

CASA DIABLO IV GEOTHERMAL POWER PLANT DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

State Clearinghouse No. 2011041008

Prepared for
Great Basin Unified Air Pollution
Control District

August 2020



CASA DIABLO IV GEOTHERMAL POWER PLANT DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT

State Clearinghouse No. 2011041008

Prepared for
Great Basin Unified Air Pollution
Control District

August 2020



550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900
www.esassoc.com

Bend	Orlando	San Jose
Camarillo	Pasadena	Santa Monica
Delray Beach	Petaluma	Sarasota
Destin	Portland	Seattle
Irvine	Sacramento	Tampa
Los Angeles	San Diego	
Oakland	San Francisco	

D201901473

TABLE OF CONTENTS

Casa Diablo IV Geothermal Power Plant Draft Supplemental Environmental Impact Report

	<u>Page</u>
Chapter 1, Introduction.....	1-1
1.1 Summary Project Description and Background	1-1
1.1.1 Project Location.....	1-1
1.1.2 Summary Project Description	1-3
1.1.3 Background	1-4
1.2 Environmental Review under the California Environmental Quality Act	1-7
1.2.1 Notice of Preparation.....	1-7
1.2.2 Draft SEIR	1-7
1.2.3 Final SEIR and Certification.....	1-8
1.3 Organization of the Draft SEIR.....	1-8
1.4 Intended Uses of the SEIR.....	1-9
Chapter 2, Project Description.....	2-1
Chapter 3, Feasibility and Analysis of Suggested Mitigation Measures	3-1
3.1 Introduction.....	3-1
3.2 Enhanced Leak Detection and Repair Procedures	3-2
3.2.1 Description.....	3-2
3.2.2 Feasibility, Analysis, and Conclusions	3-2
3.3 Leakless and Low-leak Technology.....	3-6
3.3.1 Description.....	3-6
3.3.2 Feasibility, Analysis, and Conclusions	3-6
3.4 References	3-11
Chapter 4, Revised Responses to Comments	4-1
4.1 Introduction.....	4-1
4.2 Revised Response to Comment Letter from CURE.....	4-1
Chapter 5, Report Preparation	5-1
5.1 Lead Agency	5-1
5.2 Environmental Consultant	5-1
5.3 Recipients of the Draft SEIR	5-1

	<u>Page</u>
Appendices	
A. Scoping Summary.....	A-1
B. Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies	B-1

List of Figures

1 Project Vicinity Map, Mono County, California	1-2
2 Casa Diablo IV Geothermal Power Plan	1-5

List of Tables

3-1 Technical Feasibility of Enhanced Leak Detection and Repair Procedures	3-4
3-2 Technical Feasibility of Leakless and Low-leak Technology	3-7

CHAPTER 1

Introduction

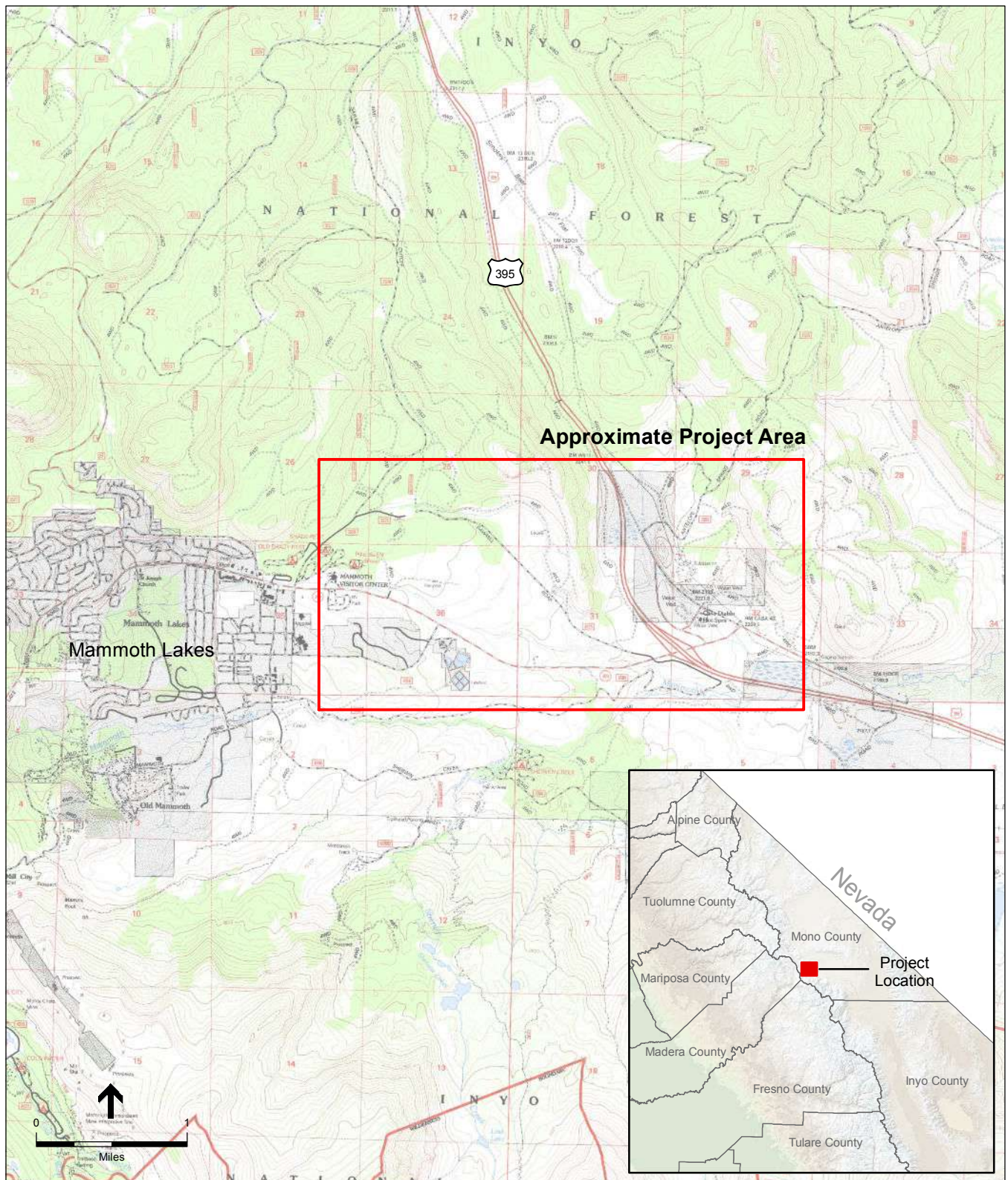
This Draft Supplemental Environmental Impact Report (Draft SEIR) is an informational document that identifies additions and changes to the Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR) that was certified by the Great Basin Unified Air Pollution Control District (GBUAPCD) on July 17, 2014, for the Casa Diablo IV Geothermal Power Plant (Project). This Draft SEIR contains supplemental information to the Final EIS/EIR to adequately inform the public and local officials in the planning and decision-making process regarding two potential and additional mitigation measures to address fugitive n-pentane emissions from the plant: (1) a stronger leak detection and repair (LDAR) program, and (2) the additional use of leakless or low-leak technology. This Draft SEIR is not meant to determine whether the Project should be approved.

GBUAPCD is accepting agency and public comments on the material included in this Draft SEIR until the close of business on Monday, October 12, 2020, as described later in the section. GBUAPCD will respond to substantive comments on significant environmental issues within the scope of this Draft SEIR and will include them in a Final SEIR to be considered for certification by GBUAPCD.

1.1 Summary Project Description and Background

1.1.1 Project Location

As discussed in the Final EIS/EIR, the Project would be located on public land (BLM Geothermal Lease # CACA-11667 and CACA-11667A) in Sections 29 and 32, Township 3 South, and Range 28 East Mount Diablo (MD) Base and Meridian (B&M). This location is approximately two miles east of the Town of Mammoth Lakes in Mono County, California. A location map of the Project area is attached to this Draft SEIR as **Figure 1**. The Project includes construction, operation, and maintenance of a geothermal power plant and up to 16 geothermal resource wells (some new and some existing) and associated pipelines on portions of BLM Geothermal Leases CACA-11667, CACA-14407, CACA-14408 and CACA-11672 located within the Inyo National Forest in Section 25, 26, and 36 of T3S, R27E and Sections 30, 31 and 32 of T3S, R28E, MD B&M. The Project is proposed in the vicinity of the existing Mammoth Pacific L.P. (MPLP) geothermal complex and entirely within the Mono-Long Valley Known Geothermal Resource Area in Mono County, California.



SOURCE: USGS 7.5- minute Old Mammoth topographic quadrangle, 1984

Casa Diablo IV Geothermal Power Plant

Figure 1
Project Vicinity Map
Mono County, California

1.1.2 Summary Project Description

Ormat Nevada Inc. (ORNI 50, LLC, or the Applicant), proposes to build, and following the expected 30-year useful life, decommission the Project. The Project would consist of the following facilities:

- a) A geothermal power plant consisting of two Ormat Energy Converter (OEC) binary generating units (21.2 megawatts [MW] gross each) with vaporizers, turbines, generators, air-cooled condensers, preheaters, pumps and piping, and related ancillary equipment. The gross power generation of the plant would be 42.4 MW. The estimated auxiliary and parasitic loads (power used within the Project for circulation pumps, fans, well pumps, loss in transformers and cables) is about 9.4 MW, thus providing a net power output of about 33 MW. Additional components of the power plant would include:
 - i. A motive fluid system consisting of motive fluid (n-pentane) storage vessels (either one or two vessels in the range of 9,000 to 12,000 gallons) and motive fluid vapor recovery systems (VRUs). Each VRU would consist of a diaphragm pump and a vacuum pump.
 - ii. A substation would be constructed on the power plant site and connected to the existing Southern California Edison (SCE) Casa Diablo Substation at Substation Road.
 - iii. An overhead 33 kilovolt (kV) transmission line approximately 650 feet (198 meters) long would connect the power plant substation with the SCE Casa Diablo Substation.
- b) Up to 16 geothermal wells are proposed. Fourteen of the wells would be located in the Basalt Canyon area and two wells would be located southeast of the proposed power plant east of U.S. Highway 395. The specific locations for these wells would be selected out of the 18 possible locations shown in **Figure 2**. The actual number of wells required may be less depending on the productivity of the wells. The final number and location of wells would be determined by modeling and actual drilling results. Approximately half of the wells would be production wells and the other half would be injection wells. Each production well would range in depth from 1,600 to 2,000 feet below ground surface (bgs) and each injection well would be drilled to approximately 2,500 feet bgs. Production wells would be equipped with a down-hole pump powered by a surface electric motor. Thirteen (13) of the 18 potential proposed well locations in the Project area were analyzed and approved for exploratory well development during previous environmental reviews (BLM 2001 and BLM 2005). Two of these previously-approved exploratory wells were drilled in 2011.
- c) Piping would be installed from production wells to the power plant and from the power plant to the individual injection wells. Two main pipelines would parallel MPLP's existing Basalt Canyon pipeline through Basalt Canyon and would cross beneath U.S. Highway 395 between the well field and the Project site. Where pipelines must cross another pipeline or a road, the crossings would be underground.
- d) Power and control cables for the wells would be installed in above-ground cable trays placed on the pipeline supports. Ancillary facilities would include pumps, tanks, valves, controls, and flow monitoring equipment.

1.1.3 Background

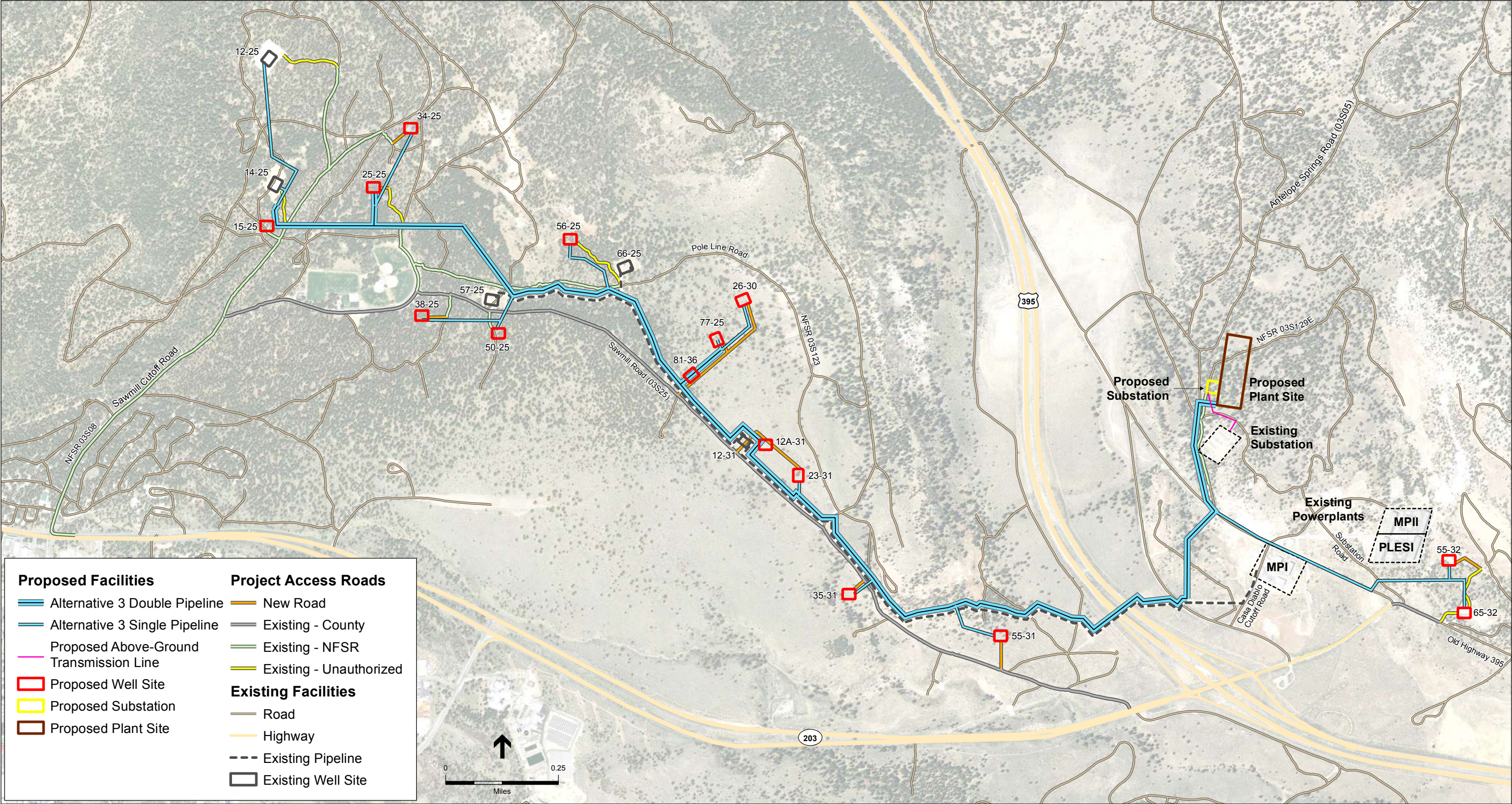
California's Renewable Portfolio Standard requires energy companies to increase their use of renewable-energy resources to 33 percent of total procurement by 2020. In addition, California adopted the Global Warming Solutions Act of 2006 (California Health and Safety Code, Section 38500 *et seq.*) to reduce statewide greenhouse gas (GHG) emissions to 1990 levels by 2020. In 2008, to attain this goal, the California Air Resources Board (CARB) directed that energy from renewable sources be increased to 33 percent by 2020. The proposed Project supports California's goals to reduce GHG and other pollutant emissions, decrease the nation's dependence on fossil fuels, and increase the use of renewable energy resources.

By using a geothermal reservoir as its energy source, the Project eliminates air emissions that would be produced by a traditional fossil fuel fired power plant. An equivalent natural gas power plant (33 MW) would produce an estimated 130,000 metric tons per year of direct GHG emissions in the form of carbon dioxide emissions, as well as other air pollutants, for the same amount of power generated by the Project. A similar-sized coal-fired power plant (33 MW) would produce an estimated 260,000 metric tons per year of direct GHG emissions in the form of carbon dioxide (BlueSkyModel, 2020). As stated in the 2013 Final EIS/EIR, the Project is estimated to generate up to 505 metric tons of carbon dioxide emission per year, including direct and indirect emissions. These emissions savings for the Project in comparison with traditional power plants are substantial.

The Project, its environmental impacts, and its feasible mitigations measures were fully analyzed in the Final EIS/EIR, with the exception of the possible additional fugitive emissions mitigation measures discussed in this SEIR. The Project was the subject of a Draft EIS/EIR that was circulated in November 2012. Following the development of responses to comments received on the Draft EIS/EIR, a Final EIS/EIR was prepared in 2013 and GBUAPCD certified the EIR and filed a Notice of Determination on July 17, 2014.

Subsequently, the Final EIS/EIR was the subject of a Petition for Writ of Mandate by petitioners alleging in relevant part that additional discussion of the feasibility of fugitive emission mitigation measures was required under the California Environmental Quality Act (CEQA). The trial court ruled in favor of the GBUAPCD on all claims finding that the GBUAPCD's "process was proper," the "findings were supported by substantial evidence" and, despite contentions to the contrary, "the administrative record demonstrates a thorough and exhaustive study by various experts based on complete data from the past decades to the present."

Petitioners appealed the decision of the trial court. Upon review, the Court of Appeal affirmed the trial court's decision on all grounds except the two addressed in this SEIR. The Court of Appeal concluded "[t]hat the District was the proper lead agency, and that the permit limiting the daily ROG [reactive organic gas] emissions is sufficient evidence of the amount of the emissions." However, it also concluded that "the District did not adequately analyze whether the additional mitigation measures proposed by petitioners were feasible to limit ROG emissions." Specifically, the Court of Appeal ordered "[t]he District to provide a reasoned analysis supported by factual information in response to the mitigation measures proposed by the petitioners..." *Covington v. Great Basin Unified Air Pollution Control District* (2019) 43 Cal.App.5th 867.



SOURCE: 2013 FEIS-EIR Figure 2-14

Casa Diablo IV Geothermal Power Plant

Figure 2

Casa Diablo IV Geothermal Power Plant

This page intentionally left blank

In response, this Draft SEIR provides the additional discussion and analysis identified by the Court of Appeal regarding two potential and additional mitigation measures to address fugitive ROG emissions from the plant: (1) a stronger LDAR program, and (2) the additional use of leakless or low-leak technology. For any such measures determined to be feasible, this Draft SEIR evaluates them pursuant to CEQA Guidelines Section 15126.4, including whether environmental impacts would result from their implementation.

Generally, leakless or low-leak technology is reserved for use for facilities where fugitive emissions of hazardous air pollutants (HAP) or toxic air contaminants (TAC) are present. By contrast, for the Project, the ROG which constitutes the fugitive emissions for the Project is normal-pentane (n-pentane), the working fluid (motive fluid) to be used in the proposed geothermal power plant. N-pentane is a regulated ozone precursor in the form of ROG and volatile organic compound (VOC), but is not classified as a regulated TAC in California and is not classified as a HAP under the federal Clean Air Act. According to Section 39655 of the California Health and Safety Code, a TAC is "an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health." In addition, United States Environmental Protection Agency (USEPA) has identified HAPs as pollutants known to cause cancer and other serious health impacts, such as reproductive effects or birth defects, or adverse environmental effects. Therefore, n-pentane is not considered by the State to increase mortality or serious illness, or otherwise to pose a hazard to human health. Further, it is not considered by the federal government to cause cancer or other serious health impacts.

1.2 Environmental Review under the California Environmental Quality Act

This section describes the process by which GBUAPCD will review the Project and the Draft SEIR.

1.2.1 Notice of Preparation

GBUAPCD initiated the environmental review process for this SEIR by filing a Notice of Preparation (NOP) with the State Clearinghouse and Responsible and Trustee Agencies on February 26, 2020. The public comment period concluded on March 27, 2020. A summary of the comments received is included in **Appendix A**.

1.2.2 Draft SEIR

This document constitutes the Draft SEIR. This and other environmental documents associated with the Project may be found on GBUAPCD's webpage at: <https://gbuapcd.org/cd4>

Public Notice and Public Review

This Draft SEIR will be available for public review for a 45-calendar-day period (i.e., from Thursday, August 27, 2020, through 5 p.m. on Monday, October 12, 2020), during which time written comments on the Draft SEIR may be submitted to GBUAPCD as provided below.

Responses to all substantive comments on the Draft SEIR will be prepared and included in the Final SEIR. Comments outside the limited scope of the Draft SEIR will not be addressed in the Final SEIR. The SEIR addresses the feasibility and potential environmental effects of potential mitigation measures identified in comments on the 2012 Draft EIS/EIR to reduce the proposed Project's fugitive ROG emissions.

All comments or questions regarding the Draft SEIR should be addressed as follows:

By email to: permits@gbuapcd.org

By mail to: Primary Agency Contact: Ann Logan
Great Basin Unified Air Pollution Control District
157 Short Street
Bishop, CA 93514-3537

1.2.3 Final SEIR and Certification

Following the public review period, a Final SEIR will be prepared. The Final SEIR will include written responses to substantive written comments on the Draft SEIR received during the public review period. CEQA does not require that a public meeting be held to accept verbal comments on a Draft SEIR, and no public meeting is proposed.

Consistent with CEQA's requirements for review of an SEIR, GBUAPCD will wait at least 10 days after issuance of the Final SEIR before taking action on the Project. Upon review and consideration of the Final SEIR, GBUAPCD may take action to approve, conditionally approve, revise, or reject the Project. A decision to approve the Project would be accompanied by written findings and a Mitigation Monitoring and Reporting Program (MMRP).

1.3 Organization of the Draft SEIR

Under CEQA and per the Court of Appeal's directives, GBUAPCD's responsibility for environmental review at this stage is limited to the feasibility and potential environmental effects of the mitigation measures identified in the Court of Appeal's decision to potentially further mitigate the proposed Project's fugitive ROG emissions. Accordingly, the Draft SEIR is a document comprised of the following:

Introduction: Chapter 1 includes a brief project description and an overview of the background to the Draft SEIR. The Introduction also describes the process that will be followed during the public review of the Draft SEIR and the preparation and consideration of a Final SEIR.

Project Description: Chapter 2 relies on and refers to the project description provided in the 2013 Final EIS/EIR except as to those portions that are being updated. Necessary details about the project description are provided in Chapter 2, with amendments to the original text shown via tracked changes (i.e., additions are underlined and deletions are ~~crossed out~~).

Feasibility and Analysis of Suggested Mitigation Measures: Chapter 3 provides a detailed analysis of the feasibility of the two potential and additional mitigation measures to address

fugitive n-pentane emissions from the plant: (1) a stronger LDAR program, and (2) the additional use of leakless or low-leak technology.

Revised Responses to Comments: Chapter 4 provides revised responses to comments received on the 2012 Draft EIS/EIR relating to issues within the scope of this SEIR. Amendments to the original text of the responses to comments are shown via tracked changes (i.e., additions are underlined and deletions are ~~crossed-out~~).

Report Preparation: Chapter 5 identifies preparers and recipients of the Draft SEIR.

Appendix A: A summary of the scoping process conducted to support the SEIR is included as Appendix A.

Appendix B: Casa Diablo IV Geothermal Project Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies (SLR, 2020). An independent technical report by Kenneth A. Malmquist analyzing the feasibility of low-leak and leakless design technologies, as well as more stringent leak detection and repair practices, is included as Appendix B.

1.4 Intended Uses of the SEIR

Once complete and certified, the 2013 Final EIS/EIR and Final SEIR will provide the CEQA compliance documentation upon which GBUAPCD's reconsideration of, and action on, all applicable air quality permits and other approvals (collectively, "approvals") for the Project may be based. Responsible and Trustee agencies also may rely on the 2013 Final EIS/EIR and Final SEIR in issuing approvals or other necessary authorizations.

1.5 References

BlueSkyModel, 2020. "1 kilowatt-hour" webpage. Obtained online at: <https://blueskymodel.org/kilowatt-hour>. Accessed: August 10, 2020.

SLR International Corporation (SLR), 2020. Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies, prepared for the Great Basin Unified Air Pollution Control District. July 2020.

This page intentionally left blank

CHAPTER 2

Project Description

This Draft SEIR evaluates the same project that was approved in the 2013 Final EIS/EIR – the initial proposal as modified by Alternative 3 (the “Project”). A summary of the Project is provided in Sections 1.1.1 and 1.1.2 of this Draft SEIR. More specifically, the GBUAPCD’s preferred alternative, Modified Pipeline Alternative (Alternative 3) was identified in the 2013 Final EIS/EIR as the Environmentally Superior Alternative. Relative to the Applicant-proposed Alternative 1, the Project modifies the geothermal production and injection pipeline alignments in Basalt Canyon, slightly alters the location of proposed well 26-30, and places pipeline crossings underground. The purposes of this alignment and well location are to minimize potential effects of the Applicant’s proposal on biological and cultural resources and to reduce potential visual effects. Power plant and wellfield construction, operation, and decommissioning would be the same as Alternative 1. For the complete detailed description of the Project, refer to the 2013 Final EIS/EIR Section 2.

This Draft SEIR Chapter 2 includes only those portions of the Project Description that have been updated or changed as part of this Draft SEIR. Additions are underlined and deletions are ~~crossed out~~. Some changes reflect clarifications of the Applicant’s standard operating procedures which are part of the Project but were not fully described in the EIS/EIR, but were fully analyzed. In some cases, these clarifications are similar to the implementation of measures suggested in the comment letters on the Draft EIS/EIR being addressed in this SEIR. For clarification, those suggested measures are described in the edits below.

Fifth paragraph, pages 2-40 and 2-43 of the Final EIS/EIR:

Motive Fluid System

A light hydrocarbon compound (n-pentane) would be the motive fluid used to drive the turbines for this Project. The system works by using the vaporized motive fluid, n-pentane, from the level 1 and level 2 vaporizers to turn the level 1 and level 2 turbines, which together would turn a common generator. The generator would produce the electricity that would be delivered to the CD-IV substation and transferred to the interconnection transmission line. The vaporized n-pentane would then be condensed in an air-cooled tube condenser, turning it back into a liquid, and returned to the preheaters and vaporizers to repeat the cycle. Each OEC [Ormat Energy Converter] Unit would contain approximately 180,000 pounds of n-pentane in the vaporizers, preheaters, condensers, piping, and n-pentane vapor vessels (either one or two vessels, likely in the range of 9,000 to 12,000 gallons (34 to 45 kl)). The motive fluid system is closed loop, and there are no routine emissions to the atmosphere. However, there can be fugitive

leaks of the n-pentane from pipes, seals, flanges, valves, and other connections and from vapor recovery systems. As described in Appendix B, design measures to reduce the potential for fugitive emissions from the motive fluid process include:

1. Double mechanical seal and barrier fluid systems meeting American Petroleum Institute (API) standards for turbines (API Plan 53B) and centrifugal pumps (API Plan 52) and instrumentation to detect pressure loss and leaks of the barrier fluid systems;
2. Rotational butterfly valves inherently lower in leaks from stem seals than linear sliding stem control valves and meeting or exceeding API specifications;
3. Graphite packing systems for gate valves meeting or exceeding API 600 Trim 8 configuration;
4. Sealless pneumatic (air) diaphragm pumps for evacuating motive fluid from isolated portions of the motive fluid process after isolation for equipment replacement or repair;
5. Combination of butterfly valves and isolation valves in a double block and bleed seal to eliminate leaks from isolated piping and equipment while motive fluid is evacuated;
6. Flanged connections for equipment that is or may be routinely removed for replacement or repair to facilitate safe maintenance while reducing the potential for n-pentane releases during such activities;
7. Flanges and gaskets compatible with motive fluid and meeting ASME specifications;
8. Direct acting pressure relief valves (PRV) meeting stringent API seat tightness standards;
9. Rupture disks to minimize leaks from PRVs; and
10. Use of leakless welded connections to the greatest extent practicable.

In addition, small amounts of air or water (noncondensable gases) typically leak into the OEC unit pentane system in the air condensers and accumulate in the loop over time, which eventually reduces the operating efficiency of the system and therefore needs to be purged out of the system. In order to remove the air, each OEC condenser would have several integrated purge units that are also equipped with VRUs to capture and recover motive fluid that may be entrained in it. This not only is effective emissions control but also helps to reduce operating costs. Because the motive fluid is expensive, it is economically beneficial to capture and return as much motive fluid to the system as possible.

Third paragraph, page 2-43 of the Final EIS/EIR:

2.2.7.6 Power Plant

Motive Fluid System

Some OEC Unit major maintenance activities require that at least a portion of an OEC Unit be cleared of pentane liquid and vapors prior to performing the maintenance activities that include “hot work” on the motive fluid system that would consist of cutting, welding, and brazing. The only hot work that would be needed for the proposed motive fluid systems would be very infrequent and would occur near flange connections for maintenance access. To control and minimize pentane emissions during these infrequent major maintenance activities, the liquid pentane would first be drained from the section of the OEC Unit (preheater, vaporizer or condenser) to be maintained or repaired and transferred to either another section of the OEC Unit, the pentane storage tanks, or another OEC Unit. The Maintenance VRU [vapor recovery unit] diaphragm pump and vacuum pump would then be used to evacuate and compress most of the remaining pentane vapors, returning the pentane liquid to the other sections of the OEC Unit, the pentane storage tanks, or another OEC Unit. As with the integrated VRUs, this maintenance VRU not only assists with emissions control, but with returning a raw material back to the system to help reduce operating costs.

The Applicant designs its geothermal facilities to minimize the need to conduct hot work on the motive fluid system due to the inherent safety issues, including an elevated risk of fire and explosion hazards due to the potential for fugitive motive fluid leaks to ignite (see N-pentane Fire Suppression discussion below). All of the system components are proposed to be welded based on standard design, with the exception of the proposed use of flanges for major maintenance access points for pumps, turbines, and the main control valves. Flanges are proposed for the major access points in order to conduct safe maintenance that does not involve hot work. For example, pipeline runs, elbows, transitions, and other minor access points would be welded, while major access points such as valves, pumps, turbines, and main control valves would be flanged in case they would ever need to be replaced and instrumentation would need to be threaded to allow for calibration and/or replacement.

Pages 2-44 and 2-45 of the Final EIS/EIR:

N-pentane Fire Suppression

Bulk quantities n-pentane would be stored in pressure vessels and bulk storage containers on the power plant site. Numerous engineering, fire-control, and safety measures would be integrated into the Project to prevent releases of n-pentane, prevent fires, and to respond to and control fires and other emergencies. Some of the fire prevention, detection, and control systems that would be included in the design of the CD-IV plant include the following:

1. Safeguards inherent to the design of the power plant would include relief valves, manual and automatic shutoffs, interlocks, vents, and check valves.
2. MPLP [Mammoth Pacific L.P.] would revise its Emergency Response Plan and Risk Management Plan/California Accidental Release Prevention Plan (RMP/CalARP) programs at the existing Casa Diablo facilities to incorporate the CD-IV plant. MPLP staff would continue to receive training on these emergency response programs to help become aware of hazards, prevent incidents, and what to do if an emergency incident should occur.
3. The fire and n-pentane detection systems, as well as fire-fighting system, would comply with National Fire Protection Association standards.
4. Normal pentane-specific vapor sensors and flame detectors would be placed at strategic locations around the turbine, motive fluid pumps, and motive fluid storage tank and these would be connected to the power plant computer control system to quickly alert the plant operators to any such potentially hazardous situations. The existing control room itself would not need to be modified, but there would be new controls and monitors for the new plant.
5. An automatic water deluge sprinkler system would be installed on the n-pentane storage vessels (which contain n-pentane in liquid phase) that would automatically activate when a flame detector is activated to cool and protect the vessels.
6. Water nozzles/monitors would be placed at the power plant site to be used to minimize the risk of a fire spreading should one start within the power plant. ORNI 50 would not install or use an automated system because of the operator discretion required to prevent the spread of a flammable liquid fire.
7. For fires involving leaks of flammable gases such as n-pentane, many experts agree that the best method of extinguishment is to isolate the source of the fuel. Refer to the following excerpt from a Material Safety Data Sheet (MSDS) for n-pentane:

The only safe way to extinguish an n-pentane fire is to stop the flow. Cylinders exposed to fire may rupture with violent force. Keep cylinders cool by applying water from a maximum possible distance with a water spray. Avoid spreading burning liquid with water used for cooling.

Therefore, automatic fire suppression systems on equipment containing n-pentane would not be used. Instead, manual and automatic shutoffs, interlocks, vents, and check valves, would be the first line of prevention and defense in the event of a fire emergency.

8. All manned/occupied and electrical buildings would have an approved automatic fire suppression system as required by code. The electrical systems would utilize an FM-200® waterless fire suppression system.
9. The water-based fire protection system would include a new fire water storage tank (approximately 340,000 gallons) and a diesel-powered (approximately 400 brake horsepower) fire water pump. Geothermal fluid would be the source of water stored in the fire water storage tank.
10. Fire suppression equipment and tools at the site would include the fire suppression system noted above, fire extinguishers, tools, and mobile equipment.

11. To prevent worker injury due to the hazards associated with “hot work,” all work on the motive fluid system that would include cutting, welding, and brazing would be conducted pursuant to ORNI 50 LLC’s Hot Work Procedure No. SMP 10 (Mammoth Pacific L.P., 2018).

Page 2-51 of the Final EIS/EIR:

2.2.9 Project Design Measures for Environmental Protection

Air Quality

1. *AQ-1:* ORNI 50, LLC will apply water during the construction and utilization of pads and access roads as necessary to control dust. Dust will not be discharged into the air for a period or periods aggregating more than three minutes in any one-hour that is as dark or darker in shade as that designated as No. 1 on the Ringelmann Chart.
2. *AQ-2:* ORNI 50, LLC will also comply with any requirements prescribed by the Great Basin Unified Air Pollution Control District (GBUAPCD) concerning emissions of air pollutants from construction engines or hydrogen sulfide from operating geothermal wells. The drilling rigs will be registered in the CARB Portable Engine Registration Program.
3. *AQ-3:* ORNI 50, LLC will utilize best available equipment and design to minimize emissions of n-pentane. This will include the use of Best Available Control Technology (BACT) as required by GBUAPCD Rule 209-A to limit emissions of n-pentane.
4. *AQ-4:* ORNI 50, LLC will apply for an air permit to construct and operate the wells and power plant. The Project will conform to GBUAPCD requirements for controlling emissions.

Pages 2-54 and 2-53 of the Final EIS/EIR:

2.2.10 Mitigation Measures

Mitigation Measure AQ-6: Implementation of Enhanced Leak Detection and Repair (LDAR) Program. ORNI 50, LLC shall obtain a portable Volatile Organic Compound (VOC) leak detector capable of meeting the performance specifications described in USEPA’s ~~Source Test Reference Method 21~~. This instrument shall be properly maintained, calibrated, and made readily available at all times on the property site. Inspections utilizing the instrument shall be used at least conducted at a minimum on a monthly basis to assist ORNI 50, LLC personnel in detecting n-pentane leaks from all flanges, valves, pump seals, safety relief valves, n-pentane accumulator vessels, and turbine gland seals, and other fugitive components. In addition to a USEPA Method 21 portable analyzer, monthly inspections shall include the use of a held infrared camera and visual inspection and observation. Pumps shall be visually inspected weekly. Whenever a leak is detected that is greater than 10,000 ppmv—2,000 ppmv for pumps or 500 ppmv for valves, pressure relief valves, flanges, n-pentane accumulator vessels, turbine gland seals, and all other fugitive components from any aforementioned equipment, ORNI 50, LLC shall initiate repairs as soon as practical possible. Once a leak is discovered, ORNI 50,

LLC shall tag and log its location, record the leak concentration, record the date, and record the dates of each repair attempt. Minimization of a leak shall occur as soon as possible and no later than 24 hours after the leak discovery. Repair of a leak shall occur as soon as possible and no later than 7 days after the leak discovery. A report that includes the six-month average daily emission calculations and n-pentane purchases shall be submitted electronically to the GBUAPCD within 30 days from the end of each calendar quarter. A summary record of the leak repairs made shall also be submitted to the GBUAPCD when reporting n-pentane losses.

The following references have been added to pages 10-2 and 10-3 of the Final EIS/EIR Chapter 10, References:

Chapter 2, References

Mammoth Pacific, L.P., 2018. Hot Work Procedure, Procedure No. SMP 10. Revision Date: 9/8/2018.

U.S. Environmental Protection Agency (USEPA), 2007. Leak Detection and Repair, A Best Practices Guide. October 2007.

USEPA, 2017. Method 21 – Determination of Volatile Organic Compound Leaks. Obtained online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_21.pdf.

CHAPTER 3

Feasibility and Analysis of Suggested Mitigation Measures

As discussed in Chapter 1, the Court of Appeal’s decision identified two potential and additional mitigation measures to address fugitive n-pentane emissions from the plant: (1) a stronger LDAR program, and (2) the additional use of leakless or low-leak technology. The Court found that all other challenged aspects of the 2013 Final EIS/EIR were sufficient.

In such an instance, the CEQA Guidelines provide that Lead Agencies “need not expand the scope of analysis on remand beyond that specified by the Court” [CEQA Guidelines Section 15234(d)]. Accordingly, this Chapter is specific to analyzing the suggested mitigation measures for operational fugitive ROG emissions only. Persons wishing to view the complete text from the 2013 Final EIS/EIR may do so at these locations:

On line at:

<https://gbuapcd.org/cd4>

By appointment, at the:

Great Basin Unified Air Pollution Control District
157 Short Street
Bishop, CA 93514-3537

Please contact GBUAPCD at 760-872-8211 or at permits@gbuapcd.org to schedule an appointment.

3.1 Introduction

Under California Public Resources Code Sections 21002 and 21801, public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects. The term “feasible” is defined in CEQA Guideline Section 15364 as “capable of being accomplished in a successful manner within a reasonable period of time, taking into account the economic, environmental, legal, social, and technological factors.” See also Public Resources Code Section 21061.1. If any suggested mitigation is found to be infeasible the lead agency must explain why and support that determination with substantial evidence, presented in its findings and a statement of overriding considerations (CEQA Guidelines Sections 15091 and 15093). The suggested mitigation measures analyzed in the following sections were proposed by petitioners in original comments to the 2012 Draft EIS/EIR and during the Court’s proceeding. This Chapter summarizes an analysis of the feasibility of the suggested mitigation measures. Additional detail

regarding the feasibility of measures is provided in Appendix B. The measures are discussed based on the following two categories: 1) enhanced leak detection and repair procedures; and 2) leakless and/or low-leak technology.

Where implementation of the petitioner suggested mitigation measures was included as part of the Project previously, clarification to that effect has been provided in Chapter 2.

3.2 Enhanced Leak Detection and Repair Procedures

3.2.1 Description

Comment Letter I9 on the Draft EIS/EIR suggested that the Project adopt the USEPA's Method 21 VOC leak detection methodology and USEPA's leak detection and repair (LDAR) Method 21 regulations for petroleum refineries and chemical manufacturing facilities (Final EIS/EIR Appendix G, Comments I9-32 and I9-172). The USEPA LDAR best practices guidance (USEPA, 2007) was used in preparation of the Final EIS/EIR to develop Mitigation Measure AQ-6 (2013 Final EIS/EIR, Chapter 2). Consistent with USEPA guidance, in the 2013 Final EIS/EIR Mitigation Measure AQ-6 originally specified that repairs be implemented on a leak greater than 10,000 parts per million, volume (ppmv) and that monitoring for leaks should be conducted on a quarterly basis.

3.2.2 Feasibility, Analysis, and Conclusions

The USEPA LDAR best practices guidance (USEPA, 2007) is feasible for use on the Project and was used in determining appropriate mitigation measures proposed within the 2013 Final EIS/EIR. The guidance states that typical refinery or chemical plants can emit 600 to 700 tons per year of volatile organic compounds (also referred to as ROG) from leaking equipment, thus LDAR programs are implemented to control emissions to the extent possible. For comparison, the Project has calculated an estimated fugitive ROG leak rate of 410 pounds per day, which equates to about 74 tons per year. Although voluntary, the USEPA specifies additional practices that can be taken to improve leak detection monitoring reliability including:

Use of a lower than required leak definition. Leak concentration thresholds ("leak definitions") for VOCs in the federal standards range from 500 to 10,000 ppmv. As defined in USEPA's BACT for Fugitive Emissions of Hydrocarbons, a leak is an emission of VOCs that measures at least 10,000 ppmv, and a leak repair is defined as a concentration measured as 1,000 ppmv or lower (USEPA, 2016). Lower leak definition thresholds of 500 ppmv or lower are typically associated with emissions of HAPs at facilities subject to National Emission Standards for Hazardous Air Pollutants (USEPA, 2007). The Bay Area Air Quality Management District (BAAQMD) and the South Coast Air Quality Management District (SCAQMD) have promulgated leak definitions as low as 100 ppmv for some equipment (valves and connections) located at petroleum refineries and chemical plants. Additionally, some BACT determinations for reducing fugitive emissions of organic compounds at major stationary sources of VOCs have also set BACT to include a leak definition threshold of 100 ppmv (see Appendix B, Section 2.2.1).

More frequent monitoring than required. LDAR work practices generally stipulate a monitoring frequency specific to component type (valves, etc.) and service (gas/vapor, light liquid or heavy liquid). For example, rather than monitoring quarterly, some refineries monitor monthly.

Established Quality Assurance/Quality Control procedures. Several refineries have initiated a program to ensure the accuracy and completeness of the monitoring results submitted by the monitoring team (in-house or contractor).

In addition to voluntary practices, some federal settlements (consent decrees) have stipulated “enhanced LDAR program” or “ELP” requirements for certain defendants, including owners and operators of petroleum refineries or chemical plants (see Appendix B, Section 2.2.1). Elements of ELP work practices have included, for example:

- Reduced leak definition thresholds for certain equipment – e.g., from 10,000 ppm to 500 ppm for valves;
- Increased leak survey frequencies – e.g., monthly;
- Implement action levels below leak definition thresholds triggering repair;
- Tightened schedules for “first attempt at repair” and final repair of leaking equipment;
- Repair verification monitoring;
- Limited delay of repair; and
- Internal or third-party audits of LDAR program.

Best practices for first attempts at repair for valves include (see Appendix B, Section 4.6):

- 1) Tightening of bonnet bolts;
- 2) Replacement of bonnet bolts;
- 3) Tightening of packing gland nuts; and
- 4) Injection of lubricant into lubricated packing.

Other best practices describe employee programs and attitudes that would not be subject to analysis. Further investigation of lowering the required leak definition revealed that this process is generally applied to equipment that does not meet performance criteria (40 CFR Section 63.180) and is subject to the Hazardous Organic National Emission Standards for Hazardous Air Pollutants (USEPA, 2007). According to the Clean Air Act Section 112(b), Hazardous Air Pollutants, n-pentane is not listed or considered a HAP. The USEPA has identified HAPs as pollutants known to cause cancer and other serious health impacts, such as reproductive effects or birth defects, or adverse environmental effects. Therefore, n-pentane is not considered by the federal government to cause cancer or serious illness. The Project requires the use of BACT and thus would not use equipment that does not meet performance criteria. Future treatment of equipment that may eventually incur wear and tear would be addressed with an approved emission management plan, as required by and detailed in the 2013 Final EIS/EIR Mitigation Measure AQ-5.

Evidence was provided by petitioners that for refineries, a quarterly monitoring program with leak rate of 10,000 ppmv will reduce emissions by 70 percent, while a leak rate of 500 ppmv with monthly monitoring will reduce emissions by 95 percent. The USEPA best practices guide presents a table (Table 4.1 Control Effectiveness for an LDAR Program at a Chemical Process Unit and a Refinery) that summarizes control effectiveness for different parts of a refinery and reports a monthly monitoring program with a leak rate of 10,000 ppmv can reduce emissions by 76 percent, when referring to liquids, and 88 percent when referring to gas, and a program with a leak rate of 500 ppmv can reduce emissions by 95 percent when referring to liquids, and 96 percent for when referring to gas (USEPA, 2007). Based on these USEPA data, leak definitions lower than 500 ppmv do not achieve substantially greater emission reductions.

Because n-pentane is not a listed HAP or a regulated air toxic compound and the Project is not a major stationary source of VOC as defined in 40 CFR section 52.21, an independent engineering review of the Project found that an enhanced LDAR program more stringent than the most rigorous USEPA New Source Performance Standards required for new chemical and natural gas processing plants is neither reasonable nor warranted for the Project (see Appendix B, Section 4.6). Nonetheless, a more stringent LDAR program is potentially feasible. Mitigation Measure AQ-6 has been revised from the 2013 Final EIS/EIR to include increased inspection frequency, lower leak definition threshold, and more stringent leak minimization and repair requirements.

Table 3-1 describes the technical feasibility of the suggested enhanced LDAR procedures as they relate to the Project, and includes analysis and conclusions of the effects that implementation of the measures would have on the ROG emissions estimate and impact findings of the Final EIS/EIR.

TABLE 3-1
TECHNICAL FEASIBILITY OF ENHANCED LEAK DETECTION AND REPAIR PROCEDURES

No.	Suggested Measure	Feasibility/Analysis	Conclusion
1	Implement USEPA's leak detection and repair (LDAR) regulations for petroleum refineries and chemical manufacturing facilities following the USEPA's Leak Detection and Repair Compliance Assistance Guidance - A Best Practices Guide (USEPA, 2007).	Feasible. It is feasible for the Project to be operated with procedures that meet or exceed USEPA LDAR guidance including more frequent inspections, lower leak definition threshold, and more stringent repair requirements.	The Project would follow the USEPA LDAR guidance. Mitigation Measure AQ-6 has been revised to include LDAR requirements that meet or exceed USEPA LDAR guidance. Implementation of more stringent LDAR practices has the potential to reduce fugitive ROG emissions associated with the Project.
2	Monitor for fugitive reactive organic gas (ROG) leaks with a USEPA Method 21 portable analyzer.	Feasible. Inspections utilizing a USEPA Method 21 portable analyzer were required per Mitigation Measure AQ-6 in the 2013 Final EIS/EIR. In addition to the portable analyzer, it is feasible to inspect the plant with a hand held infrared camera for leak checks.	Mitigation Measure AQ-6 has been revised to require use of a hand held infrared camera in addition to a USEPA Method 21 portable analyzer. There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.

TABLE 3-1 (CONTINUED)
TECHNICAL FEASIBILITY OF ENHANCED LEAK DETECTION AND REPAIR PROCEDURES

No.	Suggested Measure	Feasibility/Analysis	Conclusion
3	A lower maximum leak definition threshold of 100 ppmv should be established for all fugitive components.	Partially Feasible. It is feasible for the Project to include a leak rate definition of 500 ppmv for valves, pressure relief valves, flanges, n-pentane accumulator vessels, turbine gland seals, and all other fugitive components in the motive fluid system (Appendix B). This is a substantial reduction compared to the 10,000 ppmv leak definition threshold identified in the 2013 Final EIS/EIR, but is greater than the suggested leak rate definition of 100 ppmv. The USEPA best practices guide presents a table (Table 4.1 Control Effectiveness for an LDAR Program at a Chemical Process Unit and a Refinery) that summarizes control effectiveness for different parts of a refinery and reports a monthly monitoring program with a leak rate of 10,000 ppmv can reduce emissions by 76 percent, when referring to liquids, and 88 percent when referring to gas, and a program with a leak rate of 500 ppmv can reduce emissions by 95 percent when referring to liquids, and 96 percent for when referring to gas (USEPA, 2007). Based on these data, leak definitions for the subject components of less than 500 ppmv would not achieve substantially greater emission reductions.	Mitigation Measure AQ-6 has been revised to define the leak rate definition as 500 ppmv for valves, pressure relief valves, flanges, n-pentane accumulator vessels, turbine gland seals, and all other fugitive components. This leak rate threshold is generally consistent with the most stringent federal CAA standards for equipment leaks (Appendix B). Implementation of a lower leak definition has the potential to reduce fugitive ROG emissions associated with the Project. Further reduction of the leak definition threshold below 500 ppmv would not substantially reduce emissions.
4	A higher leak rate for pumps, no higher than the 500 ppmv as specified in BAAQMD Rule 8-18, can be used if accompanied by an analysis demonstrating that 100 ppmv is not technologically feasible or cost effective in the subject applications.	Partially Feasible. It is feasible for the Project to include a leak rate definition of 2,000 ppmv for pumps in the motive fluid system (Appendix B). This is a substantial reduction compared to the 10,000 ppmv leak definition threshold identified in the 2013 Final EIS/EIR, but is greater than the suggested leak rate definition of 100 ppmv or 500 ppmv. The USEPA best practices guide presents a table (Table 4.1 Control Effectiveness for an LDAR Program at a Chemical Process Unit and a Refinery) that summarizes control effectiveness for different parts of a refinery and reports a monthly monitoring program with a leak rate of 10,000 ppmv can reduce emissions by 76 percent, when referring to liquids, and 88 percent when referring to gas, and a program with a leak rate of 500 ppmv can reduce emissions by 95 percent when referring to liquids, and 96 percent for when referring to gas (USEPA, 2007). Based on these data, leak definitions for pumps of less than 2,000 ppmv would not achieve substantially greater emission reductions.	Mitigation Measure AQ-6 has been revised to define the leak rate threshold to 2,000 ppmv for pumps in the motive fluid system. This leak rate threshold is generally consistent with the most stringent federal CAA standards for equipment leaks (Appendix B). Implementation of a lower leak definition has the potential to reduce fugitive ROG emissions associated with the Project. Further reduction of the leak definition threshold below 2,000 ppmv would not substantially reduce emissions.
5	Leak rates are to be enforced by conducting quarterly inspections.	Feasible. Quarterly inspections were required per Mitigation Measure AQ-6 in the 2013 Final EIS/EIR. More frequent monthly inspections are feasible.	Mitigation Measure AQ-6 has been revised to require monthly inspections. Implementation of more frequent inspections has the potential to reduce fugitive ROG emissions associated with the Project.

TABLE 3-1 (CONTINUED)
TECHNICAL FEASIBILITY OF ENHANCED LEAK DETECTION AND REPAIR PROCEDURES

No.	Suggested Measure	Feasibility/Analysis	Conclusion
6	Minimization of a detected leak shall occur within 24 hours and repair within 7 days.	Feasible. The 2013 Final EIS/EIR Mitigation Measure AQ-6 stated repairs should be initiated as soon as possible. More specific and more stringent minimization and repair timelines are feasible (Appendix B).	Mitigation Measure AQ-6 has been revised to state minimization of a leak shall occur as soon as possible and no later than 24 hours after the leak discovery. Repair of a leak shall occur as soon as possible and no later than 7 days after the leak discovery. Implementation of more stringent leak repair timelines has the potential to reduce fugitive ROG emissions associated with the Project.

3.3 Leakless and Low-leak Technology

3.3.1 Description

Comment letter I9 on the Draft EIS/EIR suggested that the Project adopt leakless and/or low-leak technology. Leakless technology involves welded connections that do not leak. Low-leak technology includes bellows and diaphragm valves, double seal pumps with or without barrier fluid, diaphragm pumps, canned motor pumps, and magnetic drive pumps. These pieces of equipment have been demonstrated to have low fugitive emission leak rates. Petitioners' experts also recommended the use of graphite-packed control valves and hermetically sealed valves and flanges, which are also examples of low-leak equipment.

3.3.2 Feasibility, Analysis, and Conclusions

Leakless technology is feasible for the majority of the Project and is proposed to be implemented; however, it would not be feasible for certain equipment to have welded connections, and not all low-leak equipment would be feasible and/or applicable to the Project. BACT is required for the Project and due to quality improvements, in some cases the equipment selected would exceed the capabilities of leakless or low-leak technology.

Table 3-2 describes the technical feasibility of the suggested leakless and low-leak technology as they relate to the Project, and includes analysis of the effects that implementation of the measures would have on the ROG emissions estimate and impact findings of the Final EIS/EIR.

TABLE 3-2
TECHNICAL FEASIBILITY OF LEAKLESS AND LOW-LEAK TECHNOLOGY

No.	Suggested Measure	Feasibility/Analysis	Conclusion
1	Use leakless technology for all equipment components that could result in fugitive leaks of the motive fluid n-pentane (e.g., welded connections). For example, screwed or threaded flanges should not be used.	Not Feasible for the entire system. All of the system components are proposed to be welded based on standard design, with the exception of the proposed use of flanges for major maintenance access points for pumps, turbines, and major control valves. Flanges are proposed for the major access points in order to conduct safe maintenance; welded valves are not easily maintained without full evacuation (i.e., completely drained) of the n-pentane. Maintenance of leakless welded components at major access points would be less safe to remove and replace due to the “hot work” that would be required to maintain the valves. Hot work consists of cutting, welding, and brazing. Threaded connections are proposed only for small bore piping. Ormat designs its geothermal facilities to minimize the need to conduct hot work on the motive fluid system and has hot work procedures in place (Mammoth Pacific, L.P., 2018, Procedure No. SMP 10, <i>Hot Work Procedure</i>). Prior to conducting any hot work on the motive fluid systems, the system must be rendered gas free. The only hot work that would be needed on the proposed motive systems would be very infrequent and would occur near flange connections for maintenance access. The reason why not all components are proposed to be welded is because hot work poses a safety issue associated with elevated risk of fire and explosion hazards due to the potential for motive fluid leaks. In addition, removing a welded valve for maintenance involves more risk for n-pentane leaks than from a leaking flange.	Implementation of leakless technology has been incorporated into the Project to the greatest extent feasible and the Project Description has been revised to clarify its use of leakless technology (see Chapter 2). This results in no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
2	Project Design Measure AQ-3 should be revised to specifically refer to “BACT as required by GBUAPCD Rule 209-A Section D (for new stationary sources of emissions which would result in a net increase in emissions of 250 or more pounds/day)” instead of “best available equipment and design” for which no legal definition exists.”	Feasible. Implementation of BACT is required by GBUAPCD regulations. Per GBUAPCD Rule 209-A, <i>Standards for Authorities to Construct</i>, BACT is required for facilities with the potential to emit pollutants in excess of listed threshold amounts. For volatile organic compounds (VOCs), an ozone precursor similar to reactive organic gases (ROG), the threshold is 250 pounds per day. The estimated maximum emissions of the Project are approximately 410 pounds per day triggering the requirement for BACT. Per GBUAPCD Rule 209-A, BACT is defined as: Best Available Control Technology (BACT) means for any source the more stringent of: - The most effective emissions control technique which has been achieved in practice, for such category or class of source; or - Any other emissions control technique found, after public hearing, by the Air Pollution Control Officer or the Air Resources Board to be technologically feasible and cost/effective for such class or category of sources or for a specific source; or - The most effective emission limitation which the EPA certifies is contained in the implementation plan of any State approved under the Clean Air Act for such class or category or source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable. In no event shall the emission rate reflected by the control technique or limitation exceed the amount allowable under applicable new source performance standards.	For clarity, Project Design Measure AQ-3 has been revised to acknowledge the Project requires BACT per GBUAPCD Rule 209-A to limit emissions of n-pentane. This results in no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.

TABLE 3-2 (CONTINUED)
TECHNICAL FEASIBILITY OF LEAKLESS AND LOW-LEAK TECHNOLOGY

No.	Suggested Measure	Feasibility/Analysis	Conclusion
3	Provide a top-down analysis of control efficiencies for vapor recovery devices and revise the BACT determination accordingly.	Feasible. GBUAPCD will complete a BACT analysis as part of its permitting processes for the Project.	GBUAPCD would complete a BACT analysis as part of its permitting processes for the Project if it is approved. This results in no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
4	Use leakless valves, i.e., bellows valves and diaphragm valves.	Not Feasible/Not Applicable. Diaphragm valves are not as reliable and have a much shorter service life than the metal valves currently used. The control valves utilized in the Project design have superior operation for motive fluid application than bellows-sealed valves and diaphragm valves. The proposed control valves are quarter turn valves that isolate better (bellows-sealed valves are not applicable). Diaphragm valves can fail more readily than the proposed control valves. Also, diaphragm valves are usually used for granular solids and viscous flows and are not applicable to a motive fluid system. In addition, an independent review of specifications for diaphragm valves found none that meet the pressure and temperature specifications required for the Project, and that they are not available in the sizes needed for the Project (see Appendix B, Section 4.4). Bellows-sealed valves are not suitable for the project. Similar to diaphragm valves, it is Ormat's experience that they have a tendency to fail and are more complicated. These are often used for hazardous materials applications. In addition, the size of valves used for the motive fluid system are larger than available standard bellows-sealed valves. Also, linear sliding stem globe and gate valves, the only available type of valve for which bellows are designed, are not technically suited for motive fluid flow control while minimizing pressure drop of the system. Bellows-sealed valves can only be used in linear designs and cannot be used in rotational valves required for the Project (see Appendix B, Section 4.4).	No changes to the Project. There would be no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
5	Use low-leak dual seals for pumps with or without barrier fluid.	Feasible. The proposed process cycle pumps would have a double mechanical seal with API Plan 52 unpressurized barrier oil, with pressure and level leak detection instrumentation. Turbines are proposed to have double mechanical seal with API Plan 53B pressurized barrier oil with pressure and level leak detection instrumentation (Swagelok, 2020).	Already proposed as part of the Project. The Project Description has been revised to clarify its use of low-leak dual seals for pumps (see Chapter 2). There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.

TABLE 3-2 (CONTINUED)
TECHNICAL FEASIBILITY OF LEAKLESS AND LOW-LEAK TECHNOLOGY

No.	Suggested Measure	Feasibility/Analysis	Conclusion
6	Use low-leak diaphragm pumps.	Feasible for very limited use on small transfer pumps. Not feasible for meeting the continuous high-rate flow required for circulation of the motive fluid. Ormat uses some diaphragm pumps on smaller applications. But the pressures required for the large cycle motive fluid pumps makes use of diaphragm pumps infeasible due to pressure limitations. Maximum flow for a diaphragm pump is 280 gallons per minute (gpm), with a maximum operating pressure of 100 pounds per square inch (psi). See diaphragm pump data sheet (Sandpiper, 2017). This flow rate and maximum pressure are not applicable for Ormat's motive fluid system. Note that Ormat considers the operating pressure of the proposed motive fluid system to be proprietary information and confidential. The diaphragm itself on this pump can leak, it cannot offer steady flow, the pump does not fit to several working points and makes control on the work point difficult. This pump type has difficulty with in parallel/column connections.	Already proposed as part of the Project. The Project Description has been revised to clarify its use of low-leak diaphragm pumps for small transfer pump applications with maximum flow of 280 gpm and maximum operating pressure of 100 psi (see Chapter 2). There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
7	Use low-leak canned motor pumps.	Feasible for very limited use. Not feasible for large capacity continuous duty cycle pumps. Ormat uses canned motor pumps where feasible on smaller applications. But the flow and pressures required for the large cycle motive fluid pumps makes use of canned motor pumps infeasible due to pressure limitations. Maximum flow for a canned motor pump is 423 gpm, with a maximum operating pressure is 17 psi (Star Pump Alliance, 2020). This flow rate and maximum pressure are not applicable for Ormat's motive fluid system. Note that Ormat considers the operating pressure of the proposed motive fluid system to be proprietary information and confidential. In addition, independent research of canned motor pumps manufactured in the U.S. or U.K. was unable to identify a design capacity sufficient to meet the size, gallons per minute, and "head" capacity required for the motive liquid feed pumps (see Appendix B, Section 4.4).	Already proposed as part of the Project. The Project Description has been revised to clarify its use of low-leak canned pumps for small transfer pump applications with maximum operating pressure of 17 psi (see Chapter 2). There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
8	Use low-leak magnetic drive pumps.	Not Feasible. Not feasible for large capacity continuous duty cycle pumps. Unavailable in the capacity requirements for the cycle pumps. It is Ormat's experience that motors are not reliable and have more failures than the API Plan 52 pumps they are using. Each failure results in a large leak compared to the operation with the API Plan 52 pumps that have a double mechanical seal with API Plan 52 unpressurized barrier oil, with pressure and level leak detection instrumentation (Ormat, 2016). In addition, independent research of magnetic drive pumps manufactured in the U.S. or U.K. was unable to identify a design capacity sufficient to meet the size, gallons per minute, and "head" capacity required for the motive liquid feed pumps (see Appendix B, Section 4.4).	No changes to the Project. There would be no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.

TABLE 3-2 (CONTINUED)
TECHNICAL FEASIBILITY OF LEAKLESS AND LOW-LEAK TECHNOLOGY

No.	Suggested Measure	Feasibility/Analysis	Conclusion
9	Use low-leak graphite-packed control valves.	Feasible. Ormat uses graphite packing with API 600 Trim 8 configuration for all its manual valves.	Already proposed as part of the Project. The Project Description has been revised to clarify its use of low-leak graphite-packed control valves (see Chapter 2). There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
10	Use low-leak hermetically sealed valves and flanges.	Not Feasible/Not Applicable. See bellows valves, above	No changes to the Project. There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.
11	Use low-leak double mechanical pump seals with barrier fluid. Use low-leak magnetically coupled pumps. Use low-leak magnetic fluid sealing technology for pumps.	Feasible. See dual seals for pumps with or without barrier fluid, above	
14	Use low-leak gas seal systems for pumps vented to a thermal oxidizer or other approved control device (such as vapor recovery units).	Not Feasible. Based on Ormat's experience with its existing geothermal plants, vent gas systems are less reliable and introduce more potential leak points than the proposed pumps with double mechanical seals with barrier fluid.	No changes to the Project. There is no change to the Final EIS/EIR fugitive n-pentane emission estimates or conclusions.

3.4 References

- Ormat, 2016. Plan 52 (FM/ATEX) Flanged, Drawing Number 0.002.46.523.0. Approved March 27, 2016.
- Mammoth Pacific, L.P., 2018. Hot Work Procedure, Procedure No. SMP 10. Revision Date: 9/8/2018.
- Sandpiper, 2017. 3” Sandpiper non-metallic AODD Ball Valve Pump, Class Leading Performance, Easiest to Maintain, 2017.
- SLR International Corporation (SLR), 2020. Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies, prepared for the Great Basin Unified Air Pollution Control District. July 2020.
- Star Pump Alliance, 2020. Canned motor pumps – function, advantages, and applications, 2020.
- Swagelok, 2020. API Plan 53B Barrier Fluid Pressurized by Bladder Accumulator. Obtained online on April 30, 2020, at: <https://www.swagelok.com/en/services/design-assembly/mechanical-seal-support-systems/between-seal-planassemblies/api-plan-53b>.
- U.S. Environmental Protection Agency (USEPA), 2007. Leak Detection and Repair, A Best Practices Guide. October 2007.
- U.S. Environmental Protection Agency (USEPA), 2016. New Source Review (NSR) Archives, BACT for Fugitive Emissions of Hydrocarbons 8.10, last updated February 21, 2016. Obtained online at: https://archive.epa.gov/airquality/ttnnsr01/web/html/p8_10.html.
- U.S. Environmental Protection Agency (USEPA), 2017. Method 21 – Determination of Volatile Organic Compound Leaks. Obtained online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_21.pdf.

This page intentionally left blank

CHAPTER 4

Revised Responses to Comments

4.1 Introduction

Comment letter I9 submitted by the California Unions for Reliable Energy (CURE) is included in Appendix G of the 2013 Final EIS/EIR. The specific comments from Comment letter I9 relevant to the scope of this Draft SEIR (Comments I9-32, I9-170, I9-171, and I9-172) have been repeated (shown in italics) in this section for the reader's convenience. Each comment is followed by the response with revisions indicating additions as underlined and deletions as ~~crossed out~~.

4.2 Revised Response to Comment Letter from CURE

Comment I9-32:

Reactive Organic Gas ("ROG") emissions are almost exclusively related to fugitive emissions of the motive fluid, n-pentane, at the binary power plant. The Applicant estimates the Project will result in 410.0 lb/day and 74.8 tons/year ROG from fugitive n-pentane emissions, in exceedance of the applicable CEQA thresholds.¹⁸⁷

The draft EIS/EIR claims that the Project

[i]s proposed to include state of the art equipment and best available technology that would limit fugitive ROG (i.e., n-pentane) emissions and that no additional feasible mitigation measures are available to further substantially reduce fugitive ROG emissions, and the CD-IV Project would result in a significant and unavoidable impact related to long-term fugitive emissions of n-pentane.¹⁸⁸

Dr. Pless recommends including in a revised draft EIS/EIR additional and/or more stringent, existing, feasible best available control technology for operational emissions of ROG.¹⁸⁹

¹⁸⁷ *Id.*, at Tables 4.2-4 and 4.2-5, p. 4.2-12.

¹⁸⁸ *Id.*, at p. 4.2-11 (emphasis added).

¹⁸⁹ Pless Comments, p. 12.

Feasible mitigation exists to reduce the Project's significant ROG emissions. Pless recommends incorporating leakless technology for motive fluid systems.¹⁹⁰ Pless notes that the Applicant's proposed use of screwed or threaded, flanges will result in leakage no matter how carefully executed while welded connections on the other hand do not (unless defective). Thus, welded connections would eliminate 100% of the emissions.¹⁹¹ Leakless equipment

technology is routinely used and required for construction of new or modified existing refineries and chemical facilities and is equally feasible for the Project.¹⁹²

Pless also shows that additional and/or more stringent mitigation measures for the leak detection and repair program are feasible. While the Applicant's proposed BACT measure for equipment leaks includes the "placement of pentane specific vapor sensors at strategic locations", as well as "leak checks, inspections, monitoring, and leak logging," Pless finds those measures inadequate to address smaller and slow leaks and therefore not BACT for the Project.¹⁹³ Instead, Pless recommends the USEPA's leak detection and repair ("LDAR") regulations for petroleum refineries and chemical manufacturing facilities. The implementation of LDAR is feasible, as it incorporates the elements of the proposed inspection program with additions, such as quantification of fugitive ROG leaks with a portable analyzer.¹⁹⁴

A revised draft EIS/EIR should include a mitigation measure requirement to use leakless components for all equipment components that could result in fugitive leaks of the motive fluid n-pentane as well as a mitigation measure that includes the use of LDAR following the USEPA's Best Practices Guide¹⁹⁵

¹⁹⁰ *Id.* at p. 13.

¹⁹¹ *Ibid.*

¹⁹² *Id.*

¹⁹³ *Id.* at p. 14.

¹⁹⁴ *Ibid.*

¹⁹⁵ *Id.*, see also; USEPA, *Leak Detection and Repair Compliance Assistance Guidance, A Best Practice Guide (Attachment P)*.

19-32 Response:

The commenter indicates that there are feasible mitigation measures available to reduce fugitive n-pentane emissions beyond the best available technology proposed for the CD-IV Project. The commenter also lists the Applicant's proposed emission reduction concepts and technologies. This comment is noted.

The commenter indicates that the CD-IV Project's motive fluid system should use leakless technology to avoid fugitive emissions of n-pentane. The proposed motive fluid system does include ~~limited~~ leakless technology, including welded connections ~~wherever to the greatest extent feasible and practical~~ (Ormat 2013). All of the system components are proposed to be welded based on standard design, with the exception of the proposed use of flanges for major maintenance access points for pumps, turbines, and the main control valves. Flanges are proposed for the major access points in order to conduct safe maintenance. For example, pipeline runs, elbows, transitions, and other minor access points would be welded. Leakless technology would not be feasible or practicable for some components of the motive fluid system. For example, while major access points such as valves, pumps, turbines, and main control valves would be flanged in case they would ever need to be replaced and instrumentation would need to be threaded to allow for calibration and/or replacement.

Maintenance at major access points requiring the removal and replacement of leakless welded components would be less safe because it would require relatively frequent "hot work" on the

motive fluid system that would consist of cutting, welding, and brazing. The Applicant designs its geothermal facilities to minimize the need to conduct hot work on the motive fluid system due to the inherent safety issues, including elevated risk of fire and explosion hazards due to the potential for motive fluid leaks to ignite. When hot work is required, the Applicant has specific procedures in place to reduce the fire and explosion risks to the extent achievable, including purging (i.e., draining) all n-pentane from the fluid motive system (Mammoth Pacific L.P., 2018). In addition, because of these safety procedures, removing a welded component for maintenance involves a greater potential for n-pentane leaks than from a leaking flange because a small amount of non-condensed n-pentane vapors would be discharged to the atmosphere during the purge. The only hot work that would be needed for the proposed motive fluid systems would be very infrequent and would occur near flange connections for maintenance access. This information has been added to the Project Description to include a discussion of hot work, and its inherent hazards (see Draft SEIR Section 2). Based on these issues, it would not be feasible for components at major access points of the motive fluid system to be welded.

In addition to welding components to control leaks, bellows and diaphragm valves are used in some hazardous materials applications to control leaks. In a bellows valve, a welded seal divides the lower half of the valve, where the system flow media resides, from the upper parts of the valve, where actuation is initiated; the stem, which is entirely encased in a metal bellows, moves up and down without rotating, sealing over the inlet (Adkins, 2011). By contrast, diaphragm valves each contain a thin plastic or metal diaphragm that flexes up and down to create a leak-tight seal over the inlet (Id.). Either type can be a good choice depending on the specific circumstances when the seal to atmosphere is critical and access for maintenance is limited; however, neither is the best choice for the Project (ORNI 50 LLC, 2020). Ormat's experience, including five decades of operation of more than 150 geothermal plants with more than 2,100 MW of geothermal capacity, informs the Applicant's determination that diaphragm valves are not as reliable and have much shorter service life than the metal valves proposed for the Project. Diaphragm valves can fail more readily than the proposed control valves and are usually used for granular solids or viscous flows (Ormat, 2019). Thus, diaphragm valves are not applicable to a motive fluid system. Similarly to diaphragm valves, it is the Applicant's experience that bellows valves have a tendency to fail and are more complicated to operate. The control valves the Applicant uses operate more reliably and are better suited than bellows and diaphragm valves for the motive fluid application.

An independent review of specifications for diaphragm valves found that none meet the pressure and temperature specifications required for the Project, and that they are not available in the sizes needed for the Project (see Appendix B, Section 4.3). Also, linear sliding stem globe and gate valves, the only available type of valve for which bellows are available, are not technically suited for motive fluid flow control while minimizing pressure drop of the system. Bellows sealed valves can only be used in linear designs and cannot be used in rotational valves required for the Project (see Appendix B, Section 4.4). Therefore, bellows valves and diaphragm valves are not feasible or applicable to the Project. The proposed control valves are quarter turn valves that more efficiently isolate the motive fluid. Information has been added to the Project Description to include a discussion of the proposed valve types (see Draft SEIR Section 2).

The Project would also include the use of dual seal pumps to control ROG leaks. Process cycle pumps proposed for the Project would have a double mechanical seal with API Plan 52 technology for unpressurized barrier oil and pressure and level leak detection instrumentation (Ormat, 2016). Turbines are proposed to have a double mechanical seal with API Plan 53B pressurized barrier oil technology also with pressure and level leak detection instrumentation (Swagelok, 2020). Discussion of the proposed process cycle pumps types has been added to the Project Description (see Draft SEIR Section 2).

Use of diaphragm and canned pumps are also options to control pump leaks in some circumstances; however, these pumps are not feasible for the continuously operating large cycle pumps that would be required for the Project due to very limited capacity and/or operating pressure limits. The Applicant does propose to use diaphragm and/or canned pumps for some of the smaller applications, but the pressures required for the large cycle motive fluid pumps makes use of these pumps infeasible for that application. Maximum flow for a diaphragm pump is 280 gallons per minute (gpm), with a maximum operating pressure of 100 psi (Sandpiper, 2017). Maximum flow for a canned motor pump is 423 gpm, with a maximum operating pressure of 17 psi (Star Pump Alliance, 2020). The Applicant considers the operating pressure of its proposed motive fluid system to be proprietary information and a confidential trade secret, but has demonstrated to GBUAPCD that the maximum flow rates and pressures of available diaphragm and canned pumps are insufficient for incorporation into the Applicant's motive fluid system.¹ In addition, the diaphragm portion of diaphragm pumps can leak, it cannot offer steady flow, the pump does not fit to several working points, and it makes control on the work point difficult. In the Applicant's experience, this pump type also has difficulty with in parallel/column connections which would be needed for the Project. Discussion of the proposed diaphragm and canned pumps for some of the smaller applications has been added to the Project Description (see Draft SEIR Section 2).

Magnetic drive pumps can also reduce pump leaks; however, these pumps are not technologically feasible for large capacity continuous duty cycle pumps and are unavailable in the capacity requirements for the cycle pumps needed for the Project. It is Applicant's experience that the motors on magnetic drive pumps are not reliable and have more failures than the API Plan 52 pumps proposed for the Project. Any failure of a magnetic drive pump would result in a large ROG leak compared to operations of the proposed API Plan 52 pumps. Use of gas seal systems for pumps vented to a thermal oxidizer or other approved control device (such as vapor recovery units) can also be effective in reducing leaks for some industrial chemical applications; however, based on the Applicant's previous experience at more than 150 geothermal plants, vent gas systems are less reliable and introduce more potential leak points than the proposed pumps with double mechanical seals with barrier fluid, and are therefore not a practicable option for the Project.

The Project would include the use of graphite-packed control valves with API 600 Trim 8 configuration for all its manual valves to control ROG leaks (Werner Sölken, 2020). Discussion

¹ Public Resources Code Section 21160 provides CEQA lead agencies with broad authority to require applicants to provide information necessary to evaluate the significance of potential adverse environmental impacts of the projects they propose. If trade secrets (as defined in Government Code Section 6254.7) are needed to accomplish this task, then they must be submitted to the lead agency. However, the lead agency is precluded from disclosing the trade secrets in an EIR or otherwise as part of the public record (Public Resources Code Section 21160; 14 Cal. Code Regs. Section 15120(d)).

of the proposed graphite-packed control valves has been added to the Project Description (see Draft SEIR Section 2).

The commenter also indicates that the Draft EIS/EIR should be revised to require USEPA leak detection and repair methods. The Permit to Operate would include monitoring requirements per USEPA regulatory methods, including ~~Reference~~ Method 21 (USEPA, 2017). The exact terms and conditions of the Permit to Operate the plant would not be identified until after Project approval; therefore, it is appropriate for the EIS/EIR to identify binding mitigation that will be consistent with the requirements of the permit to ensure that leak detection monitoring is conducted per USEPA methods. Mitigation Measure AQ-6 has been added to Section 4.2.9, *Mitigation Measures*, on Draft EIS/EIR page 4.2-20 (see Response I9-172 for new Mitigation Measure AQ-6) and includes additional requirements, which meet or exceed USEPA leak detection and repair (LDAR) guidelines. The revisions to Mitigation Measure AQ-6 include a requirement for monthly inspections utilizing a USEPA Method 21 portable analyzer and the use of a handheld infrared camera, implementation of a leak definition of 2,000 ppmv for pumps and 500 ppmv for valves, pressure relief valves, flanges, n-pentane accumulator vessels, turbine gland seals, and all other fugitive components, and specific leak minimization and repair timelines. These leak rate definitions are generally consistent with the most stringent federal CAA standards for equipment leaks (Appendix B). For leak minimization and repair timelines, AQ-6 has been revised to require that minimization of a leak shall occur as soon as possible and no later than 24 hours after the leak discovery and repair of a leak shall occur as soon as possible and no later than 7 days after the leak discovery.

The fugitive emissions from the Project as mitigated are comparatively small when compared to the emissions of greenhouse gas (GHG) forming compounds from conventional coal-fired or natural gas power plants. The emission savings and corresponding environmental benefits from a geothermal renewable energy facility should be balanced against the fugitive emissions, showing the net benefits of the Project on air quality and climate change. By using a geothermal reservoir as its energy source, the Project eliminates air emissions that would be produced by a traditional fossil fuel fired power plant. An equivalent natural gas power plant (33 MW) would produce an estimated 130,000 metric tons per year of direct GHG emissions in the form of carbon dioxide emissions, as well as other air pollutants, for the same amount of power generated by the Project. A similar-sized coal-fired power plant (33 MW) would produce an estimated 260,000 metric tons per year of direct GHG emissions in the form of carbon dioxide (BlueSkyModel, 2020).

Comment I9-170:

Leakless Technology for Motive Fluid System

An additional technology available to reduce fugitive emissions of n-pentane from equipment leaks is the use of leakless technology for the Project's motive fluid system. Pipes, valves, pumps and other equipment are commonly connected using flanges that are welded or screwed. Here, it appears that the Applicant proposes to use screwed, or threaded, flanges.⁴⁰ Threaded flanges leak, no matter how carefully executed; welded connections on the other hand do not (unless defective) and, thus, eliminate 100% of the emissions. Thus, reducing the number of valves, flanges and connectors, while undoubtedly effective, as proposed, is only the first step in reducing fugitive equipment leaks. Instead, BACT for the Project's motive fluid system is the use of leakless equipment components, a technology that is routinely required for construction of new or modification of existing refineries and chemical facilities and equally feasible here. The Draft EIS/EIR should be revised to require the use of leakless components for all equipment components that could result in fugitive leaks of the motive fluid n-pentane. Further Project Design Measure AQ-3 should be revised to specifically refer

to "BACT as required by GBUAPCD Rule 209-A, Section D (for new stationary sources of emissions which would result in a net increase in emissions of 250 or more lb/day of any air pollutant or precursor except for CO and particulate matter)" instead of "best available equipment and design" for which no legal definition exists.

⁴⁰ Ibid, Attachment "Typical 36MW Air Cooled Ormat Binary Power Plant, Emissions calc" dated May 1, 2012: "Flanges, Connectors [sic], Screwed.

I9-170 Response:

The commenter indicates that the CD-IV Project's motive fluid system should use leakless technology to avoid fugitive emissions of n-pentane. The proposed motive fluid system does include limited leakless technology, including welded connections wherever feasible and practical (ORNI 50, LLC, 2013). The use of leakless components for all equipment components that could result in fugitive leaks of the motive fluid n-pentane is not feasible due to safety concerns regarding hot work which are discussed in detail in the previous response. See Response I9-32, for details.

In addition, EIS/EIR Project Design Measure AQ-3 (as set forth in 2013 Final EIR Section 2.2.9, p. 2-51) has been revised for clarity, as shown below.

AQ-3: ORNI 50, LLC will utilize best available equipment and design to minimize emissions of n-pentane. This will include the use of Best Available Control Technology (BACT) as required by GBUAPCD Rule 209-A to limit emissions of n-pentane. ~~For example, pipeline runs, elbows, and transitions would be welded. Leakless technology would not be feasible or practicable for some components of the motive fluid system. For example, valves would be flanged in case they would ever need to be replaced and instrumentation would need to be threaded to allow for calibration and/or replacement.~~

Comment I9-171:

Vapor Recovery Unit Control Efficiency

The Applicant proposes a 99% control efficiency as BACT for the vapor recovery devices. Yet, the Draft EIR states that "other facilities similar to what is proposed for the CD-IV Project have demonstrated better than 99.6 percent efficiency in controlling and recovering n-pentane emissions during normal operations,"⁴¹ Thus, it appears that BACT, as demonstrated in practice, is 99.6% rather than 99% control efficiency. The Draft EIR (and the ATC Application to the GBUAPCD) should provide a top-down analysis of control efficiency for vapor recovery devices and revise the BACT determination accordingly.

⁴¹ Draft EIS/R, p. 4.2-12, emphasis added.

I9-171 Response:

It appears that the commenter is referencing the second bullet of the proposed BACT technologies shown in Comment I9-169; however, that bullet is in reference to proposed vapor

recovery devices that are estimated to return at least 99 percent of the motive fluid back to the system. Therefore, the 99 percent is a reference to the efficiency of returning motive fluid back to the system, which is not a direct reference to the efficiency of controlling and recovering n-pentane emissions. GBUAPCD will complete a BACT analysis as part of its permit to construct and operate processes for the Project if it is approved.

Comment I9-172:

Leak Detection and Repair Program

The Applicant's proposed BACT measures for equipment leaks include the "placement of pentane-specific vapor sensors at strategic locations" as well as "leak checks, inspections, monitoring, and leak logging." While the proposed measures may prevent help prevent significant leaks, they are not adequate to address smaller and slow leaks and do not constitute BACT for the Project. The USEPA has developed leak detection and repair ("LDAR") regulations for petroleum refineries and chemical manufacturing facilities. Implementation of an LDAR program is equally feasible for the Project's motive fluid system. LDAR incorporates the elements of the proposed inspection program but goes further. For example, it requires quantification of fugitive ROG leaks with a portable analyzer (per USEPA Reference Method 21). The Draft EIR should be revised to require as a mitigation measure the use of LDAR following USEPA's Best Practices Guide.⁴²

⁴² USEPA, *Leak Detection and Repair Compliance Assistance Guidance, A Best Practices Guide*; <http://www.epa.gov/compliance/resources/publications/assistance/ldarguide.pdf>.

I9-172 Response:

The commenter indicates that the Draft EIS/EIR should be revised to require USEPA leak detection and repair methods. The Permit to Operate would include monitoring requirements per USEPA regulatory methods, including ~~Reference~~ Method 21. The exact terms and conditions of the Permit to Operate the plant would not be identified until after Project approval; therefore, it is appropriate for the EIS/EIR to identify binding mitigation that will be consistent with the requirements of the permit to ensure that leak detection monitoring is conducted per USEPA methods, including monitoring for fugitive ROG leaks with a portable analyzer. Mitigation Measure AQ-6 has been added to Section 4.2.9, *Mitigation Measures*, on Draft EIS/EIR page 4.2-20 as follows. Refer to Response I9-32 for additional details.

Mitigation Measure AQ-6: Implementation of Enhanced Leak Detection and Repair (LDAR) Program. ORNI 50, LLC shall obtain a portable Volatile Organic Compound (VOC) leak detector capable of meeting the performance specifications described in USEPA's ~~Source Test Reference~~ Method 21. This instrument shall be properly maintained, calibrated, and made readily available at all times on the property site. Inspections utilizing the instrument shall be used at least conducted at a minimum on a monthly basis to assist ORNI 50, LLC personnel in detecting n-pentane leaks from all flanges, valves, pump seals, safety relief valves, n-pentane accumulator vessels, and turbine gland seals, and other fugitive components. In addition to a USEPA Method 21 portable analyzer, monthly inspections shall include the use of a held infrared camera and visual inspection and observation. Pumps shall be visually inspected weekly. Whenever a

leak is detected that is greater than ~~10,000 ppmv~~ 2,000 ppmv for pumps or 500 ppmv for valves, pressure relief valves, flanges, n-pentane accumulator vessels, turbine gland seals, and all other fugitive components from any aforementioned equipment, ORNI 50, LLC shall initiate repairs as soon as ~~practical possible~~. Once a leak is discovered, ORNI 50, LLC shall tag and log its location, record the leak concentration, record the date, and record the dates of each repair attempt. Minimization of a leak shall occur as soon as possible and no later than 24 hours after the leak discovery. Repair of a leak shall occur as soon as possible and no later than 7 days after the leak discovery. A report that includes the six-month average daily emission calculations and n-pentane purchases shall be submitted electronically to the GBUAPCD within 30 days from the end of each calendar quarter. A summary record of the leak repairs made shall also be submitted to the GBUAPCD when reporting n-pentane losses.

The following references have been added to the Final EIS/EIR Chapter 10, References:

Chapter 10, References

- Adkins, 2011. Matching valve type to function: A tutorial in valve selection. Available online: <https://www.eng.ufl.edu/labsafety/wp-content/uploads/sites/28/2015/04/Valve-Selection.pdf>. June 2011.
- BlueSkyModel, 2020. “1 kilowatt-hour” webpage. Obtained online at: <https://blueskymodel.org/kilowatt-hour>. Accessed: August 10, 2020.
- Mammoth Pacific L.P., 2018. Hot Work Procedure, Procedure No. SMP 10, Revision Date: September 8, 2018.
- Ormat, 2016. Plan 52 (FM/ATEX) Flanged, Drawing Number 0.002.46.523.0. Approved March 27, 2016.
- Ormat, 2019. Geothermal Power. Available online: <https://www.ormat.com/en/renewables/geothermal/view/?ContentID=89>. Accessed April 30, 2020.
- ORNI 50 LLC, 2020. Technical Feasibility Checklist for Suggested Fugitive ROG Measures, Requests with Responses, April 15, 2020.
- Sandpiper, 2017, 3” Sandpiper non-metallic AODD Ball Valve Pump, Class Leading Performance, Easiest to Maintain, 2017.
- Star Pump Alliance, 2020. Canned motor pumps – function, advantages, and applications, 2020.
- Swagelok, 2020. API Plan 53B Barrier Fluid Pressurized by Bladder Accumulator. Obtained online on April 30, 2020, at: <https://www.swagelok.com/en/services/design-assembly/mechanical-seal-support-systems/between-seal-planassemblies/api-plan-53b>.
- U.S. Environmental Protection Agency (USEPA), 2007. Leak Detection and Repair, A Best Practices Guide. October 2007.

U.S. Environmental Protection Agency (USEPA), 2017. Method 21 – Determination of Volatile Organic Compound Leaks. Obtained online at: https://www.epa.gov/sites/production/files/2017-08/documents/method_21.pdf.

Werner Sölken, 2020. Valves Guide, Trim of Valves, API 600 Valve Trim No. Accessed on line at: http://www.wermac.org/valves/valves_general_trim.html, April 30, 2020.

This page intentionally left blank

CHAPTER 5

Report Preparation

5.1 Lead Agency

Great Basin Unified Air Pollution Control District

157 Short Street
Bishop, CA 93514-3537
(760) 872-8211

Phillip L. Kiddoo, Air Pollution Control Officer
Ann Logan, Deputy Air Pollution Control Officer
Luke Eisenhardt, Air Quality Specialist
Tom Schaniel, Air Quality Specialist

5.2 Environmental Consultant

Environmental Science Associates (ESA)

1425 McDowell Boulevard, Suite 200
Petaluma, California 94954
(707) 795-0900

Janna Scott, Project Director
Michael Manka, Project Manager
Jessica O'Dell, Deputy Project Manager
Matthew Fagundes, Air Quality Specialist
Shannon Bottenberg, Senior Environmental Planner

5.3 Recipients of the Draft SEIR

Great Basin Unified Air Pollution Control District

Phillip L. Kiddoo
Ann Logan
Luke Eisenhardt
Tom Schaniel

Ormat Inc.

Melissa Wendt

Federal Agencies

Name/Contact	Agency/Organization
Dale Johnson	Bureau of Land Management- Bishop
Erin Noesser	U.S. Forest Service

State Agencies

Name/Contact	Agency/Organization
Morgan, Scott	State Clearinghouse
Earl Whithycombe	California Air Resources Board
Gavin McCreary, Project Manager, Site Evaluation and Remediation Unit	Department of Toxic Substances Control
Nancy Gonzalez-Lopez, Staff Services Analyst	Native American Heritage Commission

Local Agencies

Name/Contact	Agency/Organization
Betty Hylton	Mammoth Community Water District
Mark Busby	Mammoth Community Water District
Stephanie Hake	Mammoth Community Water District
Jeff Fitzsimmons, PG Engineering Geologist; and Tom Browne, PhD, PE Water Resources Control Engineer	Lahontan Regional Water Quality Control Board
Gerry Le Francois, Executive Director	Mono County Local Agency Formation Commission
Wendy Sugimura (Community Development Department)	Mono County
Schreeneen Dedman	Mono County
Shannon Kendall	Mono County Clerk-Recorder
Darcy Ellis	Inyo County
John Carl Vallejo	Inyo County Counsel
Grace Chuchla	Inyo County Counsel
Sandra Moberly (Community and Economic Development Director)	Town of Mammoth Lakes
Fred Stump	GBUAPCD Governing Board
Matt Kingsley	GBUAPCD Governing Board
Ron Hames	GBUAPCD Governing Board
John Peters	GBUAPCD Governing Board
Arrash Agahi	Los Angeles Department of Water and Power
Lizbeth Calderon	Los Angeles Department of Water and Power
Clint Kautsky	Los Angeles Department of Water and Power
Jevon Lam	Los Angeles Department of Water and Power
Julie Marte	Los Angeles Department of Water and Power
Roderick Tashima	Los Angeles Department of Water and Power

Local Agencies

Name/Contact	Agency/Organization
Michael Tsai	Los Angeles Department of Water and Power
Jaime Valenzuela	Los Angeles Department of Water and Power

Tribal Governments

Name/Contact	Agency/Organization
Cindy Duriscoe	Big Pine Paiute Tribe
Mel Joseph	Lone Pine Paiute Shoshone Reservation
Sally Manning	Big Pine Paiute Tribe

Notices of the Availability of the Draft SEIR also were provided to the following organizations and individuals:

Name/Contact	Agency/Organization
	Mammoth Lakes Library
Rhonda Duggan	
Ceal Klingler	
Andre Long	
Liz O'Sullivan	
Ronald Ward	Rio Tinto Minerals
Sheila Sannadan	Adams Broadwell Joseph & Cardozo
Rebecca Davis	Lozeau Drury
Stacey Osborne	Lozeau Drury
Komalpreet Toor	Lozeau Drury
Sheila Sannadan	Adams Broadwell Joseph & Cardozo

This page intentionally left blank

APPENDIX A

Scoping Summary

1. Introduction

The Great Basin Unified Air Pollution Control District (GBUAPCD) formally began the process of determining the scope of issues to be evaluated in the Supplemental Environmental Impact Report (SEIR) (a process called “scoping”) when it issued a Notice of Preparation (NOP) of an SEIR for the Casa Diablo IV Geothermal Power Plant Project (Project) on February 26, 2020.

The NOP initiated agency consultation about the scope and content of information to be analyzed in the SEIR and invited early public input about potential environmental concerns (Pub. Res. Code Section 21080.4(a); CEQA Guidelines Sections 15082(b), 15083). CEQA Guidelines Section 15083 provides that a “Lead Agency may...consult directly with any person...it believes will be concerned with the environmental effects of the project.” Scoping is the process of early consultation with the affected agencies and public prior to completion of a Draft SEIR. Section 15083(a) states that scoping can be “helpful to agencies in identifying the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in an EIR and in eliminating from detailed study issues found not to be important.” Scoping is an effective way to bring together and consider the concerns of affected State, regional, and local agencies, the project proponent, and other interested persons (CEQA Guidelines Section 15083(b)).

This Scoping Summary provides an overview summarizes the comments provided by agencies during the 30-day scoping period, which closed on March 27, 2020. The GBUAPCD will use scoping comments as a tool to ensure the preparation of a comprehensive SEIR tailored to agency concerns. Under CEQA Guidelines Section 15234(d), which defines the scope of what a Lead Agency is to consider in the event of a remand, the analysis of all potential environmental effects of the Project will not be revisited in the SEIR. Instead, the SEIR will inform the public and local officials in the planning and decision-making process regarding two potential and additional mitigation to address fugitive n-pentane emissions from the plant: (1) a stronger leak detection and repair (LDAR) program, and (2) the additional use of leakless or low-leak technology. Therefore, pursuant to CEQA Guidelines Section 15082, all public comments that address these issues will be considered in the SEIR process.¹

¹ Comments not within the scope of CEQA will not be addressed through the CEQA process.

2. Scoping Comments

The GBUAPCD received four sets of comments during the public comment period, and one set of comments after the public comment period concluded. Copies of the comments are provided as attachments to this Scoping Summary. Commenting parties are listed in **Table 1** and summaries of the issues identified by the commenters are provided in Section 2.1, *Issues to be Considered in the SEIR Under CEQA*, and Section 2.2, *Issues Not Analyzed in the SEIR Under CEQA*.

TABLE 1
PARTIES THAT SUBMITTED SCOPING COMMENTS

Agency/Group	Name, Title	Received Date
Department of Toxic Substances Control, Site Mitigation and Restoration Program	Gavin McCreary, Project Manager, Site Evaluation and Remediation Unit	April 16, 2020
Lahontan Regional Water Quality Control Board	Jeff Fitzsimmons, PG Engineering Geologist; and Tom Browne, PhD, PE Water Resources Control Engineer	March 27, 2020
Mono County Local Agency Formation Commission	Gerry Le Francois, Executive Director	March 26, 2020
Native American Heritage Commission	Nancy Gonzalez-Lopez, Staff Services Analyst	February 26, 2020
Town of Mammoth Lakes, Community and Economic Development Department, Planning Division	Gina Montecallo, Assistant Planner	March 27, 2020

2.1 Issues to be Considered in the SEIR under CEQA

Issues that were identified by the Lahontan Regional Water Quality Control Board (LRWQCB) and the Town of Mammoth Lakes, Community and Economic Development Department, Planning Division that will be considered in the SEIR under CEQA are described below.

Lahontan Regional Water Quality Control Board

The LRWQCB requested that the SEIR identify and list the specific mitigation measures that will be implemented to prevent leaks of the working fluid to the environment. The mitigation measures should include procedures to identify and quantify n-pentane losses from the process, including both vapor and aqueous phase.

Response to Comment:

The SEIR identifies and evaluates the feasibility of specific mitigation measures identified in the Court of Appeal's decision that may reduce or prevent fugitive leaks of the working fluid in its vapor phase to the environment. Analysis of leaks in the aqueous phase into the environment is outside the scope of the SEIR.

Town of Mammoth Lakes, Community and Economic Development Department, Planning Division

The Town of Mammoth Lakes, Community and Economic Development Department, Planning Division requested that the SEIR demonstrate the effectiveness of the proposed mitigation measures for reducing the Project's fugitive ROG emissions.

Response to Comment:

The SEIR presents, discusses, and analyzes the feasibility of specific mitigation measures for reducing the Project's fugitive ROG emissions, including their effectiveness.

2.2 Issues Not Analyzed in the SEIR under CEQA

Per the Court of Appeal's directives, the SEIR addresses two potential and additional mitigation to address fugitive n-pentane emissions from the plant: (1) a stronger leak detection and repair (LDAR) program, and (2) the additional use of leakless or low-leak technology. The following agency comments that do not address these issues are considered to be outside the scope of the SEIR, and will not be considered in the SEIR process. Issues outside the SEIR scope and included in this summary are acknowledged so that they may be considered as part of non-CEQA decision-making process.

Department of Toxic Substances Control, Site Mitigation and Restoration Program

The Department of Toxic Substance Control (DTSC) recommended that a number of issues related to hazards and hazardous materials be addressed in the SEIR, including:

- The potential for historic or future activities to release hazardous wastes/substances on the Project site;
- The need to collect soil samples for aerially deposited lead prior to performing any intrusive activities;
- Proper investigation for mine waste should be discussed;
- Surveys should be conducted for the presence of lead-based paints or products, mercury, asbestos containing materials, and polychlorinated biphenyl caulk;
- Sampling should be conducted to ensure that the imported soil is free of contamination; and
- Current and former agricultural lands should be evaluated in accordance with DTSC's 2008 Interim Guidance for Sampling Agricultural Properties (Third Revision).

Lahontan Regional Water Quality Control Board

The LRWQCB recommended that a number of issues related to contamination of geothermal resources and groundwater be addressed in the SEIR, including:

- The presence of isobutane in fumaroles and hot springs reported by Evans, et al (2004) in the Mammoth Geothermal Complex area must be considered in the environmental analysis, particularly the fate and transport of working fluids in the subsurface.
- The SEIR must identify and list the specific mitigation measures that will be implemented to prevent leaks of the working fluid to the environment. The mitigation measures should include a monitoring program to monitor the geothermal resource for n-pentane pre- and post-injection; and a monitoring program that includes an adequate number of groundwater monitoring wells to ensure the earliest detections of n-pentane in the shallow water aquifer.
- The SEIR must identify all potential working fluids that may be used for the Casa Diablo IV Project and include an analysis of the potential impacts and hazards that these working fluids pose to all environment resources. Mitigation measures must be included in the SEIR to reduce all potential impacts to a less than significant level.
- Water Board staff request the opportunity to review and approve any contingency plans that address the containment and cleanup of any spills and/or discharges to the ground, surface water, and/or groundwater, as these spills and/or discharges have the potential to impact water quality.

Mono County Local Agency Formation Commission

Mono County Local Agency Formation Commission commented that if use of reclaimed water is considered in the future, the approval of using reclaimed water being supplied by the Mono County Water District outside of their district boundary would require Local Agency Formation Commission approval.

Native American Heritage Commission

The Native American Heritage Commission provided comments that summarized CEQA and NEPA legal requirements relative to tribal cultural resources and consultations, including compliance with Assembly Bill 52 and Senate Bill 18.

Town of Mammoth Lakes, Community and Economic Development Department, Planning Division

The Town of Mammoth Lakes, Community and Economic Development Department, Planning Division requested that the SEIR address:

- Analysis of exposed pipes for the event of a pipe break or crack that could cause super-heated steam or liquid to escape.
- Analysis of options that limit the time period between drilling, construction, and up until capping of the well head so that emissions are minimized.
- List all potential emissions associated with geothermal areas.

3. Consideration of Issues Raised in Scoping Process

A primary purpose of this Scoping Summary is to document the process of soliciting and identifying comments from agencies and the public. The scoping process provides the means to determine those issues that interested participants consider to be the principal areas for study and analysis. Every issue that has been raised during scoping that falls within the scope of this SEIR and CEQA as discussed above, will be addressed and/or be considered in the SEIR. Issues raised that fall outside the scope of this SEIR are acknowledged and included in this summary so that they may be considered as part of the non-CEQA decision-making processes.

APPENDIX B

Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies

This page intentionally left blank

CASA DIABLO IV GEOTHERMAL PROJECT

Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies

Directed to:

Ann Logan, Great Basin Unified Air Pollution Control District

July 2020



Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies

Directed to:

Ann Logan
Great Basin Unified Air Pollution Control District

This document has been prepared by SLR International Corporation (SLR). The material and data in this report were prepared under the supervision and direction of the undersigned.



Kenneth A. Malmquist
Managing Principal Engineer

CONTENTS

ACRONYMS.....	1
SUMMARY	2
1. PROCESS AND EQUIPMENT DESCRIPTION	5
1.1 Binary Process Overview	5
1.2 Motive Fluid System Process Equipment Description	5
1.2.1 Rotating Equipment Seal Systems	5
1.2.2 Valves	6
1.2.3 Piping Connections	6
1.2.4 Pressure Relief Valves	6
1.2.5 Diaphragm Pumps.....	7
2. REVIEW OF STANDARDS AND PRACTICES FOR MINIMIZING EQUIPMENT LEAKS.....	8
2.1 Equipment Design Standards Review	8
2.1.1 API Design Standards	8
2.2 Regulatory Standards Review	11
2.2.1 Leak Detection and Repair	11
2.3 Alternative Design Practices Review	13
2.3.1 Rotary Valves Versus Sliding Stem Valves	13
2.3.2 Graphite Packing Systems.....	14
2.3.3 Sealless Centrifugal Pumps	14
2.3.4 Diaphragm Pumps.....	15
2.3.5 Diaphragm Valves	15
2.3.6 Bellows Valves	16
2.3.7 Leakless Versus Flanged Connections.....	17
3. Comparison of Proposed Process with Existing Binary Plants	19
4. FEASIBILITY ANALYSIS	20
4.1 Demonstration of Infeasibility of Sealless Centrifugal Pumps	20

4.2	Demonstration of Infeasibility of Diaphragm Pumps for Motive Fluid Circulation	21
4.3	Demonstration of Infeasibility of Diaphragm Valves	21
4.4	Demonstration of Infeasibility of Bellows Valves	22
4.4.1	Flow Control Valves	22
4.4.2	Manually Operated Gate Valves	22
4.5	Leakless Connections	23
4.6	Feasibility of Implementing More Stringent LDAR Work Practices	24
5.	CONCLUSIONS	26
6.	REFERENCES	27

APPENDICES

Appendix A Author's Resume

ACRONYMS

ANSI	American National Standards Institute, Inc.
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
C	Celsius (degrees)
CAA	Clean Air Act
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CMP	canned motor drive
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
F	Fahrenheit (degrees)
gpm	gallons per minute
HAP	hazardous air pollutant
hr	hour
IR	infrared
ISO	International Organization for Standardization
kg	kilogram
kPa	kilopascals
LDAR	leak detection and repair
MAWP	maximum allowable working pressure
MDP	magnetic drive pump
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
n-pentane	normal-pentane
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPS	nominal pipe size
NSPS	New Source Performance Standards
OEC	Ormat Energy Converter
OGI	optical gas imaging
PD	positive displacement
ppm	parts per million
ppmv	parts per million, volume basis
PRV	pressure relief valve
psi	pounds per square inch pressure
psig	pounds per square inch gauge pressure
ROG	reactive organic gases
SEIR	Supplemental Environmental Impact Report
SOCMI	synthetic organic chemical manufacturing industry
SV	screening value (ppmv)
TOC	total organic carbon
TOG	total organic gases
VHAP	volatile HAP
VOC	volatile organic compound

SUMMARY

Ormat Nevada Inc. (Ormat) proposes to build the Casa Diablo IV Geothermal Power Plant (Project) consisting of two Ormat Energy Converter (OEC) binary generating units. The Final Joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Project was certified by the Great Basin Unified Air Pollution Control District (GBUAPCD or “the District”) on July 18, 2014. The District is the lead agency. A Supplemental (SEIR) addressing additions and changes to the Final EIS/EIR will be considered for certification by the District. The SEIR is focused on the feasibility of implementing additional measures beyond Ormat’s standard process design, as generally described in the EIS/EIR, to mitigate fugitive emissions of “motive fluid” from pump seals, valves and other equipment composing the closed-loop motive fluid system within the OEC. Motive fluid will be composed of normal-pentane (n-pentane), a low-boiling point hydrocarbon (Great Basin Unified Air Pollution Control District, et al., 2013). The motive fluid is a regulated reactive organic gas (ROG) and volatile organic compound (VOC), but n-pentane is not classified as a regulated air toxic compound in California and is not classified as a hazardous air pollutant (HAP) under the federal Clean Air Act (CAA).

SLR International Corporation (SLR) was retained to evaluate the feasibility of implementing leakless and low-leak fugitive emissions mitigation measures as may be applicable to certain equipment within the motive fluid system. This report will supplement the SEIR for the Project to be considered for certification by the District.

SLR reviewed current codes, standards and specifications for design and best engineering practices pertaining to specific equipment used in the motive fluid system, primarily including rotating equipment (turbines and pumps) seal systems, rotational valves (ball valves and butterfly valves) and gate valves.

SLR reviewed the proposed motive fluid process design, as generally described in the EIS/EIR and based on detailed information provided by Ormat, including process flow diagrams and piping and instrumentation diagrams. SLR identified specific types of equipment included in Ormat’s design for the Project, including rotating equipment (turbines and centrifugal pumps), valves and connectors (screwed, flanged or welded). SLR then assessed engineering design measures already incorporated into Ormat’s standard design that are intended to reduce fugitive emissions from equipment failure and leaks. Finally, SLR evaluated the feasibility of implementing additional mitigation measures to further reduce fugitive emissions. Additional mitigation measures would include feasible measures not already included in the project design.

SLR found that Ormat’s standard design package includes reliable equipment meeting best engineering codes and standards to reduce the potential for equipment failure and leaks that would result in emissions of n-pentane. SLR also found that many of Ormat’s design measures that result in reduced fugitive emissions were not explicitly articulated in the final EIS/EIR. SLR has listed equipment used in Ormat’s standard engineering package intended to maximize reliability and mechanical integrity, while reducing the potential for leaks. The standard design package described in Section 1 provides the baseline for SLR’s review of the feasibility of implementing additional mitigation measures.

SLR's evaluation of mitigation measures focused on the feasibility of using certain so called "leakless" and "low-leak" technologies, including: "leakless" bellows valves and diaphragm valves; and "sealless" pumps, including diaphragm pumps, canned motor pumps (CMPs) and magnetic drive pumps (MDPs). SLR listed available fugitive emission mitigation technologies for each equipment type and application to the process and eliminated technically infeasible options. For example, some technologies are not suitable for certain process conditions such as high temperature, high flowrate or certain fluid types.

For turbine and centrifugal pump seal systems, which represent the highest potential for fugitive emissions of any equipment within the motive fluid system, SLR finds that the double mechanical seal and barrier fluid systems used by Ormat represent the best available technology for mitigating leaks. Sealless pumps such as magnetic drive and canned motor pumps are not available in the size and capacity needed and are therefore technically infeasible for the motive fluid system.

The motive fluid system design includes numerous quarter-turn rotational butterfly valves used for process flow control. Butterfly valves inherently have a low pressure drop across the valve. A low pressure drop is critical to avoid condensation of motive fluid to liquid before passing through the turbine. Furthermore, rotational butterfly valves inherently less subject to stem seal degradation than linear sliding stem control valve packing systems. We find that the rotational butterfly valves proposed by Ormat for motive fluid flow control meet API engineering standards and represent best engineering practice. Bellows sealed valves are designed exclusively for linear valve stem designs (globe valves and gate valves) and cannot be used for rotational valve designs such as butterfly valves and ball valves. Rotational butterfly valves achieve the required control valve function within the motive fluid process – tight flow control with minimum pressure drop. Linear sliding stem valves (globe valves and gate valves) and diaphragm valve designs do not meet the functional design of the motive fluid system and are not feasible.

Manual gate valves equipped with graphite packing will be used for process isolation to facilitate removal of critical equipment for replacement and repair. The gate valves are open during normal operations. In conjunction with butterfly valves, the gate valves provide a double block and bleed system during process isolation to eliminate or minimize leakage. Bellows are technically feasible for some gate valve applications and commercially available for some pipe sizes, but bellows gate valves are not available for all pipe sizes within the motive fluid system. In addition, we find that the additional measure of installing bellows-sealed gate valves does not reduce the potential for fugitive emissions beyond that achieved using graphite packing systems combined with routine leak detection and repair (LDAR) work practices. SLR finds that bellows sealed valves are not available in all of the sizes required for use in the motive fluid system and are not otherwise feasible for the isolation valves.

Ormat has to the greatest extent feasible used welded connections for piping and fittings and minimized flanged and screwed connectors in its process design. For technical and safety reasons, it is not possible to completely eliminate flanged and screwed connections. Some critical valves and components must be connected using flanges to facilitate safe and efficient removal for replacement or repair purposes. Equipment components installed using welded connections must be installed and removed for repair or replacement using "hot work," including cutting, welding, and brazing. Hot work on process components in n-pentane service poses an elevated risk of fire and explosion due to the potential for flammable motive fluid leaks. In addition, removing a welded valve for repair or replacement involves more risk for n-pentane leaks than from a flange. A flanged connection with properly selected and installed gasket

seals has a low potential for leaks. SLR finds that best engineering practices have been implemented to minimize potential leaks from flanges and connectors. Work practices to be implemented upon project startup, including an LDAR program, will mitigate leaks from flanged and screwed connections.

We find that it is feasible to implement an LDAR program with lower leak definition thresholds for valves, more frequent monitoring and tighter repair schedules than was proposed in the EIS/EIR.

Additional background and the results of SLR's review and conclusions are provided in the following sections. The author's curriculum vitae is provided as Appendix A.

1. PROCESS AND EQUIPMENT DESCRIPTION

This section provides a description of Ormat's proposed motive fluid system design, as generally described in the EIS/EIR (Great Basin Unified Air Pollution Control District, et al., 2013). The following description details measures to mitigate fugitive emissions from equipment leaks that are part of Ormat's standard design.

1.1 BINARY PROCESS OVERVIEW

Geothermal fluid is extracted from an underground reservoir and flows from the wellhead through pipelines to heat exchangers in the OEC. Inside the heat exchangers, the geothermal fluid heats and vaporizes a secondary organic "motive fluid" with a low boiling point. The motive fluid vapors drive turbines, which rotate generators to produce power. The vapors are then condensed to liquid phase in a condenser cooled by air. Condensed motive fluid (liquid phase) is recycled back into the heat exchangers by pumps, completing the cycle in a closed loop system. The cooled geothermal fluid is re-injected into the reservoir.

1.2 MOTIVE FLUID SYSTEM PROCESS EQUIPMENT DESCRIPTION

The motive fluid cycle is a closed loop system composed of steel piping, pressure vessels, shell and tube heat exchanger vessels, centrifugal pumps, valves, flanges and connectors, and turbines. Fugitive emissions of motive fluid may result from equipment leaks. Primary equipment proposed to be used in the motive fluid process that may potentially leak includes:

1. Rotating equipment seals (turbines and centrifugal pumps)
2. Butterfly flow control valves
3. Manual gate isolation valves
4. Flanged and screwed connections
5. Pressure relief devices

1.2.1 ROTATING EQUIPMENT SEAL SYSTEMS

Each turbine will be equipped with dual mechanical seals and pressurized barrier fluid systems meeting American Petroleum Institute (API) Standard 682 (API, 2014). The seal system design will meet API Std 682 Plan 53B standards for pressurized barrier system (closed circuit) for use in seal systems with high pressures and/or for hazardous or environmentally harmful processes. The seal and barrier fluid system will also be equipped with a sensor that will detect failure of the seal system, the barrier fluid system, or both.

Vertical centrifugal pumps will be used to pump condensed motive fluid (liquid phase) to the heat exchangers. The centrifugal pumps will each be equipped with dual mechanical seals and non-pressurized barrier/buffer fluid system conforming to API Std 682 Plan 52 (API, 2014).

1.2.2 VALVES

1.2.2.1 Control Valves

Flow control valves used in the motive fluid system will be quarter-turn rotary butterfly valves ranging from 8 to 20 inches nominal pipe size (NPS). Butterfly valves meet specifications set out in API Standard 609, including specifications for valve shaft seals (API, 2016). Quarter-turn butterfly valves will be used for on/off service, but will also function to regulate flow. One-quarter turn fully opens or closes the valves.

The proposed motive fluid system design includes two one-inch NPS ball valves meeting API Standard 608—Metal Ball Valves with Flanged, Threaded and Welding Ends (API, 2020) and API Standard 6D—Specification for Pipeline and Piping Valves (API, 2014).

1.2.2.2 Isolation Gate Valves

Manual gate valves will be used to safely isolate portions of the motive fluid system to facilitate maintenance, repair or replacement of process equipment components. Gate valves will be equipped with flexible graphite packing meeting API specifications to achieve low leak performance. The gate valves will meet specifications in API Standard 6D (API, 2014); API Standard 600 (API, 2014); API Standard 603 (API, 2018); and other referenced standards.

In conjunction with butterfly valves, the gate valves provide a double block and bleed system during maintenance to eliminate or minimize leakage during process isolation activities.

1.2.3 PIPING CONNECTIONS

Welded (“leakless”) connections will be used to the greatest extent possible to connect piping and certain fittings used in the motive fluid system.

Turbines, pumps, control valves, isolation valves and other equipment will be installed with flanged connections to enable safe removal for repair or replacement and minimize risk inherent to hot work necessary to remove equipment with welded connections. Flanged connections are sealed with gaskets or ring material as suitable for process conditions and meeting American Society of Mechanical Engineers (ASME) Standard Metallic Gaskets for Pipe Flanges (ASME, 2017).

Some smaller NPS pipe and instrumentation may be installed to piping and vessels using threaded connections.

1.2.4 PRESSURE RELIEF VALVES

Direct acting pressure relief valves (PRVs) conforming to specifications set out in API Standard 527 – Seat Tightness of Pressure Relief Valves (API, 2014) will be used for emergency pressure relief. For safety purposes PRVs must be configured to vent directly to atmosphere to relieve pressure in the event of an overpressure process condition, but the normal operating condition of each PRV is closed (sealed). To

minimize or eliminate leakage to atmosphere from each PRV seal during non-relief events, a rupture disk will be installed upstream of each PRV in n-pentane service. Each PRV and rupture disk will be equipped with a “tattle tale” pressure gauge to provide a visual indication of the integrity of the rupture disk. A pressure indication of the space between the PRV and rupture disk indicates a leak.

1.2.5 DIAPHRAGM PUMPS

Small, two- to three-inch NPS, portable pneumatic (air-driven) double diaphragm pumps will be used to drain and transfer motive fluid from isolated portions of the process to storage during maintenance, replacement and repair activities.

2. REVIEW OF STANDARDS AND PRACTICES FOR MINIMIZING EQUIPMENT LEAKS

Equipment is selected for any process design based on material and chemical considerations and best fit for the process, for example based on temperature, pressure, flow and duty. Once the equipment type is selected as appropriate for the functional requirements of the process design, the selection may be optimized to eliminate or reduce maintenance requirements and equipment leaks. Minimizing or eliminating leaks is desired for safety, environmental and economic reasons. In the case of motive fluid, n-pentane is costly. Some equipment leak mitigation measures may be required by regulation, but design according to codes and standards and following industry best practices ensures optimal performance and safety. This section provides a review of current equipment design codes and standards, regulatory standards for equipment leaks, and available alternative designs for leakless and low-leak equipment.

2.1 EQUIPMENT DESIGN STANDARDS REVIEW

ANSI, API, ASME, International Organization for Standardization (ISO), MSS and other organizations set standards for code development worldwide. Codes and standards are used to define systems, tests and equipment design, including standards relevant to rotating equipment seal systems, valves and other equipment. Manufacturers and process design engineers are not required by any rule or law to meet design standards, but adherence to API and other standards is the norm in petroleum and chemical processes when the highest quality is needed. Purchase of equipment by Ormat is based on specification sheets requiring adherence to these standards.

2.1.1 API DESIGN STANDARDS

API standards are used worldwide in petroleum and petrochemical industry sectors and are appropriate for application to the light hydrocarbon motive fluid (n-pentane) system. API standards are developed under API's American National Standards Institute (ANSI) accredited process, ensuring that the API standards are recognized not only for their technical rigor but also their third-party accreditation which facilitates acceptance by state, federal, and increasingly international regulators (API, 2020).

2.1.1.1 Rotating Equipment Seal Systems

Leaks from turbines and centrifugal pumps occur at the rotating shaft seal. Mechanical seal systems combined with barrier fluid systems prevent leaks of motive fluid from the rotating shaft. All shaft seals leak to some extent, but leaks are minimized by design using double mechanical seals with a suitable barrier fluid system such that the leaked fluid may be the barrier fluid instead of the process fluid. Ormat uses a heavy seal oil for barrier fluid.

API Standard 682 specifies requirements and gives recommendations for centrifugal and rotary pumps used in the petroleum, natural gas and chemical industries. Rotating shaft sealing systems conforming to API Standard 682 are intended to operate continuously for 25,000 hours without the need for

replacement while complying with either local emission regulations, or exhibiting a maximum leak screening value of 1,000 parts per million by volume (ppmv) as measured using EPA Method 21 (EPA, 2017), whichever is more stringent.

API Standard 682 includes standards for double (“dual” or “tandem”) mechanical seal systems. Laboratory testing and field evaluation have demonstrated that properly designed tandem mechanical seals can be used on light hydrocarbon pumps to maintain near zero emission levels (<50 ppm) (Key, Wang, & Lavelle, 1991). API Standard 682 includes specifications for dual mechanical seal systems with pressurized or unpressurized barrier fluid systems. EPA’s recommended best practices provides that leaks from pumps can also be reduced by using dual seals with or without barrier fluid (EPA, 2016).

2.1.1.2 Butterfly Valves

API Standard 609, Butterfly Valves: Double-flanged, Lug- and Wafer-type, provides specifications for butterfly valves, including shaft and seals (API, 2016). Ormat’s design includes butterfly valves meeting API Standard 609 specifications.

A key advantage of rotary-style control valves in managing fugitive emissions is the rotating motion of the valve stem as the valve is opened and closed. The stem stays within the stem seal or packing area, minimizing the possibility of introducing foreign particles or debris into the sealing interfaces. As a result, these valves are typically more effective in reducing the possibility of fugitive emissions leakage, and normally deliver greater reliability and operating efficiency from this perspective (Wing & Smith, 2012).

The butterfly valve consists of a flat, circular disk hinged in its center, which closes or fully opens with a quarter turn. Seating for the disk is supplied by metal seats or resilient types of material like elastomers and plastics. Because of the advances in seating material, butterfly valves have found general acceptance in the oil, gas, chemical, water, and process fields. The valve is often used in place of a gate valve, but has the added advantage of flow regulation (Emerson, 2017). The ASME B31. 1 code (ASME, 2018) lists three valves standards, excluding cast iron and bronze valves. The standards are: 1) ASME B16. 34, Valves—Flanged, Threaded, and Weld End (ASME, 2017); 2) Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS) SP-67-2017: Butterfly Valves (MSS, 2017) and MSS SP-68-2017: High Pressure Butterfly Valves with Offset Design (MSS, 2017).

2.1.1.3 Gate Valves

API Standard 600 Steel Gate Valves—Flanged and Butt-Welding Ends, Bolted Bonnets specifies packing material suitable for steam and petroleum fluids for temperature range from -29 °C to 538 °C (-20 °F to 1000 °F) (API, 2015).

Gate valves are used for on/off service and are designed to operate fully open or fully closed. Because of excessive vibration and wear created in partially-closed gates, the valves are not intended for throttling or flow regulation (Emerson, 2017). Gate valves are generally “multi-turn” valves, operated manually using a handwheel which moves a stem connected to a wedge or double disk upward or downward in a linear motion until the closure contact the valve seat.

As a consequence of physical wear due to linear stem motion and other physical or chemical degradation, external leaks (fugitive emissions) of process fluid may result by way of the stem/packing seals. Stem seals are composed of one- or two-piece packing material that encircles the stem. As the packing bolt is tightened down on the stem, the gasket is crushed, filling the space between the stem and the body housing. Packing materials are selected based on process fluid type and other process variables, primarily temperature and pressure. Graphite packing has been shown to meet stringent tightness class (≤ 200 ppm measured leakage) based on production testing using helium (ISO, 2015).

2.1.1.4 Ball Valves

Rotary ball valve contains a ball-shaped plug within a valve body which regulates flow. The ball has a circular hole or flow-way through its center and when turned one-quarter of the way, the flow stops. Ball valves dissipate relatively little flow stream energy due to streamlined internal contours and minimal turbulence. (Emerson, 2017). Ball valves have low pressure drop and can open and close quickly. Ball valves are best suited for on-off control and are not optimal for throttling control.

API specifications for ball valves include API Standard 608—Metal Ball Valves with Flanged, Threaded and Welding Ends (API, 2020) and API Specification 6D—Specification for Pipeline and Piping Valves (API, 2014). API Standard 608 specifies the requirements for metal ball valves suitable for petroleum, petrochemical and industrial applications that have butt-welding or flanged ends for NPS 1/2 through NPS 20 and threaded or socket-welding ends for NPS 1/4 through NPS 2, corresponding to the nominal pipe sizes in ASME B36.10M. The standard also applies to metal ball valves in pressure classes 150, 300, and 600 for flanged and butt-welding ends and in pressure classes 150, 300, 600, and 800 for socket-welding and threaded ends. API Specification 6D specifies requirements and provides recommendations for the design, manufacturing, testing, and documentation of ball, check, gate, and plug valves for application in pipeline systems meeting ISO 13623 or similar requirements for the petroleum and natural gas industries.

To minimize external leaks, the standards specify that materials for stem seals, body seals and gaskets must be suitable for use at the maximum operating temperature and corresponding maximum pressure rating of the valve as stated by the valve manufacturer. Metallic parts of any flange gasket must have corrosion resisting properties equal to or superior to the shell material.

2.1.1.5 Flanges and Gaskets

API Specification 6A specifies requirements for the performance, dimensional and functional interchangeability, design, materials, testing, inspection, welding, marking, handling, storing, shipment, purchasing, repair, and remanufacture of wellhead and tree equipment for use in the petroleum and natural gas industries (API, 2018). ASME B16.20 Metallic Gaskets for Pipe Flanges covers materials, dimensions, tolerances, and markings for metal ring-joint gaskets, spiral-wound metal gaskets, metal-jacketed gaskets, and grooved metal gaskets with covering layers. These gaskets are dimensionally suitable for use with flanges described in reference flange standards ASME B16.5, ASME B16.47, API Specification 6A, and ISO 10423 (ASM171). Gasket material for flanges is also addressed in API standards for valves, including for example API Standard 608 and 609. In accordance with API standards and

recommended practices and to minimize the potential for gasket failure and leaks, gasket materials are selected to suit process conditions, such as temperature, pressure, and chemical characteristics.

2.1.1.6 Pressure Relief Valves

PRVs are safety devices designed to protect a pressurized vessel, piping or equipment from an overpressure event that could cause the pressure to increase beyond the maximum allowable working pressure (MAWP). Since the normal operation condition for a PRV is closed, one important consideration is the valve's ability to maintain a tight seal. The valve part alignment and the selection of materials of construction all play a key role to meet industry seat leakage standards such as API Standard 527 – Seat Tightness of Pressure Relief Valves (API, 2014) which is often used for process PRVs built per ASME Section VIII. API Standard 527 requires the valve seat to be tested for tightness normally at 90 percent of the set pressure. The API standard acceptance criteria allows minor bubble leakage at this operating pressure but this allowed leakage is many orders of magnitude more stringent than required for other types of valves (Emerson, 2012).

PRVs may be used independently or in combination with rupture disks to provide the required protection against excessive pressure that may result in a catastrophic release. PRVs and rupture disk devices are designed to meet API Standard 520 (API, 2014), which references API Standard 527. API Standard 527 covers specifications for flanged steel pressure relief valves and provides basic requirements such as orifice designation and area, valve size, pressure rating, materials etc. for direct spring-loaded pressure relief valves and pilot-operated pressure relief valves.

2.2 REGULATORY STANDARDS REVIEW

Equipment leaks of VOC and hazardous air pollutants (HAP) are regulated by Federal CAA programs and state/local air quality regulations for certain source categories. ROG, as defined by the California Air Resources Board, are regulated in California. Both VOC and ROG include total organic gas (TOG) minus certain excluded compounds.¹ The n-pentane motive fluid is a light hydrocarbon classified as a VOC and a ROG, but that is not a listed air toxic or HAP.²

2.2.1 LEAK DETECTION AND REPAIR

Federal CAA program regulations, including New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and other rules, require implementation of LDAR programs for certain “affected facilities.”³ LDAR work practices are designed to reduce fugitive emission of regulated VOC or HAP by identifying and eliminating equipment leaks. In general,

¹ Volatile organic compounds (VOC) and reactive organic gases (ROG) each includes any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, and excluding certain listed compounds such as methane and ethane.

² Hazardous air pollutant means any air pollutant listed in or pursuant to section 112(b) of the Act. There are 187 listed hazardous air pollutants.

³ 40 C.F.R. Parts 60, 61, 63 and 65

“equipment” means pumps, compressors, pressure relief devices, sampling connection systems, open-ended valves or lines, valves, and flanges or other connectors “in VOC service,” “in volatile HAP (VHAP) service,” and any devices or systems otherwise regulated by a rule (subpart). LDAR programs require the use of portable instruments, optical gas imaging (OGI), or sensory methods (audible, visual, olfactory) to identify leaks based on a threshold established by the referencing standards. For instrument monitoring using EPA Method 21, regulatory leak thresholds are defined in terms of a ppmv concentration reading, total organic carbon (TOC) basis. Leak concentration thresholds (“leak definitions”) in the federal standards range from 500 to 10,000 ppmv TOC. The Bay Area Air Pollution Control District (BAAQMD) and the South Coast Air Pollution Control District (SCAQMD) have promulgated leak definitions as low as 100 ppmv for some equipment (valves and connections) located at petroleum refineries and chemical plants. Best available control technology (BACT) determinations for reducing fugitive emissions of organic compounds at “major stationary sources” of VOC have also set BACT to include a leak definition threshold of 100 ppmv. For sensory methods, a leak is defined as observed evidence of a potential leak, for example dripping liquid. For OGI, a leak is generally defined as any visible emission from a fugitive emissions component observed using the infrared (IR) camera. LDAR requirements are found in 47 individual subparts, each addressing specific industrial source categories (EPA, 2017). Federal LDAR program standards primarily regulate “affected facilities” in the synthetic organic chemical manufacturing industry (SOCMI) and other chemical and petrochemical segments, and the petroleum refining, natural gas processing, and crude oil and natural gas production sectors. There are no federal LDAR standards explicitly applicable to the geothermal power industry sector.

Some federal settlements (consent decrees) have stipulated “enhanced LDAR program” or “ELP” requirements for certain defendants, including owners and operators of petroleum refineries or chemical plants. Elements of so called ELP work practices have included for example:

- Reduced leak definition thresholds for certain equipment – e.g., from 10,000 ppm to 500 ppm for valves
- Increased leak survey frequencies – e.g., quarterly
- Implement action levels below leak definition thresholds triggering repair
- Tightened schedules for “first attempt at repair” and final repair of leaking equipment
- Repair verification monitoring
- Limited delay of repair
- Internal/third-party audits of LDAR program

LDAR work practices generally stipulate a monitoring frequency specific to component type (valves, etc.) and service (gas/vapor, light liquid or heavy liquid), for example monthly, quarterly, semiannually or annually. Repair deadlines in terms of days after leaks are discovered are also provided.

Pumps equipped with a dual mechanical seal system that includes a barrier fluid system meeting specified design and work practice standards are exempt from routine LDAR requirements under federal standard for SOCM facilities and other referencing standards.⁴

2.3 ALTERNATIVE DESIGN PRACTICES REVIEW

Incremental reductions in fugitive emissions from equipment leaks can be achieved without altering the fundamental design of the process using available alternative equipment designs, if feasible and safe. In addition, fugitive emissions from pumps and valves can be reduced through the use of “leakless” valves and “sealless” pumps, if technically and economically feasible.

Common leakless valves include bellows valves and diaphragm valves. Sealless pumps include diaphragm pumps, canned motor pumps, and magnetic drive pumps. Leaks from pumps can also be reduced by using dual seals with or without barrier fluid (EPA, 2016). Technical feasibility of using leakless valves and sealless pumps may be limited by process operating conditions, including temperature and pressure, fluid properties and heavy use, materials of construction and other considerations (EPA, 2016). Conformance with these practices is not required by state or federal regulation.

Equipment design alternatives that may be considered to reduce fugitive emissions from equipment leaks are described in the following sections. Equipment design alternatives may be considered only if technically and economically feasible and within the functional constraints of the process design. That is to say, equipment alternatives may be selected for process units within the construct of the process design, but the process design would not be substantially altered only for purposes of accommodating an alternative equipment selection to incrementally reduce the potential fugitive emissions.

2.3.1 ROTARY VALVES VERSUS SLIDING STEM VALVES

Leaks from valves occur from gasketed flanged connectors (discussed separately) and packing systems. Linear sliding (rising and lowering) stem valves, including gate and globe designs, account for higher fugitive emissions than rotary designs, including butterfly and ball designs. The rising and rubbing motion inherent in sliding stem designs is more difficult to seal properly than the short, 90-degree rotary motion of a stem in a quarter-turn butterfly or ball valve. Linear valves are, in general, more cost-effective for flow control and are widely used in chemical plants, petroleum refineries and oil and gas production and gas processing applications. The use of rotary flow control valves in lieu of less expensive linear valves results in lower leak rates and reduced operation and maintenance.

⁴ 40 C.F.R. Part 60 Subpart VVa—Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for Which Construction, Reconstruction, or Modification Commenced After November 7, 2006. §60.482-2a(d)

2.3.2 GRAPHITE PACKING SYSTEMS

Flexible graphite packing is chemically resistant and self-lubricating, and capable of sealing to extremely low levels of leakage for applications subject to parts per million (ppm) limits (ISO, 2015). Subject to economic feasibility, the use of graphite packing systems versus traditional packing designs is a good practice for reducing equipment leaks from sliding stem gate valves and globe valves.

2.3.3 SEALLESS CENTRIFUGAL PUMPS

Shaft seals are a principal source of leakage in conventional centrifugal pumps. Sealless pumps avoid use of shaft seals for primary containment. The term “sealless” is a generic industrial word used for pumps not employing dynamic seals such as mechanical shaft seals, centrifugal seals, or packing as the primary method of sealing liquid or vapor from the atmosphere. “Hermetic” would accurately describe the construction of sealless pumps. It is understood that static seals may be used in pumps that are designated “sealless.” Use of the term “sealless” should not be construed as any type of warranty or guarantee against pump leaks (ANSI, 2016).

Sealless pumps fall into two categories: magnetic driven pump (MDP) and canned motor pump (CMP). Sealless pump design eliminates the dynamic shaft seal between the wetted end of a centrifugal pump and the atmosphere by enclosing the pump and its rotor assembly inside a pressure vessel with the pumped fluid. The pressure vessel or “primary containment” is sealed by static seals, such as gaskets or O-rings. The inner rotor assembly is driven by a rotating magnetic field that is transmitted through a containment barrier. Standards for sealless centrifugal pumps for petroleum, petrochemical, and gas industry process service are set out in API Standard 685 (API, 2011).

Advantages and limitations of sealless pumps are described below (ANSI, 2016). Properly designed, applied, and operated sealless pumps may offer the following advantages:

- No leakage through primary containment to the environment during normal operation.
- Optional backup secondary containment or control.
- No loss of valuable liquids.
- Lower noise levels (CMP designs).
- Suction pressure usually does not affect the axial thrust.
- No periodic shaft seal replacement cost.

Technical limitations of sealless pumps include:

- Temperature of motor windings (CMP) or magnet components (MDP)
- Control of bearing environment is required to provide clean liquid, not vapor, for good bearing life.
- Primary containment device is relatively thin and corrosion potential shall be carefully considered.
- With some circulation plans for volatile liquids, drive-generated heat may affect the net positive suction head required.
- Overheating of drive section may occur with loss of flow or loss of suction.

- Size/capacity limitations

2.3.4 DIAPHRAGM PUMPS

Diaphragm pumps are sealless reciprocating positive displacement pumps driven either by electric motor or powered pneumatically by air or gas. Diaphragm pumps are widely used in certain applications where the fluid is a slurry or contains particulates. Diaphragm pumps are best for low-flow rate applications.

API Standard 675 Positive Displacement Pumps - Controlled Volume for Petroleum, Chemical, and Gas Industry Services specifies minimum requirements for reciprocating, controlled volume pumps and pump units for use in the petroleum, petrochemical, and gas industry services (API, 2015).

Properly designed, applied, and operated reciprocating positive displacement diaphragm pumps may offer the following advantages:

- Best suited for high pressure, low flow applications.
- Optimal for slurries or particle-laden streams
- Suitable for abrasive and corrosive liquid applications
- Available in pneumatic (air or gas driven) or electric
- Portable/transportable models
- Sealless

Technical limitations of reciprocating positive displacement diaphragm pumps include:

- High maintenance and short life
- Pulsation
- Size/capacity limitations
- Low maximum speed
- Not suitable for high-rate, continuous flow

2.3.5 DIAPHRAGM VALVES

Diaphragm valves are designed to control flow in corrosive services where line content could adversely affect valve components. Other applications for diaphragm valves are in services where contamination from outside sources cannot be tolerated; for example, the pharmaceutical and food industries. Diaphragm valves differ from other valves in that the body of the valve and line content is sealed off from all moving parts of the valve by a flexible diaphragm. This flexible diaphragm seal prevents stem packing leakage of line content and flow contamination by packing lubricants. Diaphragm valves are suitable for flows which are viscous or contain solids. There are many types of diaphragm materials available, depending on service and temperature conditions. (Emerson, 2017).

Diaphragm life (replacement interval) is dependent on the diaphragm material type, stem travel distance and other factors.

Properly designed, applied, and operated diaphragm valves may offer the following advantages:

- Diaphragm valves are particularly suited for the handling of corrosive fluids, fibrous slurries, radioactive fluids, or other fluids that must remain free from contamination
- Diaphragm valves can also be used for throttling service
- The operating mechanism of a diaphragm valve is not exposed to the media within the pipeline
- There are no packing glands to maintain and no possibility of stem leakage in valves
- Tight shut-off
- Easy maintenance

Primary technical limitations of diaphragm valves include:

- Working temperatures and pressures are limited by the diaphragm material. Generally the pressures are limited to 200 psi (1,380 kPa) and temperatures up to 400 °F (204 °C)
- Diaphragm valves are available in limited sizes, usually NPS 1/2 to 12 (DN 15 to 300)

2.3.6 BELLOWS VALVES

A bellows-sealed valve is designed with a metal bellows that expands or contracts with the linear stroke of the valve while providing a solid, permanent barrier between the fluid medium in the valve body and any potential leak paths to the atmosphere. The most common valve types to be fitted with bellow seals are the gate and globe designs, which are suited for use with bellows due to their internal construction and axial movement of the valve stem. Bellows technology cannot be applied to rotational valves such as butterfly valves and ball valves, as the valve movement is not linear.

For gate and globe valves the stem/packing leak path is the most vulnerable leak path to the environment in the valve design. The valve's packing is a dynamic seal and must perform its function during idle periods, when pressure and temperatures can fluctuate within the full pressure/temperature capability of the valve, and during periods when the valve stem is stroked (Jolly, 2020). A Bellow Seal Valve is designed to eliminate any leak paths at the bonnet joint and packing. The valve, with its bellows and seal-welded construction, totally confines the flow media within the valve pressure boundary. The valve packing is totally isolated by the bellows from the flowing medium and serves in a back-up role only (Vogt, 2020). Bellows seal bonnets are used when no leakage (less than 1x10⁻⁶ cc/sec of helium) along the stem can be tolerated. Bellows-sealed valves are often used when the process fluid is toxic, volatile, radioactive, or very expensive (Emerson, 2017).

There are a number of limitations that can be expected from a bellows valve. They can be summarized as follows (Jolly, 2020):

- **Cycle Life:** Bellows have a finite life when used in valves that expose them to pressure fluctuations and full compression and extension loads. BS-5352 requires that bellows gate valves have a 2000 cycle life and globe valves to have a 10,000 cycle life. The cycle life limitation may not allow their use in some highly stroked valves whose cycle life exceeds the bellows life. The cycle life limitation will require a quality backup packing system to overcome a leak in the bellows.

- **Pressure Retention Capability:** Since bellows are designed with the intent that thin wall formulas be used, bellows with membrane thickness that provide flexibility and low spring rates are the outcome. It is highly unlikely that bellows can be designed to interface with larger high pressure valves that have traditionally used the thick wall formulas in designing of the pressure boundary. Bellows for use in gate and globe valves that must be designed to retain high pressures while providing flexibility and a low spring rate may be impossible.
- **Size Limitation:** The operating torque of a standard gate or globe valve is influenced by the area of the stem and the operating pressure acting on this area. The load on a bellows valve stem is a function of the bellows inside/outside diameters. The size of the bellows required to accommodate the stem, pressure and stroke of larger valves may lead to a bellows with a spring rate and unbalanced area on the valve stem so large that it will be impractical to operate when used in a gate or globe valve.
- **Corrosion Control:** The selection of the material for the bellows will be critical. Matching of service to the bellows material will require greater caution because unlike the pressure boundary of a valve there is no inherent corrosion allowance in the bellows of a bellows valve. Bellows are typically available in 304, 316, 321 stainless steels, Inconels 600 and 625, Incoloy 825, Monel 400, and Hastelloy "C" materials.
- **Envelope Dimensions:** Bellows gate valves will have a much greater height than the conventional gate valves. The bellows must be designed to accommodate the high stroke requirements of a gate valve. This leads to a long bellows that requires the bellows gate valve to be extended, impacting on piping configuration and layout.
- **Bellows Valve Costs:** It is expected that bellows valves will be anywhere from 3 to 10 times more expensive than their standard packed valve equivalent. This higher cost is primarily due to the cost of the bellows, and interfacing it to the valve pressure boundary. The higher price tag for reliable bellows valves still may be economically attractive when reviewed in regard to emerging EPA requirements and incentives.

2.3.7 LEAKLESS VERSUS FLANGED CONNECTIONS

Minimizing equipment leak components in process design is a best practice for reducing the potential for fugitive emissions. For example, to the extent feasible based on process considerations, welded connections may be used for some piping and fittings instead of screwed or flanged connections. Any equipment component connected to piping using welded connections can only be removed using risky hot work (cutting, welding, and brazing) any time replacement or repair is necessary. Hot work presents elevated fire and explosion hazards due to the potential for flammable motive fluid leaks to ignite. In addition, removing a welded component for maintenance involves a greater potential for n-pentane leaks than from a leaking flange because a small amount of non-condensed n-pentane vapors would be discharged to the atmosphere during the purge. Consequently, for certain equipment components that would require frequent replacement or repair over the life of the project, the use of flanged connections is a best practice.

3. COMPARISON OF PROPOSED PROCESS WITH EXISTING BINARY PLANTS

SLR looked for practices and measures for reducing fugitive emissions from equipment leaks of motive fluids from other binary geothermal plants for comparison with Ormat's proposed project. We found one study reporting fugitive emissions of motive fluid from three binary plants in California and located within the GBUAPCD and the Imperial County Air Pollution Control District. The results of the study, *Binary Power Plant CO₂ Life Cycle Emissions Including Isobutane Fugitive Leakage*, were presented at the Workshop on Geothermal Reservoir Engineering held at Stanford University in 2017 (Mattson, Mallozzi, & Mines, 2017). The report compiled data from the three binary plants, which had been operating for more than 25 years. Each binary plant used iso-butane as the motive fluid, but the binary cycle was otherwise comparable to Ormat's proposed project.

The results, derived from motive fluid "inventory changes" over a 15 month period, indicated that a well maintained binary plant releases approximately 0.13 grams of motive fluid (isobutane) per kilowatt-hour (g/kWh) from "normal leakage of valves and seals." A well maintained plant is contrasted with a binary plant experiencing equipment failures. The Ormat project will be newly constructed and will include more recent equipment technologies, so the emissions from a "well maintained plant" is comparable. In any case, we found no studies or other information describing specific design measures to mitigate fugitive emissions from equipment leaks for a binary plant.

With no documented fugitive emission mitigation measures specific to binary plants in the geothermal power sector available in the public domain, such measures and practices employed in the SOCFI, petroleum refining and upstream oil and gas production industry sectors were evaluated. The motive fluid (n-pentane) is a hydrocarbon compound commonly found in operations within the SOCFI and petroleum sectors.

4. FEASIBILITY ANALYSIS

An analysis of additional fugitive emission mitigation measures that may be available and feasible to further reduce the potential for leaks from the motive fluid process beyond the project design described in the EIS/EIR is presented. The term “feasible” is defined in the CEQA Guidelines § 15364 as “capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors.”

As part of the project generally described in the EIS/EIR, Ormat has proposed design measures that effectively reduce the potential for fugitive emissions from the motive fluid process, including:

1. Double mechanical seal and barrier fluid systems meeting API standards for turbines and centrifugal pumps and measures to detect the failure of barrier fluid systems
2. Rotational butterfly valves inherently lower in leaks from stem seals than linear sliding stem control valves and meeting or exceeding API specifications
3. Graphite packing systems for gate valves meeting or exceeding API specifications
4. Sealless pneumatic (air) diaphragm pumps for evacuating motive fluid from isolated portions of the motive fluid process after isolation for equipment replacement or repair
5. Combination of butterfly valves and isolation valves in a double block and bleed seal to eliminate leaks from isolated piping and equipment while motive fluid is evacuated
6. Flanged connections for equipment that is or may be routinely removed for replacement or repair to facilitate safe maintenance while reducing the potential for n-pentane releases during such activities
7. Flanges and gaskets compatible with motive fluid and meeting ASME specifications
8. Direct acting PRVs meeting stringent API seat tightness standards
9. Rupture disks to minimize leaks from PRVs
10. Use of leakless welded connections to the greatest extent practicable

The equipment components listed above are part of Ormat’s standard design, as generally described in the EIS/EIR. These “standard” measures, however, were not detailed in that document.

The following feasibility analysis addresses alternative equipment design, including so called “leakless” valve and “sealless” pump technologies, not already proposed for the project. The feasibility analysis also addresses “enhanced” LDAR work practices, including certain practices not proposed in the original EIS/EIR.

4.1 DEMONSTRATION OF INFEASIBILITY OF SEALLESS CENTRIFUGAL PUMPS

The range of hydraulic design capacities of sealless pumps is limited. In *A User’s Engineering Review of Sealless Pump Design Limitations and Features* (Hernandez, 1991), the author presented sealless pump

performance ranges (pumping capacities) available worldwide at the time. SLR conducted online research and we were unable to find CMPs or MDPs manufactured in the U.S. or U.K. with a design capacity sufficient to meet the size (NPS), gallons per minute (gpm) and “head” capacity (feet) required for the motive liquid feed pumps. Use of sealless pumps in the motive fluid system design is not feasible at this time.

4.2 DEMONSTRATION OF INFEASIBILITY OF DIAPHRAGM PUMPS FOR MOTIVE FLUID CIRCULATION

Circulation of motive liquid requires continuous high flowrate (>1,500 gpm) pumping capacity. Diaphragm pumps are designed to pump at a low pulsating flowrate. Diaphragm pumps are not capable of accommodating high-rate, continuous flow design requirements. In addition, the maximum design capacities of diaphragm pumps currently manufactured are insufficient to achieve the the design flow capacity for the motive fluid system. Notwithstanding pumping capacity limitations, diaphragm pumps are not reliable for continuous heavy-duty use. Frequent replacement of diaphragms is necessary, resulting in increased operation and maintenance costs.

For all of these reasons, diaphragm pumps are not feasible for application as motive liquid feed/recycle pumps.

4.3 DEMONSTRATION OF INFEASIBILITY OF DIAPHRAGM VALVES

Diaphragm valves are considered “leakless,” but leaks and releases of liquid to the environment do occur as a consequence of liquid leaks between diaphragm and valve body, and tears and ruptures of the diaphragm. To mitigate diaphragm failure due to physical wear and chemical degradation, the diaphragm must be replaced on a routine basis, resulting in costly process downtime and increased operating and maintenance costs, as well as safety concerns. Rupture of a diaphragm and the resulting release of process fluid has far greater environmental consequences than a leak from the seal of a conventional valve.

The operating temperature of the motive fluid may exceed 300 °F with operating pressures exceeding 400 psig. Maximum line pressure specifications for diaphragm valves decrease with increasing size (NPS) and increasing temperature as a function of diaphragm material type. Each diaphragm material has a maximum recommended temperature specification and each valve make/model has working pressure and temperature limits. We could find no diaphragm valves meeting the pressure and temperature specifications.

Lastly, carbon steel diaphragm valves are not commercially available in the sizes needed. The motive fluid process piping sections where control valves are utilized range from 12 to 20 inches NPS. Diaphragm valves are available in sizes less than 12 inches NPS.

Diaphragm valves are not feasible for use in the motive fluid system.

4.4 DEMONSTRATION OF INFEASIBILITY OF BELLOWS VALVES

Bellows seal valves are considered “leakless,” but as with any equipment, physical wear can result in bellows failure and leakage of process fluid. Cycle life of bellows is impacted by stroke and cyclic pressure. The cycle life limitation will require a quality backup packing system to overcome a leak in the bellows (Vogt, 2020). A demonstration of infeasibility of bellows sealed control valves and gate valves is provided in the following discussion.

4.4.1 FLOW CONTROL VALVES

Bellows seals are used in sliding-stem globe valves and gate valves, as described in Section 2.3.6. Flow control within the proposed motive fluid process will be accomplished using rotational butterfly valves, which are best suited for rapid (quarter-turn) closure and flow control with minimum pressure drop across the valve. A pressure drop results in cooling and the potential for liquid condensation in the flow line. Liquid droplets are damaging to turbines. Linear sliding stem globe and gate valves for which bellows are exclusively designed are not technically suited for motive fluid flow control while minimizing pressure drop. Butterfly valves and ball valves are rotational designs. Bellows sealed valves can only be used in linear designs and cannot be used in rotational valves. Consequently, bellows seal valves are not a technical feasible alternative technology for motive fluid flow control.

4.4.2 MANUALLY OPERATED GATE VALVES

As discussed in Section 1.2.2.2, manually operated gate valves with graphite packing will be used for process isolation in the motive fluid system. Process isolation and evacuation of motive fluid is necessary to facilitate safe maintenance, repair and replacement of critical equipment in n-pentane service. The gate valves range in size (NPS) from 4 to 12 inches. In general, bellows sealed gate valves are technically feasible to function as isolation valves, however there are limitations in valve sizes currently manufactured and commercially available. The largest steel bellows sealed gate valves with suitable pressure and temperature ratings found to be commercially available are 10-inch NPS. It is expected that bellows valves will be anywhere from 3 to 10 times more expensive than a standard packed valve equivalent (Vogt, 2020).

We can estimate the incremental reduction in potential fugitive emissions resulting from replacing a traditional packed valve with a bellows sealed valve using equipment leak emission factors and correlations developed by EPA (EPA, 1995). EPA collected data on equipment leak emissions of TOC from refineries, marketing terminals, oil and gas production operations, and SOCMI process units. Based on equipment leak data, EPA developed equipment leak emission estimation approaches and emission factors for equipment in those industry sectors. Emission factors in terms of kilograms TOC emitted per hour per source (kg/hr/source) for equipment (valves, connectors, etc.) and service (e.g., gas and light liquid) were developed where those emission factors could be applied to the number of each type of component in each service at a facility to yield mass emissions (kg/hr) of TOC. The service categories are defined based on the state (gas or liquid) at process operating conditions. The n-pentane motive fluid is in gas phase after the heat exchangers and in light liquid phase after condensation.

EPA combined the refinery, marketing terminal data, and oil and gas production operations data to develop petroleum industry correlations for equipment leaks. For valves (all services), correlation equations were developed to estimate mass emissions from a leaking valve in terms of kb/hr/valve based on leak screening values. A screening value (SV) is a measure of the concentration of leaking compounds in the ambient air that provides an indication of the leak rate from an equipment piece, and is measured in units of ppm. The correlation equation for valves is provided below (EPA, 1995):

$$\text{LEAK} = 2.29\text{E-}06 * \text{SV}^{0.746}$$

Where:

LEAK = mass emissions of TOC (kg/hr/source)

Using the correlation equation above and conservatively applying a screening value of 500 ppmv for valves, a gate valve may emit up to 4.6 pounds of n-pentane per year per valve, equivalent to 0.002 tons per year n-pentane per valve.

Assuming a zero leak rate for bellows sealed valves is achievable in practice, the 4.6 pounds per year per valve emission rate represents the difference between a bellows sealed valve and a valve with graphite packing. The 500 ppmv screening value is the leak definition threshold for an LDAR program (see discussion in Section 4.6). A valve observed to be leaking at a concentration at or above 500 ppm must be repaired and re-monitored. In practice, an infrequently used isolation valve with graphite packing may not leak at levels at or above the screening level. There are seven gate valves used for isolation in the motive fluid system design. Based on the correlation described above at the 500 ppm SV, the incremental increase in combined total potential VOC/ROG (n-pentane) emissions is 32 pounds per year, equivalent to 16 one thousandths of a ton per year.

Size limitations of bellows-sealed valves notwithstanding, for gate valves used infrequently for process isolation, bellows technology would not reduce fugitive emissions beyond reductions already achieved by graphite packing materials combined with LDAR work practices (500 ppmv SV). In practice, a gate valve with graphite packing would be expected to achieve leak rates less than 200 ppmv. Consequently, we find that bellows sealed valves are not feasible for use as isolation valves in the motive fluid system.

4.5 LEAKLESS CONNECTIONS

Welded (“leakless”) connections are used in the motive fluid system design to the greatest extent practical and wherever feasible for piping, fittings and other components. Welded connections are not technically feasible for all equipment, including control valves, pumps and other equipment that must be periodically removed for repair or replacement in a safe manner. Ormat’s motive fluid system design minimizes the need for cutting, welding, and brazing (“hot work”), which poses safety concerns and risk of fire and explosion hazards due to the potential for motive fluid leaks. In addition, removing a welded valve for maintenance involves more risk for n-pentane leaks than from a properly designed and installed flange.

The use of welded connections is not feasible for turbines, pumps, control valves and other critical components. Properly installed flanges with appropriate gaskets can achieve low-leak performance.

4.6 FEASIBILITY OF IMPLEMENTING MORE STRINGENT LDAR WORK PRACTICES

The LDAR program described in the Final EIS/EIR provided that the leak be repaired “as soon as practical” where the leak exceeds 10,000 ppmv. No timeline for “first attempt at repair” and final repair was prescribed.

Development and implementation of a more stringent LDAR program for equipment in VOC service is technically and economically feasible and widely achieved in practice by petroleum refineries and chemical plants. The motive fluid system is not comparable to a petroleum refinery or chemical plant in terms of the quantity of fugitive emissions components and the potential for VOC and air toxic/HAP compound emissions from equipment leaks, but n-pentane is a VOC and equipment within the motive fluid system is “in VOC service.” Feasible LDAR work practices for equipment in VOC service that are generally consistent with the most stringent federal CAA standards for equipment leaks⁵ and including alternative provisions for OGI survey programs provided by CAA standards for crude oil and natural gas production⁶ are summarized in Table 1.

Table 1 Feasible LDAR Work Practices for Motive Fluid Process Equipment in VOC (n-Pentane) Service

EQUIPMENT	LEAK DEFINITION ⁷	MONITORING FREQUENCY	EXCLUSIONS FROM MONITORING
Pumps	Visual indications of liquids dripping from seal or 2,000 ppmv	Weekly visual inspections; monitor if visual indication of a leak cannot be eliminated	Each pump equipped with a dual mechanical seal system that includes a barrier fluid system
PRVs	500 ppmv or visible emissions observed using OGI	Quarterly	PRVs equipped with a rupture disk upstream of the pressure relief device
Valves	500 ppmv or visible emissions observed using OGI	Quarterly	Valves in vacuum service

A feasible best practice for an LDAR program would also include routine monitoring of flanged and screwed connectors in n-pentane service at some frequency. Monitoring of connectors is not required by NSPS, but is usually conducted during monitoring surveys for valves.

The centrifugal pumps used for motive fluid circulation are equipped with double mechanical seals and a barrier fluid system, as describe in Section 1.2. PRVs are equipped with rupture disks, as described in Section 1.2.4. Such equipment would be exempt from routine monitoring (LDAR) under the federal standards. Consequently, the LDAR program would focus on valves and connectors.

⁵ Federal NSPS at 40 C.F.R. Part 60 subpart VVa. 72 FR 64883, Nov. 16, 2007

⁶ Federal NSPS at 40 C.F.R. Part 60 subpart OOOOa. 81 FR 35898, June 3, 2016, as amended at 83 FR 10638, Mar. 12, 2018

⁷ As determined using EPA Method 21 (ppmv) or visual indication of a leak using optical gas imaging or visual means.

Consistent with federal NSPS for chemical plants, when a leak is detected from a valve or connector, it shall be repaired as soon as practicable, but no later than 15 calendar days after the leak is detected. A first attempt at repair shall be made no later than 5 calendar days after each leak is detected. Best practices for first attempts at repair for valves include:

- (1) Tightening of bonnet bolts;
- (2) Replacement of bonnet bolts;
- (3) Tightening of packing gland nuts;
- (4) Injection of lubricant into lubricated packing.

Since n-pentane is neither a listed HAP nor a regulated air toxic compound and the facility is not a major stationary source of VOC, an enhanced LDAR program more stringent than the most rigorous NSPS required for new chemical and natural gas processing plants, as described above and summarized in Table 1, is not reasonable or warranted.

5. CONCLUSIONS

For all of the reasons described above and in keeping with international codes and standards and EPA guidance, we find that Ormat's proposed motive fluid system design follows best available design standards for rotating equipment, valves and connectors and incorporates best practices for minimizing the potential for fugitive emissions of ROG and VOC from equipment leaks. No additional available sealless, leakless or low-leak technologies are feasible to further reduce fugitive emissions from equipment leaks. Evidence described in Section 4 demonstrates that the alternative sealless, leakless or low-leak technologies described in Section 2.3 are infeasible for one or more of the following reasons:

- Unable to perform the intended physical function within the motive fluid process;
- Incompatible or unsuited for the motive fluid process conditions (temperature, pressure, flowrate, chemical properties or duty);
- Not available in the size or maximum design capacity needed;
- Not effective in mitigating the potential for equipment leaks beyond that already achieved through the combination of Ormat's standard process design and a robust LDAR program; and/or
- Presents unnecessary fire and explosion hazards associated with routine replacement and repair.

We find that it is feasible to enhance the LDAR work practices proposed in the EIS/EIR for valves in n-pentane service to generally conform to federal NSPS applicable to and achieved in practice for affected SOCM and petroleum industry plants. For valves, a screening level (leak definition) of 500 ppmv TOC (Method 21) or emissions observed using OGI is feasible. The LDAR program would include quarterly leak surveys of valves using either Method 21 or OGI. When a leak is observed as defined above, a first attempt at repair shall be made no later than 5 calendar days after each leak is detected. Final repair should be completed as soon as practicable, but no later than 15 calendar days after the leak is detected, unless a delay of repair is warranted. Delay of repair of valves for which leaks have been detected would be allowed if repair within 15 days is technically infeasible without a motive fluid process unit shutdown. Repair of such equipment shall occur before the end of the next process unit shutdown and monitoring to verify repair must occur within 15 days after startup of the process unit. LDAR work practices would focus on valves and connectors. Rotating equipment (turbines and pumps) equipped with double mechanical seals and barrier fluid systems and PRVs equipped with rupture disks would not be subject to LDAR, consistent with federal standards.

Process design measures already incorporated into Ormat's standard design as generally described in the EIS/EIR and additional LDAR work practice mitigation measures combine to minimize the potential for fugitive emissions of ROG/VOC from equipment leaks within the motive fluid process.

6. REFERENCES

(n.d.).

ANSI. (2016). Rotodynamic (Centrifugal) Slurry Pumps for Nomenclature, Definitions, Applications, and Operation. American National Standards Institute.

ANSI. (2016, March 24). Sealless Rotodynamic Pumps for Nomenclature, Definitions, Applications, and Operation, and Test, ANSI/HI 5.1-5.5-2016. American National Standards Institute.

API. (2011, February). API Standard 685 Sealless Centrifugal Pumps for Petroleum, Petrochemical, and Gas Industry Process Service, 2nd Edition. American Petroleum Institute.

API. (2014, August). API Specification 6D - Specification for Pipeline and Piping Valves, 24th Edition. American Petroleum Institute.

API. (2014, July). API Standard 520 Sizing, Selection, and Installation of Pressure-Relieving Devices Part I—Sizing and Selection, 9th Edition. American Petroleum Institute.

API. (2014, January). API Standard 521 Pressure-Relieving and Depressuring Systems, 6th Edition. American Petroleum Institute.

API. (2014, November). API Standard 527 Seat Tightness of Pressure Relief Valves, 4th Edition. American Petroleum Institute.

API. (2014, May). API Standard 682 Pumps—Shaft Sealing Systems for Centrifugal and Rotary Pumps, Fourth Edition. American Petroleum Institute.

API. (2014, February). Type Testing of Rising Stem Valves Equipped with Flexible Graphite, 1st Edition.

API. (2015, January). API Standard 600 Steel Gate Valves - Flanged and Butt-welding Ends, Bolted Bonnets, Thirteenth Edition.

API. (2015, April). API Standard 675 Positive Displacement Pumps - Controlled Volume for Petroleum, Chemical, and Gas Industry Services, 3rd Edition. American Petroleum Institute.

API. (2016, February). API Standard 609 Butterfly Valves: Double-flanged, Lug- and Wafer-type, Eighth Edition. American Petroleum Institute.

API. (2016, October). API Standard 641 Type Testing of Quarter-Turn Valves for Fugitive Emissions, 1st Edition.

API. (2018, November). API Spec 6A Specification for Wellhead and Tree Equipment, 21st Edition. American Petroleum Institute.

API. (2018, September). API Standard 603 Corrosion-resistant, Bolted Bonnet Gate Valves - Flanged and Butt-welding Ends, Ninth Edition. American Petroleum Institute.

- API. (2018, October). Type Testing of Process Valve Packing for Fugitive Emissions, 3rd Edition. API.
- API. (2020, January). API Standard 608 Metal Ball Valves - Flanged, Threaded, and Welding Ends, Sixth Edition.
- API. (2020). *API Standards*. Retrieved from American Petroleum Institute:
<https://www.api.org/standards/>
- ASME. (2017). ASME B16.34-2017 Valves - Flanged, Threaded, and Welding End. ASME.
- ASME. (2017). Metallic Gaskets for Pipe Flanges B16.20-2017.
- ASME. (2018). ASME B31.1-2018 Power Piping.
- Emerson. (2012). Pressure Relief Valve Engineering Handbook, Technical Publication No. TP-V-300.
- Emerson. (2017). Control Valve Handbook, Fifth Edition. Emerson Fisher.
- EPA. (1995, November). Protocol for Equipment Leak Emissions Estimates, EPA-453/R-95-017. EPA Office of Air Quality Planning and Standards.
- EPA. (2016, December 11). Retrieved from Leak Detection and Repair: A Best Practices Guide:
<https://www.epa.gov/compliance/leak-detection-and-repair-best-practices-guide>
- EPA. (2017, November 3). *Leak Detection and Repair Rule Modernization - Proactive Approach for Pollution Prevention and Minimization*. Retrieved from E-Enterprise for the Environment:
<https://e-enterprisefortheenvironment.net>
- EPA. (2017, August 3). Method 21 - Determination of Volatile Organic Compound Leaks. *Appendix A of 40 C.F.R. Part 60*. EPA. Retrieved from Air Emission Measurement Center (EMC):
<https://www.epa.gov/emc/method-21-volatile-organic-compound-leaks>
- Great Basin Unified Air Pollution Control District, et al. (2013). *Casa Diablo IV Geothermal Development Project - Final Joint EIS/EIR*. Bishop.
- Hernandez, T. (1991). A User's Engineering Review Of Sealless Pump Design Limitations And Features. *Proceedings of the Eighth International Pump Users Symposium*. Turbomachinery Laboratories, Department of Mechanical Engineering, Texas A&M University.
- ISO. (2015, June). Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 2: Production acceptance test of valves.
- ISO. (2015, June). ISO 15848-1 Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 1: Classification system and qualification procedures for type testing of valves.
- ISO. (2015, June). ISO 15848-2:2015 Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 2: Production acceptance test of valves. ISO.
-

Jolly, G. A. (2020). Bellows Seal Valves. *Vogt Valves. The Connection Bulletin for Bellows Seal Valves, CB 11*. Vogt Valves, Flow Control Division.

Key, W. E., Wang, G., & Lavelle, K. E. (1991). Tandem Seals for Near Zero Hydrocarbon Emissions. *Proceedings of the Eighth International Pump Users Symposium*. Turbomachinery Laboratories, Department of Mechanical Engineering, Texas A&M University.

Mattson, E., Mallozzi, L., & Mines, G. (2017). Binary Power Plant CO₂ Life Cycle Emissions Including Isobutane Fugitive Leakage. *Proceedings, 42nd Workshop on Geothermal Reservoir Engineering*. Stanford, California.

MSS. (2012, April). MSS SP-72-2010a Ball Valves with Flanged or Butt-Welding Ends for General Service. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

MSS. (2017, November). MSS SP-67-2017 Butterfly Valves. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. .

MSS. (2017, May). MSS SP-68-2017 High Pressure Butterfly Valves with Offset Design. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. .

Vogt. (2020). *Bellow Seal*. Retrieved from Vogt Valves: https://www.vogtvalves.com/ggc/bellow_seal/

Wing, S. M., & Smith, B. K. (2012, August 6). Controlling and Monitoring Control Valve Fugitive Emissions. *Valve Magazine*.

APPENDIX A

AUTHOR'S RESUME

Feasibility Analysis of Available Equipment Leak Mitigation Measures: Low-Emissions and Leakless Design Technologies

July 2020

KENNY MALMQUIST

Managing Principal/Fort Collins, Colorado

+1 970 999 3981/kmalmquist@slrconsulting.com



Kenny Malmquist is a Petroleum Engineer with over 32 years of diverse professional experience in air quality engineering consulting. He is an experienced technical consultant familiar with processes, systems and operations within the upstream oil and gas, gas processing, petroleum refining, chemical/petrochemical, power, mining, manufacturing and other industry sectors. Mr. Malmquist is widely experienced with air quality standards, regulations and permitting programs administered by EPA and state/local agencies throughout the U.S. Since 1989, he has provided air quality engineering, permitting and compliance solutions to clients operating across North America. He is expert in EPA CAA programs, specializing in NSPS and NESHAP standards and regulations affecting the numerous industry sectors. Mr. Malmquist has been retained to provide nontestimonial technical support to clients' inside and outside legal counsel in a variety of complex civil and criminal litigation matters, particularly pertaining to government allegations of federal CAA violations. Kenny began his consulting career in California and he is familiar with ARB, SCAQMD, BAAQMD and other district air programs. Mr. Malmquist is a Managing Principal in SLR's air practice in Colorado.

EXPERIENCE

- **Measurement and Quantification of Fugitive Emissions of Organic Compounds and Managing Compliance with Equipment Leak Standards for VOC, HAP and GHGs**

Develop, audit, implement and manage leak detection and repair programs and monitoring plans for facilities throughout the U.S. in the chemical, refining, gas processing and upstream oil and gas industry sectors. Conduct fugitive equipment component counts supporting emission inventory development. Experience with monitoring surveys using portable analyzers (EPA Method 21) to identify leaks exceeding threshold-based volume concentrations for organic compounds from valves, flanges/connectors, pumps, pressure relief devices, etc. Observe qualitative indications of equipment leaks using optical gas imaging (OGI). Quantify mass emissions of organic compounds (methane, GHG, VOC, ROG, HAP) from fugitive emission components based on emission factors for process streams in gas/vapor, light liquid, heavy liquid and oil/water service. Determine mass emissions of air pollutants from pressure relief devices and process vents using equation of state process simulation and other techniques. Assure compliance with Federal NSPS and NESHAP rules regulating equipment leaks including. Complete HAP potential to emit and major source determinations, including fugitive emissions. Measure ambient or fence line concentrations of target organic compounds using reference sampling and analytical methods. Advise clients in evaluation of emerging fugitive emission measurement methods, including optical and open-path technologies.

- **Air Quality Consulting to the U.S. Petroleum Industry**

Air quality engineering technical and regulatory compliance consulting support to major and independent oil and gas companies and assets from the Alaska North Slope to California, Appalachia, the Mid-Continent, Gulf Coast and the Rockies.

EDUCATION

- B.S., Petroleum Engineering, University of Wyoming, 1983

AREAS OF EXPERTISE

- Air Quality Permitting and Regulatory Compliance
- Federal CAA Programs - NSPS & MACT/NESHAP
- State and Local Air Quality Programs throughout the U.S.
- RACT/BACT/LAER
- Hydrocarbon Liquid Storage and Handling, Vapor Recovery, Controls, and Flaring Issues
- Production tank battery adequate design evaluations
- Conventional and Unconventional Crude Oil and Natural Gas Exploration and Production
- Natural Gas Gathering, Treating, and Processing
- Hydrocarbon Processing and Petroleum Refining
- Compliance Planning and Implementation
- Air Quality Compliance Audits and Transactional Due Diligence
- Support to Internal/Outside Counsel in Defense Against Government Civil and Criminal Investigations and Enforcement Actions
- Fugitive Emissions Assessments and Leak Detection and Repair (LDAR)

- **Legal Support, Multiple Clients and Geographies.**

Nontestimonial technical support to clients' inside and outside legal counsel in a variety of complex civil and criminal litigation matters pertaining to government allegations of federal CAA violations. Routinely support legal counsel in preparing response to information requests pursuant to Section 114 of the Clean Air Act, 42 U.S.C. § 7414 (Section 114 requests) and Grand Jury subpoenas and resolution of EPA, state and local agency enforcement matters.

- **NEPA Support, Oil and Gas.**

Support air quality aspects of EA and EIS development for large geographically dispersed oil and gas development on state and federal lands. Develop point source and fugitive emission inventories for a variety of development activities.

- **Air Quality Permitting for Upstream Crude Oil and Natural Gas Resources, Multiple Clients and Geographies.**

Air quality permitting services to clients producing from large geographically dispersed conventional and unconventional resources in basins throughout the U.S. Experienced with air permitting programs administered by state, local and federal jurisdictions in all petroleum producing states. Minor- and major-source preconstruction NSR permitting (PSD and NNSR), RACT/BACT/LAER determinations, and Title V operating permits. Experienced in permitting programs administered by EPA for stationary sources within Indian Lands.

- **Natural Gas Production, Gathering, Treating, Processing, Compression, Transportation and LNG Liquefaction/Gasification**

Experienced in natural gas production, treating (dehydration and sweetening), NGL extraction, compression, condensate and NGL handling, flares and flare gas recovery systems, process vents, combustion systems and LDAR. Expert in federal CAA and state/local programs affecting the natural gas industry sectors. Practiced in hydrocarbon phase behavior, equation of state process simulators and dynamic models in characterizing process stream composition and properties and air emissions from process vents and combustion systems. Experience with LNG liquefaction and gasification processes.

- **Tank Battery Vapor Collection and Control System Evaluation, Multiple Clients/Assets**

Engineering evaluations of upstream production tank system vapor collection and controls to ensure adequate design to accommodate peak vapor flow conditions during normal operations without venting. Use dynamic model to trend tank system pressure versus time to identify zero cost or cost-effective solutions to eliminate "routine venting" of unburned gases, reduce the volume of vented gas (planned and unplanned nonroutine venting) and improve efficiency of vent systems. Completed independent third-party audits of tank system modeling guidelines and design evaluations for large production assets in Colorado and North Dakota.

- **Federal Clean Air Act Technical Consulting, Hydrocarbon Liquid Storage and Handling, Multiple Clients and Geographies.**

Providing expert consultation in federal CAA and local programs affecting crude oil, condensate and produced water separation, treating and processing, storage and transfer operations in the upstream oil and gas industry sector.

- **Technical Consulting, Methane and GHG**

Methane and GHG emission inventory development pursuant to the federal Mandatory GHG Reporting Program, state emission inventory requirements, corporate metrics reporting, permitting and regulatory compliance and engineering evaluations for numerous producers and operations spanning North America. Expert in quantifying fugitive and point source methane emissions using a combination of direct measurements, sampling and analysis, steady state and dynamic process simulation software tools, published emission factors and other traditional and novel approaches. Gather and manage activity data for extensive and geographically dispersed production assets.

KENNY MALMQUIST

Managing Principal/Fort Collins, Colorado

+1 970 999 3981/kmalmquist@slrconsulting.com



- **Petroleum Refineries and Terminals, Multiple Clients and States.**

Air quality regulatory compliance consultant to major petroleum refiners and terminal operators in Alaska, California, Washington, Montana, Utah, Colorado, North Dakota, Indiana, Ohio, Texas and the U.S. Virgin Islands. Conducted air quality regulatory compliance audits of refineries and marine terminals.

- **Compliance Self-Evaluations, Third-Party Audits and Transactional Due Diligence Reviews of Oil and Gas Production and Midstream Operations, Multiple Assets.**

Audit team leader and auditor for numerous air quality compliance self-evaluations, third-party audits and transactional due diligence reviews of extensive and geographically-dispersed production and pipeline gathering system assets located on Indian Lands and lands under state and federal jurisdiction across the U.S.

- **Confidential Clients, Legal Support, Bakken (North Dakota).**

Retained by two separate outside law firms representing two Bakken crude oil producers to provide technical support in responding to CAA Section 114 Information Requests issued by EPA Region 8 surrounding design and operation of tank battery vapor collection and control systems.

- **Confidential Client, Air Quality Regulatory Compliance Self-Evaluation**

Retained by a national law firm representing an oil and gas producer operating in seven U.S. states. Conducted a desktop audit encompassing thousands of sites located throughout the midcontinent.

- **Air Quality Compliance Audits, Confidential Clients – Texas.**

In separate matters, retained by outside counsel to conduct self-evaluations of a petroleum refinery, compressor stations and gas processing plants in west Texas under the Texas Audit Privilege Act and an agreement with EPA. Focused on assessment of compliance with NSPS and MACT programs, including Refinery Sector Rule.

- **Third-Party Audit, Confidential Client, Colorado.**

Retained by oil and gas producer to conduct independent third-party audit of engineering evaluations of numerous production tank systems, as required by a Consent Decree.

- **Legal Support, Confidential Client, Major Petroleum Company.**

Retained by outside law firm representing major petroleum refiner to provide consulting support in connection with a grand jury subpoena and investigation by the U.S. DOJ and EPA CID arising out of allegations of noncompliance with federal CAA programs affecting flare gas recovery systems.

- **Transactional Due Diligence, Major Petroleum Company.**

In separate transactions, retained by outside law firm representing potential buyers of two marine terminals.

- **Legal Support, Confidential Client, Major Petroleum Company.**

Retained by outside counsel representing major petroleum company to provide consulting support in connection with an investigation by EPA CID and DOJ in connection with allegations of CAA violations pertaining to large crude oil process tanks and NSPS Subpart Kb at company's crude oil production facilities.

- **Legal Support, Confidential Client, Crude Oil Pipeline Company.**

Worked with client's internal and outside counsel to successfully defend client against state agency enforcement action related to alleged CAA violations of the Organic Liquids Distribution MACT rule at client's crude oil pipeline terminal facilities.

- **Legal Support and Air Quality Compliance Self-Evaluation, Confidential Client, Utah.**

Retained by client's internal counsel to provide consulting assistance in preparation of a response to an EPA Section 114 request related to allegations of CAA violations of major source MACT standards

KENNY MALMQUIST

Managing Principal/Fort Collins, Colorado

+1 970 999 3981/kmalmquist@slrconsulting.com



and requirements for glycol dehydration units and stationary reciprocating internal combustion engines at five compressor stations operated by client on state and tribal lands in the Uinta Basin.

- **Legal Support, Confidential Client, Upstream Oil and Gas Production Company, Utah.**

Worked with client's internal and outside counsel in successfully defending client against a civil enforcement action by EPA Region 8 and DOJ pursuant to 25 allegations of Clean Air Act violations at three gas gathering pipeline system compressor stations and two gas plants in the Uinta Basin.

- **Legal Support, Confidential Client, Major Oil and Gas Company, West Virginia.**

Supported client's internal and outside counsel and EHS staff to self-assess compliance with air quality standards and regulations and permitting programs administered by the West Virginia DEP for upstream gas production and booster compression sites.

- **Confidential Client, Regulatory Compliance Self-Assessment, Permian Basin, Texas.**

Supported client's external counsel in conducting asset-wide assessment of potential to emit and regulatory applicability determinations related to client's extensive and geographically dispersed Permian Basin production asset.

- **Air Quality Self-Evaluation, Confidential Client, North Dakota and Eastern Montana.**

At the direction of client's outside counsel, supported self evaluation of client's extensive Bakken and Three-Forks crude oil production assets located on the Fort Berthold Indian Reservation under the jurisdiction of EPA Region 8 and numerous sites located on lands under the jurisdiction of the North Dakota Department of Health and Montana Department of Environmental Quality.

- **Confidential Client, Upstream Oil and Gas Production Company, Colorado.**

Worked with client's internal and outside counsel to respond to state agency enforcement action related to allegations of CAA violations pertaining to the oil and gas production, stationary reciprocating internal combustion engine and organic liquids distribution MACT rules.

- **Confidential Client, Compliance Assessment, Oil and Gas Company, Colorado.**

Worked with client's outside counsel to develop a comprehensive review of federal MACT standards relevant to area and major sources comprising a large oil and gas production operation, including numerous well sites, central gathering, treating and processing facilities and ancillary operations.

- **NSPS OOOO Support, San Juan Basin Business Unit.**

Worked with client's engineering and HSE staff to assess working, breathing and flashing losses from production tanks using process simulation (ProMax® and E&P Tank). Developed production rate-based VOC emission factors used in NSPS Subpart OOOO applicability determinations.

- **MACT Applicability and Compliance, Multiple Locations, AK North Slope and Cook Inlet.**

Quantified HAP emissions and evaluated other rule applicability criteria for over 40 oil and natural gas production facilities, drill sites and supporting facilities operating on the Alaska North Slope. Evaluated 16 onshore and offshore production facilities in the Cook Inlet of Alaska.