ATTACHMENT K

INJECTION PROCEDURES

OPERATION OF INJECTION WELLS

A. ABOVE GROUND SYSTEM

Power Plant Water Conditioning
Makeup water will be pumped from the raw water storage tank to the cooling tower basin as required to replace water lost from evaporation, drift, and blowdown. A chemical feed system will supply water conditioning chemicals to the circulating water to minimize corrosion and control the formation of mineral scale and bio-fouling. Sulfuric acid will be fed into the circulating water system in proportion to makeup water flow for alkalinity reduction to control the scaling tendency of the circulating water. The acid feed equipment will consist of a bulk sulfuric acid storage tank and two full-capacity sulfuric acid metering pumps.
To further inhibit scale formation, an alkaline scale inhibitor solution will be fed into the circulating water system in an amount proportional to the circulating water blowdown flow. The scale inhibitor feed equipment will consist of a chemical solution bulk storage tank and two full-capacity scale inhibitor metering pumps.

To prevent bio-fouling in the circulating water system, a sodium hypochlorite solution will be fed into the system. The hypochlorite feed equipment will consist of a bulk storage tank and two full-capacity hypochlorite metering pumps. Two full-capacity metering pumps will be provided for feeding either stabilized bromine or sodium bromide as supplemental biocides.

Wastewater Sources
Wastewater will be disposed of using a new deep well injection system. The combined wastewater discharge from the plant will consist of cooling tower blowdown, RO rejects, evaporative cooler blowdown, CTG intercooler condensation, and water effluent from the oil-water separator (Attachment H).

Pre-injection Process Plant

Holding Tank
The combined process wastewater will be pumped at between 375 and 615 gallons per minute (gpm) via an 8 inch pipeline to a 20,000 gallons wastewater holding tank. The 20,000 gallons holding tank will also act as a reservoir to moderate the injection flow rate (Figure K1, Attachment K).

Chemical Treatment of Wastewater
The decision to add chemicals to the wastewater in the holding tank will be based on the chemical compatibility of the wastewater and formation. Chemical compatibility tests can be finalized when formation and PEC wastewater become available. Hydrochloric acid (15%) and bio-growth retardants are common additives to the injectate.

Injection Pumps
From the holding tank, the wastewater could be gravity fed by eight-inch diameter pipelines, or pumped via 6 inch pipelines to any two of three centrifugal pumps. Each variable speed drive centrifugal pump will be connected separately to any two (2) primary injection wells (eg. Well Nos. IW1 and IW2). The third injection well will be a backup injection well.

The rate of injection to each of the two selected wells is expected to range between 150 to 350 gpm for a total maximum flow of 615 gpm (excluding additives). Based on existing injection well installations, the required injection rate might be achieved within a pressure range of 50 to 150 pounds per square inch (psi).

Surge Arrestor, Valves and Meters
Water hammer will most probably occur if the flow control valves are shut rapidly, or the injection rate is increased or decreased rapidly. To minimize water hammer, all valves will be opened and closed slowly. The starting and stopping of pump motors will be controlled to eliminate abrupt start and stop of the wastewater flow. Besides reducing water hammer, the gradual shut-down and start up of injection flow will prevent excessive silting of the wells (Hayatdavoudi, 2005). The speed of the injection pump motors at startup and shutdown will be altered gradually, to eliminate or greatly reduce water hammer. If a valve should accidentally close or open abruptly, a surge arrestor, installed between each injection pump and wellhead, will prevent the destruction of the system, by water hammer (Figure K1, Attachment K).

The injection system
The array of piping and flow control valves shown on Figure K1, Attachment K, will provide complete flexibility in the operation of the wastewater injection system. The wastewater can be diverted to any of the three (3) injection pumps and injection wells IW1, IW2 and IW3. The injection pumps will be controlled so that the pressure and rate of injection are always within the operating limits specified by the UIC permit.

Operating Parameters

- The bottom hole pressure will not exceed the UIC permissible maximum;
- The injection pressure will be controlled so as not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, significantly alter the fluid containment capabilities of the confining zone, or cause the movement of injection or formation fluids into an underground source of drinking water;
- The total injection pressure will not exceed the maximum stress of the materials used to construct the well;
- The maximum sustained injection pressure will not exceed two-thirds of the most recent mechanical integrity test pressure.

- The annulus between the tubing, where required, and the innermost string of casing will be filled with a fluid and a pressure will be maintained on the annulus.
- The maximum velocity of injected fluid will not exceed the mechanical limits of the well design to a point where the formation will be adversely affected.
- The maximum injection velocity will not exceed a peak hourly flow rate of ten feet per second (ft/sec), unless the higher velocities can be shown not to compromise the integrity or operation of the well.

Well Operation Tests

The construction permit includes a period of temporary injection operation for the purposes of testing the injection wells and system.

Prior to commencement of operational testing, the PEC will complete the construction of the injection well(s) and submit a notice of completion of construction to the UIC Program Director.

The UIC Program authorization for well tests will specify the conditions under which operational testing is approved. The well test authorization will include:

1. Injection pressure limitation,
2. Injection flow rate limitation,
3. Injection well monitoring requirements,
4. Effluent monitoring requirements,
5. Weekly ground water sampling of monitor wells,
6. Monthly specific injectivity testing,
7. Reporting requirements, and
8. An expiration date for the operational testing period not to exceed two years.

(c) Before authorizing operational testing, the UIC Program Director will conduct an inspection of the facility to determine if the conditions of the permit have been met.

Each well will first be tested for integrity of construction, followed by short term injection tests to allow for the prediction of the operating pressure. The PEC will submit the following well test information to the UIC Program Director:

- A copy of the borehole video survey(s),
- Geophysical logs,
- Mechanical integrity test data,
- Data obtained during the short term injection testing conducted
- Confining zone data.
- Background water quality data for the injection and monitor zones,
- Wastewater stream analysis,
- As-built well construction specifications, and
- Other data obtained during well construction to demonstrate the well will operate in compliance with UIC Program and USEPA Class I, Non-hazardous Deep Injection Well Codes.

B. PLANS FOR WELL FAILURES

Site Specific Operation

Well Numbers IW1 and IW2 will be used as the primary injection well. Well IW3 will be the primary back-up well. Well IW4 will be constructed at a future date to provide additional security in the event of failure or deterioration of any of the Wells IW1, IW2 or IW3. All the wells will be designed and constructed to provide maximum injection efficiency. Core permeability and volume mapping indicate that any two of the proposed injection wells could probably provide adequate capacity for the disposal of the wastewater generated by operating the PEC facility at peak wastewater production.

During the temporary shutdowns of wells IW1 or IW2, injection well IW3 will be used as the auxiliary well. It is assumed that it will take approximately 2 or 3 days for any of the wells to be brought back into operation after repairs, well pressure tests or well maintenance. During this period, wastewater will be pumped into the two available wells.

If IW1 or IW2 becomes inoperable, and IW4 has not been constructed, then IW3 will become the primary well and Well IW4 will be constructed, and become the back-up well.

If any two of the three installed injection wells become inoperable, then well IW4 would become a primary well. In this event, PEC would submit a permit application to install additional backup wells.

PEC will follow the following contingency plans to cope with all shut-ins or well failures:

- In the event the PEC is temporarily unable to comply with any of the conditions of a permit due to breakdown of equipment, power outages, destruction by hazard of fire, wind, or by other cause, the PEC will notify the UIC Director, by telephone, fax and/or email within 24 hours of breakdown or malfunction.
- A written report of any noncompliance will be submitted to the UIC Program Director within five days after its occurrence. The report will describe the nature and cause of the breakdown or malfunction, the steps being taken or planned to be taken to correct the problem and prevent its reoccurrence, emergency procedures in use pending correction of the problem, and the time when the facility will again be operating in accordance with permit conditions.
- Under emergency conditions in which the PEC is unable to use the permitted primary or secondary disposal methods, the PEC will be shut down the facility until an emergency discharge permit has been obtained prior to the application of any emergency discharge methods;
- The PEC will notify the Director, UIC office, whenever an emergency discharge has been obtained and applied;
- The primary emergency disposal methods that will used at the PEC facility are fully operational backup injection wells;

- In the event a well must be redeveloped, the PEC will address disposal of backwashed fluids in a written submittal to the UIC Program. The redevelopment of the well, including the disposal method, will meet all applicable UIC Program and USEPA rules and it will not adversely affect the construction or operation of the well.
- If a well is found to lack mechanical integrity, EPA will be notified, and appropriate action will be taken to continue injection service within the applicable state, federal, and local requirements.
- In the event of tubing or packer leaks, injection will be suspended until the appropriate section of tubing or packer can be replaced.
- For pump failure, the pump, motor, or associated electrical system components will be replaced or repaired. For parts that are not readily available, spares will be stored at the plant.
- If the injection well is unable to be returned to service, the failed well will be abandoned in accordance with the original plugging and abandonment plan, or other applicable state federal and local regulations.
- In the event of a significant quake, the cement around the casing may crack. After an earthquake of magnitude 4.0 and greater, the injection of wastewater would be suspended, and sonic logs and mechanical integrity tests performed on all the injection wells. If more than one of the injection wells was found to be damaged, then the ECGS would immediately stop the wastewater disposal operations.

C. OPERATING INSTRUCTIONS AND MONITORING PROGRAM

Operation and Maintenance Manual

Operation and maintenance manuals for the injection well system, or portions thereof, will be prepared for the use of operators, maintenance personnel, technicians, laboratory personnel, and others as appropriate, and will consist of:

- Written instructions provided to the injection system operators which specify:
- Procedures for the safe reliable operation of the system; and
- Procedures to be used in the event of an emergency.
- Records of the basic engineering design and equipment description; and
- A program to assure proper maintenance of the system.
- A copy of an approved operation and maintenance manual will be provided to the operators, maintenance personnel, technicians, laboratory personnel, and others as appropriate. The manual(s) will be available for reference at the facility or other site readily available to the operator.
- The manual will be revised to reflect any facility modifications performed in order to comply with the requirements of this chapter or to reflect experience resulting from facility operation.

Monitoring Program

The monitoring program will include:

- The analysis of the injected fluids at a frequency specified in the permit to yield representative data on their characteristics;
- The installation and use of continuous indicating, recording, and totalizing devices to monitor flow rate and volume, and installation and use of continuous indicating and recording devices to monitor the injection pressure and the pressure on the annulus between the tubing and the innermost string of casing;
- A controlled injection test or a bottom hole pressure survey, if a long-term trend of increasing injection pressure is indicated.
- A demonstration of mechanical integrity at least once every five years during the life of the well;
- As part of the baseline monitoring information, a video survey from the surface to the bottom of the injection zone will be run prior to injection but after completion of testing, and is planned for every five years thereafter, or more frequently if impairment of the integrity of the casing, tubing, or formation is suspected based on physical or geochemical data such as water quality, pressure changes, or mechanical integrity results; and
- Before running the survey, adequate provisions shall be made to assure that fluid in the well is of sufficient clarity to provide a baseline survey of acceptable quality.

- The PEC will submit an injection well system report that includes the methods used in the collection and recording of operational data, and ensure the data is presented in a fashion that can will enable the UIC Program Director to readily evaluate the performance of the injection system.

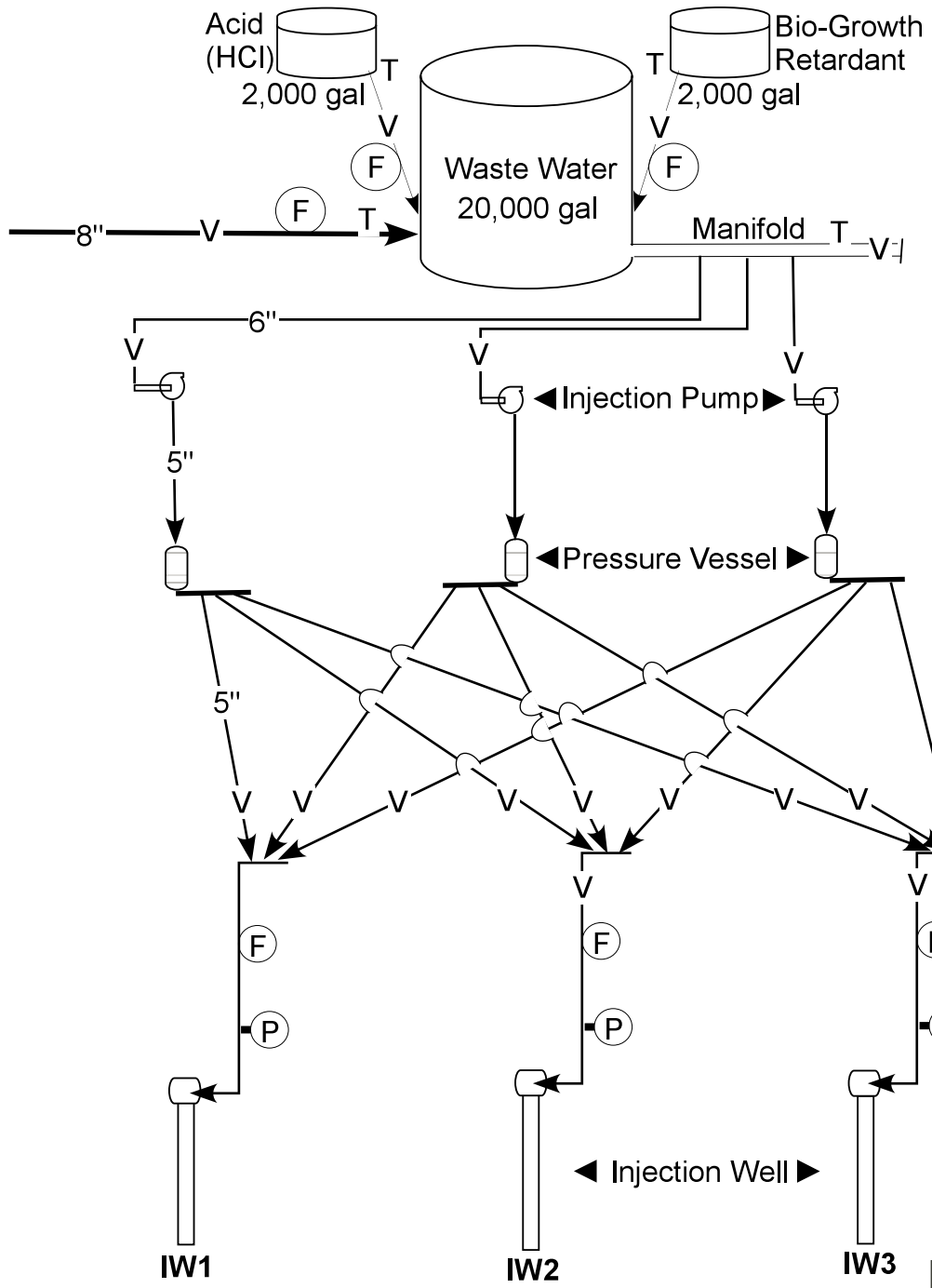
The monthly injection well system reports will include the following:

- The physical, chemical, and other relevant characteristics of injection fluids;
- Daily readings of the pressure and flow for each well;
- Monthly average, maximum and minimum values for injection pressure, flow rate and volume, and annular pressure; and
- Additional information specified in the Final UIC Class I Injection Well Permit.

In addition to the above reports, the PEC will present a report within three months after the completion of periodic mechanical integrity tests; and any other test of the injection well system performed by the PEC, as required by the UIC Program Director.

Specific injectivity testing will be performed while the pumping rate to the well(s) has been set at a predetermined level and reported as the specific injectivity index (gpm/specific pressure (psig)). As part of this test, the well will be shut-in for a period of time necessary to conduct a valid observation of pressure fall-off. The PEC will propose a pumping rate to be used, based on the expected flow, the design of the pump station including the volume of the wet well and pump type(s), and the type of pump controls used.

The PEC will conduct one pressure fall-off test annually. If physical or geochemical data such as water quality, pressure changes, or mechanical integrity test results indicate that fluid movement into or between underground sources of drinking water may be occurring, the PEC will submit additional data to provide reasonable assurance that the injection operation is in compliance with EPA requirements. The additional data shall be submitted with the periodic operations reports, the content and frequency of which will be specified in the permit.



LEGEND	
V	Valve
T	Tap
F	Flow & Volume Meter
P	Pressure Monitor

SURFACE INJECTION SYSTEM
PROPOSED PANOCHE ENERGY CENTER

URS	CREATED BY: DH	DATE: 08-31-06	FIG. NO:
	PM:	PROJ. NO: 28906795.00200	K1