HEBER GEOTHERMAL BINARY DEMONSTRATION PROJECT

HEALTH AND SAFETY MANAGEMENT PLAN

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San Diego Gas & Electric
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Prepared for
The Department of Energy
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HEALTH AND SAFETY MANAGEMENT PLAN

FOR THE

HEBER GEOTHERMAL BINARY DEMONSTRATION PROJECT

I. INTRODUCTION

Recognizing the desirability of demonstrating the operation of the binary cycle process for commercial-scale electric production, San Diego Gas & Electric Company (SDG&E) has formed a consortium of participant utilities to carry out the Heber Geothermal Binary Demonstration Project. Additional cost-sharing support is being provided by the Electric Power Research Institute (EPRI) and the United States Department of Energy (DOE).

The purpose of the Heber Binary Project (HBP) is to design, construct, and operate a nominal 65 Mwe (gross) commercial-scale, binary cycle power plant and to demonstrate the technical and economic feasibility of geothermal power generation. The Project will be the first commercial-scale hydrothermal generating facility in the United States utilizing liquid-dominated resources and the first commercial-scale plant in the world using the binary energy conversion process. It is expected that information developed by this demonstration project will be applicable to a wide range of moderate-temperature, low-salinity hydrothermal reservoirs. Geothermal generation from the Project offers the possibility of displacing 525,000 barrels of oil per year that would otherwise have to be burned in Southern California. Figure 1 shows an artist's rendering of the Project and Figure 2 shows a plot plan of the facility.

The binary process uses hot geothermal fluid directly to vaporize a secondary working fluid. The heat from the fluid is transferred to the secondary fluid by countercurrent flow through a heat exchanger. After expanding through the turbine, the secondary fluid is condensed with water from a cooling tower and pumped to the heat exchangers at a high pressure. The cooling water used in this process must be supplied by an outside source since no steam condensate is generated for cooling purposes. The entire spent geothermal fluid, is injected into the periphery of the reservoir. A simplified process flow diagram is shown in Figure 3.

II. OBJECTIVES

The Heber Binary Project (HBP) has the combined accident potential of a geothermal energy source and an electric power plant, including the presence of a flammable hydrocarbon mixture. One of the objectives of the HBP is to demonstrate the safety of the integrated system. Accordingly, the design and operation of the plant will incorporate common and unique safety features, as well as instru-

mentation for monitoring and recording the operational parameters for maintaining public and worker safety.

The objectives of this Health and Safety Management Plan are:

- A. To identify health and safety risk features of the HBP.
- B. To identify applicable health and safety requirements and standards to ensure their incorporation in the plant design, construction, and operation and maintenance.
- C. To identify monitoring and training programs, special safety plans, and operating and maintenance procedures for inclusion in the HBP.

III. RISK FEATURES

The following is a list of the health and safety risk features associated with the HBP:

A. Construction Phase

Power plant construction provides potential health and safety hazards to the public and workforce. Hazards associated with plant construction include: fires, use of hazardous chemicals, working at heights, high noise levels, rotating machinery, operation of heavy equipment, vehicle movement, and uncontrolled access to the site.

B. Start-Up and Demonstration Phase

During the start-up and demonstration phase of the HBP, health and safety risks may exist in several areas, including:

1. Process Loops

a. Geothermal Fluid Loop

This loop comprises the brine fluid path from the geothermal resource through production wells, piping, heat exchangers, pumps, and ultimate return to the reservoir through the injection wells. Potential health and safety hazards exist because the brine has a high temperature, contains numerous chemical elements and compounds, and is operated at high pressure.

Exposure of the public and workforce to these hazards may result from:

- 1) Planned releases
- 2) Accidental releases
- 3) Contact with high temperature surfaces

b. Hydrocarbon Loop

This loop is comprised of the working fluid, which is a saturated hydrocarbon mixture of 90 mole percent isobutane and 10 mole percent isopentane, and is maintained within a closed loop and circulates through four stages:

- 1) Vaporization in the brine/hydrocarbon heat exchangers to a supercritical vapor [153°C and 4×10^6 Pa (305°F and 575 psia)] through the transfer of heat from the geothermal liquid;
- 2) Expansion through the turbine;
- 3) Cooling and condensation in the hydrocarbon condensers to 43°C (110°F) by discharge of reject heat to cooling water; and
- 4) Pressurization by pumping to 4×10^6 Pa (575 psia), the pressure required at the turbine inlet.

Potential health and safety hazards to the public and workforce exist because the hydrocarbons are ignitable, toxic, volatile, and operated under pressure.

Exposure of the public and workforce to these hazards may result from:

- 1) planned releases
- 2) accidental releases

c. Cooling Water Loop

Cooling water, which is contained within the cooling loop, is cooled to 32°C (90°F) by evaporation in a multi-cell mechanical-draft cooling tower. Cooling water is circulated at a rate of $8.82 \text{ m}^3/\text{s}$ (140,000 gpm) through the hydrocarbon condensers [where it absorbs heat, raising the water to about 43°C (110°F)], before return to the cooling tower. Makeup water [0.20 to $0.22 \text{ m}^3/\text{s}$ (3,200 to 3,500 gpm)] will replace both evaporative and drift losses, as well as 0.044 to $0.050 \text{ m}^3/\text{s}$ (700 to 800 gpm) blowdown that control the total dissolved solids (TDS) content of the cooling water.

Potential health and safety hazards to the public and workforce exist depending on the source of cooling water used and the treatment of the cooling water with chemicals that may be toxic or corrosive.

Exposure of the public and workforce to these hazards may result from:

- 1) Water treatment activities
- 2) Planned emissions and discharges

2. Solid Waste

Hazardous wastes may be generated as a result of reservoir development plant construction and operation. These wastes may be comprised of such items as geothermal heat exchanger scale, biocide and chemical containers, and sludge from settling ponds.

Potential health and safety hazards to the public and workforce exist because these wastes may be toxic, corrosive, ignitable, or reactive.

Exposure of the public and workforce to these hazards may result from:

- a. Plant operation
- b. Hauling and disposal

3. Plant Security

Uncontrolled access to the power plant premises could expose public and workers to potential health and safety hazards.

Exposure of the public and workforce to these hazards could occur during:

- a. Plant operation
- b. Emergency events

4. On-Site Laboratory

Normal plant operations will require the use of an on-site chemical laboratory. Potential health and safety hazards exist to the workforce due to the use of materials which may be toxic, ignitable, reactive, or corrosive, or from operation of laboratory equipment.

5. Interface with Local Health, Fire, and Public Services

Potential health and safety hazards exist to the public and workforce due to the unique features of the geothermal binary power plant and potential unfamiliarity of local health, fire, and public services with plant hazards and operations.

Exposure of the public and workforce to these hazards may occur during:

- a. Plant operation
 - b. Emergency events (earthquake, fire, etc.)
6. General Risk Features

The operation of any power plant exposes the public and workforce to certain general health and safety hazards. The potential hazards include: fires, flammable liquids and gases, high voltage, high noise levels, rotating machinery, working at heights, operation of heavy equipment, and vehicle movement.

IV. HEALTH AND SAFETY REQUIREMENTS

Fluor Power Services, as the Architect/Engineer, is responsible for insuring that the applicable safety provisions are incorporated in the design. The Construction Manager is responsible for insuring that the construction-related safety requirements are adhered to. The Heat Supplier is responsible for conforming to safety requirements relating to the development and operation of the reservoir. SDG&E is responsible for compliance with the safety requirements during operation of the plant.

The design, construction, and operation and maintenance, of all structures and facilities shall be based on applicable portions of the latest revisions of the following codes, specifications, industry standards and regulations, and other reference documents to ensure safe plant design and public and worker health and safety.

A. Codes and Standards

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Moving and Conditioning Association (AMCA Standard)
3. American Association of State Highways and Transportation Officials (AASHTO), "Standard Specifications for Highway Bridges"
4. American Concrete Institute (ACI), "Building Code Requirements for Reinforced Concrete," (ACI 318-77)
5. American Gas Association (AGA) Report 3, "Recommended Dimensions for Orifice Plates"
6. American Gear Manufacturers Association (AGMA) Standards
7. American Institute of Steel Construction (AISC), including but not limited to:
 - a. "Specification for the Design, Fabrication, and Erection of Structural Steel for Building," November 1, 1978;

- b. "Code of Standard Practice for Steel Buildings and Bridges," September 1, 1976;
 - c. "Specifications for Structural Joints Using ASTM A325 or A490 Bolts," April 26, 1978;
- 8. American Iron and Steel Institute (AISI), "Specification for the Design of Cold-Formed Steel Structural Members," Parts 1 and 2
- 9. American National Standard Institute (ANSI)
- 10. American Petroleum Institute (API) RP550, Part III - Process Stream Analyzers
- 11. American Society for Testing and Materials (ASTM), including but not limited to:
 - a. "Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe," (ASTM Designation C76);
 - b. "Standard Specifications for Structural Steel," (ASTM Designation A36);
 - c. "Specifications for High-Strength Low-Alloy Structural Steel," (ASTM Designation A242);
 - d. "Specifications for High-Strength Low-Alloy Structural Manganese-Vanadium Steel," (ASTM Designation A441);
 - e. "High-Strength Steel Bolts for Structural Joints," (ASTM Designation A325);
 - f. "Quenched and Tempered Alloy Steel Bolts for Structural Joints," (ASTM Designation A490);
 - g. "Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners," (ASTM Designation A307);
 - h. "Specification for Steel Pipe," (ASTM Designation A120);
 - i. "Hot-Dipped Galvanizing," (ASTM Designation A123 and ASTM Designation A153);
 - j. "Standard Methods and Definitions for Mechanical Testing of Steel Products," (ASTM Designation A370);
 - k. "Billet Steel Bars for Reinforcement," (ASTM Designation A615, Grades 40, 60 and 75);
 - l. "Welded Steel Wire Fabric for Concrete Reinforcement," (ASTM Designation A185); and

- m. Applicable standards for the various construction materials specified in civil/structural specifications.
- 12. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- 13. American Society of Mechanical Engineers (ASME)
- 14. American Society of Testing and Materials (ASTM)
- 15. American Water Works Association (AWWA) "Steel Pipe Manual" - AWWA M11
- 16. American Welding Society (AWS), "Structural Welding Code," (AWS D1.1, Revision January 1980)
- 17. Anti-Friction Bearings Manufacturer Association (AFBMA)
- 18. Compressor Association (CGA) Standards
- 19. Cooling Tower Institute Standards
- 20. Federal Aviation Administration (FAA) Standards for Marking and Obstruction Lighting for Aerial Navigation
- 21. Federal Occupational Safety and Health Act (OSHA)
- 22. Heat Exchange Institute Standard (HEI)
- 23. Hydraulic Institute Standards (HI)
- 24. International Conference of Building Officials, "Uniform Building Code" (UBC), 1979, which is the building code adopted by Imperial County
- 25. International Association of Plumbing and Mechanical Officials, "Uniform Plumbing Code" (UPC)
- 26. Institute of Electrical and Electronic Engineers (IEEE)
- 27. The following Instrument Society of American (ISA) Standards, including but not limited to:
 - a. ISA S-5.1 - Instrument Symbols
 - b. ISA S-5.2 - Logic Diagram Symbols
 - c. ISA S20 - Instrument Specification Forms
 - d. ISA RP18.1 - Specification and Guide for the Use of Annunciators
 - e. ISA S12.4 - Control Panel's Air Purging
 - f. ISA RP7.2 - Color Code for Panel Tubing
- 28. Insulated Cable Engineers Association (ICEA)
- 29. National Electrical Manufacturers Association (NEMA)

30. National Electric Code (NEC)
31. National Fire Protection Association (NFPA), "National Fire Code," Volume 9, Latest Edition
32. Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Standards
33. Standards of Tubular Exchanger Manufacturers Association (TEMA)

B. Regulations

Regulations from the following federal, state, and local agencies or authorities shall apply where appropriate:

1. Federal

- a. Environmental Protection Agency

2. State

- a. California Air Resources Board
- b. California Bureau of Fire Protection
- c. California Department of Health Services
- d. California Department of Labor and Industry Regulations
- e. California Department of Motor Vehicles
- f. California Department of Transportation
- g. California Department of Water Resources
- h. California Division of Oil and Gas

3. Local

- a. Imperial County Air Pollution Control District
- b. Imperial County Department of Public Health
- c. Imperial County Department of Public Works
- d. Imperial County Planning Department

4. The following specific regulations shall apply:

- a. Resource Conservation and Recovery Act, Parts 260 to 263. California Administrative Code, Title 22, Chapter 30, "Minimum Standards for Management of Hazardous and Extremely Hazardous Waste"
- b. Hazardous Materials Transportation Act, 49 U.S. Code 1801 et. seq., and implementing regulations
- c. Interim Status Standards issued pursuant to S25200.5 of the California Health and Safety Code
- d. California Water Code, Division 7.5, "Transportation and Disposal of Waste" and implementing regulations

- e. California Health and Safety Code, Division 14, Subchapter 6.5, "Hazardous Waste Control" and implementing regulations
- f. California Government Code, Title 9.3, "Solid Waste Management and Resource Recovery" and implementing regulations
- g. Department of Health Services, "California Assessment Manual for Hazardous Waste"
- h. State Water Resources Control Board, "Waste Discharge Requirements for Non-Sewerable Waste Disposal to Land" (California Administrative Code Title 23, Subchapter 15, Section 66028, et. seq.)
- i. California Vehicle Code, Sections 2402 and 34501 and implementing regulations
- j. California Administrative Code Title 8, Chapter 3.2, Cal OSHA-Occupational Safety and Health Regulations, Subchapters 1, 4, 5, 7, and 15 in particular

V. SAFETY PLANS AND MONITORING PROGRAMS

In addition to compliance with the Health and Safety Requirements (Section IV), public and worker health and safety will be further ensured by the implementation of the following safety plans and monitoring programs:

A. Safety Analysis

Prior to the start of construction, an analysis of the Project design will be performed by an independent consultant. Any design modifications identified by the consultant necessary to ensure public and worker health and safety will be considered before construction begins. A DOE review of the Safety Analysis will be arranged by the SDG&E Project Manager and coordinated with the DOE Project office. The review will be held near the completion of final design.

B. Construction

The Construction Manager will be responsible for preparing a Safety Manual for construction activities. The manager will be responsible for establishing a Site Security Plan and Safety Program. Safety, security, and first-aid procedures will include, but not be limited to the following items:

1. Safety

- a. Job Rules
- b. Inspection Requirements
- c. Required Reports - Insurance, Accident, etc.

2. Security

- a. Access to Site
- b. On-Site Requirements
- c. Inspections - Type and Frequency

3. First Aid

- a. Program Spectrum and Objective
- b. Personnel and Facilities Required
- c. Reports and Distribution

C. Plant Operation

1. A Safety Manual will be prepared by the Architect/Engineer prior to the commencement of start-up. The manual will emphasize for operating and maintenance personnel the safety considerations associated with the HBP. Where required, it will provide specific operating and maintenance instructions.

The Safety Manual will include emergency procedures for the likely events that might occur due to the following hazards:

- a. Fires
- b. Flammable Liquids and Gases
- c. High Voltage
- d. Compressed Gases
- e. Low Temperature Surfaces and Systems
- f. High Temperature Surfaces
- g. Inert and Low Oxygen Atmospheres
- h. Hazardous Chemicals
- i. High Noise Levels
- j. Isolation of Equipment for Maintenance
- k. Toxic or Noxious Releases
- l. Rotating Machinery
- m. Working at Heights
- n. Operation of Heavy Equipment
- o. Vehicle Movement
- p. Natural Disasters

2. The following plant security measures will be implemented:

- a. Workers and Visitors

Workers will be instructed to enter and leave property in view of the Security Officer.

Visitors must have approval of the Plant Manager or his/her designate. Request for plant tours will be made and approved in advance. Minimum age of persons allowed in the plant equipment area is 12 years.

b. Security

The jobsite shall be fenced around the perimeter to limit access to the facility through the prescribed gates. The fence shall be a minimum of eight-foot (height) chain link with four strands of barbed wire at top. All gates shall be installed with electrical locks that require a key or operation from the Security Office to be opened. Outlying areas, usually not inhabited by operators or maintenance personnel, shall be adequately lighted at night to minimize intruders. Twenty-four-hour-a-day security shall be provided by guards to protect the facility from intruders. Off-hour visitors shall be admitted only upon approval of the Plant Manager or his/her designate.

The Security office shall have an unobstructed view of the plant's entrance.

3. The heat supplier/unit operator will be responsible for the preparation of a Safety Manual for the geothermal fluid loop for the construction and operation phases of the Project. The Manual should provide for potential hazards associated with well drilling, pipeline operation, injection, waste disposal, and any other risk areas associated with the geothermal brine supply (and injection) loop.
4. A Spill Prevention Control and Countermeasures Plan (SPCC) will be prepared by SDG&E as applicable to use of the hydrocarbon working fluid. This Plan will cover the following items as required (EPA Regulation on Oil Pollution Preventions, 40 CFR 112; 38 FR 34164, December 11, 1973; Amended by 39 FR 31602, August 29, 1974; 41 FR 12657, March 26, 1976):
 - a. Secondary Containment
 - b. Plant Operation
 - c. Inspecting Above-Ground Tanks
 - d. Testing Underground Tanks
 - e. Compatible Materials
 - f. Corrosion Protection
 - g. Testing Piping Systems
 - h. Pump Disconnects
 - i. Out of Service Systems
 - j. Truck Loading/Unloading Stations
 - k. Security
 - l. Maintenance
 - m. Personnel Training
 - n. Periodic Review of the SPCC Plan

D. Monitoring Programs

The following monitoring programs are planned:

1. In accordance with the Geothermal Element of the Imperial County General Plan, monitoring for subsidence and uplift will consist of a network covering the Heber geothermal anomaly and its vicinity. Monitoring will be conducted every three or six months during initial production.
2. In accordance with the Geothermal Element of the Imperial County General Plan, the heat supplier will place a seismic net in the area before production begins to provide data on baseline seismic activity and any deviations that occur during periods of power production.
3. Wells adjacent to the injection island will be monitored quarterly for contamination.
4. SDG&E will conduct an air quality monitoring program, which will include a salt drift impact assessment composed of field studies and monitoring activities to characterize the cooling tower drift patterns at the Project site.
5. Plant liquid effluent monitoring will be accomplished through weekly grab samples for total dissolved solids, pH, copper, zinc, lead, suspended matter, settleable matter, total chromium, and total chlorine. In addition, the average daily liquid effluent flow will be monitored.
6. The temperature of New River water will be monitored within 30 feet upstream, and also within 30 feet downstream of the point of effluent discharge.
7. Noise control will be in compliance with the Geothermal Element of the Imperial County General Plan. A noise measurement study will be made at the site boundary at varying times of the day and night and under varying weather conditions when the plant becomes operational.
8. On-site monitoring will include:
 - a. H₂S Detection
 - b. Hydrocarbon Detection
 - c. Cooling Tower Blowdown:
 - 1) Composition
 - 2) Temperature

FIGURE 1
HEBER BINARY PROJECT
ARTIST'S RENDERING

FIGURE 2
HEBER BINARY PROJECT
PLOT PLAN

FIGURE 3
HEBER BINARY PROJECT
SIMPLIFIED PROCESS-FLOW DIAGRAM
OF THE BINARY CONVERSION SYSTEM