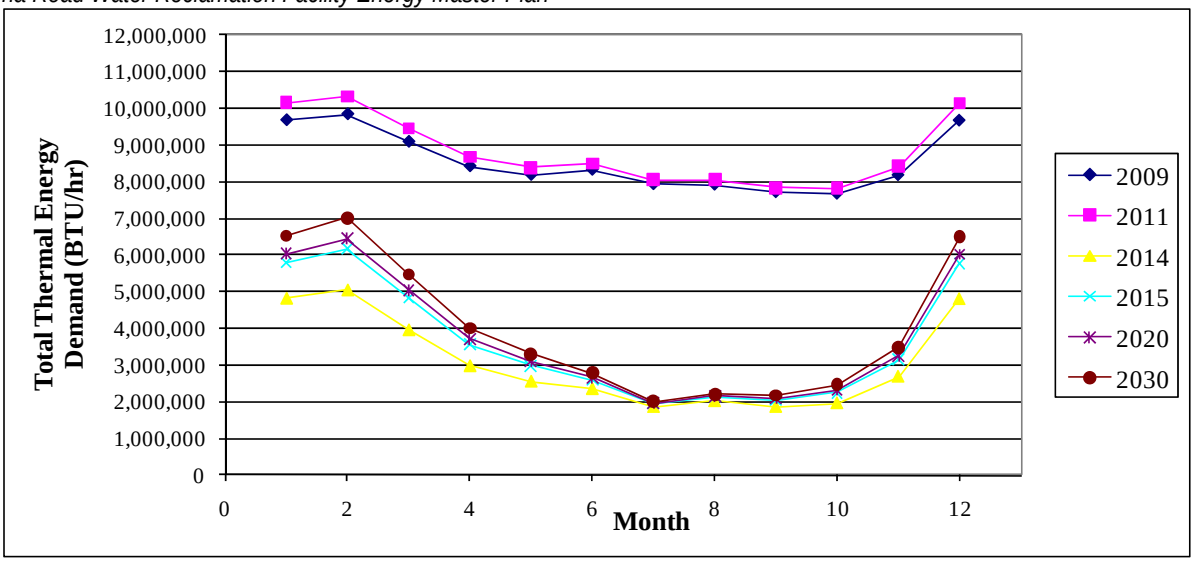


Figure 1-4 presents the trend in the combined thermal energy demands, including sludge heating, building heating, and building/process cooling. The trend is dominated by the

demolition of the Oxygen Production Facility and planned renovations of the existing Warehouse, Administration Building, and Training Facility, driving the large decrease in the overall thermal energy demands of the Ina Road WRF. After year 2014, the overall thermal energy demands are dominated by the sludge heating requirements for the digesters.

FIGURE 1-4
Monthly Total Thermal Energy Demand (Heating and Cooling)
Ina Road Water Reclamation Facility Energy Master Plan



1.4 Thermal Energy Reliability Requirements

As part of the Upgrade Project construction, numerous facilities are being added and others are being renovated. Unmodified existing facilities, new facilities, and renovated facilities are intended to be served by central heated water/chilled water systems. Sludge heating water for the digestion process as well as domestic hot water will also be generated centrally. Currently the plant wide thermal energy needs are being provided via the existing Powerhouse.

The new Energy Recovery Facility (ERF) will replace the existing Powerhouse and so must include the necessary systems to reliably provide the required sludge heating water, building heating water, building cooling water, and domestic hot water.

The purpose of this section is to describe the thermal energy system reliability requirements for the Ina Road WRF that should be incorporated in the new ERF. Each thermal energy sub-system is described and the recommended provisions for reliability are presented.

Overall Thermal Energy Production Reliability Requirements

Similar to the existing Powerhouse, it is expected that the new ERF include mechanical redundancy in the engine-generators to provide for uninterrupted generation of thermal energy to meet the Plant's needs. N+2 redundancy is recommended, providing for one unit available to start should one of the duty units fail and allowing one unit to be out of service for routine maintenance or repairs. Should N+2 units not be provided, a digester

gas/natural gas fired boiler should be provided to generate the necessary heating water and a backup chiller should be provided to supply the necessary chilled water if the engines are not running.

Digester Sludge Heating Water System

The existing four digesters and two new digesters, added via the Interim Biosolids – Digester Complex Project, will be heated by the sludge heating water system. The existing sludge heating water system consists of a single sludge heating water converter (shell and tube type heat exchanger) and primary loop water pump. Both of these pieces of equipment are located in the existing Powerhouse. The primary sludge hot water system piping currently is a closed loop system which is routed from the Powerhouse to existing Facility 11. Secondary loop pumps (four) located in Facility 11 take hot water from the primary loop, circulate it through sludge heat exchangers (four), and return it to the primary loop. The Interim Biosolids –Digester Complex Project will add two new digesters and Facility 60, Digester Control Building. This project will also extend the existing sludge heating water primary loop to Facility 60. Two new secondary loop pumps and associated heat exchangers will also be added in Facility 60 to heat the sludge for the two new digesters.

The sludge heating water system is not considered to be critical for the operation of the Ina Road WRF. It is estimated that during winter time conditions, the sludge temperature in the digesters would drop 1.5 to 2 degrees F per day if the sludge heating water system was out of service. This assumes that raw sludge is continued to be fed into the digesters. If raw sludge feed to the digesters was stopped during the time when the sludge heating water system was out of service, the digester sludge temperature would drop less than 0.5 degrees F per day. During summer time conditions the sludge temperature inside the digesters would drop less than the estimated rate for winter time conditions. At this low a rate of sludge temperature decline, it is felt that sufficient time is available to make repairs to the sludge heating water system without impacting the mesophilic operation of the digesters.

Sludge Heating Water Reliability Recommendation

The recommendation for sludge heating water system equipment redundancy is to not provide any installed redundant equipment. A single sludge hot water converter and single primary loop pump are sufficient for the sludge heating water system. One secondary loop pump per digester is already installed in Facility 11 and one additional secondary loop pump per digester will be added in Facility 60.

Chilled Water Systems

Under the Upgrade Project, chilled water cooling systems will be provided for new electrical rooms and control rooms. Chilled water cooling systems will also be provided in the remodeled Administration Building, Training Facility, and new office spaces planned for the Miscellaneous Plant Improvements. These new and revised loads will be online by the end of the Upgrade Project construction in year 2014. Cooling of the electrical rooms, control rooms, and Administration Building are considered critical to maintaining treatment plant operations. Critical process equipment may fail if the electrical and controls equipment serving them become overheated. Table 1-7 summarizes the projected critical chilled water cooling water system requirements at each facility for the 2014 condition and beyond.

TABLE 1-7
Critical Chilled Water Cooling Systems Requirements
Ina Road Water Reclamation Facility Energy Master Plan

	Facility	Status	Critical Function
1	Administration Building	renovated	office spaces
2	Warehouse/Maintenance	existing	
5	Oxygen Production Facility	demolished	
9	Solids Thickening Building	renovated	electrical/control room and lab
11	Digester Control Building	existing	
14	Powerhouse	existing	
15	Tunnels	existing	
16	Training Center	renovated	office spaces
23	Centrifuge Facility	renovated	electrical and control rooms
30	Headworks	renovated	
34	Blower Building	renovated	electrical and control rooms
37	RAS/WAS Pump Station - East	renovated	electrical room
46	Blower Building - West	new	electrical and control rooms
60	Digester Control Building	new	electrical room
	Switchgear Building	new	electrical room

The Oxygen Production Facility compressor cooling and the digester gas cooler/condenser heat exchanger in the lower level of Facility 11 are existing process critical functions on the central chilled water system that are served by the existing Powerhouse. The Oxygen Production facility is scheduled for demolition. It is assumed that the digester gas cooler/condenser heat exchanger will no longer be needed when the new ERF is started up as it is assumed the new ERF will have its own digester gas treatment system. Therefore these systems do not have any thermal reliability issues as they can continue to run on the existing chilled water system until they are no longer needed. The existing Powerhouse has an electrical and control room air handling unit cooling system that is served by chilled water. This is a process critical load as long as the existing Powerhouse is in operation.

The air conditioning systems for the existing Training Facility and labs, the existing Warehouse, the tunnels and portions of the Administration/Lab building are served by the existing chilled water systems. The control room in the Administration/Lab building is a process critical function served by a separate direct expansion Leibert cooling system, with its own air cooled condensing unit on the roof. Therefore the existing control room is not a critical load on the existing chilled water system. The control room cooling is a process critical load that could be added to the chilled water system during the planned renovation of the Administration/Lab building. The labs in the Administration building and the Training Facility do serve process but these are not deemed to be critical functions that could not be interrupted for short periods. Also, the Administration/ Lab building and the

Training Facility are scheduled for renovations when the lab functions will be removed. Tunnel cooling is convenient but it is not considered a process critical function. A new lab will be added to the lower level of Building 9 as part of the Upgrade Project. This lab will add a chilled water cooling load but this is not a process critical load.

New process critical loads will be added to the chilled water system under the Upgrade Project, when new or renovated electrical rooms in facilities 9, 23, 34, 37, 46 and 60 will be added to the chilled water system and control rooms will be added in buildings 34 and 46. These electrical room/control room systems will be provided with two air handling units each for redundancy to insure continuous cooling.

Chilled Water System Reliability Recommendations

It is recommended that redundancy be provided in the chilled water system in the new ERF to provide continuous chilled water for the process critical loads. A primary/ secondary loop distribution piping configuration is recommended for the chilled water system. The primary loop would be a closed loop system that circulates chilled water flow through the chillers within the new ERF. The secondary loop is also a closed loop system that is connected to the primary loop and circulates chilled water throughout the plant. N+1 redundancy is recommended for the chillers, with a dedicated primary pump for each chiller. There should be a primary and backup pump for the secondary loop. The secondary pumps should be variable speed to save energy. There are variations to this recommendation that the ERF Design-Build-Operate (DBO) contractor may propose to achieve equivalent redundancy and these should be considered if proposed. It is also important to make sure that the controls for the chilled water system allow manual operation to insure against control failure.

Building Heating Water Systems

The existing heating systems in the Administration/Lab building, the Training facility, and the Warehouse are served by the heating water system and will continue to be so after planned renovations at these facilities. The heating system for the new Miscellaneous Plant Improvements will be served by the heating water system. These are not process critical loads. The Upgrade Project will add heating systems to the existing heating water system for facilities 9, 23, 30, 37, and 70. These heating loads are not process critical loads. The existing Facility 11, Digester Control Building, has a heating water piping manifold in the lower level that allows the heating water system to be used as backup to the sludge heating water system. The new Facility 60 Digester Control Building does not have a similar piping manifold and function. The backup sludge heating connection at Facility 11 is not a process critical load. Therefore there are no existing or future process critical heating loads on the building heating water system.

Building Heating Water System Reliability Recommendations

Although there are no process critical loads on the building heating water system, some redundancy is still recommended for the heating water system. It is recommended that a primary/secondary loop piping distribution system be provided similar to that recommended for the chilled water system. Two heating water heat exchangers or boilers, each sized for at least 67 percent of the total design load, with a dedicated primary pump for each should be provided. There should be primary and backup heating water secondary

pumps to insure continuous flow, as needed. The secondary pumps should be variable speed to save energy. There are variations to this recommendation that the ERF DBO contractor may propose to achieve equivalent redundancy and these should be considered if proposed. It is also important to make sure that the controls for the heating water system allow manual operation to insure against control failure.

Domestic Hot Water System

There are no process critical loads on the domestic hot water system. The existing labs in the Administration/Lab building and the Training Facility use domestic hot water but these functions will not be required after planned renovations. The new lab to be added under the Upgrade Project is not a process critical function.

Domestic Hot Water System Reliability Recommendations

Redundancy is not required for the domestic water heating system. However it would be good practice to provide a backup distribution pump to insure service when needed.

1.5 Digester Gas Production

The purpose of this section is to document the forecast digester gas production at the Ina Road WRF. The forecast digester gas production rates are then used in Section 3.4, Alternative 1 – TEP Supply plus Energy Recovery Facility to forecast the electrical and thermal energy available via onsite cogeneration. The forecast gas production is also used in Section 3.5, Alternative 2 – TEP Supply plus Central Plant to forecast the thermal energy available for the central heated water/chilled water plant alternative.

Background

Currently, the Ina Road WRF performs mesophilic anaerobic digestion with four digesters and an associated Digester Control Building and equipment. The four existing anaerobic digesters are conventional in style, with a relatively shallow sidewater depth in relation to tank diameter and sloping conical bottoms. They are concrete tanks having an inside diameter of 90 feet and a maximum sidewater depth of 28 feet. When operating at the maximum sidewater depth, the digesters each have a liquid volume for active digestion of roughly 1.33 million gallons. This active digestion volume does not include the volume of the sloping conical bottoms to account for grit accumulation.

As part of the Interim Biosolids-Digester Complex Project, two additional digesters will be added to increase the plant capacity for stabilizing solids to Class B standards. The increased capacity is needed to stabilize the solids generated at the upgraded Ina Road WRF, with an influent flow up to 50-mgd, together with the solids generated and transferred from the future Water Reclamation Campus to be located near the existing Roger Road WRF, with an influent flow of 32-mgd . Each new digester will also be conventional in style but will have a larger volume of approximately 1.8 million gallons each. Each digester is 90 feet in diameter with a 38-foot sidewater depth. Both digesters will be fitted with gasholder covers with a long skirt length to provide greater storage of digester gas.

Historical Data

Operating data for the existing Powerhouse was provided by WRF staff. The data covered Powerhouse use of digester gas, natural gas, and propane from January 2006 to August 2008. The year 2006 data were combined with monthly influent wastewater data to extrapolate digester gas production to the equivalent of 82 million-gallons-per-day (mgd) in design year 2030. Monthly data from year 2006 are shown in Table 1-8. Select years of extrapolated digester gas production from this data are shown in Table 1-11.

TABLE 1-8
Year 2006 Powerhouse Operations Data
Ina Road Water Reclamation Facility Energy Master Plan

Month	Average Ina Road WRF Influent Flow (mgd)	Digester Gas Burned in Powerhouse (ft3/month)	Average Digester Gas Rate (scfm)
Jan	22.1	9,872,535	221
Feb	21.6	8,583,608	213
Mar	20.9	9,715,148	218
Apr	20.7	9,306,608	215
May	20.2	9,576,045	215
Jun	19.8	8,441,835	195
Jul	24.9	9,700,800	217
Aug	25.4	9,118,193	204
Sep	25.2	8,006,505	185
Oct	25.3	7,441,508	167
Nov	26.0	7,672,710	178
Dec	26.1	8,820,773	198
Yearly Average	23.2	8,854,689	202

Process Modeling/Solids Calculations for Digester Gas Forecast

As part of designing the Ina Road WRF Upgrade Project, CH2M HILL performed modeling of the wastewater treatment processes. Outputs, from the process modeling, included solids production rates for primary sludge and waste activated sludge (WAS), as well as the volatile solids content of these sludge streams. Process modeling was also performed for the future WRC to provide a design basis for the waste activated sludge to be transferred to and digested at the Ina Road WRF. Based on the predicted solids production rates and volatile solids content, together with the digestion volatile solids destruction efficiency and amount of digester gas produced per pound of volatile solids destroyed, the rate of digester gas production was calculated. Table 1-9 presents the process modeling solids production

results and the basis and parameters used in the solids calculations and digester gas production for year 2030.

TABLE 1-9
CH2M HILL Process Modeling Solids Production Results and Gas Production Calculation Parameters
Ina Road Water Reclamation Facility Energy Master Plan

Parameter	Value	Average Annual Year 2030	Maximum Month Year 2030
Ina Road WRF Solids Production Delivered to Digestion			
Primary Sludge – Total Dry Solids		96,966 dry lbs/day	113,074 dry lbs/day
Primary Sludge Volatile Solids Content	77%		
Primary Sludge – Volatile Solids		72,031 dry lbs/day	86,687 dry lbs/day
Waste Activated Sludge – Total Dry Solids		49,720 dry lbs/day	61,276 dry lbs/day
Waste Activated Sludge Volatile Solids Content	65%		
Waste Activated Sludge – Volatile Solids		32,289 dry lbs/day	40,070 dry lbs/day
Future Water Reclamation Campus Solids Production Delivered to Ina Road WRF Digestion			
Waste Activated Sludge – Total Dry Solids		54,173 dry lbs/day	65,485 dry lbs/day
Waste Activated Sludge Volatile Solids Content	71%		
Waste Activated Sludge – Volatile Solids		38,512 dry lbs/day	46,607 dry lbs/day
Total Sludge Feed to Ina WRF Digestion			
Total Dry Solids		197,859 dry lbs/day	239,835 dry lbs/day
Total Volatile Solids		142,831 dry lbs/day	173,364 dry lbs/day
Ina Road WRF Digester Gas Production			
Volatile Solids Destruction Rate	62%		
Volatile Solids Destroyed		88,270 dry lbs/day	105,752 dry lbs/day
Digester Gas Conversion Rate (standard cubic feet of gas produced per dry pound of volatile solids destroyed)	12 scf/dry lb		
Digester Gas Production Rate		736 scfm	881 scfm

Digester gas production, in years prior to Year 2030, was proportioned based on the equivalent plant wastewater influent flow of solids being digested at the Ina Road WRF. Year 2008 combined wastewater flow to Ina Road and Roger Road WRFs was 60-mgd, increasing by 1-mgd per year, to a total of 82-mgd in year 2030. When the future WRC is brought online in year 2015, it is assumed to base load at its rated capacity of 32-mgd. Thus, starting in year 2015, 32-mgd equivalent of WAS from the WRC will be digested in the Ina Road WRF set of six digesters. Table 1-10 presents the basis for equivalent plant wastewater influent to the Ina Road WRF digesters and the resulting forecast digester gas production.

TABLE 1-10
Ina Road WRF Equivalent Wastewater Influent Flow and Forecast Digester Gas Production
Ina Road Water Reclamation Facility Energy Master Plan

Year	Average Annual Ina Road WRF Wastewater Influent Flow (mgd)	Average Annual Plant Interconnect Wastewater Flow Sent to Ina Road WRF (mgd)	Average Annual Wastewater Influent Equivalent of WAS transferred from WRC to Ina Road WRF Digesters (mgd)	TOTAL Average Annual Wastewater Influent Equivalent of Solids to Ina Road WRF Digesters (mgd)	Average Annual Ina Road WRF Digester Gas Production Proportioned from Year 2030 (scfm)
2008	26	0	0	26	233
2009	26.5	0	0	26.5	238
2010	27	0	0	27	242
2011	27.5	0	0	27.5	247
2012	28	0	0	28	251
2013	28.5	0	0	28.5	256
2014[a]	29	5	0	34	305
2015[b]	29.5	5.5	32	67	601
2016	30	6	32	68	610
2017	30.5	6.5	32	69	619
2018	31	7	32	70	628
2019	31.5	7.5	32	71	637
2020	32	8	32	72	646
2021	32.5	8.5	32	73	655
2022	33	9	32	74	664
2023	33.5	9.5	32	75	673
2024	34	10	32	76	682
2025	34.5	10.5	32	77	691
2026	35	11	32	78	700
2027	35.5	11.5	32	79	709
2028	36	12	32	80	718
2029	36.5	12.5	32	81	727
2030	37	13	32	82	**736**

[a] Raw wastewater sent to Ina Road WRF from Roger Road WRF via Plant Interconnect

[b] WRC transfer of raw waste activated sludge to the Ina Road WRF for digestion begins

Extrapolation and Forecast Comparison

Table 1-11 compares the forecast digester gas production based on extrapolation from the year 2006 Powerhouse data and the process modeling/solids calculations. Table 1-11 shows good correlation between the two approaches. For consistency, the process modeling/solids

calculation numbers, refer to Table 1-10, have been used as the basis for analysis in the remainder of the Energy Master Plan.

TABLE 1-11
Digester Gas Production Forecasts
Ina Road Water Reclamation Facility Energy Master Plan

Year	Annual Average from Powerhouse Data (scfm)	Average Annual Forecast from 2006 Powerhouse Data (scfm)	Average Annual Forecast from 2030 Process Modelings/Solids Calculations (scfm)
2006	202	--	--
2007	206	--	--
2008	219	--	--
2009	--	227	238
2011	--	235	247
2014	--	296	305
2015[a]	--	584	601
2020	--	628	646
2030	--	715	736

[a] WRC transfer of raw waste activated sludge to the Ina Road WRF for digestion begins

2. Evaluation of Existing Facilities to Meet Future Needs and Condition Assessment of Existing Facilities

2.1 Existing Electrical Equipment Assessment

The purpose of this section is to present findings from an assessment of the existing electrical equipment at the Ina Road Wastewater Reclamation Facility (WRF).

The assessment includes identifying obsolete and difficult-to-maintain electrical equipment, identifying improvements for electrical safety, and identifying opportunities to enhance plant reliability. This includes previous and current observations by CH2M HILL engineers, discussion with Pima County Regional Wastewater Reclamation Department (PCRWRD) staff, and discussion with original equipment manufacturers.

Background

The original Ina Road Wastewater Reclamation Facility was designed in 1973 and was constructed from 1975 to 1977. The plant's electrical system consists of both medium- and low-voltage equipment, some from the original design and installation and some from subsequent plant modifications. The primary dates of manufacture for electrical equipment from these modifications are 1976, 1989, 2000, and 2002.

Assessment Methodology

Ina Road WRF's electrical system assessment consisted of visual inspections, discussion with PCRWRD staff, and discussions with the electrical equipment manufactures for each piece of major equipment. The visual inspections included the use of a form to standardize documentation of the findings. A completed form for each piece of electrical equipment evaluated is included in Appendix A, Electrical Equipment Assessment Forms.

Discussions were held with the plant staff and with equipment manufacturers to gain insight into particular pieces of equipment that have been difficult to maintain and are not supported or are to be discontinued by the manufacturers in the near future. In addition, discussions with the manufacturers included inquiries about products to improve system reliability while reducing arc-flash hazards.

With the information gained from visual observations and discussions, a determination of the suitability for each piece of equipment being assessed for continued service was made. The determination considered age, condition, and location of equipment; known maintenance and safety issues; and the availability of replacement parts.

Evaluation

The electrical equipment assessment, as defined above, included discussions with original equipment manufacturers and they have indicated that the existing equipment will continue to be supported in the future. This fact has removed equipment as being obsolete from the

assessment criteria. The remaining criteria of equipment condition and safety will be used for the determination of equipment suitability for continued use. The following contains our assessment.

Equipment to be Replaced or Removed via Upgrade Project

Some of the major electrical equipment will be replaced or removed as part of the Capacity and Effluent Quality Upgrade Project (Upgrade Project); therefore, this equipment was not evaluated as part of these assessments. This equipment is discussed below.

Substation No. 1

There is no planned role for Substation No. 1 in the present Upgrade Project 60-percent Design Development documents. Substation No. 1 is located between Gravity Thickeners No. 1 and No. 2. The substation has significant corrosion and no longer serves as a backup to other substations. PCRWRD stated that the design should show demolition of Substation No. 1, its concrete slab, and enclosure walls. Conductors to (and from) the substation should be removed.

Substation No. 3

Substation No. 3 is planned to be removed to make room for the new odor control system serving Facilities 4, 48, 58, and 70.

5 – High-purity Oxygen Facility

This entire facility will be demolished as part of the Upgrade Project.

9 – Vacuum Filtration

Existing Motor Control Center (MCC)-09 does not fit with the new loads to be powered out of this facility. A new MCC will be provided to supply both existing loads that will remain and any new loads added with the Upgrade Project.

23 – Centrifuge Facility

Existing MCC-23 does not have sufficient capacity to supply the replacement equipment to be installed as part of the Upgrade Project. A new MCC will be provided in a new ground-level electrical room. The location of the existing MCC-23 will be used for local control panels of the replacement centrifuges. A new MCC will help to maintain centrifuge operations during construction.

Equipment Evaluated

The majority of the existing electrical equipment that will be required to provide future service has been evaluated for suitability for continued use. This equipment is discussed below.

Substation No. 2 - Substation

No. 2 is critical for reliable plant operations, as it powers motor control centers in the Sludge Thickeners Control Building “Facility 8”, the Solids Thickening Building “Facility 9”, the Chlorination Building “Facility 12”, the Powerhouse “Facility 14”, the Training Center “Facility 16”, and the Service Water Building “Facility 17”. This equipment appears to be serviceable, based on external observations, and replacement parts are available. Should the unit be upgraded with modern circuit breakers, other issues arise. New circuit breakers can be problematic given the environmental conditions (heat and dust), and the cost to upgrade

the unit (new circuit breakers, trip units, replacement of the existing 4.16kV transformer with 13.8kV transformer, air-conditioning unit, and safety issues corrections) makes replacement favorable. In addition, safety issues with regards to arc-flash, egress, and working clearances have been observed. Based on this information and discussions with the plant staff, the consensus is to replace Substation No. 2.

As part of follow-on work to this Master Plan, CH2M HILL will evaluate options for the replacement of Substation No. 2. Options to be considered include:

- A new substation in a building or modular structure at or near the existing substation. The new substation structure will be provided with a controlled environment (air conditioning and enclosures for dust control) for microprocessor-based circuit breakers and controls.
- Distribution equipment inside the new Switchgear Building.
- Distributed padmount transformers located at the facilities presently served, with main circuit breakers inside the facilities.

Substation No. 4

The discussion for Substation No. 4 is similar to Substation No. 2. It too should be upgraded with modern circuit breakers, trip units, and associated equipment. The new 13.8kV system voltage that will come with the Upgrade Project will require that the substation transformer be replaced. Substation No. 4 plays a critical role, supplying the Administration Building (laboratory, phone service, and SCADA System). Substation No. 4 presents similar tradeoffs between upgrade and replacement as with Substation No. 2. The consensus is to replace the substation.

As part of follow-on work to this Master Plan, CH2M HILL will evaluate options for the replacement of Substation No. 4. Options to be considered include:

- A new substation in a building or modular structure at or near the existing substation. The new substation structure will be provided with a controlled environment (air-conditioning and enclosures for dust control) for microprocessor-based circuit breakers and controls.
- Outdoor padmount transformer(s) with main circuit breaker(s) inside the remodeled Administration Building or Warehouse.

Substation transformer oil analyses had been performed at regular intervals for some time, but for the past several years, these analyses have not been performed. In general, no major issues were found in previous analyses.

01 – Administration Building Panelboard Main Distribution Panel (MDP)

The panelboard, located in the lower-level equipment room, is relatively old but is serviceable and replacement parts are available. The Administration Building is planned to be remodeled as part of the Upgrade Project. The remodel is contingent on the laboratory functions being relocated to the central laboratory planned at the Roger Road campus. Consensus is that the panelboard is serviceable and will remain until the time of the building remodel, when the panelboard would be need to be replaced anyway to provide

service to the revised loads in the building. New conductors are recommended upon replacement of the panelboard.

02 – Warehouse Panelboard MDP

The panelboard, located in the equipment maintenance area, is relatively old but the panel is serviceable and replacement parts are available. Similar to the Administration Building panelboard, consensus was to leave the equipment alone until the building is remodeled. Plant staff indicated that underground conduits have deteriorated, and wiring has been difficult if not impossible to remove. The underground conduits were metal, with no additional corrosion protection such as PVC coating or tape wrapping. New conduit and conductors are recommended upon replacement of the panelboard.

08 – Gravity Thickeners – MCC-08W1, -08W2, -08W3, and -08W4

MCC-08W1 and -08W2 are from the original plant construction (late 1970s). According to the plant staff, the bucket stabs appear to be in good working condition; however, Westinghouse MCCs may soon begin having parts availability problems. Discussions with the manufacturer have shown that they, Eaton/Cutler-Hammer, will continue to support the MCCs for quite some time. The staff also reported that the terminal strips in the bottom of the enclosures make it impossible to properly clean the enclosure interior. Plant staff recommended that MCC-08W1 and -08W2 be replaced to provide future 30-year service. Being that these motor control centers have, or will in the near future, reached their useful life expectancy; CH2M HILL supports the recommendation for replacement. The replacement units will not be located in the Facility 8 process space to avoid potential hydrogen sulfide damage.

MCC-08W3 and -08W4 are from 1988 construction and are still in good shape; however, if a replacement of MCC-08W1 and -08W2 is performed and those MCCs are moved to a separate space, these two MCCs should be moved at the same time. MCC functions could be consolidated into a single double-ended motor control center in a controlled climate.

11 – Digesters – MCC-11W1, -11W2, -11W3, and -11W4

MCC-11W1 and -11W2 are from the original plant construction (late 1970s), while MCC-11W3 and -11W4 are from the 1988 construction. Plant staff report that loads such as gas compressors are being moved off of -11W1 and -11W2 onto -11W3 and -11W4. That trend should continue. The only current load in -11W1 and -11W2 that have been requested to remain are a circuit breaker and disconnect for digester cleaning contractor use. PCRWRD will provide a feeder for the contractor out of -11W3 or -11W4; therefore, -11W1 and -11W2 should be removed.

12 – Chlorination Building – MCC-12W1

MCC-12W1 is in maintainable condition, it is at the end of its useful service life, and the Westinghouse Type W MCC product line may not be supported into the distant future. Being that no changes in use for this facility have been planned and its existing use is non-critical in nature, the MCC-12W1 replacement should be decided based on future function. For now, MCC-12W1 will be left in place.

14 – Powerhouse – 5kV Switchgear and MCC-14W1, -14W2 and -14W3
Parts are available for the ITE-BBC 5kV circuit breakers. With regular maintenance and some upgrades (vacuum circuit breakers), the gear can be operated well into the future. Westinghouse Type W MCCs may have part availability issues in the future, as mentioned previously. Replacement depends on the future role of the Powerhouse and availability of parts from Cutler-Hammer for the Westinghouse MCCs. For now, the 5KV switchgear and MCCs will be left in place.

16 – Training Center Panelboard MDP
The panelboard is relatively old, but the panel is serviceable and replacement parts available. Similar to the Administration Building panelboard, consensus is to leave the equipment alone until the building is remodeled. Plant staff mentioned poor clearances around the equipment and wrong door swing. The building remodel should include a new and much larger electrical room to address these issues. New conduit and conductors are recommended upon replacement of the panelboard.

17 – Service Water Pump Station – MCC-17W1 and -17W2
MCC-17W1 and -17W2 are from the original plant construction (late 1970s) and likely exhibit the most deterioration of any of the MCCs onsite. Leaking water and the humid environment in the building have caused corrosion. These MCCs also suffer from inadequate interior cleaning due to the bottom-mounted terminal strips. Both MCCs should be demolished, and replacement units will be located in an adjacent climate-controlled structure.

28 – Dechlorination – MCC-A and MCC-B
MCC-A and MCC-B are relatively new Square D units and are in fair condition. No changes are recommended.

30 – Headworks – Unit substations and MCCs
All equipment is nearly new, and no changes are recommended. Plant staff mentioned tripping hazards around transformers. CH2M HILL will note these tripping hazards on the list of existing facilities issues not currently addressed in the Upgrade Project.

34 – Blower Building – Unit Substations, Switchgear, and MCCs
All equipment is nearly new, and no changes are recommended. Plant staff mentioned tripping hazards around transformers. CH2M HILL will note these tripping hazards on the list of existing facilities issues not currently addressed in the Upgrade Project. A new MCC will be added to this building as part of the Upgrade Project to support new primary clarifier and BNRAS basin loads. Plant staff also mentioned that the oil containment area for the 5MVA transformer (TX-34) occasionally floods.

37 – RAS/WAS Pumping Station – MCC-37A and -37B
All equipment is nearly new, and no changes are recommended. Plant staff mentioned leaky conduits during storm events; problem appears to be water entering the building via the conduit wall penetrations. CH2M HILL will note the sealing of these wall penetrations on the list of existing facilities issues not currently addressed in the Upgrade Project.

Reliability and Safety

The majority of the existing electrical equipment which is suitable for continued use from a maintainability viewpoint will be left in place and reused as part of the Upgrade Project. In

addition, the reliability and safe operation of the equipment to be reused was evaluated and found suitable for continued use.

For reliability, redundant equipment and multiple methods for operation are being incorporated in to the Upgrade Project for both the new and existing electrical equipment and systems. New equipment should be fault-tolerant in that a failure of one device will not affect the operation of adjacent equipment. One example would be the use of switchboards with individually-mounted, instead of group-mounted, circuit breakers. Electrical equipment selection should also consider management of arc-flash hazards to operating personnel. Arc-flash management features include construction of pathways to direct arc flashes away from personnel and arc-flash reduction mechanisms for maintenance purposes. Appendix B contains the Preliminary Arc Flash Study.

The arc-flash reduction mechanisms include circuit breakers whose inherent design reduces the let-through energy, thus reducing the potential arc-flash effects. In addition to the different type of circuit breakers, manufacturers also offer arc-flash reduction systems that can be included with new equipment or can be retrofitted into existing electrical equipment. These systems reduce the potential arc-flash energy by providing two different protective device settings. The normal protective device settings provide the appropriate level of protection of the electrical equipment and coordination with other components within the distribution system. The second setting reduces the trip setting for maintenance activities. A selector switch is used to switch between the two settings. This switch typically is monitored and activates a local warning light or beacon when in the maintenance position. This can also be monitored by the plant's control system.

These types of systems and equipment will be evaluated for incorporation in the Upgrade Project to reduce the level of arc-flash events.

Summary

In general, electrical equipment installed in the original plant construction will be removed and/or replaced in the Upgrade Project, with a few exceptions. The exceptions are for non-critical systems, and systems which may be no longer used or demolished and these will be upgraded on a case-by-case basis, as determined by PCRWRD. Table 2-1 summarizes the recommended equipment replacements.

Remaining electrical equipment may be retrofitted with arc-flash reduction measures. These measures will be determined and incorporated into the Upgrade Project.

TABLE 2-1
Summary of Recommended Electrical Equipment Replacements
Ina Road Water Reclamation Facility Energy Master Plan

Facility / Equipment Description	Year Manufactured	Replace? (Y/N)	Comments
Unit Substations			
Substation No. 1	1976	N	Remove. No replacement.
Substation No. 2	1976	Y	
Substation No. 3	1976	N	Remove. No replacement.

TABLE 2-1
Summary of Recommended Electrical Equipment Replacements
Ina Road Water Reclamation Facility Energy Master Plan

Facility / Equipment Description	Year Manufactured	Replace? (Y/N)	Comments
1 – Administration Building			
MDP	1976	Y	To be replaced during remodel.
2 – Warehouse			
MDP	1976	Y	To be replaced during remodel.
LPA	1976	Y	To be replaced during remodel.
8 – Gravity Thickeners			
MCC 08W1	1976	Y	
MCC 08W2	1976	Y	
MCC 08W3	1989	Y	
MCC 08W4	1989	Y	
LPA	1976	Y	
11 – Digester Control Building			
MCC 11W1	1976	N	Remove. No replacement.
MCC 11W2	1976	N	Remove. No replacement.
MCC 11W3	1989	N	
MCC 11W4	1989	N	
LPA	1976	Y	
12 – Chlorination Building			
MCC 12W1	1976	N	
14 – Powerhouse			
MCC 14W1	1976	N	
MCC 14W2	1976	N	
MCC 14W3	1976	N	
LPA	1976	N	
16 – Training Center			
LPA	1976	Y	To be replaced during remodel.
17 – Service Water Building			
MCC 17W1	1976	Y	
MCC 17W2	1976	Y	
28 – Dechlorination Building			
MCC-A	2002	N	
MCC-B	2002	N	
30 – Headworks			
US30-1	2000	N	Primary Feed Selector Switch, Primary Fused Switch, TX-30-1, and DS-30-1
US30-2	2000	N	Primary Fused Switch, TX-30-2, and DS-30-2
MCC 30A	2000	N	
MCC 30B	2000	N	

TABLE 2-1
Summary of Recommended Electrical Equipment Replacements
Ina Road Water Reclamation Facility Energy Master Plan

Facility / Equipment Description	Year Manufactured	Replace? (Y/N)	Comments
34 – Blower Building – East			
5kV Distribution Switchgear			
US-34-1	2002	N	Primary Fused Switch, TX-34-1, and DS-34-1
US-34-2	2002	N	Primary Fused Switch, TX-34-2, and DS-34-2
MCC-33A	2002	N	
MCC-33B	2002	N	
MCC-34	2002	N	
MCC-34C	2002	N	
MCC-34D	2002	N	
MCC-35A	2002	N	
MCC-35B	2002	N	
Power Panel P35A	2002	N	
Power Panel P35B	2002	N	
37 – RAS/WAS Pumping Station – East			
TX-37	~ 1978	N	
MCC-37A	2002	N	
MCC-37B	2002	N	

2.2 Existing Thermal Equipment Assessment

The purpose of this section is to present findings from an assessment of the existing thermal equipment at the Ina Road WRF. The function of the thermal equipment is to generate hot and chilled water which serves both the process and facilities heating and cooling demands.

The assessment included identifying obsolete and difficult-to-maintain thermal equipment and identifying opportunities to enhance plant reliability. The assessment of the thermal facilities included a visual inspection by CH2M HILL staff and discussions with PCRWRD staff.

All of the thermal equipment included in this assessment is located in Facility 14, Powerhouse. Also included in the assessment is the existing heating and chilled water piping systems.

Background

The original Ina Road WRF, including the Powerhouse, was designed in 1973 and was constructed from 1975 to 1977.

The Powerhouse uses digester gas, generated as a byproduct of the solids treatment process, and natural gas to generate power and thermal energy for heating and cooling. Modifications to the original design to enhance equipment performance and reliability were completed in 1990.

Assessment Methodology

Ina Road WRF's thermal system assessment consisted of visual inspections of equipment and piping and discussion with PCRWRD staff. The visual inspections included the use of a form to standardize documentation of the findings. A completed form for each piece of equipment evaluated is included in Appendix C, Thermal Equipment Assessment Forms.

Discussions were held with plant staff to gain insight into particular pieces of equipment, maintenance history, and if the equipment is still being supported by the manufacturer. With the information gained from visual observations and discussions, a determination of the suitability for each piece of equipment (being assessed) for continued service was made. The determination considered age and condition of equipment, known maintenance and safety issues, and the availability of replacement parts.

Evaluation

In discussions with plant staff it was determined that the thermal equipment is currently performing as designed and is producing electrical power, heated water, and chilled water as required to support the current needs of the WRF. Replacement parts are still available for all equipment and the equipment will continue to be supported in the foreseeable future. As discussed below, some existing piping is failing and will be replaced as part of the Upgrade Project. Overall equipment condition, reliability of equipment, and safety will be used for the determination of equipment suitability for continued use. The following is a summary of the assessment and further details are in Appendix C, Thermal Equipment Assessment Forms.

Thermal Equipment

All of the thermal equipment that was evaluated in this assessment is located in existing Facility 14, Powerhouse.

Engine/Generators

There are seven existing Waukesha engine/generators. At the time of the assessment, four of the units were operating to meet the electrical and thermal demands of the WRF. One unit was undergoing a complete engine rebuild. All of the units have been well maintained during their 32 years of operation. One of the units per year is scheduled for a complete engine rebuild and routine maintenance is performed as required. Maintenance of the engine heads is a continual issue because of the contaminants present in the digester gas. A recent project to clean the digester gas has been cancelled because of high construction and operating cost. This will continue to be an issue for the engines as long as they are burning the un-cleaned digester gas. The engines are set up to operate on any of three fuels: digester gas, natural gas, or propane. Typically the engines operate on either digester or natural gas and propane is seldom used. With seven engine/generators installed, there are sufficient units and redundancy available to meet the current thermal demands of the WRF.

Ebullient Boilers

Each of the seven engines has an ebullient boiler attached to the engine exhaust. These units are a shell and tube type heat exchanger which functions to extract heat from the exhaust stream and produce low pressure steam. The steam is then used in the chiller to produce chilled water, and in the converters to produce hot water. Since the ebullient boilers are a

pressure vessel, they are required to be inspected and certified on a routine basis. Staff indicated that all of the units were original, except unit No. 5 which has been re-tubed.

When the demand for electrical energy is high requiring engine/generators to operate, the ebullient boilers produce more thermal energy than is required. The excess thermal energy is then dumped into the WRF effluent as hot water which is produced in the waste heat converter.

With seven units installed, there are sufficient units and redundancy available to meet the current thermal demands of the WRF.

Low Pressure Boiler
The Low Pressure Boiler is a 15 pounds-per-square-inch steam, fire tube type boiler with the ability to burn the same three fuels as the engine/generators. The unit was designed to operate when all the engine/generators are down. The steam produced by this unit is fed into the same steam piping as the ebullient boilers. Under current mode of operation, the boiler is not operated and has not been fired since 1988. It would require a great deal of maintenance to put this unit back into operating condition. As long as the current mode of operation, with six of the seven engine/generators available for operation, the low pressure boiler is not required.

Absorption Chiller
The function of this unit is to utilize the energy in steam to produce chilled water. It is a very mechanically intensive unit which requires a great deal of routine maintenance. The original unit was replaced with a new unit in 1998. The plant staff estimates that the current unit has a remaining life expectancy of ten years. This unit has no redundancy.

Heating Water, Sludge Heating, and Waste Heat Converters
All three of these units are shell and tube type heat exchangers. Steam is utilized to produce hot water in these units. These are a very simple type unit with no moving parts and require very little maintenance. These units are all original equipment. None of these units has redundancy.

Deaerator
This is a spray bar type deaerator which function is to condition the returning condensate prior to it being utilized in the production of steam. This unit is a packaged unit which includes pumps, valves, and controls. This unit is original equipment and has no redundancy.

Domestic Hot Water Generator
This unit is a shell and tube type heat exchanger. Steam is utilized to produce hot water in this unit. This is a very simple type unit with no moving parts and requires very little maintenance. This unit is original equipment. The unit has no redundancy.

Hot Water, Waste Heat, Condenser, Lube Oil Coolant, Heat Sink, and Chilled Water Pumps
These units are all horizontal centrifugal type pumps. The function of these pumps is to circulate hot or chilled water through the converters or chiller through piping in a closed loop to the process or facility requiring heating or cooling. These are all original equipment that has had routine type maintenance preformed as required. The plant staff indicates that parts are still available for this equipment. None of these units have redundancy.

Air Compressors

There are two reciprocating type air compressors which function is to provide air to start the engine/generators and for utility air within the Energy Recovery Facility (ERF). One of the units is electric motor driven and the other is driven by a gas engine. The electric driven unit was replaced one year ago and the Kohler gas engine on the second unit was recently rebuilt. With two units, redundancy is provided.

Piping System

Although most of the existing heating and cooling water piping is routed through the tunnels, the plant is served by some existing below grade piping which has a history of leaks. This problem was discussed with plant maintenance staff during the Energy Master Plan Assessment Workshop, held November 12, 2009. During this workshop it was decided that the problematic below grade piping should be replaced and that this work will be added to the Upgrade Project. The piping to be replaced includes below grade heating and chilled water supply and return lines between the tunnel in Facility 4 and the Administration Building and the Warehouse facility. Heating and chilled water supply and return piping between the lower level of the Powerhouse and the Training Building will also be replaced. Heat sink supply and return piping between the existing Powerhouse and Building 17 is also to be replaced. However, if it is determined that the Powerhouse will no longer be used, the heat sink piping will not be replaced. As part of the Upgrade project, the majority of the existing heating and cooling water piping sizes will be evaluated to determine if the sizes are appropriate for future demands.

Equipment Reliability

The majority of the existing thermal equipment is original equipment that has been well maintained and is in good operating condition. Therefore, with continued maintenance it should be capable of operating in its current configuration until the Upgrade Project has been constructed and put into operation.

Air Permitting/Emissions

Impact of Maintaining Existing Powerhouse Generators

Similar to current practice, the existing Powerhouse engine generators could be continued to be repaired and their lifespan extended. However, the fixed capital costs for the repairs to lengthen the life span of the existing Powerhouse must be less than 50-percent of the fixed capital costs to construct a comparable new facility, or the repairs would constitute a modification to the existing Powerhouse for air quality permitting purposes (40 CFR 60.15 (d)).

A modification to the existing air permit could be classified as a significant or an insignificant modification. If the net emissions increase exceeds the values listed in Table 2-2, the modification would be classified as a significant modification. Significant modifications require air quality dispersion modeling and other air quality impact analyses. The additional analyses can take considerable amounts of time and increase the costs of a permit modification. Therefore it is recommended to pursue the modification to the existing air permit via an insignificant modification, with the aid of removing the existing Powerhouse from service as described below.

TABLE 2-2
Significant Net Emission Increases
Ina Road Water Reclamation Facility Energy Master Plan

Pollutant	Emissions Rate (tons per year)
Carbon Monoxide (CO)	100
Nitrogen Oxides (NOx)	40
Sulfur Dioxide (SO_2)	40
Particulate Matter	25
Particulate Matter 10 Microns or less (PM_{10})	15
Volatile Organic Compounds (VOCs)	40
Lead	0.6

Benefit from Removing Existing Powerhouse from Service

If the existing Powerhouse were to be removed from operations, the air quality emissions from the last two years may be averaged, and subtracted from the potential emissions of new equipment at the facility (or at the new ERF). The resulting net emissions increase would then be compared to the significant modification thresholds listed above to determine if the air permit modification would be classified as significant or insignificant. It is highly probable that new digester gas engines or boilers could be constructed as an insignificant modification to the existing air quality permit if the existing Powerhouse were removed. Conversely, it would be very difficult to add new equipment as an insignificant modification if the existing Powerhouse were to remain operational.

Summary

In general, the existing thermal equipment is capable of continued operation until the Upgrade Project has been completed. At that time new thermal equipment will be required to be installed and ready for operation to meet the demands of the Upgrade Project.

3. Master Plan of Future Facility Needs

3.1 Tucson Electric Power Tariff Rate Evaluation

The purpose of this section is to examine Tucson Electric Power (TEP) tariffs for the Ina Road Wastewater Reclamation Facility (WRF). Pima County is examining the possibility of using an interruptible power tariff. Currently, TEP does not offer any interruptible power tariffs but has one pending rider and a draft for an experimental rider to provide options for incorporation of interruptible service credits into tariffs available to large users. The current tariff and options are discussed. The proposed riders for interruptible service and their potential applicability to the Ina Road WRF are also discussed.

General Discussion of Power Tariffs

Power suppliers need to recover a variety of costs via their billings and typically have a number of different tariffs structured for different size and type of customers. Generally, the costs to be recovered include the direct costs associated with power generation and distribution, costs associated with the infrastructure for generation and distribution of power, and other business related costs.

The largest element of the direct cost of generation is the fuel. Other elements include the labor for operations, consumables other than fuel (water, chemicals, etc.), waste disposal, materials and labor for maintenance. Direct costs for distribution are generally the labor and materials for operations and maintenance of the distribution system. Infrastructure costs are the capital costs for the power generation plants and transmission and distribution system. The other costs include office buildings, warehouses, management, support services, administration, etc.

The main product being sold is energy, kilowatt hours (kWh) of electricity. The simplest tariffs use only energy, kWh consumed, as the basis of billing and are generally applicable to residential and commercial users. These customers typically do not have special requirements and it is a typical practice to account for all the costs of service by various elements that go into establishing the rate for energy ($/kWh). Larger consumers, such as industrial and process plants, are more likely to impact the distribution system and require additional analysis and equipment. The tariffs available to these users are generally more complex and involve both energy and demand charges. Demand is defined by TEP as the rate at which power is delivered during any specified period of time. TEP Rules and Regulations regarding billing indicate that demand is measured by the demand meter and rounded to the nearest whole kW. Demand charges are generally based on the largest rate (kW draw) averaged over a 15-minute period occurring in a billing cycle. The reasoning behind this approach is that the demand is indicative of the infrastructure cost required to serve a large user. The energy charge rate is lower than with energy-only tariffs and closer to the direct cost of energy. There are variations on the two basic types of tariff structures that recognize the benefit of reducing the peak demands on a utility's system, such as time of use and interruptible service. The time of use structure involves differing rates for on-

and off-peak energy consumption and is potentially attractive to users that can shift their usage to lower cost off-peak hours.

Interruptible service allows the curtailment of at least a portion of load under certain conditions in exchange for reduced cost via a reduced rate or a credit. Interruptible rates are potentially attractive to users with self-generation capability and/or the ability to make process changes to reduce demand.

There are also other tariffs such as those for green power and backup power not considered applicable to this effort for the Ina Road WRF.

Current Power Tariffs

In January 2010 the Ina Road WRF changed from TEP's PS-40 Municipal Service tariff to its Large General Service (LGS)-13 tariff. LGS-13 requires a minimum of 200kW billing demand and uses both energy and demand for billing. The current Ina Road WRF demand is well above the minimum demand but below the 3,000kW threshold for the next similar tariff, Large Light and Power Service (LLP)-14. The new facilities constructed via the Upgrade Project that are scheduled to be in service in 2012 will create sufficient demand to allow consideration of LLP-14. The risk involved with demand charges is that a short period of high demand can significantly impact a billing and, if large enough, can potentially carry over for a number of months because of minimum charges based on maximum demand during the preceding 11 months. It is expected that the new ERF will have sufficient redundancy that there is a low risk of a large spike in demand. LLP-14 also has adjustments based on power factor, and having the means to control power factor will need to be considered for future operation. An example of a monthly billing using the elements of LLP-14 is provided below. It is based on an assumed average load of 9,000 kW and peak demand of 10,350 kW (15 percent above the average load) for a 30 day month, using the average between the summer and winter power supply charge. These calculations were reviewed by TEP and adjusted to align with feedback provided by TEP.

Example Calculation for LLP-14

Description of Charges

Charge	Description
Customer and minimum bill	$500 per month
Demand	$19.024 per kW of billing demand per month [shall not be less than 3,000 kW and is equal to the current on-peak billing demand (15-minute average) or 2/3 of the maximum on-peak demand in the preceding 11-months, whichever is greater].
Energy	Basic energy charge at $0.000433/kWh
Power supply	Use average rate between summer ($0.032577/kWh) and winter ($0.025077/kWh) = $0.028827/kWh
PPFAC	Purchased Power and Fuel Adjustment Clause applied to monthly kWh usage. Charge is currently $0/kWh but could increase in the future.
REST Green Energy	0.008636/kWh, with $3,600 maximum per month per meter
DSM Green Energy	$0.000831/kWh, with no maximum
Taxes and fees (ACC assessment plus State, County, and City sales taxes)	(Total of above charges) x 10.3 percent

Assumptions

- Average monthly usage rate = 9,000 kW
- Monthly energy consumption = 9,000 kW x 24 hrs/day x 30 days/month = 6,480,000 kWh
- The peak demand is 15 percent above average = 1.15 x 9,000 kW = 10,350 kW

Cost Calculation

The following calculation does not include any charge or discount for power factor adjustment.

Charges	Amount
Demand = ($19.024/kW) x (10,350 kW)	$ 196,898
Energy = ($0.000433/kWh) x (6,480,000 kWh)	$ 2,806
Power supply = ($0.028827/kWh) x (6,480,000 kWh)	$ 186,799
PPFAC	$ 0
Customer, minimum bill	$ 500
REST Green Energy	$ 3,600
DSM Green Energy	$ 5,385
Subtotal	$ 395,988
Tax at 10.3 percent of subtotal	$ 40,787
Net Total	$ 436,775

Overall cost per kWh = $436,775 / 6,480,000 kWh = $0.0674

Interruptible Service

Currently, TEP does not have any options for interruptible service. It is understood that the Arizona Corporation Commission (ACC) has told TEP that they will offer interruptible service in the near future. Pima County personnel provided drafts of two potential riders for interruptible service, Rider-5 Interruptible Service Capacity Constraint (ISCC) and Rider-6 Experimental Critical Event Pricing (CEP), which had been issued by TEP to interested parties for review. Proposed eligibility to use either rider requires a pricing plan applicable to service for over 3,000kW, such as LLP-14. The rider approach means it is an option that modifies a current tariff and not a separate independent tariff. For Pima County to consider electing interruptible service, backup engine generators would have to be provided or else certain facilities, or plant processes, would have to be shutdown.

Rider 5

Rider 5 is proposed to be limited to interruptions required to ensure system reliability and not to be made for economic reasons. It requires subscribing to at least 1,000kW of interruptible load. A single interruption is limited to four hours in duration and there can be a maximum of two consecutive interruptions. Participation will result in a monthly Interruptible Demand Charge Credit (DCC), in $/kW, based on the agreed-upon

interruptible load and applied to the monthly demand charge for the applicable power tariff. The Demand Charge Credit will be calculated using a Market Based Capacity Price (MBCP) adjusted for a series of factors, some fixed and some dependent on agreed to maximum annual duration and notice time for interruption.

There is also a Shared Savings Factor that, based on review comments, has not been agreed on between TEP and the ACC. The fixed factors include credits for reduction in reserves and avoided line losses, and a reduction to be consistent with it being applicable to only the 6-month summer rate timeframe. The MBCP and particulars of annual duration and notice time requirements are set annually. The sample provided in the pending rider has three levels of maximum annual duration—20, 40, and 80 hours—and two levels of notification time—10 and 30 minutes or less. The MBCP is representative of opportunity capacity cost from TEP's resource procurement process. The MBCP assumed for the sample credit is $8/kW-month and results in a DCC of $0.896/kW-month for the 80-hour-per-year duration and 10-minute notice using a 25 percent shared saving factor (SSF). This value becomes $3.584/kW-month in the example if there is no SSF per ACC comments. The example using the least savings, a 20-hour-per-year maximum duration and 30-minute notice, would result in $0.358/kW-month at 25 percent SSF and $1.434/kW-month without the SSF adjustment. Considering the LLP-14 with a demand charge of $19.024/kW-month, the DCC, as outlined here, has the potential for between 1.9-percent and 18.8-percent credit on the subscribed interruptible load (1,000kW minimum). The savings percentage is not on the entire bill, only on the demand for an assumed 1,000kW reduction. There are penalties for failing to interrupt at the subscribed level for any interruption event. A first offense results in forfeit of the DCC for the billing month. A second failure could result in being removed from the program for up to two years. There is also a penalty of 10 times the incremental cost of power for any power taken in violation of the interruption order. The potential range of the DCC per 1,000kW of subscribed interruptible power is presented in Table 3-1.

TABLE 3-1
Rider 5 - Range of Annual DCC per 1,000kW of Subscribed Interruptible Power
Ina Road Wastewater Reclamation Facility Energy Master Plan

Shared Savings Factor	DCC - 80 Hr Annual/10 Min Notice	DCC - 20 Hr Annual/ 30 Min Notice
	$/1000 kW	$/1000 kW
1.0 Shared Savings Factor	43,000	17,200
0.25 Shared Savings Factor	10,750	4,300

The considerations for accepting Rider 5 for Pima County include:

- how much interruptible power for which to subscribe
- time required to reduce demand
- the economic benefits

Depending on the specifics of the air permit, it may be possible for the plant to propose an interruptible power level up to the capacity of the backup generators (if provided) and use them to self-generate when interruptible events are declared. This approach would allow the plant to operate without reducing process conditions.

Two scenarios are being considered to satisfy the WRF electrical power requirements during normal operations, one using digester gas for power generation with TEP providing the balance and one with TEP providing all the electrical power. It is expected that air permitting will allow the use of the backup generators (if provided) for interruptible events in the case of using the digester gas for power generation. The scenario of buying all power from TEP has the possibility of having to flare digester gas under some conditions; the potential for additional emissions with flaring could result in restrictions on operating the backup generators in that case. These scenarios have requirements for different levels of backup power and hence could possibly allow different levels of interruptible power.

The use of digester gas for power generation is expected to result in backup power of 6,900kW. The DCC for this would be as high as $297,000. The TEP only approach is expected to result in backup power of 8,800kW; resulting in a DCC as high as $378,000. These potential savings would need to be compared to any costs incurred by participation, such as the incremental cost of self-generation using the backup generators compared to buying power under LLP-14.

Rider 6

The proposed purpose of Rider 6 is to allow TEP to declare a Critical Event for any purpose, including economic considerations. A definition of Critical Event is not provided in the rider, but would typically involve a situation where system reliability is at risk (that is the basis for Rider 5, but Rider 6 allows TEP more discretion to interrupt service). The declaration of a Critical Event would invoke Critical Event Pricing for all energy purchased during the event. Critical Event Pricing is the greater of $0.20/kWh or 125 percent of the incremental cost of power (higher of generated cost or market cost) during the event. A single Critical Event has a maximum duration of four hours, and at least four hours notice will be provided for each Critical Event. The customer can choose a Critical Event limit of either 20 hours (five events) or 40 hours (10 events) per year. The benefit for participating in the program is a reduction in rate for all energy purchases at the delivery point, except for purchases during a Critical Event. The discounts in the draft are $0.00031/kWh for the 20-hour Critical Event limit and $0.00055/kWh for the 40-hour Critical Event limit. The proposed credits result in an approximate 1-percent discount for the 20-hour limit and about a 1.9-percent discount for the 40-hour limit based on the average of summer and winter energy rates for LLP-14 ($0.0293/kWh).

A key factor in considering Rider 6 is the ability to use the backup generators when an interruption occurs. As indicated in the Rider 5 discussion, air permitting – particularly in the scenario of TEP only supply – could factor into the feasibility of this approach. The estimated annual purchased power is approximately 44,000,000kWh for the scheme including electrical generation with digester gas and approximately 70,000,000kWh for when TEP provides all electrical power for normal operations. The estimated annual savings on energy charges are presented in Table 3-2.

TABLE 3-2
Rider 6 – Estimated Annual Savings on Energy Charges
Ina Road Wastewater Reclamation Facility Energy Master Plan

Operating Scheme	20 Hours Annually	40 Hours Annually
Digester Gas + TEP Supply	$13,600	$24,200
TEP Only Supply	$21,700	$38,500

The estimated maximum potential savings from TEP associated with Rider 6 are limited compared to Rider 5; however, Rider 6 could have less impact on plant operations because of the longer notice time and annual maximum hours. The savings would need to be compared to any costs incurred by participation, such as the incremental cost of self-generation compared to buying power under LLP-14 and the premium paid for any power purchased during a Critical Event, if the backup power approach is feasible from an air permitting perspective.

Tariff Recommendation

Based on example calculations of overall electricity cost, it is recommended that the Ina Road WRF change from the current LGS-13 tariff to the LLP-14 tariff once minimum steady demand from TEP exceeds 3,000 kW. This is anticipated to occur once the new service from TEP is implemented, the new 46 kV substation and Switchgear Building are commissioned, and the Interim Biosolids – Digester Complex (2-new digesters and digester control building) is commissioned. Plant operations under the LLP-14 tariff need to control short periods of high demand in order to mitigate excessive demand charges. LLP-14 also includes adjustments based on power factor, so Plant operations should include controls on power factor.

3.2 Principal and Backup Power Plan

The purpose of this section is to develop principal and backup electrical power plans for the Ina Road WRF. The backup power plan needs to satisfy Arizona Department of Environmental Quality (ADEQ) requirements to maintain wastewater treatment operations and maintain the permitted effluent water quality. The existing electrical system, electrical energy requirements for the Ina Road WRF, available energy sources, available technologies, and potential fuels are discussed.

Background

Currently, the Ina Road WRF has two separate independent power distribution systems serving the plant. The first system was installed with the original plant construction, referred to as the West Plant, and consists of a 4.16 kV system supplied from onsite engine generators fired on the digester gas produced via the anaerobic digestion process. This 4.16 kV system is not interconnected with TEP.

The second system was installed with the plant expansion project, referred to as the East Plant. This system consists of a 13.8 kV system supplied by utility service from TEP. This system also serves the headworks facility that is shared between the East and West Plants.

Reliability of the 4.16 kV system is provided by the redundancy in engine generators and available fuels. There is a sufficient number of engines such that at least one unit remains available to start in the event that an operating unit fails. While the primary fuel utilized in the engines is the digester gas produced onsite, both natural gas and propane are available if the supply of digester gas is not sufficient. Due to the current rate of digester gas, multiple engines are typically fired on natural gas in order to provide the required power to operate the West Plant. Propane is stored onsite in a buried 33,000-gallon storage tank.

Reliability of the 13.8 kV system is currently provided by two separate lines, routed to the plant entrance equipment. Both lines are served from the same substation, West Ina Road, but take different routes between the substation and the plant entrance equipment. There is only one service entrance section and one meter which represents a minor single point of failure.

As part of the Upgrade Project, power distribution will be consolidated to a 13.8 kV system with primary supply from TEP. The 13.8 kV power will be distributed from new switchgear in a new dedicated facility. The current plan is that if there are generators at the new ERF, they will be paralleled onto the TEP system. Since the new ERF is only intended to produce the amount of power available from utilizing the digester gas produced onsite, the new ERF will not have sufficient generation capacity to meet the electrical demand of the upgraded treatment plant should the supply from TEP become interrupted. In order to provide for uninterrupted wastewater treatment plant capacity, redundancy must be provided in the TEP supply to the new switchgear facility or additional onsite electrical generation will be required.

Based on discussions with TEP and ADEQ regarding the configuration of a new service to the Ina Road WRF, the new TEP service, to be supplied from two independent substations, will provide the necessary electrical reliability. Therefore no additional onsite electrical generation is required beyond that to be provided to utilize the produced digester gas.

The background and correspondence leading up to the above conclusion is documented below.

Existing Electrical Power Sources

Presently, power delivered from TEP originates at its West Ina Substation. The West Ina Substation is located just south of West Ina Road east of the I-10 freeway. Two 13.8kV circuits from the West Ina Substation deliver power to the Ina Road WRF boundary. At the Ina Road WRF property line, a TEP switch is used to select one of the circuits to serve the plant site. TEP normally serves the Ina Road WRF using a circuit designated WI-13 (for "West Ina No. 13"). The second circuit, available in case WI-13 is unavailable, is WI-42.

TEP has advised that the WI-13 circuit is nearing its design capacity and future load growth would necessitate switching the facility onto the WI-42 circuit. That circuit presently has about 5MVA of its design capacity available to serve customers such as the Ina Road WRF.

The existing Powerhouse uses seven 650kW engine-generator sets to generate power. With six of these units on line, and all six loaded to 80 percent of their capacity, the plant will produce about 4.9MVA.

The infrastructure that is in place today (TEP's WI-42 line and the existing Powerhouse) can supply a total site load of about 9MVA. This limit will be exceeded early in 2012. A new source from TEP must be in place by the end of 2011 in order for major components of the Upgrade Project to be supported.

TEP has agreed to route a 46kV line to the plant boundary to serve the new loads that will be brought on line as the Upgrade Project is completed. The 46kV line presently runs along – or parallel to – Silverbell Road, which is located 1/2 to 1-1/4 mile west of the Ina Road plant site. The 46kV line is a subtransmission line that interconnects TEP's West Loop substation with the DeMoss Petrie substation.

Although the 46kV line's capacity is not without limit, TEP has provided assurances that it is fully adequate for serving the loads of the upgraded Ina Road WRF.

The fact that the 46kV line is connected to two independent substations makes it a highly reliable source of power to the site.

Correspondence with TEP

Various correspondence and meetings with TEP have taken place to discuss the future needs of the Ina Road WRF and TEP's supply of those needs. The primary topics have included the future electrical load requirements; available capacity on potential supply lines and the request by Pima County to have TEP provide redundancy of supply from two independent sources. As noted above, a plan has been developed by TEP and CH2M HILL to provide an independent line from Silverbell Road to the project site. Table 3-3 is a summary of the correspondence with TEP.

TABLE 3-3
Correspondence with TEP
Ina Road Wastewater Reclamation Facility Energy Master Plan

Date	Content
October and November 2009	Emails traded regarding capacity of TEP system currently serving the Ina Road WRF and steps and studies required for interconnecting onsite generation with TEP system.
December 3, 2009	Discussed the steps needed to advance the planning for changes to the TEP system serving the Ina Road WRF site.
January 19, 2010	Discussed in more detail the technical aspects of serving the site with a 46kV line from Silverbell road. The topic of re-routing the line past the site boundary is discussed.
January 22, 2010	TEP sends e-mail to CH2M HILL agreeing to re-route the 46kV line past the Ina Road plant site.

Backup Power Supply

Providing reliable power service, "backup power", is typically provided for a wastewater treatment plant via one of two approaches: two independent sources of utility service; or onsite backup power generation.

Although TEP has indicated that they will not provide a second line to the Ina Road WRF site, the configuration of the TEP system presents essentially independent services from two substations. With the exception of a minor (i.e. short) single point of failure between the TEP terminating power pole and the service entrance equipment and meter, TEP supply would be via two independent substations. This short, single point of failure is not accessible to the public and not located near a public roadway. This TEP supply configuration was presented to ADEQ on February 26, 2010 and based on this meeting it is anticipated that this TEP supply configuration will satisfy the requirements for process backup power. Therefore no additional onsite electrical generation is required beyond that to be provided to utilize the produced digester gas.

Backup Power Needs

The ADEQ requires that the plant maintain effluent quality in the event of an electrical outage of the utility supply. Meeting the effluent quality requires essentially all of the liquid treatment process equipment and the associated solids handling equipment be connected to the liquid processes, such as gravity thickening of primary sludge, to remain operating. Solids processes with upstream storage volume, such as thickening of waste activated sludge and digested sludge dewatering, can be shed during short-term durations (less than 24 hours). Backup power requirements do not necessarily need to support all the plant loads; only the critical loads associated with meeting the ADEQ requirement are mandatory. The two operating scenarios require different levels of supply from TEP and hence different levels of backup power. The scenario using digester gas for power generation would still have that generation available and the level of backup power for the critical loads needs to consider the TEP supply loss plus the auxiliary power for the equipment necessary for the digester gas-fired engines to remain in operation. The scenario using TEP as the only source of electric power needs backup power to cover the critical loads.

In accordance with Attachment B (Preliminary Performance Standards) of the Request for Qualifications for the ERF Design-Build-Operate (DBO) project, performance requirements for power generation and thermal energy include a reliability guarantee of 99.99 percent, less than one hour per year of non-availability. The DBO contractor will be responsible for considering the risk and determining its approach to meeting this stringent guarantee. All energy supply sources and the risk of their unavailability will need to be considered in arriving at the overall scheme for providing energy. The numbers presented below assume that backup power is provided independently from the digester gas generation.

Table 3-4 summarizes the required principal, critical, and backup power requirements after the startup of the Upgrade Project in 2014 and shows the growth to full plant capacity in the design year 2030. Backup power requirement values are presented to address the two different scenarios of TEP supply.

TABLE 3-4
Principal, Critical, and Backup Power Requirements
Ina Road Water Reclamation Facility Energy Master Plan

	2014	2020	2030
Plant Requirements			
Operating Loads	9.6 MW	10.2 MW	10.8 MW
Critical Loads	7.8 MW	8.2 MW	8.8 MW
Backup Power Requirements			
Digester Gas Cogeneration plus TEP Supply	6.9 MW	6.0 MW	6.3 MW
TEP Supply Only	7.8 MW	8.2 MW	8.8 MW

Generation Technologies

If the TEP service configuration is not acceptable to ADEQ to meet the backup power requirements, it is anticipated that backup power generators would be included in the new ERF construction. In this case, the selection of generating technology would be determined by the DBO contractor. The DBO contractor would also decide the number and capacity of generating units. Given the stringent ERF performance requirements, it is expected that backup power will be based on a proven conventional technology, an easy to use fuel, and likely in multiple units. These considerations point to two potential technologies: reciprocating engines and combustion turbines. Considering power generation, reciprocating engines are more attractive in the sizes required for backup power. In comparison to similarly sized combustion turbines, engines are lower first cost, more efficient at all loads, have a wider load range, and have lower operation and maintenance costs. Combustion turbines can be more attractive in some cogeneration applications because of the higher levels of waste heat available at higher temperatures. Although the backup power scheme could be influenced by the stringent ERF performance requirements, also including thermal energy, it is expected that reciprocating engines will be selected. Similarly, digester gas primary generation is expected to be based on reciprocating engines.

Potential Fuels

The selection of fuel for the backup power will be determined by the DBO contractor. It is assumed that the existing infrastructure for fuels will be a consideration in making the selection. As indicated above, an easy-to-use fuel is expected. Readily available options include natural gas, distillate fuel oil, and propane. The existing plant infrastructure includes natural gas and propane. It is understood that the facility had infrastructure for distillate fuel oil, which has been removed. From economic and environmental perspectives, natural gas and propane are generally more attractive than distillate fuel oil. Unless demand is extreme enough to result in curtailments, natural gas usually has a significant price advantage over distillate fuel oil and propane. Natural gas and propane are both better than distillate fuel oil for emissions; however, distillate fuel oil can certainly be permitted, particularly for backup power. Fuel oil does have the additional environmental concerns of storage and degradation; long-term storage can be a concern. Sufficient natural gas should be available based on no longer using it for self-generation. Therefore, natural gas is

expected to be the first choice as a fuel for backup power. The existing buried propane storage tank could also be used in the backup power fuel approach, however before it is utilized as the primary fuel for backup power generation, the condition of the buried tank would need to be assessed.

3.3 Alternatives Introduction

Through the development of this Energy Master Plan, three major items were examined that would drive the configuration of the new Energy Recovery Facility. These items were identified during the November 12, 2009 coordination workshop:

1. Confirm the availability of electrical power from Tucson Electric Power. At the time of this meeting, it was understood that TEP would not be able to provide the full amount of electrical demand at the Ina Road WRF. If this were true, the New ERF would have to include additional engine generators, presumably fired on natural gas, to supplement the TEP supply and electrical generation from engine generators fired on digester gas in order to meet the plant electrical demand.
2. Confirm whether or not standby engine generators are required. At the time of this meeting, it was unclear whether a second power line could be provided by TEP, such that onsite standby engine generators were not required.
3. Tariff Rate applicable to the Ina Road WRF once the existing Powerhouse is taken out of service. The economic viability of on-site power generation via the ERF is greatly influenced by the power tariff options available.

As these items were examined, the configuration of the new ERF became clearer. Additional onsite power generation fired on natural gas, that may have been required to supplement TEP supply, was eliminated with the plan to connect the TEP supply from the Silverbell 46 kV transmission lines, rather than the constrained and lower-capacity lines from the West Ina substation. Based on early discussions with the Arizona Department of Environmental Quality (ADEQ) it is anticipated that the configuration of TEP service will meet the backup power requirements and eliminate the need for onsite standby engine generators. Given these developments, the ERF configuration assumed through the remainder of this report is limited to power generation based on utilizing all of the produced digester gas, with heat recovery systems to provide heated/chilled to meet the Ina Road WRF's thermal energy demands.

Based on the tariff rates that become available for the Ina Road WRF, a question was raised regarding the cost effectiveness of using cogeneration to meet the plant's thermal energy demands versus directly utilizing the digester gas to produce heated water and chilled water. In order to evaluate the merits of a new ERF versus the proposal of a central heating water/chilled water plant (Central Plant), each alternative was developed as described in Section 3.4, Alternative 1 – TEP Supply plus Energy Recovery Facility, and Section 3.5, TEP Supply plus Central Plant. Section 3.6 documents economic and qualitative analysis preformed to evaluate the two alternatives

3.4 Alternative 1 – TEP Supply plus Energy Recovery Facility

This section presents how the Ina Road WRF electrical and thermal energy demands would be met by an expanded TEP supply plus a new Energy Recovery Facility. Supply configuration of electrical and thermal energy is summarized and air permitting considerations are discussed.

Electrical Prime Power Plan

Primary electrical power for the Ina Road WRF will be provided via a new service from TEP as described in Section 3.2, Principal and Backup Power Plan. Total electrical demands from TEP will be reduced via onsite power generation in the new ERF.

Onsite power generation will be sized to fully utilize the digester gas produced, with no additional generation fired on natural gas. Although the draft Request for Proposal (RFP) document for procurement of the new ERF leaves the driver equipment type (internal combustion engines, turbines, or other) to be determined by the proposing vendor, it is assumed that the most likely technology will be internal combustion engines, similar to those currently used in the existing Powerhouse. The new ERF would also include the necessary electrical equipment to connect the engine-generators to the plant electrical distribution system to be located in the new Switchgear Facility.

Based on the forecast production of digester gas, refer to Section 1.5, Digester Gas Production, onsite power generation could range up to 2.5 megawatts (MW) in design year 2030. To provide for unit turndown it is assumed that the new ERF would include 2-duty engine generators. Given the forecasts of digester gas production a unit capacity of 1.5 MW is assumed.

Electrical Supply Balance

Electricity produced from the onsite engine generators fired on digester gas is calculated from the forecast digester gas production and assumes an overall conversion efficiency of 32 percent for fuel energy rate to generated electricity. Existing engine generators fired on natural gas are expected to continue through the Year 2012, assuming that the existing Powerhouse is kept in service during this time, so that the total onsite power generation equals 2.0 MW. Table 3-5 shows the predicted power generated from digester gas and natural gas through Year 2030, as well as the resulting balance of the power needed to be supplied by TEP.

TABLE 3-5
Alternative 1 - Electrical Supply by Digester Gas Cogeneration and Resulting Electrical Supply Balance
Ina Road Water Reclamation Facility Energy Master Plan

Year	Operating Load (MVA)	Operating Load (MW)	Electricity from Digester Gas Cogeneration (MW)	Electricity from Natural Gas Cogeneration (MW)	Balance of Electricity Needed (MW)
2009 (Present-Day Loads)	6.4	5.1	0.8	1.2	3.1
2011 (Jan-Jun)	6.8	5.4	0.8	1.2	3.4
2011 (Jul-Dec)	7.3	5.8	0.8	1.2	3.8
2012 (Jan-Jun)	12.3	9.8	0.8	1.2	7.8
2012 (Jul-Dec)	12.0	9.6	0.8	1.2	7.6
2013 (Jan-Jun)	12.0	9.6	0.9	--	8.7
2013 (Jul-Dec)	12.0	9.6	0.9	--	8.7
2014 (Jan-Jun)	12.0	9.6	1.0	--	8.6
2014 (Jul-Dec)	12.6	10.1	1.0	--	9.0
2015	12.6	10.1	2.0	--	8.0
2020	12.8	10.2	2.2	--	8.1
2030	13.2	10.6	2.5	--	8.1

Electrical Backup Power Plan

Based on the preliminary discussions with the Arizona Department of Environmental Quality (ADEQ), it is anticipated that the proposed TEP supply configuration, with supply from two independent substations, will satisfy the requirements for process backup power. There is a single circuit between the terminating TEP power pole and the service entrance equipment and meter. If this short, single-point of failure, which is not accessible to the public or in risk of damage from public vehicular traffic, is acceptable to ADEQ, then onsite backup generators will not be needed. This configuration of Alternative 1 therefore does not include onsite standby engine generators.

Thermal Energy Prime Plan

Under Alternative 1, the configuration of the thermal energy supply systems to be included in the new ERF will be determined by the DBO contractor. For the purposes of evaluating the economics and qualitative aspects of this alternative, assumptions regarding the specific configuration of the new ERF were made.

It is assumed that the new ERF would include a thermal energy production system similar to the existing Powerhouse, containing a water or steam based waste heat recovery system. A primary water or steam loop would collect heat from the engines and/or engine exhaust and supply each of the following sub-systems:

- Absorption chiller with 1-duty, 1-standby secondary loop pumps
- Sludge heating water with 1-duty secondary loop pump
- Building heating water with 1-duty secondary loop pump
- Domestic hot water with 1-duty supply pump
- Heat sink system with 1-duty, 1-standby circulation pumps

Thermal Energy Supply Balance

Forecast waste heat available from cogeneration fired on digester gas is calculated from the forecast digester gas production (refer to Section 1.5, Gas Production) and assumes an overall conversion efficiency of 40 percent for fuel energy rate to available waste heat. Table 3-6 shows the predicted waste heat generated from digester gas and the resulting balance of the thermal energy. However, the balance shown would be met via continued cogeneration fired on natural gas, assuming continued operation of the existing Powerhouse through the Year 2012, when the major cooling load of the Oxygen Production Facility is removed. Once the Oxygen Production Facility is demolished as part of the Upgrade Project, the waste heat available from cogeneration fired on digester gas only is forecast to meet or exceed the forecast thermal energy demands of the plant.

TABLE 3-6
Waste Heat Supply by Digester Gas Cogeneration and Resulting Thermal Supply Balance (all values are 10^6 BTUH)
Ina Road Water Reclamation Facility Energy Master Plan

Year	Digester Heating Load	HVAC Heating Load	HVAC / Process Cooling Load	Total of Thermal Energy Loads	Total Engine Heat Demand[a]	Digester Gas Cogeneration Engine Heat Available	Balance of Thermal Energy Needed
2009	1.03	0.47	5.78	7.27	8.55	3.43	5.13
2011	1.17	0.52	5.81	7.50	8.82	3.55	5.27
2014	1.44	0.57	0.61	2.62	3.08	4.39	--
2015	1.89	0.57	0.61	3.06	3.60	8.66	--
2020	2.00	0.57	0.61	3.17	3.73	9.31	--
2030	2.20	0.57	0.61	3.40	4.00	10.60	--

[a] (Includes 0.85 conversion factor).

Values shown above in Table 3-6 are annual average rates. Since the heating and cooling loads vary with the seasonal ambient temperature, monthly thermal energy demands and estimated available waste heat are presented in Figures 3-1 through 3-6 for years 2009, 2011, 2014, 2015, 2020, and 2030, respectively.

As shown in Figures 3-1 and 3-2, the total thermal energy demand exceeds the predicted amount of recoverable engine heat. To meet the thermal energy demands, it is anticipated that the existing Powerhouse would continue to operate through year 2012, with supplemental cogeneration fired on natural gas the same as current practice.

FIGURE 3-1
Alternative 1 - 2009 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

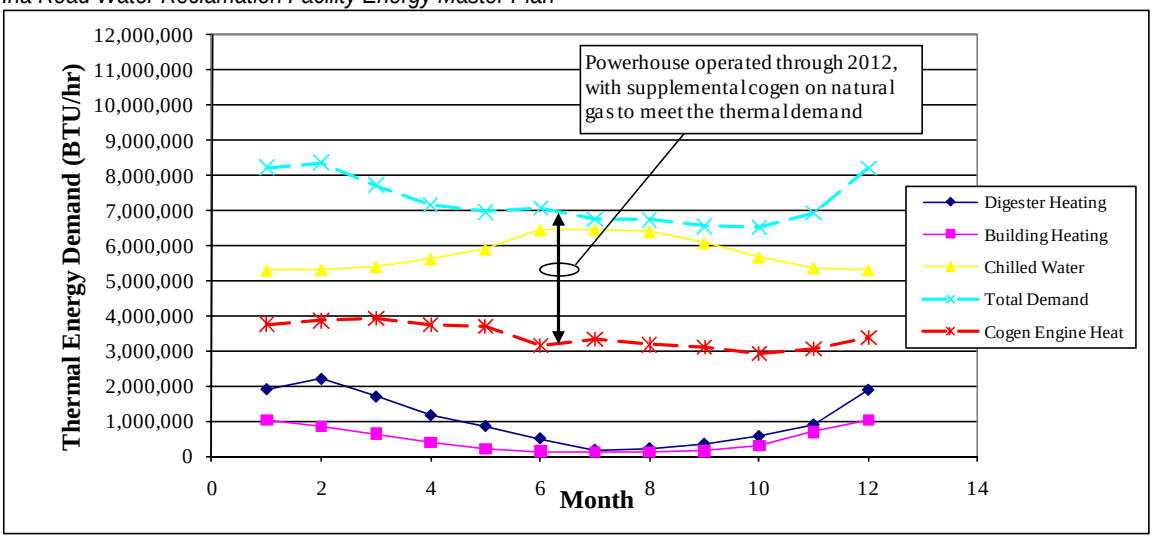


FIGURE 3-2
Alternative 1 - 2011 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

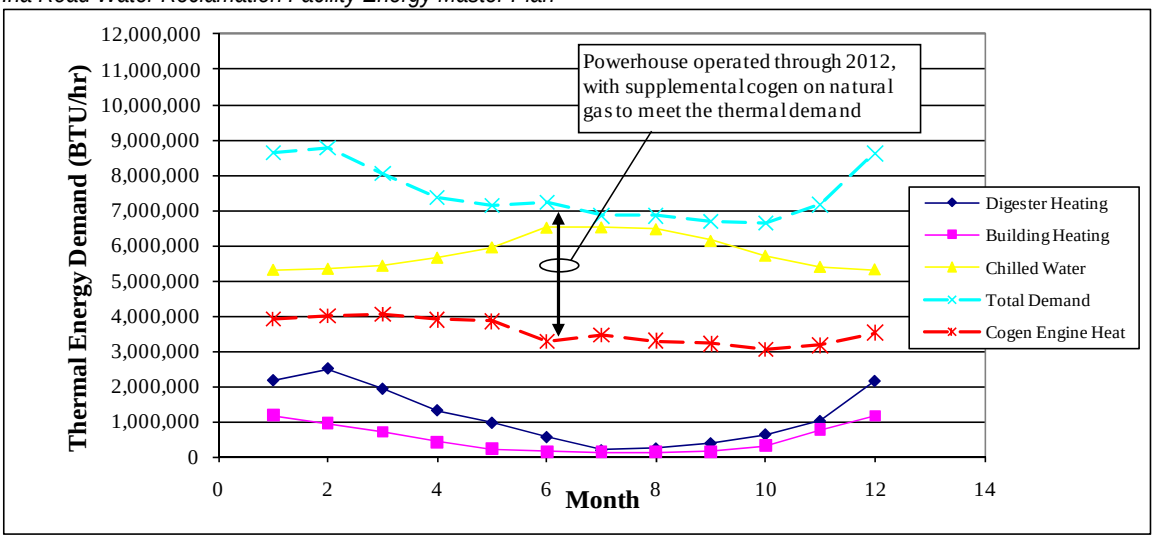
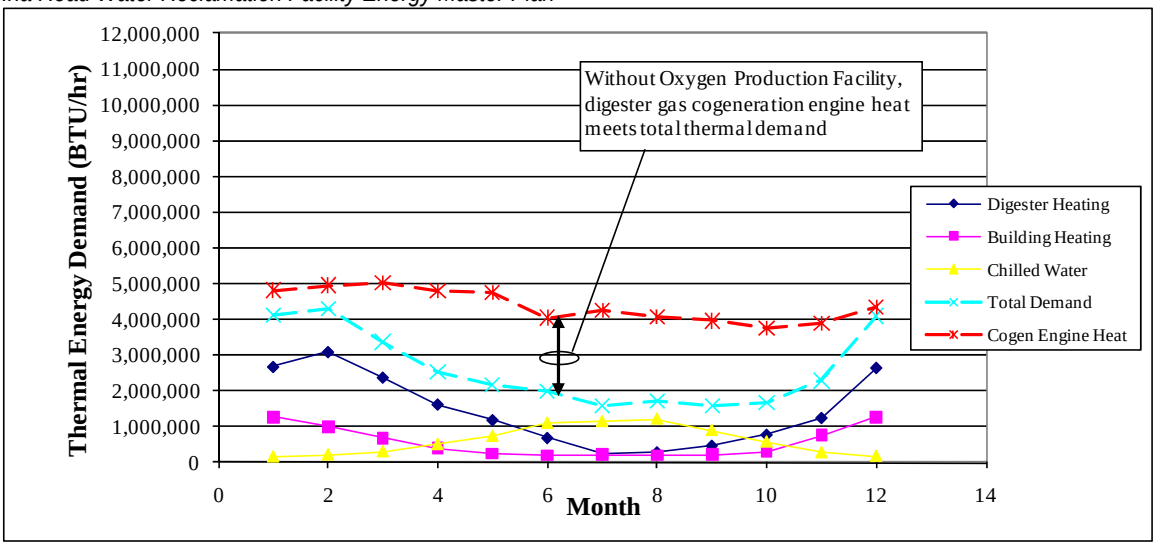


Figure 3-3 shows that when the existing Oxygen Production Facility is taken out of service as part of the Upgrade Project, the chilled water demand, and thus total thermal energy demand decreases significantly. This results in the available engine heat from cogeneration fired on digester gas only to be able to meet the forecast plant thermal demands.

FIGURE 3-3
Alternative 1 - 2014 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan



Figures 3-4 through 3-6 indicate that with the addition of the waste activated sludge transferred from the future Water Reclamation Campus (WRC), beginning in year 2015, the available engine heat from cogeneration fired on digester gas easily meets the forecast plant thermal demands. The extra engine heat is assumed to be rejected to the plant effluent similar to the current practice.

FIGURE 3-4
Alternative 1 - 2015 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

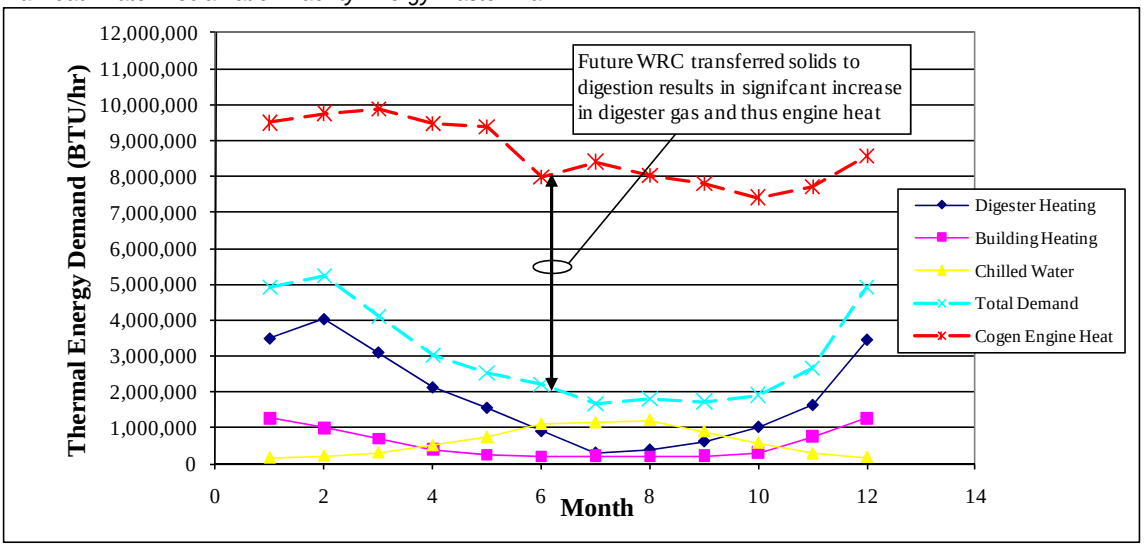


FIGURE 3-5
Alternative 1 - 2020 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

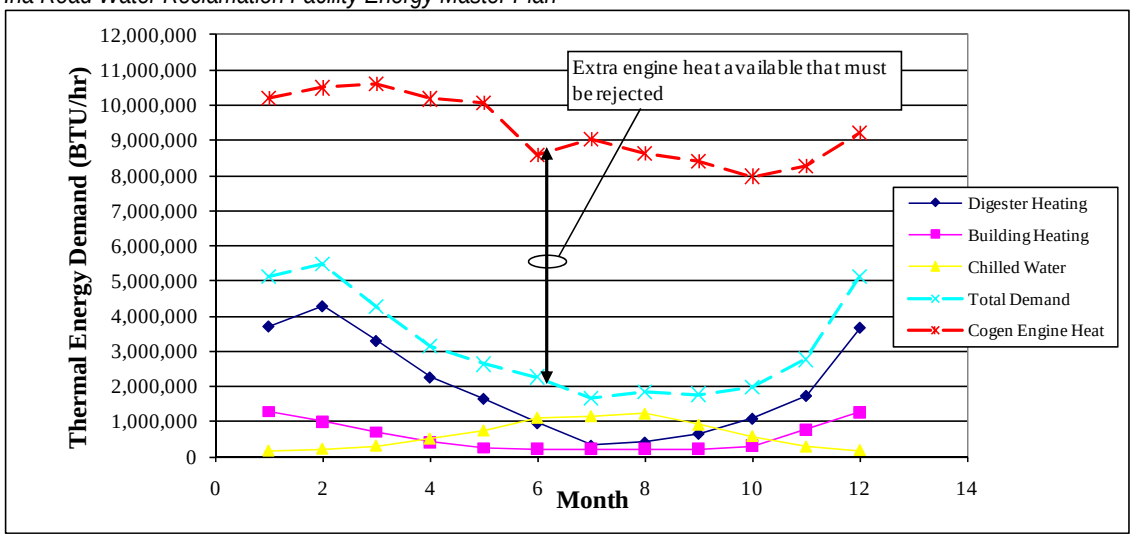
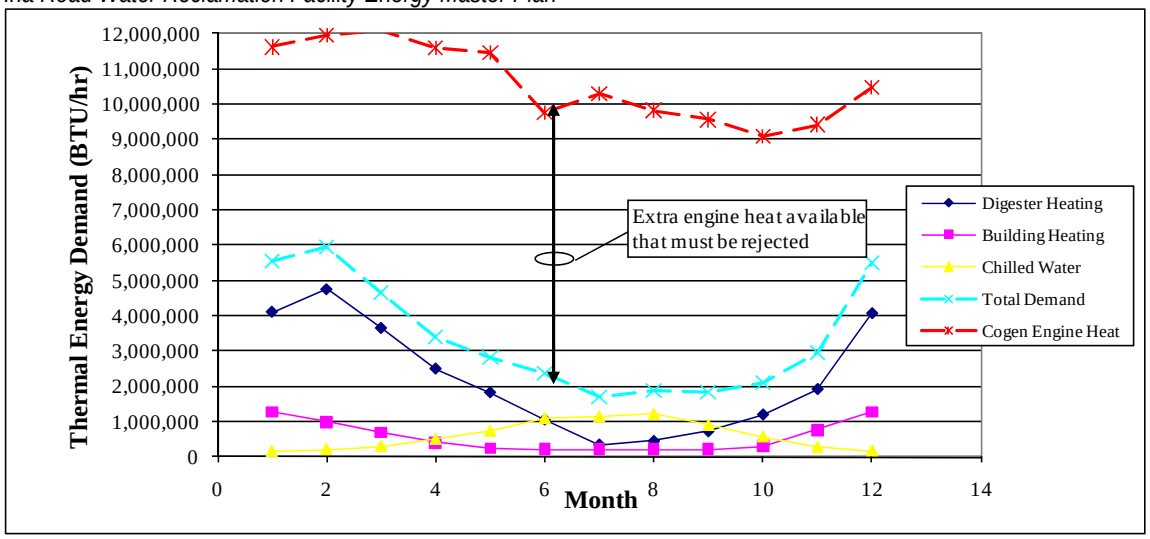


FIGURE 3-6
Alternative 1 - 2030 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan



Thermal Energy Backup Plan

Since the digester gas fired engines provide the entire supply of thermal energy for the Ina Road WRF, a high-degree of reliability must be provided. Therefore, it is assumed that two-standby engine generators would be provided by the new ERF DBO contractor in addition to the two proposed duty engine generators. This provides for two units to always be available, with one unit available should one of the primary units fail, and one-unit out of service for regular maintenance and/or repair.

Redundant primary heat recovery loop pumps (1-duty, 1-standby) are recommended. Redundant secondary loop pumps are also recommended for the chilled water system, due to the importance of cooling the electrical rooms serving critical process equipment.

Redundant heat sink pumping systems are required as they are critical to continuous engine generator operations.

Air Permitting Considerations

The addition of up to four digester gas engines (2-duty and 2-standby) and four back up power natural gas or propane-fired generators (if ultimately required) could be completed as an insignificant air quality permit modification if the existing Powerhouse engines were removed from use. Accounting for the reduction in actual emissions from discontinuing operation of the existing, older Powerhouse engines should adequately reduce the increase in emissions from new engines below the significance thresholds. Refer to Section 2.2, Existing Thermal Equipment Assessment, for a description of the significance thresholds. Actual hours of use for each engine generator would be reported annually to the Pima County Air Quality Division.

Interfaces Between New ERF and the Upgrade Project

New Switchgear Building

The new ERF is expected deliver the power it produces to the new Switchgear Building at 13.8Y/7.97kV. Two circuit breakers in the new Switchgear Building will be reserved for this tie-in. Routing of the circuits from the switchgear to the ERF step-up transformer is expected to be the responsibility of the ERF DBO contractor.

There will be no other power connections to or from the new ERF. The new ERF is expected to derive all of its own "house power" from the 13.8Y/7.97kV connection with the Switchgear Building. It is expected to have sufficient power stored for black start capability. Alternatively, similar to the existing Powerhouse, engine starting capability could be provided by engine-driven compressed air starting.

Plant Supervisory Control and Data Acquisition System

The plant Supervisory Control and Data Acquisition system will require the following signals from the new ERF:

From	Description	Type
Each Generator	Status: "Fault"	Contact Closure
Each Generator	Quantity: "kVA"	4-20mA
Each Bus	Quantity: "kV"	4-20mA
Each Power Circuit Breaker	Status: "Closed"	Contact Closure
Each Power Circuit Breaker	Quantity: "kVA	4-20mA

The analog signals may be replaced with their digital equivalent in a data format approved by Pima County.

Telecommunications Systems

There are no known requirements for telephone service to the new ERF. Onsite telephone service will be terminated in the new Switchgear Building. It may be extended to the new ERF.

An outside telephone line, if it is required by the new ERF DBO Contractor, will be available at Building 01, Administration. A pathway will be available from Building 01 to the vicinity of the new ERF.

Thermal Energy Systems

The thermal energy systems include the sludge heating water system; the heating, ventilation, and air conditioning (HVAC) heating water system; the domestic hot water system; and the chilled water systems. All of these systems are routed through the tunnels, past the new ERF location. The existing supply and return lines for these systems will have new connections made in the main tunnel, NS-1, between the existing Powerhouse and the branch tunnel, EW-2, that heads towards Building 8. New below-grade supply and return lines will be routed through the tunnel wall and across the street towards the new ERF. All new lines will have isolation valves. The new connection points will be coordinated with the design for the new Switchgear Building, and a pipe routing right of way will be maintained for new piping that will be required from the new ERF. When the connections in the tunnels are made, isolation valves between the new connections and the existing Powerhouse will be provided to eliminate the need to shutdown the thermal systems when the existing Powerhouse is taken offline or demolished.

Due to a history of leaks, existing below-grade HVAC heating and chilled water piping that serves the existing Administration Building, Warehouse, and Training Facility will be replaced during the Upgrade Project. The replacement piping connections will be located in the tunnels to avoid any potential problems associated with taking the existing Powerhouse out of service. Isolation valves will be provided.

There are existing, below-grade, heating water supply and return lines that serve Building 37 and Building 30, these lines have never been used. As-built drawings indicate these lines terminate in a manhole located on the north end of the site for the new ERF. These lines will be flushed and tested during the Upgrade Project. The intent is that the existing manhole will serve as the connection point for the new ERF for these lines.

As-built drawings also indicate that there are chilled water supply and return lines that serve Building 37. These lines are shown to terminate below grade, about 20 feet northeast from the manhole referenced above, which is on the north end of the proposed site for the new ERF. These lines have never been used and will be located, flushed, and tested during the Upgrade Project. A manhole will be provided and that manhole will serve as the connection point for the new ERF

Other Services

Potable water will be required for makeup water for the heating, sludge heating, and chilled water hydronic systems. Potable water will also be required for the domestic hot water system, and any sinks and restroom to be included in the new ERF. The new ERF will require potable water for a fire protection sprinkler system and fire department connection.

Potable water would also be used for washdown. Backflow prevention would be provided for hydronic system makeup, fire protection, and washdown. Connections to the plant drain system would be required for general drainage and a sewer connection if the new ERF will include a restroom.

The existing heat sink piping between the existing Powerhouse and Facility 17 would be reconfigured to serve the heat rejection needs of the new ERF. This system utilizes a heat exchanger in Facility 17 to reject heat to plant effluent.

3.5 Alternative 2 – TEP Supply plus Central Plant

This section presents how the Ina Road WRF electrical and thermal energy demands would be met by an expanded TEP supply plus a new central heating water/chilled water plant (Central Plant). In addition, the supply configuration of electrical and thermal energy is summarized and air permitting considerations are discussed.

Electrical Prime Power Plan

Primary electrical power for the Ina Road WRF will be provided via a new service from TEP as described in Section 3.2, Principal and Backup Power Plan. Since the Central Plant alternative includes no onsite generation, the total electrical demands would be purchased from TEP.

Electrical Supply Balance

Since the Central Plant alternative includes no onsite generation, the total electrical demands would be purchased from TEP. Table 3-7 shows the predicted power needed to be supplied by TEP.

TABLE 3-7
Alternative 2 - Electrical Supply Balance
Ina Road Water Reclamation Facility Energy Master Plan

Year	Operating Load (MVA)	Operating Load (MW)
2009 (Present-Day Loads)	6.4 MVA	5.1 MW
2011 (Jan-Jun)	6.8 MVA	5.4 MW
2011 (Jul-Dec)	7.3 MVA	5.8 MW
2012 (Jan-Jun)	12.3 MVA	9.8 MW
2012 (Jul-Dec)	12.0 MVA	9.6 MW
2013 (Jan-Jun)	12.0 MVA	9.6 MW
2013 (Jul-Dec)	12.0 MVA	9.6 MW
2014 (Jan-Jun)	12.0 MVA	9.6 MW
2014 (Jul-Dec)	12.6 MVA	10.1 MW
2020	12.8 MVA	10.2 MW
2030	13.2 MVA	10.6 MW

Electrical Backup Power Plan

Based on the preliminary discussions with the Arizona Department of Environmental Quality (ADEQ), it is anticipated that the proposed TEP supply configuration, with supply from two independent substations, will satisfy the requirements for process backup power. There is a single circuit between the terminating TEP power pole and the service entrance equipment and meter. If this short, single-point of failure, which is not accessible to the public or in risk of damage from public vehicular traffic, is acceptable to ADEQ, then onsite backup generators will not be needed. This configuration of Alternative 2 therefore does not include onsite standby engine generators.

Thermal Energy Prime Plan

For the purposes of evaluating the economics and qualitative aspects of Alternative 2, assumptions regarding the configuration of a central heated water/chilled water plant were made. This Central Plant would primarily utilize the digester gas produced onsite, with natural gas and/or propane backup. The fuel(s) would be directly utilized to provide digester heating water, building heating water, domestic hot water, and building cooling chilled water. Heated water would be provided via digester gas fired boilers, with a primary heating loop interfacing with a secondary loop for each kind of heated water. Chilled water would be provided via absorption chiller systems also fired on digester gas. In general, the Central Plant would consist of the following major elements:

- Heated water generation system. Boilers on a primary hot water loop would supply a secondary loop for each sub-system, including the following:
  - boilers, 2-duty units fired on digester gas with natural gas backup
  - primary hot water supply pumps, 1-pump per boiler
  - sludge heating water heat exchanger with 1-duty secondary loop pump
  - building heating water heat exchanger with 1-duty secondary loop pump
  - domestic hot water heat exchanger with 1-duty supply pump
- Chilled water generation system. Direct-fired absorptions chillers on a primary chilled water loop would supply a secondary loop for distribution throughout the plant, including the following:
  - absorption chillers, 2-duty fired on digester gas with natural gas backup
  - primary chilled water supply pumps, 1-pump per chiller
  - chilled water heat exchanger with 1-duty pump

During the design of the heating water systems, it should be evaluated if separate sludge heating and HVAC heating water systems are required or whether these systems should be combined to a single system within the new Central Plant. The existing HVAC heating and sludge heating supply and return plant wide distribution piping systems are two separate systems and this would remain as is.

Similar to the existing Powerhouse, absorption chillers require heat rejection. During the design of the chilled water systems, it should be evaluated if cooling towers or the existing heat rejection loop that dumps excess heat to the plant effluent flow would be the most cost

effective approach. If the existing heat rejection loop is used, the heat rejection loop should have a primary and backup pump. If cooling towers are used there should be N+1 cooling tower redundancy with a dedicated pump for each cooling tower.

Thermal Energy Supply Balance

Forecast thermal energy from direct utilization of digester gas is calculated from the forecast digester gas production, refer to Section 1.5, Digester Gas Production, and assumes an overall conversion efficiency of 75 percent for fuel energy rate to available thermal energy. Table 3-8 shows the predicted thermal energy available from digester gas and the resulting balance of the thermal energy. However, the net balance required in years 2009 and 2011 would be met via continued cogeneration fired on natural gas, assuming continued operation of the existing Powerhouse through the Year 2012, when the major cooling load of the Oxygen Production Facility is removed. Once the Oxygen Production Facility is demolished as part of the Upgrade Project, the thermal energy available from digester gas far exceeds the forecast thermal energy demands of the plant.

TABLE 3-8
Waste Heat Supply by Digester Gas Cogeneration and Resulting Thermal Supply Balance (all values are 10^6 BTUH)
Ina Road Water Reclamation Facility Energy Master Plan

Year	Digester Heating Load	HVAC Heating Load	HVAC / Process Cooling Load	Total of Thermal Energy Loads	Total Thermal Energy Demand[a]	Digester Gas Thermal Energy Available	Balance of Thermal Energy Needed	Extra Digester Gas (scfm)
2009	1.03	0.47	5.78	7.27	8.55	6.42	2.13	--
2011	1.17	0.52	5.81	7.50	8.82	6.66	2.16	--
2014	1.44	0.57	0.61	2.62	3.08	8.24	--	191
2015	1.89	0.57	0.61	3.06	3.60	16.24	--	468
2020	2.00	0.57	0.61	3.17	3.73	17.45	--	508
2030	2.20	0.57	0.61	3.40	4.00	19.87	--	588

[a] (Includes 0.85 conversion factor).

Values shown above in Table 3-8 are annual average rates. Since the heating and cooling loads vary with the seasonal ambient temperature, monthly thermal energy demands and estimated available thermal energy from digester gas are presented in Figures 3-7 through 3-12 for years 2009, 2011, 2014, 2015, 2020, and 2030, respectively.

As shown in Figures 3-7 and 3-8, the total thermal energy demand exceeds the predicted amount of available thermal energy from direct utilization of digester gas. To meet the thermal energy demands, it is anticipated that the existing Powerhouse would continue to operate through year 2012, with supplemental cogeneration fired on natural gas the same as current practice.

FIGURE 3-7
Alternative 2 - 2009 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

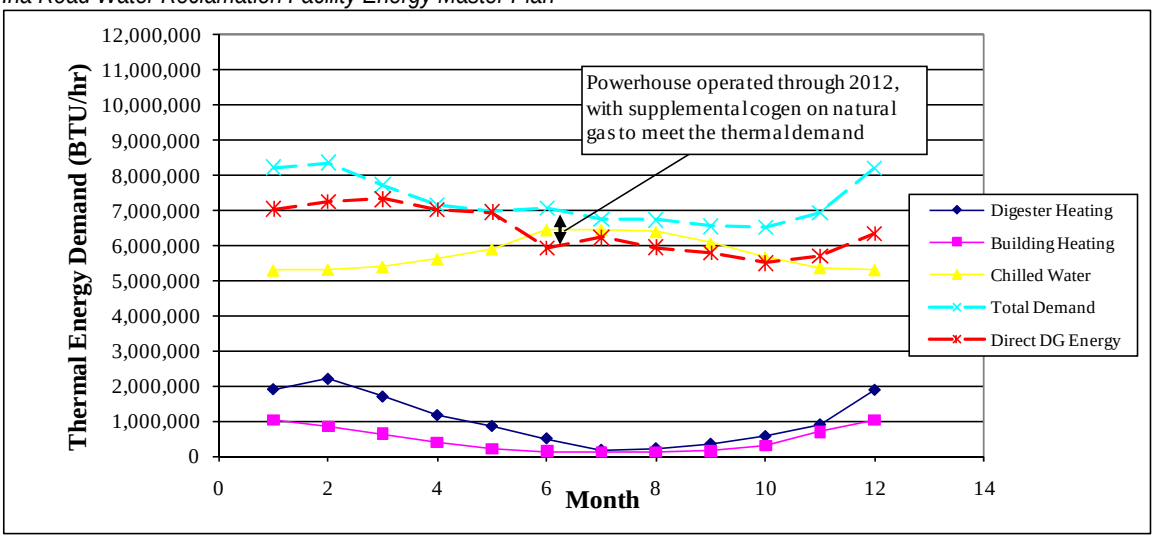


FIGURE 3-8
Alternative 2 - 2011 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

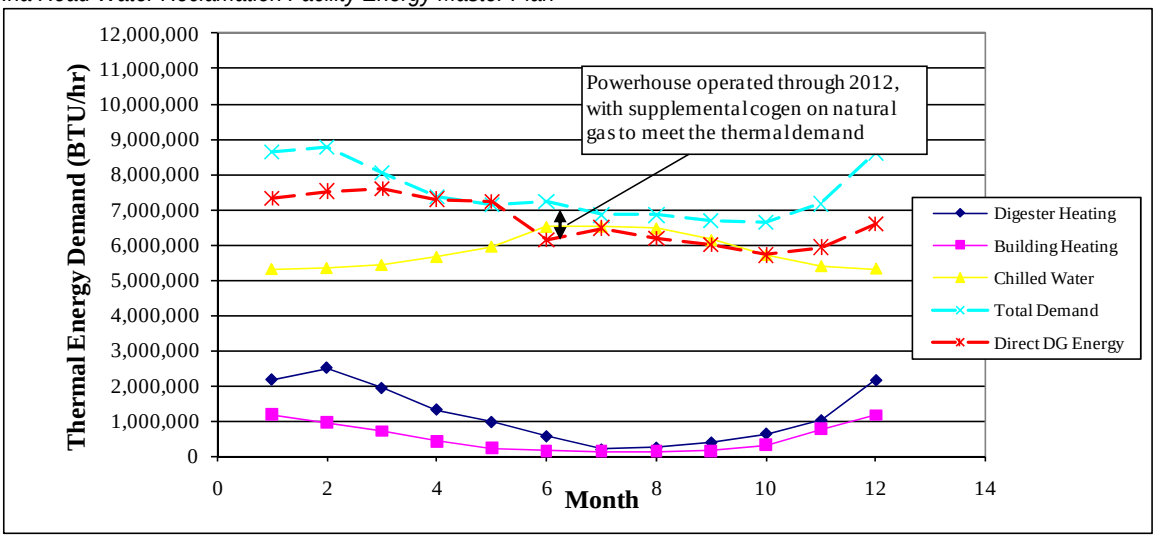
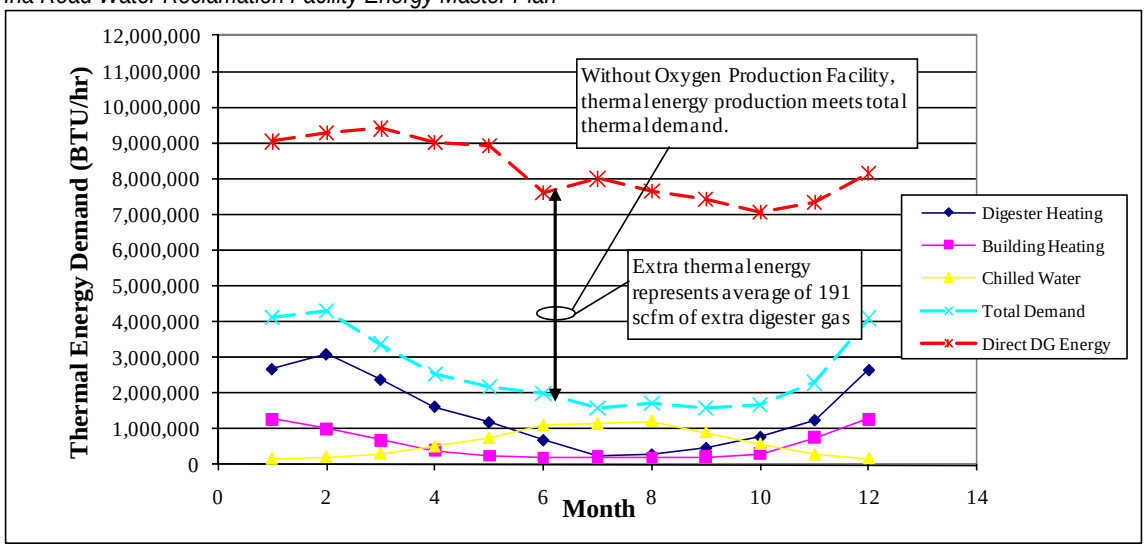


Figure 3-9 shows that when the existing Oxygen Production Facility is taken out of service as part of the Upgrade Project, the chilled water demand, and thus total thermal energy demand decreases significantly. This results in the available thermal energy from direct utilization of digester gas exceeding the forecast plant thermal demands. In fact there is significant surplus of thermal energy (i.e. extra digester gas) because the conversion efficiency from fuel energy to thermal energy is 75-percent for direct utilization of digester gas in boilers and direct absorptions chillers versus 40-percent for waste heat recovery from engine generators, as presented in Section 3.4, Alternative 1 – TEP Supply plus Energy Recovery Facility.

FIGURE 3-9
Alternative 2 - 2014 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan



Figures 3-10 through 3-12 indicate that with the addition of the waste activated sludge transferred from the future Water Reclamation Campus (WRC), beginning in year 2015, the available thermal energy from direct utilization of digester greatly exceeds the forecast plant thermal demands (note the y-axis scale change from previous figures). This surplus thermal energy represents significant extra digester gas.

FIGURE 3-10
Alternative 2 - 2015 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

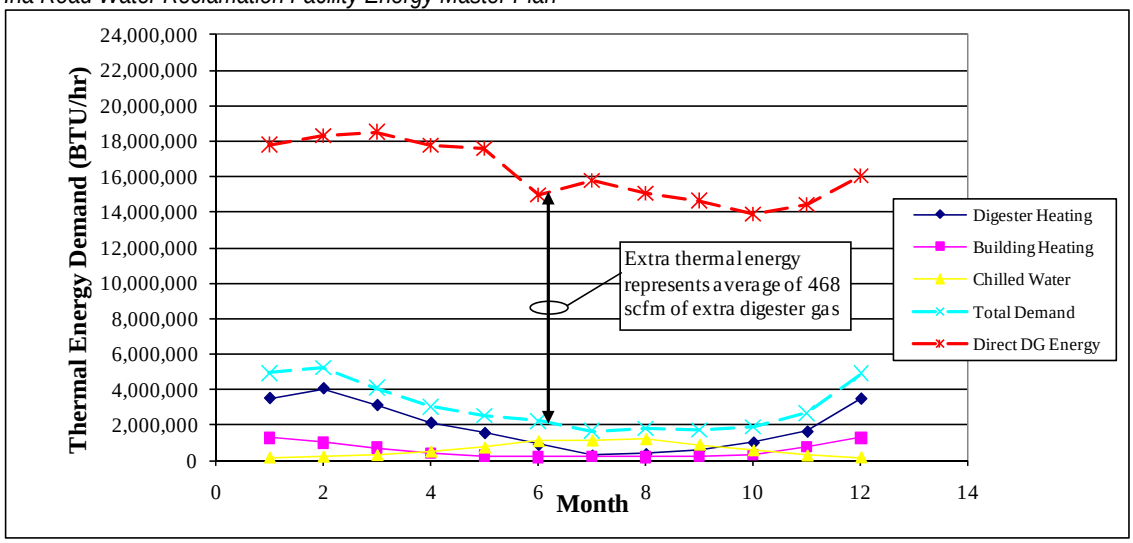


FIGURE 3-11
Alternative 2 - 2020 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan

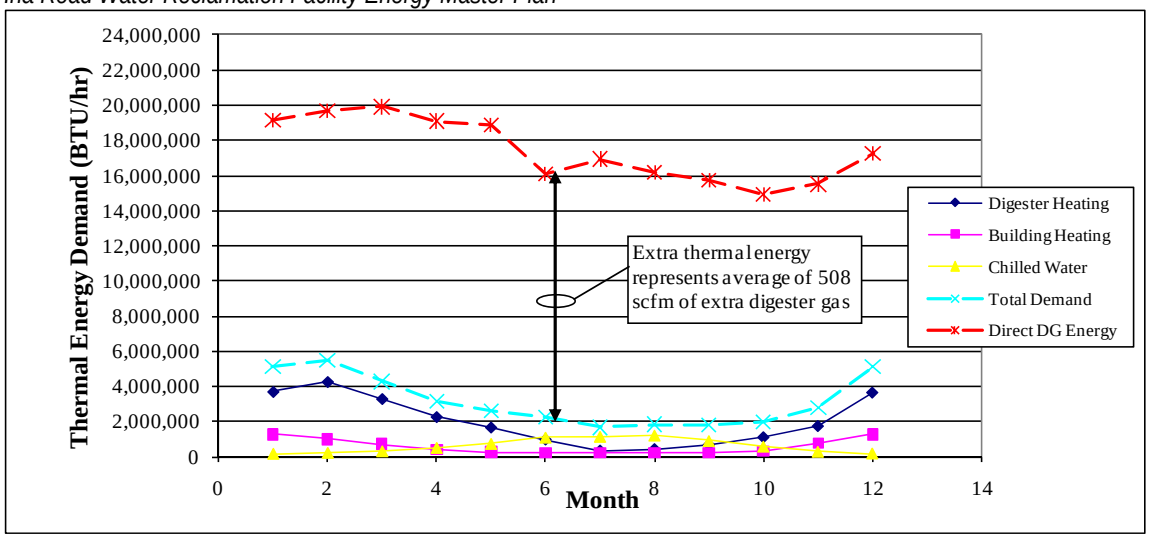
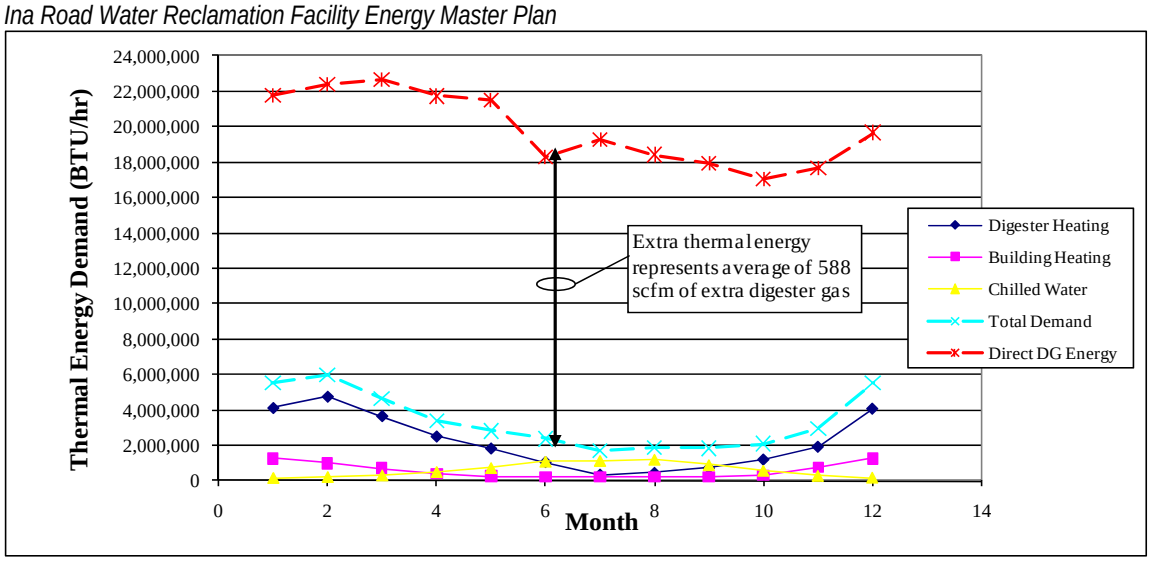


FIGURE 3-12
Alternative 2 - 2030 Monthly Thermal Energy Demands
Ina Road Water Reclamation Facility Energy Master Plan



Thermal Energy Backup Plan

Since the hot water boilers are the sole source of heat for the sludge heating water and HVAC heating water, it is assumed that 1-standby boiler would be provided. As backup to the digester gas, natural gas would also be piped to the boilers.

The individual heating loops are not critical to maintaining Plant effluent quality during short durations (less than 24 hours) and so are assumed to not require redundant heat exchangers and secondary loop pumps. This approach is consistent with the configuration of the existing Powerhouse heating water systems.

Since the chillers are the sole source of chilled water supplied to cool the electrical rooms plantwide, it is assumed that 1-standby chiller would be provided. As backup to the digester gas, natural gas would also be piped to the chillers. Due to the critical nature of the chilled water system, each chiller would have its own primary loop pump and there would be 1-duty, 1-standby pump on the secondary loop.

Air Permitting Considerations

The installation of three boilers, three direct-fired absorption chillers, two waste gas burners (flares), and four emergency natural gas or propane-fired emergency generators (if ultimately required) may be accomplished with a minor air quality permit modification assuming the existing Powerhouse engines were removed from service and the flares were the fully-enclosed type. Flares typically emit pollutants at higher rates than engines or boilers. Fully-enclosed flares have lower emission rates than open or candle-stick type flares. Detailed calculations of each piece of proposed equipment would have to be completed to determine the net emissions increase for the boilers and the flares to in order to determine if the air quality permit modification would be significant or not. Refer to Section 2.2, Existing Thermal Equipment Assessment for a description of the significance thresholds.

Interfaces Between Central Plant and the Upgrade Project

New Switchgear Building

The new Switchgear Building is assumed to provide the power to a Central Plant electrical room that would serve all the necessary facility equipment. Depending on the timing of and method of procurement for the Central Plant, the electrical/control room for the Central Plant equipment could be common-walled or even included in the Switchgear Building.

Plant Supervisory Control and Data Acquisition System

The plant Supervisory Control and Data Acquisition system would be extended to the Central Plant's control room. It is assumed that a control station would be provided.

Telecommunications Systems

Telephone service would be extended to the Central Plant control room via the Switchgear Building.

Thermal Energy Systems

Interconnection between the Central Plant configuration would be identical to that required for the new ERF. Details are not repeated here, refer to Section 3.5, Alternative 2 – TEP Supply plus Central Plant. Similar to Alternative 1, the Central Plant alternative would require connection to the sludge heating water system; the HVAC heating water system; the domestic hot water system; and the chilled water system.

Other Services

Potable water service would be provided to the Central Plant for makeup water for the heating, sludge heating, and chilled water hydronic systems; domestic hot water system; and any sinks and restroom to be included. Potable water would also be required for a fire protection sprinkler system and fire department connection. Potable water would also be

used for washdown. Backflow prevention would be provided for hydronic system makeup, fire protection, and washdown. Connections to the plant drain system would be required for general drainage and a sewer connection if Central Plant included a restroom.

The existing heat sink piping between the existing Powerhouse and Facility 17 would be reconfigured to serve the heat rejection needs of the Central Plant. This existing system utilizes a heat exchanger in Facility 17 to reject heat to plant effluent.

3.6 Economic and Qualitative Evaluation

The purpose of this section is to document an evaluation of the present worth (cost) of Alternative 1, TEP Supply plus Energy Recovery Facility, against the present worth (cost) of Alternative 2, TEP Supply plus Central Plant. No costs for electrical infrastructure have been included, as these costs are assumed to be equal for both alternatives.

Alternative 1 – TEP Supply plus Energy Recovery Facility

For the purposes of the present worth analysis presented herein, assumptions regarding the configuration of the new ERF were made. The new ERF is assumed to include the following:

- Digester gas engine generators: Up to 3 megawatts (MW) of generation is assumed, with N+2 units (to provide for thermal production reliability). Assumes a total of 4 units, at 1.5 MW capacity each.
- Digester gas treatment system. Assumes that a treatment system similar to the system initially selected for the existing Powerhouse gas scrubbing project is required.
- Waste heat recovery system. This system would be similar to the existing Powerhouse, containing a water or steam based heat recovery system. A primary water or steam loop would collect heat from the engines and/or engine exhaust and supply each of the following sub-systems:
  - absorption chiller with 1-duty, 1-standby secondary loop pumps
  - sludge heating water with 1-duty secondary loop pump
  - building heating water with 1-duty secondary loop pump
  - domestic hot water with 1-duty supply pump
  - heat sink system with 1-duty, 1-standby transfer pumps
- Additional electrical equipment required to connect the engine generators to the plant electrical distribution system.

Alternative 2 – TEP Supply plus Central Plant

Assumptions for the configuration of a central heated water/chilled water plant were made in order to estimate an initial cost and operation and maintenance (O&M) costs for this alternative. This Central Plant would primarily utilize the digester gas produced onsite, with natural gas and/or propane backup. The fuel(s) would be directly utilized to provide digester heating water, building heating water, domestic hot water, and building cooling chilled water. Heated water would be provided via digester gas fired boilers, with a

primary heating loop interfacing with a secondary loop for each kind of heated water. Chilled water would be provided via absorption chiller systems also fired on digester gas.

In general, the Central Plant would consist of the following major elements:

- Heated water generation system. Boilers on a primary hot water loop would supply a secondary loop for each sub-system, including the following:
  - boilers, 2-duty and 1-standby, fired on digester gas with natural gas backup
  - primary hot water supply pumps, 1-duty pump per boiler
  - sludge heating water heat exchanger with 1-duty secondary loop pump
  - building heating water heat exchanger with 1-duty secondary loop pump
  - domestic hot water heat exchanger with 1-duty supply pump
- Chilled water generation system. Direct-fired absorptions chillers on a primary chilled water loop would supply a secondary loop for distribution throughout the plant, including the following:
  - absorption chillers, 2-duty and 1-standby, fired on digester gas with natural gas backup
  - primary chilled water supply pumps, 1-duty per chiller
  - chilled water heat exchanger with 1-duty and 1-standby secondary loop pumps
  - heat rejection system with 1-duty, 1-standby transfer pumps
- Digester gas treatment system. Assumes that gas treatment is limited to moisture removal only.
- Waste gas burners. Two fully-enclosed type waste gas burners.

Present Worth Analysis

The evaluation presented herein is based on a 20-year present worth of construction cost plus energy and O&M costs. Table 3-9 summarizes the assumptions used for the economic analysis.

TABLE 3-9
Assumptions for Economic Analysis
Ina Road Water Reclamation Facility Energy Master Plan

Parameter	Value	Source
O&M Costs		
Operating Hours	24 hours/day, 365 day/year	
Operations / Maintenance Labor	$50.00/hour	CH2M HILL approximation, fully burdened
Annual Maintenance Materials	1 percent of equipment capital cost	CH2M HILL approximation
Energy Costs	refer to Section 3.1, TEP Tariff Rate Evaluation	TEP LLP-14

TABLE 3-9
Assumptions for Economic Analysis
Ina Road Water Reclamation Facility Energy Master Plan

Parameter	Value	Source
Other Assumptions for the Economic Analysis		
Period of Analysis	20 Years	(Years 2011 to 2030)
Salvage Value	None	
Discount Rate	3.1 percent	U.S. Office of Management and Budget, December 2009

Personnel costs for O&M are based on two shifts of operations and one shift of maintenance for Alternative 1 with the new ERF versus one shift of operations and one-quarter shift of maintenance for Alternative 2 with the central heated and chilled water plant. No electricity cost was included for the energy supplied via the onsite engine generators in Alternative 1. Costs for operations are only included for operators (personnel costs) and for gas treatment media replacement and chemical usage. No direct cost was applied to the thermal energy usage for either alternative, as this is assumed to be covered by the operating staff costs.

Electricity Usage

Cost for electricity represents the major component of the present worth cost. The total plant demand, onsite electricity generation, and thus balance of electricity that must be purchased under Alternative 1 – TEP Supply plus ERF is shown in Table 3-10. The electricity demand represents the average annual demand rate.

TABLE 3-10
Electricity Usage and TEP Purchased Electricity for Alternative 1 – TEP Supply plus ERF
Ina Road Water Reclamation Facility Energy Master Plan

Year	Plant Electricity Demand Rate (kW)	Digester Gas Production Rate (scfm)	Onsite Electricity Generation Rate (kW)	TEP Purchased Electricity Rate (kW)	ANNUAL TEP Purchased Electricity (kWh)	ANNUAL TEP Electricity Cost Based on LLP-14
2011	5,600	247	833	4,767	41,760,000	$2,820,000
2012	9,700	251	848	8,852	77,540,000	$5,190,000
2013	9,600	256	864	8,736	76,530,000	$5,120,000
2014	9,850	305	1,030	8,820	77,260,000	$5,170,000
2015	10,100	601	2,030	8,070	70,690,000	$4,740,000
2016	10,120	610	2,061	8,059	70,600,000	$4,730,000
2017	10,140	619	2,091	8,049	70,510,000	$4,730,000
2018	10,160	628	2,121	8,039	70,420,000	$4,720,000
2019	10,180	637	2,152	8,028	70,330,000	$4,710,000
2020	10,200	646	2,182	8,018	70,240,000	$4,710,000
2021	10,240	655	2,212	8,028	70,320,000	$4,710,000
2022	10,280	664	2,242	8,038	70,410,000	$4,720,000

TABLE 3-10
Electricity Usage and TEP Purchased Electricity for Alternative 1 – TEP Supply plus ERF
Ina Road Water Reclamation Facility Energy Master Plan

Year	Plant Electricity Demand Rate (kW)	Digester Gas Production Rate (scfm)	Onsite Electricity Generation Rate (kW)	TEP Purchased Electricity Rate (kW)	ANNUAL TEP Purchased Electricity (kWh)	ANNUAL TEP Electricity Cost Based on LLP-14
2023	10,320	673	2,273	8,047	70,490,000	$4,720,000
2024	10,360	682	2,303	8,057	70,580,000	$4,730,000
2025	10,400	691	2,333	8,067	70,660,000	$4,740,000
2026	10,440	700	2,364	8,076	70,750,000	$4,740,000
2027	10,480	709	2,394	8,086	70,830,000	$4,750,000
2028	10,520	718	2,424	8,096	70,920,000	$4,750,000
2029	10,560	727	2,455	8,105	71,000,000	$4,760,000
2030	10,600	736	2,485	8,115	71,090,000	$4,760,000
					20-Year Present Worth	**$69,100,000**

The total plant electrical demand is the same for Alternative 2 – TEP Supply plus Central Plant, but there is no onsite electricity generation, so the total plant demand is purchased from TEP. Total plant demand and TEP purchased electricity for Alternative 2 – TEP Supply plus Central Plant is shown in Table 3-11.

TABLE 3-11
Electricity Usage and TEP Purchased Electricity for Alternative 2 – TEP Supply plus Central Plant
Ina Road Water Reclamation Facility Energy Master Plan

Year	Plant Electricity Demand Rate (kW)	TEP Purchased Electricity Rate (kW)	ANNUAL TEP Purchased Electricity (kWh)	ANNUAL TEP Electricity Cost Based on LLP-14
2011	5,600	5,600	49,060,000	$3,300,000
2012	9,700	9,700	84,970,000	$5,680,000
2013	9,600	9,600	84,100,000	$5,630,000
2014	9,850	9,850	86,290,000	$5,770,000
2015	10,100	10,100	88,480,000	$5,920,000
2016	10,120	10,120	88,650,000	$5,930.000
2017	10,140	10,140	88,830,000	$5,940,000
2018	10,160	10,160	89,000,000	$5,950,000
2019	10,180	10,180	89,180,000	$5,960,000
2020	10,200	10,200	89,350,000	$5,970,000
2021	10,240	10,240	89,700,000	$6,000,000
2022	10,280	10,280	90,050,000	$6,020,000
2023	10,320	10,320	90,400,000	$6,040,000
2024	10,360	10,360	90,750,000	$6,070,000

TABLE 3-11
Electricity Usage and TEP Purchased Electricity for Alternative 2 – TEP Supply plus Central Plant
Ina Road Water Reclamation Facility Energy Master Plan

Year	Plant Electricity Demand Rate (kW)	TEP Purchased Electricity Rate (kW)	ANNUAL TEP Purchased Electricity (kWh)	ANNUAL TEP Electricity Cost Based on LLP-14
2025	10,400	10,400	91,100,000	$6,090,000
2026	10,440	10,440	91,450,000	$6,110,000
2027	10,480	10,480	91,800,000	$6,140,000
2028	10,520	10,520	92,160,000	$6,160,000
2029	10,560	10,560	92,510,000	$6,180,000
2030	10,600	10,600	92,860,000	$6,200,000
			20-Year Present Worth	**$85,300,000**

Present Worth Costs

Table 3-12 summarizes the present worth costs of Alternative 1 – TEP Supply plus ERF and Alternative 2 – TEP Supply plus Central Plant.

TABLE 3-12
Summary of Present Worth Evaluation Costs
Ina Road Water Reclamation Facility Energy Master Plan

Parameter	Alternative 1 TEP plus ERF	Alternative 2 TEP plus Central Plant	Assumptions
Initial Construction Costs			
Facility Cost (less equipment)	$3,000,000	$800,000	
Equipment Installation	$1,455,000	$205,000	10 percent of equipment cost
Equipment Cost			
Digester Gas Engine Generators	$6,000,000	n/a	3 MW total, n+2, 4 units at 1.5 MW each
Digester Gas Treatment System	$3,600,000	$100,000	From Black & Veatch concept design report, plus 25 percent for Alt 1
Engine Heat Recovery System	$4,000,000	n/a	
Cooling System	$850,000	n/a	
Heated Water/Chilled Water System	n/a	$1,500,000	
Interfacing Switchgear Equipment	$100,000	n/a	
Fully Enclosed Waste Gas Burners	n/a	$450,000	
ERF Vendor's Overhead and Profit	$2,280,000	n/a	12 percent of facility & equipment cost
TEP Parallel Generation Study Cost	$300,000	n/a	3 studies at $100,000 each

TABLE 3-12
Summary of Present Worth Evaluation Costs
Ina Road Water Reclamation Facility Energy Master Plan

Parameter	Alternative 1 TEP plus ERF	Alternative 2 TEP plus Central Plant	Assumptions
Initial Construction Costs			
Total Initial Construction Cost [a]	**$21,590,000**	**$3,060,000**	
Annual O&M Costs			
Maintenance Materials	$145,500	$16,000	1 percent of equipment cost
Maintenance Staff	$146,000	$36,500	See description in text
Operations Staff	$292,000	$146,000	See description in text
Gas Treatment Media Replacement	$50,000	n/a	Approximation from Black & Veatch report
Gas Treatment Chemical	$100,000	n/a	Approximation from Black & Veatch report
ERF Vendor's Overhead and Profit	$88,000	n/a	12 percent of O&M items above
Total Annual O&M Costs	$822,000	$199,000	
Present Worth of Annual O&M Costs [b]	**$12,100,000**	**$2,900,000**	
Electricity Purchases			
Present Worth of Annual Electricity Costs [b]	**$69,100,000**	**$85,300,000**	
Total Present Worth Cost	**$102,790,000**	**$91,260,000**	

[a] Excludes allowance for engineering, legal, and administration

[b] Present Worth Discount Factor = 3.1 percent per year, with 20-year Present Worth (PWF) = 14.74

Based on the assumptions for the economic analysis, the 20-year present worth cost for Alternative 1 is higher compared to Alternative 2 by approximately $11 million. These present worth costs are considered the "Base Present Worth".

Adjusted Present Worth Costs

To enhance the present worth analysis, two additional items are included as "adjustments" to the above Base Present Worth, resulting in "Adjusted Present Worth" costs for the alternatives. These adjustments include the following:

- Renewable Energy Credits (RECs): TEP has a Uniform Credit Purchase Program for renewable energy credit purchases. Credit purchases or RECs are available for biogas fueled electric and thermal energy generation systems. This is very advantageous for Alternative 1 because the onsite generated power not only saves on the electricity amount purchased from TEP, but is also provides a credit on the saved electricity.
- Value of Extra Energy Available: A credit was included for the value of the extra energy that is available beyond what is required to meet the forecast thermal needs of the Plant.

The credit is valued as the natural gas equivalent of the extra available energy. Alternative 1 has excess engine heat available and Alternative 2 has excess digester gas available.

Renewable Energy Credits

The RECs available from TEP vary depending on the configuration of the electrical/thermal energy generation system. For Alternative 1, credits are available under the Biogas-Electric option as well as under the Biogas-Combined Heat and Power (CHP) option. Under the Biogas-CHP option, credits would be paid for both the generated electricity and the metered amount of thermal energy used by the Plant. RECs were calculated for both of the above options and the Biogas-Electric option was included in the present worth analysis as it provided the largest credit for Alternative 1. For Alternative 2, credits are available under the Biogas-Thermal and Biogas-Cooling options and these were both included in the present worth analysis for Alternative 2.

TEP's program for RECs is on a first-come, first served basis. The owner of a to be constructed electrical and/or thermal energy generation system must apply for the credits. TEP solely determines which projects are selected to receive the incentive payments. It has been noted that TEP would likely select a biogas fueled system preferentially to other systems because the biogas RECs are significantly less expensive for TEP than the RECs for other systems, such as solar-electric. For example, the REC for a Biogas-Electric system is $0.048 per kWh compared to $0.162 per kWh for a Solar-Electric system. Table 3-13 summarizes the REC parameters used in the economic analysis.

TABLE 3-13
Renewable Energy Credit Parameters used in Economic Analysis
Ina Road Water Reclamation Facility Energy Master Plan

Alternative and REC Category	20-year Payment Schedule[a]
Alternative 1 = Biogas-Electric	$0.048 per kWh
Alternative 2 = Biogas-Thermal + Biogas-Cooling	$0.012 per kWh of metered heating energy use + $0.026 per kWh of metered cooling energy use

[a] From TEP Conforming Project Incentive Matrix for 2011 Program Year

Table 3-14 summarizes the Adjusted Present Worth costs of Alternative 1 and Alternative 2. The cost of Alternative 1 remains higher than Alternative 2 by approximately $7 million.

TABLE 3-14
Summary of Adjusted Present Worth Evaluation Costs
Ina Road Water Reclamation Facility Energy Master Plan

Parameter	Alternative 1 TEP plus ERF	Alternative 2 TEP plus Central Plant
Base Present Worth (from Table 3-12)	**$102,790,000**	**$91,260,000**
Adjustments		
Present Worth of Renewable Energy Credits [a]	$11,800,000	$2,300,000
Present Worth Value of Excess Engine Heat [a, b]	$3,400,000	n/a
Present Worth Value of Excess Digester Gas [a, b]	n/a	$8,500,000
Adjusted Total Present Worth Cost	**$87,590,000**	**$80,460,000**

[a] Present Worth Discount Factor = 3.1 percent per year, with 20-year Present Worth (PWF) = 14.74

[b] Heat energy valued as natural gas at $5.97 per million BTUs

Present Worth Sensitivity Analysis

To enhance the economic evaluation and provide greater insight to the impact of potential variability in the assumed parameters, a sensitivity analysis was performed. Base Present Worth and Adjusted Present Worth values are based on the conditions described previously. The following parameters were analyzed:

- Electricity cost – overall electricity rate varied from $0.05 to $0.15 per kWh.
- Engine-generator power generation efficiency – varied from 26 percent to 40 percent.
- Construction cost – varied from 80 percent to 120 percent of original estimate.
- Annual operations and maintenance cost – varied from 80 percent to 120 percent.
- Power consumption – varied from 60 percent to 100 percent of original load forecast.
- Renewable energy credits – varied from 60 percent to 100 percent of estimated credits.
- Natural gas cost – value varied from $4 to $14 per million BTUs.

The difference between the Base Present Worth and Adjusted Present Worth is most important when analyzing the sensitivity to overall electricity cost. For this reason, individual figures are included both types of present worth costs. For all other analyzed parameters, the sensitivities of the Base Present Worth and Adjusted Present Worth are essentially identical, and thus only the Adjusted Present Worth is presented herein.

Overall Electricity Rate Sensitivity

As presented earlier, electricity purchases represent the major component of the present worth cost of the alternatives. Therefore, it is no surprise that the most significant parameter that alters the present worth evaluations is the overall electricity rate. Nominal electricity rate used in the present worth evaluation (Table 3-12) is $0.0674 per kWh. Higher electricity rates favor Alternative 1 due to the electricity savings provided by the onsite power generation. Lower electricity rates favor Alternative 2. Figure 3-13 presents curves of the Base Present Worth for the alternatives over a range of electricity rates.

FIGURE 3-13
Sensitivity Analysis for Overall Electricity Rate – Base Present Worth

Ina Road Water Reclamation Facility Energy Master Plan

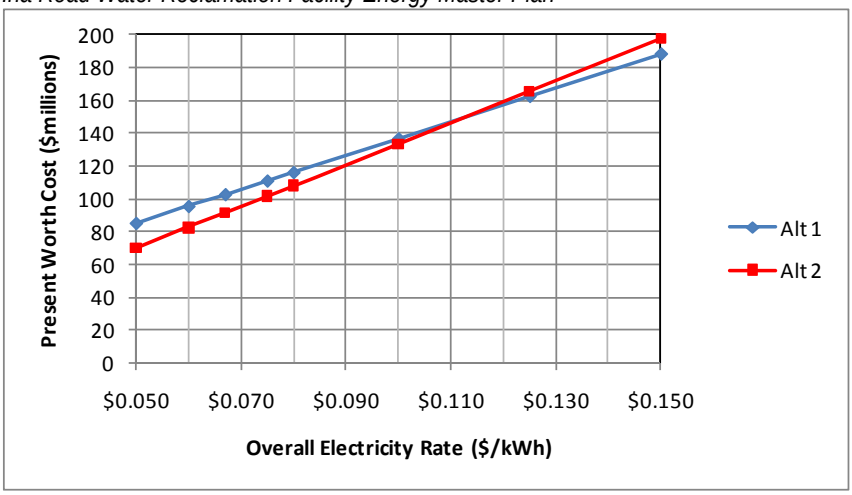
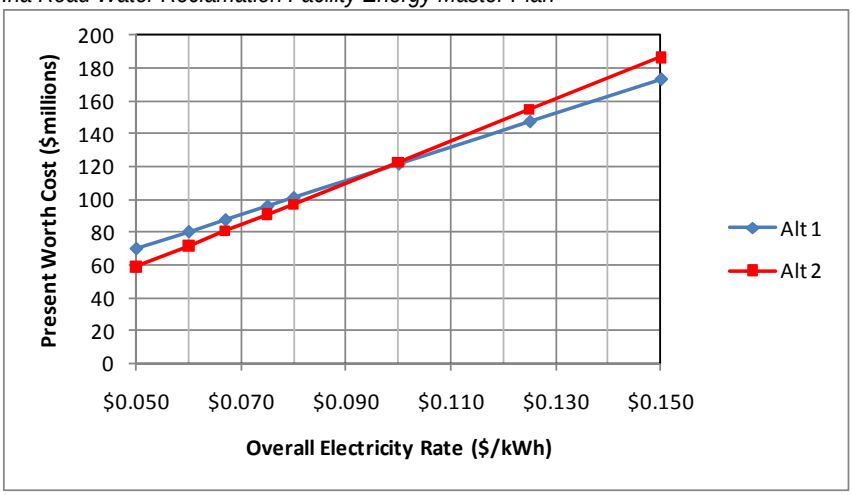


Figure 3-13 demonstrates that both alternatives are sensitive to the overall price of electricity, with Alternative 2 being slightly more sensitive (steeper sloped line). The breakeven point between the Base Present Worth costs of the two alternatives is at an overall electricity rate of $0.113 per kWh. Thus electricity rates would have to increase by nearly 70-percent for the Alternative 2 base present worth cost to equal that of Alternative 1.

Figure 3-14 demonstrates that when renewable energy credits and value of excess available energy (engine heat for Alternative 1 and digester gas for Alternative 2) are included in the present worth values, the sensitivity to electricity cost remains unchanged. Alternative 2 is still slightly more sensitive than Alternative 1. The breakeven point between the Adjusted Present Worth costs of the two alternatives is at an overall electricity rate of $0.095 per kWh. Thus electricity rates would have to increase by 40-percent for the Alternative 2 adjusted present worth cost to equal that of Alternative 1.

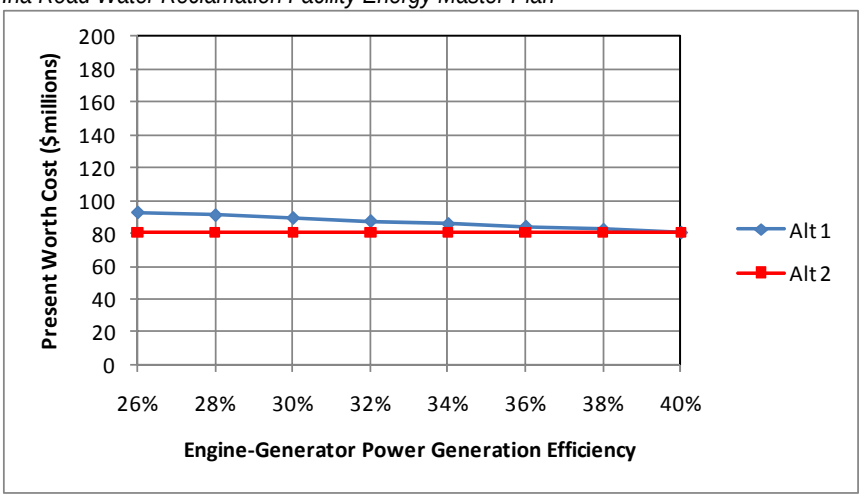
FIGURE 3-14
Sensitivity Analysis for Overall Electricity Rate – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan



Engine-Generator Power Generation Efficiency Sensitivity

Figure 3-15 presents the Adjusted Present Worth costs of the alternatives over a range of engine-generator power generation efficiencies. Nominal efficiency used in the present worth evaluation (Table 3-12) is 32-percent. Since Alternative 2 includes no onsite generators, its present worth is unaffected. As one would expect, higher power generation efficiency (conversion efficiency from digester gas to electricity) results in increased onsite electricity production for Alternative 2, increasing savings in energy purchases from TEP as well as increasing REC payments, thus decreasing the present worth cost. Power generation efficiency would have to increase by 25-percent for the Alternative 1 adjusted present worth cost to equal that of Alternative 2.

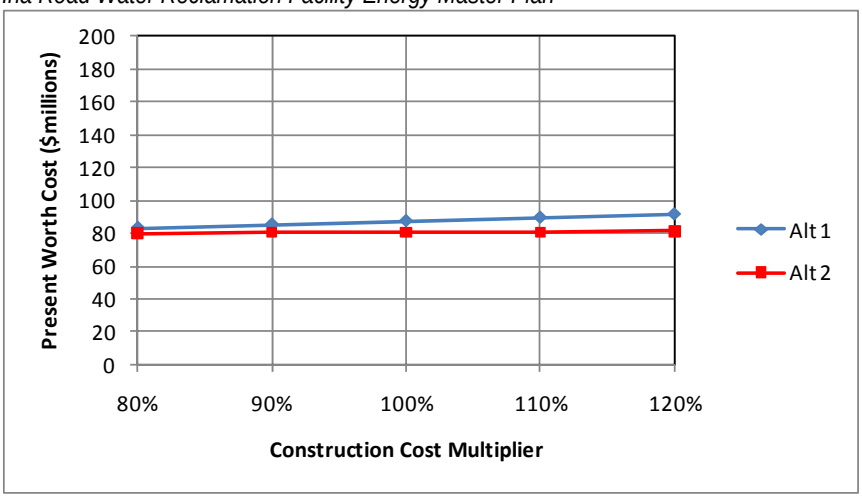
FIGURE 3-15
Sensitivity Analysis for Engine-Generator Power Generation Efficiency – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan



Construction Cost Sensitivity

Figure 3-16 presents the Adjusted Present Worth costs of the alternatives over a range of initial construction cost. As shown in the figure, Alternative 1 is more sensitive to variations in construction cost than Alternative 2. This is driven by the fact that the construction cost for Alternative 1 is so much higher than for Alternative 2. Construction costs would have o decrease by approximately 30-percent for the Alternative 1 adjusted present worth cost to equal that of Alternative 2.

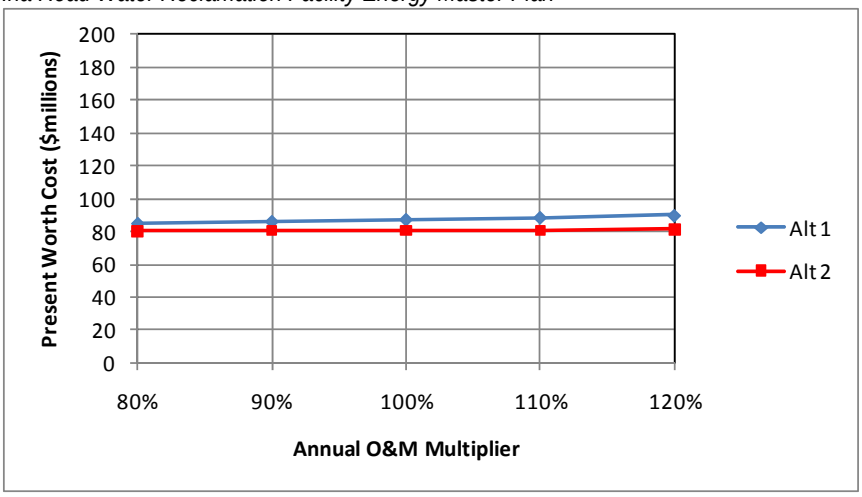
FIGURE 3-16
Sensitivity Analysis for Initial Construction Cost – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan



Annual Operations and Maintenance Sensitivity

Figure 3-17 presents the Adjusted Present Worth costs of the alternatives over a range of annual operations and maintenance cost. Since the present worth cost of both alternatives is dominated by the electricity purchases, both alternatives are essentially insensitive to variations in annual operations and maintenance cost. Over the range analyzed Alternative 2 present worth cost remains lower than Alternative 1.

FIGURE 3-17
Sensitivity Analysis for Annual O&M Costs – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan

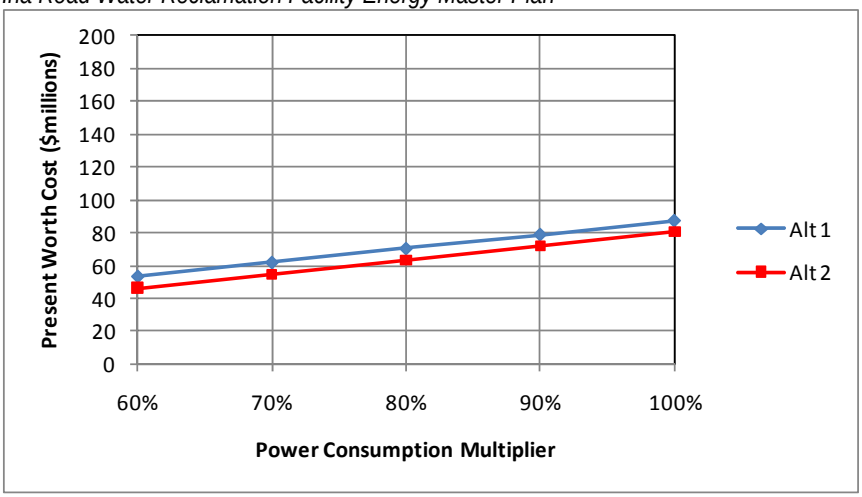


Power Consumption Sensitivity

Figure 3-18 presents the Adjusted Present Worth costs of the alternatives over a range of power consumption. Given the methodology used to forecast the electrical loads of the upgraded and expanded plant and current electricity billing information, the forecast electrical loads may be 25 to 30-percent higher than actual demand. While the present worth cost is fairly sensitive to total power consumption, reductions affect both alternatives by the

same amount, effectively subtracting cost "off the bottom". Over the range analyzed Alternative 2 present worth cost remains lower than Alternative 1.

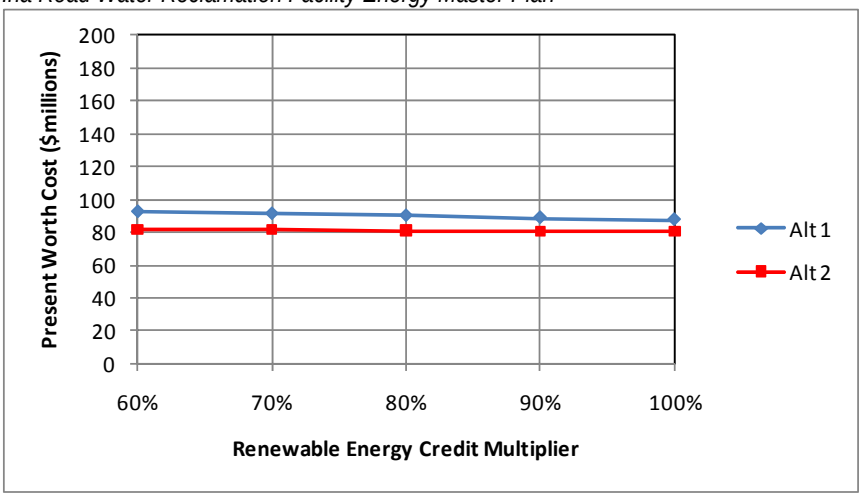
FIGURE 3-18
Sensitivity Analysis for Power Consumption – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan



Renewable Energy Credits (RECs) Sensitivity

Figure 3-19 presents the Adjusted Present Worth costs of the alternatives over a range of renewable energy credit realization. Alternative 1 has approximately four times the RECs of Alternative 2. Thus the Alternative 1 present worth is more sensitive to any reduction in the RECs actually received by the Plant versus the total potential RECs. It is assumed that TEP would likely contract for the full REC amount in both alternatives because the biogas RECs are significantly cheaper for TEP on a per kWh basis ($0.048 per kWh for Biogas-Electric versus $0.162 per kWh for solar-electric systems). Over the range analyzed Alternative 2 present worth cost remains lower than Alternative 1.

FIGURE 3-19
Sensitivity Analysis for Renewable Energy Credits – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan



Natural Gas Cost Sensitivity

Figure 3-20 presents the Adjusted Present Worth costs of the alternatives over a range of natural gas cost. Nominal cost used in the present worth evaluation (Table 3-12) is $5.97 per million BTUs (MM-BTU). Since Alternative 2 has a larger amount of excess energy available, in the form of excess digester gas, its present worth cost is more sensitive than Alternative 1. Thus higher natural gas cost favors Alternative 2, as its credit increases at a faster rate than for Alternative 1. However, this increasing difference between the alternatives cannot be considered alone, as it is anticipated that electricity rates and natural gas cost would escalate at approximately the same rate.

FIGURE 3-20
Sensitivity Analysis for Natural Gas Cost – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan

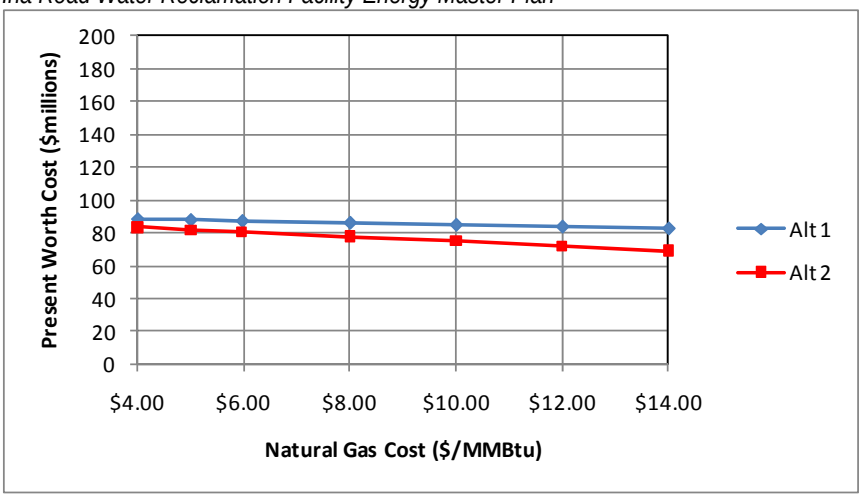
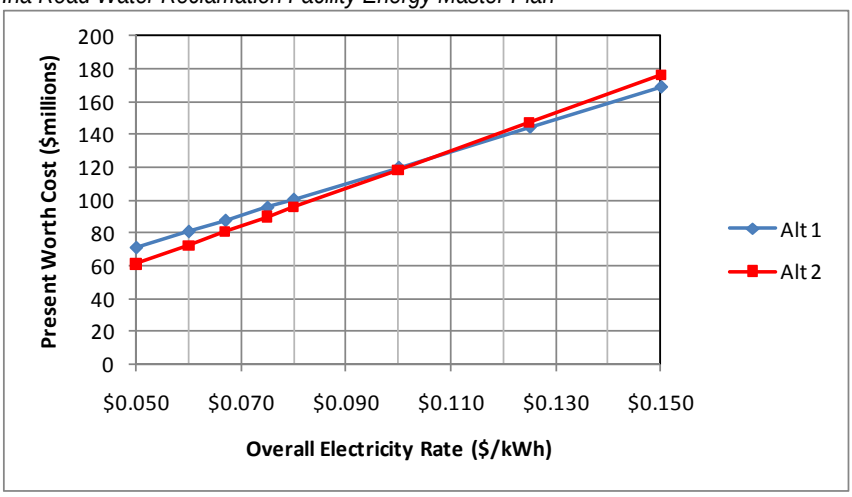


Figure 3-21 presents the Adjusted Present Worth costs of the two alternatives over a range of overall electricity cost, with the change in natural gas cost proportional to the change in electricity rate. The breakeven point between the Adjusted Present Worth costs of the two alternatives under this scenario is at an overall electricity rate of $0.108 per kWh (natural gas cost at $9.62 per million BTUs). This demonstrates that the greater amount of excess energy available for Alternative 2 helps to temper increases in present worth cost as the electricity rate escalates, assuming that natural gas cost (and thus value of excess digester gas) escalates at the same rate.

FIGURE 3-21
Sensitivity Analysis for Overall Electricity Rate and Natural Gas Cost – Adjusted Present Worth
Ina Road Water Reclamation Facility Energy Master Plan



Qualitative Evaluation

An evaluation of facility configurations for the ERF or Central Plant must consider qualitative aspects in addition to construction and annual O&M costs. Table 3-15 is a summary of qualitative considerations.

TABLE 3-15
Qualitative Comparison of Alternatives
Ina Road Water Reclamation Facility Energy Master Plan

Category	Alternative 1 – TEP plus New ERF	Alternative 2 – TEP plus Central Plant
Operations	More complicated system. Waste heat recovery system and gas treatment systems add complexity.	Simple to operate. Little system complexity.
Maintenance	More – close tolerance and complex machinery.	Less – simpler less complex machinery.
Reliability/Redundancy	More complex systems.	Less complex systems, boilers and pumps.
Procurement	More complicated, third party	Straight forward
Construction Coordination	More complicated, third party	Straight forward
Site Operations/Security	Third party contractor always onsite	No change from current operations
Air Permitting Impact	Relatively straightforward	Relatively straightforward
TEP Interconnection Requirements	Feasibility Study, System Impact Study, Facilities Study	Less or no impact depending on whether backup power engine generators are interconnected
Utilization of Digester Gas	Full utilization in onsite power generation	Incomplete. Thermal energy demands are met with a significant amount of extra digester gas available. Opportunity to utilize for additional beneficial use.

Discussion

The estimated 20-year present worth cost of the new ERF (Alternative 1), using the available information, is higher than the central heated water/chilled water plant option (Alternative 2). In addition, the qualitative analysis shows that the central heated water/chilled water plant provides numerous benefits based on its simplified systems. A notable difference between the alternatives is that minimum gas treatment (for moisture removal only) is required for Alternative 2 versus the complex and operations/maintenance intensive gas treatment system (siloxane and H2S removal) of Alternative 1. However, given the planned DBO arrangement of the new ERF, the more complex systems of the new ERF would be operated and maintained by DBO personnel, rather than by PCRWRD personnel. But the additional operations and maintenance presents additional annual cost to the PCRWRD.

Alternative 1 includes costs for the DBO contractor to operate the system based only on an assumption of the required O&M staff, and the contractor's overhead and profit at 12-percent of the O&M materials and labor. There is no cost component applied to the kWh's of ERF power generation although this seems to be the most likely method for the ERF contractor to charge for their services. However this level of cost information was not available at the time this document was prepared.

Given the available initial cost and operations and maintenance information, and the assumptions necessary to develop the 20-year present worth costs presented herein, it appears as though PCRWRD could see a cost and operations advantage from shifting from a new ERF to a central heated water/chilled water plant. In addition, site operations/security is simplified without a third-party DBO contractor operating onsite.

4. Summary Considerations and Recommendations

Economic Evaluation Summary

The economic evaluation presented in Section 3.6 shows that the 20-year Base Present Worth cost of Alternative 2, TEP Supply plus Central Plant is lower than Alternative 1, TEP Supply plus Energy Recovery Facility (ERF) by approximately $11 million, under the assumptions applied to the analysis.

Alternative 2 present worth remains lower than Alternative 1, by a difference of approximately $2 million, when renewable energy credits are included in the present worth analysis.

When the value of extra energy, available beyond what is required to meet the forecast thermal needs of the Ina Road WRF, is included in the present worth analysis, the Alternative 2 Adjusted Present Worth cost remains lower than Alternative 1, by a difference of approximately $7 million. Alternative 1 has higher renewable energy credits, while Alternative 2 has higher credits for the extra energy available, in the form of extra digester gas.

The sensitivity analysis performed on the base and adjusted present worth costs of the two alternatives highlighted the following findings:

- Both alternatives are sensitive to escalations in electricity rates, as electricity purchases from TEP form the majority of the present worth costs in both cases.
- The breakeven point of present worth costs between the two alternatives occur at an overall electricity rate of $0.113 per kWh (Base Present Worth) and $0.095 per kWh (Adjusted Present Worth). Thus electricity rates would have to increase by more than 40-percent for the Alternative 2 present worth cost to equal that of Alternative 1.
- For all other parameters analyzed, present worth costs were relatively insensitive, and over the ranges analyzed, the Alternative 2 present worth cost remained lower than Alternative 1.

Qualitative Evaluation Summary

The qualitative analysis demonstrates advantages and disadvantages with each option, and must be considered by PCRWRD management to determine relative importance of these conditions. Some primary considerations for the two alternatives that must be weighed by PCRWRD staff are discussed below.

Alternative 1 – TEP Supply plus Energy Recovery Facility

- For Alternative 1, there would be a third-party contractor continuously on site. Site security and site administration would have to be adjusted to accommodate this situation.
- Contract administration would be required by PCRWRD for the DBO operation.
- The ERF DBO procurement would need to be completed.
- All of the digester gas could be utilized by this alternative. Flaring of gas would be minimal, similar to current practice. However, because of the lowered thermal energy requirements of the Plant going forward, significant excess engine heat would be discharged to the plant effluent, also similar to the current practice.

Alternative 2 – TEP Supply plus Central Plant

- Unlike Alternative 1, there would be no third-party contractor on site eliminating the security and administrative concerns.
- The complex procurement of an ERF DBO contractor would most likely be replaced with the incorporation of a central heated and chilled water plant as part of the Upgrade Project.
- The less complicated systems fit with the overall wastewater treatment system and would be under the full control of plant operations.
- A large quantity of digester gas will be available for an alternative use. This is particularly significant once the future Water Reclamation Campus is online and solids from that facility are transferred to, and digested at, Ina Road WRF (expected year 2015). In the short-term, this would most likely mean flaring of the excess gas, which almost certainly would require fully enclosed flares, in lieu the open flares currently included in the Upgrade Project design.

Most Beneficial Use of the Produced Digester Gas

Regardless of the alternative ultimately chosen, it is important to utilize the resource of the produced digester gas to the greatest benefit of the PCRWRD. Figure 4-1 presents a breakdown of the total energy rate available from the produced digester gas under Alternatives 1 and 2 for years 2015 and 2030.

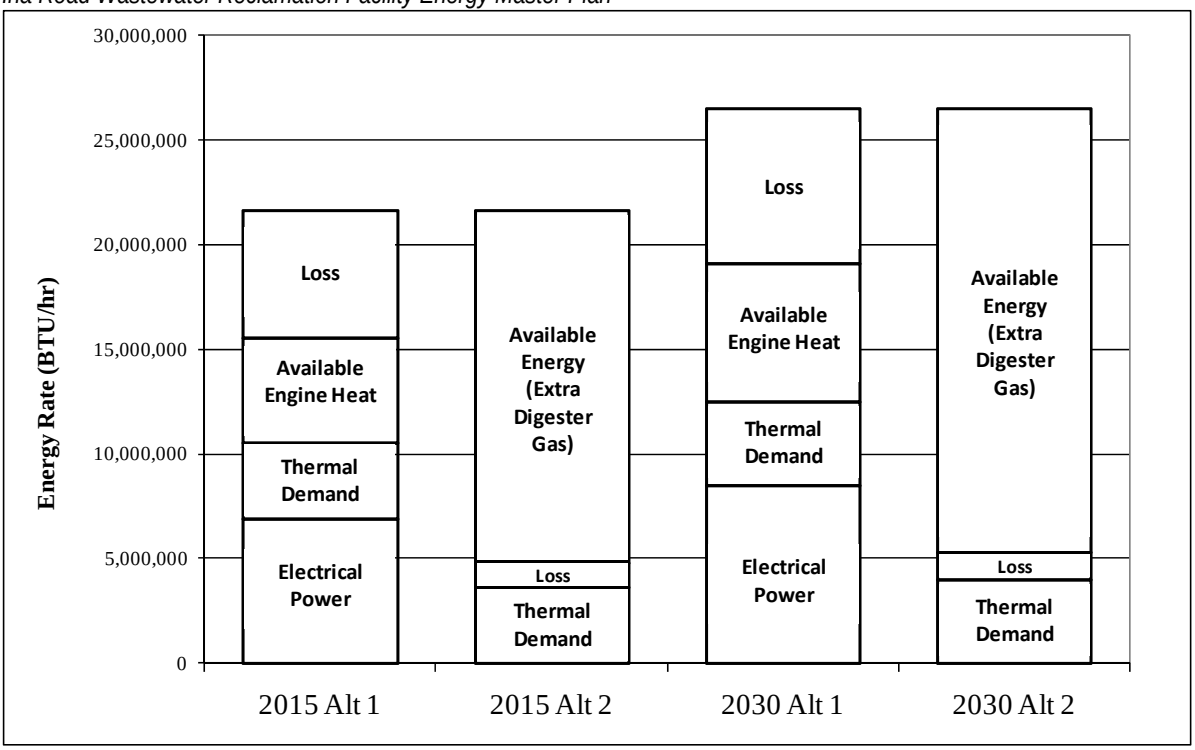
For Alternative 1, 32-percent of the digester gas energy is converted to electricity to be used in the Plant. Seventeen-percent of the energy is utilized to meet the Plant's thermal demands, captured in the form of recovered engine heat. There is another 23-percent of the total digester gas energy in the form of recovered engine heat that currently has no planned utilization, and so will be discharged to the plant effluent, similar to the current practice. The remaining 28-percent of the energy represents loss due to normal equipment efficiency and heat rejection to the atmosphere.

For Alternative 2, 17-percent of the digester gas energy is utilized to meet the Plant's thermal demands, identical to Alternative 1. The loss from meeting the Plant's thermal demands via direct utilization of the digester gas represents only 5-percent of the total

energy. Thus the remaining 78-percent of the total energy is available for other beneficial use by PCRWRD.

Comparatively, Alternative 2 results in 78-percent energy remaining as digester gas, while Alternative 1 results in 23-percent energy remaining as steam or hot water.

FIGURE 4-1
Energy Use of Alternatives
Ina Road Wastewater Reclamation Facility Energy Master Plan



Potential Mitigation of Future Process Risk

Biosolids processing at wastewater treatment facilities is an integral and often costly part of treatment plant operations. While the Ina Road WRF currently produces a Class B product for land application to relatively close farmland (approximate 25-mile haul distance), the regulatory environment, availability of the land, public perception, and available outlets for biosolids are all subject to change. As a result, a biosolids management plan is necessary to plan for mitigation of this future process risk.

The Regional Optimization Master Plan (ROMP) included recommendations for consideration by the PCRWRD in planning future biosolids processing and disposal/reuse. The ROMP recommended a biosolids management plan be performed to provide PCRWRD with the optimal biosolids processing strategy. Combining a biosolids management study with a study of the most beneficial utilization of the digester gas resource would help to identify a more comprehensive plan for the Ina Road WRF.

Utilizing the digester gas available under Alternative 2 may help to cost effectively meet the future biosolids processing needs of the PCRWRD, by helping to produce a biosolids

product (or multiple products) capable of being disposed/reused via multiple outlets. While Alternative 1 presents some available energy, the amount is smaller and of a less-flexible form than the energy in the available digester gas of Alternative 2.

Path Forward Recommendations

Based on the present worth and qualitative analyses performed with the available information, CH2M HILL recommends that PCRWRD pursue the development of Alternative 2 based on the following reasons:

- Present worth costs are lower for Alternative 2.
- Alternative 2 presents the opportunity for greater beneficial use of the digester gas.
- Alternative 2 presents simplified procurement and long-term operations that are a better fit with the overall wastewater treatment plant system.
- Alternative 2 has no site access/security complications from a third-party contractor.
- Alternative 2 does not fully preclude the utilization of digester gas for onsite power generation.
- Alternative 2 may help mitigate the future process risk to PCRWRD, by utilizing the digester gas to produce biosolids capable of disposal/reuse via multiple outlets.
- Alternative 2 presents a similar air permitting process to Alternative 1.

Follow-On Actions Recommended

In anticipation of implementation, it is recommended that PCRWRD consider the following issues:

Project Schedule/Constructability

The implementation and schedule requirements should be evaluated between PCRWRD, PM/CI, and the CMAR to determine implementation schedule and potential constructability impacts.

Additional Backup Power

Although the power supply configuration, including the rerouted 46 kV transmission lines supplied by two independent substations, is anticipated to meet the ADEQ requirements for backup power, PCRWRD should assess their comfort level with the proposed electrical supply system to determine if additional backup power is needed at specific facilities.

Under the unlikely scenario with catastrophic and complete loss of TEP power, where both substations serving the 46 kV line are out of service and/or the lines from both substations are damaged, it may be preferred to have some capability to convey the incoming wastewater through the Plant.

Biosolids/Digester Gas Utilization Master Plan

The objective would be to analyze and allow selection of the most beneficial use of the produced digester gas, while taking into account meeting the Ina Road WRF's thermal

energy needs, processing and disposal/reuse of the Plant's biosolids, and potential generation of a portion of the Plant's electrical needs. Evaluations performed would thereby address the following additional considerations of the primary electrical/thermal supply alternatives:

- Without a focused effort to identify and implement full utilization of the supplemental digester gas forecast to be available under Alternative 2, significant flaring of the unused gas will occur.
- Implementation of Alternative 1 would essentially preclude future implementation of thermal drying as a Class A biosolids management practice due to the high energy demand of this process. The resultant Class A biosolids options would most likely be limited to various thermophilic or phased anaerobic digestion processes, resulting in disposal/reuse of a dewatered Class A biosolids product.
- Implementation of Alternative 2 would significantly diminish the future economic prospects for onsite electrical energy production. Although new technologies are in development and emerging (fuel cells, stirling engines, and organic Rankine cycle systems) electrical energy production from low grade gas such as digester gas is typically most economically done in direct conjunction with heat recovery as is the plan for Alternative 1.

Supplemental Recommendations Related to the Upgrade Project

Supplemental recommendations related to the Upgrade Project that have been identified via performing the Energy Master Plan include the replacement of the following electrical and thermal system equipment and components:

- Substations No. 2 and No. 4
- 01 – Administration Bldg Panelboard MDP (replace as part of the future remodel)
- 02 – Warehouse Panelboard MDP (replace as part of the future remodel)
- 08 – Gravity Thickeners – MCC-08W1, -08W2, -08W3, and -08W4
- 16 – Training Center Panelboard MDP (replace as part of the future remodel)
- 17 – Service Water Pump Station – MCC-17W1 and -17W2
- Below grade heating water and chilled water supply and return piping between:
  - the tunnel in Facility 4 and the Administration Building and Warehouse
  - the lower level of the Powerhouse and the Training Center

In addition, the following equipment was recommended to be removed:

- 11 – Digesters – MCC-11W1 and -11W2

Appendix A
Electrical Equipment Assessment Forms

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Administration/Laboratory Building (01) EQUIPMENT TAG NUMBER: LPA	NA	NA	~1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse

Equipment Ratings: 400A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning label.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Administration/Laboratory Building (01) EQUIPMENT TAG NUMBER: MDP	NA	NA	~1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse

Equipment Ratings: 400A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☑ Lack of preventative maintenance	☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

Missing cover mounting hardware.

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning label.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Warehouse/Maintenance (02) EQUIPMENT TAG NUMBER: LPA	NA	NA	~1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse

Equipment Ratings: 225A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning label.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Warehouse/Maintenance (02) EQUIPMENT TAG NUMBER: MDP	NA	NA	~1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse

Equipment Ratings: 600A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning label.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09		
	CAPACITY		YEAR OF MFR
FACILITY NAME AND NUMBER: Sludge Thickeners/Control Building (08) EQUIPMENT TAG NUMBER: LPA-08	AVG NA	PEAK NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse

Equipment Ratings: 225A, 480Y/277V, 3 Phase, 4 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
(4)	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☑ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☑ Lack of preventative maintenance	☑ Safety issues

BACKUP/STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.
PARTS NEEDING MAINTENANCE / REPAIR:
Unused openings not closed properly.
Missing indicating lights and lenses.
Minor corrosion of outer enclosure for MCC-08W2.
ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09		
	CAPACITY		YEAR OF MFR
FACILITY NAME AND NUMBER: Sludge Thickeners/Control Building (08) EQUIPMENT TAG NUMBER: MCC-08W3 and MCC-08W4	AVG NA	PEAK NA	1989

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Westinghouse / Series 2100

Equipment Ratings: 600A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP/STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

Drips and splatters on enclosure.

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Digester Control Building (11) EQUIPMENT TAG NUMBER: LPA-11	NA	NA	~1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse

Equipment Ratings: 225A, 480Y/277V, 3 Phase, 4 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
(4)	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☑ Corrosion of equipment
- ☐ Unusual noise during operation
- ☑ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.
PARTS NEEDING MAINTENANCE / REPAIR:
Significant level of corrosion and degradation of cover gasket material.
Cover not bolted closed due to wiring routed between enclosure and cover.
ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning label.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Digester Control Building (11) EQUIPMENT TAG NUMBER: MCC-11W1 and MCC-11W2	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Westinghouse / Type W

Equipment Ratings: 600A, 480V, 3 Phase, 4 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
(3)	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☑ Corrosion of equipment
- ☐ Unusual noise during operation
- ☑ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.
PARTS NEEDING MAINTENANCE / REPAIR:
Dirty, needs cleaning. Duct tape used to seal unused openings.
Feeder conductors to panel LPA-11 not installed in conduit.
Minor corrosion of enclosure.
ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Digester Control Building (11) EQUIPMENT TAG NUMBER: MCC-11W3 and MCC-11W4	NA	NA	1989

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Westinghouse / Series 2100

Equipment Ratings: 800A, 480Y/277V, 3 Phase, 4 Wire, NEMA 4X

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☑ Lack of preventative maintenance	☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections,
and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:
Dirty and has cob webs, needs cleaning.

ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning labels.
NEMA 1 MCC installed in NEMA 4X Stainless Steel Enclosure.
Outer enclosure doors not secured properly to maintain NEMA 4X rating.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

FACILITY NAME AND NUMBER: Chlorination Building (12) EQUIPMENT TAG NUMBER: MCC-12W1	CAPACITY		YEAR OF MFR
	AVG	PEAK	
	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Westinghouse / Type W

Equipment Ratings: 600A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☑ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

Minor corrosion of enclosure.

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Energy Recovery Building (14) EQUIPMENT TAG NUMBER: No label (5kV Switchgear)	NA	NA	1977

CONDITION OF ITEMS INSPECTED:

Equipment Type: Medium Voltage Switchgear

Manufacturer / Model: Waukasha-BBC

Equipment Ratings: No nameplate

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Energy recovery Building (14) EQUIPMENT TAG NUMBER: MCC-14W1, MCC-14W2, and MCC-14W3	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Westinghouse / Type W

Equipment Ratings: 600A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Training Center (16) EQUIPMENT TAG NUMBER: LPA	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Panelboard

Manufacturer / Model: Westinghouse / WEHB

Equipment Ratings: 600A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
(4)	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections,
and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:
Inadequate working space for panel.
Egress door swings in the wrong direction. No panic hardware.

ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning label.
Inadequate working space for panel.
Egress door swings in the wrong direction. No panic hardware.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Service Water Building (17) EQUIPMENT TAG NUMBER: MCC-17W1 and MCC-17W2	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Westinghouse / Type W

Equipment Ratings: 600A, 480Y/277V, 3 Phase, 4 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
(4)	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☑ Corrosion of equipment
- ☐ Unusual noise during operation
- ☑ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.
PARTS NEEDING MAINTENANCE / REPAIR:
Unused openings not properly closed.
Significant corrosion and missing cover attachment bolts.
ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Dechlorination Building (28) EQUIPMENT TAG NUMBER: MCC-A and MCC-B	NA	NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Square D / Model 6

Equipment Ratings: 600A, 480V, 3 Phase, 3 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Headworks (30) **EQUIPMENT TAG NUMBER:** DS30-1 and DS30-2	NA	NA	2000

CONDITION OF ITEMS INSPECTED:

Equipment Type: Distribution Switchboard

Manufacturer / Model: Cutler-Hammer / POW-R-LINE

Equipment Ratings: 2500A, 480V, 3 Phase, 3 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
(3)	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☑ Corrosion of equipment
- ☐ Unusual noise during operation
- ☑ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

DS-30-1 and DS-30-2 provide redundant feeders to MCC-30A and MCC-30B. Both MCC's are currently fed from the same switchboard.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

Minor rusting of outer enclosure, dirty air filters, cob webs, cooling vent blockage.

ADDITIONAL COMMENTS / OBSERVATIONS:

Containment area trip hazards.

Last testing agency sticker date: 11/01/00.

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Headworks (30) EQUIPMENT TAG NUMBER: MCC-30A and MCC-30B	NA	NA	2000

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Cutler-Hammer / Freedom Series 2100

Equipment Ratings: 1200A, 480V, 3 Phase, 3 Wire, NEMA 1G

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

Both MCC's are currently fed from the same switchboard, DS30-2. With a single failure, the entire Headworks facility would be out of power.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

FACILITY NAME AND NUMBER: East Blower Building (34) EQUIPMENT TAG NUMBER: No label (5kV Switchgear)	CAPACITY		YEAR OF MFR
	AVG	PEAK	
	NA	NA	No Nameplate

CONDITION OF ITEMS INSPECTED:

Equipment Type: Medium Voltage Switchgear

Manufacturer / Model: No Nameplate

Equipment Ratings: No nameplate

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

Blown fuse in one of the four switches.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East Blower Building (34) EQUIPMENT TAG NUMBER: MCC-33A and MCC-33B	NA	NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Square D / Model 6

Equipment Ratings: 600A, 480V, 3 Phase, 3 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

Dual interlocked main circuit breakers with redundant feeders from US34-1 and US34-2

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East Blower Building (34) EQUIPMENT TAG NUMBER: MCC-34	NA	NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Square D / Model 6

Equipment Ratings: 600A, 480V, 3 Phase, 3 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

Dual interlocked main circuit breakers with redundant feeders from US34-1 and US34-2

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:
Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East Blower Building (34) **EQUIPMENT TAG NUMBER:** MCC-34C and MCC34D	NA	NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Medium Voltage Motor Control Center

Manufacturer / Model: Square D / Iso-Flex Model 4

Equipment Ratings: 600A, 5KV, 3 Phase, 3 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09		
	CAPACITY		YEAR OF MFR
FACILITY NAME AND NUMBER: East Blower Building (34) EQUIPMENT TAG NUMBER: MCC-35A and MCC-35B	AVG NA	PEAK NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Square D / Model 6

Equipment Ratings: 600A, 480V, 3 Phase, 3 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE

Dual interlocked main circuit breakers with redundant feeders from US34-1 and US34-2

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East Blower Building (34) EQUIPMENT TAG NUMBER: TX-34	NA	NA	

CONDITION OF ITEMS INSPECTED:

Equipment Type: Transformer

Manufacturer / Model: General Electric / Unit Substation Type

Equipment Ratings: 5.0MVA, 13.2KV-4160V, 3 Phase

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

Working clearance may not be as required.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East Blower Building (34) EQUIPMENT TAG NUMBER: US34-1 and US34-2	NA	NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Unit Substation with Primary Switch, Transformer, and Distribution Switchboard

Manufacturer / Model: Square D

Equipment Ratings: Primary Switch-600A, 4.76KV; Xfmer-1500KVA; Switchboard-2000A, 480V, 3 Phase, 3 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☑ Lack of preventative maintenance	☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE

US34-1 and US-34-2 provide redundant feeders to MCC-33A, 33B, 34, 35A and 35B.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

Missing and loose outer enclosure cover bolts, dirty air filters, and minor oil seepage from transformer.

ADDITIONAL COMMENTS / OBSERVATIONS:

Containment area trip hazards.

Last testing agency sticker date: 9/22/04.

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East RAS/WAS Pump Station (37) EQUIPMENT TAG NUMBER: MCC-37A and MCC-37B	NA	NA	2002

CONDITION OF ITEMS INSPECTED:

Equipment Type: Motor Control Center

Manufacturer / Model: Square D / Model 6

Equipment Ratings: 1200A, 480V, 3 Phase, 3 Wire, NEMA 1

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

No Arc-Flash Warning labels.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.	Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: East RAS/WAS Pump Station (37) EQUIPMENT TAG NUMBER: TX-37	NA	NA	~1978

CONDITION OF ITEMS INSPECTED:

Equipment Type: Transformer

Manufacturer / Model: Westinghouse / Unit Substation Type

Equipment Ratings: 1000KVA, 13.2KV-480Y/277V, 3 Phase

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Unit Substation No. 2 **EQUIPMENT TAG NUMBER:** US-2	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Unit Substation with Transformer and Distribution Switchgear, walk-in style

Manufacturer / Model: Westinghouse

Equipment Ratings: Transformer-2000KVA; Switchgear- 3200A, 480V, 3 Phase, 4 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☑ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

No, the backup, US-1, is out of service.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

Unused openings need to be closed.

Interior lighting does not work.

ADDITIONAL COMMENTS / OBSERVATIONS:

Working clearances for transformer primary feed does not meet code requirements.

No Arc-Flash Warning labels.

Single point for egress.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: Kyle L. Lyman, P.E.

Date of Assessment: 10-27-09 THROUGH 10-28-09

	CAPACITY		YEAR OF MFR
	AVG	PEAK	
FACILITY NAME AND NUMBER: Unit Substation No. 4 EQUIPMENT TAG NUMBER: US-4	NA	NA	1976

CONDITION OF ITEMS INSPECTED:

Equipment Type: Unit Substation with Transformer and Distribution Switchgear, walk-in style

Manufacturer / Model: Westinghouse

Equipment Ratings: Transformer-750KVA; Switchgear- 1000A, 480V, 3 Phase, 4 Wire, NEMA 3R

Rate each item by circling the number on a scale of 1 to 6 below:

Rank	Description of Condition
(1)	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

- ☐ Corrosion of equipment
- ☐ Unusual noise during operation
- ☐ Lack of preventative maintenance
- ☐ Evidence of wear
- ☐ Inability of equipment to perform designed duty
- ☑ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

No, the backup, US-1, is out of service.

CH2MHILL

INA ROAD WASTEWATER RECLAMATION FACILITY
ENERGY MASTER PLAN
PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

MAINTENANCE REQUIREMENTS:

Refer to manufacturer's documentation for recommended schedule and procedures for testing, inspections, and maintenance.

PARTS NEEDING MAINTENANCE / REPAIR:

ADDITIONAL COMMENTS / OBSERVATIONS:

Working clearances for transformer primary feed does not meet code requirements.

No Arc-Flash Warning labels.

Single point for egress.

Appendix B
Arc Flash Study and Existing Electrical Distribution System

Ina Road Wastewater Reclamation Facility – Capacity and Effluent Quality Upgrade

Arc Flash Study and Existing Electrical Distribution System

PREPARED FOR: Pima County Regional Wastewater Reclamation Department

PREPARED BY: Morgan MacRostie/CH2M HILL

REVIEWED BY: Jim Landman/CH2M HILL

DATE: January 28, 2010

Introduction

This technical memorandum (TM) describes the methodology and findings of the Arc Flash Study performed on the existing electrical distribution system of the Ina Road Wastewater Reclamation Facility (WRF). The study was performed based on existing electrical system data, and included the evaluation and potential adjustment of the existing over-current protection devices to limit incident energy at the various loadcenters. The results and adjustments are included in Attachment 1 to this TM. This evaluation was performed to give Pima County Regional Wastewater Reclamation Department an indication of the current hazard levels that are present in the electrical distribution system, any adjustments that can be made to reduce the levels, and equipment evaluations.

The following represent the codes and standards related to performing arc flash studies, and the requirements of personal protective equipment and methods to be used when working on energized electrical systems.

Codes and Standards

NFPA 70E, 2009 Edition – Standard for Electrical Safety in the Workplace

IEEE 1584, 2002 Edition – Guide for Performing Arc Flash Hazard Calculations

Arc Flash Definitions

The following terms are readily used in the codes and standards listed above, as well as any study results or signage related to arc flash protective equipment, technology, or safety boundaries.

PPE	Personal Protective Equipment. Requirements, and standards for equipment listed in section 130.7 of NFPA 70E.
Incident Energy	The amount of energy impressed on a surface, a certain distance from the source, generated during an arc flash event. Usually measured in

	cal/cm$^{2.}$
Live Parts	Energized electrical equipment components.
Flash Protection Boundary	Safe approach distance from energized equipment or parts. NFPA 70E sets the default flash protection boundary at 4 feet for low voltage (< 600V) systems where the total fault exposure is less than 5000 amperes-seconds (fault current in amperes multiplied by the upstream device clearing time in seconds. NFPA 70E also allows the boundary to be calculated. In some instances, calculations may decrease the boundary distance. Persons crossing into the flash protection boundary are required to wear the appropriate PPE as determined by calculating methods contained in NFPA 70E and IEEE 1584.

Hazard Categories and PPE Levels

Hazard categories, as summarized in Table 1, are based on the computed incident energy levels when working on energized equipment inside the Flash Protection Boundary. The categories are assigned for different ranges of incident energy levels and correspond to a certain amount of PPE per NFPA 70E – 2009.

TABLE 1
Hazard Categories

Hazard Category	Clothing Description	Required Minimum Arc Rating of PPE (cal/cm^2)
0	Long sleeve shirt and pants, non-melting per ASTM F 1506-00 or Untreated Natural Fiber. Fire rated protective equipment: Fire-rated safety glasses or goggles, hearing protection, leather gloves.	N/A
1	Fire rated clothing, minimum Arc Rating of 4. Arc-rated long sleeve shirt, pants, coveralls, face shield or arc flash suit hood, jacket, parka, or rainwear. Fire rated protective equipment: Hard hat, fire-rated safety glasses or goggles, hearing protection, leather gloves, and leather work shoes.	4
2	Fire rated clothing, minimum Arc Rating of 8. Arc-rated long sleeve shirt, pants, coveralls, face shield or arc flash suit hood, jacket, parka, or rainwear. Fire rated protective equipment: Hard hat, fire-rated safety glasses or goggles, hearing protection, leather gloves, and leather work shoes.	8
3	Fire rated clothing, minimum Arc Rating of 25. Arc-rated long sleeve shirt, pants, coveralls, jacket, parka, or rainwear, arc flash suit hood/jacket/pants. Fire rated protective equipment: Hard hat with fire rated liner, fire-rated safety glasses or goggles, hearing protection, leather gloves, and leather work shoes.	25
4	Fire rated clothing, minimum Arc Rating of 40. Arc-rated long sleeve shirt, pants, coveralls, jacket, parka, or rainwear, arc flash suit hood/jacket/pants. Fire rated protective equipment: Hard hat with fire rated liner, fire-rated safety glasses or goggles, hearing protection, leather gloves, and leather work shoes.	40
>4	Dangerous - Unapproachable	N/A

Note – See NFPA 70E – 2009, Table 130.7(C)(10) for more information.

Data Used for Analysis

The Arc Flash Study was performed using SKM PowerTools for Windows software, which is the CH2M HILL standard program for electrical distribution system modeling. This software was used to determine demand loading, available short circuit values, and voltage drop. In order to complete the Arc Flash Study, the circuit breaker settings have been entered as found at the site during field investigations. Not all data required was able to be retrieved from these field investigations, so in some cases, data was taken from existing as-built drawings. Attachment 2 includes the details of what was found on site versus what was obtained by the existing drawings. Utility data regarding the available fault current obtained from Tucson Electric Power has also been taken into account to determine fault current values at each loadcenter connected to the utility. Generator data was obtained from Waukesha, the generator manufacturer, for fault currents at substations 2 and 4 and the associated loadcenters. The hazard categories for the electrical equipment were then calculated. Note that any change to the fault current contribution values provided by the utility will impact the actual results of the study performed, including potential changes to the hazard categories listed in this TM.

Arc Flash Mitigation Technologies

One of the simplest methods of reducing incident energy at an electrical system bus is to configure the protective device settings such that the clearing times are reduced to their most minimal point without compromising the coordination of the system. The shorter the time the fault can be present before clearing, the lower incident energy. Therefore, this can be a simple, cost-effective method of reducing hazard categories for equipment. An example of this found during the study was at MCC-37A. By reducing the instantaneous setting of the Main breaker, the hazard category was able to be reduced from 3 to 1, while maintaining proper coordination with upstream and downstream breakers.

There will be situations in electrical distribution systems that the above method will not reduce the hazard category to an acceptable level. In these cases, there are additional technologies available to mitigate arc flash.

Several electrical distribution equipment manufacturers have developed arc flash mitigation technology that either reduces the incident energy available at the equipment, or provides methods and/or barriers to separate the live parts from the worker while performing maintenance. Per NFPA 70E – 2009, Table 130.7(C)(9), there are maintenance and operation functions with Arc-Resistant gear that can be done at a hazard category of 0, where the same work without Arc-Resistant gear would be at done at a category 3 or higher. This example demonstrates the usefulness of the different Arc-Flash mitigation technologies, and the benefit to maintenance staff and electricians. Currently, there is no third-party certification of Arc-Resistant electrical equipment. The technology varies greatly between manufacturers; therefore, no one manufacturer can provide each technology described below. The following subsections describe the various technologies developed for use in the different types of distribution equipment seen at treatment plants.

Medium Voltage Switchgear

Medium Voltage Switchgear rated Arc-Resistant conform to standards: ANSI C37.04 (Circuit Breaker Rating Structure), ANSI C37.06 (Circuit Breaker Ratings), ANSI C37.20.2

(Switchgear Assemblies), and tested in accordance with IEEE C37.20.7 (Guide for Testing Metal Enclosed Switchgear for Internal Arcing Faults).

Cutler-Hammer has a system called AMPGUARD for medium voltage gear that provides the ability to rack sections in and out of the gear via a remote control, so that the worker can stand up to 30 feet away.

ABB has developed a fiber optic system that detects an arc and transmits that to an arc-detection relay, which opens circuit breakers. The fiber optic system is extremely fast, and can greatly reduce the clearing time, and therefore, the incident energy at the gear. These units can be used in various types of electrical distribution equipment, including low-voltage switchgear and MCCs.

Schneider Electric has separated their control interfaces from the live parts in their medium voltage switchgear, as well as adding interlocks that prevent racking of breakers while closed.

GE offers PowlVAC Low-Voltage Switchgear that is Arc-Resistant. The gear has numerous mechanical interlocks that prevent exposure to live parts when racking in/out breakers, or other maintenance work.

Medium Voltage Motor Control Centers

Medium Voltage Motor Control Centers rated Arc-Resistant conform to standards: ANSI C37.04 (Circuit Breaker Rating Structure), ANSI C37.06 (Circuit Breaker Ratings), ANSI C37.20.2 (Switchgear Assemblies), and tested in accordance with IEEE C37.20.7 (Guide for Testing Metal Enclosed Switchgear for Internal Arcing Faults).

ABB offers SafeGear MV MCCs, which have vents built in to the structure that direct the pressure from an arc flash event up and away from the person, usually venting the blast exterior to the building. This type of structure and venting is available in a number of different types and voltage classes of gear.

Low Voltage Switchgear

Low Voltage Switchgear rated Arc-Resistant conforms to standards: ANSI C37.20.1, ANSI C37.13, ANSI C37.51 and ANSI C37.20.7.

Cutler-Hammer has developed an ARC Reduction Maintenance System (ARMS), that when activated during maintenance, sets all breakers' instantaneous settings to a low setting, thereby reducing the incident energy at the bus.

GE has a similar technology on their Entellisys™ Switchgear called Reduced Energy Let-Thru, allowing the trip settings to be temporarily set for extremely fast tripping to reduce incident energy. Attachment 3 includes a white paper published by GE regarding Entellisys™.

Low-Voltage Motor Control Centers

Cutler-Hammer has FlashGard MCCs that are arc-resistant gear. FlashGard MCCs offer an insulated horizontal bus, an insulated labyrinth vertical bus, shutters to isolate the vertical bus when a unit is removed, and finger-safe components inside the units. To reduce the time-available fault current FlashGard also has the ARC Reduction Maintenance System (ARMS) as described above, applied to the breaker feeding the MCC to reduce trip time during an arc flash.

Allen Bradley offers an Arc Shield option on their MCCs, with arc-resistant latches on all doors provide pressure relief and helps keep the door latched to the MCC during an arcing fault, arc resistant baffles for a wider range of MCC equipment for NEMA Type 1 enclosures, and maximum 1200 ampere bus with specific current-limiting protection that helps to minimize arc fault incident energy. Copper vertical ground bus on plug-in structures and heavy duty ground stab on plug-in units provides an effective path for ground fault currents which helps to minimize fault clearing times of over current protective devices. Manual or automatic shutters help to protect against potential electrical shock hazards from unused plug-in stab openings Insulating covers on horizontal bus closing plates help prevent "burn through" which may result from arcing faults in the horizontal bus compartment.

Arc Flash Analysis

Equipment Evaluated

The medium voltage switchgear, low voltage switchgear, and motor control centers were evaluated as part of the arc flash analysis. 208Y/120V panelboards are not included, as their available fault currents are too low to have a Hazard category above 0. Per NFPA 70E, section 130.3, Exception (1), panelboards 240V or below, fed from one transformer that is 125 kVA or less, is exempt from Arc Flash analysis.

Ina Road WRF Arc Flash Study Tables

Refer to one-line diagrams in Attachment 4 for a diagrammatic view of how the electrical systems are connected. The following tables represent the data used and the analysis results.

Table 1 Information regarding all protective device settings as found in the site investigation. In some cases, the data could not be obtained, and the default values from the SKM software were used. These devices are noted as such in Attachment 2.

Table 2 Attachment 1, summary of the hazard categories for Substations 2 and 4, as well as all Motor Control Centers fed from these substations. Studies were performed for when 4 generators were running, and when 5 generators were running.

Table 3 Attachment 1, summary of the hazard categories for Headworks Distribution System, as well as all Switchgear and Motor Control Centers fed from this system. Studies were performed for when the utility was connected to WI-13, and WI-42.

Table 4 Attachment 1, summary of the hazard categories for Substations 34-1 and 34-2, as well as all Switchgear and Motor Control Centers fed from this system. Studies were performed for when the utility was connected to WI-13, and WI-42.

Table 5 Attachment 1, summary of the hazard categories for RAS/WAS Distribution System, as well as all Switchgear and Motor Control Centers fed from this system. Studies were performed for when the utility was connected to WI-13, and WI-42. Included in this table is the revised hazard category after modifications to the protective device settings were implemented.

Table 6 Attachment 1, summary of the hazard categories for Facility 66 Distribution System.

Arc Flash Study Results

Currently, the majority of loadcenters in the electrical distribution system are at a hazard category of 2 or less. Per the PPE requirement in Table 1, these do not require extensive PPE to work on the equipment.

The loadcenters currently having a hazard category of 3 or greater, as highlighted in the hazard category tables, include: Substation 2A, 2B, US30-1, US30-2, US34-1, US34-2, and MCC-37A. In some cases, the hazard category was above 4, which means that they are not to be worked on while energized, per the PPE in Table 1. For the loadcenters at category 3 or greater, the protective device setting modifications that could be made to reduce the level of incident energy was analyzed and the results described below.

Substation 2A

This substation is fed via a tie breaker from Substation 2B. After adjusting the settings available on this breaker and the main breaker for Substation 2B, it was not possible to reduce the hazard category below the dangerous level. Therefore, Substation 2A will remain unapproachable when energized. Note that in other sections, this Energy Master Plan recommends a full replacement of this Substation, and therefore, provides an opportunity to install new equipment with arc-flash mitigating technologies as described above.

Substation 2B

Adjusting the settings available on the main breaker for Switchgear 2B did not reduce the hazard category below the dangerous level. Therefore, Substation 2B will remain unapproachable when energized. Note that in other sections, this Energy Master Plan recommends a full replacement of this Substation, and therefore, provides an opportunity to install new equipment with arc-flash mitigating technologies as described above.

US30-1

It is unclear, based on the field data CH2M HILL was able to obtain, what the actual ratings of the main fuses for US30-1 actually were. The manufacturer and model number of the fuses were recorded, but the actual ratings were not able to be obtained. Therefore, the initial study was performed with fuse ratings of the maximum for that model number, which resulted in a hazard category of above 4. In reviewing how the downstream breakers coordinated with the fuses at their maximum rating, it appears that this was in fact the ratings installed, as the ratings cannot be reduced and still coordinate downstream. Therefore, US30-1 will remain unapproachable when energized.

US30-2

It is unclear, based on the field data CH2M HILL was able to obtain, what the actual ratings of the main fuses for US30-1 actually were. The manufacturer and model number of the fuses were recorded, but the actual ratings were not able to be obtained. Therefore, the initial study was performed with fuse ratings of the maximum for that model number, which resulted in a hazard category of above 4. In reviewing how the downstream breakers coordinated with the fuses at their maximum rating, it appears that this was in fact the

ratings installed, as the ratings cannot be reduced and still coordinate downstream. Therefore, US30-2 will remain unapproachable when energized.

US34 -1

The ratings for the primary transformer and the US34-1 main fuse are such that the hazard category is above 4. Reducing the fuse rating to their lowest limit, while still maintaining coordination with the downstream protective devices, does not reduce the hazard category. Therefore, US34-1 will remain unapproachable when energized.

US34 -2

The ratings for the primary transformer and the US34-2 main fuse are such that the hazard category is above 4. Reducing the fuse rating to their lowest limit, while still maintaining coordination with the downstream protective devices, does not reduce the hazard category. Therefore, US34-2 will remain unapproachable when energized.

MCC-37A

By reducing the instantaneous setting of the main breaker for MCC-37A, the hazard category was reduced from 3 to 1. This setting still allowed proper coordination between this breaker and others in the system.

ratings installed, as the ratings cannot be reduced and still coordinate downstream. Therefore, US30-2 will remain unapproachable when energized.

US34 -1

The ratings for the primary transformer and the US34-1 main fuse are such that the hazard category is above 4. Reducing the fuse rating to their lowest limit, while still maintaining coordination with the downstream protective devices, does not reduce the hazard category. Therefore, US34-1 will remain unapproachable when energized.

US34 -2

The ratings for the primary transformer and the US34-2 main fuse are such that the hazard category is above 4. Reducing the fuse rating to their lowest limit, while still maintaining coordination with the downstream protective devices, does not reduce the hazard category. Therefore, US34-2 will remain unapproachable when energized.

MCC-37A

By reducing the instantaneous setting of the main breaker for MCC-37A, the hazard category was reduced from 3 to 1. This setting still allowed proper coordination between this breaker and others in the system.

Attachment 1
Arc Flash Calculation Results

TABLE 2 - SUBSTATIONS 2 & 4, ASSOCIATED EQUIPMENT

		4 GENERATORS					5 GENERATORS			
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT (kA)	CLEARING TIME (sec)	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT (kA)	CLEARING TIME (sec)	CAL/CM2	HAZARD CATEGORY
5KV GENERATOR SWGR	GEN 3 BKR	9.21	0.134	2.9	1	GEN 4 BKR	11	0.134	3.5	1
SUBSTATION NO. 2A	SUB 2B MAIN	34.79	2	48	DANGEROUS	SUB 2B TIE	36.21	2	48	DANGEROUS
SUBSTATION NO. 2B	SUB 2B MAIN	35.06	2	48	DANGEROUS	SUB 2B MAIN	36.51	2	48	DANGEROUS
SUBSTATION NO. 4	SUB 4 MAIN	11.74	0.113	3.3	1	SUB 4 MAIN	12	0.113	3.4	1
MCC-08W1	MCC-08W3 FDR	9.35	0.05	1.2	0	MCC-08W3 FDR	9.39	0.05	1.2	0
MCC-08W2	MCC-08W4 FDR	15.39	0.05	2	1	MCC-08W4 FDR	15.58	0.05	2	1
MCC-08W3	MCC-08W3 FDR	13.95	0.05	1.8	1	MCC-08W3 FDR	14.06	0.05	1.8	1
MCC-08W4	MCC-08W4 FDR	27.61	0.05	2.6	1	MCC-08W4 FDR	28.46	0.05	2.7	1
MCC-09W1	MCC-09W1 FDR	27.13	0.05	2.5	1	MCC-09W1 FDR	27.96	0.05	2.6	1
MCC-09W2	MCC-09W2 FDR	27.31	0.05	2.5	1	MCC-09W2 FDR	28.15	0.05	2.7	1
MCC-11W1	MCC-11W1 FDR	18.47	0.017	0.68	0	MCC-11W1 FDR	18.82	0.017	0.68	0
MCC-11W2	MCC-11W2 FDR	18.26	0.017	0.68	0	MCC-11W2 FDR	18.61	0.017	0.68	0
MCC-11W3	MCC-11W3 FDR	28.16	0.05	2.7	1	MCC-11W3 FDR	29.01	.05 sec	2.8	1
MCC-11W4	MCC-11W4 FDR	28.19	0.05	2.7	1	MCC-11W4 FDR	29.03	.05 sec	2.8	1
MCC-12W1	MCC-12W1 FDR	20.45	0.018	0.71	0	MCC-12W1 FDR	20.85	0.018	0.72	0
MCC-14W1	MCC-14W1 FDR	27.1	0.05	2.5	1	MCC-14W1 FDR	27.93	0.05	2.6	1
MCC-14W2	MCC-14W2 FDR	27.28	0.05	2.5	1	MCC-14W2 FDR	28.12	0.05	2.6	1
MCC-14W3	MCC-14W3 FDR	22.04	0.05	2.1	1	MCC-14W3 FDR	22.57	0.05	2.1	1
MCC-17W1	MCC-17W1 FDR	23.34	0.05	2.2	1	MCC-17W1 FDR	23.88	0.05	2.2	1
MCC-17W2	MCC-17W2 FDR	23.14	0.05	2.2	1	MCC-17W2 FDR	23.68	0.05	2.2	1
16LPA	16LPA FDR	17.73	0.017	0.69	0	16LPA FDR	18	0.017	0.69	0
ADMIN DPA	DPA FDR	2.73	0.083	0.52	0	DPA FDR	2.73	0.196	0.52	0
ADMIN MDP-01	MDP-01 FDR	10.22	0.083	1.2	0	MDP-01 FDR	10.4	0.126	1.3	0
WAREHOUSE LPA	LPA FDR	6.3	0.083	0.84	0	LPA FDR	6.35	0.139	0.85	0
WAREHOUSE MDP-02	MDP-02 FDR	8.77	0.13	1.1	0	MDP-02 FDR	8.91	0.13	1.1	0

TABLE 3 - HEADWORKS ELECTRICAL DISTRIBUTION SYSTEM

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
US30-1	TX30-1 PRI FUSE	27kA	2 sec	61	DANGEROUS	TX30-1 PRI FUSE	28.4kA	2 sec	79	DANGEROUS
US30-2	TX30-2 PRI FUSE	27kA	2 sec	60	DANGEROUS	TX30-2 PRI FUSE	28.4kA	2 sec	79	DANGEROUS
MCC-30A	MCC-30A MAIN	22.96kA	0.1 sec	4.3	2	MCC-30A MAIN	23.83kA	0.1 sec	4.4	2
MCC-30B	MCC-30B MAIN	22.35kA	0.1 sec	4.2	2	MCC-30B MAIN	23.18kA	0.1 sec	4.3	2

TABLE 4 - SUBSTATIONS US 34-1, US 34-2, ASSOCIATED EQUIPMENT

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
5kV SWITCHGEAR	T1 PRI FUSE	9.08kA	0.097	0.092	0	T1 PRI FUSE	10.98kA	.177 sec	1.8	1
US34-1	MCC-34 FDR 1	39.14kA	2 sec	78	DANGEROUS	MCC-34 FDR 1	42.01kA	2 sec	87	DANGEROUS
US34-2	MCC-34 FDR 1	39.16kA	2 sec	92	DANGEROUS	MCC-34 FDR 1	42.01kA	2 sec	87	DANGEROUS
MCC-33A	MCC-33A MAIN 2	37.08kA	.04 sec	2.8	1	MCC-33A MAIN 2	39.66kA	.04 sec	3	1
MCC-33B	MCC-33B MAIN 2	37.14kA	.04 sec	2.8	1	MCC-33B MAIN 2	39.72kA	.04 sec	3	1
MCC-34	MCC-34 FDR 2	37.02kA	.04 sec	2.8	1	MCC-34 FDR 2	39.59kA	.04 sec	3	1
MCC-35A	MCC-35A FDR 2	36.23kA	.04 sec	2.8	1	MCC-35A FDR 2	38.70kA	.04 sec	2.9	1
MCC-35B	MCC-35B FDR 2	36.23kA	.04 sec	2.8	1	MCC-35B FDR 2	38.70kA	.04 sec	2.9	1
MCC-34C	FUSE MCC-34C	8.96kA	.062 sec	0.6	0	FUSE MCC-34C	10.81kA	.047 sec	0.56	0
MCC-34D	FUSE MCC-34D	8.96kA	.062 sec	0.6	0	FUSE MCC-34D	10.81kA	.047 sec	0.56	0
P33A	BKR P33A	27.94kA	.017 sec	0.91	0	BKR P33A	29.48kA	.017 sec	0.95	0
P35A	BKR P35A	30.06kA	.017 sec	0.97	0	BKR P35A	31.84kA	.017 sec	1	0
P35B	BKR P35B	30.06kA	.017 sec	0.97	0	BKR P35B	31.83kA	.017 sec	1	0

TABLE 5 - RAS/WAS ELECTRICAL DISTRIBUTION SYSTEM

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
MCC-37A	MCC-37A MAIN	20.3kA	.29 sec	8.5	[redacted]	MCC-37A MAIN	21.4kA	.258 sec	8.1	[redacted]
MCC-37B	MCC-37B MAIN	20.2kA	.221 sec	6.6	2	MCC-37B MAIN	21.4kA	.199 sec	6.4	2

AFTER SETTING CHANGE

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
MCC-37A	MCC-37A MAIN	20.3kA	.06 sec	2.4	1	MCC-37A MAIN	21.4kA	.06 sec	2.6	1

TABLE 6 - FACILITY 66 ELECTRICAL DISTRIBUTION SYSTEM

	ASSUMED UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
WIREWAY-66	FAC 66 FUSED DISC	3.71kA	0.068	0.66	0

Attachment 2
Protective Device Ratings and Settings – As Found

TABLE 1 - PROTECTIVE DEVICE RATINGS AND SETTINGS - AS FOUND - CIRCUIT BREAKERS

CIRCUIT BREAKER LIST AND SETTINGS

		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GFPU	GFD	MANUFACTURER / MODEL NUMBERS	COMMENTS
UNIT SUBSTATION 2	MAIN	3200	3200	1.00	8	4	0.55	---	---	---	WESTINGHOUSE DS-632	
	MCC-11W3	800	600	1.00	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-11W4	800	200	1.25	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-08W2	800	100	1.00	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-09W2	800	600	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-08W1	800	100	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	BLDG 16 LP-A	800	600	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-09W1	800	600	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	TIE BKR	3200	3200	0.75	8	4	0.33	---	---	---	WESTINGHOUSE DS-632	
	DP-1	800	300	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-14W1	800	600	1.00	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-17W2	800	300	1.00	0.8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-14W2	800	600	1.00	0.8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	DP-2	800	300	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	MCC-17W1	800	300	1.00	0.8	4	0.18	12	---	---	WESTINGHOUSE DS-206	

		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GFPU	GFD		COMMENTS
UNIT SUBSTATION 4	MAIN BREAKER	1600	800	1.25	8	4	0.33	---	---	---	WESTINGHOUSE DS-416	
	WAREHOUSE MDP	800	600	0.75	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	ADMIN BLDG MDP	800	400	1.00	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	ADMIN BLDG DPA	800	100	1.00	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	
	UPS	800	60	0.50	8	4	0.18	12	---	---	WESTINGHOUSE DS-206	

		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GF	GFD			COMMENTS
US34-1	MAIN	2000	2000	1.00	2	2	0.32	6	1200	0.5	SQ D, PEF362000LSG2100		
	MCC-33A	800	800	1.00	2	4	0.25	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	
	MCC-33B	800	800	1.00	2	4	0.20	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	
	MCC-34	600	600	1.00	2	4	0.20	12	0.53	0.2	SQ D, ME36600LSG	I2T OUT	
	MCC-35A	800	400	1.00	11	4	0.20	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	
	MCC-35B	800	400	1.00	11	4	0.20	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	

		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GF	GFD			COMMENTS
US34-2	MAIN	2000	2000	1.00	2	2	0.32	6	1200	0.5	SQ D, PEF362000LSG2100		
	MCC-33A	800	800	1.00	2	4	0.25	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	
	MCC-33B	800	800	1.00	2	4	0.20	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	
	MCC-34	600	600	1.00	2	4	0.20	12	0.53	0.2	SQ D, ME36600LSG	I2T OUT	
	MCC-35A	800	400	1.00	11	4	0.20	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	
	MCC-35B	800	400	1.00	11	4	0.20	12	0.55	0.2	SQ D, ME36800LSG	I2T OUT	

TABLE 1 - PROTECTIVE DEVICE RATINGS AND SETTINGS - AS FOUND - CIRCUIT BREAKERS

CIRCUIT BREAKER LIST AND SETTINGS

		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GFPU	GFD	MANUFACTURER / MODEL NUMBERS	COMMENTS
		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GF	GFD		COMMENTS
US30-1	MCC-30A	1200	1200	---	---	6	300.00	---	3(X200)	300	C-H, DIGITRIP 310	
	MCC-30B	1200	1200	---	---	6	300.00	---	3(X200)	300	C-H, DIGITRIP 310	
		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GF	GFD		COMMENTS
US30-2	MCC-30A	1200	1200	---	---	6	300.00	---	2(X200)	150	C-H, DIGITRIP 310	
	MCC-30B	1200	1200	---	---	6	300.00	---	2(X200)	150	C-H, DIGITRIP 310	
ADMIN MDP	MAIN	---	---	---	---	---	---	---	---	---	SQUARE D	MOLDED CASE SWITCH
ADMIN DPA	MAIN	---	400	---	---	---	---	HIGH	---	---	SQ D TLB434400	
WAREHOUSE MDP	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MAIN SWITCH
MCC-08W1	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-08W2	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-08W3	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
	MCC-08W1	---	100A	---	---	---	---	---	---	---	WESTINGHOUSE	NO BKR ADJUSTMENT
MCC-08W4	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
	MCC-08W2	---	100A	---	---	---	---	---	---	---	WESTINGHOUSE	NO BKR ADJUSTMENT
MCC-09W1	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-09W2	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
BLDG 16 LP-A	MAIN	---	---	---	---	---	---	---	---	---		MOLDED CASE SWITCH
MCC-11W1	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-11W2	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-11W3	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
	MCC-11W1	---	400A	---	---	---	---	MAX	---	---	WESTINGHOUSE	
MCC-11W4	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
	MCC-11W2	---	400A	---	---	---	---	MAX	---	---	WESTINGHOUSE	
MCC-12W1	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	BREAKER UNIDENTIFIABLE
MCC-14W1	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-14W2	MAIN	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
	MCC-14W3	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	BREAKER UNIDENTIFIABLE

TABLE 1 - PROTECTIVE DEVICE RATINGS AND SETTINGS - AS FOUND - CIRCUIT BREAKERS

CIRCUIT BREAKER LIST AND SETTINGS												
		FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GFPU	GFD	MANUFACTURER / MODEL NUMBERS	COMMENTS
MCC-14W3	**MAIN**	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
16 LP-A	**MAIN**	---	---	---	---	---	---	---	---	---		MOLDED CASE SWITCH
MCC-17W1	**MAIN**	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
	MCC-12W1	---	150	---	---	---	---	---	---	---	WESTINGHOUSE	
	17LP-A	---	100	---	---	---	---	---	---	---	WESTINGHOUSE	
MCC-17W2	**MAIN**	---	---	---	---	---	---	---	---	---	WESTINGHOUSE	MOLDED CASE SWITCH
MCC-30A	**MAIN - US30-1**	---	1000	---	---	5	100 MS	---	3	150 MS	DIGITRIP 310 - 12NES1000	
	MAIN - US30-2	---	1000	---	---	5	100 MS	---	3	150 MS	DIGITRIP 310 - 12NES1000	
MCC-30B	**MAIN - US30-1**	---	1000	---	---	5	100 MS	---	3	150 MS	DIGITRIP 310 - 12NES1000	
	MAIN - US30-2	---	1000	---	---	5	100 MS	---	3	150 MS	DIGITRIP 310 - 12NES1000	
MCC-33A	**MAIN - US34-1**	800	800	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	MAIN - US34-2	800	800	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	P33A	---	100	---	---	---	---	---	---	---	SQUARE D	480V PANELBOARD
MCC-33B	**MAIN - US34-1**	800	800	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	MAIN - US34-2	800	800	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
MCC-34	**MAIN - US34-1**	800	800	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	MAIN - US34-2	800	800	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP776	I2T OUT
MCC-35A	**MAIN - US34-1**	800	400	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	MAIN - US34-2	800	400	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	P35A	---	100	---	---	---	---	---	---	---	SQUARE D	480V PANELBOARD
MCC-35B	**MAIN - US34-1**	800	400	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	MAIN - US34-2	800	400	1.00	4.5	4	0.10	8	0.35	0.1	SQ D MEL36800LSG2200, PLUG ARP775	I2T OUT
	P35B	---	100	---	---	---	---	---	---	---	SQUARE D	480V PANELBOARD
MCC-37A	**MAIN**	1200	1200	1.00	7	2	0.10	8	1.55	0.2	SQ D, PEF361200LSG2253, PLUG ARP100	I2T OUT
MCC-37B	**MAIN**	1200	1200	0.95	7	2	0.10	8	1.55	0.2	SQ D, PEF361200LSG2253, PLUG ARP100	I2T OUT
5KV SWITCHGEAR AT ERF	**GEN 1**	51V		3.00		51G	3.00	1			GE IJVC (51V), ITE 51E (51G)	
	GEN 2	51V		3.00		51G	3.00	1			GE IJVC (51V), ITE 51E (51G)	

TABLE 1 - PROTECTIVE DEVICE RATINGS AND SETTINGS - AS FOUND - CIRCUIT BREAKERS

CIRCUIT BREAKER LIST AND SETTINGS											
	FRAME	TRIP	LTPU	LTD	STPU	STD	INST	GFPU	GFD	MANUFACTURER / MODEL NUMBERS	COMMENTS
GEN 3	51V		3.00		51G	3.00	1			GE IJVC (51V), ITE 51E (51G)	
GEN 4	51V		3.00		51G	3.00	2			GE IJVC (51V), ITE 51E (51G)	
GEN 5	51V		3.00		51G	3.00	1			GE IJVC (51V), ITE 51E (51G)	
GEN 6	51V		3.00		51G	3.00	1			GE IJVC (51V), ITE 51E (51G)	
GEN 7	51V		3.00		51G	3.00	1			GE IJVC (51V), ITE 51E (51G)	
UINT SUB 1	---	---	---	---	---	---	---	---	---	N/A	
UNIT SUB 2	51	5	3.00		51G	0.06	2			ITE 51L (51), ITE 51S (51G)	
UNIT SUB 3	---	---	---	---	---	---	---	---	---	N/A	
UNIT SUB 4	51	4	2.00		51G	0.06	2			ITE 51L (51), ITE 51S (51G)	
OXYGEN COMPRESSOR 1	---	---	---	---	---	---	---	---	---	N/A	N/A, DUE TO LOW FAULT CONTRIBUTION WHEN FAULT AT SWGR
OXYGEN COMPRESSOR 2	---	---	---	---	---	---	---	---	---	N/A	N/A, DUE TO LOW FAULT CONTRIBUTION WHEN FAULT AT SWGR
OXYGEN COMPRESSOR 3	---	---	---	---	---	---	---	---	---	N/A	N/A, DUE TO LOW FAULT CONTRIBUTION WHEN FAULT AT SWGR

TABLE 1 - PROTECTIVE DEVICE RATINGS AND SETTINGS - AS FOUND - TRANSFORMERS

TRANSFORMER DATA						
	SIZE	**IMPEDANCE**	**X/R**	**VOLTAGE**	**MANUFACTURER**	**COMMENTS**
US2-TXR-01	2000 KVA	6.07%	7.2907	4160V - 480Y/277V	WESTINGHOUSE	X/R FROM PTW
US4-TXR-01	750 KVA	6.93%	5.2402	4160V - 480Y/277V	WESTINGHOUSE	X/R FROM PTW
TX-30-1	2000 KVA	5.86%	7.2907	4160 - 480V	CUTLER HAMMER	X/R FROM PTW
TX-30-2	2000 KVA	5.99%	7.2907	4160 - 480V	SQUARE D	X/R FROM PTW
TX-US34-1	1500 KVA	6.00%	6.5401	4160 - 480V	SQUARE D	X/R FROM PTW
TX-US34-2	1500 KVA	5.90%	6.5401	4160 - 480V	GENERAL ELECTRIC	X/R FROM PTW
T1	5000 KVA	5.68%	12.5785	13.8KV - 4160V	GENERAL ELECTRIC	X/R FROM PTW
T3	1000 KVA	5.87%	5.7113	13.8KV - 480V	WESTINGHOUSE	X/R FROM PTW
T2	1500 KVA	6.00%	6.5401	13.8KV - 4160V	WESTINGHOUSE	TEP XFMR - IMPEDANCE TAKEN FROM DRAWINGS, X/R FROM PTW

TABLE 1 - PROTECTIVE DEVICE RATINGS AND SETTINGS - AS FOUND - FUSES

FUSE INFORMATION					
EQUIPMENT	**FUSE**	**RATING**	**MANUFACTURER**	**MODEL #**	**COMMENTS**
MCC-34C	MAIN	400	CUTLER HAMMER	CLE-22/400X, CAT # 678C299G03	
	BLOWER 1	100	CUTLER HAMMER	---	
	BLOWER 2	100	CUTLER HAMMER	---	
MCC-34D	MAIN	400	CUTLER HAMMER	CLE-22/400X, CAT # 678299G03	
	BLOWER 3	100	CUTLER HAMMER	---	
	BLOWER 4	100	CUTLER HAMMER	---	
5KV SWITCHGEAR	MCC-34C	300E	S&C	---	USE DEFAULT 300E FUSE - FROM DRAWINGS
	MCC-34D	300E	S&C	---	USE DEFAULT 300E FUSE - FROM DRAWINGS
	US34-1	300E	S&C	---	USE DEFAULT 300E FUSE - FROM DRAWINGS
	US34-2	300E	S&C	---	USE DEFAULT 300E FUSE - FROM DRAWINGS
US30-1	MAIN FUSE	400	CUTLER-HAMMER	RBA 400	8.25 MAX KV, 400A MAX A, 598IC52G01
US30-2	MAIN FUSE	400	CUTLER-HAMMER	RBA 400	8.25 MAX KV, 400A MAX A, 598IC52G01
T3	PRI FUSE	65	---	---	FROM DRAWINGS - UNABLE TO READ IN FIELD
T1	PRI FUSE	140	---	---	FROM DRAWINGS - UNABLE TO READ IN FIELD
T2	PRI FUSE	100	---	---	FROM DRAWINGS - UNABLE TO READ IN FIELD
FACILITY 66 SVC ENTRANCE	FUSED SWITCH	200	FERRAZ SHAWMUT	A6D200R	

TABLE 2 - SUBSTATIONS 2 & 4, ASSOCIATED EQUIPMENT

		4 GENERATORS					5 GENERATORS			
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT (kA)	CLEARING TIME (sec)	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT (kA)	CLEARING TIME (sec)	CAL/CM2	HAZARD CATEGORY
5KV GENERATOR SWGR	GEN 3 BKR	9.21	0.134	2.9	1	GEN 4 BKR	11	0.134	3.5	1
SUBSTATION NO. 2A	SUB 2B MAIN	34.79	2	48	DANGEROUS	SUB 2B TIE	36.21	2	48	DANGEROUS
SUBSTATION NO. 2B	SUB 2B MAIN	35.06	2	48	DANGEROUS	SUB 2B MAIN	36.51	2	48	DANGEROUS
SUBSTATION NO. 4	SUB 4 MAIN	11.74	0.113	3.3	1	SUB 4 MAIN	12	0.113	3.4	1
MCC-08W1	MCC-08W3 FDR	9.35	0.05	1.2	0	MCC-08W3 FDR	9.39	0.05	1.2	0
MCC-08W2	MCC-08W4 FDR	15.39	0.05	2	1	MCC-08W4 FDR	15.58	0.05	2	1
MCC-08W3	MCC-08W3 FDR	13.95	0.05	1.8	1	MCC-08W3 FDR	14.06	0.05	1.8	1
MCC-08W4	MCC-08W4 FDR	27.61	0.05	2.6	1	MCC-08W4 FDR	28.46	0.05	2.7	1
MCC-09W1	MCC-09W1 FDR	27.13	0.05	2.5	1	MCC-09W1 FDR	27.96	0.05	2.6	1
MCC-09W2	MCC-09W2 FDR	27.31	0.05	2.5	1	MCC-09W2 FDR	28.15	0.05	2.7	1
MCC-11W1	MCC-11W1 FDR	18.47	0.017	0.68	0	MCC-11W1 FDR	18.82	0.017	0.68	0
MCC-11W2	MCC-11W2 FDR	18.26	0.017	0.68	0	MCC-11W2 FDR	18.61	0.017	0.68	0
MCC-11W3	MCC-11W3 FDR	28.16	0.05	2.7	1	MCC-11W3 FDR	29.01	.05 sec	2.8	1
MCC-11W4	MCC-11W4 FDR	28.19	0.05	2.7	1	MCC-11W4 FDR	29.03	.05 sec	2.8	1
MCC-12W1	MCC-12W1 FDR	20.45	0.018	0.71	0	MCC-12W1 FDR	20.85	0.018	0.72	0
MCC-14W1	MCC-14W1 FDR	27.1	0.05	2.5	1	MCC-14W1 FDR	27.93	0.05	2.6	1
MCC-14W2	MCC-14W2 FDR	27.28	0.05	2.5	1	MCC-14W2 FDR	28.12	0.05	2.6	1
MCC-14W3	MCC-14W3 FDR	22.04	0.05	2.1	1	MCC-14W3 FDR	22.57	0.05	2.1	1
MCC-17W1	MCC-17W1 FDR	23.34	0.05	2.2	1	MCC-17W1 FDR	23.88	0.05	2.2	1
MCC-17W2	MCC-17W2 FDR	23.14	0.05	2.2	1	MCC-17W2 FDR	23.68	0.05	2.2	1
16LPA	16LPA FDR	17.73	0.017	0.69	0	16LPA FDR	18	0.017	0.69	0
ADMIN DPA	DPA FDR	2.73	0.083	0.52	0	DPA FDR	2.73	0.196	0.52	0
ADMIN MDP-01	MDP-01 FDR	10.22	0.083	1.2	0	MDP-01 FDR	10.4	0.126	1.3	0
WAREHOUSE LPA	LPA FDR	6.3	0.083	0.84	0	LPA FDR	6.35	0.139	0.85	0
WAREHOUSE MDP-02	MDP-02 FDR	8.77	0.13	1.1	0	MDP-02 FDR	8.91	0.13	1.1	0

TABLE 3 - HEADWORKS ELECTRICAL DISTRIBUTION SYSTEM

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
US30-1	TX30-1 PRI FUSE	27kA	2 sec	61	DANGEROUS	TX30-1 PRI FUSE	28.4kA	2 sec	79	DANGEROUS
US30-2	TX30-2 PRI FUSE	27kA	2 sec	60	DANGEROUS	TX30-2 PRI FUSE	28.4kA	2 sec	79	DANGEROUS
MCC-30A	MCC-30A MAIN	22.96kA	0.1 sec	4.3	2	MCC-30A MAIN	23.83kA	0.1 sec	4.4	2
MCC-30B	MCC-30B MAIN	22.35kA	0.1 sec	4.2	2	MCC-30B MAIN	23.18kA	0.1 sec	4.3	2

TABLE 4 - SUBSTATIONS US 34-1, US 34-2, ASSOCIATED EQUIPMENT

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
5kV SWITCHGEAR	T1 PRI FUSE	9.08kA	0.097	0.092	0	T1 PRI FUSE	10.98kA	.177 sec	1.8	1
US34-1	MCC-34 FDR 1	39.14kA	2 sec	78	DANGEROUS	MCC-34 FDR 1	42.01kA	2 sec	87	DANGEROUS
US34-2	MCC-34 FDR 1	39.16kA	2 sec	92	DANGEROUS	MCC-34 FDR 1	42.01kA	2 sec	87	DANGEROUS
MCC-33A	MCC-33A MAIN 2	37.08kA	.04 sec	2.8	1	MCC-33A MAIN 2	39.66kA	.04 sec	3	1
MCC-33B	MCC-33B MAIN 2	37.14kA	.04 sec	2.8	1	MCC-33B MAIN 2	39.72kA	.04 sec	3	1
MCC-34	MCC-34 FDR 2	37.02kA	.04 sec	2.8	1	MCC-34 FDR 2	39.59kA	.04 sec	3	1
MCC-35A	MCC-35A FDR 2	36.23kA	.04 sec	2.8	1	MCC-35A FDR 2	38.70kA	.04 sec	2.9	1
MCC-35B	MCC-35B FDR 2	36.23kA	.04 sec	2.8	1	MCC-35B FDR 2	38.70kA	.04 sec	2.9	1
MCC-34C	FUSE MCC-34C	8.96kA	.062 sec	0.6	0	FUSE MCC-34C	10.81kA	.047 sec	0.56	0
MCC-34D	FUSE MCC-34D	8.96kA	.062 sec	0.6	0	FUSE MCC-34D	10.81kA	.047 sec	0.56	0
P33A	BKR P33A	27.94kA	.017 sec	0.91	0	BKR P33A	29.48kA	.017 sec	0.95	0
P35A	BKR P35A	30.06kA	.017 sec	0.97	0	BKR P35A	31.84kA	.017 sec	1	0
P35B	BKR P35B	30.06kA	.017 sec	0.97	0	BKR P35B	31.83kA	.017 sec	1	0

TABLE 5 - RAS/WAS ELECTRICAL DISTRIBUTION SYSTEM

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
MCC-37A	MCC-37A MAIN	20.3kA	.29 sec	8.5	3	MCC-37A MAIN	21.4kA	.258 sec	8.1	3
MCC-37B	MCC-37B MAIN	20.2kA	.221 sec	6.6	2	MCC-37B MAIN	21.4kA	.199 sec	6.4	2

AFTER SETTING CHANGE

	UTILITY CONNECTION TO WI-13					UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
MCC-37A	MCC-37A MAIN	20.3kA	.06 sec	2.4	1	MCC-37A MAIN	21.4kA	.06 sec	2.6	1

TABLE 6 - FACILITY 66 ELECTRICAL DISTRIBUTION SYSTEM

	ASSUMED UTILITY CONNECTION TO WI-42				
EQUIPMENT	CLEARING DEVICE	FAULT CURRENT	CLEARING TIME	CAL/CM2	HAZARD CATEGORY
WIREWAY-66	FAC 66 FUSED DISC	3.71kA	0.068	0.66	0

Attachment 3
Manufacturer's Reference Material

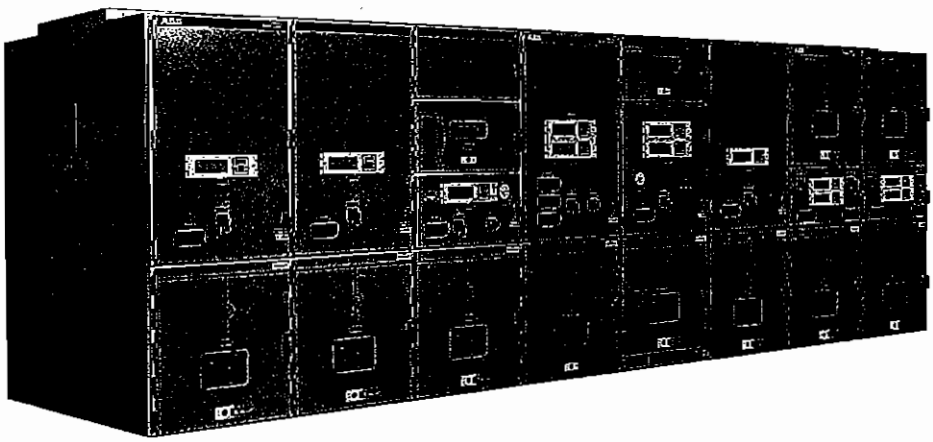
SafeGear®

metal-clad switchgear

Engineered for Safety™

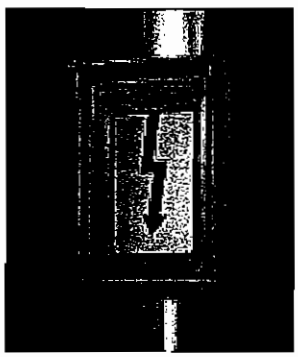
Follow the Leader.

Medium Voltage Arc Resistant Switchgear



Arc-Resistant, Metal-Clad SafeGear insures optimum safety and operational reliability.

- Arc resistance offers protection from objects or hot gases that might be ejected during an arc fault.
- Vents and flaps are located on top of the enclosure to release the pressure. This significantly reduces operator risk during handling and operation of the equipment.
- SafeGear's level of arc resistance helps protect workers from the catastrophic effects of an internal arc fault, and also helps protect nearby equipment from collateral damage.
- More than 25 years experience in arc resistant switchgear
- First manufacturer of two-high arc resistant switchgear; the ABB design allows for flexibility in configurations and promotes superior safety performance
- Small arc resistant footprint allows ABB switchgear to fit into tighter spaces
- Large arc-resistant window allows the operator to check position and status of circuit breaker without opening the cell door
- Available in ratings up to 15 kV, 3,000 A, 50 kA



VisiVolt voltage indicator, installed directly on the bus bar, provides visual voltage indication for improved operator safety

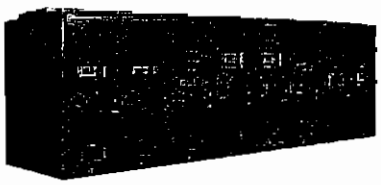
ABB

SafeGear®

metal-clad switchgear

Engineered for Safety™
Follow the Leader.

Medium Voltage Arc Resistant Switchgear



FEATURES

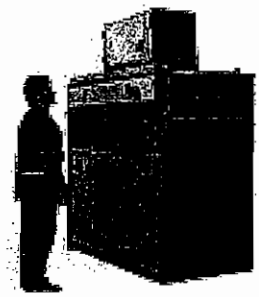
- Closed door racking
- Remote breaker racking
- Automatic secondary disconnects
- IS Limiter
- VisiVolt voltage indicator
- REA Relay:
  - Reduce incident energy by up to 80%
  - Helps meet OSHA, IEEE, NFPA & NEC standards
  - Can reduce Personal Protection Equipment (PPE) requirements for easier maintenance
  - Can be used with any manufacturer's relays and requires no re-programming or setting changes

Arc Flash Accidents

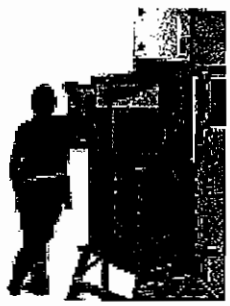
Arc Flash characteristics:

- An arc arises when at least part of the current passes through a dielectric, usually air.
- Maximum peak power up to 40 MW.
- Arc temperature up to five times the surface temperature of the sun (20,000°C).
- Light intensity more than 2000 times that of normal office light.
- Volumetric expansion approximately 40,000 times.

25%
Without Operator



10%
With Operator in front of a closed door



65%
With Operator working in the switchgear

As the pioneer and most experienced manufacturer of arc-resistant switchgear in the USA, only ABB can combine safety and performance that translate into peace of mind for those who specify, recommend, and operate electrical equipment.

Call your ABB representative for more details or for a complete presentation on SafeGear.

ABB

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Safegear 1VAL108001-FL RevA, March 07
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PRODUCT PROFILE

CENTERLINE® 2100 MCC with ArcShield™

Arc-containing designs for Low Voltage Motor Control Centers (MCC) have become a very important topic. Interest in these designs has been driven by requirements in the National Electrical Code NFPA 70-2002, Standard for Electrical Safety in the Workplace NFPA 70E-2004 and the IEEE. These standards encourage development of products that can help provide you a higher level of safety.

UNDERSTANDING ARC FLASH HAZARDS

An arc-flash hazard is defined in NFPA 70E-2004, Standard for Electrical Safety in the Workplace, as: "A dangerous condition associated with the release of energy caused by an electric arc." Electrical arcs can be caused by accidental touching, closing into faulted lines or loose connections.

Independent studies show as much as 80 percent of electrical injury cases are burns resulting from exposure to electrical arcs.

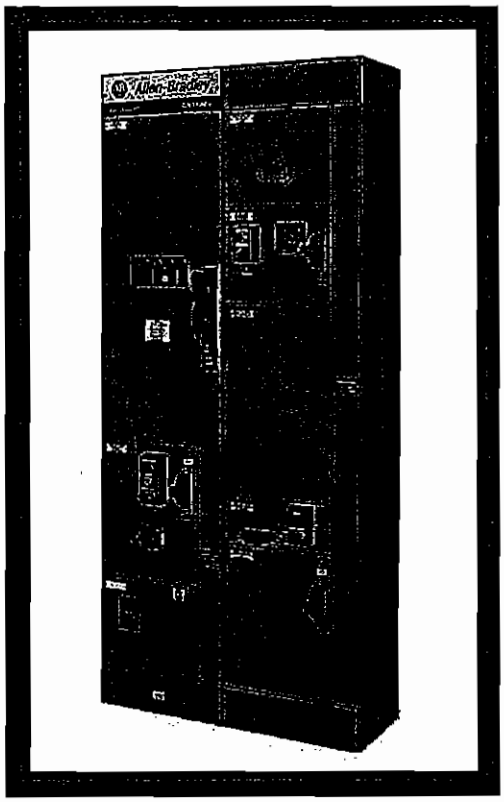
As an end-user or employer, you are responsible for performing arc-flash hazard analyses. Your analysis defines potential arc energy levels adjacent to particular electrical equipment and yields the required level of personal protective equipment (PPE) needed when working near energized electrical equipment.

PROTECTING YOUR PERSONNEL

ArcShield is an enhanced version of the industry-leading CENTERLINE 2100 MCC and the first to offer arc-containing features. Because a low voltage standard does not currently exist, ArcShield has been tested on the load side of the branch circuit protection device to specific service limits and in accordance with ANSI C37.20.7, IEEE Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults. However, using ArcShield does not eliminate your responsibility to comply with OSHA, NFPA or your company's safety requirements.

ArcShield helps provide you with Type 2 accessibility and improves protection for your personnel against internal arcing faults. Type 2 accessibility allows your personnel to be shielded at the front, rear and sides of the enclosure in the unlikely event of an arcing fault. Special door latches help deliver an extra level of protection against accidental faults that may occur when the doors are closed and latched.

ARC-CONTAINING LOW VOLTAGE MOTOR CONTROL CENTERS HELP YOU REDUCE ARC FLASH HAZARDS



CONTAINING ARC-FAULTS

ArcShield helps contain arc-faults by utilizing a lower horizontal bus rating and incoming protection size for your MCC. Smaller bus and main disconnect sizes help diminish the amount of let-through energy in your application. To help protect your workers during an arc-fault, arc-containment latches allow pressure relief and keep the doors from detaching from the structure. Manual or automatic shutters, as well as insulated bus covers help reduce fault propagation within your MCC. By containing the arc, your potential exposure to hazardous conditions can be reduced.

REDUCING ELECTRICAL SHOCK HAZARDS

Although arc-flash hazards are a concern, electrical shock hazards should also be considered. Over 30,000 nonfatal electrical shock accidents occur each year. The National Safety Council estimates 1,000 fatalities each year are due to electrocution. More than half of these fatalities occur while improperly servicing energized systems with less than 600 V.

CENTERLINE 2100 MCCs are designed to enhance safe operation by helping isolate you from potentially hazardous voltages by providing a solid grounding system and helping minimize potential electrical shock hazards. Additional options such as IntelliCENTER software, DeviceNet ports, blown fuse indicators, exterior windows on unit doors, infrared inspection ports and finger-safe component barriers can help you create a safer working environment by reducing your potential chances of making contact with energized components.

ArcShield OPTION PACKAGE

DESIGN CRITERIA:

- Arc-containment latches on all doors
- Non-vented enclosure
- Maximum 1200 A bus
- Copper vertical ground bus on plug-in structures
- Heavy duty ground stab on plug-in units
- Manual or automatic shutters on plug-in structures
- Insulating covers on horizontal bus closing plates

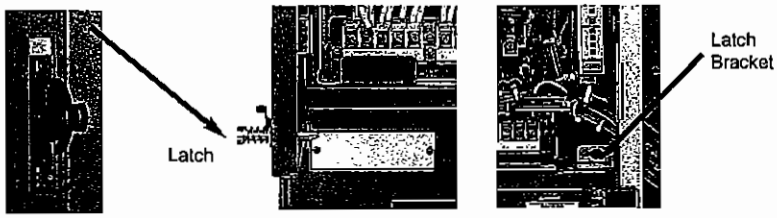
Note: All design criteria and service restrictions must be followed prior to ordering and utilizing ArcShield.

SERVICE REQUIREMENTS:

- Maximum Voltage: 600 V
- Maximum Available Fault Current: 65,000 A RMS Symmetrical
- Branch circuit protection with
  - Fuses
    - 1200 A Class L current-limiting fuses (Max)
      - Ferraz-Shawmut A4BQ or equivalent current-limiting performance
    - 800 A or less any Class J or L current limiting
  - Circuit Breakers
    - 1200 A circuit breaker (max) 65 KAIC Rated
      - HND Frame or higher current limiting performance
      - No intentional time delay
    - 800 A or less must meet interrupting rating of the breaker with the available fault current, with no intentional time delay

ARC-CONTAINMENT LATCH

- Allows pressure relief
- Keeps doors from detaching during an arcing fault



OPTIONS TO ENHANCE PERSONNEL PROTECTION

For a complete list, please contact local Rockwell Automation sales office or Allen-Bradley distributor

FEATURE	BENEFIT	STANDARD	OPTIONAL
Remote monitoring • IntelliCENTER Software • DeviceNet Port in the door	Helps allow you to remotely monitor, configure or troubleshoot your MCC using DeviceNet, well outside of the Flash Protection Boundaries and without potential exposure to hazardous voltages.		√
Grounding • Dedicated plug-in unit ground • Dedicated grounding system	Helps assure the shortest path to ground is through equipment.	√	
Isolation • Finger safe barriers • Isolation guards for starters, fuses, transformers and disconnects	Barriers can help minimize the chance of a potential arc-flash being initiated by accidental contact with energized parts. Risk of foreign materials causing a short is potentially reduced.		√
Indicating features • Blown fuse indicators • Windows on unit doors • Infrared inspection ports	Helps allow hands-off inspection of unit status.		√
Locking and interlocking • Unit interlocking system	Helps facilitate your lockout/tagout procedures.	√	
Unit Designs • Drive-Bypass	Helps allow qualified personnel to service a drive at a potentially Hazard Risk level of 0 while keeping the process running.		√

For more information about Arc-Flash, reference these publications by visiting **http://literature.rockwellautomation.com**

- Arc-Flash Protection Marking Guide for CENTERLINE Motor Control Center, 2100-AT002X-EN-P
- Arc-Flash Resistant Low Voltage Motor Control Center Designs, 2100-AP003X-EN-P

www.rockwellautomation.com

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FlashGard® Motor Control Center (MCC)

Product Focus

What is an Arc Flash?

An arc flash is a dangerous condition associated with the explosive release of energy caused by an electrical arc due to either a phase-to-ground or phase-to-phase fault. This fault can result from many factors, including dropped tools, accidental contact with electrical systems, buildup of conductive dust, corrosion and improper work procedures.

FlashGard MCC Features and Functions

FlashGard Motor Control Centers utilize many features not yet available in the electrical industry that have proven to be a reliable and effective means of providing enhanced electrical safety to minimize the dangers of arc flash. FlashGard MCCs are available with Freedom NEMA and A200 contactors.

Prevention: Insulation and Isolation

- Insulated horizontal bus.
- Insulated labyrinth vertical bus.
- Shutters to isolate the vertical bus when a unit is removed.
- Shutters on the unit to isolate the stabs when bucket is removed.

Reduction of Time-Available Fault Current Using ARMS

- Arcflash Reduction Maintenance System™.
- Applied to breaker feeding MCC to reduce trip time during an arc flash.
- Can reduce risk category from CAT3 to CAT0.

Maintaining Unit Door Closed

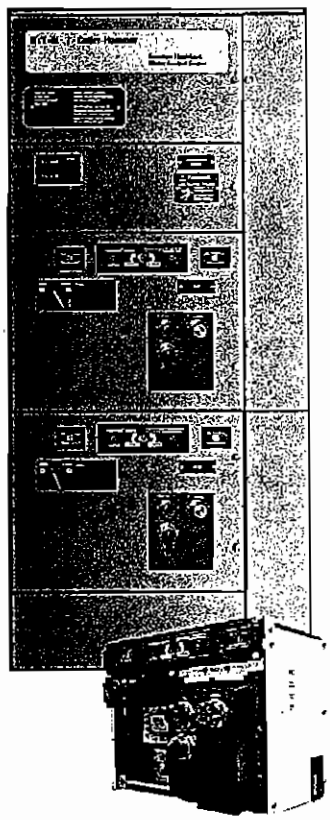
- Units disconnect from vertical bus with door closed.
- Interlock preventing removal of unit from vertical bus.
- Interlock preventing insertion of unit with stabs extended.
- A more uniform and secure connection to the vertical bus.
- RotoTract™ Stab Assembly❶:
  - Connected
  - Disconnected
- Visual indication that stabs are disconnected from vertical bus.
- Optional through-the-door voltage present indicator (VoltageVision™).
- Optional automatic motor insulation tester (Motorguard™).

Removing Voltages Dangerous to Life

- In "Disconnected" position, no voltage present.
- Internal unit shutter to isolate from vertical bus while in "Disconnected" position.
- Stab isolation shutters when unit is removed.

Enhanced Features and Functions

- Arc-free insulated bus and barriered bus system.
- Through-the-door voltage present indicator (VoltageVision).
- Arc-free bucket design.
- Remote connect/ disconnect racking motor accessory.
- Automatic insulation tester (Motorguard) to monitor insulation integrity.

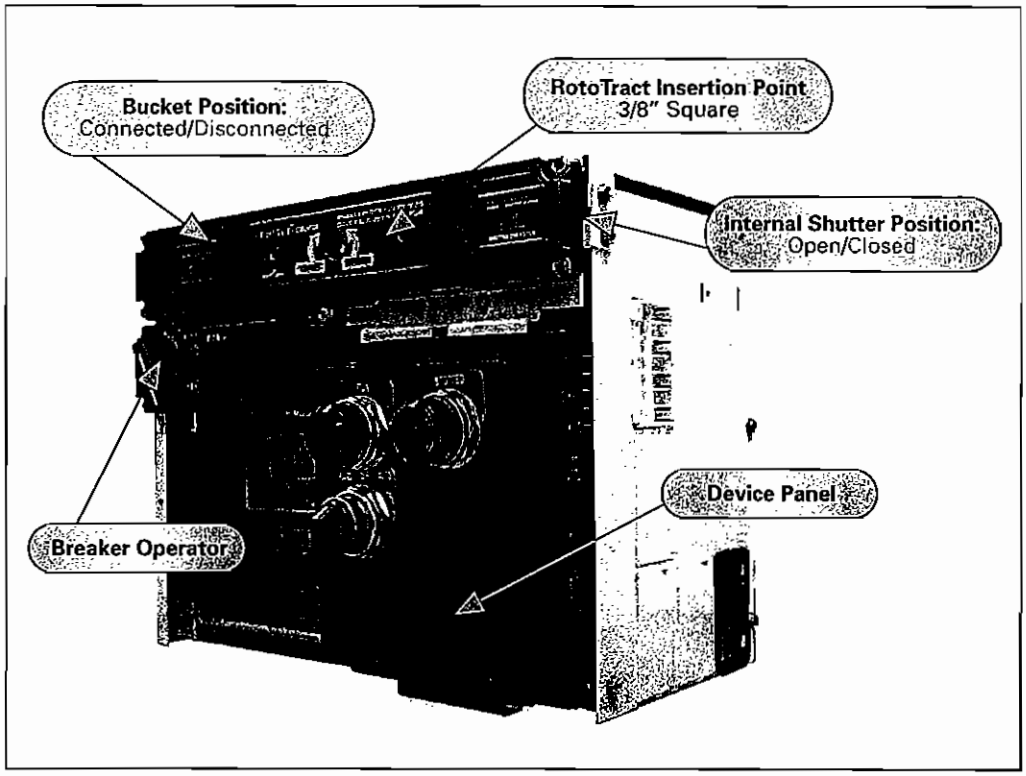


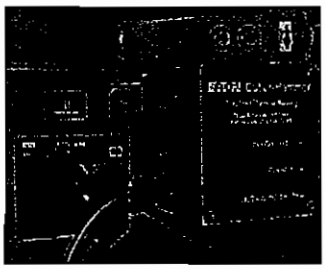
❶ The FlashGard MCC provides a state-of-the-art remote racking mechanism that provides bus isolation, stab indications and lockout features. The RotoTract stab assembly has two distinct positions as indicated above. The retractable stab assembly features a 3/8" drive socket that can accept any standard driver or a 24" remote racking tool. The stabs can be remotely operated with an optional drive motor, allowing the operator to be outside the arc-flash boundary. The Drive Socket is interlocked to prevent opening the door while inserting the stab assembly. A Manual Shutter prevents operating the breaker when the stabs are not engaged. In addition, an interlock prevents accessing the 3/8" drive socket when the breaker is in the ON position. The retractable stab assembly has a unit assembly latch to ensure the unit remains in place while in the "Connected" mode.

FlashGard MCC Benefits

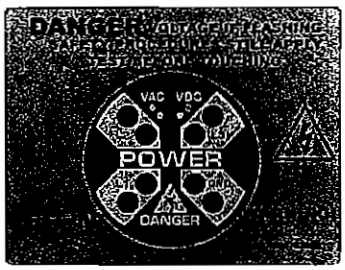
- The minimization of impact and exposure to higher PPE levels in industrial environments:
  - Increases uptime of product line operations
  - Decreases direct cost of employee incidences
  - Increases personnel safety
  - Reduces number of injury-related incidences that occur daily in North America
- Lowers the probability of the creation of a short circuit phase-to-phase or phase-to-ground.
- Lowers the probability of electrical shock.
- Proven to reduce incident arc flash energy during maintenance.❷

❷ As described by the IEEE® testing method described in IEEE 1584.

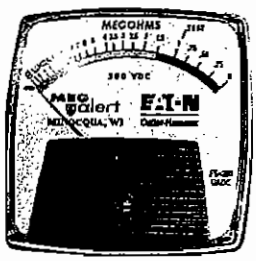




Remote Racking Accessory



VoltageVision— Voltage Presence Indicator



MegOhm Meter

Motorguard — Automatic Insulation Tester

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Electrical Group
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Moon Township, PA 15108
United States
877-ETN-CARE (877-386-2273)
Eaton.com

PowerChain Management®

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Arc Flash Mitigation with Entellisys™
By Jud Meyer, GE Specification Engineer

As time goes by, we are finding a growing number of customers that are becoming more concerned with arc flash and the injuries that can occur. We all hear the questions "Is this really a dangerous situation?" or "Does it really concern me or my facilities?" The answer is yes. Arc flash is a condition that exists with all pieces of electrical equipment. The real question becomes, how do I reduce the threat?

Let us start by reviewing the 3A's to arc flash 1) Awareness, 2) Analysis, and 3) Action. All of these are incorporated into your design process. You are aware of the hazard. The power system design contributes to the available interrupting current which is a significant variable used in the analysis. You also consider what other design actions you can take such as the functionality and selection of equipment. You also have the opportunity to consider broader elements, such operating personnel practices that will impact the hazard level. As you can see from just from these few elements, the arc flash hazard cannot be solved with one "silver bullet" solution, as much as we wish it could be. For example, arc resistant equipment contains an arc-flash event's energy provided all of the doors are closed. Unfortunately many, if not the majority of arc-flash incidents occur when maintenance is being performed to the gear. This implies a door is open resulting in an incident energy level significantly higher than calculated for closed-door equipment. Consequently a multi-layer approach consisting of power system design, equipment functionality and operator practices provides a more robust arc flash reduction strategy.

Today, we are going to review how using a multi-layered approach in the design and selection of switchgear can impact operator's actions as well as reduce the arc flash incident energy level.

First, let's consider traditional switchgear with trip units, meters, relays, PLCs and other devices mounted in the gear and on the doors. An operator must stand directly in front of the energized equipment to monitor the power system. Opening or closing a circuit breaker also requires a person to stand directly in front of the breaker being operated. All of these actions are well inside the arc flash hazard boundary. As a layer of defense, keeping operators out of the arc flash boundary makes sense. Let's call this the 4th A for Avoidance.

You now have a choice and can select switchgear that keep operators *outside* the arc-flash hazard boundary. Entellisys Low Voltage Switchgear offers multi-layered solutions to a complicated problem.

Avoidance – Operators Outside the Arc Flash Boundary

Near Gear. This is a term commonly used with the Entellisys product. Like all ANSI class switchgear, there are times when you must interface with the equipment such as reading metering functions, opening or energizing the breakers or reviewing the sequence of events. Entellisys offers a number of solutions to help the end user do these tasks more safely. In lieu of standing if front of the equipment to do these functions, an HMI (Human Machine Interface) is provided so you can do these functions at a further distance from the gear. The HMI is the system interface to the gear via a touch screen to easily view all the functions of your lineup as well as open and close circuit breakers. The HMI can be located, in a wall mounted enclosure, or in it's own stack located near the gear but outside of the hazard zone. The Near Gear wall enclosure or stack is located within 300 cable feet of the lineup.

A Control Stack is another option with Entellisys. This is a stand alone stack, again located up to 300 cable feet from the equipment. It houses the HMI as well as the key Entellisys components consisting of the redundant Central Processing Units (CPUs) and UPSs. . This control stack away from energized

equipment has only 120V control power present. In addition to monitoring and controlling the breakers, if an operator wants to check battery status of the redundant UPS they can do so outside the Arc Flash zone of the equipment.

Remote Access
If desired the HMI functionality for monitoring and control can be loaded on a laptop or stand alone PC. This allows access to view the equipment status as well as change settings or control breakers. Two versions of software are provided. One is Remote HMI View Only, which only permits users to monitor the equipment condition. The Remote HMI User Interactive allows full operability of the gear based on the user's password access. You can also have a wall mount unit outside the arc flash boundary as shown in Figure 1 below.

Figure 1

Remote Racking This option is almost always used as a very simple way of keeping workers clear of immediate danger when installing or removing a breaker. This device is simply a gear motor in a small enclosure with a 30' card. The device has a small pushbutton station on the end of the cord which when engaged turns the shaft forward or reverse depending on the desired breaker movement. A mechanical cover on the circuit breaker will prevent access to the racking mechanism unless the breaker is open or in the disconnect position (and opened).

As you can see, Entellisys provides elegant solutions for keeping operators outside the arc flash hazard zone. This is one layer of protection. Another layer of protection is sensing arcing faults quickly enabling fast protection and thus reducing the incident energy level of an arcing fault.

Fast and Selective Arc Flash Protection

Bus Differential This protective function measures every amp of every phase entering or leaving a zone. The settings associated with this protective function are independent of the settings required to serve the load. As found in IEEE arc fault testing, arcing faults are typically 40-60% of bolted fault levels. This means that current overload settings that are selected to serve the load may very likely take time before it reacts to the fault. Bus differential solves this problem and provides fast arcing fault protection without compromising the selectivity of the system. The Entellisys bus differential function can be set at very low levels, which are more sensitive in detecting bus and breaker faults. In fact, you can set the bus differential function as low as 20% of the main bus rating, so for example on a 4000A bus Entellisys will detect an 800A arcing fault and respond within 25ms.

Reduced Energy Let-Through (RELT) This option provides a lower arc flash risk to end-users when they have to work at, or near the equipment. Another set of bus differential settings allow the user to set these at more sensitive levels than the normal operating settings. . By enabling this function (at the HMI) the more sensitive settings used in Bus Differential are engaged to protect the system. Once the work has been completed the appropriate personnel can reengage the primary settings at the HMI

and move on to other tasks. This function is part of the main menu and labeled "Reduced Let-Thru Made". The user simply enables the functions with a check box and then hits OK. To return to the normal operations reverse this procedure. The difference between the RELT functions with Entellisys compared to other products is the co-ordination of the system. The Entellisys system does NOT require, or change to a lower Instantaneous Settings, as do other products. Therefore, it does not compromise the co-ordination of your system, as do other products.

The ability to sense arcing faults quickly and clear the fault reduces the incident energy level of an arc flash event. Entellisys is able to provide this functionality easily, adding another layer to your arc flash mitigation strategy.

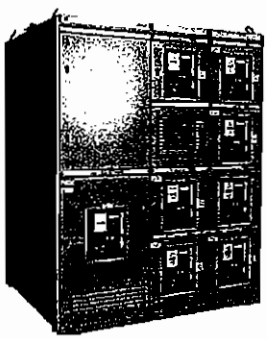
Let's look at how Avoidance and Fast and Selective arc fault protection is implemented in the field.

As an example, we will walk through a summary of steps removing a circuit breaker for maintenance in a typical Entellisys system.

- Engage the Reduced Energy Let-Thru at the HMI which is located in a control stack outside of the arc flash zone.
- Confirm the breaker being service is the correct one through visual confirmation. The operator selects the "Locater LED" on the selected breaker's control screen. A blue LED light on the breaker's messenger will be blinking.
- Open the breaker to be serviced. This again is done at the HMI and requires a confirmation 'open' command.
- Approach the opened breaker with the Remote Racking device, while wearing the proper PPE. (Personal Protection Equipment)
- Open the mechanical release on the front of the breaker and attach the Remote Racking device.
- Proceed to a safe distance and engage the Remote racking device to withdraw the circuit breaker, as your breaker is now ready for maintenance.

A replacement breaker can be installed by reversing the above steps. Once all the work near the equipment is complete, as you prepare to leave the area, return to the HMI and disengage the Reduced Energy Let-Thru and continue to your next task. It's as easy as that.

Three layers of protection have been used: Avoidance by keeping operators outside the arc flash zone for the majority of tasks, Incident Energy Reduction by using bus differential protection, and as a last line of defense wearing the proper PPE.



Entellisys Switchgear

Most customers and end users are concerned with safety, and the Entellisys switchgear safety features have some of the most comprehensive tools in the industry today.

Attachment 4
One-line Diagrams

CH2MHILL SUBJECT GENERATORS BY

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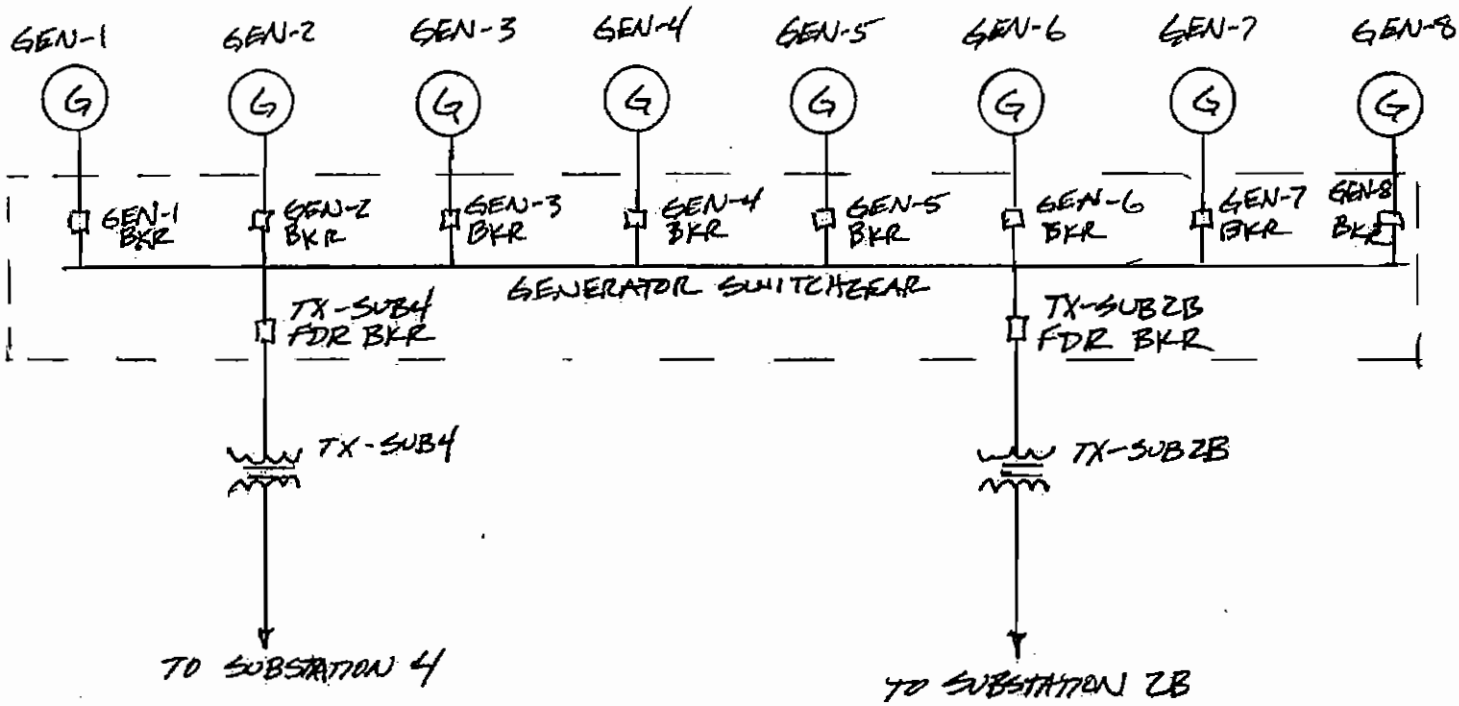

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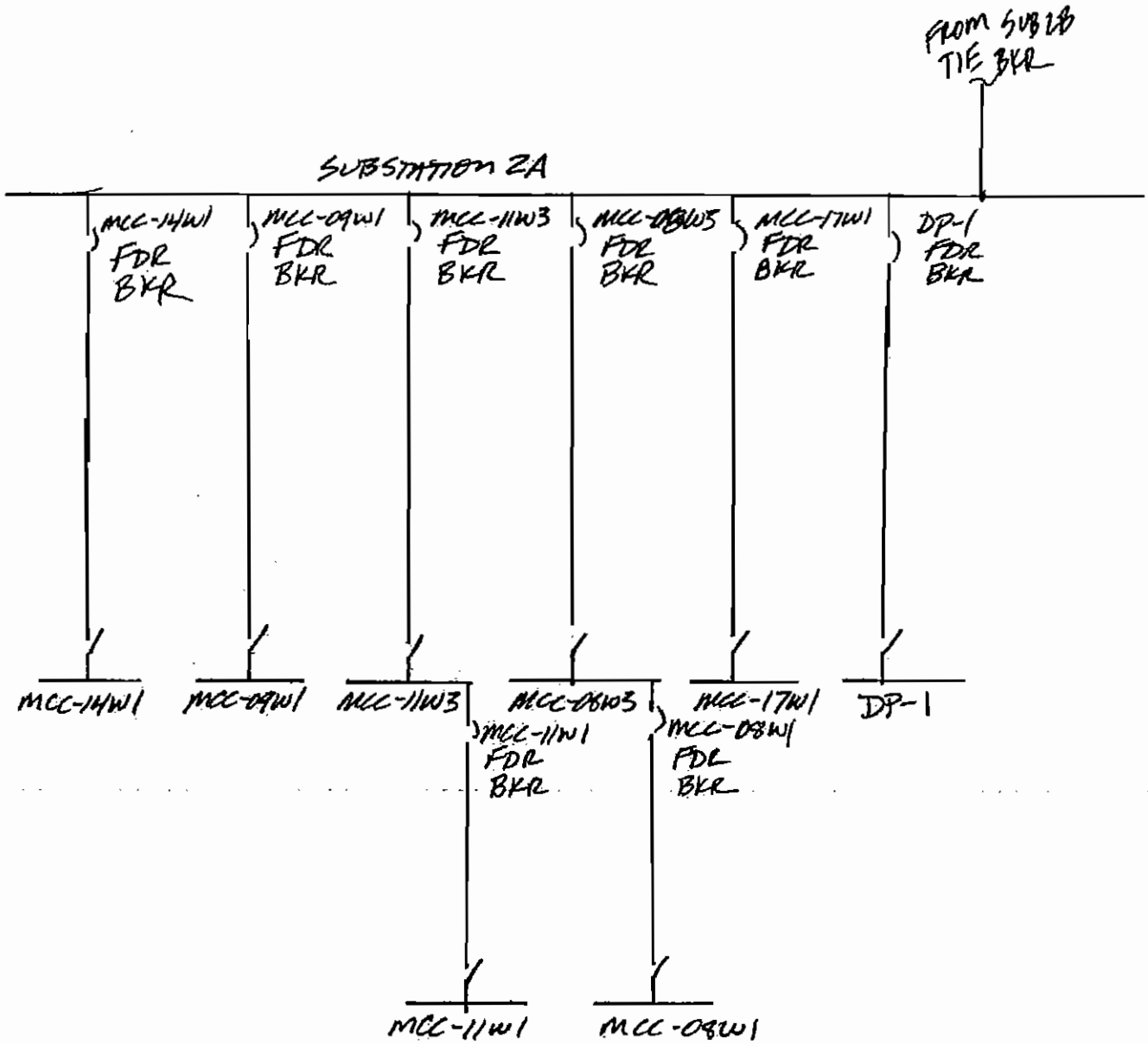

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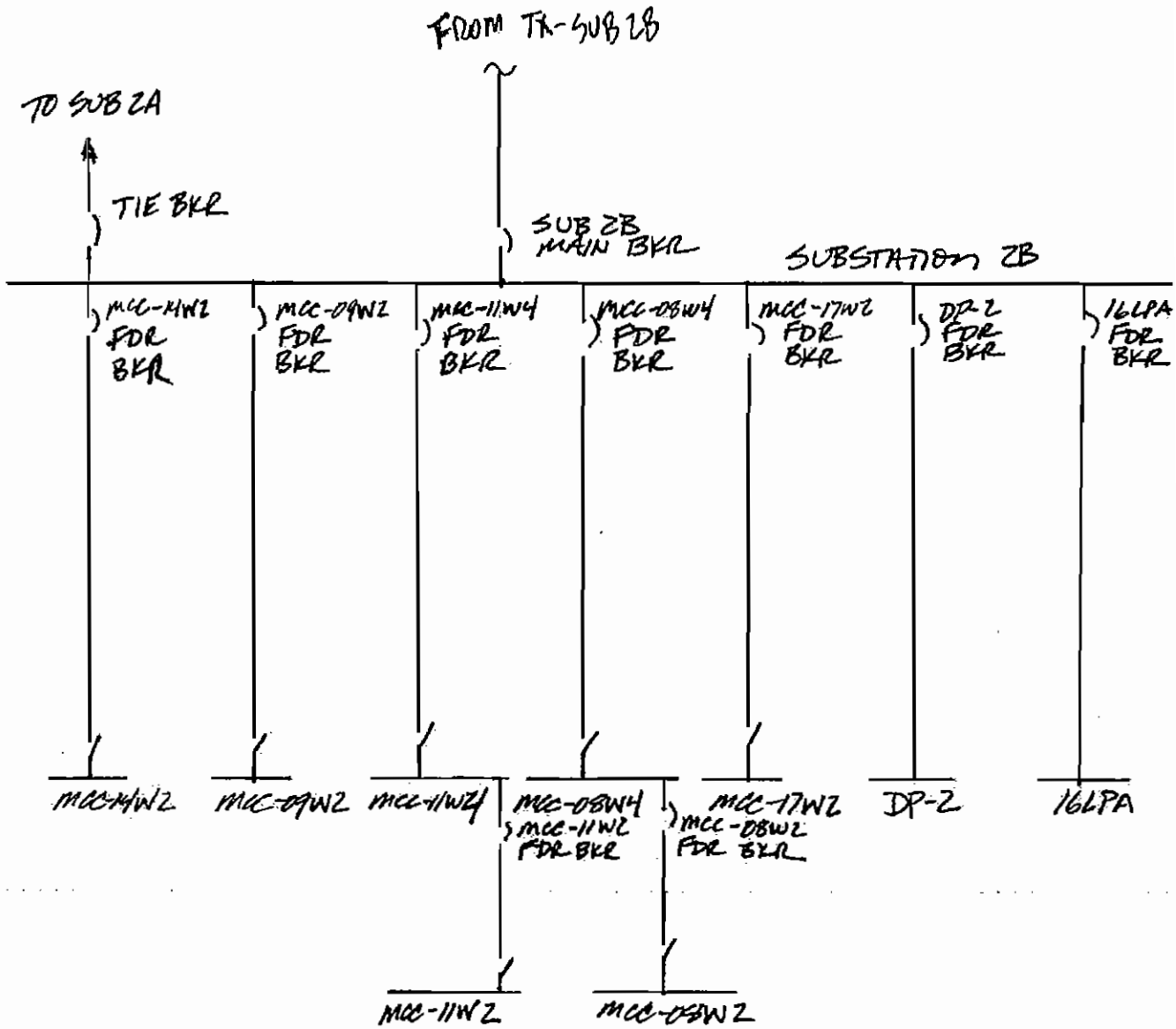

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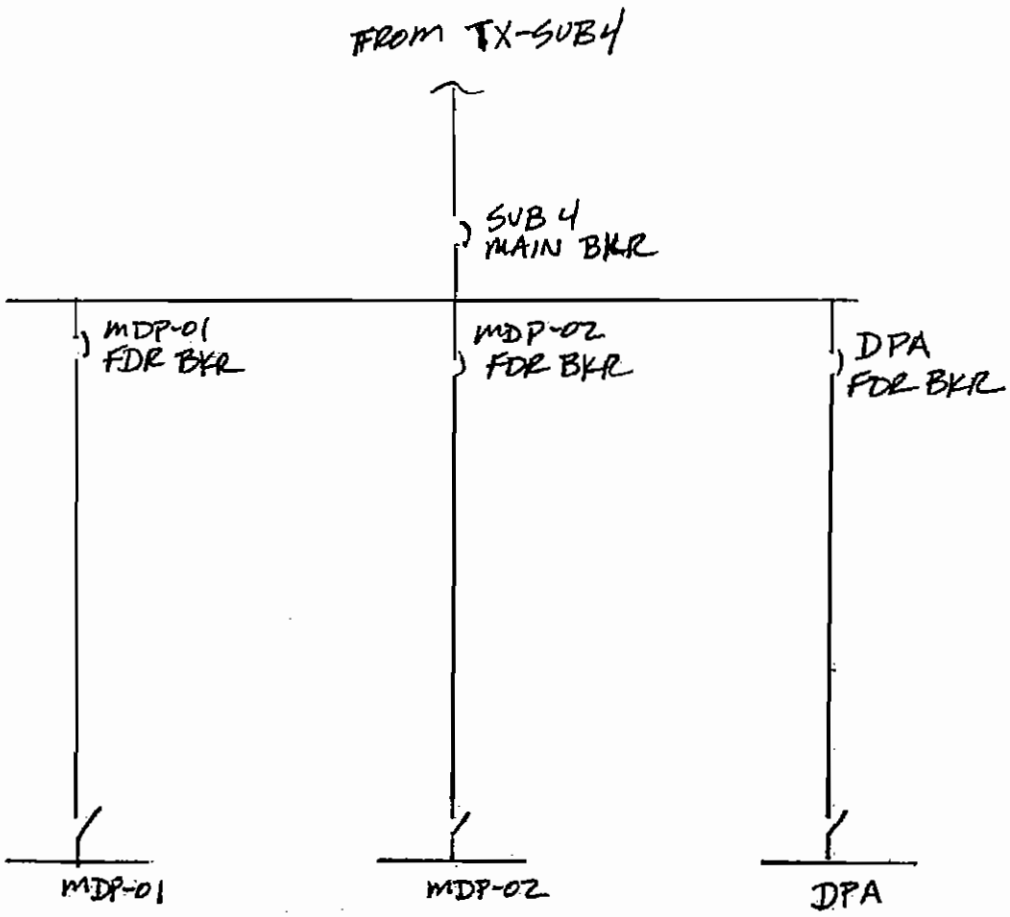

CH2MHILL SUBJECT FACILITY 30 BY
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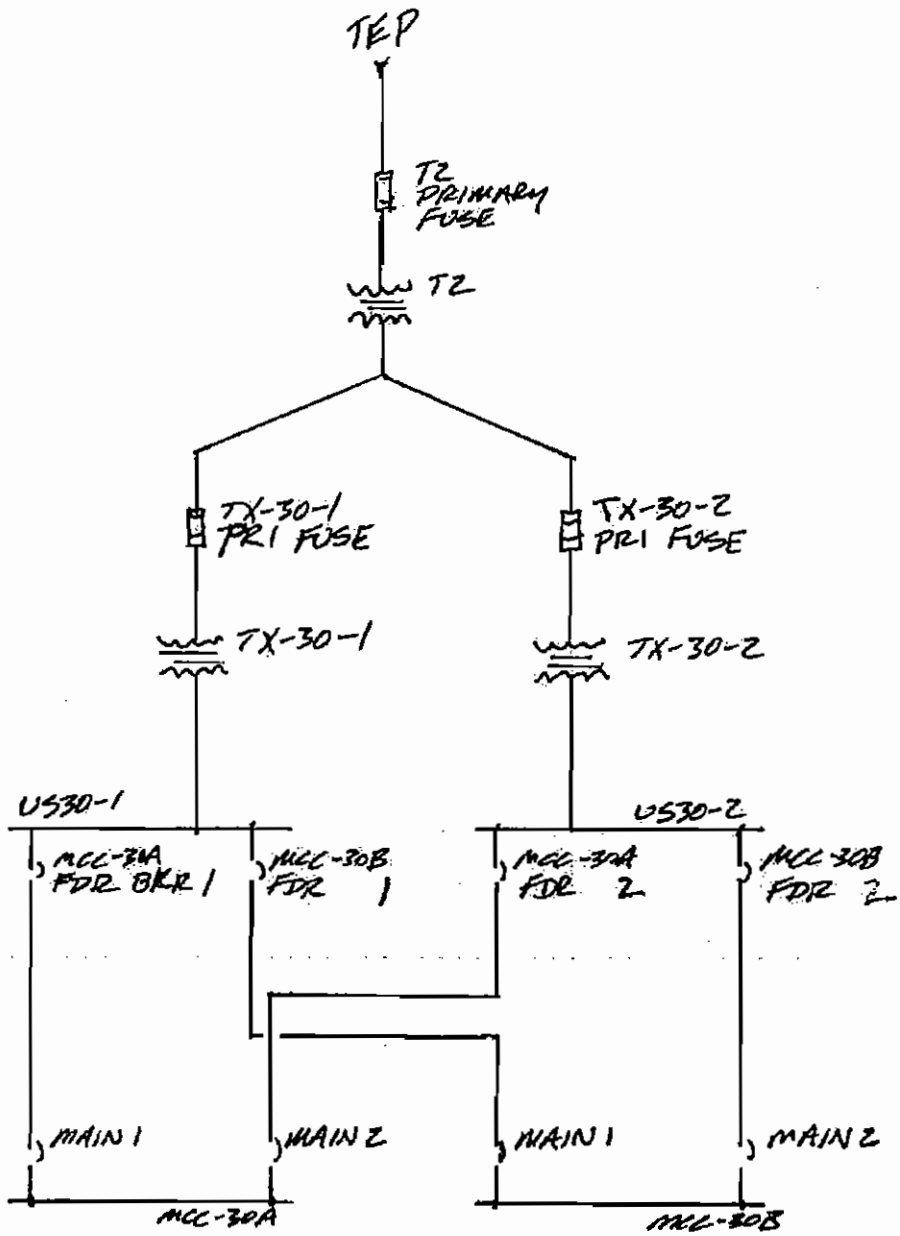

CH2MHILL SUBJECT FACILITIES 33/34/35 BY
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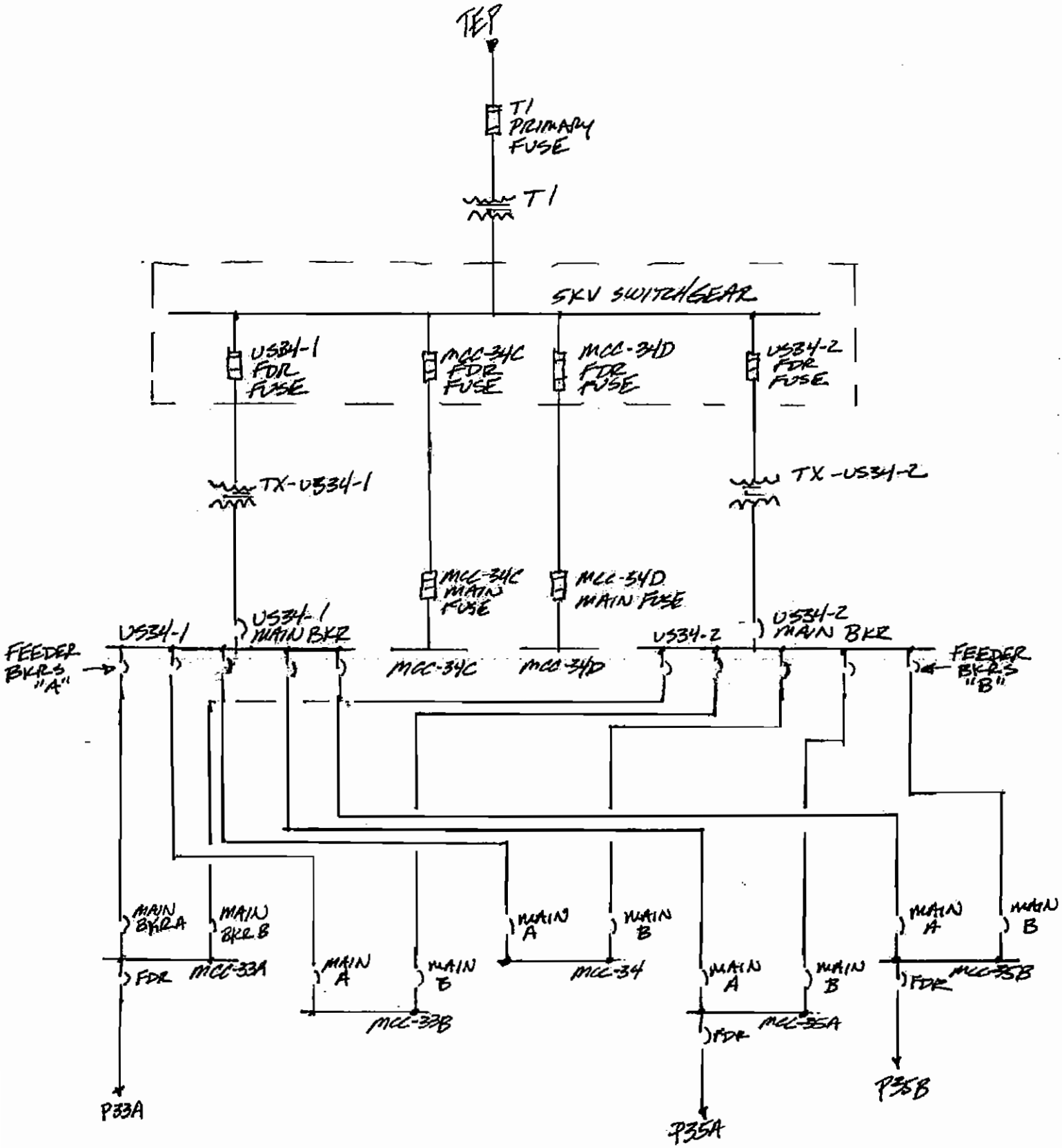

CH2MHILL SUBJECT FACILITY 37 BY

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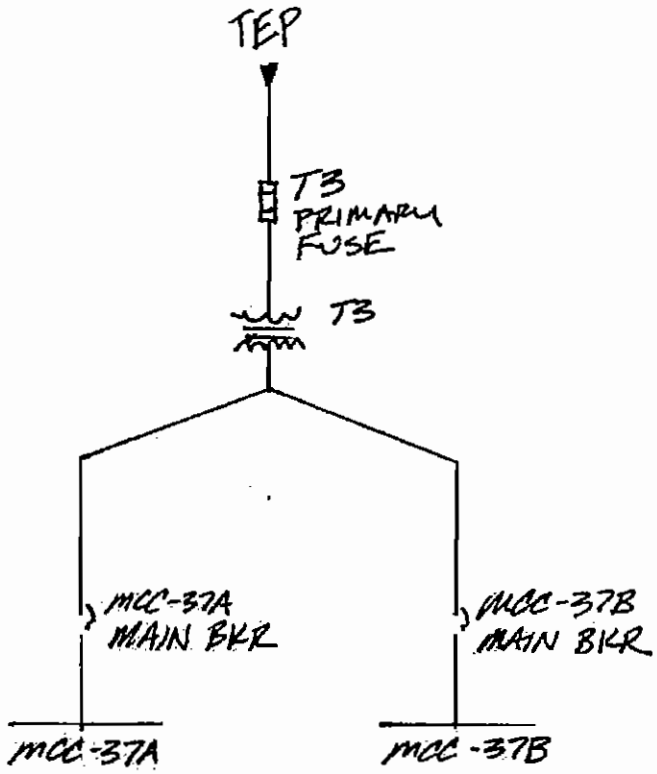

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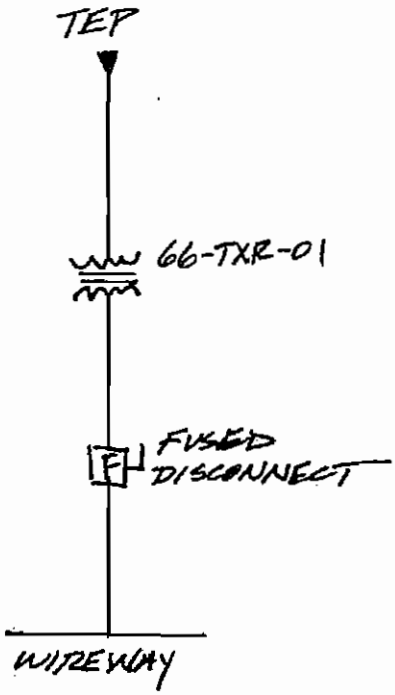

Appendix C
Thermal Equipment Assessment Forms

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	11 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Absorption Chiller**			

CONDITION OF ITEMS INSPECTED:	**Comments:**
Name of Equipment Item or Group: Absorption Chiller	
Manufacturer / Model: York Isoflow/ Model ST-10E3-48-S	**Operating during time of assessment**
System Voltage:	
Rate each item with circled number on the scale of 1 to 6 below:	

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
Staff indicated that since this unit is required to run continuously, its estimated life is 20 years.
ADDITIONAL COMMENTS / OBSERVATIONS:

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	See below
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Air Compressors (2)**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Air Compressor (electric driver) **Air Compressor (engine driver)**	**1 yr. old** **Original equipment**
Manufacturer / Model: electric drive: Ingersol Rand / 10T3NLM **Ingersol Rand / 30T538437**	**15 Hp electric motor** **Kohler 16 Hp engine (rebuilt within last year)**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

Engine driven unit serves as installed spare.

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
Both compressors have horizontal receivers. Common air dryer serves both compressors.

INA RD WRF ENERGY MASTER PLAN
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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Low Pressure Boiler**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Low Pressure Boiler	**Staff estimated that the unit was last used in 1988.**
Manufacturer / Model: Sellers Engineering Inc./ 155R 150 Hp	**Working pressure 15 psi; Input Btu 6,278,000; SN 6201**
System Voltage:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
(3)	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☒ Evidence of wear
☐ Unusual noise during operation	☒ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☒ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

This unit is standby for the thermal energy produced by the 7 engine generators

MAINTENANCE REQUIREMENTS:
Unit is required to be inspected by State boiler inspector on regular schedule (1 to 2 years)
PARTS NEEDING MAINTENANCE / REPAIR:
Staff indicated that unit would require some parts to be repaired or replaced in order for unit to be operational.
ADDITIONAL COMMENTS / OBSERVATIONS:

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Chilled Water Pump**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Chilled Water Pump	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSC 11 BFW LHR	**30 Hp, 1770 rpm, 800 gpm @ 102', 6x6x12**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Condenser Pump**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Condenser Pump	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSC 12-3/4 BPW LHR	**50 Hp, 1175 rpm, 2,500 gpm @ 51', 10x10x13**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

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Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Deaerator**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Deaerator	**Original Equipment**
Manufacturer / Model: Industrial Steam Inc. / 8SR3-FM	**Spray bar type**
Equipment No.: S/ 76-9771	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

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Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Domestic Hot Water Generator**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Domestic Hot Water Generator	**Original Equipment**
Manufacturer / Model: Sellers Engineering Co.	**Md. # RL50X150H72400**
Equipment No.: P/C # 51697	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 yrs.
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Nos. 1 thru 7 Ebullient Boilers**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Ebullient Boilers	**Shell and tube type heat exchangers, utilizing engine exhaust to generate low pressure steam.**
Manufacturer / Model:	
System Voltage:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

On this date only 4 of the 7 units are required to operate to meet the electrical and thermal demands.

MAINTENANCE REQUIREMENTS:
Units are required to be inspected by State boiler inspector on regular schedule (1 to 2 years)
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
Staff indicated that unit No. 5 was recently re-tubed.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 1**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 1	**Engine generator was down for major overhaul on this date. Engine and generator are all together, working on auxiliary equipment and piping.**
Manufacturer / Model: Waukesha Model L7042 GU	**Size: 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with a circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
2	**Minor Defects Only** Minor maintenance required
(3)	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 2**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 2	**Engine generator was running on this date – 600kw**
Manufacturer / Model: Waukesha Model L7042 GU; SN 299548	**Size: 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with a circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 3**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 3	**Engine generator was not running on this date. In standby mode.**
Manufacturer / Model: Waukesha Model L7042 GU	**Size: 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with a circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 4**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 4	**Engine generator was operating on this date – 600 kw**
Manufacturer / Model: Waukesha Model L7042 GU; SN 298503	**Size: 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 5**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 5	**Engine generator was operating on this date – 600 kw**
Manufacturer / Model: Waukesha Model L7042 GU; SN 299179	**Size: 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 6**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 6	**Engine generator was running on this date – 600 kw**
Manufacturer / Model: Waukesha Model L7042 GU; SN 299208	**Size 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Engine Generator No. 7**	650 kw		32

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Engine Generator No. 7	**Engine not running on this date. Staff doing some routine maintenance.**
Manufacturer / Model: Waukesha Model L7042 GU; SN 299547	**Size: 9 3/8 x 8 1/2**
System Voltage: 4160 General Electric generator	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

At this time only 4 of the seven engine generators each operating at 600 kw are required to meet the electrical demand

MAINTENANCE REQUIREMENTS:
Unit is taken down for major overhaul once every seven years.
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:
32 year old equipment, staff indicates that parts are still available; however they will become harder to get for equipment which is this old.

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Heat Sink System Pumps (2)**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Heat Sink System Pumps (2)	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSCS 12-1/8 BW RHR	**150 Hp, 1,750 rpm, 3600 gpm @ 110', 10x12x13**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

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Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Hot Water Converter**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Hot Water Converter	**Original equipment**
Manufacturer / Model: Taco	**Shell & Tube heat exchanger**
Equipment No.: P/C # 51662 (H-14-646)	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Hot Water Pump**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Hot Water Pump	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSC 11 BFW LHR	**30 Hp, 1760 rpm, 430 gpm @ 127', 6x6x12**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

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EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Lube Oil Coolant Pumps (2)**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Lube Oil Coolant Pumps (2)	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSC 8-7/8 BFW RHR	**20 Hp, 1,760 rpm, 700 gpm @ 57', 6x6x12**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Sludge Heat Converter**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Sludge Heat Converter	**Original Equipment**
Manufacturer / Model: Taco	**Shell & Tube heat exchanger**
Equipment No.: P/C # 51663	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	**CAPACITY**		**AGE**
	AVG	**PEAK**	**32 years**
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Sludge Heat Pump**			

CONDITION OF ITEMS INSPECTED:	**Comments:**
Name of Equipment Item or Group: Sludge Heat Pump	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSC 11 BFW LHR	**30 Hp, 1760 rpm, 430 gpm @ 127',6x6x12**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: WasteHeat Converter**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Waste Heat Converter	**Original Equipment**
Manufacturer / Model: Taco	**Shell & Tube heat exchanger**
Equipment No.: P/C # 51664 (H-14-648)	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS:

INA RD WRF ENERGY MASTER PLAN
Pima County Wastewater Reclamation Department (PCWRD)

EQUIPMENT CONDITION ASSESSMENT

NAME OF CH2M HILL ASSESSOR: C. Kirkpatrick	**Date of Assessment: 10-28-09**

NAME	CAPACITY		AGE
	AVG	PEAK	32 years
FACILITY INSPECTED: Energy Recovery Facility **EQUIPMENT INSPECTED: Waste Heat Pumps (2)**			

CONDITION OF ITEMS INSPECTED:	Comments:
Name of Equipment Item or Group: Waste Heat Pumps (2)	**Original Equipment**
Manufacturer / Model: Bell & Gossett / VSC 7-1/2 BFW LHR	**3 Hp, 1,155 rpm, 400 gpm @ 15', 6x6x9 3/4**
Equipment No.:	

Rate each item with circled number on the scale of 1 to 6 below:

Rank	Description of Condition
1	**Very Good Condition** Only normal maintenance required
(2)	**Minor Defects Only** Minor maintenance required
3	**Backlog Maintenance Required to Return to Accepted Level of Service** Significant maintenance required
4	**Requires Renewal** Significant renewal/upgrade needed.
5	**Equipment Unserviceable**
6	**Equipment Inaccessible**

CHECK ALL THAT APPLY:

☐ Corrosion of equipment	☐ Evidence of wear
☐ Unusual noise during operation	☐ Inability of equipment to perform designed duty
☐ Lack of preventative maintenance	☐ Safety issues

BACKUP STANDBY EQUIPMENT AVAILABLE:

None

MAINTENANCE REQUIREMENTS:
PARTS NEEDING MAINTENANCE / REPAIR:
ADDITIONAL COMMENTS / OBSERVATIONS: