Turlock Irrigation District

Operations Administration

ISO Metering Study

July 2001

Introduction

The Operations Administration was asked to investigate the installation of Independent System Operator (ISO)-approved revenue meters at several locations in the District. All of these locations would be in District power plants and key intertie substations. This would be a portion of an effort to obtain an agreement to market energy to the ISO itself. The ISO has defined several currently manufactured meters that are acceptable to them for this purpose. Staff would make a selection of one of these meters, and a total of twelve meters would be installed at nine locations within the District and at one site within the Modesto Irrigation District.

This report defines a method of achieving an approved metering system for internal District power plants as well as locations at three interface-metering points. Costs are indicated in dollars appropriate as of the date of this document and, where estimates are used, they are indicated as such.

Staff of the Operations Administration prepared this document with much help from both the Engineering and Power Generation Administrations.

Executive Summary

The purpose of this report is to define one possible solution to the implementation of ISO-approved meters at each of the in-District power plants as well as the contractual intertie substations. While accurate meters already exist at each of these sites, they do not meet the criteria prescribed by the ISO and changes must be made. The existing meters were installed in the 1980's and were state-of-the-art at that time, but now are outdated. The number of meters that would be required varies from site to site. Part of the variability stems from the decision to use the existing revenue metering transformers, wiring and infrastructure in all cases. This is the least costly plan, but it does allow for some confusing installations. For example, some facilities with multiple generators (Turlock Lake, Don Pedro, Hickman Power Plants) would have only one meter that would monitor the output of the entire plant. Other sites might have one meter for each generator in the plant (Walnut and LaGrange Power Plants) and would provide the opportunity to monitor each generator separately. The effort here would be to take advantage of the existing configuration and essentially to make a meter-for-meter replacement. No investigation was made into additional meters on a "per-machine" basis where they do not exist today.

New meters would be installed at Almond, Walnut, La Grange, Don Pedro, Hickman, Turlock Lake and Dawson Power Plants. In addition, new meters would be installed at Walnut and Oakdale Substations and at the Modesto I.D. Parker Substation so that the Walnut-Parker line can be measured. The existing metering configurations are used at the power plants and because of this, some plants have meters on the lines only (even if there are multiple generators). The cost would increase substantially if the wiring configurations were redone.

In researching data for this project, it was discovered that some of the current transformers do not meet the specific requirements of the ISO because they are not revenue grade instruments. These transformers are located at Almond and Walnut Power Plants. Other sites either clearly meet the requirements or most likely meet the requirements. In the latter case, these instruments

Executive Summary (cont.)

are either made in the Orient where marking and instrument standards are different, or they are older units and the manufacturer is no longer in business. Further research will be necessary to prove or disprove the accuracy of these devices.

The District's existing analog microwave backbone communication structure will provide the dedicated communication circuits to each of the new meters. This creates some potential problems as the existing microwave system is bandwidth limited and cannot utilize the full high-speed capabilities of the meter. Discussions with the ISO technical staff indicate that the new meters could communicate at quite low data speeds, if necessary, but they encourage us to utilize the highest speed that we can reliably provide. For the purposes of this effort, we have selected a data speed that will function with the District's existing microwave system.

The normal mode of communication would be a digital data (RS-232) signal from the meter itself. Because of the need to utilize the existing analog microwave equipment, it also will be necessary to have modems at each meter site. Furthermore, modems will be necessary in Turlock to change each circuit back to a digital form. The modems will not be necessary in the future when the digital radios and fiber systems are fully operational.

The proposed structure defined herein will accommodate communication to each of the meters but is only one possibility. Other options may be available, but it is believed that this suggested configuration would be the least costly and most likely to succeed. All of the added components to make these newer meters properly communicate with an older and somewhat limited microwave system are in use at other utilities in northern California and do exactly what is proposed here.

The total cost of this effort is estimated to be as follows:

Meters and Equipment	$ 134,090
Total Labor	$ 89,980
Total	$ 224,070
Total Reoccurring Charges	$ 800 per month

It is expected that a minimum of six-months would be necessary from project start to completion based on the availability of staff and certification timelines. Additional delays could occur, but would not likely have major effects on the schedule.

A bit of history…

The technology that has made up the electric revenue metering industry has gone through some really drastic changes in the last 20 years. In the early days, electromechanical meters were the standard in the power industry. Considerable effort was made over many years to provide an accurate mechanical device and have it maintain an acceptable accuracy over time. Jeweled bearings were designed to provide low friction as well as long life. Calibration standards of the time were also mechanical and were quite expensive to purchase as well as to maintain guaranteed accuracy. At that time, an accuracy of plus-or-minus 2% was thought to be an accepted value for metering accuracy and, interestingly enough, continues to be the official State of California standard today!

In the 1950's, Westinghouse (now ABB) pioneered the concept of "magnetic suspension" for mechanical meters. With magnetic suspension, there is no longer a mechanical bearing; the rotating mass of the meter disk is "supported" by a magnetic field and thus the friction is reduced. It is possible to achieve an accuracy of plus-or-minus 0.5% with this design. Magnetic suspension was a breakthrough invention and remains in all mechanical meters that are produced today.

In the 1970's, the integrated circuit, electronic display, and later the microprocessor brought sweeping changes to the metering industry. Hybrid meters were released that used a combination of mechanical rotating disk movements as a standard for accuracy but used electronic means to accumulate and display the results. Multifunction meters, Time- of-Use (TOU) meters, as well as other specialty schemes were facilitated by the new technology.

Then, in the 1980's, the fully electronic meter was made available. The delay in this product was the time necessary to develop an electronic measurement concept that could withstand the harsh environment of a revenue meter, maintain an accuracy that was better than that of the mechanical meter, and be cost effective. As that has now been accomplished, we have meters that exhibit repeatable accuracies of 0.1% - 0.15% as standard practice. Again, this meter can survive in the direct sun, rain and other harsh environments. These meters are 100% electronic with no moving parts. They can be made using robotic technology. Servicing them is accomplished by replacing major electronic components and testing is done in order to verify accuracy. There is nothing to adjust on most of these meters and, as with other technology of the day, the cost of these meters has decreased drastically.

The District has been part of all of these eras. We still have electromechanical meters in service and still install new ones in residential applications today. We use multi-function and multi-voltage meters with good results. These meters have dropped our inventory from more than 28 normally stocked metering types to 8. They are programmed with laptop computers for the specific application and voltage for which they will be used. Thus, a meter could be used one day as a simple kilowatt-hour device on a 480-volt pump and be utilized as a 240-volt, TOU meter the next day at a convenience store. This move to this multi-function meter was a very wise decision.

According to today's standards, intertie power plant metering was quite a mechanical "contraption" in the early days. Again, ball-bearing meters were used to drive switch contacts that recorded pulses on pen-and-ink type chart recorders. Small motors, and chain and sprocket drives, kept the charts in time. In the 1960's, magnetic tape devices replaced the paper chart

A bit of history…..(cont.)

recorders and became the de facto standard for high-end metering that would be at a power plant or important intertie substation. The District used mechanical meters and magnetic tape transports at all power plants and intertie stations until mid-1980. At that time, a new product allowed a meter to be connected and to store meter pulse information that then could be sent to a central station via telephone lines. Also, the first completely solid-state meters that were coming on the market could be justified where extreme accuracy was desired. The engineering staff of TID designed a package of a solid-state Scientific Columbus JEM meter and a Sangamo Data Star mass memory recorder and planned to use this as a retrofit to the mechanical meters and tape transports that existed in power plants and intertie stations. A proposal was made by the District to PG&E to use this package. It was accepted as designed and they are still in use today. The configuration also was used and specified by PG&E for other utility uses.

ISO Requirements

The ISO has defined certain requirements for the performance of the revenue meters that are used in conjunction with their accounting systems. At this time, there are four different vendors who have meters that meet the criteria prescribed by the ISO. These meters are listed in Appendix A. Any of the four could be used or combinations could be implemented. Once operational, they all perform in the same manner and the particular brand is transparent to ISO operations.

One requirement for these meters is that they be able to communicate with the ISO computer systems. This can be done with a dedicated communications link. The details will be discussed later in this document.

For each metering site, there is an ISO-published application procedure that must be followed. Engineering drawings must list details of the metering, sizes, types and manufacturers of the equipment. A separate application for each power plant and substation must be filed. A number of consultants and outside agencies are available to do this, if necessary.

Once the application has been filed and approved, and the equipment has been installed, a third party must test, or witness the test, and verify the accuracy and correctness of the installation. This third party cannot be the ISO nor the utility. An approved list of these third party organizations is posted on the ISO web site and is included in Appendix B.

Specific Meters

The meters currently approved by the ISO are listed below:

ABB ION 8400 or ION 8500
Schlumberger Q1000
Siemens PSI Quad Plus
Trans Data Mark V

Specific Meters (cont.)

These are multi-function electronic meters and can be programmed in the field. They are not totally unique; rather, they are similar to other high-end meters already in use at the District such as the Fulcrum and Vectron. These four, however, have met certain FERC-filed criteria and have been evaluated by a third party for the ISO. Either one, or a combination of these meters, may be used for ISO applications at this time.

The Engineering Administration and Operations Administration staffs have been working together to ask these four vendors to provide presentations on their specific products. Assuming this project is implemented, both will agree on which meter(s) should be considered for District use. If more than one meter is acceptable, price likely will be the determining factor.

Meters would be replaced at sites as follows:

Site	# New Meters	Existing Meter(s)
Almond P/P	1	1 ea - Jem II
Walnut P/P	2	2 ea - Jem I
LaGrange P/P	2	2 ea - Jem I
Don Pedro P/P (1)	1	1 ea – Jem I
Hickman P/P	1	2 ea – Westinghouse Electromechanical (2)
Turlock Lake P/P	1	2 ea – Westinghouse Electromechanical (2)
Dawson P/P	1	1 ea - Jem I
Walnut Intertie (4)	1	1 ea - Jem I (3)

Oakdale Intertie	1	1 ea - Jem I (3)
Parker (MID)	1	1 ea - Jem I (3)

(1) TID Lines Meter, only. Existing Jem I meters on units to remain.
(2) Older electromechanical metering package consisting of one kW-Hr meter and one K-Qhr meter. One new meter would replace both functions.
(3) Intertie sites have complete redundant systems. The proposal is to replace only one meter. The second meter would remain unaltered.
(4) Walnut Power Plant and Intertie Substation will share the same communications infrastructure. This report refers to one site at Walnut, which contains three meters (2 at the power plant, 1 at the substation).

In addition to the revenue meters themselves, the District also has a Sangamo Datastar data recorder installed on each of these existing meters. The purpose of this recorder is to store interval data and allow this data to be retrieved as desired by the District. It is planned that the new ISO meter would drive the recorders in a similar fashion and the data retrieval process could continue. Please note that the District has “read-only” capabilities on the recorders. Since the original installation of these devices, PG&E has maintained supervisory control over the recorders. Some discussion with PG&E may be necessary if the recording criteria must be changed as a result of this new contract with the ISO.

Instrument Transformers

During the course of this project, it was necessary to verify the type of potential and current transformers that are used to drive the revenue meters at each site. There are basically two types of transformers used in the utility industry: (1) relaying transformers and (2) metering transformers. Electrically they work the same, but they are calibrated differently. In particular, the ISO requires that approved metering systems utilize a specific grade of metering transformers. It was discovered that the required transformers were in place at most installations. Some of the locations are believed to contain the proper units, but further research will be necessary to verify that premise. This is because the transformers are either made in the Orient and they do not comply with the particular ANSI standards for marking, or they are quite old and the manufacturer is no longer in business.

Details of the specific instrument transformers are included in the following table.

SITE	**TRANSFORMERS**	**MEETS/DOES NOT MEET**
Almond P/P	General Electric JVS-350 (Potential) Westinghouse Bushing Type (Current)	Yes No

Walnut P/P	Westinghouse Type APT (Potential) General Electric Bushing Type (Current)	Yes No
La Grange P/P #1 #2 #1 & #2	Westinghouse Type RCR (Current) General Electric JKS-3 (Current) General Electric JVM-3 (Potential)	Yes Yes Yes
Don Pedro P/P	Westinghouse PCA-5 (Potential) Hitachi UB (Current)	Probably Does Probably Does
Hickman P/P	General Electric JKW-5 (Potential) Westinghouse KIR-11 (Current)	Yes Yes
Turlock Lake P/P	General Electric JKW-5 (Potential) Westinghouse KIR-11 (Current)	Yes Yes
Dawson P/P/	General Electric JCP-0 (Current) Fuji PB2-4F/200 (Potential)	Yes Probably Does
Oakdale Substation	Allis-Chalmers SPW-111 (Potential) SGW-11 (Current)	 Probably Does Probably Does
Walnut Substation	Westinghouse GEP4501 (Current) MSY900 (Potential)	 Yes Yes
Parker Substation (MID)	Westinghouse GEP4501 (Current) MSY900 (Potential)	 Yes Yes

Communications

While the meters themselves do monitor and store certain revenue metering data, they also must transmit this data to the ISO in Folsom by way of an internal modem. A dedicated high-speed telephone type of circuit typically performs this function. Each of the field meters connects to a centrally located router which allows the equipment in Folsom to address each meter as a separate entity, download the data from that meter, and move to the next meter. This is a full-time circuit and this process to read either one meter, a group of meters, or all of the meters is performed as necessary. This circuit can be dedicated wire lines, company-owned wire, fiber and/or high-speed microwave radios. Each meter is connected to a router. This router is located at some central point within the TID service territory. The ISO then communicates with the router via one single communications line between the router location and the ISO in Folsom. All of these lines are in place at all times – there is no dial-up function. Other combinations also are available. It is understood that current ISO procedures are to read the meters once per day.

The meters themselves communicate at a maximum of 9,600 baud. Normal communication is via an RS-232 connection to each meter that is fed to a centrally located digital router. This router would gather up all of the separate meter circuits and feed them to the ISO via the single high-speed line. There is some flexibility on the speed of this line. Circuits using 56 kbaud-reduced ISDN lines up to full T1 circuits are in use today. The speed of this line is a function of the number of revenue meters that are connected. The ISO staff indicated that a dedicated 56-kbaud circuit would be suitable for our application.

The District analog microwave system will not support the direct use of digital signals (RS-232 or otherwise). The new digital microwave and fiber optic systems will allow for this when they become fully functional. This is not scheduled for implementation for two to three years. In an effort to resolve this, we suggest that the meters use a modem at this time. The modem will allow the analog microwave radios to be used in the interim. In addition to the field modems, a modem also would be needed for each meter and would be located at the router in Turlock to change the signal back to a digital configuration. These modems would be removed when the digital microwave and fiber system becomes operational. In addition, we also would not be using the meters at their full 9,600-baud capabilities (even with the modems) because of an analog microwave limitation. We have tried this speed in the past, but with marginal results. It is proposed to operate the meters at 1,200 baud as an interim measure. Other standard communications speeds down to 300 baud will also work, although the ISO staff would like us to use the highest speed feasible for our communications systems – this is understandable. Because of a limited number of available analog channel cards, and the fact that new ones are no longer available, we have tried to use the existing stock of channel cards. A router would gather up all of the separate meter circuits and feed them to the ISO via the single high-speed line. There is some flexibility on the speed of this line. Circuits using 56 kbaud-reduced ISDN lines up to full T1 circuits are in use today. The speed of this line is a function of the number of revenue meters that are connected. The ISO staff indicated that a dedicated 56-kbaud circuit would be suitable for our application.

In an effort to conserve the analog channel cards, it is proposed to use multiplex boxes at the Walnut and La Grange sites. Using these multiplex units, we can use one pair of channel cards for each circuit (4 in total) as opposed to one pair of channel cards for each meter (total of 10). Because the number of channel cards is limited, we must use equipment such as this. These would be surplus when the digital equipment is installed.

Communications (cont.)

At the present time, all of the power plants and substations under consideration for ISO metering are part of the existing analog microwave system.

The configuration of Figure 2 reflects one plan that would allow the ISO direct access to all of the meters. It has been modeled after similar situations at PG&E where older analog radios are still in use. Once the new digital radios and fiber are fully functional, then the meters can be accessed at a higher speed and the interim multiplex equipment and modems can be removed. It is suggested that the new fiber and digital radios be planned from installation to integrate these new meters along with the other equipment to which they will be interfaced. No dollars are included in this plan to provide for the communications transition to the new fiber and digital microwave systems.

There are two additional reoccurring costs that must be considered. The high-speed line to the ISO likely will be leased from a common carrier such as Pacific Bell, MCI or Sprint. It is anticipated that this will cost $500 per month plus a one-time engineering charge of $3,000. In addition, it is anticipated that Modesto I.D. will request payment for our use of their communications channel from their equipment at Westley to their Parker Substation. We would plan for $300 per month for this plus $3,000 in engineering costs by MID staff.

Costs

Costs for the implementation of this plan includes the capital cost of the meter and necessary equipment, the labor cost to replace each of the existing twelve meters, costs to interface with the existing analog microwave equipment, costs for engineering staff to provide necessary drawing changes, costs for third part field certification and costs for application to the ISO for each site. In addition, an estimated value has been included for the portion of communications from Westley Switchyard to the MID Parker Substation for the purposes of communicating with the meter at Parker, which measures the Walnut-Parker flows.

A brief breakdown of costs is as follows:

Meters	$ 49,000

Communications	$ 56,000
Misc. Hardware	$ 16,900
Outside Labor	$ 41,200
Installation Labor	$ 34,450
Engineering Labor	$ 6,150
Contingency	$ 20,370
Total	$224,070
Reoccurring Charges	$ 800 per month

Figure 3 provides a detailed breakdown of these costs.

Time Frame

The entire project is projected to be at least a six-month effort from project go-ahead to completion. Long lead times are expected to order and receive the meters and to order, design and install the leased line from Turlock to the ISO in Folsom. Other items have shorter lead times and can be performed concurrently with ongoing tasks. Assumptions are being made based on employee and consultant availability that is current as of the date of this document. Some delays could be expected in the application and certification process but likely would not lengthen the project substantially.

Appendix A defines a proposed timeline for the project.

Figure 1

Basic Concepts

Figure 2

Communications Configuration

Figure 3

Cost Spreadsheet

Appendix A

ISO Meters

Appendix B

ISO 3rd Party
Organizations

Appendix C

Project Timeline

ISO Approved Meters

The following meters have been certified and are compliant to ISO standards for use in ISO Metered Entity applications.

For information on the Siemens PSI Quad 4 Plus meter and MAXSys 2510 Contact Rob Ingalls at:

Ingalls Power Product
P.O. Box 8335
Emeryville, CA 94662
Phone: (888) 204-9090
Fax: (510) 204-9019
Website: www.ingallspower.com

For information on the Schlumberger Q 1000 meter contact Mark Sieben at:

Schlumberger Resource Management Services, Inc.
44 Olive Ave.
Piedmont, CA 94611
Phone: (510) 547-5294
Fax: (510) 547-5282
Email: sieben1@slb.com
Website: http://www/slb.com/rms

For information on the TransData MARK -V Series Energy Meter Contact: Trace Gleibs, Executive Vice President of Sales tgleibs@transdatainc.com
Malcolm Swain, Western Regional Sales Manager
malcolm.swain@transdatainc.com

TransData, Inc.
P.O. Box 832919
Richardson, Texas 75083
Phone: (972) 470-9993
Fax: (972) 470-9550
e-mail: tdmeters@transdatainc.com
website: www.transdatainc.com

For information on ABB's ION8500 or ION8400 Meters Manufactured by Power Measurement Contact: Doug Varner, Marketing Representative, ABB Automation or Jason Sheppard, Marketing Manager Utility Systems, Power Measurement Ltd.

ABB Automation
208 South Rogers Lane
Electricity Metering
Raleigh, NC 27610
Phone: (919) 212-4800
Fax: (919) 212-4717
e-mail: doug.varner@us.abb.com
website: www.abb.com/us

Power Measurement Ltd.
2195 Keating Cross Rd.
Saanichton, BC V8M 2A5
Phone: (250) 652-7100 Ext: 7141
Fax: (250) 652-0411
e-mail: jason_sheppard@pml.com
website: www.pml.com

If there are any questions, please call Leamon Calloway at (916) 351-2214 or by e-mail at lcalloway@caiso.com

APPROVED ISO METER INSPECTION COMPANIES

The Companies listed below have entered into agreement with the ISO, have certified ISO Meter Inspectors and plan to offer ISO Meter Inspection Services to Metered Entities.

Ameren DMS
5862 Bolsa Avenue, Suite 108
Huntington Beach, CA 92649
Contact: Ben LaRussa
(714) 373-9401

Joslyn-Hi-Voltage/Fisher Pierce
90 Libbey Parkway
Weymouth, MA 02189
Contact: George Bronson
(800) 969-9797 Ext. 313

Applied Metering Technologies, Inc.
12407 Slauson Avenue, Suite A/B
Whittier, CA 90606-2833
Contact: Mario Natividad
(562) 464-9555

Lopex & Associates Engineers
700 Glendora Avenue
La Puente, CA 91744
Contact: Lourdes Lopez
(818) 330-5296

AXON Field Solutions
300 Gold Avenue, SW, Suite 1200
Albuquerque, NM 87158
Contact: Mr. Walter R. Drangmeister
(888) 353-2687

Schlumberger Industries
6960 Koll Center Parkway, Suite 300
Pleasanton, CA 94556
Contact: Jamie Arrison
(925) 461-5150

ELC Electric Incorporated
17424 Mount Cliffwood Circle
Fountain Valley, CA 92708-4101
Contact: Edward Clark, Jr.
(714) 435-0370

Trimark Associates, Inc.
893 Embarcadero Drive #4
El Dorado Hills, CA 95762
Contact: Mark Morosky
(916-941-0440)

Energy Services, Inc.
7300 Fenwick Lane
Westminster, CA 92683
Contact: Rob Morrison
(714) 895-0364

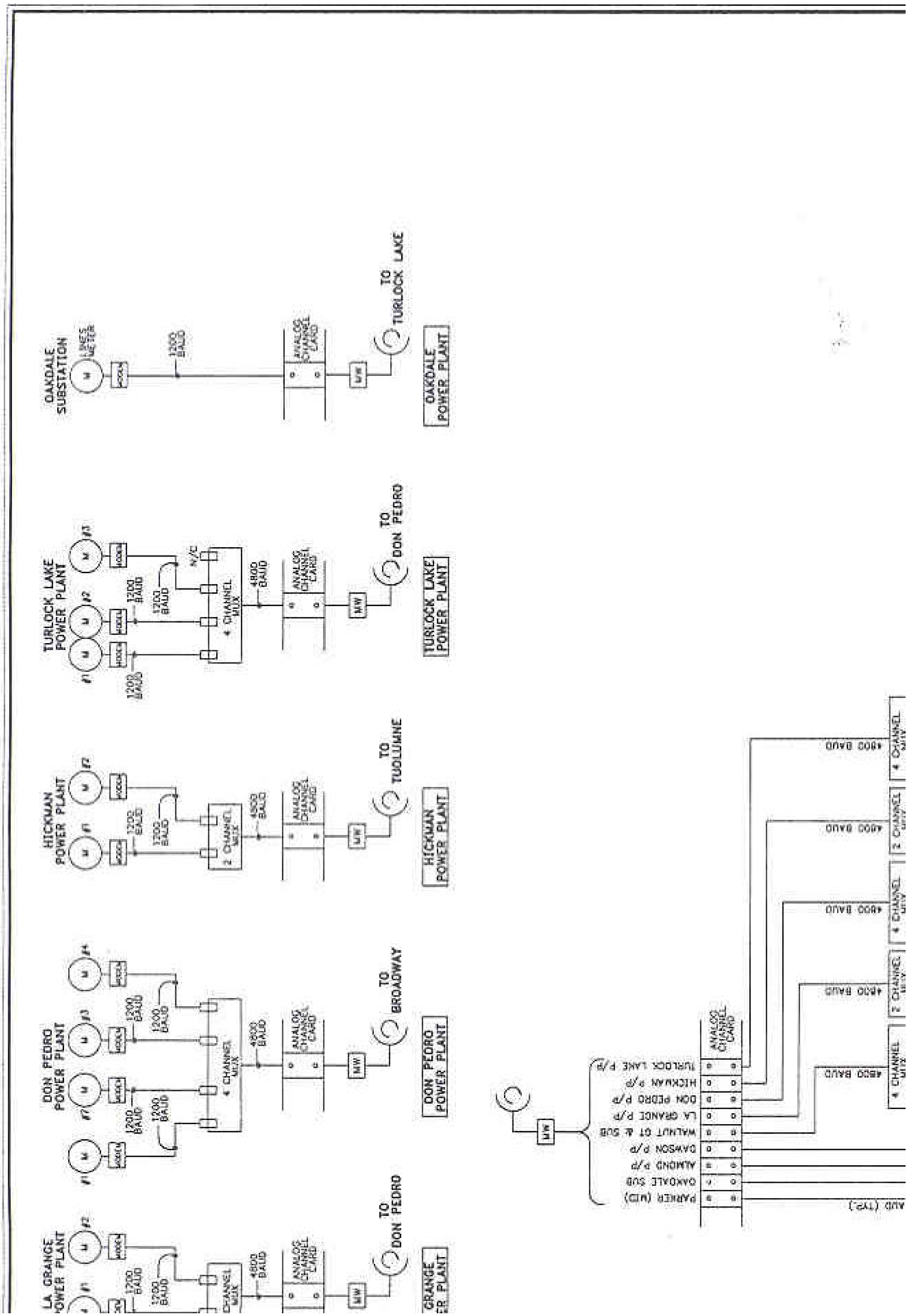
Utility Technical Services
12039 Wanda Lane
Redding, CA 96003
Contact: Kenneth B. Williams
(530) 549-4917

IS

ID		Task Name	Duration
1		**Begin Project**	**0 days**
2			
3		**Order/Receive Equipment**	**75 days**
4			
5		**Engineering Time (TID)**	**9 days**
6			
7		**Engineering Time (MID)**	**10 days**
8			
9		**Order & Install 56k baud line**	**75 days**
10			
11		**Install & Wire Channel Equipment**	**37 days**
12		Almond P/P	3 days
13		Walnut P/P & Sub	6 days
14		LaGrange P/P	5 days
15		Don Pedro P/P	5 days
16		Hickman P/P	3 days
17		Turlock Lake P/P	4 days
18		Dawson P/P	3 days
19		Oakdale Sub	3 days
20		Parker Sub (MID)	5 days
21			
22		**Install Metering Equipment**	**24 days**
23		Almond P/P	2 days
24		Walnut P/P & Sub	5 days
25		LaGrange P/P	3 days
26		Don Pedro P/P	3 days
27		Hickman P/P	2 days
28		Turlock Lake P/P	2 days

ISO

ID		Task Name	Duration	Sta
31		Parker Sub (MID)	3 days	Wed 12
32				
33		ISO Certification	28 days	Mon 12
34		Almond P/P	3 days	Mon 12
35		Walnut P/P & Sub	3 days	Thu 12/
36		LaGrange P/P	3 days	Tue 12/
37		Don Pedro P/P	3 days	Fri 12/
38		Hickman P/P	3 days	Wed 12
39		Turlock Lake P/P	3 days	Mon 12
40		Dawson P/P	3 days	Thu 1/
41		Oakdale Sub	3 days	Tue 1/
42		Parker Sub (MID)	4 days	Fri 1/1
43				
44		Test System	5 days	Thu 1/
45				
46		Project Complete	0 days	Fri 1/2


LA GRANGE POWER PLANT
1200 BAUD
4800 BAUD
ANALOG CHANNEL CARD
MW
TO DON PEDRO
DON PEDRO POWER PLANT
4 CHANNEL MUX
TO BROADWAY
HICKMAN POWER PLANT
2 CHANNEL MUX
TO TUOLUMNE
TURLOCK LAKE POWER PLANT
N/C
OAKDALE SUBSTATION
LINES METER
TO TURLOCK LAKE
OAKDALE POWER PLANT
TURLOCK LAKE P/P
HICKMAN P/P
DON PEDRO P/P
LA GRANGE P/P
WALNUT GT & SUB
DAWSON P/P
ALMOND P/P
OAKDALE SUB
PARKER (MID)

ISO Metering Study											
			Outside		Additional	Meter	Installation		Engineering		
Site	# Meters	Meter Cost	Eng. Cost	Comm. Cost	Equipment	Certification	Labor		Labor		Total
Power Plants											
Walnut P/P	2	$7,000	$2,300	$2,600	$1,500	$3,000	$3,716		$350		$20,466
Additional CTs					$9,400		$4,200				$13,600
Almond P/P	1	$3,500	$1,800	$2,600		$1,500	$1,588		$350		$11,338
Additional CTs					$4,700		$2,100				$6,800
Hickman P/P	1	$3,500	$1,800	$1,800		$1,500	$1,588		$350		$10,538
Turlock Lake P/P	1	$3,500	$2,300	$1,800		$1,500	$2,129		$350		$11,579
Don Pedro P/P	1	$3,500	$2,000	$1,800		$1,500	$3,176		$350		$12,326
LaGrange P/P	2	$7,000	$2,300	$2,600	$1,300	$3,000	$3,176		$350		$19,726
Dawson P/P	1	$3,500	$1,800	$1,800		$1,500	$1,588		$350		$10,538
Intertie Stations											
Wanlut Intertie	1	$3,500	$1,800	$1,800		$1,500	$1,012	(2)	$350		$9,962
Parker Intertie (MID)	1	$3,500	$2,300	$1,800		$1,500	$4,263	(3)	$3,000	(1)	$16,363
Oakdale Intertie	1	$3,500	$1,800	$1,800		$1,500	$1,588		$350		$10,538
Other											
Broadway Yard				$21,600			$4,326				$25,926
Central Equipment				$9,000							$9,000
Spare Equipment		$ 7,000		$5,000							$12,000
Leased Line Costs			$3,000								$3,000
(1) Estimate for MID							Total				$203,700
engineering staff.											
(2) Electronic labor							10% Contingency				$20,370
inc. @ Wanut P/P.										7	
(3) Including Westley							**Grand Total**				**$224,070**
labor.											