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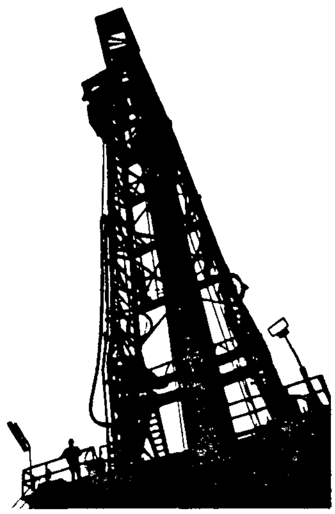

Appendix Q

Flow Test Procedures

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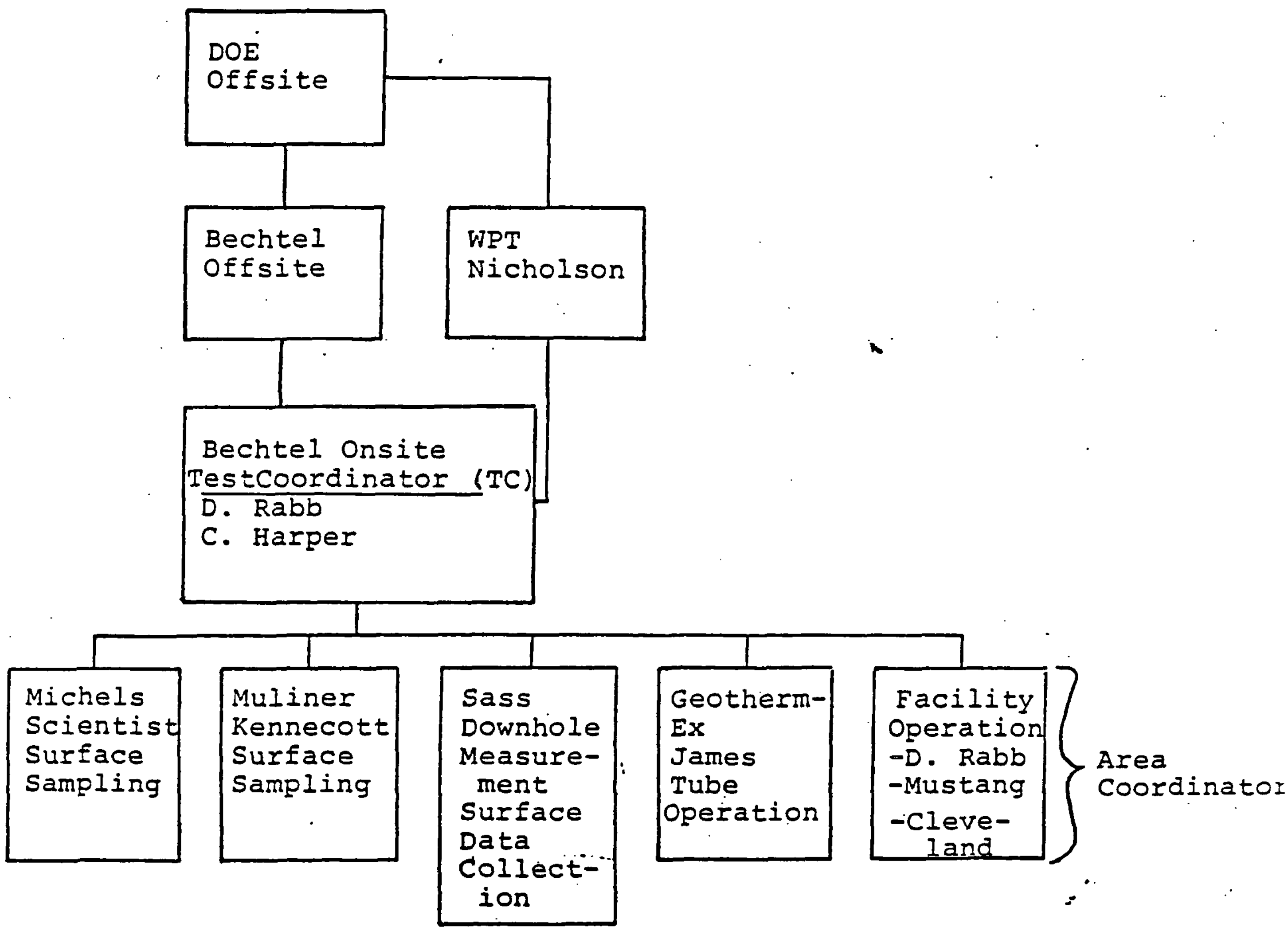
6000 Plus Feet Flow Test Program #1

At an agreed-upon production zone below the 9-5/8" casing point (at 6000'), the SSSD Project will flow the zone following the proposed test program shown in Table 1, to collect fluid samples, temperature and pressure data. This document contains the organization and procedures that will be implemented for the flow test. The five sections that will be discussed are:

- Organization
- Safety and Operation / Facility Design
- Data Collection
- Facility Operation
  - Pre Test Activity
  - Flow Test
  - Test Termination
  - Reinjection / Flush / Storage
- Work Areas
  - Operations (Bechtel)
  - James Tube (GeothermEx)
  - Data Collection & Downhole (USGS)
  - Scientist Fluid Sampling (Michels)
- Fluid Sampling Procedures
- Instrument Calibration Data

Flow Test Organization



Flow Committee

-Purpose

To decide when to flow the well.

-Members

Gerald Reich

John Sass or designee

Bob Nicholson

Wilf Elders (concurrence by phone)

Larry Grogan (concurrence by phone)

Safety and Operation

- All participants will monitor their work area for unsafe situations and developing process problems. Should a situation develop, remove personnel from situation and notify the Test Coordinator, (TC), immediately in order that a collective corrective action can be identified and executed.
- Bechtel will walk through the entire facility periodically during the flow test to look for unsafe situations.
- All process valving of 4" diameter or larger and piping changes will be performed by the operation group and with the full knowledge of the Test Coordinator (TC). Ever effort will be made to notify the Area Coordinator (AC's) of the impending changes.
- All valving will be performed by experienced technicians and operators.
- Operation of all 10" valves will be performed slowly and the upstream pressure will be monitored. If unexpected pressure responses occur, the valve operator should cease valve operation or return the valve position to the previous setting. Determine the cause of the pressure response before resuming valve operation.
- Depending on the period of the flow schedule, flow throttling will be performed by operating either, valve #2 (flow to reserve pit), valve #6 (flow to muffler), or valve #20 (flow via blooey line to brine pond).

Facility Design

Main Flow Line

The main flow line consist of 10" schedule 60 Grade B pipe, extra strong fittings, and Class 600 valves. The material is designed to handle the design conditions of:

Pressure - 700 psig maximum

Temperature - 650°F maximum

Flow - 2 phase steam and saturated brine with suspended particles.

Other Pipe

The 6" reinjection system is schedule 40 pipe, standard fitting, and 150 pound valve except at connection points to the 10" flow line (extra strong fittings and Class 600 valves).

Data Collection

- During unsteady operation, as frequently as is practical and at least once every 15 minutes.
- During steady operation, once every 30 minutes.
- Data collection will start with the monitoring of wellhead temperature and pressure during warm-up.
- Data collection will continue through the initial flow, the series of step flows, after the well is shut-in, and during reinjection.
- Instrumentation that appears to be providing erroneous data should be reported to the TC immediately. A qualified and fully equipped instrument mechanic will be on site for the flow test.

Pre-Flow Test Activities

-Decide to POOH and flow well - USGS, Drilling Supervisor, DOE Representative (concurrence from Kennecott and chief Scientist).

-Circulate mud out and water in.

-POOH

-Remove B.O.P.E. and install wellhead.

-Perform down hole measurement while well heats up. (Water resources)

-Install final connection from wellhead to flow line (10"-B-4).

-X-ray welds and hydrotest.

-Dry-run sampling:

- -equipment assembly & connection to sample locations.
- -personnel orientation: safety requirement, overall facility design limitations, on-site procedures including organization, facility familiarization, work station assignment.

-Perform final walk-thru and check operability of all valves and instruments.

-Have tools and equipment ready at James Tube and SP3, 4, 5 and 6 for orifice, James Tube and tubing changes.

-Install 0-1000 (approx.) psi pressure gauge on vertical Kennecott sample port.

-Notify vacuum truck as to when to be on-site (option).

- Set-up valving for initial flow to reserve pit.
  - Open valves 2, 13 and 20.
  - Close Valves 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 19 and 21. All valves at SP1, 2, 3, 4 and 5.
- Post signs and perform non-authorized personnel sweep.
- Check with all Area Coordinators (AC) for readiness.

Flow Test

1. Initial flow to reserve pit to expell contaminated fluid.

   -Remove "Do Not Operate" tag on valve WH3.

   -Slowly open valve WH3.

   -Open pressure gauge isolation valve on SP2.

   -Monitor and record wellhead and SP2 data.

2. Order N_2 if insufficient flow is observed (decision by flow test committee.

3. Rig-up and stimulate with N_2.

4. Flow to reserve pit until one of the following is satified.

   -the pit is approximately 2/3 full.

   -the brine energy is beginning to become unmanageable. (high fluid pressure or temperature, high flow rate).

5. Prepare to flow brine through valve #3, bypassing the scientist sample loop via valve #13, bypassing the James tube via valve #20. Check valving and confirm that valves #4, #14, #15 and #16 are CLOSED and valve #13 and #20 are open.

6. Perform flow switch without altering the fluid pressure, While watching and maintaining pressure via the guage at SP2, the isolation flow line valve (valve #3) is slowly opened and the blooey line valve (valve #2) is slowly closed SIMULTANEOUSLY.

7. Perform switch of throttling service from isolation valve #3 to throttle valve #20. While watching and maintaining the pressure at SP2, slowly open valve #3, the isolation valve,

and throttle down on valve #20 (the brine pond blooey line valve). Because of the PI location close to valve #3, the operator of valve #3 will be responsible for maintaining constant pressure via the PI at SP2.

8. After the brine cleanliness is improved (2 or 4 hours), the brine flow should be switched from the brine pond blooey line to the muffler. While watching and maintaining the pressure at PI-10, slowly throttle open valve #6 (James system throttle valve) and close valve #20 (the brine pond blooey line throttle valve).
9. Set the throttle valve at the desired flow/pressure condition (to be determined at the time of flow based on the start-up data). The expected condition is flow equals 515000 lbs/hr. and pressure equals 450 psi . It is planned to not change the throttle valve setting except to correct for a wash out of the valve.
10. In the event that valve #6 washes out, valve #3 will be used to continue the test. Any valve washed out during one test will be replaced before the next test.
11. Perform the flow switch through the science sample spools.
    - -D. Michels will request of the TC that the flow be switched to the sample spools.
    - -If required because of pressure drop considerations, the 7" James tube will be removed and replaced with the 10". This is accomplished by watching and maintaining pressure at PI-10 while slowly opening valve #20 and closing valve #6. Alternatively, the flow may be by-passed through

valve #20 for the entire sample period (approximately 6 to 8 hours).

12. -Switch James tube, as required.

-Responsibility - GeothermEx with help from Mustang.

-Finish collecting data with installed JT.

-While balancing pressure at wellhead, open isolation valve #20 to brine pond and close valve #6 to muffler.

-Disconnect 3/8" tube at lip pressure tap and flange.

Disconnect 3/8" Strahman valve at lip pressure tap (optional).

Disconnect James tube at flange.

-Check 3/8" tube and valve for pluggage.

-Change PI-9 if required to different range.

-Check and refill pressure tap line with silicone oil, if required.

-Install desired James tube.

Install 3/8" Strahman and 3/8" tube at pressure tap.

-Check installation for functionality.

-Notify Test Coordinator that system is reassembled.

Test Termination

Purpose - to shut-in the well while (a) minimizing any shock to the system and, (b) minimizing the abrasive service of the wellhead isolation valves.

Procedure - While flowing through the James tube set-up,

-notify all AC's that the test will be terminated.

-monitor and record pressure and temperature at the wellhead.

-by steps, slowly throttle down (do not close) the throttle valve (valve #6 or #20). Stop closing the valve when the pressure approaches 500 psi at PI-10.

-by steps, continue to slowly throttle down the well flow using valve WH3, but do not exceed 900 psi at the wellhead.

-continue to shut-in the well by closing valve WH1 and WH2.

-continue to monitor and record pressure and temperature change for 1 to 2 hours after shut-in.

Reinjection/Flush/Storage

Reinjection.

-Purpose: to dispose of as much brine as possible by reinjecting to the formation.

-Consideration: (a) Brine should be as free of suspended solids as possible. (b) Brine temperature should be less than 170°F to prolong life of mud pump components.

-Complete downhole temperature and pressure measurements.

-POOH - USGS wireline instrumentation.

-Rig down USGS

-Rig up kelly assembly with XO to four inch pipe thread on wellhead.

-Arrange final piping and valving from 6" line to mud pumps.

-Close valves #3, #6, #11, #14, #15, #20 and #24.

-Open valves #4, #5, #12 and #13.

-Check fuel level at Stang pump.

-Operate Stang trash pump.

-Disengage clutch and lower throttle to idle. Establish flow and increase the throttle to approximately 80-90 percent full throttle.

-Fill brine tank T-2 approximately 2/3 full.

-Reinject fluid

With valve #26 closed, open valve #24, #25, #23 and, either #28 or #29, start rig water pump (P-3), and start mud pump.

-Consider, if well goes on vacuum,

- -Pump down level in brine tank (T-3).
- -Turn off mud pump.
- -Open valve WH3.
- -Close valves WH4, 4 and 12.
- -If flow ceases, return mud pump to service and by reversing the above mentioned steps (4).

-Monitor and record flow (level drop at L1-3), fuel level, wellhead pressure, brine tank (T-2) level.

-Continue reinjection until the Stang pump looses suction due to low level.

-Shut off Stang pump, (P-1), and clean out if required.

-Lower level in brine tank (T-2) then shut off rig water pump, (P-3), and mud pumps.

Flush System with Water.

-With valve #27, #24, #28, #29 and #12 closed, open valves #25, #26, #23, #22 and #11.

-Start rig water pump (P-3).

-Monitor level in water tank, (T-3).

-Circulate water through system for 5-10 minutes.

-Open valve #20, close valve #5 and wait a few minutes. Check flow.

-Open valve #6, close valve #20 and wait a few minutes. Check flow.

-Open valve #14 and #15, close valve #13 and wait a few minutes. Check flow.

-Open valve #3 and #2, close valve #6 and wait a few minutes. Check flow.

-Shut off rig water pump (P-3) and close valve #26.

Storage and Disassemblage.

-During the period of drilling between flow tests, the flow test system will be stored in a manner condusive of good corrosion control.

-Provision will be made to disassemble, clean, or service sample locations, and all instrumentation.

-The flow line under the rig will be disassembled and laid down out of the working area of the rig. The subject pipe spools are 10"-B-1, 10"-B-2 and 10"-B-3.

-The upstream flange of 10"-B-4 will be blind flanged.

-Approximately 100-150 barrels of water treated with HlB-A (5 Gal.) and sodium Bi sulfite (100lbs.) will be placed in the confined system created by closed valves #5, #6, #20, #15, #14, #11, #12 and #2 and the blind flange at 10"-B-4. The system will remain filled with the solution until the next flow test.

-Pipe spools that are disassembled and laid down will be water washed and allowed to air dry. (10"-B-1, 10"-B-2 & 10"-B'3).

-The science sample spools will be disassembled for inspection and a water wash out. They will be air dried and reinstalled in the system.

-Operations: Dave Rabb, Larry Bailey, Red Beaver, Dave Meehan, Charlie Harper, G. Tinsley, Cleveland Rig Crew (1 Instrument mechanic)

-Purpose

Test Coordinator - Dave Rabb / Charlie Harper

Function - to provide overall coordination and management of the flow test.
- to assist and direct 10" valving changes.

Operations

Function - to perform facility operation, maintenance and over-seeing data collection.
- including: orifice plate changes at scientific sample locations and flow orifice FO-1.
- James tube change as required.
- instrument maintenance as required.

-Monitor the Barton Recorder.

-Record data at Pl-9 during unsteady operation.

Pl-10	"	"	"
Pl-11	"	"	"
L1-1	"	"	"
L1-2	"	"	"
T1-7	"	"	"

-Operate as required valves 7, 8, 10 and 21.

-Calculate enthalpy and provide same to D. Michels and Bechtel. Include raw data, date, time and originator.

-During the flow test, provide technical input and assistance to the flow test coordinator.

-Collect samples at SP-7 as required.

USGS (4)

Sass, Priest

Hendrick, Robison

-During unsteady operation--

Record data at:
TI - 1, 2 & 8
TI - 1 & 8
LI - 3
PI - @SP-2 during start-up

-Assist Lee Walden / Otis with downhole logging.

-During steady operation--

Record data at:
TI - 1, 2, 7 & 8
PI - 1, 8, 9, 10 & 11
LI - 1, 2 & 3
TI - 3, 4, 5 & 6 (during scientific sample loop flow)
PI - 3, 4, 5 & 6 (during scientific sample loop flow)

Other Science Personnel to be on Site (Partial)

(Also does not include surface liquid samplers)

1) Science Management Crew: (Brawley Bunch)
   Morning Tower: John Hendricks, John Sass
   Afternoon Tower: Sue Priest, Lori Robison

2) Curator: Wilf Elders, Jim Mehegan

3) USGS Loggers: William Bruns, Al Hess, Dick Hodges, Fred Paillet, Roger Morin

4) Occasional USGS Help: Jack Kennelly, Tom Moses

5) Downhole Fluid Samplers (LANL): (Goff's Gang)
   Fraser Goff, Jake Archuleta, Joe Cruz, Chuck Grigsby, Lisa Shevenell

6) Kuster Research Tools: Ron Smith, Ray Wall, Lance King (Kuster), Chuck Carson, Dick Traeger & 2 or 3 others (Sandia)

7) Well Log Interpertation (LLNL): Paul Kasameyer, Lee Younker, Robin Newmark, Dick Carlson, Gayle Pawloski

8) Offshore gradient drillers needing occasional support (on non interference basis with SSSDP) (Sandia):
   Peter Lysne, Bob Meyer, Ron Jacobson, Lou Burtel

<u>Scientist Fluid Sampling</u>

-D. Michels (Area Coordinator)

SSSDP

FLOW TEST

FLUID SAMPLING PROCEDURES

I. BRINE SALINITY BY HYDROMETER; ATMOSPHERIC FLASH

Objectives: Monitor cleanup of brine
Establish approximate salt content for thermodynamic purposes.

Procedure:

Begin immediately as liquid begins to discharge from the silencer.

Continue at intervals of a few to several minutes as flow progresses. As density stabilizes, sampling intervals may be increased.

Include notes of operational status and fluid character along with data entries in the log book.

Correlate with data from weir on flow rate and cumulative flow.

1. Collect fresh brine at the weir and place in a graduated cylinder.
2. Insert a hydrometer into the cylinder to float in the fresh brine.
3. Measure temperature (mercury-in-glass or digital probe thermometer).
4. Read hydrometer.
5. Enter temperature (T = deg. F) and density (p = g/ml) into the field log book.
6. Compute ND according to:
   ND = [62.42p-69.383+0.04104T]/[0.3209+.0004888T]
   (units are equivalent weight percent sodium chloride)
7. Compute NH = 0.88(ND)
8. Enter ND and NH into log books
9. Enter ND values into a plot of elapsed time since the beginning of flow.
10. Compute density for the reference temperature (200F) according to:
    D200 = 0.980 + ND(.00527).
11. Enter D200 values into the log book.

II. BRINE SALINITY BY CHLORIDE ANALYSIS, ATMOSPHERIC FLASH

Objectives: Monitor cleanup of brine
Establish approximate salt content for thermodynamic purposes

Procedure:

Begin when brine discharge from the silencer is becoming substantially clear of drilling muds or when hydrometer results indicate ND exceeds 10.

Continue at intervals of a few to several minutes until chlorinity begins to stabilize. Then, increase the sampling interval.

Include notes of operational status and fluid character along with data in the field log book.

Correlate with data from the weir on flow rate and cumulative flow.

1. Tare about 100 ml of distilled (deionized) water (DW) into a clean, dry flask and record net weight of water as WD.
2. Collect fresh brine at the weir.
3. Place about 10 ml of fresh brine into a tared flask of DW.
4. Reweigh and record the net weight of mix as WM.
5. Mix well and extract an aliquot for field titration.
6. Titrate and record results.
7. Compute chlorinity of aliquot (CA = mg/kg)) according to titer of the standard.
8. Compute ND according to:
   ND = 0.000178[CA*WM/(WM-WD)]
9. Compute NH = 0.88(ND)
10. Enter ND and NH into log books.
11. Enter ND value into a plot of elapsed time since the beginning of flow.
12. Compute D200 = .00527ND + 0.980, and enter result into lab book.

III. SELECT SIZES OF ORIFICE PLATES

Objective:

Establish increments of about 40 or 50 degrees F in the temperature cascade betweeen test spools.

Procedure:

1. Estimate enthalpy from the James Tube data.
2. Select an NH value from hydrometer or chloride results.
3. Compute the effective pre-flash temperature, TF, and salt content, NF. [Iterate on flash fraction, NH, and enthalpy to find a consistent combination of TF and NF.]
4. Estimate the maximum line temperature deliverable to the spool/orifice assembly and the minimum temperature to exit the assembly.
5. Select temperatures for the series of spools.
6. From the weir data, establish a liquid flow rate that will correspond to the estimated maximum line temperature

7. Enter fluid speed chart at actual brine density.
8. Find fluid speeds for selected combinations of temperatures, reference brine density, and mass flow rate.
9. Compute orifice diameters according to $Do/Dp = (V1/V2)^{1/2}$.

IV. SET-UP AND OPERATION OF BRINE SAMPLING PROBE ASSEMBLIES

Objectives:

- Provide clean samples to principal investigators.
- Obtain samples to characterize the chemical composition of the geothermal brine.
- Determine increments of steam removal from the brine.

A. PROCEDURE FOR SET-UP

Begin soon after the fluid flow has been diverted into the test spools and the temperature/pressure cascade has stabilized.

Set up at least two sampling ports, four if feasible.

1. Verify that each 6-o'clock sample port is clear of debris.
   a. Connect a blowdown line between the upper valve of the assembly and the catching drum.
   b. Blowdown through the upper valve of the assembly. (Do not blow down through lower valve without careful review of the possible effects and alternatives.
   c. Add the blind nipple/rod assembly to the lower valve, then open valve so debris will fall into the nipple. Work with rod.
   d. Close lower valve, reworking rod, if needed.
   e. With lower valve closed, remove blind nipple.
   f. Flush lower valve threads, etc., with fresh water.
   g. Flush nipple/rod assembly with fresh water, inside and out.
2. Connect fittings for a 1/4-inch probe to the lower valve of the assembly.
3. With access valve closed and cooling coil control valve closed, insert the probe through the fittings until it touches the gate of the access valve.
4. Adjust safety chain so probe cannot be blown out and does not rest against the gate of the access valve.
5. Adjust nut pressure on sealing gland to allow slippage of the probe.
6. Open gate of access valve all the way
7. Insert probe so that tip is above the level of the upper valve, but still in the space of the connecting nipple. (Use of vise-grips on probe is advised.)
8. Adjust the chain's second connection to support the force of line pressure on the probe.

9. Snuggle the pressure nut onto the sealing gland.
10. Place cooling coil into water (ice) bucket and adjust.
11. Prepare to receive brine samples by opening the flow control valve of the cooling coil and allowing system to flush and stabilize.
12. Collect samples by directing the stream of cooled brine into sample containers.
13. Add ice to the water bucket and adjust water level as needed.

B. PROCEDURE FOR TEMPORARY SHUTDOWN

1. Close flow control valve on the cooling coil.
2. Loosen the pressure nut on the sealing gland.
3. Push probe toward (into) the flow line until the tip is near the level of the bottom of the flow line.
4. Readjust the chain's second connection to support the probe in this new position.
5. Snuggle the pressure nut on the sealing gland.

C. PROCEDURE FOR RESTART AFTER TEMPORARY SHUTDOWN

1. Blowdown upper valve of the assembly into the collection barrel.
2. Loosen pressure nut on the sealing gland.
3. Disconnect second connection of chain.
4. Slide probe outward til tip is in sampling position.
5. Readjust chain's second connection and the sealing nut.
6. Position coil in cooling water bucket.
7. Open and clear the flow control valve.
8. Establish steady brine flow and collect samples.

D. PROCEDURE TO REMOVE SAMPLING PROBE ASSEMBLY

1. Verify closure of flow control valve on the cooling coil.
2. Remove bucket of cooling water.
3. Loosen pressure nut on sealing gland.
4. Disconnect chain's second connection.
5. Withdraw probe until it is limited by the safety chain's first connection and the tip is clear of the gate of the access valve.
6. Close the access valve (Cautiously, beware of probe being further in than intended. Also, beware of rocky debris that might bind on the probe or clog the gateway.)

7a. With probe withdrawn and gate closed:
   i) Blowdown the hot space by opening the flow control valve on the cooling coil.
   ii) Verify that flow ceases.

iii) Disconnect the safety chain and withdraw the probe assembly.

iv) Immediately flush the outside of the probe with fresh water.

v) Immediately follow by flushing the inside with fresh water (use a few syringe-fuls). Pay particular attention to working the flow control valve while flushing water through it.

vi Remove fittings from the access valve and rinse them with fresh water.

vii Flush exposed parts and threads of the access valve with fresh water.

7b. If probe or gate do not reach proper positions, or if blowdown flow does not cease, then:

i) Close flow control valve on cooling coil.

ii) Test positions of probe and safety chain attachments.
If probe moves further out then re-try 7a.
Otherwise, go on to iii.

iii) Snuggle pressure nut on sealing gland.

iv) Verify connection of safety chain.

v) Advise others of the port's status.

E. ICE BUDGET FOR BRINE SAMPLING

One liter of cooled brine (400-100F) requires about 2.6 pounds of ice.

Ten pounds of ice are in an initial bucket charge with three gallons of water. This can cool about 5 liters of brine before recharge.

Five pounds of ice per hour, are an approximate overhead melt rate per bucket.

Aa allowance for melting of stock before and after sampling gets underway should be included.

Use drinking water for floating the ice.

V. BRINE SALINITY BY CHLORIDE TITRATION -INTERMEDIATE FLASH FROM SPOOLS-

Objective:
Establish the steam flash fractions of the T-P cascade in the spool/orifice assembly.

Procedure:

Begin as soon as cleared sampling probes are available at the brine taps of the spools.
Make collections from all available taps. Collections do not need to be simultaneous.
Continue sampling throughout the flow period. Obtain a minimum of three good sample results from each available spool, but sample vigorously throughout the flow period to obtain as many good samples as practiceable.
Include samples from the weir, as described in item II, to obtain counterpart data.

1. Tare about 100 ml of DW in a flask.
2. Add about 10 ml of cooled brine from the spool taps.
3. Reweigh and record all weight data in log books. Include also:
   Time, Spool number, Spool temperature and pressure
4. Analyze and record data as in Part II.
5. Compute and record values for CA, ND, and NH.
5. Compute and record values for CA, ND, and NH.
6. Compare values of ND between spools to establish increments of steam 6. Compare values of ND between spools to establish increments of steam flash.
7. Compute total steam fractions for each spool and the weir box.

VI. BRINE COLLECTION FOR BASIC CHARACTERIZATION

Objectives:

Obtain samples for general chemical analysis and establish the nominal brine composition.
Obtain samples for archives.

Procedures:

Use the highest-pressure spool unless complicated by surging or limited access.
Use the brine sampling probe assembly of Part IV.
Collect samples at different times within the sampling period.
Collect samples with different methods of preservation.

1. Collect about 10 ml of cooled brine into nominally 30 ml of dilute nitric acid in tared polyethylene bottles of 50 ml capacity. Take a minimum of three.
2. Collect approximately 20 ml into 60 ml of dilute nitric acid in numbered, tared polyethylene bottles of about 100 ml capacity. Take 10 to 15 samples.
3. Collect as in 2, but with hydrochloric acid. Collect 5 to 10 samples.
4. Collect without dilution into 125 ml glass bottles. Collect 5 to 10.
5. Collect approximately 25 ml of cooled brine into about 75 ml of distilled water using numbered, tared glass bottles of about 125 ml capacity.

VI. BRINE COLLECTION FOR PRINCIPAL INVESTIGATORS

Watch water/ice requirements.
Beware plugging of flow control valves.
The 1/8-inch cooling coil can pass about 1/4-liter per minute.

Coplen -- three 1-liter samples in glass
Edmund -- six 1-liter samples
EPRI -- fifteen 20-ml samples in glass
Hammond -- Two 10-liter samples (weir?)
five 1-liter samples from spool
Jedwab -- two 50-ml samples
Kharaka -- 3 liters, total
Laul -- two 20-liter samples from weir
one 1-liter sample from spool
one 50-ml sample from spool
Silver -- 0.1 to 1 liter in dilute nitric
0.1 liter filtered and acifified

(plus 2 liters of canal water and daily samples of mud)

Truesdell -- Independent sampling with mini-separator

Williams -- 50 ml

VII. GAS SAMPLING FROM SPOOLS

Objectives:

Use the carbon dioxide content of steam to trace the extent of steam flashing through the spool-orifice assembly.

Provide condensate-gas mixtures to Principal Investigators.

Collect non-CO_2 gases for additional characterization of fluids.

Ice budget: For one cycle of sampling, expect to consume about one hundred pounds for basic characterization, including initial fills of buckets. Principal Investigators, less the USGS-Menlo Park group, may require an additional sixty pounds. Additional sampling rounds and wastge during storage will require more.

Procedure A -- TOTAL NON-CONDENSABLE GAS

1. Blowdown the 12-o'clock valve assemblies of the in-line separators. (Discharge is vertical, into the air.)
2. Use a hand test to find the maximum discharge rate that is useably free of carried-over brine droplets.
3. Connect pressure reduction rigging and blowdown to heat it up.
   (beware of over-pressuring the gauge)
   (Keep discharge rate below the droplet carry-over range.)
4. Insert a cooling coil assembly into a pressure reduction rig.
5. Adjust positions of coil and ice bucket, water level and ice contents.
6. Pressurize to about 8 psig and check for flow.
7. Hold closed, the Tygon sleeve (syringe connection) and check for leaks. Stabilize pressure at about 12 psig with pressure control valve. Do not exceed about 15 psig.
8. Release Tygon and allow coil to become well-flushed.
9. Chill collection syringe inside and out with bucket water. Finish with the syringe closed and the needle port filled with water.
10. Connect a syringe to the Tygon sleeve of the

freely discharging cooling coil and allow fill-up.

11. Secure plunger clamp on syringe when volume approaches 50ml.
12. Shake vigorously as syringe pressurizes. Pressure will rise as flow rate subsides. Beware of leaks if pressure rises above 15 psig.
    (Keep submerged for temperature control.)
    (Monitor flow through Tygon connecting tube.)
13. When in-flow rate is negligible, collection is finished.
    Note:
    Time, Pressure reading, Total volume in syringe.
14. Disconnect syringe, being attentive to first:
    Invert, and close, by pinching, the small tygon tubing in order to isolate the material in the syringe.
15. Carefully inject condensate into a numbered, tared condensate vial, then close the vial cap.
16. Make entries into the field log book for:
    Time, Total volume, and Pressure from item 13.
    Vial number, syringe number, spool number;
    Spool temperature, spool pressure

Repeat steps 6-13 until at least five vials are used for each spool.

17. Weigh vials promptly to the nearest 0.01 gram.
18. Record results in both the field and lab log books.
19. Review results and do additional sampling if that is warranted.

Procedure B -- NON-CO_2 GASES:

1. Hydrogen sulfide

2. Ammonia

3. Non-reactive gases.

VIII. GAS SAMPLING FOR PRINCIPAL INVESTIGATORS
(Volumes refer to CO_2-stripped samples.)

Hammond -- 200 ml
Kharaka -- 250 ml
Laul -- 50 ml
Truesdell -- 3000 ml
Williams -- 800 ml

Instrument Calibration Data

Appendix H

H

2 pgs.

FINAL

FLOW TEST #2

PLAN

Prepared By:

D. T. Rabb

SALTON SEA SCIENTIFIC

DRILLING PROGRAM

March, 1986

TOTAL DEPTH FLOW TEST

The Salton Sea Scientific Drilling Project will flow the zone at the bottom of State 2-14 (~10,475') following the proposed test program shown in Table 1. This document contains the organization and procedures that will be implemented for the flow test include the following:

- -Organization
- -Safety and Operation/Facility Design
- -Data Collection
- -Facility Operation
    - -Pre Test Activity
    - -Flow Test
    - -Test Termination
    - -Reinjection/Flush/Storage
- -Work Areas
    - -Operations (Bechtel)
    - -James Tube (GeothermEx)
    - -Flowline Data Collection & Downhole (UCR)
    - -Surface Fluid and Gas Sampling (Michels)
    - -Downhole Logging & Sampling (USGS)
    - -Safety (WPT)
- -Fluid Sampling Procedures
- -Instrument Calibration Data

FLOW TEST ORGANIZATION

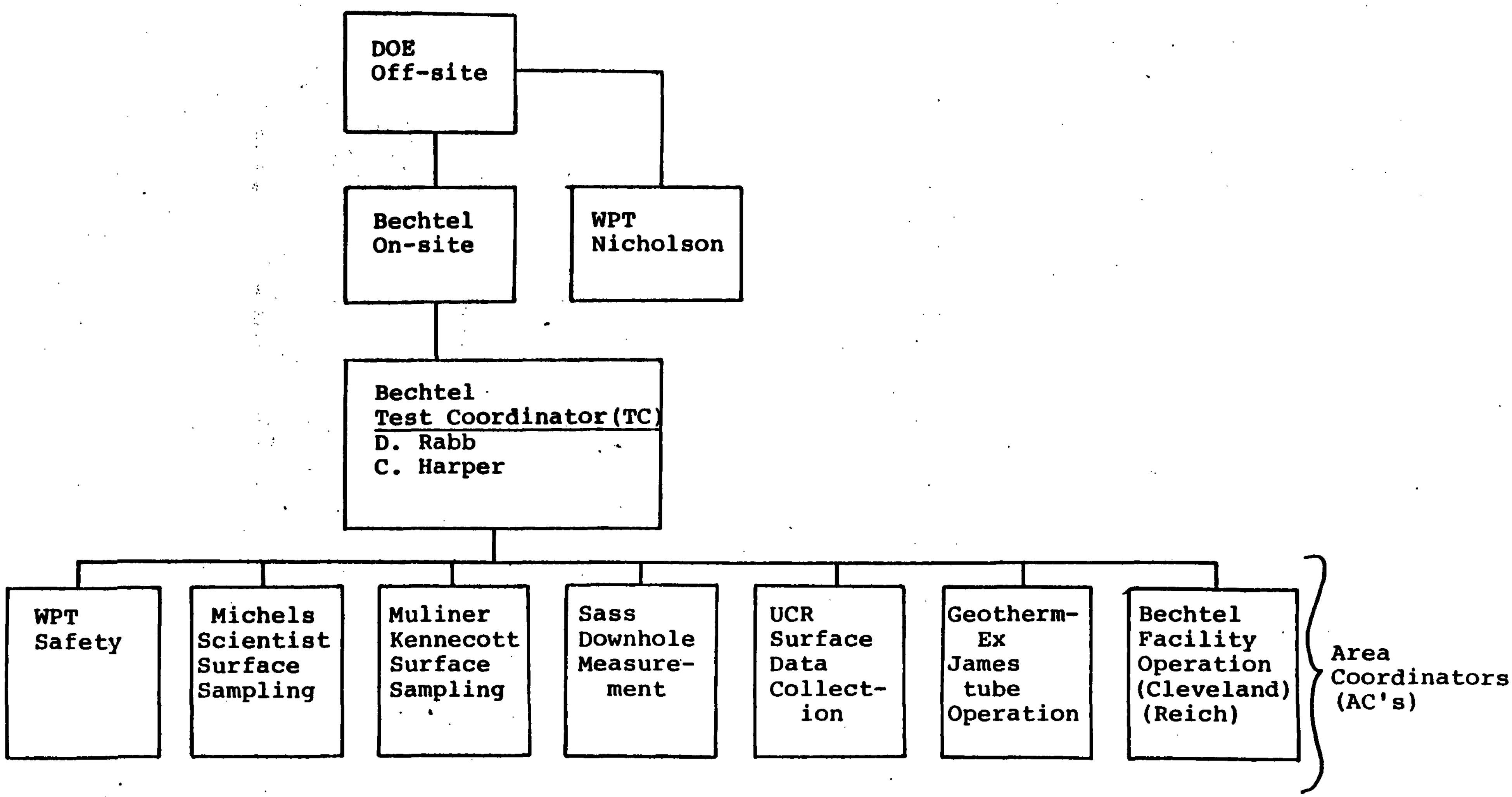


Table 1

10,135' Plus Feet Flow Test Program (Estimate)

Period	Duration (hr)	Wellhead Pressure (psi)	Wellhead Total Flow (lbs/hrs)	Brine Flow (lbs/hrs)	Total Volume (10^3 gal)
To Reserve Pit Start-up	1	Variable	Variable	Variable	6 (est)
To Brine Pit via Blooie Line	10	450	150,000	120,000	140
To Brine Pit via Muffler	48	450	150,000	120,000	645
To Brine Pit via Muffler	13	300	277,000	216,000	315
Sub-total hours	72				
Post flow pressure/ temp. build-up	36				
Downhole fluid sampling	24				
Inclusion sampling	24				
Reinjection	48				
Total Hours	204				

Assumed brine density 9 lb/gal at weir

SAFETY AND OPERATION

- All participants will monitor their work area for unsafe situations or mechanical problems. Should a situation develop, remove personnel from the area and notify the Test Coordinator (TC) immediately in order that corrective action can be identified and executed.
- WPT will walk through the entire facility periodically during the flow test to look for unsafe situations.
- Opening and closing of all valves 4" diameter or larger and any necessary piping changes will be supervised by the operations group and with the full knowledge of the Test Coordinator (TC). Every effort will be made to notify the Area Coordinators (AC's) of the impending changes.
- Opening and closing of the large valves will be performed by experienced technicians and operators provided by Cleveland Drilling working soley at the direction of the Test Coordinator.
- The TC will determine that all personnel are clear from the discharge area before any major changes in the flow pattern or the flow volume is made.
- Operation of all 10" valves will be performed slowly <u>and</u> the upstream pressure will be monitored.

  If unexpected pressure responses occur, the valve operator should cease valve operation or return the valve position to the previous setting. Determine valve operation.

-Depending on the period of the flow schedule, flow throttling will be performed by operating either, valve #2 (flow to reserve pit), valve #6 (flow to muffler), or valve #20 (flow via blooie line to brine pond).

FACILITY DESIGN

Main Flow Line.....

The main flow line consist of 10" schedule 60 Grade B pipe, extra strong fittings, and Class 600 valves. The material is designed to handle operating limits of:

- Pressure - 700 psig maximum
- Temperature - 650 F maximum
- Flow - 2 phase steam and saturated brine with suspended particles

Other Pipe.....

The 6" reinjection system is schedule 40 pipe, standard fitting, and 150 pound valve except at connection points to the 10" flow line (extra strong fittings and Class 600 valves).

DATA COLLECTION

-During unsteady operation, personnel from UCR will be responsible for flow line data collection, readings should be taken as frequently as is practical and at least once every 15 minutes.

-During steady operation, once every 30 minutes.

-Data collection will start with the monitoring of well-head temperature and pressure during warm-up.

-Data collection will continue through the initial flow, the series of step flows, after the well is shut-in, and during reinjection.

-Instrumentation that appears to be providing erroneous data should be reported to the TC immediately. A qualified and fully equipped instrument mechanic will be on site for the flow test.

-A narrative log will be maintained by the data collection team of all changes that occur in the flow regime. The TC will advise the data collection team prior to any changes in valve settings, flow paths, or other modifications in status. Where a potentially dangerous situation requires immediate corrective action, the TC should assure the data collection personnel are clear of the danger area and advise them of the steps taken after the situation is stabilized.

PRE-FLOW TEST ACTIVITIES

-Circulate mud out and water in.

-POOH, lay down drill pipe.

-Remove BOPE and install wellhead.

-Perform down hole measurement while well heats up. (Water resources).

-Install final connection from wellhead to flow line (10"-8-4).

-Dry-run sampling:

-equipment assembly & connection to sample locations.

-personnel orientation: safety requirement, overall facility design limitations, on-site procedures including organization, facility familiarization, work station assignment.

-Perform final walk-thru and check operability of all valves and instruments.

-Have tools and equipment ready at James tube and SP3, 4, 5 & 6 for orifice, James tube and tubing changes.

-Install 0-1000 (approx.) psi pressure gauge on vertical Kennecott sample port.

-Set-up valving for initial flow to reserve pit.

-Open valves 2, 13 and 20.

-Close valves 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 19, 21 & 30. All valves at SP1, 2, 3,

-Post signs and perform non-authorized personnel sweep.

-Check with all Area Coordinators (AC's) for readiness.

FLOW TEST

1. Initial flow to reserve pit to expell contaminated fluid.
   - Slowly open valve WH1, WH2 & WH3.
   - Open pressure gauge isolation valve on SP2.
   - Monitor and record SP2 data.
2. Order N2 if insufficient flow for kick off is observed.
3. Rig-up and stimulate with N2.
4. Flow to reserve pit for initial well clean-up
5. Prepare to flow brine through valve #3, bypassing the scientist sample loop via valve #13, bypassing the James tube via valve #20. Check valving and confirm that valves #4, 14, 15 & 6 are <u>CLOSED</u> and valve #13 & #20 are open.
6. Throttle flow with valve #20.
7. After the brine cleanliness is improved (2 or 8 hours), the brine flow should be diverted from the brine pond blooie line to the muffler. While watching and maintaining the pressure at PI-10, slowly open valve #6 (James system throttle valve) and close valve #20 (the brine pond blooie line throttle valve).
8. Set the throttle valve at the desired flow/pressure condition (to be determined at the time of flow based on the start-up data). The expected condition is

change the throttle valve setting except to correct for a wash out of the valve.

9. In the event that valve #13 washes out, valve #6 or 20 will be used to continue the test.

10. Perform the flow switch through the science sample spools.

    - D. Michels will request of the TC that the flow be switched to the sample spools.

    - If required because of pressure drop considerations, the 6" James tube will be removed and replaced with the 10". This is accomplished by watching and maintaining pressure at PI-10 while slowly opening valve #20 and closing valve #6. Alternatively, the flow may be by-passed through valve #20 for the entire sample period.

11. -Switch James tube, as required.

    - Responsibility - GeothermEx with help from Cleveland.

    - Finish collecting data with installed James tube.

    - While balancing pressure at wellhead, open isolation valve #20 to brine pond and close valve #6 to muffler.

    - Disconnect 3/8" tube at lip pressure tap & flange. Disconnect James tube at flange.

    - Check 3/8" tube & valve for pluggage.

    - Change PI-9 if required to different range.

    - Check and refill pressure tap line with silicone oil,

-Install desired James tube.

-Check installation for functionality.

-Notify Test Coordinator that system is reassembled.

12. Periodic cleaning of the James tube tap will be accomplished using pressurized nitrogen. The procedure will be to first CLOSE the valve leading to PI-9 and then Open the valve from the N2 bottle. The pressure regulation can be used to adjust the conditions in order to purge the solids from the pressure tap. When the procedure is completed, the pressure should be bled off, the valve from the N2 bottle closed, and the valve to PI-9 opened.

TEST TERMINATION

Purpose - to shut-in the well while (a) minimizing any shock to the system and, (b) minimizing the abrasive service of the wellhead isolation valves.

Procedure- While flowing through the James tube set-up,

-notify all AC's that the test will be terminated.

-monitor and record pressure and temperature at the wellhead.

-by steps, slowly throttle down (do not close) the throttle valve (valve #6 or #20). Stop closing the valve when the pressure approaches 500 psi at PI-10.

-continue to shut-in the well by closing valve WH1 and WH2.

-continue to monitor and record pressure and temperature change for 1 to 2 hours after shut-in.

REINJECTION/FLUSH/STORAGE

Reinjection.....

-Purpose: to dispose of as much brine as possible by reinjecting to the formation.

-Consideration: (a) Brine should be as free of suspended solids as possible. (b) Brine temperature should be less than 170 F to prolong life of mud pump components.

-Complete downhole temperature and pressure measurements.

-POOH - USGS wireline instrumentation.

-Rig down USGS.

-If well pressure indicates that direct injection from pond to wellhead is possible, then:

-close valves #2, 4, 6, 14, 15 & 20

-open valves #3, 5, 13, WH3, WH2 & WH1.

-Check fuel level at Rain-for-Rent pump.

-Continue reinjection until the Rain-for-Rent pump looses suction due to low level.

-Shut off pump, (P-1), and fill pond with canal water to dissolve as much salt as possible.

-Repeat the fluid reinjection sequence.

OPERATIONS TEAM

Operations:

Dave Rabb	Charlie Harper
Red Beaver	Gerald Reich
Dave Meehan	Cleveland Rig Crew

(1 instrument mechanic)

Purpose:

Test Coordinator - Dave Rabb/Charlie Harper

Function - to provide overall coordination and management of the flow test.

- to assist and direct 10" valving changes.

Operations -

Function - to perform facility operation, maintenance and over-seeing data collection.

- including: orifice plate changes at scientific sample locations and flow orifice FO-1.
- James tube change as required.
- instrument maintenance as required.

Reich & Meehan shall overview operations as they effect well integrity and safety in and around the wellhead and rig.

JAMES TUBE TEAM

GEOTHERMEX (2)

-Monitor the Foxboro recorder.

-Record data at PI-9 during unsteady operation.

PI-10	"	"	"
PI-11	"	"	"
LI-1	"	"	"
LI-2	"	"	"
TI-7	"	"	"
DPI-2	"	"	"

-Operate as required valves #7, 8, 10, 21 & 30.

-Periodically purge scale from James tube tap using nitrogen gas.

-Calculate enthalpy and provide same to D. Michels and Bechtel. Include raw data, date, time and originator

-During the flow test, provide technical input and assistance to the flow test coordinator.

-Collect samples at SP-7 as required.

FLOWLINE DATA COLLECTION TEAM

(University of California, Riverside)

Jim Mehegan & ~~three others~~ + Chuck Harsige

-During unsteady operation.....

-Record data at:

TI - 1 & 8

TI - 1 & 8

LI - 3

PI - @SP-2 during start-up

~~-Assist Lee Walden/Otis with downhole logging.~~

-During steady operations.....

-Record data at:

TI - 1, 7, 8 & 9

PI - 1, 8, 9, 10 & 11

LI - 1, 2 & 3

TI - 3, 4, 5 & 6 (during scientific sample loop flow)

PI - 3, 4, 5 & 6 (during scientific sample loop flow)

DPI - 2

OTHER SCIENCE PERSONNEL TO BE ON SITE (PARTIAL)

1) Science Management Crew: (Brawley Bunch)..........

Morning Tower: John Hendricks, John Sass

Afternoon Tower: Sue Priest, Lori Robison

2) Curator: Wilf Elders, Jim Mehegan

3) USGS Loggers: William Bruns, ~~Al Hess~~, Dick Hodges, ~~Fred Paillet, Roger Morin~~

4) Occasional USGS Help: Jack Kennelly, Tom Moses

5) Downhole Fluid Samplers: (LANL): Fraser Goff, Jake Archuleta, Joe Cruz, Chuck Grigsby, Lisa Shevenell (Goff's Gang)

6) Kuster Research Tools: Ron Smith, Ray Wall, Lance King (Kuster), Chuck Carson, Dick Traeger and 2 or 3 others (Sandia)

7) Well Log Interpertation: (LLNL): Paul Kasameyer, Lee Younker, Robin Newmark, Dick Carlson, Gayle Pawloski

8) Offshore gradient drillers needing occasional support (on non interference basis with SSSDP). (Sandia): Peter Lysne, Bob Meyer, Ron Jacobson, Burtel

SURFACE FLUID & GAS SAMPLING

-Don Michels (Area Coordinator)

- 4 – Menlo Park
- 2 – Washington
- 3-4 – USC
- 3 – UCR
- 3 – Menlo Park (Organic)
- 1 – Berkeley
- 2 – MIT
- 0 – USGS

~~Sampling Thursday~~ – Friday

DOWNHOLE LOGGING & SAMPLING TEAM

(USGS)

John Sass

John Hendricks

Sue Priest

Lori Robison

SAFETY TEAM

(WELL PRODUCTION TESTING)

Bob Nicholson

Glen Tinsley

INSTRUMENT CALIBRATION DATA

WEIR BOX FLOW RATE

10" Rectangular Notch:

$$GPM = 1245\ h^{3/2} - 299\ h^{5/2}$$

$\left(\frac{1}{12}\right) \times h' = h$

15" Rectangular Notch:

$$GPM = 1868\ h^{3/2} - 299\ h^{5/2}$$

h= ft

Height (h') (Inches)	Ref. Mark's Flow (GPM) l=10"	l=15"
1	29.2	44.1
2	80.8	123.0
3	146.3	224.2
4	220.1	339.9
5	301.7	469.5
6	387.3	

Francis Formula

$$Q = 3.33\ (l - .2h)h^{3/2}$$

Q = cfs

l = ft

h = ft

Brine Pond Volume

$$\text{Volume} = .0173148\,(h^3 + 2010h^2 + 734400h)$$

or

$$\text{Volume} = 29.92\,(H^3 + 167.5\,H^2 + 5100H)$$

Where volume = gallons

h = inches (height)

H = feet (height)

Example:

Height(ft)	Volume(gal)	%Full
0	0	0
1	$.1576 \times 10^6$	14
2	$.3255 \times 10^6$	30
3	$.4920 \times 10^6$	45
4	$.6925 \times 10^6$	63
5	$.8920 \times 10^6$	81
Full-----6	1.1024×10^6	100
7	1.3240×10^6	120
Overflow-8	1.5568×10^6	141

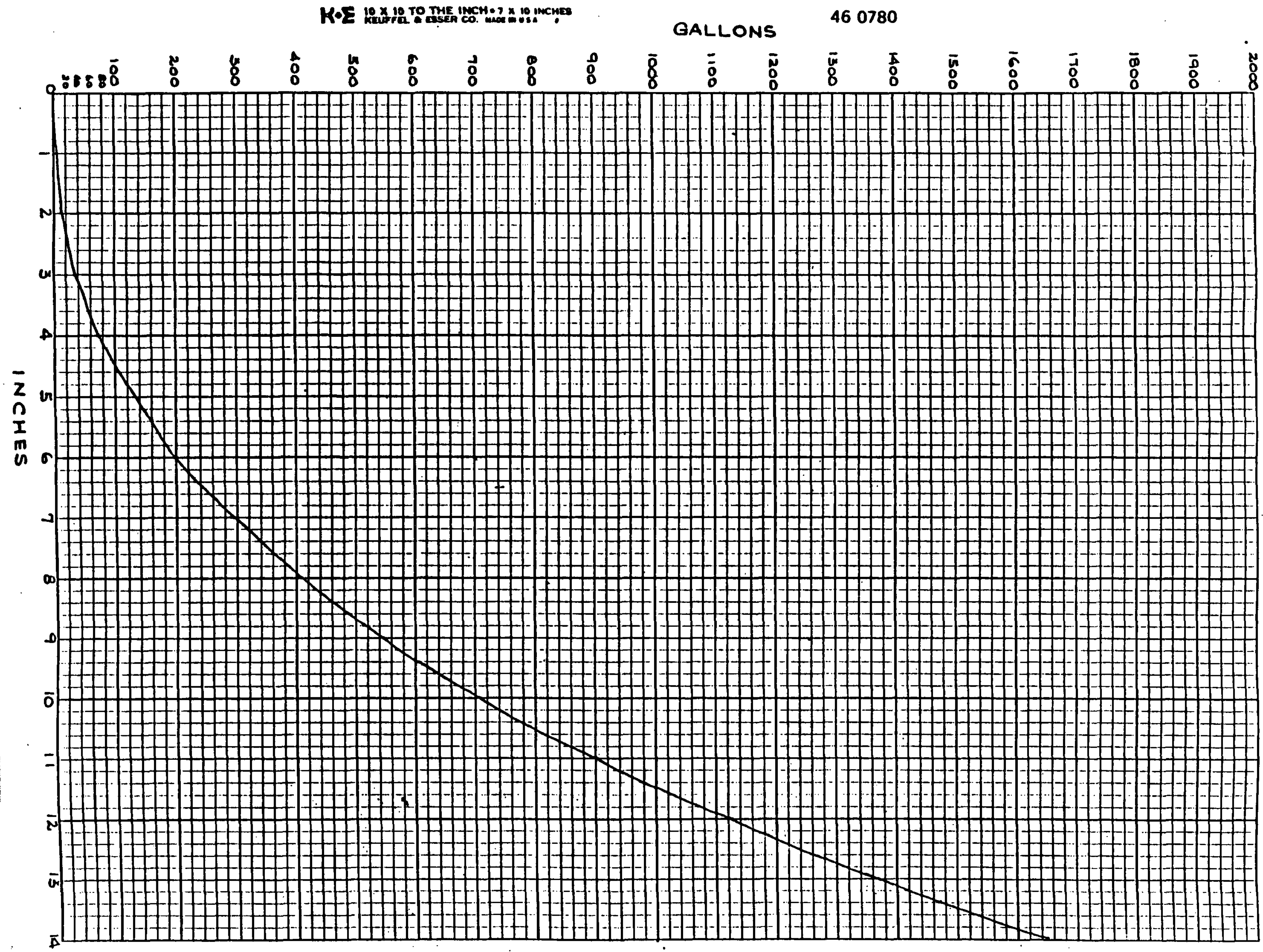
Appendix H

Weir Box Flow Rate

90° V Notch

GPM = 2.249 $(\text{inches})^{2.5}$ Ref. Mark's

Height (inches)	Flow (GPM)
1	2.25
2	12.72
3	35.06
4	71.97
5	125.72
6	198.32
7	291.56
8	407.11
9	546.50
10	711.20
11	902.55
12	1121.87
13	1370.40
14	1649.34



K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 0780
GALLONS
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
INCHES
0
1
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3
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5
6
7
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9
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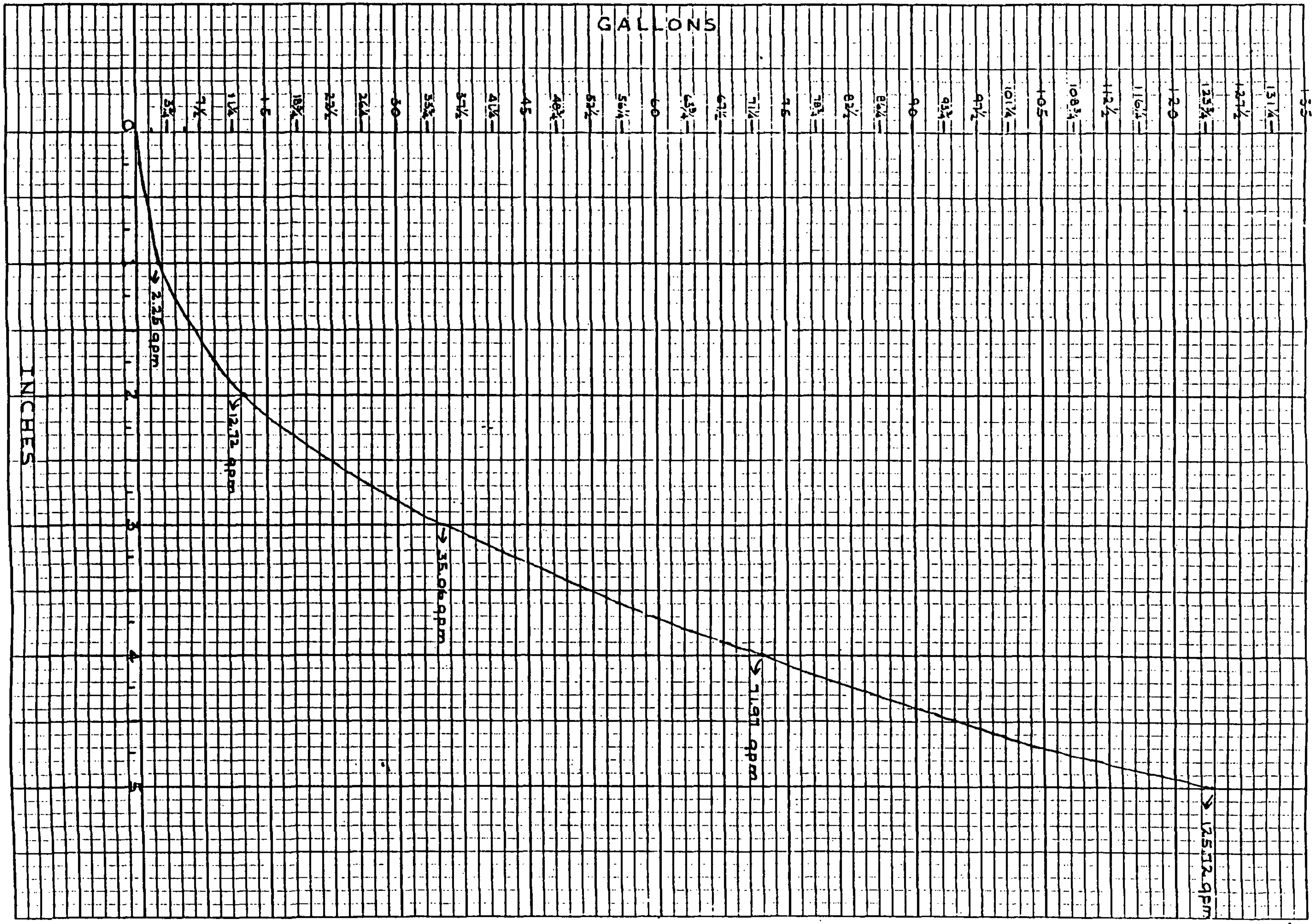
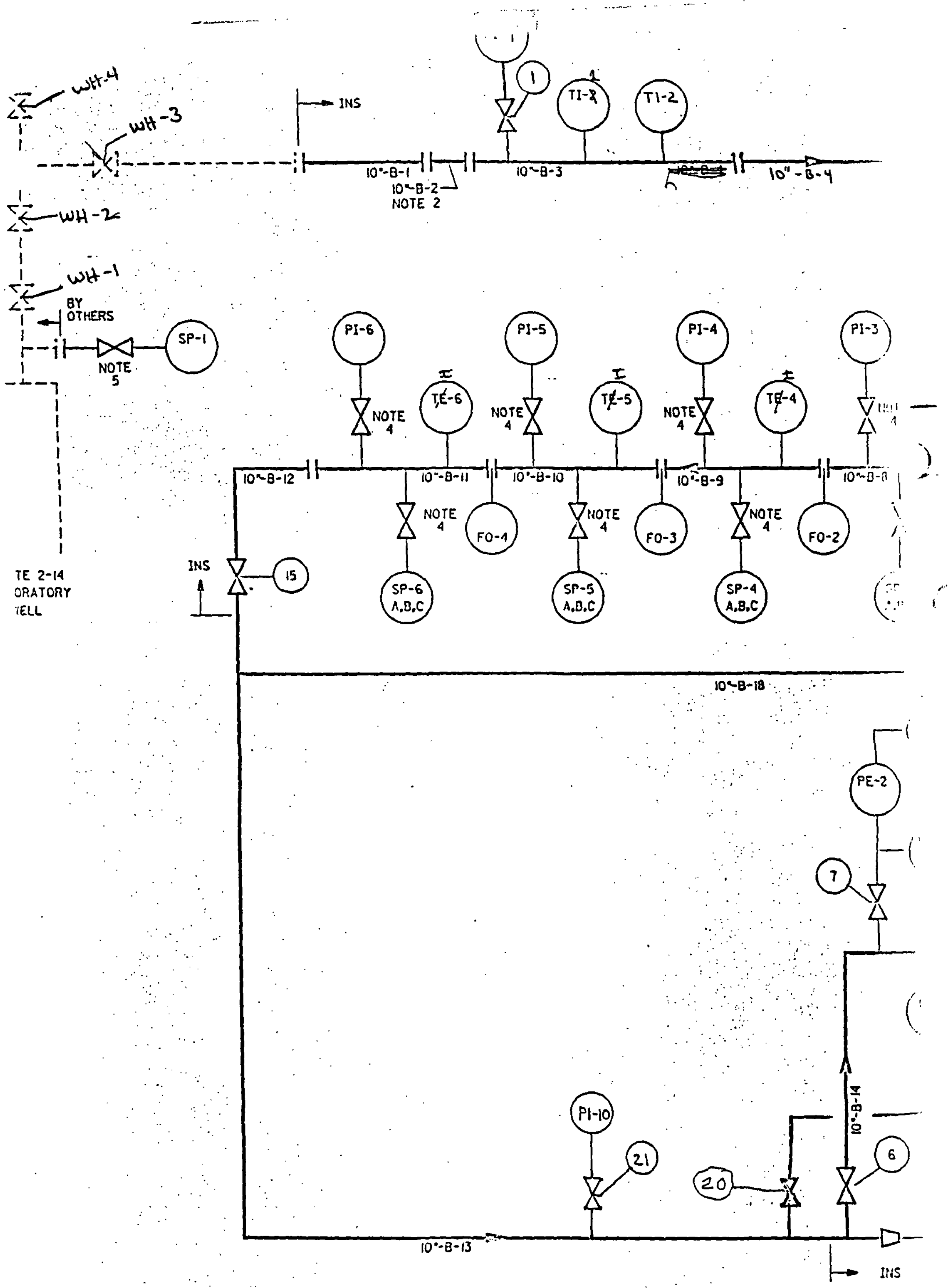
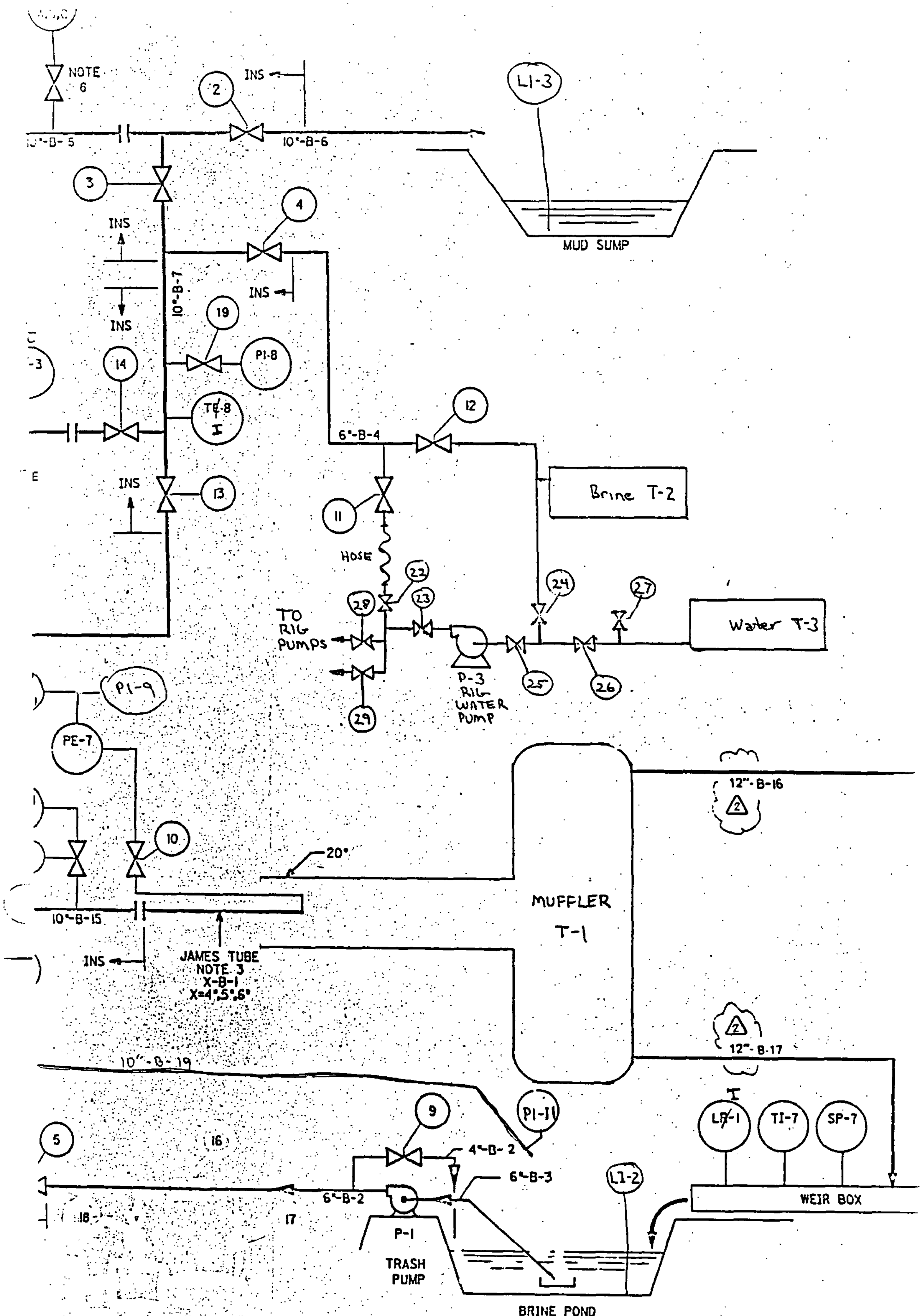
14


GALLONS
INCHES
2.26 gpm
12.72 gpm
35.06 gpm
71.97 gpm
125.12 gpm


WH-4
WH-3
WH-2
WH-1
INS
1
TI-2
TI-2
10"-B-1
10"-B-2
NOTE 2
10"-B-3
10"-B-4
BY OTHERS
NOTE 5
SP-1
PI-6
PI-5
PI-4
PI-3
TE-6
TE-5
TE-4
NOTE 4
10"-B-12
10"-B-11
10"-B-10
10"-B-9
FO-4
FO-3
FO-2
INS
15
SP-6 A,B,C
SP-5 A,B,C
SP-4 A,B,C
TE 2-14
ORATORY
ELL
10"-B-18
PE-2
7
PI-10
21
20
6
10"-B-14
10"-B-13
INS



NOTES: 1. ALL (TE) ~~ARE THERMOCOUPLES THAT WILL BE RECORDED ON MULTI-POINT RECORDERS~~