Box 13
273

MIRAVALLS GEOTHERMAL PROJECT

PORTABLE WELL FLOW TEST EQUIPMENT

AND

PROCEDURES MANUAL

PREPARED FOR

INSTITUTO COSTARRICENSE de ELECTRICIDAD

SAN JOSE, COSTA RICA, CENTRAL AMERICA

Donated By:
Herbert Rogers Jr.
Rogers Engineering Co.

JOB NO. S-75016-31

MAY 1980

ROGERS

Engineering • San Francisco

VICKERY-SIMMS Incorporated

A *Standco* company

905 MAYFIELD RD.-P.O. BOX 459
ARLINGTON, TEXAS 76010
Ph. 817/261-4446 TELEX 75-8278

DATA TRANSMITTAL

NO. 14785

DATE: 7/7/80
PAGE 1 OF 1

CUSTOMER- Belilove Co.

CUSTOMER P.O.- VSI-18

PROJECT-

SEND TO- Belilove Co.
P.O. Box 8612
Oakland, CA 94662

VSI JOB NO.- P-48493

REP- 946

ATTN.-

David Golner

ITEM	DOCUMENT NO.	REV.	DESCRIPTION	TAG NO.	PRINT	REPRO	CERT.
A	BC-P-48493-3 -2	B B	Bore Calculation "			2 2	X X
<div>RECEIVED JUL 14 1980 BELILOVE CO.</div> <div>Rogers Engineering Co., Inc. SAN FRANCISCO RECEIVED JUL 16 1980 PROJ. MGR. <u>WIN BOTT</u> JOB No. <u>S-75016-31</u></div>							

ORDER STATUS

MFG. HELD FOR APPROVAL	xxx	MFG. PROCEEDING-RECORD ONLY
MFG. PROCEEDING-APPROVAL REQD.		MFG. COMPLETE- RECORD ONLY

ANY QUESTION CONCERNING THIS TRANSMITTAL
PLEASE CONTACT UNDERSIGNED

NOTES:

Per your telecon w/Dr. Lin, the
customer with rebore the plate
in the field.

SIGNATURE
by Terri Huskey

Terri Huskey

K.L. Lin

CUSTOMER

VICKERY-SIMMS Incorporated

A *Standco* company

905 MAYFIELD RD.-P.O. BOX 459
ARLINGTON, TEXAS 76010
Ph. 817/261-4446 TELEX 75-8278

David

DATA TRANSMITTAL

NO. 14785

DATE: 7/7/80
PAGE 1 OF 1

CUSTOMER- Belilove Co.

CUSTOMER P.O.- VSI-18

PROJECT-

SEND TO- Belilove Co.
P.O. Box 8612
Oakland, CA 94662

VSI JOB NO.- P-48493

REP- 946

ATTN.-

David Golner

ITEM	DOCUMENT NO.	REV.	DESCRIPTION	TAG NO.	PRINT	REPRO	CERT.
A	BC-P-48493-3	B	Bore Calculation			2	X
	-2	B	" "			2	X
<div><i>Working Copy</i></div> <div>RECEIVED JUL 14 1980 BELILOVE CO.</div> <div>Rogers Engineering Co., Inc. SAN FRANCISCO RECEIVED JUL 16 1980</div> <div>PROJ. MGR. _____ JOB No. _____</div>							

ORDER STATUS

MFG. HELD FOR APPROVAL	xxx	MFG. PROCEEDING-RECORD ONLY
MFG. PROCEEDING-APPROVAL REQD.		MFG. COMPLETE- RECORD ONLY

ANY QUESTION CONCERNING THIS TRANSMITTAL
PLEASE CONTACT UNDERSIGNED

NOTES:

Per your telecon w/Dr. Lin, the
customer with rebore the plate
in the field.

SIGNATURE *Terri Huskey* K.L. Lin
by Terri Huskey

CUSTOMER

VICKERY-SIMMS Incorporated

A *Sundco* company

Rogers Engineering Co., Inc.
SAN FRANCISCO
RECEIVED

JUL 16 1980

ORIFICE PLATE STEAM BORE CALCULATION

PROJ. MGR. _____
JOB No. _____

CUSTOMER: Belilove Co.
CUSTOMER P.O.: VSI-18
TAG NO.: FE-121B (LOW RANGE)

VSI JOB NO.: P-48493

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)	13.250
METER TYPE (Dry or Hg)	DRY
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)	177.1654 (4500 HM)
MAXIMUM FLOW, lbs/hr (Wm)	39682.00 (5 KG/SEC.)
NORMAL FLOW, lbs/hr	25400.00
FLOWING TEMPERATURE, deg. F	375.98 (191.1°C)
FLOWING PRESSURE, p.s.i.a.	187.74 (13.2 kg/cm²)
PERCENT OF MOISTURE	0.00
SUPERHEAT, deg. F	0.00
SPECIFIC WEIGHT AT FLOW CONDITION, lbs/cu.ft.	0.4117
OPERATING VISCOSITY, centipoises	0.0153
ATMOSPHERIC PRESSURE, p.s.i.a.	14.70
ORIFICE TYPE	CONCENTRIC
METER TAP LOCATION	FLANGE
STATIC PRESSURE TAP LOCATION	DOWNSTREAM
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER @ NORMAL FLOW	791851.03

CALCULATIONS:

(1) Wm	39682.00	(6) Y	1.0026
(2) D x D	175.5625	(7) SQ. ROOT sp. wt.	0.6417
(3) Fa	1.0060	(8) SQ. ROOT Hm	13.3103
(4) Fm	1.0000	(9) 358.9x(2) THRU(8)	540343.2018
(5) Fc	0.9955		

S = (1) / (9) 0.0734
BETA = 0.3480

BORE = 4.6113

FLOW RATE (lbs/hr) = 2981.289 x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 332, EQ. 44

CERTIFIED CORRECT
Low-Lance Jr.
VICKERY-SIMMS, INC.

DOCUMENT NO. BC-P-48493- 3
DATE: 7/3/80
REV. B BY: MJJ *OK*

VP-105-4-2

RECEIVED
JUL 14 1980
BELILOVE CO.

VICKERY-SIMMS Incorporated

A *Standco* company

Rogers Engineering Co., Inc.
SAN FRANCISCO
RECEIVED

JUL 16 1980

ORIFICE PLATE STEAM BORE CALCULATION

PROJ. MGR. _____

JOB No. _____

CUSTOMER: Belilove Co.
CUSTOMER P.O.: VSI-18
TAG NO.: FE-121A (HIGH RANGE)

VSI JOB NO.: P-48493

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)	13.250
METER TYPE (Dry or Hg)	DRY
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)	177.1654 (4.500 MM)
MAXIMUM FLOW, lbs/hr (Wm)	89683.00 (11.3 Kg/sec.)
NORMAL FLOW, lbs/hr	25400.00
FLOWING TEMPERATURE, deg. F	323.96 (162.2 °C)
FLOWING PRESSURE, p.s.i.a.	95.29 (6.7 Kg/cm ²)
PERCENT OF MOISTURE	0.00
SUPERHEAT, deg. F	0.00
SPECIFIC WEIGHT AT FLOW CONDITION, lbs/cu.ft.	0.2127
OPERATING VISCOSITY, centipoises	0.0144
ATMOSPHERIC PRESSURE, p.s.i.a.	14.70
ORIFICE TYPE	CONCENTRIC
METER TAP LOCATION	FLANGE
STATIC PRESSURE TAP LOCATION	DOWNSTREAM
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER @ NORMAL FLOW	841341.72

CALCULATIONS:

(1) Wm	89683.00	(6) Y	1.0008
(2) D x D	175.5625	(7) SQ. ROOT sp. wt.	0.4612
(3) Fa	1.0050	(8) SQ. ROOT Hm	13.3103
(4) Fm	1.0000	(9) 358.9x(2) THRU(8)	383196.3558
(5) Fc	0.9849		

S = (1) / (9) 0.2340

BETA = 0.5969

BORE = 7.9094

FLOW RATE (lbs/hr) = 6737.840 x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 332, EQ. 44

DOCUMENT NO.: BC-P-48493- 2

DATE: 7/3/80

REV. B BY: MJJ *[Signature]*

CERTIFIED CORRECT

[Signature]
VICKERY-SIMMS, INC.

VP-
40-105-3-2

RECEIVED
JUL 14 1980
BELILOVE CO.

VICKERY-SIMMS Incorporated

A *Standco* company

Rogers Engineering Co., Inc.
SAN FRANCISCO
RECEIVED

JUL 16 1980

ORIFICE PLATE STEAM BORE CALCULATION

PROJ. MGR. WIN BOTT
JOB No. S-75016-31

CUSTOMER: Belilove Co.
CUSTOMER P.O.: VSI-18
TAG NO.: FE-121A (HIGH RANGE)

VSI JOB NO.: P-48493

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)	13.250
METER TYPE (Dry or Hg)	DRY
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)	177.1654 (4.500 MM)
MAXIMUM FLOW, lbs/hr (Wm)	89683.00 (11.3 Kg/sec.)
NORMAL FLOW, lbs/hr	25400.00
FLOWING TEMPERATURE, deg. F	323.96 (162.2 °C)
FLOWING PRESSURE, p.s.i.a.	95.29 (6.7 kg/cm ²)
PERCENT OF MOISTURE	0.00
SUPERHEAT, deg. F	0.00
SPECIFIC WEIGHT AT FLOW CONDITION, lbs/cu.ft.	0.2127
OPERATING VISCOSITY, centipoises	0.0144
ATMOSPHERIC PRESSURE, p.s.i.a.	14.70
ORIFICE TYPE	CONCENTRIC
METER TAP LOCATION	FLANGE
STATIC PRESSURE TAP LOCATION	DOWNSTREAM
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER @ NORMAL FLOW	841341.72

CALCULATIONS:

(1) Wm	89683.00	(6) Y	1.0008
(2) D x D	175.5625	(7) SQ. ROOT sp. wt.	0.4612
(3) Fa	1.0050	(8) SQ. ROOT Hm	13.3103
(4) Fm	1.0000	(9) 358.9x(2)THRU(8)	383196.3558
(5) Fe	0.9849		

S = (1) / (9) 0.2340
BETA = 0.5969

BORE = 7.9094

FLOW RATE (lbs/hr) = 6737.840 x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 332, EQ. 44

CERTIFIED CORRECT

Lowell J. ...
VICKERY-SIMMS, INC.

DOCUMENT NO.: BC-P-48493- 2
DATE: 7/3/80
REV. B BY: MJJ *...*

RECEIVED
JUL 14 1980
BELILOVE CO.

VENDOR PRINT No. 40-105-3-2

VENDOR DRAWING REVIEW	
Review is for General Compliance with Contract Documents. No responsibility is assumed by this review. Contractor or Supplier has complete responsibility for design, performance and compliance with Contract Document, Drawings, Specifications and Purchase Orders.	
1	No Exceptions Taken
2	Make Corrections Noted
3	Rejected
4	Amend and Resubmit
5	Send Certified Drawing
6	Fabrication May Proceed
ROGERS ENGINEERING CO., INC. ENGINEERS-ARCHITECTS	
Job No. <u>S-75016-31</u>	Equip. No. _____
By _____	Date _____

VICKERY-SIMMS Incorporated

A *Sundco* company

Rogers Engineering Co., Inc.
SAN FRANCISCO
RECEIVED

JUL 16 1980

ORIFICE PLATE
STEAM BORE CALCULATION

PROJ. MGR. WIN BOTT
JOB No. S-75016-31

CUSTOMER: Belilove Co.
CUSTOMER P.O.: VSI-18
TAG NO.: FE-121B (LOW RANGE)

VSI JOB NO.: P-48493

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)	13.250
METER TYPE (Dry or Hg)	DRY
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)	177.1654 (4500 MM)
MAXIMUM FLOW, lbs/hr (Wm)	39682.00 (5 KG/SEC.)
NORMAL FLOW, lbs/hr	25400.00
FLOWING TEMPERATURE, deg. F	375.98 (191.1°C)
FLOWING PRESSURE, p.s.i.a.	187.74 (13.2 kg/cm ²)
PERCENT OF MOISTURE	0.00
SUPERHEAT, deg. F	0.00
SPECIFIC WEIGHT AT FLOW CONDITION, lbs/cu.ft.	0.4117
OPERATING VISCOSITY, centipoises	0.0153
ATMOSPHERIC PRESSURE, p.s.i.a.	14.70
ORIFICE TYPE	CONCENTRIC
METER TAP LOCATION	FLANGE
STATIC PRESSURE TAP LOCATION	DOWNSTREAM
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER @ NORMAL FLOW	791851.03

CALCULATIONS:

(1) Wm	39682.00	(6) Y	1.0026
(2) D x D	175.5625	(7) SQ. ROOT sp. wt.	0.6417
(3) Fa	1.0060	(8) SQ. ROOT Hm	13.3103
(4) Fm	1.0000	(9) 358.9x(2) THRU(8)	540343.2018
(5) Fc	0.9955		

S = (1) / (9) 0.0734
BETA = 0.3480 BORE = 4.6113

FLOW RATE (lbs/hr) = 2981.289 x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 332, EQ. 44

CERTIFIED CORRECT
Loe-Lane Jr.
VICKERY-SIMMS, INC.

DOCUMENT NO. BC-P-48493- 3
DATE: 7/3/80
REV. B BY: MJJ *Doc*

RECEIVED
JUL 14 1980
BELILOVE CO.

VENDOR PRINT No. 40-105-4-2

VENDOR DRAWING REVIEW	
Review is for General Compliance with Contract Documents. No responsibility is assumed by this review. Contractor or Supplier has complete responsibility for design, performance and compliance with Contract Document, Drawings, Specifications and Purchase Orders.	
1	No Exceptions Taken
2	Make Corrections Noted
3	Rejected
4	Amend and Resubmit
5	Send Certified Drawing
6	Fabrication May Proceed
ROGERS ENGINEERING CO., INC. ENGINEERS-ARCHITECTS	
Job No. <u>S-75016-31</u>	Equip. No. _____
By _____	Date _____

MIRAVALLS GEOTHERMAL PROJECT
PORTABLE WELL FLOW TEST EQUIPMENT AND PROCEDURES

Contents

- 1.0 SUMMARY**
- 2.0 EQUIPMENT FOR WELL TEST**
- 3.0 ARRANGEMENT AND OPERATION OF EQUIPMENT**
- 4.0 INSTRUMENTATION**
- 5.0 START-UP PROCEDURE**
- 6.0 TEST RUNS**
- 7.0 SHUTDOWN PROCEDURE**
- 8.0 SYSTEM CHECKING AND MAINTENANCE DURING SHUTDOWN**

APPENDICES

- APPENDIX A - PERFORMANCE CRITERIA FOR MECHANICAL EQUIPMENT**
- APPENDIX B - EQUIPMENT DATA SHEETS**
- APPENDIX C - DRAWINGS ASSOCIATED WITH PORTABLE WELL TEST SYSTEM**
- APPENDIX D - TEST RESULT TABLES**

MIRAVALLS GEOTHERMAL PROJECT

PORTABLE WELL FLOW TEST EQUIPMENT AND PROCEDURES

1.0 SUMMARY

1.1 The well flow test program has been designed to facilitate the gathering of information, with portable test equipment, from various wells with regard to their capability of flow, the quality of steam produced at various back pressures, the composition and quantity of noncondensable gases flashed from the wells and the composition and quantity of solids in the well's liquid streams (brine).

1.2 The test program includes procedures for obtaining the following basic flow data pertinent to the plant power cycle design:

1.2.1 Effluent steam and brine flows, pressures and temperatures.

1.2.2 Noncondensable and dissolved gas contents in steam and brine.

1.2.3 H₂S content in gases formed.

1.2.4 Solids content and chemical analysis of steam and brine.

2.0 EQUIPMENT FOR WELL TEST

2.1 The portable flow test equipment is shown in general on P & ID B-03-001, included in Appendix C. This same drawing contains the identifying tag numbers for the equipment listed below.

2.2 In addition the portable flow test equipment is shown on drawings D-04-001 and D-04-002, in Appendix C. These drawings reflect the placement of the various pieces of equipment and piping as they would be assembled at any particular test location and identify the various pipe spool numbers used during assembly.

2.3 Drawing D-45-001, in Appendix C, reflects equipment which must be constructed at each well flow test site. These are mainly concrete equipment pads and pipe supports. The only exception is the structural steel skid shown on D-45-001. It is prefabricated and moved about from site to site.

2.4 Major Equipment Employed During A Flow Test

2.4.1 Wellhead valve arrangement (by others) contains a local pressure gauge (PI-101).

2.4.2 Portable flash steam separator (10-1) including:

- a. Pressure safety valve (PSV-105).
- b. Brine liquid level gauges (LG-108A & B)

2.4.3 Portable flow test skid, including:

- a. Effluent flashed-steam pressure gauge connection (PI-120); flow metering orifice plate and flanges assembly (FE-121) and pressure control valve (HCV-123).
- b. Effluent hot brine pressure gauge connection (PI-110); flow metering orifice plate and flanges assembly (FE-111) and brine level control valve (HCV-113).

2.4.4 Portable instrument mounting rack containing:

- a. Effluent flashed steam pressure gauge (PI-120) and differential pressure indicator (FI-121).
- b. Effluent hot brine pressure gauge (PI-110) and differential pressure indicator (FI-111).

2.4.5 Muffler (by others)

2.4.6 Interconnecting piping:

- a. Wellhead to muffler blowdown-contains lip pressure gauge (PI-108) at extreme end in muffler.
- b. Wellhead to separator-contains local temperature gauge (TI-102).
- c. Effluent flash steam to test skid-contains local temperature gauge (TI-122).
- d. Effluent hot brine to test skid-contains local temperature gauge (TI-112).
- e. Test skid to muffler piping.

3.0 ARRANGEMENT AND OPERATION OF EQUIPMENT

3.1 Steam and Effluent Brine System

3.1.1 The equipment arrangement as shown on Drawings D-04-001 and D-04-002 in Appendix C functions generally as follows:

3.1.1.1 The well fluid to be tested passes as a flashing two-phase mixture through one of the 10" well discharge valves to the portable flash steam separator (10-1). Inside the separator the two-phase flow separates into the steam and hot liquid (brine) phases (See Appendix A for a discussion on well and flash separator performance).

3.1.1.2 The steam phase is gathered at the top of the separator (inside) and exits through the bottom passing first through the orifice plate meter (FE-121) and then through the pressure control valve (HCV-123). This valve is used to control the separator pressure and in turn the flow rate from the well.

3.1.1.3 The brine phase from the separator (10-1) flows out the bottom-side discharge of the separator, through the orifice plate meter (FE-111) and through the brine level control valve (HCV-113). The brine will start to flash across the valve as the pressure decreases to atmosphere in flowing through the discharge line.

3.1.1.4 Just downstream of both the steam and brine control valves, the partly flashing brine flow is injected into the steam line in an attempt to aid in the reduction of noise by using the liquid phase to attenuate the generated sound.

3.1.1.5 Finally the total process is passed into a muffler, provided by others, which functions to quiet the total well effluent.

3.2 Well Blowdown

3.2.1 The well fluid, when not being tested, passes through an alternate 10" well discharge valve and ultimately is discharged into the same muffler described above.

4.0

INSTRUMENTATION

Various instrumentation as described below is provided to measure pressure, temperature and flow of flashed steam and effluent brine during the ensuing tests. All of these devices are to be calibrated in accordance with the manufacturers recommended procedures and/or standard calibration procedures.

4.1

Wellhead

Local pressure (PI-101) and temperature (TI-102) gauges are provided for indicating temperature and pressure at the wellhead. A blowout preventer should be installed to allow usage of the downhole instruments during flow testing.

4.2

Flash Separator

4.2.1

Local level gauges (LG-108A & B), on the flash separator, are provided to indicate separator level. Wall taps in the steam space are provided for pressure and temperature measurement and process sample collection if desired.

4.2.2

The flash separator level is controlled manually by a control valve (HCV-113) in the effluent brine line.

- 4.2.3 The flash separator pressure is controlled manually by control valve (HCV-123) in the effluent steam line.

4.3 Effluent Brine

The flow of effluent brine from the separator is measured by an orifice plate and flange assembly (FE-111) which generates a differential pressure that is registered on an indicator (FI-111) mounted on a local instrument rack. Pressure gauge (PI-110) and temperature gauge (TI-112) afford local measurement of the process just prior to its passage through the orifice.

4.4 Steam

The steam flow from the separator is measured by an orifice plate and flange assembly (FE-121) which generates a differential pressure that is registered on a flow indicator (FI-121) mounted on a local instrument rack. Pressure gauge (PI-120) and temperature gauge (TI-122) afford local measurement of the process just prior to its passage through the orifice.

4.5 Blowdown

A tap for pressure gauge (PI-108) is located at the extreme end of the pipe inside the muffler to provide lip pressure readings of the two phase process as a comparison against the separator flows.

5.0 START-UP PROCEDURE

5.1 Preparation

5.1.1 The system shall be completely installed, inspected, tested, and calibrated prior to the start of the test.

5.1.2 The steam pressure control valve (HCV-123) and the brine level control valve (HCV-113) should both be set to full open position. Proper orifice plates should be inserted in their appropriate flange assemblies. All grab sample, drain and process measuring root valves shall be closed. Level glass (LG-108A & B) root valves on the separator shall be opened.

5.1.3 Important Note: The "U"-Bolts securing the piping to the test skid are to be loosened, raised 1.6 mm (1/16") and locked in place to form pipe guides (Ref. Note 1 on Dwg. D-04-001 in Appendix C).

5.2 Initial-Warm Up Procedure

5.2.1 To start the well flowing, with the main wellhead valve closed the 10" wellhead valve in the blowdown line to the muffler is opened and the 10" wellhead valve in the line to the flash separator must be closed.

The well is then started up by opening the main wellhead valve. Depending on the length of time the well has been shut down, it may be necessary to stimulate the well by removing the column of cold water in the well bore with an air probe, by baling the well, or other suitable method. Once clear flow is established and a steady flow-state is achieved, the flow can be switched from the muffler to the flash separator by appropriate manipulation of the two 10" wellhead valves.

5.2.2 Initial flow to the flash separator must be low to allow gradual heat up of the system. Flow increase is achieved by a controlled, gradual opening of the 10" wellhead valve in the line to the separator. When this valve is fully open, further flow is controlled by closing the 10" wellhead valve on the blowdown line to the muffler and by simultaneously throttling down on the steam pressure control valve (HCV-123) and the brine level control valve (HCV-113). The separator must be operated at pressures lower than those which are expected to cause slug flow from the well (approximately 200 psig).

5.2.3 When the above procedure has been completed and steady brine levels and non-slugging flow has been obtained, the equipment and system will be ready to start testing. All process root valves can be opened and the various instruments placed in service.

5.3 Additional Operating Procedures

- 5.3.1 During testing it is important to maintain a relatively constant level in the flash separator (equivalent to the mid-range point of the upper gauge glass LG-108A) otherwise brine flow rates will need to be corrected for brine level changes for a given steam rate. Therefore, HCV-113 is used to maintain relatively constant level in the separator. Should conditions exist where a constant level cannot be maintained at the desired point, the rate of change of the level should be noted and recorded on Table #3 in Appendix D. This information can then be used to factor the measured flow rate.

6.0 TEST RUNS

6.1 Summary

6.1.1 Since the purpose of the well test program is to obtain data concerning the characteristics of various wells and the total production capability along with other factors which will affect the design of a power plant, the following tests have been selected to meet this objective.

6.1.2 The methods of testing referenced herein are given in the technical paper "Sampling and Analysis Methods for Geothermal Fluids and Gases" by J. C. Watson, PNL-MA-572 VC-66d published by Pacific Northwest Laboratory for U. S. Department of Energy under Contract EY-76-C-06-1830. Copies of the applicable methods have been included in Appendix C for convenience.

6.1.3 These methods or other acceptable analytical methods may be used.

6.2 Index

6.2.1 Test 1 - Downhole pressure and temperature: Static and Dynamic

- a. The static test will be conducted before and after the well flow test #2.

b. The dynamic test will be conducted during the well flow test #2.

6.2.2 Test 2 - Flash steam and residual brine flow versus wellhead pressure.

6.2.3 Test 3 - Steam quality (chloride method).

6.2.4 Test 4 - Noncondensable gas content in steam versus steam flow rate.

6.2.5 Test 5 - Analysis of noncondensable gas fraction for H₂S content.

6.2.6 Test 6 - Residual brine temperature, % gas content and analysis of gas and liquid at specified steam flow rates.

6.2.7 Test 7 - Noise level monitoring at the muffler versus steam flow rate.

6.3 Details

6.3.1 Test 1 -- Downhole Temperature and Pressure -- Static and Dynamic

6.3.1.1 An instrument package lowered down the well will provide data on the temperature and pressure conditions in the well at various depths.

- 6.3.1.2 The static condition will be measured with the well shut in prior to the start of the well flow test and immediately following the final well test. The results shall be tabulated on Table 1, (Appendix D).
- 6.3.1.3 The dynamic condition will be measured with the well flowing during various stages of the well flow test. The results will be tabulated on Table 2, (Appendix D).
- 6.3.2 Test 2 -- Flash Steam and Residual Brine Flow versus Wellhead Pressure
- 6.3.2.1 The object of this test is to determine the total well flow as a function of wellhead pressure by separately metering the effluent steam and brine flows after separating the two phases in a steam separator.
- 6.3.2.2 Orifice plate meters, FI-111 and FI-121, are located on the downstream side of the flash separator on the test skid. Readings can be taken directly from these instruments and converted into flow rates. Pressure and temperature readings can be taken from pressure gauges (PI-110 and PI-120), and temperature gauges (TI-112 and TI-122), directly upstream of the orifice plates and from the wall taps on the flash separator, if so desired.
- 6.3.2.3 The brine orifice plate (FE-111) is capable of operating over the entire range expected to be encountered. However, the expected

steam flow range cannot be covered with one orifice size. As a result orifice plate FE-121A should be used for flow ranges of from 11.34 Kg/sec. (90,000 lbs./hr.) down to around 5.4 Kg/sec. (40,000 lbs./hr.) and FE-121B should be used for lower flows down to around 3.15 Kg/sec. (25,000 lbs./hr.).

6.3.2.4 Flow measurements should be taken, at least, at six different separator pressures, including points "a." and "e." listed below, so that a plot can be prepared over the full range of stable well flow. However, depending on the time required to reach stability at each flow-state point, and the length of well test schedule agreed to, it may be necessary to limit the number of flow state points to a minimum of three or four. Should this be necessary, then the minimum and maximum flow-state point "a." and "e." shall be used along with an intermediate point between them. The suggested flow-state points are as shown below:

- a. Flow (maximum) at or near 5.63 Kg/cm^2 (80 psig) - limited by liquid entrainment (separator performance).
- b. Flow at 10.9 Kg/cm^2 (155 psig).
- c. Flow at 12.16 Kg/cm^2 (173 psig).
- d. Flow at 12.3 Kg/cm^2 (175 psig).

- e. Flow (minimum) at incipient slug flow conditions representing maximum stable operating pressure estimated to be 14.6 Kg/cm² (200 psig).

- 6.3.2.5 The maximum flow shall be measured first. The wellhead flow pressure shall be slowly increased to obtain the other points. The test run shall be conducted twice. The second run shall be done in reverse order of pressure. By running the test in reverse any hysteresis will show on the graph. Each flow-state point will be identified when three identical pressure and steam flow readings are obtained for a given point which will indicate that a steady state condition of the well exists. The effluent brine flow rate shall be calculated at each steady flow-state condition for the steam.
- 6.3.2.6 The results of these test runs shall be tabulated on Table 3 (Appendix D). However, it should be noted that FI-111 and FI-121 have been specified to read 0-100% so that calibration to ranges other than provided, but within the capability of the instrument, may be accomplished without additional scales. This percentage reading must then be converted to a differential pressure figure represented by so many inches (i.e. millimeters) of water which is then converted to flow rate.
- 6.3.2.7 With reference to the applicable instrument data sheets in Appendix B the following represents the method by which readings on the differential pressure indicators (FI-111 and FI-121) should be converted:

- a) Using the calibration range for brine (Ref. DS-40-004) of 0-31.5 inches of water to represent up to a maximum of 520,000 lbs./hr. of flow, the following sequence will yield a flow rate for a given indication on the flow meter (FI-111).
- b) Assume the flowmeter reading is 75, then:
31.5 in. water x .75 = 23.63 in. water
- c) To convert to the equivalent flow rate
(Ref. Orifice Plate - Liquid Bore Calculation DOC. #BC-P-48493-1 Appendix C):
$$\text{Flow Rate (Kg/sec.)} = \frac{92628.116 \sqrt{23.63}}{7936.5} = 56.73 \text{ Kg/sec.}$$
- d) When solving for other orifice plate flow rates refer to appropriate calculation sheets in Appendix "C", use inches of water differential and the 7936.5 denominator to convert to Kg/sec.

6.3.3 Test 3 -- Steam Quality (Chloride Method)

- 6.3.3.1 It is expected that the steam quality will be relatively consistent over the entire pressure and flow range. However, the performance of the flash separator is to be determined by the quality of steam discharged from it; therefore, the chloride content test is required to serve as the acceptance or efficiency test for the flash separator. The value of the chloride content shall be taken for each flow-state point to determine, what variances, if any, may occur in the separators' efficiency.
- 6.3.3.2 The chloride content test will measure the chloride carryover in the steam from the separation inside the flash separator. The chloride

content naturally present in liquid can be established by analysis of the brine samples taken from the separator. By obtaining a steam sample and measuring the amount of chloride present, an accurate determination can be made of the amount of water entrained by the steam since the concentration of chloride in the entrained water is the same as that in the separated hot brine. The results shall be tabulated on Table 4 (Appendix D).

6.3.4 Test 4 -- Noncondensable Gas Content in Steam Versus Steam Flow Rate

- 6.3.4.1 The amount of noncondensable gas in the steam must be measured in order that condensers, cooling towers and any probable hydrogen sulfide removal system can be accurately sized and designed.
- 6.3.4.2 The preferred sampling method is No. 16-S, Edition 7/78, p. B-18, Figure 1 (Appendix C). The adaption for this well test is detailed in Drawing A-40-005, Sheets 8, 9 and 10 (Appendix C).
- 6.3.4.3 The sample from the steam line is taken via the sample nozzle (ANX-1) located ahead of TI-122 and collected in a suitable container for analysis by either direct reading on a meter or indirectly by chemical methods.
- 6.3.4.4 Samples shall be taken at all flow-state points. The results shall be tabulated in Table 5, (Appendix D).

6.3.5 Test 5 -- Analysis of Noncondensable Gas Fraction for H₂S Content

- 6.3.5.1 An analysis of the constituents of the gas is required primarily to determine the amount of H₂S (hydrogen sulfide) present. The determination of the H₂S fraction will establish the size of the probable H₂S abatement system; therefore, every effort shall be made to obtain at least one H₂S analysis during each well test.
- 6.3.5.2 The preferred analysis method is by use of a gas chromatograph and is probably most practically accomplished in a laboratory rather than in the field. To extract gas samples therefore, a technique is included whereby gas samples may be collected in gas collecting tubes for transport to a laboratory. (Reference sampling method 16-S, edition 7/78 figure 1, adopted as shown on Drawing A-40-005, Sheet 10 included in Appendix C).
- 6.3.5.3 Before any samples are extracted the entire sample tubing and collecting apparatus should be purged of air with a known-inert-single element gas such as nitrogen.
- 6.3.5.4 The sample from the steam line is then taken via the sample nozzle (ANX-1) located ahead of TI-122 and passed into the collection apparatus and through a wet test meter so that a volumetric flow rate may be established.

6.3.5.5 With the system arranged as shown in A-40-005, Sheet 10, the gas to be collected passes through from one to two filtering flasks which contain reagents that trap out various gases in the noncondensable gas mixture and leave a refined gas to be analyzed. Should the entire noncondensable gas composition be required to be analyzed then connection from the aspirator bottle should be made directly to the gas collection tube.

6.3.5.6 Samples shall be taken at each flow-state point. The results shall be tabulated in Table 5, (Appendix C).

6.3.6 Test 6 -- Residual Brine Temperature, % Gas Content and Analysis of Gas and Liquid at Specified Steam Flow Rates

6.3.6.1 The preferred sampling method is No. 11-S, edition 7/78, page B-13 (Appendix C). The adaption for this well test is detailed in Drawing A-40-005, Sheet 7 included in Appendix C.

6.3.6.2 Samples shall be taken, at all flow-state points, from the sample tap (ANX-2) ahead of TI-112. The results shall be tabulated in Table 5, (Appendix D).

6.3.6.3 The major components of geothermal brine are generally well-known; therefore, tests should be run and laboratory analysis be performed to check for at least the following constituents.

<u>Constituent</u>		<u>Information Required</u>
Sodium	Na^+	ppm
Calcium	Ca^{++}	ppm
Magnesium	Mg	ppm
Potassium	K^+	ppm

<u>Constituent</u>		<u>Information Required</u>
Chlorides	Cl^-	ppm
Sulfate	SO_4^{--}	ppm
Carbonate	CO_3^{--}	ppm
Sulfide	S^{--}	ppm
pH		
Bicarbonate	HCO_3^-	ppm

6.3.6.4 The following should be adhered to when performing the sampling method referenced above:

- a) Preparation of sample bottles and containers used to collect geothermal samples:

1) Bottles and Containers

Brine samples will be collected in Pyrex glass or virgin-linear-polyethylene bottles and carboys with appropriate top seals or polypropylene caps.

2) Preparation of Containers

All bottles and carboys shall be washed prior to sample collection using the following sequence:

- a. Distilled water rinse,
- b. Two more distilled water rinses.

b) Methods Used to Collect Brine Samples for Analysis:

- 1) Raw Untreated (RU) brine shall be collected through the stainless steel cooling coil(s). The coil(s) should be cooled by a flowing water bath or with ice. pH shall be determined on this sample in the field.
- 2) Raw Acidified (RA) brine shall be collected through the cooling coil(s) and acidified with 10 mls of high purity concentrated HCL per liter of unfiltered brine. Parameters determined using the RA sample include hardness, aluminum, ammonia, antimony, arsenic, barium, boron,

calcium, cesium, copper, iron, lead, lithium, magnesium, manganese, mercury, potassium, rubidium, silver, sodium, strontium, zinc, and silicon. Not all the above elements will necessarily be determined.

c) Alternative Methods:

- 1) Filtered Untreated (FU) brine shall be collected through the previously mentioned cooling coil(s) followed by passing the brine through a 0.45 u membrane filter. Parameters determined using the FU sample include alkalinity, bicarbonate-carbonate, chloride, fluoride, bromide, iodide, phosphate, sulfate, and total dissolved solids.
- 2) Filtered Acidified (FA) brine shall be acidified with 10 mls of high purity concentrated HCL per liter of brine. This brine shall be collected by passing the brine through the previously mentioned cooling coil(s) and through a 0.45 u membrane filter. Parameters determined using the FA sample shall be the same as for the RA sample.
- 3) A 20:1 dilution for silica (SiO_2) using cooled filtered brine and distilled, deionized water for the dilution.

- 4) A sample shall be collected for entrained H_2S bypassing cooled filtered brine through a sintered glass frit immersed in a solution of 0.5 N zinc acetate; the sample collected represents a 1:1 dilution of the brine.
- 5) A sample shall be collected for entrained CO_2 bypassing cooled filtered brine through a sintered glass frit immersed in a solution of 2 N NaOH; the sample collected represents a 1:1 dilution of the brine.

6.3.7 Test 7 -- Noise Level Monitoring at the Muffler Versus Steam Flow Rate

- 6.3.7.1 Environmental considerations usually require that all sources of pollution be monitored and controlled. This is, therefore, assumed to apply equally to noise.
- 6.3.7.2 The muffler should be designed on previous experience gained at other geothermal facilities and should be able to attenuate the noise to within acceptable levels.
- 6.3.7.3 Monitoring points should be selected to measure the maximum noise level which would be experienced by personnel working in the areas and the noise distribution at the site boundary and beyond. Site inspection will reveal these locations and readings will be taken by a hand-held dBa meter.

6.3.7.4 Readings should be taken for all flow-state points. Results will be tabulated on Table 6, Appendix D and a graph of noise level dBa versus steam flow should be compiled.

7.0 SHUTDOWN PROCEDURE

7.1 Steam System

7.1.1 After the well testing has been completed the following well shutdown procedure shall be followed.

7.1.2 The 10" wellhead valve in the line to the flash separator will be open before the shutdown procedure starts; the 10" wellhead valve in the blowdown line to the muffler will be closed.

7.1.3 The two-phase flow to the separator should be slowly decreased to the incipient slug flow condition by first opening the 10" valve in the blowdown line to the silencer and then by slowly closing the 10" wellhead valve in the line to the separator. This should be done evenly over a minimum time period of 10 minutes so that no shock condition is imposed on the well casing shaft and formation. When slug flow condition is reached, the valve in the line to the separator should be rapidly closed. As soon as the 10" wellhead valve in the line to the separator is fully closed the 10" valve in the blowdown line to the silencer may be closed slowly. Finally the main vertical 10" wellhead valve located directly on the wellhead flange must be fully closed. Steam pressure control valve (HCV-123) may also be closed at this time.

7.2 Effluent Brine System

7.2.1 If the system is to be shut down for an extended period of time, the effluent brine, remaining in the bottom of the flash separator (10-1) must be removed from the vessel. The level control valve (HCV-113) will have to be completely opened as well as the separator drain valve. The pressure and static head remaining in the flash separator (10-1) will force the brine out through both valves.

7.2.2 Condensate and brine in the two phase line from the wellhead to the separator should be drained off via the low end drain valve in the pipe. Likewise both pipe runs ahead of the control valves (HCV-113 and 123) on the test skid should be drained via their low end drain valves and all pipelines flushed with clean water.

8.0 SYSTEM CHECKING & MAINTENANCE DURING SHUTDOWN

8.1 When the flash separator has cooled down, the manhole cover should be removed and the interior and internals should be washed down with clean water using a high pressure water jet to remove all chemical scale which has built up on the surfaces.

8.2 The relief valve should also be removed, cleaned and checked to ensure that it is in good working order and then properly reinstalled.

8.3 After separator cleaning is completed the vessel should be closed up again, using new gaskets on flange connections where required.

8.4 After the well test is completed, valving and piping should be examined to see to what extent any silica build up has occurred. This will give a good idea of what potential problems may occur under full load plant conditions if appreciable build up is observed.

8.5 Other maintenance work, as follows, must be carried out prior to re-starting the system again after a shutdown.

- a) Check sight glasses (LG-108A & B) on the separator; make sure liquid is visible through the glass. If necessary, clean out the sight glasses.

- b) Disconnect instrument sensing lines and flush with clean water and reconnect.
- c) Orifice plates should be removed, inspected for wear in accordance with manufacturer's recommendations and chemical deposits and then be cleaned and reinstalled, if found to be in serviceable condition.

APPENDIX A

Performance Criteria for Mechanical Operating Equipment

1.0 Flash Separator (10-1)

- 1.1 The Flash Separator is designed to operate between a minimum pressure of 5.63 Kg/cm² (80 psig) and a maximum pressure of 21.1 Kg/cm² (300 psig) at which point the safety relief valve will blow. The two-phase flow rates associated with the maximum and minimum pressure values are expected to be 44.98 Kg/sec. (357,000 lbs./hr.) and 76.23 Kg/sec. (605,000 lbs./hr.) respectively.
- 1.2 The minimum pressure, operating pressure, and maximum pressure for the purpose of the test are expected to be 5.63 (80), 10.9 (155), and 14.06 (200 Kg/cm² (psig) respectively.

APPENDIX B

EQUIPMENT DATA SHEETS

<u>Document No.</u>	<u>Rev.</u>	<u>Description</u>
DS-10-001	1	Vessel Design Data Sheet (10-1)
DS-40-001	2	Relief Valves
DS-40-002	2	Control Valves
DS-40-004	3	Differential Pressure Instruments
DS-40-005	2	Orifice Plates
DS-40-006	2	Pressure Gauges
DS-40-007	2	Indicating Thermometers

INSTRUMENT NO. PSV-105
 P & ID NO. B-03-001
 SERVICE FLASH SEPARATOR
 EQUIP NO. OR LINE NO & SIZE 10-1
 COMMODITY SAT. STEAM 2)
 NORMAL OPER. PRESS & TEMP. 200 PSIG, 387.9°F
 SOURCE OF RELIEVING PRESS. External to Vessel

DESIGN CONDITIONS & BASIS FOR
 SELECTION: SEE API RP 520, AND
 ASME BOILER & PRESSURE VESSEL
 CODE SECTION VIII, IN 407-O DES. GUIDE

SP. GR. (AIR-WATER=1.0) SAT. STEAM
 MOLECULAR WEIGHT —
 COMP. FACTOR $Z = PV/RT$ —
 CP/CV NOZ. GAS CONSTANT —
 FACTORY SET PRESSURE 300 PSIG
 BACK BUILT-UP Ø
 PRESS. MAX. SUPERIMPOSED ATMO
 PRESS. @ WHICH VALVE OPENS 300 PSIG
 ACCUMULATION % PSIG 10 30
 TOTAL RELIEVING PRESS. 330 PSIG
 (INCL. ACCUM) PSIG (30 PSIG)
 MAX. REL. TEMP. SAT.
 EQUIP. DESIGN PRESS. 300 PSIG
 EQUIP. DESIGN TEMP. 470°F
 PERCENT VAPOR 2.2 %
 CAPACITY - MAX. REQ'D. 268,000 lb/hr
 CAPACITY - RATED 270,000 lb/hr
 MFR'S ORIF. DESIGNAT'N P
 ORIFICE AREA REQ/SELECT 6.38 6.38

CONN'S. IN-SIZE, RATING, TYPE 4" 300 lb R.F.
 OUT-SIZE, RATING, TYPE 6" 150 lb R.F.

MAT'L'S OF CONSTR. BODY BONNET CS CS
 TRIM NOZZLE & DISC 304 SS
 SPRING C.S. CAD PLATE

DETAILS OF MANUFACTURE TYPE LIFTING GEAR PKD. LIFT LEVER
 PRESSURE BALANCED NO
 CODE STAMP REQUIRED YES

PURCH'G MANUFACTURER CROSBY
 CATALOG NO. JB-35 TYPED
 M.R. NO. MR-40-101

CODE REFERENCE
 ASME Unfired P.V.C., Sec. VIII
 ANSI B16.5 (For flanges)

REMARKS: *BINDER TO SUPPLY INFO. OR VERIFY SELECTED VALUES
 NOTE: 1) REF. DS-00-001; 316 SS/TEFLON COATED
 2) BELLOWS PROTECTION OF SPRING
 3) INTERNALS

2) VALVE IS TO BE SUITABLE FOR BOTH WATER & STEAM, AND 2 PHASE SERVICE

NO.	REVISIONS	DATE	BY	CHK	APPROVED
2	REVISED AS MARKED & ISSUED FOR CLIENT APPROVAL & PURCHASE	6/21/79	SCP	DRB	9/8/79
1	REVISED & REISSUED AS MARKED	5/2/79	SCP	DRB	5/10/79
0	ISSUED FOR BID	11/30/79	SCP	DRB	1/16/80

CHK DRB
 DATE 1-30-79
 APPD. 7/2/79

RELIEF VALVES
 GUANACASTE GEOTHERMAL PROJECT
 WELL FLOW TEST FACILITY

JOB NO. S-75016-31
 SHT 1 OF 1
 DS-40-001 2

IN 417-1

VALVE NO.	HCV-113	HCV-123
WELD NO.	B-03-001	B-03-001
SERVICE	SEP. LEVEL	SEP. VAPOR
FLUID	GEO. BRINE (1)	GEO. STEAM (1)
CORROSIVE, FLASHING, SUPERHEAT, ETC.	CORROSIVE (1) & FLASHING	CORROSIVE (1)
LINE NO.	1	

OPERATING CONDITIONS PRESSURE = 1000 KPa TEMP = 100°C	SP. GR.	FLUID AT SIZING TEMP.		GAS MOLE-CULAR WT.	
	TEMP.	MAX	NORM.	MIN.	
	PRESS.	MAX	NORM.	MIN.	
	Δ P @ MAX.	SIZING			
	PUMP SHUT-OFF Δ P MAX.	N/A		N/A	
	SIZING (MAX) FLOW W/UNITS		65.52 KG/SEC		11.34 KG/SEC
	NORM FLOW		MIN. FLOW		
	Cv Req'd @ SIZING (MAX)		MAX Cv. FURN.		
	COMPRESS- IBILITY, %		VISCOSITY @ NORM. TEMP.		

VALVE REQUIREMENTS	BODY	SIZE	TYPE	6" ECCENTRIC ROTATE DISK	8" ECCENTRIC ROTATE DISK
	CONN.	RATING	FACING	300# RF	300# RF
	BODY MATERIAL			316 SST	CS
	BONNET (PLAIN, FINS, EXTEND, SCREWED, BOLTED)			INTEGRAL	
	PORT SIZE	NO. OF PORTS	6"	ONE	8"
	CHARACTERISTIC	PLUG TYPE	LINEAR	CAM	
	GUIDING (SKIRT, TOP, BOTTOM)		TOP & BSTM		
	TRIM MATERIAL		316 SST	STELLITE	
	PACKING OR SEAL		TEF	ASB	
	LUBRICATOR		ISOLATION VALVE	NO	NO

ACTUATOR & ACCESSORIES	TYPE (DIAPH., PISTON, ETC.)			
	AIR OPENS-A.O.	SPRING RANGE		
	AIR CLOSES-A.C.			
	POSITIONER INPUT-OUTPUT			
	BY-PASS	GAUGES		
	AIR SET MOUNTED & TUBED			
	HANDWHEEL, JACK, ETC.		HANDWHEEL	HANDWHEEL

PURCH	MANUFACTURER	MASONELLAN
	MODEL NO.	20-35002
	M.R. NO.	MR-40-102
	PUBLISHED Cv	500

REMARKS: * BIDDER TO SUPPLY INFO

NOTES: 1) Ref. DS-00-001 for Chem. comp.

2) 316 SS min. REQ'D.

3) $Cv = \frac{1.16 W}{\sqrt{G_f \Delta P}}$ where $W = 235.9$ 1000 Kg/Hour; $G_f = 0.906$ SpGr; $\Delta P = 0.392$ Bar

4) $Cv = \frac{72.4 W}{\sqrt{P_1 - P_2}}$ where $W = 40.8$ 1000 Kg/Hour; $P_1 = 6.27$ Bar. abs; $P_2 = 4.7$ Bar. abs.

NO.	REVISIONS	DATE	BY	CHK	APPROVED
2.	REVISED AS MARKED & ISSUED FOR CLIENT APPROVAL & PURCHASE	7/1/79	SCP	JHGS	
1	REVISED AS MARKED & REISSUED FOR BID	4/13/79	SCP	JHGS	
0	ISSUE FOR BIDS	11/30/79	SCP	JHGS	

IN 416	CHK	DEC	CONTROL VALVES	JOB NO. S-75016-S1
	DATE	1-5-79		
	APPD.	JHGS		
GUANACASTE GEOTHERMAL PROJECT			SHT 1 OF 1	
WELL FLOW TEST FACILITY			DS-40-002 2	

INSTRUMENT NO.		FI-111			FI-121													
P. & I D NO		B-03-001			B-03-001													
SERVICE		SEPERATOR LEVEL			SEPERATOR VAPOR													
LOCATION - LINE OR EQUIP. NO.		A 12"-SCH 30			14"-SCH 30													
OPERATING CONDITIONS	FLUID		GEOTHERMAL BRINE			GEOTHERMAL STEAM												
	TEMP. °C	MAX.	OPER.	MIN.	197.8	186.7	162.2	198.4	186.7	162.2								
	PRESS. Kg/cm²A	ψ	ψ	ψ	15.4	12.2	7	15	12	6.7								
	FLOWRATE Kg/hr (AT ABOVE CONDITIONS)			41			56.8			65.5								
CORR. LIVE - SUPERHEAT - ETC.		CORROSIVE 1 & 2			CORROSIVE 1 & 2													
BLIND, INDICATING, RECORDING		INDICATING			INDICATING													
CASE	TYPE		WEATHERTIGHT			WEATHERTIGHT												
	COLOR		MFGRS STD			MFGRS STD												
	MOUNTING		PIPE			PIPE												
ACTUATING UNIT	CALIBRATED RANGE (METRIC)		0-800 mm H₂O			0-4500 mm H₂O												
	ACCURACY		1/2 OF 1% FULL SCALE			1/2 OF 1% FULL SCALE												
	HOUSING / PRESS. RATING / MAT.		35.2 KG/CM² / C.S.			35.2 KG/CM² / C.S.												
	PROCESS CONN.		1" NPT			1" NPT												
STATIC ELEMENT	MATERIAL & TYPE		316SS BELLOWS			316SS BELLOWS												
	RANGE CAPABILITY		*			*												
	ELEMENT PROTECTION		YES 2)			YES 2)												
SCALE	TYPE & SIZE		270° ARC - 6" MIN			270° ARC - 6" MIN												
	RANGE		0-100 %			0-100 %												
	GRADUATIONS		UNIFORM 0 to 100			UNIFORM 0 to 100												
	FIGURE INTERVAL		10			10												
OPTIONS	OVERANGE PROTECTION		YES			YES												
			—			—												
REMARKS: * BIDDER TO SUPPLY INFO																		
NOTES	1) REF. DS-00-001 FOR CHEM. COMP.																	
	2) ELEMENT PROTECTED BY CHEM. SEAL; 316SS DIAPHRAGMS; 1" NPT PROCESS CONN.; 5' ARMORED CAPILLARY TUBING AND HIGH TEMP (650°F)																	
PURCH.	MANUFACTURER		ITT BARTON			SILICONE FILL FLUID, ARMOR MATERIAL 316SS												
	MODEL NO.		R27-352															
	M.R. NO.		MR-40-104			MR-40-104

10.	NO REVISIONS		DATE	BY	CHK	DATE	DATA SHEET DIFFERENTIAL PRESSURE INSTR. GUANACASTE GEOTHERMAL PROJECT WELL FLOW TEST FACILITY	JOB NO. S-79016-31		REV 3
		3	REV RANGE FI-111 & ISSUED FOR APPROVED PURCHASE	6/15/80	SP	6/15/80	SHT 1 OF 1				
		2	REVISED AS MARKED & ISSUED FOR PURCHASE & CLIENT APPROVAL	2/27/78	SP	2/27/78					
		1	REVISED AS MARKED: FOR BID	1/27/78	SP	1/27/78					
		0	ISSUED FOR R.D.	1/27/78	SP	1/27/78					

INSTRUMENT NO.				FE-III		FE-121A		FE-121B	
P. & I. D. NO.				B-03-001		B-03-001		B-03-001	
SERVICE				SEP. LEVEL		SEP. VAPOR		SEP. VAPOR	
						(HIGH RANGE)		(LOW RANGE)	
LINE NO. & SIZE & SCHEDULE				12" SCH 30		14" SCH 30		14" SCH 30	
COMMODITY				GEO. BRINE (1)		GEO. STEAM (1)		GEO. STEAM	
OPER'G DATA	PRESS KG/CM ² A	MAX.	MIN.	15.4	7.1	15	6.7	15	13.2
	TEMP. °C			197.8	162.2	197.8	162.2	197.8	191.1
	FLOW KG/SEC (AT ABOVE CONDITIONS)			41	65.5	3.2	11.3	3.2	5
FLANGE	TYPE			WELD NECK		WELD NECK			
	RATING & FACING			300# RF		300# RF			
	MATERIAL			CS		CS			
	PRESS. TAPS	TYPE & SIZE		FLANGE	1/2" NPT	FLANGE	1/2" NPT		
METER RUN	DIAMETERS UP STREAM	DIAMETERS DOWN STREAM							
WELL	PLATE MAT'L. & THICKNESS			316 SS-1/4" (2)		316 SS-1/4" (2)		316 SS-1/4" (2)	
	PIPE I.D. (O)		ORIFICE I.D. (O)	12.09" (3)		13.25" (3)		13.25" (3)	
	d/D RATIO (β)			(2)(3)		(2)(3)		(2)(3)	
	METER TYPE			AP BELLWS		AP BELLWS		AP BELLWS	
	METER RANGE		STATIC SPRG. RANGE	800 mm H ₂ O		4500 mm H ₂ O		4500 mm H ₂ O	
	TEMP. BASE		PRESS. BASE	—		—		—	
	CHART OR SCALE RANGE			0-100 %		0-100 %		0-100 %	
	SEAL'G FLUID OR PURGE		SP. GR. @ 60° F.	—		—		—	
	TYPE OF PLATE & O.D.			PADDLE		PADDLE		PADDLE	
	BEVEL		DRAIN OR VENT HOLE	(4)(2) REQ'D (2)		(4)(2) REQ'D (2)		(4)(2) REQ'D (2)	
BASIC ORIFICE CONSTANT I *			(4)		(4)		(4)		
ACTUAL CHART FACTOR			(4)		(4)		(4)		
NOMINAL CHART FACTOR			—		—		—		
PURCH-ASING	ORIFICE FLANGE MFG'R.			PRECISION FLOW PRODS.		—		—	
	M.R. NO.			MR-40-105		—		—	
	PLATE MFG'R.			PRECISION FLOW PRODS.		—		—	
	M.R. NO.			MR-40-105		MR-40-105		MR-40-105	
INSTALLATION SCHEDULE				—		—		—	
REMARKS: * BIDDER TO SUPPLY INFO									
NOTE: (1) REF. DS-00-001 for Chem. comp.									
(2) AS REQ'D to comply w/ ASME requirements									
(3) VENDOR TO CALC. β RATIO REQ'D									
(4) TO BE STATED IN CALCULATIONS									
NO.	REVISIONS					DATE	BY	CHK	APPROVED
2	Revised range of FE-III because of revised orifice & line size					10/25/77	SEP	DRB	DRB
1	REVISED AS MARKED & ISSUED FOR PURCHASE					6/15/77	SEP	DRB	DRB
0	ISSUE FOR P.I.D.					4/24/77	SEP	DRB	DRB
CHK		DRB		DATA SHEET			JOB NO. S-75016-31		
DATE		1/30/77		ORIFICE PLATES			SHT 1 OF 1		
APPD.		G.M.		GUANACASTE GEOTHERMAL PROJECT			DS-40-005		
				WELL FLOW TEST FACILITY			2		

GENERAL NOTES

OPERATING CONDITIONS ALL
GAUGES THIS SHEET:

PRESS MAX = 300PSIG

NORM = 200PSIG

TEMP. MAX = 446°F

NORM = 387°F

REF. DS-00-001 FOR CHEM. COMP.

INSTRUMENT NUMBERS

PI-101 3) PI-108 3) 2

PI-110

PI-120 3)

ELEMENT	RANGE (METRIC)		0-35 Kg/cm ²	0-28 Kg/cm ²	Δ
	TYPE		BOURDON	BOURDON	
	ELEMENT MATERIAL		316 SS	316 SS	
	SOCKET MATERIAL		316 SS	316 SS	
	SERVICE TYPE (STD. OR TEST)		TEST	TEST	
	CONN. SIZE & TYPE		1/2" NPT	1/2" NPT	
	CONN. ORIENTATION		BOTTOM	BOTTOM	
CASE	DIAL SIZE & FIG. INTERVAL		6" 10	6" 10	
	DIAL COLOR SCHEME		BLK ON WHITE	BLK ON WHITE	
	CASE MATERIAL		ALUM. & EPOXY PAINT		Δ
	RING TYPE		THREADED		Δ
	MOUNTING TYPE		SEE NOTE 1)	SEE NOTE 1)	
	WINDOW		SHATTERPROOF	SHATTERPROOF	
	MICROMETER ZERO ADJ.		YES	YES	
MOV'T.	BLOW OUT DISC		YES	YES	
	MOVEMENT MATERIAL		316 SS	316 SS	
GAUGE PROTECTOR	GUARANTEED ACCURACY		1/4 OF 1% FULL SCALE	1/4 OF 1% FULL SCALE	
	BODY MATERIAL		316 SS	316 SS	
	DIAPHRAGM MATERIAL		4)	4)	
	FILL LIQUID		SEE NOTE 2)	SEE NOTE 2)	
	CLEANOUT CONNECTION		YES	YES	
PURCH	SNUBBER ON GAUGE SIDE		YES	YES	
	MANUFACTURER		ROBERT SHAW		Δ
	MODEL NO.		TR1713B	TR1713B	
M.R. NO.		MR-40-106	MR-40-106		

REMARKS: * BIDDER TO SUPPLY INFO

NOTES: 1) CASE WALL MOUNT W/ BOTTOM STEM FOR WALL OR STEM MTG.

2) HIGH TEMP. SILICONE OIL (650°F MAX.)

3) SIPHON REQUIRED FOR PI-101, -108 & -120

4) 316 SS OR 316L SS IF DIAPHRAGM WELD IS EXPOSED TO GEOTHERMAL FLUID

NO.	REVISIONS	DATE	BY	CHK	APPROVED
2	Revised TAG # PI-106 to 108 & ISSUED FOR APPROVED PURCHASE	10/11/79	SCP	FDD	9/10
1	REMOVED AS MARKED & ISSUED FOR CLIENT APPROVAL & PURCHASE	6/27/79	SCP	LMH	9/10
0	ISSUE FOR BID	11/30/79	SCP	LMH	9/10

CHK DLRB

DATE 1/30/79

APPD 9/10

DATA SHEET

PRESSURE GAUGES

GUANACASTE GEOTHERMAL PROJECT

WELL FLOW TEST FACILITY

JOB NO. S-75016-31

SHT 1 OF 1

DS-40-006

2

GENERAL NOTES

OPERATING CONDITIONS ALL
GAUGES THIS SHEET:

PRESS. - MAX = 300 PSIG

- NORM = 200 PSIG

TEMP - MAX = 446°F

- NORM = 387°F

REF. DS-00-001 FOR CHEM. COMP.

INSTRUMENT NUMBERS

TI-102

TI-107

△ (SPARE)

TI-112

TI-122

THERMOMETER

TYPE

DIAL

RANGE X (METRIC)

0-300 °C

DIAL SIZE / FIG. INTERVAL

2" / 50

CASE MATERIAL

316 SS

ACTUATION

BI METAL

SERVICE TYPE (STD OR TEST)

STD.

CONNECTION SIZE & TYPE

1/2" NPT

STEM MATERIAL

316 SS

STEM POSITION

ADJUSTABLE

STEM LENGTH

9"

ACCURACY

±1% FULL SCALE

WELL

PROCESS
CONN.

TYPE

THRED 1/2 CPG.

SIZE & RATING

3/4-3000 LB.

FLANGE FACING

—

FLANGE MATERIAL

—

LGTH. BELOW THD. OR FLG.

4 1/2"

INSIDE THREAD SIZE

1/2" NPT

LAGGING EXTENSION

3"

STAMPING

TAG # & MAT.

REFERENCE DWG. NO.

—

PURCH.

MANUFACTURER

ASHCROFT

MFR'S TYPE NO. THERMOMETER

50E160E040

MFR'S TYPE NO. WELL

75W0450LHTR60S

M.R. NO.

NR-40-107

REMARKS : △ THERMOMETER SUPPLIED

NO.	REVISIONS	DATE	BY	CHK	APPROVED
2	SPARED TI-107 ISSUED FOR APPROVED PURCHASE	10/11/79	SD	FDD	SD
1	REVISED AS MARKED, ISSUED FOR CLIENT APPROVAL & PURCHASE	6/22/79	SD	SD	SD
0	ISSUE FOR BID	1/30/79	SD	SD	SD

CHK DKB

DATE 1/30/79

APPD SD

DATA SHEET

INDICATING THERMOMETERS

GUANACASTE GEOTHERMAL PROJECT

WELL FLOW TEST FACILITY

JOB NO S-75016-31

SHT 1 OF 1 REV

DS-40-007 2

APPENDIX C

DRAWINGS ASSOCIATED WITH PORTABLE WELL TEST SYSTEM

<u>Document No.</u>	<u>Rev.</u>	<u>Description</u>
A-02-001	2	Flow Diagram
B-03-001	4	Piping & Instrument Diagram
A-40-005, Sht. 1	2	Inst. Detail - Flow Measurement Inst. Rack
A-40-005, Sht. 2	0	Inst. Detail - Pressure Gauges
A-40-005, Sht. 3	1	Inst. Detail - Differential Pressure Indicator
A-40-005, Sht. 4	0	Inst. Detail - Temperature Gauges
A-40-005, Sht. 5	1	Inst. Detail - Grab Sample Connections
A-40-005, Sht. 6	0	Inst. Detail - Lip Pressure Gauge
A-40-005, Sht. 7	0	Inst. Detail - Hot Brine Sampling-ANX-2
A-40-005, Sht. 8	0	Inst. Detail - Steam Sample Probe/Connection-ANX-1
A-40-005, Sht. 9	0	Inst. Detail - Steam Sample Conn's-ANX-1
A-40-005, Sht. 10	0	Inst. Detail - Steam N.C.G. Piping
D-04-001	2	Piping Plan & Elevation
D-04-002	2	Piping Plan, Elevation & Details
D-45-001	1	Miscellaneous Foundations & Flow Test Skid Details
BC-P-48493-1	A	Orifice Plate - Liquid Bore Calculation
BC-P-48493-2	A	Orifice Plate - Steam Bore Calculation
BC-P-48493-3	A	Orifice Plate - Steam Bore Calculation
*11-S	7/78	Sampling Method: Sampling Condensed Brine
*16-S	7/78	Sampling Method: Sampling Steam for Non- condensable Gas

APPENDIX C (Cont'd)

*These documents are excerpts from: "Sampling and Analysis Methods for Geothermal Fluids and Gases" by J. C. Watson as prepared for the U. S. Dept. of Energy under Contract No. EY-76-C-1830. They are included in this document only as a means of providing the user instant access to a referenced work and are not to be considered a part of Rogers Engineering Co., Inc. original design.

WELL HEAD

10-1 FLASH STEAM SEPARATOR

DESIGN : $P_{MAX.} = 300 \text{ PSIG}$
 $T_{MAX.} = 450^{\circ} \text{ F}$

STEAM CONDITIONS:

@ MAX FLOW: FLOW = 11.21 Kg/SEC. (88,900 LB/HR)
VELOCITY: PRESS = 5.63 Kg/CM² (80 PSIG)
36.64 M/S (70.2 FT/S) TEMP = 162.22 °C (324 °F)
@ MIN. FLOW: FLOW = 3.42 Kg/SEC. (27,100 LB/HR)
PRESS = 14.06 Kg/CM² (200 PSIG)
TEMP = 197.8 °C (388 °F)

2 PHASE :

@ MAX FLOW: FLOW = 76.23 Kg/SEC. (605,000 LB/HR)
PRESS = 5.63 Kg/CM² (80 PSIG)
TEMP = 162.22 °C (324 °F)

@ MIN FLOW: FLOW = 44.98 Kg/SEC. (357,000 LB/HR)
PRESS = 14.06 Kg/CM² (200 PSIG)
TEMP = 197.8 °C (388 °F)

BRINE CONDITIONS:

@ MAX FLOW: FLOW = 65.02 Kg/SEC. (516,100 LB/HR)
VELOCITY: IN 8" SEC. PRESS = 5.63 Kg/CM² (83 PSIG)
2.23 M/S (7.3 FT/S) TEMP = 162.22 °C (324 °F)
@ MIN FLOW: FLOW = 41.56 Kg/SEC. (329,900 LB/HR)
PRESS = 14.06 Kg/CM² (203 PSIG)
TEMP = 197.8 °C (388 °F)

NOTES:

1- CHEMICAL COMPOSITION PER DS-00-001

2	3/3/80	REV'D AS MKD.	SEP	SEP	SEP
1	9/11/79	ISSUE FOR CLIENT APPROVAL / REVISED PROCESS CONDITIONS	SEP	SEP	SEP
0	1/30/77	ISSUE FOR PROJECT APPROVAL	SEP	FDD	SEP
NO	DATE	Description	ENGR	CK	RAPP CAP

FLOW DIAGRAM

MIRAVALLES GEOTHERMAL PROJECT

DRAWING NO

A - 02 - 001

2

OB NO S-75016-31

Client:

SHEET 1 OF 1

NOTE:
G.S. = GAS SAMPLE

WELLHEAD
(BY OTHERS)

STEAM FLASH
SEPARATOR

<div>REVISIONS</div> <table><tr><th>REV.</th><th>DATE</th><th>REVISION</th><th>ENG.</th><th>CHK.</th><th>REC'D APPR.</th><th>CLIENT APPR.</th></tr><tr><td>1</td><td></td><td>REVISED AS MARKED</td><td></td><td></td><td></td><td></td></tr></table>		REV.	DATE	REVISION	ENG.	CHK.	REC'D APPR.	CLIENT APPR.	1		REVISED AS MARKED					<div>ROGERS ENGINEERING CO., INC.</div> <div>ENGINEERS & ARCHITECTS</div> <div>171 FINE STREET, SAN FRANCISCO, CALIF. 94111</div>		<div>INSTITUTO COSTARRICENSE</div> <div>DE ELECTRICIDAD</div>		<div>MIRAVALLS GEOTHERMAL PROJECT</div> <div>WELL FLOW TEST FACILITY</div> <div>PIPING & INSTRUMENT DIAGRAM</div> <div>TEST FLASH STEAM SEPARATION</div>	
REV.	DATE	REVISION	ENG.	CHK.	REC'D APPR.	CLIENT APPR.															
1		REVISED AS MARKED																			
		<div>SCALE: N.T.S.</div> <div>DATE: 1/20/77</div> <div>DR: E. CHK: [Signature] ENG: [Signature] APPROVED: [Signature]</div>		<div>APPROVED:</div> <div>DATE:</div>		<div>JOB NO.</div> <div>S-75016-3 B-03-001</div> <div>REV. 1</div>

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
1	1	3/8" (10mm) PL. 8"x8" (204x204mm) DRILLED, BASE			
1	2	3" (80mm) x 3'-0" (915mm) PIPE, SUPPORT, C.S. Sch-40			
1	3	3" (76mm) x 3" (76mm) x 1/4" (6mm) x 3' (915mm) ANGLE			
1	4	2" (50mm) x 3' (915mm) C.S. - SCH 40 PIPE			
2	5	"U" BOLT & NUTS (TO SECURE 1/2" (15mm) PIPE)			

2 5/16/80 REVISED TO ADD FABRICATED DIMS
 1 10-29-79 REVISED SEC. A-A TO OPPOSITE DIRECTION
 0 10-17-79 ISSUED FOR CLIENT APPROVAL

CHK
 DATE
 APPD.

INSTRUMENT INSTALLATION DETAIL
 FLOW MEASUREMENT INSTRUMENT RACK
 INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO
 DRAWING NO
 SHT 1 OF
 5-75016-31 A-40-005

NOTE:

1.) PRESSURE GAUGE w/CHEMICAL SEAL TO BE MOUNTED ON RACK PER DETAIL A-40-005 SH.1

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
1	1	1/2" (15mm) - 3000* (210 KG/SQ CM.)	REF. DWG.	7	1/2" (15mm) - GATE SHUT-OFF VALVE, TBE, NPT, C.S.
		HALF-COUPLING, NPT			
REF. DWG.	2	1/2" (15mm) x 3" (80mm) NIPPLE, TH'D.			
		BOTH ENDS, NPT			
REF. DWG.	3	1/2" (15mm) - ELBOW, NPT			
AR	4	1/2" (15mm) - PIPE, C.S., Sch 80			
-	5	PRESSURE GAUGE w/CHEMICAL SEAL			
REF. DWG.	6	1/2" (15mm) - UNION, NPT			

0 10-17-79 ISSUED FOR CLIENT APPROVAL

CHK
DATE
APPD.

INSTRUMENT INSTALLATION DETAIL
PRESSURE GAUGES
INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO

DRAWING NO

SHT 2 OF

S-75016-31

A-40-005

0

NOTE:

1.) INDICATOR TO BE MOUNTED ON RACK PER DETAIL A-40-005 SH. 1

2.) = INDICATES DIRECTION OF SLOPE

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
REF. DWG.	1	1/2"(15mm) x 3"(80mm) NIPPLE T.B.E.			
2	2	1/2"(15mm) - ELBOW, N.P.T.			
2	3	1/2"(15mm) - GATE SHUT-OFF VALVE, T.B.E., C.S.			
2	4	1/2"(15mm) x 1"(25mm) N.P.T. BUSHING			
-	5	SENSOR HOUSING w/INST.			
-	6	CAPILLARY TUBING w/INST.			
-	7	DIFFERENTIAL PRESSURE INDICATOR			
2	8	1/4"(6mm) BLEED VALVE, T.B.E., N.P.T.			

1 5/23/80 Added Note 2 & sensing line slope symbols

0 10-17-79 ISSUED FOR CLIENT APPROVAL

CHK
DATE
APPD.

INSTRUMENT INSTALLATION DETAIL
DIFFERENTIAL PRESSURE INDICATOR
INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO
5-75016-31

DRAWING NO
SHT 3 OF
A-40-005

REV
1

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
1	1	3/4" (20 mm) - 3000* (210 kg/sq. cm)			
		TH'D. HALF CPLG., C.S.			
1	2	3/4" (20 mm) - MNPT THERMOWELL			
		(PURCHASED W/TEMP. GAUGE)			
1	3	TEMP. GAUGE w/1/2" (15 mm)			
		MNPT CONNECTION			

0 10-17-79 ISSUED FOR CLIENT APPROVAL

CHK
DATE
APPD.

INSTRUMENT INSTALLATION DETAIL
TEMPERATURE GAUGES
INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO

5-75016-31

DRAWING NO

SHT 4 OF

A-40-005

REV

0

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
2	1	1"(25mm)-3000 [#] (210KG/SQ.CM) THREADED HALF-COUPLING C.S.			
1	2	1"(25mm)x 3"(80mm)THD NIPPLE			
1	3	1"(25mm)-BALL VALVE,S.S.,TBR			
1	4	1"(25mm)-3000 [#] (210KG/CM ²) NUT PLUG-SQUARE HD.			

1 5/16/80 REVISED AS MARKED
0 10-17-79 ISSUED FOR CLIENT APPROVAL

209
SEP 1980

CHK
DATE
APPD.

INSTRUMENT INSTALLATION DETAIL
GRAB SAMPLE CONNECTIONS
INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO DRAWING NO
SHT. 5 OF
6-75016-31 A-40-005

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
1	1	1/2" (15MM) - 3000# (210 KG/CM ²)			
		HALF COUPLING, NPT			
2	2	1/2" (15MM) x 3" (80MM) THD NIPPLE			
2	3	1/2" (15MM) ELBOW, NPT			
1 1/2 FT	4	1/2" (15MM) PIPE C.S. - SCH. 80			
2	5	WOODEN WEDGES			
AR	6	METAL BAND OR WIRE			
W/ GAGE	7	DIAPHRAM SEAL			

1 5/16/80 REVISED AS MARKED

0 10-17-79 ISSUED FOR CLIENT APPROVAL

CHK

DATE

APPD.

INSTRUMENT INSTALLATION DETAIL

LIP PRESSURE GAUGE

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO

DRAWING NO

REV

SHT 6 OF

5-75016-31

A-40-005

1

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
3	1	1" (25 mm) x 3" (80 mm) NIPPLE, TBE, SCH. 80, C.S.	4FT	10	1/4" (8 mm) TUBING - 316 SS
1	2	1" (25 mm) TEE, SCH. 80, C.S.	1	11	ASPIRATOR BOTTLE - 4 LITER PYREX VWR NO. 16331-363
1	3	1" (25 mm) GLOBE VALVE, C.S.	12	12	BOTTLE, W/ CAP, 2 LITER VWR NO. 16055-167
1	4	1" (25 mm) MNPT x 1/2" (15 mm) F-TUBE RED. BUSHING	1	13	CLAMP-HOSE COCK VWR NO.
5FT	5	1/2" (15 mm) TUBING - 316 SS	LB	14	RUBBER STOPPERS #13 VWR NO. 56380-449
1	6	1/2" (15 mm) x 12" (305 mm) FLEX. HOSE W/F-TUBE CONN'S	10 FT	15	RUBBER TUBING 3/8" I.D. VWR NO. 56425-310
20FT	7	1/2" (15 mm) TUBING - 316 SS	1	16	1" (25 mm) BALL VALVE, SS, TBE
1	8	1/2" (15 mm) SS INST. VLVE, GLOBE, F-TUBE CONN'S	1	17	1" (25 mm) 90° ELL. FNPT
1	9	1/2" (15 mm) x 1/4" (8 mm) RED. BUSH. TUBE CONN'S (M&F)	SHELF PAK	18	GLASS TUBING, PYREX 10 mm C.D. VWR NO. 32813-097

0	3/3/80	ISSUED FOR USE WITH FLOW TEST PROCEDURE	CHK	R. APP.	C. APP.
NO	DATE	DESCRIPTION	CHK	R. APP.	C. APP.
CHK	DATE	INSTRUMENT INSTALLATION DETAIL	JOB NO	DRAWING NO	REV
APPD.		INST. INSTALL. DET.		SHT 7 OF	
		HOT BRINE SAMPLING - ANX-2		A-40-005	0
		INSTITUTO COSTARRICENSE DE ELECTRICIDAD	S-75016-31

NOTES:

1. BOLT HOLES TO STRADDLE ϕ
2. NOZZLE TO BE LOCATED ON SIDE OF PIPE (REF. DWG'S D-04-101 & 102)
3. REF. DWG. A-40-005 SHTS 9 & 10 FOR SAMPLE PIPING ARRANGEMENT.

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
1	1	3" (80 mm) SCH. 40, PIPE, C.S.			
1	2	3" (80 mm) - 300# (21.1 kg/cm ²) RF - WN FLANGE, C.S.			
1	3	3" (80 mm) - 300# (21.1 kg/cm ²) RF BLIND FLANGE, C.S.			
1.5 FT	4	1/2" (15 mm) - SCH. 80, 316 SS, PIPE			

0 13/3/20 ISSUED FOR FABRICATION

CHK	INSTRUMENT INSTALLATION DETAIL	JOB NO	DRAWING NO	REV
DATE	STEAM SAMPLE PROBE/CONN.-ANX-1		SHT 8	
APPD.	INSTITUTO COSTARRICENSE DE ELECTRICIDAD	S-75016-31	A-40-005	0

PROBE PER DWG.
A-40-005 SHT.8

CONNECTIONS FOR NCG SAMPLE
(REF DWG. A-40-005 SHT. 10)

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
3	1	1/2" (15mm) GATE VALVE, CS, TBE			
1	2	1/2" (15mm) x 3" (80mm) CS NIPPLE, TBE MNPT.			
1	3	1/2" (15mm) CS TEE, FNPT			
2	4	1/2" (15mm) CS 90°-ELL, MNPT			

0 3/3/80 ISSUED FOR USE WITH FLOW TEST PROCEDURE

Supdt Shop

CHK
DATE
APPD.

INSTRUMENT INSTALLATION DETAIL
STEAM SAMPLE CONNS - ANX-I
INSTITUTO COSTARRICENSE DE ELECTRICIDAD

JOB NO

DRAWING NO

REV

S-75016-31

SHT 9

A-40-005

0

REAGENTS FOR FILTERING FLASKS:

1st FLASK = ZINC ACETATE OR CADMIUM CHLORIDE - TRAPS H_2S .

2nd FLASK = 2N NaOH (SODIUM HYDROXIDE) - TRAPS CO_2 .

ALTERNATE:

SINGLE FLASK = 4N NaOH (SODIUM HYDROXIDE) - TRAPS H_2S & CO_2 .

N.C.G. SAMPLING
ARRANGEMENT.

LIST OF MATERIALS

QTY	ITEM NO	DESCRIPTION	QTY	ITEM NO	DESCRIPTION
1	1	1/2" (15mm) x 12" (305mm) SS FLEX	1	10	ADAPTOR 1/2" (15mm) FNPT TUBE
		HOSE F-TUBE & MNPT CONN'S.			TO 3/8" (10mm) MNPT TUBE.
12	2	BOTTLE W/CAP, 1 LITER VWR NO. BOSTON ROUND 16077-142	1	11	3/8" (10mm) VALVE - 316 SS
1 LB	3	RUBBER STOPPERS NO 8 SIZE VWR NO. 56380-267			F-TUBE CONN'S.
2	4	GAS DISPERSION TUBES VWR-32578-044	20 FT	12	3/8" (10mm) TUBING - 316 SS
2	5	FLASK FILTERING, 1 LITER VWR NO. 29417-121	4	13	250 ml - KIMAX - VWR NO. 32310-176
1	6	CLAMP - HOSE CLAMP VWR-31716-103	9	14	ASPIRATOR BOTTLE - 4 LITER PYREX VWR NO. 16331-363
	7		1 LB	15	RUBBER STOPPERS NO 13 SIZE VWR NO 56380-449
	8		1 SET	16	STOPPER BORER - HARD POLISHED STEEL VWR NO 23460-043
1	9	WET TEST METER - LITERS VWR NO 19502-004	1 SET	17	GLASS TUBING PYREX, 10mm O.D. VWR NO. 32813-097
			10 FT PACK.	18	RUBBER 3/8" I.D. VWR NO. 56425-310

0 3/3/80 ISSUED FOR USE WITH FLOW TEST PROCEDURE

CHK	INSTRUMENT INSTALLATION DETAIL	JOB NO	DRAWING NO	REV
DATE	STEAM N.C.G. PIPING		SHT. 10	
APPD.	INSTITUTO COSTARRICENSE DE ELECTRICIDAD	S-75016-31	A-40-005	0

VICKERY-SIMMS Incorporated

A **Standco** company

ORIFICE PLATE LIQUID BORE CALCULATION

CUSTOMER: **ROGERS EN ROGERS ENGINEERING CO**
CUSTOMER P.O.: **1869 1869**
TAG NO.: **FE-111**

VSI JOB NO: **P-48493**

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)
METER TYPE (Dry or Hg)
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)
MAXIMUM FLOW AT BASE CONDITIONS (Qm or Wm)
MIN. FLOW AT BASE CONDITIONS
FLOWING TEMPERATURE, deg. F
FLOWING PRESSURE, p.s.i.a.
FLOWING MATERIAL
SPECIFIC GRAVITY AT 60 DEG. F (G1)
SPECIFIC GRAVITY AT FLOW COND. (Gf)
OPERATING VISCOSITY, centipoises
ATMOSPHERIC PRESSURE, p.s.i.a.
ORIFICE TYPE
METER TAP LOCATION
ORIFICE PLATE MATERIAL
REYNOLDS NUMBER @ NORMAL FLOW (70% MAX.)

12.090
DRY
31.4960 (800 MM)
519841.00 LBS/HR (65.5 Kg/s)
325400.00 LBS/HR (41 Kg/s)
388.04 197.8°F
219.03 15.4 Kg/cm²
BRINE
0.8765
0.180
14.70
CONCENTRIC
FLANGE
316 SS
1056785.49

CALCULATIONS:

(1) Qm x G1 or Wm	519841.00	(6) SQ. ROOT Gf	0.9362
(2) N	2835.0000	(7) SQ. ROOT Hm	5.6121
(3) D x D	146.1681	(8) Fc	0.9837
(4) Fa	1.0060	(9) Fp	1.0000
(5) Fm	1.0000	(10) (2) THRU (9)	2154618.6880

S = (1) / (10) 0.2413
BETA = 0.6046

BORE = 7.3100

FLOW RATE (LBS/HR) = 92628.116 x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 216, EQ. 21 or 21a

DOCUMENT NO.: **BC-P-48493- 1**
DATE: **12-26-79**
REV. A BY: **KLL**

CERTIFIED CORRECT
[Signature]
VICKERY-SIMMS, INC.

VICKERY-SIMMS Incorporated

A *Standard* company

ORIFICE PLATE STEAM BORE CALCULATION

CUSTOMER: *ROGERS ENGINEERING Co*
CUSTOMER P.O.: *1844 1869*
TAG NO.: FE-121 A (HIGH RANGE)

VSI JOB NO.: P-48493

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)
METER TYPE (Dry or Hg)
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)
MAXIMUM FLOW, lbs/hr (Wm)
MIN. FLOW, lbs/hr
FLOWING TEMPERATURE, deg. F
FLOWING PRESSURE, p.s.i.a.
PERCENT OF MOISTURE
SUPERHEAT, deg. F
SPECIFIC WEIGHT AT FLOW CONDITION, lbs/cu.ft.
OPERATING VISCOSITY, centipoises
ATMOSPHERIC PRESSURE, p.s.i.a.
ORIFICE TYPE
METER TAP LOCATION
STATIC PRESSURE TAP LOCATION
ORIFICE PLATE MATERIAL
REYNOLDS NUMBER @ NORMAL FLOW (70% MAX.)

13.250
DRY
177.1654 (4500 MM)
89693.00 (11.3 Kg/SEC)
25400.00 (3.2 Kg/SEC)
388.04 (197.8°F)
213.35 (15 Kg/cm²)
0.00
0.00
0.4651
0.0155
14.70
CONCENTRIC
FLANGE
DOWNSTREAM
316 SS
1931868.98

CALCULATIONS:

(1) Wm	89683.00	(6) Y	1.0025
(2) D x D	175.5625	(7) SQ. ROOT sp. wt.	0.6820
(3) Fa	1.0060	(8) SQ. ROOT Hm	13.3103
(4) Fm	1.0000	(9) 358.9x(2) THRU(8)	572323.8800
(5) Fc	0.9922		

S = (1) / (9) 0.1567
BETA = 0.4999

BORE = 6.6235

FLOW RATE (lbs/hr) = 6737.840x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 332, EQ. 44

DOCUMENT NO.: BC-P-48493- 2
DATE: 12-21-79
REV. A BY: KLL *KL*

CERTIFIED CORRECT
Lois Lawrence
VICKERY-SIMMS, INC.

VICKERY-SIMMS Incorporated

A **Standco** company

ORIFICE PLATE STEAM BORE CALCULATION

CUSTOMER: **ROGERS EN
R.O.S. ENGINEERING CO**
CUSTOMER P.O.: **1869 1869**
TAG NO.: **FE-121 B (LOW RANGE)**

VSI JOB NO.: **P-48493**

OPERATING CONDITIONS:

METER TUBE I.D., inches (D)	13.250
METER TYPE (Dry or Hg)	DRY
DIFFERENTIAL @ MAX. FLOW, in. water, (Hm)	177.1654 (4500 MM)
MAXIMUM FLOW, lbs/hr (Wm)	39682.00 (5 Kg/sec)
MIN. FLOW, lbs/hr	25400.00 (3.2 Kg/sec)
FLOWING TEMPERATURE, deg. F	388.04 (197.8°F)
FLOWING PRESSURE, p.s.i.a.	213.35 (15 Kg/cm ²)
PERCENT OF MOISTURE	0.00
SUPERHEAT, deg. F	0.00
SPECIFIC WEIGHT AT FLOW CONDITION, lbs/cu.ft.	0.4651
OPERATING VISCOSITY, centipoises	0.0155
ATMOSPHERIC PRESSURE, p.s.i.a.	14.70
ORIFICE TYPE	CONCENTRIC
METER TAP LOCATION	FLANGE
STATIC PRESSURE TAP LOCATION	DOWNSTREAM
ORIFICE PLATE MATERIAL	316 SS
REYNOLDS NUMBER @ NORMAL FLOW (70% MAX.)	854793.27

CALCULATIONS:

(1) Wm	39682.00	(6) Y	1.0027
(2) D x D	175.5625	(7) SQ. ROOT sp. wt.	0.6820
(3) Fa	1.0060	(8) SQ. ROOT Hm	13.3103
(4) Fm	1.0000	(9) 358.9x(2) THRU(8)	574303.0599
(5) Fc	0.9954		

S = (1) / (9) 0.0691
BETA = 0.3378

BORE = 4.4755

FLOW RATE (lbs/hr) = 2981.289x SQ. ROOT(DIFF. in. water)

REFERENCE: PRINCIPLES AND PRACTICES OF FLOW METER ENGINEERING
FOXBORO - NINTH EDITION, PAGE 332, EQ. 44

DOCUMENT NO.: **BC-P-48493- 3**
DATE: **12-21-79**
REV. **A** BY: **KLL**

CERTIFIED CORRECT

Loe-Lawrence
VICKERY-SIMMS, INC.

METHOD TITLE:

Cooling coils

NO.

11-S

SAMPLE TYPE:

Liquid

SAMPLE POINT:

Pipeline, separator or other

APPLICATION:

Sampling condensed brine

REFERENCES:

Appendix 1: Field Test 1978.

DESCRIPTION

1. Cooling coils are made of stainless steel with total length 20 - 24 ft., ID 0.25 - 0.50 in. and OD 0.25 - 0.50 in. Wall thickness not less than 0.02 in. fulfills most requirements for sample cooling.
2. Varying diameters of tubing are used because of variability in sampling requirements.
3. Coil diameter is normally 8 - 10 in. to fit into container that acts as cooling bath. Five gallon buckets are most frequently used for this purpose.
4. Two coils commonly used; first is immersed in a water bath to cool sample to boiling point of water, second coil is immersed in an ice bath. This saves usage of large amounts of ice.
5. Flow of brine through coils must be carefully watched to avoid flashing of the sample in the coils.
6. Alternatively, a water cooled condenser can be used if a sufficient supply of cooling water is available.

COMMENTS:

1. During field test Whitey or equivalent shutoff or regulating needle valves were used for maintaining proper flow rates through the coils. Gate or ball valves are not suitable for regulating flow.
2. Flexible armored lines equipped with quick disconnect fittings were used upstream of coils to connect to 1" ball valves on pipelines, etc. This allowed for portability of cooling coils for various sample locations.
3. Coils of 1/4" ID or larger normally used for condensing brine. Smaller (1/8" ID) lines may be used to sample steam lines.

EDITION:

7/78

4. During field test, brine surging in pipelines resulted in pulsating effects while collecting through coils. It is not advisable to attempt to correct this effect with the flow regulating needle valves as steam can be emitted at

PAGE:

B-13

ILLUSTRATION:

SAMPLING CONDENSED BRINE USING COOLING COILS

SAMPLING CONDENSED BRINE USING JACKETED CONDENSER

high velocity through the coils resulting in a potentially dangerous burn situation for the operator.

METHOD TITLE:

Wet test meter method.

NO.

16-S

SAMPLE TYPE:

Gas

SAMPLE POINT:

Steam line from separator.

APPLICATION:

Sampling steam for noncondensable gases.

REFERENCES:

1. Christofferson, D.J., R.N. Wheatley, and J.A. Baur, "Union Oil Co. of California's Geothermal Sampling Techniques," Proceedings of the 1st Workshop on Sampling Geothermal Effluents, Las Vegas, NV, Oct. 1975, pp. 165-173
2. Appendix 1: Field Test 1978.

DESCRIPTION

1. The condenser coil in an ice water bath is connected to the steam line via a by-pass valve by means of a 25-foot flexible, stainless steel tubing using appropriate fittings at both ends (Figure 1). The by-pass valve is positioned to vent with no flow to the condenser and the sample port valve on the steam line is fully opened. After flowing steam through the connecting tubing for sufficient time (usually 10 to 15 minutes) for the tubing to come to temperature, steam is valved to the disconnected condenser until a condensate flow rate of about 50 ml/min is obtained. Approximately one liter of condensate is purged through the condenser. This allows the condenser system to come to an equilibrated condition and also cleans the tubing of any possible residue or contamination from prior samplings.

The wet test meter is equilibrated by attaching the equilibrated condenser to the sample train and passing the noncondensable gases through the wet test meter for 10 to 15 minutes. The condenser is disconnected from the sample train. The collection bottle is replaced by a tared one-quart bottle and the wet test meter reading is noted. The condenser is quickly attached to the sample train by means of rubber tubing and actual sampling begins. Sampling continues until the collection bottle is filled or 3 to 4 liters of noncondensable gas volume is reached. The condenser is then disconnected from the train and the noncondensable gas content of the steam determined from the weight of water collected and the volume of gas measured after appropriate corrections for temperature and barometric pressure.

2. The system shown in Figure 2 was used to evaluate the method under field conditions. The steam and noncondensable flow passed from the steam line through an insertable sample probe (inserted to the center of the steam line) into a flexible armored line. Flow then continued to a cooling bath filled with water followed by a second cooling bath filled with ice water. The flow then passed into the glass separator with the condensed steam being removed from the bottom for analysis or alternatively the rate could be measured with a graduated cylinder. Noncondensables from the top of the glass separator passed through the wet test meter or alternatively were (cont.)

COMMENTS:

1. Wet test meters must be properly equilibrated to prevent absorption of gases such as carbon dioxide for accurate volume measurements.
2. Glass separator should only be used under low pressure conditions (for field test the steam line inlet pressure was 7-9 psig).
3. Field test showed improved collection results are obtained and more controllable flow regulation using 1/2" ID insertable probes instead of smaller ID probes (1/4" ID) due to better collection rates from the steam line.
4. Filling the gas collection bulb initially with water (in field test) and allowing the gas to displace the water proved to be a useful way to determine if air was excluded. Collection is continued for 3-4 volume displacements.

EDITION:

7/78

PAGE:

B-18

ILLUSTRATION:

FIG 1. STEAM SAMPLING APPARATUS

FIG 2. WET TEST METER METHOD USED IN FIELD TEST TO SAMPLE NONCONDENSABLES IN STEAM LINE

collected in gas sampling bulbs. The noncondensable gas flow rate can be checked using the graduated cylinder water displacement method.

APPENDIX D

TEST RESULT TABLES

<u>Document</u>	<u>Rev.</u>	<u>Description</u>
Table #1	0	Downhole Temperature & Pressure - Static
Table #2	0	Downhole Temperature & Pressure - Dynamic
Table #3	0	Flow Test Data
Table #4	0	Steam Quality
Table #5	0	Noncondensable Gas & H ₂ S Content in Steam & Brine
Table #6	0	Noise Levels

TABLE 1-DOWNHOLE TEMPERATURE AND PRESSURE-STATIC

DATE	DEPTH		STATIC TEMPERATURE		STATIC PRESSURE	
	METERS	FEET	°C	°F	Kg/cm ² g	PSIG
	300	984				
	450	1480				
	600	1970				
	750	2460				
	900	2950				
	1050	3450				
	1200	3940				
	1350	4430				
	1500	4920				

NOTE : TO BE DONE BEFORE AND AFTER THE FLOW TEST.

0 5/25/80 ISSUED FOR USE WITH FLOW TEST PROCEDURE

AP 7.9.8
Ck. R.App C.Ape

ROGERS ENGINEERING CO., INC.
11 PINE STREET
SAN FRANCISCO, CALIF. 94111

DOWNHOLE TEMPERATURE & PRESSURE-STATIC
MIRVALLES GEOTHERMAL PROJECT
WELL FLOW TEST FACILITY

DRAWING NO
TABLE # 1 0

JOB NO. S-75016-31 Client Date SHEET 1 OF 1

FLOW TEST DATA:

NOTE: 1. # T.W.C. = TOP OF WATER COLUMN

[illegible]

TABLE 4-STEAM QUALITY

[illegible]

0 5/25/80 ISSUED FOR USE WITH FLOW TEST PROCEDURE

No.	Date	Description
-----	------	-------------

Ck.	R.App	C.App
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
21	21	21
22	22	22
23	23	23
24	24	24
25	25	25
26	26	26
27	27	27
28	28	28
29	29	29
30	30	30
31	31	31
32	32	32
33	33	33
34	34	34
35	35	35
36	36	36
37	37	37
38	38	38
39	39	39
40	40	40
41	41	41
42	42	42
43	43	43
44	44	44
45	45	45
46	46	46
47	47	47
48	48	48
49	49	49
50	50	50
51	51	51
52	52	52
53	53	53
54	54	54
55	55	55
56	56	56
57	57	57
58	58	58
59	59	59
60	60	60
61	61	61
62	62	62
63	63	63
64	64	64
65	65	65
66	66	66
67	67	67
68	68	68
69	69	69
70	70	70
71	71	71
72	72	72
73	73	73
74	74	74
75	75	75
76	76	76
77	77	77
78	78	78
79	79	79
80	80	80
81	81	81
82	82	82
83	83	83
84	84	84
85	85	85
86	86	86
87	87	87
88	88	88
89	89	89
90	90	90
91	91	91
92	92	92
93	93	93
94	94	94
95	95	95
96	96	96
97	97	97
98	98	98
99	99	99
100	100	100

ROGERS ENGINEERING CO., INC.
111 PINE STREET
SAN FRANCISCO, CALIF. 94111

STEAM QUALITY MIRAVALLS GEOTHERMAL PROJECT WELL FLOW TEST FACILITY

DRAWING NO

REV.

TABLE #4

JOB NO. 8-75 016-31

Client	
---------------	--

Date _____

SHEET | **OF**

IOB NO. 5-75016-31

Client

Date _____

SHEET 1 OF 1

SAN FRANCISCO, CALIF. 94111

WELL FLOW 1531 FACILITY

11

711 PINE STREET

MIRVALLES GEOTHERMAL PROJECT
WELL E10W TEST FACILITY

TABLE #5

ROGERS ENGINEERING CO., INC.

NOG. AND H2S CONTENT IN STEAM & BRINE

DRAWING NO.	REV.
-------------	------

No.	Date	Description
-----	------	-------------

CK. K:APP	CAD
-----------	-----

0	7/24/82	ISSUED FOR USE WITH FLOW TEST PROCEDURE
---	---------	---

449

TABLE 5 - NONCONDENSABLE GAS & H₂S CONTENT IN STEAM & BRINE

[illegible]

ROGERS ENGINEERING CO., INC. 111 PINE STREET SAN FRANCISCO, CALIF. 94111		NOISE LEVELS MIRVALLES GEOTHERMAL PROJECT WELL FLOW TEST FACILITY		DRAWING NO TABLE # 6		REV. 0	
JOB NO. S-75016-31		Client		Date		SHEET 1 OF 1	

No.	Date	Description
0	5/24/82	ISSUED FOR USE WITH FLOW TEST PROCEDURE

TABLE 6 NOISE LEVELS

DATE	RUN #	FLOW- STATE POINT NO.	WIND	LOCATIONS								
				MUFFLER			ALT. #1:			ALT. #2		
			VEL./DIRECTION	HORIZ. DIST.(M)	VERT. DIST.(M)	INTENSITY dBA	HORIZ. DIST.(M)	VERT. DIST.(M)	INTENSITY dBA	HORIZ. DIST.(M)	VERT. DIST.(M)	INTENSITY dBA

Ch. R. App Capt

WELLHEAD
(BY OTHERS)

SEPARATOR 10-1

FLOW TEST SKID

NOTES:

1. U-BOLT ARRANGEMENT SHOWN IS FOR SKID TRANSPORTATION ONLY. BEFORE TEST RUN U-BOLTS ARE TO BE LOOSENED, RAISED 1/16 INCH (1.6MM), AND LOCKED IN PLACE TO FORM PIPE GUIDES.
2. ALL INSULATION 1/2" (12.7MM) THICK PERSONNEL PROTECTION.
3. PROTECTION SADDLES TO BE 1 FOOT (305MM) LONG.
4. DESIGN DETAIL AND DIMENSIONS ARE BASED ON FOREIGN PRINTS & VERBAL COMMUNICATION AVAILABLE PRIOR TO ISSUE OF THIS DRAWING. DISCREPANCIES BETWEEN INFORMATION ON THIS DRAWING AND FIELD CONDITIONS WILL BE RESOLVED IN THE FIELD.
5. GRADE IS ASSUMED TO BE AT EL. 0'-0" (0MM) EVERYWHERE.
6. B.O.P. IS BOTTOM OF PIPE.
7. PIPE SUPPORT DESIGN AND LOCATIONS SHOWN ON DWG. D-45-002.
8. ONE DRAIN VALVE AND FITTINGS AHEAD OF EACH CONTROL VALVE. TAP TO BE 3' (914MM) AHEAD OF VALVE.
9. METRIC MEASUREMENTS ARE FOR REFERENCE ONLY, ENGLISH UNITS GOVERN DIMENSIONS.
10. U-BOLTS TIGHTENED FOR SKID TRANSPORTATION SHOULD NOT BE TIGHTENED SO AS TO CAUSE DEFORMATION OF THE PIPE SADDLES.
11. USED TO DESIGNATE PIPE SPOOL NUMBERS.

PLAN

D-45-002	PIPE SUPPORT PLAN & DETAILS
D-04-002	PIPING PLAN, ELEVATIONS & DETAILS
A-40-005	INSTRUMENT INSTALLATION DETAILS
429050	SEPARATOR DETAILS (REF. MR. -10-101)
D-45-001	MISC. FOUNDATIONS & FLOW TEST SKID
REFERENCE DRAWINGS	

REV.	ZONE	DATE	REVISION	DR.	CHK.	APP.
1			REVISED TO SHOW ASSEMBLED CONFIGURATION FOR CONSTRUCTION	SN		
2			REVISED TO SHOW ASSEMBLED CONFIGURATION FOR CONSTRUCTION	SN		
3			ISSUED FOR CLIENT APPROVAL	SN		

ROGERS ENGINEERING CO., INC. ENGINEERS - ARCHITECTS 111 FINE STREET, SAN FRANCISCO, CALIFORNIA 94103	
SCALE 1/4" = 1'-0" (1" = 3'-0")	DATE 1/31/77
DR. RS	CHK. J.V.
ENG. J.P.	APPROVED J.P.

INSTITUTO COSTARRICENSE DE ELECTRICIDAD	
APPROVALS	
DATE	DATE

MIRAVALLS GEOTHERMAL PROJECT WELL FLOW TEST FACILITY PIPING PLAN & ELEVATIONS FIELD ASSEMBLY CONFIGURATION	
JOB NO. S-75016-31	D-04-001
2

TABLE 1 PIPE SPECIFICATIONS

NOM. DIA.	SCHEDULE	WALL	ASTM A53 GRADE B ERW
6" (152mm)	40	280" (7mm)	
8" (203mm)	40	328" (8.2mm)	
10" (254mm)	30	301" (7.9mm)	
12" (305mm)	30	330" (8.7mm)	
14" (350mm)	30	375" (9.7mm)	

TABLE 2 "U"-BOLTS & SADDLES

TYPE	PIPE SIZE	A	B	C	D	E
A	8" (203mm)	1/8" (3.2mm)	12 1/8" (321mm)	3 1/4" (84mm)	1 1/2" (38mm)	6" (153mm)
B	10" (254mm)					7 1/2" (191mm)
C	12" (305mm)	3/8" (9.5mm)	14 1/8" (361mm)	1" (25mm)	1 1/4" (32mm)	8 1/2" (216mm)
D	14" (350mm)	1" (25mm)	16 1/8" (413mm)	1 1/8" (30mm)	1 3/8" (35mm)	9 1/2" (241mm)

0-01-001	PIPING PLAN & ELEVATIONS	1/14	REVISED TO SHOW ASSEMBLY CONFIGURATION FOR CONSTRUCTION	S.N.	10/3/77	APPROVALS	MIRAVALLER - GEOTHERMAL PROJECT
A-10-003	INSTRUMENT INSTALLATION DETAILS	1/14	COMBINED STEAM & BRINE LINES	R.S.	10/3/77	DATE	WELL FLOW TEST FACILITY
1-20-000	SEPARATION DETAILS (REF. MR-10-101)	1/14	ADDED SPOOL NO. 5	R.S.	10/3/77	DATE	PIPING PLAN ELEVATIONS & DETAILS
0-13-001	MISC. FOUNDATIONS & FLOW TEST SKID	1/14	ISSUED FOR CLIENT APPROVAL	R.S.	10/3/77	DATE	FIELD ASSEMBLY CONFIGURATION
	REFERENCE DRAWINGS						

REV. ZONE DATE REVISION DR. CHK. APPR. APPROV.

ROGERS ENGINEERING CO., INC.
ENGINEERS - ARCHITECTS
111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111

INSTITUTE COSTARRICENSE DE ELECTRICIDAD

SCALE 1/4" = 1'-0" UNLESS NOTED
(1mm = 4.8mm)

DR. R.S. CHK. S.N. ENG. 8/11 APPROVED 8/15

JOB NO. S-75016-31 D-04-002 2

SEPARATOR FOUNDATION

PIPE SIZE	E.
8" (200mm)	6" (152)
10" (250mm)	7 1/4" (184)
12" (300mm)	8 1/8" (206)
14" (350mm)	8 3/4" (222)

FLOW TEST SKID FDN

PIPE SUPPORT DESCRIPTION

TYPE 1 - PIPE IS FREE TO SLIDE IN BOTH DIRECTIONS. $P = 2000^{\#}$ (909 KGS.)

TYPE 1A - SAME AS 1 EXCEPT $P = 5500^{\#}$ (2500 KGS.)

TYPE 2 - PIPE IS FREE TO SLIDE IN LONGITUDINAL DIRECTION BUT RESTRAINED IN THE TRANSVERSE DIRECTION. APPROXIMATE VERTICAL LOAD $P = 1200^{\#}$ (545 KGS.) APPROXIMATE HORIZONTAL LOAD $F = 600^{\#}$ (273 KGS.) PIPE WOULD BE LIFTED UP FROM SUPPORT WHEN HOT AND SHOULD BE ALLOWED TO MOVE UP.

TYPE 3 - PIPE IS FREE TO SLIDE IN BOTH DIRECTIONS. $P_{max} = 3000^{\#}$ (1363 KGS.)

TYPE 3A - PIPE IS FREE TO SLIDE IN LONGITUDINAL DIRECTION BUT IS RESTRAINED IN THE TRANSVERSE DIRECTION. $P_{max} = 3000^{\#}$ (1363 KGS.) RECOMMENDED LOCATIONS - EVERY THIRD SUPPORT, STARTING WITH 2ND FROM ELBOW (5700[#] SS COIL)

PIPE SUPPORT LOCATION PLAN

- NOTES:
1. USE CLASS 'A' CONCRETE WITH A MIN. COMPRESSIVE STRENGTH OF 3000 PSI @ 28 DAYS, (1:2:4 MIX).
 2. USE ASTM A-615 DEFORMED BARS REINFC. STEEL GRADE 40 WITH $F_y = 40,000$ PSI. (2812 $\frac{kg}{cm^2}$)
 3. FABRICATION AND PLACING OF REINFC. STEEL MIXING AND POURING OF CONC. SHALL BE DONE IN ACCORDANCE WITH THE LATEST ACI CODE REQUIREMENTS.
 4. ALL STRUCTURAL STEEL SHALL BE ASTM A-36 CARBON STEEL.
 5. ALL PIPE STEEL SHALL BE ASTM A-53 GRADE B CARBON STEEL.
 6. USE E70 XX ELECTRODES.
 7. ANCHOR BOLTS SHALL BE A-307 STEEL.
 8. ALL DIMENSIONS SHOWN IN () ARE MILLIMETER EQUIVALENTS.

ROGERS ENGINEERING CO., INC. ENGINEERS - ARCHITECTS 111 PINE STREET, SAN FRANCISCO, CALIFORNIA 94111		INSTITUTO COSTARRICENSE DE ELECTRICIDAD		MIRAVALLS GEOTHERMAL PROJECT WELL FLOW TEST FACILITY MISC. FOUNDATIONS & FLOW TEST SKID FIELD ASSEMBLY CONFIGURATION	
SCALE AS SHOWN DATE 3/10/79 DR. B.M.C. CHK. RT. ENGR. 18 APPROVED 712		APPROVALS DATE DATE		JOB NO. 573016-31 D-45-001	