GEOTHERMAL RESOURCES
OPERATIONAL ORDERS

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GRO Order 6. Pipelines and Surface Production Facilities
GRO Order 7. Production and Royalty Measurement, Equipment, and Testing Procedures

United States Department of Interior
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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 6

Effective January 1, 1977

PIPELINES AND SURFACE PRODUCTION FACILITIES

This Order is established pursuant to the authority prescribed in 30 CFR 270.11. The design, operation, and testing of all pipelines and surface facilities will be conducted in accordance with the provisions of this Order. All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. References in this Order to approvals, determinations, or requirements are to those given or made by the Area Geothermal Supervisor (Supervisor) or his delegated representative.

The design of all pipelines and surface facilities, including but not limited to, production, injection, and waste water disposal systems, shall be submitted with the Application for Permit to Drill or on a Sundry Notice to the Supervisor for approval prior to construction. In addition, a Plan of Operation with contents and approval according to 30 CFR 270.34, shall be required when surface or environmental disturbances are anticipated beyond those covered by a previously approved Plan of Operation.

1. Design and Construction Requirements. All geothermal pipelines and surface facilities shall be designed and constructed in accordance with the following:

A. General Design

(1) Thermal Expansion. All pipelines and production facilities shall be designed to prevent failure in tension or compression due to thermal stresses based on limitations specified in applicable piping codes. Pipelines shall be anchored to isolate or transfer stress to the ground or solid structure, and to prevent unsafe movement in case of line failure. Main anchor locations are to be predicated on the surface configuration of the area, and may be required at pipe ends, at changes in direction, at shut-off valves, at manifolds where lines are interconnected, or at other points as dictated by the expansion design adopted. Intermediate anchors may be required to divide the pipeline into separate expanding sections and to bear any unbalanced

thrust. Intermediate supports between anchors should allow free lateral and longitudinal movement. Vibration, expansion direction and magnitude, and internal tubulence as well as effects of mineral scaling should be considered before including slip joints or expansion bellows in the design.

(2) Two-Phase Flow. Submission of complete design criteria and calculations may be required for planned two-phase production pipelines and surface facilities to demonstrate that the design of such facilities has given consideration to the water hammer stresses that may be caused by two-phase flow. Example stress calculations for the pipeline shall be submitted.

(3) Environmental Considerations. All pipelines and surface facilities shall be designed and constructed in accordance with the environmental protection requirements of GRO Order No. 4 and other applicable laws and regulations.

B. Safety Control Devices

(1) Production Pipelines and Related Facilities. All steam and hot water production pipelines and related surface facilities shall be equipped with the following devices except as noted in 1.B.(1)(d) below:

(a) Each producing well shall be equipped with a low pressure sensing device to actuate a valve to shut in production to minimize safety or pollution hazards caused by pipeline or facility failure.

(b) Pipelines and related surface facilities shall be protected against pressure buildup in excess of the system's design limit by high pressure sensors which will actuate either (1) well shut-in valves, or (2) system or well pressure relief valves and/or rupture discs. If only pressure relief valves and/or rupture discs are installed, it must be demonstrated that such venting in an emergency will not result in exceeding applicable pollution standards; otherwise shut-in valves shall be installed. Vented production must be properly muffled so as to comply with provisions of GRO Order No. 4. A remote controlled shut-in or venting system may be required, in addition to pressure sensors.

(c) Check valves or other approved devices shall be required in the system to prevent uncontrolled crossflow from other parts of the system in case of a line or facility failure, or where a line failure may result in pollution due to line drainage.

(d) Exceptions to requirements 1.B.(1)(a) through (c) above may be made for systems or parts of systems where the lessee can demonstrate to the satisfaction of the Supervisor that lack of such controls will not result in danger of pollution or to public health

and safety. Information to be considered in an evaluation of a requested exception should include, but is not limited to, chemical analysis of the produced fluids, steam and gases; the rate, temperature and pressure of production; environmental conditions in the area; type of geothermal reservoir system; type of resource utilization; the number, hourly coverage, and supervision of personnel operating the facilities; and the type of manually operated controls installed.

(2) Injection Facilities. All injection pipelines and related surface facilities must be designed to safely accommodate maximum expected surface injection pressures and shall be equipped with the following devices, except as noted in 1.B.(1)(d) above.

(a) Each injection well shall be equipped with a pressure sensing or other approved device to actuate a valve to shut in injection to minimize safety or pollution hazards caused by injection pipeline or facility failure.

(b) Injection pipelines and related surface injection facilities shall be protected against pressure buildup in excess of the system's design limit by pressure sensors which will actuate either (1) well shut-in valves, or wellhead or injection pipeline shut-in valves, or (2) a system of well pressure relief valves and/or rupture discs. If only pressure relief valves and/or rupture discs are installed, it must be demonstrated that such venting in an emergency will not result in exceeding applicable pollution standards; otherwise, shut-in valves shall be installed. A remote-controlled shut-in or venting system may be required, in addition to pressure sensors.

(c) Check valves or other approved devices shall be required to prevent uncontrolled backflow from injection wells in the system in case of a line or facility failure, or where a line failure may result in pollution due to line drainage.

C. Testing and Operation

(1) Pipeline Integrity Tests.

(a) Pipeline - steam. The pipes shall be joined and joints tested in accordance with appropriate piping codes for steam distribution systems. The pipeline shall be operationally tested in service with steam during the initial clean-out by pressure testing to the maximum anticipated working pressure for one hour. The Supervisor shall be notified at least 48 hours in advance of the estimated date and time of each test so that the test may be witnessed.

(b) Pipeline - water. The pipeline shall be hydrostatically tested to 1.25 times the design working pressure for a minimum of 2 hours prior to placing the line in service. Certain low pressure lines such as waste disposal drains and all piping designed for internal pressures

at or below 5 psig. regardless of temperature, may be exempted from this requirement, if authorized by the Supervisor. The Supervisor shall be notified at least 48 hours in advance of the estimated date and time of each test so that the test may be witnessed.

(2) Safety Device Tests. The automatic and remote control devices installed in accordance with 1.B.(1) and (2) above shall be tested semiannually or at more frequent intervals as required by the Supervisor. Advance notification of at least 48 hours shall be given so that the Supervisor may witness the test. The lessee shall maintain records on each device showing present status and past history, including dates and details of inspection, testing, repairing, adjustment, reinstallation or replacement, and will forward copies of these records to the Supervisor semiannually.

(3) Operator Monitoring. Production, injection, and other waste disposal systems which are not completely equipped with shut-in or relief devices, shall require 24-hour on-site monitoring by operator personnel unless it can be demonstrated to the satisfaction of the Supervisor that less frequent monitoring will not increase the danger of pollution or to human life and health. Supervisory control system monitoring by power plant or steam supply operators of steam turbine header pressure, water disposal liquid level and injection line pressure can be substituted for the above monitoring provision, if approved by the Supervisor.

2. Application for Construction of Pipeline and Related Surface Facilities. The operator shall submit the items listed below with the Application for Permit to Drill or on a Sundry Notice, in triplicate, to the Supervisor for approval. In addition, as appropriate, a Plan of Operation according to 30 CFR 270.34 items (a) through (i) may be required for submittal for joint approval by the Supervisor and the appropriate land management agency. Production and injection pipelines for wells may be included as a part of the Application for Permit to Drill and Plan of Operation required for drilling the well.

A. Maps. A plat(s) showing the major topographic features and other pertinent data including the proposed route, length, size, and location of the line(s), and any connecting facilities.

B. Equipment Plans. A schematic drawing showing the location of the following pipeline and facilities safety equipment and the manner in which the equipment functions:

(1) high-low pressure sensor(s)
(2) automatic shut-in valve(s)
(3) check valve(s)
(4) metering system(s)
(5) pressure relief valve(s)
(6) other manual or automatic valve(s) or equipment

C. Design Information. General information concerning the pipeline and facilities including the following;

(1) Product(s) to be transported by the pipeline
(2) Size, weight, and grade of the pipeline
(3) Length of line(s)
(4) Type(s) of corrosion protection
(5) Description of protective coatings
(6) Description of pipe insulation and the application of exterior color camouflage
(7) Anticipated gravity or density of the product(s) and a chemical analysis
(8) Design working pressure and capacity
(9) Maximum working pressure and capacity
(10) Pipeline integrity tests
Steam Pipeline - testing pressure and hold time to which the pipeline will be tested after installation.

Water Pipeline - hydrostatic pressure and hold time to which the pipeline will be tested after installation.

(11) Other related information as required by the Supervisor

3. Completion Report. The operator shall submit a report to the Supervisor when installation of the pipeline is completed, accompanied by all hydrostatic test data, including procedure, test pressure, hold time, and results.

Reid T. Stone
Area Geothermal Supervisor

APPROVED:

for Eddie R. Wyatt

Russell G. Wayland
Acting Chief, Conservation Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 7

Effective January 1, 1977

PRODUCTION AND ROYALTY MEASUREMENT, EQUIPMENT, AND TESTING PROCEDURES

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and 270.12 and in accordance with 30 CFR 270.60, 270.64, 270.74, and 270.75. All geothermal production and the resulting produced energy (electricity) or byproducts, and leasehold operational utilization thereof, shall be measured and monitored in accordance with the provisions of this Order.

All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. References in this Order to approvals, determinations, or requirements are to those given or made by the Area Geothermal Supervisor (Supervisor) or his delegated representatives.

All metering systems shall be approved by the Supervisor prior to installation. Field production metering shall be accomplished with sufficient accuracy to assure that royalty calculations using such measurement data will result in fair market value to the Government, and to enable evaluation of well and reservoir production performance and trends. Where royalty is due on other than a well production basis, i.e., plant output in kilowatt hours or production of byproducts, metering systems used in that regard shall also be approved by the Supervisor.

1. Metering. The general requirements and accuracy for measuring production and utilized energy or byproducts of geothermal resources are outlined below:

A. Measurement of Production. Surface facilities and measuring devices shall be installed so that the production mass flow rate (or volume, when appropriate) of water and/or steam and the pressure and temperature of the produced fluids from each well are accurately determined. If metering is not to be accomplished on a continuous basis, each well shall be gauged periodically at the frequency prescribed by the Supervisor.

The operator shall maintain detailed records available for inspection by the Supervisor concerning the performance measurements relative to each well. The record shall show average flow rates, temperature, pressure, and any other pertinent data gathered. Except for drilling and well workover operations, and low rate venting of new geothermal wells to prevent well bore damage prior to facility hook up, vented production shall also be measured and reported.

Each well shall be equipped to permit fluid sampling for determining the enthalpy and chemical content of produced geothermal fluids. Enthalpy and chemical analysis for each well shall be provided the Supervisor yearly or more frequently if required by the Supervisor.

B. Royalty Metering. Metering systems involved in the calculation of royalty values due shall be designed, installed, operated, and maintained to attain the accuracy herein specified. However, the Supervisor may require greater accuracy where conditions dictate that necessity and the technology exists, or may permit a lesser degree of accuracy when physical problems, such as severe corrosion or scaling, preclude attainment of the desired standards.

(1) Steam. Dry steam metering systems and the mass flow calculations derived therefrom shall be designed and maintained to achieve an accuracy of ±4.0% of the measured flow.

(2) Hot Water. Hot water metering systems and the mass flow or volumetric calculations derived therefrom shall be designed and maintained to achieve an accuracy of ±2.0% of the measured flow.

(3) Steam and Water (two-phase flow). Metering of two-phase flow shall be designed and maintained to achieve the maximum reasonable attainable accuracy consistent with the nature of the production to be measured. Due to the complexity and difficulties involved in this type of metering, the Supervisor shall establish the initial accuracy limits for each specific installation based on the nature of existing flow conditions and commensurate with the then existing state-of-the-art. The operator shall, upon request, demonstrate to the satisfaction of the Supervisor that the approved metering system(s) being employed is operating within the prescribed range of accuracy. The Supervisor is authorized, when warranted, to require modifications in the system consistent with new technology to improve the accuracy of measurement or, when required accuracy is not attainable, to direct that the two-phase fluid flow be separated and the steam and water metered individually.

(4) Heat Content. Where the heat content of produced water or steam is the primary use, including but not limited to heating a greenhouse complex, space heating, and plant processing, metering systems shall be designed and maintained to achieve an accuracy of ±2.0% for both the input and discharge flows.

(5) Electrical Power Output or Consumption. Where the resource sales payment is equated to kilowatts of electric power output or geothermal-produced electricity is consumed in geothermal operations, the metering systems shall be designed and maintained to achieve an accuracy of ±0.5%.

(6) By-Products. When the by-product is in liquid form, metering accuracies shall be maintained within ±1.0%. When the by-product is a solid, measurement thereof shall be either by volume or weight and shall be accurate to ±1.0%.

(7) Waste Heat. Waste heat shall be metered in accordance with the standards set forth in 1.B.(4) when such measurements are involved in royalty calculations.

C. Non-Royalty Metering. Measurement of produced or injected fluids that are not involved directly in royalty calculations, such as waste waters or injected waters shall be metered with accuracies sufficient to evaluate well, reservoir, and project performance. Such metering systems shall be designed and maintained to achieve an accuracy of ±5.0%, unless otherwise specified by the Supervisor.

2. Commingling Production. In accordance with 30 CFR 270.64, the Supervisor may authorize a lessee to commingle production from wells on a lease with production from other leases held by the lessee or by other lessees subject to such conditions as the Supervisor may prescribe. Where utilization of the geothermal resource for energy and/or by-products involves commingling production from two or more leases, the following conditions and requirements shall be met:

A. The surface facilities, metering, and fluid sampling systems employed shall be approved by the Supervisor.

B. The commercially utilized production leaving each lease shall be measured in accordance with the standards set forth in Section 1 hereof, either on or off the leasehold, in a manner that will allow accurate allocation and royalty calculation for that lease.

3. Common Storage. Where commercial utilization involves common storage from two or more leases, e.g., a common brine evaporation pool for production of chemical by-products, the contributions of each lease to that facility shall be measured in accordance with the standards set forth in Section 1 hereof, either on or off the leasehold, in a manner that will allow accurate allocation and royalty calculation for that lease. The surface facilities, metering, and fluid sampling systems employed shall be approved by the Supervisor.

4. Meter Testing and Maintenance. All meters and metering systems shall be maintained in acceptable working condition and shall be inspected, tested, and adjusted to meet appropriate design standards.

The frequency and stringency of tests shall be prescribed by the Supervisor. The Supervisor may witness any periodic metering system test or inspection, and the operator shall schedule an acceptable time and date for such tests when requested by the Supervisor.

A. Royalty Meter Tests and Inspections. The following tests and inspections shall be performed on all meters involved in royalty calculations. Depending on inspection results, the Supervisor may alter the inspection frequencies herein specified.

(1) Orifice Meter Tests and Inspections.

(a) Visual functional inspection shall be performed as part of the daily well check. Recorders shall be inspected for malfunctions at that time and repaired if necessary.

(b) Recorders shall be inspected and the calibration checked with master test gauges at least once per month. The equipment used for the calibration check shall verify the differential and static pressure ranges. Field error of a meter exceeding ±1.0% of the meter's differential and static pressure ranges shall require removal of that instrument and installation of a recalibrated instrument.

(c) Orifice plates and meter tube runs shall be inspected by the operator for wear and recalipered to the nearest thousandth of an inch. Worn plates or runs shall be remachined or replaced. The inspection period shall depend on well performance and on the production demand, but meter runs and accessory equipment shall be inspected at intervals not exceeding one year.

(2) Turbine Meter Tests and Inspections.

(a) Daily readout checks shall be made to verify functional operation.

(b) At least once every six months, the turbine meter shall be checked for accuracy with a prover. If a descrepancy in excess of ±0.5% over limited range or ±1.0% over stated range is noted, the meter shall be inspected for bearing wear, turbine damage, or corrosion and repaired or replaced as necessary.

(3) Electrical Meters (Power Meters).

(a) Inspect daily for function.

(b) A detailed check and inspection shall be accomplished at least once each month.

(c) At least every six months, the meter shall be calibrated with a master meter. The meter shall be repaired or replaced if a discrepancy greater than ±0.5% is found.

(4) Other Types of Meters.

(a) Where metering systems depend on static and differential pressure measurements, e.g., venturi or nozzles, testing shall be as outlined above for orifice meters in 4.A.(1).

(b) Testing procedures and frequencies for all other metering systems shall be as approved by the Supervisor.

B. Non-Royalty Meter Tests and Inspections. Metering systems measuring produced or injected fluids which are not involved in royalty calculation shall normally be checked at least weekly for functional operation, and be inspected, calibrated, and/or proven at yearly intervals to demonstrate an overall accuracy of ±5.0%, unless otherwise specified by the Supervisor.

5. Application for Meter Installation. All metering systems shall be approved by the Supervisor prior to installation. Approval may be obtained by inclusion of the required details in a Plan of Exploration, Development, or Production, or where appropriate, separately by submission of a Sundry Notice, in triplicate, to the Supervisor.

Applications shall include the following information:

A. Purpose of the meter and whether it will be involved in royalty calculations.

B. Location; e.g., Well No. 53-6, SE¼SE¼, Section 6, T. 3 S., R. 10E., M.D.M.

C. What is to be metered, such as steam, water, or combination thereof, and appropriate physical characteristics, such as the temperature, pressure, density, corrosive or scaling tendencies, and a chemical analysis.

D. Anticipated average and range of daily rates to be metered.

E. If the meter is involved in royalty calculations, the estimated monthly gross dollar value that will be measured by the meter and how the measurement will be used in royalty calculations.

F. Drawing of the installation showing piping, locations of equipment, and valves.

G. If not shown in a drawing, indicate (a)type of meter, manufacturer, model number, and range of coverage; (b)pressure ratings of piping, valves, and other equipment; and, (c)design code or standards used for installation design.

H. Anticipated accuracy.

I. Proposed inspection, testing or calibration procedures and the testing schedule.

Reid T. Stone

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